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.

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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:

- **Mutli-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.

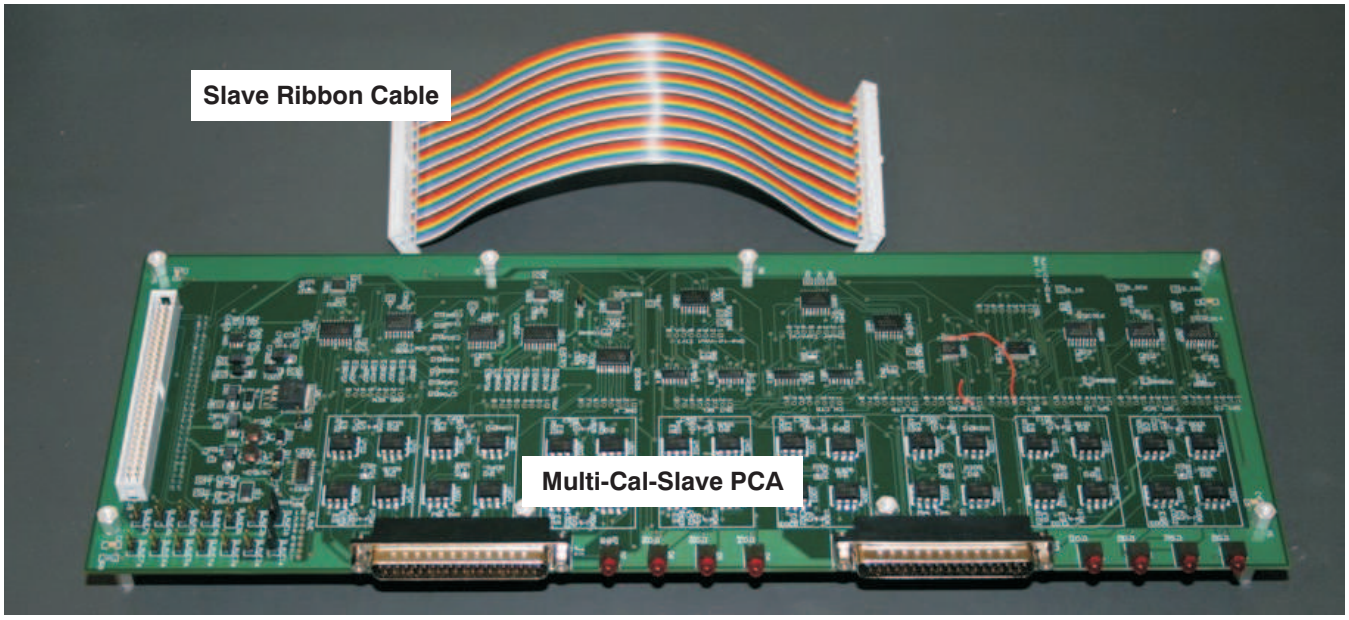

Figure 1. Hardware Included with the Multi-Cal-Slave EVM Kit

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 on 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 connecter. 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.

