

# MCT User Interface Reference Manual

Motor Control Technologies; LLC

[www.mocontech.com](http://www.mocontech.com)



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## Release Notes

- Version 1.01 – Initial Release
- Version 1.02 – General editing.

## 1. MCT Interface

The MCT User Interface is a Windows application designed to make interfacing with MCT products fast and easy. The User Interface (UI) provides a graphical interface to simplify hardware configuration and setup. The MCT UI supports all MCT hardware and currently interfaces with following hardware manufactured by [LabJack Corporation](#):

- U12
- U3LV and U3HV
- U6 and U6Pro
- UE9 and UE9 Pro

## 2. Software Download and Installation

### 2.1. LabJack Devices

Verify the latest LabJack drivers are installed on your computer, depending on what LabJack device you will be using. The U.I. cannot communicate with LabJack devices unless the required driver is installed. LabJack drivers may be downloaded from the [LabJack](#) website. The following table lists supported LabJack devices and required driver.

**Table 1. LabJack devices supported by the MCTU UI and their associated driver.**

| LabJack Device  | Driver Name   |
|-----------------|---------------|
| U12             | ljackuw.dll   |
| U3LV andU3HV    | labjackUD.dll |
| U6 and U6 Pro   | labjackUD.dll |
| UE9 and UE9 Pro | labjackUD.dll |

Note:

The driver required for the device being used is the only driver that must be installed on your PC for the U.I. to function properly. Both LabJack drivers do not have to be installed on the host PC.

### 2.2. Downloading and Installing the MCT UI

- Download the latest version of the MCT UI from the MCT downloads page:

[www.mocontech.com/downloadsandexamples](http://www.mocontech.com/downloadsandexamples)

- Extract the MCT installer from the zip file onto your computer (MCT User Interface.msi). The installer is a Microsoft installer file that will copy the MCT User Interface application and supporting drivers onto your hard drive.
- Start the MCT Installer by double-clicking on the *MCT User Interface.msi*.
- Follow the prompts on the screen to install the MCT U.I. to the desired location on the hard drive. The default installation path is C:\Program Files\Motor Control Technologies. Alternate drive locations may be specified during the installation process.

On completion, the MCT User Interface.exe and the MCTUI.dll will be located in the Motor Control Technologies folder at the drive location specified in the installation process. Start the MCT U.I. by either navigating directly to the executable file in the Motor Control Technologies folder, or use the shortcut on the Start Menu.

The MCT U.I. is compatible Windows XP SP3, and Windows 7. The MCT UI requires Windows .Net Framework Version 2.0 or later. The .Net framework may be downloaded from the [Microsoft](#) website if a compatible version is not already installed your PC.

### 3. MCT U.I. Operation

#### 3.1. Starting a New Session

Use of the MCT UI begins by starting a new session. Starting a new session establishes the MCT device and communication hardware that will be used. MCT hardware and communication may be changed at any time by starting a new session.

- Select **File→New Session** from the main menu.

A new window will open prompting the user to start a new session (Figure 1). Select the MCT hardware and communication hardware being used for this session. The hardware selected in the *Start New Session* window will be used through the duration of the current session. MCT or communication hardware may be changed at any time by starting a new session. All data collected during a session is deleted when a new session is started.

- Select the appropriate MCT and communication hardware to use in this session.

- Select the OK button.

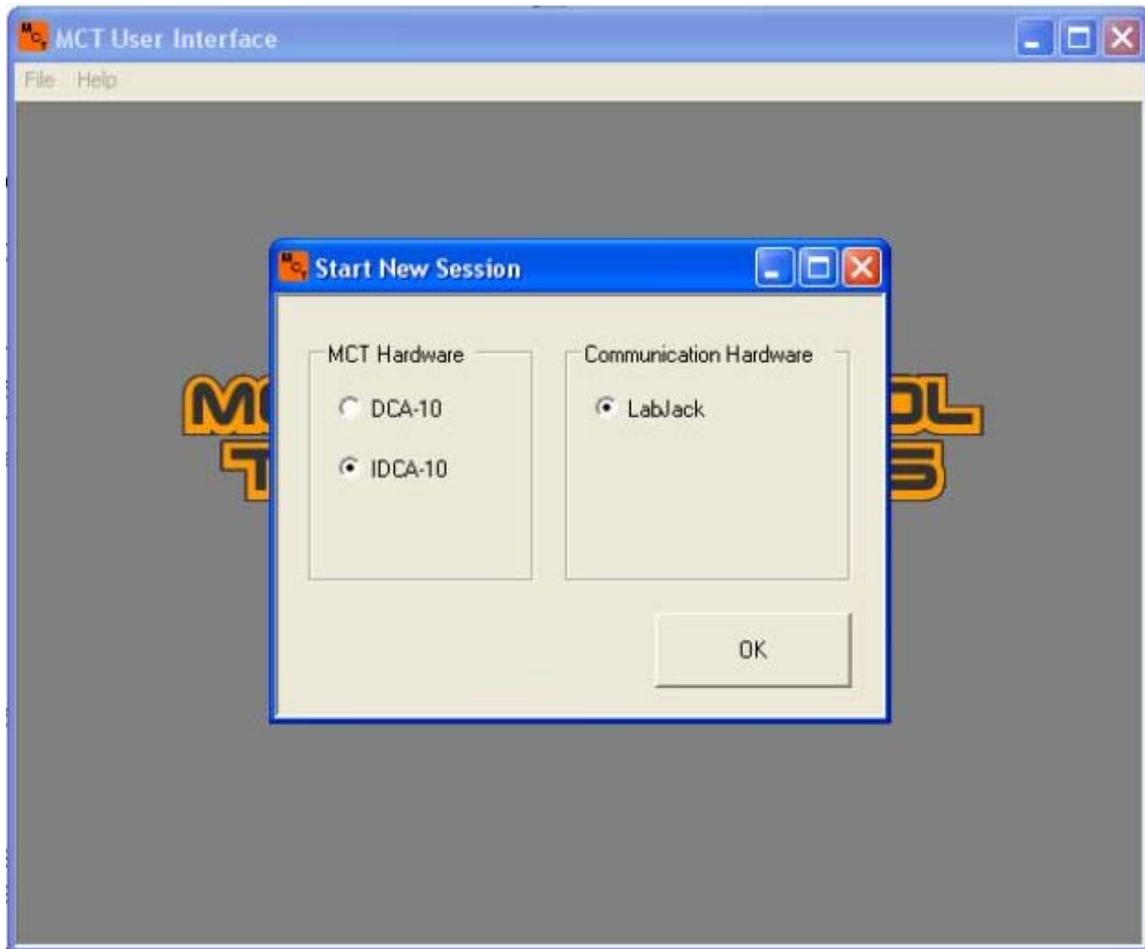


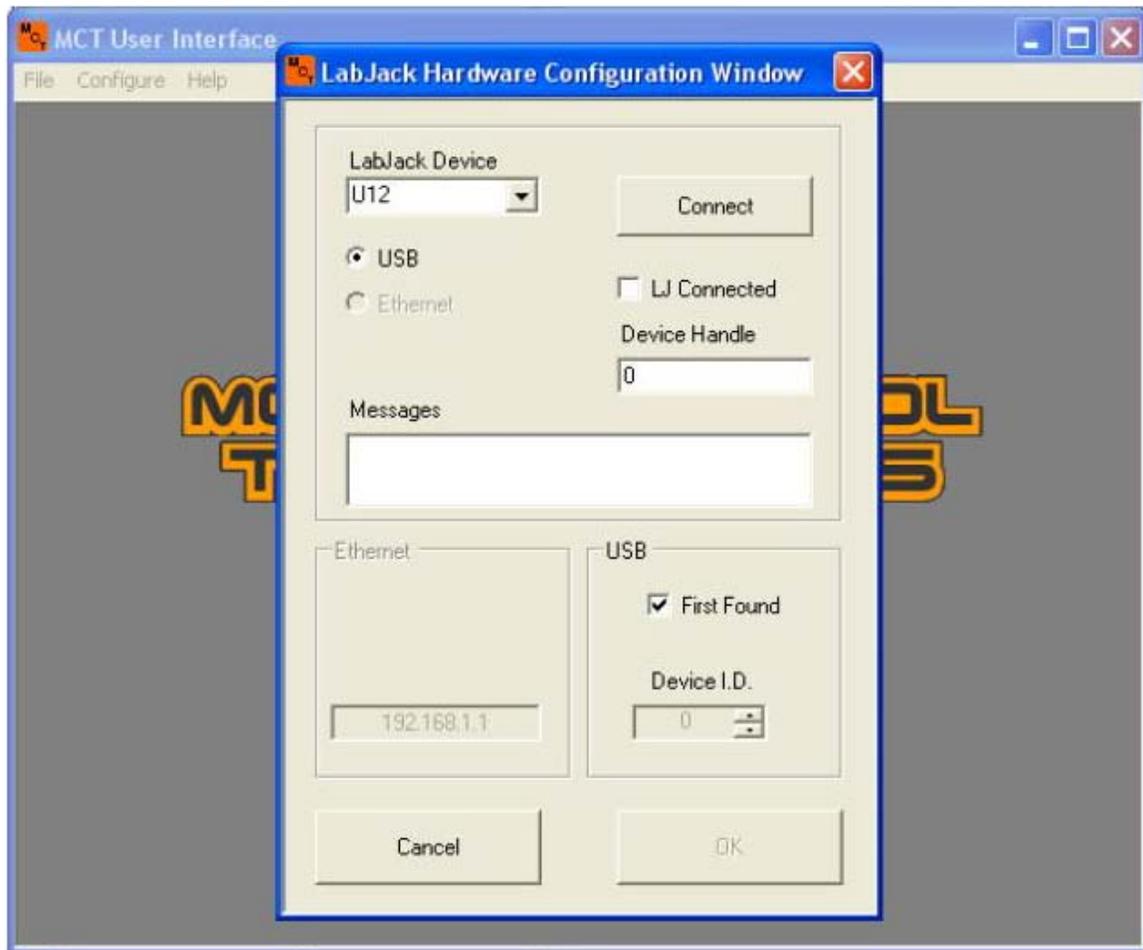
Figure 1. New session window.

## 3.2. Using the MCT U.I. with the DCA-10

### 3.2.1. LabJack Configuration

- Select **Configure**→**LabJack Configuration** from the main menu.

A new dialog window will open that provides options to establish communication between your PC and your LabJack device (Figure 2). It is assumed the user is already familiar with the LabJack connection parameters. Please refer to the appropriate hardware documentation for the LabJack hardware being used for further information about LabJack functionality.



**Figure 2. LabJack hardware configuration window.**

- Select the LabJack device from the *LabJack Device* drop-down menu.
- Configure USB or Ethernet options as necessary to communicate with your LabJack hardware.
- Select the *Connect* button to connect with the LabJack device.

The application will attempt to connect with your LabJack hardware. A success message will appear in the message box if a connection was successful. Any errors encountered during the connection process will be reported in the message box.

- Select the *OK* button if communication was established between the PC and LabJack device.

### 3.2.2. Communication IO Setup

- Select **Configure**→**Communication IO Setup** from the main menu.

A new window will open for configuring communication lines (Figure 3). The current master device and handle are listed at the top of the window. Below the *Master Device* and *Device Handle* boxes are the *Digital IO* and *Analog Inputs* group boxes. Inside the group box are controls to set which of the master's IO lines will connect to the DCA-10's digital and analog lines. The channels listed in the *Digital IO* group box are used to send control signals to the DCA-10. The channels listed in the *Analog Input* group box are used to read the analog voltage output from the DCA-10's CS pin.

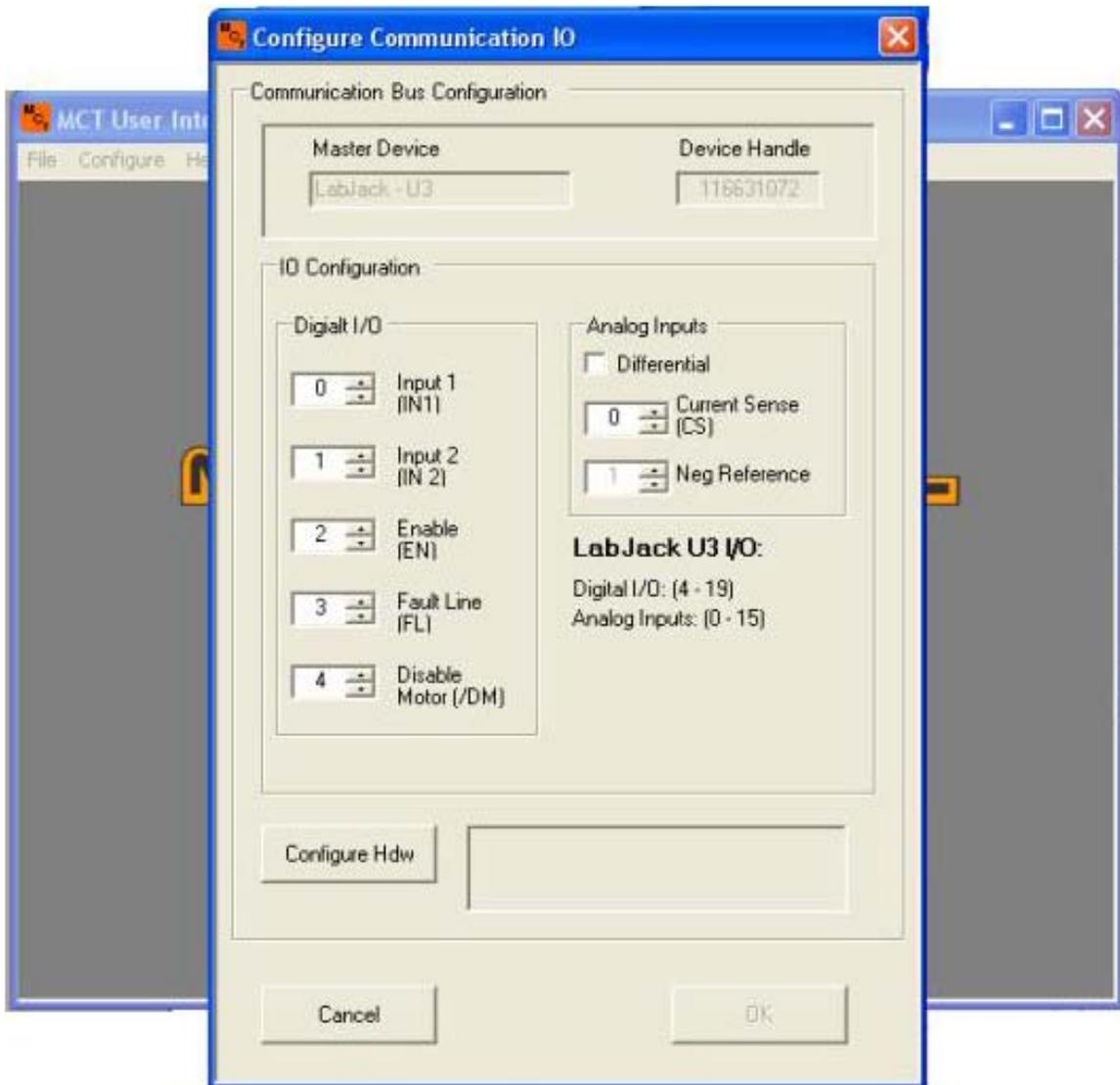


Figure 3. Communication IO Setup DCA-10.

The numbers displayed in the control boxes correspond to an IO channel number on the master hardware. The text to the right of each box lists the communication line name and the corresponding channel on the DCA-10 (listed in parentheses). Verify the connections made between the DCA-10 and the master hardware corresponds to what is listed in the *Digital IO* group box. Valid channel numbers for the master hardware are listed to in the bottom-right corner of the *IO Configuration* group box.

The MCT U.I. provides differential analog inputs for the CS pin. Differential readings may be necessary if ground offsets exist between the master hardware and the DCA-10 ground. Select the Differential checkbox to enable differential inputs. Set the negative reference to the appropriate analog input. Connect the negative reference to the DCA-10 GND pin.

