# MSC1201/02EVM User's Guide

***MSC1201/02 Precision ADCs with 8051 Microcontroller and Flash Memory Evaluation Module***

This user's guide describes the function and operation of the MSC1201/02EVM evaluation module. This manual will help you quickly set up the EVM and its accompanying software, so that you can rapidly test and evaluate the MSC1201 and the MSC1202. For a more detailed description of the MSC1201 or the MSC1202, please refer to the product datasheets available from the Texas Instruments web site at http://www.ti.com. Additional support documents are listed in the section of this guide entitled ***Related Documentation from Texas Instruments***. Throughout this document, the abbreviation *EVM* and the phrase *evaluation module* are synonymous with the MSC1201/02EVM. A complete circuit description is included, as well as schematic diagrams and bill of materials.

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# 1 Introduction

This User's Guide gives a general overview of the MSC1201/02EVM and software, and provides a general description of the features and functions to be considered while using this device.

## *1.1 MSC1201/02 Device Characteristics*

The MSC1201 and MSC1202 are precision 24-bit delta-sigma ($\Delta\Sigma$) analog-to-digital converters with an 8051 microcontroller and up to 8K of flash memory. Both have eight differential or single-ended analog input channels. The delta-sigma architecture employed in the MSC1201/02 enables the devices to achieve 22 bits of effective resolution (0.45ppm RMS noise) at a data rate of 10Hz. They can be programmed for other data rates over 1kHz that have lower effective resolution. In addition to the standard 8051 peripherals and functions, the MSC1201/02 include a 32-bit accumulator, a basic SPI®/I$^2$C® interface, 16-bit PWM output, up to 5K of data flash memory, 256 bytes of data RAM, UART and dual DPTR registers.

The MSC1201/02 has an enhanced 8051 core which only requires four clock cycles per machine cycle. It has extra timers as well as watchdog, brownout and low voltage detect circuits; additionally, the device has power management control and hardware breakpoint registers.

SPI is a registered trademark of Motorola, Inc.
I$^2$C is a registered trademark of Royal Philips Electronics B.V., The Netherlands.

## 1.2 EVM System Overview

A block diagram of the MSC1201/02 evaluation module is shown in Figure 1.

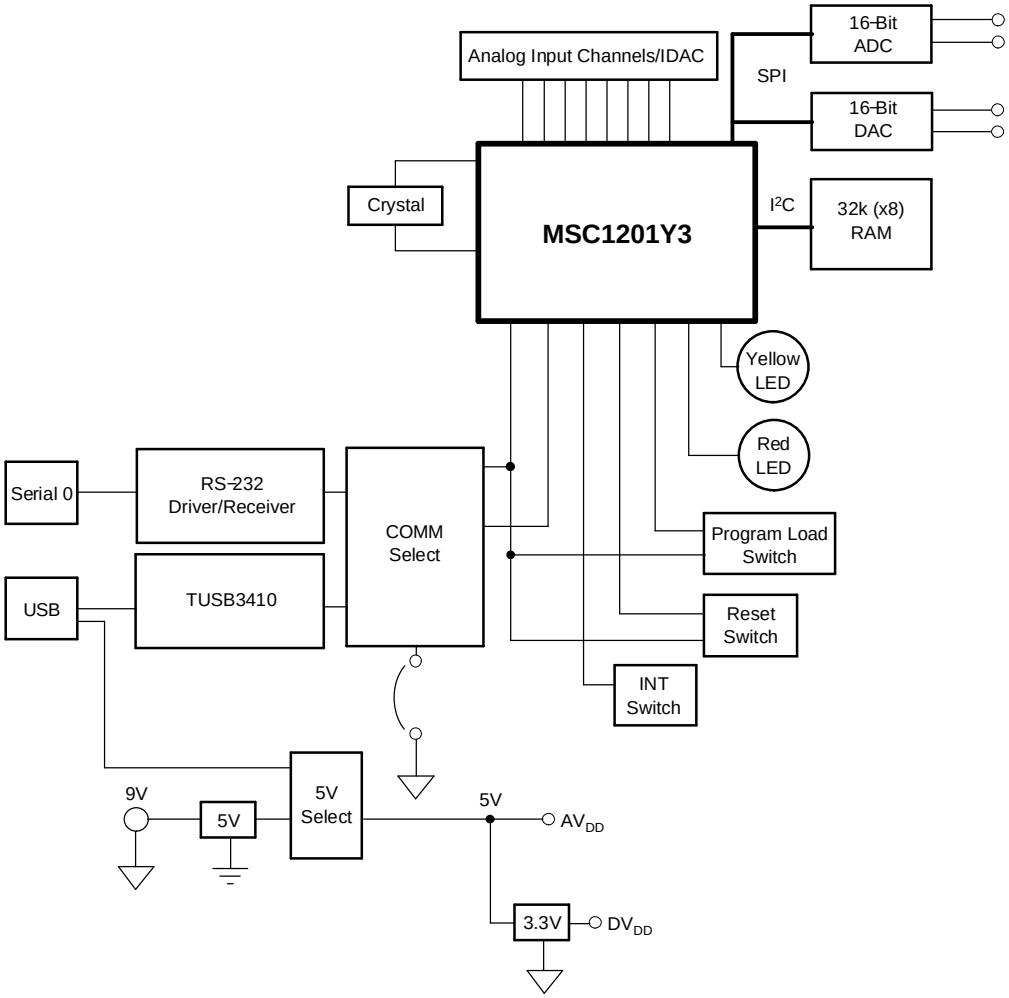


**Figure 1. MSC1201/02EVM Overview**

During normal operation, programs are developed on the PC and then downloaded into the MSC1201/02 for execution. The primary development environment is Raisonance or Keil for assembly and C language programming.

## 1.3 Analog Inputs

Analog input is supplied through the 9-way screw terminal block J4 and the two-way terminal J8. The seven analog inputs (AIN0-5, AINCOM) are connected to the MSC1201/02 through a 100Ω resistor. There is also a terminal block for AGND (GND) and IDAC output. The inputs have only the 100Ω resistor to protect against overvoltage.

## 1.4 Power Requirements

When the MSC1201/02EVM uses J3 (RS-232) connector for communications, power (5.5V to 15V) must be supplied to J2 and a jumper must be uninstalled on JMP14. Additionally, JMP1 would connect pins 2-3 for proper operation.

A 9V wall mount power supply is included with the MSC1201/02EVM to provide this power.

When using USB communications, power is provided from the USB connector (J1); pins 1-2 are connected on JMP1 and the jumper on JMP14 is installed.

Power can also be provided from the USB source with communications using the RS-232 connector. In such a case, JMP1 would connect pins 1-2 and JMP14 would be uninstalled.

## 1.5 Host Computer Requirements

The Keil or Raisonance software development environments are designed to run on a PC that is using any Microsoft Windows™ platform (Windows 9x/NT/2K/XP).

Minimum operating system requirements are:

- IBM-compatible 486 PC or higher
- 64MB RAM
- 20MB available hard disk space
- CD-ROM drive
- Available RS-232 or USB serial port

## 1.6 Related Documentation from Texas Instruments

The following documents provide information regarding Texas Instrument integrated circuits used in the assembly of the MSC1201/02EVM. The latest revisions of these documents are available from the TI web site at http://www.ti.com.

| Data Sheet | Literature Number |
|---|---|
| MSC1201 | SBAS317 |
| MSC1202 | SBAS328 |
| REG102NA-5, REG102NA-3.3 | SBVS024 |
| TUSB3410VF | SLLS519 |
| MAX3243CPWR | SLLS350 |
| TPS3837L30DBVT, TPS3838L30DBVT | SLVS292 |
| DAC8531E | SBAS192 |
| ADS8325IBDGKT | SBAS226 |
| SN74AHC1G07DBVR | SCES296 |

# 2 Getting Started

This section will guide you through unpacking the EVM and setting it up so that you can begin working with it immediately.

