

## ***Quick Start Guide for MS3110BDPC-USB Operation and Installation***

**September 26, 2012**



## MS3110BDPC-USB Quick Start Guide

### **1. MS3110BDPC-USB OVERVIEW:**

This 'Quick-Start Guide' is intended to help the end-user become familiar with the general operation of the MS3110 Universal Capacitive Readout IC. This guide explains how to bias the MS3110, adjust the gain and trim controls for a simple example, program the EEPROM, and verify the contents of the internal control register.

This 2012 board iteration incorporates a USB interface between the PC and the UCR Demo board. A microcontroller, located on the demo board, isolates the UCR chip from fluctuations in the data stream due to PC port priority structure.

For more detailed information on the operation of the MS3110, please consult the **MS3110 Universal Capacitive Readout ICTM Data Sheet**. This document is available from the ISC web site ([www.ISC.com](http://www.ISC.com)). Also, a user's guide for the MS3110BDPC-USB Evaluation Board is available. It can be found on the CD included with the board. Please contact ISC for additional information on these products.

The user needs to refer to "UCR\_install-B.doc" for the proper PC computer configuration.

### **2. EQUIPMENT LIST:**

This list only represents the equipment necessary to complete the 'Quick-Start Guide.' Additional equipment may be necessary to examine other features of the MS3110.

- ✓ (1) +16VDC source will be needed to program the MS3110 EEPROM
- ✓ (2) Multi-meters
- ✓ (1) Oscilloscope or Frequency Counter
- ✓ (1) IBM — compatible PC running Windows XP or Windows 7
- ✓ MS310BDPC-USB Eval Board w/interface program
- ✓ USB A to MINI-B port cable
- ✓ (5) MS3110p 16-pin SOIC

### **3. COMPUTER REQUIREMENTS:**

- ✓ Windows 7 (x86)
- ✓ Windows XP running Service Pack 3 (all editions except Starter Edition)
  - 1.6GHz or faster processor
  - 1GB (32-bit) RAM
  - 3GB available disc space
  - DirectX 9 capable video card running 1024x768 or higher-resolution video
  - DVD drive
  - .net framework 4.0 must be installed
  - Computer must be in the 32-bit mode (0x86)

