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.
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.
1.1.7 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>
<thead>
<tr>
<th>MOTION ORIENTATION</th>
<th>POWER ACTUATOR</th>
<th>POWER TRANSFER</th>
<th>SENSOR SIGNAL</th>
<th>PANEL RESPONSE</th>
<th>STAND-ALONE POWER INPUT</th>
<th>STAND-ALONE POWER OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table I-1. Test Matrix
<table>
<thead>
<tr>
<th>SYMBOL</th>
<th>PARAMETER MEASURED</th>
<th>INSTRUMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>FREQUENCY</td>
<td>FREQUENCY COUNTER</td>
</tr>
<tr>
<td>H</td>
<td>HARMONIC COMPONENTS</td>
<td>SPECTRUM ANALYZER</td>
</tr>
<tr>
<td>IA</td>
<td>CURRENT IN A SIDE OF INVERTER 1</td>
<td>CURRENT PROBE—OSCILLOSCOPE—CAMERA</td>
</tr>
<tr>
<td>IB</td>
<td>CURRENT IN B SIDE OF INVERTER 1</td>
<td>CURRENT PROBE—OSCILLOSCOPE—CAMERA</td>
</tr>
<tr>
<td>IC</td>
<td>CURRENT IN C SIDE OF INVERTER 2</td>
<td>CURRENT PROBE—OSCILLOSCOPE—CAMERA</td>
</tr>
<tr>
<td>ID</td>
<td>CURRENT IN D SIDE OF INVERTER 2</td>
<td>CURRENT PROBE—OSCILLOSCOPE—CAMERA</td>
</tr>
<tr>
<td>IE</td>
<td>CURRENT IN E SIDE OF BIDIRECTIONAL MODULE</td>
<td>CURRENT PROBE—OSCILLOSCOPE—CAMERA</td>
</tr>
<tr>
<td>IF</td>
<td>CURRENT IN F SIDE OF BIDIRECTIONAL MODULE</td>
<td>CURRENT PROBE—OSCILLOSCOPE—CAMERA</td>
</tr>
<tr>
<td>IG</td>
<td>CURRENT IN G SIDE OF INVERTER 3</td>
<td>CURRENT PROBE—OSCILLOSCOPE—CAMERA</td>
</tr>
<tr>
<td>IH</td>
<td>CURRENT IN H SIDE OF INVERTER 3</td>
<td>CURRENT PROBE—OSCILLOSCOPE—CAMERA</td>
</tr>
<tr>
<td>IK1</td>
<td>AC RESONANT TANK CURRENT OF INVERTER 1</td>
<td>CURRENT PROBE—OSCILLOSCOPE—CAMERA</td>
</tr>
<tr>
<td>IK2</td>
<td>AC RESONANT TANK CURRENT OF INVERTER 2</td>
<td>CURRENT PROBE—OSCILLOSCOPE—CAMERA</td>
</tr>
<tr>
<td>IK3</td>
<td>AC RESONANT TANK CURRENT OF INVERTER 3</td>
<td>CURRENT PROBE—OSCILLOSCOPE—CAMERA</td>
</tr>
<tr>
<td>IS</td>
<td>STEADY-STATE CURRENT</td>
<td>AMMETER</td>
</tr>
<tr>
<td>IT</td>
<td>TRANSIENT CURRENT</td>
<td>CURRENT PROBE—OSCILLOSCOPE—CAMERA</td>
</tr>
<tr>
<td>n</td>
<td>EFFICIENCY</td>
<td>CALCULATION FROM PA</td>
</tr>
<tr>
<td>PS</td>
<td>STEADY-STATE POWER</td>
<td>V-A-W METER</td>
</tr>
<tr>
<td>T</td>
<td>TOTAL HARMONIC DISTORTION</td>
<td>DISTORTION ANALYZER</td>
</tr>
<tr>
<td>VK1</td>
<td>AC RESONANT TANK VOLTAGE OF INVERTER 1</td>
<td>OSCILLOSCOPE—CAMERA</td>
</tr>
<tr>
<td>VK2</td>
<td>AC RESONANT TANK VOLTAGE OF INVERTER 2</td>
<td>OSCILLOSCOPE—CAMERA</td>
</tr>
<tr>
<td>VK3</td>
<td>AC RESONANT TANK VOLTAGE OF INVERTER 3</td>
<td>OSCILLOSCOPE—CAMERA</td>
</tr>
<tr>
<td>VS</td>
<td>STEADY-STATE VOLTAGE</td>
<td>VOLTMETER</td>
</tr>
<tr>
<td>VT</td>
<td>TRANSIENT VOLTAGE</td>
<td>OSCILLOSCOPE—CAMERA</td>
</tr>
<tr>
<td>VX1</td>
<td>SECONDARY OF INVERTER 1 TRANSFORMER</td>
<td>DIFFERENTIAL VOLTMETER</td>
</tr>
<tr>
<td>VX2</td>
<td>SECONDARY OF INVERTER 2 TRANSFORMER</td>
<td>DIFFERENTIAL VOLTMETER</td>
</tr>
<tr>
<td>VX3</td>
<td>SECONDARY OF INVERTER 3 TRANSFORMER</td>
<td>DIFFERENTIAL VOLTMETER</td>
</tr>
</tbody>
</table>
Figure I-1. Configuration 1: Driver with Resistive Load
Figure 1-2. 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)
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
INVERTER SCHEMATIC

FIGURE 1-13. 4.2-kW Inverter Schematic.
FIGURE 1-14. Configuration 7: 25.0-kW, Three-Phase Drivers--Transmission Line--Three Receivers and Resistive Loads
DATA SHEETS AND TEST RESULTS
2.3.1 Power Startup of a Single Inverter

Location of Power Relay.

Power switch → 200ms Delay → Scope Trigger

Power Relay Coil Energized
**2.3.1 No Load**

- **VIN = 87 V DC**
- **R_L = ∞**
- **I_OUT = 0**

**Input Current (Before DC Capacitor)**

- **Input Voltage**

**Input Current (After DC Capacitor)**

- **Input Voltage**

**Input Current (After DC Capacitor)**

- **Output Voltage**
2.3.1

-3.2.1  NO LOAD

Branch Current 1A

Branch Current 1B

Branch Current 2A

Branch Current 2B
2.3.1 10% LOAD

\[ V_{IN} = 87 \text{VDC} \]
\[ R_{	ext{LOAD}} = 116 \Omega \]
\[ P_{	ext{OUT}} = 129 \text{W} \]

- Input Current (Before DC Capacitor)
- Input Voltage
- Input Current (After DC Capacitor)
- Output Current
- Output Voltage
2.3.1 10% LOAD

Branch Current IA

Branch Current IB

Branch Current 2A

Branch Current 2B
2.3.1

- 3.2.1 50% LOAD

Input Current
(Before DC Capacitor)

Input Voltage

Input Current
(After DC Capacitor)

Output Current

Output Voltage

\[ V_{\text{IN}} = 87.0 \text{VDC} \]
\[ R_{\text{LOAD}} = 25.4 \Omega \]
\[ P_{\text{out}} = 571 \text{W} \]
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-Driven System

As in Configuration 2.3.2, the dual-driven 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.
Configuration - Test 2.3.6-3.3.1  POWER START UP
OF 5.0-KW SYSTEM
(Logic Before Relay)

Test Circuits

D₁ > D₂

Scope Trigger

Logic Circuit Turn On

Relay Delay

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

TRANSIENT TEST DATA SHEET

<table>
<thead>
<tr>
<th>Test Configuration: 7.3.6 - 3.2.1 Power Turn On</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case: No Load (1.5) (Early Logic T.O.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input Voltage:</th>
<th>0 → 120.2 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC ACVR:</td>
<td>28.4 V / OW</td>
</tr>
<tr>
<td>Input Current:</td>
<td>0 → 9.69A short</td>
</tr>
<tr>
<td>AC ACVR:</td>
<td>0V - Turn OFF</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>20.336 kHz</td>
</tr>
<tr>
<td>Output Power:</td>
<td>0W</td>
</tr>
<tr>
<td>BD Module:</td>
<td>194.79 V / OW</td>
</tr>
</tbody>
</table>

![Graphs showing transient test data](image-url)

**Input Voltage** | Scale: 20mV
---|---
**Output Voltage**
---|---
**Input Current** | Scale: 10mA
---|---
**Output Current**
---|---

---

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT TEST PROGRAM (NAS-3-32777)

TRANSIENT TEST DATA SHEET

Test Configuration: 2.3.6-3.2.1 Power Turn On

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

- Input Voltage: 0 → 120.2 V
- DC Receiver: 0 → 28.4 V / 0 W
- Input Current: 0 → 9.69 A (shunt)
- AC Receiver: 0 V - Turned Off
- System Frequency: 20.336 kHz
- Output Power: 0 W
- BD Module: 0 → 194.79 / 0 W

Other:

---

**Graphs:**

- **V_{IN}**
- **I_{A}**
- **V_{IN}**
- **I_{A} + V_{IN}**
- **I_{A} + V_{IN}**
- **I_{B}**
- **I_{1}**
- **I_{2}**
# Resonant AC Power System Proof-of-Concept Test Program (NAS-2-22777)

**Transient Test Data Sheet**

<table>
<thead>
<tr>
<th>Test Configuration: 2.3.6-3.2</th>
<th>Power Turn On</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case: No Load (1.5 F) Early Logic</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input Voltage:</th>
<th>DC Receiver:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current:</td>
<td>AC Receiver:</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>BD Module:</td>
</tr>
<tr>
<td>Output Power:</td>
<td>Other:</td>
</tr>
</tbody>
</table>

![Graph 1](Image)

**Graph 1**

<table>
<thead>
<tr>
<th>Scale: 20A</th>
</tr>
</thead>
</table>

![Graph 2](Image)

**Graph 2**

<table>
<thead>
<tr>
<th>Scale: 20A</th>
</tr>
</thead>
</table>
# RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
## TEST PROGRAM (NAS3-22777)
### TRANSIENT TEST DATA SHEET

**Test-Configuration:** 236-3.2.1  
**Power On**  

<table>
<thead>
<tr>
<th>Specific Case</th>
<th>DC Rcvr</th>
<th>AC Rcvr</th>
<th>BD Module</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na Load (1.5μF)</td>
<td>Early Logic T.O.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input Voltage</th>
<th>Input Current</th>
<th>System Frequency</th>
<th>Output Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>SAME</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Input Voltage & Current Scale:** 50A/

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

**Scale:**

10 mS

50A

---

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Configuration - Test 2.36 - 3.2.1 POWER TURN ON
OF 50-KW SYSTEM
(Relay Before Logic)

Test Circuits

```
<table>
<thead>
<tr>
<th>Scope Trigger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delay D2</td>
</tr>
<tr>
<td>Relay Delay</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Logic Circuit Turn On</td>
</tr>
<tr>
<td>Relay Closed</td>
</tr>
</tbody>
</table>

D1 < D2

POWER SUPPLIES

INV 1
INV 2
INV 3
```
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, 1.5 mF

Input Voltage: 0 → 120.1 DC Rcvr: 0 → 28.4 0 W
Input Current: 0 → 9.70 AC Rcvr: 0 W
System Frequency: 20.35 Hz BD Module: 194.79 0 W
Output Power: 0 W Other:

Input Voltage and Current Scale: 70A/ Scale: 10A/ 100/50V
Input Voltage and Current Scale: 20A/ Scale: 20A/ 100/50V

w/ BD Module at 0V prior to switching
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.36 - 3.2.1
Specific Case: No Load, 1.5 μF
Input Voltage: DC Rcvr: AC Rcvr: AC Module: BD Module:
Input Current: SAME Input Current: SAME
System Frequency: Output Power: Other:

Scale: 20A/
Scale: 20A/
Scale: 20A/
Scale:
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 23.6-3.2.1 Power Turn On
Specific Case: No Load, 1.5 μF
Input Voltage: Same
Input Current: AC Rcvr:
System Frequency: BD Module: Various Modes
Output Power: Other:

---

<table>
<thead>
<tr>
<th>Current (I_c)</th>
<th>Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mV</td>
<td>500 μS</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Current (I_d)</th>
<th>Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mV</td>
<td>500 μS</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Current (I_c)</th>
<th>Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 mV</td>
<td>100 μS</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Current (I_c)</th>
<th>Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 mV</td>
<td>200 μS</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Current (I_c)</th>
<th>Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 mV</td>
<td>200 μS</td>
</tr>
</tbody>
</table>

RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.6-3.2.1 Power Turn ON
Specific Case: NO LOAD, 15μF
Input Voltage: Same as DC Rcvr: Various Modes
Input Current: AC Rcvr: 
System Frequency: BD Module: 
Output Power: Other: 

---

![Graph 1: Ig - DC Rcvr OFF Scale: 20A/](image)

![Graph 2: Ih - DC Rcvr OFF Scale: 20A/](image)

![Graph 3: Ig - DC Rcvr OFF Scale: 50A/](image)

Doesn't Short
TEST PROGRAM (HAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 236-3.2.1
Specific Case: No Load, 15uF

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

---

**Graph**

$I_G$ - DC Rcvr @ OW, Scale: 20A/

---

Scale: 10.5
Test-Configuration: 23.6-3.21 Power Turn On
Specific Case: No Load, 15uF, Inverter 3
Input Voltage: Same
Input Current: DC Rcvr: 
System Frequency: AC Rcvr: 
Output Power: BD Module: 
Other: 

Scaled Down DC Rcvr OFF
Transmission Line Voltage Scale: ?

Scaled Down DC Rcvr On @ 28.4V
Transmission Line Voltage Scale:?

Occasional Oscillation @ 28.4Vdc Occasional Oscillation
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 236-321 Power Turn On
Specific Case: No Load, 15μF, Inverter 2
Input Voltage: DC Rcvr: 
Input Current: AC Rcvr: 
System Frequency: BD Module: Various Modes
Output Power: Other: 

Scaled Down
Transmission Line Voltage Scale: P

Scaled Down
Line Voltage Scale: ?

IK2 - BD Module @ 0V Scale: 10A/

IK2 - BD Module OFF Scale: 20A/
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 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:

| Scale: 20A/ | Scale: 20A/ |

Scaled Down Line Voltage Scale?
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.36-3.2.1  Power Turn On
Specific Case: No Load, 1.5 mF
Input Voltage: SAME  DC Rcvr:
Input Current:  AC Rcvr:
System Frequency:  BD Module:
Output Power:  Other:

\[ V_{AC} \]
\[ V_{DC} \]
\[ I_{AC} \]
\[ I_{DC} \]
\[ V_{BD} \]
\[ I_{BD} \]

\[ V_{AC} - I_{AC} \]: INV 2-3 off Scale: 1A/
\[ V_{DC} - I_{DC} \]: INV 1-2 off Scale: 1A/
\[ V_{BD} + I_{BD} \]: INV 1-2 off Scale: 1A/

Photo

Scale: 14
**RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT**

**TEST PROGRAM (NAS3-22777)**

**TRANSIENT TEST DATA SHEET**

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>Power Turn ON 10% Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>10% Load, 1.5 A</td>
</tr>
</tbody>
</table>

| Input Voltage: | 0 → 120.0 |
| Input Current: | 12.5 A |
| System Frequency: | 20.073 kHz |
| Output Power: | 318.7 W |

**Diagrams:**

- **V_{IN}**
- **V_{OUT}**
- **I_{IN}**
- **I_{OUT}**

- **SYSTEM SHORT**
  - **V_{IN}**
  - **V_{OUT}**
  - **I_{IN}**
  - **I_{OUT}**

- **V_{IN} * I_{IN}**
  - Scale: 10 A/DIV

- **V_{OUT} * I_{OUT}**
  - Scale: 10 A/DIV
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: Power train on 10% load
Specific Case: 10% load, 15µf - INV #2 is OFF
Input Voltage: 1200 DC Rcvr: 142.5V
Input Current: 8.39 A AC Rcvr: 75W
System Frequency: 20110 kHz BD Module: OFF
Output Power: Other:

\[ \begin{align*}
I_a &\quad 10 \text{V} \\
O_a &\quad 50 \text{mS} \\
\text{INV. 2 OFF} &\quad \text{INV. 2 OFF}
\end{align*} \]

\[ \begin{align*}
V_{L1} &\quad 10 \text{V} \\
O_v &\quad 20 \text{V} \\
I_a &\quad 50 \text{mS} \\
O_a &\quad \text{INV. 2 OFF}
\end{align*} \]

\[ \begin{align*}
\text{LINE VOLTAGE + Ia Scale: 20V/Div} &\quad \text{LINE V. Not to Scale}
\end{align*} \]

\[ \begin{align*}
I_a &\quad 10 \text{V} \\
O_a &\quad 50 \text{mS} \\
\text{INV. 2 OFF} &\quad \text{INV. 2 OFF}
\end{align*} \]

\[ \begin{align*}
V &\quad 10 \text{V} \\
O_v &\quad 20 \text{V} \\
I &\quad 50 \text{mS} \\
O_a &\quad \text{INV. 2 OFF}
\end{align*} \]

\[ \begin{align*}
\text{INV. 2 OFF} &\quad \text{INV. 2 OFF}
\end{align*} \]
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:        

![Graphs showing waveforms and measurements]
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: **Power Turn On, 10% Load**
Specific Case: **Line ON and 50% Load ON (10%)**
Input Voltage: **Same**
Input Current: **AC Rcvr:**
System Frequency: **BD Module:**
Output Power: **Other:**

---

**I_C**

**O_A**

Scale: 500/5V

---

**I_D**

**O_A**

Scale: 500/5V

---

**O_V**

**I_D**

Scale: 500/5V

---

**O_A**

**Line Voltage (not to scale) and**

**I_D** 50% is on.

Scale: 500/5V

---

Photo
**Test-Configuration:**

<table>
<thead>
<tr>
<th>Specific Case</th>
<th>Input Voltage</th>
<th>Input Current</th>
<th>System Frequency</th>
<th>Output Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Transformer - Inverter #3 - DC Rec on</td>
<td>Same</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC Rcvr: Same</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AC Rcvr: Up</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BD Module: Off</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Graphs:**

- **System Does Not Short**
  - Scale: 50a/div

- **System Doesn't Short**
  - Scale: 2a/div
### Resonant AC Power System Proof-of-Concept Test Program (NAS3-22777)

#### Transient Test Data Sheet

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>Power Turn ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>10% Load</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>Same</td>
</tr>
<tr>
<td>Input Current:</td>
<td></td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td></td>
</tr>
</tbody>
</table>

**Input Voltage**: 50V

**Output Power**: 20W

**System Frequency**: 20kHz

**Input Current**: 5mA

**Output Power**: 2.0W

**Scale**: 50mA/div, 50V/div

**Photo**: System does not short

---

### Photos

1. [Photo 1](image1)
2. [Photo 2](image2)
**Resonant AC Power System Proof-of-Concept**
**Test Program (NAS3-Z22777)**
**Transient Test Data Sheet**

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>Power Tube Off</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>10% Load</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>Same</td>
</tr>
<tr>
<td>Input Current:</td>
<td></td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td></td>
</tr>
</tbody>
</table>

**Input Voltage:** 

- **Frequency:** 

**Output Power:**

- **AC Rcvr:** 
- **DC Rcvr:** 
- **BD Module:** 
- **Other:**

---

**Graphs:**

- **IK1 - 1UV#2 is Off**
  - Scale: 20A/Div

- **IK2 - B/D is On**
  - Scale: 20A/Div

- **IK3 - 1UV#2 is Off**
  - Scale: 20A/Div

---

**Caption:**

- **Original Page is of Poor Quality**
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:

```
<table>
<thead>
<tr>
<th>Vac</th>
<th>Ov</th>
</tr>
</thead>
<tbody>
<tr>
<td>50V</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vac</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ov</td>
</tr>
</tbody>
</table>

Scale: 2A/DIV.
```

```
<table>
<thead>
<tr>
<th>Iac</th>
<th>Oa</th>
</tr>
</thead>
<tbody>
<tr>
<td>10mS</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Iac</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oa</td>
</tr>
</tbody>
</table>

Scale: 5A/DIV.

