E-mu Systems, Inc.

applied magic for the arts

EMAX

12 - BIT DIGITAL SOUND SYSTEM

DIAGNOSTICS AND TRIMS

EMAX DIAGNOSTICS

The Emax 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!

BOOTPROM DIAGNOSTICS

The bootprom diagnostic tests are invoked each time Emax is powered up. The bootprom tests are very simple tests and the results should not be taken as absolute truth. The tests can, however, point a technician into a general problem area before even opening the unit.

On power up, all the LED's are lit. As each test is passed, an LED is turned off. When a test fails, it leaves the LED on, but goes on to the next test. Below is a description of the test that failed for each LED left on.

Enter LED:
Unable to write to DRAM at location 17FFFH and then read it back.

Dynamic Allocation LED:
Unable to initialize the LCD. If this test fails, the unit will lock up.

Transpose LED:
Unable to write a pattern to a page of DRAM (8001-8100) and then read it back.

Sequencer LED:
Unable to write and read back an E-Chip register.

Master LED:
Unable to write and then read back a test byte to location 0 of the E-Chip RAM.

Preset Definition LED:
Wrote command to 1772 Floppy Disk Controller to restore head on the drive, but the drive never reached track 0, or the 1772 never responded.

Analog Processing LED:
Unable to load software from disk.

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
> [1 - 6] / Slider

2. Press **8** on the keypad. The display will now say:

> Emax Diagnostics
> Are You Sure *Y/N*

Press **Yes** to enter diagnostics.
The display will now say:

> Emax Diagnostics
> [1 - 7] / Slider

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

1. Bank RAM Test
2. ERAM Test
3. RS-422 Test
4. Wr/Ver Fl Test
5. Ver Fl Test
6. Panel Test
7. Filter Trims

1. BANK RAM TEST
This tests the bank portion of the main processor (32008) RAM. This is the same RAM that the diagnostics are running from, so this RAM probably has to be working in order to be able to test itself!

When this test is selected, the display will say:

> Testing Bank RAM

If the test passes, (as it almost certainly will), the display will say:

Testing Bank RAM
Bank RAM OK

In the unlikely event that this test fails, errors will be displayed as follows:

is 00 sb 01 ic 24
ad   0000   bank

is   =   Data read is 00
sb   =   Data should have been 01
ic   =   Probable ic # is IC 24
ad   =   Failure occurred at address 0
bank =   Bank Test

2. ERAM TESTS

This tests both banks of the E-Chip sound RAM. The test is broken into 4 parts.

a) Galpat   Loosely named for Galloping Pattern test. This test runs a 1 bit across the data lines at 8 consecutive addresses. This is intended to catch shorted lines.

b) Addrss   Runs a bit across the address lines while storing consecutively higher numbers starting at 0 (17 locations).

c) Cross   Checks for address to data line shorts (Crossed bits). Runs a 1 bit across the address lines while writing 0's as data.

d) Comb   Combs through every address of both banks with AA in one bank, 55 in the other. When it's done, the display reads, "Pass 1 OK". Then it reverses the pattern and runs again.

These tests are run in the sequence given above, and are designed to reveal the most common faults first. The first three tests run in under 1 second.

Failures are displayed as follows:

is00 sb01 bk0 ic50
 ad 000000 galpat

is	=	Data read is 00
sb	=	Data should have been 01
ad	=	Failure occured at address 0
bk	=	Lower Bank 0
ic	=	Probable IC designator is IC 50
galpat	=	Galpat Test

**Note:** ERAM failures can be E-Chip related!!

The IC number displayed usually will just give you a point to start troubleshooting if the failure occurs during the first three tests. If the failure occurs during Comb Test, swapping out the Indicated IC will probably fix the problem. Unlike the Bank Test, this is a very complete diagnostic test.