Note:

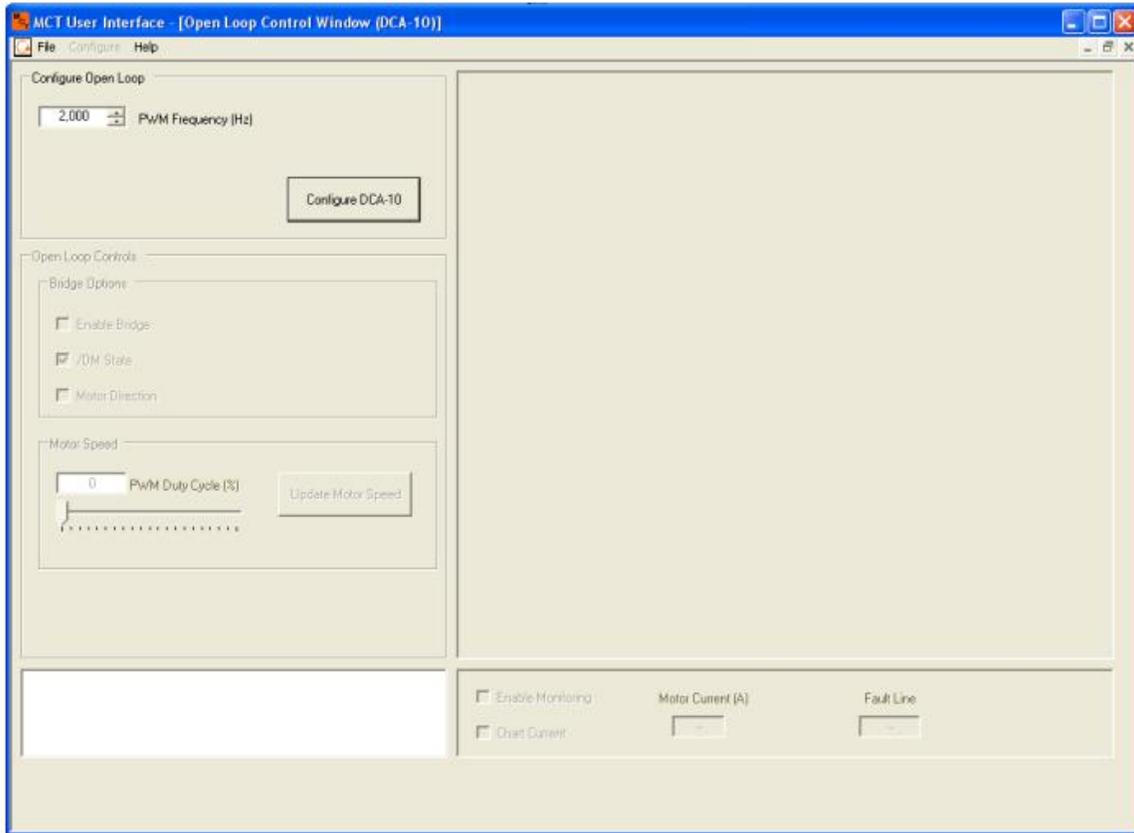
Analog inputs on the U12 are not supported by the user interface.

- Set the digital IO channels as required.
- Set the analog input channels as required.
- Select the *Configure Hdw* button to configure the master hardware. The OK button will activate if the configuration was successful and a success message will be displayed.
- Select the *OK* button to close the *Communication IO* window.

### 3.2.3. Open-loop Control Window

- Verify power is applied to the DCA-10.
- Select **Configure→Operating Mode→Open-loop**

A new *Open-loop* control window will open (Figure 4). All controls are disabled except those in the *Configure Open-loop* group box at the top of the window. In the top-left corner of the *Configure Open-loop* group box is the *PWM Frequency* control box. This control sets the PWM frequency output from the master hardware. Valid frequencies are 1kHz to 10kHz.



**Figure 4. DCA-10 Open-loop Window**

- Set the PWM frequency as required.
- Press the *Configure DCA-10* button.

The *Configure Open-loop* group box will become disabled and the *Open-loop Controls* will activate if the IDCA-10 configures successfully (Figure 5). At this point the DCA-10 is ready for open-loop operation. Controls necessary for operation are described in further detail in sections 3.2.3.1n and 3.2.3.2.

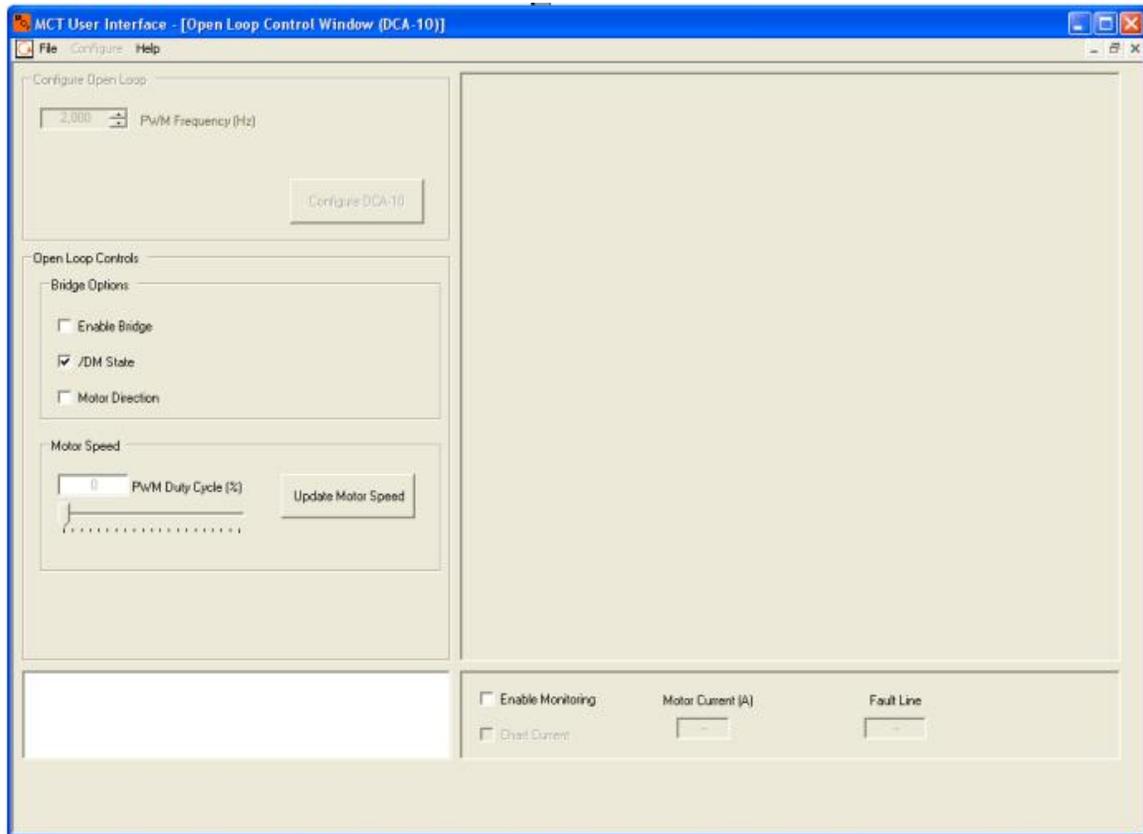


Figure 5. DCA-10 Open-loop operation

### 3.2.3.1. Bridge Options Group Box

#### **Enable Bridge**

The *Enable Bridge* checkbox enables and disables the DCA-10's H-bridge. The H-bridge is enabled when the check box is checked and disabled when the checkbox is unchecked. Disabling the H-bridge with the *Enable Bridge* check box places the H-bridge into a low power sleep mode and forces OUT1 and OUT2 into a high impedance state.

#### **/D1 State**

The */D1 State* checkbox controls the state of the disable line on the H-bridge. The bridge outputs (Out1 and Out2) are disabled and placed into high impedance state when */D1 State* checkbox is checked. Disabling the outputs using the */D1 State* checkbox is different than disabling the bridge with the Enable Bridge Checkbox. Disabling the outputs with the */D1 State* check box preserves H-bridge functionality and protection features. The */D1* line is useful for allowing a motor to decelerate without braking.

#### **Motor Direction**

The *Motor Direction* check box controls the direction the motor rotates. Changing the state of the check box will reverse the motor from the current direction of rotation.

Note:

The actual motor direction (clockwise vs. counter-clockwise) will depend on how the motor terminals are connected at OUT1 and OUT2.

### **3.2.3.2. Motor Speed**

#### **PWM Duty Cycle**

The *PWM Duty Cycle* control box defines the duty cycle for the PWM motor signal. The value reported in the control box is updated using the slider bar directly below it. Valid values are 0% (OFF) to 100% (Full power).

#### **Update Motor Speed**

Click this button when to update the PWM duty cycle to the value currently reported in the *PWM Duty Cycle* control box. Motor speed will only change when the *Update Motor Speed* button is pressed.

### **3.2.4. Data Options**

#### **3.2.4.1. Data Monitoring and Plotting Data**

The Open-loop control window provides options for monitoring certain parameters reported from the DCA-10. When enabled, the data monitor will check the listed parameters once every second and report the values to the text boxes at the bottom of the window. Data monitoring is enabled when the *Enable Monitoring* checkbox is checked.

A 128 second history of the motor current data can be displayed on the screen. To enable charting history, set the check in the *Chart Current* checkbox. (Figure 6).

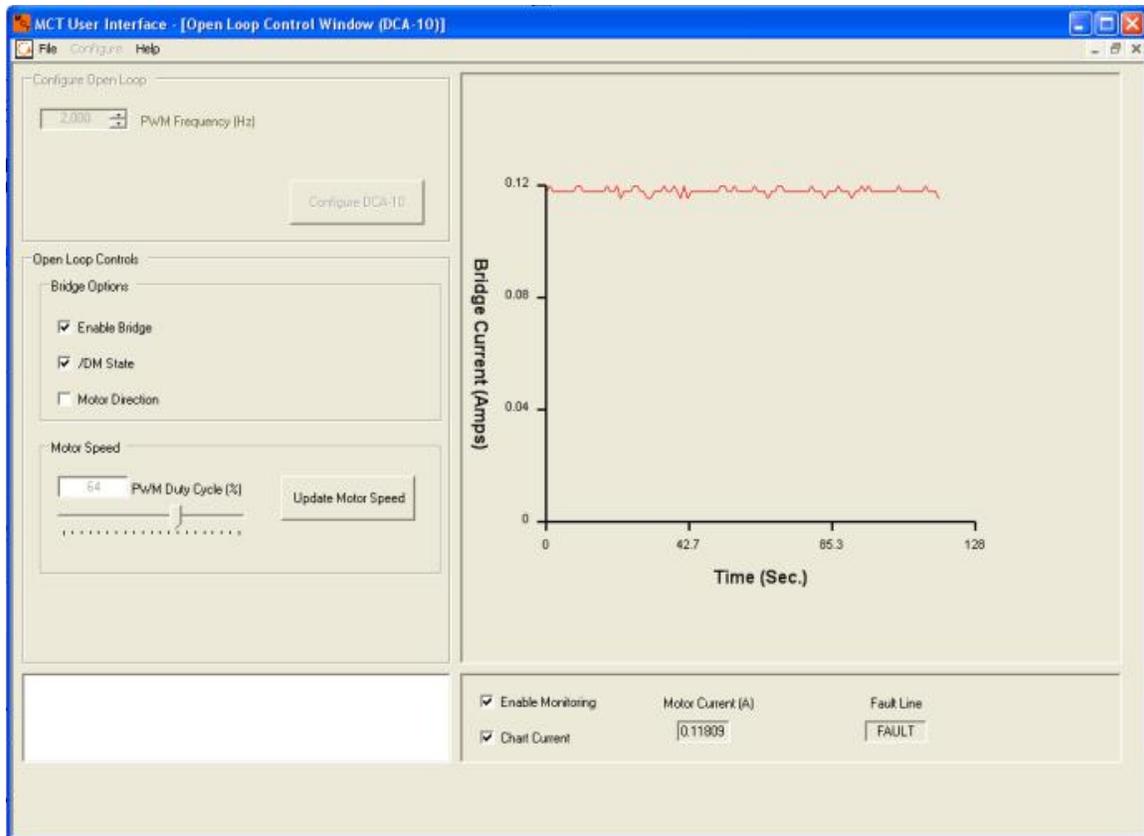


Figure 6. Open-loop control window with data plotting.

### 3.2.4.2. Saving Log or Monitor Data

Motor current data plotted during operation may be saved to file at any time.

- Configure the DCA-10 for operations.
- Select the *Enable Monitoring* check box
- Select the *Chart Current* check box to start plotting motor current data to the screen.
- Select **File**→**Save Log Data** from the main menu.

A save file dialog box will open prompting the user for a location to save the data file. Select the file destination and press the *OK* button. Data saved to file is saved as a tab-delimited text file.

### 3.3. Using the MCT U.I. with the IDCA-10

#### 3.3.1. LabJack Configuration

- Select **Configure**→**LabJack Configuration** from the main menu.

A new dialog window will open that provides options to establish communication between your PC and your LabJack device (Figure 7).

Note:

It is assumed the user is already familiar with the LabJack connection parameters. Please refer to the appropriate hardware documentation for the LabJack hardware being used for further information about LabJack functionality.

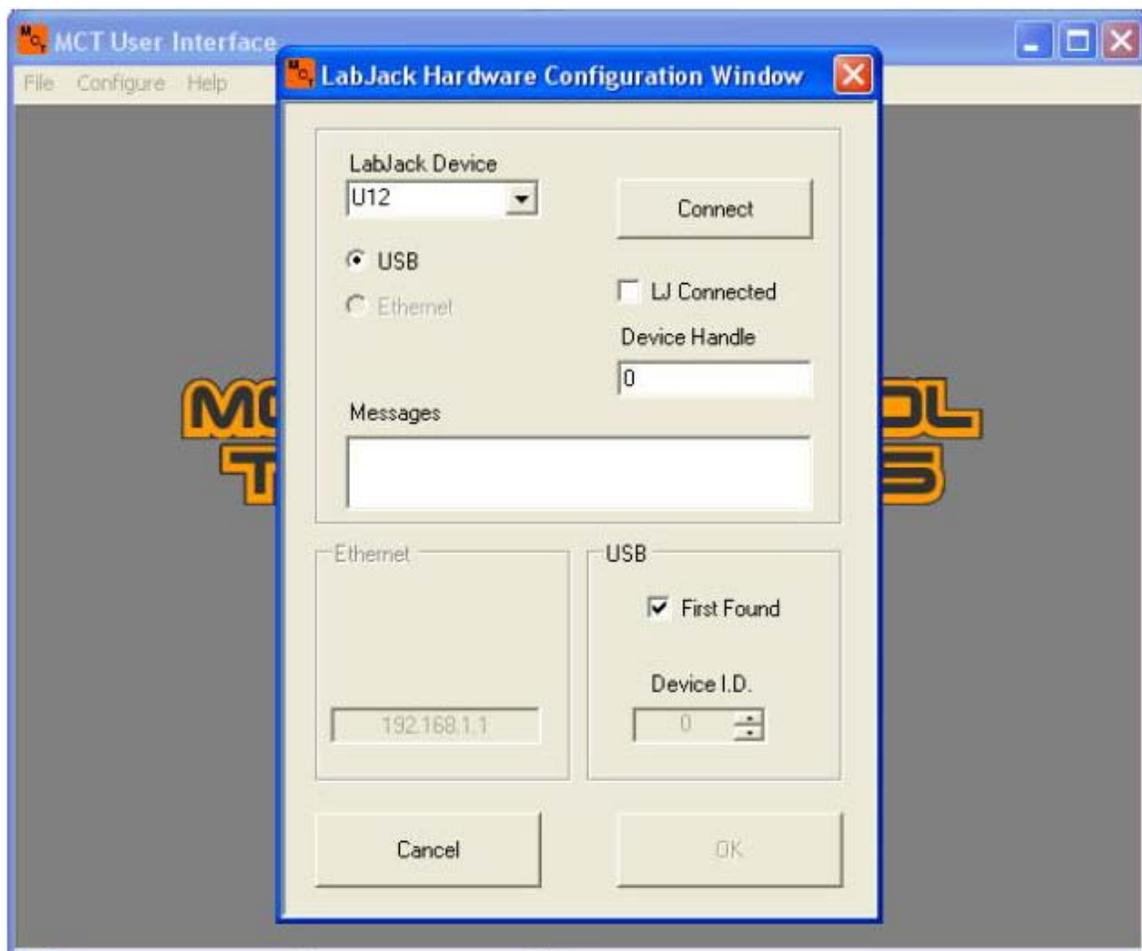


Figure 7. LabJack hardware configuration window.