## 2.1 Unpacking the EVM

After unpacking the MSC1201/02EVM kit, verify that you have received all of the items listed here:

- MSC1201/02EVM board
- 9V wall mount power supply, with international connectors
- 9-pin D-sub male-female 2m serial cable
- 2m A-B USB cable
- Software CD-ROM
- This user's guide (on the CD-ROM)

If any of these items are missing, contact Texas Instruments to receive a replacement.

## 2.2 Default Configuration

Although much of the MSC1201/02EVM operation is controlled by the host PC, some configuration must be done directly on the board, using ten jumpers (shorting blocks). The MSC1201/02EVM is configured at the factory as described in Table 1.

**Table 1. Factory Jumper Settings**

| Jumper Identifier | Description | Default Setting |
|---|---|---|
| JMP1 | 5V power supply source (U1) | 2-3 |
| JMP2 | Digital power supply select (5V) | 2-3 |
| JMP3 | USB reset | Open |
| JMP4 | IDAC 1K load resistor | Open |
| JMP5 | $AV_{DD}$ power source (5V) | 1-2 |
| JMP6 | AINCOM to AGND connection | 1-2 |
| JMP7 | Red LED enable | 1-2 |
| JMP8 | Yellow LED enable | 1-2 |
| JMP9 | DIN SPI/$I^2C$ select (SPI) | 1-2 |
| JMP10 | SPI/$I^2C$ clock source (SPI) | 1-2 |
| JMP11 | External reference input | Open |
| JMP12 | REF- to AGND | 1-2 |
| JMP13 | DOUT SPI/$I^2C$ select (SPI) | 2-3 |
| JMP14 | RS232/USB communications (RS-232) | Open |

For more information about the jumpers, see Section 3.1.

## 2.3 Quick Start Guide

Once the MSC1201/02EVM has been unpacked from its shipping container, and you have verified that the board is configured as shown in Table 1, it can be powered on and tested.

### 2.3.1 USB Connection

Connect the board to the host PC using the supplied USB serial cable. When the board is properly powered on, the green *power-good* LED near the power USB connector will glow brightly.

### 2.3.2 Wall Mount Power Connection

Connect the board to the host PC using the supplied 9-pin D-sub serial cable. Then power on the board by plugging the wall power adapter into a suitable AC power source and inserting the barrel plug into the barrel jack on the MSC1201/02EVM. (You do not have to connect the serial cable first; it is safe to apply power to the board first.) When the board is properly powered on, the green *power-good* indicator lamps near the USB connector will glow brightly.

Place the CD-ROM into your PC CD-ROM drive. You should then see a screen display similar to the installation screen shown in Figure 2.

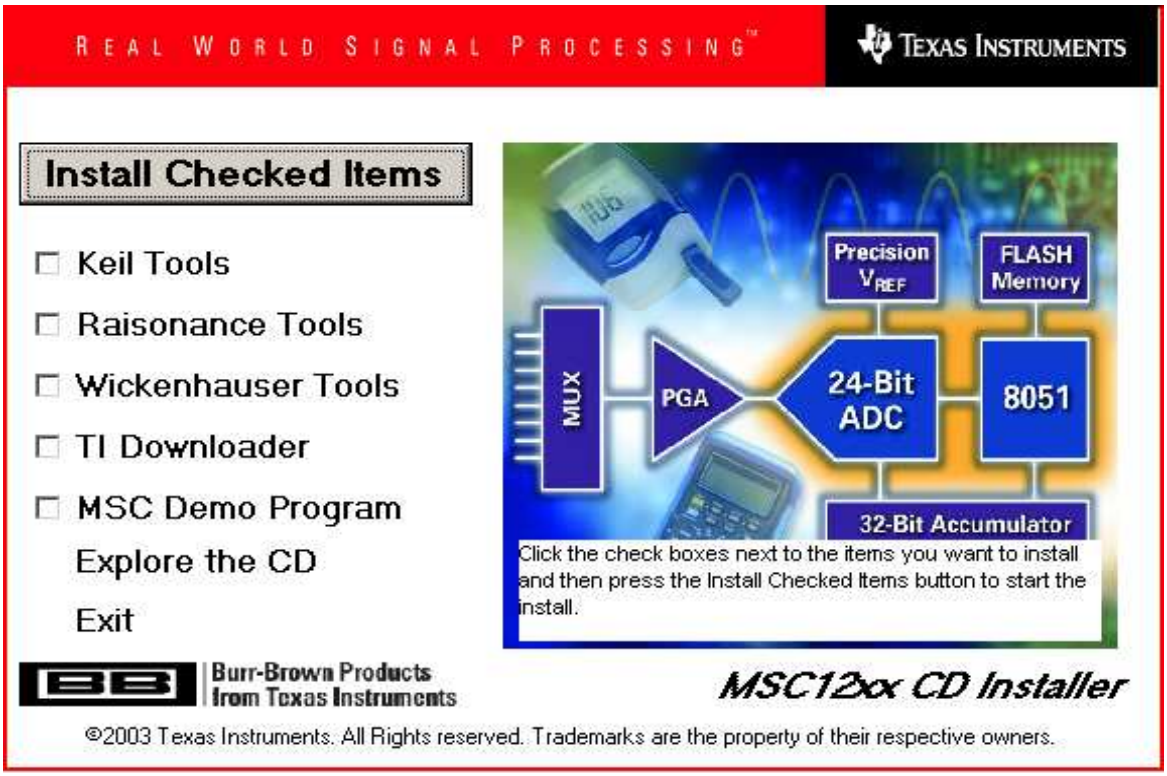


**Figure 2. Installation Screen**

Select the tools that you want to install. Keil, Raisonance and Wickenhauser are all C compilers. The Keil and Raisonance tools include a complete integrated development environment (IDE) with debug support. The TI Downloader is used to load the compiled HEX file into the MSC1201/02EVM.

Install any (or all) of the compilers that you wish to use. Also, choose the TI Downloader. (**Note:** If you are running Windows NT or Windows 2000, you will need administrator privileges in order to install the software.) Follow the instructions provided by the installer. When the software is installed you can select ***Explore the CD***, and find some example programs in the **\Example Programs\MSC1200 Examples** directory.

Once the programs have been successfully installed, you can execute them. If you examine the **MSC1200 HelloWorld** directory, you will see project files for both Keil (HelloWorld.Uv2) and Raisonance (HELLOWORLD.PRJ). If you have installed both compilers, you can double-click on either project file and it will open up the appropriate IDE.

When the Keil uVision2 development system is run, it will display a title screen; you will then see a screen like that shown in Figure 3.

