Evaluation Board User Guide

MAX40109 Evaluation System

Evaluates: MAX40109

General Description

The MAX40109 evaluation system (EV system) demonstrates the precision sensor conditioning analog front end (AFE) for pressure sensors. The MAX40109 EV system includes the MAX40109 EV kit and the MAX32666FTHR board. Windows®-compatible software provides a graphical user interface (GUI) to demonstrate the features of the MAX40109. The GUI supports I2C, SPI, and 1-Wire® communication.

The MAX40109 EV kit PCB comes with a MAX40109IATP+ installed which is the I^2C and 1-Wire variant IC.

Features and Benefits

- On-Board Microcontroller (MAX32666) to Evaluate the MAX40109
- Accommodates Easy-to-Use Components
- Proven PCB Layout
- Fully Assembled and Tested

Quick Start

Required Equipment

- MAX40109 EV System (USB Cable Included)
- Windows PC
- 3V to 36V, 100mA DC Power Supply
- 2.75V to 6V, 100mA DC Power Supply
- Two DC Voltage Sources
- Voltmeter
- MAX40109EVkitSetupVXXX.zip File

Note: In the following sections, software-related items are identified by bolding. Text in bold refers to items directly from the EV kit software. Text in bold and underlined refers to items from the Windows operating system.

Procedure

Procedure for Voltage Output

The MAX40109 EV kit is fully assembled and tested. Follow the steps below to verify board operation.

1. Set the 3V to 36V supply to 5V. Connect the positive terminal of the 3V to 36V supply to the VDDHV test point and the negative terminal to the AGND test point of the EV kit, respectively.
2. Measure the voltage at the VDD5V test point.
3. Set the 2.75V to 6V supply to the voltage measured at the VDD5V test point. Connect the positive terminal of the second supply to the VDDA5 test point and the negative terminal to the DGND test point of the EV kit, respectively.
4. Connect the first DC voltage source at INP- and AGND test points. Set the DC source to 1V. Connect the second DC voltage source at INP+ and INP- test points. Set the DC source to 20mV.
5. Connect the voltmeter between the OUT and AGND test points.
6. The shunt of each jumper should be placed in the following position:

   J3: 1-2

   J4: Not installed

   J5: Not installed

   J6: Not installed

   J7: 1-2

   J8: Not installed

   J9: 1-2

   J10: Not installed

   J11: Installed

   J12: 2-3

   J13: 1-2

7. Turn on the power supplies and DC voltage sources.
8. Start the MAX40109 GUI as shown in *Figure 1*.
9. Within the **Register Settings** tab sheet, start by selecting **Bypass (Raw Mode)** from the **Pressure Cal** dropdown list within the **Configuration Register** group box. The default **PGA Gain** is set to 10. Select 8 from the **Analog Output Stage** dropdown list on the right. Click the **Set All** button when the desired settings are finalized.
10. Monitor the voltage at the OUT test point.

Ordering Information **appears at end of data sheet.**

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MAX40109 EV System Photo

Procedure for Current Output

The MAX40109 EV kit is fully assembled and tested. Follow the steps below to verify board operation.

1. Remove the bypass capacitors C5 and C6. The VDDHV supply ground changes to the EXT test point.
2. Set the 3V to 36V supply to 5V. Connect the positive terminal of the 3V to 36V supply to the VDDHV test point and the negative terminal to the EXT test point of the EV kit, respectively.
3. Measure the voltage at the VDD5V test point.
4. Set the 2.75V to 6V supply to the voltage measured at the VDD5V test point. Connect the positive terminal of the second supply to the VDDA5 test point and the negative terminal to the DGND test point of the EV kit, respectively.
5. Connect the first DC voltage source at the INN and AGND test points. Set the DC source to 1V.
6. Connect the second DC voltage source at INP+ and INP- test points. Set the DC source to 20mV.
7. The shunt of each jumper should be placed in the following position:

   J3: 1-2
   J4: 1-2
   J5: Not installed
   J6: 2-3

J7: 1-2
J8: Installed
J9: 1-2
J10: Installed
J11: Installed
J12: 2-3
J13: 1-2

8. Turn on the power supplies and DC voltage sources.
9. Start the MAX40109 GUI as shown in *Figure 1*.
10. Within the **Register Settings** tab sheet, start by selecting **Bypass (Raw Mode)** from the **Pressure Cal** dropdown list within the **Configuration Register** group box. The default **PGA Gain** is set to 10. Select 7 from the **Analog Output Stage** dropdown list on the right. Click **Set All** button when the desired settings are finalized.
11. Monitor the voltage between the EXT and AGND test point. The measured voltage is divided by 50Ω (R11) and the value here is the current at the output. The expected current is 4mA.
12. Repeat from Step 6 but adjust the DC calibrator from 20mV to 100mV. The expected current is 20mA.