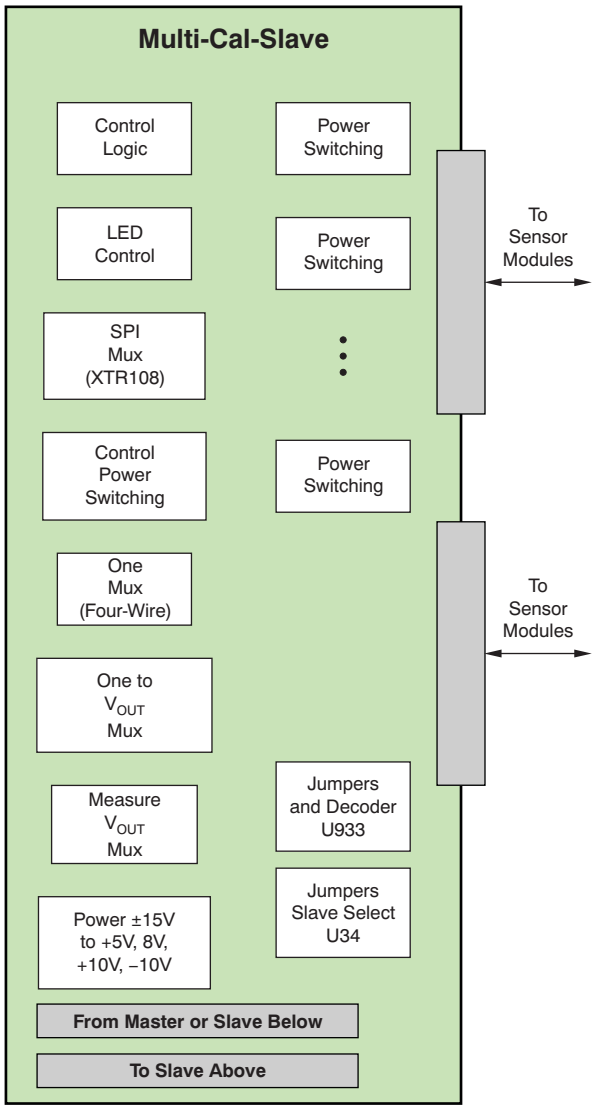

Figure 2. Multi-Cal-Slave System Block Diagram

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.

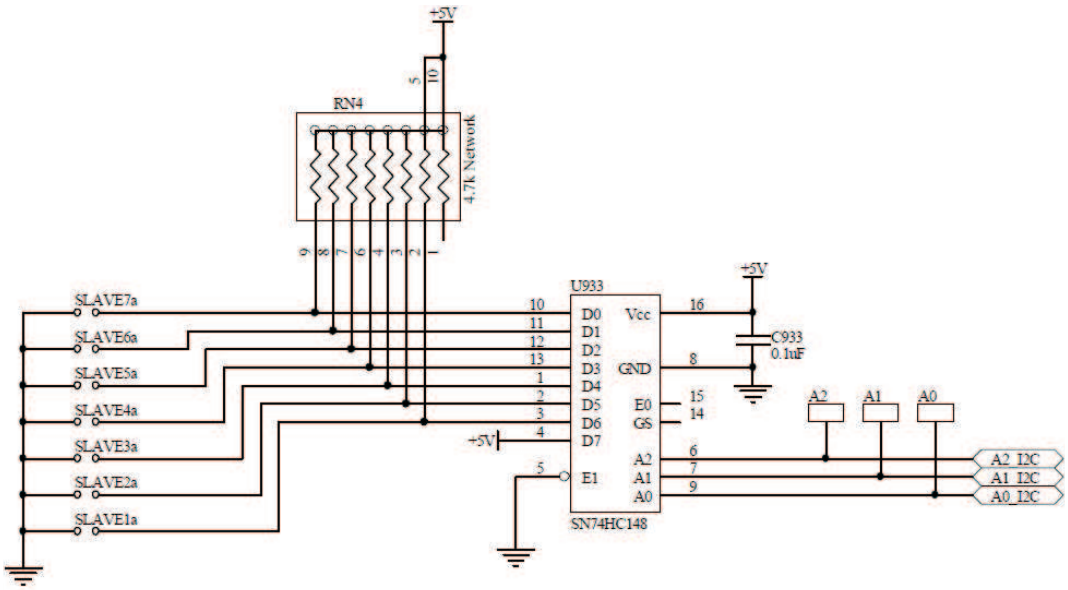

Figure 3. Slave Select Jumpers to U933

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.