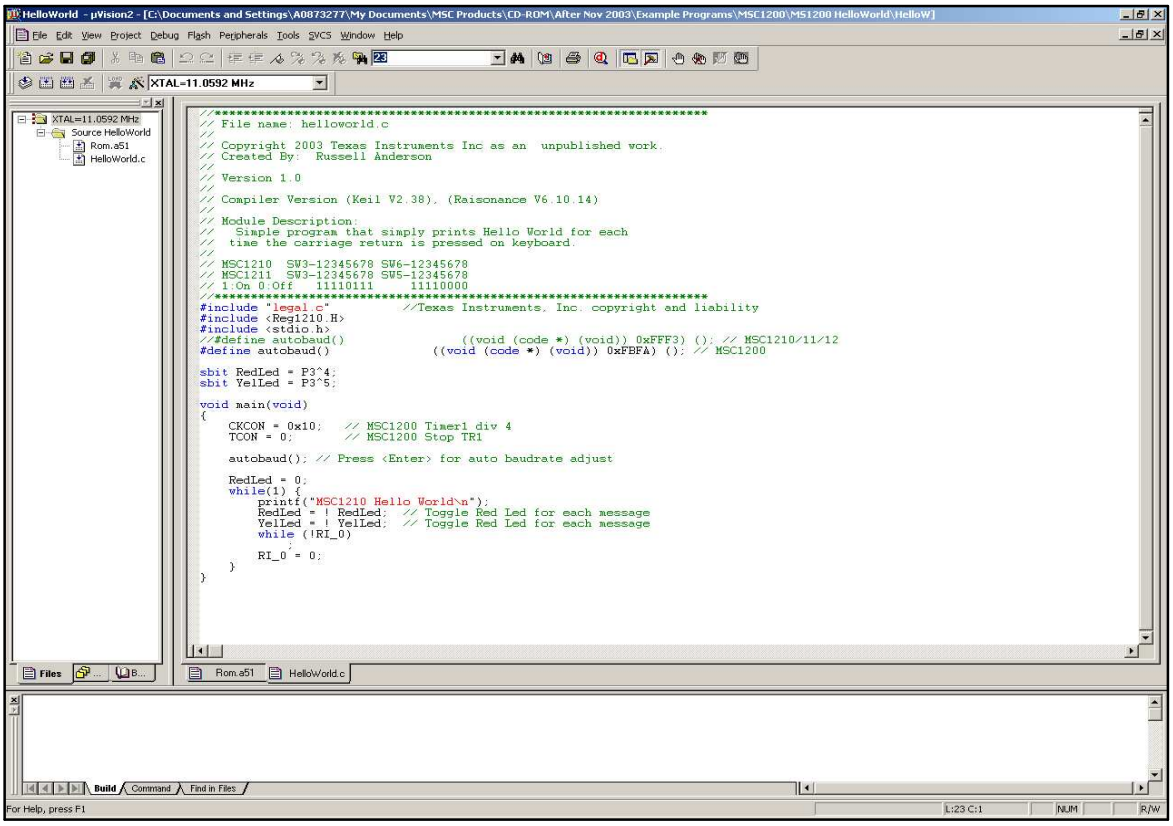


**Figure 3. Keil uVision2 Display Screen**

Refer to the Keil documentation and Help menus for more information about how to interact with the Keil environment. When a program is compiled, it can be immediately downloaded into the MSC1201/02EVM by using the TI download utility program.

In the Project Menu, select **Options for target '. . . '** Then select the ***Output*** tab. (Or, click on the magic wand, then select the ***Output*** tab.) You will see a screen like the one shown in Figure 4.

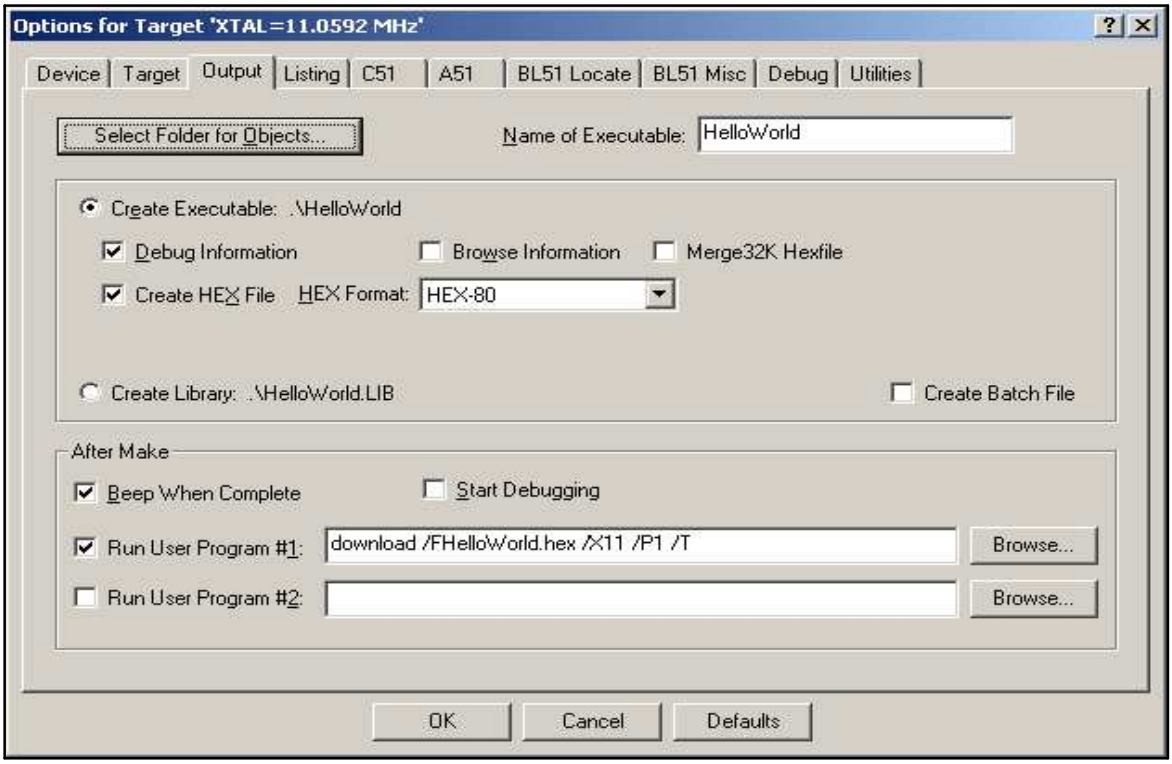


**Figure 4. Options for Target (Output)**

Check the box to **Create HEX File** and **Run User Program #1**. Then enter the download command with its parameters in the window. The ***download.exe*** file will need to be in the current directory or the Windows path.

All operands should immediately follow the switch character with no spaces except between options. For example:

- download.exe /Fconv.hex /B9600 /P1

If the filename, crystal frequency or port are not included, then a display screen will prompt you for the values.

- /Ffile *(required)* hex file; #H in the Keil environment will substitute the hex file.
- /Xfreq *(required)* MSC1201/02 Xtal Clock frequency
- /Pport *(required)* PC Comm Port 1, 2, 3 or 4
- /Bbaud Download baud rate (standard rates); otherwise, computed from /Xfreq
- /H If this flag is present, the configuration bytes will be erased
- /Tbaud This flag requests a terminal window after download; can specify baud.
- /D Debug mode. Displays a terminal window of the command interactions.
- /Epages Specify a partial erase of the flash memory.
- /M Pause for the MSC1201/02 to be manually reset into programmable mode.

# 3 EVM Operation

This section describes each function of the MSC1201/02EVM, as well as how to use the accompanying software to program and use the MSC1201/02.

## 3.1 Jumpers

Table 2 shows a detailed summary of each jumper on the MSC1201/02EVM.

**Table 2. Jumper and Function Reference**

| Reference Designator | Setting/Pin | Function | Default | Subsection (for more information) |
|---|---|---|---|---|
| JMP1 | 1 to 2 | 5V is supplied by USB | 1-2 | Section 3.1.1 |
| | 2 to 3 | 5V is supplied by U1 from J2 | | |
| JMP2 | 1 to 2 | 3.3V $DV_{DD}$ | 2-3 | Section 3.1.2 |
| | 2 to 3 | 5V $DV_{DD}$ | | |
| JMP3 | 1 | AGND | Disconnected | Section 3.1.3 |
| | 2 | $\overline{\text{RESET}}$ for U3 (TUSB3410) | | |
| JMP4 | 1 | R15 – 1K Resistor to AGND | 1-2 | Section 3.1.4 |
| | 2 | IDAC | | |
| JMP5 | 1 | +5V | 1-2 | Section 3.1.5 |
| | 2 | R18 – 10Ω to $AV_{DD}$ (MSC1201/02) | | |
| JMP6 | 1 | AGND | 1-2 | Section 3.1.6 |
| | 2 | AINCOM | | |
| JMP7 | 1 | P3.4/T0 | 1-2 | Section 3.1.7 |
| | 2 | LED D5 connected to R13 to $DV_{DD}$ | | |
| JMP8 | 1 | P3.5/T1 | 1-2 | Section 3.1.8 |
| | 2 | LED D6 connected to R13 to $DV_{DD}$ | | |
| JMP9 | 1 | DOUT U13 (ADS8531) [SPI] | 1-2 | Section 3.1.9 |
| | 2 | P1.3/DIN | | |
| | 3 | SDA U12 (MCP_24LC256) [$I^2C$] | | |
| JMP10 | 1 | SCLK (U11), DCLK (U13) [SPI] | 1-2 | Section 3.1.10 |
| | 2 | P3.6/SCK | | |
| | 3 | SCL (U12) [$I^2C$] | | |
| JMP11 | 1 | $V_{REF}$ input to REFOUT/REFIN+ U8 | Disconnected | Section 3.1.11 |
| | 2 | AGND | | |
| JMP12 | 1 | REFIN- U8 AGND | 1-2 | Section 3.1.12 |
| | 2 | AGND | | |
| JMP13 | 1 | SDA U12 (MCP_24LC256) [$I^2C$] | 2-3 | Section 3.1.13 |
| | 2 | P1.2/DOUT | | |
| | 3 | DIN U11 (DAC8531) [SPI] | | |
| JMP14 | 1 | R4 – 10K to 3.3V (RS-232 signal select) | Disconnected | Section 3.1.14 |
| | 2 | AGND | | |