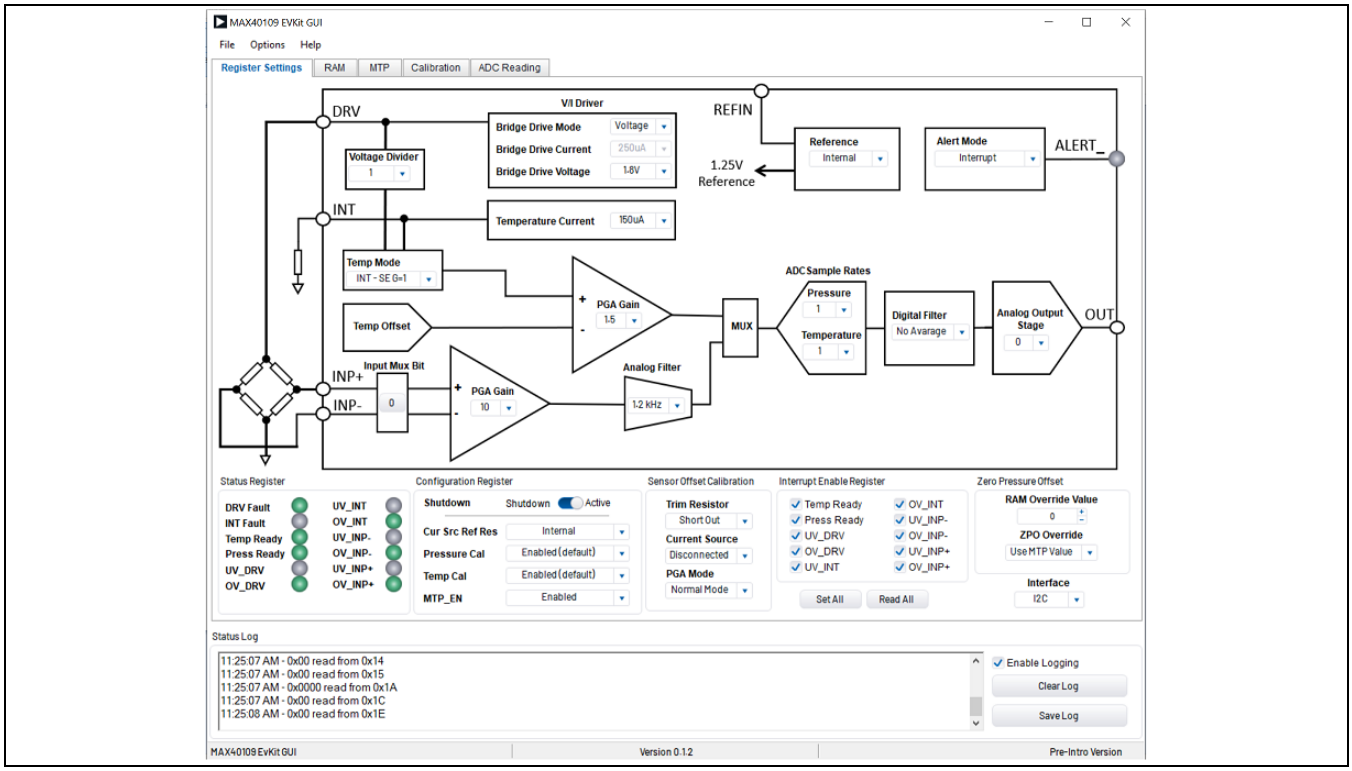


Figure 1. MAX40109 EV System GUI Main Window (Register Setting Tab)

Table 1. MAX40109 EV System Jumper Descriptions

JUMPER	SHUNT POSITION	DESCRIPTION
J3	1-2*	I²C SDA connection to the on-board microcontroller.
	2-3	Reserved.
J4	1-2	FB+ connection.
	2-3	Reserved.
	Not installed*	Not used.

J5	Installed	Connects the 5V supply from the USB supply. The AGND ground must be externally connected to the microcontroller ground.
	Not installed*	User-supplied VDDHV. User must apply 3V to 36V at VDDHV. Disconnects the 5V from the USB supply.
J6	1-2	Reserved.
	2-3	FB- connection.
	Not installed*	Not used.
J7	1-2*	I²C SCL connection to the on-board microcontroller.
	2-3	Reserved.
J8	Installed	Connects collector of the transistor to VDDHV.
	Not installed*	Disconnects collector of the transistor to VDDHV.
J9	1-2*	Connects the thermistor to the INT pin.
	2-3	Connects AGND to the INT pin.
J10	Installed	Connects the OUT pin to the base of transistor Q1.
	Not installed*	Disconnects the OUT pin to the base of transistor Q1.
J11	Installed*	Connects $\overline{\text{ALERT}}$ to the on-board microcontroller.
	Not installed	Disconnects $\overline{\text{ALERT}}$ to the on-board microcontroller.
J12	1-2	1-Wire DQ connection to the on-board microcontroller.
	2-3*	Connects to VDD5V for I²C and PLC communications.
J13	1-2*	User-supplied 5V supply to isolators.
	2-3	Reserved.

**Default position.*

Detailed Description of Hardware

The MAX40109 calibration board is used to calibrate the MAX40109, precision sensor conditioning AFE for pressure sensors.

I²C Interface

To evaluate the EV kit with a user-supplied I²C bus, the jumpers J3 and J7 must not have shunts installed. Apply the user-supplied I²C to the SDA/DIN and SCL/SCLK test points, respectively. Make sure the return ground is DGND.

1-Wire Interface

To evaluate the EV kit with a user-supplied 1-Wire bus, jumper J12 must not have a shunt installed. Applied the user-supplied 1-Wire to the DQ test point. Make sure the return ground is DGND.

$\overline{\text{ALERT}}$

To evaluate the EV kit with a user-supplied $\overline{\text{ALERT}}$, jumper J11 must not have a shunt installed. Apply the user-supplied $\overline{\text{ALERT}}$ to the $\overline{\text{ALERT}}$ test point.

Detailed Description of Software

The main window of the MAX40109 EV kit software contains controls to evaluate the MAX40109 IC. There are five tabs to demonstrate the features of the part. The **Register Settings** tab allows for a user-friendly access to the RAM register. The **RAM** and **MTP** tabs display a bit view of the register map. The **Calibration** tab allows the user to prototype coefficients

before burning into MTP. The **ADC Reading** tab allows for sample collection of pressure and temperature in a time domain.

Register Settings Tab

The **Register Settings** tab (*Figure 1*) displays the control of the frequently used RAM registers. In addition, the user can select the digital interface from I2C, SPI,1-Wire, and VDDHV. Once the interface is selected, a pop-up window appears to ensure the user places the appropriate jumper settings on the EV kit. The SPI and VDDHV selections should not be used for now and are intended for future use. Once the desired settings are configured, the user needs to click the **Set All** button.

RAM Tab

The **RAM** tab displays all RAM registers in a bit view (*Figure 2*). This tab is helpful in verifying the data of each RAM register. Refer to the MAX40109 IC data sheet for a detailed description of the RAM registers.