- Select the LabJack device from the *LabJack Device* drop-down menu.

- Configure USB or Ethernet options as necessary to communicate with your LabJack hardware.
- Select the *Connect* button to connect with the LabJack device.

The application will connect with your LabJack hardware when the *Connect* button is pressed. A success message will appear in the message box if a connection was successful. Any errors encountered during the connection process will be reported in the message box.

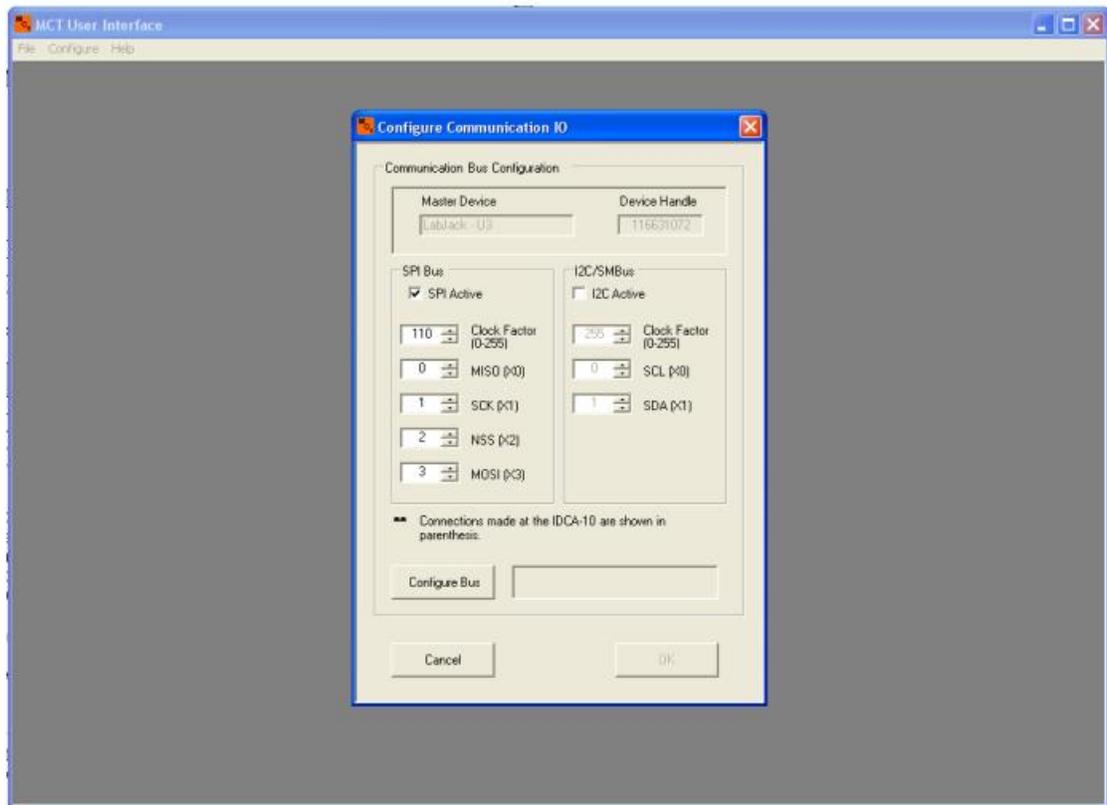
Note:

The *Tools* option is activated in main menu once communication is established with the LabJack hardware. Please see section 3.3.10 for more information on options in the *Tools* menu.

### 3.3.2. Communication IO Setup

- Select **Configure**→**Communication IO Setup** from the main menu.

A new window will open for configuring communication lines (Figure 8). The current master device and handle are listed at the top the window. Below the *Master Device* and *Device Handle* boxes are two group boxes for SPI and I<sup>2</sup>C/SMBus communications. One or both group boxes will be visible, depending on which methods are supported by the master hardware.



**Figure 8. Communication IO window.**

- Select the desired communication method by checking the *SPI Active* or *I<sup>2</sup>C /SMBus Active* checkbox.

Inside each group box are a number of controls to set the communication IO channels and clock speed. Begin by setting the clock factor, which determines the clock speed for the serial bus.

Table 2 and Table 3 list clock factors and the approximate clock speed for SPI and I2C/SMBus communications on LabJack hardware, respectively.

Note:

10 kHz is the recommended maximum serial clock frequency that should be used with the IDCA-10.

**Table 2. Clock factors and clock speeds for LabJack SPI serial communications.**

| LabJack Device | SPI Clock Factor | SPI Clock Speed (Hz) |
|----------------|------------------|----------------------|
| U12            | NA               | 10 kHz (default)     |
| U3             | 110              | 10 kHz               |
| U6             | 110              | 10 kHz               |
| UE9            | 20               | 10 kHz               |

**Table 3. Clock factors and clock speeds for LabJack I2C/SMBus communications.**

| LabJack Device | SPI Clock Factor | SPI Clock Speed (Hz) |
|----------------|------------------|----------------------|
| U12            | NA               | NA                   |
| U3             | 255              | 10 kHz               |
| U6             | 255              | 10 kHz               |
| UE9            | 255              | 10 kHz               |

The control boxes located below the *Clock Factor* determine which IO lines will be used for serial communications. The number inside each box corresponds to an IO channel number on the master hardware. To the right of each IO control box is text describing the serial bus channel name and the corresponding IDCA-10 channel (listed in parentheses).

- Set the master's serial lines to the appropriate IO channels.
- Verify the connections between the IDCA-10 and the master corresponds to the values set in the previous step.
- Select the *Configure Bus* button to configure the master hardware. The OK button will activate if the configuration was successful and a success message will be displayed.
- Select the *OK* button if the serial bus to close the *Communications IO Window*.

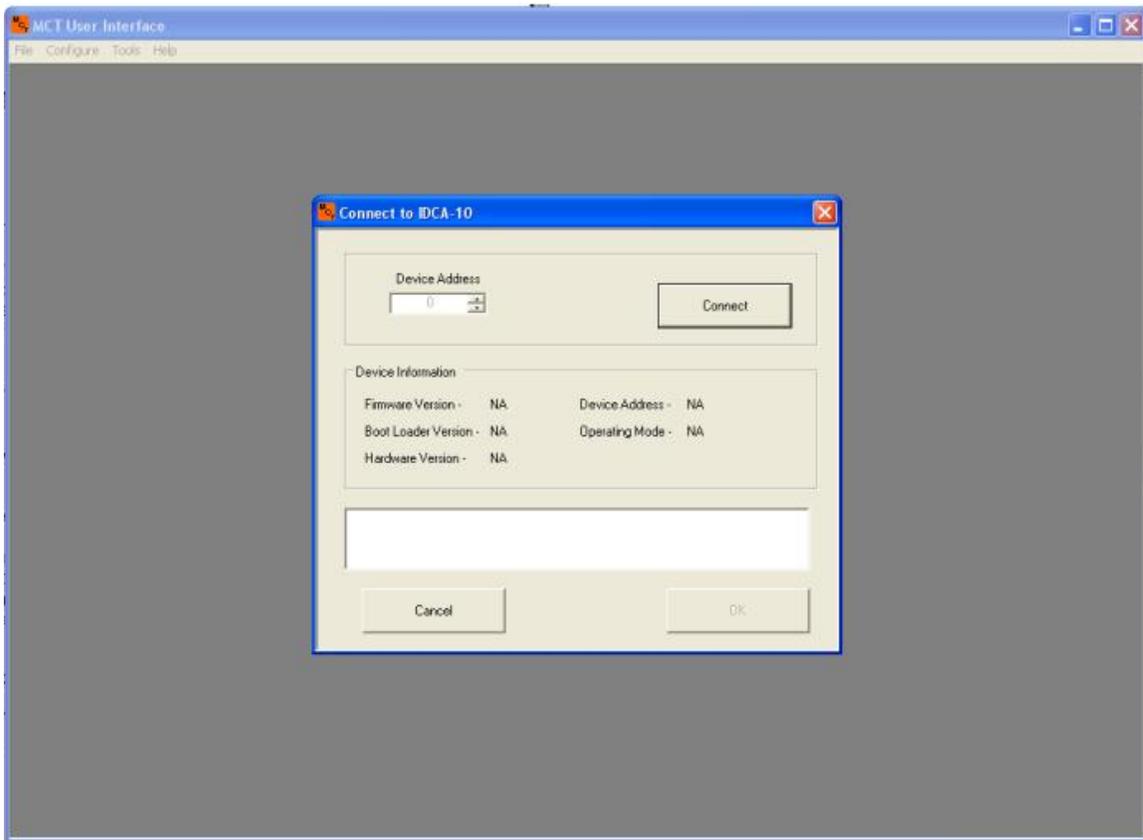
### 3.3.3. Connect with MCT Hardware

Select **Configure**→**Connect with MCT Hardware** from the main menu

A new dialog window will open (Figure 9). At the top of the box is a control for setting the device address for the IDCA-10.

Note:

The device address is only used for I<sup>2</sup>C/SMBus communications and will be disabled when using SPI as the communication method.



**Figure 9. Connect MCT Hardware window.**

- Set the device address to appropriate value between 0 (default) and 127 if you are using I<sup>2</sup>C/SMBus communications. Ignore the Device ID box if using SPI communications.
- Select the *Connect* button.

The data in the Device Information group box will update when a communication connection is established between the master hardware and the IDCA-10. The data will provide hardware/firmware version information and the device address stored in the nonvolatile memory. The window will also report the current mode the IDCA-10 is operating in. Default/Idle is the default startup state. Other operating modes can appear if the user programmed the IDCA-10 to start up in a particular mode.

- Review the data and select the *OK* button to close the window.

**Note:**

The device address stored in memory is reported even if SPI is being used as the communication method. This provides a convenient method

for determining the device address for I<sup>2</sup>C/SMBus communications if it is not known. In the event the user does not know the address for I<sup>2</sup>C communication; record the device address using SPI and then reconfigure for I2C, using the recorded address.

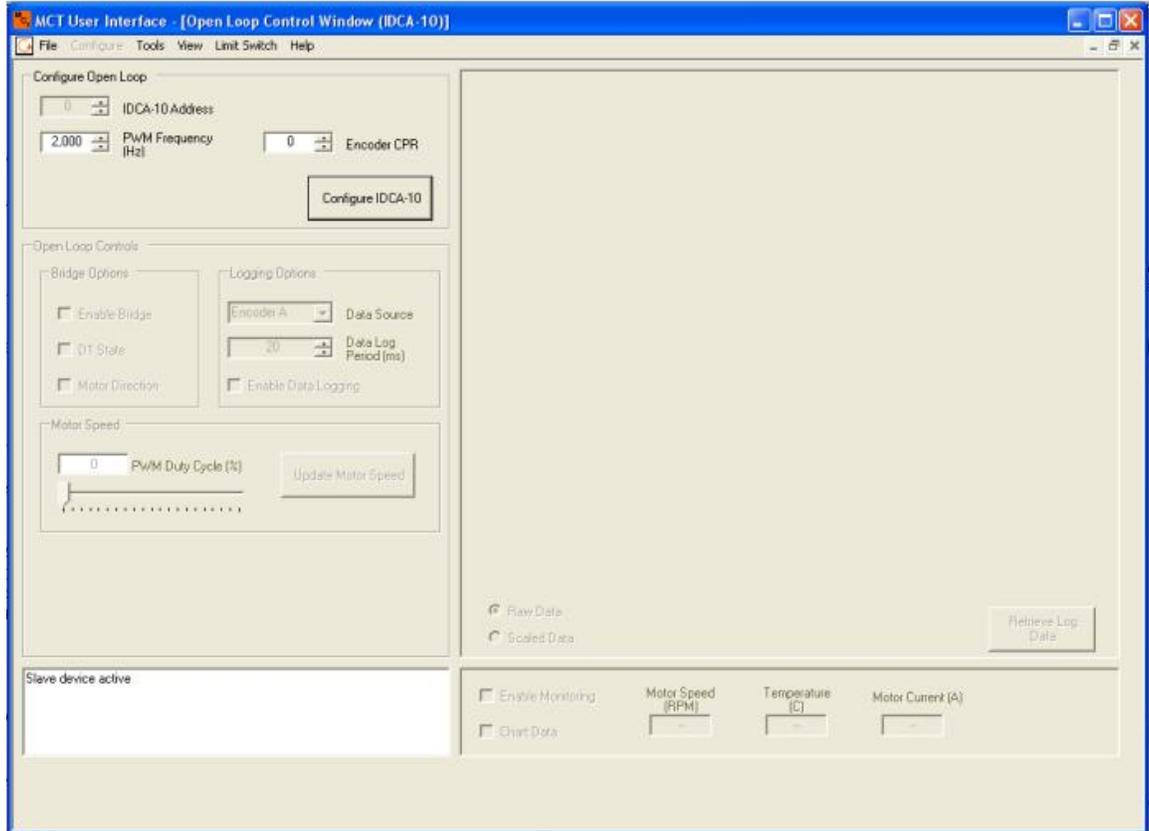
### 3.3.4. Configure Operating Mode

The IDCA-10 is capable of operating in four different modes:

1. Open-loop – Open-loop motor control. Motor speed is defined by the PWM duty cycle commanded by the user. Refer to section 3.3.5 for more information.
2. Speed Control – Closed loop speed control. A PID controller is used to maintain motor speed at a commanded set point. Feedback for the PID controller is derived from a quadrature encoder on the motor. Refer to section 3.3.6 for more information.
3. Position Control – Closed loop speed and position control. Motor speed and position are controlled using feed back control methods. The feedback signal is derived from a quadrature encoder on the motor. Refer to section 3.3.7 for more information.
4. Stand-alone – A special mode for any of the three of the operating modes described above. Stand-alone enables control of the IDCA-10 via the analog input line AIN instead of the serial bus. See section 3.3.8 for more information.

### 3.3.5. Open-loop Control Window

Select **Configure**→**Operating Mode**→**Open-loop** from the main menu. A new Open-loop control window will open (Figure 10).



**Figure 10. Open-loop Control window.**

All controls are disabled except those in the *Configure Open-loop* group box when the window first loads. The IDCA-10 must be configured before open-loop functionality is made available. Controls for configuring open-loop mode are described in section 3.3.5.1.

- Set the configuration controls to appropriate values.
- Press the *Configure IDCA-10* button to configure the IDCA-10 for open-loop operation.

The *Configure Open-loop* group box will disable and the *Open-loop Controls* group box will activate if configuration is successful (Figure 11). At this point the IDCA-10 is ready for open-loop operation. Controls necessary for operation are described in further detail in sections 3.3.5.2 through 3.3.5.4.

