![Texas Instruments logo] **TEXAS INSTRUMENTS**

MSC1210-DAQ-EVM User's Guide and Examples

User's Guide

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EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the analog input voltage range of 0V to 3.3V. The output voltage range is 3.3V. The EVM derives power from the RS232 port.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than 40°C. The EVM is designed to operate properly with certain components above 40°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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MCS1210-DAQ-EVM Users Guide and Examples

Hugo Cheung   *Data Acquisition Product – Microsystem*

DESCRIPTION

The MSC1210 embeds an 8051 CPU, a high performance delta-sigma 24-bit Analog-to-Digital Converter (ADC), and many peripherals to give a system on-chip solution for a high precision data acquisition system [1]. The MCS1210-DAQ-EVM is a low-cost MSC1210 evaluation module (EVM) that does not compromise the MSC1210 sub-100nV$_{rms}$ performance. When the DAQ-EVM is used with the Raisonance Ride [2] 4kB demo, most of the advance MSC1210 features can be examined. This article describes the functions of the DAQ-EVM, and introduces the basic device usage examples program — DAQ-EVM.

Contents

MCS1210-DAQ-EVM Features

- A simplified evaluation module design of **MCS1210-**EVM [3].

- On-board MSC1210 Y5 32kB Flash memory running at 1.8432MHz.

- Compatible with Keil IDE [4] and Raisonance IDE [2].

- Compatible with TI Downloader for downloading Intel Hex user code to **DAQ-EVM**.

- Sub-100nV$_{rms}$ conversion accuracy.

- Connectors for eight AIN lines and reference voltage input output line.

- Connectors for second serial port, and four I/O lines that are configurable as an SPI interface, interrupt input, or I/O port lines.

- The DAQ-EVM is powered from a PC RS232 Comm Port for internal 3.3V operation.

- Serial port support for applications up to 57,600 Baud.

- Compact size of 6cm x 2cm (2.4in x 0.8in).

- Complete feature evaluation with Raisonance 4kB demo software [5].

- Comprehensive example code.

Getting Started

- Unpack the MCS1210-DAQ-EVM: Includes a MSC1210-DAQ-EVM Board and a MCS1210-DAQ-EVM CD.

- Install the Raisonance 4kB demo software, installation program is at the CD \Ride\kit51_725_.exe, installation procedure is at the CD \MSC1210-DAQ-EVM Doc\RideMSC1210\RideMSC1210.doc.

- Install the MSC1210 Downloader (See the *TI MSC1210 DownLoader* section of this doc).

- Run the DAQ-EVM demo code (See the DAQ-EVM section of this doc).
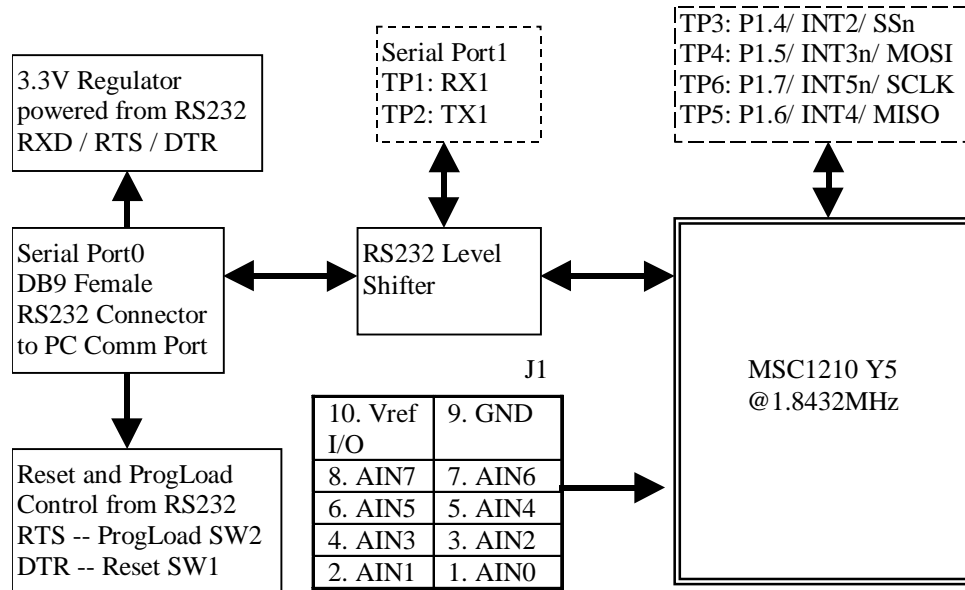
MCS1210-DAQ-EVM

