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Engineer D S Grosso
D. S. Grosso

Release F A Stone
F. A. Stone

TAPE REPRODUCER

MODEL 1738

OPERATIONAL MANUAL

RAYMOND ENGINEERING LABORATORY, INC.
Smith Street
Middletown, Connecticut

NAS 7-100

63-491

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1.0 SCOPE

1.1 Scope. This manual delineates the functions of the 1738 Video Recorder.

1.2 Purpose. The manual describes input and output signals as well as waveshapes of testpoints to facilitate the operational setup of the system.

2.0 APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect form a part of this specification:

TEST PLAN

Raymond Engineering Laboratory

1738 REL General Test Requirements

DRAWINGS

Jet Propulsion Laboratory

J 4901042 Mariner C Package Assembly

3.0 SYSTEM OPERATION

3.1 Function. The model 1738 recorder accepts serial-bit RZ binary data at a fixed input rate of 10,700 bits per second and can store a minimum of 5×10^6 bits. It reproduces jitter free, synchronous, serial NRZ binary data at a fixed output rate of 8.33 bits per second.

3.2 Basic Parameters. The basic mechanism employs an endless loop of 1/4" mylar tape 330 feet long. This

includes extra tape for run-up and run-down periods.

Incoming RZ data is converted to frequency doubled code and steered into one of two data storage tracks. When the first track is filled with information, a pulse from the end of tape sensor switches the incoming signal to the second channel. The same end of tape sensor switches channels in playback. Any prerecorded data will be erased by the incoming signal.

The tape moves at 12.84 inches per second during record and plays back at .01 inches per second giving a tape speed ratio of 1284:1.

Run-up to speed and run-down from speed time in the record mode is 10 seconds. This consumes 5 feet of tape. There is enough extra tape to allow 20 such starts and stops. Each one of these start and stops causes a playback quiet time of 100 minutes.

Once the data is recorded, the machine is switched into playback by an external command. The playback signal is fed to a preamplifier located on the transport. NRZ data is constructed from this frequency doubled recorded code along with a sync pulse. The phase difference between the tape sync pulse and the master clock pulse determines whether the playback data is in proper time relation with respect to the master clock.

Comparisons are made every .83 seconds and determine indirectly the frequency of the voltage controlled oscil-

lator which dictates playback speed. When the correct playback speed and phase are achieved, the tape sync and the reference clock are in the proper phase relation for the accurate read-out of NRZ data. This condition is called phase-lock.

A prime source of 100 volts peak to peak 2400 cps square-wave is all the power necessary to run the system except for the 62 vpp, 400 cps, single phase square-wave needed to drive the record motor.

The recorder is in five separate subassemblies: One a sealed transport subassembly containing motors, tape, heads, playback preamplifiers, a temperature transducer to facilitate environmental testing, and a pressure transducer to verify a proper seal, and the others containing the remainder of the electronics circuitry.

The system is designed to operate in a vacuum in an ambient temperature range between -10°C and 80°C. Exceeding the environment limits or breaking of the transport seal should be performed only upon the approval by the REL project manager and the JPL cognizant engineer.

The record tape time is 5.06 to 5.14 minutes per track or a total of 10.12 to 10.28 minutes. The playback tape time is 108.3 - 110 hours per track or a total of 216.6 - 220 hours.

3.3 Sequence of events. Upon application of 2400 cps and 400 cps power and a record command, the machine will begin its

record mode.

Upon application of data, the machine will record for 10 minutes in several intermittent steps.

After the stop command, a playback command is issued and the machine goes into its playback mode.

The interface connections comprise all inputs and outputs to the recorder system. Functional origination or destination of these signals can be found on Figure 1.

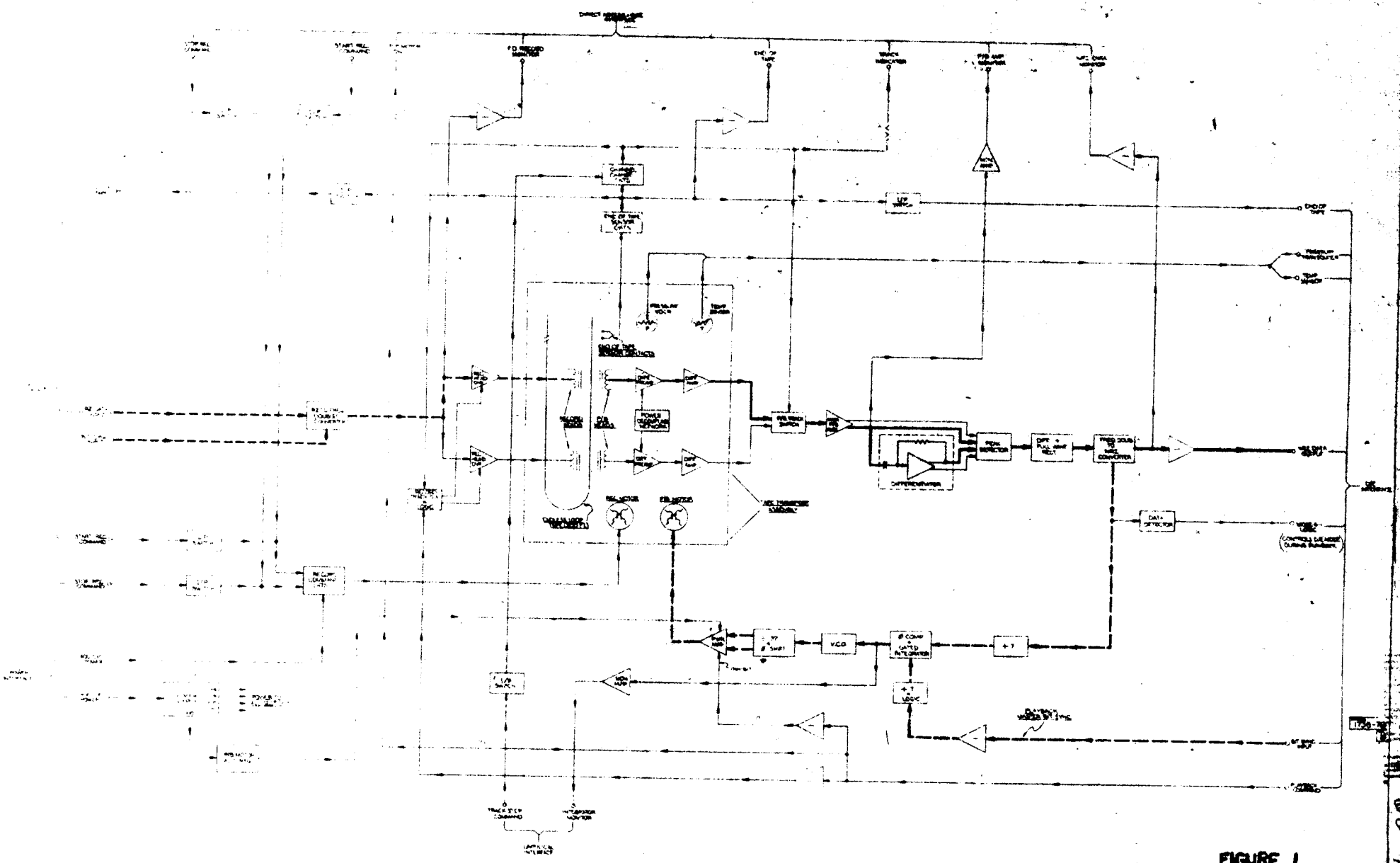


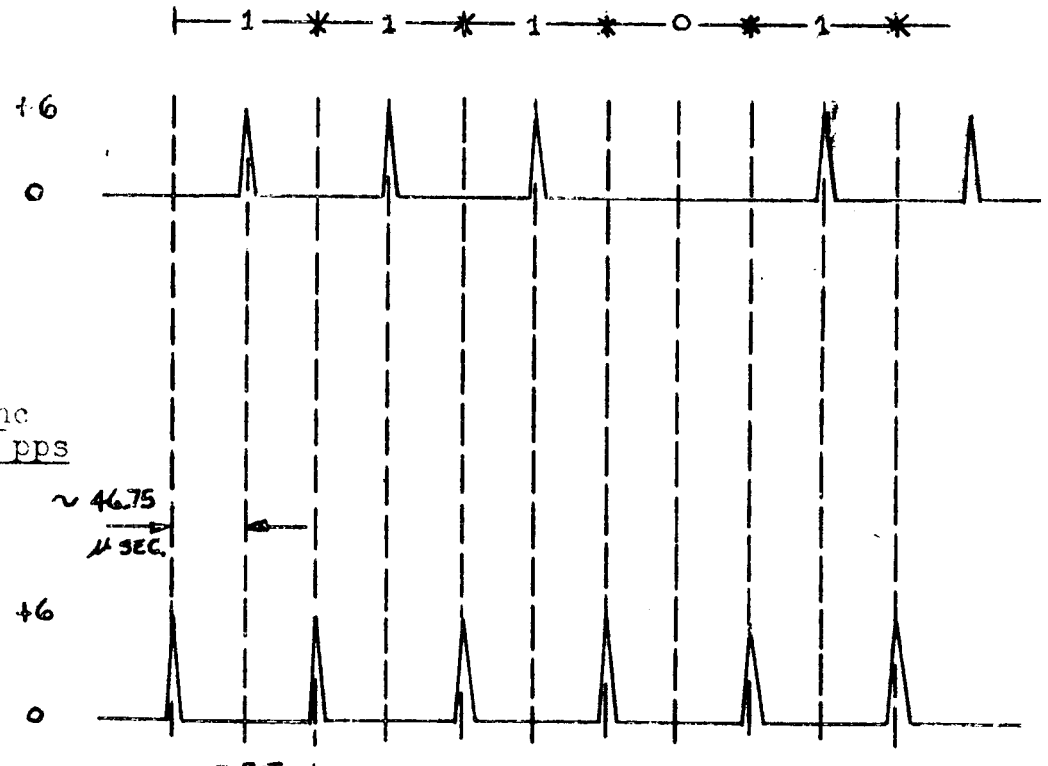
FIGURE 1

4.0 DAS INTERFACE WAVEFORMS

The DATA AUTOMATION SYSTEM supplies information to the recorder during the record cycle. The RZ data and the bit sync comprise the data to be recorded. The Start and Stop signals are the commands that control the record cycle. The End of Tape signal is a pulse from the recorder that informs the DATA AUTOMATION SYSTEM that the recorder is switching tracks.

The following are sample wave forms:

4.1 RZ Data

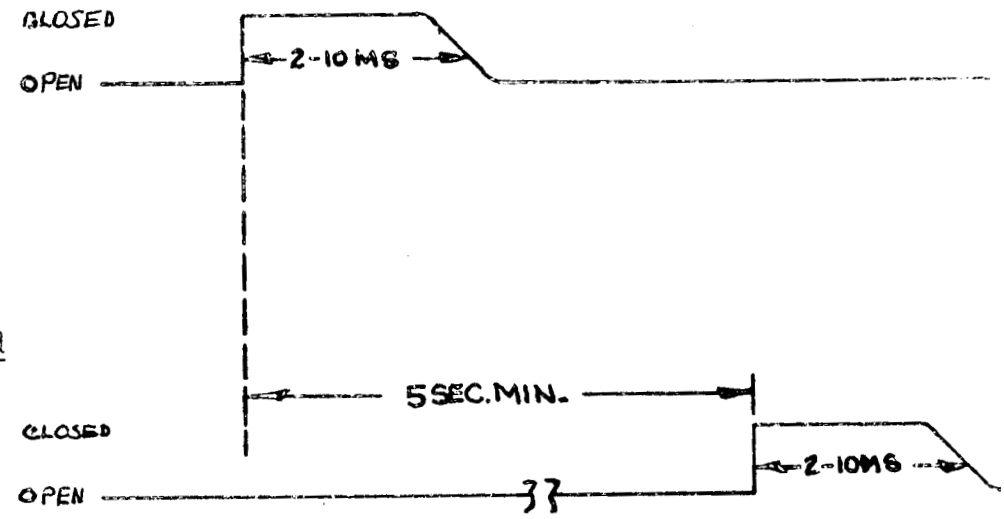


4.2 Bit Sync 10,700 pps

RZ data combined with the bit sync signal comprises

the input information. From these two inputs frequency doubled code is constructed.

4.3 Start Record



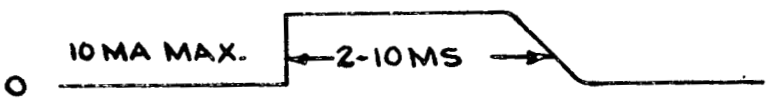
4.4 Stop Record

The start and stop commands are short closures of an IP switch used to start and stop the recorder. A minimum of 5 sec. is required between commands to allow the circuits to re-energize. Because the system has the ability to remember its last command, it is necessary to give the system a stop command before removing power and thereby avoiding accidental data erasure when power is re-applied.

If 400 cps power is removed without issuing the stop command, the integrator monitor at the umbilical interface during playback will not present the integrator signal but will be at +20 V dc.

The system has the potential of drawing tape at the high speed only when the 400 cps is present. However, when the power is present, a record command will override the playback command. While no damage will occur, this is not a preferred condition.

4.5 End of Tape. The end of tape signal from the recorder is an informative pulse that references the tape splice and tells that the recorder is switching tracks.



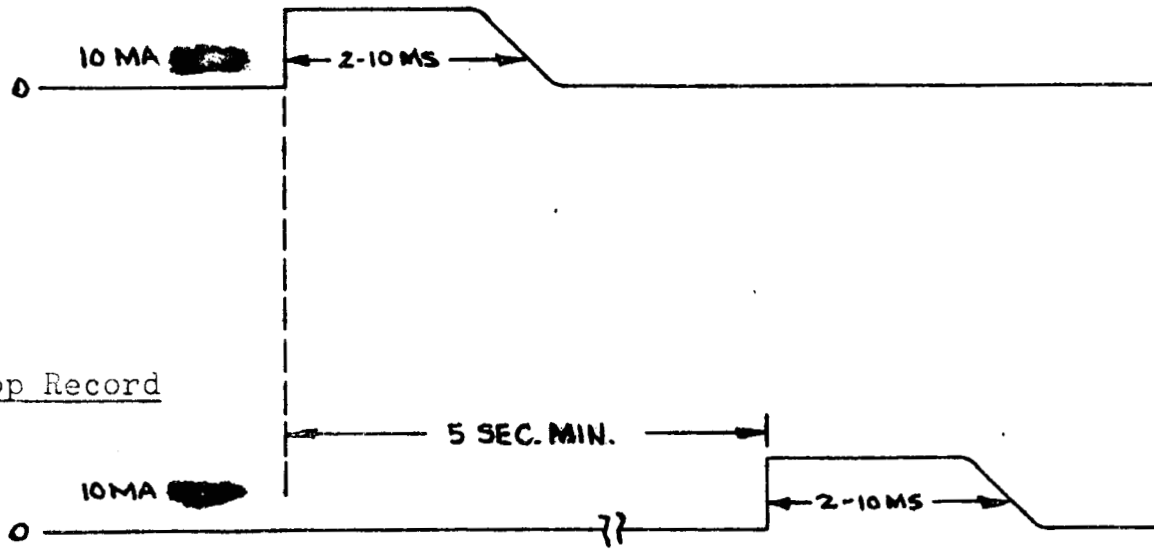
5.0 OSE INTERFACE WAVE FORMS

The Operational Support Equipment system has the power to start and stop the record cycle, to command the recorder to playback. These commands will be used to exercise the recorder for tests.

The OSE system also examines several signals within the recorder to detect any malfunction. They are the Frequency Doubled signal, the End of Tape signal, the Track Indicator signal, the Playback Amplifier signal, and the Inverted NRZ Data signal.

The following are sample wave forms:

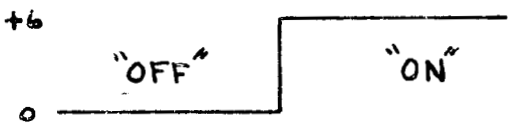
5.1 Start Record



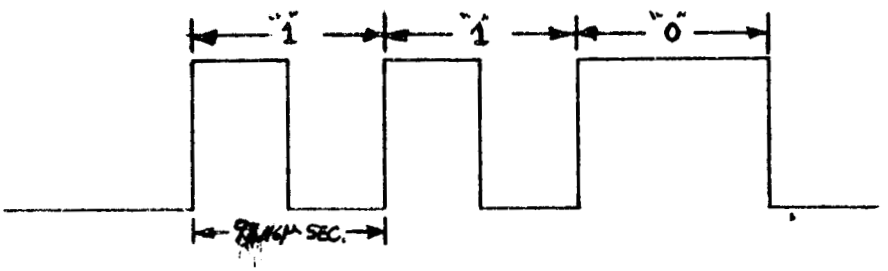
5.2 Stop Record

The stop and start commands on the OSE interface are the same as on the DAS interface.

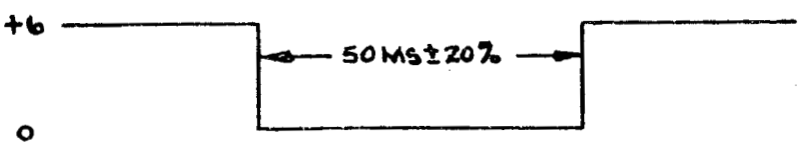
5.3 Playback Motor On. A +6 volt signal from the recorder is indicative that the playback motor is energized.



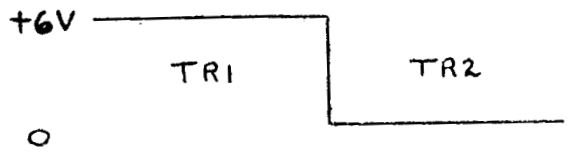
5.4 Frequency Double Monitor. The frequency double monitor signal from the recorder is the combined form of the RZ data and the bit sync.



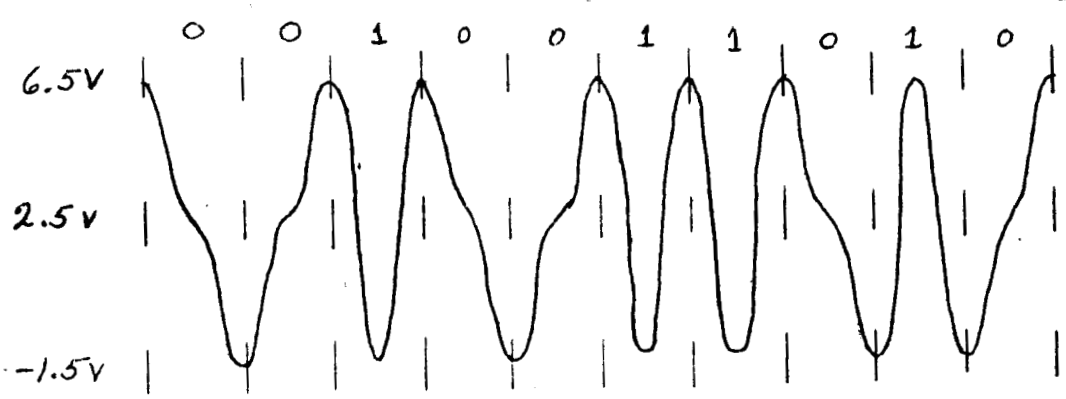
5.5 End of Tape. The end of tape signal from the recorder references the tape splice.



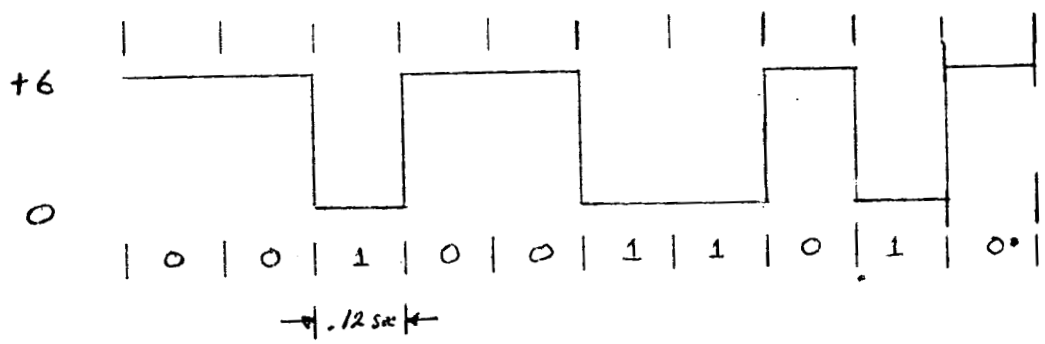
5.6 Track Indicator. The track indicator signal from the recorder tells what channel the machine is operating on.