```

AC Rec. B/D is on and shorts out the system.

```
<table>
<thead>
<tr>
<th>Vbd</th>
<th>Ov</th>
</tr>
</thead>
<tbody>
<tr>
<td>10V</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vbd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ov</td>
</tr>
</tbody>
</table>

Scale: 1A/DIV.

B/D starting V and I

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

Page 22
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.7-3.2.1 Power Turn On

C. Compensation

Test Circuits

Scope Trigger

Delay Circuit

$\phi_A$

$\phi_B$

$\phi_C$
**Original page is of poor quality.**

**Resonant AC Power System Proof-of-Concept**

**Test Program (NAS3-22777)**

**Transient Test Data Sheet**

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>2.3.7-3.2.1</th>
<th>Power Turn On</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>C - Compensation, No Load</td>
<td></td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>150 V, 0 W</td>
<td></td>
</tr>
<tr>
<td>Input Current:</td>
<td>20.5 A</td>
<td></td>
</tr>
<tr>
<td>System Frequency:</td>
<td>19.95 kHz</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td>20.1 W</td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

![Data Sheet Images]
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-2.1 Power Turn ON
Specific Case: C - Compensation, No Load
Input Voltage: 0-150.5 Vac
Input Current: 0-70.5 Aac
System Frequency: 19.95 KHz
Output Power: 20.1 W

Other: None
RESONANT AC POWER SYSTEM

TEST PROGRAM (NON-TRANSIENT TEST)

Test-Configuration: 2.3.2 - 3.2.1
Specific Case: C - Condensation
Input Voltage: 
Input Current: 
System Frequency: 
Output Power: 

VIN, dc - Input voltage reference for photos on this page
Scale: 50 V/div

Vki
Scale: 50 A/div

Ia
Scale: 50 A/div

Scale: Ungal.

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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, Faster Restart

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

![Graphs showing transient test data](image-url)
# Resonant AC Power System Proof-of-Concept

**Test Program (NAS3-22777)**

**Transient Test Data Sheet**

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>2.3.7 - 3.2.1 Power Turn On</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>C-Compensation, No Load</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td></td>
</tr>
<tr>
<td>DC Rcvr:</td>
<td></td>
</tr>
<tr>
<td>Input Current:</td>
<td></td>
</tr>
<tr>
<td>AC Rcvr:</td>
<td></td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
</tr>
<tr>
<td>BD Module:</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
</tr>
</tbody>
</table>

![Waveforms](image)

**Scale:** 50 A/div

- **Iin**
- **Iis**
- **Vmi**

- **Iin**
- **Iis**
- **Vmi**

**Scale:** 55 V/200μs

- **Iin**
- **Vmi**

**Scale:** Uncal.
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: __________________

![Graphs showing voltage and current waveforms.](image)
I) **INPUT POWER**

<table>
<thead>
<tr>
<th>V_in</th>
<th>149.5 Vdc</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_in</td>
<td>44.04 Adc</td>
</tr>
<tr>
<td>P_in</td>
<td>6.58 kW</td>
</tr>
</tbody>
</table>

**T.H.D.**

<table>
<thead>
<tr>
<th>ΦA</th>
<th>db</th>
</tr>
</thead>
<tbody>
<tr>
<td>ΦB</td>
<td>db</td>
</tr>
<tr>
<td>ΦC</td>
<td>db</td>
</tr>
</tbody>
</table>

**Test Config. 23.3-22.1 Power Turn On**

**Specific Case**

C-Compensation 13? 6A

**Frequency** 19.91 kHz

II) **OUTPUT POWER**

<table>
<thead>
<tr>
<th>ΦA</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vo</td>
<td></td>
</tr>
<tr>
<td>I0</td>
<td></td>
</tr>
<tr>
<td>P0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ΦB</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vo</td>
<td></td>
</tr>
<tr>
<td>I0</td>
<td></td>
</tr>
<tr>
<td>P0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ΦC</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vo</td>
<td></td>
</tr>
<tr>
<td>I0</td>
<td></td>
</tr>
<tr>
<td>P0</td>
<td></td>
</tr>
</tbody>
</table>

**A.C. RCVR**

<table>
<thead>
<tr>
<th>Vo</th>
<th>OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Io</td>
<td></td>
</tr>
<tr>
<td>P0</td>
<td></td>
</tr>
</tbody>
</table>

**B/D MOD.**

<table>
<thead>
<tr>
<th>Vo</th>
<th>OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Io</td>
<td></td>
</tr>
<tr>
<td>P0</td>
<td></td>
</tr>
</tbody>
</table>

**D.C. RCVR**

<table>
<thead>
<tr>
<th>Vo</th>
<th>OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Io</td>
<td></td>
</tr>
<tr>
<td>P0</td>
<td></td>
</tr>
</tbody>
</table>

**T.H.D. out of RCVR**

| db |

**RESISTIVE LOADS**

<table>
<thead>
<tr>
<th>ΦA</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>V_o</td>
<td>447.9 Vac</td>
</tr>
<tr>
<td>I_o</td>
<td>12.81 mV</td>
</tr>
<tr>
<td>P_o</td>
<td>1.13 kW</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ΦB</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>V_o</td>
<td>436.7 Vac</td>
</tr>
<tr>
<td>I_o</td>
<td>13.22 mV</td>
</tr>
<tr>
<td>P_o</td>
<td>1.15 kW</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ΦC</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>V_o</td>
<td>439.0 Vac</td>
</tr>
<tr>
<td>I_o</td>
<td>13.38 mV</td>
</tr>
<tr>
<td>P_o</td>
<td>1.16 kW</td>
</tr>
</tbody>
</table>

**Total System Efficiency**

\[
\text{Eff} = \frac{\text{Pout}}{\text{Pin}} = \frac{3.42}{6.58} = 0.520
\]
**Resonant AC Power System Proof-of-Concept**

**Test Program (NAS3-22777)**

**Transient Test Data Sheet**

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>2.3.7-3.7.1 Power Turn-On</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>C-Compensation, 137Ω Load</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td></td>
</tr>
<tr>
<td>Input Current:</td>
<td></td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td></td>
</tr>
<tr>
<td>DC Rcvr:</td>
<td></td>
</tr>
<tr>
<td>AC Rcvr:</td>
<td></td>
</tr>
<tr>
<td>BD Module:</td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
</tr>
</tbody>
</table>

---

**Input Voltage: 10mV 200μs**

**Input Current: 10mV 200μs**

**Output Power: 10mV 1μs**

**Scale: 50mA/Div**

**Input Voltage: 50mV 1μs**

**Input Current: 50mV 1μs**

**Scale: 50V/Div**

---

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## RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

**TEST PROGRAM (NAS3-22777)**

**TRANSIENT TEST DATA SHEET**

Test-Configuration: 2.3.7-3.2.1 Power Turn-On

<table>
<thead>
<tr>
<th>Specific Case: C-Compensation</th>
<th>137a Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage: 149.5 Vdc</td>
<td>DC Rcvr: OFF</td>
</tr>
<tr>
<td>Input Current: 44.04 Adc</td>
<td>AC Rcvr: OFF</td>
</tr>
<tr>
<td>System Frequency: 19.91 KHz</td>
<td>BD Module: OFF</td>
</tr>
<tr>
<td>Output Power: 3.42 kW</td>
<td>Other: Res. Loads 1.1 kV/Phase</td>
</tr>
</tbody>
</table>

![Graphs showing transient test data](image)

- **Vin + Iin (A.C.)**
- **Vin**
- **Iin (D.C.)**
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.2.2 - 3.2.1 Power Turn-On
Specific Case: C-Compensation 1307 Load
Input Voltage: DC Rxvr: AC Rxvr: 
Input Current: 
System Frequency: BD Module: 
Output Power: Other: 

![Graphs showing test data]
### Test Config. 2.3.7-3.2.1 Power Turn-On

**Specific Case C: Compensation, 4496 ft.**

#### (I) Input Power

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vin</td>
<td>149.5</td>
</tr>
<tr>
<td>Iin</td>
<td>97.6</td>
</tr>
<tr>
<td>Pin</td>
<td>14.6 kW</td>
</tr>
</tbody>
</table>

- **Frequency:** 19.91 kHz

**T.H.D.:**
- OA: db
- OB: db
- OC: db

#### (II) Output Power

**A.C. Rect.**
- Vo: __
- Io: __
- Po: __

- **T.H.D. out of rect.** db

**B/D Mod.**
- Vo: __
- Io: __
- Po: __

**D.C. Rect.**
- Vo: __
- Io: __
- Po: __

---

**Resistive Loads**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vo</td>
<td>340.5 Vac 31.8</td>
</tr>
<tr>
<td>Io</td>
<td>47.0 mV 29.6</td>
</tr>
<tr>
<td>Pox</td>
<td>3.63 kW 1.84 kW</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>VO</td>
<td>533.6 Vac 30.2</td>
</tr>
<tr>
<td>Io</td>
<td>43.2 mV 29.9</td>
</tr>
<tr>
<td>Pox</td>
<td>2.51 kW 1.61 kW</td>
</tr>
</tbody>
</table>

- **Loaded After Power Turn-On**
  - Vo: 436.5 Vac 31.2 kW
  - Io: 43.2 mV 29.9 kW
  - Pox: 2.51 kW 1.61 kW

- **Loaded Before Power Turn-On**
  - Vo: 340.5 Vac 31.8 kW
  - Io: 47.0 mV 29.6 kW
  - Pox: 3.63 kW 1.84 kW

**Total System Efficiency:**

\[
\eta = \frac{P_{out}}{P_{in}} = \frac{11.11 \text{ kW}}{14.6} = 76.1\%
\]
### 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

<table>
<thead>
<tr>
<th>Specific Case:</th>
<th>C-Compensation, 44% Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage:</td>
<td>149.5 V</td>
</tr>
<tr>
<td>DC Rcvr:</td>
<td>OFF</td>
</tr>
<tr>
<td>Input Current:</td>
<td>55.86 A</td>
</tr>
<tr>
<td>AC Rcvr:</td>
<td>OFF</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>19.91 KHz</td>
</tr>
<tr>
<td>BD Module:</td>
<td>OFF</td>
</tr>
<tr>
<td>Output Power:</td>
<td>8.4 kW</td>
</tr>
</tbody>
</table>

**Note:** Even numbered inverters (42, 44, 46) would not start for this test.

---

**Photo**

---

**Diagram:**

- **Scale:** 50 V/Div
- **VIN**
- **VKA**
  - Scale: 320 V/Div
- **VKA**
  - Scale: 320 V/Div

---

**Page:** 68
<table>
<thead>
<tr>
<th>I) Input Power</th>
<th>Test Conf. 2.3.7-3.2.1 Power Turn On Specific Case - Comp. Full Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{in} )</td>
<td>148.0 ( \text{Vac} )</td>
</tr>
<tr>
<td>( I_{in} )</td>
<td>196.8 ( \text{A} )</td>
</tr>
<tr>
<td>( P_{in} )</td>
<td>29.1 ( \text{kW} )</td>
</tr>
<tr>
<td>Frequency</td>
<td>( _ _ _ _ _ _ _ _ _ _ _ )</td>
</tr>
<tr>
<td>( \phi_A )</td>
<td>( _ _ _ _ _ _ _ _ _ _ _ )</td>
</tr>
<tr>
<td>( \phi_B )</td>
<td>( _ _ _ _ _ _ _ _ _ _ _ )</td>
</tr>
<tr>
<td>( \phi_C )</td>
<td>( _ _ _ _ _ _ _ _ _ _ _ )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>II) Output Power</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>( \phi_A )</td>
<td>( \phi_B )</td>
<td>( \phi_C )</td>
</tr>
<tr>
<td>( V_o )</td>
<td>( V_o )</td>
<td>( V_o )</td>
</tr>
<tr>
<td>( I_o )</td>
<td>( I_o )</td>
<td>( I_o )</td>
</tr>
<tr>
<td>( P_o )</td>
<td>( P_o )</td>
<td>( P_o )</td>
</tr>
<tr>
<td>A.C. Receiver</td>
<td>B.I.D. Mod.</td>
<td>D.C. Receiver</td>
</tr>
<tr>
<td>( V_o )</td>
<td>( V_o )</td>
<td>( V_o )</td>
</tr>
<tr>
<td>( I_o )</td>
<td>( I_o )</td>
<td>( I_o )</td>
</tr>
<tr>
<td>( P_o )</td>
<td>( P_o )</td>
<td>( P_o )</td>
</tr>
<tr>
<td>T.H.D. out of Receiver</td>
<td>( _ _ _ _ _ _ _ _ _ _ _ )</td>
<td></td>
</tr>
</tbody>
</table>

**Resistive Loads**

| \( \phi_A \) | \( \phi_B \) | \( \phi_C \) |
| \( V_o \) | 435.8 \( \text{Vac} \) | 913.7 \( \text{Vac} \) | 431.4 \( \text{Vac} \) |
| \( I_o \) | 96.52 \( \text{mA} \) | 94.57 \( \text{mA} \) | 100.3 \( \text{mA} \) |
| \( I_o \) | 19.20 \( \text{A} \) | 19.57 \( \text{A} \) | 19.89 \( \text{A} \) |
| \( P_o \) | 8.37 \( \text{kW} \) | 9.26 \( \text{kW} \) | 3.58 \( \text{kW} \) |

**Total System Efficiency**

\[
\text{Efficiency} = \frac{P_{out}}{P_{in}} = \frac{25.21}{29.1} = 87.0\% 
\]
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 inverter would not start for this test

---

\[ V_{in} + I_{in}(A.C.) \]

---

\[ I_{in} \]

---

\[ V_{xa} \]

---

\[ I_{in} \]

---

\[ V_{in} + I_{in}(A.C.) \]
2.3.1 STEADY-STATE OPERATION

![Diagram of steady-state operation]

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Measurement Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IN}$</td>
<td>Fluke 8000A Multimeter</td>
</tr>
<tr>
<td>$I_{IN}$</td>
<td>Fluke 8000A Multimeter</td>
</tr>
<tr>
<td>$V_{OUT}$</td>
<td>Fluke 8000A Multimeter</td>
</tr>
<tr>
<td>$I_{OUT}$</td>
<td>P6303 Tektronix Current Probe</td>
</tr>
<tr>
<td>$f$</td>
<td>7704A Tektronix Oscilloscope</td>
</tr>
<tr>
<td>$n$</td>
<td>HP 5315B Universal Counter</td>
</tr>
</tbody>
</table>

Calculation using $V_{EN}, I_{EN}, V_{IN}, I_{IN}$
\[ V_{IN} = 87.60 \, \text{VDC} \]
\[ I_{INA} = 1.315 \, \text{ADC} \]
\[ V_{OUT} = 123.8 \, \text{VRMS} \]
\[ I_{OUT} = 0 \, \text{A} \]
\[ f = 20.01 \, \text{kHz} \]
\[ P_{IN} = 115 \, \text{W} \]
\[ P_{OUT} = 0 \, \text{W} \]
\[ R_{LOAD} = \infty \]

No Load
2.3.1
- 3.2.2 10% LOAD

\[ V_{IN} = 87.55 \text{ VDC} \]
\[ I_{IN} = 2.675 \text{ ADC} \]
\[ V_{OUT} = 123.5 \text{ VRMS} \]
\[ I_{OUT} = 1.06 \text{ ARMS} \]
\[ f = 20.01 \text{ kHz} \]
\[ P_{IN} = 234 \text{ W} \]
\[ P_{OUT} = 131 \text{ W} \]
\[ n = 55.9\% \]
2.3.1 - 3.2.2  50\%  LOAD

\[ V_{IN} = 87.27 \text{ VDC} \]
\[ I_{INA} = 7.510 \text{ A DC} \]
\[ V_{OUT} = 121.0 \text{ VRMS} \]
\[ I_{OUT} = 4.77 \text{ ARMS} \]
\[ f = 20.00 \text{ kHz} \]

\[ P_{IN} = 655 \text{ W} \]
\[ P_{OUT} = 577 \text{ W} \]
\[ n = 88.1 \% \]
2.3.1 FULL LOAD

- 3.2.2 FULL LOAD

\[ V_{IN} = 87.20 \text{ VDC} \]
\[ I_{INA} = 13.12 \text{ ADC} \]
\[ V_{OUT} = 116.8 \text{ VRMS} \]
\[ I_{OUT} = 9.48 \text{ ARMS} \]
\[ f = 20.00 \text{ KHz} \]

\[ P_{IN} = 1140 \text{ W} \]
\[ P_{OUT} = 1110 \text{ W} \]
\[ n = 96.8\% \]
2.3.1
110% LOAD

\[ V_{IN} = 87.25 \text{ VDC} \]
\[ I_{IN} = 14.52 \text{ A DC} \]
\[ V_{OUT} = 114.6 \text{ VRMS} \]
\[ I_{OUT} = 10.61 \text{ ARMS} \]
\[ f = 20.00 \text{ kHz} \]

\[ P_{IN} = 1270 \text{ W} \]
\[ P_{OUT} = 1216 \text{ W} \]
\[ n = 96.0\% \]

\[ R_{load} = 10.8 \Omega \]
\[ P_{out} = 1220 \text{ W} \]
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

![Graph showing the relationship between input current and load power.](image-url)
2.3.1

OUTPUT VOLTAGE vs.
LOAD POWER

![Graph showing the relationship between output voltage and load power.](image)
2.3.1

OUTPUT CURRENT VS. LOAD POWER

![Graph showing the relationship between output current (Amps) and power (W) with a linear trend. The axes are labeled with values ranging from 1 to 11 for current and 100 to 1000 for power.]
2.3.1 FREQUENCY vs. LOAD POWER

![Frequency vs Load Power Graph]

EFFICIENCY vs. POWER

![Efficiency vs Power Graph]
2.3.2  STEADY-STATE OPERATION

-3.2.2

---

**Measurement**

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IN}$</td>
<td>Fluke 8000A Multimeter</td>
</tr>
<tr>
<td>$I_{IN}$</td>
<td>$\frac{V_{IN}}{R_{LOAD}}$</td>
</tr>
<tr>
<td>$V_{OUT}$</td>
<td>Fluke 893A Diff. Voltmeter</td>
</tr>
<tr>
<td>$I_{OUT}$</td>
<td>SRI 900083 Current Meter</td>
</tr>
<tr>
<td>$f$</td>
<td>HP 5315B Universal Counter</td>
</tr>
<tr>
<td>$n$</td>
<td>Calculation using $V_{IN}, I_{IN}, V_{OUT}$</td>
</tr>
</tbody>
</table>
2.3.2  NO LOAD

\[ V_{IN} = 90.2 \text{ Vdc} \]
\[ I_{IN} = 2.25 \text{ Adc} \]
\[ n = 0\% \]
\[ V_{OUT} = 28.0 \text{ Vdc} \]

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 Voltage

Branch Current 2B
Resonant Tank Voltage
2.3.2
-3.2.2
10% LOAD

\[ P_{out} = 34 \, W \]
\[ R_{load} = 23.4 \, \Omega \]

\[ V_{IN} = 90.1 \, V_{dc} \]
\[ I_{IN} = 2.94 \, A_{dc} \]
\[ V_{out} = 28.07 \, V_{dc} \]
\[ I_{out} = 1.2 \, A_{dc} \]
\[ f = 20.723 \, kHz \]
\[ n = 12.7\% \]
2.3.2 50Ω LOAD

$P_{out} = 180\, W$
$R_{load} = 4.28\, \Omega$

Resonant Tank Voltage
Resonant Tank Current

Branch Current 1A
Resonant Tank Voltage

Branch Current 1B
Resonant Tank Voltage

$V_{IN} = 90.0\, V_{dc}$
$I_{IN} = 4.60\, A_{dc}$
$V_{OUT} = 27.8\, V_{dc}$
$I_{OUT} = 6.5\, A_{dc}$
$f = 20.723\, kHz$
$n = 43.6\%$
\[ V_{IN} = 90.0 \text{ Volts} \]
\[ I_{IN} = 7.13 \text{ Amps} \]
\[ V_{OUT} = 35.8 \text{ Volts} \]
\[ I_{OUT} = 15.32 \text{ Amps} \]
\[ f = 20.72 \text{ kHz} \]

Input Voltage

\[ P_{IN} = 449.3 \text{ Watts} \]

Output Voltage

\[ P_{OUT} = 405.5 \text{ Watts} \]

\[ R_{LOAD} = 1.76 \text{ Ohms} \]
23.2  110% LOAD

**Resonant Tank Voltage**

**Resonant Tank Current**

**Input Voltage**
**Input Current**
(After DC Capacitor)

**Branch Current IA**
**Resonant Tank Voltage**

**Branch Current 2A**
**Resonant Tank Voltage**

**Branch Current IB**
**Resonant Tank Voltage**

**Branch Current 2B**
**Resonant Tank Voltage**
2.3.3 **BIDIRECTIONAL MODULE**  
* (DRIVER MODE) *

![Diagram of bidirectional module](image)

**SCRs** 2N3658  
**Diodes** 1N394  
**Snubbers** 31Ω, 0.02μF

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 STEADY-STATE OPERATION

Measurements

\[ V_{IN} \]

\[ I_{IN} = \frac{V_{IN}}{R_{IN}} \]

\[ V_{OUT} \]

\[ I_{OUT} \]

\[ f \]

\[ P_{IN}, P_{OUT}, \eta \]

Equipment

Fluke 8000A Multimeter

Fluke 8000A Multimeter (V_{IN})

Tektronix 7834 Oscilloscope

Tektronix P6303 Current Probe

7834 Oscilloscope

7834 Oscilloscope

5315B Universal Counter

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
### 50% Load

- **Output Voltage**
  - Resonant Tank Current

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{in} )</td>
<td>50V</td>
</tr>
<tr>
<td>( V_{out} )</td>
<td>10.6V</td>
</tr>
<tr>
<td>( % )</td>
<td>20.6%</td>
</tr>
</tbody>
</table>

### Full Load

- **Output Voltage**
  - Resonant Tank Current

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{in} )</td>
<td>46.7V</td>
</tr>
<tr>
<td>( V_{out} )</td>
<td>9.5V</td>
</tr>
<tr>
<td>( % )</td>
<td>20.6%</td>
</tr>
</tbody>
</table>

**Power Out**
- 583W
- 1130W
110% LOAD \( P_{out} = 129\,W \)

- \( V_{in} = 96.3\,V \)
- \( I_{in} = 19.7\,mA \)
- \( P_{in} = 133\,mW \)

- \( V_{out} = 144\,V \)
- \( I_{out} = 1.3\,A \)
- \( f = 20.0\,kHz \)

\[ 7 = 99.8\% \]

\[ 2.33 \]

-3.22

Output Voltage
Resonant Tank Current

Branch Current E

Branch Current F
2.3.4 STEADY-STATE OPERATION

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

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IN}$</td>
<td>Fluke 8000A Multimeter</td>
</tr>
<tr>
<td>$I_{IN}$</td>
<td>Fluke 8000A Multimeter</td>
</tr>
<tr>
<td>$V_{DC}$</td>
<td>Fluke 893A Diff. Voltmeter</td>
</tr>
<tr>
<td>$I_{DC}$</td>
<td>SAE 9000 Current Meter</td>
</tr>
<tr>
<td>$V_{BD}$</td>
<td>Triplet 630 Multimeter</td>
</tr>
<tr>
<td>$I_{BD}$</td>
<td>LYN 5305 Impedance Bridge ($R_{lead}$)</td>
</tr>
<tr>
<td>$V_{AC}$</td>
<td>Tektronix 7834 Oscilloscope</td>
</tr>
<tr>
<td>$I_{AC}$</td>
<td>Tektronix 7834 Oscilloscope</td>
</tr>
<tr>
<td>$f$</td>
<td>HP 5315B Universal Counter</td>
</tr>
</tbody>
</table>

Calculations using

$V_{IN}, I_{IN}, V_{AC}, I_{AC}, V_{BD}, I_{BD}$

Photographs

All voltage photos
Tektronix: 7834 Oscilloscope
C-27 Camera

All current photos
Tektronix: 7834 Oscilloscope
P0303 Current Probe
C-27 Camera
The eight load combinations to be tested in Section 3.2.2 are listed:

<table>
<thead>
<tr>
<th>Load Configuration</th>
<th>P_{in}</th>
<th>P_{oc}</th>
<th>P_{ed}</th>
<th>P_{ac}</th>
<th>P_{out}</th>
<th>Eff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>796</td>
<td>200</td>
<td>210</td>
<td>0</td>
<td>410</td>
<td>51.7%</td>
</tr>
<tr>
<td>b</td>
<td>1020</td>
<td>423</td>
<td>205</td>
<td>0</td>
<td>628</td>
<td>61.6%</td>
</tr>
<tr>
<td>c</td>
<td>1024</td>
<td>202</td>
<td>210</td>
<td>190</td>
<td>613</td>
<td>60.0%</td>
</tr>
<tr>
<td>d</td>
<td>1210</td>
<td>418</td>
<td>205</td>
<td>171</td>
<td>794</td>
<td>65.7%</td>
</tr>
<tr>
<td>e</td>
<td>1000</td>
<td>200</td>
<td>413</td>
<td>0</td>
<td>613</td>
<td>61.3%</td>
</tr>
<tr>
<td>f</td>
<td>1210</td>
<td>418</td>
<td>413</td>
<td>0</td>
<td>831</td>
<td>68.6%</td>
</tr>
<tr>
<td>g</td>
<td>1200</td>
<td>200</td>
<td>405</td>
<td>170</td>
<td>780</td>
<td>64.8%</td>
</tr>
<tr>
<td>h</td>
<td>1370</td>
<td>403</td>
<td>405</td>
<td>140</td>
<td>950</td>
<td>69.5%</td>
</tr>
</tbody>
</table>

*P_{in} - Total System Input Power*

*P_{oc} - DC Receiver Output Power*

*P_{ed} - Bidirectional Module Output Power*

*P_{ac} - AC Receiver Output Power*

*P_{out} - Total System Output Power*

All in Watts
2.3.4 \( \odot \)

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

\[
\begin{align*}
V_{IN} &= 91.7 V_{DC} \\
I_{IN} &= 8.68 A_{DC} \\
V_{DC} &= 28.893 V_{DC} \\
I_{DC} &= 7.0 A_{DC} \\
V_{BD} &= 192 V_{DC} \\
I_{BD} &= 205 A_{DC} \\
V_{AC} &= 0 V_{RMS} \\
I_{AC} &= 0 A_{RMS} \\
f &= 20.44 kHz
\end{align*}
\]

\[
\begin{align*}
R_{IN} &= 796 W \\
P_{DC} &= 200 W \\
R_{LOAD_{DC}} &= 4.132 \Omega \\
P_{BD} &= 210 W \\
R_{LOAD_{BD}} &= 49.8 \Omega \\
P_{AC} &= 0 \\
R_{LOAD_{AC}} &= \infty \\
P_{TOT} &= 410 W \\
\eta &= 51.7\% 
\end{align*}
\]
2.3.4
-3.2.2

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

\[ V_{IN} = 91.2V_{DC} \]
\[ I_{IN} = 11.17A_{DC} \]
\[ P_{IN} = 1020W \]

\[ R_{LOAD_{DC}} = 1.96\Omega \]
\[ V_{OCC} = 28.74V_{DC} \]
\[ I_{OCC} = 14.7A_{DC} \]
\[ P_{OCC} = 423W \]

\[ R_{LOAD_{BD}} = 428\Omega \]
\[ V_{BD} = 101V_{DC} \]
\[ I_{BD} = 203A_{DC} \]
\[ P_{BD} = 205W \]

\[ R_{LOAD_{AC}} = \infty \]
\[ V_{AC} = 0V \]
\[ I_{AC} = 0A \]
\[ P_{AC} = 0W \]

\[ f = 20.44 \text{ kHz} \]
\[ P_{out} = 628W \]
\[ \eta = 61.6\% \]
25% DC LOAD, 50% AC LOAD, 25% BD LOAD

\[
\begin{align*}
V_{IN} &= 91.15 \text{ V}_{DC} \\
I_{IN} &= 11.23 \text{ A}_{DC} \\
V_{ODC} &= 28.876 \text{ V}_{DC} \\
I_{ODC} &= 7.0 \text{ A}_{DC} \\
V_{OBD} &= 102 \text{ V}_{DC} \\
I_{OBD} &= 2.05 \text{ A}_{DC} \\
V_{OAC} &= 82 \text{ V}_{RMS} \\
I_{OAC} &= 2.32 \text{ A}_{RMS} \\
f &= 20.44 \text{ kHz} \\
p_{IN} &= 1024 \text{ W} \\
p_{OBD} &= 202 \text{ W} \\
p_{OAC} &= 190 \text{ W} \\
p_{out} &= 613 \text{ W} \\
\eta &= 60.0\% 
\end{align*}
\]
2.3.4
- 3.2.2 (d)

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

\[ V_{\text{IN}} = 90.7 \, V_{\text{DC}} \]
\[ I_{\text{IN}} = 13.34 \, A_{\text{DC}} \]
\[ P_{\text{IN}} = 1210 \, W \]

\[ V_{\text{ODC}} = 28.657 \, V_{\text{DC}} \]
\[ I_{\text{ODC}} = 14.6 \, A_{\text{DC}} \]
\[ P_{\text{ODC}} = 418 \, W \]

\[ V_{\text{OBD}} = 101 \, V_{\text{DC}} \]
\[ I_{\text{OBD}} = 2.03 \, A_{\text{DC}} \]
\[ P_{\text{OBD}} = 205 \, W \]

\[ V_{\text{AC}} = 77.8 \, V_{\text{RMS}} \]
\[ I_{\text{AC}} = 22 \, A_{\text{RMS}} \]
\[ f = 20.44 \, \text{kHz} \]
\[ P_{\text{AC}} = 171 \, W \]
\[ P_{\text{OUT}} = 794 \, W \]
\[ \eta = 65.7\% \]
2.3.4
-3.2.2

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

\[ V_{IN} = 91.2V_{DC} \]
\[ I_{IN} = 10.99A_{DC} \]
\[ P_{IN} = 1000W \]
\[ V_{O DC} = 28.876V_{DC} \]
\[ I_{O DC} = 7.0A_{DC} \]
\[ P_{O DC} = 200W \]
\[ V_{O BD} = 101V_{DC} \]
\[ I_{O BD} = 4.07A_{DC} \]
\[ P_{O BD} = 413W \]
\[ V_{O AC} = 0V \]
\[ I_{O AC} = 0A \]
\[ P_{O AC} = 0W \]
\[ P_{OUT} = 613W \]
\[ \eta = 61.4\% \]
2.3.4
-3.2.2

ORIGINAL PAGE 13
OF POOR QUALITY

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

\[ V_{IN} = 90.3 \, V_{DC} \]
\[ I_{IN} = 13.43 \, A_{DC} \]
\[ P_{IN} = 1,210 \, W \]
\[ V_{DC} = 28.65 \, V_{DC} \]
\[ I_{DC} = 14.6 \, A_{DC} \]
\[ P_{DC} = 418 \, W \]
\[ V_{BD} = 101 \, V_{DC} \]
\[ I_{BD} = 4.09 \, A_{DC} \]
\[ P_{BD} = 413 \, W \]
\[ V_{AC} = 0 \, V \]
\[ I_{AC} = 0 \, A \]
\[ P_{AC} = 0 \, W \]
\[ f = 20.44 \, kHz \]
\[ \eta = 68.6\% \]

\[ R_{LOAD_{DC}} = 1.96 \, \Omega \]
\[ R_{LOAD_{BD}} = 24.7 \, \Omega \]
\[ R_{LOAD_{AC}} = \infty \]
2.3.4
-3.2.2

INVERTER #1

\[ V_{r1} \]

Resonant Tank Voltage
Resonant Tank Current

INVERTER #2

\[ I_{r2} \]

Resonant Tank Voltage
Resonant Tank Current

\[ I_{a} \]

Branch Current A

\[ I_{c} \]

Branch Current C

\[ I_{b} \]

Branch Current B

\[ I_{d} \]

Branch Current D
25% DC LOAD, 50% AC LOAD, 50% BD LOAD

\[ V_{IN} = 90.7V_{dc} \]
\[ I_{IN} = 13.23A_{dc} \]
\[ P_{IN} = 1200W \]
\[ V_{ODC} = 28.876V_{dc} \]
\[ I_{ODC} = 7.0A_{dc} \]
\[ P_{OBC} = 200W \]
\[ V_{OBD} = 100V_{dc} \]
\[ I_{OBD} = 4.05A_{dc} \]
\[ P_{OBD} = 405W \]
\[ V_{OAC} = 77.8V_{RMS} \]
\[ I_{OAC} = 2.2A_{RMS} \]
\[ P_{OAC} = 170W \]
\[ P_{OUT} = 780W \]
\[ \eta = 64.8\% \]
2.3.4
-3.2.2
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
50% DC LOAD, 50% AC LOAD, 50% BD LOAD

\[ V_{IN} = 90.3 \, V_{DC} \]
\[ I_{IN} = 15.13 \, A_{DC} \]
\[ P_{IN} = 1370 \, W \]

\[ V_{0DC} = 28.0 \, V_{DC} \]
\[ I_{0DC} = 14.4 \, A_{DC} \]
\[ P_{0DC} = 403 \, W \]

\[ V_{0BD} = 100 \, V_{DC} \]
\[ I_{0BD} = 4.05 \, A_{DC} \]
\[ P_{0BD} = 405 \, W \]

\[ V_{0AC} = 71 \, V_{RMS} \]
\[ I_{0AC} = 2.0 \, A_{RMS} \]
\[ f = 20.44 \, kHz \]
\[ P_{0AC} = 140 \, W \]
\[ \eta = 69.5\% \]

\[ R_{LOAD_{0C}} = 1.94 \, \Omega \]
\[ R_{LOAD_{0B}} = 24.7 \, \Omega \]
\[ R_{LOAD_{0A}} = 35.3 \, \Omega \]
Configuration - Test 2.36-3.2.2

STEADY-STATE OPERATION

Test Circuits
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 236-322 STEADY STATE OPERATIONS
Specific Case: STEADY STATE - 0 LOAD

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>120.0</td>
</tr>
<tr>
<td>Input Current</td>
<td>9.28</td>
</tr>
<tr>
<td>System Frequency</td>
<td>20.03 kHz</td>
</tr>
<tr>
<td>Output Power: AC Rcvr</td>
<td>0.007</td>
</tr>
<tr>
<td></td>
<td>DO Module:</td>
</tr>
<tr>
<td></td>
<td>Other:</td>
</tr>
</tbody>
</table>

![Graphs showing test configuration data]
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 234-322 STEADY-STATE OPERATION

Specific Case: \( N_o \) Load

Input Voltage: \( \text{SAME} \)  \( \text{DC Rcvr:} \)

Input Current:  \( \text{AC Rcvr:} \)

System Frequency:  \( \text{BD Module:} \)

Output Power:  \( \text{Other:} \)

\[
\begin{array}{c}
I_D \quad \text{10uA} \\
O_D \\
\hline
I_G \quad \text{10uA} \\
O_G \\
\hline
I_H \quad \text{10uA} \\
O_H \\
\hline
I_{K1} \quad \text{10uA} \\
V_{K1} \\
\hline
I_{K1} \quad \text{50A/Div} \\
V_{K1} \quad \text{Not To Scale} \\
\end{array}
\]
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.2.3.2.2 STEADY-STATE OPERATION

<table>
<thead>
<tr>
<th>Specific Case:</th>
<th>No Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage:</td>
<td>SAME</td>
</tr>
<tr>
<td>Input Current:</td>
<td></td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td></td>
</tr>
</tbody>
</table>

![Graphs showing test results](image)

<table>
<thead>
<tr>
<th>Inv. 2</th>
<th>Inv. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_k^2 - V_k^2$</td>
<td>$I_k^2 - V_k^2$</td>
</tr>
<tr>
<td>V-Not To Scale</td>
<td>V-Not To Scale</td>
</tr>
<tr>
<td>Scale: 50 mV/div</td>
<td>Scale: 50 mV/div</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DC Rcvr - No Load</th>
<th>B/D Rcvr - No Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale: -</td>
<td>Scale: -</td>
</tr>
</tbody>
</table>
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6 - 3.7.2 STEADY-STATE OPERATION

<table>
<thead>
<tr>
<th>Specific Case:</th>
<th>10% LOAD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage:</td>
<td>120.0 Vdc</td>
</tr>
<tr>
<td>DC Rcvr:</td>
<td>28.51 Vdc - 200W</td>
</tr>
<tr>
<td>Input Current:</td>
<td>14.79 Adc</td>
</tr>
<tr>
<td>AC Rcvr:</td>
<td>120.0 Vrms - 190W</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>20.20</td>
</tr>
<tr>
<td>BD Module:</td>
<td>103.0 Wc - 220W</td>
</tr>
<tr>
<td>Output Power:</td>
<td>610 W</td>
</tr>
<tr>
<td>Other:</td>
<td>0W</td>
</tr>
</tbody>
</table>

![Graph 1](image1)

![Graph 2](image2)

![Graph 3](image3)

![Graph 4](image4)
Resonant AC Power System Proof-of-Concept
Test Program (NAS3-22777)
Transient Test Data Sheet

Test-Configuration: 2.36 - 3.22 Steady-State Operation

Specific Case: 10% Load

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

DC Rcvr:
AC Rcvr:
BD Module:
Other:

[Graphs of Ic and Id for INV. 2 and INV. 3 with scales of 20A/]

INV. 2 Ic Scale: 20A/ INV. 2 Id Scale: 20A/