Block Diagram
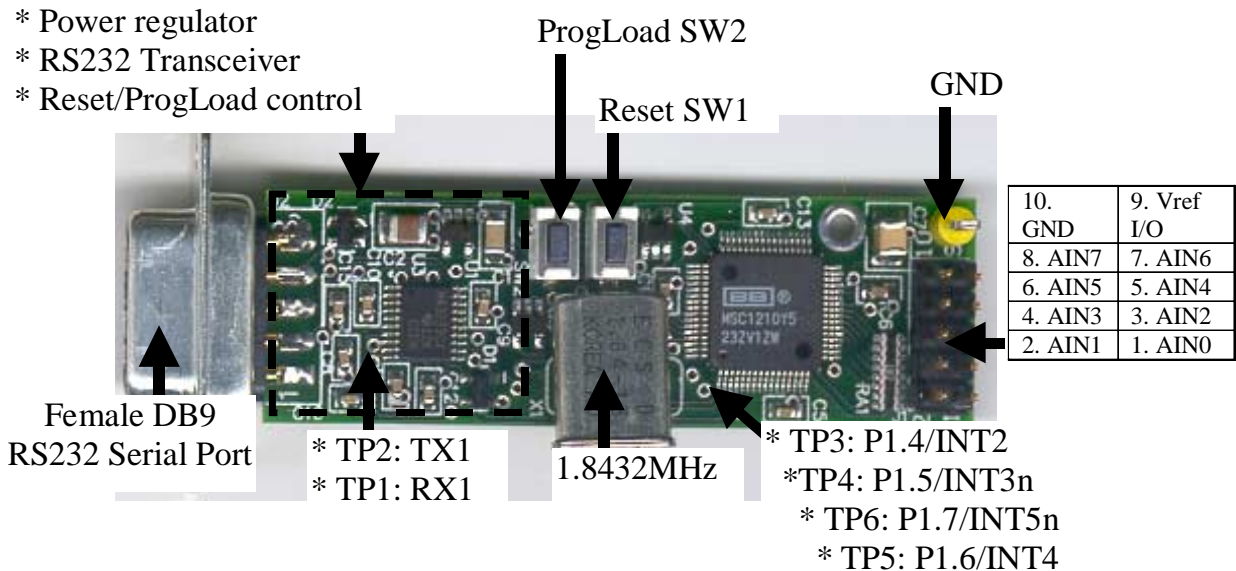

Figure 1. MCS1210-DAQ-EVM Block Diagram

Figure 2. MCS1210-DAQ-EVM Components

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Termial Program

The MCS1210-DAQ-EVM regulates the DB9 RS232 port power on the RTS, DTR and RXD lines to give 3.3V. PC terminal programs, when used with the DAQ-EVM, must turn RTS/DTR active (positive voltage on the RS232 line). The DAQ-EVM may operate with different PC terminal programs such as Windows HyperTerm, Tera Term, Procomm, Telix. See Appendix A – MCS1210-DAQ-EVM Schematic for the RS232 connection.

Reset SW1 and Program Load SW2

When SW1 is pressed, it will reset the DAQ-EVM. When SW2 is pressed, it will put the DAQ-EVM in Flash Serial Programming mode. The DAQ-EVM will expect an Intel Hex File from the PC Comm Port. Instead of pressing SW1/SW2, the DAQ-EVM Reset and Program Load may also be triggered from PC programs through the control of the RS232 RTS and DTR lines. Any RTS transition, *inactive (line at negative voltage) -> active (line at position voltage)* or *active->inactive*, DAQ-EVM will be put into ProgLoad operation. Similarly, any DTR transition, *inactive -> active* or *active->inactive*, DAQ-EVM will be reset.

