REPORT NUMBER CR175069- vol II

RESONANT AC POWER SYSTEM
PROOF OF CONCEPT TEST PROGRAM
FINAL REPORT

VOLUME 2

October 1986

Appendix 1

(NASA-CR-175069-Vol-2) RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT TEST PROGRAM, VOLUME 2, APPENDIX 1 Final Report (General Dynamics Corp.) 523 p Avail: NTIS HC A22/MF A01 CSCL 09C G3/33

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FOREWARD

This report contains two volumes. The main text (Volume 1) summarizes the test results and gives a detailed discussion of the response of three early , first generation configurations of ac power system IRAD breadboards to the contracted tests imposed on them. It explains photographs, measurements, and data calculations, as well as any observed anomalies or lessons learned. This volume (No. 2, Appendix 1, Test Results and Data), published under separate cover, includes all of the data taken on the 1.0 kW single-phase; 5.0 kW three-phase; and 25.0-kW three-phase system breadboards. The format of this data is raw, ie. it is a direct copy of the data sheets for the test data notebook.

TESTS RESULTS AND DATA

I.1 TEST CONFIGURATIONS

Table I-1 is a matrix listing the system test configurations and the tests performed on each configuration. The tests began on a single inverter module, progressed through two system upgrades, and concluded with the testing of the 25.0-kW ac power processing system breadboard. The following sections describe each of the system test configurations listed in Table I-1. These sections contain schematics showing the module and system parameters measured throughout this test program.

I.1.7 25.0-KW, THREE-PHASE SYSTEM (CONFIGURATION 7). This test configuration is a 25.0-kW power system breadboard consisting of six newly-designed 4.2-kW resonant inverters (Figure I-13); six new inverter transformers; the 1.0-kW dc receiver module (Figure I-3); the 1.0-kW bidirectional module (Figure I-7); the 1.0-kW variable-frequency, variable-voltage ac receiver module (Figure I-11); a 50-meter, three-phase bus; and 22.0 kW of resistive loads arranged as in Figure I-14. A new feature of this breadboard is that it uses the "Phasor" regulation technique in which the outputs of two or more inverters are summed by connecting them in series. The voltage of the sinusoidal output waveform is regulated by shifting the phase relationships between the inverters.

The 25.0-kW system was subjected to the same set of tests as were run on the other two breadboards. In addition, the line and load bus voltage regulation and the conducted susceptibility and emissivity of the 25.0-kW system were measured. Photographs were also taken of the response of the system and its fault-isolation switches to a bus short. The measurement points used throughout the testing on this system are shown on the system diagram of Figure I-14.

I.2 TESTS

The following series of tests was performed on the system configurations described in the preceding paragraphs. The tests are listed by section number of the Test Plan and Table I-1. The numbers in parenthesis are the corresponding section number in the main text of this final report.

3.2.1 Power Turn On (4.1)

3.2.2 Steady-State Operation (4.2)

3.2.3 Transient Load Response (4.3)

3.2.4 Output Response to Reference/Control Signal Changes (4.4)

3.2.4.1 Steady-State Control Signal Gain (4.4.1)

3.2.4.2 Control Signal Step Response (4.4.2)

3.2.4.3 Control Signal Frequency Response (4.4.3)

3.2.5 Power Supply Sensitivity (4.5)

3.2.5.1 Steady-State Power Supply Sensitivity (4.5.1)

3.2.5.2 Power Supply Step Response (4.5.2)

3.2.6 Power Turn Off (4.6)

3.2.7 Power Factor Testing (4.7)

3.2.8 Three-Phase Motor Testing (4.8)

3.2.9 Fault Isolation Testing (4.9)

3.2.10 EMI Measurements (4.10)

Tests 4.7 and 4.8 were added to the test plan after completion of the first phase of testing , which tested Configurations 1 through 4. Power Factor Testing and Three-Phase Motor Testing (Tests 4.7 and 4.8) were performed only on the three-phase system configurations (Configuration 5 ,6, and 7). Tests 4.9 and 4.10 were added prior to the final phase of testing and were only performed on the 25.0-kW power system breadboard (Configuration 7). A diagram showing how the testing was performed and any special measurements recorded is included with each section of data.

Table I-1. Test Matrix

CONFIGURATIONS				POWER TURNON LOADS (4)	STEADY-STATE OPERATION	TRANSIENT LOAD RESPONSE				STEADY-STATE CONTROL GAIN			CONTROL SIGNAL STEP RESPONSE		CONTROL SIGNAL FREQ RESPONSE			STEADY-STATE POWER SUPPLY SENSITIVITY (±20%)	POWER SUPPLY STEP RESPONSE (±20%)	POWER TURNOFF LOADS (4)	POWER FACTOR (−0.87 TO +0.87)	MOTOR OPERATION
						20 kHz	DC RECEIVER	AC RECEIVER	BIDIRECTIONAL RECEIVER	DC RECEIVER	AC RECEIVER	BIDIRECTIONAL RECEIVER (50%)	DC RECEIVER	BIDIRECTIONAL RECEIVER	DC RECEIVER	AC RECEIVER	BIDIRECTIONAL RECEIVER					
SYSTEM I	DRIVER-AC LOAD	(1)	INPUT OUTPUT OTHER	VT, IT VT, IT IA, IB IC, ID	VS, IS VS, IS, I IA, IB n	VT, IT VT, IT IA, IB	—	—	—	—	—	—	—	—	—	—	—	VS, IS VS, IS f	VT, IT VT, IT —	VT, IT VT, IT IA, IB	—	—
	DRIVER-TRANS LINE- DC RECEIVER	(1) (1)	INPUT OUTPUT OTHER	VT, IT VT, IT IA, IB	VS, IS VS, IS IA, IB VK1, IK1 f, n	—	VT, IT VT, IT IA, IB VK1, IK1	—	—	VS, IS VS, IS VK1, IK1 f, n	—	—	VT, IT VT, IT VK1, IK1	—	VT, IT VT, IT VK1, IK1	—	—	VS, IS VS, IS f, n	VT, IT VT, IT VK1, IK1	VT, IT VT, IT IA, IB	—	—
	BIDIRECTIONAL MODULE- AC LOAD (INVERTOR LOAD)	(1)	INPUT OUTPUT OTHER	—	VS, IS VT, IT IE, IF n	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	DRIVERS-TRANS LINE- DC RECEIVER AC RECEIVER BIDIRECTIONAL MODULE (RECEIVER MODE)	(2) (1) (1) (1)	INPUT DC OUT AC OUT BD OUT OTHER	VT, IT VT, IT VT, IT VT, IT IA, IB IC, ID VK1, IK1 VK2, IK2	VS, IS VS, IS VS, IS VS, IS IA, IB IC, ID VK1, IK1 VK2, IK2 I	—	VT, IT VT, IT — — IA, IB IC, ID VK1, IK1 VK2, IK2	VT, IT — VT, IT — IA, IB IC, ID VK1, IK1 VK2, IK2	VT, IT — — VT, IT IA, IB IC, ID VK1, IK1 VK2, VK2	VS, IS VS, IS — — —	—	VS, IS — — VS, IS —	—	—	—	VI, IT — VT, IT — IA, IB IC, ID VK1, IK1 VK2, IK2	—	VS, IS VS, IS VS, IS VS, IS —	VT, IT VT, IT VT, IT VT, IT IA, IB IC, ID VK1, IK1 VK2, IK2	VT, IT VT, IT VT, IT VT, IT IA, IB IC, ID VK1, IK1 VK2, IK2	—	—
SYSTEM II	DRIVERS-3-φ LINE DC RECEIVER AC RECEIVER BIDIRECTIONAL MODULE (RECEIVER MODE)	(3) (1) (1) (1)	INPUT DC OUT AC OUT BD OUT OTHER	—	VS, IS VS, IS VS, IS VS, IS IA, IB, IC ID, IG, IH VK1, IK1 VK2, IK2 VK3, IK3 VX1, VX2 VX3, n f, H	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	DRIVERS-3-φ LINE- DC RECEIVER AC RECEIVER BIDIRECTIONAL MODULE (RECEIVER MODE)	(3) (1) (1) (1)	INPUT DC OUT AC OUT BD OUT OTHER	VT, IT VT, IT VT, IT VT, IT IA, IB, IC ID, IG, IH VK1, IK1 VK2, IK2 VK3, IK3	VS, IS VS, IS VS, IS VS, IS IA, IB, IC ID, IG, IH VK1, IK1 VK2, IK2 VK3, IK3 VX1, VX2 VX3, e, H, f T	—	VT, IT VT, IT — — IA, IB, IC ID, IG, IH VK1, IK1 VK2, IK2 VK3, IK3	VT, IT — VT, IT — IA, IB IC, ID IG, IH VK1, IK1 VK2, IK2 VK3, IK3	VT, IT — — VT, IT IA, IB IC, ID IG, IH VK1, IK1 VK2, IK2 VK3, IK3	VS, IS VS, IS — — —	VS, IS — VS, IS — —	VS, IS — — VS, IS —	VT, IT VT, IT — — —	VT, IT — — VT, IT —	VT, IT VT, IT — — —	VT, IT — VT, IT — —	VT, IT — — VT, IT —	VS, IS VS, IS VS, IS VS, IS VK1, IK1 VK2, IK2 VK3, IK3 VX1, VX3 VX2, n	VT, IT VT, IT VT, IT VT, IT —	VT, IT VT, IT VT, IT VT, IT	VS, IS — — — IA, IB, IC ID, IG, IH VK1, IK1 VK2, IK2 VK3, IK3 n	VS, IS — VT, IT — IA, IB, IC ID, IG, IH VK1, IK1 VK2, IK2 VK3, IK3 VX1, VX2 VX3, n
SYSTEM III 25.0 kW	DRIVERS-3-φ LINE- DC RECEIVER AC RECEIVER BIDIRECTIONAL MODULE (RECEIVER MODE)	(3) (1) (1) (1)		SAME AS SYSTEM II						—	—	—	—	—	—	—	SAME AS SYSTEM II					VT, IT — VT, IT — IB, IH VK3 IK3

270.126.8-1

*KEY

SYMBOL	PARAMETER MEASURED	INSTRUMENT
f	FREQUENCY	FREQUENCY COUNTER
H	HARMONIC COMPONENTS	SPECTRUM ANALYZER
IA	CURRENT IN A SIDE OF INVERTER 1	CURRENT PROBE–OSCILLOSCOPE–CAMERA
IB	CURRENT IN B SIDE OF INVERTER 1	CURRENT PROBE–OSCILLOSCOPE–CAMERA
IC	CURRENT IN C SIDE OF INVERTER 2	CURRENT PROBE–OSCILLOSCOPE–CAMERA
ID	CURRENT IN D SIDE OF INVERTER 2	CURRENT PROBE–OSCILLOSCOPE–CAMERA
IE	CURRENT IN E SIDE OF BIDIRECTIONAL MODULE	CURRENT PROBE–OSCILLOSCOPE–CAMERA
IF	CURRENT IN F SIDE OF BIDIRECTIONAL MODULE	CURRENT PROBE–OSCILLOSCOPE–CAMERA
IG	CURRENT IN G SIDE OF INVERTER 3	CURRENT PROBE–OSCILLOSCOPE–CAMERA
IH	CURRENT IN H SIDE OF INVERTER 3	CURRENT PROBE–OSCILLOSCOPE–CAMERA
IK1	AC RESONANT TANK CURRENT OF INVERTER 1	CURRENT PROBE–OSCILLOSCOPE–CAMERA
IK2	AC RESONANT TANK CURRENT OF INVERTER 2	CURRENT PROBE–OSCILLOSCOPE–CAMERA
IK3	AC RESONANT TANK CURRENT OF INVERTER 3	CURRENT PROBE–OSCILLOSCOPE–CAMERA
IS	STEADY-STATE CURRENT	AMMETER
IT	TRANSIENT CURRENT	CURRENT PROBE–OSCILLOSCOPE–CAMERA
n	EFFICIENCY	CALCULATION FROM PA
PS	STEADY-STATE POWER	V-A-W METER
T	TOTAL HARMONIC DISTORTION	DISTORTION ANALYZER
VK1	AC RESONANT TANK VOLTAGE OF INVERTER 1	OSCILLOSCOPE–CAMERA
VK2	AC RESONANT TANK VOLTAGE OF INVERTER 2	OSCILLOSCOPE–CAMERA
VK3	AC RESONANT TANK VOLTAGE OF INVERTER 3	OSCILLOSCOPE–CAMERA
VS	STEADY-STATE VOLTAGE	VOLTMETER
VT	TRANSIENT VOLTAGE	OSCILLOSCOPE–CAMERA
VX1	SECONDARY OF INVERTER 1 TRANSFORMER	DIFFERENTIAL VOLTMETER
VX2	SECONDARY OF INVERTER 2 TRANSFORMER	DIFFERENTIAL VOLTMETER
VX3	SECONDARY OF INVERTER 3 TRANSFORMER	DIFFERENTIAL VOLTMETER

270.126-8-2

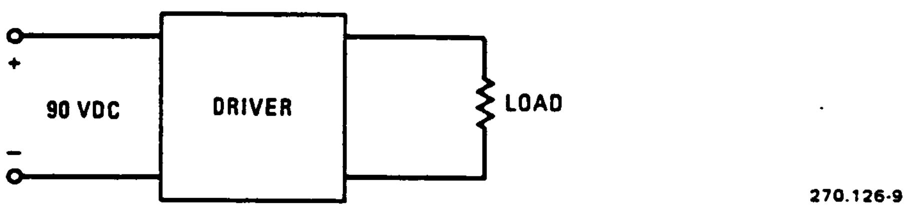
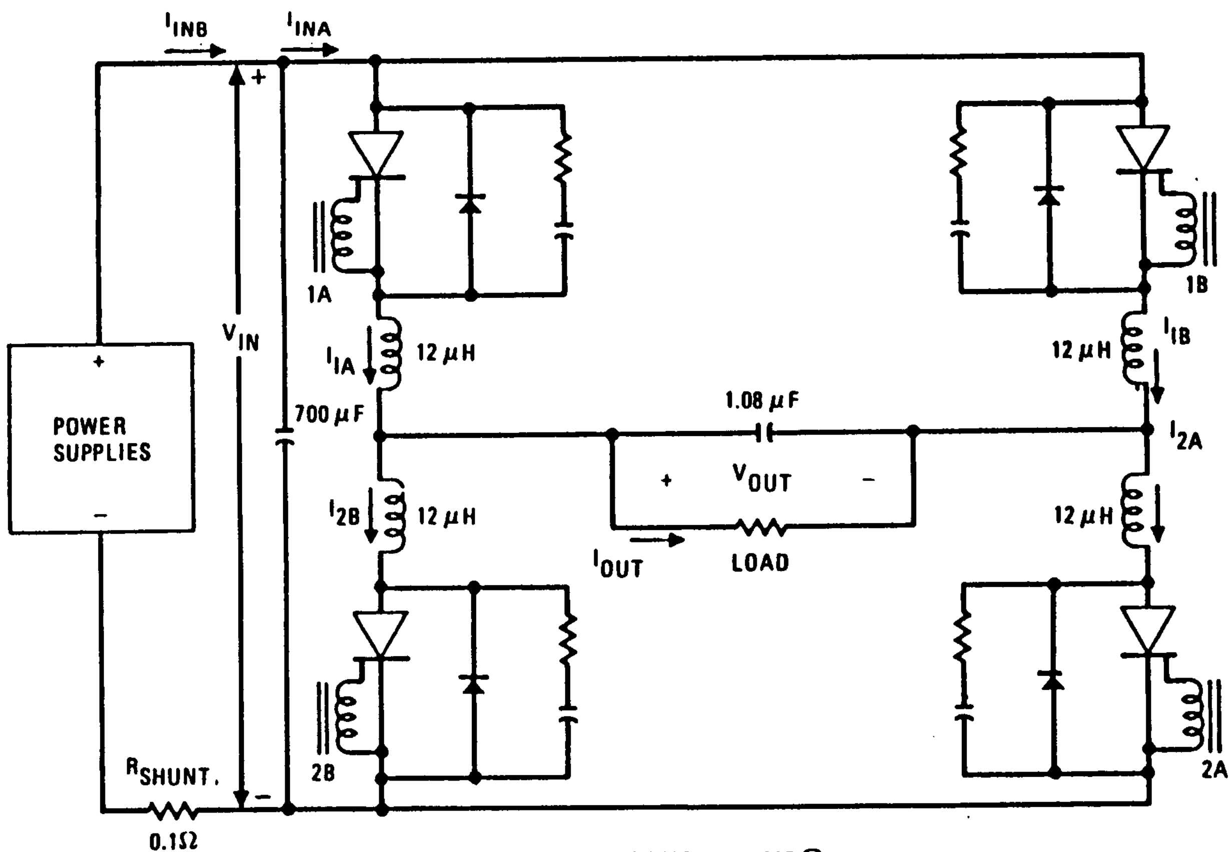


Figure I-1. Configuration 1: Driver with Resistive Load



SCRs	2N3658	
DIODES	A139M	
SNUBBERS	110 Ω	0.01 μF

270.126-10

Figure I-2. 1.0-kW Inverter Schematic

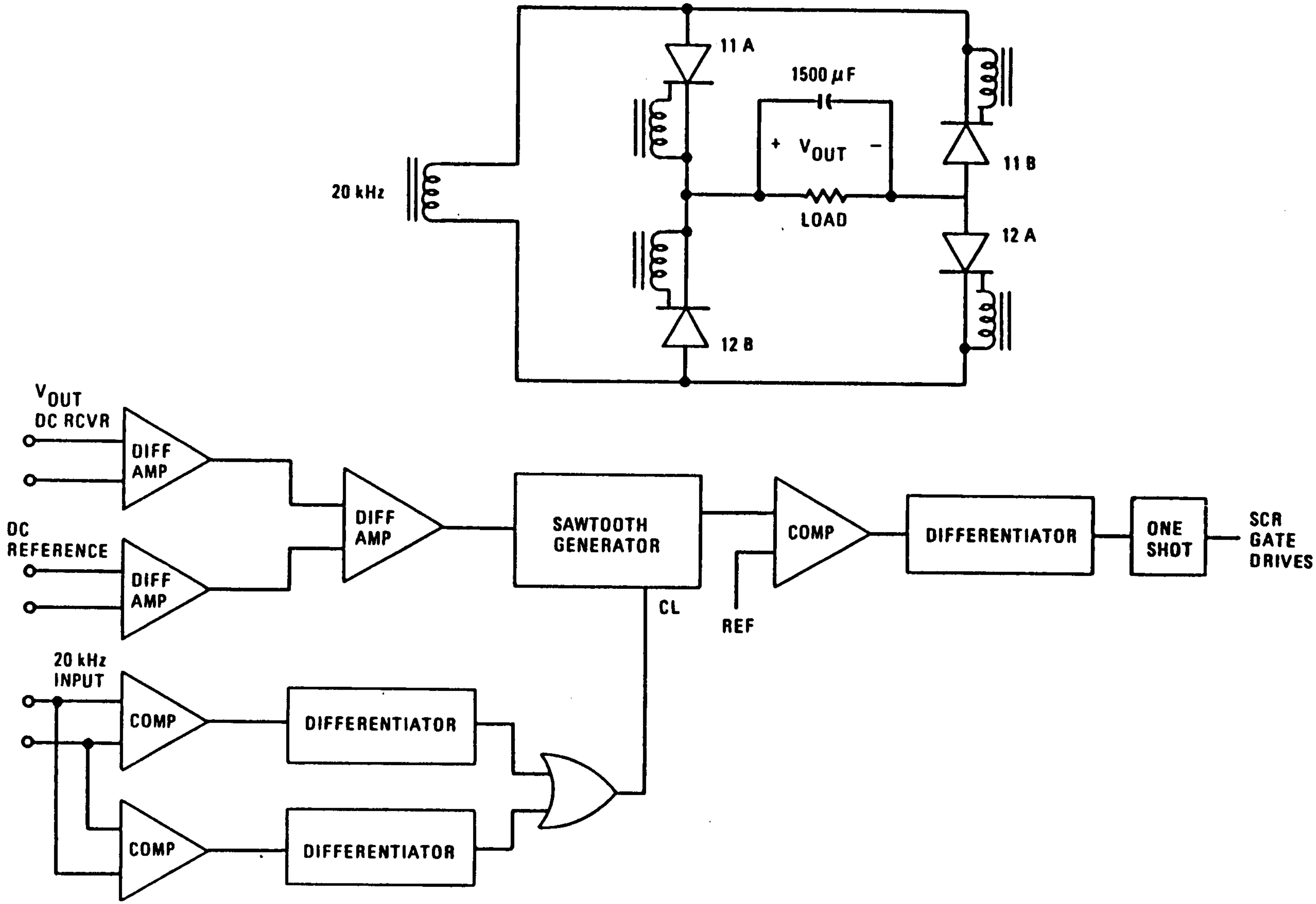


Figure I-3. Block Diagram of the dc Receiver Module and its Closed-Loop Controller

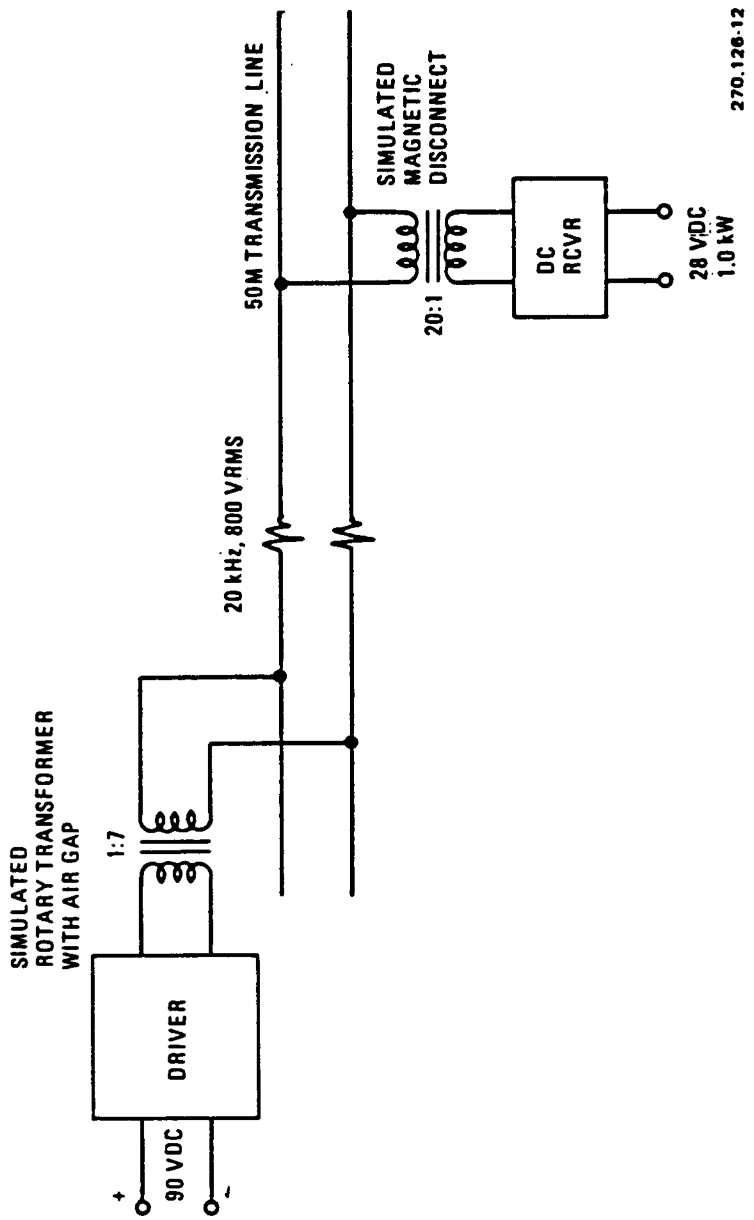


Figure I-4. Configuration 2: Driver-Transmission Line-dc Receiver

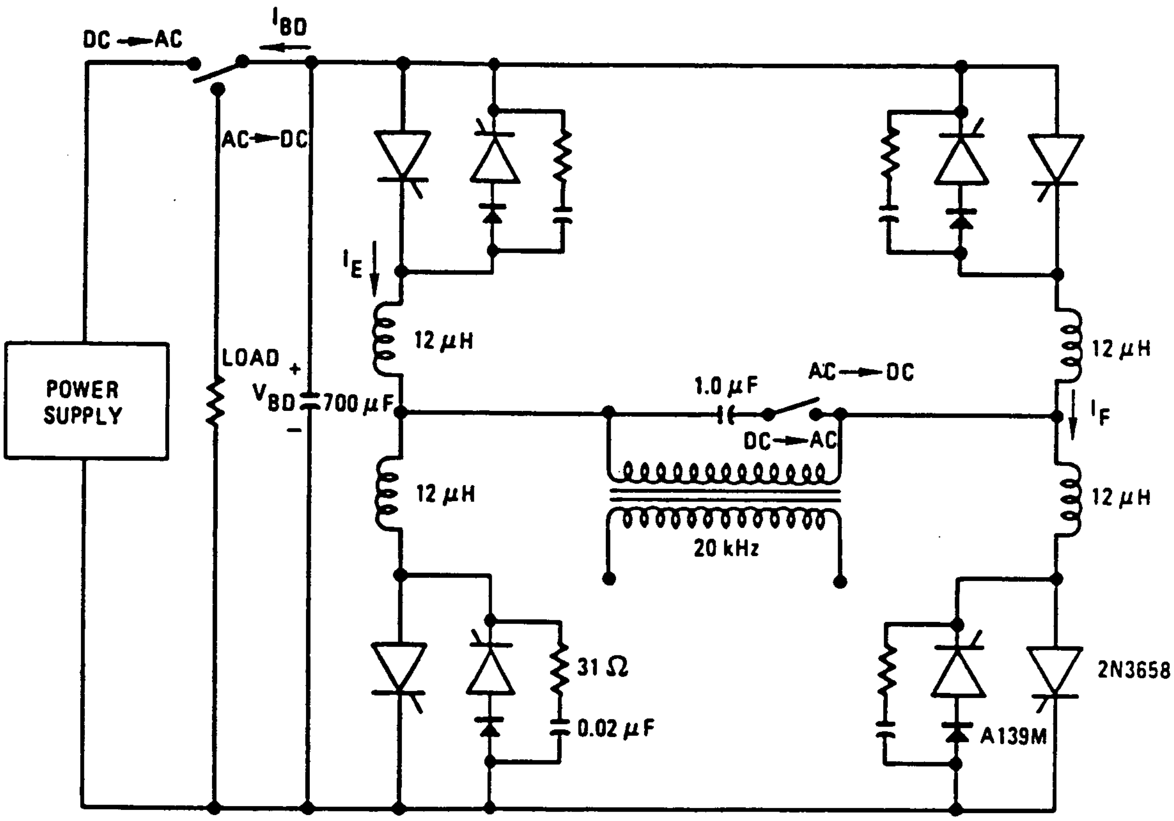


Figure I-5. Bidirectional Module Schematic

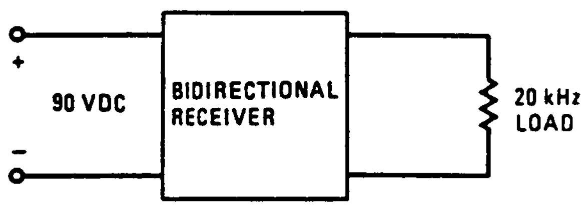
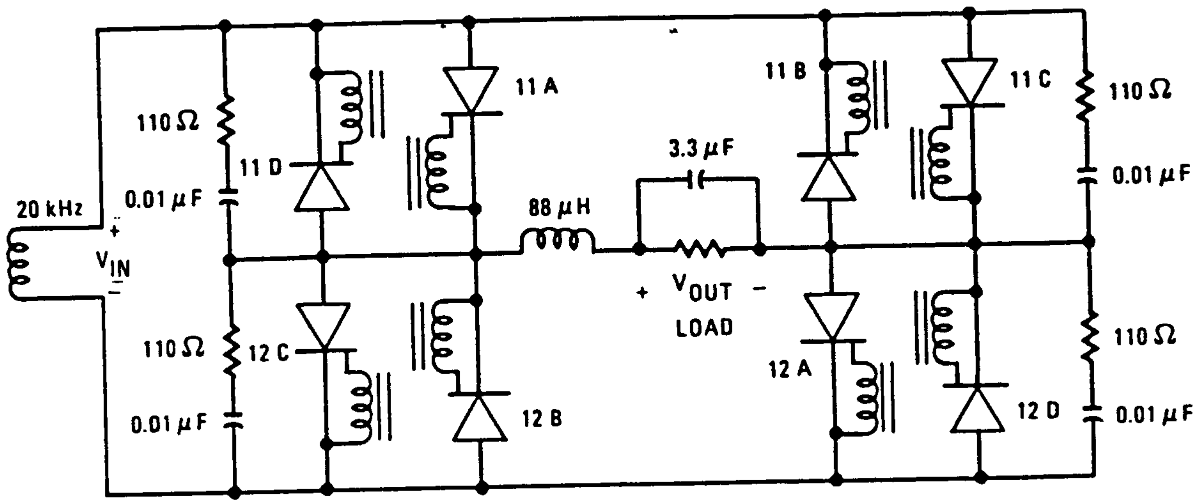


Figure I-6. Configuration 3: Bidirectional Module (dc-to-ac Mode)



270.126-15

Figure I-7. ac Receiver Schematic

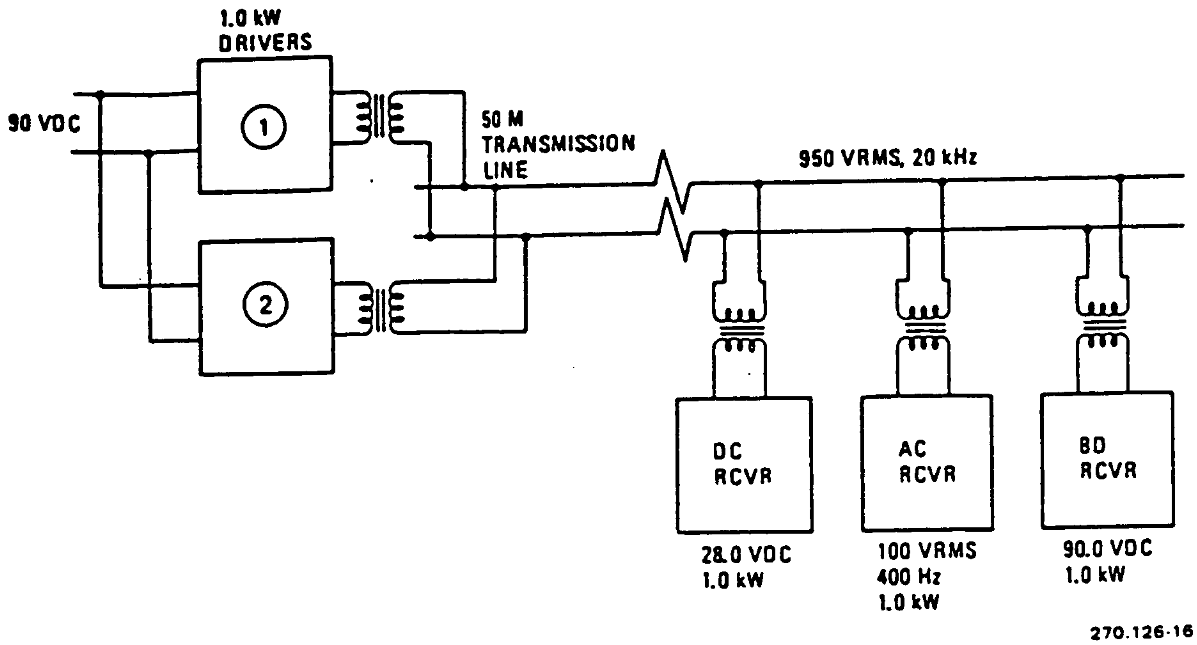


Figure I-8. Configuration 4: Dual Driver System

(TURN PAGE)

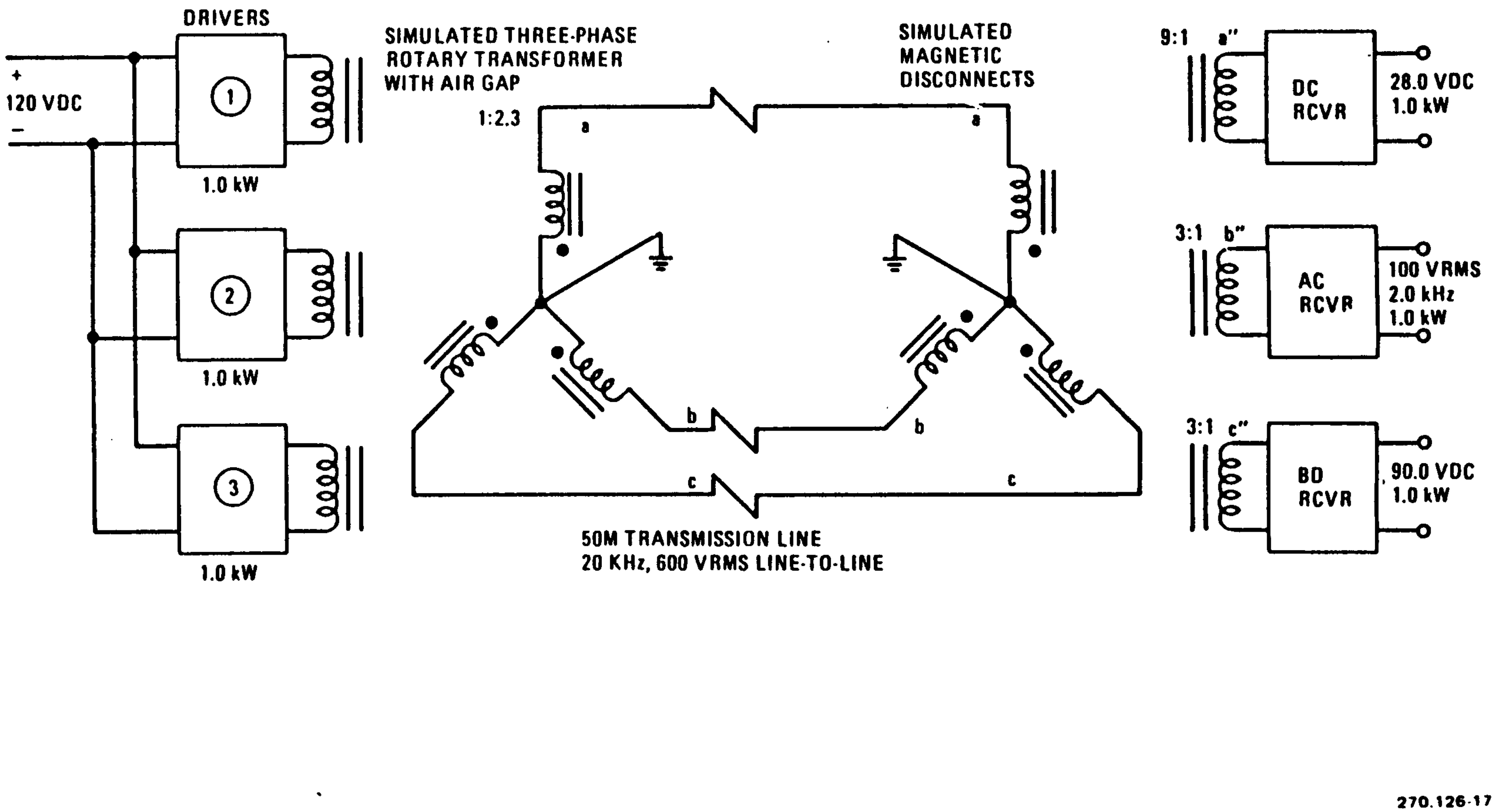


Figure I-9. Configuration 5: Three-Phase, 3.0-kW ac Power System Breadboard

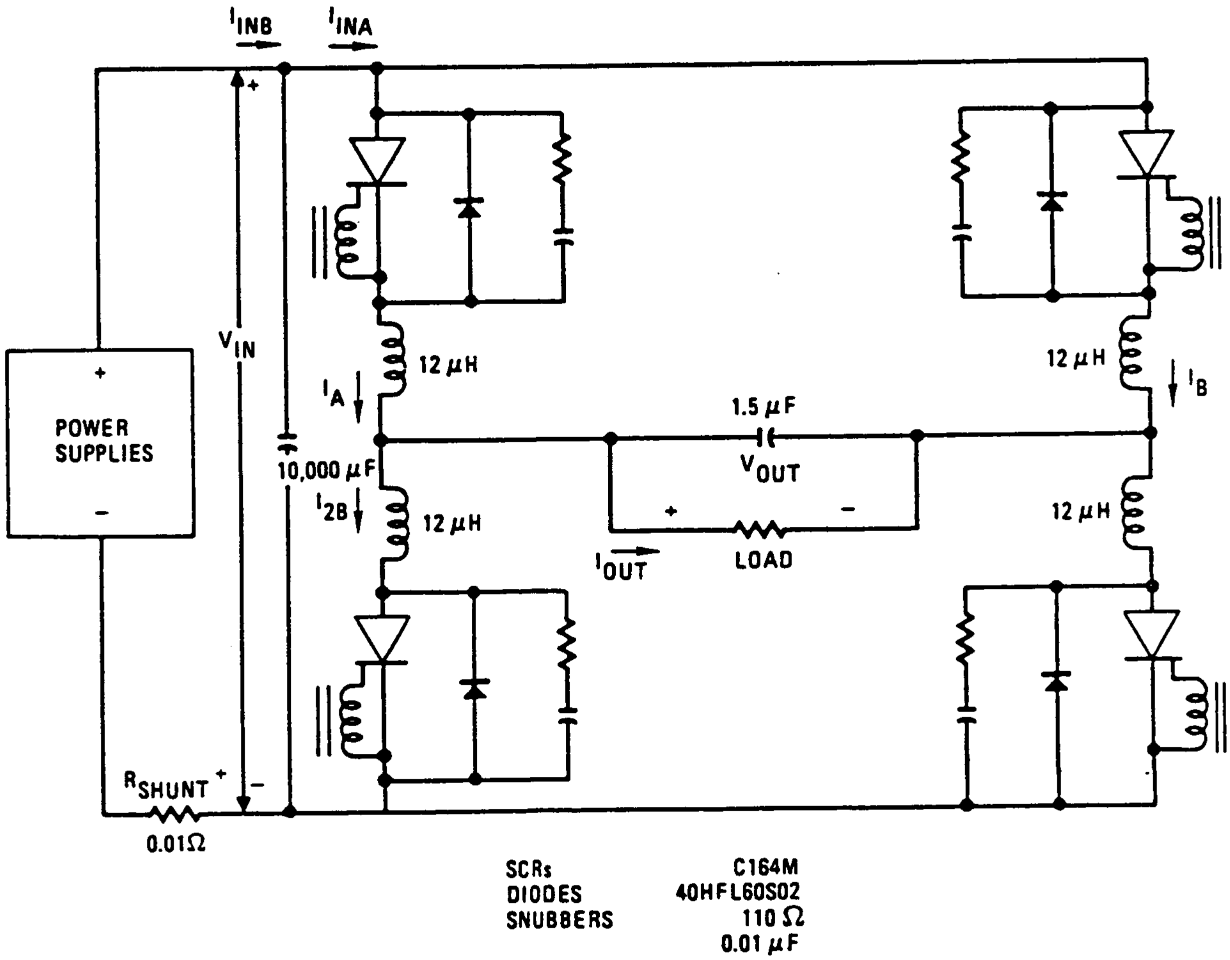


Figure I-10. 1.7-kW Inverter Schematic

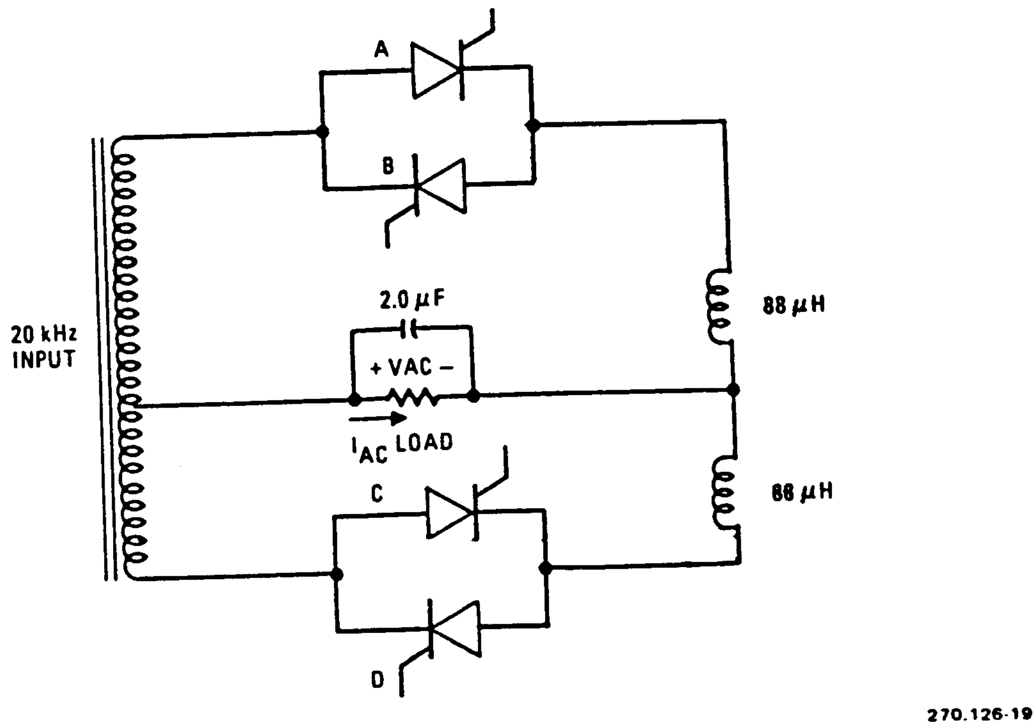


Figure I-11. Variable-Voltage, Variable-Frequency ac Receiver Schematic

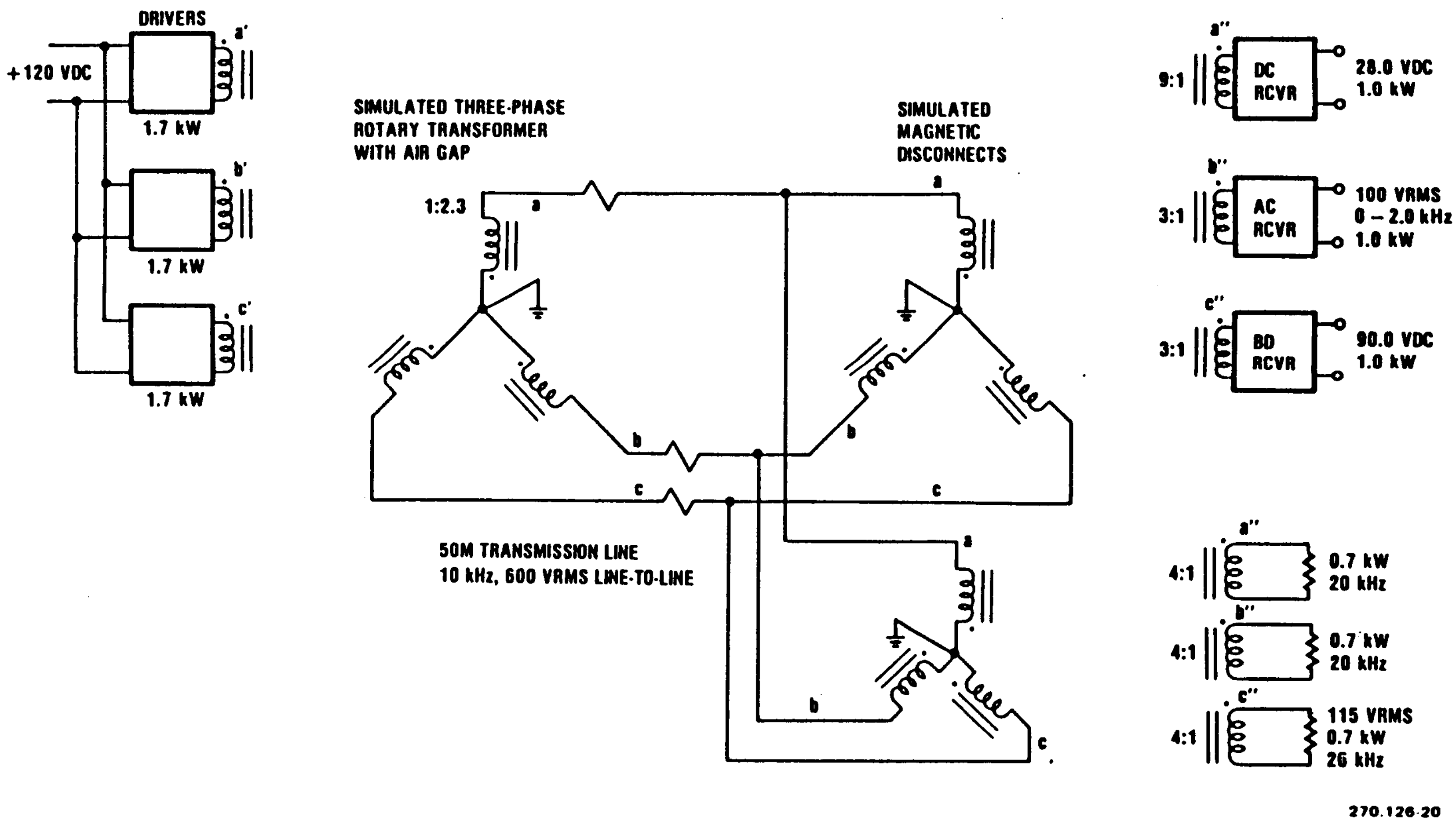
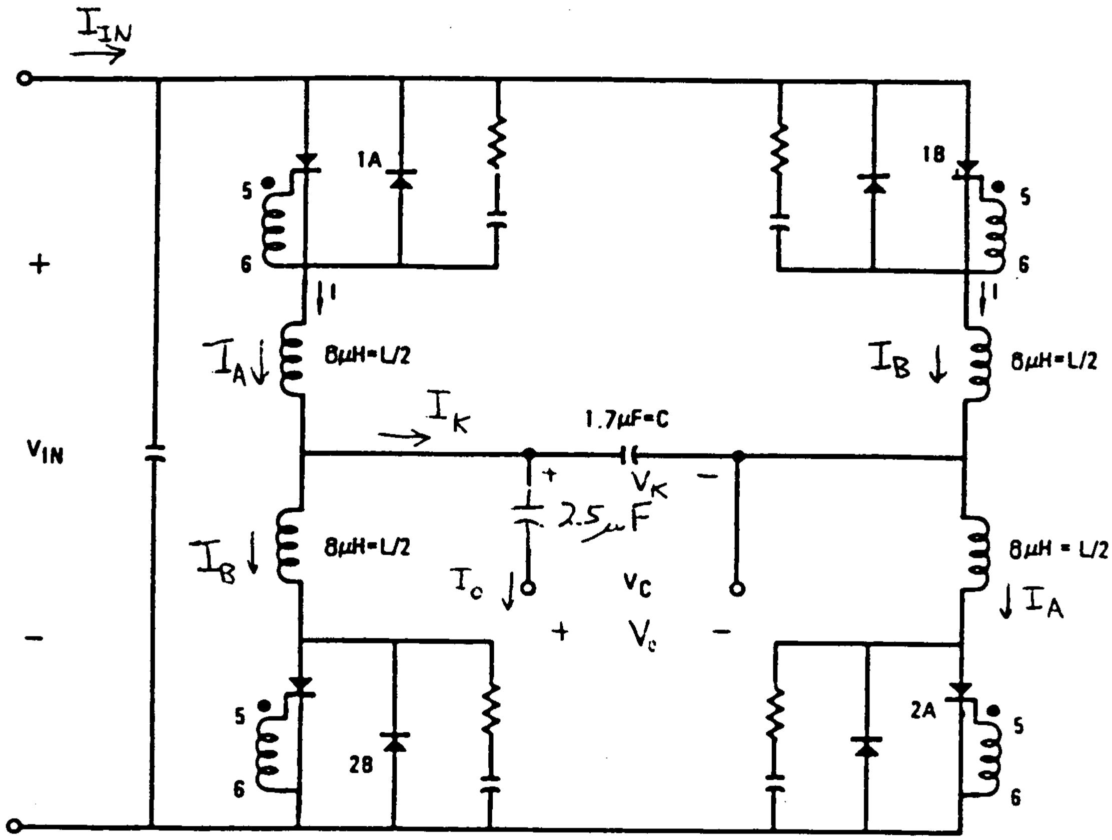


Figure I-12. Configuration 6: 5.0-kW, Three-Phase ac Power System Breadboard



SCRs	C164M
DIODES	A139M
SNUBBER	110Ω
	.01μF

INVERTER SCHEMATIC

FIGURE I-13. 4.2-kW Inverter Schematic.

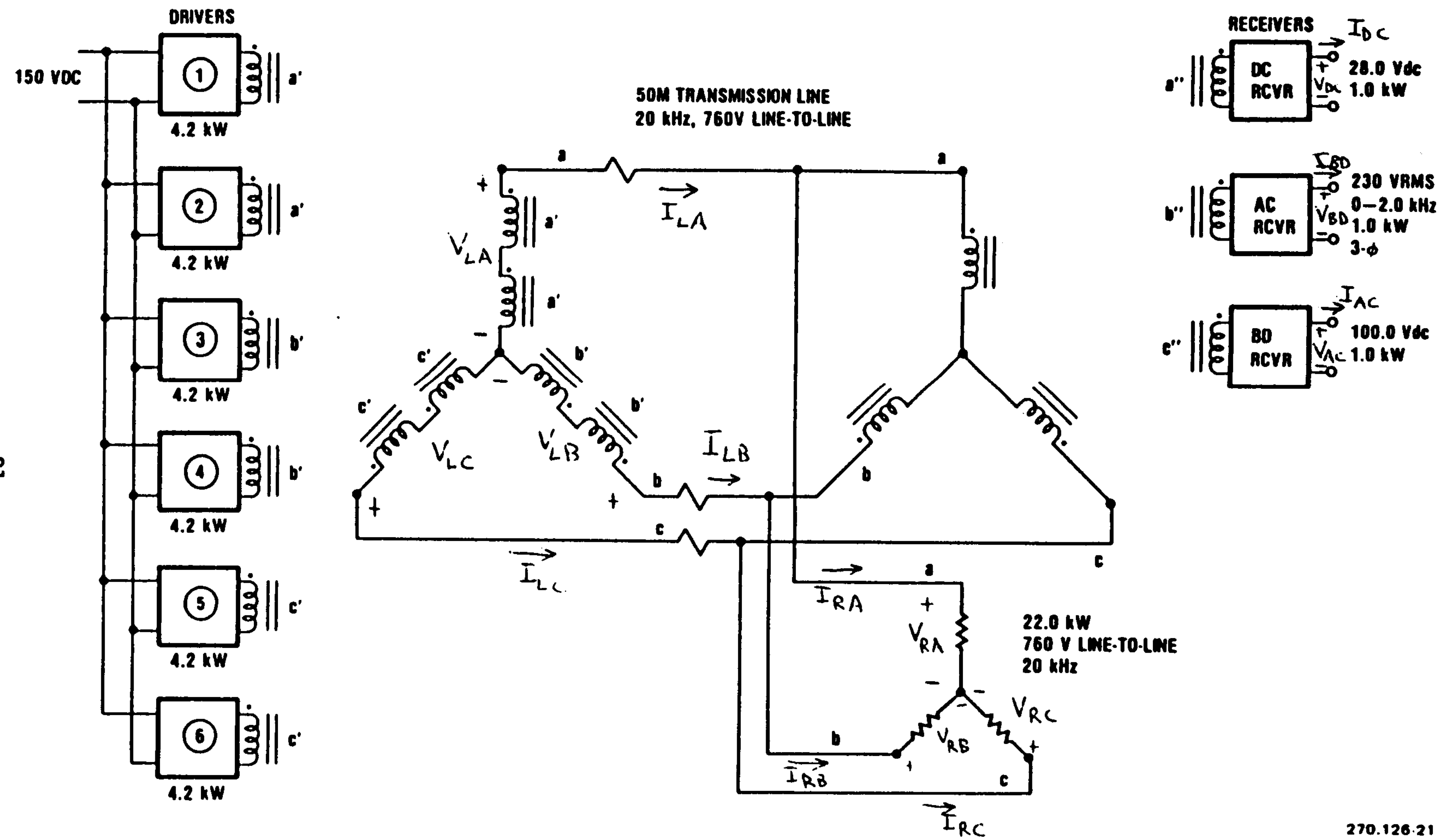
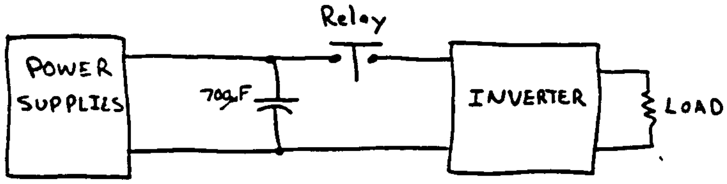


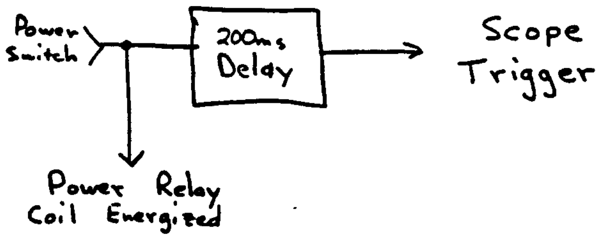
FIGURE I-14. Configuration 7: 25.0-kW, Three-Phase Drivers--Transmision Line--Three Receivers and Resistive Loads

DATA SHEETS AND TEST RESULTS

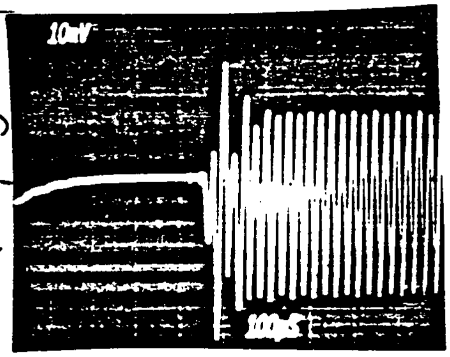
2.3.1 –3.2.1 POWER STARTUP OF A SINGLE INVERTER



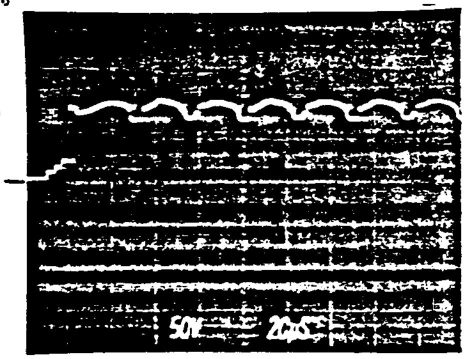
Location of Power Relay.



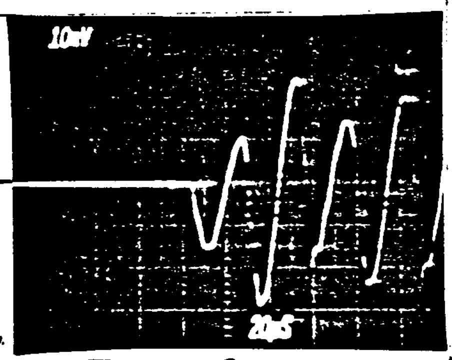
2.3.1
– 3.2.1 NO LOAD V_{IN} = 87 VDC
R_{LOAD} = ∞ I_{OUT} = 0



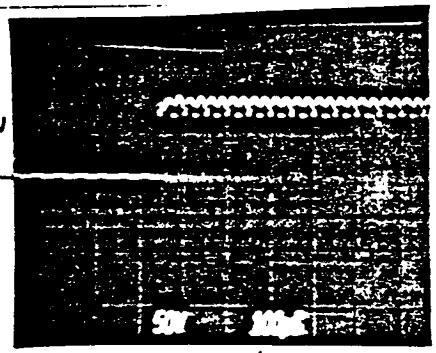
Input Current
(Before DC Capacitor)



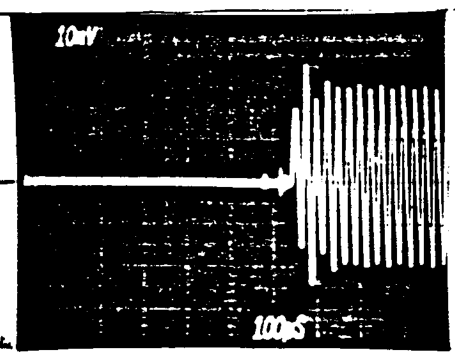
Input Voltage



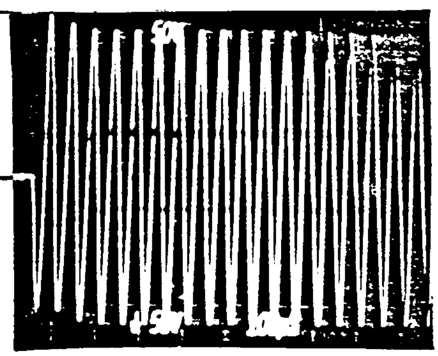
Input Current
(After DC Capacitor)



Input Voltage



Input Current
(After DC Capacitor)



Output Voltage

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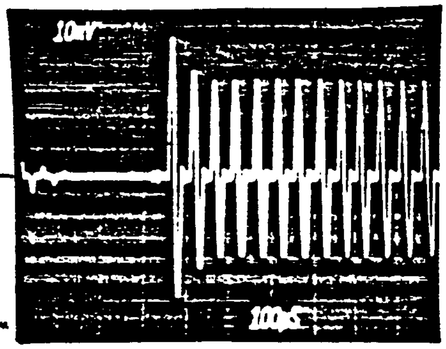
2.3.1
-3.2.1 NO LOAD

V_{IN} = 87.0 Vdc
I_{OUT} = 0.0 Arms

I_{1A}

0

10A/div

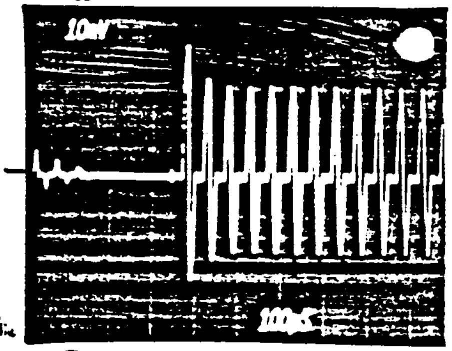


Branch Current 1A

I_{1B}

0

10A/div

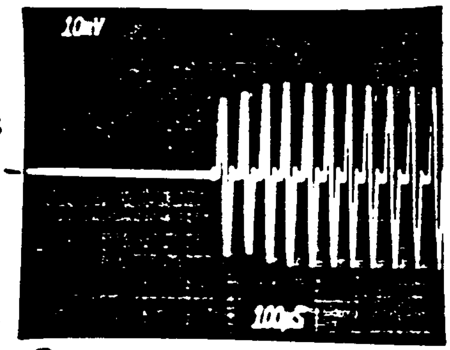


Branch Current 1B

I_{2B}

0

10A/div.

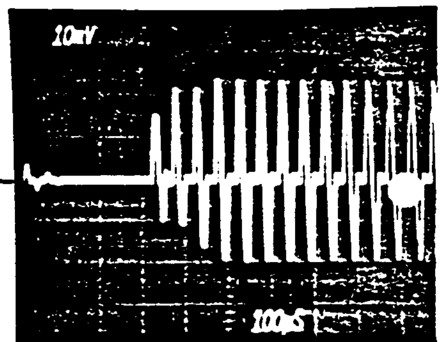


Branch Current 2B

I_{2A}

0

10A/div.



Branch Current 2A

4

2.3.1
-3.2.1

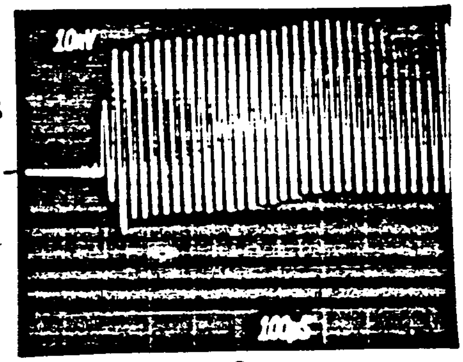
10% LOAD

V_{IN} = 87 VDC
R_{LOAD} = 116Ω
P_{OUT} = 129W

I_{INB}

0

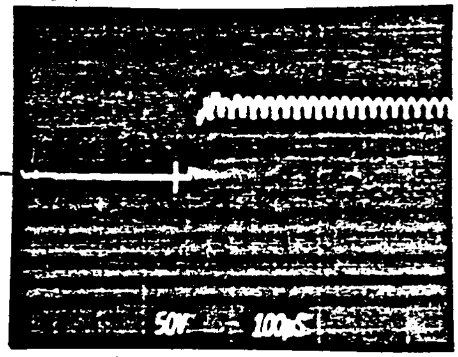
2A/div.



Input Current
(Before DC Capacitor)

V_{IN}

0

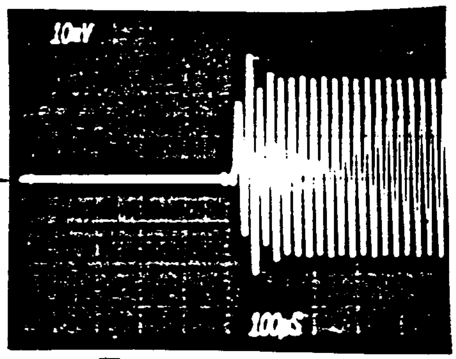


Input Voltage

I_{INA}

0

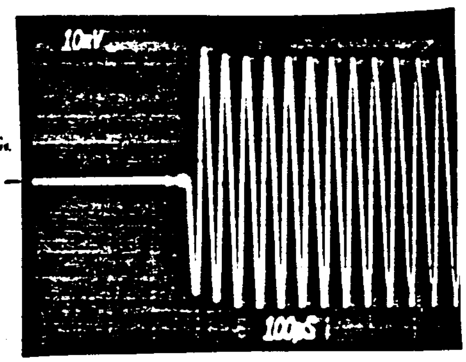
10A/div.



Input Current
(After DC Capacitor)

I_{OUT}
500mA/div.

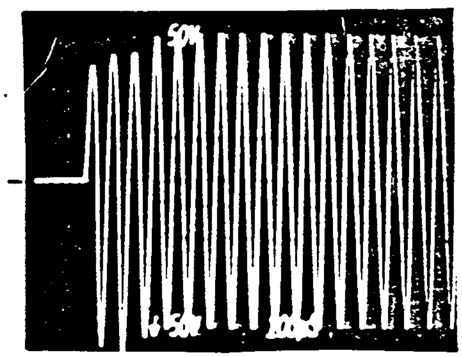
0



Output Current

V_K

0



Output Voltage

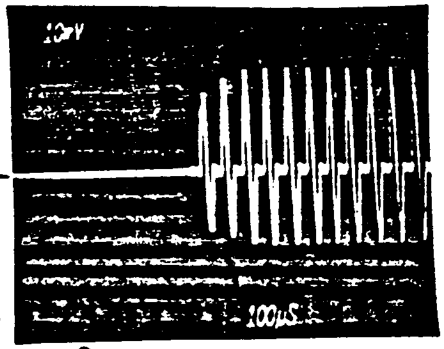
5

ORIGINAL PAGE IS
OF POOR QUALITY

2.3.1
-3.2.1 10% LOAD

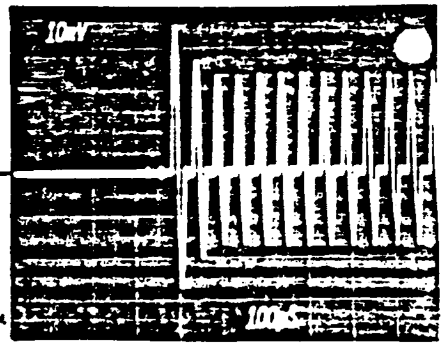
V_{IN} = 87 VDC
R_{LOAD} = 116Ω
P_{OUT} = 129W

I_{1A}



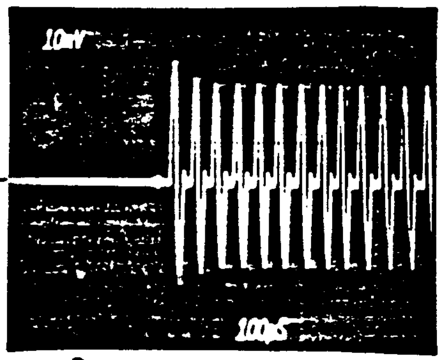
Branch Current 1A

I_{1B}



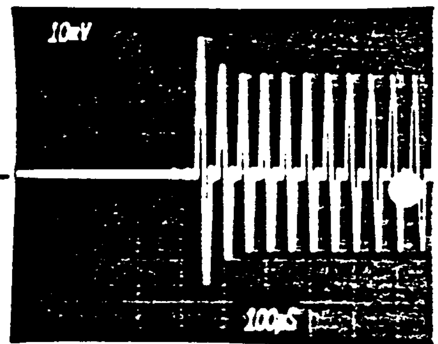
Branch Current 1B

I_{2B}



Branch Current 2B

I_{2A}



Branch Current 2A

6

2.3.1
-3.2.1

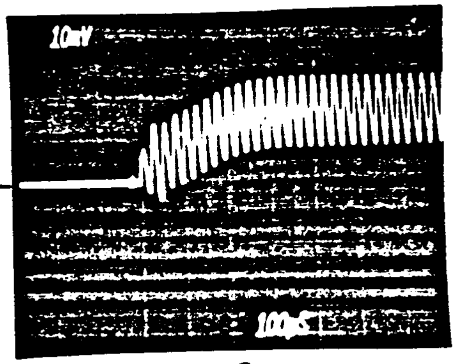
50% LOAD

V_{IN} = 87 VDC
R_{LOAD} = 25.4 Ω
P_{OUT} = 571 W

I_{INB}

0 –

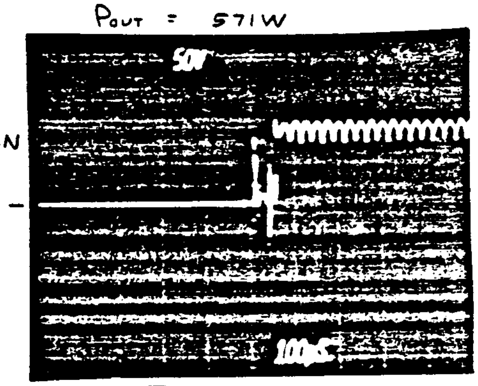
5A/div.



Input Current
(Before DC Capacitor)

V_{IN}

0 –

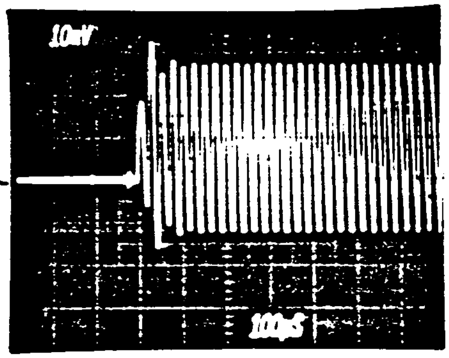


Input Voltage

I_{INA}

0 –

10A/div.

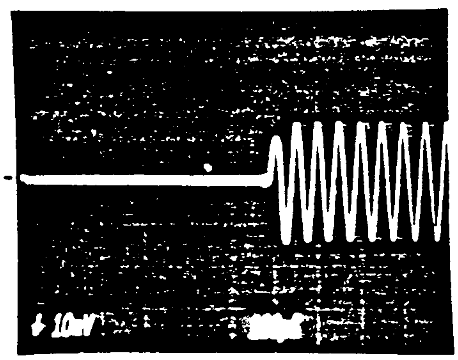


Input Current
(After DC Capacitor)

I_{OUT}

0 –

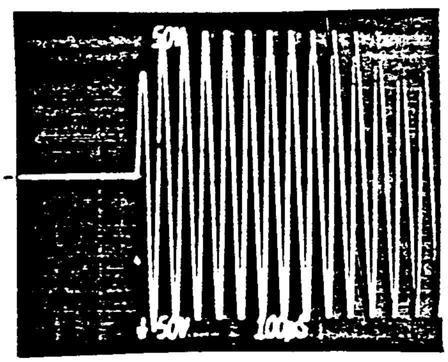
5A/div.



Output Current

V_K

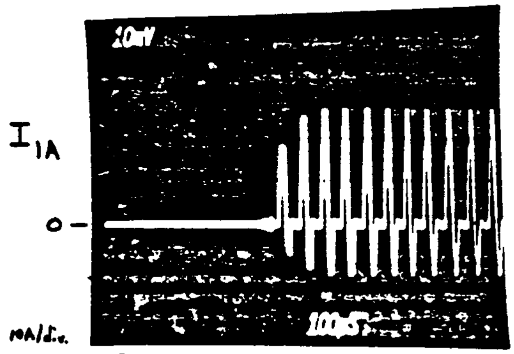
0 –



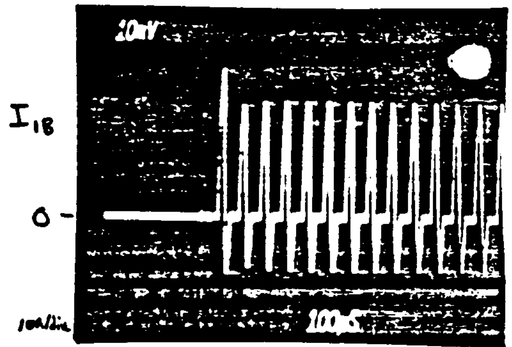
Output Voltage

2.3.1
-3.2.1 50% LOAD

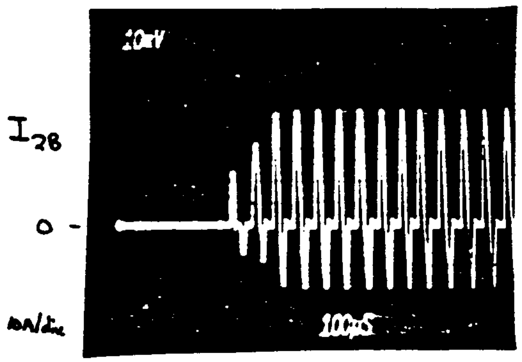
$V_{IN} = 87\,VDC$
$R_{LOAD} = 25.4\,\Omega$
$P_{OUT} = 571\,W$



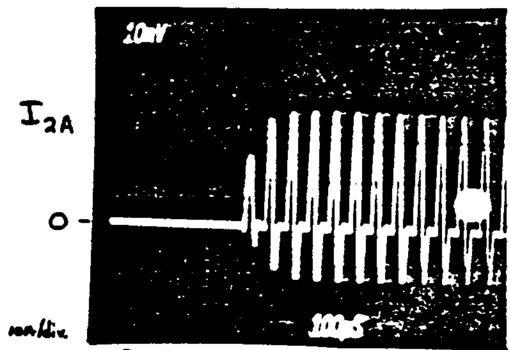
Branch Current 1A



Branch Current 1B



Branch Current 2B



Branch Current 2A

The inverter could not be step-started when fully loaded.

2.3.2 – 3.2.1 POWER STARTUP OF A SINGLE INVERTER AND RECEIVER

When the capacitor-filtered dc receiver module was added to the inverter and 50m transmission line, the system was unable to be started with a step function application of power. The discharged capacitor effectively increases the resonant capacitance of the inverter and decreases the resonant frequency below the switching frequency. This causes all four SCRs to be on at one time and the SCRs to latch up.

The effect does not occur if an L-C filter is used on receiver modules. For example, the 5.0-kW system is started with the ac receiver module. Its L-C filter is as shown in a following section.

2.3.4-3.2.1 POWER STARTUP OF A DUAL-DRIVER SYSTEM

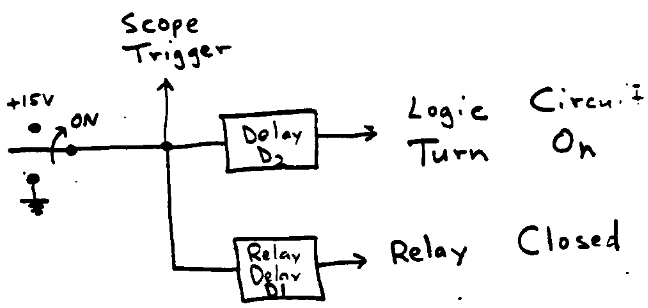
As in Configuration 2.3.2, the dual-driver system would not start with a step-function application of power because of the capacitive filters of both the dc receiver and the bidirectional module. These discharged capacitors increase the effective inverter resonant capacitors, increasing the resonant frequency and causing all four SCRs to turn on simultaneously. This is overcome by replacing the capacitive receiver filters with L-C filters.

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

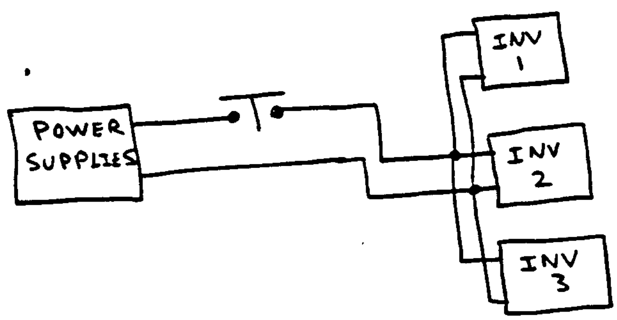
TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6-3.2.1 POWER START UP OF 5.0-KW SYSTEM (Logic Before Relay)

Test Circuits



$D_1 > D_2$



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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS 3-22777)

TRANSIENT TEST DATA SHEET

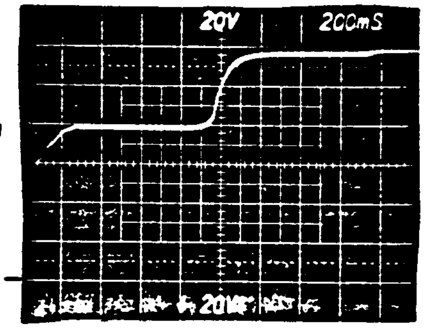
Test-Configuration: 2.3.6-3.2.1 Power Turn On

Specific Case: No Load (1.5μF) (Early Logic T.O.)

Input Voltage: 0 → 120.2 V	DC RCVR: 28.4V / 0W
Input Current: 0 → 9.69A shunt	AC RCVR: 0V - Turned OFF
System Frequency: 20.336 kHz	BD Module: 194.79V / 0W
Output Power: 0W	Other:

V_{IN}

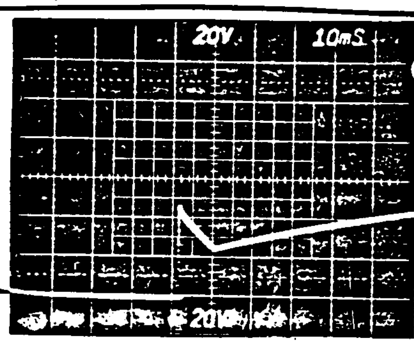
0V



Input Voltage | Scale: 200ms/

V_{IN}

0V



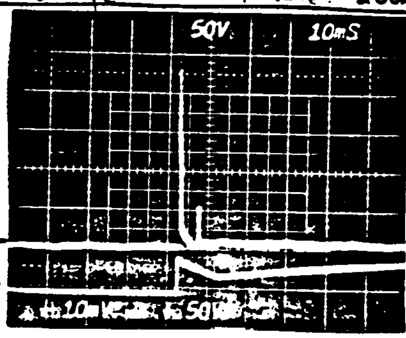
Input Voltage | Scale: 10ms/

I_{IN}

0A

V_{IN}

0V



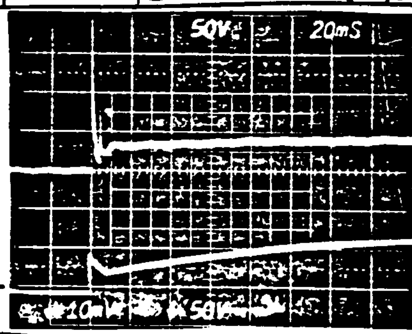
Input Voltage + Current | Scale: 50A/div

I_{IN}

0A

V_{IN}

0V



Input Voltage + Current | Scale: 10A/

2

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS 3-22777)

TRANSIENT TEST DATA SHEET

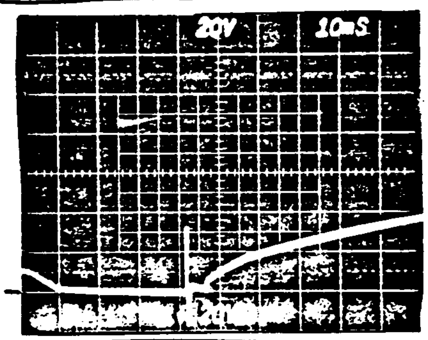
Test - Configuration: 2.3.6- 3.2.1 Power Turn On

Specific Case: No Load (1.5μF) (Early Logic T.O.)

Input Voltage: $0 \rightarrow 120.2$ V	DC RCVR: $0 \rightarrow 28.4$V / 0W
Input Current: $0 \rightarrow 9.69$A (shunt)	AC RCVR: 0V – Turned Off
System Frequency: 20.336 KHz	BD Module: $0 \rightarrow 194.79$ / 0W
Output Power: 0W	Other:

V_{IN}

0

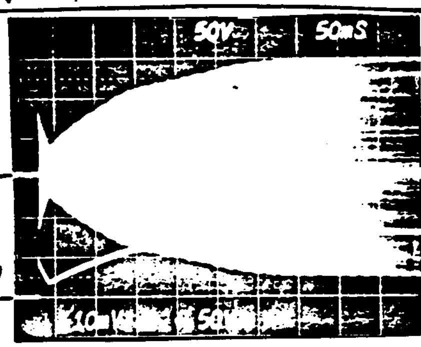


I_A

0_A

V_{IN}

0_V

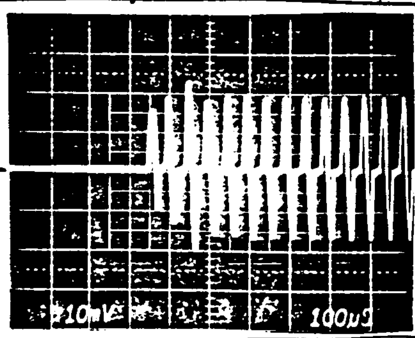


Input Voltage | Scale: 10ms /

$I_A + V_{IN}$ | Scale 10A /

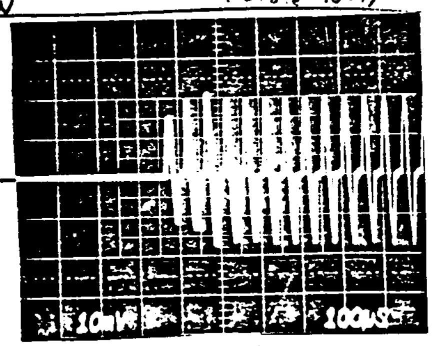
I_A

0



I_B

0



I_A | Scale: 20A /

I_B | Scale 20A /

3

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS 3-22777)

TRANSIENT TEST DATA SHEET

Test - Configuration: 2.3.6 - 3.2.1 Power Turn On

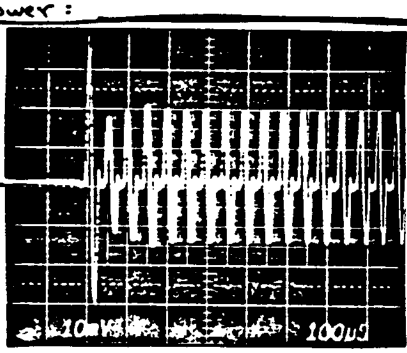
Specific Case: No Load (1.5μF) Early To Logic

Input Voltage:
Input Current: SAME
System Frequency:
Output Power:

DC RCVR:
AC RCVR:
BD Module:
Other:

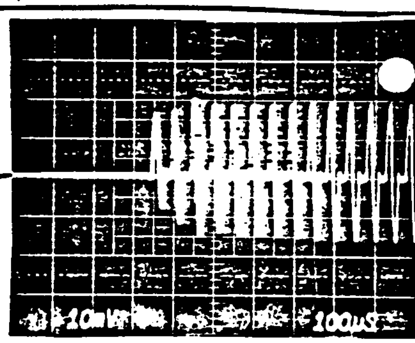
I_C

0



I_D

0



I_C | Scale: 20A/

I_D | Scale 20A/

Photo

Photo

| Scale:

| Scale:

4

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.1 Power Turn On

Specific Case: No Load (1.5μF) Current Spikes

Input Voltage: ~~0~~ DC Rcvr: Early Logic T.O.

Input Current: SAME AC Rcvr:

System Frequency: BD Module:

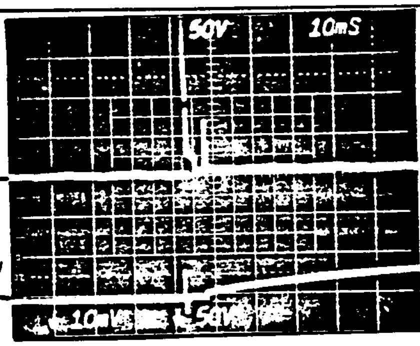
Output Power: Other:

I_{IN}

0A

V_{IN}

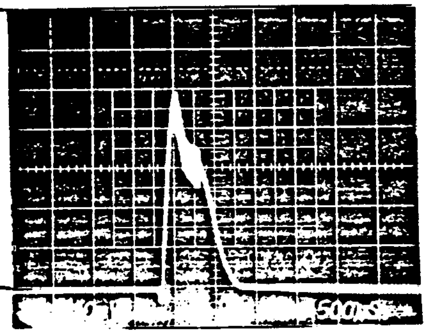
0V



Input Voltage & Current Scale: 50A/

I_G

0A



I_G Scale: 50A/div

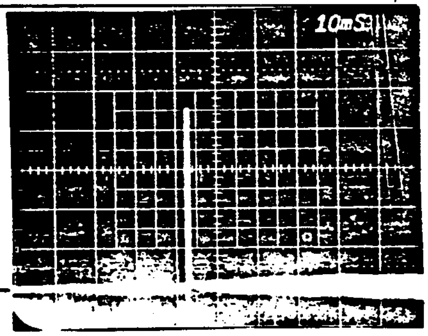
Current Spike in inductor seems to be present whenever inverter is turned on with 80V or less on the DC input cap. previous to turn on

Photo

Scale:

I_G

0A



I_G Scale: 50A/div.

5

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS 3-22777)

TRANSIENT TEST DATA SHEET

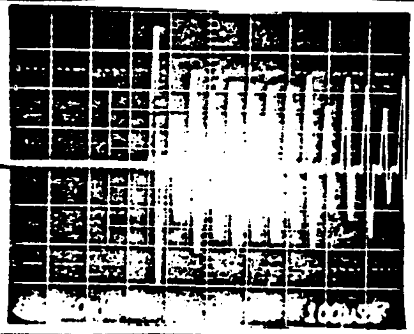
Test - Configuration: 2.3.6-3.2.1 Power Turn On

Specific Case: No Load (1.5μF) Inverter 3

Input Voltage:	DC RCVR: Early Logic T.O.
Input Current: SAME	AC RCVR:
System Frequency:	BD Module:
Output Power:	Other:

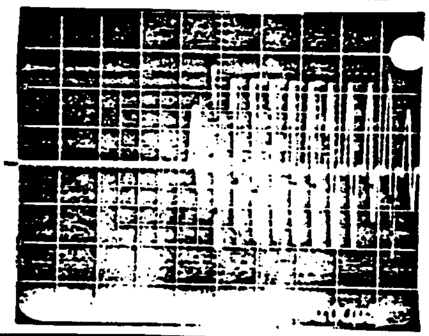
I_G

0



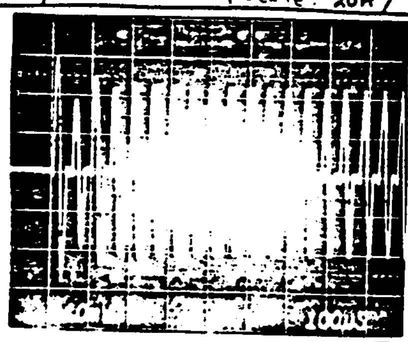
I_H

0



I_G w/DC RCVR | Scale: 20A/

I_H w/DC RCVR | Scale:



Photo

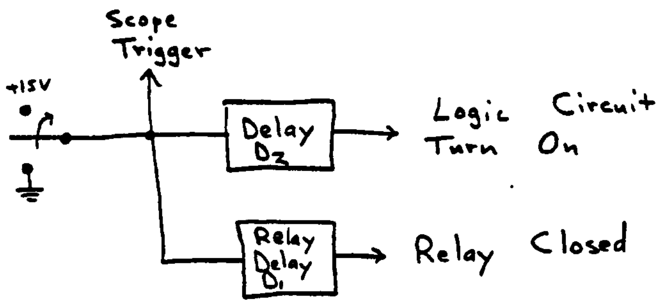
I_H w/o DC RCVR | Scale: 20A/

| Scale 20A/

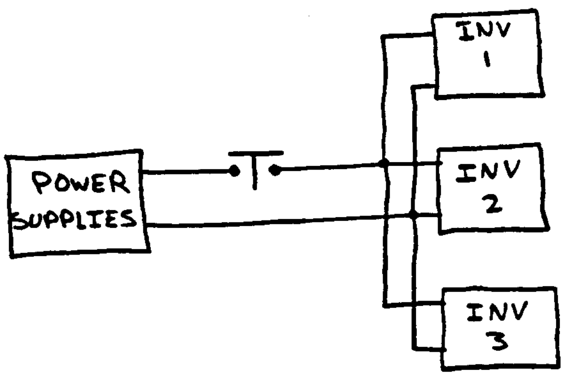
6

Configuration - Test 2.3.6-3.2.1 POWER TURN ON OF 5.0-KW SYSTEM (Relay Before Logic)

Test Circuits



$D_1 < D_2$



RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6- 3.2.1 Power Turn On

Specific Case: No Load , 1.5μF

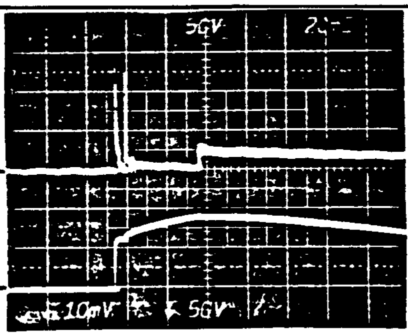
Input Voltage:	0 → 120.1	DC Rcvr:	0 → 28.4 0W
Input Current:	0 → 9.70	AC Rcvr:	OFF 0W
System Frequency:	20.352	BD Module:	194.79 0W
Output Power:	0W	Other:	

I_{IN}

0A

V_{IN}

0V



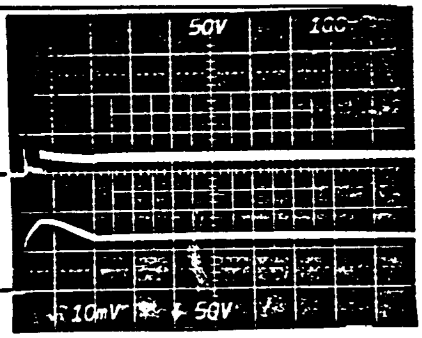
Input Voltage + Current Scale: 20A/

I_{IN}

0A

V_{IN}

0V



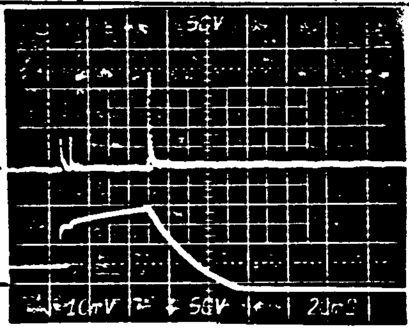
Input Voltage + Current Scale: 20A/

I_{IN}

0A

V_{IN}

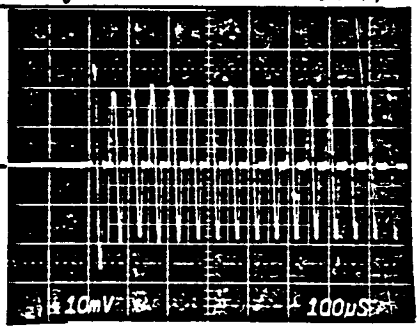
0V



Input Voltage, and Current Scale: 50A/
w/ BD Module at 0V prior to switching

I_A

0A



I_A Scale: 20A/

7

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6 – 3.2.1

Specific Case: No Load, 1.5μF

Input Voltage: ______ DC Rcvr: ______

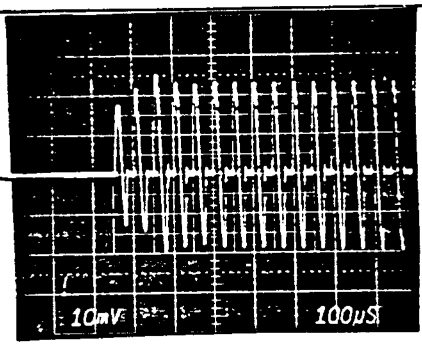
Input Current: SAME AC Rcvr: ______

System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______

I_B

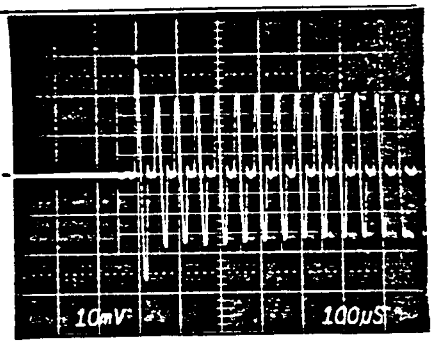
0A



I_B Scale: 20A/

I_C

0A

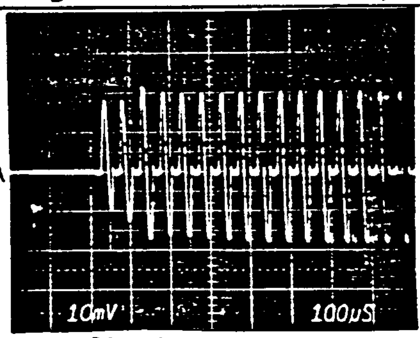


BD MODULE OFF

I_C Scale: 20A/

I_D

0A



BD MODULE OFF

I_D. Scale: 20A/

Photo

Scale: ______

8

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

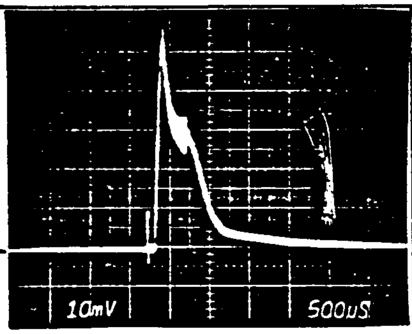
Test-Configuration: 2.3.6-3.2.1 Power Turn On

Specific Case: No Load, 1.5µF

Input Voltage:	Same	DC Rcvr:	↓
Input Current:	↓	AC Rcvr:	↓
System Frequency:	↓	BD Module:	Various Modes
Output Power:	↓	Other:	

I_c

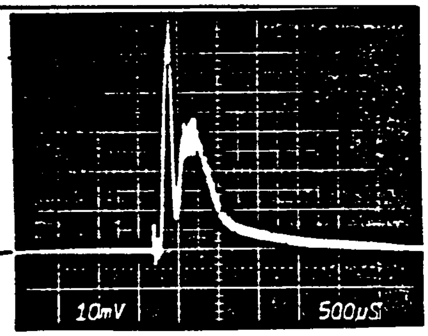
0A—



I_c w/ BD Module (Shorts out) at 0Vdc Scale: 50A/

I_D

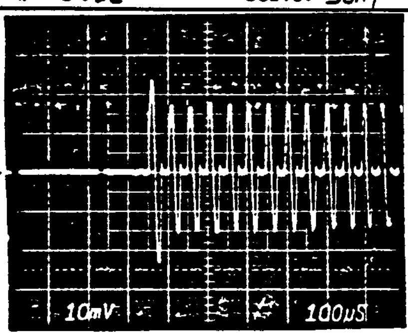
0A—



I_D with BD Module at 0Vdc Scale: 50A/

I_c

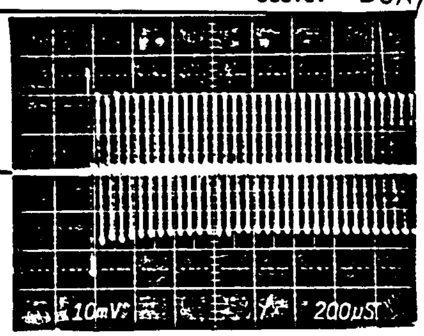
0A—



I_c w/ BD Mod. charged to 195Vdc Scale: 20A/

I_c

0A—



I_c w/o BD Module (expanded time) Scale: 20A/

9

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.1 Power Turn ON

Specific Case: NO LOAD, 1.5µF

Input Voltage: Same as

Input Current:

System Frequency:

Output Power:

DC Rcvr: Various Modes

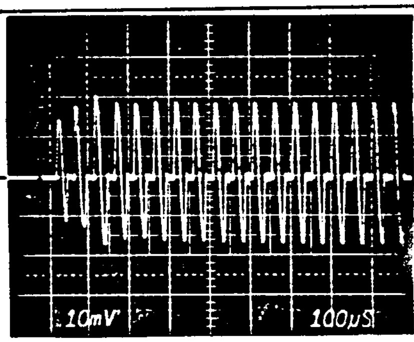
AC Rcvr:

BD Module:

Other:

I_G

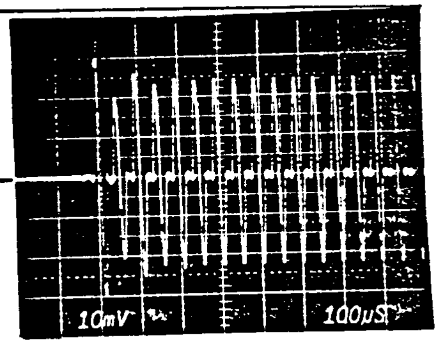
0A



I_G - DC RCVR OFF Scale: 20A/

I_H

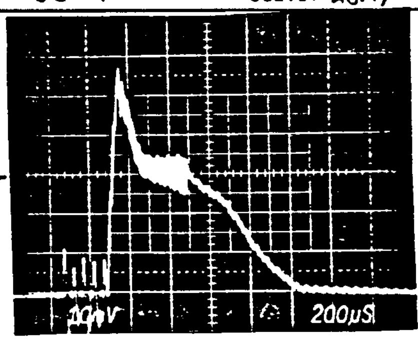
0A



I_H - DC RCVR OFF Scale: 20A/

I_G

0A



I_G - DC RCVR at 0VDC Scale: 50A/

Doesn't Short

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.1

Specific Case: No Load, 1.5μF

Input Voltage:

Input Current:

System Frequency:

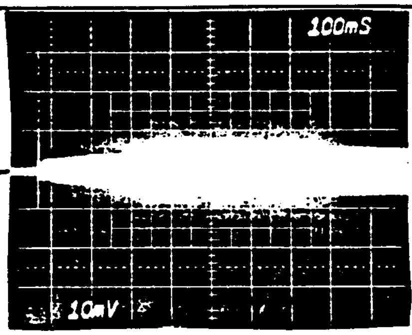
Output Power:

DC Rcvr:

AC Rcvr:

BD Module:

Other:



I_G - DC RCVR @ 0V Scale: 20A/

Photo

Scale:

Photo

Scale:

Photo

Scale:

10.5

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.1 Power Turn On

Specific Case: No Load, 1.5µF, Inverter 3

Input Voltage: Same | DC Rcvr:

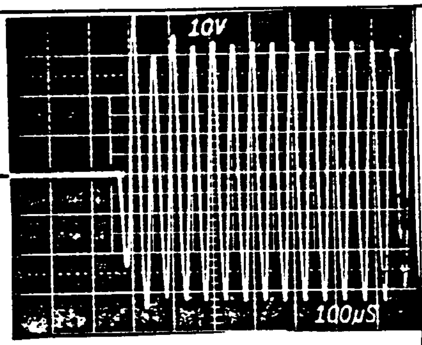
Input Current: | AC Rcvr:

System Frequency: | BD Module:

Output Power: | Other:

V_{K3}

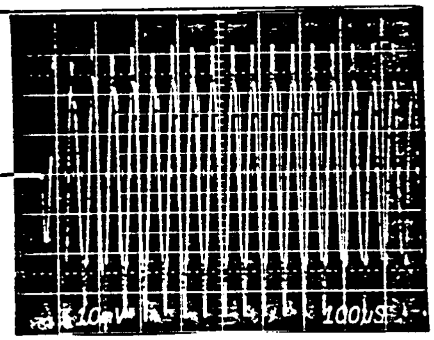
0V



Scaled Down Transmission Line Voltage DC RCVR OFF Scale: ?

I_{K3}

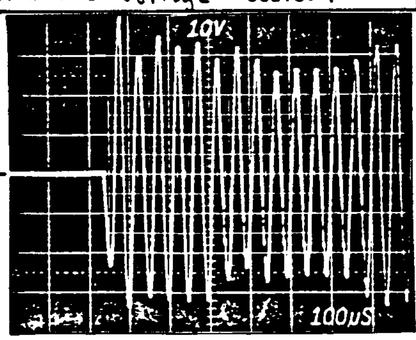
0A



I_{K3} – DC RCVR OFF Scale: 20A/

V_{K3}

0V

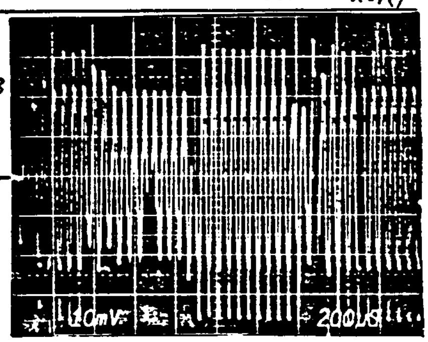


Scaled Down Transmission Line Voltage DC RCVR ON @ 28.4V Scale: ?

Occassional Oscillation

I_{K3}

0A



I_{K3} – DC RCVR @ 28.4VDC Scale: 20A/

Occassional Oscillation

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.1 Power Turn On

Specific Case: No Load, 1.5μF, Inverter 2

Input Voltage: ↓ **DC Rcvr:** ↓

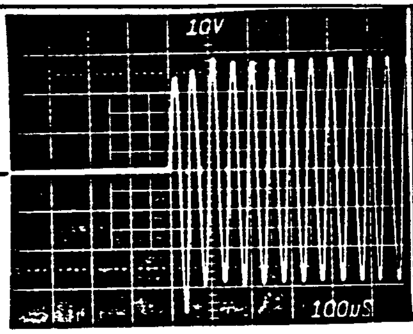
Input Current: **AC Rcvr:**

System Frequency: **BD Module:** Various Modes

Output Power: **Other:**

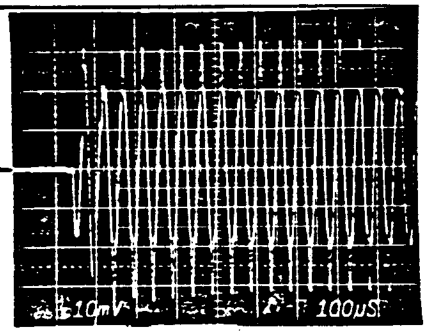
V_{K2}

0V –



Ik2

0A –

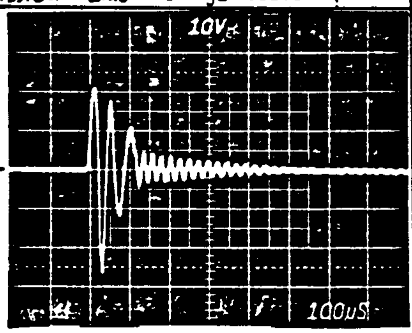


Scaled Down BD Module off
Transmission Line Voltage **Scale:** ?

Ik2 - BD Mod. OFF **Scale:** 20 A/

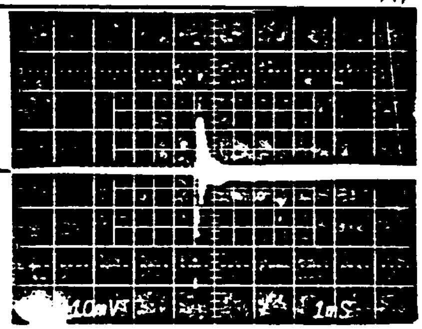
V_{K2}

0V –



Ik2

0A –



Scaled Down BD Module @ 0Vdc
Line Voltage **Scale:** ?
Shorts Out

Ik2 - BD Module @ 0V **Scale:** 10A/
Shorts Out

12

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.1 Power Turn On

Specific Case: No Load, 1.5μF, Inverter 1

Input Voltage: ______ DC Rcvr: ______

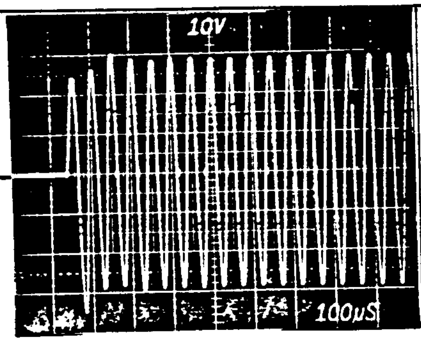
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______

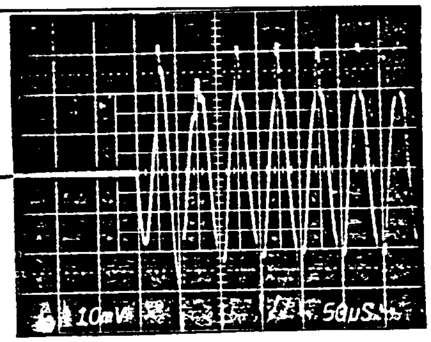
Vk1

0V



Ik1

0A



Scaled Down Line Voltage Scale: ?

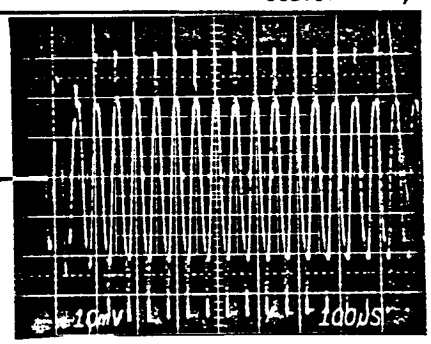
Ik1 Scale: 20A/

Photo

Scale:

Ik1

0A



Ik1 Scale: 20A/

13

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6 - 3.2.1 Power Turn On

Specific Case: No Load, 1.5μF

Input Voltage: SAME

DC Rcvr:

Input Current:

AC Rcvr:

System Frequency:

BD Module:

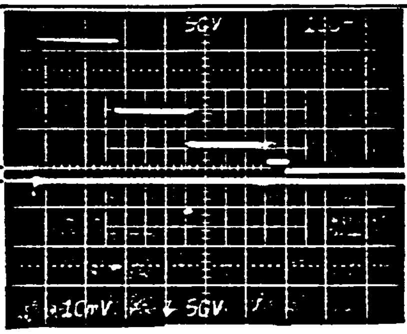
Output Power:

Other:

V_{AC}

0V

I_{AC} 0A

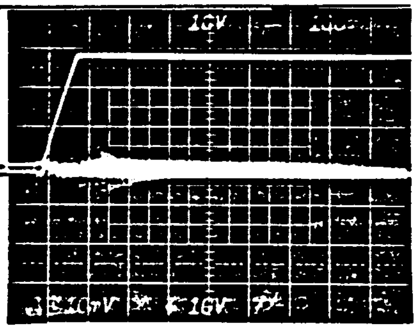


V_{AC} & I_{AC}: INV 2&3 off Scale: 1A/

V_{DC}

0V

I_{DC} 0A

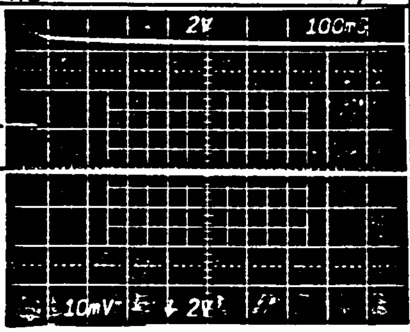


V_{DC} & I_{DC} - INV. 1&2 off Scale: 1A/

V_{BD}

0V

I_{BD} 0A



V_{BD} + I_{BD} - INV. 1&3 off Scale: 1A/

Photo

Scale:

14

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

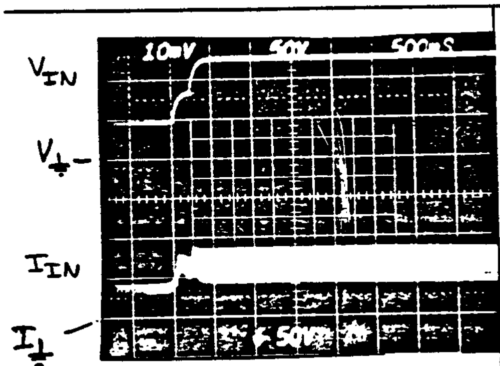
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

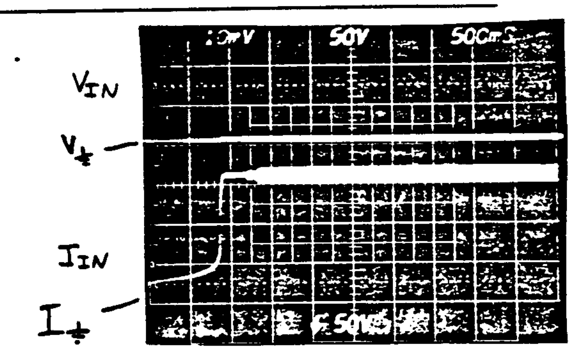
Test-Configuration: POWER TURN ON 10% LOAD

Specific Case: 10% LOAD, 1.5 A

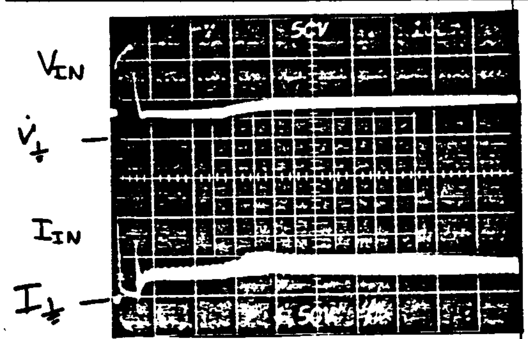
Input Voltage: 0→120.0	DC Rcvr: (28.5)(5A) = 142.5w
Input Current: 12.5 a	AC Rcvr: 120(.7) ≈ 75w
System Frequency: 20.073 KHz	BD Module: (101.2)(1A) = 101.2w
Output Power: 318.7w	Other:



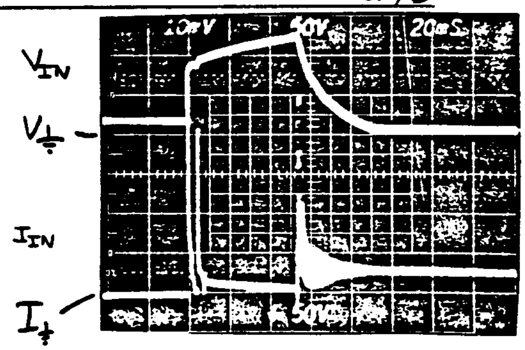
$V_{IN} \cdot I_{IN}$ Scale: 10A/D



$V_{IN} \cdot I_{IN}$ SYSTEM SHORTING Scale: 10A/D



$V_{IN} \cdot I_{IN}$ Scale: 10A/DIV.



$V_{IN} \cdot I_{IN}$ System Shorting Scale: 10A/DIV

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: Power turn on 10% load

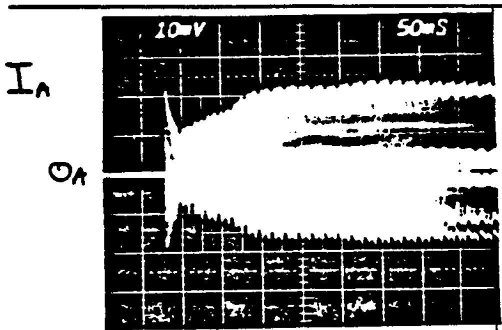
Specific Case: 10% Load, 15uf - Inv #2 is OFF

Input Voltage: 1200 DC Rcvr: 142.5w

Input Current: 8.89A AC Rcvr: 75w

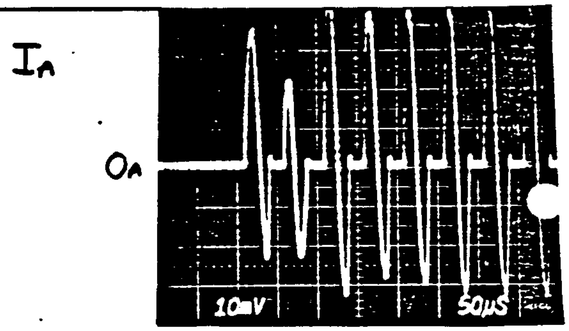
System Frequency: 20110 KHz BD Module: OFF

Output Power: Other:

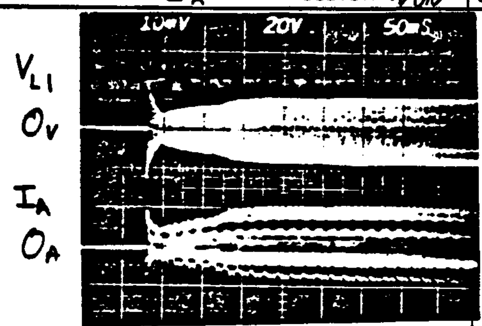


INV. 2 OFF

I_A Scale: 10A/DIV



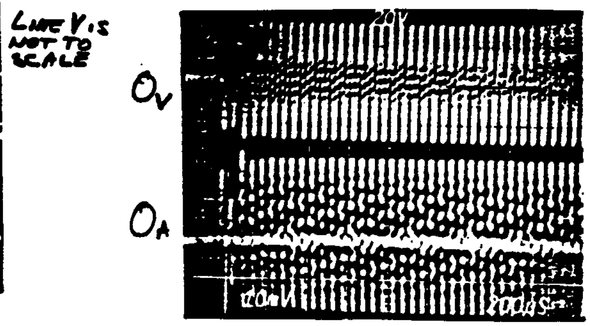
I_A - Inv #2 is OFF Scale: 10A/DIV



INV. 2 OFF

LINE VOLTAGE + IA Scale: 20A/DIV

Line V. Not to Scale



I_A + Line V; Inv #2 is OFF Scale: 20A/DIV

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

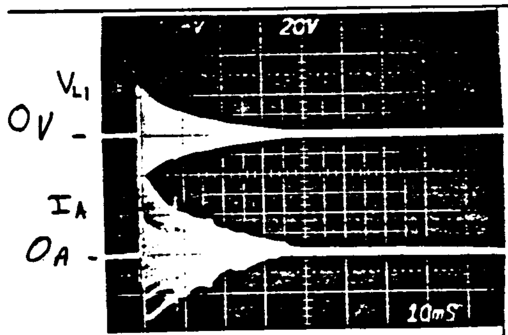
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: POWER TURN ON

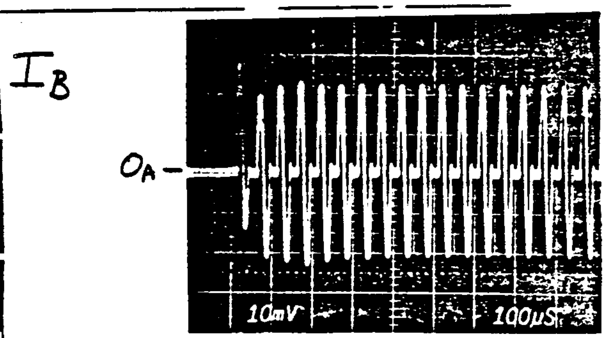
Specific Case: 10% LOAD

Input Voltage:	SAME	DC Rcvr:	
Input Current:		AC Rcvr:	
System Frequency:		BD Module:	
Output Power:		Other:	

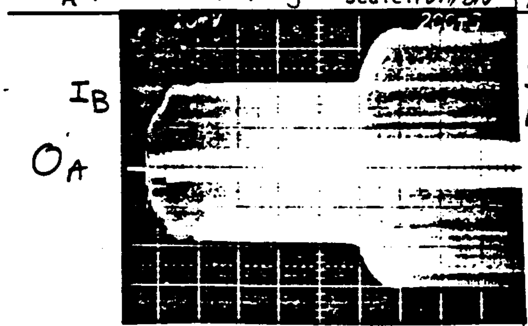


INV. 2 ON

I_A + Line Voltage Scale: 10A/DIV

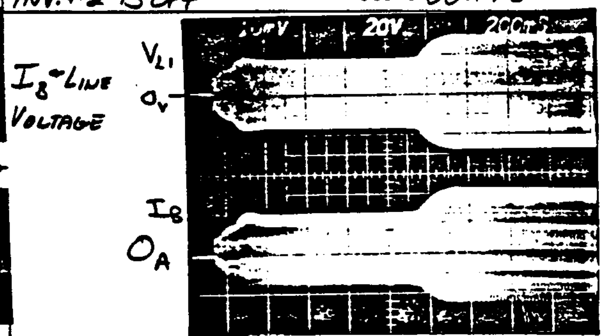


INV. #2 IS OFF Scale: 20A/DIV



INV. 2 OFF

I_B Scale: 10A/DIV



INV. 2 OFF

I_B + Line Voltage Scale: 20A/DIV

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: Power Turn On, 10% Load

Specific Case: Inv #2 And B/D Load On (10%)

Input Voltage: Same — DC Rcvr:

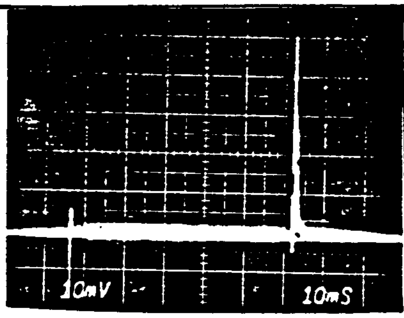
Input Current: — AC Rcvr:

System Frequency: — BD Module:

Output Power: — Other:

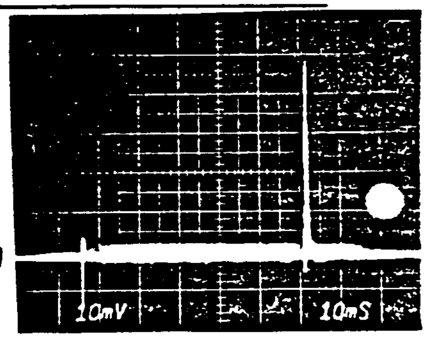
I_C

0_A



I_D

0_A



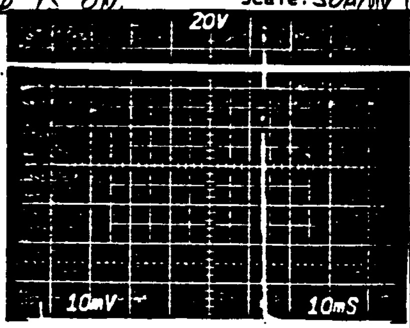
I_C - System Shorting; B/D is on. Scale: 50A/DIV

- System Shorting; B/D is on Scale: 50A/DIV

0_V

I_D

0_A



Photo

Line Voltage (not to scale) and I_D. B/D is on.. Scale: 50A/DIV.

Scale:

Pg 18

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: ______

Specific Case: Power Turn On - Inv#3 - DC Rec ON

Input Voltage: SAME | DC Rcvr: SAME

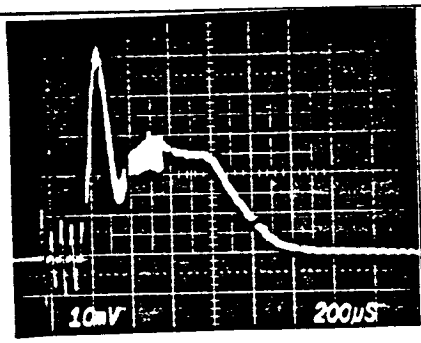
Input Current: ↓ | AC Rcvr: ↓

System Frequency: | BD Module: OFF

Output Power: | Other: ______

I_G

0_A

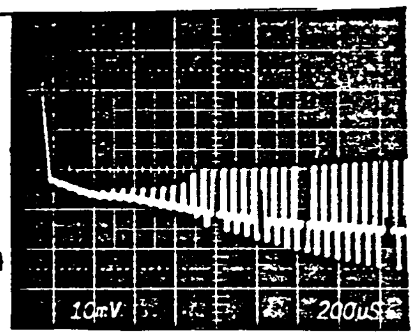


SYSTEM DOES NOT SHORT

Scale: 50A/DIV

I_G

0_A

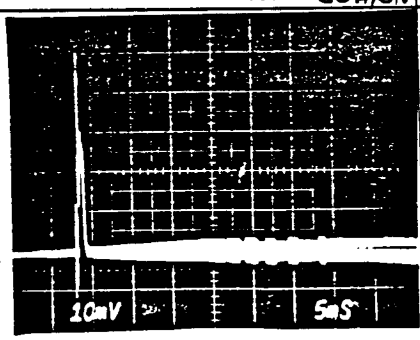


SYSTEM DOESN'T SHORT

Scale: 2A/DIV

I_G

0_A



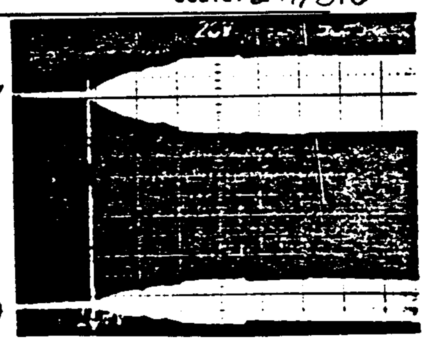
SYSTEM DOES NOT SHORT

Scale: 50A/DIV

I_G & LINE VOLTAGE

0_V

0_A



SYSTEM DOES NOT SHORT

Scale: 50A/DIV

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: POWER TURN ON

Specific Case: 10% LOAD

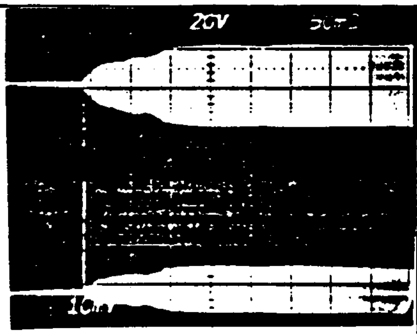
Input Voltage: SAME | DC Rcvr: SAME

Input Current: ↓ | AC Rcvr: ↓

System Frequency: | BD Module: OFF

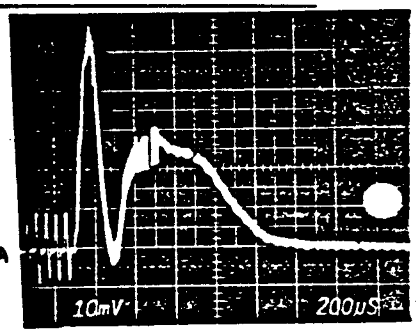
Output Power: | Other:

Ov



OA

OA



I_H + LINE VOLTAGE Scale: 50A/DIV

Line Voltage Not to Scale

Photo

Scale:

I_H Scale: 50A/DIV

SYSTEM DOES NOT SHORT

Photo

Scale:

Pg 20

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

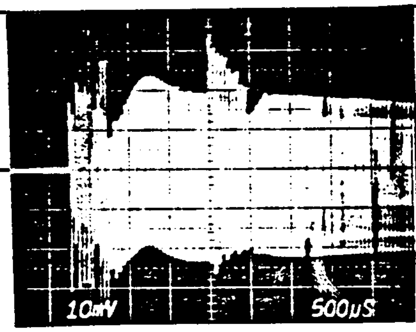
TRANSIENT TEST DATA SHEET

Test-Configuration: Power Turn On

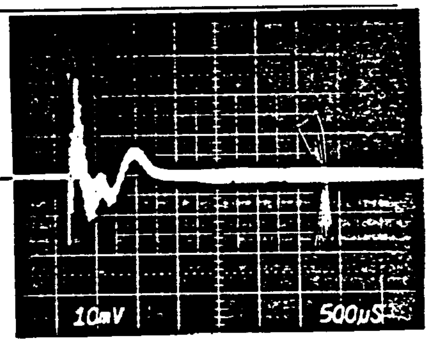
Specific Case: 10% LOAD

Input Voltage:	SAME	DC Rcvr:	
Input Current:		AC Rcvr:	
System Frequency:		BD Module:	
Output Power:		Other:	

0



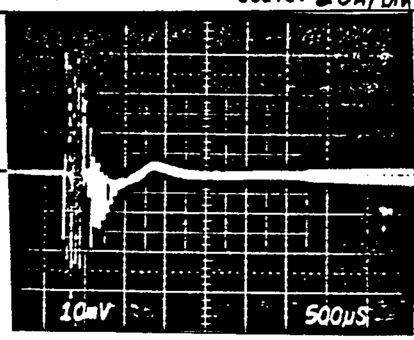
0



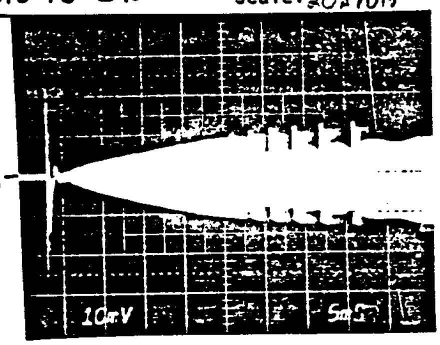
I_{K1} - INV#2 is OFF Scale: 20A/DIV

I_{K2} - B/D IS ON Scale: 20A/DIV

0



0



I_{K3} - INV #2 IS OFF Scale: 20A/DIV

I_{K3} - INV # 2 IS OFF. Scale: 20A/DIV

Pg 21

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

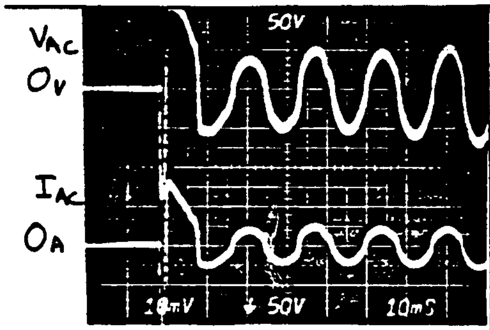
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: Power Turn On 10% Load

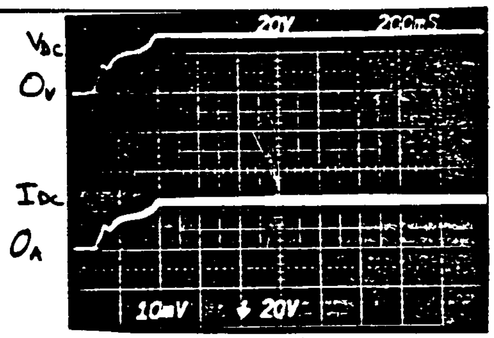
Specific Case: Receiver Outputs

Input Voltage:	SAME	DC Rcvr:	↓
Input Current:	↓	AC Rcvr:	↓
System Frequency:	↓	BD Module:	↓
Output Power:		Other:	

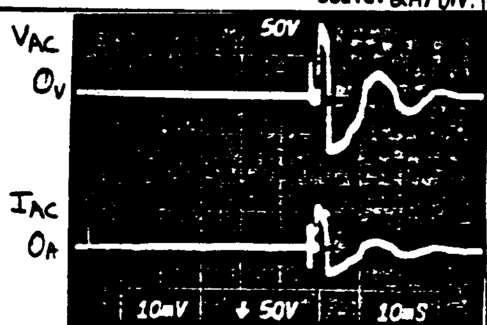


Scale: 2A/DIV.

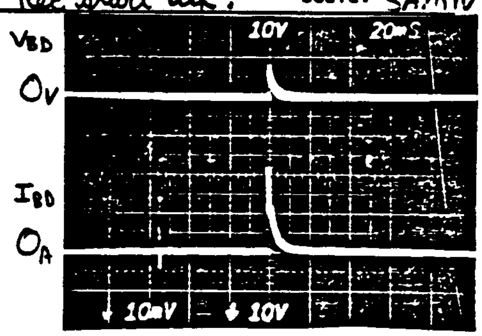
DC Rec start up*



Scale: 5A/DIV



AC Rec. B/D is on and shorts out the system. Scale: 5A/DIV



B/D-STARTING V AND I ON THE B/D Scale: 1A/DIV.

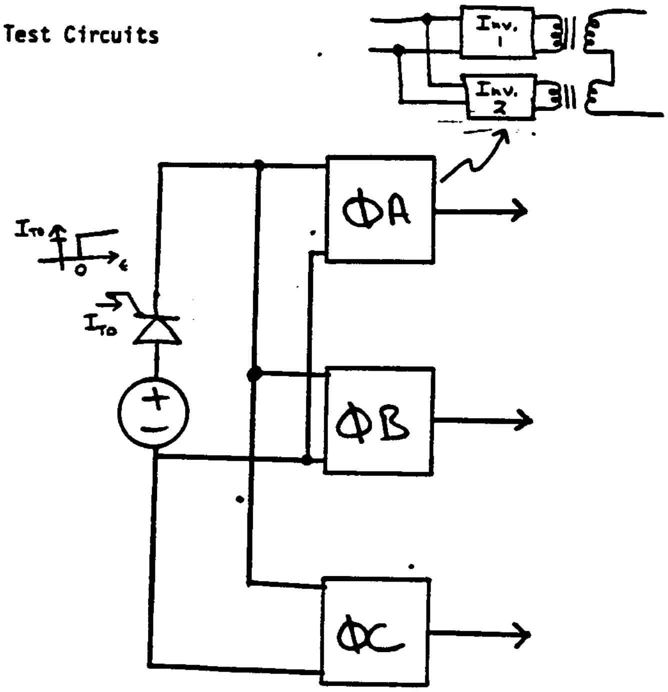
* When the B/D is on and the system shorts out, you do not see any Volt. or I on the DC Rec.

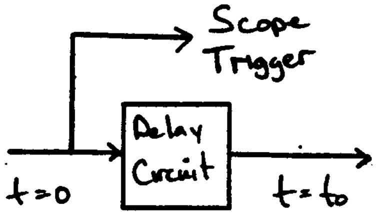
Pg 22

Configuration - Test 2.3.7-3.2.1 Power Turn On

C- Compensation

Test Circuits





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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.1 Power Turn On

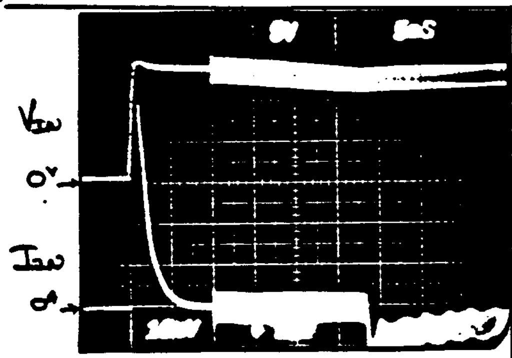
Specific Case: C - Compensation, No Load

Input Voltage: 0 → 150.5 Vdc **DC Rcvr:** 28.7 Vdc, 0W

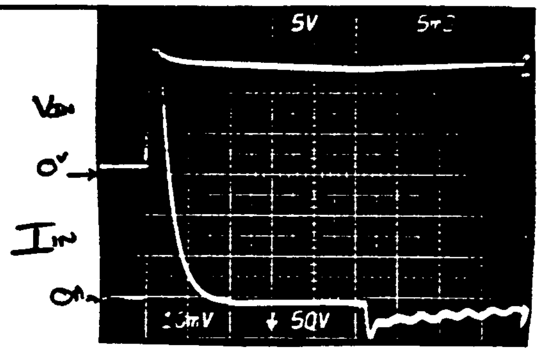
Input Current: 0 → 20.5 Adc **AC Rcvr:** OFF

System Frequency: 19.95 KHZ **BD Module:** 111.6 Vdc, 20.1W

Output Power: 20.1 W **Other:** NONE

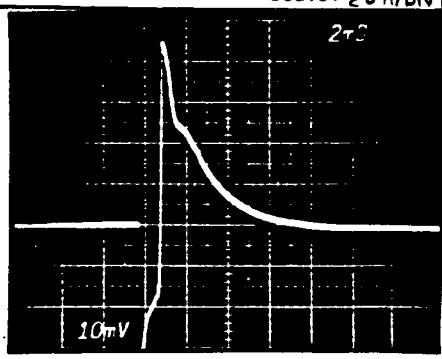


Scale: 50V/Div 20 A/Div

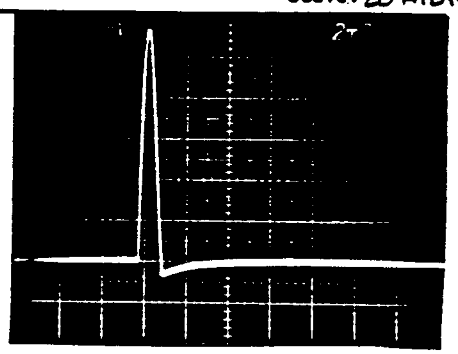


Scale: 50 V/Div 20 A/Div

B's P. dr



Scale: 50 A/Div



Scale: 500 A/Div

2

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.1 POWER TURN ON

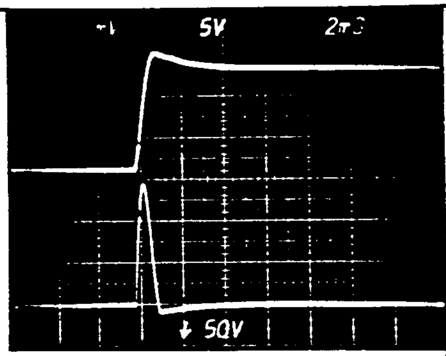
Specific Case: C-Compensation, No Load

Input Voltage: 0 → 150.5 VDC DC Rcvr: 0-28.7 VDC / 0 W

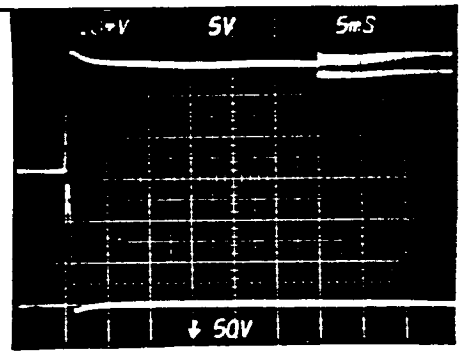
Input Current: 0 → 20.5 ADC AC Rcvr: OFF

System Frequency: 19.95 KHZ BD Module: 0 - 111.6 VDC / 20.1 W

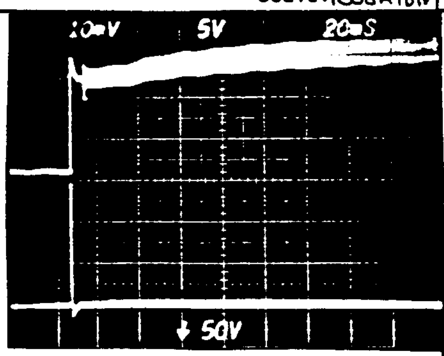
Output Power: 20.1 W Other: NONE



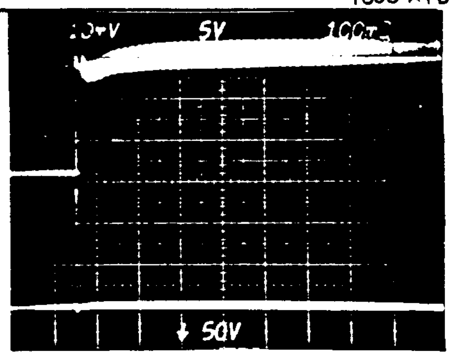
Scale: 50 V/DIV 1000 A/DIV



Scale: 50 V/DIV 1000 A/DIV



Scale: 50 V/DIV 1000 A/DIV



Scale: 50 V/DIV 1000 A/DIV

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3

RESONANT AC POWER SYSTE

TEST PROGRAM (N

TRANSIENT TEST

Test-Configuration: 2.3.7 -3.2.1

Specific Case: C- Compensation

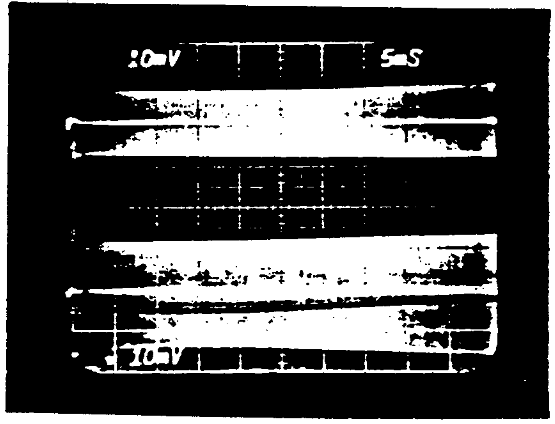
Input Voltage: ____________

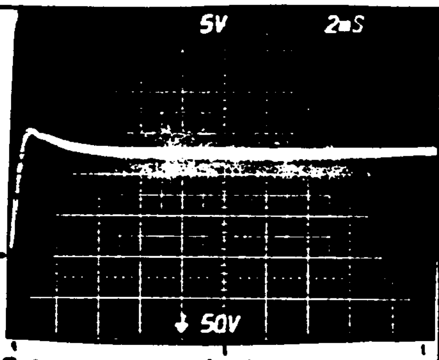
Input Current: ____________

System Frequency: ____________

Output Power: ____________

Vin



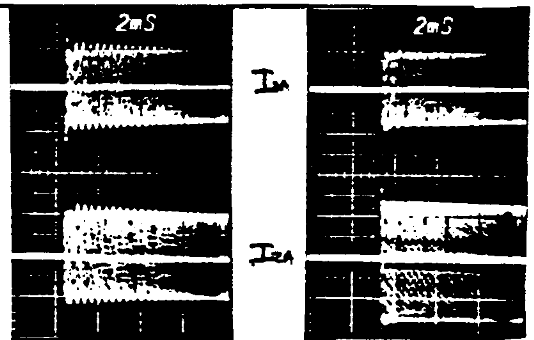


0V

0ms 10ms 20ms

$V_{IN,DC}$ - Input voltage reference for photos on this page

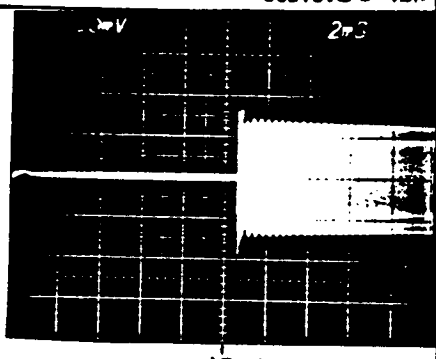
Scale: 50 V/DIV



I_{1A} I_{1B} I_{1A} I_{2A}

10ms 20ms 10ms 20ms

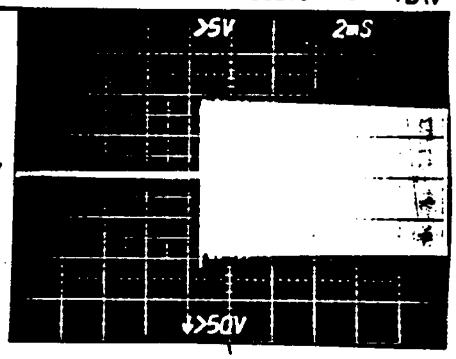
Scale: 50 A/DIV



10ms

I_{K1}

Scale: 50A/DIV



0V

10ms

V_{K1}

Scale: Scope UnCal.

4

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.1 Power Turn On

Specific Case: C- Compensation, No Load, Faster Restart

Input Voltage: ______ DC Rcvr: ______

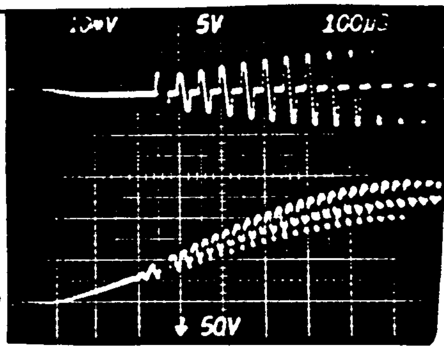
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______

I_{1A}

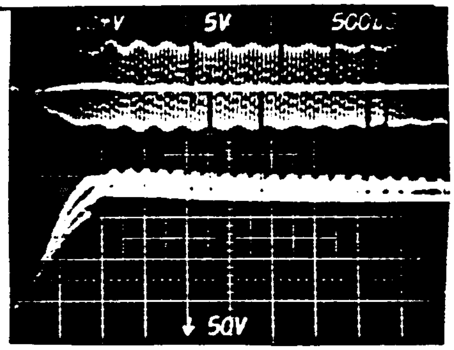
V_{IN}



Scale: 50 A/DIV
50 V/DIV

I_{1A}

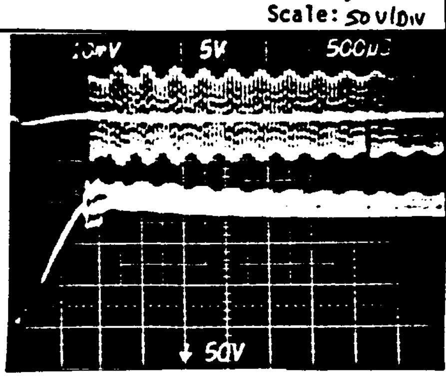
V_{IN}



Scale: 50 A/DIV
50 V/DIV

I_{1A}

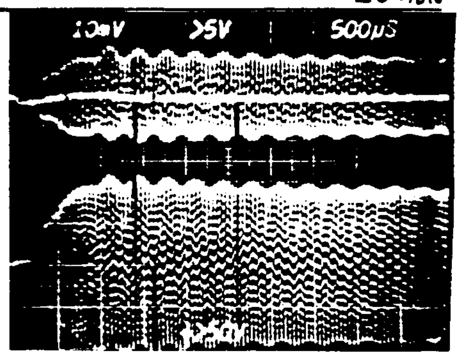
V_{IN}



Scale: 50 A/DIV
50 V/DIV

I_{1A}

V_{H1}



Scale: 50 A/DIV
V_{H1}-UnCal

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5

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.1 Power Turn On

Specific Case: C-Compensation, No Load

Input Voltage: ______ DC Rcvr: ______

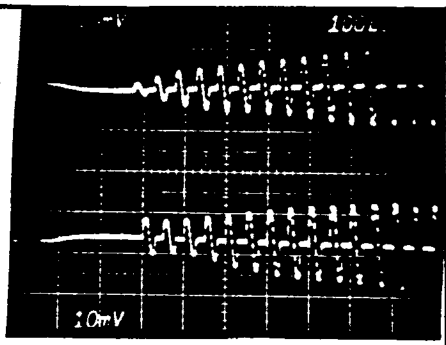
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______

I_{IA}

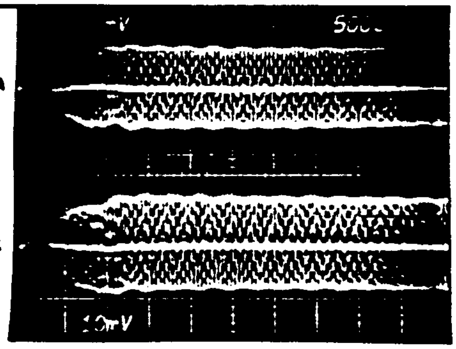
I_{IB}



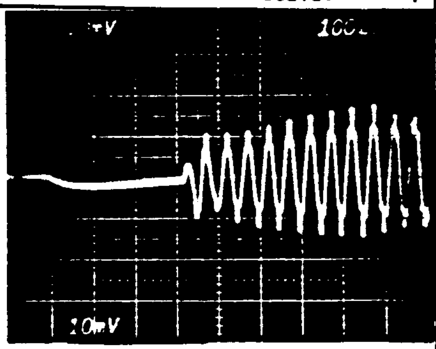
Scale: 50 A/DIV

I_{IA}

I_{IB}

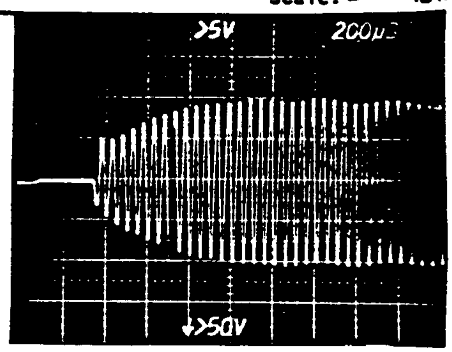


Scale: 50 A/DIV



I_{K1}

Scale: 50A/DIV



V_{K1}

Scale: UnCal

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.1 Power Turn On

Specific Case: C-Compensation, No Load

Input Voltage: ______ DC Rcvr: ______

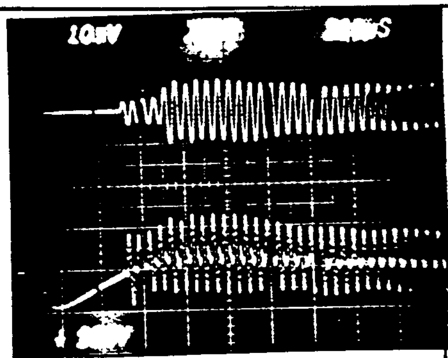
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______

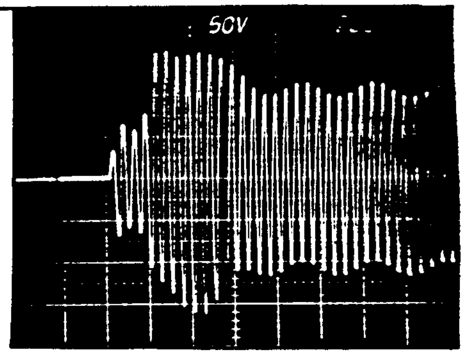
V_{XA}

I_{K1}



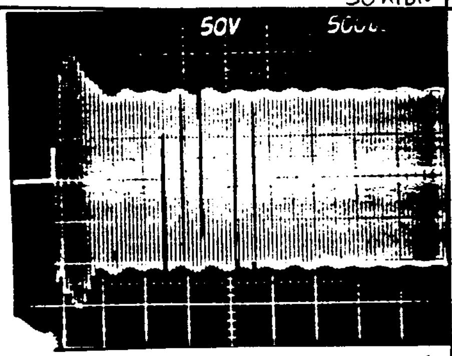
Scale: UnCal 50 A/DIV

V_{XA}



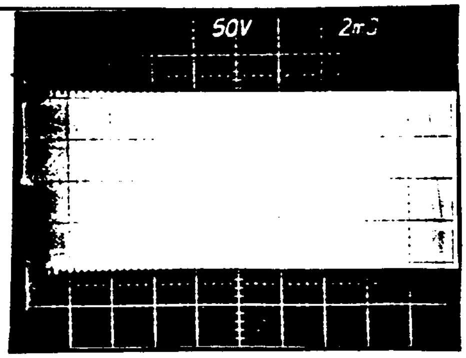
Scale: 320 V/DIV

V_{XA}



Scale: 320 V/DIV

V_{XA}



Scale: 320 V/DIV

Test Config. 3.3.7-3.3.1 Power Turn On
Specific Case C-Compensation 13% Load

I) Input Power

V_{in} 149.5 Vdc
I_{in} 44.04 Adc
P_{in} 6.58 KW

Frequency 19.91 KHz

T.H.D.
ΦA ___ db
ΦB ___ db
ΦC ___ db

T.H.D. – Transmission Line
Into the line
ΦA

II) Output Power

ΦA	ΦB	ΦC
V_o ___	V_o ___	V_o ___
I_o ___	I_o ___	I_o ___
P_o ___	P_o ___	P_o ___

A.C. RCVR	B/D MOD.	D.C. RCVR
V_o OFF	V_o OFF	V_o OFF
I_o ___	I_o ___	I_o ___
P_o ___	P_o ___	P_o ___

T.H.D. Out of RCVR
___ db

Resistive Loads

ΦA	ΦB	ΦC
V_A 442.9 Vac	V_B 436.2 Vac	439.0 Vac
I_A 12.81 mV	I_B 12.72 mV	13.38 mV
I_A 2.55 Aac	I_B 2.58 Aac	I_C 2.65 Aac
P_{RA} 1.13 KW	P_{RB} 1.13 KW	P_{RC} 1.16 KW

Total System Efficiency = $\frac{P_{out}}{P_{in}} = \frac{3.42}{6.58} = .520$

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.7.1 Power Turn-On

Specific Case: C-Compensation, 13% Load

Input Voltage: ______ DC Rcvr: ______

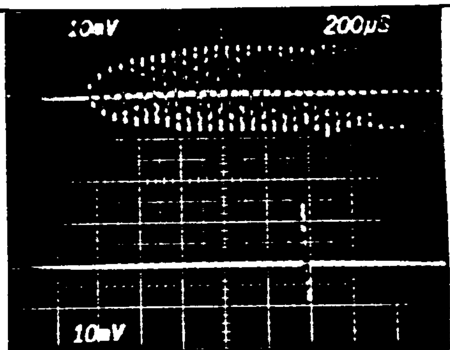
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______

I_{1A}

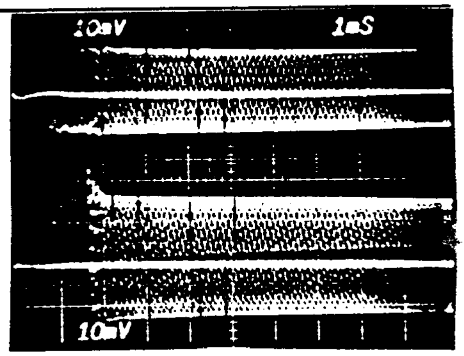
I_{2A}



Scale: 50A/Div

I_{1A}

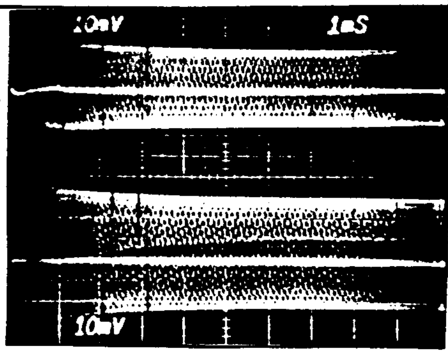
I_{2A}



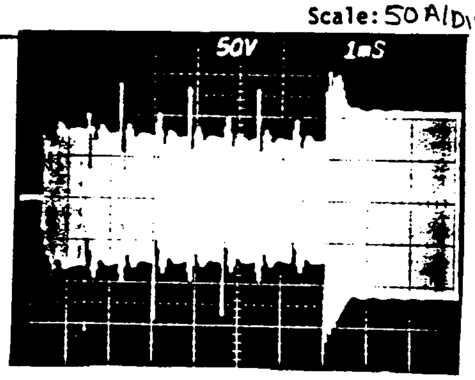
Scale: 50A/Div

I_{1A}

I_{2A}



Scale: 50A/Div



V_{LA}

Scale: 320V/Div

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.1 Power Turn-On

Specific Case: C-Compensation, 13% Load

Input Voltage: 149.5 Vdc DC Rcvr: OFF

Input Current: 44.04 Adc AC Rcvr: OFF

System Frequency: 19.91 KHZ BD Module: OFF

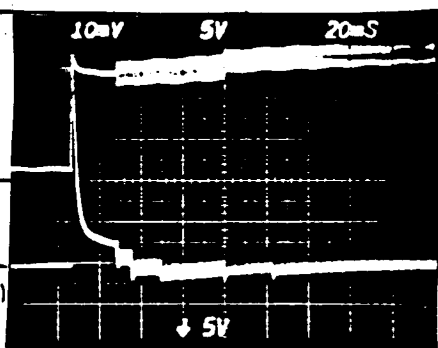
Output Power: 3.42 KW Other: Res. Loads 1.1 KW/Phase

V_{IN}

0^V

0^A

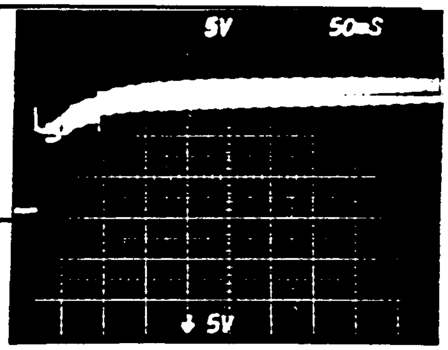
I_{IN}(A.C)



V_{IN} + I_{IN} (A.C)

Scale: 50 V/DIV, 50 A/DIV

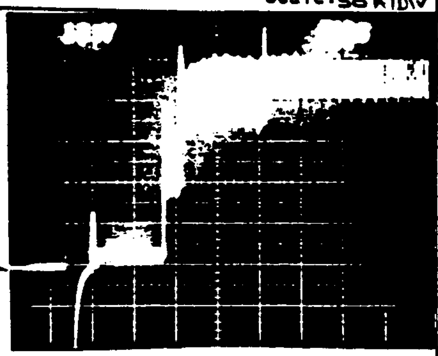
0^V



V_{IN}

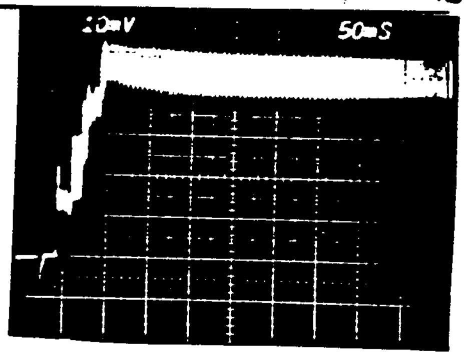
Scale: 50 V/DIV

0^A



I_{IN} (D.C.)

Scale: 10 A/DIV



I_{IN} (D.C.)