INV. 3 Id Scale: 20A/
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:

<table>
<thead>
<tr>
<th>INV. 1</th>
<th>INV. 2</th>
<th>INV. 3</th>
<th>INV. 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{L1} )</td>
<td>( V_{L2} )</td>
<td>( V_{L3} )</td>
<td>( I_{01} )</td>
</tr>
<tr>
<td>( I_{K1} )</td>
<td>( I_{K2} )</td>
<td>( I_{K3} )</td>
<td></td>
</tr>
</tbody>
</table>

Tank Current Scale: 50A
Line Voltage Scale: 10V/div

Tank Current Scale: 20A
Line Voltage Scale: 10V/div

Tank Current Scale: 5A
Line Voltage Scale: 10V/div

Inverter Output Current Scale: 5A/
**Resonant AC Power System Proof-of-Concept Test Program (NAS3-22777)**

**Transient Test Data Sheet**

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>236-322 Steady-State Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>10% Load</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>Same</td>
</tr>
<tr>
<td>Input Current:</td>
<td>DC Rcvr:</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>AC Rcvr:</td>
</tr>
<tr>
<td>Output Power:</td>
<td>BD Module:</td>
</tr>
<tr>
<td></td>
<td>Other:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input Voltage:</th>
<th>0% Load</th>
<th>10% Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current:</td>
<td>0% Load</td>
<td>10% Load</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>0% Load</td>
<td>10% Load</td>
</tr>
<tr>
<td>Output Power:</td>
<td>0% Load</td>
<td>10% Load</td>
</tr>
</tbody>
</table>

**Graphs: INV. 2 and INV. 3**

- **INV. 2**: LINE Voltage, VAH, NTS a, INVERTER, OUTPUT Current Scale: 5A/|.
- **INV. 3**: LINE Voltage, VAH, NTS a, INVERTER, OUTPUT Current Scale: 5A/|.

**AC Rcvr**

- Output Voltage, Current Scale: 1A/

**BD Module**

- Output Voltage, 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 STEADY-STATE OPERATION

Specific Case: 10% Load

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

<table>
<thead>
<tr>
<th>DC Rcvr</th>
<th>Output Voltage</th>
<th>Scale: 5A/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vdc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idc</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INV. 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA</td>
</tr>
<tr>
<td>O</td>
</tr>
</tbody>
</table>

Photo

Photo

Scale:

Scale:
I) **INPUT POWER**

- **VIN** 480V
- **IN** 27.23
- **PIN** 326.8

**THD**
- IN#1 ___ db
- IN#2 ___ db
- IN#3 ___ db

**THD - TRANSMISSION LINE**

<table>
<thead>
<tr>
<th>Into the Line</th>
<th>Out of the Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>IN#1 28.8 db</td>
<td>IN#1 ___ db</td>
</tr>
<tr>
<td>IN#2 21.8 db</td>
<td>IN#2 ___ db</td>
</tr>
<tr>
<td>IN#3 23.2 db</td>
<td>IN#3 ___ db</td>
</tr>
</tbody>
</table>

II) **OUTPUT POWER**

**A.C. RCVR**

- **Vin** 120 V
- **Iout** 3.38
- **P** 40.9

**THD**
- Into the RCVR ___ db
- Out of the RCVR ___ db

**DC. RCVR**

- **Vin** 28.06
- **Iout** 3.00
- **P** 8.92

**THD**
- Into the RCVR ___ db

**B/D RCVR**

- **Vin** 100.2
- **Iout** 7.77
- **P** 77.9

**THD**
- Into the RCVR ___ db

**TOTAL SYSTEM EFFICIENCY**

\[
\text{Total System Efficiency} = \frac{2027 \text{ Btu}}{326.8 \text{ kWh}} \times 62\% = 33\%
\]
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
Input Current: 27.9 Adc
System Frequency: 20.12 kHz
Output Power: 2140 W

DC Rcvr: 28.75 Vdc / 830 W
AC Rcvr: 110 Vrms / 360 W
BD Module: 100.2 Vdc / 950 W
Other: 0 W

Input V & I Scale: 10A
Input Current Scale: 5A

Photo

Line Voltage Scale: NTS

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.36-3.2.2 STEADY-STATE OPERATION
Specific Case: 60% Load - Inverter

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

Scale:

Photo

Scale:

Scale:
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 1
Input Voltage: Same
Input Current: AC Receiver: 
System Frequency: BD Module: Other: 
Output Power: 

INV. 1
Line Voltage and Tank Current Scale: 20A/
Inverter Output Current Scale: 5A/

INV. 1

AC RCVR Output Vo Scale: 2A/ Scale: 35
Test-Configuration: 23.6-3.22 STEADY-STATE OPERATION

Specific Case: 60% Load - Inverter 2

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

DC Rcvr: 
AC Rcvr: 
BD Module: 
Other: 

![Graphs showing waveforms for Current (Ic) and Voltage (Vl2) with scales: 20A and 10V, and Tank Current with scale: 20A.](image)

![Graphs showing waveforms for Voltage (Vl2) and Current (I0) with scales: 20A and 10V, and Inverter Output Current with scale: 20A.](image)
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 23.6-32.2 STEADY-STATE OPERATION
Specific Case: 60% Load - Inverter 2
Input Voltage: DC Rcvr: 
Input Current: AC Rcvr: 
System Frequency: BD Module: 
Output Power: Other: 

![Graph of V and I](image1)

BD MODULE
Output V vs I Scale: 2A/

![Graph of V and I](image2)

Photo

Photo

Scale:
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 23.6-32.2 STEADY-STATE OPERATION
Specific Case: 60% Load - Inverter 3

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

[Diagrams of waveforms for Ig, Ih, Vl3, Ix3, Vl3, Ip3, Line Voltage, and Tank Current]

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

INV. 3
Line Voltage and Inverter Output Current
Scale: 10A/
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
Input Current: 
System Frequency: 
Output Power: 

INV. 3
Line Voltage and
Line Current (Phase) Scale: 1.2A/

DC RCVR Input V/I Scale: 20A/

DC RCVR Output V/I Scale: 10A/

Photo

Scale:
### I) Input Power

<table>
<thead>
<tr>
<th></th>
<th>2.3.6-3.22 steady-state operation (1.0uF, full load)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{in}$</td>
<td>120</td>
</tr>
<tr>
<td>$P_{in}$</td>
<td>3684</td>
</tr>
<tr>
<td>T.H.D.</td>
<td></td>
</tr>
<tr>
<td>$INV#1$</td>
<td>-20.4 dB</td>
</tr>
<tr>
<td>$INV#2$</td>
<td>-72.4 dB</td>
</tr>
<tr>
<td>$INV#3$</td>
<td>-79.4 dB</td>
</tr>
<tr>
<td>Frequency</td>
<td>20.06 kHz</td>
</tr>
</tbody>
</table>

#### THD - Transmission Line

<table>
<thead>
<tr>
<th></th>
<th>into the line</th>
<th>out of the line</th>
</tr>
</thead>
<tbody>
<tr>
<td>$INV#1$</td>
<td>12.7 dB</td>
<td></td>
</tr>
<tr>
<td>$INV#2$</td>
<td>26.4 dB</td>
<td></td>
</tr>
<tr>
<td>$INV#3$</td>
<td>28.2 dB</td>
<td></td>
</tr>
</tbody>
</table>

### II) Output Power

<table>
<thead>
<tr>
<th>A.C. Rcvr Vout</th>
<th>110</th>
<th>Toaster Loads</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{out}$</td>
<td>3.0</td>
<td>$V_{out}$ 27.9</td>
</tr>
<tr>
<td>$P$</td>
<td>330</td>
<td>$I_{out}$ 4.38</td>
</tr>
<tr>
<td>T.H.D.</td>
<td></td>
<td>$P$ 299</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DC. Rcvr Vout</th>
<th>25.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{out}$</td>
<td>23.2</td>
</tr>
<tr>
<td>$P$</td>
<td>532</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B/D Rcvr Vout</th>
<th>99.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{out}$</td>
<td>63.5</td>
</tr>
<tr>
<td>$P$</td>
<td>631</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>T.H.D.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>into the Rcvr</td>
<td></td>
</tr>
<tr>
<td>$INV#3$</td>
<td></td>
</tr>
<tr>
<td>$V_{out}$</td>
<td>2.79</td>
</tr>
<tr>
<td>$I_{out}$</td>
<td>47.0</td>
</tr>
<tr>
<td>$P$</td>
<td>299</td>
</tr>
<tr>
<td>T.H.D.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total System Efficiency</th>
<th>2738 Pout</th>
<th>74.3%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3684 Pin</td>
<td></td>
</tr>
</tbody>
</table>
# 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**

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>2.3.6-3.2.2 STEADY-STATE OPERATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>1.0 μF, Full Load</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>120.0 Vdc</td>
</tr>
<tr>
<td>DC Rcvr:</td>
<td>253 Vdc / 582 W</td>
</tr>
<tr>
<td>Input Current:</td>
<td>30.70 Adc</td>
</tr>
<tr>
<td>AC Rcvr:</td>
<td>110 Vrms / 330 W</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>20.06</td>
</tr>
<tr>
<td>BD Module:</td>
<td>-99.3 Vdc / 631 W</td>
</tr>
<tr>
<td>Output Power:</td>
<td>2,740 W</td>
</tr>
<tr>
<td>Other:</td>
<td>d1 = 597 W, d2 = 299 W, d3 = 299 W</td>
</tr>
</tbody>
</table>

---

![Graph of 3-Phase Line Voltage](image)

**Scale:** NTS

---

**Photo**

**Photo**

---

**Scale:**
I) Input Power

\[ V_{in} = 120 \]
\[ I_{in} = 541 A \]
\[ P_{in} = 64922 W \]

**Frequency** 20.16 kHz

**THD** (at the input)

\[ V_{in1} = 28.8 \text{ dB} = 3.62\% \]
\[ V_{in2} = 28.6 \text{ dB} = 3.72\% \]
\[ V_{in3} = 20.2 \text{ dB} = 5.09\% \]

**THD** - Transmission Line

**Into the line**

\[ V_{in1} = 28.2 \text{ dB} = 3.81\% \]
\[ V_{in2} = 28.4 \text{ dB} = 6.76\% \]
\[ V_{in3} = 24.2 \text{ dB} = 6.17\% \]

**Output Power**

**AC RCVR**

\[ V_{out} = 120 \]
\[ I_{out} = 3.4 \]
\[ P = 408 \]

**THD**

\[ \text{THD} = 29.3 \text{ dB} = 6.17\% \]

**DC RCVR**

\[ V_{out} = 27.6 \]
\[ I_{out} = 30 \]
\[ P = 828 \]

**THD**

\[ \text{THD} = 16.8 \text{ dB} = 14.5\% \]

**B/D RCVR**

\[ V_{out} = 99.8 \]
\[ I_{out} = 78 \]
\[ P = 778 \]

**THD**

\[ \text{THD} = 19.4 \text{ dB} = 10.7\% \]

**Total System Efficiency**

\[ \frac{5004 \text{ BUT}}{6492 \text{ FH}} = 77.1\% \]
**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

<table>
<thead>
<tr>
<th>Input Voltage: 120.7 Vdc</th>
<th>DC Rcvr: 27.3 Vdc / 790 W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current: 54.0 Adc</td>
<td>AC Rcvr: 95.5 Vrms / 250 W</td>
</tr>
<tr>
<td>System Frequency: 20.14 kHz</td>
<td>BD Module: 99.8 Vdc / 850 W</td>
</tr>
<tr>
<td>Output Power: 5,120 W</td>
<td>Other: ( V = 1270 \text{W}, \theta = 830, \alpha = 1120 )</td>
</tr>
</tbody>
</table>

---

**Graphs:**

- **Input V+I**: Scale: 20A/
- **Input V+I**: Scale: 20A/

---

Photo

---

Scale: 42
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>23.6-32.2 STEADY-STATE OPERATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>FULL LOAD - Inverter</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input Voltage:</th>
<th>Same</th>
<th>DC Rcvr:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current:</td>
<td></td>
<td>AC Rcvr:</td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
<td>BD Module:</td>
</tr>
<tr>
<td>Output Power:</td>
<td></td>
<td>Other:</td>
</tr>
</tbody>
</table>

![Graphs](image1.png)

<table>
<thead>
<tr>
<th>IA</th>
<th>Scale: 10A/DIV</th>
</tr>
</thead>
<tbody>
<tr>
<td>IB</td>
<td>Scale: 10A/DIV</td>
</tr>
</tbody>
</table>

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: 236-32.2 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, = Vline (not to scale) Scale: 20A/div I out on line #1 = Vline (not to scale) Scale: 20A/div
Resistive Load Scale: 20A/div AC Rcvr output Scale: 2A/div
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.36-3.22 STEADY-STATE OPERATION

<table>
<thead>
<tr>
<th>Specific Case:</th>
<th>Full Load - Inverter 2</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Input Voltage:</th>
<th>Same</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current:</td>
<td></td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td></td>
</tr>
</tbody>
</table>

| DC Rcvr:             |                        |
| AC Rcvr:             |                        |
| BD Module:           |                        |
| Other:               |                        |

Graphs:

- IC
- ID

Scale: 10A/DIV

Photo

Scale:

Photo

Scale:
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.22 STEADY-STATE OPERATION
Specific Case: Full Load - Inverter 2
Input Voltage: Same
Input Current: AC Recvr:
System Frequency: BD Module:
Output Power: Other:

[Graphs showing waveforms]

I_k3 - V_line Scale: 2A/DIV
I_out of INV. #2 - V_line Scale: 2A/DIV

RESISTIVE LOAD Scale: 10A/DIV
V/D OUTPUT Scale: 2A/DIV
**Resonant AC Power System Proof-of-Concept**

**Test Program (NAS3-22777)**

**Transient Test Data Sheet**

**Test Configuration:** 23.6-3.27 Steady-State Operation

<table>
<thead>
<tr>
<th>Specific Case:</th>
<th>Full Load - Inverter 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage:</td>
<td>Same</td>
</tr>
<tr>
<td>Input Current:</td>
<td></td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DC Rcvr:</th>
<th>AC Rcvr:</th>
<th>BD Module:</th>
<th>Other:</th>
</tr>
</thead>
</table>

![Graphs showing current (IG) and phase shift (φ) and harmonic current (IH) and phase shift (φ)](image)

<table>
<thead>
<tr>
<th>IG</th>
<th>IH</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Waveform" /></td>
<td><img src="image" alt="Waveform" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scale:</th>
<th>Scale:</th>
</tr>
</thead>
<tbody>
<tr>
<td>10mA/DV</td>
<td>10A/DV</td>
</tr>
</tbody>
</table>

**Photo**

---

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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 3
Input Voltage: Same
Input Current: AC Rcvr:
System Frequency: BD Module:
Output Power: Other:

---

![Waveform Diagrams]

---

IK3 = V_L3 (N.T.S.) Scale: 20A/Div
I out of 100*3 = LINE (N.T.S) Scale: 20A/Div

DC Rcvr

Resistive Load Output Scale: 20A/Div
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

- Tektronix 7104 Oscilloscope
- Tek 7A24 Dual-Trace Amplifier
- Tek 7853A Time Base

Measurement Point

Tek P6062 Voltage Probes

HP8514T Display
HP 8556A LF Section
HP 8552B Spectrum Analyzer
Resonant AC Power System Proof-of-Concept
Test Program (NAS3-22777)
Transient Test Data Sheet

Test-Configuration: 23.6-3.33 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, 410W

System Frequency: 20.711 kHz
BD Module: 99.9 V, 780W

Output Power: 5000 W
Other: \( \phi_a = 1230W, \phi_b = 754W, \phi_c = 1010W \)

---

Photos:

- Phase a Line to Neutral, AC Rcvr at 60 Hz, Scale: 20 kHz
- Phase a Line to Neutral, AC Rcvr at 1000 Hz, Scale: 20 kHz

---

Scale:
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: **2.3.6-3.3.2 STEADY-STATE OPERATION**
Specific Case: Harmonic Components, Phase a

<table>
<thead>
<tr>
<th>Input Voltage:</th>
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<th>DC Rcvr:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current:</td>
<td></td>
<td>AC Rcvr:</td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
<td>BD Module:</td>
</tr>
<tr>
<td>Output Power:</td>
<td></td>
<td>Other:</td>
</tr>
</tbody>
</table>

![Photo](image1)

\[AC Rcvr \text{ at } 60\text{Hz}\]

Inverter Output Voltage Scale: 20kV/

\[AC Rcvr \text{ at } 60\text{Hz}\]

Phase a Line-to-Neutral V Scale: 20kV/

![Photo](image2)

Scale: 250kHz

Scale: 250kHz
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: 

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

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

<table>
<thead>
<tr>
<th>Input Voltage:</th>
<th>Same</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current:</td>
<td></td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td></td>
</tr>
</tbody>
</table>

| DC Rcvr: |      |
| AC Rcvr: |      |
| BD Module: |     |
| Other: |      |

![Photo](image)

---

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

**Inverter Output Voltage Scale: 20kHz**

---

**FULL LOAD**

---

**NO DC Rcvr**

---

**FULL LOAD**
**Resonant AC Power System Proof-of-Concept**

**Test Program (NAS3-22777)**

**Transient Test Data Sheet**

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>2.3.6 - 3.2.2 Steady-State Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>Harmonic Components, Phase C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input Voltage:</th>
<th>Same</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current:</td>
<td></td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DC Revr:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Revr:</td>
<td></td>
</tr>
<tr>
<td>BD Module:</td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
</tr>
</tbody>
</table>

**Photo**

Full Load, Phase A + B Off

Inverter 3 Output Voltage Scale: 20kHz

---

Inverter 3 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

<table>
<thead>
<tr>
<th>Specific Case</th>
<th>Harmonic Components</th>
<th>Phase c</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>Same</td>
<td></td>
</tr>
<tr>
<td>Input Current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Frequency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Power</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DC Rcvr:**

**AC Rcvr:**

**BD Module:**

**Other:**

---

### Photos

**250 kHz**

- **Full Load**
- **Phase c Line-to-Neutral Scale:** 20 kHz

- **No DC Rcvr**
- **Phase c Line-to-Neutral Scale:** 20 kHz

---

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.3.2 STEADY-STATE OPERATION
Specific Case: Harmonic Components, Line-to-Line

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

Input Voltage: Same
Input Current: AC Rcvr:
System Frequency:
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 2.36 - 3.22 STEADY-STATE

OPERATION — REGULATION

Test Circuits

50-meter Transmission Line
### 2.36 - 3.22 Steady-State Operation

**Regulation**

#### 230W Load

<table>
<thead>
<tr>
<th></th>
<th>( V_{IN} )</th>
<th>( 60,\text{Vdc} )</th>
<th>( 120,\text{Vdc} )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input Voltage</strong></td>
<td>( V_{E} )</td>
<td>60.05 ( \text{Vdc} )</td>
<td>120.0 ( \text{Vdc} )</td>
</tr>
<tr>
<td><strong>Input Current</strong></td>
<td>( I_{E} )</td>
<td>7.41 ( \text{Adc} )</td>
<td>6.89 ( \text{Adc} )</td>
</tr>
<tr>
<td><strong>Inv. 1 Output Voltage</strong></td>
<td>( V_{K1} )</td>
<td>93.9 ( \text{Vrms} )</td>
<td>186.0 ( \text{Vrms} )</td>
</tr>
<tr>
<td><strong>Inv. 2 Output Voltage</strong></td>
<td>( V_{K2} )</td>
<td>80.1 ( \text{Vrms} )</td>
<td>186.0 ( \text{Vrms} )</td>
</tr>
<tr>
<td><strong>Transmission Line Voltage</strong></td>
<td>( V_{L} )</td>
<td>250 ( \text{Vrms} )</td>
<td>249 ( \text{Vrms} )</td>
</tr>
<tr>
<td><strong>Load Voltage</strong></td>
<td>( V_{LOAD} )</td>
<td>34.8 ( \text{Vrms} )</td>
<td>35.9 ( \text{Vrms} )</td>
</tr>
</tbody>
</table>

#### 450W Load

<table>
<thead>
<tr>
<th></th>
<th>( V_{IN} )</th>
<th>( 60,\text{Vdc} )</th>
<th>( 120,\text{Vdc} )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input Voltage</strong></td>
<td>( V_{E} )</td>
<td>60.50 ( \text{Vdc} )</td>
<td>120.03 ( \text{Vdc} )</td>
</tr>
<tr>
<td><strong>Input Current</strong></td>
<td>( I_{E} )</td>
<td>11.42 ( \text{Adc} )</td>
<td>9.28 ( \text{Adc} )</td>
</tr>
<tr>
<td><strong>Inv. 1 Output Voltage</strong></td>
<td>( V_{K1} )</td>
<td>94.4 ( \text{Vrms} )</td>
<td>168.6 ( \text{Vrms} )</td>
</tr>
<tr>
<td><strong>Inv. 2 Output Voltage</strong></td>
<td>( V_{K2} )</td>
<td>69.6 ( \text{Vrms} )</td>
<td>160.9 ( \text{Vrms} )</td>
</tr>
<tr>
<td><strong>Transmission Line Voltage</strong></td>
<td>( V_{L} )</td>
<td>248 ( \text{Vrms} )</td>
<td>249 ( \text{Vrms} )</td>
</tr>
<tr>
<td><strong>Load Voltage</strong></td>
<td>( V_{LOAD} )</td>
<td>34.2 ( \text{Vrms} )</td>
<td>34.7 ( \text{Vrms} )</td>
</tr>
</tbody>
</table>
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
Input Current: 7.41 Adc
System Frequency: 20.3 KHz
Output Power: 233.9 W

Other: Load Voltage - 36.8 Vrms

Input Voltage & Current

Load Voltage

Scale: 5A/40V

Scale: 20V/40V

Photo

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

![Graphs showing current waves for Inverter 1 and Inverter 2.](image)

ORIGINAL PAGE IS OF POOR QUALITY
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 3.36-3.2.2 STEADY-STATE OPERATION

Specific Case: REGULATION - 230 W, 60 V

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: 2.3.6-3.3.2 STEADY-STATE OPERATION
Specific Case: REGULATION - 230 W, 120 V
Input Voltage: 120.0 V DC
Input Current: 6.89 A AC
System Frequency: 20.3 kHz
Output Power: 224.3 W

Other: LOAD = 35.9 Vrms

Scale: 2A/

Photo

Scale:

Photo

Scale:
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.2.6-3.2.2 STEADY-STATE OPERATION

Specific Case: REGULATION - 230W, 120V

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

I_A
(I

0

1A Leg Current Scale: 20A/

I_B
(I

0

1B Leg Current Scale: 20A/

I_C
(I

0

1C Leg Current Scale: 20A/

I_D
(I

0

1D Leg Current Scale: 20A/
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-2277)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.2.2 STEADY-STATE OPERATION
Specific Case: REGULATION - 230 W, 120 V in

<table>
<thead>
<tr>
<th>Input Voltage:</th>
<th>DC Rcvr:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current:</td>
<td>AC Rcvr:</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>BD Module:</td>
</tr>
<tr>
<td>Output Power:</td>
<td>Other:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INVERTER 1</th>
<th>INVERTER 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Voltage Scale:</td>
<td>Tank Current Scale: 20A</td>
</tr>
<tr>
<td>$V_{k1}$</td>
<td>$I_{k1}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INVERTER 2</th>
<th>INVERTER 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Voltage Scale:</td>
<td>Tank Current Scale: 20A</td>
</tr>
<tr>
<td>$V_{k2}$</td>
<td>$I_{k2}$</td>
</tr>
</tbody>
</table>
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

Input Voltage: 60.50 V AC
Input Current: 11.42 A DC
System Frequency: 20.3 kHz

Output Power: 421.7 W
Other: LOAD = 34.2 Vrms

Input Voltage + Current Scale: 5A/
Load Voltage Scale:

Photo

Scale:
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.2.6-3.2.2 STEADY-STATE OPERATION

Specific Case: REGULATION — 450W, 60V

Input Voltage: 24V DC
Input Current: 15A
System Frequency: 10kHz

Output Power: 450W

<table>
<thead>
<tr>
<th>INVERTER 1</th>
<th>INVERTER 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA</td>
<td>IB</td>
</tr>
<tr>
<td>1A Leg Current Scale: 10A</td>
<td>1B Leg Current Scale: 10A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INVERTER 2</th>
<th>INVERTER 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>IC</td>
<td>ID</td>
</tr>
<tr>
<td>1C Leg Current Scale: 10A</td>
<td>1D Leg Current Scale: 10A</td>
</tr>
</tbody>
</table>
**RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT**

**TEST PROGRAM (NAS3-22777)**

**TRANSIENT TEST DATA SHEET**

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>23.6-3.22 STEADY-STATE OPERATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>REGULATION- 450W, 60 V, W</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>DC Rcvr:</td>
</tr>
<tr>
<td>Input Current:</td>
<td>AC Rcvr:</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>BD Module:</td>
</tr>
<tr>
<td>Output Power:</td>
<td>Other:</td>
</tr>
</tbody>
</table>

### INVERTER 1

- **Output Voltage Scale:**
- **Tank Current Scale:** 10 A/

### INVERTER 2

- **Output Voltage Scale:**
- **Tank Current Scale:** 10 A/
## Resonant AC Power System Proof-of-Concept

**Test Program (NAS-22777)**

**Transient Test Data Sheet**

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>2.3.6 - 3.2.2 steady-state operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>Regulation - 450W, 120Vdc</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>120.03 Vdc</td>
</tr>
<tr>
<td>Input Current:</td>
<td>9.28 Adc</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>20.3 kHz</td>
</tr>
<tr>
<td>Output Power:</td>
<td>447.9 W</td>
</tr>
<tr>
<td>Other:</td>
<td>Load: 34.7 Vrms</td>
</tr>
</tbody>
</table>

**Input Voltage** and **Current** Scale: 5A /

**Load Voltage** Scale:

[Graphs showing input and load voltages and currents]

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.36-3.23 STEADY-STATE OPERATION
Specific Case: REGULATION - 450W, 120V

<table>
<thead>
<tr>
<th>Input Voltage:</th>
<th>Sine</th>
<th>DC Rcvr:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current:</td>
<td>AC Rcvr:</td>
<td></td>
</tr>
<tr>
<td>System Frequency:</td>
<td>BD Module:</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td>Other:</td>
<td></td>
</tr>
</tbody>
</table>

**INVERTER 1**
- \( I_a \) Leg Current Scale: 20A/
- \( I_b \) Leg Current Scale: 20A/
- \( I_c \) Leg Current Scale: 20A/

**INVERTER 2**
- \( I_a \) Leg Current Scale: 20A/
- \( I_d \) 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: ___ Some ___ DC Rcvr: ___
Input Current: ___ AC Rcvr: ___
System Frequency: ___ BD Module: ___
Output Power: ___ Other: ___

---

INVERTER 1
Output Voltage Scale: ___ Scale: ___

INVERTER 1
Tank Current Scale: 20A/

INVERTER 2
Output Voltage Scale: ___ Scale: ___

INVERTER 2
Tank Current Scale: 20A/
INVERTER SCHEMATIC

\[ I_{\text{in}} + I_{\text{o}} \]

Tektronix 6303 Current Probe 143498 146540
INSTRUMENTATION

DC Input
V: Fluke 8850A
I: Fluke 8850A + 300A/50mV(D.C.)
  194.26A
  Tetramix AG330 Current Probe, NSVHC (A.C.)
  Tetramix CT-9 Current Transformer, NHVT4 (A.C.)
  with Tetramix AG330 Current Probe

Inverter End of Bus
Phase a: V: HP3435A (13428)
Phase b: V: Fluke 8850A (134778)
Phase c: V: Fluke 8850A (14380)
Phase a: I: Fluke 8810A (14380)
  1.0118 mA
Phase b: I: Fluke 8810A (143180)
  1.0106 mA
Phase c: I: Fluke 8810A (143180)
  1.0170 mA

Receivers
AC RCVR: V-I-P: Cloveke-Hess 755
  (143363)

DC RCVR: V: Fluke 8050A
  194.26A
  SRI 900079 +
  50mA/50mV Shunt
  (145304)

BD RCVR: V: Tek DM501A
  (143410)
  SDA/50mV Shunt
  (149328)
  Tek DM502A
  (143408)

ORIGINAL PAGE IS
OF POOR QUALITY
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
Configuration - Test 2.3.7-3.2.2 Steady-State Operation

UnCompensated

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: C-Compensation, No Load
Input Voltage: 150
Input Current: DC Revr: 28.7 Vac
System Frequency: AC Revr: OFF
Output Power: BD Module: 11.3 Vac, 20.1 W
Other:

Resonant Tank Current of Inverter und, I_1

\[ I_{in} - I_{a} = I_{x1} \]

Scale: 50 A/div

In - Ir

\[ I_{in} \]

Scale: 50 A/div

Photo

Photo
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: ____________________

\[ \text{Graphs showing waveforms for different measurements.} \]
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. Local
Input Voltage: Same  DC Rcvr: Same  
Input Current: AC Rcvr:  
System Frequency: BD Module:  
Output Power: Other:  

<table>
<thead>
<tr>
<th>Iac</th>
<th>Iac</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Scale: 50 A/Div

<table>
<thead>
<tr>
<th>Vac</th>
<th>Vac</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Scale: 50 V/Div

D.C. Input Voltage A.C. Component of Input Current 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: 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: ( ) Other: None

Graphics showing waveforms and traces with scales.
I) **Input Power**

- **Vin**: 152.6 V
- **Iin**: 21.0 A
- **Pin**: 3200 W

**Test Config. 23.7-22.2 - Steady-State**

**Specific Case C - Compensation, No Load**

**Frequency**: 19.96 kHz

**T.H.D.**
- $\phi_A - 24.3^\circ dB = 6.10\%$
- $\phi_B - 24.5^\circ dB = 5.96\%$  \( \phi_A \)
- $\phi_C - 26.5^\circ dB = 4.73\%$

II) **Output Power**

- $\phi_A$  \( V_o = 441 \)
- $\phi_B$  \( V_o = 442 \)
- $\phi_C$  \( V_o = 442 \)
- $I_o$  \( P_o \)
- $P_o$

**A.C. Recur**

- **B1D Mod.**
  - $V_o$  \( V_o = 203 Vdc \)
  - $I_o$  \( P_o \)
  - $P_o$

