Service Packet

Digital Reverberator

Model 200

lexicon

1 INTRODUCTION

This service information packet contains specifications, service and
warranty information, performance tests and calibration procedures,
troubleshooting guide, schematics and assembly drawings, and a parts list
for the Lexicon Model 200 Digital Reverberator. This packet can be used
as a reference for standard servicing procedures.

IMPORTANT: Service operations must be performed in the order described
by a competent service technician only. If you have doubts about
performing a procedure, please contact your Lexicon dealer or Lexicon for
assistance. Lexicon is not responsible for damage resulting from
incorrectly followed service procedures. Lexicon has taken considerable
care in determining the accuracy of the information in this manual;
however, it is not responsible for consequential damage resulting from the
implementation of the procedures described.

**WARNING: Hazardous voltages exist inside this unit when the power cord is
connected; use extreme caution when servicing and adjusting. Service
should be performed only by qualified service personnel. Always place
the unit on an isolation transformer before servicing.**

PRECAUTIONS

Many of the internal components of this unit are extremely sensitive to
static electricity. To ensure that static charges are dissipated safely,
do not hand a component or board directly to another person -- place the
device on a nonconductive surface and then have it picked up. The
following practices minimize possible damage to ICs that can result from
electrostatic discharge:

1   Minimize handling of integrated circuits (ICs).
2   Keep parts in original containers until ready for use.
3   Discharge personal static before handling devices.
4   Handle each IC by its body.
5   Use antistatic containers for handling and transport.
6   Do not slide devices over a surface.
7   Avoid plastic, vinyl, or styrofoam in the work area.
8   When removing plug-in boards, handle only by nonconductive surfaces
     and <u>never</u> touch open-edge connectors except at a static-free work
     station. Placing shorting strips on edge connectors usually
     provides complete protection to installed ICs.
9   Handle ICs only at a static-free work station.
10   Use only grounded-tip soldering irons.

Always disconnect the power cord before servicing internal components.

1.1 Description

The Model 200 Digital Reverberator is an economical, general-purpose
digital reverberation device designed for recording studios, musicians,
film/video production houses, and broadcasters. It is a two-in, two-out
all-electronic digital system that simulates the acoustics of a variety of
architectural spaces.

The 200 converts analog audio input signals into a digital format that is continuously written into memory. Data is accessed from memory and processed. The processed signals are then reconverted to analog and added to the output mix.

For a comprehensive description of the Model 200 and its operating instructions, refer to the Lexicon Model 200 Owner's Manual, part no. 070-03567.

1.2 Specifications

Program Capacity*   Software expandable by installing additional
                               ROMs. Current Version 1.2 software provides
                               four programs.

Register Storage*   Software dependent. Nonvolatile registers
                               store programs and all parameter settings.

Predelay*   Maximum values range from 39 to 999
                               milliseconds (program- and size-dependent).

Size*   Maximum values range from 40 to 99 meters
                               (program-dependent).

Reverberation Time*   Adjustable from approximately 0.6 to 70
                               seconds (program- and size-dependent).

Frequency Contouring
of Reverberant Signals*   Selectable: full bandwidth (10 kHz),
                               7 kHz, or 3 kHz.

Displays   7-segment displays for Program and Register;
                               7-segment displays for Predelay, Reverb Time,
                               and Size. 12-position LED displays for signal
                               level in each channel; single LED displays for
                               Preechoes on/off, Diffusion high/med/low,
                               RT Contour Low and High (3 positions each),
                               and Rolloff low/med/high.

Frequency Response   Reverberant Signal: 20 Hz to 10 kHz
                               ($\pm$1dB when measured in input/output
                               program).
                               Direct Signal: 20 Hz to 20 kHz, $\pm$0.5 dB.

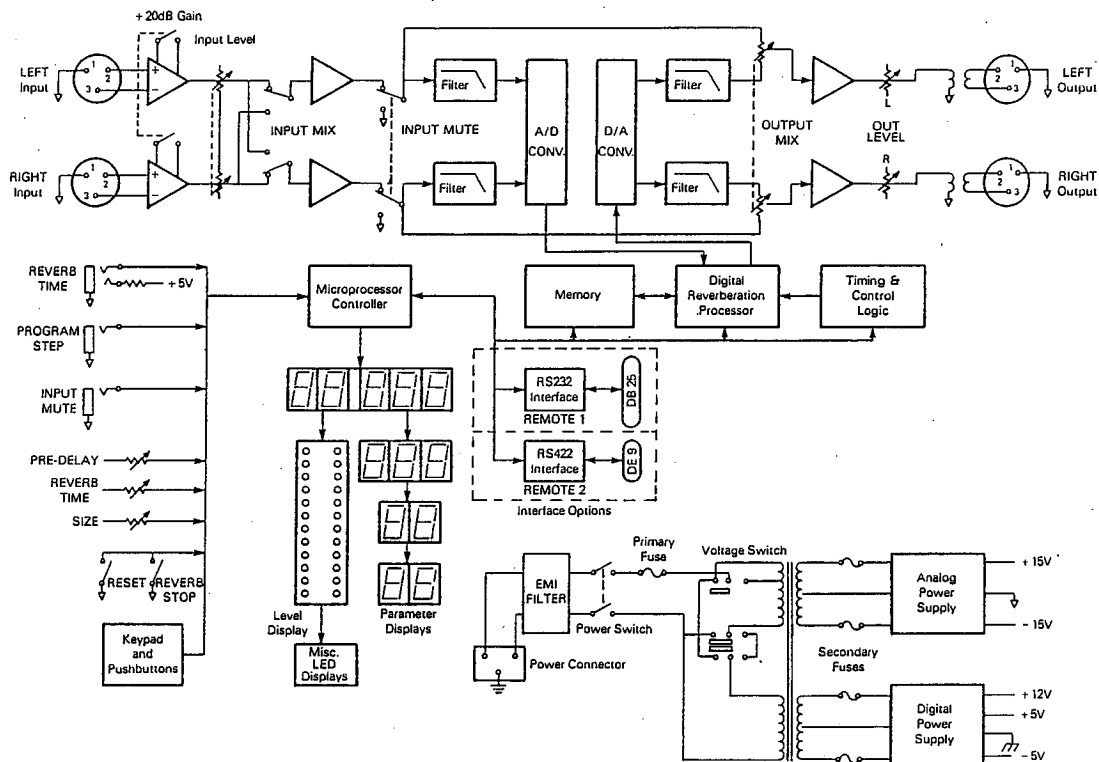*These specifications are software dependent.

Dynamic Range*   Reverberant Signal: 84 dB typical, 81 dB
                                        minimum relative to reference level,
                                        20-Hz to 20-kHz noise bandwidth.

Total Harmonic
Distortion (THD)
and Noise*   Reverberant Signal: 0.04% typical, 0.07%
                                        maximum (@ 1 kHz, relative to reference
                                        level).
                                        Direct Signal: 0.02% (@ 1 kHz).

Inputs   Two, balanced. Impedance is 100 kilohms in
                                        parallel with 150 pF for balanced inputs and
                                        50 kilohms in parallel with 300 pF for
                                        unbalanced inputs; maximum level = +24 dBm.
                                        Minimum level for full output = -18 dBm.

Outputs   Two, balanced and transformer-isolated.
                                        Impedance <150 ohms; maximum output
                                        level = +24 dBm.

Power   Nominal: 100, 120, 220, 240 Vac (-10%, +5%)
                                        switch-selectable; 50 to 60 Hz; 75 W.

RFI Shielding   Enclosure and ac power connector are RFI
                                        shielded.

Protection   Mains fused; secondaries fused; voltage
                                        crowbar and/or current limiting; thermal
                                        protection.

Connectors   Audio: XLR-3; power: standard IEC 3-pin;
                                        optional remotes: DB-25 and DE-9.

Cooling   Forced air.

Environment   Operating: 0 to 35°C (32 to 95°F);
                                        storage: -30 to 75°C (-22 to 167°F);
                                        relative humidity: 95% maximum (without
                                        condensation).

Size   Standard 19-in. rack mount: 19"w x 5 1/4"h x
                                        15"d (483 x 133 x 381 mm).

Weight   18 lb (8.1 kg); shipping: 22 lb (10 kg).

Specifications subject to change without notice.

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*Measured in Program 1.0; the Reference Level (+18 dBm) is determined with
input sensitivity set (using diagnostic test program 8) so that a 1-kHz,
+12-dBm input level falls short of just lighting the overload LED (+12
dB); output sensitivity is set (with diagnostic program 8) to produce +12
dBm into a 600-ohm load (dry) or +18 dBm (wet).

1.3 Block Diagram

+ 20dB Gain
Input Level

LEFT Input

RIGHT Input

INPUT MIX INPUT MUTE

Filter A/D CONV. D/A CONV. Filter

OUTPUT MIX OUT LEVEL

LEFT Output

RIGHT Output

REVERB TIME +5V

PROGRAM STEP

INPUT MUTE

PRE-DELAY

REVERB TIME

SIZE

RESET REVERB STOP

Keypad and Pushbuttons

Microprocessor Controller

Memory Digital Reverberation Processor Timing & Control Logic

Level Display

Parameter Displays

Misc. LED Displays

RS232 Interface DB 25
REMOTE 1

RS422 Interface DE 9
REMOTE 2

Interface Options

Primary Fuse Voltage Switch

EMI FILTER

Power Switch

Power Connector

Secondary Fuses

Analog Power Supply + 15V - 15V

Digital Power Supply + 12V + 5V - 5V

2 SERVICE/WARRANTY

2.1 Periodic Maintenance

Under normal conditions, the 200 requires minimal maintenance. At six-month intervals, the air filter on the left-hand side of the unit should be cleaned or replaced. Filter elements can be cleaned using a mild detergent and warm water, and a new filter (Lexicon no. 720-03387) can be obtained from Lexicon.

Use a soft lint-free cloth lightly dampened with a mild detergent and warm water to clean the exterior surfaces of the 200.

During servicing, a vacuum or blower can be used to clean dust out of the interior of the 200.

2.2 Returning Units for Service

If the Model 200 must be returned to Lexicon or a designated facility for service, Lexicon assumes no responsibility for the unit in shipment from customer to factory, whether in or out of warranty. All shipments must be well packed (using the original packing materials, if possible), properly insured, and consigned to a reliable agent, such as UPS or Federal Air Express. If original packing materials are not available, please procure a new packing kit from Lexicon.

Before returning a unit, always consult with Lexicon to determine the extent of the problem and to decide on a shipping procedure.

When returning a unit for service, include the following information:

- Name
- Company name
- Address
- City, State, ZIP
- Telephone number (include area code)
- Serial number of unit
- Description of problem
- Desired return date
- Preferred method of return shipment

Please include a note describing conversations with Lexicon personnel, and give the name and telephone number of the person directly responsible for maintaining the equipment. Do NOT include accessories, such as power cords, manuals, or remote switches.

2.3 Ordering Parts

Replacement parts can be ordered from:

Lexicon, Inc.
60 Turner Street
Waltham, MA 02154 USA
(617) 891-6790
Telex 923 468
Attn: Customer Service

2.4 Limited Warranty

Lexicon warrants each Model 200 Digital Reverberator to be free from
defects in material and workmanship under normal use and service for one
year. This warranty begins on the date of delivery to the purchaser or
his authorized agent or carrier. During the warranty period, Lexicon will
repair, or at its option replace, at no charge components that prove to be
defective provided that the equipment is returned, shipping prepaid, to
Lexicon's factory or designated service facility.

The warranty is null and void under the following conditions:

1. Abuse, neglect, alteration, or repair by
    unauthorized personnel.
2. Damage caused by improper use or operation from
    . an incorrect power source.
3. Damage caused by accident, act of God, war,
    or civil insurrection.

Lexicon shall not be responsible for loss or damage, direct or
consequential, resulting from machine failure or the inability of the
product to perform. Lexicon shall not be responsible for damage or loss
during shipment to or from its factory or designated service facility.

Lexicon reserves the right to make changes or improvements in the design
or construction of the machine without obligation to make such changes or
improvements in the purchaser's machine.

No equipment may be returned under this warranty without prior
authorization from Lexicon. Shipments must be packed in authorized
Lexicon packing material, fully insured, and prepaid.

This warranty is in lieu of all other warranties, expressed or implied,
and of any other liabilities on Lexicon's part; in addition, Lexicon does
not assume or authorize anyone to make any warranty or assume any
liability not strictly in accordance with the above.

3 PERFORMANCE TESTS AND CALIBRATION

Performance tests are used to check the operation of the unit. ,Always execute the performance tests before proceeding to calibration.

The following equipment is needed:

1. Variable ac voltage source with isolation transformer, voltmeter, and ammeter
2. Digital voltmeter (DVM)
3. Dual trace oscilloscope with >20-MHz bandwidth
4. Audio band low distortion sine wave generator with a 20-dBm maximum output
5. Harmonic distortion analyzer with level meter
6. Noise meter
7. High-quality music source
8. Lexicon-compatible footswitch and footpedal
9. Headphone amplifier and headphones

See Figs. 3.1 and 3.2 at the end of this section for internal views of the digital board and motherboard, respectively.

3.1 Initial Tests

Power-up diagnostics and nonvolatile storage

> When the 200 is turned on or reset, it will run a series of diagnostic programs.

1. Make sure that the unit passes all power-up diagnostics. Repeat the diagnostics several times.
2. Store a front panel setting in a register, then leave the unit off for a while (>1 min). Turn on the unit and make sure that the last front-panel setting is restored. Check to see that the contents of the register are unchanged by calling the register.

Front panel

3. Make sure that all LEDs are on during the first power-up diagnostics and that the display window is blanked when the reset button is pushed in.
4. Run Diagnostic Program No. 0 by pushing button 0 on the numeric select keypad during power-up diagnostics (see Sec. 5.2.5 of Owner's Manual). Make sure that all pushbuttons on the front panel that are read by the microprocessor (all except the input mute and the input mix switches) give the correct display when pushed. Table 3.1 lists the correct displays. Make sure that the hexadecimal codes corresponding

to the three rotary pots (predelay, reverb time, and size)
cover the full range (0 to FE) and that there are no codes
missing. Make sure that the three rear panel jacks (reverb
time, program step, and input mute) also function properly,
using the proper footswitches and footpedals. (Note that the
reverb time footpedal will give a display of 0 to
approximately FA.)

5. Make sure that the front-panel LEDs do not flicker
    excessively.

Table 3.1. Front Panel Test Displays.

Pushbutton	Function Display Window Reading
0	10
.	11
F	12
1	20
2	21
3	22
4	30
5	31
6	32
7	40
8	41
9	42
CLR	13
STO	23
REG	33
PGM	43
PRE-ECHOES	44
DIFFUSION	34
RT CONTOUR LOW	14
RT CONTOUR HIGH	24
ROLLOFF	45

	Right Level Indicator Lit
REVERB STOP	-30
INPUT MUTE*	-24
PROGRAM STEP*	-18

*The input mute and program step control jacks are located
 on the rear panel.

4 TROUBLESHOOTING

4.1 Introduction

This section contains troubleshooting procedures to help locate
malfunctions in the 200. A good general knowledge of digital and analog
electronics is assumed.

The electronics of the 200 consist of three physically detachable modules:
the motherboard and chassis assembly; the digital board assembly; and the
front panel board assembly. The motherboard and chassis assembly contains
the power supply, the A/D and D/A converters, most of the analog input and
output circuitry, and the microprocessor circuitry. The digital board
assembly contains the data memory and all the digital signal processor
logic used to perform the reverberation function. The front panel board
assembly contains the LEDs, potentiometers, pushbuttons used to display
and enter information, the digital logic to control the pushbuttons, and
the analog signal conditioning circuitry.

A thorough visual inspection of the unit is good general troubleshooting
practice. Check for any obvious component failures, such as burnt or
overheated parts or damaged PC board traces. There should be no loose
ICs, connectors, or cables. Observe whether the malfunction is
intermittent, heat related, or shock related.

4.2 System Troubleshooting

If a properly operating Model 200 unit is available, you can identify
which of the three main assemblies is malfunctioning by exchanging
assemblies. If a second unit is not available, there are several system
diagnostic aids that can be used to isolate problems: (1) power-up
diagnostics; (2) various diagnostic programs that can be called up during
power-up diagnostics, including a signature analysis program, an input-
output program, a delay line program, and a front-panel test program; and
(3) a self-test jumper located at the A/D and D/A converters, which
disassociates the analog circuitry from the data memory and the digital
signal processor.

The power-up diagnostics are executed every time the 200 is turned on or
reset; they take up to approximately 15 seconds to complete. The
diagnostics make a single pass through all the testable features of the
unit (that is, all the digital circuitry that can be directly or
indirectly examined by the microprocessor). If an error is found, the
power-up diagnostics will be halted and the LEDs will display an error
message. Figure 4.1 shows a sample error message display. The PROG
display field will contain the test group number, followed by a digit
cycling from one to eight until the test is completed. The REG display
field will contain the error code. The PRE-DELAY display field will
contain an address code or an I/O port code that is associated with the
error. The REVERB TIME display field will contain the good data that
should have been received. The SIZE display field will contain the bad

data that was received. All the displays will be in hexadecimal notation.
A complete listing of the error codes is given in Sec. 4.6. If no errors
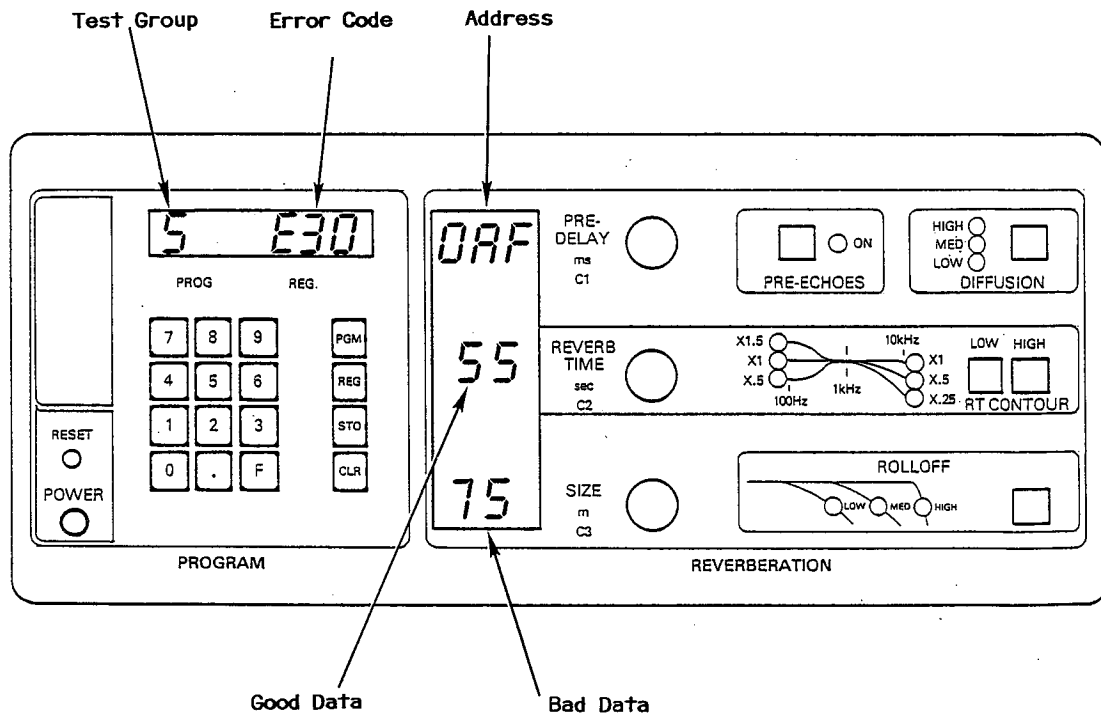are detected, the regular reverberation program will be activated.

Test Group   Error Code   Address

Good Data   Bad Data

Fig. 4.1. Error Message Display.

During the power-up diagnostics, the front-panel keypad can be used to
control the diagnostics as follows:

      1   ignore current error and continue diagnostics
      2   bypass further diagnostics and enter reverberation
           programs
      3   test nonvolatile memory in addition to power-up diagnostics
      4   run test group 4 (RAM/ROM test) continuously
      5   run test group 5 (ARU test) continuously
      6   run test group 6 (DMEM test) continuously
      7   run signature analysis test program
      8   run input/output test program
      9   run delay line program
      0   run front-panel test program

Pushing any of the PROG, REG, STO, and CLR buttons will also bypass
further diagnostics and enter a regular reverberation program.

