

Multi-Cal-Slave Evaluation Module

This user's guide describes the characteristics, operation, and the use of the Multi-Cal-Slave evaluation module (EVM). It covers all pertinent areas involved to properly use this EVM board. The document includes the bill of materials (BOM) and complete circuit descriptions.

Contents

1	Overview	1
2	Theory of Operation for Multi-Cal-Slave EVM Hardware	4
3	Bill of Materials	9

List of Figures

1	Hardware Included with the Multi-Cal-Slave EVM Kit	2
2	Multi-Cal-Slave System Block Diagram	4
3	Slave Select Jumpers to U933	5
4	Slave Select Jumpers to U35	6
5	I ² C Address Decoding from U933 to U800	6

List of Tables

1	J0: Signal Connection Summary	7
2	J1: Signal Connection Summary	8
3	Multi-Cal-Slave EVM Parts List	9

1 Overview

The Multi-Cal-Slave Evaluation Module is part of a series of EVMs that is used to calibrate multiple [PGA308 sensor modules](#). The PGA308 is a programmable analog sensor signal conditioner. All components in the Multi-Cal-System can be expanded to calibrate up to 64 sensors simultaneously. For a more detailed description of the PGA308, refer to the product data sheet ([SBOS440](#)) 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](#).

The Multi-Cal-Slave Evaluation Module consists of a single printed circuit board (PCB) and related ribbon cable. The complete Multi-Cal-System contains a series of printed circuit assemblies (PCAs), and can be expanded to meet your specific system requirements.

Throughout this document, the abbreviation *EVM* and the term *evaluation module* are synonymous with the Multi-Cal-Slave Evaluation Module.

1.1 Multi-Cal-Slave Hardware Options

Figure 1 shows the hardware included with the Multi-Cal-Slave EVM. Depending on your specific hardware requirements, you will use various combinations of the different Multi-Cal-System EVMs in your application.

The Multi-Cal-Slave EVM contains these items:

- **Multi-Cal-Slave board:** This PCB multiplexes all the communication signals, sensor module output signals, and power.
- **Slave Ribbon Cable:** This cable connects the Multi-Cal-Slave to the board assembly stacked beneath it. All of the slave boards in a Multi-Cal-System are interconnected using the Slave Ribbon cable.

Contact the factory if any component is missing.

