



## MAX17106 Evaluation Kit

Evaluates: MAX17106

### General Description

The MAX17106 evaluation kit (EV kit) is a fully assembled and tested surface-mount PCB that provides the voltages and features required for active-matrix TFT LCD applications. The EV kit contains a step-up switching regulator for the MAIN supply, a step-up switching regulator with temperature compensation for the TFT VON supply, a two-stage negative charge pump for the TFT VOFF supply, a linear regulator (LOUT), three high-current op amps (VCOM1, VCOM2, VCOM3), a digitally adjustable VCOM calibration device with nonvolatile memory, two EEPROM memory blocks with separate I<sup>2</sup>C interfaces, and a high-voltage level-shifting scan driver with complementary outputs for charge sharing during state changes to drive the TFT panel integrated gate drivers. A high-voltage stress (HVS) mode increases the MAIN and VOFF charge-pump output voltages for stress testing the display panel during production.

The EV kit operates from a +2.4V to +5.5V DC supply voltage. The MAIN step-up switching regulator is configured for a +8V output providing at least 300mA. The VON step-up switching regulator is configured for a +22V output (at room temperature) providing at least 20mA. The VOFF negative charge pump is configured for a -12V output providing at least 20mA. The internal linear regulator (LOUT) provides a fixed +2.5V output and 300mA. The three high-current op amps are each configured for a +4V output. Each can source or sink 50mA. The MAX17106 switches at 1.2MHz, allowing the use of tiny surface-mount components. The MAX17106 TQFN package, with low-profile external components, allows this circuit to be less than 1.2mm high.

The EV kit provides two on-board USB interface circuits to communicate with the two separate 2-wire I<sup>2</sup>C interface circuits in the MAX17106 IC. One of the I<sup>2</sup>C interface circuits provides the VCOM calibrator (DVR) and 2kb extended display identification data (EDID) EEPROM communication, while the other provides the 16kb timing controller (TCON) EEPROM communication. The MAX17106 I<sup>2</sup>C interface circuits communicate at a data rate of 100kHz.

The EV kit features Windows® 2000-, Windows XP®, or Windows Vista®-compatible software that provides the user interface for exercising the MAX17106's features. The MAX17106DVR.EXE software controls the VCOM calibrator and EDID EEPROM, while the MAX17106TCON.EXE software controls the TCON EEPROM in the MAX17106 IC. Both programs are menu-driven and offer a graphical user interface (GUI). **The two software programs are independent of one another and can operate alone or simultaneously.**

### Features

- ◆ +2.4V to +5.5V Single-Supply Operation
- ◆ Output Voltages
  - +8V Output at 300mA (MAIN Step-Up Switching Regulator)
  - +22V Output at 20mA (VON Step-Up Switching Regulator at Room Temperature)
  - 12V Output at 20mA (Negative Charge Pump)
  - +2.5V Output at 300mA (Low Dropout Linear Regulator)
- ◆ Three High-Current Op Amps (±50mA)
- ◆ Temperature-Compensated VON Output Voltage
- ◆ 1.2MHz Switching Frequency
- ◆ All Output Voltages are Resistor Adjustable
- ◆ HVS Mode for the MAIN and VON Step-up Output Voltages
- ◆ On-Board USB Interface Circuit Generates I<sup>2</sup>C-Compatible Signals for VCOM Calibrator and EDID EEPROM
- ◆ On-Board USB Interface Circuit Generates I<sup>2</sup>C-Compatible Signals for TCON EEPROM
- ◆ USB-PC Connection and Power (Two Cables Included)
- ◆ PCB Pads for User-Supplied I<sup>2</sup>C-Compatible Signals
- ◆ Evaluates the MAX17106ETN+ in a 56-Pin TQFN (7mm x 7mm x 0.8mm) Package
- ◆ Windows 2000-, Windows XP-, and Windows Vista (32-Bit)-Compatible Software for VCOM Calibrator and EDID EEPROM (MAX17106DVR.EXE) and TCON EEPROM (MAX17106TCON.EXE)
- ◆ Proven PCB Layout
- ◆ Fully Assembled and Tested

### Ordering Information

PART	TYPE
MAX17106EVKIT+	EV Kit

+Denotes lead(Pb)-free and RoHS compliant.

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## Component List

DESIGNATION	QTY	DESCRIPTION
C1, C2	2	10 $\mu$ F $\pm$ 20%, 6.3V X5R ceramic capacitors (0603) Murata GRM188R60J106M or TDK C1608X5R0J106M
C3, C4	2	4.7 $\mu$ F $\pm$ 10%, 16V X5R ceramic capacitors (1206) Murata GRM319R61C475KA or TDK C3216X5R1C475K
C5	1	1 $\mu$ F $\pm$ 20%, 50V X5R ceramic capacitor (1206) Murata GRM31MR61H105M or TDK C3216X5R1H105M
C6, C7, C10, C114, C116, C121–C124, C214, C216, C221, C222, C223, C224	15	1 $\mu$ F $\pm$ 10%, 10V X5R ceramic capacitors (0603) Murata GRM188R61A105K or TDK C1608X5R1A105K
C8	1	1 $\mu$ F $\pm$ 20%, 10V X5R ceramic capacitor (0805) Murata GRM219R61A105M or TDK C2012X5R1A105M
C9, C11–C19	10	0.1 $\mu$ F $\pm$ 10%, 50V X7R ceramic capacitors (0603) Murata GRM188R71H104K or TDK C1608X7R1H104K
C20, C120, C220	3	3300pF $\pm$ 10%, 50V X7R ceramic capacitors (0603) Murata GRM188R71H332K or TDK C1608X7R1H332K
C21	1	220pF $\pm$ 10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H221K or TDK C1608X7R1H221K
C22	1	47pF $\pm$ 5%, 50V C0G ceramic capacitor (0603) Murata GRM1885C1H470J or TDK C1608C0G1H470J
C23–C26	0	Not installed, ceramic capacitors (0603)

DESIGNATION	QTY	DESCRIPTION
C27	0	Not installed, ceramic capacitor (1206)
C28, C118, C119, C218, C219	5	22pF $\pm$ 5%, 50V C0G ceramic capacitors (0603) Murata GRM1885C1H220J or TDK C1608C0G1H220J
C29	1	100pF $\pm$ 5%, 50V C0G ceramic capacitor (0603) Murata GRM1885C1H101J or TDK C1608C0G1H101J
C101, C103–C110, C117, C201, C203–C210, C217	20	0.1 $\mu$ F $\pm$ 10%, 16V X7R ceramic capacitors (0603) Murata GRM188R71C104K or TDK C1608X7R1C104K
C102, C113, C115, C202, C213, C215	6	10 $\mu$ F $\pm$ 20%, 6.3V X5R ceramic capacitors (0805) Murata GRM21BR60J106M or TDK C2012X5R0J106M
C111, C112, C211, C212	4	10pF $\pm$ 5%, 50V C0G ceramic capacitors (0603) Murata GRM1885C1H100J or TDK C1608C0G1H100J
D1	1	3A, 30V Schottky diode (M-Flat) Toshiba CMS02(TE12L,Q)
D2	1	1A, 60V Schottky diode (SOD123F) Central Semi CMMSH1-60+ (Top Mark: CS60F)
D3, D4	2	200mA, 100V dual diodes (SOT23) Fairchild MMBD4148SE or (Top Mark: D4) Central Semi CMPD7000+ (Top Mark: C5C)
D101, D201	2	Green LEDs (0603)
FB101, FB201	0	Not installed, ferrite beads (0603)
JU1–JU8	8	2-pin headers
JU101	1	3-pin header

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## Component List (continued)

DESIGNATION	QTY	DESCRIPTION
L1	1	3.6 $\mu$ H, 1.8A power inductor Sumida CMD6D11BNP-3R6MC
L2	1	3.3 $\mu$ H, 0.86A power inductor Sumida CDRH4D11-3R3MC
R1, R21	2	100k $\Omega$ $\pm$ 5% resistors (0603)
R2, R23–R27	0	Not installed, resistors (0603)
R3–R6, R108, R109, R208, R209	8	2k $\Omega$ $\pm$ 5% resistors (0603)
R7, R8	2	200 $\Omega$ $\pm$ 5% resistors (0603)
R9	1	20k $\Omega$ $\pm$ 5% resistor (0603)
R10	1	118k $\Omega$ $\pm$ 1% resistor (0603)
R11	1	187k $\Omega$ $\pm$ 1% resistor (0603)
R12	1	34k $\Omega$ $\pm$ 1% resistor (0603)
R13	1	237k $\Omega$ $\pm$ 1% resistor (0603)
R14	1	10k $\Omega$ $\pm$ 1% resistor (0603)
R15–R20	6	200k $\Omega$ $\pm$ 1% resistors (0603)
R22	1	24.9k $\Omega$ $\pm$ 1% resistor (0603)
R28	1	6.19k $\Omega$ $\pm$ 1% resistor (0603)
R29	1	12.1k $\Omega$ $\pm$ 1% resistor (0603)
R30	1	4.02k $\Omega$ $\pm$ 1% resistor (0603)
R31	1	4.99k $\Omega$ $\pm$ 1% resistor (0603)
R32	1	49.9k $\Omega$ $\pm$ 1% resistor (0603)
R101, R201	2	0 $\Omega$ $\pm$ 5% resistors (0603)
R102, R202	2	220 $\Omega$ $\pm$ 5% resistors (0603)
R103, R203	2	10k $\Omega$ $\pm$ 5% resistors (0603)
R104, R204	2	2.2k $\Omega$ $\pm$ 5% resistors (0603)
R105, R205	2	1.5k $\Omega$ $\pm$ 5% resistors (0603)
R106, R107, R206, R207	4	27 $\Omega$ $\pm$ 5% resistors (0603)
RT1	1	10k $\Omega$ $\pm$ 5% thermistor (0603) Murata NCP18XH103J03

DESIGNATION	QTY	DESCRIPTION
RT2	0	Not installed, thermistor (0603)
U1	1	TFT LCD power system (56 TQFN-EP*) Maxim MAX17106ETN+
U101, U201	2	32-bit microcontrollers (68 QFN-EP*) Maxim MAXQ2000-RAX+
U102, U202	2	93C46 type 3-wire E <sup>2</sup> PROMs (8 SO)
U103, U203	2	UART-to-USB converters (32 TQFP)
U104, U204	2	3.3V regulators (5 SC70) Maxim MAX8511EXK33+T (Top Mark: AEI)
U105, U205	2	2.5V regulators (5 SC70) Maxim MAX8511EXK25+T (Top Mark: ADV)
U106, U107, U206, U207	4	Low-voltage level translators (10 $\mu$ MAX®) Maxim MAX1840EUB+
USB1, USB2	2	USB type-B right-angle female receptacles
Y101, Y201	2	16MHz crystals Hong Kong X'tals SSM1600000E18FAF
Y102, Y202	2	6MHz crystals Hong Kong X'tals SSL6000000E18FAF
—	2	USB type-A male to USB type-B male receptacle, 6ft, beige
—	9	Shunts (JU1–JU8, JU101)
—	1	PCB: MAX17106 EVALUATION KIT+

\*EP = Exposed pad.

