General Description

The MAX14001 peripheral module provides the hardware to evaluate the MAX14001 isolated ADC to measure two channels of data, line voltage (up to 230V AC or ±325V DC) and load current (up to 5A). All power and communication is with a simple USB cable—no separate field side power is required. The integrated DC-DC converter provides power isolation for the system and powers all field-side circuitry. This integrated design reduces the BOM and board dimension for building an isolated ADC system. Refer to the MAX14001 IC data sheet for detailed information regarding operation of the IC.

The MAX14001PMB has a 12-pin Pmod™-compatible connector for SPI communication. The peripheral module can be used in various ways. Maxim sells a low-cost USB2PMB2 adapter board that uses the Munich GUI software for communication through a USB cable. This is not included with this board, but is available from Maxim or one of our distributors. Alternatively, any microcontroller or FPGA with a 12-pin Pmod-compatible connector for SPI communication can be used.

Features

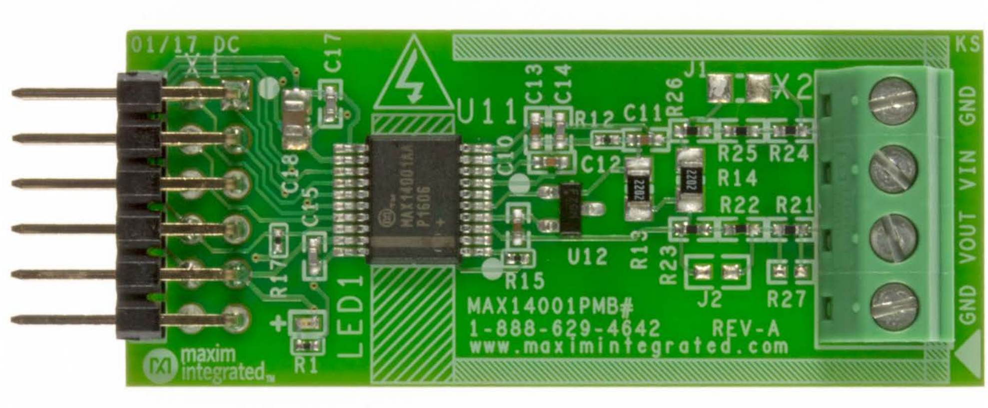
- Easy Evaluation of the MAX14001/MAX14002
- 3.75kV$_{RMS}$ Isolation for Both Data (SPI) and Power (DC-DC Supply)
- Peripheral Module Is Powered from a Single 3.3V Supply (USB2PMB2 Is USB-Powered), No Field Side Supply Required
- Measure AC or DC, Voltages Up to 230V AC or ±325V DC and Current Up to 5A
- Programmable Comparator Output
- Works With USB2PMB2 Adapter and Munich GUI Software
- Fully Assembled and Tested
- Proven PCB Layout
- RoHS Compliant

Contents

- MAX14001PMB, including two MAX14001s

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

MAX14001PMB Photo



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19-8795; Rev 0; 3/17

Quick Start

Required Equipment

- MAX14001PMB peripheral module
- USB2PMB2 adapter board
- Micro-USB cable
- Windows XP®, Windows® 7, Windows 8.1, or Windows 10 PC with a spare USB port

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

Procedure

If the USB2PMB1 adapter is used, download software by following the steps below to get started:

1) Visit www.maximintegrated.com/evkitsoftware to download the latest version of the Munich_GUI software, version 2.12 or later, Munich_GUISetupV2.12.ZIP.
2) Save the software to a temporary folder. Unzip the .ZIP file and double-click the .EXE file to run the installer. A message box asking **Do you want to allow the following program to make changes to this computer?** can appear. If so, click **Yes**.
3) The installer includes the drivers for the hardware and software. Follow the instructions on the installer and once complete, click **Finish**. The default location of the software is in the program files directory.
4) Connect the MAX14001PMB Pmod connector X1 to the connector on USB2PMB2.
5) Connect the USB2PMB2 to the PC with the Mini-USB cable. Windows should automatically recognize the device and display a message near the **System Icon** menu indicating that the hardware is ready to use.
6) Once the hardware is ready to use, launch the software. The status bar in the GUI should display **Disconnected** in the bottom right-hand corner. Go to the **Device** tab to select the MAX14001PMB.

