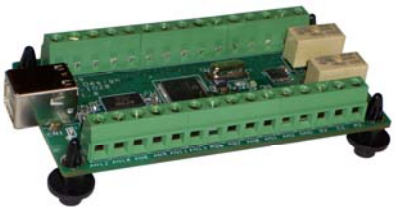


# DLP-IO20-G

*LEAD-FREE*

## USB-BASED 20-CHANNEL DATA ACQUISITION MODULE

Features:

- 20 Channels: 14 Analog Inputs 0-5V, Up To 20Ksps Sample Rate, 2 Latching Relays, Digital I/O
- Two Relay Driver Outputs (5V Coil)
- Digital Temperature Sensor Feature Supported On All Digital I/Os
- Two 32-Bit Interrupt Driven Event Counters
- USB Port Powered
- USB 1.1 And 2.0 Compatible Interface
- Small Footprint; Easily Fits on Desktop
- Easy To Use Programming Interface

Applications:

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

## 1.0 INTRODUCTION

The DLP-IO20 Data Acquisition Module is a low-cost, easy-to-use data acquisition system for analyzing AC voltages, driving 5 volt relays, controlling and monitoring processes, and measuring DC voltages in the range of 0-5 volts. This module provides top side wire terminal blocks for the wiring connections.

The 20 channels on the DLP-IO20 are broken down as follows: 3 outputs with high current relay/LED drivers, and 17 Digital I/O, 14 of which can be set to analog input mode. The DLP-IO20 also provides 2 latching relay contacts. Each of the channels and relay contacts can be controlled via simple multi-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-IO20 is an all 5-volt system that derives its power from the host USB port. Channels have the following capabilities:

Relay Contacts: There are 2 sets of relay contacts on the board. These contacts are latching, and are capable of handling resistive loads of up to 4A @ 30 VDC, 0.6A @ 110 VDC, and 1 A @ 125 VAC. Each of the two on-board relays has two sets of SPDT contacts that have been connected in parallel to increase the current carrying capability. These are detailed in section 6 under the table describing K1 and K2.

Relay Drivers : There are 3 relay driver outputs on the board. These outputs connect to one side of a 5V relay coil, the side of the coil is connected to the +5V terminal.

Analog In: 14 inputs can read and return the voltage on the Analog inputs using a 10-bit ADC. The maximum sample rate is 20Ksps. The input voltage range is 0 to 5 Volts. Refer to section 7 of this document for more details.

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

Digital Input: Read the inputs high/low state.

## 3.0 ABSOLUTE MAXIMUM RATINGS

Stresses above those listed here may cause permanent damage to the DLP-IO20:

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-IO20.
- Isolate the bottom of the board from all conductive surfaces.
- Observe static precautions to prevent damage to the DLP-IO20 module.

## 5.0 USB DRIVERS

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

| | |
|---|---|
| Windows XP x64 | Mac OSX |
| Windows Server 2003 | Mac OS9 |
| Windows 2000 | Mac OS8 |
| Windows 98, ME | Linux |

These drivers are available for download from the following page: http://www.dlpdesign.com/DNLD8/.

NOTE: If using 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. Right click on the entry under USB Controllers that appears when the DLP-IO20 is connected, select Properties, select the Advanced tab, put a check in the option for "Load VCP" and click OK. Unplug and replug the DLP-IO20 and a COM port should appear in Device Manager under Ports (COM & LPT).

## 6.0 TERMINAL BLOCK PIN DEFINITIONS

The wiring terminals on the DLP-IO20 are explained in the following table.