Pushbutton 1 is used to skip over the current error message and continue
with the diagnostics. This can be used to collect all the error messages
found. It should be noted, however, that many diagnostic errors are
related; therefore, in general, the source of the first error code should
be located first. Pushbutton 2 is used to bypass the power-up
diagnostics. Pushbutton 3 is used to test the nonvolatile memory in
addition to the power-up diagnostics. The nonvolatile memory is not
tested during normal power-up diagnostics because of the inherent danger
of destroying its contents if the unit is powered down or reset during the
test.

Pushbuttons 4, 5, and 6 are used to run specific sections of the power-up
diagnostics continuously. These continuous tests can help isolate
intermittent errors. If an error is detected within a particular section,
the error message will be logged on the display until the next error is
detected. The continuous test is exited by pushing any other pushbutton.

Test group 4 tests the microprocessor RAM (including the nonvolatile RAM),
the ROM, and the writable control store RAM in the digital signal
processor. Because test group 4 includes a test of the nonvolatile RAM in
the unit, it should only be exited by pushing another pushbutton and not
by reset or power down, or the contents of the nonvolatile RAM might be
lost.

Test group 5 tests the functionality of the ARU in the digital signal
processor. Test group 6 tests the 64K x 16 RAM array in the data memory
of the digital signal processor. This test takes approximately 12 seconds
to complete once; the display cycles from 6.1 to 6.8 three times. Errors
are displayed only after the test has cycled at least once from 6.1 to
6.8.

Pushbuttons 7, 8, 9, and 0 call up four different test programs. Pushing
pushbutton 7 calls up a signature test program that places the digital
signal processor and the microprocessor in a stable loop that exercises
many of the signal nodes for signature analysis. The display contains all
digit 7's and can be exited only by a reset or power down.

Pushing pushbutton 8 calls up an input/output program that returns the analog data input to the analog data output through the ARU in the digital signal processor without any processing. This program does not use the data memory. It is useful in testing the analog circuitry and setting levels. In the input/output program, the PROG display field contains the letters "io" and the level indicators function normally.

Pushing pushbutton 9 calls up a delay-line program with a fixed delay of approximately 1.4 seconds per channel. (This is the maximum delay provided by the data memory.) The output channels are swapped in the program. This test program is useful for testing the integrity of the data memory in the digital signal processor and for isolating problems between the analog input and output channels. In the delay program, the PROG display contains the letters "dl" and the level indicators function normally.

Pushing pushbutton 0 calls up a front-panel test program. This program reads all the front and rear panel pushbuttons, pots, and footswitches that are readable by the microprocessor, and displays them on the front panel (see Table 3.1 in Sec. 3.1). The PROG display field contains the letters "Pn" and changes to a numeric code for the pushbuttons when a pushbutton is pushed. The REG display field contains the reverb time footpedal input values. The PRE-DELAY, REVERB TIME, and SIZE display fields contain the respective pot settings. The above four displays are in hexadecimal code. The minimum value is 0 and the maximum value is FE (due to hysteresis). The maximum value for the reverb time footpedal is approximately FA. The upper eight LEDs of the left- and right-channel level indicators display the eight-bit-level information read by the microprocessor in binary. The lower four LEDs of the right-channel level indicators display the reverb stop pushbutton, input mute and program step footswitches, and the lower-order bit of the jumper options. The lower two LEDs of the left-channel level indicator display the status of the upper two bits of the jumper options. The front panel test can only be exited by reset or power down.

The self-test jumper option is located at the A/D and D/A converters. When self-test is activated, the only external signal required to run the analog circuitry is the sample clock AS2 from the digital signal processor. Thus, the analog circuitry can be tested without consideration for much of the functionality of the digital circuitry. The only difference between the self-test exercise of the A/D and D/A converters and the input/output program is that the output gain range levels are different in the D/A converter. They are the same as the input gain range levels for self-test.

4.3 Motherboard Troubleshooting

The motherboard contains the power supply, the microprocessor circuitry, the A/D and D/A converters, and the input output analog circuitry.

The power supplies should be checked first. Check the fuses F1 to F5; check the voltage changeover switches; and check the $\pm$15-V, +12-V, +5-V, -5-V, and the battery voltage Vb (see Secs. 3.2 and 3.3).

The ±15-V power supplies are interlocking. Therefore, if one of the
supplies is down, the other should be down also. If not, investigate the
interlock circuit U6 and Q5. The +12-V supply is controlled by -5V.
Therefore, if -5-V supply is down and the +12-V supply is not, investigate
the interlock circuit Q4. Because the +5-V regulator U3 is powered off
the +18-V unregulated supply, if the +18-V unregulated supply fails, both
+12-V and +5-V supplies should fail also. If only the +5-V supply is
down, the pass transistor Q3 may have failed or the crowbar protection
circuitry may be activated. If the current foldback circuitry is
activated, increase the foldback level by adjusting R17. If the +5-V
supply comes back on, measure the +5-V supply current by measuring the
voltage across R1. Investigate abnormal current draw on the +5-V supply
(the current draw should be <3.5 A).

Next, check the microprocessor circuitry. Since the front-panel display
is controlled by the microprocessor, a good indication of whether the
microprocessor is running at all is to check the front panel. If the
display is blank or stuck, the microprocessor may be stuck or there may be
some malfunction of the control and data path from the microprocessor to
the display. Since the display is interrupt driven on the microprocessor,
the interrupt line on the microprocessor (U17) should be examined. If it
is stuck at either logic state, the microprocessor is stuck. Check the
interrupt flip-flop U8A, and the control inputs to the microprocessor
(ZCLK, RST/, NMI/, and WAIT/). If the RST/ or NMI/ signal is stuck low,
the power-fail circuitry is probably at fault (refer to Sec. 3.6). If
WAIT/ or ZCLK is stuck low, check these signals on the digital board when
they are generated. If nothing is wrong, the data bus DB0-7 and the
address bus AB0 to AB15 should be examined.

If the problem cannot be found, a basic signature analysis test program
can be run with a signature analyzer (HP 5004A or equivalent). This test
is exercised by exchanging the first and the second program ROMs (U25 and
U26). To run this program, the microprocessor must be able to read the
first 60 locations or so of the first ROM slot. Interrupt is disabled and
no RAM locations are used. This program tests most of the relevant nodes
of the microprocessor without gating unstable data onto the data bus (no
inputs from I/O ports). The LED displays should contain all 7's. The
start and stop signals (ROM1/), the clock signal (WR/), and the signatures
for the microprocessor section are given in Sec. 4.7.

If the basic signature analysis test program fails to execute, a free-run
test of the microprocessor can be used. For this test, move the jumper
block on pins 1 and 2 of W15 to pins 2 and 3 of W15; remove U16; lift U23
pin 1 and jumper to +5V. This forces a constant NOP (all zeros on the
microprocessor data bus DB0-DB7) to the microprocessor, thus cycling the
address bus from 0 to FFFFH. (The microprocessor will continue to gate
its own refresh address onto the address bus between these opcode fetch
addresses.)

If the microprocessor can start running the power-up diagnostics, a good
portion of the microprocessor circuitry is functioning. The entire power-
up diagnostic program is contained in the first program ROM. Therefore,
the power-up diagnostics will come up even with only the first ROM

installed. In the power-up diagnostics, a ROM checksum is performed for all the program ROMs in the unit. The error codes are E00 to E0F. Each of the lower four bits of the error codes represents one of the four program ROMs in the 200: bit 0 for ROM 1, bit 1 for ROM 2, etc. Therefore, an error code of E06 means that ROM 2 and ROM 3 are bad, and an error code of E0A means that ROM 2 and ROM 4 are bad. The checksum program is set up so that the checksum of ROM 1 is 1, the checksum of ROM 2 is 2, etc. In this way, ROMs with all FF's or 00's (e.g., missing ROMs) will fail the checksum test. Putting ROMs in the wrong locations will also cause a checksum error.

The RAM is also tested with a semi-random pattern. The test data comes from the contents of ROM 1. The test is sensitive to both address and data errors. (In most cases, however, if the RAM is not functioning, the microprocessor will not run properly.) An E10 error code will be produced. The normal power-up diagnostics do not test the nonvolatile section of the microprocessor RAM because of the risk of inadvertently destroying the nonvolatile memory. The complete RAM can be tested by pushing pushbutton 3 in the power-up diagnostics.

The ROM checksum and microprocessor RAM test are the only tests in the power-up diagnostics that relate to the microprocessor. They are also grouped in test group 4, which can be called up by pushing pushbutton 4 in power-up diagnostics. Note that test group 4 also contains tests for the writable control store RAM, which is located on the digital board assembly.

The microprocessor does not interact with the analog circuitry on the remainder of the motherboard. It communicates with the digital board via connector P2 and with the front panel boards via connector J11. The only signal the microprocessor needs to run from these connectors is its clock ZCLK/, generated on the digital board.

The rest of the motherboard contains the A/D and D/A converters and the analog input and output circuitry. Check the 200 block diagram (Sec. 1.3) for the flow of the analog signals. The analog signal flow in the 200 is rather straightforward, and problems in the input and output stages should be easy to locate, particularly if a known good front panel is used in troubleshooting the motherboard. If the analog output is incorrect in one or both channels, a stage-by-stage examination should be done to locate the malfunctioning stage. Figure 4.2 shows how some of the signals should look.
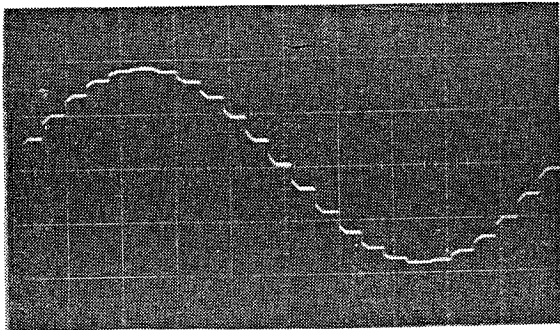
U45 pin 6 (AGR)
(output of input S/H)
2 V/DIV., 0.1 ms/DIV.
1 kHz input
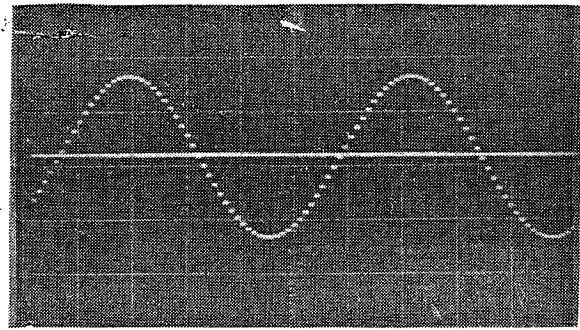
U44 pin 14
(output of channel MUX)
2 V/DIV., 0.2 ms/DIV.
1 kHz input
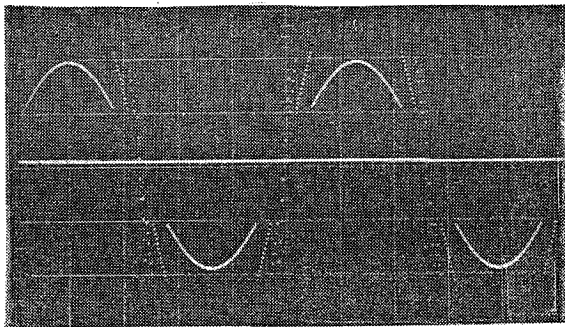
U43 pin 6
(output of input gain range
 amplifier)
2 V/DIV., 0.2 ms/DIV.
100 Hz input
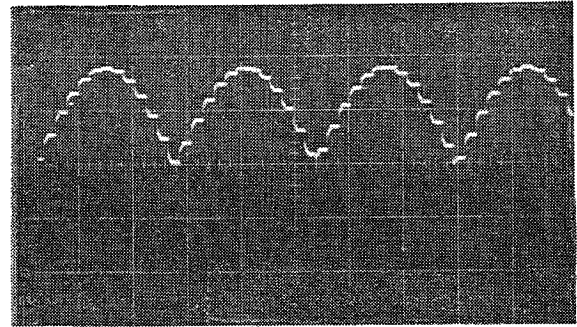
U57 pin 1
(output of gain range
 rectifier)
2 V/DIV., 0.2 ms/DIV
1 kHz input

These waveforms are observed with the unit in the I/O test program.
Input signal level is +12 dBm to the left channel; 20-dB gain switch
is out; input mix switches are both out (stereo); input level
potentiometer is set so that the level indicator is just beneath
overload.

Fig. 4.2. Converter Waveforms.
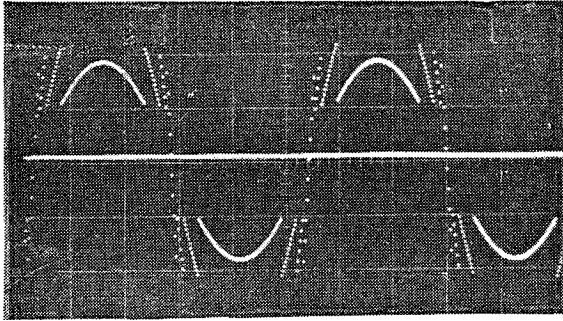
U66 pin 18
(output of DAC)
2 V/DIV., 0.2 ms/DIV.
100 Hz input
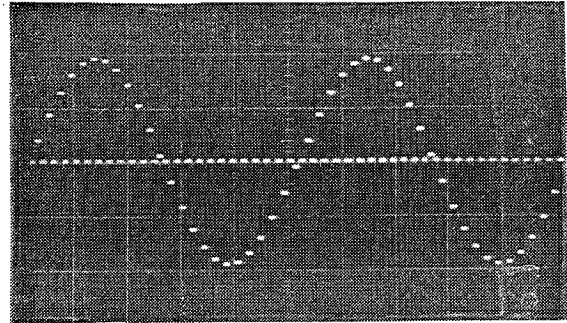
U68 pin 6
(output of output gain range
 amplifier)
2 V/DIV., 0.2 ms/DIV.
1 kHz input
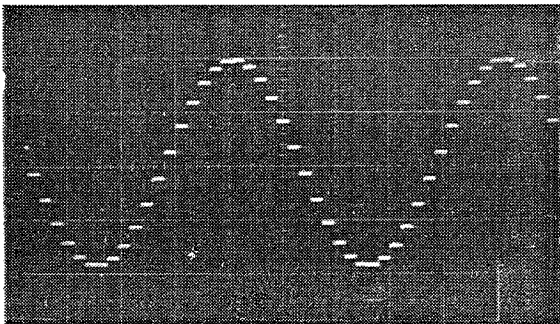
U70 pin 1
(output of output S/H)
2 V/DIV., 0.2 ms/DIV.
1 kHz input
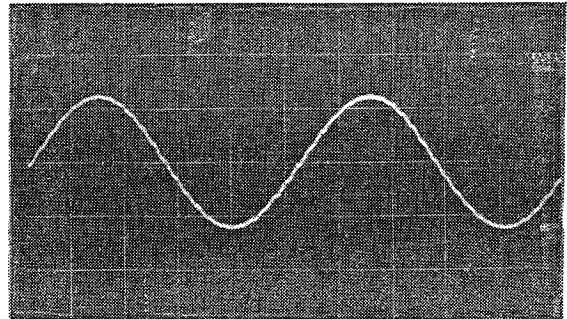
U72 pin 7
(output of output deemphasis)
2 V/DIV., 0.2 ms/DIV.
1 kHz input

These waveforms are observed with the unit in the I/O test program.
Input signal level is +12 dBm to the left channel; 20-dB gain switch
is out; input mix switches are both out (stereo); input level
potentiometer is set so that the level indicator is just beneath
overload.

Fig. 4.2 (cont'd.). Converter Waveforms.

The analog circuitry should be tested with either the self-test function or the I/O program in the software diagnostics. The difference between the self-test and the I/O program is that the self-test does not use the gain correction logic on the digital board. Rather, it takes the input gain bits and outputs them to the output gain range amplifier. Therefore, the output gain range levels are different from those in the I/O test program.

Begin the analog self-test by removing the jumper block from pins 2 and 3 of W17 and connecting it to pins 2 and 3 of W18. This allows the analog timing ROM U64 to free run using only a clock signal AS2 from the digital board. Self-test disassociates the A/D and D/A converters from the digital signal processor. If the unit functions in self-test but not in the I/O program, the problem is most likely with the signal path from the A/D and D/A converters to the digital board (if the digital board passes all diagnostics). If the D/A converter does not gain range correctly in the I/O program only, the problem is most likely with the gain range logic (U85, U49, U33) on the digital board (which is not tested by the software diagnostics). If the unit functions properly in the I/O program but not in self-test, the problem is most likely with the self-test register (U50, U51).

If only one channel malfunctions, the delay line program can be used to show where the problem is. Because the delay line program swaps the channels, if only the left channel is bad in self-test or the I/O program and the left channel is also bad in the delay line program, then the left output channel is bad. If the right channel is bad in the delay line program instead, then the left input channel is bad.

If distortion and noise are high and the problem cannot be associated with a particular signal in a certain stage, then sections can be jumpered out to isolate the problem. For example, the entire A/D and D/A converters can be jumpered out by removing U72 and connecting a jumper from the output of the input filters to the input of the output filters. Similarly, the A/D, the D/A, and the gain range amplifiers can be jumpered out by removing U68 and connecting a jumper from U43 pin 3 to U68 pin 6.

4.4 Digital Board Troubleshooting

The major tools for troubleshooting the digital board are the power-up diagnostics and a signature analyzer (HP 5004A or equivalent). A listing of the error codes generated by the software diagnostics is given in Sec. 4.6. An explanation of the error codes relating to the digital board will be given here. Note that all the error codes are in hexadecimal.

Error codes starting at E20 relate to digital board problems. Generally, an even error code relates to a low byte and an odd error code relates to a high byte, except in diagnostics for the register file and the memories. The diagnostics are ordered in logical precedence so that the more basic blocks in the circuitry are tested first and the blocks requiring more circuitry to function are tested last. For example, the data memory that

is tested last requires most of the writable control store and some of
the ARU to function. The following discussion of error codes is presented
in the order the corresponding tests are performed by the power-up
diagnostics.

E20-E23. Writable control store (WCS) memory. (U61-U64, U77-U80, U30,
U44, U1, U2, and related circuitry.) The WCS memory is tested the same
way as the microprocessor RAM. Semi-random data from the microprocessor
ROM 1 is written in the WCS memory and read back for verification. E20
relates to the lowest eight bits (MI0-MI7) of the 32-bit WCS memory (U64,
U80, and related circuitry). E21 relates to the next eight bits
(MI8-MI15) (U63, U79, and related circuitry). E22 relates to the next
eight bits (MI16-MI23) (U62, U78, and related circuitry). E23 relates to
the most significant eight bits (MI24-MI31) (U61, U77, and related
circuitry).

If one of the memory chips is suspected to be bad, it can be swapped with
another in the circuit to see whether the error code changes. If none of
the four memory chips seems to function, the addressing logic (U81, U84)
and the synchronization circuitry (U30, U44, and associated circuitry) may
be bad. If the synchronization circuit is bad, this diagnostic may take a
long time to complete, or even get stuck.

E64-E67. X register. (U86, U87, U88, U89, U90, and associated
circuitry.) This test writes into the X register that interfaces the
microprocessor data bus to the digital audio bus (DAB) in the digital
signal processor, and reads the data back immediately for verification.
E64 and E66 relate to the low byte (U88, U90) and E65 and E67 relate to
the high byte (U87, U89) of the X register. E64 and E65 use 5555 as
source data. E66 and E67 use AAAA as source data. The associated decode
logic for microprocessor access of the X register may also be bad (U86).
This test does not depend on the ARU functioning, but does depend on some
of the WCS and timing and control functioning. Therefore, this test is
also an indication of whether a small program can be loaded into the WCS
memory and executed. Note, though, that only a small number of the 32
control bits in the WCS memory are used in this program (e.g., OP/,
OFST2/, and OFST3/) (U45, U65).