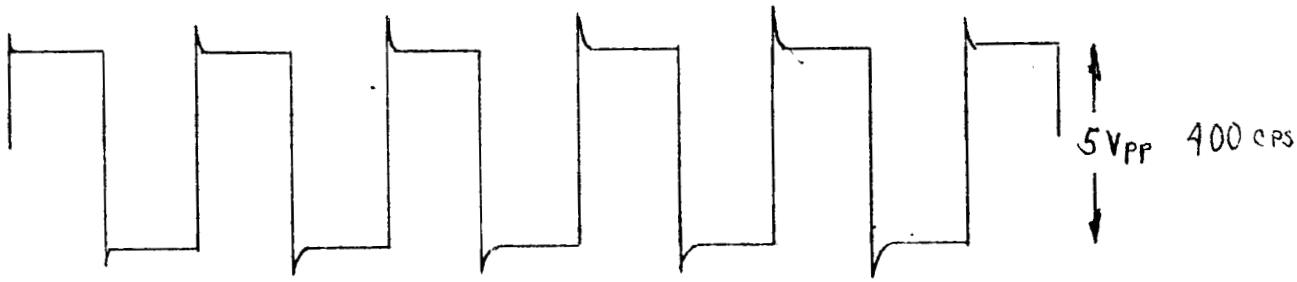
5.7 Playback Amplifier Monitor. The playback amplifier monitor indicates the quality of the recorded signal.



5.8 NRZ $\overline{\text{Data}}$ Monitor. The NRZ $\overline{\text{data}}$ monitor is a monitor of the inverted recorder output signal.



5.9 <u>400 CPS Monitor</u>. The 400 cps monitor gives a five vpp output when the 400 cps power is applied to the transport.



5.10 <u>Power Monitors</u>. Plus and minus 6 volts dc, plus and minus 20 volts dc, and the 4 to 6 volt dc motor voltage have been brought out for monitoring.

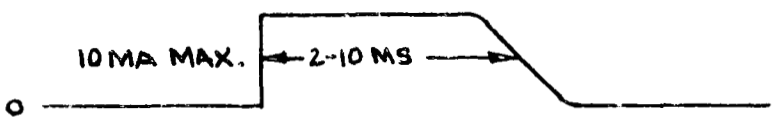
6.0 D/E INTERFACE WAVE FORMS

During playback the Data Encoder receives the signals from the recorder. These are the NRZ data signal, the End of Tape signal, the temperature sensor signal, the pressure transducer signal, and the Mode 4-1 logic signal. The Mode 4-1 logic signal informs the Data Encoder whether there is data being read back off the tape. When there is no data from the tape, the Data Encoder transmits engineering data. This condition would occur during a splice or to a quiet time on the tape due to run-up or run-down time in the record mode.

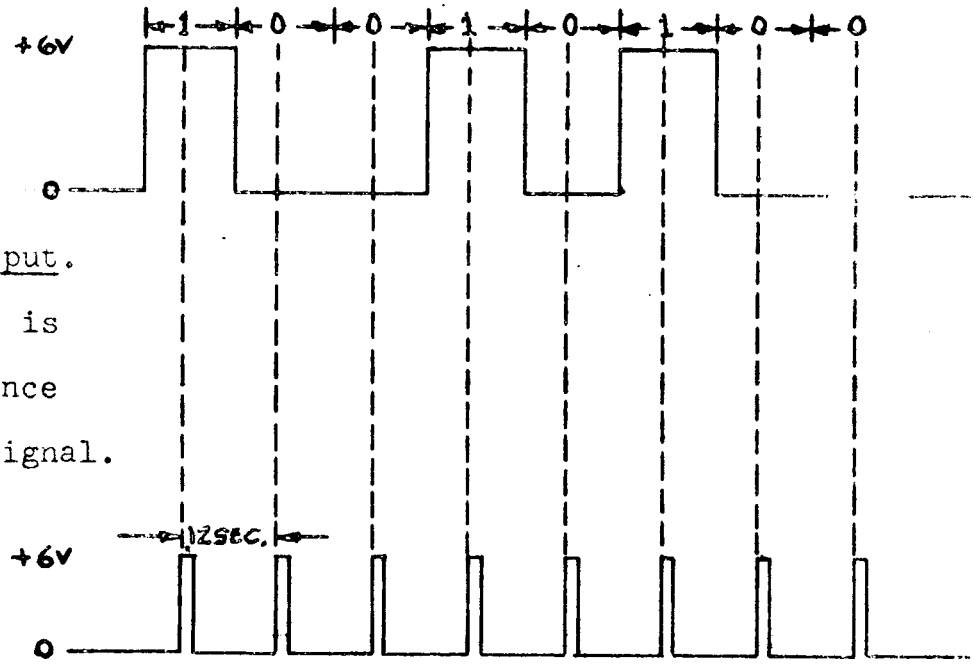
The Data Encoder sends two signals to the recorder. They are the playback command and the bit sync. The bit sync is used to phase-lock the playback signal.

The following are sample wave forms:

6.1 End of Tape. The end of tape signal from the recorder references the tape splice.



6.2 NRZ Data. NRZ data is the recorder output.

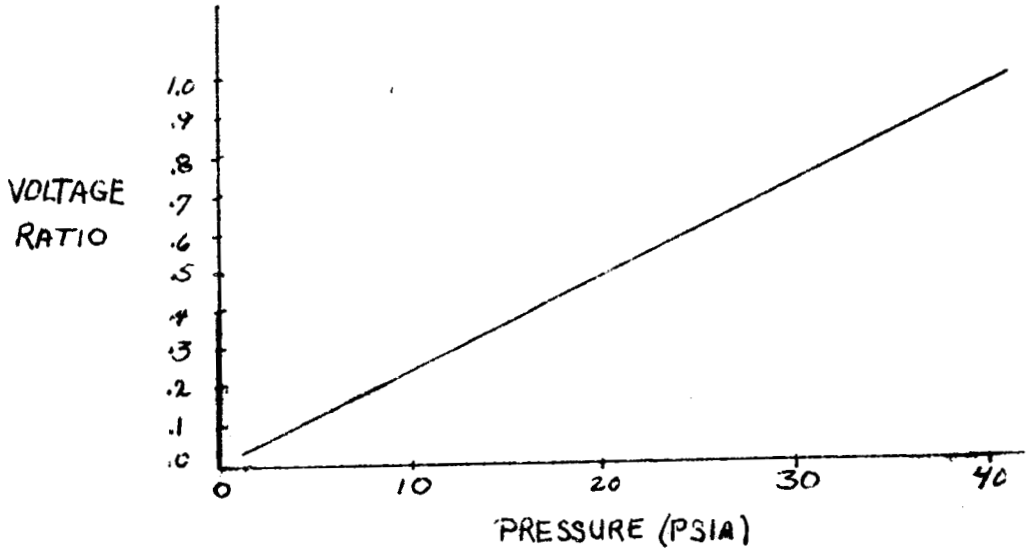


6.3 Bit Sync Input.

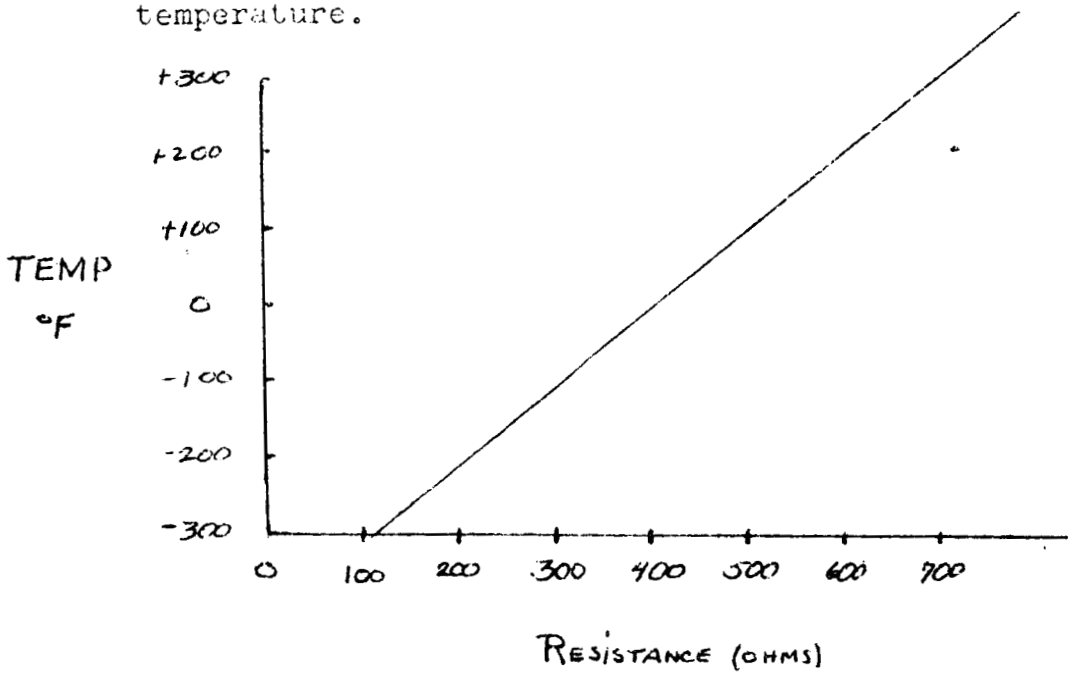
The bit sync is the speed reference for the output signal.

6.4 Mode 4-1 Logic. Mode 4-1 logic tells whether data is being reproduced.

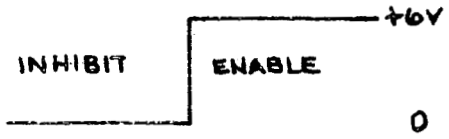
6.5 Pressure Transducer. The pressure transducer mounted within the transport allows a check on the leak rate of the cover seal.



6.6 Temperature sensor. The temperature sensor mounted within the transport allows a check on the main plate temperature.



6.7 Playback Command. A +6 volt playback command enables the playback motor, and inhibits the record amplifiers.

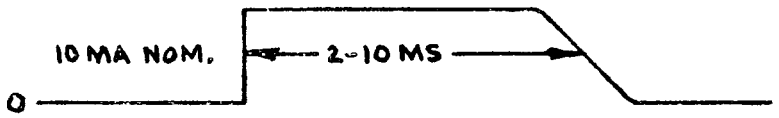


7.0 UMBILICAL INTERFACE WAVE FORMS

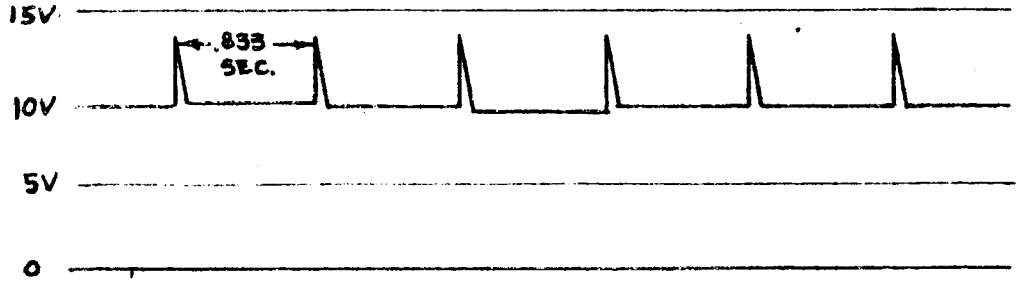
The umbilical system has two connections to the recorder. One is to monitor the integrator and the other is to command a track step.

The following are sample wave forms:

7.1 Track Step Command. The track step command is the external means of changing channels.



7.2 Integrator Monitor. The integrator monitor indicates whether the playback signal is phase-locked. The system is properly locked-in when the monitor signal is as shown below. When the system is out of lock, the monitor signal will wander between 5 and 15 volts. The system will normally lock-in within seven seconds in the presence of the playback data observed at the playback preamplifier monitor.



8.0 TEST POINT WAVE FORMS

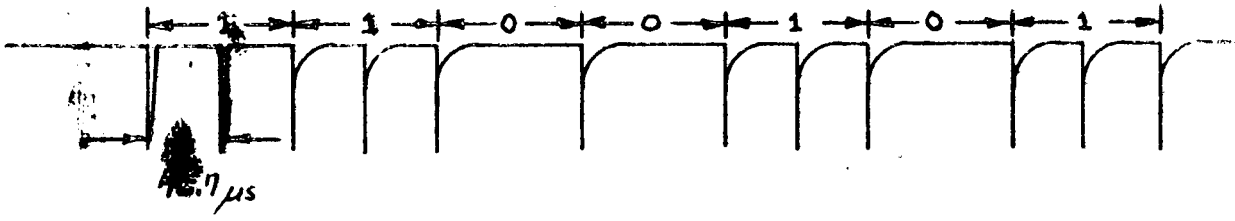
In order to determine the whereabouts of a malfunction, a number of critical points are brought out for monitoring.

The following wave forms will be present at their respective test points when a machine is functioning properly.

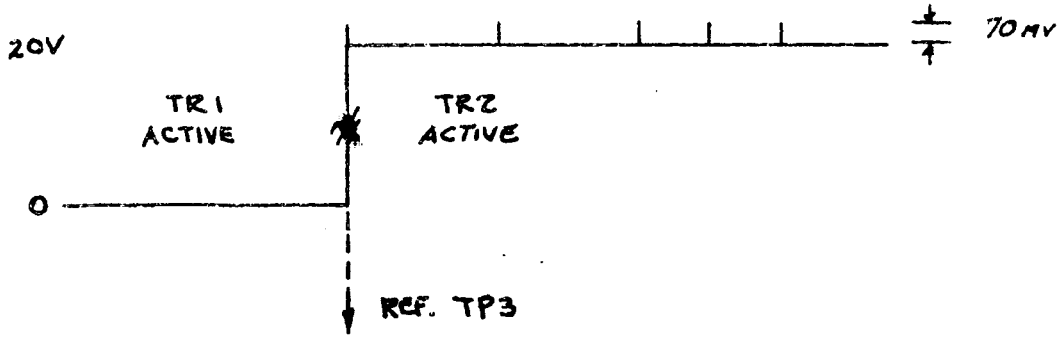
CAUTION: Observe test points with low capacitance, high impedance, differential scope.

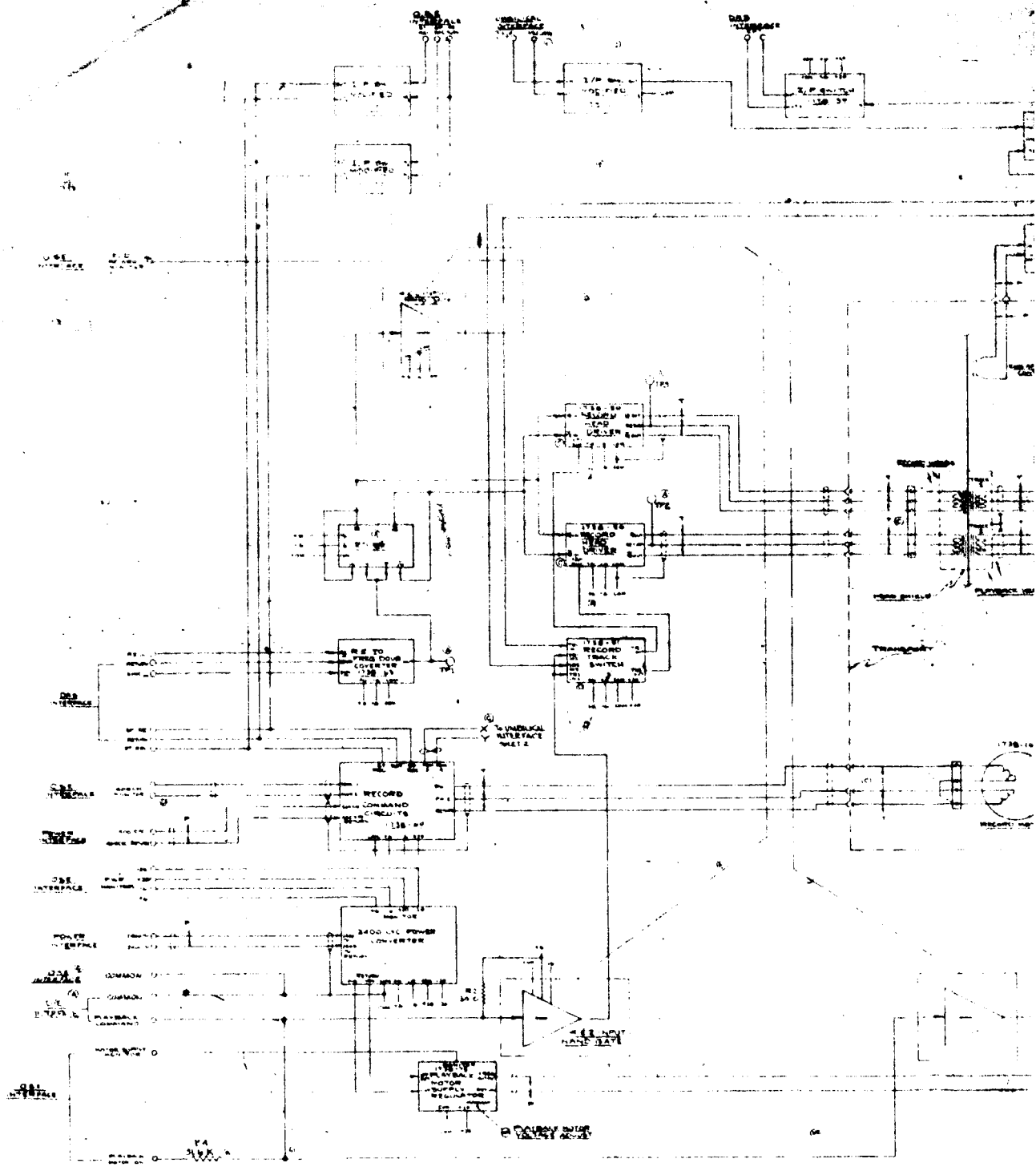
Origination of these signals can be found on Figures 2 and 3.

8.1 RZ to Frequency Double Converter Monitor (TP1). The F. D. record monitor shows the signal sent to the record amplifier.