Detailed Description of Software

Connect to Hardware

The **Device** menu has options to search and connect to the hardware. Use the **Scan Adapters** option to search for the USB2PMB2 modules connected to the PC. If modules are found, the serial numbers of the modules are listed in the **USB2PMB** adapter drop-down list. Select the serial number in the **USB2PMB2's** list to connect the software to communicate with that module. The software can only communicate to one module at a time.

Sample

To start continuous monitoring, click the **Sample Continuously** button (see Figure 1). For a single status, click the **Sample Once** button. Moving the cursor over the graph area allows the user to select channel type (voltage or current), change scale, zoom, print, or save waveforms.

Detailed Description of Hardware

The MAX14001PMB peripheral module has two MAX14001 devices (U11 and U51). One channel is configured to measure the line voltage with maximum voltage range selected by a resistor chain. The other channel is configured to measure the voltage across a shunt resistor to provide load current. Both AC and DC signals can be measured. No external field side (high voltage) power is required as the MAX14001 has an integrated, isolated DC-DC converter. The complete peripheral module is powered from a single 3.3V supply, VDD, which is called the logic side (or low voltage side). If the USB2PMB2 module is used this takes power from the 5V supply on the USB connector to the PC. The SPI-compatible connector uses two chip-select signals ($\overline{CS1}$ and $\overline{CS2}$) to control each chip through a single connector/GUI interface.

MAX14001 Isolated ADC

The MAX14001 has a free-running, 10-bit SAR ADC, sampling at ~10ksps, that continosly updates the data register for each new conversion. If the source being monitored is DC or low-frequency AC (such as 50Hz or 60Hz mains) this sample rate easily meets the Nyquist criteria and, although the two ADCs are not synchronized, the reading can be considered to be simultaneous given the relatively high sample rate.

The device digitizes the input voltage on the field side and transmits the data across the isolation barrier to a data receiver on the logic side; which also has a programmable comparator. The host can read the ADC value from the data receiver through the SPI interface. Additionally, the comparator compares the digitized reading to the programmable thresholds and outputs high if data is above the upper threshold, and low if data is below the lower threshold. This hardware feature is extremely use-

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ful for setting real-time trip points, or as demonstrated, it can be used to measure periodic signals. For example, the frequency of the field-side input voltage can be easily calculated using zero-crossing of the comparator output.

AC or DC Line Monitor Application

To demonstrate the features and ease-of-use of the MAX14001, this peripheral module shows how to build an isolated ADC and provides software demonstrating how it can be used to measure mains power, such as a 120V, 60Hz single-phase load or 230V, 50Hz single-phase load, with currents of a few amps.

The MAX14001 peripheral module uses two MAX14001s, one to measure the voltage and another to measure current. The whole board is controlled and powered by the USB2PMB2 adapter that uses the USB power from a PC. The live (L) and neutral (N) lines are input to the board and a fuse on the board protects circuits from large currents. Loads can be connected to the board from the terminal connectors.

Logic Versus Field Side

The MAX14001PMB hardware has two channels, one to measure voltage and one to measure current, as well as three power domains with different isolated ground potentials:

- The logic side or low-voltage side connects to the SPI-compatible Pmod connector, and is powered from a single 3.3V source connected to VDD, referred to logic ground GNDL.
- The current measurement field side, U51 provides field-side power from VDDF1, which is nominally 3V and can power circuitry up to 70µA. This single supply is used to power the ADC field side circuitry in addition to the external signal conditioning from ultra-low bias MAX44265 op amp (U53) and precision voltage reference MAX6006 (U52). All signals are referenced to Field Ground 1 or GNDF1.
- The voltage measurement field side, U11 provides field-side power from VDDF2, which is nominally 3V and can power circuitry up to 70µA. This single supply is used to power the ADC field side circuitry, in addition to the precision voltage reference MAX6006 (U12). All signals are referenced to ‘Field Ground 2’ or GNDF2.

Note: GNDF1 and GNDF2 are floating grounds only and do not have the same potential or provide earthed protection.