**TABLE 1**

**J1 Prototyping Terminal Block Pin Definitions**

| Pin Name | Description |
|---|---|
| R1 | Latching Relay 1 Reset Contact (see note 3) |
| C1 | Latching Relay 1 Common Contact (see note 3) |
| S1 | Latching Relay 1 Set Contact (see note 3) |
| GND | Ground |
| P7 | Relay Driver Output P7. Driven by Darlington pair transistors powered by 5V from the USB port. (see note 4) |
| P6 | Relay Driver Output P6. Driven by Darlington pair transistors powered by 5V from the USB port. (see note 4) |
| P5 | Relay Driver Output P5. Driven by Darlington pair transistors powered by 5V from the USB port. (see note 4) |
| +5V | VCC Output +5.0V. Limit current drawn from this pin to 100mA to avoid exceeding the available current from the host USB port. |
| AN7 | Analog Input AN7. Input voltage range is zero to +5V. (see note 1) Digital I/O AN7, Configurable as a digital Input, a digital output (5V), or an open drain output (5V MAX pullup). (see note 2) |
| AN6 | Analog Input AN6. Input voltage range is zero to +5V. (see note 1) Digital I/O AN6, Configurable as a digital Input, a digital output (5V), or an open drain output (5V MAX pullup). (see note 2) |
| AN5 | Analog Input AN5. Input voltage range is zero to +5V. (see note 1) Digital I/O AN5, Configurable as a digital Input, a digital output (5V), or an open drain output (5V MAX pullup). (see note 2) |
| AN4 | Analog Input AN4. Input voltage range is zero to +5V. (see note 1) Digital I/O AN4, Configurable as a digital Input, a digital output (5V), or an open drain output (5V MAX pullup). (see note 2) |
| RA4 | Digital I/O RA4, Configurable as a digital Input, a digital output (5V), or an open drain output (5V MAX pullup). (see note 2) |

| | |
|---|---|
| AN3 | Analog Input AN3. Input voltage range is zero to +5V. (see note 1) Digital I/O AN3, Configurable as a digital Input, a digital output (5V), or an open drain output (5V MAX pullup). (see note 2) |
| GND | Ground |
| AN12 | Analog Input AN12. Input voltage range is zero to +5V. (see note 1) Digital I/O AN12, Configurable as a digital Input, a digital output (5V), or an open drain output (5V MAX pullup). (see note 2) |
| AN10 | Analog Input AN10. Input voltage range is zero to +5V. (see note 1) Digital I/O AN10, Configurable as a digital Input, a digital output (5V), or an open drain output (5V MAX pullup). (see note 2) |
| AN8 | Analog Input AN8. Input voltage range is zero to +5V. (see note 1) Digital I/O AN8, Configurable as a digital Input, a digital output (5V), or an open drain output (5V MAX pullup). (see note 2) |
| AN9 | Analog Input AN9. Input voltage range is zero to +5V. (see note 1) Digital I/O AN9, Configurable as a digital Input, a digital output (5V), or an open drain output (5V MAX pullup). (see note 2) |
| AN11 | Analog Input AN11. Input voltage range is zero to +5V. (see note 1) Digital I/O AN11, Configurable as a digital Input, a digital output (5V), or an open drain output (5V MAX pullup). (see note 2) |
| AN13 | Analog Input AN13. Input voltage range is zero to +5V. (see note 1) Digital I/O AN13, Configurable as a digital Input, a digital output (5V), or an open drain output (5V MAX pullup). (see note 2) |
| RB6 | Digital I/O RB6, Configurable as a digital Input, a digital output (5V), or an open drain output (5V MAX pullup). (see note 2) |
| RB7 | Digital I/O RB7, Configurable as a digital Input, a digital output (5V), or an open drain output (5V MAX pullup). (see note 2) |
| AN0 | Analog Input AN0. Input voltage range is zero to +5V. (see note 1) Digital I/O AN0, Configurable as a digital Input, a digital output (5V), or an open drain output (5V MAX pullup). (see note 2) |
| AN1 | Analog Input AN1. Input voltage range is zero to +5V. (see note 1) Digital I/O AN1, Configurable as a digital Input, a digital output (5V), or an open drain output (5V MAX pullup). (see note 2) |
| AN2 | Analog Input AN2. Input voltage range is zero to +5V. (see note 1) Digital I/O AN2, Configurable as a digital Input, a digital output (5V), or an open drain output (5V MAX pullup). (see note 2) |
| GND | Ground |
| S2 | Latching Relay 2 Set Contact (see note 3) |
| C2 | Latching Relay 2 Common Contact (see note 3) |
| R2 | Latching Relay 2 Reset Contact (see note 3) |

Notes:

1. The analog input range is 0-5V. The maximum sample rate is 20Ksps. Refer to section 7 for more details.
2. Digital outputs can sink or source 25mA, 90mA for all combined. Open drain outputs are implemented by making the IO pin an input. The maximum pull-up voltage is 5.3 volts.
3. Relay contacts can support resistive loads of up to 4A @ 30 VDC, 0.6A @ 110 VDC, and 1 A @ 125 VAC. If this value is exceeded the DLP-IO20 can be damaged. The relay is set and reset under software control. For a functional schematic of the relay connections refer to figure 8.
4. The DLP-IO20 uses a single package multi-device driver (ULN2003APW). If only one of the driver channels is being used it can provide a peak current of 300mA at a 100% duty cycle, but if all three channels are being used they can only provide a peak current of 100mA each at a

100% duty cycle. The 5V power source provided by the host USB interface has limited power. For this reason the amount of current drawn by the relay drivers MUST be limited to 300mA or there may not be enough current available to power the board, and the PC's USB port could be damaged.

