DLP-IO14

LEAD FREE

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USB-Based 14-Channel
Data-Acquisition Module

FEATURES:

- 14 IO's: 0-5V Analog, Digital In/Out, Temperature
- Two Bipolar Analog Inputs; ±5V Input Range Max
- All Analog Inputs: Up to 30Ksps Sample Rate and Selectable Sample Size:
  Rate: 200, 500, 1K, 2K, 4K, 10K, 20K, 30K, 40K, 50K Samples Per Second
  Size: 32, 64, 128, 256, 512, 1024, 2048, 4096, 8192 Samples (Binary Mode)
- SPDT Latching Relay
- Digital Temperature Sensor Feature Supported on 12 Digital I/O Lines
- Both Binary and ASCII (HyperTerminal) Modes Available
- Two 32-Bit Interrupt-Driven Event Counters; 5KHz Max Count Rate
- USB Port Powered
- USB 1.1- and 2.0-Compatible Interface
- Small Footprint; Easily Fits on a Desktop
- Easy-To-Use Programming Interface

APPLICATIONS:

- Robotics Control
- Motion Control/Presentation
- Data Acquisition
- Industrial/Process Control
- Process Monitoring
- Relay Control
- Audio Analysis

1.0 INTRODUCTION

The DLP-IO14 Data-Acquisition Module is a low-cost, easy-to-use data-acquisition system for analyzing AC voltages, controlling and monitoring processes and measuring DC voltages in the range of both 0-5 volts and ±5 volts. This module provides topside wire terminal blocks for the wiring connections.

The 14 channels on the DLP-IO14 are broken down as follows: 12 digital I/O; all of which can also be set to Analog Input Mode (0-5V). The DLP-IO14 also provides SPDT latching relay contacts. Each of

the channels and relay contacts can be controlled via simple single- and dual-byte commands. All operational power is taken from the host PC via the USB port.

The mode of each I/O is automatically changed with each command sent. For example, if an I/O is set to Digital Output-High and then the Digital Input Mode is selected; the I/O is first changed to Input Mode, and then the high/low state is read and returned to the host.

2.0 SPECIFICATIONS

The DLP-IO14 is an all 5-volt system that derives its power from the host USB port. Channels have the following capabilities:

Relay Contacts: There is one set of SPDT relay contacts on the board. These contacts are latching and are capable of handling loads of up to 2A. The relay has two sets of SPDT contacts that have been connected in parallel to increase their current carrying capability. (These are detailed in Section 6 under the table describing K1.)

Analog In: Fourteen inputs can read and return the voltage on the analog inputs using a 10-bit ADC. The maximum sample rate is 30Ksps. The input voltage range is 0-5 volts. (Refer to Section 8 of this document for more details.) Two additional channels are dedicated to analog in only and can measure voltages in the range of -5 volts to +5 volts.

Digital Output: Set high or clear low; configurable as digital outputs (5V). (The actual high/low voltage depends upon sink/source current.)

Digital Input: Reads the input's high/low state.

Temperature Measurement: Up to 12 DS18B20+ temperature sensors can be connected to Channels 1 through 12. Four settings of temperature measurement accuracy and speed are supported, as well as the ability read the permanent serial number of the sensor.

3.0 ABSOLUTE MAXIMUM RATINGS

Stresses beyond the ranges listed below may cause permanent damage to the DLP-IO14:

Operating Temperature: 0-70°C

Voltage on Digital Inputs with Respect to Ground: -0.3V to +5.3V

Voltage on Analog Inputs with Respect to Ground: -0.3V to +5.3V

Voltage on Relay Contacts with Respect to Ground/Return: 110VDC, 125VAC

Sink/Source Current on Any I/O: 25mA

Sink/Source Current on All I/O Combined: 90mA

4.0 WARNINGS

- Unplug from the host PC before connecting to the I/O terminals on the DLP-IO14.

- Isolate the bottom of the board from all conductive surfaces.

- Observe static precautions to prevent damage to the DLP-IO14 module.