Scale: 10 A/DIV

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 7.3.7 - 3.2.1 Power Turn-On

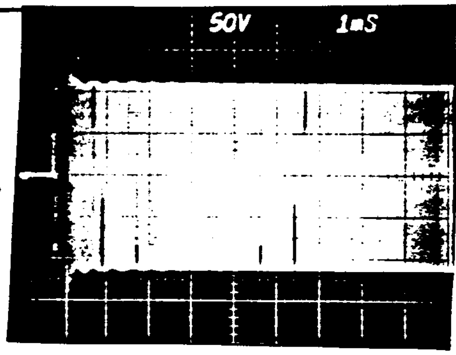
Specific Case: C-Compensation, 13% Load

Input Voltage: ______ DC Rcvr: ______

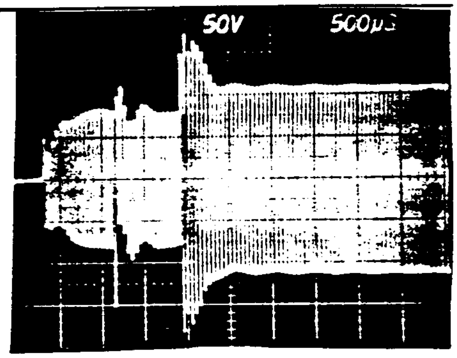
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

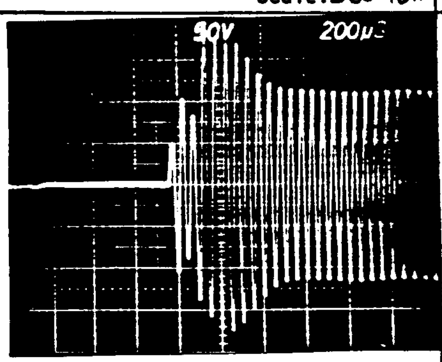
Output Power: ______ Other: ______



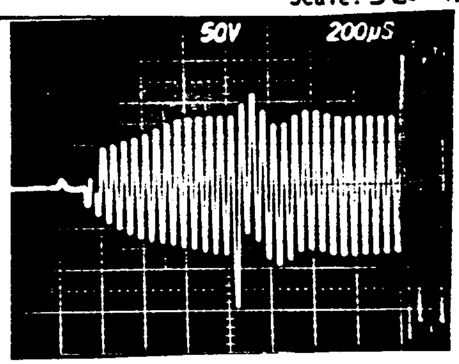
V_{LA} Scale: 320 V/DIV



V_{XA} Scale: 320 V/DIV



V_{LA} Scale: 320 V/DIV



V_{XA} Scale: 320 V/DIV

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TEST CONFIG. 2.3.7-3.2.1 Power Turn-On
SPECIFIC CASE C-Compensation, 44% Load

I) INPUT POWER

	Loaded after Power Turn-on	Loaded before Power Turn-on
V_{in}	149.5	149.5
I_{in}	97.6	55.86
P_{in}	14.6KW	8.4KW

Frequency 19.91KHz

T.H.D.
ΦA ___ db
ΦB ___ db
ΦC ___ db

T.H.D. — TRANSMISSION LINE
INTO THE LINE
ΦA

II) OUTPUT POWER

ΦA
V_o ___
I_o ___
P_o ___

ΦB
V_o ___
I_o ___
P_o ___

ΦC
V_o ___
I_o ___
P_o ___

A.C. RCVR
V_o ___
I_o ___
P_o ___

T.H.D. Out of RCVR
___ db

B/D MOD.
V_o ___
I_o ___
P_o ___

D.C. RCVR
V_o ___
I_o ___
P_o ___

RESISTIVE LOADS

ΦA			ΦB			ΦC (Loaded After Power Turn-On)		Loaded Before Power Turn-on
V_A	440.5 Vac	311.8	I_B	433.6 Vac	312.3	I_C	436.5 Vac	312.4
I_A	42.0 mv	29.6	I_B	41.9 mv	30.2	I_C	43.2 mv	30.9
I_A	8.35 Aac	5.89	I_B	8.51 Aac	6.14	I_C	8.56 Aac	6.13
P_{RA}	3.68 KW	1.84KW	P_{RB}	3.69 KW	1.92KW	P_{RC}	3.74 KW	1.91KW

Total System Efficiency: $\frac{P_{out}}{P_{in}} = \frac{11.11\ KW}{14.6} = 76.1$

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.1 Power Turn-On

Specific Case: C-Compensation, 44% Load

Input Voltage: 149.5 DC Rcvr: OFF

Input Current: 55.86 AC Rcvr: OFF

System Frequency: 19.91 KHz BD Module: OFF

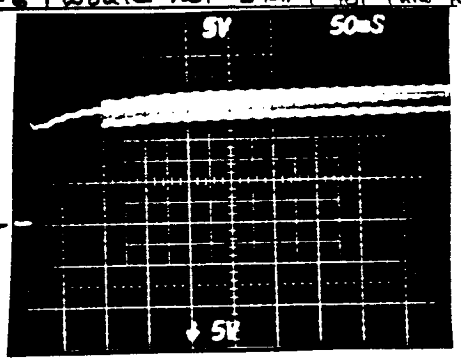
Output Power: 8.4KW Other:

Note: Even numbered inverters (#2,4,+6) would not start for this test

Photo

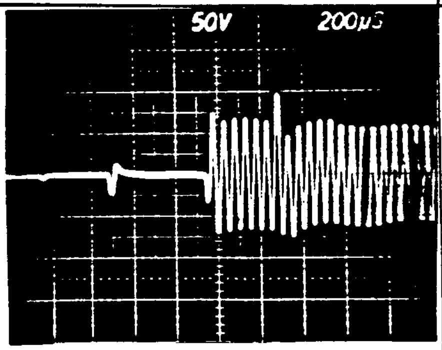
Scale:

0V



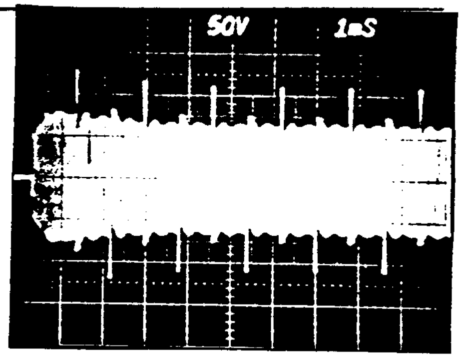
VIN

Scale: 50 V/DIV



VXA

Scale: 320 V/DIV



VXA

Scale: 320 V/DIV

TEST CONFIG. 2.3.2-3.2.1 Power Turn On
SPECIFIC CASE C-Comp, Full Load

I) INPUT POWER

V_{in} 148.0
I_{in} 196.8 Adc
P_{in} 29.1 KW

Frequency ______

T.H.D.
ΦA ___ db
ΦB ___ db
ΦC ___ db

T.H.D. – TRANSMISSION LINE
INTO THE LINE
ΦA

II) OUTPUT POWER

ΦA	ΦB	ΦC
V_o ___	V_o ___	V_o ___
I_o ___	I_o ___	I_o ___
P_o ___	P_o ___	P_o ___

A.C. RCVR	B/D MOD.	D.C. RCVR
V_o ___	V_o ___	V_o ___
I_o ___	I_o ___	I_o ___
P_o ___	P_o ___	P_o ___

T.H.D. Out of Rcvr
______ db

RESISTIVE LOADS

ΦA	ΦB	ΦC
V_A 435.8 Vac	V_B 428.7 Vac	V_C 431.4 Vac
I_A 96.52 mV	I_B 94.87 mV	I_C 100.31 mV
I_A 19.20 Aac	I_B 19.27 Aac	I_C 19.89 Aac
P_{RA} 8.37 kW	P_{RB} 8.26 kW	P_{RC} 8.58 kW

Total System Efficiency = $\frac{P_{out}}{P_{in}} = \frac{25.21}{29.1} = 87.0\ \%$

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.1 Power Turn On

Specific Case: C-Compensation, Full Load

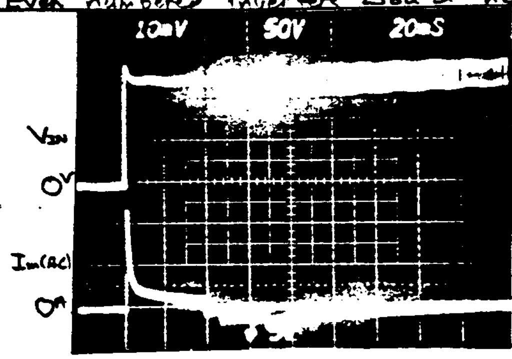
Input Voltage: 148 DC Rcvr: OFF

Input Current: AC Rcvr: OFF

System Frequency: BD Module: OFF

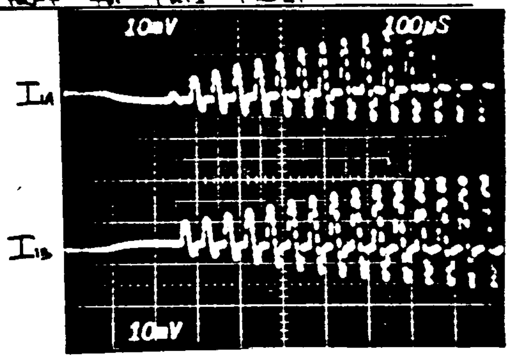
Output Power: Other:

Even numbered inverters would not start for this test



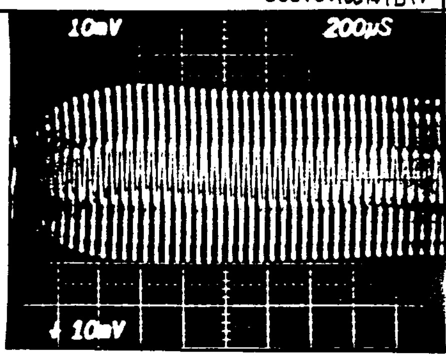
V_{IN} + I_{IN}(A.C.)

Scale: 50 V/DIV 100 A/DIV



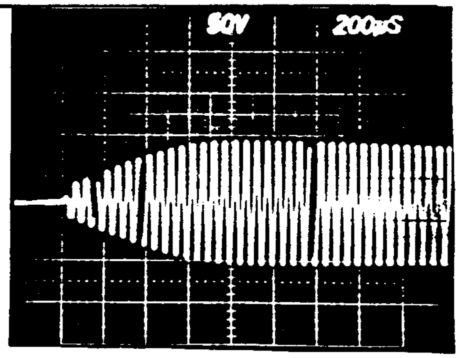
I_{1A} I_{1B}

Scale: 50 A/DIV



I_{K1}

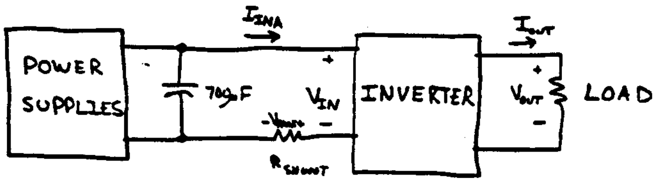
Scale: 50 A/Div



V_{XA}

Scale: 320 V/DIV

2.3.1 -3.2.2 STEADY-STATE OPERATION



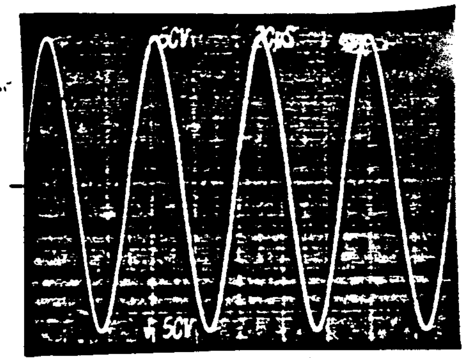
Measurement		Measurement Equipment
V_{IN}		Fluke 8000A Multimeter
I_{IN}	$= \frac{V_{SHUNT}}{R_{SHUNT}}$	Fluke 8000A Multimeter
V_{OUT}		Fluke 8000A Multimeter
I_{OUT}		P6303 Tektronix Current Probe 7704A Tektronix Oscilloscope
f		HP 5315B Universal Counter
n		Calculation using $V_{IN}, I_{IN}, V_{OUT}, I_{OUT}$

2.3.1
-3.2.2 No Load

$P_{OUT} = 0W$
$R_{LOAD} = \infty$

V_K

0

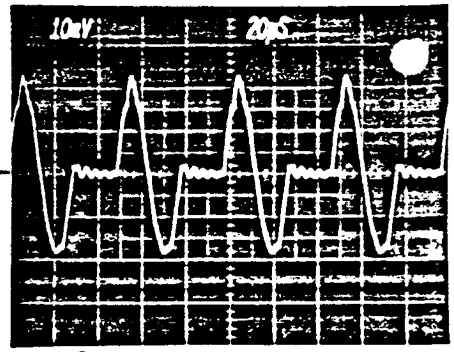


Output Voltage

I_{Br}

0

10A/div



Branch Current

V_{IN} = 87.60 VDC
I_{INA} = 1.315 ADC
P_{IN} = 115W

V_{OUT} = 123.8 VRMS
I_{OUT} = 0 A
P_{OUT} = 0W

f = 20.01 kHz
η = 0%

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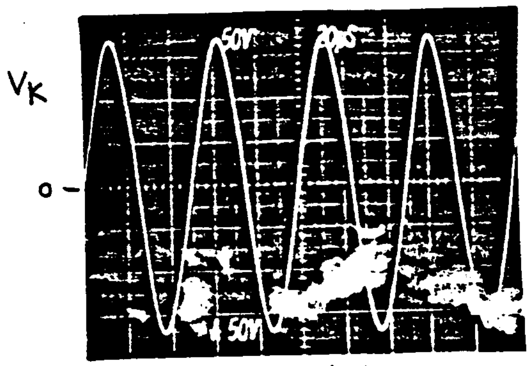
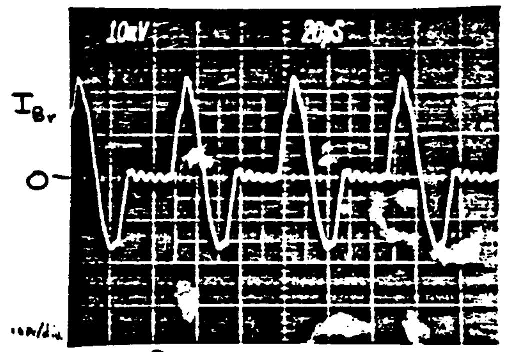
2.3.1
- 3.2.2

10% LOAD

$R_{Load} = 117\Omega$
$P_{OUT} = 130W$



Inverter Output Voltage



Branch Current

V_{IN} = 87.55 VDC
I_{IN} = 2.675 ADC
V_{OUT} = 123.5 VRMS
I_{OUT} = 1.06 ARMS
f = 20.01 kHz

P_{IN} = 234W

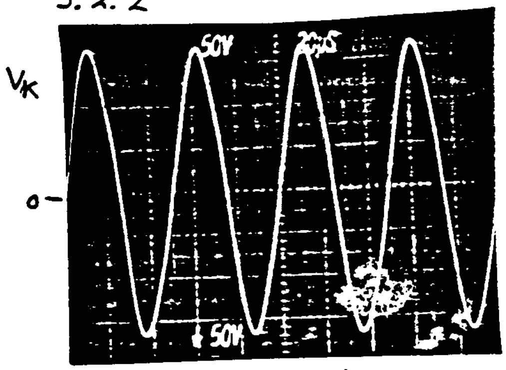
P_{OUT} = 131 W

η = 55.9%

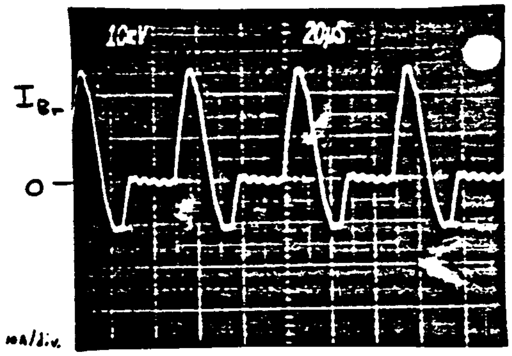
2.3.1
- 3.2.2

50% LOAD

R_{Load} = 25.4Ω
P_{OUT} = 580W



Inverter Output Voltage



Branch Current

V_{IN} = 87.27 VDC

I_{INA} = 7.510 ADC

V_{OUT} = 121.0 V RMS

I_{OUT} = 4.77 A RMS

f = 20.00 kHz

P_{IN} = 655 W

P_{OUT} = 577 W

n = 88.1 %

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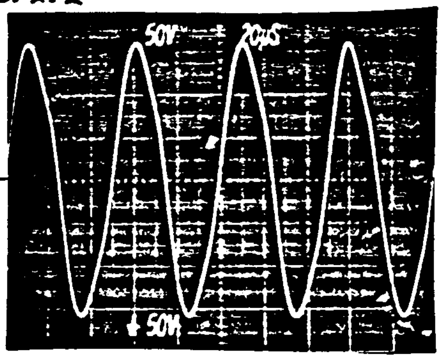
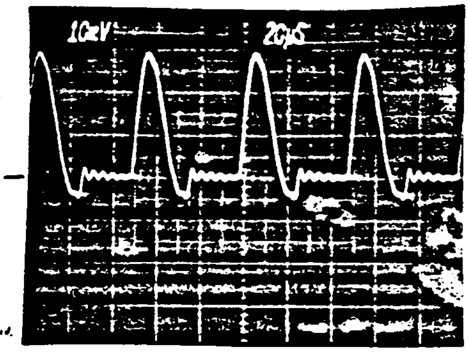
2.3.1
-3.2.2

FULL LOAD

$R_{Load} = 12.3\Omega$
$P_{OUT} = 1140$



Inverter Output Voltage

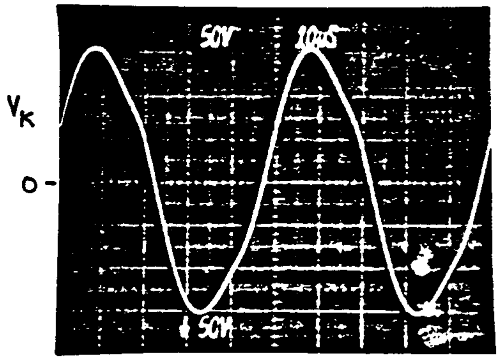


Branch Current

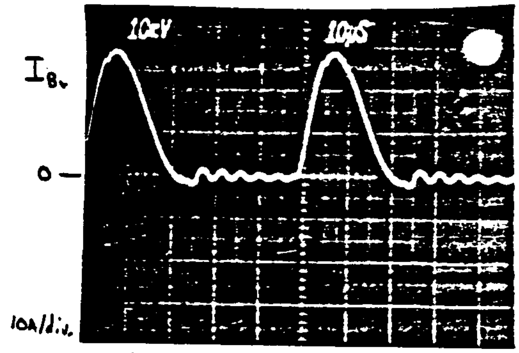
V_{IN} =	87.20	VDC		P_{IN} =	1140 W
I_{INA} =	13.12	ADC			
V_{OUT} =	116.8	VRMS			
I_{OUT} =	9.48	ARMS		P_{OUT} =	1110 W
f =	20.00	kHz		η =	96.8 %

2.3.1
-3.2.2 110% LOAD

$R_{Load} = 10.8\Omega$
$P_{OUT} = 1220$ W



Output Voltage



Branch Current

V_{IN} = 87.25 VDC

I_{IN} = 14.52 ADC

V_{OUT} = 114.6 VRMS

I_{OUT} = 10.61 ARMS

f = 20.00 kHz

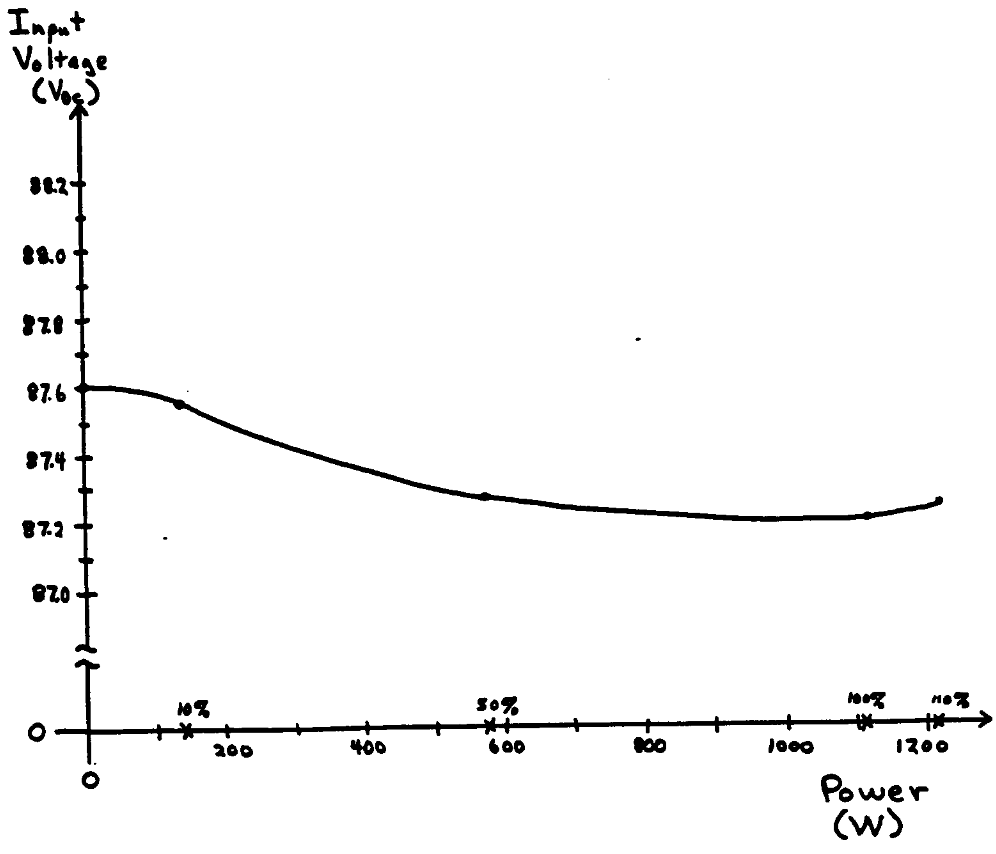
P_{IN} = 1270 W

P_{OUT} = 1216 W

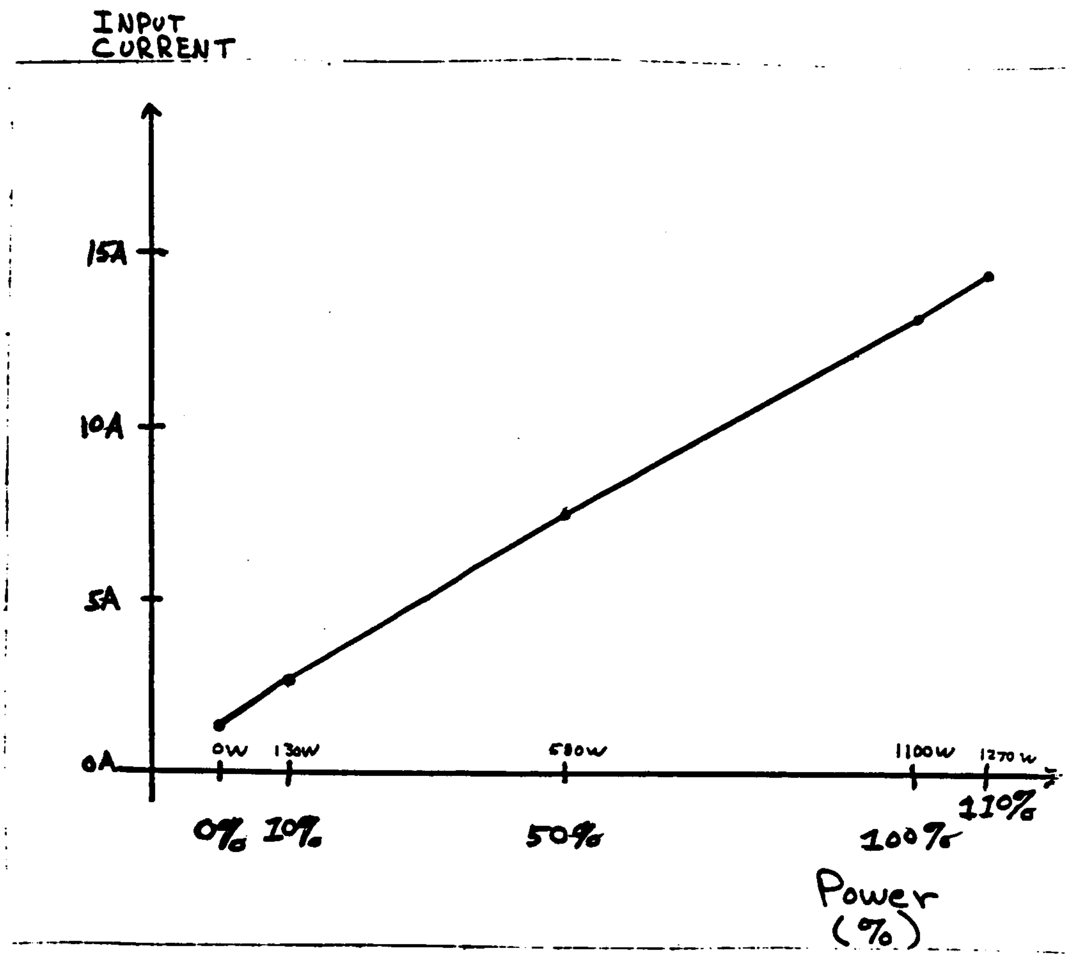
η = 96.0%

The following graphs have various system parameters plotted with respect to load power for the DRIVER-AC LOAD configuration (2.3.1).

2.3.1 INPUT VOLTAGE vs. LOAD POWER

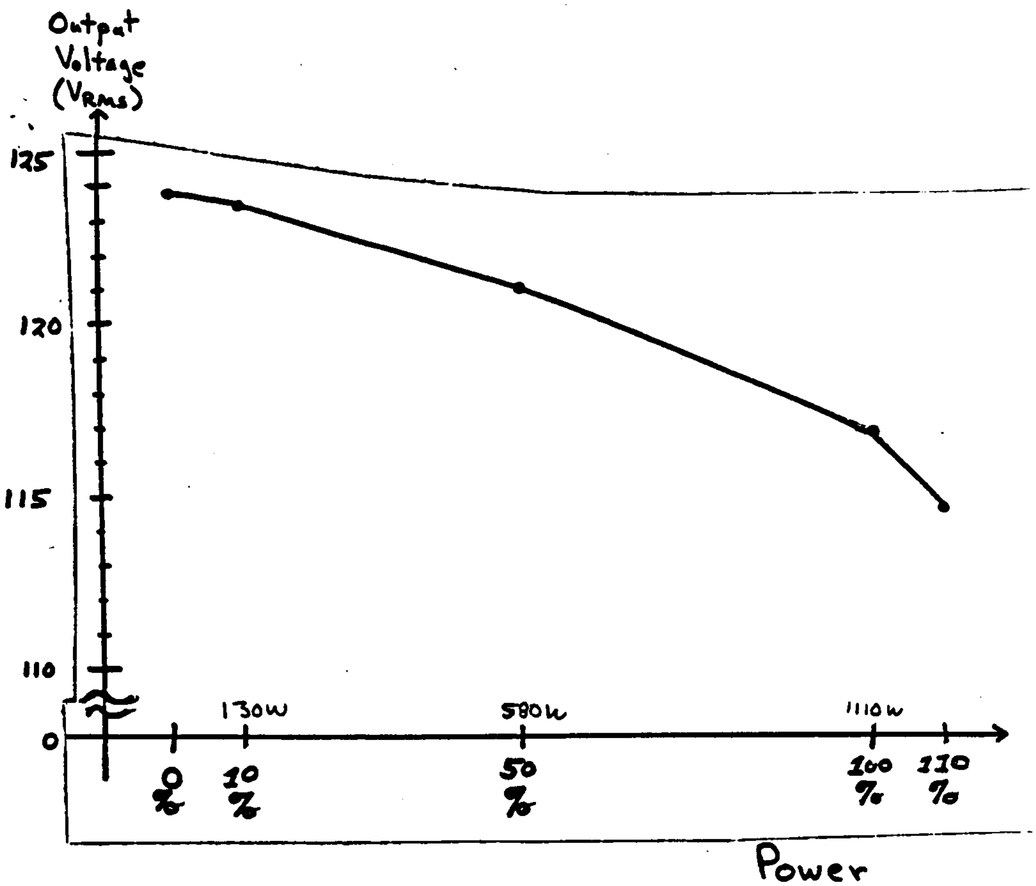


2.3.1 INPUT CURRENT vs. LOAD POWER



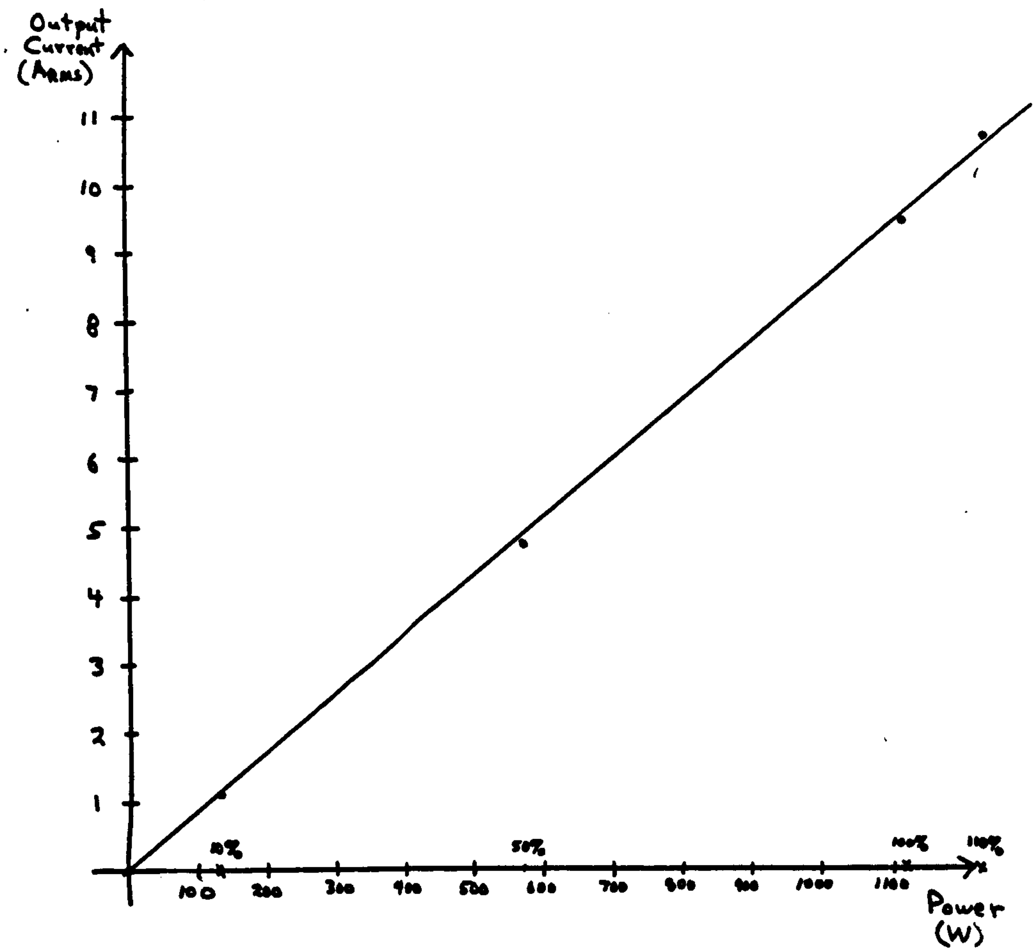
2.3.1

OUTPUT VOLTAGE vs. LOAD POWER



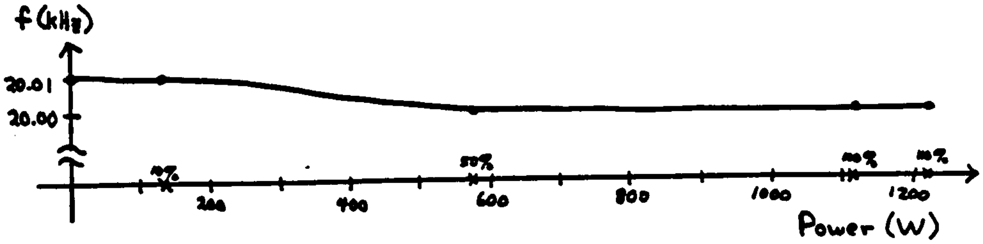
2.3.1

OUTPUT CURRENT VS. LOAD POWER

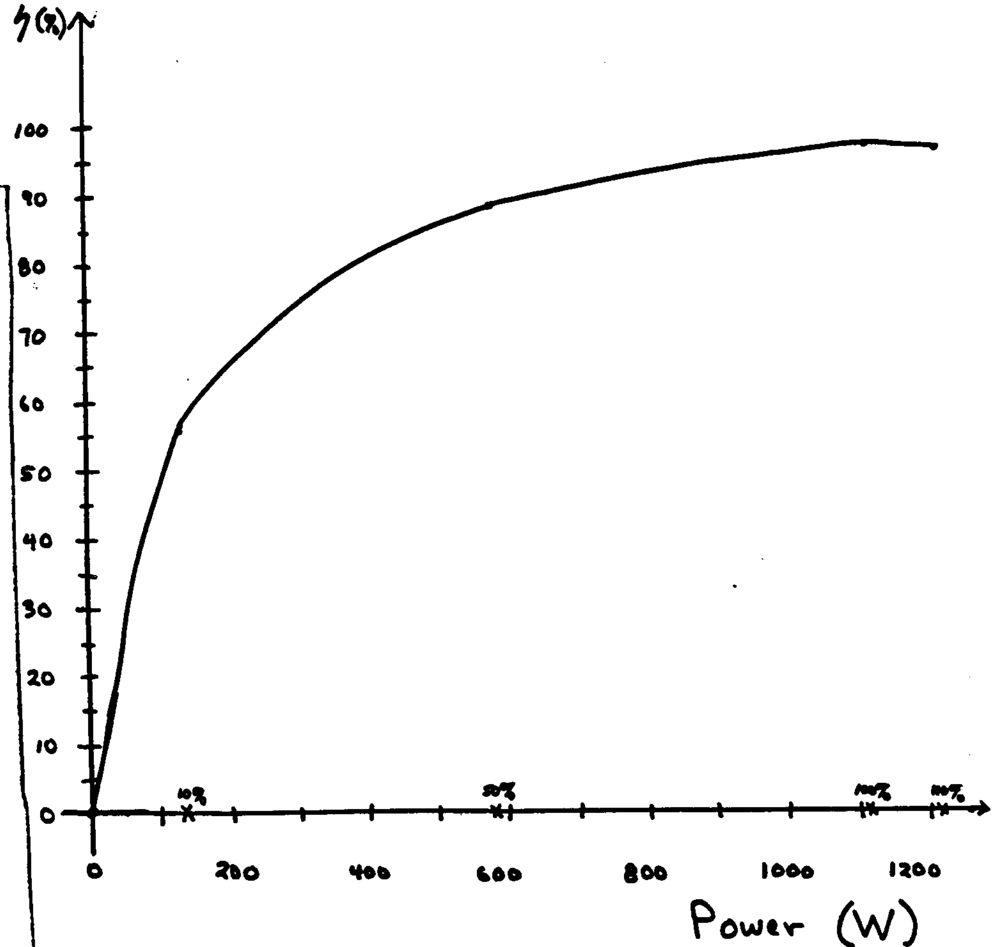


2.3.1

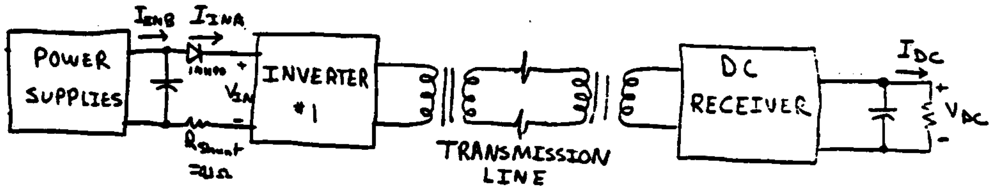
FREQUENCY vs. LOAD POWER



EFFICIENCY vs. POWER



2.3.2 -3.2.2 STEADY - STATE OPERATION

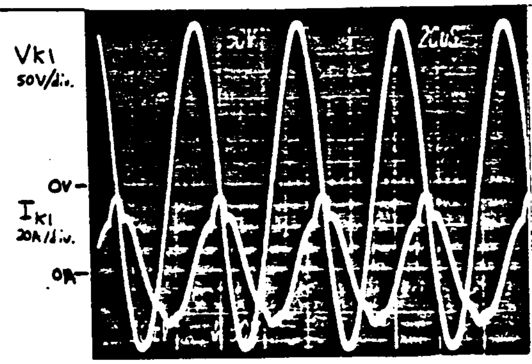


Measurement		Measurement Equipment
V_{IN}		Fluke 8000A Multimeter
I_{IN}	$= \frac{V_{Shunt}}{R_{Shunt}}$	Fluke 8000A Multimeter (V_{Shunt})
V_{OUT}		Fluke 893A Diff. Voltmeter
I_{OUT}		SRI # 900083 Current meter
f		HP 5315B Universal Counter
n		Calculation using V_{IN}, I_{IN}, V_{OUT}, I_{OUT}

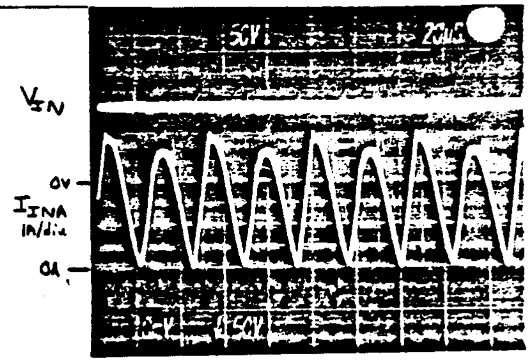
2.3.2 NO LOAD
-3.2.2

V_{IN} = 90.2 Vdc
I_{IN} = 2.25 Adc
V_{OUT} = 28.0 Vdc

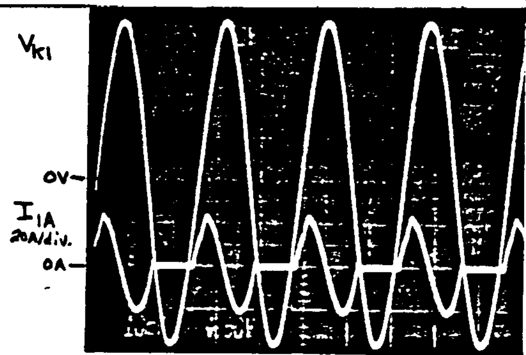
f = 20.721 kHz
n = 0%



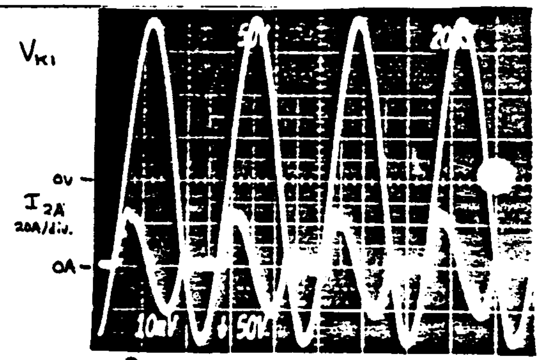
Resonant Tank Voltage
Resonant Tank Current



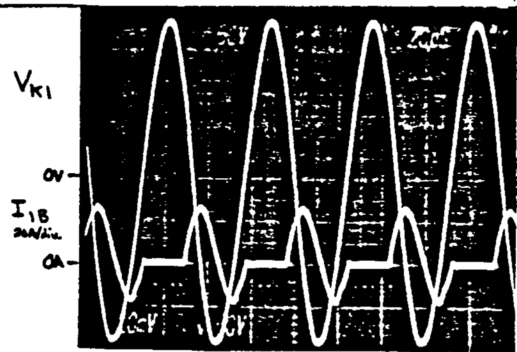
Input Voltage
Input Current
(After DC Capacitor)



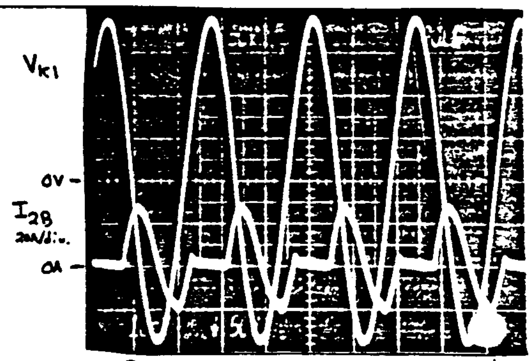
Branch Current 1A 20us/div.
Resonant Tank Voltage



Branch Current 2A
Resonant Tank Voltage



Branch Current 1B
Resonant Tank Voltage



Branch Current 2B
Resonant Tank Voltage

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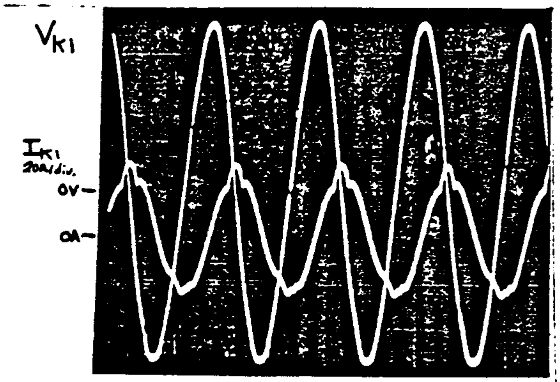
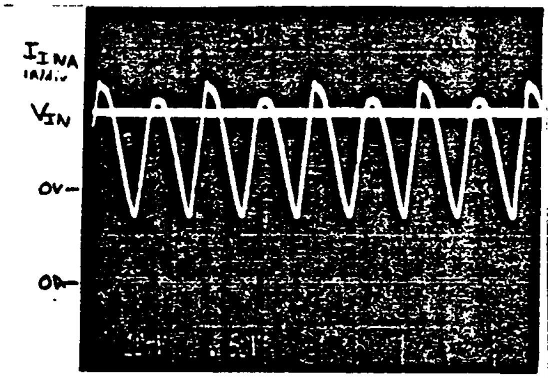
2.3.2
-3.2.2

10% LOAD

P_{out} 34 W
R_{load} 23.4 Ω

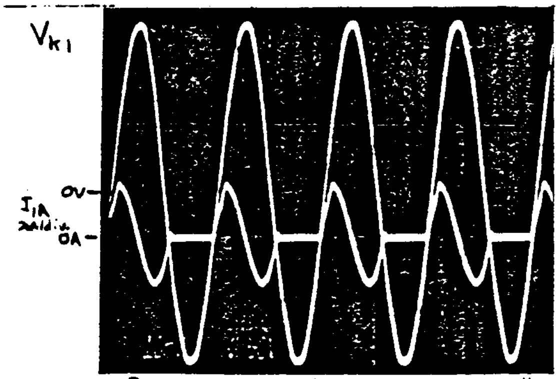


Resonant Tank Current
Resonant Tank Voltage

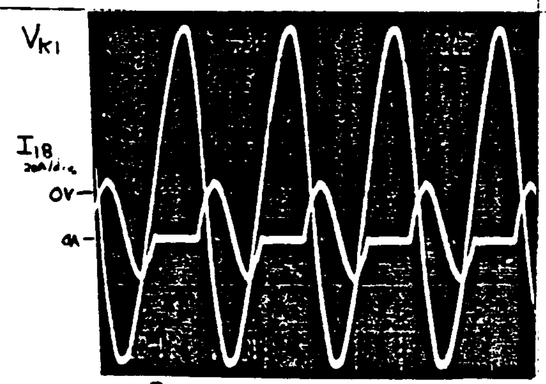


Input Voltage
Input Current
(After DC Capacitor)

V_{IN} = 90.1 V_{DC}
I_{IN} = 2.94 A_{DC}
V_{OUT} = 28.07 V_{DC}
I_{OUT} = 1.2 A_{DC}
f = 20.723 kHz
η = 12.7%



Branch Current 1A 20A/div.
Resonant Tank Voltage



Branch Current 1B
Resonant Tank Voltage

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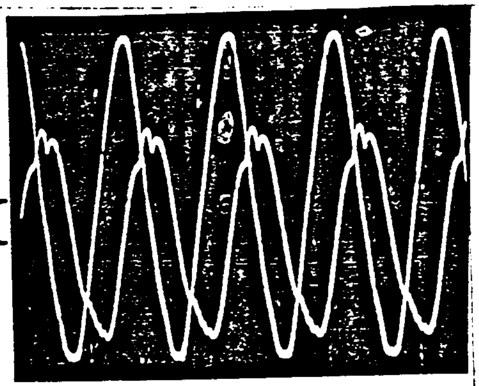
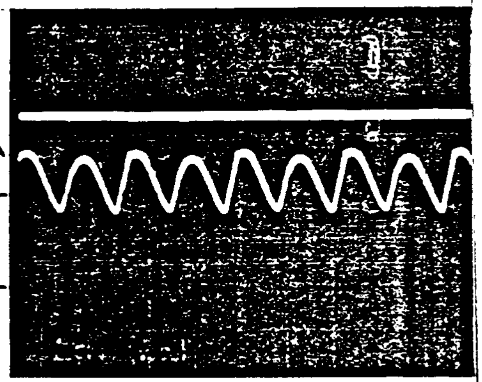
2.3.2 - 3.2.2 50% LOAD

P_{OUT} = 180 W
R_{Load} - 4.28 Ω

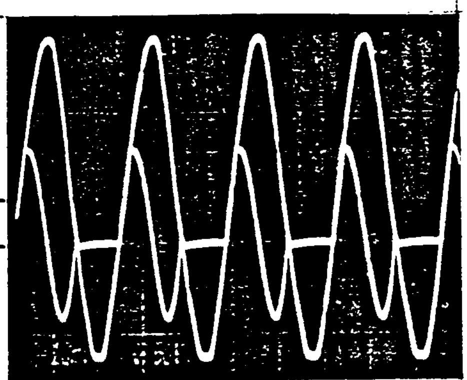


Resonant Tank Voltage
Resonant Tank Current

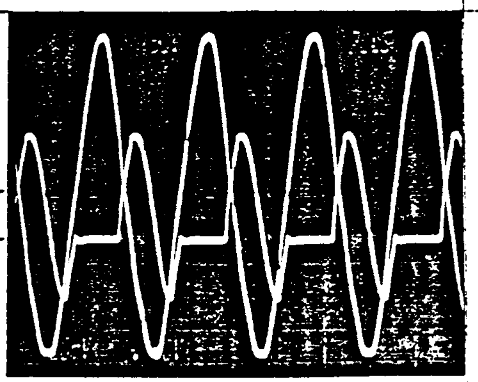


Input Voltage
Input Current
(After DC Capac...

V_{IN} - 90.0 V_{DC}
I_{IN} - 4.60 A_{DC}
V_{OUT} = 27.8 V_{DC}
I_{OUT} = 6.5 A_{DC}
f = 20.723 kHz
η = 43.6%



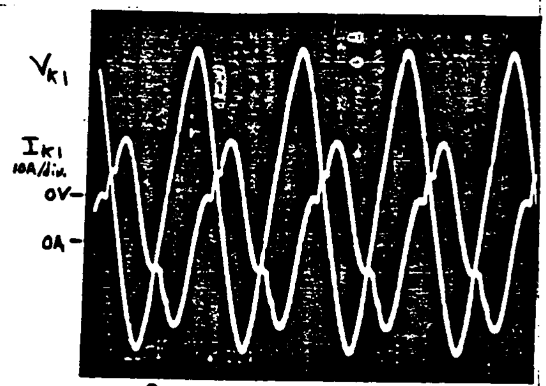
Branch Current 1A
Resonant Tank Voltage



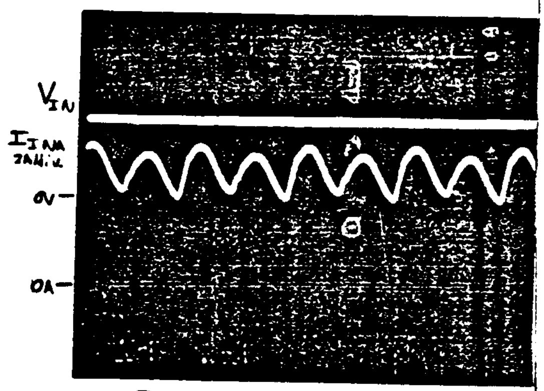
Branch Current 1B
Resonant Tank Volt...

2.3.2
-3.2.2 FULL LOAD

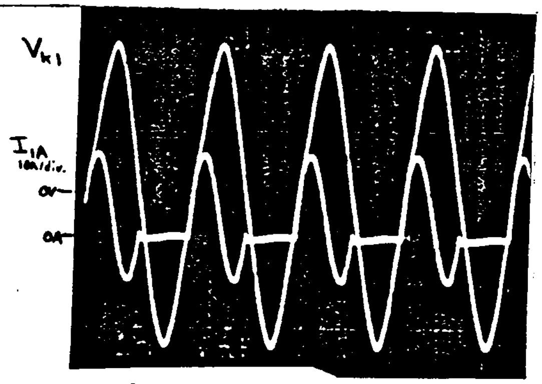
P_{OUT} = 410W
R_{Load} = 1.76Ω



Resonant Tank Voltage
Resonant Tank Current



Input Voltage
Input Current
(After DC Capacitor)



Branch Current 1A
Resonant Tank Voltage

V_{IN} = 90.0 V_{DC}

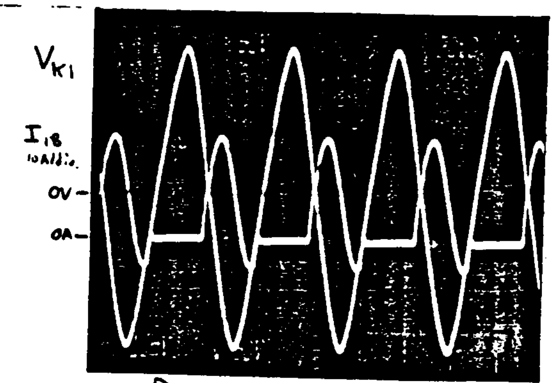
I_{IN} = 7.13 A_{DC}

V_{OUT} = 26.8 V_{DC}

I_{OUT} = 15.25 A_{DC}

f - 20.724 kHz

η - 63.7%



Branch Current 1B
Resonant Tank Voltage

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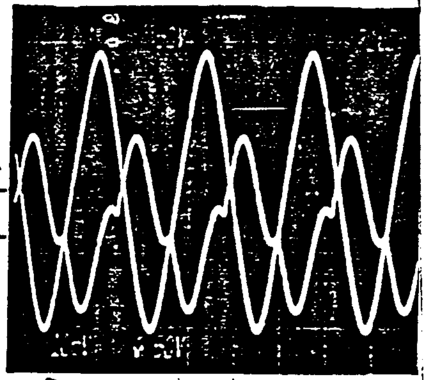
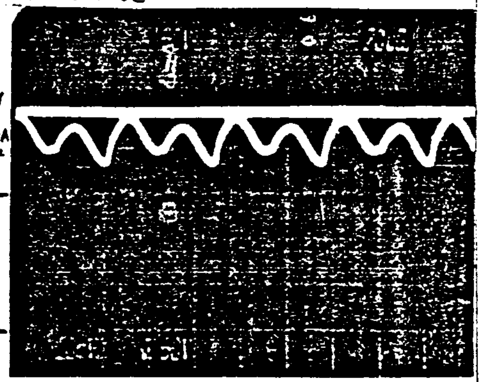
2.3.2
-3.2.2

110% LOAD

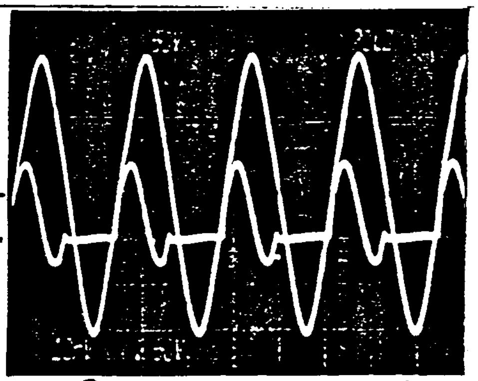
V_{IN} 40.0 V_{DC}
I_{IN} = 8.16 A_{DC}
V_{OUT} = 24.84 V_{DC}
I_{OUT} = 20.4 A_{DC}
η = 68.9%
P_{OUT} = 510 W
R_{Load} = 1.22 Ω



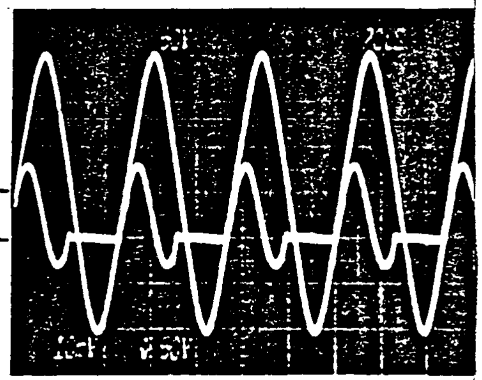
Resonant Tank Voltage
Resonant Tank Current



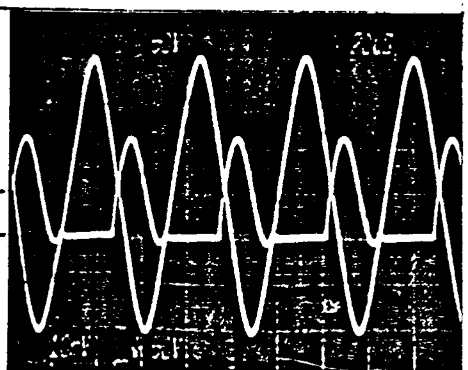
Input Voltage
Input Current
(After DC Capacitor)



Branch Current 1A
Resonant Tank Voltage



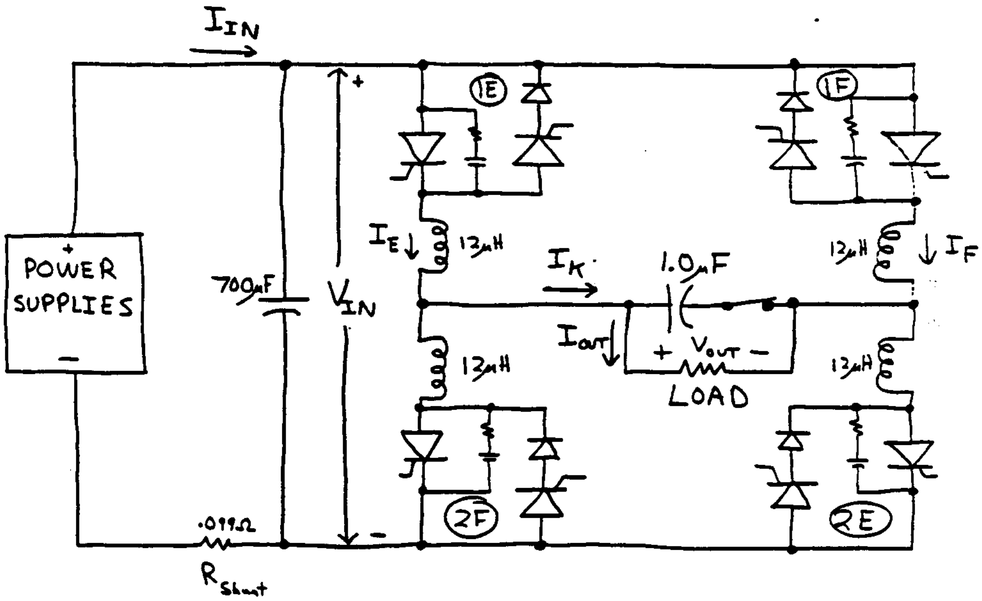
Branch Current 2A
Resonant Tank Voltage



Branch Current 1B
Resonant Tank Voltag

Branch Current 2B
Resonant Tank Voltage

2.3.3 BIDIRECTIONAL MODULE (DRIVER MODE)



SCRs 2N3658
Diodes A139M
Snubbers 31Ω, .02µF

Due to the similarity in operation between the Bidirectional Module in the driver mode and the inverter tested in 2.3.1, only the Steady-State Operation testing was performed in Configuration 2.3.3 to verify the operation of the Bidirectional Module as a driver.

2.3.3 -3.2.2 STEADY-STATE OPERATION

Measurements	Measurement Equipment
V_{IN}	Fluke 8000A Multimeter
$I_{IN} = \frac{V_{shunt}}{R_{shunt}}$	Fluke 8000A Multimeter (V_{shunt})
V_{OUT}	Tektronix 7834 Oscilloscope
I_{OUT}	Tektronix P6303 Current Probe & 7834 Oscilloscope
f	HP 5315B Universal Counter
P_{IN}, P_{OUT}, η	Calculations from $V_{IN}, I_{IN}, V_{OUT}, I_{OUT}$

Photographs	
V_{OUT}	Tektronix 7834 Oscilloscope & C-27 Camera
I_K, I_E, I_F	Tektronix: 7834 Oscilloscope, P6303 Current Probe, C-27 Camera

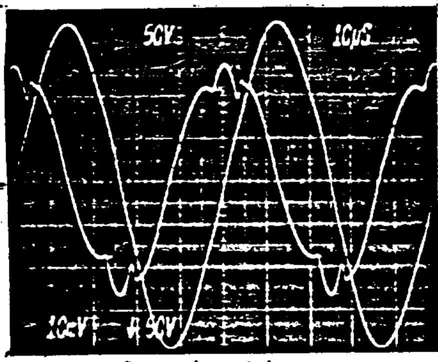
NO LOAD $P_{OUT} = 0$

$V_{IN} = 93.0\,V_{DC}$ $V_{OUT} = 136\,V_{RMS}$ $f = 20.0\,KHz$
$I_{IN} = 1.34\,A_{DC}$ $I_{OUT} = 0A$ $\eta = 0\%$
$P_{IN} = 125\,W$ $P_{OUT} = 0A$

I_K mA/div.

%

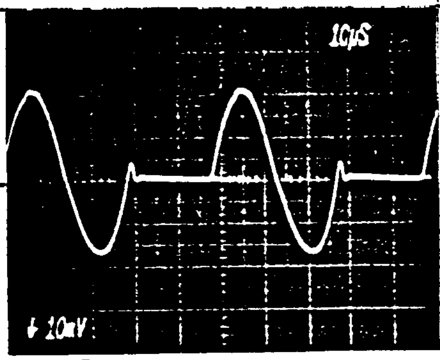
V_K



Output Voltage
Resonant Tank Current

I_E mA/div.

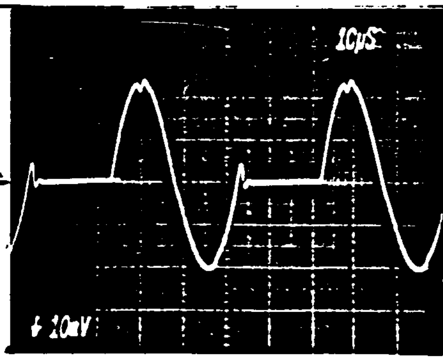
0A



Branch Current E

I_F mA/div.

0A



Branch Current F

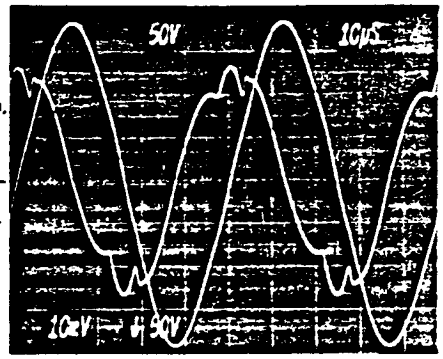
10% LOAD $P_{OUT} = 123\,W$

$V_{IN} = 92.8\,V_{DC}$ $V_{OUT} = 134\,V_{RMS}$ $f = 20.0\,KHz$
$I_{IN} = 2.49\,A_{DC}$ $I_{OUT} = .92\,A_{RMS}$ $\eta = 53.4\%$
$P_{IN} = 231\,W$ $P_{OUT} = 123\,W$

I_K mA/div.

%

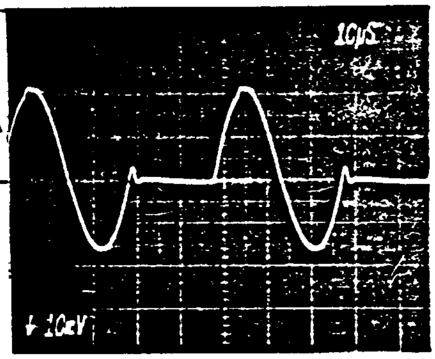
V_{OUT}



Output Voltage
Resonant Tank Current

I_E mA/div.

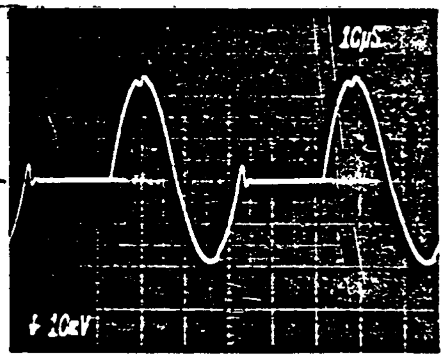
0A



Branch Current E

I_F mA/div.

0A



Branch Current F

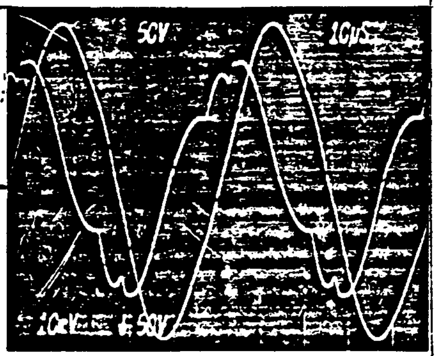
50% LOAD		P_{OUT} = 583 W
V_{IN} = 91.9 V_{DC}	V_{OUT} = 131 V_{RMS}	f = 20.0 kHz
I_{IN} = 7.01 A_{DC}	I_{OUT} = 4.45 A_{RMS}	η = 90.5%
P_{IN} = 644 W	P_{OUT} = 583 W	

FULL LOAD		P_{OUT} = 1130 W
V_{IN} = 90.7 V_{DC}	V_{OUT} = 119 V_{RMS}	f = 20.0 kHz
I_{IN} = 12.84 A_{DC}	I_{OUT} = 9.49 A_{RMS}	η = 96.9%
P_{IN} = 1165	P_{OUT} = 1130	

I_K mA/div

0/0

V_K

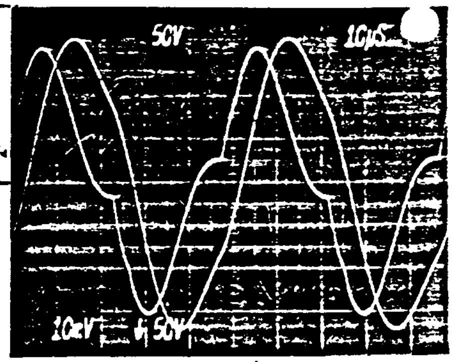


Output Voltage
Resonant Tank Current

I_K mA/div

0/0

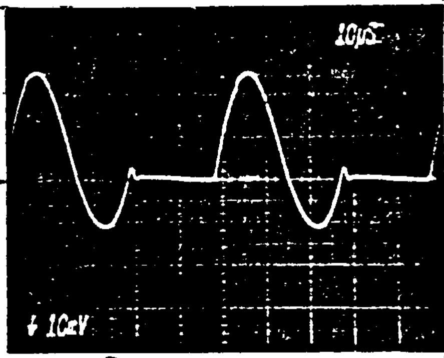
V_K



Output Voltage
Resonant Tank Current

I_E 10A/div

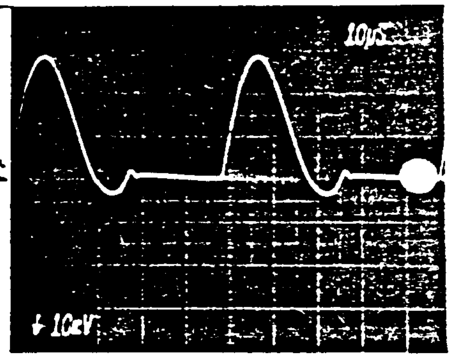
0A



Branch Current E

I_E mA/div

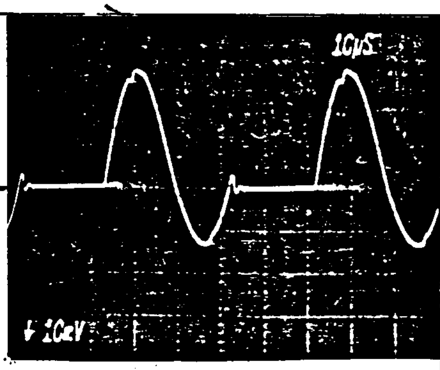
0A



Branch Current E

0A

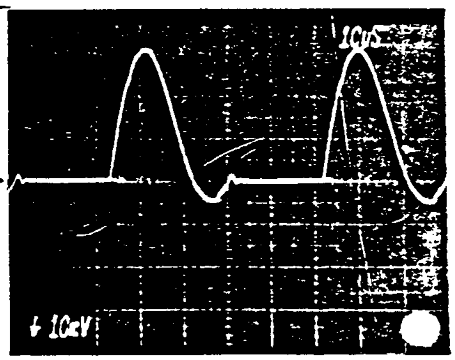
I_F mA/div



Branch Current F

I_F mA/div

0A



Branch Current F

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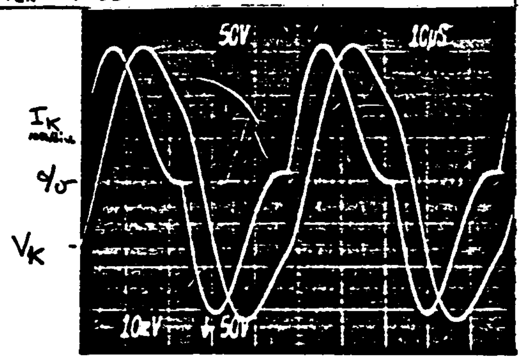
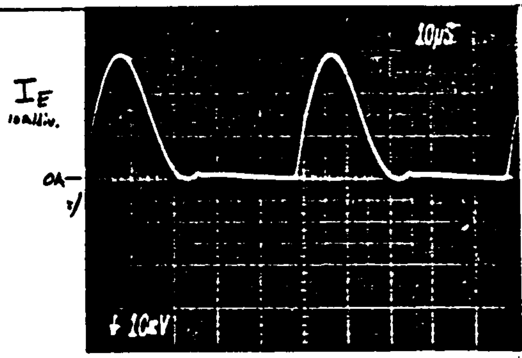
110% LOAD P_{OUT} = 1290W

V_{IN} = 90.3V_{DC}	V_{OUT} = 114V_{RMS}	f = 20.0KHz
I_{IN} = 14.74A_{DC}	I_{OUT} = 11.3A_{RMS}	η = 96.8%
P_{IN} = 1330	P_{OUT} = 1290W	

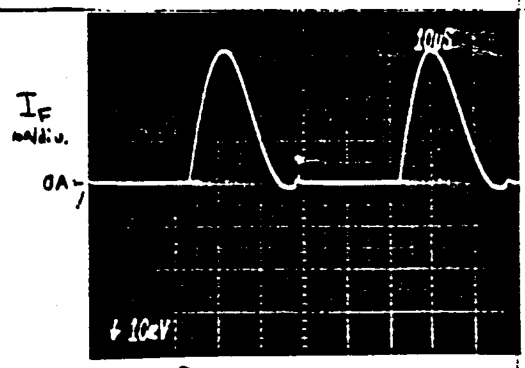
2.33
-3.2.2



Output Voltage
Resonant Tank Current



Branch Current E



Branch Current F

2.3.4 -3.2.2 STEADY-STATE OPERATION

Steady-state system characteristics were recorded for a combination of eight loads on the three receivers.

Measurement		Measurement Equipment
V_{IN}		Fluke 8000A Multimeter
I_{IN}	$= \frac{V_{Shunt}}{R_{Shunt}}$	Fluke 8000A Multimeter
V_{DC}'		Fluke 893A Diff. Voltmeter
I_{DC}		SRI #900083 Current Meter
V_{BD}		Triplett 630 Multimeter
I_{BD}	$= \frac{V_{BD}}{R_{Load}}$	L&N 5305 Impedance Bridge (R_{Load})
V_{AC}		Tektronix 7834 Oscilloscope
I_{AC}		Tektronix 7834 Oscilloscope P6303 Current Probe
f		HP 5315B Universal Counter
$P_{OAC}, P_{OBD}, P_{ODC}, \eta$		Calculations using $V_{IN}, I_{IN}, V_{AC}, I_{AC}, V_{DC}, I_{DC}, V_{BD}, I_{BD}$

Photographs

All voltage photos	Tektronix: 7834 Oscilloscope C-27 Camera
All current photos	Tektronix: 7834 Oscilloscope P6303 Current Probe C-27 Camera

2.3.4
-3.2.2

The eight load combinations to be tested in Section 3.2.2 are listed:

Load Configuration	P_{IN}	P_{DC}	P_{BD}	P_{AC}	P_{OUT}	Eff.
a	796	200	210	0	410	51.7%
b	1020	423	205	0	628	61.6%
c	1024	202	210	190	613	60.0%
d	1210	418	205	171	794	65.7%
e	1000	200	413	0	613	61.3%
f	1210	418	413	0	831	68.6%
g	1200	200	405	170	780	64.8%
h	1370	403	405	140	950	69.5%

P_{IN} - Total System Input Power
P_{DC} - DC Receiver Output Power
P_{BD} - Bidirectional Module Output Power
P_{AC} - AC Receiver Output Power
P_{OUT} - Total System Output Power

All in Watts

2.3.4
-3.2.2 (a.)

25% DC LOAD, NO AC LOAD, 25% BD LOA(

$V_{IN} = 91.7\,V_{DC}$	$P_{IN} = 796\,W$
$I_{IN} = 8.68\,A_{DC}$	
$V_{DC} = 28.893\,V_{DC}$	$P_{DC} = 200W$
$I_{DC} = 7.0\,A_{DC}$	$R_{LOAD_{DC}} = 4.13\Omega$
$V_{BD} = 102\,V_{DC}$	$P_{BD} = 210W$
$I_{BD} = 2.05\,A_{DC}$	$R_{LOAD_{BD}} = 49.8$
$V_{AC} = 0\,V_{RMS}$	$P_{AC} = 0$
$I_{AC} = 0\,A_{RMS}$	$R_{LOAD_{AC}} = \infty$
$f = 20.44\,kHz$	$P_{OUT} = 410W$
	$\eta = 51.7\%$

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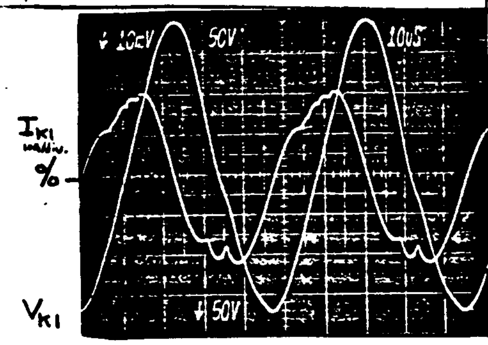
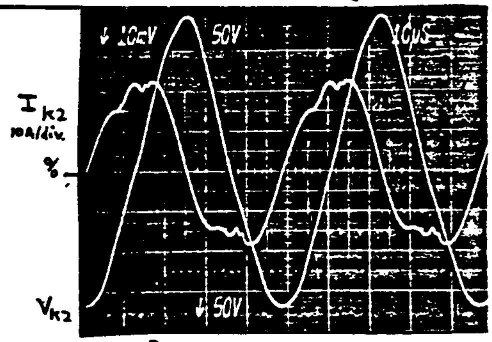
2.3.4
-3.2.2 (a.)

INVERTER #1

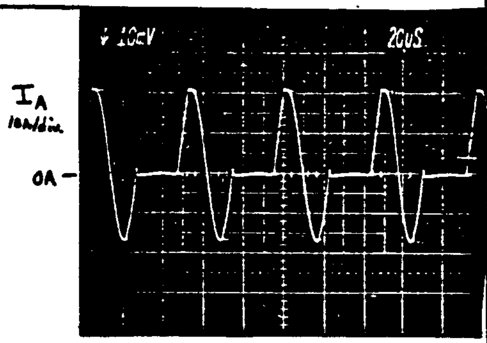


Resonant Tank Voltage
Resonant Tank Current

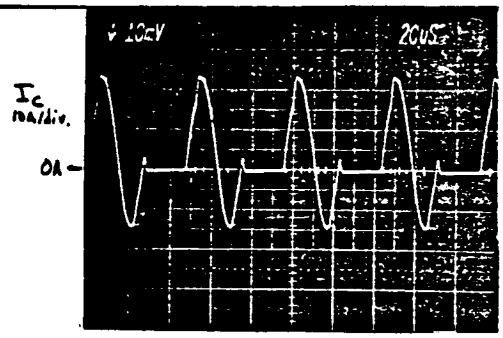
INVERTER #2



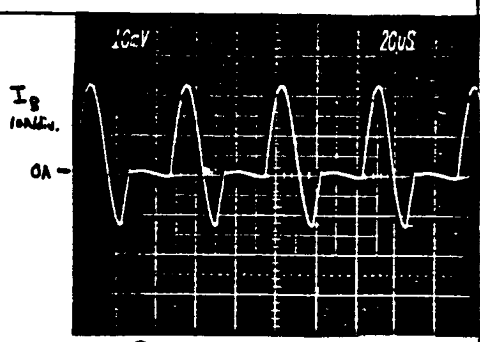
Resonant Tank Voltage
Resonant Tank Current



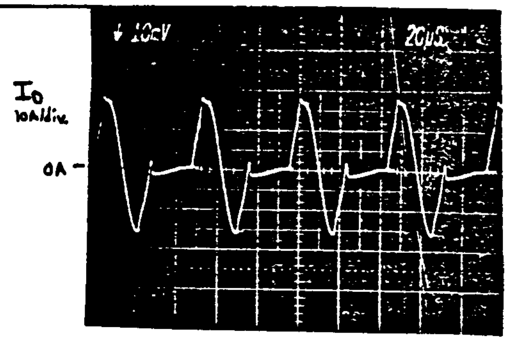
Branch Current A



Branch Current C



Branch Current B



Branch Current D

2.3.4
-3.2.4 (b.)

50% DC LOAD, NO AC LOAD, 25% BD LOAD

	$V_{IN} = 91.2 V_{DC}$	
	$I_{IN} = 11.17 A_{DC}$	$P_{IN} = 1020 W$
$R_{LOAD_{DC}} = 1.96 \Omega$	$V_{ODC} = 28.744 V_{DC}$	$P_{ODC} = 423 W$
	$I_{ODC} = 14.7 A_{DC}$	
$R_{LOAD_{BD}} = 49.8 \Omega$	$V_{BD} = 101 V_{DC}$	$P_{OBD} = 205 W$
	$I_{BD} = 2.03 A_{DC}$	
$R_{LOAD_{AC}} = \infty$	$V_{OAC} = 0 V$	$P_{OAC} = 0 W$
	$I_{OAC} = 0 A$	
	$f = 20.44 kHz$	$P_{OUT} = 628 W$
		$\eta = 61.6 \%$

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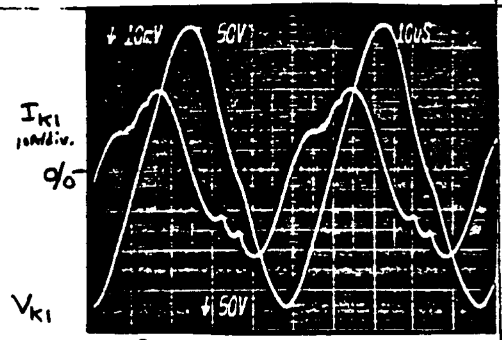
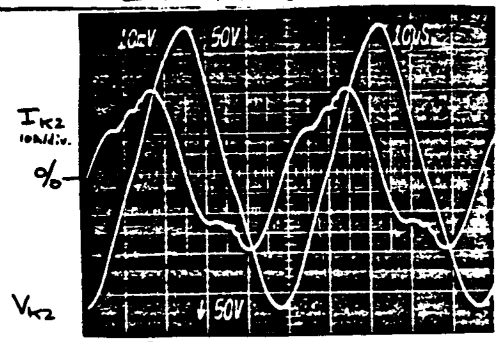
2.3.4
-3.2.2 b.

INVERTER #1

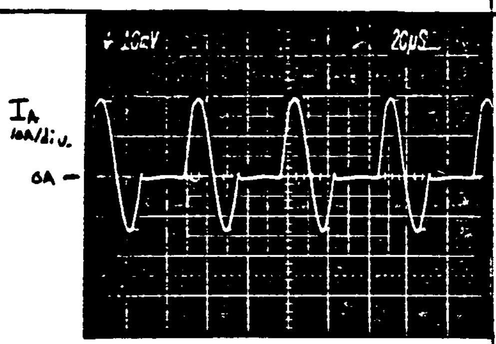


Resonant Tank Voltage
Resonant Tank Current

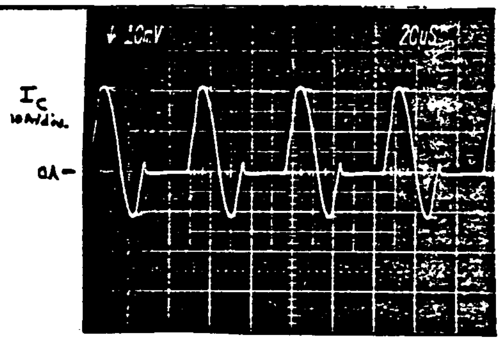
INVERTER #2



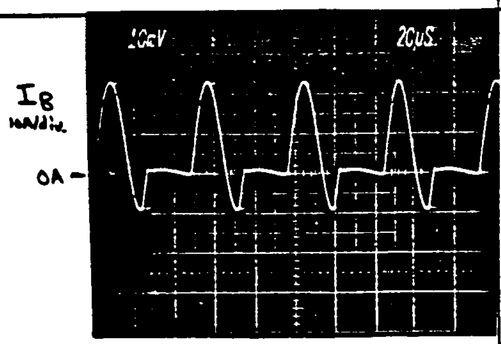
Resonant Tank Voltage
Resonant Tank Current



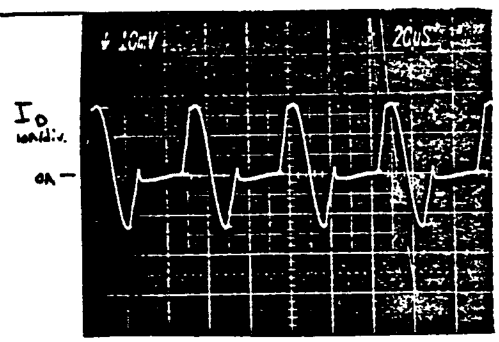
Branch Current A



Branch Current C



Branch Current B



Branch Current D

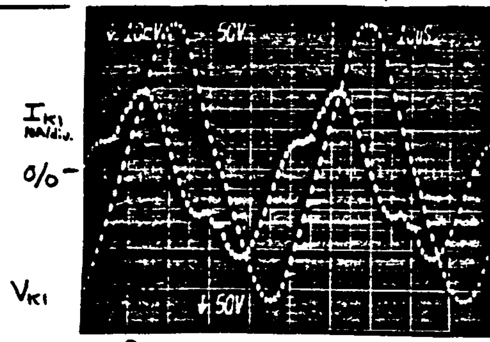
2.3.4
-3.2.2 (C.)

25% DC LOAD, 50% AC LOAD, 25% BD LOAD

	$V_{IN} = 91.15\ V_{DC}$	
	$I_{IN} = 11.23\ A_{DC}$	$P_{IN} = 1024\ W$
$R_{LOAD_{DC}} = 4.13\Omega$	$V_{ODC} = 28.876\ V_{DC}$	
	$I_{ODC} = 7.0\ A_{DC}$	$P_{ODC} = 202\ W$
$R_{LOAD_{BD}} = 49.8\Omega$	$V_{OBD} = 102\ V_{DC}$	
	$I_{OBD} = 2.05\ A_{DC}$	$P_{OBD} = 210\ W$
$R_{LOAD_{AC}} = 35.3\Omega$	$V_{OAC} = 82\ V_{RMS}$	
	$I_{OAC} = 2.32\ A_{RMS}$	$P_{OAC} = 190\ W$
	$f = 20.44\ kHz$	$P_{OUT} = 613\ W$
		$\eta = 60.0\%$

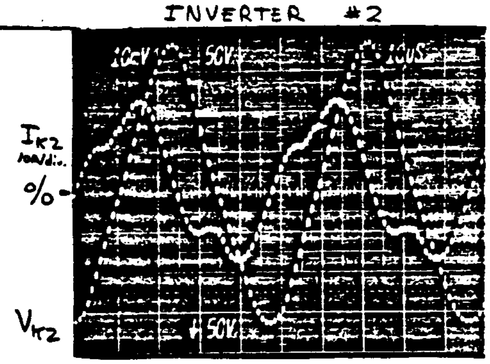
2.3.4
-3.2.2 C.

INVERTER #1

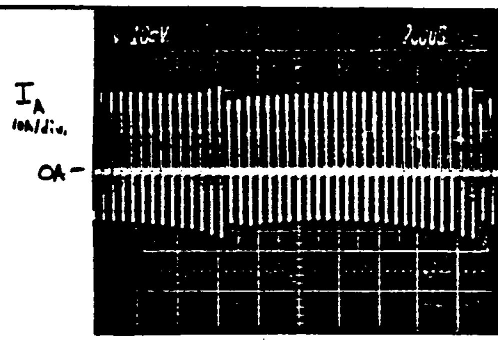


Resonant Tank Voltage
Resonant Tank Current

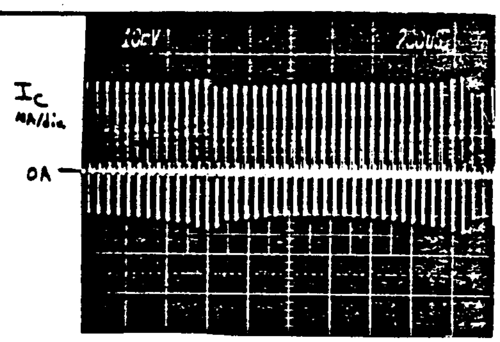
INVERTER #2



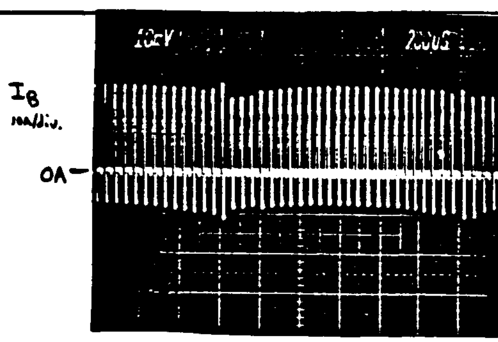
Resonant Tank Voltage
Resonant Tank Current



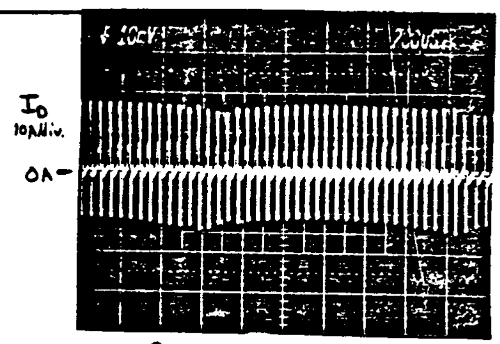
Branch Current A



Branch Current C



Branch Current B



Branch Current D

2.3.4
-3.2.2 d.

50% DC LOAD, 50% AC LOAD, 25% BD LOAD

	$V_{IN} = 90.7\ V_{DC}$ $I_{IN} = 13.34\ A_{DC}$	$P_{IN} = 1210\ W$
$R_{LOAD_{DC}} = 1.94\ \Omega$	$V_{ODC} = 28.657\ V_{DC}$ $I_{ODC} = 14.6\ A_{DC}$	$P_{ODC} = 418\ W$
$R_{LOAD_{BD}} = 49.8\ \Omega$	$V_{OBD} = 101\ V_{DC}$ $I_{OBD} = 2.03\ A_{DC}$	$P_{OBD} = 205\ W$
$R_{LOAD_{AC}} = 35.3$	$V_{OAC} = 77.8\ V_{RMS}$ $I_{OAC} = 2.2\ A_{RMS}$	$P_{OAC} = 171\ W$
	$f = 20.44\ kHz$	$P_{OUT} = 794\ W$
		$\eta = 65.7\%$

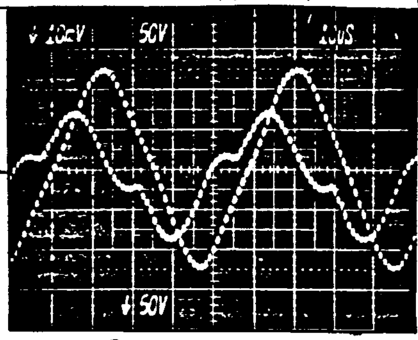
2.3.4
-3.2.2 d.

INVERTER #1

I_{K1} 10A/div.

0/0

V_{K1}



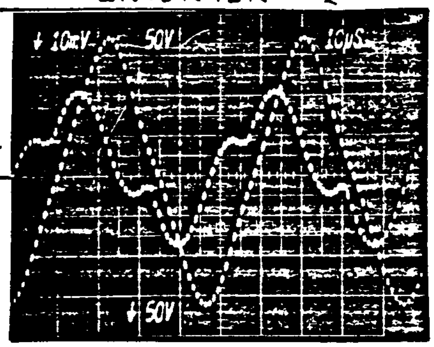
Resonant Tank Voltage
Resonant Tank Current

INVERTER #2

I_{K2} 10A/div.

0/0

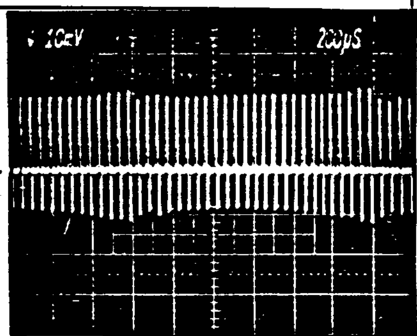
V_{K2}



Resonant Tank Voltage
Resonant Tank Current

I_A 10A/div.

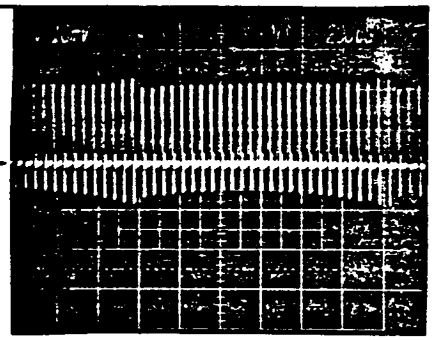
0A



Branch Current A

I_C 10A/div.

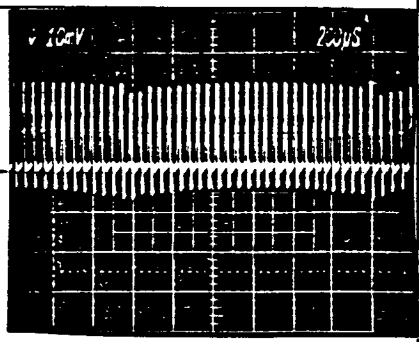
0A



Branch Current C

I_B 10A/div.

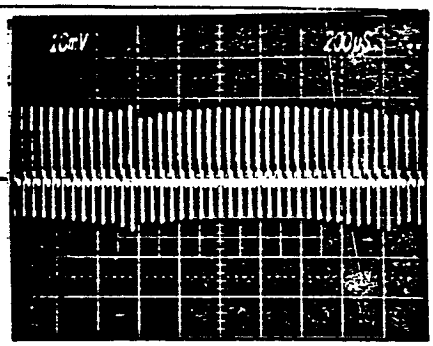
0A



Branch Current B

I_D 10A/div.

0A



Branch Current D

2.3.4
- 3.2.2 e.

25% DC LOAD, NO AC LOAD, 50% BD LOAD

	$V_{IN} = 91.2 V_{DC}$	$P_{IN} = 1000 W$
	$I_{IN} = 10.99 A_{DC}$	
	$V_{ODC} = 28.826 V_{DC}$	
$R_{LOAD_{DC}} = 4.13\Omega$	$I_{ODC} = 7.0 A_{DC}$	$P_{ODC} = 200 W$
	$V_{OBD} = 101 V_{DC}$	
$R_{LOAD_{BD}} = 24.7\Omega$	$I_{OBD} = 4.09 A_{DC}$	$P_{OBD} = 413 W$
$R_{LOAD_{AC}} = \infty$	$V_{OAC} = 0 V$	
	$I_{OAC} = 0 A$	$P_{OAC} = 0 W$
	$f = 20.44 kHz$	$P_{OUT} = 613 W$
		$\eta = 61.4\%$

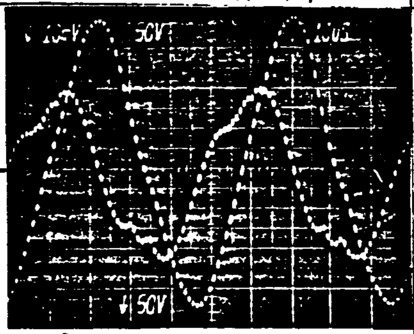
2.3.4
-3.2.2 (e.)

INVERTER #1

I_{K1} 10A/div

0/0

V_{K1}



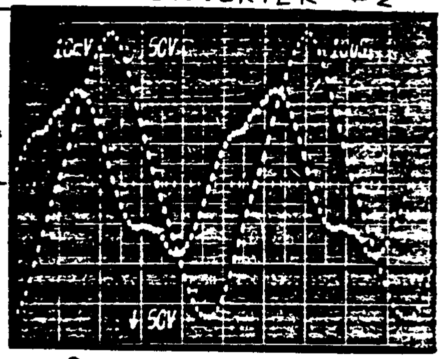
Resonant Tank Voltage
Resonant Tank Current

INVERTER #2

I_{K2} 10A/div

%

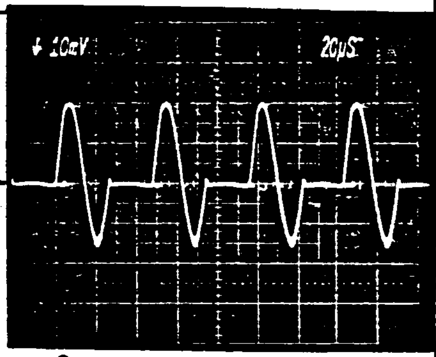
V_{K2}



Resonant Tank Voltage
Resonant Tank Current

I_A 10A/div

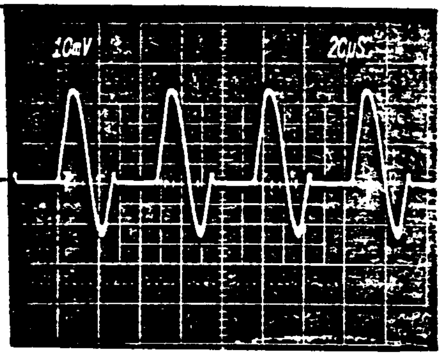
0A



Branch Current A

I_C 10A/div

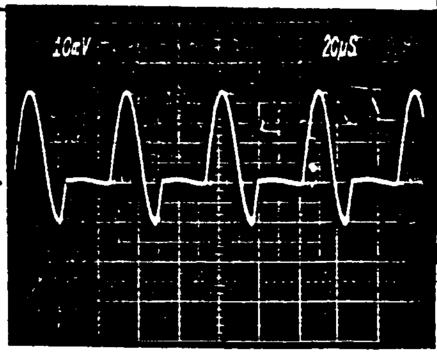
0A



Branch Current C

I_B 10A/div.

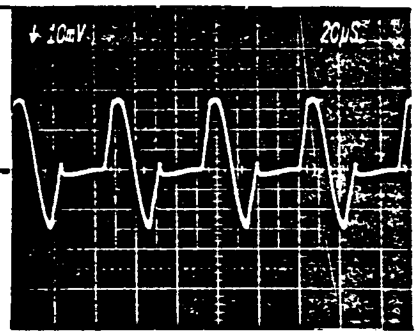
0A



Branch Current B

I_D 10A/div.

0A



Branch Current D

2.3.4
-3.2.2 f.

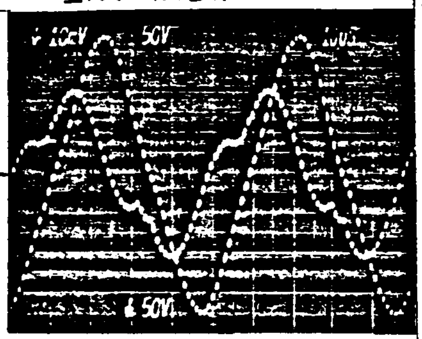
50% DC LOAD, NO AC LOAD, 50% BD LOAD

	$V_{IN} = 90.3 V_{DC}$	$P_{IN} = 1,210 W$
	$I_{IN} = 13.43 A_{DC}$	
$R_{LOAD_{DC}} = 1.96 \Omega$	$V_{ODC} = 28.652 V_{DC}$	$P_{ODC} = 418 W$
	$I_{ODC} = 14.6 A_{DC}$	
$R_{LOAD_{BD}} = 24.7 \Omega$	$V_{OBD} = 101 V_{DC}$	$P_{OBD} = 413 W$
	$I_{OBD} = 4.09 A_{DC}$	
$R_{LOAD_{AC}} = \infty$	$V_{OAC} = 0V$	$P_{OAC} = 0 W$
	$I_{OAC} = 0A$	
	$f = 20.44 kHz$	$P_{OUT} = 831 W$
		$\eta = 68.6\%$

2.3.4
-3.2.2 (f.)

INVERTER #1

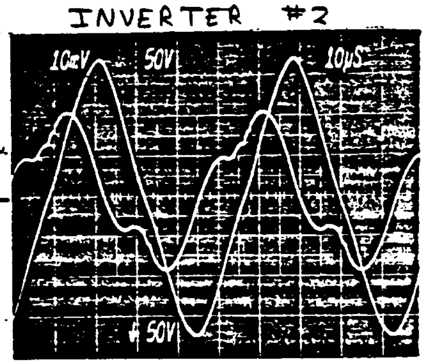
I_{K1} 10A/div.
0/0
V_{K1}



Resonant Tank Voltage
Resonant Tank Current

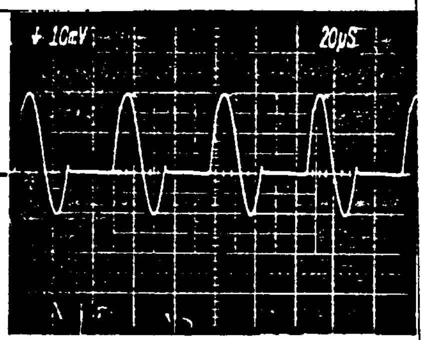
INVERTER #2

I_{K2} 10A/div.
0/0
V_{K2}



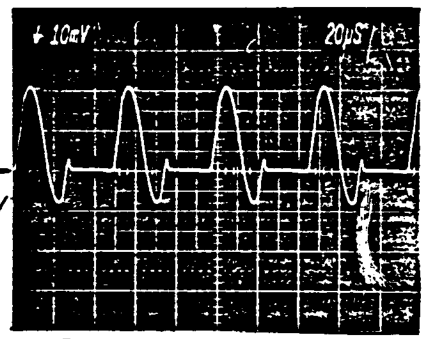
Resonant Tank Voltage
Resonant Tank Current

I_A
10A/



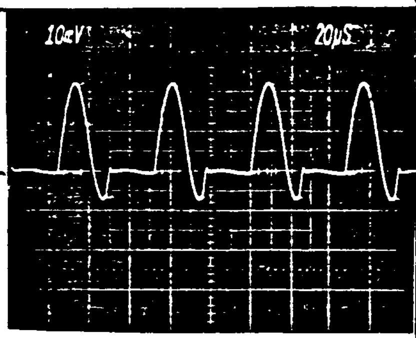
Branch Current A

I_C
10A/



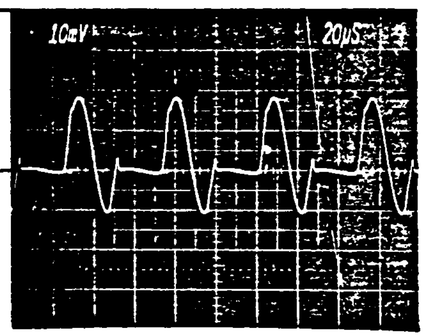
Branch Current C

I_B
10A/



Branch Current B

I_D
10A/div.



Branch Current D

2.3.4
-3.2.2

9.

25% DC LOAD, 50% AC LOAD, 50% BD LOAD

	$V_{IN} =$ 90.7 V_{DC}		
	$I_{IN} =$ 13.23 A_{DC}		$P_{IN} =$ 1200 W
$R_{LOAD_{DC}} =$ 4.13 Ω	$V_{ODC} =$ 28.876 V_{DC}		$P_{ODC} =$ 200 W
	$I_{ODC} =$ 7.0 A_{DC}		
$R_{LOAD_{BD}} =$ 24.7 Ω	$V_{OBD} =$ 100 V_{DC}		$P_{OBD} =$ 405 W
	$I_{OBD} =$ 4.05 A_{DC}		
$R_{LOAD_{AC}} =$ 35.3 Ω	$V_{OAC} =$ 77.8 V_{RMS}		$P_{OAC} =$ 170 W
	$I_{OAC} =$ 2.2 A_{RMS}		
	f = 20.44 kHz		$P_{OUT} =$ 780 W
			$\eta =$ 64.8%

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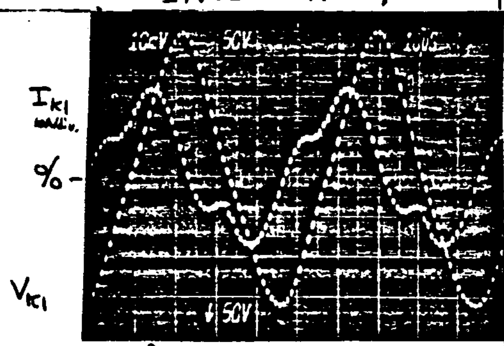
2.3.4
-3.22

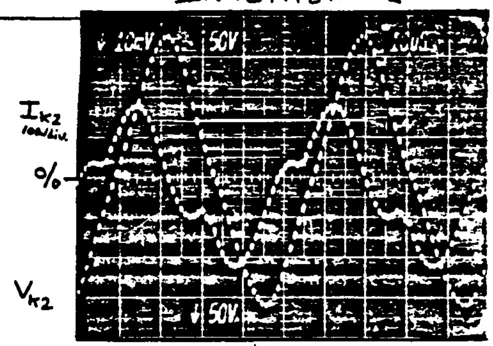
9.

INVERTER #1

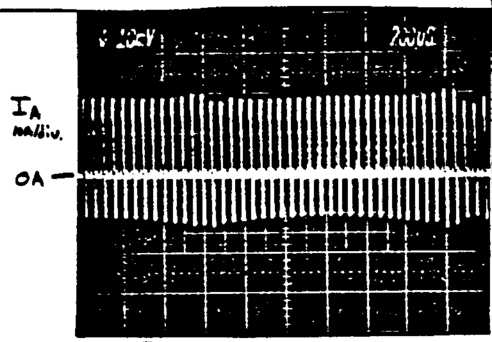
INVERTER #2



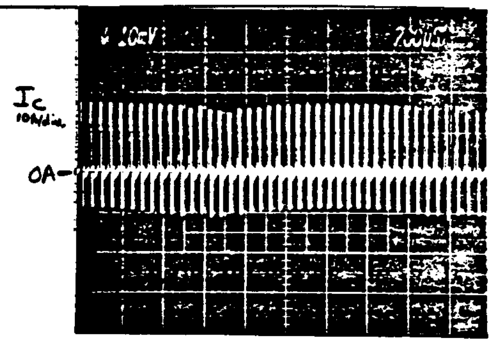
Resonant Tank Voltage
Resonant Tank Current



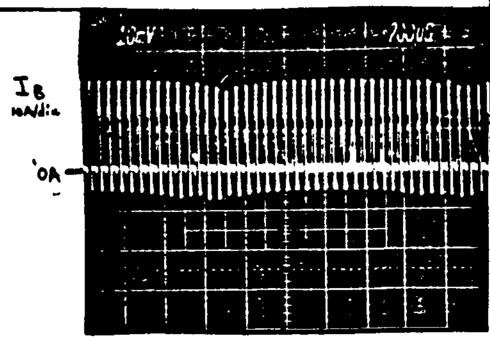
Resonant Tank Voltage
Resonant Tank Current



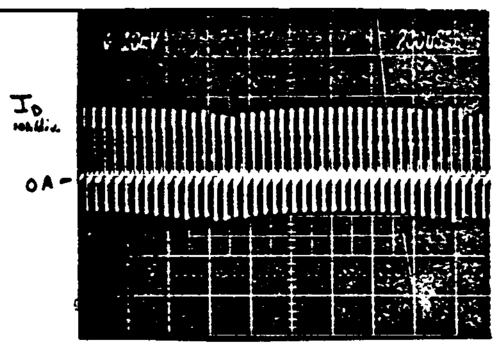
Branch Current A



Branch Current C



Branch Current B



Branch Current D

2.3.4
-3.2.2 h.

50% DC LOAD, 50% AC LOAD, 50% BD LOAD

		V_{IN} = 90.3 V_{DC} I_{IN} = 15.13 A_{DC}	P_{IN} = 1370 W
$R_{LOAD_{DC}}$ =	1.94 Ω	V_{ODC} = 28.0 V_{DC} I_{ODC} = 14.4 A_{DC}.	P_{ODC} = 403 W
$R_{LOAD_{BD}}$ =	24.7 Ω	V_{OBD} = 100 V DC I_{OBD} = 4.05 A_{DC}	P_{OBD} = 405 W
$R_{LOAD_{AC}}$ =	35.3 Ω	V_{OAC} = 71 V_{RMS} I_{OAC} = 2.0 A_{RMS}	P_{OAC} = 140 W
		f = 20.44 kHz	P_{OUT} = 950 W
			η = 69.5%

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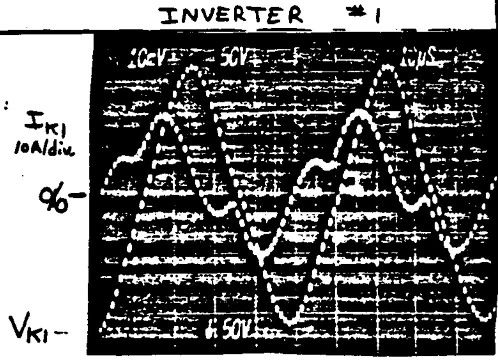
2.3.4
-3.22

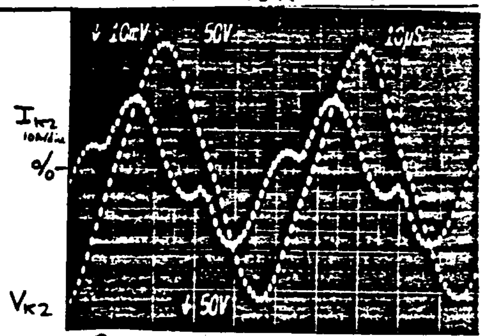
h.

INVERTER #1

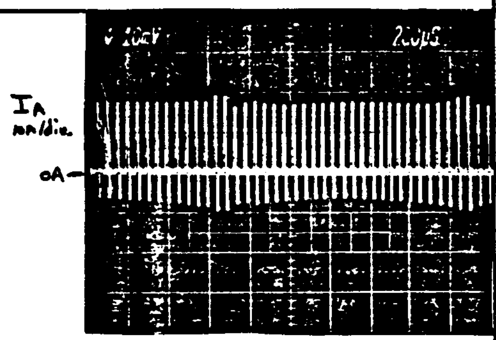
INVERTER #2



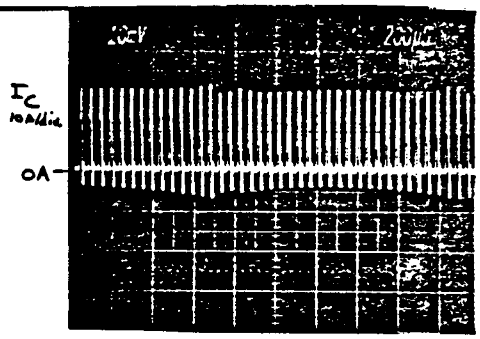
Resonant Tank Voltage
Resonant Tank Current



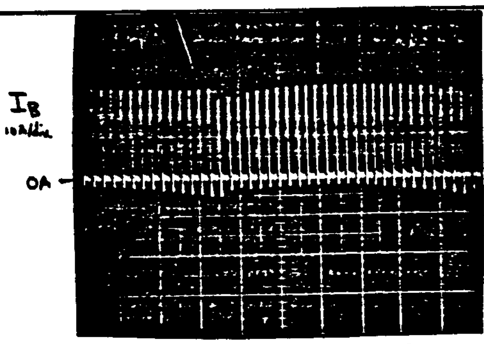
Resonant Tank Voltage
Resonant Tank Current



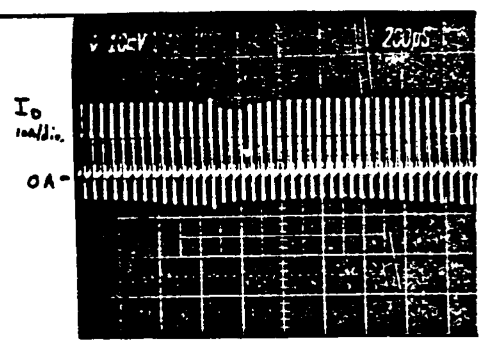
Branch Current A



Branch Current C



Branch Current B



Branch Current D

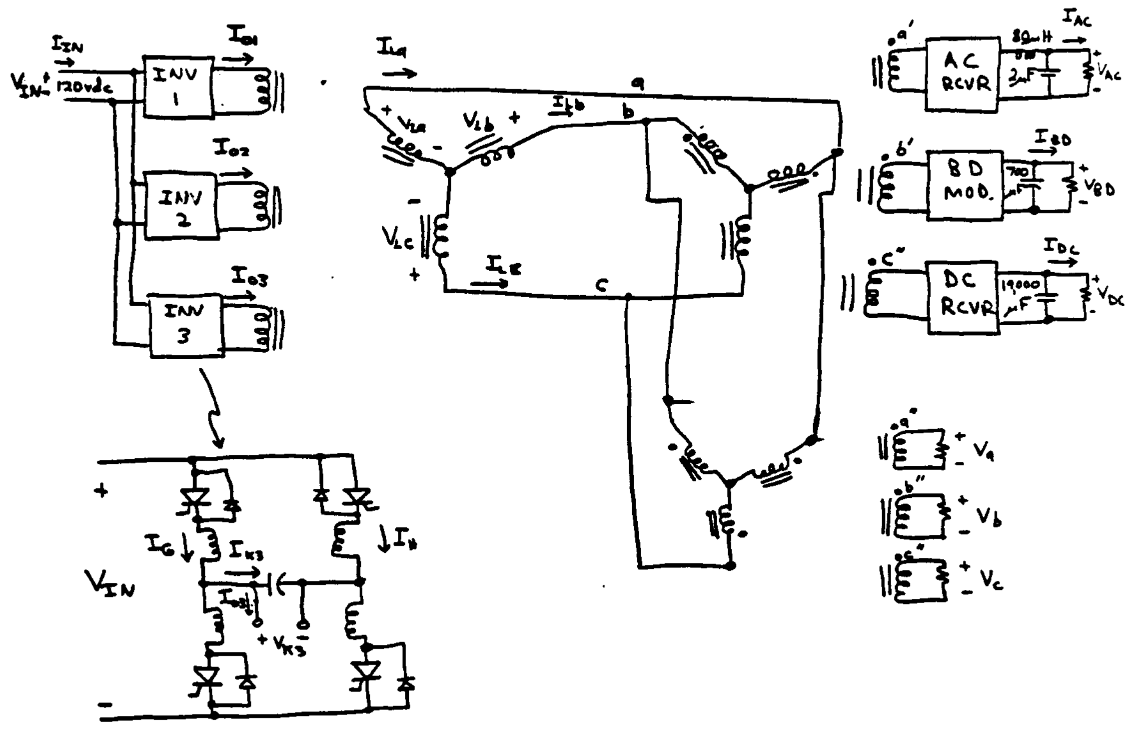
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6-3.2.2

STEADY- STATE OPERATION

Test Circuits



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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

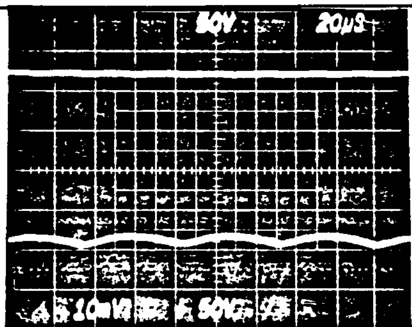
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

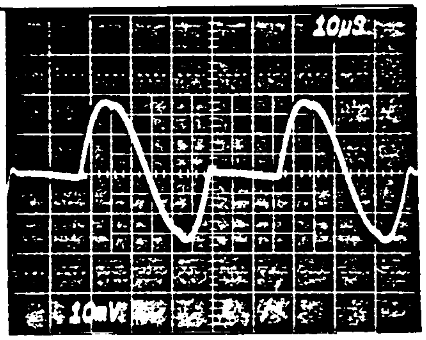
Test-Configuration: 2.3.6-3.2.2 STEADY STATE OPERATIONS

Specific Case: STEADY STATE - 0 LOAD

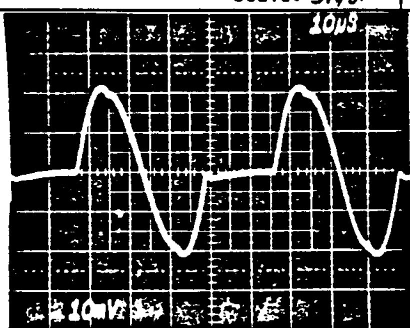
Input Voltage: 120.0	DC Rcvr: 28.6V - NO LOAD
Input Current: 9.28	AC Rcvr: NOT ON
System Frequency: 20.23 KHz	BD Module: 222.0V - NO LOAD
Output Power: 0	Other: Ø



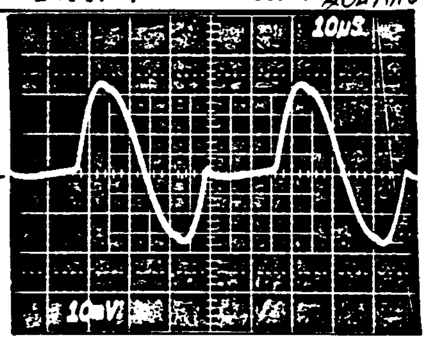
INPUT V-I Scale: 5A/DIV



IA INV. 1 Scale: 20A/DIV



IB INV. 1 Scale: 20A/DIV



IC INV. 2 Scale: 20A/DIV

24

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

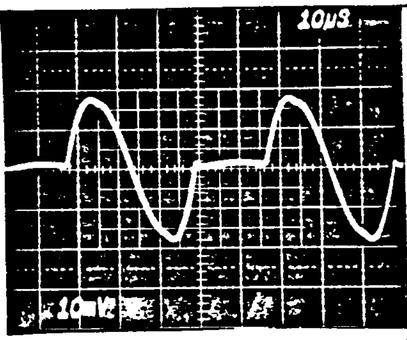
Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

Specific Case: No Load

Input Voltage:	SAME	DC Rcvr:	
Input Current:		AC Rcvr:	
System Frequency:		BD Module:	
Output Power:		Other:	

I_D

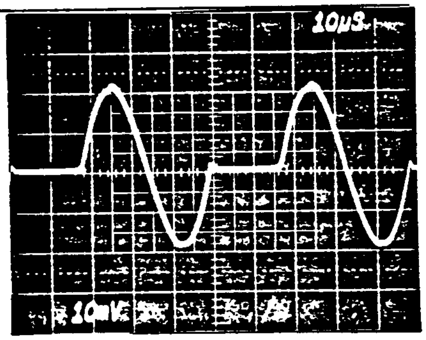
O



1D INV. 2 Scale: 20A/DIV

I_G

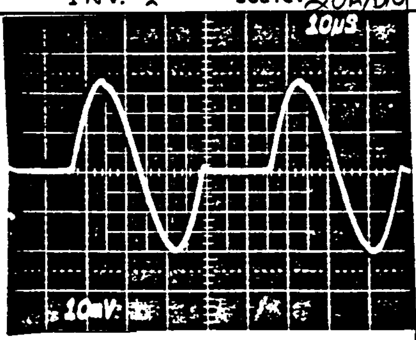
O



1G INV. 3 Scale: 20A/DIV

I_H

O_I

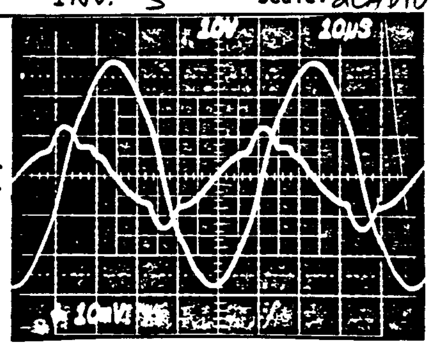


1H INV. 3 Scale: 20A/DIV

I_{K1}

O_{V} & I

V_{K1}



INV. 1

1K1 - VK1

*V - NOT TO SCALE Scale: 50A/DIV

25

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

Specific Case: No Load

Input Voltage: SAME

DC Rcvr:

Input Current:

AC Rcvr:

System Frequency:

BD Module:

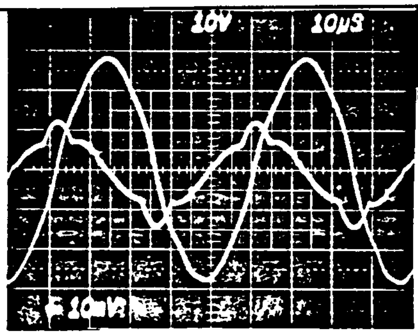
Output Power:

Other:

I_{K2}

0_V-I

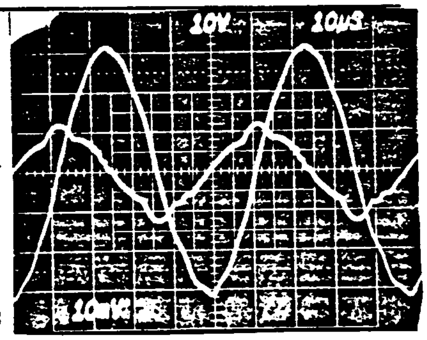
V_{K2}



I_{K3}

0_V-I

V_{K3}



I_{K2}-V_{K2} INV. 2
V-NOT TO SCALE Scale: 50A/DIV

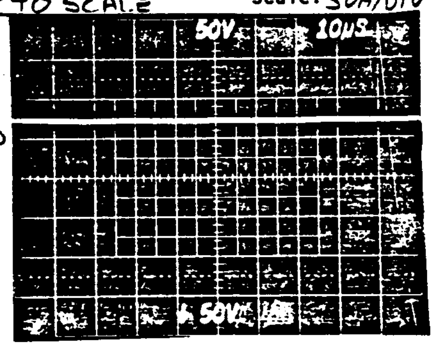
I_{K3}-V_{K3} INV. 3
V-NOT TO SCALE Scale: 50A/DIV

V_{DC}

0_V-

V_{BD}

0_V



DC RCVR - NO LOAD Scale: —

B/D RCVR - NO LOAD Scale: —

26

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

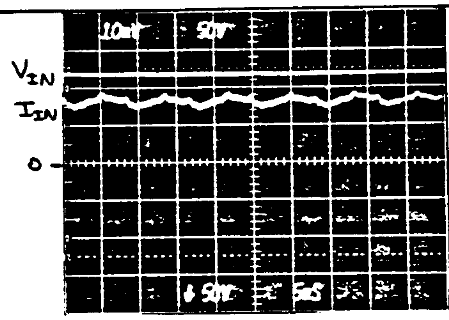
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

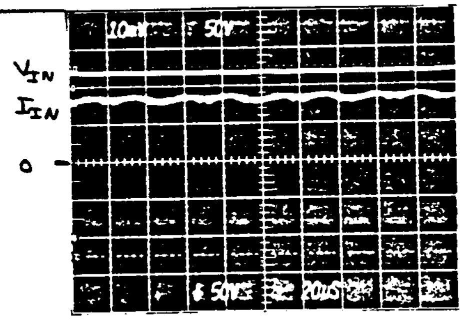
Test-Configuration: 2.3.6 - 3.2.2 STEADY-STATE OPERATION

Specific Case: 10% LOAD

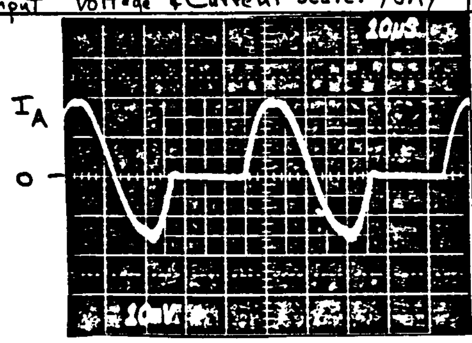
Input Voltage: 120.0 Vdc	DC Rcvr: 28.51 Vdc — 200W
Input Current: 14.79 Adc	AC Rcvr: 120.0 Vrms — 190W
System Frequency: 20.20	BD Module: 103.0 Vdc — 220W
Output Power: 610 W	Other: 0W



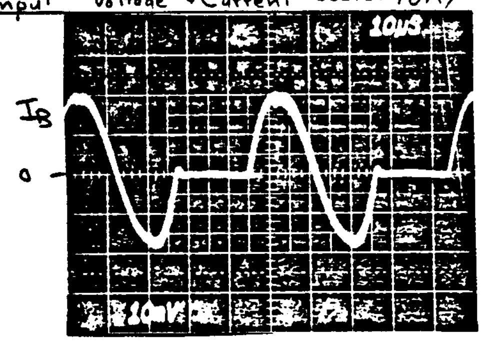
Input Voltage + Current Scale: 10A/



Input Voltage + Current Scale: 10A/



I_A . INV 1 Scale: 20A/Div



INV. 1

I_B Scale: 20A/

28

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6 - 3.2.2 STEADY-STATE OPERATION

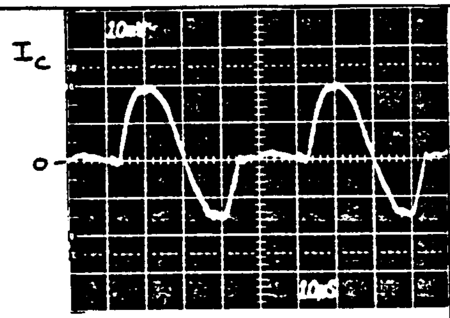
Specific Case: 10% Load

Input Voltage: Same | DC Rcvr:

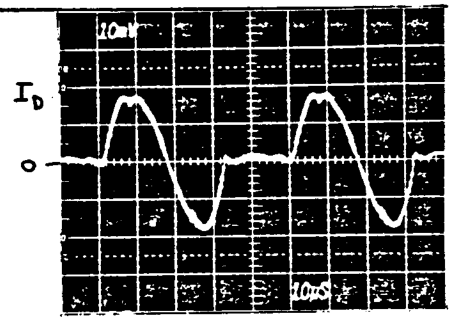
Input Current: | AC Rcvr:

System Frequency: | BD Module:

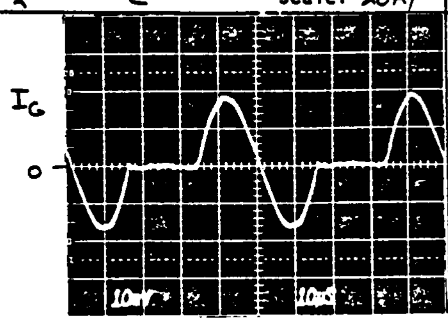
Output Power: | Other:



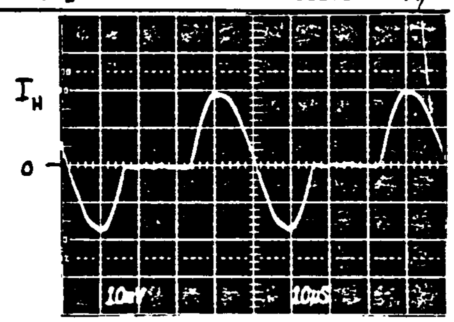
INV. 2 I_C Scale: 20A/



INV. 2 I_D Scale: 20A/



INV. 3 I_G Scale: 20A/



INV. 3 I_H Scale: 20A/

29

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.36-3.2.2 STEADY-STATE OPERATION

Specific Case: 10% Load

Input Voltage: Same

Input Current: ↓

System Frequency: ↓

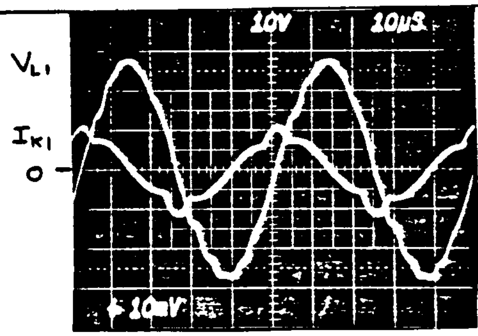
Output Power: ↓

DC Rcvr: ↓

AC Rcvr: ↓

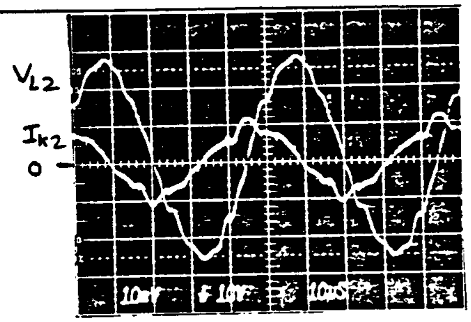
BD Module: ↓

Other: ↓



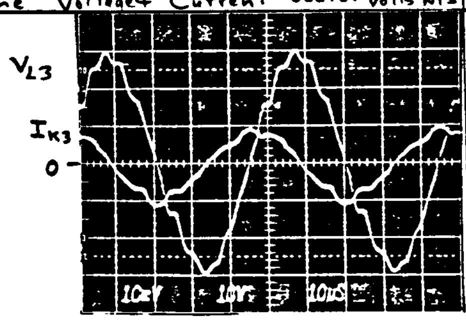
INV. 1

Line Voltage & Tank Current Scale: 50A/Volts NTS



INV. 2

Line Voltage & Tank Current Scale: 50A/Volt NTS



INV. 3

Line Voltage & Tank Current Scale:

INV. 1

Inverter Output Current Scale: 5A/

30

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

Specific Case: 10% Load

Input Voltage: Same

Input Current:

System Frequency:

Output Power:

DC Rcvr:

AC Rcvr:

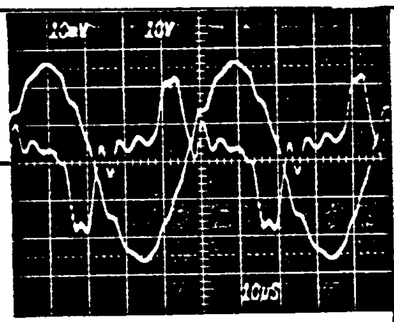
BD Module:

Other:

V_{L2}

0

I_{a1}



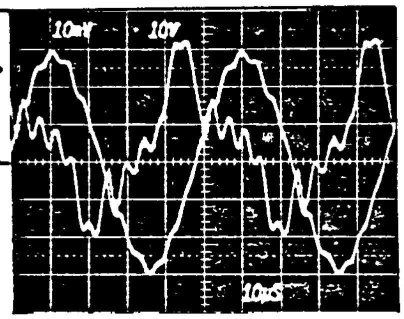
INV. 2

Line Voltage & Inverter Output Current Scale: Volt.NTS & 5A/

V_{L3}

0

I_{k3}



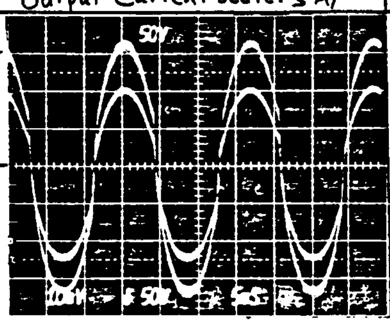
INV. 3

Line Voltage & Inverter Output Current Scale: Volt. NTS & 5A/

V_{AC}

I_{AC}

0



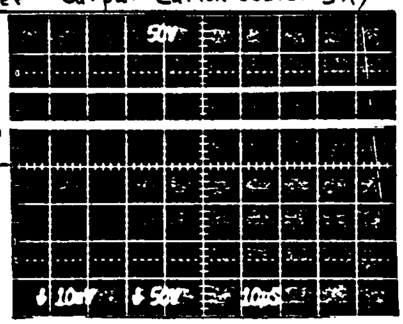
AC RCVR

Output Voltage & Current Scale: 1A/

V_{BD}

I_{BD}

0



BD Module

Output Voltage & Current Scale: 2A/

31

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.3 STEADY-STATE OPERATION

Specific Case: 10% Load

Input Voltage: Same

Input Current:

System Frequency:

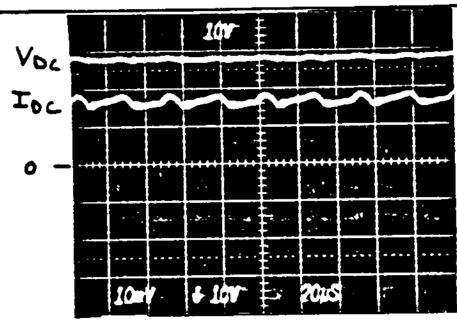
Output Power:

DC Rcvr:

AC Rcvr:

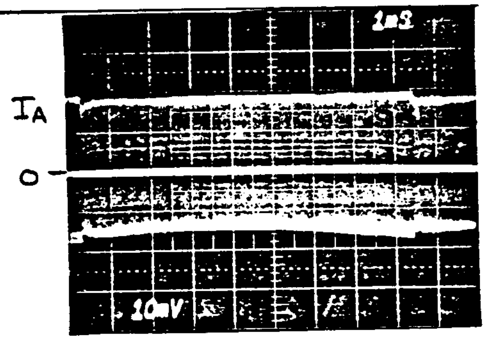
BD Module:

Other:



DC RCVR

Output V & I Scale: 5A/



INV. 1

I_A Scale: 20A/

Photo Scale:

Photo Scale:

32

60% LOAD TEST 6/26/84

SYSTEM FREQ 20.15 KHz

1.5 mf

I) INPUT POWER

V_{IN} 120.0
I_{IN} 27.23
P_{IN} 3268

T.H.D.

INV#1 ____ db
INV#2 ____ db
INV#3 ____ db

THD - TRANSMISSION LINE

INTO THE LINE	OUT OF THE LINE
INV.#1 28.3 db	INV #1 ____ db
INV.#2 21.8 db	INV.#2 ____ db
INV.#3 23.0 db	INV.#3 ____ db

II) OUTPUT POWER

A.C. RCVR
V_{OUT} 120.6
I_{OUT} 3.38
P 408

T.H.D.
INTO THE RCVR ____ db
OUT OF THE RCVR ____ db

DC. RCVR
V_{OUT} 28.06
I_{OUT} 30.0
P 842

T.H.D.
INTO THE RCVR ____ db

B/D RCVR
V_{OUT} 100.2
I_{OUT} 7.77
P 779

T.H.D.
INTO THE RCVR ____ db

TOASTER LOADS

INV#1
V_{OUT} NA
I_{OUT} ____
P ____ w
THD ____ db

INV#2
V_{OUT} NA
I_{OUT} ____
P ____
THD ____ db

INV#3
V_{OUT} NA
I_{OUT} ____
P ____
THD ____ db

TOTAL SYSTEM EFFICIENCY $\frac{2029\ P_{OUT}}{3268\ P_{IN}}$ = 62 %

33

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

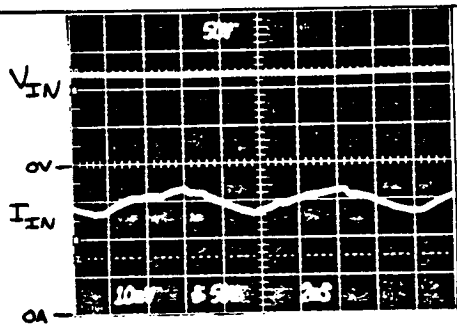
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

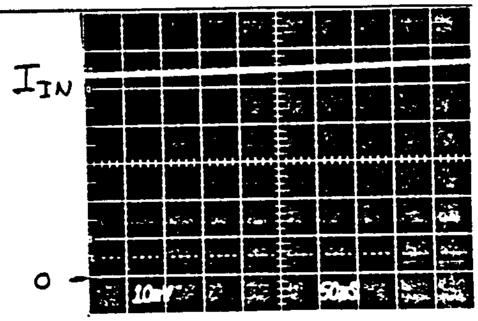
Test-Configuration: 2.3.6 - 3.2.2 STEADY- STATE OPERATION

Specific Case: 60% Load

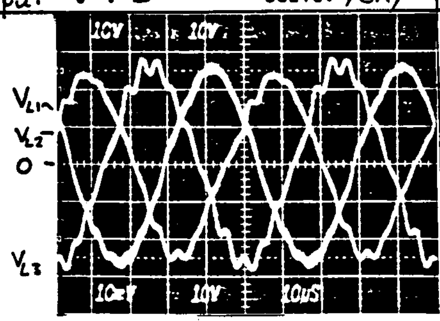
Input Voltage: 120.3 Vdc	DC Rcvr: 28.25 Vdc / 830 W
Input Current: 27.9 Adc	AC Rcvr: 110 Vrms / 360 W
System Frequency: 20.12 kHz	BD Module: 100.2 Vdc / 950 W
Output Power: 2140 W	Other: 0 W



Input V & I Scale: 10A/



Input Current Scale: 5A/



Line Voltage Scale: NTS

Photo

Scale:

3.4

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

Specific Case: 60% Load - Inverter 1

Input Voltage: Same

DC Rcvr:

Input Current:

AC Rcvr:

System Frequency:

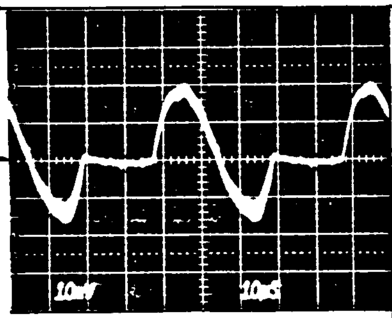
BD Module:

Output Power:

Other:

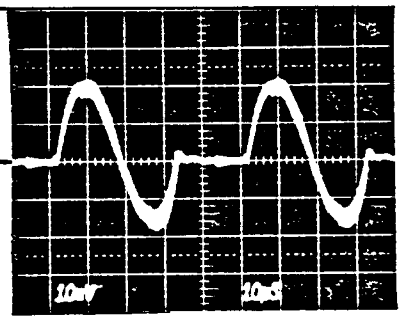
I_A

0



I_B

0

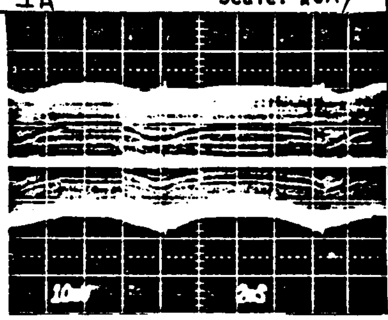


I_A Scale: 20A/

Scale:

I_B

0



Photo

I_B Scale: 20A

Scale:

35

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

Specific Case: 60% Load - Inverter 1

Input Voltage: Same DC Rcvr: ____

Input Current: ____ AC Rcvr: ____

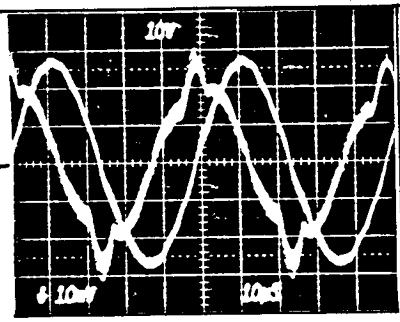
System Frequency: ____ BD Module: ____

Output Power: ____ Other: ____

I_{k1}

V_{L1}

0

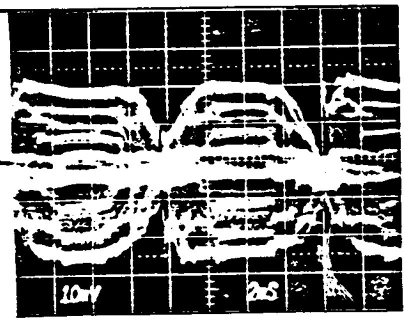


INV. 1

Line Voltage and Tank Current Volt. N.T.S. Scale: 20A /

I_{o1}

0



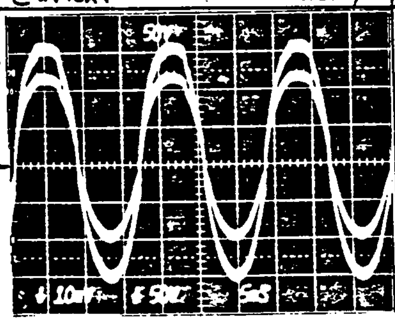
INV. 1

Inverter Output Current Scale: 5A /

V_{AC}

I_{AC}

0



AC RCVR

Output V_o Scale: 2A /

Photo

Scale:

35

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

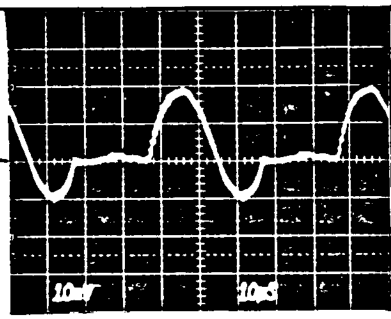
Specific Case: 60% Load - Inverter 2

Input Voltage: Same DC Rcvr: ______

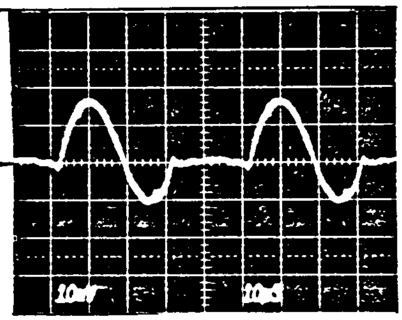
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

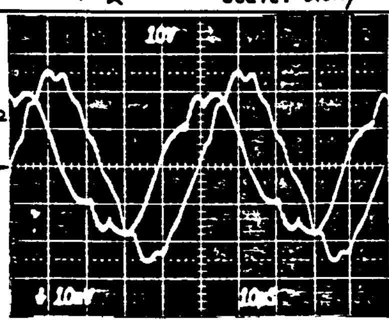
Output Power: ______ Other: ______



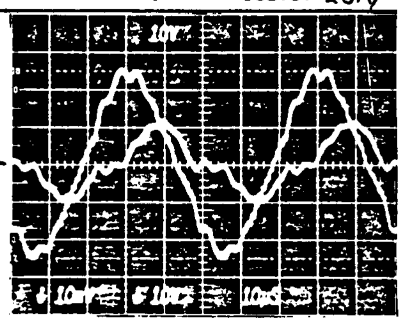
I_c - INV. 2 Scale: 20A/



I_D - INV. 2 Scale: 20A/



INV. 2
Line Voltage + Tank Current Volt.: NTS Scale: 20A/



INV. 2
Line Voltage + Inverter Output Current Volt.: NTS Scale: 20A/

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

Specific Case: 60% Load - Inverter 2

Input Voltage: Same

Input Current:

System Frequency:

Output Power:

DC Rcvr:

AC Rcvr:

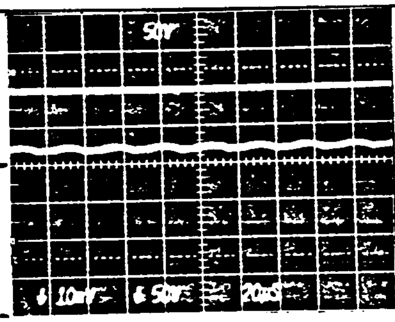
BD Module:

Other:

V_{BD}

I_{BD}

0V -



0A -

BD MODULE
Output V & I

Scale: 2A/

Photo

Scale:

Photo

Scale:

Photo

Scale:

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

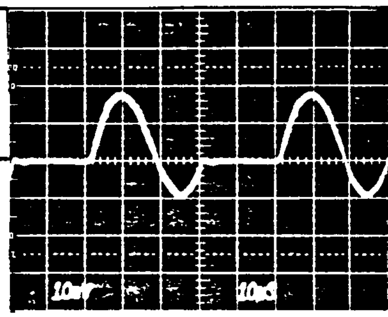
Test-Configuration: 23.6-3.2.2 STEADY-STATE OPERATION

Specific Case: 60% Load - Inverter 3

Input Voltage:	Same	**DC Rcvr:**	
Input Current:		**AC Rcvr:**	
System Frequency:		**BD Module:**	
Output Power:		**Other:**	

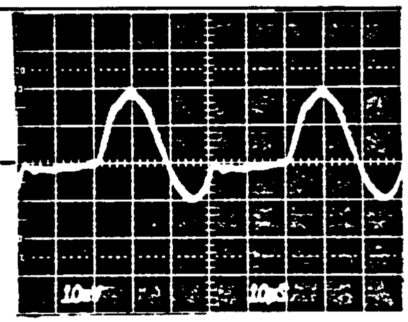
I_G

0



I_H

0



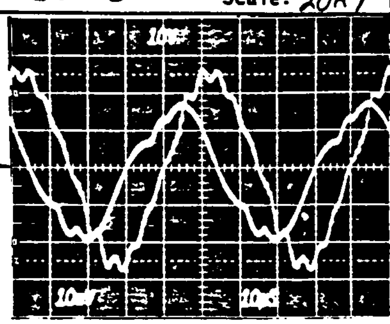
I_G - INV. 3 **Scale:** 20A/

I_H - INV. 3 **Scale:** 20A/

V_{L3}

I_{K3}

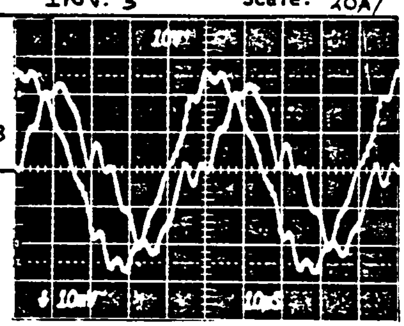
0



V_{L3}

I_{O3}

0



INV. 3
Line Voltage and
Tank Current **V: NTS**
Scale: 20A/

INV. 3
Line Voltage and
Inverter Output Current **V: NTS**
Scale: I: 10A/

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

Specific Case: 60% Load – Inverter 3

Input Voltage: Same

Input Current: ↓

System Frequency: ↓

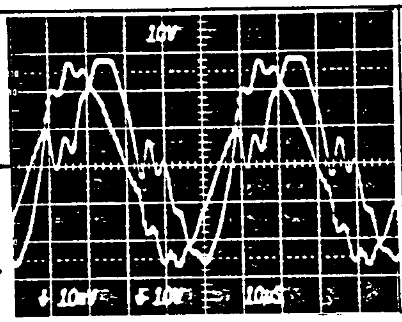
Output Power: ↓

DC Rcvr: ↓

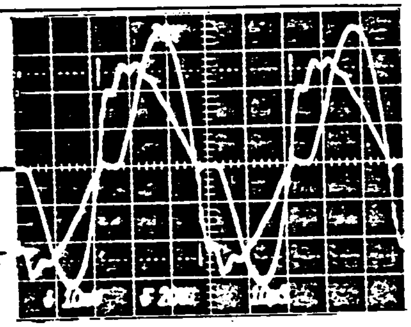
AC Rcvr: ↓

BD Module: ↓

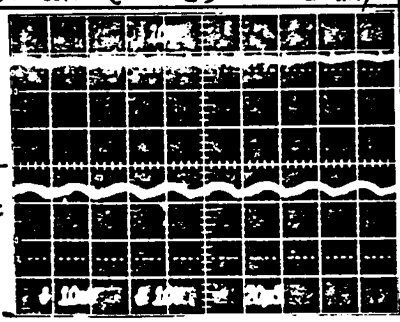
Other: ↓



INV. 3
Line Voltage and
Line Current (Phase c) Scale: V: NTS I: 2A/



DC RCVR Input V+I Scale: 20A/



DC RCVR Output V+I Scale: 10A/

Photo

Scale:

6/25/84

I) INPUT POWER

V_{IN} 120
I_{IN} 30.70
P_{IN} 3684

2.3.6-3.22 STEADY-STATE OPERATION
(1.0μF, Full Load)

T.H.D.
INV#1 ~~20.4~~ db
INV#2 17.4 db
INV#3 19.4 db

Frequency 20.06 KHZ

THD-TRANSMISSION LINE

INTO THE LINE	OUT OF THE LINE
INV.#1 17.4 db	INV#1 ____ db
INV.#2 16.4 db	INV.#2 17.8 db
INV.#3 18.2 db	INV.#3 ____ db

II) OUTPUT POWER

A.C. RCVR
V_{OUT} 110
I_{OUT} 3.0
P 330

T.H.D.
INTO THE RCVR ____ db
OUT OF THE RCVR ____ db

DC. RCVR
V_{OUT} 25.3
I_{OUT} 23
P 582

T.H.D.
INTO THE RCVR ____ db

B/D RCVR
V_{OUT} 99.3
I_{OUT} 6.35
P. 631

T.H.D.
INTO THE RCVR ____ db

TOASTER LOADS

INV#1
V_{OUT} 74.96
I_{OUT} 7.96
P 597 w
THD ____ db

INV#2
V_{OUT} 68.3
I_{OUT} 4.38
P 299
THD ____ db

INV#3
V_{OUT} 67.9
I_{OUT} 4.40
P 299
THD ____ db

Total System Efficiency $\frac{2738 \; P_{OUT}}{3684 \; P_{IN}}$ = 74.3%

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

Specific Case: 1.0μF, Full Load

Input Voltage: 120.0 Vdc　　DC Rcvr: 25.3 Vdc / 582 W

Input Current: 30.70 Adc　　AC Rcvr: 110 Vrms / 330 W

System Frequency: 20.06　　BD Module: 99.3 Vdc / 631W

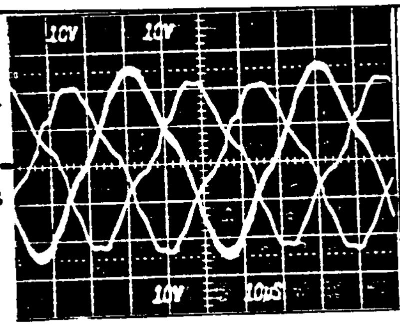
Output Power: 2,740 W　　Other: ϕ_a = 597W, ϕ_b = 299W, ϕ_c = 299W

V_{L2}

0

V_{L3}

V_{L1}



3-Phase Line Voltage　Scale: NTS

Photo

Scale:

Photo

Scale:

Photo

Scale:

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2.3.6-3.2.2 STEADY-STATE OPERATION
(1.5μF, Full Load)

I) INPUT POWER

V_{IN} 120
I_{IN} 54.1A
P_{IN} 6492w

T.H.D. (AT THE INV.)

Frequency 20.16kHz

INV#1 -28.8 db = 3.63%
INV#2 -28.6 db = 3.72%
INV#3 -30.2 db = 3.09%

-33.0 db = 2.24%
-29.2 db = 3.47%
-30.8 db = 2.88%

THD - EACH PHASE IS RUN INDEPENDENT OF THE OTHERS (OTHERS TURNED OFF)

THD - TRANSMISSION LINE

INTO THE LINE
INV#1 -28.2 db = 3.89%
INV.#2 -23.4 db = 6.76%
INV.#3 -24.2 db = 6.17%

OUT OF THE LINE
INV#1 -26.8 db = 4.57%
INV.#2 -24.8 db = 5.75%
INV.#3 -20.0 db = 10.0%

II) OUTPUT POWER

AC RCVR
V_{OUT} 120
I_{OUT} 3.4
P 408

T.H.D.
INTO THE RCVR -24.3 db = 6.1%
OUT OF THE RCVR (60Hz) -13.6 db = 20.9%

DC. RCVR
V_{OUT} 27.6
I_{OUT} 30
P 828

T.H.D.
INTO THE RCVR -16.8 db = 14.5%

B/D RCVR
V_{OUT} 99.8
I_{OUT} 7.8
P 778

T.H.D.
INTO THE RCVR -19.4 db = 10.7%

TOASTER LOADS

INV#1
V_{OUT} 83.6
I_{OUT} 14.67
P 1226w
THD -28.4 db = 3.80%

INV#2
V_{OUT} 77.2
I_{OUT} 9.77
P 754w
THD -24.4 db = 6.03%

INV#3
V_{OUT} 76.5
I_{OUT} 13.2
P 1010w
THD -23.2 db = 6.53%

Total System Efficiency $\frac{5004\ P_{OUT}}{6492\ P_{IN}}$ = 77.1%

41

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

Specific Case: Full Load — INPUT

Input Voltage: 120.7 Vdc

Input Current: 54.0 Adc

System Frequency: 20.14 kHz

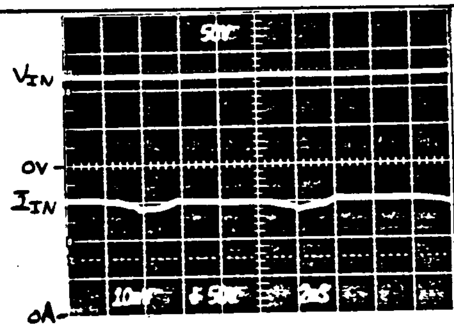
Output Power: 5,120 W

DC Rcvr: 27.3Vdc / 790W

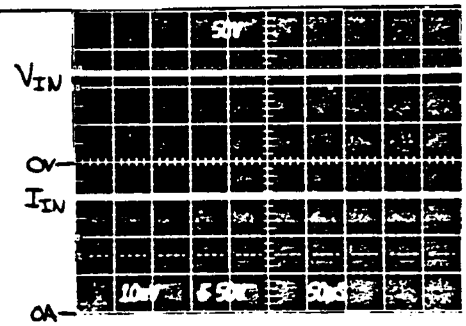
AC Rcvr: 95.5Vrms / 250W

BD Module: 99.8 Vdc / 850W

Other: ϕ_a = 1270W, ϕ_b = 830, ϕ_c = 1130



Input V + I   Scale: 20A/



Input V + I   Scale: 20A/

Photo

Scale:

Photo

Scale:

42

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

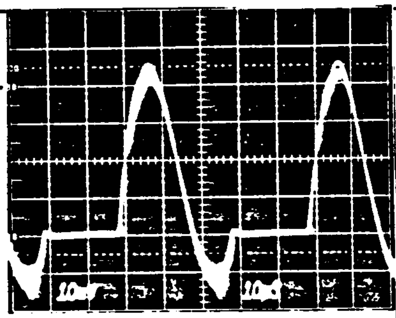
Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

Specific Case: FULL LOAD — Inverter 1

Input Voltage:	Same	**DC Rcvr:**	
Input Current:		**AC Rcvr:**	
System Frequency:		**BD Module:**	
Output Power:		**Other:**	

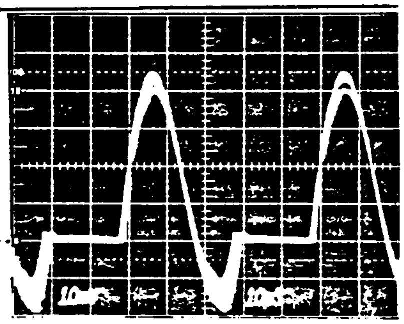
I_A

0-



I_B

0-



IA **Scale:** 10A/DIV

IB **Scale:** 10A/DIV

Photo

Scale:

Photo

Scale:

43

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

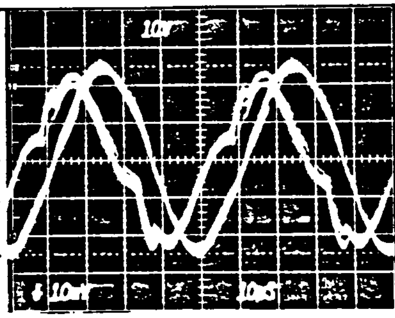
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

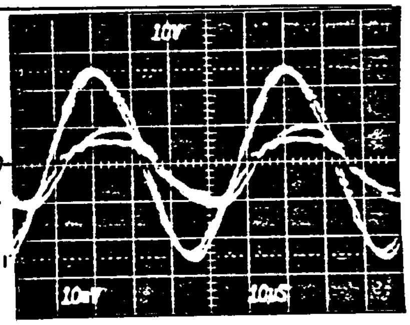
Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

Specific Case: FULL LOAD- Inverter 1

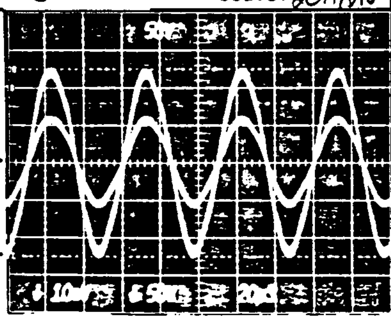
Input Voltage: Same	DC Rcvr:
Input Current:	AC Rcvr:
System Frequency:	BD Module:
Output Power:	Other:



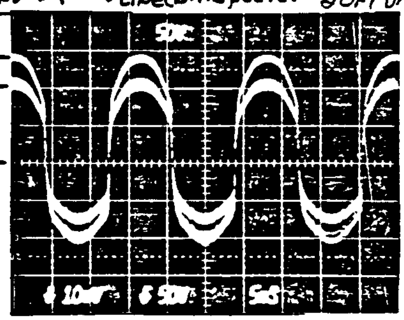
IK_1 & V_{LINE} (NOT TO SCALE) Scale: 20A/DIV



I_{OUT} OF INV #1 & V_{LINE} (U.T.S) Scale: 20A/DIV



RESISTIVE LOAD Scale: 20A/DIV.