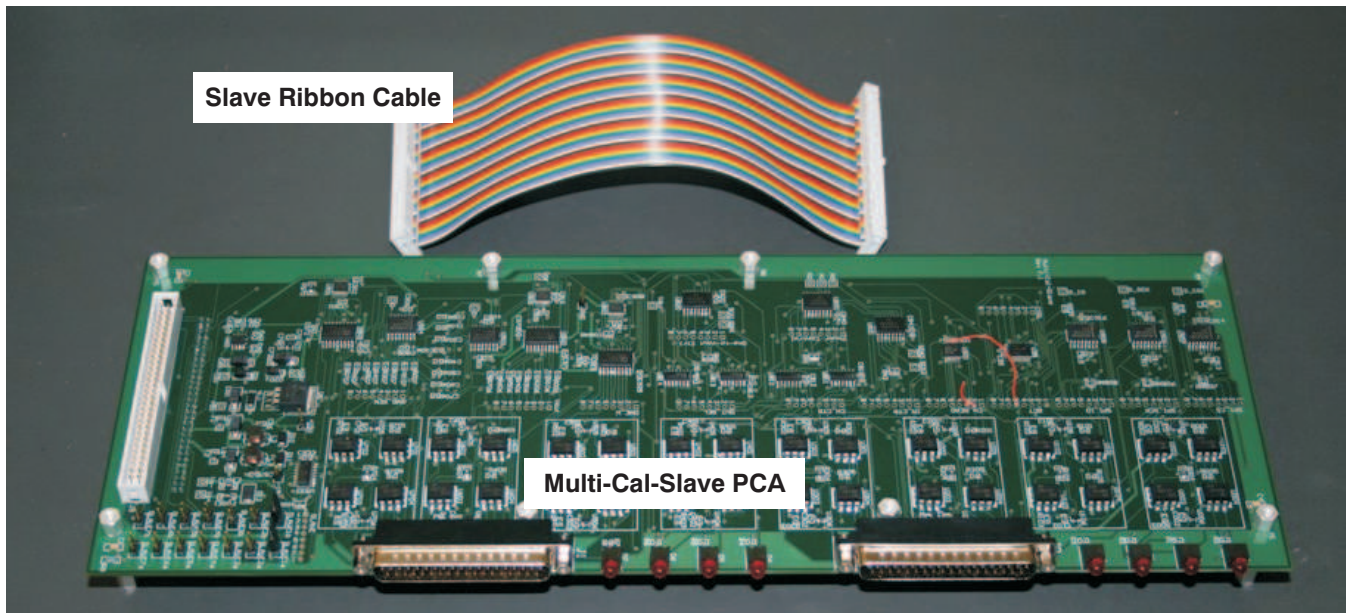


Figure 1. Hardware Included with the Multi-Cal-Slave EVM Kit

1.2 Related Documentation from Texas Instruments

The following documents provide information regarding Texas Instruments integrated circuits used in the assembly of the Multi-Cal-Slave EVM. This user's guide is available from the TI website under literature number [SBOU094](#). Any letter appended to the literature number corresponds to the document revision that is current at the time of the writing of this document. Newer revisions may be available from the TI web site at <http://www.ti.com/>, or call the Texas Instruments Literature Response Center at (800) 477-8924 or the Product Information Center at (972) 644-5580. When ordering, identify the document by both title and literature number.

Document	Literature Number
Multi-Cal-Test EVM User's Guide	SBOU088
Multi-Cal-Master EVM User's Guide	SBOU089
USB DAQ Platform User's Guide	SBOU056
Multi-Cal-System EVM User's Guide	SBOU087
Multi-Cal-Cable User's Guide	SBOU092
Multi-Cal-Interface User's Guide	SBOU093

1.3 *Electrostatic Discharge Warning*

Many of the components on the Multi-Cal-Slave are susceptible to damage by electrostatic discharge (ESD). Customers are advised to observe proper ESD handling precautions when unpacking and handling the EVM, including the use of a grounded wrist strap at an approved ESD workstation.

CAUTION

Failure to observe ESD handling procedures may result in damage to EVM components.

1.4 *Applications Questions*

If you have questions about this or other Texas Instruments evaluation modules, post a question in the *Amplifiers* forum at <http://e2e.ti.com>. Include in the subject heading the product in which you are interested.

2 Theory of Operation for Multi-Cal-Slave EVM Hardware

This section discusses the operation of the Multi-Cal-Slave EVM hardware.

2.1 Multi-Cal-Slave

Figure 2 shows the block diagram of the Multi-Cal-Slave. Note that most of the functional blocks on the slave are direct copies from the master. There are several key differences:

- The connections to the USB-DAQ (J101 and J102) are not included on the slave (master only).
- The power and DMM connection (J9) is not included on the slave (master only).
- Slave boards have two ribbon cable connectors. One connector is on top of the board and one connector is on the bottom. The master board only has one connector. These connectors connect the communications, signal, and power signals between the boards.
- The slave has jumpers and associated circuitry for decoding the slave board (U933). The master does not have these jumpers.
- The slave has jumpers and associated circuitry for selecting the slave board (U34). The master does not have these jumpers.