3.   **RS-422 TEST**
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 Emax. The LED's 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, 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 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 LED's, and 2 small pieces of wire. Wire the test plug as per the diagram below.
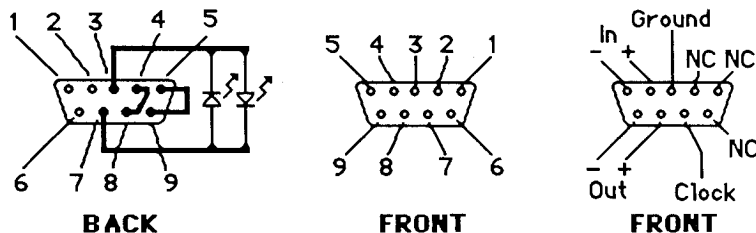
4. **FLOPPY WRITE/VERIFY TEST**
This test writes and reads worst-case data patterns in a butterfly seek pattern. It starts at the OD (outside diameter) of the disk, jumps to the ID (inside diameter), then back to 1 track In from the OD, 1 track in from the ID, etc. etc.. The display shows the number of passes, hard and soft errors.

This test is destructive to disk data, and a reminder prompt is given upon entry to the test. The test runs until the disk is removed.

5. **FLOPPY VERIFY TEST**
Requires a disk that has been run through at least one pass of the Write/Verify test (above). It runs a butterfly pattern while verifying the data as in the previous test.

ERRORS →   Pass = Test Passes
                Hard = 2 Passes Failed
                Soft   = 1 Pass Failed, 1 Pass Good

6. **PANEL TEST**
All the panel buttons will either toggle the corresponding LED or display their value on the screen if there is no LED. Pressing ENTER twice in succession, exits the test.

7. **FILTER TRIMS**
The Emax allows you to calibrate the SSM filter (Fc and Q), and stores the calibrations in the EEPROM. The Main CPU adds the calibration values in with the other control voltages. This system of calibration allows the Emax to compensate for chip differences and component aging without the need for physical trimmers. These calibrations are not very critical. Their purpose is to make all the channels basically homogenous.

NOTES
1)   "Slider' refers to data slider.
2)   Underlined words and numbers indicate a button to be pressed.
3)   "(PXX)" indicates a preset number needed for a particular test.
4)   C1 refers to the lowest key. C6 is the highest key.
5)   Watch the Emax display when executing panel functions; it often tells you helpful things or gives you instructions.

To Calibrate the Filters:
- Select preset 12. <u>Master, 8, 8, Yes, 7</u>

- Use the data slider and cursors to set all bottom row display numbers to 00.

- <u>Analog Processing. Enter</u>. Set range: play C1, <u>Enter</u>, play C6,

- <u>Enter. 1, 3.</u> Play and listen to each key in lower octave.

- Adjust Q with the slider until the loudest channel cuts off.

- <u>Master. 8. 8. Yes. 7.</u> Press to select bottom row of display.

- Play C1. This is channel 1.

- Raise the data slider until filter oscillates.

- Lower the data slider until tone cuts off.

- Repeat for each channel using D1 thru C2 to play the channel, and using < and > to select next channel entry in display.

- Press <u>Yes</u> to select Fc trim.

- Use C4 thru C5 to play each corresponding channel.

- Move the data slider to seven on the first channel.

- This will be the reference point.

- Adjust other channels to match the cutoff frequency of the first channel, using slider.

- Use the cursor buttons to access next channel entry in display.

- When all locations are filled press <u>Enter, Yes</u>.

- Play C4 thru C5 and listen for uniform Fc.

- Play G2 thru G3 and listen for uniform Q.

- Try different positions of right wheel since it controls Fc. <u>Master</u>.

POWER SUPPLY SPECIFICATIONS

POWER SUPPLY TEST
The Emax uses a KEC Switching Power Supply. We do not repair these supplies at the factory and do not even have schematics for them. If a supply is defective, contact E-mu Systems customer service at (408) 438-1921, to obtain a swap supply.

Note: Switching supplies will not operate without a load.

CAUTION: The exposed metal on the supply conducts high voltage! Do not touch the supply while it is operating.

▪ Locate CN7.

Verify +12V on orange wire.

Verify +SV on yellow wire.

Verify -l2V on purple wire.

Verify + 10V on pin 3 of Q2.

