DIAGNOSTICS and TRIMS

The Emulator Three is made up of literally thousands of individual components. Because of its complexity, a good understanding of the operation of the EIII will help immensely when troubleshooting. We suggest you first perform a functional test on the unit. Many times a complete functional test will reveal important clues to the problem that might have otherwise been overlooked. Try to isolate the problem as much as possible through the operational controls, then go in with your instruments to nail it down. The Channel Disable function is an invaluable tool to determine which channel is at fault. A high quality amplifier and speaker system is also necessary to pick out subtle problems that would otherwise be missed.

Certain boards on the Emulator Three can be more difficult to troubleshoot than others. The microcontroller board because of its complexity can be a nightmare to diagnose and repair. In many cases, if you have isolated the board but cannot seem to locate the exact problem, a board swap is in order. Simply call the E-mu Customer Service department to arrange for a board swap.

The EIII contains a number of on-board diagnostic tests and trim procedures. These can be accessed or read from the front panel without even opening the unit!

SPECIAL FUNCTION DIAGNOSTICS

The on-board tests are hidden in the Special functions and can be accessed in the following manner:

1. Activate **MASTER 8** (Special). The display will say:

```
SPECIAL


Select a Submodule
```

2. Press **8** on the keypad (Software Version 1.21 and above).
Hint: A good way to remember this is: **1 number past the last choice.**
The display will now say:

```
DIAGNOSTICS


Enter MagicCode:
```

NOW LISTEN CLOSELY!
Pssst, the secret code is: **1-3-5-8** or ... the intervals of a major chord.

The display will now say:

```
DIAGNOSTICS


Select a Submodule
```

Moving the data slider will show the following tests and calibrations:

1. Panel/Keyboard Test
2. Sound RAM Test
3. Serial Test
4. Freq. Response Test
5. Analog Trims
6. ADC Trims
7. Sample Gain Check
8. Disk Diagnostics
9. Disable Channels

1 PANEL/KEYBOARD TEST

1. Flashes the LCD with all pixels on to test the LCD.

2. All button names are displayed to the LCD as they are pressed, and all buttons toggle their corresponding LED. In addition, keyboard note on and note off as well as key velocity are displayed.

2 SOUND RAM TEST

1. Tests Sound RAM for shorted address lines, shorted data lines, crossed bits, and address to data problems.

2. Displays the amount of RAM installed and does a 3 word pattern Write/Read comb of the entire installed RAM. Flags all errors.

Note: Reboot the EIII after running a RAM test or sounds may distort. There is garbage in memory.

3 SERIAL TEST (loop through test)

1. MIDI - tests the signal path and the SCC in its intended operating mode.

2. RS422 - This test writes and reads an AA and then a 55 to the RS-422 port. The test waits a reasonable length of time, for each response. If there is no response, it records a timeout error. In order for the test to work, a jumper plug must be inserted into the RS-422 jack on the back panel of EIII. The LEDs show that the 500 kHz clock is running. If you do not wish to make the test plug, you can simply connect pins 4 and 8, and pins 5 and 9 together with clip leads. To test the 500 kHz clock, monitor pin 7 with your oscilloscope.

Construction of the RS-422 Test Plug: This will come in handy if you plan to repair many EIII's or Emax's. It allows you to test the USART and Clock in one operation.
To build the test plug, you will need: a 9 pin D-type female RS-422 connector, 2 LEDs, and 2 small pieces of wire. Wire the test plug as per the diagram below.

BACK   FRONT   FRONT
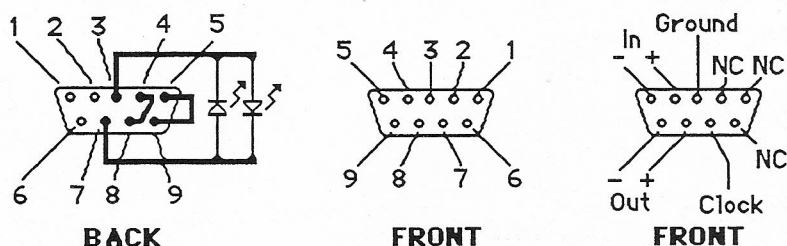
3. SMPTE- Test still N/A as the SCC must be in two different modes to read and write SMPTE time code.

To Test SMPTE: First, stripe a multitrack tape with SMPTE, then record a simple sequence in the EIII sequencer. Extend the sequence using song mode so that it is several minutes long. Next record the sequence to another track of the tape with the sequencer synced to SMPTE. Lastly, rewind the tape and sync the EIII up again, this time monitoring both the recorded track and the EIII. Slight flanging is OK but the two "tracks" must remain in sync.

