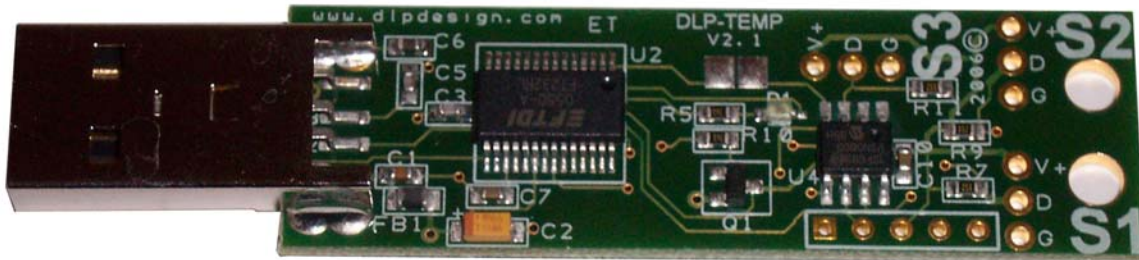# DLP Design

DLP-TEMP-G

USB / Data-Acquisition Module

NOW LEAD-FREE

Features:

- 3 Digital I/Os, 3 Analog Inputs (0-5 Volts) or any combination
- USB 1.1 and 2.0 Compatible Interface
- 4th Generation Silicon from FTDI
- Supports Up To 3 Digital Temperature Sensors

Applications:

- Data Acquisition
- Temperature Monitoring

INTRODUCTION

The DLP-TEMP-G is a USB/microcontroller based 3-channel data-acquisition system preprogrammed with firmware for digital I/O or reading digital temperature-sensing devices. The DLP-TEMP-G board is equipped with a Type A male USB connector for direct connection to a USB port. No cable is required unless the board is to be located away from the PC, in which case a user supplied USB A-A (male-female) extension cable can be used.

The digital temperature-sensing device supported is the Dallas Semiconductor DS18B20. Three of these sensors can be monitored simultaneously while connected to the DLP-TEMP-G via Category 5 cable at distances up to 200 feet. (For instruction on how to connect the sensors to the DLP-TEMP-G via Category 5 cable, refer to the Application section of this document.) All power for the DLP-TEMP-G's circuitry and DS18B20 temperature sensors is taken from the USB port so no external power source is required.

The microcontroller used is the PIC12F683, 8-pin, Flash-based microcontroller from Microchip. As mentioned above, the 12F683 is preprogrammed for analog voltage measurement and for reading the digital temperature sensors, but it can also be erased and reprogrammed with user code if desired. Reprogramming the micro requires a user-supplied device programmer. (Refer to the schematic at the end of this document for the pin out of the programming header.)

The microcontroller uses a single port pin and a pull-up resistor to communicate with each digital temperature sensor. Refer to the DS18B20's datasheet for a complete description of its communications protocol. The firmware for the DLP-TEMP-G was written in C and can be downloaded from **dlpdesign.com**.

USB INTERFACE

The USB interface was implemented using the FT232RL USB-UART IC from FTDI. This device connects to the host computer via the Type A USB (male) connector and supports the 8 standard RS232 serial signals. Only the TX and RX signals are used on the DLP-TEMP-G board and are all that is required to form a serial connection to the host computer. Since handshaking is not used in this design, the firmware in the 12F683 processor must be ready to accept all incoming serial data from the host computer or the data will be lost.

In order for the DLP-TEMP-G (and FT232RL) to receive incoming serial data from the host, FTDI's VCP (Virtual Com Port) drivers must be installed. The driver installation process is initiated by simply plugging the DLP-TEMP-G into a USB port. The driver installation wizard will prompt for the location of the drivers files (in a folder or on a floppy) and will copy the required files to the proper destination such that the next time the board is connected the driver files will be automatically loaded without prompting the user. The VCP driver files can be downloaded for free from **dlpdesign.com** or **ftdichip.com**.

Once the drivers are loaded and the com port number for the DLP-TEMP-G is set in Device Manager, the application program running on the host simply opens what it thinks is an RS232 port (9600, N, 8, 1) and begins communicating with the 12F683 microcontroller.