Q2 Is mounted on a black heatsink on the digital board.

▪ Locate VR1.

Measure the voltage on Input pin 3 of VR1.

VR1 is the little black box on the digital board. It Is a DC to DC converter which supplies the high voltage to the backlight on the LCD. This outputs about 200 Volts, so keep your hands away from the output pin.

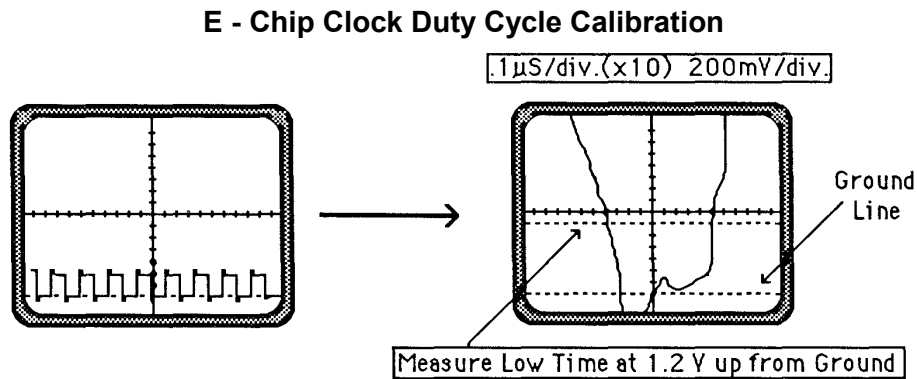Verify +5VDC +/- 5% (4.75 - 5.25) at pin 3.

TRIM PROCEDURE

E-CLOCK TRIM
Symptoms of E-Chip clock problems are: missing notes, wrong notes, crackling noises, or distortion. If alter trimming the clock, these types of problems still occur, the E-Chip may be defective.

To Calibrate:
Set up oscilloscope for 100 nS/div. and 200mV/div (or use 0.lµS/div. and pull 10x multiplier). Connect probe to IC 54 pin 12. Adjust trace position so that centerline of the scope is about one volt higher than peak of waveform. Refer to the diagram shown below.

E - Chip Clock Duty Cycle Calibration

.1µS/div.(x10) 200mV/div.

Ground Line

Measure Low Time at 1.2 V up from Ground

- While playing sequence 03 E-Circus (or any other complicated sequence), turn trimmer for minimum distortion. What we mean by distortion here is, missing notes, wrong notes, crackling noises, or distorted waveforms.
- Rotate trimmer CCW until one channel starts distorting.
- Determine period of waveform from scope and write it down.
- Play and listen while rotating trimmer CW through minimum distortion range.
- Keep turning trimmer CW until one channel starts distorting.
- Determine period of waveform from scope and write it down.
- Calculate the mid-point of the two periods.
- Adjust the trimmer to make the lower pulse width match this midpoint.
- Goop the trimmer in two places with Latex or Glypt. Use a minimum amount.

COMMON EMAX PROBLEMS

When troubleshooting the Emax, we recommend checking the power supply first. Other common sources of problems are connectors, sockets, and broken solder joints. You should also make sure that you are using the latest version of software to avoid chasing phantoms. If you suspect a software problem and you are using the latest version, contact the factory. The most frequent problems seem to be with the switching power supply and the disk drive; neither of which are normally field repairable.

Component failures seem to center around the E-Chip, and the SSM chips (especially SSM 2300).

If you get stuck on a problem, please feel free to contact our Customer Service department at (408) 438-1921. They will be happy to assist you. Telephone support hours are between 8:30 am and 5:30 pm PST Monday through Friday.

