

MAX30001 Evaluation System

Evaluates: MAX30001
MAX30002

General Description

The MAX30001 evaluation system (EV system) provides a single platform to evaluate the functionality and features of the MAX30001 with Biopotential (ECG, R-to-R, and Pace Detection) and Bioimpedance (BioZ) measurement capabilities. The EV system includes a MAX30001 evaluation kit (EV kit) and a MAX32630FTHR Cortex-M4F microcontroller for wearables. The MAX32630FTHR provides power to the MAX30001 EV kit and contains the firmware necessary to use the EV kit GUI program. The EV kit ships with jumpers installed and supply voltages set to typical operating values. Optional connections exist which can be shunted to make use of different functionalities.

Note that the MAX30002 is register compatible with the MAX30001. By disabling the ECG, PACE, and R-to-R blocks, the MAX30001 is equivalent to the MAX30002 and the EV kit evaluates the MAX30002 functionality and performance.

This EV system is not a medical device.

Features

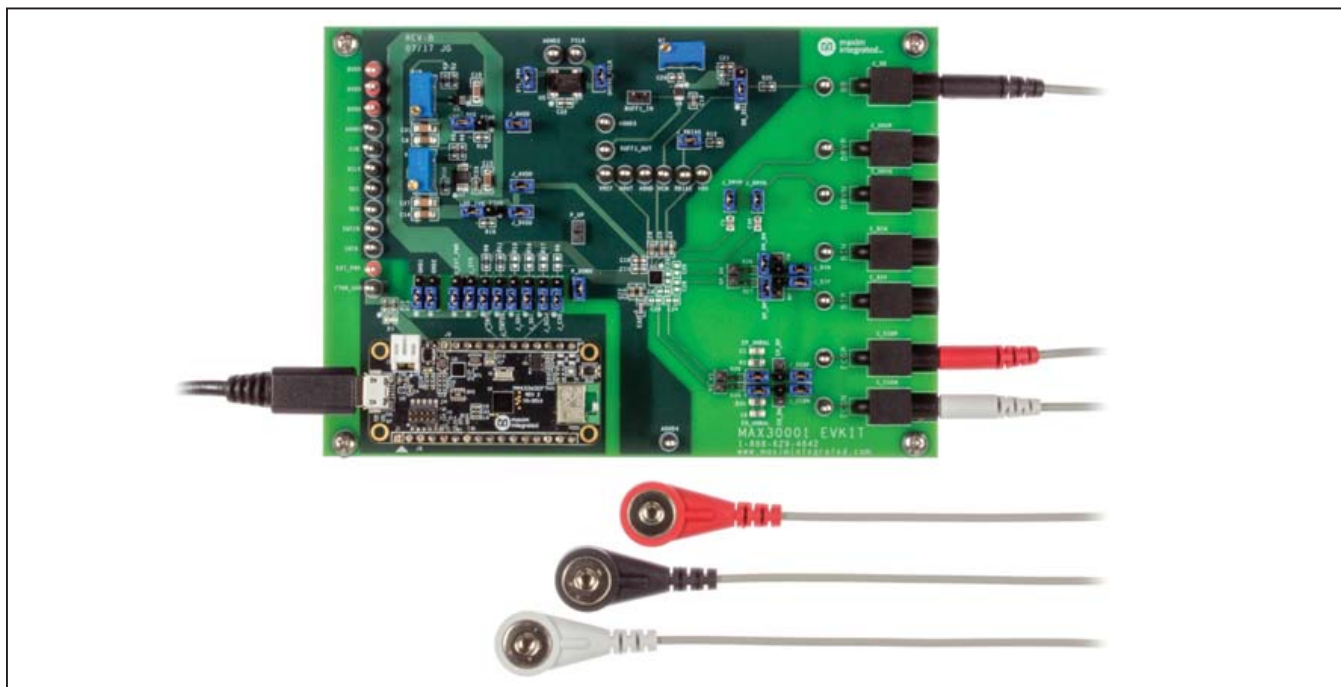
- Convenient Platform to Evaluate the MAX30001
- Many Easy-to-Reach Test Points
- Measure Individual Supply Currents
- Touchproof Cable Connectors
- Windows® 7/8/10 Compatible GUI software
- Fully Assembled and Tested
- Facilitates IEC 60601-2-47 Compliance Testing
- Ultra-Low-Power Design

EV System Contents

- MAX30001 EV kit
- MAX32630FTHR
- USB A to micro-USB cable
- Three (3) ECG cables

[Ordering Information](#) appears at end of data sheet.

MAX30001 EV Kit Photo



Windows is a registered trademark and registered service mark of Microsoft Corporation.

MAX30001 Evaluation System Files

FILE	DESCRIPTION
MAX30001EVKit.exe	PC GUI Program

Quick Start

Required Equipment

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

- MAX30001 EV kit
- MAX32630FTHR
- Micro-USB cable
- Windows PC with USB port

Procedure

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

- 1) Confirm that the MAX32630FTHR is firmly seated in connectors J8 and J7 in the proper orientation.
- 2) Set the EV kit hardware on a nonconductive surface to ensure that nothing on the PCB shorts together.
- 3) Connect the EV kit hardware to a PC with the provided USB cable. Attach the micro-USB end to the MAX32630FTHR board and the type A end to the host PC. Once connected, LED D1 on the MAX32630FTHR will blink red and LED D1 on the EV kit board will be green.
- 4) Windows should automatically begin installing the necessary device driver. The USB interface of the EV kit hardware is configured as an HID device and therefore does not require a unique/custom device driver. Once the driver installation is complete, a Windows message appears near the System Icon menu, indicating that the hardware is ready to use. Do not attempt to run the GUI prior to this message. If you do, then you must close the application and restart it once the driver installation is complete. On some versions of Windows, administrator privileges may be required to install the USB device.
- 5) Once the device drivers have been installed, download the latest EV kit software (MAX30001EVKitSoftwareInstall.ZIP) and extract it to a temporary folder.
- 6) Open the extracted ZIP folder and double-click the .EXE file to run the installer. If a message box stating "The publisher could not be verified. Are you

sure you want to run this software?" appears, select the **Yes** option.

- 7) When the installer GUI appears, click **Next**. Select the installation paths and if a shortcut should be created on the desktop. When prompted, press **Install**. Once complete, click **Close**.
- 8) Double-click the shortcut to start the GUI. Alternatively, go to Start | All Programs. Look for the MAX30001EVKitSoftware folder and click on the MAX30001EVKitSoftware.EXE file inside the folder.
- 9) After the initial splash screen, when the GUI appears, the text in the right field of the status strip at the bottom of the GUI window should display **Hardware Connected** and the COM port associated with the EV kit.

Detailed Description of Software

Software Startup

If the EV system is connected when the software is opened, the software first initializes the hardware to communicate. The software then reads the device registers and updates all the associated control fields displayed on the GUI. The status strip at the bottom of the GUI displays MAX32630FTHR firmware version, the GUI version, and the hardware's associated COM port.

If the EV system is not connected on startup, the **Connection Issue** dialog box shown in [Figure 1](#) appears after the GUI splash screen. Clicking **OK** opens the **Connection** window of the GUI. Use the **Scan Ports** button to identify all COM ports in use by the PC and select the port associated with the EV kit hardware in the **COM Port** drop down menu. This window, shown in [Figure 2](#), may appear if connecting to the EV kit for the first time even if the hardware is connected before starting the GUI.

Once the correct COM port is selected, press **Connect** at the bottom center of the GUI to enter the main window. The program reads all device registers and updates the control fields of the GUI.

ToolStrip Menu Bar

The ToolStrip menu bar ([Figure 3](#)) is located at the top of the GUI window. This bar comprises the **File**, **Device**, **Options**, **Logging**, and **Help** menus whose functions are detailed in the following sections.

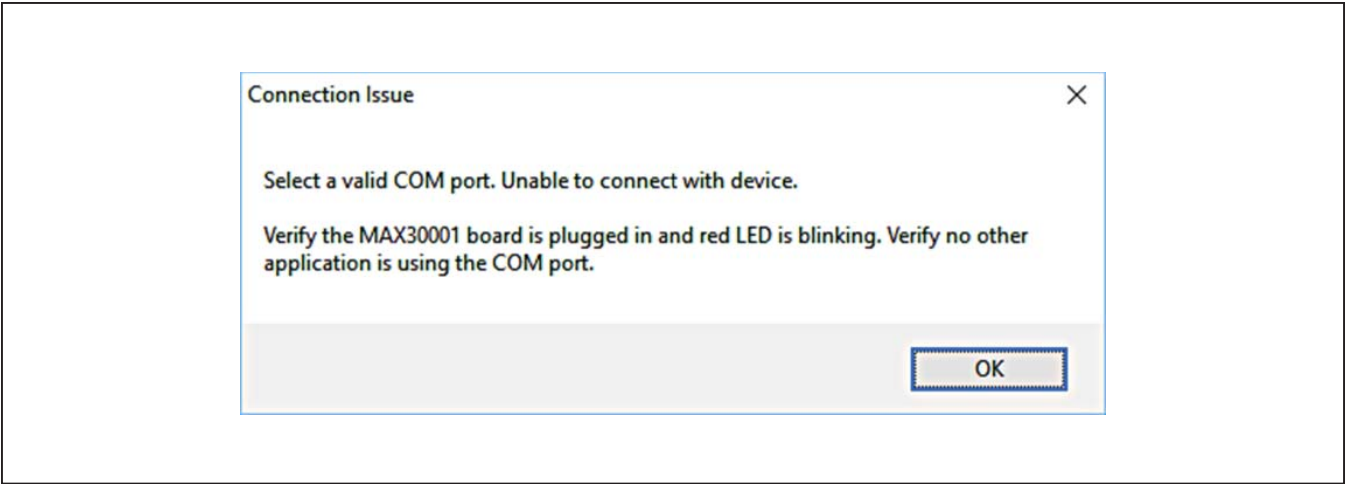


Figure 1. The Connection Issue Dialog Box Appears If The GUI Does Not Detect the EV Kit.

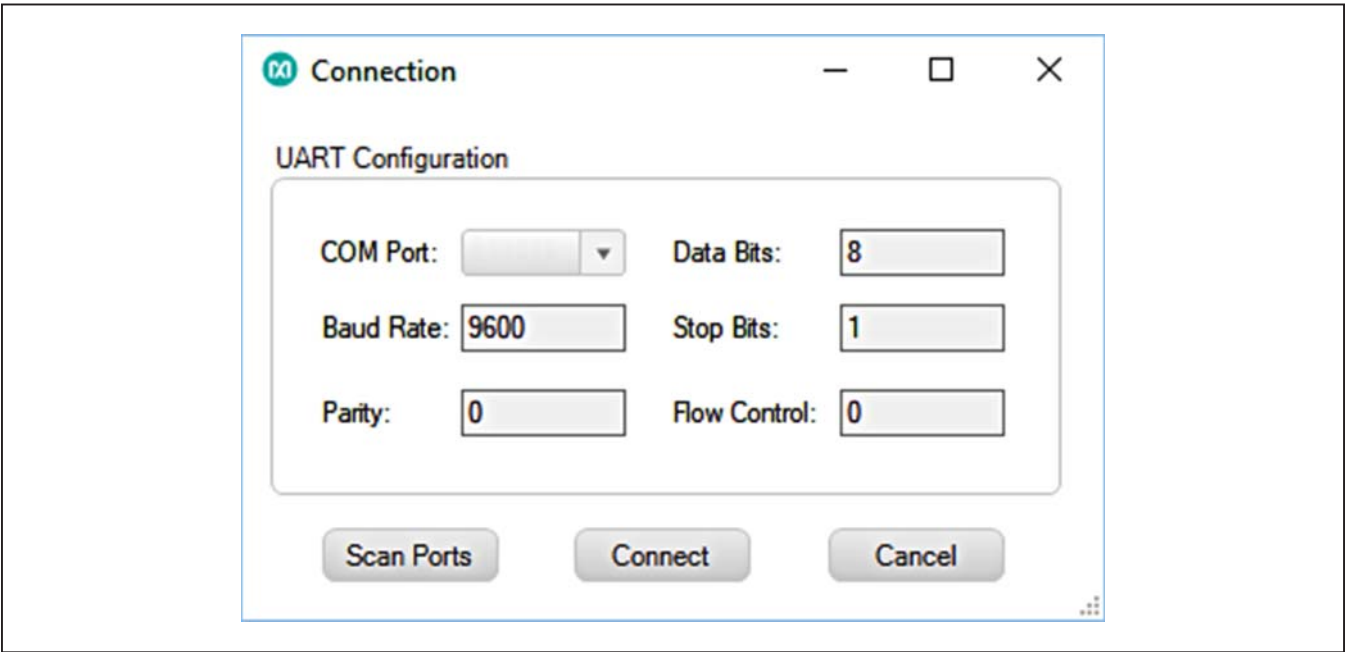


Figure 2. The Connection Screen Allows The User to Select Which COM Port Contains the EV Kit.

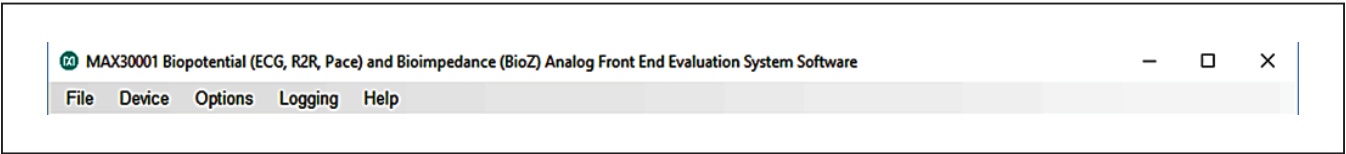


Figure 3. The ToolStrip Menu Items.

File Menu

The **File** menu contains the option to exit out of the GUI program.

Device Menu

The **Device** menu provides the ability to connect or disconnect an EV system to the GUI. If a board is disconnected while the GUI is open the GUI will display **Hardware Not Connected** in the lower right corner. If the device is then plugged back in, the user will be able to navigate to the **Device** menu and select **Connect**. If successful, the bottom right corner of the GUI will read **Device Connected** and display the COM port to which the hardware is connected.

Options Menu

The **Options** menu provides several settings to access more features offered by the GUI. **Show MAX30001 Register Names** changes all the control field names to correspond with their register names in the data sheet. **BioZ Milliohm Scale** configures the scaling on the BioZ plot to be shown in milliohms rather than ohms for a zoomed in display of the BioZ measurement. **Plots Maximum Time** allows the user to select how many seconds of data they want to be shown on the plot at one time. The selected time will still show 10 divisions and each division will be 1/10 of the maximum time. By default, the maximum time is 10 seconds.

Load Register Settings allows the user to quickly set up the GUI based on previous, saved register settings. The **Save Register Settings** item is used to save the current register settings in order to be loaded again at a later time. The **Show Advanced Tab** setting will add an extra tab in the GUI called **Advanced**. The advanced tab is described in depth in the **Tab Control** section of this document.

Logging Menu

The **Logging** menu provides a way to export accurate, exact data that is being measured by the device. The four log options are **ECG File Log**, **R-To-R File Log**, **Pace File Log**, and **BioZ File Blog**. Selecting any log option opens a prompt asking for a name for the comma-separated-value (CSV) log file, as well as the location to save the generated file. [Figure 4](#) shows the GUI when creating a log file. Data logging begins when **Start Monitor** is pressed on the **Plots** tab and ends when **Stop Monitor** is pushed. The GUI disables logging after one monitoring session and a new file must be generated through the **Logging** menu to log the next dataset.

Help Menu

The **Help** menu contains information that can be helpful in aiding with any problems which may arise in the use of the GUI. **Online Documentation** takes the user to the Maxim Integrated website associated with the MAX30001 where all documents that are associated with the part are located. The **About** option displays the GUI splash screen which tells the user which GUI version is being used.

Tab Control

The main interface structure of the GUI consists of a tab control, where each tab contains controls relevant to various blocks of the device. Changing these interactive controls triggers a write operation to the MAX30001 to update the register contents. Likewise, these controls are refreshed when reading from the device.

Tabs responsible for configuring measurements contain block diagrams of their respective channel. To configure a measurement channel, select the desired values from the drop down list items in and below the diagram. Switches in the block diagrams open and close according to the device configuration.

