

**DLP-
2232MSP**
LEAD FREE

USB / MICROCONTROLLER MODULE

The DLP-2232MSP combines the same USB interface used in the DLP-2232H and the DLP-1232H modules with a Texas Instruments microcontroller to form a rapid development tool. The MSP430F2618 microcontroller is preprogrammed with basic functionality for accessing the port pins and can be reprogrammed with user firmware via a 10-pin header using a device programmer (purchased separately).

FEATURES:

- Send/receive data over a high-speed USB 2.0 interface to a host computer
- 32 digital I/O lines (8 can be configured as A/D inputs; 2 can be configured as D/A outputs) plus the 8-bit data bus available for interfacing to user electronics
- Texas Instruments 16-bit RISC architecture processor with 116K bytes FLASH ROM, 8K bytes RAM, a multi-channel, 12-bit A/D converter and dual, 12-bit D/A converters
- “Token I/O” code preprogrammed into the MSP430F2618’s FLASH memory for basic port pin input/output capability including access to the A/D and D/A converters
- The FLASH memory can be easily erased and reprogrammed utilizing a user-supplied compatible programmer
- No in-depth knowledge of USB is required as all USB protocols are handled automatically by the on-board FT232H and its support circuitry
- Royalty-free device drivers eliminate the need for USB driver development in most cases
- USB bulk or isochronous data-transfer modes
- Required 5V supply can be taken directly from the USB port or supplied by user electronics
- USB 1.1 and USB 2.0 compatible
- USB VID, PID, serial number and product-description strings stored in an on-board EEPROM memory
- Royalty-Free Virtual COM Port (VCP) Drivers for:
 - Windows 2000, Server 2003 and Server 2008
 - Windows XP and XP 64 bit
 - Windows Vista and Vista 64 bit
 - Windows 7
 - Windows CE 4.2-, 5.0- and 5.2-based OS
 - MAC OS-X
 - Linux (tested using kernel 2.6.32)

- Royalty-Free D2XX Direct Drivers (USB drivers + DLL S/W interface) for:
 - Windows 2000, Server 2003 and Server 2008
 - Windows XP and XP 64 bit
 - Windows Vista and Vista 64 bit
 - Windows 7
 - Windows CE 4.2-, 5.0- and 5.2-based OS
 - MAC OS-X
 - Linux (tested using kernel 2.6.32)

APPLICATION AREAS:

- Prototype development
- USB ISDN and ADSL modems
- USB interface for digital cameras
- USB interface for MP3 players
- High-speed USB instrumentation
- USB smart-card readers
- Set top box (STB) PC-USB interface
- USB hardware modems
- USB wireless modems
- USB bar code readers

1.0 GENERAL DESCRIPTION

The DLP-2232MSP provides a cost-effective, microcontroller-based method of interfacing an electronic peripheral to a host computer via USB.

To send data from the peripheral to the host computer, the microcontroller simply writes the byte-wide data into the FT2232H when TXE# is low. If the FT2232H's transmit buffer fills up or is busy storing the previously written byte, it will take TXE# high in order to stop further data from being written until some of the FIFO data has been transferred over USB to the host.

When the host sends data to the peripheral over USB, the FT2232H will take RXF# low to let the microcontroller know that at least one byte of data is available. The microcontroller then reads the data until RXF# goes high indicating that no more data is available to be read.

By using FTDI's Virtual COM Port Drivers, the peripheral looks like a standard COM port to the application software. Commands to set the baud rate are ignored--the FT2232H always transfers data at its fastest rate regardless of the application's baud-rate setting. The latest versions of the drivers are available for download from DLP Design's website at **www.dlpdesign.com**.

2.0 DRIVER SOFTWARE

FTDI's VCP (Virtual COM Port) driver-executable files are provided royalty free on the condition that they are used only with designs incorporating an FTDI device (i.e. the FT2232H on the DLP-2232MSP). The latest version of the drivers can be downloaded from **www.dlpdesign.com** or **www.ftdichip.com**.