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## Component Suppliers

SUPPLIER	PHONE	WEBSITE
Central Semiconductor Corp.	631-435-1110	www.centrasemi.com
Fairchild Semiconductor	888-522-5372	www.fairchildsemi.com
Hong Kong X'tals Ltd.	852-35112388	www.hongkongcrystal.com
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com
Sumida Corp.	847-545-6700	www.sumida.com
TDK Corp.	847-803-6100	www.component.tdk.com
Toshiba America Electronic Components, Inc.	949-623-2900	www.toshiba.com/taec

**Note:** Indicate that you are using the MAX17106 when contacting these component suppliers.

### MAX17106 EV Kit DVR Software Files

FILE	DESCRIPTION
INSTALL.EXE	Installs the EV kit files on the computer
MAX17106DVR.EXE	Application program
FTD2XX.INF	USB driver file
UNINST.INI	Uninstalls the EV kit software
USB_Driver_Help.PDF	USB driver installation help file

### MAX17106 EV Kit TCON Software Files

FILE	DESCRIPTION
INSTALL.EXE	Installs the EV kit files on the computer
MAX17106TCON.EXE	Application program
FTD2XX.INF	USB driver file
UNINST.INI	Uninstalls the EV kit software
USB_Driver_Help.PDF	USB driver installation help file

### Quick Start

#### Required Equipment

- MAX17106 EV kit (two USB cables, included)
- One or two user-supplied Windows 2000, Windows XP, or Windows Vista PCs, each with an available USB port
- +2.4V to +3.6V, 2A DC power supply
- Voltmeter

**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. The test procedure assumes Windows XP SP2 is being used. Similar steps are required for the other supported operating systems.

#### Procedure

The MAX17106 EV kit is fully assembled and tested. Follow the steps below to verify board operation.

**Caution: Do not turn on the power supply until all connections are completed.**

- 1) Visit [www.maxim-ic.com/evkitsoftware](http://www.maxim-ic.com/evkitsoftware) to download the latest version of the MAX17106 EV kit DVR

software (17106DVRxx.ZIP) to the first PC. Save the EV kit software to a temporary folder and uncompress the ZIP files.

- 2) Download the latest version of the MAX17106 EV kit TCON software (17106TCONRxx.ZIP) to the second PC (or the first PC if a second PC is not available). Save the EV kit software to a temporary folder and uncompress the ZIP files.
- 3) Install the MAX17106 EV kit DVR software on the first PC by running the INSTALL.EXE program inside the temporary folder. The program files are copied and icons are created in the Windows **Start | Programs** menu.
- 4) Install the MAX17106 EV kit TCON software on the second PC by running the INSTALL.EXE program inside the temporary folder. The program files are copied and icons are created in the Windows **Start | Programs** menu.
- 5) Verify that shunts are installed in the default position for all the jumpers listed in the following table:

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JUMPER	SHUNT POSITION	EV KIT FUNCTION
JU1	Installed	Device enabled
JU2	Installed	Write protect disabled
JU3	Installed	SCL receives clock signal from the VCOM and EDID EEPROM USB interface circuit (USB1)
JU4	Installed	SDA receives data signal from the VCOM and EDID EEPROM USB interface circuit (USB1)
JU5	Installed	SCLT receives clock signal from the TCON EEPROM USB interface circuit (USB2)
JU6	Installed	SDAT receives data signal from the TCON EEPROM USB interface circuit (USB2)
JU7	Not installed	HVS disabled
JU8	Installed	VDD supplied by VIN
JU101	Pins 1-2	I <sup>2</sup> C logic level supplied by the MAX17106 power supply

- 6) Turn on the power supply and set the supply to +3.3V; disable the power supply.
- 7) Connect the positive terminal of the power supply to the VIN pad on the EV kit. Connect the negative terminal of the power supply to the PGND pad next to the VIN pad.
- 8) Enable the power supply.
- 9) Verify that the MAIN step-up switching regulator output (MAIN) is +8V.
- 10) Verify that the VON step-up switching regulator output (VON) is +22V.
- 11) Verify that the unregulated VOFF negative charge-pump output (VOFF) is approximately -12V.
- 12) Verify that the op-amp outputs (VCOM1, VCOM2, and VCOM3) are +4V.
- 13) Connect the first USB cable from the first PC (DVR software) to the USB1 USB connector on the EV kit board. A **New Hardware Found** window pops up when installing the USB driver for the first time. If a window is not seen that is similar to the one described above after 30s, remove the USB cable from the board and reconnect it. Administrator privileges are required to install the USB device driver on Windows.

- 14) Follow the directions of the **Add New Hardware Wizard** to install the USB device driver. Choose the **Search for the best driver for your device** option. Specify the location of the device driver to be **C:\Program Files\MAX17106DVR** (default installation directory) using the **Browse** button. During device driver installation, Windows may show a warning message indicating that the device driver Maxim uses does not contain a digital signature. This is not an error condition and it is safe to proceed with installation. Refer to the USB\_Driver\_Help.PDF document included with the software for additional information.
- 15) Connect the second USB cable from the second PC (TCON software) to the USB2 USB connector on the EV kit board. A **New Hardware Found** window pops up when installing the USB driver for the first time. If a window is not seen that is similar to the one described above after 30s, remove the USB cable from the board and reconnect it. Administrator privileges are required to install the USB device driver on Windows.
- 16) Follow the directions of the **Add New Hardware Wizard** to install the USB device driver. Choose the **Search for the best driver for your device** option. Specify the location of the device driver to be **C:\Program Files\MAX17106TCON** (default installation directory) using the **Browse** button. During device driver installation, Windows may show a warning message indicating that the device driver Maxim uses does not contain a digital signature. This is not an error condition and it is safe to proceed with installation. Refer to the USB\_Driver\_Help.PDF document included with the software for additional information.
- 17) Start the MAX17106 EV kit DVR and TCON software by opening their icon in the **Start | Programs** menu of the respective PC.
- 18) Observe as the programs automatically detect the I<sup>2</sup>C addresses in the MAX17106 and start the programs. After successful connection, the EV kit software main windows (Figures 1 and 2, respectively) appear in the top-left corner of the PC monitors.
- 19) The MAX17106 EV kit is ready for additional testing. See the *Detailed Description of MAX17106 EV Kit DVR (and/or TCON) Software* sections for more information on the software features. **Note:** Text in **bold** refers to user-selectable features in the MAX17106 EV kit DVR and TCON software programs. The MAX17106 EV kit DVR and TCON software are independent of one another, and can operate alone or simultaneously.

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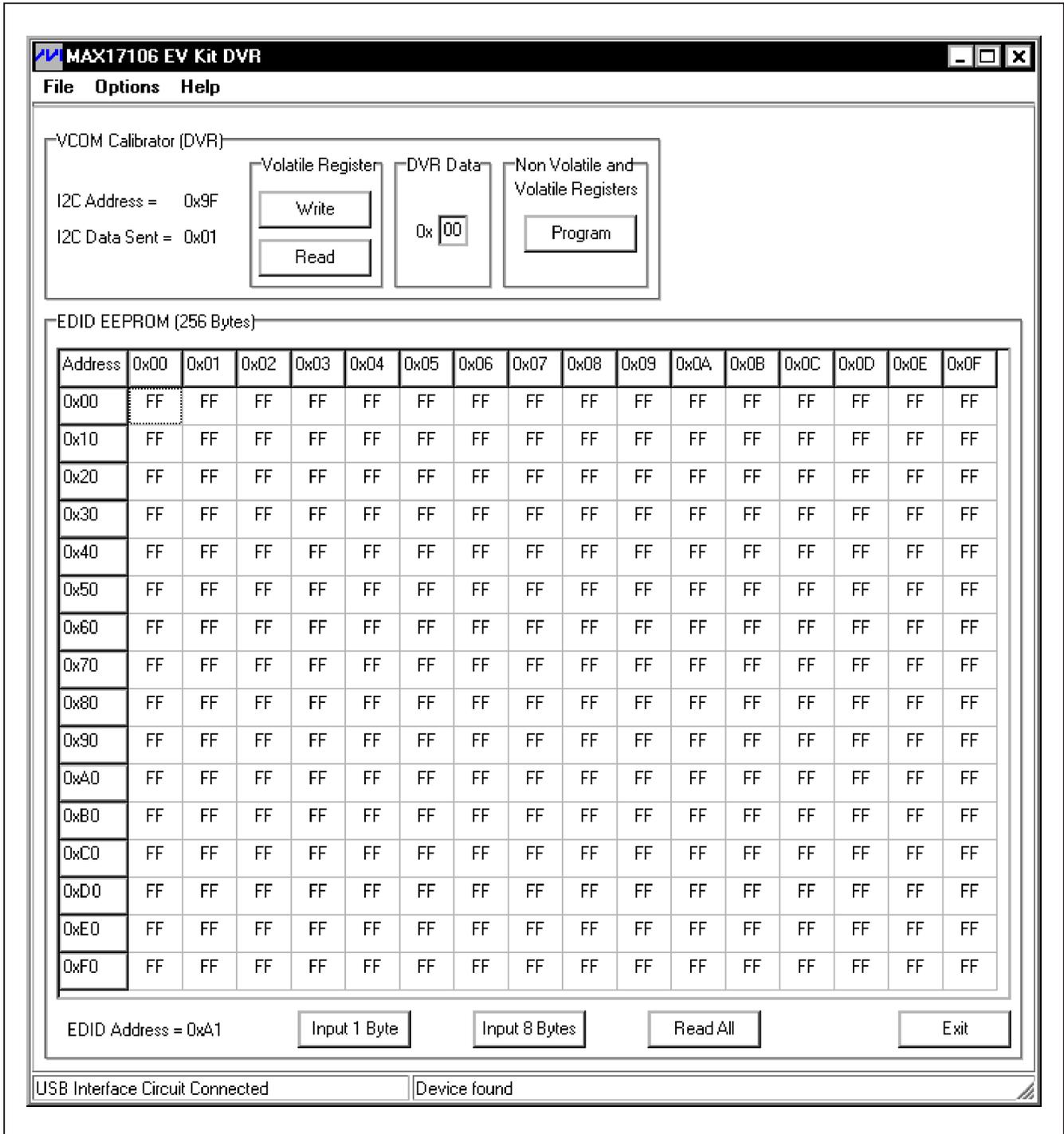