Shunt Reference

The MAX14001 has an integrated voltage reference; however, for this application, which measures AC signals, both the positive and negative values need to be read. Therefore, an external 1.25V shunt reference MAX6006 is used for each ADC with a DC offset of $V_{REF}/2$ so the negative part of the AC input is shifted above ground, ensuring the AIN signal input is within the accepted positive voltage range. The control registers within each MAX14001 are set for external voltage reference source and for pin REFIN to be a current source output, which connects to the MAX6006.

Current Measurement

The current ADC measures the voltage across a small 10mΩ sense resistor (R50) in the live wire to obtain the live line current value. The MAX14001 accepts and analog input voltage from 0 to +VREFIN. U52 (MAX6006) is an ultra-low power shunt 1.25V voltage reference that draws on 1µA, which is used instead of the on-chip voltage reference to bias the input AIN at a midpoint to allow AC or positive and negative input signals. U53 (MAX44265) is an ultra-low 4µA supply current op amp with an ultra-low 1pA input bias current. This op amp is configured as an inverting op amp with a gain of 10, with its input centered around $V_{REF}/2$ or 0.62V. The amplified voltage across the sense resistor is ±0.500mV, allowing head room for the maximum input range of the ADC.

Voltage Measurement

A voltage divider is used comprising R21–R26 in conjunction with U12 voltage reference and R12–R14. This limits the input voltage seen at pin AIN of U11 to < 1.25V and centers it around $V_{REF}/2$. The MAX14001 accepts positive voltage inputs at AIN from 0–1.25V with respect to AGND, so the sense resistor and resistor dividers need to be selected based on input RMS voltage and maximum RMS. Resistor values are selected so that it is close to but not exceeding the calculated ratio to utilize the full ADC range. R21–R26 should be larger than 1MΩ to ensure low current and low power consumption.

Pmod-Style Connector

The MAX14001PMB can plug directly into a Pmod-compatible port through X1. The pin defintions are SPI-compatible; see Figure 2 for the X1 pinout. The ADC readings are transmitted to the USB2PMB adapter by the SPI interface.