AC RCVR OUTPUT Scale: 2A/DIV

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY- STATE OPERATION

Specific Case: Full Load - Inverter 2

Input Voltage: Same

Input Current:

System Frequency:

Output Power:

DC Rcvr:

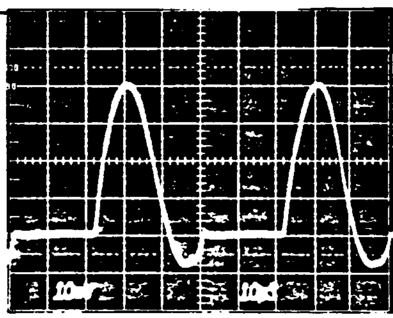
AC Rcvr:

BD Module:

Other:

I_C

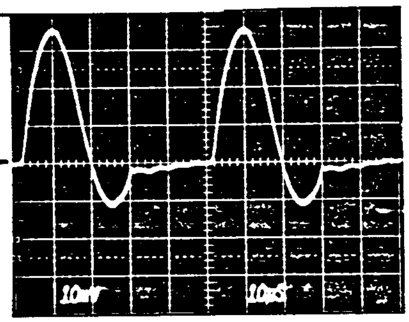
ϕ -



1C **Scale:** 10A/DIV

I_D

ϕ -



1D **Scale:** 10/DIV

Photo

Scale:

Photo

Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

Specific Case: Full Load – Inverter 2

Input Voltage: Same

Input Current:

System Frequency:

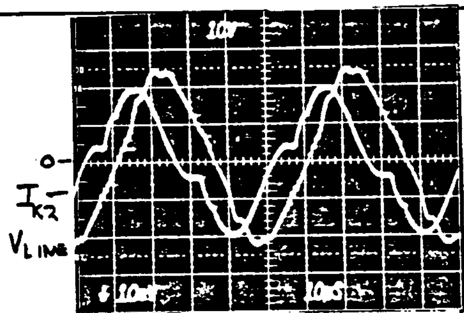
Output Power:

DC Rcvr:

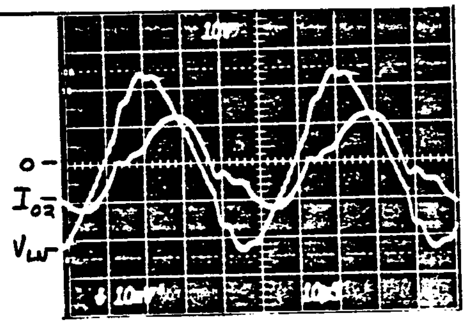
AC Rcvr:

BD Module:

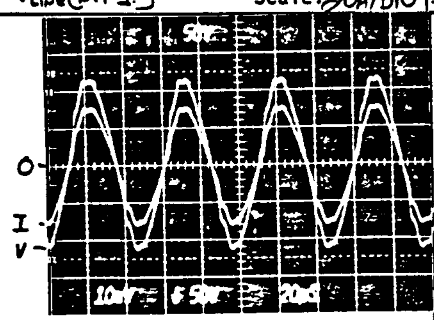
Other:



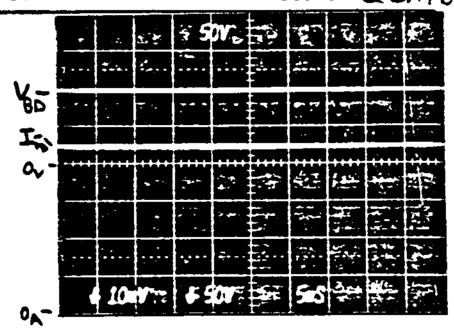
I_{K2} – V_{LINE} (N.T.S.) Scale: 20A/DIV



I OUT OF INV. #2 – V_{LINE} Scale: 20A/DIV



RESISTIVE LOAD Scale: 10A/DIV



B/D OUTPUT Scale: 2A/DIV

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

Specific Case: Full Load - Inverter 3

Input Voltage: Same

Input Current:

System Frequency:

Output Power:

DC Rcvr:

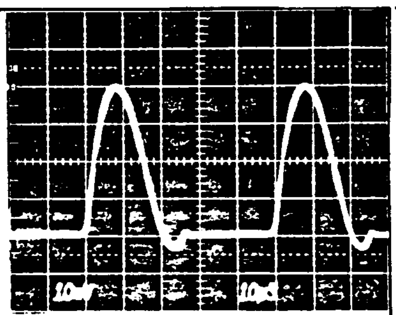
AC Rcvr:

BD Module:

Other:

I_G

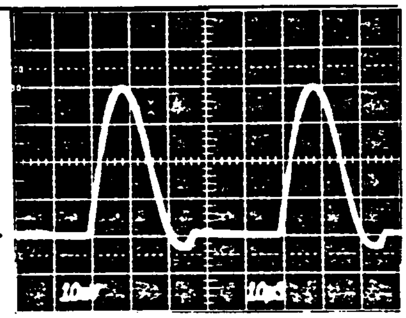
ø-



IG Scale: 10A/DIV

I_H

ø-



IH Scale: 10A/DIV

Photo

Scale:

Photo

Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

Specific Case: Full Load – Inverter 3

Input Voltage: Same

DC Rcvr:

Input Current:

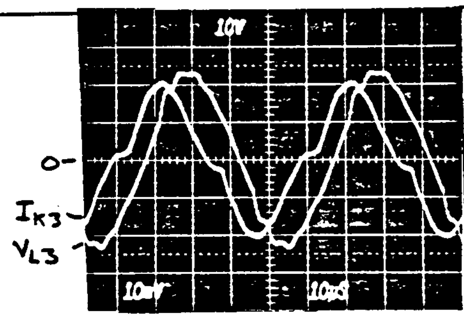
AC Rcvr:

System Frequency:

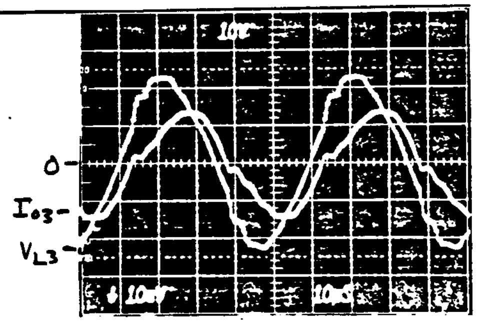
BD Module:

Output Power:

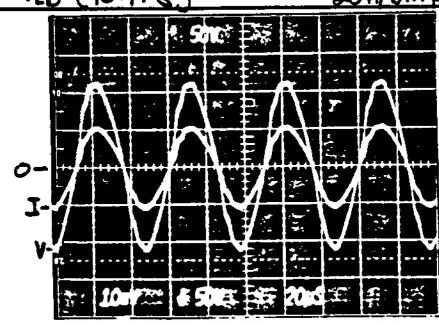
Other:



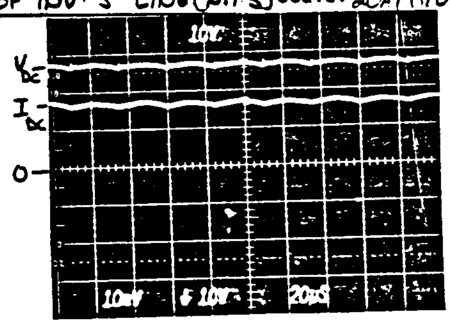
I_{K3} – V_{L3} (N.T.S) Scale: 20A/DIV.



I OUT OF INV#3 – LINE (N.T.S) Scale: 20A/DIV



RESISTIVE LOAD OUTPUT Scale: 20A/DIV



DC RCVR

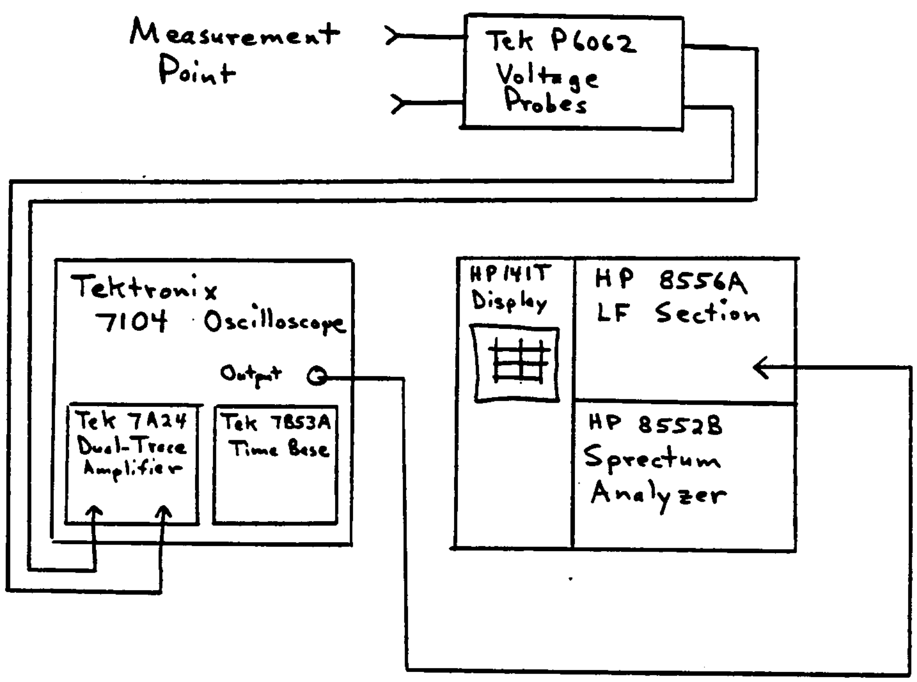
Output V+I Scale: 20A/DIV

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6-3.2.2 STEADY-STATE OPERATION, HARMONIC COMPONENTS MEASUREMENT

Test Circuits



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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

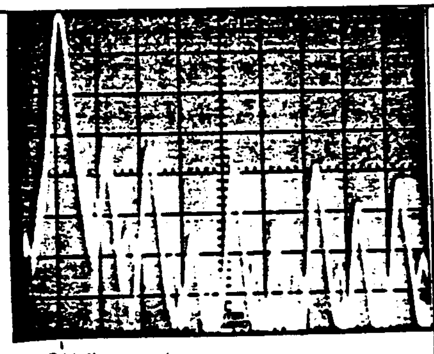
Specific Case: HARMONIC COMPONENTS, Phase a

Input Voltage: 120.0 V — DC Rcvr: 27.6 V, 830W

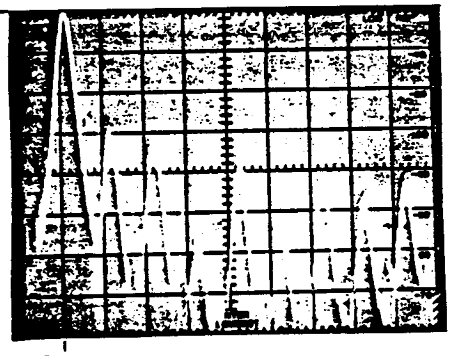
Input Current: 54.1 A — AC Rcvr: 120 V, 410 W

System Frequency: 20.211 KHz — BD Module: 99.8V, 780W

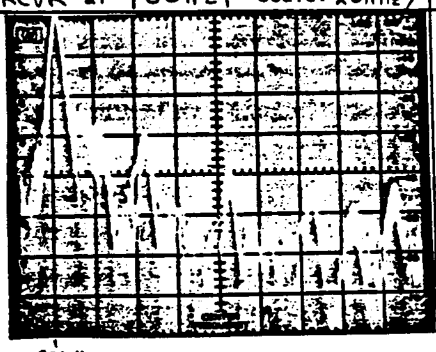
Output Power: 5000 W — Other: ϕ_a = 1230W, ϕ_b = 754W, ϕ_c = 1010W



Phase a Line-neutral
AC RCVR at $\boxed{60Hz}$ Scale: 20KHz/



Phase a Line to Neutral
AC RCVR at $\boxed{400Hz}$ Scale: 20KHz/



AC RCVR at $\boxed{1KHz}$
Phase a Line-to-Neutral Scale: 20KHz/

Photo

Scale:

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

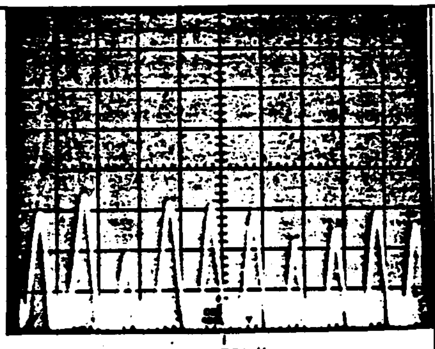
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

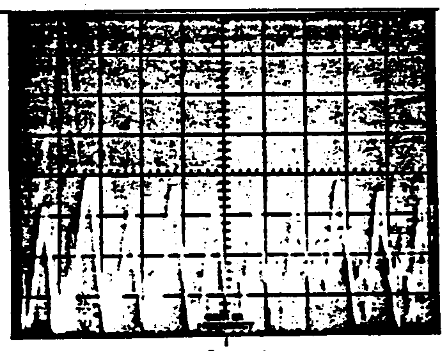
Specific Case: Harmonic Components, Phase a

Input Voltage:	Same	DC Rcvr:	
Input Current:		AC Rcvr:	
System Frequency:		BD Module:	
Output Power:		Other:	



AC RCVR at $\boxed{60Hz}$

Inverter Output Voltage Scale: 20kHz/



AC RCVR at $\boxed{60Hz}$

Phase a Line-to-Neutral V. Scale: 20KHz/

Photo

Scale:

Photo

Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6 -3.2.2 STEADY-STATE OPERATION

Specific Case: Harmonic Components, Phase b

Input Voltage: Same

Input Current:

System Frequency:

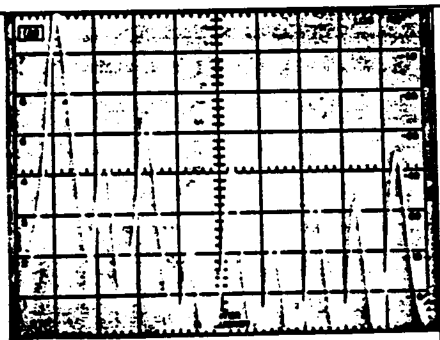
Output Power:

DC Rcvr:

AC Rcvr:

BD Module:

Other:

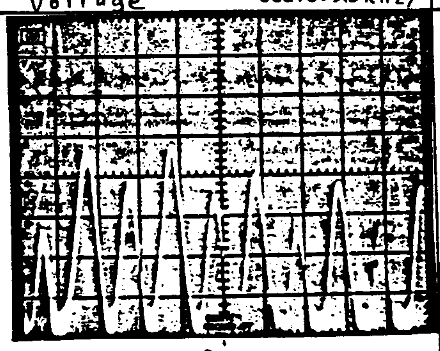


20kHz

Phase b Line-to-Neutral Voltage Scale: 20kHz/

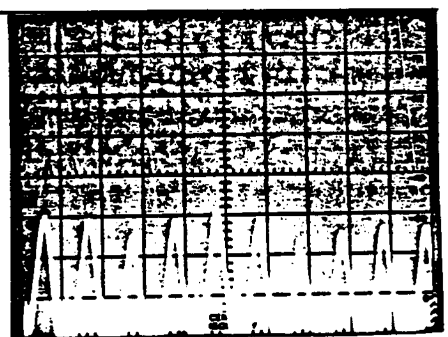
Photo

Scale:



250kHz

Phase b Line-to-Neutral Scale: 20kHz/



250kHz

Inverter Output Voltage Scale: 20kHz/

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY STATE OPERATION

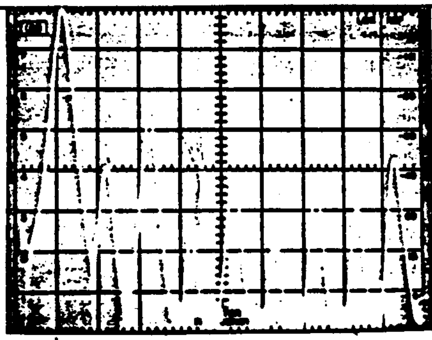
Specific Case: Harmonic Components, Phase c

Input Voltage: Same | DC Rcvr:

Input Current: | AC Rcvr:

System Frequency: | BD Module:

Output Power: | Other:

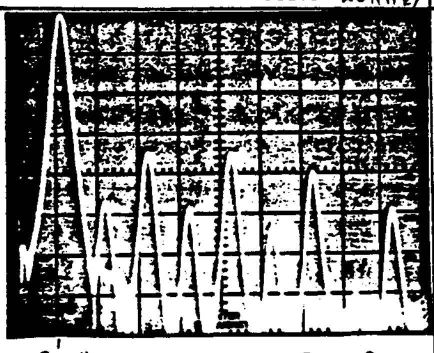


20KHz FULL LOAD

Phase c Line-to-Neutral Scale: 20KHz/

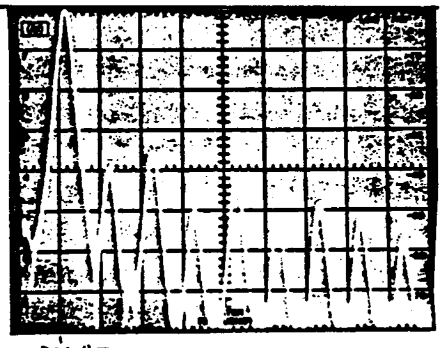
Photo

Scale:



20KHz NO DC RCVR

Inverter Output Voltage Scale: 20KHz/



20KHz FULL LOAD

Inverter Output Voltage Scale: 20KHz/

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6 - 3.2.2 STEADY- STATE OPERATION

Specific Case: Harmonic Components, Phase c

Input Voltage: Same

DC Rcvr:

Input Current:

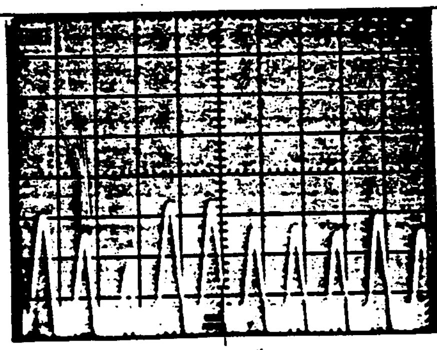
AC Rcvr:

System Frequency:

BD Module:

Output Power:

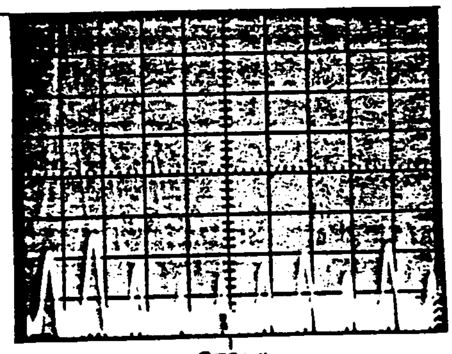
Other:



250KHz

FULL LOAD

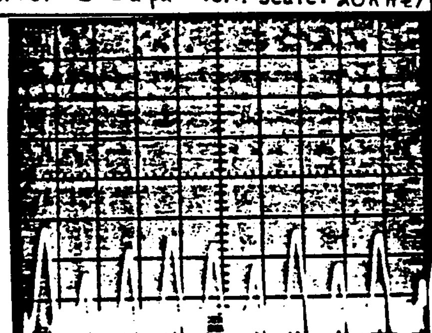
Inverter 3 Output Volt. Scale: 20kHz/



250KHz

NO DC RCVR

Inverter 3 Output Voltage Scale: 20kHz/



250KHz

FULL LOAD, PHASE A + B OFF

Inverter 3 Output Volt. Scale: 20kHz/

Photo

Scale:

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TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

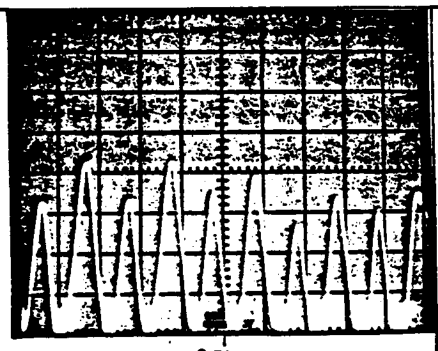
Specific Case: Harmonic Components, Phase c

Input Voltage: Same | **DC Rcvr:** ______

Input Current: ______ | **AC Rcvr:** ______

System Frequency: ______ | **BD Module:** ______

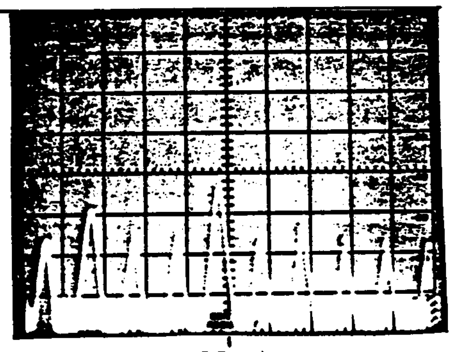
Output Power: ______ | **Other:** ______



250KHz

FULL LOAD

Phase c Line-to-Neutral **Scale:** 20KHz



250KHz

NO DC RCVR

Phase c Line-to-Neutral **Scale:** 20 KHz

Photo

Scale:

Photo

Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

Specific Case: Harmonic Components, Line-to-Line

Input Voltage: Same

DC Rcvr:

Input Current:

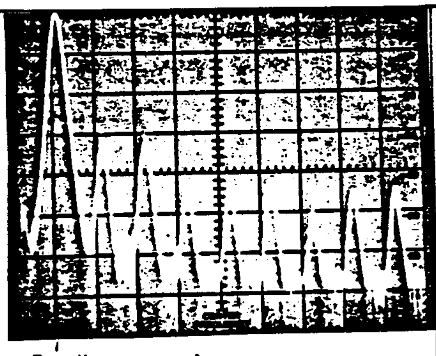
AC Rcvr:

System Frequency:

BD Module:

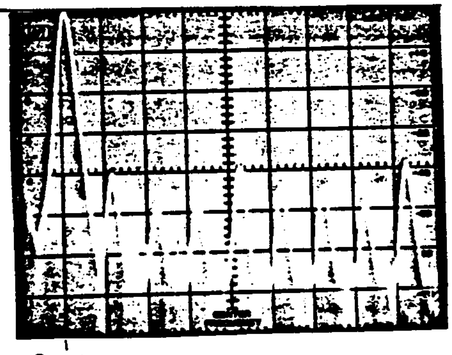
Output Power:

Other:



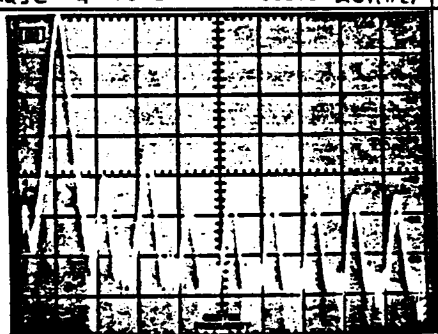
20kHz

Line-to-Line Voltage
Phase a to b Scale: 20kHz/



20kHz

Line-to-Line Voltage
Phase b-to-c Scale: 20kHz/



20kHz

Line-to-Line Voltage
Phase c-to-a Scale: 20kHz/

Photo

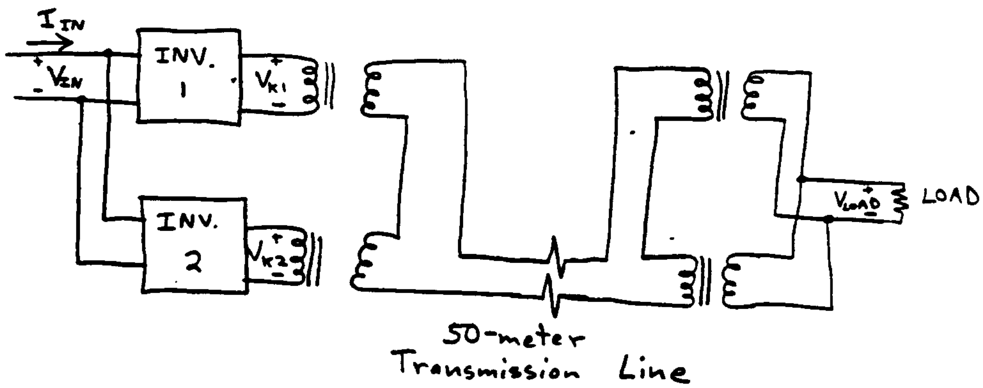
Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6. - 3.2.2 STEADY - STATE OPERATION — REGULATION

Test Circuits



2.3.6 – 3.2.2 STEADY-STATE OPERATION

REGULATION

230 W Load

		V_{IN}	
		60 Vdc	120 Vdc
Input Voltage	V_{IN}	60.05 Vdc	120.0 Vdc
Input Current	I_{IN}	7.41 Adc	6.89 Adc
Inv. 1 Output Voltage	V_{K1}	93.9 Vrms	186.0 Vrms
Inv. 2 Output Voltage	V_{K2}	80.1 Vrms	186.0 Vrms
Transmission Line Voltage	V_L	250 Vrms	249 Vrms
Load Voltage	V_{LOAD}	36.8 Vrms	35.9 Vrms

450 W Load

		V_{IN}	
		60 Vdc	120 Vdc
Input Voltage	V_{IN}	60.50 Vdc	120.03 Vdc
Input Current	I_{IN}	11.42 Adc	9.28 Adc
Inv. 1 Output Voltage	V_{K1}	94.4 Vrms	168.6 Vrms
Inv. 2 Output Voltage	V_{K2}	69.6 Vrms	160.9 Vrms
Transmission Line Voltage	V_L	248 Vrms	249 Vrms
Load Voltage	V_{LOAD}	34.2 Vrms	34.7 Vrms

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

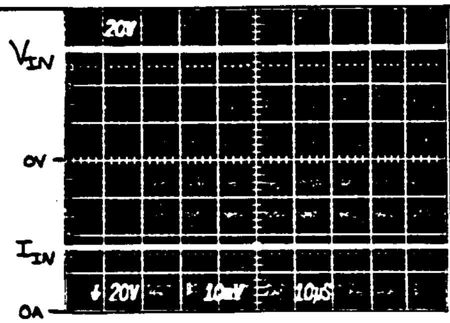
Specific Case: REGULATION — 230W LOAD, 60Vdc

Input Voltage: 60.05 Vdc **DC Rcvr:** —

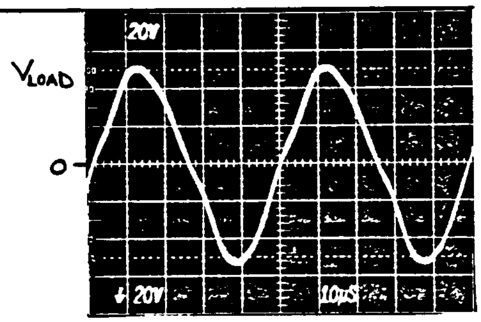
Input Current: 7.41 Adc **AC Rcvr:** —

System Frequency: 20.3 KHz **BD Module:** —

Output Power: 233.9 W **Other:** Load Voltage - 36.8 Vrms



INPUT VOLTAGE & CURRENT **Scale:** 5A/



LOAD VOLTAGE **Scale:**

Photo

Scale:

Photo

Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

Specific Case: REGULATION - 230W LOAD, 60 V_{IN}

Input Voltage: Same

DC Rcvr:

Input Current:

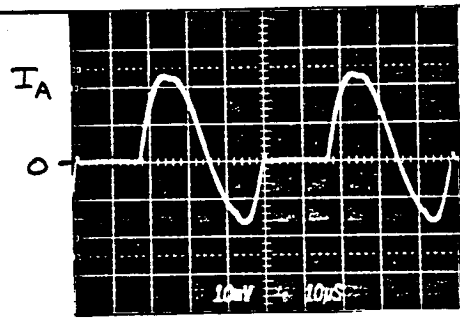
AC Rcvr: -

System Frequency:

BD Module:

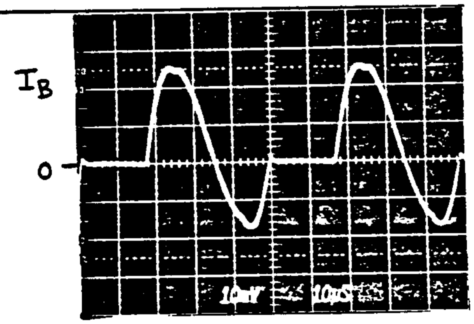
Output Power:

Other:



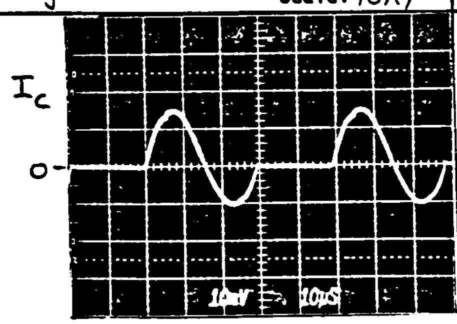
INVERTER 1

1A Leg Current Scale: 10A/



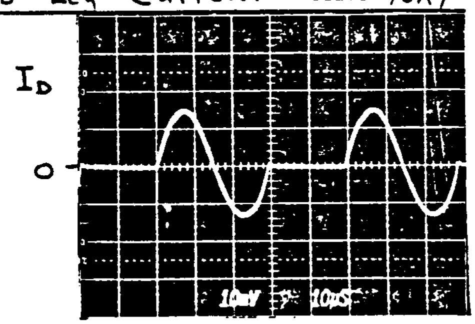
INVERTER 1

1B Leg Current Scale: 10A/



INVERTER 2

1C Leg Current Scale: 10A/



INVERTER 2

1D Leg Current Scale: 10A/

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 3.3.6-3.2.2 STEADY-STATE OPERATION

Specific Case: REGULATION – 230 W, 60 V_{IN}

Input Voltage: ______ DC Rcvr: ______

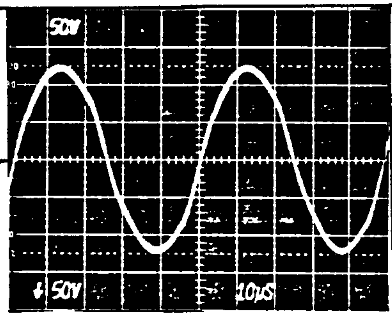
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______

V_{K1}

0

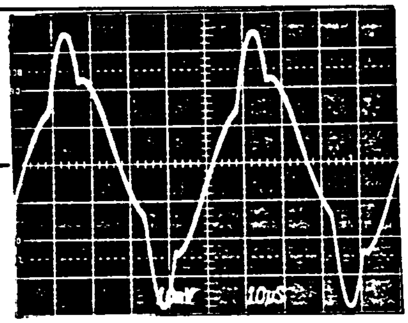


INVERTER 1

Output Voltage Scale:

I_{K1}

0

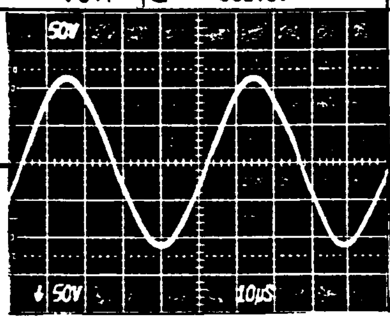


INVERTER 1

Tank Current Scale: 10A/

V_{K2}

0

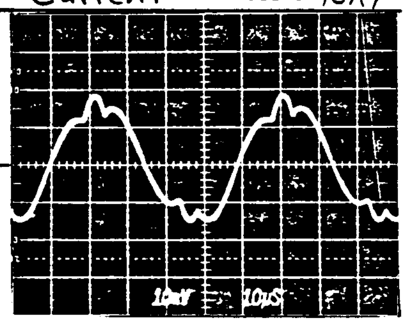


INVERTER 2

Output Voltage Scale:

I_{K2}

0



INVERTER 2

Tank Current Scale: 10A/

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

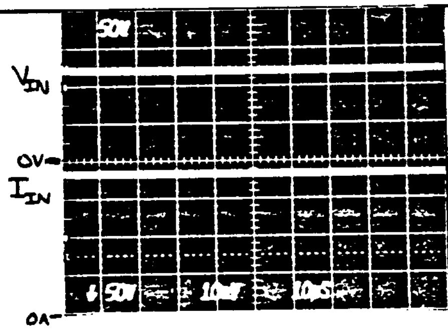
Specific Case: REGULATION — 230 W, 120 VIN

Input Voltage: 120.0 Vdc DC Rcvr: —

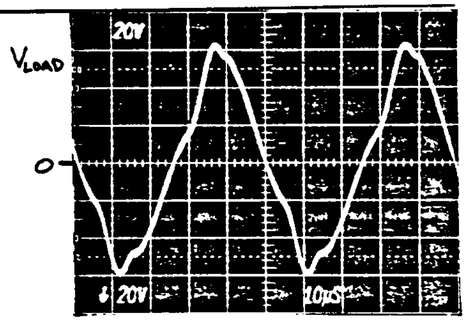
Input Current: 6.89 Adc AC Rcvr: —

System Frequency: 20.3 kHz BD Module: —

Output Power: 224.3 W Other: LOAD — 35.9 Vrms



Scale: 2A/



Scale:

Photo

Scale

Photo

Scale:

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

Specific Case: REGULATION – 230W, 120 V_{IN}

Input Voltage: Same

DC Rcvr: ______

Input Current: ______

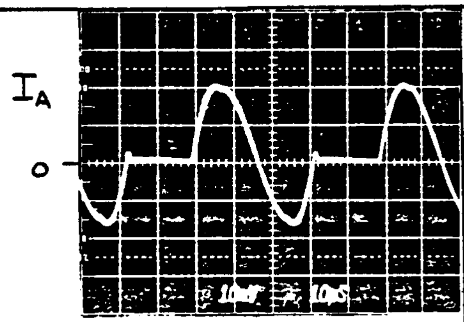
AC Rcvr: ______

System Frequency: ______

BD Module: ______

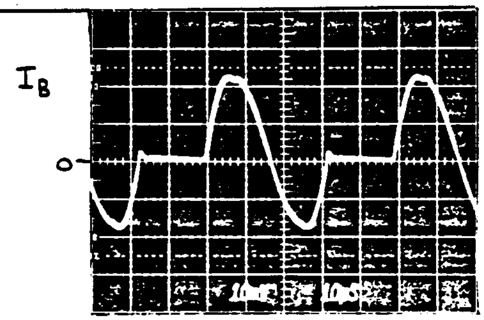
Output Power: ______

Other: ______



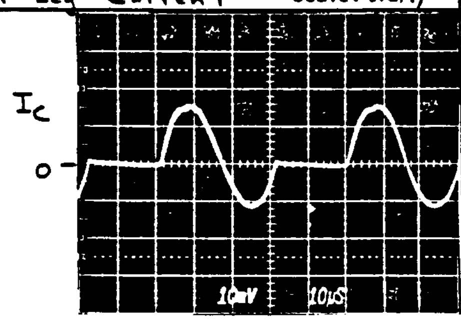
INVERTER 1

1A Leg Current Scale: 20A/



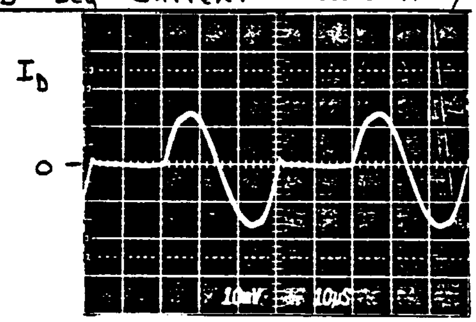
INVERTER 1

1B Leg Current Scale: 20A/



INVERTER 2

1C Leg Current Scale: 20A/



INVERTER 2

1D Leg Current Scale: 20A/

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY- STATE OPERATION

Specific Case: REGULATION — 230W, 120 V_{IN}

Input Voltage: ______ DC Rcvr: ______

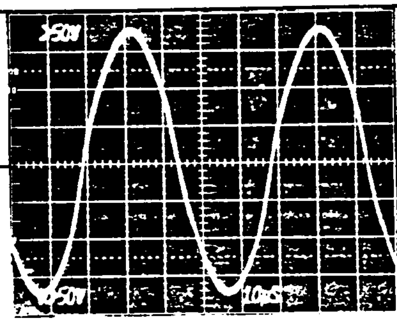
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______

V_{K1}

0

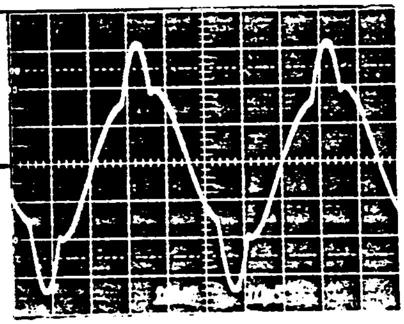


INVERTER 1

Output Voltage Scale: Not to Scale

I_{K1}

0

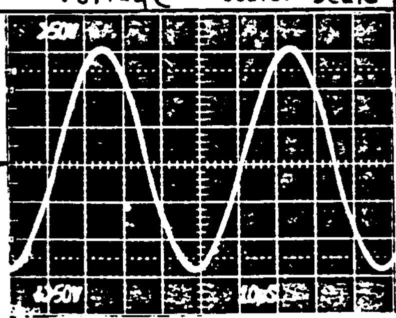


INVERTER 1

Tank Current Scale: 20A/

V_{K2}

0

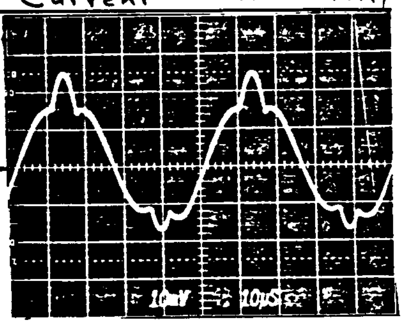


INVERTER 2

Output Voltage Scale: Not to Scale

I_{K2}

0



INVERTER 2

Tank Current Scale: 20A/

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

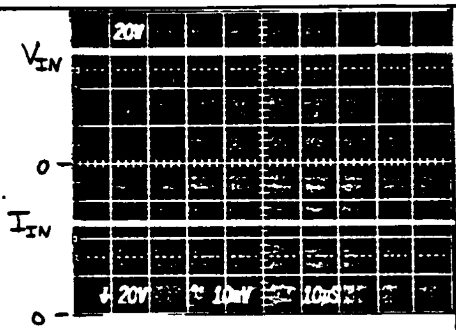
Specific Case: REGULATION-450W, 60 V_{IN}

Input Voltage: 60.50 Vdc — **DC Rcvr:** —

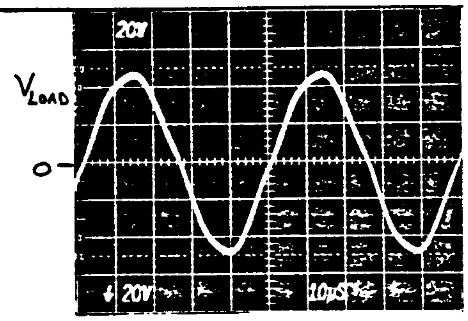
Input Current: 11.42 Adc — **AC Rcvr:** —

System Frequency: 20.3 KHz — **BD Module:** —

Output Power: 421.7 W — **Other:** LOAD - 34.2 V_{rms}



INPUT VOLTAGE & CURRENT **Scale:** 5A/



LOAD VOLTAGE **Scale:**

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Scale:

Photo

Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

Specific Case: REGULATION — 450W, 60V/IN

Input Voltage: Same. DC Rcvr:

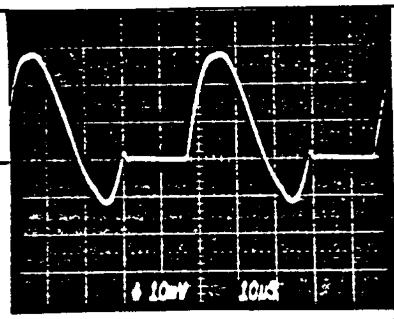
Input Current: AC Rcvr:

System Frequency: BD Module:

Output Power: Other:

I_A

0

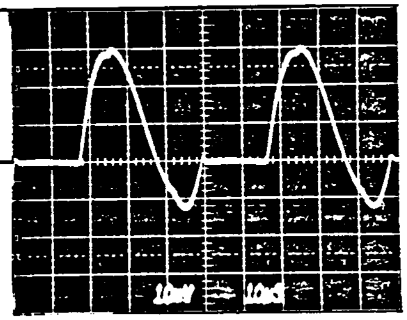


INVERTER 1

1A Leg Current Scale: 10A/

I_B

0

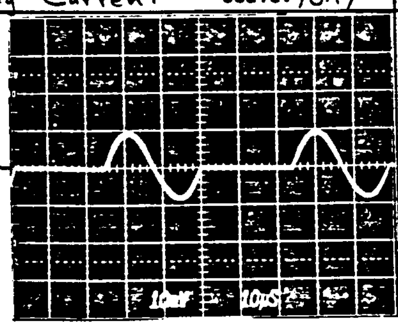


INVERTER 1

1B Leg Current Scale: 10A/

I_C

0

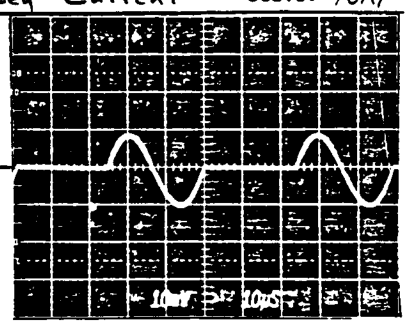


INVERTER 2

1C Leg Current Scale: 10A/

I_D

0



INVERTER 2

1D Leg Current Scale: 10A/

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

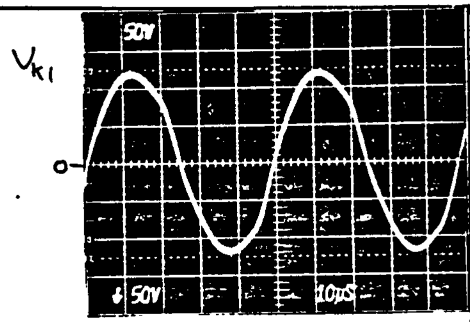
Specific Case: REGULATION- 450W, 60 V_{IN}

Input Voltage: ____________ DC Rcvr: ____________

Input Current: ____________ AC Rcvr: ____________

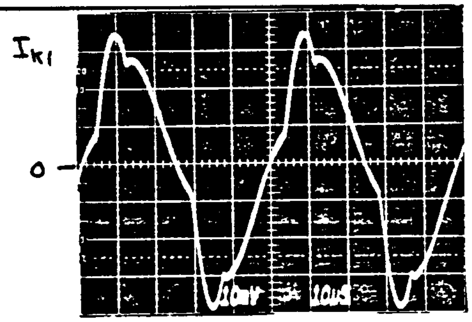
System Frequency: ____________ BD Module: ____________

Output Power: ____________ Other: ____________



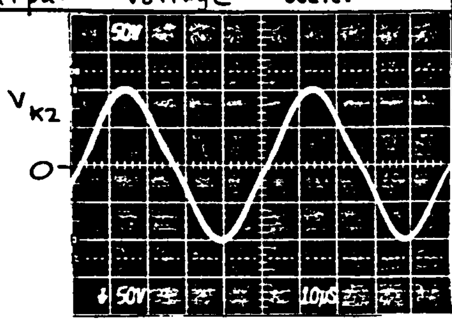
INVERTER 1

Output Voltage Scale:



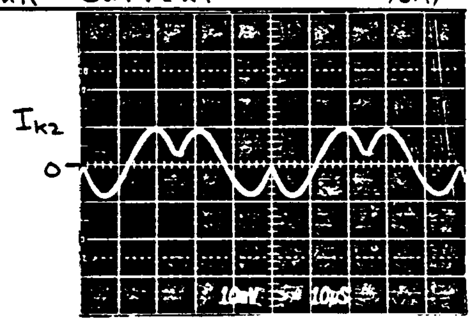
INVERTER 1

Tank Current Scale: 10A/



INVERTER 2

Output Voltage Scale:



INVERTER 2

Tank Current Scale: 10A/

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6.-3.2.2 STEADY-STATE OPERATION

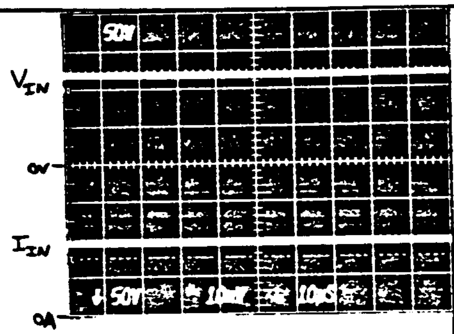
Specific Case: REGULATION- 450W, 120 Vdc

Input Voltage: 120.03 Vdc   DC Rcvr: —

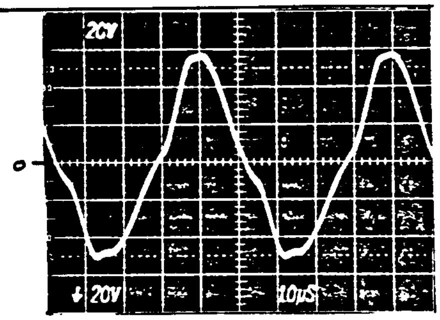
Input Current: 9.28 Adc.   AC Rcvr: —

System Frequency: 20.3 KHz   BD Module: —

Output Power: 447.9 W   Other: Load: 34.7 Vrms



INPUT VOLTAGE
+ CURRENT   Scale: 5A/



LOAD VOLTAGE   Scale:

Photo

Scale:

Photo

Scale:

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION

Specific Case: REGULATION — 450W, 120V

Input Voltage: Same

DC Rcvr:

Input Current:

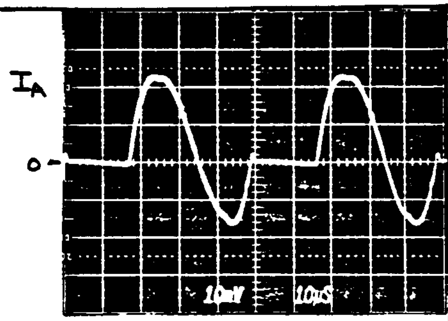
AC Rcvr:

System Frequency:

BD Module:

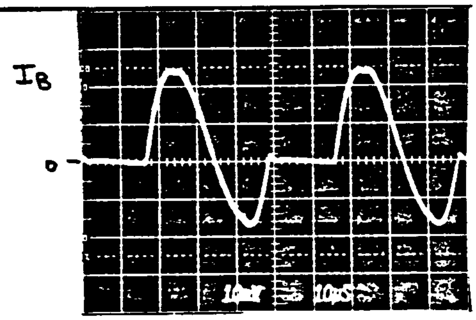
Output Power:

Other:



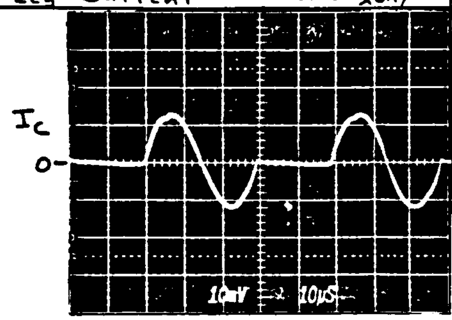
INVERTER 1

I_A Leg Current Scale: 20A/



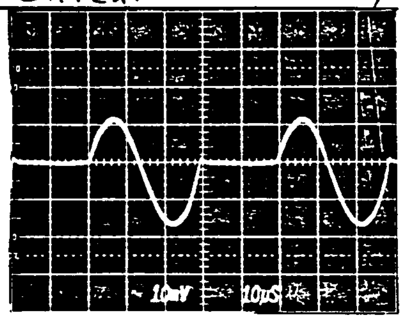
INVERTER 1

I_B Leg Current Scale: 20A/



INVERTER 2

I_C Leg Current Scale: 20A/



INVERTER 2

I_D Leg Current Scale: 20A/

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY STATE OPERATION

Specific Case: REGULATION - 450W, 120Vdc

Input Voltage: Same

DC Rcvr:

Input Current:

AC Rcvr:

System Frequency:

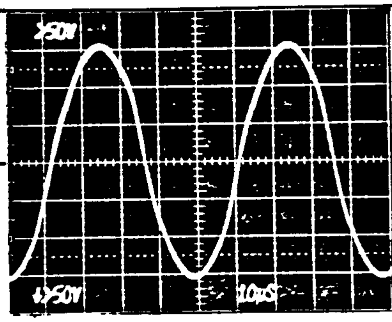
BD Module:

Output Power:

Other:

V_{k1}

0

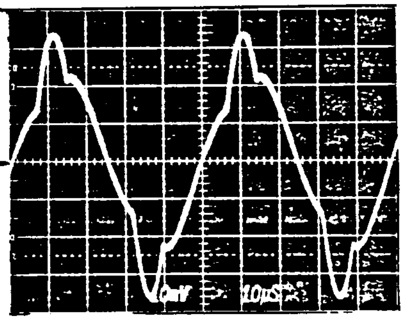


INVERTER 1

Output Voltage Scale: Not to Scale

I_{k1}

0

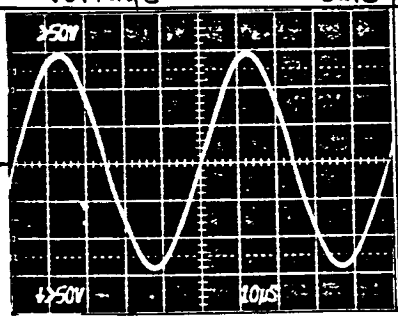


INVERTER 1

Tank Current Scale: 20A/

V_{k2}

0

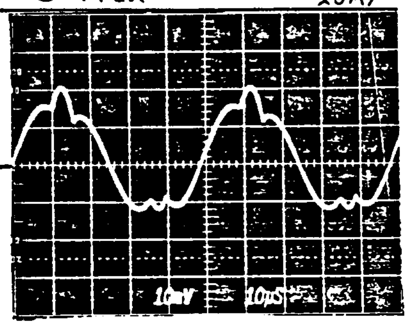


INVERTER 2

Output Voltage Scale: Not to Scale

I_{k2}

0



INVERTER 2

Tank Current Scale: 20A/

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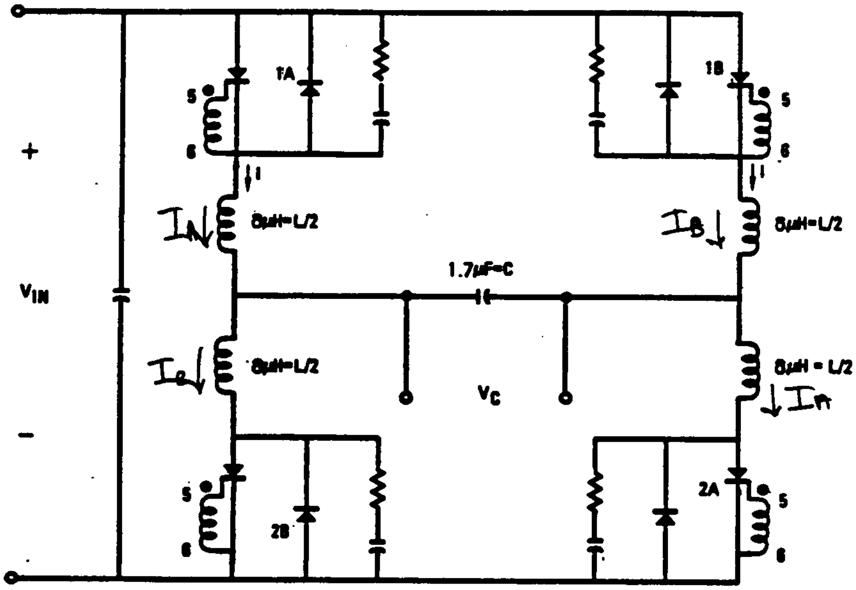

SCRs	C164M
DIODES	A139M
SNUBBER	110Ω
	.01μF

INVERTER SCHEMATIC

$I_A + I_B$

Tetronix 6303 Current Probe 143498
146540

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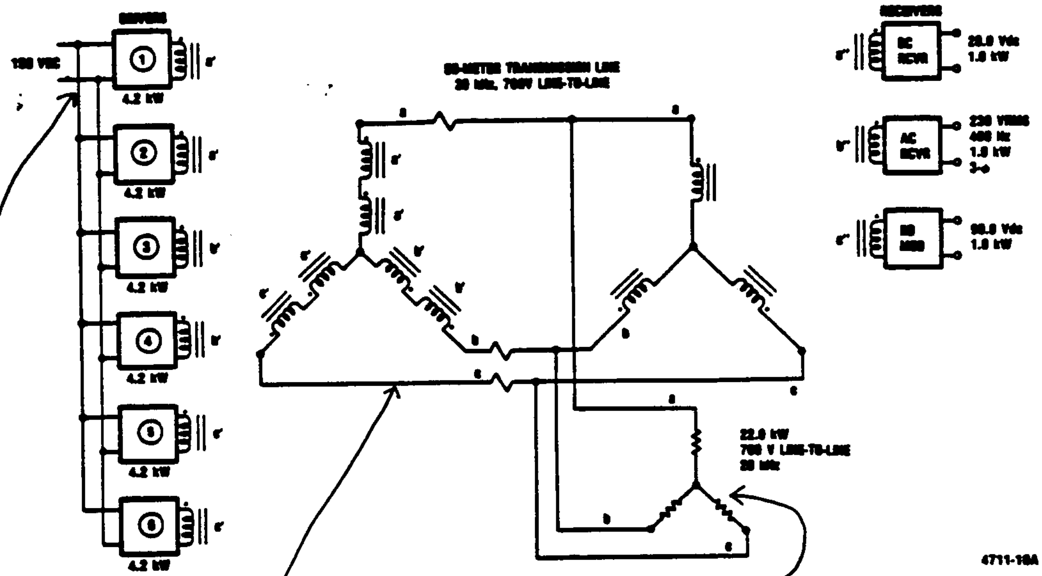


Inverter End Bus

7603 Tektronix Scope – (143207)
HP 332A (129193)
Distortion Analyzer

Bus Frequency

HP 5315A
(142898)

Resistive Loads

Phase a: V: HP 3466A (143140)
I: T&M 5.028 mΩ +
Fluke 8810A (143180)

Phase b: V: HP 3466A (143140)
I. T&M 4.922 mΩ
Fluke 8810A (143180)

Phase c: V: HP 3466A (143140
I. T&M 5.044 mΩ
Fluke 8810A (143180)

INSTRUMENTATION

DC Input

V: Fluke 8050A
146266
I: Fluke 8850A + 300A/50mV (D.C.)
146268 Shunt
Tetronix A6303 Current Probe 143498 (A.C.)
Tetronix CT-5 Current Trans. 146477 (A.C.)
with Tektronix A6302 Current Probe

Inverter End of Bus

Phase a: V: HP3435A (43428)
Phase b: V: Fluke 8000A (134778)
Phase c: V: Fluke 8810A (143180)
Phase a: I: Fluke 8810A (143180)
T&M 1.0118 mΩ
Phase b: I: Fluke 8810A (143180)
T&M 1.0106 mΩ
Phase c: I: Fluke 8810A (143180)
T&M 1.0170 mΩ

RECEIVERS

AC RCVR: V-I-P: Clarke-Hess 255
(143363)

DC RCVR: V: Fluke 8050A
(146265)
I: SRI 900079 +
50A/50mV Shunt
(145340)

BD RCVR: V: Tek DM501A
(143410)
I: 50A/50mV Shunt +
(145338)
Tek DM502A
(143408)

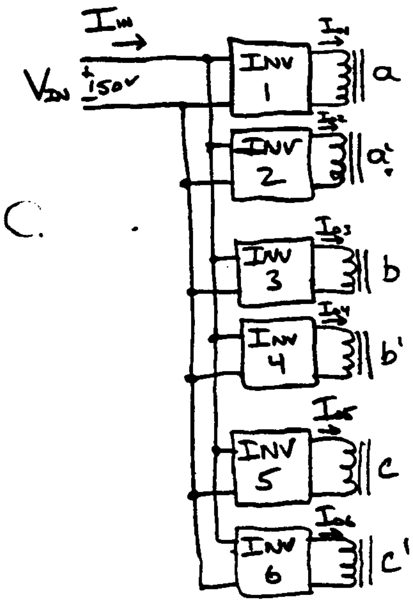
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.7 - 3.2.2 Steady State Operation

STEADY STATE OPERATION

Test Circuits



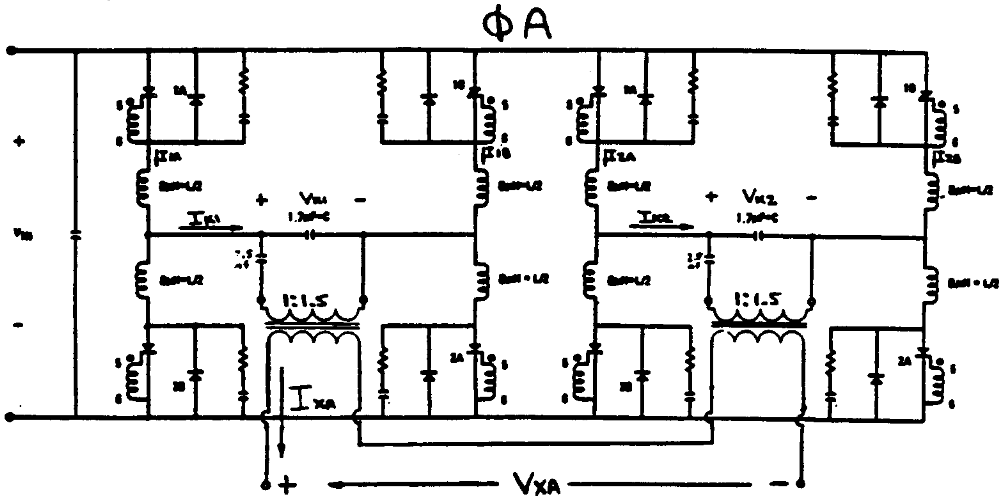
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.7 - 3.2.2 Steady-State Operation

UnCompensated

Test Circuits



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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.2 Steady State Operation

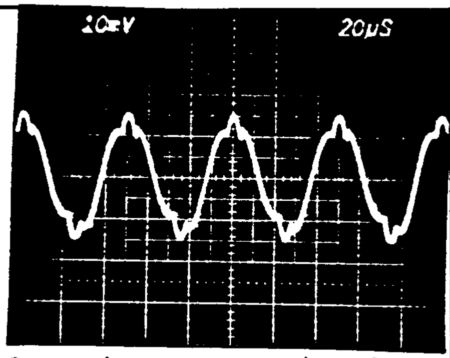
Specific Case: C-Compensation, No Load

Input Voltage: 150 DC Rcvr: 28.7 V_{DC}

Input Current: ______ AC Rcvr: OFF

System Frequency: ______ BD Module: 111.3 V_{DC}, 20.1 W

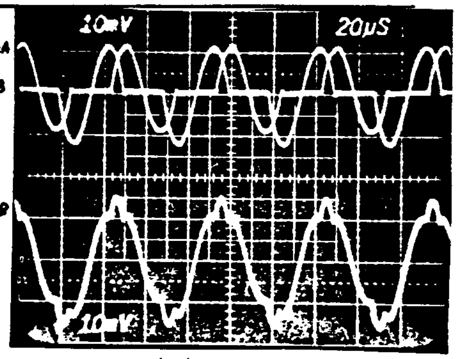
Output Power: ______ Other: ______



Resonant Tank Current of Inverter #1, I_{K1}

Scale: 50A/Div

I_A
$-I_B$
$I_A - I_B = I_{K1}$



$I_A - I_B$ addition performed by Oscilloscope

Scale: 50 A/Div

Photo

Scale:

Photo

Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.2 Steady-State Operation

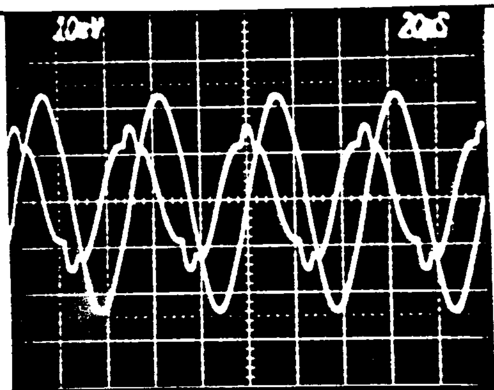
Specific Case: C - Compensation, No Load

Input Voltage: ______ DC Rcvr: ______

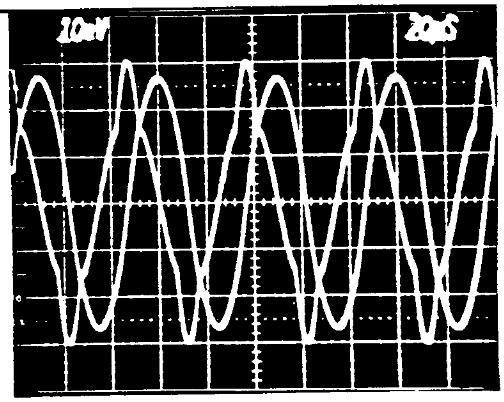
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

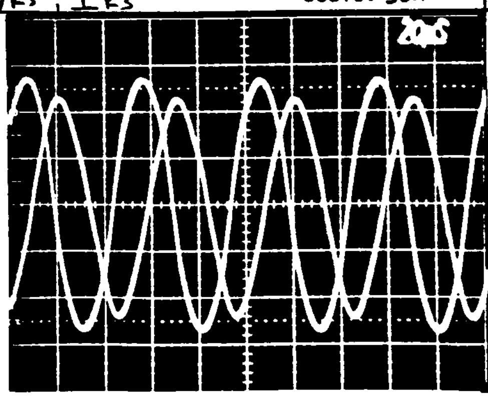
Output Power: ______ Other: ______



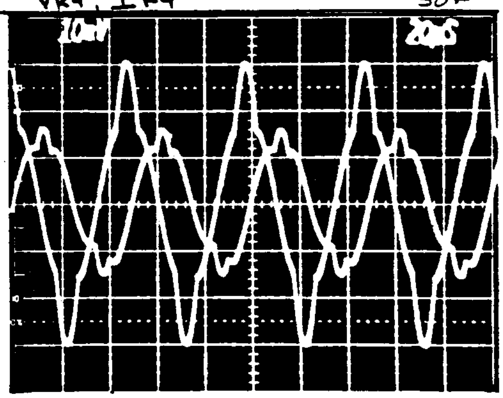
V_{K3}, I_{K3} Scale: UnCal V 50A



V_{K4}, I_{K4} Scale: UnCal V 50A



V_{K3}, V_{K4} 108° Scale: UNCAL



I_{K3}, I_{K4} Scale: 50 A

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

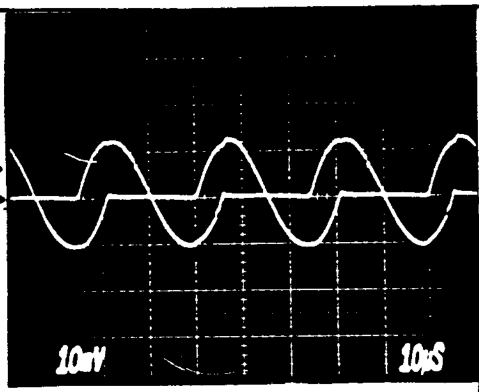
Test-Configuration: 2.3.7 - 3.2.2 Steady State Operation

Specific Case: C-Compensation, No Load

Input Voltage:	Same	DC Rcvr:	Same
Input Current:		AC Rcvr:	
System Frequency:		BD Module:	
Output Power:		Other:	

I_{SA}

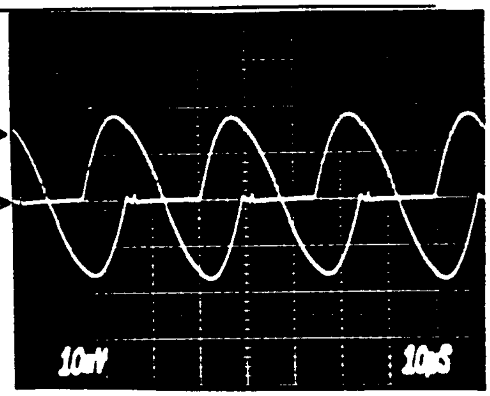
I_{SB}



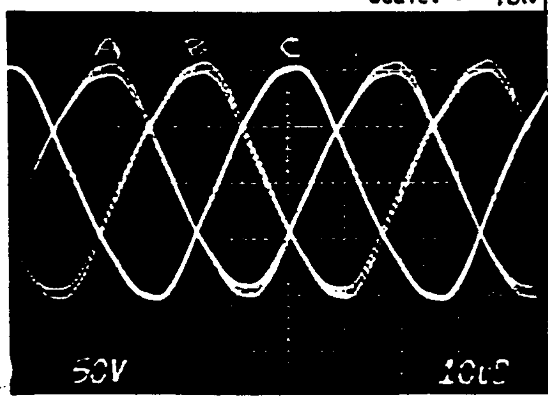
Scale: 50A/Div

I_{CA}

I_{CB}



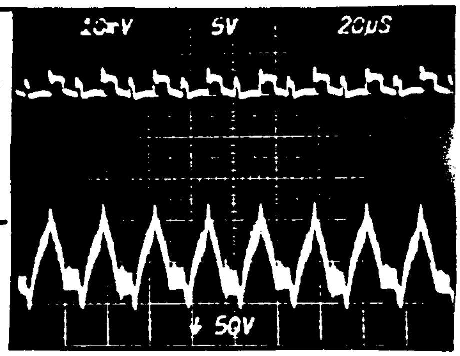
Scale: 50 A/Div



Scale: 320V/Div

V_{IN}

0V



D.C. Input Voltage 50 V/Div

A.C. Component of Input Current Scale: 5 A/Div

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady State Operation

Specific Case: C-Compensation, No Load

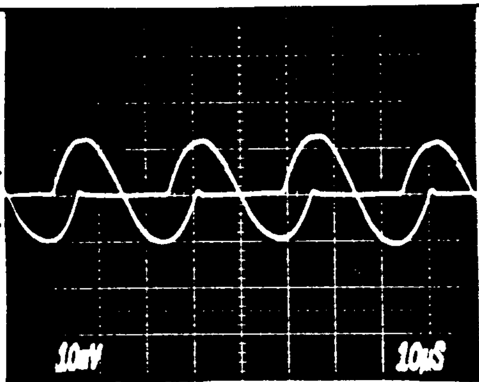
Input Voltage: 152.60 Vdc DC Rcvr: 28.75 Vdc, 0 Adc

Input Current: 21.0 Adc AC Rcvr: OFF

System Frequency: 19.96 KHz BD Module: 203 Vdc, 0 Adc

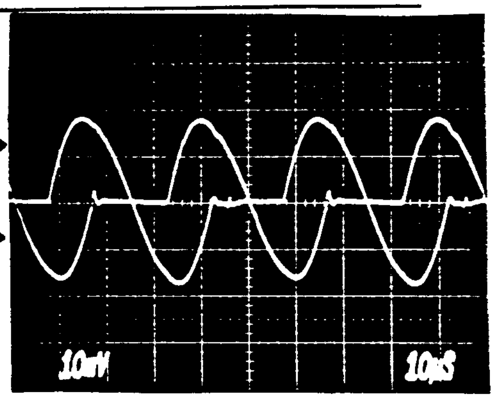
Output Power: 0 Other: NONE

I_{1B} →
I_{1A} →



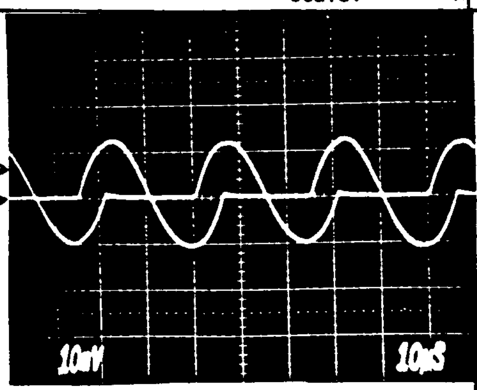
Scale: 50 A/Div

I_{2B} →
I_{2A} →



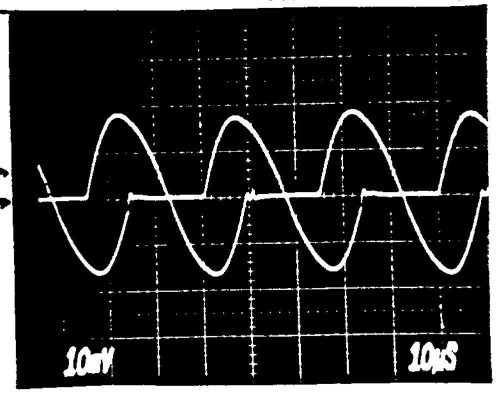
Scale: 50 A/Div

I_{3A} →
I_{3B} →



Scale: 50 A/Div

I_{4A} →
I_{4B} →



Scale: 50 A/Div

TEST CONFIG. 2.3.7-3.2.2 - Steady-State Op
SPECIFIC CASE C - Compensation, No Load

I) INPUT POWER

V_{in} 152.60
I_{in} 21.0 Adc
P_{IN} 3200 Watts

Frequency 19.96 KHz

T.H.D.
ΦA -24.3 db = 6.10%
ΦB -24.5 db = 5.96%
ΦC - 26.5 db = 4.73%

T.H.D. — TRANSMISSION LINE
INTO THE LINE
ΦA

II) OUTPUT POWER

ΦA	ΦB	ΦC
V_o 441	V_o 442	V_o 442
I_o ____	I_o ____	I_o ____
P_o ____	P_o ____	P_o ____

A.C. RCVR	B/D MOD.	D.C. RCVR
V_o OFF	V_o 203 Vdc	V_o 28.75
I_o ____	I_o 0	I_o 0
P_o ____	P_o ____	P_o ____

T.H.D. Out of RCVR
________ db

RESISTIVE LOADS

ΦA	ΦB	ΦC
V_A 445.3 Vac	V_B 444.6 Vac	V_C 445.0 Vac
I_A 0 mv	I_B 0 mv	I_C 0 mv
I_A ____ Aac	I_B ____ Aac	I_C ____ Aac
P_{RA} ____	P_{RB} ____	P_{RC} ____

Total System Efficiency = $\frac{P_{OUT}}{P_{in}}$ = ________ = %

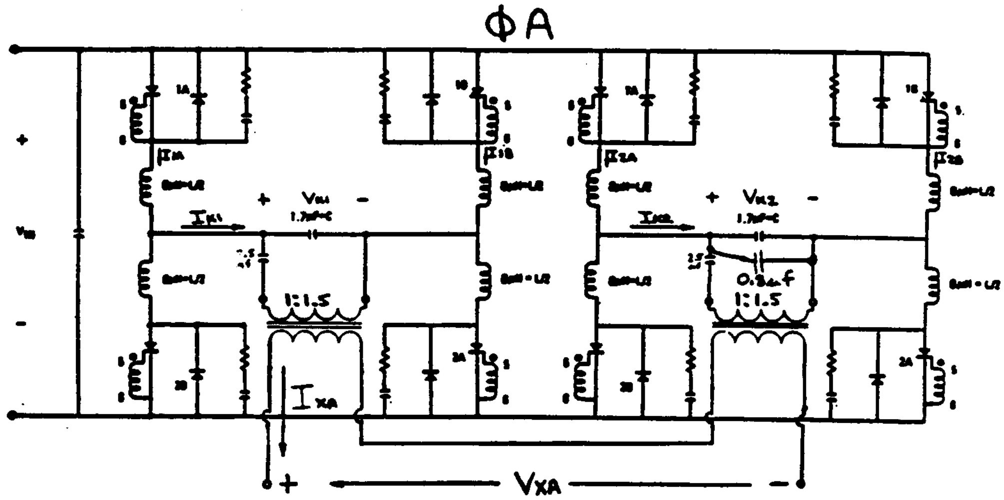
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.7 - 3.2.2 Steady-State Operation

C- Compensation

Test Circuits



RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady-State Operation

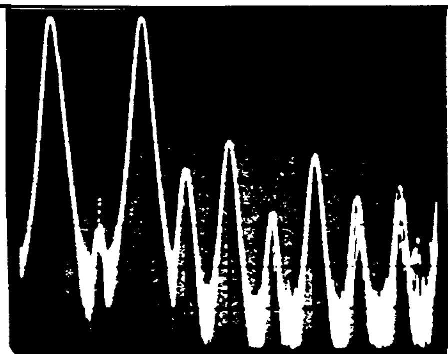
Specific Case: No Compensation, Full Load

Input Voltage: ______ DC Rcvr: ______

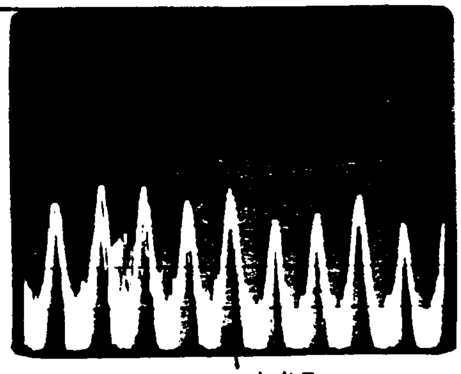
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______



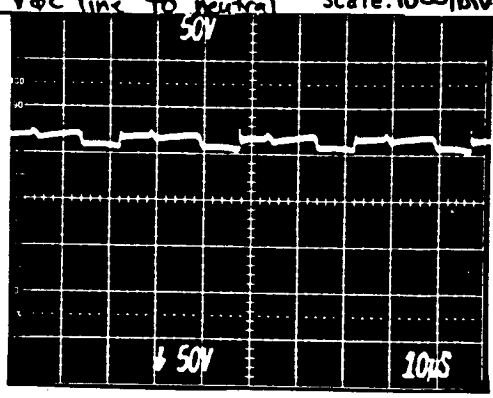
60KHZ



200KHZ

Voc line to neutral Scale: 10db/DIV

Voc line to neutral Scale: 10db/DIV



Scale: 50V/DIV

Photo

Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

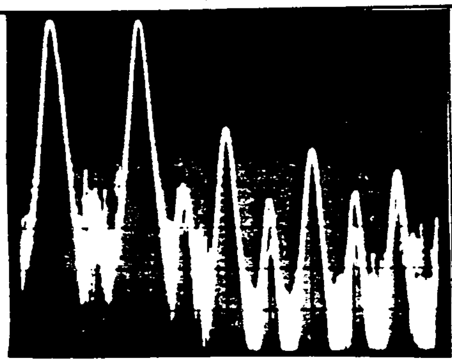
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

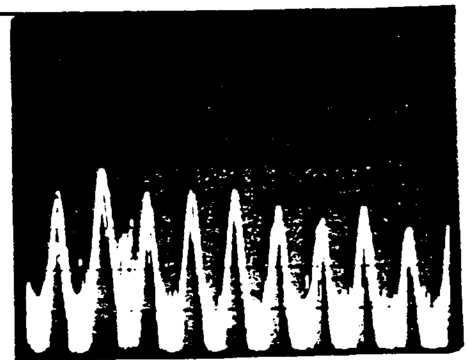
Test-Configuration: 2.3.7 - 3.2.2 Steady- State Operation

Specific Case: No Compensation; Full Load

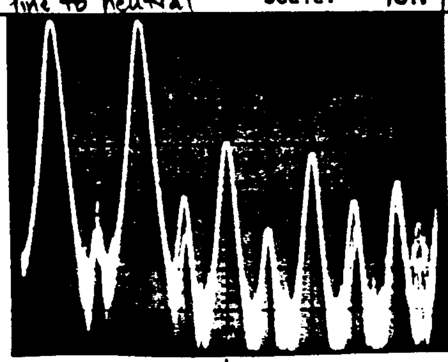
Input Voltage: Same	DC Rcvr: Same
Input Current:	AC Rcvr:
System Frequency:	BD Module:
Output Power:	Other:



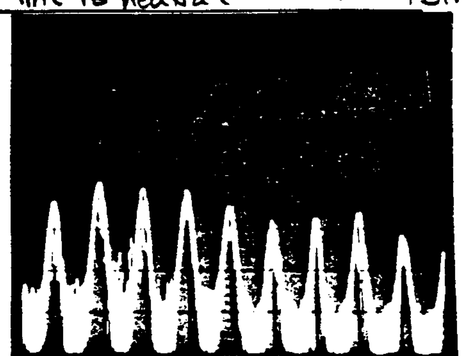
Vφa line to neutral Scale: 10db/DIV



Vφa line to neutral Scale: 10 db/DIV



Vφb line to neutral Scale: 10db/DIV



Vφb line to neutral Scale: 10 db/DIV

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady-state Operation

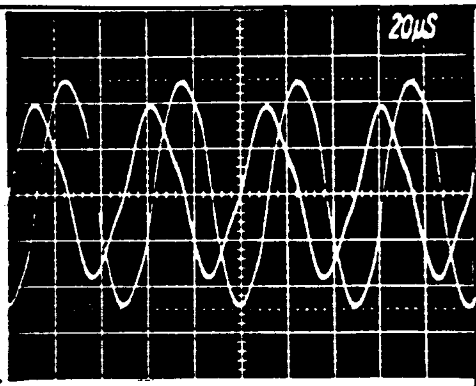
Specific Case: Un Compensated, Full Load

Input Voltage: ______ DC Rcvr: ______

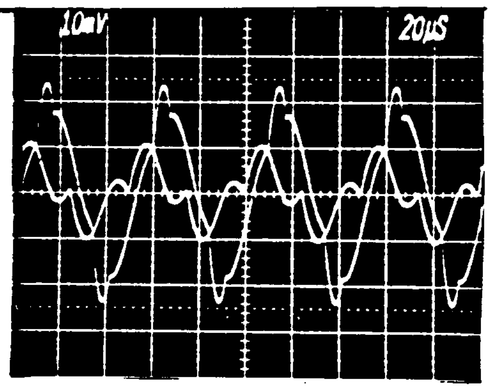
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

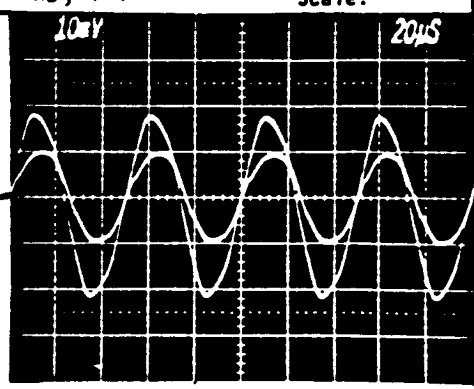
Output Power: ______ Other: ______



V_{K3}, V_{K4} Scale:



I_{K3}, I_{K4} Scale: 50A/Div



Scale: 320V/Div 20A/Div

SCR SWITCH

Photo

Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

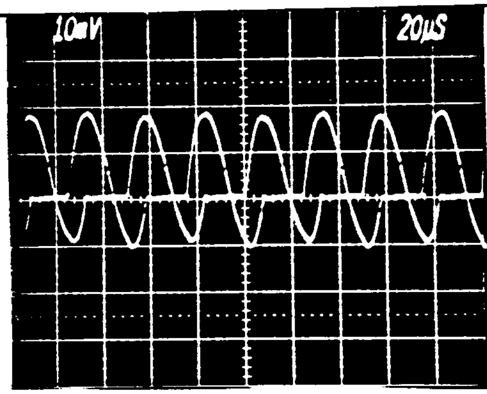
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

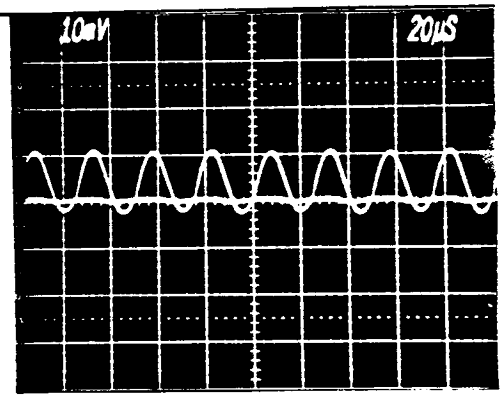
Test-Configuration: 2.3.7-3.2.2 Steady-State Operation

Specific Case: UNCompensated, Full Load

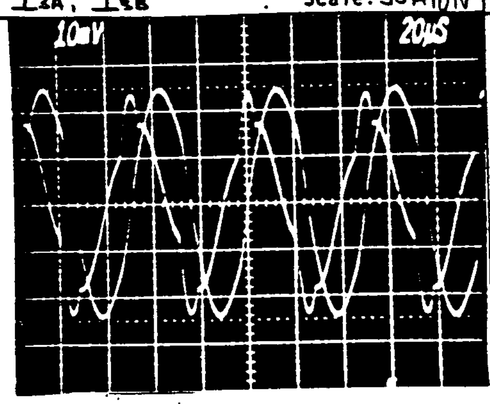
Input Voltage:	DC Rcvr:
Input Current:	AC Rcvr:
System Frequency:	BD Module:
Output Power:	Other:



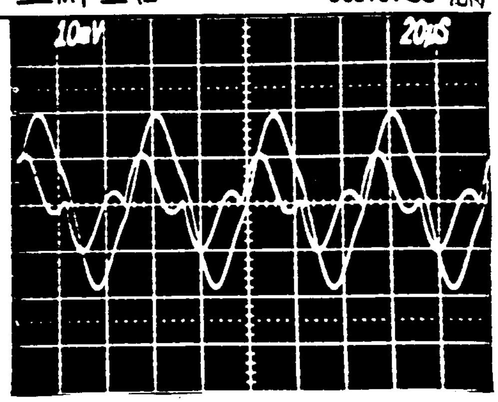
I_{3A}, I_{3B} Scale: 50A/Div



I_{4A}, I_{4B} Scale: 50A/Div



V_{K3}, I_{K3} Scale: 50 A/Div



V_{K4}, I_{K4} Scale: 50A/Div

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.2 Steady - State Operation

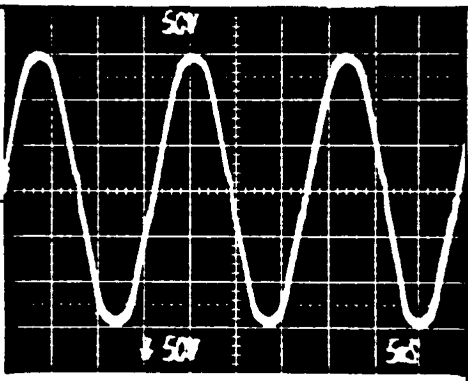
Specific Case: UNCOMPENSATED, FULL LOAD

Input Voltage: Same DC Rcvr: Same

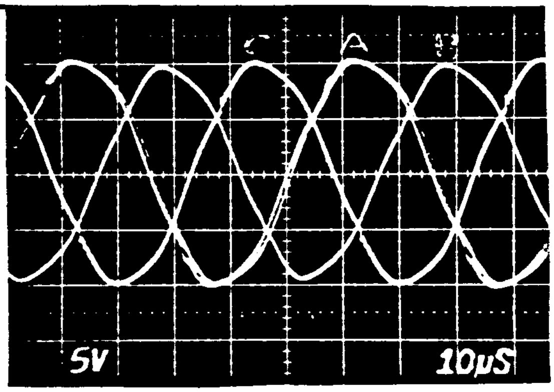
Input Current: AC Rcvr:

System Frequency: BD Module:

Output Power: Other:



A.C. Receiver Output Voltage Scale: 50 V/DIV



Scale: 320 V/DIV

Photo

Scale:

Photo

Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.2 Steady-State Operation

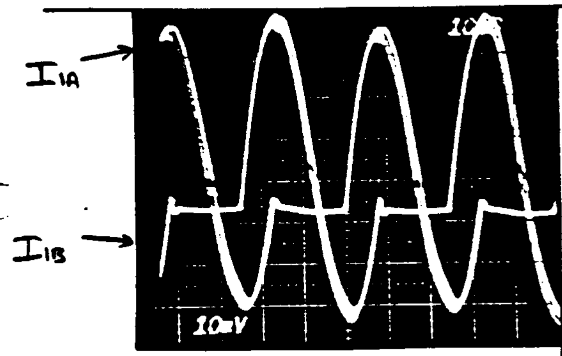
Specific Case: UNCOMPENSATED, FULL LOAD

Input Voltage: 150.2 VDC | DC Rcvr: 1026 Watts

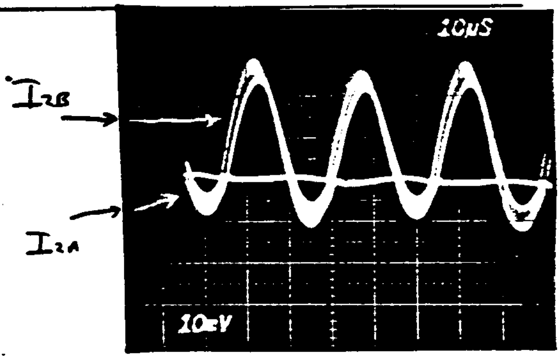
Input Current: 128.9 ADC | AC Rcvr: 480 Watts

System Frequency: ______ | BD Module: 809 Watts

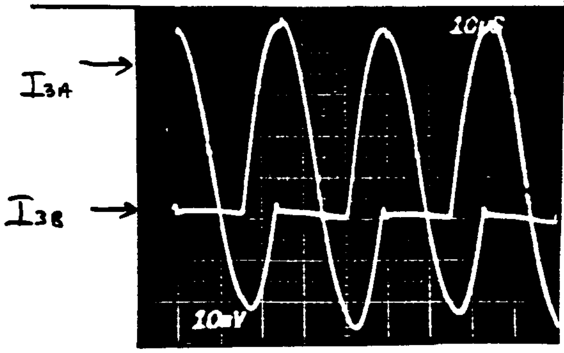
Output Power: 16.2 KW | Other: None



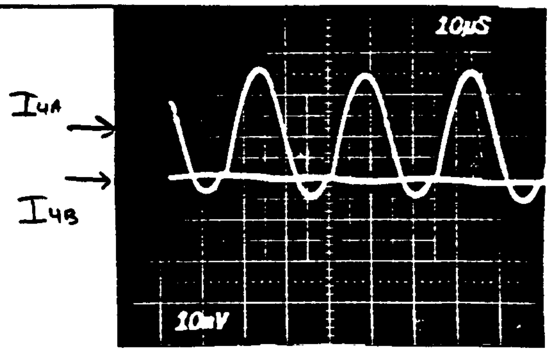
Scale: 20 A/DIV



Scale: 20 A/DIV



Scale: 20 A/DIV



Scale: 20 A/DIV

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STEADY-STATE OPER.
SPECIFIC CASE NO COMP, FULL LOAD

I) INPUT POWER

V_{in} 150.2
I_{in} 128.9
P_{in} 19.36 kW

T.H.D.
ΦA -27.21 db = 4.36%
ΦB -28.75 db = 3.65%
ΦC -28.0 db = 3.98%

T.H.D. — TRANSMISSION LINE
INTO THE LINE
ΦA

II) OUTPUT POWER

ΦA	ΦB	ΦC
V_o 445	V_o 445	V_o 444.95
I_o	I_o	I_o
P_o	P_o	P_o

A.C. RCVR	D.C. RCVR	BIO RCVR
V_o 106	V_o 28.16	V_o 97.7
I_o 452	I_o 36.44	I_o 8.28
P_o 480	P_o 1026 watts	P_o 809 watts

T.H.D. Out of Rcvr
-30.4 db = 3.02%

RESISTIVE LOADS

ΦA	ΦB	ΦC
V_A 431.1	V_B 432.1	V_C 429.7
I_A 10.58	I_B 11.77	I_C 9.94
P 4.56 kW	P 5.09 kW	P 4.27 kW

Total System Efficiency $= \frac{16,235}{19,360} =$ 83.86 %

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.2 Steady-State Operation

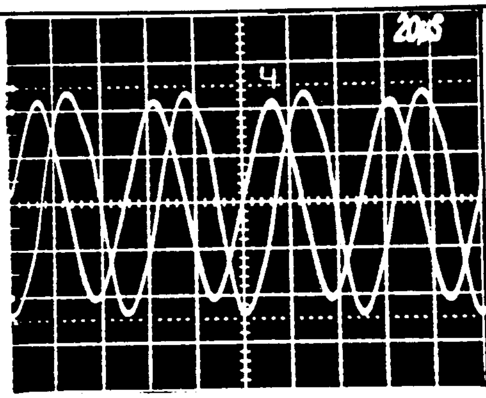
Specific Case: Un Compensated, 50 % Load

Input Voltage: ____ DC Rcvr: ____

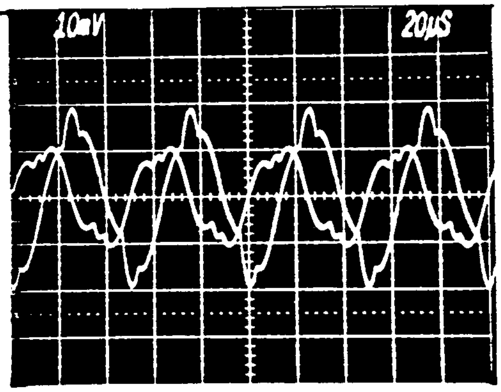
Input Current: ____ AC Rcvr: ____

System Frequency: ____ BD Module: ____

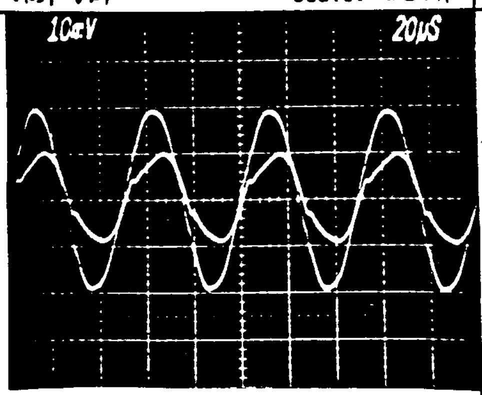
Output Power: ____ Other: ____



V_{K3}, V_{K4} Scale: UnCal.



I_{K3}, I_{K4} Scale: 50A



V_{X8}, I_{X8} Scale: 320V/Div 10A/Div

SCR ([illegible]) SWITCH IN SERIES WITH LOAD

Photo

Scale:

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady-State Operation

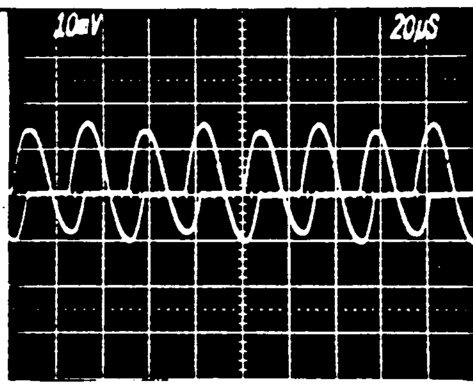
Specific Case: UnCompensated, 50% Load

Input Voltage: ______ DC Rcvr: ______

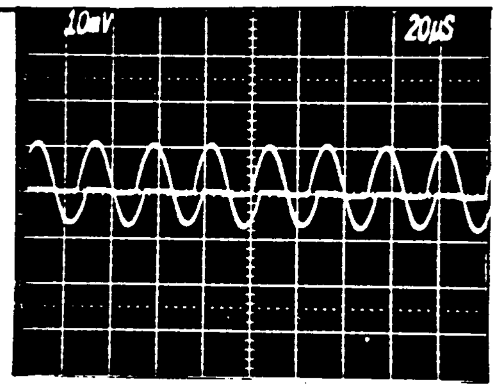
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

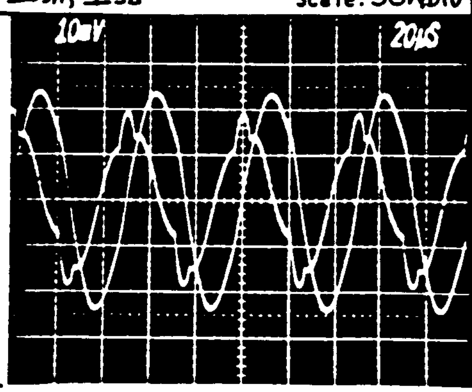
Output Power: ______ Other: ______



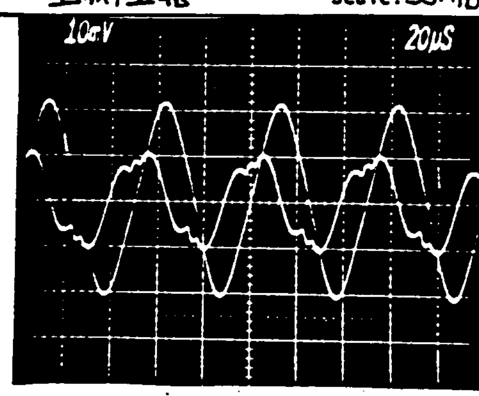
I_{3A}, I_{3B} Scale: 50A/Div



I_{4A}, I_{4B} Scale: 50A/Div



V_{K3}, I_{K3} Scale: Uncal V. 50 A/Div



V_{K4}, I_{K4} Scale: Uncal V 50A

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady State Operation

Specific Case: 50% Load, No Compensation

Input Voltage: 151.1 Vdc   DC Rcvr: 1035 Watts

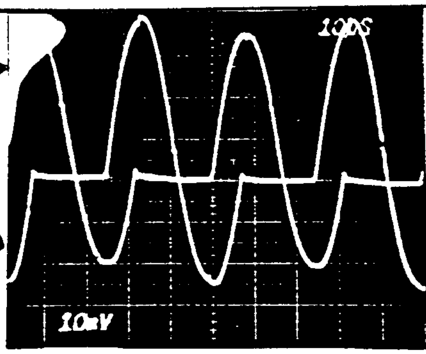
Input Current: 69.42 Adc   AC Rcvr: 455 Watts

System Frequency: ______   BD Module: 886 Watts

Output Power: 7,536 Watts   Other: None

I_{3A}

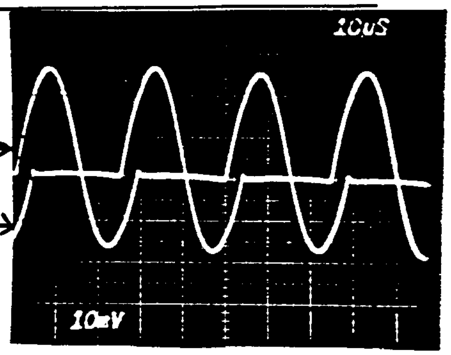
I_{3B}



Scale: 20A/DIV

I_{4A}

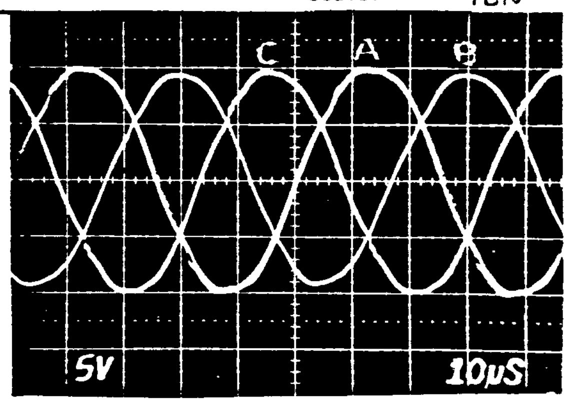
I_{4B}



Scale: 20 A/DIV

Photo

Scale:



INVERTER OUTPUT VOLTAGES Scale: 320V/DIV

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2.3.7-3.2.2 Steady-State Oper.

SPECIFIC CASE NO COMP, 50% LOAD

I) INPUT POWER

V_{in} 151.1

I_{in} 11.57×6

P_{in} 10,490

T.H.D.

ΦA -28.4 db = 3.80%

ΦB -32.9 db = 2.26%

ΦC -31.0 db = 2.82%

T.H.D. — TRANSMISSION LINE

INTO THE LINE

ΦA

II) OUTPUT POWER

ΦA	ΦB	ΦC
V_o ____	V_o ____	V_o ____
I_o ____	I_o ____	I_o ____
P_o ____	P_o ____	P_o ____

A.C. RCVR	D.C. RCVR	B/D RCVR
V_o 106	V_o 28.15	V_o 94.6
I_o 4.46	I_o 36.76	I_o 9.37
P_o 455	P_o 1035	P_o 886.4

T.H.D. out of RCVR

________ db

RESISTIVE LOADS

ΦA	ΦB	ΦC
V_A 433.7	V_B 434.9	V_C 431.3
I_A 24.65mv = 4.90 Aac	I_B 18.99mv = 3.80 Aac	I_C 15.88mv = 3.15 Aac
P 3126 Watts	P 1676 Watts	P 1358 Watts

Total System Efficiency $= \frac{7536}{10,490} = 71.8\%$

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 -3.2.2 Steady-State Operation

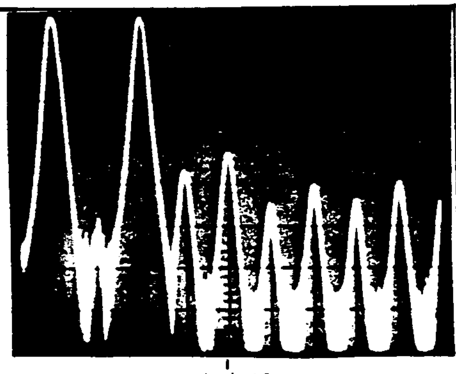
Specific Case: No Compensation, No Load

Input Voltage: ____________ DC Rcvr: ____________

Input Current: ____________ AC Rcvr: ____________

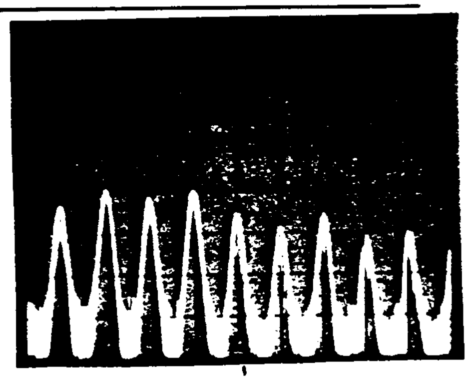
System Frequency: ____________ BD Module: ____________

Output Power: ____________ Other: ____________



60KHz

Vac line to neutral Scale: 10db/div



200KHz

Vac line to neutral Scale: 10db/Div

Photo

Scale:

Photo

Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady-State Operation

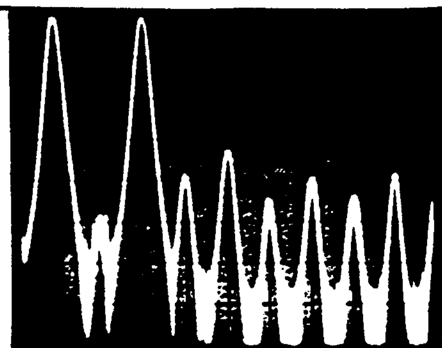
Specific Case: No Compensation, No Load

Input Voltage: Same DC Rcvr: Same

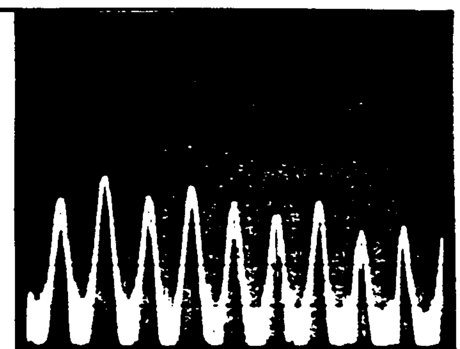
Input Current: AC Rcvr:

System Frequency: BD Module:

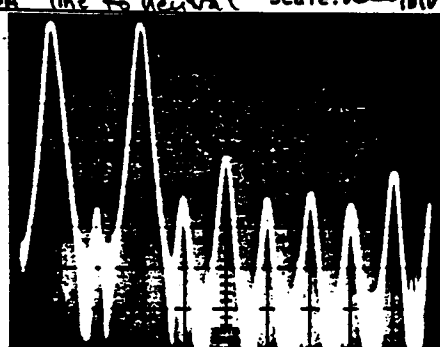
Output Power: Other:



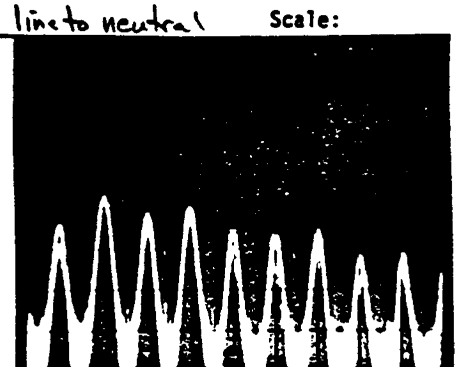
VAN line to neutral Scale: 10db/div



VAN line to neutral Scale:



VAB line to neutral Scale: l



VAB line to neutral Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.2 Steady-State Operation

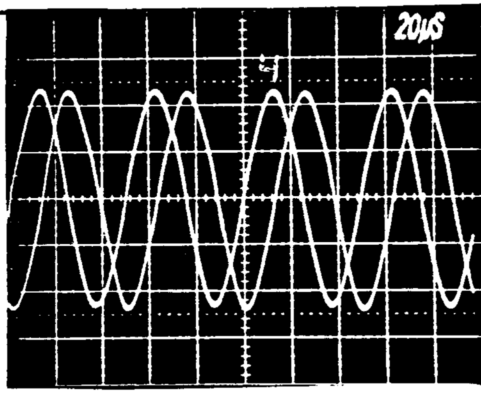
Specific Case: Un Compensated, No Load

Input Voltage: ____________ DC Rcvr: ____________

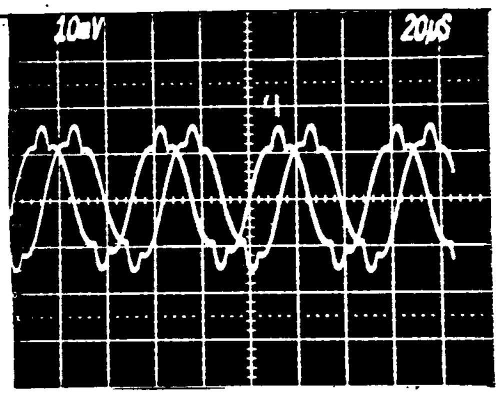
Input Current: ____________ AC Rcvr: ____________

System Frequency: ____________ BD Module: ____________

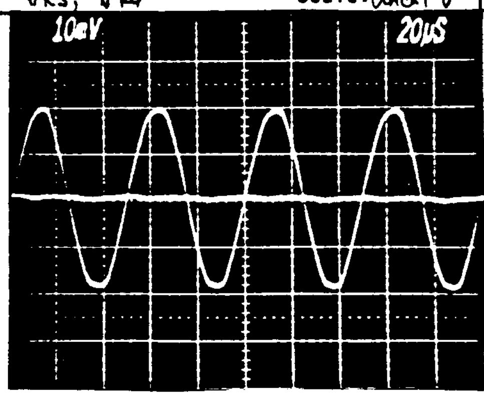
Output Power: ____________ Other: ____________



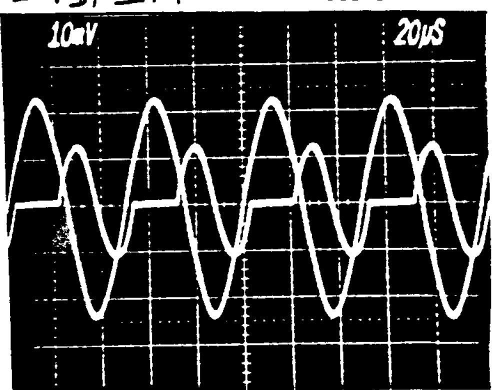
V_{K3}, V_{K4} Scale: Uncal V



I_{K3}, I_{K4} Scale:



V_{XB}, I_{XB} Scale: 320 V/Div 50 A/Div



V_{K3}, I_{3B} Scale: Uncal V 50A

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.2 Steady-State Operation

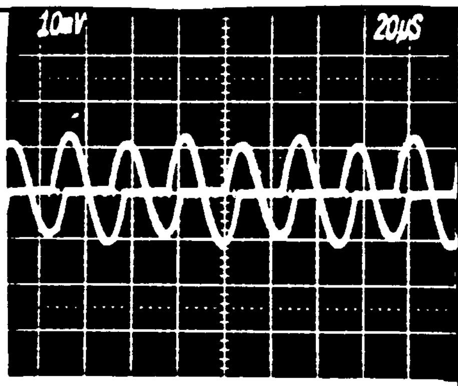
Specific Case: UnCompensated, No Load

Input Voltage: ______ DC Rcvr: ______

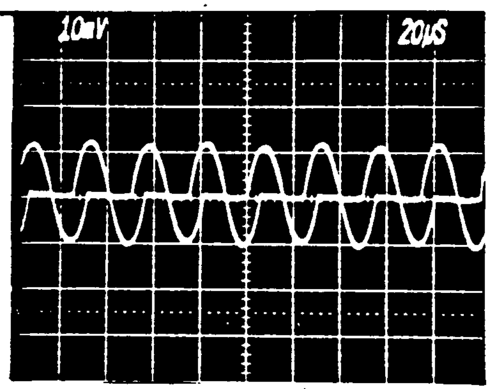
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

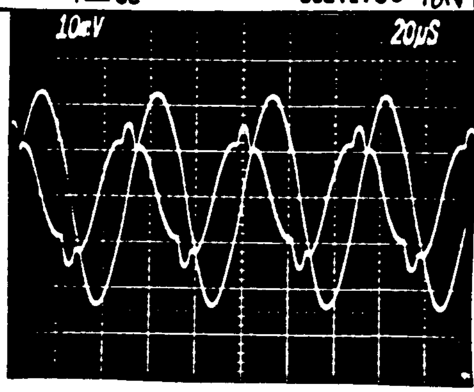
Output Power: ______ Other: ______



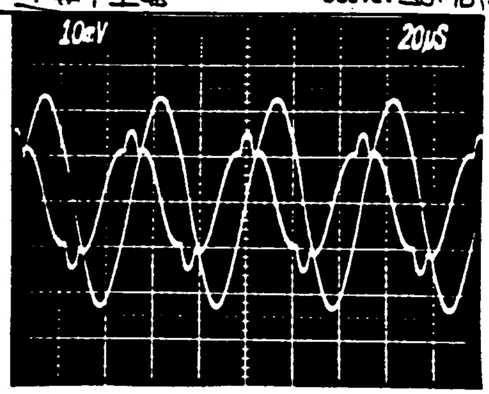
I_{3A}, I_{3B} Scale: 50A/Div



I_{4A}, I_{4B} Scale: 50A/Div



V_{K3}, I_{K3} Scale: Uncal V 50A/Div



V_{K4}, I_{K4} Scale: Uncal V 50A/Div

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 – 3.2.2 Steady State Operation

Specific Case: No Load, No Compensation

Input Voltage: 150.0 DC Rcvr: OFF

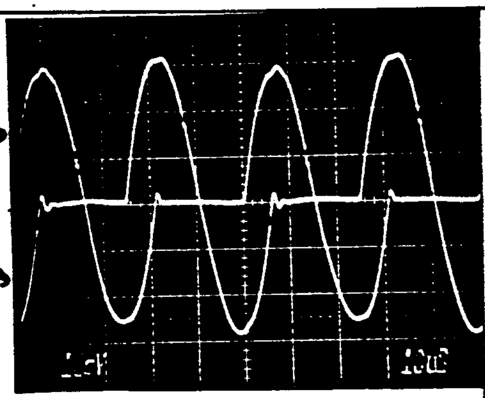
Input Current: 13.8 Amps AC Rcvr: OFF

System Frequency: 19.84 KHZ BD Module: OFF

Output Power: Ø. Other: Φ

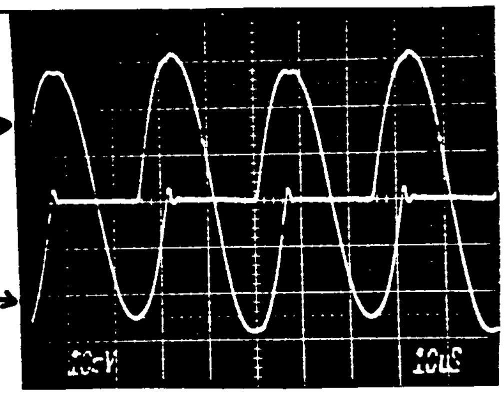
I1A →

I1B →



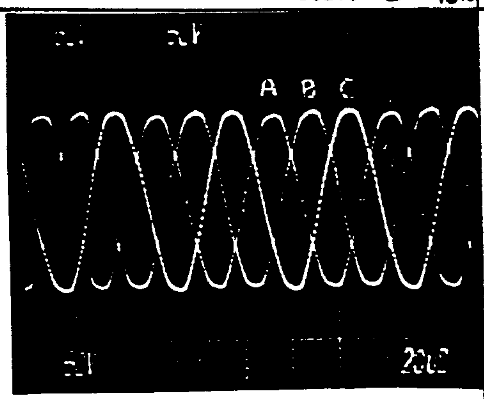
I2A →

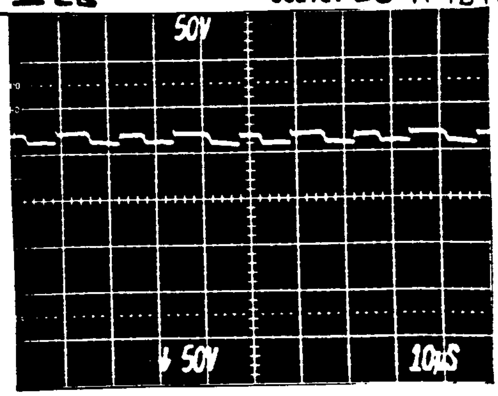
I2B →



I1A, I1B Scale: 20A/Div

I2A, I2B Scale: 20 A/Div





VA, VB, + VC Scale: 320V/Div

Input Voltage, VDC Scale: 50V/Div

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STEADY-STATE OPER.
SPECIFIC CASE Uncompensated - No load

I) INPUT POWER

V_{in} 150.9
I_{in} 13.98
P_{in} 2110W

F = 19.912 kHz

T.H.D.
ΦA -33.6 db = 2.09%
ΦB -34.8 db = 1.82%
ΦC -33.35 db = 2.15%

T.H.D. — TRANSMISSION LINE
INTO THE LINE
ΦA

II) OUTPUT POWER

ΦA	ΦB	ΦC
V_o 437.8	V_o 441.5	V_o 442.3
I_o ___	I_o ___	I_o ___
P_o ___	P_o ___	P_o ___

A.C. RCVR OFF	D.C. RCVR	B/D RCVR
V_o 0	V_o 28.73Vdc	V_o 206Vdc
I_o 0	I_o 0	I_o 0
P_o ___	P_o ___	P_o ___

T.H.D. out of RCVR
-28.4 db

RESISTIVE LOADS

ΦA	ΦB	ΦC
V_A 438.5	V_B 442.2	V_C 442.8
I_A 0	I_B 0	I_C 0
P ___	P ___	P ___

Total System Efficiency

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.2 Steady State Operation

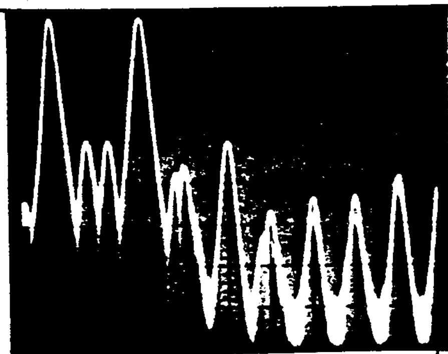
Specific Case: C - Compensation, No Load

Input Voltage: Same | DC Rcvr: Same

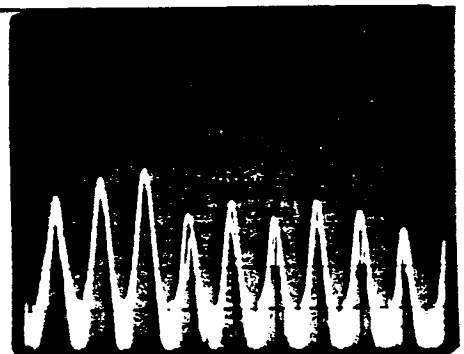
Input Current: | AC Rcvr:

System Frequency: | BD Module:

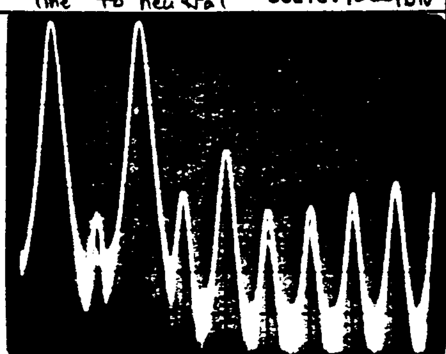
Output Power: | Other:



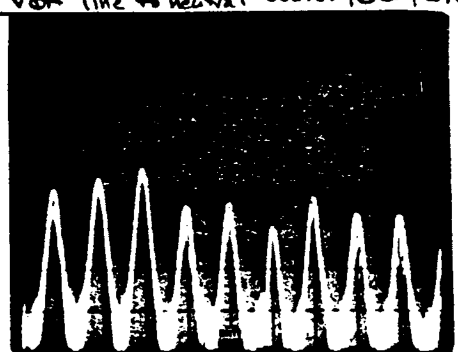
VφA line to neutral Scale: 10db/DIV



VφA line to neutral Scale: 10db/div



VφB line to neutral Scale: 10db/div



VφB line to neutral Scale: 10db/div

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 3.3.7-3.2.2 Steady-State Operation

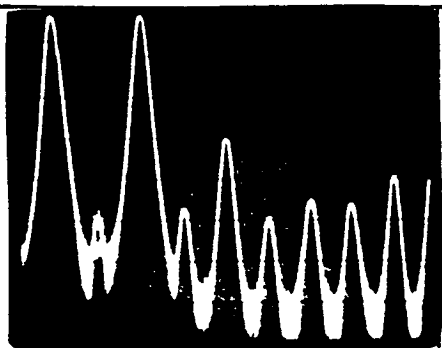
Specific Case: C-Compensation, No Load

Input Voltage: Same | DC Rcvr: same

Input Current: | AC Rcvr:

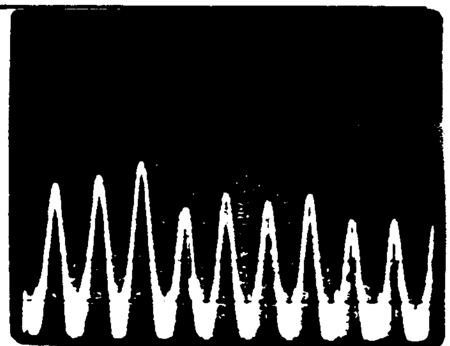
System Frequency: | BD Module:

Output Power: | Other:



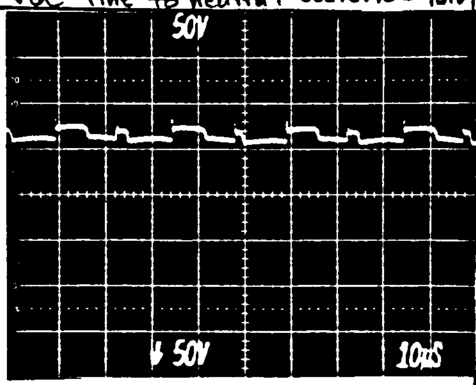
20KHz

Voc line to neutral Scale: 10db/div

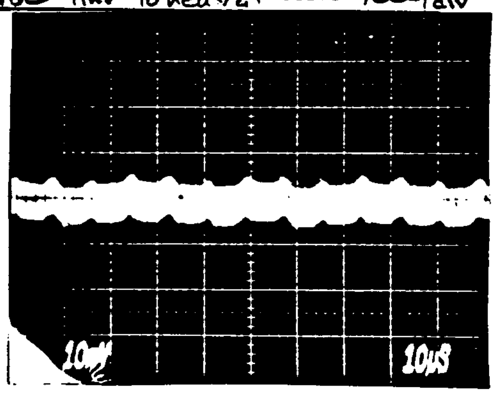


200KHz

Voc line to neutral Scale: 10db/div



V_{IN} Scale: 50V/DIV



I_{in}, A.C. Component Scale: 5A/DIV

TEST CONFIG. 2.3.7-3.2.2 Steady-state
SPECIFIC CASE C-Compensation, 50% load

I) INPUT POWER

V_{in} 149.64 Vdc
I_{in} 20.69×6 = 124.14 Adc
P_{IN} 18.58 kW

Frequency 19.97 kHz

T.H.D.
ΦA 5.6% ~~%~~ %
ΦB 6.4% ~~%~~ %
ΦC 5.9% ~~%~~ %

T.H.D. – TRANSMISSION LINE
INTO THE LINE
ΦA

II) OUTPUT POWER

ΦA	ΦB	ΦC
Vo ____	Vo 442	Vo 444
Io ____	Io ____	Io ____
Po ____	Po ____	Po ____

A.C. RCVR	B/D MOD.	D.C. RCVR
Vo 109 Vrms	Vo 96.6 Vac	Vo 28.15 Vdc
Io 4.56 Arms	Io 8.53 Adc	Io 36.44 Adc
Po 494 Watts	Po 824 Watts	Po 1030 W

T.H.D. Out of RCVR
____ db

RESISTIVE LOADS

ΦA	ΦB	ΦC
V_A 437.6 Vac	V_B 434.4 Vac	V_C 434.0 Vac
I_A 49.65 mV	I_B 46.31 mV	I_C 48.31 mV
I_A 9.87 Aac	I_B 9.41 Aac	I_C 9.58 Aac
P_{RA} 4320 W	P_{RB} 4090 W	P_{RC} 4160 W

Total System Efficiency = $\frac{P_{OUT}}{P_{IN}} = \frac{14,920}{18,580} = 80.3$ %

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.7.2 Steady State Operation

Specific Case: C-Compensation, 50% Load

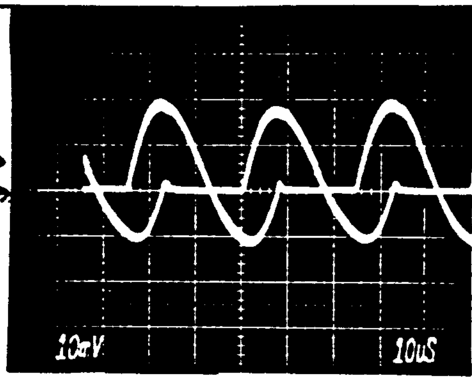
Input Voltage: ______ **DC Rcvr:** ______

Input Current: ______ **AC Rcvr:** ______

System Frequency: ______ **BD Module:** ______

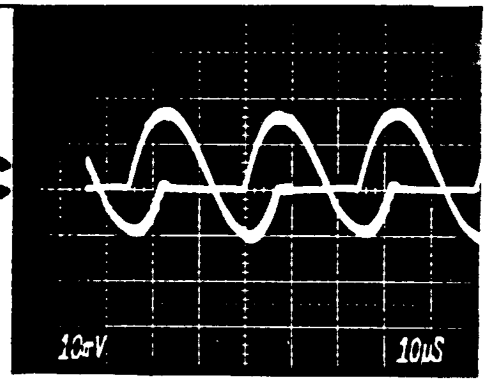
Output Power: ______ **Other:** ______

I_{1A} →
I_{1B}



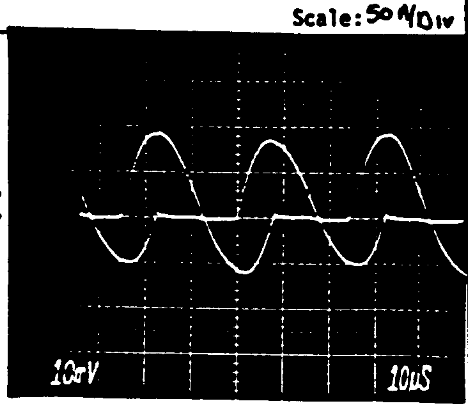
Scale: 50 A/Div

I_{2A} →
I_{2B}



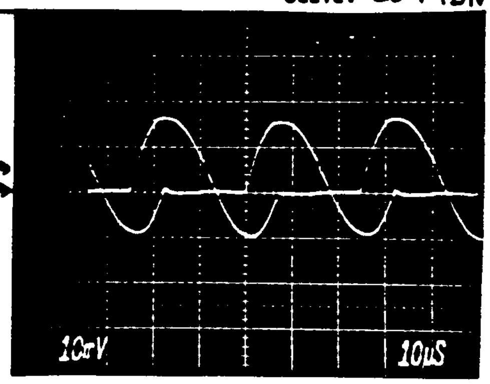
Scale: 50 A/Div

I_{3A} →
I_{3B}



Scale: 50 A/Div

I_{4A} →
I_{4B}



Scale: 50 A/Div

2

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: ____________________

Specific Case: C - Compensation, 50 % Load

Input Voltage: ____________ DC Rcvr: ____________

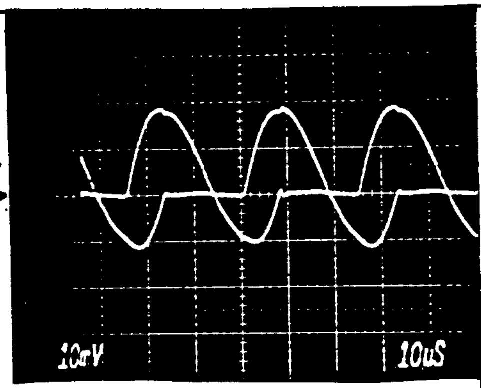
Input Current: ____________ AC Rcvr: ____________

System Frequency: ____________ BD Module: ____________

Output Power: ____________ Other: ____________

I_{SA} →

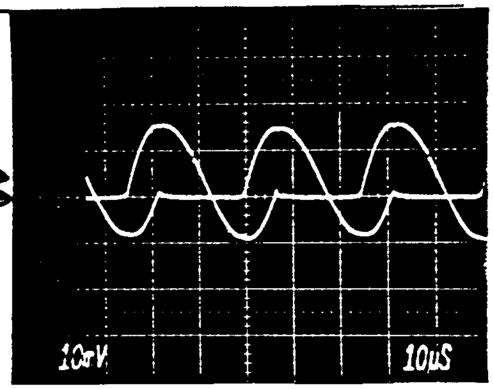
I_{SB} →



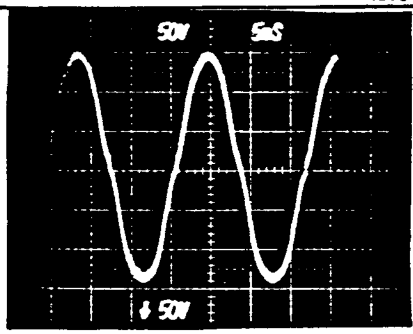
Scale: 50 A/Div

I_{SA} →

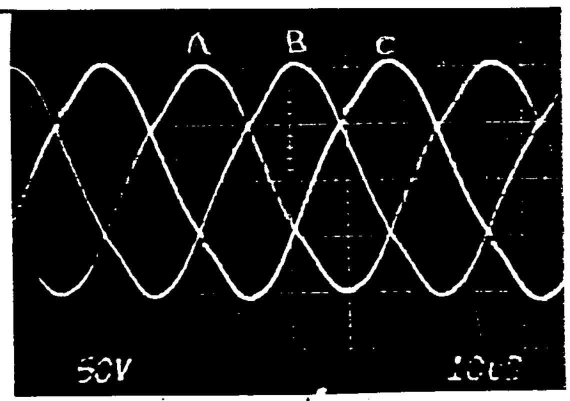
I_{SB} →



Scale: 50 A/Div



A.C. Receiver Voltage Scale:



Scale: 320 V/Div

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady-State Operation

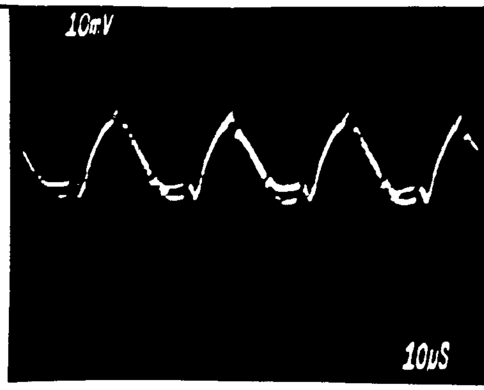
Specific Case: C-Compensation, 50% load

Input Voltage: ______ DC Rcvr: ______

Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______



I_{in} (A.C) Scale: 5A/Div

Photo

Scale:

Photo

Scale:

Photo

Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady-State Operation

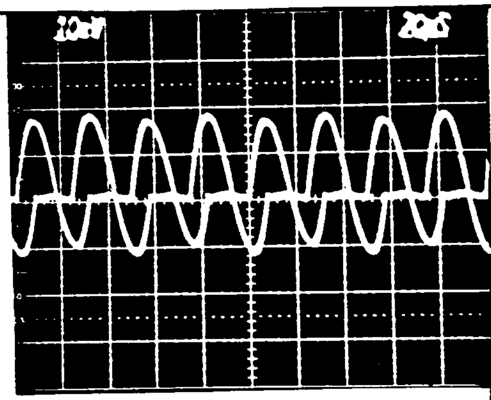
Specific Case: C Comp, 50 % Load

Input Voltage: ______ DC Rcvr: ______

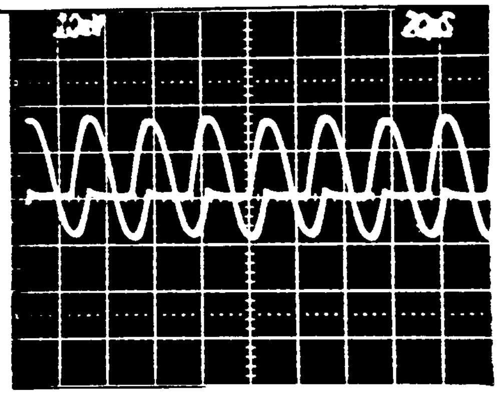
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

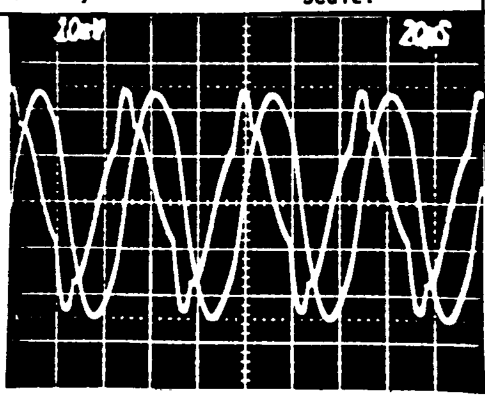
Output Power: ______ Other: ______



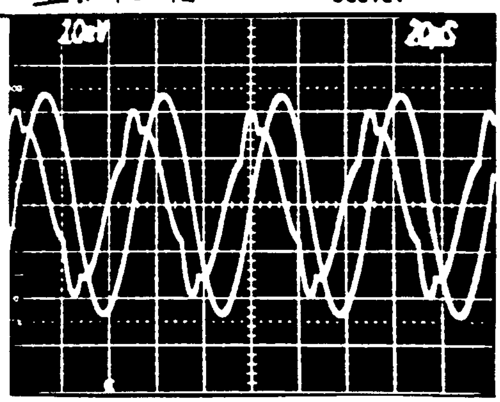
I_{3A}, I_{3B} Scale:



I_{4A}, I_{4B} Scale:



V_{K3}, I_{K3} Scale:



V_{K4}, I_{K4} Scale:

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-2.2.2 Steady-State Operation

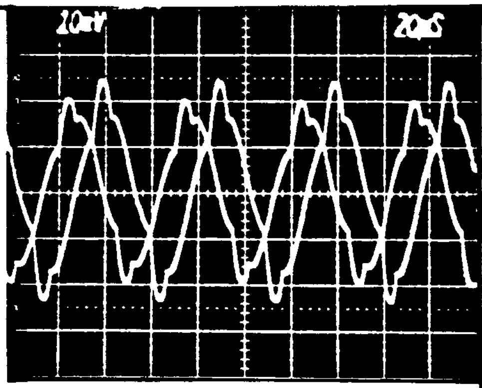
Specific Case: C-Compensation, 50% Load

Input Voltage: ______ **DC Rcvr:** ______

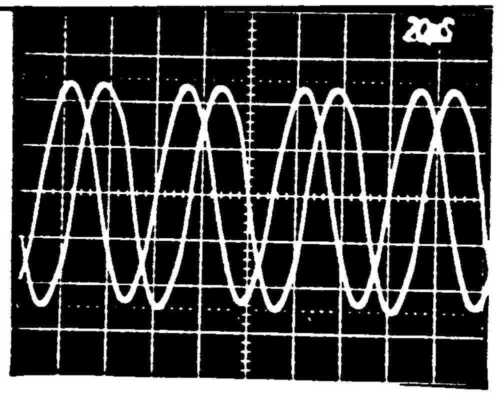
Input Current: ______ **AC Rcvr:** ______

System Frequency: ______ **BD Module:** ______

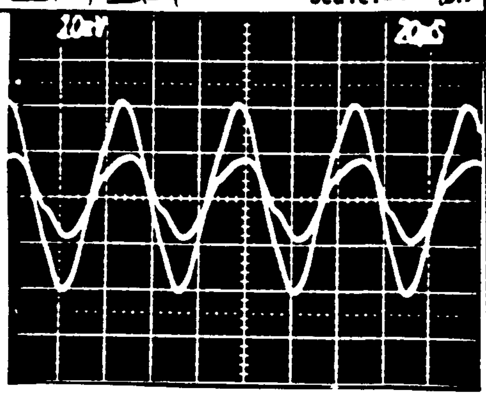
Output Power: ______ **Other:** ______



I_{K3}, I_{K4} **Scale:** 50 A/Div



V_{K3}, V_{K4} **Scale:** UNCAL



SCR SWITCH

V_{XB}, I_{XB} **Scale:** 320 V/Div 20 A/Div

Photo

Scale:

C-3

TEST CONFIG. 2.3.7-3.2.2 Steady State Op.
SPECIFIC CASE C-Compensation Full Load

I) INPUT POWER

V_{in} 149.15 VDC
I_{in} 33.49x6 = 200.9 Adc
P_{IN} 29.97 KW

Frequency 19.96 KHZ

T.H.D.
ΦA 5.8 ~~%~~ %
ΦB 6.6 ~~%~~ %
ΦC 6.0 ~~%~~ %

T.H.D. — TRANSMISSION LINE
INTO THE LINE
ΦA

II) OUTPUT POWER

ΦA	ΦB	ΦC
V_o 1	V_o 443	V_o 443
I_o	I_o	I_o
P_o	P_o	P_o

A.C. RCVR	B/D MOD.	D.C. RCVR
V_o 105	V_o 95.6	V_o 28.18
I_o 4.50	I_o 8.49	I_o 36.51
P_o 472	P_o 812 W	P_o 1029 W

T.H.D. Out of RCVR
~~3.8%~~ ~~%~~ %
4.2%

RESISTIVE LOADS

ΦA	ΦB	ΦC
V_A 433.3 Vac	V_B 430.3 Vac	V_C 430.0 Vac
I_A 91.30 mV	I_B 87.48 mV	I_C 91.61 mV
I_A 18.16 Aac	I_B 17.77 Aac	I_C 18.16 Aac
P_{RA} 7870 W	P_{RB} 7650 W	P_{RC} 7810

Total System Efficiency = $\frac{P_{out}}{P_{in}} = \frac{25,600}{30,000} = 85.3\%$

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady-State Operation

Specific Case: C-Compensation, Full Load

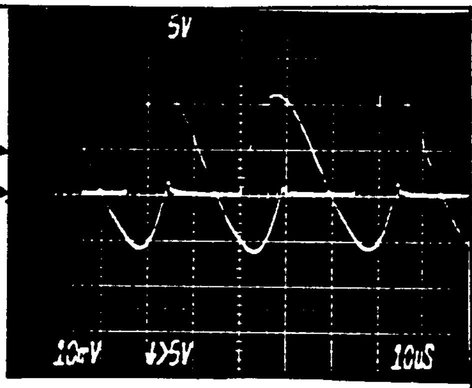
Input Voltage: 149.15 Vdc **DC Rcvr:** 1030 W

Input Current: 200.9 Adc **AC Rcvr:** 470 W

System Frequency: 19.96 KHZ **BD Module:** 810 W

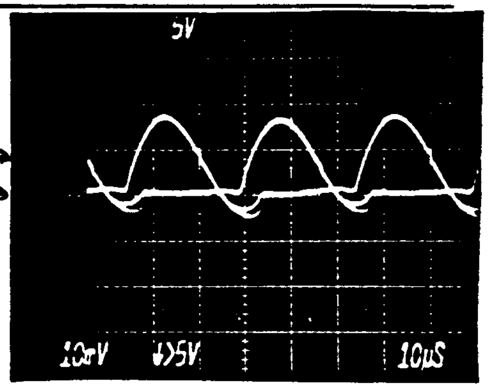
Output Power: 25.6 KW **Other:** None

I_{1A} →
I_{1B} →



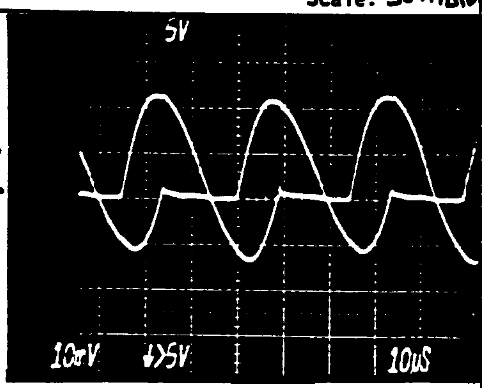
Scale: 50 A/Div

I_{2A} →
I_{2B} →



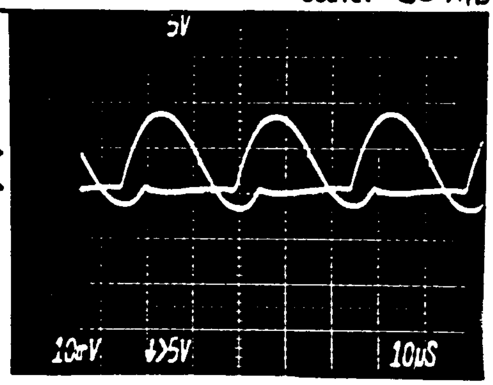
Scale: 50 A/Div

I_{3A} →
I_{3B} →



Scale: 50 A/Div

I_{4A} →
I_{4B} →



Scale: 50 A/Div

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.2 Steady State Operation

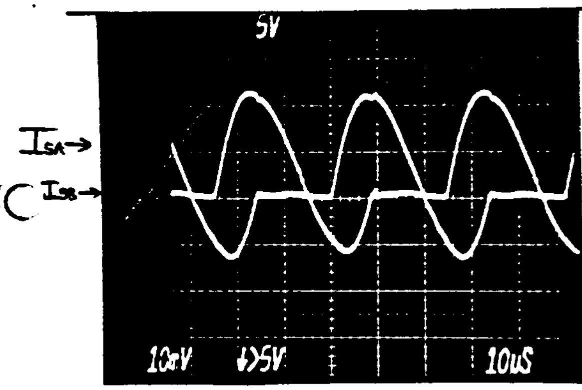
Specific Case: C - Compensation , Full Load

Input Voltage: ____________ DC Rcvr: ____________

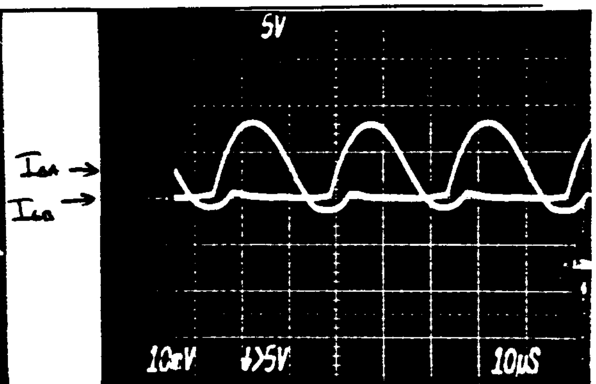
Input Current: ____________ AC Rcvr: ____________

System Frequency: ____________ BD Module: ____________

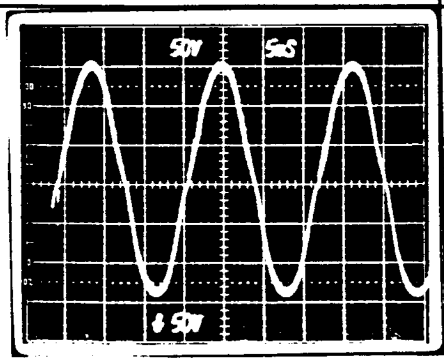
Output Power: ____________ Other: ____________



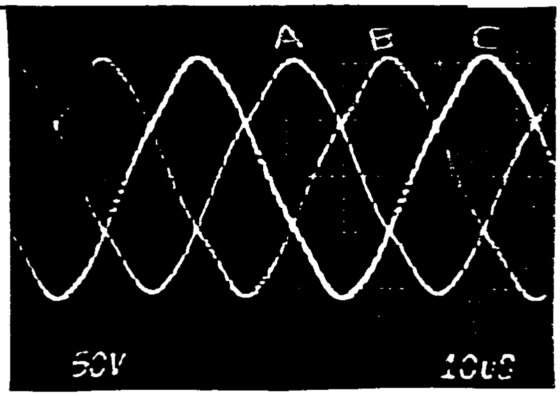
Scale: 50 A/Div



Scale: 50 A/Div



Scale:



Scale: 320 V/Div

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7- 3.2.2 Steady-State Operation

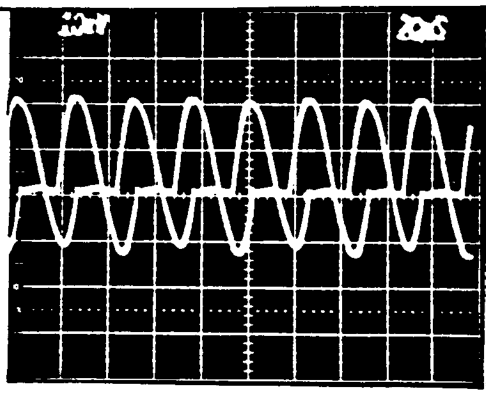
Specific Case: C- Compensation, Full Load

Input Voltage: ____________ DC Rcvr: ____________

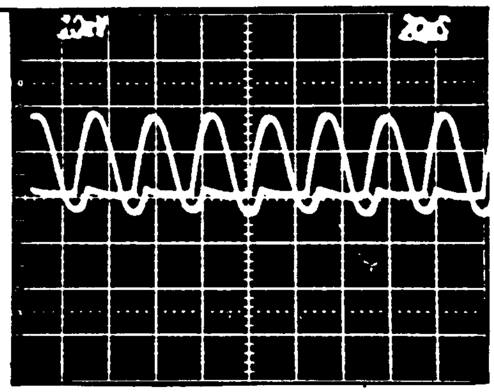
Input Current: ____________ AC Rcvr: ____________

System Frequency: ____________ BD Module: ____________

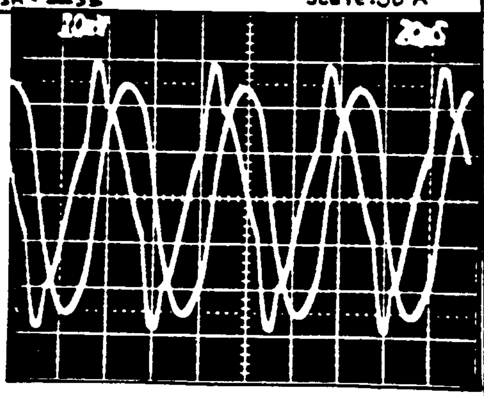
Output Power: ____________ Other: ____________



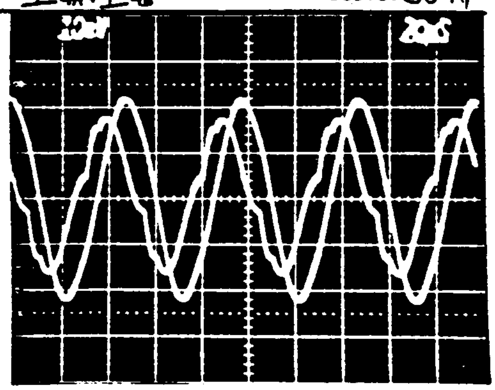
$I_{3A}+I_{3B}$ Scale: 50 A



$I_{4A}+I_{4B}$ Scale: 50 A/



V_{K3}, I_{K3} Scale: UNCAL V 50 A



V_{K4}, I_{K4} Scale: Uncal V 50 A

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady-State Operation

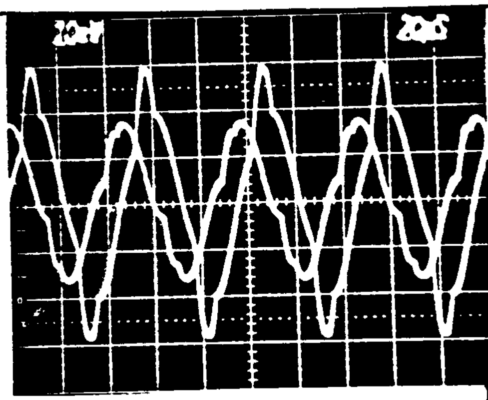
Specific Case: C-Compensation, Full Load

Input Voltage: ______ DC Rcvr: ______

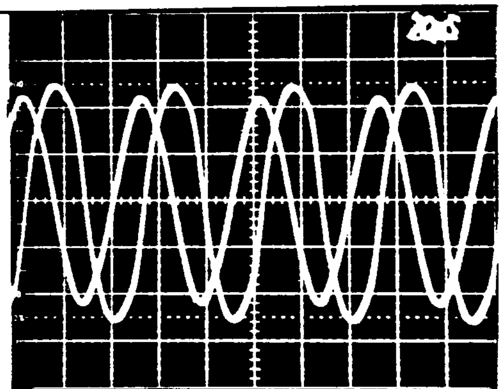
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______

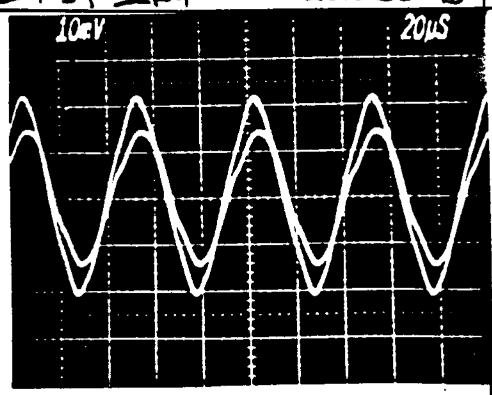


I_{K3}, I_{K4} Scale: 50 A/D

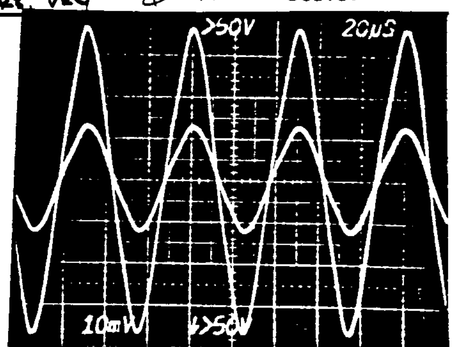


Used same probes + Amp to measure both voltages, so relative magnitudes can be compared, $\Phi = 93.6°$

V_{K3}, V_{K4} Scale: uncal V



V_{XB}, I_{XB} Scale: 320 V/Div, 20 A/Div



Voltage taken directly from output transformer

V_{XA}, I_{XA} Scale: uncal V, 20 A

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

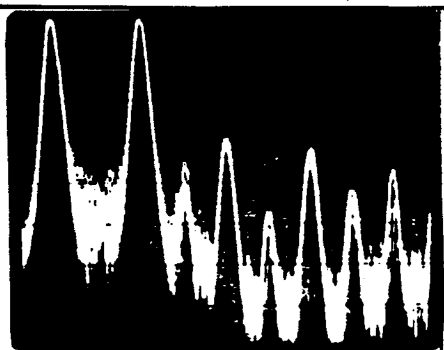
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

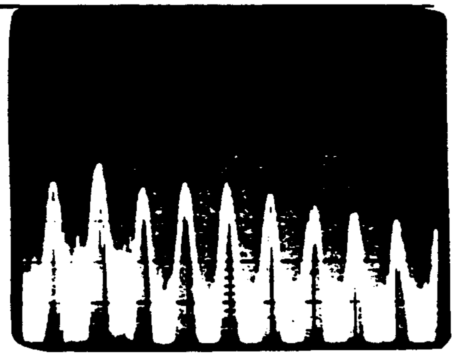
Test-Configuration: 2.3.7-3.2.2 Steady-State Operation

Specific Case: C-Compensation, Full Load

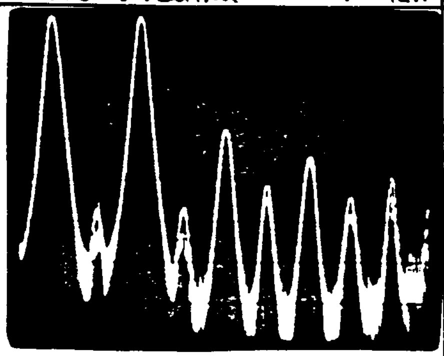
Input Voltage: Same | DC Rcvr: Same
Input Current: | AC Rcvr:
System Frequency: | BD Module:
Output Power: | Other:



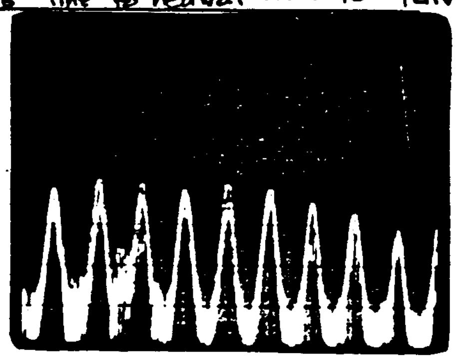
$V_{\phi A}$ line to neutral Scale: 10db/div



$V_{\phi B}$ line to neutral Scale: 10db/div



$V_{\phi B}$ line to neutral Scale: 10db/div



$V_{\phi B}$ line to neutral Scale: 10db/div

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.2 Steady State Operation

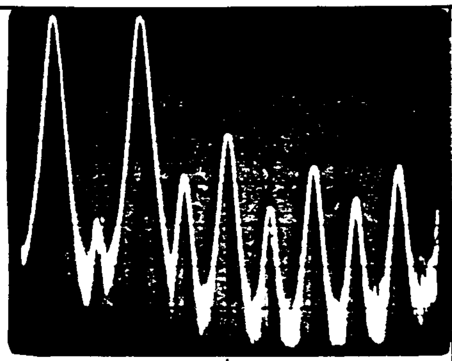
Specific Case: C - Compensation, Full Load

Input Voltage: ______ DC Rcvr: ______

Input Current: ______ AC Rcvr: ______

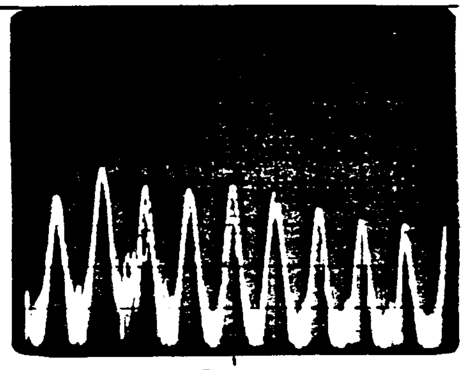
System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______



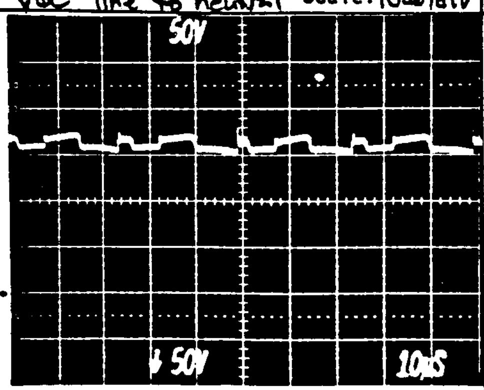
60 KHz

Vac line to neutral Scale: 10db/div

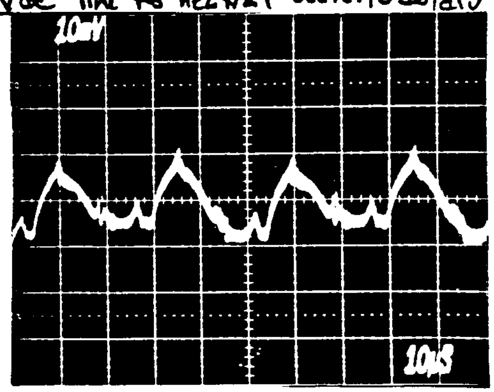


200 KHz

Vac line to neutral Scale: 10db/div



V_{IN} Scale: 50 V/Div



I_{IN} (A.C.) Scale: 5A/Div

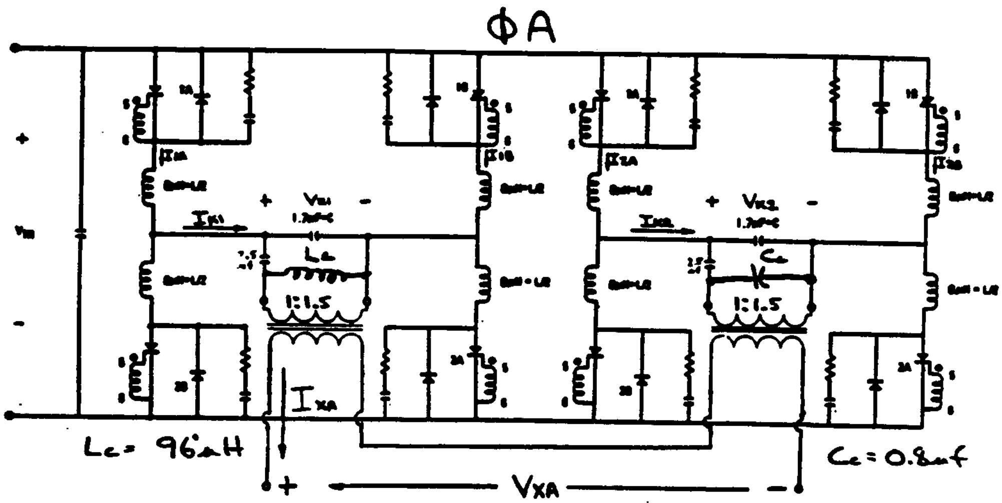
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.7 - 3.2.2 Steady - State Operation

LC Compensation

Test Circuits



TEST CONFIG. 2.3.7-3.2.2 Steady-State
SPECIFIC CASE LC Compensation, No Load

I) INPUT POWER

V_{in} 150.9 Vdc

I_{in} 2.53×6=15.18Adc

P_{IN} 2.29KW

Frequency 19.96 kHz

T.H.D.