Figure 1. MAX17106 EV Kit DVR Software Main Window

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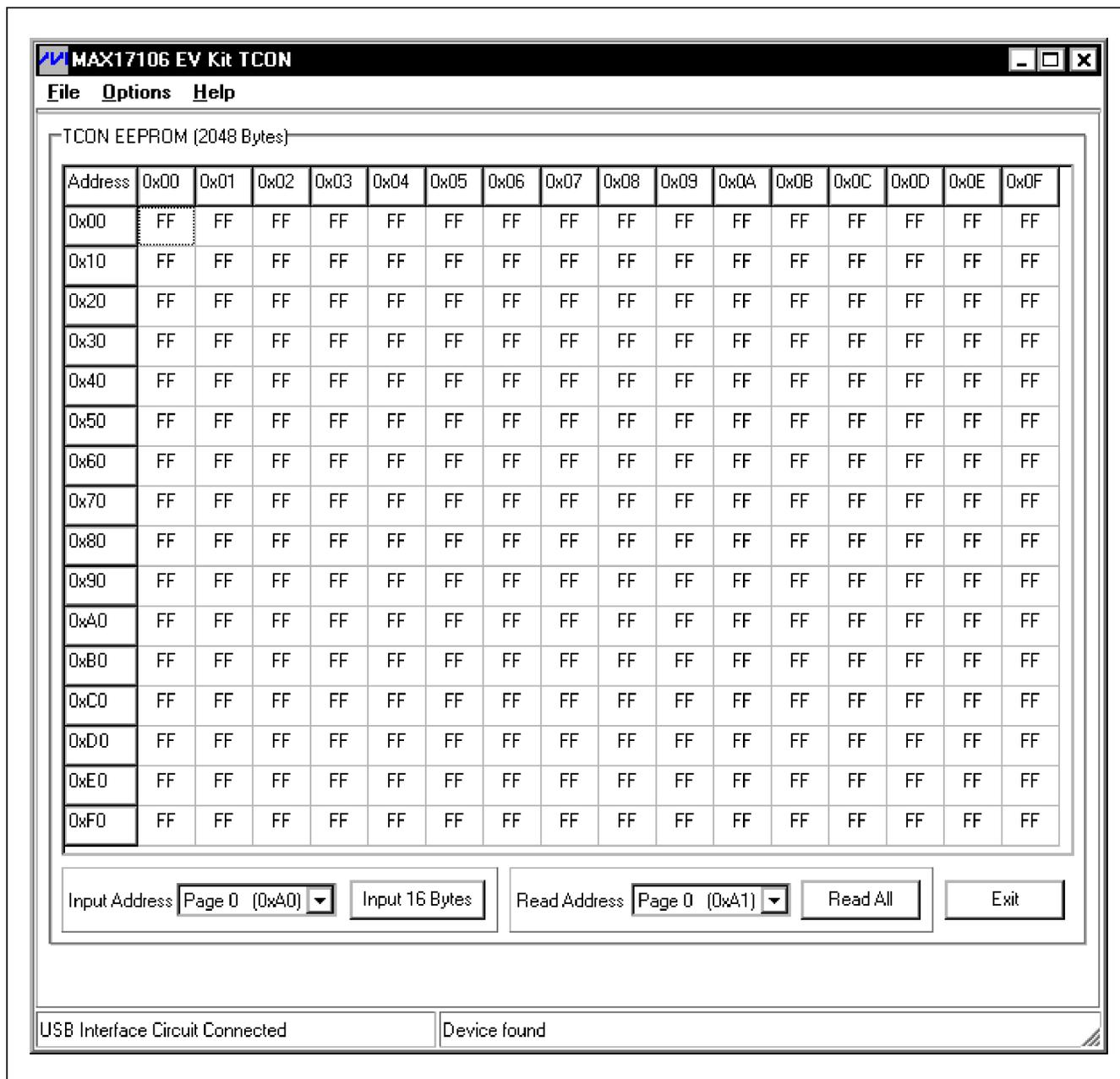


Figure 2. MAX17106 EV Kit TCON Software Main Window

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## Detailed Description of MAX17106 EV Kit DVR Software (MAX17106DVR.EXE)

### Graphical User Interface (GUI) Panel

The MAX17106 EV kit DVR software GUI, shown in Figure 1, is the MAX17106 EV kit DVR software's main window. This window provides a convenient means to control the MAX17106 VCOM calibrator and EDID EEPROM. Use the mouse or press the Tab key to navigate through the GUI controls. The correct I<sup>2</sup>C communication is generated to update the MAX17106 internal memory registers when any of these controls are executed.

The MAX17106 EV kit DVR software's main window (Figure 1) divides the EV kit software functions into two group boxes, **VCOM Calibrator (DVR)** and **EDID EEPROM (256 Bytes)**. The **VCOM Calibrator (DVR)** group box controls the MAX17106 VCOM1 on the EV kit. The VCOM2 and VCOM3 outputs on the EV kit are not controlled by the MAX17106 VCOM calibrator.

The **VCOM Calibrator (DVR)** group box displays the DVR's **I<sup>2</sup>C Address** and **I<sup>2</sup>C Data Sent** indicators, which are used to confirm proper device operation. The **Volatile Register** block contains the **Write** and **Read** buttons that writes data to, or reads data from the VCOM calibrator (DVR) volatile register in the MAX17106. The **DVR Data** block accepts and/or displays the DVR data for the MAX17106. The **Non Volatile and Volatile Registers** block contains the **Program** button to write the DVR data into both the volatile and nonvolatile registers.

The **EDID EEPROM (256 Bytes)** group box displays the EDID EEPROM address and the 256 bytes of EDID EEPROM data in a 16 x 16 string grid. The 256 bytes of data are stored in memory locations from 0x00 to 0xFF in the MAX17106. The fixed address row displays the column index, while the fixed address column displays the row index of the memory locations. The data byte address is the sum of the row address and the column address. The data can be input 1 byte or 8 bytes at a time and all 256 bytes of data can be read at the same time.

The bottom-left status bar of the main window provides the USB interface circuit communication status. The bottom-right status bar indicates the presence or absence of the MAX17106 IC.

### Software Startup

Upon starting the program, the MAX17106 EV kit DVR software automatically searches for the USB interface circuit connection, and then for the MAX17106 device address. The software enters the normal operating mode when the USB connection is detected and the IC has acknowledged its device address. The **DVR Data** edit box displays the data from the volatile register. The **EDID EEPROM (256 Bytes)** group box displays the 256 bytes of data from the EDID EEPROM in the MAX17106. If the USB connection is not detected, the software prompts the user to retry, exit the program, or enter the demo mode.

### Demo Mode

The MAX17106 EV kit DVR software enters demo mode, when the USB connection is not detected, by selecting **Cancel** on the MAX17106 EV kit DVR software interface circuit popup window (Figure 3). The software can also enter the demo mode at any time by selecting the **Options | Demo Mode** menu item from the main window menu bar. When in demo mode, all software communication to the EV kit circuit is disabled; however, most of the software GUI is functional. Demo mode allows the user to evaluate the software without hardware connectivity. To exit demo mode, select **Options | Demo Mode** from the menu bar.

### Volatile Register

The MAX17106 EV kit DVR software's **Volatile Register** block contains the **Write** and **Read** buttons to write and read the VCOM calibrator (DVR) data to and from the MAX17106. Press the **Write** button to write the DVR data in the **DVR Data** edit box to the MAX17106's VCOM calibrator volatile register. Press the **Read** button to read the DVR data from the MAX17106's VCOM calibrator volatile register and display the DVR data in the **DVR Data** edit box.

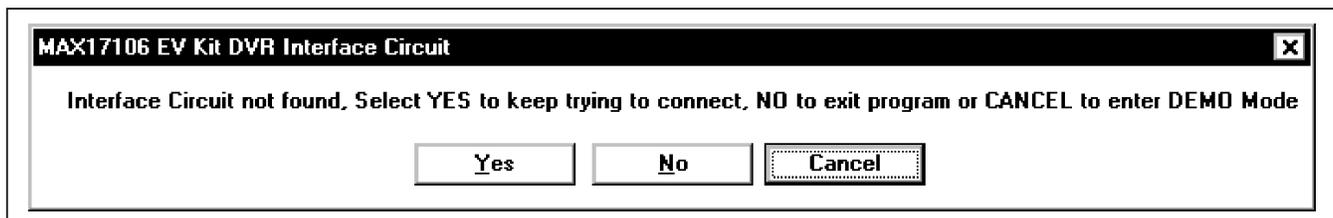


Figure 3. MAX17106 EV Kit DVR Software Interface Circuit Popup Window

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## DVR Data

The MAX17106 EV kit DVR software's **DVR Data** block contains an edit box to input DVR data to the MAX17106 VCOM calibrator volatile or both volatile and nonvolatile registers, and to display data from the volatile register. The DVR data ranges from 0x00 to 0x7F. The **DVR Data** edit box accepts a hexadecimal number from 00 to 7F, equivalent to the decimal range of 0 to 127. The VCOM calibrator DVR data adjusts the VCOM1 output voltage on the MAX17106 EV kit because the calibrator OUT pin is connected to the VCOM1's POS1 pin.