4 FREQUENCY RESPONSE TEST

The frequency response test is a quick way to test all the EIII channels at once.
Simply follow the instructions given in the display.

```
FREQUENCY  RESPONSE
Hook  MonoMix->R.Smpl
Set   SmplInputLevel=0
Press ENTER to start
```

When ENTER has been pressed, the EIII will measure the frequency response of all channels, then the display will show either:

```
FREQUENCY  RESPONSE


All Channels:    OK
```

or

```
FREQUENCY  RESPONSE
0  =  Dead  Channel(s)
X  =   Bad  Channel(s)
0000 0000  0000  0000
```

1. Loop-through test

2. Checks peak-peak amplitude response of all 16 channels at 32Hz, 1kHz, and 16kHz.

3. Compares to make sure p-p voltages at the 3 test frequencies are within 6dB (2X p-p) of each other.

4. Also checks for dead channels. Compares signal amplitude to 2X the amplitude of the noise floor (no signal).

5. Flags good, bad and dead channels.

5 ANALOG TRIMS

The analog trims on the EIII are stored with the software on the hard disk. After trimming a customer's machine, it would be a good idea to save the system software on a 3.5" floppy disk and give this to the customer so that they will have a backup in case of hard disk failure (Disk Utilities, 4).

Rules relating to saving and loading trims:
Rule #1: Saving software from HD to floppy saves the trims *and* software to the floppy.
Rule #2: Loading software from floppy to a HD with software resident *does not* load trims.
Rule #3: Loading software from floppy to a HD without software resident *does* load trims.
So, to load the trims from a floppy disk to the HD, you must erase software from the HD first.

The Analog Trim menu shows:

```
   _____
          ANALOG  TRIMS


      Select  a  Submodule
   _____


   0  Exit  Trim  Module

   1  Manual  Trims

   2  Autotrims  (All)

   3  Autotrim  Setup

   4  Volume  Autotrim

   5  Fc  Autotrim

   6  Q  Autotrim
```

ANALOG TRIM PROCEDURE

Tools Needed:
1. 12/30 UST (Universal Sound Test) disk
2. Short 1/4" phone cable
3. Oscilloscope

Information you need to know:
The lowest 16 keys correspond to channels 1-16 respectively.
The 17th key (E3) cycles through all 16 channels.

Before you Start:
1. Make sure that the sliders are calibrated. Master, Special, 3.
2. Save all trims after each step.
3. Warm up the EIII (closed) for at least 1 hour before you begin this procedure.

1. Load the UST disk.

2. Go to preset 16, "500Hz sine wave, 100% VCA level".

3. Go to "Analog Trims" in this way.
      A. Choose Master module.
      B. Choose Special (8) submodule.
      C. Choose Diagnostics (8) (It's not on the menu. Remember it's 1 number past the last choice.)
      D. The display will respond, "Enter Magic Code".
      E. Enter 1-3-5-8 (Major Chord).
      F. Choose Analog Trims (5).
      G. Choose Manual Trims (1).

4. You will now see a screen of many numbers.

```
Analog Trims  Ch:01
Fc:96909393  85818590
 Q:80808585  86808179
Vo:81837896  88839980
```

The top row represents "Fc".
The middle row represents the "Q" of the filter.
The bottom row represents the "Amplitude or Volume" of the channel.
There are two pages of these numbers representing all 16 channels.

5. With the volume slider at maximum, measure the output at the Mono out jack, using your oscilloscope. All channels should measure at least 4V p-p (If E.C.O.#1036 has been installed, otherwise levels should be 1Vp-p).

6. Amplitude Trim.
      A. Press Master again to exit the module.
      B. Choose preset 28 (500Hz sine, 60% VCA level).
      C. Enter the Diagnostics submodule again and choose Analog Trims.
      D. Locate the channel with the lowest output and leave its value at 99.
      E. Trim the other channels to match it.
      F. Hit "Enter". Save New Trims? YES.

7. Resonance.
      A. Select preset 13 (Filter Resonance).
      B. Enter the Diagnostics submodule again and choose Analog Trims.
      C. Press the first 16 keys and locate the dullest sounding channel. This will be our reference channel.
      D. Lower the dullest channel's Fc trim to 95. (This gives you some leeway which you may need later on).
      E. Match the other channels to this one.
      F. Hit "Enter". Save New Trims? YES.

8. Q trim.
      A. Without exiting this module, and using the first 16 keys to listen, lower the Q values until the filter just drops out of oscillation. You should hear a hollow sound instead of a squeal.
      B. Hit "Enter". Save New Trims? YES.