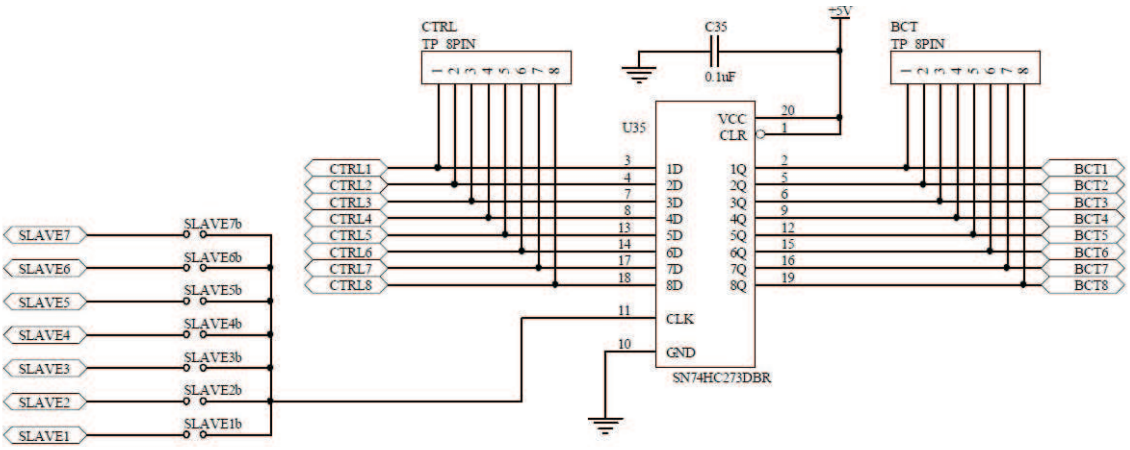

Figure 4. Slave Select Jumpers to U35

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.

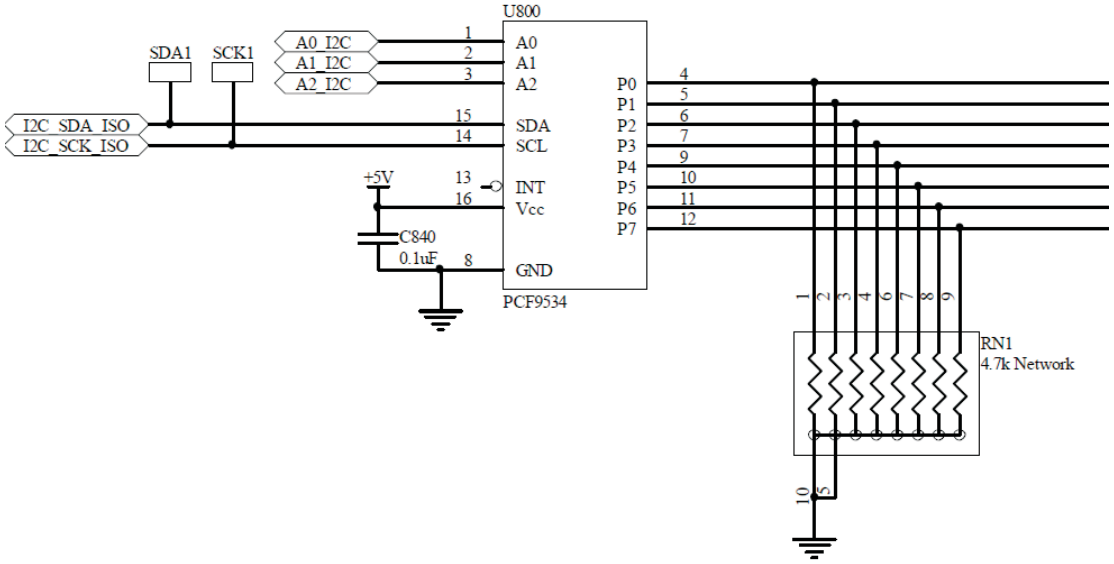

Figure 5. I²C Address Decoding from U933 to U800

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^2C 8B 16SOIC	Texas Instruments	PCA9534DWR
2	U820, U821	IC I/O Expander I^2C 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 Ml .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

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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.

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