**T.H.D. out of Reuse**

**dB**

**Resistive Loads**

- $\phi_A$  \( V_a = 445.3 Vdc \)
- $\phi_B$  \( V_b = 444.6 Vdc \)
- $\phi_C$  \( V_c = 445.0 Vdc \)
- $I_a$  \( I_a = 0 mA \)
- $I_b$  \( I_b = 0 mA \)
- $I_c$  \( I_c = 0 mA \)
- $I_a$  \( I_a = 0 A \)
- $I_b$  \( I_b = 0 A \)
- $I_c$  \( I_c = 0 A \)

**Total System Efficiency**

\[
\text{Efficiency} = \frac{P_{out}}{P_{in}} = 8\%
\]
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: 2.2.2 - 3.2.2 Steady-State Operation
Specific Case: No Compensation - Full Load
Input Voltage: DC Rcvr: AC Rcvr:
Input Current: System Frequency: 80 Module:
Output Power: Other:

![Graphs showing frequency response](image)

60kHz

20kHz

Vac. line to neutral Scale: 10dB/Div

Vac. line to neutral Scale: 10dB/Div

Photo

Scale: 50V/Div
Test-Configuration: 2.3.7-3.2.2 Steady-State Operation
Specific Case: No Compensation; Full Loss
Input Voltage: Same
Input Current: AC Rcvr: Same
System Frequency: BD Module:
Output Power: Other:

![Waveform Diagrams]

- Van line to neutral scale: 10 dB/Div
- Van line to neutral scale: 10 dB/Div
- Van line to neutral scale: 10 dB/Div
- Van 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: 2.3.3 - 3.7.7 Steady-State Operation
Specific Case: Uncompensated, Full Load

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td></td>
</tr>
<tr>
<td>Input Current</td>
<td></td>
</tr>
<tr>
<td>System Frequency</td>
<td></td>
</tr>
<tr>
<td>Output Power</td>
<td></td>
</tr>
<tr>
<td>DC Rcvr:</td>
<td></td>
</tr>
<tr>
<td>AC Rcvr:</td>
<td></td>
</tr>
<tr>
<td>BD Module:</td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
</tr>
</tbody>
</table>

![Graphs and waveforms](image-url)

![Photo](image-url)
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 Recvr: 
Input Current: AC Recvr: 
System Frequency: BD Module: 
Output Power: Other: 

\begin{figure}
\centering
\includegraphics[width=\textwidth]{waveforms}
\caption{Waveform plots for various measurements.}
\end{figure}
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

<table>
<thead>
<tr>
<th>Input Voltage:</th>
<th>Same</th>
<th>DC Revr:</th>
<th>Same</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current:</td>
<td></td>
<td>AC Revr:</td>
<td></td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
<td>BD Module:</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td>Other:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Waveform Diagram](image1.png)

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

![Waveform Diagram](image2.png)

Scale: 320 V/Div

Photo

Photo

Scale:
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 32.2 Steady-State Operation
Specific Case: UN COMPENSATED, FULL LOAD
Input Voltage: 150.2 Vdc DC Rcvr: 1026 Watts
Input Current: 120.9 Adc AC Rcvr: 480 Watts
System Frequency: 809 Watts
Output Power: 16.2 kw Other: None

[Graphs showing waveforms for different currents and voltages with scale: 20 A/Div]
I) **Input Power**

<table>
<thead>
<tr>
<th>V in</th>
<th>150.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>I in</td>
<td>128.9</td>
</tr>
<tr>
<td>P in</td>
<td>19.34 kW</td>
</tr>
</tbody>
</table>

**T.H.D.**

\[
\begin{align*}
\phi_A &= \frac{27.2}{100} \text{ dB} = 4.36\% \\
\phi_B &= \frac{28.75}{100} \text{ dB} = 3.65\% \\
\phi_C &= \frac{28.0}{100} \text{ dB} = 3.18\%
\end{align*}
\]

II) **Output Power**

\[
\begin{align*}
\phi_A &= V_o \frac{44.5}{V_o} \\
\phi_B &= V_o \frac{44.5}{V_o} \\
\phi_C &= V_o \frac{44.5}{V_o}
\end{align*}
\]

**A.C. Reactor**

\[
\begin{align*}
V_o &= 100 \\
I_o &= 45\% \\
P_o &= 480
\end{align*}
\]

**D.C. Reactor**

\[
\begin{align*}
V_o &= 28.16 \\
I_o &= 26.44 \\
P_o &= 1026.445
\end{align*}
\]

**T.H.D. out of reactor**

\[
\begin{align*}
\phi_A &= \frac{30.4}{100} \text{ dB} = 3.02\%
\end{align*}
\]

**Resistive Loads**

\[
\begin{align*}
\phi_A &= V_o \frac{431.1}{V_o} \\
\phi_B &= V_o \frac{432.1}{V_o} \\
\phi_C &= V_o \frac{479.7}{V_o}
\end{align*}
\]

\[
\begin{align*}
I_o &= 10.58 \\
I_o &= 11.77 \\
P_o &= 4.56 kW \\
P_o &= 5.89 kW
\end{align*}
\]

**Total System Efficiency**

\[
\frac{16,235}{19,360} = 83.8\%\text{ at 70}
\]
Test-Configuration: **2.3.7 - 8.7.7 Steady-State Operation**

Specific Case: **UnCompensated, 50 Hz Load**

Input Voltage: ____________  DC Recvr: ____________

Input Current: ____________  AC Recvr: ____________

System Frequency: ____________  BD Module: ____________

Output Power: ____________  Other: ____________

---

**Graphs:**

- **Vx3, Vx4**
  - Scale: Unset
  - 10V/Div 20µS

- **Ix3, Ix4**
  - Scale: 500A

- **Vx8, Ix8**
  - 320V/Div 20µS

---

**Photo:**

- **Image:**
  - Caption: SCF2 (x1), With Load, 10µS, 20V/Div, 200KHz
  - Note: Description of the image content.
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANSIENT TEST DATA SHEET

Test-Configuration: Z3.7-32-2, Steady-State Operation

Specific Case: Uncompensated, 50% Load

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

![Graphs]
# Resonant AC Power System Proof-of-Concept

**Test Program (NAS3-22777)**

**Transient Test Data Sheet**

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>2.3.7-3.2.2 Steady State Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>50% Load, No Communication</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>151.1 Vdc</td>
</tr>
<tr>
<td>Input Current:</td>
<td>69.42 Aac</td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td>7,536 Watts</td>
</tr>
<tr>
<td>DC Rcvr:</td>
<td>1035 Watts</td>
</tr>
<tr>
<td>AC Rcvr:</td>
<td>455 Watts</td>
</tr>
<tr>
<td>BD Module:</td>
<td>886 Watts</td>
</tr>
<tr>
<td>Other:</td>
<td>None</td>
</tr>
</tbody>
</table>

### Waveform Diagrams

- **Scale:** 20 A/DIV
- **Photo:**

### Inverter Output Voltages

- **Scale:** 320 V/DIV

*Original page is of poor quality*
I) **Input Power**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{in}$</td>
<td>15.11</td>
</tr>
<tr>
<td>$I_{in}$</td>
<td>11.57 x 6</td>
</tr>
<tr>
<td>$P_{in}$</td>
<td>10.490</td>
</tr>
</tbody>
</table>

**T.H.D.**

- $\phi_A$: 28.4 dB = 3.80%
- $\phi_B$: 32.9 dB = 2.26%
- $\phi_C$: 31.0 dB = 2.82%

**T.H.D. - Transmission Line**

*Into the line*

II) **Output Power**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$\phi_A$</td>
<td>$\phi_B$</td>
</tr>
<tr>
<td>$V_o$</td>
<td>$V_o$</td>
</tr>
<tr>
<td>$I_o$</td>
<td>$I_o$</td>
</tr>
<tr>
<td>$P_o$</td>
<td>$P_o$</td>
</tr>
</tbody>
</table>

**A.C. R.C.U.R.**

- $V_o$: 106
- $I_o$: 4.46
- $P_o$: 4.56

**D.C. R.C.U.R.**

- $V_o$: 28.15
- $I_o$: 36.74
- $P_o$: 103.5

**BIQ R.C.U.R.**

- $V_o$: 94.6
- $I_o$: 9.37
- $P_o$: 886.4

**T.H.D. Out of R.C.U.R.**

- $\phi_A$: 12 dB

**Resistive Loads**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$\phi_A$</td>
<td>$\phi_B$</td>
</tr>
<tr>
<td>$V_a$: 425.7</td>
<td>$V_b$: 424.9</td>
</tr>
<tr>
<td>$P_a$: 3126 Watts</td>
<td>$P_b$: 1676 Watts</td>
</tr>
</tbody>
</table>

**Total System Efficiency**

\[ \frac{7536}{10,490} = 71.87 \% \]
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.7.3 Steady-State Operation
Specific Case: No Compensation, No Load
Input Voltage: DC Revr: 
Input Current: AC Revr: 
System Frequency: BD Module: 
Output Power: Other: 

---

Voc line to neutral Scale: 100mV/Div

---

Voc line to neutral Scale: 100mV/Div

---

Scale: 
Scale: 
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: No Compensation, No Load

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

200KHz

60KHz

Vcm line to neutral Scale:

60KHz

Vcm line to neutral Scale:

200KHz

Vcm line to neutral Scale:
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.37-3.22 Steady-State Operation
Specific Case: Uncompensated, No Load
Input Voltage: _______________ DC Rcvr: _______________
Input Current: _______________ AC Rcvr: _______________
System Frequency: _______________ BD Module: _______________
Output Power: _______________ Other: _______________

---

V_k3, V_k4 Scale: Uncl. V
I_k3, I_k4 Scale: 20uS
V_k8, I_k8 Scale: 50 mV/10uV
V_k3, I_k8 Scale: 50A

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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, No Local

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

Graphs showing waveforms for V_k3, I_k3, V_k4, I_k4, I_n4, I_n5, and I_n5, with scales of 50V/10V and 50A/10A.
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
Input Current: 13.8 A
System Frequency: 19.84 KHz
Output Power: 0

Original page is of poor quality
I) **Input Power**

<table>
<thead>
<tr>
<th>Vm</th>
<th>Im</th>
<th>Pm</th>
</tr>
</thead>
<tbody>
<tr>
<td>150.9</td>
<td>13.98</td>
<td>2170W</td>
</tr>
</tbody>
</table>

**T.H.D.**

<table>
<thead>
<tr>
<th>FA</th>
<th>FB</th>
<th>FC</th>
</tr>
</thead>
<tbody>
<tr>
<td>-33.6</td>
<td>-34.8</td>
<td>-23.35</td>
</tr>
</tbody>
</table>

**T.H.D. - Transmission Line**

<table>
<thead>
<tr>
<th>FA</th>
<th>FB</th>
<th>FC</th>
</tr>
</thead>
<tbody>
<tr>
<td>d1 = 2.09%</td>
<td>d5 = 1.82%</td>
<td>d5 = 2.15%</td>
</tr>
</tbody>
</table>

**Specific Case** Uncompensated - No Load

**F = 19.918 kHz**

II) **Output Power**

<table>
<thead>
<tr>
<th>FA</th>
<th>FB</th>
<th>FC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vo 437.8</td>
<td>Vo 441.5</td>
<td>Vo 442.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>V0</th>
<th>I0</th>
<th>P0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vo 28.73Vdc</td>
<td>I0</td>
<td>P0</td>
</tr>
</tbody>
</table>

**A.C. RCVR**

<table>
<thead>
<tr>
<th>FA</th>
<th>FB</th>
<th>FC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vo 0</td>
<td>Vo 0</td>
<td>Vo 0</td>
</tr>
</tbody>
</table>

**BIO RCVR**

<table>
<thead>
<tr>
<th>V0</th>
<th>I0</th>
<th>P0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vo 205Vdc</td>
<td>I0</td>
<td>P0</td>
</tr>
</tbody>
</table>

**TH-D. out of RCVR**

<table>
<thead>
<tr>
<th>FA</th>
<th>FB</th>
<th>FC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vo 28.73Vdc</td>
<td>Vo 442.7</td>
<td>Vo 442.8</td>
</tr>
</tbody>
</table>

**Resistive Loads**

<table>
<thead>
<tr>
<th>FA</th>
<th>FB</th>
<th>FC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vo 28.73Vdc</td>
<td>Vo 442.7</td>
<td>Vo 442.8</td>
</tr>
</tbody>
</table>

**Total System Efficiency**

---

187
Test-Configuration: 2.3.7-3.3.2 Steady State Operation
Specific Case: C - Compensation, No Load
Input Voltage: Same
Input Current: AC Rcvr:
System Frequency: BD Module:
Output Power: Other:

0 60kHz

Voa line to neutral scale: 10db/div

0 60kHz

Voa line to neutral scale: 10db/div
**Test Configuration:** 2.8.7-3.7.2 Steady-State Operation

**Specific Case:** C - Compensation, No Load

<table>
<thead>
<tr>
<th>Parameter</th>
<th>DC Rcvr</th>
<th>AC Rcvr</th>
<th>BD Module</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>Same</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Current</td>
<td></td>
<td>AC Rcvr</td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Frequency</td>
<td></td>
<td></td>
<td>BD Module</td>
<td></td>
</tr>
<tr>
<td>Output Power</td>
<td></td>
<td></td>
<td></td>
<td>Other</td>
</tr>
</tbody>
</table>

![Waveform Diagrams](image-url)

Voc line to neutral scale: 10kHz/div

Voc line to neutral scale: 20kHz/div

50V scale: 50V/div

A.C. comp. scale: 5A/div
I) **Input Power**

- **Vim** = 149.64 Vac
- **Im** = 20.69 x 6 = 124.14 Amp
- **Pin** = 18.58 kW

**Test Config.** 2.37-3.72 Std. Stack

**Specific Case** C - Compensation, 50% load

**Frequency** 19.97 kHz

**T.H.D.**
- **OA** = 5.6% ± 7%
- **OB** = 6.9% ± 7%
- **OC** = 5.9% ± 7%

**T.H.D. - Transmission Line**

**QNA**

II) **Output Power**

<table>
<thead>
<tr>
<th><strong>OA</strong></th>
<th><strong>OB</strong></th>
<th><strong>OC</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vo</td>
<td>442</td>
<td>444</td>
</tr>
<tr>
<td>Io</td>
<td>3.56</td>
<td>3.56</td>
</tr>
<tr>
<td>Po</td>
<td>324</td>
<td>324</td>
</tr>
</tbody>
</table>

**A.C. Recvr**

- **Vo** = 109.0 Vrms
- **Io** = 4.56 Amps
- **Po** = 494 Watts

**B/D Mod.**

- **Vo** = 96.6 Vac
- **Io** = 3.53 Acc
- **Po** = 324 Watts

**D.C. Recvr**

- **Vo** = 28.15 Vac
- **Io** = 36.44 Acc
- **Po** = 1030 W

**T.H.D. Out of Recvr**

- **db**

**Resistive Loads**

<table>
<thead>
<tr>
<th><strong>OA</strong></th>
<th><strong>OB</strong></th>
<th><strong>OC</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vc</td>
<td>494.4 Vac</td>
<td></td>
</tr>
<tr>
<td>Ic</td>
<td>49.65 mV</td>
<td></td>
</tr>
<tr>
<td>Pc</td>
<td>9.87 Acc</td>
<td></td>
</tr>
<tr>
<td>432.0 W</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total System Efficiency**

\[
\text{Efficiency} = \frac{P_{out}}{P_{in}} = \frac{14,920}{18,580} = 80.3\%
\]
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 23.7-3.73 Steady State Operation
Specific Case: C-Compensation, 50.7a Load

<table>
<thead>
<tr>
<th>Input Voltage:</th>
<th>DC Rcvr:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current:</td>
<td>AC Rcvr:</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>BD Module:</td>
</tr>
<tr>
<td>Output Power:</td>
<td>Other:</td>
</tr>
</tbody>
</table>

![Graphs showing waveforms with labels](image)

Scale: 50 A/Div

Scale: 50 V/Div
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: ________________________________
Specific Case: C - Conventional, 50 Hz. Load
Input Voltage: ________________________________ DC Rcvr: ________________________________
Input Current: ________________________________ AC Rcvr: ________________________________
System Frequency: ________________________________ BD Module: ________________________________
Output Power: ________________________________ Other: ________________________________

Ima

100V

10μS

Ims

Ima

Scale: 50A/Div

50μS

A

50V

100μS

B

C

A.C. Receiver Voltage Scale:

Scale: 320 V/Div
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7.3.7.3 Steady-State Operation
Specific Case: C-Compensation, 50Ω, no load

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

Image: [Waveform Diagram]

Scale:

Photo

Scale: 5m/DV

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 Hz Load

Input Voltage: ____________________________ DC Rcvr: ____________________________

Input Current: ____________________________ AC Rcvr: ____________________________

System Frequency: ____________________________ BD Module: ____________________________

Output Power: ____________________________ Other: ____________________________

\[ \text{(C)} \]

\[ \text{(C)} \]

\[ \text{(C)} \]

\[ \text{(C)} \]
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: 

Photo
I) **Input Power**

\[
\begin{align*}
\text{Vin} & = 149.15 \text{ Vol} \\
I_{in} & = 33.49\times10^3 \text{ Aac} \\
P_{in} & = 29.97 \text{ kW}
\end{align*}
\]

Frequency \(19.96 \text{ kHz}\)

T.H.D.

\[
\begin{align*}
\Phi_A & = 5.9 \% \\
\Phi_B & = 5.6 \% \\
\Phi_C & = 6.0 \% \\
\Phi_{dc} & = 0 \%
\end{align*}
\]

II) **Output Power**

\[
\begin{align*}
\Phi_A & = \Phi_B = \Phi_C = 0 \%
\end{align*}
\]

\[
\begin{align*}
V_o & = 943 \\
I_o & = 8.49 \\
P_o & = 812 \text{ W}
\end{align*}
\]

T.H.D. \(4.27\%\) \(0\%\)

\[
\begin{align*}
\Phi_{ac} & = 0 \%
\end{align*}
\]

Resistive Loads

\[
\begin{align*}
V_a & = 433.3 \text{ Vac} \\
I_a & = 91.30 \text{ mV} \\
P_a & = 7870 \text{ W}
\end{align*}
\]

\[
\begin{align*}
V_b & = 430.3 \text{ Vac} \\
I_b & = 87.58 \text{ mV} \\
P_b & = 7650 \text{ W}
\end{align*}
\]

\[
\begin{align*}
V_c & = 430.0 \text{ Vac} \\
I_c & = 91.61 \text{ mV} \\
P_c & = 7810 \text{ W}
\end{align*}
\]

Total System Efficiency:

\[
\text{Efficiency} = \frac{P_{out}}{P_{in}} = \frac{25600}{20000} = 98.3 \%
\]
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

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage (Vac)</td>
<td>149.15</td>
</tr>
<tr>
<td>Input Current (A)</td>
<td>200.9</td>
</tr>
<tr>
<td>System Frequency (KHz)</td>
<td>19.96</td>
</tr>
<tr>
<td>Output Power (kW)</td>
<td>25.6</td>
</tr>
<tr>
<td>DC Receiver Power (W)</td>
<td>1030</td>
</tr>
<tr>
<td>AC Receiver Power (W)</td>
<td>470</td>
</tr>
<tr>
<td>DC Module Power (W)</td>
<td>810</td>
</tr>
<tr>
<td>Other</td>
<td>None</td>
</tr>
</tbody>
</table>
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (MAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 3.2.2 Steady State Operation
Specific Case: C - Compensated, Full Load

Input Voltage: _______________  DC Recvr: __________________
Input Current: _______________  AC Recvr: __________________
System Frequency: _______________  BD Module: _______________
Output Power: _______________  Other: __________________

Scale: 50 A/div

Scale: 50 A/div

Scale: 50 V/div

Scale: 320 V/div

198
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.37 - 2.77 Steady-State Operation
Specific Case: C - Compensation, Full Load

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

DC Recvr: 
AC Recvr:  
BD Module:  
Other:  

---

---

---

---

---

---

---

---

---
null
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 23.7-3.2.2 Steady-State Operation

Specific Case: C- Compensation, Eq. Loss

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

\[ \text{Graphs showing waveforms with labels:}\]

- Veq line to neutral Scale: 10 dB/div
- Veq line to neutral Scale: 10 dB/div
- Veq line to neutral Scale: 10 dB/div
- Veq line to neutral Scale: 10 dB/div
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: 

**Graphs**

- **Left Graph:**
  - Title: 60 KHz
  - Y-axis: Vdc line to neutral Scale: 10 div/div
  - X-axis: Scale: 50 V/Div

- **Right Graph:**
  - Title: 200 KHz
  - Y-axis: Vdc line to neutral Scale: 10 div/div
  - X-axis: Scale: 5 A/Div

**Table**

- **Columns:** Title, Scale, Div, Div
- **Rows:**
  - Vdc line to neutral: 10 div/div
  - Vdc line to neutral: 50 V/Div
  - Vdc line to neutral: 5 A/Div
Configuration - Test 2.3.7-3.2.2 Steady-State Operation

LC Compensation

Test Circuits

\[ L_a = 96.4 \mu H \]

\[ V_{xa} \]

\[ C_a = 0.8 \mu F \]
I) **INPUT POWER**

\[
\begin{align*}
V_{in} &= 150.9 \text{ Vdc} \\
I_{in} &= 2.58 \times 15.16 \text{ A dc} \\
P_{in} &= 2.29 \text{ kW}
\end{align*}
\]

**Frequency** 19.96 KHz

**T.H.D.**

| φA | 6.9 | 6% |
| φB | 21 | 9% |
| φC | 7.3 | 9% |

**T.H.D. - TRANSMISSION LINE INTO THE LINE**

φA

II) **OUTPUT POWER**

| φA | φB | φC |
| V_o | 4428 | 4325 | 4418 |
| I_o | — | — | — |
| P_o | — | — | — |

**A.C. RCVR**

| V_o | V0.112 |
| I_o | I_o.19 |
| P_o | P_o.21.3 Wth |

**D.C. RCVR**

| V_o | V_o.29.76 |
| I_o | I_o.0 |
| P_o | P_o.0 |

**T.H.D. OUT OF RCVR** 86

**RESISTIVE LOADS**

| φA | φB | φC |
| V_o | 442.8 Vdc | 4325 Vdc | 4418 Vdc |
| I_o | 0.54 MV | 0.59 MV | 0.5 MV |
| P_o | Prod | Prod | Prod |

**Total System Efficiency** \( \frac{P_{out}}{P_{in}} \) = %
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
Input Current: 15.18 Adc
System Frequency: 19.96 KHz
Output Power: 21 Watts

Input Voltage: Scale: 20 V/div
Input Current: Scale: 20 A/div
System Frequency: Scale: 50 A/div
Output Power: Scale: 50 A/div
### RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
### TEST PROGRAM (NAS3-22777)
### TRANSIENT TEST DATA SHEET

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>Steady State Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>LC Compensation, No Load</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>Same</td>
</tr>
<tr>
<td>Input Current:</td>
<td></td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td>Other:</td>
</tr>
</tbody>
</table>

**Graphs:**

- **Graph 1:**
  - **Label:** *i_a + i_b*
  - **Scale:** 20 A/div

- **Graph 2:**
  - **Label:** *i_a + i_b*
  - **Scale:** 50 A/div

- **Graph 3:**
  - **Label:** *50V 10us*
  - **Scale:** 325 V/div

**Photo:**

- **Description:**
**Test Configuration:** 2.3.7 - 3.2.2, Steady-State Operation

**Specific Case:** LC Compensation, No Load

<table>
<thead>
<tr>
<th>Input Voltage</th>
<th>DC Rcvr:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current</td>
<td>AC Rcvr:</td>
</tr>
<tr>
<td>System Frequency</td>
<td>BD Module:</td>
</tr>
<tr>
<td>Output Power</td>
<td>Other:</td>
</tr>
</tbody>
</table>

![Graphs showing waveforms](image-url)
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:

[Graphs showing waveforms with labels and scales]
**Resonant AC Power System Proof-of-Concept Test Program (NASA-22777)**

**Transient Test Data Sheet**

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>2.3.7 - 3.2.2 Steady State Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>LC Compensation, No Load</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>DC Rcvr: Same</td>
</tr>
<tr>
<td>Input Current:</td>
<td>AC Rcvr: Same</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>BD Module:</td>
</tr>
<tr>
<td>Output Power:</td>
<td>Other:</td>
</tr>
</tbody>
</table>

![Graphs](image)
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
Input Current: DC Rcvr: Same
System Frequency: AC Rcvr: BD Module:
Output Power: Other:

![Waveform Image]

Frequency to neutral Scale: 100kHz/div

![Waveform Image]

Frequency to neutral Scale: 200kHz

![Waveform Image]

Frequency to neutral Scale: 10mV/div

![Waveform Image]

Frequency to neutral Scale: 10μS

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

[Diagram and waveform images]
**I) Input Power**

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>150.6 Vdc</td>
</tr>
<tr>
<td>Current</td>
<td>115.4 Adc</td>
</tr>
<tr>
<td>Power</td>
<td>17.39 kW</td>
</tr>
</tbody>
</table>

**Frequency** 19.92 KHz

THD:
- OA: 6.3% R
- OB: 6.5% R
- OC: 5.9% R

**II) Output Power**

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>442.9 V</td>
</tr>
<tr>
<td>Current</td>
<td>11.35 A</td>
</tr>
<tr>
<td>Power</td>
<td>5.03 kW</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>436.0 V</td>
</tr>
<tr>
<td>Current</td>
<td>11.6 A</td>
</tr>
<tr>
<td>Power</td>
<td>3.08 kW</td>
</tr>
</tbody>
</table>

THD - Transmission Line into the Line

THD - Out of Receiver

A.C. Rect. B/D Mod.

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>10.7 V</td>
</tr>
<tr>
<td>Current</td>
<td>4.25 A</td>
</tr>
<tr>
<td>Power</td>
<td>47.5 W</td>
</tr>
</tbody>
</table>

D.C. Rectifier

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>28.29 V</td>
</tr>
<tr>
<td>Current</td>
<td>22.23 A</td>
</tr>
<tr>
<td>Power</td>
<td>629.8 W</td>
</tr>
</tbody>
</table>

THD - Out of Rectifier

**Resistive Loads**

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>431.8 V</td>
</tr>
<tr>
<td>Current</td>
<td>51.04 mA</td>
</tr>
<tr>
<td>Power</td>
<td>4380 W</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>429.0 V</td>
</tr>
<tr>
<td>Current</td>
<td>50.91 mA</td>
</tr>
<tr>
<td>Power</td>
<td>4440 W</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage</td>
<td>432.7 V</td>
</tr>
<tr>
<td>Current</td>
<td>45.45 mA</td>
</tr>
<tr>
<td>Power</td>
<td>3900 W</td>
</tr>
</tbody>
</table>

**Total System Efficiency**

\[ \text{Efficiency} = \frac{P_{out}}{P_{in}} \]

\[ \text{Efficiency} = \frac{14,600}{17,390} = 84.0\% \]
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.3 Steady State Response

Specific Case: LC Compensation: 50Ω Load

Input Voltage: 150.6 DC Recvr: 
Input Current: 115.44 AC Recvr: 
System Frequency: 19.92 kHz BD Module: 
Output Power: Other: 

---

![Waveforms](image)
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
Input Current: Same
System Frequency: BD Module:
Output Power: Other:

---

Input Voltage: 100 V
Input Current: 10 A
System Frequency: 60 Hz
Output Power: 500 W
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, SO 7k Load

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

[Graphs and waveforms showing AC current and voltage waveforms]
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: LC Compensation, 50 Ω Load

Input Voltage: _____________ DC Rcvr: _____________
Input Current: _____________ AC Rcvr: _____________
System Frequency: ___________ BD Module: ___________
Output Power: ______________ Other: _______________

Photo
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 Hz Local
Input Voltage: Same
Input Current: Same
System Frequency: Other:
Output Power: AC Receiver:

A.C. Component of Vna line to neutral scale: 5 A/div
scale: 10 dB/Div

Vna line to neutral scale: 10 dB/Div

Vna line to neutral scale: 10 dB/Div

20 kHz 100 kHz
20 kHz 100 kHz

10 mV

10 dB down

10 dB down
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: Scan DC Rcvr: Scan
Input Current: AC Rcvr: 
System Frequency: BD Module: 
Output Power: Other: 

\[ \text{Graphs showing waveforms at different frequencies:} \]

- 20 kHz
- 200 kHz

Volts line to neutral
Scale: 10dB/div

Volts line to neutral
Scale: 10dB/div

Volts line to neutral
Scale: 10dB/div

Volts line to neutral
Other off scale: 10dB/div
I) **INPUT POWER**

- **A)** 184.6
- **B)** 131.0

- **In:** 10.44 X 10.64 (11.1X 12.6)
- **Pin:** 31.0 kW

**Test Config. 23.7-3.22 Steady State Operation**

- **Specific Case:** UC Connection, Full Load
- **Phase:** A

- **Frequency:** 19.92 KHz

- **T.H.D.**
  - **ΔA:** 4.7 %
  - **ΔB:** 4.1 %
  - **ΔC:** 4.3 %

- **T.H.D. - Transmission Line**
- **Into The Line**

II) **OUTPUT POWER**

- **ΔA:** 445.1 V
- **ΔB:** 427.1 V
- **ΔC:** 444.1 V

- **Ia:** 18.72 A
- **Ib:** 22.3 A
- **Ic:** 22.3 A

- **Po:** 626.6 W

- **T.H.D. Out of Recur**
  - **Δ5**

- **A.C. RECVR**
  - **BiD MOD.**
  - **Vo:** 106 V
  - **Ig:** 2.5 A
  - **P:** 471 Watts

- **D.C. RECVR**
  - **Vo:** 28.58 V
  - **Ig:** 22.1 A
  - **P:** 626 W

**RESISTING LOADS**

- **ΔA**
  - **V:** 427.1 Vac
  - **I:** 9.1 A
  - **P:** 7.73 KW

- **ΔB**
  - **V:** 403.4 Vac
  - **I:** 110.2 mA
  - **P:** 22.4 A

- **ΔC**
  - **V:** 473.7 Vac
  - **I:** 104.7 mA
  - **P:** 20.7 A
  - **Pre:** 98.37 KW

**Total System Efficiency**

\[ \text{Efficiency} = \frac{\text{Power Output}}{\text{Power Input}} \]

\[ \text{Efficiency} = \frac{27.5}{31.5} = 87.3\% \]
Test-Configuration: 2.3.7-3.2.2 Steady-state Operation
Specific Case: LC Compensation, Full Load
Input Voltage: 
Input Current: 
System Frequency: 
Output Power: 

[Graphs and charts showing waveforms]

Vx3, Vx4 Scale: [Graphs with scales indicated]
Ix3, Ix4 Scale: [Graphs with scales indicated]
Vz3, Iz3 Scale: [Graphs with scales indicated]
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 237-2322 Steady State Operation
Specific Case: LC Compensation; Full load
Input Voltage: 151.5 (Ac) CCR DC Recvr: 626 W
Input Current: 208.3 A dc AC Recvr: 471 W
System Frequency: 19.92 kHz BD Module: 728 W
Output Power: 27.5 kW

Note: Measurements + photographs taken with only one plane on at a time.
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

<table>
<thead>
<tr>
<th>Specific Case</th>
<th>Input Voltage</th>
<th>DC Rcvr:</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC Compensation, Full Load</td>
<td>Default</td>
<td>Details</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input Current:</th>
<th>AC Rcvr:</th>
<th>BD Module:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default</td>
<td>Details</td>
<td>Other:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>System Frequency:</th>