The VCP driver download file is a combined set of drivers for Windows 7, Windows Vista and Windows 2000/XP. Unzip the file to a blank floppy disk or folder on your PC. (The drivers can coexist on the same floppy disk or folder since the INF files determine which set of drivers to load for each operating system version.) Once loaded, the VCP drivers allow the application software running on your host PC to communicate with the DLP-2232MSP as though it were connected to a COM (RS-232) port.

In addition to VCP drivers, FTDI's D2XX direct drivers offer an alternative solution to the VCP drivers that allow application software to interface with the DLP-2232MSP using a DLL instead of a Virtual COM Port. The architecture of the D2XX drivers consists of a Windows WDM driver that communicates with the device via the Windows USB stack and a DLL that interfaces the application software (written in VC++, C++ Builder, Delphi, VB, etc.) to the WDM driver. An INF installation file, uninstaller program and D2XX Programmer's Guide complete the package.

The D2XX direct drivers add support for simultaneous access and control of multiple FT2232H devices. The extended open function (FT_OpenEx) allows the device to be opened by either its product description or serial number, both of which can be programmed to be unique. The list devices function (FT_ListDevices) allows the application software to determine which devices are currently available for use, again by product description or by serial number.

Download FTDI Application Notes AN232-03, AN232-05, AN232-06 and AN232-07 for detailed instructions on how to install and remove the drivers.

3.0 EEPROM WRITE UTILITY

The DLP-2232MSP has the option to accept manufacturer-specific information that is written into on-board EEPROM memory. Parameters that can be programmed include the VID and the PID identifiers, the manufacturer's product string or a serial number.

MPROG is an EEPROM serializer and testing utility from FTDI for the FT2232H device. MPROG is based on the new D2XX drivers and will work on Windows 7, Windows Vista and Windows 2000/XP platforms. You must install the latest release of the CDM drivers in order to run this application. (Refer to the MPROG User's Guide for details on the program's use.)

4.0 QUICK START GUIDE

This guide requires the use of a Windows 7/Vista/2000/XP PC that is equipped with a USB port.

1. Download the WHQL-certified CDM device drivers from either **www.dlpdesign.com** or **www.ftdichip.com**. Unzip the drivers onto a blank floppy disk or into a folder on the hard drive.

Note: The DLP-2232MSP can be configured to receive its operating power from the USB port or from user electronics. Pins 24 and 25 or the barrel jack allow for this configuration. (Refer to the Pinout Description in the next section for details on the DLP-2232MSP electrical interface.)

****The board will not operate until a power source has been connected.****

2. Connect the DLP-2232MSP board to the PC via a standard A-B, 6-foot USB cable. This action initiates the loading of the USB drivers. When prompted, select the folder where the CDM device drivers were stored in Step 1. Windows will then complete the installation of the device drivers for the DLP-2232MSP board. The next time the DLP-2232MSP board is attached, the host PC will immediately load the correct drivers without any prompting. Reboot the PC if prompted to do so.

The DLP-2232MSP is shipped with default VID, PID, etc. values programmed into the EEPROM memory. You only need to run MPROG if you want to change the default values.

At this point, the DLP-2232MSP is ready for use. Note that the DLP-2232MSP will appear non-responsive if data sent from the host PC is not read from the FT2232H device by the MSP430F2618 microcontroller. The token firmware with which the DLP-2232MSP comes preloaded will read data sent by the host by default. Custom user firmware should also follow this protocol.

5.0 TOKEN I/O

The MSP430F2618 microcontroller on the DLP-2232MSP comes preprogrammed with firmware that provides rudimentary access to the port pins via either the VCP or DLL drivers. Features include the ability to read and write individual port pins.