8.2 Track 2 Head Current Monitor (TP2).





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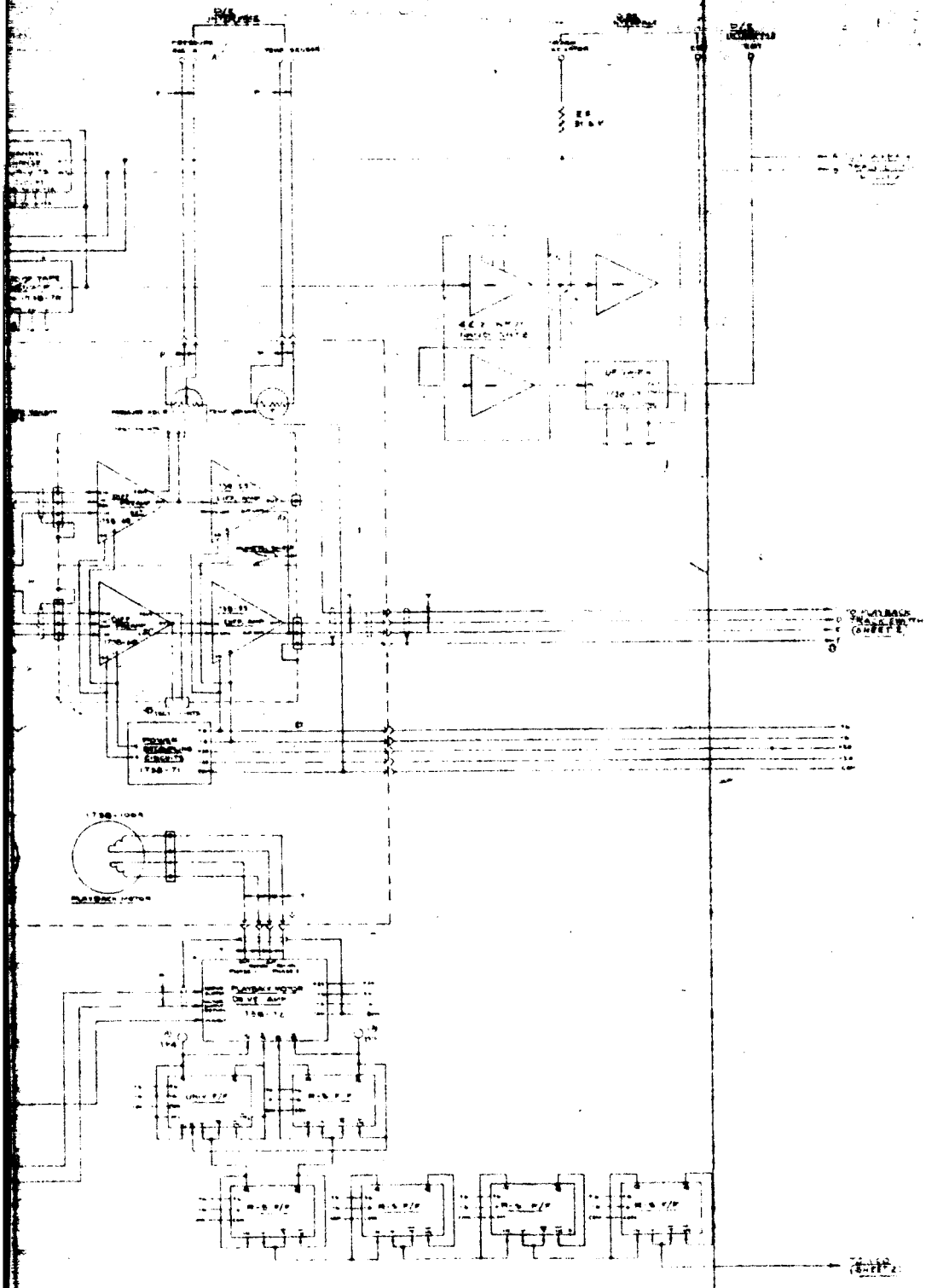
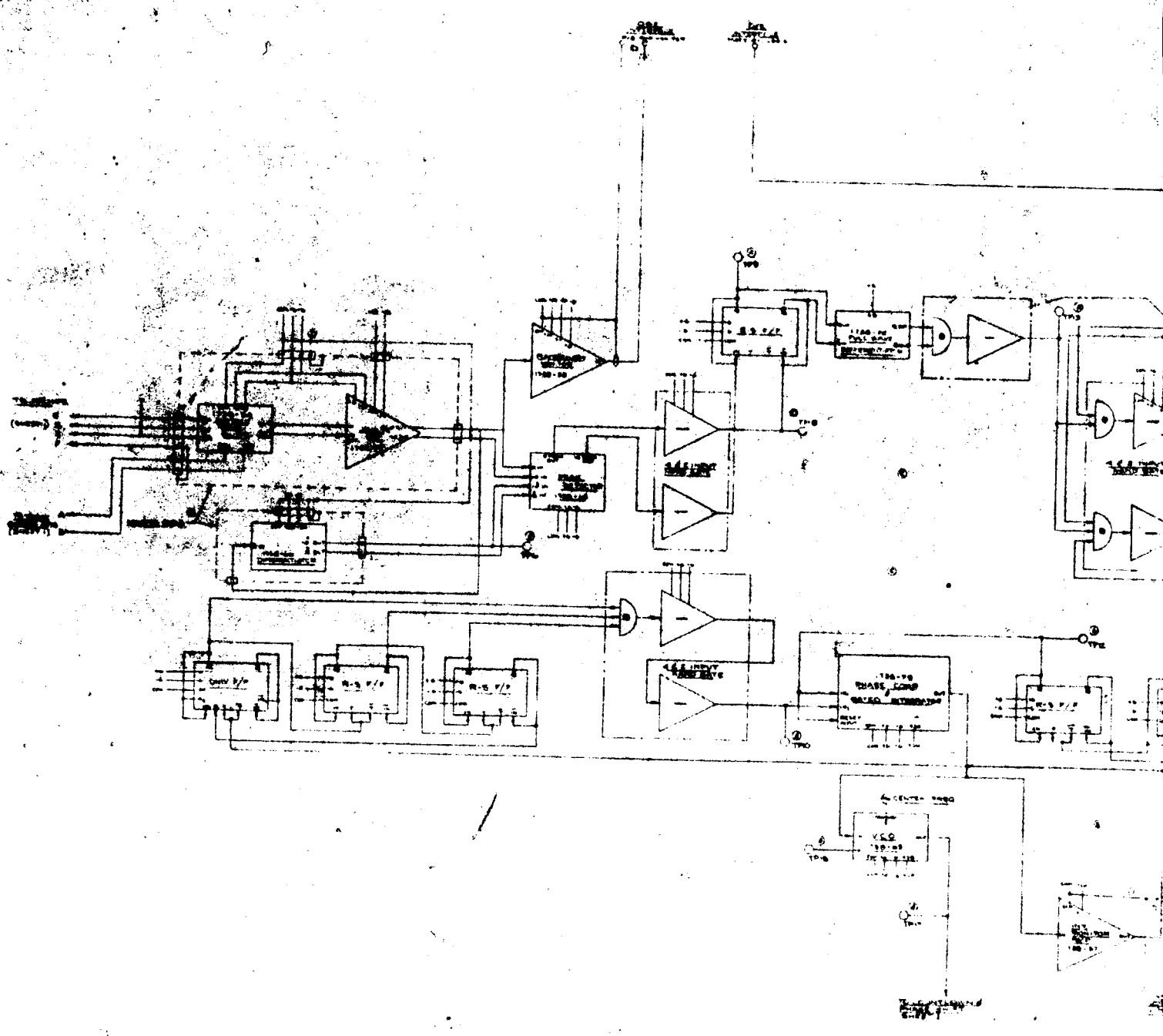


FIGURE 2



RECORD No. 63-491

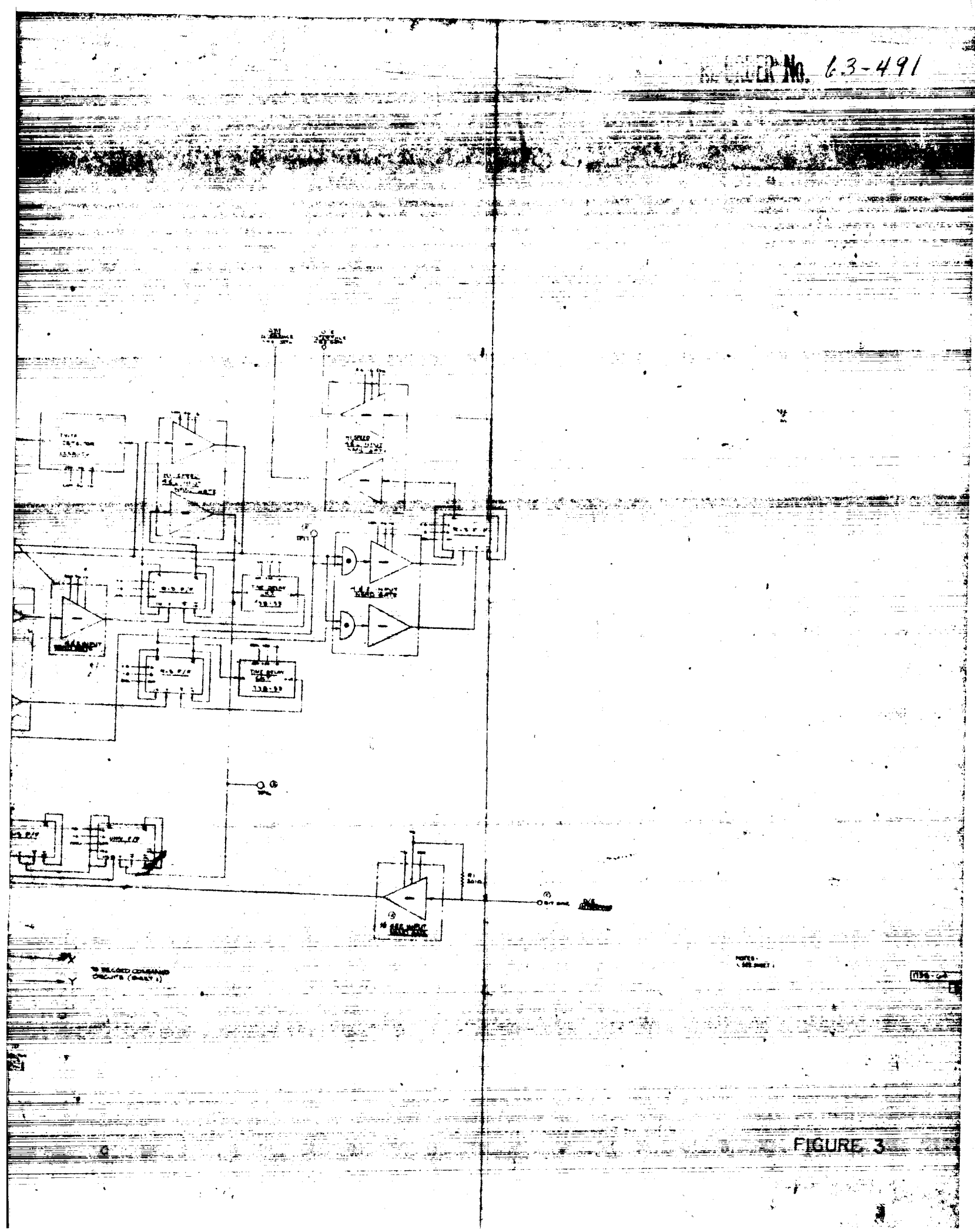
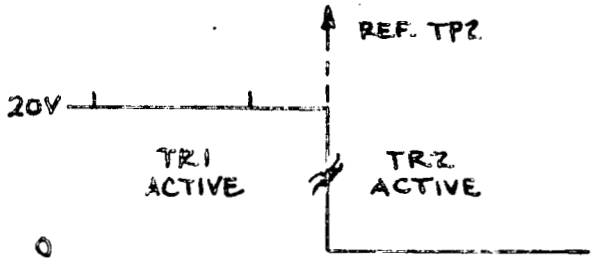


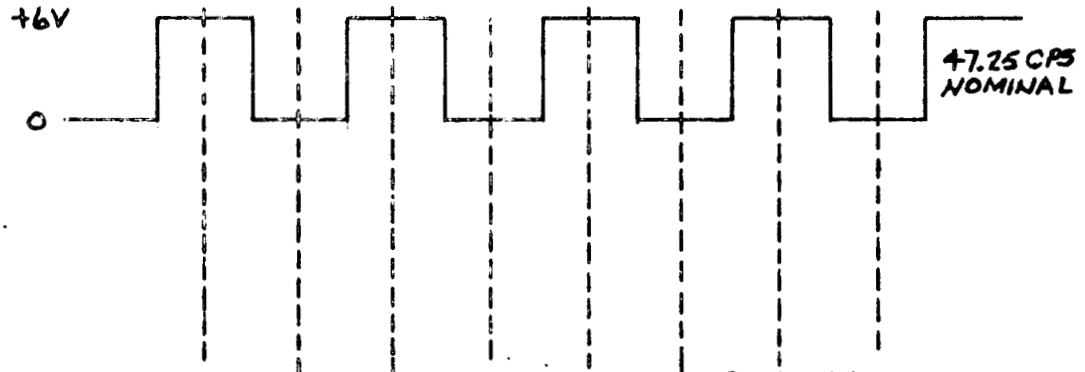
FIGURE 3

8.3 Track 1 Head Current Monitor (TP3).

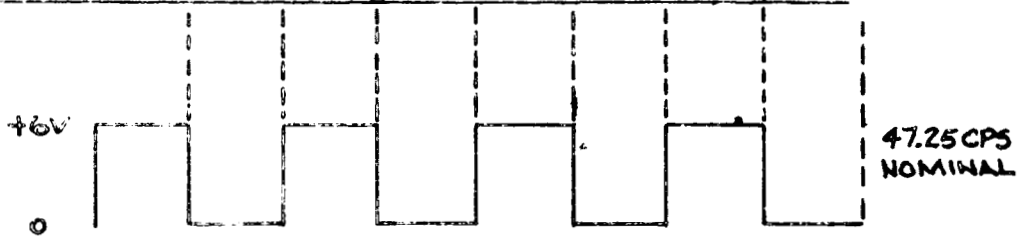


The head current monitors indicate which channel is active in the record mode.

8.4 Playback Motor Drive Logic Monitor Phase 2 (TP5).

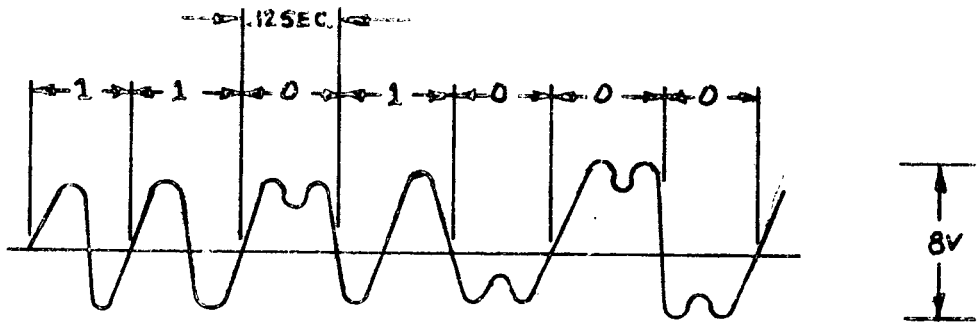


8.5 Playback Motor Drive Logic Monitor Phase 1 (TP4).



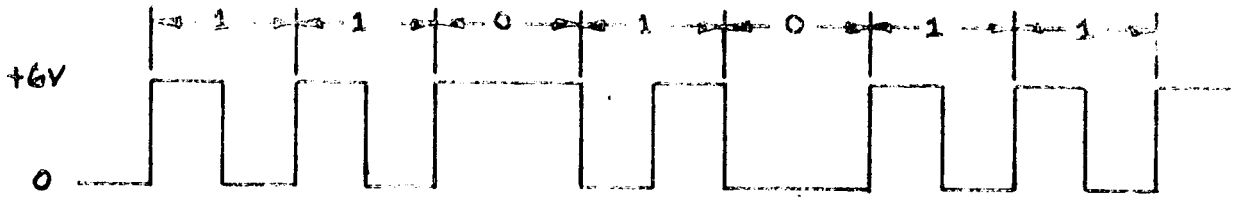
The playback motor drive logic monitor shows the counted down and phase shifted signal from the VCO.

8.6 Differentiator Output (TP6).

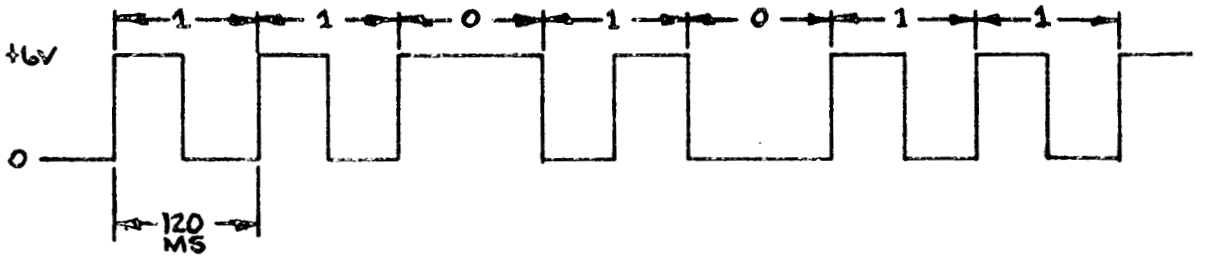


8.7 Peak Detector Trigger-obsolete.

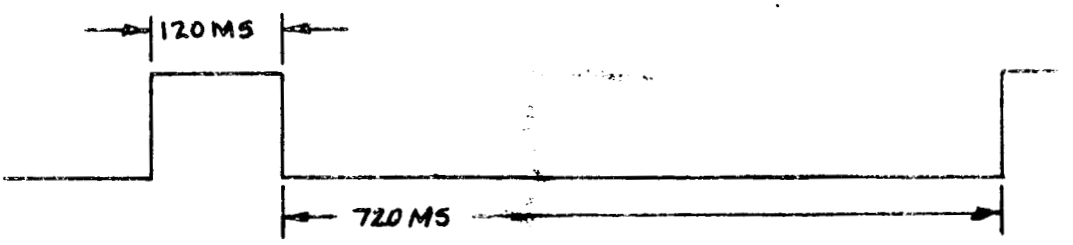
8.8 Peak Detector Trigger (TP8).



8.9 Playback Reconstructed Frequency Doubled Code (TP9).

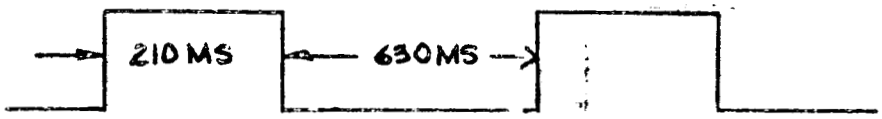


8.10 Phase Comparator Reference Input (TP10).

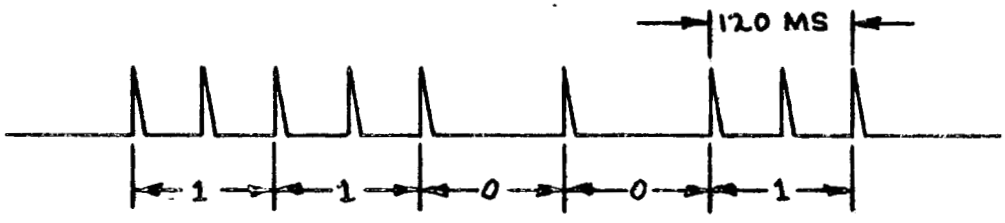


8.11 Obsolete.

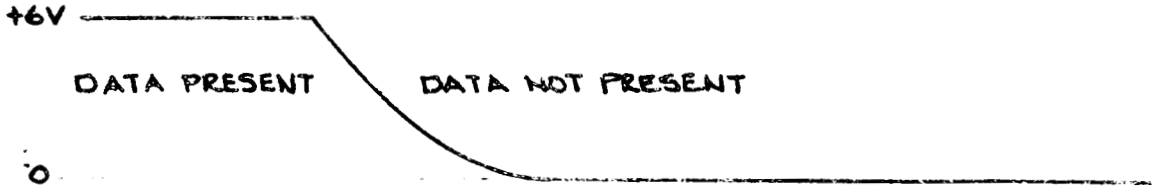
8.12 Phase Comparator Tape Input.



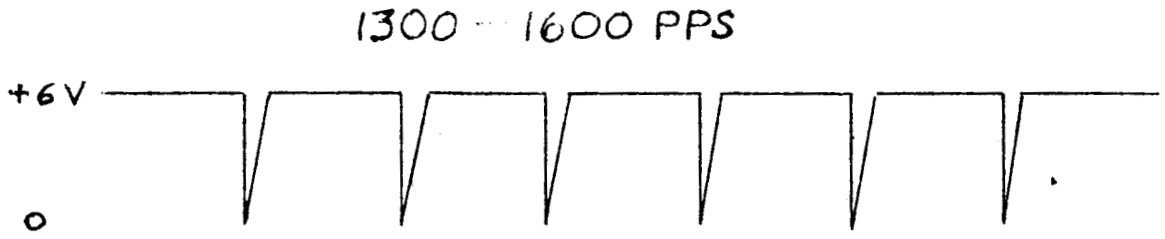
8.13 Differentiator and Fall Wave Rectifier Output (TP13).



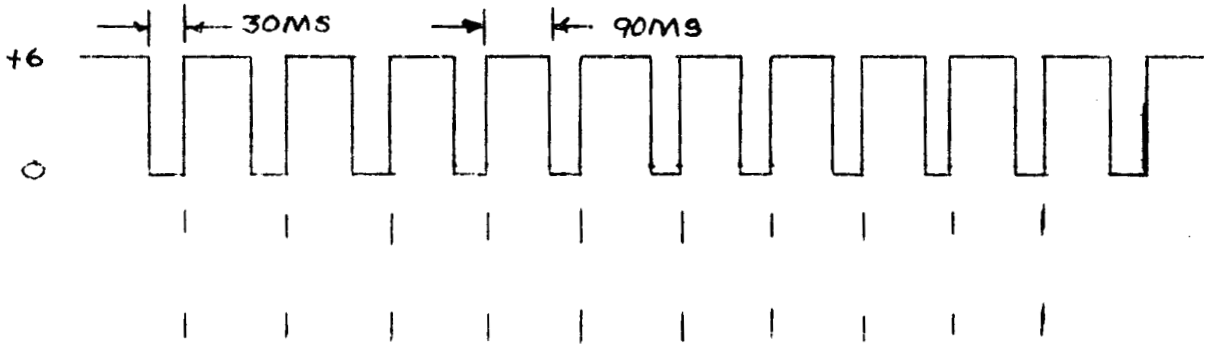
8.14 Data Detector Output (TP14).