E71-E7F, E81-E8F. Register files. (U38, U39, U40, U41, U42, U43, and
associated circuitry.) This test writes into the 4 x 16 register files
and reads them back directly via the transfer register. It tests all four
locations of the register files. E71-E7F relate to the low byte of the
register file (U40, U41) and E81-E8F relate to the high byte (U38, U39).
The last digit of the error code indicates which addresses are bad. Bit 0
relates to address 0, bit 1 relates to address 1, etc. Thus, E75 means
the low byte of address 0 and address 2 is bad. In this case, the lower
order bit of the read or write register file address is probably bad. E8A
means the high byte of address 1 and address 3 is bad. In this case, the
higher order bit of the read or write register file address is probably
bad. If the data path is bad in the register file, the error code E7F or
E8F will probably be displayed. The bad bits are then located by
comparing the good and bad data. Bad bits can be caused by opens or
shorts in the data path between the X register, the register files, and
the transfer register, or by malfunctioning ICs. This test does not

4.6 Software Diagnostic Error Codes

Summary

E00-E0F	microprocessor ROM checksum error
E10-E1F	microprocessor RAM error
E20-E2F	writable control store (WCS) error
E30-E6F	ARU error
E70-E8F	register file error
E90-EA7	data memory (DMEM) error

Error Code	Test Description	Primary Suspect	Secondary Suspect
Motherboard			
E01	ROM checksum	U25	U23,U24
E02	ROM checksum	U26	U23,U24
E03	ROM checksum	U25,U26	U23,U24
E04	ROM checksum	U27	U23,U24
E05	ROM checksum	U25,U27	U23,U24
E06	ROM checksum	U26,U27	U23,U24
E07	ROM checksum	U25,U26,U27	U23,U24
E08	ROM checksum	U28	U23,U24
E09	ROM checksum	U25,U28	U23,U24
E0A	ROM checksum	U26,U28	U23,U24
E0B	ROM checksum	U25,U26,U28	U23,U24
E0C	ROM checksum	U27,U28	U23,U24
E0D	ROM checksum	U25,U27,U28	U23,U24
E0E	ROM checksum	U26,U27,U28	U23,U24
E0F	ROM checksum	U25,U26,U27,U28	U23,U24
E10-E1F	RAM test	U30	U23,U24,U15,U21
Digital Board			
E20	WCS test	U64,U80	U81,U84,U30,U44
E21	WCS test	U63,U79	U81,U84,U30,U44
E22	WCS test	U62,U78	U81,U84,U30,U44
E23	WCS test	U61,U77	U81,U84,U30,U44
E30	Double-precision multiply	U13,U15,U11,U12,U25-U28	U29,U18,U19,U32,U46
E31	Double-precision multiply	U13,U15,U11,U12,U25-U28	U29,U18,U19,U32,U46
E32	Double-precision multiply	U13,U15,U11,U12,U25-U28	U29,U18,U19,U32,U46
E33	Double-precision multiply	U13,U15,U11,U12,U25-U28	U29,U18,U19,U32,U46
E34	Double-precision multiply	U7,U9,U5	U29,U18,U19,U32,U46
E35	Double-precision multiply	U7,U9,U5	U29,U18,U19,U32,U46
E36	Double-precision multiply	U7,U9,U5	U29,U18,U19,U32,U46
E37	Double-precision multiply	U7,U9,U5	U29,U18,U19,U32,U46
E38	Double-precision multiply	U25-U28,U29	U18,U19,U32,U46
E39	Double-precision multiply	U25-U28,U29	U18,U19,U32,U46

Error Code	Test Description	Primary Suspect	Secondary Suspect
Digital Board cont'd.			
E3A	Double-precision multiply	U25-U28,U29	U18,U19,U32,U46
E3B	Double-precision multiply	U25-U28,U29	U18,U19,U32,U46
E3C	Double-precision multiply	U25-U28,U29	U18,U19,U32,U46
E3D	Double-precision multiply	U25-U28,U29	U18,U19,U32,U46
E3E	Double-precision multiply	U25-U28,U29	U18,U19,U32,U46
E3F	Double-precision multiply	U25-U28,U29	U18,U19,U32,U46
E40	Double-precision multiply	U25-U28,U29	U18,U19,U32,U46
E41	Double-precision multiply	U25-U28,U29	U18,U19,U32,U46
E42	Double-precision multiply	U25-U28,U29	U18,U19,U32,U46
E43	Double-precision multiply	U25-U28,U29	U18,U19,U32,U46
E44	Double-precision multiply	U25-U28,U29	U18,U19,U32,U46
E45	Double-precision multiply	U25-U28,U29	U18,U19,U32,U46
E46	Double-precision multiply	U25-U28,U29	U18,U19,U32,U46
E47	Double-precision multiply	U25-U28,U29	U18,U19,U32,U46
E48	Double-precision multiply	U8,U10	U25-U28,U29,U18,U19,U32,U46
E49	Double-precision multiply	U8,U10	U25-U28,U29,U18,U19,U32,U46
E4A	Double-precision multiply	U8,U10	U25-U28,U29,U18,U19,U32,U46
E4B	Double-precision multiply	U8,U10	U25-U28,U29,U18,U19,U32,U46
E4C	Double-precision multiply	U25-28,U29	U5,U18,U19,U32,U46
E4D	Double-precision multiply	U25-28,U29	U5,U18,U19,U32,U46
E4E	Double-precision multiply	U25-28,U29	U5,U18,U19,U32,U46
E4F	Double-precision multiply	U25-28,U29	U5,U18,U19,U32,U46
E50	Single-precision multiply	U31,U32,U3,U18	U25-U28,U29
E51	Single-precision multiply	U31,U32,U3,U18	U25-U28,U29
E52	Single-precision multiply	U31,U32,U3,U18	U25-U28,U29
E53	Single-precision multiply	U31,U32,U3,U18	U25-U28,U29
E54	Single-precision multiply	U31,U32,U3,U18	U25-U28,U29
E55	Single-precision multiply	U31,U32,U3,U18	U25-U28,U29
E56	Single-precision multiply	U31,U32,U3,U18	U25-U28,U29
E57	Single-precision multiply	U31,U32,U3,U18	U25-U28,U29
E58	Single-precision multiply	U31,U32,U3,U18	U25-U28,U29
E59	Single-precision multiply	U31,U32,U3,U18	U25-U28,U29
E5A	Single-precision multiply	U31,U32,U3,U18	U25-U28,U29
E5B	Single-precision multiply	U31,U32,U3,U18	U25-U28,U29
E5C	Single-precision multiply	U31,U32,U3,U18	U25-U28,U29
E5D	Single-precision multiply	U31,U32,U3,U18	U25-U28,U29
E5E	Single-precision multiply	U31,U32,U3,U18	U25-U28,U29
E5F	Single-precision multiply	U31,U32,U3,U18	U25-U28,U29
E60	Single-precision multiply	U31,U32,U3,U18	U25-U28,U29
E61	Single-precision multiply	U31,U32,U3,U18	U25-U28,U29
E62	Single-precision multiply	U31,U32,U3,U18	U25-U28,U29
E63	Single-precision multiply	U31,U32,U3,U18	U25-U28,U29
E64	X register low	U88,U90,U86	U45,U65
E65	X register high	U87,U89,U86	U45,U65,U83,U82
E66	X register low	U88,U90,U86	U45,U65
E67	X register high	U87,U89,U86	U45,U65

ARU

Error Code	Test Description	Primary Suspect	Secondary Suspect
Digital Board cont'd.			
E68	Double-precision multiply	U3,U31	U25-U28,U29
E69	Double-precision multiply	U3,U31	U25-U28,U29
E6A	Double-precision multiply	U3,U31	U25-U28,U29
E6B	Double-precision multiply	U3,U31	U25-U28,U29
E6C	saturation low	U14,U16	U6,U33
E6D	saturation high	U14,U16	U6,U33
E6E	saturation low	U14,U16	U6,U33
E6F	saturation high	U14,U16	U6,U33
E71-7F	register file low	U40,U41,U42,U43	U45,U46,U31,U32
E81-8F	register file high	U38,U39,U42,U43	U45,U46,U31,U32
E90	Data memory	U60	U22,U23,U52,U36,U37
E91	Data memory	U59	U22,U23,U52,U36,U37
E92	Data memory	U58	U22,U23,U52,U36,U37
E93	Data memory	U57	U22,U23,U52,U36,U37
E94	Data memory	U56	U22,U35,U52,U36,U37
E95	Data memory	U55	U22,U35,U52,U36,U37
E96	Data memory	U54	U22,U35,U52,U36,U37
E97	Data memory	U53	U22,U35,U52,U36,U37
E98	Data memory	U76	U34,U51,U67,U36,U37
E99	Data memory	U75	U34,U51,U67,U36,U37
E9A	Data memory	U74	U34,U51,U67,U36,U37
E9B	Data memory	U73	U34,U51,U67,U36,U37
E9C	Data memory	U72	U34,U66,U67,U36,U37
E9D	Data memory	U71	U34,U66,U67,U36,U37
E9E	Data memory	U70	U34,U66,U67,U36,U37
E9F	Data memory	U69	U34,U66,U67,U36,U37
EA0-A7	Data memory address	U50,U65	U23,U35,U51,U66,U52,U67

U 31,32

4.7 Signature Analysis

The signature analysis test helps in troubleshooting the digital circuits.
The signatures and the conditions they are taken under are listed on the
following pages. Use an HP 5004A signature analyzer or equivalent.

There are currently two versions of the signature analysis results.
Version 0 applies to those units with version 0 timing ROM and version 1
applies to those units with version 1 timing ROM. The part number for
version 0 is 350-03494 and the part number for version 1 is 350-03494 R1;
the part number appears on U18 on the digital board assembly.

The primary set of tests should be performed before the secondary set.

DIGITAL BOARD (DMEM) (cont'd.)

VERSION 1, PRIMARY SET

pins	U53	29F9	U69	A908		U66	1	7CH9	16	00UP
2,14	U54	7FC1	U70	H5F4			2	UF86	15	32U9
	U55	087F	U71	HH3C			3	0055	14	0033
	U56	7FC1	U72	7FC1			4	U34H	13	H196
	U57	087F	U73	P5AH			5	P625	12	00U1
	U58	7FC1	U74	5H04			6	4F0A	11	7828
	U59	087F	U75	087F			7	5962	10	8CHC
	U60	A541	U76	7FC1			8	0000	9	–

U67	1	0000	16	00UP		U68	1	–	14	00UP
	2	U34H	15	0000			2	–	13	6AC3
	3	CU71	14	8CHC			3	–	12	6A4H
	4	U34H	13	4229			4	–	11	P430
	5	7CH9	12	8CHC			5	–	10	P4FP
	6	8C88	11	H196			6	–	9	00UP
	7	7CH9	10	UFCU			7	0000	8	0000
	8	0000	9	H196						

U87	1	P430	20	00UP		U88	1	P430	20	00UP
	2	7FC1	19	A908			2	A541	19	29F9
	3	–	18	–			3	–	18	–
	4	–	17	–			4	–	17	–
	5	087F	16	H5F4			5	087F	16	7FC1
	6	5H04	15	HH3C			6	7FC1	15	087F
	7	–	14	–			7	–	14	–
	8	–	13	–			8	–	13	–
	9	P5AH	12	7FC1			9	087F	12	7FC1
	10	0000	11	–			10	0000	11	–

U89	1	00UP	20	00UP		U90	1	00UP	20	00UP
	2	–	19	–			2	–	19	–
	3	7FC1	18	A908			3	A541	18	29F9
	4	087F	17	H5F4			4	087F	17	7FC1
	5	–	16	–			5	–	16	–
	6	–	15	–			6	–	15	–
	7	5H04	14	HH3C			7	7FC1	14	087F
	8	P5AH	13	7FC1			8	087F	13	7FC1
	9	–	12	–			9	–	12	–
	10	0000	11	4950			10	0000	11	4950

DIGITAL BOARD (T&C) –– no feedback mode

VERSION 1, SECONDARY SET

SETUP = Diagnostic Program 7; lift pins 2 & 5 of U4 and connect a jumper
from U21 pin 13 to ground and a jumper from U24 pin 13 to +5V.
(This disables the accumulator (U11, U12, U14, U16) and the
T register (U7, U9). No feedback inside the ARU.)
Refer to Sheet 1 of Schematic #060-03305 (T&C).

```
START = RESET/  (J4 pin 3) __▁▔
 STOP = RESET/  (J4 pin 3) __▁▔
CLOCK = MC   (J4 pin 1) __▁▔
  +5V = 096H
GROUND = 0000   (J4 pin 2)
```

U3	1	A38A	16	096H		U4	1	0000	20	096H
	2	CA8A	15	0000			2	A32U	19	HF1P
	3	67FU	14	4300			3	5HP8	18	A38A
	4	H428	13	4516			4	0178	17	CA8A
	5	5H4H	12	6AC7			5	A32U	16	HH45
	6	PUU1	11	HH45			6	7A23	15	C3P7
	7	0000	10	HF1P			7	PUU1	14	67FU
	8	0000	9	5HP8			8	–	13	H428
							9	–	12	67FU
							10	0000	11	0000

U5	1	H710	14	096H		U6	1	FA35	14	096H
	2	3660	13	C78A			2	6102	13	0163
	3	8CH4	12	A17P			3	AC37	12	0163
	4	8CH4	11	CPP7			4	5P0U	11	0000
	5	F358	10	A813			5	3U0H	10	5P0U
	6	488F	9	571F			6	6102	9	0000
	7	0000	8	1037			7	0000	8	5P0U

U17	1	–	14	096H		U18	1	HF1P	20	096H
	2	–	13	HH45			2	HH45	19	H90C
	3	P15P	12	H428			3	1851	18	H90C
	4	P833	11	67FU			4	4H0P	17	AU50
	5	C3P7	10	6PA2			5	9A5C	16	54P4
	6	CA8A	9	1AU0			6	F380	15	0000
	7	0000	8	139H			7	20P3	14	096H
							8	594C	13	096H
							9	A17P	12	5026
							10	0000	11	594C

DIGITAL BOARD (T&C) (cont'd.)

VERSION 1, SECONDARY SET

U19	1	0000	20	096H		U21	1	261C	14	096H
	2	1P3P	19	PF1C			2	261C	13	0000
	3	27FC	18	F380			3	6PA2	12	096H
	4	5420	17	20P3			4	2395	11	0000
	5	27FC	16	9HAA			5	139H	10	746H
	6	A813	15	HHHP			6	5563	9	43F1
	7	5026	14	CCCF			7	0000	8	096H
	8	594C	13	58HU						
	9	A17P	12	AF6U						
	10	0000	11	0000						

U24	1	096A	14	096H		U31	1	C3P7	20	096H
	2	0007	13	096H			2	0U0U	19	4300
	3	3U0H	12	0000			3	05A8	18	9HC7
	4	3660	11	7006			4	05A8	17	54P4
	5	HP7H	10	796C			5	0U0U	16	5P0U
	6	H710	9	FU41			6	6AC7	15	6C74
	7	0000	8	F62F			7	FPH9	14	FH5U
							8	6AC7	13	096H
							9	4516	12	096H
							10	0000	11	0000

U32	1	H428	20	096H		U33	1	096H	16	096H
	2	1851	19	096H			2	746H	15	346C
	3	4H9P	18	096H			3	571F	14	7361
	4	18P2	17	4516			4	C78A	13	7361
	5	4H0P	16	AU50			5	7006	12	346C
	6	9A5C	15	101H			6	A813	11	1037
	7	45C4	14	4074			7	43F1	10	261C
	8	7U48	13	147C			8	0000	9	1P3P
	9	54P4	12	FP28						
	10	0000	11	0000						

U47	1	139H	14	096H		U48	1	096H	14	096H
	2	C7CF	13	P563			2	0000	13	096H
	3	096H	12	139H			3	096H	12	–
	4	CA8A	11	48U5			4	096H	11	–
	5	096H	10	139H			5	096H	10	096H
	6	C3P7	9	62H7			6	0000	9	–
	7	0000	8	FU41			7	0000	8	–

DIGITAL BOARD (T&C) (cont'd.)

VERSION 1, SECONDARY SET

U49	1	H428	20	096H
	2	H90C	19	4U41
	3	48U5	18	7A0F
	4	48U5	17	48U5
	5	H90C	16	H90C
	6	7361	15	7A0F
	7	H90C	14	P833
	8	H90C	13	H90C
	9	7361	12	7361
	10	0000	11	0000

U68	1	096H	14	096H
	2	0000	13	05A8
	3	67FU	12	0FF5
	4	6PA2	11	FU41
	5	–	10	F62F
	6	–	9	096H
	7	0000	8	0000

U85	1	48U5	16	096H
	2	U66F	15	096H
	3	UU01	14	0000
	4	U66F	13	0000
	5	UU01	12	48U5
	6	U66F	11	48U5
	7	UU01	10	096H
	8	0000	9	096H

U91	1	0000	14	096H
	2	–	13	096H
	3	096H	12	096H
	4	–	11	0000
	5	–	10	5H4H
	6	–	9	096H
	7	0000	8	5420

DIGITAL BOARD (ARU) — normal mode

VERSION 1, SECONDARY SET

   SETUP = Diagnostic Program 7; unmodified digital board.
          Refer to Sheet 3 of Schematic #060-03305 (ARU).

  START = RESET/ (J4 pin 3) ⎍
   STOP = RESET/ (J4 pin 3) ⎍
  CLOCK = MC (J4 pin 1) ⎍
    +5V = 096H
GROUND = 0000 (J4 pin 2)

U7	1	A32U	20	096H		U8	1	AA42	20	096H
	2	1448	19	30A9			2	1448	19	30A9
	3	5HHF	18	216U			3	U5A8	18	U5A8
	4	HHFU	17	6261			4	2F92	17	2F92
	5	F36H	16	F36H			5	F36H	16	F36H
	6	30A9	15	8F63			6	30A9	15	8F63
	7	216U	14	5P32			7	U5A8	14	1CF4
	8	HHFU	13	2374			8	2F92	13	2F92
	9	F36H	12	CF30			9	F36H	12	CF30
	10	0000	11	0000			10	0000	11	0000

U9	1	A32U	20	096H		U10	1	AA42	20	096H
	2	FP12	19	H17P			2	FP12	19	H17P
	3	63C7	18	UCH8			3	U5A8	18	7F1U
	4	A04P	17	6HH5			4	F2UP	17	6333
	5	4084	16	6P04			5	4084	16	6P04
	6	08C3	15	U4FP			6	08C3	15	U4FP
	7	4HU6	14	CHC8			7	C3A8	14	1P0H
	8	009U	13	9H59			8	CP70	13	1P0H
	9	H52P	12	1A1P			9	H52P	12	1A1P
	10	0000	11	0000			10	0000	11	0000

U11	1	5P5C	20	096H		U12	1	5P5C	20	096H
	2	2F92	19	1P0H			2	U947	19	1CF4
	3	2374	18	CHC8			3	F198	18	5P32
	4	63C7	17	6HH5			4	5HHF	17	6261
	5	U5A8	16	6333			5	U5A8	16	2F92
	6	F2UP	15	7F1U			6	2F92	15	U5A8
	7	A04P	14	UCH8			7	HHFU	14	216U
	8	4HU6	13	009U			8	216U	13	HHFU
	9	C3A8	12	CP70			9	U5A8	12	2F92
	10	0000	11	1P3P			10	0000	11	1P3P

DIGITAL BOARD (ARU) (cont'd.)