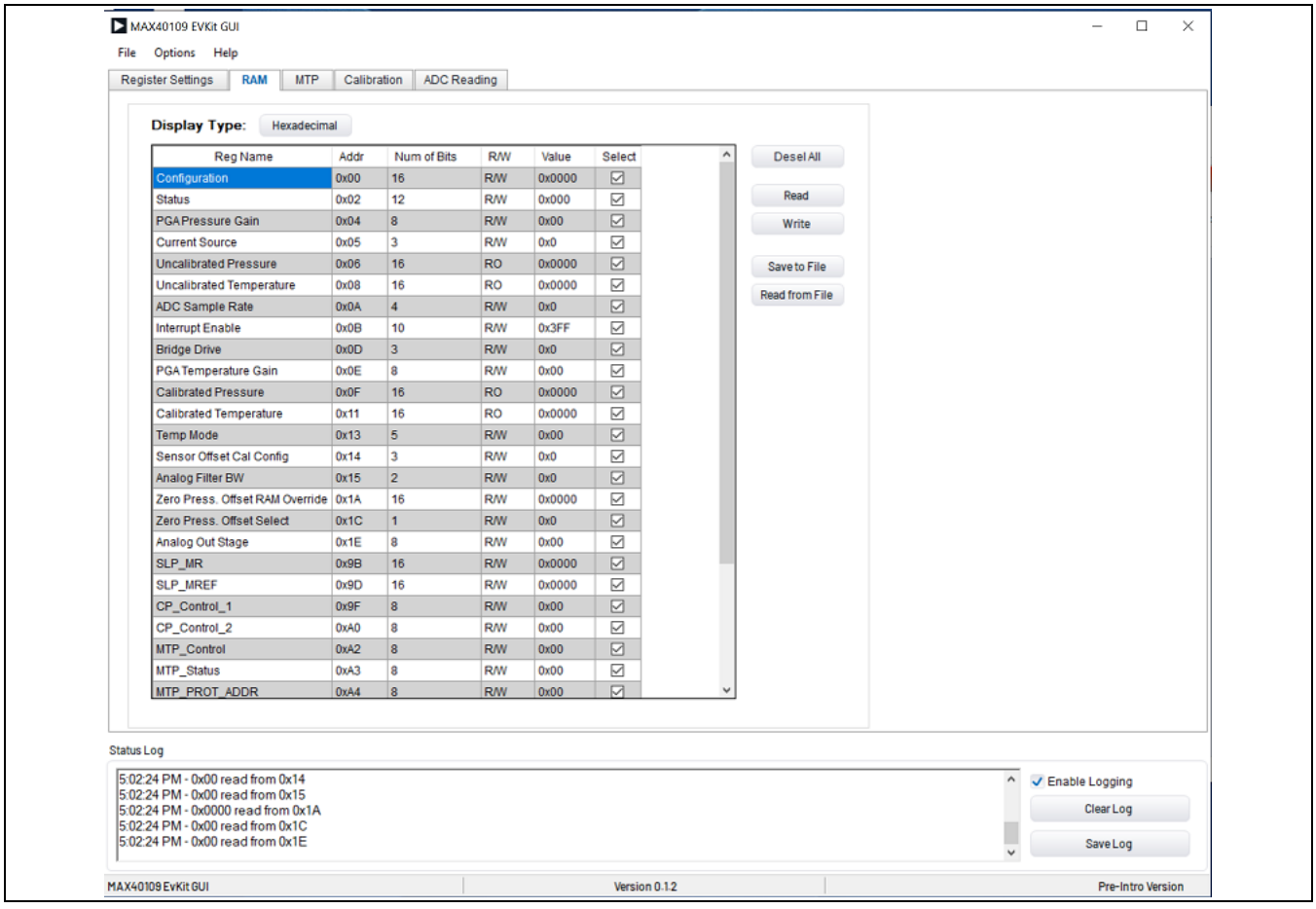


Figure 2. MAX40109 EV System GUI Main Window (RAM Tab)

MTP Tab

The **MTP** tab displays the MTP registers in a bit view (*Figure 3*). This tab is helpful in verifying the data of each MTP register. Always click the **Initialize** button before writing or burning into MTP. The user should be careful with the **Burn** button since there is a limited number of burns to the MTP register. Refer to the MAX40109 IC data sheet for a detailed description of the MTP registers.

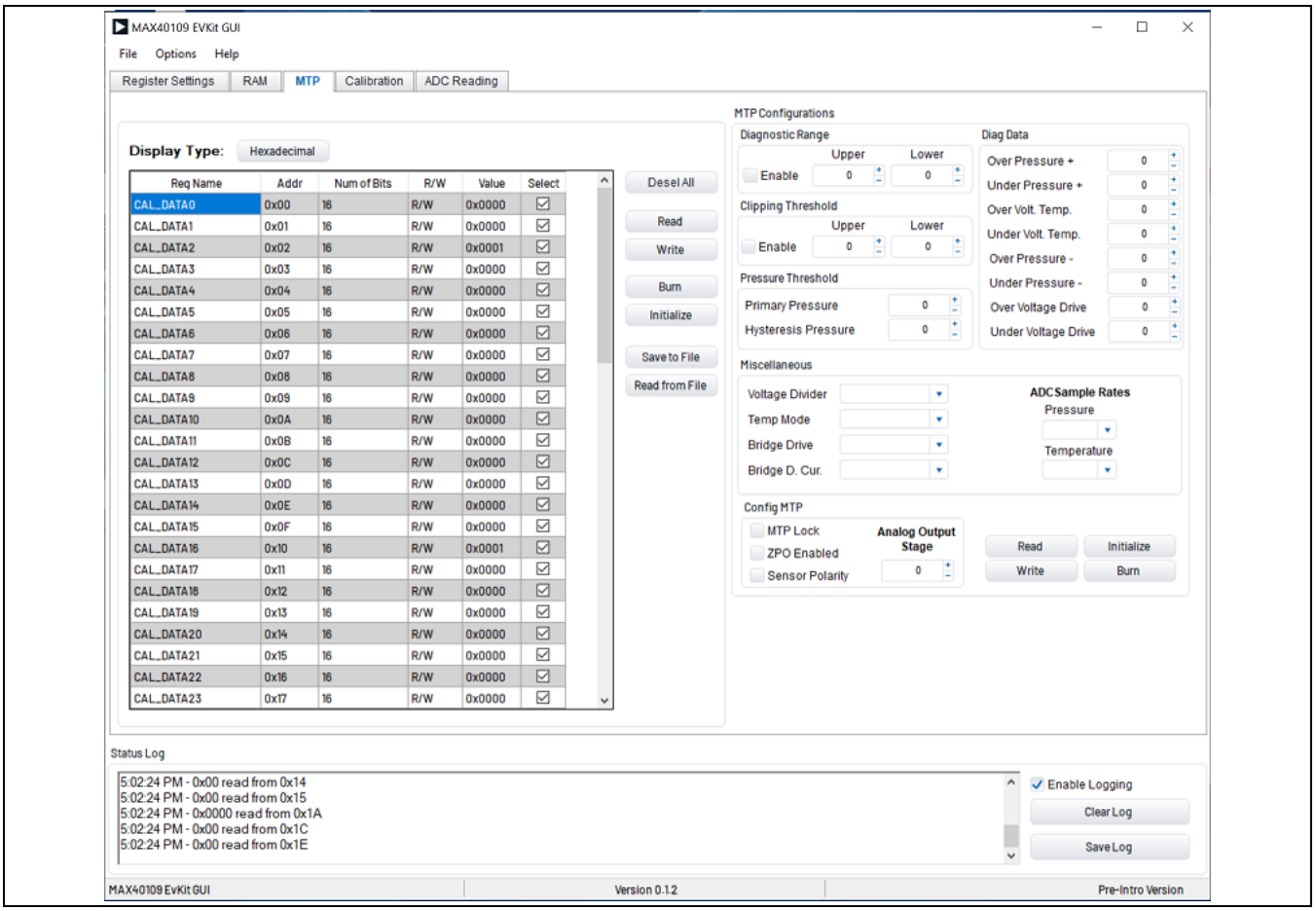


Figure 3. MAX40109 EV System GUI Main Window (MTP Tab)

Calibration Tab

The **Calibration** tab displays the coefficients within the MTP registers. This tab is useful for prototyping coefficients before burning into MTP. Always click the **Initialize** button before writing or burning into MTP. The user should be careful with the **Burn** button since there is a limited number of burns to the MTP register**.**

Below are the steps to calibrate for temperature.