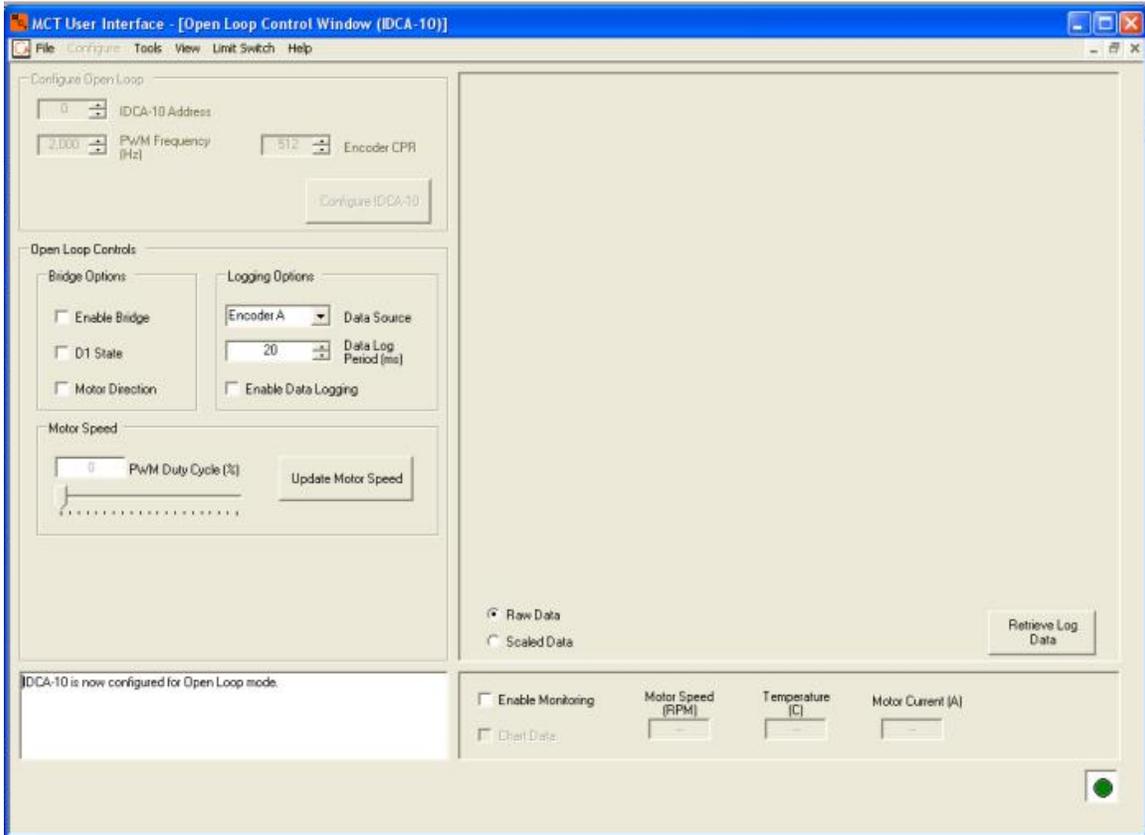


Figure 11. Open-loop Controls.

### 3.3.5.1. *Configure Open-loop Control*

#### **IDCA-10 Address**

The *IDCA-10 address* box reports the IDCA-10 device address. Change the address value to communicate with a different device or leave alone to communicate with the current device. SPI communications does not use device addressing for communication. The *IDCA-10 Address box* is disabled when using SPI communication.

#### **PWM Frequency (Hz)**

The *PWM Frequency* control box determines the frequency of the PWM signal output to the motor. Valid frequencies are 1kHz to 10kHz.

#### **Encoder CPR**

The number of counts per revolution for the encoder installed on the motor. The value in Encoder CPR is used for logging and monitoring processes. Incorrect values entered here will result in incorrect motor speeds reported by the application.

#### **Note:**

A motor encoder is not required for open-loop operations. Set the encoder CPR value to a nonzero number if a encoder is not being used.

### **3.3.5.2. Bridge Options Group Box**

#### **Enable Bridge**

The *Enable Bridge* checkbox enables and disables the H-bridge on the IDCA-10. The H-bridge is enabled when the check box is checked and disabled when the checkbox is unchecked. Disabling the H-bridge with the *Enable Bridge* check box places the H-bridge into a low power sleep mode and forces OUT1 and OUT2 into a high impedance state.

#### **D1 State**

The *D1 State* checkbox controls the state of the disable line on the H-bridge. The bridge outputs (Out1 and Out2) are disabled and placed into high impedance state when *D1 State* checkbox is checked. Disabling the outputs using the *D1 State* checkbox is different than disabling the bridge with the Enable Bridge Checkbox. Disabling the outputs with the D1 State check box preserves H-bridge functionality and protection features, and allows the motor to decelerate without braking.

#### **Motor Direction**

The *Motor Direction* check box controls the direction the motor rotates. Changing the state of the check box will reverse the motor from the current direction of rotation.

#### **Note:**

The actual motor direction (clockwise vs. counter-clockwise) will depend on how the motor terminals are connected at OUT1 and OUT2.

### **3.3.5.3. Logging Options**

#### **Data Source Dropdown**

Select between one of three sources for logging data on the IDCA-10.

- Encoder A – Motor encoder channel A.
- Encoder B – Motor encoder channel B.
- Motor Current – Current flowing through the motor windings.

#### **Data Log Period (ms)**

Sets the data logger period, measured in milliseconds. Data is logged in 128 sample bursts. The total time required to collect data is the data log period multiplied by 128. Valid values for the data log period are 5 ms to 255 ms.

Note:

Data logging can consume a considerable portion of controller resources. Multiple consecutive calls to log data can impact controller performance.

#### **3.3.5.4. Motor Speed**

##### **PWM Duty Cycle**

The *PWM Duty Cycle* control box defines the duty cycle for the PWM motor signal. The value reported in the control box is updated using the slider bar directly below it. Valid values are 0% (OFF) to 100% (Full power).

##### **Update Motor Speed**

Click this button to update the PWM duty cycle to the value currently reported in the *PWM Duty Cycle* control box. Motor speed will only change when the *Update Motor Speed* button is pressed.

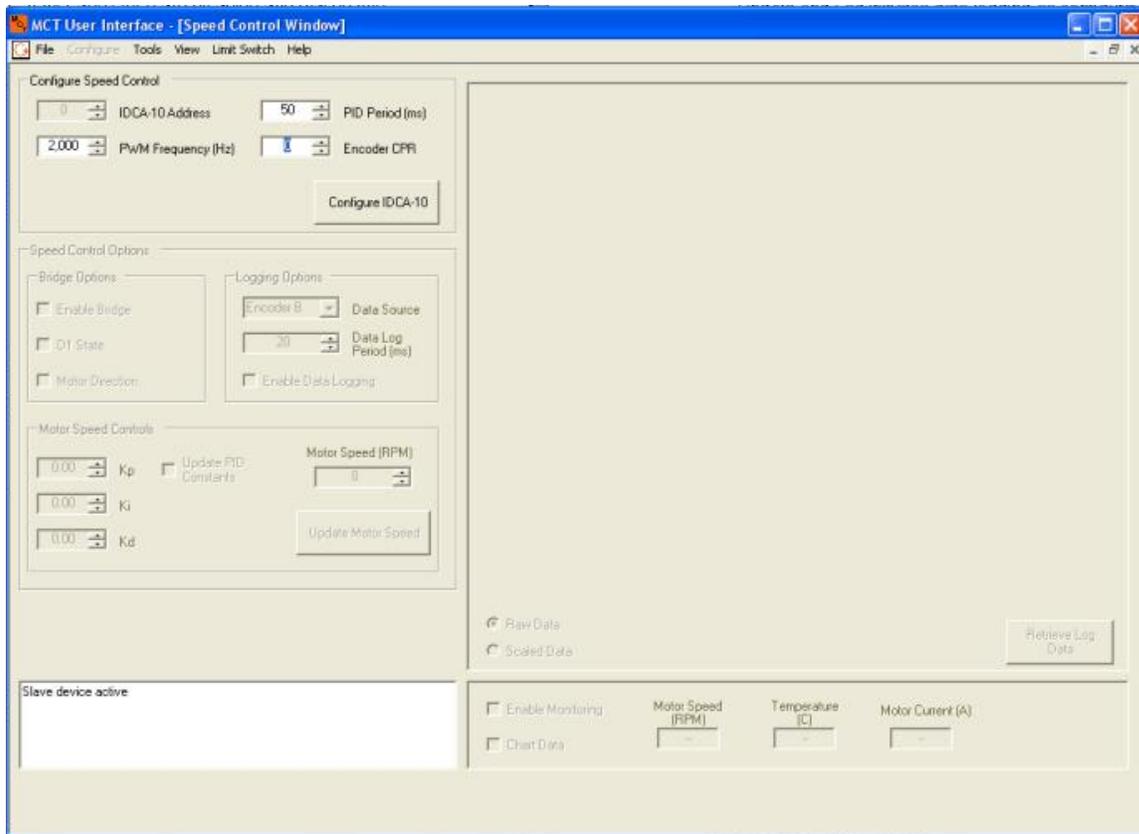
##### **Enable Data Logging**

The *Enable Data Logging* check box enables data logging on the IDCA-10 when checked. Data logging parameters are determined by the values set in *Data Source* drop down menu and *Data Log Period* control box. Once enabled, data logging will begin when the user updates the motor speed by selecting the *Update Motor Speed* button. The check in the *Enable Data Logging* checkbox will automatically clear when data collection has finished. The UI data logging option is useful for monitoring the step response of a motor.

#### **3.3.6. Speed Control Window**

- Select **Configure→Operating Mode→Speed Control** from the main menu.

A new speed control window will open (Figure 12). All controls are disabled except those in the *Configure Speed Control* group box. The IDCA-10 must be configured before speed control functionality is made available. Options for configuring speed control mode are described in the section 3.3.6.1.



**Figure 12. Speed Control Window**

- Set the IDCA-10 address field to an appropriate value (I<sup>2</sup>C mode only). The IDCA-10 address field will be disabled when the SPI bus is being used for communication.
- Set the *PWM Frequency* field.
- Set the *PID Period* field.
- Set the *Encoder CPR* field.
- Press the *Configure IDCA-10* button to configure hardware.

Upon successful configuration, the *Configure Speed Control* group box will become disabled, and previously disabled group boxes will become enabled (Figure 13). At this point the IDCA-10 is ready for speed control. Controls necessary for operation are described in further detail in sections 3.3.6.2 through 3.3.6.4.

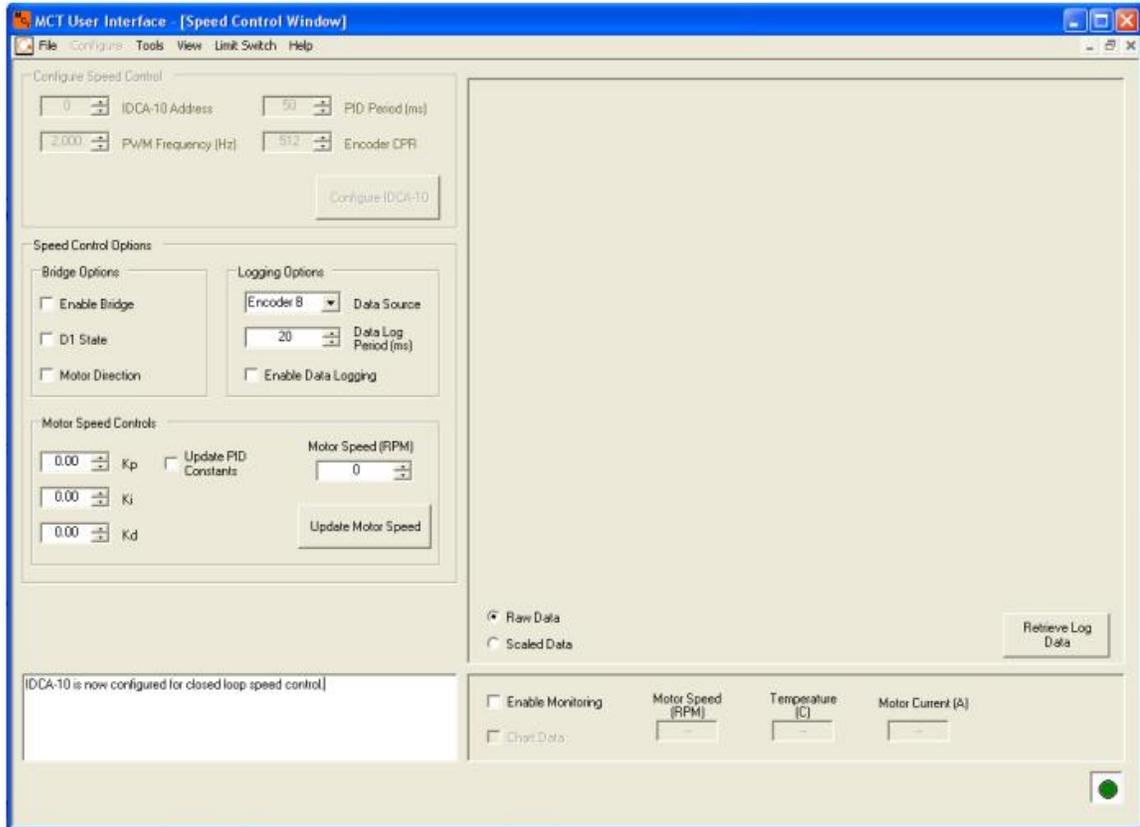


Figure 13. Speed control window configured.

### 3.3.6.1. *Configure Speed Control Options*

#### **IDCA-10 Address**

The *IDCA-10 address* box reports the IDCA-10 device address of the device connected to in the previous configuration steps. Change the address value to communicate with a different device or leave alone to communicate with the current device. SPI communications does not use device addressing for communication. The *IDCA-10 Address box* is disabled when using SPI communication.

#### **PWM Frequency (Hz)**

The *PWM Frequency* control box determines the frequency of the PWM signal output to the motor. Valid frequencies are 1kHz to 10kHz.

#### **PID Period**

The *PID Period* control box defines the update rate used by the PID controller. This period controls how often the PID controller reads the feedback signal to control motor speed. Valid values are 5 ms to 255 ms.

#### **Encoder CPR**

The *Encoder CPR* control box defines number of counts per revolution for the encoder installed on the motor. The value in Encoder CPR is used by the PID controller and is used for logging and monitoring processes. Incorrect values entered in the *Encoder CPR* control box will result in incorrect controller operation.

### **3.3.6.2. Bridge Options Group Box**

#### **Enable Bridge**

The *Enable Bridge* checkbox enables and disables the IDCA-10's H-bridge. The H-bridge is enabled when the check box is checked and disabled when the checkbox is unchecked. Disabling the H-bridge with the *Enable Bridge* check box essentially turns off the h-bridge and places it into a low-current sleep mode. Protection features available through the H-bridge are disabled when it is placed into sleep mode.

#### **D1 State**

The *D1 State* checkbox controls the state of the disable line on the H-bridge. The bridge outputs (Out1 and Out2) are disabled and placed into high impedance state when *D1 State* checkbox is checked. Disabling the outputs using the *D1 State* checkbox is different than disabling the bridge with the Enable Bridge Checkbox. Disabling the outputs with the D1 State check box preserves H-bridge functionality and protection features, and allows the motor to decelerate without braking.

#### **Motor Direction**

The *Motor Direction* check box controls the direction the motor rotates. Changing the state of the check box will reverse the motor from the current direction of rotation.

#### **Note:**

The actual motor direction (clockwise vs. counter-clockwise) will depend on how the motor terminals are connected at OUT1 and OUT2.

### **3.3.6.3. Logging Options**

#### **Data Source**

The *Data Source* dropdown menu is used to select what data to log on the IDCA-10.

- Encoder B – Motor encoder channel B.
- Motor Current – Current flowing through the bridge and motor.

#### **Data Log Period (ms)**

The Data Log Period is the period used to log data measured in ms. Data is logged in bursts, consisting of 128 samples. The total time required to

collect data is the data log period multiplied by 128. Valid logging periods are 5 ms to 255 ms.

Note:

Data logging can consume a considerable portion of controller resources. Multiple consecutive calls to log data can impact controller performance.

### **Enable Data Logging**

The *Enable Data Logging* check box enables data logging on the IDCA-10 when checked. Data logging parameters are determined by the values set in *Data Source* drop down menu and *Data Log Period* control box. Once enabled, data logging will begin when the user updates the motor speed by selecting the *Update Motor Speed* button (section 3.3.6.4). The check in the *Enable Data Logging* checkbox will automatically clear when data collection has finished. The UI data logging option is useful for monitoring PID controller performance when motor speed is changed.

## **3.3.6.4. Motor Speed Controls**

### **PID Gain Constants (Kp, Ki, and Kd)**

The PID gain constant control boxes define the proportional, integral, and derivative gain used by the PID controller. The gain constants can be updated at any time by changing the value in the text box and selecting the *Update PID Constants* checkbox.