VERSION 1, SECONDARY SET

U13	1	7A23	20	096H		U14	1	2C3F	20	096H
	2	93AC	19	8AA0			2	32C7	19	2C3F
	3	2F92	18	1P0H			3	2F92	18	1P0H
	4	U5A8	17	6333			4	3CHA	17	3CHA
	5	CC16	16	U643			5	U5A8	16	6333
	6	4AFC	15	5F32			6	3CHA	15	3CHA
	7	F2UP	14	7F1U			7	F2UP	14	7F1U
	8	C3A8	13	CP70			8	3CHA	13	3CHA
	9	5AA8	12	U622			9	C3A8	12	CP70
	10	0000	11	0000			10	0000	11	3CHA

U15	1	7A23	20	096H		U16	1	2C3F	20	096H
	2	PUH7	19	6276			2	3CHA	19	2C3F
	3	U947	18	1CF4			3	U947	18	1CF4
	4	U5A8	17	2F92			4	3CHA	17	3CHA
	5	CC16	16	93AC			5	U5A8	16	2F92
	6	93AC	15	CC16			6	3CHA	15	3CHA
	7	2F92	14	U5A8			7	2F92	14	U5A8
	8	U5A8	13	2F92			8	3CHA	13	3CHA
	9	CC16	12	93AC			9	U5A8	12	2F92
	10	0000	11	0000			10	0000	11	3CHA

U24	1	096A	14	096H		U25	1	H17P	24	096H
	2	0007	13	A32U			2	U622	23	5F32
	3	1522	12	AA42			3	AF6U	22	6P04
	4	1F4U	11	3CHA			4	HHHP	21	U643
	5	A17P	10	32C7			5	9HAA	20	U4FP
	6	A813	9	FU41			6	PF1C	19	8AA0
	7	0000	8	F62F			7	C02C	18	1A1P
							8	A17P	17	8H0P
							9	009U	16	1522
							10	UCH8	15	H116
							11	6HH5	14	0000
							12	0000	13	CHC8

U26	1	FP12	24	096H		U27	1	30A9	24	096H
	2	93AC	23	CC16			2	93AC	23	CC16
	3	AF6U	22	4084			3	AF6U	22	F36H
	4	HHHP	21	4AFC			4	HHHP	21	93AC
	5	9HAA	20	08C3			5	9HAA	20	8F63
	6	PF1C	19	5AA8			6	PF1C	19	6276
	7	A9A3	18	H52P			7	F889	18	CF30
	8	A17P	17	C6PH			8	A17P	17	UC4F
	9	2374	16	C02C			9	HHFU	16	A9A3
	10	63C7	15	CH6U			10	216U	15	8991
	11	A04P	14	0000			11	6261	14	0000
	12	0000	13	4HU6			12	0000	13	5P32

DIGITAL BOARD (ARU) (cont'd.)

VERSION 1, SECONDARY SET

U28	1	1448	24	096H		U29	1	UC4F	16	096H
	2	PUH7	23	CC16			2	8991	15	CH6U
	3	AF6U	22	F36H			3	HUAH	14	C6PH
	4	HHHP	21	93AC			4	P8CC	13	A813
	5	9HAA	20	30A9			5	8H0P	12	F889
	6	PF1C	19	CC16			6	H116	11	A9A3
	7	A813	18	F36H			7	P354	10	1F4U
	8	A17P	17	HUAH			8	0000	9	C02C
	9	F198	16	F889						
	10	5HHF	15	P8CC						
	11	HHFU	14	0000						
	12	0000	13	216U						

U38	1	UC32	16	096H		U39	1	F8C3	16	096H
	2	24CF	15	HP74			2	420H	15	6HFC
	3	5727	14	0U0U			3	C266	14	0U0U
	4	101H	13	0U0U			4	101H	13	0U0U
	5	FP28	12	67FU			5	FP28	12	67FU
	6	1P0H	11	7567			6	C3A8	11	7567
	7	6333	10	CP70			7	F2UP	10	2F92
	8	0000	9	7F1U			8	0000	9	U5A8

U40	1	F8C3	16	096H		U41	1	F8C3	16	096H
	2	6HFC	15	6HFC			2	6HFC	15	883C
	3	P775	14	0U0U			3	F8C3	14	0U0U
	4	101H	13	0U0U			4	101H	13	0U0U
	5	FP28	12	67FU			5	FP28	12	67FU
	6	1CF4	11	7567			6	U5A8	11	7567
	7	2F92	10	2F92			7	2F92	10	U947
	8	0000	9	U5A8			8	0000	9	U5A8

U42	1	F62F	20	096H		U43	1	F62F	20	096H
	2	6HFC	19	5727			2	883C	19	P775
	3	2F92	18	1P0H			3	U947	18	1CF4
	4	U5A8	17	6333			4	U5A8	17	2F92
	5	F8C3	16	24CF			5	F8C3	16	6HFC
	6	420H	15	UC32			6	6HFC	15	F8C3
	7	F2UP	14	7F1U			7	2F92	14	U5A8
	8	C3A8	13	CP70			8	U5A8	13	2F92
	9	C266	12	HP74			9	F8C3	12	6HFC
	10	0000	11	6C74			10	0000	11	6C74

DIGITAL BOARD (DMEM) — normal mode, slow clock

VERSION 1, SECONDARY SET

SETUP = Diagnostic Program 7; unmodified digital board; U34 pin 13
        lifted and jumpered to U34 pin 1.
        Refer to Sheet 4 of Schematic #060-03305 (DMEM).

START = MSB of current position counter   (U34 pin 8) _⌐
 STOP = MSB of current position counter   (U34 pin 8) _⌐
CLOCK = RESET/ (J4 pin 3) _⌐
  +5V = 826P
GROUND = 0000   (J4 pin 2)

U22	1	826P	14	826P		U34	1	C25F	14	826P
	2	0000	13	C133			2	0000	13	C25F
	3	7P25	12	0000			3	5H21	12	0000
	4	2A1F	11	8P3U			4	19H6	11	5H21
	5	A206	10	3319			5	HP66	10	19H6
	6	C133	9	7C47			6	U81P	9	HP66
	7	0000	8	C25F			7	0000	8	U81P

U35	1	3319	16	826P		U51	1	19H6	16	826P
	2	826P	15	826P			2	826P	15	826P
	3	3319	14	7C47			3	19H6	14	HP66
	4	8P3U	13	7C47			4	5H21	13	HP66
	5	8P3U	12	C25F			5	5H21	12	U81P
	6	826P	11	826P			6	826P	11	826P
	7	826P	10	C25F			7	826P	10	U81P
	8	0000	9	826P			8	0000	9	826P

U52	1	826P	16	826P		U66	1	19H6	16	826P
	2	5H21	15	0000			2	826P	15	826P
	3	7P25	14	U81P			3	19H6	14	HP66
	4	7P25	13	C133			4	5H21	13	HP66
	5	19H6	12	C133			5	5H21	12	U81P
	6	2A1F	11	HP66			6	826P	11	826P
	7	2A1F	10	A206			7	826P	10	U81P
	8	0000	9	A206			8	0000	9	826P

U67	1	826P	16	826P		U68	1	826P	14	826P
	2	5H21	15	0000			2	0000	13	826P
	3	8P3U	14	U81P			3	826P	12	0000
	4	–	13	C25F			4	0000	11	826P
	5	19H6	12	C25F			5	–	10	0000
	6	3319	11	HP66			6	–	9	826P
	7	3319	10	7C47			7	0000	8	0000
	8	0000	9	–						

DIGITAL BOARD (T&C) — no saturation

VERSION 1, SECONDARY SET

SETUP = Diagnostic Program 7; unmodified digital board.
        Refer to Sheet 1 of Schematic #060-03305 (T&C).

START = RESET/ (J4 pin 3) _⎍‾
 STOP = OFST12/ (U50 pin 12) ‾⌐_
CLOCK = MC (J4 pin 1) _⎍‾
  +5V = HH7P
GROUND = 0000 (J4 pin 2)

U3	1	5F5P	16	HH7P		U4	1	0000	20	HH7P
	2	FA93	15	0000			2	9U4F	19	9HPP
	3	2UHA	14	3U49			3	591A	18	5F5P
	4	3837	13	7462			4	A3F5	17	FA93
	5	9A08	12	959A			5	P223	16	P549
	6	U542	11	P549			6	F960	15	17PH
	7	A3F5	10	9HPP			7	U542	14	2UHA
	8	0000	9	591A			8	–	13	3837
							9	–	12	2UHA
							10	0000	11	0000

U5	1	667F	14	HH7P		U6	1	3620	14	HH7P
	2	692F	13	1PU0			2	70AP	13	883F
	3	47HU	12	CC02			3	468P	12	C524
	4	47HU	11	6317			4	F4UF	11	3H18
	5	U49H	10	667F			5	C452	10	5UP8
	6	C342	9	53AP			6	70AP	9	3H18
	7	0000	8	7897			7	0000	8	62U0

U17	1	–	14	HH7P		U18	1	9HPP	20	HH7P
	2	–	13	P549			2	P549	19	HH7P
	3	HH7P	12	3837			3	6A0H	18	HH7P
	4	0000	11	2UHA			4	1F82	17	89U0
	5	17PH	10	U2A4			5	3267	16	H725
	6	FA93	9	3130			6	768F	15	0000
	7	0000	8	PF4P			7	FHP5	14	HH7P
							8	95H9	13	HH7P
							9	2PC0	12	FF5C
							10	0000	11	1125

DIGITAL BOARD (T&C) (cont'd.)

VERSION 1, SECONDARY SET

U19	1	0000	20	HH7P		U21	1	HH7P	14	HH7P
	2	UCUF	19	8887			2	HH7P	13	P223
	3	907A	18	768F			3	U2A4	12	3U5H
	4	4776	17	FH47			4	66F3	11	P223
	5	907A	16	5533			5	PF4P	10	U71H
	6	667F	15	4APF			6	HH7P	9	82A2
	7	FFU9	14	95H9			7	0000	8	HH7P
	8	1187	13	2PC0						
	9	CC02	12	9758						
	10	0000	11	0000						

U24	1	HH7P	14	HH7P		U31	1	17PH	20	HH7P
	2	0000	13	9U4F			2	HH7P	19	3U49
	3	C452	12	4232			3	HH7P	18	1911
	4	692F	11	UP3H			4	HH7P	17	H725
	5	CC02	10	2343			5	HH7P	16	5UP8
	6	667F	9	3130			6	959A	15	6AFP
	7	0000	8	PF4P			7	4FC6	14	C21P
							8	959A	13	HH7P
							9	7462	12	HH7P
							10	0000	11	0000

U32	1	3837	20	HH7P		U33	1	HH7P	16	HH7P
	2	6A0H	19	HH7P			2	U71H	15	HH7P
	3	00C0	18	HH7P			3	468P	14	HH7P
	4	HA8P	17	7462			4	3620	13	HH7P
	5	1F82	16	89U0			5	UP3H	12	HH7P
	6	3267	15	A2C2			6	667F	11	7897
	7	6118	14	8AF9			7	82A2	10	HH7P
	8	U412	13	80A9			8	0000	9	UCUF
	9	H725	12	0A0C						
	10	0000	11	0000						

U47	1	PF4P	14	HH7P		U48	1	HH7P	14	HH7P
	2	1P19	13	3CA6			2	0000	13	HH7P
	3	HH7P	12	PF4P			3	HH7P	12	–
	4	FA93	11	HH7P			4	HH7P	11	–
	5	HH7P	10	PF4P			5	HH7P	10	HH7P
	6	17PH	9	H7P8			6	0000	9	–
	7	0000	8	3130			7	0000	8	–

DIGITAL BOARD (T&C) (con't'd.)

VERSION 1, SECONDARY SET

U49	1	3837	20	HH7P		U68	1	HH7P	14	HH7P
	2	HH7P	19	0000			2	0000	13	HH7P
	3	HH7P	18	0000			3	2UHA	12	0000
	4	HH7P	17	HH7P			4	U2A4	11	3130
	5	HH7P	16	HH7P			5	–	10	PF4P
	6	HH7P	15	0000			6	–	9	HH7P
	7	HH7P	14	0000			7	0000	8	0000
	8	HH7P	13	HH7P						
	9	HH7P	12	HH7P						
	10	0000	11	0000						

U85	1	HH7P	16	HH7P		U86	1	–	16	HH7P
	2	2HA1	15	HH7P			2	–	15	–
	3	8023	14	0000			3	–	14	–
	4	16AH	13	0000			4	HH7P	13	–
	5	66A4	12	HH7P			5	HH7P	12	HH7P
	6	H7C2	11	HH7P			6	HH7P	11	HH7P
	7	P4U1	10	HH7P			7	HH7P	10	–
	8	0000	9	HH7P			8	0000	9	HH7P
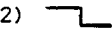
U91	1	0000	14	HH7P
	2	–	13	HH7P
	3	HH7P	12	HH7P
	4	–	11	0000
	5	–	10	9A08
	6	–	9	HH7P
	7	0000	8	4776

DIGITAL BOARD (ARU) — no saturation

VERSION 1, SECONDARY SET

SETUP = Diagnostic Program 7; unmodified digital board.
        Refer to Sheet 3 of Schematic #060-03305 (ARU).

 START = RESET/ (J4 pin 3) ⎍
  STOP = OFST12/ (U50 pin 12) ⎍
 CLOCK = MC (J4 pin 1) ⎍
   +5V = HH7P
GROUND = 0000 (J4 pin 2)

U7	1	9U4F	20	HH7P		U8	1	4232	20	HH7P
	2	49A6	19	2093			2	49A6	19	2093
	3	A30H	18	7167			3	7H02	18	7H02
	4	15HU	17	24C7			4	43UU	17	43UU
	5	ACAU	16	ACAU			5	ACAU	16	ACAU
	6	2093	15	5A08			6	2093	15	5A08
	7	7167	14	13C7			7	7H02	14	1U3A
	8	15HU	13	H07P			8	43UU	13	43UU
	9	ACAU	12	F97U			9	ACAU	12	F97U
	10	0000	11	0000			10	0000	11	0000

U9	1	9U4F	20	HH7P		U10	1	4232	20	HH7P
	2	P532	19	P5CF			2	P532	19	P5CF
	3	FC4H	18	103U			3	7H02	18	H63F
	4	C02F	17	A533			4	21F7	17	2120
	5	353P	16	91AA			5	353P	16	91AA
	6	7U4A	15	883F			6	7U4A	15	883F
	7	C10P	14	1P0U			7	P3U0	14	99C3
	8	3PH6	13	8CCC			8	9372	13	99C3
	9	673H	12	883F			9	673H	12	883F
	10	0000	11	0000			10	0000	11	0000

U11	1	3U5H	20	HH7P		U12	1	3U5H	20	HH7P
	2	43UU	19	99C3			2	HUH5	19	1U3A
	3	H07P	18	1PU0			3	517C	18	13C7
	4	FC4H	17	A533			4	A30H	17	24C7
	5	7H02	16	2120			5	7H02	16	43UU
	6	21F7	15	H63F			6	43UU	15	7H02
	7	C02F	14	103U			7	15HU	14	7167
	8	C10P	13	3PH6			8	7167	13	15H0
	9	P3U0	12	9372			9	7H02	12	43UU
	10	0000	11	UCUF			10	0000	11	UCUF

DIGITAL BOARD (ARU) (cont'd.)

VERSION 1, SECONDARY SET

U13	1	F960	20	HH7P		U14	1	HH7P	20	HH7P
	2	321P	19	C524			2	HFHA	19	HH7P
	3	43UU	18	99C3			3	43UU	18	99C3
	4	7H02	17	2120			4	01A4	17	01A4
	5	P308	16	C083			5	7H02	16	2120
	6	2AH8	15	5UP1			6	01A4	15	01A4
	7	21F7	14	H63F			7	21F7	14	H63F
	8	P3U0	13	9372			8	01A4	13	01A4
	9	72F5	12	P790			9	P3U0	12	9372
	10	0000	11	0000			10	0000	11	01A4

U15	1	F960	20	HH7P		U16	1	HH7P	20	HH7P
	2	4870	19	UCFP			2	01A4	19	HH7P
	3	HUH5	18	1U3A			3	HUH5	18	1U3A
	4	7H02	17	43UU			4	01A4	17	01A4
	5	P308	16	321P			5	7H02	16	43UU
	6	321P	15	P308			6	01A4	15	01A4
	7	43UU	14	7H02			7	43UU	14	7H02
	8	7H02	13	43UU			8	01A4	13	01A4
	9	P308	12	321P			9	7H02	12	43UU
	10	0000	11	0000			10	0000	11	01A4

U24	1	HH7P	14	HH7P		U25	1	P5CF	24	HH7P
	2	0000	13	9U4F			2	P790	23	5UP1
	3	2UAP	12	4232			3	9758	22	91AA
	4	U2H0	11	01A4			4	4APF	21	C083
	5	CC02	10	HFHA			5	5533	20	883F
	6	667P	9	3130			6	8887	19	C524
	7	0000	8	PF4P			7	4F3A	18	883F
							8	CC02	17	0C25
							9	3PH6	16	2UAP
							10	103U	15	0494
							11	A533	14	0000
							12	0000	13	1PU0

U26	1	P532	24	HH7P		U27	1	2093	24	HH7P
	2	321P	23	P308			2	321P	23	P308
	3	9758	22	353P			3	9758	22	ACAU
	4	4APF	21	2AH8			4	4APF	21	321P
	5	5533	20	7U4A			5	5533	20	5A08
	6	8887	19	72F5			6	8887	19	UCFP
	7	9FP2	18	673H			7	2C46	18	F97U
	8	CC02	17	683H			8	CC02	17	1PAU
	9	H07P	16	4F3A			9	15HU	16	9FP2
	10	FC4H	15	H9UU			10	4PH1	15	A240
	11	C02F	14	0000			11	24C7	14	0000
	12	0000	13	C10P			12	0000	13	13C7

DIGITAL BOARD (ARU) (cont'd.)

VERSION 1, SECONDARY SET

U28					U29				
	1	49A6	24	HH7P		1	1PAU	16	HH7P
	2	4870	23	P308		2	A240	15	H9UU
	3	9758	22	ACAU		3	779A	14	683H
	4	4APF	21	321P		4	15P4	13	667F
	5	5533	20	2093		5	0C25	12	2C46
	6	8887	19	P308		6	2494	11	9FP2
	7	667F	18	ACAU		7	HU70	10	U2H0
	8	CC02	17	779A		8	0000	9	4F3A
	9	517C	16	2C46					
	10	A30H	15	15P4					
	11	15HU	14	0000					
	12	0000	13	7167					

U38					U39				
	1	H7C2	16	HH7P		1	2HA1	16	HH7P
	2	P4U1	15	66A4		2	9445	15	31F0
	3	16AH	14	HH7P		3	493C	14	HH7P
	4	A2C2	13	HH7P		4	A2C2	13	HH7P
	5	0A0C	12	2UHA		5	0A0C	12	2UHA
	6	99C3	11	P223		6	P3U0	11	P223
	7	2120	10	9372		7	21F7	10	43UU
	8	0000	9	H63F		8	0000	9	7H02

U40					U41				
	1	2HA1	16	HH7P		1	2HA1	16	HH7P
	2	31F0	15	31F0		2	31F0	15	8023
	3	8824	14	HH7P		3	2HA1	14	HH7P
	4	A2C2	13	HH7P		4	A2C2	13	HH7P
	5	0A0C	12	2UHA		5	0A0C	12	2UHA
	6	1U3A	11	P223		6	7H02	11	P223
	7	43UU	10	43UU		7	43UU	10	HUH5
	8	0000	9	7H02		8	0000	9	7H02

U42					U43				
	1	PF4P	20	HH7P		1	PF4P	20	HH7P
	2	31F0	19	16AH		2	8023	19	8824
	3	43UU	18	99C3		3	HUH5	18	1U3A
	4	7H02	17	2120		4	7H02	17	43UU
	5	2HA1	16	P4U1		5	2HA1	16	31F0
	6	9445	15	H7C2		6	31F0	15	2HA1
	7	21F7	14	H63F		7	43UU	14	7H02
	8	P3U0	13	9372		8	7H02	13	43UU
	9	493C	12	66A4		9	2HA1	12	31F0
	10	0000	11	6AFP		10	0000	11	6AFP

MOTHERBOARD — ROMs 1 & 2 switched

VERSION 0, PRIMARY SET

SETUP = Motherboard with ROMs 1 & 2 (U25 & U26) switched.
        Refer to Sheet 1 of Schematic #060-03298 (Microprocessor)

START = ROM1/ (U24 pin 6)
 STOP = ROM1/ (U24 pin 6)
CLOCK = WR/ (W16 pin 1)
  +5V = 4P19
GROUND = 0000

U13					U16				
	1	4P19	16	4P19		1	–	20	4P19
	2	HA6H	15	–		2	1HA0	19	9474
	3	4P19	14	–		3	UP67	18	–
	4	0000	13	–		4	4774	17	–
	5	0000	12	–		5	A46A	16	–
	6	0000	11	–		6	6742	15	–
	7	4P19	10	4P19		7	U6P0	14	–
	8	0000	9	–		8	C91C	13	–
						9	AU74	12	–
						10	0000	11	–

U17					U18				
	1	6742	40	U6P0		1	–	14	4P19
	2	A46A	39	C91C		2	–	13	HA6H
	3	4774	38	AU74		3	9474	12	9474
	4	U6P7	37	1A1U		4	HA6H	11	–
	5	1HA0	36	8966		5	–	10	–
	6	HA6H	35	2822		6	–	9	–
	7	A46A	34	U4H9		7	0000	8	–
	8	6742	33	H48F					
	9	4774	32	8P6C					
	10	U6P7	31	1A1U					
	11	4P19	30	8U69					
	12	U6P0	29	0000					
	13	1HA0	28	4P19					
	14	AU74	27	4P19					
	15	C91C	26	–					
	16	–	25	–					
	17	4P19	24	–					
	18	–	23	–					
	19	HA6H	22	–					
	20	4P19	21	–					

MOTHERBOARD (cont'd.)