- Within the **Register Settings** tab sheet, start by selecting **Bypass (Raw Mode)** from the **Temp Cal** dropdown list within the **Configuration Register** group box. Next, select the desired **PGA Gain**, **V/I Driver**, **ADC Sample Rates** for **Temperature**, and **Sensor Offset Calibration** options. Lastly, select the desired temperature measurement option from INT or DRV in the **Temp Mode** dropdown list. Click **Set All** button when desired settings are finalized.
- Within the **RAM** tab sheet, read the **Uncalibrated Temperature (0x08)** register. Record codes at desired temperature range. Used the codes to create coefficient for K0–K3.
- Within the **Calibration** tab sheet, enter the user's coefficients within the **T0** and **Pout** group box. Enter 0 for any coefficients that are not used. Once set, click the **Initialize** button followed by the **Write** button. The user can write to the coefficient register as many times as possible to make changes. Only click the **Burn** button if the coefficients are finalized.
- Return to the **Register Setting** tab sheet. Select **Enabled (default)** from the **Temp Cal** dropdown list within the **Configuration Register** group box. Click the **Set All** button.
- Within the **RAM** tab sheet, read the **Calibrated Temperature (0x11)** register. Record the codes at the desired temperature and compare with the initial uncalibrated temperature.

Below are the steps to calibrate for pressure.

- Within the **Register Settings** tab sheet, start by selecting **Bypass (Raw Mode)** from the **Pressure Cal** dropdown list within the **Configuration Register** group box. Next, select the desired **PGA Gain**, **ADC Sample Rates** for **Pressure**, and **Bridge Drive** options. Lastly, make sure the **Sensor Offset Calibration** options are left at **Trim Resistor-Connected**, **Current Source-Disconnected**, and **PGA Mode-Normal**. Click the **Set All** button when the desired settings are finalized.
- Within the **MPT** tab, enable the zero-pressure offset by entering 0x404D to the **CONFIG MTP** (0x44) register. Once set, click the **Initialize** button followed by the **Write** button.
- Within the **MTP** tab sheet, enter the value field of the ZERO_PRESSURE_OFFSET (0x3D) register. Refer to the *Zero Pressure Offset* section of the MAX40109 IC data sheet for details on how to obtain the offset. Once set, click the **Initialize** button followed by the **Write** button.
- Within the **RAM** tab sheet, read the **Uncalibrated Pressure (0x06)** register. Record the data.
- Within the **Calibration** tab sheet, enter the user's coefficients within the **T0** and **Pout** group box. Enter 0 for any coefficient that is not used. Once set, click the **Initialize** button followed by the **Write** button. The user can write to the coefficient register as many times as possible to make changes. Only click the **Burn** button if the coefficients are finalized.
- Return to the **Register Setting** tab sheet. Select **Enabled (default)** from the **Pressure Cal** dropdown list within the **Configuration Register** group box. Click the **Set All** button.
- Within the **RAM** tab sheet, read the **Calibrated Pressure (0x0F)** register. Record codes at desired pressure and compare with the initial uncalibrated pressure.

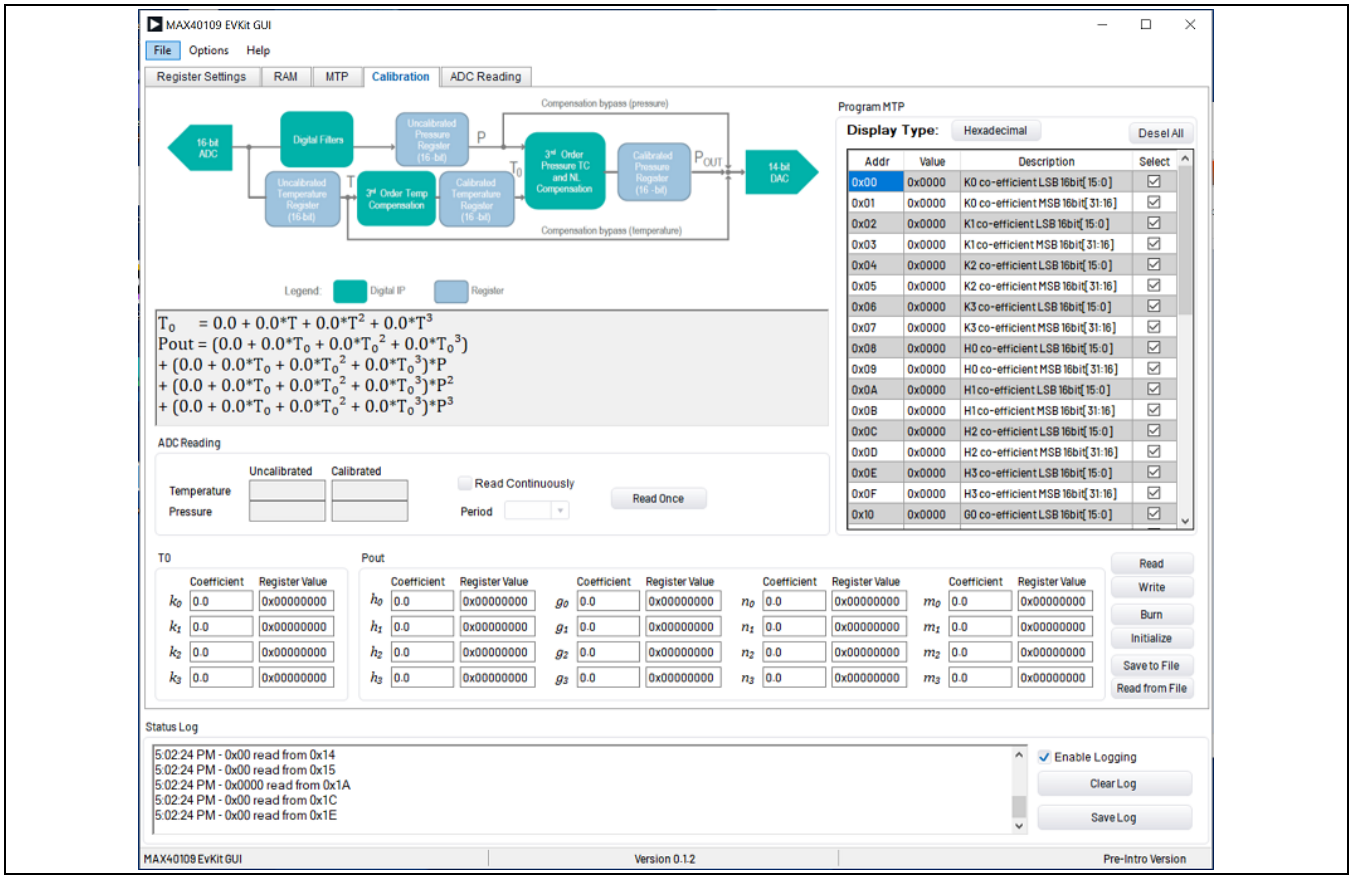


Figure 4. MAX40109 EV System GUI Main Window (Calibration Tab)

ADC Reading Tab

The **ADC Reading** tab displays the readings from the calibrated/uncalibrated pressure and temperature of the RAM registers.