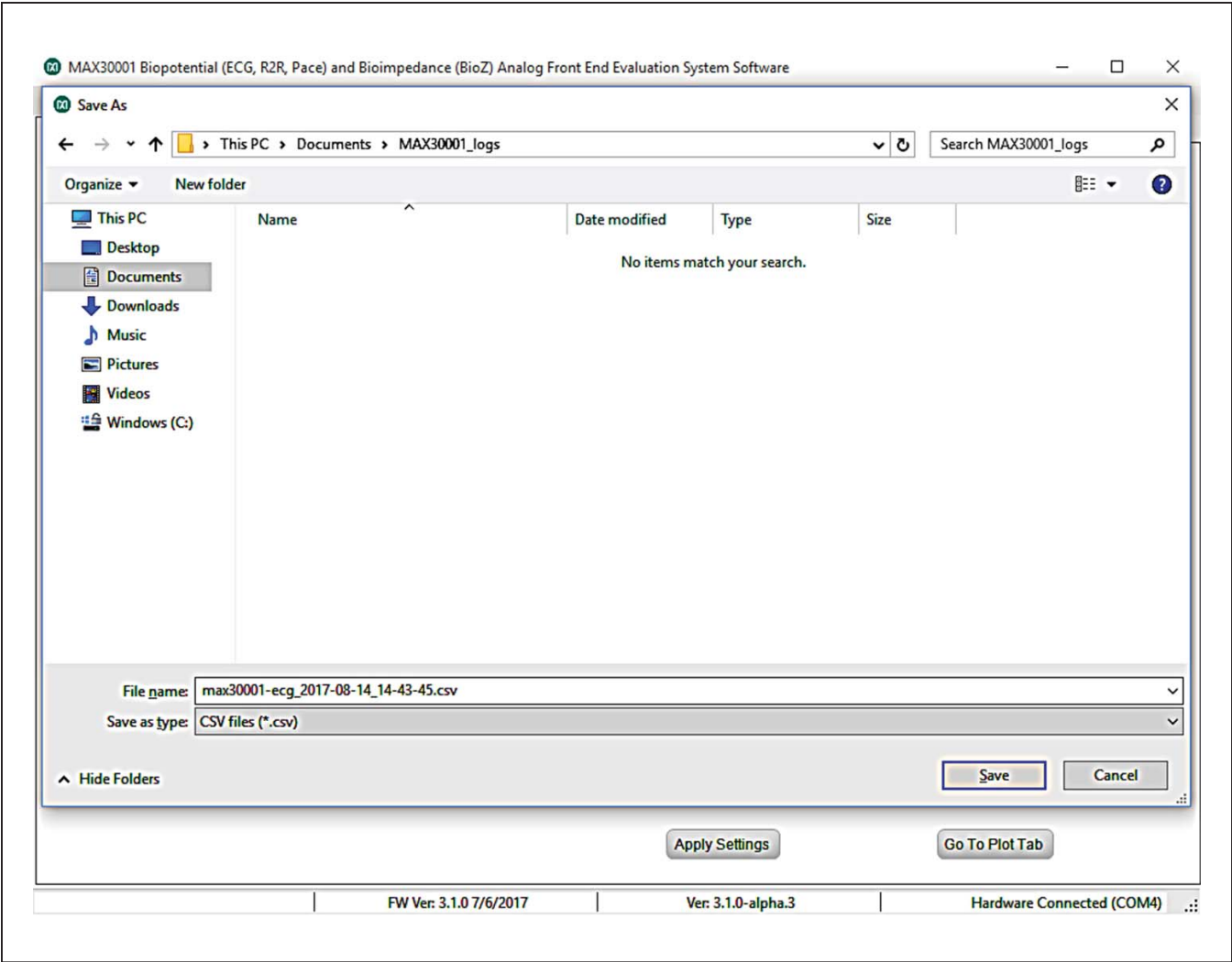


Figure 4. Saving a Log File.

Home Tab

The **Home** tab (Figure 5) provides an overview of the MAX30001 EV kit’s features and preset register configurations. Teal text in the MAX30001 block diagram links to that functional block’s tab in the GUI.

Below the block diagram are six **Quick Start Settings** that configure the device’s registers according to the **Quick Start Settings** description. To load a **Quick Start Setting**, click on the desired setting in the left box and click on **Apply Settings**. The MAX30001 will be written with the specified configuration. These presets allow users to quickly verify the functionality of the EV kit. A button labeled “**Go To Plot Tab**” will change the GUI to the **Plots** tab where a live graph of data being measured can be initiated by clicking the “Start Monitor” button.

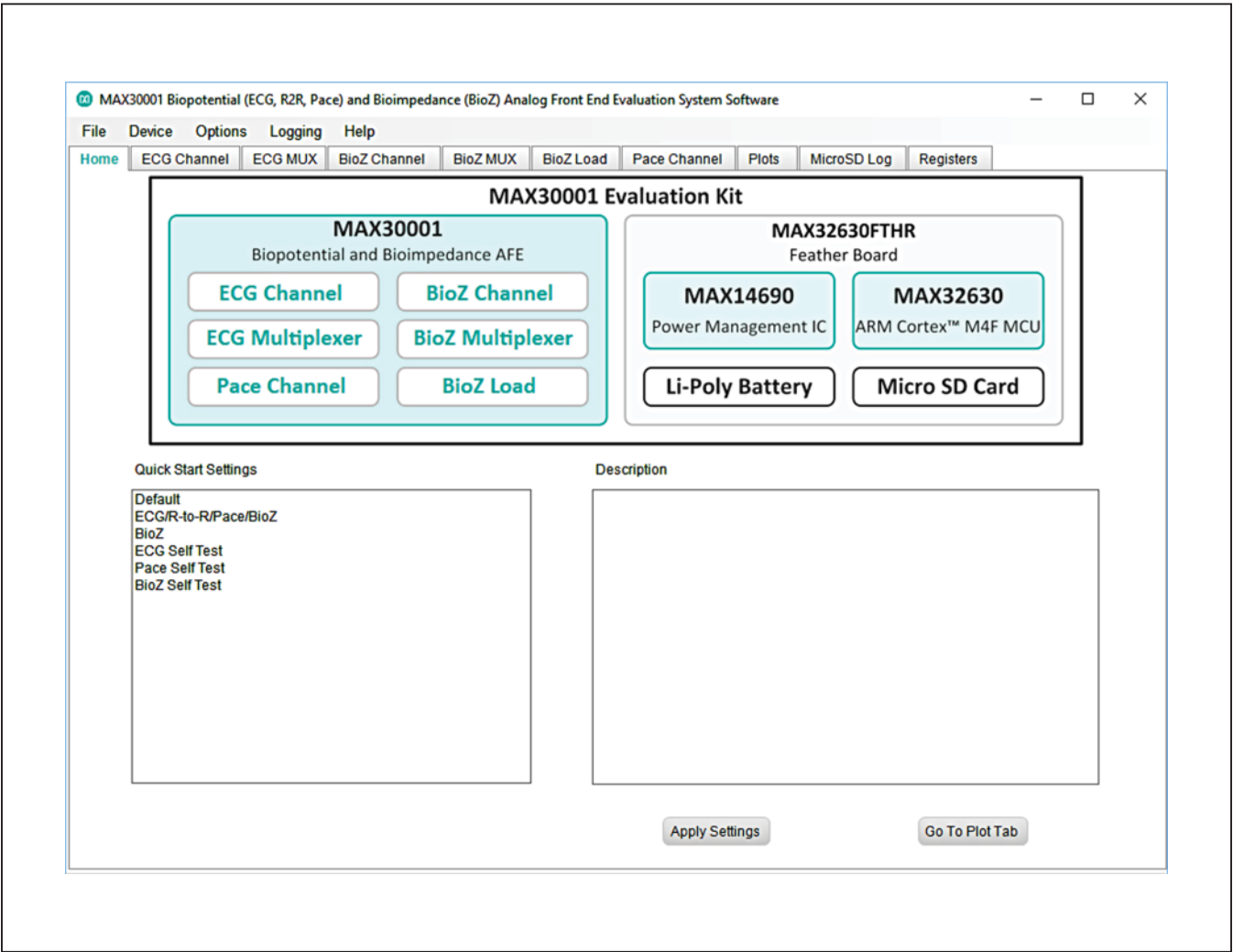


Figure 5. MAX30001 EV Kit GUI Home Tab

ECG Channel Tab

The **ECG Channel** tab (Figure 6) contains all settings which dictate the signal processing behavior of the ECG measurement channel. Controls for the ECG input channel, such as Fast Recovery settings, gain for the programmable amplifier, and the ADC sampling rate, are found in the **ECG Channel** block diagram. The **R-to-R** box configures R-to-R detection using the ECG input data.

A detailed description of all ECG channel configuration settings and R-to-R functionality can be found in the MAX30001 data sheet.

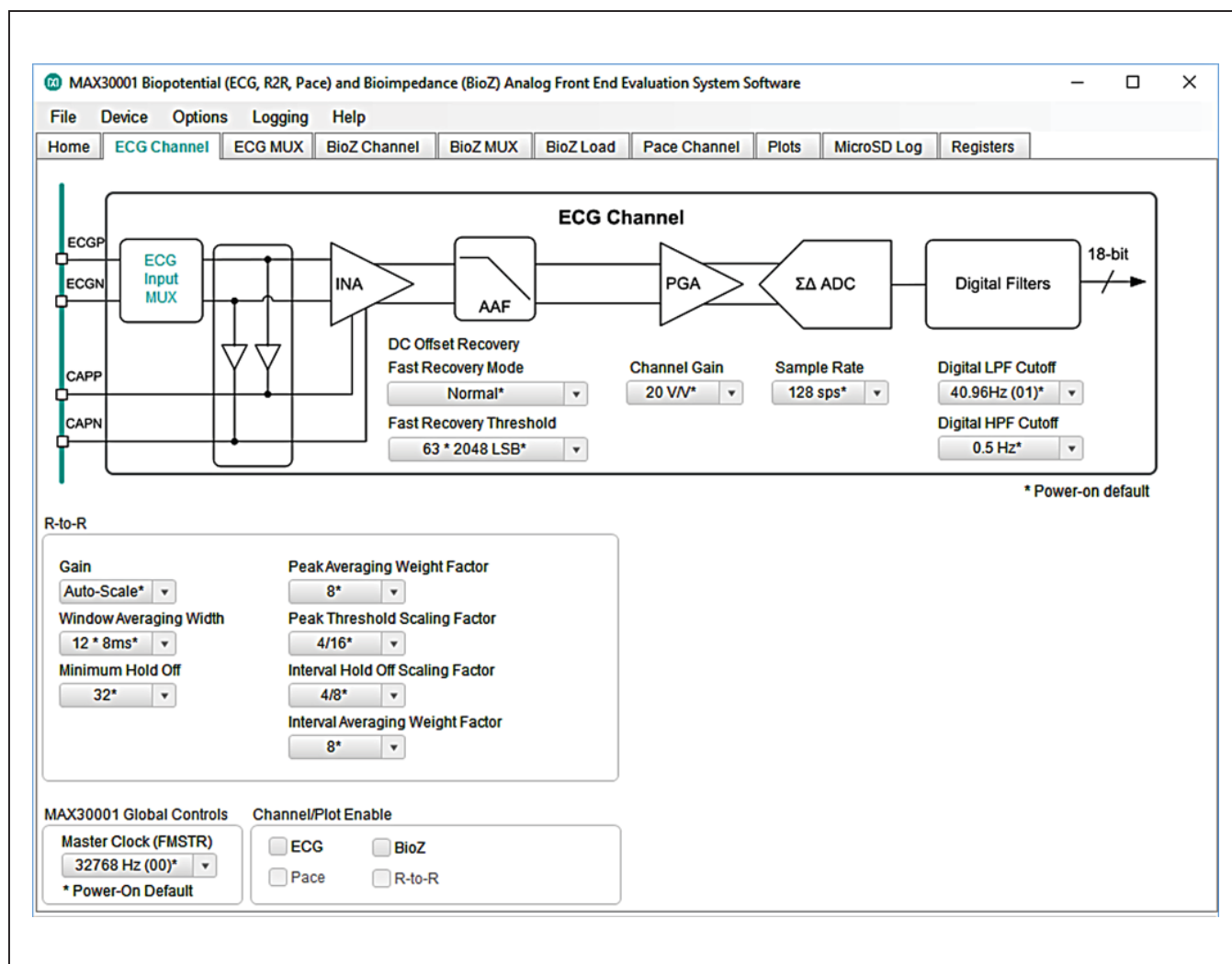


Figure 6. ECG Channel Tab.

ECG MUX Tab

The **ECG MUX** tab (Figure 7) configures the internal ECG switches that precede the ECG amplifiers and filters. Internal calibration and verification functions of the IC are also accessible from this tab. In order to measure external ECG signals, the **ECGP Switch** and **ECGN Switch** in the **Switches** block must be set to **Connected**. The switches should be set to **Isolated** if **Calibration Test Voltage** is used. It is also recommended to have **Resistive Lead Bias Enable** set to **ECG Bias**, **Resistive Bias Value** set to **100MΩ**, **Positive Input Bias Enable** and **Negative Input Bias Enable** set to **Connected**. **DC Lead-Off Check**, **ULP Lead-On Check**, and **Calibration Test Voltage** functionalities are detailed further in depth in the MAX30001 data sheet.

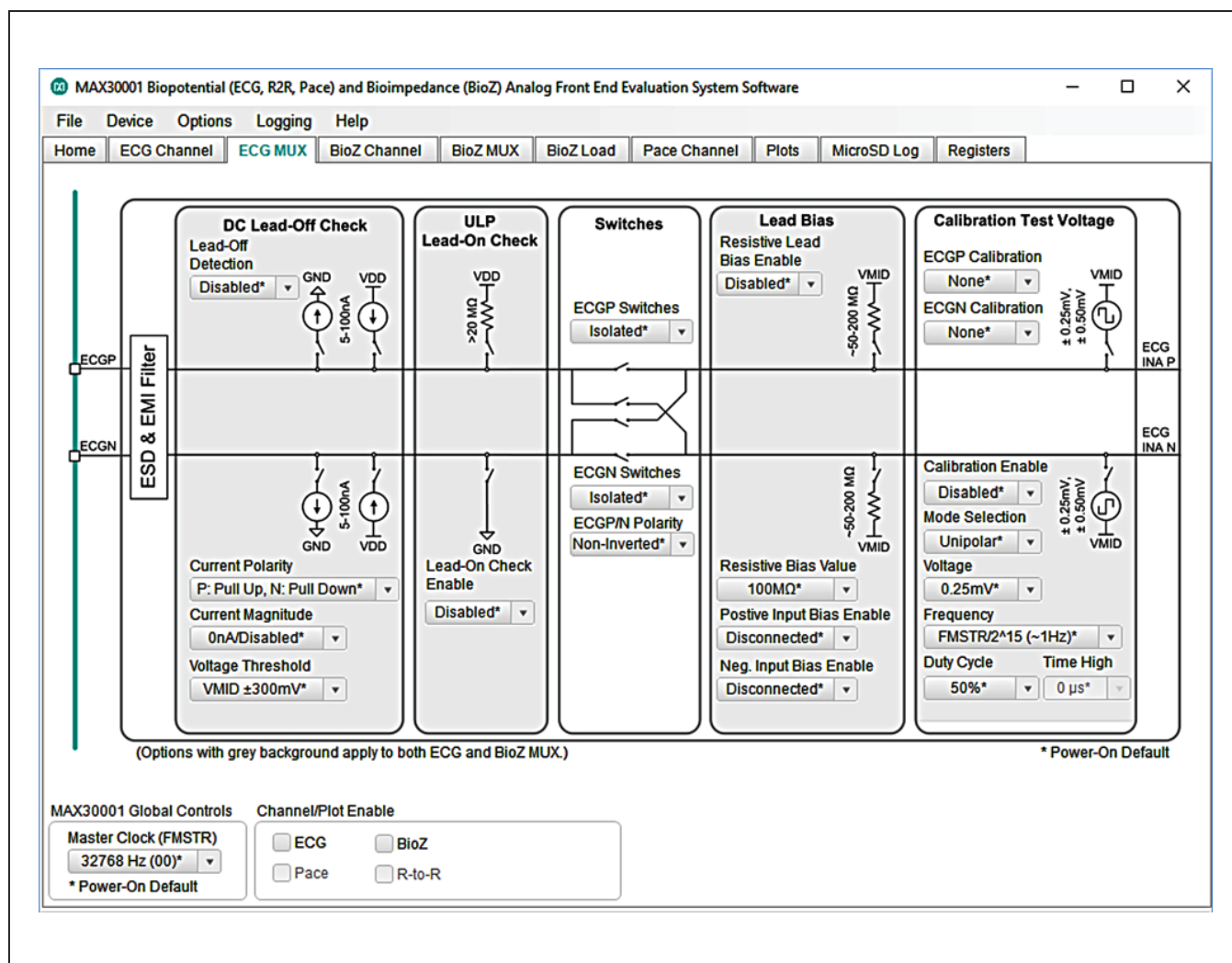


Figure 7. ECG MUX Tab

BioZ Channel Tab

The **BioZ Channel** tab (Figure 8) hosts the settings that control the BioZ components following the BioZ Input MUX. As in the **ECG Channel** tab, controls on this tab configure the filters and amplifiers of the device's BioZ channel.

A detailed description of all BioZ channel configuration settings can be found in the MAX30001 data sheet.