ΦA 6.9 ~~db~~ %

ΦB 7.1 ~~db~~ %

ΦC 7.3 ~~db~~ %

T.H.D. — TRANSMISSION LINE

INTO THE LINE

ΦA

II) OUTPUT POWER

ΦA	ΦB	ΦC
V_o 442.8	V_o 437.5	V_o 441.8
I_o ____	I_o ____	I_o ____
P_o ____	P_o ____	P_o ____

A.C. RCVR	B/D MOD.	D.C. RCVR
V_o OFF	V_o 112	V_o 28.76
I_o ____	I_o .19	I_o 0
P_o ____	P_o 21.3 Watts	P_o 0

T.H.D. Out of RCVR

____ db

RESISTIVE LOADS

ΦA	ΦB	ΦC
V_A 442.8 Vac	V_B 437.5 Vac	V_C 441.8 Vac
I_A 0.54 mV	I_B 0.54 mV	I_C 0.54 mV
I_A ____ Aac	I_B ____ Aac	I_C ____ Aac
P_{RA} ____	P_{RB} ____	P_{RC} ____

Total System Efficiency = $\frac{P_{out}}{P_{in}}$ = ____ = %

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady-State Operation

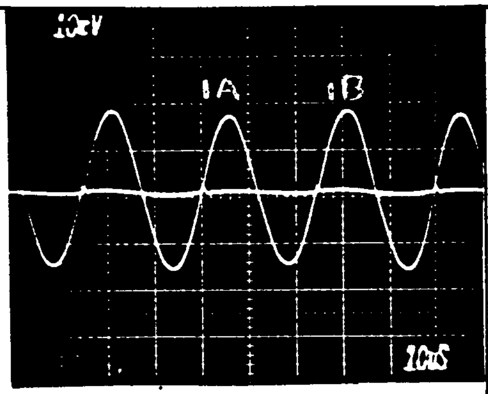
Specific Case: LC Compensation, No Load

Input Voltage: 150.9 Vdc   DC Rcvr: 0

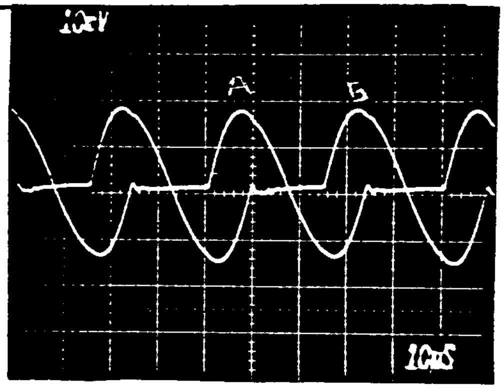
Input Current: 15.18 Adc   AC Rcvr: 0

System Frequency: 19.96 KHZ   BD Module: 21 Watts

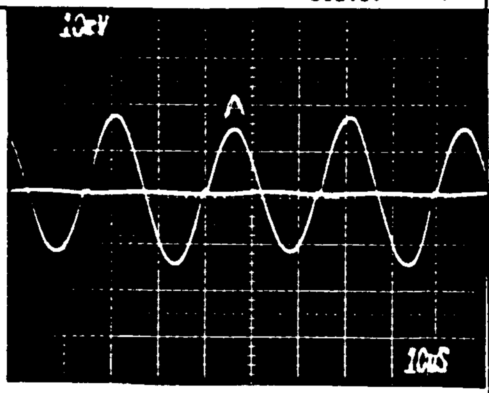
Output Power: 21 Watts   Other: None



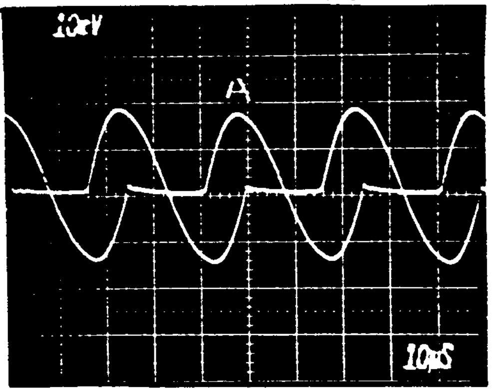
$I_{1A}+I_{1B}$ Scale: 20A/Div



$I_{2A}+I_{2B}$ Scale: 50A/Div



$I_{3A}+I_{3B}$ Scale: 20 A/Div



$I_{4A}+I_{4B}$ Scale: 50 A/Div

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady State Operation

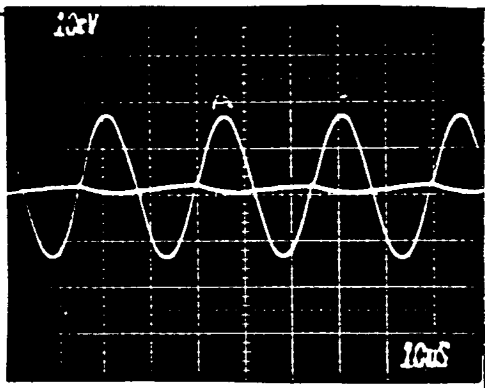
Specific Case: LC Compensation, No Load

Input Voltage: Same DC Rcvr: Same

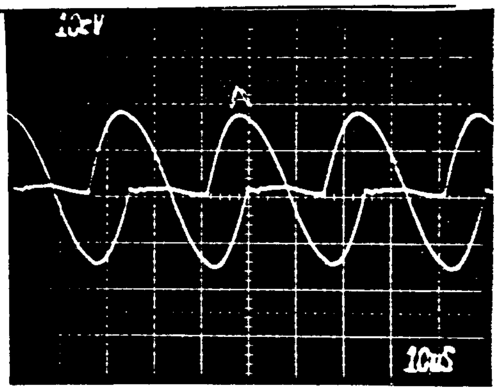
Input Current: AC Rcvr:

System Frequency: BD Module:

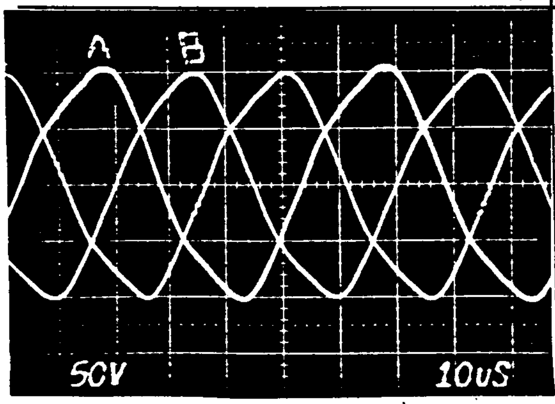
Output Power: Other:



$I_{5A} + I_{5B}$ Scale: 20 A/Div



$I_{6A} + I_{6B}$ Scale: 50 A/Div



Scale: 320 V/DIV

Photo

Scale:

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.2 Steady-State Operation

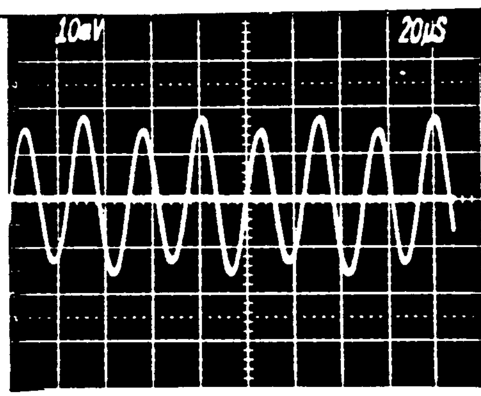
Specific Case: LC - Compensation, No Load

Input Voltage: ____________ DC Rcvr: ____________

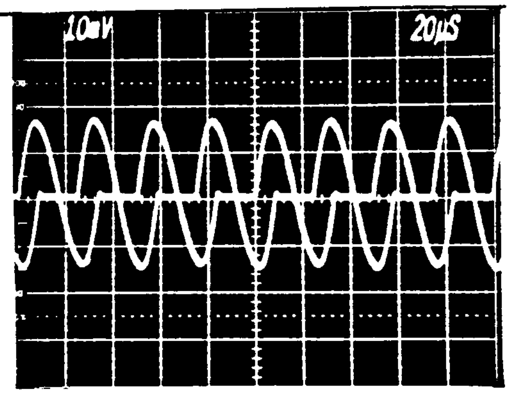
Input Current: ____________ AC Rcvr: ____________

System Frequency: ____________ BD Module: ____________

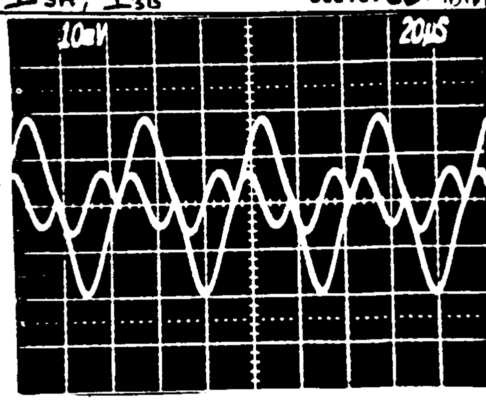
Output Power: ____________ Other: ____________



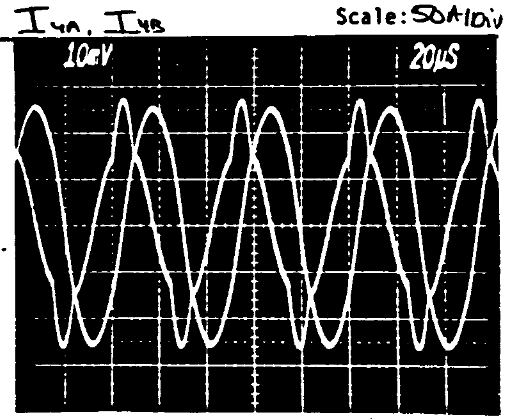
I_{3A}, I_{3B} Scale: 20A/Div



I_{4A}, I_{4B} Scale: 50A/Div



V_{K3}, I_{K3} Scale: Uncal V, 50 A/Div



V_{K4}, I_{K4} Scale: Uncal V, 50A/Div

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady-State Operation

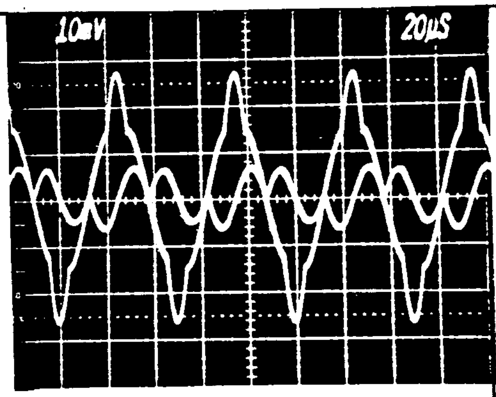
Specific Case: LC-Compensation, No Load

Input Voltage: ______ DC Rcvr: ______

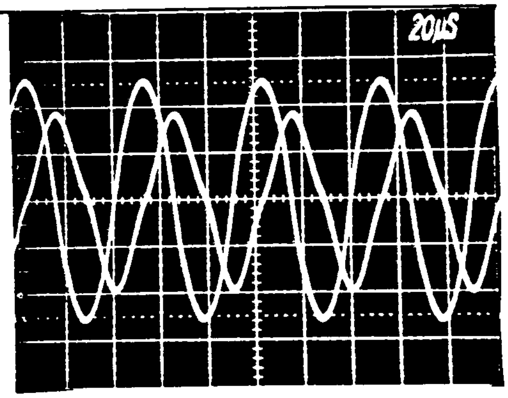
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

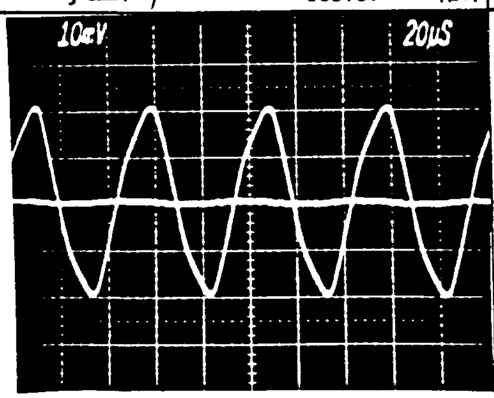
Output Power: ______ Other: ______



I_{K3}, I_{K4} Scale: 50 A/Div



V_{K3}, V_{K4} Scale:



V_{XB}, I_{XB} Scale: 320 V/Div, 20 A/Div

Photo

Scale:

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.2 Steady State Operation

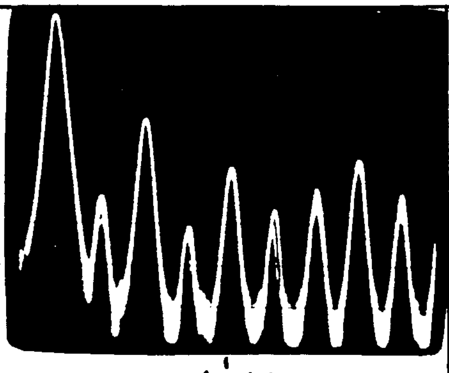
Specific Case: LC Compensation, No Load

Input Voltage: Same — DC Rcvr: Same

Input Current: — AC Rcvr:

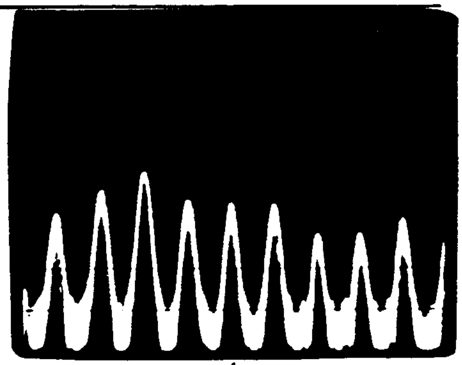
System Frequency: — BD Module:

Output Power: — Other:



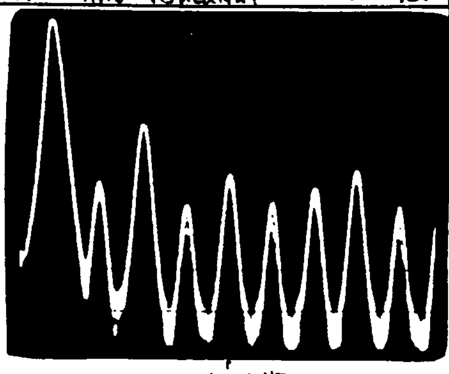
100 KHZ

Vøa line to neutral Scale: 10db/div



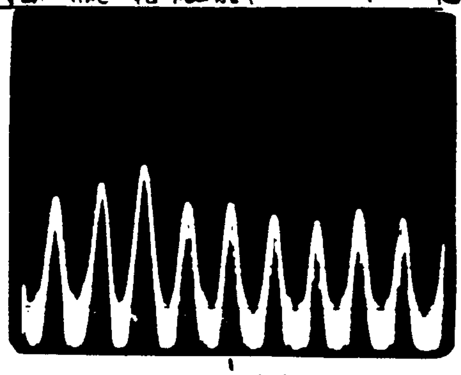
200 KHZ

Vøa line to neutral Scale: 10 db/div



100 KHZ

Vøb line to neutral Scale: 10db/div



200 KHZ

Vøb line to neutral Scale: 10db/div

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

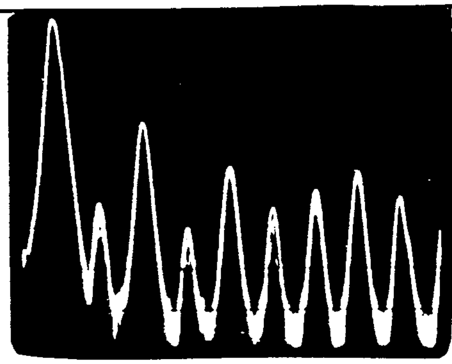
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

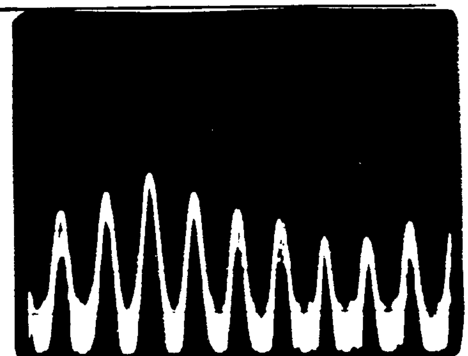
Test-Configuration: 2.3.7 - 3.2.2 Steady State Operation

Specific Case: LC Compensation, No Load

Input Voltage:	Same	DC Rcvr:	Same
Input Current:	↓	AC Rcvr:	↓
System Frequency:	↓	BD Module:	↓
Output Power:		Other:	

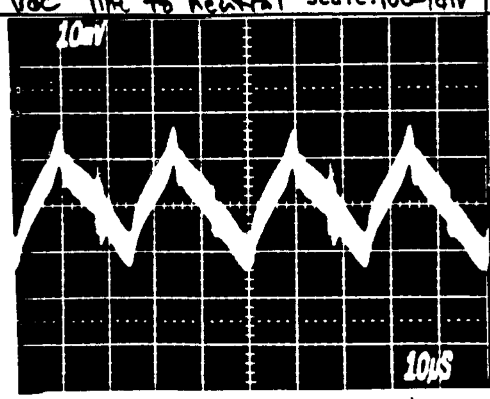


Voc line to neutral Scale: 10db/div



200kHz

Voc line to neutral Scale:



In (A.C.) Scale: 5 A/Div

Photo

Scale:

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TEST CONFIG. 2.3.7-3.2.2 Steady State Operati
SPECIFIC CASE LC Compensation, 50%

I) INPUT POWER

V_{in} 150.6 Vac
I_{in} 115.4 Adc
P_{in} 17.39 KW

Frequency 19.92 KHZ

T.H.D.
ΦA 6.8 ~~db~~ %
ΦB 6.5 ~~db~~ %
ΦC 5.9 ~~db~~ %

T.H.D. – TRANSMISSION LINE
INTO THE LINE
ΦA

II) OUTPUT POWER (with H.P. used to measure voltage at output)

*ΦA	*ΦB	ΦC
V_o 442.9	V_o 438.0	V_o 442.9
I_o 11.25	I_o 11.6	I_o 10.18
P_o 5.03 KW	P_o 5080	P_o —

T

A.C. RCVR	B/D MOD.	D.C. RCVR
V_o 107	V_o 95.5	V_o 28.29
I_o 4.52 A	I_o 8.16	I_o 22.23 Adc
P_o 475 Watts	P_o 779 W	P_o 629 W

T.H.D. Out of RCVR
______ db

RESISTIVE LOADS

ΦA	ΦB	ΦC
V_A 431.8 Vac	V_B 429.0 Vac	V_C 432.7 Vac
I_A 51.04 mv	I_B 50.91 mv	I_C 45.45 mv
I_A 10.15 Aac	I_B 10.34 Aac	I_C 9.011 Aac
P_{RA} 4380 W	P_{RB} 4440 W	P_{RC} 3900 W

Total System Efficiency $= \frac{P_{out}}{P_{in}} = \frac{14{,}600}{17{,}390} = 84.0\ \%$

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady State Response

Specific Case: LC-Compensation; 50% Load

Input Voltage: 150.6 | DC Rcvr: ____

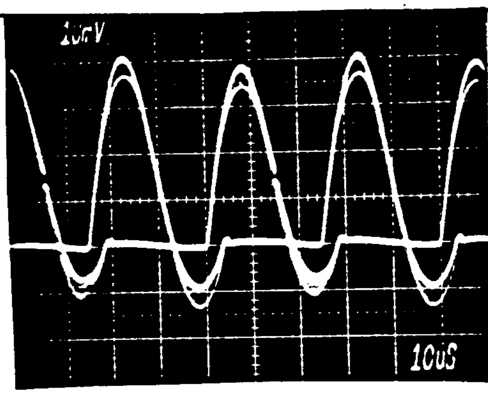
Input Current: 115.44 | AC Rcvr: ____

System Frequency: 19.92 kHz | BD Module: ____

Output Power: ____ | Other: ____

I_{1A}

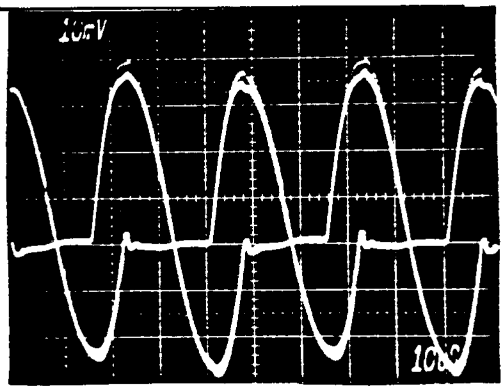
I_{1B}



Scale: 20A/Div

I_{2A}

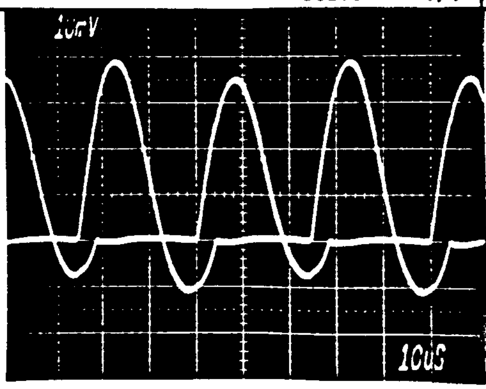
I_{2B}



Scale: 20A/Div

I_{3A}

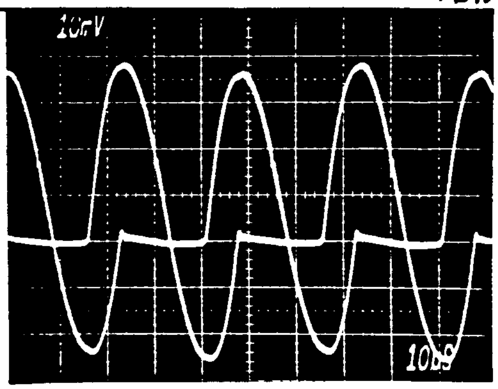
I_{3B}



Scale: 20A/Div

I_{4A}

I_{4B}



Scale: 20A/Div

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.7.2 Steady-State Operation

Specific Case: LC Compensation; 50% Load

Input Voltage: Same DC Rcvr: Same

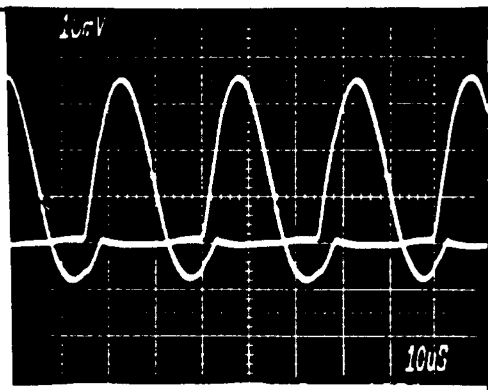
Input Current: AC Rcvr:

System Frequency: BD Module:

Output Power: Other:

I_{SA}

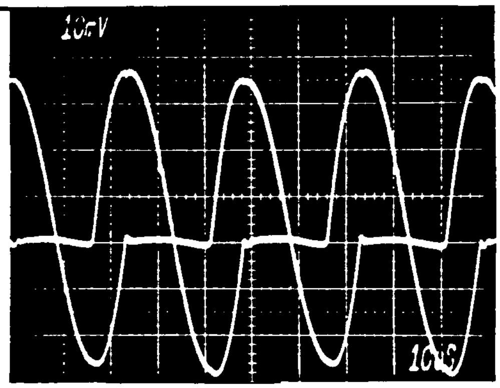
I_{SB}



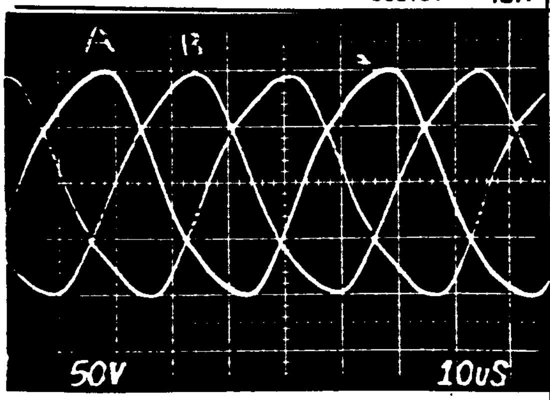
Scale: 20A/DIV

I_{GA}

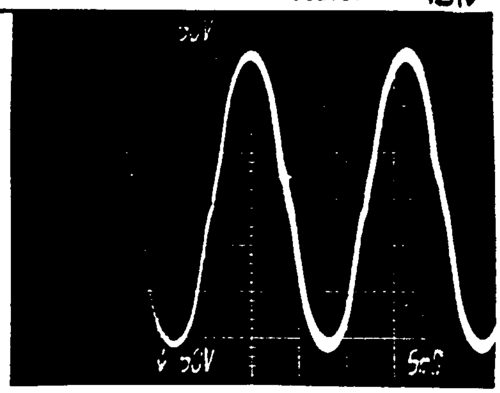
I_{GB}



Scale: 20 A/DIV



Scale: 320V/DIV



A.C. RECEIVER Scale: 50 V/DIV

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady-State Operation

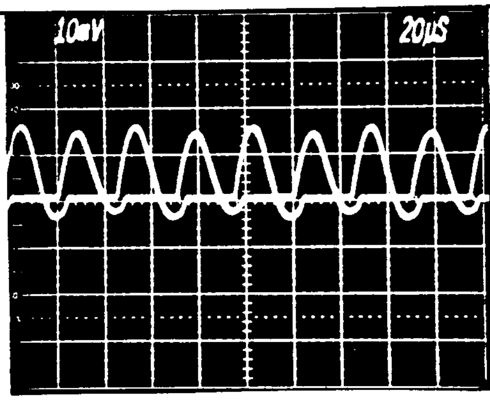
Specific Case: L C Compensation, 50% Load

Input Voltage: ______ DC Rcvr: ______

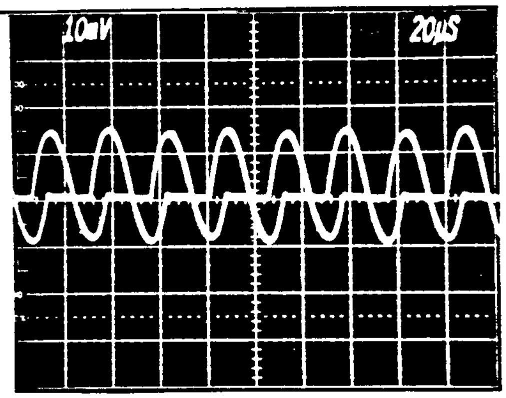
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

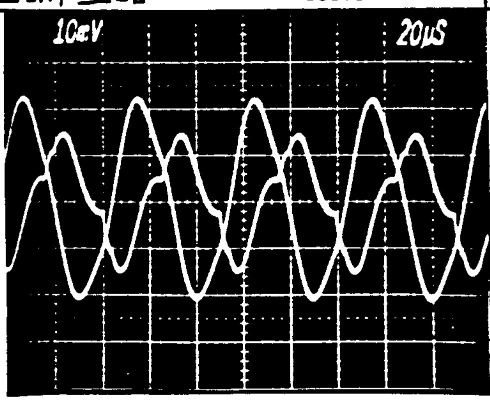
Output Power: ______ Other: ______



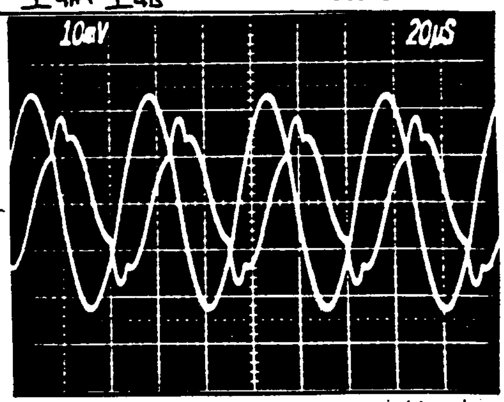
I_{3A}, I_{3B} Scale: 50A



$I_{4A}+I_{4B}$ Scale: 50A



V_{K3}, I_{K3} Scale: Uncal V 50 A/Div



V_{K4}, I_{K4} Scale: Uncal V. 50A/Div

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady-State Operation

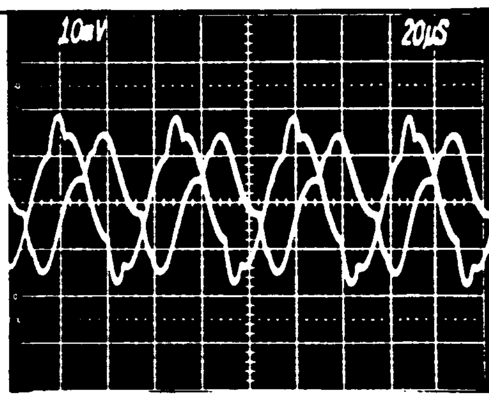
Specific Case: LC Compensation, 50 % Load

Input Voltage: ______ DC Rcvr: ______

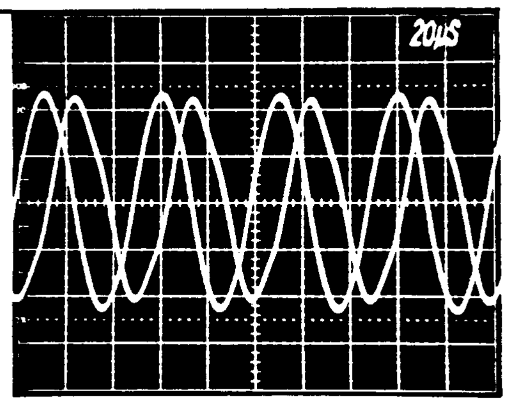
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

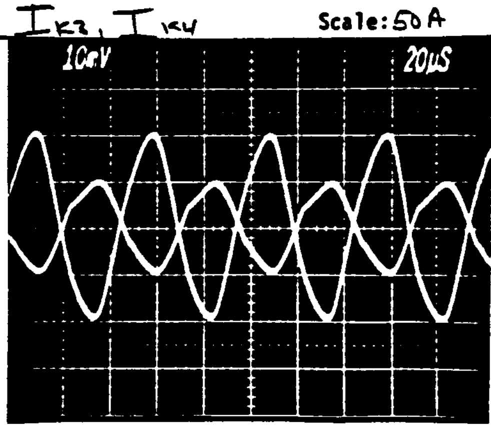
Output Power: ______ Other: ______



I_{K3}, I_{K4} Scale: 50A



V_{K3}, V_{K4} Scale: Uncal



V_{XA}, $-I_{XA}$ Scale: 320V/Div. 20A/Div

SCR Switch

Photo

Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady State Operation

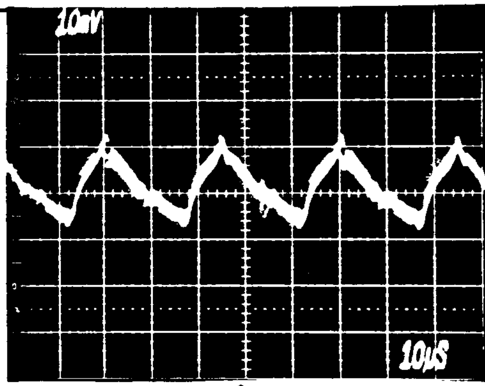
Specific Case: LC Compensation; 50 % Load

Input Voltage: Same | DC Rcvr: Same

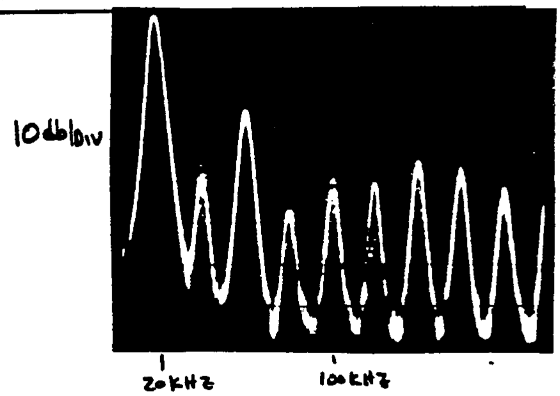
Input Current: ↓ | AC Rcvr: ↓

System Frequency: | BD Module:

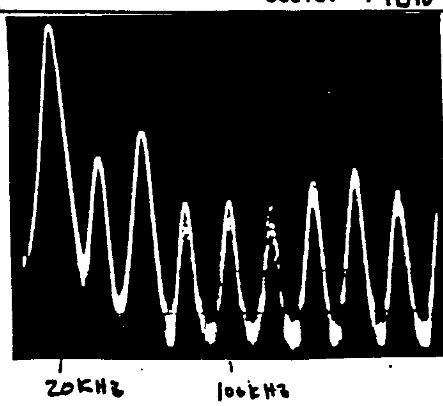
Output Power: | Other:



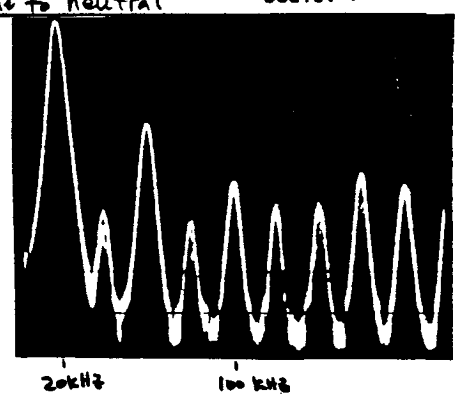
A.C. Component of In. Scale: 5A/DIV



Voa - line to neutral Scale: 10 db/DIV



Voa line to neutral Scale: 10db/DIV



Voc line to neutral Scale: 10 db/div

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.2 Steady State Operation

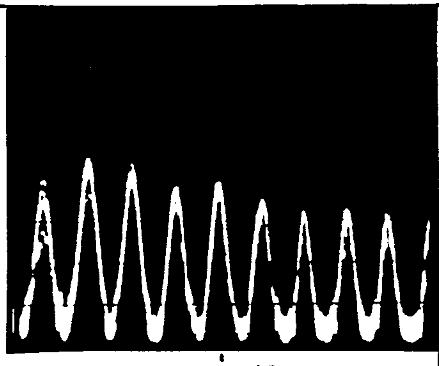
Specific Case: LC Compensation, 50% Load

Input Voltage: Same — DC Rcvr: Same

Input Current: — AC Rcvr:

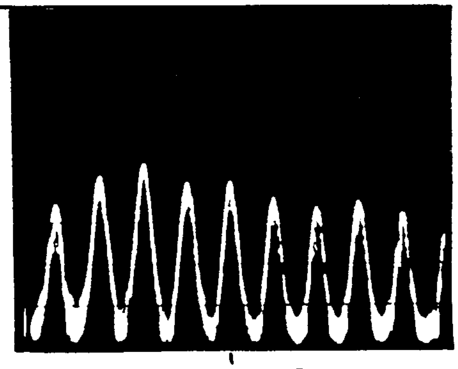
System Frequency: — BD Module:

Output Power: — Other:



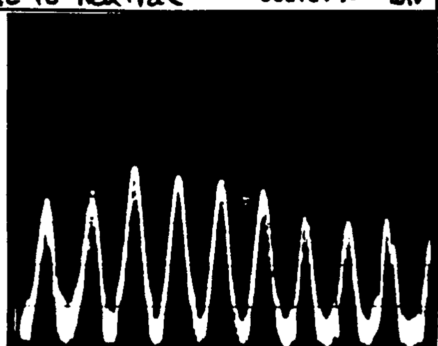
200 KHZ

Vφa line to neutral Scale: 10db/Div



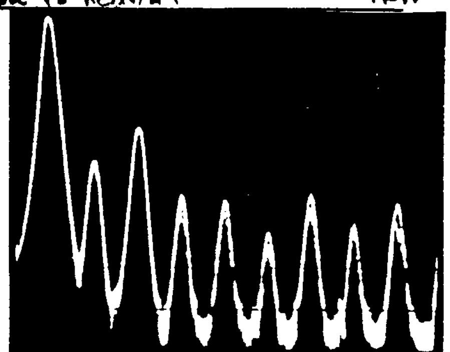
200 KHZ

Vφa line to neutral Scale: 10db/Div



200 KHZ

Vφc line to neutral Scale: 10db/div



20 KHZ 100 KHZ

Vφa line to neutral, other φs off Scale: 10db/Div

TEST CONFIG. 2.3.7-3.2.2 Steady State Operation
*SPECIFIC CASE LC Compensation, Full Load
* Phase by Phase

I) INPUT POWER

V_{in} A) 151.6 (C) 152.0 B) 151.0

I_{in} A) 10.44x6 = 62.64 (C) 12.11x6 = 72.66 B) 12.17x6 = 71.02

P_{IN} A) 9.50 KW (C) 11.0 KW B) 11.0 KW

P_T = 31.5 KW

Frequency 19.92 KHZ

T.H.D.
ΦA 4.7 ~~db~~ %
ΦB 4.1 ~~db~~ %
ΦC 4.3 ~~db~~ %

T.H.D. – TRANSMISSION LINE
INTO THE LINE
ΦA

II) OUTPUT POWER

ΦA	ΦB	ΦC
Vo 445.1	Vo 427.1	Vo 444.1
Io 18.72mV	Io 22.40mV	Io 22.7mV
Po ____	Po ____	Po ____

25.9 mV = ΦC
[illegible] mV = ΦA
5.5 mV = ΦB
4.4% distortion
[illegible]

A.C. RCVR	B/D MOD.	D.C. RCVR
Vo 106	Vo 90.2	Vo 28.28
Io 4.51	Io 8.08	Io 22.13
Po 471 Watts	Po 729 Watts	Po 626 W

T.H.D. Out of RCVR
______ db

RESISTIVE LOADS

ΦA	ΦB	ΦC
V_A 427.1 Vac	V_B 407.4 Vac	V_C 423.7 Vac
I_A 91.0 mV	I_B 110.2 mV	I_C 104.2 mV
I_A 18.1 Aac	I_B 22.4 Aac	I_C 20.7 Aac
P_{RA} 7.73 KW	P_{RB} 9.13 KW	P_{RC} 8.77 KW

Total System Efficiency = $\frac{P_{out}}{P_{in}} = \frac{27.5}{31.5} = 87.3\%$

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.22 Steady-state Operation

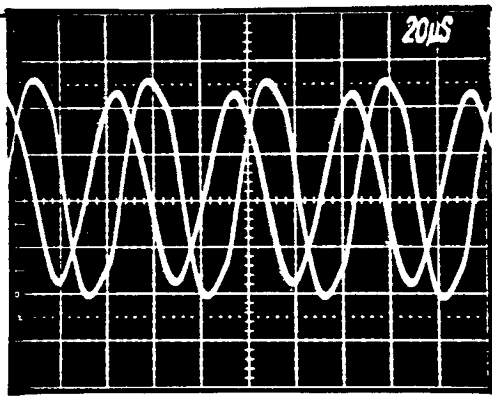
Specific Case: LC Compensation, Full Load

Input Voltage: ______ DC Rcvr: ______

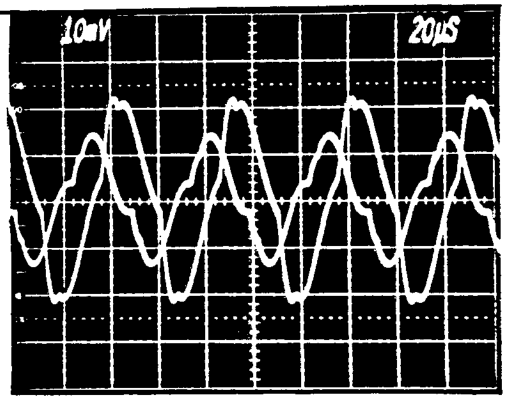
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

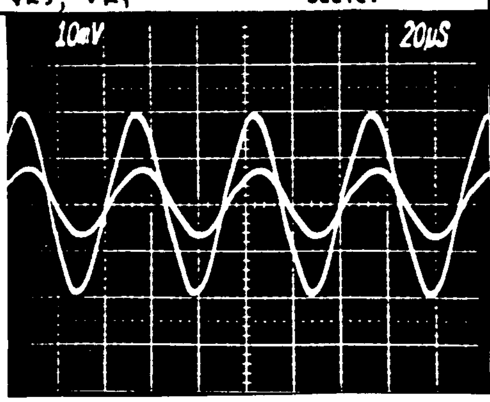
Output Power: ______ Other: ______



V_{K3}, V_{K4} Scale: Uncal V/Div



I_{K3}, I_{K4} Scale: 50 A/Div



V_{X8}, I_{X8} Scale: 320 V/DIV 50 A/DIV

Photo

Scale:

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady State Operation

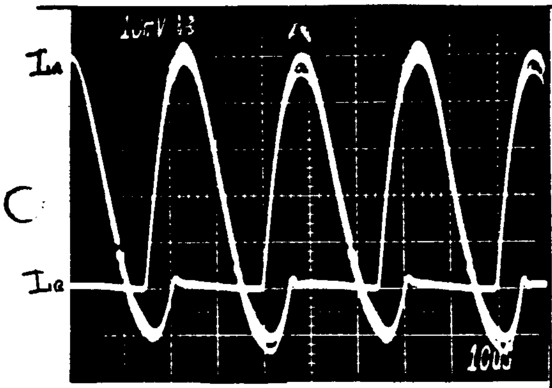
Specific Case: LC Compensation; Full load

Input Voltage: 151.5 (Adc) average   DC Rcvr: 626 W

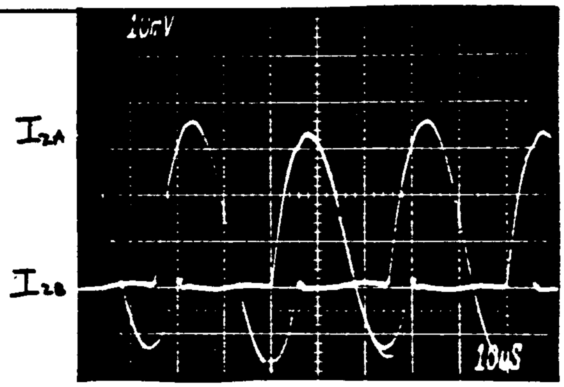
Input Current: 208.3 Adc   AC Rcvr: 471 W

System Frequency: 19.92 KHz   BD Module: 729 W

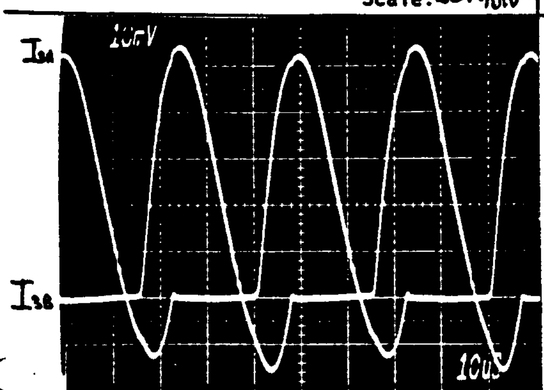
Output Power: 27.5 kW   Note: Measurements + photographs taken with only one phase on at a time



Scale: 20A/DIV



Scale: 20 A/DIV



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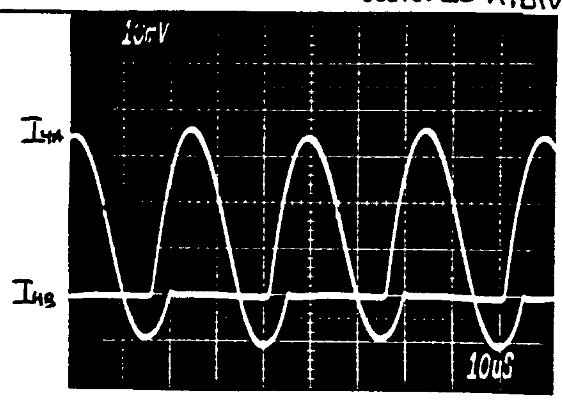

Scale: 20 A/DIV

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady State Operation

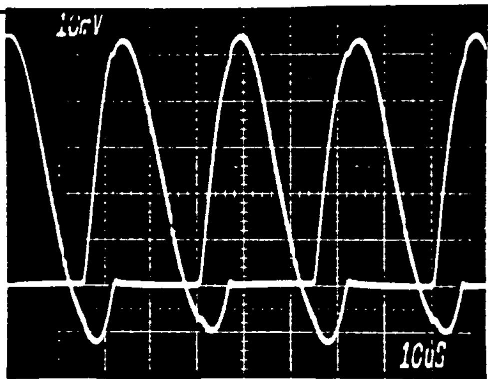
Specific Case: LC Compensation, Full Load

Input Voltage: ____________ DC Rcvr: ____________

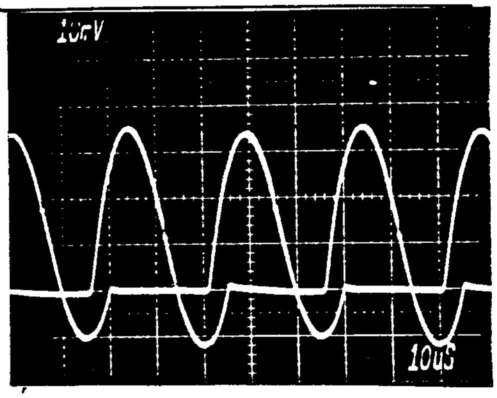
Input Current: ____________ AC Rcvr: ____________

System Frequency: ____________ BD Module: ____________

Output Power: ____________ Other: ____________



Scale: 20 A/Div



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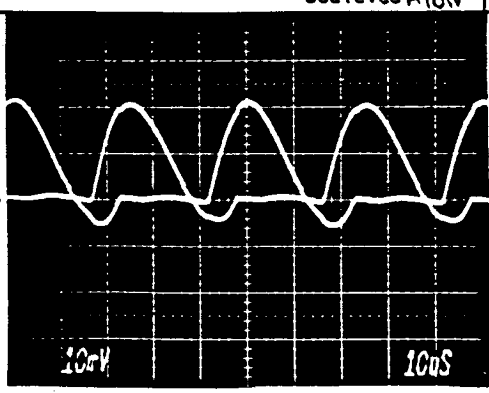
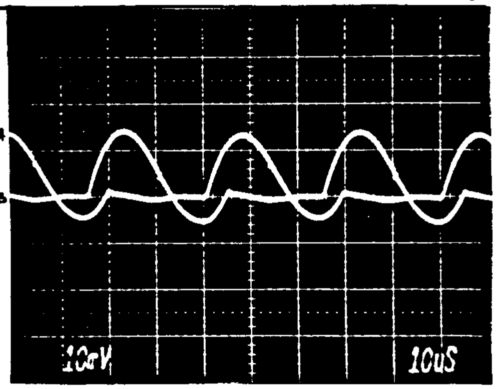


Scale: 50 A/Div



Scale: 50 A/Div

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady-State Operation

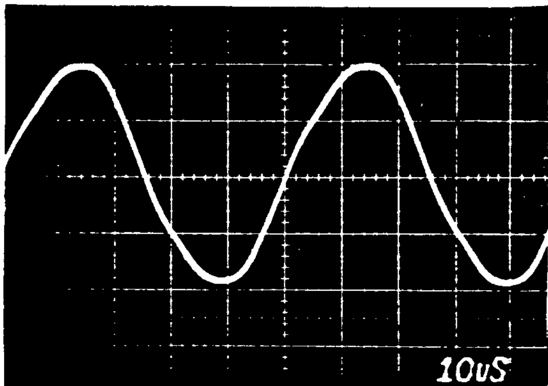
Specific Case: LC Compensation, Full Load

Input Voltage: ______ DC Rcvr: ______

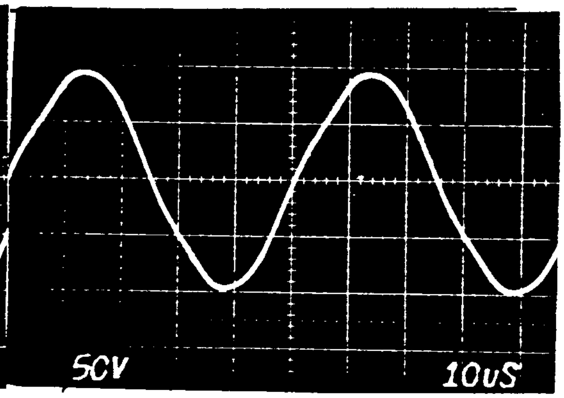
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

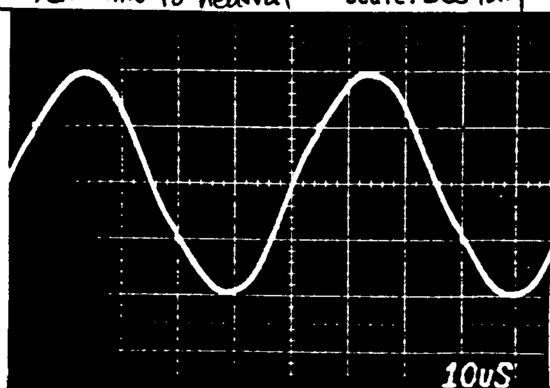
Output Power: ______ Other: ______



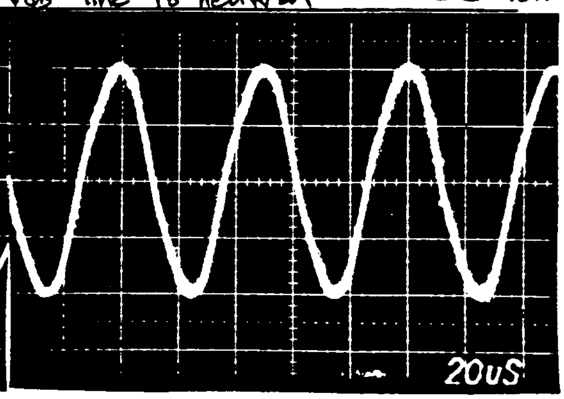
V_{OA} line to neutral Scale: 320V/DIV



V_{OB} line to neutral Scale: 320V/DIV



V_{OC} line to neutral Scale: 320V/DIV



V_{OC} line to neutral Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady-State Operation

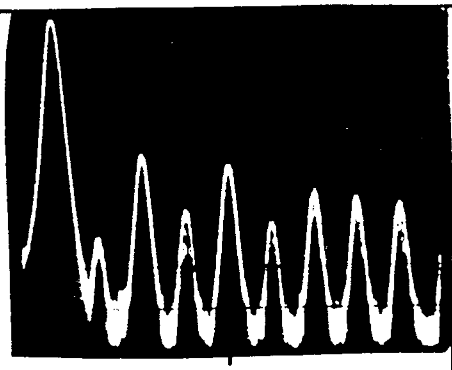
Specific Case: LC Compensation, Full Load

Input Voltage: ____________ DC Rcvr: ____________

Input Current: ____________ AC Rcvr: ____________

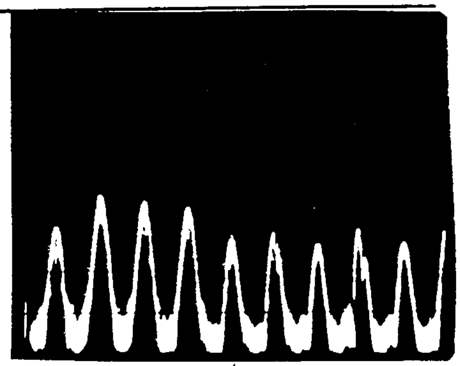
System Frequency: ____________ BD Module: ____________

Output Power: ____________ Other: ____________



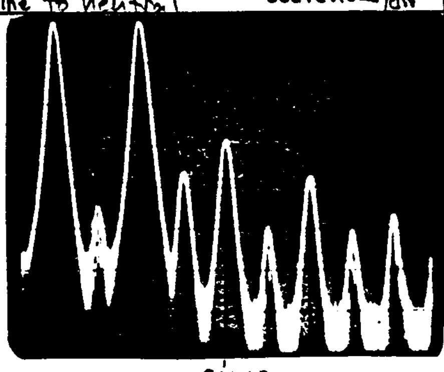
100KHZ

Vφβ line to neutral Scale: 10db/div



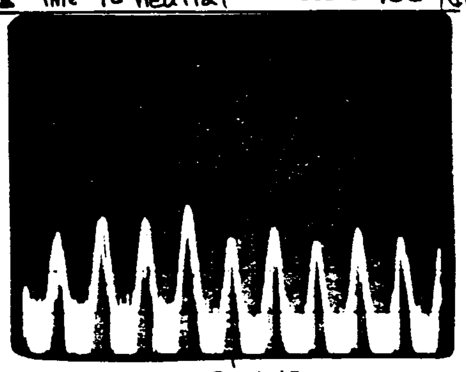
200KHZ

Vφβ line to neutral Scale: 10db/div



60KHZ

Vφc Scale: 10db/div



200KHZ

Vφc Scale: 10db/div

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Test Config. 2.3.7-3.2.2 Steady-state
Specific Case ΦC only, LC Comp, Full Load
Date 7-23-85

I) Input Power

V_{in} 151.6 Vdc
I_{in} 70.32 Adc
P_{in} 10,620W

Frequency ______

T.H.D.
ΦA ___ db
ΦB ___ db
ΦC 4.4 ~~db~~ %

T.H.D. – Transmission Line
Into the line
ΦA

II) Output Power

ΦA	ΦB	ΦC
V_o ___	V_o ___	V_o 417.2
I_o 4.61mv	I_o 2.45mv	I_o 20.9 Aac; 21.6mv – 0.44mv = 21.2mv
P_o ___	P_o ___	P_o 9,200

A.C. RCVR	B/D MOD.	D.C. RCVR
V_o ___	V_o ___	V_o 28.25
I_o ___	I_o 2.45mv	I_o 22.06
P_o ___	P_o ___	P_o 623 W

T.H.D. Out of RCVR
______ db

Resistive Loads

ΦA	ΦB	ΦC
V_A 3.5 Vac	V_B 3.0 Vac	V_C 422.0 Vac
I_A 0.81 mv	I_B 0.43 mv	I_C 101.40 mv
I_A ___ Aac	I_B ___ Aac	I_C 20.10 Aac
P_{RA} ___	P_{RB} ___	P_{RC} 8,483

Total System Efficiency = $\frac{P_{out}}{P_{in}} = \frac{9,100}{10,620} = 85.7\%$

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.6 TRANSIENT LOAD RESPONSE

Specific Case: DC RCVR

Input Voltage: Same — DC Rcvr: 0 ↔ 726W

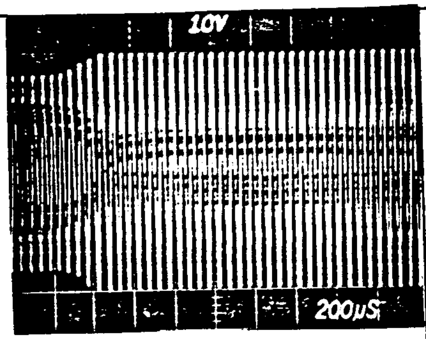
Input Current: ______ — AC Rcvr: ______

System Frequency: ______ — BD Module: ______

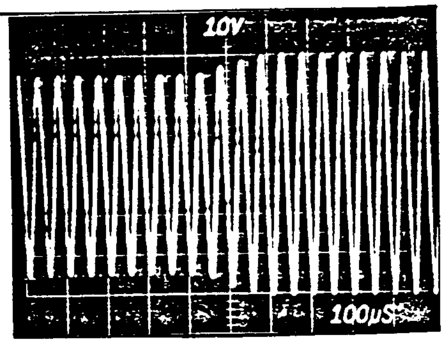
Output Power: ______ — Other: ______

V_{LINE}* / 3

V_o



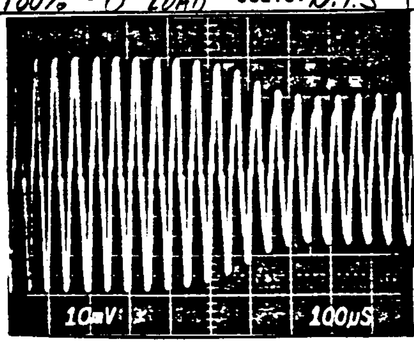
V_{L3}*



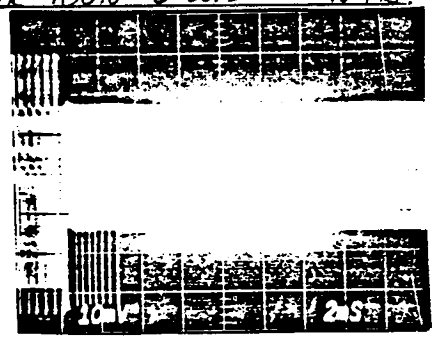
DC RCVR 100% → 0 LOAD Scale: N.T.S

DC RCVR 100% → 0 LOAD Scale: N.T.S.

IK_3



IK3



DC RCVR 0→100% LOAD Scale: 10A/DIV

OSC. DUE TO TRANSFORMER.
DC RCVR 0→100% LOAD. Scale: 10A/DIV

* LINE VOLTAGE IS NO TO SCALE

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.36-3.2.3 TRANSIENT LOAD RESPONSE

Specific Case: DC RCVR

Input Voltage: Same

Input Current:

System Frequency:

Output Power:

DC Rcvr: 0 ↔ 726W

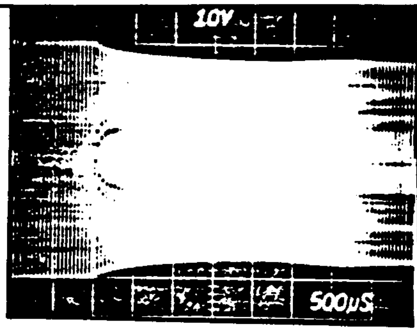
AC Rcvr:

BD Module:

Other:

V_{LINE_3}*

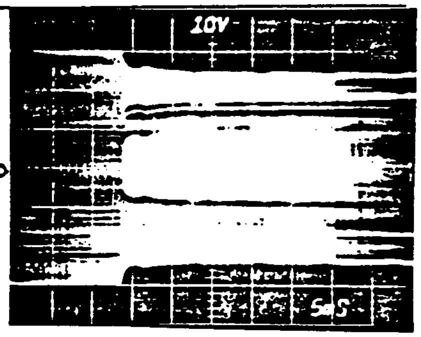
0



DC RCVR 0→100% LOAD Scale: N.T.S.

V_{LINE_3}*

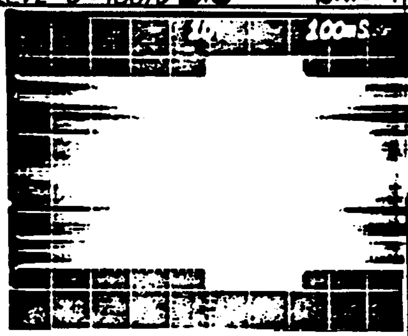
0



DC RCVR 0→100% LOAD Scale: N.T.S.

V_{LINE_3}*

V_O



DC RCVR - SWITCHING,
0→100%→0 LOAD Scale: N.T.S.

Photo

Scale:

* VOLTAGE READ IS NOT TO SCALE

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.3 TRANSIENT LOAD RESPONSE

Specific Case: DC RCVR

Input Voltage: Same | DC Rcvr: 0 ⟷ 726W

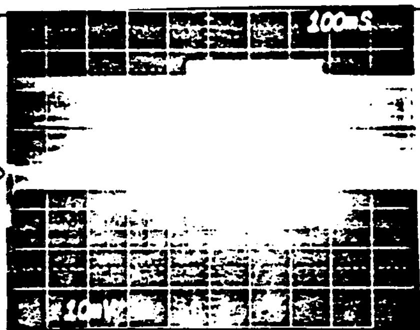
Input Current: ↓ | AC Rcvr:

System Frequency: ↓ | BD Module:

Output Power: ↓ | Other:

I_G

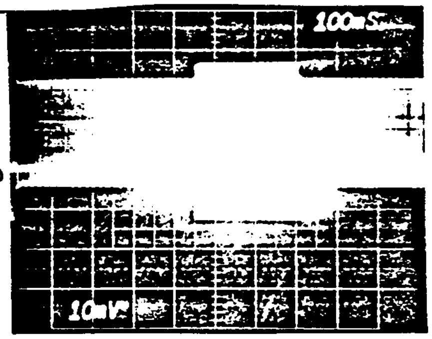
0



DC RCVR SWITCHING FROM 100% → 0 LOAD AND FROM 0 → 100% LOAD Scale: 20A/DIV

I_H

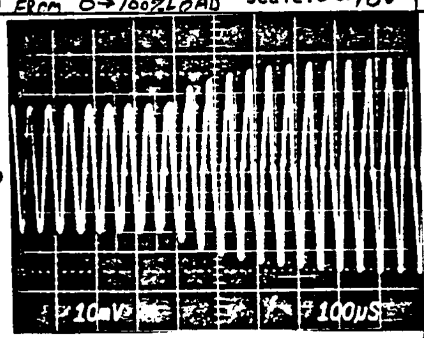
0



DC RCVR SWITCHING FROM 100% → 0 LOAD AND FROM 0 → 100% LOAD Scale: 20A/DIV

IK3

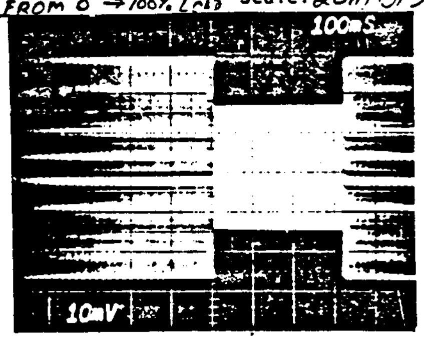
0



DC RCVR, TURNED ON FROM 100% → 0 LOAD. Scale: 10A/DIV

IK3

0



DC RCVR, LOAD CHANGED FROM 0 → 100% → 0 Scale: 10A/DIV

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.3 TRANSIENT LOAD RESPONSE

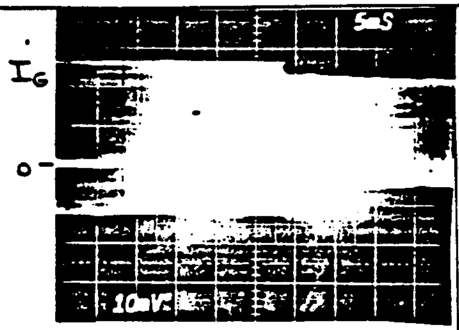
Specific Case: DC RCVR

Input Voltage: Same | DC Rcvr: 0→726W

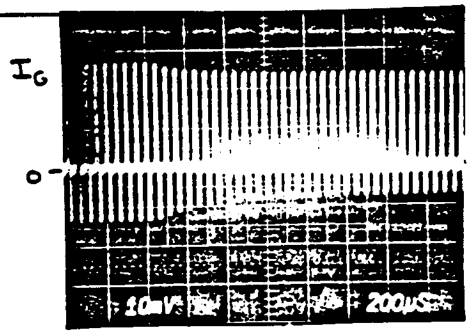
Input Current: | AC Rcvr:

System Frequency: | BD Module:

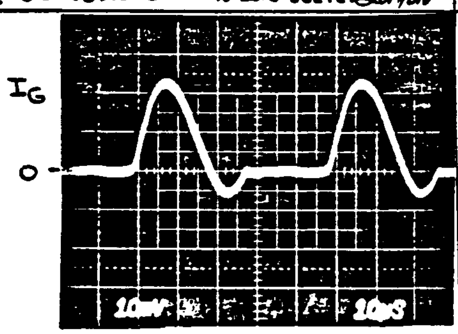
Output Power: | Other:



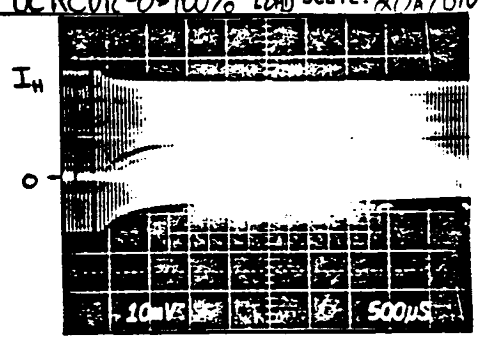
I_G-DC RCVR 0→100% LOAD Scale: 20A/DIV



IG-DC RCVR-0→100% LOAD Scale: 20A/DIV



IG-DC RCVR-100% LOAD Scale: 20A/DIV



IH-DC RCVR 0→100% LOAD Scale: 20A/DIV

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

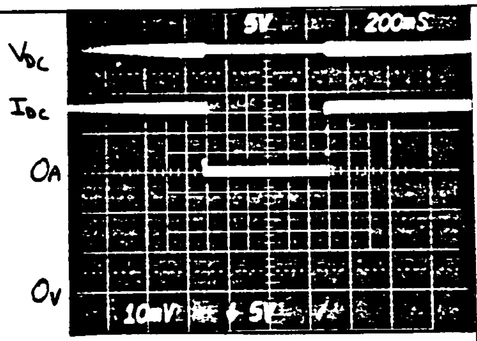
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

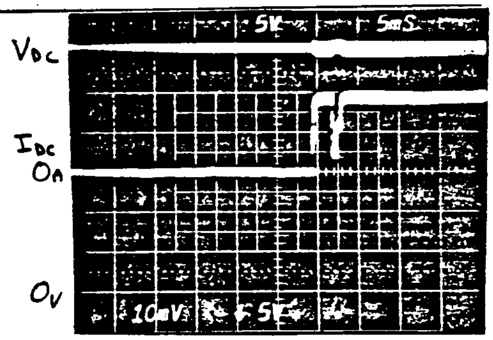
Test-Configuration: 2.3.6-3.2.3 Transient load response

Specific Case: DC RCVR (no load ↔ Full load)

Input Voltage: 120.2v	DC Rcvr: 726w
Input Current: 50.3A	AC Rcvr: 427w
System Frequency: 20.21 KHz	BD Module: 935w
Output Power: 4806w	Other: Ø1=978/Ø2=720/Ø3=1020

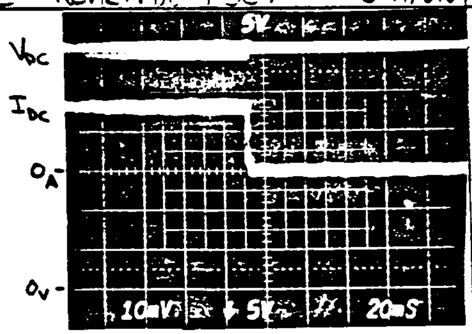


DC Rcvr (VDC-IDC) Scale: 20A/DIV



DC RCVR Output Voltage + Current

DC Rcvr. 0→Full load Scale: [illegible]/DIV



(VDC IDC)
DC RCVR - Full load → Ø Scale: 20A/DIV

Scale:

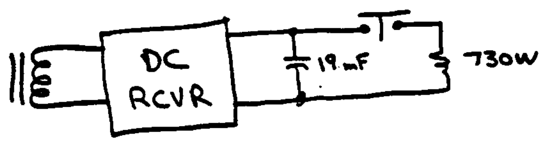
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6-3.2.3 TRANSIENT

LOAD RESPONSE - DC RCVR

Test Circuits



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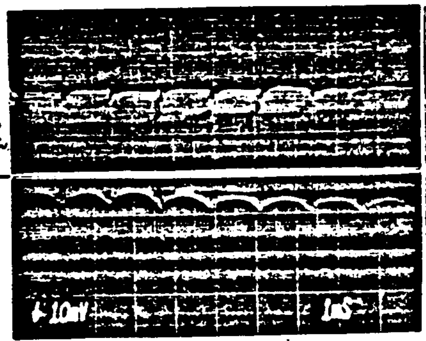
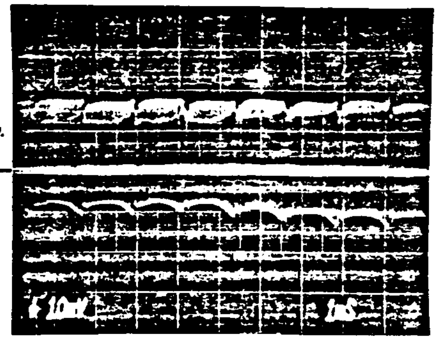
2.3.4
-3.2.3 50% DC LOAD → 25% DC LOAD

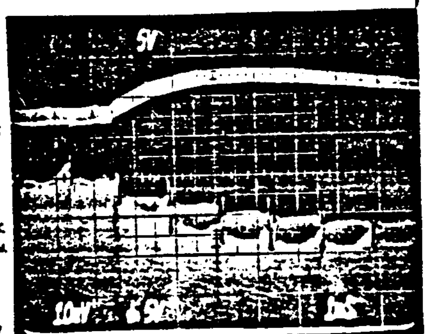
$V_{IN} = 90V$
$f = 20.44 kHz$



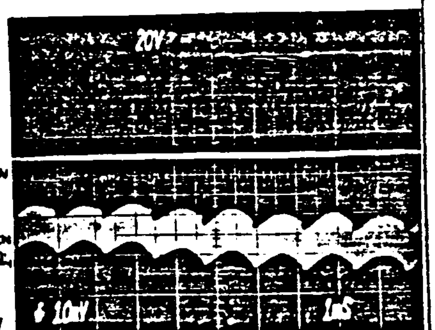
Branch Current B
Inverter #1



Branch Current D
Inverter #2



Output Voltage
Output Current
(Including Filter Current)
DC Receiver



Input Voltage
Input Current

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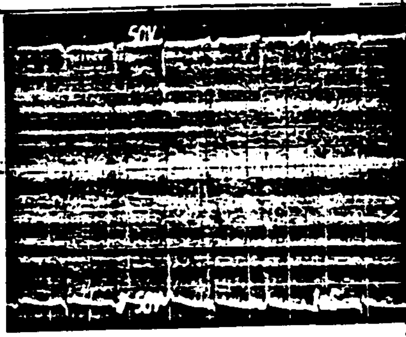
2.3.4
-3.2.3

50% DC LOAD → 25% DC LOAD

V_{IN} = 90V
f = 20.44 kHz

V_{K1}

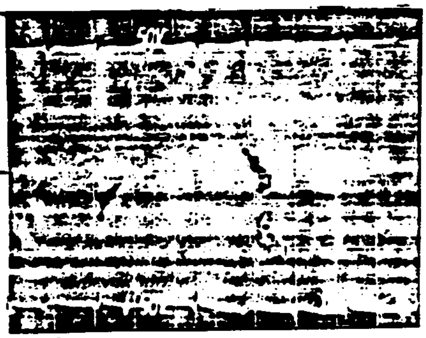
0V



Resonant Tank Voltage

V_{K2}

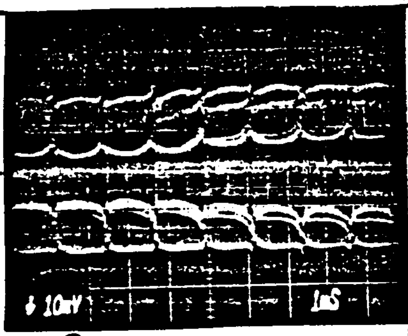
0V



Resonant Tank Voltage

I_{K1}
mA/div.

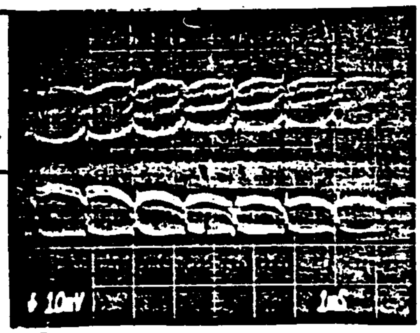
0A



Resonant Tank Current

I_{K2}
10A/div

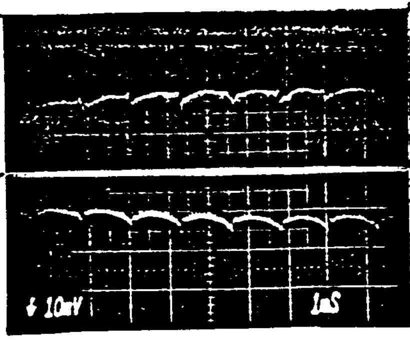
0A



Resonant Tank Voltage

I_A
mA/div.

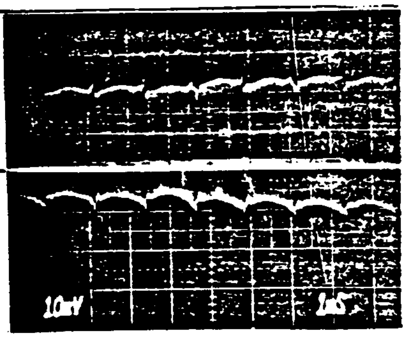
0A



Branch Current A

I_C
mA/div.

0A



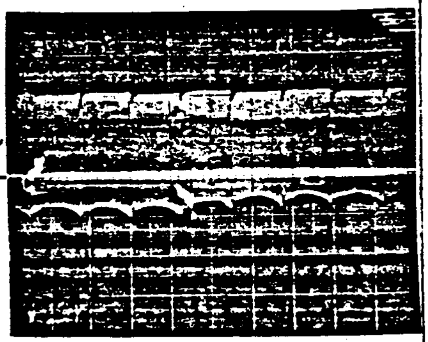
Branch Current C

2.3.4
-3.2.3

25% DC LOAD → 50% DC LOAD

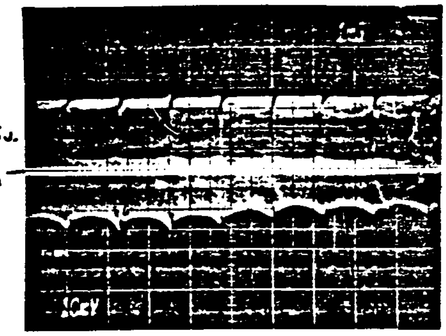
$V_{IN} = 90V$
$f = 20.44kHz$

I_B
10A/div
0A



Branch Current B
Inverter #1

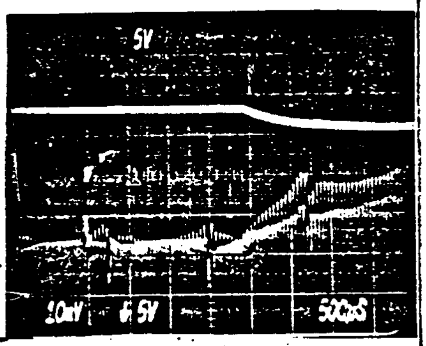
I_D
10A/div.
0A



Branch Current D
Inverter #2

V_{ODC}

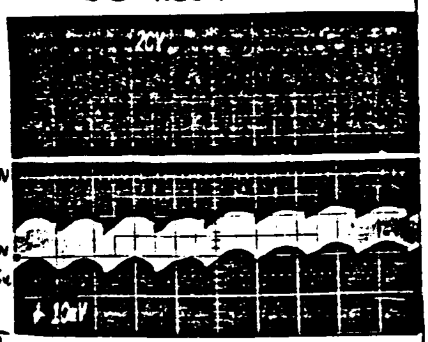
I_{ODC}
5A/div
%



Output Voltage
Output Current
(Including Filter Current)
DC Receiver

V_{IN}

I_{IN}
5A/div
0/0



Input Voltage
Input Current

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2.3.4
-3.2.3

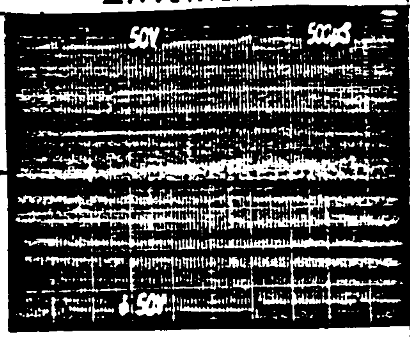
25% DC LOAD → 50% DC LOAD

V_{IN} = 90V
f = 20.44kHz

INVERTER #1

V_{K1}

0V

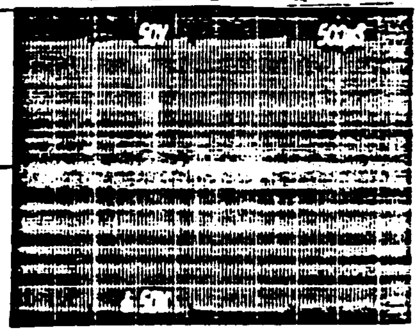


Resonant Tank Voltage

INVERTER #2

V_{K2}

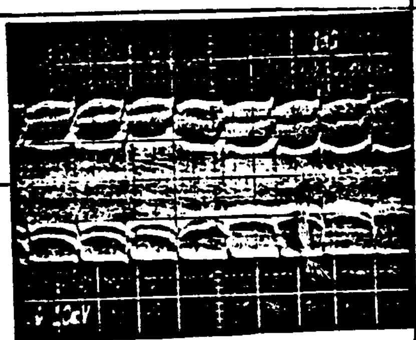
0V



Resonant Tank Voltage

I_{K1}
10A/div.

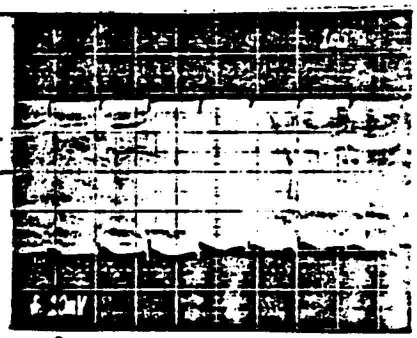
0A



Resonant Tank Current

I_{K2}
10A/div.

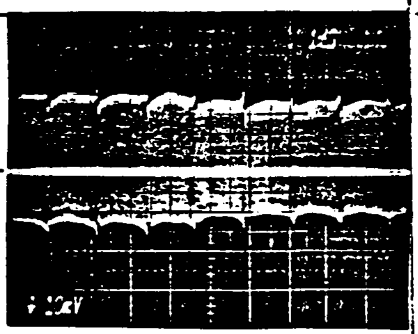
0A



Resonant Tank Current

I_A
10A/div.

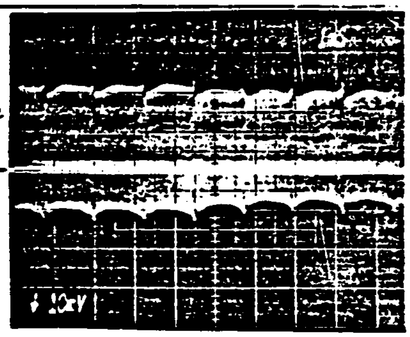
0A



Branch Current A

I_C
10A/div.

0A

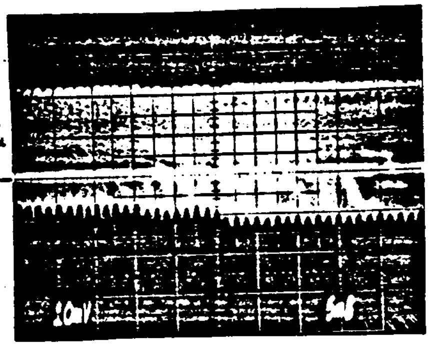


Branch Current C

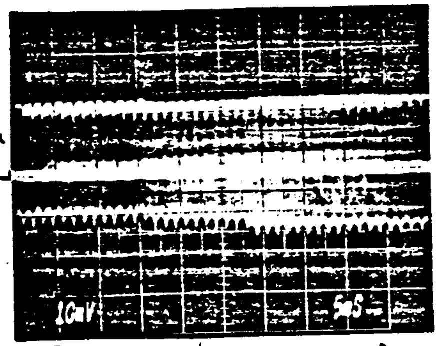
2.3.4
-3.23

50% BD LOAD → 25% BD LOAD

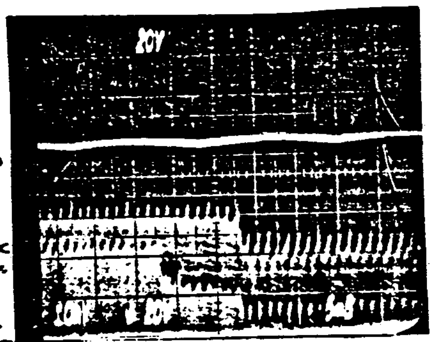
$V_{IN} = 90V$
$f = 20.44kHz$



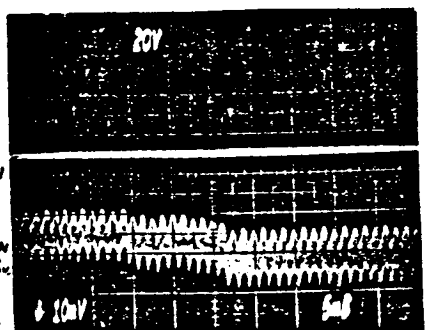
Branch Current B
Inverter #1



Branch Current D
Inverter #2



Output Voltage
Output Current
(Including Filter Current)
BD Module



Input Voltage
Input Current

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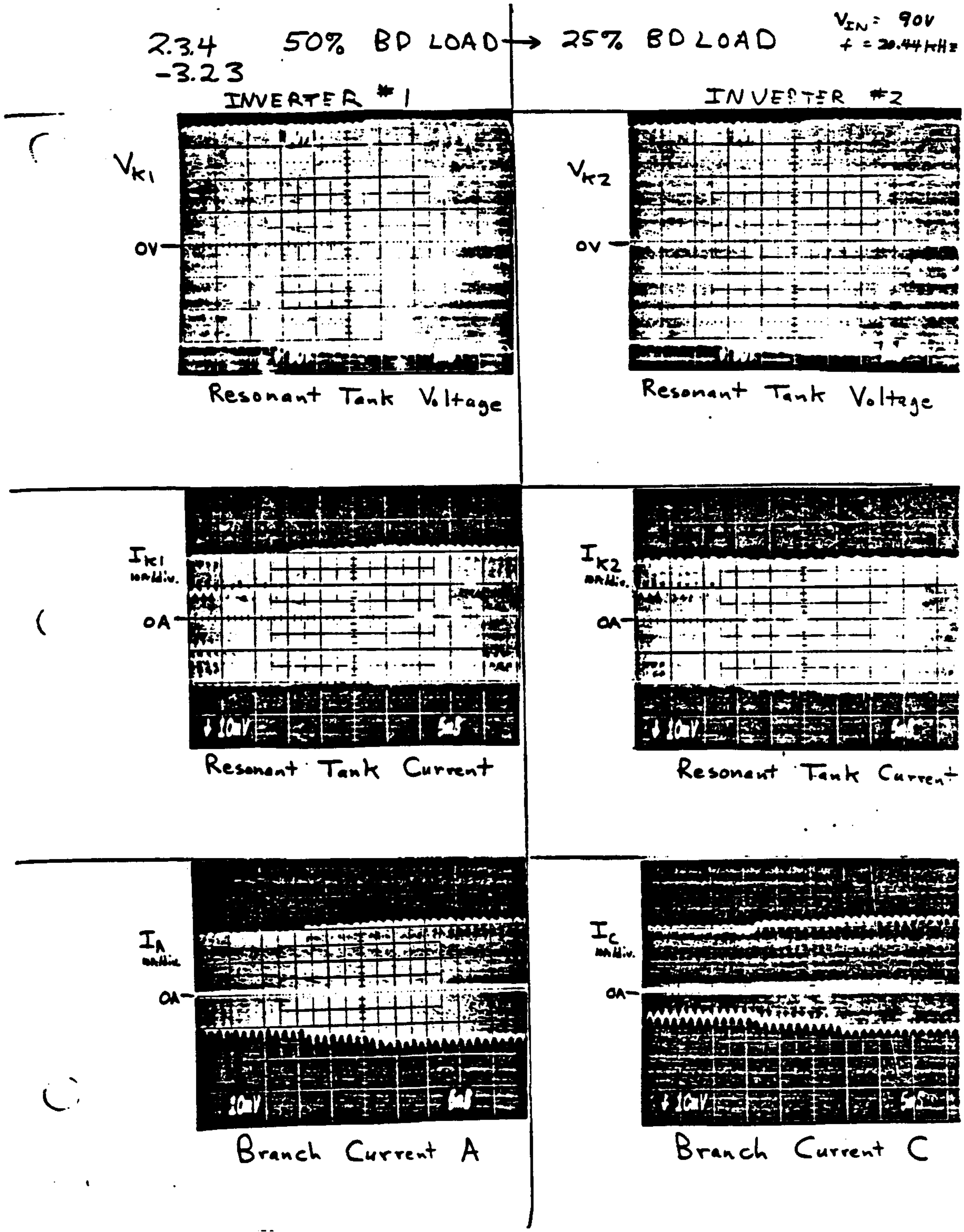
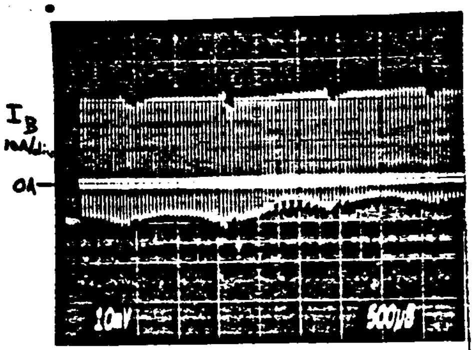
OF POOR QUALITY

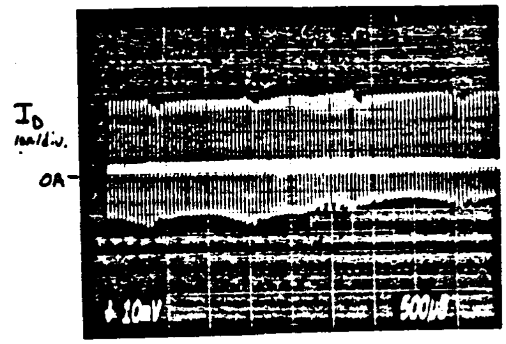


2.3.4
-3.2.3 25% BD LOAD → 50% BD LOAD

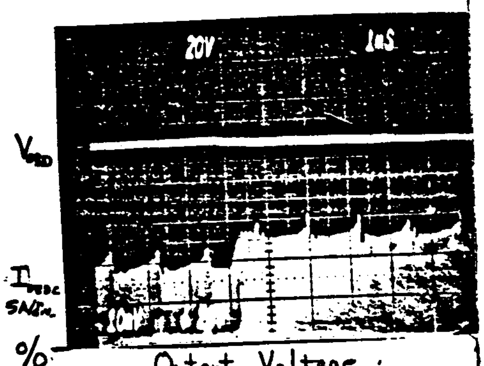
$V_{IN} = 90V$
$f = 20.44kHz$



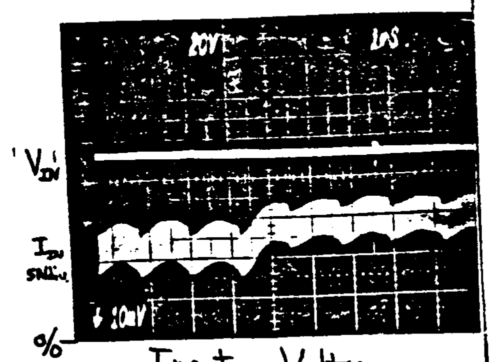
Branch Current B
Inverter #1



Branch Current D
Inverter #2



Output Voltage
Output Current
(Including Filter Current)
Bidirectional Module



Input Voltage
Input Current

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OF POOR QUALITY

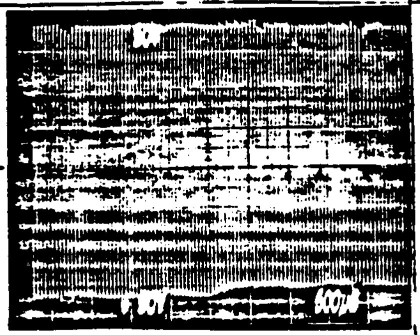
2.3.4
-3.2.3 25% BD LOAD → 50% BD LOAD

V_{IN}=90V
f=20.44kHz

INVERTER #1

V_{K1}

0V

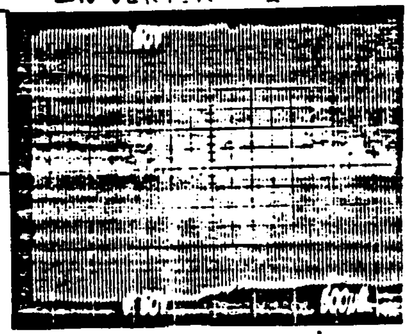


Resonant Tank Voltage

INVERTER #2

V_{K2}

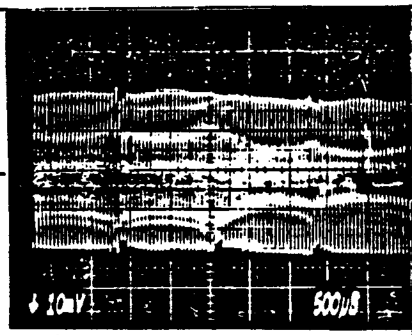
0V



Resonant Tank Voltage

I_{K1}
10A/div.

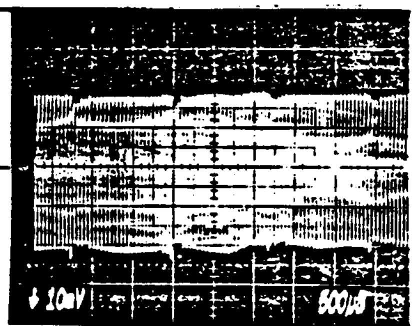
0A



Resonant Tank Current

I_{K2}
10A/div.

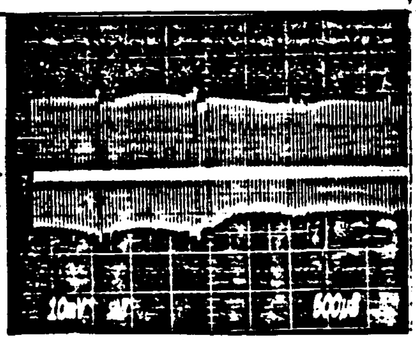
0A



Resonant Tank Current

I_A
10A/div.

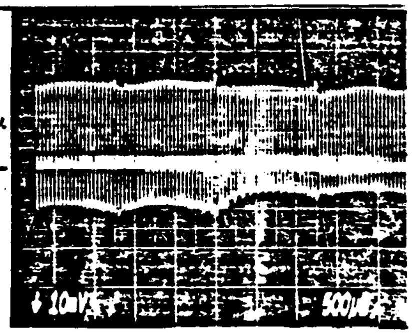
0A



Branch Current A

I_C
10A/div.

0A

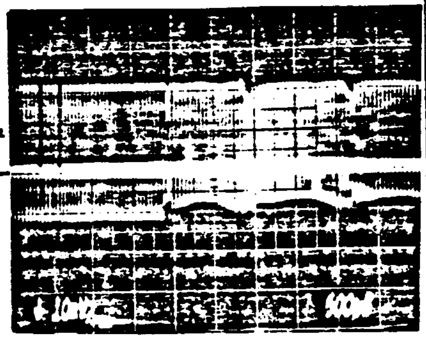


Branch Current C

23.4-3.2.3 NO AC LOAD → 50% AC LOAD

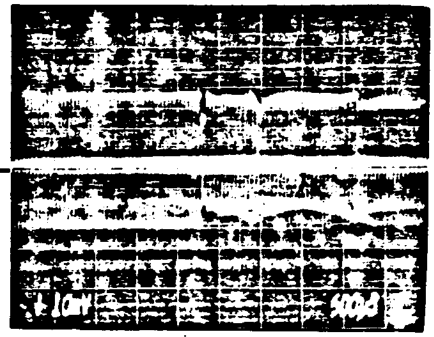
$V_{IN} = 90V$
$f = 20.44$ kHz

I_B 10A/div
OA



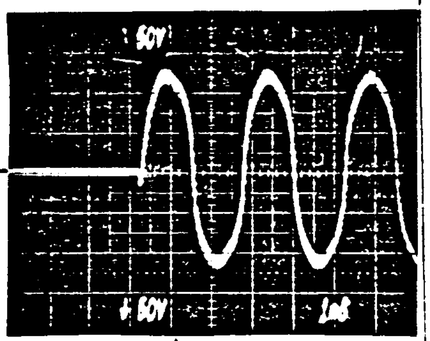
Branch Current B
(Inverter #1)

I_D 10A/div
OA



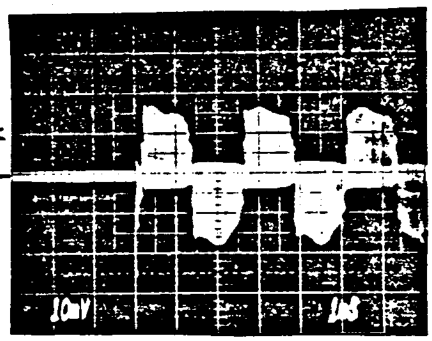
Branch Current D
(Inverter #2)

V_{OAC}
0V



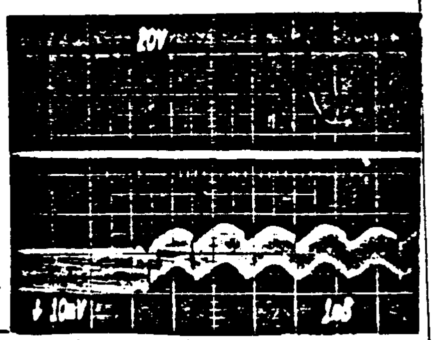
Output Voltage
(AC Receiver)

I_{OACC} 5A/div
OA



Output Current
(Including Filter Current)
AC Receiver

V_{IN}
I_{IN} 5A/div
%



Input Voltage
Input Current

2.3.4
-3.2.3

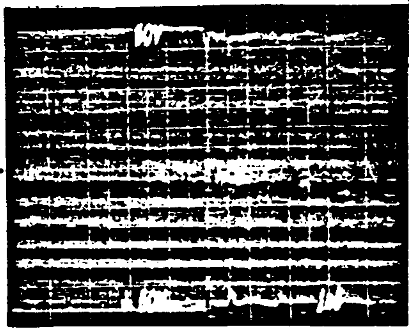
NO AC LOAD → 50% AC LOAD

V_{IN} = 90V
f = 20.44 KHz

INVERTER #1

V_{K1}

0V

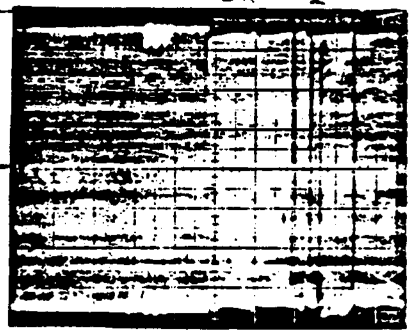


Resonant Tank Voltage

INVERTER #2

V_{K2}

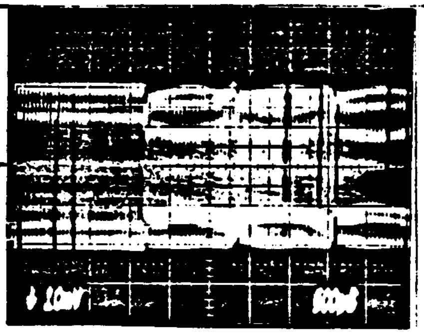
0V



Resonant Tank Voltage

I_{K1}
10A/div

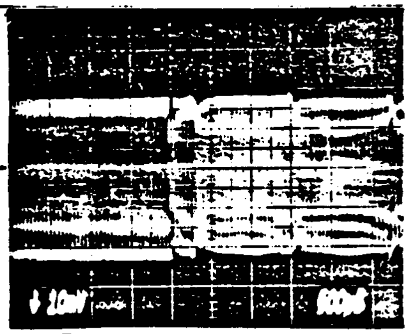
0A



Resonant Tank Current

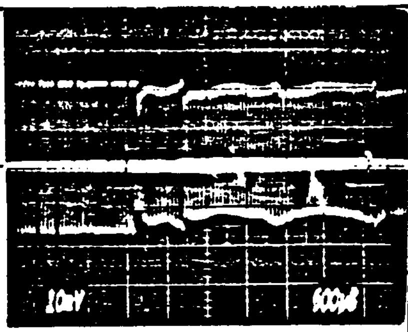
I_{K2}
10A/div.

0A



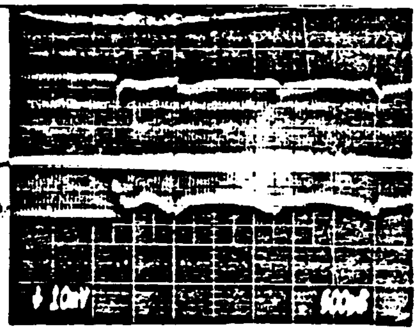
Resonant Tank Current

I_A
10A/



Branch Current A

I_C
10A

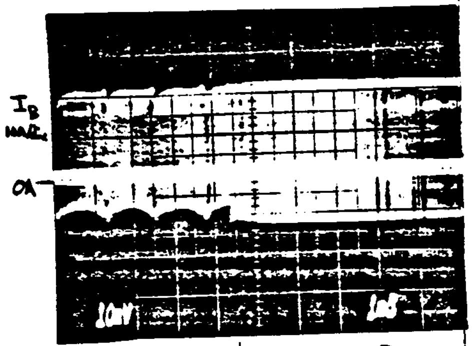


Branch Current C

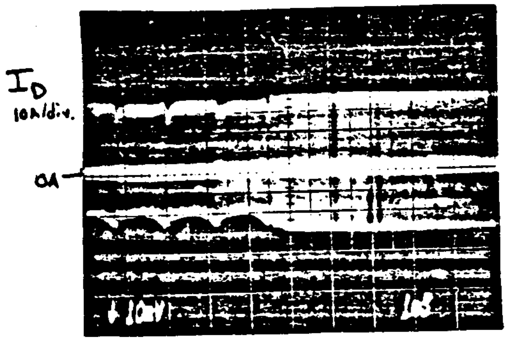
2.3.4
-3.2.3

50% AC LOAD → NO AC LOAD

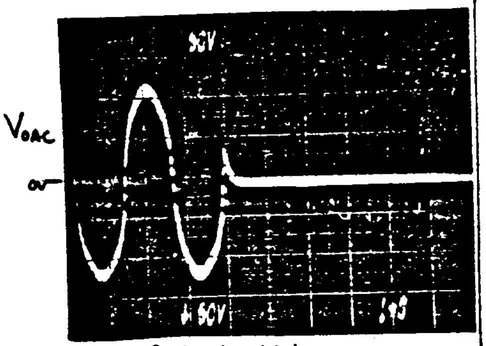
$V_{IN}=90V$
$f=20.44kHz$



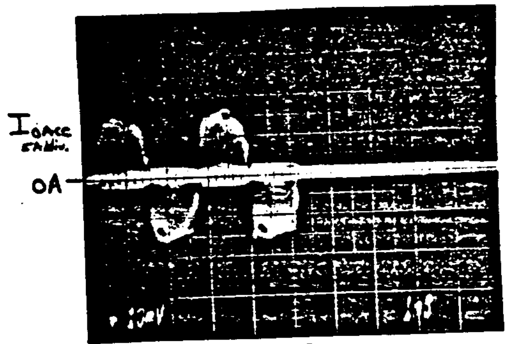
Branch Current B
Inverter #1



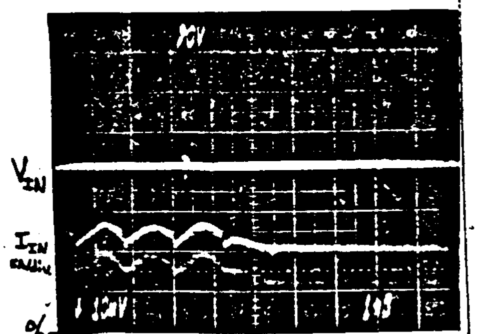
Branch Current D
Inverter #2



Output Voltage
AC Receiver



Output Current
(Including Filter Current)
AC Receiver



Input Voltage
Input Current

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2.3.4
-3.2.3

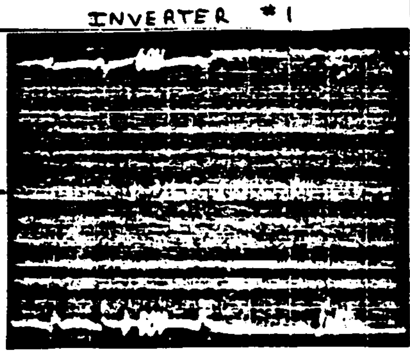
50% AC LOAD → NO AC LOAD

$V_{IN} = 90V$
$f = 20.44kHz$

INVERTER #1

V_{K1}

0V

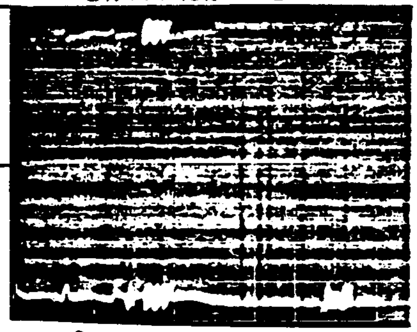


Resonant Tank Voltage

INVERTER #2

V_{K2}

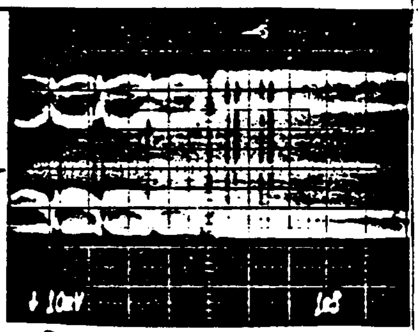
0V



Resonant Tank Voltage

I_{K1}
10A/div.

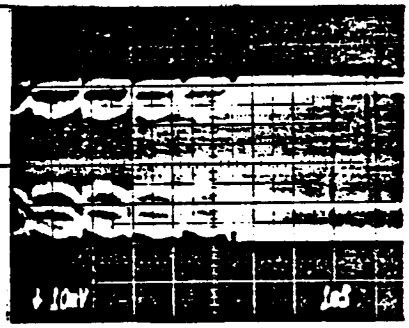
0A



Resonant Tank Current

I_{K2}
10A/div.

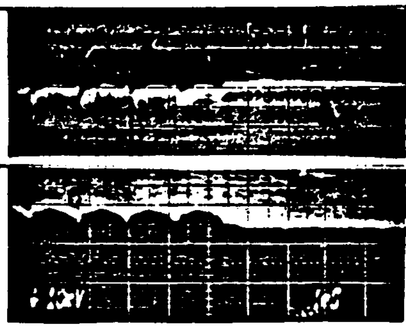
0A



Resonant Tank Current

I_A
10A/div.

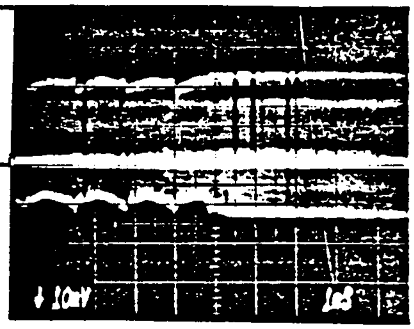
0A



Branch Current A
INV. 1

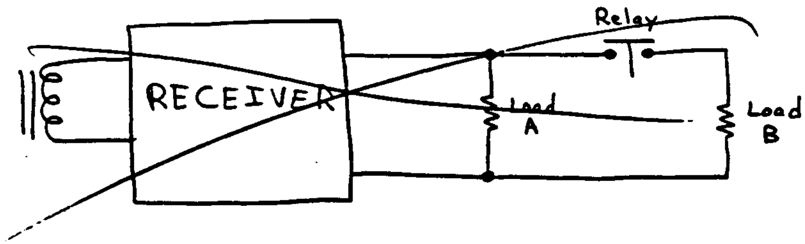
I_C
10A/div.

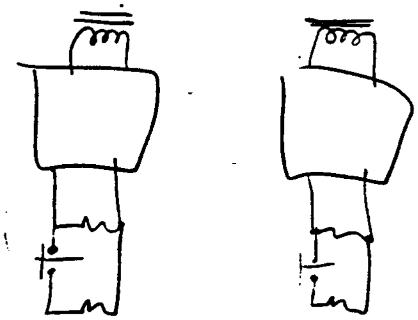
0A



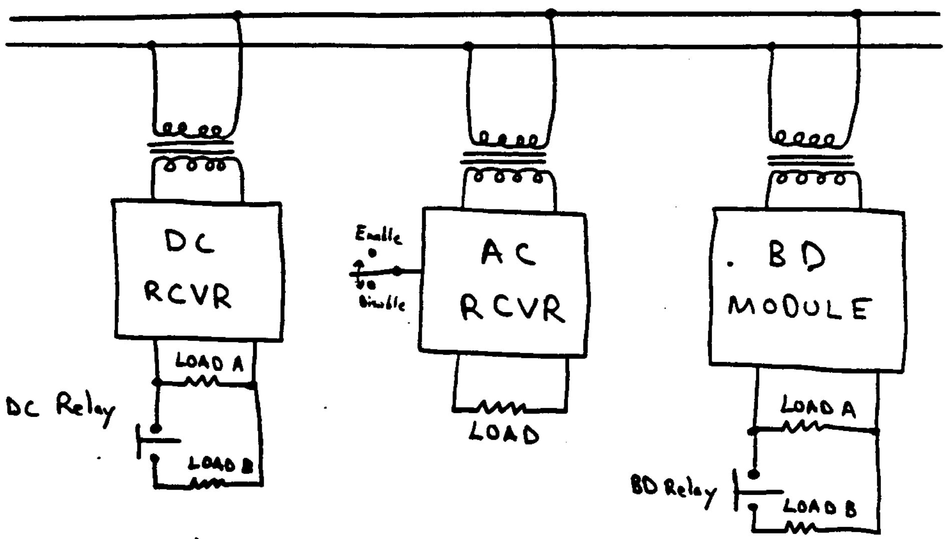
Branch Current C
INV. 2

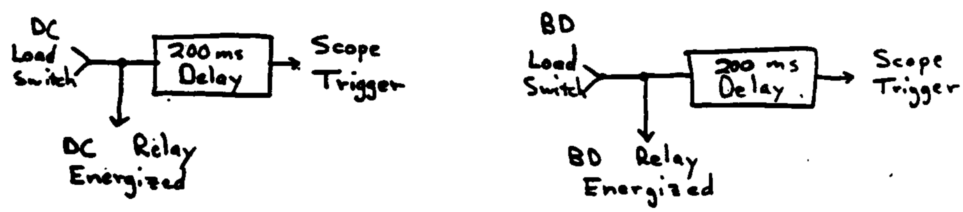
3.2.3 TRANSIENT LOAD RESPONSE





2.3.4 TRANSIENT LOAD RESPONSE
-3.2.3

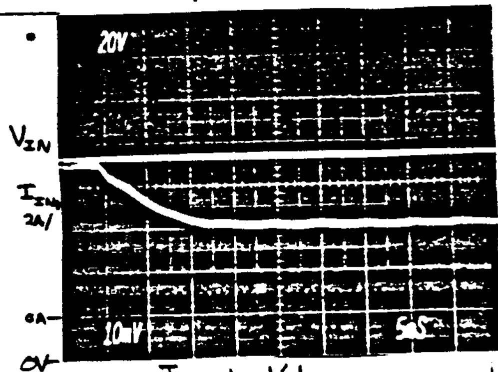




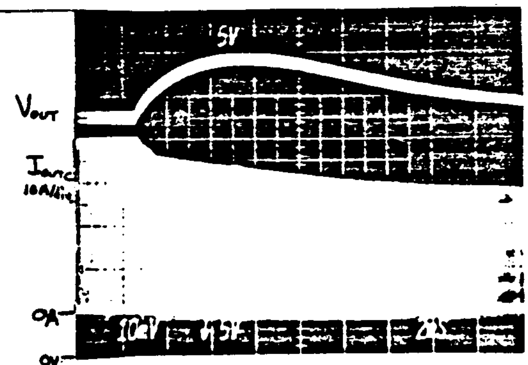
Load switching is done for each receiver while the two other receivers maintain 50% loading.

2.3.2 Full → 50% Load $V_{IN} = 92.0\ V_{DC}$

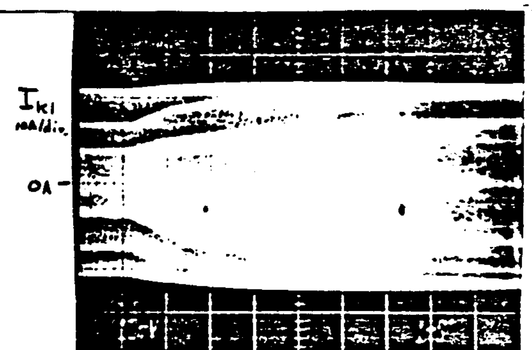
-3.2.3.1



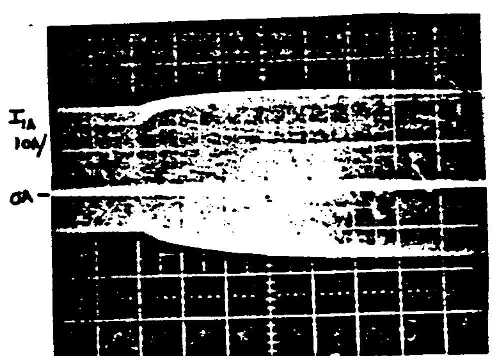
Input Voltage
Input Current
(Before DC Capacitor)



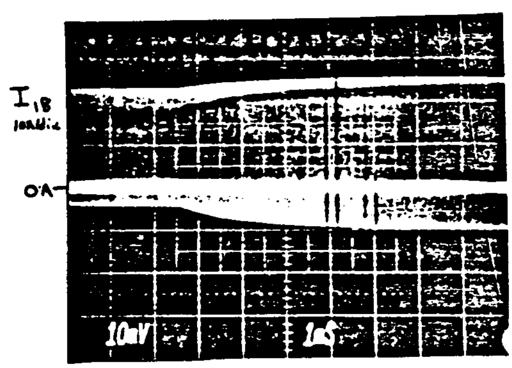
Output Voltage
Output Current
(Including Filter Current)



Resonant Tank Current 1ms/div.



Branch Current 1A 2ms/div.

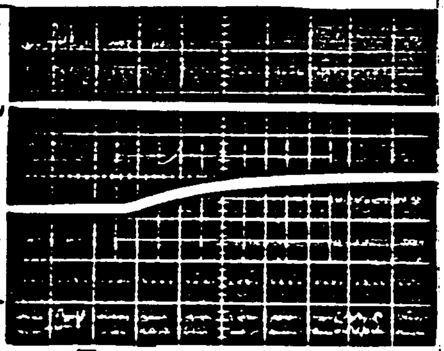


Branch Current 1B

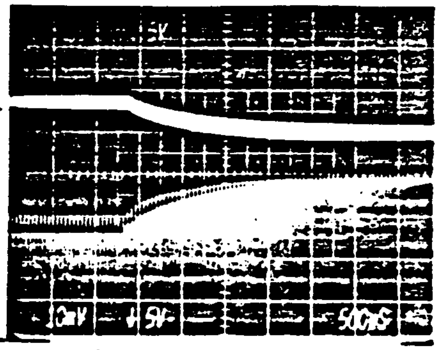
$V_{IN} = 920\,V_{DC}$

2.3.2
-3.2.3.1

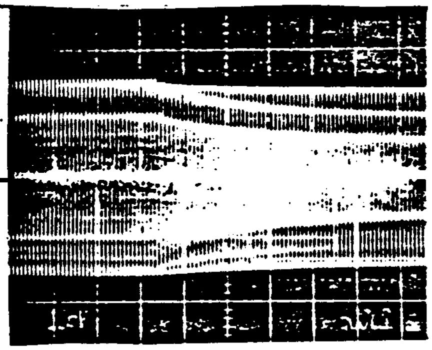
50% → Full Load



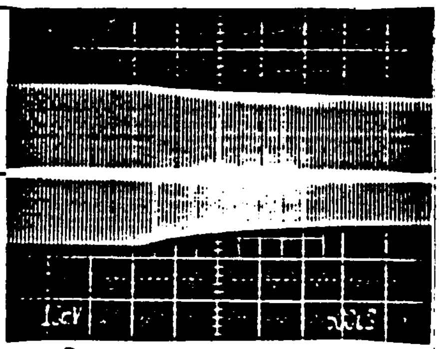
Input Voltage
Input Current
(Before DC Capacitor)



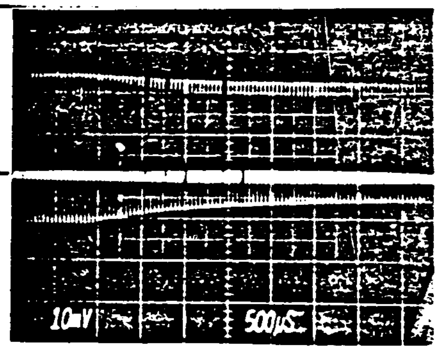
Output Voltage
Output Current
(Including Filter Current)



Resonant Tank Current



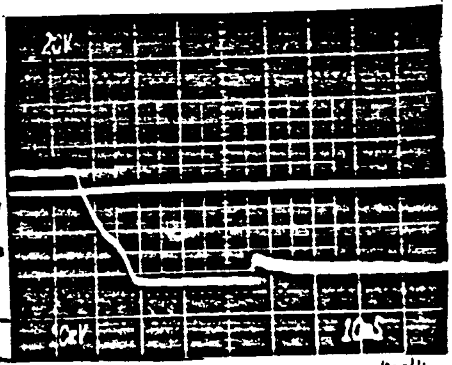
Branch Current 1A



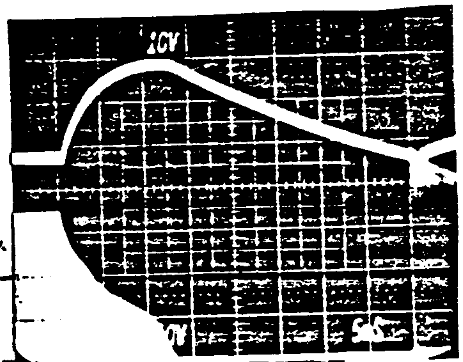
Branch Current 1B

2.3.2 Full → 10% Load
-3.2.3.1

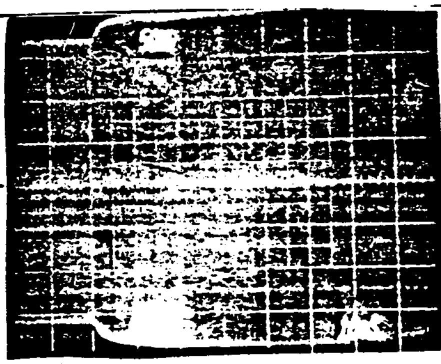
$V_{IN} = 92.0\ V_{DC}$



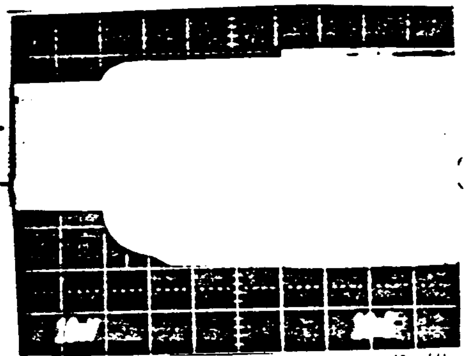
Input Voltage
Input Current
(Before DC Capacitor)



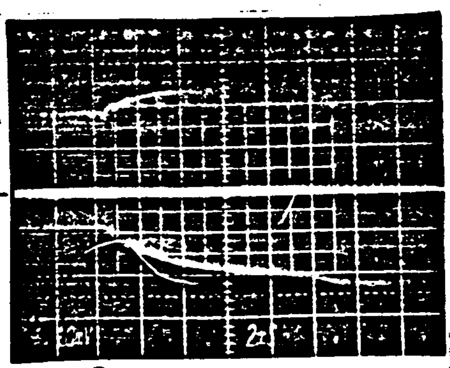
Output Voltage
Output Current
(Including Filter Current)



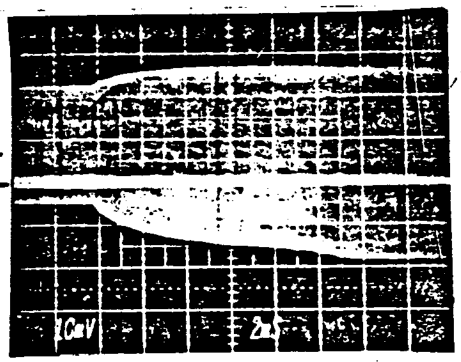
Resonant Tank Voltage



Resonant Tank Current



Branch Current 1A



Branch Current 1B

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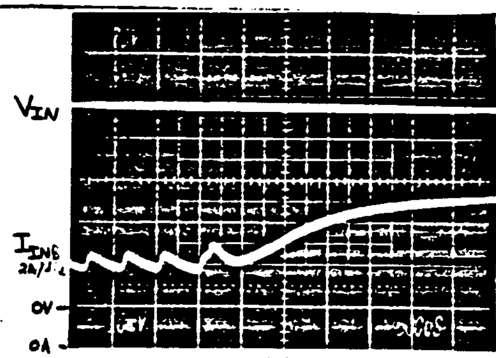
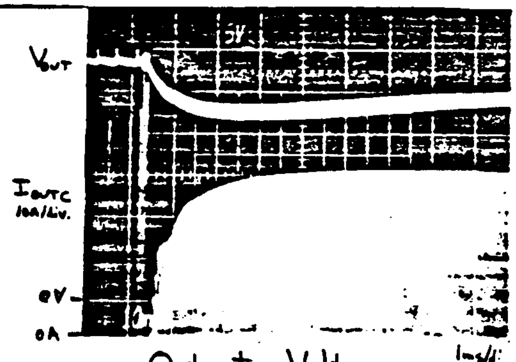
23.2
- 3.2.3.1

10% → Full Load

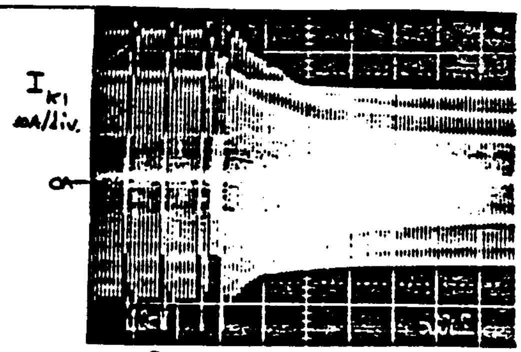
V_{IN} = 92.0 V_{DC}



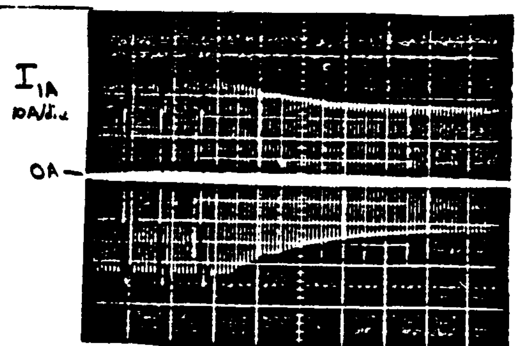
Input Voltage
Input Current
(Before DC Capacitor)



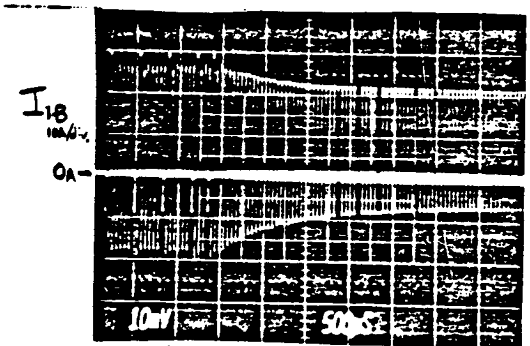
Output Voltage
Output Current
(Including Filter Current)



Resonant Tank Current

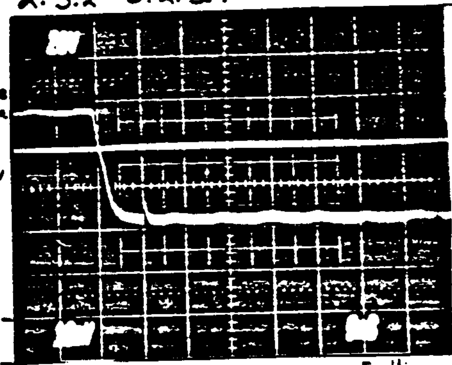


Branch Current 1A 500μs/div.

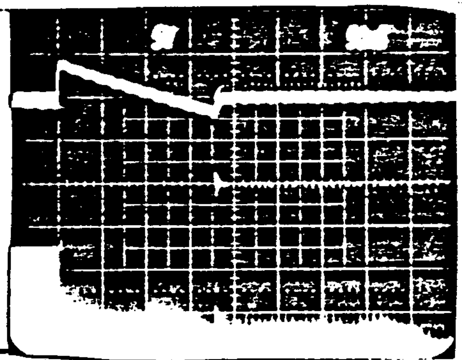


Branch Current 1B

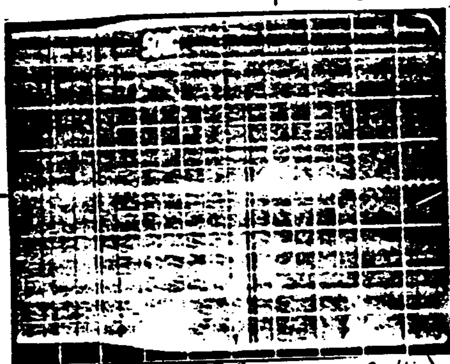
2.3.2-3.2.3.1 50% → No Load V_{IN} = 92.0 V_{DC}



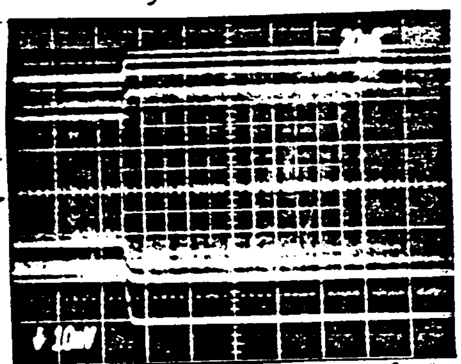
Input Voltage
Input Current
(Before DC capacitor)



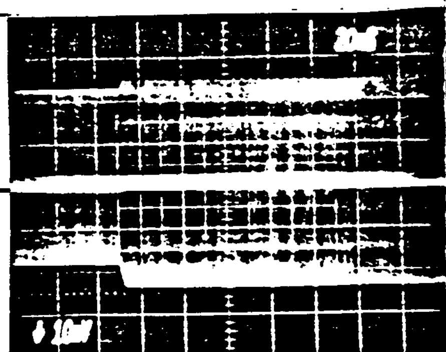
Output Voltage
Output Current
(Including Filter Current)



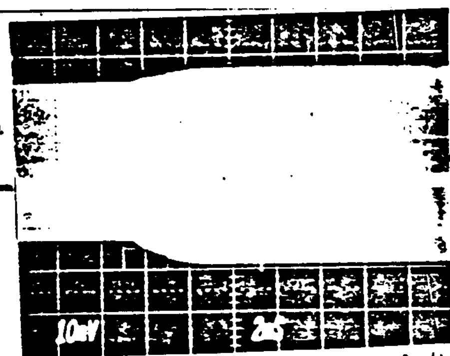
Resonant Tank Voltage



Resonant Tank Current



Branch Current 1A



Branch Current 1B

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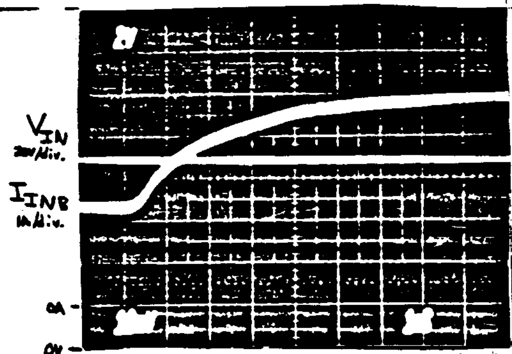
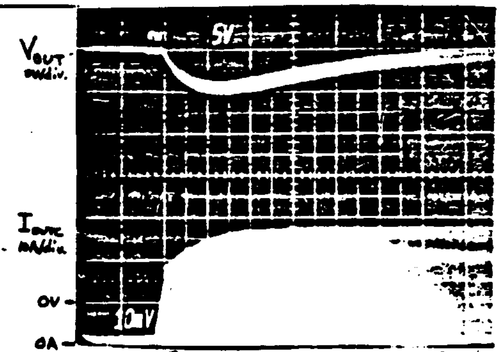
2.3.2
-3.2.3

0→50% Load

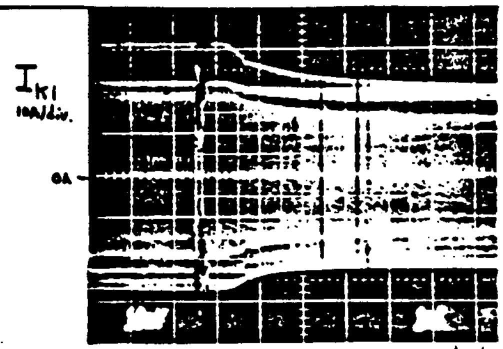
$V_{IN} = 920 V_{DC}$



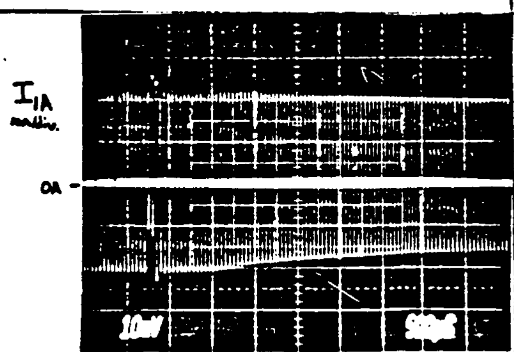
Input Voltage
Input Current
(Before DC Capacitor)



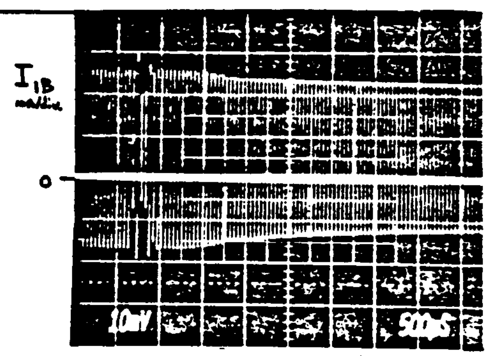
Output Voltage
Output Current
(Including Filter Current)



Resonant Tank Current

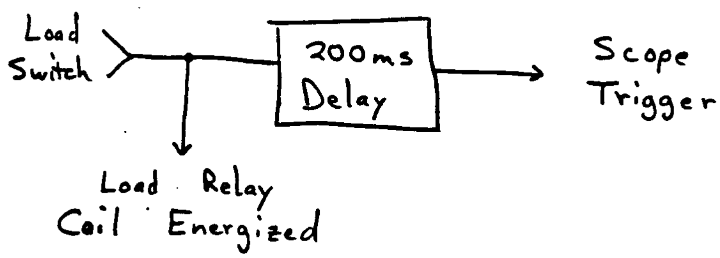


Branch Current 1A



Branch Current 1B

2.3.2 -3.2.3 TRANSIENT LOAD RESPONSE



Some relay bounce may be present in the photos.

ORIGINAL PAGE IS
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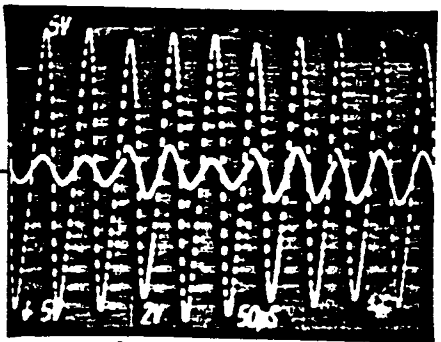
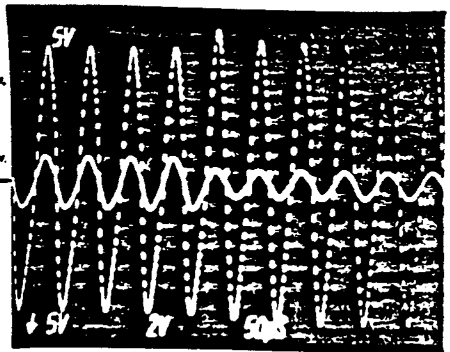
2.3.1 50% LOAD → FULL LOAD
-3.2.3 FULL LOAD → 50% LOAD

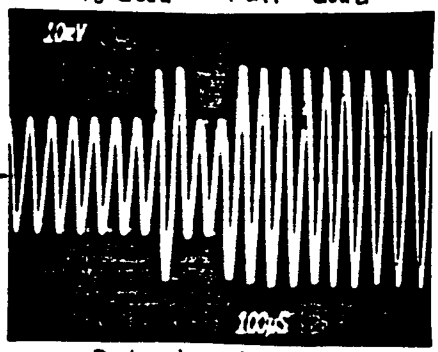
$V_{IN} = 820\ V_{DC}$



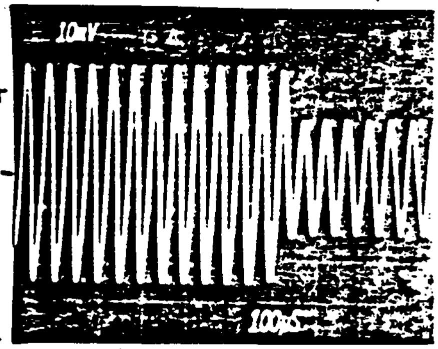
Output Voltage
Output Current
(Some relay bounce pictured)
50% Load → Full Load



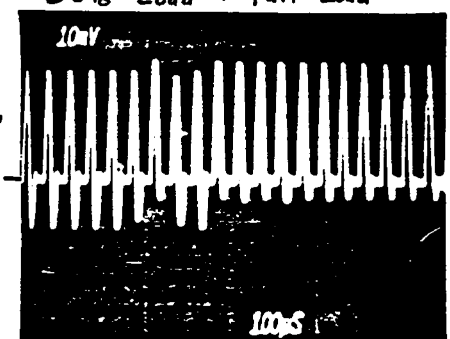
Output Voltage
Output Current
Full Load → 50% Load



Output Current
(Some relay bounce pictured)
50% Load → Full Load

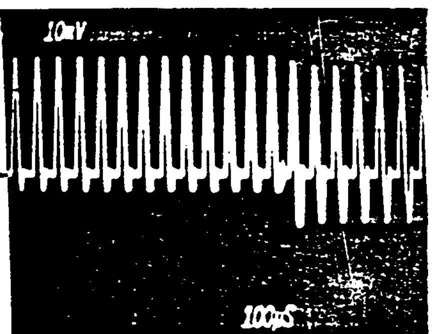


Output Current
Full Load → 50% Load



Branch Current

50% Load → Full Load



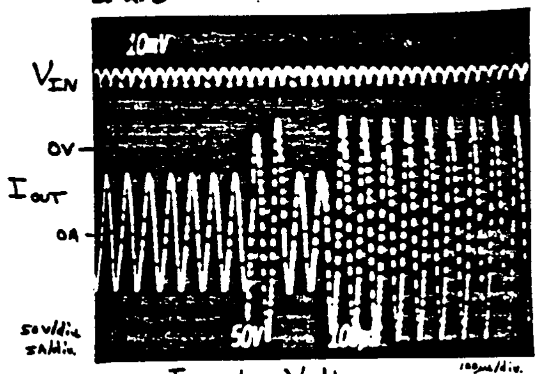
Branch Current

Full Load → 50% Load

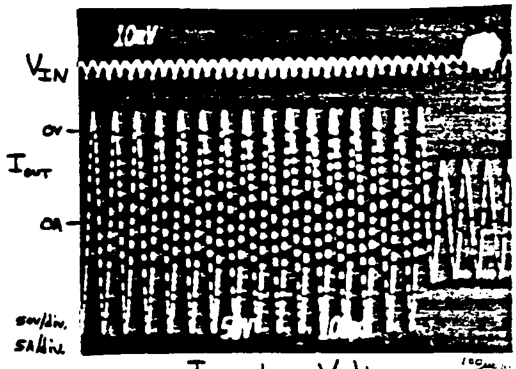
2.3.1 50% LOAD → FULL LOAD

-3.2.3 FULL LOAD → 50% LOAD

$V_{IN} = 87.0 V_{DC}$

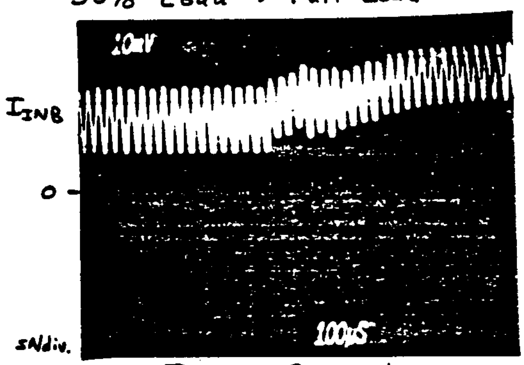


Input Voltage
Output Current
(Some relay bounce present)
50% Load → Full Load



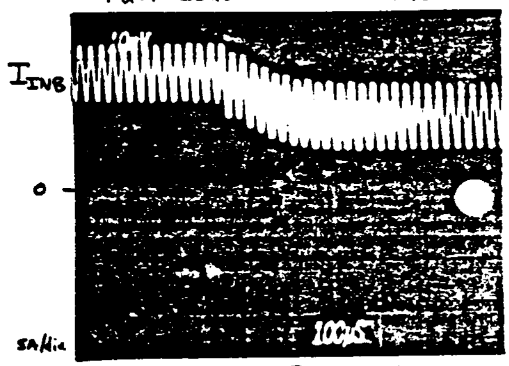
Input Voltage
Output Current

Full Load → 50% Load



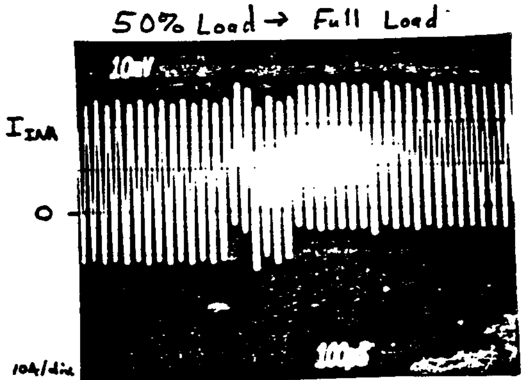
Input Current
(Before DC Capacitor)

50% Load → Full Load

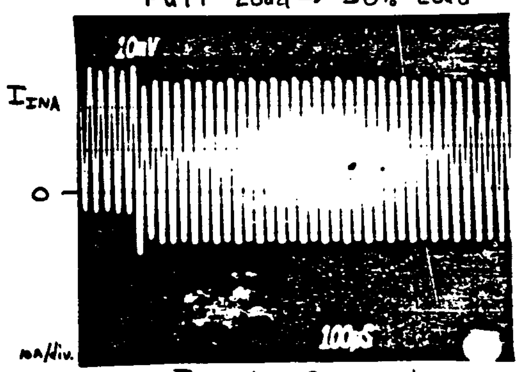


Input Current
(Before DC Capacitor)

Full Load → 50% Load



Input Current
(After DC Capacitor)
50% Load → Full Load



Input Current
(After DC Capacitor)
Full Load → 50% Load

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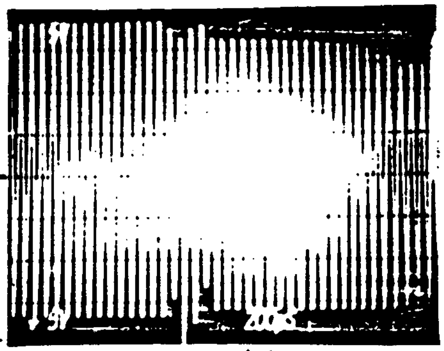
23.1 10% LOAD → FULL LOAD

-323 FULL LOAD → 10% LOAD V_{IN} = 57.0V

V_{K1}

0

5V/div.

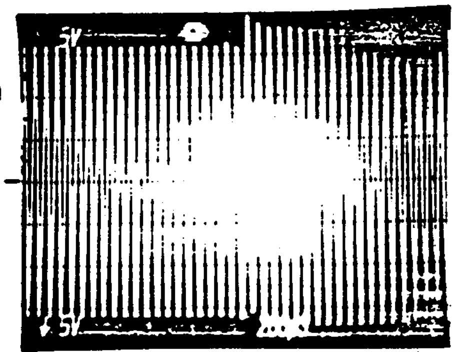


Output Voltage

10% Load → Full Load

V_{K1}

0



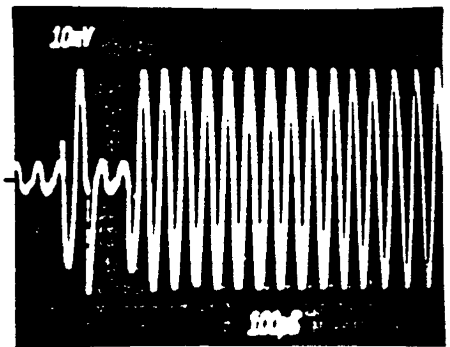
Output Voltage 200μs/div.

Full Load → 10% Load

I_{OUT}

0

5A/div.



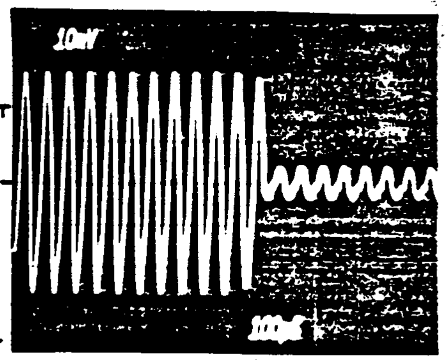
Output Current
(Some relay bounce present)

10% Load → Full Load

I_{OUT}

0

5A/div.



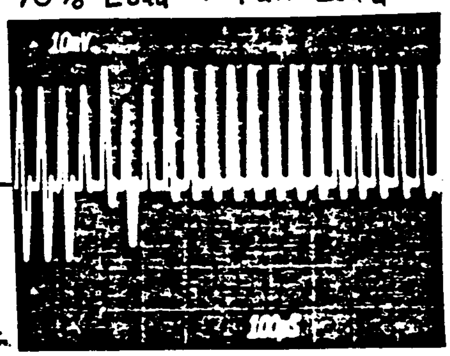
Output Current

Full Load → 10% Load

I_A

0

10A/div.



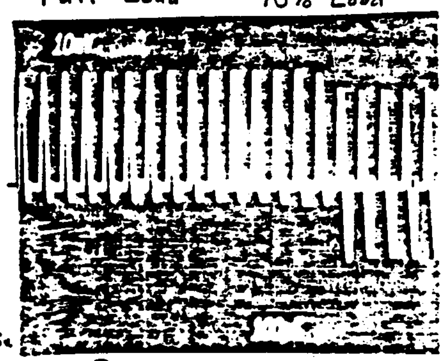
Branch Current

10% Load → Full Load

I_A

0

10A/div.



Branch Current

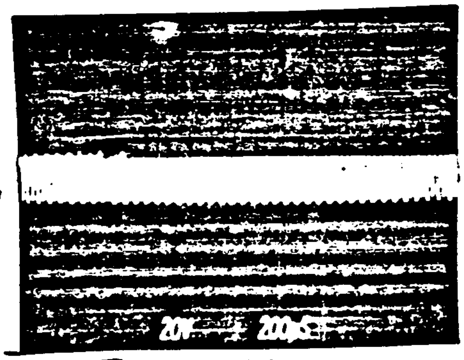
Full Load → 10% Load

2.3.1 10% LOAD → FULL LOAD V_{IN}=87.0 V_{DC}

-3.2.3 FULL LOAD → 10% LOAD

V_{IN}

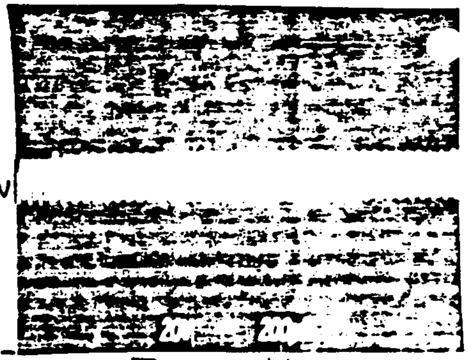
0



Input Voltage

V_{IN}

0



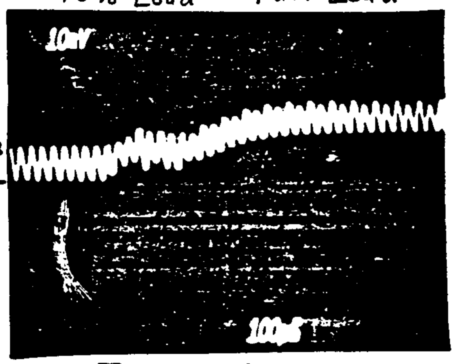
Input Voltage

10% Load → Full Load

I_{INB}

0

10A/div.

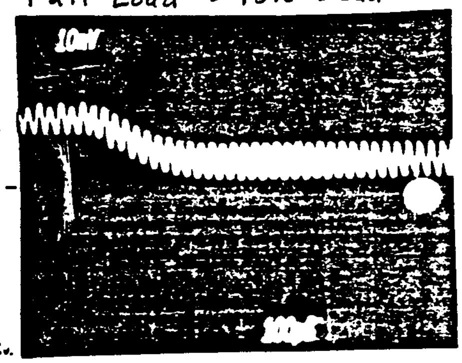


Input Current
(Before DC Capacitor)
10% Load → Full Load

Full Load → 10% Load

I_{INB}

10A/div.

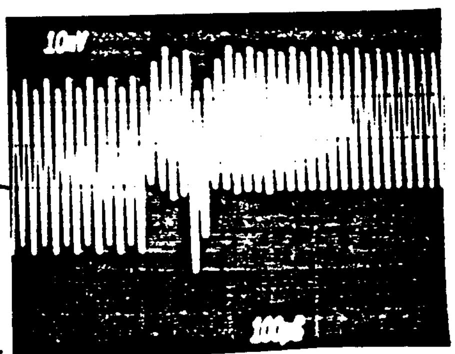


Input Current
(Before DC Capacitor)
Full Load → 10% Load

I_{INA}

0

10A/div.

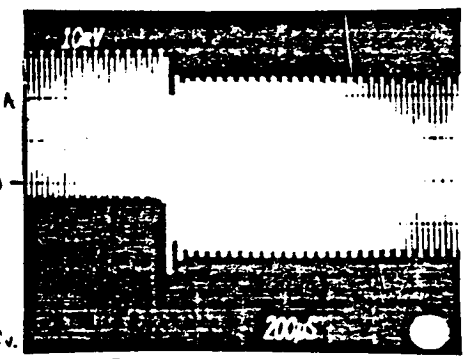


Input Current
(After DC Capacitor)
10% Load → Full Load

I_{INA}

0

10A/div.



Input Current
(After DC Capacitor)
Full Load → 10% Load

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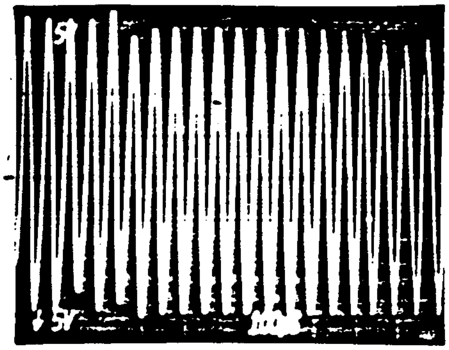
2.3.1 – 3.2.3

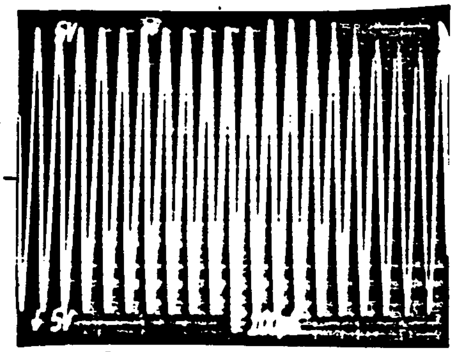
NO LOAD → 50% LOAD

50% LOAD → NO LOAD

$V_{IN} = 870\,V_{DC}$

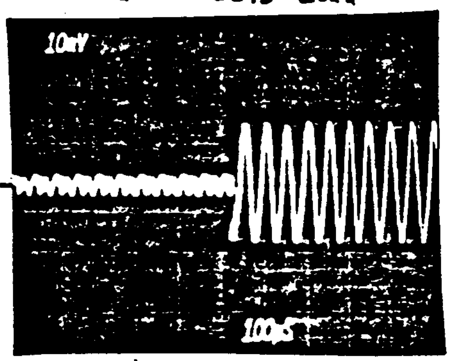


Inverter Output Voltage



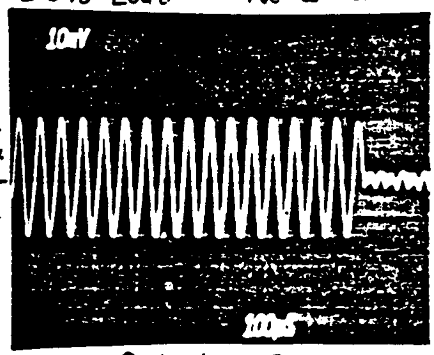
Output Voltage

No Load → 50% Load



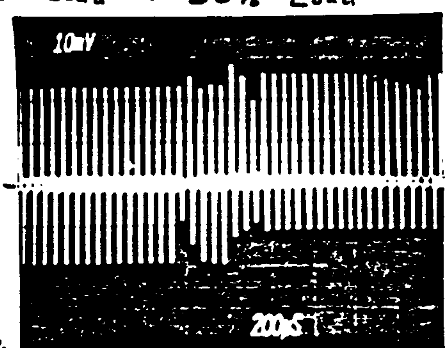
Output Current

50% Load → No Load



Output Current

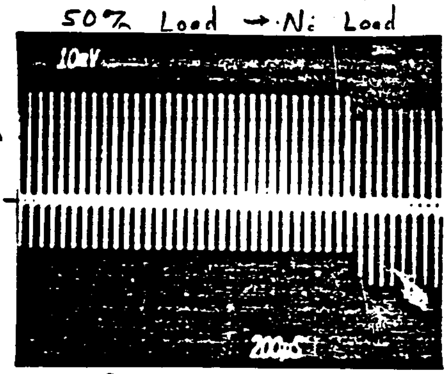
No Load → 50% Load



Branch Current

No Load → 50% Load

50% Load → No Load



Branch Current

50% Load → No Load

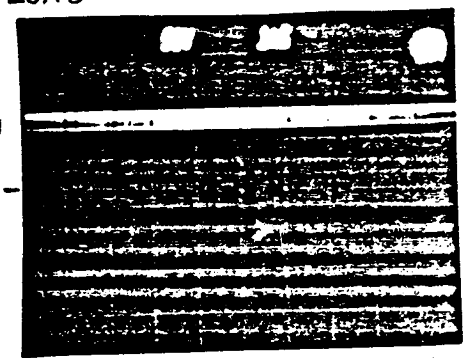
ORIGINAL PAGE IS
OF POOR QUALITY

.2.3.1 NO LOAD → 50% LOAD V_{IN} = 870 V_{DC}

-3.2.3 + 50% LOAD → NO LOAD

V_{IN}

0 -



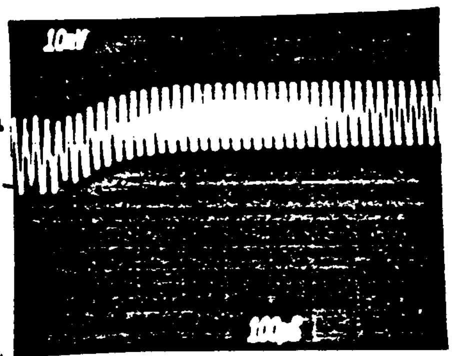
Input Voltage 1mV/div.

(Several Load Switches Captured)

I_{INB}

0 -

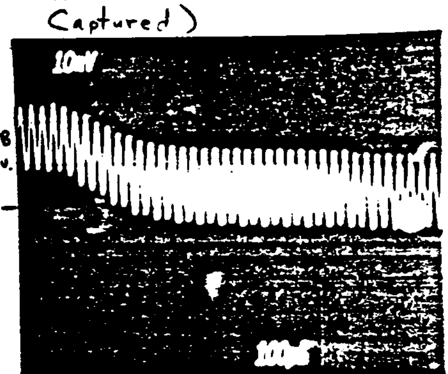
5A/div.



Input Current
No Load ⟶ 50% Load
(Before DC Capacitor)

I_{INB}
5A/div.

0 -

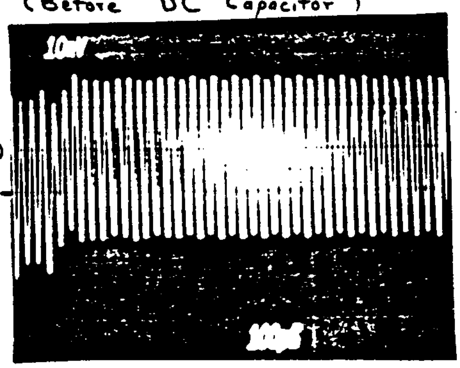


Input Current
(Before DC Capacitor)

50% Load → No Load

I_{INA}
(10A/div.)

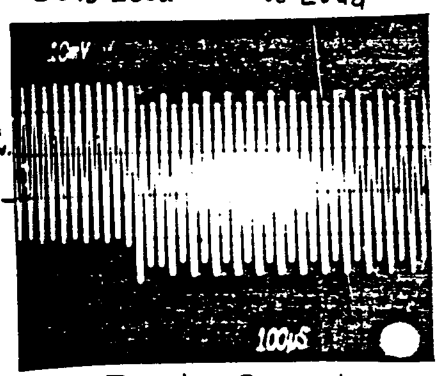
0 -



Input Current
(After DC Capacitor)
No Load → 50% Load

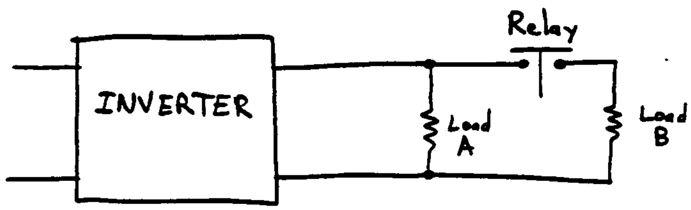
I_{INA}
10A/div.

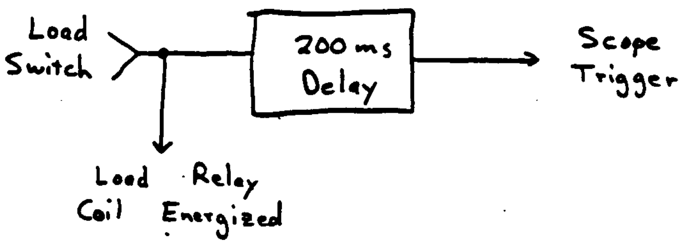
0 -



Input Current
(After DC Capacitor)
50% Load → No Load

2.3.1 -3.2.3 TRANSIENT LOAD RESPONSE





Some relay bounce is present in the photos.