VERSION 0, PRIMARY SET

U19	1	—	14	4P19		U22	1	U4H9	16	4P19
	2	—	13	4P19			2	2822	15	4P19
	3	—	12	9474			3	8966	14	4P19
	4	9474	11	HA6H			4	4P19	13	4P19
	5	4P19	10	HA6H			5	1A1U	12	4P19
	6	HA6H	9	4P19			6	4P19	11	4P19
	7	0000	8	9474			7	4P19	10	4P19
							8	0000	9	4P19

U23	1	HA6H	16	4P19		U24	1	4P19	16	4P19
	2	U6P7	15	—			2	AP52	15	0000
	3	1HA0	14	—			3	4774	14	5693
	4	AP52	13	—			4	1976	13	A46A
	5	22AF	12	—			5	U9CH	12	4P19
	6	5693	11	—			6	4P18	11	5406
	7	4P19	10	—			7	4P98	10	4P19
	8	0000	9	—			8	0000	9	4F8F

U25	1	1A1U	24	4P19
	2	8966	23	AU74
	3	2822	22	C91C
	4	U4H9	21	6742
	5	H48F	20	—
	6	8P6C	19	U6P0
	7	1A1U	18	—
	8	8U69	17	1HA0
	9	AU74	16	UP67
	10	C91C	15	4774
	11	U6P0	14	A46A
	12	0000	13	6742

FRONT PANEL BOARDS — ROMs 1 & 2 switched

VERSION 0, PRIMARY SET

SETUP = Diagnostic Program 7; unmodified front panel #1 board;
        Roms 1 & 2 (U25 & U26) switched on motherboard.
        Refer to Sheet 1 of Schematic #060-03312 (front panel bds, digital).

START = AB3   U17 pin 33
 STOP = AB3   U17 pin 33
CLOCK = LEDC/ U22 pin 12
  +5V = 01UF
GROUND = 0000

U3	1	01UF	16	01UF		U4	1	01UF	18	–
	2	010A	15	–			2	01UF	17	–
	3	0011	14	–			3	01UF	16	–
	4	0008	13	0001			4	0000	15	–
	5	0004	12	0102			5	0000	14	–
	6	0005	11	0002			6	0000	13	–
	7	0100	10	0001			7	0000	12	–
	8	0000	9	0000			8	0000	11	–
							9	0000	10	–

U6	1	01UF	16	01UF		U7	1	0001	20	01UF
	2	0183	15	0010			2	01UF	19	0000
	3	007U	14	01PF			3	0103	18	0002
	4	0103	13	0020			4	0081	17	0005
	5	0081	12	0041			5	01UF	16	0000
	6	01CF	11	00HP			6	01UF	15	0000
	7	0040	10	0122			7	0041	14	0008
	8	0000	9	0000			8	0020	13	0011
							9	0000	12	0000
							10	0000	11	0000

U8	1	01UH	20	01UF		U9	1	01UF	18	–
	2	01UF	19	0000			2	01UF	17	–
	3	0103	18	0002			3	01UF	16	–
	4	0081	17	0005			4	0000	15	–
	5	01UF	16	0000			5	0000	14	–
	6	01UF	15	0000			6	0000	13	–
	7	0041	14	0008			7	0000	12	–
	8	0020	13	0011			8	0000	11	–
	9	0000	12	0000			9	0000	10	–
	10	0000	11	0000						

FRONT PANEL BOARDS (cont'd.)

VERSION 0, PRIMARY SET

U11	1	—	14	01UF		U12	1	01UF	28	0000
	2	—	13	01UF			2	0000	27	0000
	3	—	12	0000			3	0000	26	0000
	4	—	11	0001			4	01UF	25	0103
	5	—	10	01UH			5	01UF	24	0081
	6	—	9	01UF			6	0000	23	0041
	7	—	8	0000			7	0000	22	0000
							8	0000	21	0000
							9	0000	20	0000
							10	—	19	0000
							11	01UF	18	0000
							12	01UF	17	0000
							13	0000	16	0000
							14	0000	15	0000

U13	1	01UF	20	01UF
	2	0000	19	01UF
	3	0103	18	0002
	4	0000	17	0000
	5	0081	16	0005
	6	0000	15	0000
	7	0041	14	0008
	8	0000	13	0000
	9	0020	12	0011
	10	0000	11	0000

DIGITAL BOARD (T&C) — normal mode

VERSION 0, PRIMARY SET

SETUP = Diagnostic Program 7; unmodified digital board.
        Refer to Sheet 1 of Schematic #060-03305 (T&C)

START = RESET/ (J4 pin 3) _⌐‾
 STOP = RESET/ (J4 pin 3) _⌐‾
CLOCK = MC (J4 pin 1) _⌐‾
  +5V = 096H
GROUND = 0000 (J4 pin 2)

U3	1	A38A	16	096H		U4	1	0000	20	096H
	2	CA8A	15	0000			2	A32U	19	HF1P
	3	67FU	14	4300			3	5HP8	18	A38A
	4	H428	13	4516			4	U178	17	CA8A
	5	5H4H	12	6AC7			5	7567	16	HH45
	6	PUU1	11	HH45			6	7A23	15	C3P7
	7	U178	10	HF1P			7	PUU1	14	67FU
	8	0000	9	5HP8			8	0724/0P49	13	H428
							9	0P49/0724	12	67FU
							10	0000	11	0000

U5	1	H710	14	096H		U6	1	PCF6	14	096H
	2	1PU3	13	PCF6			2	H92U	13	1A1P
	3	FF34	12	HP7H			3	32P9	12	8AA0
	4	FF34	11	516H			4	FPC1	11	90CP
	5	516H	10	H710			5	179P	10	5P0U
	6	9H59	9	32P9			6	H92U	9	90CP
	7	0000	8	P244			7	0000	8	FPC1

U17	1	0P49/0724	14	096H		U18	1	HF1P	20	096H
	2	0724/0P49	13	HH45			2	HH45	19	H90C
	3	P15P	12	H428			3	1851	18	H90C
	4	P833	11	67FU			4	4H0P	17	AU50
	5	C3P7	10	6PA2			5	9A5C	16	54P4
	6	CA8A	9	1AU0			6	9U06	15	0000
	7	0000	8	139H			7	HPP5	14	–
							8	A80F	13	–
							9	P9PU	12	AP20
							10	0000	11	A74H

DIGITAL BOARD (T&C) (cont'd.)

VERSION 0, PRIMARY SET

U19	1	0000	20	096H		U21	1	54AC	14	096H
	2	1P3P	19	F258			2	54AC	13	7567
	3	27FC	18	9U06			3	6PA2	12	5P5C
	4	5420	17	HPP5			4	2395	11	7567
	5	27FC	16	P2A9			5	139H	10	60P7
	6	H710	15	5406			6	5563	9	43F1
	7	AP20	14	A80F			7	0000	8	2C3F
	8	A74H	13	P9PU						
	9	HP7H	12	74U7						
	10	0000	11	0000						

U24	1	096A	14	096H		U31	1	C3P7	20	096H
	2	0007	13	A32U			2	0U0U	19	4300
	3	179P	12	AA42			3	05A8	18	9HC7
	4	1PU3	11	—			4	05A8	17	54P4
	5	HP7H	10	—			5	0U0U	16	5P0U
	6	H710	9	—			6.	6AC7	15	6C74
	7	0000	8	—			7	FPH9	14	FH5U
							8	6AC7	13	096H
							9	4516	12	096H
							10	0000	11	0000

U32	1	H428	20	096H		U47	1	139H	14	096H
	2	1851	19	096H			2	C7CF	13	P563
	3	4H9P	18	096H			3	096H	12	139H
	4	18P2	17	4516			4	CA8A	11	48U5
	5	4H0P	16	AU50			5	096H	10	139H
	6	9A5C	15	101H			6	C3P7	9	62H7
	7	45C4	14	4074			7	0000	8	FU41
	8	7U48	13	147C						
	9	54P4	12	FP28						
	10	0000	11	0000						

U48	1	—	14	096H		U49	1	H428	20	096H
	2	—	13	096H			2	H90C	19	4U41
	3	—	12	—			3	48U5	18	7A0F
	4	—	11	0724/0P49			4	48U5	17	48U5
	5	—	10	096H			5	H90C	16	H90C
	6	—	9	—			6	7361	15	7A0F
	7	0000	8	—			7	H90C	14	P833
							8	H90C	13	H90C
							9	7361	12	7361
							10	0000	11	0000

DIGITAL BOARD (T&C) (cont'd.)

VERSION 0, PRIMARY SET

U68	1	–	14	096H		U85	1	48U5	16	096H
	2	–	13	–			2	F8C3	15	096H
	3	67FU	12	–			3	883C	14	0000
	4	6PA2	11	–			4	5727	13	0000
	5	–	10	–			5	HP74	12	48U5
	6	–	9	–			6	UC32	11	48U5
	7	0000	8	–			7	24CF	10	096H
							8	0000	9	096H

U86	1	–	16	096H		U91	1	–	14	096H
	2	–	15	–			2	–	13	–
	3	–	14	–			3	–	12	–
	4	–	13	–			4	–	11	–
	5	–	12	096H			5	–	10	5H4H
	6	096H	11	096H			6	–	9	096H
	7	096H	10	–			7	0000	8	5420
	8	0000	9	–						

DIGITAL BOARD (WCS) — normal mode

VERSION 0, PRIMARY SET

SETUP = Diagnostic Program 7; unmodified digital board.
        Refer to Sheet 2 of Schematic #060-03305 (WCS).

START = RESET/ (J4 pin 3) ⌐
 STOP = RESET/ (J4 pin 3) ⌐
CLOCK = AS0/ (J4 pin 4) ⌐
  +5V = 6PCP
GROUND = 0000 (J4 pin 2)

U45					U46				
	1	0000	20	6PCP		1	0000	20	6PCP
	2	A609	19	A736		2	437U	19	AC66
	3	UUH0	18	UHAU		3	353H	18	56FF
	4	UUH0	17	UUH0		4	3040	17	5855
	5	A609	16	A609		5	F1F1	16	75FC
	6	13AU	15	H583		6	717A	15	2F88
	7	949F	14	18F5		7	5137	14	PAH2
	8	0AP5	13	6PCF		8	4PPA	13	2U6F
	9	HF93	12	6PCU		9	7P94	12	FP57
	10	0000	11	0000		10	0000	11	0000

U50					U61				
	1	0000	20	6PCP		1	0000	24	6PCP
	2	751U	19	A1CA		2	UUH0	23	2595
	3	59UF	18	U0C7		3	UUH0	22	1F8F
	4	2PA6	17	87PH		4	949F	21	U97F
	5	4PC2	16	9A17		5	0AP5	20	5A34
	6	751U	15	12CA		6	6PCF	19	91FC
	7	59UF	14	96C7		7	18F5	18	3CPF
	8	2PA6	13	48A6		8	UUH0	17	A70F
	9	4PC2	12	UHC2		9	UHAU	16	6PCP
	10	0000	11	0000		10	6PCP	15	0000
						11	0000	14	0000
						12	0000	13	6PCP

U62					U63				
	1	0000	24	6PCP		1	0000	24	6PCP
	2	353H	23	2595		2	59UF	23	2595
	3	3040	22	1F8F		3	2PA6	22	1F8F
	4	5137	21	U97F		4	59UF	21	U97F
	5	4PPA	20	5A34		5	2PA6	20	5A34
	6	2U6F	19	91FC		6	48A6	19	91FC
	7	PAH2	18	3CPF		7	96C7	18	3CPF
	8	5855	17	A70F		8	87PH	17	A70F
	9	56FF	16	6PCP		9	U0C7	16	6PCP
	10	6PCP	15	0000		10	6PCP	15	0000
	11	0000	14	0000		11	0000	14	0000
	12	0000	13	6PCP		12	0000	13	6PCP

DIGITAL BOARD (WCS) (cont'd.)

VERSION 0, PRIMARY SET

U64	1	0000	24	6PCP		U65	1	0000	20	6PCP
	2	P730	23	2595			2	AA79	19	4PC2
	3	58HH	22	1F8F			3	P730	18	2PA6
	4	CF96	21	U97F			4	58HH	17	59UF
	5	7500	20	5A34			5	U58U	16	751U
	6	59UF	19	91FC			6	07AA	15	4PC2
	7	2PA6	18	3CPF			7	CF96	14	2PA6
	8	59UF	17	A70F			8	7500	13	59UF
	9	2PA6	16	6PCP			9	P361	12	751U
	10	6PCP	15	0000			10	0000	11	0000
	11	0000	14	0000						
	12	0000	13	6PCP						

U77	1	6PCP	20	6PCP		U78	1	6PCP	20	6PCP
	2	UHAU	19	6PCP			2	56FF	19	6PCP
	3	UUH0	18	–			3	5855	18	–
	4	18F5	17	–			4	PAH2	17	–
	5	6PCF	16	–			5	2U6F	16	–
	6	0AP5	15	–			6	4PPA	15	–
	7	949F	14	–			7	5137	14	–
	8	UUH0	13	–			8	3040	13	–
	9	UUH0	12	–			9	353H	12	–
	10	0000	11	–			10	0000	11	–

U79	1	6PCP	20	6PCP		U80	1	6PCP	20	6PCP
	2	U0C7	19	6PCP			2	2PA6	19	6PCP
	3	87PH	18	–			3	59UF	18	–
	4	96C7	17	–			4	2PA6	17	–
	5	48A6	16	–			5	59UF	16	–
	6	2PA6	15	–			6	7500	15	–
	7	59UF	14	–			7	CF96	14	–
	8	2PA6	13	–			8	58HH	13	–
	9	59UF	12	–			9	P730	12	–
	10	0000	11	–			10	0000	11	–

U81	1	6PCP	20	6PCP		U82	1	0000	20	6PCP
	2	0000	19	6PCP			2	–	19	2595
	3	2595	18	–			3	–	18	4C2C
	4	–	17	–			4	4P18	17	3919
	5	1F8F	16	A70F			5	A70F	16	1F8F
	6	–	15	–			6	3CPF	15	U97F
	7	U97F	14	3CPF			7	77H9	14	U2U8
	8	–	13	–			8	2397	13	C469
	9	5A34	12	91FC			9	91FC	12	5A34
	10	0000	11	–			10	0000	11	0000

DIGITAL BOARD (WCS) (cont'd.)

VERSION 0, PRIMARY SET

U83	1	0000	14	6PCP		U84	1	0000	16	6PCP
	2	0001	13	C469			2	–	15	0000
	3	4C2C	12	0001			3	–	14	6PCP
	4	3919	11	2397			4	6PCP	13	–
	5	U2U8	10	77H9			5	6PCP	12	6PCP
	6	C469	9	4P18			6	6PCP	11	6PCP
	7	0000	8	–			7	6PCP	10	6PCP
							8	0000	9	6PCP

DIGITAL BOARD (ARU) — no feedback mode

VERSION 0, PRIMARY SET

SETUP = Diagnostic Program 7; lift pins 2 & 5 of U4 and connect a
jumper from U21 pin 13 to ground and a jumper from U24 pin 13
to +5 V. (This disables the accumulator (U11, U12, U14, U16) and
the T register (U7, U9). No feedback inside the ARU.)
Refer to Sheet 3 of Schematic #060-03305 (ARU).

```
 START = RESET/   (J4 pin 3)  _____|‾
  STOP = RESET/   (J4 pin 3)  ___|‾
 CLOCK = MC   (J4 pin 1)  _____|‾
   +5V = 096H
GROUND = 0000   (J4 pin 2)
```

U7					U8				
1	096H	20	096H		1	0000	20	096H
2	0163	19	0163		2	0163	19	0163
3	PAF4	18	PAF4		3	1970	18	1970
4	75U7	17	75U7		4	101H	17	101H
5	080P	16	080P		5	080P	16	080P
6	0163	15	0163		6	0163	15	0163
7	PAF4	14	PAF4		7	1970	14	1970
8	75U7	13	75U7		8	101H	13	101H
9	080P	12	080P		9	080P	12	080P
10	0000	11	0000		10	0000	11	0000

U9					U10				
1	096H	20	096H		1	0000	20	096H
2	0163	19	0163		2	0163	19	0163
3	PAF4	18	PAF4		3	1970	18	1970
4	75U7	17	75U7		4	101H	17	101H
5	080P	16	080P		5	080P	16	080P
6	0163	15	0163		6	0163	15	0163
7	PAF4	14	FA35		7	1970	14	1970
8	75U7	13	488F		8	101H	13	1970
9	080P	12	0163		9	080P	12	0163
10	0000	11	0000		10	0000	11	0000

U11					U12				
1	096H	20	096H		1	096H	20	096H
2	101H	19	1970		2	101H	19	1970
3	75U7	18	FA35		3	75U7	18	PAF4
4	PAF4	17	75U7		4	PAF4	17	75U7
5	1970	16	101H		5	1970	16	101H
6	101H	15	1970		6	101H	15	1970
7	75U7	14	PAF4		7	75U7	14	PAF4
8	PAF4	13	75U7		8	PAF4	13	75U7
9	1970	12	101H		9	1970	12	101H
10	0000	11	1P3P		10	0000	11	1P3P

DIGITAL BOARD (ARU) (cont'd.)

VERSION 0, PRIMARY SET

U13,	1	7A23	20	096H		U14	1	096H	20	096H
U15	2	080P	19	0163			2	796C	19	096H
	3	101H	18	1970			3	101H	18	1970
	4	1970	17	101H			4	7006	17	7006
	5	0163	16	080P			5	1970	16	101H
	6	080P	15	0163			6	7006	15	7006
	7	101H	14	1970			7	101H	14	1970
	8	1970	13	101H			8	7006	13	7006
	9	0163	12	080P			9	1970	12	101H
	10	0000	11	0000			10	0000	11	7006

U16	1	096H	20	096H		U24	1	–	14	096H
	2	7006	19	096H			2	–	13	–
	3	101H	18	1970			3	–	12	–
	4	7006	17	7006			4	–	11	7006
	5	1970	16	101H			5	–	10	796C
	6	7006	15	7006			6	–	9	FU41
	7	101H	14	1970			7	0000	8	F62F
	8	7006	13	7006						
	9	1970	12	101H						
	10	0000	11	7006						

U25	1	0163	24	096H		U26	1	0163	24	096H
	2	080P	23	0163			2	080P	23	0163
	3	74U7	22	080P			3	74U7	22	080P
	4	5406	21	080P			4	5406	21	080P
	5	P2A9	20	0163			5	P2A9	20	0163
	6	F258	19	0163			6	F258	19	0163
	7	1F25	18	0163			7	1F25	18	080P
	8	HP7H	17	3660			8	HP7H	17	F258
	9	75U7	16	3U0H			9	75U7	16	–
	10	PAF4	15	2400			10	PAF4	15	5406
	11	75U7	14	–			11	75U7	14	–
	12	0000	13	FA35			12	0000	13	PAF4

DIGITAL BOARD (ARU) (cont'd.)