5.0 USB DRIVERS

USB drivers for the following operating systems are available for download from the DLP Design website:

Windows 7 x64	Windows Server 2008 x64
Windows XP	Windows Vista
Windows XP x64	Mac OSX
Windows Server 2003	Mac OS8, OS9
Windows CE, 98, ME	Linux

These drivers are available for download from the following pages: http://www.dlpdesign.com and http://www.ftdichip.com/FTDrivers.htm.

Note: If you are utilizing the dual-mode drivers from FTDI (CDM2.x.x) and you want to use the Virtual COM Port (VCP) drivers, then it may be necessary to disable the D2XX drivers first via Device Manager. To do so, right click on the entry under USB Controllers that appears when the DLP-IO14 is connected, select Properties, select the Advanced tab, put a check mark in the option for "Load VCP" and click OK. Then unplug and replug the DLP-IO14, and a COM port should appear in Device Manager under Ports (COM & LPT).

6.0 TERMINAL BLOCK PIN DEFINITIONS

TABLE 1	
Terminal Block Pin Definitions	
PIN NAME	**DESCRIPTION**
A1	Analog Input A1. Channel 13. Input voltage range is -5V to +5V.
A2	Analog Input A2. Channel 14. Input voltage range is -5V to +5V.
G	Ground
1	Channel 1, Analog Input: Voltage range is 0 to +5V (see Note 1). Digital I/O: Configurable as a digital input, a digital output (5V) or an open-drain output (5V max pullup) (see Note 2).
2	Channel 2, Analog Input: Voltage range is 0 to +5V (see Note 1). Digital I/O: Configurable as a digital input, a digital output (5V) or an open-drain output (5V max pullup) (see Note 2).
C2	32-bit Counter Input with a max countable frequency of 5KHz. Count increments after toggling low then high.
G	Ground
3	Channel 3, Analog Input: Voltage range is 0 to +5V (see Note 1). Digital I/O: Configurable as a digital input, a digital output (5V) or an open-drain output (5V max pullup) (see Note 2). External Reference Input (see Command 0x2A for details).

4	Channel 4, Analog Input: Voltage range is 0 to +5V (see Note 1). Digital I/O: Configurable as a digital input, a digital output (5V) or an open-drain output (5V max pullup) (see Note 2).
C1	32-bit Counter Input with a max countable frequency of 5KHz. Count increments after toggling low then high.
5	Channel 5, Analog Input: Voltage range is 0 to +5V (see Note 1). Digital I/O: Configurable as a digital input, a digital output (5V) or an open-drain output (5V max pullup) (see Note 2).
6	Channel 6, Analog Input: Voltage range is 0 to +5V (see Note 1). Digital I/O: Configurable as a digital input, a digital output (5V) or an open-drain output (5V max pullup) (see Note 2).
COM	Latching Relay Common Contact (see Note 3).
R	Latching Relay Reset Contact (see Note 3).
S	Latching Relay Set Contact (see Note 3).
7	Channel 7, Analog Input: Voltage range is 0 to +5V (see Note 1). Digital I/O: Configurable as a digital input, a digital output (5V) or an open-drain output (5V max pullup) (see Note 2).
8	Channel 8, Analog Input: Voltage range is 0 to +5V (see Note 1). Digital I/O: Configurable as a digital input, a digital output (5V) or an open-drain output (5V max pullup) (see Note 2).
G	Ground
9	Channel 9, Analog Input: Voltage range is 0 to +5V (see Note 1). Digital I/O: Configurable as a digital input, a digital output (5V) or an open-drain output (5V max pullup) (see Note 2).
10	Channel 10, Analog Input: Voltage range is 0 to +5V (see Note 1). Digital I/O: Configurable as a digital input, a digital output (5V) or an open-drain output (5V max pullup) (see Note 2).
11	Channel 11, Analog Input: Voltage range is 0 to +5V (see Note 1). Digital I/O: Configurable as a digital input, a digital output (5V) or an open-drain output (5V max pullup) (see Note 2).
5V	VCC Output +5.0V. Limit current drawn from this pin to 100mA to avoid exceeding the available current from the host USB port.
12	Channel 12, Analog Input: Voltage range is 0 to +5V (see Note 1). Digital I/O: Configurable as a digital input, a digital output (5V) or an open-drain output (5V max pullup) (see Note 2).
G	Ground