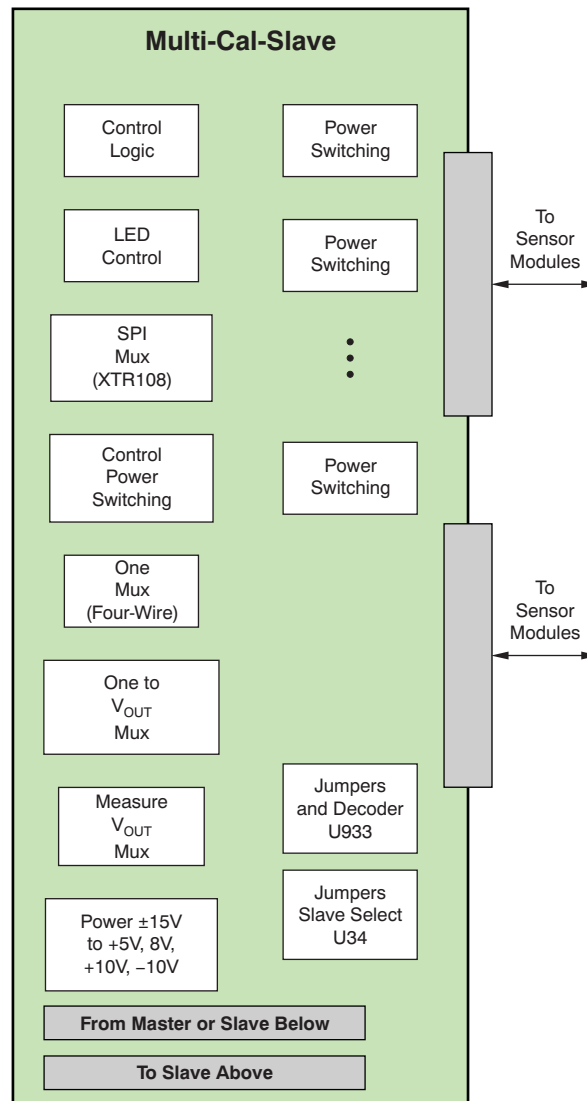


Figure 2. Multi-Cal-Slave System Block Diagram

2.2 Control Schematics

The detailed theory of operation for the Multi-Cal-Slave does not cover every circuit in the hardware because the slave and master hardware designs are very similar. This document covers only those circuits that are unique to the slave board. Refer to the *Multi-Cal-Master User Guide* ([SBOU089](#)) for complete details on other circuits.

Figure 3 shows the jumpers and associated circuitry for decoding the slave address (1 through 7). The output of this decoder will be used to set the I²C™ address on the I²C bus expanders that are used to control the power-switching circuits on each slave board. Thus, each slave board will have different I²C addresses for the control circuitry.

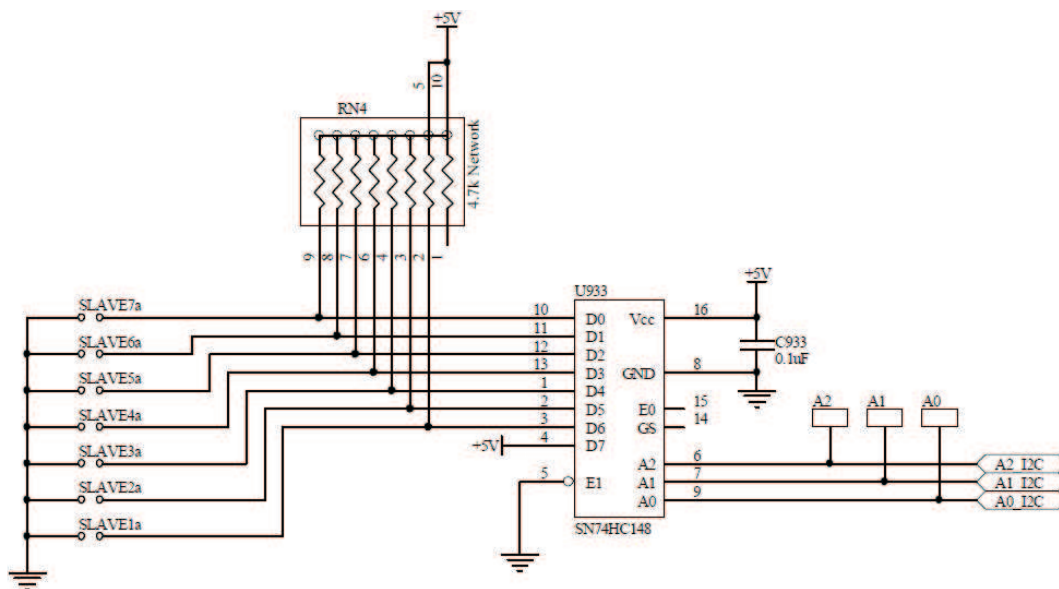


Figure 3. Slave Select Jumpers to U933

Figure 4 illustrates the jumpers and associated circuitry for selecting the slave (1 through 7). The seven slave signals are used to clock in data to U35. These data are used to control the multiplexers on the slave board.