### **Update PID Constants**

The *Update PID Constants* check box is used to change the PID constants. All three PID constants are updated to the current value in each control box when the *Update PID Constants* checkbox is selected. A check will appear in the checkbox when constants are being updated, and will clear when the update process is complete. PID values are stored in RAM and will be erased when the unit is reset. See section 3.3.10.7 for more information on how to save PID constants to nonvolatile memory.

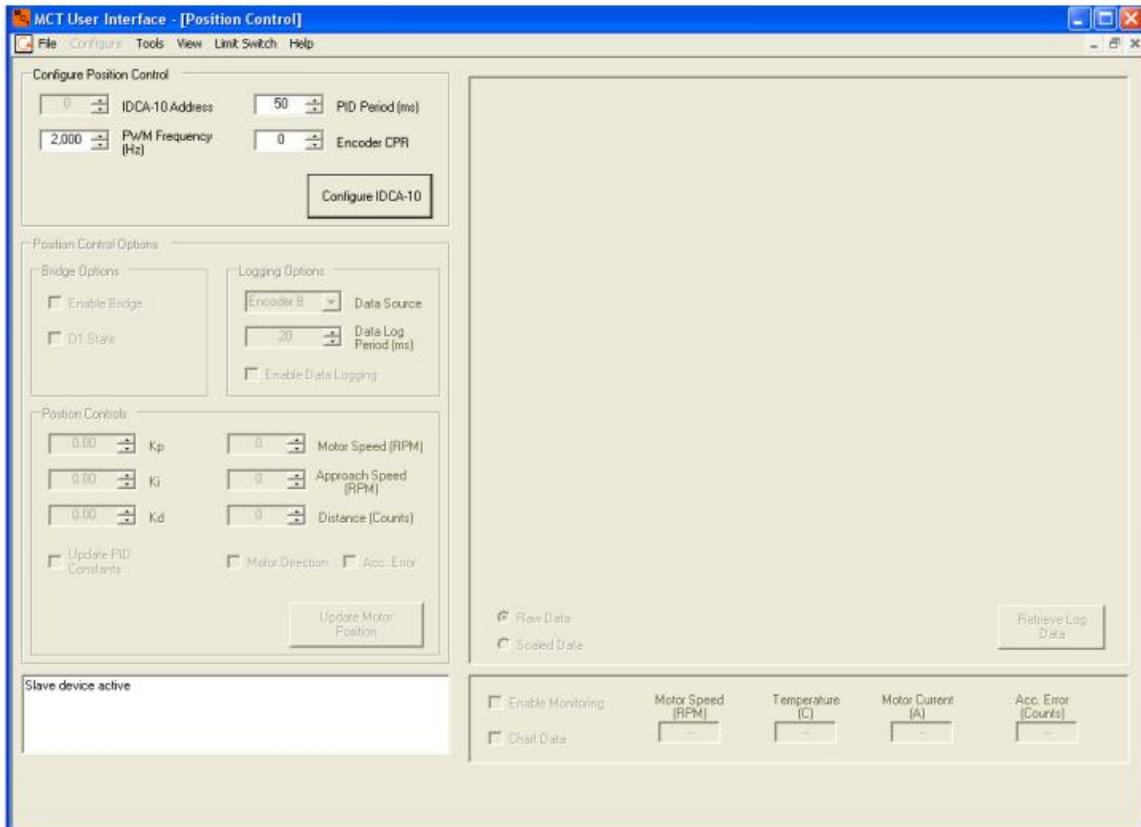
### **Update Motor Speed**

The *Update Motor Speed* button is used to update the speed set point for the PID controller. Motor speed will only change when the *Update Motor Speed* button is pressed. Data logging will begin when the *Update Motor Speed* button is pressed if the *Enable Data Logging* check box is checked in the *Logging Options* group box.

### 3.3.7. Position Control Window

- Select **Configure**→**Operating Mode**→**Position Control** from the main menu.

A new position control window will open (Figure 14). All controls are disabled except those in the *Configure Position Control* group box. All values in the Configure Position Control box must be set to valid values before configuration can continue.



**Figure 14. Position control window.**

- Set the IDCA-10 address field to an appropriate value (I<sup>2</sup>C mode only). The IDCA-10 address field will be disabled when the SPI bus is being used for communication.
- Set the *PWM Frequency* field.
- Set the *PID Period* field.
- Set the *Encoder CPR* field.

- Press the *Configure IDCA-10* button to configure hardware.

Upon successful configuration, the *Configure Position Control* group box will become disabled, and previously disabled group boxes will become enabled (Figure 15). At this point the controller is waiting for commands to position the motor. All positioning is done using the controls in the *Position Control Options* group box. Further discussion on the use of each control is provided in sections 3.3.7.1 through 3.3.7.3.

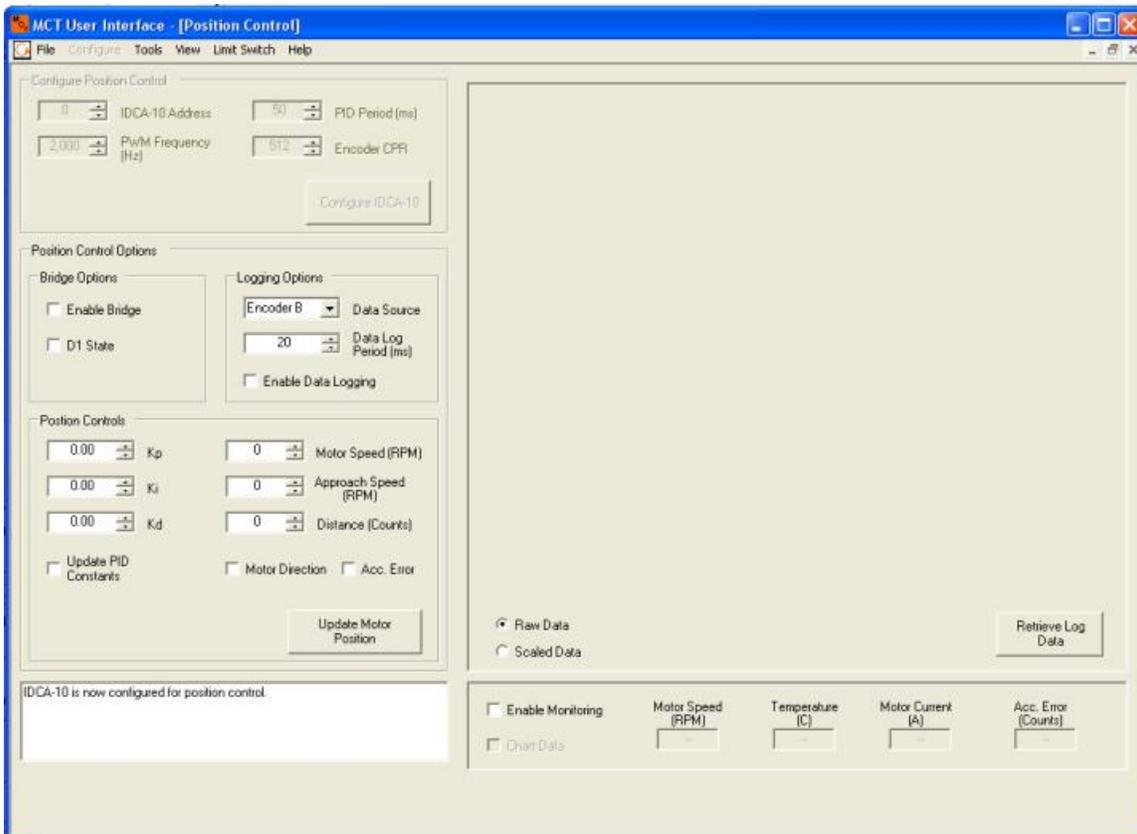


Figure 15. Position control window after successful configuration.

### 3.3.7.1. Bridge Options

#### Enable Bridge

The *Enable Bridge* checkbox enables and disables the IDCA-10's H-bridge. The H-bridge is enabled when the check box is checked and disabled when the checkbox is unchecked. Disabling the H-bridge with the *Enable Bridge* check box places the H-bridge into a low-current sleep mode and sets the outputs to a high-impedance state. Protection features available through the H-bridge are disabled when it is placed into sleep mode.

### **D1 State**

The *D1 State* checkbox controls the state of the disable line on the H-bridge. The bridge outputs (Out1 and Out2) are disabled and placed into high impedance state when *D1 State* checkbox is checked. Disabling the outputs using the *D1 State* checkbox is different than disabling the bridge with the Enable Bridge Checkbox. Disabling the outputs with the *D1 State* check box preserves H-bridge functionality and protection features, and allows the motor to decelerate without braking.

### **3.3.7.2. Logging Options**

#### **Data Source**

The *Data Source* dropdown menu is used to select the data source on the IDCA-10.

- Encoder B – Motor encoder channel B.
- Motor Current – Current flowing through the bridge and motor.

#### **Data Log Period (ms)**

The *Data Log Period* is the period used to log data measured in ms. Data is logged in 128 sample bursts. The total time required to collect data is the data log period multiplied by 128. Valid logging periods are 5 ms to 255 ms.

#### **Note:**

Data logging can consume a considerable portion of controller resources. Multiple consecutive calls to log data can impede controller performance.

#### **Enable Data Logging**

The *Enable Data Logging* check box enables data logging on the IDCA-10 when checked. Data logging parameters are determined by the values set in *Data Source* drop down menu and *Data Log Period* control box. Once enabled, data logging will begin when the user updates the motor position by selecting the *Update Motor Position* button. The check in the *Enable Data Logging* checkbox will automatically clear when data collection has finished. The UI data logging option is useful for monitoring PID controller performance when motor position is changed.

### **3.3.7.3. Position Controls**

#### **PID Gain Constants (Kp, Ki, and Kd)**

The PID gain constant values define the proportional, integral, and derivative gain used by the PID controller. The values initially reported in the control boxes are set to the same values stored in the IDCA-10 RAM. The gain constants can be updated at any time by changing the value in the text box and selecting the *Update PID Constants* checkbox.

### **Update PID Constants**

The *Update PID Constants* check box is used to change the PID constants in RAM. All three PID constants are updated to the current value in each control box when the *Update PID Constants* checkbox is selected. A check will appear in the checkbox when constants are being updated, and will clear when the update process is complete. PID values are stored in RAM. Constants stored in RAM are erased when the unit is reset. See section 3.3.10.7 for more information on how to save PID constants to nonvolatile memory.

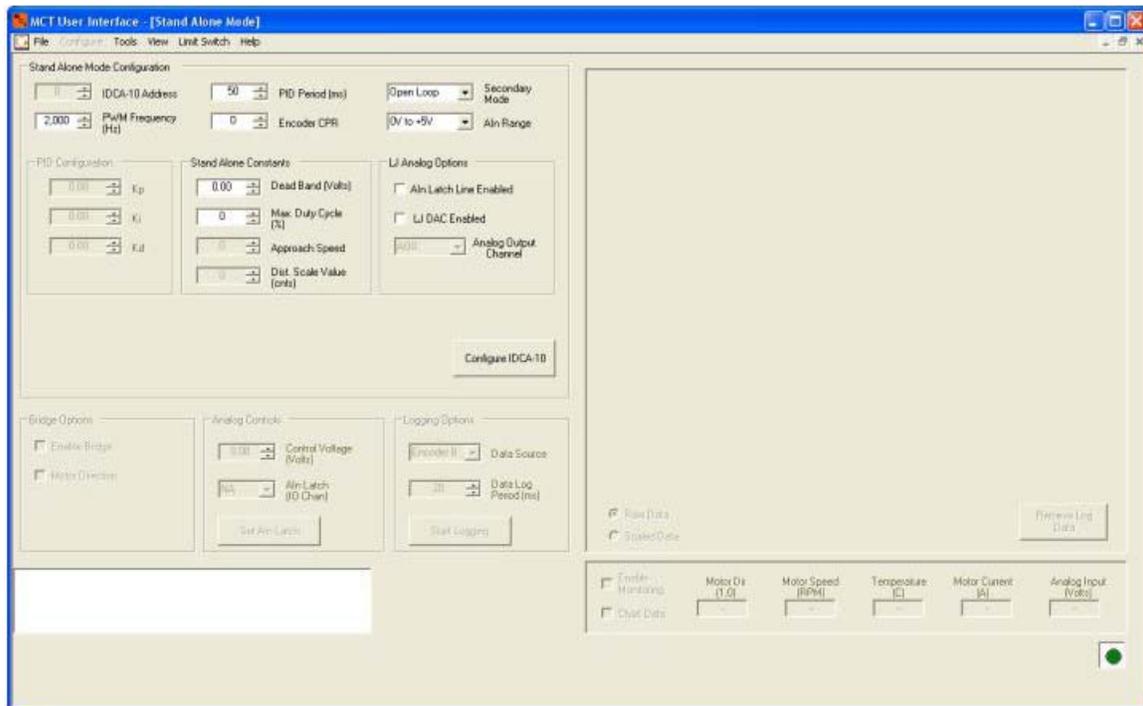
### **Update Motor Position**

The *Update Motor Speed* button is used to update the speed set point for the PID controller. Motor speed will only change when the *Update Motor Speed* button is pressed.

## **3.3.8. Stand-alone Control Window**

- Select **Configure→Operating Mode→Stand-alone** from the main menu.

A new stand-alone control window will open (Figure 16). All controls are disabled except those in the *Stand-alone Configuration* group box. All values in the *Stand-alone Configuration* group box must be set to valid values before configuration can continue. Each control in the *Stand-alone Configuration* group box is discussed in detail in sections 3.3.8.1 through 3.3.8.4.



**Figure 16. Stand-alone control window.**

- Set the IDCA-10 address field to the appropriate value (I<sup>2</sup>C mode only). The IDCA-10 address field will be disabled when the SPI bus is being used for communication.
- Set the *PWM Frequency* field.
- Set the *PID Period* field.
- Set the *Encoder CPR* field.
- Select a secondary mode from the *Secondary Mode* drop down menu.
- Select a valid analog input range from the *Ain Range* drop down menu.
- Set the appropriate values in the *PID Configuration* group box.
- Set the appropriate values in the *Stand-alone Constants* group box.
- Set the appropriate values in the *LJ Analog Options* group box.
- Press the *Configure IDCA-10* button to configure hardware.

Upon successful configuration, the Configure Position Control group box will become disabled and the other group boxes will become enabled

(Figure 17). At this point the IDCA-10 is ready for stand-alone control mode. Although the AIN line is the only required control input, the MCT U.I. provides useful data logging tools for testing in stand-alone mode operation. Section 3.3.8.5 discusses each of these tools in further detail.

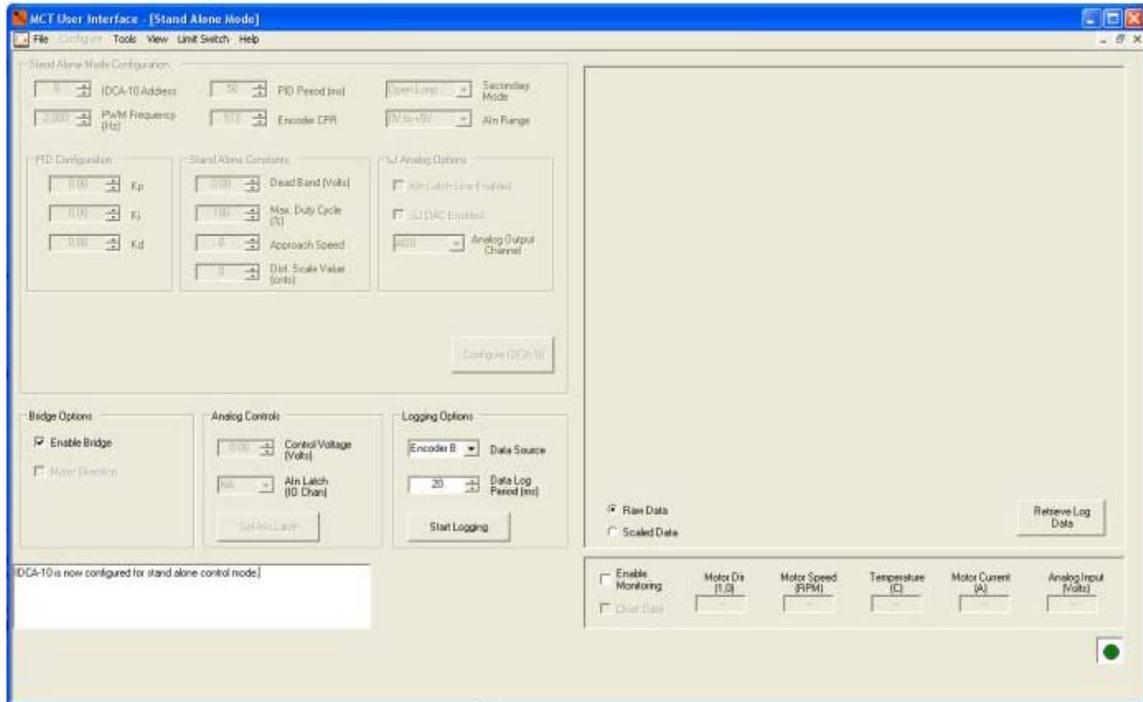


Figure 17. Stand-alone control window after successful configuration.