## Nonvolatile and Volatile Registers

The MAX17106 EV kit DVR software's **Non Volatile and Volatile Registers** block contains the **Program** button to write the VCOM calibrator (DVR) data into the VCOM calibrator nonvolatile and volatile registers. Press the **Program** button to write the VCOM calibrator (DVR) data into the VCOM calibrator nonvolatile and volatile registers in the MAX17106 IC.

## Input 1 Byte

The MAX17106 EV kit DVR software's **EDID EEPROM (256 Bytes)** group box contains the **Input 1 Byte** button to write 1 byte of data into the EDID EEPROM. Press the **Input 1 Byte** button to activate the MAX17106 EV kit DVR software's **Input 1 Byte of Data** popup window (Figure 4). Enter the starting address\* between 00 and FF for the EDID EEPROM location in the **0x** edit box. Press the

**Update Grid** button to update and display the starting address in the string grid. Enter a 2-digit hex number between 00 and FF in the data field, and press the **Write 1 Byte** button to write the data into the EDID EEPROM.

## Input 8 Bytes

The MAX17106 EV kit DVR software's **EDID EEPROM (256 Bytes)** group box contains the **Input 8 Bytes** button to input 8 bytes of data into the EDID EEPROM. Press the **Input 8 Bytes** button to activate the MAX17106 EV kit DVR software's **Input 8 Bytes of Data** popup window (Figure 5). Enter the starting address\* between 00 and F8 for the EDID EEPROM location in the **0x** edit box. Press the **Update Grid** button to update and display the addresses in the string grid. Enter a 2-digit hex number between 00 and FF in each of all 8 data fields, and press the **Write 8 Bytes** button to write the data into the EDID EEPROM.

## Read All

The MAX17106 EV kit DVR software's **EDID EEPROM (256 Bytes)** group box contains the **Read All** button to read all 256 bytes of data from the EDID EEPROM. Select the **Read All** button to read all 256 bytes of data from the MAX17106 EDID EEPROM. The data are displayed in the data grid with the address column index labeled along the top row, and the address row index labeled along the left column.

\*Starting address: Writing to location 00 automatically erases the entire EDID memory before writing. If the EDID EEPROM is not empty, be sure to start writing from location 00 to initially clear the EEPROM. Do not overwrite already written location.

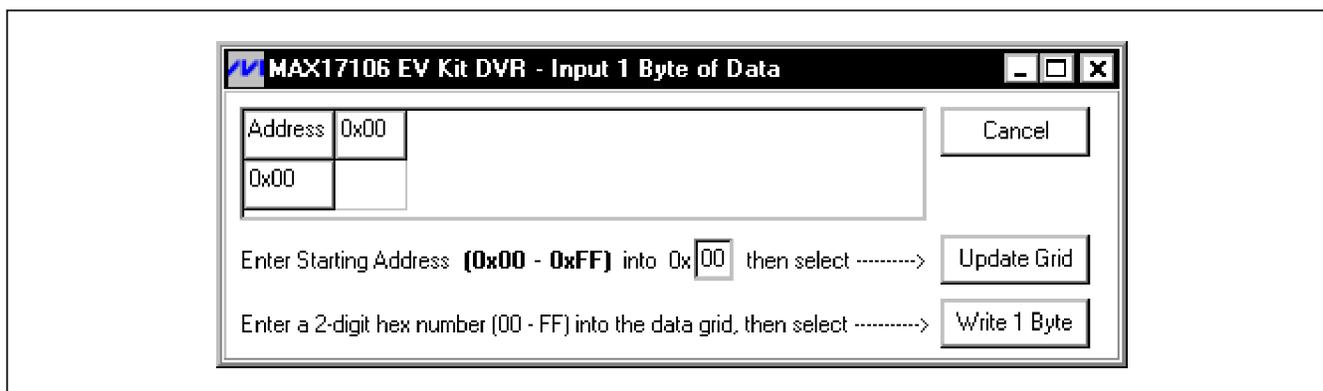


Figure 4. MAX17106 EV Kit DVR Software Input 1 Byte of Data Popup Window

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## Detailed Description of MAX17106 EV Kit TCON Software (MAX17106TCON.EXE)

### Graphical User Interface (GUI) Panel

The MAX17106 EV kit TCON software GUI, shown in Figure 2, is the MAX17106 EV kit TCON software's main window. This window provides a convenient means to control the MAX17106 TCON EEPROM. Use the mouse or press the Tab key to navigate through the GUI controls. The correct I<sup>2</sup>C communication is generated to update the MAX17106 internal memory registers when any of these controls are executed.

The MAX17106 EV kit TCON software's main window (Figure 2) divides the EV kit functions into three group boxes, **TCON EEPROM (2048 Bytes)**, **Input 16 Bytes**, and **Read All**. The **TCON EEPROM (2048 Bytes)** group box displays the TCON EEPROM data. The **Input 16 Bytes** group box inputs data to the TCON EEPROM and the **Read All** group box reads data from the TCON EEPROM.

The **TCON EEPROM (2048 Bytes)** group box displays one of eight pages of TCON EEPROM data. Each of the TCON EEPROM pages contains 256 bytes of TCON

EEPROM data in a 16 x 16 string grid. The 256 bytes of data are stored in memory locations from 0x00 to 0xFF in the selected page. Page selections are in the **Input 16 Bytes** and **Read All** group boxes. The fixed address row displays the column index, while the fixed address column displays the row index of the memory locations. The data byte address is the sum of the row address and the column address. The data must be input 16 bytes at a time, sequentially starting from address page 0xA0 and byte 0x00. All 2048 bytes of data can be read at the same time.

The bottom-left status bar of the main window provides the USB interface circuit communication status. The bottom-right status bar indicates the presence or absence of the MAX17106 IC.

### Software Startup

Upon starting the program, the MAX17106 EV kit TCON software automatically searches for the USB interface circuit connection, and then for the MAX17106 device address. The software enters the normal operating mode when the USB connection is detected and the IC has acknowledged its device address. The **TCON EEPROM (2048 Bytes)** group box displays the first 256 bytes (page) of data from the TCON EEPROM in the MAX17106. If the

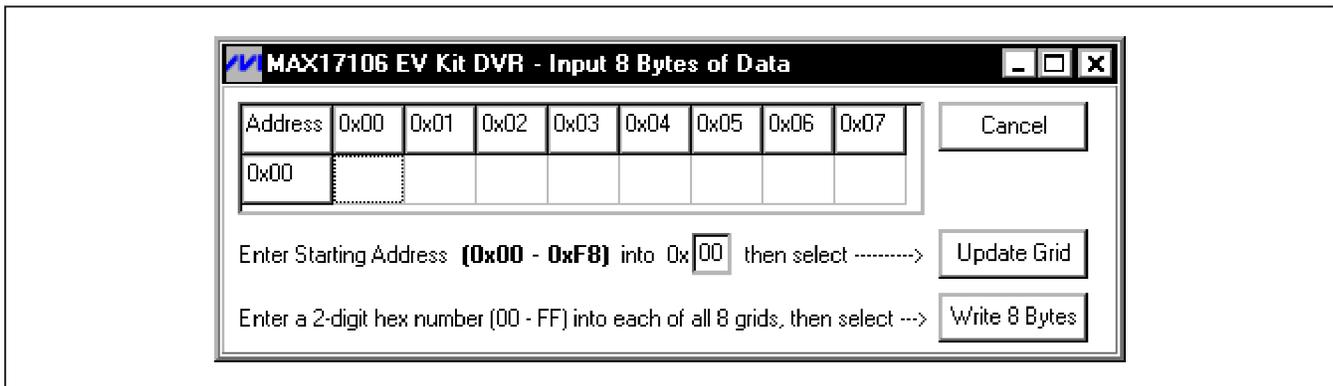


Figure 5. MAX17106 EV Kit DVR Software Input 8 Bytes of Data Popup Window

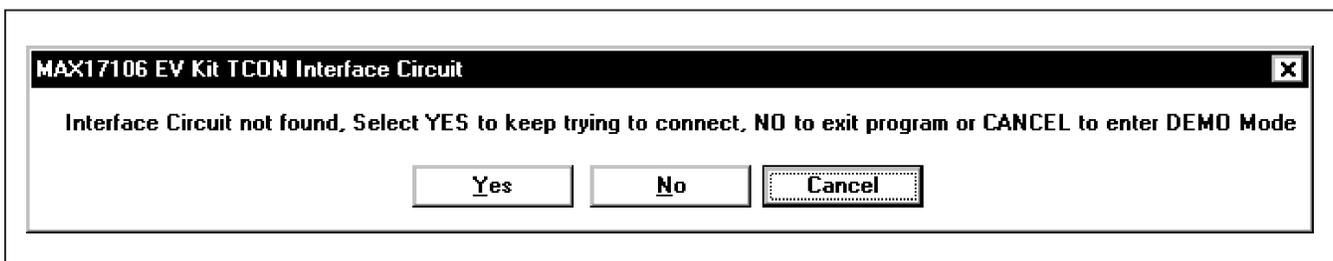


Figure 6. MAX17106 EV Kit TCON Software Interface Circuit Popup Window

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USB connection is not detected, the software prompts the user to retry, exit the program, or enter the demo mode.

## Demo Mode

The MAX17106 EV kit TCON software enters demo mode, when the USB connection is not detected, by pressing the **Cancel** button on the MAX17106 EV kit TCON software popup window (see Figure 6). The software can also enter demo mode at any time by selecting the **Options | Demo Mode** menu item from the main window menu bar. When in demo mode, all software communication to the EV kit circuit is disabled; however, most of the software GUI is functional. Demo mode allows the user to evaluate the software without hardware connectivity. To exit demo mode, select **Options | Demo Mode** from the menu bar.