Notes:

1. The Analog Input Range is 0-5V. The maximum sample rate is 30Ksps. Refer to Section 8 for more details.

2. Digital outputs can sink or source 25mA; 90mA for all outputs combined. Open-drain outputs are implemented by making the I/O pin an input. The maximum pullup voltage is 5.0 volts.

3. Relay contacts can support resistive loads of up to 2A @ 30 VDC, 0.6A @ 110 VDC and 1 A @ 125 VAC. **If this value is exceeded, the DLP-IO14 can be damaged**. The relay is set and reset only under software control. For a functional schematic of the relay connections, refer to Section 7.

7.0 RELAY FUNCTIONAL SCHEMATIC

The DLP-IO14 contains one latching relay. The relay is controlled by host software. The relay contacts R, S and COM are described in Table 1. A functional view of how the relay works is shown here:
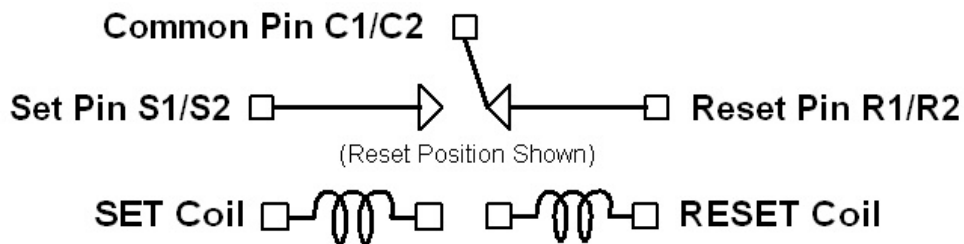

Figure 1: Relay Functional Schematic

Note: On power-up of the DLP-IO14, the relay states will be unknown. Each can power up in either the Set or Reset state. If a known initial state is required, the user will need to issue either a Set or Reset Command upon power-up.

8.0 USING THE DLP-IO14

Simply connect the DLP-IO14 to the PC to initiate the loading of USB drivers. Once the USB drivers are loaded, the DLP-IO14 is ready for use. All commands are issued as single-byte or double-byte command packets. First a channel is set by sending an ASCII 1-9, a, b, c, d or e for the desired channel. Then a byte is sent for the desired function. Table 2 describes all of the available functions.

You can either utilize the TestApp program provided with the DLP-IO14, or you can write your own program in your language of choice. If the DLP-IO14 is set to ASCII mode, HyperTerminal can be used as the user interface. Begin by opening the COM port, and then send commands as shown in Table 2 below. There is no need to set the baud rate because the DLP-IO14 uses a parallel interface between the USB IC and the microcontroller. (The Ping Command can be used to locate the correct COM port used for communicating with the DLP-IO14, or you can look in Device Manager to see which port was assigned by Windows.)

TABLE 2				
Command Packets				
Command Packet	**Description**	**ASCII Byte**	**Hex Value**	**Return/Comments**
Ping	Issue Ping	'	0x27	If the DLP-IO14 is found on the selected port, N is returned in ASCII Mode; 0x4E if in Binary Mode.
LED Control	LED Flash, On, Off	+	0x2B	Flash LED; Nothing Returned
		.	0x2E	LED ON; Nothing Returned
		`	0x60	LED OFF; Nothing Returned
Channel Select	Select the Channel	1-9, a,b,c, d,e	0x31-0x39, 0x61-0x65	Sets the active channel to be used with the commands in this table. If in ASCII Mode, the channel is returned plus CR/LF. Nothing is returned in Binary Mode. a, b, and c are Channels 10,11 and 12 on the module; d and e are A1 and A2 on the module.
Relay Control	Set/Reset Relay	k	0x6B	Relay Set; Nothing Returned
		m	0x6D	Relay Reset; Nothing Returned