## 7.0 Relay Functional Schematic

The DLP-IO20 contains two latching relays. These are controlled by host software. The relay contacts R1, S1, C1, R2, S2, and C2 are described in table 1. A functional view of how one of the relays works is shown here.

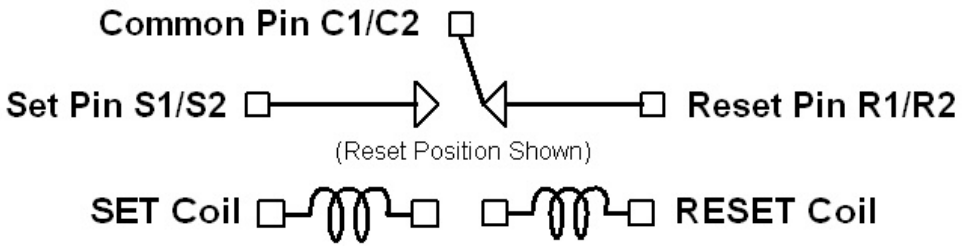



Figure 1: Relay Functional Schematic

Note: On power up of the DLP-IO20, 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 on power up.

## 8.0 USING THE DLP-IO20

Simply connect the DLP-IO20 to the PC to initiate the loading of USB drivers. Once the USB drivers are loaded, the DLP-IO20 is ready for use. All commands are issued as multi-byte command packets consisting of at least two bytes.

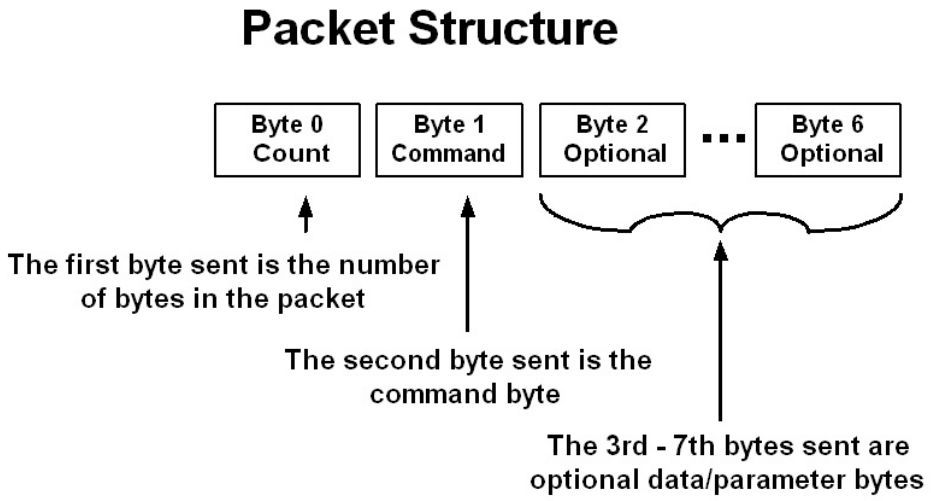



Figure 2: Multi-Byte Command Packets

You can either utilize the TestApp program (described in the following section number 8) provided with the DLP-IO20, or write your own program in your language of choice. Begin by opening the COM port, and send multi-byte commands as shown in Table 2 below. There is no need to set the baud rate because the DLP-IO20 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-IO20, or you can look in Device Manager to see which port was assigned by Windows.

**TABLE 2**

**Command Packets**

| Command Packet | Description | Byte | Hex Value | Return / Comments |
|---|---|---|---|---|
| Ping | Issue Ping | 0 | 0x02 | 2 byte packet |
| | | 1 | 0x27 | Y (0x59) will be returned if the DLP-IO20 is found on the selected port |
| Flash LED | Flashes the D1 LED | 0 | 0x02 | 2 byte packet |
| | | 1 | 0x28 | Nothing returned |
| LED Control | Turn the D1 LED on/off | 0 | 0x03 | 3 byte packet |
| | | 1 | 0x29 | LED Control Command |
| | | 2 | 0x00<br>0x01 | LED D1 port pin set low (0) turns LED ON<br>LED D1 port pin set high (1) turns LED OFF<br>Nothing Returned |
| Relay Control | Set / Reset Relays | 0 | 0x04 | 4 byte packet |
| | | 1 | 0x30 | Relay Control Command |
| | | 2 | 0x01<br>0x02 | Select Relay 1<br>Select Relay 2 |
| | | 3 | 0x00<br>0x01 | Set Relay<br>Reset Relay<br>Nothing Returned |

