Getting Started with MCE

With Trouble-Shooting and Maintenance Guides

Revision History

Rev.	*Date*	*Who*	*Description of change*
1.0	2005	EL	Initial release
1.1	2006	BB	Added a section on how to trigger the MCE with Data Valid pulses. (Committed to CVS, the equivalent version on the Physics server is v1.3.)
1.2	2006	MA	Added section 5.2, updated section 5.1 and 8.2.
1.3	2006	BB	Added a note about un-mating the MDM connectors, to prevent the mating screw from seizing.
1.4	2006	BB	Moved all the non-hardware related topics to "MCE User's Guide" and renamed this file "MCE Hardware Manual."
2.0	20070627	MA	Taken from MCE Hardware Manual 1.4. (This document was originally released as MCE-Users's Manual and then MCE Hardware Manual.) added header and footer updated table 2.1 and corrected heater/tes bias updated power consumption in section 4.1 updated section 4.2 by mce_check script
2.1	20070629	TF	Deleted PSC references and converted to PSU with ACDCU. Updated pictures.
2.2	20071010	BB	Added a section on using Quartus to reprogram the MCE with new firmware.
2.3	20080110	MA	Updated TOC, header date and minor changes to section 4.2
2.4	20080522	MA	Updated fiber connection, cheater plug, section 3.2, 3.3, 4.2

Table of Contents

1. Introduction

The purpose of this manual is to familiarize the user with the installation of the Multi-Channel Electronics hardware. This manual presents a logical progression of steps required to setup the MCE, starting from installation of the MCE subrack on the cryostat, to verification of the installation, and finally to troubleshooting. The intended audience of this manual is an operator with minimal technical background.

2. Overview of the MCE

Each MCE subrack has ten slots containing the electronics cards designated as in the figure below.

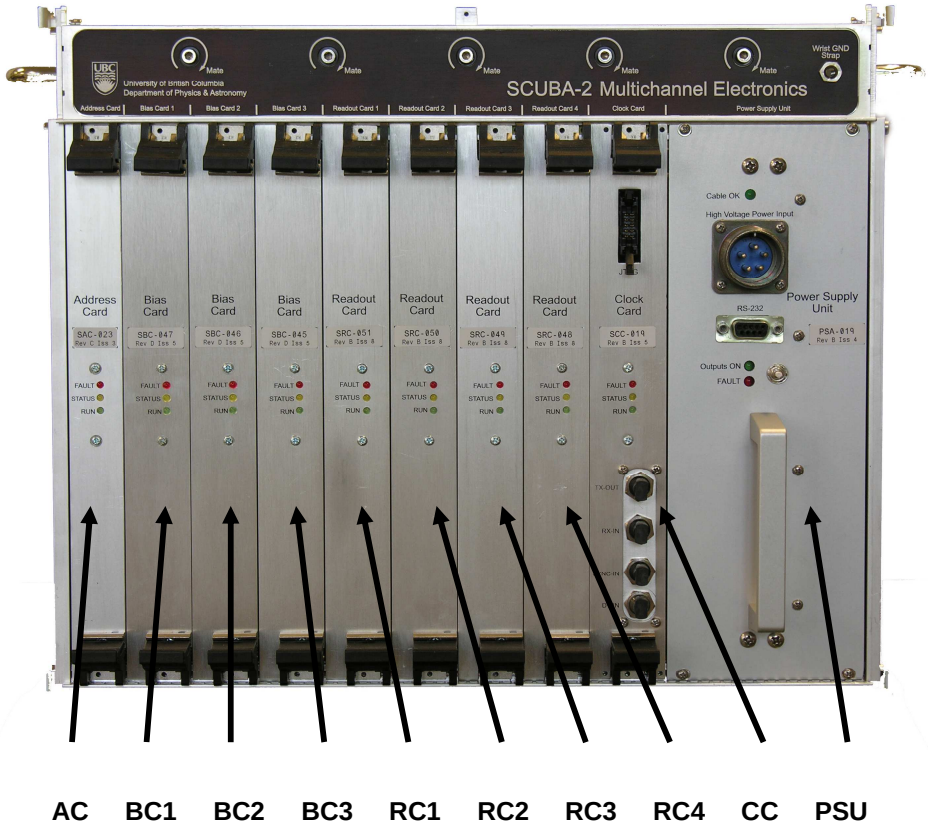


Figure 2.1 MCE subrack with switching power supply card.

The Power Supply Unit connects to the ACDCU which supplies +/-150DC. The PSU converts this into lower voltages required by the MCE electronics. A linear power supply feed card is also available but this card only provides a connection for the external linear supplies to the MCE.

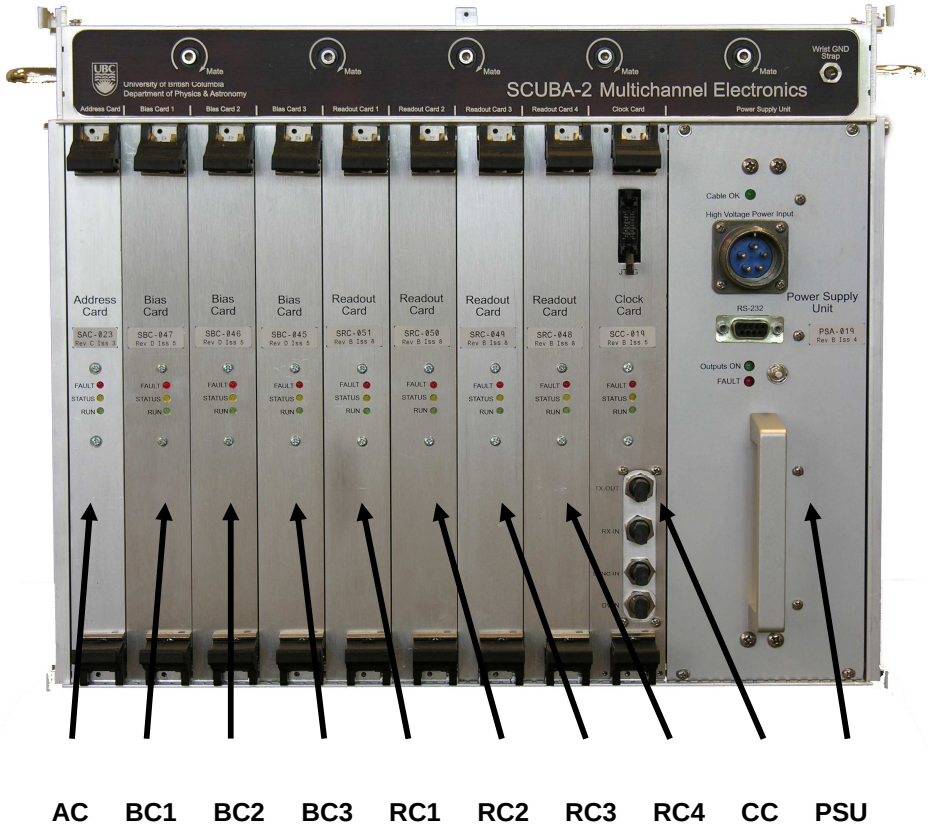


Figure 2.2 MCE subrack with external-linear power supply card.

The address card, bias cards and readout cards process the signals to/from the cryogenic imaging sub-arrays. The clock card coordinates the signal-processing cards and provides the interface to the RTL PC.

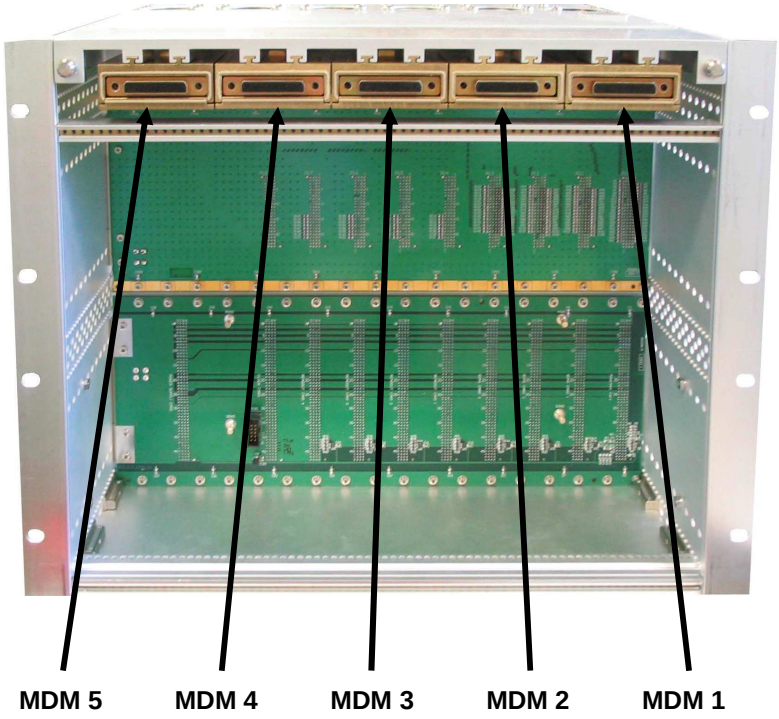


Figure 2.3 MCE subrack, rear view with MDM connector numbering indicated.

Connections from the signal-processing cards to the cryogenic arrays are accomplished through five MDM connectors as designated in the Figure 2.3 above.

The signal-processing cards are connected to the MDM connectors as follows:

MDM 5	MDM 4	MDM 3	MDM 2	MDM 1
RC4 S1_FB[31:24] SSA_SIG[31:24]	RC3 S1_FB[23:16] SSA_SIG[23:16]	RC2 S1_FB[15:8] SSA_SIG[15:8]	RC1 S1_FB[7:0] SSA_SIG[7:0]	AC all signals S1_Bias [41:0]
BC1 SSA_FB[31:24]	BC1 SSA_FB[23:16]	BC1 SSA_FB[15:8] BC2 Detector Bias	BC1 SSA_FB[7:0]	
BC2 S2_FB[31:24]	BC2 S2_FB[23:16]	BC2 S2_FB[15:8]	BC2 S2_FB[7:0]	
BC3 S2_Bias[31:24]	BC3 S2_Bias[23:16]	BC3 S2_Bias[15:8] BC1 Heater	BC3 S2_Bias[7:0]	

Table 2.1 MDM connector signals

Production subracks will have no screens on the top and bottom, while prototype subracks will have a top cover equipped with three fans and four support legs to facilitate airflow.

The operation of the MCE is coordinated by the RTL PC. The RTL PC software will refer to the cards by their designations from Figure 2.1. Please refer to the RTL PC software documentation for its features, set-up, and operation [1].

3. Installing the MCE

This section describes how to complete the mechanical and electrical installation of the MCE.

3.1 Mounting the MCE on the Cryostat

Parts and Tools Required:

- 8 x M6x16 mm hex head cap screws
- 1 x 5mm ball driver
- 1 x Torque wrench
- 1 x 3mm hex driver bit for torque wrench

Instructions:

1. Prior to mounting the subrack check that the five 100-pin MDM connectors are retracted so there is no interference when the subrack is mounted. The no interference position of these five connectors is when the connector is not extended past the mounting surface of the subrack. We also recommend that you test the connections to the MDM connectors on the cryostat wall before mounting the MCE.

2. Have the M6 screws within easy reach. Align the subrack locator pins with the corresponding holes on the cryostat wall. *Gently* press the subrack into position. Install M6x16mm screws (8 pieces) and tighten. Figure 3.1 shows the locations of the mounting holes. Note that the other four mounting holes are located on the opposite side.

Figure 3.1 Fully-populated subrack with mounting holes highlighted.

3. Mate the cryostat connectors by turning the mating screws clockwise. The mating screws are located on the front of the MCE, near the top edge. Use the torque wrench to torque the screws to 5 inch-pounds (56.49 Newton-centimetres). *Important: when dismounting the subrack, be sure to retract the MDM connectors first. Four counter-clockwise turns of the mating screws are sufficient to un-mate the MDM connectors entirely. If you do more than 4 turns, the mating screw may bottom out and seize in the MDM-connector box's tapped bore.

3.2 Connecting the MCE to the PCs

Parts and Tools Required:

- 1 x duplex fibre-optic cable for connecting the MCE to the data-acquisition PC.
- A PC with a PCI Arc-64 card that has data-acquisition software installed.
- (optional) 1x duplex fibre optic cable for connecting the MCE to the Sync box
- (optional) 1 x Altera ByteBlasterMV or USB-Blaster cable
- (optional) 1 x parallel port or USB extension cable (if needed)
- (optional) A Windows PC with Altera Quartus Software installed.

Instructions:

1. Inspect the fibre-optic cable for any damage such as kinks in the fibre, loose connectors, or damage in the cable jacket. If there appears to be any damage, replace the cable. Note that as an industry standard, fibres are marked with "A" at one end and "B" at the other end , e.g. RX at one end and TX at the other end. Sometimes they may be color coded.

2. Connect the PC and the MCE with a pair of fibres. On the PC side, the fibre is connect to the connectors on the PCI card in the back of the PC. On the MCE side, the fibre is connected to the connectors labelled as RX-in and TX-out.

   The red LED being "ON" on the clock card of the MCE indicates lack of signal either due to cables being swapped or PC being off.
   The red LED being "ON" on the back of the PC indicates lack of signal either due to cables being swapped or the MCE being off.

   Note that the connectors are keyed. If it does not fit, rotate the connector until it mates. Also note that the connectors are spring-loaded and must be stretched and rotated clockwise in order to lock the connector. Repeat process to connect the other end of the fibre to the SDSU card.

3. Connect the MCE to the Sync Box (not shown in Figure 3.2). Connect one end of the fibre to one of the connectors labelled as mce0 to mce7 in the back of the Sync box. Connect the other end to the connector labelled as Sync-in on the MCE. When the Sync box is connected and on, the yellow LED on the MCE goes off.

4. Connect the 2x5-pin female header on the ByteBlasterMV or USB-Blaster cable to the 2x5-pin male header on the clock card.

   Note: The connector is keyed. If it does not fit, *do not force it*! Calmly rotate the connector π radians and try again.

5. If you are using a ByteBlasterMV cable, connect the 25-pin male connector to the parallel port of the Windows PC. Use the parallel port extension cable if necessary. If you are using a USB-Blaster cable, connect the A (rectangular) end of the USB cable to the PC and the B (square) end to the receptacle on the USB-Blaster.