TI MSC1210 DownLoader

The TI MSC1210 Downloader [6] will download an Intel Hex file from the PC to the DAQ-EVM. The Downloader program must be installed using the setup.exe program. The setup program and the Downloader usage document is on the DAQ-EVM CD at: /DownLoader/sbac018.zip. The latest version of the Download Tool is located in the "related software" section of the MSC1210 product folder (http://focus.ti.com/docs/prod/folders/print/msc1210.html).
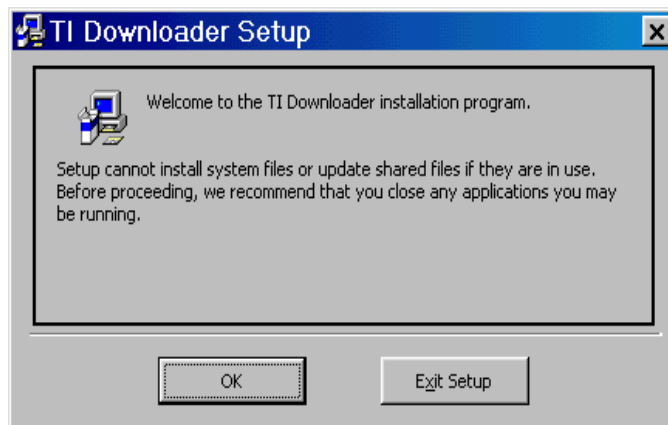
Figure 3. DownLoader Installation Screen

Follow the prompts and complete the installation as shown in Figure 3. If the installation doesn't complete, run the setup.exe program a second time. The Downloader program can be programmed with command line arguments. This can be done by setting up a shortcut to the program and then setting the properties. The download.exe program is placed in the Windows directory so you will not have to include the path to download.exe.

The downloader will control DTR and RTS properly for Reset and ProgLoad operations. For the next program, the following command line can be used with the Windows menu *Start->Run*:
c:\windows\download.exe /Fd:\data\msc1210\ride\daqevm\daqevm.hex /P3 /X2 /B2400

Users have to use their appropriate path for the files *download.exe* and *daqevm.hex*, and the correct PC Comm port number (example is /P3 as in PC Com3). The download baud rate is set to 2400 baud. Since an auto-baud-rate checking is used in the MSC1210 BootROM when DAQ-EVM is serial downloading program to Flash, the download baud rate is limited to no higher than 2400 baud. Higher baud rate may be possible only for some individual PCs.

Clock Frequency

The onboard crystal is specified at 1.8432MHz. The MSC1210 maximum operation frequency is much higher than this frequency. Since higher clock frequency requires more operating power, and the DAQ-EVM is powered off the RS232 communication line, the maximum clock frequency for DAQ-EVM is limited.

Two timing control values are essential for the DAQ-EVM setup — RS232 baud rate and ADC data conversion rate. The following section shows the serial port baud rate generation and ADC data conversion rate setting and calculation.

T1 Baud Rate Generator

When T1 is used as baud rate generator, we can use Equation 1 to calculate baud rate. When SMOD1 = 1, TM1 = 1, and CLK = 1.8432MHz. 28800 baud is the maximum rate for T1. However, 28800 baud is not common for terminal programs. Table 1 shows the baud rates when SMOD1 = 0 and TM1 = 0. List 1 shows the example code for using T1 as baud rate generator with SMOD1 and TM1 bits default at 0. Note that, to maintain compatibility with 8051, when TM1 = 0, setting SMOD1 has no effect and is the same as SMOD1 = 0.

$$TH1 = 256 - \frac{2^{SMOD1} xCLK}{32xNxBaudRate}\Big|_{N=4\,whenTM1=1}^{N=12\,whenTM1=0}$$

Equation 1. Timer 1 Baud Rate

TH1	Baud
255	4800
254	2400
252	1200

Table 1. T1 Baud Rates When SMOD1 = 0, TM1 = 0, and CLK = 1.8432MHz

```
TH1 = 255;              // 4800 Baud @ 1.8432MHz
SCON = 0x52;            // Async mode 1, 8-bit UART, enable rcvr, TI=1, RI=0
TMOD = 0x20;            // T1 at 8 bit counter with auto reload
TR1 = 1;               // Run T1
```