9. Fine tune Fc.
      A. Exit Master module and select preset 10 (Filter Cutoff).
      B. Tune all channels to the reference channel (as closely as possible).
      C. Hit "Enter". Save New Trims? YES.

Manual trims

1. Allows the technician to trim (by ear or test gear) the Volume, Fc, and Q of the CEM VCA/VCF for each channel of the EIII. Trim range is 0 to 99. Volume and Q trims should be as high as possible (least effect). Fc trims will vary as to trim each machine to the displayed frequency in the Analog Processing module.

Autotrims

Autotrims may be useful on a completely uncalibrated machine in order to get the trims "in the ballpark". Unfortunately, the Autotrim procedure is not as accurate as trimming by ear and is not recommended except in cases where saving time is a factor. To Autotrim, simply follow the instructions given in the display.

1. A loop-thru test to automatically trim the CEM chips. The Sample Input Gain is first set by using a level calibrated test signal. With this known input reference each channel is then trimmed in order Volume, Fc, and Q.

2. Channels can be disabled if necessary to allow autotrimming a machine with known bad channels, which might otherwise cause the test to abort.

6 ADC TRIM PROCEDURE

Tools Needed:
1. Signal Generator (1kHz sine wave at 2.82 Volts peak-peak).
3. Long Trimpot Tweeker
4. Several mono phone cables

Information you need to know:
1. Make sure ECO 1036 has been implemented (220pf cap at C2 and C3; 10K resistor at R4 and R5 on analog jack board). This ECO increases the mix output level.
2. A trimpot location diagram is shown at the end of this section.

Before you Start:
1. Warm up the EIII for at least 1 hour. It is important to trim the EIII ADC board when it is at its normal operating temperature.
2. Ensure that the Analog Trims are O.K.

1. Set "Sample Input" slider to -10dB by the following steps:
    A. Enter "Sample Gain Check" mode:
        1. Choose Master module.
        2. Choose Special (8) submodule.
        3. Choose Diagnostics (8) (It's not on the menu. Remember it's 1 number past the last choice.)
        4. The display will respond, "Enter Magic Code".
        5. Enter 1-3-5-8 (Major Chord).
        6. Choose Sample Gain Check (7).

    B. Inject a 1kHz 2.82Vpp sine wave into the left Sample Input jack. Measure at the right side of R8 (which is not stuffed) on the analog jack board or measure with a standard Y-splitter cord.
    C. Set the Sample Input slider so that the EIII's VU reads -10dB. (To avoid having to repeat this procedure, index the slider position with a light pencil mark on the front panel label.

2. Go to ADC Trims in Diagnostics.

    A. Follow the screen instructions.

```
        DC TRIM
Remove  cables  from
Set  SmplInputLevel=0
Press  ENTER  to  start
```

B. Adjust the DC offset trimpots for minimum offset.

```
       ZERO TRIM
Left:+065  Right:+003
L:||||||||
R:||||
```

C. Press "Enter".

D. Follow the screen instructions.

```
ADC TRIM        Ch:Left
Connect  Mono  Mix  Out
to  Left  Sample  Input
Press  ENTER  to  start
```

E. While looking at the bar graph, adjust the left channel slope trimpot (RT4) for the most stable settings.

```
2ndHD TRIM      Ch:Left
Bar=.04%  Avg2hd=.08%
```

F. Adjust left 2nd Harmonic trimpot (RT1) for minimum overall distortion.

G. Alternate between steps E and F for an optimum reading. All channels must be below the midpoint of the bargraph range (typically below 0.12%).

H. Follow the screen instructions and repeat for the right input.
    Right input.
        Right DC Offset Trimpot (RT6).
        Right Slope Trimpot (RT5).
        Right 2nd Harmonic Trimpot (RT2).

I. Start over at step 2 and repeat at least once. This is important as these adjustments are interactive.

On early EIII units, the trimpots are not mounted vertically on the ADC board and are very hard to reach. Technicians with very thin hands may be able to reach the trimpots when the ADC board is in the cage. If you are working on an early EIII with the hard to reach trimpots you may wish to change the trimmers to the upright variety (This is covered under warranty). If this is not practical, the ADC board may be trimmed while out on the extender board. Obviously, when the ADC board is out on the extender, it is going to cool down. One technique to overcome this is, to feel

the temperature of the ADC board ICs after it has been on a while, then try to simulate this temperature with a heat gun when it is out on the extender board. Be extremely careful not to overheat and damage the ICs when using a heat gun. After trimming, close the machine up and watch for any change in the diagnostic displays.