### 3.3.8.1. Stand-alone Configuration Values

#### Device Address

The device address assigns a unique identifying address to the IDCA-10, and is only used with I<sup>2</sup>C communications. The device address will be disabled when using SPI as the communication method. Valid device addresses are 0-127.

#### PWM Frequency

Sets the switching frequency for the PWM signal output on OUT 1 and OUT 2. Valid PWM frequencies are between 1 kHz and 10 kHz.

#### PID Period

Sets the update rate for the internal PID control loop. The PID period in the control box is represented in milliseconds.

#### Encoder CPR

Sets the resolution of the motor's encoder. The value set in the Encoder CPR field is equal to the number of counts reported by the encoder for every one revolution of the motor shaft.

**Secondary Mode**

Sets the secondary mode used in for stand-alone mode. The secondary mode may be set to:

1. Open-loop
2. Closed loop speed control
3. Position control

**Analog Input Range**

Sets the analog input range used for controlling the motor in stand-alone mode. The analog input range is scaled to span the operating range defined by the values in the *Stand-alone Constants* group box.

**3.3.8.2. PID Configuration**

**PID Gain Constants (Kp, Ki, and Kd)**

The PID gain constant control boxes define the proportional, integral, and derivative gain used by the PID controller. The values initially reported in the control boxes are set to the same values stored in the IDCA-10 RAM. The gain constants can be updated at any time by changing the value in the text box and selecting the *Update PID Constants* checkbox.

**3.3.8.3. Stand-alone Constants**

Different values in the *Stand-alone Constants* group box are available depending on the operating mode being used. Table 4 lists the stand-alone constants and their applicable operating modes.

**Table 4. Stand-alone constants and applicable operating modes.**

| <b>Stand-alone Constant</b> | <b>Open-loop control</b> | <b>Speed Control</b> | <b>Position Control</b> |
|-----------------------------|--------------------------|----------------------|-------------------------|
| Dead Band                   | <b>X</b>                 | <b>X</b>             | <b>X</b>                |
| Max Duty Cycle              | <b>X</b>                 |                      |                         |
| Max Speed                   |                          | <b>X</b>             | <b>X</b>                |
| Approach Speed              |                          |                      | <b>X</b>                |
| Dist. Scale Value           |                          |                      | <b>X</b>                |

**Dead Band**

*Dead Band* sets the dead band for the analog input. The dead band represents the change in analog voltage the IDCA-10 will allow before taking action. For example, setting the dead band to 0.1 volt will set a +/- 0.1 volt range on the last valid analog reading made by at AIN. The

controller will not take action until an analog voltage is read that falls outside the dead band range. This option is useful to deal with noise that may be present on the analog control signal.

### **Max Duty Cycle**

In open-loop mode the Max Duty Cycle value is used to map a range of duty cycles to the analog input range. The Max Speed value should be the maximum permissible duty cycle measured in percent.

### **Max Speed**

In speed control mode the *Max Speed* value is used to map a motor speed range to the analog input range. The *Max Speed* value should be the maximum permissible motor speed represented in RPM.

In position control mode the *Max Speed* value determines the speed the motor starts at when a new position command is sent to the controller.

### **Approach Speed**

Sets the target motor speed as the motor reaches its target position.

### **Dist. Scale Value**

The distance scale value is used to map the maximum distance the motor is allowed to move over the analog input range. For example, the distance scale value for a motor allowed to rotate a maximum distance of 100,000 counts, using a 0-5VDC analog input range is:

$$\text{Dist. Scale Value} = 100,000 \text{ counts} \div 5\text{VDC} \div 183 = 109.28 \rightarrow 109$$

Note: The Dist. Scale Value represents a discrete value. Round all calculated values to the nearest whole number.

The *Dist. Scale Value* maps motor rotation to the analog input range as seen from the motor's encoder. Additional scaling may be required to account for any gear reduction in the end application.

#### **3.3.8.4. LJ Analog Options**

##### **Note:**

The LJ Analog Options are only available when using the IDCA-10 with LabJack data acquisition hardware.

### **AIN Latch Line Enabled**

Enables the ability to use one of the LabJack's digital IO lines to control the AIN Latch (L.S. 1) on the IDCA-10. The actual channel used is set

after the IDCA-10 is configured for stand-alone mode. See section 3.3.8.5 for further details on selecting a digital IO line.

#### **LJ DAC Enabled**

Enables use of LabJack's DAC outputs to use for the analog input signal to the IDCA-10.

#### **Analog Output Channel**

Sets the DAC channels to use as an analog output. Analog Output Channel is made available after the *LJ DAC Enabled* checkbox is checked.

### **3.3.8.5. Stand-alone Tools**

Stand-alone mode is intended for use in applications where a master device is not available for serial data transmissions. The MCT UI provides some useful tools for testing the IDCA-10 in stand-alone operations before putting it into service.

#### **Bridge Options**

##### **Enable Bridge**

Enables or disables the bridge in stand-alone mode. The bridge is enabled when the checkbox is checked (default) and disabled when the checkbox is unchecked. The bridge must be disabled in order to save the stand-alone configuration to nonvolatile memory (see section 3.3.10.7).

##### **Motor Direction**

Indicates the current motor direction. The *Motor Direction* checkbox is only used to report motor direction and cannot be changed by the user.

#### **Analog Controls**

The options in the *Analog Controls* group box are enabled if any of the LJ analog options were enabled when the IDCA-10 was configured.

##### **Control Voltage**

Sets the analog output voltage at the LabJack analog output. Valid values are 0V to +5VDC.

##### **AIN Latch**

Sets the digital IO line that will act as the AIN latch signal.

#### **Logging Options**

The logging options allow the user to use the internal logger to record relevant data at any time.

### Data Source

The *Data Source* dropdown menu is used to select the data source on the IDCA-10.

- Encoder B – Motor encoder channel B.
- Motor Current – Current flowing through the bridge and motor.

### Data Log Period (ms)

The *Data Log Period* is the period used to log data measured in ms. Data is logged in 128 sample bursts. The total time required to collect data is the data log period multiplied by 128. Valid logging periods are 5 ms to 255 ms.

### Start Logging Data

The *Start Logging Data* button starts the data logger. Data logging parameters are determined by the values set in *Data Source* drop down menu and *Data Log Period* control box.

### Note:

Data logging can consume a considerable portion of controller resources. Multiple consecutive calls to log data can impede controller performance.

## **3.3.9. Data Options**

Each of the three control windows discussed in sections 3.3.5 through 3.3.8 provide tools for visualizing data retrieved from the IDCA-10. Data plotting tools are located on the right hand side of each control window and consist of a plotting area and real-time data monitoring area. In addition, data can be saved to a file for later analysis. The following sections discuss data options.

### **3.3.9.1. Plotting Log Data**

Data logged using the IDCA-10's internal data logger may be plotted to the screen for visualization. Plot log data to the plot panel at the right-hand side of the window by pressing the *Retrieve Log Data* button. The data plotted in the window represents all the data stored in the IDCA-10's internal log buffer.

Two radio buttons to the left of the *Retrieve Log Data* will become active when the button is pressed. These two radio buttons control how the data is scaled on the screen. The Raw Data radio button reports the data in its raw form from the IDCA-10's data buffer. The Scaled Data button will scale the data to relevant engineering units, depending on the data source selected by the user. Figure 18 depicts example data plotted to the UI screen.

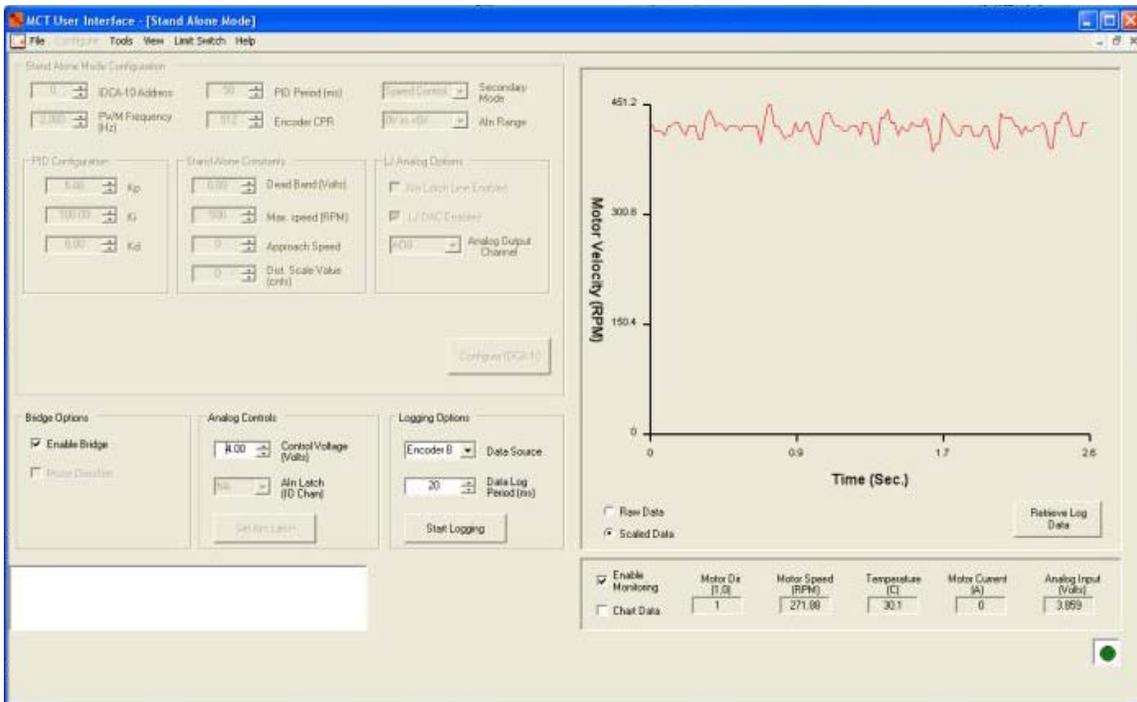


Figure 18. Data stored in internal log buffer plotted to screen.

### 3.3.9.2. Data Monitoring and Plotting Data

Data monitoring is used for real-time monitoring of motor speed, IDCA-10 temperature, and motor current. Enable data monitoring by setting the check mark in the *Enable Monitoring* checkbox. When enabled, the data monitor will update the parameter values at the bottom of the window once every second.

A 128 second history of the monitor data can be displayed on the screen. To enable chart history, set the check in the *Chart Data* checkbox after enabling data monitoring. Radio buttons will appear next to each parameter after charting is enabled. Select the radio button next to the parameter to view its data history. Figure 19 depicts monitor data displayed on the screen.

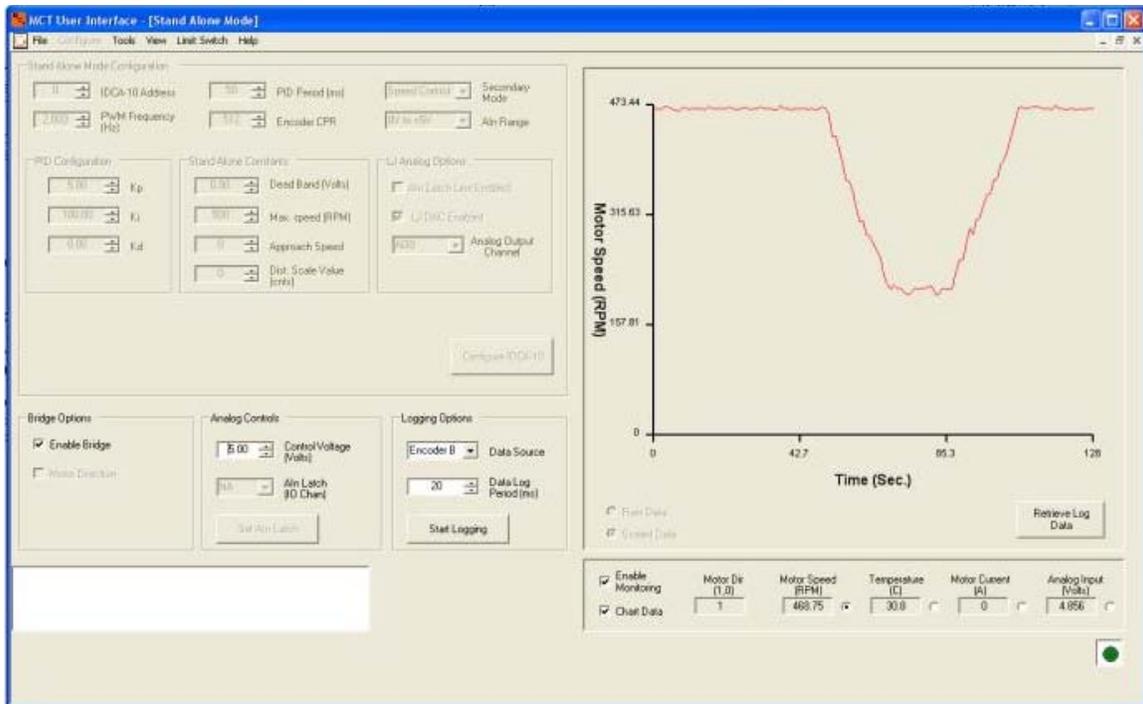


Figure 19. Motor speed history plotted to the screen.

### 3.3.9.3. Saving Log or Monitor Data

Controller data plotted during operation may be saved to file at any time.

- Configure the IDCA-10 for a particular operating mode.
- Plot log data or monitor data to the plot area.
- Select **File**→**Save Log Data** from the main menu.