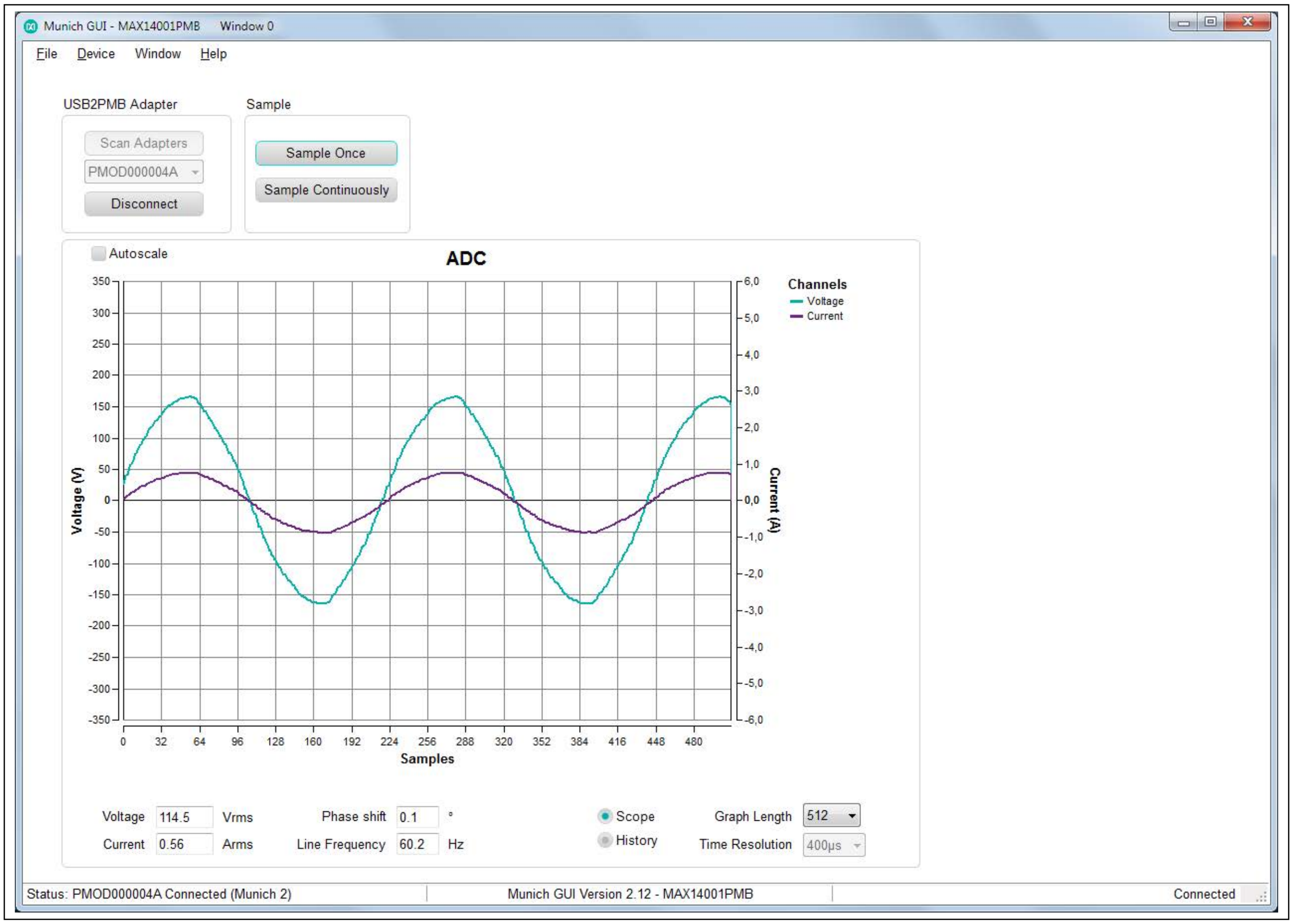

Figure 1. MAX4001PMB Software (Munich GUI Tab)