<th>Output Power:</th>
<th>Other:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default</td>
<td>Details</td>
<td>Other:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test Configuration:</th>
<th>Scale: 20 A/div</th>
<th>10uS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Scale: 20 A/div</td>
<td>10uS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test Configuration:</th>
<th>Scale: 50 A/div</th>
<th>10uS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Scale: 50 A/div</td>
<td>10uS</td>
</tr>
</tbody>
</table>
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 23.7-3.2.2 Steady-State Operation
Specific Case: LC Compensation, Full Load

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

![Graphs showing waveforms with scales and labels indicating voltage and time measurements.](image-url)
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.7 Steady-State Operation
Specific Case: LC Compensation, Full Load

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td></td>
</tr>
<tr>
<td>Input Current</td>
<td></td>
</tr>
<tr>
<td>System Frequency</td>
<td></td>
</tr>
<tr>
<td>Output Power</td>
<td></td>
</tr>
</tbody>
</table>

![Graphs showing voltage waveforms at 60 kHz and 200 kHz](image)

Input line to neutral Scale: 10 V/div
Input line to neutral Scale: 100 V/div
Input line to neutral Scale: 10 V/div
Input line to neutral Scale: 100 V/div

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II) **Output Power**

<table>
<thead>
<tr>
<th>( \Phi A )</th>
<th>( \Phi B )</th>
<th>( \Phi C )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_o ) 4.476 V</td>
<td>( V_o ) 2.45 mV</td>
<td>( V_o ) 28.25 V</td>
</tr>
<tr>
<td>( I_o ) 1.044 mV</td>
<td>( I_o ) 0.93 mV</td>
<td>( I_o ) 10.44 mV</td>
</tr>
<tr>
<td>( P_o ) P.o. 8.200</td>
<td>( P_o ) P.o. 623 W</td>
<td>( P_o ) P.o. 563 W</td>
</tr>
</tbody>
</table>

**A.C. RCUR**

| \( V_o \) 2.45 mV | \( I_o \) 2.45 mV | \( P_o \) P.o. 8.200 |

**BID MOD.**

| \( V_o \) 2.45 mV | \( I_o \) 2.45 mV | \( P_o \) P.o. 8.200 |

**T.H.D. out of RCUR**

| dB | dB |

**Resistive Loads**

<table>
<thead>
<tr>
<th>( \Phi A )</th>
<th>( \Phi B )</th>
<th>( \Phi C )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_o ) 3.0 Vac</td>
<td>( V_o ) 3.0 Vac</td>
<td>( I_c ) 47.0 Vac</td>
</tr>
<tr>
<td>( I_o ) 0.81 mV</td>
<td>( I_o ) 0.93 mV</td>
<td>( I_o ) 10.44 mV</td>
</tr>
<tr>
<td>( P_{RA} )</td>
<td>( P_{RA} )</td>
<td>( P_{RA} )</td>
</tr>
</tbody>
</table>

**Total System Efficiency:**

\[
\text{Efficiency} = \frac{P_{out}}{P_{in}} = \frac{9100}{10,620} = 85.7\%
\]
Resonant AC Power System Proof-of-Concept Test Program (NAS3-22777)

Transient Test Data Sheet

Test-Configuration: 226-3.26 TRANSIENT LOAD RESPONSE

Specific Case: DC RCVR

Input Voltage: Same DC RCVR: C ↔ 726W
Input Current: AC RCVR:
System Frequency: BD Module:
Output Power: Other:

\[ V_{L1} = \frac{V}{3} \]

\[ V_{L3} \]

DC RCVR 100% → 0 LOAD Scale: N.T.S.

DC RCVR 100% → 0 LOAD Scale: N.T.S.

1KΩ

DC RCVR 0 → 100% LOAD Scale: 100/div

Osc. due to transformer.

DC RCVR 0 → 100% LOAD Scale: 10A/div

Live voltage is not to scale.
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: AC Rcvr: 0 → 726W
System Frequency: BD Module:
Output Power: Other:

*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:  

---

**DC RCVR SWITCHING**
- FROM 100% → 0 LOAD
- AND FROM 0 → 100% LOAD
- Scale: 200 mV

---

**DC RCVR, TURNEO ON**
- FROM 100% → 0 LOAD
- Scale: 10A/DIV

---

**DC RCVR, LOAD CHANGED FROM**
- 0 → 100% → 0
- Scale: 10A/DIV
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

TEST PROGRAM (NAS3-22777)

TRANIENT TEST DATA SHEET

Test-Configuration: 23.6-3.2.3 TRANSIENT LOAD RESPONSE

Specific Case: DC RCVR

<table>
<thead>
<tr>
<th>Input Voltage:</th>
<th>Same</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current:</td>
<td></td>
</tr>
<tr>
<td>System Frequency:</td>
<td>4</td>
</tr>
<tr>
<td>Output Power:</td>
<td></td>
</tr>
</tbody>
</table>

DC Rcvr: 0 → 726W
AC Rcvr: 30 → 726W
BD Module: 0 → 800W
Other: 116 → 712W

Graphs showing transient load response with voltage and current waveforms, scale 20mA/Div.
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.36-3.23 Transient load response

Specific Case: DC Rcvr (No load ↔ Full load)

Input Voltage: 120.2 V
Input Current: 50.3 A
System Frequency: 20.21 kHz
Output Power: 4806 W

DC Rcvr: 726 W
AC Rcvr: 427 W
BD Module: 93.5 W
Other: $P_1 = 978/\theta_2 = 720/\theta_2 = 1020$

---

Test-Configuration: DC Rcvr (Vdc-Tdc) Scale: 20 A/div

DC Rcvr: O ↔ Full load Scale: 250 V/div

---

Test-Configuration: DC Rcvr (Vdc: Idc) Scale: 20 A/div

DC Rcvr: Full load $\varnothing$ Scale: 20 A/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
2.3.4 50% DC LOAD → 25% DC LOAD  

-3.23  

V\text{IN} = 90 V  

f = 20.44 kHz  

Branch Current B  
Inverter #1  

Branch Current D  
Inverter #2
2.3.4  50% DC LOAD  →  25% DC LOAD  V_{in}=90V  f=36.44kHz

Resonant Tank Voltage

Resonant Tank Voltage

Resonant Tank Current

Resonant Tank Voltage

Branch Current A

Branch Current C
2.3.4 25% DC LOAD → 50% DC LOAD

Branch Current B
Inverter #1

Branch Current D
Inverter #2

Output Voltage
Output Current (Including Filter Current)
DC Receiver

Input Voltage
Input Current

$V_{IN} = 90V$
$f = 20.44kHz$
2.3.4 - 3.2.3

INVERTER #1

25% DC LOAD → 50% DC LOAD

INVERTER #2

\( V_{r1} \)

\( V_{r2} \)

Resonant Tank Voltage

Resonant Tank Voltage

\( I_{A1} \)

\( I_{A2} \)

Resonant Tank Current

Resonant Tank Current

\( I_{A} \)

\( I_{A} \)

Branch Current A

Branch Current C

\( V_{zn} = 90V \)

\( f = 20.44kHz \)
23.4  50% BD LOAD → 25% BD LOAD

-3.23

\[ V_{DC} = 90V \]
\[ f = 2044kHz \]

Branch Current B
Inverter #1

Branch Current D
Inverter #2

Output Voltage
Output Current (Including Filter Current)
BD Module

Input Voltage
Input Current
Inverter #1

Resonant Tank Voltage

Inverter #2

Resonant Tank Voltage

Resonant Tank Current

Branch Current A

Branch Current C

\[ V_{\text{in}} = 90V \]

\[ f = 20.44 \text{Hz} \]
2.3.4
25% BD LOAD → 50% BD LOAD

-3.23

Branch Current B
Inverter #1

Branch Current D
Inverter #2
2.3.4 25% BD LOAD → 50% BD LOAD

V_{K1}

ON

Resonant Tank Voltage

V_{K2}

ON

Resonant Tank Voltage

I_{K1}

HOLD

OA

Resonant Tank Current

I_{K2}

HOLD

OA

Resonant Tank Current

I_{A}

HOLD

OA

Branch Current A

I_{C}

HOLD

OA

Branch Current C

V_{N}=90V

f=20.44kHz
23.4  NO AC LOAD $\rightarrow$ 50% AC LOAD
-3.2.3

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
2.3.4 NO AC LOAD → 50% AC LOAD $V_{in} = 90V$

- 3.2.3

**INVERTER #1**

Resonant Tank Voltage

**INVERTER #2**

Resonant Tank Voltage

Resonant Tank Current

Resonant Tank Current

Branch Current A

Branch Current C

$\psi = 20.4/4 \text{kHz}$
2.3.4  50% AC LOAD

-3.2.3

NO AC LOAD

$V_{IN}=36\, V$

$f=22.4\, kHz$

Branch Current B
Inverter #1

Branch Current D
Inverter #2

Output Voltage
AC Receiver

Input Voltage
Input Current

Output Current (Including Filter Current)
AC Receiver
2.3.4 50% AC LOAD \[\rightarrow\] NO AC LOAD \[V_{in}=90V\]
\[f=20.44kHz\]

**INVERTER #1**
- \(V_{k1}\)
  - Resonant Tank Voltage
- \(I_{k1}\)
  - Resonant Tank Current
- \(I_{A}\)
  - Branch Current A

**INVERTER #2**
- \(V_{k2}\)
  - Resonant Tank Voltage
- \(I_{k2}\)
  - Resonant Tank Current
- \(I_{C}\)
  - Branch Current C

**INV. 1**

**INV. 2**
TRANSIENT LOAD RESPONSE

3.2.3
2.3.4 TRANSIENT LOAD RESPONSE

Load switching is done for each receiver while the two other receivers maintain 50% loading.
2.3.2 Full → 50% Load  
-3.2.3.1 

Input Voltage 
Input Current 
(Before DC Capacitor)

Output Voltage 
Output Current 
(Including Filter Current)

Resonant Tank Current

Branch Current 1A

Branch Current 1B

\[ V_{\text{IN}} = 92.0 \, V_{\text{DC}} \]
2.3.2
-3.2.3.1

50% → Full Load

$V_{in} = 920V_{dc}$

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 Full → 10% 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
23.2 - 3.2.3.1

10% → Full Load

$V_{IN} = 92.0 \text{ V}_{DC}$

**Input Voltage**
**Input Current**
(Before DC Capacitor)

**Output Voltage**
**Output Current**
(Including Filter Current)

**Branch Current 1A**

**Resonant Tank Current**

**Branch Current 1B**
2.3.2-3.2.31  50% → No Load  $V_{EN} = 92.0 \ V_{DC}$

- 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
2.3.2
-3.2.3
0 \rightarrow 50\% Load

\[ V_{2W} = 920 V_{dc} \]

Input Voltage
Input Current
(Before DC Capacitor)

Output Voltage
Output Current
Including Filter Current

Resonant Tank Current

Branch Current IA

Branch Current IB
2.3.2 TRANSIENT LOAD RESPONSE

Some relay bounce may be present in the photos.
2.3.1 50% LOAD → FULL LOAD
- 3.2.3 FULL LOAD → 50% LOAD

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

Output Voltage
Output Current
Full Load → 50% Load

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

Branch Current
50% Load → Full Load

Branch Current
Full Load → 50% Load
2.3.1 50% LOAD -> FULL LOAD

-3.23  FULL LOAD -> 50% LOAD

V_\text{IN} = 87.6\text{VDC}

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

Input Current
(Before DC Capacitor)
50% Load -> Full Load

Input Current
(After DC Capacitor)
50% Load -> Full Load

Full Load -> 50% Load

Input Current
(Before DC Capacitor)
Full Load -> 50% Load

Input Current
(After DC Capacitor)
Full Load -> 50% Load
23.1 10% LOAD → FULL LOAD
-32.3 FULL LOAD → 10% LOAD

$V_{IN} = 570V$

10% Load → Full Load
Full Load → 10% Load

Output Voltage

Output Current

(Some relay bounce present)

Branch Current

10% Load → Full Load
Full Load → 10% Load
2.3.1 10% LOAD → FULL LOAD
V_{IN} = 820 \text{ Vdc}

3.2.3 FULL LOAD → 10% LOAD

- Input Voltage

10% Load → Full Load

Input Current
(Before DC Capacitor)

10% Load → Full Load

Full Load → 10% Load

Input Current
(After DC Capacitor)

10% Load → Full Load

Full Load → 10% Load
2.3.1 NO LOAD $\rightarrow$ 50% LOAD
- 3.2.3 50% LOAD $\rightarrow$ NO LOAD

Inverter Output Voltage

Output Voltage

No Load $\rightarrow$ 50% Load

Output Current

50% Load $\rightarrow$ No Load

Output Current

No Load $\rightarrow$ 50% Load

Branch Current

50% Load $\rightarrow$ No Load
2.3.1 No load → 50% load
- 3.2.3 + 50% load → no load

Input Voltage
(Several load switches captured)

Input Current
No load → 50% load
(Before DC capacitor)

Input Current
50% load → no load
(After DC capacitor)

Input Current
No load → 50% load
(After DC capacitor)

Input Current
50% load → no load
(After DC capacitor)
23.1 - 3.2.3 TRANSIENT LOAD RESPONSE

Some relay bounce is present in the photos.
Test-Configuration: 2.3.6 - 3.2.3 Transient Load Response
Specific Case: DC Reversal (724W → CW)
Input Voltage: Same
Input Current: DC Reversal: 724W → CW
System Frequency: BD Module: Other:
Output Power:

DC Reversal -100% → 0 Scale: 20A/DIV DC Reversal 100% → 0 Scale: 20A/DIV

Photo

Photo

Scale:
### Resonant AC Power System Proof-of-Concept

**Test Program (NASJ-2777) Transient Test Data Sheet**

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>23.6-3.2.3 TRANSIENT LOAD RESPONSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>DC RCVR O ↔ Full Load</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>Same DC Rcvr: 0 → 726 W</td>
</tr>
<tr>
<td>Input Current:</td>
<td>AC Rcvr:</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>BD Module:</td>
</tr>
<tr>
<td>Output Power:</td>
<td>Other:</td>
</tr>
</tbody>
</table>

#### Waveforms:

- **Input Voltage** and **Current Scale:** 10A/
- **Output Voltage** and **Current Scale:** 10A/

---

*Photo*
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)

Configuration - Test 23.6-3.2.3 TRANSIENT LOAD

RESPONSE — Bidirectional Module

Full Load ↔ No Load

Test Circuits

![Circuit Diagram]

5/23/84
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 23.6-3.2.3
Specific Case: Bidirectional Module (0 ≤ Full Load)

Input Voltage: 120.0
Input Current: 49.16 ± 3.88
System Frequency: 19.95 kHz
Output Power: 4540 W

DC Rcvr: 810 W
AC Rcvr: 350 W
BD Module: 0 ≤ 980 W

Other: f = 108 W, β = 580 W, γ = 328 W

5/23/84

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### Test-Configuration: 2.3.6-3.2.3 TRANSIENT LOAD RESPONSE

**Specific Case:** BD MODULE (Full Load → 0)

<table>
<thead>
<tr>
<th>Input Voltage</th>
<th>DC Rcvr:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current</td>
<td>AC Rcvr:</td>
</tr>
<tr>
<td>System Frequency</td>
<td>BD Module:</td>
</tr>
<tr>
<td>Output Power</td>
<td>Other:</td>
</tr>
</tbody>
</table>

- **Full Load → 0**
- **Scale:** 20A/

---

### Diagrams:

- **ID OLA: Full Load → 0**
- **Scale:** 20A/

- **V12 OVA: Full Load → 0**
- **Scale:** NTS

- **ID OLA: Full Load → 0**
- **Scale:** 20A/

- **I12 OVA: Full Load → 0**
- **Scale:** 20A/
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT TEST PROGRAM (NASS-2777)

TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-2.2.3
Module: Standard
Load: Response

Specific Case: Bidirectional

Input Voltage: 500 V
System Frequency: 60 Hz
Input Current: 1 A

Output Power:
Output Voltage:

Input Power:
Input Current:

Other:
AC Module:
DC Module:
BD Module:

Other:

Accept Voltage & Current Scale: 5 A
Scale: 200 V

Output Voltage & Current Scale: 5 A
Scale: 200 V

Transmit Power: 200 W
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: | |

![Graph 1](image1.png)  
**Tank Current** Scale: 20A/

![Graph 2](image2.png)  
**Line Voltage** Scale: N.T.S

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 — AC RCVR (0 ≤ Full Load)

Test Circuits
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
Input Current: 48.94 ± 48.78
System Frequency: 20.05
Output Power: 4360W → 4590W

Input Voltage & Current Scale: 10A/

AC Recvr: 810 W
AC Recvr: 170 W → 400 W
BD Module: 980 W
Other: d1: 1050 W, d2: 512 W, d3: 832 W

O → FL

O → FL

O → FL

O → FL

I_A Scale: 20A/

I_A Scale: 20A/
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: **2.3.6-3.2.3**

<table>
<thead>
<tr>
<th>Specific Case</th>
<th>AC RCVR</th>
<th>DC RCVR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>Same</td>
<td></td>
</tr>
<tr>
<td>Input Current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Frequency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Power</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Waveform Diagrams](image)

- **I_B** (Scale: 20A/Div)
- **V_L** (Scale: Line Voltage: NTS)
- **I_E1** (Scale: 20A/Div)
- **Tank Current** (Scale: 20A/Div)

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

\[ V_L \]
\[ I_{AC} \]

Line Voltage Scale: NTS
AC Rcvr Output I Scale: 2A/

\[ V_{ac} \]
\[ 0 \rightarrow FL \]

\[ 0 \rightarrow FL \]

AC Rcvr. Output V Scale: 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: AC RCVR (0 ≤ Full Load)

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

DC RCVR:
AC RCVR:
BD Module:
Other:

I_in

V_in

OA

F.L. → 0 → F.L. → etc.

Input Voltage: Scale: 10V
Input Current: Scale: 10A
Tank Current: Scale: 20A

I_a

I_b

F.L. → 0 Scale: 20A

I_a (F.L. → 0) Scale: 20A

I_k1

O → F.L.

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RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 23.6-32.3 TRANSIENT LOAD RESPONSE

Specific Case: AC RCVR (Full Load → 0)

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

Output Voltage: 0
Output Current: 0

- Scale:

Photo Scale:

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Resonant AC Power System Proof-of-Concept

Test Program (NAS3-22777)

Configuration - Test 23.6-3.2.3 Transient Load Response

Simultaneous Three-Phase Load Switching

Test Circuits
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 Switching

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>120.0 Vr</td>
</tr>
<tr>
<td>DC Rcvr:</td>
<td>810 W → 0 W</td>
</tr>
<tr>
<td>Input Current</td>
<td>28.7 → 11.6 AØ</td>
</tr>
<tr>
<td>AC Rcvr:</td>
<td>400 W → 170 W</td>
</tr>
<tr>
<td>System Frequency</td>
<td>20.01 kHz</td>
</tr>
<tr>
<td>BD Module:</td>
<td>980 W → 0 W</td>
</tr>
<tr>
<td>DC Rcvr:</td>
<td>810 W → 0 W</td>
</tr>
<tr>
<td>Output Power</td>
<td>2190 W</td>
</tr>
<tr>
<td>Other:</td>
<td></td>
</tr>
</tbody>
</table>

INPUT V & I

F.L. → 0 → F.L.

Scale: 100V/Div

Scale: 10A/Div

DC Rcvr: 810 W → 0 W

Scale: 20A/Div

Scale: 20A/Div

BD Module: 980 W → 0 W 2 relays

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 Load Switching (Full Load→0)
Input Voltage: 120
Input Current: 28.7→11.6 A
System Frequency: 20.01 KHz
Output Power: 2190

Phase a: Line-to-neutral

Phase b: Line-to-neutral

Other:

Scale: 20A/Div

Scale: N.T.S.
Resonant AC Power System Proof-of-Concept

Test Program (NAS3-22777)

Transient Test Data Sheet

Test Configuration: 2.36-3.23 Transient Load Response

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

Input Voltage: 120.0

Input Current: 29.7 → 11.16 A

System Frequency: 60.01

Output Power: 219.0

DE Rcvr: 510W → 0

AC Rcvr: 100W → 100W

BD Module: 190 → 0

Other: 0W

Photo

Scale: 20mV

Phase C line-to-neutral

Scale: NTS

Photo

Scale:
**RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT**

**TEST PROGRAM (NAS3-22777)**

**TRANSIENT TEST DATA SHEET**

Test-Configuration: 2.36 - 2.77777 TRANSIENT LOAD RESPONSE

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage:</td>
<td>121.3 → 120.0</td>
</tr>
<tr>
<td>Input Current:</td>
<td>10.76 A → 28.63 A</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>20.03 kHz</td>
</tr>
<tr>
<td>Output Power:</td>
<td>170 → 2190 W</td>
</tr>
</tbody>
</table>

**Other:**

**Inverter 1 (O → F.L.)**  
Scale: 20A

**Inverter 2 (O → F.L.)**  
Scale: 20A

**Inverter 3 (O → F.L.)**  
Scale: 20A
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.26-3.2.3 TRANSIENT LOAD RESPONSE
Specific Case: Simultaneous 3-φ Switching (0→Full Load)

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

Line to Neutral
Line Voltage (1) Scale: NTS

Line to Neutral
Line Voltage (2) Scale: NTS

Hot X-fmr.
Line Voltage (3) Scale: NTS

Line to Neutral
Line Voltage (3) Scale: NTS
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 3-6 Switching (0 → Full Load)
Input Voltage: Same
Input Current: DC Rcvr:
System Frequency: AC Rcvr:
Output Power: BD Module: Other:

Tank Current 1 Scale: 20A
Tank Current 2 Scale: 20A
Tank Current 3 Scale: 20A
Configuration - Test 2.3.7 - 3.2.3 Transient Load Response

D.C. Receiver

Test Circuits
I) **Input Power**

- **Vin**: 150.29
- **Im**: 11.29
- **Pin**: ___

**T.H.D.**
- **fA**: ___%
- **fB**: ___%
- **fC**: ___%

**Test Config**: 23.7 - 3.2.3

**Specific Case**: D-C Receiver

**Frequency**: ___

II) **Output Power**

<table>
<thead>
<tr>
<th>fA</th>
<th>fB</th>
<th>fC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vo</td>
<td>Vo</td>
<td>Vo</td>
</tr>
<tr>
<td>Io</td>
<td>Io</td>
<td>Io</td>
</tr>
<tr>
<td>Po</td>
<td>Po</td>
<td>Po</td>
</tr>
</tbody>
</table>

**A.C. Recur**

| Vo | 10.2 |
| Io | 3.40 |
| Po | ___ |

**D.C. Recur**

| Vo | 26.52 |
| Io | 36.53 |
| Po | ___ |

**T.H.D. out of Recur**: ___ dB

**Resistive Loads**

<table>
<thead>
<tr>
<th>fA</th>
<th>fB</th>
<th>fC</th>
</tr>
</thead>
<tbody>
<tr>
<td>V0</td>
<td>490 Vac</td>
<td>Ic</td>
</tr>
<tr>
<td>I0</td>
<td>0.462 mV</td>
<td>Ic</td>
</tr>
<tr>
<td>Ia</td>
<td>___ Aa</td>
<td>Ic</td>
</tr>
<tr>
<td>P0</td>
<td>___</td>
<td>___</td>
</tr>
</tbody>
</table>

**Total System Efficiency**: ___

---

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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: 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: ____________________________

![Waveform Diagrams](image)

Scale: 10V/div Scale: 10A/div

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: 2.3.7 - 2.2.3 Transient Load Response

Specific Case: DC Receiver 0 → 705 W

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

\[ \text{Graphs showing transient load response} \]

\[ \text{Graphs showing waveforms} \]

\[ \text{Graphs showing waveforms} \]
**RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT**

**TEST PROGRAM (NASA-22777)**

**TRANSIENT TEST DATA SHEET**

<table>
<thead>
<tr>
<th>Test-Configuration: 2.3.3-3.7.3 Transient Load Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case: DC Receiver, 0 ( \rightarrow ) 705 Watts</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input Voltage: DC Rcvr:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current: AC Rcvr:</td>
</tr>
<tr>
<td>System Frequency: BD Module:</td>
</tr>
<tr>
<td>Output Power: Other:</td>
</tr>
</tbody>
</table>

![Graphs showing voltage and current waveforms](image)

**Graph Details:**
- **V(x)**: Scale: 320 V/div
- **I(x)**: Scale: 10 A/div
- **V(x)**: Scale: 200 V/div
- **I(x)**: 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: 2.3.3 - 3.2.3 Transient Load Responses

<table>
<thead>
<tr>
<th>Specific Case</th>
<th>DC Receiver, No Load -&gt; 705 Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>DC Recvr:</td>
</tr>
<tr>
<td>Input Current</td>
<td>AC Recvr:</td>
</tr>
<tr>
<td>System Frequency</td>
<td>BD Module:</td>
</tr>
<tr>
<td>Output Power</td>
<td>Other:</td>
</tr>
</tbody>
</table>

![Graphs of transient load responses](image-url)

<table>
<thead>
<tr>
<th>I_{K5}</th>
<th>Scale: 50 A/div</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_{K6}</td>
<td>Scale: 50 A/div</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>V_{K5}</th>
<th>Scale: UNCAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{KR}</td>
<td>Scale: UNCAL</td>
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</table>
**Test Configuration:** 2.3.7-3.2.3  Transient Load Response

**Specific Case:** DC Receiver, No Load → 705 Watts

<table>
<thead>
<tr>
<th>Input Voltage:</th>
<th>DC Rcvr:</th>
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<tbody>
<tr>
<td>Input Current:</td>
<td>AC Rcvr:</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>BD Module:</td>
</tr>
<tr>
<td>Output Power:</td>
<td>Other:</td>
</tr>
</tbody>
</table>

---

**Photo**

![Photo](image)

**Scale:** 500 μA

---

**Photo**

![Photo](image)

**Scale:** 50 mV

---

**Photo**

![Photo](image)

**Scale:**
### RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
### TEST PROGRAM (NAS3-22777)
### TRANSIENT TEST DATA SHEET

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
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<tr>
<td>Specific Case:</td>
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<td>Input Voltage:</td>
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<td>DC Rcvr:</td>
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<tr>
<td>Input Current:</td>
<td></td>
</tr>
<tr>
<td>AC Rcvr:</td>
<td></td>
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<tr>
<td>System Frequency:</td>
<td></td>
</tr>
<tr>
<td>BD Module:</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Scale:</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Scale:</td>
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</table>

<table>
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<td></td>
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</table>
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>Specific Case:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage:</td>
<td>DC Rcvr:</td>
</tr>
<tr>
<td>Input Current:</td>
<td>AC Rcvr:</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>BD Module:</td>
</tr>
<tr>
<td>Output Power:</td>
<td>Other:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Photo</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale:</td>
<td>Scale:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Photo</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale:</td>
<td>Scale:</td>
</tr>
</tbody>
</table>

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## RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

**TEST PROGRAM (NAS3-22777)**

**TRANSIENT TEST DATA SHEET**

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>DC Rcvr:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>AC Rcvr:</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>BD Module:</td>
</tr>
<tr>
<td>Input Current:</td>
<td>Other:</td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td></td>
</tr>
</tbody>
</table>

![Photo](image1)

![Photo](image2)

![Photo](image3)

![Photo](image4)

![Scale:](image5)
Configuration - Test 2.2.2-3.2.3 Transient Load Response

B/D Receiver \( 20\,\text{W} \rightarrow 816\,\text{W} \)

Test Circuits

\[ \Phi B \quad \text{B/D} \quad \text{RCVR} \quad 20\,\text{W} \quad 796\,\text{W} \]
I) INPUT POWER

\[
\begin{align*}
\text{Vin} & : 153.2V \\
\text{Iin} & : 105.6A \Rightarrow 111.4V \\
\text{Pin} & : \\
\text{T.H.D.} & : \\
\text{dB} & : \\
\end{align*}
\]

II) OUTPUT POWER

\[
\begin{align*}
\text{OA} & : \\
\text{OB} & : \\
\text{OC} & : \\
\text{Vo} & : \\
\text{Ia} & : \\
\text{Po} & : \\
\text{A.C. RCVR} & : \\
\text{B/D MOD.} & : \\
\text{V0} & : 97.5V \\
\text{I0} & : 3.27A \\
\text{P0} & : 337W \\
\text{T.H.D. out of RCVR} & : \\
\text{dB} & : \\
\end{align*}
\]

TEST CONFIG. 2.2.7-3.2.3

SPE=CASE B/D Receiver Low=916W

FREQUENCY

A.C. RCVR

B/D MOD.

D.C. RCVR

RESISTIVE LOADS

\[
\begin{align*}
\text{OA} & : \\
\text{V0} & : 434.2 Vcc \\
\text{Ia} & : 0.046 mV \\
\text{Cia} & : \\
\text{Pra} & : \\
\text{DB} & : \\
\text{V0} & : 4390 Vcc \\
\text{Ib} & : 0.046 mV \\
\text{Cib} & : \\
\text{Pib} & : \\
\end{align*}
\]

Total System Efficiency = \( \frac{\text{Pin}}{\text{Pout}} \)
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-2.7.3 Transient Load Response
Specific Case: B10 Receiver: 20W → 816W
Input Voltage: 153.2 → 153.0 DC Revr: OFF
Input Current: 106.6 → 111.4 AC Revr: 3341 W
System Frequency: BD Module: 20W → 816W
Output Power: Other: 

---

![Graphs](image_url)
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: B10 RCVR - 70W → 816W

Input Voltage: 10 V
Input Current: 1 A
System Frequency: 50 Hz
Output Power: 816 W

DC Rcvr: 10 A/div
AC Rcvr: 10 A/div
BD Module: 5 V/div
Other: 50 V/div

Graphs showing IxB and VxB waveforms with scales.
**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:** B10 RCVR: 20V -> 816V

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td></td>
</tr>
<tr>
<td>Input Current</td>
<td></td>
</tr>
<tr>
<td>System Frequency</td>
<td></td>
</tr>
<tr>
<td>Output Power</td>
<td></td>
</tr>
<tr>
<td>DC RCVR</td>
<td></td>
</tr>
<tr>
<td>AC RCVR</td>
<td></td>
</tr>
<tr>
<td>BD Module</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

![Graphs](image)

**Scale:** 50V/Div

**294**
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: Bin RCVR: 20W → 216W

<table>
<thead>
<tr>
<th>Parameter</th>
<th>DC Rcvr:</th>
<th>AC Rcvr:</th>
<th>BD Module:</th>
<th>Other:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Current</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Frequency</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Power</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Waveform Graphs](image)

---

Scale: 500V/Div

Scale: 50A/Div

Photo

Photo
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