| TABLE 2 (Continued) | | | | |
|---|---|---|---|---|
| **Command Packets** | | | | |
| **Command Packet** | **Description** | **Byte** | **Hex Value** | **Return / Comments** |
| Digital I/O Command | Control direction and output value on Digital IO | 0 | 0x05 | 5 byte packet |
| | | 1 | 0x35 | Digital IO Command |
| | | 2 | 0x00<br>0x01<br>0x02<br>0x03<br>0x04<br>0x05<br>0x06<br>0x07<br>0x08<br>0x09<br>0x0A<br>0x0B<br>0x0C<br>0x0D<br>0x0E<br>0x0F<br>0x10<br>0x11<br>0x12<br>0x13 | Select Channel AN0<br>Select Channel AN1<br>Select Channel AN2<br>Select Channel AN3<br>Select Channel AN4<br>Select Channel AN5<br>Select Channel AN6<br>Select Channel AN7<br>Select Channel AN8<br>Select Channel AN9<br>Select Channel AN10<br>Select Channel AN11<br>Select Channel AN12<br>Select Channel AN13<br>Select Channel RA4<br>Select Channel P5<br>Select Channel P6<br>Select Channel P7<br>Select Channel RB7<br>Select Channel RB6 |
| | | 3 | 0x00<br>0x01 | Channel configured as Digital Output<br>Channel configured as Digital Input |
| | | 4 | 0x00<br>0x01 | Digital Output set low (0)<br>Digital Output set high (1)<br>Note:<br>1. Byte 4 is only used in output mode but must be included in all Digital IO Command Packets.<br><br>When byte 3 is set for input (0x01) a single byte is returned. |
| Enable / Clear Event Counter Command | Enable and Clear Event Counter on Channels RB6 and RB7 | 0 | 0x04 | 4 byte packet |
| | | 1 | 0x36 | Enable and Clear Event Counter Command |
| | | 2 | 0x06<br>0x07 | Channel RB6<br>Channel RB7 |
| | | 3 | 0x00<br>0x01 | Trigger Event Count on Falling Edge<br>Trigger Event Count on Rising Edge<br>Nothing Returned |
| Read Event Counter Command | Read Event Counter on Channels RB6 and RB7 | 0 | 0x03 | 3 byte packet |
| | | 1 | 0x37 | Read Event Counter Command |
| | | 2 | 0x06<br>0x07 | Channel D6<br>Channel D7<br>32 bit count value returned as 4 bytes, with the LS Byte first. |

| TABLE 2 (Continued) | | | | |
|---|---|---|---|---|
| **Command Packets** | | | | |
| **Command Packet** | **Description** | **Byte** | **Hex Value** | **Return / Comments** |
| Detect Sensor Command | Determine if temperature sensor is present and retrieve the serial number<br><br>Designed to work with the **DS18B20+** sensor. | 0 | 0x03 | 3 byte packet |
| | | 1 | 0x39 | Detect Sensor Command (see Note 3) |
| | | 2 | 0x00<br>0x01<br>0x02<br>0x03<br>0x04<br>0x05<br>0x06<br>0x07<br>0x08<br>0x09<br>0x0A<br>0x0B<br>0x0C<br>0x0D<br>0x0E<br>0x12<br>0x13 | Select Channel AN0<br>Select Channel AN1<br>Select Channel AN2<br>Select Channel AN3<br>Select Channel AN4<br>Select Channel AN5<br>Select Channel AN6<br>Select Channel AN7<br>Select Channel AN8<br>Select Channel AN9<br>Select Channel AN10<br>Select Channel AN11<br>Select Channel AN12<br>Select Channel AN13<br>Select Channel RA4<br>Select Channel RB7<br>Select Channel RB6<br><br>8 bytes are returned by the detect command:<br>0 : LS Byte (0) of Sensor Serial Number, or the following:<br>1 = Error: Short circuit, data always low<br>2 = Error: No DS18B20+ sensor detected<br>1 : Byte (1) of Sensor Serial Number, 0x00 on Error<br>2 : Byte (2) of Sensor Serial Number, 0x00 on Error<br>3 : Byte (3) of Sensor Serial Number, 0x00 on Error<br>4 : Byte (4) of Sensor Serial Number, 0x00 on Error<br>5 : Byte (5) of Sensor Serial Number, 0x00 on Error<br>6 : Byte (6) of Sensor Serial Number, 0x00 on Error<br>7 : MS Byte (7) of Sensor Serial Number, 0x00 on Error |
| Convert Sensor Command | Initiate Sensor conversion | 0 | 0x03 | 3 byte packet |
| | | 1 | 0x40 | Convert Sensor Command (see Notes 3 & 4) |
| | | 2 | 0x01-0x13 | Select Channel 0x00-0x13 (See Command 0x39 above)<br><br>Host software must wait for conversion to complete before valid data can be read.<br><br>Nothing Returned. |
| Read Sensor Command | | 0 | 0x03 | 3 byte packet |
| | | 1 | 0x41 | Read Sensor Command (see Note 3) |
| | | 2 | 0x01-0x13 | Select Channel 0x00-0x13 (See Command 0x39 above)<br><br>2 bytes are returned:<br>0 : LS Byte Temperature Value (see Note 5)<br>1: MS Byte of Temperature Value (see Note 5)<br>0x00 returned for both bytes indicates conversion not complete<br>A successful read initiates another conversion. |