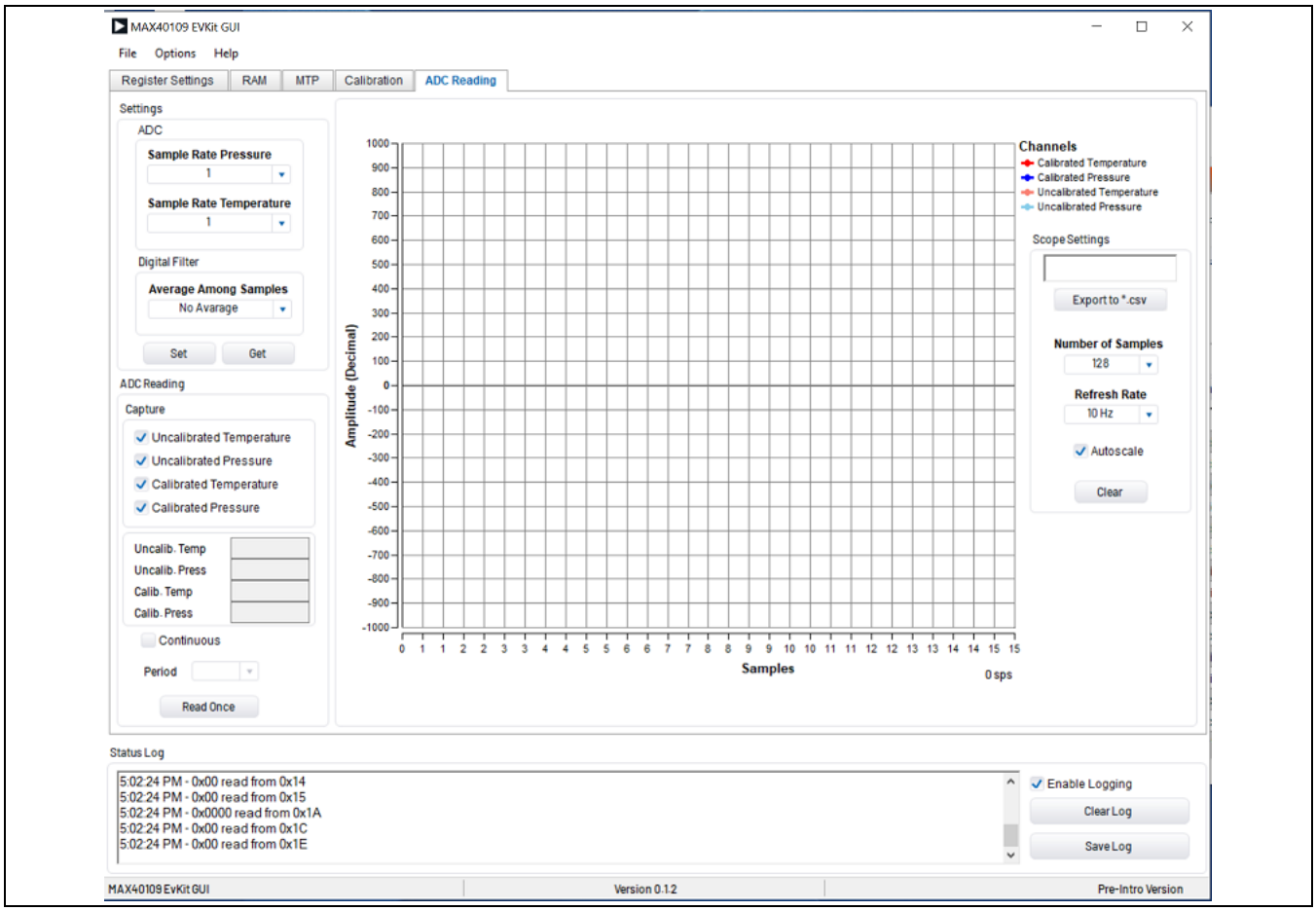


Figure 5. MAX40109 EV System GUI Main Window (ADC Reading Tab)

Ordering Information

PART	TYPE
MAX40109ITEVSYS1#	EV System (EV Kit and Microcontroller Board)

 # Denotes RoHS-compliant.

Component List

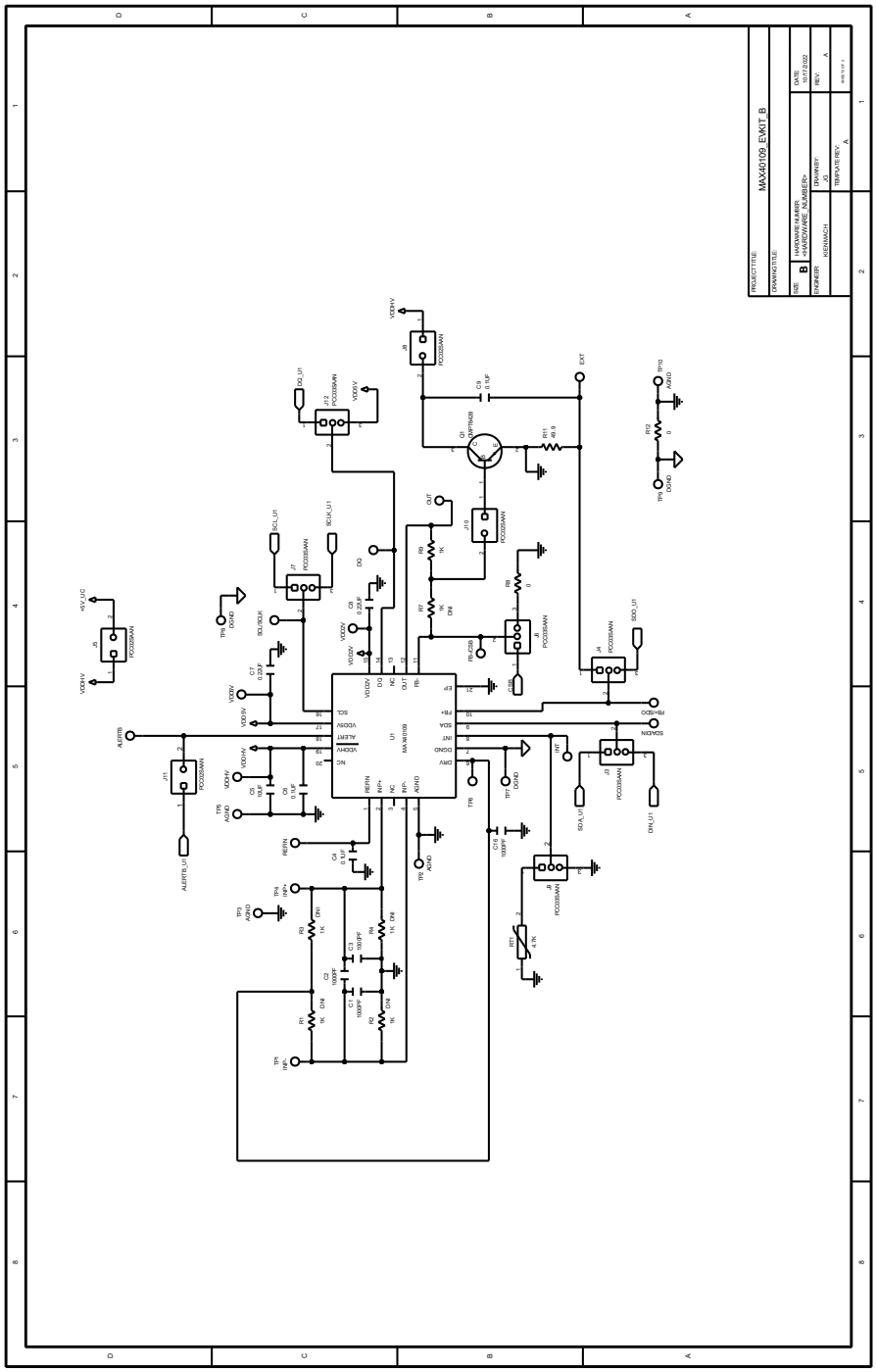
ITEM	REF_DES	DNI/DNP	QTY	MANUFACTURER PART NUMBER	MANUFACTURER	VALUE	DESCRIPTION
1	ALERTB, DQ, EXT, FB+/SDO, FB-/CSB, INT, OUT, SCL/SCLK, SDA/DIN, TP1, TP4, TP6	—	12	5012	KEYSTONE	N/A	TEST POINT; PIN DIA=0.125IN; TOTAL LENGTH=0.445IN; BOARD HOLE=0.063IN; WHITE; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH;
2	C2, C16	—	2	06035C102KAT2AL;C1608X7R1H102K080AE	AVX;TDK	1000PF	CAP; SMT (0603); 1000PF; 10%; 50V; X7R; CERAMIC
3	C4, C6, C9-C15	—	9	C0603C104K5RAC;C1608X7R1H104K;ECJ-1VB1H104K;GRM188R71H104KA93;CGJ3E2X7R1H104K080AA;C1608X7R1H104K080AA;CL10B104KB8NNN;CL10B104KB8NFN;06035C104KAT2A;06035C104KAT4A	KEMET;TDK;PANASONIC;MURATA;TDK;TDK;SAMSUNG;SAMSUNG;AVX;AVX	0.1UF	CAP; SMT (0603); 0.1UF; 10%; 50V; X7R; CERAMIC;
4	C5	—	1	CC0805KKX5R9BB106;GRM21BR61H106KE43	YAGEO;MURATA	10UF	CAP; SMT (0805); 10UF; 10%; 50V; X5R; CERAMIC
5	C7, C8	—	2	C1608X7R1H224K080; GRM188R71H224KAC4	TDK;MURATA	0.22UF	CAP; SMT (0603); 0.22UF; 10%; 50V; X7R; CERAMIC
6	J1	—	1	PPPC121LFBN-RC	SULLINS ELECTRONICS CORP	PPPC121LFBN-RC	CONNECTOR; FEMALE; THROUGH HOLE; HEADER FEMALE; STRAIGHT; 12PINS
7	J2	—	1	PPPC161LFBN-RC	SULLINS ELECTRONICS CORP.	PPPC161LFBN-RC	CONNECTOR; FEMALE; THROUGH HOLE; LFB SERIES; 2.54MM CONTACT CENTER; STRAIGHT; 16PINS