### 3.1.1 JMP1: 5V Power Source Select

The MSC1201/02EVM can use either the USB connection or the voltage regulator U1 for the source of +5V. Shorting pins 1 and 2 connects a filtered version of the 5V power from the USB source. Shorting pins 2 and 3 connects the 5V signal to the output of the voltage regulator U1.

### 3.1.2 JMP2: $DV_{DD}$ Power Source Select

The MSC1201/02 have separate analog and digital power supplies. Use JMP2 to connect the desired voltage source for the digital power supply $DV_{DD}$. Shorting pins 1 and 2 connects $DV_{DD}$ to the onboard 3.3V regulator; shorting pins 2 and 3 connects $DV_{DD}$ to 5V.

### 3.1.3 JMP3: TUSB3410 $\overline{\text{RESET}}$ Pin

JMP3 provides a method to reset the TUSB3410. Shorting pin 1 to 2 resets U3 (TUSB3410).

### 3.1.4 JMP4: Enable Voltage Output for IDAC

If a jumper is between pins 1 and 2 of JMP4, a 1K resistor is connected from the output of the IDAC to AGND. This connection provides a method to convert the current from the IDAC pin to a voltage.

### 3.1.5 JMP5: $AV_{DD}$ Power

If a jumper is between pins 1 and 2 of JMP5, the 5V that is derived from either the USB or the regulator IC U1 will be filtered and used for the $AV_{DD}$ power. If another source of $AV_{DD}$ voltage is desired, then the jumper can be removed and the voltage applied between pin 2 and $AV_{DD}$.

### 3.1.6 JMP6: AINCOM to AGND

By shorting the two pins of JMP6, the AINCOM signal will be connected to AGND.

### 3.1.7 JMP7: Red LED Enable

When this jumper is inserted, the Red LED D5 is connected to port pin 3.4. The other side of D5 is connected to a 220Ω resistor which connects to the $DV_{DD}$ voltage. This 220Ω resistor provides the current limiting when the P3.4 is output as a low voltage.

### 3.1.8 JMP8: Yellow LED Enable

When this jumper is inserted, the Yellow LED D6 is connected to port pin 3.5. The other side of D6 is connected to a 220Ω resistor which connects to the $DV_{DD}$ voltage. This 220Ω resistor provides the current limiting when the P3.5 is output as a low voltage.

### 3.1.9 JMP9: SPI/I2C Data Connection

When pins 1 and 2 are connected, the DIN pin of U8 is connected with the DOUT pin of U13 for SPI data communications with the 16-bit ADC (ADS8325). With the jumper on pins 2-3, the DIN signal from U8 is connected to pin 1 of JMP11 so that it can be connected to DOUT for $I^2C$ operation.

### 3.1.10 JMP10: SPI/I2C Clock Select

When pins 1 and 2 are connected, the clock signal (P3.6/SCK) is connected to the SPI devices. When pins 2 and 3 are connected, the clock signal is connected to the $I^2C$ memory device.

### 3.1.11 JMP11: External Reference Positive Input

A single-ended reference can be connected between pin 1 (positive) and pin 2 (AGND) for use by U8. This assumes that JMP12 is installed.

### 3.1.12 JMP12: External Reference Negative Input

For normal operation, this jumper will be installed so that REFIN– will be connected to AGND. JMP12 can also be used in combination with JMP11 for a differential reference. A differential reference can be applied to pin 1 of JMP11 (positive) and pin 2 of JMP12 (negative).

### 3.1.13 JMP13: SPI/I2C Clock Select

When pins 1 and 2 are connected, the DOUT pin of U8 is connected to the DIN/DOUT signal for $I^2C$ operation with U12, the $I^2C$ memory. When pins 2 and 3 are connected, the DOUT pin of U8 is connected to the DIN pin of the DAC8531 (U11).

### 3.1.14 JMP14: RS-232 Communication Selection

When JMP14 is installed, the RS-232 communications are directed through the USB port. The DB9 connector J3 is used for RS-232 communication when JMP14 is removed.

## *3.2 INT Switch*

Switch SW2 is a miniature pushbutton which, when pressed, shorts Port 3.2 to ground (through a 1K resistor). This pin is the $\overline{\text{INT0}}$ pin and can therefore be set up to cause an interrupt when this pin goes low.

## *3.3 Reset Switch*

Switch SW1 is a miniature pushbutton which, when pressed, forces the MSC1201/02 RST line high. When released, the MSC1201/02 will enter a reset cycle. If communications become disrupted between the host and the board, or if the board is unresponsive, pressing RESET will return the system to normal operation.

## *3.4 PRG LD Switch*

Switch SW3 is a miniature pushbutton which, when pressed, forces the MSC1201/02 RST line high. It also pulls the Port 1.0 line low so that when RST ends, the MCU will enter the Program Load mode. Program execution will be from the on-chip ROM; it starts first by waiting for a carriage return so that it can perform an autobaud function. This mode is used to load a hex file into the flash memory for later execution.

## 3.5 I/O Connectors and Signals

This section describes the various connectors on the MSC1201/02EVM.

### 3.5.1 J1: USB Type B Connector

This connector routes the USB signals to U3, where they are converted to RS-232 signals for communication with the MSC1201/02 (U8). All of the same modes of operation are available through the USB, so program loading and communication can occur via USB. JMP14 determines whether RS-232 communication uses USB (J1), with JMP14 on, or J3, with JMP14 off.

Table 3 describes the J1 USB port pinout configuration.

**Table 3. J1: USB Port Pinout**

| Pin Number | Signal Name | USB Name | Direction (at board) | Function |
|---|---|---|---|---|
| 1 | GND | Power Ground | Input | Ground return for VCC power |
| 2 | D– | USB data pin Data- | Bidirectional | USB data |
| 3 | D+ | USB data pin Data+ | Bidirectional | USB data |
| 4 | VCC | +5V Power | Input | +5V power (500mA max) |

### 3.5.2 J3: Serial RS-232 Connector

The host PC can communicate with the MSC1201/02EVM via this connector, which is a 9-pin female D-shell type, pinned out in the usual manner. Certain of the flow control lines are used for special purposes by the MSC1201/02EVM board; these particular lines are described in Table 4. The host communication uses J3 or J1 depending on JMP14.

**Table 4. J3: RS-232 Port Pinout**

| Pin Number | Signal Name | RS-232 Name | Direction (at board) | Function |
|---|---|---|---|---|
| 1 | DCD | Data Carrier Detect | Output | None |
| 2 | RD | Receive Data | Output | Serial data output to host PC |
| 3 | TD | Transmit Data | Input | Serial data intput from host PC |
| 4 | DTR | Data Terminal Ready | Input | Connected to the reset circuit. A low to high transition on this line resets the MCU. |
| 5 | SG | Signal Ground | Power | Ground reference |
| 6 | DSR | Data Set Ready | Output | None |
| 7 | RTS | Request To Send | Input | Connected to PROG LOAD function. Used to enter serial programming mode. A high-to-low transition resets the MCU and puts it into the serial programming mode. |
| 8 | CTS | Clear To Send | Output | None |
| 9 | RI | Ring Indicator | Output | None |

In the RS-232 electrical specification, –5V to –15V on a line indicates a logic *high* (mark), and +5V to +15V indicates a logic *low* (space). Line states are described here according to their logical states.