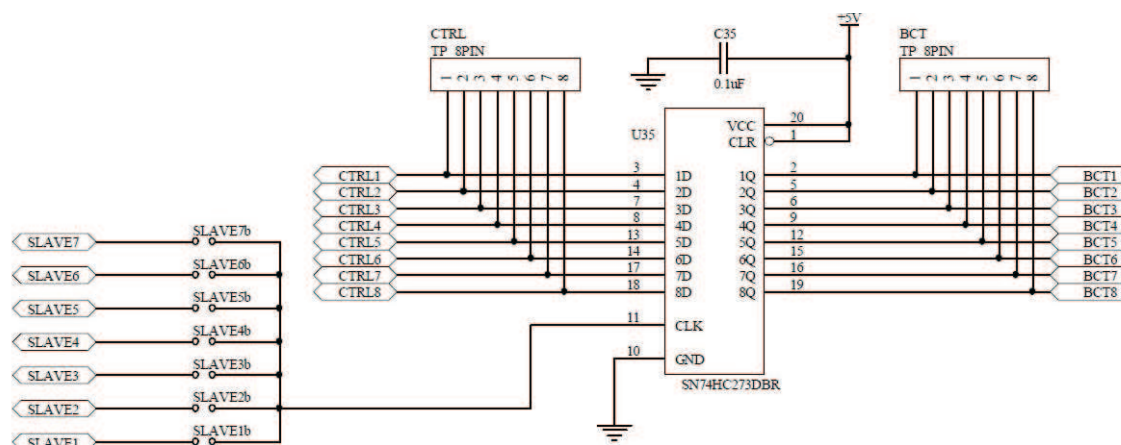


Figure 4. Slave Select Jumpers to U35

The signals from U933 are used throughout the Multi-Cal-Slave board to set the I²C address on bus expanders. Figure 5 shows a typical example of this configuration. Pins 1, 2, and 3 on U800 select the I²C address for this device. The same connections are made on U820, U821, and U921.

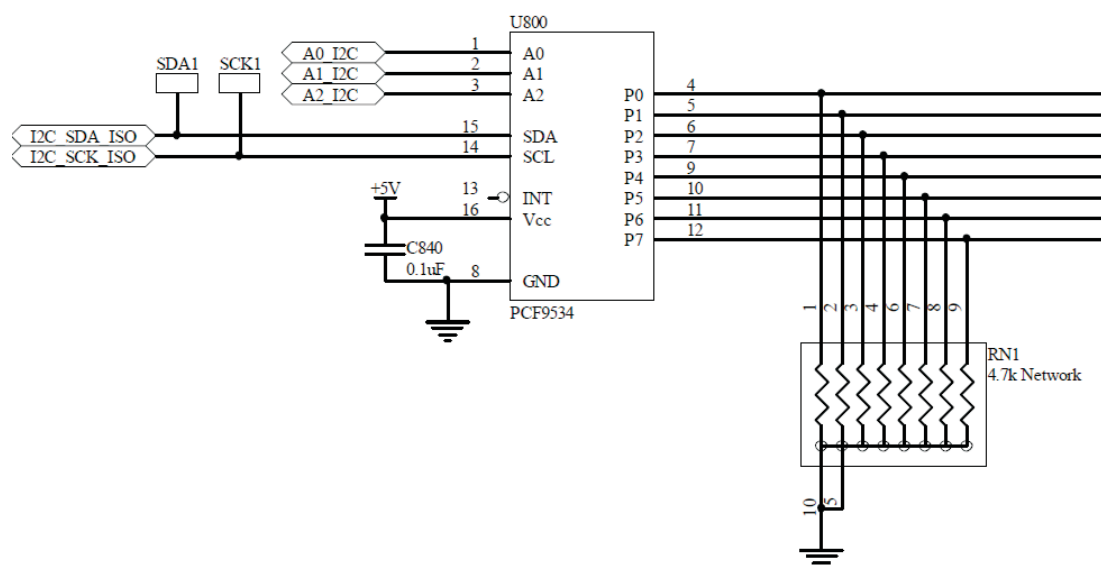


Figure 5. I²C Address Decoding from U933 to U800

2.3 Signal Definitions

Table 1 and Table 2 summarize the signals on J0 and J1, respectively.