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6 – 3.2.3 TRANSIENT LOAD RESPONSE

Specific Case: DC RCVR (726W → 0W)

Input Voltage: Same

Input Current:

System Frequency:

Output Power:

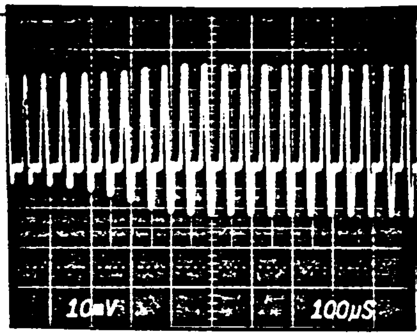
DC Rcvr: 726W → 0W

AC Rcvr:

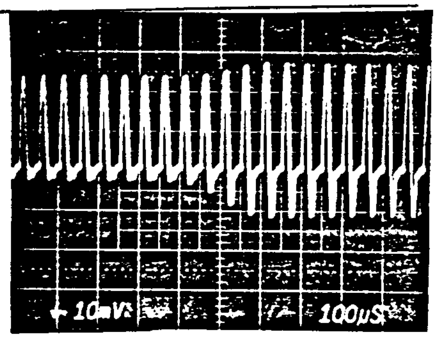
BD Module:

Other:

I_G



I_H



DC RCVR - 100% → 0 Scale: 20A/DIV

DC RCVR 100% → 0 Scale: 20A/DIV

Photo

Scale:

Photo

Scale:

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.3 TRANSIENT LOAD RESPONSE

Specific Case: DC RCVR 0 ↔ Full Load

Input Voltage: Same | DC Rcvr: 0 ↔ 726W

Input Current: ______ | AC Rcvr: ______

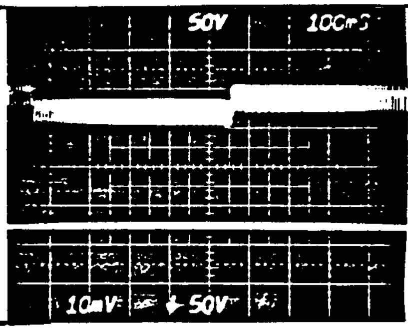
System Frequency: ______ | BD Module: ______

Output Power: ______ | Other: ______

I_{IN}

V_{IN}

0

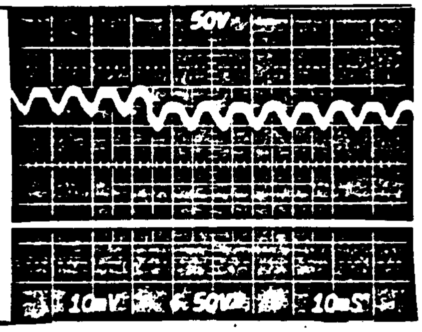


Input Volt. & Current Scale: 10A/

I_{IN}

V_{IN}

0



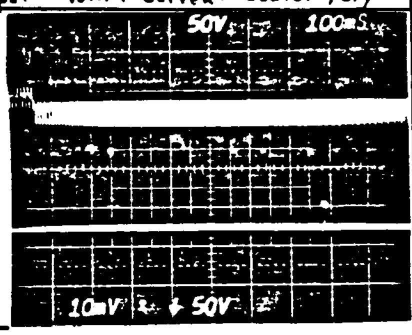
Full DC Load → 0

Input Voltage & Current Scale: 10A/

I_{IN}

V_{IN}

0



Full DC Load → 0

Input Voltage & Current Scale: 10A/

Photo

Scale:

5/23/84

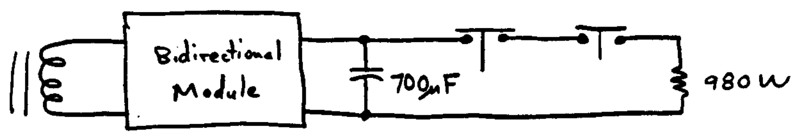
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6-3.2.3 TRANSIENT LOAD RESPONSE — Bidirectional Module

Full Load ⇆ No Load

Test Circuits



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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

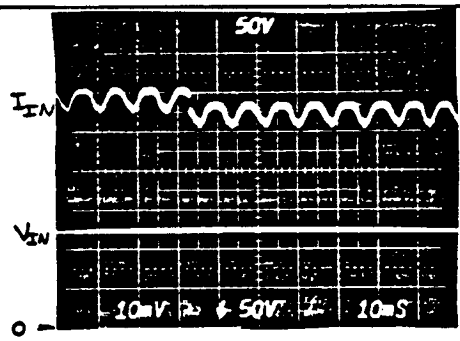
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.3 TRANSIENT LOAD RESPONSE

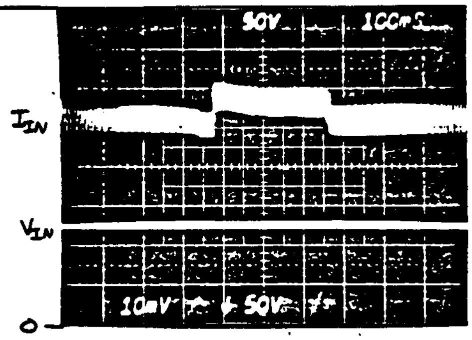
Specific Case: Bidirectional Module (0 ⇆ Full Load)

Input Voltage:	120.0	DC Rcvr:	810W
Input Current:	49.16 ⇆ 42.88	AC Rcvr:	350
System Frequency:	19.95 kHz	BD Module:	0 ⇆ 980W
Output Power:	4540 W	Other:	ϕ_1 = 1050W, ϕ_2 = 530W, ϕ_3 = 820W



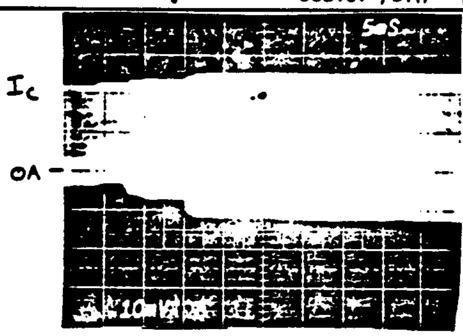
Full Load → 0

Input Voltage & Current Scale: 10A/



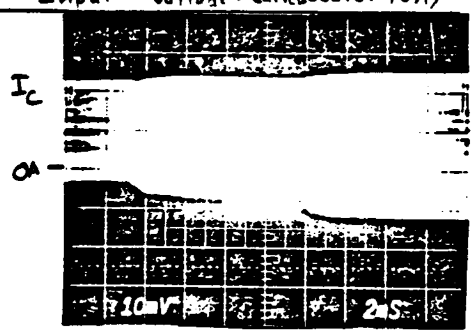
0 → Full Load → 0

Input Voltage & Current Scale: 10A/



Full Load → 0

I_C Scale: 20A/



Full Load → 0

I_C Scale: 20A/

5/23/84

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.3 TRANSIENT LOAD RESPONSE

Specific Case: BD MODULE (Full Load → 0)

Input Voltage: Same

Input Current:

System Frequency:

Output Power:

DC Rcvr:

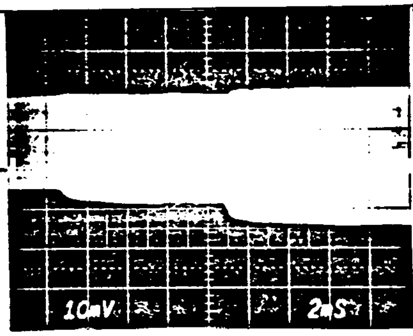
AC Rcvr:

BD Module:

Other:

I_D

0A

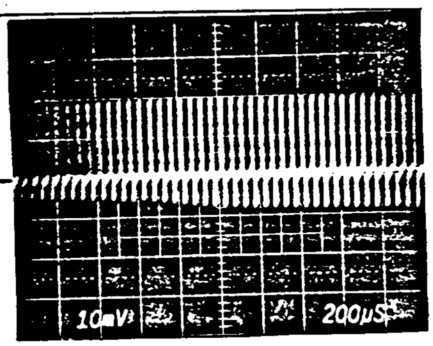


Full Load → 0

I_D Scale: 20A/

I_D

0A

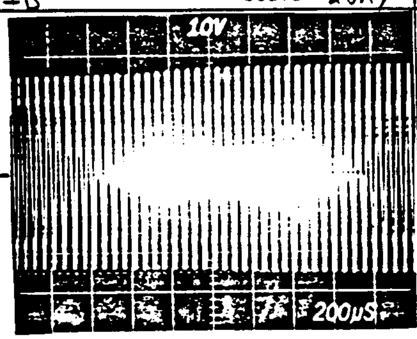


Full Load → 0

I_D Scale: 20A/

V_{L2}

0V

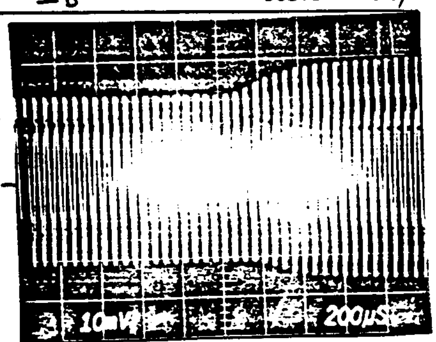


Full Load → 0

V_{L2} Scale: NTS

I_{K2}

0A



Full Load → 0

I_{K2} Scale: 20A/

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.3 TRANSIENT LOAD RESPONSE

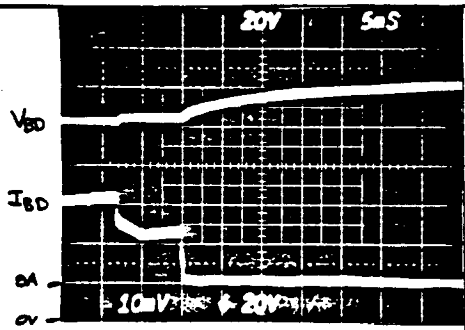
Specific Case: Bidirectional Module

Input Voltage: Same — **DC Rcvr:**

Input Current: — **AC Rcvr:**

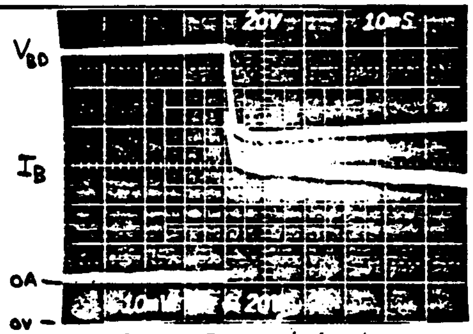
System Frequency: — **BD Module:**

Output Power: — **Other:**



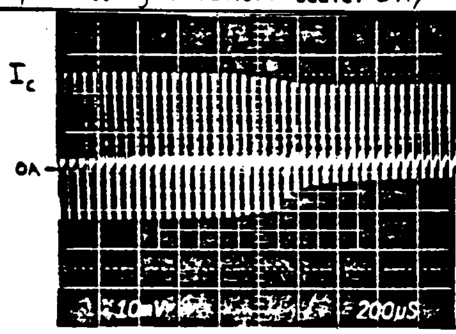
Full Load → 0   2 relays

Output Voltage & Current **Scale:** 5A/



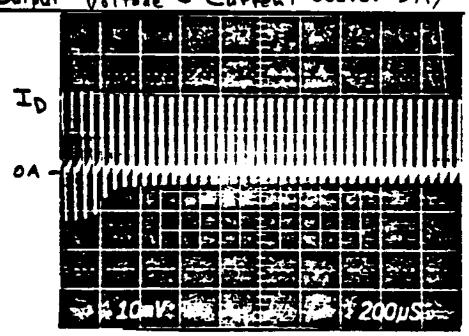
0 → Full Load

Output Voltage & Current **Scale:** 5A/



0 → Full Load

I_c **Scale:** 20A/



0 → Full Load

I_D **Scale:** 20A/

5/23/84

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.3 TRANSIENT LOAD RESPONSE

Specific Case: BD MODULE — 0 → Full Load

Input Voltage: Same

Input Current:

System Frequency:

Output Power:

DC Rcvr:

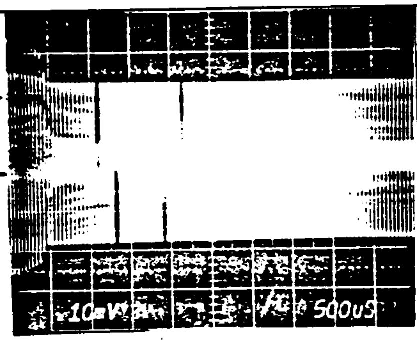
AC Rcvr:

BD Module:

Other:

I_{K2}

0A –

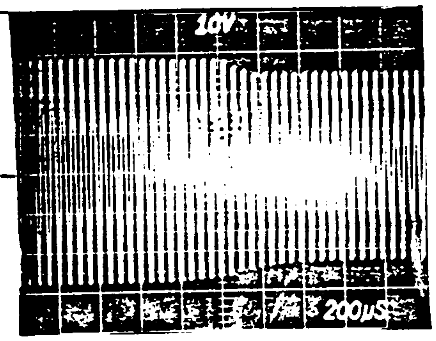


0 → Full Load

Tank Current Scale: 20A/

V_{L2}

0V –



0 → Full Load

Line Voltage Scale: N.T.S

Photo

Scale:

Photo

Scale:

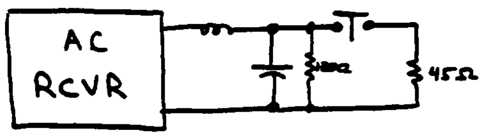
5/24/84

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6-3.2.3 TRANSIENT LOAD RESPONSE — AC RCVR (0 ⇆ Full Load)

Test Circuits



5/24/84

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

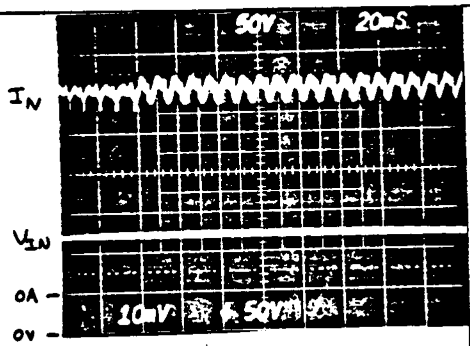
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.3 TRANSIENT LOAD RESPONSE

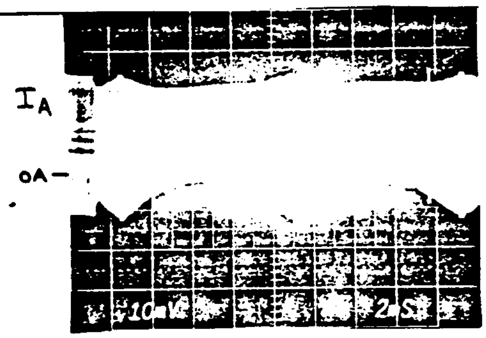
Specific Case: AC RCVR (No Load → Full Load)

Input Voltage: 120.1 ⇄ 120.3	DC Rcvr: 810 W
Input Current: 48.94 ⇆ 48.28	AC Rcvr: 170W → 400W
System Frequency: 20.05	BD Module: 980W
Output Power: 4360W → 4590W	Other: ϕ_1 = 1050W, ϕ_2 = 530W, ϕ_3 = 820W



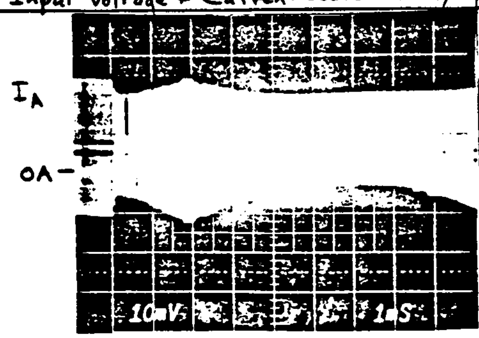
0 → F.L.

Input Voltage & Current Scale: 10A/



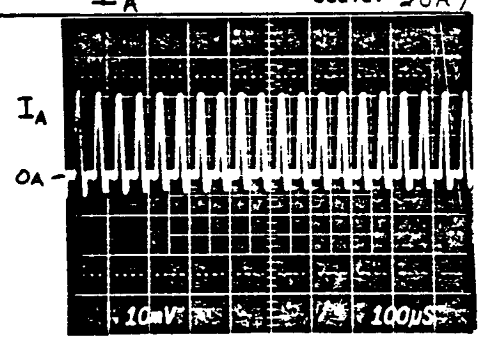
0 → F.L.

I_A Scale: 20A/



0 → F.L.

I_A Scale: 20A/



0 → F.L.

I_A Scale: 20A/

5/24/84

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.3 TRANSIENT LOAD RESPONSE

Specific Case: AC RCVR (0 → Full Load)

Input Voltage: Same | DC Rcvr:

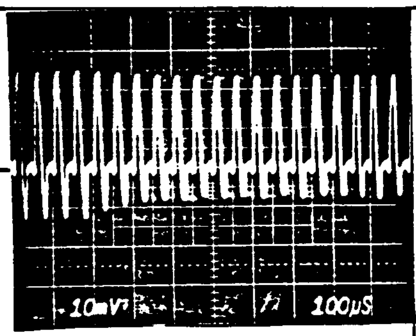
Input Current: | AC Rcvr:

System Frequency: | BD Module:

Output Power: | Other:

I_B

0A

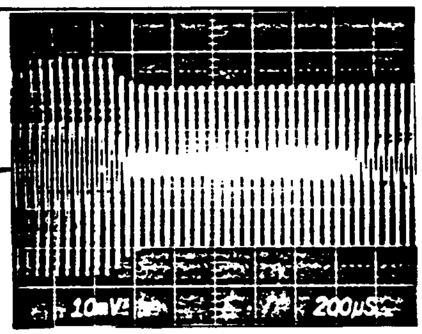


0 → F.L.

I_B Scale: 20A/

I_{K1}

0

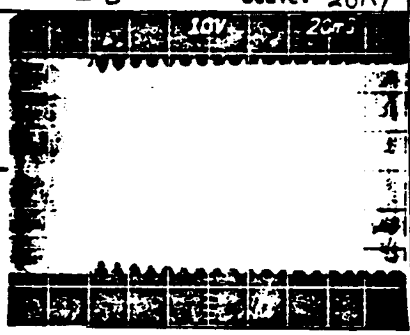


0 → F.L.

Tank Current Scale: 20A/

V_{L1}

0V

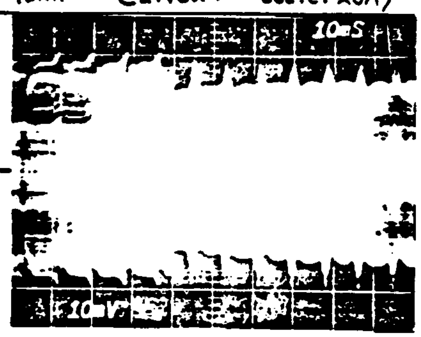


0 → F.L.

Line Voltage Scale: NTS

I_{K1}

0A



0 → F.L.

Tank Current Scale: 20A/

5/24/84

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.3 TRANSIENT LOAD RESPONSE

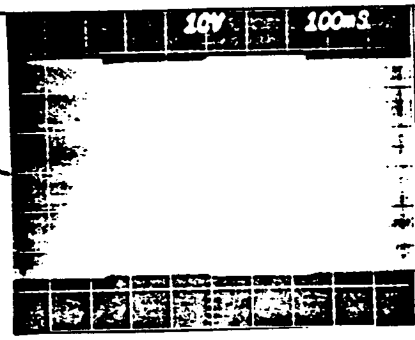
Specific Case: AC RCVR (O ⇄ Full Load)

Input Voltage: Same
Input Current:
System Frequency:
Output Power:

DC Rcvr:
AC Rcvr:
BD Module:
Other:

V_L

0V

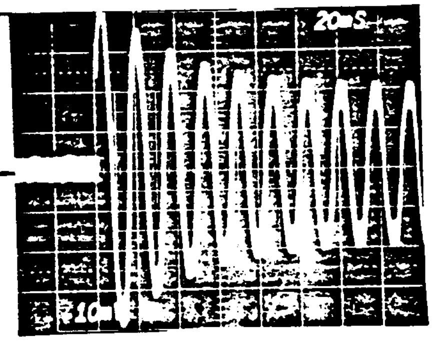


O ⇆ F.L.

Line Voltage Scale: NTS

I_{AC}

0A

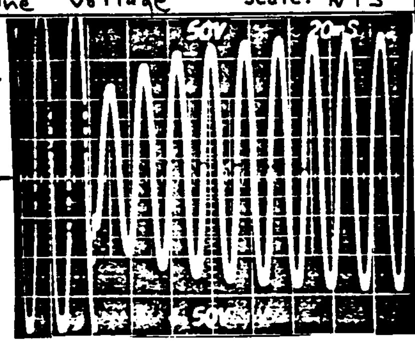


O → F.L.

AC RCVR Output I Scale: 2A/

V_{AC}

0



O → F.L.

AC RCVR Output V Scale:

Photo

Scale:

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5/24/84

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

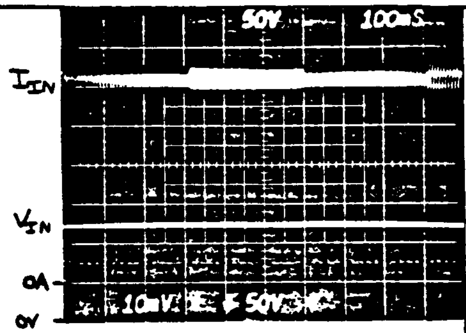
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.3 TRANSIENT LOAD RESPONSE

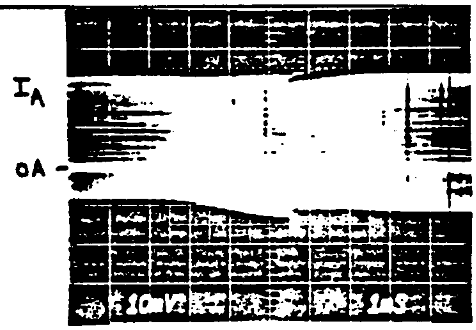
Specific Case: AC RCVR (0 ⇆ Full Load)

Input Voltage:	Same	**DC Rcvr:**	
Input Current:	↓	**AC Rcvr:**	↓
System Frequency:	↓	**BD Module:**	↓
Output Power:	↓	**Other:**	↓

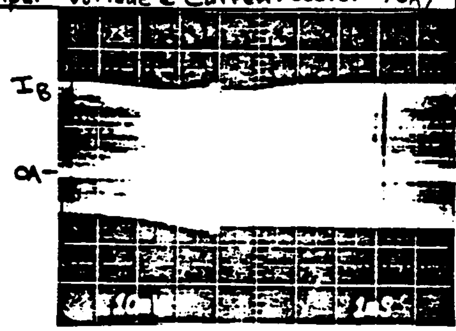


F.L. → 0 → F.L. → etc.

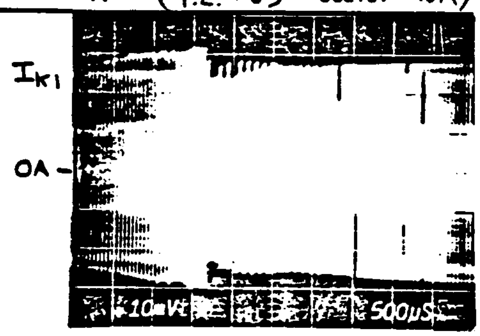
Input Voltage & Current **Scale:** 10A/



I_A (F.L. → 0) **Scale:** 20A/



I_B F.L. → 0 **Scale:** 20A



0 → F.L.

Tank Current **Scale:** 20A/

5/24/84

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6 - 3.2.3 TRANSIENT LOAD RESPONSE

Specific Case: AC RCVR (Full Load → 0)

Input Voltage: Same

Input Current: ↓

System Frequency: ↓

Output Power: ↓

DC Rcvr: ↓

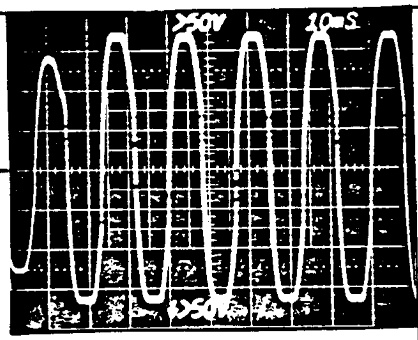
AC Rcvr: ↓

BD Module: ↓

Other:

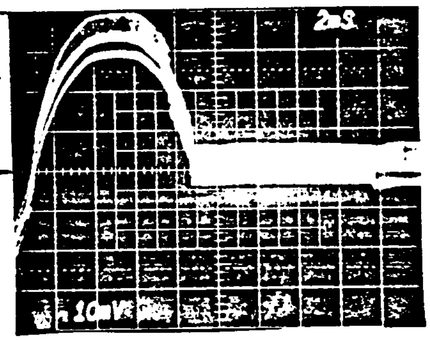
V_{AC}

0V



I_{AC}

0A



F.L. → 0

Output Voltage Scale: NTS

F.L. → 0

Output Current Scale: 1A/

Photo

Scale:

Photo

Scale:

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5/25/84

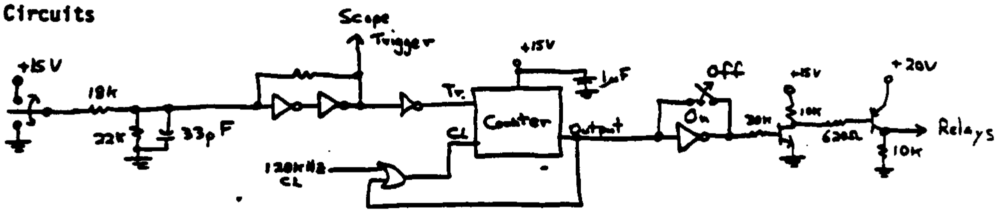
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

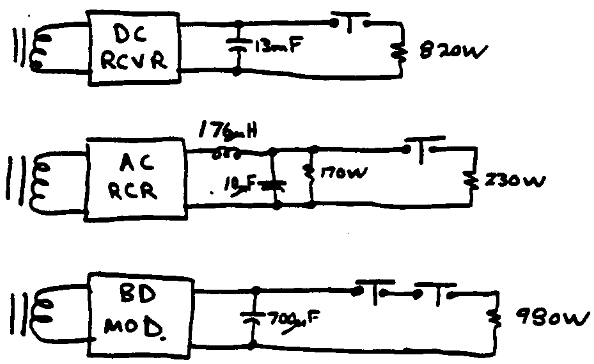
TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6-3.2.3 TRANSIENT LOAD RESPONSE

SIMULTANEOUS THREE-PHASE LOAD SWITCHING

Test Circuits





5/25/84

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.3 TRANSIENT LOAD RESPONSE

Specific Case: Simultaneous 3-ϕ Switching

Input Voltage: 120.0 Vdc — DC Rcvr: 810w → 0 W

Input Current: 28.7 → 11.16 Adc — AC Rcvr: 400 w → 170 W

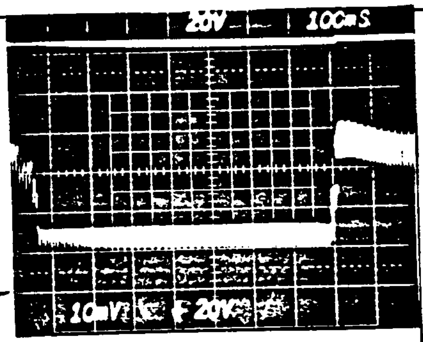
System Frequency: 20.01 KHz — BD Module: 980w → 0w

Output Power: 2190 W — Other: ~~0~~

V_{IN}

I_{IN}

0 —

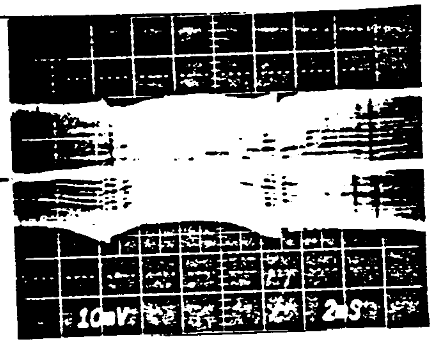


INPUT V & I — F.L. → 0 → F.L.

Scale: 10A/DIV

I_A

0 —

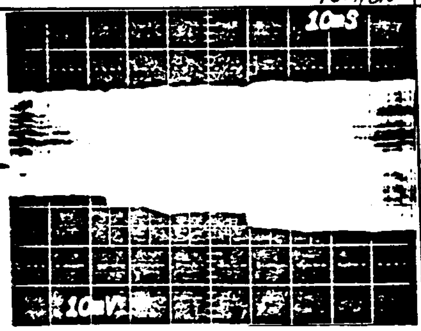


AC RCVR: 400 → 170W

I_A — Scale: 20A/DIV

I_C

0 —

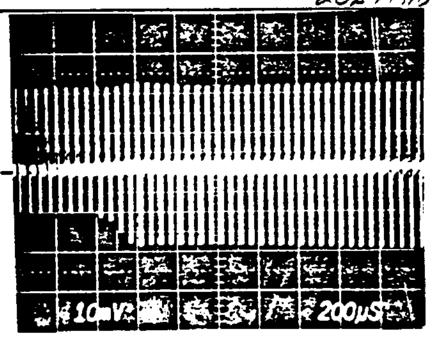


BD Mod.: 980w → 0w — 2 relays

I_C — Scale: 20A/DIV

I_G

0 —



DC RCVR: 810 → 0W

I_G — Scale: 20A/DIV

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5/25/84

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

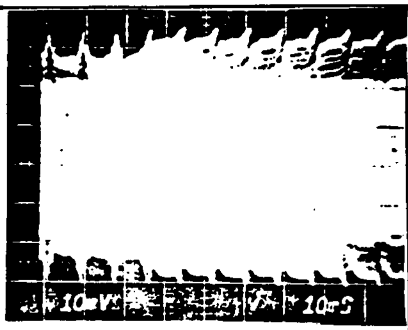
Test-Configuration: 2.3.6-3.2.3 TRANSIENT LOAD RESPONSE

Specific Case: Simultaneous 3-ø Load Switching (Full Load→0)

Input Voltage: 120	DC Rcvr: 810w →0
Input Current: 28.7→11.16 Adc	AC Rcvr: 400w →170
System Frequency: 20.01 KHz	BD Module: 980w →0
Output Power: 2190	Other: ø

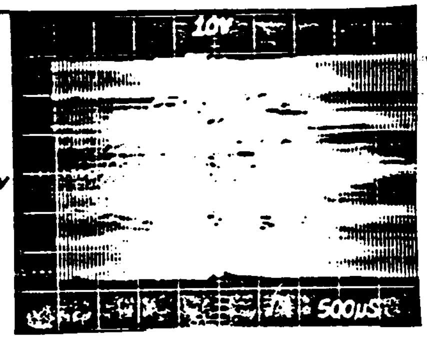
I_{K1}

0_A



V_{L1}

0_V



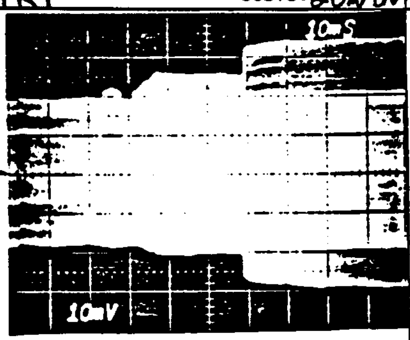
Phase a Line-to-neutral

IK1 Scale: 20A/DIV

VLINE 1 Scale: N.T.S.

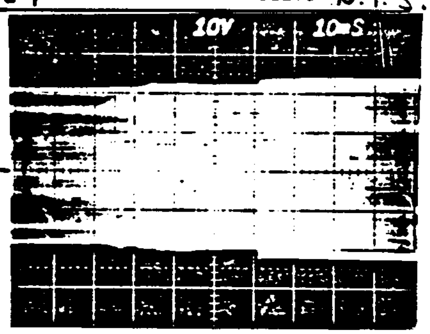
I_{K2}

0



V_{L2}

0



2 relays

Phase b line-to-neutral

IK2 Scale: 20A/DIV

VLINE 2 Scale: NTS

5/25/84

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.3 TRANSIENT LOAD RESPONSE

Specific Case: Simultaneous, 3-ϕ Switching (Full Load → 0)

Input Voltage: 120.0 DC Rcvr: 910w - 0

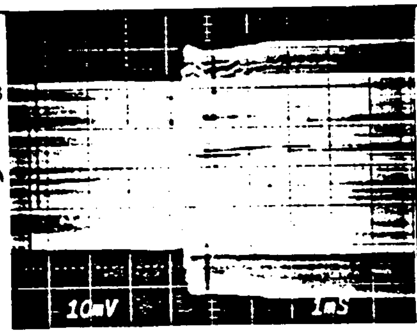
Input Current: 28.7 → 11.16 Adc AC Rcvr: 400w → 170w

System Frequency: 20.01 BD Module: 440 → 0

Output Power: 2190 Other: 0W

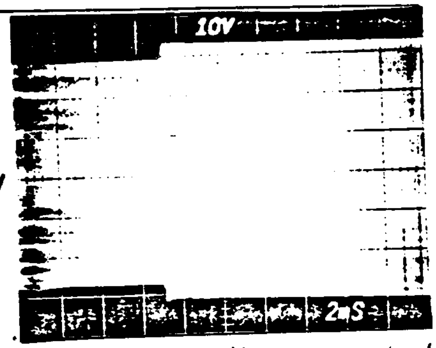
I_{K3}

0_A



V_{L3}

0_V



Phase c line-to-neutral

IK_3 Scale: 20A/DIV

V_{LINE} 3 Scale: NTS

Photo

Photo

Scale:

Scale:

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

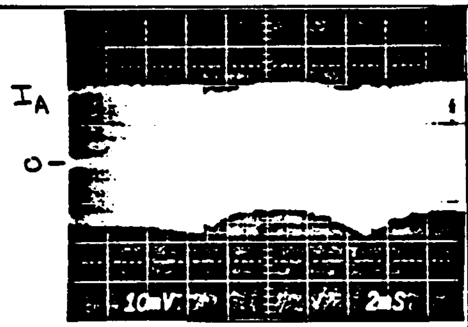
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6 - 2.2.3 TRANSIENT LOAD RESPONSE

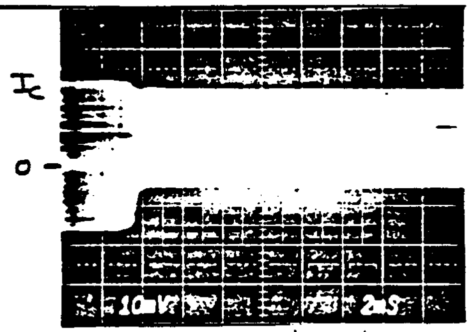
Specific Case: Simultaneous 3-ϕ Switching (0 → Full Load)

Input Voltage:	121.3 → 120.0	DC Rcvr:	0 → 810 W
Input Current:	10.76 Adc → 28.63 Adc	AC Rcvr:	170 W → 400 W
System Frequency:	20.03 kHz	BD Module:	0 → 980 W
Output Power:	170 → 2190 W	Other:	—



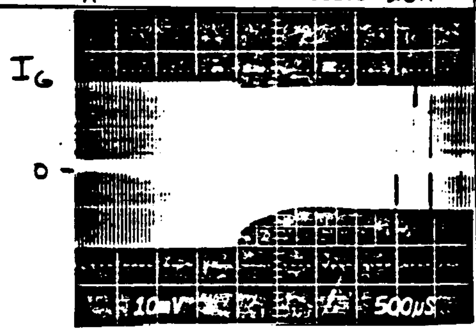
Inverter 1
(0 → F.L.)

I_A Scale: 20A



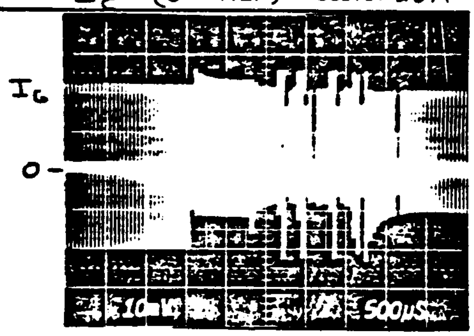
Inverter 2

I_C (0 → F.L.) Scale: 20A



Inverter 3

I_G (0 → F.L.) Scale: 20A



Hot X-frmr.

I_G (0 → F.L.) Scale: 20A

5/25/84

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

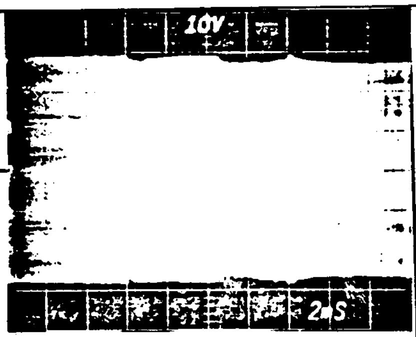
Test-Configuration: 236-3.2.3 TRANSIENT LOAD RESPONSE

Specific Case: Simultaneous 3-ϕ Switching ($0 \rightarrow$ Full Load)

Input Voltage: Same	DC Rcvr:
Input Current:	AC Rcvr:
System Frequency:	BD Module:
Output Power:	Other:

V_{L1}

0

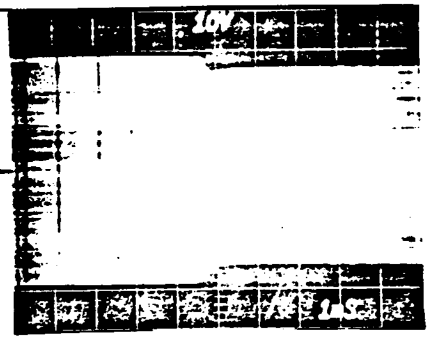


Line to Neutral

Line Voltage (1) Scale: NTS

V_{L2}

0

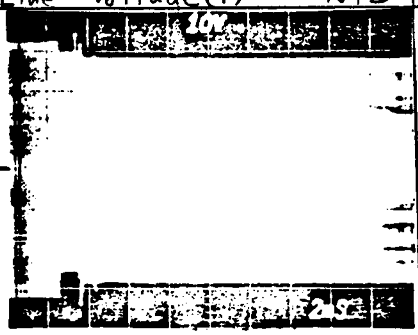


Line to Neutral

Line Voltage (#2) Scale: NTS

V_{L3}

0

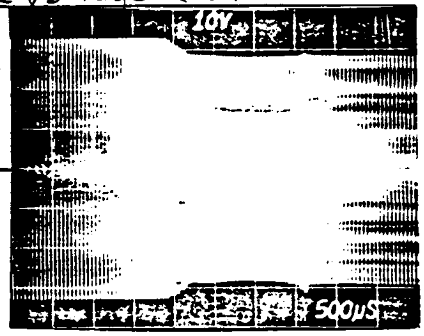


Hot X-frmr.

Line Voltage (#3) Scale: NTS

V_{L3}

0



Line-to-Neutral

Line Voltage (3) Scale: NTS

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

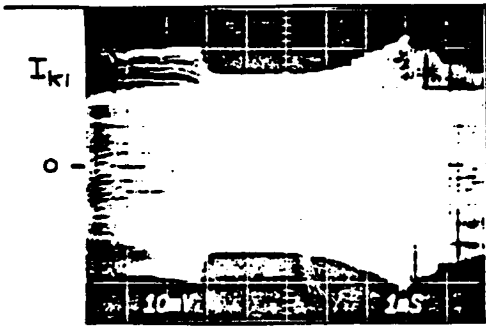
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

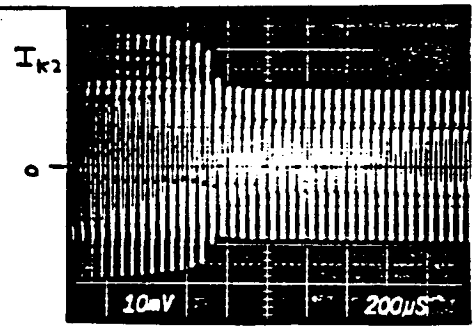
Test-Configuration: 2.3.6-3.2.3 TRANSIENT LOAD RESPONSE

Specific Case: Simultaneous 3-ϕ Switching (0 → Full Load)

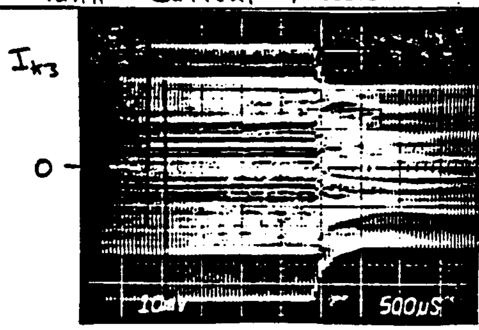
Input Voltage:	Same	DC Rcvr:	
Input Current:		AC Rcvr:	
System Frequency:		BD Module:	
Output Power:		Other:	



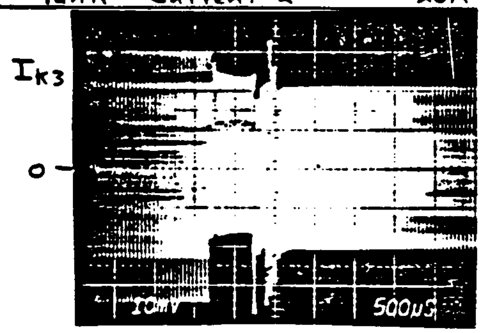
Tank Current 1 Scale: 20A



Tank Current 2 Scale: 20A



Tank Current 3 Scale: 20A



Hot X-fmr.

Tank Current 3 Scale: 20A

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.7 - 3.2.3 Transient Load Response

D.C. Receiver

Test Circuits

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TEST CONFIG. 2.3.7-3.2.3
SPECIFIC CASE D-C Receiver

I) INPUT POWER

V_{in} 150.28
I_{in} 112.8
P_{IN} ____

Frequency ____

T.H.D.
ΦA ____ %
ΦB ____ %
ΦC ____ %

T.H.D. – TRANSMISSION LINE
INTO THE LINE
ΦA

II) OUTPUT POWER

ΦA	ΦB	ΦC
V_o ____	V_o ____	V_o ____
I_o ____	I_o ____	I_o ____
P_o ____	P_o ____	P_o ____

A.C. RCVR	B/D MOD.	D.C. RCVR
V_o ~~OFF~~	V_o 101.2	V_o 26.57
I_o ____	I_o 3.40	I_o 26.53
P_o ____	P_o ____	P_o ____

T.H.D. Out of RCVR
____ db

RESISTIVE LOADS

ΦA	ΦB	ΦC
V_A ~~.4827~~ VAC	V_B 440 VAC	V_C 434.7 VAC
I_A .0463 mV	I_B .0464 mV	I_C .0482 mV.
I_A ____ AAC	I_B ____ AAC	I_C ____ AAC
P_{RA} ____	P_{RB} ____	P_{RC} ____

Total System Efficiency = $\frac{P_{OUT}}{}$ = ____ = %

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.3 Transient Load Response

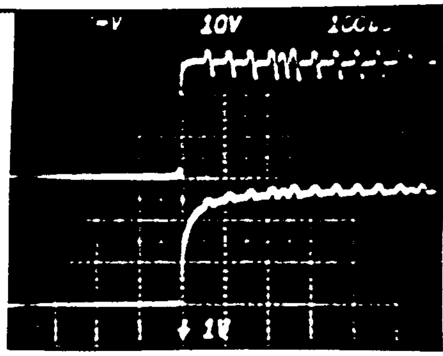
Specific Case: D-C Receiver - No Load to 705 W

Input Voltage: ______ DC Rcvr: 705 W

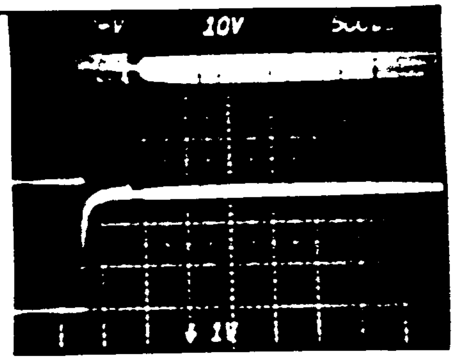
Input Current: ______ AC Rcvr: OFF

System Frequency: ______ BD Module: 344 W

Output Power: ______ Other: ______



Scale: 10A/DIV



Scale: 10 A/DIV

Photo

Scale:

Photo

Scale:

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.3 Transient Load Response

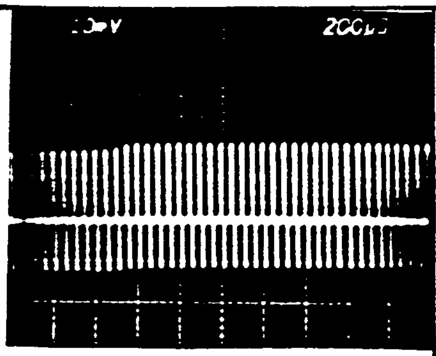
Specific Case: DC Receiver 0 → 705 W

Input Voltage: ______ **DC Rcvr:** ______

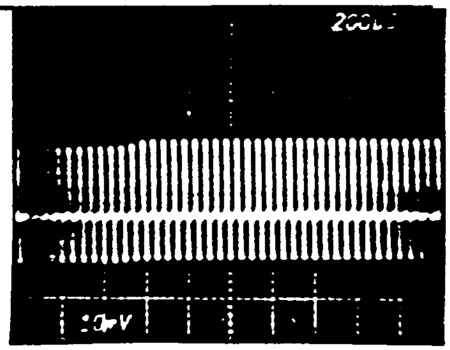
Input Current: ______ **AC Rcvr:** ______

System Frequency: ______ **BD Module:** ______

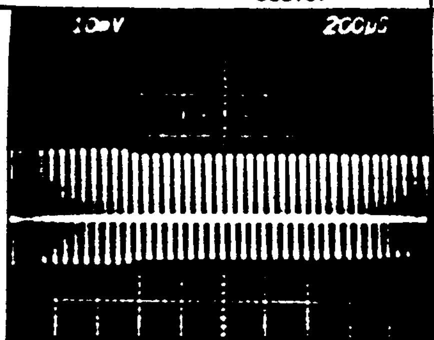
Output Power: ______ **Other:** ______



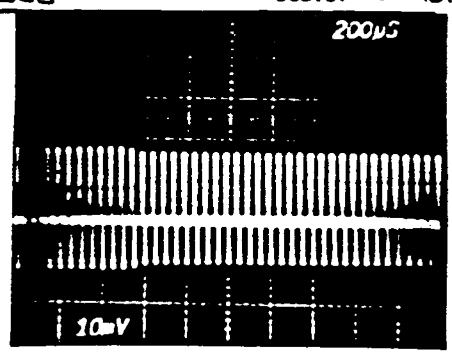
I_{SA} **Scale:** 50A/Div



I_{SB} **Scale:** 50A/Div



I_{GA} **Scale:** 50A/Div



I_{GB} **Scale:** 50A/Div

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.3 Transient Load Response

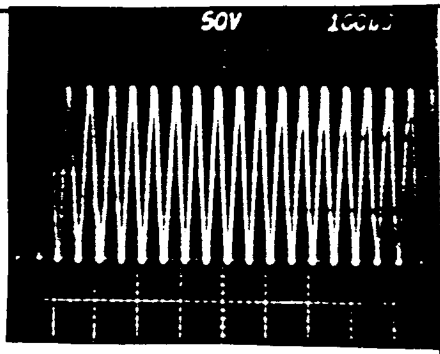
Specific Case: DC Receiver, 0 → 705 Watts

Input Voltage: ______ DC Rcvr: ______

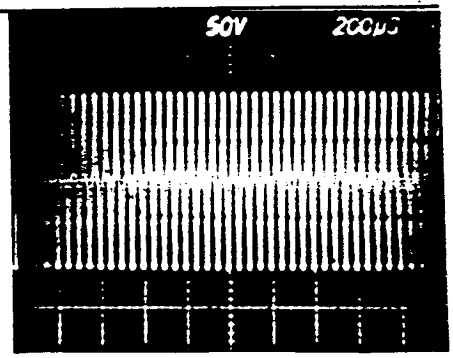
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

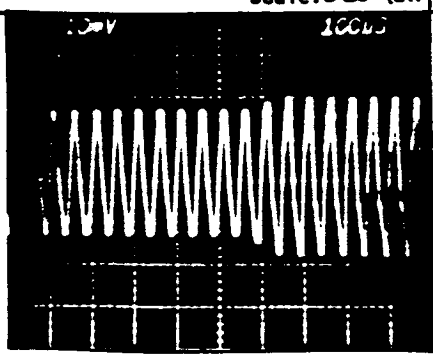
Output Power: ______ Other: ______



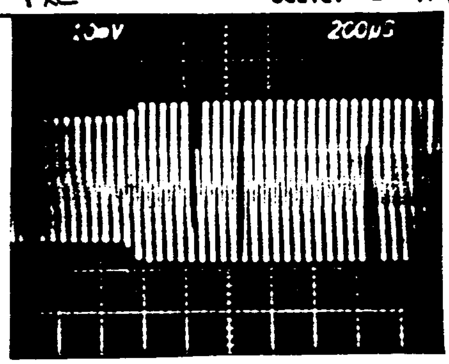
Vxc Scale: 320 V/Div



Vxc Scale: 320 V/Div ✓



Ixc Scale: 10 A/Div



Ixc Scale: 10 A/Div

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.3 Transient Load Response

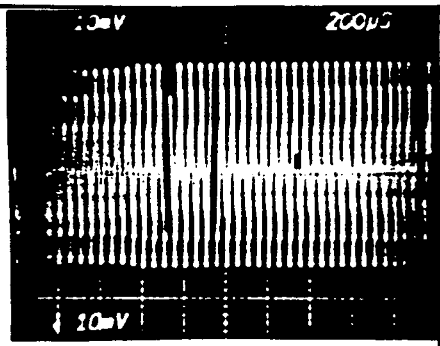
Specific Case: DC Receiver, No Load → 705 Watts

Input Voltage: ______ **DC Rcvr:** ______

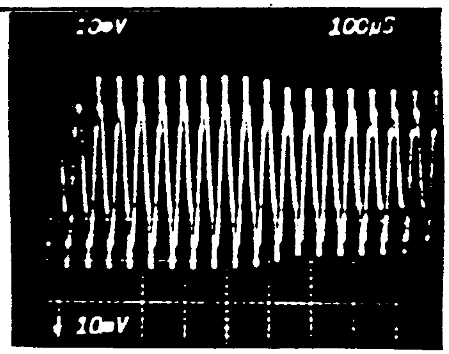
Input Current: ______ **AC Rcvr:** ______

System Frequency: ______ **BD Module:** ______

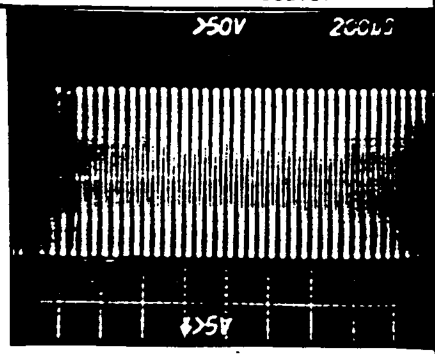
Output Power: ______ **Other:** ______



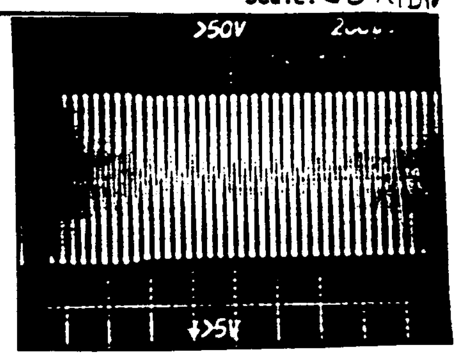
I_{K5} **Scale:** 50 A/Div



I_{K6} **Scale:** 50 A/Div



V_{K5} **Scale:** UNCAL



V_{K6} **Scale:** UNCAL

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.3 Transient Load Response

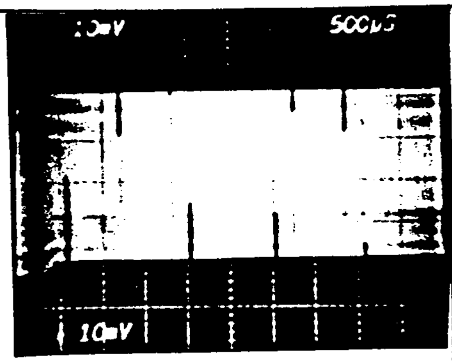
Specific Case: DC Receiver, No Load → 705 Watts

Input Voltage: ______ DC Rcvr: ______

Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______



I_{RL}

Scale: 50A/Div

Photo

Scale:

Photo

Scale:

Photo

Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: ______________________

Specific Case: ______________________

Input Voltage: ____________ DC Rcvr: ____________

Input Current: ____________ AC Rcvr: ____________

System Frequency: ____________ BD Module: ____________

Output Power: ____________ Other: ____________

Photo Scale:	Photo Scale:
Photo Scale:	Photo Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: ______________________

Specific Case: ______________________

Input Voltage: __________ DC Rcvr: __________

Input Current: __________ AC Rcvr: __________

System Frequency: __________ BD Module: __________

Output Power: __________ Other: __________

Photo Scale:	Photo Scale:
Photo Scale:	Photo Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: ______________________________

Specific Case: ______________________________

Input Voltage: ____________ DC Rcvr: ____________

Input Current: ____________ AC Rcvr: ____________

System Frequency: ____________ BD Module: ____________

Output Power: ____________ Other: ____________

Photo Scale:	Photo Scale:
Photo Scale:	Photo Scale:

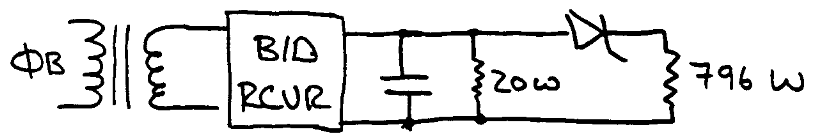
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.7 - 3.2.3 Transient Load Response

B/D Receiver 20W → 816W

Test Circuits



TEST CONFIG. 2.3.7-3.2.3
SPECIFIC CASE B/D Receiver 20W → 816W

I) INPUT POWER

V_{in} 153.2V
I_{in} 105.6A → 111.4
P_{IN} ____

Frequency ____

T.H.D.
ΦA ____ db
ΦB ____ db
ΦC ____ db

T.H.D. – TRANSMISSION LINE
INTO THE LINE
ΦA

II) OUTPUT POWER

ΦA	ΦB	ΦC
V_o ____	V_o ____	V_o ____
I_o ____	I_o ____	I_o ____
P_o ____	P_o ____	P_o ____

A.C. RCVR	B/D MOD.	D.C. RCVR
V_o 97	V_o 97.5	V_o 28.76
I_o 3.57	I_o 8.37	I_o 0A
P_o 334W	P_o 816W	P_o 0W.

T.H.D. Out of RCVR
____ db

RESISTIVE LOADS

ΦA	ΦB	ΦC
V_A 434.2 Vac	V_B 439.0 Vac	V_C 441.3 Vac
I_A .046 mV	I_B .046 mV	I_C .0492 mV
I_A ____ Aac	I_B ____ Aac	I_C ____ Aac
P_{RA} ____	P_{RB} ____	P_{RC} ____

Total System Efficiency = $\frac{P_{OUT}}{P_{in}}$ = ____ :

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.3 Transient Load Response

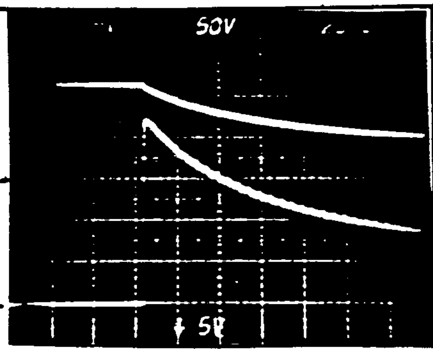
Specific Case: B/D Receiver: 20W → 816W

Input Voltage: 153.2 → 153.0 DC Rcvr: OFF

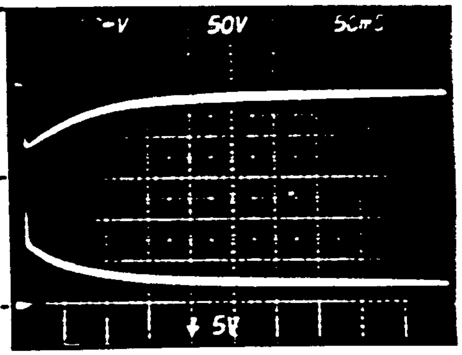
Input Current: 106.6 → 111.4 AC Rcvr: 334 W

System Frequency: BD Module: 20W → 816W

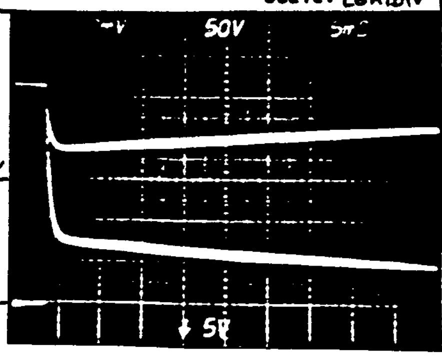
Output Power: Other:



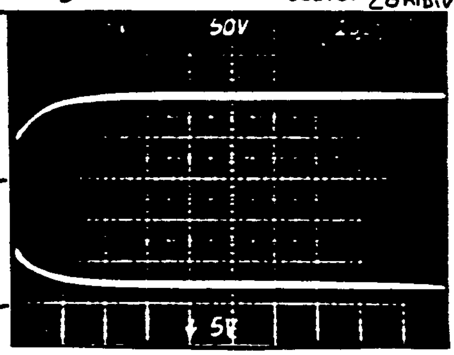
0V
0A
V_{BD}
I_{BD}
Scale: 50V/DIV 20A/DIV



0V
0A
V_{BD}
I_{BD}
Scale: 50V/DIV 20A/DIV



0V
0A
V_{BD}
I_{BD}
Scale: 50V/DIV 20A/DIV



0V
0A
V_{BD}
I_{BD}
Scale: 50V/DIV 20A/DIV

C-4

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.3 Transient Load Response

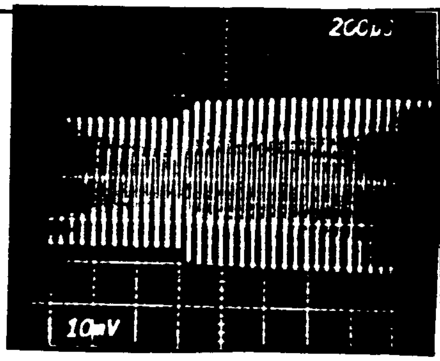
Specific Case: B/D RCVR - 20W → 816W

Input Voltage: ____ DC Rcvr: ____

Input Current: ____ AC Rcvr: ____

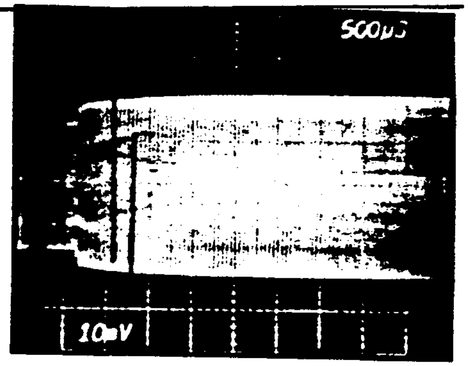
System Frequency: ____ BD Module: ____

Output Power: ____ Other: ____



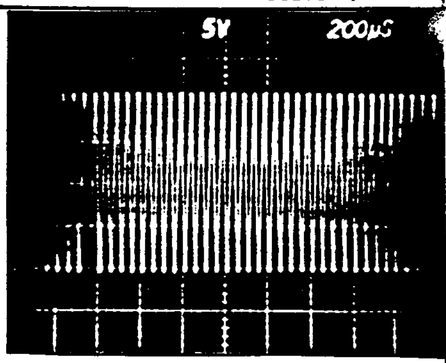
I_{XB}

Scale: 10A/Div



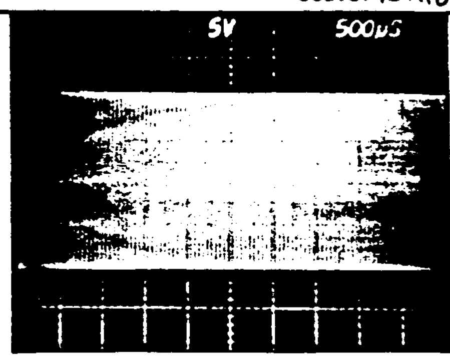
I_{XB}

Scale: 10A/Div



V_{XB}

Scale: 50V/Div



V_{XB}

Scale: 10A/Div

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.3 Transient Load Response

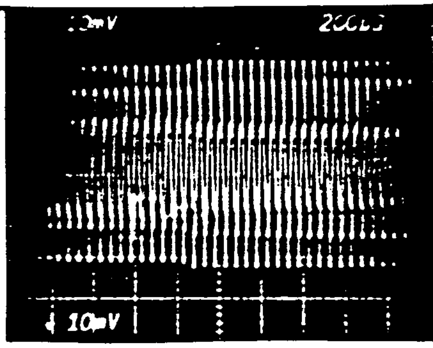
Specific Case: B/D RCVR: 20W → 816W

Input Voltage: ______ DC Rcvr: ______

Input Current: ______ AC Rcvr: ______

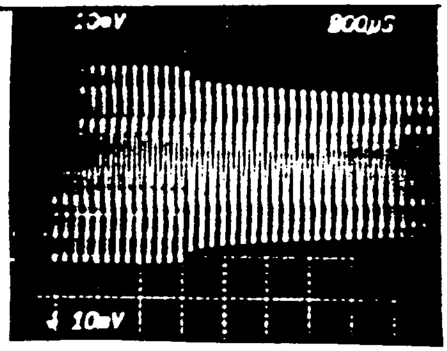
System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______



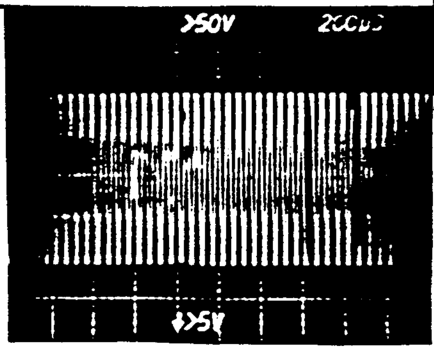
I_{K3}

Scale: 50 A/Div



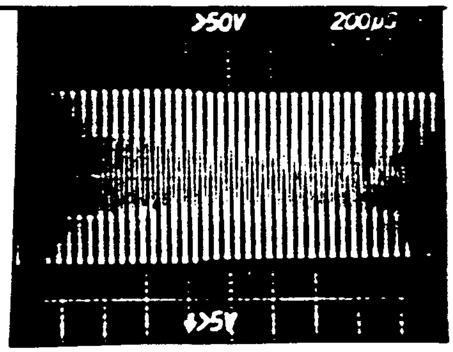
I_{K4}

Scale: 50 A/Div



V_{K3}

Scale: 50V/Div



V_{K4}

Scale: 50V/Div

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.3 Transient Load Response

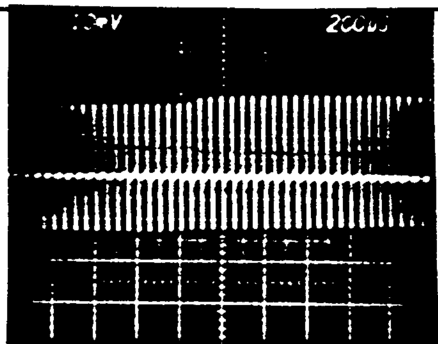
Specific Case: BIA RCVR: 20W → 816W

Input Voltage: ______ DC Rcvr: ______

Input Current: ______ AC Rcvr: ______

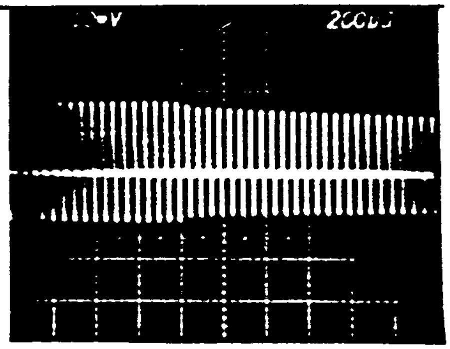
System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______



I_{3A}

Scale: 50A/Div



I_{4A}

Scale: 50A/Div

Photo

Scale:

Photo

Scale:

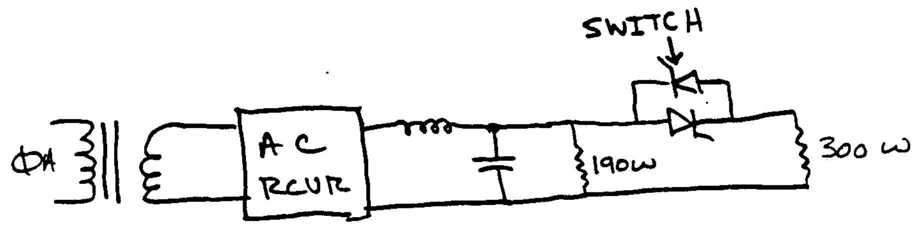
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.7 - 3.2.3 Transient Load Response

AC RCVR: 190 w → 490 w

Test Circuits



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TEST CONFIG. 2.3.7-3.2.3
SPECIFIC CASE AC RCVR

I) INPUT POWER

V_{in} 149.2V
I_{in} 111.78A
P_{in} ____

FREQUENCY ____

T.H.D.
ΦA ____ %
ΦB ____ %
ΦC ____ %

T.H.D. – TRANSMISSION LINE
INTO THE LINE
ΦA

II) OUTPUT POWER

ΦA	ΦB	ΦC
V_o ____	V_o ____	V_o ____
I_o ____	I_o ____	I_o ____
P_o ____	P_o ____	P_o ____

A.C. RCVR	B/D MOD.	D.C. RCVR
V_o 95	V_o 99.9	V_o ____
I_o 5.40	I_o 5.03	I_o ____
P_o 490	P_o ____	P_o ____

T.H.D. Out of RCVR
____ db

RESISTIVE LOADS

ΦA	ΦB	ΦC
V_A 432.0 Vac	V_B 439.9 Vac	V_C 441.2 Vac
I_A .0460 mV	I_B .0465 mV	I_C .0495 mV
I_A ____ Aac	I_B ____ Aac	I_C ____ Aac
P_{RA} ____	P_{RB} ____	P_{RC} ____

Total System Efficiency = $\frac{P_{OUT}}{}$ = ____ = %

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.3 Trasient Load

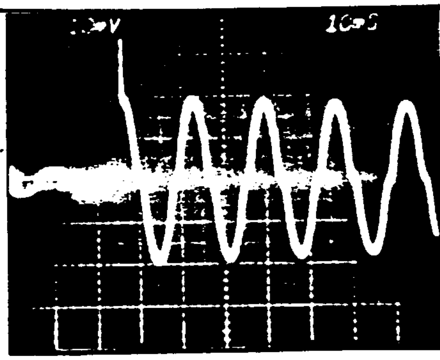
Specific Case: AC RCVR: 190 → 490 W

Input Voltage: ______ DC Rcvr: ______

Input Current: ______ AC Rcvr: ______

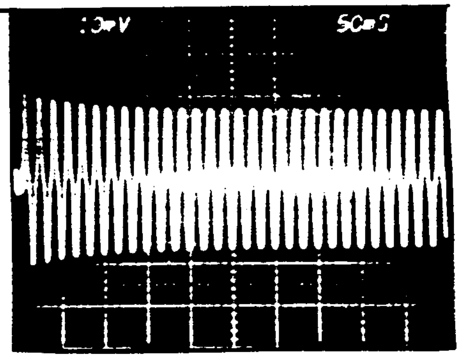
System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______



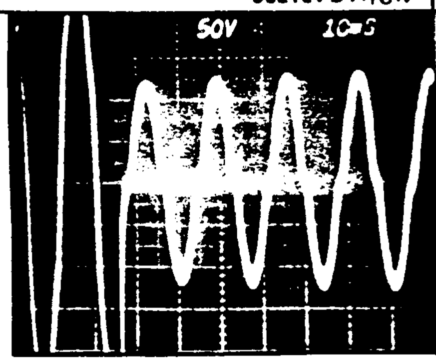
I_{AC}

Scale: 5A/Div



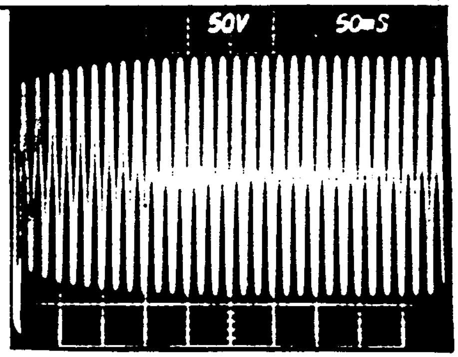
I_{AC}

Scale: 5A/Div



V_{AC}

Scale: 50V/Div



V_{AC}

Scale: 50V/Div

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

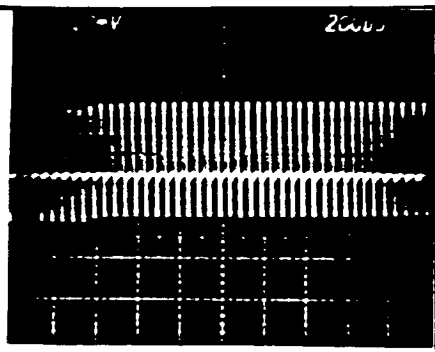
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.23 Transient Load Response

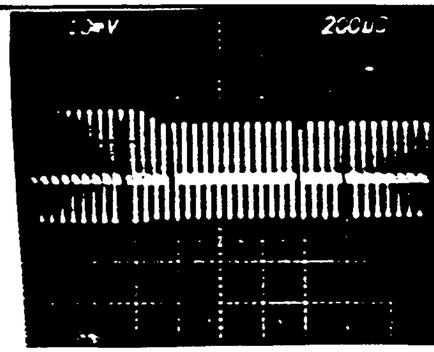
Specific Case: AC RCVR: 190 → 490 W

Input Voltage:		DC Rcvr:	
Input Current:		AC Rcvr:	
System Frequency:		BD Module:	
Output Power:		Other:	



I_{1A}

Scale: 50A/Div



I_{2A}

Scale: 50 A/Div

Photo

Scale:

Photo

Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.3 Transient Load Response

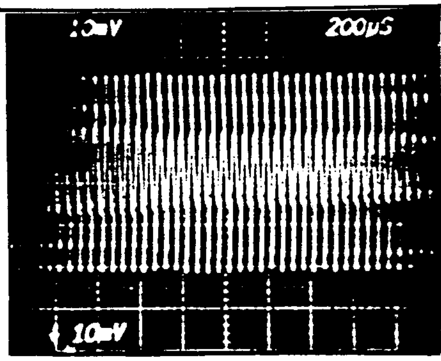
Specific Case: AC RCVR: 190 → 490 W

Input Voltage: ______ DC Rcvr: ______

Input Current: ______ AC Rcvr: ______

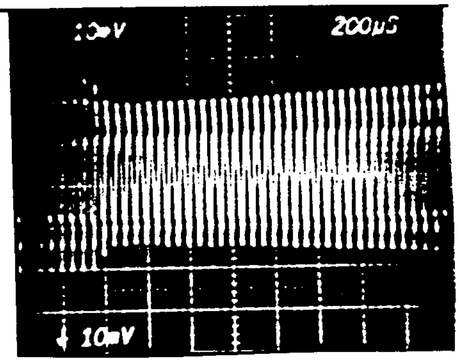
System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______



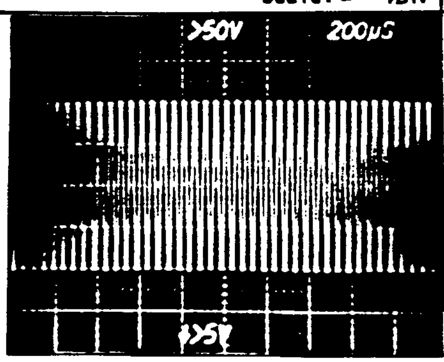
I_{K1}

Scale: 50A/Div



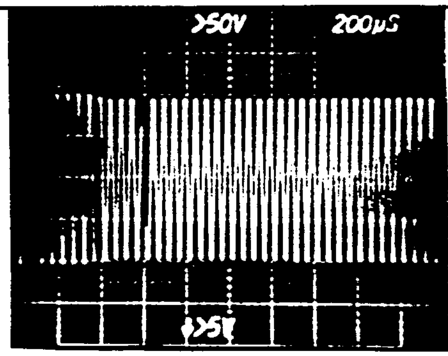
I_{K2}

Scale: 50A/Div



V_{K1}

Scale: UNCAL



V_{K2}

Scale: UNCAL

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TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.3 Transient Load Response

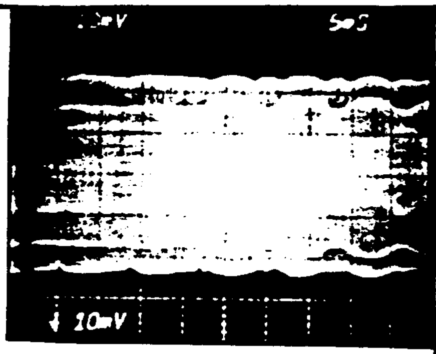
Specific Case: AC RCVR: 190 → 490 W

Input Voltage: ________ DC Rcvr: ________

Input Current: ________ AC Rcvr: ________

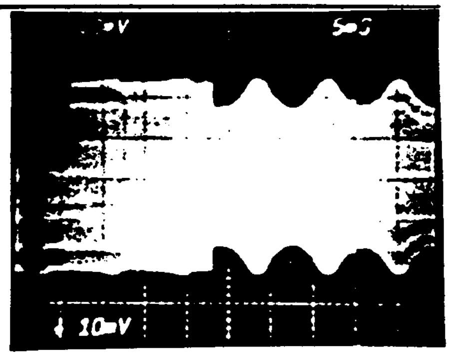
System Frequency: ________ BD Module: ________

Output Power: ________ Other: ________



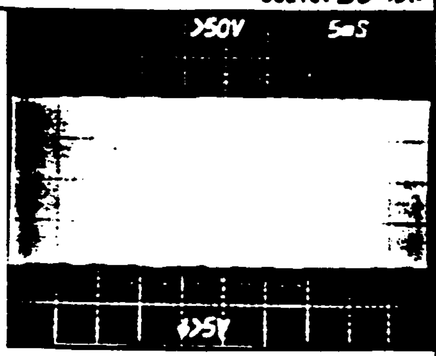
I_{K1}

Scale: 50A/Div



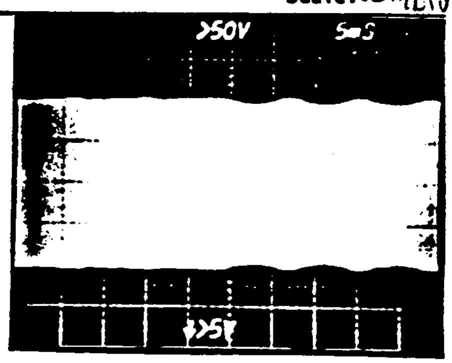
I_{K2}

Scale: 50A/Div



V_{K1}

Scale: UNCAL



V_{K2}

Scale: UNCAL

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.3 Transient Load Response

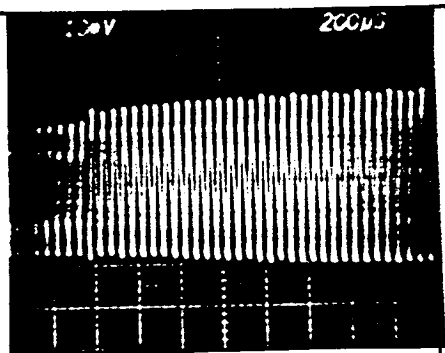
Specific Case: AC RCVR: 190 → 490 W

Input Voltage: ______ DC Rcvr: ______

Input Current: ______ AC Rcvr: ______

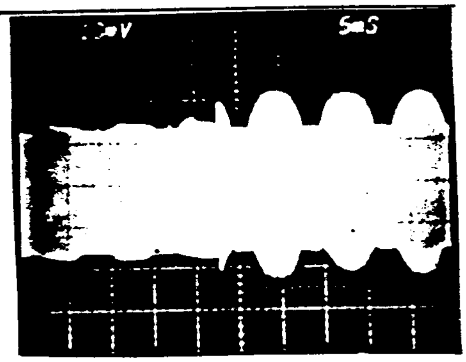
System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______



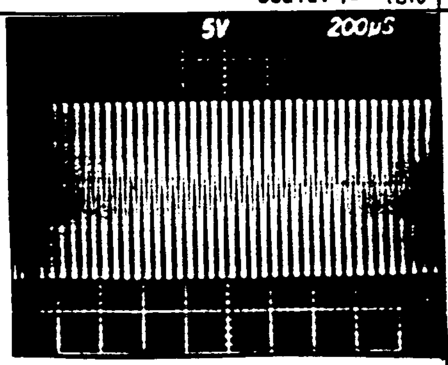
I_{xA}

Scale: 10 A/Div



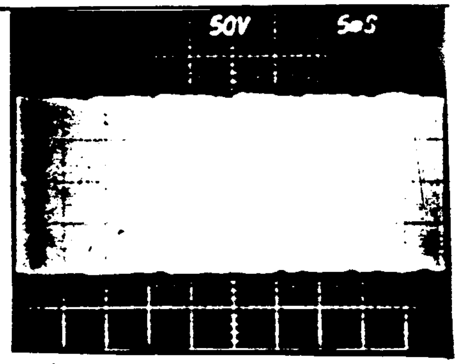
I_{xA}

Scale: 10 A/Div



V_{xA}

Scale: UNCAL



V_{xA}

Scale: UNCAL

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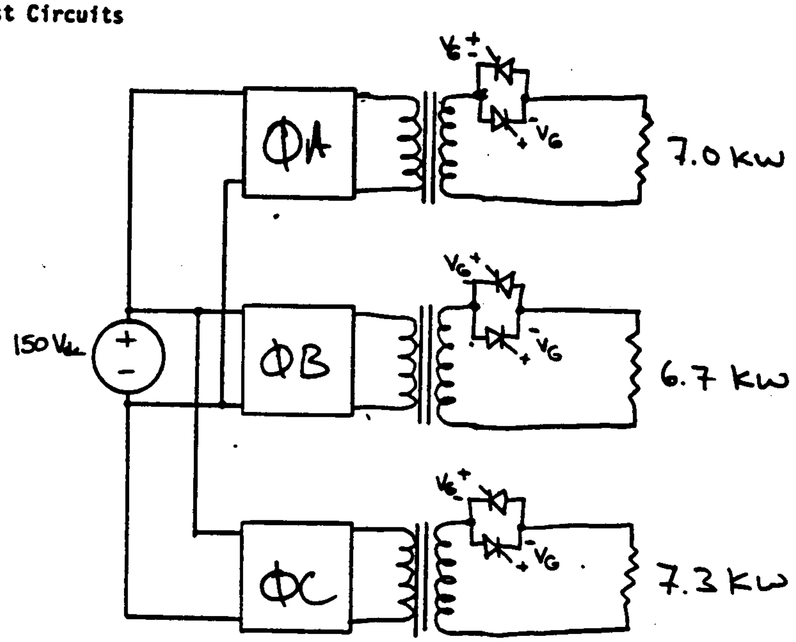
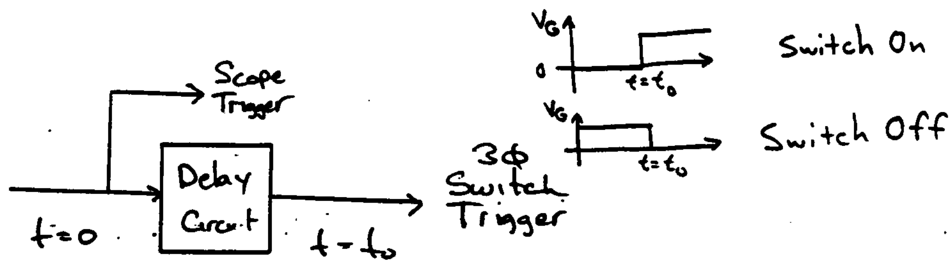
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.7 - 3.2.3 Transient Load Response Simultaneous 3Φ switching (0 → 21 kw)

Test Circuits





Test Config. 2.3.7 - 3.2.3
Specific Case 0 → 21kW Res Loads

I) Input Power

V_{in} 151.0V
I_{in} 165A
P_{in} 24.9kW

Frequency ______

T.H.D.
ΦA ____ %
ΦB ____ %
ΦC ____ %

T.H.D. – Transmission Line
Into the line
ΦA

II) Output Power

ΦA	ΦB	ΦC
V_o ____	V_o ____	V_o ____
I_o ____	I_o ____	I_o ____
P_o ____	P_o ____	P_o ____

A.C. RCVR	B/D MOD.	D.C. RCVR
V_o N/C	V_o N/C	V_o N/C
I_o ____ N/A	I_o ____ N/A	I_o ____ N/A
P_o ____	P_o ____	P_o ____

T.H.D. Out of RCVR
______ db

Resistive Loads

ΦA	ΦB	ΦC
V_A 432.5 Vac	V_B 437.9 Vac	V_C 434.5 Vac
I_A 81 mV	I_B 75 mV	I_C 85 mV
I_A 16.1 Aac	I_B 15.2 Aac	I_C 16.9 Aac
P_{RA} 7.0 kW	P_{RB} 6.7 kW	P_{RC} 7.3 kW

Total System Efficiency = $\frac{P_{out}}{} = \frac{21\text{ kW}}{24.9} = 84.3\ \%$

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3 2.3 Transient Load Response

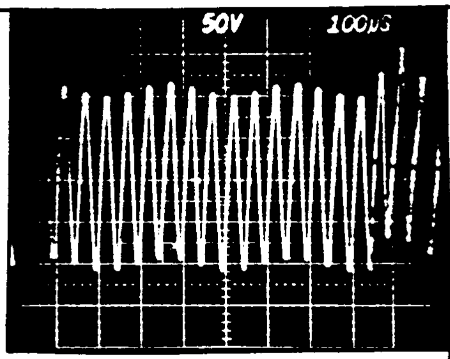
Specific Case: Simultaneous 3Φ Switching (0 → 21 kW)

Input Voltage: ______ DC Rcvr: ______

Input Current: ______ AC Rcvr: ______

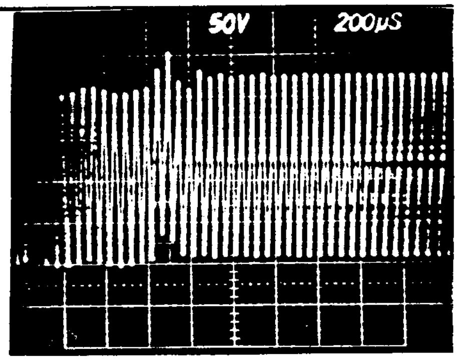
System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______



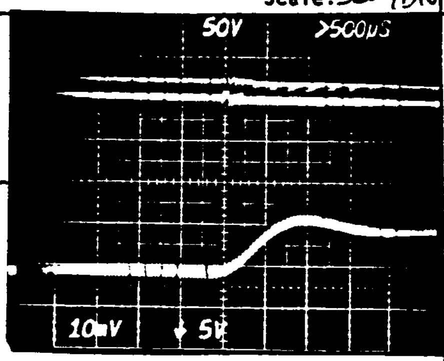
Vxb

Scale: 320 V/Div



Vxb

Scale: 320 V/D



0V

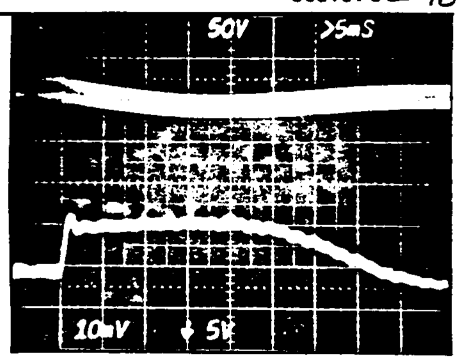
Vin

Iin (A.C. Component)

time: UNCAL

50V/DIV

Scale: 100 A/DIV



Vin

Iin (A.C. Comp)

time: UNCAL

50V/Div

Scale: 100 A/Div

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.3 Transient Load Response

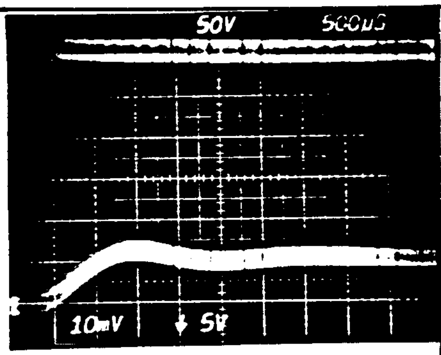
Specific Case: Simultaneous 3Φ Switching (0 → 21 KW)

Input Voltage: ______ DC Rcvr: ______

Input Current: ______ AC Rcvr: ______

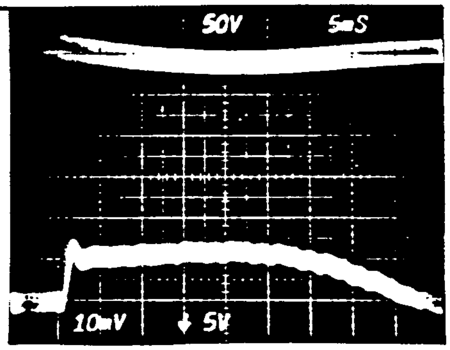
System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______



V_{IN}

I_{IN} (A.C. Component) Scale: 50 V/Div, 100 A/Div



V_{IN}

I_{IN} (A.C. Component) Scale: 50 V/Div, 100 A/Div

Photo

Scale:

Photo

Scale:

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.3 Transient Load Response

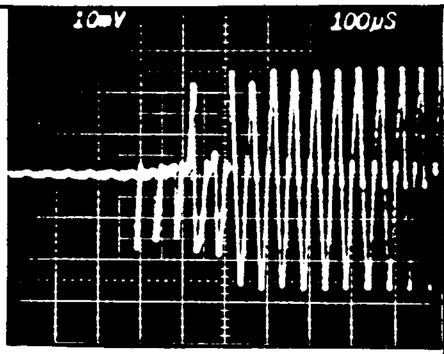
Specific Case: Simultaneous 3ϕ switching (0 → 21 kW)

Input Voltage: ______ DC Rcvr: ______

Input Current: ______ AC Rcvr: ______

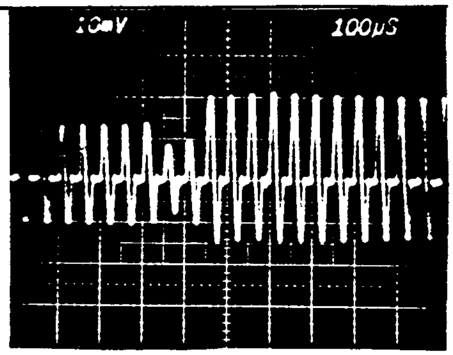
System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______



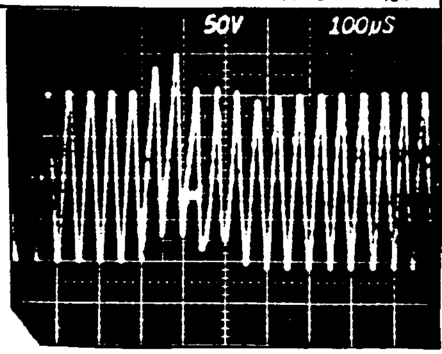
I_{LC}

Scale: 10A/Div



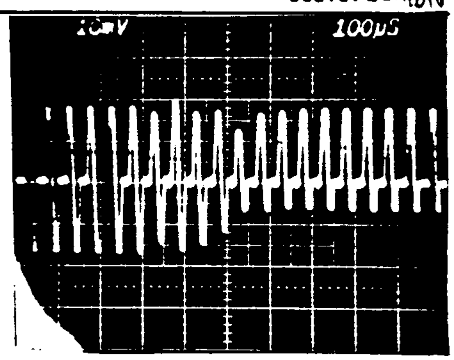
I_{SA}

Scale: 50A/Div



V_{LC}

Scale: 320V/Div



I_{GA}

Scale: 50A/Div

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.3 Transient Load Response

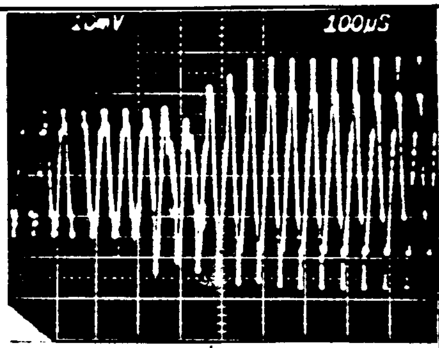
Specific Case: Simultaneous 3Φ Switching (0 → 21 KW)

Input Voltage: ______ DC Rcvr: ______

Input Current: ______ AC Rcvr: ______

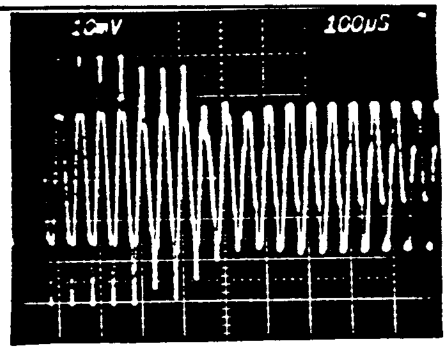
System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______



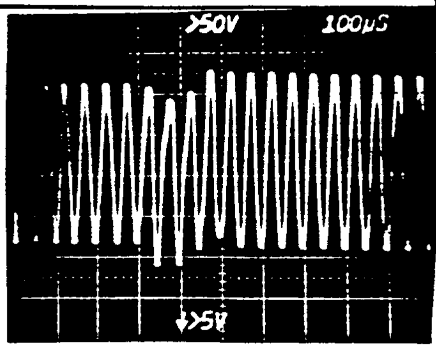
I_{K5}

Scale: 50 A/Div



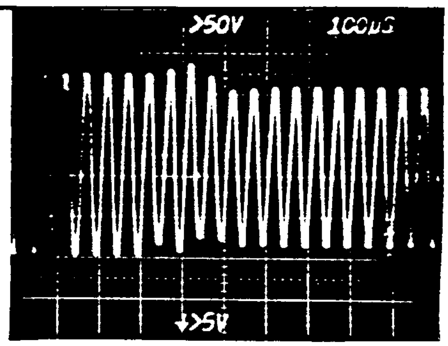
I_{K6}

Scale: 50 A/Div



V_{K5}

Scale: UNCAL



V_{K6}

Scale: UNCAL

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.3 Transient Load Response

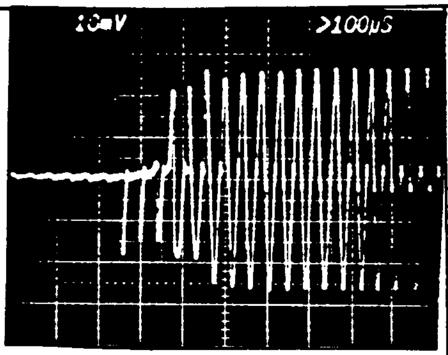
Specific Case: Simultaneous 3Φ switching (0 → 21 KW)

Input Voltage: ______ DC Rcvr: ______

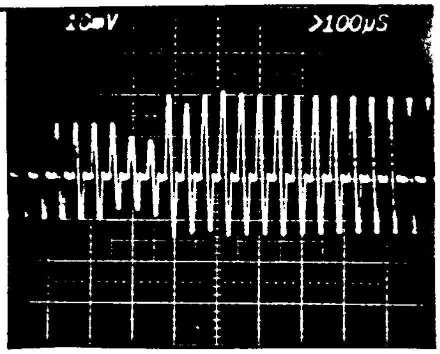
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

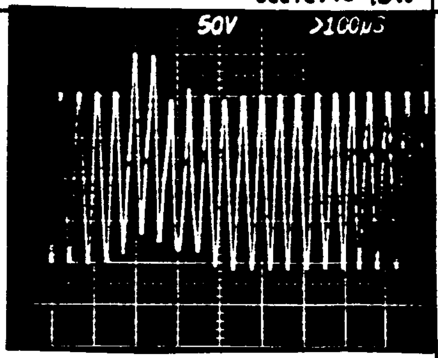
Output Power: ______ Other: ______



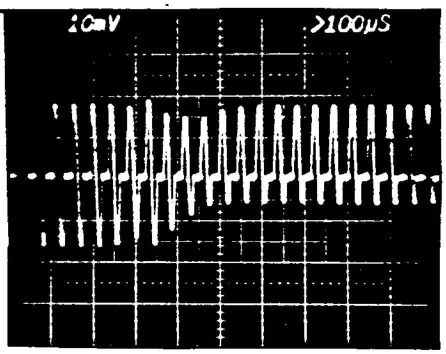
Ixc Scale: 10A/Div



ISA Scale: 50A/Div



Vxc Scale: 320V/Div



IGA Scale: 50A/Div

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.3 Transient Load Response

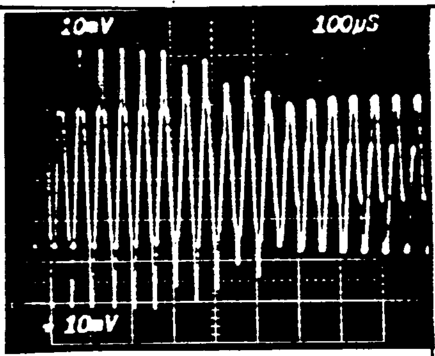
Specific Case: Simultaneous 3Φ switching (0 → 21 kW)

Input Voltage: ______ DC Rcvr: ______

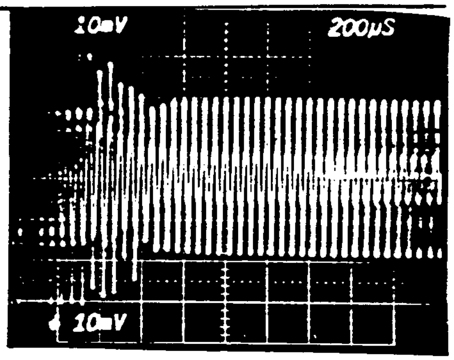
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

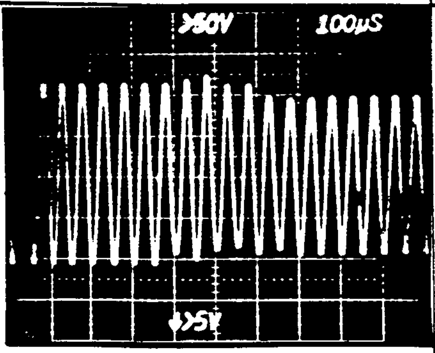
Output Power: ______ Other: ______



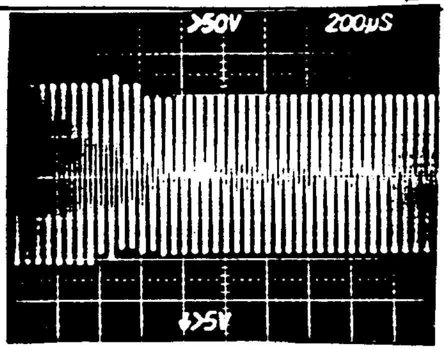
I_{K2} Scale: 50A/Div



I_{K2} Scale: 50A/Div



V_{K2} Scale: UNCAL



V_{K2} Scale: UNCAL

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.3 Transient Load Response

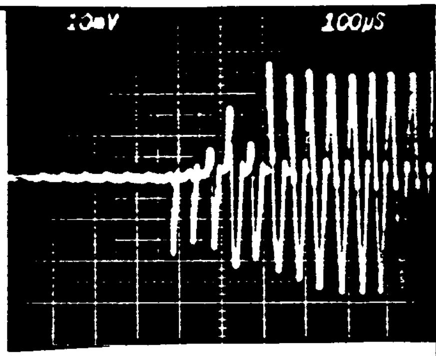
Specific Case: Simultaneous 3φ Switching (0 → 21 kW)

Input Voltage: ____________ DC Rcvr: ____________

Input Current: ____________ AC Rcvr: ____________

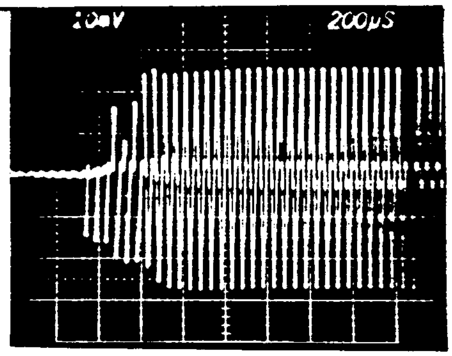
System Frequency: ____________ BD Module: ____________

Output Power: ____________ Other: ____________



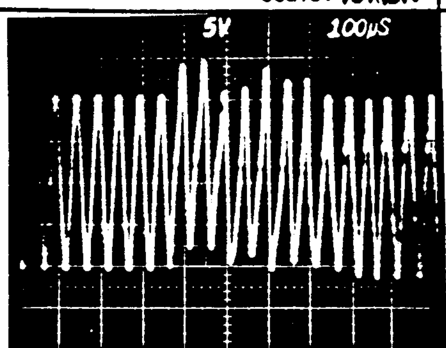
I_{LA}

Scale: 10A/Div



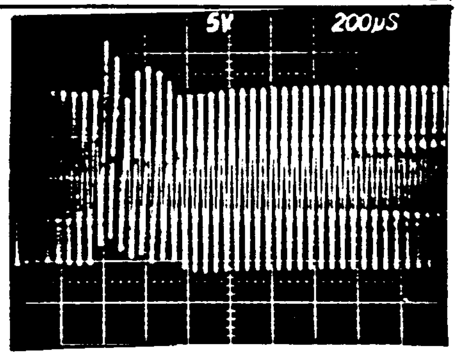
I_{XA}

Scale: 10A/Div



V_{LA}

Scale: 320V/Div



V_{XA}

Scale: 320V/Div

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.3 Transient Load Response

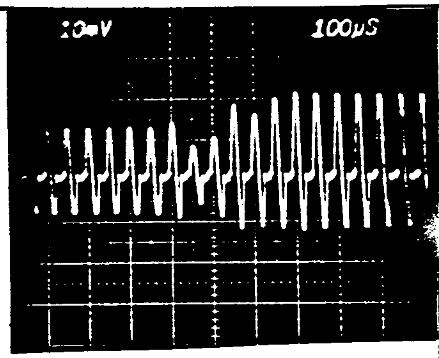
Specific Case: Simultaneous 3φ Switching (0→ 21KW)

Input Voltage: ______ DC Rcvr: ______

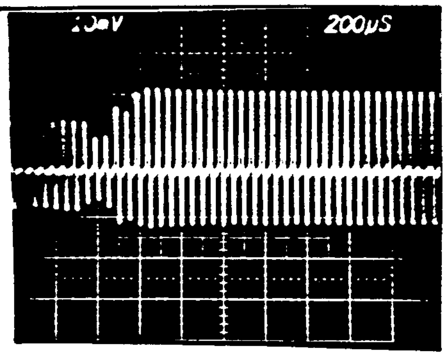
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

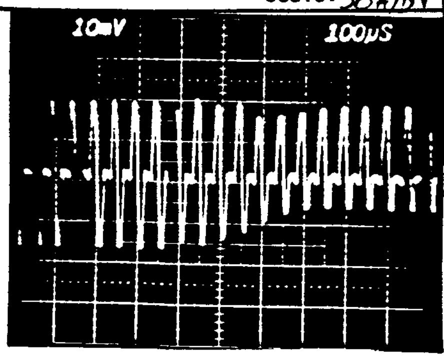
Output Power: ______ Other: ______



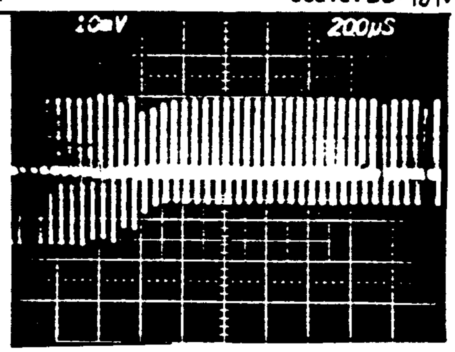
I 1A Scale: 50A/DiV



I 1 A Scale: 50A/DiV



I 2A Scale: 50A/DiV



I 2A Scale: 50A/DiV

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.3 Transient Load Response

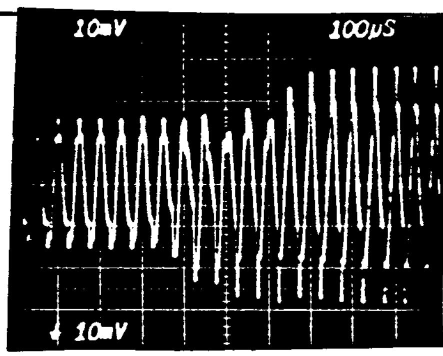
Specific Case: Simultaneous 3Φ Switching (0 → 21 KW)

Input Voltage: ______ DC Rcvr: ______

Input Current: ______ AC Rcvr: ______

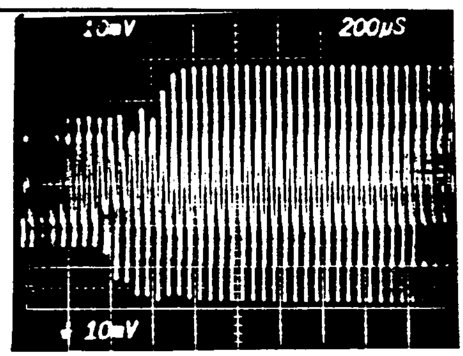
System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______



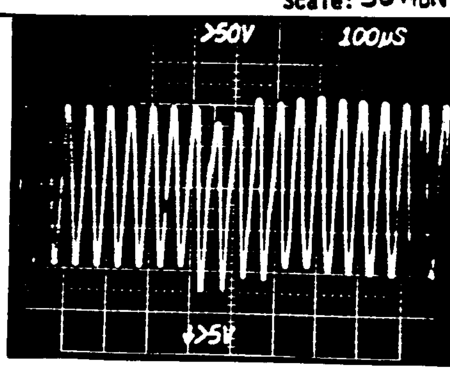
I_{K1}

Scale: 50 A/Div



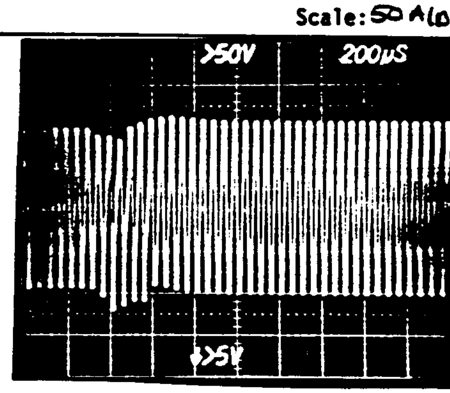
I_{K1}

Scale: 50 A/Div



V_{K1}

Scale: UNCAL



V_{K1}

Scale: UNCAL

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.3 Transient Load Response

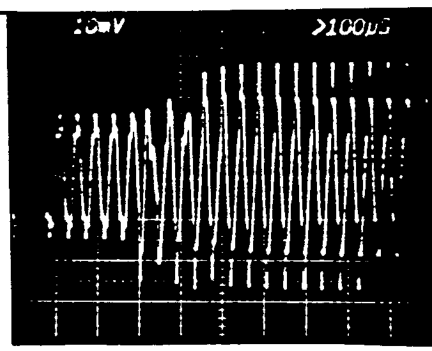
Specific Case: Simultaneous 3Φ switching (0→21kW)

Input Voltage: ______ DC Rcvr: ______

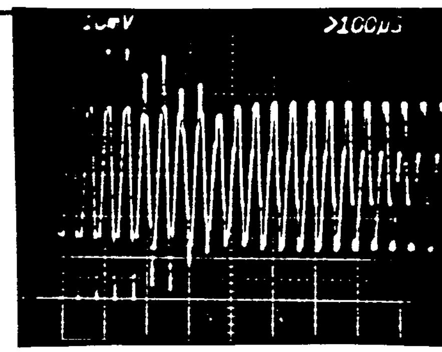
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

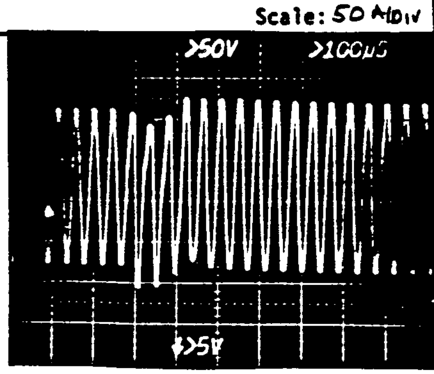
Output Power: ______ Other: ______



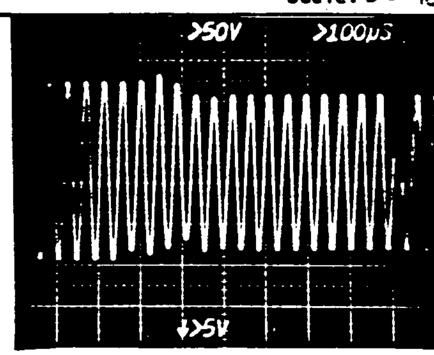
I_{K5} time: UNCAL Scale: 50 A/DIV



I_{K6} time: UNCAL Scale: 50 A/DIV



V_{K5} time: UNCAL Scale: UNCAL



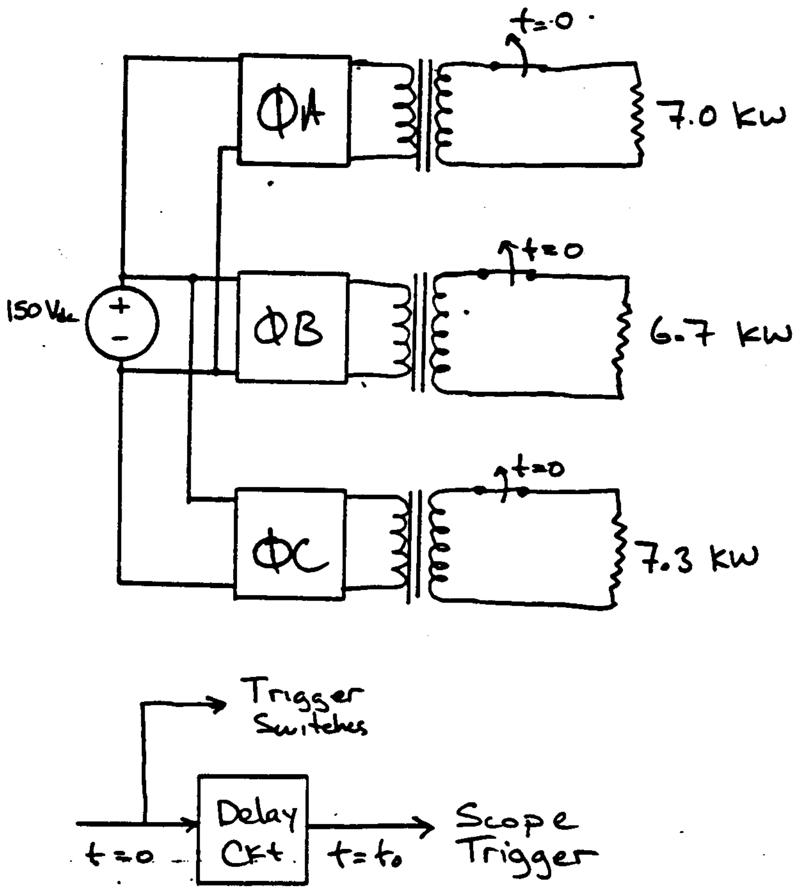
V_{K6} time: UNCAL Scale: UNCAL

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.7-3.2.3 Transient Load Response Simultaneous 3Φ switching (21KW-0W)

Test Circuits



RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.3 TRANSIENT LOAD RESPONSE

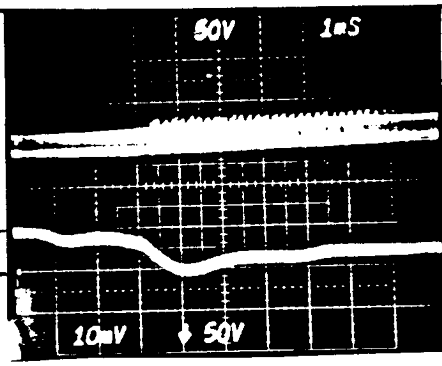
Specific Case: SIMULTANEOUS 3Φ SWITCHING (21 KW → 0W)

Input Voltage: 151.0 Vdc   DC Rcvr: N/C

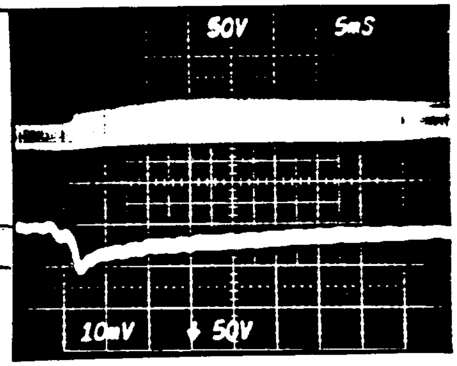
Input Current: 165 Adc   AC Rcvr: N/C

System Frequency: ______   BD Module: N/C

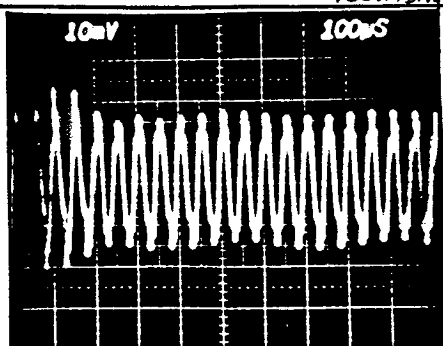
Output Power: 21 KW   Other: Resistive: ΦA-7.0 KW ΦB-6.7 KW ΦC-7.3 KW



V in / I in   Scale: 50V/DIV / 100A/DIV



V in / I IN   Scale: 50V/DIV / 100A/DIV



IKS t1   Scale: 50A/DIV

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.3. Transient Load Response

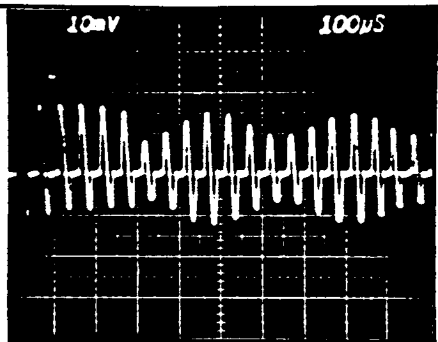
Specific Case: Simultaneous 3Φ Switching (21 kW → 0 W)

Input Voltage: ______ DC Rcvr: ______

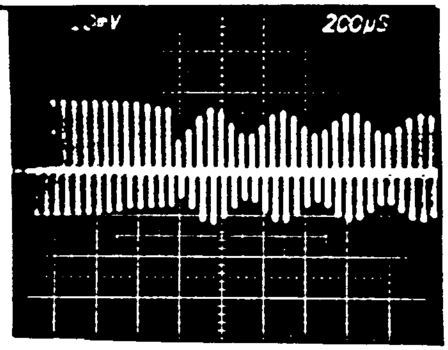
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

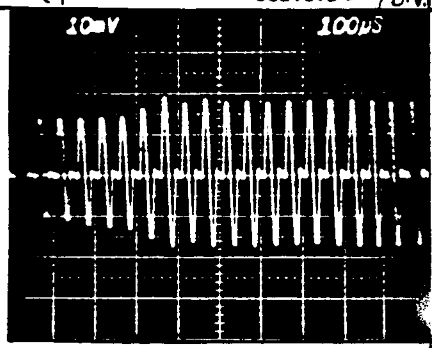
Output Power: ______ Other: ______



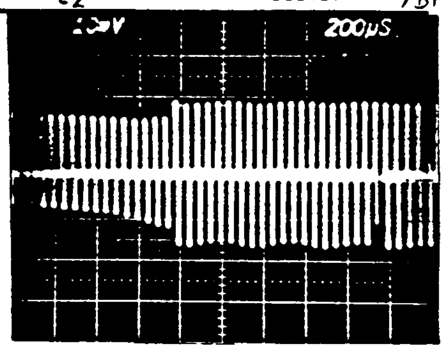
I_{1A} t_1 Scale: 50A/DIV.



I_{1A} t_2 Scale: 50A/DIV.



I_{2A} t_1 Scale: 50A/DIV.



I_{2A} t_2 Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.3 Transient Load Response

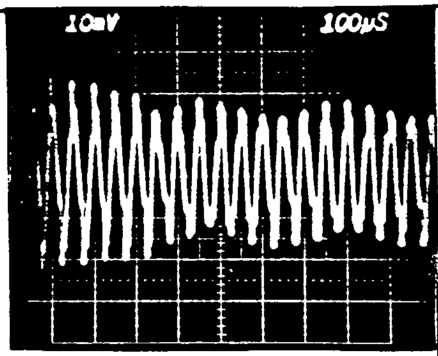
Specific Case: Simultaneous 3Ø Switching (21 kW → 0W)

Input Voltage: ____________ DC Rcvr: ____________

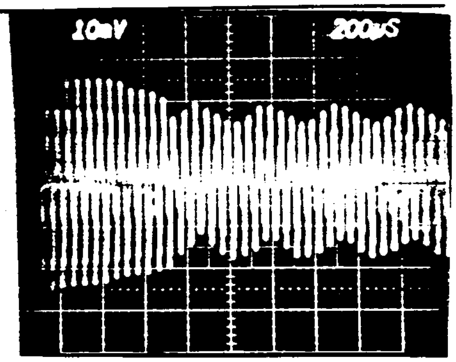
Input Current: ____________ AC Rcvr: ____________

System Frequency: ____________ BD Module: ____________

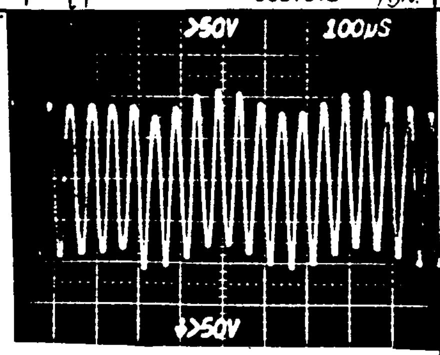
Output Power: ____________ Other: ____________



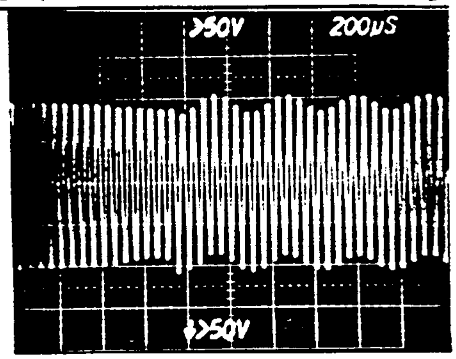
I_{K1} t_1 Scale: 50A/Div.



I_{K1} Scale: 50A/Div



V_{K1} t_1 Scale: UNCAL.



V_{K1} t_2 Scale: UNCAL

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 – 3.2.3 Transient Load Response

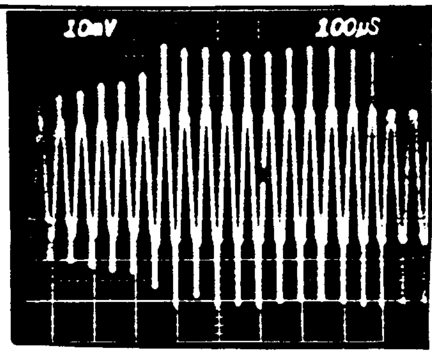
Specific Case: Simultaneous 3Φ switching (21kw → 0w)

Input Voltage: ______ DC Rcvr: ______

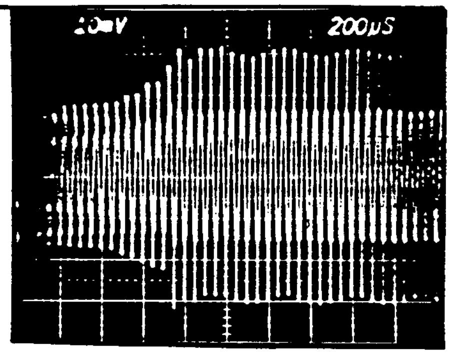
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

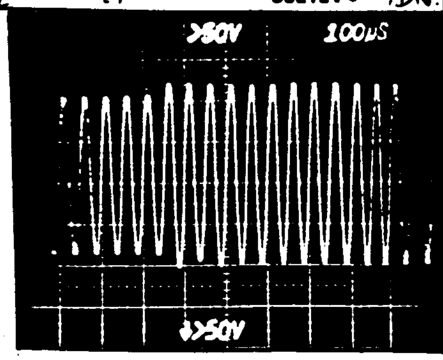
Output Power: ______ Other: ______



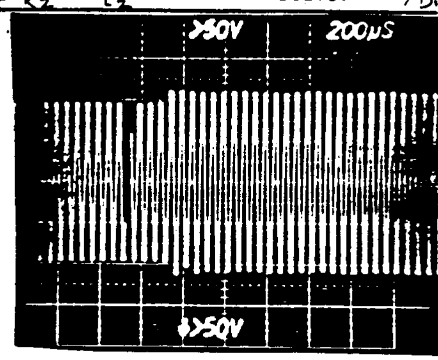
I_{K2} t_1 Scale: 50A/DIV.



I_{K2} t_2 Scale: 50A/Div.



V_{K2} t_1 Scale: UNCAL



V_{K2} t_2 Scale: UNCAL

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 – 3.2.3 TRANSIENT LOAD RESPONSE

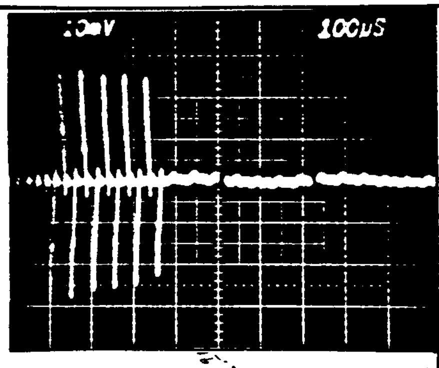
Specific Case: SIMULTANEOUS 3Ø SWITCHING (21KW → 0W)

Input Voltage: ______ DC Rcvr: ______

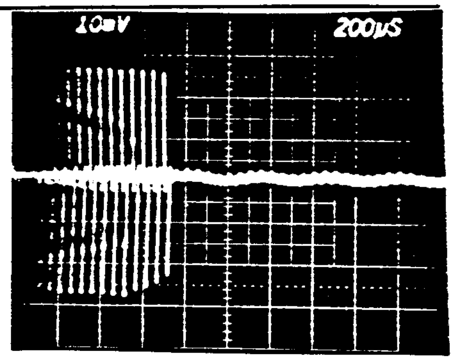
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

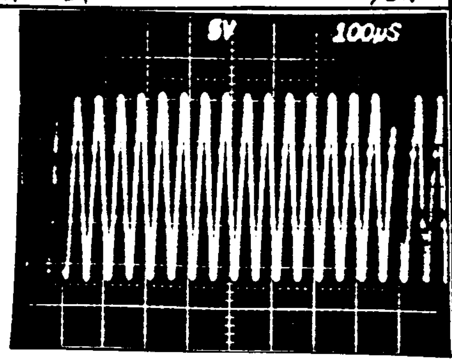
Output Power: ______ Other: ______



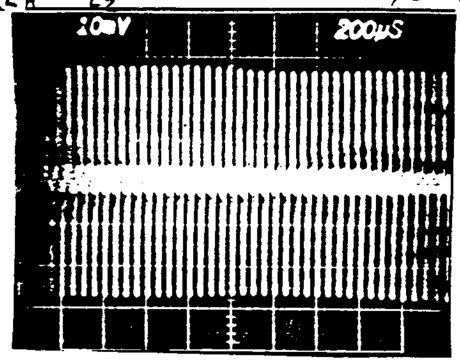
ILA t_1 Scale: 10 A/DIV



ILA t_2 Scale: 10 A/DIV



VLA t_1 Scale: 320V/DIV



VLA t_2 Scale: 320V/DIV.

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.3 Transient Load Response

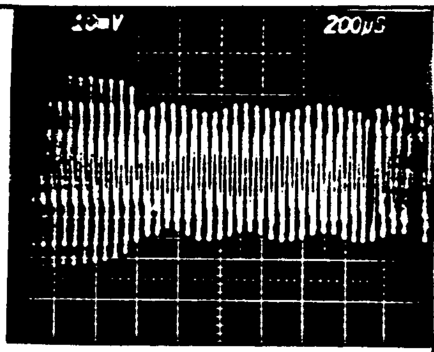
Specific Case: Simultaneous 3Φ switching (21kW → 0W)

Input Voltage: ______ DC Rcvr: ______

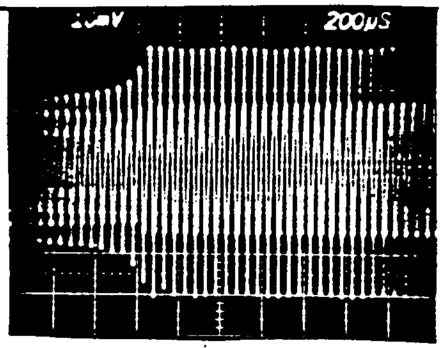
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

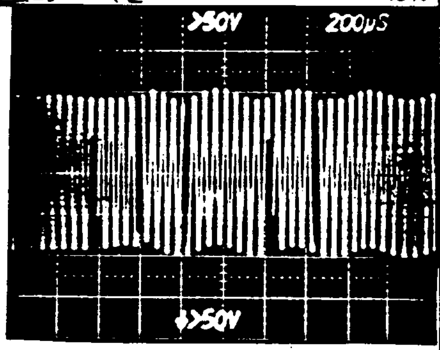
Output Power: ______ Other: ______



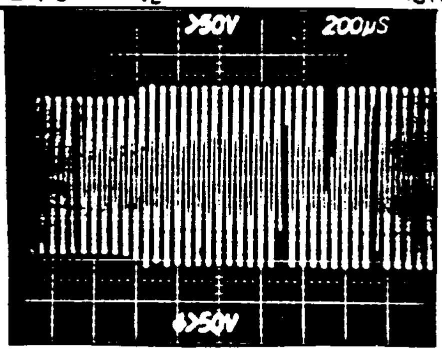
I_{K5} t_2 Scale: 50A/Div



I_{K6} t_2 Scale: 50A/Div



V_{K5} t_2 Scale: UNCAL



V_{K6} t_2 Scale: UNCAL

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.3 Transient Load Response

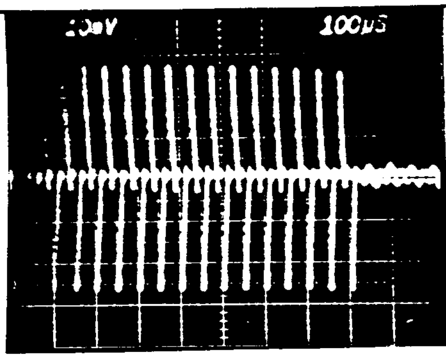
Specific Case: Simultaneous 3φ switching (21 kW → 0 W)

Input Voltage: ______ DC Rcvr: ______

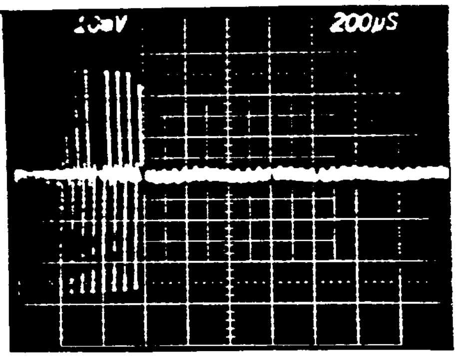
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

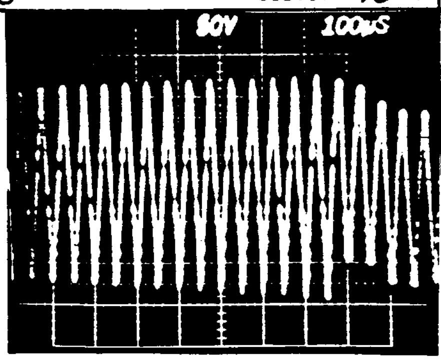
Output Power: ______ Other: ______



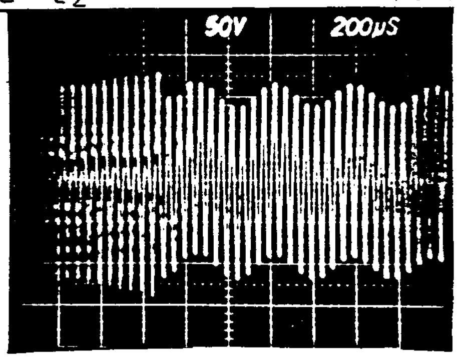
Ixc Scale: 10A/DiV.



Ixc t_2 Scale: 10A/DiV



Vxc Scale: 320V/DiV.



Vxc t_2 Scale: 320V/DiV.

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.3 Transient Load Response

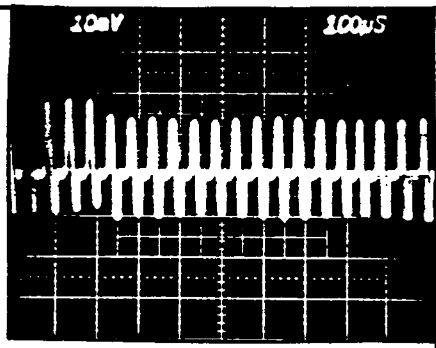
Specific Case: Simultaneous 3φ Switching (21 kW → 0 W)

Input Voltage: ______ **DC Rcvr:** ______

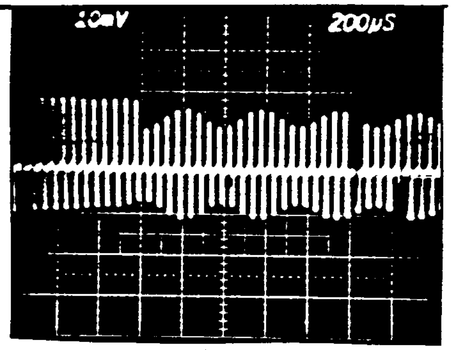
Input Current: ______ **AC Rcvr:** ______

System Frequency: ______ **BD Module:** ______

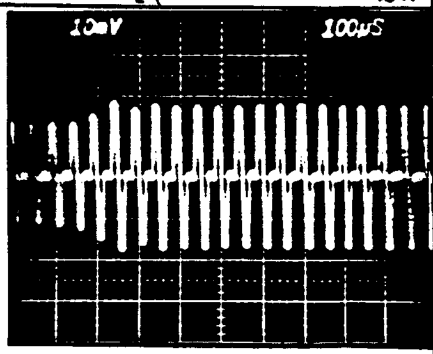
Output Power: ______ **Other:** ______



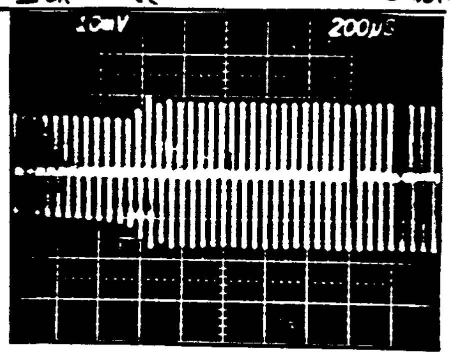
I_{5A} t_1 Scale: 50A/Div



I_{5A} t_2 Scale: 50A/Div



I_{6A} t_1 Scale: 50A/Div



I_{6A} t_2 Scale: 50A/Div

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-323 TRANSIENT LOAD RESPONSE

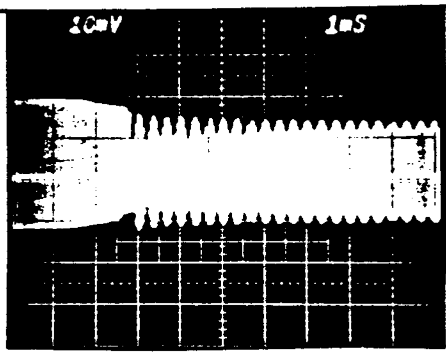
Specific Case: SIMULTANEOUS 3Ø SWITCHING (21KW → 0W)

Input Voltage: ____ DC Rcvr: ____

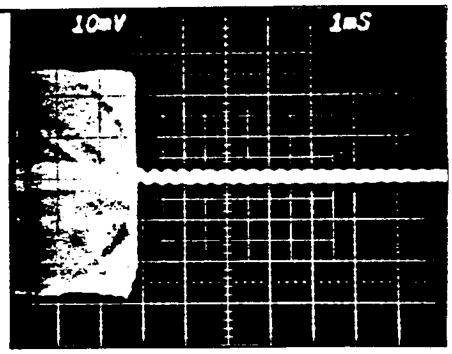
Input Current: ____ AC Rcvr: ____

System Frequency: ____ BD Module: ____

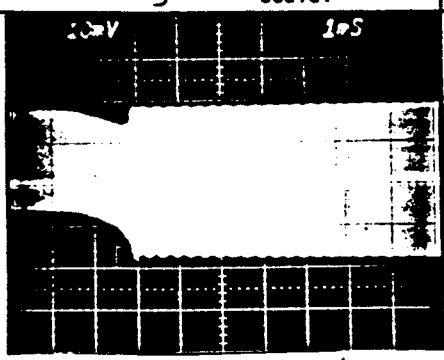
Output Power: ____ Other: ____



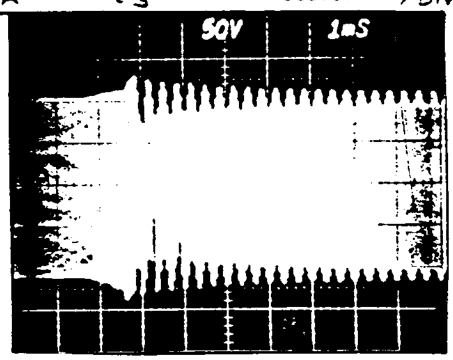
I_{1A} t_3 Scale:



I_{xA} t_3 Scale: 10 A/DIV



I_{2A} t_3 Scale:



V_{xA} t_3 Scale: 320V/DIV

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 – 3.2.3 TRANSIENT LOAD RESPONSE

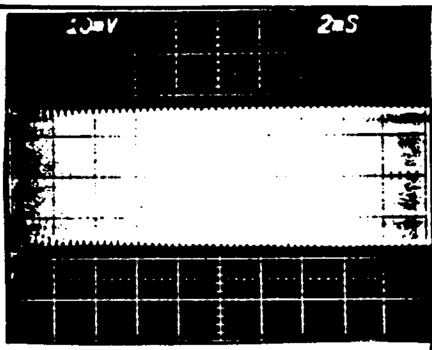
Specific Case: SIMULTANEOUS 3Φ SWITCHING (21KW → 0W)

Input Voltage: ______ **DC Rcvr:** ______

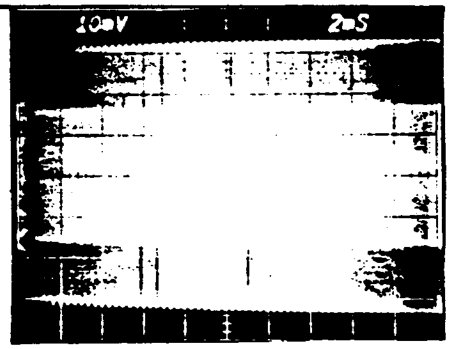
Input Current: ______ **AC Rcvr:** ______

System Frequency: ______ **BD Module:** ______

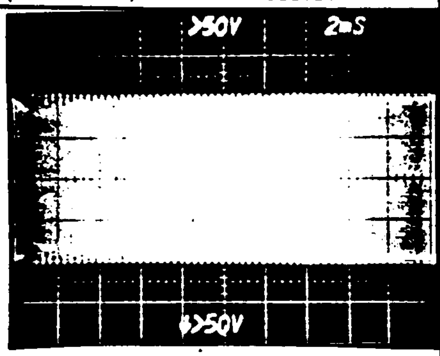
Output Power: ______ **Other:** ______



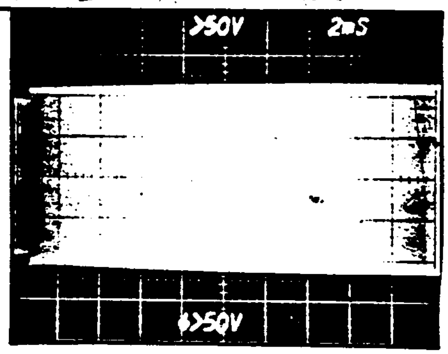
I_{K1} t_4 **Scale:**



I_{K2} t_4 **Scale:**



V_{K1} t_4 **Scale:**



V_{K2} t_4 **Scale:**

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 – 3.2.3 Transient Load Response

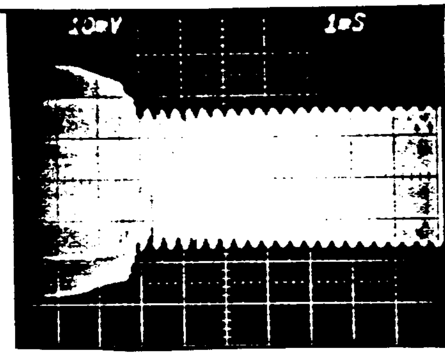
Specific Case: Simultaneous 3 ϕ Switching (21 KW → 0W)

Input Voltage: ____________ **DC Rcvr:** ____________

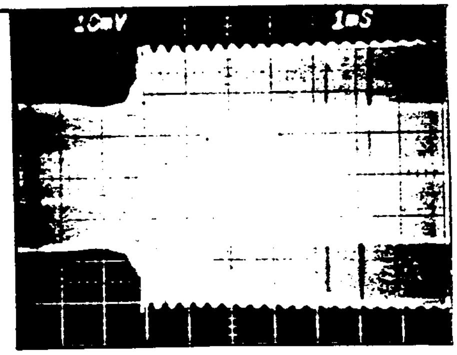
Input Current: ____________ **AC Rcvr:** ____________

System Frequency: ____________ **BD Module:** ____________

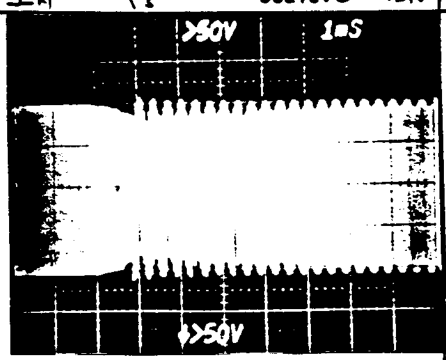
Output Power: ____________ **Other:** ____________



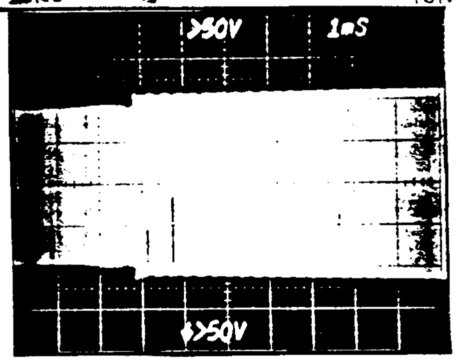
I_{K1} t_2 Scale: 50A/Div



I_{K2} t_3 Scale: 50 A/Div



V_{K1} t_2 Scale: 50 A/Div



V_{K2} t_3 Scale: 50A/Div

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3.2.12 Parallel Operation

I) INPUT POWER SPECIFIC CASE ______

Vin 143.8 146.42
Iin 42 42
Pin ______

Frequency ______

T.H.D.
ΦA ___ %
ΦB ___ %
ΦC ___ %

T.H.D. – TRANSMISSION LINE
INTO THE LINE
ΦA

2 row reds
1 row greens
1 row blues
Switcher

II) OUTPUT POWER

ΦA	ΦB	ΦC	
Vo ___	Vo ___	Vo 317.5	333.4
Io ___	Io ___	Io ___	
Po ___	Po ___	Po ___	

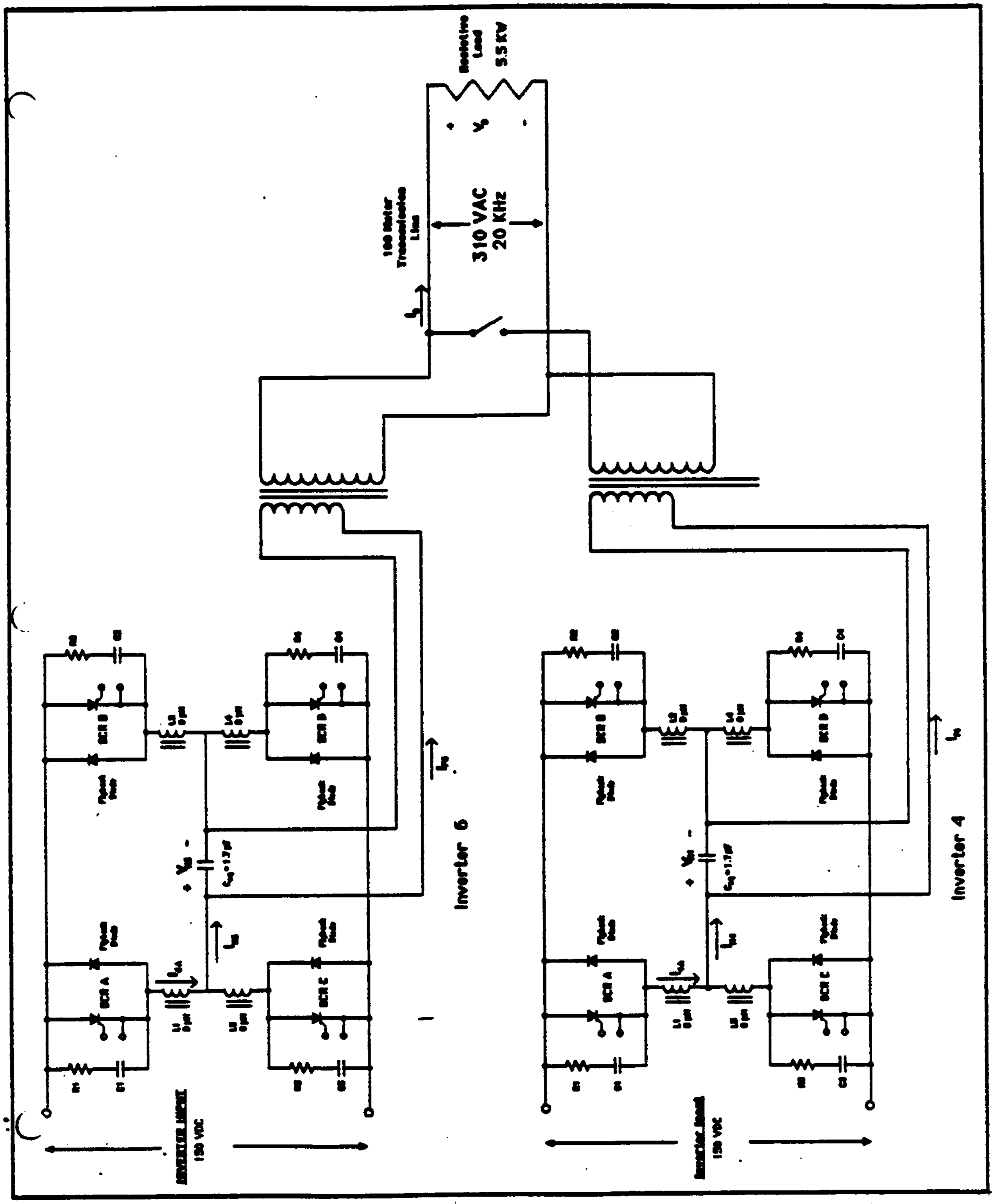
A.C. RCVR	B/D MOD.	D.C. RCVR
Vo ___	Vo ___	Vo ___
Io ___	Io ___	Io ___
Po ___	Po ___	Po ___

T.H.D. Out of RCVR
______ db

RESISTIVE LOADS

ΦA	BEFORE ΦB	AFTER
VA ___ Vac	V 304 Vac	V 318 Vac
IA ___ mV	I 83.3 mV	I 87.1 mV
IA ___ Aac	IB ___ Aac	IC ___ Aac
PRA ___	PRB 5.1 KW	PRC 5.5 KW

Total System Efficiency = $\frac{P_{out}}{P_{in}}$ = ______ = %


Resistive Load
5.5 KV
310 VAC
20 KHz
Inverter 6
Inverter 4
130 VDC
130 VDC
SCR A
SCR B
SCR C
SCR D
SCR A
SCR B
SCR C
SCR D

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 3.2.12 Parallel Operation

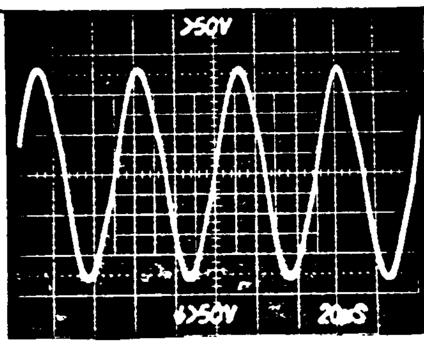
Specific Case: Steady-State Response, Output Voltage + Current

Input Voltage: 143/146 VDC — DC Rcvr: OFF

Input Current: 40/41 ADC — AC Rcvr: OFF

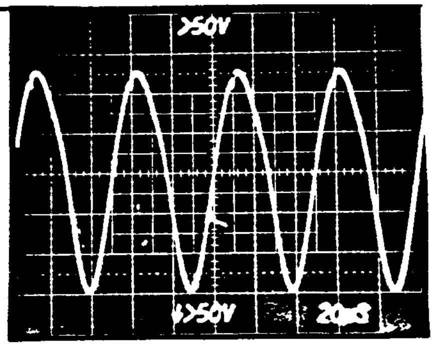
System Frequency: 20 KHZ — BD Module: OFF

Output Power: 5.1 KW/5.5 KW — Other: Resistive: 5.1/5.5 KW



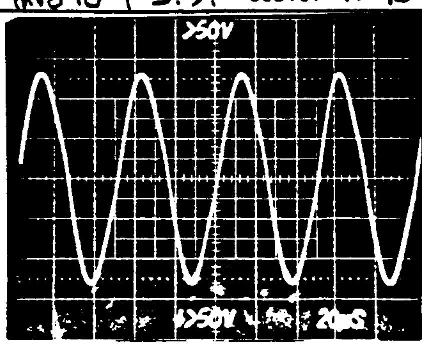
Mono operation

Vo, 1 inverter, S.S. Scale: ~180V/D



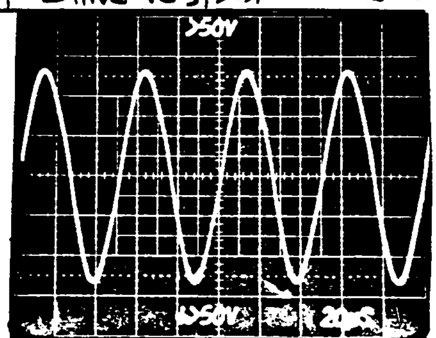
Dual, Parallel Operation

Vo, 2 inverters, S.S, Scale: ~180V/D



Mono Operation

Io, 1 inverter, S.S, Scale: 10 A/DIV



Dual, Parallel Operation

Io, 2 inverters, S.S. Scale: 10A/DIV

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 3.2.12 Parallel Operation

Specific Case: Steady - State Response

Input Voltage: Same | DC Rcvr: OFF

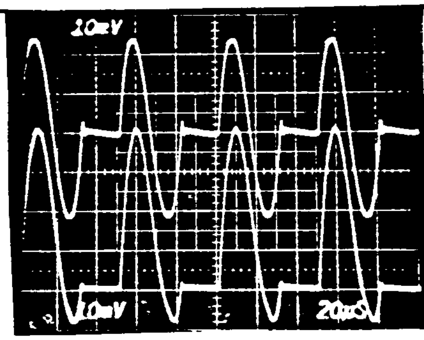
Input Current: | AC Rcvr: OFF

System Frequency: | BD Module: OFF

Output Power: | Other: Resistive: 5.1kW | 5.5kW

I_{MA}

I_{LA}

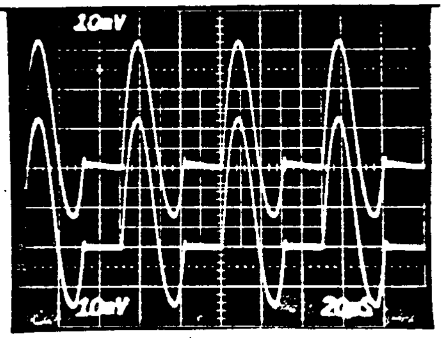


MONO OPERATION

Scale: 20A/DIV

I_{MA}

I_{LA}

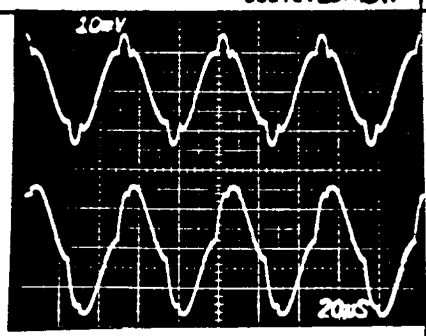


DUAL, PARALLEL OPERATION

Scale: 20A/D

I_{K4}

I_{K6}

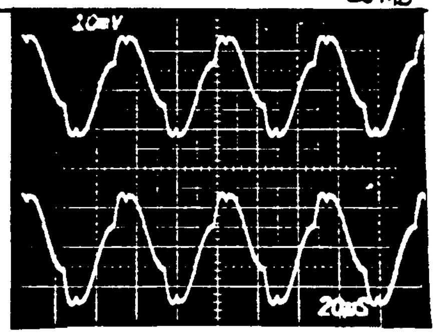


MONO OPERATION

Scale: 50A/DIV

I_{K4}

I_{K6}



DUAL, PARALLEL OPERATION

Scale: 50A/DIV

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 3.2.12 Parallel Operation

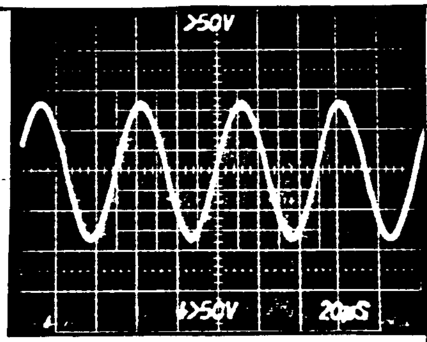
Specific Case: Steady-State Response

Input Voltage: Same | DC Rcvr: Same

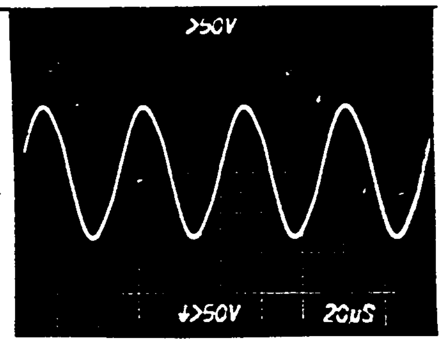
Input Current: | AC Rcvr:

System Frequency: | BD Module:

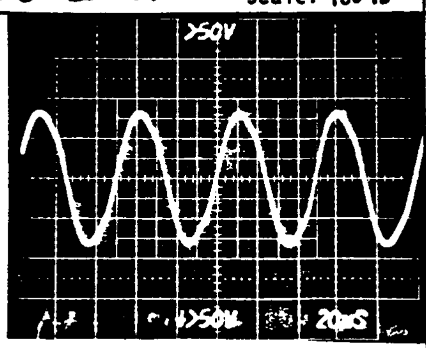
Output Power: | Other:



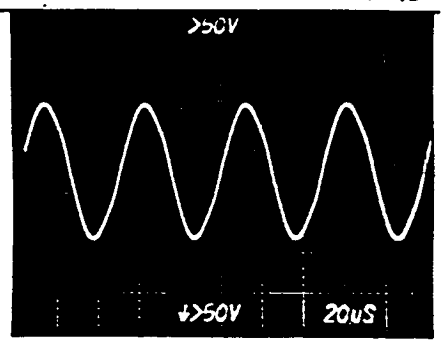
VK4 Mono Operation, #6 Connected Scale:~180V/D



VK4, Dual Parallel Op. Scale:~180V/D



VK6, Mono Operation #6 Connected Scale:~180V/D



VK6, Dual Parallel Operation Scale:~180V/D

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 3.2.12 Parallel Operation

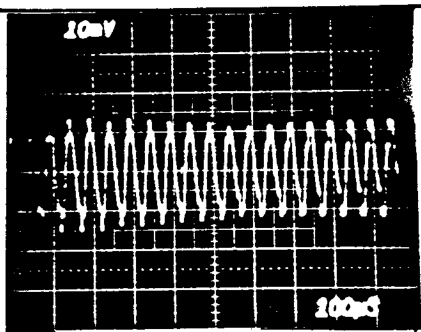
Specific Case: Transient Response

Input Voltage: 143 / 146 Vdc　　DC Rcvr: OFF

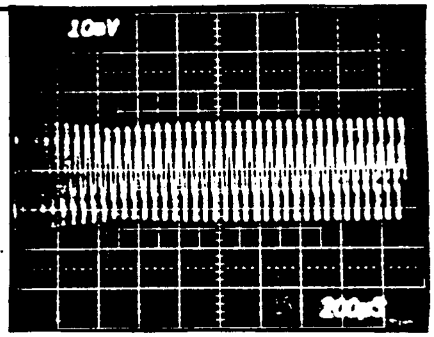
Input Current: 40 / 41 Adc　　AC Rcvr: OFF

System Frequency: 20 KHZ　　BD Module: OFF

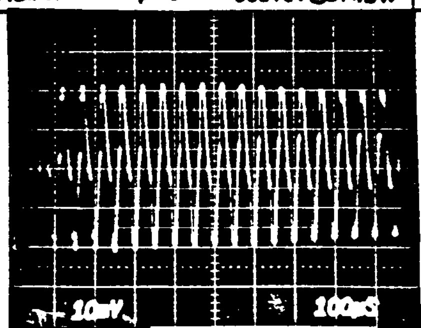
Output Power: 5.1 KW / 5.5 KW　　Other: Resistive – 5.1 KW / 5.5 KW