PROBLEM	CAUSE	SOLUTION
No Boot		
No lights, no power	Power supply bad or bad power connector crimp	Replace supply or fix connector.
No Boot	Bad CS PAL	Replace CS PAL
Won't load disks	Drive pulled out of alignment by mounting screws	Loosen mounting screws then re-tighten
Won't load disks	Drive out of alignment	Replace or align drive
Won't load disks	Unit has "A" Boot ROM	Update to "B", or higher Boot ROM
Won't load disks	Drive out of alignment or bad disk	Try different disks
Loads software then display goes blank	Bad Scanner MPU	Replace bad chip
Digital Distortion		
Static on some channels	Long style ribbon cable between the micro processor and output boards is picking up RF.	Tape cable loop tightly together to cancel RF effects.
Bad distortion on 1 channel	Bad 74HCT1 74 data latch	Replace bad latch
Distortion, missing notes, wrong notes when playing fast sequence or arpeggiator.	E-Chip clock not in calibration or bad E-Chip.	Calibrate E-Chip clock or replace E-Chip.
ERAM test fails but all RAM's seem good	E-Chip clock not in calibration or bad E-Chip.	Calibrate E-Chip clock or replace E-Chip.

| PROBLEM	CAUSE	SOLUTION
Analog Problems		
Clicks during loops on some channels.	Bad SSM 2300 S/H	Swap to determine bad chip and replace.
Whistling or hissing samples at 42 kHz sample rate.	Bad SSM 2300 S/H in Gain location.	Replace bad chip.
No Fc, Gain, Pan, 0 control	Bad SSM 2300 S/H	Replace bad chip.
Warbling Fc	Bad SSM 2300 S/H	Replace bad chip.
Pop on attack	Bad SSM 2047	Replace bad chip.
Pan not centered	Bad SSM 2047 or SSM 2300	Replace bad chip.
Amplitude variations between channels	Bad SSM 2047 or SSM 2300	Replace bad chip.
Slow decay even when decay is set to zero	Bad Germanium diode in envelope filter circuit	Replace bad diode.
Mushy attack even when attack is set to zero	Bad Germanium diode in envelope filter circuit	Replace bad diode.
Keyboard Problems		
Single key drones or has no slow velocity	Key contact spring needs adjustment	Adjust contact spring with nylon screw.
Low C key clicks	KYBD not shimmed correctly	Install shims on end of KYBD to correct.
Other		
Slider doesn't work	Broken solder joint at pot	Resolder or replace pot
Slider or wheels don't work	Emax needs recalibration	Recalibrate wheels and sliders

E-MAX FUNCTIONAL TEST PROCEDURE

OVERVIEW
This functional test procedure is very similar to the E-mu factory final test for a new Emax. A functional test can be performed to verify that a problem exists or as a final test to verify that the unit is working perfectly before you return it to your customer. Instruments to be serviced should be thoroughly tested beforehand. This will verify that a malfunction has indeed occurred; perhaps reveal related or unrelated malfunctions and provide a basis for troubleshooting. When performing these tests, remember to play all 8 channels. Most of the tests are performed by ear, so you will need at least one of these in addition to the equipment listed below.

Equipment needed:
- Amplifier and headphones
- 2 mono audio cables
- MIDI cable
- Sample source
- Sync source
- Footpedal simulator
- Footswitch
- MUST disk (Version 2.3 or higher)
- Scratch diskette

CONSTRUCTION OF THE FOOTPEDAL SIMULATOR

To test and calibrate Emax's footpedal input, either a footpedal (voltage or resistance type; see Interface Specification), or a footpedal simulator is required. The construction of a footpedal simulator is described below.
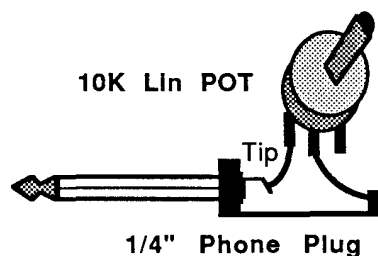
NOTES

1) "Slider" refers to data slider.
2) Underlined words and numbers indicate a button to be pressed.
3) "(PXX)" indicates a preset number needed for a particular test.
4) C1 refers to the lowest key. C6 is the highest key.
5) Watch the Emax display when executing panel functions; it will often tell you helpful things or give you instructions.

SET-UP

Plug audio cables into the left and right output jacks. Verify the 110/220 V switch is in correct position. Boot the MUST disk. (P13) Verify the output by playing first 2 octaves. Play C2 eight times, to verify all 8 voices are working.