COMMUNICATIONS PROTOCOL

For this design, a rather simplistic protocol was selected in an attempt to present the design in as basic a way as possible. Single-byte commands are used to communicate with the 12F683 microcontroller. The following table shows the command list:

COMMAND	12F683 Response
R (read and convert)	Send back 18 bytes of data from the sensors and start another temperature conversion in both sensors. Provided as legacy support for compatibility with the original DLP-TEMP.
P (ping)	Echo the letter 'Q' back to the host. Provided as legacy support for compatibility with the original DLP-TEMP.
S	Read temperature sensor at S1, return data and convert

T	Read temperature sensor at S2, return data and convert
U	Read temperature sensor at S3, return data and convert
A	Setup S1/AN2/GP2 for analog, read voltage and return 2 bytes
B	Setup S2/AN0/GP0 for analog, read voltage and return 2 bytes
C	Setup S3/AN3/GP4 for analog, read voltage and return 2 bytes

Example host voltage read code:
```
//declare tx[] and  rx[] buffers
tx[0] = 'A';
PutBuffer(tx, 1);//send tx out serial port – substitute your serial port code here
GetBuffer(rx, 2, timeout); //again, substitute your serial port code here
Int temp = rx[1] | (rx[0] << 8);//convert returned data
float  actual_voltage = temp/1024.0*5.0);
```

M	Setup S1/AN2/GP2 for digital and read state - return 1 byte
N	Setup S2/AN0/GP0 for digital and read state - return 1 byte
O	Setup S3/AN3/GP4 for digital and read state - return 1 byte
J	Setup S1/AN2/GP2 for digital, and set high
K	Setup S2/AN0/GP0 for digital, and set high
L	Setup S3/AN3/GP4 for digital, and set high
G	Setup S1/AN2/GP2 for digital, and set low
H	Setup S2/AN0/GP0 for digital, and set low
I	Setup S3/AN3/GP4 for digital, and set low

APPLICATION

The DLP-TEMP-G can be used to monitor temperature at the board or at a distance from the board. The board supports monitoring of two temperatures. If more than two temperature measure-ments are required, then the DLP-TEMP9 can be used to monitor/measure up to nine temperatures.

The board comes with one sensor that is not soldered to the board so that the user has the option of locating the sensor at a distance from the board using Category 5 cable. This design has been successfully tested with both sensors located 200 feet away from the board using Category 5 cable. Two pairs of wires in the Category 5 cable are required for the connection. One pair is for power and ground, and the other pair is for data and ground. If using both sensors, you can either connect them to the board using one cable for both sensors since the cable has 4 pairs, or 2 cables if the sensors are to be placed in different locations.

DISCLAIMER

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

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DLP-TEMP Version 2.1

DLP Design

JP4
DS18B20 / TO92
Sensor 3

JP3
DS18B20 / TO92
Sensor 2

JP1
DS18B20 / TO92
Sensor 1

SWVCC

SWVCC

SWVCC

USB Type A Male Connector

CN1

C6
.47uF

C1
.01

FB1
240-1018-1

C2
10/10 Tant

USBVCC

PWREN#

Q1
IRLML6402CT P

SWVCC

R10
360

R11
1.5K

R7
1.5K

R9
1.5K

12MHz

U4
PIC12F683

OSC1
OSC2

GP2

GP0/PGD

GND

GP1/PGC

GP3/Vpp

VCC

RXD

TXD

C10
.1

SWVCC

JP2
PROGRAMMING HEADER

Vpp
Clock
Vcc
Gnd
Data

SWVCC
RXD
TXD

C5
47pF

C3
47pF

C7
.1uF

U2
FT232R

3V3OUT

OSCO
OSCI
AVCC/NC
RESET#
VCCIN/NC
USBDM
USBDP
VCC5 IN

AGND
GND
GND
GND
TEST

VCCIO

TXD
RXD
RTS#
CTS#
DTR#
DSR#
DCD#
RI#
CBUS0
CBUS1
CBUS2
CBUS3
CBUS4

USBVCC

SWVCC

TXD (From host ->)
RXD (To host <-)

12MHz

PWREN#

R5
360

D1
LED

SWVCC