SWITCH

300 W
I) **Input Power**

<table>
<thead>
<tr>
<th>V_{in}</th>
<th>I_{in}</th>
<th>P_{in}</th>
</tr>
</thead>
<tbody>
<tr>
<td>149.2 V</td>
<td>111.79 A</td>
<td></td>
</tr>
</tbody>
</table>

Frequency __________

T.H.D.
\( \phi_A \) __ __ %
\( \phi_B \) __ __ %
\( \phi_C \) __ __ %

T.H.D. - Transmission Line
\( \phi_A \) __ __ A

II) **Output Power**

| \( \phi_A \) | \( \phi_B \) | \( \phi_C \) |
| 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 __
I_o __
P_o __

T.H.D. out of RCVR
\( \phi_B \) __

**Resistive Loads**

| \( \phi_A \) | \( \phi_B \) | \( \phi_C \) |
| V_o | I_o | P_o |
| 432.0 Vac | 499.9 Vac | 441.2 Vac |
| 0.2460 mV | 0.0465 mV | 0.0495 mV |
| I_A | I_B | I_C |

Total System Efficiency \( \eta \) __ __ %
**Test-Configuration:** 2.2.2 - 2.2.3 Transient Load

<table>
<thead>
<tr>
<th>Specific Case:</th>
<th>AC Rcvr: 190 - 490 W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage:</td>
<td>DC Rcvr:</td>
</tr>
<tr>
<td>Input Current:</td>
<td>AC Rcvr:</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>BD Module:</td>
</tr>
<tr>
<td>Output Power:</td>
<td>Other:</td>
</tr>
</tbody>
</table>

![Graphs of voltage and current](image)

*ORIGINAL PAGE IS OF POOR QUALITY*
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.2-3.2.3 Transient Load Response
Specific Case: AC Rcvr: 190 - 460 W

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

---

Input Voltage: Scale: 50 mV/Div
Input Current: Scale: 50 mA/Div

---

Photo

---

Output Power: 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:

[Diagrams of waveforms with labels I₁, I₂, V₁, V₂, and annotations]
Resonant AC Power System Proof-of-Concept
Test Program (NAS3-22777)
Transient Test Data Sheet

Test-Configuration: 2.2.7-3.2.3 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: ____________________

![Graphs and Waveforms]

Scale: UNCAL
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>2.3.7-3.2.3 Transient Load Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>DC Rcvr: 190 → 490 W</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>AC Rcvr:</td>
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<td>Input Current:</td>
<td>BD Module:</td>
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<tr>
<td>System Frequency:</td>
<td>Other:</td>
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<tr>
<td>Output Power:</td>
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</tr>
</tbody>
</table>

![Graphs showing transient response](image)

ORIGINAL PAGE IS OF POOR QUALITY
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

\[ \text{Switch On} \]
\[ \text{Switch Off} \]
I) **INPUT POWER**

- $V_{in} = 151.0 V$
- $I_{in} = 165 A$
- $P_{in} = 29.9 kW$

II) **OUTPUT POWER**

<table>
<thead>
<tr>
<th>$\phi_A$</th>
<th>$\phi_B$</th>
<th>$\phi_C$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_o$</td>
<td>$V_o$</td>
<td>$V_o$</td>
</tr>
<tr>
<td>$I_o$</td>
<td>$I_o$</td>
<td>$I_o$</td>
</tr>
<tr>
<td>$P_o$</td>
<td>$P_o$</td>
<td>$P_o$</td>
</tr>
</tbody>
</table>

T.H.D. - Transmission Line

<table>
<thead>
<tr>
<th>$\phi_A$</th>
<th>$\phi_B$</th>
<th>$\phi_C$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_o$</td>
<td>$V_o$</td>
<td>$V_o$</td>
</tr>
<tr>
<td>$I_o$</td>
<td>$I_o$</td>
<td>$I_o$</td>
</tr>
<tr>
<td>$P_o$</td>
<td>$P_o$</td>
<td>$P_o$</td>
</tr>
</tbody>
</table>

T.H.D. out of RECUR

- $V_o = N/C$
- $I_o = N/A$
- $P_o = N/A$

A.C. RECUR

<table>
<thead>
<tr>
<th>$V_o = 437.5 Vac$</th>
<th>$I_o = 81 mV$</th>
<th>$P_o = 7.0 kW$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_o = 16.1 Ares$</td>
<td>$P_o = 6.7 kW$</td>
<td>$P_{tot} = 21 kW = 84.3 %$</td>
</tr>
</tbody>
</table>

B/D MOD.

| $V_o = N/C$ | $I_o = N/A$ | $P_o = N/A$ |

D.C. RECUR

| $V_o = 437.9 Vac$ | $I_o = 75 mV$ | $P_o = 7.3 kW$ |

Resistive Loads

<table>
<thead>
<tr>
<th>$\phi_A$</th>
<th>$\phi_B$</th>
<th>$\phi_C$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_a = 437.9 Vac$</td>
<td>$I_a = 81 mV$</td>
<td>$P_{a} = 7.0 kW$</td>
</tr>
<tr>
<td>$I_a = 16.1 Ares$</td>
<td>$I_o = 15.2 Ares$</td>
<td>$P_{tot} = 21 kW = 84.3 %$</td>
</tr>
</tbody>
</table>

Test Config. 2.3.3 - 3.2.3
Specific Case: $O \rightarrow 21 kW Res. Loads$
# 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)

<table>
<thead>
<tr>
<th>Input Voltage:</th>
<th>DC Rcvr:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current:</td>
<td>AC Rcvr:</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>BD Module:</td>
</tr>
<tr>
<td>Output Power:</td>
<td>Other:</td>
</tr>
</tbody>
</table>

![Voltage Waveform](image1)

![Current Waveform](image2)

**V\text{IN} (A.C. Component)** Scale: 50 mV/Div

**I\text{IN} (A.C. Component)** Scale: 500 mA/Div

**Photo**

---

Scale: 

---

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**RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT**

**TEST PROGRAM (NAS3-22777)**

**TRANSIENT TEST DATA SHEET**

<table>
<thead>
<tr>
<th>Test-Configuration: 2.3.7 - 3.2.3 Transient Load Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case: Simultaneous 3Φ switching (0 → 21 kV)</td>
</tr>
<tr>
<td>Input Voltage:</td>
</tr>
<tr>
<td>Input Current:</td>
</tr>
<tr>
<td>System Frequency:</td>
</tr>
<tr>
<td>Output Power:</td>
</tr>
</tbody>
</table>

![Graphs showing voltage and current waveforms](image-url)

- **V1c**: Scale: 320 V/div
- **I1c**: Scale: 10 A/div
- **I2c**: Scale: 50 A/div
- **I3a**: 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: 2.3.7-3.2.3 Transient Load Response
Specific Case: Simultaneous 3Ø Switching (0 → 21 kW)
Input Voltage: DC Rcvr: AC Rcvr:
Input Current: BD Module:
System Frequency: Other:
Output Power: 

---

[Graphs showing waveforms for Iⱽ, IⱿ, Vⱽ, VⱿ]
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 → 2.1 kW)

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

---

[Graphs showing transient load response with labels for voltage, current, and scale information]
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3:3-3.2:3  Transient Load Response
Specific Case: Simultaneous 24 Switching (0 & 21 KHz)
Input Voltage: DC Rcvr: 
Input Current: AC Rcvr: 
System Frequency: BD Module: 
Output Power: Other: 

---

![Graphs showing transient load response with scales in volts and microseconds.](image-url)
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 & Switching (0 → 21 kW)
Input Voltage: DC Rcvr: ____________________________________________
Input Current: AC Rcvr: ____________________________________________
System Frequency: BD Module: ______________________________________
Output Power: Other: ______________________________________________

\[ \text{Input Voltage: } \text{DC Rcvr: } \]
\[ \text{Input Current: } \text{AC Rcvr: } \]
\[ \text{System Frequency: } \text{BD Module: } \]
\[ \text{Output Power: } \text{Other: } \]

\[ \frac{10\text{mV}}{100\mu s} \quad \frac{10\text{mV}}{200\mu s} \]
\[ \frac{5\text{V}}{100\mu s} \quad \frac{5\text{V}}{200\mu s} \]

\[ \frac{10\text{mA/Div}}{} \quad \frac{10\text{mA/Div}}{} \]
\[ \frac{320\text{V/Div}}{} \quad \frac{320\text{V/Div}}{} \]
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: 
Input Current: 
System Frequency: 
Output Power: 

DC Recvr: 
AC Recvr: 
BD Module: 
Other: 

[Graphs showing waveforms labeled I1A, I2A with scales 10mV/100μs and 10mV/200μs]
**RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT**

**TEST PROGRAM (NAS3-22777)**

**TRANSIENT TEST DATA SHEET**

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>2.3.7-3.2.3 Transient Load Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>Simultaneous 30 Switching (0 → 21 kW)</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td></td>
</tr>
<tr>
<td>Input Current:</td>
<td></td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td></td>
</tr>
</tbody>
</table>

| DC Rcvr:            |          |
| AC Rcvr:            |          |
| BD Module:          |          |
| Other:              |          |

![Voltage Waveforms](image1)

![Current Waveforms](image2)

![Waveforms](image3)
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-2.3.3 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: ____________________________

[Graphs showing waveforms for Vm, Im, Vm, and Im with different scales and units]

Scale: UNCAL

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Resonant AC Power System Proof-of-Concept
Test Program (NAS3-22777)

Configuration - Test 2.27-3.23
Transient Load Response
Simultaneous 3Φ switching (21kW-0W)

Test Circuits

![Diagram of test circuits with labels for ΦA, ΦB, ΦC, 7.0 kW, 6.7 kW, 7.3 kW, Trigger Switches, Delay Circuit, Scope Trigger, and time points t=0 and t=to.](image-url)
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 (2: kW → 0W)

Input Voltage: 151.0 Vac
Input Current: 165 Aac
System Frequency:
Output Power: 21 kW

DC Rcvr: NIC
AC Rcvr: NIC
BD Module: NIC
Other: Resistive, φA = 6.7 kHz = 7.35V

Photo

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**RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT**

**TEST PROGRAM (NAS3-22777)**

**TRANSIENT TEST DATA SHEET**

<table>
<thead>
<tr>
<th>Test-Configuration: 2.3.7 - 3.2.3.</th>
<th><strong>Transient Load Response</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case: Simultaneous B &amp; O Switching (21\text{KW} \rightarrow 0\text{KW})</td>
<td></td>
</tr>
</tbody>
</table>

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

![Waveform Diagram](image1.png)

**Diagram:**

- \(I_{1A} t_1\) Scale: 50A/div
- \(I_{2A} t_1\) Scale: 50A/div

- \(I_{1A} t_2\) Scale: 50A/div
- \(I_{2A} t_2\) Scale: 50A/div
Test-Configuration: 2.3.7 - 3.2.3 Transient Load Response

Specific Case: Simultaneous 30 W Switching (11kW to 0W)

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

![Waveform Diagrams]

**Ik1, t1** Scale: 50A/div  **Ik2, t2** Scale: 50A/div

**Vn1, t1** Scale: UNCAL  **Vn2, t2** 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 (21kW → 0W)

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

[Graphs and Data Plots]

\[
\frac{1}{k_2} t_1 \quad \text{Scale: UNCAL} \quad \frac{1}{k_2} t_2 \quad \text{Scale: UNCAL}
\]
**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 30° switching (31 kW - 70 W)

- **Input Voltage:**
  - DC Rcvr: 
  - AC Rcvr: 

- **Input Current:**
  - BD Module: 
  - Other: 

- **System Frequency:**

- **Output Power:**

---

**Graphs**

- **Voltage vs. Time**
  - ILA t1  
  - VLA t1  

- **Current vs. Time**
  - ILA t2  
  - VLA t2  

- **Additional Notes**
  - Scale: 10 A/Div  
  - Scale: 10 V/Div  
  - Scale: 320 V/Div  
  - Scale: 200 μS/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 30 Switching (Simultaneous 30 Switching)

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

[Graphs and waveforms shown]
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 (2.1 kW -> 0 kW)

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

![Graphs showing waveforms of Ix, Ux, Ix, and Ux with specified scales.](image)
Resonant AC Power System Proof-of-Concept

Test Program (NAS3-22777)

Transient Test Data Sheet

Test-Configuration: 2.7-3.2-3 Transient Load Response
Specific Case: Simultaneous 3d Switching (21kW - 30kW)

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

\[\text{Graphs showing waveforms}\]

\[\text{Graphs showing waveforms}\]
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:

---

[Diagram of waveforms with scaled axes]
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: 

450V 2ms 
I_k1  t_y  Scale:  I_k2  t_w  Scale:  

450V 2ms 
V_k1  t_y  Scale:  V_k2  t_y  Scale:
Test-Configuration: 23.7 – 3.2.3 Transient Load Response
Specific Case: Simultaneous 3 φ Switching (21 kV to 0 kV)
Input Voltage: DC Rcvr: __________________________
Input Current: AC Rcvr: __________________________
System Frequency: BD Module: ______________________
Output Power: Other: _____________________________
### 3.212 Parallel Operation

#### I) Input Power

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Vin</td>
<td>143.8</td>
<td>146.4</td>
</tr>
<tr>
<td>Im</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pm</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Frequency**

#### II) Output Power

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DB</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC</td>
<td>314.5</td>
<td>333.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vo</th>
<th>Vo</th>
<th>Vdc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Io</td>
<td>Io</td>
<td>Io</td>
</tr>
<tr>
<td>Po</td>
<td>Po</td>
<td>Po</td>
</tr>
</tbody>
</table>

**THD - Transmission Line**

- T. H. D. INTO THE LINE: 1% 5% 6%
- T. H. D. OUT OF LINE: 3.5% 4%

#### III) Resistive Loads (Before & After)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DA</td>
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<tr>
<td>DB</td>
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</table>

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Va</td>
<td>304 Vac</td>
<td>318 Vac</td>
</tr>
<tr>
<td>Ia</td>
<td>63.3 mA</td>
<td>87.1 mA</td>
</tr>
<tr>
<td>Pca</td>
<td>5.1 kW</td>
<td>5.5 kW</td>
</tr>
</tbody>
</table>

**Total System Efficiency**

\[ \text{Efficiency} = \frac{\text{Output}}{\text{Input}} \times 100\% \]
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: 480 / 480 VDC
Input Current: 40/41 Aac.
System Frequency: 20 KHZ
Output Power: 5.1 KW / 5.5 KW

DC Rcvr: OFF
AC Rcvr: OFF
BD Module: OFF
Other: Resistance: 5.1 / 5.5 KW

Mono Operation

Vo, 1 inverter, SS, Scale: 180°/10

Dual, Parallel Operation

Vo, 2 inverters, SS, Scale: 18°/10

Mono Operation

Io, 1 inverter, SS, Scale: 10 A/10V

Dual, Parallel Operation

Io, 2 inverters, SS, Scale: 10 A/10V
**Resonant AC Power System Proof-of-Concept**

**Test Program (NAS3-22777)**

**Transient Test Data Sheet**

<table>
<thead>
<tr>
<th>Test Configuration:</th>
<th>Parallel Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>Steady-State Response</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>Same</td>
</tr>
<tr>
<td>Input Current:</td>
<td></td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td></td>
</tr>
<tr>
<td>DC Recvr:</td>
<td>OFF</td>
</tr>
<tr>
<td>AC Recvr:</td>
<td>OFF</td>
</tr>
<tr>
<td>BD Module:</td>
<td>OFF</td>
</tr>
<tr>
<td>Other:</td>
<td>Reactive 5.1kW</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mono Operation</th>
<th>Dual, Parallel Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale: 20A/div</td>
<td>Scale: 20A/0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mono Operation</th>
<th>Dual, Parallel Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scale: 50A/div</td>
<td>Scale: 50A/0</td>
</tr>
</tbody>
</table>

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## Resonant AC Power System Proof-of-Concept Test Program (NAS3-22777)

### Transient Test Data Sheet

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>32-12 Parallel Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>Steady-State Response</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>Same</td>
</tr>
<tr>
<td>DC Receiver:</td>
<td>Same</td>
</tr>
<tr>
<td>Input Current:</td>
<td></td>
</tr>
<tr>
<td>AC Receiver:</td>
<td></td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
</tr>
<tr>
<td>DC Module:</td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
</tr>
</tbody>
</table>

### Waveform Diagrams

- **Mono Operation, Vks, #6 Connected**: Scale: 180 V/100
- **Mono Operation, Vks, #6 Connected**: Scale: 180 V/100
- **Dum Parallel Op.**: Scale: 180 V/100
- **Dum Parallel Op.**: Scale: 180 V/100
**RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT**

**TEST PROGRAM (NASA-22777)**

**TRANSIENT TEST DATA SHEET**

Test-Configuration: 3.2.12 Parallel Operation

Specific Case: Transient Response

Input Voltage: 143 / 146 Vdc

Input Current: 40 / 41 Aac

System Frequency: 20 KHz

DC Rcvr: OFF

AC Rcvr: OFF

BD Module: OFF

Output Power: 5.1 kW / 5.5 kW

Other: Resistive - 5.1 kW / 5.5 kW

---

Graphs showing transient responses with scales: 50A/Div and 200μs/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

<table>
<thead>
<tr>
<th>Input Voltage:</th>
<th>DC Rcvr:</th>
<th>AC Rcvr:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same</td>
<td>Same</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Input Current:</th>
<th>BD Module:</th>
<th>Other:</th>
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<tbody>
<tr>
<td></td>
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<table>
<thead>
<tr>
<th>System Frequency:</th>
<th>Other:</th>
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<tbody>
<tr>
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<table>
<thead>
<tr>
<th>Output Power:</th>
<th>Other:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

Diagram: Chart showing transient responses with labels and scales:
- Vo transient, Scale: 100 Volts
- Vo transient, Scale: 100 Volts
- Io transient response, Scale: 10 A
- Io transient response, Scale: 10 A
RESOFLAHT 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, Phasor, Voltage, Current
Input Voltage: Same
Input Current: AC Rcvr: Same
System Frequency: BD Module: Other:
Output Power: Other:

[Graphs showing transient responses]
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 Recvr: Same

Input Current:
AC Recvr:

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/Div
**RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT**

**TEST PROGRAM (NAS3-22777)**

**TRANSIENT TEST DATA SHEET**

Test-Configuration: 8.2.12 Parallel Operation

<table>
<thead>
<tr>
<th>Specific Case:</th>
<th>Transient Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage:</td>
<td>Same</td>
</tr>
<tr>
<td>Input Current:</td>
<td></td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td></td>
</tr>
<tr>
<td>DC Revr:</td>
<td>Same</td>
</tr>
<tr>
<td>AC Revr:</td>
<td></td>
</tr>
<tr>
<td>BD Module:</td>
<td></td>
</tr>
<tr>
<td>Other:</td>
<td></td>
</tr>
</tbody>
</table>

![Image of test results](image1.jpg)

![Image of test results](image2.jpg)

**V<sub>in</sub>, transient response** Scale: 180 Volts  **V<sub>dc</sub>, transient response** Scale: 180 Volts

**Photo**

**Photo**

**Scale:**

**Scale:**

336
2.3.2 Output Response to Reference/Control Signal Changes

Simplified DC Receiver Control Circuit Block Diagram

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Measurement Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{IN} )</td>
<td>Fluke 8000A Multimeter</td>
</tr>
<tr>
<td>( I_{IN} )</td>
<td>Fluke 8000A Multimeter (( V_{OUT} ))</td>
</tr>
<tr>
<td>( V_{OUT} )</td>
<td>Fluke 8030A Diff. Voltmeter</td>
</tr>
<tr>
<td>( I_{OUT} )</td>
<td>SRT 9000AG Current Meter</td>
</tr>
<tr>
<td>( f )</td>
<td>HP 5315B Universal Counter</td>
</tr>
<tr>
<td>( h )</td>
<td>Calculation Using ( V_{OUT}, I_{IN}, V_{REF}, I_{OUT} )</td>
</tr>
<tr>
<td>( V_{REF} )</td>
<td>Fluke 8000A Multimeter</td>
</tr>
</tbody>
</table>
2.3.2. - 3.2.4.1

**STeady-state Control Signal Gain**

<table>
<thead>
<tr>
<th>C</th>
<th>V&lt;sub&gt;K1&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&lt;sub&gt;Load&lt;/sub&gt; = 3.32Ω</td>
<td></td>
</tr>
</tbody>
</table>

| V<sub>IN</sub> = 9.10 V<sub>dc</sub> |
| I<sub>IN</sub> = 4.28 A<sub>dc</sub> |
| f = 2573 kHz |
| R<sub>Load</sub> = 1.75Ω |

| V<sub>OUT</sub> = 7.11 V<sub>dc</sub> |
| I<sub>OUT</sub> = 2.83 A<sub>dc</sub> |
| P<sub>out</sub> = 250 W |

| Resonant Tank Voltage |
| Resonant Tank Current |

<table>
<thead>
<tr>
<th>C</th>
<th>V&lt;sub&gt;K1&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&lt;sub&gt;Load&lt;/sub&gt; = 3.32Ω</td>
<td></td>
</tr>
</tbody>
</table>

| V<sub>IN</sub> = 9.10 V<sub>dc</sub> |
| I<sub>IN</sub> = 4.28 A<sub>dc</sub> |
| f = 2573 kHz |
| R<sub>Load</sub> = 1.75Ω |

| V<sub>OUT</sub> = 7.11 V<sub>dc</sub> |
| I<sub>OUT</sub> = 2.83 A<sub>dc</sub> |
| P<sub>out</sub> = 400 W |

| Resonant Tank Voltage |
| Resonant Tank Current |

<table>
<thead>
<tr>
<th>C</th>
<th>V&lt;sub&gt;K1&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&lt;sub&gt;Load&lt;/sub&gt; = 3.32Ω</td>
<td></td>
</tr>
</tbody>
</table>

| V<sub>IN</sub> = 9.10 V<sub>dc</sub> |
| I<sub>IN</sub> = 4.28 A<sub>dc</sub> |
| f = 2573 kHz |
| R<sub>Load</sub> = 1.75Ω |

| V<sub>OUT</sub> = 7.11 V<sub>dc</sub> |
| I<sub>OUT</sub> = 2.83 A<sub>dc</sub> |
| P<sub>out</sub> = 479 W |

| Resonant Tank Voltage |
| Resonant Tank Current |

<table>
<thead>
<tr>
<th>C</th>
<th>V&lt;sub&gt;K1&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&lt;sub&gt;Load&lt;/sub&gt; = 3.32Ω</td>
<td></td>
</tr>
</tbody>
</table>

| V<sub>IN</sub> = 9.10 V<sub>dc</sub> |
| I<sub>IN</sub> = 4.28 A<sub>dc</sub> |
| f = 2573 kHz |
| R<sub>Load</sub> = 1.75Ω |

| V<sub>OUT</sub> = 7.11 V<sub>dc</sub> |
| I<sub>OUT</sub> = 2.83 A<sub>dc</sub> |
| P<sub>out</sub> = 104 W |
2.3.2 CONTROL SIGNAL
- 3.2.4.2 STEP RESPONSE

\[ V_{\text{in}} = 10.0 \, V_{\text{DC}} \]
\[ R_{\text{LOAD}} = 3.37 \, \Omega \]

\[ V_{\text{ref}} = 7V \rightarrow 10V \]

**Input Voltage Reference Signal**

**Output Voltage Reference Signal**

**Input Current (Before DC Capacitor) Reference Signal**

**Output Current (Including Filter Current) Reference Signal**

**Resonant Tank Voltage Reference Signal**

**Resonant Tank Current Reference Signal**
### 2.3.2 CONTROL SIGNAL

#### 3.2.4.2 STEP RESPONSE

<table>
<thead>
<tr>
<th>Input Voltage Reference Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Voltage Reference Voltage</td>
</tr>
<tr>
<td>Resonant Tank Voltage Reference Signal</td>
</tr>
</tbody>
</table>

- **Input Voltage Reference Signal**
  - **V_{in}: 7V → 3.9V**

- **Output Voltage Reference Voltage**

- **Resonant Tank Voltage Reference Signal**

- **Input Current (Before DC Capacitor) Reference Signal**

- **Output Current (Including Filter Current) Reference Signal**

**V_{EN} = 90V_{dc}**

**R_{load} = 2372Ω**
2.3.2 CONTROL SIGNAL

- 3.2.4.3 FREQUENCY RESPONSE

\[ V_{\text{ref}} = 7\text{V} + \text{AC signal} \]

\( V_{\text{IN}} = 90\text{V} \)
\( R_{\text{LOAD}} = 3.37\Omega \)
\( 100\text{Hz AC} \)

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 FREQUENCY RESPONSE

V_{IN} = 39.0V_{DC}

2kHz AC

V_{REF} = 7V + AC Signal

Input Voltage Reference Signal

I_{IN}

V_{REF} = 90%

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

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2.34 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 **STEADY-STATE CONTROL SIGNAL GAIN**

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IN}$</td>
<td>Fluke 8000A Multimeter</td>
</tr>
<tr>
<td>$I_{IN}$</td>
<td>Fluke 8000A Multimeter ($V_{shunt}$)</td>
</tr>
<tr>
<td>$V_{ODC}$</td>
<td>Fluke 893A Diff. Voltmeter</td>
</tr>
<tr>
<td>$I_{ODC}$</td>
<td>SRI #900083 Current Meter</td>
</tr>
<tr>
<td>$V_{OBD}$</td>
<td>Triplet 630 Multimeter</td>
</tr>
<tr>
<td>$I_{OBD}$</td>
<td>L&amp;N 5305 Bridge ($P_{load}$)</td>
</tr>
<tr>
<td>$V_{REF,DC}$</td>
<td>Fluke 893A Diff. Voltmeter</td>
</tr>
<tr>
<td>$V_{REF,BD}$</td>
<td>Fluke 893A Diff. Voltmeter</td>
</tr>
</tbody>
</table>
2.3.4 STEADY-STATE CONTROL GAIN

-3.2.4.1

**DC RECEIVER**

<table>
<thead>
<tr>
<th>$V_{\text{Ref}}$ ($V_{dc}$)</th>
<th>$V_{\text{in}}$ ($V_{dc}$)</th>
<th>$I_{\text{in}}$ ($A_c$)</th>
<th>$V_{\text{dc}}$ ($V_{dc}$)</th>
<th>$I_{\text{o}}$ ($A_c$)</th>
<th>$P_{\text{dc}}$ (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5%</td>
<td>3.61</td>
<td>91.5</td>
<td>9.50</td>
<td>14.43</td>
<td>3.75</td>
</tr>
<tr>
<td>-</td>
<td>7.22</td>
<td>91.15</td>
<td>11.15</td>
<td>28.90</td>
<td>7.0</td>
</tr>
<tr>
<td>+50%</td>
<td>9.98</td>
<td>90.7</td>
<td>12.98</td>
<td>38.49</td>
<td>9.35</td>
</tr>
</tbody>
</table>

**BIDIRECTIONAL MODULE**

<table>
<thead>
<tr>
<th>$V_{\text{Ref}}$ ($V_{dc}$)</th>
<th>$V_{\text{in}}$ ($V_{dc}$)</th>
<th>$I_{\text{in}}$ ($A_c$)</th>
<th>$V_{\text{o}}$ ($V_{dc}$)</th>
<th>$I_{\text{o}}$ ($A_c$)</th>
<th>$P_{\text{o}}$ (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5%</td>
<td>0.86</td>
<td>91.4</td>
<td>9.71</td>
<td>54.5</td>
<td>1.10</td>
</tr>
<tr>
<td>-</td>
<td>1.71</td>
<td>91.0</td>
<td>11.18</td>
<td>100</td>
<td>2.01</td>
</tr>
<tr>
<td>+50%</td>
<td>2.57</td>
<td>90.7</td>
<td>12.67</td>
<td>129</td>
<td>2.6</td>
</tr>
</tbody>
</table>
CONTROL SIGNAL FREQUENCY RESPONSE OF AC RECEIVER

INVERTER #1

Resonant Tank Voltage
Resonant Tank Current

INVERTER #2

Resonant Tank Voltage
Resonant Tank Current

Branch Current A

Branch Current B

Branch Current C

Branch Current D
2.3.4 CONTROL SIGNAL FREQUENCY RESPONSE

-3.2.4.3 [Vac: 480 Hz]

<table>
<thead>
<tr>
<th>Input Voltage</th>
<th>Output Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current</td>
<td>Output Current</td>
</tr>
<tr>
<td>(Including Filter Current)</td>
<td></td>
</tr>
<tr>
<td>AC Receiver</td>
<td></td>
</tr>
</tbody>
</table>

ORIGINAL PAGE IS OF POOR QUALITY
CONTROL SIGNAL FREQUENCY RESPONSE

OF A.C. RECEIVER

RESONANT TANK VOLTAGE

RESONANT TANK CURRENT

Branch Current A

Branch Current B

Branch Current C

Branch Current D
2.3.4 CONTROL SIGNAL FREQUENCY
-3.2.4.3 RESPONSE OF AC RECEIVER

\[ V_{\text{ref.}} = 2\text{kHz} \]

\[ V_{\text{in}} = 90\text{V} \]
\[ R_{\text{load}} = 35.3\text{\Omega} \]
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

<table>
<thead>
<tr>
<th>Nominal</th>
<th>Gate Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>$V_{Ref}$</strong></td>
<td>3.600 Vdc</td>
</tr>
<tr>
<td><strong>$V_{IN}$</strong></td>
<td>119.9</td>
</tr>
<tr>
<td><strong>$I_{IN}$</strong></td>
<td>54.9 A</td>
</tr>
<tr>
<td><strong>$V_{OUT}$</strong></td>
<td>2732</td>
</tr>
<tr>
<td><strong>$I_{OUT}$</strong></td>
<td>25.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>-50%</th>
<th>+50%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>$V_{Ref}$</strong></td>
<td>1.820</td>
</tr>
<tr>
<td><strong>$V_{IN}$</strong></td>
<td>120.4 V</td>
</tr>
<tr>
<td><strong>$I_{IN}$</strong></td>
<td>52.07</td>
</tr>
<tr>
<td><strong>$V_{OUT}$</strong></td>
<td>13.91</td>
</tr>
<tr>
<td><strong>$I_{OUT}$</strong></td>
<td>12.9 A</td>
</tr>
<tr>
<td><strong>$V_{Ref}$</strong></td>
<td>4.515</td>
</tr>
<tr>
<td><strong>$V_{IN}$</strong></td>
<td>120.5</td>
</tr>
<tr>
<td><strong>$I_{IN}$</strong></td>
<td>55.21</td>
</tr>
<tr>
<td><strong>$V_{OUT}$</strong></td>
<td>28.48</td>
</tr>
<tr>
<td><strong>$I_{OUT}$</strong></td>
<td>27.00</td>
</tr>
</tbody>
</table>

| **$V_{Ref.}$** | 2.656 V |
| **$V_{IN}$** | 120.4 V |
| **$I_{IN}$** | 52.5 |
| **$V_{OUT}$** | 20.88 V |
| **$I_{OUT}$** | 19 A |
| **$V_{Ref.}$** | 5.408 V |
| **$V_{IN}$** | 120.1 |
| **$I_{IN}$** | 54.96 |
| **$V_{OUT}$** | 28.64 |
| **$I_{OUT}$** | 26.5 A |
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)

Configuration - Test 23.6 - 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**

**SPECIFIC CASE** BD MODULE

<table>
<thead>
<tr>
<th>Nominal Gate Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{\text{Ref}}$</td>
</tr>
<tr>
<td>$V_{\text{IN}}$</td>