| TABLE 2 (Continued) | | | | |
|---|---|---|---|---|
| **Command Packets** | | | | |
| **Command Packet** | **Description** | **Byte** | **Hex Value** | **Return / Comments** |
| Sensor Resolution Command | Configure the sensor's resolution | 0 | 0x04 | 4 byte packet |
| | | 1 | 0x42 | Set Resolution Command (see Note 3) |
| | | 2 | 0x01-0x13 | Select Channel 0x00-0x13 (See Command 0x39 above) |
| | | 3 | 0x09<br>0x0A<br>0x0B<br>0x0C | 9 bit resolution (0.5 $^{O}$C), 94mS max convert time<br>10 bit resolution (0.25 $^{O}$C), 188mS max convert time<br>11 bit resolution (0.125 $^{O}$C), 375mS max convert time<br>12 bit resolution [default] (0.0625 $^{O}$C), 750mS max convert time.<br><br>Nothing Returned. |
| Single Channel A/D Conversion Command | Convert and read the analog voltage on selected channel | 0 | 0x03 | 3 byte packet |
| | | 1 | 0x50 | Single Channel A/D Convert/Read Command |
| | | 2 | 0x00<br>0x01<br>0x02<br>0x03<br>0x04<br>0x05<br>0x06<br>0x07<br>0x08<br>0x09<br>0x0A<br>0x0B<br>0x0C<br>0x0D | Select Channel AN0<br>Select Channel AN1<br>Select Channel AN2<br>Select Channel AN3<br>Select Channel AN4<br>Select Channel AN5<br>Select Channel AN6<br>Select Channel AN7<br>Select Channel AN8<br>Select Channel AN9<br>Select Channel AN10<br>Select Channel AN11<br>Select Channel AN12<br>Select Channel AN13<br><br>2 bytes are returned by the A/D command:<br>0 : Least Significant Byte of Voltage Value<br>1 : Most Significant Byte of Voltage Value |
| Single Channel A/D Multiple Conversion Command | Perform multiple A/D conversions on the selected channel and return the data after each conversion. | 0 | 0x05 | 5 byte packet |
| | | 1 | 0x51 | Single Channel A/D Multiple Conversion Command |
| | | 2 | 0x01-0x0D | Select Channel 0x00-0x0D (See Command 0x50) |
| | | 3 | 0x00<br>0x01<br>0x02<br>0x03<br>0x04 | Rate = 1K samples per second<br>Rate = 2K samples per second<br>Rate = 4K samples per second<br>Rate = 10K samples per second<br>Rate = 20K samples per second |
| | | 4 | 0x00<br>0x01<br>0x02<br>0x03<br>0x04<br>0x05<br>0x06 | Number of Samples = 128<br>Number of Samples = 256<br>Number of Samples = 512<br>Number of Samples = 1024<br>Number of Samples = 2048<br>Number of Samples = 4096<br>Number of Samples = 8192<br>Returns data in real time as each A/D conversion completes. 2 bytes are returned for each conversion. |