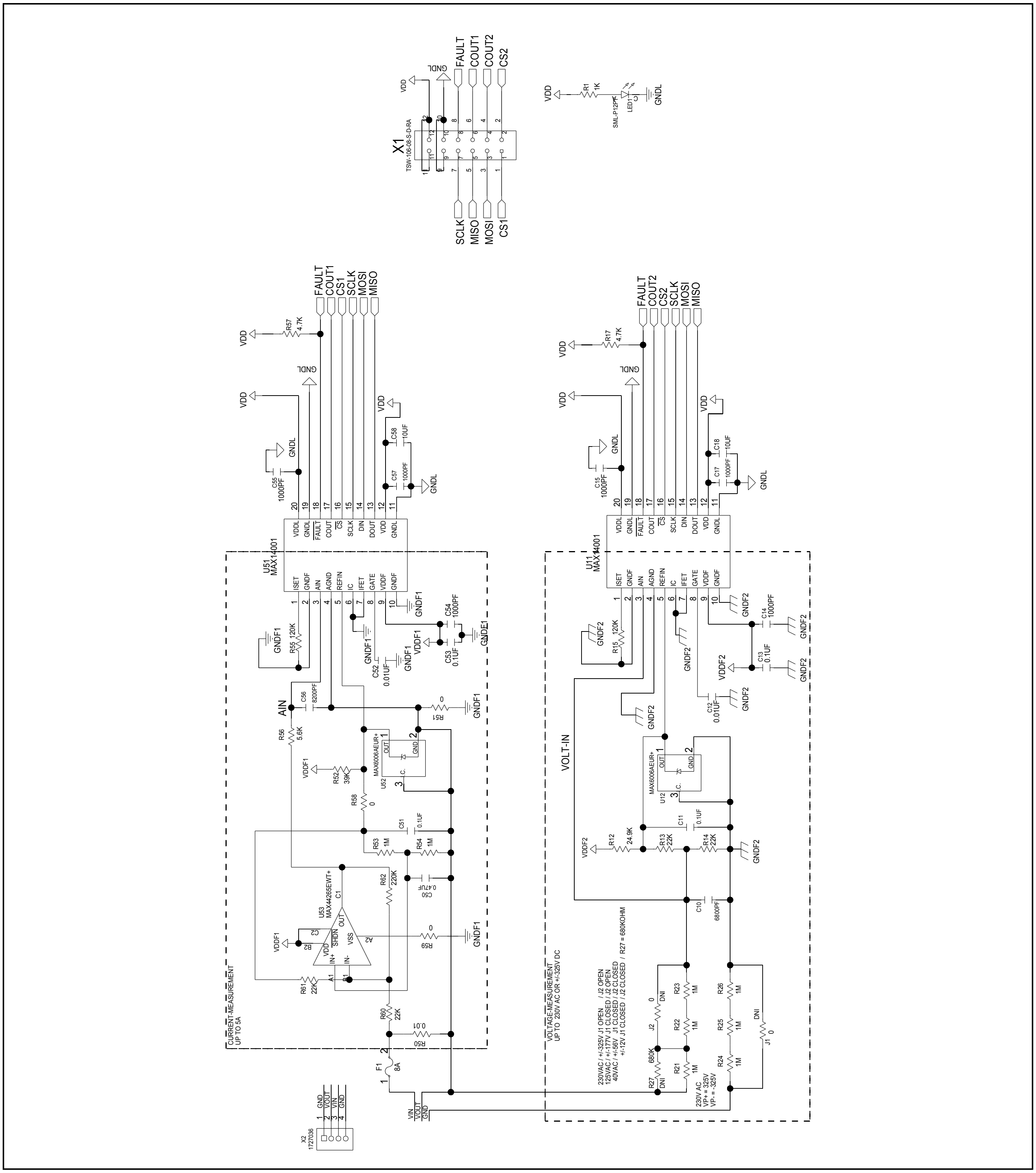

Figure 2. MAX14001PMB Schematic

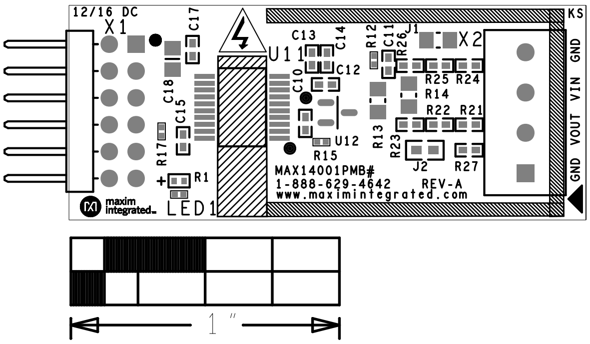

Figure 3. MAX14001PMB PCB Layout—SilkscreenTop

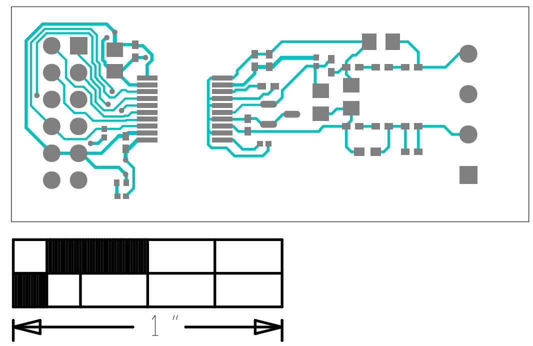

Figure 4. MAX14001PMB PCB Layout—Top

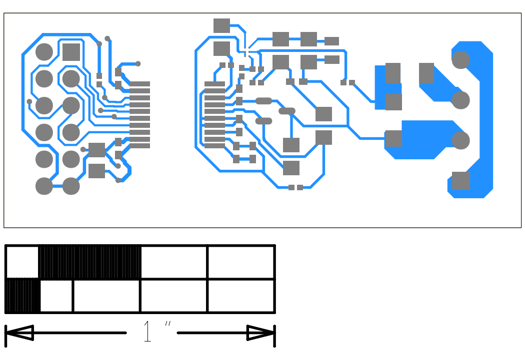

Figure 5. MAX14001PMB PCB Layout—Bottom

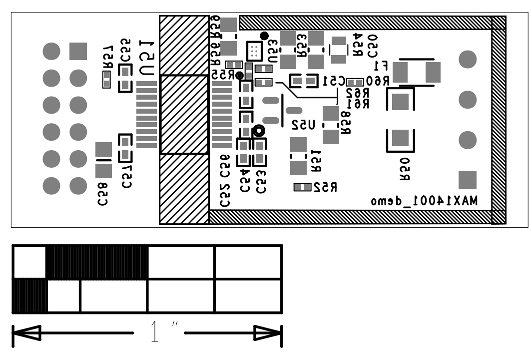

Figure 6. MAX14001PMB PCB Layout—Silkscreen Bottom

MAX14001PMB Bill of Materials

ITEM	REF_DES	DNI/DNP	QTY	MFG PART #	MANUFACTURER	VALUE	DESCRIPTION
1	C10	-	1	TMK105BJ682KVH	TAIYO YUDEN	6800PF	CAPACITOR; SMT (0402); CERAMIC CHIP; 6800PF; 25V; TOL=10%; TG=-55 DEGC TO +85 DEGC; TC=X5R; AUTO
2	C11, C13, C53	-	3	CGA2B3X7R1V104K050BB	TDK	0.1UF	CAPACITOR; SMT (0402); CERAMIC CHIP; 0.1UF; 35V; TOL=10%; TG=-55 DEGC TO +125 DEGC; TC=X7R; AUTO
3	C12, C52	-	2	C1005X7R1C103K050BA	TDK	0.01UF	CAPACITOR; SMT (0402); CERAMIC; 0.01UF; 16V; TOL=10%; TG=-55 DEGC TO +125 DEGC; TC=X7R
4	C14, C15, C17, C54, C55, C57	-	6	GRM1555C1E102JA01D; C1005C0G1E102J050BA	MURATA; TDK	1000PF	CAPACITOR; SMT (0402); CERAMIC CHIP; 1000PF; 25V; TOL=5%; TG=-55 DEGC TO +125 DEGC; TC=C0G
5	C18, C58	-	2	CL21B106KOQNNN	SAMSUNG ELECTRONICS	10UF	CAPACITOR; SMT (0805); CERAMIC CHIP; 10UF; 16V; TOL=10%; TG=-55 DEGC TO +125 DEGC; TC=X7R
6	C50	-	1	C0805C474K3RAC; GRM21BR71E474KA01; C2012X7R1E474K	KEMET; MURATA; TDK	0.47UF	CAPACITOR; SMT (0805); CERAMIC CHIP; 0.47UF; 25V; TOL=10%; TG=-55 DEGC TO +125 DEGC; TC=X7R;
7	C51	-	1	GRM155R71E104KE14	MURATA	0.1UF	CAPACITOR; SMT (0402); CERAMIC CHIP; 0.1UF; 25V; TOL=10%; MODEL=GRM SERIES; TG=-55 DEGC TO +125 DEGC; TC=X7R