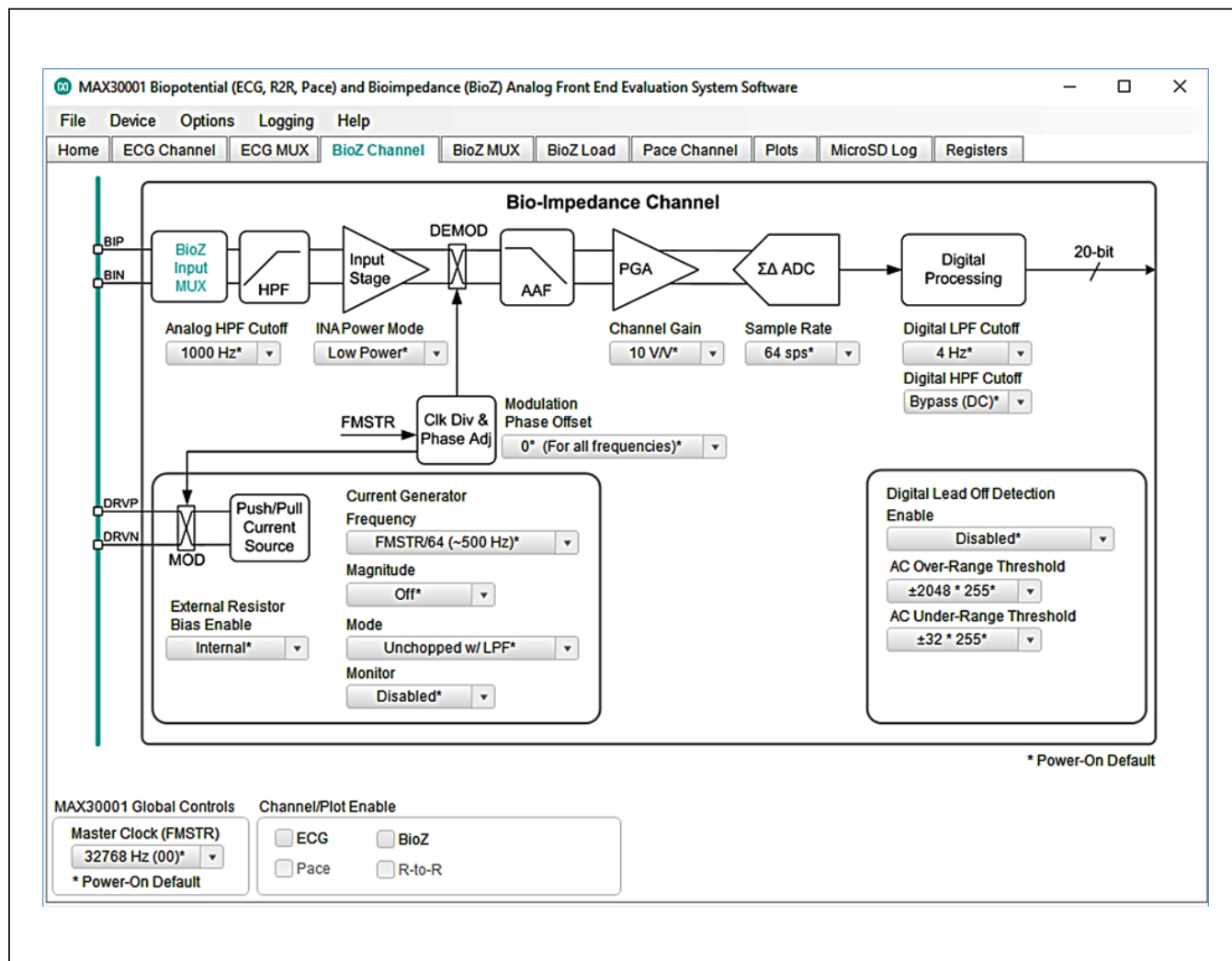


Figure 8. BioZ Channel Tab.

BioZ MUX Tab

The **BioZ MUX** tab (Figure 9) configures the internal BioZ switches that precede the BioZ signal path. Internal calibration and verification functions of the IC are also accessible from this tab. In order to use the BioZ channel, the **BIP Switch** and **BIN Switch** in the **Switches** block must be set to **Connected**. The switches should be set to **Isolated** if using the internal self-test features. As part of the BioZ self-test, a resistive load is available on the DRVP and DRVN pins. Clicking on **Selectable Resistive Load** will bring the GUI to the **BioZ Load** tab. Refer to the full MAX30001 data sheet for detailed descriptions of the BioZ MUX configurations.

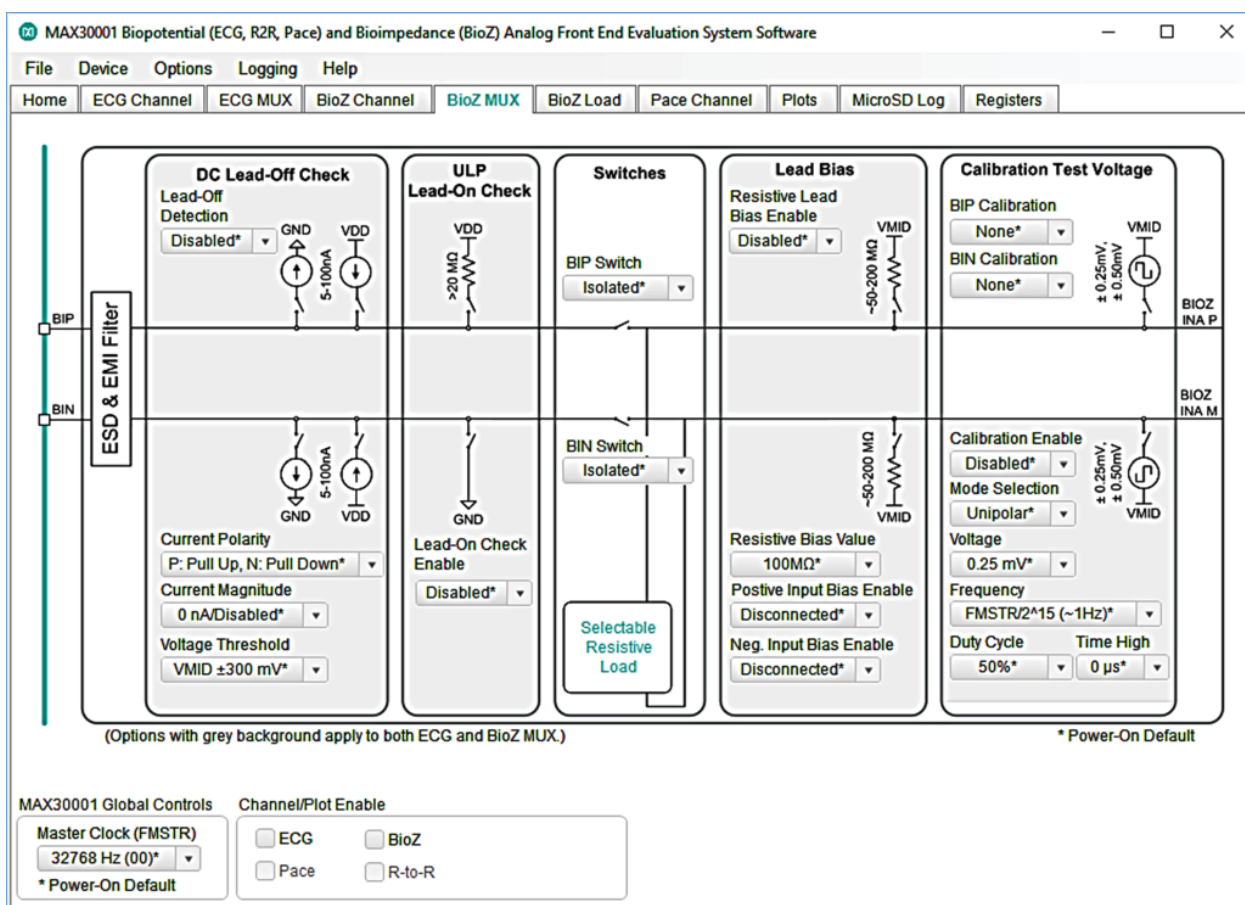


Figure 9. BioZ MUX Tab.

BioZ Load

The **BioZ Load** tab (Figure 10) configures the resistive load used for the self-test of the BioZ channel. The nominal resistance and modulation frequency are set by the **Nominal Resistance** and **Frequency** controls in the **Modulated Resistance Built-In-Self-Test (RMOD BIST)** block. **RMOD BIST Enable** configures the BioZ channel to connect or detach the resistive load.

Refer to the full IC data sheet for a description of the modulated resistive load.

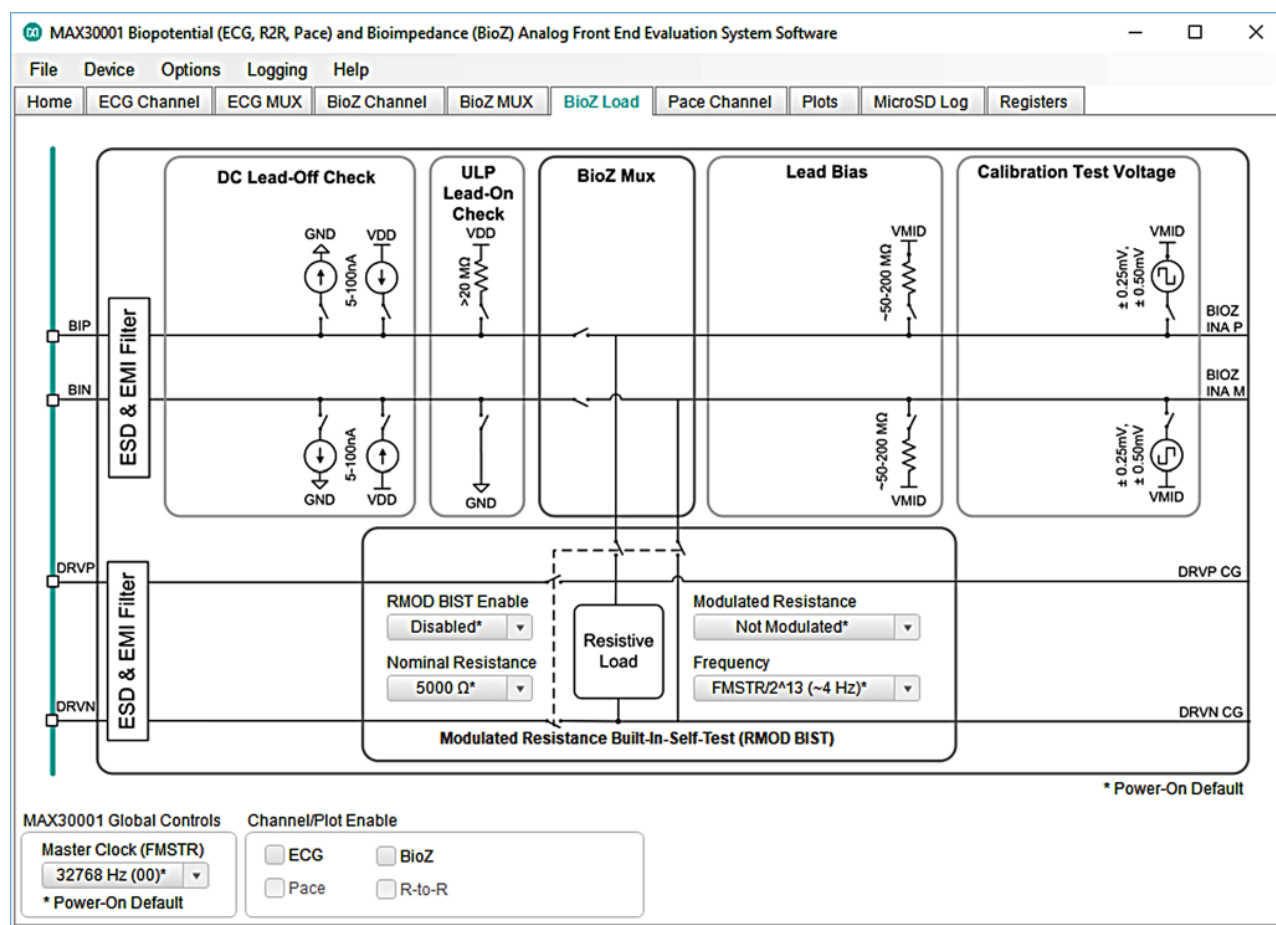


Figure 10. BioZ Load Tab.

Pace Channel Tab

The **Pace Channel** tab (Figure 11) configures the input channel for pace detection. In addition to setting the channel gain and detection thresholds, this tab can route signals at various points in the input path to AOUT using the **Signal Selection** control. To enable pace detection, **BIP Switch** and **BIN Switch** in the **BioZ MUX** tab must be set to **Connected**. If using the current generator to measure BioZ and pace simultaneously, the frequency must be 40kHz or 80kHz.

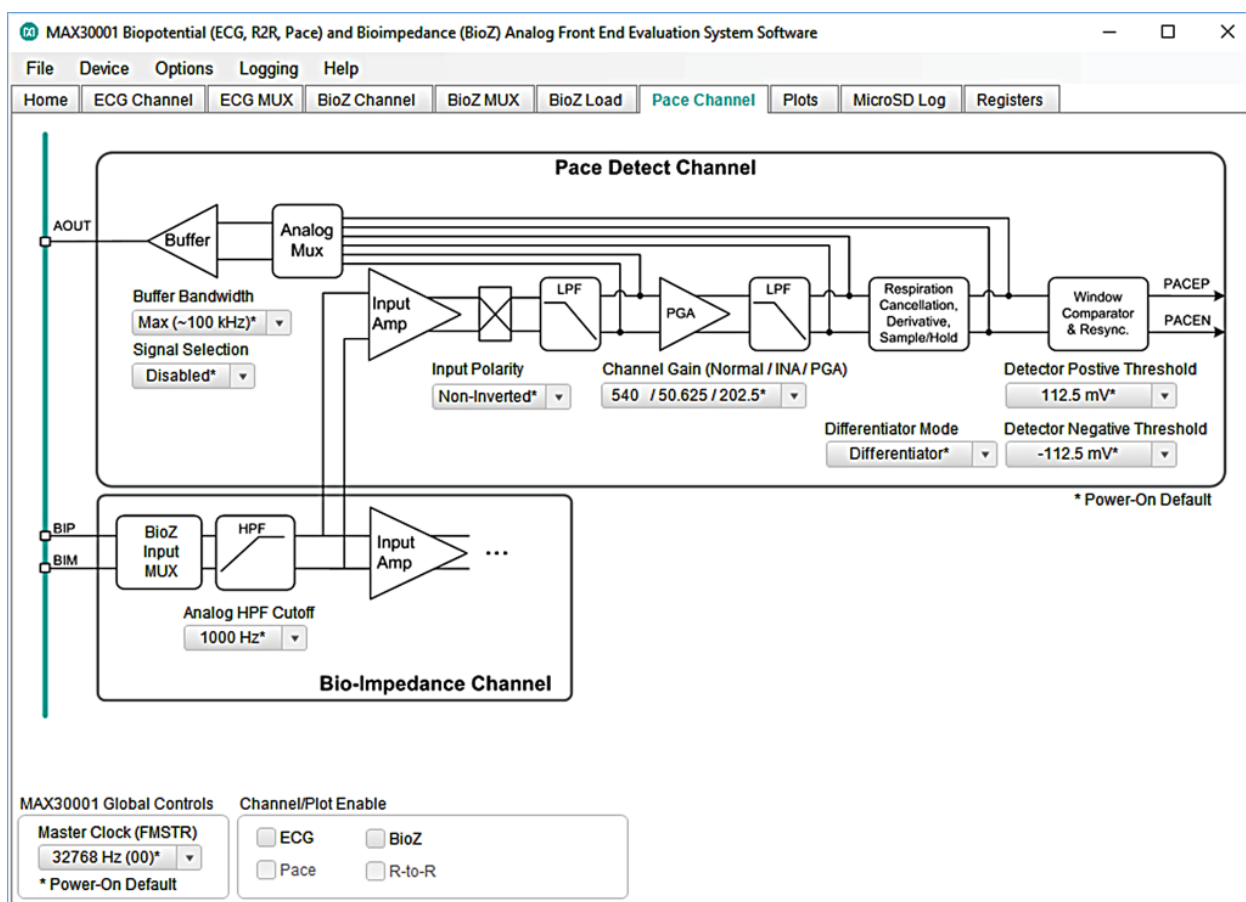


Figure 11. Pace Channel Tab.

Plots Tab

The **Plots** tab (Figure 12) enables real time monitoring of ECG and BioZ waveforms. By default, both ECG and BioZ plots are visible. Toggling the controls in **Channel/Plot Enable** changes which of the two plots is displayed. If **ECG** is enabled and **BioZ** is disabled, the plot area will be occupied entirely by the ECG waveform. Likewise, if **BioZ** is enabled instead of **ECG**, the BioZ plot is maximized. When both measurement channels are enabled, the plotting space contains both ECG and BioZ data.