</tr>
<tr>
<td>$I_{\text{IN}}$</td>
</tr>
<tr>
<td>$V_{\text{OUT}}$</td>
</tr>
<tr>
<td>$I_{\text{OUT}}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>-50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{\text{Ref}}$</td>
</tr>
<tr>
<td>$V_{\text{IN}}$</td>
</tr>
<tr>
<td>$I_{\text{IN}}$</td>
</tr>
<tr>
<td>$V_{\text{OUT}}$</td>
</tr>
<tr>
<td>$I_{\text{OUT}}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>+50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{\text{Ref}}$</td>
</tr>
<tr>
<td>$V_{\text{IN}}$</td>
</tr>
<tr>
<td>$I_{\text{IN}}$</td>
</tr>
<tr>
<td>$V_{\text{OUT}}$</td>
</tr>
<tr>
<td>$I_{\text{OUT}}$</td>
</tr>
</tbody>
</table>

| V_{\text{Ref}} | 2.118 | 1.8 |
| V_{\text{IN}} | 120.4 | 120.1 |
| I_{\text{IN}} | 4.83 | 4.1 |
| V_{\text{OUT}} | 60.14 | 51.5 |
| I_{\text{OUT}} | 6.3 | 5.6 |

| V_{\text{Ref}} | 4.938 | 5.4 |
| V_{\text{IN}} | 118.6 | 119.4 |
| I_{\text{IN}} | 50.57 | 50.94 |
| V_{\text{OUT}} | 123.75 | 117.2 |
| I_{\text{OUT}} | 9.5 | 9.2 |
2.3.6-3.2.4.1 STEADY-STATE

CONTROL SIGNAL GAIN

SPECIFIC CASE AC RCVR

\[ f = 20.215 \text{ kHz} \]

Nominal Gate Signal

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{\text{Ref}} )</td>
<td>1.387 V</td>
</tr>
<tr>
<td>( V_{\text{IN}} )</td>
<td>120.64 V</td>
</tr>
<tr>
<td>( I_{\text{IN}} )</td>
<td>53.78 A</td>
</tr>
<tr>
<td>( V_{\text{OUT}} )</td>
<td>120.6 V</td>
</tr>
<tr>
<td>( I_{\text{OUT}} )</td>
<td>2.83 A</td>
</tr>
</tbody>
</table>

\(-50\%\) \hspace{1cm} \(+50\%\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{\text{Ref}} )</td>
<td>0.692 V</td>
<td>( V_{\text{Ref}} )</td>
<td>2.07 V</td>
</tr>
<tr>
<td>( V_{\text{IN}} )</td>
<td>120.2 V</td>
<td>( V_{\text{IN}} )</td>
<td>119.8 V</td>
</tr>
<tr>
<td>( I_{\text{IN}} )</td>
<td>52.69 A</td>
<td>( I_{\text{IN}} )</td>
<td>54.54 A</td>
</tr>
<tr>
<td>( V_{\text{OUT}} )</td>
<td>91.9 V</td>
<td>( V_{\text{OUT}} )</td>
<td>135.8 V</td>
</tr>
<tr>
<td>( I_{\text{OUT}} )</td>
<td>2.33 A</td>
<td>( I_{\text{OUT}} )</td>
<td>2.97 A</td>
</tr>
</tbody>
</table>
### 2.3.6-3.2.4.1 STEADY-STATE

**CONTROL SIGNAL GAIN**

**SPECIFIC CASE** AC RCVR

---

Nominal Gate Signal

\( f = 20,188 \, \text{kHz} \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{\text{Ref}} )</td>
<td>1.358 V</td>
</tr>
<tr>
<td>( V_{\text{EN}} )</td>
<td>119.9 V</td>
</tr>
<tr>
<td>( I_{\text{IN}} )</td>
<td>53.49 A</td>
</tr>
<tr>
<td>( V_{\text{OUT}} )</td>
<td>117.8 V</td>
</tr>
<tr>
<td>( I_{\text{OUT}} )</td>
<td>2.83 A</td>
</tr>
</tbody>
</table>

\(-50\%\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{\text{Ref}} )</td>
<td>0.676 V</td>
</tr>
<tr>
<td>( V_{\text{EN}} )</td>
<td>120.0 V</td>
</tr>
<tr>
<td>( I_{\text{IN}} )</td>
<td>52.58 A</td>
</tr>
<tr>
<td>( V_{\text{OUT}} )</td>
<td>91.3 V</td>
</tr>
<tr>
<td>( I_{\text{OUT}} )</td>
<td>2.47 A</td>
</tr>
</tbody>
</table>

\(+50\%\)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{\text{Ref}} )</td>
<td>2.03 V</td>
</tr>
<tr>
<td>( V_{\text{EN}} )</td>
<td>119.7 V</td>
</tr>
<tr>
<td>( I_{\text{IN}} )</td>
<td>54.21 A</td>
</tr>
<tr>
<td>( V_{\text{OUT}} )</td>
<td>132.4 V</td>
</tr>
<tr>
<td>( I_{\text{OUT}} )</td>
<td>4.3 A</td>
</tr>
</tbody>
</table>

---
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: 236-3.2.4.2  Control Sig. Step Response

Specific Case: DC Receiver

- Input Voltage: 120.4 Vdc
- Input Current: ~43 A
- System Frequency: 20.237 kHz
- Output Power: 3410 W ↔ 4160 W

---

Input Voltage
Reference Voltage Scale: 20A/

I_{DC}

Reference Voltage Scale: 10A/

DC Rcvr Output Current
4 Reference Voltage Scale: 10A/

---

Output Power: 3410 W ↔ 4160 W

AC Rcvr: 14V ↔ 29V, 240W ↔ 990

AC Rcvr: 120V, 410W

BD Module: 99.8V, 780W

Other: f1 = 1230W, f2 = 750W, f3 = 0W

---

Scale: 0A/5V 500mV

Scale: 10V 50mV 500mV
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.
### Test-Configuration: 23.6-3.24.2 CTRL SIGNAL STEP RESP.

<table>
<thead>
<tr>
<th>Specific Case:</th>
<th>Bidirectional Module</th>
</tr>
</thead>
</table>

| Input Voltage:   | 120.0 V             |
| Input Current:   | 41.9 A ↔ 50.94 A    |
| System Frequency:| 20.16 kHz           |
| Output Power:    | 4500 W ↔ 3000 W     |

| DC Recvr: 27.6 V, 830 W |
| AC Recvr: 120Vrms, 400 W |
| BD Module: 51.5 V ↔ 117.2 |

**Other:** δ₁ = 1230W, δ₃ = 750W, δ₅ = 1060W

---

**Reference Voltage**

**Input V + I**

**Scale:** 10A/

---

**Reference Voltage**

**Input V + I**

**Scale:** 2A/

---

**Photo**

**Photo**

---

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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.
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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>120.0 V</td>
</tr>
<tr>
<td>Input Current</td>
<td>54.1 A</td>
</tr>
<tr>
<td>System Frequency</td>
<td>70.16</td>
</tr>
<tr>
<td>Output Power</td>
<td>5000 W</td>
</tr>
<tr>
<td>DC Receiver Power</td>
<td>830 W</td>
</tr>
<tr>
<td>AC Receiver Power</td>
<td>120 V, 400 W</td>
</tr>
<tr>
<td>BD Module Power</td>
<td>99.8 V, 780 W</td>
</tr>
<tr>
<td>Other Power</td>
<td>0.2 = 1230 W, \phi = 750 W, \phi = 1010 W</td>
</tr>
</tbody>
</table>

![DC Receiver Output Voltage and Current](image1)
![DC Receiver Output Voltage and Reference Voltage Scale](image2)

DC RECEIVER: Output Voltage, Current and Reference Voltage Scale:

![DC Receiver Output Voltage and Current](image3)

DC RECEIVER: Output Voltage, Current and Reference Voltage Scale:

Photo

Scale:
Configuration - Test 2.3.6-3.24.3 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: 2.3.6-32.4.3 CTRL SIG. FREQ RESP.
Specific Case: Bidirectional Module

Input Voltage: 120.0 V
Input Current: 54.1 A
System Frequency: 20.16 kHz
Output Power: 5000 W

DC Rcvr: 27.6 V / 830 W
AC Rcvr: 120 V / 400 W
BD Module: 780 W
Other: \( P_{in} = 1230 \) W, \( P_{out} = 750 \) W, \( P_{c} = 1010 \) W

Input Voltage & Current Reference Voltage Scale:
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**

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>23.6-324.3 CTRL. SIG. FREQ. RESPONSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>Bidirectional Module</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>Same</td>
</tr>
<tr>
<td>Input Current:</td>
<td></td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scale:</th>
<th>100Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage &amp; Current Reference Voltage Scale:</td>
<td>10A/</td>
</tr>
<tr>
<td>Output Voltage &amp; Current Reference Voltage Scale:</td>
<td>2A/</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scale:</th>
<th>1kHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage &amp; Current Reference Voltage Scale:</td>
<td>10A/</td>
</tr>
<tr>
<td>Output Voltage &amp; Current Reference Voltage Scale:</td>
<td>2A/</td>
</tr>
</tbody>
</table>

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Configuration - Test 23.6-32.43 CONTROL SIGNAL  
FREQUENCY RESPONSE - AC RECEIVER

Test Circuits

AC Receiver Output Voltage

Reference Signal

40 kHz Synchronized to the Trans. Line
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
Input Current: 54.1 A
System Frequency: 20.16 kHz
Output Power: 5000 W

DC Rcvr: 27.6 V/830 W
AC Rcvr: 120V/400 W
BD Module: 99.8/780W
Other: $P_1=1330W$, $P_2=750W$, $P_3=1010W$

Input Voltage & Current Scale: 10 A
Output Voltage & Current Scale: 1 A

Input Voltage & Current Scale: 10 A
Output Voltage & Current Scale: 5 V/S

AC Rcvr

10 Hz

60 Hz

10 Hz

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

Specific Case: AC Receiver

Input Voltage: Same

Input Current: AC Rcvr:

System Frequency: BD Module:

Output Power: Other:

Input Voltage & Current Scale: 10A/

Output Voltage & Current Scale: 1A/

Input Voltage & Current Scale: 1000U/

Output Voltage & Current Scale: 1A/

Input Voltage & Current Scale: 1000U/

Output Voltage & Current Scale: 1A/
2.3.1
-3.2.5

POWER SUPPLY
SENSITIVITY

\[ V_1 \]
\[ V_2 \]

Relay 1
Relay 2

INVERTER
LOAD

200 ms
Delay

Scope
Trigger

Relay 1
Relay 2

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### Steady-State Power Supply Sensitivity

<table>
<thead>
<tr>
<th>$V_{IN}$ (Vdc)</th>
<th>$I_{IN}$ (Aoc)</th>
<th>$V_{KL}$ (VRMS)</th>
<th>$I_{out}$ (ARMS)</th>
<th>$f$ (kHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>69.6</td>
<td>10.20</td>
<td>93.0</td>
<td>6.9</td>
<td>20.0</td>
</tr>
<tr>
<td>87.0</td>
<td>12.76</td>
<td>117.0</td>
<td>8.6</td>
<td>20.0</td>
</tr>
<tr>
<td>104.4</td>
<td>15.24</td>
<td>140.6</td>
<td>10.2</td>
<td>20.0</td>
</tr>
</tbody>
</table>
23.1

POWER SUPPLY

STEP RESPONSE

$P = 10 \text{ W}$

$R_{\text{Load}} = 13.6 \Omega$

$f = 20.0 \text{ kHz}$

$V_{\text{IN}}: 87.0 \text{ V } \rightarrow 69.6 \text{ V}$

$V_{\text{OUT}}: 87.0 \text{ V } \rightarrow 104.4 \text{ V}_{\text{DC}}$

$V_{\text{IN}}: 87.0 \text{ V } \rightarrow 69.6 \text{ V}_{\text{DC}}$

$V_{\text{OUT}}: 87.0 \text{ V } \rightarrow 104.4 \text{ V}_{\text{DC}}$

$V_{\text{IN}}: 87.0 \text{ V } \rightarrow 69.6 \text{ V}_{\text{DC}}$

$V_{\text{OUT}}: 87.0 \text{ V } \rightarrow 104.4 \text{ V}_{\text{DC}}$
2.3.2 - 3.2.5 POWER SUPPLY SENSITIVITY

![Diagram of power supply and sensitivity circuit]

200 ms Delay → Scope Trigger
### Steady-State Power Supply Sensitivity

<table>
<thead>
<tr>
<th>Parameter</th>
<th>$-20%$</th>
<th></th>
<th></th>
<th>$+20%$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IN}$</td>
<td>72.0 V\text{dc}</td>
<td>87.0 V\text{dc}</td>
<td>104.4 V\text{dc}</td>
<td></td>
</tr>
<tr>
<td>$I_{IN}$</td>
<td>6.33 A\text{dc}</td>
<td>7.60 A\text{dc}</td>
<td>7.84 A\text{dc}</td>
<td></td>
</tr>
<tr>
<td>$V_{DC}$</td>
<td>21.5 V\text{dc}</td>
<td>26.3 V\text{dc}</td>
<td>28.9 V\text{dc}</td>
<td></td>
</tr>
<tr>
<td>$I_{DC}$</td>
<td>13.4 A\text{dc}</td>
<td>16.4 A\text{dc}</td>
<td>17.8 A\text{dc}</td>
<td></td>
</tr>
<tr>
<td>$f$</td>
<td>20.725 kHz</td>
<td>20.726 kHz</td>
<td>20.726 kHz</td>
<td></td>
</tr>
<tr>
<td>$\eta$</td>
<td>63.2%</td>
<td>65.2%</td>
<td>62.8%</td>
<td></td>
</tr>
</tbody>
</table>

Resonant Tank Voltage at $V_{EN} = 72.0V_{DC}$ and $V_{EN} = 87.0V_{DC}$

Resonant Tank Voltage at $V_{IN} = 87.0V_{DC}$ and $V_{EN} = 104.4V_{DC}$
2.3.2 POWER SUPPLY
-3.2.5.2 STEP RESPONSE

Input Voltage
Input Current
(Before DC Capacitor)
\[ V_{IN}: \text{87.0V} \rightarrow \text{72.0V} \]

Output Voltage
Output Current
(Including Filter Current)
\[ V_{IN}: \text{87.0V} \rightarrow \text{72.0V} \]

Resonant Tank Voltage
Input Voltage
\[ V_{IN}: \text{87.0V} \rightarrow \text{720V} \]

\[ R_{LOAD} = 1.6\Omega \]
2.3.4 Power Supply Sensitivity

- 3.2.5

Diagram of power supply system with relays and inverters.
### Power Supply Sensitivity

#### Steady-State

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IN}$</td>
<td>Fluke 8000A Multimeter</td>
</tr>
<tr>
<td>$I_{IN} = \frac{V_{IN}}{R_{SHUNT}}$</td>
<td>Fluke 8000A Multimeter ($V_{SHUNT}$)</td>
</tr>
<tr>
<td>$V_{OCC}$</td>
<td>Fluke 893A Diff. Ultrimeter</td>
</tr>
<tr>
<td>$I_{OCC}$</td>
<td>SRI 9000A3 Current Meter</td>
</tr>
<tr>
<td>$V_{OBD}$</td>
<td>Triplett 630 Multimeter</td>
</tr>
<tr>
<td>$I_{OBD} = \frac{V_{OBD}}{R_{LOAD}}$</td>
<td>L&amp;N 5305 Bridge ($R_{LOAD}$)</td>
</tr>
<tr>
<td>$V_{OAC}$</td>
<td>Tektronix 7034 Oscilloscope</td>
</tr>
<tr>
<td>$I_{OAC} = \frac{V_{OAC}}{R_{LOAD}}$</td>
<td>L&amp;N 5305 Bridge ($R_{LOAD}$)</td>
</tr>
</tbody>
</table>

Calculations from above measurements.
### 2.3.4

#### 3.25.1

**STEADY-STATE POWER SUPPLY SENSITIVITY**

<table>
<thead>
<tr>
<th>INPUT</th>
<th>DC RECEIVER</th>
<th>BD MODULE</th>
<th>AC RECEIVER</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IN}(N_{dc})$</td>
<td>$I_{IN}(A_{dc})$</td>
<td>$P_{IN}(W)$</td>
<td>$V_{IN}(N_{dc})$</td>
</tr>
<tr>
<td>68.2</td>
<td>10.28</td>
<td>70.1</td>
<td>26.39</td>
</tr>
<tr>
<td>85.4</td>
<td>11.02</td>
<td>94.1</td>
<td>28.86</td>
</tr>
<tr>
<td>102.3</td>
<td>11.47</td>
<td>119.0</td>
<td>28.95</td>
</tr>
</tbody>
</table>

$R_{Load}$: 4.06Ω  
$R_{Load}$: 49.7Ω  
$R_{Load}$: 35.3Ω
2.3.4 STEP RESPONSE

\[ V_{IN}: 85V \rightarrow 68V \]

<table>
<thead>
<tr>
<th>INVERTER #1</th>
<th>INVERTER #2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>( V_{K1} )</strong></td>
<td><strong>( V_{K2} )</strong></td>
</tr>
<tr>
<td>0V</td>
<td>0V</td>
</tr>
</tbody>
</table>

Resonant Tank Voltage

<table>
<thead>
<tr>
<th><strong>( I_{K1} )</strong></th>
<th><strong>( I_{K2} )</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>0A</td>
<td>0A</td>
</tr>
</tbody>
</table>

Resonant Tank Current

<table>
<thead>
<tr>
<th><strong>( I_A )</strong> (10A/Div)</th>
<th><strong>( I_C )</strong> (10A/Div)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Branch Current A

Branch Current C

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2.3.4  STEP RESPONSE

-3.2.5.2  \( V_{IN}: 9.5V \rightarrow 68V \)

Inverter #1

Branch Current B

Inverter #2

Branch Current D

Input Current
Input Voltage
2.34 STEP RESPONSE

-3.25.2 \[ V_{IN}: 85V \rightarrow 68V \]

(c) \[ V_{OAC} \]

Output Voltage
AC Receiver

I_{OAC}

Output Current (Including Filter Current)
AC Receiver

(c) \[ V_{OBD} \]

Output Voltage
Output Current (Including Filter Current)
BD Module

(c) \[ V_{OBC} \]

Output Voltage
Output Current (Including Filter Current)
DC Receiver
2.3.4  
STEP RESPONSE  
-3.2.5.2  
\[ V_{in}: 85V \rightarrow 102V \]

INVERTER #1

\( V_{in1} \)

Resonant Tank Voltage

INVERTER #2

\( V_{in2} \)

Resonant Tank Voltage

\( I_{in1} \)  
Resonant Tank Current

\( I_{in2} \)  
Resonant Tank Current

\( I_{in} \)  
Branch Current A

\( I_{in} \)  
Branch Current C
2.3.4  
STEP RESPONSE  
-3.2.5.2  
VIN: 85V - 102V

Branch Current B  
Inverter #1

Branch Current D  
Inverter #2

Input Voltage  
Input Current

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2.3.4 Step Response

$V_{in}$: 85V → 102V

Output Voltage
AC Receiver

Output Current (Including Filter Current)
AC Receiver

Output Voltage
Output Current (Including Filter Current)
BD Module

Output Voltage
Output Current (Including Filter Current)
DC Receiver
Configuration - Test 2.36 - 3.2.5 POWER SUPPLY

SENSITIVITY

Steady-State and Transient Response

Test Circuits
Test-Configuration: 3.25.1.5.1 S.S. Power Supply Sens.

Specific Case: 80V in, Full Load

Input Voltage: 80.0 Vdc

Input Current: 40.9 Adc

System Frequency:

Output Power: 2.451 W

Other: $\phi_2 = 706 W; \phi_1 = 317 W; \phi_3 = 467 W$

**Graphs:**

- **INV. 1**
  - THD = 21.4 dB
  - Line V & Tank I
  - Scale: 10A/

- **INV. 2**
  - THD = 20.0 dB
  - Tank I & Line V
  - Scale: 10A/

- **Output I & Line V**
  - Scale: 10A/
## RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
### TEST PROGRAM (NAS3-22777)
### TRANSIENT TEST DATA SHEET

**Test-Configuration:** 2.36-3.251 S.S. POWER SUPPLY SENS.

<table>
<thead>
<tr>
<th>Specific Case:</th>
<th>( V_m = 80 ), Full Load</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input Voltage:</strong></td>
<td>Same</td>
</tr>
<tr>
<td><strong>Input Current:</strong></td>
<td>DC Rcvr:</td>
</tr>
<tr>
<td><strong>System Frequency:</strong></td>
<td>AC Rcvr:</td>
</tr>
<tr>
<td><strong>Output Power:</strong></td>
<td>BD Module:</td>
</tr>
<tr>
<td></td>
<td>Other:</td>
</tr>
</tbody>
</table>

### Photos

**Line V & Tank I**
- Scale: 10A/

**Line V & Output I**
- Scale: 10A/

**Input V+I**
- Scale: 10A/

**THD = 2.8 dB** on the line

**Photo**
I) **Input Power**

- **Vin**: 80
- **Iin**: 0.8
- **Pin**: 3264

---

2.3.6-3.2.5.1 **Steady-State Power Supply Sensitivity**

(1.5μF, Full Load)

80V

---

II) **Output Power**

- **AC Rect.**
  - **Vout**: 79.14
  - **Iout**: 2.50
  - **P**: 198

- **DC Rect.**
  - **Vout**: 12.3
  - **Iout**: 18.0
  - **P**: 310

- **B/D Rect.**
  - **Vout**: 71.0
  - **Iout**: 63.8
  - **P**: 453

---

**Toaster Loads**

1) **INV#1**

- **Vout**: 52.5
- **Iout**: 184.5
- **P**: 706

2) **INV#2**

- **Vout**: 50.3
- **Iout**: 63.1
- **P**: 317

3) **INV#3**

- **Vout**: 56.3
- **Iout**: 91.1
- **P**: 467

\[\frac{2451}{3264} = 75.1\%\]
I) Input Power

\[ V_{in} \text{ LDD} = 110 \text{ V} \]
\[ V_{in} \text{ SEL} = 56 \text{ V} \]
\[ P_{in} = 5080 \text{ W} \]

Power Supply Sensitivity

\[ 100 \text{ V} \]

(1.5 \mu F, Full Load)

II Output Power

AC RCLR
\[ V_{out} LDR = 105 \text{ V} \]
\[ I_{out} = 2.88 \text{ A} \]
\[ P = 308.8 \text{ W} \]

DC RCLR
\[ V_{out} = 22 \text{ V} \]
\[ I_{out} = 2.15 \text{ A} \]
\[ P = 522 \text{ W} \]

B/D RCLR
\[ V_{out} = 94.5 \text{ V} \]
\[ I_{out} = 3.46 \text{ A} \]
\[ P = 701 \text{ W} \]

Toaster Loads

\[ INV#1 \]
\[ V_{out} = 66.6 \text{ V} \]
\[ I_{out} = 1715 \text{ W} \]
\[ P = 1142 \text{ W} \]

\[ INV#2 \]
\[ V_{out} = 64.7 \text{ V} \]
\[ I_{out} = 81.1 \text{ W} \]
\[ P = 525 \text{ W} \]

\[ INV#3 \]
\[ V_{out} = 44.3 \text{ V} \]
\[ I_{out} = 1144 \text{ W} \]
\[ P = 736 \text{ W} \]

\[ \frac{P_{out}}{P_{in}} = \frac{3928}{5080} = 77.3\% \]
**I) INPUT POWER**

<table>
<thead>
<tr>
<th>VN</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>In0</td>
<td>523</td>
</tr>
<tr>
<td>P, in</td>
<td>6876</td>
</tr>
</tbody>
</table>

2.36-3.25, STEADY-STATE

POWER SUPPLY SENSITIVITY

(1.5 μF, Full Load)

<table>
<thead>
<tr>
<th>THD</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>INV#1</td>
<td>db</td>
</tr>
<tr>
<td>INV#2</td>
<td>db</td>
</tr>
<tr>
<td>INV#3</td>
<td>db</td>
</tr>
</tbody>
</table>

**THD - TRANSMISSION LINE**

<table>
<thead>
<tr>
<th>INTO THE LINE</th>
<th>OUT OF THE LINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>INV#1</td>
<td>db</td>
</tr>
<tr>
<td>INV#2</td>
<td>db</td>
</tr>
<tr>
<td>INV#3</td>
<td>db</td>
</tr>
</tbody>
</table>

**II) OUTPUT POWER**

**A.C. RCVR**

<table>
<thead>
<tr>
<th>Vout</th>
<th>120.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iout</td>
<td>3.20</td>
</tr>
<tr>
<td>P</td>
<td>386</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>THD</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>INTO THE RCVR</td>
<td>db</td>
</tr>
<tr>
<td>OUT OF THE RCVR</td>
<td>db</td>
</tr>
</tbody>
</table>

**DC. RCVR**

<table>
<thead>
<tr>
<th>Vout</th>
<th>9.97</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iout</td>
<td>2.73</td>
</tr>
<tr>
<td>P</td>
<td>274</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>THD</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>INTO THE RCVR</td>
<td>db</td>
</tr>
</tbody>
</table>

**B/D RCVR**

<table>
<thead>
<tr>
<th>Vout</th>
<th>2.4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iout</td>
<td>0.7</td>
</tr>
<tr>
<td>P</td>
<td>6.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>THD</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>INTO THE RCVR</td>
<td>db</td>
</tr>
</tbody>
</table>

**TOTAL**

| 5365| 78.0% |

**CAPACITORS**

| 6876 μF |

C.5

389
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.36 - 3.25 Power Supply Step Response
Specific Case: 100V → 80V, Full Load
Input Voltage: 100V → 80V
Input Current: 50.8 → 40.8A
System Frequency: 20.17 kHz
Output Power: 3728 → 2.451 W

DC Rcvr: 22.2 → 17.3 Vdc
AC Rcvr: 79.4 → 71.0 Vrms
BD Module: 94.0 → 71.0 Vdc

Input V+I scale: 20A/
Input V+I scale: 20A/
DC Rcvr: 100 → 80V
Output V+I scale: 5A/
Output V+I scale: 5A/
Resonant AC Power System Proof-of-Concept

Test Program (NAS3-22777)

Transient Test Data Sheet

Test-Configuration: 2.3.6-3.2.5.2 Power Supply Step Response

Specific Case: 100V → 80V, Full Load

Input Voltage: Same

Input Current: DC Recvr:

System Frequency:

Output Power: AC Recvr:

BO Module:

Other:

![Graphs showing voltage and current responses](image-url)
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.36-3.25.2 POWER SUPPLY STEP RESPONSE

<table>
<thead>
<tr>
<th>Test-Configuration</th>
<th>Power Supply Step Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>100V → 80V, Full Load</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>Same</td>
</tr>
<tr>
<td>Input Current:</td>
<td>AC Rcvr:</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>BD Module:</td>
</tr>
<tr>
<td>Output Power:</td>
<td>Other:</td>
</tr>
</tbody>
</table>

![Graphs showing AC Rcvr 100V → 80V](image)

Output Voltage Scale: 1V/div

Output Current Scale: 1A/div

![Photo](image)
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 236-3252 Power Supply Step Response

Specific Case: 100 V → 120 V

Input Voltage: 100.0 → 120.0 Vdc
Input Current: 50.8 → 57.3 Adc
System Frequency:
Output Power: 3928 → 5,365 W

Input V+I Scale: 20 A/

Input V+I Scale: 20 A/

DC Rcvr: 22.2 → 26.0 Vdc
AC Rcvr: 105.0 → 120.5 Vdc
BD Module: 94.0 → 99.7 Vdc

Other:

Input V+I Scale: 5 A/

Output V+I Scale: 7 A/
### Test-Configuration:

**Specific Case:** 236-3.25.2 Power Supply Step Response

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>Power Supply Step Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>100V → 120V Full Load</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>Same</td>
</tr>
<tr>
<td>Input Current:</td>
<td>BD Hmodule:</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>Other:</td>
</tr>
<tr>
<td>Output Power:</td>
<td></td>
</tr>
</tbody>
</table>

---

**AC Receiver**

![AC Receiver Waveform](image1)

**Output Voltage Scale:**

![Voltage Scale](image2)

**Output Current Scale:** 1A

---

**AC Receiver**

![AC Receiver Waveform](image3)

**Output Current Scale:**

![Current Scale](image4)

---

**Photo**

![Photo](image5)

---

**Photo**

![Photo](image6)
2.3.1  POWER TURN OFF

- 3.2.6

Diagram:

- POWER SUPPLIES
- Relay
- INVERTER
- LOAD

200 ms Delay

Power Switch

Scope Trigger

Power Relay

de-energized

395
2.3.1

-3.2.6

NO LOAD

$V_{IN} = 87.0\text{VDC}$

$P_{out} = 0\text{W}$

**Input Voltage**

**Input Current** (Before DC Capacitor)

**Input Current** (After DC Capacitor)

**Output Voltage**

$V_{KI}$

$0$
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 10% LOAD

$V_{IN} = 87.0V$
$R_{load} = 117.5Q$
$P_{out} = 130W$

Input Voltage

Input Current (Before DC Capacitor)

Input Current (After DC Capacitor)

Branch Current IA

Output Voltage

Output Current
2.3.1
- 3.2.6 FULL LOAD

Input Voltage

Input Current
(Before DC Capacitor)

Input Current
(After DC Capacitor)

Branch Current 1A

Output Voltage

Output Current

V_{IN} = 87.0 V_{DC}
R_{load} = 12.3 \Omega
P_{out} = 1140 W
2.3.2 POWER TURN OFF

![Diagram of power supply and inverter circuit]

200ms Delay

Scope Trigger

Power Relay Coil De-energized

Power Switch
2.3.2 - 3.26 No Load

\[ V_{IN} = 90.2 \, V_{DC} \]
\[ P_{out} = 0 \, W \]

Input Voltage
Input Current
(Before DC Capacitor)

Output Voltage
Output Current
(Including Filter Current)

Branch Current 1A

Branch Current 1B
\[ V_{IN} = 90.1 \ V_{DC} \]
\[ R_{Load} = 23.4 \Omega \]
\[ P_{Out} = 34 \text{W} \]
2.3.2 -3.2.6 50% LOAD

\[ V_{IN} = 90.0 \ V_{oc} \]
\[ R_{load} = 4.28 \ \Omega \]
\[ P_{out} = 180 \ W \]

Input Voltage
Input Current
(Before DC Capacitor)

Output Voltage
Output Current
(Including Filter Current)

Branch Current IA

Branch Current IB
2.3.2 Full Load

Input Voltage
Input Current
(Before DC Capacitor)

Output Voltage
Output Current
(Including Filter Capacitor)

\( V_{IN} = 90.0 \text{Vdc} \)
\( R_{load} = 1.76 \Omega \)
\( P_{out} = 410 \text{W} \)
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

Output Voltage
AC Receiver

Output Current
(Including Filter Current)
AC Receiver

V_{BO}

I_{BOC} \%

Output Voltage
Output Current
(Including Filter Current)
BD Module

V_{DC}

I_{DEC} \%

Output Voltage
Output Current
(Including Filter Current)
DC Receiver

ORIGINAL PAGE IS OF POOR QUALITY
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)

Configuration - Test 2.3.6-3.2.6 POWER TURN OFF

Test Circuits

- Scope Trigger
- +15V
- \( t_0 \)
- \( t_{on} \)
- Delay \( D_2 \) → Logic Circuit Turn Off
- Relay Delay \( D_2 \) → Relay Open
- \( D_1 > D_2 \)
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
Input Current: 9.35A dc → 0
System Frequency: 20.17 kHz
Output Power: 0 W

DC Rcvr: 28.4 Vdc / 0 W
AC Rcvr: OFF / 0 W
BD Module: 194.79 Vdc / 0 W
Other: 0 W

Input V & I Scale: 2A/

Photo

Photo

Photo
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 23.6 - 3.22 POWER TURN OFF
Specific Case: No Load
Input Voltage: Same
Input Current:
System Frequency:
Output Power:

DC Rect:
AC Rect:
BD Module:
Other:

IN1

10V
20µS

IN2

10V
20µS

IN3

10V
20µS

IN4

10V
20µS
**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**

<table>
<thead>
<tr>
<th>Specific Case</th>
<th>DC Rcvr: 28.35 Vdc</th>
<th>830 W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage: 120.0 Vdc</td>
<td>AC Rcvr: 110 Vrms</td>
<td>360 W</td>
</tr>
<tr>
<td>Input Current: 27.57 A, 0</td>
<td>BD Module: 100.2 Vdc</td>
<td>950 W</td>
</tr>
<tr>
<td>System Frequency: 20.17 kHz</td>
<td>Other: 0 W</td>
<td></td>
</tr>
</tbody>
</table>

**Output Power:** 2140 W

![Waveform Graphs]

- **V_L1** Scale: VTS
- **V_L2** Scale: VTS
- **V_L3** Scale: VTS
- **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
Input Current: 53.88 A
System Frequency: 20.17 kHz
Output Power: 5,120 W

DC Recvr: 27.3 Vdc / 790 W
AC Recvr: 95.5 Vrms / 250 W
BD Module: 99.8 Vdc / 850 W
Other: \( P_L = 1270 \text{W}, \, P_L = 830 \text{W}, \, P_L = 1130 \text{W} \)

![Graphs showing voltage and current waveforms](image-url)
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: AC Rcvr:
System Frequency: BD Module:
Output Power: Other:

[Diagrams showing various measurements such as Ibd, Vbd, OA, Ld, R, and Vdc, with scales for each diagram.]
Test-Configuration: 2.36-3.26 Power TURN OFF
Specific Case: 60% & Full Load

Input Voltage: Same
Input Current: No AC Recvr.
System Frequency: BD Module:
Output Power: Other:

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 20kVA, 415 volt loads.
Configuration - Test 2.3.6 - 3.2.7 Power Factor

0.7 Lagging, Full Load

\[(1.5 \times F_2, V_{in} = 50 V_{dc})\]

Test Circuits
23.6 - 3.2.7 Power Factor Testing

Specific Case: 0.7 LAGGING
(1.5x F, Full Load)

<table>
<thead>
<tr>
<th>Input Power</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{IN} )</td>
<td>50.0 Vdc</td>
<td>50.0</td>
</tr>
<tr>
<td>( I_{IN} )</td>
<td>5.09 Adc</td>
<td>4.83</td>
</tr>
<tr>
<td>( P_{IN} )</td>
<td>255 W</td>
<td>242</td>
</tr>
</tbody>
</table>

Output Power (Resistive Loads)

| \( V_{out} \) | 22.14 | 19.8 | 21.4 |
| \( I_{out} \) | 8.87 | 9.42 | 9.33 |
| \( P_{out} \) | 196 | 187 | 200 |

\( \eta_1 \) 76.9% \( \eta_2 \) 77.3% \( \eta_3 \) 75.5% \( \eta_{Total} \) 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.
Test-Configuration: 2.36 - 3.27 \text{ Power Factor} 
Specific Case: 0.7 lagging \((V_{in}=50V, C=1.5\mu F)\) 
Input Voltage: \text{Same} 
Input Current: \text{BD Module} 
System Frequency: \text{DC Rcvr:} 
Output Power: \text{AC Rcvr:} 

- \(\text{INV. } 1\) 
  \(V_1\) 
  \(I_1\) 
  \(I_{12}\) 

- \(\text{INV. } 2\) 
  \(V_{12}\) 
  \(I_{12}\) 

\(\text{LINE Voltage} \quad \text{NTS} \quad \text{LINE CURRENT} \quad \text{Scale: 1A/Div}\) 
\(\text{IA} \quad \text{Scale: 5A/Div}\)