8	C56	-	1	C0402X7R500822KNP	VENKEL LTD.	8200PF	CAPACITOR; SMT; 0402; CERAMIC; 8200pF; 50V; 10%; X7R; -55degC to + 125degC; 0 +/-15% degC MAX.
9	F1	-	1	0685F8000	BEL FUSE	8A	FUSE; SMT (1206); FAST ACTING; IC=8A; VC=125V
10	LED1	-	1	SML-P12PT	ROHM	SML-P12PT	DIODE; LED; SML-P1 SERIES; ULTRA COMPACT HIGH BRIGHTNESS LED; GREEN; SMT (0402); VF=2.2V; IF=0.02A
11	R1	-	1	CRCW02011K00FK	VISHAY DALE	1K	RESISTOR; 0201; 1K OHM; 1%; 100PPM; 0.05W; THICK FILM
12	R12	-	1	ERJ-1GNF2492C	PANASONIC	24.9K	RESISTOR; 0201; 24.9K OHM; 1%; 200PPM; 0.05W; THICK FILM
13	R13, R14	-	2	CRCW080522K0FK	VISHAY DALE	22K	RESISTOR; 0805; 22K OHM; 1%; 100PPM; 0.125W; THICK FILM
14	R15, R55	-	2	ERJ-1GNF1203	PANASONIC	120K	RESISTOR; 0201; 120K OHM; 1%; 200PPM; 0.05W; THICK FILM
15	R17, R57	-	2	MCR006YRTF4701	ROHM SEMICONDUCTOR	4.7K	RESISTOR; 0201; 4.7K OHM; 1%; 250PPM; 0.05W; THICK FILM
16	R21-R26	-	6	ERJ-2RKF1004	PANASONIC	1M	RESISTOR; 0402; 1M OHM;1%; 100PPM; 0.10W; THICK FILM
17	R50	-	1	PMR18EZPFU10L0	ROHM SEMICONDUCTOR	0.01	RESISTOR; 1206; 0.01 OHM; 1%; 100PPM; 1W; METAL FILM
18	R51, R58, R59	-	3	CRCW08050000ZS; ERJ-6GEY0R00V; RC2012J000; RMCF0805ZT0R00	VISHAY DALE/PANASONIC/STACKPOLE ELECTRONICS INC	0	RESISTOR; 0805; 0 OHM; JUMPER; 0.125W; THICK FILM
19	R52	-	1	ERJ-1GEF3902C	PANASONIC	39K	RESISTOR; 0201; 39K OHM; 1%; 100PPM; 0.05W; THICK FILM 3-LAYER ELECTRODE
20	R53, R54	-	2	CRCW08051M00FK; RC0805FR-071ML	VISHAY DALE/YAGEO PHICOMP	1M	RESISTOR; 0805; 1M; 1%; 100PPM; 0.125W; THICK FILM