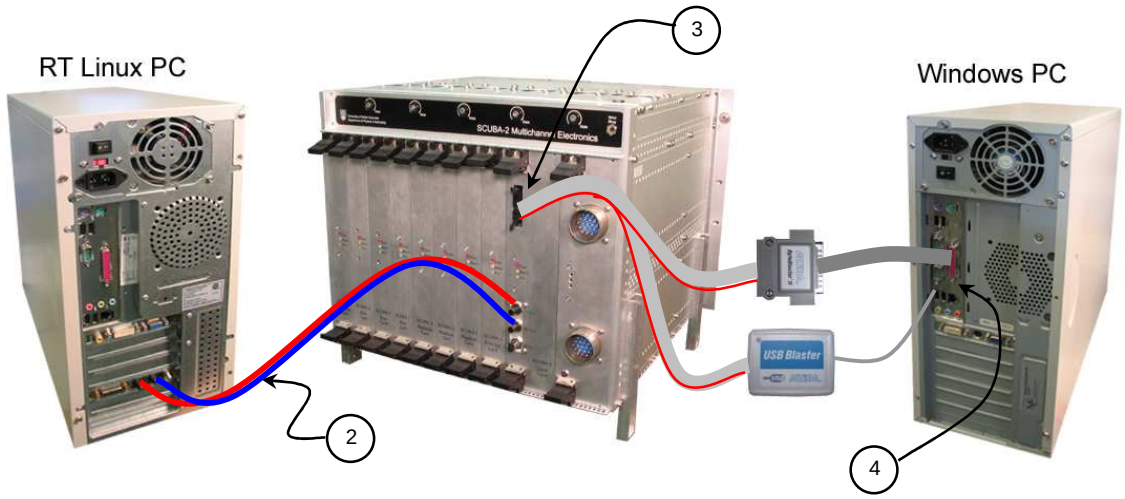


Figure 3.2 Connections to the Data Acquisition and Windows PCs. (Note: Only one of ByteBlaster or USB-Blaster should be used.)

3.3 Connecting the MCE to the AC-DC Converter Unit

Parts Required:

- 1 x ACDCCU power supply cable SC2-ELE-S580-170
- 1 x ACDCCU Cheater Plug SC2-ELE_S580-106 (replaces Sync Box) (Fig. 3.3)
- 1 x Synchronizer Box SC2-ELE-S589-101 (optional)
- 1 x Synchronizer Box Cable SC2-ELE-S580-171 (optional)

This method of powering the MCE uses the AC-DC Converter Unit. AC-DC Converter Units are designed to provide power to a pair of MCE subracks using 1 cable for each MCE subrack. A single channel AC-DC Converter Unit is also available for lab use to power a single MCE subrack. The AC-DC Converter Unit must either be connected to a Synchronizer Box or have a dummy plug installed in the control input connector.

Instructions:

1. Connect the power cable from the wall outlet to the ACDC Converter Unit.

2. Connect the power supply cable between the MCE and the ACDCU. Note 2 pins are short and mate last and disconnect first. This is a safety feature to ensure that there is no voltage on the cable when the voltage pins are disconnected.

3. Connect the “cheater plug” to the control input connector if you are going to turn the ACDCU on and off manually.

   If you want to remotely turn on/off the ACDCU through the Sync Box, then use the Sync-Box-to-ACDCU control cable to connect the ACDCU to one of the 8 ACDCU0 to ACDCU7 connectors in the back of the Synchronizer Box.

4. Connect the fan power supply cable from the external power supply to the fan power connector located on the top panel of the MCE.

Figure 3.3 Cheater Plug for ACDCU

3.4 Connecting the MCE to the Linear Power Supply

Parts Required:

- 2 x DC power supply cable
- 1 x fan power supply cable
- 1 x power cable

Instructions:

1. Connect the power cable from the wall outlet to the external power supply.

2. Connect both DC power supply cables from the external power supply to the power supply card in the MCE.

3. Connect the fan power supply cable from the external power supply to the fan power connector located on the top panel of the MCE.

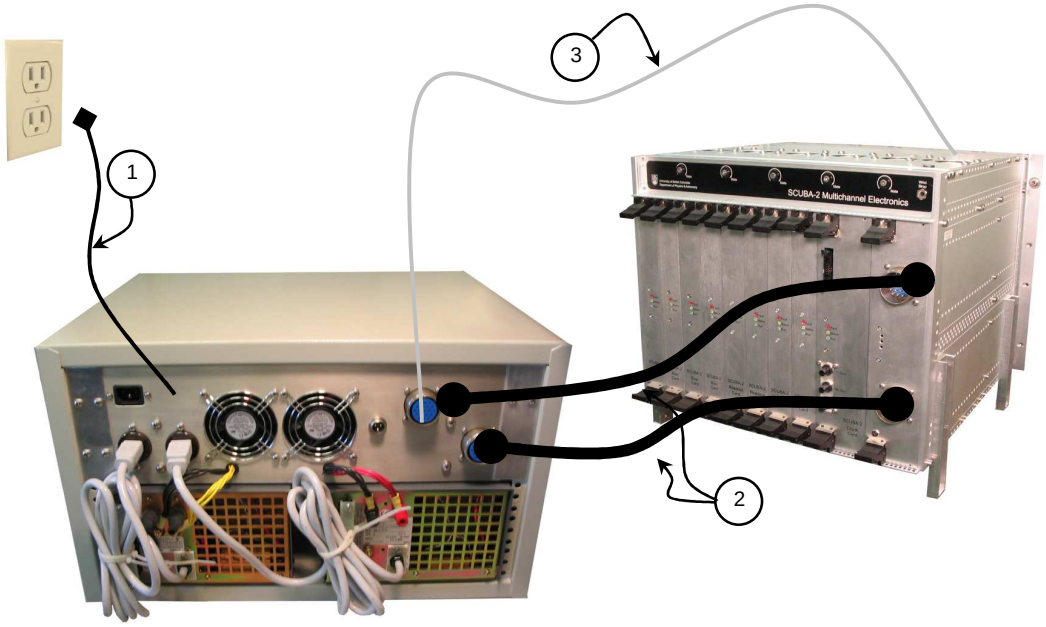


Figure 3.4 Power connections to external linear power supply. (Note: PC connections not shown.)

4. Verifying the MCE Installation

This section describes how to verify that the MCE has been set-up correctly, that the instrument firmware has been automatically loaded, and that the MCE is functioning normally.

4.1 Power-Up Check

MCEs are fully tested at the factory before shipping. These tests include continuity checks of the MDM connector signals, and functionality of all the cards with an RTL PC. We recommend that the connections to the MDM connectors on the cryostat wall be pre-tested before installing the MCE.

Once the MCE is installed, follow this procedure to verify that the MCE was received and installed in good order:

1. If you are using the ACDCCU and PSU, turn on the ACDCCU and verify that the green LED on the PSU is illuminated.

   If you are using individual external linear power supplies, turn on the supplies in the following order: +4.5VD, +5.0VD, +6.7VA, -6.7VA, +12.0VA, +2.7VD. The most important feature of this sequence is that the +2.7VD (FPGA Core Voltage) is turned on last, otherwise the FPGAs may not configure properly.

   With a fully populated subrack (with all cards present), you can expect the following power consumption:

Supply Voltage (V)	Power Consumtion (Watts)
+5V	0
+2.7V	12.5
+4.5V	6.8
12.0VA	0.8
+6.7VA	90
-6.7VA	9

Table 4.1 MCE Power Consumption

2. Immediately check to make sure that the fans on the top cover are running, if your MCE is so-equipped. If not, turn off the power (ACDCCU, or the external power rack toggle switches in any order although right to left is preferred) and check the fan-power connections.

3. If you should see black smoke emanating from the MCE, *immediately* switch off the power supply. This indicates that a component has shorted and the resulting high current has started to melt the IC packaging. If, on the other hand, you see white smoke, do not be alarmed as this is usually dust trapped in the MCE that was expelled by the fans.

4. When you first power on the MCE, a series of red LEDs on each card are on, after a few seconds, the red LEDs go off and green LEDs are turned on indicating that firmware is loaded to all FPGAs.

5. The MCE may now be tested through the RTL PC. Or, it may be turned off by shutting off the ACDCCU, or shutting down the external power rack toggle switches in any order, although a right-to-left shutdown sequence is preferred.

Should the mating of the MDM connectors be in question, the instrumentation bus tester may be used in each signal-processing card slot to verify connectivity to the subarrays. Please take care and electrostatic discharge precautions whilst handling the cards, and refer to the IBT manual for instructions [2].

4.2 Running System-Level Test on MCE

Now you can control the MCE through the PC by issuing commands and running test scripts to evaluate the health of your MCE.

Starting the MCE Acquisition Software on PC

Be sure that the MCE and the acquisition PC are linked with a duplex fibre-optic cable. Power on the MCE and if needed configure the MCE with the correct firmware (see Appendix B: "Upgrading MCE Firmware").

The MCE is controlled via commands issued through the acquisition software running on the PC. Please refer to [1] and [2] for detailed descriptions of the communications protocol and list of commands. The following section assumes MAS acquisition software is installed on your PC:

- Log on to the PC as "mce"
- In order to create a data directory for today's tests, in a terminal window type:
  `>set_directory`

Now there is a directory in /data/cryo/current_data where the test results for today will be stored.

Issuing Commands to the MCE

The following section assumes MAS acquistion software is installed on your PC. For information about MAS, see the wiki. For a list of MCE refer to "MCE Command Description" on MCE Command Description.

You may read and write different parameters of the MCE. To read the offset value of a readout card, type:

```
>mce_cmd -x rb rc3 offset
```

where:

`mce_cmd`	is the name of the software utility that executes the command
-x	execute the remainder of the line as an MCE command.
`rb`	stands for read
`rc3`	is the target card that the command is issued for
`offset`	is the name of the parameter

You can find out more about mce_cmd by typing:

```
>mce_cmd -h
```

To modify the row length value:

```
>mce_cmd -x wb sys row_len 128
```

Another way to issue commands to MCE is to make a batch file and include a list of commands and then execute the batch file by calling mcebatchgo. This batch file has to be under das/configfiles directory.

For example, you may create a batch file called "temp.bat" that contains the following commands:

```
rb rc3 offset
wb sys row_len 64
```

To run the batch file, type:

```
>mce_cmd -f temp.bat
```

Note: The collection of scripts located in $MAS_SCRIPT directory are designed to control the MCE and facilitate the basic operations of MCE. A brief description for each script is also provided in the wiki.

Running a Test Script

You may now proceed to verify the overall health of your MCE by running a test script. This test script checks whether the communication link between the RTL PC and the MCE is reliable and that the MCE firmware is operational. The test is interactive and goes through following steps:

- toggles the faceplate LEDs.
- Records firmware revisions of all cards
- Records temperatures of all cards
- Records electronic Ids of all cards
- Records voltage/current draws
- acquires several data frames and verifies them.

Run the test script by typing the following at the command prompt:

```
>mce_check
```

The results are saved in `filename` in $MAS_DATA directory which is typically set to /data/cryo/current_data

```
mandana@mce-act-a2:~/mce_script/trunk/test_suite$./mce_check
./mce_check run under MAS on Thu May 22 13:20:32 PDT 2008
watch the LEDs flash

ac fw_rev  0x2000005
bc1 fw_rev  0x1040001
bc2 fw_rev  0x1040001
bc3 fw_rev  0x1040001
rc1 fw_rev  0x4000006
rc2 fw_rev  0x4000006
rc3 fw_rev  0x4000006
rc4 fw_rev  0x4000006
cc fw_rev  0x4000009
-------------------------------------------------------------------
ac fpga_temp  14
bc1 fpga_temp  25
bc2 fpga_temp  25
bc3 fpga_temp  28
rc1 fpga_temp  32
rc2 fpga_temp  34
rc3 fpga_temp  33
rc4 fpga_temp  33
cc fpga_temp  76
-------------------------------------------------------------------
ac card_temp  24
bc1 card_temp  24
bc2 card_temp  24
bc3 card_temp  24
rc1 card_temp  28
rc2 card_temp  28
rc3 card_temp  28
rc4 card_temp  26
cc card_temp  24
-------------------------------------------------------------------
ac card_id  12002161
bc1 card_id  17479857
bc2 card_id  17472657
bc3 card_id  17505530
```

```
rc1 card_id  17497557
rc2 card_id  17499096
rc3 card_id  17496123
rc4 card_id  17512731
cc card_id  9664016
```

```
ac slot_id  0
bc1 slot_id  1
bc2 slot_id  2
bc3 slot_id  3
rc1 slot_id  4
rc2 slot_id  5
rc3 slot_id  6
rc4 slot_id  7
cc slot_id  8
*************************
ac card_type  0
bc1 card_type  1
bc2 card_type  1
bc3 card_type  1
rc1 card_type  2
rc2 card_type  2
rc3 card_type  2
rc4 card_type  2
cc card_type  3
*************************
card_id         00936433
PSUC firmware version    3.2
TEMP1 (PSUC)            32 C
TEMP2 (PSU)             32 C
TEMP3 (HS)              35 C
V_VCORE         3425 units      ( 3.43V)        Nominal  3.00
V_VLVD          3196 units      ( 4.81V)        Nominal  4.50
V_VAH           2997 units      (10.04V)        Nominal 10.00
V_VA+           3029 units      ( 6.28V)        Nominal  6.20
V_VA-           3187 units      ( 6.62V)        Nominal  6.20
I_VCORE         739 units       ( 3.85A)        Nominal 13.00
I_VLVD          893 units       ( 1.43A)        Nominal  4.00
I_VAH           1325 units      ( 0.08A)        Nominal  0.15
I_VA+           2393 units      (14.38A)        Nominal 15.00
I_VA-           1576 units      ( 1.26A)        Nominal  2.00
This is mce_cmd version MAS/act/218M
Line   0 : ok
Processed 0 lines, exiting.
RUNFILE_NAME=/data/cryo/current_data//.tmp.data.run
FRAME_BASENAME=/data/cryo/current_data//.tmp.data
MCE information collected and simple data acquisition test Passed!
```

5 Troubleshooting the MCE

Symptom	Probable Cause of Error (see below)																											
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
The PSU front panel LED is not on.					✗	✗	✗																					
The cards' green and yellow LEDs do not all illuminate on power-up.										✗	✗																	
MCE front panels are hot to the touch.												✗	✗	✗														
Power supply makes a hissing noise.								✗	✗																			
MCE appears to execute a command, RTL reports timeout.																		✗							✗			
Data file is empty.																			✗	✗								
Data file contains unexpected or invalid data.																			✗		✗	✗	✗	✗				
Card cannot be fully inserted.			✗	✗																								
MCE does not mate easily to cryostat mounting plate.	✗	✗																										
Quartus Error Messages																												
"Unable to scan device chain."					✗	✗	✗								✗	✗	✗											
"Conf_done failed to go high."																	✗											
"Can't configure device. Expected JTAG ID code…but found JTAG ID code…"																	✗											
"Can't access JTAG chain."					✗	✗	✗								✗	✗	✗											
"Programming hardware cable not detected."															✗	✗	✗											
"Device chain in chain descriptor file does not match physical device chain…"					✗	✗	✗								✗		✗											
RTL Error Messages																												
"Timeout waiting for MCE/SDSU…"					✗	✗	✗											✗	✗						✗			
"Failed to locate parameter…failed to call mcexml_translate"																										✗		
"Error parsing XML file…failed to call mcexml_readXML"																											✗	
"Error – MCE is still in an application"																												✗

5.1 List of Probable Causes of Error

1 Filter boxes not fully retracted

The brass RF filter boxes must be fully retracted using the hex-socket drives on the front panel of the subrack before mating to the cryostat mounting plate. Failure to do so will make it almost impossible to mate the subrack to the cryostat, or even cause severe damage to the MDM connectors.