### **4. MS3110BDPC-USB BOARD LAYOUT:**

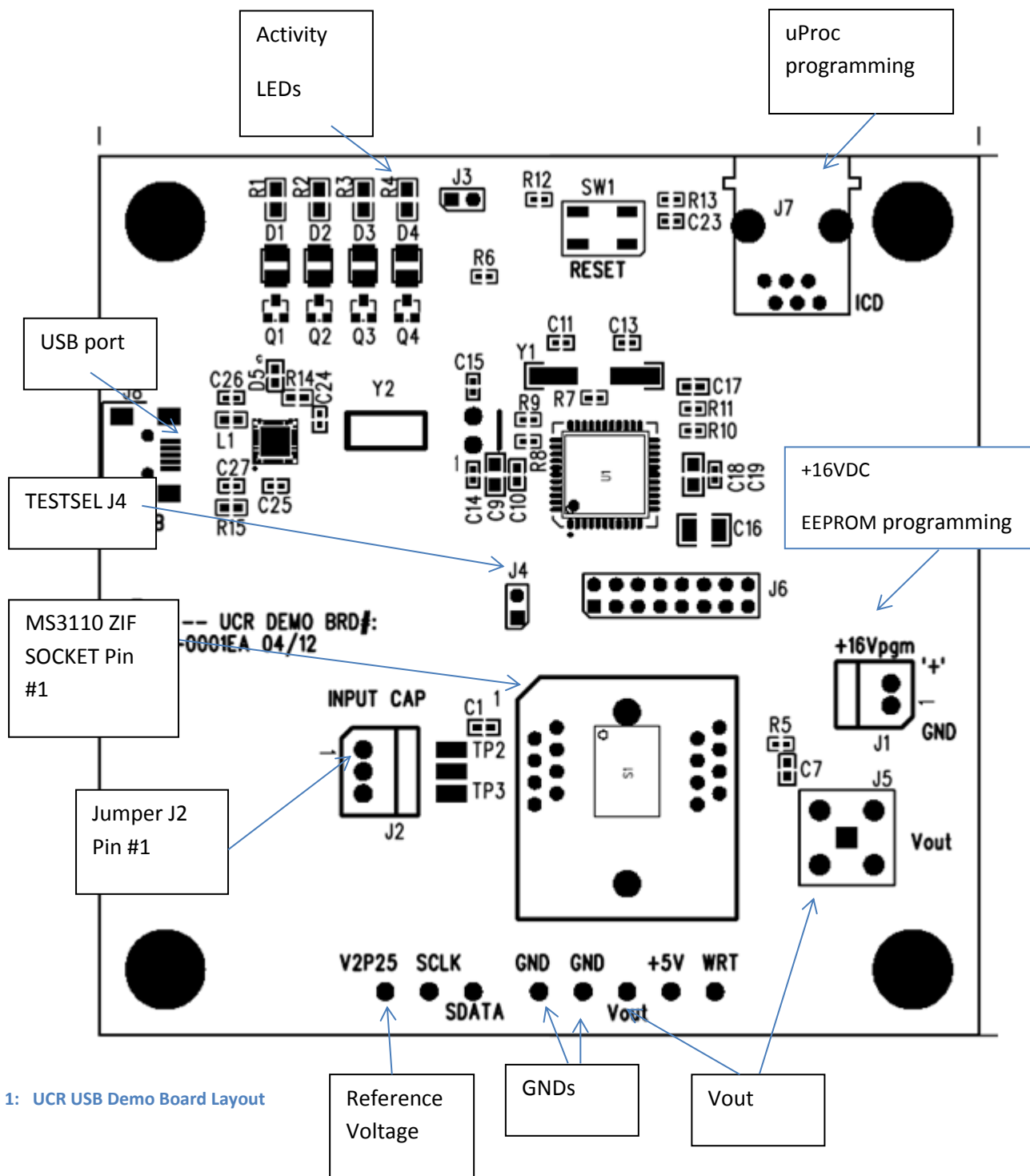


Figure 1: UCR USB Demo Board Layout

- **LED Indications**
  - D1: Indicates RS232 activity
  - D2: Indicates a MS3110 register write activity
  - D3: Indicates a MS3110 register read activity
  - D4: Indicates a MS3110 EEPROM write activity
  - D5: Indicate power is applied via the USB bus
- **J1:** +16V power input connector for EEPROM programming of MS3110.
- **J7:** JTAG programming port of microcontroller. Not supported --- for ISC use only.
- **J4:** Jumper to allow for “TESTSEL” testing current feature
- **S1:** Socket for MS3110P device.
- **V2P25:** Reference test point for MS3110P reference test voltage
- **GND:** Available ground test points
- **VOUT:** Connector and/or test point to access MS3110P analog output voltage
- **J3:** jumper to enable D1, D2, D3, D4 LED power