DC offset (zero) trim
Sets the center point of the ADC. The technician should be aware that this will drift considerably with temperature and the sampling routines will compensate for this. It is trimmed here for nominal center and to ensure a proper slope trim.

Slope trim
Sets the slope of the ADC current generator at low signal levels.

2nd harmonic distortion (symmetry) trim
Adjusts the symmetry of the dbx 2155 input amp. Unevenness in the positive and negative half-cycles will cause even harmonic distortion, hence we can trim this by monitoring the 2nd harmonic. As the CEM 3387 VCF/VCA adds its own 2nd harmonic distortion, we use a loop-thru type of test to minimize 2nd harmonic distortion system throughput. The test uses all 16 channels to let the technician average the distortion, that is, get the best compromise for the system. Pressing the MASTER button (this is not labeled on the display) demultiplexes the test and displays only channel 1, allowing a quick comparison with outboard test equipment.

7 SAMPLE GAIN CHECK
Displays left and right calibrated VU meters to check the gain of the sample input path. 0 VU = 16 bits = 2^{16} = full scale (consider a digital audio system as having no headroom). Using a 0dBV = 2.82Vpp 1kHz sinewave input signal as a reference, verify that the sample input path has approximately 40dB gain at maximum slider setting to approximately -15 to -20dB attenuation at the lowest slider position.

8 DISK DIAGNOSTICS

0 Exit Disk Module- Returns you to the Diagnostics submodule.

1 HD Select Drive- Allows you to select any currently mounted drive.

2 HD Read Only- Non-Destructive. Exercises (reads) the entire HD media for data read errors. Runs continuously. Press and hold ENTER to quit. Exiting the drive in this manner sets the drive Error Correction to ON.

3 HD Read/Reassign- Potentially Destructive. Same as Read Only, but first turns error correction OFF and reassigns bad blocks using the drive block reassignment.

4 HD Write/Read/Reass- DESTROYS ALL DATA. Exercises the entire HD media by writing a test pattern, reading it back, and comparing. Runs continuously. Disk must currently be reformatted after this test with the standard EIII disk utility. This installs the file system to allow the EIII to recognize the drive. Press and hold ENTER to quit.

5 HD Error Correct - Allows investigation and change of the drive error correction state.

6 HD Result - SCSI Sense Key and Sense Code, Sector number and Status of the last HD operation.

7 HD Media Defects - Displays HD's defect list in Hex.

8 Floppy Read Only - Continuously reads the entire floppy surface and verifies to a known test pattern. Must use a disk previously written using the Floppy Write/Verify test. Logs all soft errors according to sector number, byte number, and data compared. Useful for read exercising and for checking drive to drive compatibility (alignment, etc.).

9 Floppy Write/Verify - Runs continuously. Writes a test pattern and reads it back, comparing the data. Logs errors as in the read test. The test pattern is an ascending pattern (i.e. 104, 105, 106, ...) The first byte in the sector is the sector number mod 256. Each sector has 512 data bytes. There are 10 sectors * 80 tracks * 2 sides = 1600 sectors per disk.

IMPORTANT- Powering down the EIII while it is running a HD continuous test will leave the drive Error Correction OFF! Make sure the Error Correction is turned ON when finished.

9 DISABLE CHANNELS
Allows the technician to disable specific output channels without having to leave the Diagnostics submodule. Channels can also be disabled by the user in the MASTER, Special, submodule.

THE DEBUG/EXTENDER BOARD
The EIII Extender board serves as both an extender board and as a powerful debugging tool when coupled with a "smart" computer monitor. Many E-mu Service Centers will already have a monitor which was used in debugging the Emulator II. Most EIII problems can be easily traced without getting down to the "nuts and bolts" of the machine, but every once in a while a problem will arise which defies normal troubleshooting techniques. In these cases, the debugger can be an invaluable tool.

The Debug board
The Debug board can be used as an interface from your monitor to the Dbmon program which is resident in the EIII boot PROMs. Since the Debug boards do not have the interface parts installed by E-mu, you will have to stuff them yourself if you wish to use the monitor function. The parts layout is shown in the following diagram. The schematic diagram is shown in the schematic diagram section of this manual. All parts for the Debugger are commonly available but can also be obtained from E-mu Systems. In addition to these parts you will need a 16-pin ribbon cable which interfaces with your monitor. The pinouts for construction of this cable are also diagramed.
There are two buttons on the Debug board; NMI and RESET. NMI stops the program that is currently running and returns control to the user. RESET will give the same result as turning off the machine then back on again. Any programs that you enter using the Dbmon will be lost is you push RESET.