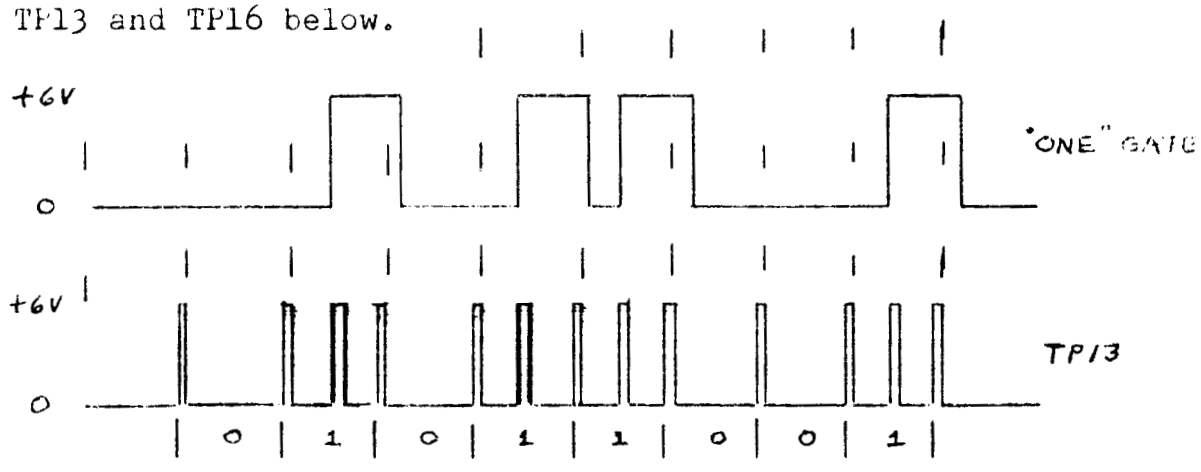
8.15 VCO Output (TP15).



8.16 Tape Bit Sync (TP16). The tape bit sync is the reconstructed sync recorded on the tape.



8.17 "One" Gate (TP17). The one gate is shown in relation to TP13 and TP16 below.



8.18 **VCO Auxiliary Input.** The VCO Auxiliary is a means of externally varying the frequency of the VCO and over riding the integrator output for test purposes.

It provides open loop (asynchronous) operation during playback.

A VCO frequency, measured at TP15, between 1360 and 1660 pps can be achieved by applying a dc voltage between 3.8 and 7.6 volts.

9.0 POWER REQUIREMENTS

9.1 Current Drain. The nominal current drain for the system is as follows:

MODE	+6	-6	+20	-20
PLAYBACK	56 MA	12 MA	33 MA	3.8 MA
RECORD	58 MA	12 MA	28 MA	3.7 MA

9.2 400 cps Requirement:

400 cps ± .1%, 62 volts p-p ± 1% sq. wave, 8 watts

9.3 2400 cps Requirement:

2400 cps ± 1%, 100 volts, <3 watts

2% Regulation average rectified value.

Less than 10° phase jitter

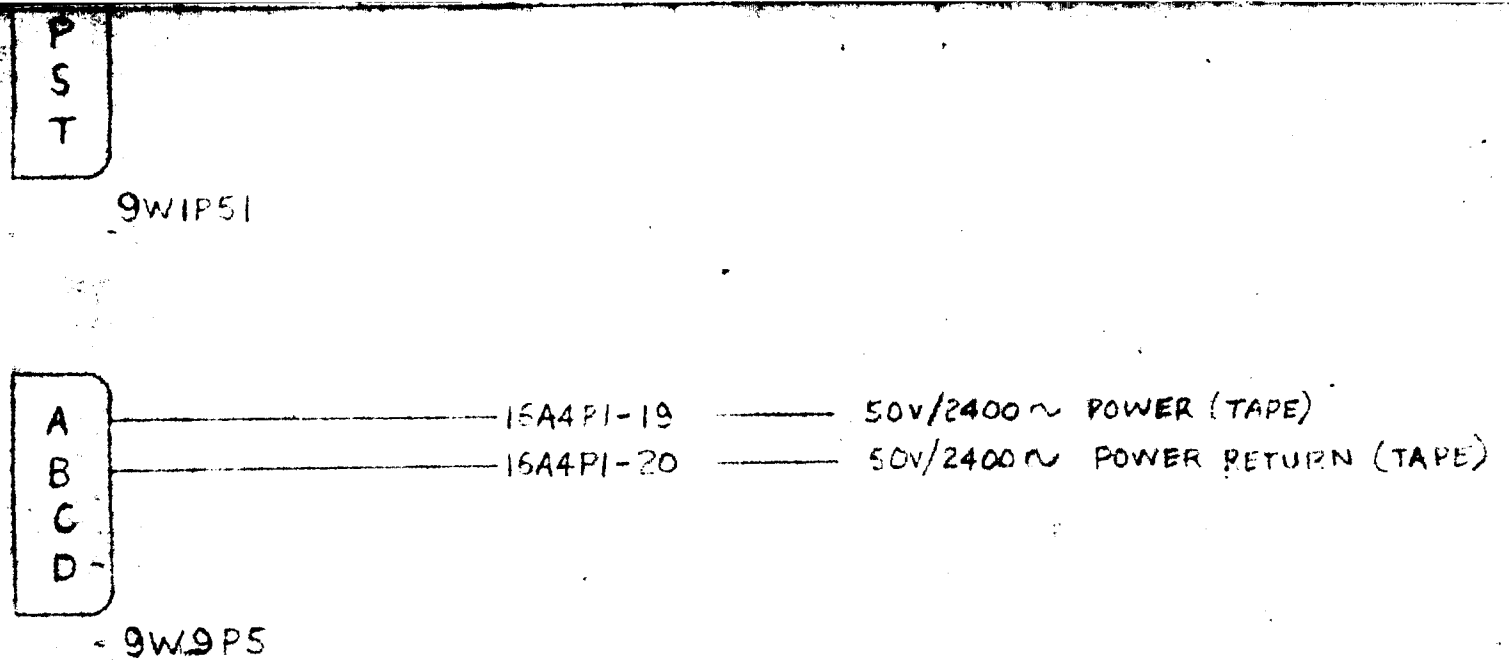
Rise and fall time 5 μsec ± 4 μsec

10.0 HARNESS DRAWING

Figures 4 thru 12 are the harness drawings describing the interconnection of the transport and the electronic modules.

RECORDER No. 23-491

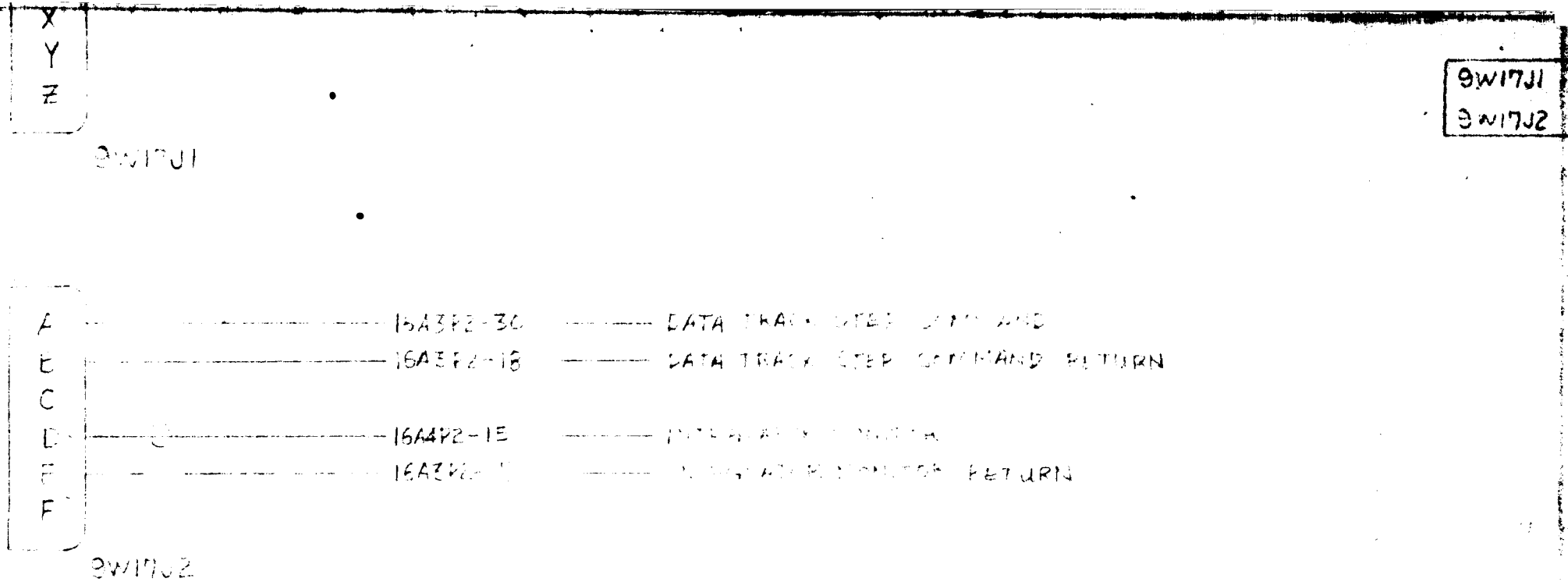
J	16A4P2-32	1Ø 400~ POWER (TAPE)
b	16A4P2-33	1Ø 400~ POWER RETURN (TAPE)
S	16A2P1-5	TAPE RECORDER DATA OUTPUT
t	16A2P1-1	BIT SYNC TO TAPE FROM ENCODER
Y	16A2P1-3	DATA MODE 4/1 LOGIC
d	16A1P1-1	RECORDER PRESSURE EXC.
c	16A1P1-20	RECORDER PRESSURE
R	16A1P1-35	RECORDER TEMPERATURE
Z	16A1P1-17	RECORDER TEMPERATURE RETURN
U	16A5P1-16	ENCOUNTER DATA TO RECORDER
V	16A5P1-14	DAS BIT SYNC TO RECORDER
F	16A5P1-11	DAS/TAPE RETURN (-SR)
A	16A4P1-1	DAS START RECORDER
B	16A4P1-3	DAS STOP RECORDER
C	16A4P1-2	DAS START/STOP RECORDER RETURN
D	16A3P2-20	END OF TAPE SIGNAL TO DAS
E	16A3P2-2	END OF TAPE SIGNAL TO DAS RETURN
b		
X	16A3P2-21	END OF TAPE LOOP TO COUNTER #3
W	16A4P2-28	RECORDER/DATA ENCODER RETURN
e	16A3P2-4	STOP/START RECORDER PLAYBACK
G	16A4P2-1	TAPE CASE GROUND
H		
J		
K		
L		
M		
N		



WO 801 9W17
WIRING HARNESS
13-AUG-63

RECORDER No. 63-491

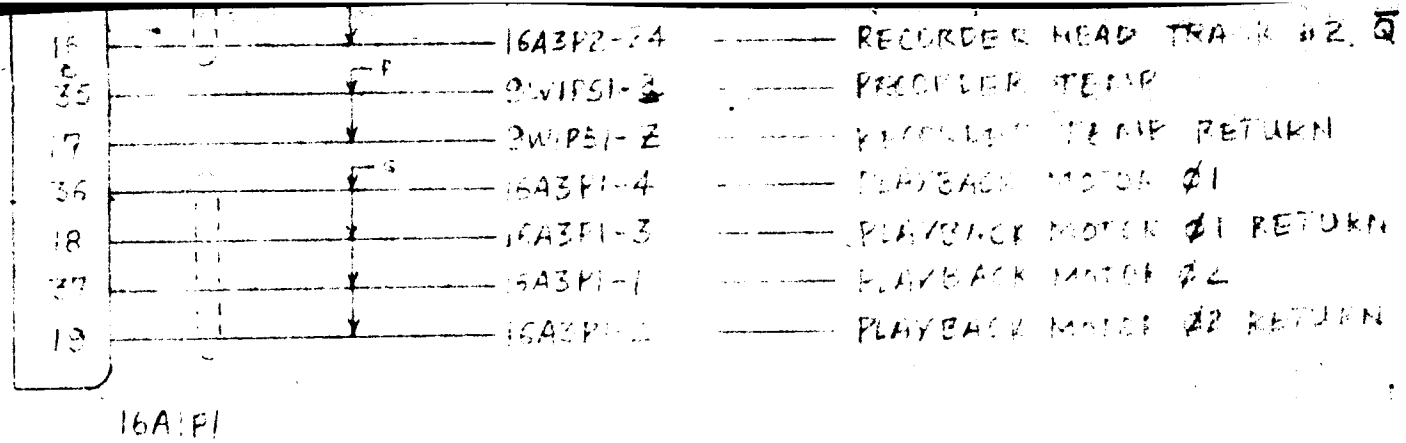
c	16A2P1-31	PLAYBACK AMPLIFIER MONITOR
g	16A3P2-7	FREQUENCY DOUBLED RECORD MONITOR (OSE)
d	16A3P2-19	PLAYBACK MOTOR ON (OSE)
f	16A3P2-6	END OF TAPE (OSE)
e	16A3P2-36	TRACK INDICATOR (OSE)
L		
J		
K		
b	16A3P2-14	RECORD START COMMAND (OSE)
a	16A3P2-13	RECORD STOP COMMAND (OSE)
j	16A3P2-15	RECORD COMMAND RETURN (OSE)
h	16A2P1-2[illegible]	$\overline{\text{DATA}}$ OUTPUT MONITOR
E	16A4P1-25	+20 VDC POWER MONITOR (OSE)
D	16A4P2-30	−20 VDC POWER MONITOR (OSE)
B	16A4P2-1[illegible]	+6 VDC POWER MONITOR (OSE)
A	16A4P2-[illegible]	−8 VDC POWER MONITOR (OSE)
C	16A4P1-10	+4 TO +6 VDC POWER MONITOR (OSE)
F	16A4P2-[illegible]	POWER MONITOR RETURN
G	P 16A4P[illegible]-34	400~ POWER MONITOR (OSE)
H	16A4P2-3[illegible]	400~ POWER MONITOR RETURN (OSE)
M		
N	16A2P1-33	SHIELD RETURN
P		
R		
S		
T		
U		
V		
W		



WO 801 9W17
WIRING HARNESS
13-AUG-63

RECORDER No. 63-4191

1	9W1P51-1	RECORDER PRESSURE EXC.
20	9W1P51-5	RECORDER PRESSURE SIGNAL
2	16A4P2-2	TRANSPORT CASE GROUND
21	16A4P2-4	+6VDC TRANSPORT DECOUPLING NETWORK
3	16A4P2-21	−6VDC TRANSPORT DECOUPLING NETWORK
22	16A4P1-22	+20VDC TRANSPORT DECOUPLING NETWORK
4	16A4P2-20	−20VDC TRANSPORT DECOUPLING NETWORK
23	16A4P2-3	TRANSPORT DECOUPLING NETWORK COMMON
5		
24	16A4P2-36	RECORDER MOTOR RETURN
6	16A4P2-37	RECORDER MOTOR Ø1
25	16A4P2-19	RECORDER MOTOR Ø2
7		
26		
8	10A2P1-25	SHIELD RETURN
27	10A2P1-27	PLAYBACK PREAMP COMMON
9	16A2P1-22	PLAYBACK PREAMP TRACK #1
28	16A2P1-23	PLAYBACK PREAMP TRACK #2
10		
29		
11		
30	16A5P2-11	END OF TAPE SENSOR HI
12	16A5P2-10	END OF TAPE SENSOR COMMON
31		
13		
32	16A3P2-28	RECORDER HEAD TRACK #1 Q
14	16A3P2-10	RECORDER HEAD TRACK #1 RETURN
33	16A3P2-27	RECORDER HEAD TRACK #1 $\overline{Q}$
15	16A3P2-26	RECORDER HEAD TRACK #2 Q
34	16A3P2-25	RECORDER HEAD TRACK #2 RETURN

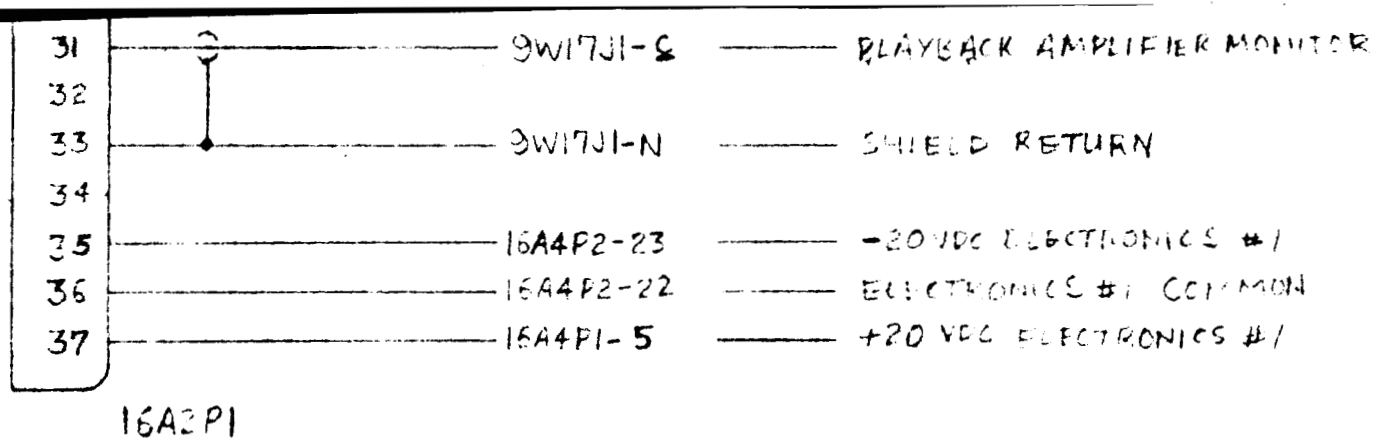


16A1P1

WO 801 9W17
WIRING HARNESS
13-446-63

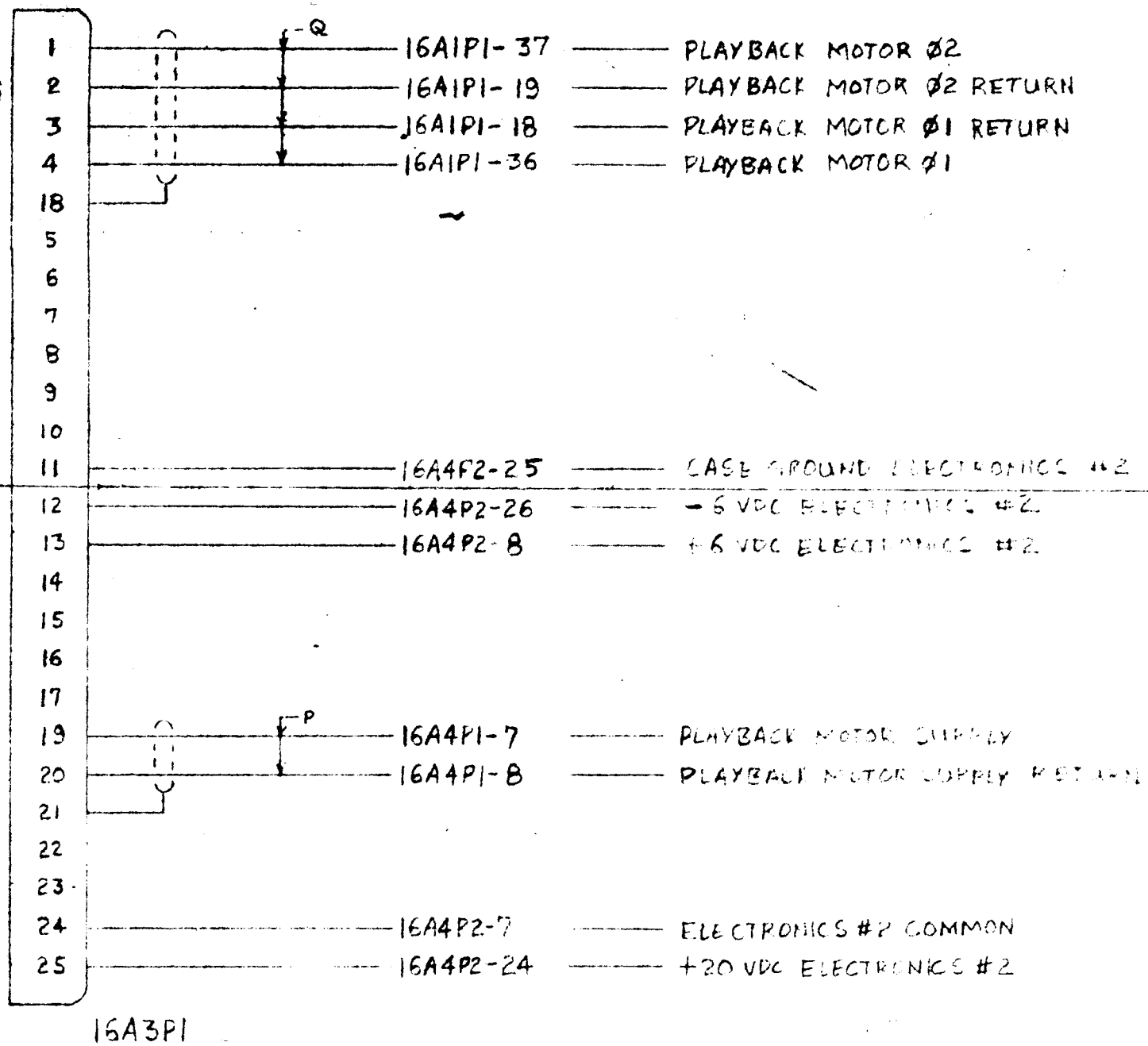
Ch 63-491

1	9W1P51-f	BIT SYNC TO TAPE FROM DATA ENCODER
2		
3	9W1P51-Y	DATA MODE 4/1 LOGIC
4		
5	9W1P51-g	TAPE RECORDER DATA OUTPUT
6		
7		
8		
9		
10		
11	16A3P2-3	TRACK #1
12		
13	16A3P2-5	TRACK #2
14		
15		
16		
17	16A4P2-5	CASE GROUND
18	16A4P2-24	-6 VDC ELECTRONICS #1
19	16A4P2-6	+6 VDC ELECTRONICS #1
20	16A3P2-37	INTEGRATOR OUTPUT TO VCO
21		
22	9W17J1-b	$\overline{\text{DATA}}$ OUTPUT MONITOR
23		
24		
25	16A1P1-8	SHIELD RETURN
26		
27	16A1P1-27	PLAYBACK PREAMP COMMON
28	16A1P1-28	PLAYBACK PREAMP TRACK #1
29	16A1P1-9	PLAYBACK PREAMP TRACK #2