Digital I/O Command	Select Direction and Output Value	w	0x77	Output-High: Make current channel digital output and set it high; nothing returned.
		s	0x73	Output-Low: Make current channel digital output and clear it low; nothing returned.
		r	0x72	Input: Make current channel digital input and return state. If ASCII Mode is enabled; returns ASCII 0 or 1 plus CR, LF. If Binary Mode is enabled; returns a binary 0 or 1.
Set °C / °F Mode & Save	Select Temperature Display Mode	f	0x66	Select Fahrenheit Mode and save. Nothing returned. (Default) Selection saved for power-up default.
		g	0x67	Select Celsius Mode and save. Nothing returned. Selection saved for power-up default.
Temperature Sensor Detect	Detect Sensor & Return Serial Number from Current Channel	]	0x5D	If a DS18B20+ sensor is detected on the current channel, will return the 8-byte sensor serial number in byte-reversed order. If in ASCII Mode, will return hex characters. In Binary Mode, will return binary data. A working sensor must be connected to the selected channel.
Temperature Sensor Read	Convert, Read and Return Data from Current Channel	t	0x74	If a DS18B20+ sensor is detected on the current channel, will start a temperature conversion, wait for the conversion to complete and return data. If in ASCII Mode, will return temperature in current °C/°F Mode plus CR/LF. In Binary Mode, will return 2 bytes of raw sensor data. (See Note 1.)
Temperature Sensor Resolution	Select Temperature Sensor Resolution for the Current Channel	-	0x2D	Set sensor resolution to 9-bit / Fast. Nothing returned.
		,	0x2C	Set sensor resolution to 10-bit. Nothing returned.
		0	0x30	Set sensor resolution to 11-bit. Nothing returned.
		\	0x5C	Set sensor resolution to 12-bit / Slow (Default). Nothing returned.
Set Return Mode & Save	ASCII / Binary Mode Select	q	0x71	ASCII Mode selected. (Default) "ASCII mode" returned.
		h	0x68	Binary Mode selected. Nothing returned.
Reset 32-Bit Event Counter	Clear C1 or C2 Event Counter	u	0x75	Clear C1 Event Counter to zero. Nothing Returned.
		y	0x79	Clear C2 Event Counter to zero. Nothing Returned.
Read 32-bit Event Counter	Read the C1 and C2 Event Counters	n	0x6E	Read and return C1 counter state.
		p	0x70	Read and return C2 counter state.
				If in Binary Mode, will return 4 bytes--MSByte first. If in ASCII Mode, returns "C1:" or "C2:" followed by count (base 10) and CR/LF.
INT / EXT Voltage Reference Select & Save	Select Internal or External Reference	i	0x69	Select internal 5V reference provided by the host PC USB port. (See Note 2.) (Default) Nothing returned.
		x	0x78	Select (user-provided) external reference connected to Channel 3. Remember to select the reference voltage using Command 0x2A (Set Reference Voltage). Nothing returned. Selection is saved for power-up default. Remember to set the reference jumper accordingly for use with Channels A1 and A2. (See Section 9.)