2 Cryostat mounting plate is faulty

The tolerance for the mounting plate to subrack mechanics is about 0.25mm. If the mating parts have incurred any damage or distortion, mating will be difficult and potentially damaging to the MDM connectors. Carefully inspect the mechanics and contact the UBC Physics and Astronomy SCUBA-2 team if you have any doubts about the integrity of these parts.

3 Card has fallen off the guide rails

The subrack has been fitted with card-guide stiffening bars to reduce the chances of a card slipping out of the guide rails; however, it can still happen. Under no circumstances force the card if it does not slide smoothly into the card slot. It may be interfering with chassis structures or with the adjacent card. Carefully remove the card and inspect the card guides and backplane connectors for the card slot before reattempting to insert the card. See also probable cause #4, below.

4 Ejector latches closed while inserting card

During the final 5mm of card insertion, the open ejector latches will normally engage the subrack. However, if the latches have been closed prior to engaging, they will bind against the subrack and prevent final mating of the card. Retract the card slightly and ensure the latches are open, then the card should slide smoothly until the latches engage--then close the latches to mate the backplane connectors. If there is any resistance, do not force the card, as doing so could cause severe damage to the MCE. See also probable cause #3, above.

5 MCE not powered on

Check that either a cheater plug is installed at the Control Input Connector of the ACDCCU or a Synchronizer Box is connected and powered on.

6 The power supply is not plugged in

Check to ensure that all the switches of the linear power rack are in the “on” position. If you are using the ACDCCU and PSU ensure that the power cable is fully mated. Check that the Cable OK and High Voltage On LED are illuminated on the ACDCCU.

7 The linear power supply or power supply unit is faulty

If the MCE does not receive power despite the cables being attached and the power supply being switched on, there may be open fuses in the power supply. Refer to the power supply manual and check the fuses, but do not replace the fuses until you have determined the cause for the overload. Under no circumstances replace a fuse with one of a higher rating or slower response characteristic.

In the event that the fuses are alright, then the power supply may have failed internally. Contact the UBC Physics and Astronomy SCUBA-2 team in this case.

8 Fan bearings are failing

Ventilation fans may begin to make hissing, groaning or grinding sounds as their bearings dry out and begin to fail. Try to ascertain which fan is making the noise, but be careful when placing your ear close to

it as the noise may really be from a snake (see probable cause #8, below). Power off the power supply, and place a pen or pencil in the suspect fan to prevent it from turning, and then turn on the power supply momentarily. If the noise is no longer present, the stopped fan requires servicing or replacement. Do not leave the power supply on for more than 30 seconds with a fan stopped. If a fan has failed entirely (i.e. it does not turn at all) then continuing to operate the power supply could result in catastrophic failure due to overheating – do not run a power supply under such a condition.

9 Removed

10 Power supply turned on in wrong sequence

The cards' FPGAs will automatically configure only if the LOGIC voltage (+4V5d) is switched on before the CORE voltage (+2V5d). Make sure you activate the linear power rack's toggle switches in the correct sequence, as indicated on its front panel. If you are using the PSC and 24V power unit, the sequencing is automatic and this diagnosis does not apply to your problem; in this case, see probable cause #11, below.

11 Instrumentation firmware not loaded into cards

The MCE cards were pre-loaded with instrumentation firmware and should automatically configure and illuminate their red, yellow and green front-panel lamps a few seconds after power-up. Should this not occur, the affected card(s) may have been reprogrammed with different firmware. Follow the instructions in this manual for programming the configuration devices to restore the instrumentation firmware.

12 Subrack fans are not powered

The prototype subrack is fitted with six ventilation fans, and these are essential for the proper operation and survival of the MCE. Check that these fans are powered through the grey cable (see the Installation section) and that they are moving air. If not, immediately shut off the power supply to the MCE and remedy the non-operational fan(s) before continuing to use the system. See also probable cause #13, below.

13 Restricted airflow through subrack

The prototype subrack is fitted with legs to ensure adequate airflow in case it is placed on a flat surface. A production subrack only has top and bottom screens, and no fans or legs. Adequate airflow *must* be provided or the MCE will overheat and be severely damaged. If the MCE is hotter than usually, then check the airflow immediately.

14 Readout cards normally generate large quantities of heat

The metal surfaces of the subrack will be warm under normal operation. The front panels of the readout cards will be almost uncomfortable to touch for more than five seconds at a time – this is normal. However, no part of the MCE should be hot enough to cause a reflex upon contact.

15 ByteBlaster/USB-Blaster is not connected

Ensure that both the computer end (parallel or USB cable) and subrack end (ribbon cable) end of the Altera programming adapter (“ByteBlaster” or “USB-Blaster”) are connected. If in doubt, disconnect and reconnect the cables.

16 Incorrect parallel or USB port settings

The PC you are using may have parameters in its BIOS or operating system that enable or disable, or set special modes, for the parallel or USB port. Check these parameters for inappropriate values.

17 MCE JTAG chain has encountered an error

Occasionally, a bit error may occur in the JTAG chain. When this occurs, the MCE and/or Quartus Programmer software may be left in a bad state, causing any or all of the error messages you are seeing. To

clear this condition, shut off the MCE's power supply, disconnect the Altera programming adapter ("ByteBlaster" or "USB-Blaster"), and close Quartus. Then, turn on the power supply, reconnect the programming adapter and re-launch Quartus. Note that leaving the programming adapter connected could prevent the error condition from being cleared, despite power-cycling the subrack and restarting Quartus.

18 Fibre-optic cable is disconnected or broken

Check to ensure that both fibre-optic cables are connected to the correct connectors and that they have not been damaged. Note that a functional RTL-PC-to-MCE cable with a non-functional MCE-to-RTL-PC cable can cause timeout errors that mimic software errors in some situations. (The MCE receives and executes commands, but the RTL PC does not receive the responses.)

19 SDSU card DSP software is corrupted

The SDSU fibre-optic card in the RTL PC contains and executes software in its on-board DSP chip. Bugs may exist which cause this software to become corrupted or crash. Should you suspect this to be the case, you must completely power down the RTL PC by following the standard Linux shutdown procedure. Only if the SDSU card is powered cycled will this condition be cleared.

20 Wrong filename was specified

Make sure you have specified the correct script, configuration or log file name. Note that the RTL PC scripts may locate files in directories that may not be obvious to you. Refer to the MCE Command Manual for information about expected script and directory names.

21 Connection problems to cryostat

"Bad" collected data may be due to connection problems at the MDM connectors, cold (internal cryostat) connections or internal MCE connections. We fully tested the MCE subrack connections and have found them to be highly reliable. If data collection has been previously successful and has become bad, it is more likely that a connection problem has developed in the cold connections and MDM connectors than in the MCE.

22 Incorrect bias values specified

Since bias values are specified, in many cases, on RTL command lines, it is easy to type incorrect parameter values resulting in bias currents that are out of range for your subarray. Check your scripts and command lines for typographical errors.

23 Power supply has browned out

Excessive heat in the subrack can cause the on-card voltage regulators to shut down. Additionally, excessive heat can cause the linear power rack to brown out. If you are experiencing "bad" data after running for a long period of time on a hot day, try shutting down the system and blowing cool air through the subrack and linear power rack with external fans for 15 to 20 minutes, and recapturing your data.

24 Faulty readout card ADCs

The AD6644 analogue-to-digital converters used in the readout cards are known to exhibit anomalous behaviour that we have not been able to explain yet. NIST noticed this, too, and replaced some ADCs in the past. An ADC problem will affect the same subarray column in all your data, and may appear as noise or badly distorted waveforms. Should you suspect an ADC failure, please contact the UBC Physics and Astronomy SCUBA-2 team.

25 One or more cards' FPGAs have become corrupted

FPGAs are RAM-based devices and are subject to corruption under certain, rare, circumstances. Should one card in the subrack become unresponsive (as reported the RTL PC software), try reconfiguring that one card's FPGA using Quartus Programmer. Alternately, resetting the subrack (via the reset button on the

subrack or by power-cycling the power supply) will clear the problem. Please keep a record of such loss-of-configuration occurrences and report them to the UBC Physics and Astronomy SCUBA-2 team.

26 Invalid command was specified

Your script or command-line referred to an MCE command that is not defined in the mce.xml file you had in-place when you started the DASDRAMA system. Please refer to the MCE Command Manual for information on MCE command definitions.

27 mce.xml is corrupted

The DASDRAMA system could not understand the contents of your mce.xml file. You may have edited this file and made a typographical error. The error message will indicate which line of the mce.xml file the error is on. Correct the error and restart DASDRAMA. Please refer to the DAS manual for instructions on how to do this.

28 DASDRAMA is corrupted

A software bug prevents DASDRAMA from exiting gracefully when an impatient user aborts a data return command by pressing Control-C. Shut down the DASDRAMA process then restart it. Please refer to the DAS manual for instructions on how to do this.

5.2 List of Known Issues

1 JTAG programming failures

Mostly during programming of a full subrack, Quartus Programmer will report a wrong silicon ID for a device in the JTAG chain and a programming failure. Quartus is now in a bad state, and must be closed and re-launched; Auto-Detect will work but programming reports Device Chain Busy unless Quartus is restarted. Sometimes, the subrack is also left in a bad state and will need to be power-cycled with the ByteBlaster unplugged from the Clock Card's front panel connector.

6 Maintaining the MCE

The MCE is shipped with spare backplanes and filter boxes which can be used if the original parts are defective or broken. Also, it may become necessary to start with a clean re-install of the Windows software if it becomes corrupt. The procedures described below outline how to perform basic maintenance of the MCE.

6.1 Hardware

This section outlines how to replace the backplane and the filter boxes.

6.1.1 Replacing a Backplane

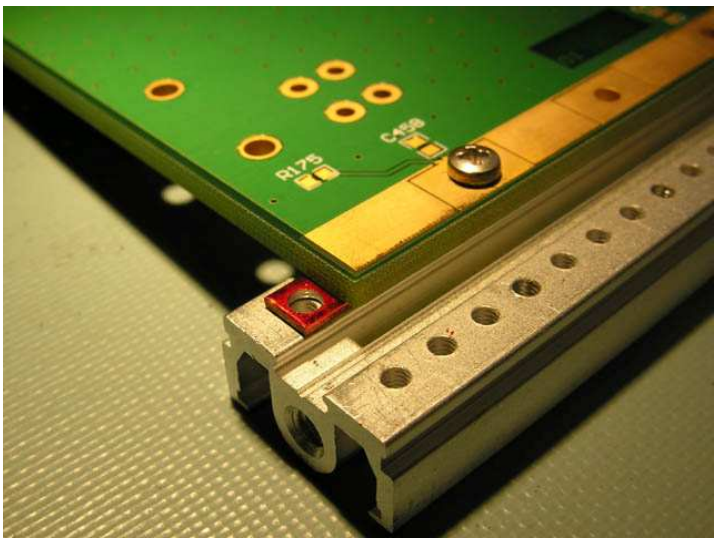
The procedure for replacing either the instrument backplane or the bus backplane is basically the same. However, extra work is required with the IB due to the Delphi flex connections.

Parts and Tools Required:

- 1 x Backplane PCB (instrument backplane or bus backplane)
- 1 x Torque wrench
- 1 x 1mm spacer bar
- 2 x PCB alignment plug-in card

Instructions:

1. Be sure that all cards are removed from the subrack.
2. (Applies to IB only) Remove the filter boxes and Delphi flex circuits connected to the IB.
3. Remove the back panel of the subrack. Place the subrack with the front panel on the work bench.
4. Remove the M2.5 x 8mm screws holding the backplane to the rails. Also remove the screws (highlighted in yellow, below) connecting the backplane to the grounding bracket at the right hand side.
5. Carefully remove the backplane taking care not to bend any connector pins.
6. Place the new backplane into the subrack. Be sure that the 1mm thick spacer bar (in red, below) goes between the backplane and the rail. This spacer bar moves the backplane 1mm away from the plug-in cards.



7. Reinstall all M2.5 x 8mm screws finger tight.

8. Insert the address card into the AC slot (slot 0) and the clock card into the CC slot (slot 8). This will align the backplane to the cards.

9. Using a torque wrench set to 3 lb-in, tighten all screws. Do not over-tighten the screws as the tapped aluminium rails only have 2mm of tap and are easily stripped. Remove the AC and the CC from the subrack.

10. (Applies to IB only) Install the 5 Delphi Flex circuits and torque mounting screws to 8 lb-in. See Section 7.1.2 for instructions on how to install the filter boxes.

6.1.2 Replacing a Filter Box

Parts and Tools Required:

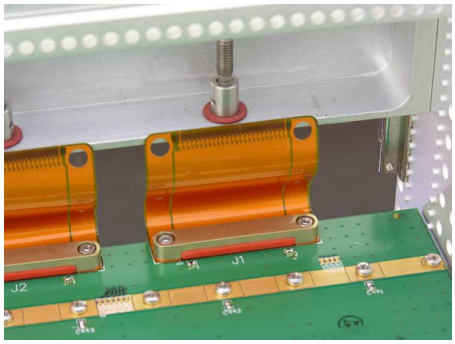
- 1 x Filter box assembly
- 1 x Delphi Flex and hardware
- 1 x Torque wrench
- 1 x 3/32" hex driver bit for torque wrench

Instructions:

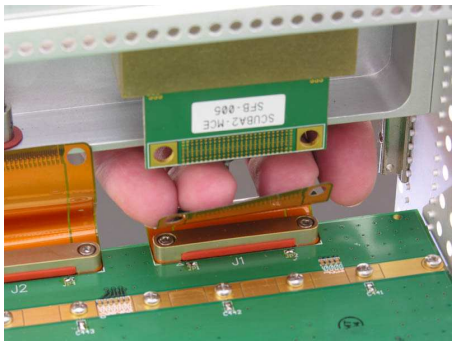
1. Remove the subrack's top fan cover and rear panel.