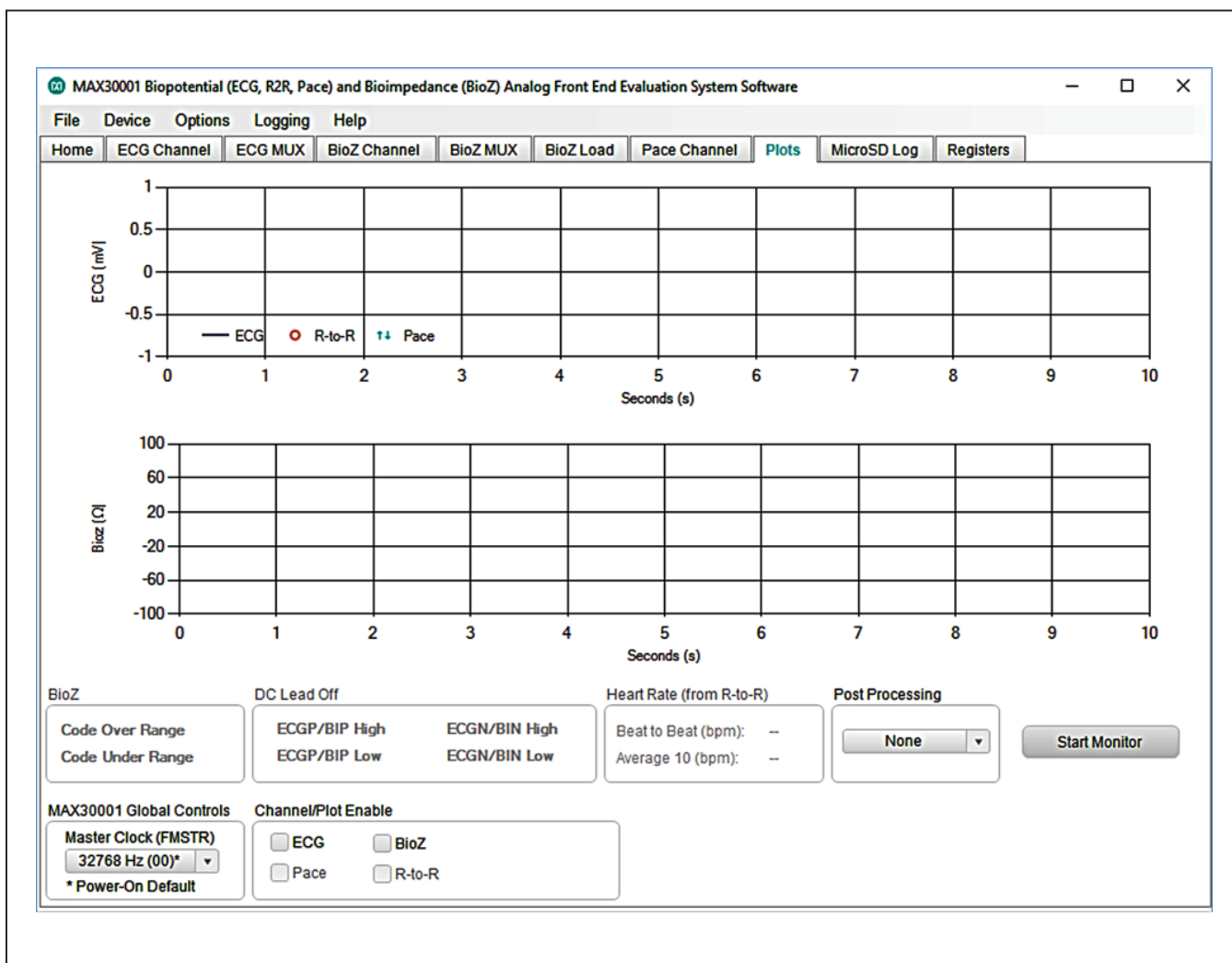


Figure 12. Plots Tab.

R-to-R and Pace data is shown in the ECG plot. R-to-R peak detection is indicated by a red circle at the peaks of the R waves. Pace data appears as teal arrows on the rising and falling slopes of the pace signal. Heart rate information gathered from R-to-R detection can be found in the **Heart Rate (from R-to-R)** box below the plotting area. [Figure 13](#) illustrates an ECG waveform with R-to-R and pace detection enabled. The ECG sample rate is 512sps and the BioZ current generator frequency is 80kHz.

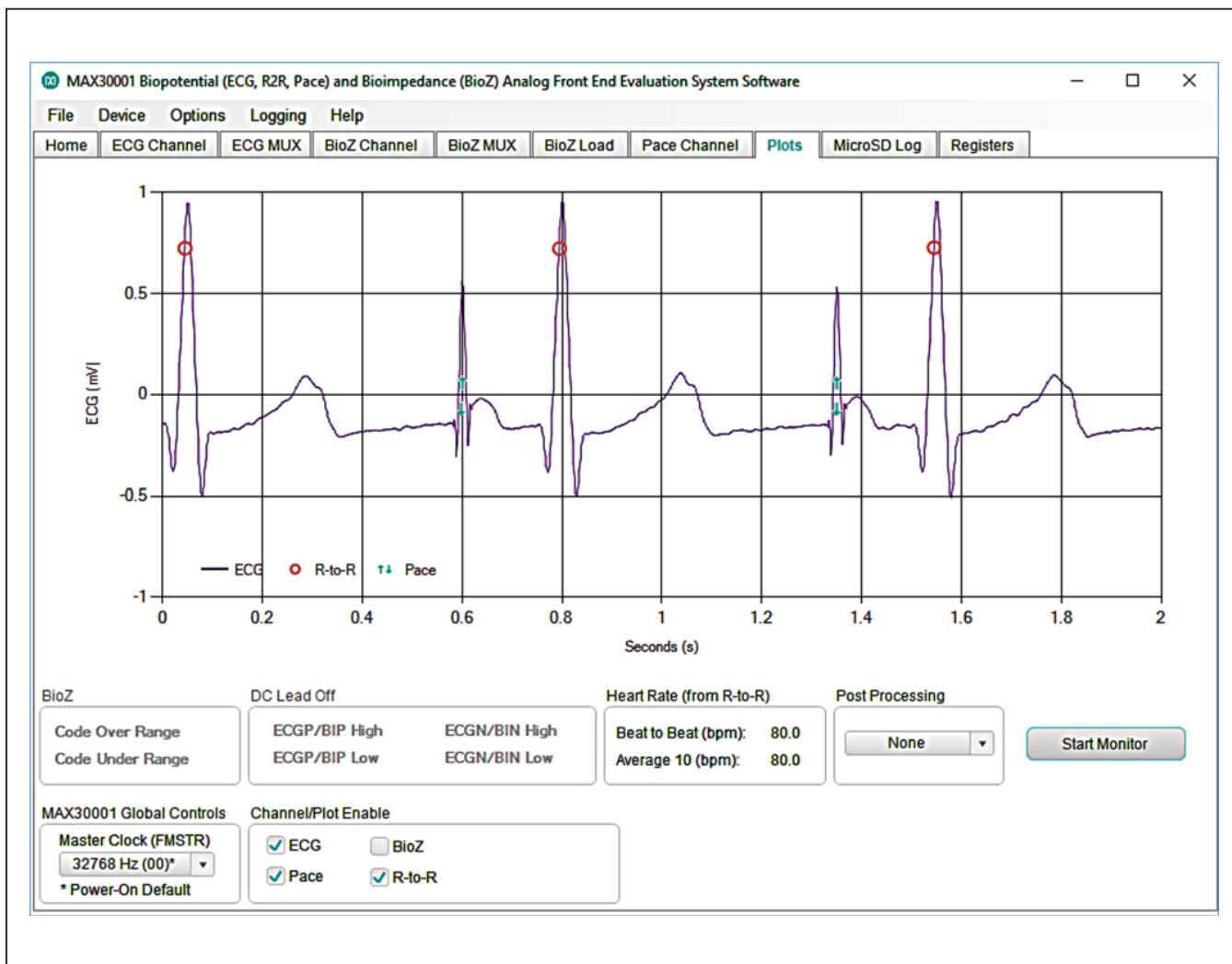


Figure 13. An ECG Waveform with R-to-R and Pace Detection Enabled.

MicroSD Log Tab

The MAX30001 EV kit can use the SD card read/write functionality of the MAX32630FTHR to store and recall log data to and from a microSD card. This allows data to be with the USB cable connected or with the USB disconnected from the PC host and powering the EV kit with a battery. To use an SD card, insert the card into connector CN2 on the underside of the MAX32630FTHR board prior to starting the GUI.

SD card logging is configured in the **MicroSD Log** tab (Figure 14). The GUI can save, load, and clear stored register configuration settings with the **Read**, **Write**, and

Erase buttons, respectively. Pressing **Advanced** displays the current register contents to be written to an SD card setting file when **Write** is pressed. After confirming the register configurations, select the type of data to save in the **ECG Channel Log Enable** box and press **Write** to load the measurement parameters to the SD card. Press SW2 on the MAX32630FTHR board to start logging and press it a second time to stop logging.

When the EV kit is reconnected to the GUI after logging data, data from the SD card can be saved to the host PC. Press **Save to File** to open a file dialogue and select the location and file name of the logged data. Data is stored in a CSV format.

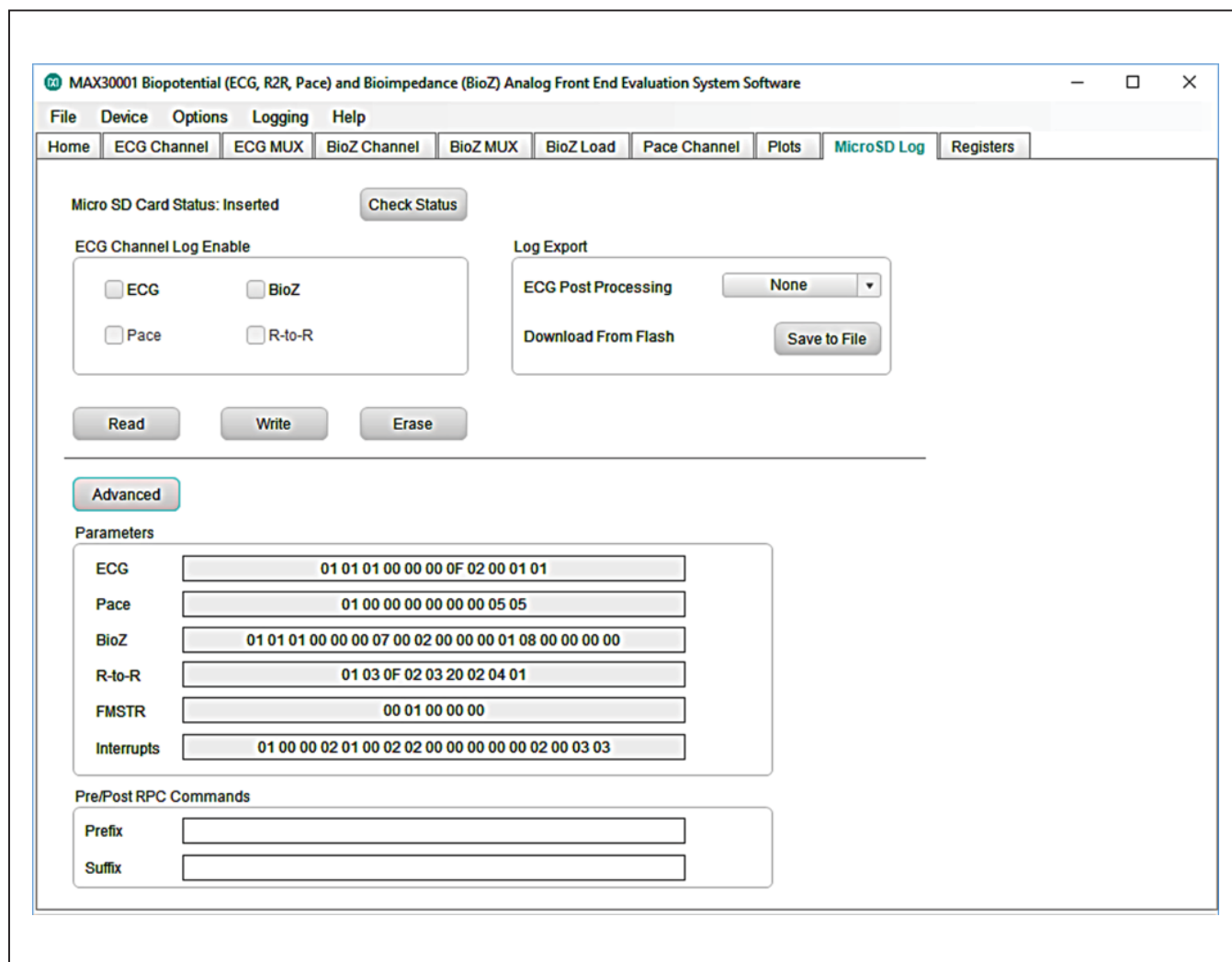


Figure 14. MicroSD Log Tab with Advanced Toggled On.

Registers Tab

The Registers tab (Figure 15) provides more direct access to the internal registers of the MAX30001. From this tab, it is possible to read the contents of individual registers and to manually enter the desired bit settings for a write operation. For the register address selected in the table on the left, the contents are displayed at the bottom of the tab and visualized as bold and non-bold bit names. When a bit is bold, its value is 1. Otherwise, the bit is 0. Full descriptions of each bit are available in the **Bit Description** field for quick reference. Pressing **Read** reads the selected register, highlighted in teal, while pressing **Read All** reads all registers and updates their values in the **Registers** tab. To write to a register, set the desired bit values by clicking on the bit names to make bold or non-bold and then press **Write**. Alternatively, double click the **Value (Hex)** cell of a selected row to manually enter a value and press the “Enter” key to write the value to the device register.

MAX30001 Biopotential (ECG, R2R, Pace) and Bioimpedance (BioZ) Analog Front End Evaluation System Software

File Device Options Logging Help

Home ECG Channel ECG MUX BioZ Channel BioZ MUX BioZ Load Pace Channel Plots MicroSD Log **Registers**

Read All

Bit Description: STATUS Register

Address	Register	Value (Hex)	Bit	Name	Description
01h	STATUS (Read Only)	000000	Bit [23]	EINT	ECG FIFO Interrupt: indicates ECG records meeting/exceeding the ECG FIFO Interrupt Threshold (EFIT) are available for read back. Remains active until ECG FIFO is read back to the extent required to clear the EFIT condition.
02h	EN_INT	000003	Bit [22]	EOVF	ECG FIFO Overflow: indicates the ECG FIFO has overflowed and the data record has been corrupted.
03h	EN_INT2	000003	Bit [21]	FSTINT	ECG Fast Recovery Mode: Issued when the ECG Fast Recovery Mode is engaged (either manually or automatically).
04h	MNGR_INT	7B0004	Bit [20]	DCLOFFINT	DC Lead Off Detection Interrupt: indicates the part has determined it is in an ECG/BIOZ Leads Off condition (as selected in CNFG_GEN) for more than 90ms. Remains active as long as the Leads Off condition persists even after a STATUS register read, then held until cleared by STATUS register read (30th SCLK) if condition has ceased. Note: Exact time depends on BIOZ modulation frequency (the clock used for counting) and can range from 90ms to 140ms.
05h	MNGR_DYN	3FFFFFF	Bit [19]	BINT	BIOZ FIFO Interrupt: indicates BIOZ records meeting/exceeding the BIOZ FIFO Interrupt Threshold (BFIT) are available for read back. Remains active until BIOZ FIFO is read back to the extent required to clear the BFIT condition.
08h	SW_RST (Write Only)	000000	Bit [18]	BOVF	BIOZ FIFO Overflow: indicates the BIOZ FIFO has overflowed and the data record has been corrupted.
09h	SYNCH (Write Only)	000000			
0Ah	FIFO_RST (Write Only)	000000			
0Fh	INFO (Read Only)	5210B8			
10h	CNFG_GEN	000004			
12h	CNFG_CAL	004800			
14h	CNFG_EMUX	300000			
15h	CNFG_ECG	805000			
17h	CNFG_BMUX	300040			
18h	CNFG_BIOZ	201800			

Note: Double Click "Value" Column to Edit

23 / 15 / 7	22 / 14 / 6	21 / 13 / 5	20 / 12 / 4	19 / 11 / 3	18 / 10 / 2	17 / 9 / 1	16 / 8 / 0
EINT	EOVF	FSTINT	DCLOFFINT	BINT	BOVF	BOVER	BUNDR
BCGMON	PINT	POVF	PEDGE	LONINT	RRINT	SAMP	PLLINT
-	-	BCGMF	BCGMN	LDOFF_PH	LDOFF_PL	LDOFF_NH	LDOFF_NL

Note: Click text to set or clear bit and "Write" to commit to device. Bold text is logic 1. Regular text is logic 0.

Read Write

Figure 15. Registers Tab.