VERSION 0, PRIMARY SET

U27	1	0163	24	096H		U28	1	0163	24	096H
	2	080P	23	0163			2	080P	23	0163
	3	74U7	22	080P			3	74U7	22	080P
	4	5406	21	080P			4	5406	21	080P
	5	P2A9	20	0163			5	P2A9	20	0163
	6	F258	19	0163			6	F258	19	0163
	7	1F25	18	080P			7	H710	18	080P
	8	HP7H	17	F258			8	HP7H	17	F258
	9	75U7	16	–			9	75U7	16	–
	10	PAF4	15	5406			10	PAF4	15	5406
	11	75U7	14	–			11	75U7	14	–
	12	0000	13	PAF4			12	0000	13	PAF4

U29	1	F258	16	096H		U38–	1	U66F	16	096H
	2	5406	15	5406		U41	2	UU01	15	UU01
	3	F258	14	F258			3	U66F	14	0U0U
	4	5406	13	H710			4	101H	13	0U0U
	5	3660	12	1F25			5	FP28	12	67FU
	6	2400	11	1F25			6	1970	11	0000
	7	–	10	–			7	101H	10	101H
	8	0000	9	1F25			8	0000	9	1970

U42,	1	F62F	20	096H
U43	2	UU01	19	U66F
	3	101H	18	1970
	4	1970	17	101H
	5	U66F	16	UU01
	6	UU01	15	U66F
	7	101H	14	1970
	8	1970	13	101H
	9	U66F	12	UU01
	10	0000	11	6C74

DIGITAL BOARD (DMEM) — normal mode, fast clock

VERSION 0, PRIMARY SET

SETUP = Diagnostic Program 7; digital board with U34 pin 13 lifted
and connected to U34 pin 1 via a jumper.
Refer to Sheet 4 of Schematic #060-03305 (DMEM).

START = MSB of current position counter (U34 pin 8)
STOP = MSB of current position counter (U34 pin 8)
CLOCK = AS0/ (J4 pin 4)
+5V = 00UP
GROUND = 0000 (J4 pin 2)

U22	1	9A43	14	00UP
	2	0000	13	15HU
	3	89F1	12	0000
	4	31PC	11	7U42
	5	34C1	10	PC1A
	6	15HU	9	9C51
	7	0000	8	U540

U23	1	0U0C	16	00UP
	2	50P2	15	UPUH
	3	31PC	14	34C1
	4	A62A	13	PCPF
	5	89F1	12	15HU
	6	2U15	11	194F
	7	00UP	10	67A9
	8	0000	9	4246

U34	1	U540	14	00UP
	2	0000	13	U540
	3	P625	12	0000
	4	0055	11	P625
	5	0033	10	0055
	6	00U1	9	0033
	7	0000	8	00U1

U35	1	8C88	16	00UP
	2	F8A4	15	8275
	3	PC1A	14	9C51
	4	CU71	13	UFCU
	5	7U42	12	U540
	6	8275	11	F8A4
	7	4246	10	4229
	8	0000	9	40A8

U37	1	00UP	14	00UP
	2	00UP	13	00UP
	3	00UP	12	0000
	4	00UP	11	00UP
	5	6A4H	10	00UP
	6	6AC3	9	6A4H
	7	0000	8	6AC3

U51	1	2UP2	16	00UP
	2	F8A4	15	8275
	3	0055	14	0033
	4	24U8	13	3H76
	5	P625	12	00U1
	6	8275	11	F8A4
	7	40A8	10	33AH
	8	0000	9	5962

U52	1	0000	16	00UP
	2	24U8	15	0000
	3	A62A	14	33AH
	4	24U8	13	67A9
	5	2UP2	12	33AH
	6	0U0C	11	3H76
	7	2UP2	10	PCPF
	8	0000	9	3H76

U53– U60& U69– U76	1	00UP	16	0000
	2	*	15	6AC3
	3	P4FP	14	*
	4	6AC3	13	H196
	5	24U8	12	33AH
	6	3H76	11	U34H
	7	2UP2	10	7CH9
	8	00UP	9	8CHC

*Signatures for pins 2 & 14 on next page

MOTHERBOARD

Part No.	Qty/Description	Ref.
ASSEMBLIES		
023-03193	2 PL,INPT FILTER BD ASSY,LP-1	P7,8
023-03196	2 PL,OTPT FILTER BD ASSY,LP-2	P5,6
TRIM RESISTORS		
201-00159	2 RES,TRM,ST,PC,100K,SA,CER	R85,123
201-00427	2 RES,TRM,ST,PC,1K,SA,CER	R17,37,
201-01619	2 RES,TRM,ST,PC,500 OHM,SA,CER	R16,21
CARBON FLM RES		
202-00498	4 RES,CF,5%,1/2W,5.1 OHM	R62-65
202-00514	7 RES,CF,5%,1/4W,100 OHM	R4,13,18,48,49,59,60
202-00519	1 RES,CF,5%,1/4W,240 OHM	R29
202-00524	1 RES,CF,5%,1/4W,470 OHM	R3
202-00527	1 RES,CF,5%,1/4W,750 OHM	R8
202-00529	4 RES,CF,5%,1/4W,1K OHM	R12,14,26,33
202-00533	6 RES,CF,5%,1/4W,2K OHM	R11,90,91,96,110,118
202-00535	1 RES,CF,5%,1/4W,2.4K OHM	R7
202-00537	5 RES,CF,5%,1/4W,3K OHM	R10,66-69
202-00538	6 RES,CF,5%,1/4W,3.3K OHM	R82,87-89,135,136
202-00539	1 RES,CF,5%,1/4W,3.6K OHM	R83
202-00543	2 RES,CF,5%,1/4W,5.1K OHM	R74,75
202-00546	1 RES,CF,5%,1/4W,7.5K OHM	R9
202-00549	12 RES,CF,5%,1/4W,10K OHM	R30,31,35,38,40,42,44,47,78-81
202-00559	1 RES,CF,5%,1/4W,30K OHM	R43
202-00563	1 RES,CF,5%,1/4W,47K OHM	R46
202-00570	5 RES,CF,5%,1/4W,100K OHM	R15,39,41,92,93
202-00580	4 RES,CF,5%,1/4W,1M OHM	R27,28,36,45
202-01157	1 RES,CF,5%,1/2W,33 OHM	R2
202-01228	1 RES,CF,5%,1/4W,620 OHM	R32
202-01245	1 RES,CF,5%,1/4W,1.6K OHM	R34
202-02649	2 RES,CF,5%,1/4W,300 OHM	R70,71
202-02650	1 RES,CF,5%,1/2W,750 OHM	R107
METAL FLM RES		
203-00456	6 RES,MF,1%,1/8W,1.00K OHM	R50,53,54,57,112,113
203-00459	9 RES,MF,1%,1/8W,2.00K OHM	R97,98,100,101,114,124-127
203-00471	8 RES,MF,1%,1/8W,10.0K OHM	R22,23,94,108,109,111,116,117
203-00482	2 RES,MF,1%,1/8W,20.0K OHM	R72,73
203-00483	1 RES,MF,1%,1/8W,22.6K OHM	R115
203-00486	2 RES,MF,1%,1/8W,28.0K OHM	R103,104
203-01143	1 RES,MF,1%,1/8W,2.49K OHM	R19
203-01145	2 RES,MF,1%,1/8W,1.24M OHM	R84,122

203-02290   1/8w   1.21KΩ   R137,139 (handwritten)

MOTHERBOARD cont'd.

Part No.	Qty/Description	Ref.
METAL FLM RES cont'd.		
203-01229	4 RES,MF,1%,1/8W,6.98K OHM	R99,106,120,133
203-01459	1 RES,MF,1%,1/8W,243 OHM	R20
203-01460	1 RES,MF,1%,1/8W,2.05K OHM	R6
203-01491	4 RES,MF,1%,1/8W,4.22K OHM	R128-131
203-01665	1 RES,MF,1%,1/8W,237 OHM	R5
203-02353	4 RES,MF,1%,1/8W,49.9K OHM	R51,52,55,56
203-02611	2 RES,MF,1%,1/8W,5.62K OHM	R76,77
203-02613	4 RES,MF,1%,1/8W,21.0K OHM	R102,105,119,132
203-03351	2 RES,MF,1%,1/8W,44.2K OHM	R121,134
WIREWOUND RES		
204-01523	1 RES,WW,5%,10W,0.1 OHM	R1
NETWORK RES		
205-00240	1 RES,NET,SIP,2%,3.3KX7	RP7
205-00330	1 RES,NET,SIP,2%,3.3KX9	RP1
205-01456	4 RES,NET,DIP,0.5%/0.1%,1KX8	RP4-6,8
205-02212	2 RES,NET,SIP,2%,47KX9	RP2,3
ELECTROLYT CAP		
240-00613	13 CAP,ELEC,22uF,25V,RAD	C9,13,16,84,86,96,101,113,C116 117,C152,153,157
240-00614	3 CAP,ELEC,47uF,16V,RAD	C140,141,143
240-00620	1 CAP,ELEC,1000uF,35V,RAD	C15
240-01262	5 CAP,ELEC,330uF,25V,RAD	C4,17,18,29,30
240-01446	2 CAP,ELEC,3300uF,35V,RAD	C24,25
240-02835	2 CAP,ELEC,220uF,25V,RAD,NON-POL	C70,71
240-03273	2 CAP,ELEC,10000uF,16V,RAD	C7,8
TANTALUM CAP		
241-00654	6 CAP,TANT,22uF,16V,RAD	C19,57,87,88,90,91
241-00655	1 CAP,TANT,22uF,25V,RAD	C22
PCRB/PP CAP		
244-00660	2 CAP,MYL,.01uF,100V,10%,RAD	C114,156
244-01166	2 CAP,PP,240pF,2.5%	C163,166
244-01167	2 CAP,PP,750pF,2.5%	C165,170
244-01172	2 CAP,PP,6800pF,2.5%	C164,167
244-01488	3 CAP,MYL,.22uF,100V,10%,RAD	C51-53
244-02104	8 CAP,PP,100pF,160V,2.5%,AX	C73-75,77,78,80,173,174
244-02342	1 CAP,MYL,68uF,100V,10%,RAD	C56
244-02486	2 CAP,PP,510pF,160V,2.5%,AX	C130,131
244-03712	4 CAP,PP,2400pF,1%	C139,142,144,172

MOTHERBOARD cont'd.

Part No.	Qty/Description		Ref.
CERAMIC CAP			
245-00585	1	CAP,CER,18pF,100V,10%	C123
245-00586	4	CAP,CER,30pF,100V,10%	C26,27,95,97
245-00587	1	CAP,CER,82pF,1000V,10%	C59
245-00590	11	CAP,CER,150pF,500V,10%	C32-42
245-00594	2	CAP,CER,.001uF,500V,10%,Z5F	C1,58
245-00598	4	CAP,CER,.01uF,16V,80/20%	C20,50,54,55
245-00600	60	CAP,CER,.02uF,35V,80/20%	C5,6,10,11,14,21,23,43-49 C60-69,72,76,C79,81-83,105 107-110,121,122,C124-129,132 137,138,145-150,C155,158 160-162,168,169,171
245-01164	2	CAP,CER,10pF	C92,94
245-01651	20	CAP,CER,.1uF,50V,80/20%	C12,28,31,85,89,93,98,102-104 C106,111,112,C115,118-120,151 154,159
245-02105	4	CAP,CER,5pF,500V,10%,NPO	C133-136
INDUCTORS			
270-00779	8	FERRITE,BEAD	FB1-8
DIODES			
300-01025	2	DIODE,MR751	CR2,3
300-01026	1	DIODE,1N753	CR1
300-01029	24	DIODE,1N914 AND 4148	CR4,7,9,11,17,19,20,25-37 C40-43 — (4)
300-01030	11	DIODE,1N4004 AND 4005	CR8,10,12-15,18,21-24
300-01032	2	DIODE,1N5404	CR5,6
300-01154	1	DIODE,1N751,ZENER,5.1V	CR44 — 1
300-02401	2	DIODE,BAR 35,SCHOTTKY,LOW VF	CR38,39
300-03546	1	DIODE,BRIDGE,2A,200V	CR16
TRANSISTORS			
310-01007	1	TRANSISTOR,2N3904	Q8
310-01008	2	TRANSISTOR,2N3906	Q6,7
310-01009	4	TRANSISTOR,2N4393	Q4,5,17,18
310-01237	4	TRANSISTOR,MJE-170,PNP	Q9,10,13,14
310-01238	4	TRANSISTOR,MJE-180,NPN	Q11,12,15,16
DIGITAL/CMOS IC			
330-00692	2	IC,DIGITAL,74LS00	U19,54
330-00698	2	IC,DIGITAL,74LS14	U18,52
330-00703	1	IC,DIGITAL,74LS74	U8
330-00712	3	IC,DIGITAL,74LS163	U13,62,63
330-00714	1	IC,DIGITAL,74LS175	U55
330-00718	1	IC,DIGITAL,74LS367	U7

310 - 01004   Q3   Transitor _ -

MOTHERBOARD cont'd.

Part No.	Qty/Description	Ref.
DIGITAL/CMOS IC cont'd		
330-00765	1 IC,DIGITAL,4001,CMOS	U15
330-00768	1 IC,DIGITAL,4049,CMOS	U21
330-01282	1 IC,DIGITAL,74LS138	U22
330-01283	2 IC,DIGITAL,74LS139	U23,53
330-01284	1 IC,DIGITAL,74LS155	U24
330-01293	7 IC,DIGITAL,74LS374	U37,38,48-51,65
330-01295	1 IC,DIGITAL,74LS393	U20
330-02085	1 IC,DIGITAL,AM25L04	U39
330-03211	1 IC,DIGITAL,74LS245	U16
330-03482	2 IC,DIGITAL,74HC04	U60,61
LINEAR IC		
340-00722	1 IC,LINEAR,LM301	U6
340-00730	1 IC,LINEAR,UA 723	U3
340-01183	4 IC,LINEAR,LF 356	U43,45,59,68
340-01363	1 IC,LINEAR,LM339	U56
340-01525	1 IC,LINEAR,7905,-5V REG	U4
340-01566	5 IC,LINEAR,LF353,DUAL OP AMP	U57,58,70-72
340-02674	1 IC,LINEAR,CMP-05FZ	U41
340-02676	5 IC,LINEAR,NE5532	U31-33,36,47
340-03328	2 IC,LINEAR,NE5534	U34,35
SS SW IC		
346-02677	3 IC,SS SWITCH,DG211	U42,44,67
346-03329	2 IC,SS SWITCH,SD5000N	U46,69
MEMORY IC		
350-03205	1 IC,RAM,6116LP,2KX8	U30
350-03492	1 IC,ROM,82S123,ANA,M200	U64
CONVERTER IC		
355-00774	1 DAC,80-CBI-V	U66
355-01362	1 DAC-80-I	U40
SEMICONDUCTORS		
360-01612	2 SEMICOND,VARISTOR	VR1,2
MICROPROC IC		
365-02530	1 IC,uPROC,MK3880N-4,Z-80A CPU	U17
FUSES		
440-00867	2 FUSE,3AG,SLO-BLO,2AMP	F4,5
440-02664	2 FUSE,3AG,SLO-BLO,15AMP,32V	F2,3
SLIDE SWITCH		
451-02230	2 SW,SL,2P2T,V-CHNG,PC,4A	SW2,3

MOTHERBOARD cont'd.

Part No.		Qty/Description	Ref.
PSH BUT SWITCH			
453-02111	1	SW,PBPP,2P2T,SCHADOW,PCRA	SW4
453-02226	1	SW,PBPP,2P2T,LINE RATED,PCRA	SW1
BATTERIES			
460-02641	1	BAT,NI CAD,110mAh,3.6V	B1
TRANSFORMERS			
470-00261	2	XFORMER,OTPT,M92	T2,3
CABLE CONN			
490-02356	7	CONN,JUMPER,.1X025,2FCG	W7,9,15-17
490-02712	1	CONN,POST,156X045,INS-DSP,6FCG	P1
PC MNT CONN			
510-02106	3	1/4" PHONE JACK,PCRA,3C,SWITCH	J4-6
			NUTS AND WASHERS SUPPLIED WITH THIS PART SHOULD BE ADDED TO CHASSIS FIN KIT #023-03182
510-02534	2	CONN,XLR,3MC,PCRA	J7,8
510-02535	2	CONN,XLR,3FC,PCRA	J9,10
510-02671	7	CONN,POST,100X025,HDR,3MC,GOLD	W7,9,15-18
510-03204	1	CONN,POST,100X025,HDR,26MCG	J11
510-03711	1	CONN,POST,100X025,HDR,26MC,LOK	J12
SOCKETS			
520-00941	20	IC SCKT,8 PIN,PC,LO-PRO	U6,11,12,31-36,41,43,45,47 U57-59,68,U70-72
520-00942	12	IC SCKT,14 PIN,PC,LO-PRO	U8-10,15,18-20,52,54,56,60,61
520-00943	16	IC SCKT,16 PIN,PC,LO-PRO	U7,13,21-24,42,44,46,53,55 U62-64,67,69
520-00945	9	IC SCKT,24 PIN,PC,LO-PRO	U25-30,39,40,66
520-00946	1	IC SCKT,40 PIN,PC,LO-PRO	U17
520-01361	8	IC SCKT,20 PIN,PC,LO-PRO	U16,37,38,48-51,65
520-01458	1	IC SCKT,28 PIN,PC,LO-PRO	U14
ELECTRONIC HDWR			
600-00871	8	FUSE CLIP,1/4",PC	F2-5
MACHINE SCREWS			
640-01716	4	SCRW,6-32X3/8,PNH,PH,ZN	T2,3 MTG
640-01841	2	SCRW,2-56X1/4,PNH,PH,ZN	SW1 MTG
THRD-FORM SCRW			
641-02827	4	SCRW,TAP,F,2-56X3/16,PNH,PH,ZN	J7-10 MTG

MOTHERBOARD cont'd.

Part No.	Qty/Description	Ref.
NUTS		
643-01730	4 NUT,6-32,KEP,SMALL,ZN	T2,3 MTG
643-01855	2 NUT,2-56,HEX,SMALL,ZN	SW1 MTG
WASHERS		
644-01854	2 WSHR,LOCK,SPLIT,#2	SW1 MTG
644-02485	4 WSHR,FL,#8CLX.50DX.05THK	T2,3 MTG
BULK WIRE		
670-01768	1 WIRE,JMP,22AWG,0.5",TEF,WHT	R95
PRE-CUT WIRE		
675-02861	2 WIRE,18G,BLK,8",ST&T1/4X0	P1,CUT 4" FROM UNSTRIPPED SIDE
675-02867	2 WIRE,18G,RED,8",ST&T1/4X0	P1,CUT 4" FROM UNSTRIPPED SIDE
CABLES/CORDS		
680-03385	2 CABLE,ASSY,26 COND,M200	P2,3
PC BOARDS		
710-03299	1 PC BD,MOTHERBD,M200	
PLASTICS		
720-03571	6 TAPE,KAPTON,1/2"	

DIGITAL BOARD

Part No.		Qty/Description	Ref.
CARBON FLM RES			
202-00506	1	RES,CF,5%,1/4W,20 OHM	R5
202-00508	3	RES,CF,5%,1/4W,33 OHM	R6-8
202-00519	1	RES,CF,5%,1/4W,240 OHM	R4
202-00521	2	RES,CF,5%,1/4W,330 OHM	R1,2
202-00529	1	RES,CF,5%,1/4W,1K OHM	R3
NETWORK RES			
205-01485	1	RES,NET,DIP,2%,33X8	RP1
ELECTROLYT CAP			
240-02048	1	CAP,ELEC,47uF,25V,AX	C43
CERAMIC CAP			
245-00586	1	CAP,CER,30pF,100V,10%	C9
245-00593	1	CAP,CER,560pF,500V,10%,Z5F	C5
245-00598	32	CAP,CER,.01uF,16V,80/20%	C2-4,6,7,10-16,18,20,22,25,26 C45-51,57,C61-67
245-01651	19	CAP,CER,.1uF,50V,80/20%	C1,8,17,19,21,23,24,27-34,44 C58-60
INDUCTORS			
270-00779	1	FERRITE,BEAD	FB1
TRANSISTORS			
310-02517	1	TRANSISTOR,2N5910	Q1
DIGITAL/CMOS IC			
330-00692	5	IC,DIGITAL,74LS00	U1,2,5,47,91
330-00695	3	IC,DIGITAL,74LS04	U17,24,68
330-00697	2	IC,DIGITAL,74LS10	U21,37
330-00703	3	IC,DIGITAL,74LS74	U30,44,48
330-00713	1	IC,DIGITAL,74LS174	U33
330-00716	4	IC,DIGITAL,74LS283	U23,35,51,66
330-01272	1	IC,DIGITAL,74S04	U20
330-01284	2	IC,DIGITAL,74LS155	U84,86
330-01290	3	IC,DIGITAL,74LS244	U14,16,81
330-01293	14	IC,DIGITAL,74LS374	U4,7-12,42,43,82,87-90
330-01294	9	IC,DIGITAL,74LS377	U13,15,31,32,45,46,49,50,65
330-01295	3	IC,DIGITAL,74LS393	U22,34,83
330-01296	4	IC,DIGITAL,74LS670	U38-41
330-01313	1	IC,DIGITAL,74LS86	U6
330-02077	1	IC,DIGITAL,AM2902A (74S182)	U29
330-02504	2	IC,DIGITAL,74S157	U52,67
330-02933	4	IC,DIGITAL,74F181,ALU	U25-28
330-03211	4	IC,DIGITAL,74LS245	U77-80
330-03342	1	IC,DIGITAL,74F374	U19

DIGITAL BOARD cont'd.