List 1. Example Code to Setup T1 Baud Rate Generator

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T2 Baud Rate Generator

$$RCAP2 = 65536 - \frac{CLK}{32\,xBaudRate}$$

Equation 2. Timer 2 Baud Rate

RCAP2	Baud
65535	57600
65534	28800
65533	19200
65532	14400
65530	9600
65524	4800

**Table 2. T2 Baud Rates When CLK = 1.8432MHz**

```
   T2CON  = 0x34;   // T2 as baudrate generator
   RCAP2  = 65535;  // 57600 Baud @ 1.8432MHz
   SCON   = 0x52;   // Async mode 1, 8-bit UART, enable rcvr, TI=1, RI=0
```

List 2. Example Code to Setup T2 Baud Rate Generator

Equation 2 shows the 16-bit SFR RCAP2, and 8-bit SFR T2CON/SCON setting when T2 is used as a baud rate generator. T2 uses CLK divided by two signal for the 16X-baud rate generator, therefore, Equation 2 has a 32 in the denominator. Note that TM2 does not affect the baud rate generation. The maximum baud rate when T2 is used will be 57600 as shown in Table 2. List 2 shows example code for using T2 as a baud rate generator.

ADC Data Conversion Rate
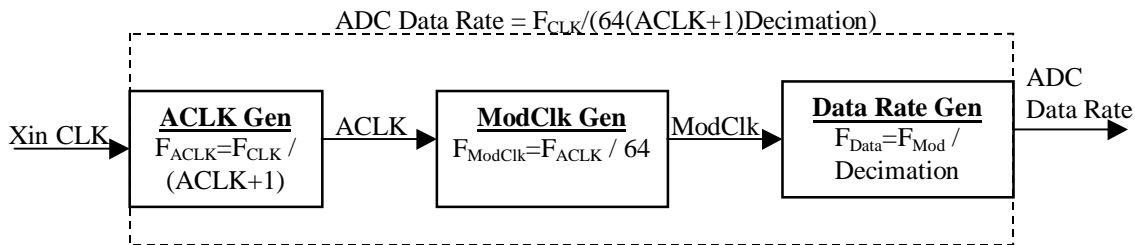
Figure 4. ADC Data Clock Divider

The ADC data rate is controlled by three 8-bit SFRs — ACLK, ADCON2 and ADCON3, where ACLK SFR +1 to give ACLK, ACLK is divided by 64 to give the ADC modulation clock ModClk, and ModClck is ADCON3 (MSB) and ADCON2 (LSB) compose a 16-bit SFR DECIMATION. CLK is divided by divided by the 16-bit SFR DECIMATION to give the ADC data rate. For example, to get 10.000Hz data rate from a 1.8432MHz crystal, we can set SFR ACLK to 1 and 16-bit SFR DECIMATION to 1440.

TP and J Connectors

Connector points TP1 and TP2 are the RS232 level shifted MSC1210 P1.2 and P1.3. TP3~TP5 may be used as P1.4~P1.6 I/O line, INT2~5 input, or SPI interface.

| Connector	I/O	MSC1210 pin
TP1	DAQ-EVM RS232 Serial Input	P1.2 RXD1
TP2	DAQ-EVM RS232 Serial Output	P1.3 TXD1
TP3	DAQ-EVM Digital {I/O, Input, Input}	{P1.4, INT2, SSn}
TP4	DAQ-EVM Digital {I/O, Input, I/O}	{P1.5, INT3n, MOSI}
TP5	DAQ-EVM Digital {I/O, Input, I/O}	{P1.6, INT4, MISO}
TP6	DAQ-EVM Digital {I/O, Input, Input}	{P1.7, INT5n, SCLK}

Table 3. MSC1210-DAQ-EVM Digital Input Output Connector

Analog input pins on connector J1:

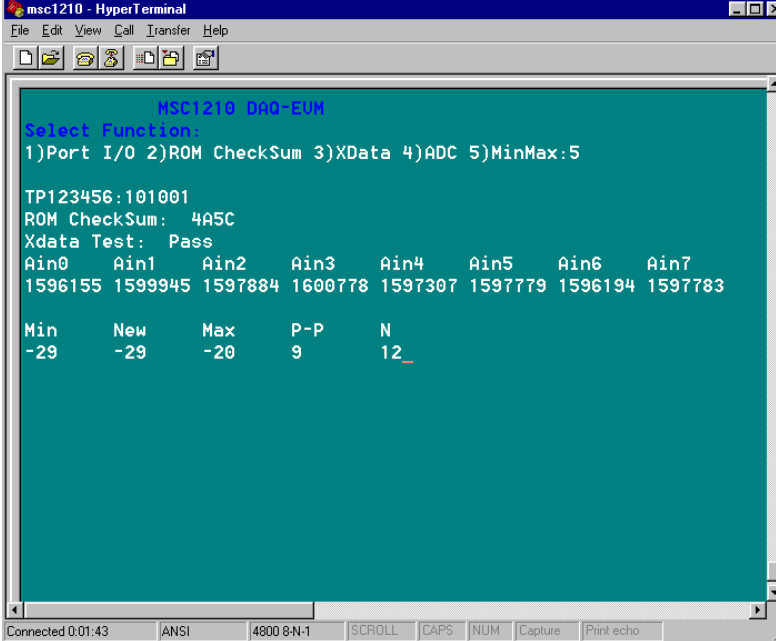| 10. GND	9. Vref I/O
8. AIN7	7. AIN6
6. AIN5	5. AIN4
4. AIN3	3. AIN2
2. AIN1	1. AIN0

Table 4. MCS1210-DAQ-EVM Analog Input Output Connector

The MSC1210 Pin AINCOM is connected to analog ground (AGND) onboard, as shown in Figure 5. MSC1210 REF_{IN}+ input is connected to internal REF_{OUT} and J1-10 V_{REF} I/O, and REF_{IN}- is connected to AGND. When Internal REF_{OUT} is enabled, J1-9 is for Internal reference voltage output. When internal REF_{OUT} is disabled. Internal REF_{OUT} pin will be high impedance, and J1-9 V_{REF} I/O pin will be used as reference voltage input for the ADC.
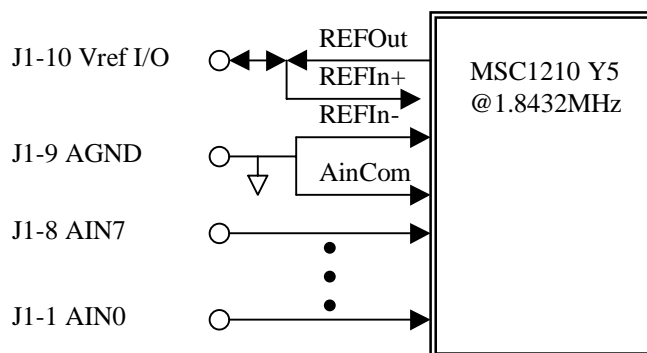
Figure 5. MCS1210-DAQ-EVM Analog I/O Configuration

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DAQ-EVM — An Example Code

Figure 6. Example Code DAQ-EVM

An example code — DAQ-EVM comes with this User's Guide. This program is compiled with the Raisonance Integrated Development Environment (RIDE) 4kB demo software and is located on the DAQ-EVM CD at: /Ride/DaqEvm. Copy all files in this directory to your local hard drive with the same directory name /Ride/DaqEvm. Once copied, make sure you remove the read-only file properties for recompiling. This program is hard coded to use 56700 baud with ANSI terminal interface. Setup terminal program (e.g. HyperTerm) 4800 baud and ANSI emulation. There are five parts in this program: Port I/O, ROM CheckSum, Xdata, ADC, and MinMax.

Port I/O

Port I/O constantly reads the input TP1 and output binary counting to TP2~TP6 with TP2 the LSB and TP6 the MSB of the binary counting. Note that TP3~6 output are driving with 3.3V internal pull-up logic, TP2 output is driving with MAX3223 RS232 line driver, and TP1 input is receiving with MA3223 RS232 line receiver.

ROM Checksum

This program displays the checksum of the MSC1210 internal 2kB BootROM. The checksum may change with the BootROM version. The current checksum shown is for Version "000303F10", which can be found when the device enters serial Flash memory program operation.