2. The Delphi flex connection consists of the flex PCB with gold dots on each end. Each end has a two piece mounting fixture held together with two 4-40 x 0.375" cap screws. To assemble the connection be sure that the gold dots on the flex are mating with the gold pads on the PCB.

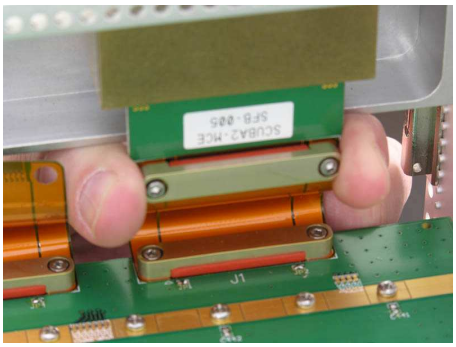
3. Install the instrument bus mounted Delphi connection first. Torque the mounting hardware to 8 lb-in.



4. Install the filter box Delphi connection last. Push the flex so gold dots go on the correct side of the filter box PCB as shown below:



5. Grasp assembly as shown below. The Delphi black tapped strip can also be grasped at the same time. Hand tighten the two 4-40 cap screws.



6. Torque the two 4-40 cap screws to 8 lb-in as shown.

7. Repeat steps for remaining filter boxes. Release torque setting on wrench when completed.

7 Additional Resources

If you are encountering problems with the Multi-Channel Electronics that are not addressed in this manual, additional help is available through our offices listed below. Related documents are also available and can be downloaded from the SCUBA–2 web site.

7.1 Contact Information

MCE web site: http://www.phas.ubc.ca/~mce

Hardware / Firmware Engineering Team:
Department of Physics and Astronomy
#204 – 6224 Agricultural Road
Vancouver, BC
V6T 1Z1
Canada

Software Engineering Team:
UK ATC, Royal Observatory of Edinburgh
Blackford Hill
Edinburgh, Scotland
EH9 3HJ
United Kingdom

7.2 References

[1] SCUBA2-das-engineer-user-manual-V2.0.doc
[2] IBT manual
[3] “MCE Command Description”, SC2_ELE_S580_515_mce_command_description.pdf

7.3 Acknowledgements

Thanks to everyone who contributed, edited, critiqued, and otherwise helped me put this document together:

Mandana Amiri, Bryce Burger, Tom Felton, Gar Fisher, Mark Halpern, William Hue, Anthony Ko, Janos Molnar, Marcel Veronesi, and finally Bridget in the Main Office for allowing me to borrow the department’s digital camera for extended periods of time.

Appendix A: External Linear Power Supply Manual

CAUTION

DO NOT OPEN THE CABINET OR TAMPER WITH THE LOCKING BARS THAT ARE ON THE FRONT OF THE KEPCO SUPPLIES.

DO NOT USE ANY FRONT PANEL TIP JACKS TO SUPPLY POWER TO EXTERNAL CIRCUITRY.

HOOK UP THE EXTERNAL FANS CABLE PRIOR TO POWERING UP THE SUBRACK.

ENSURE THAT THE AC POWER CORDS FOR THE KEPCO SUPPLIES ARE BOTH PLUGGED INTO THE REAR PANEL.

ENSURE THAT THE DC POWER CORDS FROM THE REAR PANEL ARE FASTENED TO THE KEPCO SUPPLIES.

A.1 Overview

The schematics of the power supply can be found on the following pages, in figures A.1 to A.5.

The pin out of both DC output power cables is identical. This means that the cables can be swapped without any concern. The pin out of the Amphenol connectors on the rear panel is listed in figure A.6.

The output voltages are as follows. +2V5d, +4V5d, +5V0d, +6V7a, -6V7a, +15Va.

There are aluminum bars that lock the voltage and current adjustment on the Kepco supplies found on the lower portion of the 8U high cabinet. Do NOT remove the bars or adjust the knobs. The voltage and current levels on the Kepco supplies have been pre-set.

There are tip jacks on the front panel that allow the user to read the output voltages and currents of the supply. It is important to ensure that the tip jacks are *not* used to supply power to any external circuitry.

The +2V5d and +6V7a supplies have panel meters for current monitoring and tip jacks for voltage monitoring on the front panel. The +4V5d, +5V0d, -6V7a, +15Va have jacks that the user can measure both voltage and current. The “COMMON” black tip jacks refer to the current and voltage tip jacks above them. They are not common to each other, or any tip jacks in other columns.

Voltage measurement is done using a DVM connected to the “VOLTAGE” and “COMMON” jacks and is read directly with no conversion factor.

Current is measured as a voltage read across the appropriate shunt resistor for the circuit in question. The +4V5d and -6V7a power supply circuits express measured current values as 10mV/A. The +5V0d and +15Va power supply circuits express measured current values as 100mV/A.

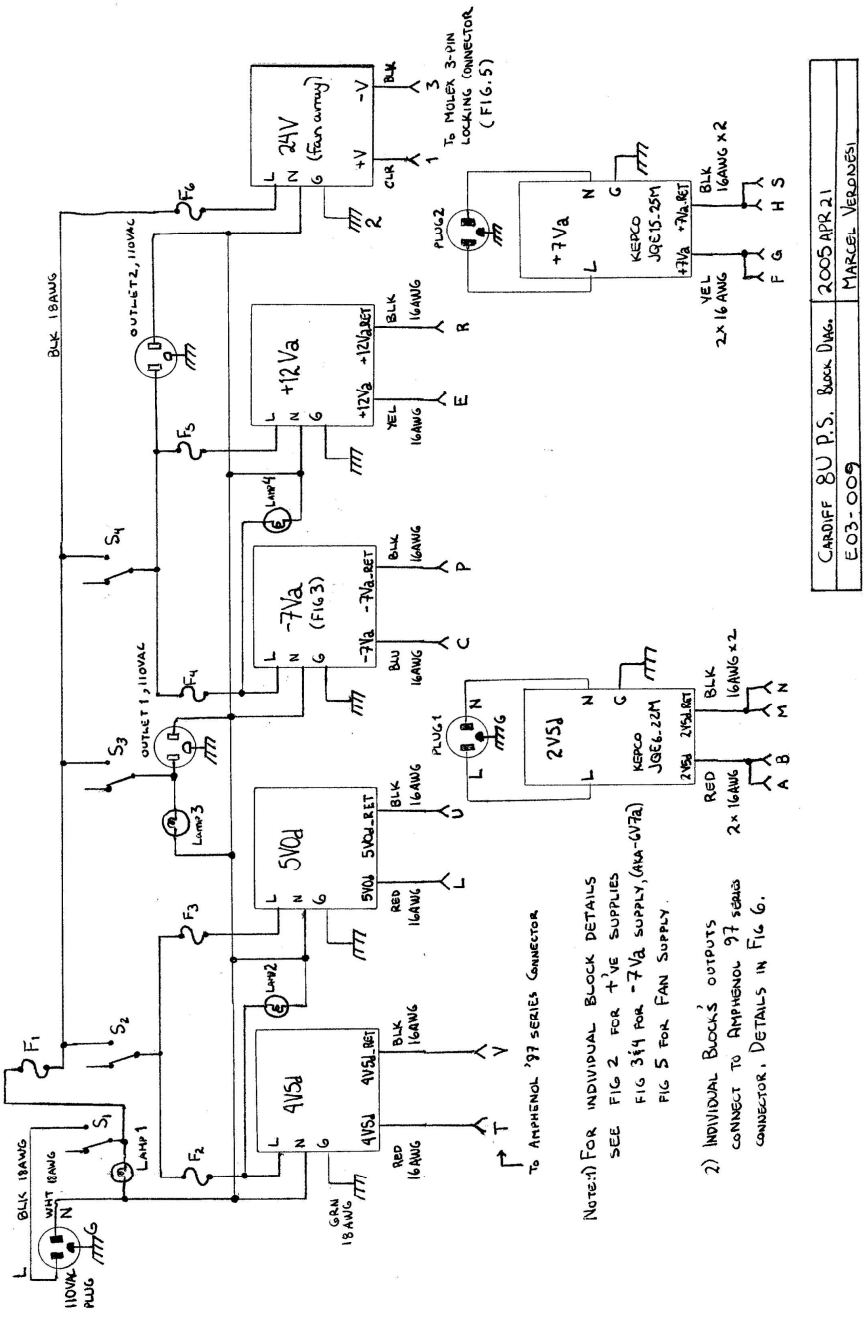


Figure A.1 Power supply schematics. (1 of 5)

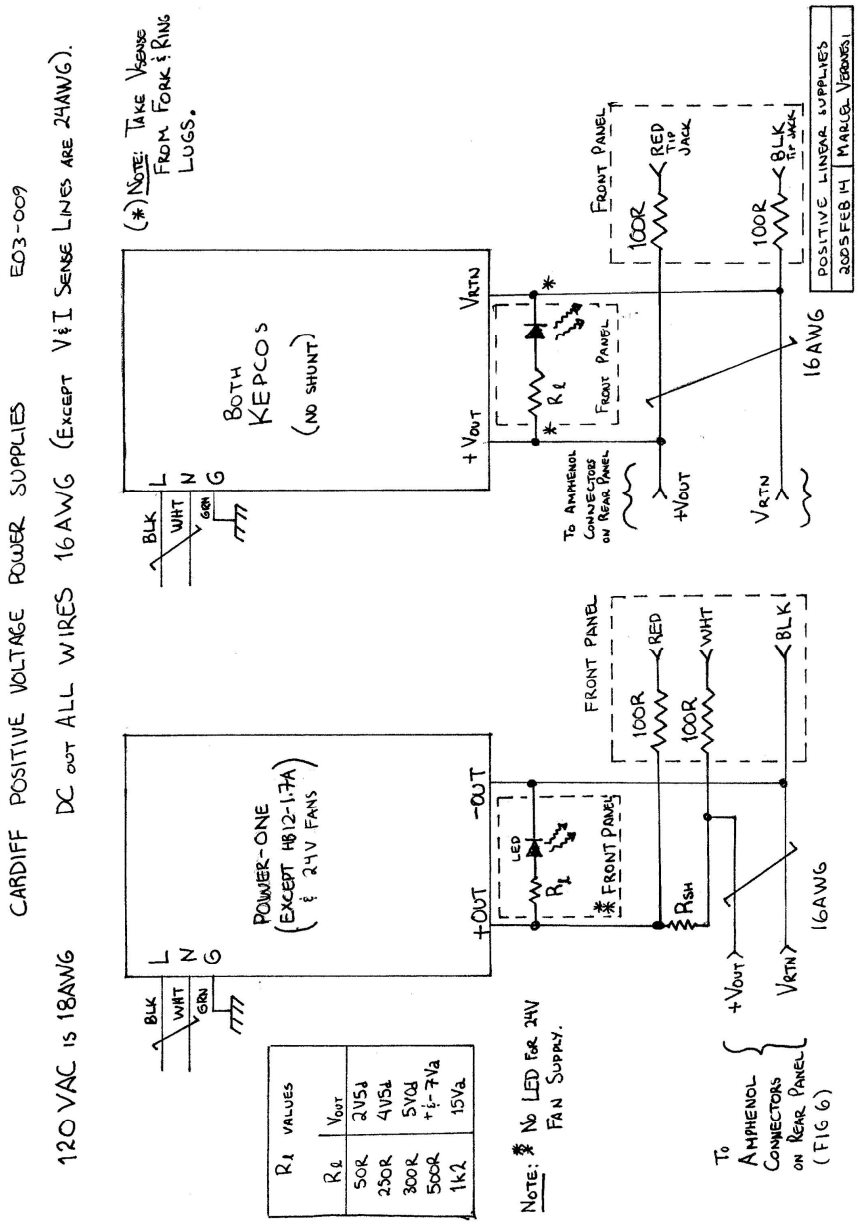


Figure A.2 Power supply schematics. (2 of 5)

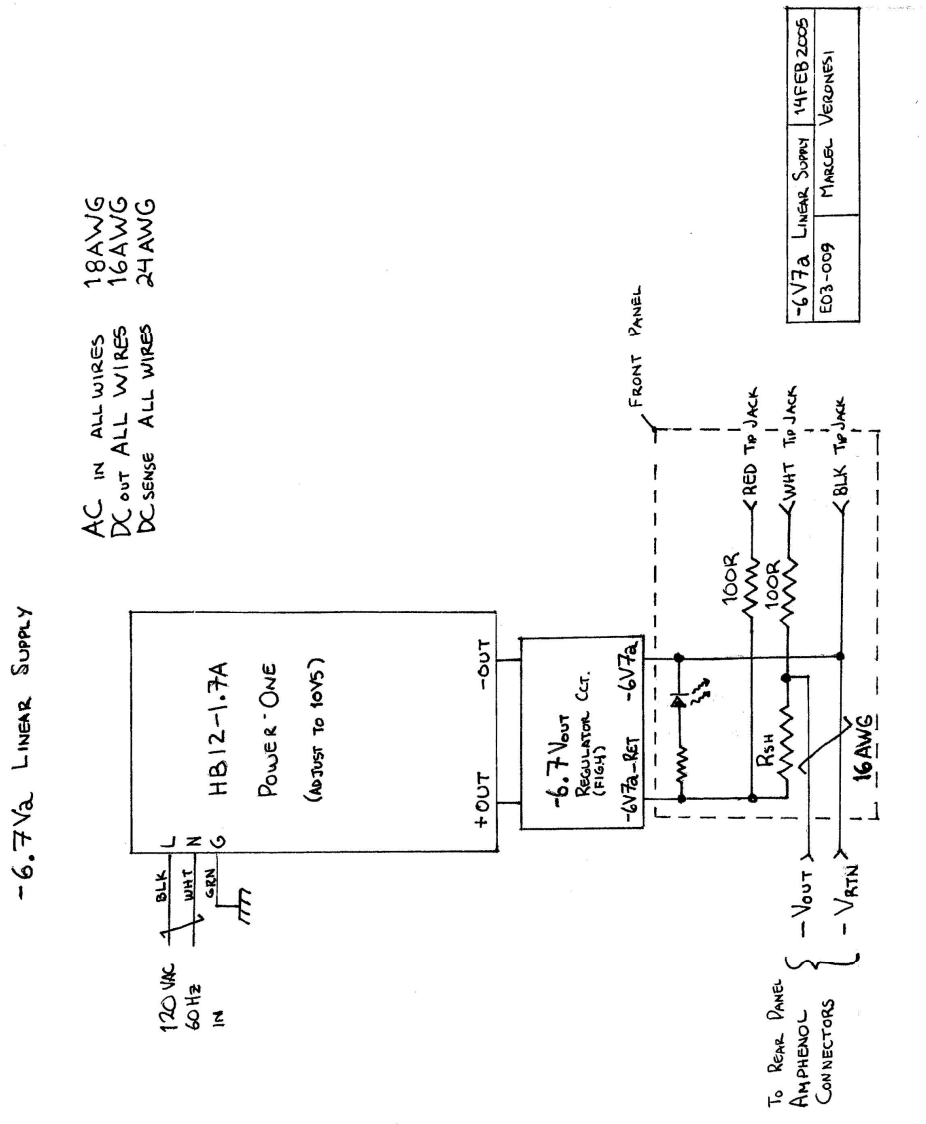


Figure A.3 Power supply schematics. (3 of 5)