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 23.6-3.2.7 Power Factor
Specific Case: 0.7 Lagging, Inverter 3, Full Load
Input Voltage: Same
Input Current: 
System Frequency: 
Output Power: 

DC Rcvr: 
AC Rcvr: 
BD Module: 
Other: 

Line Voltage
Line Current
Scale: 10V/Div

IG
Scale: 5A/Div

Photo

419
Configuration - Test 2.3.6-3.2.7 POWER FACTOR

Nominal \(1.5 \mu F, V_{IN} = 500 Vdc\)

Test Circuits
2.36 - 3.27 Power Factor Testing

Specific Case: Nominal, Same
Resistive Load Value as 0.7 Leading Case

Input Power

<table>
<thead>
<tr>
<th>Case</th>
<th>( \phi_1 )</th>
<th>( \phi_2 )</th>
<th>( \phi_3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{IN} )</td>
<td>50.0 V</td>
<td>50.2 V</td>
<td>50.4 V</td>
</tr>
<tr>
<td>( I_{IN} )</td>
<td>9.86 A</td>
<td>9.39 A</td>
<td>9.4 A</td>
</tr>
<tr>
<td>( P_{IN} )</td>
<td>493 W</td>
<td>471 W</td>
<td>474 W</td>
</tr>
</tbody>
</table>

Output Power (Resistive Loads)

<table>
<thead>
<tr>
<th>Case</th>
<th>( V_{OUT} )</th>
<th>( I_{OUT} )</th>
<th>( P_{OUT} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{OUT_1} )</td>
<td>31.18 V</td>
<td>11.85 A</td>
<td>36.95 W</td>
</tr>
<tr>
<td>( V_{OUT_2} )</td>
<td>33.72 V</td>
<td>10.48 A</td>
<td>35.34 W</td>
</tr>
<tr>
<td>( V_{OUT_3} )</td>
<td>36.11 V</td>
<td>9.43 A</td>
<td>34.11 W</td>
</tr>
</tbody>
</table>

\[ \lambda_1 = 74.9\% \quad \lambda_2 = 75.7\% \quad \lambda_3 = 71.9\% \]

\[ \lambda_{Total} = 74.0\% \]
23.6-3.2.7 Power Factor Testing

Specific Case: Nominal, Full Load

Input Power

<table>
<thead>
<tr>
<th>Power</th>
<th>$\phi_1$</th>
<th>$\phi_2$</th>
<th>$\phi_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IN}$</td>
<td>50.0 Vdc</td>
<td>50.2 V</td>
<td>50.4 V</td>
</tr>
<tr>
<td>$I_{IN}$</td>
<td>9.86 Adc</td>
<td>10.11 A</td>
<td>10.27 A</td>
</tr>
<tr>
<td>$P_{IN}$</td>
<td>493 W</td>
<td>508 W</td>
<td>518 W</td>
</tr>
</tbody>
</table>

Output Power (Resistive Loads)

<table>
<thead>
<tr>
<th>Power</th>
<th>$\phi_1$</th>
<th>$\phi_2$</th>
<th>$\phi_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{OUT_1}$</td>
<td>31.18 Vrms</td>
<td>31.43 V</td>
<td>32.02 V</td>
</tr>
<tr>
<td>$I_{OUT_1}$</td>
<td>11.85 Arms</td>
<td>12.23 A</td>
<td>11.88 A</td>
</tr>
<tr>
<td>$P_{OUT_1}$</td>
<td>367.5 W</td>
<td>384.4 W</td>
<td>380.4 W</td>
</tr>
</tbody>
</table>

$\eta_1 = 74.9\%$, $\eta_2 = 75.7\%$, $\eta_3 = 73.4\%$

$\eta_{Total} = 74.7\%$
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NASA-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.6-3.3.7 Power Factor
Specific Case: Nominal • Full Load
Input Voltage: Sense DC Rcvr: 
Input Current: AC Rcvr: 
System Frequency: BD Module: 
Output Power: Other: 

INV 1

Leg Current Scale: 5A/

INV 2

Leg Current Scale: 5A/

INV 1

Line Voltage
Line Current Scale: 2A/

INV 2

Line Voltage
Line Current Scale: 2A/
### RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

#### TEST PROGRAM (NAS3-22777)

#### TRANSIENT TEST DATA SHEET

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>2.3.6-3.2.7 POWER FACTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>Nominal, Full Load, Inverter 3</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>Same</td>
</tr>
<tr>
<td>Input Current:</td>
<td>DC Rcvr:</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>AC Rcvr:</td>
</tr>
<tr>
<td>Output Power:</td>
<td>BD Module:</td>
</tr>
<tr>
<td></td>
<td>Other:</td>
</tr>
</tbody>
</table>

#### Photos

- **INV 3**
  - Leg Current Scale: 5A/
  - Line Voltage NTS4
  - Line Current Scale: 2A/

- **INV 3**
  - Photo

- **Photo**

#### Scale:

- Scale:

---

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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} = 50Vdc)

Test Circuits
2.3.6-3.2.7 POWER FACTOR TESTING

Specific Case: Unity Power Factor

Full Load

Input Power

\[ \phi_1 \]
\[ V_{IN} = 50.0 \text{Vdc} \]
\[ I_{IN} = 11.11 \text{ADC} \]
\[ P_{IN} = 556 \text{W} \]

\[ \phi_2 \]
\[ V_{IN} = 50.0 \text{Vdc} \]
\[ I_{IN} = 11.39 \text{ADC} \]
\[ P_{IN} = 570 \text{W} \]

\[ \phi_3 \]
\[ V_{IN} = 50.0 \text{Vdc} \]
\[ I_{IN} = 13.60 \text{ADC} \]
\[ P_{IN} = 680 \text{W} \]

Output Power (Resistive Loads)

\[ V_{OUT_1} = 32.94 \text{Vrms} \]
\[ I_{OUT_1} = 12.57 \text{A rms} \]
\[ P_{OUT_1} = 414.1 \text{W} \]

\[ V_{OUT_2} = 33.07 \text{V} \]
\[ I_{OUT_2} = 12.9 \text{A} \]
\[ P_{OUT_2} = 427 \text{W} \]

\[ V_{OUT_3} = 36.51 \text{V} \]
\[ I_{OUT_3} = 13.6 \text{A} \]
\[ P_{OUT_3} = 497 \text{W} \]

\[ \eta_1 = 74.5\% \]
\[ \eta_2 = 75\% \]
\[ \eta_3 = 73.0\% \]

\[ \eta_{Total} = 74.2\% \]
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

Input Current: AC Rcvr:

System Frequency: BD Module:

Output Power: Other:

Graphs:

INV 1

Line Voltage

Line Current

Scale: 1A/

INV 2

Line Voltage

Line Current

Scale: 1A/

Legend

Current Scale: 5A/
### Test-Configuration: 2.3.6-3.2.7 Power Factor

<table>
<thead>
<tr>
<th>Test-Configuration</th>
<th>Specific Case</th>
<th>Input Voltage</th>
<th>Input Current</th>
<th>System Frequency</th>
<th>Output Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3.6-3.2.7 Power Factor</td>
<td>Unity Power Factor, F.L.</td>
<td>Same</td>
<td>DC Rcvr:</td>
<td>AC Rcvr:</td>
<td>BD Module:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Transient Test Data Sheet

![Graphs](image.png)

- **Leg Current** Scale: 5 A/
- **Line Voltage** Scale: NTS
- **Line Current** Scale: 1 A/

![Photos](image.png)

Scale: Scale:
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)

Configuration - Test 23.6-3.2.7 POWER FACTOR TESTING

\[1.5 \mu F, \text{Full Load}, V_{\text{IN}} = 50V_{ac}\]

0.7 LEADING

Test Circuits

The input voltage was reduced to 50V_{ac} because of the large power drawn by the inverters. The power supplies are limited to 60A_{dc}. 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
(1.5μF, Full Load) Per Phase

<table>
<thead>
<tr>
<th>Input Power</th>
<th>$\phi_1$</th>
<th>$\phi_2$</th>
<th>$\phi_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{IN}$</td>
<td>50.0 V</td>
<td>50.2 V</td>
<td>50.4 V</td>
</tr>
<tr>
<td>$I_{IN}$</td>
<td>18.30 A</td>
<td>15.90 A</td>
<td>26.0 A</td>
</tr>
<tr>
<td>$P_{IN}$</td>
<td>915 W</td>
<td>798 W</td>
<td>1310 W</td>
</tr>
</tbody>
</table>

Output Power (Resistive Loads)

<table>
<thead>
<tr>
<th>$V_{OUT_1}$</th>
<th>40.9 Vrms</th>
<th>$V_{OUT_2}$</th>
<th>43.05 V</th>
<th>$V_{OUT_3}$</th>
<th>56.33 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{OUT_1}$</td>
<td>15.07 Ams</td>
<td>$I_{OUT_2}$</td>
<td>13.37 A</td>
<td>$I_{OUT_3}$</td>
<td>14.77 A</td>
</tr>
<tr>
<td>$P_{OUT_1}$</td>
<td>616 W</td>
<td>$P_{OUT_2}$</td>
<td>575.6 W</td>
<td>$P_{OUT_3}$</td>
<td>832.0 W</td>
</tr>
</tbody>
</table>

$\eta_1 = 67.3\%$, $\eta_2 = 72.1\%$, $\eta_3 = 63.5\%$

$f = 20.3\text{kHz}$, $\eta_{total} = 66.9\%$
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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage:</td>
<td>Same</td>
</tr>
<tr>
<td>DC Rcvr:</td>
<td></td>
</tr>
<tr>
<td>Input Current:</td>
<td></td>
</tr>
<tr>
<td>AC Rcvr:</td>
<td></td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
</tr>
<tr>
<td>BD Module:</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td>Other</td>
</tr>
</tbody>
</table>

![Graphs showing line voltage and current](image_url1)

![Graphs showing line voltage and current](image_url2)

![Graphs showing line voltage and current](image_url3)

![Graphs showing line voltage and current](image_url4)
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.36-3.27 POWER FACTOR

Specific Case: 0.7 LEADING, INVERTERS 2±3

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

DC Revr: 
AC Revr: 
BD Module: 
Other: 

INV. 2

Line Voltage
Line Current

INV. 3

Leg Current

NTS +

NTS~
Configuration - Test 2.3.7 - 3.7.7  Power Factor

Logging Power Factor (P.F. = 0.7)

Test Circuits

[Diagram showing a circuit with labeled components and values]
I) Input Power

\[ V_{in} = 119.65 \text{ V} \]
\[ I_{in} = 20.22 \text{ A} \]
\[ P_{in} = 13.5 \text{ kW} \]

Frequency \( 19.95 \text{ kHz} \)

T.H.D.
\[ \phi_A = \_\% \]
\[ \phi_B = \_\% \]
\[ \phi_C = \_\% \]

T.H.D. - Transmission Line Into the Line
\[ \phi_A \]

II) Output Power

\[ V_o = 457.7 \text{ V} \]
\[ I_o = 15.5 \text{ A} \]
\[ P_o = 4.43 \text{ kW} \]

\[ V_o = 440.4 \text{ V} \]
\[ I_o = 17.0 \text{ A} \]
\[ P_o = 5.24 \text{ kW} \]

\[ V_o = 435.7 \text{ V} \]
\[ I_o = 19.2 \text{ A} \]
\[ P_o = 5.36 \text{ kW} \]

\[ E_o = \frac{15.5}{18.5} = 85.4\% \]

A.C. R.C.V.R. B.I.D. MOD.

\[ V_o = \_ \text{ V} \]
\[ I_o = \_ \text{ A} \]
\[ P_o = \_ \text{ kW} \]

T.H.D. out of R.C.V.R.
\[ \phi_o = \_\% \]

Resistive Loads

\[ V_o = 414.5 \text{ V} \]
\[ I_o = 79.3 \text{ mm} \]
\[ P_o = 4.43 \text{ kW} \]

\[ I_o = 93.8 \text{ mm} \]
\[ I_o = 13.0 \text{ A} \]
\[ P_o = 5.47 \text{ kW} \]

\[ I_o = 97.5 \text{ mm} \]
\[ I_o = 19.2 \text{ A} \]
\[ P_o = 5.47 \text{ kW} \]

\[ P.F. = 0.70 \]

Total System Eff. \( \frac{18.8}{18.8} = 100.0\% \)
**Resonant AC Power System Proof-of-Concept**

**Test Program (NAS3-22777)**

**Transient Test Data Sheet**

<table>
<thead>
<tr>
<th>Test Configuration:</th>
<th>2.3.7-3.2.7 Power Factor ≠ 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>Logging 0.7 p.f.</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>149.65</td>
</tr>
<tr>
<td>Input Current:</td>
<td>173.6</td>
</tr>
<tr>
<td>System Frequency:</td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td>14.9 kW</td>
</tr>
</tbody>
</table>

**Graphs:**

- V_a, I_a
- V_b, I_b
- V_c, I_c
- V_in, I_in
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2·3·7-3·7·3
Power Factor Loads # 1
Specific Case: Lagging 0.7 p.f.

<table>
<thead>
<tr>
<th></th>
<th>DC Revr:</th>
<th>AC Revr:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Frequency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Power</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Other:

[Graphs and charts depicting various power system parameters and waveforms.]

Photo

Scale:

ORIGINAL PAGE IS OF POOR QUALITY
### 2.3.6-3.2.4.1 STEADY-STATE

**CONTROL SIGNAL GAIN**

**SPECIFIC CASE: AC RCU**

\[ f = 20.215 \text{ kHz} \]

**Gate Signal**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{\text{ref}} )</td>
<td>1.387 V</td>
</tr>
<tr>
<td>( V_{\text{IN}} )</td>
<td>120.64</td>
</tr>
<tr>
<td>( I_{\text{IN}} )</td>
<td>53.78 A</td>
</tr>
<tr>
<td>( V_{\text{OUT}} )</td>
<td>128.6 V</td>
</tr>
<tr>
<td>( I_{\text{OUT}} )</td>
<td>2.83 A</td>
</tr>
</tbody>
</table>

-50%  +50%

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{\text{ref}} )</td>
<td>0.692 V</td>
</tr>
<tr>
<td>( V_{\text{IN}} )</td>
<td>120.2</td>
</tr>
<tr>
<td>( I_{\text{IN}} )</td>
<td>52.69</td>
</tr>
<tr>
<td>( V_{\text{OUT}} )</td>
<td>91.9 V</td>
</tr>
<tr>
<td>( I_{\text{OUT}} )</td>
<td>2.33 A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{\text{ref}} )</td>
<td>2.07 V</td>
</tr>
<tr>
<td>( V_{\text{IN}} )</td>
<td>119.8</td>
</tr>
<tr>
<td>( I_{\text{IN}} )</td>
<td>54.54</td>
</tr>
<tr>
<td>( V_{\text{OUT}} )</td>
<td>135.8</td>
</tr>
<tr>
<td>( I_{\text{OUT}} )</td>
<td>2.97 A</td>
</tr>
</tbody>
</table>
### 2.3.6 - 3.2.4.1  STEADY-STATE

**CONTROL SIGNAL GAIN**

**SPECIFIC CASE** | AC | RCVR

---

\[ f = 20.188 \text{ kHz} \]

Nominal Gate Signal

| \( V_{\text{Ref}} \) | 1.358 V |
| \( V_{\text{IN}} \) | 119.9 V |
| \( I_{\text{IN}} \) | 53.4 A |
| \( V_{\text{OUT}} \) | 117.8 V |
| \( I_{\text{OUT}} \) | 2.83 A |

\(-50\%\)

| \( V_{\text{Ref}} \) | 0.676 V |
| \( V_{\text{IN}} \) | 128.0 V |
| \( I_{\text{IN}} \) | 52.5 A |
| \( V_{\text{OUT}} \) | 91.3 V |
| \( I_{\text{OUT}} \) | 2.47 A |

\(+50\%\)

| \( V_{\text{Ref}} \) | 2.03 |
| \( V_{\text{IN}} \) | 119.7 V |
| \( I_{\text{IN}} \) | 54.2 A |
| \( V_{\text{OUT}} \) | 132.4 V |
| \( I_{\text{OUT}} \) | 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 ± P.f.
Input Voltage: Same
Input Current: DC Rcvr:
System Frequency: AC Rcvr:
Output Power: BD Module:
Other:

---

C)

---

C)

---

C)

---

C)}
Test-Configuration: 2.3.7 - 3.2.7  Power Factor

Specific Case: lagging 0.7 p.f.

Input Voltage: Same

Input Current: 

System Frequency: 

Output Power: 

---

![Graphs showing waveforms and measurements](image-url)
**Resonant AC Power System Proof-of-Concept Test Program (NAS3-22777)**

**Transient Test Data Sheet**

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>2.3.7 - 3.2.7 Power Factor (-0.7 - 0.7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>Lagging P.F.</td>
</tr>
</tbody>
</table>

**Input Voltage:**

**Input Current:**

**System Frequency:**

**Output Power:**

![Graphs showing waveforms with labels and scales](image)

**Additional Information:**

- Scale: 50 A
- Scale: 50 V

---

**439**
Configuration - Test 2.3.7-3.2.7 Power Factor

Leading Power Factor (P.F. = 0.7)

Test Circuits

\[ \begin{align*}
&\Phi A \\
&\Phi B \\
&\Phi C \\
&150 \text{ Vac} \\
&- \\
&20.1 \text{ A} \\
&20.1 \text{ A} \\
&20.1 \text{ A} \\
&\text{V.L} \\
&.33e^f = -j24.1A \\
&.33e^f = -j24.1A \\
&.33e^f = -j24.1A \\
&.33e^f = -j24.1A
\end{align*} \]
I) INPUT POWER

Test Conf: 2.37-3.77 Power Factor

Specific Case: Leading + P.F. Load

Frequency

T.H.D.

\( \Phi_A \) -- dB
\( \Phi_B \) -- dB
\( \Phi_C \) -- dB

T.H.D. - Transmission Line

\( \phi_A \) into the line

All high voltage measurements made with H.P. 346A DVM,
Calc'd 146,516

II) OUTPUT POWER

\( \Phi_A \)
\( V_o = 431.7 \)
\( I_o = I_o \)
\( P_o = P_o \)

\( \Phi_B \)
\( V_o = 470.6 \)
\( I_o = I_o \)
\( P_o = P_o \)

\( \Phi_C \)
\( V_o = 496.8 \)
\( I_o = I_o \)
\( P_o = P_o \)

A.C. RCVR:

\( V_o \) NIC
\( I_o = I_o \)
\( P_o = P_o \)

B/D MOD.:

\( V_o \) NIC
\( I_o = I_o \)
\( P_o = P_o \)

D.C. RCVR:

\( V_o \) NIC
\( I_o = I_o \)
\( P_o = P_o \)

T.H.D. out of RCVR -- dB

REACTIVE LOADS

\( \Phi_A \)
\( V_o = 449.6 \text{ Vac} \)
\( I_o = 73.5 \text{ A} \)
\( P_o = 4.66 \text{ KW} \)

\( \Phi_B \)
\( V_o = 458.7 \text{ Vac} \)
\( I_o = 76.0 \text{ A} \)
\( P_o = 5.02 \text{ KW} \)

\( \Phi_C \)
\( V_o = 463.6 \text{ Vac} \)
\( I_o = 76.0 \text{ A} \)
\( P_o = 5.11 \text{ KW} \)

Total System Efficiency = \( \frac{\text{Input}}{\text{Pout}} \) = \( \frac{14.9}{19.2} \) = 77.4%
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 Receiver: __________

Input Current: __________ AC Receiver: __________

System Frequency: __________ BD Module: __________

Output Power: __________ Other: __________
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7 - 2.2.7 Power Factor
Specific Case: Leading 0.7 P.F.

<table>
<thead>
<tr>
<th>Input Voltage:</th>
<th>DC Rcvr:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current:</td>
<td>AC Rcvr:</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>BD Module:</td>
</tr>
<tr>
<td>Output Power:</td>
<td>Other:</td>
</tr>
</tbody>
</table>

![Graphs](image.png)
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  DC Rcvr: 
Input Current:  AC Rcvr: 
System Frequency:  BD Module: 
Output Power:  Other: 

[Graphs showing waveforms for various measurements]
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:  Loading 0.7 p.f.

Input Voltage: Same

DC Rcvr:

Input Current:

AC Rcvr:

System Frequency:

BD Module:

Output Power:

Other:

[Graphs and charts showing waveforms for current and voltage.]
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:

Input Current:

System Frequency:

Output Power:

<table>
<thead>
<tr>
<th>Current</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_A</td>
<td>V_A</td>
</tr>
<tr>
<td>I_B</td>
<td>V_B</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Current</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_K</td>
<td>V_K</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Current</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>I_KU</td>
<td>V_KU</td>
</tr>
<tr>
<td>I_KL</td>
<td>V_KL</td>
</tr>
</tbody>
</table>
Configuration - Test 2.3.7-22.7 Steady-State Operation
C-Compensation, Unbalanced Power and Power Factor Loads

Test Circuits

\[ 7.14\, \text{KW} \quad 25.3\, \text{A} \]

\[ 17.96\, \text{A} \]

\[ -22.7\, \text{A} \]

\[ 334.4 \]

\[ 20.1\, \text{A} \]

\[ 150\, \text{W} \]
I) **Input Power**

- \( V_{in} = 149.95 \text{ Vac} \)
- \( I_{in} = 23.5 \text{ mV} = 141 \text{ Adc} \)
- \( P_{in} = 221 \text{ kW} \)

**Frequency**

\[ \text{T.H.D.} \]
- \( \Phi A = \% \)
- \( \Phi B = \% \)
- \( \Phi C = \% \)

\[ \text{T.H.D. - Transmission Line} \] into the line
- \( \Phi A = \% \)

**Output Power**

- \( \Phi A \)
- \( \Phi B \)
- \( \Phi C \)

\[ V_o = 446.8 \text{ Vac} \]
- \( I_o = 15.1 \text{ A} \)
- \( P_o = 5.99 \text{ kW} \)

\[ V_o = 446.8 \text{ Vac} \]
- \( I_o = 15.1 \text{ A} \)
- \( P_o = 5.99 \text{ kW} \)

---

**A.C. Rect.**

- \( V_o = \text{Nl} \)
- \( I_o = \text{Nl} \)
- \( P_o = \text{Nl} \)

**B/D Mod.**

- \( V_o = \text{Nl} \)
- \( I_o = \text{Nl} \)
- \( P_o = \text{Nl} \)

**D.C. Rect.**

- \( V_o = \text{Nl} \)
- \( I_o = \text{Nl} \)
- \( P_o = \text{Nl} \)

---

**Resistive Loads**

- \( \Phi A \)

\[ V_o = 472.9 \text{ Vac} \]
- \( I_o = 84.0 \text{ mV} \)
- \( P_{oa} = 2.14 \text{ kw} \)

- \( \Phi B \)

\[ V_o = 472.9 \text{ Vac} \]
- \( I_o = 84.8 \text{ mV} \)
- \( P_{ob} = 5.03 \text{ kw} \)

- \( \Phi C \)

\[ V_o = 466.0 \text{ Vac} \]
- \( I_o = 76.7 \text{ mV} \)
- \( P_{oc} = 5.49 \text{ kw} \)

\[ \text{Total System Efficiency} = \frac{P_{out}}{P_{in}} = \frac{17.7}{21.1} = 83.9\% \]
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 Vdc
Input Current: 141 A dc
System Frequency: 50 Hz
Output Power: 17.7 kW

AC Rcvr: NIC
DC Rcvr: NIC
BD Module: NIC
Other: 50 hp inductive load
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-Camp

Input Voltage: Same

Input Current: AC Rcvr:

System Frequency: BD Module:

Output Power: Other:

---

Graphs showing various test results with scales indicated.

---

450
### RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT

**TEST PROGRAM (NAS3-22777)**

**TRANSIENT TEST DATA SHEET**

<table>
<thead>
<tr>
<th>Test-Configuration:</th>
<th>2.3.7 - 3.2.2 Steady-State Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Case:</td>
<td>C - Comp. Unbalanced P.f. Loads</td>
</tr>
<tr>
<td>Input Voltage:</td>
<td>Same</td>
</tr>
<tr>
<td>Input Current:</td>
<td>AC Rcvr:</td>
</tr>
<tr>
<td>System Frequency:</td>
<td>BD Module:</td>
</tr>
<tr>
<td>Output Power:</td>
<td>Other:</td>
</tr>
</tbody>
</table>

![Waveform Graphs](image-url)

*Photo*
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2-3-7-3-2-7 Steady-State Operation
Specific Case: C - Ccm, Unbalanced p.f., loads

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

---

[Graphs and waveforms showing transient test data]
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: 2.3.7-3.2.7 Steady-State Operation
Specific Case: C - Comp, Unbalanced D.C. Loads

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

Photo
Specific Case: Unbalanced p.c. loads

Input Voltage: _____ DC Rcvr: _____
Input Current: _____ AC Rcvr: _____
System Frequency: _____ BD Module: _____
Output Power: _____ Other: _____
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)

Configuration - Test 2.36 - 3.28 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: 120.0 V
DC Rcvr: ____________________________
Input Current: ____________________________
AC Rcvr: 60 Hz, 230 V
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: 200V/

INVERTER 3
Tank Current Scale: 20A/
RESONANT AC POWER SYSTEM PROOF-OF-CONCEPT
TEST PROGRAM (NAS3-22777)
TRANSIENT TEST DATA SHEET

Test-Configuration: **23.6 - 32.8 MOTOR TESTING**

<table>
<thead>
<tr>
<th>Input Voltage:</th>
<th><strong>Same</strong></th>
<th>DC Revr:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Current:</td>
<td>AC Revr:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Frequency:</td>
<td>BD Module:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output Power:</td>
<td>Other:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Photo](image1.jpg)

**MOTOR DRIVER**

<table>
<thead>
<tr>
<th>Output Voltage</th>
<th>Scale:</th>
<th>Not to</th>
</tr>
</thead>
</table>

![Photo](image2.jpg)
10-17-85

I) **Input Power**
- **In** = 150
- **In** = 180 A
- **Pin** =

II) **Output Power**
- **ΔA**
- **ΔB**
- **ΔC**
- **Vo**
- **Io**
- **Po**
- **Vo**
- **Io**
- **Po**

**T.H.D.**
- **ΔA**
- **ΔB**
- **ΔC**

**T.H.D. - Transmission Line**
- **ΔA**

**A.C. RECVR**
- **Vo** = 109
- **Io** = 4.4 A
- **Po** = 475

**B/D MOD.**
- **Vo** = 99 Vac
- **Io** = 6.9 Aac
- **Po** =

**D.C. RECVR**
- **Vo** = 24.1
- **Io** = 23.1
- **Po** =

**T.H.D. out of RECVR**
- dB

**Resistive Loads**
- **ΔA**
  - **Va** = 426.1 Vac
  - **Ia** = 83.14 MV
  - **Ia** = 16.53 Anc
  - **Poa** =
- **ΔB**
  - **Va** = 423.4 Vac
  - **Ib** = 81.24 MV
  - **Ib** = 16.58 Anc
  - **Pob** =
- **ΔC**
  - **Va** = 427.5 Vac
  - **Ic** = 80.13 MV
  - **Ic** = 17.65 Anc
  - **Poc** =

**Total System Efficiency =**

458
## Item: Space Station PS 1380000

**Narrowband Conducted Emission**

**Frequency Range:** 3000Hz-15kHz

**Prototype:** NIL-STD-461B, Part 3

**Conditions:** 150VDC Hot Line Test at 15Amps

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**Conducted By:** Ed Price

**Approved By:** A. K. Miller

**Certified By:**

---

460

Original page is of poor quality.
NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

ITEM: SPACE STATION PS
CONDITIONS: 150VDC HOT LINE TESTED AT 180 AMPS

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CONDUCTED BY
APPROVED BY
CERTIFIED BY

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Test conducted by: E. P. Patel

Approved by: B. H. Miller

Certified by: [Signature]

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Certified by: [Signature]

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NARROWBAND CONDUCTED EMISSION CE03 15KHZ-50MHZ

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CONDITIONS: 150 VDC RETURN LINE

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APPROVED BY

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**General Dynamics**

**Electronics Division**

**Tab No.: 6-1 OF 1**

**OCT 28, 1985 11:26:26**

**Broadband Conducted Emission GEB3 1kHz-50MHz**

**Item: Space Station P3**

**MFG: Convair**

**SN: Prototype**

**Spec: MIL-STD-461B PART 3**

**Conditions: 150 VDC Return Line**

---

**Freq.: Meter: Range: Cable: Band: Emission Spec: Over Reading:**

**Factor**

**Limit**

**Limit**

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**Conducted By:**

**APPROVED BY:**

**CERTIFIED BY:**

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CONDUCTED BY: Ed Price
APPROVED BY: A. X. Miller
CERTIFIED BY: 

Original Page Is of Poor Quality
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**Model:** Convair  
**Spec:** MIL-STD-461B, Part 3  
**Conditions:** 20kHz Transmission Bus, Phase A

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Certified by: ___________________________
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APPROVED BY: AK MILL

CERTIFIED BY: SHEET

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GENERAL DYNAMICS
ELECTRONICS DIVISION

TAB NO: 12-1 OF 1
OCT 28 1985 12:37:52

NARROWBAND CONDUCTED EMISSION CEII 30kHz-150kHz

ITEM: SPACE STATION PS
MFG: CONVAIR
SN: Prototype

SPEC: MIL-STD-461B PART 3
CONDITIONS: 30kHz TRANSMISSION BUS- PHASE C

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APPROVED BY: A. M.
CERTIFIED BY: __________

SHEET 1/1

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NARROWBAND CONDUCTED EMISSION  CE03  15KHZ-50MHZ

ITEM: SPACE STATION PS
CONDITIONS: 20KHZ TRANSMISSION BUSS, PHASE C

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Approved By: A.L. Putah

Certified By: __________________________

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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
## GENERAL DYNAMICS
### ELECTRONICS DIVISION

**CONDUCTED EMISSION CE01 30Hz-150kHz**

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**SPEC: MIL-STD-461E PART 3**
**CONDITION: 20KHz TRANSMISSION BUS/CABLE SHIELD**

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**APPROVED BY**

**CERTIFIED BY**

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495
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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APPROVED BY: 

CERTIFIED BY: 

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ORIGINAL PAGE IS OF POOR QUALITY
NARROWBAND CONDUCTED EMISSION CE01 30HZ-15KHZ

ITEM: SPACE STATION PS
CONDITIONS: DC RECEIVER OUTPUT

GRAPH NO. 19  OCT 28, 1985  13:29:29
### Narrowband Conducted Emission CEBI 30Hz-15KHz

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**SN:** Prototype  
**Spec:** MIL-STD-461B Part 3  
**Conditions:** DC Receiver Output

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**Approved by:** [Signature]

**Certified by:** [Signature]

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CONDUCTED BY: EDPaine
APPROVED BY: M. Mill
CERTIFIED BY: ________ SHEET _______
GENERAL DYNAMICS
ELECTRONICS DIVISION

--- MIL-STD-461B, PART 3 LIMIT

*Note: This emission at 60Hz is the intentionally generated signal output of the AC Receiver, and does not, therefore, constitute a failure of this test.

NARROWBAND CONDUCTED EMISSION CE01 30HZ-15KHZ
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**Conducted by**

**APPROVED BY**

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Conducted by: ED Price
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Certified by: SHEET

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Conducted By: 
Approved By: 
Certified By: 

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APPROVED BY: [Signature]
CERTIFIED BY: [Signature]
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CONDUCTED BY: Ed Paid
APPROVED BY: A. M. Oli
CERTIFIED BY: 

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Conducted by: Ed Plant
Approved by: A. J. Miller
Certified by: [Signature]

Sheet: 521
**SUSCEPTIBILITY TEST DATA**

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**MANUFACTURER:** _GDC_  
**SERIAL NO:**  
**TEST NO:** _CSO2_  
**DATE OF TEST:** _10-27-85_  
**TEST CONDUCTED PER:**  
**INPUT VOLTAGE:** _150 VDC_  
**PICKUP DEVICE:** _HP-440 & TES-2445_  
**TYPE OF TEST:**  
**TEST METER:**  
**SERIAL NO:**  
**DATE OF LAST CAL:**  
**OTHER INFO:**  

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**EPS PASSES TEST**

**CONDUCTED BY:** _ED PRICE_  
**APPROVED BY:** _A. HINCHI_  
**CERTIFIED BY:**  
**DATA SHEET:** _A_  
**SIZE:** _A_  
**REV SYM:**  

**FORM 5-277**

522  
**ORIGINAL PAGE IS OF POOR QUALITY**
**SUSCEPTIBILITY TEST DATA**

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This test sequence was terminated due to audio system damage after it was found that the EPS could not tolerate a 50 volt peak, 0.15ms duration transient applied to its 150volt DC power source.

**Conducted By:** Ed Mcll

**Approved By:** A. Ray

**Certified By:**

**DATA SHEET:** A

**FORM 3-277**

523.