## Input 16 Bytes

The MAX17106 EV kit TCON software contains the **Input Address** drop-down list and the **Input 16 Bytes** button, which are used to enter writing mode at the desired address. The **Input Address** drop-down list selects one of eight TCON EEPROM address pages. Each address page contains 256 bytes of TCON EEPROM data. Select one of the eight TCON EEPROM address pages from the **Input Address** drop-down list to input data to that address page. Press the **Input 16 Bytes** button to activate the MAX17106 EV kit TCON software's **Input 16 Bytes of Data** popup window (Figure 7). Enter the starting address between 00 and F0 for the TCON EEPROM location in the **0x** edit box. Note that the starting address must be a multiple of 16 (i.e., 0x00, 0x10, 0x20, 0x30... ..0xF0), and data must be entered sequentially into the TCON EEPROM starting from memory location 0x00.

Press the **Update Grid** button to update and display the addresses in the string grid. Enter a 2-digit hex number between 00 and FF in each of all 16 data fields, and press the **Write 16 Bytes** button to write the data into the TCON EEPROM.

## Read All

The MAX17106 EV kit TCON software contains the **Read Address** drop-down list and the **Read All** button to read 2048 bytes of data from the TCON EEPROM. Press the **Read All** button to read all 2048 bytes of data from the MAX17106 TCON EEPROM. The 2048 bytes of TCON EEPROM data are stored in eight address pages. Each address page contains 256 bytes of TCON EEPROM data. The **Read Address** drop-down list selects one of eight TCON EEPROM address pages. Select one of the eight TCON EEPROM address pages from the **Read Address** drop-down list to display data from that address page. The data are displayed in the data grid with the address column index labeled along the top row, and the address row index labeled along the left column.

## Keyboard Navigation

Press the Tab key to select each GUI control. Most of the selected control is indicated by a dotted outline. Using Shift + Tab moves the selection to the previously selected control. Buttons respond to the keyboard's Space bar. Some controls respond to the keyboard Up and Down arrow keys. Activate the program's menu bar by pressing the F10 key, then press the letter of the desired menu item. When the Alt key is pressed and released, most menu items show one letter underlined, indicating their shortcut key.

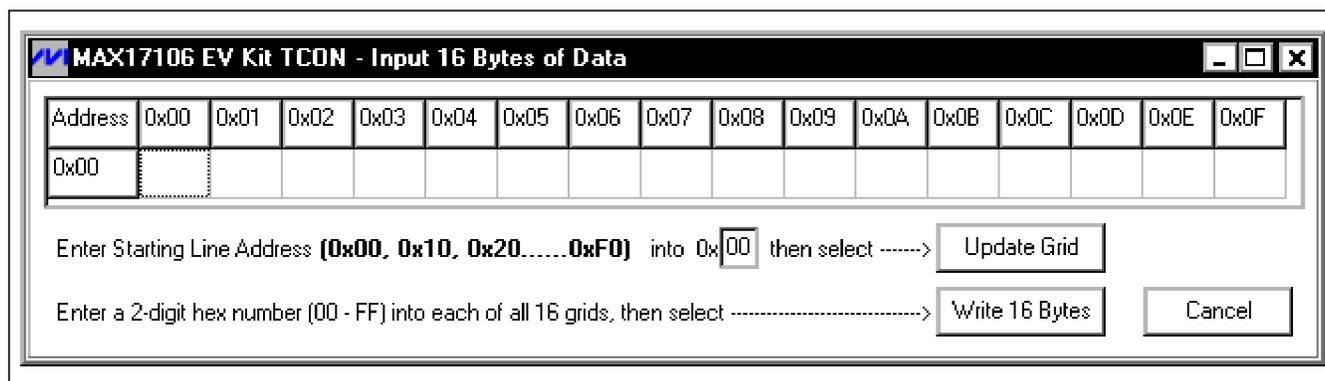


Figure 7. MAX17106 EV Kit TCON Software Input 16 Bytes of Data Popup Window

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## Simple I<sup>2</sup>C Commands

There are two methods for communicating with the MAX17106 EV kit, through the normal user-interface panel (Figures 1 and 2), or by using low-level SMBus™ commands available through a 2-wire interface diagnostic tool. Activate the **2-Wire Interface** (Figure 8) utility from the main program's **Options | Interface (Advanced Users)** main menu bar. A window is displayed that allows I<sup>2</sup>C operations, such as **SMBusReceiveByte** and **SMBusSendByte**.

**Note:** The I<sup>2</sup>C dialog boxes accept numeric data in binary, decimal, or hexadecimal. Hexadecimal numbers must be prefixed by \$ or 0x. Binary numbers must be exactly eight binary digits. See Figure 8 for an example of this tool. Figure 8 shows a simple SMBus send-byte operation using the included 2-wire interface diagnostics tool. In this example, the software is sending data (Cmd)

0xFF to the device with the device address 0x9E. The data sequence calibrates the MAX17106 EV kit's VCOM1 to +2.4V (min).

Refer to Application Note 476: *Comparing the I<sup>2</sup>C Bus to the SMBus*, available from [www.maxim-ic.com](http://www.maxim-ic.com), for information regarding the differences between the SMBus and I<sup>2</sup>C protocols.

## General Troubleshooting

**Problem: Software reports it cannot find the interface circuit**

- Is the interface circuit power LEDs (D101, D201) lit?
- Is the USB cable connected?
- Has Windows plug-and-play detected the board? Bring up Control Panel->System->Device Manager, and look at what device nodes are indicated for USB. If there is an "unknown device" node attached

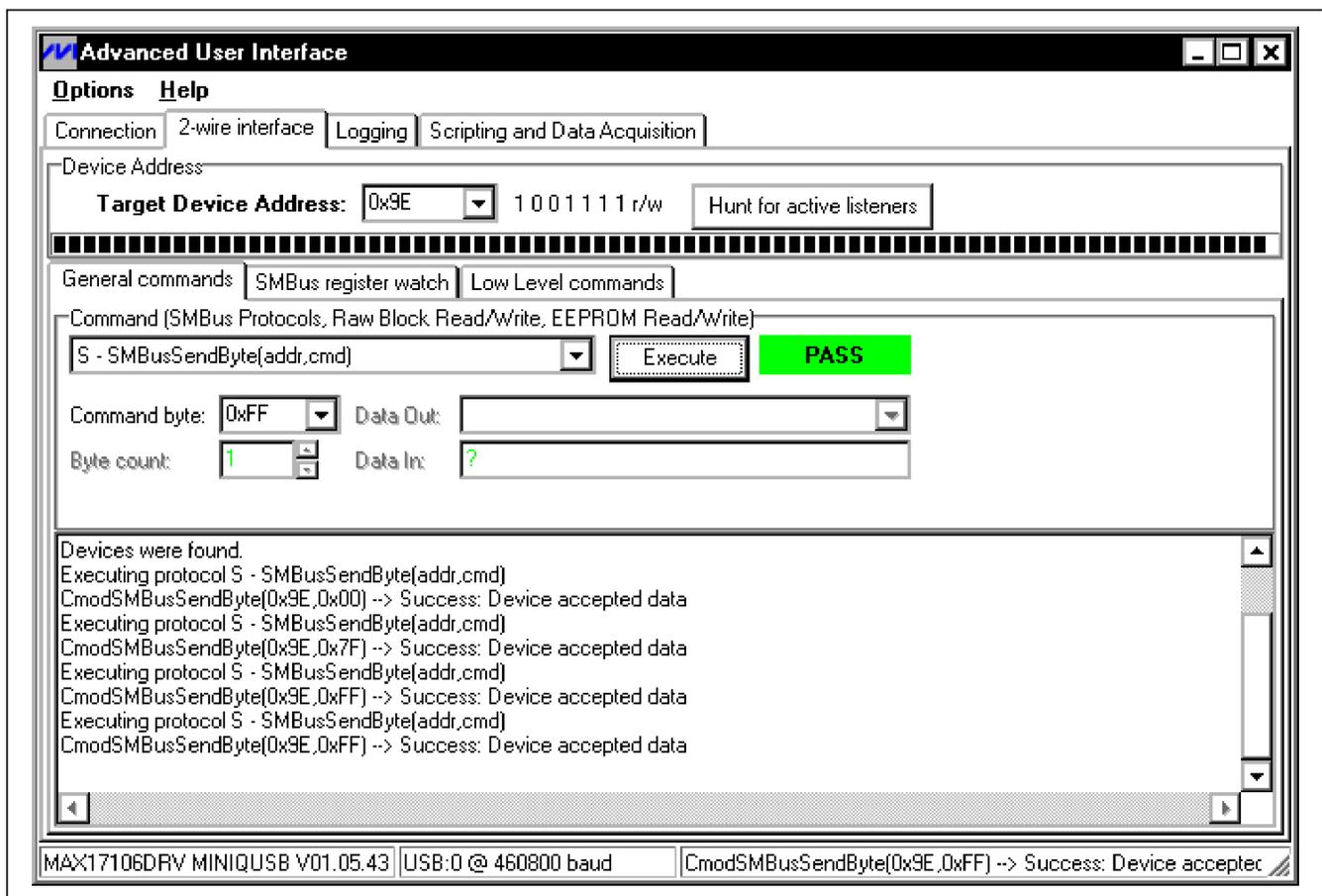


Figure 8. Simple Low-Level 2-Wire Interface

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to the USB, delete it—this forces plug-and-play to try again.

- Are jumpers JU101, JU1–JU6, and JU8 properly configured?

## Detailed Description of Hardware

The MAX17106 EV kit contains a step-up switching regulator for the MAIN supply, a second step-up switching regulator with temperature compensation for the TFT VON supply, a two-stage negative charge pump for the TFT VOFF supply, a linear regulator (LOUT), three high-current op amps (VCOM1, VCOM2, and VCOM3), a digitally adjustable VCOM calibration device with nonvolatile memory (connected to VCOM1), two EEPROM memory blocks with separate I<sup>2</sup>C interfaces, and a high-voltage level-shifting scan driver with complementary outputs that allow charge sharing during state changes to drive the TFT panel integrated gate drivers. A high-voltage stress (HVS) mode is provided to increase the MAIN and the VOFF charge-pump output voltages for stress testing the display panel during production. The EV kit is configured to operate from a +2.4V to +3.6V DC supply voltage. If jumper JU8 is removed, separating the VIN from VDD, then the input-voltage range for VIN is +2.4V to +5.5V and the input-voltage range for VDD is +2.4V to +3.6V. The MAX17106 switching frequency is 1.2MHz.