Part No.	Qty	Description	Ref.
MEMORY IC			
350-02626	4	IC,RAM,MCM68B10	U61-64
350-03439	16	IC,DRAM,4164,64KX1,150NS	U53-60,69-76
350-03493	1	IC,ROM,82S123,DIG,M200	U3
350-03494	1	IC,ROM,74S472,M200	U18
350-03495	1	IC,ROM,74S287,M200	U85
MODULES			
380-02509	1	MOD,DLY,LINE,5 TAPS,30/150 NS	U36
CRYSTALS			
390-03339	1	CRYSTAL,18.432 MHz	X1,
PC MNT CONN			
510-01066	1	CONN POST,100X025,HDR,10MC	J4
510-02355	1	CONN,POST,156X045,HDR,6MCG,RAL	J1
510-02693	2	CONN,POST,100X025,HDR,26MC,PCR	J2,3
SOCKETS			
520-00942	19	IC SCKT,14 PIN,PC,LO-PRO	U1,2,5,6,17,20-22,24,30,34,36 U37,44,47,48,C68,83,91
520-00943	32	IC SCKT,16 PIN,PC,LO-PRO	U3,23,29,33,35,38-41,51-60,U66 67,69-76,U84-86
520-00945	8	IC SCKT,24 PIN,PC,LO-PRO	U25-28,61-64
520-01361	32	IC SCKT,20 PIN,PC,LO-PRO	U4,7-16,18,19,31,32,42,43,45 U46,49,50,65,U77-82,87-90
ELECTRONIC HDWR			
600-02211	3	BUSS BAR,2C,.7X16,.3 OFF,PVF/N	
THREADLS FASTNR			
650-02586	2	FASTNR,NYLATCH,HN5G-52-1	
650-02587	2	FASTNR,NYLATCH,HN5P-52-4-1	
PC BOARDS			
710-03306	1	PC BD,DIG BD,M200	
PLASTICS			
720-03571	4	TAPE,KAPTON,1/2"	J11,12 (COMPONENT SIDE)

FRONT PANEL 1

Part No.	Qty	Description	Ref.
POTENTIOMETERS			
200-02616	3	POT,RTY,PC,10K-U,1/8X3/4	R2-4
			NUTS AND WASHERS SUPPLIED WITH
			THIS PART SHOULD BE ADDED TO
			FP#2 POST-SLDR KIT 025-03188
200-03210	2	POT,RTY,PC,5K-U,1/8X3/8	R57,59
200-03378	2	POT,SLD,PC 10K-UX2,20MMX60MM	R54,55
CARBON FLM RES			
202-00498	1	RES,CF,5%,1/2W,5.1 OHM	R1
202-00514	4	RES,CF,5%,1/4W,100 OHM	R22,29,36,51
202-00538	2	RES,CF,5%,1/4W,3.3K OHM	R7,8
202-00542	2	RES,CF,5%,1/4W,4.7K OHM	R5,6
202-00543	2	RES,CF,5%,1/4W,5.1K OHM	R9,15
202-00549	4	RES,CF,5%,1/4W,10K OHM	R60-63
202-00564	4	RES,CF,5%,1/4W,51K OHM	R10,14,16,20
202-00570	4	RES,CF,5%,1/4W,100K OHM	R12,13,18,19
202-01228	2	RES,CF,5%,1/4W,620 OHM	R52,53
202-01497	2	RES,CF,5%,1/4W,2M OHM	R11,17
202-02649	2	RES,CF,5%,1/4W,300 OHM	R56,58
202-02650	1	RES,CF,5%,1/2W,750 OHM	R21
METAL FLM RES			
203-00464	8	RES,MF,1%,1/8W,4.99K OHM	R24,27,30,31,34,35,43,44
203-00471	2	RES,MF,1%,1/8W,10.0K OHM	R23,28
203-00482	2	RES,MF,1%,1/8W,20.0K OHM	R42,45
203-01671	2	RES,MF,1%,1/8W,47.5K OHM	R37,50
203-01672	8	RES,MF,1%,1/8W,14.0K OHM	R38-41,46-49
203-02660	4	RES,MF,1%,1/8W,3.57K OHM	R25,26,32,33
NETWORK RES			
205-00330	1	RES,NET,SIP,2%,3.3KX9	RP1
205-02900	2	RES,NET,DIP,2%,120X8	RP2,3
ELECTROLYT CAP			
240-00614	10	CAP,ELEC,47uF,16V,RAD	C18,31,36,37,39,41,43,45,47,51
240-00617	1	CAP,ELEC,470uF,16V,RAD	C6
240-02048	3	CAP,ELEC,47uF,25V,AX	C5,23,24
TANTALUM CAP			
241-00652	2	CAP,TANT,4.7uF,25V,RAD	C12,14
CERAMIC CAP			
245-00600	9	CAP,CER,.02uF,35V,80/20%	C1-3,7-11,49
245-01164	10	CAP,CER,10pF	C13,15,16,21,25-27,30,32,33
245-01651	16	CAP,CER,.1uF,50V,80/20%	C4,17,19,20,22,28,29,34,35,38
			C40,42,44,46,C48,50

FRONT PANEL 1 cont'd.

Part No.		Qty/Description	Ref.
DIODES			
300-01029	6	DIODE,1N914 AND 4148	CR2-4,6-8
300-01154	1	DIODE,1N751,ZENER,5.1V	CR9
300-02401	2	DIODE,BAR 35,SCHOTTKY,LOW VF	CR1,5
TRANSISTORS			
310-01007	2	TRANSISTOR,2N3904	Q1,2
DIGITAL/CMOS IC			
330-00698	1	IC,DIGITAL,74LS14	U11
330-00713	1	IC,DIGITAL,74LS174	U3
330-00714	1	IC,DIGITAL,74LS175	U6
330-00718	1	IC,DIGITAL,74LS367	U5
330-01290	1	IC,DIGITAL,74LS244	U13
330-01294	2	IC,DIGITAL,74LS377	U7,8
LINEAR IC			
340-01566	2	IC,LINEAR,LF353,DUAL OP AMP	U14,15
340-02676	3	IC,LINEAR,NE5532	U16-18
INTERFACE IC			
345-00751	3	IC,INTER,D8877,75492 LED DRVR	U1,2,10
345-02913	2	IC,INTER,NE594,DSP DRVR,8-SEG	U4,9
CONVERTER IC			
355-02903	1	IC,CONVERTER,ADC 0809	U12
DSPLY/IND/LED			
430-02684	12	LED,DSPLY,7-SEG,0.4",ORG	DS1-12
PSH BUT SWITCH			
453-01074	1	SW,PBM,1P2T,PC,4A	SW1
453-03330	2	SW,PBPP,2P2T,ALPS SPH121A,PC	SW2,3
453-03377	2	SW,PBM,2P2T,ALPS SPH122A,PC	SW4,5
SOCKETS			
520-00941	5	IC SCKT,8 PIN,PC,LO-PRO	U14-18
520-00942	4	IC SCKT,14 PIN,PC,LO-PRO	U1,2,10,11
520-00943	3	IC SCKT,16 PIN,PC,LO-PRO	U3,5,6
520-01361	3	IC SCKT,20 PIN,PC,LO-PRO	U7,8,13
520-01458	1	IC SCKT,28 PIN,PC,LO-PRO	U12
520-02177	2	IC SCKT,18 PIN,PC,LO-PRO	U4,9
520-02341	12	IC SCKT,14 PIN,WRAP-1L	DS1-12

FRONT PANEL 1 cont'd.

Part No.	Qty	Description	Ref.
SPCR,NON-INSUL			
635-01453	7	SPCR,SWAGE,6-32X1/2,1/4RD,BR/N	
635-02361	10	SPCR,SWAGE,#6CLX1/2,1/4RD,BR/N	
MACHINE SCREWS			
640-02746	2	SCRW,2-M3X.5MMX.175L,PNH,PH,ZN	BUSS WIRE MTG
BULK WIRE			
670-01506	1	CABLE,FLEX-JUMP,27 COND,1X0.1	P1
670-01844	1	WIRE,JMP,24AWG,BUSS WIRE	(6" REQUIRED)
CABLES/CORDS			
680-03385	2	CABLE,ASSY,26 COND,M200	P2,3
PC BOARDS			
710-03313	1	PC BD,FP #1,M200	

FRONT PANEL 2

Part No.	Qty	Description	Ref.
DSPLY/IND/LED			
430-02285	15	LED,RED,.118 DIA	CR1-14,26
430-02286	16	LED,GRN,.118 DIA	CR18-25,30-37
430-02287	6	LED,YEL,.118 DIA	CR15-17,27-29
PSH BUT SWITCH			
453-02222	5	SW,PBM,1P1T,SQ,NO LEGEND,PC	SW17-21
453-02292	1	SW,PBM,1P1T,SQ,"0",LEGEND,PC	SW4
453-02293	1	SW,PBM,1P1T,SQ,"1",LEGEND,PC	SW3
453-02294	1	SW,PBM,1P1T,SQ,"2",LEGEND,PC	SW7
453-02295	1	SW,PBM,1P1T,SQ,"3",LEGEND,PC	SW11
453-02296	1	SW,PBM,1P1T,SQ,"4",LEGEND,PC	SW2
453-02297	1	SW,PBM,1P1T,SQ,"5",LEGEND,PC	SW6
453-02298	1	SW,PBM,1P1T,SQ,"6",LEGEND,PC	SW10
453-02299	1	SW,PBM,1P1T,SQ,"7",LEGEND,PC	SW1
453-02300	1	SW,PBM,1P1T,SQ,"8",LEGEND,PC	SW5
453-02301	1	SW,PBM,1P1T,SQ,"9",LEGEND,PC	SW9
453-02302	1	SW,PBM,1P1T,SQ,".",LEGEND,PC	SW8
453-02303	1	SW,PBM,1P1T,SQ,"STO",LEGEND,PC	SW15
453-02306	1	SW,PBM,1P1T,SQ,"F",LEGEND,PC	SW12
453-03216	1	SW,PBM,1P1T,SQ,"PGM",LEGEND,PC	SW13
453-03217	1	SW,PBM,1P1T,SQ,"CLR",LEGEND,PC	SW16
453-03441	1	SW,PBM,1P1T,SQ,"REG",LEGEND,PC	SW14
INSUL/SPACRS			
630-02740	37	SPCR,#4CLX.21,3/16 RD,NYL	
NUTS			
643-00000	3	NUT	NUT,5/16" THESE NUTS SUPPLIED WITH RESISTOR 200-02616 FOUND ON POST-SLDR FP#1 025-03185
WASHERS			
644-00000	3	WSHR	WSHR,INTER STAR THESE WASHERS SUPPLIED WITH RESISTOR 200-02616 FOUND ON POST-SLDR FP#1 BD 025-03185
BULK WIRE			
670-01844	1	WIRE,JMP,24AWG,BUSS WIRE	SHIELD CONNECT (CUT 3 PIECES OF 1" EACH)
PANELS			
702-03569	1	SHIELD,CU/FISHPAPER,6.5X3.2	
PC BOARDS			
710-03318	1	PC BD,FP #2,M200	

INPUT FILTER BOARD

Part No.	Qty/Description	Ref.
ADHESIVES		
120-02023	0 ADHESIVE,SILICONE,RTV,CLEAR	SHIELD,(NEED 2 DROPS)
METAL FLM RES		
203-00455	1 RES,MF,1%,1/8W,681 OHM	R21
203-00456	1 RES,MF,1%,1/8W,1.00K OHM	R3
203-00460	1 RES,MF,1%,1/8W,2.15K OHM	R4
203-00462	1 RES,MF,1%,1/8W,2.55K OHM	R6
203-00464	8 RES,MF,1%,1/8W,4.99K OHM	R7,8,12,13,17,18,22,23
203-00466	2 RES,MF,1%,1/8W,6.81K OHM	R1,9
203-00493	1 RES,MF,1%,1/8W,215K OHM	R2
203-01137	1 RES,MF,1%,1/8W,4.12K OHM	R16
203-01138	1 RES,MF,1%,1/8W,9.76K OHM	R5
203-01230	1 RES,MF,1%,1/8W,8.25K OHM	R20
203-02291	1 RES,MF,1%,1/8W,5.49K OHM	R14
203-02611	1 RES,MF,1%,1/8W,5.62K OHM	R11
203-02656	1 RES,MF,1%,1/8W,182K OHM	R25
203-02702	1 RES,MF,1%,1/8W,8.66K OHM	R24
203-03346	1 RES,MF,1%,1/8W,6.34K OHM	R19
203-03348	1 RES,MF,1%,1/8W,9.09K OHM	R10
203-03349	1 RES,MF,1%,1/8W,11.8K OHM	R15
PCRB/PP CAP		
244-01170	8 CAP,PP,2400pF,2.5%	C5,8,11,14,15,18,21,24
244-03712	2 CAP,PP,2400pF,1%	C1,25
CERAMIC CAP		
245-01164	8 CAP,CER,10pF	C6,7,12,13,16,17,22,23
245-01651	6 CAP,CER,.1uF,50V,80/20%	C3,4,9,10,19,20
LINEAR IC		
340-02676	4 IC,LINEAR,NE5532	U2-5
340-03328	1 IC,LINEAR,NE5534	U1
PC MNT CONN		
510-03209	12 CONN,F POST,AMP 1-380953-0/2	
BULK WIRE		
670-01844	1 WIRE,JMP,24AWG,BUSS WIRE	CU/FISHPAPER SHIELD
PANELS		
702-03577	1 SHIELD,CU/FISHPAPER,4.9X1.1	
PC BOARDS		
710-03152	1 PC BD,ANLG FILTER BD	

OUTPUT FILTER BOARD

Part No.	Qty	Description	Ref.
ADHESIVES			
120-02023	0	ADHESIVE,SILICONE,RTV,CLEAR	SHIELD,(NEED 2 DROPS)
METAL FLM RES			
203-00456	1	RES,MF,1%,1/8W,1.00K OHM	R3
203-00462	1	RES,MF,1%,1/8W,2.55K OHM	R16
203-00463	1	RES,MF,1%,1/8W,3.24K OHM	R4
203-00464	8	RES,MF,1%,1/8W,4.99K OHM	R7,8,12,13,17,18,22,23
203-00465	1	RES,MF,1%,1/8W,6.49K OHM	R14
203-00467	1	RES,MF,1%,1/8W,7.15K OHM	R19
203-00474	1	RES,MF,1%,1/8W,11.0K OHM	R5
203-00476	1	RES,MF,1%,1/8W,12.1K OHM	R15
203-01230	1	RES,MF,1%,1/8W,8.25K OHM	R20
203-01494	1	RES,MF,1%,1/8W,10.5K OHM	R10
203-01664	1	RES,MF,1%,1/8W,133K OHM	R25
203-02612	2	RES,MF,1%,1/8W,7.32K OHM	R1,9
203-02656	1	RES,MF,1%,1/8W,182K OHM	R2
203-03343	1	RES,MF,1%,1/8W,432 OHM	R21
203-03344	1	RES,MF,1%,1/8W,1.58K OHM	R6
203-03345	1	RES,MF,1%,1/8W,3.4K OHM	R11
203-03347	1	RES,MF,1%,1/8W,8.45K OHM	R24
PCRB/PP CAP			
244-01170	8	CAP,PP,2400pF,2.5%	C5,8,11,14,15,18,21,24
244-03712	2	CAP,PP,2400pF,1%	C1,25
CERAMIC CAP			
245-01164	8	CAP,CER,10pF	C6,7,12,13,16,17,22,23
245-01651	6	CAP,CER,.1uF,50V,80/20%	C3,4,9,10,19,20
LINEAR IC			
340-02676	4	IC,LINEAR,NE5532	U2-5
340-03328	1	IC,LINEAR,NE5534	U1
PC MNT CONN			
510-03209	12	CONN,F POST,AMP 1-380953-0/2	
BULK WIRE			
670-01844	1	WIRE,JMP,24AWG,BUSS WIRE	CU/FISHPAPER SHIELD
PANELS			
702-03577	1	SHIELD,CU/FISHPAPER,4.9X1.1	
PC BOARDS			
710-03152	1	PC BD,ANLG FILTER BD	

SHIPPING KIT

Part No.	Qty/Description	Ref.
CUST LITERATURE		
070-02813	1 CARD,WARRANTY,LEXICON	
070-03567	1 MANUAL,OWNER'S,M200	
CABLES/CORDS		
680-00841	1 CORD,POWER,PHILLIP #13E37-1	
SHIPPING MAT		
730-02808	1 BOX,OUT,23X19.5X9-3/4,M97	
730-02820	1 BAG,CLEAR,19.5X28X.004	

HARDWARE KIT

Part No.	Qty/Description	Ref.
TRANSISTORS		
310-01004	1 TRANSISTOR,2N3055	Q3
310-01017	1 TRANSISTOR,TIP31 A	Q2
SCR		
320-01014	1 TRANSISTOR,C122F1,SCR	Q1
LINEAR IC		
340-00747	1 IC,LINEAR,7915 (LM 320 T-15)	U2
340-03212	2 IC,LINEAR,LM317T,TO-220	U1,5
MEMORY IC		
350-02427	4 IC,EPROM,4KX8,350NS,2732	U25-28
FANS/MOTRS/RELY		
410-03677	1 FAN,TUBE-AX,3-1/4X1,18CFM,12DC	
TRANSFORMERS		
470-02585	1 XFORMER,POWER,M97	T1
CABLE CONN		
490-00396	1 CONN,AC AND RFI FILTER	J1
SOCKETS		
520-00947	1 XISTOR SCKT,TO3,SOLDER	Q3 MTG
STRAIN REL		
530-02489	2 TIE,CABLE,NYL,.1"X4"	T1
GROMMETS		
540-00873	1 GROMMET,7/16 OD,5/16 ID	FAN CORD MTG
540-01769	8 GROMMET,NYL,.125 THK	FRONT PANEL CHASSIS INSERT
540-03334	1 GUARD,DUST,M200	
540-03483	4 GROMMET,3/8 OD,7/32 ID,BLUE	FAN MTG
FEET		
541-00780	4 BUMPER,FEET,3-M #SJ5023	
KNOBS/CAPS		
550-01117	1 PB CAP,BLU,C&K 7089	
550-02228	5 BUTTON,TANG,WHT/BLK	SW4
550-02229	1 BUTTON,TANG,WHT/RED	SW1
550-02344	3 KNOB,21MM,1/8SHFT,BLK	
550-02627	2 KNOB,SLIDE,TANG,BLK/WHT LN	
550-02695	3 KNOB CAP,21MM,BLU	
ELECTRONIC HDWR		
600-00872	1 FUSE HOLDER,3AG,PANEL,RA	F1

HARDWARE KIT cont'd.