The firmware in the DLP-2232MSP also provides access to the MSP430F2618's A/D converter, D/A converter and communications. Commands sent to the Token I/O firmware must adhere to a specific communications protocol. Each command sequence contains the following information:

Byte 0:	Number of bytes in command sequence
Byte 1:	Command
Byte 2...n:	Parameter/data bytes

For example, setting Port Pin P1.1 high would require the following string of bytes:

0x04, 0x30, 0x11, 0x00, 0x01

Definition of the Bytes:

0x04 – Number of bytes in command
0x30 – Command for digital port pin access
0x11 – Affected port pin
0x00 – Set port pin to output
0x01 – Desired state of port pin

The port pins equate to hexadecimal numeric constants as defined here:

PORT 1:

0x10 = P1.0 MSP430F2618 Pin 12, DLP-2232MSP module Pin J1.12
0x11 = P1.1 MSP430F2618 Pin 13, DLP-2232MSP module Pin J1.13

PORT 2:

0x20 = P2.0 MSP430F2618 Pin 20, DLP-2232MSP module Pin J1.14
0x21 = P2.1 MSP430F2618 Pin 21, DLP-2232MSP module Pin J1.16
0x22 = P2.2 MSP430F2618 Pin 22, DLP-2232MSP module Pin J1.18
0x23 = P2.3 MSP430F2618 Pin 23, DLP-2232MSP module Pin J1.20
0x24 = P2.4 MSP430F2618 Pin 24, DLP-2232MSP module Pin J1.19
0x25 = P2.5 MSP430F2618 Pin 25, DLP-2232MSP module Pin J1.17
0x26 = P2.6 MSP430F2618 Pin 26, DLP-2232MSP module Pin J1.15
0x27 = P2.7 MSP430F2618 Pin 27, DLP-2232MSP module Pin J1.21

PORT 3:

0x30 = P3.0 MSP430F2618 Pin 20, DLP-2232MSP module Pin J1.39
0x31 = P3.1 MSP430F2618 Pin 21, DLP-2232MSP module Pin J1.41
0x32 = P3.2 MSP430F2618 Pin 22, DLP-2232MSP module Pin J1.37
0x33 = P3.3 MSP430F2618 Pin 23, DLP-2232MSP module Pin J1.38
0x34 = P3.4 MSP430F2618 Pin 24, DLP-2232MSP module Pin J1.36
0x35 = P3.5 MSP430F2618 Pin 25, DLP-2232MSP module Pin J1.40

PORT 5:

0x50 = P5.0 MSP430F2618 Pin 44, DLP-2232MSP module Pin J1.43
0x51 = P5.1 MSP430F2618 Pin 45, DLP-2232MSP module Pin J1.45
0x52 = P5.2 MSP430F2618 Pin 46, DLP-2232MSP module Pin J1.44
0x53 = P5.3 MSP430F2618 Pin 2, DLP-2232MSP module Pin J1.46
0x54 = P5.4 MSP430F2618 Pin 48, DLP-2232MSP module Pin J1.47
0x55 = P5.5 MSP430F2618 Pin 49, DLP-2232MSP module Pin J1.48
0x56 = P5.6 MSP430F2618 Pin 50, DLP-2232MSP module Pin J1.50
0x57 = P5.7 MSP430F2618 Pin 51, DLP-2232MSP module Pin J1.49

PORT 6:

0x60 = P6.0/A0 MSP430F2618 Pin 59, DLP-2232MSP module Pin J1.2
0x61 = P6.1/A1 MSP430F2618 Pin 60, DLP-2232MSP module Pin J1.3
0x62 = P6.2/A2 MSP430F2618 Pin 61, DLP-2232MSP module Pin J1.4
0x63 = P6.3/A3 MSP430F2618 Pin 2, DLP-2232MSP module Pin J1.5
0x64 = P6.4/A4 MSP430F2618 Pin 3, DLP-2232MSP module Pin J1.7
0x65 = P6.5/A5 MSP430F2618 Pin 4, DLP-2232MSP module Pin J1.8
0x66 = P6.6/A6/DAC0 MSP430F2618 Pin 5, DLP-2232MSP module Pin J1.9
0x67 = P6.7/A7/DAC1 MSP430F2618 Pin 6, DLP-2232MSP module Pin J1.10

The source code for the Token I/O firmware (developed using the CCS C compiler) is available as a free download upon purchase and receipt of the hardware. Example Visual C++ source code developed using Microsoft Visual C for communicating with the DLP-2232MSP via the Token I/O firmware is also available for download. (The Windows source code also contains the port pin definitions listed above.)