Table 1. J0: Signal Connection Summary

Pin J0	Signal	Function on J0
1	Chassis ground	Chassis ground
2	One0	One-wire digital communication line.
3	Pos0	Positive device supply.
4	Neg0	Negative device supply.
5	GND0	Ground force for current modules. Ground sense for voltage modules.
6	V _{OUT} 0	Output voltage measurement.
7	SCK0	SPI SCK for XTR108.
8	CS0	SPI CS0 for XTR108
9	IO0	SPI Input / Output for XTR108
10	Chassis ground	Pins 10 to 18 repeat the function of pins 1 to 9 for channel 2
11	One1	
12	Pos1	
13	Neg1	
14	GND1	
15	V _{OUT} 1	
16	SCK1	
17	CS1	
18	IO1	
19	—	No connection
20	Chassis ground	Pins 20 to 28 repeat the function of pins 1 to 9 for channel 3
21	One2	
22	Pos2	
23	Neg2	
24	GND2	
25	V _{OUT} 2	
26	SCK2	
27	CS2	
28	IO2	
29	Chassis ground	Pins 29 to 37 repeat the function of pins 1 to 9 for channel 4
30	One3	
31	Pos3	
32	Neg3	
33	GND3	
34	V _{OUT} 3	
35	SCK3	
36	CS3	
37	IO3	

Table 2. J1: Signal Connection Summary

Pin J1	Signal	Function on J1
1	Chassis ground	Chassis ground
2	One4	One wire digital communication line.
3	Pos4	Positive device supply.
4	Neg4	Negative device supply.
5	GND4	Ground force for current modules. Ground sense for voltage modules.
6	V _{OUT} 4	Output voltage measurement.
7	SCK4	SPI SCK for XTR108.
8	CS4	SPI CS0 for XTR108
9	IO4	SPI Input / Output for XTR108
10	Chassis ground	Pins 10 to 18 repeat the function of pins 1 to 9 for channel 2
11	One5	
12	Pos5	
13	Neg5	
14	GND5	
15	V _{OUT} 5	
16	SCK5	
17	CS5	
18	IO5	
19	—	No connection
20	Chassis ground	Pins 20 to 28 repeat the function of pins 1 to 9 for channel 3
21	One6	
22	Pos6	
23	Neg6	
24	GND6	
25	V _{OUT} 6	
26	SCK6	
27	CS6	
28	IO6	
29	Chassis ground	Pins 29 to 37 repeat the function of pins 1 to 9 for channel 4
30	One7	
31	Pos7	
32	Neg7	
33	GND7	
34	V _{OUT} 7	
35	SCK7	
36	CS7	
37	IO7	

3 Bill of Materials

Table 3 shows the parts list for the Multi-Cal-Slave EVM.

Table 3. Multi-Cal-Slave EVM Parts List

Qty	Ref Des	Description	Vendor	Part Number
9	C006, C106, C206, C306, C406, C506, C606, C706, C71	Capacitor, 10000pF 50V Ceramic X7R 0603	KEMET	C0603C103K5RACTU
52	C35, C60, C61, C62, C70, C840, C842, C907, C908, C909, C910, C901, C902, C903, C904, C905, C906, C911, C912, C913, C914, C915, C916, C921, C928, C929, C970, C971, C972, C973, C001, C002, C101, C102, C201, C202, C301, C302, C401, C402, C501, C502, C601, C602, C701, C702, C811, C812, C813, C814, C820, C933	Capacitor, .10μF 25V Ceramic Y5V 0603	KEMET	C0603C104M3VACTU
2	C56, C57	Capacitor, Ceramic 1μF 25V X5R 0603	Murata Electronics North America	GRM188R61E105KA12D
5	C54, C55, C50, C65, C72	Capacitor, Tantalum 4.7μF 35V 20% SMD	Nichicon	F931V475MCC
4	C1, C2, C3, C4	Capacitor, Ceramic .01μF 10% 1000V X7R 1206	Vishay/Vitramon	VJ1206Y103KXGAT5Z
1	R970	Resistor, 0.0Ω 1/4W 5% 1206 SMD	Vishay/Dale	CRCW12060000Z0EA
1	R938	Resistor, 49.9kΩ 1/10W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF4992V
1	R8	Resistor, 1MΩ 1% 1206 TF High Voltage	Stackpole Electronics Inc	HVCB 1206 T2 1M 1% I
8	R0, R1, R2, R3, R4, R5, R6, R7	Resistor, 499Ω 1/10W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF4990V
19	R006, R106, R206, R306, R406, R506, R606, R706, R007, R107, R207, R307, R407, R507, R607, R707, R939, R917, R916	Resistor, 100Ω 1/10W 5% 0603 SMD	Stackpole Electronics Inc	RMCF 1/16 100 5% R
8	R004, R104, R204, R304, R404, R504, R604, R704,	Resistor, 200Ω 1/4W 5% 1206 SMD	Stackpole Electronics Inc	RMCF 1/8 200 5% R