FUNCTIONAL PROCEDURE

Step 1 : Recalibrate Wheels, Pressure, Footpedal, and Sliders

- Master. 8. 4. 1.
- Move left wheel for minimum post value in display. Enter.
- Rotate left wheel for maximum value. Enter.
- Return left wheel to center position. Enter. Yes. Enter.
- Position right wheel for minimum value. Enter.
- Rotate right wheel to maximum value. Enter. Yes. Enter.
- Press key hard and hold. Enter.
- Press key softly. Enter.
- Release key. Yes, Enter.
- Plug in footpedal simulator.
- Move simulator to minimum value. Enter.
- Move to maximum value. Enter. Yes. Enter.
- Move data slider to minimum position. Enter.
- Move data slider to maximum position. Enter. Yes. Enter.
- Move volume slider to minimum position. Enter.
- Move volume slider to maximum position. Yes. Master.

Note: Pressure is not implemented, but pretend that it is.

Step 2 : Function Check

- Select (P03)
- Play the keyboard and check volume fader.
- Select (P00)
- Play G1 and move the left wheel.
- Verify pitch change.
- Return pitch wheel to center position.
- Preset Definition. 9.

- Play G1 repeatedly while pushing <u>1,0</u> and <u>1,1</u>
- Listen and verify no pitch change.
- <u>Preset Definition, (P01).</u>
- Play G1 and move the right wheel.
- Listen for a change in tonal quality.

Step 3 : Pan, Mono Out, Channel and Stereo Outputs Check

- Select (P11)
- Play G2 and verify sound moving left and right.
- Remove the left audio plug.
- Verify constant output on right side.
- Play G1 thru G2 to check all eight channels.
- Remove right audio plug and check each channel output jack.
- Remove right audio plug.
- Plug headphones into Left/Stereo jack.
- Play C1 thru B1 to silence all but one channel.
- Listen for panning.
- Remove headphones and reconnect audio cables.
- Play C2 to silence all channels.

Step 4 : Loop Check

- Select (P06)
- Play B1 eight times.
- Select (P07) Play B1 eight times.
- Select (P08) Play B1 eight times.
- Select (P09) Play chromatic scale across entire keyboard.

Step 5 : Truncate and Loop Check

- Select (P06)
- <u>Digital Processing. Enter. 1.</u>
- Play G1.
- Move slider until start number is around 5000.
- Play G1 and listen to verify "loop" changed to "oop".
- Press cursor <u>></u>.
- Move slider to bottom position and verify no sound.
- Play G1 repeatedly and slowly move slider up.
- Notice click sound changes to "uh', then "ou", and then 'oop".
- Leave slider at max. <u>Enter. Yes. 2.</u>
- Play G1 and listen for "ioop".
- Move the slider until the length is about 5000.
- Play G1 and listen for a rapid "ou" loop.
- Press cursor <u><.</u>

- Play G1 while moving slider up and listen to the loop starting point.
- Verify that the starting point advances.
- <u>Digital Processing.</u>

Step 6 : MIDI Check

- Select (P01)
- Connect a MIDI cable between MIDI In and Out jacks.
- Play G2 and hold it down.
- Unplug one end of MIDI cable and release G2.
- Verify the note is still playing.

Step 7 : Sync Check

- <u>Play</u>
- Verify sequence plays.
- Turn amp volume down.
- Briefly insert one audio cable into Clock Out jack and listen for buzzing sound.
- Press <u>Stop</u> twice. <u>Manage. 2.</u>
- Move slider up to select click 24 - external sync.
- The Emax is waiting for sync input.
- Connect Clock Out (from Drum Box or signal generator, see Interface Specifications) to Clock In on the Emax.
- Sequence should start.
- Vary external clock tempo thru full range.
- Verify sequencer follows tempo changes perfectly thru full range.
- Unplug sync input.
- Sequence should stop.
- Press <u>Stop</u> twice.