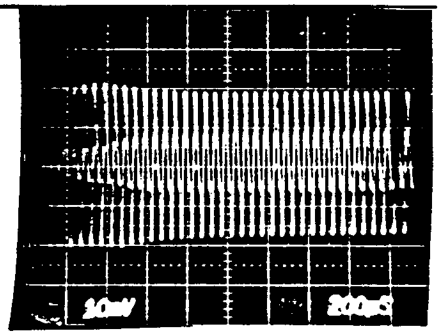
IK4, transient response　Scale: 50A/DIV



IK4, transient response　Scale: 50A/DIV



IK6, transient response　Scale: 50A/DIV



IK6, transient response　Scale: 50A/DIV

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

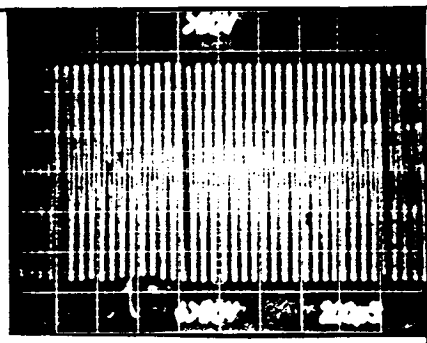
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

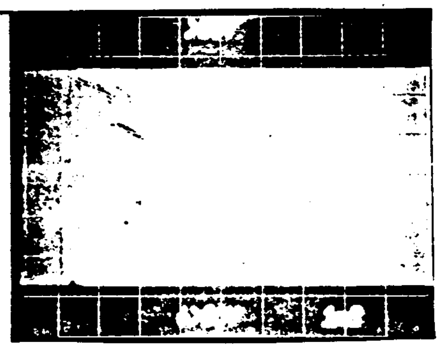
Test-Configuration: 3.2.12 Parallel Operation

Specific Case: Transient Response, Output Voltage + Current

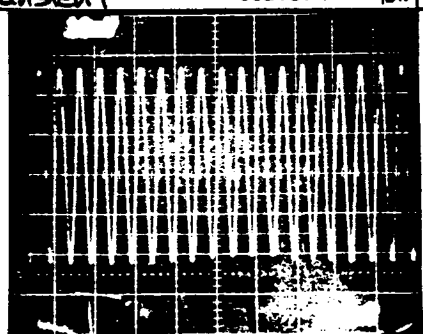
Input Voltage: Same	DC Rcvr: Same
Input Current:	AC Rcvr:
System Frequency:	BD Module:
Output Power:	Other:



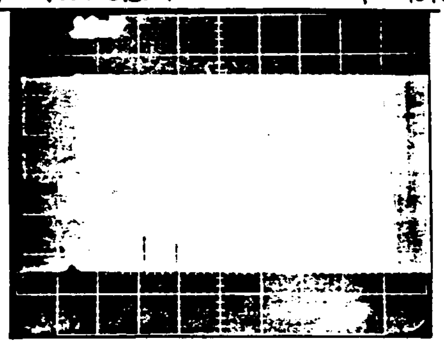
Vo transient Scale: ~180 V/Div



Vo transient Scale: ~180V/Div



Io transient response Scale: 10A/D



Io transient response Scale: 10A/Div

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 3.2.12 Parallel Operation

Specific Case: Transient Response, Primary Voltage + Current

Input Voltage: Same

DC Rcvr: Same

Input Current:

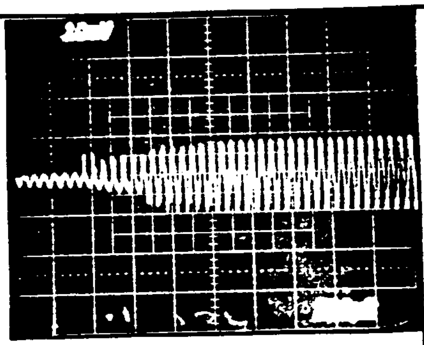
AC Rcvr:

System Frequency:

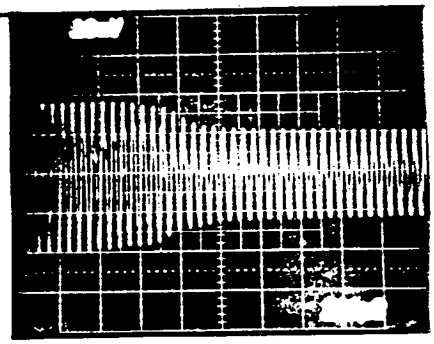
BD Module:

Output Power:

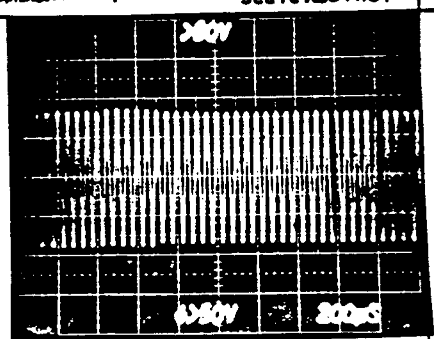
Other:



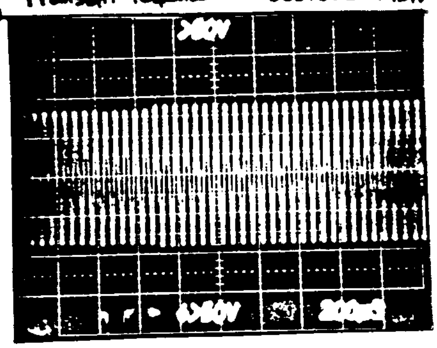
I_{P4}, transient response Scale: 20A/DIV



I_{P6}, transient response Scale: 20A/DIV



V_{K4}, transient response Scale: ~180 V/DIV



V_{K6}, transient response Scale: ~180 V/D

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 3.2.12 Parallel Operation

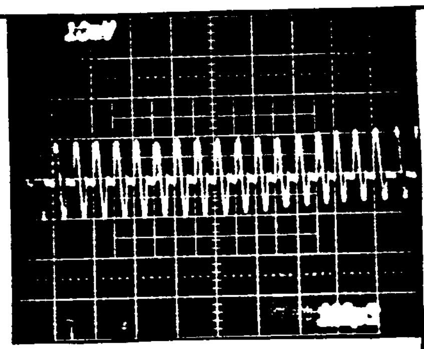
Specific Case: Transient Response

Input Voltage: Same | DC Rcvr: Same

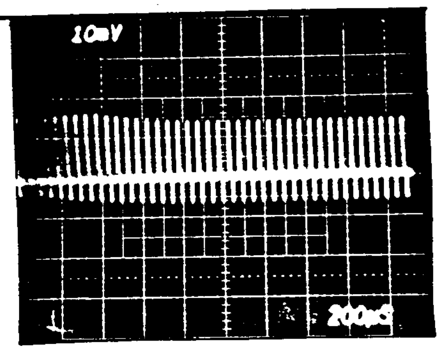
Input Current: | AC Rcvr:

System Frequency: | BD Module:

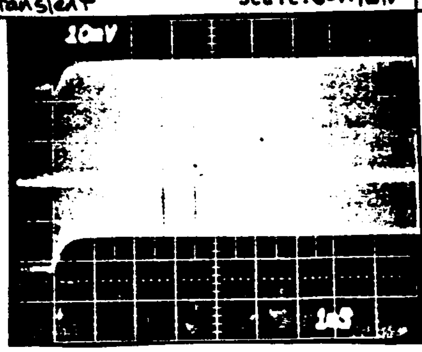
Output Power: | Other:



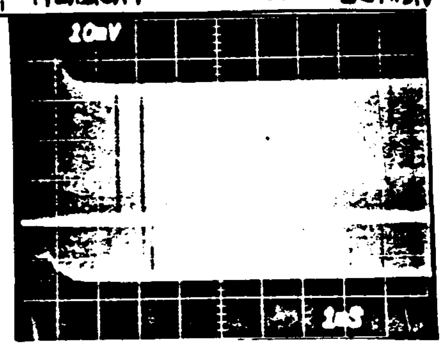
I_{4A}, transient Scale: 50A/Div



I_{6A}, transient Scale: 50A/Div



I_{4A}, transient response Scale: 20A/Div



I_{6A}, transient response Scale: 20A/D

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 3.2.12 Parallel Operation

Specific Case: Transient Response

Input Voltage: Same

Input Current:

System Frequency:

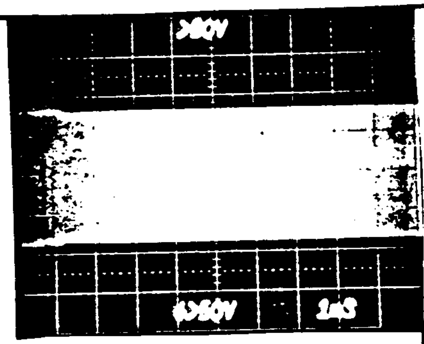
Output Power:

DC Rcvr: Same

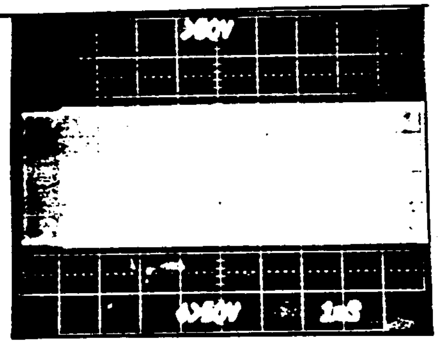
AC Rcvr:

BD Module:

Other:



V_{K4}, transient response Scale: ~180 V/div



V_{K6}, transient response Scale: ~180 V/div

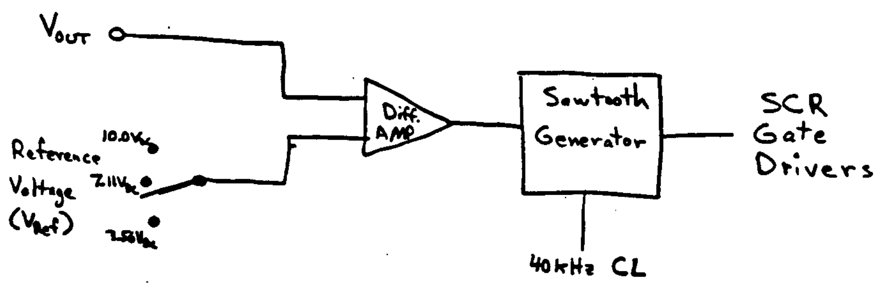
Photo

Scale:

Photo

Scale:

2.3.2 -3.2.4 OUTPUT RESPONSE TO REFERENCE/CONTROL SIGNAL CHANGES



Simplified DC Receiver Control Circuit Block Diagram

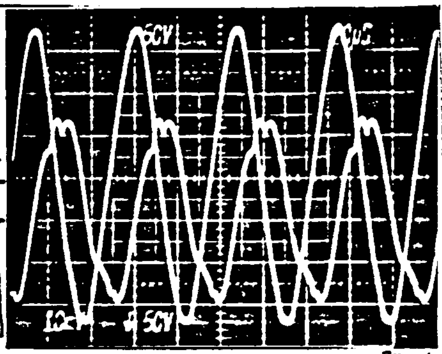
Measurement		Measurement Equipment
V_{IN}		Fluke 8000A Multimeter
I_{IN}	$= \frac{V_{shunt}}{R_{shunt}}$	Fluke 8000A Multimeter (V_{shunt})
V_{OUT}		Fluke 893A Diff. Voltmeter
I_{OUT}		SRI #900089 Current Meter
f		HP 5315B Universal Counter
h		Calculation Using V_{IN}, I_{IN}, V_{OUT}, I_{OUT}
$V_{Ref.}$		Fluke 8000A multimeter

2.3.2. — 3.2.4.1

Resonant Tank Voltage
Resonant Tank Current

STEADY-STATE CONTROL SIGNAL GAIN

V_{K1}, I_{K1} 10A/div, 0V, 0A

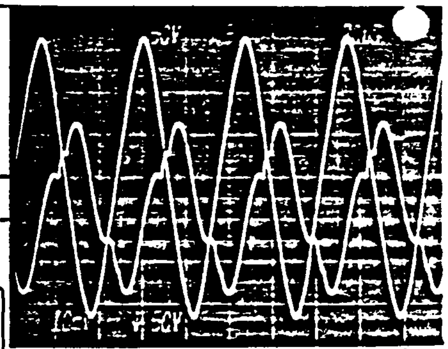


$R_{Load} = 3.37\Omega$

20μs/

$V_{IN} = 90.7\ V_{DC}$ $V_{DC} = 22.14\ V_{DC}$ $\boxed{V_{Ref.} = 7.11\ V_{DC}}$
$I_{IN} = 6.53\ A_{DC}$ $I_{DC} = 8.1\ A_{DC}$
$f = 20.709\ kHz$ $\eta = 37.1\%$ $P_{out} = 220\ W$

V_{K1}, I_{K1} 10A/div, 0V, 0A

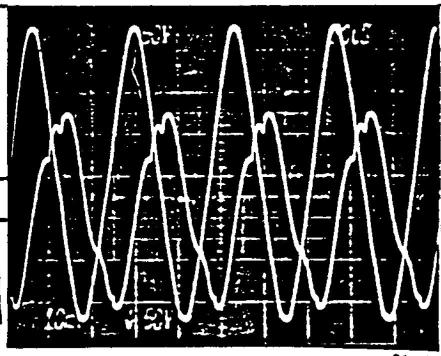


$R_{LOAD} = 1.75\Omega$

20μs/

$V_{IN} = 90.1\ V_{DC}$ $V_{DC} = 26.7\ V_{DC}$ $\boxed{V_{Ref.} = 7.11\ V_{DC}}$
$I_{IN} = 8.53\ A_{DC}$ $I_{DC} = 15.3\ A_{DC}$
$f = 20.710\ kHz$ $\eta = 51.3\%$ $P_{OUT} = 409\ W$

V_{K1}, I_{K1} 10A/div., 0V, 0A

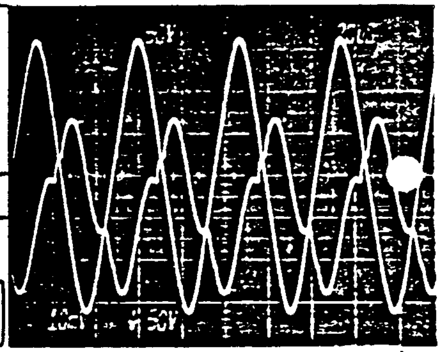


$R_{Load} = 3.37\Omega$

20μs/

$V_{IN} = 90.0\ V_{DC}$ $V_{DC} = 37.10\ V_{DC}$ $\boxed{V_{Ref.} = 10.00\ V_{DC}}$
$I_{IN} = 8.70\ A_{DC}$ $I_{DC} = 11.0\ A_{DC}$
$f = 20.709\ kHz$ $\eta = 52\%$ $P_{out} = 408\ W$

V_{K1}, I_{K1} 10A/div, 0V, 0A

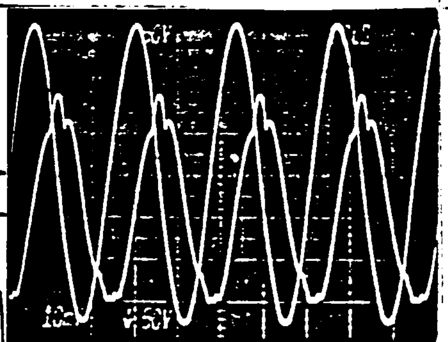


$R_{LOAD} = 1.75\Omega$

20μs/

$V_{IN} = 89.9\ V_{DC}$ $V_{DC} = 28.7\ V_{DC}$ $\boxed{V_{Ref.} = 10.00\ V_{DC}}$
$I_{IN} = 9.57\ A_{DC}$ $I_{DC} = 16.7\ A_{DC}$
$f = 20.708\ kHz$ $\eta = 55.7\%$ $P_{OUT} = 479\ W$

V_{K1}, I_{K1} 10A/div, 0V, 0A

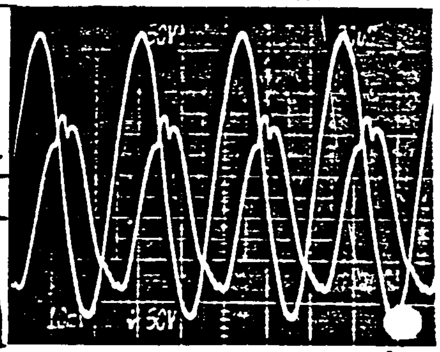


$R_{Load} = 3.37\Omega$

20μs/

$V_{IN} = 90.0\ V_{DC}$ $V_{DC} = 13.24\ V_{DC}$ $\boxed{V_{Ref} = 3.56\ V_{DC}}$
$I_{IN} = 4.55\ A_{DC}$ $I_{DC} = 3.90\ A_{DC}$
$f = 20.719\ kHz$ $\eta = 12.6\%$ $P_{OUT} = 51.6\ W$

V_{K1}, I_{K1} 10A/div., 0V, 0A



$R_{LOAD} = 1.75\Omega$

20μs/

$V_{IN} = 90.1\ V_{DC}$ $V_{DC} = 13.5\ V_{DC}$ $\boxed{V_{Ref.} = 3.56\ V_{DC}}$
$I_{IN} = 5.16\ A_{DC}$ $I_{DC} = 7.7\ A_{DC}$
$f = 20.704\ kHz$ $\eta = 22.4\%$ $P_{OUT} = 104\ W$

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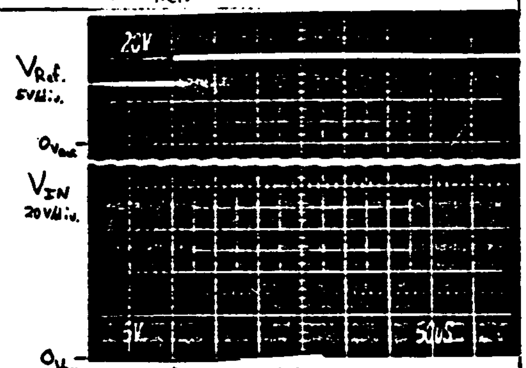
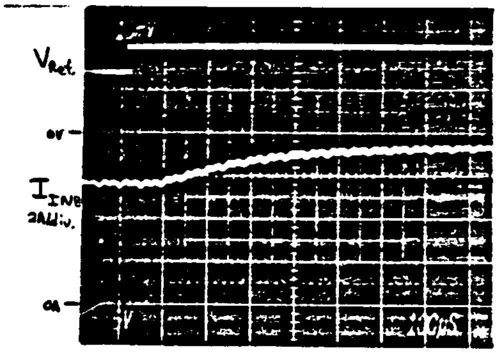
2.3.2 - 3.2.4.2 CONTROL SIGNAL STEP RESPONSE V_{IN} = 70.0 V_{DC}
R_{LOAD} = 3.37Ω

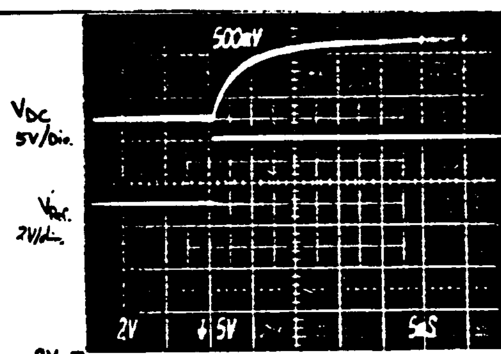
$V_{Ref.}$: 7V → 10V



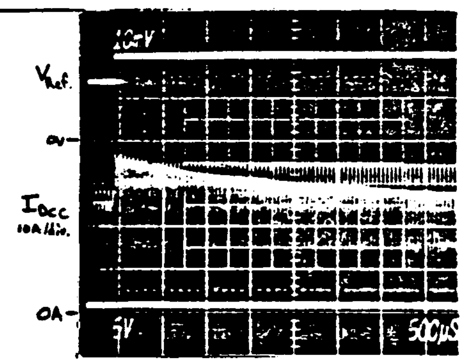
Input Voltage
Reference Signal



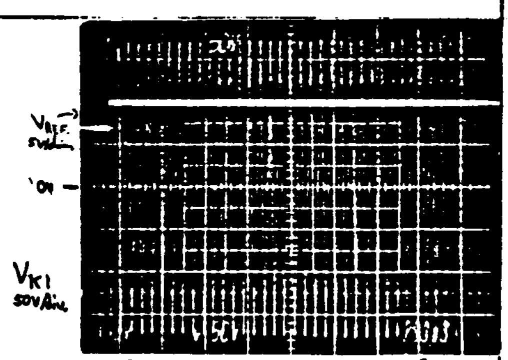
Input Current
(Before DC Capacitor)
Reference Signal



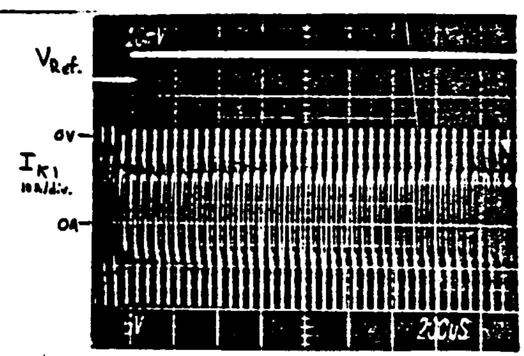
Output Voltage
Reference Signal



Output Current
(Including Filter Current)
Reference Signal



Resonant Tank Voltage
Reference Signal



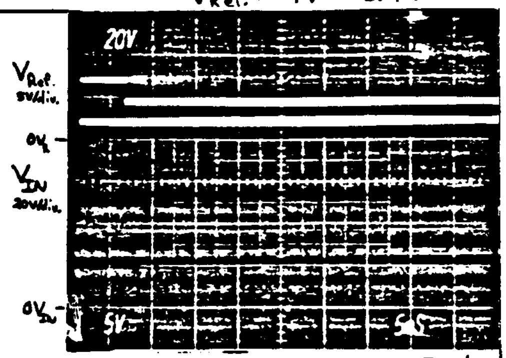
Resonant Tank Current
Reference Signal

2.3.2 -3.2.4.2 CONTROL SIGNAL STEP RESPONSE

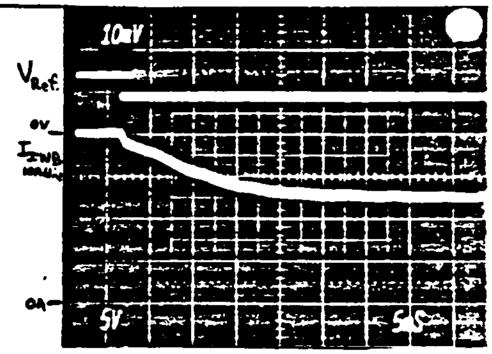
$V_{IN} = 90V_{DC}$

$R_{LOAD} = 3.37\Omega$

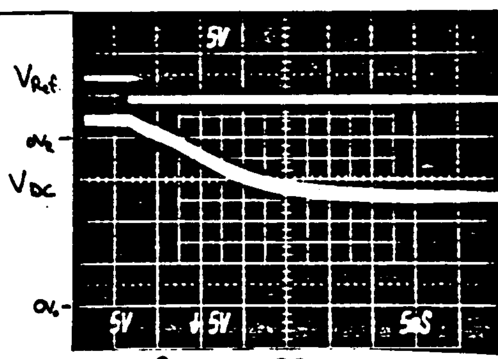
$V_{Ref.}$: 7V → 3.9V



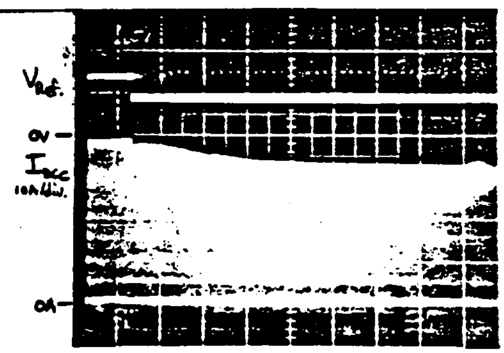
Input Voltage
Reference Signal



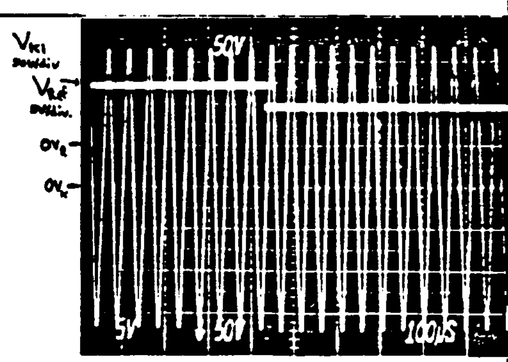
Input Current
(Before DC Capacitor)
Reference Signal



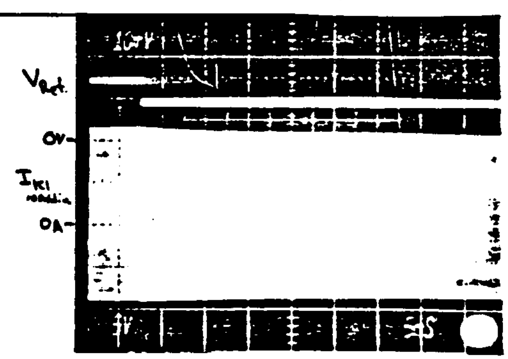
Output Voltage
Reference Voltage



Output Current
(Including Filter Current)
Reference Signal



Resonant Tank Voltage
Reference Signal

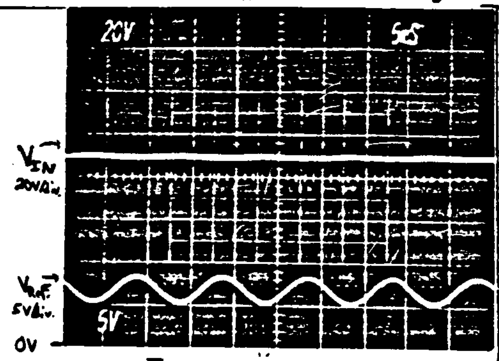


Resonant Tank Current
Reference Signal

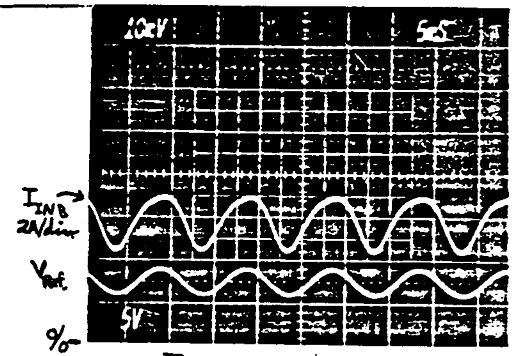
2.3.2-3.2.4.3 CONTROL SIGNAL FREQUENCY RESPONSE

$V_{Ref.}$ = 7V + AC signal

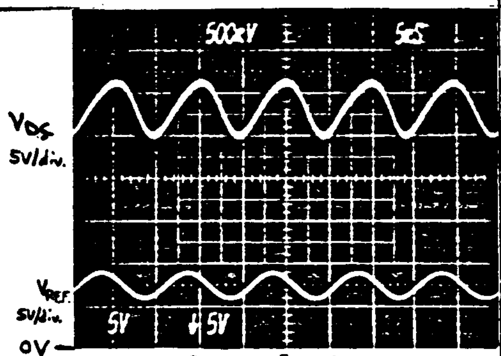
V_{IN} = 90V
R_{LOAD} = 3.37Ω
100Hz AC



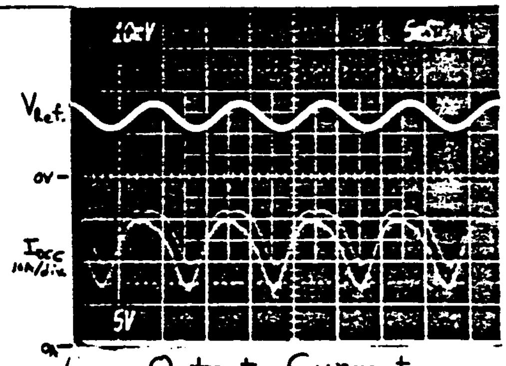
Input Voltage
Reference Signal



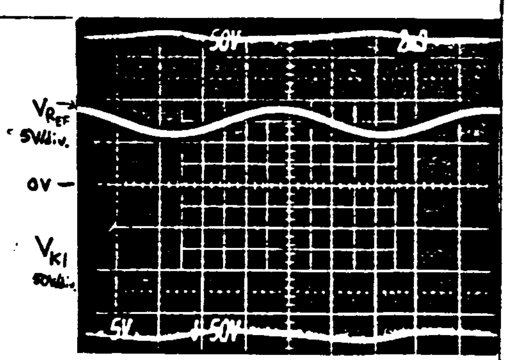
Input Current
(Before DC Capacitor)
Reference Signal



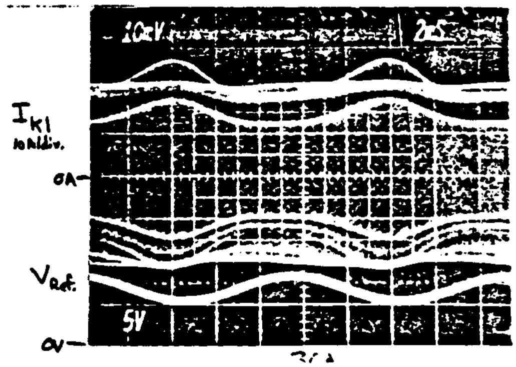
Output Voltage
Reference Signal



Output Current
(Including Filter Current)
Reference Signal



Resonant Tank Voltage
Reference Signal

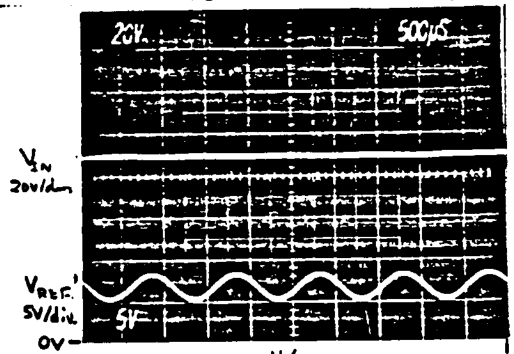


Resonant Tank Current
Reference Signal

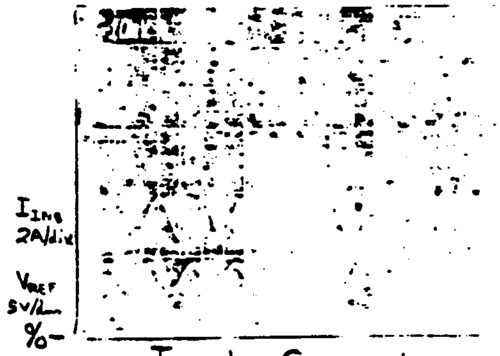
2.3.2 CONTROL SIGNAL
-3.2.4.3 FREQUENCY RESPONSE

$V_{IN} = 90.0\ V_{DC}$
$R_{LOAD} = 3.37\Omega$
1kHz AC

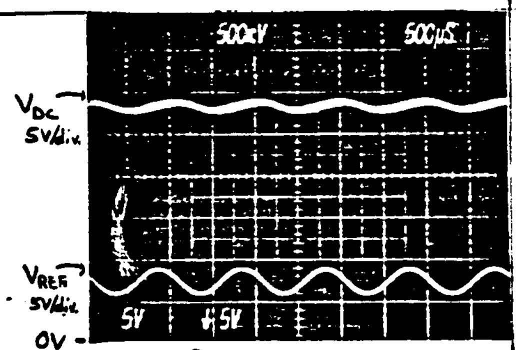
$V_{Ref.} = 7V + AC$ Signal



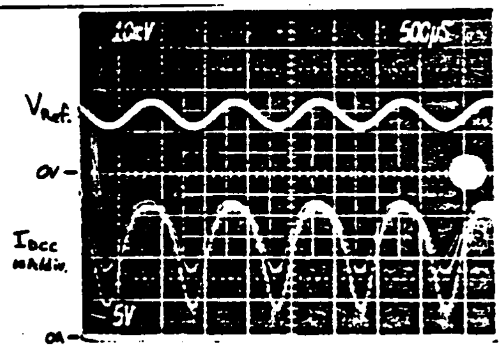
Input Voltage
Reference Signal



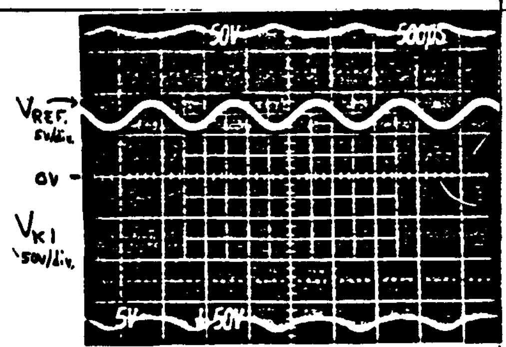
Input Current
(Before DC Capacitor)
Reference Signal



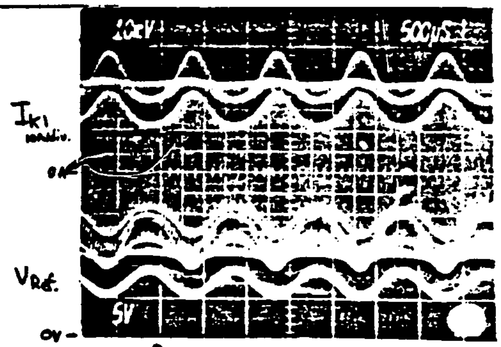
Output Voltage
Reference Signal



Output Current
(Including Filter Current)
Reference Signal



Resonant Tank Voltage
Reference Signal



Resonant Tank Current
Reference Signal

2.3.2 – 3.2.4.3 CONTROL SIGNAL FREQUENCY RESPONSE

$V_{IN} = 90.0 V_{DC}$
$R_{LOAD} = 3.37\Omega$

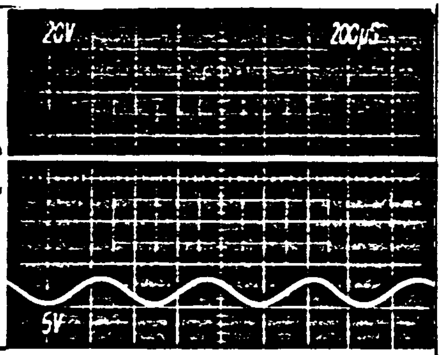
2KHz AC

$V_{Ref.} = 7V + AC$ Signal

V_{IN} 20V/div

V_{REF} 5V/div

0V

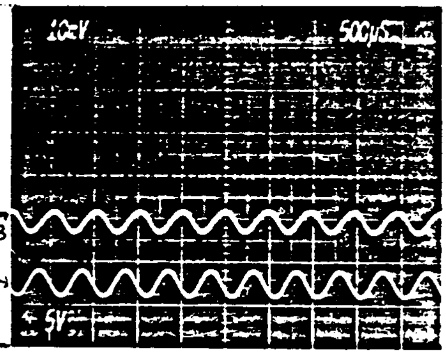


Input Voltage
Reference Signal

I_{INB} 2A/div

V_{REF} 5V/div

0/0

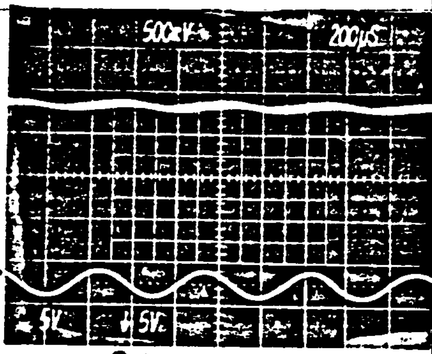


Input Current
(Before DC Capacitor)
Reference Signal

V_{DC} 5V/div

V_{REF} 5V/div

0V



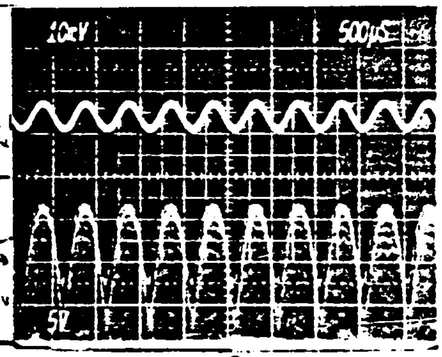
Output Voltage
Reference Signal

V_{REF} 5V/div

0V

I_{DCC} 10A/div

0A

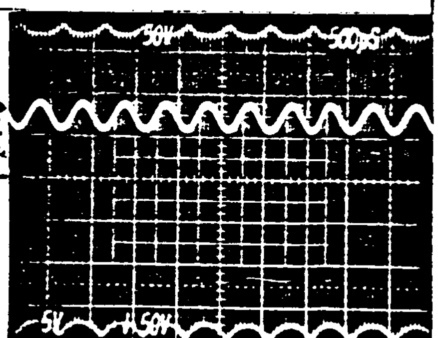


Output Current
(Including Filter Current)
Reference Signal

V_{REF} 5V/div

0V

V_{K1} 50V/div



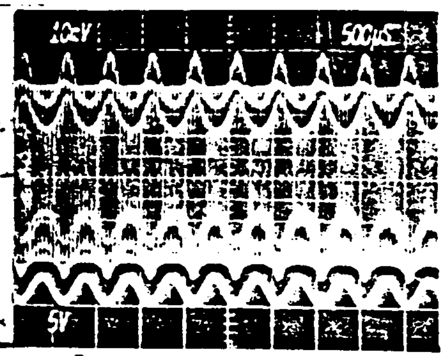
Resonant Tank Voltage
Reference Signal

I_{K1} 10A/div

0A

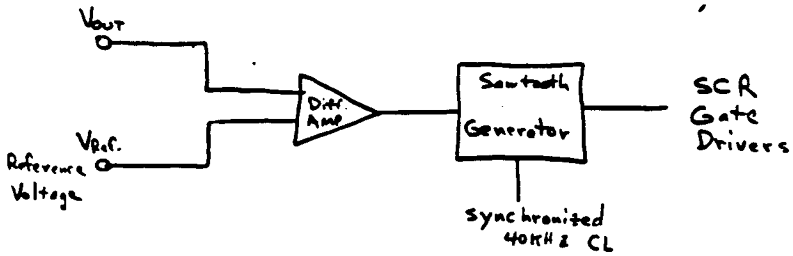
V_{REF} 5V/div

0V

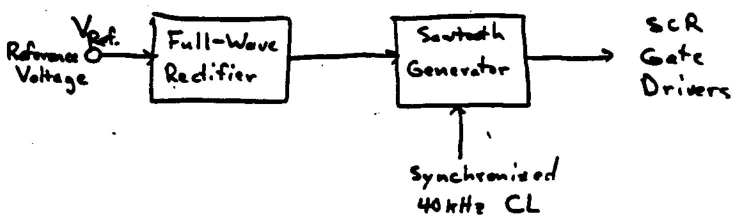


Resonant Tank Current
Reference Signal

2.3.4 -3.2.4 OUTPUT RESPONSE TO REFERENCE/CONTROL SIGNAL CHANGES



Simplified Block Diagram for the DC Receiver and Bidirectional Module Load Regulation Circuitry.



Simplified Block Diagram for the Open-Loop AC Receiver Control Circuitry.

2.3.4 -3.2.4.1 STEADY-STATE CONTROL SIGNAL GAIN

Measurements		Equipment
V_{IN}		Fluke 8000A Multimeter
I_{IN}	$= \frac{V_{shunt}}{R_{shunt}}$	Fluke 8000A Multimeter (V_{shunt})
V_{oDC}		Fluke 893A Diff. Voltmeter
I_{oDC}		SRI #900083 Current Meter
V_{oBD}		Triplett 630 Multimeter
I_{oBD}	$= \frac{V_{oBD}}{R_{LOAD}}$	L&N 5305 Bridge (R_{LOAD})
$V_{REF \cdot DC}$		Fluke 893A Diff. Voltmeter
$V_{REF\,BD}$		Fluke 893A Diff. Voltmeter

2.3.4 STEADY - STATE CONTROL GAIN
-3.2.4.1

DC RECEIVER $R_{LOAD} = 4.12\Omega$

	$V_{Ref.}$ (V_{DC})	V_{IN} (V_{DC})	I_{IN} (A_{DC})	V_{DC} (V_{DC})	I_{DC} (A_{DC})	P_{ODC} (W)
-50%	3.61	91.5	9.50	14.43	3.75	54.1
-	7.22	91.15	11.15	28.90	7.0	200 W
+50%	9.98	90.7	12.98	38.49	9.35	360 W

BIDIRECTIONAL MODULE $R_{LOAD} = 49.7\Omega$

	$V_{Ref.}$ (V_{DC})	V_{IN} (V_{DC})	I_{IN} (A_{DC})	V_{OBD} (V_{DC})	I_{OBD} (A_{DC})	P_{OBD} (W)
-50%	0.86	91.4	9.71	54.5	1.10	60.0
-	1.71	91.0	11.18	100	2.01	201
+50%	2.57	90.7	12.67	129	2.6	340

2.3.4
-3.2.4.3

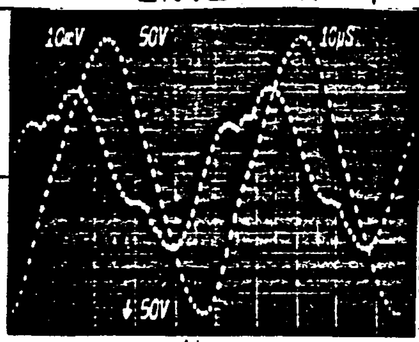
CONTROL SIGNAL FREQUENCY RESPONSE OF AC RECEIVER

$\boxed{V_{Ref.}: 400\,Hz}$

$V_{IN} = 90V$
$R_{load_{AC}} = 35.3\Omega$

INVERTER #1

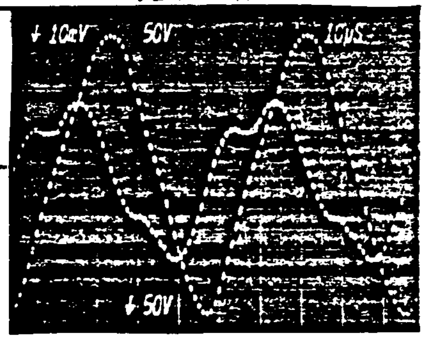
I_{K1}
10A/div
0/0
V_{K1}



Resonant Tank Voltage
Resonant Tank Current

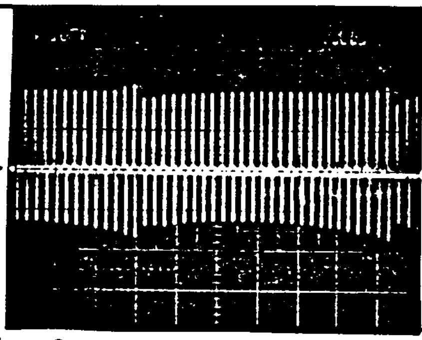
INVERTER #2

I_{K2}
10A/div.
0/0
V_{K2}



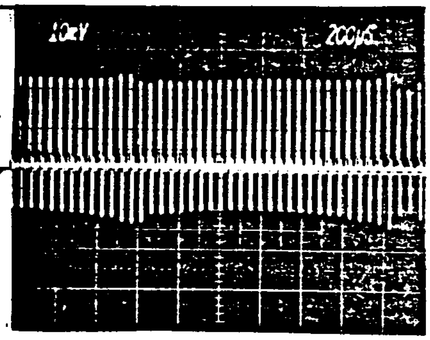
Resonant Tank Voltage
Resonant Tank Current

I_A
10A/div
0A



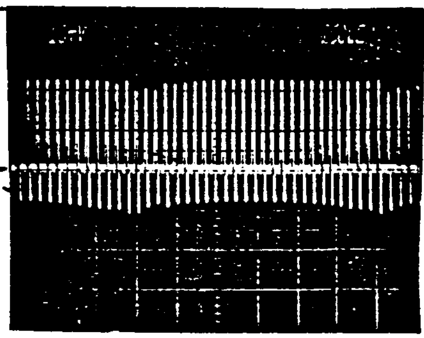
Branch Current A

I_C
10A/div.
0A



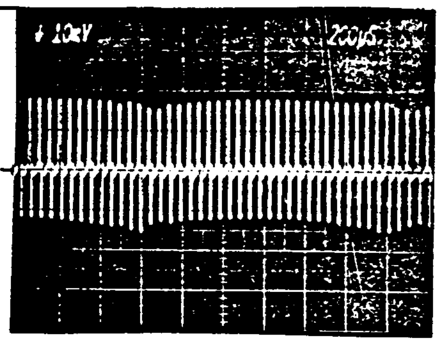
Branch Current C

I_B
10A/div.
0A



Branch Current B

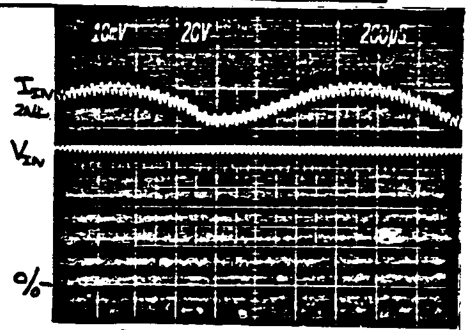
I_D
10A/div
0A



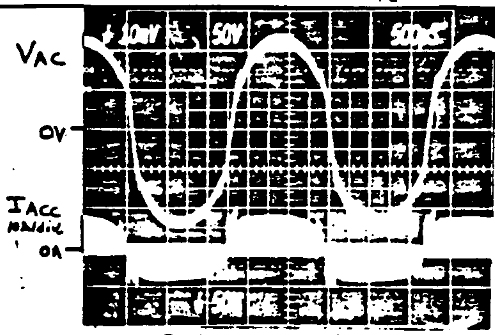
Branch Current D

2.3.4 CONTROL SIGNAL FREQUENCY RESPONSE
-3.2.4.3 $\boxed{V_{Ref.}: 400Hz}$ OF AC RECEIVER

$V_{IN} = 90V$
$R_{Load_{AC}} = 33.3\Omega$



Input Voltage
Input Current



Output Voltage
Output Current
(Including Filter Current)
AC Receiver

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CONTROL SIGNAL FREQUENCY RESPONSE
OF AC RECEIVER

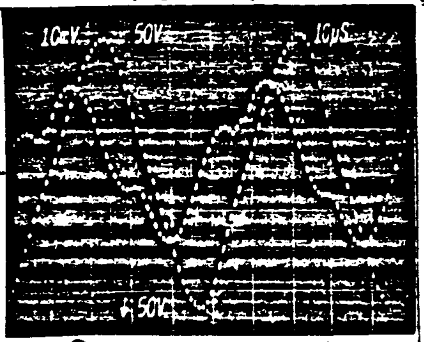
2.3.4
-3.2.4.3

$\boxed{V_{Ref.}: 2kHz}$

$V_{IN} = 90V$
$R_{Load} = 35.3\Omega$

INVERTER #1

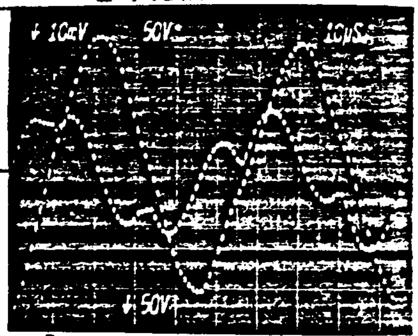
I_{K1}
mA/div.
0/0
V_{K1}



Resonant Tank Voltage
Resonant Tank Current

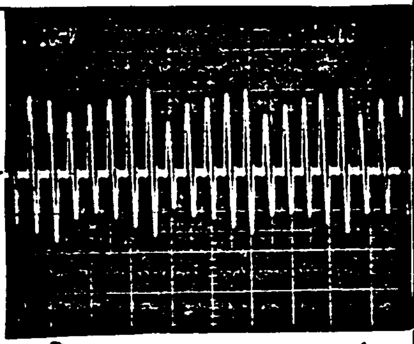
INVERTER #2

I_{K2}
mA/div.
0/0
V_{K2}



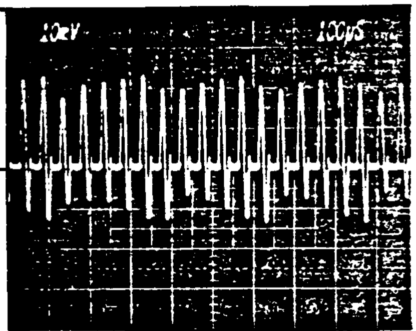
Resonant Tank Voltage
Resonant Tank Current

I_A
10A/div.
0A



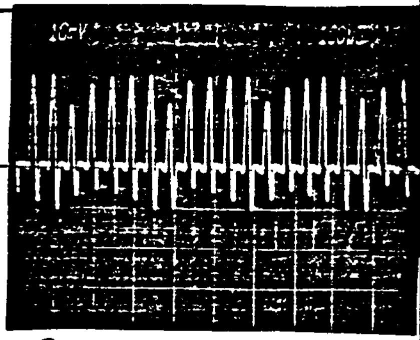
Branch Current A

I_C
mA/div.
0A



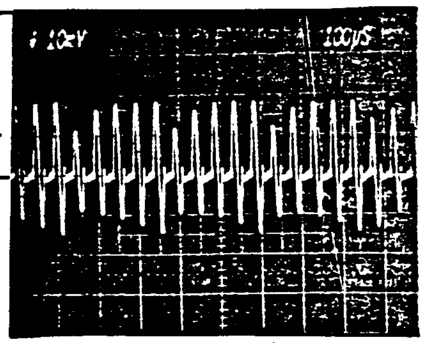
Branch Current C

I_B
10A/div.
0A

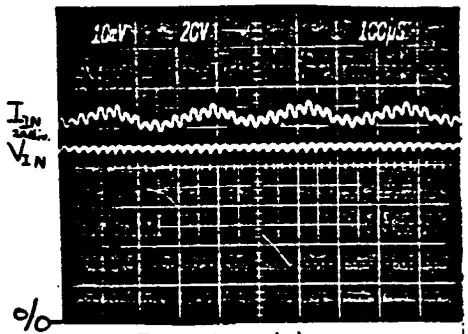


Branch Current B

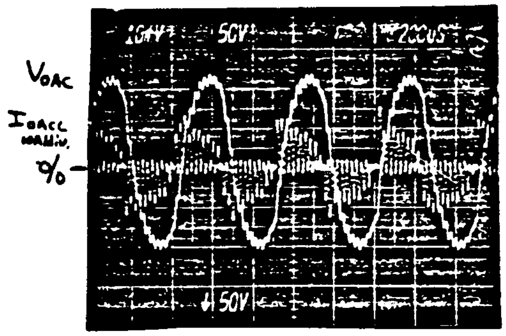
I_D
10A/div.
0A



Branch Current D



Input Voltage
Input Current



Output Voltage
Output Current
(Including Filter Current)
AC Receiver

2.3.4 -3.2.43 CONTROL SIGNAL FREQUENCY RESPONSE OF AC RECEIVER

$\boxed{V_{Ref.} : 2kHz}$

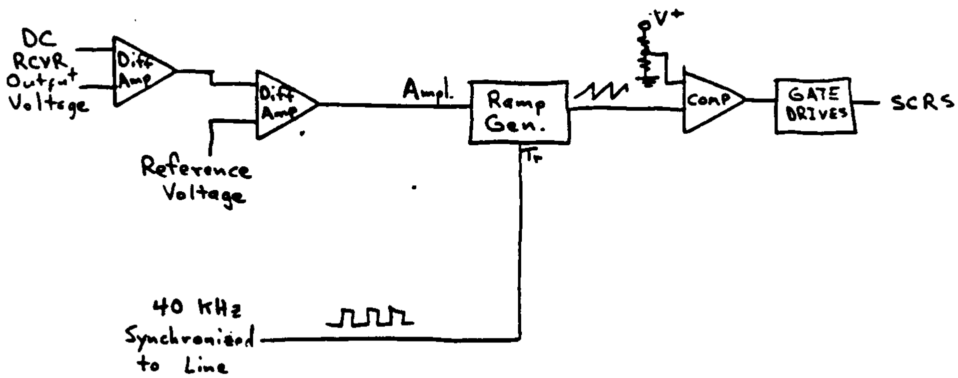
$V_{IN} = 90V$
$R_{Load_{AC}} = 35.3\Omega$

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6- 3.2.4.1 Steady-State Control Signal Gain — DC RCVR

Test Circuits



Block diagram of the DC Receiver control electronics.

This testing was done by varying the reference voltage ±50% from the nominal 3.600 Volts.

2.3.6-3.2.4.1 STEADY-STATE

CONTROL SIGNAL GAIN

SPECIFIC CASE DC RCVR

Full Load, Constant Load Resistance

Nominal Gate Signal

$V_{Ref.}$	3.600 Vdc
V_{IN}	119.9
I_{IN}	54.9 A
V_{OUT}	27.32
I_{OUT}	25.0

-50%

$V_{Ref.}$	1.820
V_{IN}	120.4V
I_{IN}	52.07
V_{OUT}	13.91
I_{OUT}	12.9A

$V_{Ref.}$	2.656V
V_{IN}	120.4V
I_{IN}	52.50
V_{OUT}	20.88V
I_{OUT}	19A

+50%

V_{Ref}	4.515
V_{IN}	120.5
I_{IN}	55.21
V_{OUT}	28.48
I_{OUT}	27.00

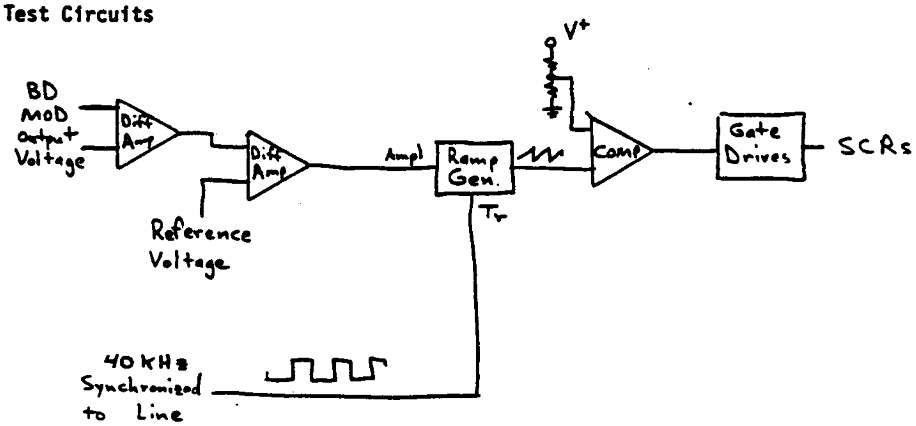
V_{Ref}	5.408V
V_{IN}	120.1
I_{IN}	54.96
V_{OUT}	28.64
I_{OUT}	26.5A

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6-3.2.4.1 STEADY-STATE CONTROL SIGNAL GAIN - Bidirectional Module

Test Circuits



Block diagram of the Bidirectional Module control electronics.

This testing was done by varying the reference voltage ±50% from the nominal 3.62 Volts.

2.3.6 - 3.2.4.1 STEADY - STATE

CONTROL SIGNAL GAIN

SPECIF... CASE BD MODULE

Nominal Gate Signal

$V_{Ref.}$	3.619
V_{IN}	120
I_{IN}	
V_{OUT}	100.23
I_{OUT}	8.1

-50%

V_{Ref}	1.58
V_{IN}	120
I_{IN}	
V_{OUT}	45.2
I_{OUT}	5.4

+50%

V_{Ref}	4.75
V_{IN}	120
I_{IN}	
V_{OUT}	117.2
I_{OUT}	9.0

V_{Ref}	2.118	1.8
V_{IN}	120.4	120.1
I_{IN}	44.03	41.9
V_{OUT}	60.14	51.5
I_{OUT}	6.3	5.8

V_{REF}	4.938	5.4
V_{IN}	118.6	119.4
I_{IN}	50.57	50.94
V_{OUT}	123.75	117.2
I_{OUT}	9.5	9.2

2.3.6 - 3.2.4.1 STEADY - STATE

CONTROL SIGNAL GAIN

SPECIFIC CASE AC RCVR

f = 20.215 kHz

Nominal Gate Signal

$\boxed{60Hz}$

$V_{Ref.}$	1.387 V
V_{IN}	120.64
I_{IN}	53.78 A
V_{OUT}	120.6 V
I_{OUT}	2.83 A

-50%

V_{Ref}	.692 V
V_{IN}	120.2
I_{IN}	52.69
V_{OUT}	91.9 V
I_{OUT}	2.33 A

+50%

V_{Ref}	2.07 V
V_{IN}	119.8
I_{IN}	54.54
V_{OUT}	135.8
I_{OUT}	2.97 A

2.3.6- 3.2.4.1 STEADY - STATE

CONTROL SIGNAL GAIN

SPECIFIC CASE AC RCVR

f = 20.188 kHz

Nominal Gate Signal

$V_{Ref.}$ 1.358 V

V_{IN} 119.9 V

I_{IN} 53.49 A

V_{OUT} 117.8 V

I_{OUT} 2.83 A

400 Hz

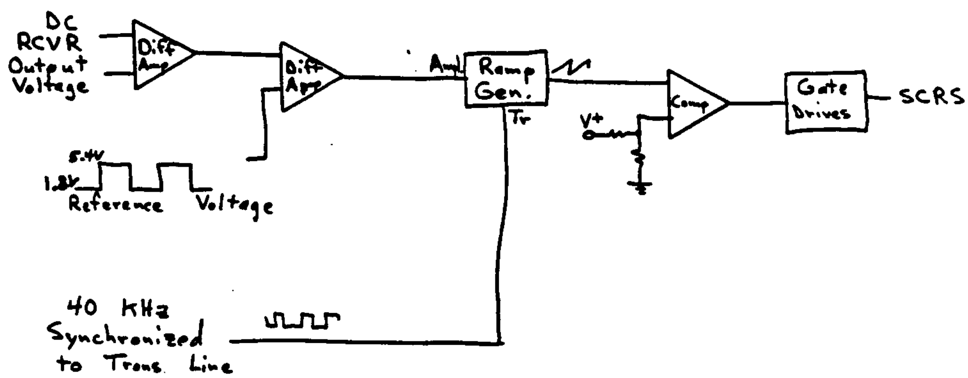
-50%		+50%	
V_{Ref}	.676 V	V_{Ref}	2.03
V_{IN}	120.0 V	V_{IN}	119.7 V
I_{IN}	52.58 A	I_{IN}	54.21 A
V_{OUT}	91.3 V	V_{OUT}	132.4 V
I_{OUT}	2.47 A	I_{OUT}	4.3 A

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6 - 3.2.4.2 CONTROL SIGNAL STEP RESPONSE - DC RCVR

Test Circuits



Block Diagram of the DC Receiver Control Electronics. This Testing was Done Using a Square Wave as the Output Reference Signal. The Square Wave was Centered about 3.6V and Varied Between 1.8V and 5.4V.

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.4.2 Control Sig. Step Response

Specific Case: DC Receiver

Input Voltage: 120.4 Vdc

Input Current: ~43 A

System Frequency: 20.222 kHz

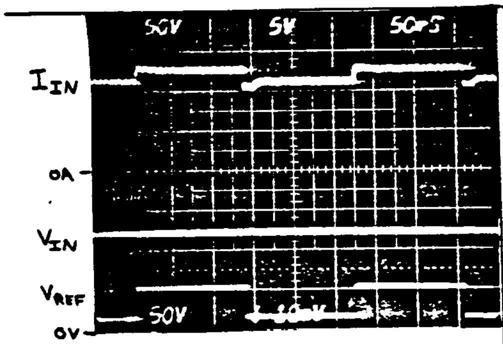
Output Power: 3410W ↔ 4160W

DC Rcvr: 14V ↔ 29V, 240W ⟷ 990

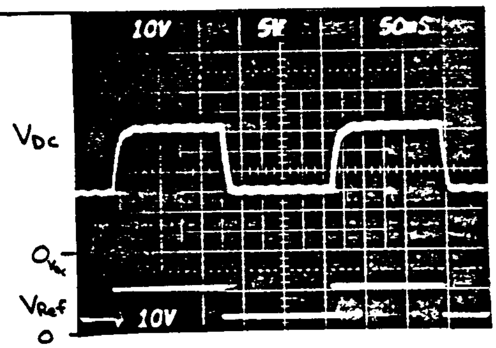
AC Rcvr: 120V, 410W

BD Module: 99.8V, 780W

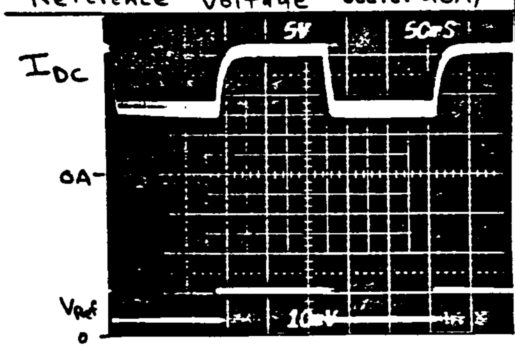
Other: ϕ_a = 1230W, ϕ_b = 750W, ϕ_c = 0W



Input V & I, Reference Voltage Scale: 20A/



Reference Voltage & DC RCVR Output Volt Scale:



DC RCVR Output Current & Reference Voltage Scale: 10A/

Photo

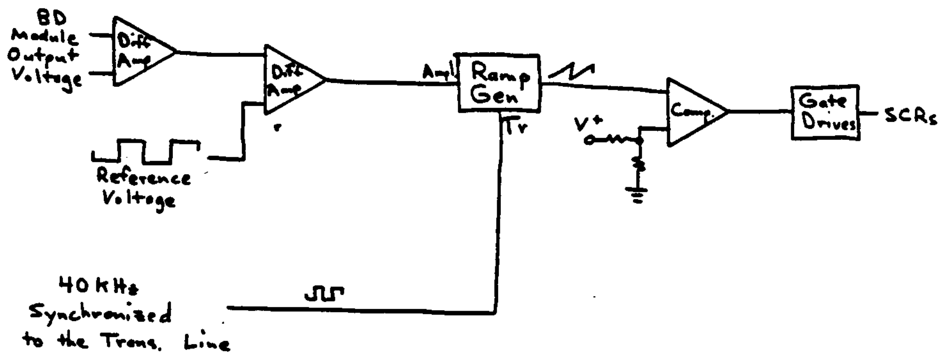
Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6-3.2.4.2 CONTROL SIGNAL STEP RESPONSE — BD MODULE

Test Circuits



Block diagram of the ac to dc control electronics of the bidirectional module. This testing was done using a square wave as the output reference signal. The square wave was centered about 3.6V and switched between 1.8V and 5.4V.

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.4.2 CTRL. SIGNAL STEP RESP.

Specific Case: Bidirectional Module

Input Voltage: 120.0 V

DC Rcvr: 27.6 V, 830 W

Input Current: 41.9 A ⟷ 50.94 A

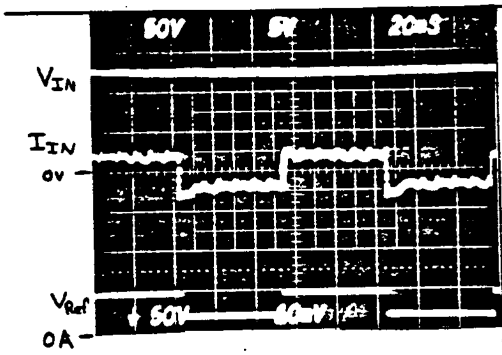
AC Rcvr: 120 Vrms, 400 W

System Frequency: 20.16 kHz

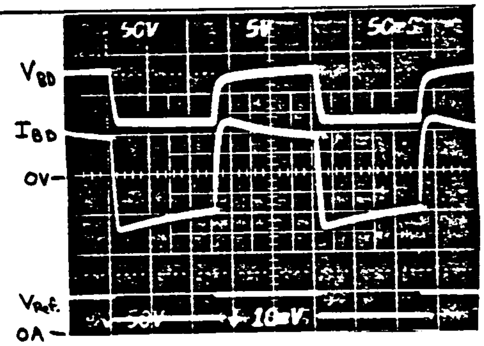
BD Module: 51.5 V ⟷ 117.2

Output Power: 4500 ⟷ 5300 W

Other: ϕ_1 = 1230 W, ϕ_2 = 750 W, ϕ_3 = 1000 W



Reference Voltage
Input V & I   Scale: 10A/



Reference Voltage
Input V & I   Scale: 2A/

Photo

Scale:

Photo

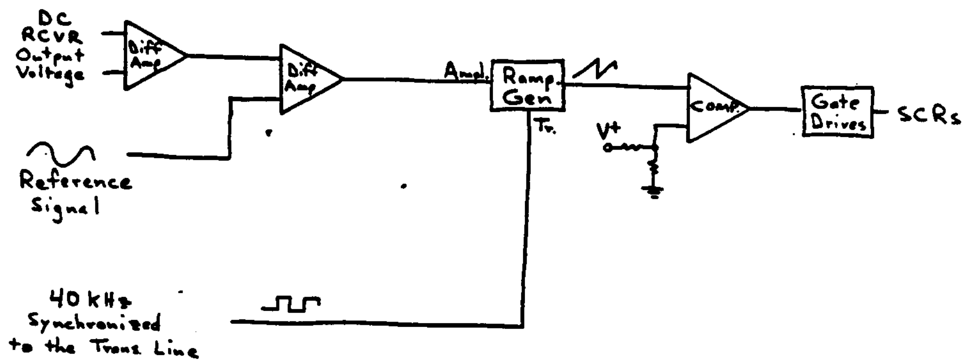
Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6-3.2.4.3 CONTROL SIGNAL FREQUENCY RESPONSE - DC RCVR

Test Circuits



Block diagram of the DC receiver module control electronics. This testing was done using a dc offset sine wave as the reference signal and varying the frequency of this sine wave.

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

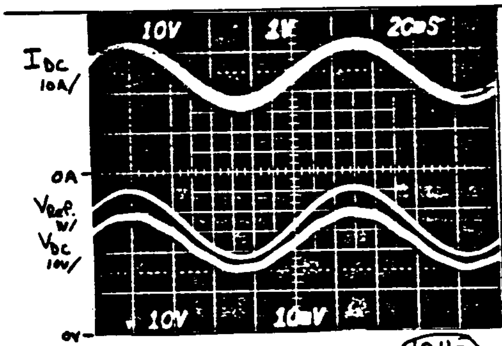
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.4.3 CTRL. SIG. FREQ. RESP.

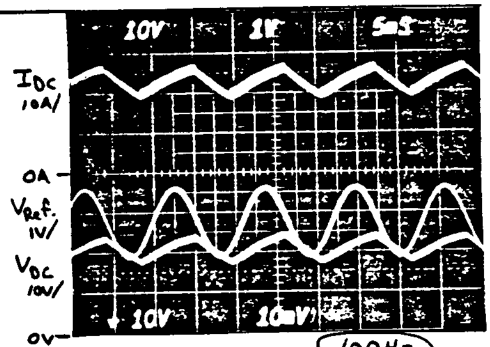
Specific Case: DC RECEIVER

Input Voltage:	120.0 V	DC Rcvr:	830W
Input Current:	54.1 A	AC Rcvr:	120V, 400W
System Frequency:	20.16	BD Module:	99.8V, 780W
Output Power:	5000W	Other:	ϕ_a = 1230W, ϕ_b = 750W, ϕ_c = 1010W



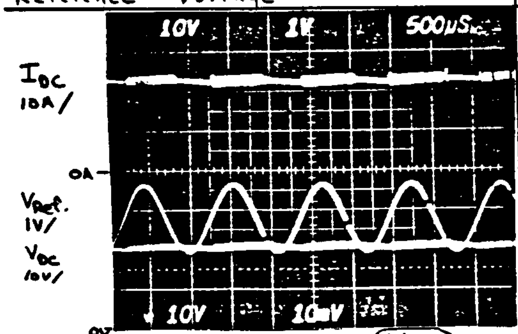
10Hz

DC RCVR Output Voltage & Current and Reference Voltage Scale:



100Hz

DC RCVR Output Voltage & Current and Reference Voltage Scale:



1KHz

DC RCVR Output Voltage & Current and Reference Voltage Scale:

Photo

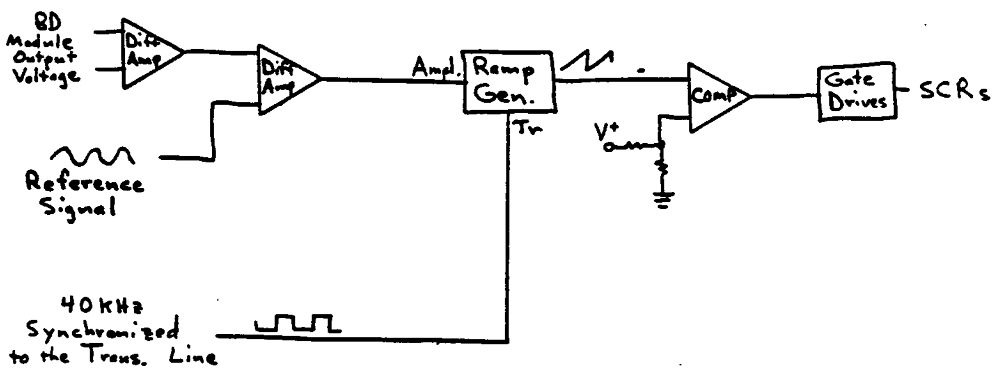
Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6 – 3.2.4.3 CONTROL SIGNAL FREQUENCY RESPONSE - BD MODULE

Test Circuits



Block diagram of the bidirectional module control electronics. This testing was done using a dc offset sine wave as the reference signal and varying the frequency of this sine wave.

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.4.3 CTRL. SIG. FREQ. RESP.

Specific Case: Bidirectional Module

Input Voltage: 120.0 V DC Rcvr: 27.6 V/830 W

Input Current: 54.1 A AC Rcvr: 120V / 400W

System Frequency: 20.16 kHz BD Module: 780W

Output Power: 5000W Other: ϕ_a = 1230W, ϕ_b = 750W, ϕ_c = 1010W

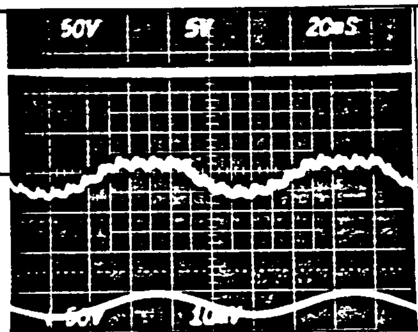
V_{IN} 50V/

0V

I_{IN} 10A/

V_{Ref} 5V/

0A



10Hz

Input Voltage + Current
Reference Voltage Scale:

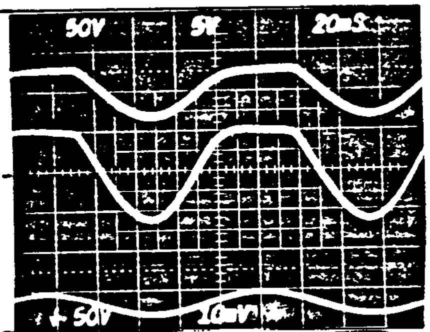
V_{BD} 50V/

I_{BD} 2A/

0V

$V_{Ref.}$ 5V/

0A



10Hz

Bidirectional Module
Output Voltage + Current
Reference Voltage Scale:

Photo

Scale:

Photo

Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.4.3 CTRL. SIG. FREQ. RESPONSE

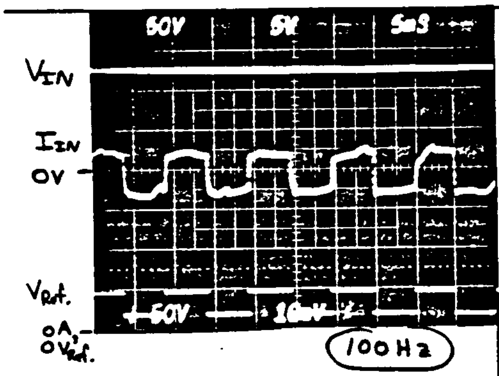
Specific Case: Bidirectional Module

Input Voltage: Same DC Rcvr: ____

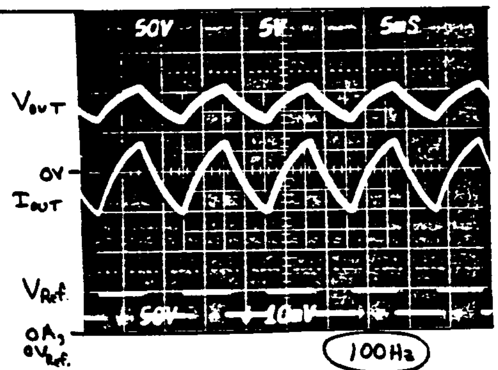
Input Current: ____ AC Rcvr: ____

System Frequency: ____ BD Module: ____

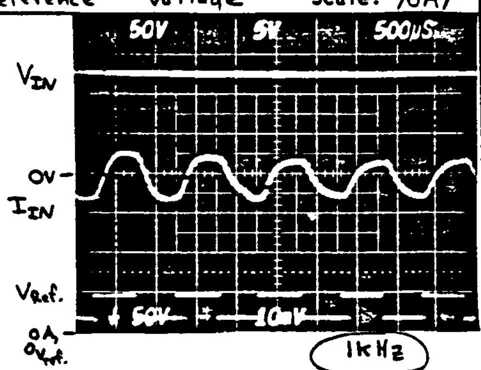
Output Power: ____ Other: ____



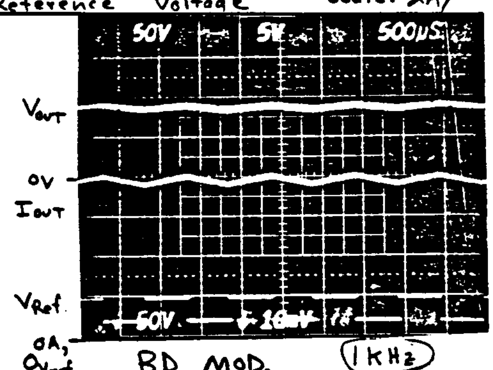
Input Voltage & Current
Reference Voltage Scale: 10A/



Bidirectional Mod.
Output Voltage & Current
Reference Voltage Scale: 2A/



Input Voltage & Current
Reference Voltage Scale: 10A/



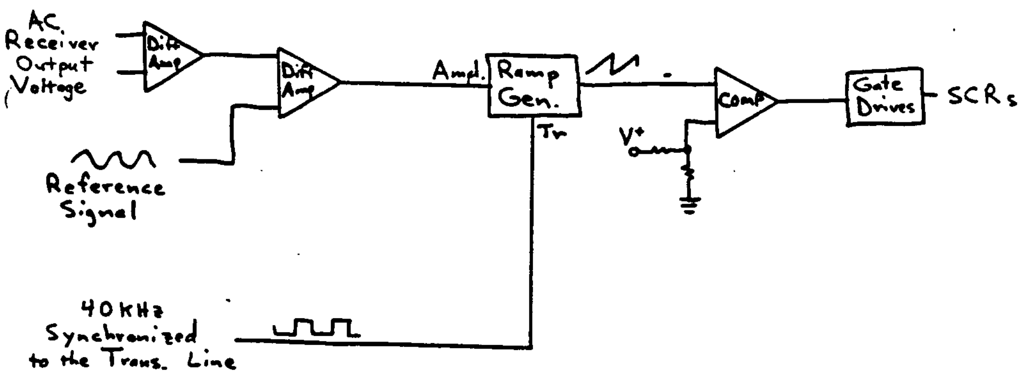
Output Voltage & Current
Reference Voltage Scale: 2A/

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6-3.2.4.3 CONTROL SIGNAL FREQUENCY RESPONSE — AC RECEIVER

Test Circuits



RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.4.3 CTRL. SIG. FREQ. RESP.

Specific Case: AC Receiver

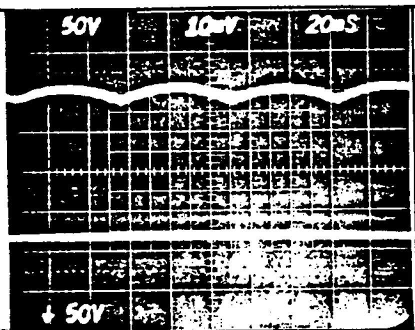
Input Voltage: 120 V DC Rcvr: 27.6V / 830 W

Input Current: 54.1 A AC Rcvr: 120V / 400 W

System Frequency: 20.16 kHz BD Module: 99.8 / 780W

Output Power: 5000 W Other: ϕ_a=1230W, ϕ_b=750W, ϕ_c= 1010W

I_{IN}



V_{IN}

0

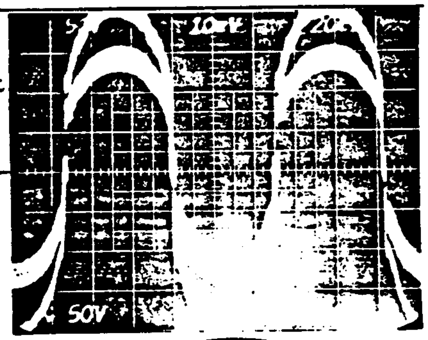
10Hz

Input Voltage & Current Scale: 10A/

V_{AC}

I_{AC}

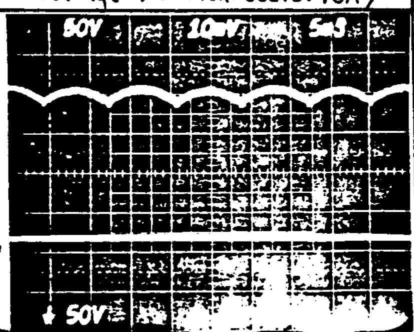
0



AC RCVR 10 Hz

Output Voltage & Current Scale: 1A/

I_{IN}



V_{IN}

0

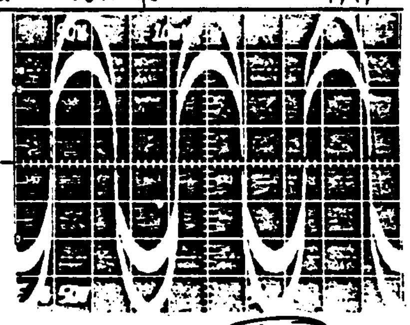
60Hz

Input Voltage & Current Scale: 10A/

V_{AC}

I_{AC}

0



AC RCVR 60Hz

Output Voltage & Current Scale: 1A/ 5mS/

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.4.3 CTRL. SIG. FREQ RESP.

Specific Case: AC Receiver

Input Voltage: Same

DC Rcvr:

Input Current:

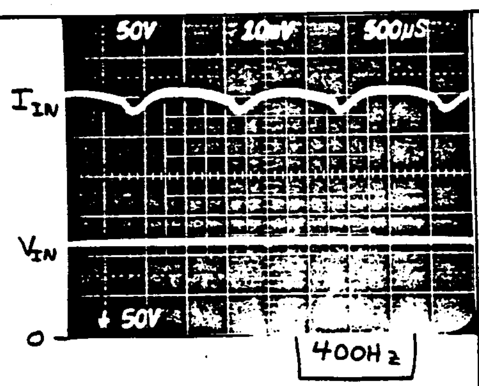
AC Rcvr:

System Frequency:

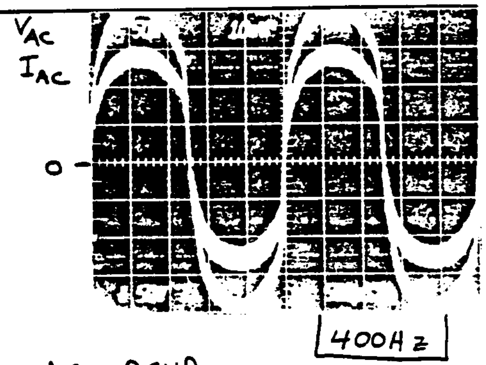
BD Module:

Output Power:

Other:

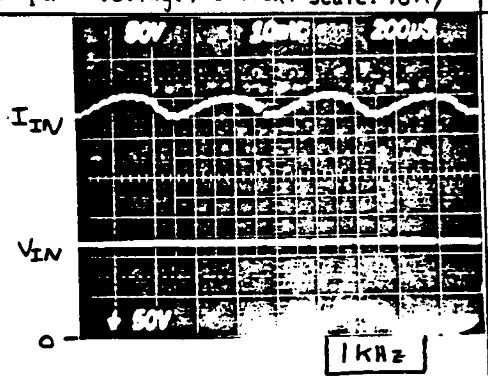


Input Voltage+Current Scale: 10A/

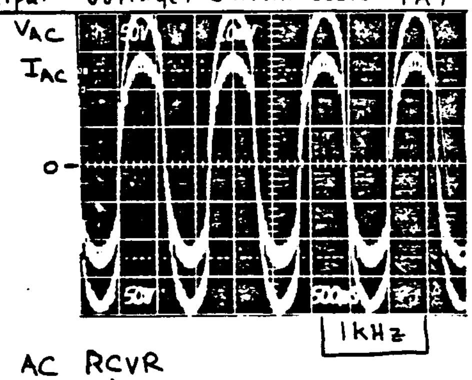


AC RCVR

Output Voltage+Current Scale: 1A/



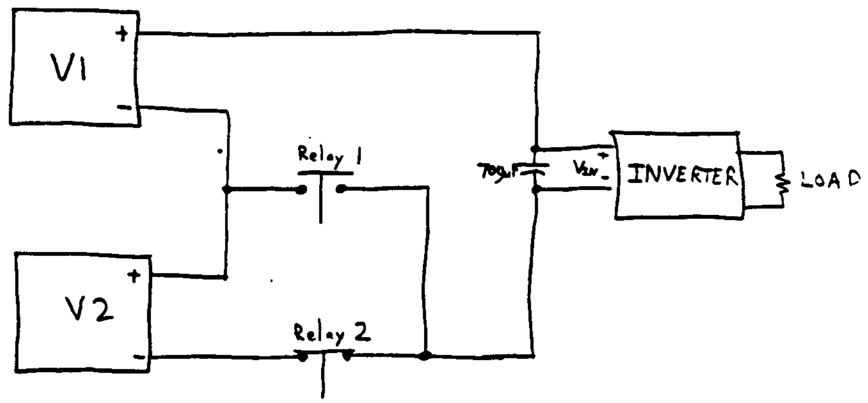
Input Voltage+Current Scale: 10A/

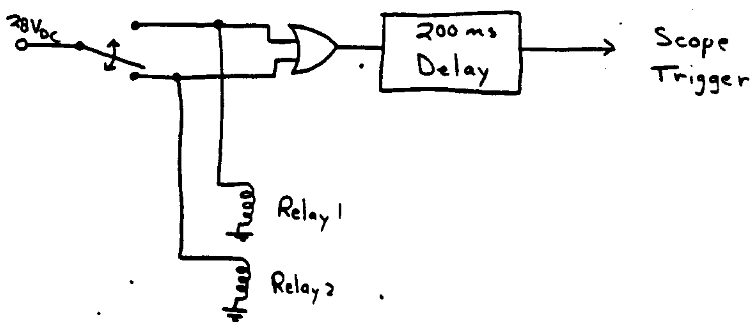


AC RCVR

Output Voltage+Current Scale: 1A/

2.3.1 -3.2.5 POWER SUPPLY SENSITIVITY





2.3.1
-3.2.5.1

STEADY-STATE POWER SUPPLY SENSITIVITY

V_{IN} (VDC)		I_{IN} (ADC)	V_{K1} (VRMS)	I_{OUT} (ARMS)	f (kHz)
69.6	-20%	10.20	93.0	6.9	20.0
87.0	-	12.76	117.0	8.6	20.0
104.4	+20%	15.24	140.6	10.2	20.0

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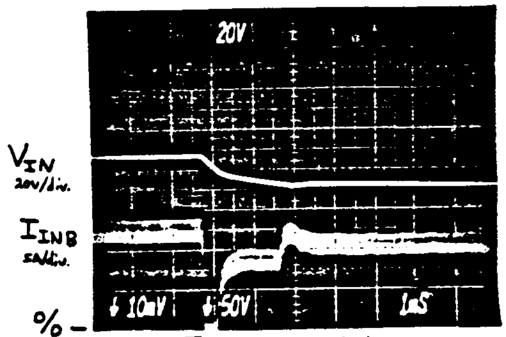
23.1
-3.2.5.2

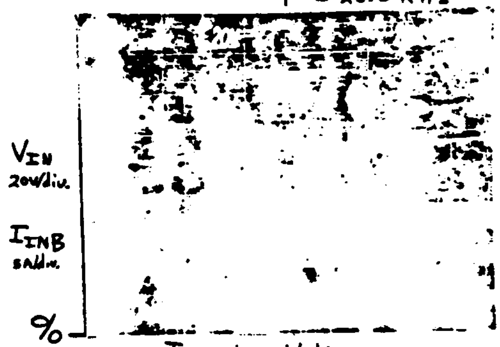
POWER SUPPLY STEP RESPONSE

P=1010W
R_{Load} = 13.6 Ω
f = 20.0 kHz



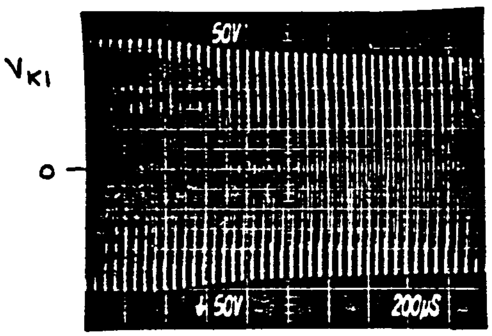
Input Voltage
Input Current

V_{IN}: 87.0 V → 69.6 V



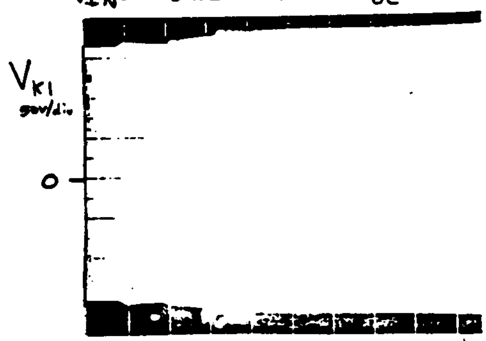
Input Voltage
Input Current

V_{IN}: 87.0 → 104.4 V_{DC}



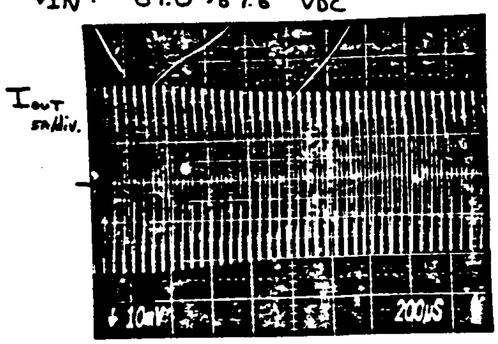
Output Voltage

V_{IN}: 87.0 → 69.6 V_{DC}



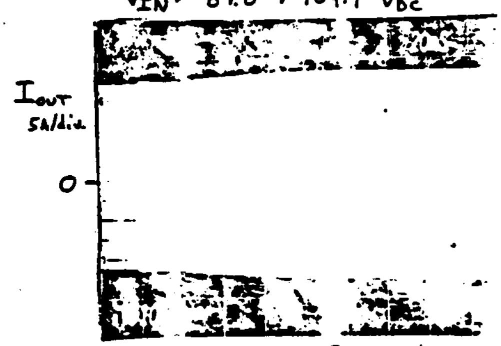
Output Voltage 20ms/d

V_{IN}: 87.0 → 104.4 V_{DC}



Output Current

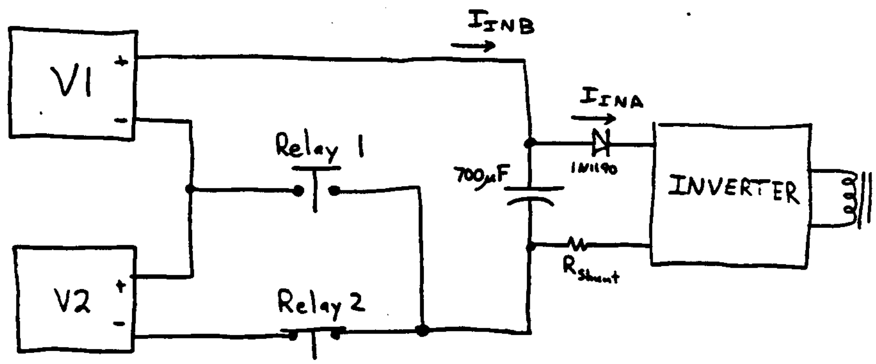
V_{IN}: 87.0 → 69.6 V_{DC}

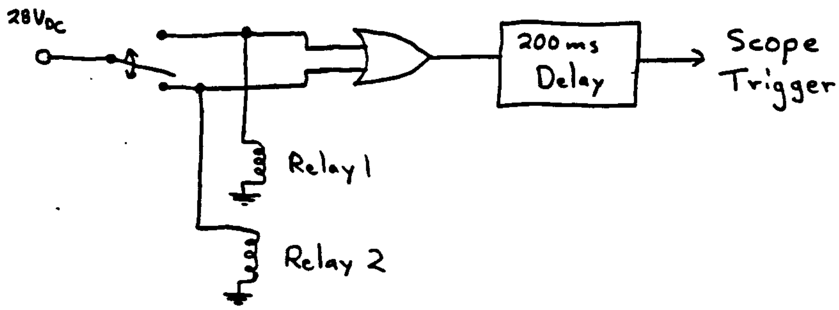


Output Current

V_{IN}: 87.0 → 104.4 V_{DC}

2.3.2
-3.2.5 POWER SUPPLY SENSITIVITY



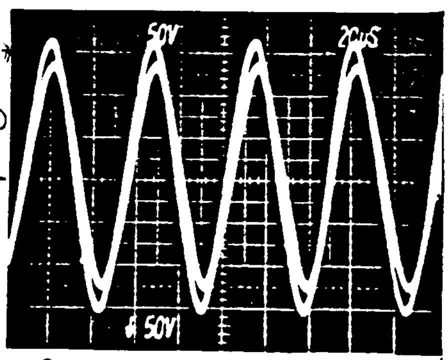


2.3.2
-3.2.5.1

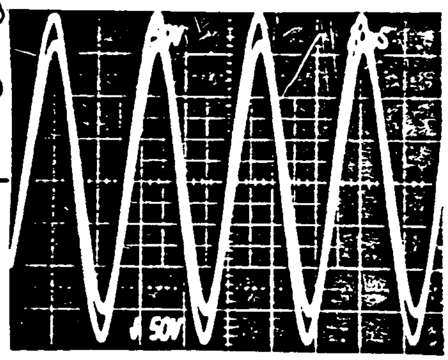
STEADY-STATE
POWER SUPPLY SENSITIVITY

$R_{LOAD} = 1.6\,\Omega$

	-20%		+20%	
V_{IN}	72.0 V_{DC}	87.0 V_{DC}	104.4 V_{DC}	Fluke 8000A
I_{IN}	6.33 A_{DC}	7.60 A_{DC}	7.84 A_{DC}	Fluke 8000A
V_{DC}	21.5 V_{DC}	26.3 V_{DC}	28.9 V_{DC}	Fluke 893A
I_{DC}	13.4 A_{DC}	16.4 A_{DC}	17.8 A_{DC}	SRI #900083
f	20.725 kHz	20.726 kHz	20.726 kHz	HP 5315B
η	63.2%	65.2%	62.8%	



Resonant Tank Voltage
at V_{IN}= 72.0V_{DC} & V_{IN}= 87.0V_{DC}

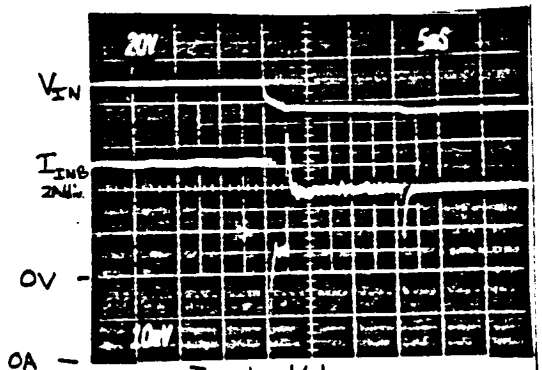


Resonant Tank Voltage
at V_{IN}= 87.0 V_{DC} & V_{IN}= 104.4V_{DC}

2.3.2
-3.2.5.2

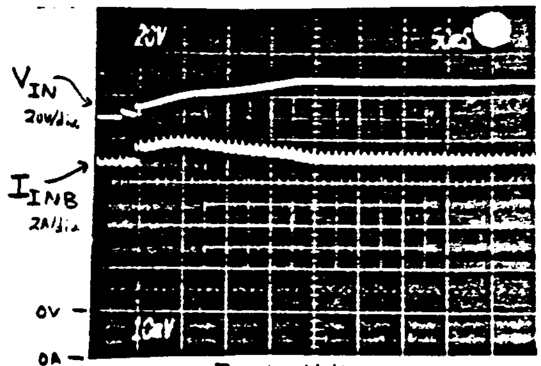
POWER SUPPLY STEP RESPONSE

$R_{LOAD} = 1.6\Omega$



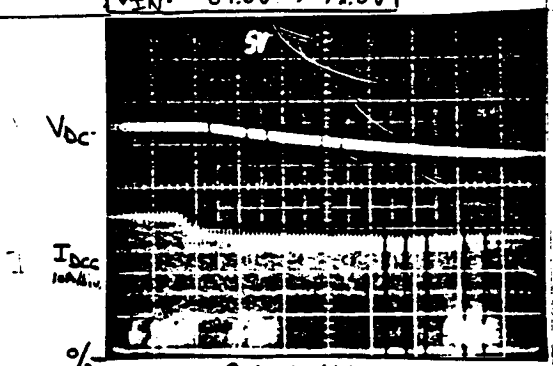
Input Voltage
Input Current
(Before DC Capacitor)

V_{IN}: 87.0V → 72.0V



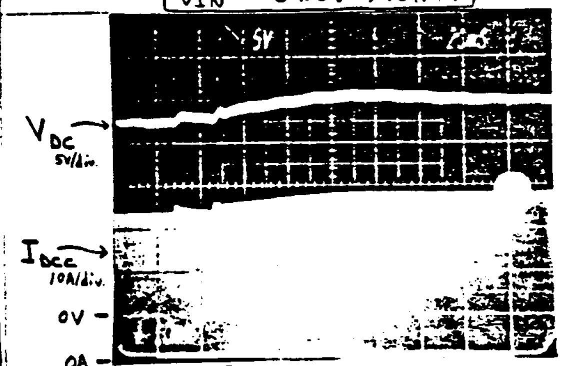
Input Voltage
Input Current
(Before DC Capacitor)

V_{IN}: 87.0V → 104.4V



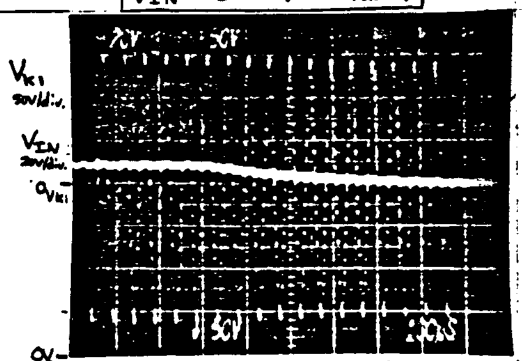
Output Voltage
Output Current
(Including Filter Current)

V_{IN}: 87.0 V → 72.0V



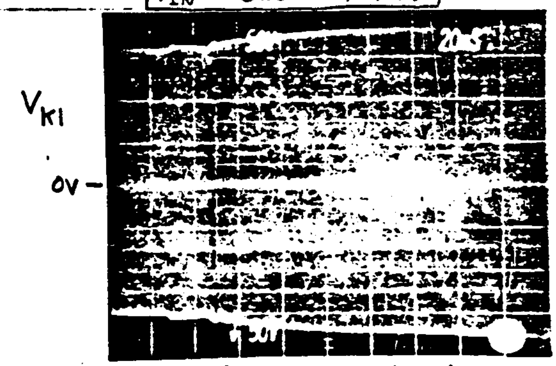
Output Voltage
Output Current
(Including Filter Current)

V_{IN}: 87.0V → 104.4V



Resonant Tank Voltage
Input Voltage

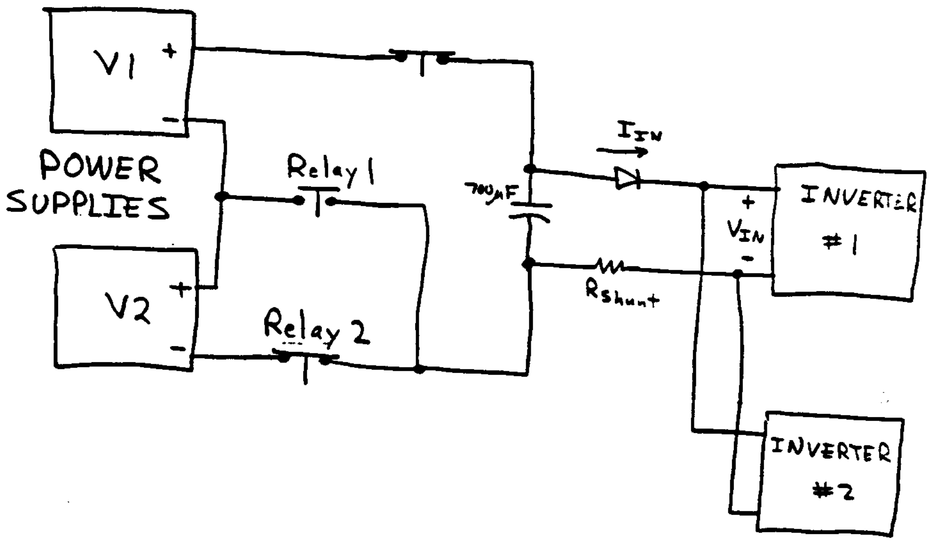
V_{IN} : 87.0 V → 72.0V

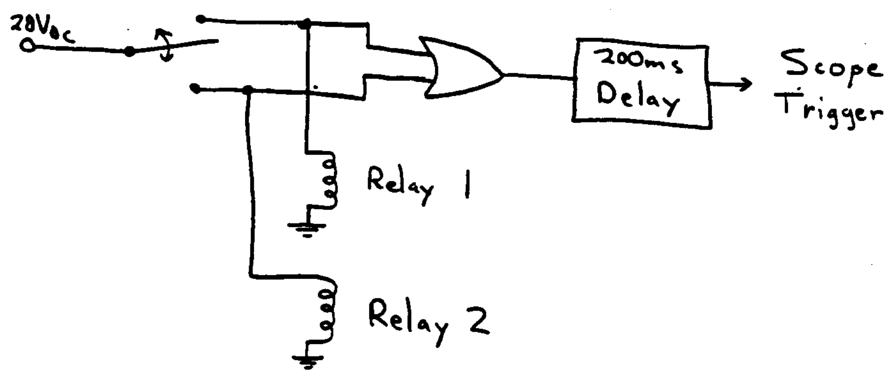


Resonant Tank Voltage

V_{IN}: 87.0V → 104.4V

2.3.4 -3.2.5 POWER SUPPLY SENSITIVITY





2.3.4
-3.2.5.1 STEADY-STATE

POWER SUPPLY SENSITIVITY

Measurement		Equipment
V_{IN}		Fluke 8000A Multimeter
I_{IN}	$= \frac{V_{shunt}}{R_{shunt}}$	Fluke 8000A Multimeter (V_{shunt})
V_{ODC}		Fluke 893A Diff. Voltmeter
I_{ODC}		SRI 900083 Current Meter
V_{OBD}		Triplett 630 Multimeter
I_{OBD}	$= \frac{V_{OBD}}{R_{LOAD}}$	L&N 5305 Bridge (R_{LOAD})
V_{OAC}		Tektronix 7834 Oscilloscope
I_{OAC}	$= \frac{V_{OAC}}{R_{LOAD}}$	L&N 5305 Bridge (R_{LOAD})
$P_{IN}, P_{ODC}, P_{OAC}, P_{OBD}$		Calculations from above measurements

2.3.4
-3.2.5.1

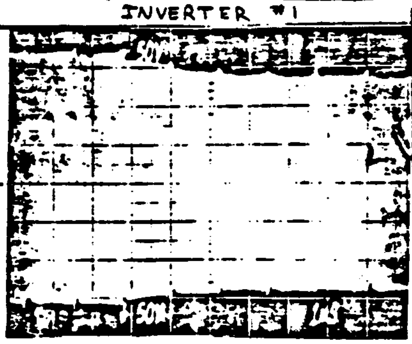
STEADY - STATE POWER SUPPLY SENSITIVITY

INPUT			DC RECEIVER			B.D. MODULE			AC RECEIVER		
$V_{IN}(V_{DC})$	$I_{IN}(A_{DC})$	$P_{IN}(W)$	$V_{ODC}(V_{DC})$	$I_{ODC}(A_{DC})$	$P_{ODC}(W)$	$V_{OBD}(V_{DC})$	$I_{OBD}(A_{DC})$	$P_{OBD}(W)$	$V_{OAC}(V_{RMS})$	$I_{OAC}(A_{RMS})$	$P_{OAC}(W)$
68.2	10.28	701	26.39	6.5	172	96	1.93	185	54.4	1.54	83.8
85.4	11.02	941	28.86	7.1	205	99	1.99	197	76	2.14	163
102.3	11.67	1190	28.95	7.1	206	100	2.01	201	96	2.72	261
			R_{Load} = 4.06Ω			R_{Load} = 49.7Ω			R_{Load} = 35.3Ω		

2.3.4 STEP RESPONSE

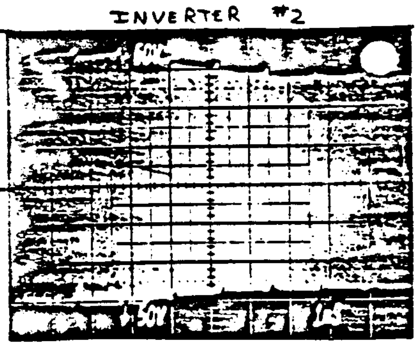
-3.2.5.2 $\boxed{V_{IN}: 85V \rightarrow 68V}$

INVERTER #1

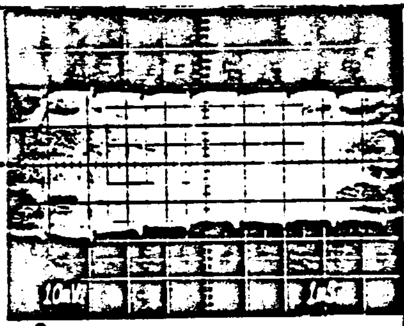


Resonant Tank Voltage

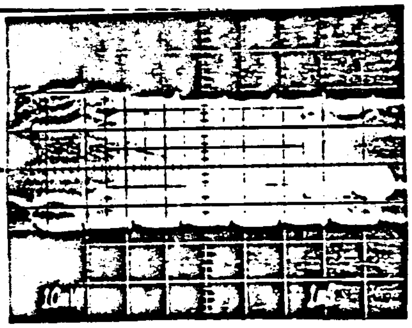
INVERTER #2



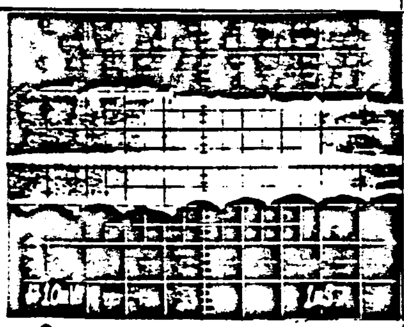
Resonant Tank Voltage



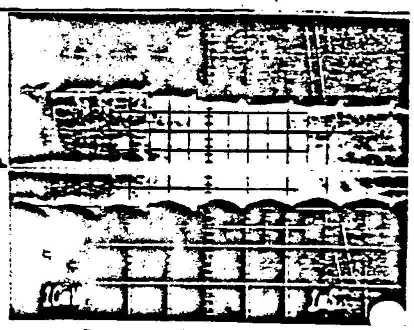
Resonant Tank Current



Resonant Tank Current



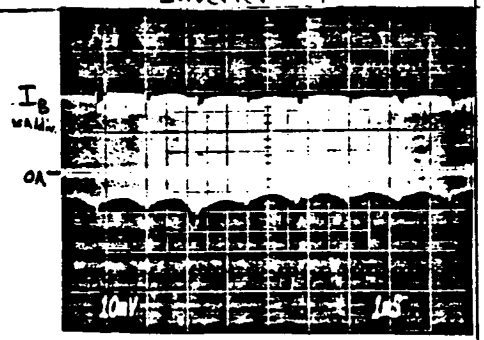
Branch Current A



Branch Current C

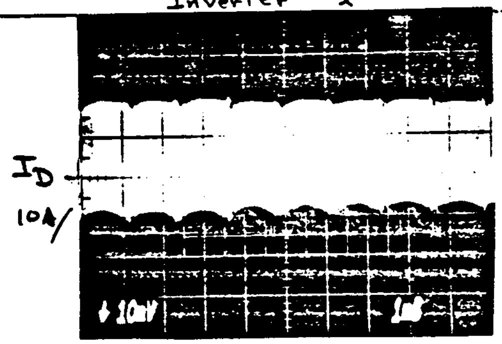
2.3.4 STEP RESPONSE
-3.2.5.2 $\boxed{V_{IN} : 85V \rightarrow 68V}$

Inverter #1

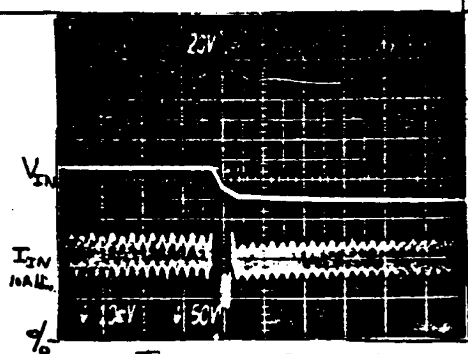


Branch Current B

Inverter #2



Branch Current D

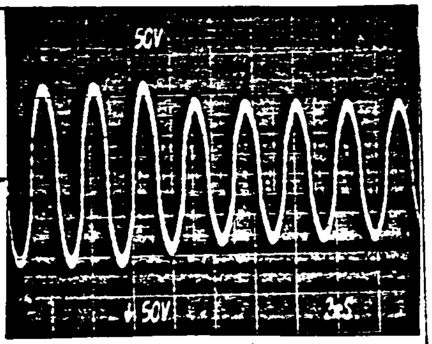


Input Current
Input Voltage

2.3.4 STEP RESPONSE
-3.2.5.2 $\boxed{V_{IN}: 85V \rightarrow 68V}$

V_{OAC}

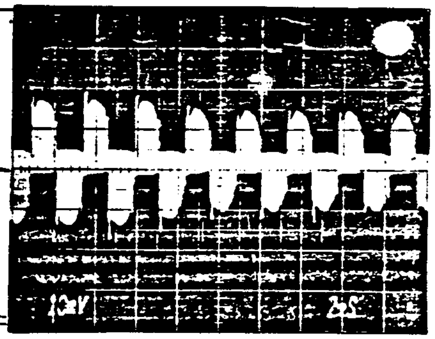
0V



Output Voltage
AC Receiver

I_{OACC}
5A/div.

0A

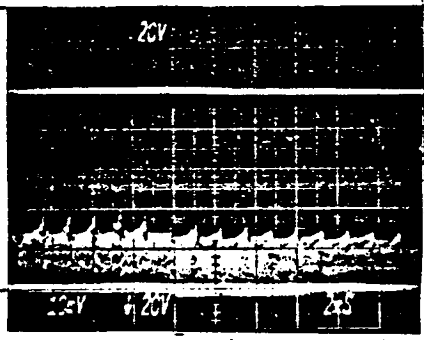


Output Current
(Including Filter Current)
AC Receiver

V_{OBD}

I_{OBDC}
5A/div.

0/0

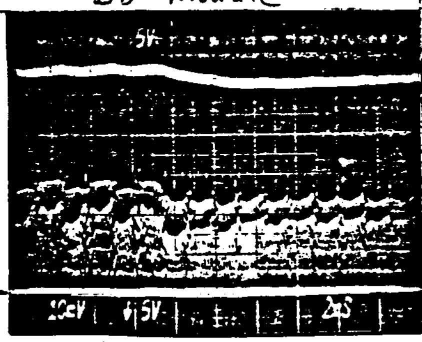


Output Voltage
Output Current
(Including Filter Current)
BD Module

V_{ODC}

I_{ODCC}
10A/div.

0/0



Output Voltage
Output Current
(Including Filter Current)
DC Receiver

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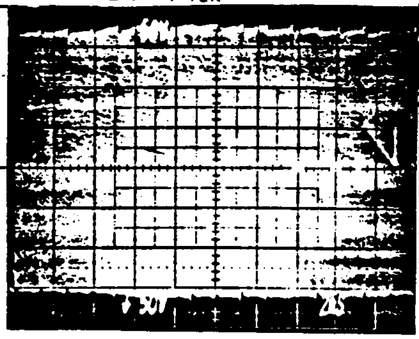
2.3.4 -3.2.5.2 STEP RESPONSE

V_{IN}: 85V → 102V

INVERTER #1

V_{K1}

0V

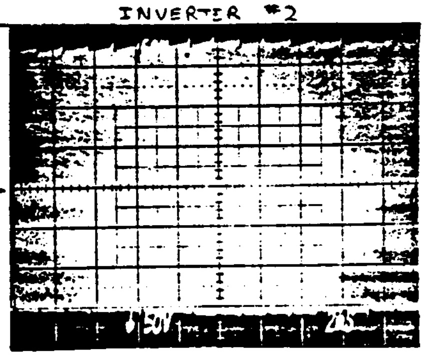


Resonant Tank Voltage

INVERTER #2

V_{K2}

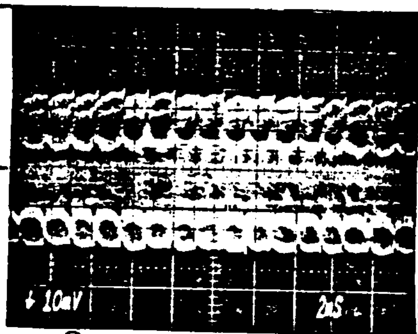
0V



Resonant Tank Voltage

I_{K1}
mA/div.

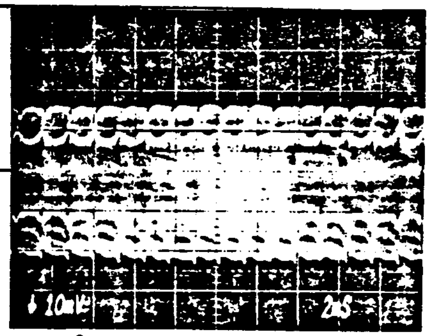
0A



Resonant Tank Current

I_{K2}
mA/div.

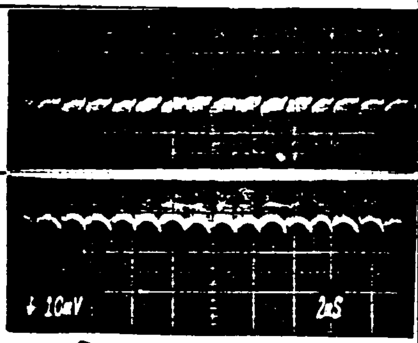
0A



Resonant Tank Current

I_A
mA/div.

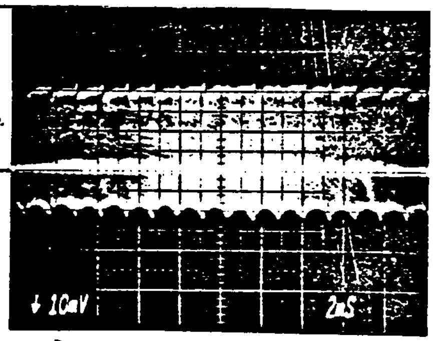
0A



Branch Current A

I_C
mA/div.

0A

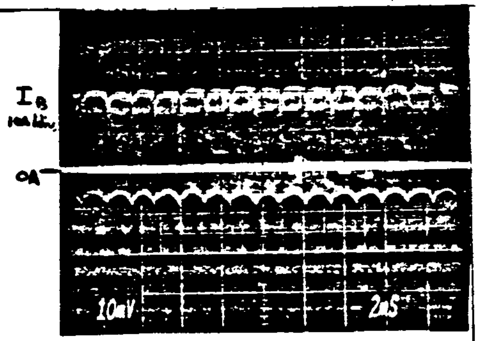


Branch Current C

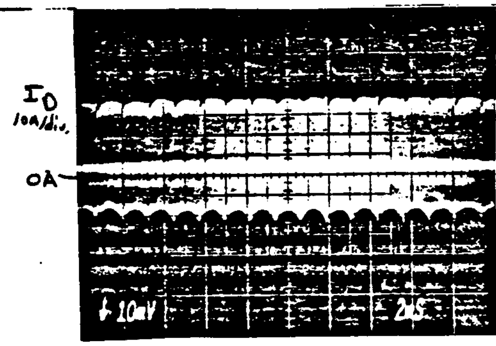
2.3.4
-3.2.5.2

STEP RESPONSE

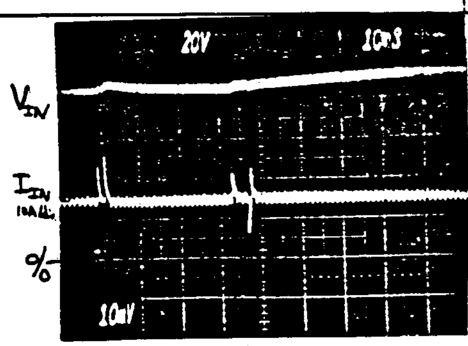
$\boxed{V_{IN} : 85V - 102V}$



Branch Current B
Inverter #1



Branch Current D
Inverter #2



Input Voltage
Input Current

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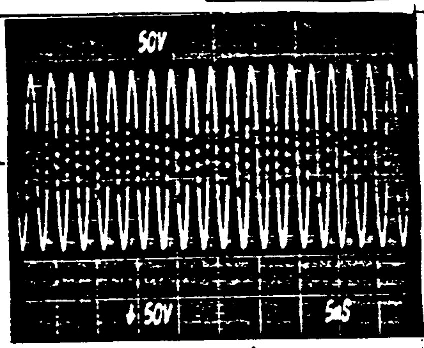
2.3.4 -3.2.5.2 STEP RESPONSE

$\boxed{V_{IN}: 85V \rightarrow 102V}$

V_{OAC}

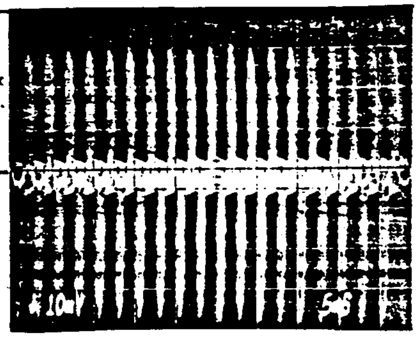
0V



Output Voltage
AC Receiver

I_{OAC}
2A/div.

0A

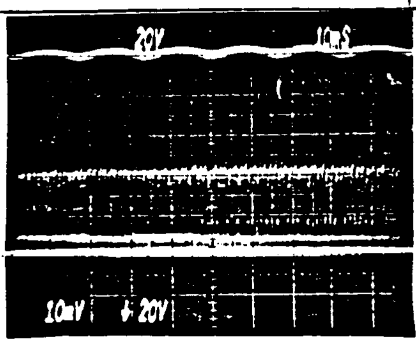


Output Current
(Including Filter Current)
AC Receiver

V_{OBD}

I_{OBDC}
5A/div.

0

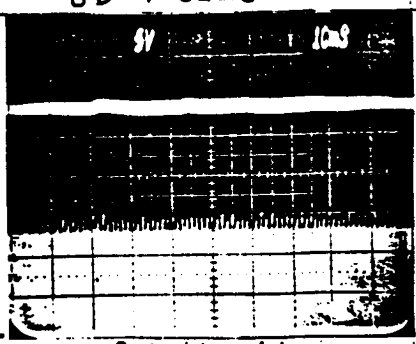


Output Voltage
Output Current
(Including Filter Current)
BD Module

V_{ODC}

I_{ODCC}
10A/

0



Output Voltage
Output Current
(Including Filter Current)
DC Receiver

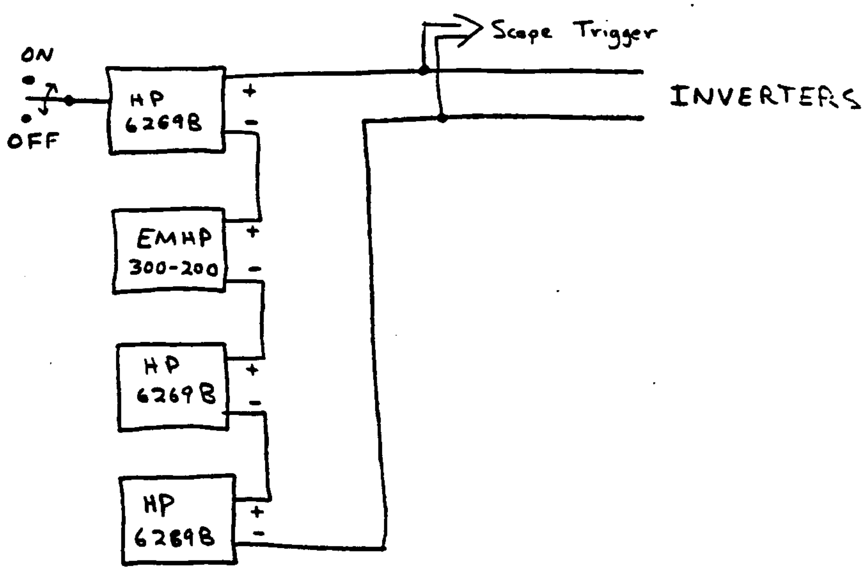
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6 - 3.2.5 POWER SUPPLY SENSITIVITY

Steady-State and Transient Response

Test Circuits



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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.5.1 S.S. POWER SUPPLY SENS.

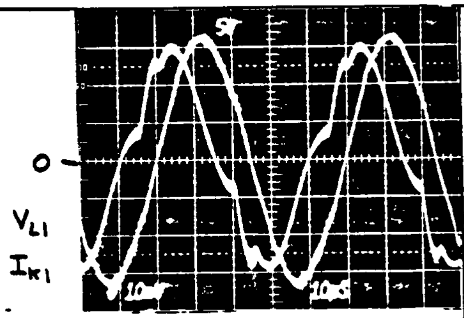
Specific Case: $80V_{IN}$, Full Load

Input Voltage: 80.0 Vdc | DC Rcvr: 17.3 Vdc / 310 W

Input Current: 40.8 Adc | AC Rcvr: 79.14 Vrms / 198 W

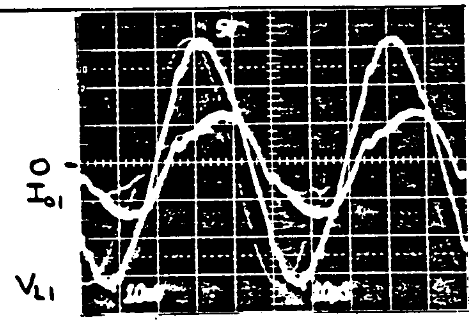
System Frequency: | BD Module: 71.0 Vdc / 453 W

Output Power: 2,451 W | Other: ϕ_a = 706 W; ϕ_b = 317 W; ϕ_c = 467 W



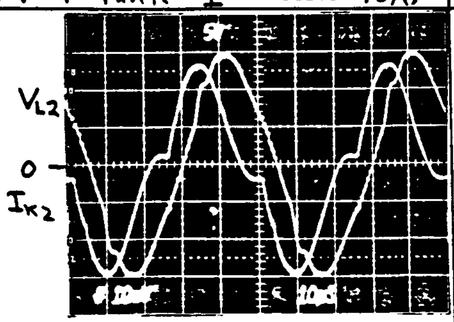
INV. 1 THD= 21.4 db on the line

Line V & Tank I Scale: 10A/



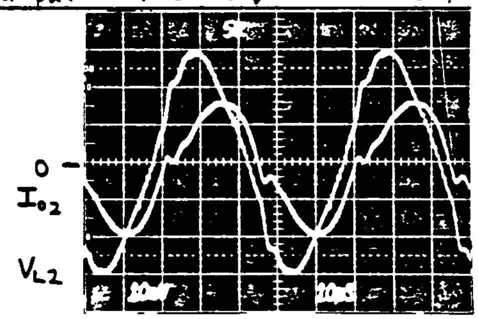
INV. 1

Output I & Line V Scale: 10A/



INV. 2 THD= 20.0 db on the line

Tank I & Line V Scale: 10A/



INV. 2

Line V & Output I Scale: 10A/

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.5.1 S.S. POWER SUPPLY SENS.

Specific Case: V_{IN} = 80 , Full Load

Input Voltage: Same

Input Current:

System Frequency:

Output Power:

DC Rcvr:

AC Rcvr:

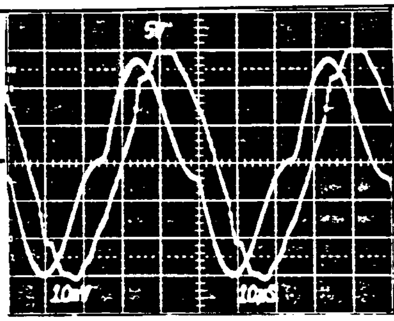
BD Module:

Other:

V_{L3}

0 -

I_{K3}



THD= 20.8db

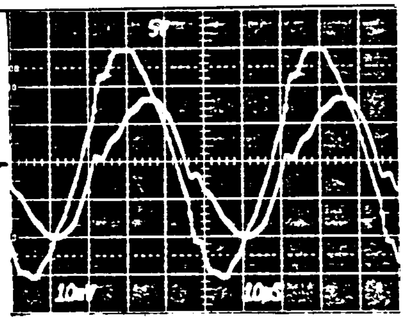
INV. 3 on the line

Line V. & Tank I Scale: 10A/

0 -

I_{O3}

V_{L3}



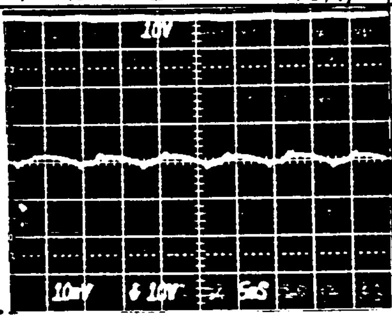
INV. 3

Line V & Output I Scale: 10A/

V_{IN}

I_{IN}

0 -



Input V+I Scale: 10A/

Photo

Scale:

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I) INPUT POWER

V_{IN} 80
I_{IN} 40.8
P_{IN} 3264

2.3.6-3.2.5.1 STEADY-STATE POWER SUPPLY SENSITIVITY

(1.5 μF, Full Load)

80V

II OUTPUT POWER

AC RCVR
V_{OUT} 79.14
I_{OUT} 2.50
P 198

DC RCVR
V_{OUT} 123
I_{OUT} 18.0
P 310

B/D RCVR
V_{OUT} 71.0
I_{OUT} 6.38
P 453

TOASTER LOADS

INV#1
V_{OUT} 52.5
I_{OUT} 13.45
P 706

INV#2
V_{OUT} 50.3
I_{OUT} 6.31
P 317

INV.#3
V_{OUT} 51.3
I_{OUT} 9.11
P 467

2451
75%

$$\frac{P_{OUT}}{P_{IN}} = \frac{2451}{3264} = 75.1\%$$

I) INPUT POWER

2.3.6-3.2.5.1 STEADY-STATE POWER SUPPLY SENSITIVITY

100 V

(1.5μF, Full Load)

V_{IN} 100

I_{IN} 50.8

P_{IN} 5080

II OUTPUT POWER

AC RCVR
V_{OUT} 105
I_{OUT} 2.88
P 302W

DC RCVR
V_{OUT} 22.2
I_{OUT} 23.5
P 522

B/D RCVR
V_{OUT} 94.0
I_{OUT} 7.46
P 701

TOASTER LOADS

INV#1
V_{OUT} 66.6
I_{OUT} 17.15
P 1142

INV#2
V_{OUT} 64.7
I_{OUT} 8.11
P 525

INV.#3
V_{OUT} 64.3
I_{OUT} 11.44
P 736

$$\frac{P_{OUT}}{P_{IN}} = \frac{3928}{5080} = 77.3\%$$

I) INPUT POWER

V_{IN} 120
I_{IN} • 57.3
P_{IN} 6876

2.3.6-3.2.5.1 STEADY-STATE POWER SUPPLY SENSITIVITY

(1.5μF, Full Load)

120V

T.H.D.
INV#1 ____ db
INV#2 ____ db
INV#3 ____ db

THD-TRANSMISSION LINE

INTO THE LINE	OUT OF THE LINE
INV.#1 ____ db	INV #1 ____ db
INV.#2 ____ db	INV.#2 ____ db
INV.#3 ____ db	INV.#3 ____ db

II) OUTPUT POWER

A.C. RCVR
V_{OUT} 120.5
I_{OUT} 3.20
P 386

T.H.D.
INTO THE RCVR ____ db
OUT OF THE RCVR ____ db

D.C. RCVR
V_{OUT} 26
I_{OUT} 28
P 728

T.H.D.
INTO THE RCVR ____ db

B/D RCVR
V_{OUT} 99.7
I_{OUT} 7.73
P 771

T.H.D.
INTO THE RCVR ____ db

TOASTER LOADS

INV#1
V_{OUT} 80.2
I_{OUT} 20.5
P 1644 w
THD ____ db

INV#2
V_{OUT} 77.4
I_{OUT} 9.70
P 751
THD ____ db

INV#3
V_{OUT} 77.8
I_{OUT} 13.95
P 1085
THD ____ db

Total System Efficiency $\frac{5365 \text{ Pout}}{6876 \text{ Pin}}$ = 78.0%

C-5

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.25.2 POWER SUPPLY STEP RESPONSE

Specific Case: 100V → 80V, Full Load

Input Voltage: 100V → 80Vdc

DC Rcvr: 22.2→17.3 Vdc

Input Current: 50.8 → 40.8Adc

AC Rcvr: 105 → 79.14 Vrms

System Frequency: 20.17 kHz

BD Module: 94.0 → 71.0 Vdc

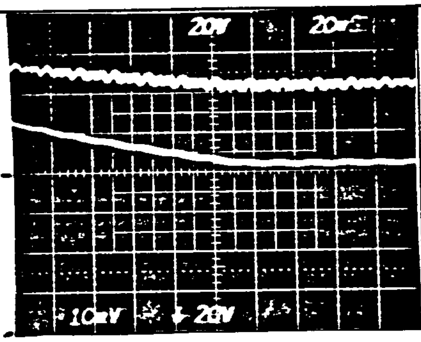
Output Power: 3,928 → 2,451 W

Other:

I_{IN}

V_{IN}

0A



0V

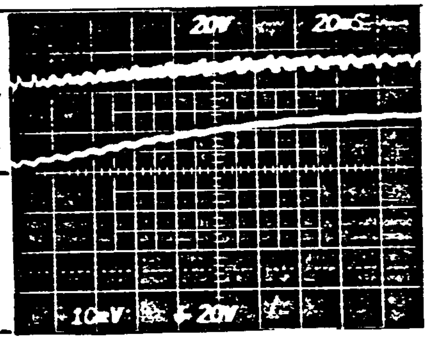
100V → 80V

Input V+I Scale: 20A/

I_{IN}

V_{IN}

0A



0V

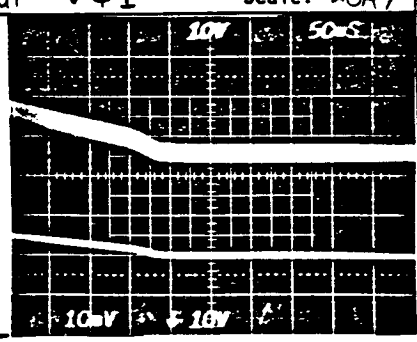
80V → 100V

Input V+I Scale: 20A/

I_{DC}

V_{DC}

0



100 → 80V

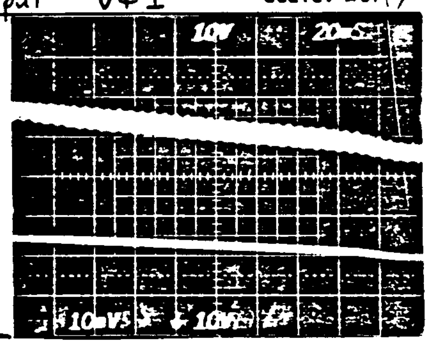
DC RCVR

Output V+I Scale: 5A/

I_{DC}

V_{DC}

0



100 → 80V

DC RCVR

Output V+I Scale: 5A/

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.5.2 POWER SUPPLY STEP RESPONSE

Specific Case: 100V → 80V , Full Load

Input Voltage: Same

DC Rcvr:

Input Current:

AC Rcvr:

System Frequency:

BD Module:

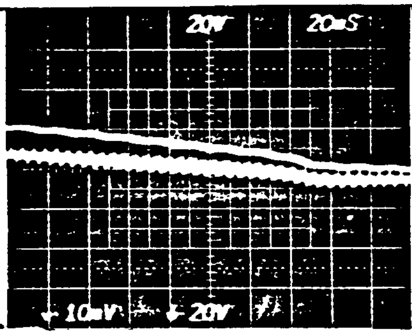
Output Power:

Other:

V_{BD}

I_{BD}

0



100V → 80V

BD MOD

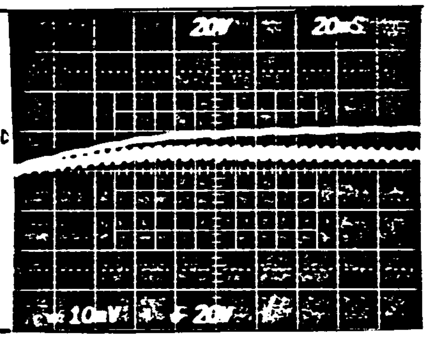
Output V + I

Scale: 2A/

V_{BD}

I_{BD}

0



80V → 100V

BD MOD

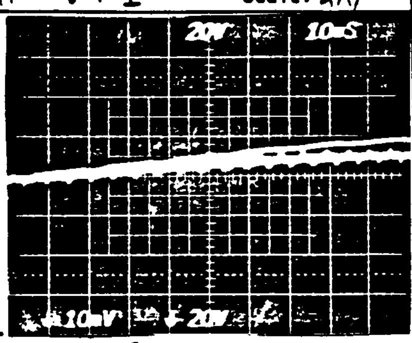
Output V + I

Scale: 2A/

V_{BD}

I_{BD}

0



80V → 100V

BD MOD

Output V + I

Scale: 2A/

Photo

Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.5.2 POWER SUPPLY STEP RESPONSE

Specific Case: 100V → 80V , Full Load

Input Voltage: Same

Input Current:

System Frequency:

Output Power:

DC Rcvr:

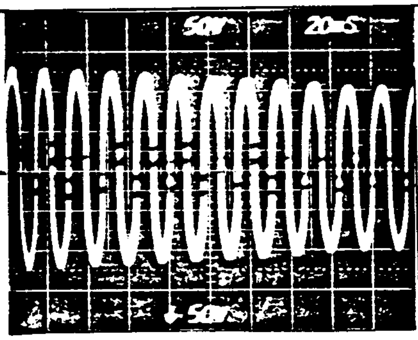
AC Rcvr:

BD Module:

Other:

V_{AC}

0 -

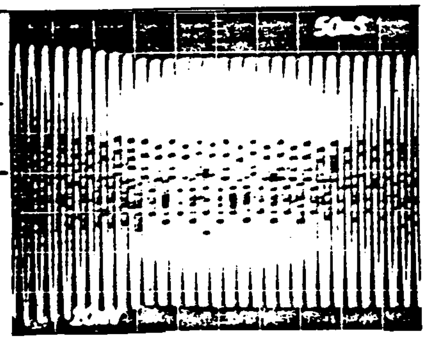


AC RCVR 100V → 80V

Output Voltage Scale:

I_{AC}

0 -

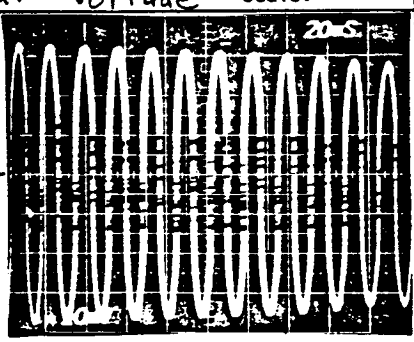


AC RCVR 100V → 80V

Output Current Scale: 1A/

I_{AC}

0 -



AC RCVR

Output Current Scale: 1A/

Photo

Scale:

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.5.2 POWER SUPPLY STEP RESPONSE

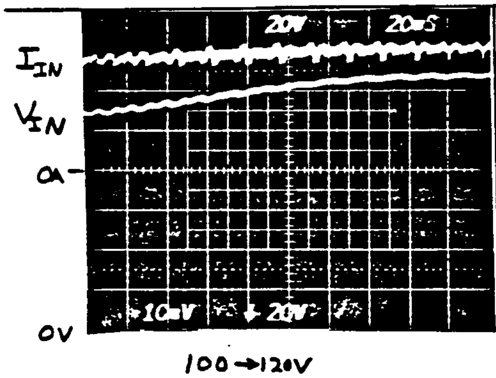
Specific Case: 100V → 120V , Full Load

Input Voltage: 100.0 → 120.0 Vdc DC Rcvr: 22.2 → 26.0 Vdc

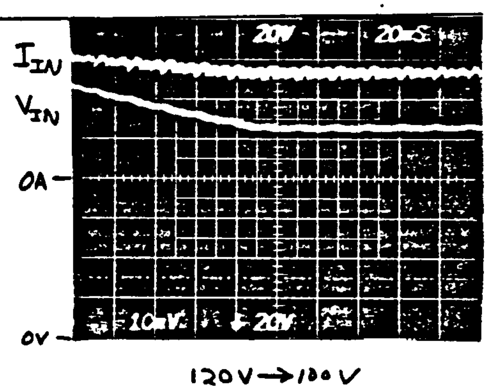
Input Current: 50.8 → 57.3 Adc AC Rcvr: 105.0 → 120.5 Vrms

System Frequency: BD Module: 94.0 → 99.7 Vdc

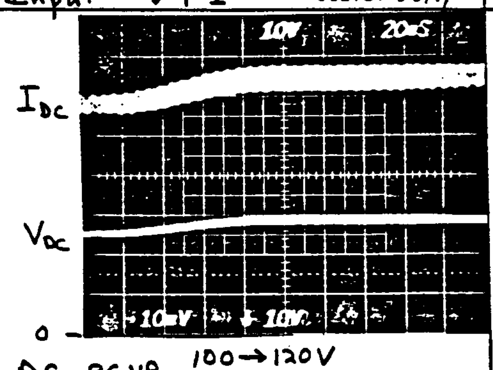
Output Power: 3928 → 5,365 W Other:



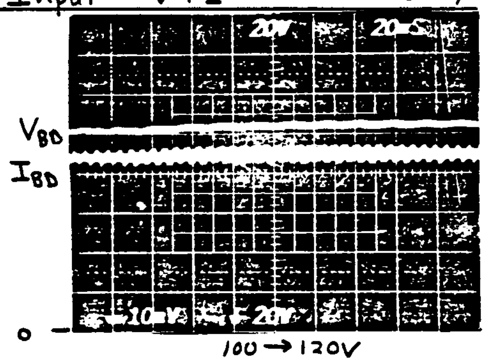
Input V + I Scale: 20A/



Input V + I Scale: 20A/



DC RCVR
Output V + I Scale: 5A/



BD MOD
Output V + I Scale: 2A/

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.25.2 POWER SUPPLY STEP RESPONSE

Specific Case: 100V → 120V , Full Load

Input Voltage: Same

Input Current:

System Frequency:

Output Power:

DC Rcvr:

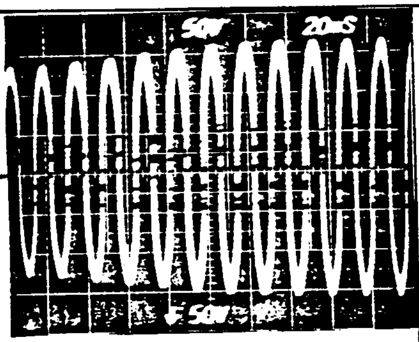
AC Rcvr:

BD Module:

Other:

VAC

0



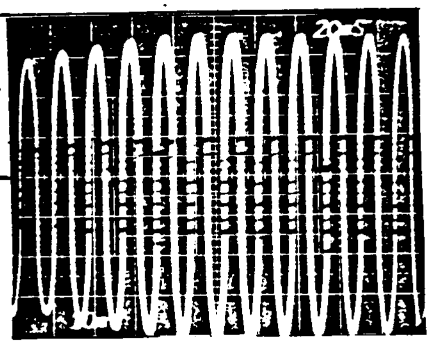
100V → 120V

AC RCVR

Output Voltage Scale:

IAC

0



100 → 120V

AC RCVR

Output Current Scale: 1A/

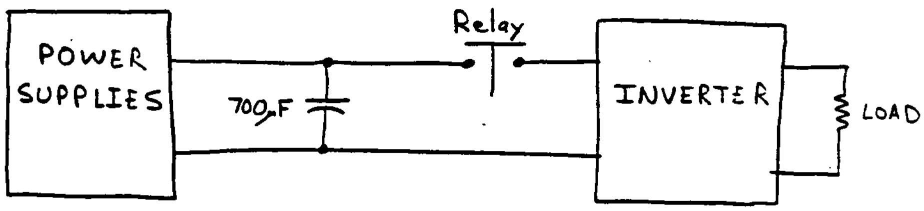
Photo

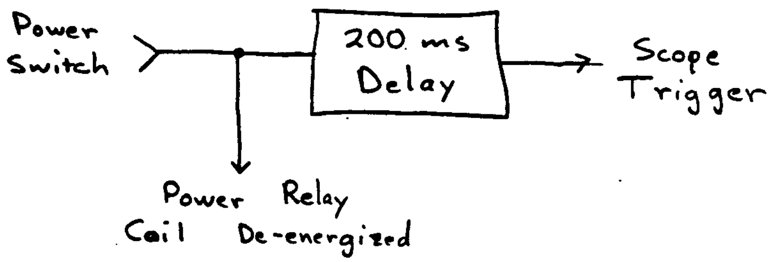
Scale:

Photo

Scale:

2.3.1 -3.2.6 POWER TURN OFF

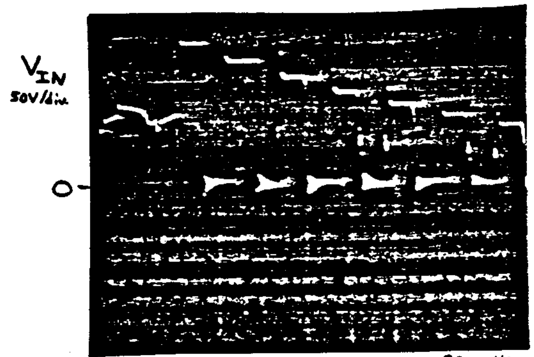




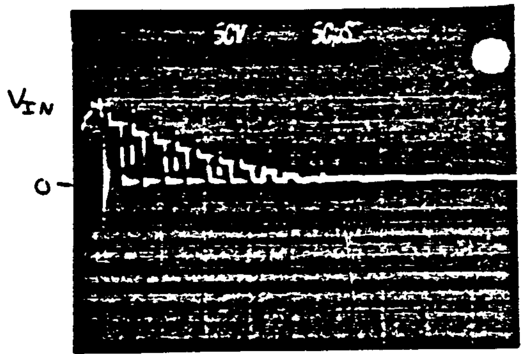
2.3.1
-3.2.6

NO LOAD

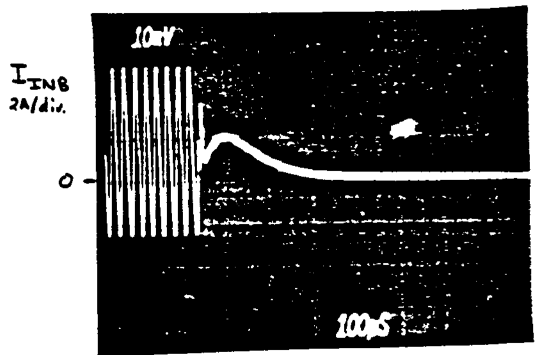
$V_{IN} = 87.0V_{DC}$
$P_{OUT} = 0W$



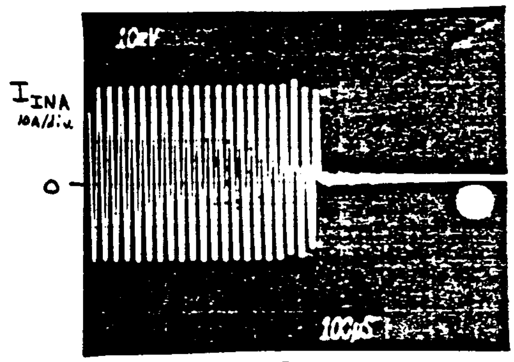
Input Voltage 20μs/div.



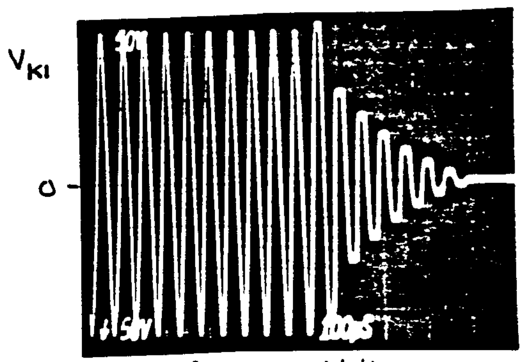
Input Voltage



Input Current
(Before DC Capacitor)



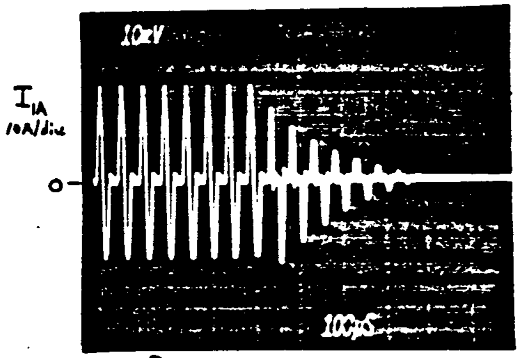
Input Current
(After DC Capacitor)



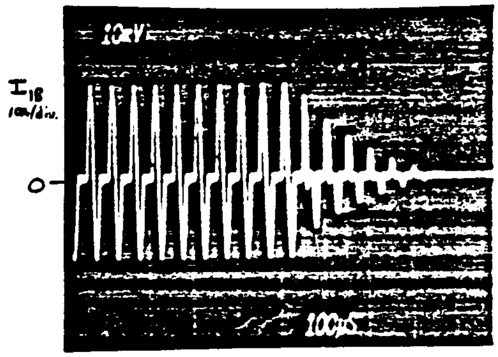
Output Voltage

2.3.1
—3.2.6 NO LOAD

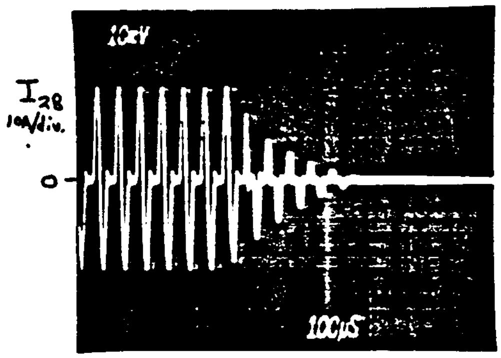
V_{IN} = 87.0 V_{DC}
P_{OUT} = 0 W



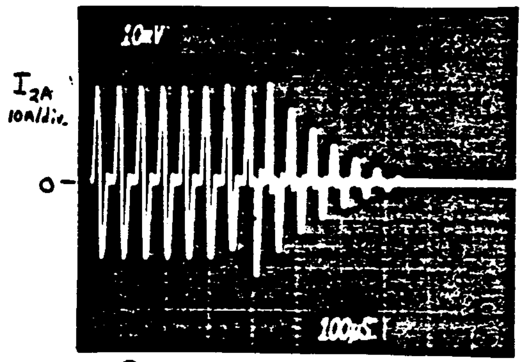
Branch Current 1A



Branch Current 1B



Branch Current 2B

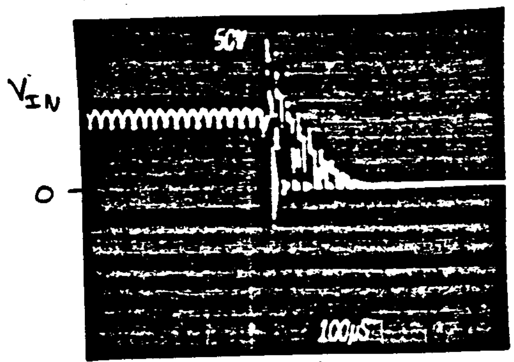


Branch Current 2A

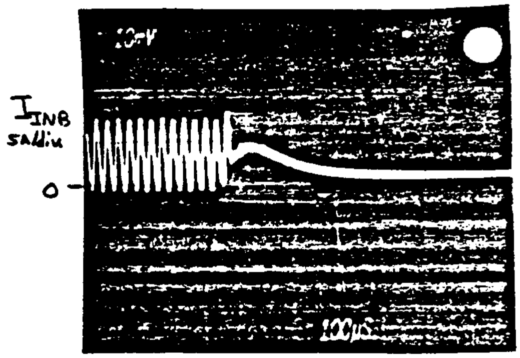
2.3.1
−3.26

10% LOAD

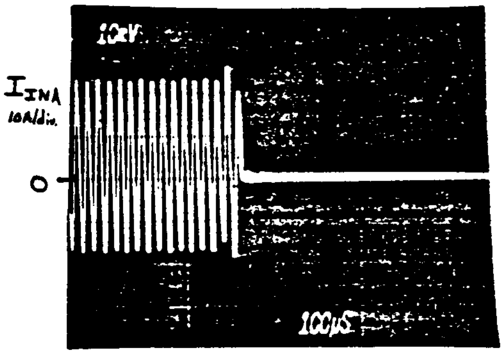
V_{IN} = 87.0 V
R_{Load} = 117 Ω
P_{OUT} = 130W



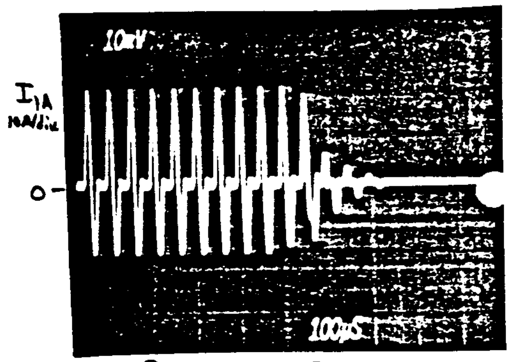
Input Voltage



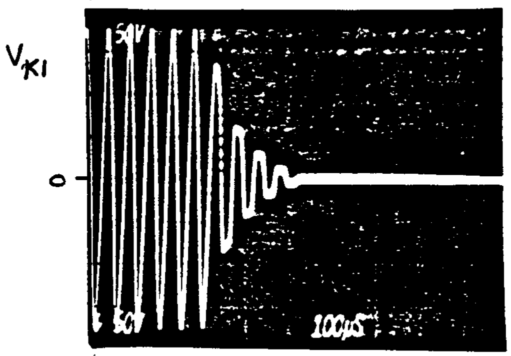
Input Current
(Before DC Capacitor)



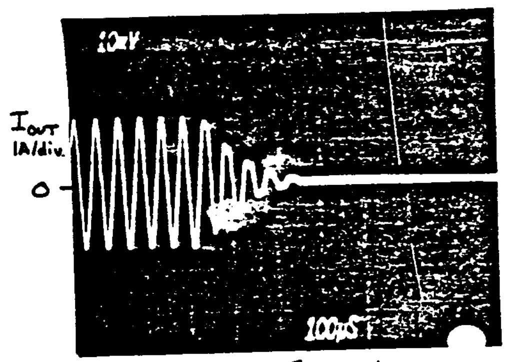
Input Current
(After DC Capacitor)



Branch Current 1A



Output Voltage



Output Current

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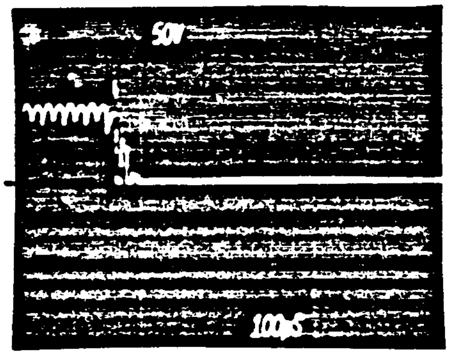
2.3.1
-3.2.6 FULL LOAD

V_{IN} = 87.0 V_{DC}
R_{Load} = 12.3 Ω
P_{OUT} = 1140W

V_{IN}

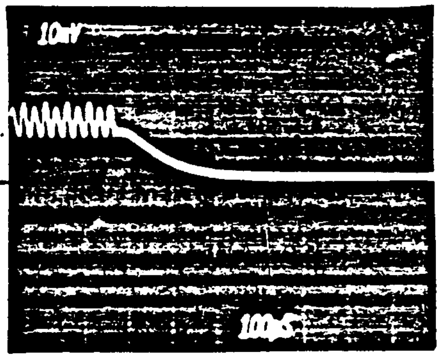
0



Input Voltage

I_{INB}
10A/div.

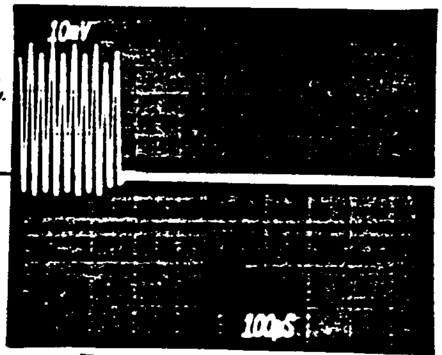
0



Input Current
(Before DC Capacitor)

I_{INA}
10A/div.

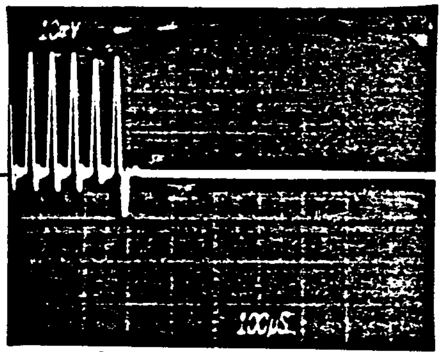
0



Input Current
(After DC Capacitor)

I_{1A}
10A/div.