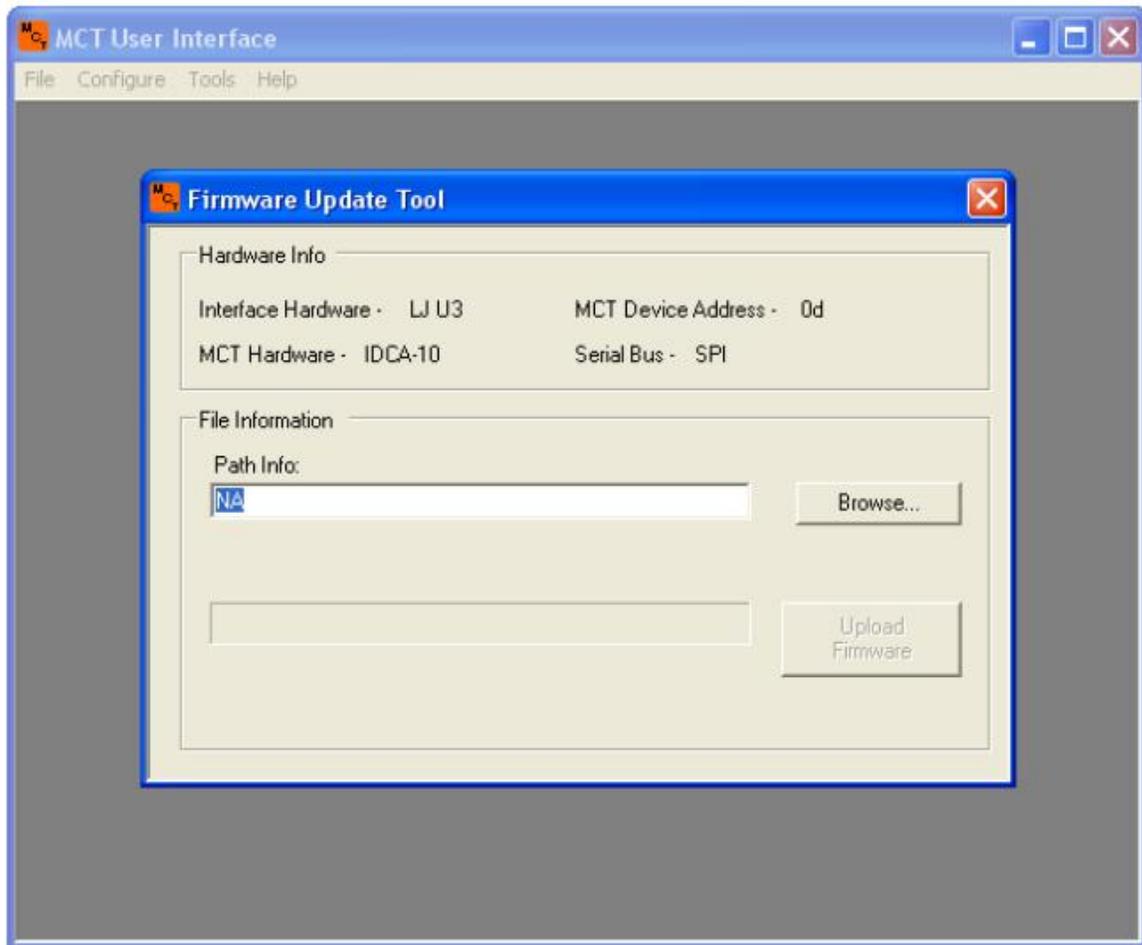
A save file dialog box will open prompting the user for a location to save the data file. Select the file destination and press the *OK* button. Data saved to file is saved as a tab-delimited text file.

### 3.3.10. MCT U.I. Tools Menu

#### 3.3.10.1. Firmware Update

- Select **Tools**→**Firmware Update** from the main menu.

The *Firmware Update Utility* will open on the screen (Figure 20). At the top of the dialog window is hardware information that reports master device, MCT device, and communication information.



**Figure 20. Firmware update tool.**

- Select the Browse button in the *File Information* group box to locate the firmware source file.

**Note:**

MCT firmware files are denoted by the .fmw file extension.

- Select the Upload Firmware button to start the update process. A confirmation dialog window will appear asking the user if they want to start the update process.
- Select the OK button in the confirmation window to start the update process.

The MCT UI will start the update process by resetting the MCT hardware. A series of flashes from the red and green LEDs indicates the update activity is in progress. The firmware update window will post various update messages and a progress bar at the bottom of the dialog box.

Note:

THE MCT hardware will remain in boot mode if the update process is terminated due to power interruption or other error. In such an event, cycle power on the MCT hardware. The green LED will flash four times followed by four flashes from the red LED, indicating it is still in firmware update mode. Repeat the firmware update process, starting at the first step in this section.

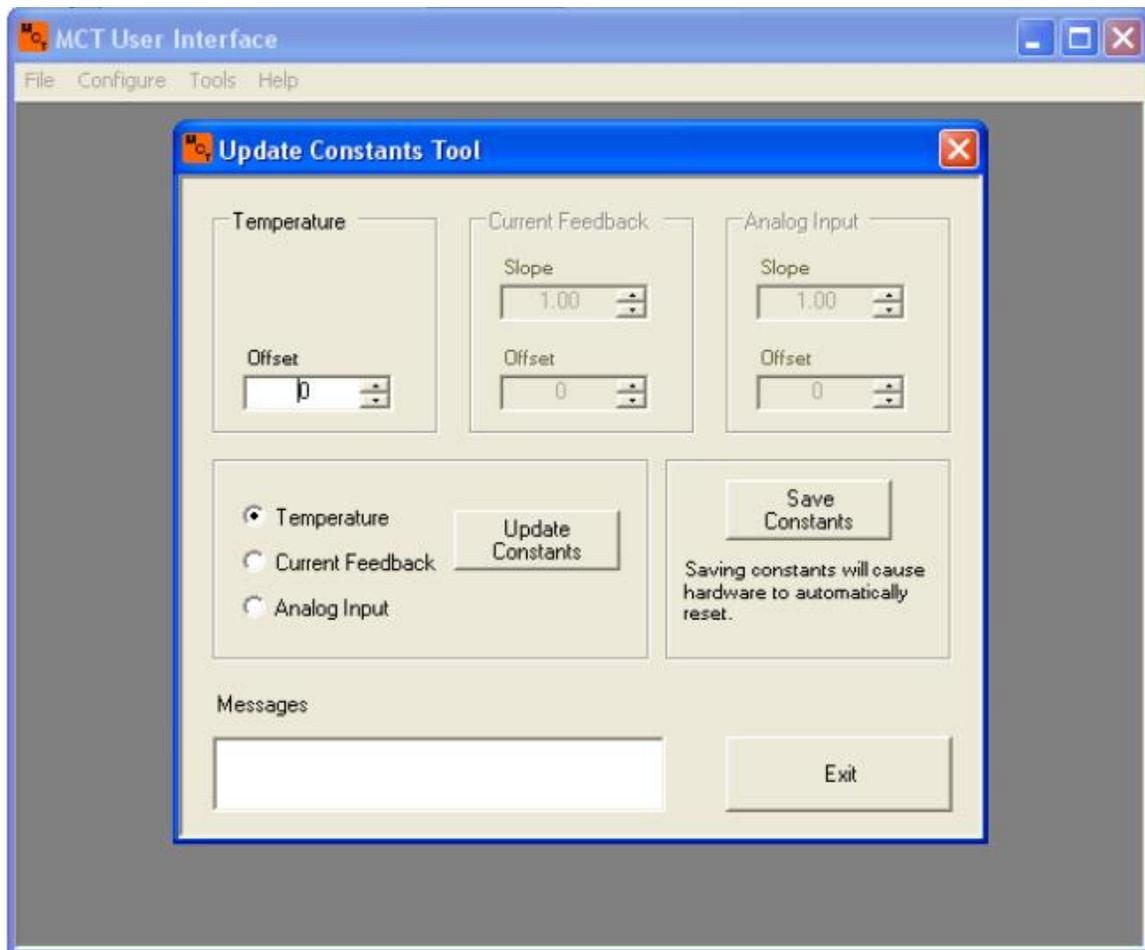
- Select the OK button when the FLASH update is complete.

### **3.3.10.2. Calibration Constants**

The *Update Constants Tool* accesses the calibration constants for temperature, current feedback and analog input. These parameters are calibrated at the factory, but may be adjusted if necessary.

- Select **Tools**→**Calibration Constants** from the main menu.

The Update Constants tool will open on the screen (Figure 21). At the top of the screen are three group boxes corresponding to three sets of calibration parameters. The values stored in RAM will populate each of the control boxes when the window opens. The group box located below the *Temperature* and *Current Feedback* group boxes contains the controls for updating each constant. Each radio button in the group box controls which parameter set is active for updating. The *Update Constants* button writes the value from the active parameter group box to RAM.



**Figure 21. Update calibration constant tool.**

- Activate one of the calibration constant set by selecting the appropriate radio button (Temperature, Current Feedback, or Analog Input).
- Update the slope and offset values as required.
- Press the *Update Constants* button to write the calibration constants to RAM.
- Repeat update procedure for other parameter sets if necessary

The calibration constants will be used by firmware immediately after they are written to RAM. Although the updated constants are in memory, they will be lost if the device is reset. The calibration constants must be saved to nonvolatile memory to make changes permanent.

- Select the *Save Constants* button located in the group box below the *Analog Input* group box.

The UI will command the device to save the constants to nonvolatile memory. The save operation will not take place if the IDCA-10 is currently controlling a motor. In such an event, the UI will post a warning message instructing the user to place the controller into a safe state before data is written to memory.

The controller will automatically reset after the calibration parameters are saved to nonvolatile memory. The MCT hardware will return to Idle mode after reset unless it is programmed to power up in a specific mode. Some degree of reconfiguration will be necessary after the reset is performed.

- Select the *Exit* button.
- Select **Tools**→**Calibration Constants** from the main menu.
- Verify the updated calibration constants appear in their respective control boxes when the *Update Constants Tool* opens.
- Select the *Exit* button to return to normal operation.

Note:

Factory calibration constants are permanently deleted when constants are written to nonvolatile memory. The user should record factory values for future reference before any changes are made.

### **3.3.10.3. Reset Slave Device**

Select **Tools**→**Reset Slave Device** from the main menu.

The Reset Slave Device Utility window will appear on the screen (Figure 22).

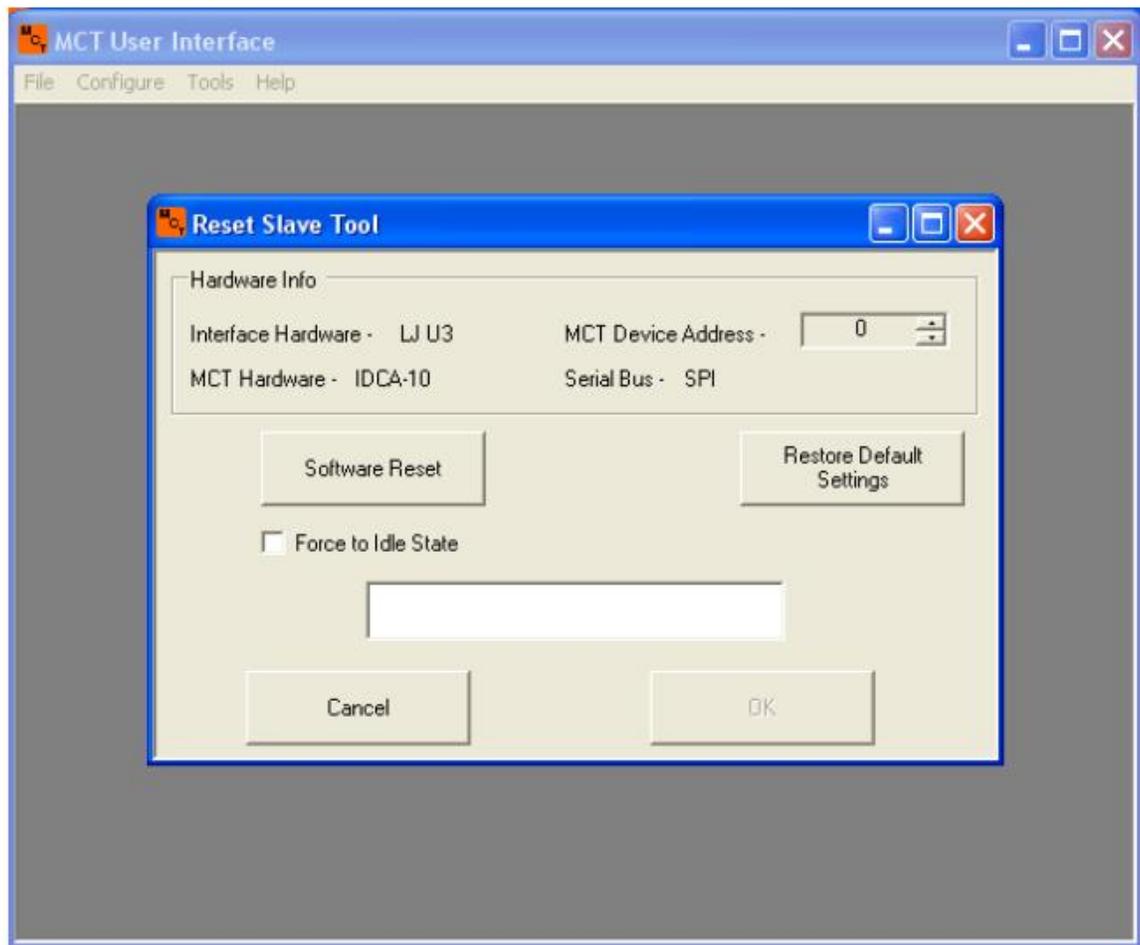


Figure 22. Reset slave device utility window.

The *Reset Slave Utility* will force the IDCA-10 to reset. Three different resets are available in the reset utility and are described below.

### **Software Reset**

*Software Reset* forces the MCT device to reset much the same as cycling power. The MCT device will reset and go through normal power-up initialization. Data stored in RAM will be lost when the IDCA-10 resets.

### **Force to Idle State**

Performing a software reset with the *Force to Idle State* radio button selected forces the IDCA-10 to reset into idle mode, regardless of what state it is programmed to start in. This option is useful for reconfiguring the IDCA-10 when it is programmed to power up in a specific mode.

### **Restore Default Settings**

The *Restore Default Settings* button forces a software reset, and causes the IDCA-10 to revert to its default factory settings. Nonvolatile memory

contents are erased after this option is invoked. Calibration constants are not affected by option.

#### 3.3.10.4. Set Slave Address

- Select **Tools**→**Set Slave Address** from the main menu.

The *Slave Address Tool* window will appear in the window (Figure 23). The current slave address is displayed in the box at the top of the window. Change the device address by entering a new device address in the *New Address* control box.

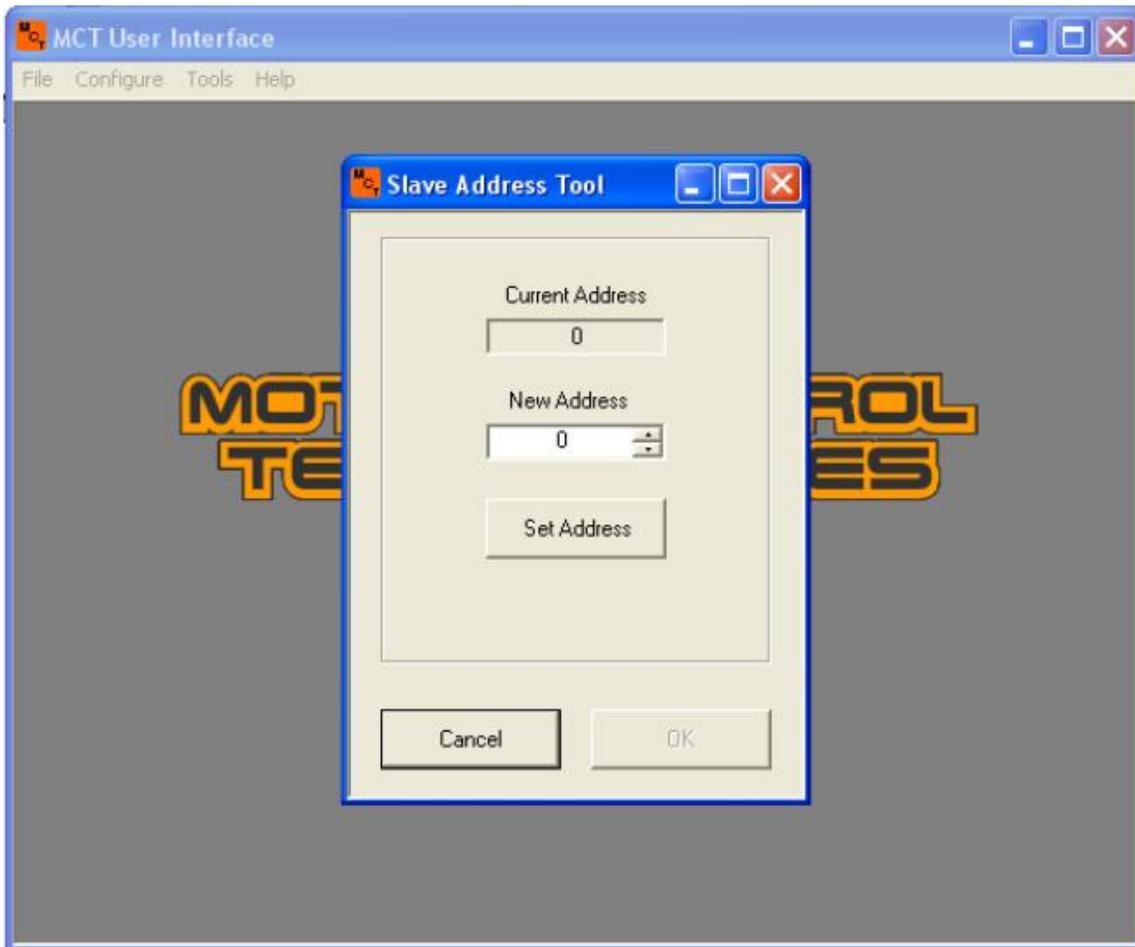


Figure 23. Update slave address box.