## 5. MS3110BDPC-USB Program Screen Display

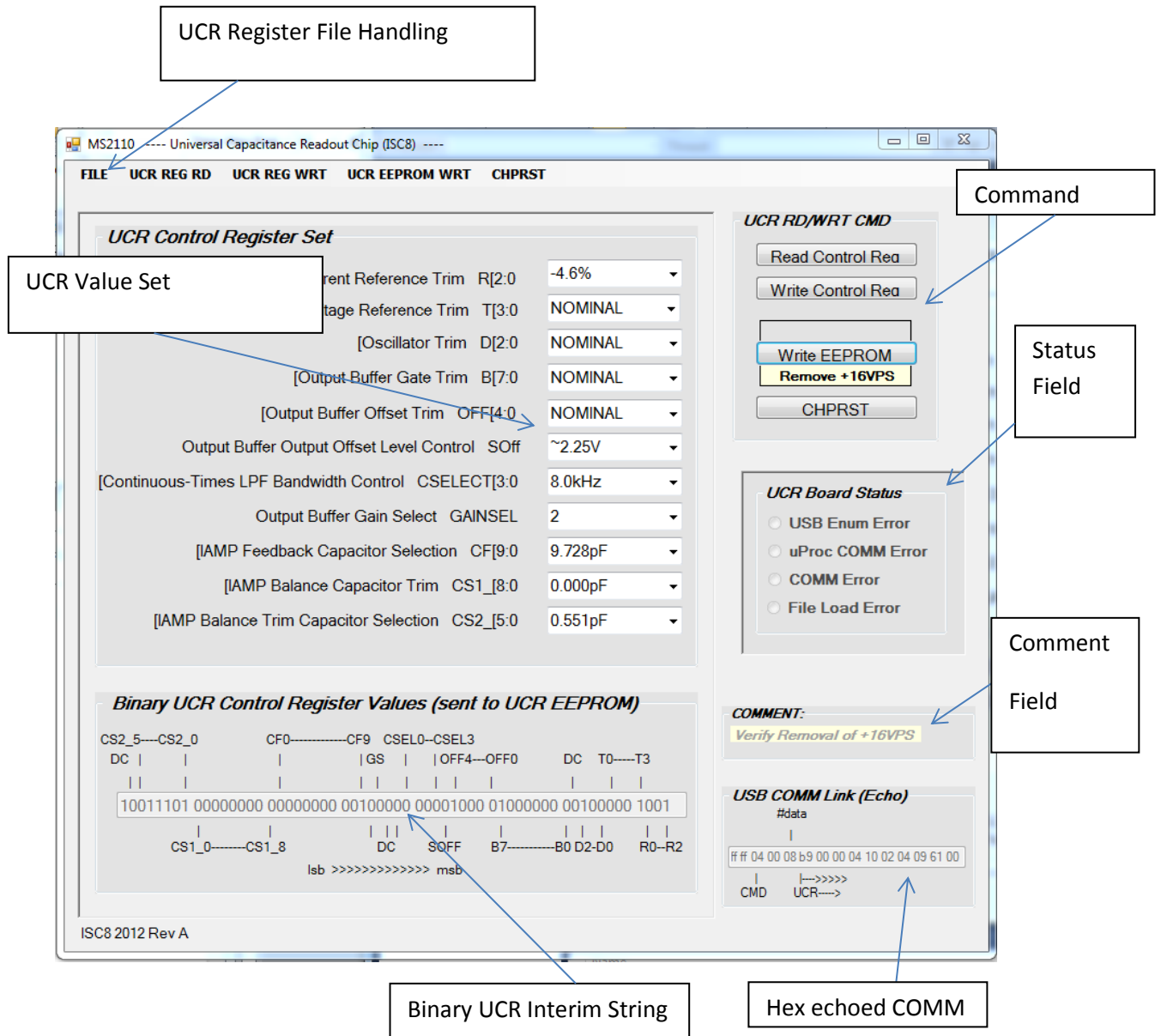


Figure 2: UCR (USB) Demo Board PC Screen Display

### 5.0 UCR RD/WRT Command Field:

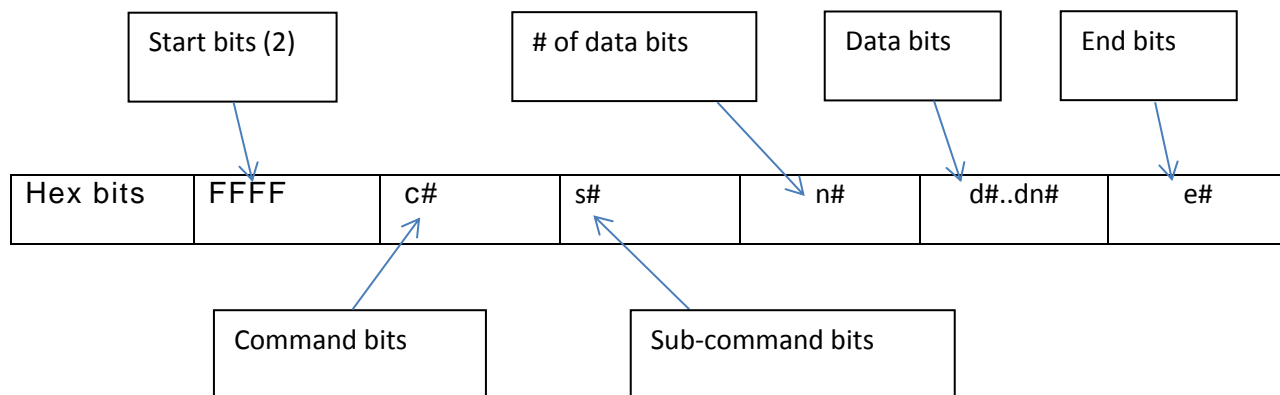
This field initializes the command to the UCR chip via the USB communication link. The UCR chip commands may also be initiated via the menu toolbar at the top of the screen. The following commands are supported:

- Read UCR chip: This will read the values of the UCR chip registers and displays the returned values in **the Binary UCR Control Register Value** field. Note: Depending on the UCR chip register load sequence the read operation may return the operational state of the chip or the previously stored EEPROM values.
- Write UCR chip: This will write the value of the PC interim UCR chip registers values, which have previously been displayed in **the Binary UCR Control Register Value** field. Note: A write command only writes to the UCR registers and not to the UCR chip EEPROM memory.
- Write EEPROM chip: This will write the value of the PC interim UCR chip register values, which have previously been displayed in **the Binary UCR Control Register Value** field. During this sequence, the software prompts the operator for connection/disconnection of the +16V programming power supply. Note: A write EEPROM command only writes to the UCR EEPROM and does not update the UCR Control Register Values. The operation state of the UCR chip is not changed.
- CHPRST chip: This operation resets the UCR chip. The UCR EEPROM values are uploaded to the UCR operation registers. Note: No register read operation is performed. This must be performed in a separate sequence.