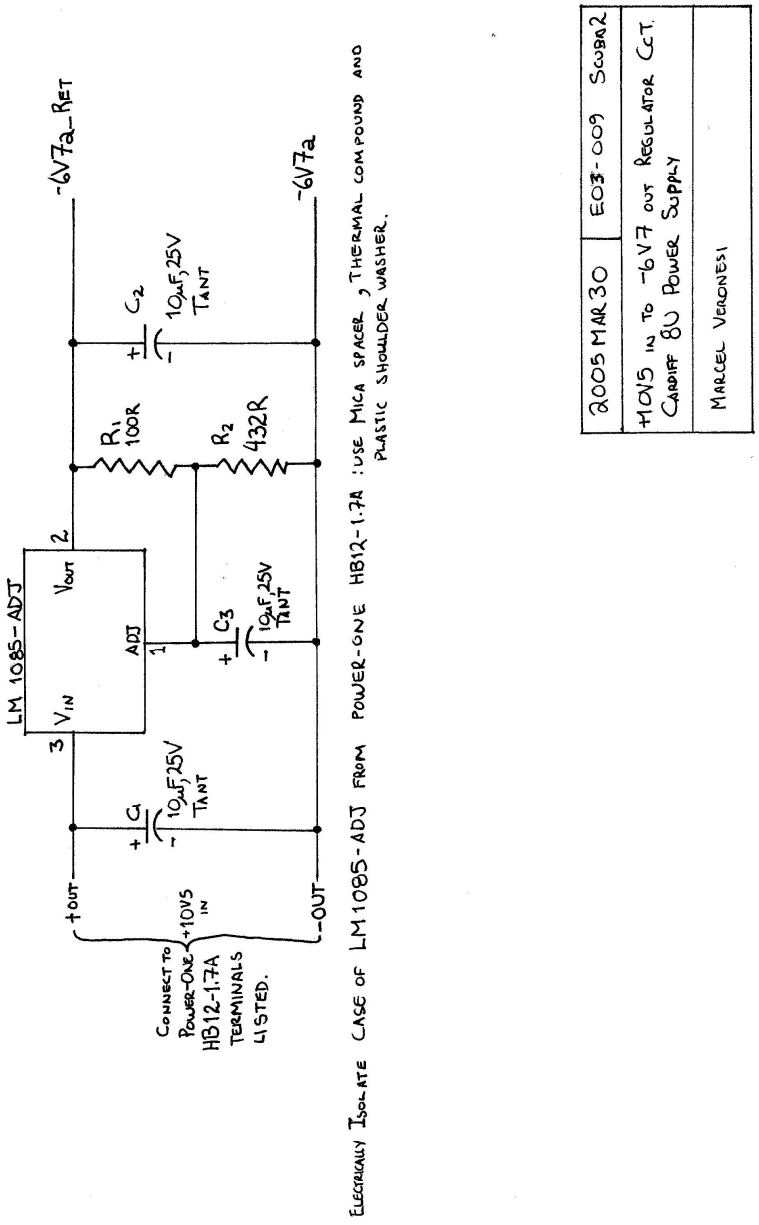


Figure A.4 Power supply schematics. (4 of 5)

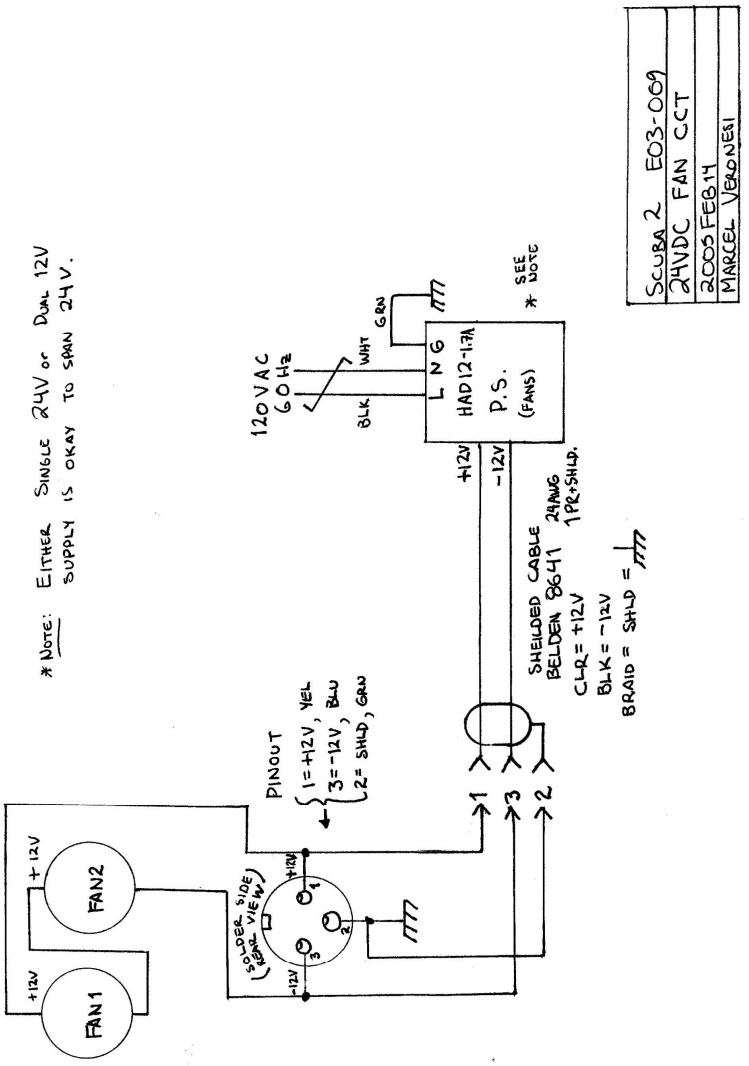
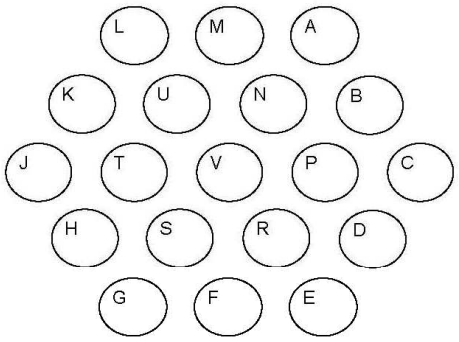


Figure A.5 Power supply schematics. (5 of 5)

Pinout of the Dual Connector Power Supply Card for SCUBA2 E03-009
All wires are 82" x 16AWG Belden 8521 series

Connector REAR VIEW (solder side view)



Amphenol 97 Series Insert 22-14

Notes :
2V5 is supplied by the KEPCO JQE6-22M
4V5d is supplied by HC5-6/OVP-A
5Vd is supplied by HA5-1.5/OVP-A
+7Va is supplied by the KEPCO JQE15-25M
-7Va is supplied by the HB12-1.7-A and an external regulator circuit
-7Va is the -OUT , -7Va_Ret is the +OUT from the HB12-1.7-A.
+15Va is supplied by the HAD15-0.4-A
All Return lines are Black 16AWG
Pins "J" & "K" are freed up for alternate use

Amphenol Connector Pinout		
Pin	Voltage	Wire colour
A	2V5d	red
B	2V5d	red
C	-7Va	blu
D	SHLD	-
E	+15Va	yel
F	+7Va	yel
G	+7Va	yel
H	+7Va_Ret	blk
J	NC	-
K	NC	-
L	5Vd	red
M	2V5d_Ret	blk
N	2V5d_Ret	blk
P	-7Va_Ret	blk
R	+15Va_Ret	blk
S	+7Va_Ret	blk
T	4V5d	red
U	5Vd_Ret	blk
V	4V5d_Ret	blk

Wire Colour	Signal Type
red	d= digital +
yel	a= analog +
blue	a= analog -
black	Ret

Figure A.6 Amphenol connector pinout.

The upper removable shelf of the power supply is populated with the following Power-One linear power supplies:

Part Number	Function	Output Current
HC5-6/OVP	4V5d power	6A
HA5-1.5/OVP-A	5V0d power	1.5A
HB12-1.7-A	–6V7a power	1.7A
HAD15-0.4-A	+15Va power	0.4A
HAD12-.4-A	24V external fan	N/A

Table A.1 Upper shelf components.

Fuse	Type
F1	10 A, SLO BLOW
F2	1.0 A, SLO BLOW
F3	0.5 A, SLO BLOW
F4	0.5 A, SLO BLOW
F5	0.5 A, SLO BLOW
F6	0.5 A, SLO BLOW

Table A.2 Upper shelf fuse specifications.

The lower deck of the power supply cabinet has two pre-set Kepco JQE series power supplies. The front panel adjustments have been locked with aluminum bars. Do not remove these or unscrew the set screws.

Part Number	Function	Output Current
JQE6-22M	+2V5d power	22A
JQE15-25M	+6V7d power	25A

Table A.3 Lower deck components.

The listed current output values are from the manufacturer of the modules within the cabinet and do not take into account parasitic losses from cables and interconnects.

For further details on the power supply modules that make up the power supply, refer to the manufacturer's websites, http://www.power-one.com and http://www.kepcopower.com.

For JQE6-22M see Kepco Instruction Manual Doc. # M576220 Rev. 19 (included).
For JQE15-25M see Kepco Instruction Manual Doc. # M607540 Rev. 24 (included).

A.2 Switch On & Switch Off Sequence

Switching sequence for ON: MAIN, LOGIC, CORE, ANALOG (switch on from Left to Right)
Switching sequence for OFF: ANALOG, CORE, LOGIC, MAIN (switch off from Right to Left).

A.3 Removing the Upper Shelf

1. Turn off the power supply. See above for switch off sequence.
2. Remove all external connections to the power supply.
3. At the rear of the power supply:
    a. Disconnect the DC power connections from the two Kepco's
    b. Unplug the AC line cords from the upper shelf rear panel
    c. Remove the *inner* 4 x 10-32 PHI screws that hold the rear panel to the inverted U-shaped aluminum keeper plate

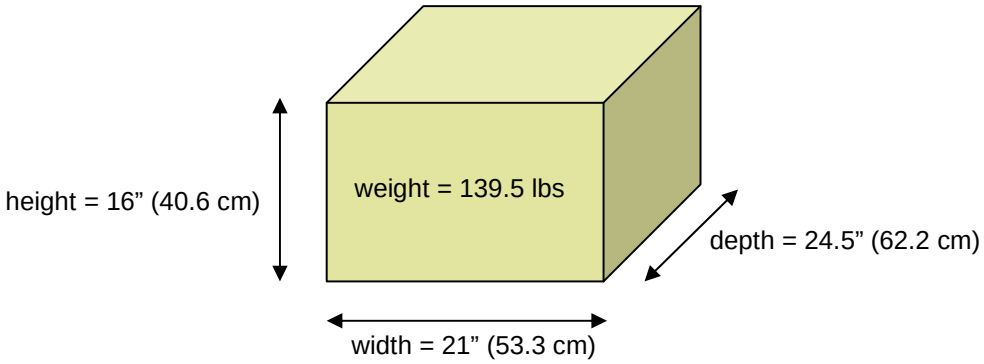
4. At the front of the power supply:
    a. Remove 4 x 10-32 PHI screws that fasten the grill to the front panel to the mounting rails.
    b. Remove the grill components.
    c. Remove the *outer* 4 x 10-32 PHI screws that fasten the front panel to the mounting rails.
    d. *Slowly* pull out the upper shelf. Ensure the DC power connectors at the rear do not snag on the perforations of the Kepcos' cabinets.

A.4 Installing the Upper Shelf

Installation of upper shelf is the reverse of removal.

A.5 Dimensions

The overall mechanical dimensions of the power supply, (excluding foldable handles), is:



Appendix B: Upgrading MCE Firmware

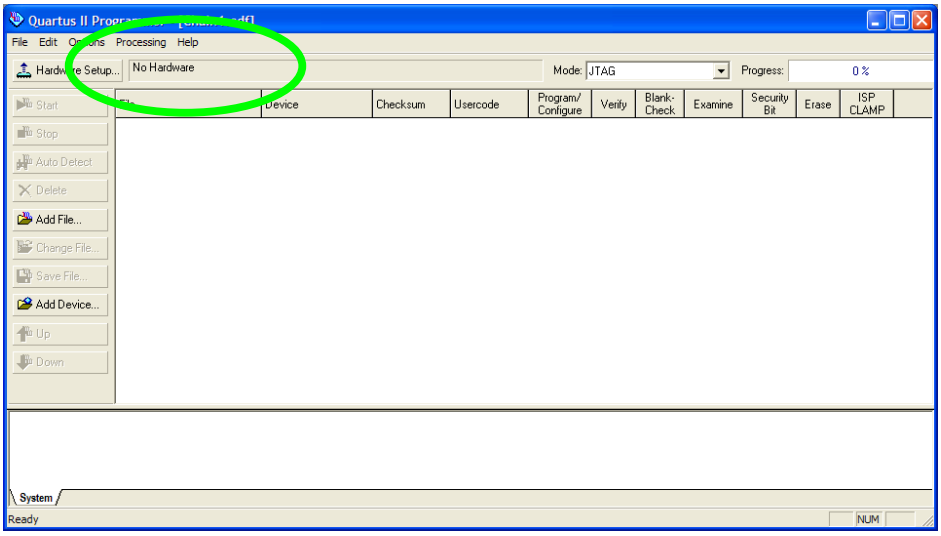
This section describes how to load firmware into the MCE. We currently support two methods of updating firmware; both involve using the Quartus II Programmer software. A third method of updating firmware, using the RTL PC, is not currently supported. With the Quartus Programmer, one can use a CDF file that automatically selects each card's firmware (recommended), or one can load the firmware manually by individually choosing what firmware goes into each card. CDF files can be obtained from the UBC firmware engineering team.