Advanced Tab

The **Advanced** tab (Figure 16) is accessible through the **Options** ToolStrip menu. The tab provides manual communication with the MAX30001 to bypass the GUI controls entirely. Enter the register address, as a hexadecimal value, in the **Address** field. Read data from a register by pressing the **ReadReg** button and the data will populate the **Read Data** field. To write data, enter the hexadecimal value in the **Write Data** field and press the **WriteReg** button. **Command Line** displays the formatted command sent by the GUI to the EV kit.

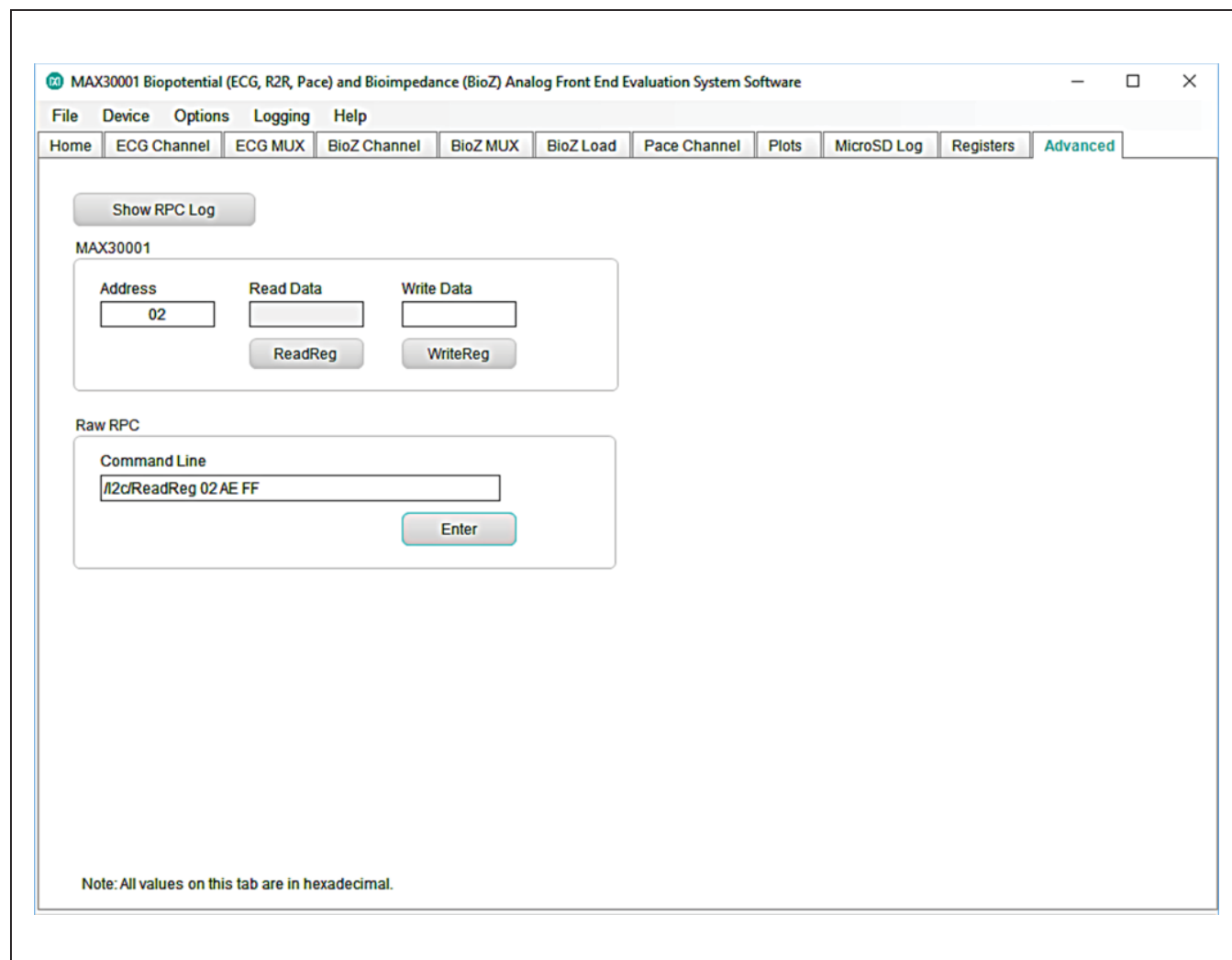


Figure 16. Advanced Tab.

Detailed Description of Hardware

The MAX30001 EV system provides a single platform to evaluate the functionality and features of the MAX30001 with Biopotential (ECG, R-to-R, and Pace Detection) and Bioimpedance (BioZ) measurement capabilities. The board contains jumpers and optional resistors and capacitors to test the MAX30001 under several conditions. A list of all jumpers and their respective functions is available in [Table 1](#). An onboard 32.768kHz crystal oscillator (U5) supplies FCLK to the IC, but external frequency generation is supported.

The EV system utilizes the MAX32630FTHR Cortex-M4F Microcontroller for Wearables for interfacing with the GUI and optionally providing power to the MAX30001. The MAX32630FTHR operates either from a host PC or directly from a Li+ battery. If an SD card is present in the MAX32630FTHR, register settings and measurement configurations can be saved through the GUI. When the EV kit operates without a host PC, pressing SW2 on the MAX32630FTHR initiates the measurement and saves log files to the SD card. Logging is stopped by pressing SW2 a second time.

Refer to [Figure 17](#) for a simplified schematic of the EV kit biopotential circuitry.

Table 1. Description Of Jumpers

JUMPER	SHUNT POSITION	DESCRIPTION
J_ECGN	1-2*	Connects ECGN on the IC to C_ECGN on the EV kit.
J_ECGP	1-2*	Connects ECGP on the IC to C_ECGP on the EV kit.
EN_BN	1-2	Connects ECGN to BIN.
EP_BP	1-2	Connects ECGP to BIP.
EN_UNBAL	1-2*	Bypasses the ECG electrode unbalance on ECGN.
EP_UNBAL	1-2*	Bypasses the ECG electrode unbalance on ECGP.
EP_EN	1-2	Short ECGP to ECGN.
J_BIN	1-2*	Connects BIN on the IC to C_BIN on the EV kit.
J_BIP	1-2*	Connects BIN on the IC to C_BIN on the EV kit.
RN	1-2*	Connects one end of R28 to BIN.
RP	1-2*	Connects one end of R28 to BIP.
DN_BN	1-2	Connects DRVN to BIN.
DP_BP	1-2	Connects DRVP to BIP.
BP_BN	1-2	Short BIP to BIN.
J_DRVN	1-2	Connects DRVN on the IC to C_DRVN on the EV kit.
J_DRVP	1-2	Connects DRVP on the IC to C_DRVP on the EV kit.
BB_SEL	1-2*	Use VCM as the body bias.
	2-3	Use an adjustable voltage from 0V to OVDD as the body bias. Adjust voltage with R7.
J_RBIA	1-2*	Connect an external 324kΩ resistor to RBIA.
BUFF1_IN	1-2	Input to second buffer of U4.

Table 1. Description Of Jumpers (continued)

JUMPER	SHUNT POSITION	DESCRIPTION
1V8	1-2	Supply 1.8V to J_AVDD and J_DVDD from the MAX32630FTHR.
	2-3*	Supply an adjustable voltage to J_AVDD and J_DVDD from an LDO (U2).
3V3	1-2	Supply 3.3V to J_OVDD and OVDDX from the MAX32630FTHR.
	2-3*	Supply an adjustable voltage to J_OVDD and OVDDX from an LDO (U3).
J_AVDD	1-2*	Connect AVDD to pin 2 of jumper 1V8.
J_DVDD	1-2*	Connect DVDD to pin 2 of Jumper 1V8.
J_OVDD	1-2*	Connect OVDD to pin 2 of jumper 3V3.
XTL_PWR	1-2*	Power the onboard crystal from OVDDX.
ONBRD_FCLK	1-2*	Connect the onboard crystal to FCLK.
GND1	1-2**	Connect GND of the MAX32630FTHR to AGND1.
GND2	1-2**	Connect GND of the MAX32630FTHR to AGND2.
J_EXT_PWR	1-2	Connect an external supply to the 5V rail.
	2-3	Do not use.
J_SYS	1-2**	Connect SYS on the MAX32630FTHR to the 5V rail.
J_INTB	1-2**	Connect INTB to the MAX32630FTHR.
J_INT2B	1-2**	Connect INT2B to the MAX32630FTHR.
J_SDO	1-2**	Connect SDO to MISO of the MAX32630FTHR.
J_SDI	1-2**	Connect SDI to MOSI of the MAX32630FTHR.
J_SCLK	1-2**	Connect SCLK to SCLK of the MAX32630FTHR.
J_CSB	1-2**	Connect CSB to the MAX32630FTHR.
P_UP	1-2	Connect R8-11 to OVDDX.
P_DWN	1-2*	Connect R15-17 to GND.

* Default shunt position

** Default shunt position, do not use alternate position

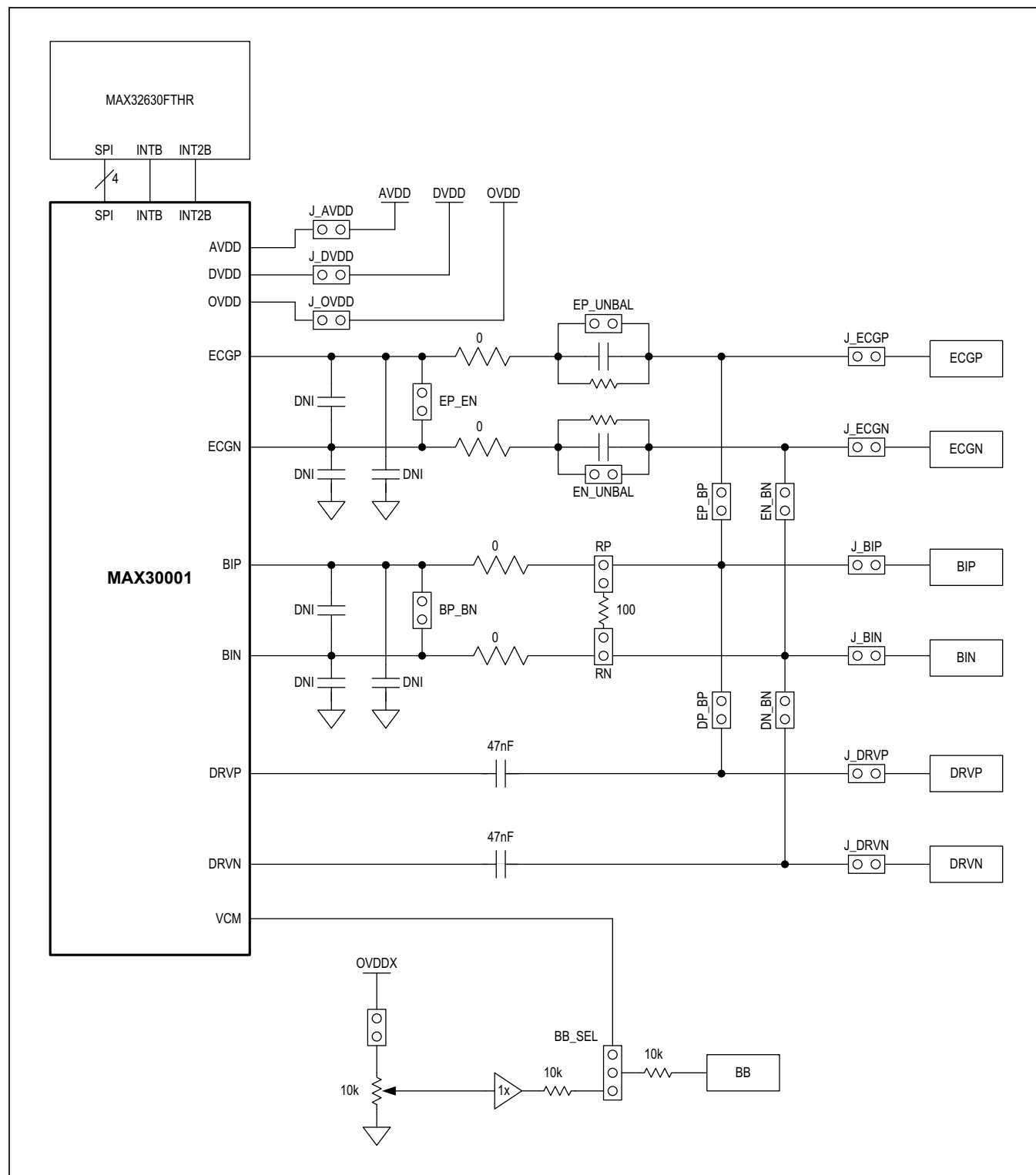


Figure 17. Simplified Schematic.

Powering the EV Kit

The MAX30001 EV kit can be powered from an external supply or directly from the MAX32630FTHR. To use an external supply, install a shunt on jumper J_EXT_PWR in the 1-2 position. This connects the EXT_PWR test point to the board's 5V rail. Set the power supply's output to +5V, disable the output, connect the positive lead to EXT_PWR and the negative to AGND1, then enable the supply. To power the EV kit with the MAX32630FTHR, install a shunt on jumper J_SYS in the 1-2 position to connect the SYS node to the 5V rail. SYS regulates the USB voltage or directly connects to the battery if present.

The MAX30001 IC receives power from OVDD, AVDD, and DVDD. These pins receive power either through the MAX32630FTHR, externally through test points, or through adjustable LDOs U2 and U3. To supply the IC from the MAX32630FTHR's 1.8V and 3.3V rails, place a shunt in the 1-2 position on the 1V8 and 3V3 jumpers. To use the onboard LDOs, place the shunts in the 2-3 position. Two potentiometers are available to set the U2 and U3 voltages: R4 and R10.

To operate the EV kit without a connection to a host PC or power supply, insert a microSD card into the MAX32630FTHR. After saving a test configuration, disconnect the board from the host PC and connect a Li+ battery to the MAX32630FTHR. Refer to the MAX32630FTHR documentation for details on connecting a Li+ battery. Press SW2 to trigger the measurements saved to the SD card. The J_SYS shunt must be in the 1-2 position for this configuration.

Configuring the Board for Measurement

The MAX30001 EV kit offers several potential connection and component configurations to enable a variety of tests. Both the ECG channel and BioZ channel allow for user-defined line resistance with resistors R26 and R27 for BioZ, and R29 and R30 for ECG. By default, these resistors are populated with 0Ω shunts but can be changed to suit the application. The board also allows for the installation of external low-pass filtering capacitors on the ECG and BioZ lines. Capacitors C8 and C25 can create an external common mode filter for the ECG and BioZ lines, respectively. C24, C29, C26, and C28 filter ECGP, ECGN, BIP, and BIN. The cutoff frequency of the filters is set by the value of these capacitors and the input resistors R26, R27, R29, and R30. The board also allows the ECGN and ECGP or BIN and BIP inputs to be shorted with jumpers EP_EN and BP_BN, respectively.

Refer to the MAX30001 EV kit schematic and MAX30001 EV kit PCB layout sections for component connections and placements.

ECG Measurement

The EV kit ships configured to measure ECG with balanced electrodes, R-to-R, and BioZ signals. The jumper configurations required for these measurements are shown in [Figure 18](#). Connected jumpers are distinguished with solid black nodes in the jumper box. To use the electrode connectors on the EV kit, ensure the required shunts are installed.

By default, the EV kit leaves the ECG channel balanced. By removing the shunts on EN_UNBAL and EP_UNBAL, the ECGN and ECGP lines each include a 51kΩ resistor and 47nF capacitor in parallel.