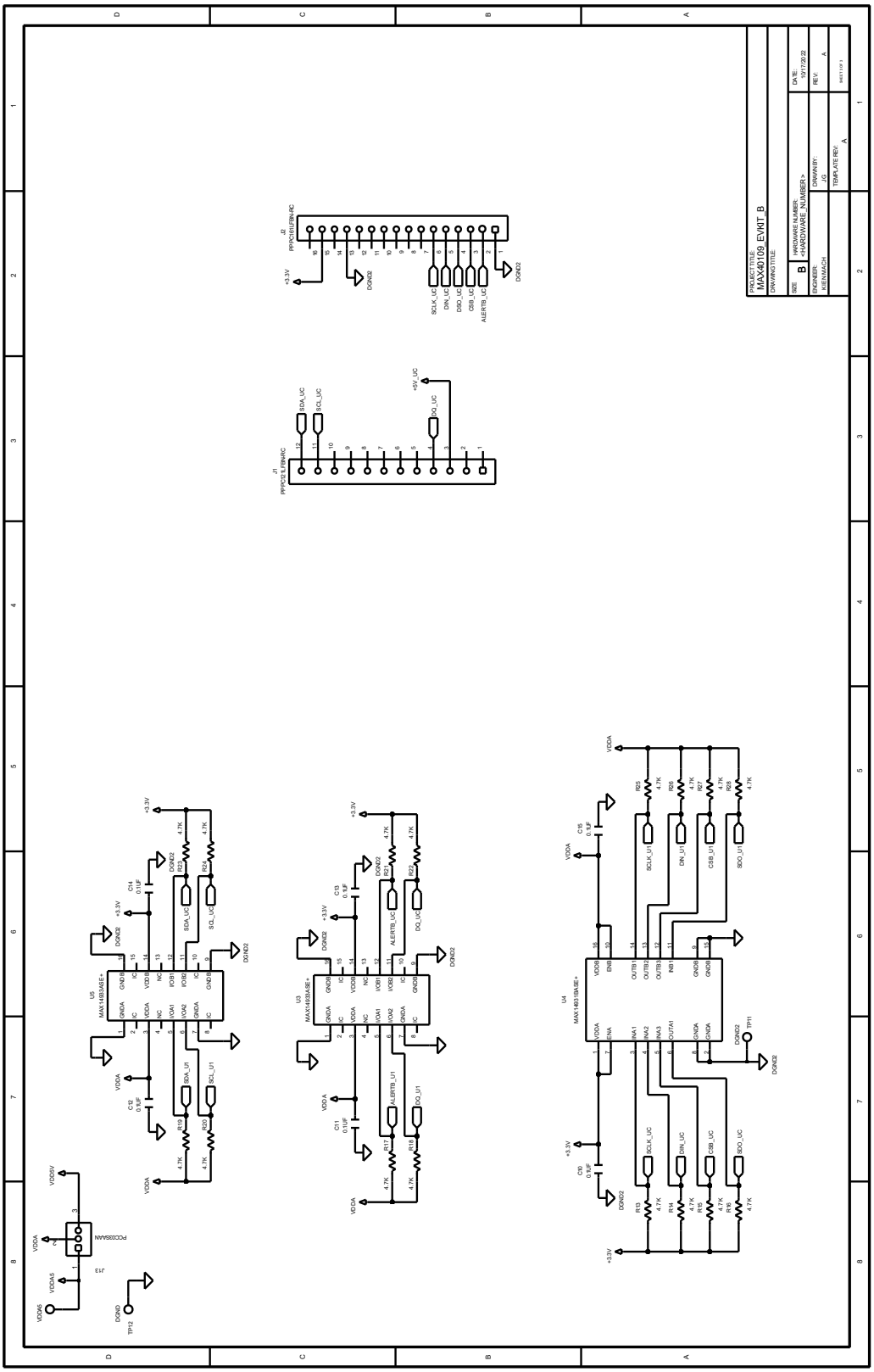
ITEM	REF_DES	DNI/DNP	QTY	MANUFACTURER PART NUMBER	MANUFACTURER	VALUE	DESCRIPTION
8	J3, J4, J6, J7, J9, J12, J13	—	7	PCC03SAAN	SULLINS	PCC03SAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT THROUGH; 3PINS; -65 DEGC TO +125 DEGC
9	J5, J8, J10, J11	—	4	PCC02SAAN	SULLINS	PCC02SAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT THROUGH; 2PINS; -65 DEGC TO +125 DEGC
10	MH1-MH4	—	4	9032	KEYSTONE	9032	MACHINE FABRICATED; ROUND-THRU HOLE SPACER; NO THREAD; M3.5; 5/8IN; NYLON
11	Q1	—	1	CMPT6428	CENTRAL SEMICONDUCTOR	CMPT6428	TRANSISTOR, NPN, SOT-23, PD=0.35W, IC=0.2A, VCEO=60V
12	R8, R12	—	2	RC1608J000CS;CR0603-J/-000ELF;RC0603JR-070RL	SAMSUNG ELECTRONICS;BOURNS;YAGEO PH	0	RES; SMT (0603); 0; 5%; JUMPER; 0.1000W
13	R9	—	1	ERJ-3GEYJ102	PANASONIC	1K	RES; SMT (0603); 1K; 5%; +/-200PPM/DEGC; 0.1000W
14	R11	—	1	CRCW060349R9FK	VISHAY DALE	49.9	RES; SMT (0603); 49.9; 1%; +/-100PPM/DEGC; 0.1000W
15	R13-R28	—	16	ERJ-3GEYJ472	PANASONIC	4.7K	RES; SMT (0603); 4.7K; 5%; +/-200PPM/DEGC; 0.1000W