21	R56	-	1	ERJ-1GEF5601C	PANASONIC	5.6K	RESISTOR; 0201; 5.6K OHM; 1%; 100PPM; 0.05W; THICK FILM 3-LAYER ELECTRODE
22	R60, R61	-	2	ERJ-1GEF2202C	PANASONIC	22K	RESISTOR; 0201; 22K OHM; 1%; 100PPM; 0.05W; THICK FILM 3-LAYER ELECTRODE
23	R62	-	1	ERJ-1GEF2203C	PANASONIC	220K	RESISTOR; 0201; 220K OHM; 1%; 100PPM; 0.05W; THICK FILM 3-LAYER ELECTRODE
24	U11, U51	-	2	MAX14001	MAXIM	MAX14001	EVKIT PART - IC; MAX14001; PACKAGE OUTLINE DEVICE: 21-0056; PACKAGE CODE AS20-6
25	U12, U52	-	2	MAX6006AEUR+	MAXIM	MAX6006AEUR+	IC; VREF; 1UA SOT23 PRECISION SHUNT VOLTAGE REFERENCE; SOT23
26	U53	-	1	MAX44265EWT+	MAXIM	MAX44265EWT+	IC; OPAMP; RAIL-TO-RAIL; 200KHZ OP AMP WITH SHUTDOWN; WLP6 0.9X1.3
27	X1	-	1	TSW-106-08-S-D-RA	SAMTEC	TSW-106-08-S-D-RA	CONNECTOR; THROUGH HOLE; POST TERMINAL STRIP ASSEMBLY; RIGHT ANGLE; 12PINS;
28	X2	-	1	1727036	PHOENIX CONTACT	1727036	CONNECTOR; FEMALE; THROUGH HOLE; GREEN PCB TERMINAL BLOCK; STRAIGHT; 4PINS
29	PCB	-	1	MAX14001_DEMO_A	MAXIM	PCB	PCB:MAX14001_DEMO_A
30	J1	DNP	0	CRCW08050000Z0EAHP	VISHAY DRALORIC	0	RESISTOR; 0805; 0 OHM; 0%; JUMPER; 0.5W; THICK FILM
31	J2	DNP	0	CRCW06030000ZS; MCR03EZPJ000; ERJ-3GEY0R00	VISHAY DALE/ROHM/PANASONIC	0	RESISTOR; 0603; 0 OHM; 0%; JUMPER; 0.10W; THICK FILM
32	R27	DNP	0	ERJ-2RKF6803X	PANASONIC	680K	RESISTOR, 0402, 680K OHM, 1%, 100PPM, 0.0625W, THICK FILM

NOTE: DNI--> DO NOT INSTALL(PACKOUT) ; DNP--> DO NOT PROCURE

Ordering Information

PART	TYPE
MAX14001PMB#	Peripheral Module

#Denotes RoHS compliant.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	3/17	Initial release	—