Automatic Update Using a CDF File

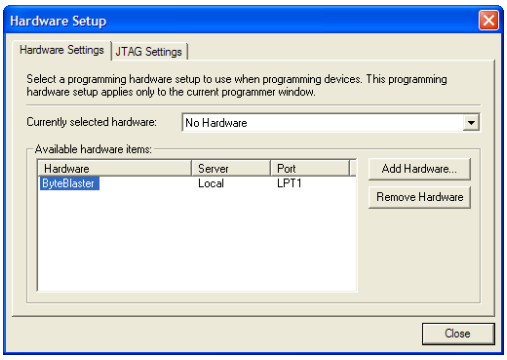
Note: In order to use a CDF file, your MCE subrack must be fully populated (all cards must be plugged in). Otherwise, the programmer will report an error.

1. Start the Quartus Programmer by selecting Start ➔ Altera ➔ Quartus II 4.2sp1 Programmer. If you did not install into the "Altera" program folder, substitute the correct folder name above.

   Verify that the correct programming hardware is selected. If "No Hardware" is displayed in the top left-hand corner, click on Hardware Setup. Otherwise, proceed to Step 3.

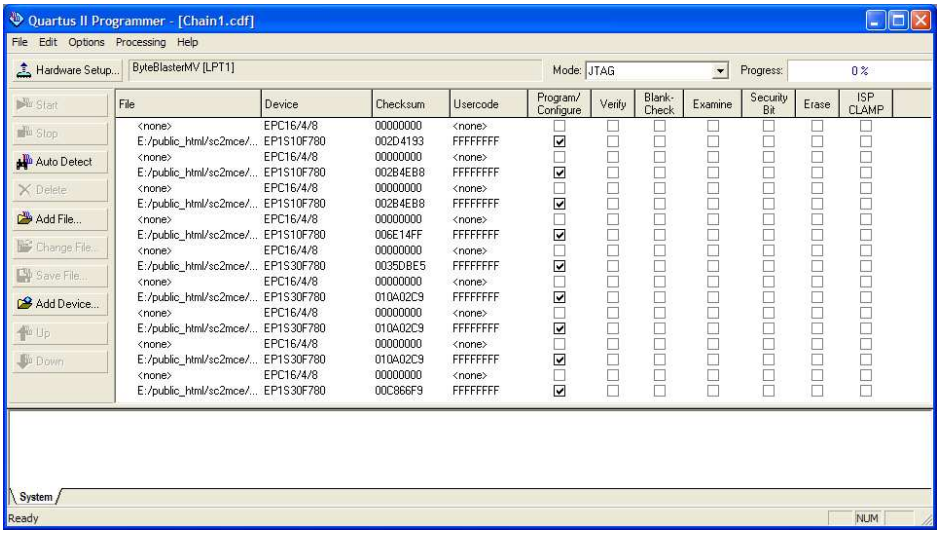


2. Double-click on "ByteBlaster" or "USB-Blaster" under "Available hardware items" to select the programming hardware. If no such device is available, verify that the Altera ByteBlaster or Altera USB-Blaster driver has been installed on the system. Click Close. You should now see "ByteBlaster" or "USB-Blaster" in the top left-hand corner.

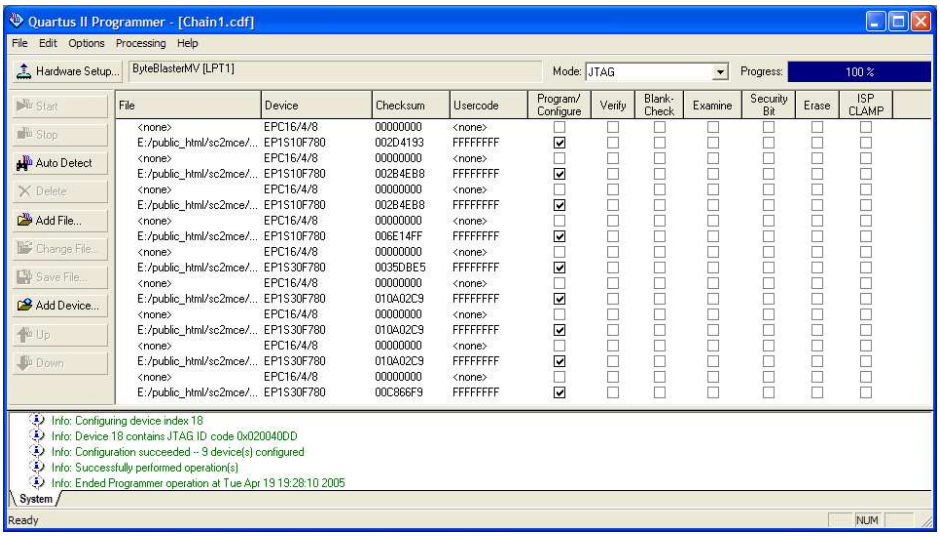


3. Click on File ➔ Open… and browse to the directory containing the CDF file. Select the CDF file and click Open.

4. Click Start to begin the firmware update process.



5. Upon successful completion, the status messages at the bottom will appear in green at the bottom of the window. If there is a problem, error messages will be displayed in red. Refer to the troubleshooting guide for assistance.

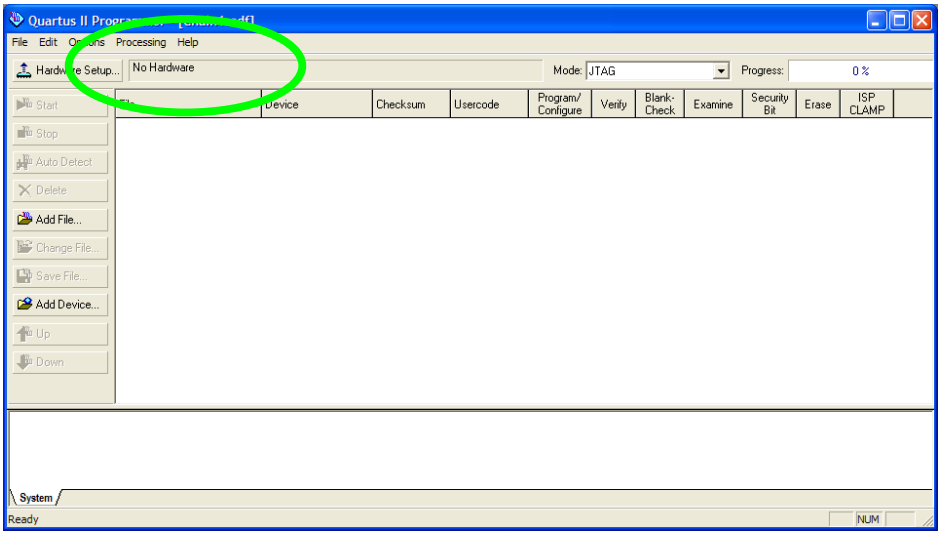


Manual Update Using the Quartus II Programmer

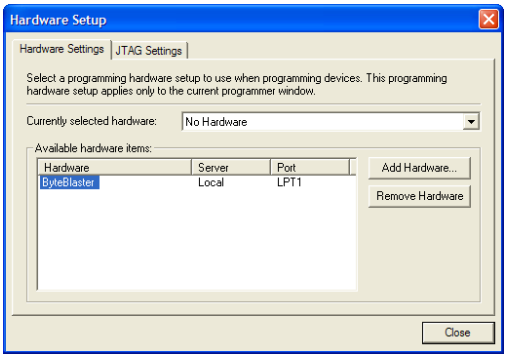
Note: In order to program the clock card's Factory configuration device, put the clock card on an extender card and connect the programming cable to the JTAG header (header P2).

1. Start the Quartus Programmer by selecting Start ➔ Altera ➔ Quartus II 4.2sp1 Programmer. If you did not install into the "Altera" program folder, substitute the correct folder name above.

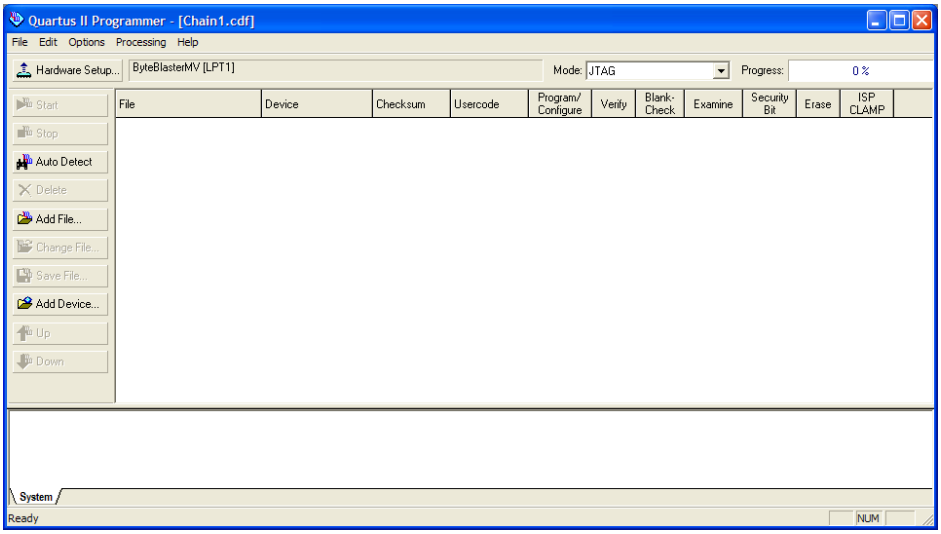
   Verify that the correct programming hardware is selected. If "No Hardware" is displayed in the top left-hand corner, click on Hardware Setup. Otherwise, proceed to Step 3.



2. Double-click on “ByteBlaster” or “USB-Blaster” under “Available hardware items” to select the programming hardware. If no such device is available, verify that the Altera ByteBlaster or Altera USB-Blaster driver has been installed on the system. Click Close. You should now see “ByteBlaster” or “USB-Blaster” in the top left-hand corner.

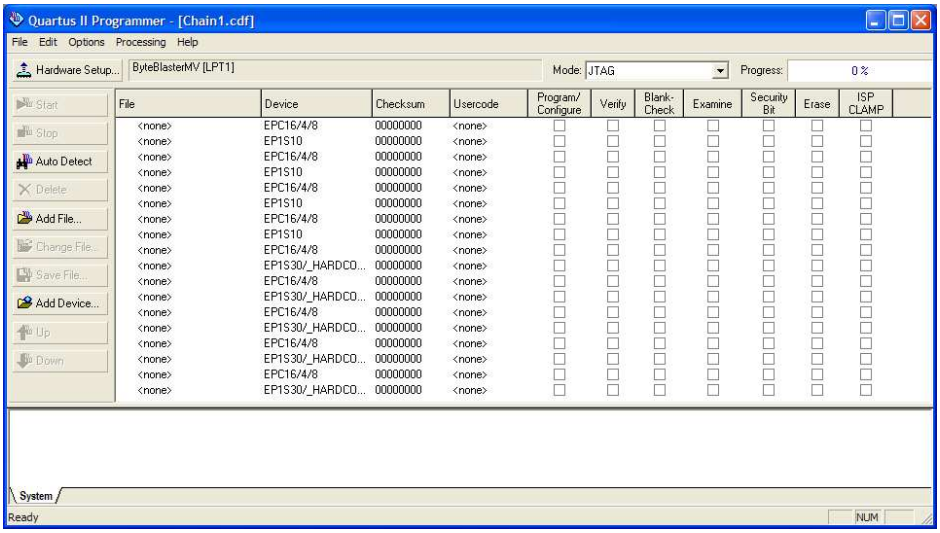


3. Click Auto Detect. In the list of devices that appears, each card in the MCE appears as a group of two devices, consisting of one “EPC16/4/8” configuration device and one “EP1Sxx” FPGA device. Furthermore, each card is listed in order from MCE slot 1 (address card) at the top of the list to MCE slot 9 (clock card) at the bottom.

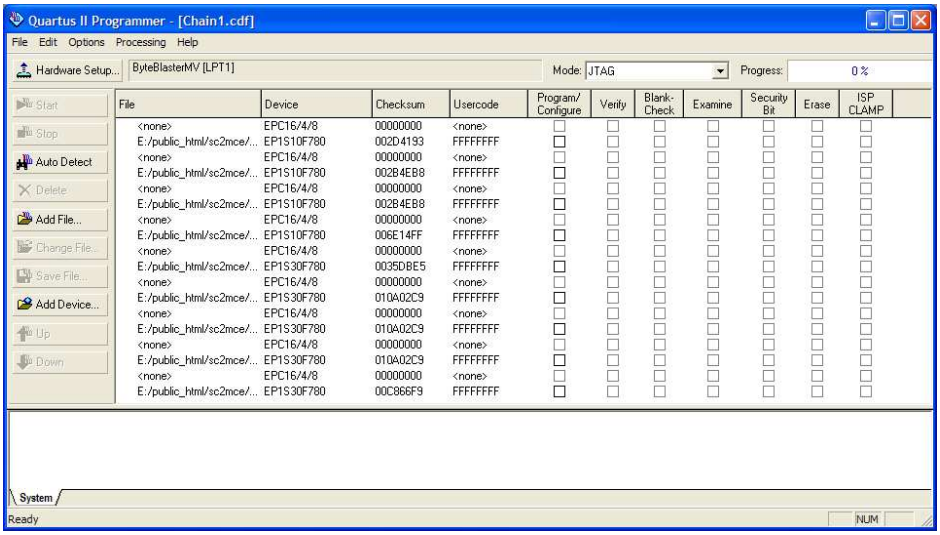


4. If you are programming the FPGAs, double click on the "<none>" beside each EP1Sxx device that you wish to program and select the appropriate programming file. FPGA programming files have file extension .sof.