Step 8 : Panel and Footswitch Check

- <u>Master. 8. 6, Yes. 6.</u>
- While watching display and LED's, check all buttons except Enter and Transpose.
- Plug In footswitch and check both Footswitch jack Inputs.
- Push <u>Enter</u> twice.

Step 9 : Memory, RS422, and Disk Test

- <u>Master. 8. 8. Yes.</u>
- Perform the following diagnostic tests:

    1. RAM Test
    2. ERAM Test.
    3. RS422 check. Use RS-422 test plug.
    4. Write and Read Disk Test.
       Be sure to use scratch diskette for test disk.
       Eject disk alter 8 seconds to stop test.
       Verify no errors indicated in display.
    5. Floppy Verify Test.
       Perform after Write and Read Disk Test.
       Watch display for errors.

Step 10 : Sample Check

Note: A 0dB gain setting should be used when sample quality is in question.

- Press <u>Master, 4</u> to erase memory.
- <u>Sample, 3.</u>
- Move slider to max to select 42kHz. <u>4.</u>
- Use slider to select 12.4 seconds. <u>1.</u>
- Select +40dB.
- Connect sample source and check display for no overload.
- Push to sample.
- Play the sample for its entire duration, and listen for distortion and noise.

Step 11 : Final Check

- Boot up the Emax.
- Insert the Piano disk.
- Select a preset without velocity control, and listen to each key using a soft touch.
- Verify uniformity across keyboard.

Step 12 : Shake Test.

- Reassemble the Emax, and verify there are no loose parts.

M.U.S.T. DISK

The M.U.S.T. disk (Max Universal Sound Test Disk) is provided to facilitate easier and more thorough functional tests and troubleshooting. The disk contains various presets, which have Emax parameter set-ups programmed into them. When used in conjunction with the Functional Test Procedure, the M.U.S.T. disk provides a very complete test of Emax functions. We recommend that you play other disks (such as the Piano) in addition to the M.U.S.T. disk after performing your functional test in order to make certain that the unit is problem free.

Note: It is a good idea to keep your M.U.S.T. disk updated with the most recent version of software so that you won't have to worry about software problems while doing your functional test.

M.U.S.T. PRESETS

PRESET	TITLE	FUNCTION	PLAY
P00	PITCH WHEEL	Tests operation of Spring Wheel	Low Octave
P01	MOD WL	Tests operation of Right Wheel	Low Octave
P02	FILTER Fc	Filter Fc on Right Wheel	Low Octave
P03	FILTER Hi Q	Filter in full Resonance	Low Octave
P04	FILTER Mid Q	Filter in mid Resonance	Low Octave
P05	PANNER Mid Q	Tests Panning function	Low Octave
P06	LOOP	Tests Loop function	Low Octave
P07	BACKWARD	Tests Backward Loop function	Low Octave
P08	CHORUS	Tests Chorus function	Low Octave
P09	FULL /	Test to make sure a Key plays before it reaches bottom of travel.	Full KYBD
P10	PEDAL	Tests Control Pedal Input	Low Octave
P11	CHANNEL Chek	Play 8 notes and check individual outputs.	4 Octaves
P12	Q & Fc Trim	Simplifies 0 & Fc Trim.	4 Octaves
P13	sine.997.44s	IkHz Sinewave	MiddleC
P14	sine 50.27sh	50 hz Sine wave	Middle C

P15[1]	sine 8k 44sh	8kHz Sine wave	Middle C
P17	Sample Now!	Sample Test	Low Octave
P18	AmbiantVibe	VibeSample	Full KYBD

M.U.S.T. SEQUENCES

SEQUENCE	TITLE	DESCRIPTION
S01	Theo's Mood	Tech Tune
S02	Down the River	Tech Tune
S03	E-Circuz	Tech Tune
S04	Silent Temple	Tech Tune
S05	Scale	Automatic Scales
S06	Channel Check	Holds Keys down
S07	Pan Test	Automatic Pan Test
S08	LOOP Test	Automatic Loop Test
S09	Backtest	Auto. Backwards Loop Test
S10	Chorus Test	Auto. Chorus Test

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[1] The original manual does not mention a preset 16