Set Sample Rate & Save **Two-Byte Command**	Select the A/D Sample Rate Used by Command 0x7A Command: '=' (0x3D) Followed by '0'-'7' or 0x30-0x37	0	0x30	200s/s selected and saved.
		1	0x31	500s/s selected and saved.
		2	0x32	1Ks/s selected and saved.
		3	0x33	2Ks/s selected and saved.
		4	0x34	4Ks/s selected and saved.
		5	0x35	10Ks/s selected and saved.
		6	0x36	20Ks/s selected and saved.
		7	0x37	30Ks/s selected and saved.
				Sets the A/D sample rate for Command 0x7A. The selection is saved for power-up default. EX: 0x3D, 0x05 sets the conversion rate at 10K samples per second.
Set Number of Samples & Save **Two-Byte Command**	Set the Number of Samples Acquired by Command 0x7A Command: '[' (0x5B) Followed by '0'-'8' or 0x30-0x38	0	0x30	32 return samples selected and saved.
		1	0x31	64 return samples selected and saved.
		2	0x32	128 return samples selected and saved.
		3	0x33	256 return samples selected and saved.
		4	0x34	512 return samples selected and saved.
		5	0x35	1024 return samples selected and saved.
		6	0x36	2048 return samples selected and saved.
		7	0x37	4096 return samples selected and saved.
		8	0x38	8192 return samples selected and saved.
				Sets the number of A/D samples returned from Command 0x7A. The selection is saved for power-up default. EX: 0x5B, 0x06 sets the number of samples to 2048.
Read Current Setup	Read and Return the Current Saved Setup	j	0x6A	Returns the six saved parameters. (See Table 3 for a description of each parameter.) In ASCII Mode, six ASCII characters (0-9) separated by spaces are returned followed by a CR/LF. In Binary Mode, 6 bytes are returned.
Set Reference Voltage & Save **Two-Byte Command**	Select Reference Voltage for ASCII Mode Voltage Calculation Command: '*' (0x2A) Followed by '0' – '9'.	0	0	2.2V reference selected and saved.
		1	1	2.5V reference selected and saved.
		2	2	3.0V reference selected and saved.
		3	3	3.3V reference selected and saved.
		4	4	3.5V reference selected and saved.
		5	5	4.0V reference selected and saved.
		6	6	4.096V reference selected and saved.
		7	7	4.5V reference selected and saved.
		8	8	4.8V reference selected and saved.
		9	9	5.0V reference selected and saved. (Default)
				Reference voltage used in ASCII Mode by the DLP-IO14 for calculating voltage. (Not required in Binary Mode since actual voltage is calculated in the host program.) Selection is saved for power-up default. EX: *9 sent via HyperTerminal sets 5.0 volt reference.

Single A/D Conversion	Read Analog Voltage from the Current Channel and Return to Host	v	0x76	Read a single voltage from the selected channel. 2 bytes are returned for each conversion. If in ASCII Mode, voltage is calculated using current voltage reference parameters (see Table 3) and returned as an ASCII string followed by CR/LF. If in Binary Mode, two bytes for the 10-bit A/D counts are returned--LSByte first. To calculate voltage for Channels 1-12: **int temp = byte2 * 255 + byte1;** **float volts = temp / 1023 * reference voltage;** To calculate voltage for ch13 or ch14, *add* this line of code: **volts = (volts - (vrefvoltage/2.0)) * 2.0;**
Multiple A/D Conversion	Read Multiple Analog Voltages from the Current Channel and Return to Host	z	0x7A	Read multiple voltages from the selected channel per the selected setup parameters (see Table 3). 2 Bytes are returned for each conversion. **This command is only available in Binary Mode.** Two bytes for the 10-bit A/D counts from each measurement are returned; MSByte first. To calculate voltage for Channels 1-12: **int temp = byte1 * 255 + byte2;** **float volts = temp / 1023 * reference voltage;** To calculate voltage for ch13 and ch14, *add* this line of code: **volts = (volts - (vrefvoltage/2.0)) * 2.0;**

Notes:

1. Requires a DS18B20+ digital temperature sensor (purchased separately). See Section 10.0 of this document for connection details. Before issuing a Convert Sensor Command, make sure that a digital temperature sensor is present on the selected digital I/O channel with a 1.5K-ohm pullup resistor. (Refer to the DLP-IO14 demo code provided for temperature calculation method in Binary Mode.) Other examples are available from www.maxim-ic.com in Application Note AN162.pdf.

2. Using the host 5V power supply as a reference may not produce accurate voltage measurements. For better accuracy, connect and select a precision voltage reference to Channel 3. (See Commands 0x78 and 0x2A for more details.)