If a non-handshaking RS-232 cable is used – one which connects only RD, TD, and signal ground – the board can still operate normally; however, it cannot be reset by the host PC, and bootstrap firmware upgrading cannot be performed through the serial port unless commands are defined in the User Application program.

### 3.5.3 J2, JMP1, JMP2, JMP5: Power Connectors

The MSC1201/02EVM features a flexible power supply system. External power supplies, USB, the on-board regulator circuitry and/or the supplied wall mount adapter may all be used in some combinations to supply power to the EVM. Furthermore, the separate analog and digital power supplies may be powered differently; for example, the analog power supply may be powered externally, and the digital power supply may use the onboard regulator, at the same time. (This is configured using jumpers JMP2 and JMP5.)

The analog power $AV_{DD}$ is always 5V from either the regulator U1 or from a filtered version of the USB power, although external power could be applied to pin 2 of JMP5 to provide any desired $AV_{DD}$ voltage from 2.7V to 5.25V with the ground connected to TP1 (AGND).

The digital power $DV_{DD}$ is supplied from pin 2 of JMP2. If connected to pin 1, then $DV_{DD}$ will be 3.3V from voltage regulator U2. If pin 2 of JMP2 is connected to pin 3, then $DV_{DD}$ is the 5V at the input of U2. This 5V can come from either the output of U1 or the USB; or, it could be supplied from an external supply voltage to the center pin of JMP1. Pin 2 of JMP2 could also be supplied from an external supply voltage with the ground connected to TP2.

**CAUTION**

**Be very careful when connect external power supplies to JMP5, JMP2 and JMP1. They are not protected against reversed polarity. If you connect them backwards (that is, with reversed polarity), it is likely that the MSC1201/02EVM will be permanently damaged.**

Table 5 through Table 8 summarize the power options for the MSC1201/02EVM.

**Table 5. J2: Unregulated Power Input Connector**

| Terminal Name | Function |
|---|---|
| tip | Positive power supply input |
| Sleeve | Power ground |

**Table 6. JMP1: 5V Power Source Select**

| Terminal Name | Function |
|---|---|
| 1 | USB power |
| 2 | 5V for U2, $AV_{DD}$ or $DV_{DD}$ |
| 3 | U1 voltage regulator output |

**Table 7. JMP2: $DV_{DD}$ Power Source Select**

| Terminal Name | Function |
|---|---|
| 1 | 3.3V from voltage regulator U2 |
| 2 | $DV_{DD}$ |
| 3 | 5V from JMP1 pin 2 |

**Table 8. JMP5: $AV_{DD}$ Power Source Select**

| Terminal Name | Function |
|---|---|
| 1 | 5V from JMP1 pin 2 |
| 2 | $AV_{DD}$ to U8 through R18 & (C27,C28) |

### 3.5.4 J4: Analog Inputs, IDAC Output

Terminal block J4 is the main analog input to the MSC1201/02EVM. One terminal is provided for each of the nine differential inputs on the MSC1201/02. Each terminal is connected to the MSC1201/02 through a 100Ω resistor.

Table 9 summarizes the analog inputs for the MSC1201/02EVM.

**Table 9. J13: Analog Inputs**

| Terminal Number | Terminal Name | MSC1201/02 Pin Number | Function |
|---|---|---|---|
| 1 | AIN0 | 24 | Analog Input 0 |
| 2 | AIN1 | 23 | Analog Input 1 |
| 3 | AIN2 | 22 | Analog Input 2 |
| 4 | AIN3 | 21 | Analog Input 3 |
| 5 | AIN4 | 20 | Analog Input 4 |
| 6 | AIN5 | 19 | Analog Input 5 |
| 9 | AINCOM | 12 | Analog Common |
| 10 | AGND | 10, 11 | Analog Ground |
| 11 | IDAC | 13 | IDAC Output |

### 3.5.5 TP16: Reference Output/Input

The MSC1201/02EVM has an onboard 2.5V/1.25V bandgap reference. If a lower-noise reference source or a reference with a different voltage is desired, it can be connected to test point JMP12 (or test points JMP12 and JMP13). When using an external reference, the internal reference should be shut off (using ADCON0) since they use the same pin. C37 and C32 provide bypassing for the Reference Inputs.

### 3.5.6 TP1-6: Test Points

The test points (summarized in Table 10) can be used to monitor certain signals on the board.

Consult the MSC1201/02 datasheets for information on the signals connected directly to the MSC1201/02.

**Table 10. TP1–6: Test Points**

| Test Point Designator | MSC1201/02 Pin Number | MSC1201/02 Pin Name | Signal Description |
|---|---|---|---|
| TP1 | 10, 11 | AGND | Analog Ground |
| TP2 | 33, 34, 38 | DGND | Digital Ground |
| TP3 | - | 100kΩ Pullup | Uncommitted |
| TP4 | - | 100kΩ Pullup | Uncommitted |
| TP5 | - | X1/CLK1 | Clock Input for TUSB3410 (U3) |
| TP6 | 2 | XIN | Clock input for MSC1201/02 (U8) |
| AIN5 | 19 | AIN5 | Analog input 5 |
| AIN4 | 20 | AIN4 | Analog input 4 |
| AIN3 | 21 | AIN3 | Analog input 3 |
| AIN2 | 22 | AIN2 | Analog input 2 |
| AIN1 | 23 | AIN1 | Analog input 1 |
| AIN0 | 24 | AIN0 | Analog input 0 |
| TP14 | 5 | RST | Reset for MSC1201/02 (U8) |
| VREF | 14 | REFOUT/REFIN+ | Internal Reference Output or Positive Reference Input |

## *3.6 Circuit Description*

The MSC1201/02EVM combines the MSC1201/02 microcontroller, 24LC256 32Kx8 EEPROM, DAC8531, ADS8325, a 22.11842MHz crystal, support for one serial port, and other support circuits to aid in the evaluation of the MSC1201/02. In addition, the TUSB3410 microcontroller is included so that the MSC1201/02 serial communications can come via either RS-232 or USB.

### 3.6.1 MSC1201/02

The MSC1201/02 (U3) is clocked by the internal oscillator or a 22.1184MHz crystal. Analog inputs come from J4 through current-limiting resistors RA2.

Programs can be loaded into the 8K bytes of flash memory using the serial port (RS-232 or USB). The MSC1201/02 has 256 bytes of RAM on-chip.

For detailed information about the MSC1201/02, consult the MSC1201/02 product datasheets.

### 3.6.2 Programming and Host Communication

The Keil or Raisonance integrated software environments, combined with the TI Downloader program, provide a convenient system of program development, download and execution.

Full source code for the MSC1201/02EVM test firmware is included on the CD-ROM.

### 3.6.3 Power Supply

Power is brought into the board through external power connectors J2, the USB, or to the individual pins on JMP1, JMP2 or JMP5. If JMP14 is installed, the USB communications are enabled.

Power supplied through J2 is regulated by voltage regulators U1 and U2, which provide +5V digital and +3.3V analog supplies, respectively. Power supplied directly to JMP1, JMP2 or JMP5 is not filtered; regulated power of the correct voltages must be supplied to these pins.

The board is laid out with separate analog and digital power supplies. Analog power is 5V and is supplied from regulator U1, the USB, or external power connected to JMP1 or JMP5. 3.3V digital power is supplied from regulator U2 or JMP2. When the external power connector J2 is used, it supplies power to regulator U1, which then supplies power to regulator U2.

# 4 Physical Description

This section contains the schematic drawings, PCB layouts and bill of materials for the MSC1201/02EVM board.