Table 3. Multi-Cal-Slave EVM Parts List (continued)

Qty	Ref Des	Description	Vendor	Part Number
32	R001, R002, R003, R005, R101, R102, R103, R105, R201, R202, R203, R205, R301, R302, R303, R305, R401, R402, R403, R405, R501, R502, R503, R505, R601, R602, R603, R605, R701, R702, R703, R705	Resistor, 402Ω 1/10W 1% 0603 SMD	Panasonic - ECG	ERJ-3EKF4020V
1	R64	Resistor, 10kΩ 1/10W 1% 0603 SMD	Stackpole Electronics Inc	RMCF 1/16 10K 1% R
1	R63	Resistor, 69.8kΩ 1/10W 1% 0603 SMD	Yageo	RC0603FR-0769K8L
8	RN1, RN2, RN3, RN4, RN902, RN906, RN907, RN908	Resistor, Array 100ΩΩ 10TRM BSS SMD	CTS Resistor Products	746X101104JP
3	U901, U902, U905	IC SW Mux Analog 1/8CH 16-TSSOP	Analog Devices Inc	ADG1408YRUZ
5	U903, U904, U906, U907, U908	IC Multiplexer 8X1 16SOIC	Maxim	MAX354CWE
3	U919, U920, U909	IC Chan Protector Octal 18-SOIC	Analog Devices Inc	ADG467BRZ
32	U001, U002, U003, U004, U101, U102, U103, U104, U201, U202, U203, U204, U301, U302, U303, U304, U401, U402, U403, U404, U501, U502, U503, U504, U601, U602, U603, U604, U701, U702, U703, U704,	Relay Opto dc 60V 600MA 6-SMD	Panasonic Electric Works	AQV102A
1	U933	IC 8-TO-3 Priority Encod 16-SOIC	Texas Instruments	SN74HC148D
1	U800	IC I/O Expander I ² C 8B 16SOIC	Texas Instruments	PCA9534DWR
2	U820, U821	IC I/O Expander I ² C 8B 16SOIC	Texas Instruments	PCA9534ADWR
1	U70	IC LDO Reg 10V 150mA SOT23-5	Texas Instruments	LP2985A-10DBVR
1	U921	IC 3-TO-8 Decoder/Demux 16-SSOP	Texas Instruments	SN74HC138DBR
1	U60	IC .5A Neg Adj Lin LDO Reg 8SOIC	Texas Instruments	UCC384DP-ADJ
1	U6	IC LDO Reg 150mA 5V D2PAK-3 TO-263	Texas Instruments	TL750L05CKTTR
8	U005, U105, U205, U305, U405, U505, U605, U705	IC SGL 2in Pos-AND Gate SOT23-5	Texas Instruments	SN74AHC1G08DBVR
8	U006, U106, U206, U306, U406, U506, U606, U706	IC Single Inverter Gate SOT23-5	Texas Instruments	SN74AHC1G04DBVR
2	U811, U812	IC Quad 2-In NOR Gate 14-SOIC	Texas Instruments	SN74HC02D

Table 3. Multi-Cal-Slave EVM Parts List (continued)