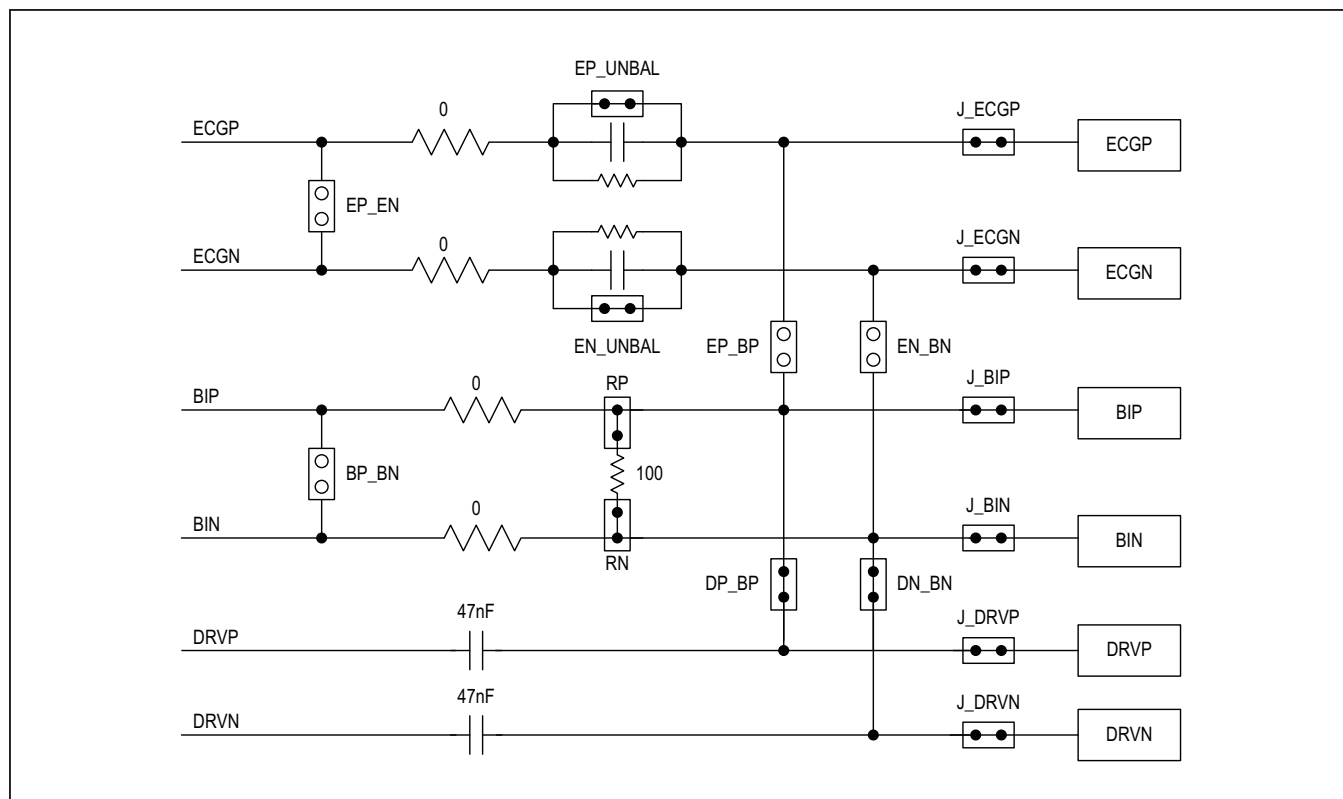


Figure 18. Default Measurement Channel Jumper Configurations

BioZ Measurement

Additionally, the EV kit includes a 100Ω resistor to verify the BioZ configuration. Attach shunts on RP and RN to connect the resistor to the BioZ inputs and shunts on DP_BP and DN_BN to route the drive signal to the BioZ channel. [Figure 19](#) illustrates these connections.

Refer to the MAX30001 data sheet for details on configuring a BioZ measurement. Note that the default setting of the current generator is FMSTR/64 (about 500Hz) and the BioZ channel has an internal high-pass filter with a default 1kHz cutoff frequency. In order to correctly measure the 100Ω resistor, bypass or lower the filter cutoff frequency or increase the current generator frequency.

Pace Detection

To enable pace detection, the ECGN and ECGP lines must be connected to BIN and BIP by shunting EN_BN and EP_BP, then configuring the device registers as described in the IC datasheet. Refer to [Figure 20](#) for a jumper configuration to measure ECG with pace detection.

Alternatively, EP_BP and EN_BN can be left open and J_BIP and J_BIN shunted. This measures pace directly on the BIP and BIN inputs and allows another signal to be measured on the ECG channel. In this configuration, the measured pace signal may not correspond to the ECG measurement.

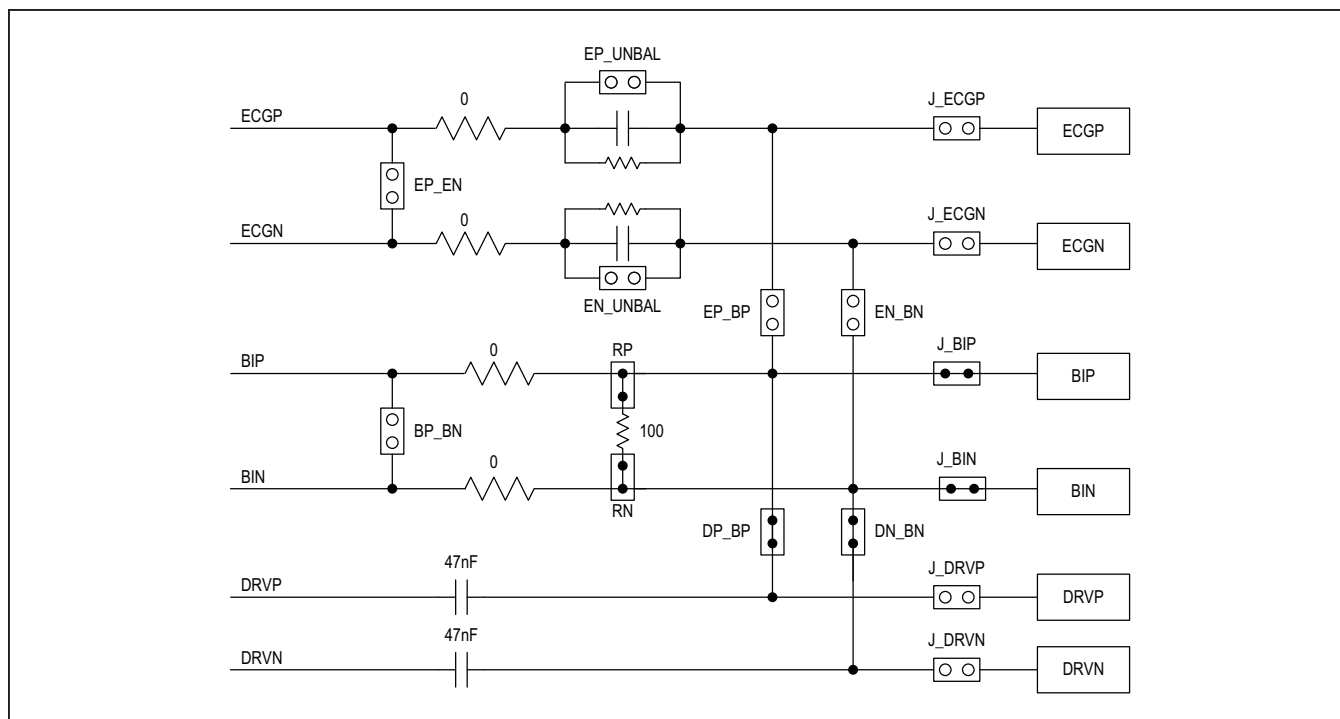


Figure 19. BioZ Measurement with 100Ω Test Impedance.

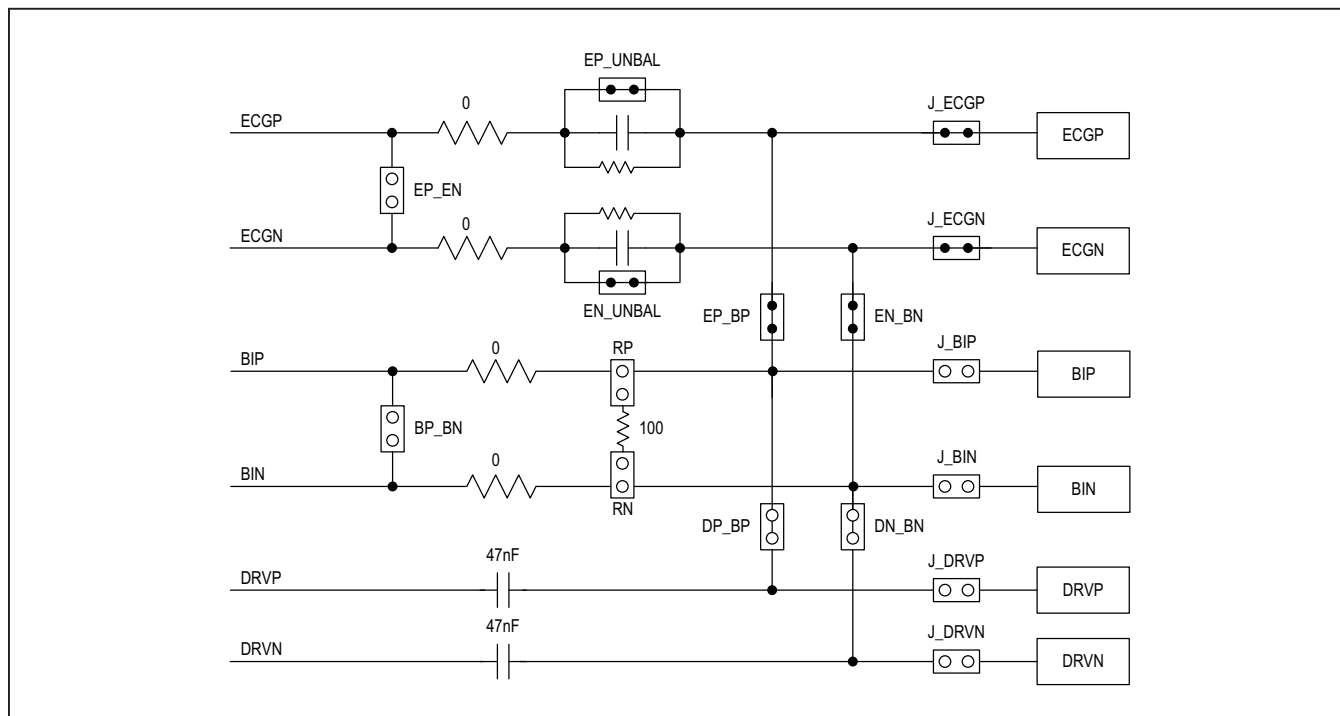


Figure 20. Configuring the EV Kit to Detect Pace Signals.

Component Suppliers

SUPPLIER	WEBSITE
Bourns	www.bourns.com
Epson	www.epson.com
Kemet	www.kemet.com
Keystone	www.keyelco.com
Lite-On Electronics	us.liteon.com
Maxim Integrated	www.maximintegrated.com
Murata	www.murata.com
Panasonic	www.panasonic.com
Plastics One	www.plasticsone.com
Sullins Connector Solutions	www.sullinscorp.com
Susuma	www.susuma-usa.com
Taiyo Yuden	www.t-yuden.com
TDK	www.global.tdk.com
TE Connectivity	www.te.com
Vishay Dale	www.vishay.com

Note: Indicate that you are using the MAX30001 EV kit when contacting these component suppliers.

Ordering Information

PART	TYPE
MAX30001EVSYS#	EV System

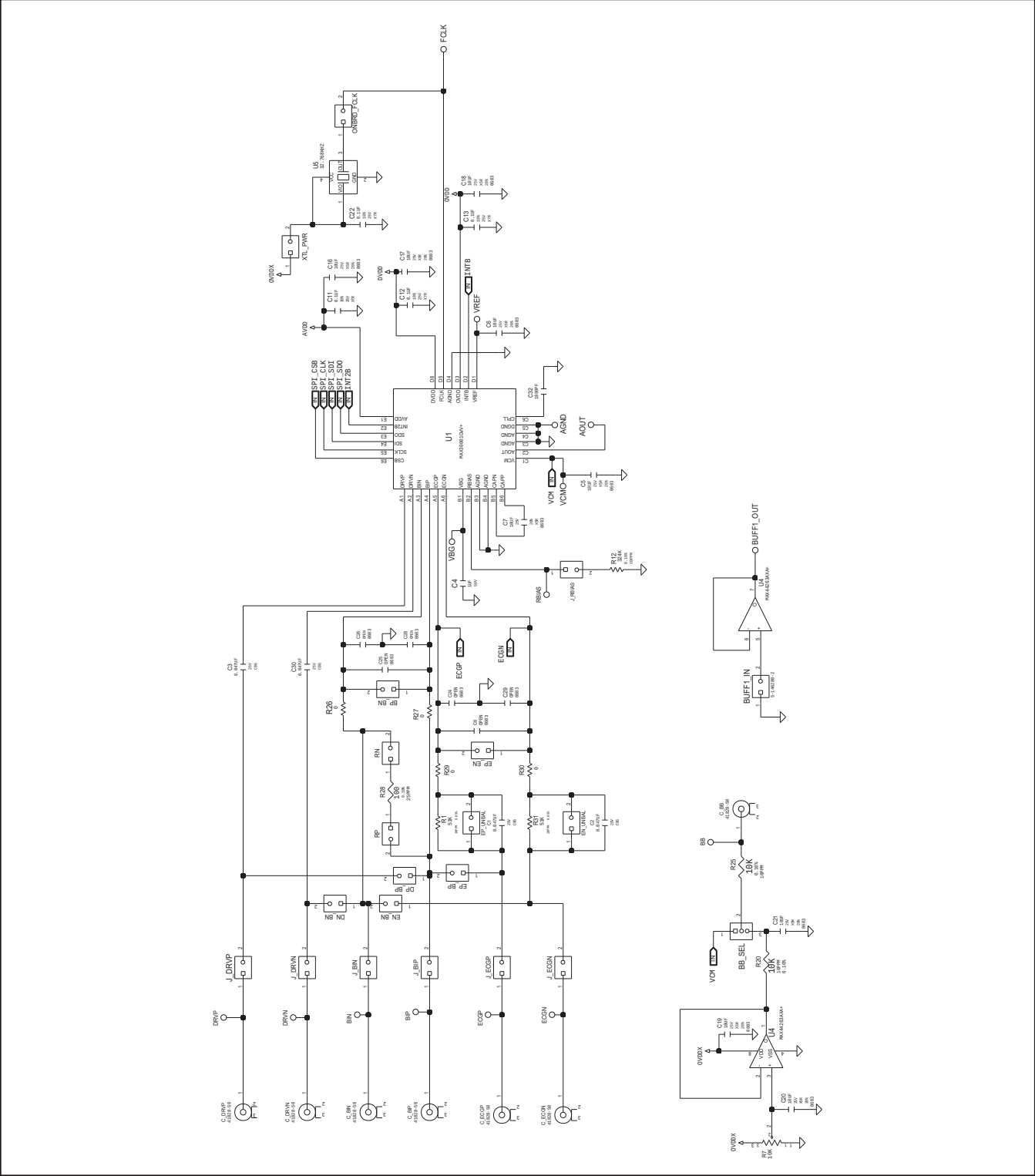
MAX30001 Evaluation System

Evaluates: MAX30001
MAX30002

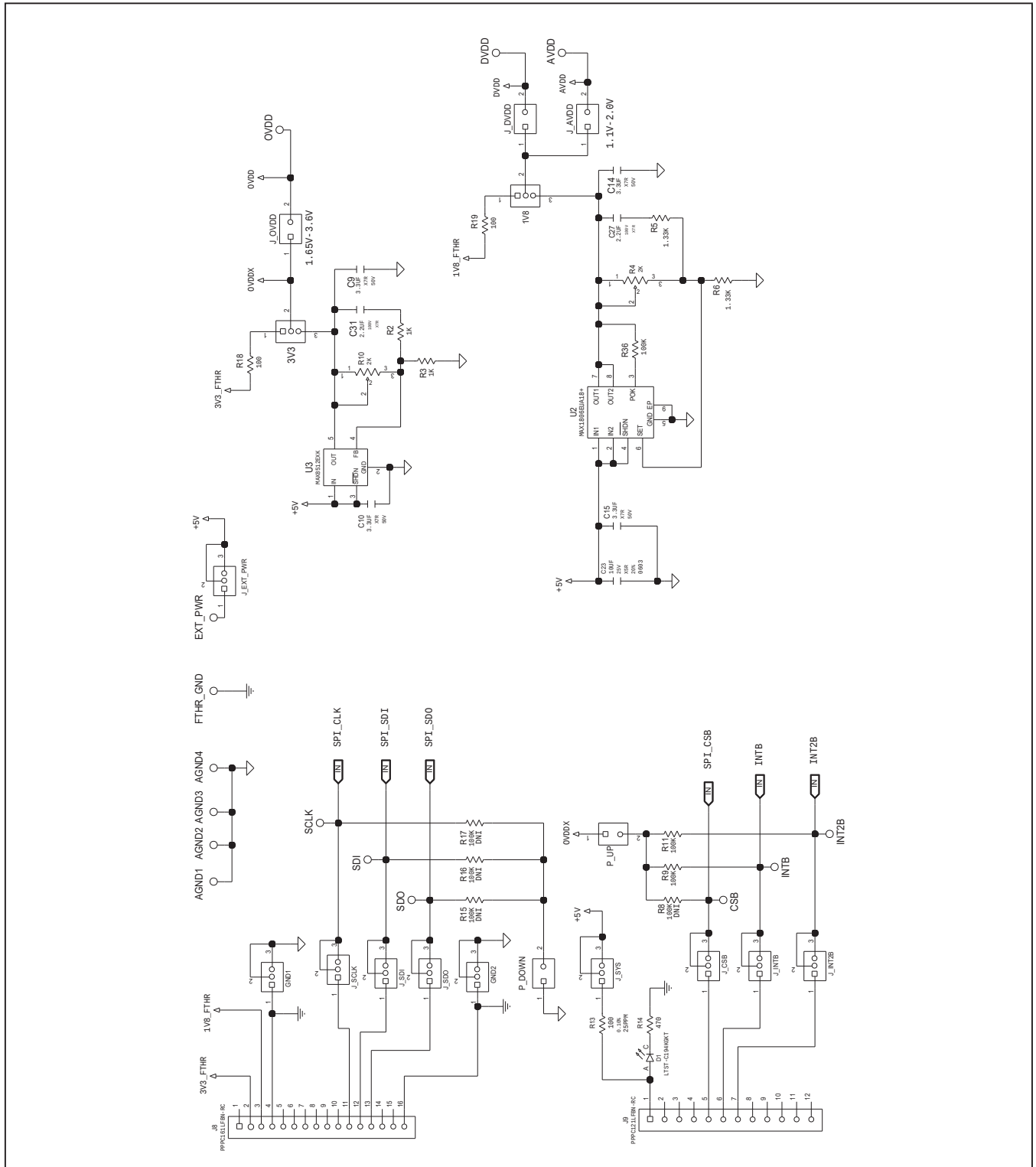
MAX30001 EV Kit Bill of Materials (BOM)