TABLE 3						
Selectable Power-Up Default Settings						
Range	Voltage Reference	Sample Rate	Number of Samples Returned	°C/°F	Return Mode	Reference Source
0	2.2V	200s/s	32	°F	ASCII	Internal 5V
1	2.5V	500s/s	64	°C	Binary	External
2	3.0V	1Ks/s	128			
3	3.3V	2Ks/s	256			
4	3.5V	4Ks/s	512			
5	4.0V	10Ks/s	1024			
6	4.096V	20Ks/s	2048			
7	4.5V	30Ks/s	4096			
8	4.8V		8192		Default	
9	5.0V					

9.0 REFERENCE JUMPER SELECTION

A three-pin jumper selection is provided for setting the reference used by the analog input buffer for Channels 13 and 14. These channels accept voltages in the range of ±5V if the internal reference is selected. If the external reference is selected and an external reference voltage is applied to Channel 3, then the input voltage range can be from ±2.2V up to ±5.0V.

Pin 1 of this 3-pin jumper is closest to Wiring Terminal A1. Place a jumper across Pins 1 and 2 to select the external reference applied to the terminal for Channel 3. Place the jumper across 2 and 3 to select the internal 5V reference (factory default).

10.0 CONNECTING THE DIGITAL TEMPERATURE SENSOR

Up to 12 DS18B20+ digital temperature sensors can be connected to the DLP-IO14. For best performance, use Category 5/6-type computer cable to connect the sensors to the DLP-IO14. Two twisted pairs in the Cat 5/Cat 6 cable are required for the connection. The first twisted pair is for Power (5V) and Ground, and the second twisted pair is for as Data and Ground. In addition, a 1.5K-ohm pullup resistor is required for the data line.

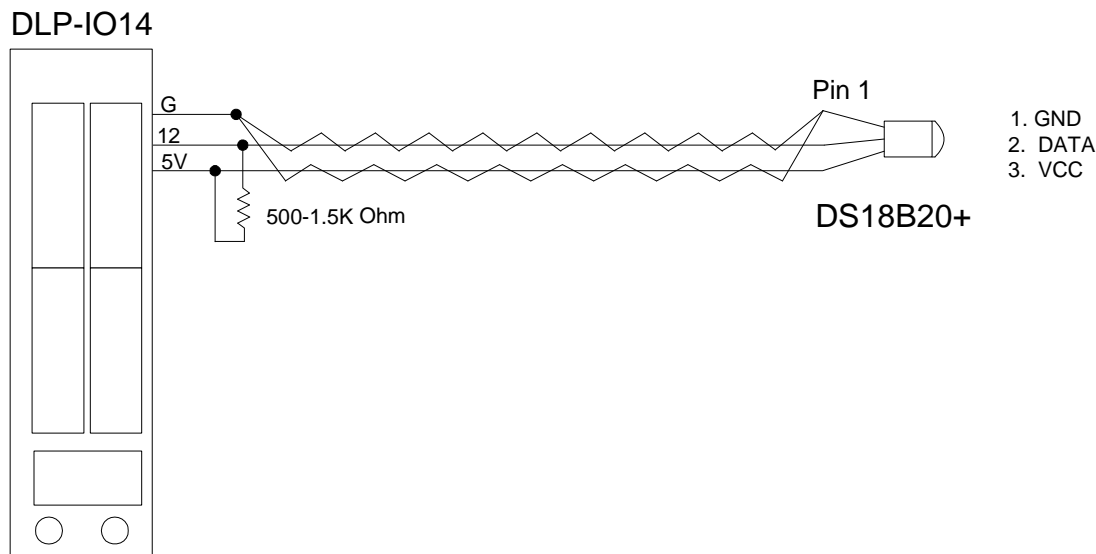Figure 3 shows an example of this connection using Channel 12:

Figure 3: Digital Temperature Sensor Connection Example

To detect a sensor, select a channel with a sensor connected, and then send the DLP-IO14 the Detect Sensor Command ']' (0x5D). The permanent serial number will be returned to the host PC. If the channel is stuck Low, a "1" will be returned in the first byte on the 8 bytes returned. If no sensor is present, then a "2" will be returned in the first byte. In these two cases, the remaining seven bytes will be all zeroes. If a sensor is present and functional, its 8-byte serial number will be returned.