ITEM	REF_DES	DNI/DNP	QTY	MANUFACTURER PART NUMBER	MANUFACTURER	VALUE	DESCRIPTION
16	REFIN, VDD2V, VDD5V, VDDA5, VDDHV	—	5	5010	KEYSTONE	N/A	TEST POINT; PIN DIA=0.125IN; TOTAL LENGTH=0.445IN; BOARD HOLE=0.063IN; RED; PHOSPHOR BRONZE WIRE SIL;
17	RT1	—	1	TFPT0805L4701FV	VISHAY	4.7K	THERMISTOR; SMT (0805); 4.7K; TOL=+/-1%
18	TP2, TP3, TP5, TP7-TP12	—	9	5011	KEYSTONE	N/A	TEST POINT; PIN DIA=0.125IN; TOTAL LENGTH=0.445IN; BOARD HOLE=0.063IN; BLACK; PHOSPHOR BRONZE WIRE SILVER PLATE FINISH;
19	U1	—	1	MAX40109IATP+	ANALOG DEVICES	MAX40109IATP+	EVKIT PART - IC; SNSR; PRECISION SENSOR CONDITIONING AFE FOR PRESSURE SENSORS; PACKAGE CODE:T2044-5C; PACKAGE OUTLINE DRAWING:21-0139; PACKAGE LAND PATTERN:90-0429; TQFN20-EP
20	U3, U5	—	2	MAX14933ASE+	ANALOG DEVICES	MAX14933ASE+	IC; ISO; TWO-CHANNEL; 2.75KV I2C ISOLATOR; NSOIC16
21	U4	—	1	MAX14931BASE+	ANALOG DEVICES	MAX14931BASE+	IC; DISO; 3/1 CHANNEL; 25MBPS;

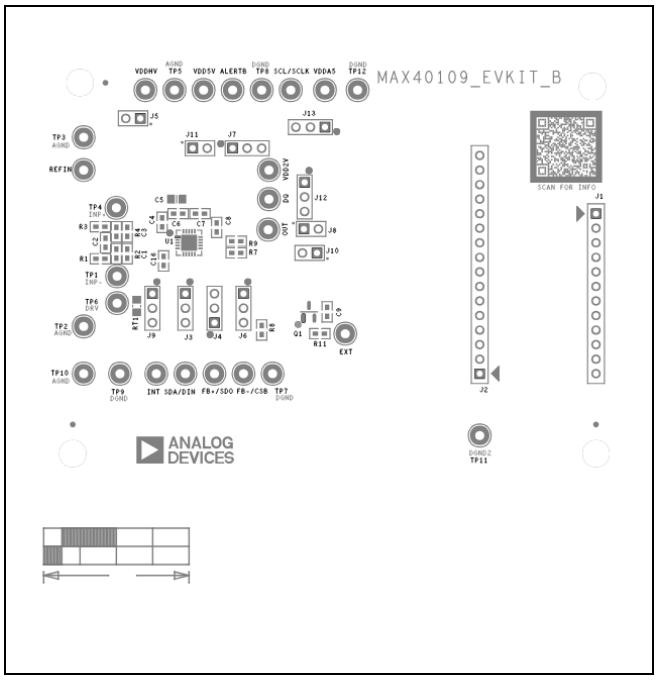
ITEM	REF_DES	DNI/DNP	QTY	MANUFACTURER PART NUMBER	MANUFACTURER	VALUE	DESCRIPTION
							2.75KVRMS DIGITAL ISOLATOR; NSOIC16 150MIL
22	PCB	—	1	MAX40109	ANALOG DEVICES	PCB	PCB:MAX
23	C1, C3	DNP	0	06035C102KAT2AL;C1608X7R1H102K080AE	AVX;TDK	1000PF	CAP; SMT (0603); 1000PF; 10%; 50V; X7R; CERAMIC
24	R1–R4, R7	DNP	0	ERJ-3GEYJ102	PANASONIC	1K	RES; SMT (0603); 1K; 5%; +/- 200PPM/DEGC; 0.1000W