## 5.1 HEX Echoed COMM Field

Any command sequence, which is transmitted to the UCR Development board over the USB port, will be echoed back to the PC. The command sequence (shown below) consists of a (2) start bits-0xff, followed by the command to be executed. The number of data bits is then followed by the data bits. The displayed value is shown in hex notation. This complements the interim **Binary UCR Register String**. When a UCR chip write operation is requested, eight hex data bits of the UCR register sequence string are sent.

## Transmit Data Stream Format:



### **5.2 Comment Field:**

The Comment Field prompts the operator for actions required to complete a command sequence or displays pertinent system status information

### **5.3 UCR BOARD STATUS Field:**

The **UCR Board Status Field** displays results of download/upload error status and results of communication & UCR register load/save operations.

### **5.4 UCR Control Register Set:**



The operator may change any of the UCR chip register settings by selecting one of the eleven register parameters. Once values are selected, they will be automatically updated to the **Binary UCR Control Register Value** field. Note: These values are interim (only stored in the PC) until a UCR chip write operation is requested. The drop down notation of each register reflects the actual circuit parameter changed by the action (e.g. 19pf). For a bit-decoding of digital downloaded value see the **Binary UCR Control Register Value** field.

## **5.5 Binary UCR Control Register Value Field:**

This field displays, in a binary format, the values of the interim UCR registers. The serial sequence shown in the field reflects bit-sequence of the read/write operation directly into the UCR chip. It is shown in this manner to ease the designer debugging of the UCR chip communication format. Note: The text notation peripheral to the binary field directly reflect the bit-downloadable values

## **5.6 UCR Register File Handling:**

A fixed default file (ISC\_UCR\_config2.txt) stores the UCR register default bit sequence. Default values may be either loaded from or saved to the PC **Binary UCR Control Register** field via the '**File**' handling routine. This field is located in the menu toolbar at the top of the screen.

## **5.7 UCR RD/WRT Command Field:**

This contains the pushbuttons for sending and receiving commands from the UCR Demo Board MS31000P chip.

## 6. MS3110BDPC-USB SETUP PROCEDURE

- Connect the USB port cable from the PC to J8 on the Eval Board.
- Make sure that there is a jumper on J4.
- Connect a multi-meter between TP10 (**V2P25**) and TP5 or TP6 (**GND**)
- Place the multi-meter in Volts DC mode
- Put a MS3110P 16-pin SOIC in the ZIF socket S1. The orientation of the part is such that pin 1 is in the upper right corner.
- Once the USB cable is installed the MS3110 is operating correctly the multi-meter should show a voltage from 2.11V to 2.45V
- On the MS3110 Program, click the **CHPRST** button

### 6.0 **Setting up Bias on the MS3110**

The reference voltage V2P25 needs to be adjusted to  $2.25V + 0.01V$ . Start by selecting the 'nominal' for the Voltage reference trim T[3:0] on the interface program. Click on the Write control reg. button. Note the reference voltage at TP1. If the voltage is above 2.26V, select the next setting down on the program menu. If the voltage is below 2.24V, select the next larger setting on the program. Then click on **Write Control reg.** to load that setting. Continue making adjustment until the reference voltage is within specifications ( $2.25V \pm 0.01V$ ).

Next, adjust the reference current. Remove the jumper on J4, and place the second multi-meter across the pins. Set the meter to measure DC current (ammeter). The meter should show 8pA to 12juA. If the current is above 10pA, select the next lowest value from the **Current reference trim R[2:0]** menu on the interface program. Click the **Write control reg.** button to load that setting, and note the current again. If the current is below 10uA, select the next highest setting from the **Current reference trim R[2:0]** and load it into the MS3110. You should attempt to get the reference current as close to 10uA as possible. Once the current has been set, remove the multi-meter and replace the jumper on J4.

The last bias setting is the oscillator frequency. Using an oscilloscope, place the probe on pin 1 of J2 (bottom pin), and the ground on TP6 (**GND**). Adjust the monitor to display a  $\sim 2.25V_{pp}$   $\sim 100kHz$  square wave. Alternatively, use a frequency counter to measure the oscillator signal. The specification for the oscillator is  $100kHz + 5kHz$ . Adjust the **Oscillator Trim D[2:0]** as necessary to trim the frequency. Remember to load each

change in to the MS3110 control register by clicking on the **Write control reg.** button.

Remove the oscilloscope or frequency counter probe from J2. The bias parameters for the MS3110 have now been set.