XData

This program runs the memory test for the internal 1kB Xdata memory. Memory test algorithm March-C-Plus is used.

Continuous ADC

This program constantly converts the analog voltage on input Ain0~Ain7 using an internal 2.5V reference generator at the data rate of 10Hz. The result displayed is the 24-bit signed integer value that ranged from +8,388,607 to -8,388,608. The following are the procedures for each AIN conversion result updated:

1. Setup ADMUX input for AIN0 to AIN7 for positive input, and AINCOM for negative.

2. Set ADCON1 for self offset and gain calibration.

3. Perform 5 dummy conversions to wait for the end of conversion and input settle.

4. Display the next conversion result in signed integer format.

MinMax

The program sets both the ADMUX positive and negative input to AIN0, therefore, the conversion result shows the maximum accuracy for the device. Even the data rate is set to 10Hz, the internal summation hardware will average 32 conversions of 10Hz each that give a conversion result of 3.2 conversion per second. Statistic result Min (lowest result of all conversions), Max (highest result of all conversions), P-P (the peak to peak of all conversions), and N (the total number of conversions.

Conclusion

The MCS1210-DAQ-EVM is a high precision, but low-cost MSC1210 evaluation board. When working with the Raisonance RIDE 4kB demo, most MSC1210 analog as well as digital features can be evaluated. The attached DAQ-EVM program demonstrates analog data conversion, system accuracy, serial port operations, and digital I/O functions.

References

[1] *MSC1210 Data Sheet* **http://www-s.ti.com/sc/ds/msc1210.pdf**

[2] *Raisonance RIDE Programming and Debugging Manual* **http://www.raisonance.com/**

[3] *MCS1210-EVM Manual (SBAU073, 1263 KB - Updated: 10/08/2001)*
http://www-s.ti.com/sc/psheets/sbau073/sbau073.pdf

[4] *Getting Started and Creating Applications with µVision2 and the C51 Microcontroller Development Tools*
http://www.keil.com/dd/chiploc.asp?f=8051&v=TI

[5] *Application Note: Running MCS1210-DAQ-EVM With Raisonance 4KB Demo*

[6] *Programming the MSC1210 (Rev. A) (SBAA076A - Updated: 04/17/2002)*
http://www-s.ti.com/sc/psheets/sbaa076a/sbaa076a.pdf