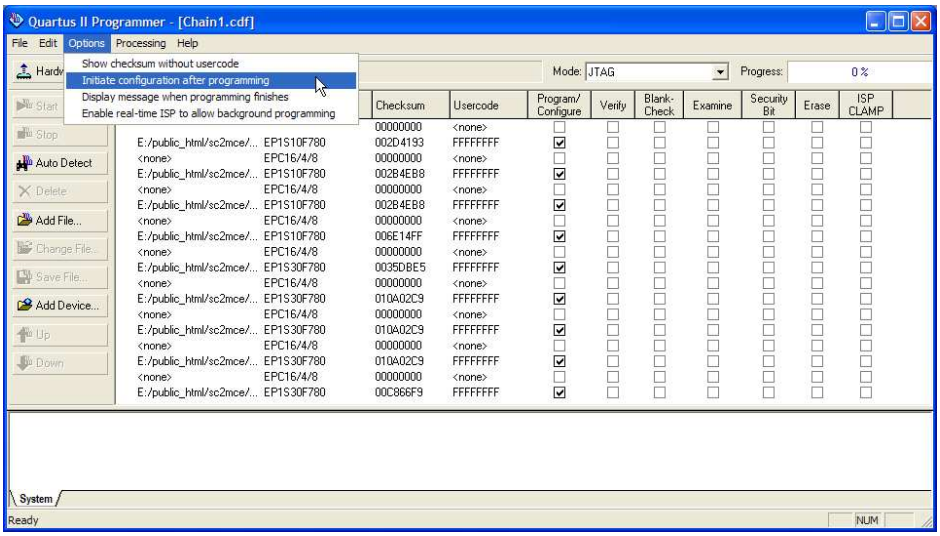
   If you are programming the configuration devices, double click on the "<none>" beside each EPC16/4/8 device that you wish to program and select the appropriate programming file. Configuration device programming files have file extension .pof



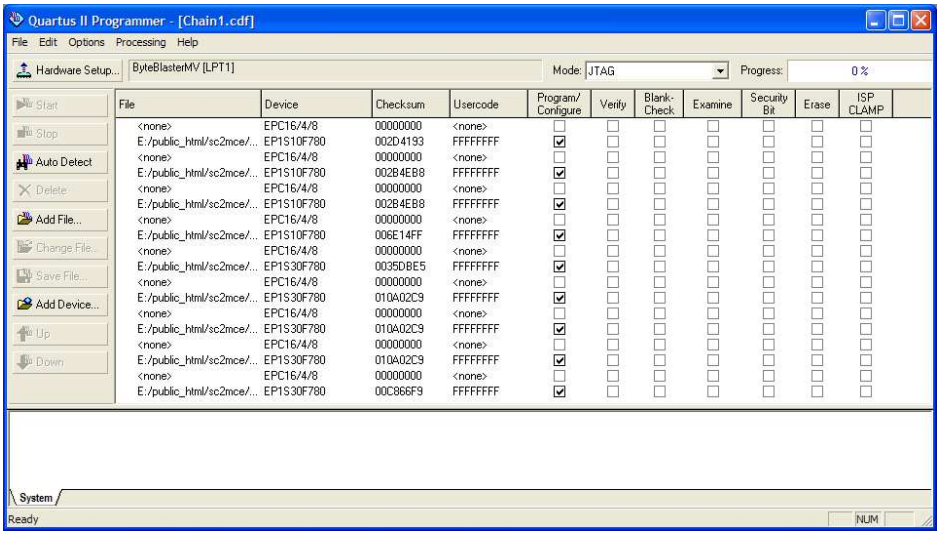
5. Put a checkmark in each box under "Program/Configure" corresponding to the FPGA or configuration device that you selected in Step 4.



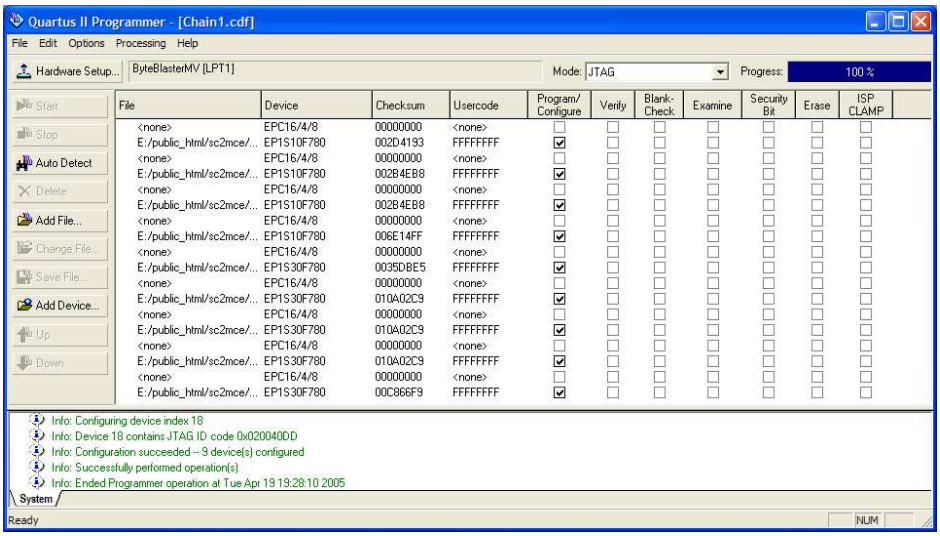
6. If you are programming configuration devices, you will need to tell the Quartus Programmer to trigger an automatic reconfiguration of the FPGAs after the configuration devices have been loaded. To enable this, click on Options ➔ Initiate Configuration After Programming.



7. Click Start to begin the firmware update process.



8. Upon successful completion, the status messages at the bottom will appear in green at the bottom of the window. If there is a problem, error messages will be displayed in red. Refer to the troubleshooting guide for assistance.



Updating Firmware Using the RTL PC

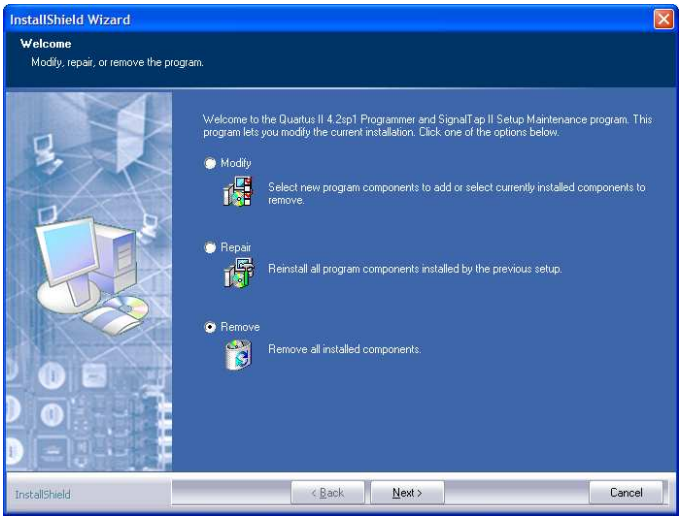
Updating the firmware using the RTL PC via the fibre-optic link is not supported as of yet. This document will be updated when this functionality comes online.

Appendix C: Installing Quartus Software

This section describes how to reinstall the software and drivers required for loading the MCE firmware.

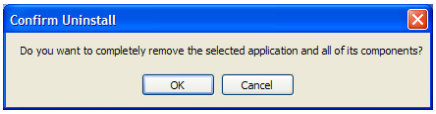
Installing the Quartus II Programmer

1. Uninstall the existing software by clicking on Start ➔ All Programs ➔ Altera ➔ Quartus II Programmer and SignalTap Uninstall, Repair or Modify. Select Remove and click Next.



Note: If this does not work, try using the Add/Remove Programs wizard from the Windows Control Panel. You can also attempt to reinstall the Programmer on top of the old installation without removing it first.

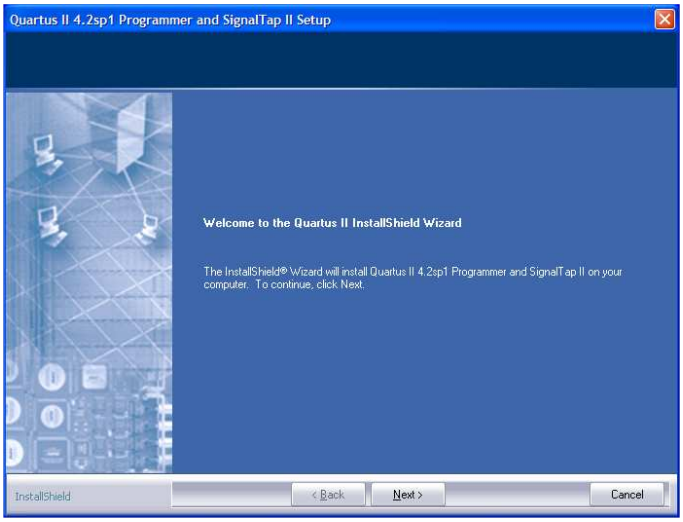
2. Click OK to remove the Quartus II Programmer from your system. When prompted, click Finish to complete the uninstall.



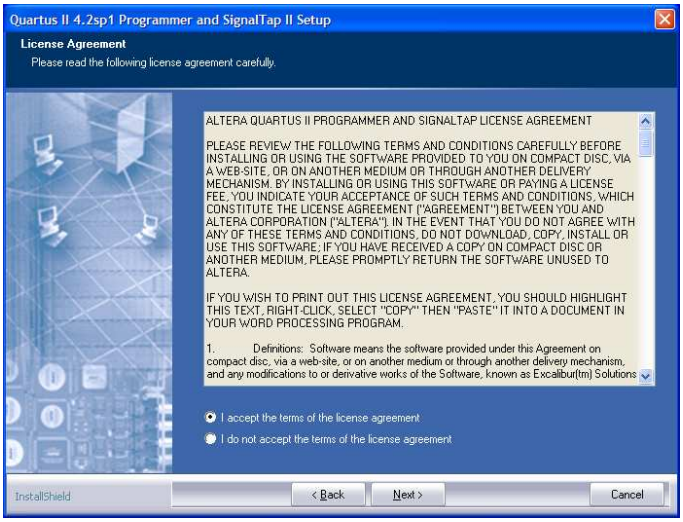
3. Download the Quartus II Programmer, version 4.2 SP1, from the following location:

   http://www.physics.ubc.ca/~scuba2/sc2mce/system/sys_fw/quartus2programmer.exe

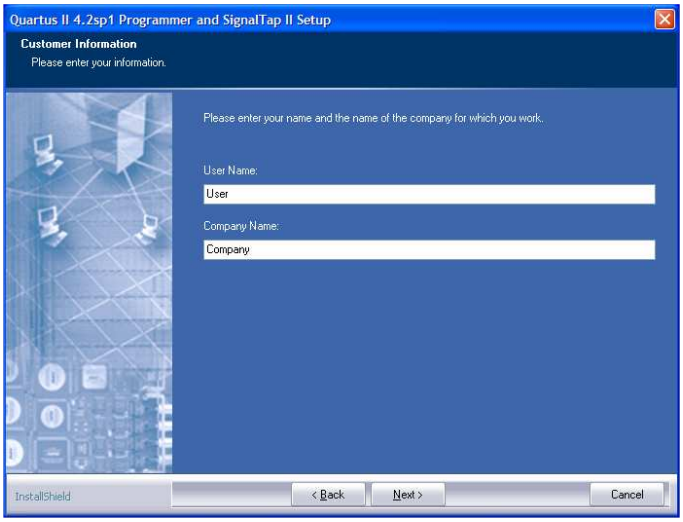
4. Double-click on the downloaded file to start the installation program. Click Next.



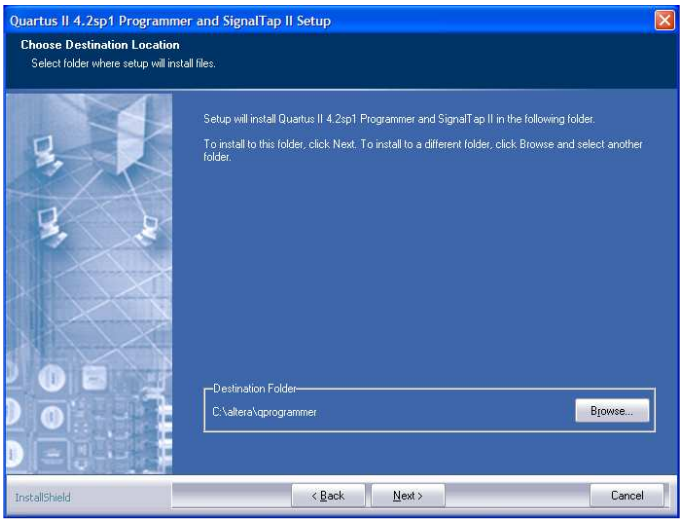
5. Select “I accept the terms of the license agreement” then click Next.



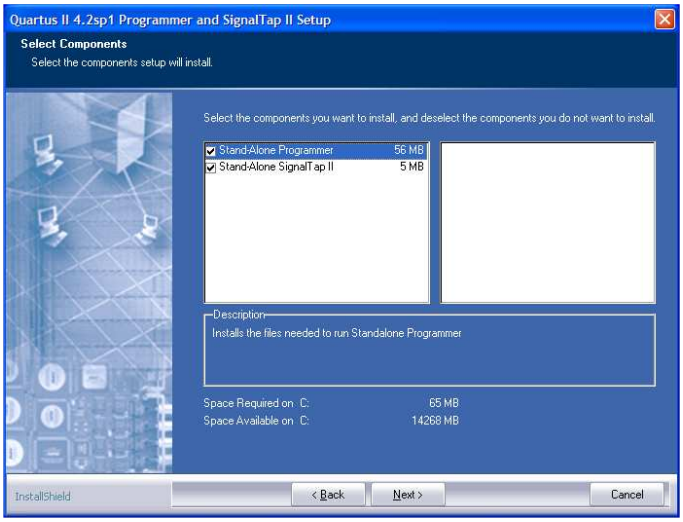
6. Enter your information in the appropriate fields then click Next.



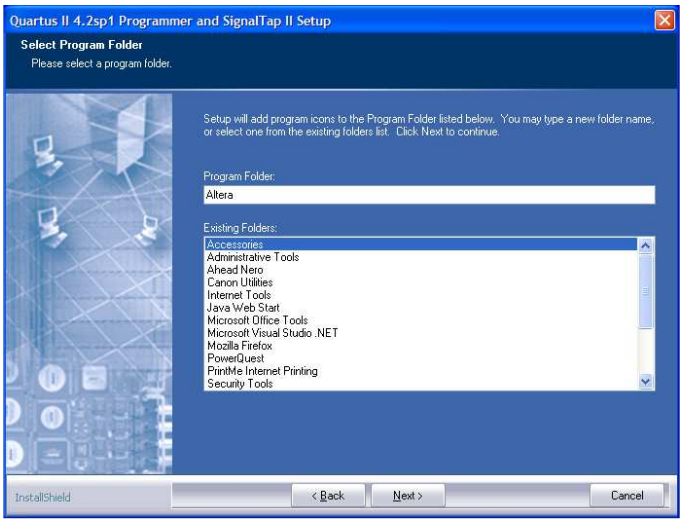
7. Click Next if you agree to install the programmer in the indicated location. Otherwise, select a different directory then click Next.