MAX40109 EV System Schematic

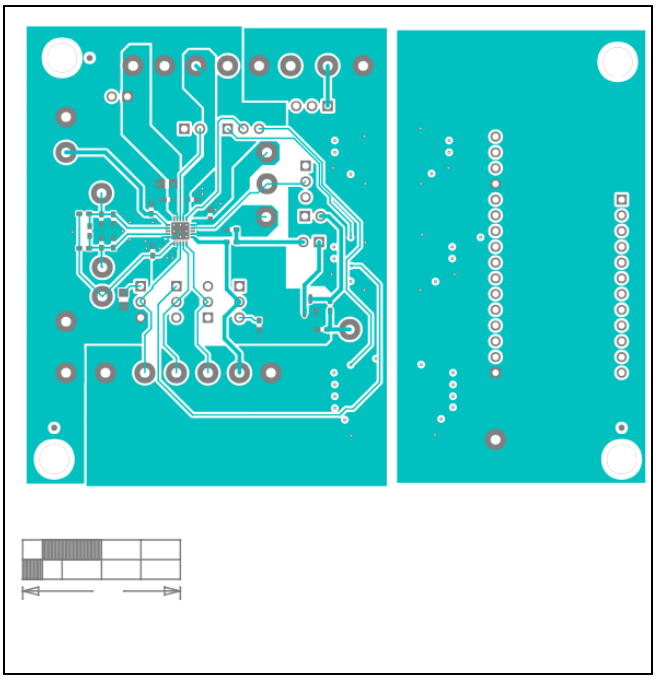




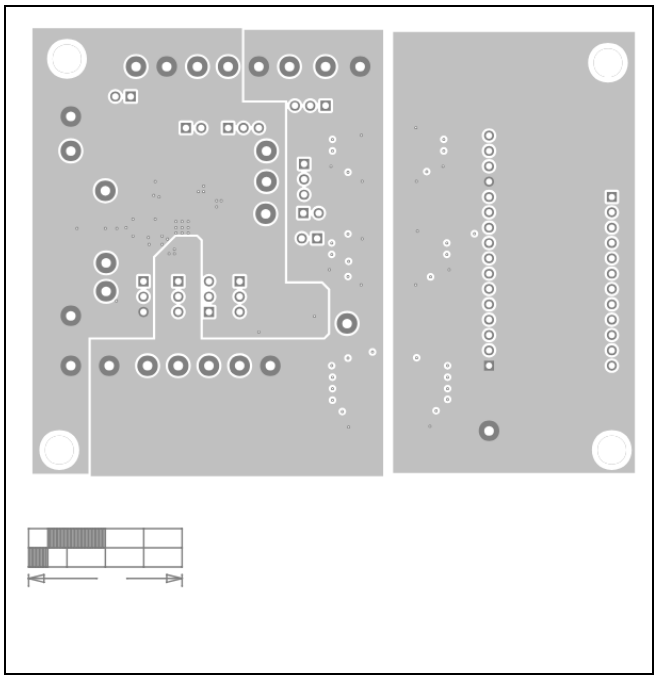
MAX40109 EV System Layout



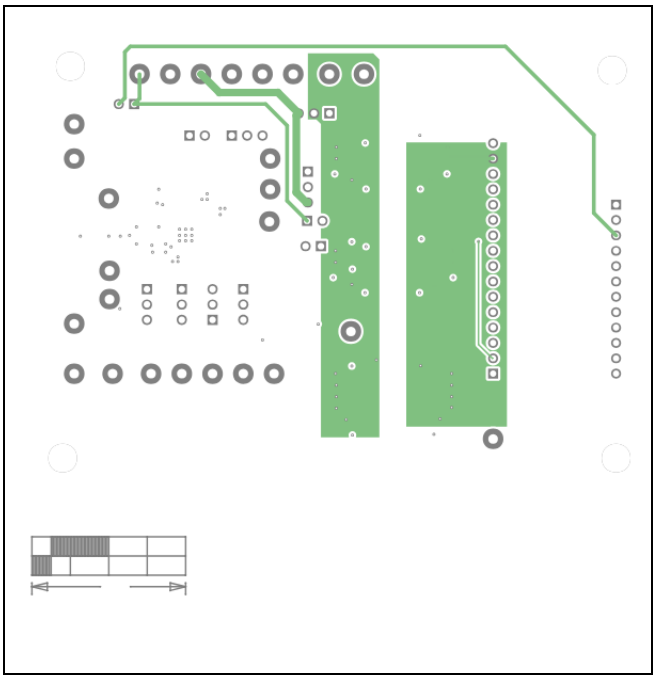
MAX40109 EV System Component Placement Guide—Top Silkscreen



MAX40109 EV System PCB Layout—Layer 2

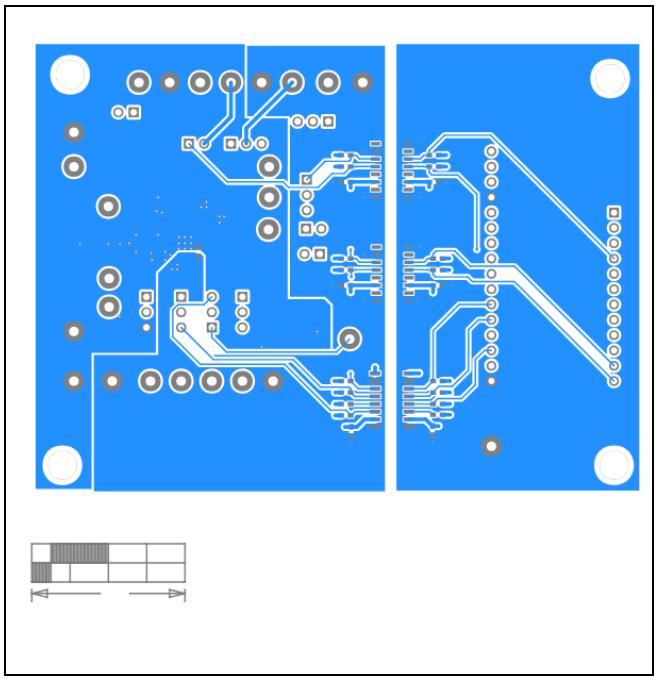


MAX40109 EV System PCB Layout—Top

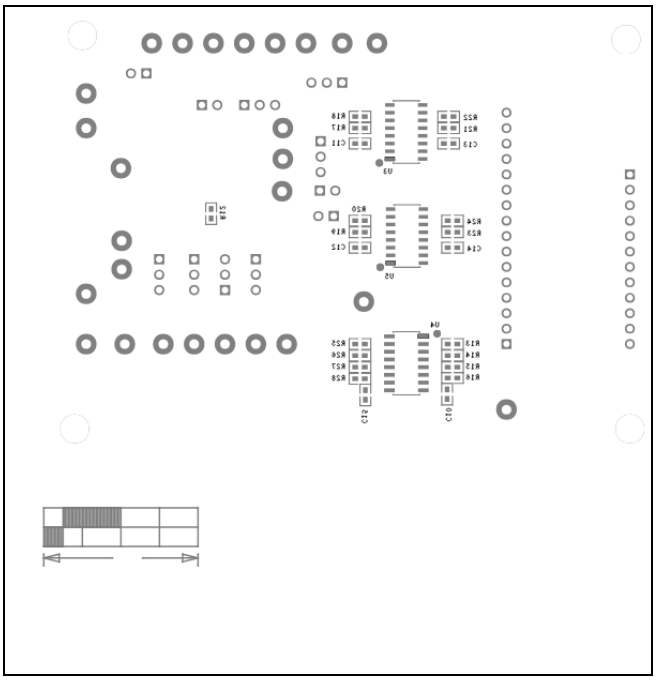


MAX40109 EV System PCB Layout—Layer 3

MAX40109 EV System PCB Layout (continued)



MAX40109 EV System PCB Layout—Bottom



MAX40109 EV System Component Placement Guide—Bottom Silkscreen

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGE(S) CHANGED
0	10/23	Initial release	—
1	10/23	Removed individual boards from Ordering Information section.	8
2	6/25	Updated the Procedure section and Table 1.	1-4

Notes