16A2P1

WD 801 9W17



1
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18
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21
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23
24
25
Q
P
16A1P1-37
PLAYBACK MOTOR Ø2
16A1P1-19
PLAYBACK MOTOR Ø2 RETURN
16A1P1-18
PLAYBACK MOTOR Ø1 RETURN
16A1P1-36
PLAYBACK MOTOR Ø1
16A4P2-25
CASE GROUND ELECTRONICS #2
16A4P2-26
-6 VDC ELECTRONICS #2
16A4P2-8
+6 VDC ELECTRONICS #2
16A4P1-7
PLAYBACK MOTOR SUPPLY
16A4P1-8
PLAYBACK MOTOR SUPPLY RETURN
16A4P2-7
ELECTRONICS #2 COMMON
16A4P2-24
+20 VDC ELECTRONICS #2
16A3P1

16A3P1

WO 801 9W17

WIRING HARNESS

13-AUG-63

E.O.G.

No. 63-491

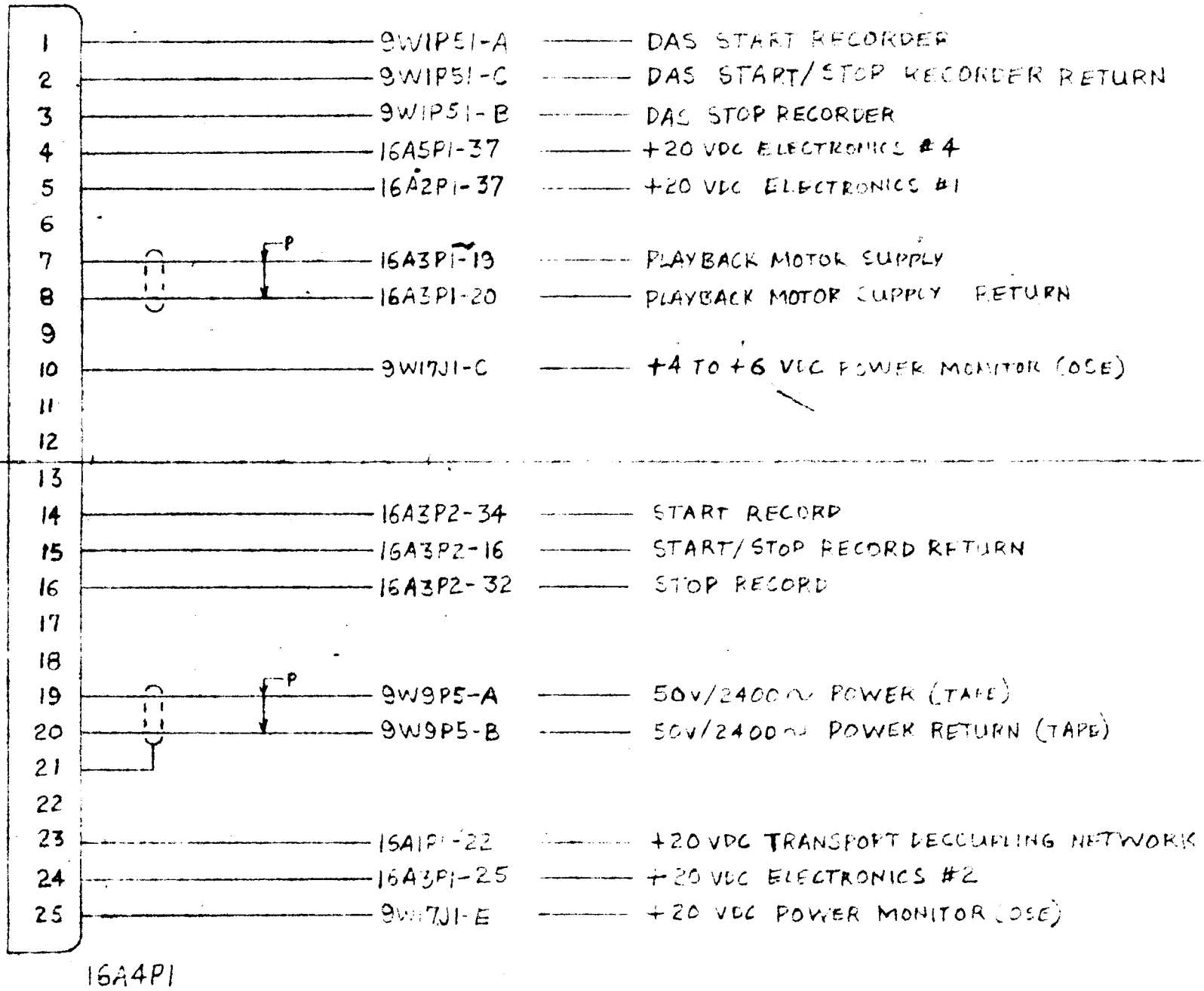
1		
2	9W1P51-E	END OF TAPE SIGNAL TO DAS RETURN
3	16A2P1-11	TRACK #1
4	9W1P51-e	STOP/START RECORDER PLAYBACK
5	16A2P1-13	TRACK #2
6	9W17J1-f	END OF TAPE (OSE)
7	9W17J1-g	FREQUENCY DOUBLED RECORD MONITOR (OSE)
8	16A5P1-15	RZ TO FL CONVERTER OUTPUT
9		
24	16A1P1-16	RECORDER HEAD TRACK #2 $\bar{Q}$
25	16A1P1-34	RECORDER HEAD TRACK #2 RETURN
26	16A1P1-15	RECORDER HEAD TRACK #2 Q
10	16A1P1-14	RECORDER HEAD TRACK #1 RETURN
27	16A1P1-33	RECORDER HEAD TRACK #1 $\bar{Q}$
28	16A1P1-32	RECORDER HEAD TRACK #1 Q
11	16A1P1-30	END OF TAPE SENSOR (1)
29	16A1P1-12	END OF TAPE SENSOR COMMAND
12	16A5P1-10	EOT SENSOR OUTPUT
13	9W17J1-a	RECORD STOP COMMAND (OSE)
14	9W17J1-b	RECORD START COMMAND (OSE)
15	9W17J1-j	RECORD COMMAND RETURN (OSE)
16	16A4P1-15	START/STOP RECORD RETURN
17	9W17J2-E	INTEGRATOR MONITOR RETURN
18	9W17J2-B	DATA TRACK STOP COMMAND RETURN
35	16A4P2-14	INTEGRATOR MONITOR
19	9W17J1-d	PLAYBACK MOTION (OSE)
20	9W1P51-D	END OF TAPE SIGNAL TO DAS
21	9W1P51-X	END OF TAPE STOP TO RECORDER #3
22	16A5P1-13	CHANNEL CHANGE OUT TRACK #1 [illegible]

29	16A5P1-12	CHANNEL CHANGE CKT TRACK #2 OUTPUT GATE
30	9W17J2-A	DATA TRACK STEP COMMAND
31	16A5P1-9	CHANNEL CHANGE CIRCUIT IN
32	16A4P1-16	STOP RECORD
33		
34	16A4P1-14	START RECORD
36	9W17J1-E	TRACK INDICATOR (ODD)
37	16A2P1-20	INTEGRATOR OUTPUT TO VCO

16A3P2

16A3P2

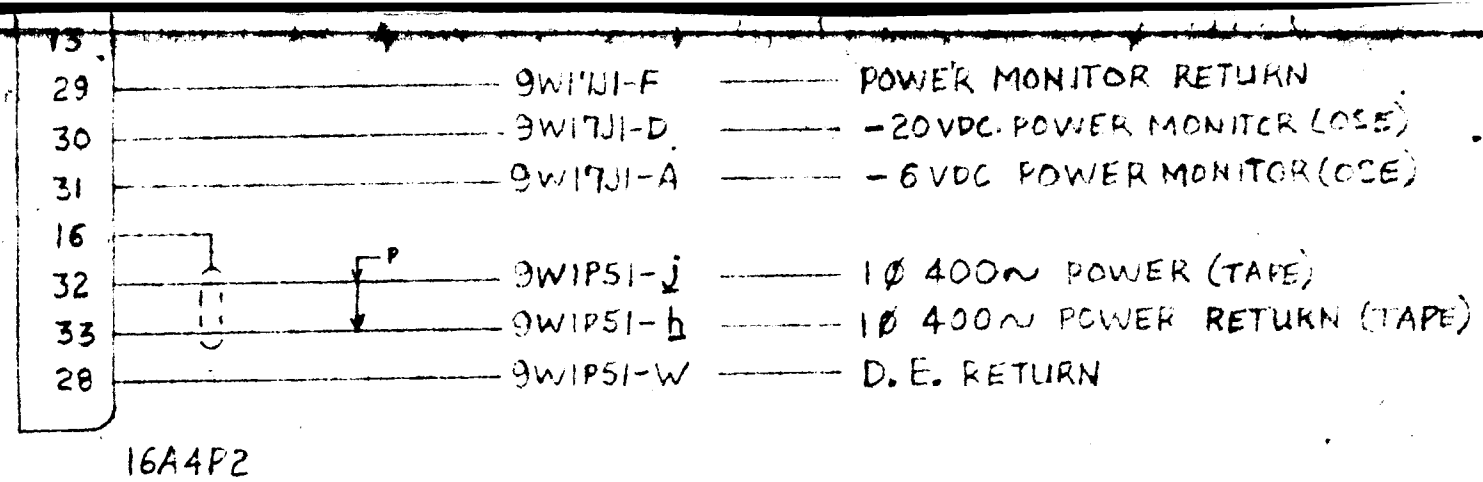
VJ0801 9W17
WIRING HARNESS
13-AUG-73


1 — 9W1P51-A — DAS START RECORDER
2 — 9W1P51-C — DAS START/STOP RECORDER RETURN
3 — 9W1P51-B — DAS STOP RECORDER
4 — 16A5P1-37 — +20 VDC ELECTRONICS #4
5 — 16A2P1-37 — +20 VDC ELECTRONICS #1
6
7 — 16A3P1-19 — PLAYBACK MOTOR SUPPLY
8 — 16A3P1-20 — PLAYBACK MOTOR SUPPLY RETURN
9
10 — 9W17J1-C — +4 TO +6 VDC POWER MONITOR (OSE)
11
12
13
14 — 16A3P2-34 — START RECORD
15 — 16A3P2-16 — START/STOP RECORD RETURN
16 — 16A3P2-32 — STOP RECORD
17
18
19 — 9W9P5-A — 50V/2400~ POWER (TAPE)
20 — 9W9P5-B — 50V/2400~ POWER RETURN (TAPE)
21
22
23 — 15A1P1-22 — +20 VDC TRANSPORT DECOUPLING NETWORK
24 — 16A3P1-25 — +20 VDC ELECTRONICS #2
25 — 9W17J1-E — +20 VDC POWER MONITOR (OSE)
P
16A4P1

16A4P1

WO 801 9W17
WIRING HARNESS
12-AUG-63
P.O.G.

1	9W1P51-G	TAPE CASE GROUND
2	16A1P1-2	TRANSPORT CASE GROUND
3	16A1P1-23	TRANSPORT DECOUPLING NETWORK COMMON
4	16A1P1-21	+6 VDC TRANSPORT DECOUPLING NETWORK
18		
19	16A1P1-25	RECORDER MOTOR Ø2
36	16A1P1-24	RECORDER MOTOR RETURN
37	16A1P1-6	RECORDER MOTOR Ø1
20	16A1P1-4	-20 VDC TRANSPORT DECOUPLING NETWORK
21	16A1P1-3	-6 VDC TRANSPORT DECOUPLING NETWORK
5	16A2P1-17	CASE GROUND ELECTRONICS #1
6	16A2P1-19	+6 VDC ELECTRONICS #1
22	16A2P1-36	ELECTRONICS #1 COMMON
23	16A2P1-35	-20 VDC ELECTRONICS #1
24	16A2P1-18	-6 VDC ELECTRONICS #1
7	16A3P1-24	ELECTRONICS #2 COMMON
8	16A3P1-13	+6 VDC ELECTRONICS #2
15	9W17J2-D	INTEGRATOR MONITOR
14	16A3P2-35	INTEGRATOR MONITOR
17		
34	9W17J1-G	400~ POWER MONITOR (OSE)
35	9W17J1-H	400~ POWER MONITOR RETURN (OSE)
25	16A3P1-11	CASE GROUND ELECTRONICS #2
26	16A3P1-12	-6 VDC ELECTRONICS #2
9	16A5P1-17	CASE GROUND ELECTRONICS #4
10	16A5P1-36	ELECTRONICS #4 COMMON
11	16A5P1-19	+6 VDC ELECTRONICS #4
27	16A5P1-18	-6 VDC ELECTRONICS #4
12	9W17J1-B	+6 VDC POWER MONITOR (OSE)



16A4P2

WO 801 9W17
WIRING HARNESS
14-AUG-63

63-491

9	16A3P2-31	CHANNEL CHANGE CIRCUIT IN,
10	16A3P2-12	ECT SENSOR OUTPUT
11	9W1P51-F	DAS/TAPE RETURN (-SR)
12	16A3P2-23	CHANNEL CHANGE CIRCUIT TRACK #2 OUTPUT GATE
13	16A3P2-22	CHANNEL CHANGE CIRCUIT TRACK #1 OUTPUT GATE
14	9W1P51-V	DAS BIT SYNC TO RECORDER
15	16A3P2-8	RZ TO FD CONVERTER OUTPUT
16	9W1P51-U	ENCOUNTER DATA TO RECORDER
17	16A4P2-9	CASE GROUND ELECTRONICS #4
18	16A4P2-27	-6 VDC ELECTRONICS #4
19	16A4P2-11	+6 VDC ELECTRONICS #4