5.1 TOKEN I/O COMMAND SET

0x27 – Ping – Host Notification

Length: 2 Bytes
Parameters: None
Returns: 1 Byte: ASCII “S” or hex 0x53
Function: This function returns an ASCII ‘S’ to tell the host that the module is up and running
Example: 0x02, 0x27 – Causes the module to return a 0x53 to the host

0x28 – Flash LED – Toggle the LED

Length: 2 Bytes
Parameters: None
Returns: 1 Byte: command echo acknowledgement=0x28
Function: This function will cause the module’s green LED to flash briefly
Example: 0x02, 0x28 – Causes the LED to toggle briefly

0x29 – LED On/Off

Length: 3 Bytes
Parameters: 1 Byte: 0=Turn LED Off; 1=Turn LED On
Returns: 1 Byte: command echo acknowledgement=0x29
Function: This function will turn the module’s green LED on or off
Example: 0x03, 0x29, 0x01 - Turns on the LED

0x30 – Digital I/O Read/Write

Length: 4 or 5 Bytes
Parameters: 2 or 3 Bytes:
1. Port Selection – Select the desired MSP430F2618 port pin (refer to the port list under the previous section)
2. Port Direction: 1=Input; 0=Output
3. Port Value if Byte 2 specifies Output
Returns: 2 Bytes for Input=Value on port pin; command echo acknowledgement=0x30
1 byte for Output=command echo acknowledgement=0x30
Function: This function will read from or write to the selected port pin
Example: 0x04, 0x30, 0x60, 0x00, 0x01 – Sets Port 6 Pin 0 high

0x40 – A/D Conversion

Length: 3 Bytes
Parameters: Mode: 0=Single conversion, 1=Continuous conversions (~1 per second)

Note: Setting the ADC mode to continuous (1) starts an infinite loop. The ADC will perform a conversion approximately once a second and report the result to the host. To exit, break the code using the debugger or reset the module.

Returns: 2 Bytes: The 12-bit voltage data; MSB first
Function: This function will enable A/D conversion on the selected channel and ADC, pause 10uS, perform the A/D conversion and then return 2 bytes to the host (MSB first). Command 0x42 must have been previously called to configure the desired analog

channel as an A/D input, and 0x43 / 0x44 must have been called to configure the voltage reference.

Example: 0x3, 0x40 0x00 – Performs the A/D conversion and, using ADC0, returns 2 bytes of data

0x41 – Disable A/D

Length: 3 Bytes

Parameters: 0=ADC0, 1=ADC1

Returns: 1 Byte: command echo acknowledgement=0x41

Function: This function disables the specified A/D converter

Example: 0x3, 0x41 0x01 – Disables A/D Converter 1

0x42 – Select A/D Input

Length: 3 Bytes

Parameters: 0x00=Select input A0 (P6.0)

0x01=Select input A1 (P6.1)

0x02=Select input A2 (P6.2)

0x03=Select input A3 (P6.3)

0x04=Select input A4 (P6.4)

0x05=Select input A5 (P6.5)

0x06=Select input A6 (P6.6)

0x07=Select input A7 (P6.7)

0x08=Select internal input Vref+

0x09=Select internal input Vref-/Vref-

0x0A=Select internal temperature diode

0x0B=Select internal input $(V_{cc} - V_{ss})/2$

Returns: 1 Byte: command echo acknowledgement=0x42

Function: This function selects the analog input to be used by the specified A/D converter

Example: 0x3, 0x42 0x03 – Selects analog input A3

0x43 – External Reference

Length: 2 Bytes

Parameters: None

Returns: 1 Byte: command echo acknowledgement=0x43

Function: This function sets the A/D and D/A references to be external

Example: 0x2, 0x43 – Select External Voltage Reference

0x44 – Internal Reference

Length: 2 Bytes

Parameters: None

Returns: 1 Byte: command echo acknowledgement=0x44

Function: This function sets the A/D and D/A references to be internal; use command 0x50 to select the Internal Voltage Reference value

Example: 0x2, 0x44 – Select Internal Voltage Reference

0x50 – Select Internal Reference Source

Length: 3 Bytes
Parameters: 0=+1.5V, 1=+2.5V
Returns: 1 Byte: command echo acknowledgement=0x50
Function: This function sets the A/D and D/A internal voltage reference values
Example: 0x3, 0x50 0x00 – Select Internal Voltage Reference of +1.5V