**Note:**
Board layouts are not to scale. These are intended to show how the board is laid out; they are not intended to be used for manufacturing MSC1201/02EVM PCBs.

## 4.1 MSC1201/02EVM Schematics

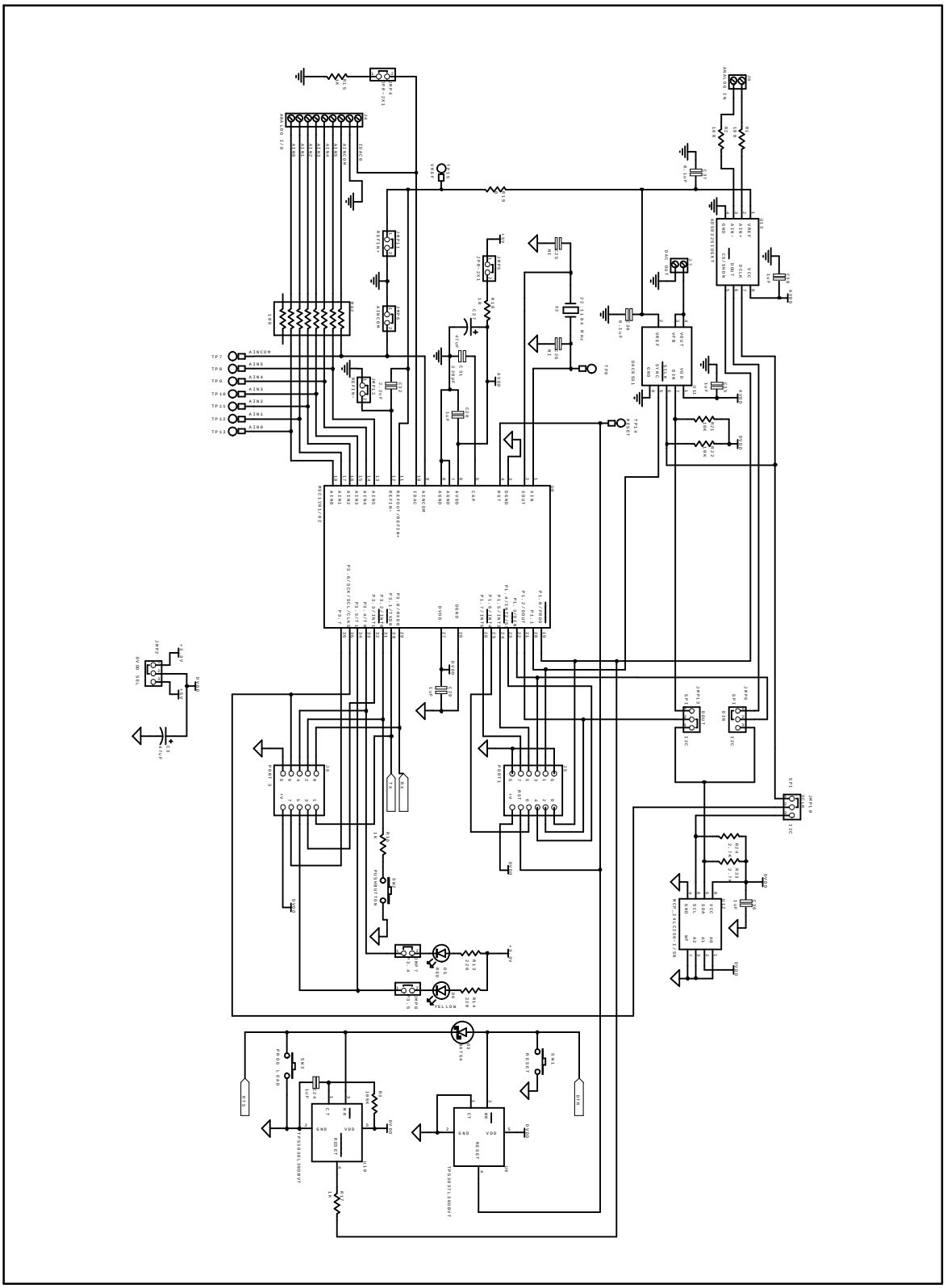

**Figure 5. MSC1201/02EVM Processor and Analog Inputs**

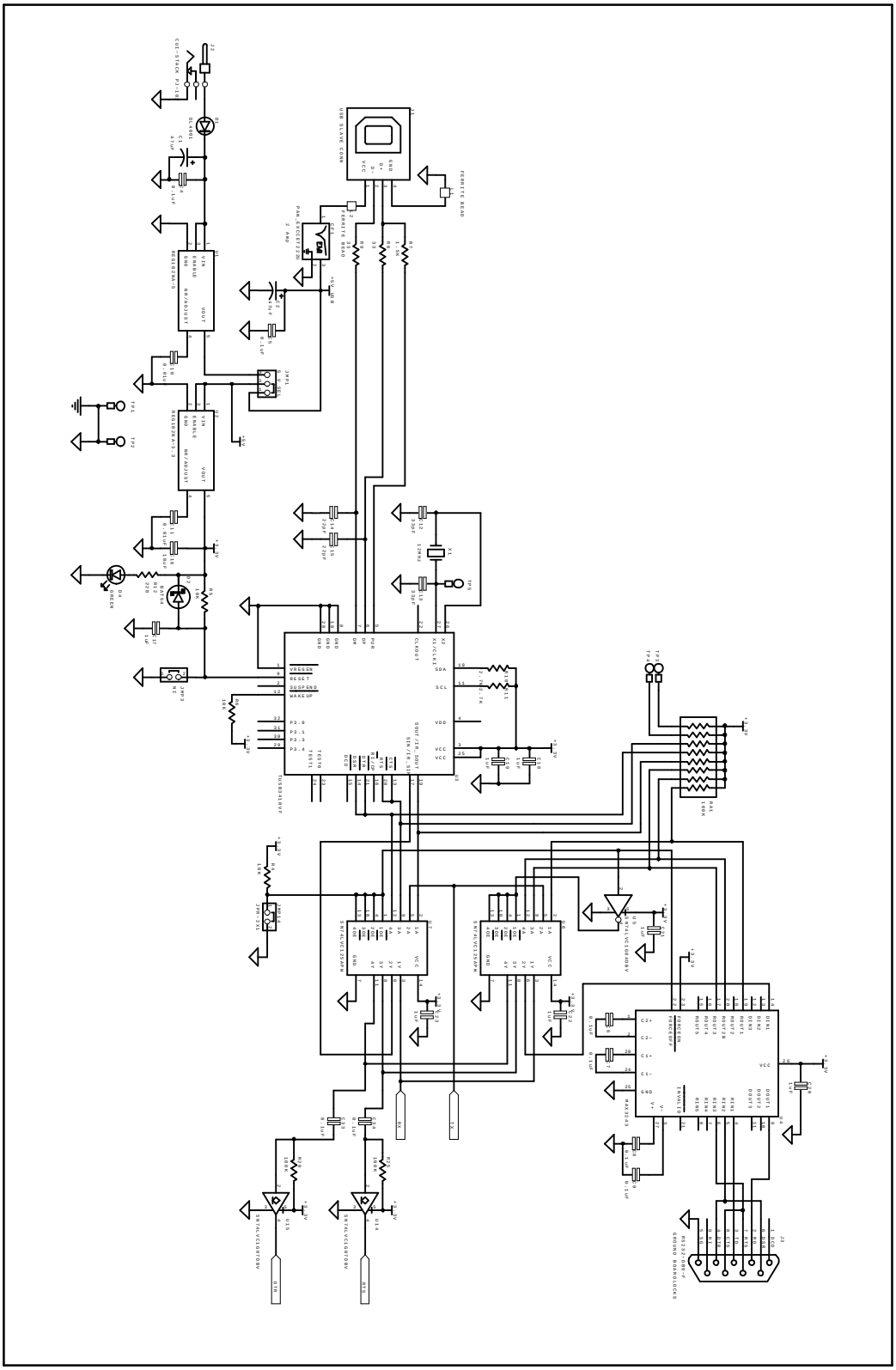

**Figure 6. MSC1201/02EVM Power and Communications Selection**

## 4.2 Component Locations

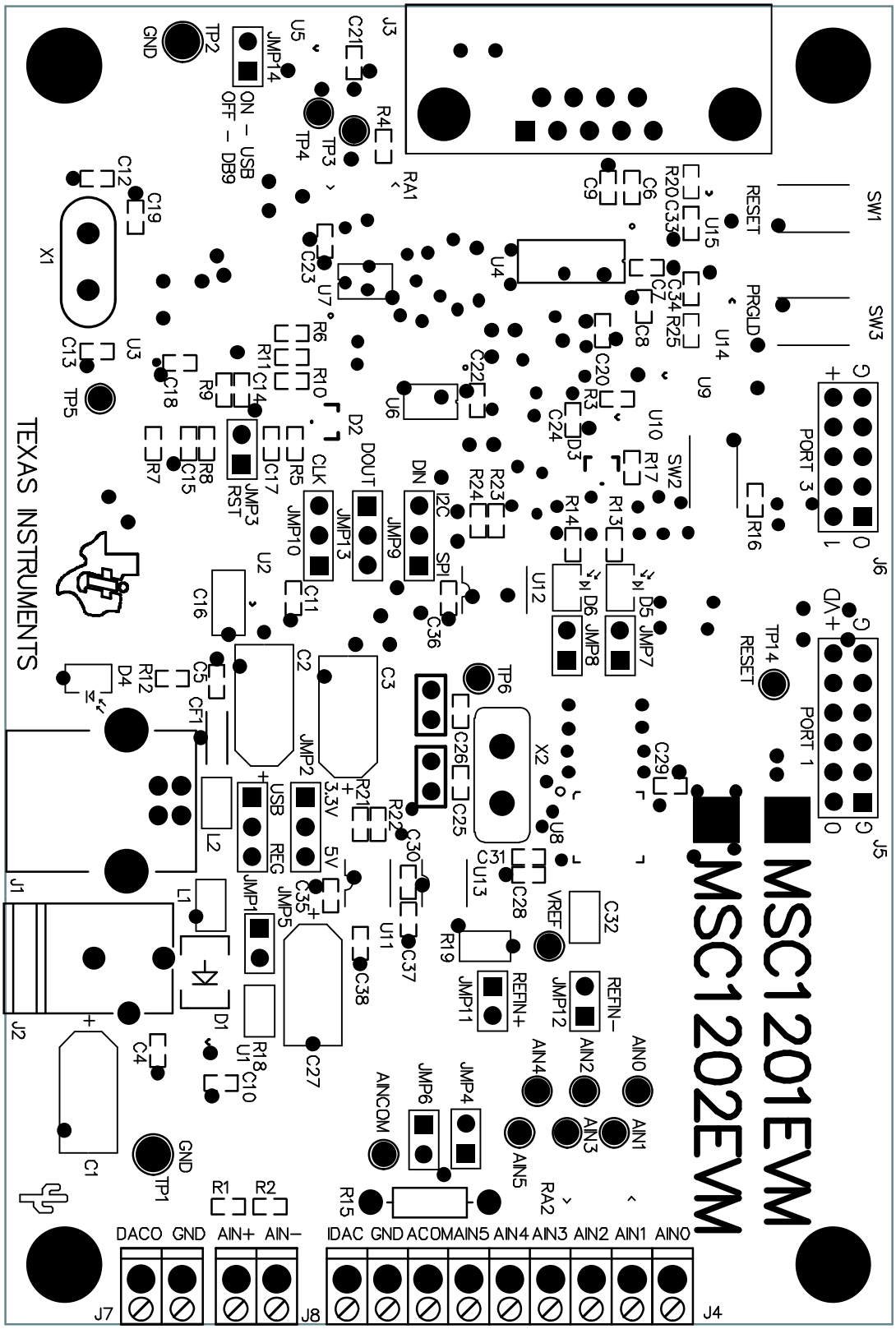


**Figure 7. MSC1201/02EVM Layout**

## 4.3 Bill of Materials

**Table 11. MSC1201/02EVM Bill of Materials**

| ITEM NO. | QTY | VALUE | REF. DES. | DESCRIPTION | VENDOR | MFG. PART NUMBER |
|---|---|---|---|---|---|---|
| 1 | 2 | 0 | R20, R27 | 1/8W 5% Chip Resistor | Panasonic | ERJ-6GEY0R00V |
| 2 | 1 | 10 | R18 | 1/8W 5% Chip Resistor | Panasonic | ERJ-6GEYJ100V |
| 3 | 2 | 33 | R8, R9 | 1/10W 5% Chip Resistor | Panasonic | ERJ-3GEYJ330V |
| 4 | 3 | 100 | R19, R25, R26 | 1/10W 5% Chip Resistor | Panasonic | ERJ-3GEYJ101V |
| 5 | 1 | 100 | RA2 | 1/16W 5% Chip Resistor Array | CTS Corporation | 742C163101JTR |
| 6 | 3 | 220 | R12- R14 | 1/10W 5% Chip Resistor | Panasonic | ERJ-3GEYJ221V |
| 7 | 2 | 1K | R16, R17 | 1/10W 5% Chip Resistor | Panasonic | ERJ-3GEYJ102V |
| 8 | 1 | 1K | R15 | 1/4W 1% Axial Lead Resistor | Yageo | MFR-25FBF-1K00 |
| 9 | 1 | 1.5K | R7 | 1/10W 5% Chip Resistor | Panasonic | ERJ-3GEYJ152V |
| 10 | 4 | 2.7K | R10, R11, R23, R24 | 1/10W 5% Chip Resistor | Panasonic | ERJ-3GEYJ272V |