ITEM	REF_DES	DWIDNP	QTY	MFG PART #	MANUFACTURER	VALUE	DESCRIPTION
1	1V8, 3V3, GND1, GND2, J_CS8, J_SDI, J_SDO, J_SYS, BB_SEL, J_INTB, J_SCLK, J_INT2B, J_EXT_PWR	-	13	PC033SAAN	SULLINS	PC033SAAN	CONNECTOR, MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT THROUGH; 3PINS; -65 DEGC TO +125 DEGC
2	BB, BIN, BIP, CS8, SDI, SDO, VBG, VCM, AGND, AOUT, DRVN, DRVP, ECGN, ECGP, FCLK, INTB, SCLK, VREF, AGND1-AGND4, INT2B, RBIAS, FTHR_GND, BUFF1_OUT	-	26	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;
3	AVDD, DVDD, OVDD, EXT_PWR	-	4	5010	KEYSTONE	N/A	TESTPOINT WITH 1.80MM HOLE DIA, RED, MULTIPURPOSE;
4	RN, RP, P_UP, BP, BN, DN, BN, DP, BP, EN, BN, EP, BP, EP, EN, J_BIN, J_BIP, J_AVDD, J_DRVN, J_DRVP, J_DVDD, J_ECGN, J_ECGP, J_OVDD, P_DOWN, J_RBIAS, XTAL_PWR, BUFF1_IN, EN_UNBAL, EP_UNBAL, ONBRD_FCLK	-	25	5-146280-2	TE CONNECTIVITY	5-146280-2	CONNECTOR, MALE; THROUGH HOLE; HEADER ASSEMBLY; MOD II; BREAKWAY; SINGLE ROW; HIGH TEMPERATURE; VERTICAL; W/0.025 SQ POST; 0.100 C; STRAIGHT; 2PINS
5	C1-C3, C30	-	4	C0805C473J3GAC	KEMET	0.047UF	CAPACITOR; SMT (0805); CERAMIC CHIP; 0.047UF; 25V; TOL=5%; TG=55 DEGC TO +125 DEGC; TC=CG
6	C4	-	1	UMK107AB7105KA	TAIYO YUDEN	1UF	CAPACITOR; SMT (0603); CERAMIC CHIP; 1UF; 50V; TOL=10%; TG=55 DEGC TO +125 DEGC; TC=XTR
7	C5-C7, C16-C21, C23	-	10	GRM188R61E106MA73	MURATA	10UF	CAPACITOR; SMT (0603); CERAMIC CHIP; 10UF; 25V; TOL=20%; TG=55 DEGC TO +85 DEGC; TC=XSR; GRM SERIES; MURATA
8	C9, C10, C14, C15	-	4	C3216X7R1H335M160AC	TDK	3.3UF	CAPACITOR; SMT (1206); CERAMIC CHIP; 3.3UF; 50V; TOL=20%; MODEL=C SERIES; TG=55 DEGC TO +125 DEGC; TC=XTR
9	C11-C13, C22	-	4	C1608X7R1E104K080A4	TDK	0.1UF	CAPACITOR; SMT (0603); CERAMIC CHIP; 0.1UF; 25V; TOL=10%; MODEL=C SERIES; TG=55 DEGC TO +125 DEGC; TC=XTR
10	C27, C31	-	2	GRM31CR72A225KA73; KRM31KR72A225KH01	MURATA	2.2UF	CAPACITOR; SMT (1206); CERAMIC CHIP; 2.2UF; 100V; TOL=10%; MODEL=GRM SERIES; TG=55 DEGC TO +125 DEGC; TC=XTR
11	C32	-	1	C0603C102J5GAC; 0603A102JAT2A	KEMET/AVX/MURATA	1000PF	CAPACITOR; SMT; 0603; CERAMIC; 1000pF; 50V; 5%; COG; -55degC to +125degC
12	C_BB, C_BIN, C_BIP, C_DRVN, C_DRVP, C_ECGN, C_ECGP	-	7	41828-50	PLASTICS ONE	41828-50	CONNECTOR; FEMALE; THROUGH HOLE; JACK; PCB; 1.5MM; TOUCHPROOF WAVE SOLDER VERSION WITH STAMPING; RIGHT ANGLE; 3PINS
13	D1	-	1	LTST-C194KGKT	LITE-ON ELECTRONICS INC	LTST-C194KGKT	DIODE; LED; SMD CHIP LED; WATER CLEAR LENS; AinGap GREEN; GREEN; SMT (0803); VF=2.1V; IF=0.02A
14	J8	-	1	PPPC161LFBN-RC	SULLINS ELECTRONICS CORP.	PPPC161LFBN-RC	CONNECTOR; FEMALE; THROUGH HOLE; LFB SERIES; 2.54MM CONTACT CENTER; STRAIGHT; 16PINS
15	J9	-	1	PPPC121LFBN-RC	SULLINS ELECTRONICS CORP	PPPC121LFBN-RC	CONNECTOR; FEMALE; THROUGH HOLE; HEADER FEMALE; STRAIGHT; 12PINS
16	R1, R31	-	2	ERA-6ARWS13	PANASONIC	51K	RESISTOR; 0805; 51K OHM; 0.05%; 10PPM; 0.125W; THIN FILM
17	R2, R3	-	2	CRCW06031001FK; ERJ-3EKF1001V	VISHAY DALE; PANASONIC	1K	RESISTOR; 0603; 1K; 1%; 100PPM; 0.10W; THICK FILM
18	R4, R10	-	2	3296Y-202LF	BOURNS	2K	RESISTOR; THROUGH HOLE-RADIAL LEAD; 3296Y SERIES; 2K OHM; 10%; 100PPM; 0.5W
19	R5, R6	-	2	CRCW06031K33FK	VISHAY DALE	1.33K	RESISTOR; 0603; 1.33K; 1%; 100PPM; 0.10W; THICK FILM
20	R7	-	1	3296Y-1-103LF	BOURNS	10K	RESISTOR; THROUGH-HOLE; 10K OHM; 10%; 100PPM; 0.5W; MOLDER CERAMIC OVER METAL FILM
21	R9, R11, R36	-	3	CRCW06031003FK; ERJ-3EKF1003	VISHAY DALE/PANASONIC	100K	RESISTOR; 0603; 100K; 1%; 100PPM; 0.10W; THICK FILM
22	R12	-	1	RN73C1324KB; 4-1879135-8	TE CONNECTIVITY	324K	RESISTOR; 0603; 324K OHM; 0.1%; 10PPM; 0.063W; THIN FILM
23	R13, R18, R19, R28	-	4	RG1608P-101-B-T5; ERA-3YEB101V	SUSUMU CO LTD./PANASONIC	100	RESISTOR; 0603; 100 OHM; 0.1%; 25PPM; 0.1W; THICK FILM
24	R14	-	1	RG1608P-471-B-T5	SUSUMU CO LTD.	470	RESISTOR; 0603; 470 OHM; 0.1%; 25PPM; 0.10W; THICK FILM
25	R20, R25	-	2	ERA-3AR8103	PANASONIC	10K	RESISTOR; 0603; 10K OHM; 0.1%; 10PPM; 0.1W; THIN FILM
26	R26, R27, R29, R30	-	4	CRCW06030000Z5; MCR03EZP3000; ERJ-3GEV0R00	VISHAY DALE/ROHM/ PANASONIC	0	RESISTOR; 0603; 0 OHM; 0%; JUMPER; 0.10W; THICK FILM
27	U1	-	1	MAX30001CWW+	MAXIM	MAX30001CWW+	EVKIT PART-IC; MAX30001; ULTRA-LOW POWER; SINGLE-CHANNEL INTEGRATED BIOPOTENTIAL AND BIOIMPEDANCE AFE; PACKAGE OUTLINE: 21-100074; PACKAGE CODE: W302L2+1; WLP30
28	U2	-	1	MAX1806EUA18+	MAXIM	MAX1806EUA18+	IC; VREG; LOW-VOLTAGE LINEAR REGULATOR; UMAX8-EP
29	U3	-	1	MAX8512EXK	MAXIM	MAX8512EXK	IC; VREG; Ultra-Low-Noise, High-PSRR, Adjustable Vout; SC70-5
30	U4	-	1	MAX44263AXA+	MAXIM	MAX44263AXA+	IC; OPAMP; 1.8V; 15MHZ LOW-OFFSET; LOW-POWER; RAIL-TO-RAIL I/O DUAL OPERATIONAL AMPLIFIER; SC70-8
31	U5	-	1	SG-3030-JF-32.768000KHZ-B	EPSON	32.768KHZ	OSCILLATOR; SMT; 32.768KHZ;
32	PCB	-	1	MAX	MAXIM	PCB	PCB MAX
33	C8, C24-C26, C28, C29	DNP	0	N/A	N/A	OPEN	PACKAGE OUTLINE 0603 NON-POLAR CAPACITOR
34	R8, R15-R17	DNP	0	CRCW06031003FK; ERJ-3EKF1003	VISHAY DALE/PANASONIC	100K	RESISTOR; 0603; 100K; 1%; 100PPM; 0.10W; THICK FILM
TOTAL			134				

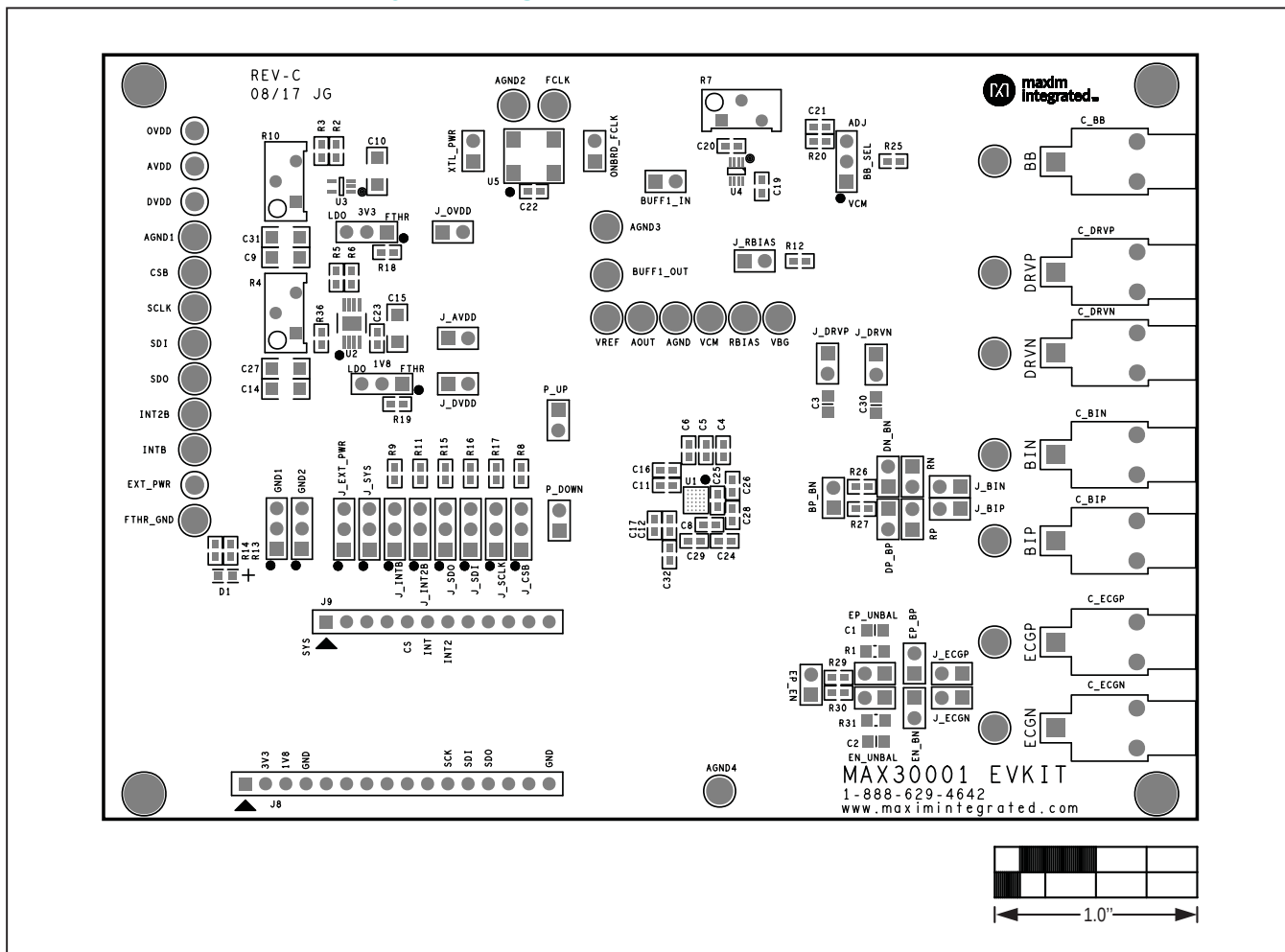
MAX30001 EV Kit Schematic



MAX30001 EV Kit Schematic (continued)