## 6.1 Setting up the Gain

This example uses the MS3110 in differential mode. Verify that the **Output Buffer Offset Level Control SOFF** is set for 2.25V. Also, check that the **Output Buffer Gain Selection GAINSEL** is set at 2.

Next, set the **IAMP Feedback Capacitor Selection CF[9:0]** to 5.13pF, the **IAMP Balance Capacitor Trim CS1\_[8:0]** to OpF, and the **IAMP Balance Trim Capacitance Selection CS2\_[5:0]** to OpF. The gain of the MS3110 is primarily determined by the feedback capacitor CF. With a setting of 5.13pF, the scale factor of the MS3110 is **~-1V/pF**.

Verify that the **Output Buffer Gain Trim B[7:0]** is set to 'nominal' and that the **Output Buffer Offset Trim OFF[4:0]** is set to 'nominal' as well. Make the necessary changes to the program and click on **Write control reg.** to load the settings into the MS3110. The output voltage at TP5 (*VOUT*) should be ~2.25V. It is possible to trim this value closer using the **Output Buffer Offset Trim OFF[4:0]** menu selection.

## 6.2 Verifying the MS3110 response

Set the **IAMP Balance Trim Capacitance Selection CS2\_[5:0]** to 1.0pF and click the **Write control reg.** button. The output voltage should go up by ~1V.

Next, move the **IAMP Balance Capacitor Trim CS1\_[8:0]** to 1.0pF and program the MS3110. The output should go back to the 'nominal' level, ~2.25V.

Finally, set the **IAMP Balance Trim Capacitance Selection CS2\_[5:0]** to OpF, and program the MS3110 by clicking on the **Write control reg.** button. The output voltage should go below the nominal by ~1.0V.

With the feedback capacitor CF set to 5.13pF, the MS3110 output should be about ~1.0V/pF. To estimate the output voltage, subtract CS2 from CS1, and add this to the output offset voltage. For example, if CS2 = 0.798pF and CS1 = 2.052pF, the output will be ~1.0V. In this case, the assumed trimmed reference voltage is 2.25V (Vref), and GAINSEL is set at 2.

The following calculation shows how the output is determined from the transfer function of the MS3110.

$$V_{out} = (V_{ref}) * (1.14) * (GAINSEL) * (CS2 - CS1) / CF + V_{ref}$$

$$V_{out} = (2.25) * (1.14) * (2) * (CS2 - CS1) + 2.25$$

$$V_{out} = 5.13 * (0.798 \text{ pF} - 2.052 \text{ pF}) / 5.13 \text{ pF} + 2.25$$

$$V_{out} = -1.25 + 2.25$$

$$V_{out} = 1.0V$$

### 6.3 Programming the EEPROM

The MS3110 EEPROM is ready for programming once a set of variables is selected in the software menu. Any change to the menu **UCR Control Register Set** is automatically referenced in the menu **Binary UCR**

**Control Register Values.** The first pressing of the software **Write EEPROM** button will prompt the operator to connect the +16VDC programming power supply to J1. Once this is verified, the operator must again click on the **Write EEPROM** button. This causes the interface program to load the settings into the MS3110 EEPROM for long term storage. Each time the MS3110 is powered-up or re-set (**CHPRST**) the EEPROM contents are loaded into the volatile control registers. Once the programming is complete the +16VDC power source is prompted by the software for removal. The menu **COMMENT** field walks the operator through this sequence.

## 6.4 Read back of the control register contents

The interface program can be used to examine the contents of the MS3110 control register. Therefore, it is possible to indirectly verify the EEPROM. Anytime that the **Read Control Reg** button on the interface program is pressed, the contents of the control register is sent to the PC and displayed by the software. Note that the various menu selections will jump to the corresponding settings. To verify the EEPROM is correctly programmed, issue a chip rest to the MS3110 by clicking on the **CHPRST** button on the interface program. This causes the MS3110 to load the EEPROM contents into the control register. Next, click on the **Read Control Reg** button, and examine the settings displayed by the interface software. If the settings are as desired, then the MS3110 EEPROM is programmed correctly. If any changes are necessary, just select the appropriate setting in the menu, and click the **Write EEPROM** button. Remember to connect the +16VDC source to J1.

## 6.5 Write the control register contents

The interface program can be used to write to the contents of the MS3110 control.

Register. This function does not write to the EEPROM but only to the **UCR Control Registers**. Any change to the menu **UCR Control Register Set** is automatically referenced in the menu **Binary UCR Control Register Values**, ready for download. Clicking the **Write Control Reg** button will write the selected UCR values to the UCR device.