[7] *Application Note: MSC1210 Debugging Strategies*

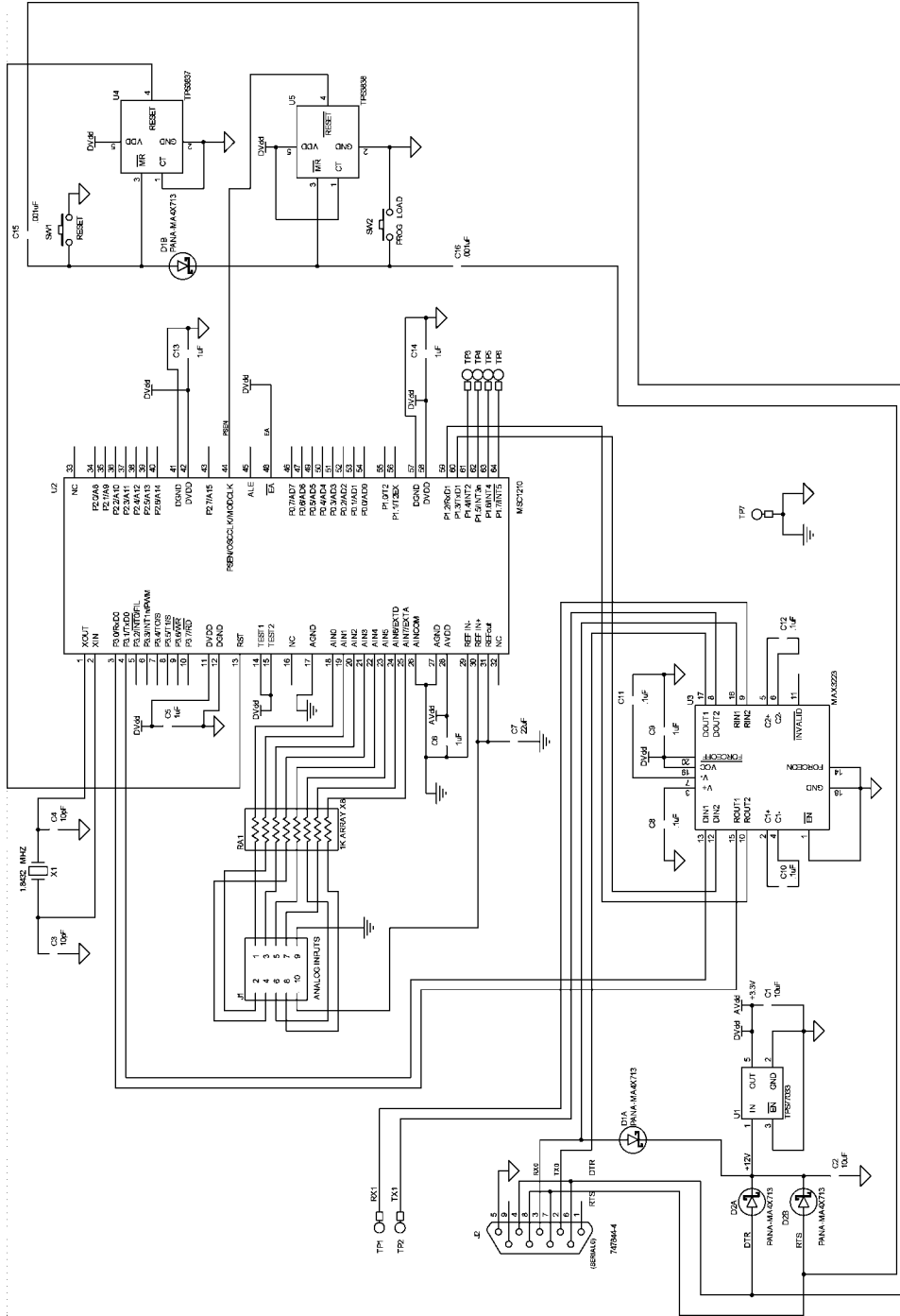# Appendix A -- MCS1210-DAQ-EVM Schematic