| 11 | 5 | 10K | R4-R6, R21, R22 | 1/10W 5% Chip Resistor | Panasonic | ERJ-3GEYJ103V |
| 12 | 5 | 100K | R1-R3, R28, R29 | 1/10W 5% Chip Resistor | Panasonic | ERJ-3GEYJ104V |
| 13 | 1 | 100K | RA1 | 1/16W 5% Chip Resistor Array | CTS Corporation | 742C163104JTR |
| Not Installed | 2 | NI (10pF) | C25, C26 | 50V Ceramic Chip Capacitor, ±0.5pF, NPO | TDK | C1608C0G1H100D |
| 14 | 2 | 22pF | C14, C15 | 50V Ceramic Chip Capacitor, ±5%, NPO | TDK | C1608C0G1H220J |
| 15 | 2 | 33pF | C12, C13 | 50V Ceramic Chip Capacitor, ±5%, NPO | TDK | C1608C0G1H330J |
| 16 | 1 | 220pF | C31 | 50V Ceramic Chip Capacitor, ±5%, NPO | TDK | C1608C0G1H221J |
| 17 | 2 | 0.01µF | C10, C11 | 50V Ceramic Chip Capacitor, ±10%, X7R | TDK | C1608X7R1H103K |
| 18 | 10 | 0.1µF | C4-C9, C33, C34,C37, C38 | 25V Ceramic Chip Capacitor, ±10%, X7R | TDK | C1608X7R1E104K |
| 19 | 14 | 1µF | C17-C24, C28-C30, C35, C36, C39 | 6.3V Ceramic Chip Capacitor, ±10%, X5R | TDK | C1608X5R0J105K |
| 20 | 1 | 2.2µF | C32 | 10V Ceramic Chip Capacitor, ±10%, X5R | TDK | C2012X5R1A225K |
| 21 | 1 | 10µF | C16 | 6.3V Ceramic Chip Capacitor, ±10%, X5R | TDK | C3216X5R0J106K |
| 22 | 4 | 47µF | C1-C3, C27 | 16V Tantalum Chip Capacitor, ±10% | Kemet | T491D476K016AS |
| 23 | 1 | | CF1 | 50V, 2200pF EMI Filter | Panasonic | EXC-CET222U |
| 24 | 1 | | D1 | 50V, 1A Diode | Micro Commercial Co. | DL4001 |
| 25 | 2 | | D2, D3 | 30V, 200mA Schottky Diode | Fairchild Semiconductor | BAT54 |
| 26 | 1 | | D4 | Green LED | Lumex | SML-LX0603GW-TR |
| 27 | 1 | | D5 | Red LED | Lumex | SML-LX0603IW-TR |