The MAIN step-up switching regulator (MAIN) is configured for a +8V output providing at least 300mA. The MAIN step-up switching regulator output voltage can be adjusted from +VIN to +10V—limited by the two-stage VOFF charge pump and the -18V input range of the scan driver—by replacing the feedback resistors, R11 and R12 (refer to the *Design Procedure, Main Step-Up Regulator, Output Voltage Selection* section in the MAX17106 IC data sheet). **Do not allow VMAIN to exceed +10V, even in HVS mode to avoid overvoltage on the scan driver's VOFF input.**

The VON step-up switching regulator is configured for a +22V output (at room temperature), providing at least 20mA. The VON output voltage is adjusted for temperature to compensate for TFT mobility. The VON output voltage has five output levels depending on thermistor RT1's temperature:

- 1) For temperatures less than approximately -5°C, the VON output is +31.1V.
- 2) For temperatures between approximately -5°C and +10°C, the VON output is gradually changed from +31.1V to +22V.
- 3) At room temperature, the VON output is +22V.

- 4) For temperatures between approximately +40°C and +70°C, the VON output is gradually changed from +22V to +16V.
- 5) For temperatures greater than approximately +70°C, the VON output is +16V.

The VON output voltage at room temperature can be adjusted from VMAIN to +38V by replacing the feedback resistors, R13 and R14 (refer to the *Design Procedure, VON Temperature-Compensated Step-Up Regulator* section in the MAX17106 IC data sheet for information on adjusting the output voltage and temperature compensation curve). **Do not allow VON to exceed +38V at any temperature.**

The VOFF negative charge pump is configured for a -12V output providing at least 20mA. The internal LOU provides a fixed +2.5V output and 300mA.

The MAX17106 provides three high-current op amps that can each source or sink 50mA. The output of the amplifiers (VCOM1, VCOM2, and VCOM3) are configured for +4V (VMAIN/2). The VCOM1, VCOM2, and VCOM3 output voltages can be adjusted from 0V to MAIN by replacing voltage-divider resistors R15 and R16, R17 and R18, or R19 and R20, respectively.

One of the high-current op amps (VCOM1) is connected to the VCOM calibrator OUT pin. The VCOM1 output voltage can be adjusted between +2.4V and +4V using the MAX17106 VCOM calibrator and the MAX17106 EV kit DVR software. The VCOM1's calibrating range can be adjusted by replacing the full-scale sink-current adjustment resistor (R22). Refer to the *Design Procedure, Setting the VCOM Adjustment Range* section in the MAX17106 IC data sheet for additional details.

The MAX17106 EV kit provides two on-board USB interface circuits to communicate with the two separate 2-wire I<sup>2</sup>C interface circuits in the MAX17106 IC. One of the I<sup>2</sup>C interface circuits in the MAX17106 provides the VCOM calibrator and the 2kb EDID EEPROM communication, while the other I<sup>2</sup>C interface circuit provides the 16kb TCON EEPROM communication. The VCOM and EDID EEPROM interface circuit connection is available on USB connector USB1, while the TCON EEPROM interface circuit connection is available on USB connector USB2. Both I<sup>2</sup>C interface circuits in the MAX17106 IC communicate at a maximum data rate of 100kHz.

The MAX17106 also features a high-voltage level-shifting scan driver to drive the TFT panel integrated gate drivers. The outputs of the drivers swing from VON to VOFF. To save power, a set of complementary outputs are provided to allow charge sharing during state changes. The MAX17106 EV kit provides PCB pads to connect the

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logic inputs, scan drive outputs, and the VSS discharge input (DISVSS).

The MAX17106 features HVS mode, which can increase the output-voltage magnitudes of the MAIN step-up switching-regulator and the negative charge pump to stress test the display panel during production. The MAIN step-up switching-regulator's output is increased to +10V in HVS mode, set by resistor R10 (refer to the *Design Procedure, HVS Function* section in the MAX17106 IC data sheet). The unregulated negative charge-pump output is set to -16V in HVS mode and is approximately  $2 \times V_{MAIN} - 4V$ . **Do not allow  $V_{MAIN}$  to exceed +10V, even in HVS mode, to avoid overvoltage on the scan driver's VOFF input.**

## Jumper Selection

### Shutdown Mode ( $\overline{SHDN}$ )

Jumper JU1 controls the shutdown pin ( $\overline{SHDN}$ ) of the MAX17106 IC. The shutdown pin can also be controlled by an external logic controller connected to the EV kit's  $\overline{SHDN}$  pad. Remove the shunt from jumper JU1 before connecting an external controller to the  $\overline{SHDN}$  pad. See Table 1 for shunt positions.

### Write-Protect Input (WPN)

Jumper JU2 controls the write-protect input pin (WPN) of the MAX17106 IC. WPN can also be controlled by an external logic controller connected to the EV kit's WPN pad. Remove the shunt from jumper JU2 before connecting an external controller to the WPN pad. See Table 2 for shunt positions.

**Table 1. JU1 Jumper Selection ( $\overline{SHDN}$ )**

SHUNT POSITION	$\overline{SHDN}$ PIN CONNECTED TO	EV KIT FUNCTION
Installed*	VIN	Enabled
Not installed	GND (through resistor R1)	Shutdown mode
None (external logic controller connected to $\overline{SHDN}$ pad)	External logic controller	$\overline{SHDN}$ driven by external logic controller ( $\overline{SHDN}$ is active low)

\*Default position.

**Table 2. JU2 Jumper Selection (WPN)**

SHUNT POSITION	WPN PIN CONNECTED TO	EV KIT FUNCTION
Installed*	VDD	Write protect disabled
Not installed	GND (240k $\Omega$ internal pulldown)	Write protect enabled (I <sup>2</sup> C commands at SCL and SDA are ignored)
None (external logic controller connected to WPN pad)	External logic controller	WPN driven by external logic controller (WPN is active low)

\*Default position.

**Table 3. JU3, JU4 Jumper VCOM and EDID E2PROM Functions (SCL, SDA)**

SHUNT POSITION	I <sup>2</sup> C INTERFACE CONTROL SIGNALS CONNECTED TO	I <sup>2</sup> C INTERFACE SIGNALS CONTROLLED BY
Installed*	On-board VCOM and EDID EEPROM USB interface circuit	On-board VCOM and EDID EEPROM USB interface circuit through connector USB1 and MAX17106 EV kit DVR software
Not installed	PCB pads	User-supplied external I <sup>2</sup> C interface signals**

\*Default position.

\*\*Connect the external I<sup>2</sup>C interface ground to the GND pad.

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## **VCOM and EDID EEPROM I<sup>2</sup>C Clock and Data Inputs (SCL, SDA)**

The MAX17106 features clock and data input pins for I<sup>2</sup>C-compatible communication to control the MAX17106 VCOM and EDID EEPROM. The clock and data pins can be driven by the on-board USB interface circuit through USB connector USB1, or the PCB pads along with user-supplied external I<sup>2</sup>C-compatible controller. An external I<sup>2</sup>C-compatible controller can be connected to the SCL, SDA, and GND pads to communicate with the MAX17106 VCOM and EDID EEPROM. The external controller must include bus pullup resistors for SCL and SDA. Jumpers JU3 and JU4 select the I<sup>2</sup>C serial-interface-signal control sources for the MAX17106 VCOM and EDID EEPROM. Table 3 lists the various options for configuring SCL and SDA I<sup>2</sup>C input signal controls.

## **TCON EEPROM I<sup>2</sup>C Clock and Data Inputs (SCLT, SDAT)**

The MAX17106 features clock and data pins for I<sup>2</sup>C-compatible communication to control the MAX17106 TCON EEPROM. The clock and data pins can be driven by the on-board USB interface circuit through connector USB2, or the PCB pads along with the user-supplied external I<sup>2</sup>C-compatible controller. An external I<sup>2</sup>C-compatible controller can be connected to the SCLT, SDAT, and GND pads to communicate with the MAX17106 TCON EEPROM. The external controller must include bus pullup resistors for SCLT and SDAT. Jumpers JU5 and JU6 select the I<sup>2</sup>C serial-interface-signal control sources for the MAX17106 TCON EEPROM. Table 4 lists the various options for configuring SCLT and SDAT I<sup>2</sup>C input signal controls.

**Table 4. JU5, JU6 Jumper TCON E<sup>2</sup>PROM Functions (SCLT, SDAT)**

SHUNT POSITION	I <sup>2</sup> C INTERFACE CONTROL SIGNALS CONNECTED TO	I <sup>2</sup> C INTERFACE SIGNALS CONTROLLED BY
Installed*	On-board TCON EEPROM USB interface circuit	On-board TCON EEPROM USB interface circuit through connector USB2 and MAX17106 EV kit TCON software
Not installed	PCB pads	User-supplied external I <sup>2</sup> C interface signals**

\*Default position.

\*\*Connect the external I<sup>2</sup>C interface ground to the GND pad.

**Table 5. JU7 Jumper Selection (HVS)**

SHUNT POSITION	HVS PIN CONNECTED TO	OPERATING MODE
Installed	VIN	HVS mode
Not installed*	Not connected	Normal mode

\*Default position.

**Table 6. JU8 Jumper Selection (VDD)**

SHUNT POSITION	VDDS/VUDE/VDDT PINS CONNECTED TO	VIN VOLTAGE RANGE
Installed*	VIN	VIN = +2.4V to +3.6V
Not installed	External VDD supply (+2.4V to +3.6V) across VDD and GND PCB pads	VIN = +2.4V to +5.5V

\*Default position.

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### High-Voltage Stress (HVS) Mode

The MAX17106 EV kit features an option to increase the output-voltage magnitudes of the step-up switching regulator and the negative charge pump to stress test the display panel during production. Since the op-amp inputs are derived from the step-up converter output (MAIN), their output voltages increase when MAIN increases. **Do not allow V<sub>MAIN</sub> to exceed +10V, even in HVS mode, to avoid overvoltage on the scan driver's VOFF input.** Jumper JU7 selects the HVS mode for the MAX17106. Table 5 lists the selectable JU7 jumper options.