0x60 – D/A Output

Length: 5 Bytes
Parameters: 3 Bytes:
1. 0=DAC0 output on Port A6; 1=DAC1 output on Port A7
2. 0x0n (n=MSB 4 bits of 12-bit DAC output value)
3. 0xmm (mm=LSB 8 bits of 12-bit DAC output value)
Returns: 1 Byte: command echo acknowledgement=0x60
Function: This function selects the D/A converter and specifies the output value
Example: 0x5, 0x60 0x00 0x01 0x23 – Select DAC 0 to output value 0x123; the actual voltage depends upon the reference selected

0x61 – Disable D/A

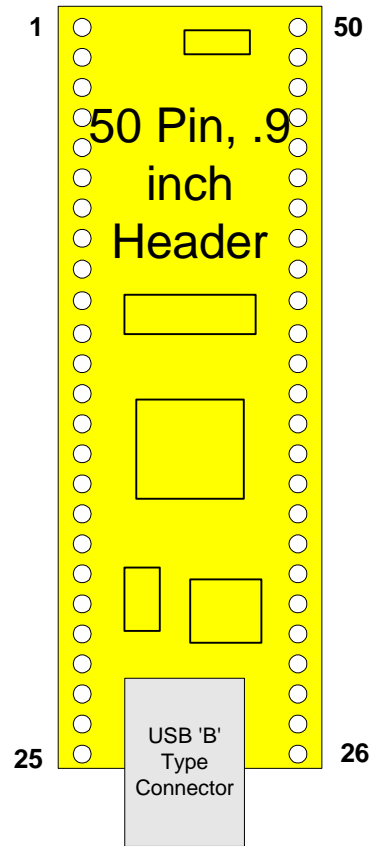
Length: 3 Bytes
Parameters: 0=DAC0; 1=DAC1
Returns: 1 Byte: command echo acknowledgement=0x61
Function: This function disables the specified D/A converter
Example: 0x3, 0x61 0x00 – Disables D/A converter 0

0x70 – UART Loopback

This command configures UART 1 to loop back any bytes received on its input port to its transmit output port. Port B on the FT2232H must be set to UART mode with a baud rate of 115200. Once set any bytes sent through Port B of the FT2232H will be echoed back. This command initiates an infinite loop in which all bytes sent are looped back. To exit, break the code using the debugger or reset the module.

Length: 2 Bytes
Parameters: None
Returns: 1 Byte: command echo acknowledgement=0x70
(After a command is sent, subsequent bytes sent to the UART via FT2232H Port B will be echoed back)
Function: This function configures UART 1 to loop back received bytes
Example: 0x2, 0x70 – UART 1 loopback enabled