16A5P1

31		
32		
33		
34		
35		
36	16A4P2-10	ELECTRONICS #4 COMMON
37	16A4P1-4	+20 VDC ELECTRONICS #4

16A5P1

WO 801 9W17
WIRING HARNESS
14-AUG-63

```
      CHIDP=-2.*SAVE*CONST*SUML
      PSI=.166666667*SAVE*CONST*SUMM
      PHILO=2.*CONST*SAVE*SUMM
      PRINT 503,BEE,CHI,CHIP,CHIDP,PSI,PHILO
  503 FORMAT (1X,4HBEE=E20.10,2X,4HCHI=E20.10,2X,5HCHIP=E20.10/1X,6HCHI
     1P=E20.10,2X,4HPSI=E20.10,2X,4HPHI=E20.10/)
      RETURN
   24 CONTINUE
C     INTEGRATION SECTION C
      PRINT 61
   61 FORMAT (10H SECTION C)
      PRINT 39, RONE, RLESSER, RGREATR
   39 FORMAT (1X,5HRONE=E20.10,2X,8HRLESSER=E20.10,2X,9HRGREATER=E20.10
      RV=(RONE+RLESSER)*.5
      RQ=RGREATR +1.
      SUMA=0.
      SUMB=0.
      SUMC=0.
      SUMD=0.
      SUME=0.
      SUMF=0.
      SUMG=0.
      SUMH=0.
      SUMI=0.
      SUMJ=0.
      SUMK=0.
      SUML=0.
      SUMM=0.
      DRBCDE=(RV-RONE)*.5
      DRJKLM=(RQ-RV)*.5
      DO 30 N=1,MEHLERC
      DIV=1.-CY(N)
      RA=2.*RONE/DIV
      DRA=RA/DIV
      CULT=CY(N)-1.
      RBCDE=RV+DRBCDE*CULT
      RJKLM=RQ+DRJKLM*CULT
      CFACT=SQRTF(1.-CY(N)*CY(N))
      SUMA=SUMA+DRA/(RA*RA*SQRTF(1.-PHIHI(0,RA)))*CFACT
      CALL ABCD(RBCDE,A,B,C,D,0.)
      SAME=DRBCDE/SQRTF(1.-PHIHI(0,RBCDE))*CFACT
      SUMB=SUMB+SAME*A
      SUMC=SUMC+SAME*B
      SUMD=SUMD+SAME*C
      SUME=SUME+SAME*D
      CALL ABCD(RJKLM,A,B,C,D,0.)
      SAME=1.-PHIHI(0,RJKLM)
      SAMERT=SQRTF(SAME)
```

```
      SAMECU=SAME*SAMERT
      SAMEFIV=SAMECU*SAME
      RSQ=RJKLM*RJKLM
      PTWO=PHIHI(2,RJKLM)
      RFOR=RSQ*RSQ
      RSIX=RFOR*RSQ
      TERM=DRJKLM*CFACT
      SUMJ=SUMJ+TERM*(1./(RSQ*SAMERT)+BSQ/(RFOR*SAMECU))
      SUMK=SUMK+3.*TERM*(1./(RFOR*SAMECU)+BSQ/(RSIX*SAMEFIV))
      SUML=SUML+TERM*(PTWO/(RSQ*SAMEFIV)+6./(RFOR*SAMECU))
      SUMM=SUMM+TERM*((-804.     /RSIX-(228.  *PTWO/RSQ+10.        *PHIHI(
     14,RJKLM))/(RSQ*SAME)-49.        *PTWO*PTWO/(RSQ*SAME*SAME))/SAMEFIV
     2) /1536.
      RFGHI=2.*RQ/DIV
      DRFGHI=RFGHI/DIV
      CALL ABCD(RFGHI,A,B,C,D,0.)
      SAME=DRFGHI/SQRTF(1.-PHIHI(0,RFGHI))*CFACT
      SUMF=SUMF+SAME*A
      SUMG=SUMG+SAME*B
      SUMH=SUMH+SAME*C
      SUMI=SUMI+SAME*D
   30 CONTINUE
      CONST=3.141592654/FLOATF(NUMLERC)
      CALL ABCD(RQ,HOLDA,HOLDB,HOLDC,HOLDD,1.)
      CALL ABCD(RV,ANSA,ANSB,ANSC,ANSD,1.)
      SAVE=     BEE
      CHI=3.141592654-2.*BEE*CONST*SUMA
      CHIP=2.     *(CONST*(SUMB+SUMF-SUMJ)+HOLDA-ANSA)
      IF(S) 41, 41,42
   41 S=1.
      CHIDP=-2.*SAVE*(CONST*(SUMC+SUMG+SUMK)-HOLDB+ANSB)
      PSI=.1666666667*SAVE*(CONST*(SUMD+SUMH+.75*SUML)-HOLDC+ANSC)
      PHILO=2.*SAVE     *(CONST*(SUME+SUMI+SUMM)+HOLDD-ANSD)
      DHIDP=CHIDP
      DSI=PSI
      DHILO=PHILO
      CHIDP=0.
      PSI=0.
      PHILO=0.
      GO TO 43
   42 CHIDP=-2.*SAVE*(CONST*(SUMC+SUMG+SUMK)-HOLDB+ANSB)
      IF(CHIDP-DHIDP) 49,49,47
   47 DHIDP=CHIDP
      CHIDP=0.
   49 PSI=.1666666667*SAVE*(CONST*(SUMD+SUMH+.75*SUML)-HOLDC+ANSC)
      IF(PSI-DSI) 54,54,52
   52 DSI=PSI
      PSI=0.
```

```
   54 PHILO=2.*SAVE     *(CONST*(SUME+SUMI+SUMM)+HOLDD-ANSD)
      IF(PHILO-DHILO) 43, 43,57
   57 DHILO=PHILO
      PHILO=0.
   43 PRINT 504,BEE,CHI,CHIP,CHIDP,PSI,PHILO
  504 FORMAT (1X,4HBEE=E20.10,2X,4HCHI=E20.10,2X,5HCHIP=E20.10/1X,6HCHID
     1P=E20.10,2X,4HPSI=E20.10,2X,4HPHI=E20.10/)
      RETURN
   25 CONTINUE
C     INTEGRATION SECTION D
      PRINT 62
   62 FORMAT (10H SECTION D)
      PRINT 40, RONE, RTWO, RTHREE, RLESSER
   40 FORMAT (1X,5HRONE=E20.10,2X,5HRTWO=E20.10,2X,7HRTHREE=E20.10,2X,
     18HRLESSER=E20.10)
      RV=(RONE+RLESSER)*.5
      RQ=(RLESSER+RTWO)*.5
      SUMA=0.
      SUMB=0.
      SUMC=0.
      SUMD=0.
      SUME=0.
      SUMF=0.
      SUMG=0.
      SUMH=0.
      SUMI=0.
      SUMJ=0.
      SUMK=0.
      SUML=0.
      SUMM=0.
      SUMN=0.
      SUMO=0.
      SUMP=0.
      SUMQ=0.
      SUMR=0.
      DRA=(RTWO-RONE)*.5
      DRBCDE=(RV-RONE)*.5
      DRKLMN=(RTWO-RQ)*.5
      DROPQR=(RQ-RV)*.5
      DO 31 N=1,MEHLERD
      CULT=DY(N)-1.
      DIV=1.-DY(N)
      RA=RTWO+DRA*CULT
      RBCDE=RV+DRBCDE*CULT
      RKLMN=RTWO+DRKLMN*CULT
      ROPQR=RQ+DROPQR*CULT
       RFGHIJ=2.*RTHREE/DIV
      DRFGHIJ=RFGHIJ/DIV
```

```
      CFACT=SQRTF(1.-DY(N)*DY(N))
      SUMA=SUMA+DRA/(RA*RA*SQRTF(1.-PHIHI(0,RA)))*CFACT
      CALL ABCD(RBCDE,A,B,C,D,0.)
      SAME=DRBCDE/SQRTF(1.-PHIHI(0,RBCDE))*CFACT
      SUMB=SUMB+SAME*A
      SUMC=SUMC+SAME*B
      SUMD=SUMD+SAME*C
      SUME=SUME+SAME*D
      CALL ABCD(RFGHIJ,A,B,C,D,0.)
      SAME=DRFGHIJ/SQRTF(1.-PHIHI(0,RFGHIJ))*CFACT
      SUMF=SUMF+SAME/(RFGHIJ*RFGHIJ)
      SUMG=SUMG+SAME*A
      SUMH=SUMH+SAME*B
      SUMI=SUMI+SAME*C
      SUMJ=SUMJ+SAME*D
      CALL ABCD(RKLMN,A,B,C,D,0.)
      SAME=DRKLMN/SQRTF(1.-PHIHI(0,RKLMN))*CFACT
      SUMK=SUMK+SAME*A
      SUML=SUML+SAME*B
      SUMM=SUMM+SAME*C
      SUMN=SUMN+SAME*D
      SAVE=1.-PHIHI(0,ROPQR)
      SAVERT=SQRTF(SAVE)
      SAVECU=SAVE*SAVERT
      RSQ=ROPQR*ROPQR
      SAVEFIV=SAVECU*SAVE
      PTWO=PHIHI(2,ROPQR)
      RFOR=RSQ*RSQ
      RSIX=RFOR*RSQ
      TERM=DROPQR*CFACT
      SUMO=SUMO+TERM*(1./(RSQ*SAVERT)+6SQ/(RFOR*SAVECU))
      SUMP=SUMP+TERM*(3./(RFOR*SAVECU)+3.*8SQ/(RSIX*SAVEFIV))
      SUMQ=SUMQ+TERM*(PTWO/(RSQ*SAVEFIV)+6./(RFOR*SAVECU))
      SUMR=SUMR+TERM*((-804.     /RSIX-(228.   *PTWO/RSQ+10.        *PHIHI(
     14,ROPQR))/(RSQ*SAME)-49.        *PTWO*PTWO/(RSQ*SAME*SAME))/SAMEFIV
     2) /1536.
   31 CONTINUE
      CONST=3.141592654/FLOATF(MEMLERD)
      CALL ABCD(RQ,HOLDA,HOLDB,HOLDC,HOLDD,1.)
      CALL ABCD(RV,ANSA,ANSB,ANSC,ANSD,1.)
      CHI=3.141592654-2.*BEE*(CONST*(SUMA+SUMF))
      CHIP=2.*(CONST*(SUMG-SUMB+SUMK-SUMN)+HOLDA-ANSA)
      CHIDP=-2.*BEE*(CONST*(SUMH+SUMC-SUML+SUMP)-HOLDB+ANSB)
      PSI=.166666667*BEE*(CONST*(SUMI+SUMD+SUMM+.75*SUMQ)-HOLDC+ANSC)
      PHILO=2.*BEE*(CONST*(SUMJ+SUME+SUMN+SUMR)+HOLDD-ANSD)
      PRINT 505,BEE,CHI,CHIP,CHIDP,PSI,PHILO
  505 FORMAT (1X,4HBEE=E20.10,2X,4HCHI=E20.10,2X,5HCHIP=E20.10/1X,6HCHID
     1P=E20.10,2X,4HPSI=E20.10,2X,4HPHI=E20.10/)
```

```
      RETURN
      END



      FUNCTION F(K,X)
      FACTFI=NFACT(5+K)
      F=(-1.)**K*4.*(GACT(K)/(X**(12+K))-FACTFI/(120.*X**(6+K)))
      END



      FUNCTION GACT(K)
      GACT=1.
      DO 1 J=1,K
    1 GACT=GACT*(J+11)
      END



      FUNCTION NFACT(K)
      NFACT=1
      DO 2 J=1,K
    2 NFACT=NFACT*J
      END



      FUNCTION PHIHI(M,X)
      DIMENSION AY(128),CY(99),DY(128),        GY(64),GCOEF(64)
      COMMON MEHLERA,MEHLERC,MEHLERD,         NGAUSS,GCOEF, AY,CY,DY,GY
      COMMON GEE,BEE,GSQ,BSQ,RONE,RLESSER
      COMMON S,T,U,V,DHIDP,DSI,DHILO
      FACTM=NFACT(M+1)
      PHIHI= F(M,X)/GSQ+(-1.)**M*FACTM*BSQ/X**(M+2)
      END
```

```
      SUBROUTINE ABCD(X,[illegible],COUNT)
      DIMENSION AY(128),CY(99),DY(128),        GY(64),GCOEF(64)
      COMMON MEHLERA,MEHLERC,MEHLERD,         NGAUSS,GCOEF, AY,CY,DY,GY
      COMMON GEE,BEE,GSQ,BSQ,RONE,RLESSER
      COMMON S,T,U,V,DHIDP,DSI,DHILO
      ONE=PHIHI(1,X)
      TWO=PHIHI(2,X)
      THREE=PHIHI(3,X)
      FOUR =PHIHI(4,X)
      FIVE =PHIHI(5,X)
      ONESQ=ONE*ONE
      ONECUB=ONESQ*ONE
      ONEFOR=ONECUB*ONE
      ONEFIV=ONEFOR*ONE
      ONESIX=ONEFIV*ONE
      ONESEV=ONESIX*ONE
      ONEEIGH=ONESEV*ONE
      TWOSQ=TWO*TWO
      TWOCU=TWOSQ*TWO
      TWOFOR=TWOCU*TWO
      TWOFIV=TWOFOR*TWO
      THREESQ=THREE*THREE
      XSQ=X* X
      XCU=XSQ*X
      XFOR=XCU*X
      XFIV=XFOR*X
      XSIX=XFIV*X
      XSEV=XSIX*X
      IF(COUNT)2,1,2
    1 FONE=TWO/(XFOR*ONESQ)
      FTWO=1./(XSEV*ONESQ*X)
      FTHREE=1./(XFOR*ONEFOR)
      FFOUR=1./(XSQ*ONEFIV)
      FFIVE=1./(XSQ*ONESEV)
      FSIX=1./(XSQ*ONESIX)
      FSEVEN=1./(XSQ*ONEFOR)
      FEIGH=1./(XCU*ONESEV)
      FNIN=1./(XCU*ONESIX)
      FTEN=1./(XCU*ONEFIV)
      FELEV=1./(XCU*ONEFOR)
      FTWEL=1./(XCU*ONECUB)
      FTHIR=1./(XSQ*ONEEIGH)
      A=-1./XSQ-8.*BSQ/(XFIV*ONE)-2.*BSQ*FONE
      B=24./(XFIV*ONE)+6.*FONE+168.*BSQ*FTWO+72.*BSQ*TWO/(XSEV*ONECUB)+
     112.*BSQ*TWOSQ/(XSIX*ONEFOR)-4.*BSQ*THREE/(XSIX*ONECUB)
      C=36./(XFIV*ONE)+15.*FONE+6.*TWOSQ/(XCU*ONECUB)-4.*(THREE/(XCU
     1*ONESQ)+TWO*THREE/(XSQ*ONECUB))+3.*TWOCU/(XSQ*ONEFOR)+FOUR/(XSQ*
     2ONESQ)
```

```
      D=-42210. *FTWO-31770. *TWO/(XSEV*ONECUB)+7645.        *THREE/(XSIX*
     1ONECUB)-17535.        *TWOSQ/(XSIX*ONEFOR)-8520.        *TWOCU/(XFIV*
     2ONEFIV)+8640.*TWO*THREE/(XFIV*ONEFOR)-1488.*FOUR/(XFIV*ONECUB)
     3-3600.*TWOFOR/(XFOR*ONESIX)-950.      *THREESQ*FTHREE+5790.        *
     4TWOSQ*THREE/(XFOR*ONEFIV)-1482.        *TWO*FOUR*FTHREE+204.
     5*FIVE/(XFOR*ONECUB)-1470.        *TWOFOR*TWO*FEIGH+3360.    *
     6TWOCU*THREE*FNIN-1400.        *TWO*THREESQ*FTEN    -1060.        *TWOSQ
     7*FOUR*FTEN+    2205.*      TWOFOR*THREE*FFIVE-1540.        *TWOSQ
     8*THREESQ*FSIX-810. *TWOCU*FOUR*FSIX+222.        *TWOSQ*FIVE*FFOUR+
     9680.        *TWO*THREE*FOUR*FFOUR-76.        *THREE*FIVE*FSEVEN
      D=D-44.        *TWO*PHIHI(6,X)*FSEVEN-47.        *FOUR**2*FSEVEN+
     1140.        *THREESQ*THREE*FFOUR+6.        *PHIHI(7,X)/(XSQ*
     2ONECUB)    +376.        *THREE*FOUR*FELEV    +232.        *TWO*FIVE*FEL
     3EV    -30.        *PHIHI(6,X)*FTWEL        -735.        *TWOFIV*TWO*FTH
     4IR
      D=D/1440.
      RETURN
C     Q OR V PORTION OF SUBROUTINE
    2 FSIX=1./(XFOR*ONE)
      FONE=1./(XCU*ONEFOR)
      FTWO=1./(XSQ*ONEFOR)
      FTHREE=1./(XSQ*ONEFIV)
      FFOUR=1./(XCU*ONECUB)
      FFIVE=1./(XSQ*ONECUB)
      FSEV=1./(XCU*ONESQ)
      FEIGHT=1./(XFOR*ONEFOR)
      FNINE=1./(XSQ*ONESQ)
      FTEN=1./(XFIV*ONEFOR)
      E=48240./(XSIX*X*ONESQ)+26280. *TWO/(XSIX*ONECUB)+ 12288.      *TWO
     1SQ*FTEN   -7296.        *THREE/(XFIV*ONECUB)+4752.*TWOCU/(XFOR*ONEFIV
     2)-5664.        *TWO*THREE*FEIGHT+1152.*FOUR/(XFOR*ONECUB)+1680.
     3*TWOFOR/(XCU*ONESIX)-3136.        *TWOSQ*THREE/(XCU*ONEFIV)+
     4 672.        *THREESQ*FONE+912.        *TWO*FOUR*FONE- 160.*
     5FIVE*FFOUR-   232.        *TWO*FIVE*FTWO+40.        *PHIHI(6,X)*FFIV
     5E-
     6376.*        THREE*FOUR*FTWO +840.        *TWOSQ*FOUR*FTHREE+1120.
     7*TWO*THREESQ*FTHREE-2240.*        TWOCU*THREE/(XSQ*ONESIX)+840.
     8*TWOFIV/(XSQ*ONESIX*ONE)
      F=4020.        /(XSIX*ONE)+1824.        *TWO/(XFIV*ONESQ)+624.
     1*TWOSQ/(XFOR*ONECUB)-456.        *THREE/(XFOR*ONESQ)+168.*
     2TWOCU*FONE+40.        *FOUR*FSEV-224.*        TWO*THREE*FFOUR+
     384.        *TWOFOR/(XSQ*ONEFIV)+56.        *THREESQ*FFIVE-
     4196.        *TWOSQ*THREE/(XSQ*ONEFOR)+76.        *TWO*FOUR*FFIVE-
     520.        *FIVE*FNINE
      G=684.    *TWO*FSIX+84.        *TWOSQ*FSEV+42.        *TWOCU*FFIVE+
     130.        *FOUR/(XSQ*ONE)-84.        *TWO*THREE*FNINE
      COEF=2.*BSQ
      CKEEP=1.-PHIHI(0,X)
```

```
      CKEEPRT=SQRTF(CKEEP)
      A=COEF*FSIX/CKEEPRT
      B=COEF/(XSIX*ONE*CKEEPRT*CKEEP)*(6.*FSIX+24.*BSQ/(XSIX*X*ONESQ )+
     1 4.*BSQ*TWO/(XSIX*ONECUB))/CKEEPRT
      C=(9.*FSIX+2.*TWO*FSEV+TWOSQ*FFIVE-THREE*FNINE)/CKEEPRT+.5*TWO/(XS
     1Q*ONE*CKEEP*CKEEPRT)
      D=(E+(F+(G+105.        *TWOSQ/(XSQ*ONE*CKEEP))/CKEEP)/CKEEP)/CKEEPRT
      D=D/11520.
      END
      END
```

```
      FUNCTION NFACT(K)
      NFACT=1
      DO 1 J=1,K
    1 NFACT=NFACT*J
      END
      END
```

```
      PROGRAM OMEGA
      DIMENSION Z(100),QONECL(100),QONEIO(100),QONEII(100),F(100)
     1QONEOI(100),QONEOO(100)
      READ 9, S,EL
    9 FORMAT (2F10.0)
      PRINT 10, S,EL
   10 FORMAT (    3H1S=E20.10,3X,2HL=E20.10//)
      READ 11, T
   11 FORMAT (F10.0)
      READ 12, DELTAT
   12 FORMAT(F10.0)
      READ 13, TEND
   13 FORMAT(F10.0)
      JIN=1
    4 JON=JIN+4
      DO 1 K=JIN,JON
      READ 2, Z(K),QONECL(K),QONEIO(K),QONEII(K)
    2 FORMAT (E9.0,11X,E11.0,2X,E11.0,9X,E11.0)
      READ 14, QONEOI(K),QONEOO(K)
   14 FORMAT (E11.0,9X,E11.0)
      IF(Z(K)+1000.)3,3,8
    8 Z(K)=2.30258509*Z(K)
    1 F(K)=(S+2.)*Z(K)
      JIN=JON+1
      GO TO 4
    3 ACL=0.
      AOI=0.
      AIO=0.
      AOO=0.
      AII=0.
      N= JIN-1
      DO 5 J=1,N,5
       ACL=ACL+(14.*QONECL(J)*EXPF(F(J)-EXPF(Z(J))/T)
     1+81.*QONECL(J+1)*EXPF(F(J+1)-EXPF( Z(J+1))/T)
     2+110.*QONECL(J+2)*EXPF(F(J+2)-EXPF( Z(J+2))/T)
     3+81.*QONECL(J+3)*EXPF(F(J+3)-EXPF( Z(J+3))/T)+
     414.*QONECL(J+4)*EXPF(F(J+4)-EXPF( Z(J+4))/T))*(Z(J+4)-Z(J))/2.
       AOI=AOI+(14.*QONEOI(J)*EXPF(F(J)-EXPF(Z(J))/T)
     1+81.*QONEOI(J+1)*EXPF(F(J+1)-EXPF( Z(J+1))/T)
     2+110.*QONEOI(J+2)*EXPF(F(J+2)-EXPF( Z(J+2))/T)
     3+81.*QONEOI(J+3)*EXPF(F(J+3)-EXPF( Z(J+3))/T)+