Next, send a Convert Sensor Command 't' (0x74) to initiate the temperature conversion. The temperature value is automatically returned after the conversion is complete. The conversion can take up to 750mS to complete depending upon the resolution setting. In the lowest resolution mode, the conversion takes approximately 100mS to complete.

11.0 DEMO APPLICATION PROGRAM

A test application program called IO14GUI is provided with the purchase of the DLP-IO14 that runs on Windows and can be used to interface with and control the DLP-IO14. (Note that the Visual C++ source is also available with the purchase of the DLP-IO14.) This application is designed to demonstrate all of the unit's available features:
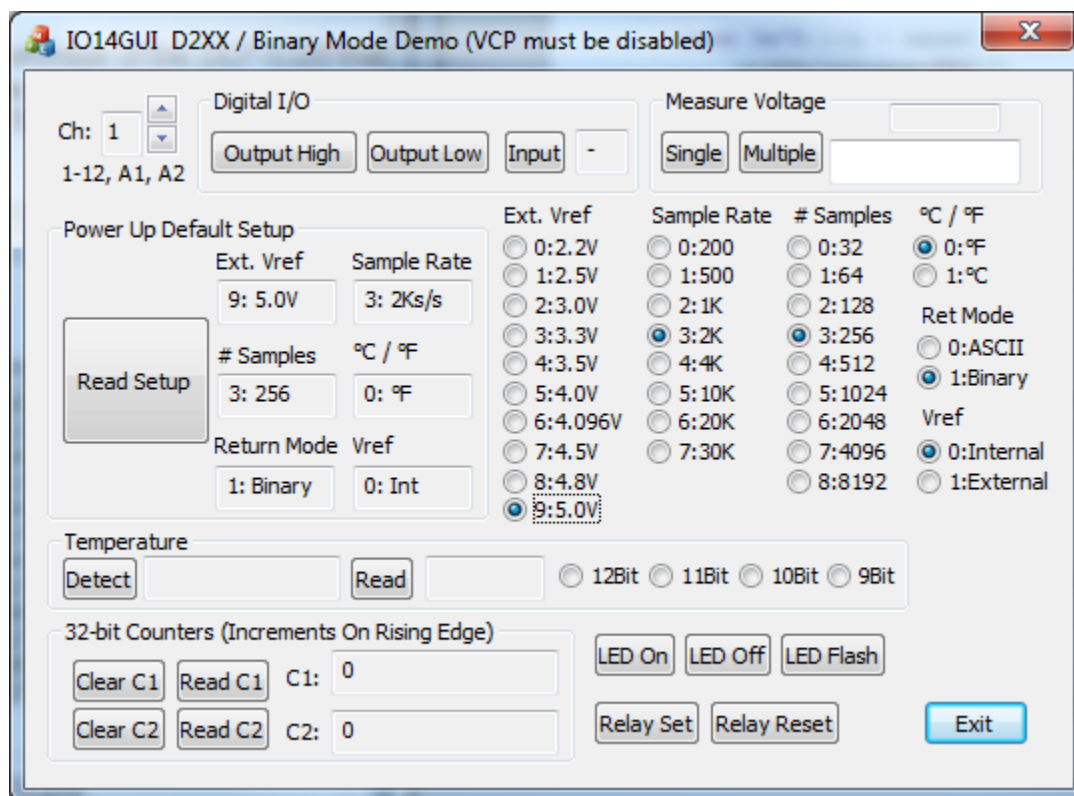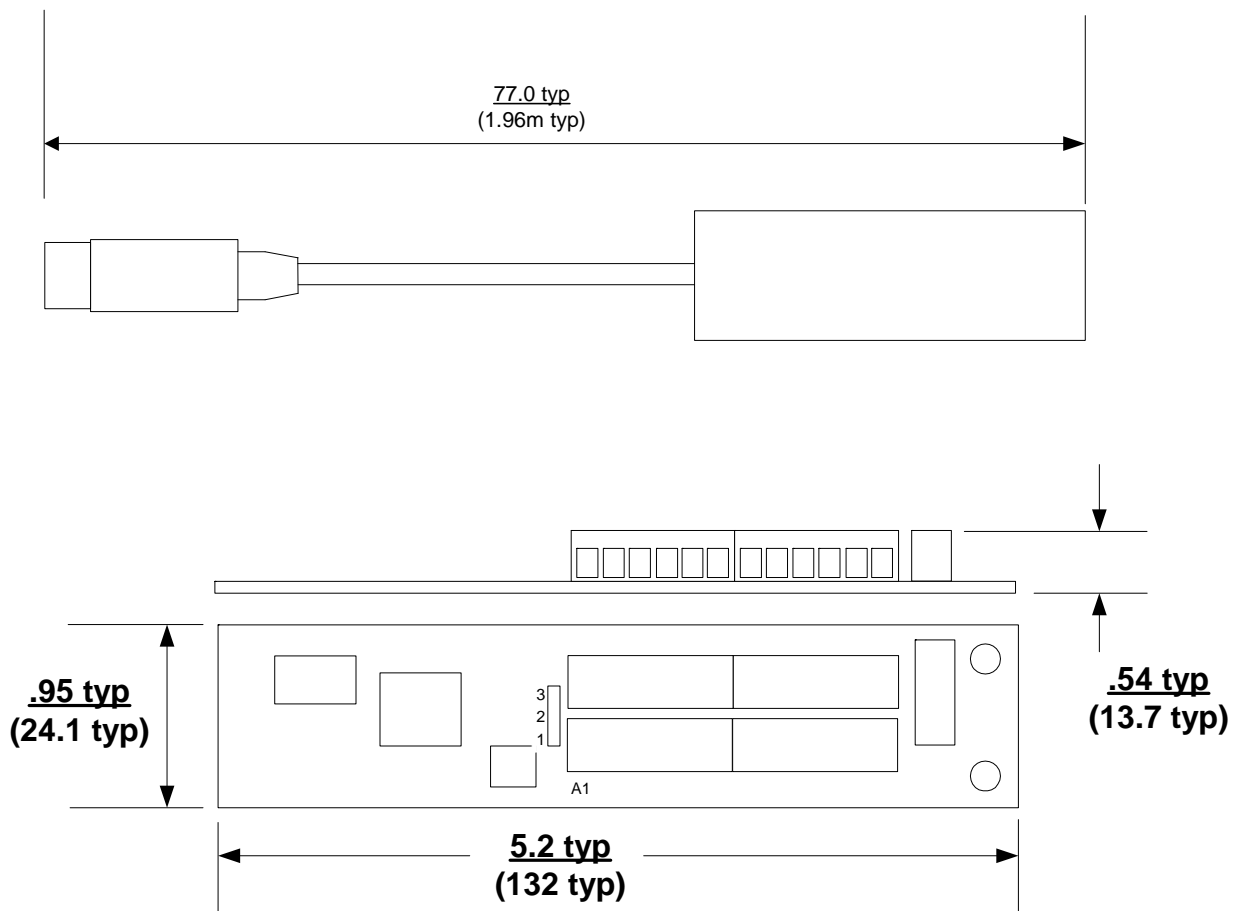

Figure 4: Test Application GUI

12.0 MECHANICAL DIMENSIONS IN INCHES (MM) (Preliminary)

77.0 typ
(1.96m typ)

.95 typ
(24.1 typ)

3
2
1

A1

5.2 typ
(132 typ)

.54 typ
(13.7 typ)

13.0 DISCLAIMER

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14.0 CONTACT INFORMATION

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