TABLE 1: DLP-2232MSP PINOUT DESCRIPTION

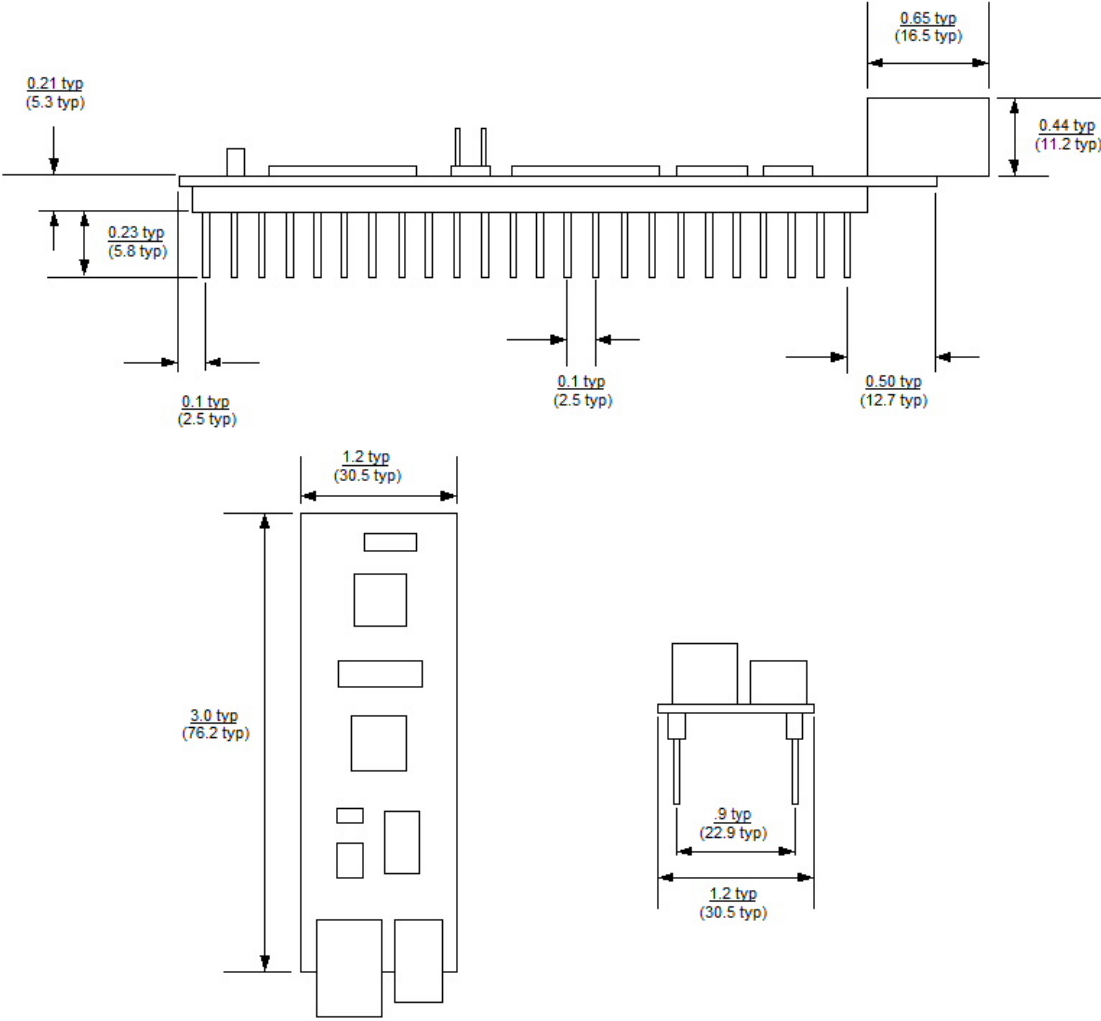


PIN #	DESCRIPTION
1	GROUND
2	P6.0/A0 (I/O) Port 6 Pin 0 connected to the MSP430F2618 Digital I/O P6.3 and Analog Input 0
3	P6.1/A1 (I/O) Port 6 Pin 1 connected to the MSP430F2618 Digital I/O P6.3 and Analog Input 1
4	P6.1/A2 (I/O) Port 6 Pin 2 connected to the MSP430F2618 Digital I/O P6.3 and Analog Input 2
5	P6.3/A3 (I/O) Port 6 Pin 3 connected to the MSP430F2618 Digital I/O P6.3 and Analog Input 3
6	GROUND
7	P6.3/A4 (I/O) Port 6 Pin 4 connected to the MSP430F2618 Digital I/O P6.4 and Analog Input 4
8	P6.3/A5 (I/O) Port 6 Pin 5 connected to the MSP430F2618 Digital I/O P6.5 and Analog Input 5
9	P6.3/A6/DAC0 (I/O) Port 6 Pin 6 connected to the MSP430F2618 Digital I/O P6.6, Analog Input 6 and D/A output DAC0
10	P6.3/A7/DAC1 (I/O) Port 6 Pin 7 connected to the MSP430F2618 Digital I/O P6.7, Analog Input 7 and D/A output DAC01
11	GROUND
12	P1.0 (I/O) Port 1 Pin 0 connected to the MSP430F2618 Digital I/O P1.0