     414.*QONEOI(J+4)*EXPF(F(J+4)-EXPF( Z(J+4))/T))*(Z(J+4)-Z(J))/2.
       AIO=AIO+(14.*QONEIO(J)*EXPF(F(J)-EXPF(Z(J))/T)
     1+81.*QONEIO(J+1)*EXPF(F(J+1)-EXPF( Z(J+1))/T)
     2+110.*QONEIO(J+2)*EXPF(F(J+2)-EXPF( Z(J+2))/T)
     3+81.*QONEIO(J+3)*EXPF(F(J+3)-EXPF( Z(J+3))/T)+
     414.*QONEIO(J+4)*EXPF(F(J+4)-EXPF( Z(J+4))/T))*(Z(J+4)-Z(J))/2.
       AOO=AOO+(14.*QONEOO(J)*EXPF(F(J)-EXPF(Z(J))/T)
```

```
 1+81.*GONEOO(J+1)*EXPF(F(J+1)-EXPF( Z(J+1))/T)
 2+110.*GONEOO(J+2)*EXPF(F(J+2)-EXPF( Z(J+2))/T)
 3+81.*GONEOO(J+3)*EXPF(F(J+3)-EXPF( Z(J+3))/T)+
 414.*GONEOO(J+4)*EXPF(F(J+4)-EXPF( Z(J+4))/T))*(Z(J+4)-Z(J))/2.
5  AII=AII+(14.*GONEII(J)*EXPF(F(J)-EXPF(Z(J))/T)
 1+81.*GONEII(J+1)*EXPF(F(J+1)-EXPF( Z(J+1))/T)
 2+110.*GONEII(J+2)*EXPF(F(J+2)-EXPF( Z(J+2))/T)
 3+81.*GONEII(J+3)*EXPF(F(J+3)-EXPF( Z(J+3))/T)+
 414.*GONEII(J+4)*EXPF(F(J+4)-EXPF( Z(J+4))/T))*(Z(J+4)-Z(J))/2.
  ACL=ACL/150.
  AOI=AOI/150.
  AIO=AIO/150.
  AOO=AOO/150.
  AII=AII/150.
  M=S
  SFACT=NFACT(M+1)
  OMEGACL=ACL/(SFACT*(T**(J+2.)))
  OMEGAOI=AOI/(SFACT*(T**(J+2.)))
  OMEGAIO=AIO/(SFACT*(T**(J+2.)))
  OMEGAOO=AOO/(SFACT*(T**(J+2.)))
  OMEGAII=AII/(SFACT*(T**(J+2.)))
  PRINT 7, T,OMEGACL,OMEGAOI,OMEGAIO,OMEGAOO,OMEGAII
7 FORMAT (1X,2HT=E9.2,2X,10HOMEGACL=E11.4,2X,7HOMEGAI=E11.4,2X,8HOMEG
 1AII=E11.4,2X,9HOMEGAIII=E11.4,2X,10HOMEGAIV=E11.4/)
  T=T-DELTAT
  IF(T-TEND) 6,6,3
6 STOP
  END



  FUNCTION NFACT(K)
  NFACT=1
  DO 1 J=1,K
1 NFACT=NFACT*J
  END
  END
```

```
      PROGRAM SCAELLP
      TYPE DOUBLE QONE,QTWO,PHASE,A,B,C,T,ARGU,ARGUP,G,GP,RESULT,FR,X,F
      DIMENSION PHASE(105),A(300),B(300),C(300),T(300)
      GEESQD=1.66
      ELAMST=.1
      LEL=105
      ARGU=2.*3.14159265358979323846264*DSQRT(GEESQD)/ELAMST
      ARGUP=2.*3.14159265358979323846264*DSQRT(GEESQD+1.)/ELAMST
      D = 1.
      G=DSQRT(3.14159265358979323846264/(2.*ARGU))
      GP=DSQRT(3.14159265358979323846264/(2.*ARGUP))
      EL = 0.
      CALL SPHEBE(LEL ,ARGU,A,RESULT)
      DO 23  J=1,LEL
   23 A(J)=A(J)/G
      CALL SPHEBE(LEL ,ARGUP,B,RESULT)
      DO 24 K=1,LEL
   24 B(K)=B(K)/GP
      CALL SPHEBE(-LEL ,ARGU,C,RESULT)
      DO 25 L=1,LEL
   25 C(L)=C(L+1)/G
      DO 26 L=1,LEL
      FR=((ARGU*B(L)*A(L+1)-ARGUP*A(L)*B(L+1))/(ARGUP*C(L)*B(L+1)+
     1ARGU*B(L)*C(L+1)))*D
      D=-1.*D
      PHASE(L+1)=DATAN(FR)
      PRINT 20, EL, PHASE(L + 1)
   20 FORMAT (E20.0,D48.20)
      IF(EL - 1.) 7, 8, 17
    8 QONE     = 4.*EL* DSIN(PHASE( L + 1 )- PHASE( L))*DSIN(PHASE(L + 1
     1) - PHASE(L))/(ARGU*ARGU)
      QTWO    =0.
    7 EL = EL + 1.
      GO TO 26
   17 QTWO     = QTWO          + 3.*(EL - 1.)*EL* DSIN(PHASE( L + 1 ) -
     1PHASE(L-1))*DSIN(PHASE(L+1)-PHASE(L-1))/((EL-.5)*ARGU*ARGU)
      QONE     = QONE          + 4.*EL* DSIN(PHASE( L + 1 ) - PHASE( L))
     1*DSIN(PHASE(L+1)-PHASE(L))/(ARGU*ARGU)
      PRINT 102, EL, QONE      , QTWO
  102 FORMAT (E20.0,2D45.20)
      GO TO 7
   26 CONTINUE
      PRINT 13, GEESQD, ARGU, ARGUP, QONE    , QTWO
   13 FORMAT (2E20.10,2D45.20)
      END
```

```
      SUBROUTINE SPHESE(LEL,X,T,RESULT)
      TYPE DOUBLE GONE,QTWO,PHASE,A,B,C,T,ARGU,ARGUP,G,GP,RESULT,FR,X,F
      DIMENSION PHASE(105),A(300),B(300),C(300),T(300)
    1 IF(X) 18, 12, 18
   12 IF(LEL) 16, 13, 14
   13 RESULT=1.0
      RETURN
   14 RESULT=0.0
      RETURN
   16 RESULT=.9999999999E199
      RETURN
   18 IF(LEL) 55, 51, 19
   19 MO=LEL
      JO=2*XFIXF(X)
      IF(MO-JO) 2, 21, 21
    2 MO=JO
   21 MO=MO+11
   22 T(MO)=0.
      T(MO-1)=1.0E-300
      LO=MO-2
   23 F=2*(MO-1)
  231 MO=MO-3
      I2=MO
  232 F=F-2.0
      T(I2+1)=(F+1.)/X*T(I2+2)-T(I2+3)
      IF(I2) 4,3,4
    4 I2=I2-1
      GO TO 232
    3 F=DSIN(X)/X/T(1)
      DO 5 J=1,MO
    5 T(J)=F*T(J)
      RESULT=T(LEL+1)
      RETURN
   51 RESULT=DSIN(X)/X
      RETURN
   55 LO=-LEL+1
      T(1)=DSIN(X)/X
      T(2)=DCOS(X)/X
      DO 6 J=3,LO
    6 T(J )=(-2.*FLOATF(J-2)+1.)/X*T(J-1 )-T(J-2)
      RESULT=T(LO)
      RETURN
      END
      END
```

```
      PROGRAM MONOTON
      DIMENSION AY(128),OY(64),GCOEF(64),GY(64)
      COMMON MEHLERA,MEHLERO,NGAUSS,AY,OY,GY,GCOEF,GEE,GSQ,YO,YONE,L
      NGAUSS=32
      MEHLERA=64
      L=12
      PRINT 3, L
    3 FORMAT (3H1L=I2//)
      EL=12.
      G=.0005
      FA=MEHLERA
      DO 7 I=1, MEHLERA
      FI=I
    7 AY(I)=COSF(((2.*FI-1.)/(2.*FA))*3.141592654)
C     32 GAUSS-LEGENDRE WEIGHTS AND POINTS - TO +
      GY(01)=-.9972638618
      GY(02)=-.9856115115
      GY(03)=-.9647622556
      GY(04)=-.9349060759
      GY(05)=-.8963211558
      GY(06)=-.8493676137
      GY(07)=-.7944837960
      GY(08)=-.7321821187
      GY(09)=-.6630442669
      GY(10)=-.5877157572
      GY(11)=-.5068999089
      GY(12)=-.4213512761
      GY(13)=-.3318686023
      GY(14)=-.2392873623
      GY(15)=-.1444719616
      GY(16)=-.0483076657
      GY(17)= .0483076657
      GY(18)= .1444719616
      GY(19)= .2392873623
      GY(20)= .3318686023
      GY(21)= .4213512761
      GY(22)= .5068999089
      GY(23)= .5877157572
      GY(24)= .6630442669
      GY(25)= .7321821187
      GY(26)= .7944837960
      GY(27)= .8493676137
      GY(28)= .8963211558
      GY(29)= .9349060759
      GY(30)= .9647622556
      GY(31)= .9856115115
      GY(32)= .9972638618
      GCOEF(01)=.007018610
```

```
      GCOEF(02)=.0162743947
      GCOEF(03)=.0253920653
      GCOEF(04)=.0342738629
      GCOEF(05)=.0428358980
      GCOEF(06)=.0509980393
      GCOEF(07)=.0586840935
      GCOEF(08)=.0658222227
      GCOEF(09)=.0723457941
      GCOEF(10)=.0781938957
      GCOEF(11)=.0833119242
      GCOEF(12)=.0876520930
      GCOEF(13)=.0911736767
      GCOEF(14)=.0938443991
      GCOEF(15)=.0956387201
      GCOEF(16)=.0965400885
      GCOEF(17)=.0965400885
      GCOEF(18)=.0956387201
      GCOEF(19)=.0938443991
      GCOEF(20)=.0911736767
      GCOEF(21)=.0876520930
      GCOEF(22)=.0833119242
      GCOEF(23)=.0781938957
      GCOEF(24)=.0723457941
      GCOEF(25)=.0658222227
      GCOEF(26)=.0586840935
      GCOEF(27)=.0509980393
      GCOEF(28)=.0428358980
      GCOEF(29)=.0342738629
      GCOEF(30)=.0253920653
      GCOEF(31)=.0162743947
      GCOEF(32)=.0070318610
C     Q INTEGRALS
      SUMT=0.
      SUMU=0.
      SUMV=0.
      SUMW=0.
      SUMX=0.
      SUMY=0.
      DIV=1.-GY(1)
      YO=(GY(1)+1.)/DIV
      YONE=YO*(EL**(1./L))
      ALPHA=((1.-EL*G)/(2.*G))**(1./L)
      DO 10 J=1,NGAUSS
      YO=ALPHA*(1.+GY(J))/2.
      DYO=ALPHA/2.
      CALL RINTEG(CHI,CHIP,CHIDP,PSI,PHILO)
      COSINE=COSF(CHI)
      SINEB= SINF(CHI)
```

```
      CHID=2.*CHI
      SINED=SINF(CHID)
      COSINEB=COSF(CHID)
      CHISQ=CHI*CHI
      CHIPPSI=CHIP*PSI
      CHIPSQ=CHIP*CHIP
      SINEA=SINF(.5*CHI)
      SUMT=SUMT+GCOEF(J)*YO *SINEA*SINEA*DYO
      SUMU=SUMU+DYO *GCOEF(J)*(                -YO *CHIPSQ*COSINE+(24.*YO
     1*PSI+2.          *CHIP)*SINEB)/48.
      SUMV=SUMV+DYO *GCOEF(J)*(COSINE*( 8.          *CHIDP*CHIDP*YO +
     1480.        *PSI*YO*CHIDP+42.*CHIP*CHIDP
     2+PSI*PSI*2880.* YO     +                    YO *CHIPSQ*CHIPSQ+480.
     3    *CHIPPSI          )+(4.*CHIP*CHIPSQ+5760.*PHILO* YO     -42.*CHIPS
     4Q*CHIP-240.   *CHIPSQ*PSI*YO)*SINEB)/11520.
      SUMW=SUMW+GCOEF(J)*DYO *SINEB*SINEB*YO
      SUMX=SUMX+GCOEF(J)*DYO*(12.*PSI*YO*SINED-4.      *YO*CHIPSQ*COSINEB
     1 -3./YO*SINEB*SINEB)/12.
      SUMY=SUMY+GCOEF(J)*DYO *
     1(((-89.25*CHIP*CHIDP+16.*CHIDP*CHIDP+8.*CHIPSQ*CHIPSQ)*YO+360.*PSI
     2*PSI* YO     +240. *YO*(CHIPPSI/YO+ CHIDP*PSI))*COSINEB+(16.
     3    *CHIPSQ*CHIP-240. YO*CHIPSQ*PSI+360.*PHILO* YO     -15.
     4/YO*CHIDP-90.*PSI/(YO     )+89.25*CHIPSQ*CHIP)*SINED)/360.
   10 CONTINUE
      QONECL=4.*SUMT
      QONEI=.101321184    *(SUMU+1./24.)
      QONEII=.00256649556*SUMV
      QTWOCL=3.*SUMW
      QTWOI=.075990887     *SUMX
      QTWOII = .0019248717*SUMY
      PRINT 11,QONECL,QONEI,QONEII,QTWOCL,QTWOI,QTWOII
   11 FORMAT (1X,3HA1=,E20.10,3X,3HB1=,E20.10,3X,3HC1=,E20.10/
     11X,3HA2=,E20.10,3X,3HB2=E20.10,3X,3HC2=E20.10)
      END
```

```
      SUBROUTINE RINTEG(CHI,CHIP,CHIDP,PSI,PHILO)
      DIMENSION AY(128),OY(64),GCOEF(64),GY(64)
      COMMON MEHLERA,MEHLERO,NGAUSS,AY,OY,GY,GCOEF,GEE,GSQ,YO,YONE,L
      R=YONE
   19 SAVE=R-((1.-PHIHI(0,R))/(-(R**(L-1))/(YO**L)-2.*(R**1)))
      IF(ABSF(ABSF(SAVE/R)-1.)-1.E-05)18,17,17
   17 R=ABSF(SAVE)
      GO TO 19
   18 YONE=SAVE
```

```
      PRINT 38, YONE
   38 FORMAT (1X,5HYONE=E20.10)
      SUMJ=0.
      SUMK=0.
      SUML=0.
      SUMM=0.
      SUMN=0.
      DO 29 N=1,MEHLERA
      RB=YONE*(1.+AY(N))/2.
      DRB=YONE/2.
      SAME=DRB*SQRTF((1.-AY(N)*AY(N))/(1.-PHIHI(0,RB)))
      CALL ABCD(RB,A,B,C,D)
      SUMJ=SUMJ+SAME
      SUMK=SUMK+SAME*A
      SUML=SUML+SAME*B
      SUMM=SUMM+SAME*C
      SUMN=SUMN+SAME*D
   29 CONTINUE
      CONST=3.1415[illegible]/FLOAT([illegible]MEHLERA)
      CHI=3.1415[illegible]-2.      *CONST*SUMJ
      CHIP=2.      CONST*SUMK/YO
      CHIDP=-2.      *CONST*SUML/(YO*YO)
      PSI=.16666[illegible]      *CONST*SUMM/(YO*YO)
      PHILO=2.*CONST      *SUMN/(YO*YO)
      PRINT 503,YO,CHI,CHIP,CHIDP,PSI,PHILO
  503 FORMAT (1X,4HYO =E20.10,2X,4HCHI=E20.10,2X,5HCHIP=E20.10/1X,6HCHID
     1P=E20.10,2X,4HPSI=E20.10,2X,6HPHI=E20.10/)
      RETURN
      END
```

```
      SUBROUTINE ABCD(X,[illegible])
      DIMENSION AY(64),[illegible]GY(64)
      COMMON MEHLERA,MEHLERA[illegible]GY,GCOEF,GEE,GSQ,YO,YONE,L
      ONE=PHIHI(1,X)
      TWO=PHIHI(2,X)
      THREE=PHIHI(3,X)
      FOUR=PHIHI(4,X)
      FIVE=PHIHI(5,X)
      ONEFOR=ONE*ONE
      ONEFOUR=ONEFOR*ONE
      ONEFOR=ONEFOUR*ONE
      ONEFIV=ONEFOR*ONE
      ONESIX=ONEFIV*ONE
      ONESEV=ONESIX*ONE
```

```
ONEEIGH=ONESEV*ONE
TWOSQ=TWO*TWO
TWOCU=TWOSQ*TWO
TWOFOR=TWOCU*TWO
TWOFIV=TWOFOR*TWO
THREESQ=THREE*THREE
XSQ=1./(X*X)
XCU=XSQ/X
XFOR=XCU/X
XFIV=XFOR/X
XSIX=XFIV/X
XSEV=XSIX/X
FONE=TWO/(XFOR*ONESQ)
FTWO=1./(XSEV*ONESQ/X)
FTHREE=1./(XFOR*ONEFOR)
FFOUR=1./(XSQ*ONEFIV)
FFIVE=1./(XSQ*ONESEV)
FSIX=1./(XSQ*ONESIX)
FSEVEN=1./(XSQ*ONEFOR)
FEIGH=1./(XCU*ONESEV)
FNIN=1./(XCU*ONESIX)
FTEN=1./(XCU*ONEFIV)
FELEV=1./(XCU*ONEFOR)
FTWEL=1./(XCU*ONECUB)
FTHIR=1./(XSQ*ONEEIGH)
A=-1./XSQ-6.     /(XFIV*ONE)-2.     *FONE
B=24./(XFIV*ONE)+6.*FONE+180.     *FTWO-72.     *TWO/(XSEV*ONECUB)+
112.     *TWOSQ/(XSIX*ONEFOR)-4.     *THREE/(XSIX*ONECUB)
C=36./(XFIV*ONE)+15.*FONE+6.*TWOSQ/(XCU*ONECUB)-4.*(THREE/(XCU
1*ONESQ)+TWO*THREE/(XSQ*ONECUB))+3.*TWOCU/(XSQ*ONEFOR)+FOUR/(XSQ*
2ONESQ)
D=-42210. *FTWO-31770. *TWO/(XSEV*ONECUB)+7845.     *THREE/(XSIX*
1ONECUB)-17535.     *TWOSQ/(XSIX*ONEFOR)-8520.     *TWOCU/(XFIV*
2ONEFIV)+8640.*TWO*THREE/(XFIV*ONEFOR)-1488.*FOUR/(XFIV*ONECUB)
3-3600.*TWOFOR/(XFOR*ONESIX)-960.     *THREESQ*FTHREE+5790.     *
4TWOSQ*THREE/(XFOR*ONEFIV)-[illegible]     *TWO*FOUR*FTHREE+204.
5*FIVE/(XFOR*ONECUB)-1470.     *TWOFOR*TWO*FEIGH+3360.     *
6TWOCU*THREE*FNIN-1400.     *TWO*THREESQ*FTEN     -1060.     *TWOSQ
7*FOUR*FTEN+     2205.*     TWOFOR*THREE*FFIVE-1540.     *TWOSQ
8*THREESQ*FSIX-810. *TWOCU*FOUR*FSIX+222.     *TWOSQ*FIVE*FFOUR+
9660.     *TWO*THREE*FOUR*FFOUR-76.     *THREE*FIVE*FSEVEN
D=D-44.     *TWO*PHIHI(6,X)*FSEVEN-47.     *FOUR**2*FSEVEN+
1140.     *THREESQ*THREE*FFOUR+5.     *PHIHI(7,X)/(XSQ*
2ONECUB)     +376.     *THREE*FOUR*FELEV     -232.     *TWO*FIVE*FEL
3EV     -30.     *PHIHI(6,X)*FTWEL     -735.     *TWOFIV*TWO*FTH
4IR
D=D/1440.
A=A*XSQ
```

```
      B=B*XSQ
      C=C*XSQ
      D=D*XSQ
      RETURN
      END


      FUNCTION F(K,X)
      DIMENSION AY(128),BY(64),GCOEF(64),GY(64)
      COMMON MEHLERA,MEHLERO,NGAUSS,AY,BY,GY,GCOEF,GEE,GSQ,YO,YONE,L
      F=((-1.)**K)*GACT(K)*(X**(L+K))/(Y0**L)
      END


      FUNCTION GACT(K)
      DIMENSION AY(128),BY(64),GCOEF(64),GY(64)
      COMMON MEHLERA,MEHLERO,NGAUSS,AY,BY,GY,GCOEF,GEE,GSQ,YO,YONE,L
      GACT=1./L
      DO 1 J=1,K
    1 GACT=GACT*(J+L-1)
      END


      FUNCTION NFACT(K)
      NFACT=1
      DO 2 J=1,K
    2 NFACT=NFACT*J
      END


      FUNCTION PHIHI(H,X)
      DIMENSION AY(128),BY(64),GCOEF(64),GY(64)
      COMMON MEHLERA,MEHLERO,NGAUSS,AY,BY,GY,GCOEF,GEE,GSQ,YO,YONE,L
      PHIHI=F(H,X)+((-1.)**H)*NFACT(H+L)*(X**(H+L))
      END
      END
```

```
      PROGRAM FINST
      DIMENSION AY(128),GY(64),GCOEF(64),GY(64)
      COMMON MEHLERA,MEHLERA,NGAUSS,AY,GY,GY,GCOEF,GEE,GSQ,YO,YONE,L
      NGAUSS=32
      MEHLERA=64
      L=12
      PRINT 3, L
    3 FORMAT (5H1L=I2//)
      FL=12.
      G=.0005
      FA=MEHLERA
      DO 7 I=1, MEHLERA
      FI=I
    7 AY(I)=COSF(((2.*FI-1.)/(2.*FA))*3.141592654)