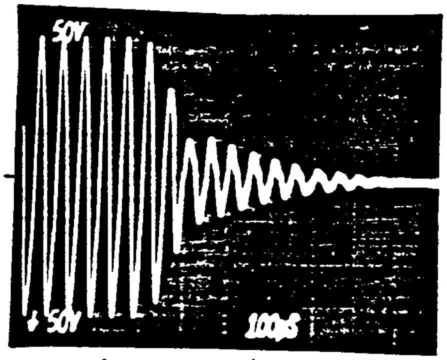
0



Branch Current 1A

V_{K1}

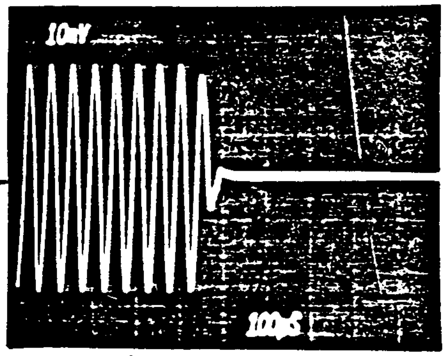
0



Output Voltage

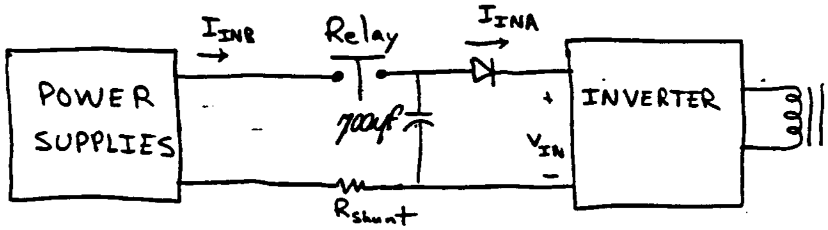
I_{OUT}
5A/div.

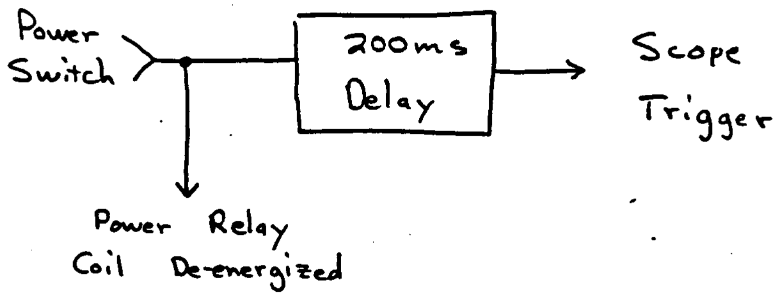
0



Output Current

2.3.2 -3.2.6 POWER TURN OFF





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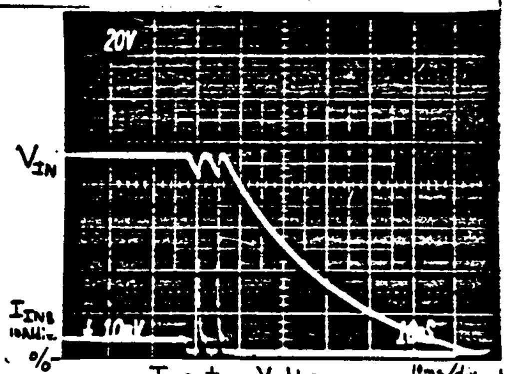
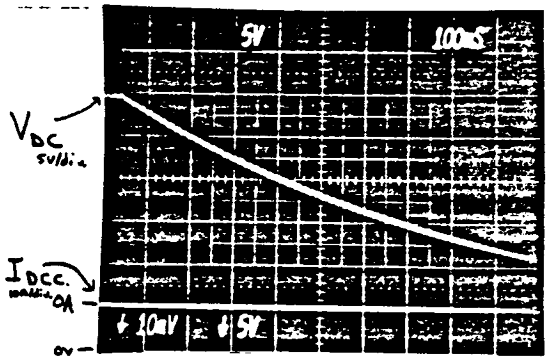
2.3.2
-3.2.6 No Load

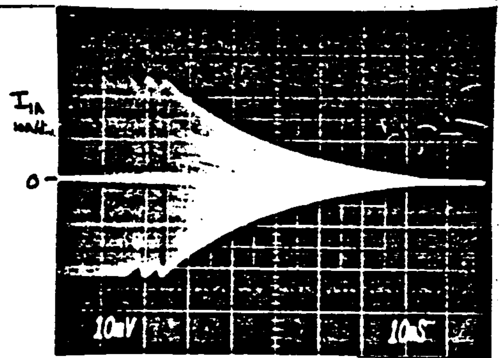
V_{IN} = 90.2 V_{DC}
P_{OUT} = 0W



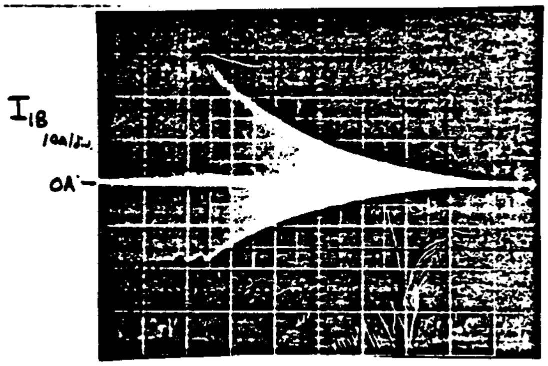
Input Voltage
Input Current
(Before DC Capacitor)



Output Voltage
Output Current
(Including Filter Current)



Branch Current 1A

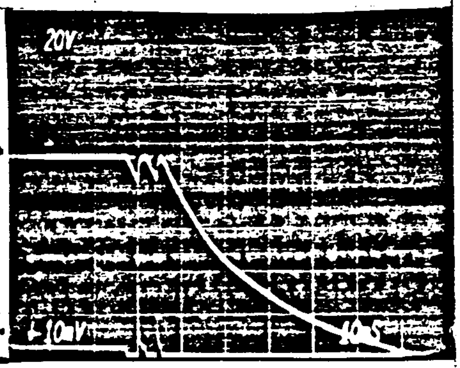


Branch Current 1B

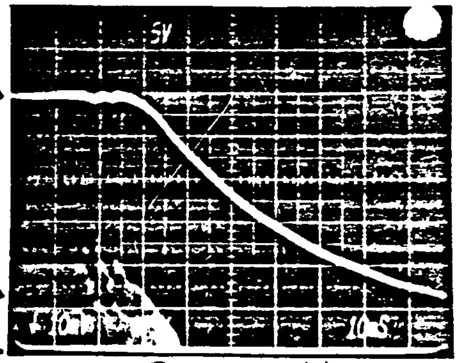
2.3.2
-3.2.6

10% Load

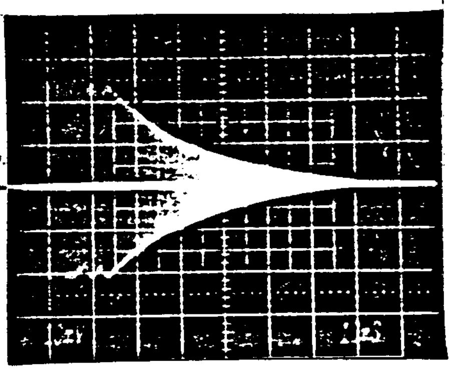
V_{IN} = 90.1 V_{DC}
R_{Load} = 23.4 Ω
P_{OUT} = 34W



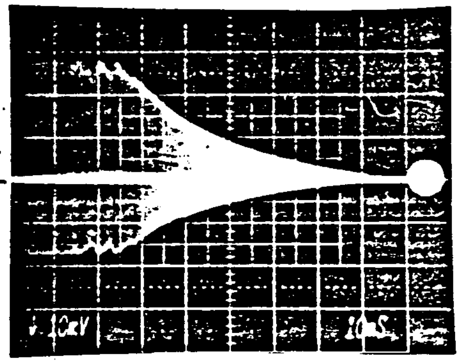
Input Voltage
Input Current
(Before DC Capacitor)



Output Voltage
Output Current
(Including Filter Current)



Branch Current 1A



Branch Current 1B

2.3.2
-3.2.6

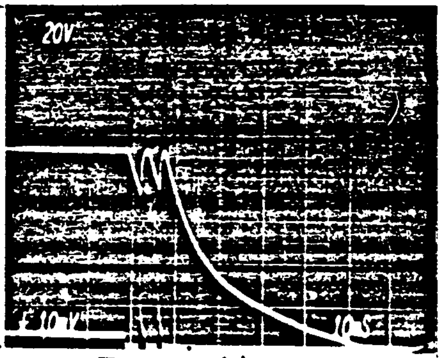
50% LOAD

$V_{IN} = 90.0\ V_{DC}$
$R_{Load} = 4.28\ \Omega$
$P_{OUT} = 180\ W$

V_{IN}

I_{INB} 20A/div.

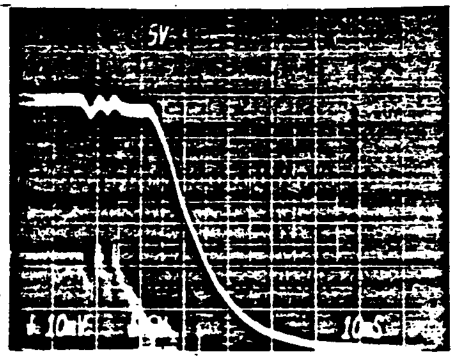
%



Input Voltage
Input Current
(Before DC Capacitor)

V_{DC}

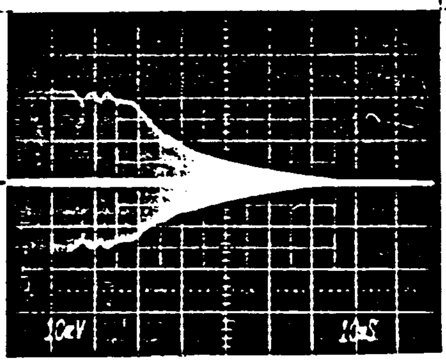
I_{DCC} 10A/div.



Output Voltage
Output Current
(Including Filter Current)

I_{1A} 10A/div.

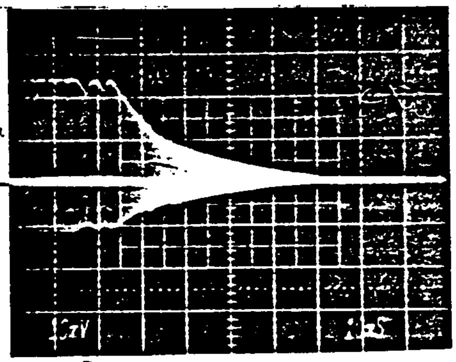
0A



Branch Current 1A

I_{1B} 10A/div.

0A

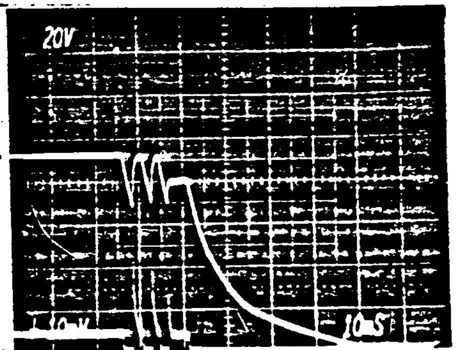


Branch Current 1B

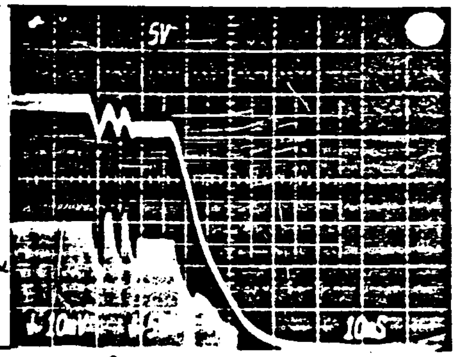
2.3.2
-3.26

FULL LOAD

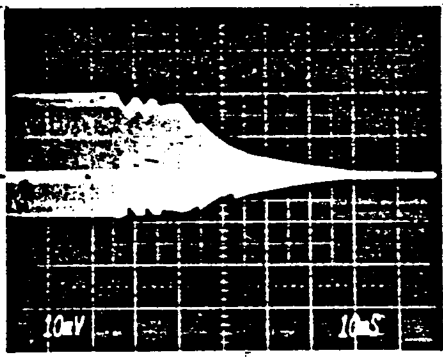
V_{IN} = 90.0 V_{DC}
R_{Load} = 1.76 Ω
P_{OUT} = 410 W



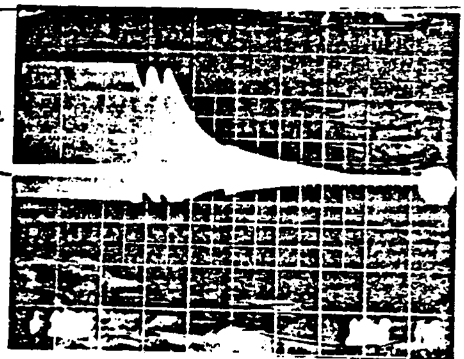
Input Voltage
Input Current
(Before DC Capacitor)



Output Voltage
Output Current
(Including Filter Capacitor)

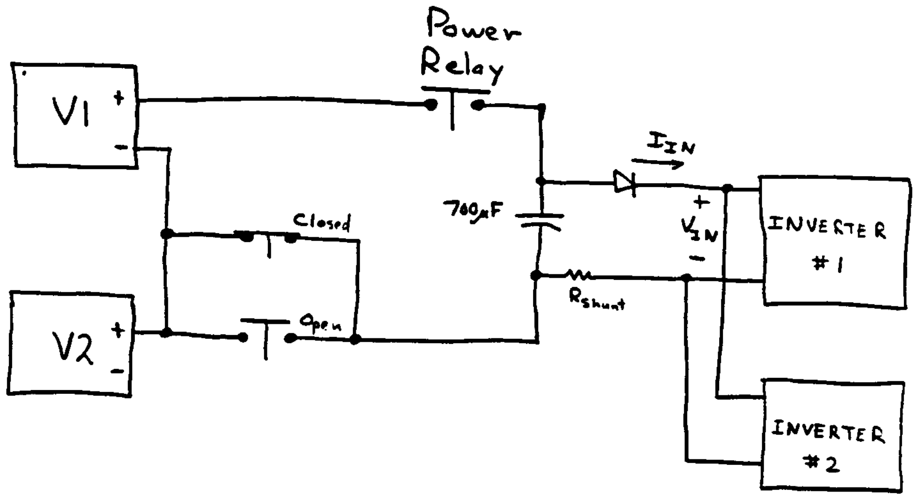


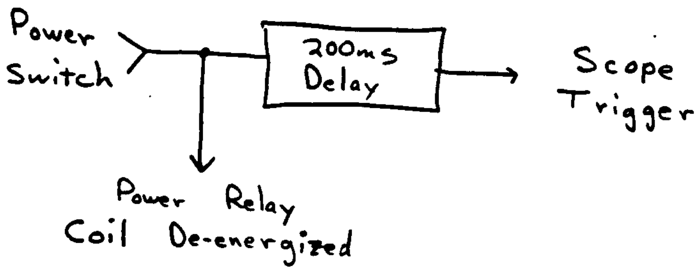
Branch Current 1A



Branch Current 1B 10ms/div

2.3.4 POWER TURN OFF
-3.2.6





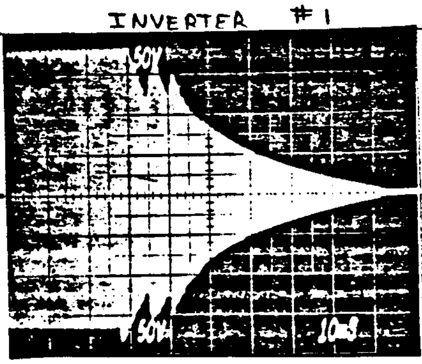
Most of the photographs in this section display some relay bounce.

2.3.4
-3.2.6

INVERTER #1

V_{K1}

0V

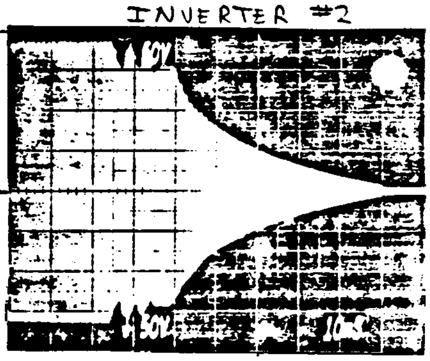


Resonant Tank Voltage

INVERTER #2

V_{K2}

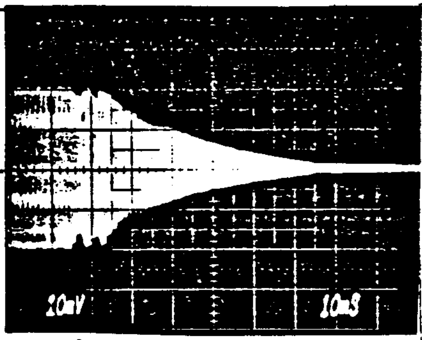
0V



Resonant Tank Voltage

I_{K1} 10A/div.

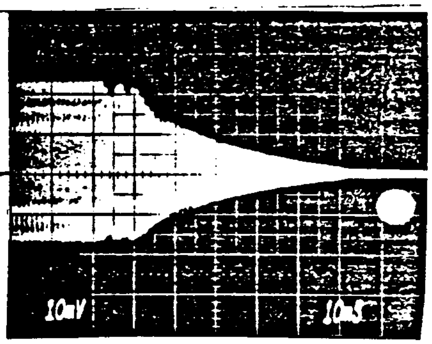
0A



Resonant Tank Current

I_{K2} 10A/div.

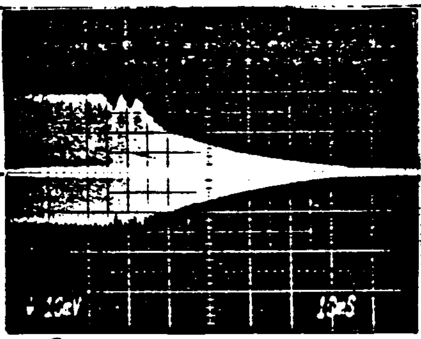
0A



Resonant Tank Current

I_A 10A/div.

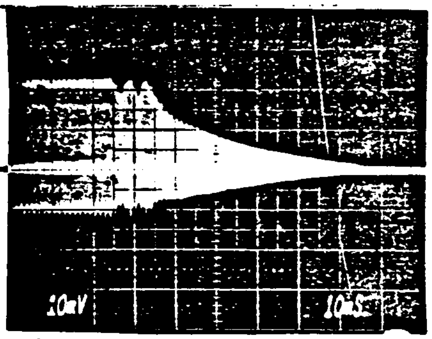
0A



Branch Current A

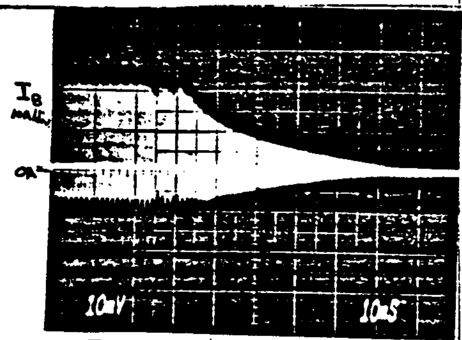
I_C 10A/div.

0A

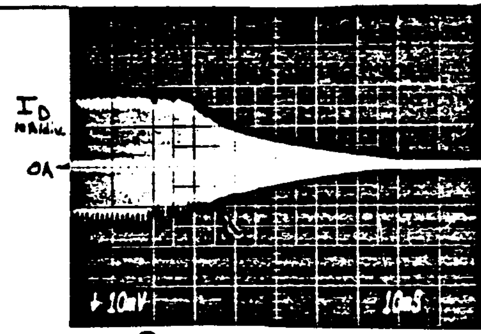


Branch Current C

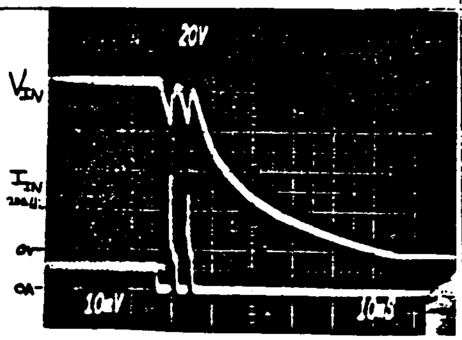
2.3.4
-3.2.6



Branch Current B
Inverter #1

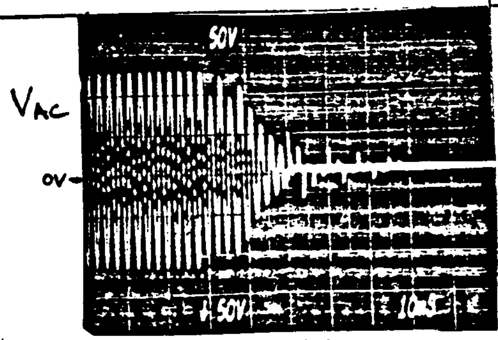


Branch Current D
Inverter #2

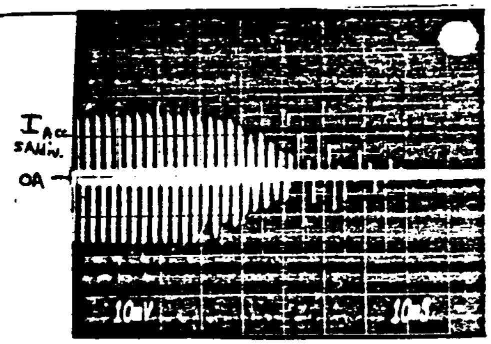


Input Voltage
Input Current

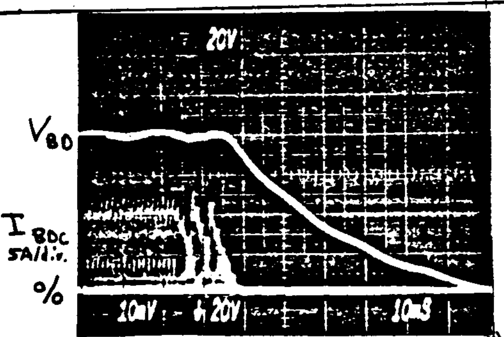
2.3.4
-3.2.6



Output Voltage
AC Receiver



Output Current
(Including Filter Current)
AC Receiver



Output Voltage
Output Current
(Including Filter Current)
BD Module

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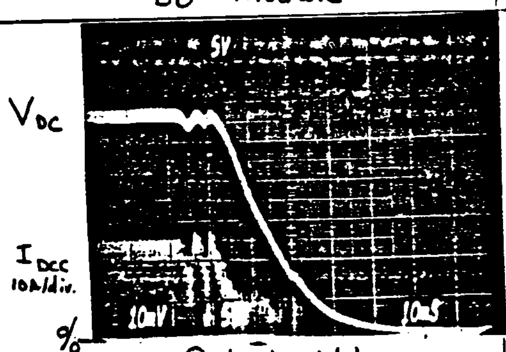


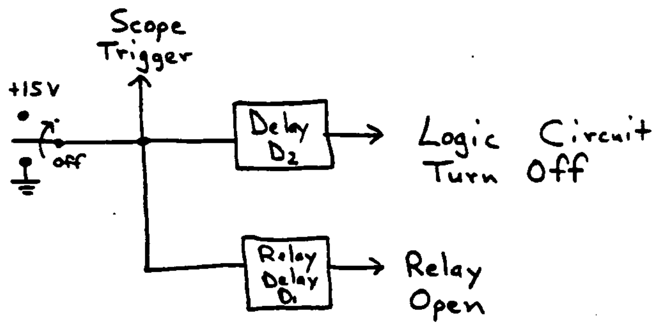
Output Voltage
Output Current
(Including Filter Current)
DC Receiver

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6-3.2.6 POWER TURN OFF

Test Circuits



$D_1 > D_2$

49

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 23.6-32.6 POWER TURN OFF

Specific Case: No Load

Input Voltage: 120.0 Vdc

DC Rcvr: 28.4 Vdc / OW

Input Current: 9.35Adc→0

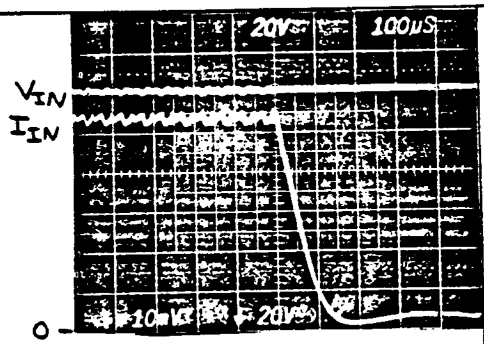
AC Rcvr: OFF / OW

System Frequency: 20.17 kHz

BD Module: 194.79Vdc / OW

Output Power: OW

Other: OW



Input V & I Scale: 2A/

Photo

Scale:

Photo

Scale:

Photo

Scale:

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 POWER TURN OFF

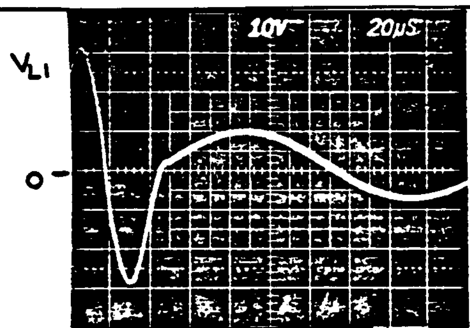
Specific Case: No Load

Input Voltage: Same | DC Rcvr:

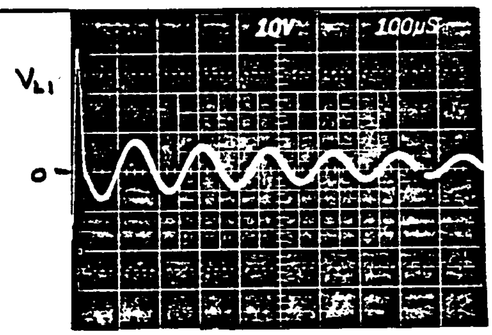
Input Current: | AC Rcvr:

System Frequency: | BD Module:

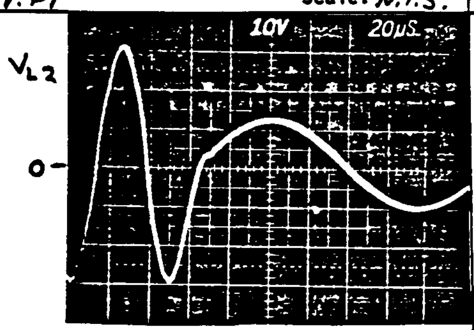
Output Power: | Other:



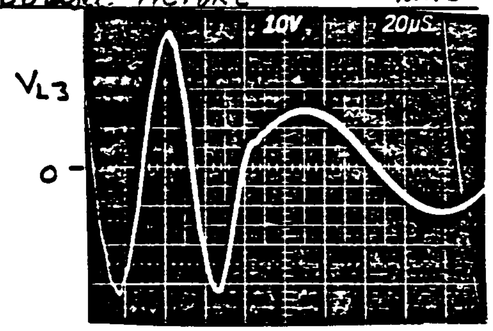
INV. #1 Scale: N.T.S.



INV #1
100 μsec. PICTURE Scale: N.T.S.



INV. # 2 Scale: N.T.S.



INV. #3 Scale: N.T.S.

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

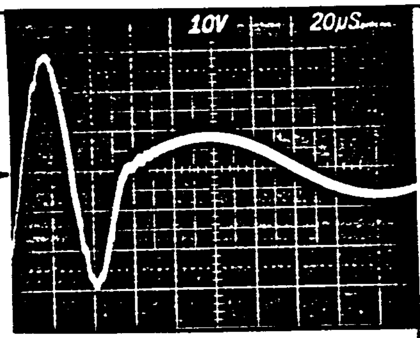
Test-Configuration: 2.3.6-3.2.6 POWER TURN OFF

Specific Case: POWER TURN OFF - 60% LOAD

Input Voltage:	120.0 Vdc	DC Rcvr:	28.25 Vdc / 830 W
Input Current:	27.57 Adc → 0	AC Rcvr:	110 Vrms / 360 W
System Frequency:	20.17 kHz	BD Module:	100.2 Vdc / 950 W
Output Power:	2140 W	Other:	0 W

V_{L1}

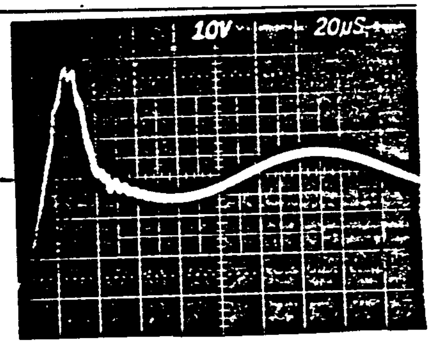
0 -



INV. #1 Scale: N.T.S

V_{L2}

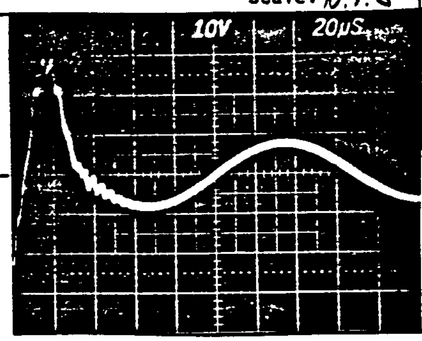
0 -



INV. #2 Scale: N.T.S

V_{L3}

0 -

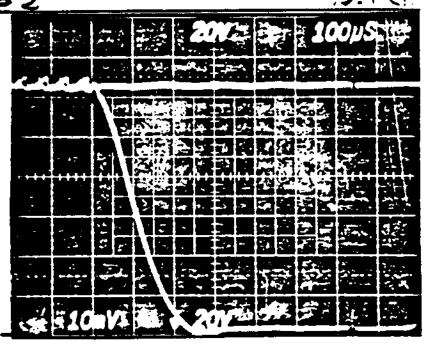


INV. #3 Scale: N.T.S

V_{IN}

I_{IN}

0 -



Input V + I Scale: 5A/

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

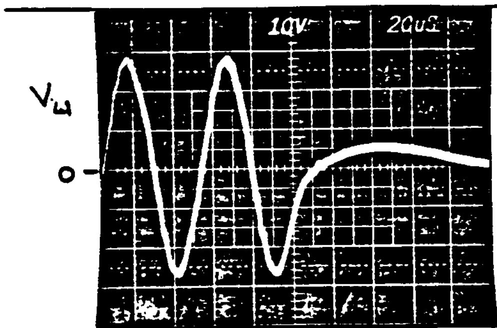
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

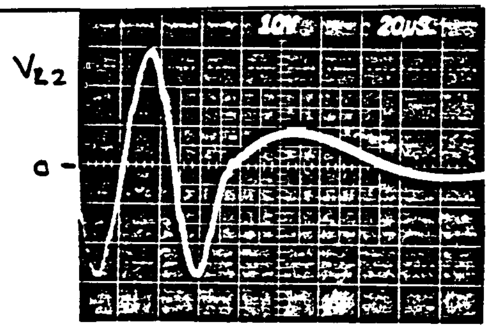
Test-Configuration: 2.3.6-3.2.6

Specific Case: POWER TURN OFF (100% LOAD)

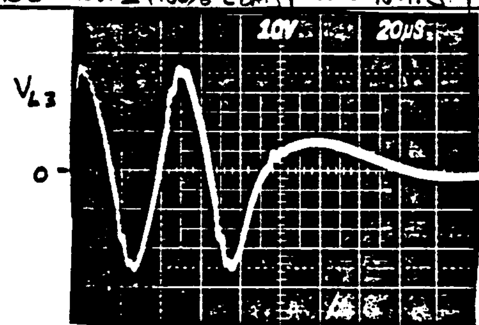
Input Voltage: 120.0 Vdc	DC Rcvr: 27.3 Vdc / 790W
Input Current: 53.88 Adc	AC Rcvr: 955 Vrms / 250W
System Frequency: 20.17 KHz	BD Module: 99.8 Vdc / 850W
Output Power: 5,120W	Other: ϕ_a = 1270W, ϕ_b = 830W, ϕ_c = 1130W



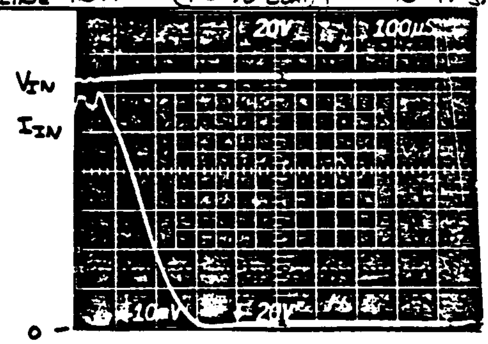
VLINE INV. 1 (100% LOAD) Scale: N.T.S.



VLINE INV. #2 (100% LOAD) Scale: N.T.S.



VLINE INV#3 (100% LOAD) Scale: N.T.S.



Input V+I Scale: 10A/

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.6

Specific Case: POWER TURN OFF (60% + Full Load)

Input Voltage: Same

Input Current:

System Frequency:

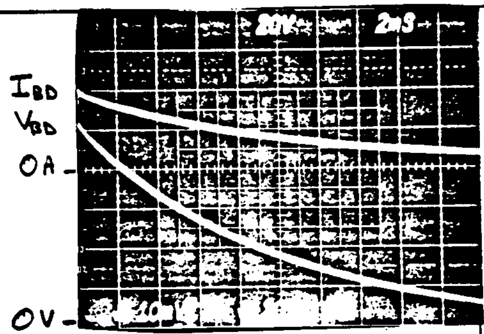
Output Power:

DC Rcvr:

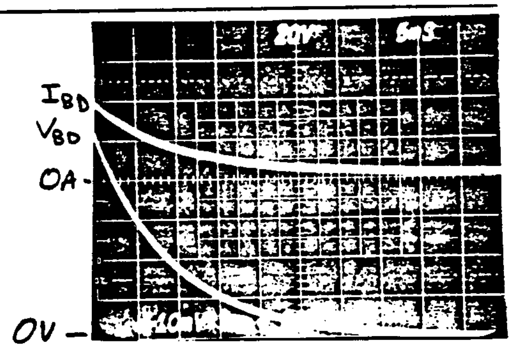
AC Rcvr:

BD Module:

Other:

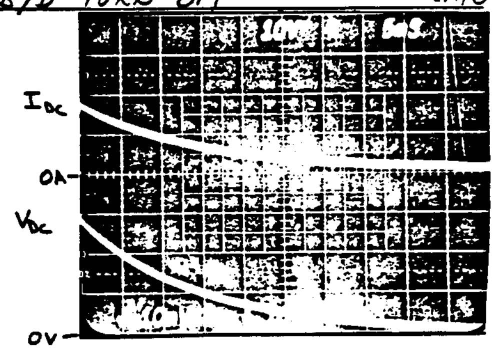


B/D TURN OFF Scale: 5A/DIV



B/D TURN OFF Scale: 5A/DIV

DC RCVR TURN OFF Scale: 20A/DIV



DC RCVR TURN OFF Scale: 20A/DIV

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.6 POWER TURN OFF

Specific Case: 60% + Full Load

Input Voltage: Same **DC Rcvr:**

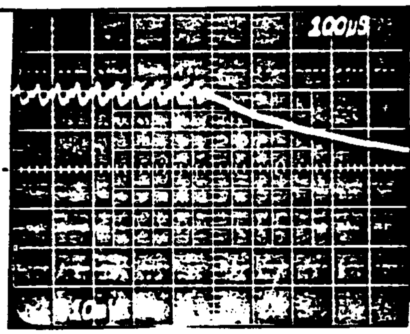
Input Current: **AC Rcvr:**

System Frequency: **BD Module:**

Output Power: **Other:**

I_{AC}

OA-



OV-

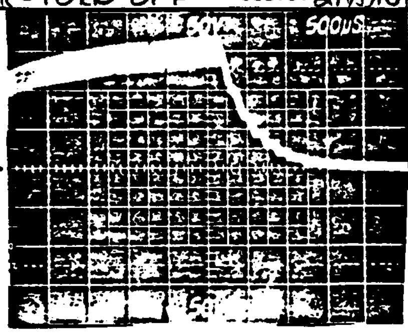
V_{AC}

AC RCVR - TURN OFF **Scale:** 2A/DIV

AC RCVR - TURN OFF **Scale:**

V_{AC}

OV-



AC RCVR - TURN OFF **Scale:**

The receiver modules operate at the same power levels at 60% system load and 100% system load. The extra power at 100% load is delivered to 20kHz, r... loads.

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

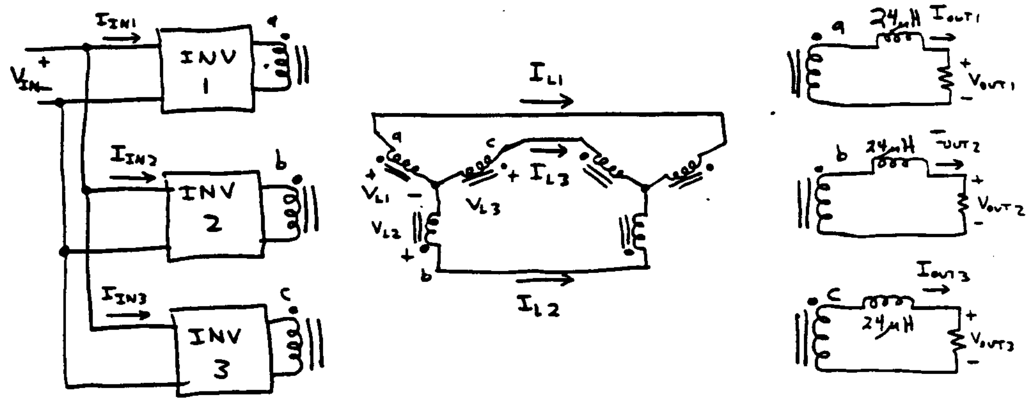
TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6 - 3.2.7 POWER FACTOR

0.7 LAGGING, FULL LOAD

($1.5\mu F$, $V_{IN} = 50 V_{dc}$).

Test Circuits



2.3.6- 3.2.7 POWER FACTOR TESTING

Specific Case: 0.7 LAGGING
(1.5μF, Full Load)

Input Power

ϕ_1	ϕ 2	ϕ 3
V_{IN} 50.0 Vdc	V_{IN} 50.0	V_{IN} 50.0
I_{IN} 5.09 Adc	I_{IN} 4.83	I_{IN} 5.29
P_{IN} 255 W	P_{IN} 242	P_{IN} 265

Output Power (Resistive Loads)

V_{OUT1} 22.14	V_{OUT2} 19.8	V_{OUT3} 21.4
I_{OUT2} 8.87	I_{OUT2} 9.42	I_{OUT3} 9.33
P_{OUT3} 196	P_{OUT2} 187	P_{OUT3} 200

η_1 76.9% η_2 77.3% η_3 75.5

η_{Total} 76.5%

Note:
Because of the 24μH inductors used, the toasters could not fully load the inverters. If the toasters would have had lower resistances, the efficiency would be even higher.

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6 – 3.2.7 POWER FACTOR

Specific Case: 0.7 lagging (V_{IN} = 50V, C = 1.5μF)

Input Voltage: Same

Input Current: ↓

System Frequency: ↓

Output Power: ↓

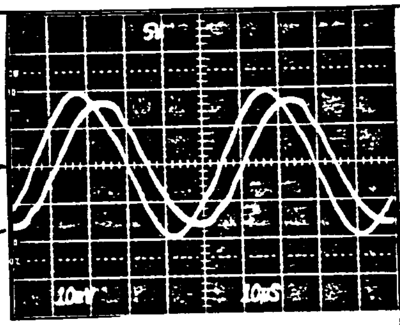
DC Rcvr: ↓

AC Rcvr: ↓

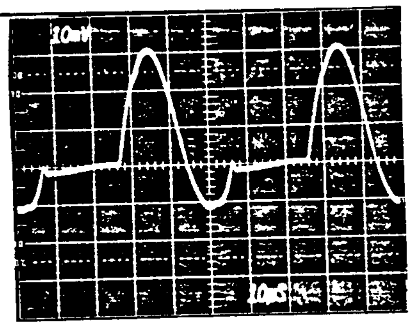
BD Module: ↓

Other:

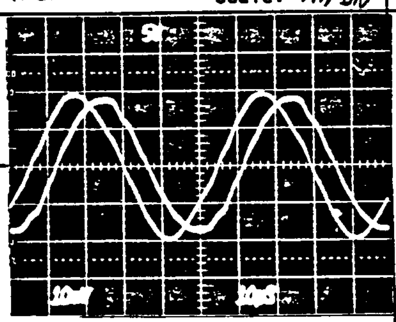
INV. #1



LINE VOLTAGE
LINE CURRENT
NTS *
Scale: 1A/DIV

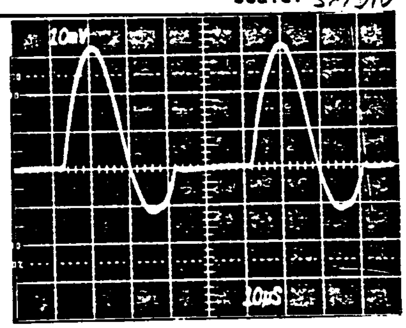


I_A
Scale: 5A/DIV



INV. 2

LINE VOLTAGE
LINE CURRENT
NTS *
Scale: 1A/DIV.



INV. 2

I_C
Scale: 5A/DIV

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.7 POWER FACTOR

Specific Case: 0.7 Lagging, Inverter 3, Full Load

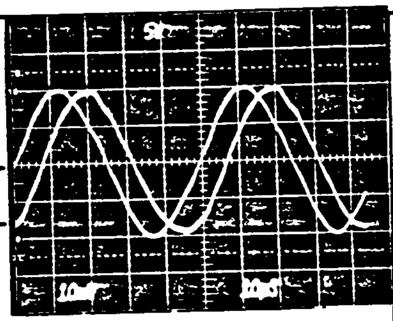
Input Voltage: Same **DC Rcvr:**

Input Current: **AC Rcvr:**

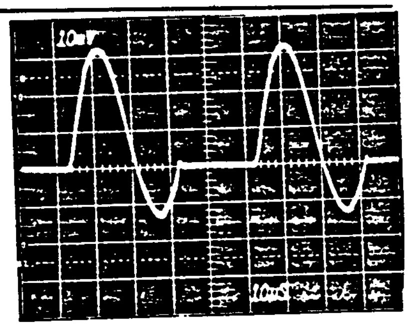
System Frequency: **BD Module:**

Output Power: **Other:**

INV. # 3



LINE VOLTAGE
LINE CURRENT
Scale: 1A/DIV



IG
Scale: 5A/DIV

Photo

Scale:

Photo

Scale:

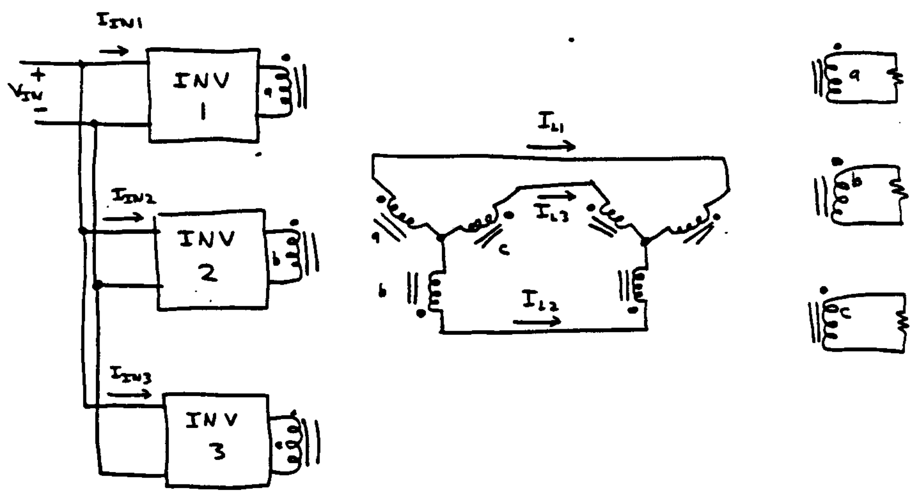
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6- 3.2.7 POWER FACTOR

Nominal (1.5μF, V_{IN} = 50Vdc)

Test Circuits



2.3.6-3.2.7 POWER FACTOR TESTING

Specific Case: Nominal, Same Resistive Load Value as 0.7 Leading Case

Input Power

ϕ_1	ϕ 2	ϕ 3
V_{IN} 50.0	V_{IN} 50.2V	V_{IN} 50.4V
I_{IN} 9.86	I_{IN} 9.39A	I_{IN} 9.4A
P_{IN} 493W	P_{IN} 471W	P_{IN} 474W

Output Power (Resistive Loads)

V_{OUT1} 31.18V	V_{OUT2} 33.72V	V_{OUT3} 36.11V
I_{OUT2} 11.85 A	I_{OUT2} 10.48 A	I_{OUT3} 9.43A
P_{OUT3} 369.5W	P_{OUT2} 353.4W	P_{OUT3} 341W

η_1 74.9% η_2 75% η_3 71.9%

η_{Total} = 74.0%

2.3.6- 3.2.7 POWER FACTOR TESTING

Specific Case: Nominal, Full Load

Input Power

ϕ_1	ϕ_2	ϕ_3
V_{IN} 50.0 Vdc	V_{IN} 50.2V	V_{IN} 50.4 V
I_{IN} 9.86 Adc	I_{IN} 10.11A	I_{IN} 10.27 A
P_{IN} 493W	P_{IN} 508 W	P_{IN} 518W

Output Power (Resistive Loads)

V_{OUT1} 31.18 Vrms	V_{OUT2} 31.43V	V_{OUT3} 32.02 V
I_{OUT2} 11.85 Arms	I_{OUT2} 12.23 A	I_{OUT3} 11.88 A
P_{OUT3} 369.5 W	P_{OUT2} 384.4W	P_{OUT3} 380.4W

η_1 74.9% η_2 75.7% η_3 73.4%

η_{Total} 74.7%

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6 – 3.2.7 POWER FACTOR

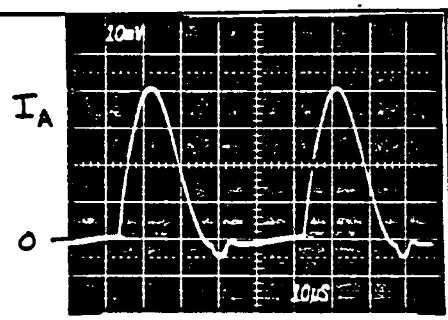
Specific Case: Nominal, Full Load

Input Voltage: Same   DC Rcvr:

Input Current: AC Rcvr:

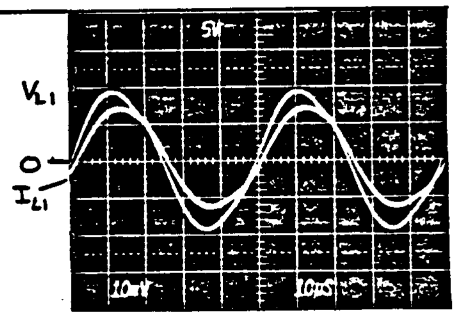
System Frequency: BD Module:

Output Power: Other:



INV 1

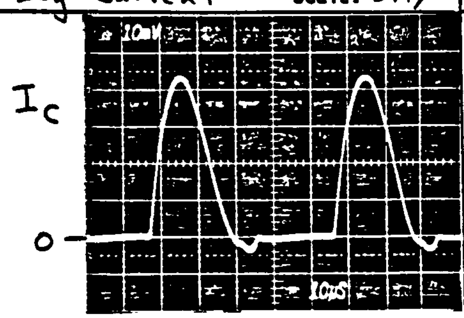
Leg Current   Scale: 5A/



INV 1

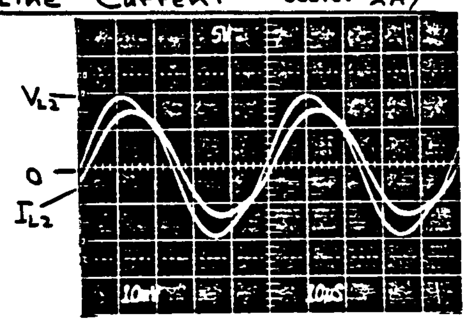
Line Voltage   NTS+

Line Current   Scale: 2A/



INV 2

Leg Current   Scale: 5A/



INV 2

Line Voltage   NTS+

Line Current   Scale: 2A/

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.7 POWER FACTOR

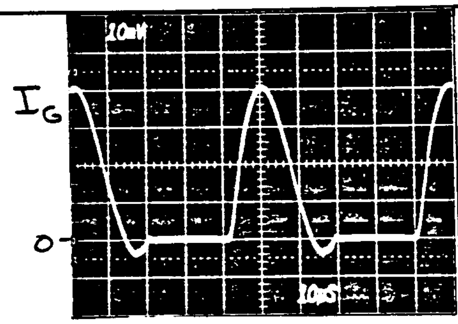
Specific Case: Nominal, Full Load, Inverter 3

Input Voltage: Same DC Rcvr:

Input Current: AC Rcvr:

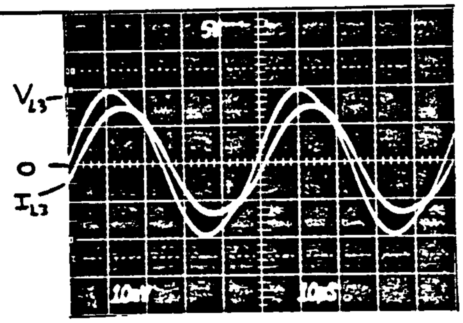
System Frequency: BD Module:

Output Power: Other:



INV 3

Leg Current Scale: 5A/



INV 3

Line Voltage NTS
Line Current Scale: 2A/

Photo

Scale:

Photo

Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

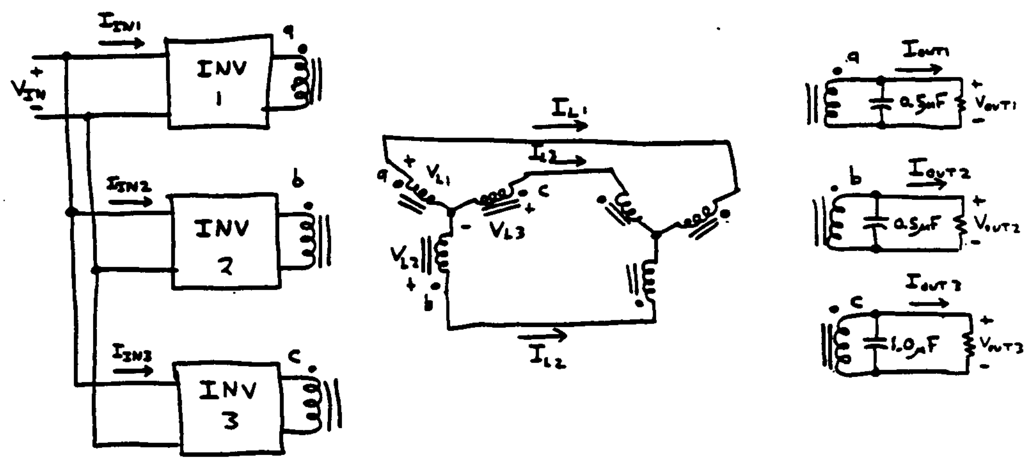
TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6- 3.2.7 POWER FACTOR

Unity Power Factor, Full Load

(1.5 μF, V_{IN} = 50 V_{dc})

Test Circuits



2.3.6- 3.2.7 POWER FACTOR TESTING

Specific Case: Unity Power Factor Full Load

Input Power ϕ_1	$\phi 2$	$\phi 3$
V_{IN} 50.0 Vdc	V_{IN} 50.0 Vdc	V_{IN} 50.0
I_{IN} 11.11 Adc	I_{IN} 11.39	I_{IN} 13.60 Adc
P_{IN} 556 W	P_{IN} 570	P_{IN} 680 W

Output Power (Resistive Loads)

V_{OUT1} 32.94 Vrms	V_{OUT2} 33.07 V	V_{OUT3} 36.51 V
I_{OUT2} 12.57 Arms	I_{OUT2} 12.9	I_{OUT3} 13.6 A
P_{OUT3} 414.1 W	P_{OUT2} 427	P_{OUT3} 497 W

η_1 74.5% η_2 75% η_3 73.0%

η_{Total} 74.2%

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.7 POWER FACTOR

Specific Case: Unity Power Factor, Full Load

Input Voltage: Same | **DC Rcvr:**

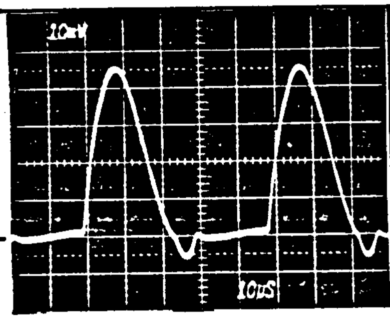
Input Current: | **AC Rcvr:**

System Frequency: | **BD Module:**

Output Power: | **Other:**

I_A

0



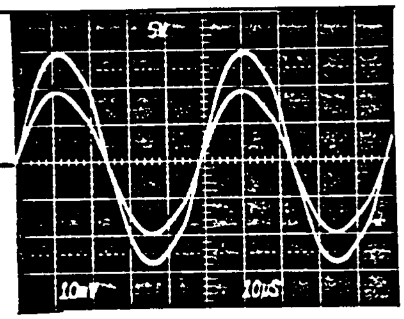
INV 1

Leg Current **Scale:** 5A/

I_{L1}

V_{L1}

0



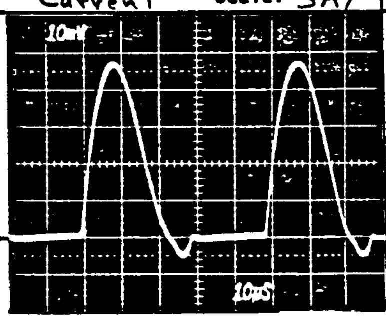
INV 1

Line Voltage NTS+

Line Current **Scale:** 1A/

I_C

0



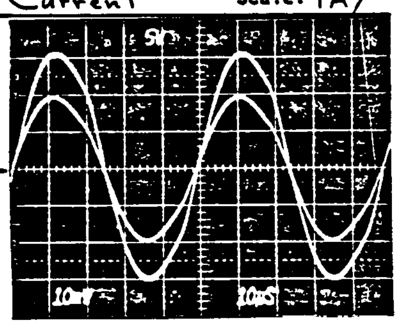
INV 2

Leg Current **Scale:** 5A/

I_{L2}

V_{L2}

0



INV 2

Line Voltage NTS+

Line Current **Scale:** 1A/

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.7 POWER FACTOR

Specific Case: Unity Power Factor, F.L., INVERTER 3

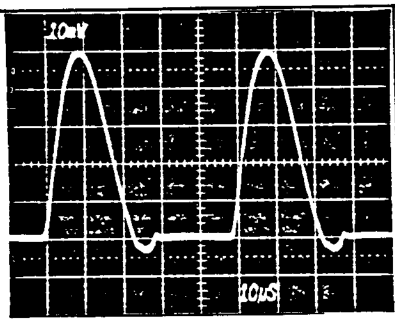
Input Voltage: Same | DC Rcvr:

Input Current: | AC Rcvr:

System Frequency: | BD Module:

Output Power: | Other:

I_G



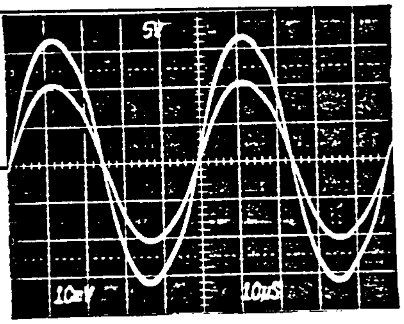
INV 3

Leg Current Scale: 5A/

I_{L3}

V_{L3}

0



IN 3

Line Voltage

Line Current NTS + Scale: 1A/

Photo

Scale:

Photo

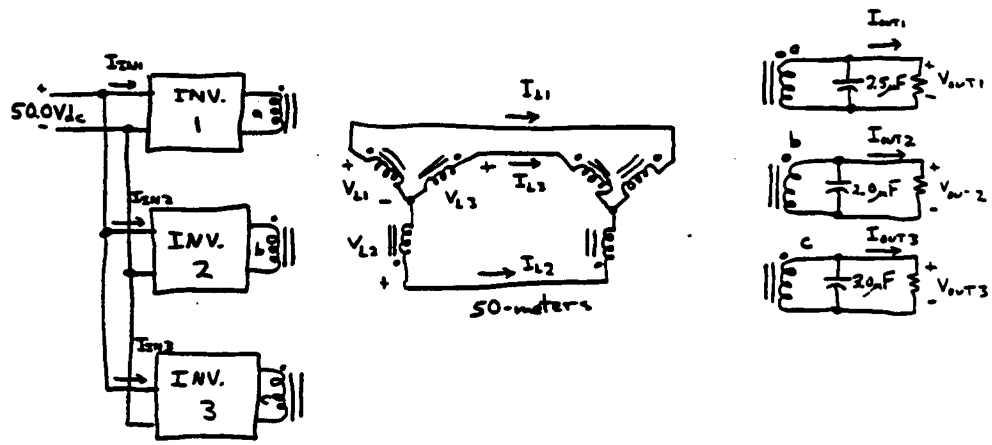
Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6-3.2.7 POWER FACTOR TESTING (1.5 μF, Full Load, V_{IN} = 50Vdc) 0.7 LEADING

Test Circuits



The input voltage was reduced to 50Vdc because of the large power drawn by the inverters. The power supplies are limited to 60Adc. The capacitors used are the largest that the inverters would tolerate. The calculated load power factors are 0.76, 0.78, and 0.57 for phase 1, 2, and 3 respectively. These capacitors were so large as to affect the inverter output waveforms. As a result, phase differences between the voltages and currents on the bus were not as large as might be expected.

2.3.6 - 3.2.7 POWER FACTOR TESTING

Specific Case: 0.7 Leading
(1.5 μF, Full Load) Per Phase

Input Power

ϕ_1	ϕ_2	ϕ_3
V_{IN} 50.0 V	V_{IN} 50.2 V	V_{IN} 50.4 V
I_{IN} 18.30 A	I_{IN} 15.90 A	I_{IN} 26.0 A
P_{IN} 915 W	P_{IN} 798 W	P_{IN} 1310 W

Output Power (Resistive Loads)

V_{OUT1} 40.9 Vrms	V_{OUT2} 43.05 V	V_{OUT3} 56.33 V
I_{OUT2} 15.07 Arms	I_{OUT2} 13.37 A	I_{OUT3} 14.77 A
P_{OUT3} 616 W	P_{OUT2} 575.6 W	P_{OUT3} 832.0 W

η_1 67.3%	η_2 72.1%	η_3 63.5%

f = 20.3 kHz η_{Total} = 66.9%

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.7 POWER FACTOR

Specific Case: 0.7 LEADING, INVERTER 1

Input Voltage: Same

DC Rcvr:

Input Current:

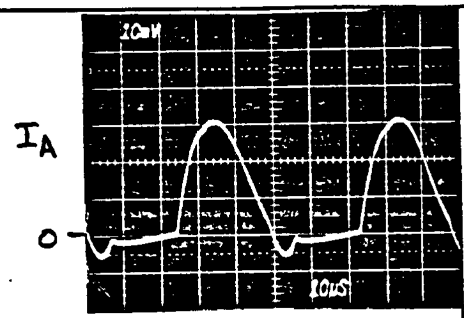
AC Rcvr:

System Frequency:

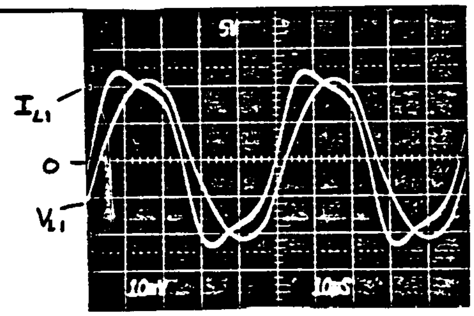
BD Module:

Output Power:

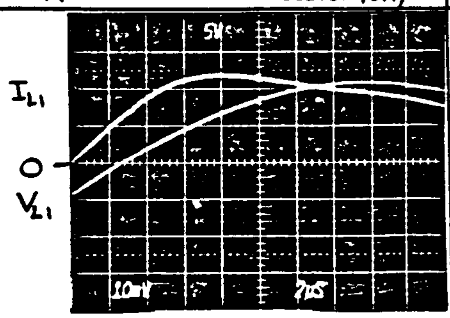
Other:



I_A Scale: 10A/



Line Voltage N.T.S ＋
Line Current Scale: 2A/



Line Voltage NTS ＋
Line Current Scale: 2A/

Photo

Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.7 POWER FACTOR

Specific Case: 0.7 LEADING, INVERTERS 2 & 3

Input Voltage: Same

DC Rcvr: ______

Input Current: ______

AC Rcvr: ______

System Frequency: ______

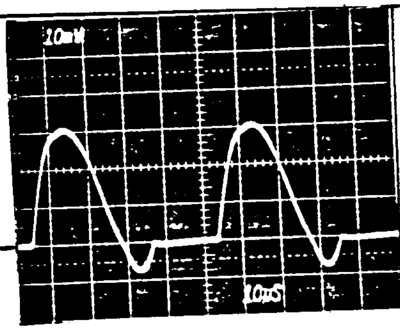
BD Module: ______

Output Power: ______

Other: ______

I_C

0



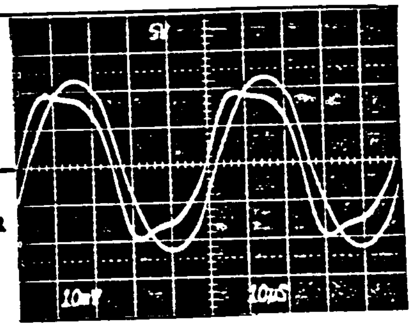
INV. 2

I_C Scale: 10A/

I_{L2}

0

V_{L2}



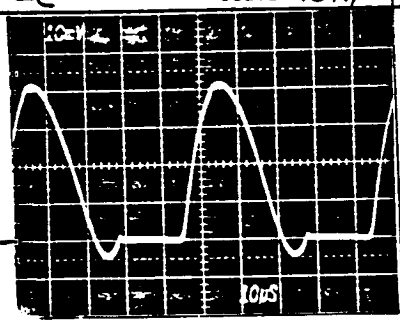
INV. 2

Line Voltage NTS

Line Current Scale: 2A/

I_G

0



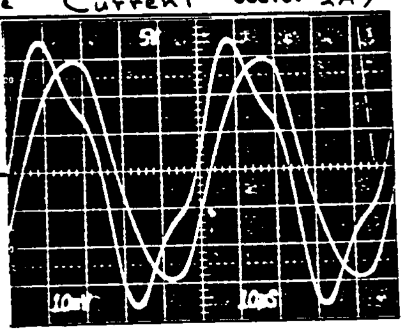
INV. 3

Leg Current Scale: 10A/

I_{L3}

0

V_{L3}



INV. 3

Line Voltage NTS

Line Current Scale: 2A/

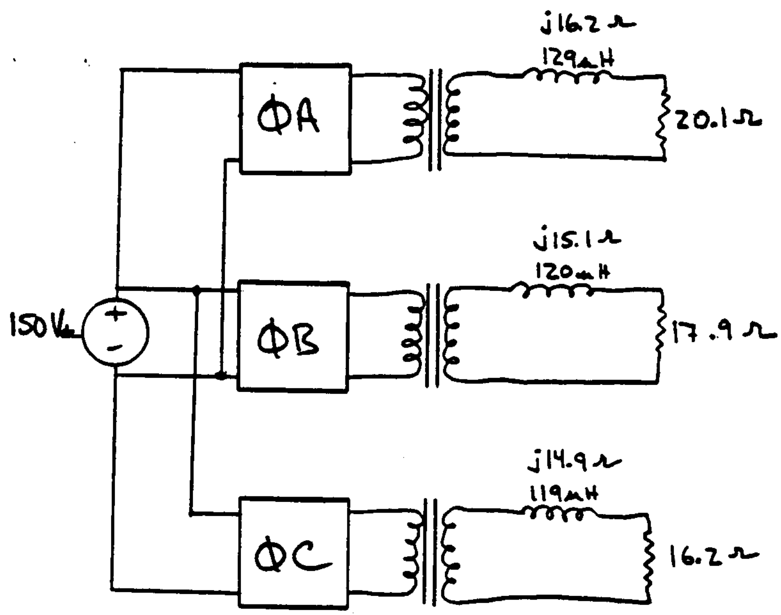
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.7 – 3.2.7 Power Factor

Lagging Power Factor (P.F. = 0.7)

Test Circuits



TEST CONFIG. 2.3.7-3.2.7 P.F.
SPECIFIC CASE Lagging p.f. 0.7

I) INPUT POWER

V_{in} 149.65

I_{in} 20.60 mv = 123.6 A

P_{IN} 18.5 KW

Frequency 19.95 khz

T.H.D.

ΦA ___ %

ΦB ___ %

ΦC ___ %

T.H.D. – TRANSMISSION LINE

INTO THE LINE

ΦA

All Voltage (440 v) readings with H.P. 3466A #146516

II) OUTPUT POWER

ΦA	ΦB	ΦC
V_o 437.7	V_o 440.4	V_o 435.7
I_o 15.5	I_o 17.0	I_o 19.2
P_o 4.68 KW	P_o 5.24	P_o 5.86

$\mathcal{E}_o = \frac{15.8}{18.5} = 85.4\%$

A.C. RCVR	B/D MOD.	D.C. RCVR
V_o ___	V_o ___	V_o ___
I_o ___	I_o ___	I_o ___
P_o ___	P_o ___	P_o ___

T.H.D. Out of RCVR

___ db

RESISTIVE LOADS

ΦA	ΦB	ΦC
V_A 414.5 Vac	V_B 414.2 Vac	V_C 407.0 Vac
I_A 78.3 mv	I_B 83.8 mv	I_C 97.5 mv
I_A 15.5 Aac	I_B 17.0 Aac	I_C 19.2 Aac
P_{RA} 4.43 KW	P_{RB} 4.93 KW	P_{RC} 5.47 KW
p.f. = .69	p.f. = .70	p.f. = .70

Total System Efficiency = $\frac{P_{OUT}}{}$ = $\frac{14.8}{18.5}$ = 80.0 %

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

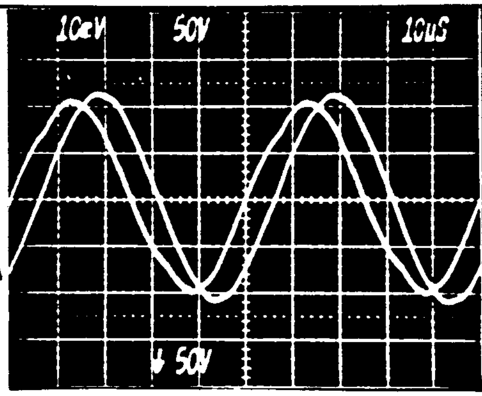
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

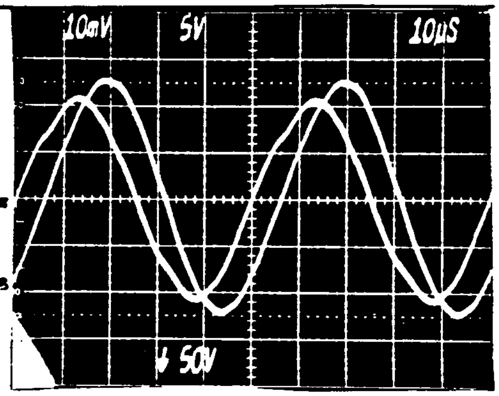
Test-Configuration: 2.3.7 - 3.2.7 Power Factor ≠ 1

Specific Case: Lagging 0.7 p.f.

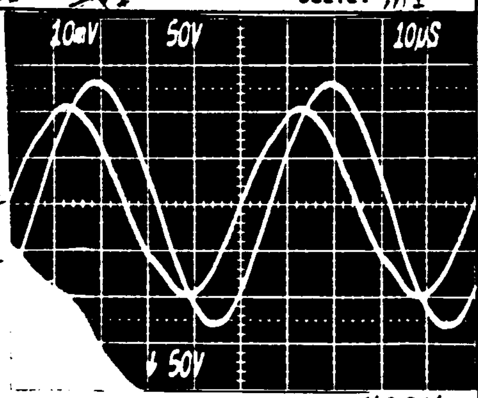
Input Voltage:	149.65	DC Rcvr:	N/C
Input Current:	123.6	AC Rcvr:	N/C
System Frequency:		BD Module:	N/C
Output Power:	14.8 KW	Other:	



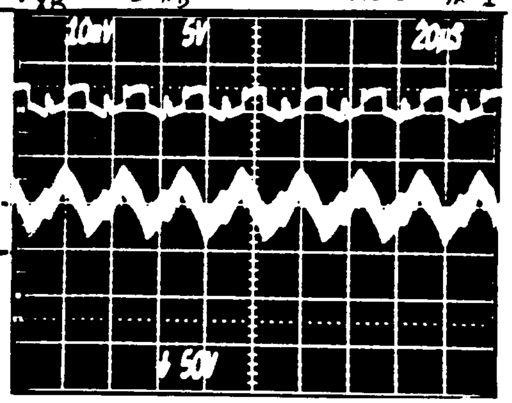
V_{xA} I_{xA} Scale: 320V/10A



V_{xB} I_{xB} Scale: 320V/10A



V_{xC} I_{xC} Scale: 320V/10A



V_{IN}, I_{IN} Scale: 50V/10A

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.7 Power Factor Loads ≠ 1

Specific Case: lagging 0.7 p.f.

Input Voltage: ________ DC Rcvr: ________

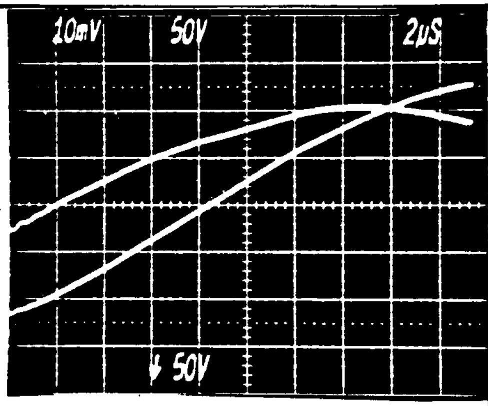
Input Current: ________ AC Rcvr: ________

System Frequency: ________ BD Module: ________

Output Power: ________ Other: ________

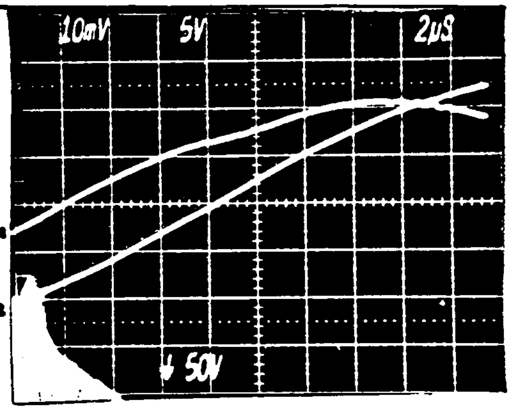
V_{xA}

I_{xA}



V_{xB}

I_{xB}

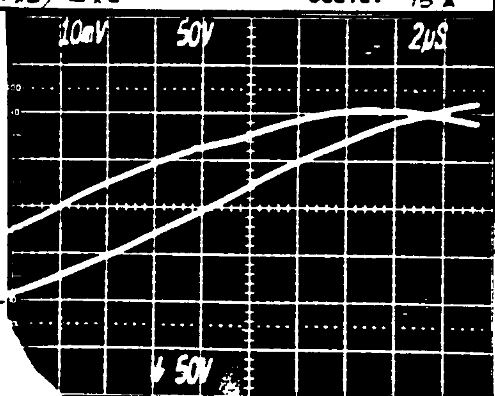


V_{xc} / I_{xc} Scale: 320 V / 10 A

V_{xB} / I_{xB} Scale: 320 V / 10 A

V_{xc}

I_{xc}



Photo

V_{xA} / I_{xA} Scale: 320V / 10 A

Scale:

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2.3.6-3.2.4.1 STEADY-STATE

CONTROL SIGNAL GAIN

SPECIFIC CASE AC RCVR

$f = 20.215$ kHz

Nominal Gate Signal

$\boxed{60Hz}$

$V_{Ref.}$	1.387 V
V_{IN}	120.64
I_{IN}	53.78 A
V_{OUT}	120.6 V
I_{OUT}	2.83 A

-50%

V_{Ref}	.692 V
V_{IN}	120.2
I_{IN}	52.69
V_{OUT}	91.9 V
I_{OUT}	2.33 A

+50%

V_{Ref}	2.07 V
V_{IN}	119.8
I_{IN}	54.54
V_{OUT}	135.8
I_{OUT}	2.97 A

2.3.6-3.2.4.1 STEADY-STATE

CONTROL SIGNAL GAIN

SPECIFIC CASE AC RCVR

$f = 20.188$ kHz

Nominal Gate Signal

$V_{Ref.}$ 1.358 V

V_{IN} 119.9 V

I_{IN} 53.49 A

V_{OUT} 117.8 V

I_{OUT} 2.83 A

$\boxed{400\text{ HZ}}$

−50%

V_{Ref} .676 V

V_{IN} 120.0 V

I_{IN} 52.58 A

V_{OUT} 91.3 V

I_{OUT} 2.47 A

+50%

V_{Ref} 2.03

V_{IN} 119.7 V

I_{IN} 54.21 A

V_{OUT} 132.4 V

I_{OUT} 4.3 A

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.7 Power Factor

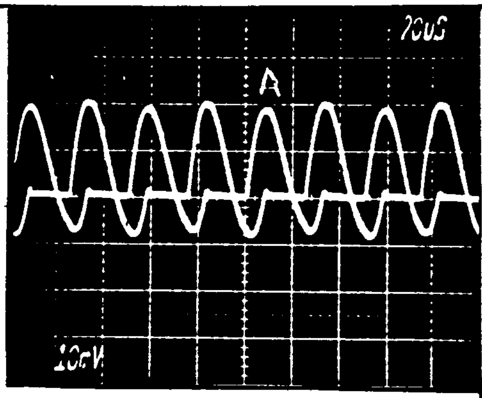
Specific Case: lagging 0.7 p.f.

Input Voltage: Same | **DC Rcvr:**

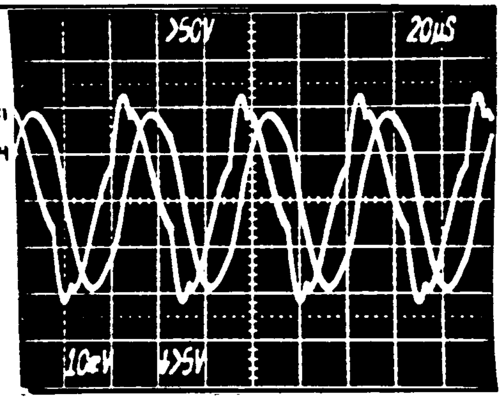
Input Current: | **AC Rcvr:**

System Frequency: | **BD Module:**

Output Power: | **Other:**

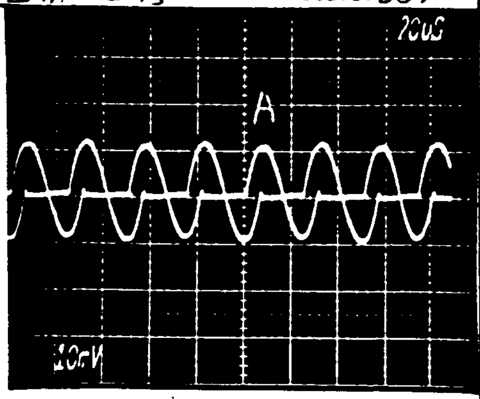


I_{1A} I_{1B} **Scale:** 50 A



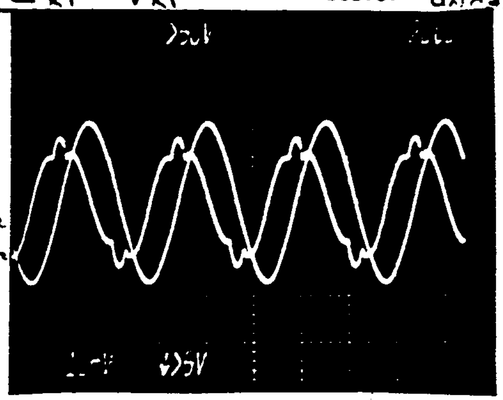
I_{H} V_{H}

I_{K1} V_{K1} **Scale:** 50 A / UNICAL



I_{2A} I_{2B} **Scale:** 50 A

V_{K2} I_{K2}



I_{K2} V_{K2} **Scale:** 50 A / UNCAL

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.7 Power Factor

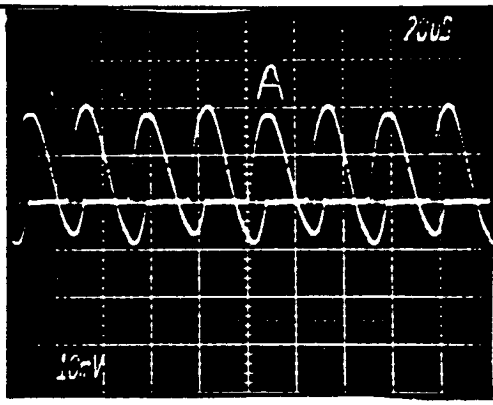
Specific Case: lagging 0.7 p.f.

Input Voltage: Same | DC Rcvr:

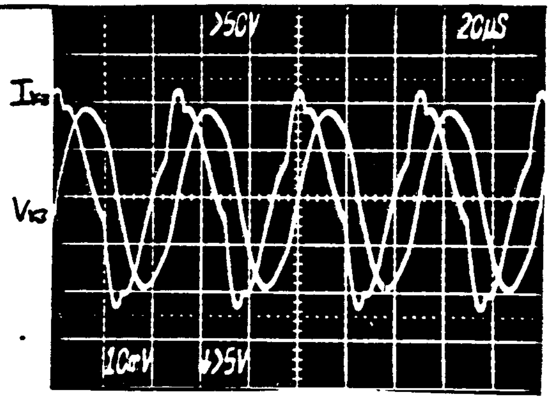
Input Current: | AC Rcvr:

System Frequency: | BD Module:

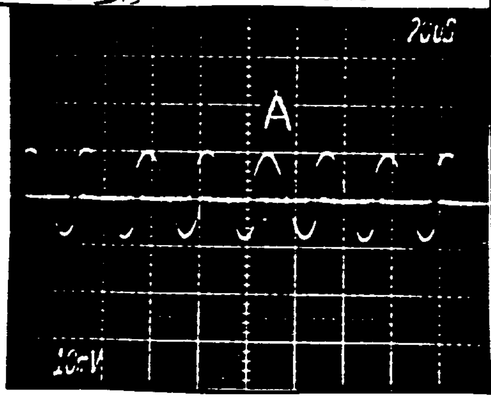
Output Power: | Other:



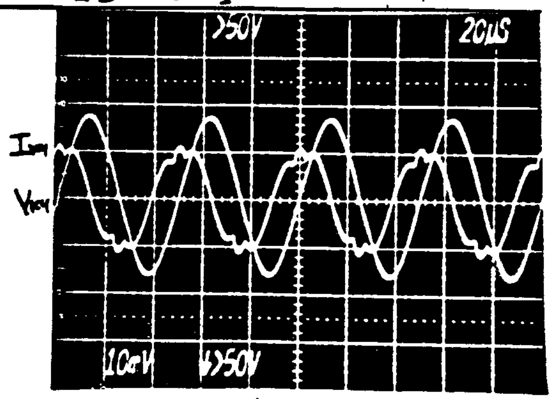
I_{3A} I_{3B} Scale: 50 A



V_{K3} I_{K3} Scale:



I_{4A} I_{4B} Scale:



I_{K4} V_{K4} Scale:

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.7.7 Power Factor (-0.7 - +0.7)

Specific Case: Lagging P.F.

Input Voltage: Same

Input Current:

System Frequency:

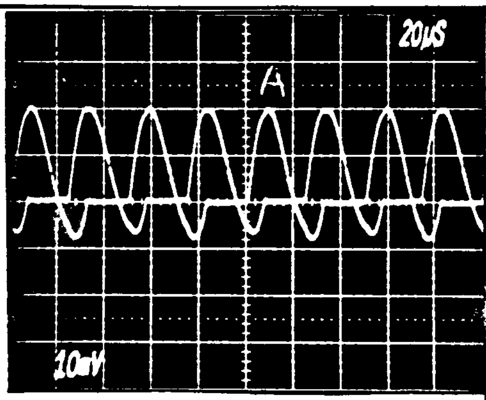
Output Power:

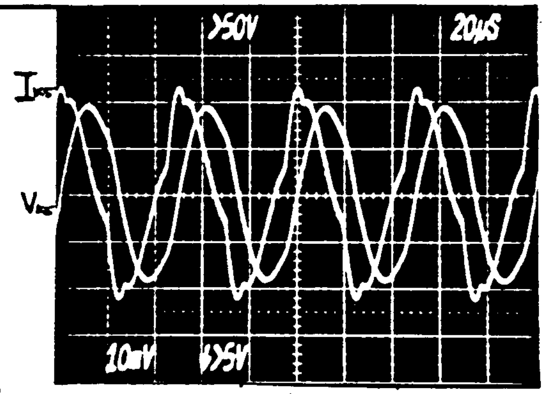
DC Rcvr:

AC Rcvr:

BD Module:

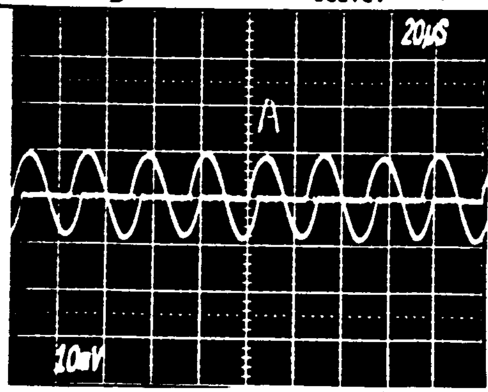
Other:

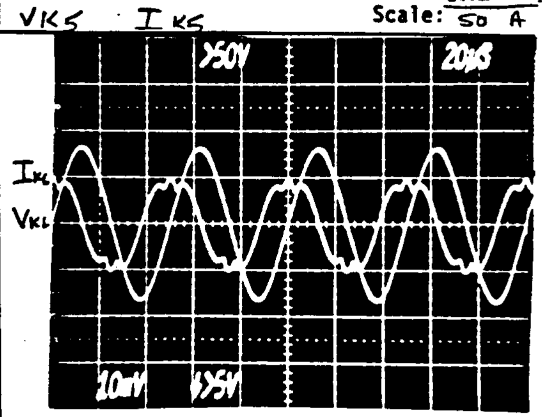




I5A I5B Scale: 50 A

VK5 IK5 Scale: UNCAL V. / 50 A





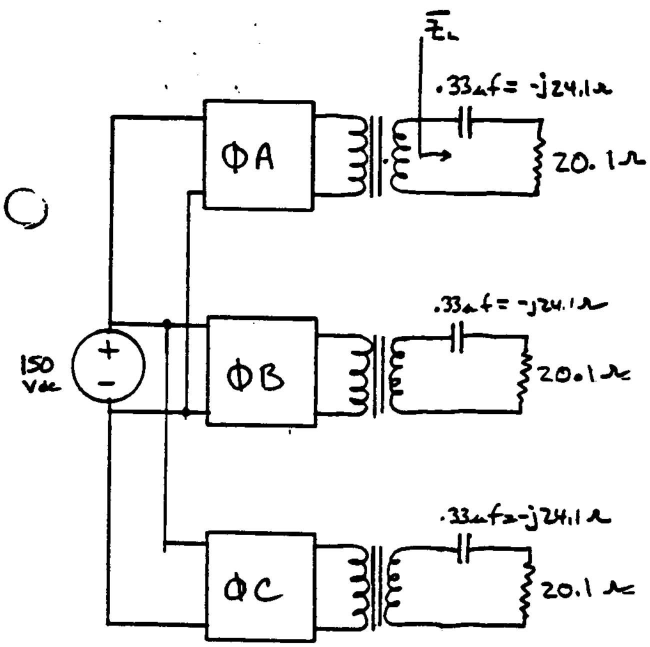
I6A I6B Scale: 50 A

VK6 IK6 Scale: UNCAL V / 50 A

Configuration - Test 2.3.7 - 3.2.7 Power Factor

Leading Power Factor (P.f. = 0.7)

Test Circuits



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Test Config. 3.3.7-3.2.7 Power Factor
Specific Case Leading .7 P.f. Load

I) Input Power

V_{in} 153.0 VDC

I_{in} 20.9mv = 125.4 Adc

P_{in} 19.2 kW

Frequency ______

T.H.D.

ΦA ___ db

ΦB ___ db

ΦC ___ db

T.H.D. – Transmission Line
Into the line
ΦA

All high voltage measurements made with H.P. 3466A DVM, Cal # 146,516

II) Output Power

ΦA	ΦB	ΦC
V_o 431.7	V_o 440.6	V_o 446.8
I_o ___	I_o ___	I_o ___
P_o ___	P_o ___	P_o ___

A.C. RCVR	B/D MOD.	D.C. RCVR
V_o N/C	V_o N/C	V_o N/C
I_o ___	I_o ___	I_o ___
P_o ___	P_o ___	P_o ___

T.H.D. Out of RCVR
______ db

Resistive Loads

ΦA	ΦB	ΦC
V_A 449.6 Vac	V_B 458.2 Vac	V_C 463.6 Vac
I_A 73.5 mv	I_B 74.0 mv	I_C 76.0 mv
I_A 14.6 Aac	I_B 15.0 Aac	I_C 15.1 Aac
P_{RA} 4.66 kW	P_{RB} 5.02	P_{RC} 5.11 kW
P.f. = .71	P.f. = .73	P.f. = .73

Total System Efficiency $= \frac{P_{out}}{P_{in}} = \frac{14.8}{19.2} = 77.1\%$

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.7 Power Factor

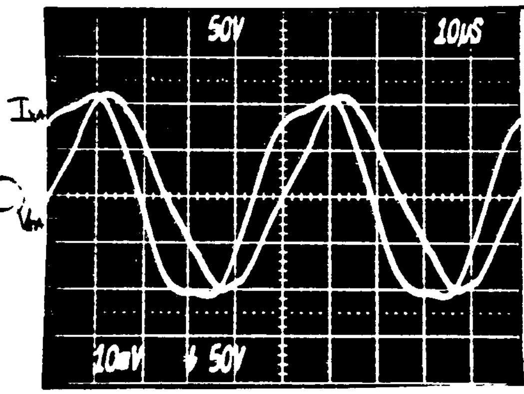
Specific Case: LEADING 0.7 p.f.

Input Voltage: ______ DC Rcvr: ______

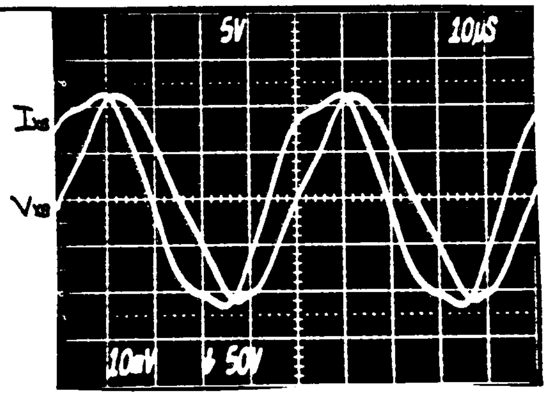
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

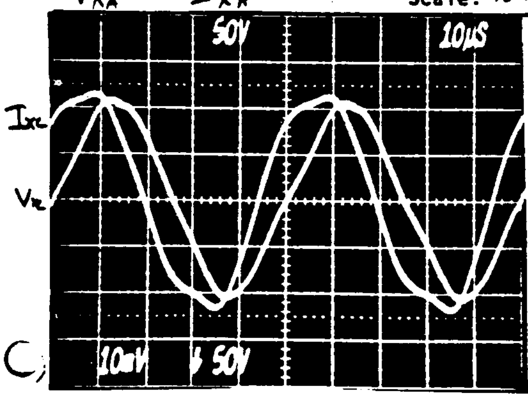
Output Power: ______ Other: ______



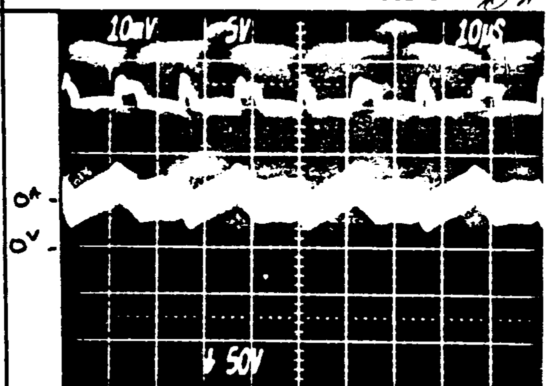
V_{XA} I_{XA} Scale: 320V / 10 A



V_{XB} I_{XB} Scale: 320V / 10 A



V_{XC} I_{XC} Scale: 320V / 10 A



V_{IN} I_{IN} Scale: 50V / 10A

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.7 Power Factor

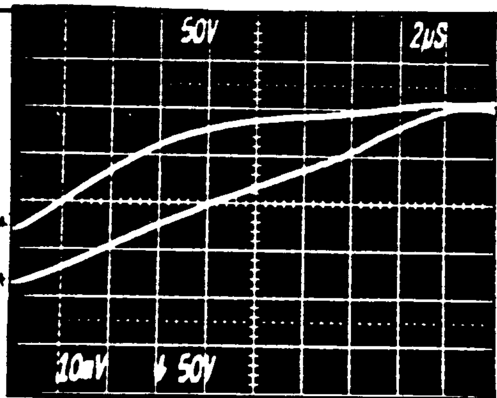
Specific Case: Leading 0.7 P.f.

Input Voltage: ______ DC Rcvr: ______

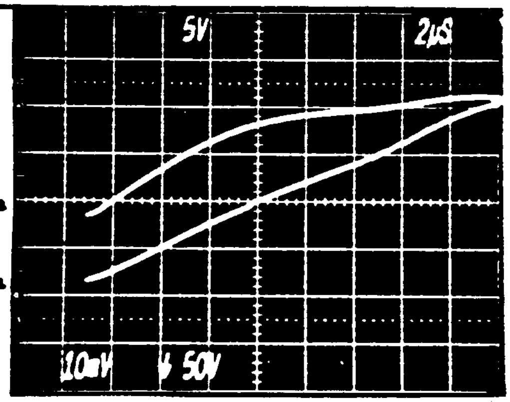
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

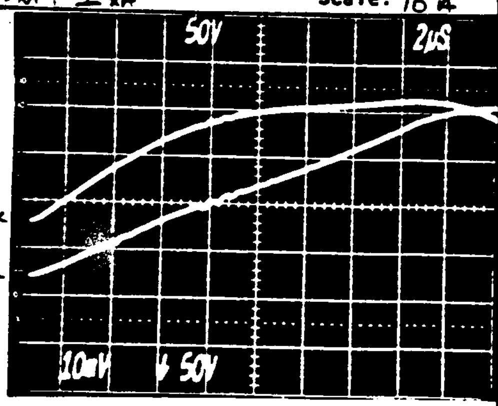
Output Power: ______ Other: ______



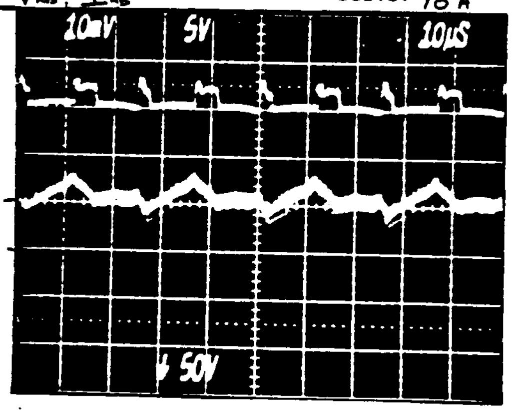
V_{xA}, I_{xA} Scale: $\frac{320\,V}{10\,A}$



V_{xB}, I_{xB} Scale: $\frac{320\,V}{10\,A}$



V_{xC}, I_{xC} Scale: $\frac{320\,V}{10\,A}$



V_{IN} I_{IN}(A.C) Scale: $\frac{50\,V}{10\,A}$

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 – 3.2.7 Power Factor ≠ 1

Specific Case: LeADiNG 0.7 P.f.

Input Voltage: Same

Input Current:

System Frequency:

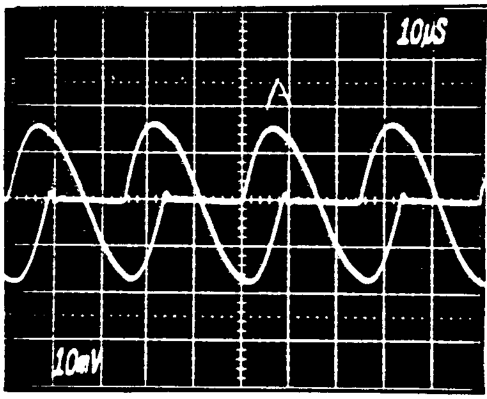
Output Power:

DC Rcvr:

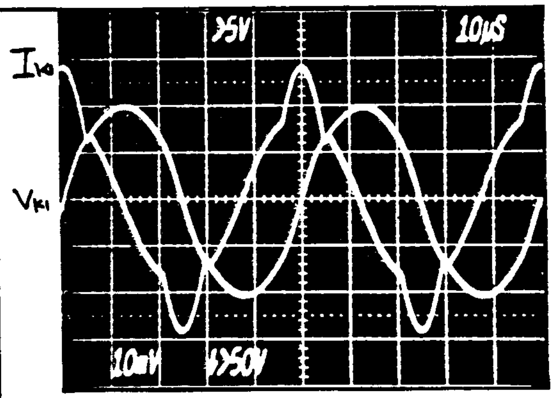
AC Rcvr:

BD Module:

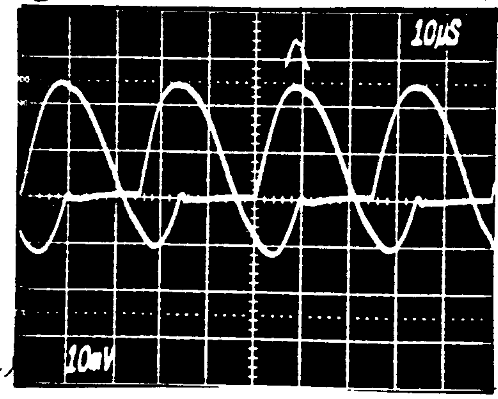
Other:



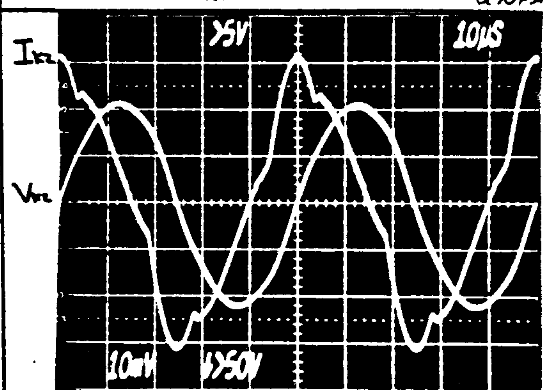
I1A I1B Scale: 50A



IK1 VK1 Scale: 50A UNCAL



I2A I2B Scale: 50A



IK2 VK2 Scale: 50A UNCAL.

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.7 Power Factor

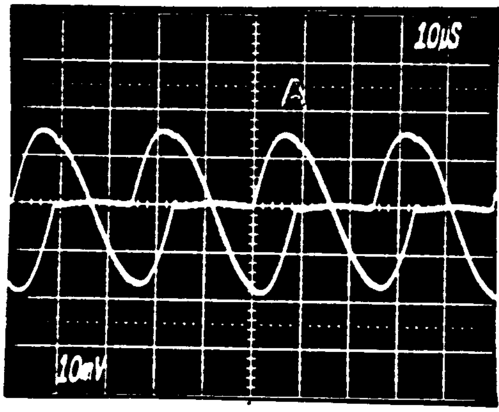
Specific Case: LEADING 0.7 p.f.

Input Voltage: Same DC Rcvr:

Input Current: AC Rcvr:

System Frequency: BD Module:

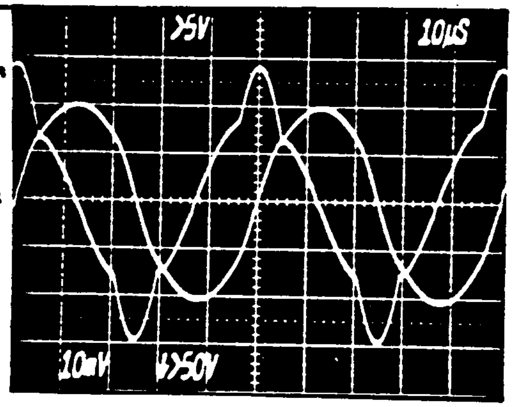
Output Power: Other:



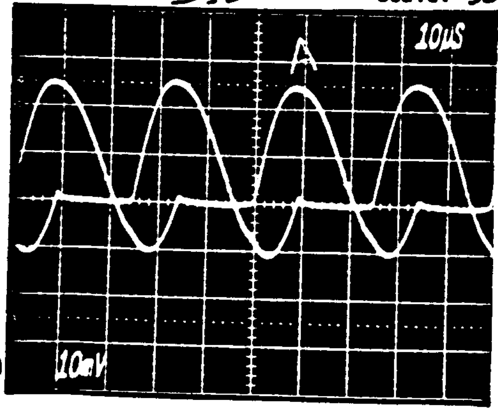
I_{3A} I_{3B} Scale: 50 A

I_{K3}

V_{K3}



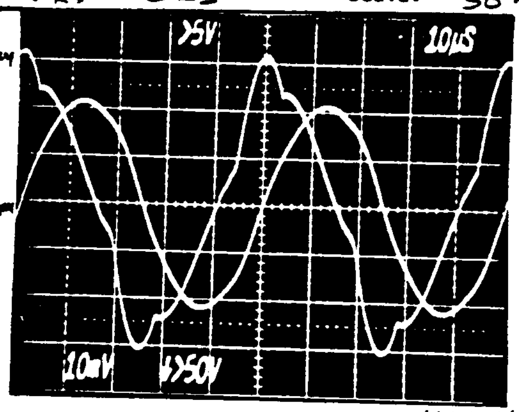
V_{K3} I_{K3} Scale: UNCAL / 50 A



I_{4A} I_{4B} Scale: 50 A

I_{K4}

V_{K4}



V_{K4} I_{K4} Scale: UNCAL V / 50 A

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.7 Power Factor

Specific Case: LEADING 0.7 P.f.

Input Voltage: Same

DC Rcvr:

Input Current:

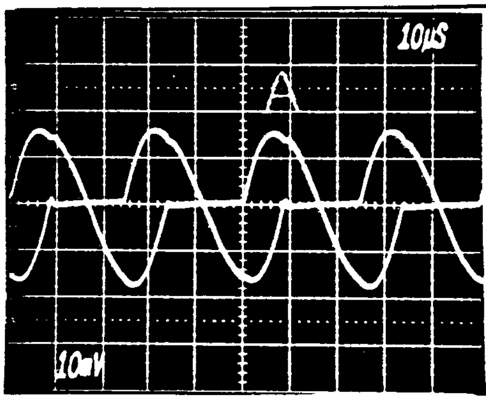
AC Rcvr:

System Frequency:

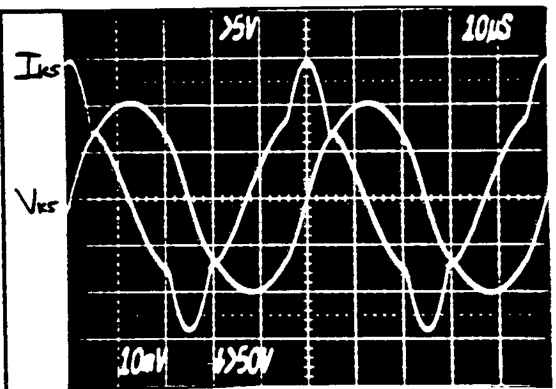
BD Module:

Output Power:

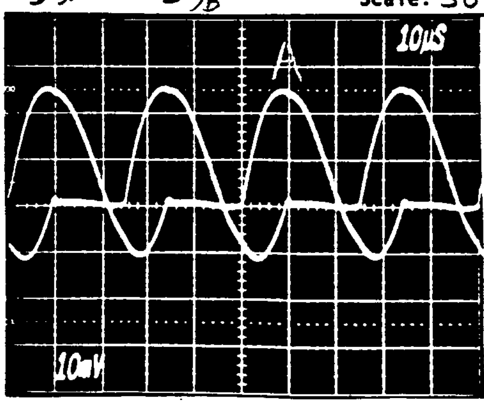
Other:



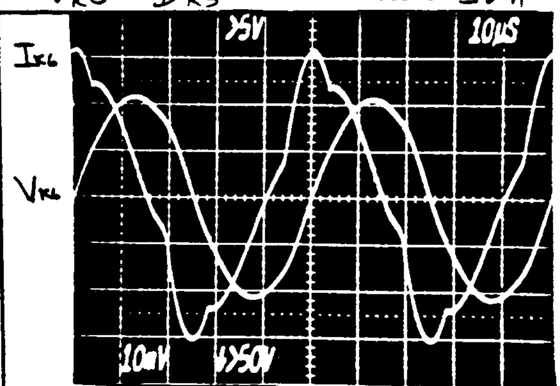
I_{5A} I_{5B} Scale: 50 A



V_{K5} I_{K5} Scale: UNCAL V 50 A



I_{6A} I_{6B} Scale: 50 A



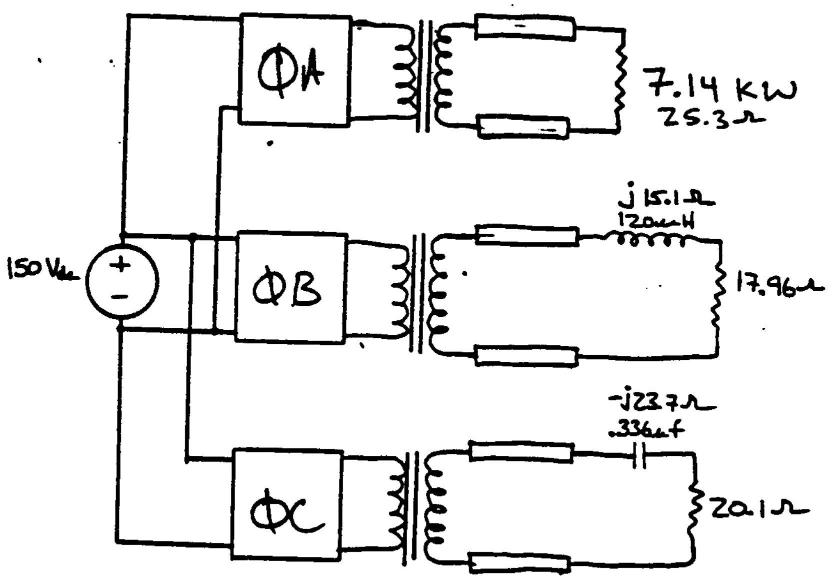
V_{K6} I_{K6} Scale: UNCAL V 50 A

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.7-3.2.2 Steady-State Operation C-Compensation, Unbalanced Power + Power Factor Loads

Test Circuits



2.3.7-3.2.2 Steady-State

SPECIFIC CASE Unbalanced Power Factor Loads
C- Compensation

I) INPUT POWER

V_{in} 149.93 Vdc

I_{in} 23.5 mv = 141 Adc

P_{IN} 21.1 KW

Frequency ______

T.H.D.

ΦA ____ %

ΦB ____ %

ΦC ____ %

T.H.D. — TRANSMISSION LINE

INTO THE LINE

ΦA

All high voltage measurement made with H.P. 3466A DVM, CAL # 146516

II) OUTPUT POWER

ΦA	ΦB	ΦC
V_o 436.4	V_o 439.8	V_o 446.8
I_o 16.7	I_o 17.2	I_o 15.1
P_o 7.29 KW	P_o 5.37 KW	P_o 5.26 KW

$\eta = \frac{17.9}{21.1} = 84.8\%$

A.C. RCVR	B/D MOD.	D.C. RCVR
V_o N/C	V_o N/C	V_o N/C
I_o ____	I_o ____	I_o ____
P_o ____	P_o ____	P_o ____

T.H.D. Out of RCVR

______ db

RESISTIVE LOADS

ΦA	ΦB	ΦC
V_A 427.9 Vac	V_B 412.2 Vac	V_C 466.0 Vac
I_A 84.0 mv	I_B 84.8 mv	I_C 76.2 mv
I_A 16.7 Aac	I_B 17.2 Aac	I_C 15.1 Aac
P_{RA} 7.14 KW	P_{RB} 5.03 KW	P_{RC} 5.49
P.f. = .9997	P.f. = .71	P.f. = .78

Total System Efficiency = $\frac{P_{OUT}}{P_{IN}} = \frac{17.7}{21.1} = 83.9\%$

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady-State Operation

Specific Case: C-Compensation, Unbalanced p.f. Loads

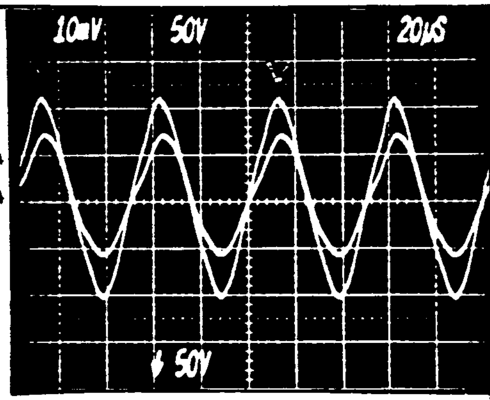
Input Voltage: 149.9 V_{DC} DC Rcvr: N/C

Input Current: 141 A_{DC} AC Rcvr: N/C

System Frequency: BD Module: N/C

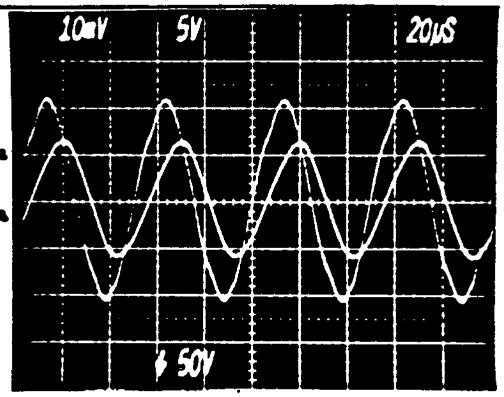
Output Power: 17.7 KW Other: ΦA - 7.14 KW res ΦC - 5.5 KW Capacitive ΦB - 5.03 KW inductive real

V_{XA}, I_{XA}



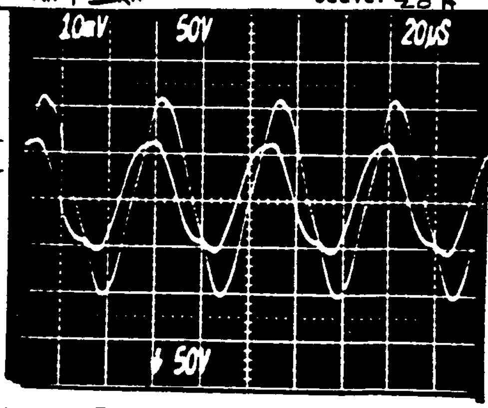
V_{XA}, I_{XA} Scale: $\frac{320V}{20A}$

V_{XB}, I_{XB}



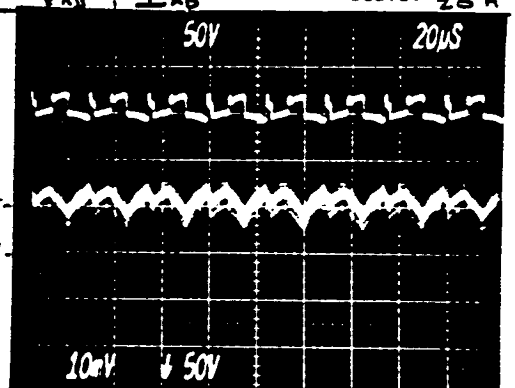
V_{XB}, I_{XB} Scale: $\frac{320V}{20A}$

I_{XC}, V_{XC}



V_{XC}, I_{XC} Scale: $\frac{320V}{20A}$

0A-
0V-



V_{IN}, I_{IN} Scale: 50 V/Div 10 A/Div

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.2 Steady-State Operation

Specific Case: Unbalanced P.f. Loads, C-Comp

Input Voltage: Same

Input Current:

System Frequency:

Output Power:

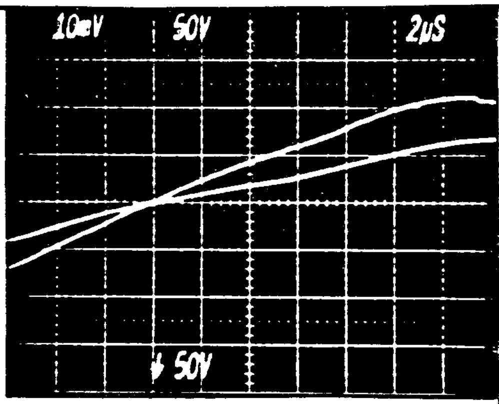
DC Rcvr:

AC Rcvr:

BD Module:

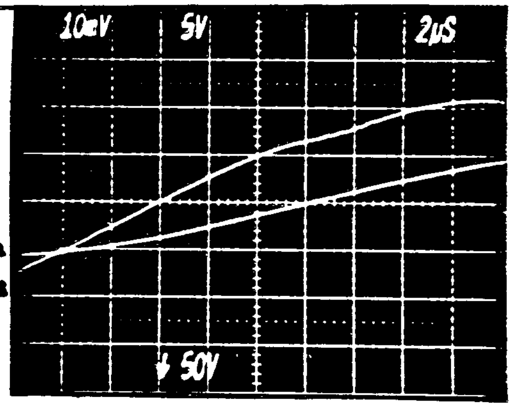
Other:

I_{XA}
V_{XA}



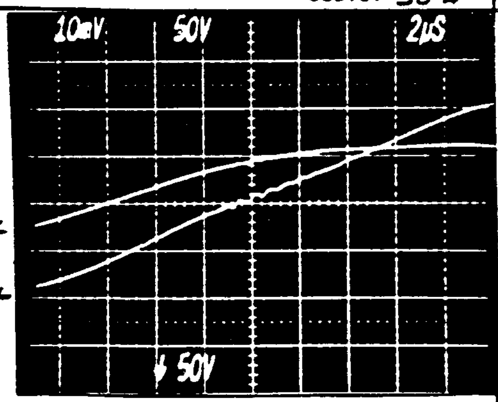
V_{XA} , I_{XA} Scale: $\frac{320\,V}{50\,A}$

I_{XB}
V_{XB}



V_{XB} , I_{XB} Scale: $\frac{320\,V}{50\,A}$

I_{XC}
V_{XC}



V_{XC} , I_{XC} Scale: $\frac{320\,V}{50\,A}$

Photo

Scale:

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.2 Steady-State Operation

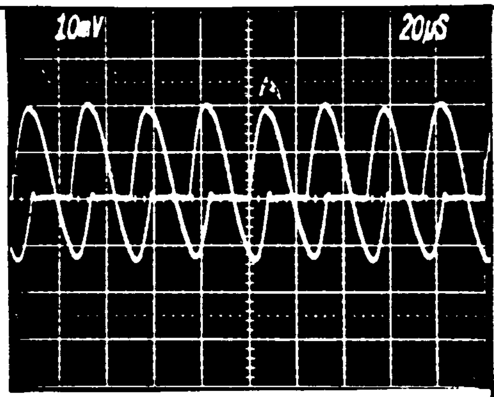
Specific Case: C-Comp, Unbalanced p.f. loads

Input Voltage: Same — DC Rcvr:

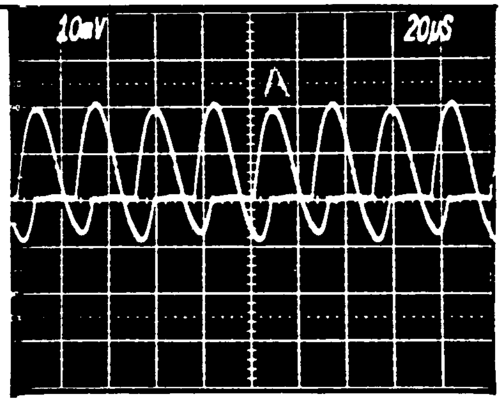
Input Current: — AC Rcvr:

System Frequency: — BD Module:

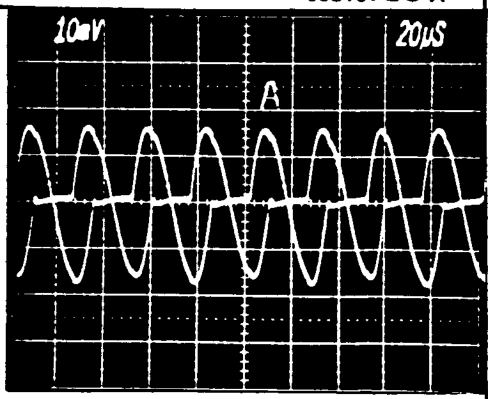
Output Power: — Other:



I_{1A}, I_{1B} Scale: 50A



I_{5A}, I_{5B} Scale: 50 A



I_{5A}, I_{5B} Scale: 50 A

Photo

Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.2 Steady - State operation

Specific Case: C - Case, Unbalanced p.f. loads

Input Voltage: same

Input Current:

System Frequency:

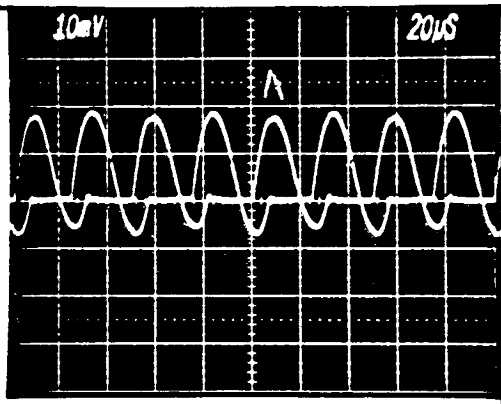
Output Power:

DC Rcvr:

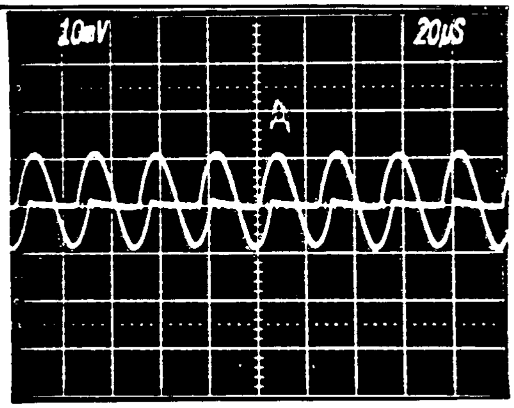
AC Rcvr:

BD Module:

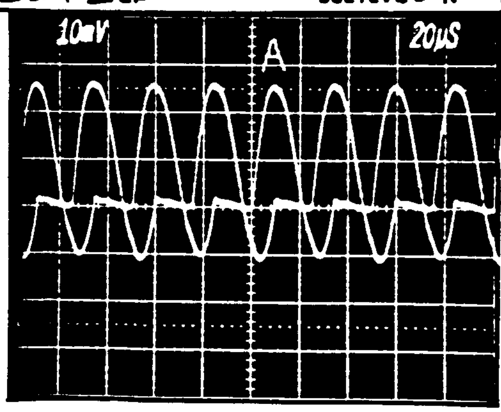
Other:



I_{2A} , I_{2B} Scale: 50 A



I_{4A} , I_{4B} Scale: 50 A



I_{6A} , I_{6B} Scale: 50 A

Photo

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.2 Steady-State Operation

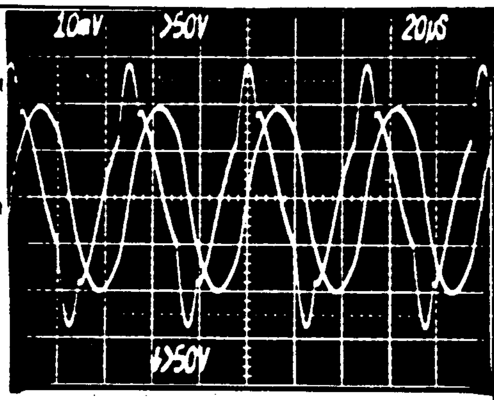
Specific Case: C-Comp, Unbalanced p.f. loads

Input Voltage: ______ DC Rcvr: ______

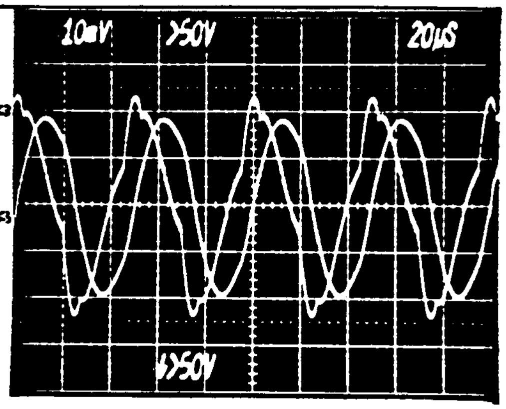
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

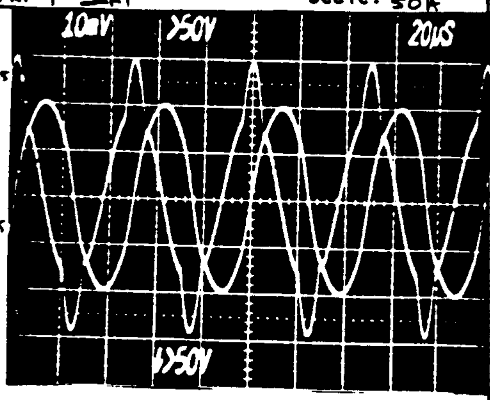
Output Power: ______ Other: ______



V_{K1}, I_{K1} Scale: $\frac{\text{UNCAL V}}{50\text{A}}$



V_{K3}, I_{K3} Scale: $\frac{\text{UNCAL V}}{50\text{A}}$



V_{K5}, I_{K5} Scale: $\frac{\text{UNCAL V}}{50\text{ A}}$

Photo

Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.7.2 Steady-State Operation

Specific Case: C-Comp, Unbalanced p.f. loads

Input Voltage: ______ DC Rcvr: ______

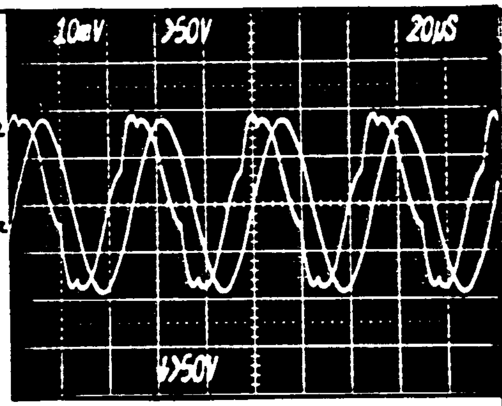
Input Current: ______ AC Rcvr: ______

System Frequency: ______ BD Module: ______

Output Power: ______ Other: ______

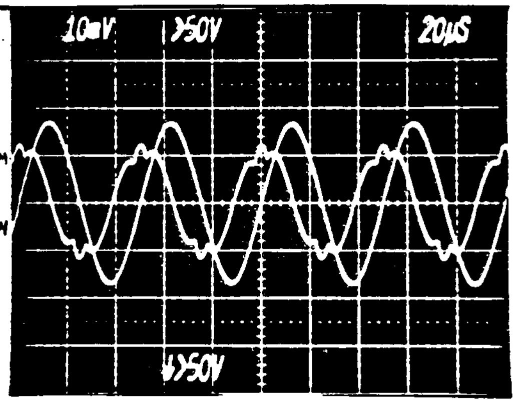
I_{K2}

V_{K2}



I_{K4}

V_{K4}

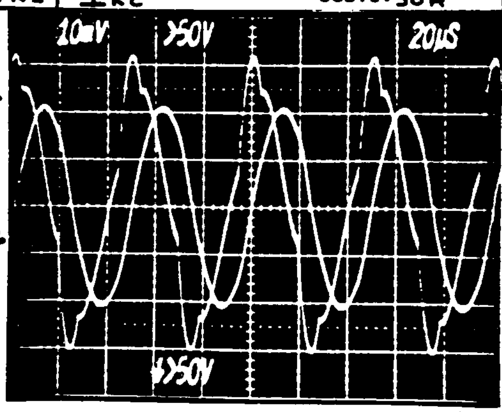


V_{K2}, I_{K2} Scale: UNCAL 50A

V_{K4}, I_{K4} Scale: UNCAL 50A

I_{K6}

V_{K6}



Photo

V_{K6} I_{K6} Scale: UNCAL 50A

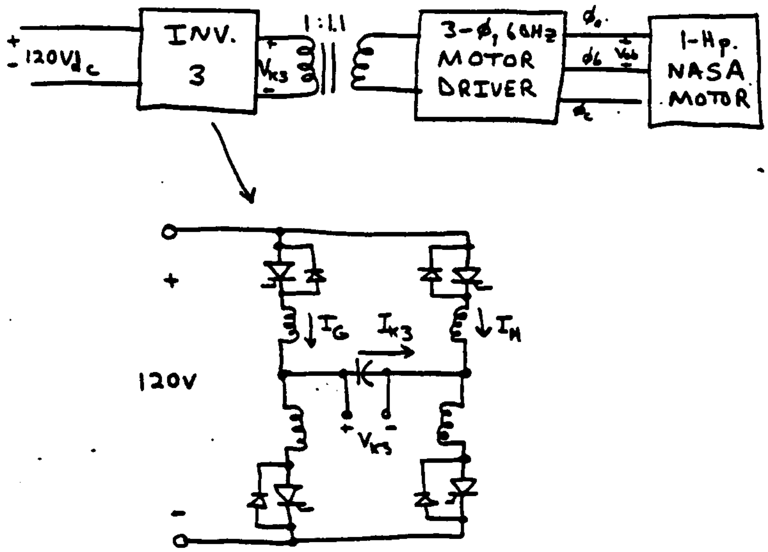
Scale:

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6 - 3.2.8 60Hz MOTOR TESTING — LOADED

Test Circuits



RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6- 3.2.8 MOTOR TESTING

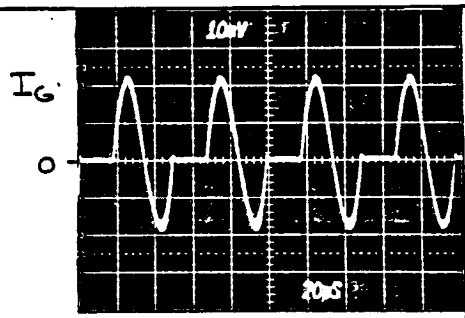
Specific Case:

Input Voltage: 120.0V DC Rcvr: —

Input Current: — AC Rcvr: 60Hz , 230 V_{LL}

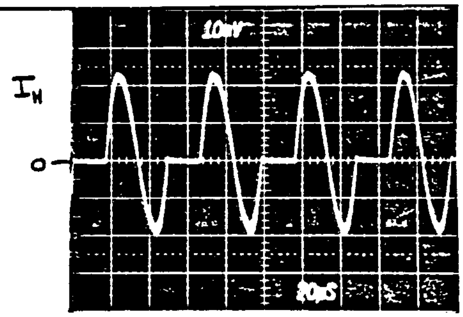
System Frequency: 20.3 kHz BD Module: —

Output Power: — Other: —



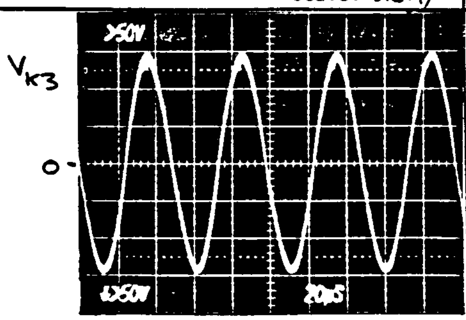
INVERTER 3

LEG CURRENT Scale: 20A/



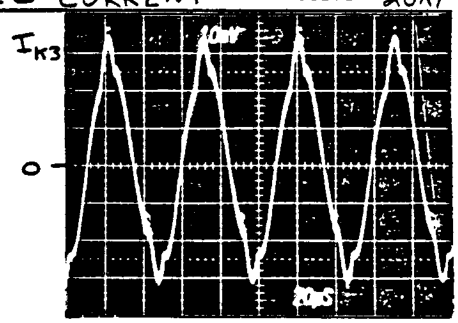
INVERTER 3

LEG CURRENT Scale: 20A/



INVERTER 3

Output Voltage Scale: Not to Scale



INVERTER 3

Tank Current Scale: 20A/

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 23.6 - 3.2.8 MOTOR TESTING

Specific Case:

Input Voltage: Same DC Rcvr:

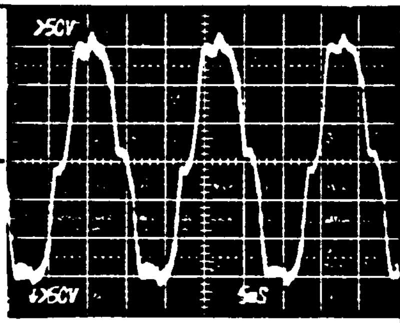
Input Current: AC Rcvr:

System Frequency: BD Module:

Output Power: Other:

V_{ab}

0 -



MOTOR DRIVER

Output Voltage Scale: Not to Scale

Photo

Scale:

Photo

Scale:

Photo

Scale:

10-17-85

TEST CONFIG. 3.2.10 EMI
SPECIFIC CASE CE03-INPUT

I) INPUT POWER

V_{in} 150
I_{in} 180 A
P_{IN} ______

Frequency ______

~~T.H.D.~~
~~ΦA ____ %~~
~~ΦB ____ %~~
~~ΦC ____ %~~

T.H.D. – TRANSMISSION LINE
INTO THE LINE
ΦA

II) OUTPUT POWER

ΦA	ΦB	ΦC
V_o ____	V_o ____	V_o ____
I_o ____	I_o ____	I_o ____
P_o ____	P_o ____	P_o ____

A.C. RCVR	B/D MOD.	D.C. RCVR
V_o 109	V_o 99 Vac	V_o 24.1
I_o 4.4 A	I_o 6.9 Adc	I_o 23.1
P_o 475	P_o ____	P_o ____

T.H.D. Out of RCVR
______ db

RESISTIVE LOADS

ΦA	ΦB	ΦC
V_A 426.1 Vac	V_B 423.4 Vac	V_C 427.5 Vac
I_A 83.14 mv	I_B 81.24 mv	I_C 89.13 mv
I_A 16.53 Aac	I_B 16.48 Aac	I_C 17.66 Aac
P_{RA} ______	P_{RB} ______	P_{RC} ______

Total System Efficiency = $\frac{P_{OUT}}{}$ = ______ = %

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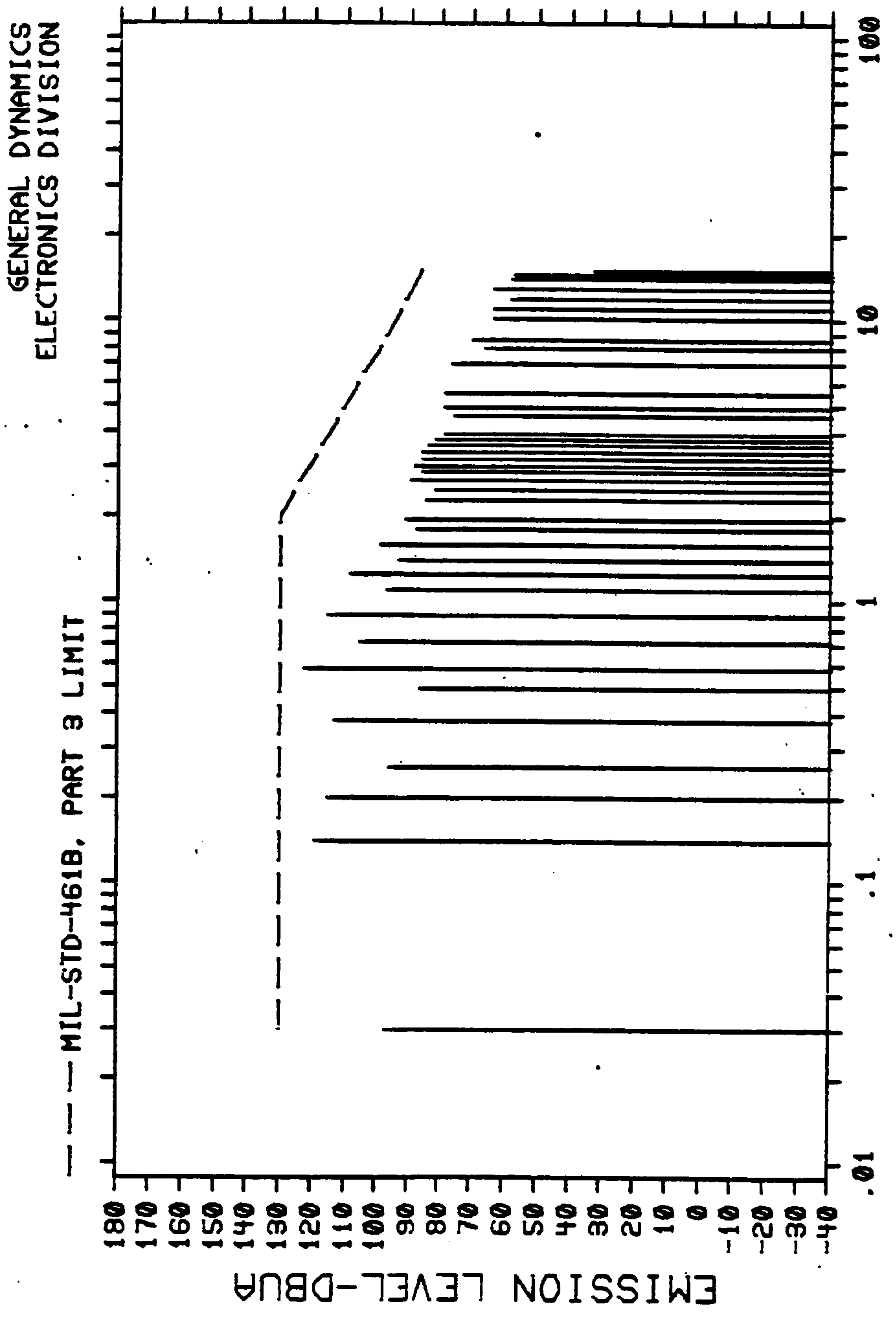

NARROWBAND CONDUCTED EMISSION CE01 30HZ-15KHZ
ITEM: SPACE STATION PS
CONDITIONS: 150VDC HOT LINE TESTED AT 180 AMPS
GRAPH NO. 1 OCT 17, 1985 13:48:41

SHEET _____

GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 1-1 OF 1
OCT 17 1985 13:48:41

NARROWBAND CONDUCTED EMISSION CE01 30HZ-15KHZ

ITEM: SPACE STATION PS MFG: CONVAIR
SN: PROTOTYPE PN:
SPEC: MIL-STD-461B PART 3
CONDITIONS: 150VDC HOT LINE, TESTED AT 180 AMPS

FREQ KHZ	METER READING DBUV	PROBE FACTOR DB	CABLE LOSS DB	EMISSION LEVEL DBUA	SPEC LIMIT	OVER LIMIT DB
0.03000	52	45	0	97	130	
0.14000	87	32	0	119	130	
0.20000	87	28	0	115	130	
0.26000	78	26	0	96	130	
0.38000	90	23	0	113	130	
0.49000	65	21	0	86	130	
0.58000	102	20	0	122	130	
0.72000	86	19	0	105	130	
0.90000	96	17	0	113	130	
1.10000	81	16	0	97	130	
1.25000	93	15	0	108	130	
1.40000	78	15	0	93	130	
1.60000	85	14	0	99	130	
1.80000	73	14	0	87	130	
1.96000	77	14	0	91	130	
2.30000	71	13	0	84	127	
2.50000	68	13	0	81	125	
2.70000	76	13	0	89	123	
2.90000	72	13	0	85	122	
3.05000	76	12	0	88	121	
3.20000	73	12	0	85	120	
3.40000	73	12	0	85	118	
3.60000	71	12	0	83	117	
3.80000	69	12	0	81	116	
3.95000	66	12	0	78	115	
4.60000	64	11	0	75	112	
4.90000	67	11	0	78	110	
5.50000	67	11	0	78	108	
7.00000	65	11	0	76	103	
8.00000	55	11	0	66	100	
8.60000	59	11	0	70	98	
10.200	53	10	0	63	94	
11.000	53	10	0	63	93	
12.000	48	10	0	58	91	
13.000	53	10	0	63	89	
14.000	48	10	0	58	88	
14.500	47	10	0	57	87	
15.000	23	10	0	33	86	

CONDUCTED BY Ed Price

APPROVED BY A. K. Mill

CERTIFIED BY

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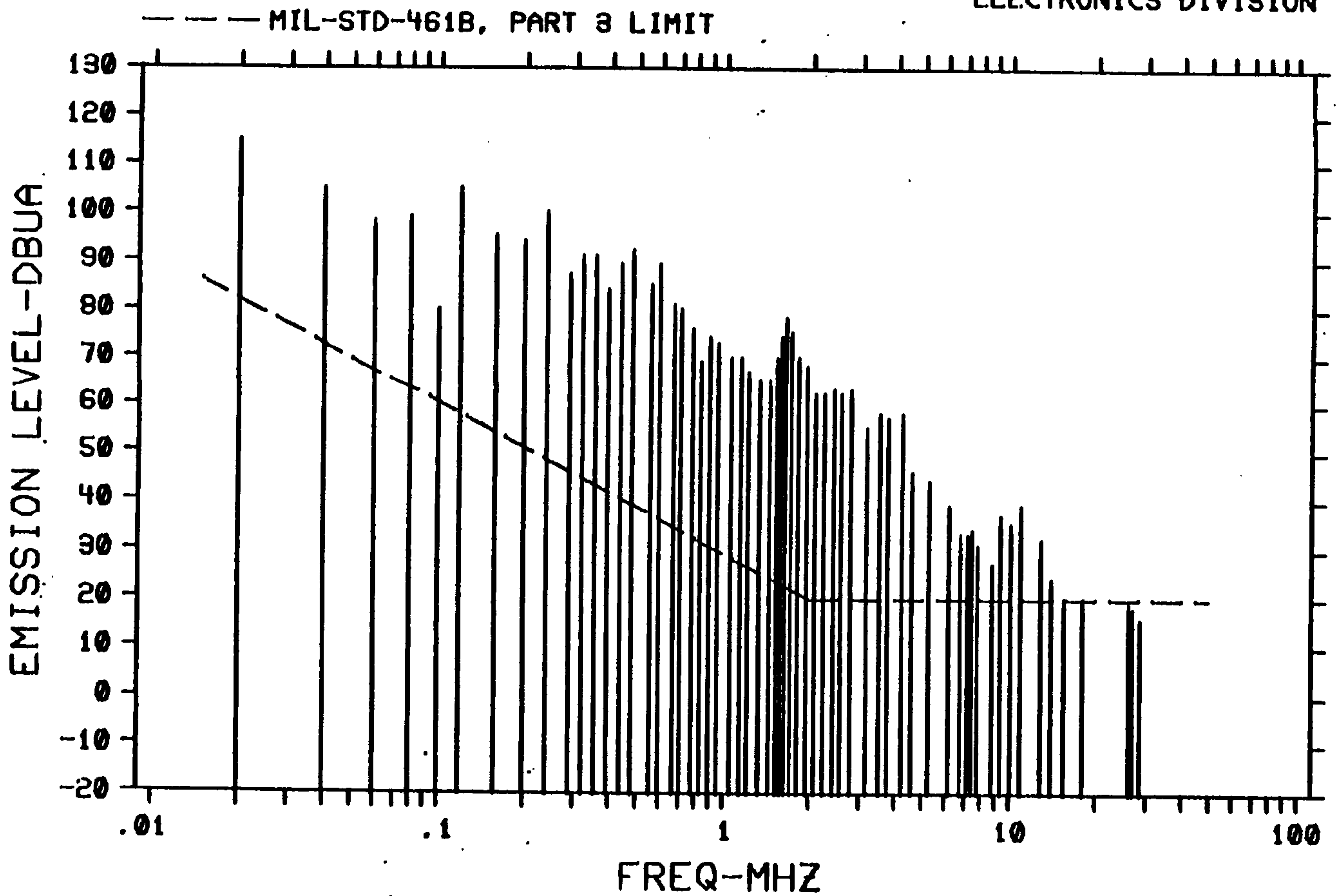
GENERAL DYNAMICS
ELECTRONICS DIVISION



NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ
ITEM: SPACE STATION PS
CONDITIONS: 150VDC HOT LINE TESTED AT 180 AMPS
GRAPH NO. 2 OCT 17, 1985 13:17:04

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GENERAL DYNAMICS   TAB NO. 2-1 OF 2
ELECTRONICS DIVISION   OCT 17, 1985 13:17:04

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS   MFG: CONVAIR
SN: PROTOTYPE   PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: 150VDC HOT LINE TESTED AT 100 AMPS

FREQ	METER READING	PROBE FACTOR	CABLE LOSS	EMISSION LEVEL	SPEC LIMIT	OVER LIMIT
MHZ	DBUV	DB	DB	DBUA	DBUA	DB
0.02000	103	12	0	115	82	33
0.04000	99	6	0	105	73	32
0.06000	95	3	0	98	67	31
0.08000	99	0	0	99	63	36
0.10000	82	-2	0	80	60	20
0.12000	108	-3	0	105	58	47
0.16000	100	-5	0	95	54	41
0.20000	101	-7	0	94	51	43
0.24000	108	-8	0	100	49	51
0.29000	96	-9	0	87	46	41
0.32000	101	-10	0	91	45	46
0.35500	101	-10	0	91	43	48
0.39500	94	-10	0	84	42	42
0.44000	100	-11	0	89	40	49
0.48000	103	-11	0	92	39	53
0.56000	97	-12	0	85	37	48
0.65000	101	-12	0	89	36	53
0.67000	93	-12	0	81	35	46
0.71000	92	-12	0	80	34	46
0.78000	88	-12	0	76	33	43
0.84000	82	-13	0	69	32	37
0.90000	87	-13	0	74	31	43
0.96000	86	-13	0	73	30	43
1.06000	83	-13	0	70	29	41
1.15000	83	-13	0	70	27	43
1.22000	81	-14	0	67	27	40
1.34000	79	-14	0	65	25	40
1.46000	79	-14	0	65	24	41
1.54000	84	-14	0	70	24	46
1.60000	88	-14	0	74	23	51
1.65000	92	-14	0	78	23	55
1.73000	89	-14	0	75	22	53
1.83000	84	-14	0	70	21	49
1.96000	82	-14	0	68	20	48
2.10000	76	-14	0	62	20	42
2.25000	76	-14	0	62	20	42
2.45000	77	-14	0	63	20	43
2.60000	76	-14	0	62	20	42
2.80000	77	-14	0	63	20	43

CONDUCTED BY ED PRICE

APPROVED BY A.H. Mills

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 2-2 OF 2
OCT 17, 1985 13:17:04

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS
SN: PROTOTYPE
SPEC: MIL-STD-461B PART 3
CONDITIONS: 150VDC HOT LINE TESTED AT 150 AMPS

MFG: CONVAIR
PN:

FREQ MHZ	METER READING DBUV	PROBE FACTOR DB	CABLE LOSS DB	EMISSION LEVEL DBUA	SPEC LIMIT	OVER LIMIT DB
2.15000	69	14	1	55	20	35
2.52000	72	14	1	58	20	38
3.08000	71	14	1	57	20	37
4.25000	72	14	1	58	20	38
4.62000	61	14	1	46	20	26
5.30000	58	14	1	44	20	24
6.00000	53	14	1	39	20	19
6.62000	[illegible]	[illegible]	1	[illegible]	20	13
7.30000	47	[illegible]	1	33	20	13
[illegible]	[illegible]	[illegible]	[illegible]	34	20	14
[illegible]	[illegible]	[illegible]	[illegible]	31	20	11
[illegible]	[illegible]	[illegible]	[illegible]	27	20	7
[illegible]	[illegible]	[illegible]	[illegible]	37	20	17
10.200	[illegible]	14	1	35	20	15
11.200	52	14	1	39	20	19
13.000	45	14	1	32	20	12
14.050	37	14	1	24	20	4
15.000	33	14	1	20	20	
16.000	33	14	1	20	20	
26.200	32	14	1	19	20	
27.100	31	14	1	18	20	
28.000	28	13	1	16	20	

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APPROVED BY A.H. Mills

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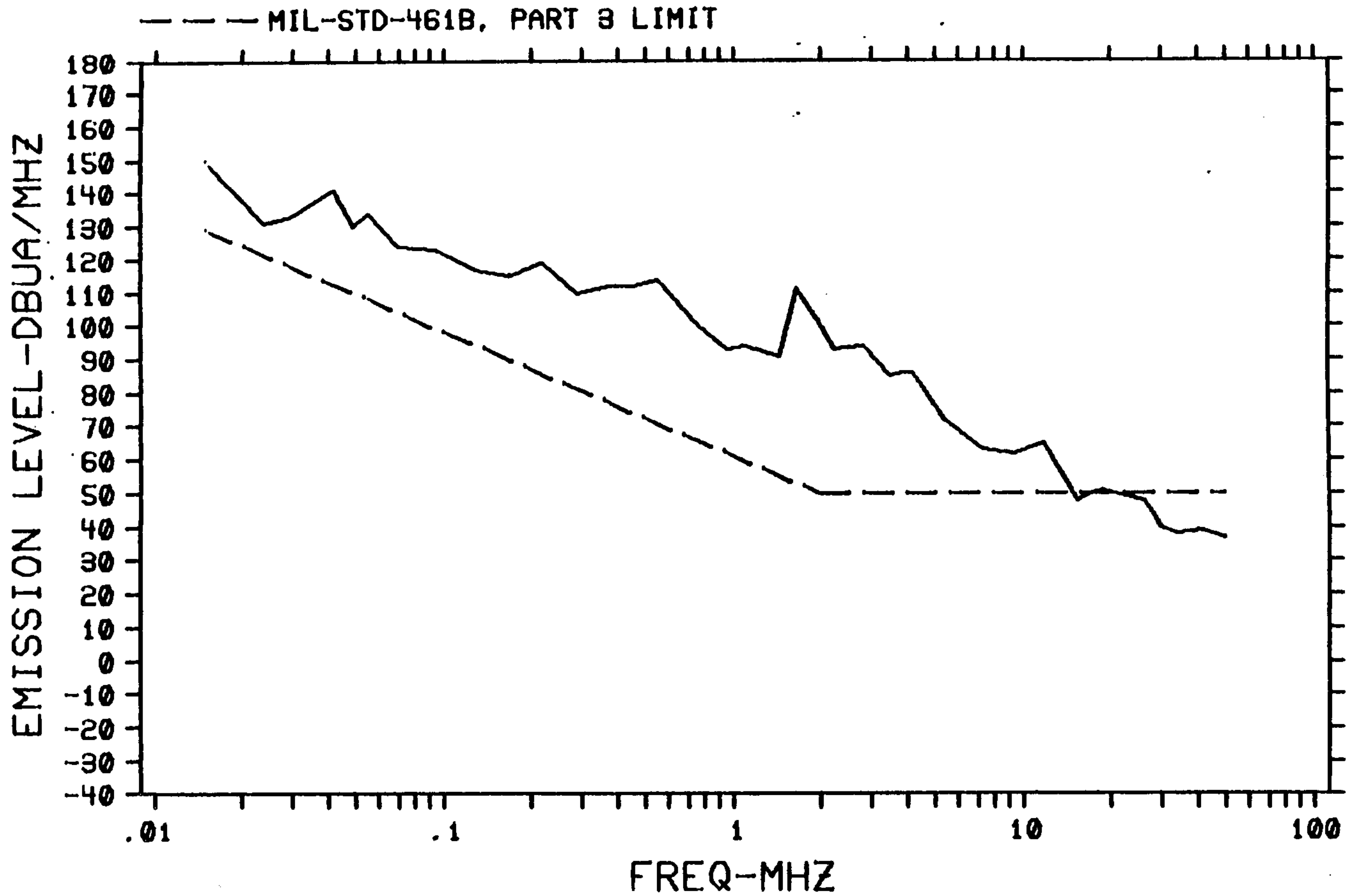
GENERAL DYNAMICS
ELECTRONICS DIVISION



BROADBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ
ITEM: SPACE STATION PS
CONDITIONS: 150 VDC HOT LINE
GRAPH NO. 3 OCT 28, 1985 9:11:46

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 3-1 OF 1
OCT 28, 1985 9:11:46

BROADBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS   MFG: CONVAIR
SN: PROTOTYPE   PN:
SPEC: MIL-STD-461B, PART 2
CONDITIONS: [illegible]

FREQ MHZ	METER READING DBUV	PROBE FACTOR DB	CABLE LOSS DB	BROAD BAND FACTOR DB	EMISSION LEVEL DBUA/MHZ	SPEC LIMIT	OVER LIMIT DB
0.01500	74	16	0	60	150	129	21
0.02400	60	11	0	60	131	121	10
0.03000	64	9	0	60	133	118	15
0.04200	75	6	0	60	141	112	29
0.04900	66	4	0	60	130	110	20
0.05500	71	3	0	[illegible]	134	108	26
0.07[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	124	[illegible]	20
0.09[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	123	99	24
0.1[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	117	94	23
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	23
0.22000	55	[illegible]	[illegible]	40	119	86	33
0.29000	79	[illegible]	[illegible]	[illegible]	110	81	29
0.35000	62	11	0	40	112	77	35
0.46000	53	11	0	40	112	74	38
0.55000	56	12	0	40	114	71	43
0.76000	72	12	0	40	100	66	34
0.96000	66	13	0	40	93	62	31
1.11000	67	13	0	40	94	60	34
1.43000	65	14	0	40	91	55	36
1.66000	53	14	0	40	111	53	58
1.95000	76	14	0	40	102	50	52
2.25000	51	14	0	26	93	50	43
2.65000	52	14	0	26	94	50	44
3.50000	73	14	0	26	85	50	35
3.90000	74	14	0	26	86	50	36
4.20000	74	12	0	26	86	50	36
5.40000	60	14	0	26	72	50	22
7.40000	51	12	0	26	63	50	13
9.50000	50	14	0	26	62	50	12
12.000	52	14	1	26	65	50	15
15.600	35	14	1	26	46	50	
17.500	37	14	1	26	50	50	
19.200	38	14	1	26	51	50	1
26.500	35	14	1	26	45	50	
30.000	26	13	1	26	40	50	
34.000	50	13	1	6	38	50	
42.000	50	12	1	0	39	50	
50.000	47	11	1	0	37	50	

CONDUCTED BY Ed [illegible]

APPROVED BY A.H. Mill

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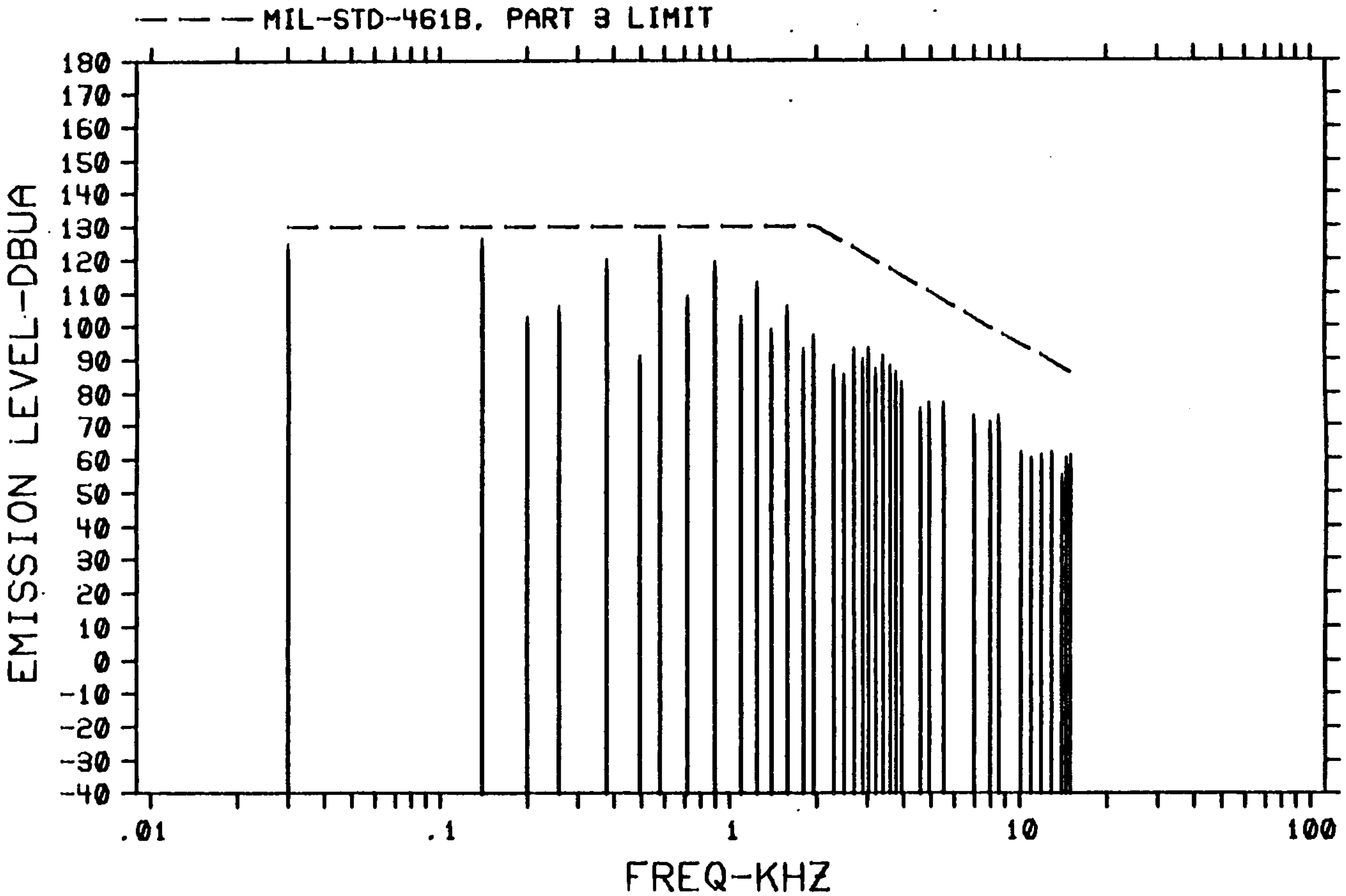
GENERAL DYNAMICS
ELECTRONICS DIVISION