| TABLE 2 (Continued) | | | | |
|---|---|---|---|---|
| **Command Packets** | | | | |
| **Command Packet** | **Description** | **Byte** | **Hex Value** | **Return / Comments** |
| Continuous Read Command | Stream voltage data collected from selected channel until commanded to stop. | 0 | 0x04 | 4 byte packet |
| | | 1 | 0x52 | Single Channel A/D Multiple Conversion Command |
| | | 2 | 0x01-0x0D | Select Channel 0x00-0x0D (See Command 0x50) |
| | | 3 | 0x00<br>0x01<br>0x02<br>0x03<br>0x04 | Rate = 1K samples per second<br>Rate = 2K samples per second<br>Rate = 4K samples per second<br>Rate = 10K samples per second<br>Rate = 20K samples per second<br>Data will be streamed to host until any byte is sent at which point this command will be terminated. |
| Set External A/D Reference | | 0 | 0x02 | 2 byte packet |
| | | 1 | 0x53 | Select the A/D reference voltage connected to the AN3 pin. The valid range is 2.7-5.0V. This voltage sets the maximum voltage that can be measured by the A/D. |
| Set Internal A/D Reference | | 0 | 0x02 | 2 byte packet |
| | | 1 | 0x54 | Use the USB host 5V power source as the reference voltage. [default] |

Notes:

1. Requires DS18B20+ digital temperature sensor (purchased separately). See Section 8.0 of this document for connection details.
2. Before issuing a convert sensor command, make sure that a digital temperature sensor is present on the selected digital IO channel with a 1.5K Ohms pull-up resistor.
3. The temperature value returned is in $^{O}$C and is a signed 16 bit value. When the MS Bit is high this indicates a negative temperature. The user will need to handle the sign and convert the negative number before translating the binary representation into a decimal temperature value. One example of how to do this is shown in the DLP-IO20 Demo code provided. Other examples are available from www.maxim-ic.com in application note AN162.pdf.

## 9.0 Connecting the Digital Temperature Sensor

Up to 17 DS18B20+ digital temperature sensors can be connected to the DLP-IO20. For best performance, use Category 5/6 type computer cable to connect the sensors to the DLP-IO20. Two twisted pair wires in the Cat5/Cat6 cable are required for the connection. The first pair is for Power (5V) and Ground, and the second pair is designated as Data and Ground. In addition, a 1.5K Ohm pull-up resistor is required for the data line. Figure 3 shows an example of this connection using Channel AN7.