Figure 7. MCS1210-DAQ-EVM Schematic.
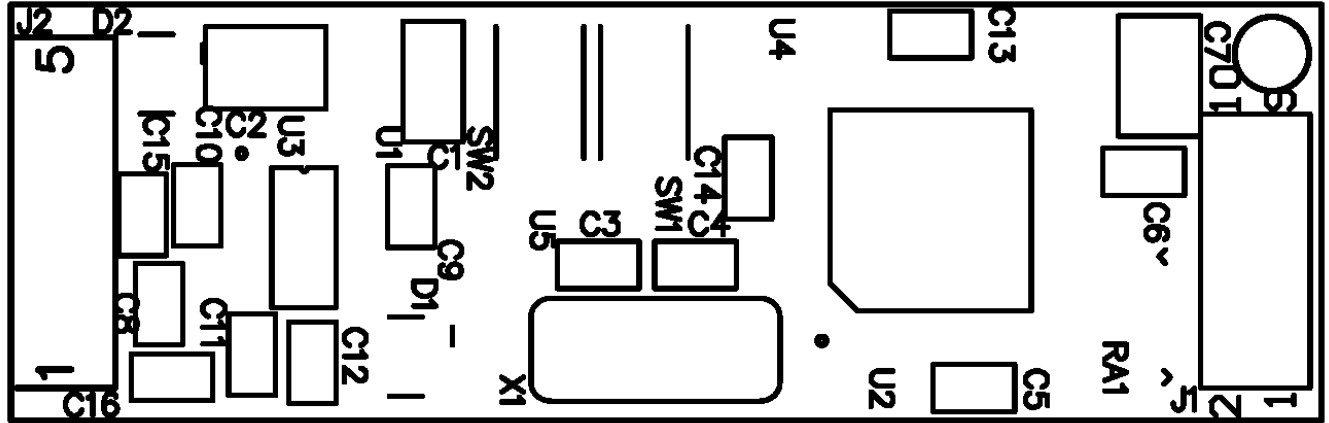
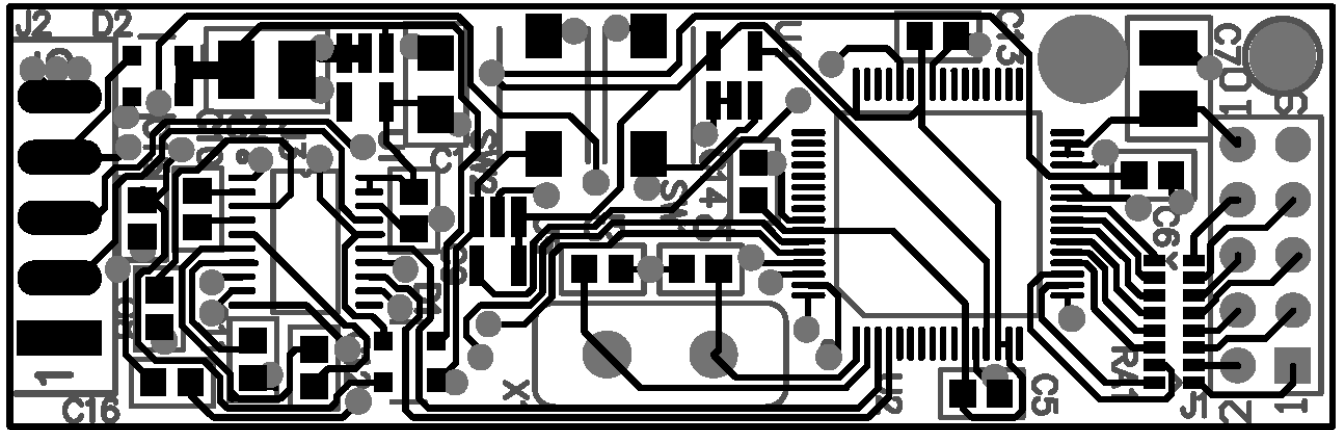## Appendix B—MCS1210-DAQ-EVM PCB
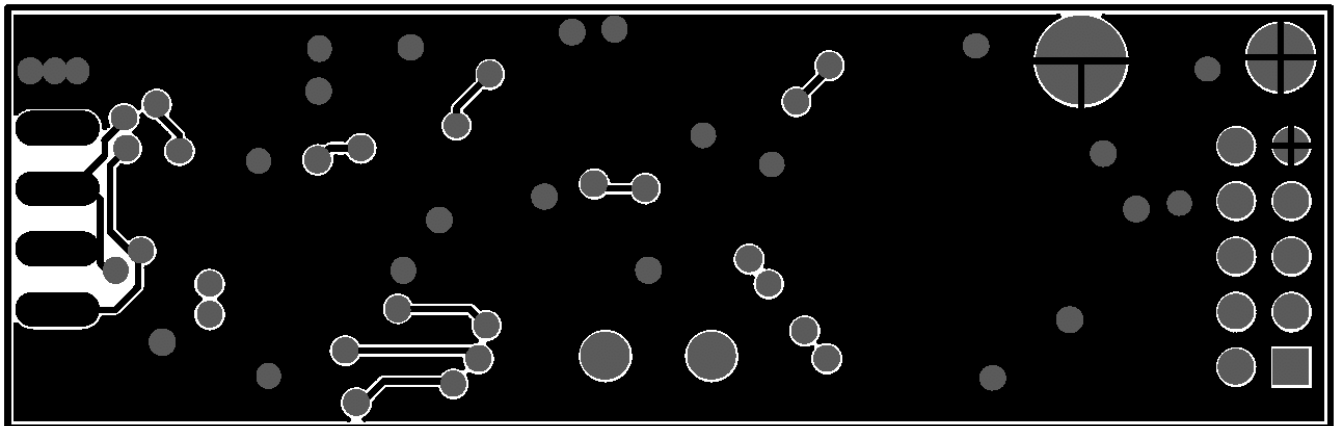

Figure 8. Silk Screen

Figure 9. Silk Screen and Component Side PCB

Figure 10. Solder Side PCB