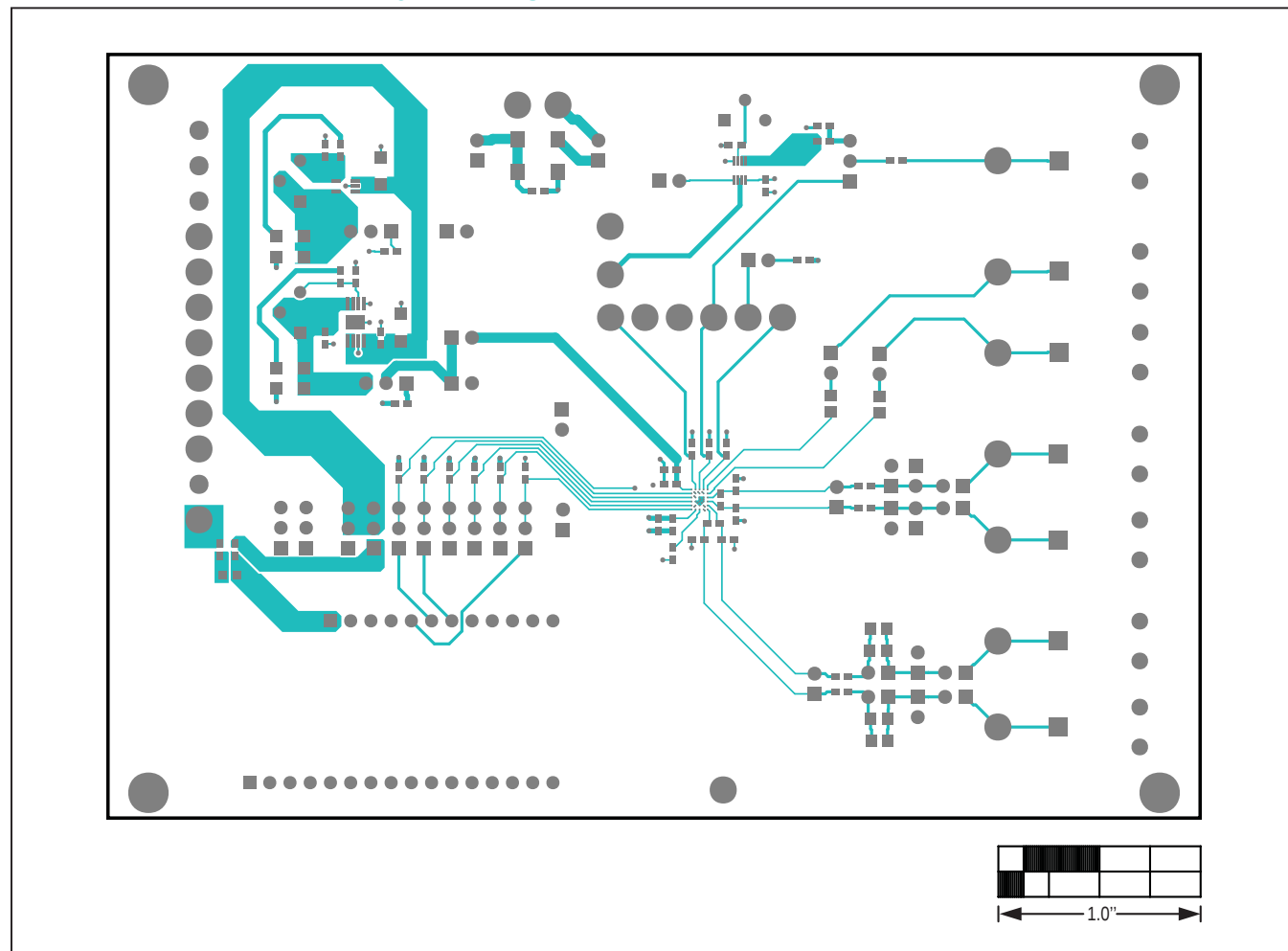


MAX30001 EV Kit PCB Layout Diagrams



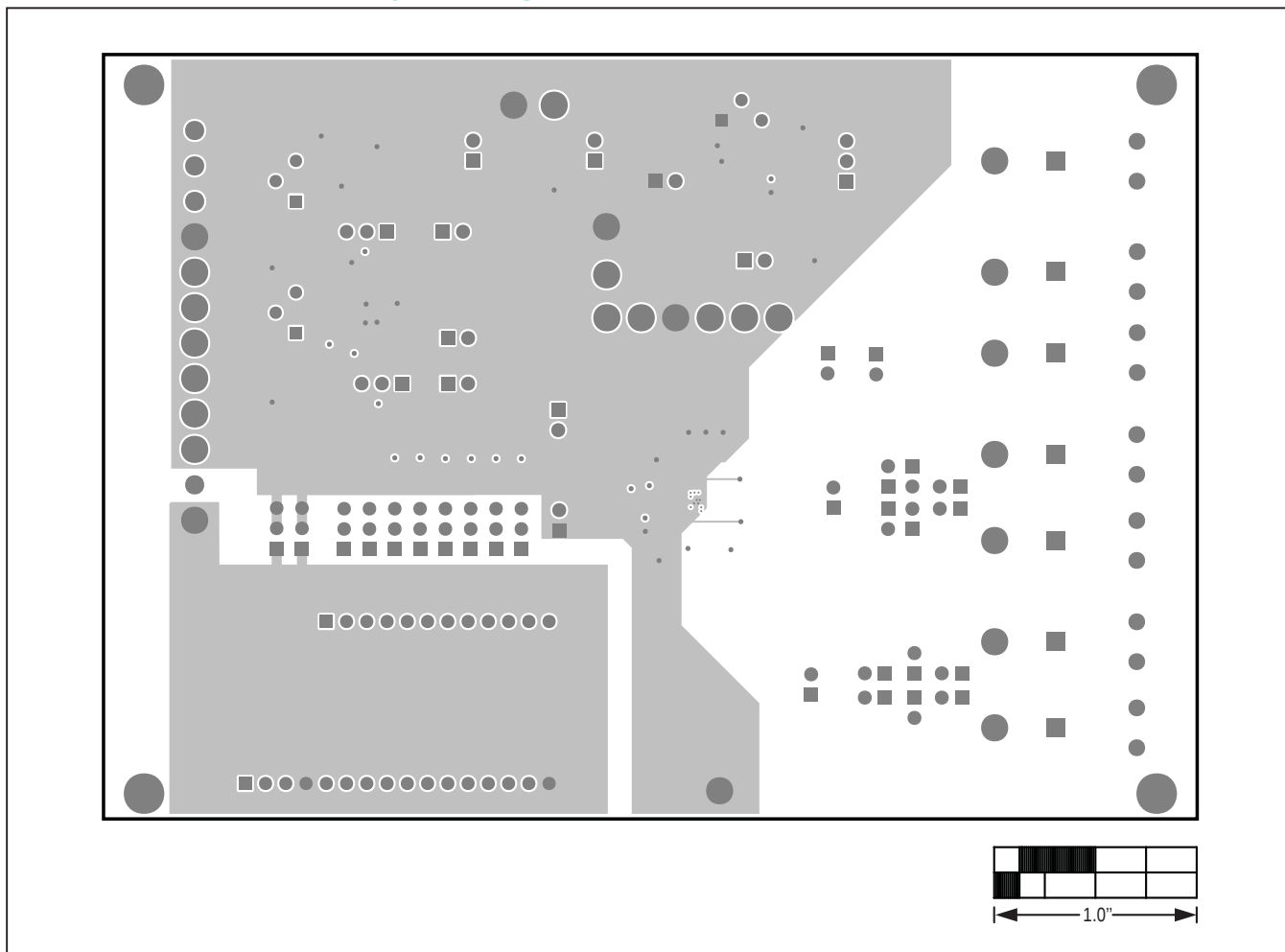
MAX30001 EV Kit—Top Silkscreen

MAX30001 EV Kit PCB Layout Diagrams (continued)



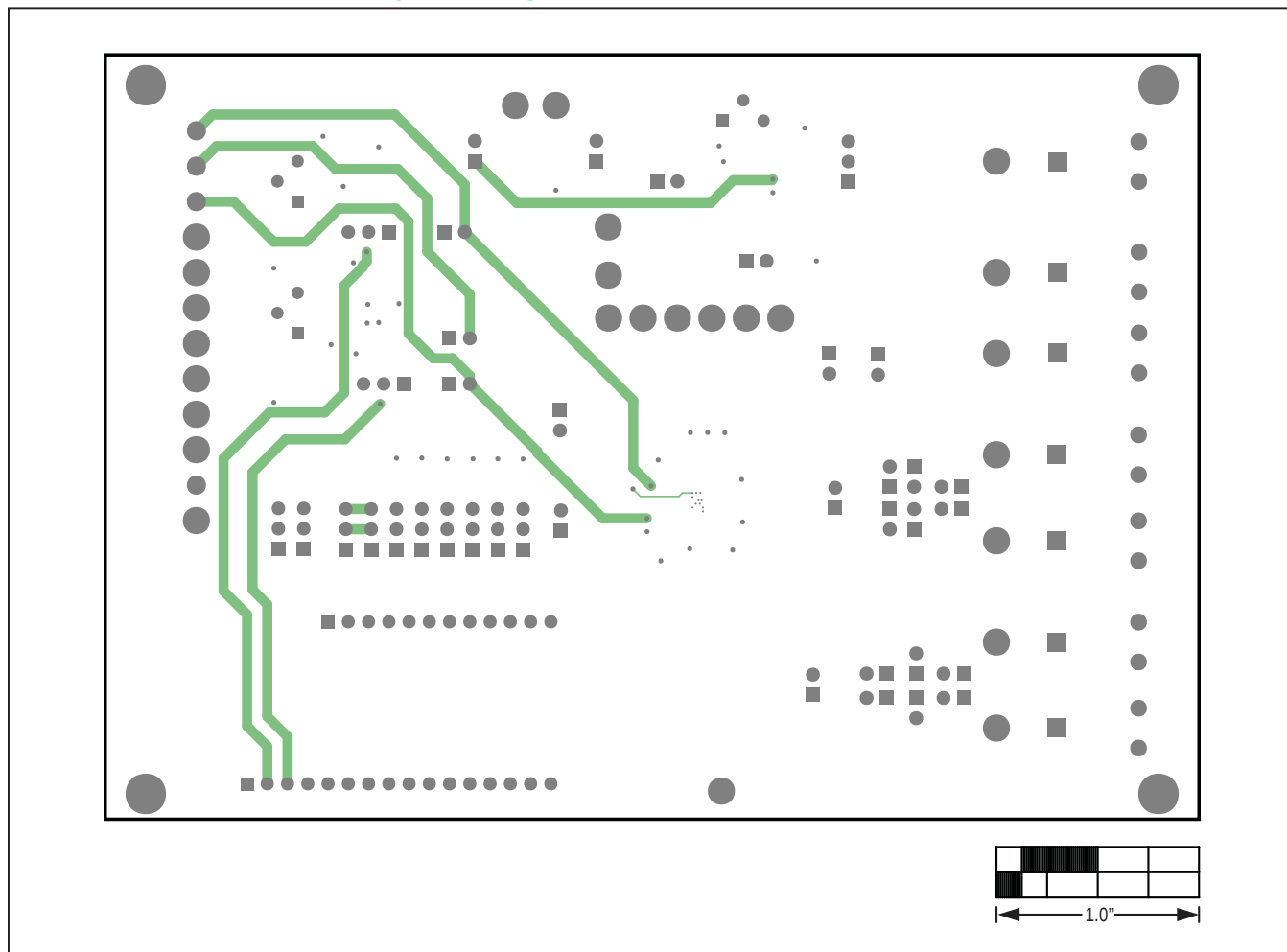
MAX30001 EV Kit—Top

MAX30001 EV Kit PCB Layout Diagrams (continued)



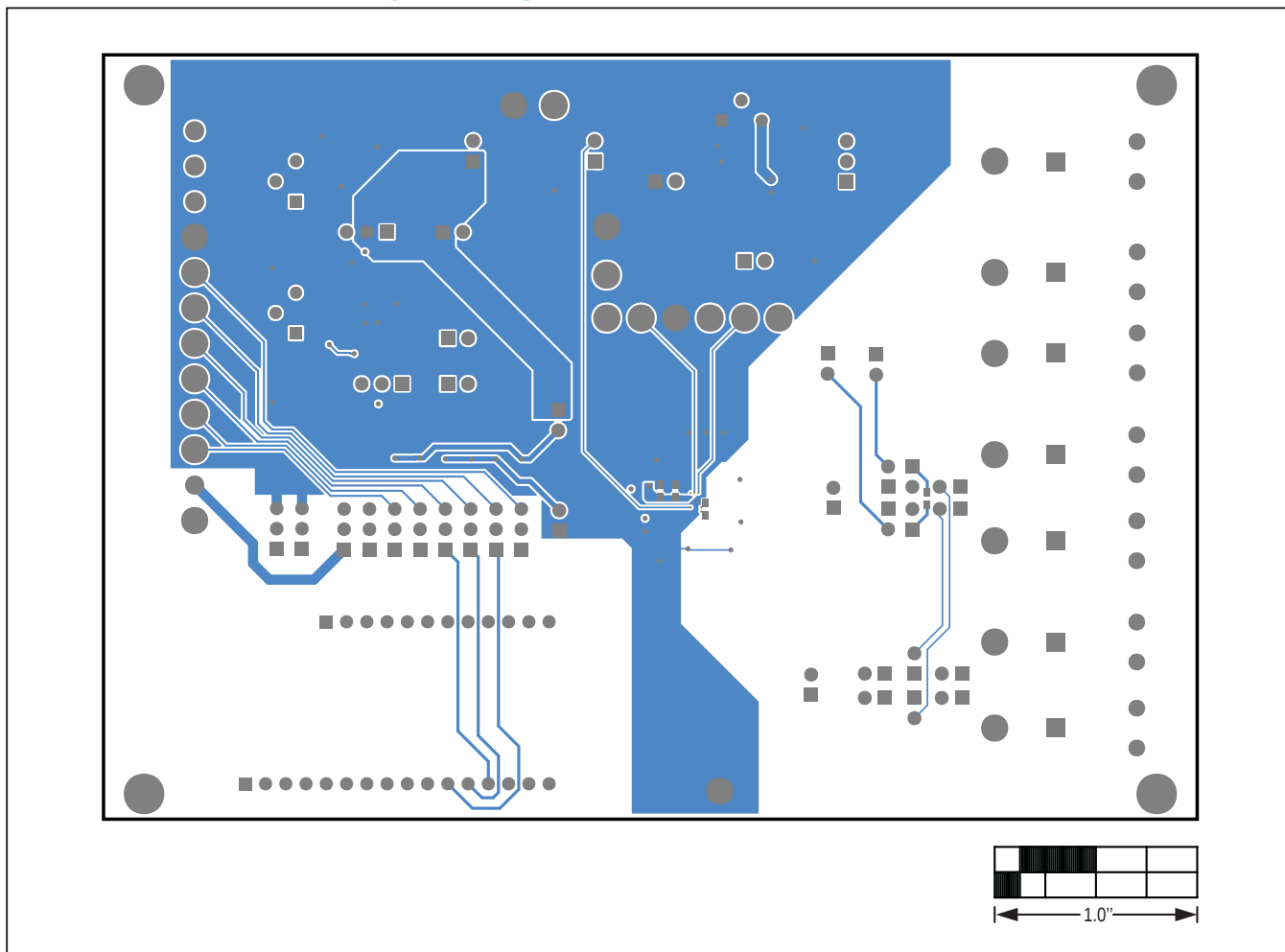
MAX30001 EV Kit—Layer 2

MAX30001 EV Kit PCB Layout Diagrams (continued)



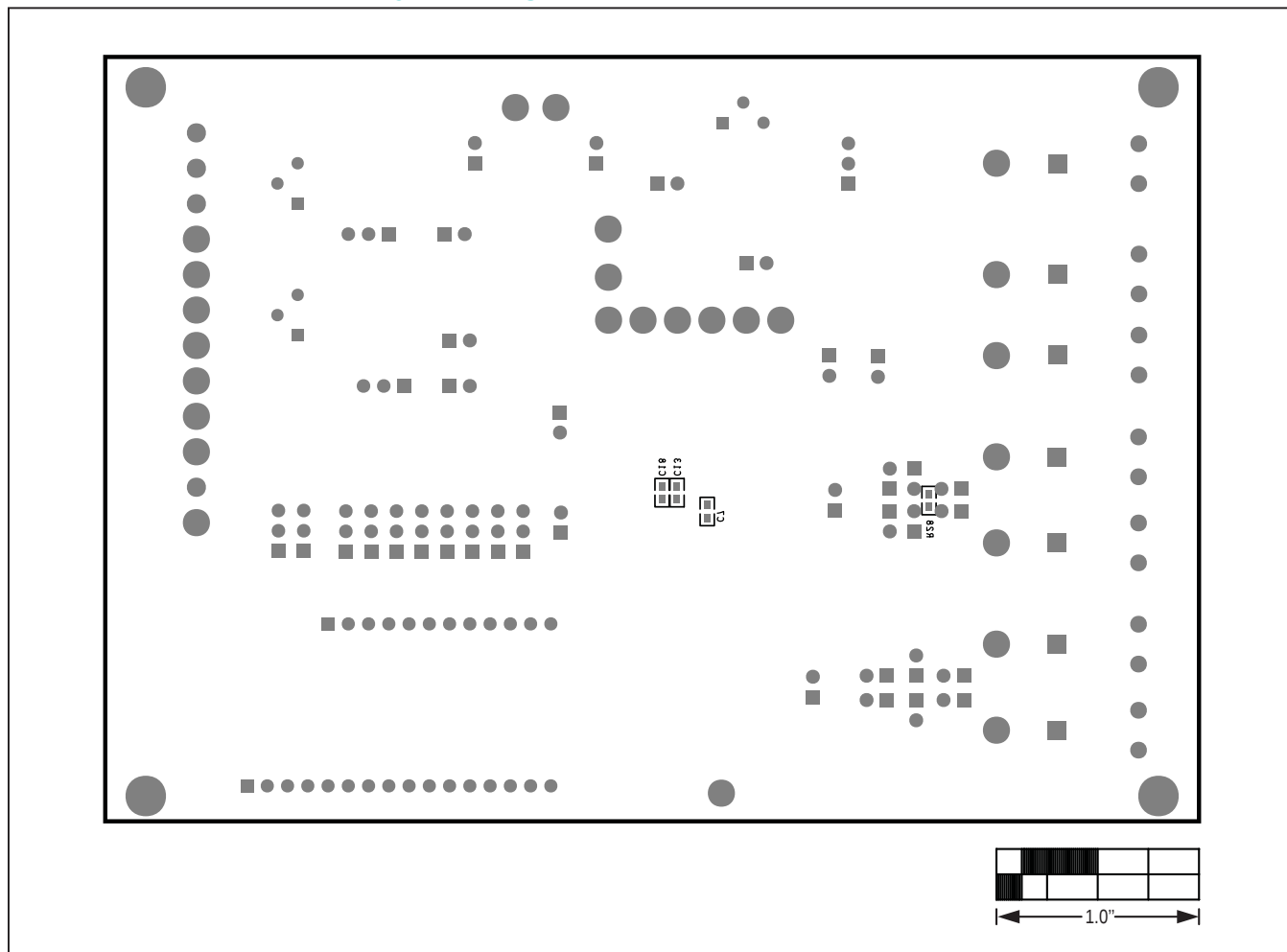
MAX30001 EV Kit—Layer 3

MAX30001 EV Kit PCB Layout Diagrams (continued)



MAX30001 EV Kit—Bottom

MAX30001 EV Kit PCB Layout Diagrams (continued)



MAX30001 EV Kit—Bottom Silkscreen

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	10/17	Initial release	—
1	5/18	Added MAX30002 part number to data sheet	1–34

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