C     32 GAUSS-LEGENDRE WEIGHTS AND POINTS - TO +
      GY(01)=-.9972638618
      GY(02)=-.9856115115
      GY(03)=-.9647622555
      GY(04)=-.9349060759
      GY(05)=-.8963211557
      GY(06)=-.8493676137
      GY(07)=-.7944837959
      GY(08)=-.7321821187
      GY(09)=-.6630442669
      GY(10)=-.5877157572
      GY(11)=-.5068999089
      GY(12)=-.4213512761
      GY(13)=-.3318686023
      GY(14)=-.2392873622
      GY(15)=-.1444719616
      GY(16)=-.0483076657
      GY(17)= .0483076657
      GY(18)= .1444719616
      GY(19)= .2392873622
      GY(20)= .3318686023
      GY(21)= .4213512761
      GY(22)= .5068999089
      GY(23)= .5877157572
      GY(24)= .6630442669
      GY(25)= .7321821187
      GY(26)= .7944837959
      GY(27)= .8493676137
      GY(28)= .8963211557
      GY(29)= .9349060759
      GY(30)= .9647622555
      GY(31)= .9856115115
      GY(32)= .9972638618
      GCOEF(01)=.0070186510
```

```
      GCOEF(02)=.0162743947
      GCOEF(03)=.0253920656
      GCOEF(04)=.0542736629
      GCOEF(05)=.0428358[illegible]
      GCOEF(06)=.0309980[illegible]
      GCOEF(07)=.0586840[illegible]
      GCOEF(08)=.0656222[illegible]
      GCOEF(09)=.0731457[illegible]
      GCOEF(10)=.0781936[illegible]
      GCOEF(11)=.0831119[illegible]
      GCOEF(12)=.0876520930
      GCOEF(13)=.0911736767
      GCOEF(14)=.0936443991
      GCOEF(15)=.0956387201
      GCOEF(16)=.0961400[illegible]
      GCOEF(17)=.0965400[illegible]
      GCOEF(18)=.0956387[illegible]
      GCOEF(19)=.0936044[illegible]
      GCOEF(20)=.0911736[illegible]
      GCOEF(21)=.0876520[illegible]
      GCOEF(22)=.0831[illegible]
      GCOEF(23)=.0781[illegible]
      GCOEF(24)=.0731[illegible]
      GCOEF(25)=.0656[illegible]
      GCOEF(26)=.0586[illegible]
      GCOEF(27)=.0309[illegible]
      GCOEF(28)=.0428[illegible]
      GCOEF(29)=.0542736[illegible]
      GCOEF(30)=.0253920[illegible]
      GCOEF(31)=.0162743947
      GCOEF(32)=.007016610
C     Q INTEGRALS
      SUMT=0.
      SUMU=0.
      SUMV=0.
      SUMW=0.
      SUMX=0.
      SUMY=0.
      DIV=1.-GY(1)
      YO=(GY(1)+1.)/DIV
      YOMP=YO*(EL**(1./L))
      ALPMN=((1.-EL*G)/(G-[illegible]))**(1./L)
      DO 10 J=1,NGAUSS
      YO=ALPMN*(1.+GY(J))/2.
      DYO=ALPMN/2.
      CALL KINTEG(CHI,CHIP,CHIDP,PSI,PHILO,CHIL,CHIPL,CHIDPL,PSIL,PHIL
     1)
      CHIPSQ=CHIP*CHIP
```

```
      COSINE=COSF(CHI)
      SINEB= SINF(CHI)
      CHID=2.*CHI
      SINED=SINF(CHID)
      COSINEB=COSF(CHID)
      SUMT=SUMT+GCOEF(J)*YO*CHIL*SINEB*DYO/2.
      BO=-2.
      SUMU=SUMU+DYO*GCOEF(J)*((BO*YO*CHIP*CHIPL+24.*YO*PSI*CHIL+2.*CHIP*
     1CHIL)*COSINE+(24.*YO*PSIL+2.*CHIPL+YO*CHIPSQ*CHIL)*SINEB)/48.
      SUMV=0.
      SUMW=SUMW+GCOEF(J)*YO*CHIL*SINED*DYO
      SUMX=SUMX+GCOEF(J)*DYO*((12.*YO*PSIL+8.*YO*CHIPSQ*CHIL-3.*CHIL/YO)
     1*SINED+(24.*YO*PSI*CHIL-8.*YO    *CHIP*CHIPL)*COSINEB)/12.
      SUMY=0.
   10 CONTINUE
      QONECL=4.*SUMT
      QONEI=.101321184    * SUMU
      QONEII=.00256649556*SUMV
      QTWOCL=3.*SUMW
      QTWOI=.075990687     *SUMX
      QTWOII  =  .0019248717*SUMY
      PRINT 11,QONECL,QONEI,QONEII,QTWOCL,QTWOI,QTWOII
   11 FORMAT (1X,4HAL1=E20.10,3X,4HBL1=E20.10,3X,4HCL1=E20.10/1X,4HAL2=E
     120.10,3X,4HBL2=E20.10,3X,4HCL2=E20.10)
      END



      SUBROUTINE RINTEG(CHI,CHIP,CHIDP,PSI,PHILO,CHIL,CHIPL,CHIDPL,PSIL,
     1PHILOL)
      DIMENSION AY(128),OY(64),GCOEF(64),GY(64)
      COMMON MEHLERA,MEHLERO,KGAUSS,AY,OY,GY,GCOEF,GEE,GSQ,YO,YONE,L
      R=YONE
   19 SAVE=R-((1.-PHIHI(0,R))/(1-(R**(L-1))/(YO**L)-2.*(R**1)))
      IF(ABSF(ABSF(SAVE/R)-1.)-1.E-07)18,17,17
   17 R=ABSF(SAVE)
      GO TO 19
   18 YONE=SAVE
      PRINT 38, YONE
   38 FORMAT (1X,5HYONE=E20.10)
      SUMJ=0.
      SUMK=0.
      SUML=0.
      SUMM=0.
      SUMN=0.
      SUMO=0.
```

```
      SUMP=0.
      SUMR=0.
      DO 29 N=1,MEHLERA
      RB=YONE*(1.+AY(N))/2.
      DRB=YONE/2.
      SAME=DRB*SQRTF((1.-AY(N)*AY(N))/(1.-PHIHI(0,RB)))
      CALL ABCD(RB,A,B,C,D,E,F,G,H,O)
      SUMJ=SUMJ+SAME
      SUMK=SUMK+SAME*A
      SUML=SUML+SAME*B
      SUMM=SUMM+SAME*C
      SUMN=SUMN+SAME*D
      SUMO=SUMO+SAME*E
      SUMP=SUMP+SAME*F
      SUMR=SUMR+SAME*H
   29 CONTINUE
      CONST=3.141592654/FLOATF(MEHLERA)
      CHI=3.141592654-2.     *CONST*SUMJ
      CHIP=2.     *CONST*SUMK/YO
      CHIDP=-2.      *CONST*SUML/(YO*YO)
      PSI=.1666666667      *CONST*SUMM/(YO*YO)
      PHILO=2.*CONST      *SUMM/(YO**4)
      CHIL=8.*CONST*SUMO/(YO**6)
      CHIPL=8.*CONST*SUMP/(YO**7)
      CHIDPL=0.
      PSIL=.3333333333*CONST*SUMP/(YO**8)
      PHILOL=0.
      PRINT 1, CHIL,CHIPL,CHIDPL,PSIL,PHILOL
    1 FORMAT (1X,5HCHIL=E20.10,2X,6HCHIPL=E20.10,2X,7HCHIDPL=E20.10/1X,
     15HPSIL=E20.10,2X,7HPHILOL=E20.10/)
      RETURN
      END
```

```
      SUBROUTINE ABCD(X,A,B,C,D,E,F,G,H,O)
      DIMENSION AY(128),OY(64),GCOEF(64),GY(64)
      COMMON MEHLERA,MEHLERO,NOAUSS,AY,OY,GY,GCOEF,GEE,GSQ,YO,YONE,L
      ONE=PHIHI(1,X)
      TWO=PHIHI(2,X)
      THREE=PHIHI(3,X)
      FOUR =PHIHI(4,X)
      FIVE =PHIHI(5,X)
      ONESQ=ONE*ONE
      ONECUB=ONESQ*ONE
      ONEFOR=ONECUB*ONE
```

```
ONEFIV=ONEFOR*ONE
ONESIX=ONEFIV*ONE
ONESEV=ONESIX*ONE
ONEEIGH=ONESEV*ONE
TWOSQ=TWO*TWO
TWOCU=TWOSQ*TWO
TWOFOR=TWOCU*TWO
TWOFIV=TWOFOR*TWO
THREESQ=THREE*THREE
XSQ=1./(X*X)
XCU=XSQ/X
XFOR=XCU/X
XFIV=XFOR/X
XSIX=XFIV/X
XSEV=XSIX/X
XEIGH=XSEV/X
XNIN=XEIGH/X
XTEN=XNIN/X
XELEV=XTEN/X
XTWEL=XELEV/X
FONE=TWO/(XFOR*ONESQ)
FTWO=1./(XSEV*ONESQ/X)
FTHREE=1./(XFOR*ONEFOR)
FFOUR=1./(XSQ*ONEFIV)
FFIVE=1./(XSQ*ONESEV)
FSIX=1./(XSQ*ONESIX)
FSEVEN=1./(XSQ*ONEFOR)
FEIGH=1./(XCU*ONESEV)
FNIN=1./(XCU*ONESIX)
FTEN=1./(XCU*ONEFIV)
FELEV=1./(XCU*ONEFOR)
FTWEL=1./(XCU*ONECUB)
FTHIR=1./(XSQ*ONEEIGH)
FFOURT=1./(XEIGH*ONESQ)
FFIVT=1./(XNIN*ONE )
FSIXT=1./(XTWEL*ONESQ)
FSEVT=1./(XELEV*ONECUB)
FEIGHT=1./(XTEN*ONECUB)
FNINT=1./(XTEN*ONEFOR)
FTWT=1./(XNIN*ONEFIV)
FTWTON=1./(XNIN*ONEFOR)
FTWTTW=1./(XEIGH*ONEFIV)
FTWTTH=1./(XEIGH*ONEFOR)
FTWTFO=1./(XNIN*ONECUB)
FTWTFI=1./(XEIGH*ONESIX)
FTWTSI=1./(XEIGH*ONECUB)
A=-1./XSQ-8.     /(XFIV*ONE)-2.     *FONE
B=0.
```

```
 C=36./(XFIV*ONE)+15.*FONE+8.*TWOSQ/(XCU*ONECUB)-4.*(THREE/(XCU
1*ONESQ)+TWO*THREE/(XSQ*ONECUB))+3.*TWOCU/(XSQ*ONEFOR)+FOUR/(XSQ*
2ONESQ)
 D=0.
 D=D/1440.
 E=8.*FFIVT+TWO*FFOURT
 F=8.*FFIVT+TWO*FFOURT+220.*FSIXT+60.*TWO*FSEVT-2.*THREE*FEIGHT+6.*
1TWOSQ*FNINT
 G=0.
 SAM=-5610.
 H=SAM  *FSIXT-2250.*TWO*FSEVT-[illegible]5.*TWOSQ*FNINT-120.*TWOCU*FTWT+267
1.*THREE*FEIGHT+126.*TWO*THREE*FTWTON+25.*TWOSQ*THREE*FTWTTW-7.*TWO
2*FOUR*FTWTTH-4.*THREESQ*FTWTTH-24.*FOUR*FTWTFO-15.*TWOFOR*FTWTFI+
3FIVE*FTWTSI
 A=A*XSQ
 B=B*XSQ
 C=C*XSQ
 D=D*XSQ
 E=E*XSQ
 F=F*XSQ
 G=G*XSQ
 H=H*XSQ
 O=O*XSQ
 RETURN
 END
```

```
 FUNCTION F(K,X)
 DIMENSION AY(128),OY(64),GCOEF(64),GY(64)
 COMMON MEHLERA,MEHLERO,MGAUSS,AY,OY,GY,GCOEF,GEE,GSQ,YO,YONE,L
 F=((-1.)**K)*GACT(K)*(X**(L+K))/(YO**L)
 END
```

```
 FUNCTION GACT(K)
 DIMENSION AY(128),OY(64),GCOEF(64),GY(64)
 COMMON MEHLERA,MEHLERO,MGAUSS,AY,OY,GY,GCOEF,GEE,GSQ,YO,YONE,L
 GACT=1./L
 DO 1 J=1,K
1 GACT=GACT*(J+L-1)
 END
```

```
      FUNCTION NFACT(K)
      NFACT=1
      DO 2 J=1,K
    2 NFACT=NFACT*J
      END
```

```
      FUNCTION PHIHI(M,X)
      DIMENSION AY(128),OY(64),GCOEF(64),GY(64)
      COMMON MEHLERA,MEHLERO,NGAUSS,AY,OY,GY,GCOEF,GEE,GSQ,YO,YONE,L
      PHIHI=F(M,X)+((-1.)**M)*NFACT(M+1)*(X**(M+2))
      END
      END
```

```
      PROGRAM SECOND
      DIMENSION AY(128),OY(64),GCOEF(64),GY(64)
      COMMON MEHLERA,MEHLERO,NGAUSS,AY,OY,GY,GCOEF,GEE,GSQ,YO,YONE,L
      NGAUSS=32
      MEHLERA=64
      L=12
      PRINT 3, L
    3 FORMAT (3H1L=I2//)
      EL=12.
      G=.0005
      FA=MEHLERA
      DO 7 I=1, MEHLERA
      FI=I
    7 AY(I)=COSF(((2.*FI-1.)/(2.*FA))*3.141592654)
C     32 GAUSS-LEGENDRE WEIGHTS AND POINTS - TO +
      GY(01)=-.9972638618
      GY(02)=-.9856115115
      GY(03)=-.9647622556
      GY(04)=-.9349060759
      GY(05)=-.8963211558
      GY(06)=-.8493676137
      GY(07)=-.7944837960
      GY(08)=-.7321821187
      GY(09)=-.6630442669
      GY(10)=-.5877157572
      GY(11)=-.5068999089
      GY(12)=-.4213512761
      GY(13)=-.3318686023
      GY(14)=-.2392873623
      GY(15)=-.1444719616
      GY(16)=-.0483076657
      GY(17)= .0483076657
      GY(18)= .1444719616
      GY(19)= .2392873623
      GY(20)= .3318686023
      GY(21)= .4213512761
      GY(22)= .5068999089
      GY(23)= .5877157572
      GY(24)= .6630442669
      GY(25)= .7321821187
      GY(26)= .7944837960
      GY(27)= .8493676137
      GY(28)= .8963211558
      GY(29)= .9349060759
      GY(30)= .9647622556
      GY(31)= .9856115115
      GY(32)= .9972638618
      GCOEF(01)=.007018610
```

```
      GCOEF(02)=.0162743947
      GCOEF(03)=.0253920655
      GCOEF(04)=.0342738829
      GCOEF(05)=.0428358980
      GCOEF(06)=.0509960593
      GCOEF(07)=.0586840935
      GCOEF(08)=.0658222228
      GCOEF(09)=.0723457941
      GCOEF(10)=.0781938957
      GCOEF(11)=.0833119242
      GCOEF(12)=.0876520930
      GCOEF(13)=.0911738787
      GCOEF(14)=.0938443991
      GCOEF(15)=.0956387201
      GCOEF(16)=.0965400885
      GCOEF(17)=.0965400885
      GCOEF(18)=.0956387201
      GCOEF(19)=.0938443991
      GCOEF(20)=.0911738787
      GCOEF(21)=.0876520930
      GCOEF(22)=.0833119242
      GCOEF(23)=.0781938957
      GCOEF(24)=.0723457941
      GCOEF(25)=.0658222228
      GCOEF(26)=.0586840935
      GCOEF(27)=.0509980593
      GCOEF(28)=.0428358980
      GCOEF(29)=.0342738829
      GCOEF(30)=.0253920655
      GCOEF(31)=.0162743947
      GCOEF(32)=.0070186l0
C     Q INTEGRALS
      SUMT=0.
      SUMW=0.
      DIV=1.-GY(1)
      YO=(GY(1)+1.)/DIV
      YONE=YO*(EL**(1./L))
      ALPHA=((1.-EL*G)/(2.*G))**(1./L)
      DO 10 J=1,NGAUSS
      YO=ALPHA*(1.+GY(J))/2.
      DYO=ALPHA/2.
      CALL RINTEG(CHI,CHIL,CHIDL)
      COSINE=COSF(CHI)
      SINEB= SINF(CHI)
      CHID=2.*CHI
      SINED=SINF(CHID)
      COSINEB=COSF(CHID)
      SUMT=SUMT+GCOEF(J)*DYO*YO*(CHIDL*SINEB+   CHIL*CHIL*COSINE)/2.
```

```
      SUMW=SUMW+GCOEF(J)*DYO*YO*(CHIDL*SINED+2.*CHIL*CHIL*COSINEB)
   10 CONTINUE
      QONECL=4.*SUMT
      QTWOCL=3.*SUMW
      PRINT 11,QONECL,QTWOCL
   11 FORMAT(1X,4HAL2=E20.10,3X,4HBL2=E20.10)
      END



      SUBROUTINE RINTEG(CHI,CHIL,CHIDL)
      DIMENSION AY(128),OY(64),GCOEF(64),GY(64)
      COMMON MEHLERA,MEHLERO,NGAUSS,AY,OY,GY,GCOEF,GEE,GSQ,YO,YONE,L
      R=YONE
   19 SAVE=R-((1.-PHIHI(0,R))/(-(R**(L-1))/(YO**L)-2.*(R**1)))
      IF(ABSF(ABSF(SAVE/R)-1.)-1.E-09)18,17,17
   17 R=ABSF(SAVE)
      GO TO 19
   18 YONE=SAVE
      PRINT 38, YONE
   38 FORMAT (1X,5HYONE=E20.10)
      SUMJ=0.
      SUMO=0.
      SUMT=0.
      DO 29 N=1,MEHLERA
      RB=YONE*(1.+AY(N))/2.
      DRB=YONE/2.
      SAME=DRB*SQRTF((1.-AY(N)*AY(N))/(1.-PHIHI(0,RB)))
      CALL ABCD(RB,E,P)
      SUMJ=SUMJ+SAME
      SUMO=SUMO+SAME*E
      SUMT=SUMT+SAME*P
   29 CONTINUE
      CONST=3.141592654/FLOATF(MEHLERA)
      CHI=3.141592654-2.     *CONST*SUMJ
      CHIL=8.*CONST*SUMO/(YO**6)
      CHIDL= 8.*CONST*SUMT/(YO**12)
      PRINT 503, YO,CHIDL
  503 FORMAT(1X,3HYO=E20.10,2X,6HCHIDL=E20.10/)
      RETURN
      END
```

```
SUBROUTINE ABCD(X,E,P)
DIMENSION AY(128),OY(64),GCOEF(64),GY(64)
COMMON MEHLERA,MEHLERO,NGAUSS,AY,OY,GY,GCOEF,GEE,GSQ,YO,YONE,L
ONE=PHIHI(1,X)
TWO=PHIHI(2,X)
THREE=PHIHI(3,X)
ONESQ=ONE*ONE
ONECUB=ONESQ*ONE
ONEFOR=ONECUB*ONE
TWOSQ=TWO*TWO
XSQ=1./(X*X)
XCU=XSQ/X
XFOR=XCU/X
XFIV=XFOR/X
XSIX=XFIV/X
XSEV=XSIX/X
XEIGH=XSEV/X
XNIN=XEIGH/X
XTEN=XNIN/X
XELEV=XTEN/X
XTWEL=XELEV/X
XTHIR=XTWEL/X
XFORT=XTHIR/X
XFIVT=XFORT/X
XSIXT=XFIVT/X
FFOURT=1./(XEIGH*ONESQ)
FFIVT=1./(XNIN*ONE )
FTWTSE=1./(XSIXT*ONESQ)
FTWTEI=1./(XFIVT*ONECUB)
FTWTNI=1./(XFORT*ONECUB)
FTHTON=1./(XFORT*ONEFOR)
E=8.*FFIVT+TWO*FFOURT
P=-840.*FTWTSE-168.*TWO*FTWTEI+4.*THREE*FTWTNI-12.*TWOSQ*FTHTON
E=E*XSQ
P=P*XSQ
RETURN
END
```

```
FUNCTION F(K,X)
DIMENSION AY(128),OY(64),GCOEF(64),GY(64)
COMMON MEHLERA,MEHLERO,NGAUSS,AY,OY,GY,GCOEF,GEE,GSQ,YO,YONE,L
F=((-1.)**K)*GACT(K)*(X**(L+K))/(YO**L)
END
```

```
      FUNCTION GACT(K)
      DIMENSION AY(128),OY(64),GCOEF(64),GY(64)
      COMMON MEHLERA,MEHLERO,NGAUSS,AY,OY,GY,GCOEF,GEE,GSQ,YO,YONE,L
      GACT=1./L
      DO 1 J=1,K
    1 GACT=GACT*(J+L-1)
      END



      FUNCTION NFACT(K)
      NFACT=1
      DO 2 J=1,K
    2 NFACT=NFACT*J
      END



      FUNCTION PHIHI(M,X)
      DIMENSION AY(128),OY(64),GCOEF(64),GY(64)
      COMMON MEHLERA,MEHLERO,NGAUSS,AY,OY,GY,GCOEF,GEE,GSQ,YO,YONE,L
      PHIHI=F(M,X)+((-1.)**M)*NFACT(M+1)*(X**(M+2))
      END
      END
```