### Logic Supplies (VDD)

The MAX17106 EV kit features an option to select the input source for the logic supply VDD to power the VDDS, VDDE, and VDDT pins. When VIN is in the range of +2.4V to +3.6V, install a shunt on jumper JU8 to con-

nect VDD to VIN. When VIN is greater than +3.6V and up to +5.5V, remove the shunt from jumper JU8, and connect an external supply (+2.4V to +3.6V) across the VDD and GND PCB pads to power the VDDS, VDDE, and VDDT logic supplies. Table 6 shows the selectable jumper options for jumper JU8 on the MAX17106 EV kit.

### MAX17106 I<sup>2</sup>C Signal Pullup Voltage Level

The MAX17106 EV kit circuit features an option to select the pullup voltage level for the I<sup>2</sup>C signals for the MAX17106 IC. Jumper JU101 selects the I<sup>2</sup>C signals' pullup voltage level of the MAX17106 IC. The MAX17106 I<sup>2</sup>C signals can be pulled up to the EV kit's logic input power VDD or to a user-supplied external DC power supply connected across the VDDIO and GND PCB pads. The external VDDIO power supply can range from +1.7V to +3.6V. Table 7 shows the selectable jumper options for jumper JU101 on the MAX17106 EV kit.

**Table 7. JU101 Jumper Function (VDDIO)**

SHUNT POSITION	MAX17106 I <sup>2</sup> C SIGNALS PULL UP TO	VOLTAGE RANGE
1-2*	VDD	+2.4V to +3.6V
2-3	VDDIO (external DC power supply)	+1.7V to +3.6V

\*Default position.

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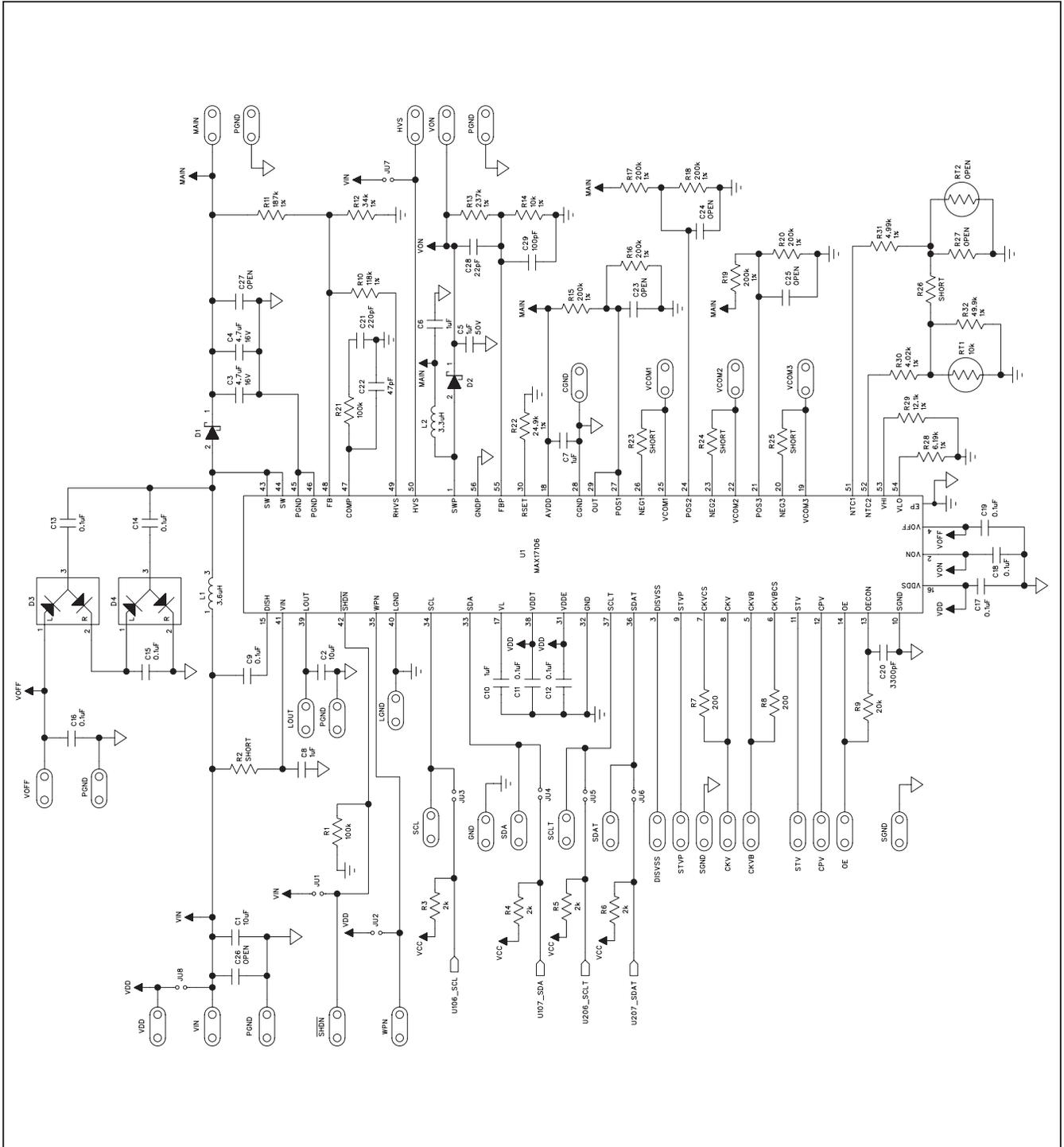


Figure 9a. MAX17106 EV Kit Schematic (Sheet 1 of 3)





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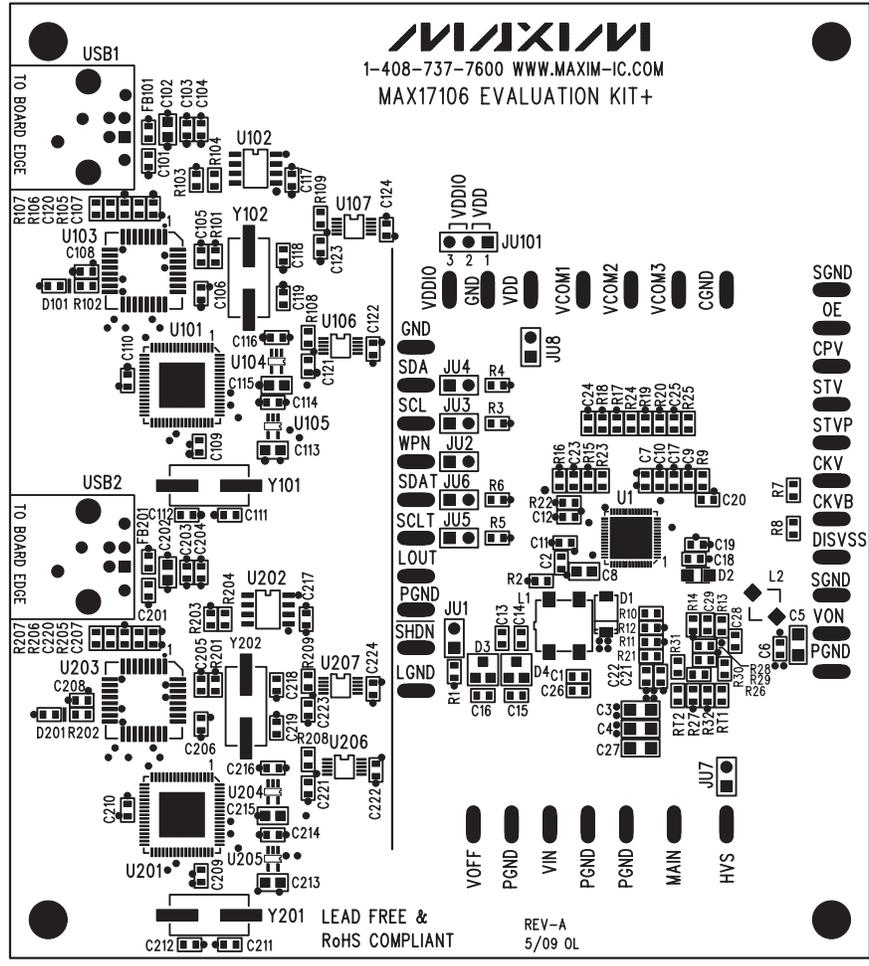


Figure 10. MAX17106 EV Kit Component Placement Guide—Component Side

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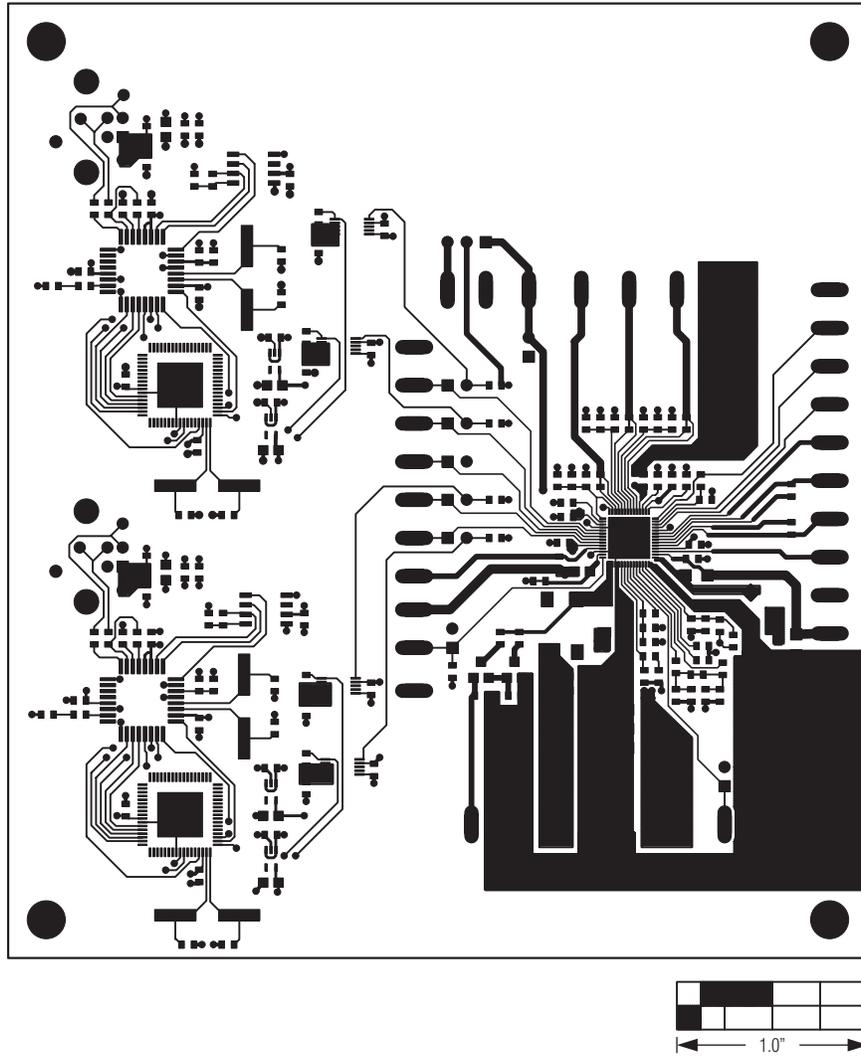