Part No.	Qty	Description	Ref.
PC HDWR			
610-02269	3	HARDWARE,PC,RICHCO #MB-3-156	FISH PAPER MTG
LUGS			
620-01999	1	LUG,SOLDER,LCKNG,#6,.020THK	GND LUG
620-02717	1	LUG,RING,INSUL #10,22-16 GA	T1 SHIELD TERM
INSUL/SPACRS			
630-00887	1	INSUL,SEMI,COVER,TO-3	Q3 MTG
630-00952	5	INSUL,SEMI,BUSHING,TO-220	Q1,2, U1,3,4 MTG
630-01852	1	INSUL,SEMI,SIL RUB,TO-3	Q3 MTG
630-01853	5	INSUL,SEMI,SIL RUB,TO-220	Q1,2, U1,3,4 MTG
630-02267	1	SPCR,PCB PUSHON/STUD,1/4	SW1
630-02529	1	SPCR,#8CLX10,1/4RD,PHEN	SW1
630-02628	2	WSHR,FL,5/16CLX1/20DX1/16,NYL	HINGE ASSY
630-02705	8	WSHR,FL,#6CLX1/40DX.02,BLK,NYL	FRONT PANEL MTG
630-03666	4	WSHR,SHLDR,.187SHK,#6CL,NYL	HEAT SINK TO CHASSIS MTG
SPCR,NON-INSUL			
635-00949	4	SPCR,#6CLX1/4,AL	FAN MTG
635-00956	2	SPCR,#6CLX1/16,3/16RD,AL	Q3 MTG
635-02682	4	SPCR,#10CLX1/2,1/2RD,AL	T1 MTG
635-03449	2	SPCR,6-32X2-1/4,1/4RD,BR/N	MOTHERBD MTG
MACHINE SCREWS			
640-01710	4	SCRW,6-32X1/4,PNH,PH,ZN	FAN GUARD MTG
640-01720	16	SCRW,6-32X3/4,PNH,PH,ZN	FP #1 MTG,Q3 MTG(2) FAN MTG(4)
640-02683	4	SCRW,10-32X2 1/4,TH,PH,BLK	T1 MTG
640-02706	8	SCRW,6-32X1/4,BH,SCKT,BLK	FRONT PANEL MTG
640-02715	8	SCRW,4-40X1/4,FH,PH,ZN	J7-10 MTG
640-02749	27	SCRW,6-32X1/4,PNH,PH,SEMS,BLK	CHASSIS INSERT MTG (4), BRACE MTG (1), TOP & BOTTOM COVER MTG
640-02811	8	SCRW,8-32X3/8,PNH,PH,SEMS,BLK	RACK EAR MTG
640-02812	7	SCRW,4-40X3/8,PNH,PH,BLK	Q1,2, U1,3,4 MTG,J1 MTG
640-03087	5	SCRW,6-32X3/8,PNH,PH,SEMS,BLK	GND LUG & FAN BRKT MTG
640-03670	4	SCRW,6-32X3/8,TH,PH,SS,BLK	HEAT SINK TO CHASSIS MTG
640-03713	23	SCRW,6-32X1/4,PNH,PH,SEMS,ZN	FP#2 (7),MTHBD (8),DIG BD (3), BRACE MTG(5)

HARDWARE KIT cont'd.

Part No.		Qty/Description	Ref.
NUTS			
643-00000	3	NUT	NUT,3/8-24X1/2
			THESE NUTS SUPPLIED WITH
			PHONE JACK 510-02106 FOUND ON
			POST-SLDR MOTHERBD #024-03191
643-01727	4	NUT,10-32,KEP,ZN	T1 MTG
643-01728	4	NUT,6-32,KEP,ZN	FAN MTG
643-01729	1	NUT,6-32,HEX,SMALL,ZN	GND LUG MTG
643-01730	4	NUT,6-32,KEP,SMALL,ZN	HEATSINK TO CHASSIS MTG
643-01732	2	NUT,4-40,KEP,ZN	J1 MTG
643-01733	5	NUT,4-40,HEX,SMALL,ZN	Q1,2, U1,3,4 MTG
WASHERS			
644-00000	3	WSHR	J4-6 MTG,WSHR,FLAT
			.375IDX.6150DX.020
			THESE WSHRS SUPPLIED WITH
			PHONE JACK 510-02106 FOUND ON
			POST-SLDR MOTHERBD #024-03191
644-01735	4	WSHR,FL,#6CLX3/80DX1/32THK	FAN GUARD MTG
644-01736	5	WSHR,FL,#4CLX.2180DX.032THK	Q1,2, U1,3,4 MTG
644-01737	5	WSHR,LOCK,SPLIT,#4	Q1,2, U1,3,4 MTG
644-01738	3	WSHR,INT STAR,3/8CLX.690DX.031	J4-6 MTG
644-01739	10	WSHR,INT STAR,#6	FP #1 MTG
644-01740	4	WSHR,LOCK,SPLIT,#6	FAN GUARD MTG
644-02629	2	WSHR,WAVE,.2961DX.5510DX.0085	HINGE ASSY
644-03554	8	WSHR,FL,#6CLX9/160DX.04THK	FAN MTG
644-03667	2	WSHR,LOCK,EXT STAR,#4,SS	J1 MTG
644-03668	4	WSHR,LOCK,EXT STAR,#6,SS	HEAT SINK TO CHASSIS MTG
PRE-CUT WIRE			
675-02838	1	WIRE,16G,RED,7",ST&T1/4X1/4	Q3
675-02841	1	WIRE,16G,YEL,7",ST&T1/4X1/4	Q3
675-02843	1	WIRE,18G,WHT,4",ST&T1/4X1/4	J1 AC WIRING
675-02847	2	WIRE,18G,BLK,4",ST&T1/4X1/4	J1,F1,AC WIRING
675-02852	1	WIRE,16G,GRN,4",ST1/4XST&T1/4	J1 GND
675-02875	1	WIRE,18G,PRP,7",ST&T1/4X1/4	Q3
SLEEVING			
690-02060	6	SLEEVING,SHRINK,3/16"	J1,F1,Q3,1/2" LENGTHS

HARDWARE KIT cont'd.

Part No.	Qty/Description	Ref.
CHASSIS/MECH		
700-01962	1 CHASSIS,"PC BRACE",HINGED,M97	
700-03319	1 CHASSIS,WRAPAROUND,M200	
700-03320	1 CHASSIS,INSERT,FP ASSY,M200	
700-03321	2 COVER,TOP/BOTTOM,M200	
700-03325	1 CHASSIS,"PC BRACE",STA,M200	
700-03326	1 CHASSIS,BRACKET,FAN,M200	FAN MTG
700-03555	1 FAN GUARD,3.25"MNT	
BRACKETS		
701-00299	8 BRACKET,KEYSTONE #617	SUPPLIED TO CHASSIS VENDOR
701-01972	2 BRACKET,MTG,M97	
PANELS		
702-01551	1 COVER,HOLE,DB-25	OPTION CONN
702-03214	1 COVER,HOLE,DE-9	OPTION CONN
702-03322	1 PANEL,FRONT,M200	
702-03333	1 COVER,PROTECTIVE,M200	
702-03657	1 PANEL,OVERLAY,M200	FRONT PANEL
LENS/PLATE/PANL		
703-03323	1 LENS,DISPLAY,M200,1.19X3.53	
703-03324	1 LENS,DISPLAY,M200,.7X2.3	
HEAT SINKS		
704-03327	1 HEAT SINK,POWER SUPPLY,M200	Q3 MTG
PLASTICS		
720-03387	1 AIR FILTER,CHASSIS,M200	
LABEL/NAMEPLTS		
740-02729	1 LABEL,FCC COMPLIANCE	
LABELS,SERIAL #		
745-03566	1 LABEL,SERIAL NO,M200,CHASSIS	

REMOTE OPTION 1

Part No.	Qty/Description	Ref.
INTERFACE IC		
345-01584	1 IC,INTER,DS1488N	U10,PICK AND ADD TO MTHBD POST-SLDR KIT 024-03191
345-01585	1 IC,INTER,DS1489AN	U9,PICK AND ADD TO MTHBD POST-SLDR KIT 024-03191
MICROPROC IC		
365-01583	1 IC,uPROC,8251 A	U14,PICK AND ADD TO MTHBD POST-SLDR KIT 024-03191
PC MNT CONN		
510-01504	1 CONN,D-SUB,25FC,MB,PCRA	J3,PICK AND ADD TO MTHBD PRE-SLDR KIT 025-03192
CONN HDWR		
527-00138	2 CONN,D-SUB,JACKSOCKET	CONN TO CHASSIS MTG PICK AND ADD TO CHASSIS FIN KIT 023-03182
INSUL/SPACRS		
630-03544	2 WSHR,FL,#6CLX3/80DX.032,FBR	CONN TO PCB MTG PICK AND ADD TO CHASSIS FIN KIT 023-03182
MACHINE SCREWS		
640-01706	2 SCRW,4-40X3/8,PNH,PH,ZN	CONN TO PCB MTG PICK AND ADD TO CHASSIS FIN KIT 023-03182
NUTS		
643-01732	4 NUT,4-40,KEP,ZN	CONN TO PCB AND CHASSIS MTG PICK AND ADD TO CHASSIS FIN KIT 023-03182
BULK WIRE		
670-01974	6 WIRE,JMP,22AWG,0.1",NON-INSUL	W8,10-14,PICK AND ADD TO MTHBD PRE-SLDR KIT 025-03192

REMOTE OPTION 2

Part No.	Qty/Description	Ref.
INTERFACE IC		
345-03207	1 IC,INTER,uA9638,LINE DRVR	U12,PICK AND ADD TO MTHBD POST-SLDR KIT 024-03191
345-03208	1 IC,INTER,uA9637A,LINE RCVR	U11,PICK AND ADD TO MTHBD POST-SLDR KIT 024-03191
MICROPROC IC		
365-01583	1 IC,uPROC,8251 A	U14,PICK AND ADD TO MTHBD POST-SLDR KIT 024-03191
PC MNT CONN		
510-03550	1 CONN,D-SUB,9FC,MB,PCRA	J2,PICK AND ADD TO MTHBD PRE-SLDR KIT 025-03192
CONN HDWR		
527-00138	2 CONN,D-SUB,JACKSOCKET	CONN TO CHASSIS MTG PICK AND ADD TO CHASSIS FIN KIT 023-03182
INSUL/SPACRS		
630-03544	2 WSHR,FL,#6CLX3/80DX.032,FBR	CONN TO PCB MTG PICK AND ADD TO CHASSIS FIN KIT 023-03182
MACHINE SCREWS		
640-01706	2 SCRW,4-40X3/8,PNH,PH,ZN	CONN TO PCB MTG PICK AND ADD TO CHASSIS FIN KIT 023-03182
NUTS		
643-01732	2 NUT,4-40,KEP,ZN	CONN TO PCB MTG PICK AND ADD TO CHASSIS FIN KIT 023-03182
BULK WIRE		
670-01974	3 WIRE,JMP,22AWG,0.1",NON-INSUL	W12-14,PICK AND ADD TO MTHBD PRE-SLDR 025-03192

INPUT TRANSFORMER OPTION

Part No.	Qty/Description	Ref.
CUST LITERATURE		
070-03723	1 INSTR,INPT XFORMER OPT,M200	
TRANSFORMERS		
470-03206	2 XFORMER,INPT,M200	T4,5,PICK AND ADD TO MTHBD POST-SLDR KIT 024-03191

EUROPEAN FUSE OPTION

Part No.	Qty/Description	Ref.
FUSES		
440-02349	1 FUSE,5X20MM,SLO-BLO,.500AMP	F1,PICK AND ADD TO CHASSIS FIN KIT 023-03182
ELECTRONIC HDWR		
600-01878	1 FUSE,ADAPTOR,5X20MM TO 3AG	F1,PICK AND ADD TO CHASSIS FIN KIT 023-03182

JAPANESE & DOMESTIC FUSE OPTION

Part No.	Qty/Description	Ref.
FUSES		
440-00864	1　FUSE,1A,SLO	KIT AND ADD TO CHASSIS FINISHING KIT 023-03182
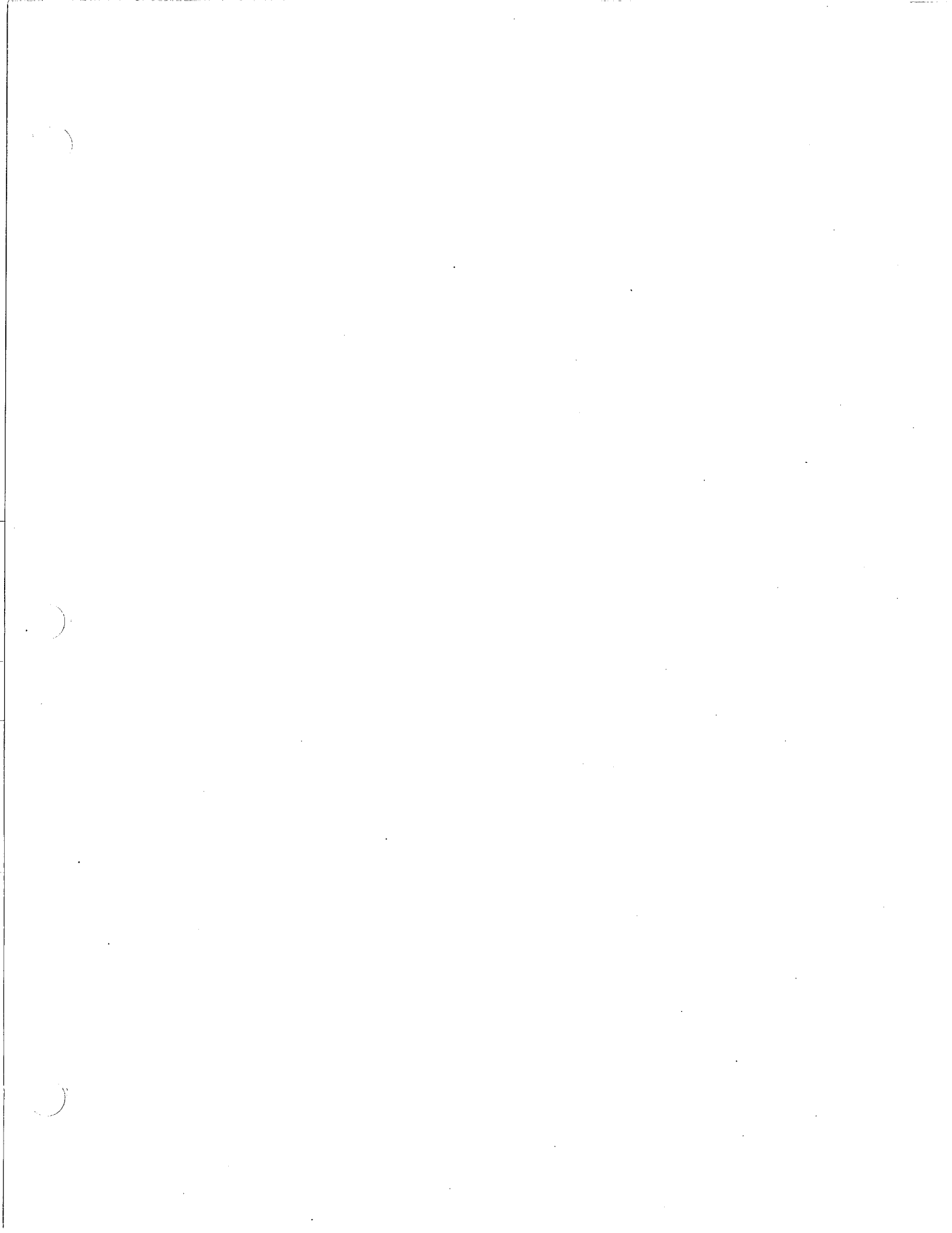
VARIATIONS: Each of the six programs in the M200 has up to 10 variations. These variations are organized similarly in all programs.   The figure below shows the general organization of variations by parameters for each program.   The size of the reverberant space is the same within each row; while reverb times and pre-echoes are the same in each column.

Reverb Time	medium	medium	short
Pre-echoes	none	medium	high

Size			
small	7	8	9
medium	4	5	6
Large	1	2	3
Large	0*	.	F

•Variation 0 is the same as Variation 1, except it is more metallic and should be used if modulation noise occurs with pure high-frequency tones or if clicking occurs with pure low-frequency tones.

The variations have been arranged to make them easy to remember and use. The first column has no pre-echoes and may be the most generally useful. Variation 1 should always be tried first when ambiance or depth is needed (This variation is automatically running when a program is first loaded.) It tends to be best on mixed material.

When you need a brighter and tighter reverb, especially on percussive material, try variation 4.

Variation 7 is best when an impression of very small size is required.

Variations 2, 5, and 8 add pre-echoes that imitate floor and stage reflections. They tend to strengthen a close-miked sound, making it louder and fuller.

Variations 3, 6, and 9 add loud pre-echoes to simulate strong reflections from hard surfaces.   With their short reverb times, these variations sound like a gymnasium or a modern general-purpose auditorium.

HOW THE CONTROLS AFFECT THE SOUND: The controls on the M200 can produce a great variety of reverberant sounds, allowing you to match the reverb to a tremendous range of material. You can also use the different reverb effects as the mood of a piece changes -- changes in the reverb time or other parameters can capture or emphasize different phrases, and the momentary fade resulting from a program or size change can clear the reverb for a new sound. Although there can be no substitute for actually experimenting with the controls and listening to what they do, the following descriptions should help as you begin to create your own unique sounds.

The ROLLOFF control selects one of three high-frequency filters affecting the sound passing through the reverb processing circuits of the M200. (The direct sound has full 20 kHz bandwidth at all times.) In the HIGH position of this control, the reverb is limited only by very sharp antialiasing filters at 10 kHz. In the MEDIUM and LOW positions, there is a 6 dB/octave filter in the circuit at 7 kHz and 3 kHz, respectively. This filter mimics the effect of air absorption. Without it, the reverb in large sizes may sound unnaturally bright.

Effects of the SIZE control are discussed in the program descriptions. After a program or register has been called, the PREDELAY, REVERB TIME, and SIZE controls are inactive until they are moved through the position that corresponds to the setting stored in the M200's memory for that program or variation. For example, program 2.1 has zero predelay, so before that control can work, it must be rotated all the way counterclockwise. Once this is done, the knob works normally.

The PREDELAY control sets the time before reverberation commences. Program 1 (Halls) has a minimum of 23 milliseconds of predelay built in, but in the rest of the programs, this parameter can be brought to 0. Depending on the program, the maximum available predelay varies somewhat at extreme settings of the SIZE control. The predelay should be kept under about 40 ms if the reverberation is to blend closely with the direct sound, but the control may be set much higher to convey a sense of distance and space, and can be set very high to create special effects.

The PRE-ECHOES emulate stage reflections. They are independent of the PREDELAY setting and may arrive before the predelayed sound. The number of pre-echoes as well as their level and timing are not necessarily the same for all variations of a program. For this reason, it is not always possible to duplicate a variation by changing the settings on another variation of the same program.

DIFFUSION is a measure of the extent to which the reflections of the initial sound are spread out in time. Varying the diffusion effectively changes the nature of the boundaries of the reverberation space created by the M200. Higher diffusion makes the boundaries more irregular, creating a sound that is smoother, more mellow, and also more colored. Decreasing the diffusion gives a clearer, brighter, less colored sound. In general, percussion requires high diffusion to help blend the reflections together, while vocals and other "smooth" material may benefit from lower diffusion.

The REVERB TIME control sets the time required for 60 dB of decay in the midrange (at 1 kHz). The REVERB TIME control changes the acoustic space from almost completely dead to something much more alive and reverberant than anything found in nature. In all but the Inverse Room program, REVERB TIME can be affected by the SIZE control.

Changing the RT CONTOUR settings alters the timbre of the reverb, allowing it to take on the character of anything from a warm-sounding old wooden concert hall to a hard, metal-walled room.

HEADROOM DETECTION: In an effort to further improve the M200's wet noise performance, software version 1.3 has altered the headroom threshold levels from what they have been up until now. This was done to encourage users to take full advantage of the converter's dynamic range. The following chart illustrates the impact of this change.

Comparison of V1.0 - V1.3 Headroom Threshold Levels

Rev 0,FP Graphics	LED Color	<-----V1.0 - V1.2----->		<----------V1.3---------->	
		dB below ref.level	absolute inp.level	dB below ref.level	absolute inp.level
+12 (OVLD)	R	0	+12 dBm	0	+12 dBm
+9	Y	-2	+10	-1	+11
+6	Y	-5	+7	-2	+10
+3	Y	-8	+4	-4	+8
0	G	-11	+1	-6	+6
-3	G	-14	-2	-9	+3
-6	G	-17	-5	-12	0
-9	G	-20	-8	-18	-6
-12	G	-23	-11	-23	-11
-18	G	-29	-17	-29	-17
-24	G	-35	-23	-35	-23
-30	G	-42	-30	-42	-30
			± 1 dB		± 1 dB