**Table 11. MSC1201/02EVM Bill of Materials (continued)**

| ITEM NO. | QTY | VALUE | REF. DES. | DESCRIPTION | VENDOR | MFG. PART NUMBER |
|---|---|---|---|---|---|---|
| 28 | 1 | | D6 | Yellow LED | Lumex | SML-LX0603YW-TR |
| 29 | 2 | | L1, L2 | Ferrite Bead Core | Panasonic | EXC-ML20A390U |
| 30 | 1 | 12MHz | X1 | Quartz Crystal | Citizen | HC49US12.000MABJ |
| 31 | 1 | 22.1184 MHz | X2 | Quartz Crystal | Citizen | HC49US22.1184MABJ |
| 32 | 1 | | U1 | 5V, 250mA, LDO Regulator | Texas Instruments | REG102NA-5 |
| 33 | 1 | | U2 | 3.3V, 250mA, LDO Regulator | Texas Instruments | REG102NA-3.3 |
| 34 | 1 | | U3 | USB/Serial Converter | Texas Instruments | TUSB3410VF |
| 35 | 1 | | U4 | RS-232 Transceiver | Texas Instruments | MAX3243CPWR |
| 36 | 1 | | U5 | Single IC Inverter | Texas Instruments | SN74LVC1G04DBVR |
| 37 | 2 | | U6, U7 | Quad Bus Buffer w/ Tri-State Enable | Texas Instruments | SN74LVC125APW |
| 38 | 1 | | U8 | Precision ADC/DAC with 8051 Microcontroller | Texas Instruments | MSC120xY3PFBT |
| 39 | 1 | | U9 | Supervisory Circuit, Reset High | Texas Instruments | TPS3837L30DBVT |
| 40 | 1 | | U10 | Supervisory Circuit, Reset Low | Texas Instruments | TPS3838L30DBVT |
| 41 | 1 | | U11 | 16-Bit, Digital-to-Analog Converter | Texas Instruments | DAC8531E |
| 42 | 1 | | U12 | 256K I2C EEPROM | Texas Instruments | 24LC256-I/SN |
| 43 | 1 | | U13 | 16-Bit, Analog-to-Digital Converter | Texas Instruments | ADS8325IBDGKT |
| 44 | 2 | | U14, U15 | Single Gate, Open Drain Buffer | Texas Instruments | SN74LVC1G07DBVT |
| 45 | 1 | | N/A | MSC12xx EVM PWB | Texas Instruments | xxxxxxx |
| 46 | 1 | | J1 | USB Type **B** Socket | Mill-Max | 897-30-004-90-000000 |
| 47 | 1 | | J2 | 2.5mm Power Jack | CUI Inc. | PJ-102B |
| 48 | 1 | | J3 | DB9 Right Angle Female Connector | AMP/Tyco Electronics | PJ-102B 747844-4 |
| 49 | 1 | | J4 | 11-Position Terminal Block, 3.5mm Spacing | On Shore Technology | ED555/11DS |
| 50 | 2 | | J7, J8 | 2-Position Terminal Block, 3.5mm Spacing | On Shore Technology | ED555/2DS |
| 51 | 1 | | J6 | 5-Position, Dual Row Header, 0.1in Spacing | Samtec | TSW-105-07-L-D |
| 52 | 1 | | J5 | 6-Position, Dual Row Header, 0.1in Spacing | Samtec | TSW-106-07-L-D |
| 53 | 5 | | JMP1, JMP2, JMP9, JMP10, JMP13 | 3-Position Jumper, 0.1in Spacing | Samtec | TSW-103-07-L-S |

**Table 11. MSC1201/02EVM Bill of Materials (continued)**

| ITEM NO. | QTY | VALUE | REF. DES. | DESCRIPTION | VENDOR | MFG. PART NUMBER |
|---|---|---|---|---|---|---|
| 54 | 9 | | JMP3-JMP8, JMP11-JMP12, JMP14 | 2-Position Jumper, 0.1in Spacing | Samtec | TSW-102-07-L-S |
| 55 | 3 | | SW1, SW2, SW3 | Normally Open Pushbutton Switch | Panasonic | EVQ-PJU04K |
| 56 | 2 | | TP1, TP2 | Large Loop Test Point Terminal | Keystone Electronics | 5011 |
| 57 | Not In-stalled | | TP3-TP14 | Miniature Test Point Terminal | Keystone Electronics | 5000 |
| 58 | 14 | | N/A | Shorting Jumper | Samtec | SNT-100-BK-TH |
| 59 | 4 | | N/A | 0.25in x 0.625 hex 4-40 Threaded Standoff | Keystone Electronics | 1808 |
| 60 | 4 | | N/A | Pan Head Machine Screws 4-40 x 0.5in Phillips | Building Fasteners | PMS 440 0050 PH |

# Appendix A Certificate of Conformity

## A.1 Wall Mount Power Supply

03-JAN-2000 14:14 VON -FRIWO SALES EXPORT +49-2532-81-112 T-170 P.003/004 F-587

FRIWO Gerätebau GmbH
Von-Liebig-Str. 11
D-48346 Ostbevern
Germany

FRIWO

**CE-Konformitätserklärung**
***Declaration of Conformity***

Wir, der Hersteller, erklären hiermit, daß das Produkt:
*We, the manufacturer, hereby confirm, that the product:*

Typ: *Type:* **FW 7207/9**

Zeichnungs-Nr.: *Part-No.:* **15.0661.500-00**

weitere Merkmale:
*additional information:*

mit der beiliegenden Beschreibung die Anforderungen der Niederspannungsrichtlinie 73/23/EWG, CE-Kennzeichnungsrichtlinie 93/68/EWG und der EMV-Richtlinien 89/336/EWG, 92/31/EWG erfüllt.
*with the enclosed description fulfills the requirements of the Low Voltage Directive 73/23/EEC, CE Marking Standard 93/68/EEC and the regulations of the EMC Directives 89/336/EEC, 92/31/EEC.*

Das Gerät entspricht der:
*The unit corresponds to:*

a) Niederspannungsrichtlinie
*Low Voltage Directive*

- ☐ EN 60742 9/95
- ☐ EN 60335 5/95
- ☒ EN 60950 9/94
- ☐ EN 60601 9/94

b) EMV-Richtlinie
*EMC-Directive*

- ☒ EN 50081-1 3/93
- ☐ EN 50081-2 3/94
- ☐ EN 50082-1 3/93
- ☒ EN 50082-2 2/96

Ausstelldatum:
*Date of issue:* 98-10-02

FRIWO Gerätebau GmbH
Von-Liebig-Straße 11
48346 Ostbevern

Firmenstempel Company stamp

Quality Manager ppa. Busche

R & D Manager i.V. Dr. Ehart

checked: R & D Electr. Man. i. V. Schulz

## FCC Warnings

This equipment is intended for use in a laboratory test environment only. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to subpart J of part 15 of FCC rules, which are designed to provide reasonable protection against radio frequency interference. Operation of this equipment in other environments may cause interference with radio communications, in which case the user at his own expense will be required to take whatever measures may be required to correct this interference.

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## EVM WARNINGS AND RESTRICTIONS

It is important to operate this EVM within the input voltage range of 5.5V to 15V for power input, and 0V to 5V for analog inputs AIN0–AIN7, AINCOM and Analog In, and the output voltage range of 0V to 5V for DACOUT and IDAC.

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 100° C. The EVM is designed to operate properly with certain components above 100° 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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