Figure 11. MAX17106 EV Kit PCB Layout—Component Side

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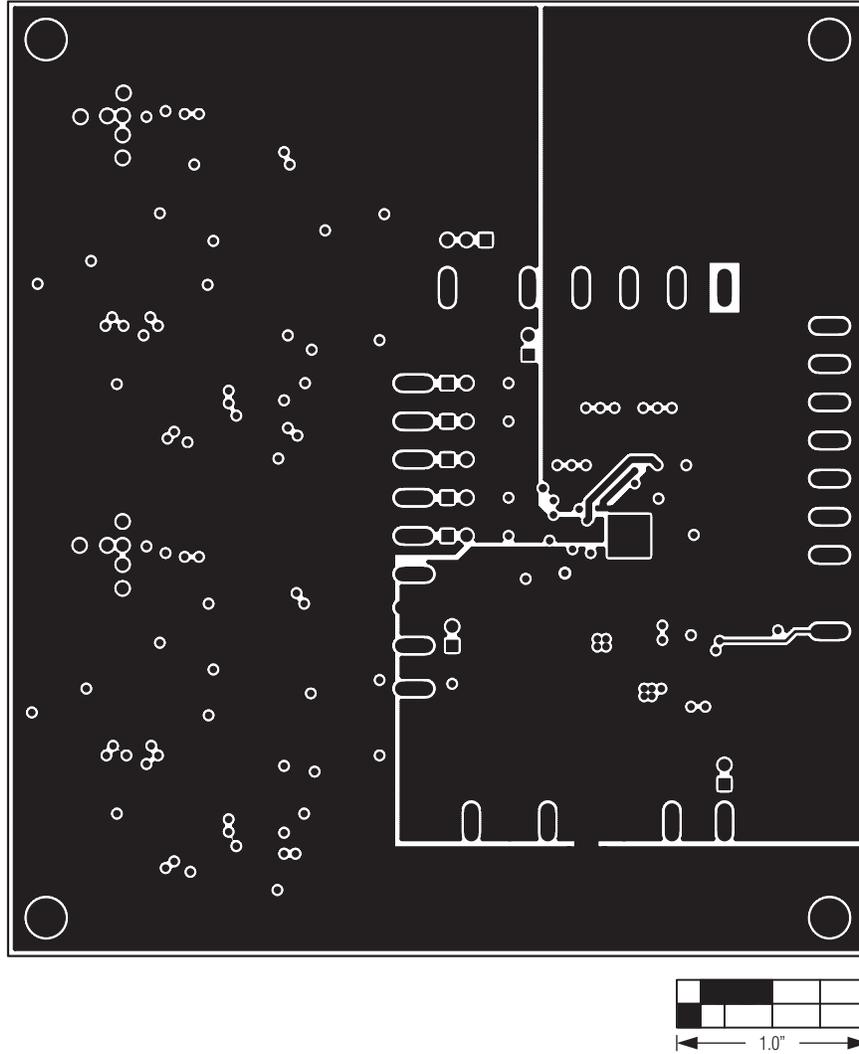


Figure 12. MAX17106 EV Kit PCB Layout—GND Layer 2

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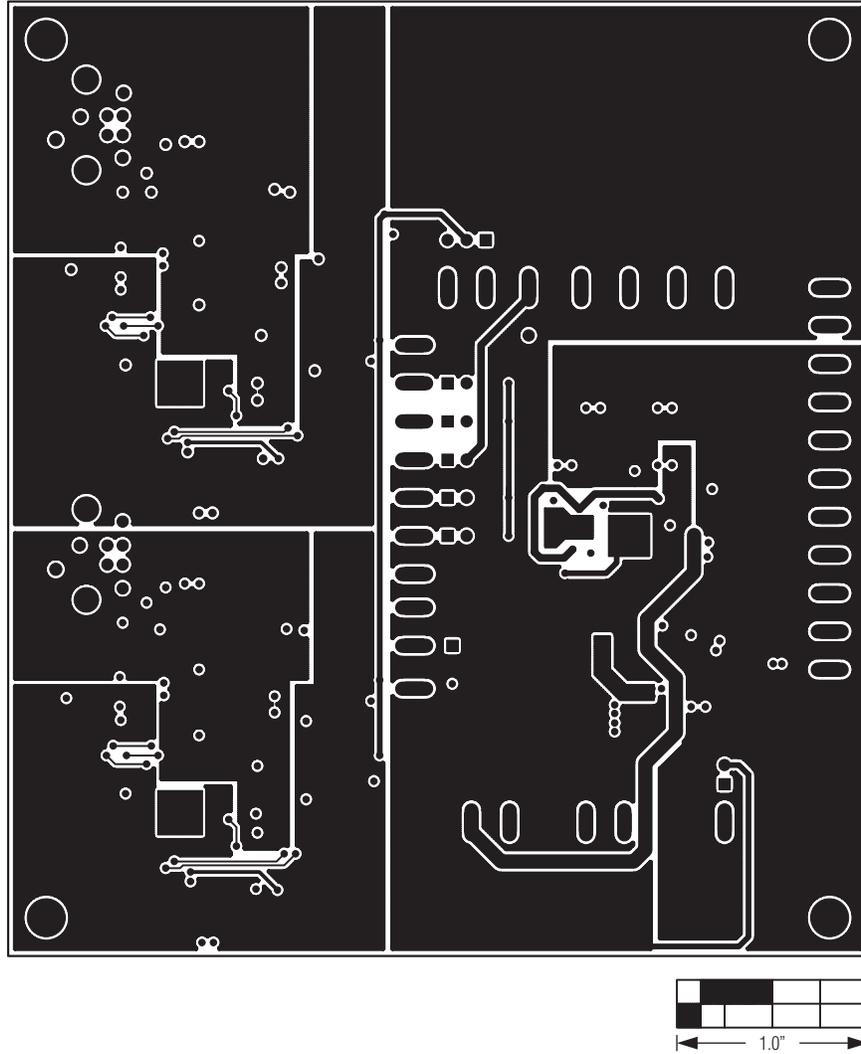


Figure 13. MAX17106 EV Kit PCB Layout—PWR Layer 3

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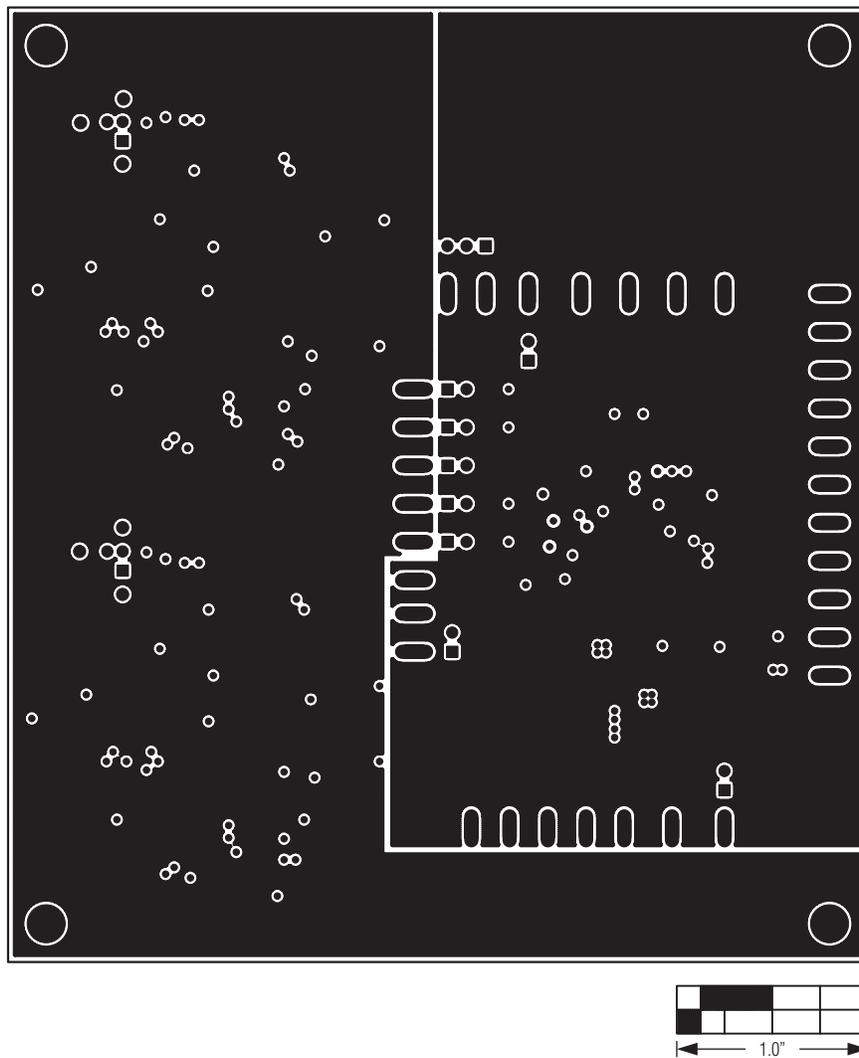


Figure 14. MAX17106 EV Kit PCB Layout—Solder Side

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