13	P1.1 (I/O) Port 1 Pin 1 connected to the MSP430F2618 Digital I/O P1.1
14	P2.0 (I/O) Port 2 Pin 0 connected to the MSP430F2618 Digital I/O P2.0
15	P2.6 (I/O) Port 2 Pin 6 connected to the MSP430F2618 Digital I/O P2.6
16	P2.1 (I/O) Port 2 Pin 1 connected to the MSP430F2618 Digital I/O P2.1
17	P2.5 (I/O) Port 2 Pin 5 connected to the MSP430F2618 Digital I/O P2.5
18	P2.2 (I/O) Port 2 Pin 2 connected to the MSP430F2618 Digital I/O P2.2
19	P2.4 (I/O) Port 2 Pin 4 connected to the MSP430F2618 Digital I/O P2.4
20	P2.3 (I/O) Port 2 Pin 3 connected to the MSP430F2618 Digital I/O P2.3
21	P2.7 (I/O) Port 2 Pin 7 connected to the MSP430F2618 Digital I/O P2.7
22	SWVCC (Out) Power from EXT VCC (Pin 24) controlled via Pin 60 (PWREN#) of the FT2232H and Q1 MOSFET power switch; R8 and C24 control the power-up rate to help limit inrush current
23	GROUND
24	EXTVCC (In) Use for applying main power (4.4-5.25 volts) to the module; connect to PORTVCC if the module is to be powered by the USB port (typical configuration)
25	PORTVCC (Out) Power from USB port—Connect to EXTVCC if the module is to be powered by the USB port (typical configuration); 500mA is the maximum current available to the DLP-2232MSP and target electronics if the USB device is configured for high power
26	GROUND
27	DB0 (I/O) Line 0 of the data bus between the MSP430F2618 and the FT2232H USB-FIFO
28	DB1 (I/O) Line 1 of the data bus between the MSP430F2618 and the FT2232H USB-FIFO
29	DB2 (I/O) Line 2 of the data bus between the MSP430F2618 and the FT2232H USB-FIFO
30	DB3 (I/O) Line 3 of the data bus between the MSP430F2618 and the FT2232H USB-FIFO
31	DB4 (I/O) Line 4 of the data bus between the MSP430F2618 and the FT2232H USB-FIFO
32	DB5 (I/O) Line 5 of the data bus between the MSP430F2618 and the FT2232H USB-FIFO
33	DB6 (I/O) Line 6 of the data bus between the MSP430F2618 and the FT2232H USB-FIFO
34	DB7 (I/O) Line 7 of the data bus between the MSP430F2618 and the FT2232H USB-FIFO
35	GROUND
36	P3.4 (I/O) Port 3 Pin 4 connected to the MSP430F2618 Digital I/O P3.4
37	P3.2 (I/O) Port 3 Pin 2 connected to the MSP430F2618 Digital I/O P3.2
38	P3.3 (I/O) Port 3 Pin 3 connected to the MSP430F2618 Digital I/O P3.3
39	P3.0 (I/O) Port 3 Pin 0 connected to the MSP430F2618 Digital I/O P3.0
40	P3.5 (I/O) Port 3 Pin 5 connected to the MSP430F2618 Digital I/O P3.5
41	P3.1 (I/O) Port 3 Pin 1 connected to the MSP430F2618 Digital I/O P3.1
42	GROUND
43	P5.0 (I/O) Port 5 Pin 0 connected to the MSP430F2618 Digital I/O P5.0
44	P5.2 (I/O) Port 5 Pin 2 connected to the MSP430F2618 Digital I/O P5.2
45	P5.1 (I/O) Port 5 Pin 1 connected to the MSP430F2618 Digital I/O P5.1
46	P5.3 (I/O) Port 5 Pin 3 connected to the MSP430F2618 Digital I/O P5.3
47	P5.4 (I/O) Port 5 Pin 4 connected to the MSP430F2618 Digital I/O P5.4
48	P5.5 (I/O) Port 5 Pin 5 connected to the MSP430F2618 Digital I/O P5.5

49	P5.7 (I/O) Port 5 Pin 7 connected to the MSP430F2618 Digital I/O P5.7
50	P5.6 (I/O) Port 5 Pin 6 connected to the MSP430F2618 Digital I/O P5.6