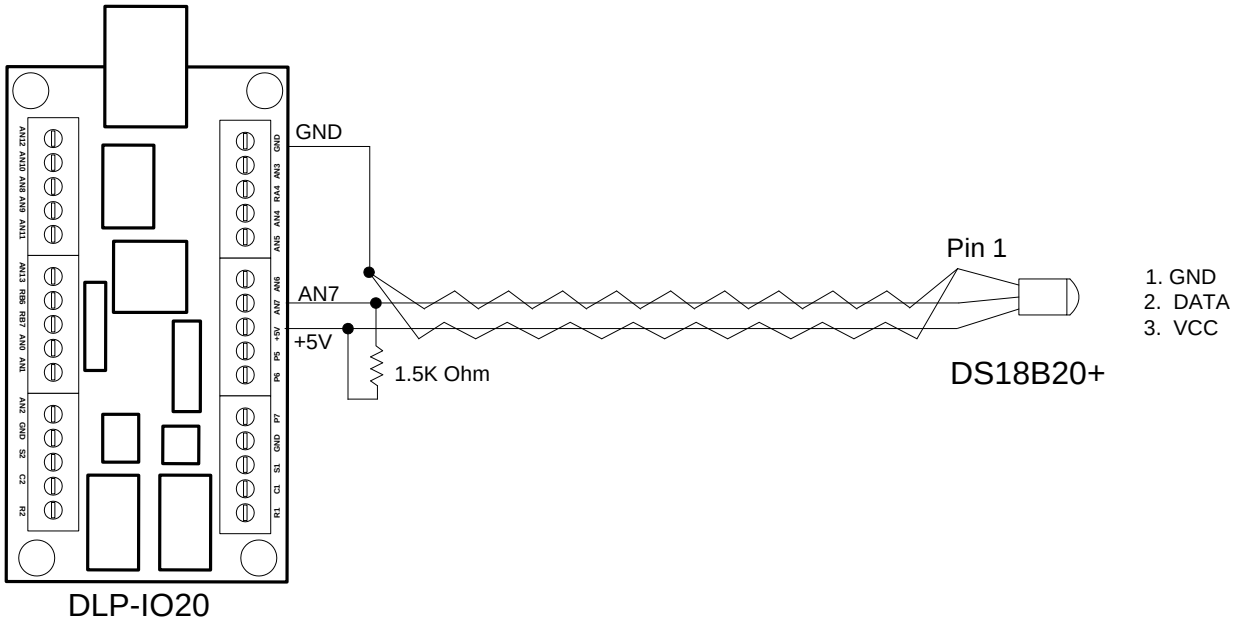



Figure 3: Digital Temperature Sensor Connection Example

To detect a sensor, send the DLP-IO20 the Detect Sensor command (0x39) packet for the appropriate channel. Eight bytes will be returned from this command packet. If the channel is stuck low a 1 will be returned in the first byte. If no sensor is present a 2 will be returned in the first byte. In these two cases, the remaining 7 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 (0x40) to initiate a temperature conversion process. At this point, a Read Sensor command (0x41) packet can be issued to obtain the temperature value. The conversion can take up to 750mS to complete, depending on the resolution setting.

All commands are detailed in table 2 under section 8 of this datasheet.

## 10.0 Demo Application Program

A test application program called IO20Demo is provided with the purchase of the DLP-IO20 that runs on Windows XP / Vista, and can be used to interface with and control the DLP-IO20. Note that the Visual C++ source is also available with the purchase of the DLP-IO20. This application is designed to demonstrate all available features.