- Enter slave address in the *New Address* control box.
- Press the *Set Address* button to update the device address.
- Select the OK button to exit.

Note:

The slave address is set with the *Slave Address Tool* will be erased when if the device is reset. The address will only be stored in nonvolatile memory and made available at boot if the current configuration is saved. See section 3.3.10.7 for more information on saving data to nonvolatile memory.

### 3.3.10.5. Read Error Queue

The *Read Error Queue* tool reads the current error/warning value stored in the internal error register.

- Select **Tools**→ **Error Queue** from the main menu.

A new window will appear on the screen (Figure 24).

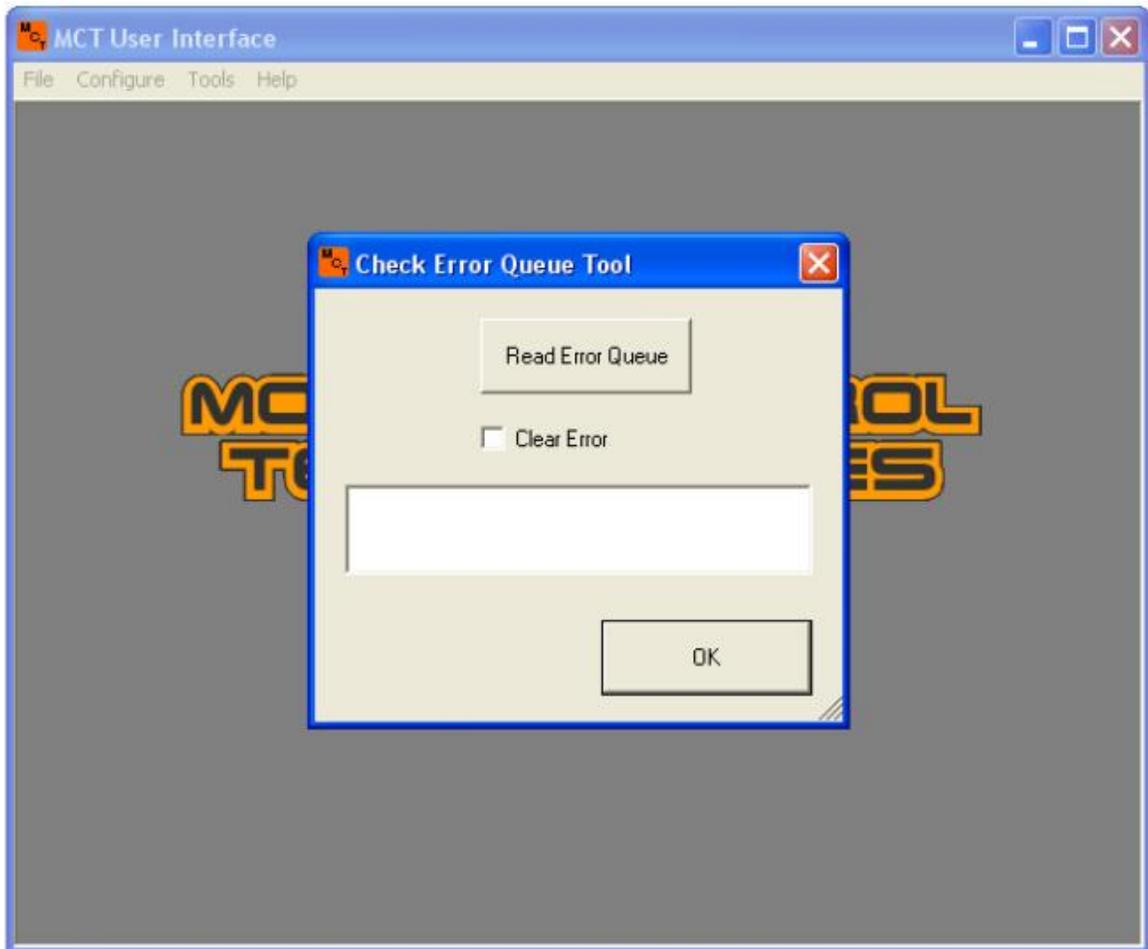


Figure 24. Check Error Queue window.

- Press the *Read Error Queue* button to read the current error code. The error code will be displayed in the message box. Set the *Clear Error*

button before pushing the *Read Error Queue* to reset the error code in RAM after reading.

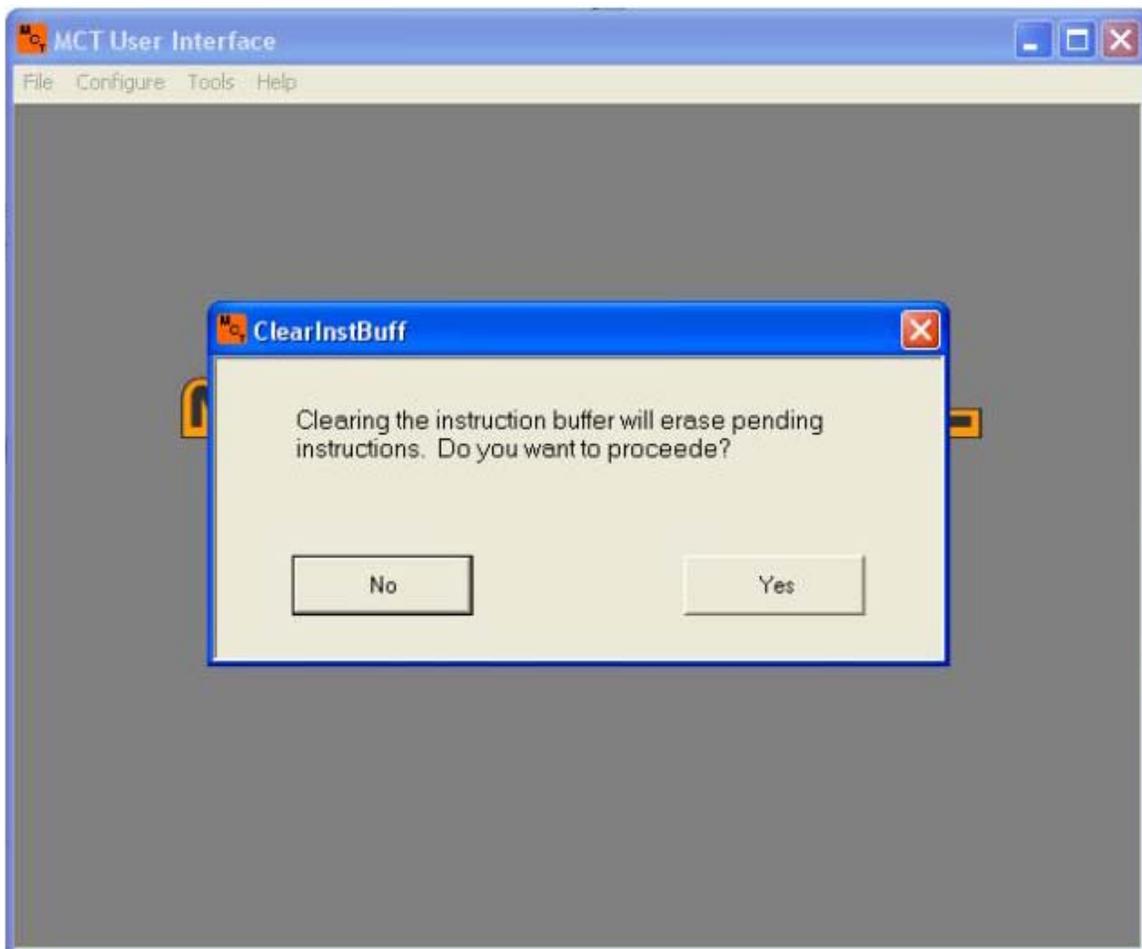
- Press the *OK* button to close the window.

### 3.3.10.6. *Clear Instruction Buffer*

The Clear Instruction Buffer tool allows the user to clear pending instructions in the instruction buffer.

- Select **Tools**→**Instruction Buffer**→**Clear Buffer** from the main menu.

A dialog box will appear on the screen informing the user that buffer contents will be erased (Figure 25).



**Figure 25. Clear instruction buffer dialog box.**

- Select *Yes* to continue and erase pending instructions. Select *No* to quit without erasing instruction buffer.

### 3.3.10.7. Save Slave Configuration

Select Tools→Save Hardware Config from the main menu.

A dialog box will appear on the screen warning the user that they are about to set the current configuration as the default hardware configuration at power up.

- Select the OK button to save the current configuration to nonvolatile memory. The IDCA-10 will automatically reset when configuration values are saved to memory.

Note:

The IDCA-10 will not allow the user to save data to nonvolatile memory if the bridge is enabled. Always stop the motor and disable the bridge before saving data to nonvolatile memory.

### 3.3.11. Serial Data View

The MCT UI provides a useful tool for inspecting data packets passed between the IDCA-10 and communication hardware. This option is made available on the main menu after the IDCA-10 is configured for an operating mode.

- Select **View**→**Serial Data** from the main menu.

The *Serial Data* window will open next the current operations window in the UI (Figure 26). The *Serial Data* window has two data boxes that display the data packets as they are transmitted between the master hardware and the IDCA-10. Data in the display boxes is updated any time a new command is sent to the IDCA10 from the UI.

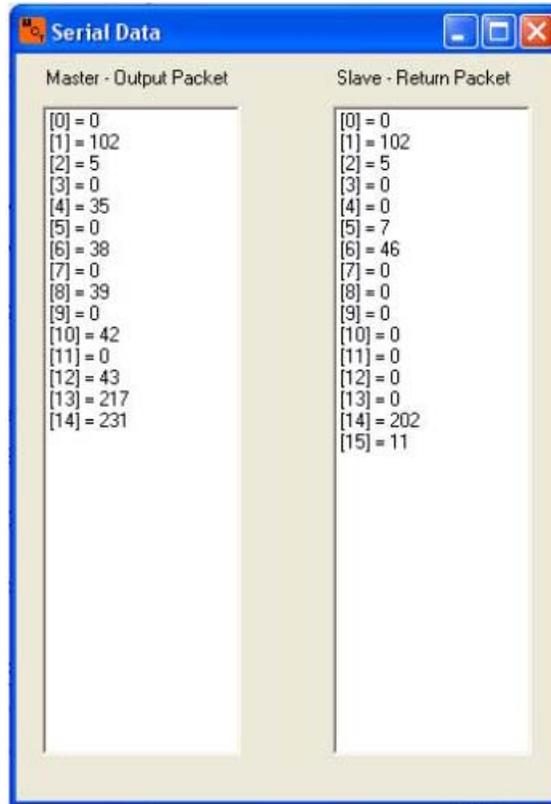


Figure 26. Serial data view window.

### 3.3.12. Limit Switch Configuration Window

The Limit Switch Configuration window configures the two limit switch inputs on the IDCA-10 (LS1 and LS2). Limit switch configuration is enabled after the IDCA-10 is configured for Open-loop, Speed Control, or Position control modes.

- Configure the IDCA-10 for one of its operating modes.
- Select **Limit Switch**→**Configure** from the main menu to open the *Limit Switch Configuration Window*.

A new window will open on the screen with options for configuring the two limit switches (Figure 27). Each limit switch has three control options described below.

#### **Enable L.S.**

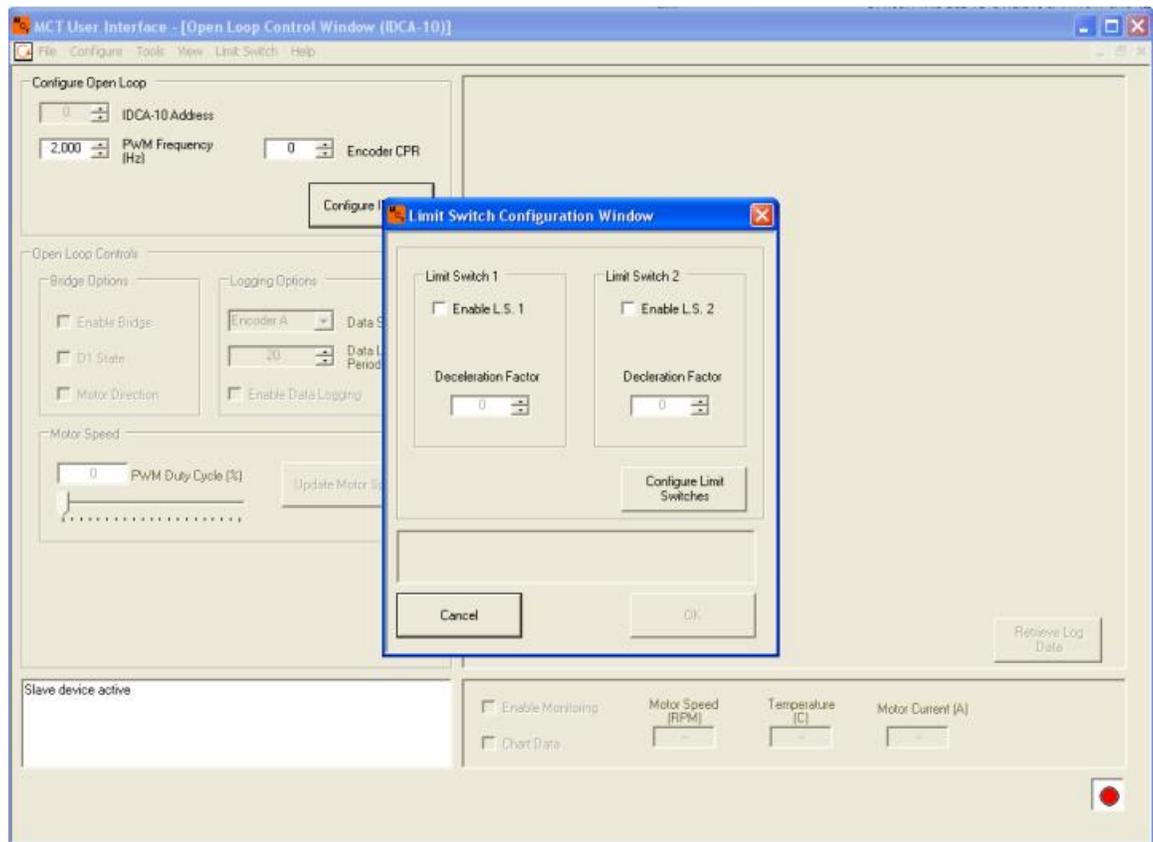
The *Enable L.S. 1* and *Enable L.S. 2* check boxes enable and disable limit switch operation. Both limit switches are disabled by default. Set the check in the enable checkbox to enable a limit switch input. One or both of the limit switch inputs can be enabled at any time.

### **Deceleration Factor**

The declaration Factor determines the rate the motor decelerates when the limit switch input is activated. The IDCA-10 will decrease the command speed according the *Declaration Factor* once every 50 ms until the motor comes to a stop. Valid values for the deceleration factor are 1-255.

### **AIN Latch (Standalone mode only)**

An AIN Latch option will appear below *Enable LS 1* when operating in stand-alone mode. AIN Latch is used to inform the IDCA-10 that the analog voltage at AIN is valid and an action should be taken. The IDCA-10 will not read the analog input voltage unless the LS1 line is logic LOW when the AIN Latch box is selected.



**Figure 27. Limit switch configuration screen.**

- Enable/Disable limit switch inputs as necessary
- Enable/Disable AIN Latch if operating in stand-alone mode.
- Update the *Deceleration Factor* control box for enabled limit switch inputs.

- Press the Configure Limit Switches button to configure the inputs on the IDCA-10.
- Press the OK button to exit the *Limit Switch Configuration Window*.