NARROWBAND CONDUCTED EMISSION CE01 30HZ-15KHZ
ITEM: SPACE STATION PS
CONDITIONS: 150 VDC RETURN LINE
GRAPH NO. 4 OCT 28, 1985 10:27:37

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 4-1 OF 1
OCT 28, 1985 10:27:37

NARROWBAND CONDUCTED EMISSION CE01 30HZ-15KHZ

ITEM: SPACE STATION PS MFG: CONVAIR
SN: PROTOTYPE PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: 150 VDC RETURN LINE

FREQ KHZ	METER READING DBUV	PROBE FACTOR DB	CABLE LOSS DB	EMISSION LEVEL DBUA	SPEC LIMIT	OVER LIMIT DB
0.03000	80	45	0	125	130	
0.14000	94	32	0	126	130	
0.20000	75	28	0	103	130	
0.26000	80	26	0	106	130	
0.35000	97	23	0	120	130	
0.49000	70	21	0	91	130	
0.55000	107	20	0	127	130	
0.72000	91	18	0	109	130	
0.90000	102	17	0	119	130	
[illegible]	[illegible]	[illegible]	0	123	130	
1.25000	98	15	0	113	130	
1.40000	84	15	0	99	130	
1.60000	92	14	0	106	130	
1.80000	79	14	0	93	130	
1.96000	83	14	0	97	130	
2.30000	75	13	0	88	127	
2.50000	72	13	0	85	125	
2.70000	80	13	0	93	123	
2.90000	77	13	0	90	122	
3.05000	81	12	0	93	121	
3.20000	75	12	0	87	120	
3.40000	79	12	0	91	118	
3.60000	76	12	0	88	117	
3.80000	74	12	0	86	116	
3.95000	71	12	0	83	115	
4.60000	64	11	0	75	112	
4.90000	66	11	0	77	110	
5.30000	66	11	0	77	108	
7.00000	62	11	0	73	103	
8.00000	60	11	0	71	100	
8.60000	62	11	0	73	98	
10.200	52	10	0	62	94	
11.000	50	10	0	60	93	
12.000	51	10	0	61	91	
13.000	52	10	0	62	89	
14.000	45	10	0	55	88	
14.500	50	10	0	60	87	
15.000	51	10	0	61	86	

CONDUCTED BY Ed Price

APPROVED BY A. H. Mills

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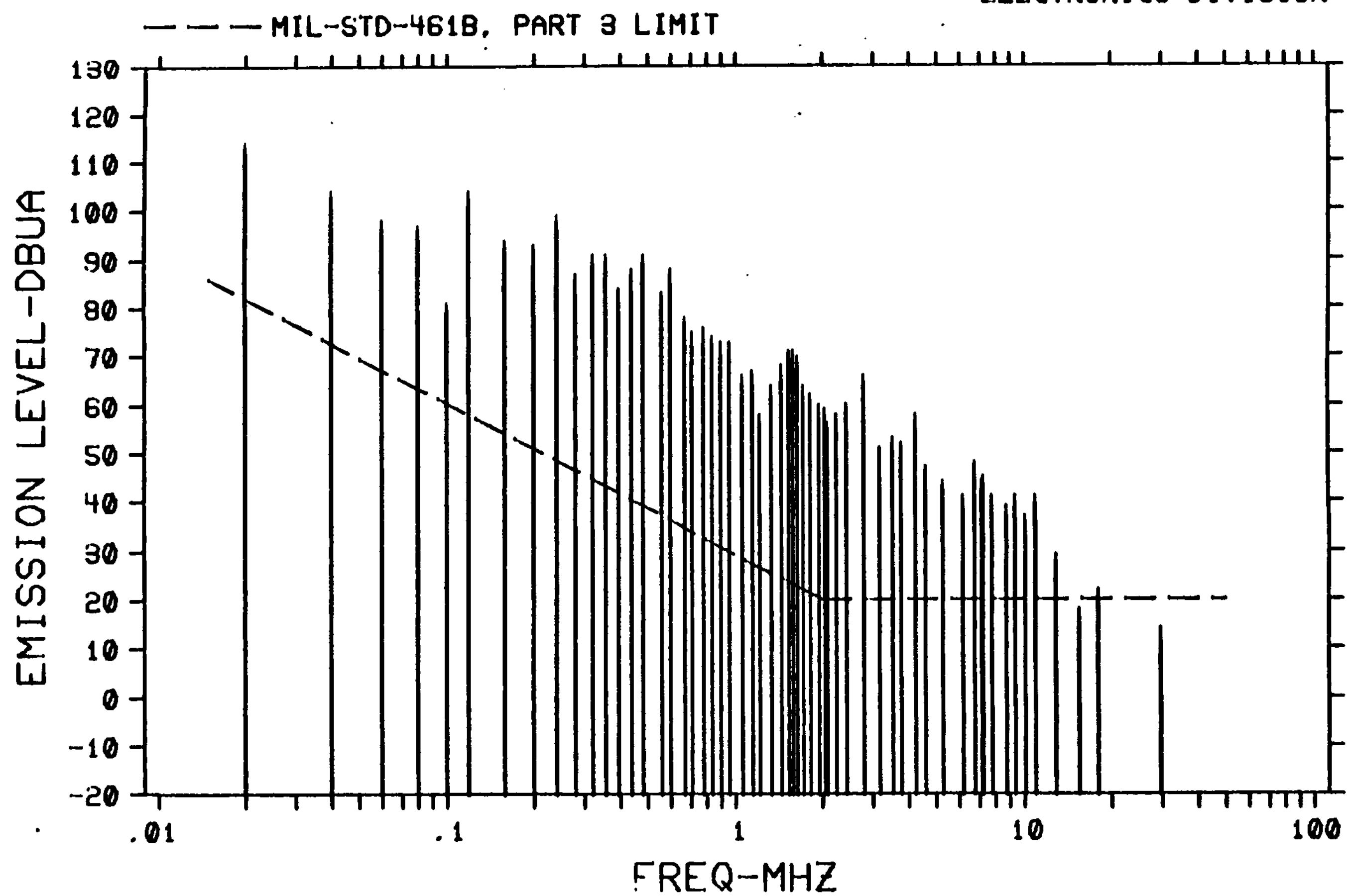
GENERAL DYNAMICS
ELECTRONICS DIVISION



NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ
ITEM: SPACE STATION PS
CONDITIONS: 150 VDC RETURN LINE
GRAPH NO. 5 OCT 28, 1985 11:15:19

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 5-1 OF 2
OCT 28, 1985 11:15:19

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS MFG: CONVAIR
SN: PROTOTYPE PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: 150 VDC RETURN LINE

FREQ MHZ	METER READING DBUV	PROBE FACTOR DB	CABLE LOSS DB	EMISSION LEVEL DBUA	SPEC LIMIT DBUA	OVER LIMIT DB
0.02000	102	12	0	114	82	32
0.04000	98	6	0	104	73	31
0.06000	95	3	0	98	67	31
0.08000	97	0	0	97	63	34
0.10000	83	-2	0	81	60	21
0.12000	107	-3	0	104	58	46
0.16000	99	-5	0	94	54	40
0.20000	[illegible]	[illegible]	0	93	51	42
0.24000	107	-8	0	99	49	50
[illegible]	96	[illegible]	0	87	47	40
[illegible]	101	[illegible]	0	91	45	46
0.35500	101	-10	0	91	43	48
0.39500	94	-10	0	84	42	42
0.44000	99	-11	0	88	40	48
0.48000	102	-11	0	91	39	52
0.56000	95	-12	0	83	37	46
0.60000	100	-12	0	88	36	52
0.67000	90	-12	0	78	35	43
0.71000	87	-12	0	75	34	41
0.78000	88	-12	0	76	33	43
0.84000	87	-13	0	74	32	42
0.90000	86	-13	0	73	31	42
0.96000	86	-13	0	73	30	43
1.06000	79	-13	0	66	29	37
1.15000	80	-13	0	67	27	40
1.22000	72	-14	0	58	27	31
1.34000	78	-14	0	64	25	39
1.46000	82	-14	0	68	24	44
1.54000	85	-14	0	71	24	47
1.60000	85	-14	0	71	23	48
1.65000	84	-14	0	70	23	47
1.73000	78	-14	0	64	22	42
1.83000	76	-14	0	62	21	41
1.96000	74	-14	0	60	20	40
2.06000	73	-14	0	59	20	39
2.10000	70	-14	0	56	20	36
2.25000	72	-14	0	58	20	38
2.45000	74	-14	0	60	20	40
2.80000	80	-14	0	66	20	46

CONDUCTED BY ED PAKE

APPROVED BY A.H. Mill

CERTIFIED BY ____________________

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 5-2 OF 2
OCT 28, 1985 11:15:19

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS MFG: CONVAIR
SN: PROTOTYPE PN:
SPEC: MIL-STD-461B PART 3
CONDITIONS: 150 VDC RETURN LINE

FREQ	METER READING	PROBE FACTOR	CABLE LOSS	EMISSION LEVEL	SPEC LIMIT	OVER LIMIT
MHZ	DBUV	DB	DB	DBUA		DB
3.18000	65	- 14	0	51	20	31
3.52000	67	- 14	0	53	20	33
3.80000	66	- 14	0	52	20	32
4.25000	72	- 14	0	58	20	38
4.62000	61	- 14	0	47	20	27
5.30000	58	- 14	0	44	20	24
6.20000	55	- 14	0	41	20	21
6.62000	62	- 14	0	48	20	28
7.20000	58	- 14	0	44	20	24
7.30000	59	- 14	0	45	20	25
7.60000	55	- 14	0	41	20	21
8.80000	53	- 14	0	39	20	19
9.40000	55	- 14	0	41	20	21
10.200	50	- 14	1	37	20	17
11.000	54	- 14	1	41	20	21
13.000	42	- 14	1	29	20	9
15.500	31	- 14	1	18	20	
18.000	35	- 14	1	22	20	2
29.600	26	- 13	1	14	20	

CONDUCTED BY ED Price

APPROVED BY A.H. Mill

CERTIFIED BY ______

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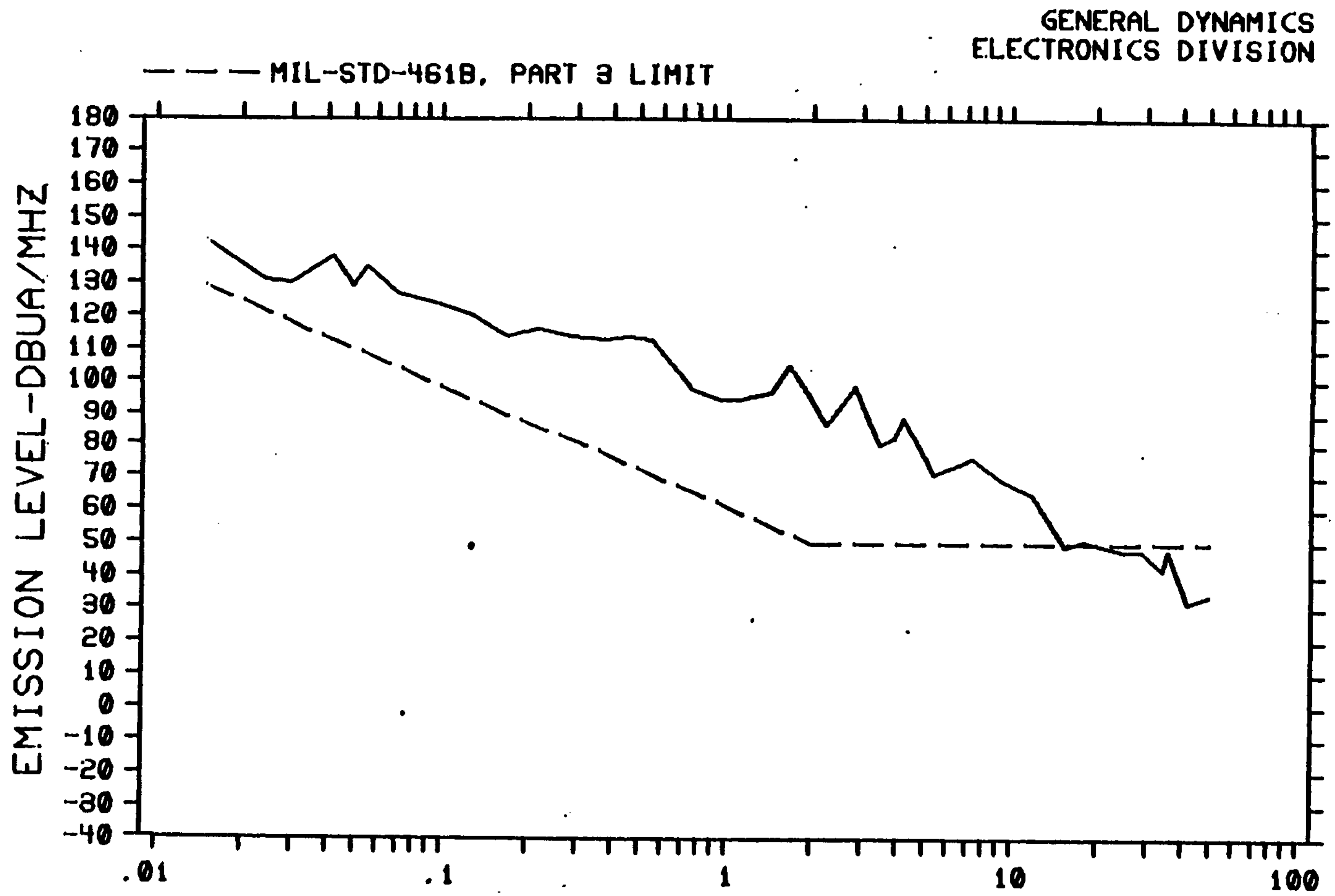

BROADBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS

CONDITIONS: 150 VDC RETURN LINE

GRAPH NO. 6 OCT 28, 1985 11:26:26

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 6-1 OF 1
OCT 28, 1985 11:26:26

BROADBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS
MFG: CONVAIR
SN: PROTOTYPE
PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: 158 VDC RETURN LINE

FREQ MHZ	METER READING DBUV	PROBE FACTOR DB	CABLE LOSS DB	BROAD-BAND FACTOR DB	EMISSION LEVEL DBUA/MHZ	SPEC LIMIT DBUA/MHZ	OVER LIMIT DB
0.01500	67	16	0	60	143	129	14
0.02400	60	11	0	60	131	121	10
0.03000	61	9	0	60	130	118	12
0.04200	72	6	0	60	138	112	26
0.04900	65	4	0	60	129	110	19
0.05500	92	3	0	40	135	108	27
0.07000	86	1	0	40	127	104	23
0.09500	85	-1	0	40	124	99	25
0.13000	84	-4	0	40	120	94	26
0.17500	80	-6	0	40	114	90	24
0.22000	83	-7	0	40	116	86	30
0.29000	83	-9	0	40	114	81	33
0.38000	83	-10	0	40	113	77	36
0.46000	85	-11	0	40	114	74	40
0.55000	85	-12	0	40	113	71	42
0.76000	70	-12	0	40	98	66	32
0.96000	68	-13	0	40	95	62	33
1.11000	68	-13	0	40	95	60	35
1.45000	71	-14	0	40	97	55	42
1.66000	79	-14	0	40	105	53	52
1.95000	70	-14	0	40	96	50	46
2.25000	75	-14	0	26	87	50	37
2.85000	87	-14	0	26	99	50	49
3.50000	68	-14	0	26	80	50	30
3.90000	70	-14	0	26	82	50	32
4.20000	77	-14	0	26	89	50	39
5.40000	59	-14	0	26	71	50	21
7.00000	63	-14	0	26	75	50	25
7.40000	64	-14	0	26	76	50	26
9.50000	57	-14	0	26	69	50	19
12.000	52	-14	1	26	65	50	15
15.600	36	-14	1	26	49	50	
18.000	38	-14	1	26	51	50	1
25.000	35	-14	1	26	48	50	
29.000	34	-13	1	26	48	50	
34.000	54	-13	1	0	42	50	
35.500	60	-13	1	0	48	50	
42.000	43	-12	1	0	32	50	
50.000	44	-11	1	0	34	50	

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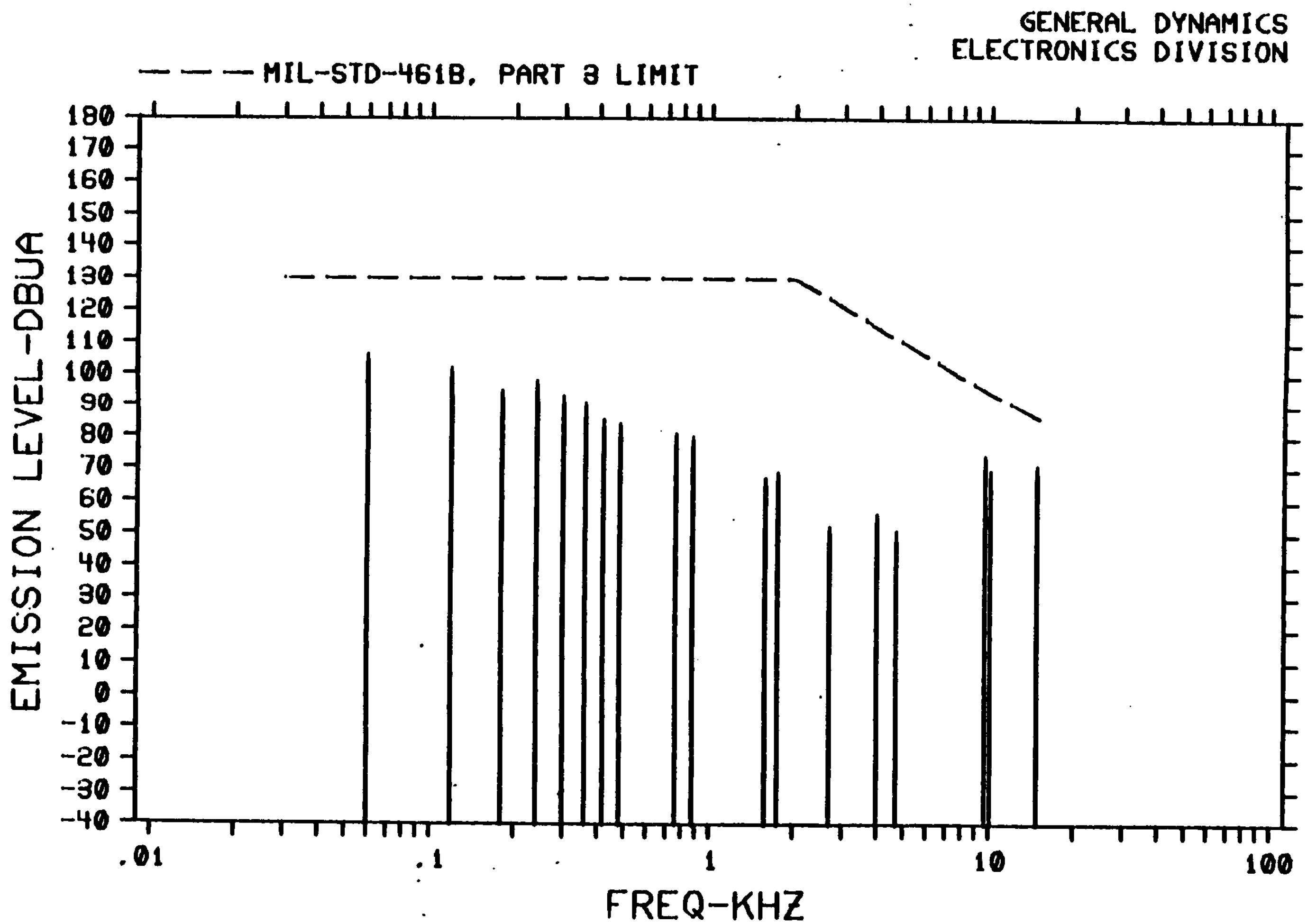

NARROWBAND CONDUCTED EMISSION CE01 30HZ-15KHZ
ITEM: SPACE STATION PS
CONDITIONS: 20KHZ TRANSMISSION BUSS, PHASE A
GRAPH NO. 7 OCT 28, 1985 11:34:40

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 7-1 OF 1
OCT 28, 1985 11:34:40

NARROWBAND CONDUCTED EMISSION CE01 30HZ-15KHZ

ITEM: SPACE STATION PS
MFG: CONVAIR
SN: PROTOTYPE
PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: 20KHZ TRANSMISSION BUSS, PHASE A

FREQ.	METER READING	PROBE FACTOR	CABLE LOSS	EMISSION LEVEL	SPEC LIMIT	OVER LIMIT
KHZ	DBUV	DB	DB	DBUA		DB
0.06000	67	39	0	106	130	
0.12000	69	33	0	102	130	
0.18000	65	30	0	95	130	
0.24000	71	27	0	98	130	
0.30000	68	25	0	93	130	
0.36000	67	24	0	91	130	
0.42000	63	22	0	85	130	
0.48000	62	22	0	84	130	
0.76000	63	18	0	81	130	
0.88000	63	17	0	80	130	
1.68000	53	14	0	67	130	
1.76000	55	14	0	69	130	
2.78000	39	13	0	52	123	
4.10000	44	12	0	56	115	
4.78000	40	11	0	51	111	
9.67000	63	11	0	74	96	
10.200	60	10	0	70	94	
14.900	61	10	0	71	86	

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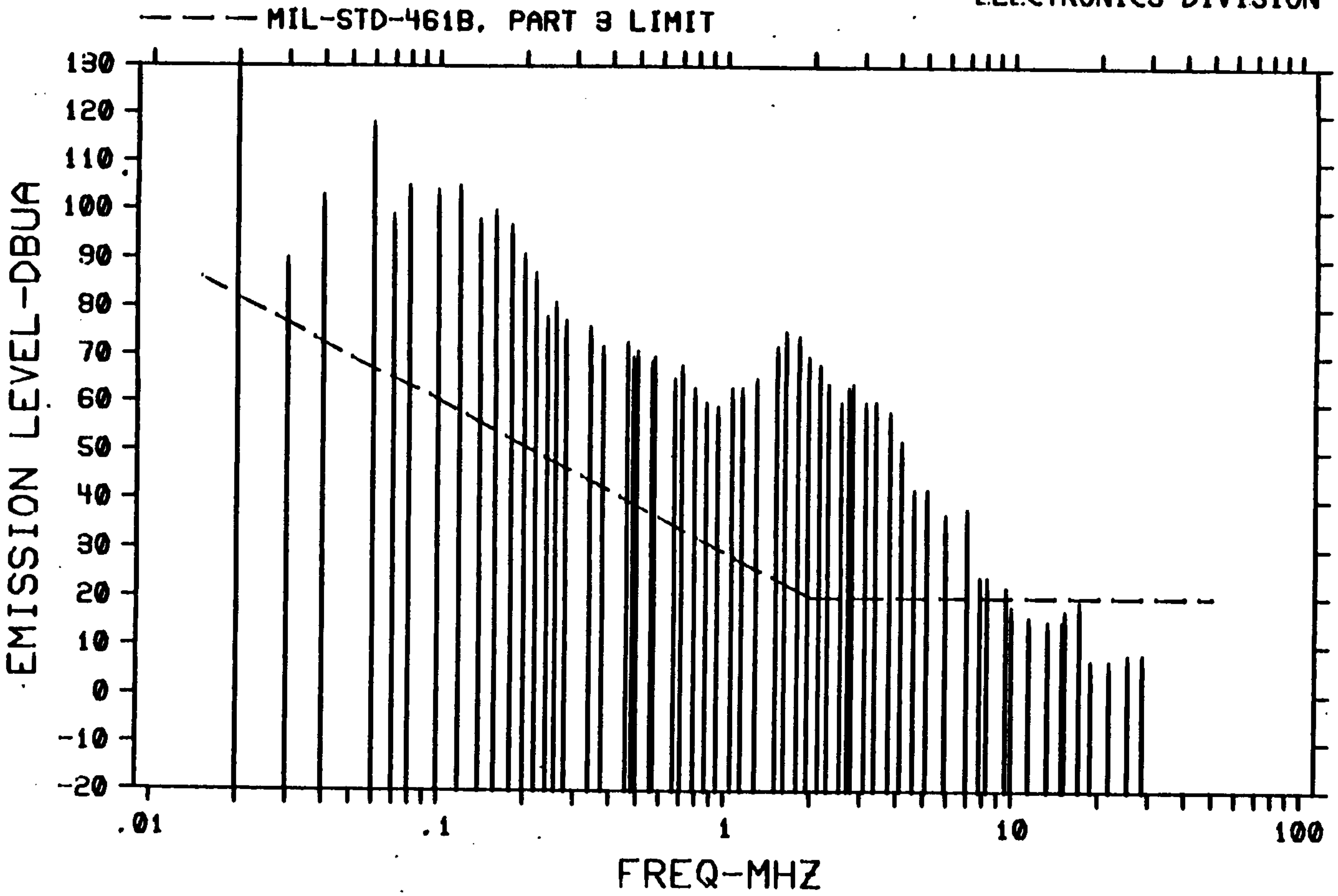

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ
ITEM: SPACE STATION PS
CONDITIONS: 20KHZ TRANSMISSION BUSS, PHASE A
GRAPH NO. 8 OCT 28, 1985 11:41:33

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 8-1 OF 2
OCT 28, 1985 11:41:33

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS MFG: CONVAIR
SN: PROTOTYPE PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: 20KHZ TRANSMISSION BUSS, PHASE A

FREQ. MHZ	METER READING DBUV	PROBE FACTOR DB	CABLE LOSS DB	EMISSION LEVEL DBUA	SPEC LIMIT DBUA	OVER LIMIT DB
0.02000	130	12	0	142	82	60
0.03000	81	9	0	90	77	13
0.04000	97	6	0	103	73	30
0.06000	115	3	0	118	67	51
0.07000	98	1	0	99	65	34
0.08000	105	0	0	105	63	42
0.10000	106	-2	0	104	60	44
0.12000	108	-3	0	105	58	47
0.14000	102	-4	0	98	56	42
0.16000	105	-5	0	100	54	46
0.18000	103	-6	0	97	52	45
0.20000	98	-7	0	91	51	40
0.22000	94	-7	0	87	50	37
0.24000	86	-8	0	78	49	29
0.26000	89	-8	0	81	48	33
0.28000	86	-9	0	77	47	30
0.34000	86	-10	0	76	44	32
0.38000	82	-10	0	72	42	30
0.46000	84	-11	0	73	40	33
0.48000	81	-11	0	70	39	31
0.50000	82	-11	0	71	39	32
0.56000	81	-12	0	69	37	32
0.57000	82	-12	0	70	37	33
0.67000	77	-12	0	65	35	30
0.71000	80	-12	0	68	34	34
0.79000	75	-12	0	63	33	30
0.87000	73	-13	0	60	31	29
0.95000	72	-13	0	59	30	29
1.06000	76	-13	0	63	29	34
1.16000	76	-13	0	63	27	36
1.30000	79	-14	0	65	26	39
1.52000	86	-14	0	72	24	48
1.64000	89	-14	0	75	23	52
1.80000	88	-14	0	74	21	53
1.96000	84	-14	0	70	20	50
2.15000	82	-14	0	68	20	48
2.30000	78	-14	0	64	20	44
2.55000	74	-14	0	60	20	40
2.70000	77	-14	0	63	20	43

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ELECTRONICS DIVISION

TAB NO. 6-2 OF 2
OCT 28, 1985 11:41:33

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS MFG: CONVAIR
SN: PROTOTYPE PN:
SPEC: MIL-STD-461B PART 3
CONDITIONS: 20KHZ TRANSMISSION BUSS PHASE A

FREQ	METER READING	PROBE FACTOR	CABLE LOSS	EMISSION LEVEL	SPEC LIMIT	OVER LIMIT
MHZ	DBUV	DB	DB	DBUA		DB
2.80000	78	-14	0	64	20	44
3.10000	74	-14	0	60	20	40
3.35000	74	-14	0	60	20	40
3.75000	72	-14	0	58	20	38
4.15000	66	-14	0	52	20	32
4.60000	56	-14	0	42	20	22
5.10000	56	-14	[illegible]	42	20	22
5.90000	51	-14	[illegible]	37	20	17
[illegible]	[illegible]	-14	[illegible]	[illegible]	20	18
[illegible]	[illegible]	-14	[illegible]	24	20	4
8.30000	[illegible]	-14	[illegible]	24	20	4
9.00000	36	-14	[illegible]	22	20	2
10.100	31	-14	1	18	20	
11.500	29	-14	1	16	20	
13.400	28	-14	1	15	20	
15.000	28	-14	1	15	20	
15.400	30	-14	1	17	20	
17.200	32	-14	1	19	20	
19.600	20	-14	1	7	20	
22.000	21	-14	1	7	20	
25.300	21	-14	1	8	20	
28.600	20	-13	1	8	20	

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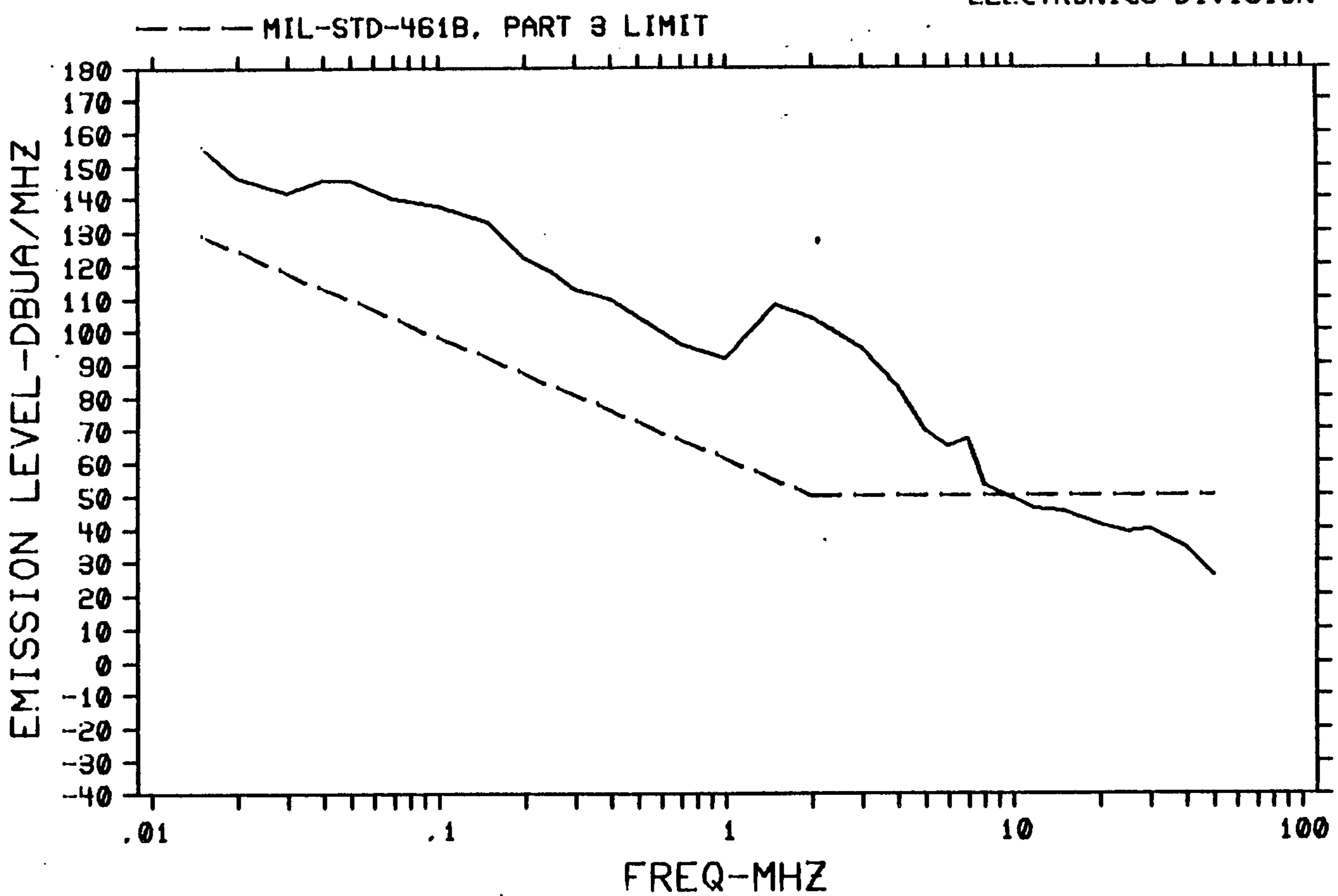

BROADBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ
ITEM: SPACE STATION PS
CONDITIONS: 20KHZ TRANSMISSION BUSS, PHASE A
GRAPH NO. 9 OCT 28, 1985 11:53:21

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ELECTRONICS DIVISION

TAB NO. 9-1 OF 1
OCT 28, 1985 11:53:21

BROADBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS MFG: CONVAIR
SN: PROTOTYPE PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: 20KHZ TRANSMISSION BUSS, PHASE A

FREQ MHZ	METER READING DBUV	PROBE FACTOR DB	CABLE LOSS DB	BROAD-BAND FACTOR DB	EMISSION LEVEL DBUA/MHZ	SPEC LIMIT DBUA/MHZ	OVER LIMIT DB
0.01500	[illegible]	16	0	60	156	129	27
0.02000	75	12	0	60	147	124	23
0.03000	73	9	0	60	142	118	24
0.04000	80	[illegible]	0	60	146	113	33
0.05000	82	[illegible]	0	60	146	110	36
0.07000	99	[illegible]	0	40	140	104	36
0.10000	[illegible]	[illegible]	0	40	138	98	40
0.15000	96	[illegible]	0	40	133	92	41
0.20000	[illegible]	[illegible]	0	40	122	87	35
0.25000	86	[illegible]	0	40	118	84	34
0.30000	82	9	0	40	113	81	32
0.40000	80	[illegible]	0	40	110	76	34
0.70000	68	-12	0	40	96	67	29
1.00000	65	-13	0	40	92	61	31
1.50000	82	-14	0	40	108	55	53
2.00000	78	-14	0	40	104	50	54
3.00000	83	-14	0	26	95	50	45
4.00000	71	-14	0	26	83	50	33
5.00000	58	-14	0	26	70	50	20
6.00000	53	-14	0	26	65	50	15
7.00000	55	-14	0	26	67	50	17
8.00000	41	-14	0	26	53	50	3
10.000	36	-14	1	26	49	50	
12.000	33	-14	1	26	46	50	
15.000	32	-14	1	26	45	50	
20.000	28	-14	1	26	41	50	
25.000	26	-14	1	26	39	50	
30.000	26	-13	1	26	40	50	
40.000	45	-12	1	0	34	50	
50.000	36	-11	1	0	26	50	

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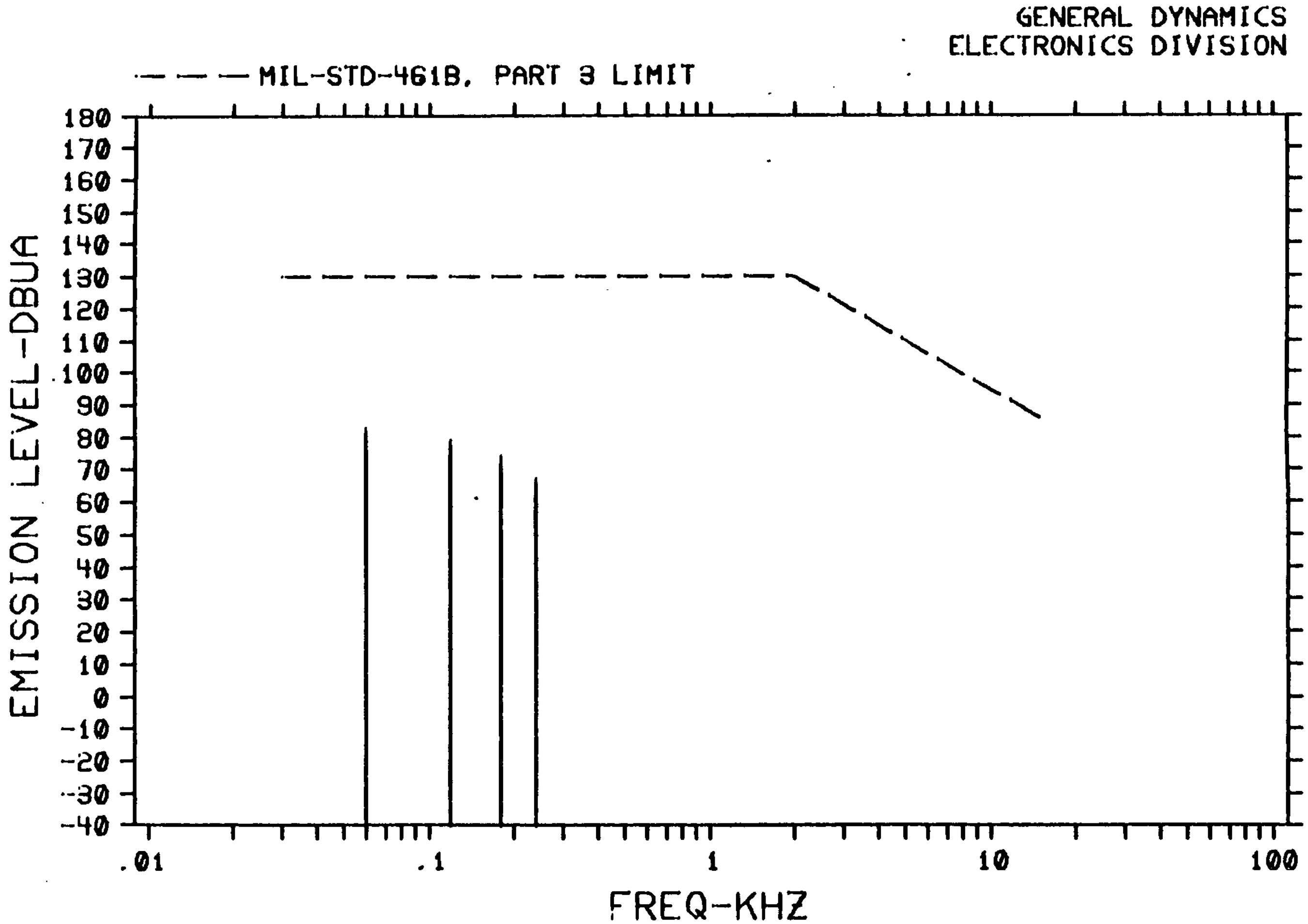

NARROWBAND CONDUCTED EMISSION CE01 30HZ-15KHZ
ITEM: SPACE STATION PS
CONDITIONS: 20KHZ TRANSMISSION BUSS, PHASE B
GRAPH NO. 10 OCT 28, 1985 12:03:59

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ELECTRONICS DIVISION

TAB NO. 10-1 OF 1
OCT 28, 1985 12:03:59

NARROWBAND CONDUCTED EMISSION TEST 30HZ-15KHZ

ITEM: SPACE STATION PS   MFG: CONVAIR
SN: PROTOTYPE   PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: 20KHZ TRANSMISSION BUSS, PHASE B

FREQ	METER READING	PROBE FACTOR	CABLE LOSS	EMISSION LEVEL	SPEC LIMIT	OVER LIMIT
KHZ	DBUV	DB	DB	DBUA		DB
0.06000	44	39	0	83	130	
0.12000	46	33	0	79	130	
0.18000	44	30	0	74	130	
0.24000	40	27	0	67	130	

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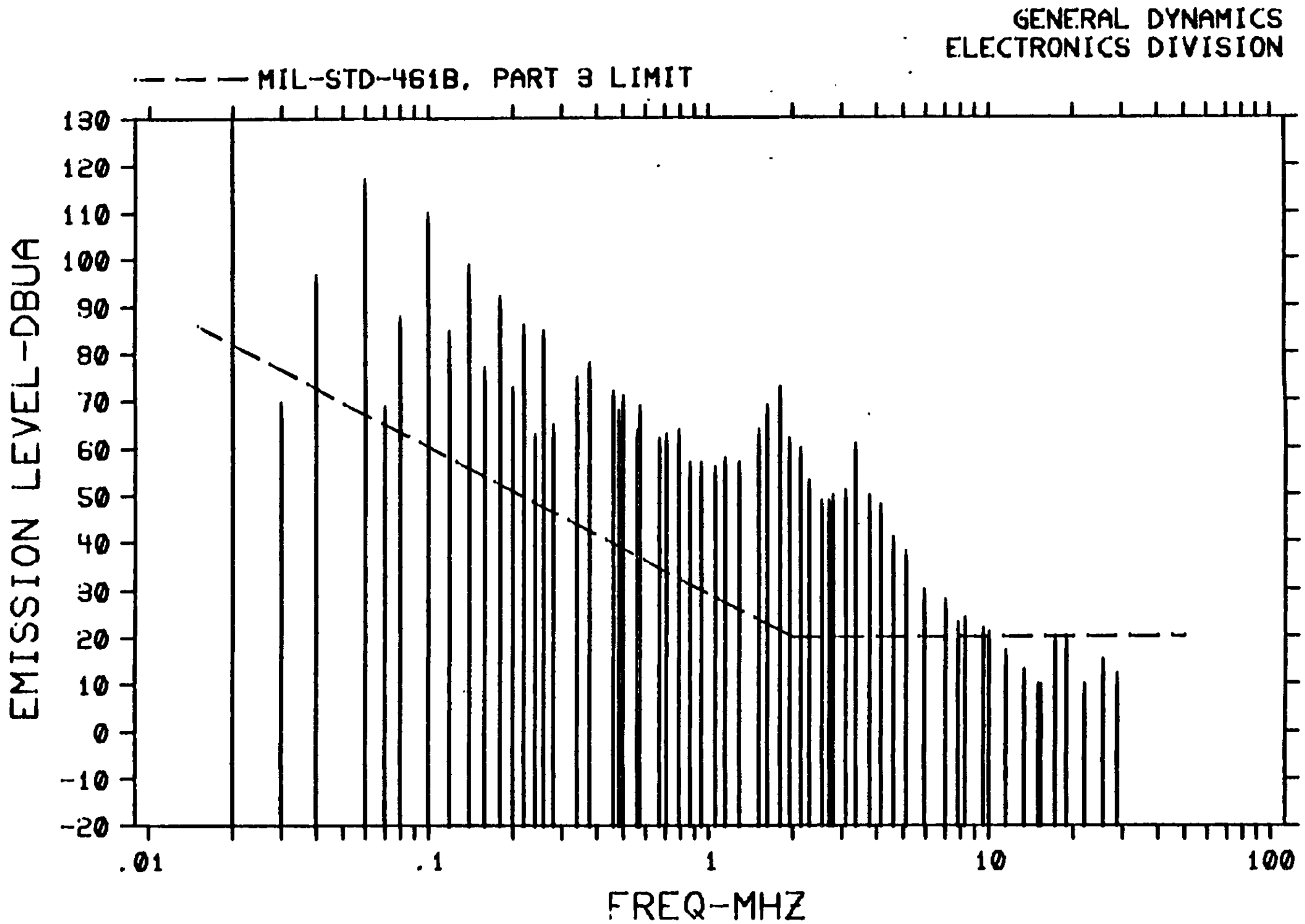

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ
ITEM: SPACE STATION PS
CONDITIONS: 20KHZ TRANSMISSION BUSS, PHASE B
GRAPH NO. 11 OCT 28, 1985 12:06:30

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 11-1 OF 2
OCT. 28, 1985 12:06:30

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS MFG: CONVAIR
SN: PROTOTYPE PN:
SPEC: MIL-STD-461B PART 3
CONDITIONS: 20KHZ TRANSMISSION BUSS, PHASE B

FREQ	METER READING	PROBE FACTOR	CABLE LOSS	EMISSION LEVEL	SPEC LIMIT	OVER LIMIT
MHZ	DBUV	DB	DB		DBUA	DB
0.02000	130	12	0	142	82	60
0.03000	61	9	0	70	77	
0.04000	91	6	0	97	73	24
0.06000	114	3	0	117	67	50
0.07000	68	1	0	69	65	4
0.08000	88	[illegible]	0	88	63	25
0.10000	112	[illegible]	0	110	60	50
0.12000	88	[illegible]	0	85	58	27
0.14000	103	[illegible]	0	99	56	43
0.16000	82	[illegible]	0	77	54	23
0.18000	96	[illegible]	0	92	52	40
0.20000	[illegible]	[illegible]	0	73	51	22
0.22000	93	-7	0	86	50	36
0.24000	71	-8	0	63	49	14
0.26000	93	-8	0	85	48	37
0.28000	74	-9	0	65	47	18
0.34000	85	-10	0	75	44	31
0.38000	88	-10	0	78	42	36
0.46000	83	-11	0	72	40	32
0.48000	79	-11	0	68	39	29
0.50000	82	-11	0	71	39	32
0.56000	76	-12	0	64	37	27
0.57000	81	-12	0	69	37	32
0.67000	74	-12	0	62	35	27
0.71000	75	-12	0	63	34	29
0.79000	76	-12	0	64	33	31
0.87000	70	-13	0	57	31	26
0.95000	70	-13	0	57	30	27
1.06000	69	-13	0	56	29	27
1.16000	71	-13	0	58	27	31
1.30000	71	-14	0	57	26	31
1.52000	78	-14	0	64	24	40
1.64000	83	-14	0	69	23	46
1.80000	87	-14	0	73	21	52
1.96000	76	-14	0	62	20	42
2.13000	74	-14	0	60	20	40
2.30000	67	-14	0	53	20	33
2.55000	63	-14	0	49	20	29
2.70000	63	-14	0	49	20	29

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 11-2 OF 2
OCT 28, 1985 12:06:30

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS   MFG: CONVAIR
SN: PROTOTYPE   PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: 20KHZ TRANSMISSION BUSS, PHASE B

FREQ	METER READING	PROBE FACTOR	CABLE LOSS	EMISSION LEVEL	SPEC LIMIT	OVER LIMIT
MHZ	DBUV	DB	DB	DBUA		DB
2.80000	64	- 14	0	50	20	30
3.18000	65	- 14	0	51	20	31
3.35000	75	- 14	0	61	20	41
3.78000	64	- 14	0	50	20	30
4.15000	62	- 14	0	48	20	28
4.60000	55	- 14	0	41	20	21
5.10000	52	- 14	0	38	20	18
5.90000	44	- 14	0	30	20	10
7.00000	42	- 14	0	28	20	8
7.80000	37	- 14	0	23	20	3
8.30000	38	- 14	0	24	20	4
9.60000	36	- 14	0	22	20	2
10.100	34	- 14	1	21	20	1
11.500	30	- 14	1	17	20	
13.400	26	- 14	1	13	20	
15.000	23	- 14	1	10	20	
15.400	23	- 14	1	10	20	
17.200	33	- 14	1	20	20	
19.800	33	- 14	1	20	20	
22.000	23	- 14	1	10	20	
25.500	28	- 14	1	15	20	
28.800	24	- 13	1	12	20	

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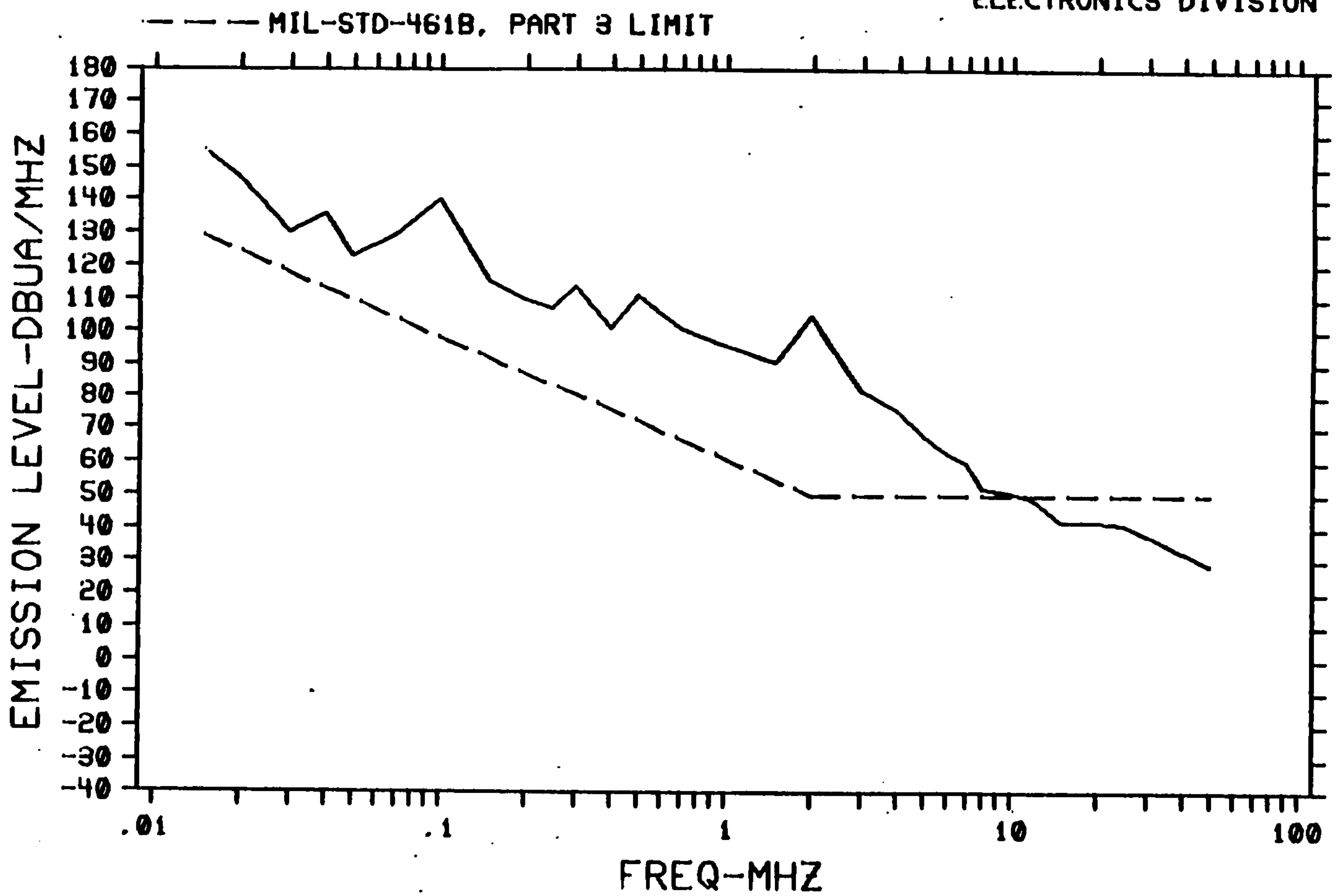

BROADBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ
ITEM: SPACE STATION PS
CONDITIONS: 20KHZ TRANSMISSION BUSS, PHASE B
GRAPH NO. 12 OCT 28, 1985 12:21:59

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GENERAL DYNAMICS — TAB NO. 12-1 OF 1
ELECTRONICS DIVISION — OCT 28, 1985 12:21:59

BROADBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS — MFG: CONVAIR
SN: PROTOTYPE — PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: 20KHZ TRANSMISSION BUSS, PHASE B

FREQ MHZ	METER READING DBUV	PROBE FACTOR DB	CABLE LOSS DB	BROAD-BAND FACTOR DB	EMISSION LEVEL DBUA/MHZ	SPEC LIMIT DBUA/MHZ	OVER LIMIT DB
0.01500	79	16	0	60	155	129	26
0.02000	75	12	0	60	147	124	23
0.03000	61	9	0	60	130	118	12
0.04000	70	6	0	60	136	113	23
0.05000	59	4	0	60	123	110	13
0.07000	88	1	0	40	129	104	25
0.10000	102	-2	0	40	140	98	42
0.15000	80	-5	0	40	115	92	23
0.20000	77	-7	0	40	110	87	23
0.25000	75	-8	0	40	107	84	23
0.30000	83	-9	0	40	114	81	33
0.40000	71	-10	0	40	101	76	25
0.50000	82	-11	0	40	111	72	39
0.70000	73	-12	0	40	101	67	34
1.00000	69	-13	0	40	96	61	35
1.50000	65	-14	0	40	91	55	36
2.00000	79	-14	0	40	105	50	55
3.00000	70	-14	0	26	82	50	32
4.00000	64	-14	0	26	76	50	26
5.00000	56	-14	0	26	68	50	18
6.00000	51	-14	0	26	63	50	13
7.00000	48	-14	0	26	60	50	10
8.00000	40	-14	0	26	52	50	2
10.000	38	-14	1	26	51	50	1
12.000	36	-14	1	26	49	50	
15.000	29	-14	1	26	42	50	
20.000	29	-14	1	26	42	50	
25.000	28	-14	1	26	41	50	
30.000	24	-13	1	26	38	50	
40.000	44	-12	1	0	33	50	
50.000	39	-11	1	0	29	50	

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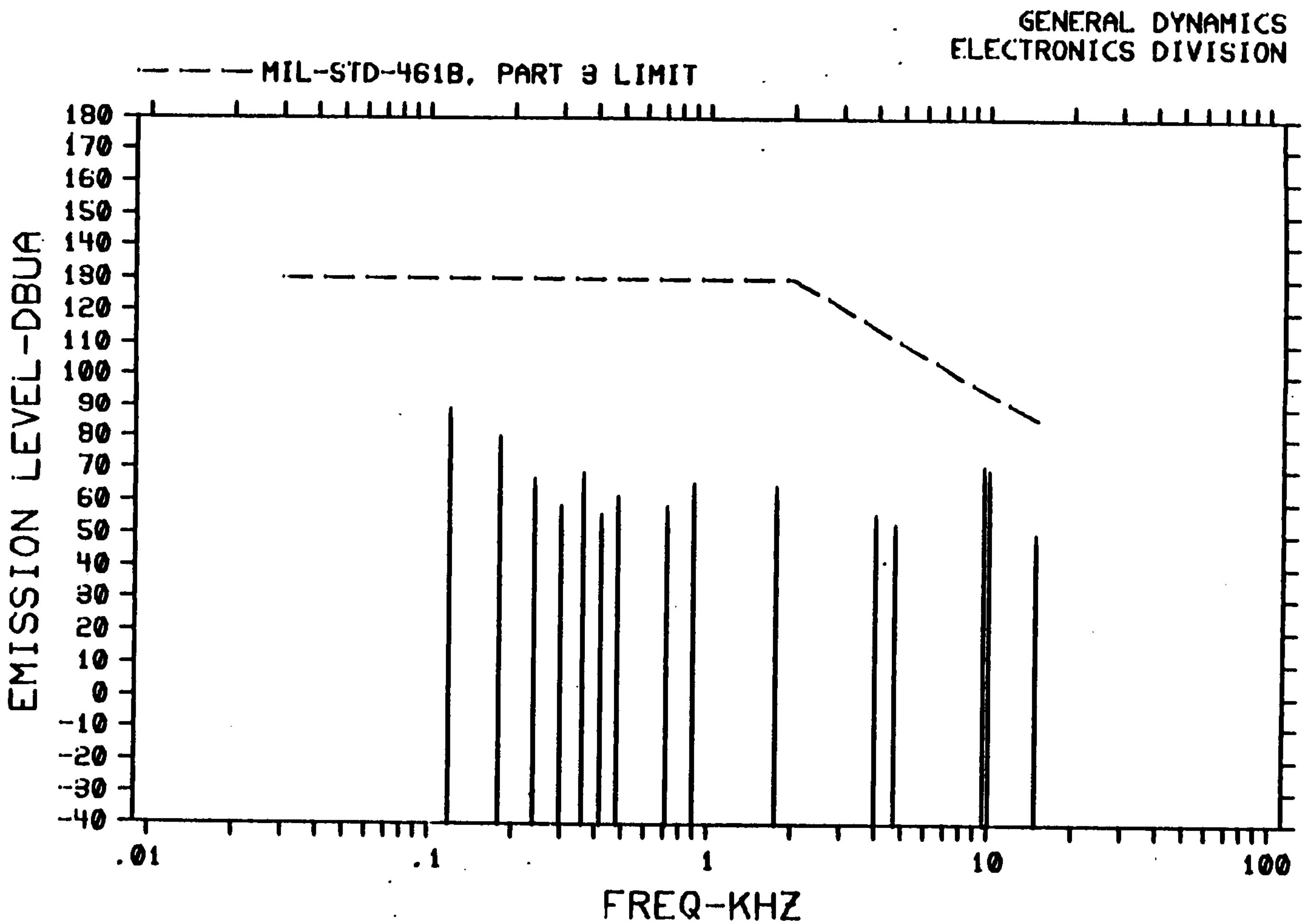

NARROWBAND CONDUCTED EMISSION CE01 30HZ-15KHZ
ITEM: SPACE STATION PS
CONDITIONS: 20KHZ TRANSMISSION BUSS, PHASE C
GRAPH NO. 13 OCT 28, 1985 12:37:52

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 13-1 OF 1
OCT 28, 1985 12:37:52

NARROWBAND CONDUCTED EMISSION CE01 30HZ-15KHZ

ITEM: SPACE STATION PS MFG: CONVAIR
SN: PROTOTYPE PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: 20KHZ TRANSMISSION BUSS, PHASE C

FREQ	METER READING	PROBE FACTOR	CABLE LOSS	EMISSION LEVEL	SPEC LIMIT	OVER LIMIT
KHZ	DBUV	DB	DB	DBUA		DB
0.12000	56	33	0	89	130	
0.18000	50	30	0	80	130	
0.24000	40	27	0	67	130	
0.30000	34	25	0	59	130	
0.36000	45	24	0	69	130	
0.42000	34	22	0	56	130	
0.48000	40	22	0	62	130	
0.72000	40	19	0	59	130	
0.90000	49	17	0	66	130	
1.76000	51	14	0	65	130	
4.80000	44	12	0	56	115	
4.78000	42	11	0	53	111	
9.67000	60	11	0	71	96	
10.200	60	10	0	70	94	
14.900	40	10	0	50	86	

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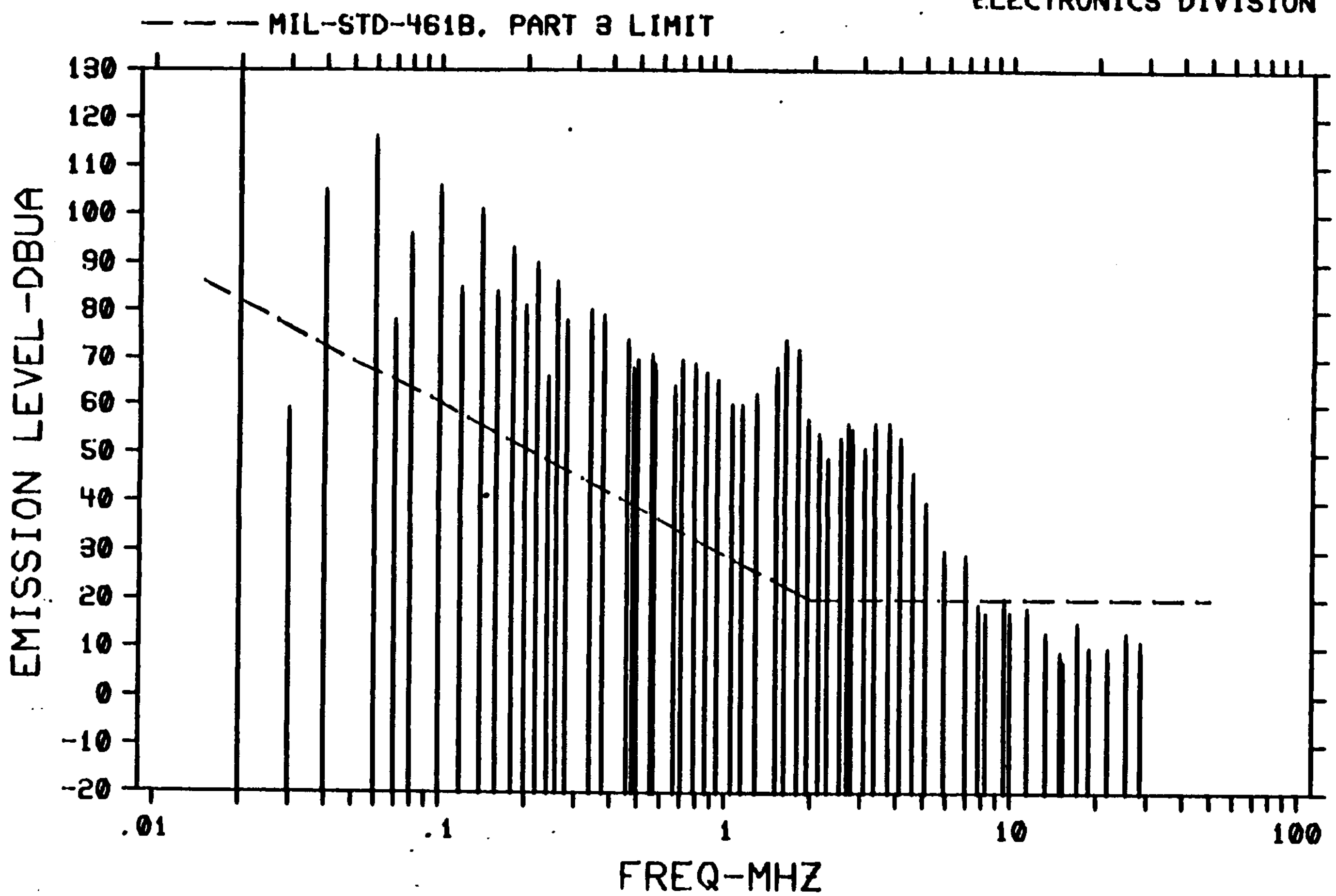

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS

CONDITIONS: 20KHZ TRANSMISSION BUSS, PHASE C

GRAPH NO. 14 OCT 28, 1985 12:41:28

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 14-1 OF 2
OCT 28, 1985 12:41:28

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS
MFG: CONVAIR
SN: PROTOTYPE
PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: 20KHZ TRANSMISSION BUSS, PHASE C

FREQ	METER READING	PROBE FACTOR	CABLE LOSS	EMISSION LEVEL	SPEC LIMIT	OVER LIMIT
MHZ	DBUV	DB	DB	DBUA		DB
0.02000	129	12	0	141	82	59
0.03000	50	9	0	59	77	
0.04000	99	6	0	105	73	32
0.06000	113	3	0	116	67	49
0.07000	77	1	0	78	65	13
0.08000	96	0	0	96	63	33
0.10000	108	-2	0	106	60	46
0.12000	88	-3	0	85	58	27
0.14000	105	-4	0	101	56	45
0.16000	89	-5	0	84	54	30
0.18000	99	-6	0	93	52	41
0.20000	88	-7	0	81	51	30
0.22000	97	-7	0	90	50	40
0.24000	74	-8	0	66	49	17
0.26000	94	-8	0	86	48	38
0.28000	87	-9	0	78	47	31
0.34000	90	-10	0	80	44	36
0.38000	89	-10	0	79	42	37
0.46000	85	-11	0	74	40	34
0.48000	79	-11	0	68	39	29
0.50000	81	-11	0	70	39	31
0.56000	83	-12	0	71	37	34
0.57000	81	-12	0	69	37	32
0.67000	76	-12	0	64	35	29
0.71000	82	-12	0	70	34	36
0.79000	81	-12	0	69	33	36
0.87000	80	-13	0	67	31	36
0.95000	78	-13	0	65	30	35
1.06000	73	-13	0	60	29	31
1.16000	73	-13	0	60	27	33
1.30000	76	-14	0	62	26	36
1.52000	82	-14	0	68	24	44
1.64000	88	-14	0	74	23	51
1.80000	86	-14	0	72	21	51
1.96000	71	-14	0	57	20	37
2.15000	68	-14	0	54	20	34
2.30000	63	-14	0	49	20	29
2.55000	67	-14	0	53	20	33
2.70000	70	-14	0	56	20	36

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 14-2 OF 2
OCT 28, 1985 12:41:28

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS MFG: CONVAIR
SN: PROTOTYPE PN:
SPEC: MIL-STD-461B PART 3
CONDITIONS: 20KHZ TRANSMISSION BUSS PHASE C

FREQ	METER READING	PROBE FACTOR	CABLE LOSS	EMISSION LEVEL	SPEC LIMIT	OVER LIMIT
MHZ	DBUV	DB	DB	DBUA		DB
2.80000	69	-14	0	55	20	35
3.10000	65	-14	0	51	20	31
3.35000	70	-14	0	56	20	36
3.78000	70	-14	0	56	20	36
4.15000	67	-14	0	53	20	33
4.60000	60	-14	0	46	20	26
5.10000	54	-14	0	40	20	20
5.90000	44	-14	0	30	20	10
7.80000	43	-14	0	29	20	9
[illegible]	33	-14	0	19	20	
8.30000	31	-14	0	17	20	
9.60000	34	-14	0	20	20	
10.100	30	-14	1	17	20	
11.500	31	-14	1	18	20	
13.400	26	-14	1	13	20	
15.000	22	-14	1	9	20	
15.400	20	-14	1	7	20	
17.200	28	-14	1	15	20	
19.800	23	-14	1	10	20	
22.000	23	-14	1	10	20	
25.300	26	-14	1	13	20	
28.500	23	-13	1	11	20	

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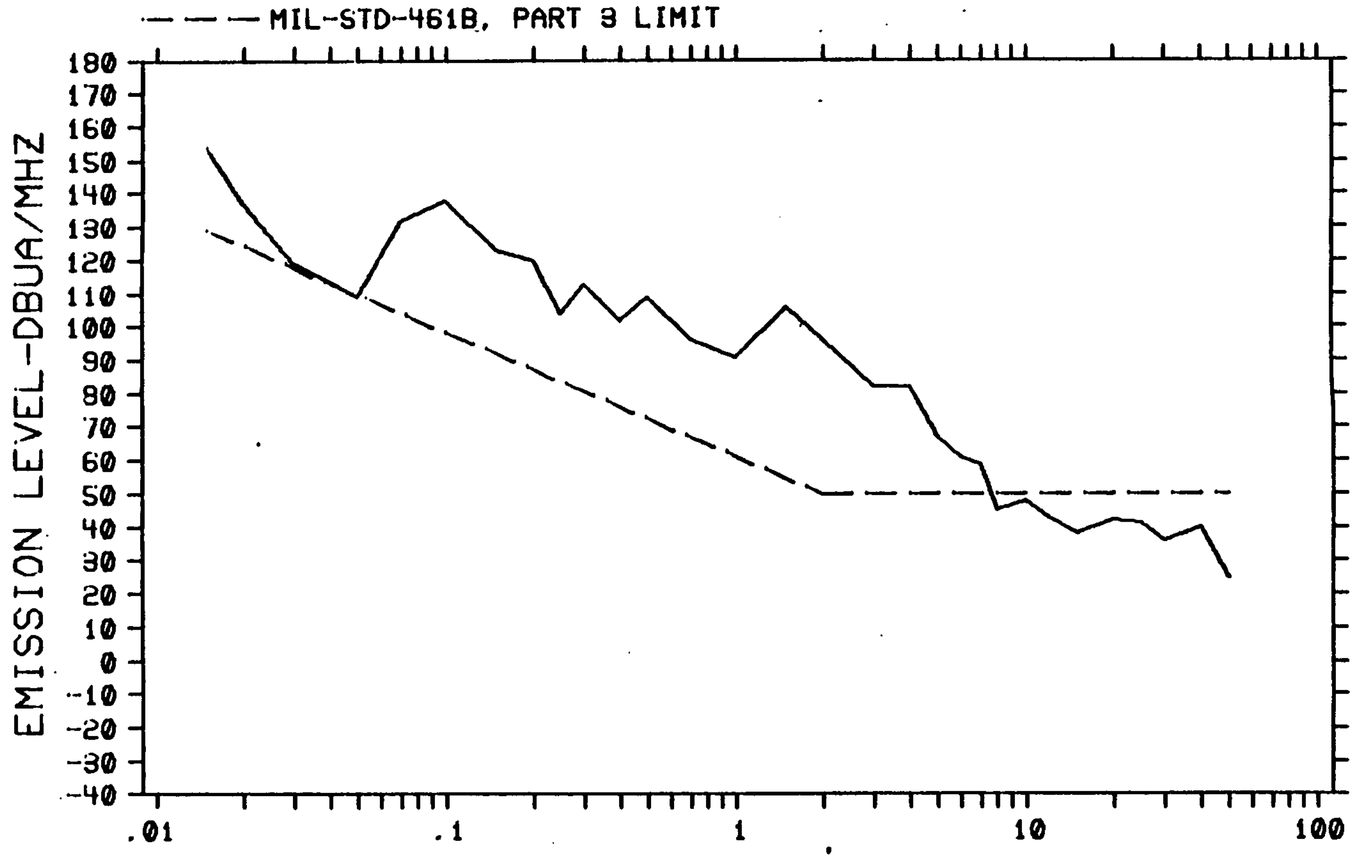
GENERAL DYNAMICS
ELECTRONICS DIVISION



BROADBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ
ITEM: SPACE STATION PS
CONDITIONS: 20KHZ TRANSMISSION BUSS, PHASE C
GRAPH NO. 15 OCT 28, 1985 12:50:44

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 15-1 OF 1
OCT 28, 1985 12:50:44

BROADBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS MFG: CONVAIR
SN: PROTOTYPE MN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: 20KHZ TRANSMISSION BUSS, PHASE C

FREQ MHZ	METER READING DBUV	PROBE FACTOR DB	CABLE LOSS DB	BROAD-BAND FACTOR DB	EMISSION LEVEL DBUA/MHZ	SPEC LIMIT DBUA/MHZ	OVER LIMIT DB
0.01500	78	16	0	60	154	129	25
0.02000	65	12	0	60	137	124	13
0.03000	50	9	0	60	119	118	1
0.04000	48	6	0	60	114	113	1
0.05000	45	4	0	60	109	110	
0.07000	91	1	0	40	132	104	28
0.10000	[illegible]	2	0	40	138	98	40
0.15000	[illegible]	5	0	40	123	92	31
0.20000	87	[illegible]	[illegible]	40	120	87	33
0.25000	[illegible]	[illegible]	[illegible]	40	104	84	20
0.30000	[illegible]	9	[illegible]	40	113	81	32
0.40000	72	[illegible]	0	40	102	76	26
0.50000	58	11	0	40	109	72	37
0.70000	68	-12	0	40	96	67	29
1.00000	64	-13	0	40	91	61	30
1.50000	60	-14	0	40	106	55	51
2.00000	78	-14	0	40	96	50	46
3.00000	70	-14	0	26	82	50	32
4.00000	70	-14	0	26	82	50	32
5.00000	55	-14	[illegible]	26	67	50	17
6.00000	[illegible]	-14	0	26	61	50	11
7.00000	47	-14	0	26	59	50	9
8.00000	33	-14	0	26	45	50	
10.000	35	-14	1	26	[illegible]	50	
12.000	30	-14	1	26	43	50	
15.000	25	-14	1	24	38	50	
20.000	29	-14	1	26	42	50	
25.000	28	-14	1	26	41	50	
30.000	22	-13	1	26	36	50	
40.000	51	-12	1	0	40	50	
50.000	35	-11	1	0	25	50	

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APPROVED BY A.H. Mills

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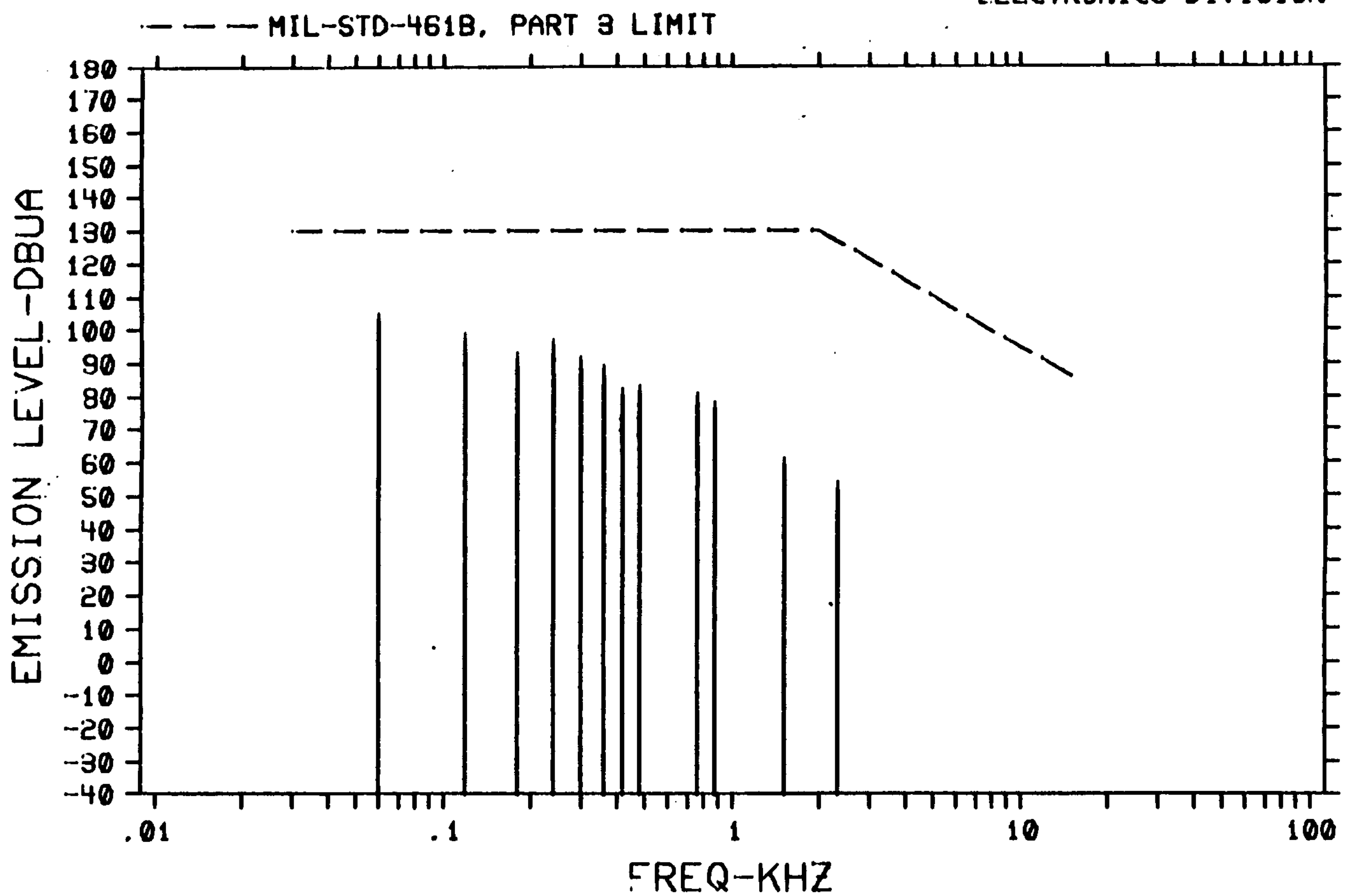
GENERAL DYNAMICS
ELECTRONICS DIVISION



NARROWBAND CONDUCTED EMISSION CE01 30HZ-15KHZ
ITEM: SPACE STATION PS
CONDITIONS: 20KHZ TRANSMISSION BUSS, CABLE SHIELD
GRAPH NO. 16 OCT 28, 1985 13:01:44

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 16-1 OF 1
OCT 28, 1985 13:01:44

NARROWBAND CONDUCTED EMISSION CE01 30HZ-15KHZ

ITEM: SPACE STATION PS
MFG: CONVAIR
SN: PROTOTYPE
PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: 20KHZ TRANSMISSION BUSS, CABLE SHIELD

FREQ	METER READING	PROBE FACTOR	CABLE LOSS	EMISSION LEVEL	SPEC LIMIT	OVER LIMIT
KHZ	DBUV	DB	DB	DBUA		DB
0.06000	66	39	0	105	130	
0.12000	66	33	0	99	130	
0.18000	63	30	0	93	130	
0.24000	70	27	0	97	130	
0.30000	67	25	0	92	130	
0.36000	65	24	0	89	130	
0.42000	60	22	0	82	130	
0.48000	61	22	0	83	130	
0.76000	[illegible]	18	0	[illegible]	130	
[illegible]	61	[illegible]	0	78	130	
1.32000	47	14	0	61	130	
2.32000	41	[illegible]	0	54	127	

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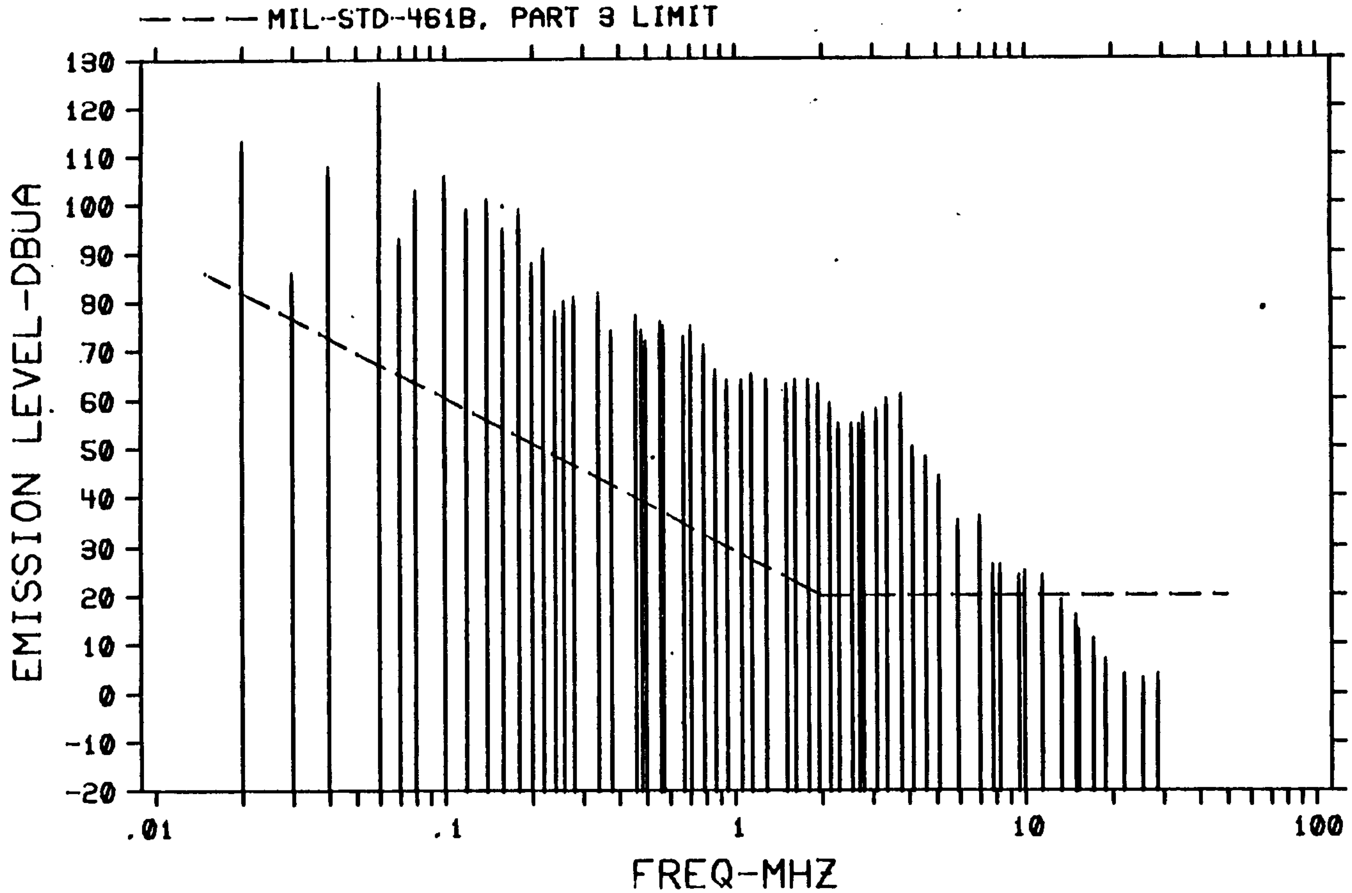
GENERAL DYNAMICS
ELECTRONICS DIVISION



NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ
ITEM: SPACE STATION PS
CONDITIONS: 20KHZ TRANSMISSION BUSS, CABLE SHIELD
GRAPH NO. 17 OCT 28, 1985 13:06:37

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 17-1 OF 2
OCT 28, 1985 13:06:37

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS
MFG: CONVAIR
SN: PROTOTYPE
PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: 20KHZ TRANSMISSION BUSS, CABLE SHIELD

FREQ MHZ	METER READING DBUV	PROBE FACTOR DB	CABLE LOSS DB	EMISSION LEVEL DBUA	SPEC LIMIT DBUA	OVER LIMIT DB
0.02000	[illegible]	12	0	113	82	31
0.03000	77	9	0	86	77	9
0.04000	102	6	0	108	73	35
0.06000	122	3	0	125	67	58
0.07000	92	1	0	93	65	28
0.08000	103	0	0	103	63	40
0.10000	108	2	0	106	60	46
0.12000	102	[illegible]	0	99	58	41
0.14000	105	4	0	101	56	45
[illegible]	[illegible]	[illegible]	0	95	54	41
[illegible]	[illegible]	[illegible]	0	99	52	47
[illegible]	[illegible]	[illegible]	0	88	51	37
[illegible]	[illegible]	[illegible]	0	91	50	41
0.24000	86	8	0	78	49	29
0.26000	88	8	0	80	48	32
0.28000	90	-9	0	81	47	34
0.34000	92	-10	0	82	44	38
0.38000	84	-10	0	74	42	32
0.46000	88	-11	0	77	40	37
0.48000	85	-11	0	74	39	35
0.50000	83	-11	0	72	39	33
0.56000	88	-12	0	76	37	39
0.57000	87	-12	0	75	37	38
0.67000	85	-12	0	73	35	38
0.71000	87	-12	0	75	34	41
0.79000	83	-12	0	71	33	38
0.87000	79	-13	0	66	31	35
0.95000	77	-13	0	64	30	34
1.06000	77	-13	0	64	29	35
1.16000	78	-13	0	65	27	38
1.30000	78	-14	0	64	26	38
1.52000	77	-14	0	63	24	39
1.64000	78	-14	0	64	23	41
1.80000	78	-14	0	64	21	43
1.96000	77	-14	0	63	20	43
2.15000	73	-14	0	59	20	39
2.30000	69	-14	0	55	20	35
2.55000	69	-14	0	55	20	35
2.70000	69	-14	0	55	20	35

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APPROVED BY A. H. Mills

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 17-2 OF 2
OCT 28, 1985 13:06:37

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS — MFG: CONVAIR
SN: PROTOTYPE — PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: 20KHZ TRANSMISSION BUSS, CABLE SHIELD

FREQ	METER READING	PROBE FACTOR	CABLE LOSS	EMISSION LEVEL	SPEC LIMIT	OVER LIMIT
MHZ	DBUV	DB	DB	DBUA		DB
2.80000	71	-14	0	57	20	37
3.10000	72	-14	0	58	20	38
3.35000	74	-14	0	60	20	40
3.78000	75	-14	0	61	20	41
4.15000	64	-14	0	50	20	30
4.60000	62	-14	0	48	20	28
5.10000	58	-14	0	44	20	24
5.90000	49	-14	0	35	20	15
7.00000	50	-14	0	36	20	16
7.60000	40	-14	0	26	20	6
8.30000	40	-14	0	26	20	6
9.60000	38	-14	0	24	20	4
10.100	38	-14	1	25	20	5
11.500	37	-14	1	24	20	4
13.400	32	-14	1	19	20	
15.000	29	-14	1	16	20	
15.400	26	-14	1	13	20	
17.200	24	-14	1	11	20	
19.000	20	-14	1	7	20	
22.000	17	-14	1	4	20	
25.500	16	-14	1	3	20	
28.000	16	-13	1	4	20	

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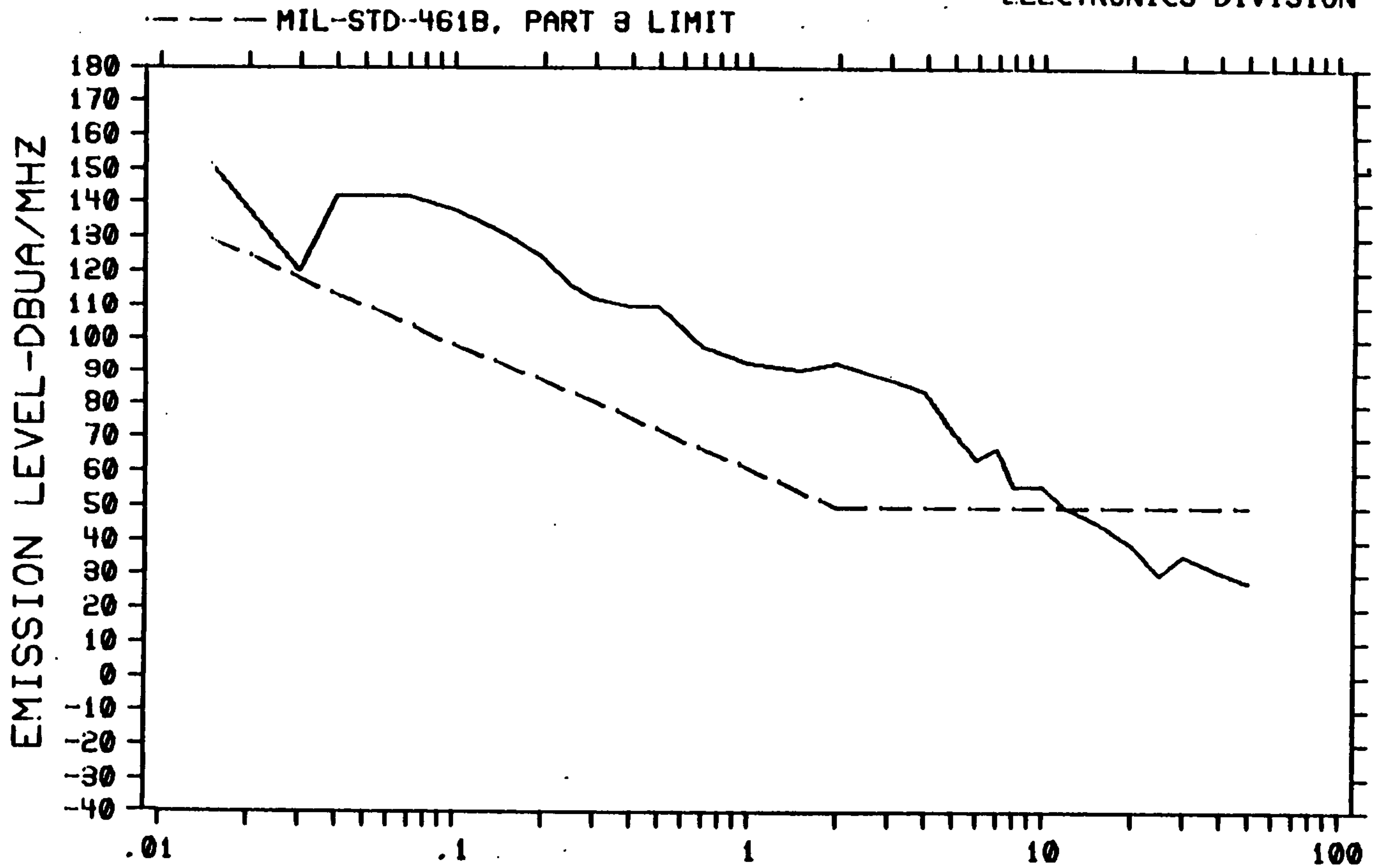

BROADBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ
ITEM: SPACE STATION PS
CONDITIONS: 20KHZ TRANSMISSION BUSS, CABLE SHIELD
GRAPH NO. 18 OCT 28, 1985 13:19:03

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 18-1 OF 1
OCT 28, 1985 13:19:03

BROADBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS MFG: CONVAIR
SN: PROTOTYPE PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: 20KHZ TRANSMISSION BUSS, CABLE SHIELD

FREQ	METER READING	PROBE FACTOR	CABLE LOSS	BROAD-BAND FACTOR	EMISSION LEVEL	SPEC LIMIT	OVER LIMIT
MHZ	DBUV	DB	DB	DB	DBUA/MHZ		DB
0.01500	75	16	0	60	151	129	22
0.02000	66	12	0	60	138	124	14
0.03000	51	9	0	60	120	118	2
0.04000	76	6	0	60	142	113	29
0.05000	78	4	0	60	142	110	32
0.07000	101	1	0	40	142	104	38
0.10000	100	-2	0	40	138	98	40
0.15000	96	-5	0	40	131	92	39
0.20000	91	-7	0	40	124	87	37
0.25000	84	-8	0	40	116	84	32
0.30000	81	-9	0	40	112	81	31
0.40000	80	-10	0	40	110	76	34
0.50000	81	-11	0	40	110	72	38
0.70000	70	-12	0	40	98	67	31
1.00000	66	-13	0	40	93	61	32
1.50000	65	-14	0	40	91	55	36
2.00000	67	-14	0	40	93	50	43
3.00000	76	-14	0	26	88	50	38
4.00000	72	-14	0	26	84	50	34
5.00000	60	-14	0	26	72	50	22
6.00000	52	-14	0	26	64	50	14
7.00000	55	-14	0	26	67	50	17
8.00000	44	-14	0	26	56	50	6
10.000	43	-14	1	26	56	50	6
12.000	37	-14	1	26	50	50	
15.000	33	-14	1	26	46	50	
20.000	26	-14	1	26	39	50	
25.000	17	-14	1	26	30	50	
30.000	22	-13	1	26	36	50	
40.000	42	-12	1	0	31	50	
50.000	38	-11	1	0	28	50	

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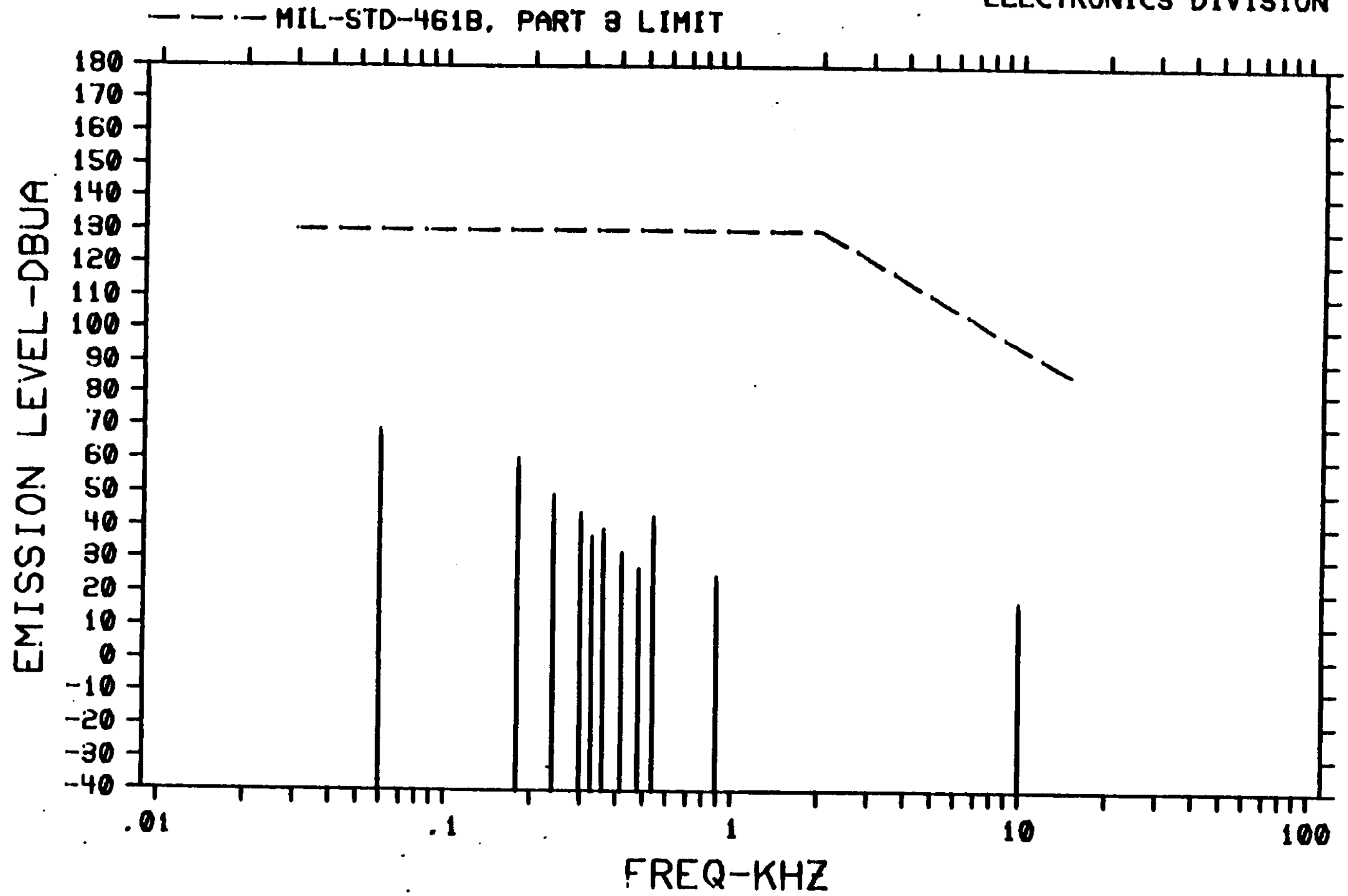

NARROWBAND CONDUCTED EMISSION CE01 30HZ-15KHZ
ITEM: SPACE STATION PS
CONDITIONS: DC RECEIVER OUTPUT
GRAPH NO. 19 OCT 28, 1985 13:29:29

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 19-1 OF 1
OCT 28, 1985 13:29:29

NARROWBAND CONDUCTED EMISSION CE01 30HZ-15KHZ

ITEM: SPACE STATION PS MFG: CONVAIR
SN: PROTOTYPE PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: DC RECEIVER OUTPUT

FREQ	METER READING	PROBE FACTOR	CABLE LOSS	EMISSION LEVEL	SPEC LIMIT	OVER LIMIT
KHZ	DBUV	DB	DB	DBUA		DB
0.06000	30	39	0	69	130	
0.18000	30	30	0	60	130	
0.24000	22	27	0	49	130	
0.30000	19	25	0	44	130	
0.33000	13	24	0	37	130	
0.36000	15	24	0	39	130	
0.42000	10	22	0	32	130	
0.48000	5	22	0	27	130	
0.54000	22	21	0	43	130	
0.90000	8	17	0	25	130	
10.000	1	16	0	17	95	

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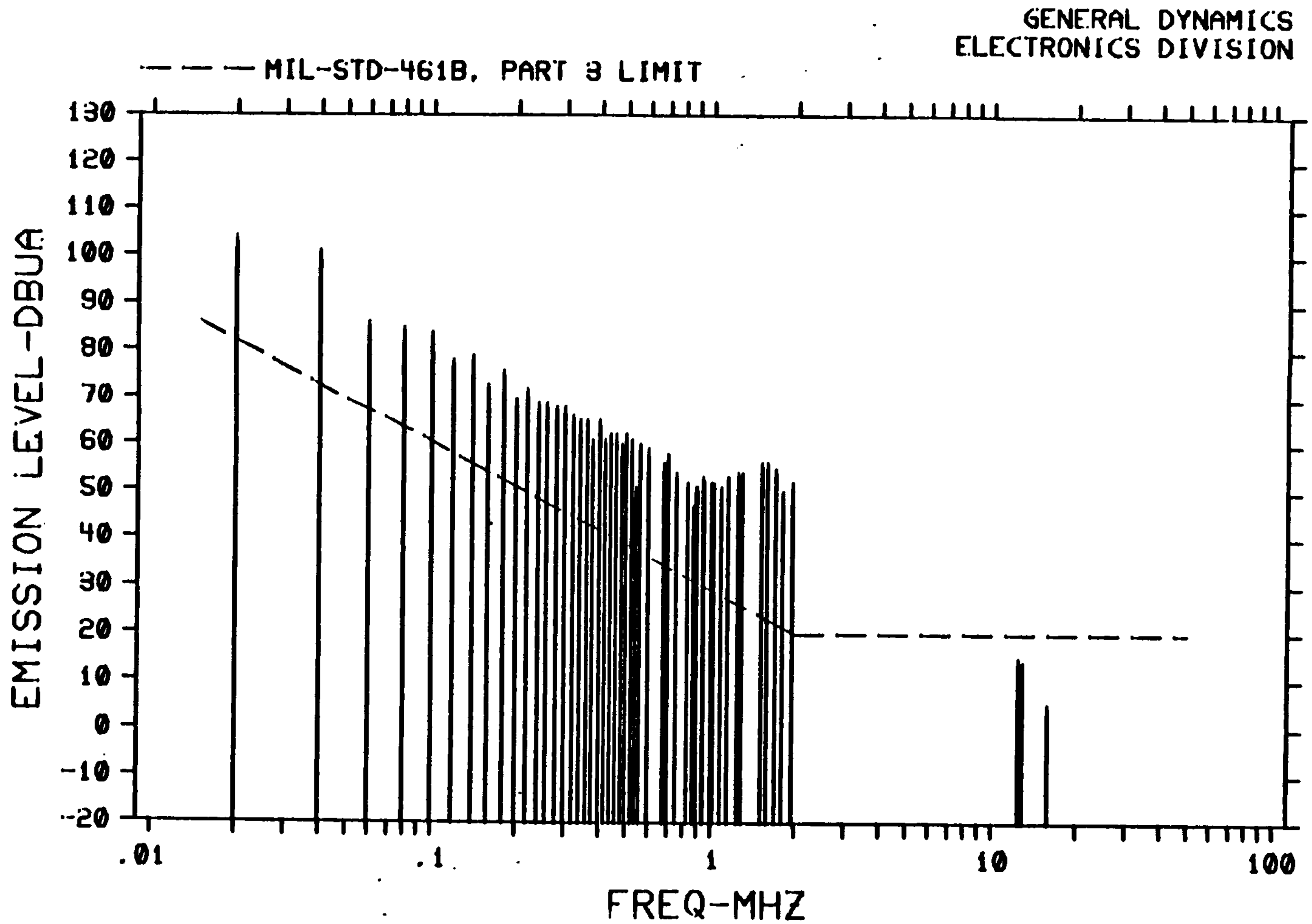

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ
ITEM: SPACE STATION PS
CONDITIONS: DC RECEIVER OUTPUT
GRAPH NO. 20 OCT 28, 1985 13:31:54

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 20-1 OF 2
OCT 28, 1985 13:31:54

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION, PS MFG: CONVAIR
SN: PROTOTYPE PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: DC RECEIVER OUTPUT

FREQ	METER READING	PROBE FACTOR	CABLE LOSS	EMISSION LEVEL	SPEC LIMIT	OVER LIMIT
MHZ	DBUV	DB	DB	DBUA	DBUA	DB
0.02000	92	12	0	104	82	22
0.04000	95	6	0	101	73	28
0.06000	83	3	0	86	67	19
0.08000	85	0	0	85	63	22
0.10000	86	-2	0	84	60	24
0.12000	81	-3	0	78	58	20
0.14000	83	-4	0	79	56	23
0.16000	78	-5	0	73	54	19
0.18000	82	-6	0	76	52	24
0.20000	77	-7	0	70	51	19
0.22000	79	-7	0	72	50	22
0.24000	77	-8	0	69	49	20
0.26000	77	-8	0	69	48	21
0.28000	77	-9	0	68	47	21
0.30000	77	-9	0	68	46	22
0.32000	76	-10	0	66	45	21
0.34000	75	-10	0	65	44	21
0.36000	75	-10	0	65	43	22
0.38000	71	-10	0	61	42	19
0.40000	75	-10	0	65	42	23
0.42000	72	-11	0	61	41	20
0.44000	73	-11	0	62	40	22
0.46000	73	-11	0	62	40	22
0.48000	71	-11	0	60	39	21
0.50000	73	-11	0	62	39	23
0.52000	72	-11	0	61	38	23
0.54000	62	-11	0	51	38	13
0.56000	72	-12	0	60	37	23
0.60000	71	-12	0	59	36	23
0.68000	68	-12	0	56	35	21
0.70000	70	-12	0	58	34	24
0.75000	66	-12	0	54	33	21
0.83000	65	-13	0	52	32	20
0.87000	60	-13	0	47	31	16
0.89000	64	-13	0	51	31	20
0.90000	64	-13	0	51	31	20
0.94000	66	-13	0	53	30	23
0.95000	65	-13	0	52	30	22
1.00000	65	-13	0	52	29	23

CONDUCTED BY Ed Price

APPROVED BY A.H. Mills

CERTIFIED BY ____________

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 20-2 OF 2
OCT 28, 1985 13:31:54

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS MFG: CONVAIR
SN: PROTOTYPE PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: DC RECEIVER OUTPUT

FREQ MHZ	METER READING DBUV	PROBE FACTOR DB	CABLE LOSS DB	EMISSION LEVEL DBUA	SPEC LIMIT	OVER LIMIT DB
1.03000	65	-13	[illegible]	52	29	23
1.09000	64	-13	[illegible]	51	28	23
1.15000	66	-12	[illegible]	53	27	26
1.25000	68	-14	[illegible]	54	26	28
1.30000	68	-14	[illegible]	54	26	28
1.52000	70	-14	[illegible]	56	24	32
1.60000	70	[illegible]	[illegible]	56	23	33
1.70000	69	[illegible]	[illegible]	55	22	33
1.80000	64	[illegible]	[illegible]	50	21	29
1.90000	[illegible]	[illegible]	[illegible]	52	20	32
12.550	25	[illegible]	[illegible]	15	20	
13.900	27	[illegible]	[illegible]	14	20	
15.200	18	[illegible]	[illegible]	15	20	

CONDUCTED BY ED Price

APPROVED BY A.H. Mill

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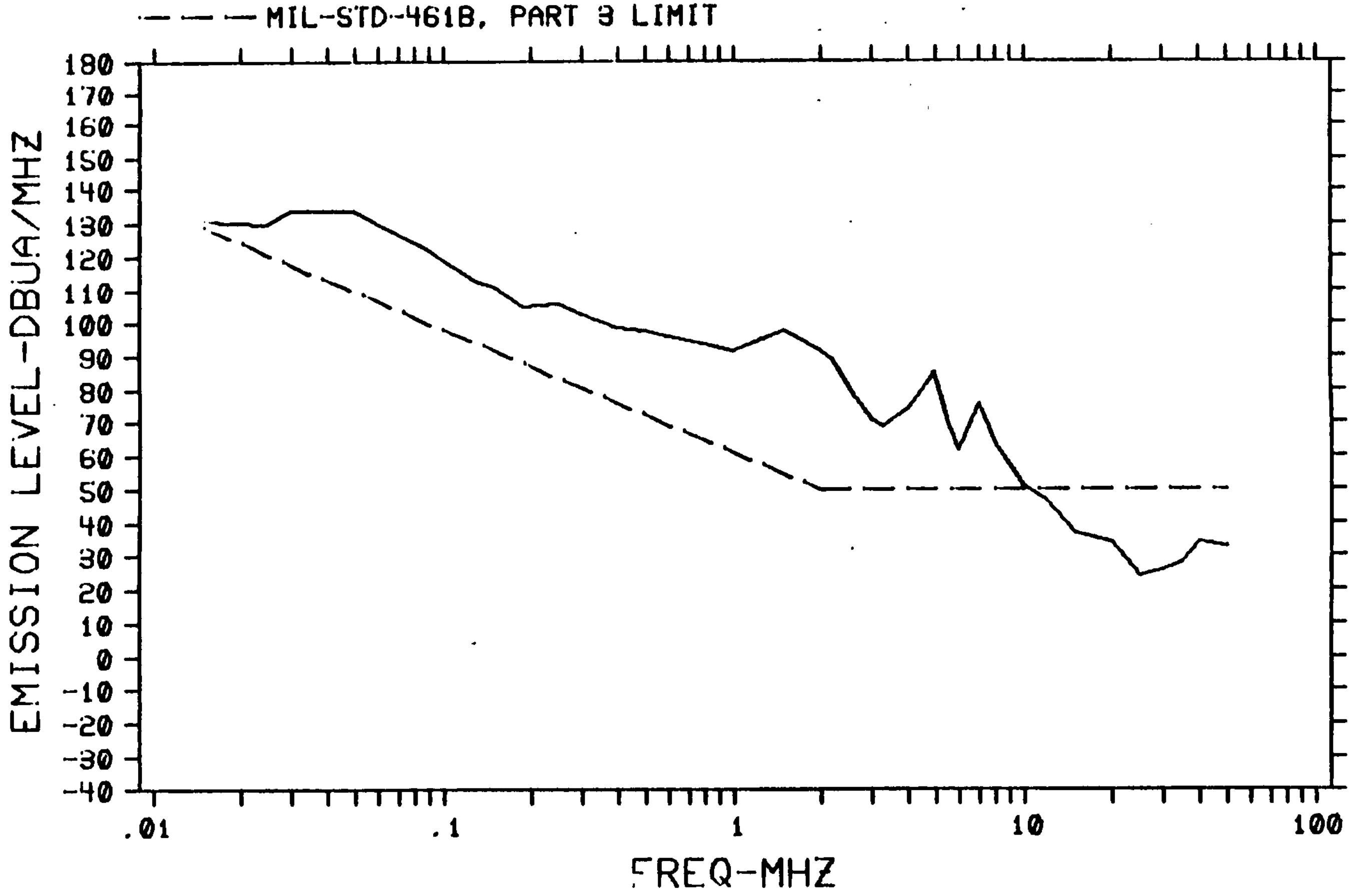
GENERAL DYNAMICS
ELECTRONICS DIVISION



BROADBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ
ITEM: SPACE STATION PS
CONDITIONS: DC RECEIVER OUTPUT
GRAPH NO. 21 OCT 28, 1985 13:46:26

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 21-1 OF 1
OCT 28, 1985 13:46:26

BROADBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS MFG: CONVAIR
SN: PROTOTYPE PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: DC RECEIVER OUTPUT

FREQ MHZ	METER READING DBUV	PROBE FACTOR DB	CABLE LOSS DB	BROAD-BAND FACTOR DB	EMISSION LEVEL DBUA/MHZ	SPEC LIMIT	OVER LIMIT DB
0.01500	55	16	0	60	131	129	2
0.02500	60	10	0	60	130	121	9
0.03000	65	9	0	60	134	118	16
0.05000	70	4	0	60	134	110	24
0.07000	66	1	0	60	127	104	23
0.09000	63	-1	0	60	122	100	22
0.13000	77	-4	0	40	113	94	19
0.15000	76	-5	0	40	111	92	19
0.19000	[illegible]	[illegible]	0	40	105	88	17
0.25000	74	-8	0	40	106	84	22
0.31000	[illegible]	-9	0	40	103	81	22
0.40000	69	-10	0	40	99	76	23
0.49000	69	-11	0	40	98	73	25
0.60000	68	-12	0	40	96	69	27
0.79000	66	-12	0	40	94	65	29
1.00000	65	-13	0	40	92	61	31
1.50000	72	-14	0	40	98	55	43
2.00000	66	-14	0	40	92	50	42
2.20000	77	-14	0	26	89	50	39
2.60000	67	-14	0	26	79	50	29
3.00000	59	-14	0	26	71	50	21
3.30000	57	-14	0	26	69	50	19
4.00000	62	-14	0	26	74	50	24
4.50000	68	-14	0	26	80	50	30
4.90000	73	-14	0	26	85	50	35
5.50000	58	-14	0	26	70	50	20
6.00000	50	-14	0	26	62	50	12
7.00000	64	-14	0	26	76	50	26
8.00000	52	-14	0	26	64	50	14
10.000	38	-14	1	26	51	50	1
12.000	34	-14	1	26	47	50	
15.000	24	-14	1	26	37	50	
20.000	21	-14	1	26	34	50	
25.000	11	-14	1	26	24	50	
30.000	12	-13	1	26	26	50	
35.000	40	-13	1	0	28	50	
40.000	45	-12	1	0	34	50	
50.000	43	-11	1	0	33	50	

CONDUCTED BY ED PAKE

APPROVED BY A. H. Mill

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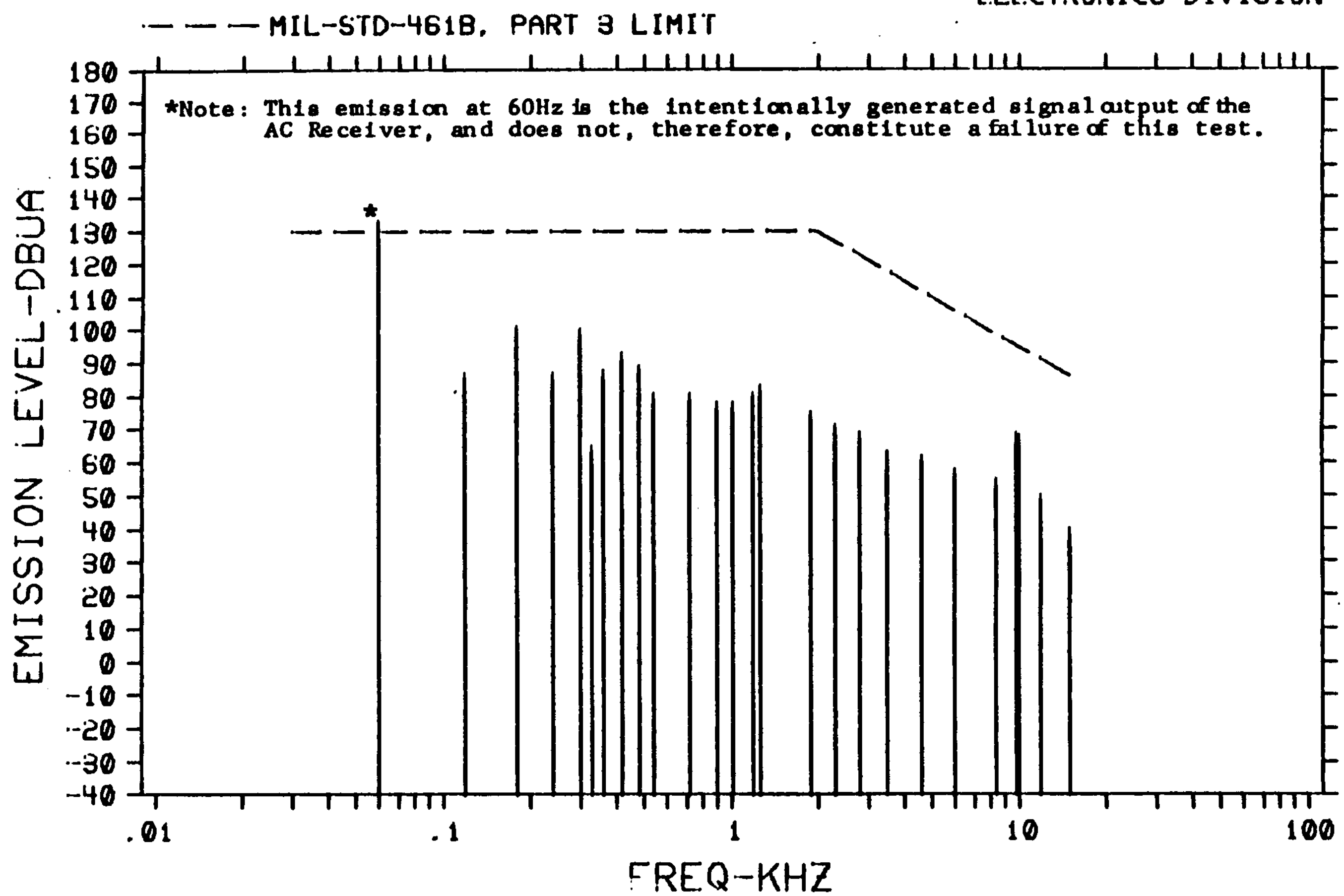
GENERAL DYNAMICS
ELECTRONICS DIVISION



NARROWBAND CONDUCTED EMISSION CE01 30HZ-15KHZ
ITEM: SPACE STATION PS
CONDITIONS: AC RECEIVER OUTPUT
GRAPH NO. 22 OCT 28, 1985 13:54:22

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 22-1 OF 1
OCT 28, 1985 13:54:22

NARROWBAND CONDUCTED EMISSION CE01 30HZ-15KHZ

ITEM: SPACE STATION PS — MFG: CONVAIR
SN: PROTOTYPE — PN:
SPEC: MIL-STD-461B PART 3
CONDITIONS: AC RECEIVER OUTPUT

FREQ	METER READING	PROBE FACTOR	CABLE LOSS	EMISSION LEVEL	SPEC LIMIT	OVER LIMIT
KHZ	DBUV	DB	DB	DBUA	DBUA	DB
0.06000	95	39	0	* 134	130	* 4
0.12000	54	33	0	87	130	
0.18000	71	30	0	101	130	
0.24000	60	27	0	87	130	
0.30000	75	25	0	100	130	
0.33000	41	24	0	65	130	
0.36000	64	24	0	88	130	
0.42000	71	22	0	93	130	
0.48000	67	22	0	89	130	
0.54000	[illegible]	[illegible]	0	81	130	
0.72000	62	19	0	81	130	
0.90000	51	17	0	78	130	
1.02000	62	16	0	78	130	
1.20000	66	15	0	81	130	
1.26000	68	15	0	83	130	
1.90000	61	14	0	75	130	
2.30000	58	13	0	71	127	
2.80000	56	13	0	69	123	
3.50000	51	12	0	63	118	
4.60000	51	11	0	62	112	
6.00000	47	11	0	58	106	
8.40000	44	11	0	55	99	
9.80000	58	11	0	69	95	
10.000	58	10	0	68	95	
12.000	40	18	0	58	91	
15.000	30	10	0	40	86	

* THIS LEVEL AT 60HZ IS NOT A FAILURE BECAUSE THE EMISSION IS THE INTENTIONALLY GENERATED SIGNAL OUTPUT OF THE AC RECEIVER.

CONDUCTED BY ED PRICE

APPROVED BY A.H. Mill

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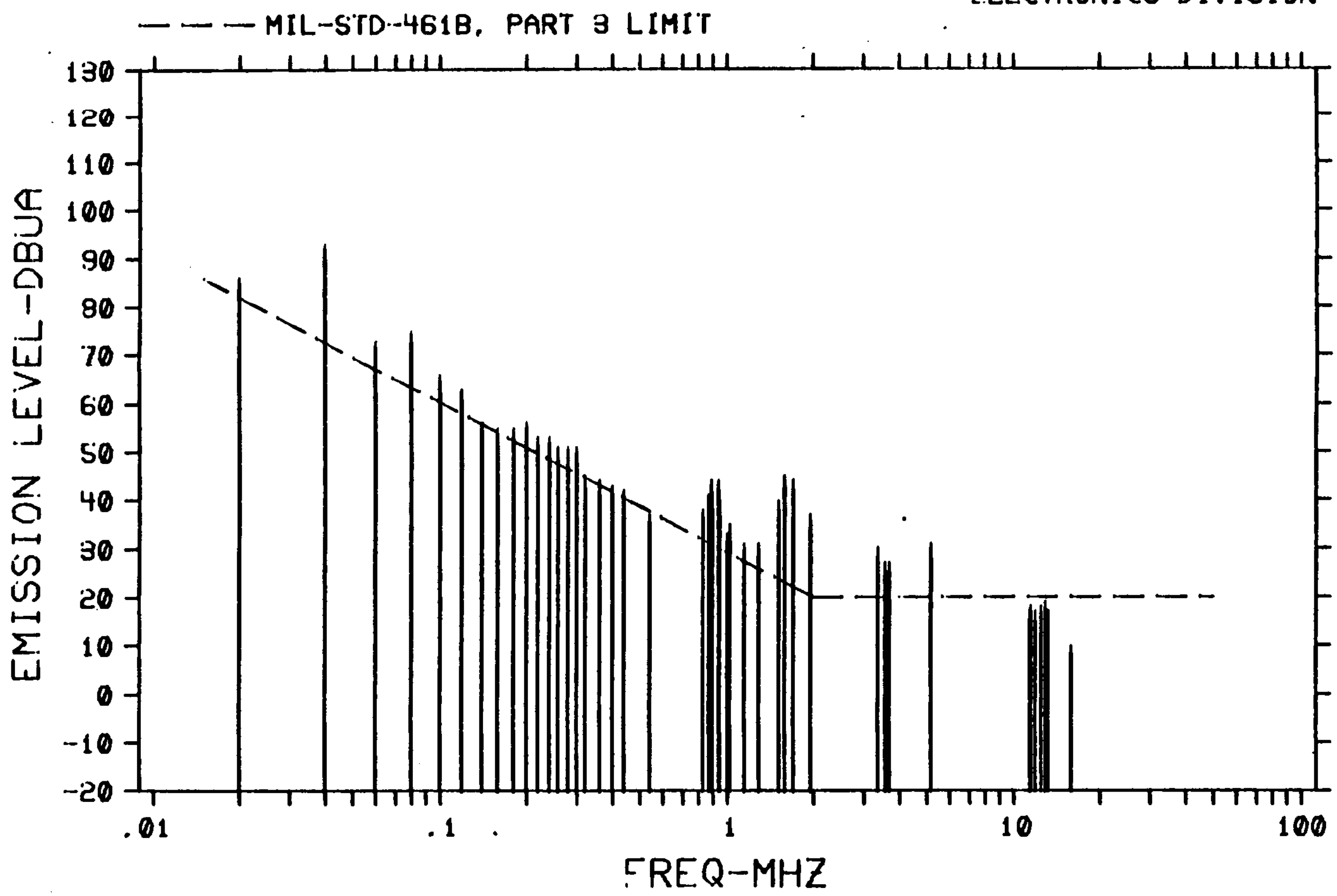
GENERAL DYNAMICS
ELECTRONICS DIVISION



NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ
ITEM: SPACE STATION PS
CONDITIONS: AC RECEIVER OUTPUT
GRAPH NO. 23 OCT 28, 1985 13:59:53

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 23-1 OF 2
OCT 28, 1985 13:59:53

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS
MFG: CONVAIR
SN: PROTOTYPE
PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: AC RECEIVER OUTPUT

FREQ MHZ	METER READING DBUV	PROBE FACTOR DB	CABLE LOSS DB	EMISSION LEVEL DBUA	SPEC LIMIT DBUA	OVER LIMIT DB
0.02000	74	12	0	86	82	4
0.04000	87	6	0	93	73	20
0.06000	78	3	0	73	67	6
0.08000	75	0	0	75	63	12
0.10000	68	-2	0	66	60	6
0.12000	66	-3	0	63	58	5
0.14000	60	-4	0	56	56	
0.16000	60	-5	0	55	54	1
0.18000	61	-6	0	55	52	3
0.20000	63	-7	0	56	51	5
0.22000	60	-7	0	53	50	3
0.24000	61	-8	0	53	49	4
0.26000	59	-8	0	51	48	3
0.28000	60	-9	0	51	47	4
0.30000	60	-9	0	51	46	5
0.32000	55	-10	0	45	45	
0.36000	54	-10	0	44	43	1
0.40000	53	-10	0	43	42	1
0.44000	53	-11	0	42	40	2
0.54000	48	-11	0	37	38	
0.83000	51	-13	0	38	32	6
0.87000	54	-13	0	41	31	10
0.89000	57	-13	0	44	31	13
0.90000	53	-13	0	40	31	9
0.94000	57	-13	0	44	30	14
0.95000	53	-13	0	40	30	10
1.00000	46	-13	0	33	29	4
1.03000	48	-13	1	35	29	6
1.15000	44	-13	0	31	27	4
1.30000	45	-14	0	31	26	5
1.52000	54	-14	0	40	24	16
1.60000	59	-14	0	45	23	22
1.70000	58	-14	0	44	22	22
1.95000	51	-14	0	37	20	17
3.35000	44	-14	0	30	20	10
3.55000	41	-14	0	27	20	7
3.70000	41	-14	0	27	20	7
5.15000	45	-14	0	31	20	11
11.450	30	-14	1	17	20	

CONDUCTED BY Ed Price

APPROVED BY A.H. Mills

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 23-2 OF 2
OCT 28, 1985 13:59:53

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS
MFG: CONVAIR
SN: PROTOTYPE
PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: AC RECEIVER OUTPUT

FREQ	METER READING	PROBE FACTOR	CABLE LOSS	EMISSION LEVEL	SPEC LIMIT	OVER LIMIT
MHZ	DBUV	DB	DB	DBUA		DB
11.600	31	- 14	1	18	20	
12.000	30	- 14	1	17	20	
12.550	31	- 14	1	18	20	
12.980	32	- 14	1	19	20	
13.300	30	- 14	1	17	20	
15.900	23	- 14	1	10	20	

CONDUCTED BY ED Price

APPROVED BY A.H. Mills

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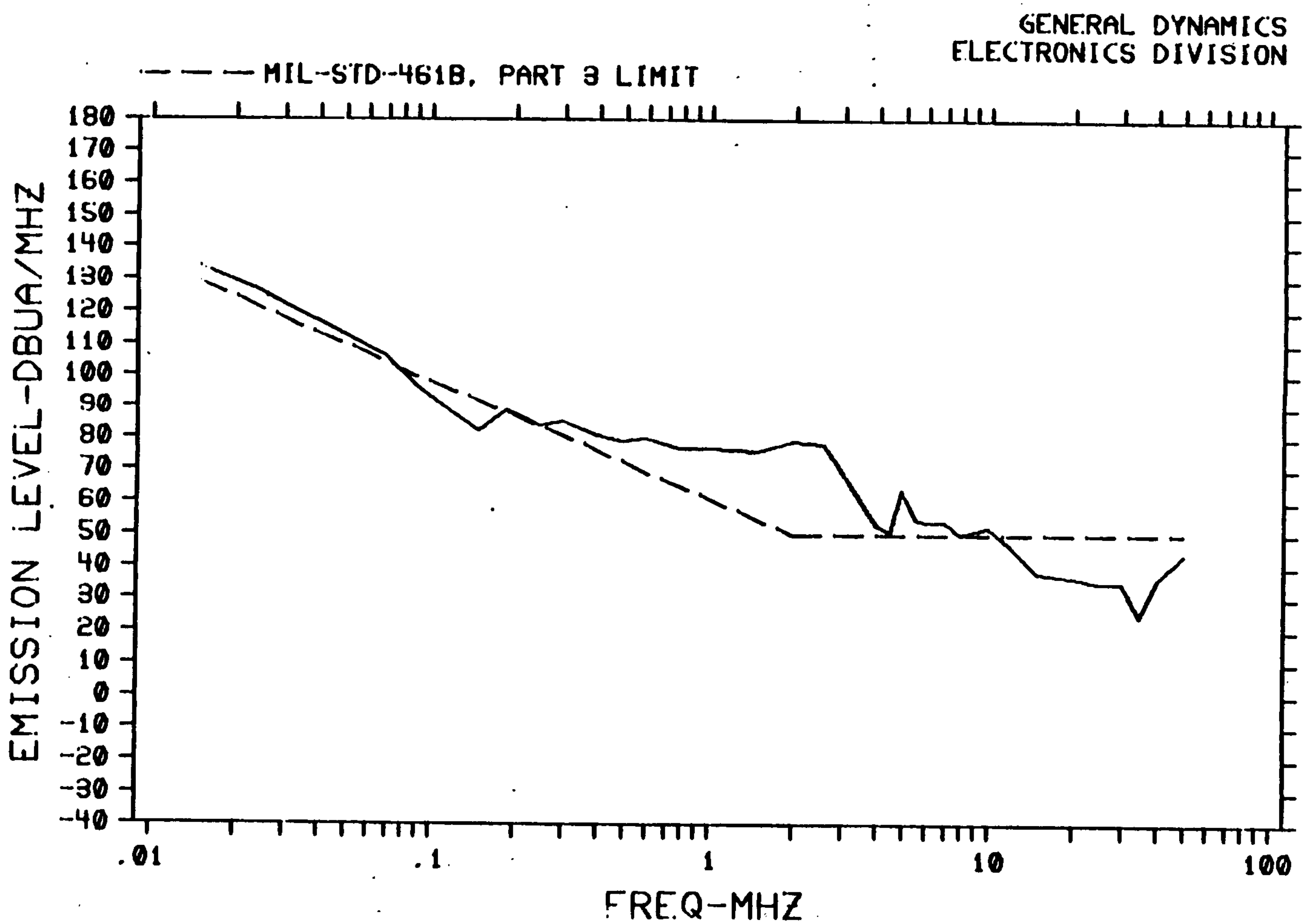

BROADBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ
ITEM: SPACE STATION PS
CONDITIONS: AC RECEIVER OUTPUT
GRAPH NO. 24 OCT 28, 1985 14:12:00

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GENERAL DYNAMICS TAB. NO. 24-1 OF 1
ELECTRONICS DIVISION OCT 28, 1985 14:12:00

BROADBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS MFG: CONVAIR
SN: PROTOTYPE PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: AC RECEIVER OUTPUT

FREQ	METER READING	PROBE FACTOR	CABLE LOSS	BROAD-BAND FACTOR	EMISSION LEVEL	SPEC LIMIT	OVER LIMIT
MHZ	DBUV	DB	DB	DB	DBUA/MHZ		DB
0.01500	58	16	0	60	134	129	5
0.02500	56	10	0	60	126	121	5
0.03000	53	9	0	60	122	118	4
0.05000	49	4	0	60	113	110	3
0.07000	65	1	0	40	106	104	2
0.09000	58	-1	0	40	97	100	
0.13000	50	-4	0	40	86	94	
0.15000	47	-5	0	40	82	92	
0.19000	56	-7	0	40	89	88	1
0.25000	52	-8	0	40	84	84	
0.30000	54	-9	0	40	85	81	4
0.40000	51	-10	0	40	81	76	5
0.49000	50	-11	0	40	79	73	6
0.60000	52	-12	0	40	80	69	11
0.79000	49	-12	0	40	77	65	12
1.00000	50	-13	0	40	77	61	16
1.50000	50	-14	0	40	76	55	21
2.00000	53	-14	0	40	79	50	29
2.60000	66	-14	0	26	78	50	28
3.00000	58	-14	0	26	70	50	20
4.00000	41	-14	0	26	53	50	3
4.50000	39	-14	0	26	51	50	1
4.90000	52	-14	0	26	64	50	14
5.50000	43	-14	0	26	55	50	5
6.00000	42	-14	0	26	54	50	4
7.00000	42	-14	0	26	54	50	4
8.00000	38	-14	0	26	50	50	
10.000	39	-14	1	26	52	50	2
12.000	34	-14	1	26	47	50	
15.000	25	-14	1	26	38	50	
20.000	24	-14	1	26	37	50	
25.000	22	-14	1	26	35	50	
30.000	21	-13	1	26	35	50	
35.000	37	-13	1	0	25	50	
40.000	47	-12	1	0	36	50	
50.000	54	-11	1	0	44	50	

CONDUCTED BY ED Price

APPROVED BY A. H. Mills

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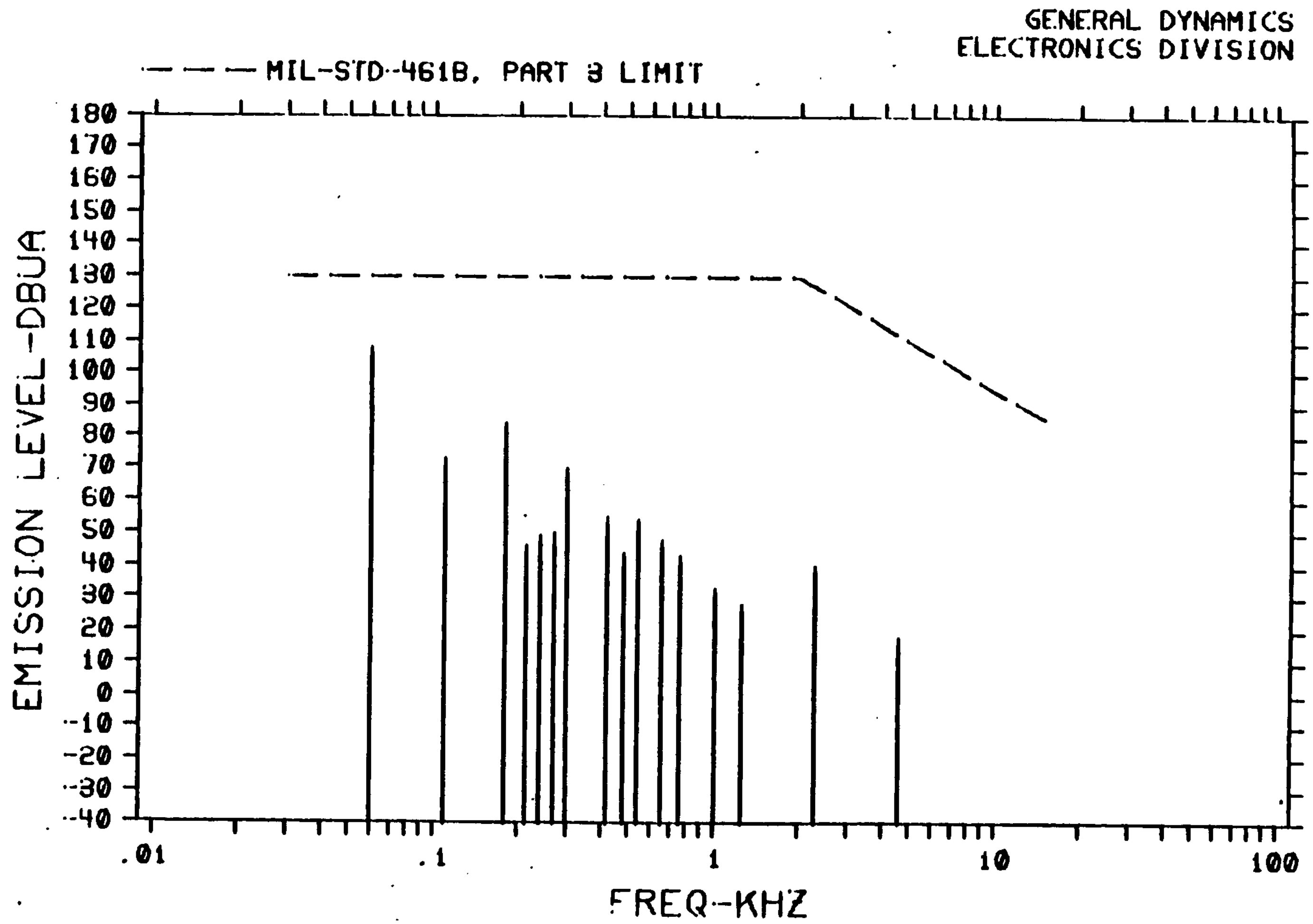

NARROWBAND CONDUCTED EMISSION CE01 30HZ-15KHZ
ITEM: SPACE STATION PS
CONDITIONS: BI-DIRECTIONAL RECEIVER OUTPUT
GRAPH NO. 25 OCT 28, 1985 14:21:45

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 25-1 OF 1
OCT 28, 1985 14:21:45

NARROWBAND CONDUCTED EMISSION CE01 30HZ-15KHZ

ITEM: SPACE STATION PS
MFG: CONVAIR
SN: PROTOTYPE
PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: BI-DIRECTIONAL RECEIVER OUTPUT

FREQ	METER READING	PROBE FACTOR	CABLE LOSS	EMISSION LEVEL	SPEC LIMIT	OVER LIMIT
KHZ	DBUV	DB	DB		DBUA	DB
0.06000	69	39	0	108	130	
0.11000	39	34	0	73	130	
0.16000	54	30	0	84	130	
0.21500	18	28	0	46	130	
0.24000	22	27	0	49	130	
0.27000	24	26	0	50	130	
0.30000	45	25	0	70	130	
0.42000	33	22	0	55	130	
0.48000	22	22	0	44	130	
0.54000	33	21	0	54	130	
0.66000	29	19	0	48	130	
0.76000	25	18	0	43	130	
1.02000	17	16	0	33	130	
1.26000	13	15	0	28	130	
2.30000	27	13	0	40	127	
4.60000	7	11	0	18	112	

CONDUCTED BY Ed Parke

APPROVED BY A.H. Mills

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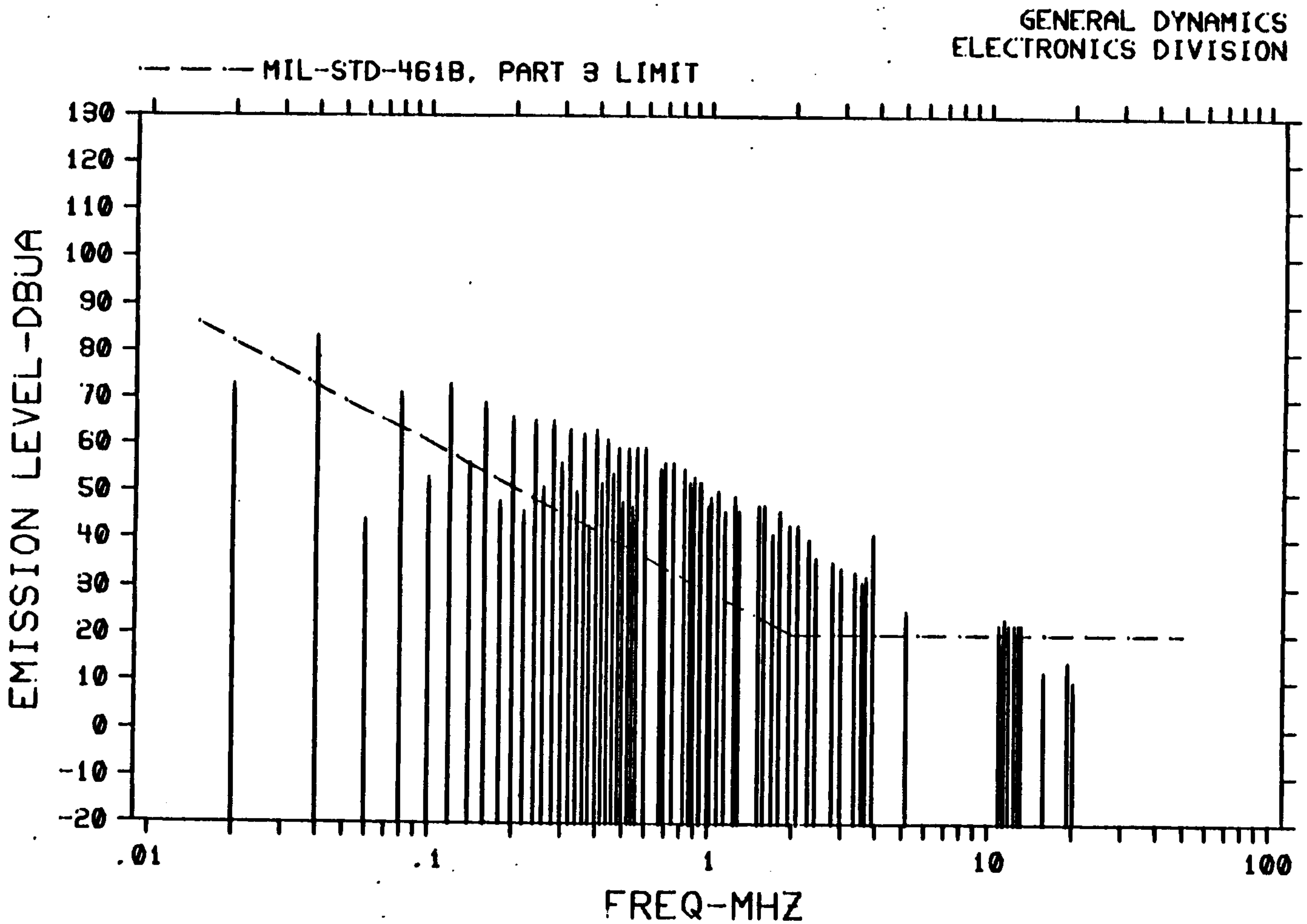

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ
ITEM: SPACE STATION PS
CONDITIONS: BI-DIRECTIONAL RECEIVER OUTPUT
GRAPH NO. 26 OCT 28, 1985 14:25:58

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GENERAL DYNAMICS TAB NO. 26-1 OF 2
ELECTRONICS DIVISION OCT 28, 1985 14:25:58

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS MFG: CONVAIR
SN: PROTOTYPE PN:
SPEC: MIL-STD-461B PART 3
CONDITIONS: BI-DIRECTIONAL RECEIVER OUTPUT

FREQ	METER READING	PROBE FACTOR	CABLE LOSS	EMISSION LEVEL	SPEC LIMIT	OVER LIMIT
MHZ	DBUV	DB	DB	DBUA		DB
0.02000	61	12	0	73	82	
0.04000	77	6	0	83	73	10
0.06000	41	3	0	44	67	
0.08000	71	0	0	71	63	8
0.10000	55	-2	0	53	60	
0.12000	76	-3	0	73	58	15
0.14000	60	-4	0	56	56	
0.16000	74	-5	0	69	54	15
0.18000	54	-6	0	48	52	
0.20000	73	-7	0	66	51	15
0.22000	53	-7	0	46	50	
0.24000	73	-8	0	65	49	16
0.26000	59	-8	0	51	48	3
0.28000	74	-9	0	65	47	18
0.30000	65	-9	0	56	46	10
0.32000	73	-10	0	63	45	18
0.34000	60	-10	0	50	44	6
0.36000	72	-10	0	62	43	19
0.38000	53	-10	0	43	42	1
0.40000	73	-10	0	63	42	21
0.42000	63	-11	0	52	41	11
0.44000	72	-11	0	61	40	21
0.46000	65	-11	0	54	40	14
0.48000	70	-11	0	59	39	20
0.50000	59	-11	0	48	39	9
0.52000	70	-11	0	59	38	21
0.54000	58	-11	0	47	38	9
0.56000	71	-12	0	59	37	22
0.60000	71	-12	0	59	36	23
0.68000	67	-12	0	55	35	20
0.70000	68	-12	0	56	34	22
0.75000	68	-12	0	56	33	23
0.83000	68	-13	0	55	32	23
0.87000	65	-13	0	52	31	21
0.89000	63	-13	0	50	31	19
0.90000	66	-13	0	53	31	22
0.94000	65	-13	0	52	30	22
0.95000	65	-13	0	52	30	22
1.00000	60	-13	0	47	29	18

CONDUCTED BY Ed Price

APPROVED BY A.H. Mills

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ELECTRONICS DIVISION

TAB NO. 26-2 OF 2
OCT 28, 1985 14:25:58

NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS MFG: CONVAIR
SN: PROTOTYPE PN:
SPEC: MIL-STD-461B, PART 3
CONDITIONS: BI-DIRECTIONAL RECEIVER OUTPUT

FREQ MHZ	METER READING DBUV	PROBE FACTOR DB	CABLE LOSS DB	EMISSION LEVEL DBUA	SPEC LIMIT	OVER LIMIT DB
1.03000	62	-13	0	49	29	20
1.09000	63	-13	0	50	28	22
1.15000	59	-13	0	46	27	19
1.25000	63	-14	0	49	26	23
1.30000	60	-14	0	46	26	20
1.52000	61	-14	0	47	24	23
1.60000	61	-14	0	47	23	24
1.72000	55	-14	0	41	22	19
1.80000	60	-14	0	46	21	25
1.93000	57	-14	0	43	20	23
2.10000	57	-14	0	43	20	23
2.30000	54	-14	0	40	20	20
2.45000	50	-14	0	36	20	16
2.80000	49	-14	0	35	20	15
3.00000	48	-14	0	34	20	14
3.35000	47	-14	0	33	20	13
3.55000	45	-14	0	31	20	11
3.73000	46	-14	0	32	20	12
3.98000	55	-14	0	41	20	21
6.15000	[illegible]	-14	0	25	20	5
11.000	35	-14	1	22	20	2
11.450	32	-14	1	19	20	
11.600	36	-14	1	23	20	3
12.000	35	-14	1	22	20	2
12.550	35	-14	1	22	20	2
12.900	35	-14	1	22	20	2
13.300	35	-14	1	22	20	2
15.900	25	-14	1	12	20	
19.400	27	-14	1	14	20	
20.200	23	-14	1	10	20	

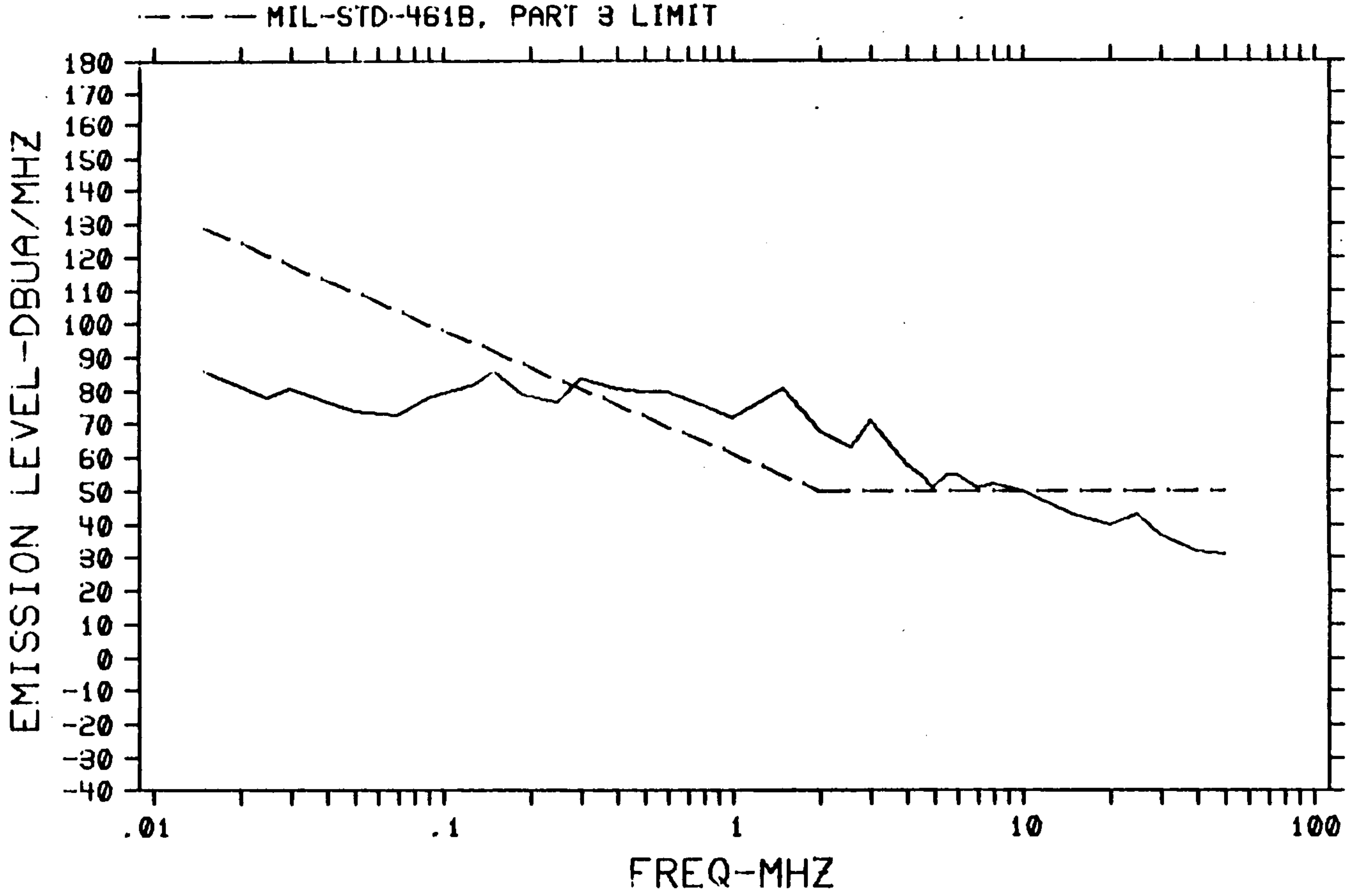
CONDUCTED BY Ed Price

APPROVED BY A H [illegible]

CERTIFIED BY ____________

SHEET ____

GENERAL DYNAMICS
ELECTRONICS DIVISION



BROADBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS

CONDITIONS: BI-DIRECTIONAL RECEIVER OUTPUT

GRAPH NO. 27 OCT 28, 1985 14:44:36

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO. 27-1 OF 1
OCT 25. 1985 14:44:36

BROADBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS MFG: CONVAIR
SN: PROTOTYPE PN:
SPEC: MIL-STD-461B. PART 3
CONDITIONS: BI-DIRECTIONAL RECEIVER OUTPUT

FREQ MHZ	METER READING DBUV	PROBE FACTOR DB	CABLE LOSS DB	BROAD-BAND FACTOR DB	EMISSION LEVEL DBUA/MHZ	SPEC LIMIT	OVER LIMIT DB
0.01500	10	16	0	60	86	129	
0.02500	8	10	0	60	78	121	
0.03000	12	9	0	60	81	118	
0.05000	10	4	0	60	74	110	
0.07000	32	1	0	40	73	104	
0.09000	39	-1	0	40	78	100	
0.13000	46	-4	0	40	82	94	
0.15000	51	-5	0	40	86	92	
0.19000	46	-7	0	40	79	88	
0.25000	45	-8	0	40	77	84	
0.30000	53	-9	0	40	84	81	3
0.40000	51	-10	0	40	81	76	5
0.49000	51	-11	0	40	80	73	7
0.68000	52	-12	0	40	80	69	11
0.79000	48	-12	0	40	76	65	11
1.00000	45	-13	0	40	72	61	11
1.50000	55	-14	0	40	81	55	26
2.00000	42	-14	0	40	68	50	18
2.60000	51	-14	0	26	63	50	13
3.00000	59	-14	0	26	71	50	21
4.00000	46	-14	0	26	58	50	8
4.50000	43	-14	0	26	55	50	5
4.90000	39	-14	0	26	51	50	1
5.50000	43	-14	0	26	55	50	5
6.00000	43	-14	0	26	55	50	5
7.00000	39	-14	0	26	51	50	1
8.00000	40	-14	0	26	52	50	2
10.000	37	-14	1	26	50	50	
12.000	34	-14	1	26	47	50	
15.000	30	-14	1	26	43	50	
20.000	27	-14	1	26	40	50	
25.000	30	-14	1	26	43	50	
30.000	23	-13	1	26	37	50	
40.000	43	-12	1	0	32	50	
50.000	41	-11	1	0	31	50	

CONDUCTED BY ED PRICE

APPROVED BY A.W.M.O.

CERTIFIED BY ____________________

SHEET ____

SUSCEPTIBILITY TEST DATA

TEST ITEM: EPS MANUFACTURER: GDC
SERIAL NO: TEST NO: CS02 DATE OF TEST: 10-23-85
TEST CONDUCTED PER: INPUT VOLTAGE: 150 VDC
PICKUP DEVICE: HP-400 + TEK-2445 TYPE OF TEST:
TEST METER: SERIAL NO: DATE OF LAST CAL:
OTHER INFO:

PHASE		A									
MHz	VRMS										
.05	71			NO	RESPONSES						
↓	71			"	"						
400	71			"	"						
PHASE		B									
MHz	VRMS										
.05	71			NO	RESPONSES						
↓	71			"	"						
400	71			"	"						
PHASE		C									
MHz	VRMS			NO							
.05	71			NO	RESPONSES						
↓	71			"	"						
400	71			"	"						

EPS PASSES TEST

CONDUCTED BY: ED PRICE	DATA SHEET 28	SIZE A	REV SYM
APPROVED BY: A. Hmill			
CERTIFIED BY:			
	SCALE		SHEET

FORM 5-277

SUSCEPTIBILITY TEST DATA

TEST ITEM: EPS MANUFACTURER: GDC

SERIAL NO: TEST NO: C506 DATE OF TEST: 10-23-85

TEST CONDUCTED PER: INPUT VOLTAGE: 150 VDC

PICKUP DEVICE: TEK- 2445 TYPE OF TEST:

TEST METER: SERIAL NO: DATE OF LAST CAL:

OTHER INFO:

PHASE C INJECTION POINT				
10uS,	30Hz PRR,	100V,	+ POLARITY	NO RESPONSES
10uS,	30Hz PRR,	100V,	− POLARITY	NO RESPONSES
.15uS,	30Hz PRR,	100V,	− POLARITY.	PHASE SHUTDOWN
.15uS,	30Hz PRR,	50V,	− POLARITY	" "
5uS,	30Hz PRR,	100V,	− POLARITY	NO RESPONSES
5uS,	30Hz PRR,	200V,	− POLARITY	" "
5uS,	30Hz PRR,	300V,	− POLARITY	" "
5uS,	30Hz PRR,	400V,	− POLARITY	" "
5uS,	30Hz PRR,	400V,	+ POLARITY	" "
5uS,	30Hz PRR,	150V,	+ POLARITY	PHASE SHUTDOWN

THIS TEST SEQUENCE WAS TERMINATED TO AVOID SYSTEM DAMAGE AFTER IT WAS FOUND THAT THE EPS COULD NOT TOLERATE A 50 VOLT PEAK, 0.15 uS DURATION TRANSIENT APPLIED TO ITS 150 VOLT DC POWER SOURCE.

CONDUCTED BY: ED PRICE	DATA SHEET 29	SIZE A	REV SYM
APPROVED BY: A.H. Mills			
CERTIFIED BY:			
	SCALE		SHEET

FORM 5-277