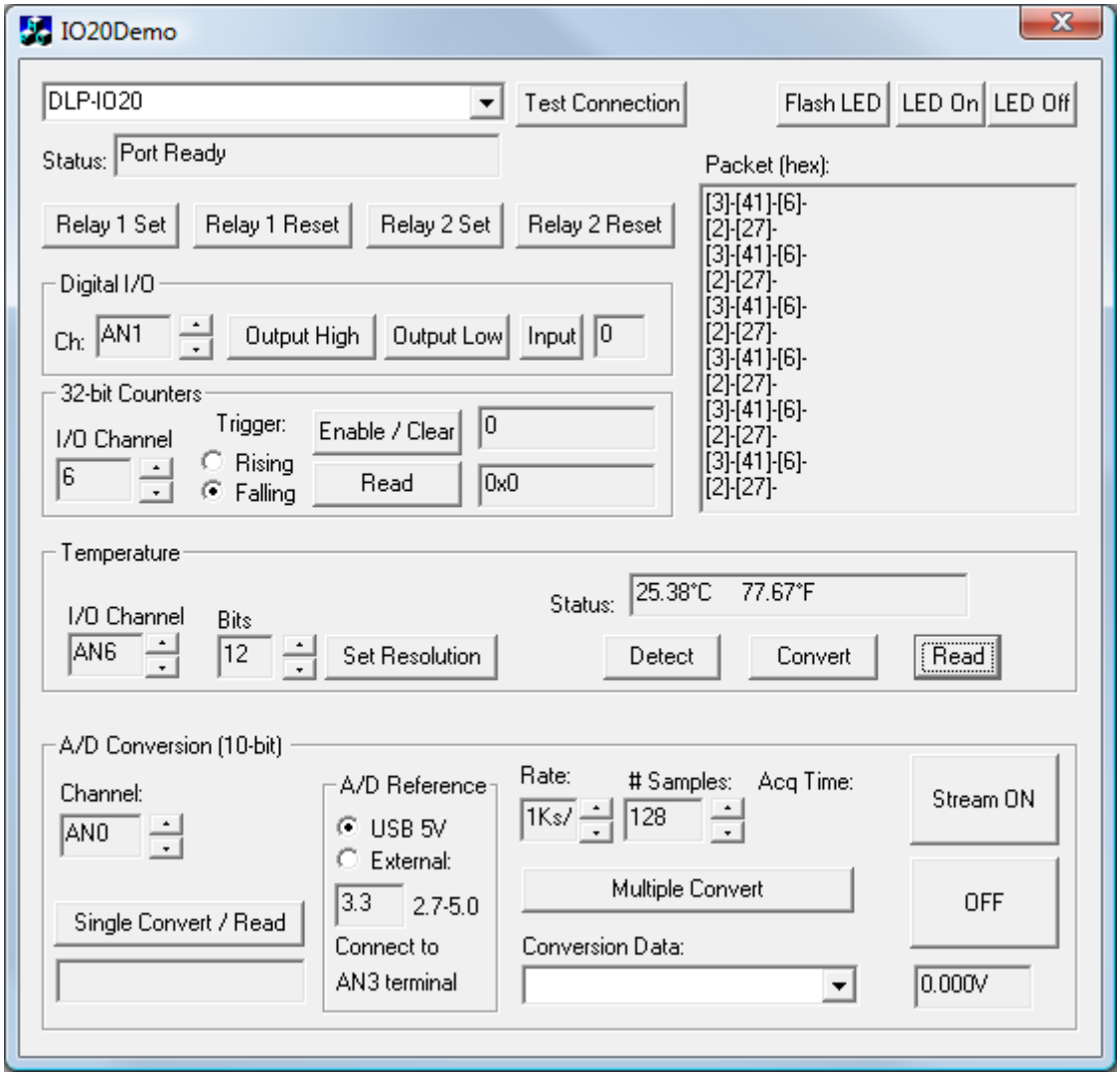
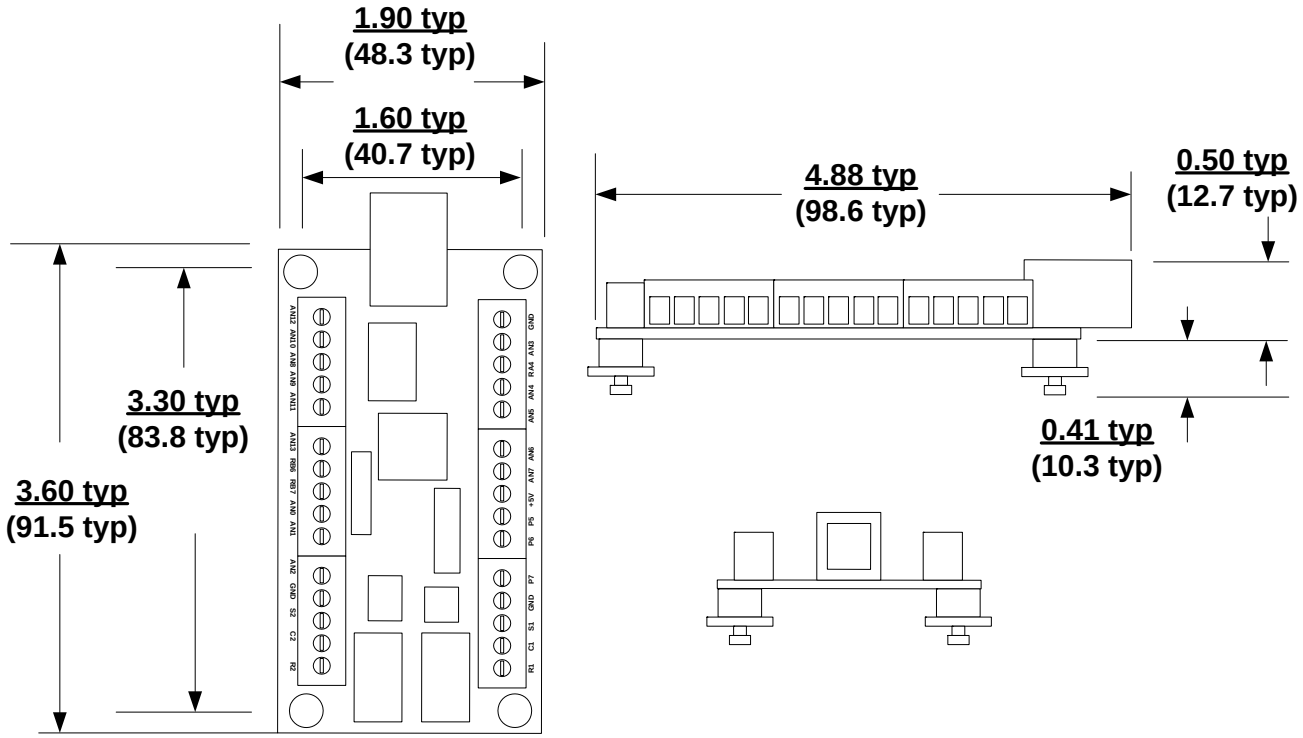



Figure 4: Test Application GUI

The version of the application provided for download with the DLP-IO20 targets Windows XP and Vista, but the Visual C++ 6.0 source code is available (upon purchase of the DLP-IO20) so that the application can be retargeted for different operating systems.

## 11.0 MECHANICAL DIMENSIONS IN INCHES (MM)




DLP-IO20

## 12.0 DISCLAIMER



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This document provides preliminary information that may be subject to change without notice.

## 13.0 CONTACT INFORMATION

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