**6.0 MECHANICAL DRAWINGS (PRELIMINARY) INCHES (MILLIMETERS)
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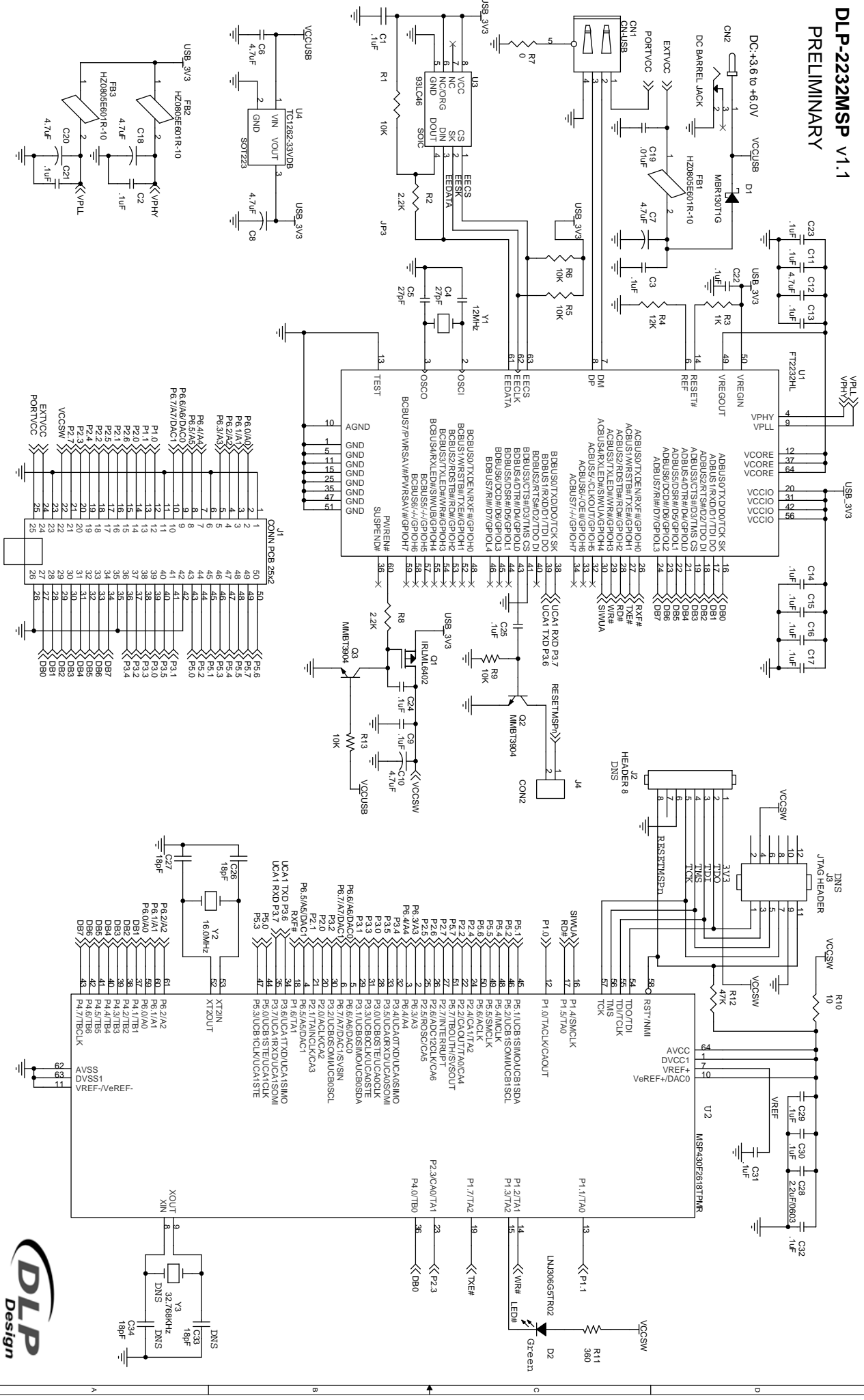
8.0 CONTACT INFORMATION

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