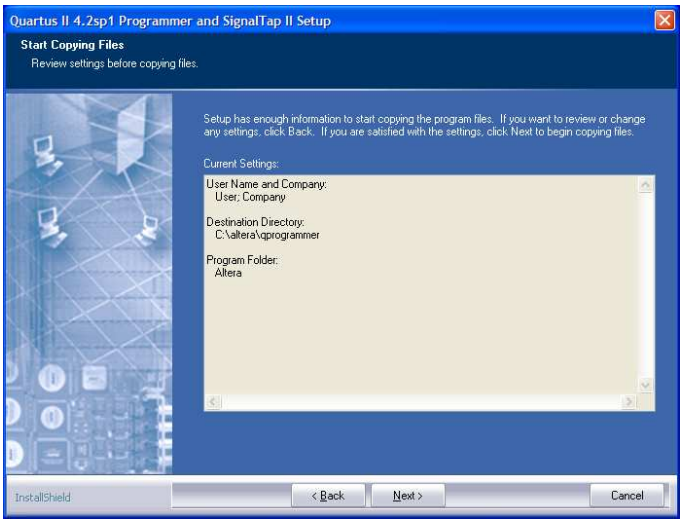
8. Click Next to install both the Programmer and SignalTap II.



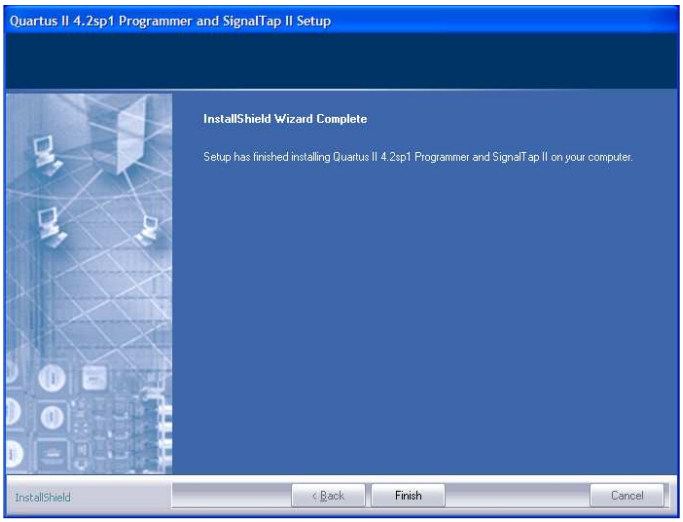
9. Click Next if you agree to the default program folder name. Otherwise, choose a different name then click Next.



10. Click Next to accept the settings and start installation. If you disagree with any of the settings, click Back until you arrive at the appropriate page and then make your corrections.



11. The stand-alone programmer does not require licensing, so installation is complete. Click Finish.

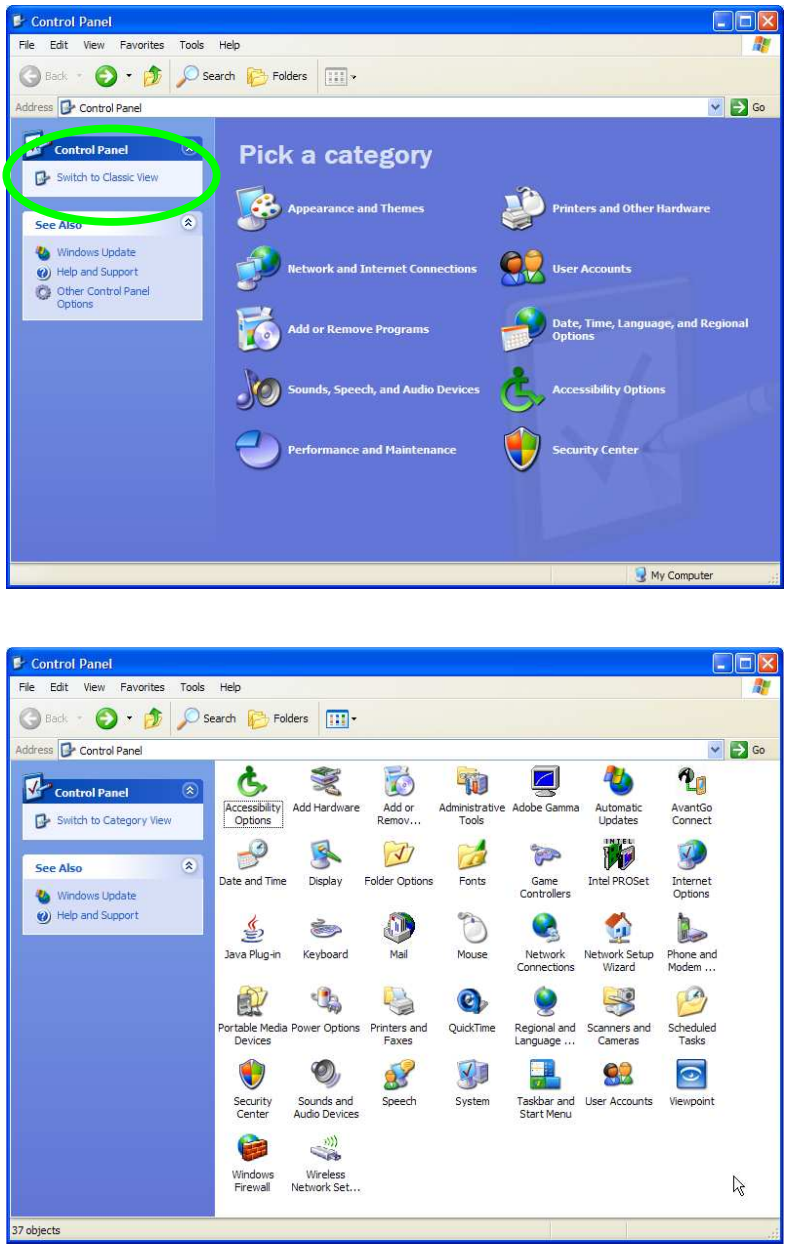


Reinstalling the ByteBlaster/USB-Blaster Cable Drivers

1. Download the ByteBlaster and USB-Blaster driver files from the following location: http://www.physics.ubc.ca/~scuba2/sc2mce/system/sys_fw/drivers.zip

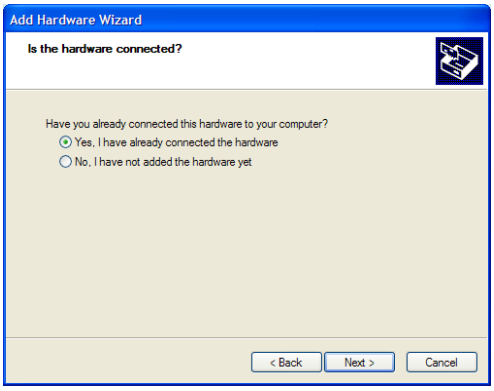
2. Extract the files. Note the location of the extracted files.

3. Open the Windows Control Panel. Open the Add Hardware Wizard. In Windows XP, you may have to click on “Switch to Classic View” in order to see the “Add Hardware” icon.

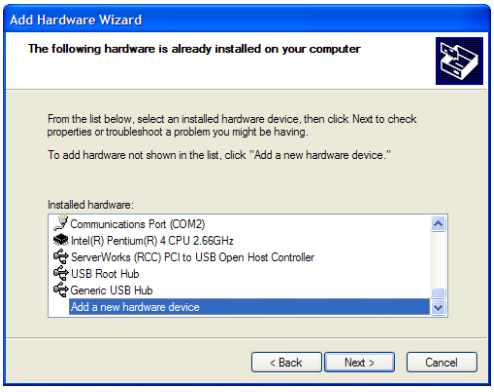

Control Panel
File Edit View Favorites Tools Help
Back Search Folders
Address Control Panel
Go
Control Panel
Switch to Classic View
See Also
Windows Update
Help and Support
Other Control Panel Options
Pick a category
Appearance and Themes
Printers and Other Hardware
Network and Internet Connections
User Accounts
Add or Remove Programs
Date, Time, Language, and Regional Options
Sounds, Speech, and Audio Devices
Accessibility Options
Performance and Maintenance
Security Center
My Computer
Control Panel
File Edit View Favorites Tools Help
Back Search Folders
Address Control Panel
Go
Control Panel
Switch to Category View
See Also
Windows Update
Help and Support
Accessibility Options
Add Hardware
Add or Remov...
Administrative Tools
Adobe Gamma
Automatic Updates
AvantGo Connect
Date and Time
Display
Folder Options
Fonts
Game Controllers
Intel PROSet
Internet Options
Java Plug-in
Keyboard
Mail
Mouse
Network Connections
Network Setup Wizard
Phone and Modem ...
Portable Media Devices
Power Options
Printers and Faxes
QuickTime
Regional and Language ...
Scanners and Cameras
Scheduled Tasks
Security Center
Sounds and Audio Devices
Speech
System
Taskbar and Start Menu
User Accounts
Viewpoint
Windows Firewall
Wireless Network Set...
37 objects

4. Click Next.

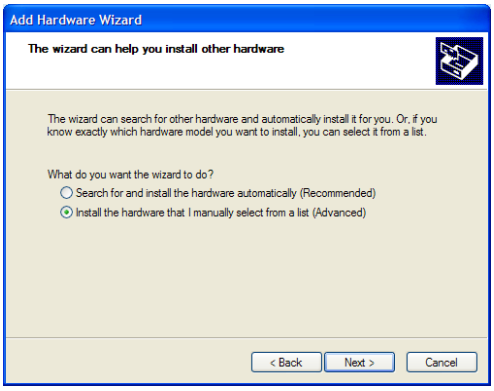
5. Select “Yes, I have already connected the hardware” then click Next.



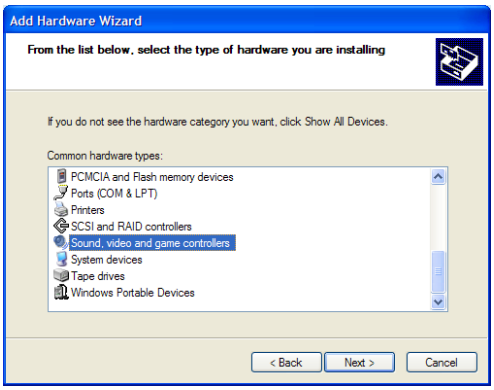
6. Scroll down and select “Add a new hardware device” then click Next.



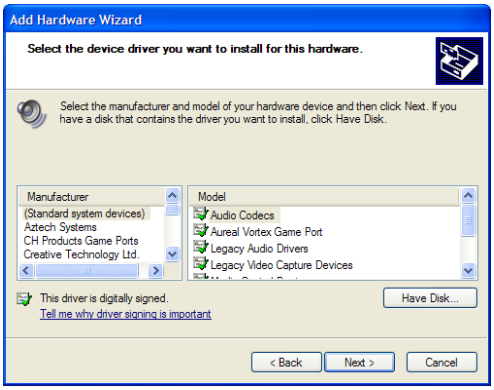
7. Select “Install the hardware that I manually select from a list (Advanced)” then click Next.



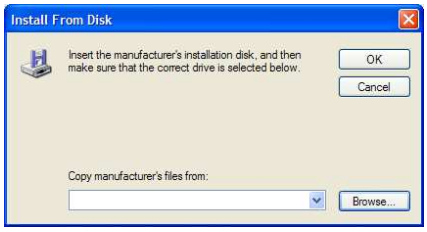
8. Scroll down and select “Sound, video and game controllers” then click Next.

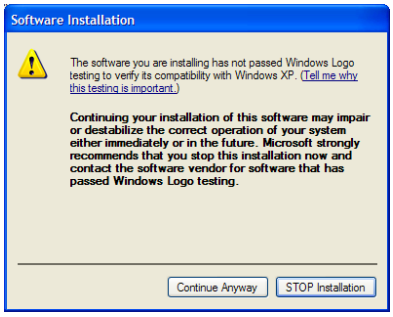


9. Click on Have Disk.

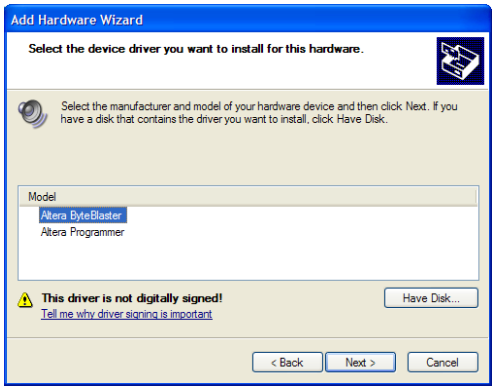


10. Browse to the folders in which you extracted the drivers. If you are installing a ByteBlasterMV, browse to the /byteblaster subdirectory. Otherwise, browse to the /usbblaster subdirectory. Click OK. If a warning appears, click Continue Anyway.

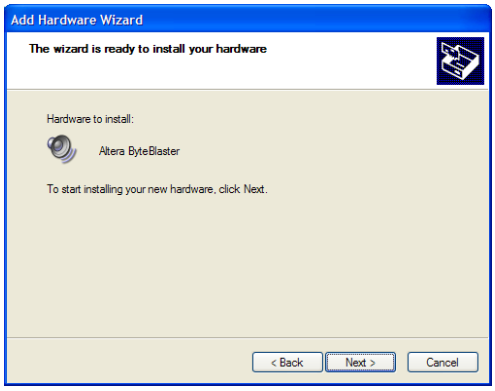


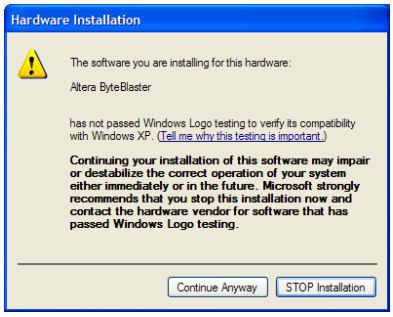


11. Select Altera ByteBlaster or Altera USB-Blaster (depending on which one you are installing) then click Next.

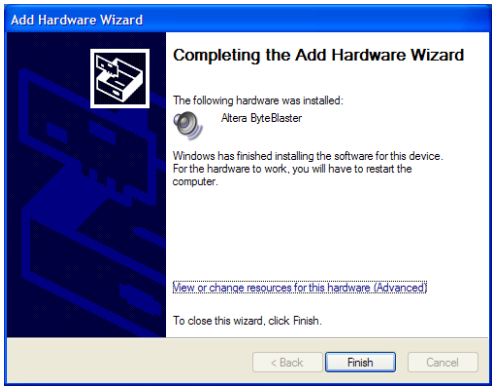


12. Click Next to begin installation. If a warning appears, click Continue Anyway.





13. Click Finish. Reboot the PC to complete the installation.



Appendix D: List of Acronyms

AC	Address Card
BB	Bus Backplane
BC	Bias Card
CC	Clock Card
CDF	Chain Descriptor File
IB	Instrument Bus (backplane)
IBT	Instrument Bus Tester
MCE	Multi-Channel Electronics
MDM	Micro-D Metal
PC	Personal Computer
PCB	Printed Circuit Board
PSC	Power Supply Card
RC	Readout Card
RTL	Real-Time Linux
SDSU	San Diego State University (refers to a PCI card in the RTL PC)