Qty	Ref Des	Description	Vendor	Part Number
2	U813, U814	IC Quad 2-Input AND Gate 14-SOIC	Texas Instruments	SN74HC08D
1	U35	IC OCT D-Type F-F w/CLR 20-SSOP	Texas Instruments	SN74HC273DBR
8	D0, D1, D2, D3, D4, D5, D6, D7	LED RED T1-3/4 Rt Ang PCB	CML Innovative Technologies	5307H1
2	D10, D11	Diode TVS 16V 400W Uni 5% SMA	Littelfuse Inc	SMAJ16A
2	D20, D21	TVS 400W 11V Unidirect SMA	Littelfuse Inc	SMAJ11A-TP
1	D16	Diode TVS 6.0V 400W Uni 5% SMA	Littelfuse Inc	SMAJ6.0A
1	D12	Diode Schottky 100V 5A PowerDI5	Diodes Inc	PDS5100H-13
2	Fuse1, Fuse2	PTC Resistor, ET 30V .200A SMD 1210	Littelfuse Inc	1210L020WR
2	L2, L3	Inductor Unshield 100µH .52A SMD	JW Miller A Bourns Company	PM54-101K-RC
2	F1, F2	Ferrite chip 120Ω 3000mA 1206	Murata Electronics North America	BLM31PG121SN1
2	J0, J1	Conn DB37 MI .318" R/A Nickel	Norcomp Inc.	182-037-113R531
2	J8, J9	Conn Header LOW-PRO 60-Pos Gold	Assmann Electronics Inc	AWHW60G-0202-T-R
8	CH_ON, CH_OFF, MBIT, SPI_SCK, SPI_CS, SPI_IO, ONE, Vout, GND_SEN	Connector	OMIT	OMIT
14	Slave 1a thru Slave 7a, Slave 1b thru Slave 7b	Header, 2-pos 0.100" SGL Gold	Samtec	TSW-102-07-G-S
4	JMP1, JMP2, JMP4, JMP5	Shunt LP w/Handle 2-Pos 30AU	Tyco Electronics	881545-2
16	M1-M8 & USB DAQ Standoffs (bottom)	Standoff Hex M/F 4-40 1.125" Alum	Keystone Electronics	8406
16	M1-M8 & USB DAQ Standoffs (top)	Standoff Hex 4-40thr Alum .250"	Keystone Electronics	2201
4	use on J0, J1	Female Screwlock 4-40 .312"	Norcomp Inc.	SFSO4401NR
1	Ribbon cab	Cable 60 Cond 300ft Multi-color	3M	3302/60 300SF
2	Ribbon connector	Conn Socket IDC 60-pos w/Str Gold	Assmann Electronics Inc	AWP60-7241-T-R

Evaluation Board/Kit Important Notice

Texas Instruments (TI) provides the enclosed product(s) under the following conditions:

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. Persons handling the product(s) must have electronics training and observe good engineering practice standards. As such, the goods being provided are not intended to be complete in terms of required design-, marketing-, and/or manufacturing-related protective considerations, including product safety and environmental measures typically found in end products that incorporate such semiconductor components or circuit boards. This evaluation board/kit does not fall within the scope of the European Union directives regarding electromagnetic compatibility, restricted substances (RoHS), recycling (WEEE), FCC, CE or UL, and therefore may not meet the technical requirements of these directives or other related directives.

Should this evaluation board/kit not meet the specifications indicated in the User's Guide, the board/kit may be returned within 30 days from the date of delivery for a full refund. **THE FOREGOING WARRANTY IS THE EXCLUSIVE WARRANTY MADE BY SELLER TO BUYER AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, OR STATUTORY, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.**

The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies TI from all claims arising from the handling or use of the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge.

EXCEPT TO THE EXTENT OF THE INDEMNITY SET FORTH ABOVE, NEITHER PARTY SHALL BE LIABLE TO THE OTHER FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES.

TI currently deals with a variety of customers for products, and therefore our arrangement with the user **is not exclusive**.

TI assumes **no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein.**

Please read the User's Guide and, specifically, the Warnings and Restrictions notice in the User's Guide prior to handling the product. This notice contains important safety information about temperatures and voltages. For additional information on TI's environmental and/or safety programs, please contact the TI application engineer or visit www.ti.com/esh.

No license is granted under any patent right or other intellectual property right of TI covering or relating to any machine, process, or combination in which such TI products or services might be or are used.

FCC Warning

This evaluation board/kit is intended for use for **ENGINEERING DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY** and is not considered by TI to be a finished end-product fit for general consumer use. It generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to 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.

EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of 5.7V to 9V and the output voltage range of 0V to 5V.

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 +25°C. The EVM is designed to operate properly with certain components above +25°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.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2010, Texas Instruments Incorporated

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		Applications	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DLP® Products	www.dlp.com	Communications and Telecom	www.ti.com/communications
DSP	dsp.ti.com	Computers and Peripherals	www.ti.com/computers
Clocks and Timers	www.ti.com/clocks	Consumer Electronics	www.ti.com/consumer-apps
Interface	interface.ti.com	Energy	www.ti.com/energy
Logic	logic.ti.com	Industrial	www.ti.com/industrial
Power Mgmt	power.ti.com	Medical	www.ti.com/medical
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
RFID	www.ti-rfid.com	Space, Avionics & Defense	www.ti.com/space-avionics-defense
RF/IF and ZigBee® Solutions	www.ti.com/lprf	Video and Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless-apps