19-4966; Rev 0; 9/09

MAX17039 Evaluation Kit

Evaluates: MAX17000/MAX17007A/MAX17039

General Description

The MAX17039 evaluation kit (EV kit) demonstrates the high-power, dynamically adjustable, multiphase IMVP-7 notebook application circuit. This DC-DC converter steps down high-voltage batteries and/or AC adapters, generating two precision, low-voltage CPU/GPU core rails. The EV kit meets the Intel mobile IMVP-7 CPU's transient voltage specification, power-good signaling, voltage regulator thermal monitoring ($\overline{VR\_HOT}$), power-good outputs (VR__READY), and serial VID communication and control specification. The MAX17039 consists of two high-current SMPSs for the CPU and GPU cores. The CPU regulator is a 3-phase interleaved Quick-PWM™ architecture with one MAX8791 single-synchronous MOSFET driver. The second GPU regulator is also a 1-phase Quick-PWM architecture. The 3-phase CPU core SMPS runs 120° out-of-phase for true interleaved operation, minimizing input capacitance.

Both CPU/GPU output voltages are controlled independently and are dynamically changed through a 3-wire serial VID interface (3-wire SVID: VCLK, VDIO, $\overline{ALERT}$), allowing the switching regulators to be individually programmed to different voltages. The EV kit includes active voltage positioning with adjustable gain, reducing power dissipation and bulk output capacitance requirements. A slew-rate controller allows controlled transitions among VID codes, controlled soft-start, and shutdown. SVID also allows each regulator to be individually set into a low-power, pulse-skipping state.

The MAX17039 provides a digitally adjustable 0 to 1.5200V output-voltage range from a 7V to 20V battery-input range. Each phase of the CPU core SMPS is designed for a 20A thermal-design current and delivers up to 33A peak output current for a total of 99A. The 1-phase GPU core SMPS is designed for 20A thermal-design current and delivers up to 33A peak output current. The CPU core SMPS operates at 350kHz switching frequency (per phase) and has superior line- and load-transient response. The GPU core SMPS operates at 440kHz switching frequency relative CPU core SMPS.

The MAX17039 EV kit also evaluates the MAX17000 and MAX17007A DC-DC converters. The EV kit also includes Windows® 2000-, Windows XP®-, and Windows Vista®-compatible software that provides a simple graphical user interface (GUI) for exercising the features of the MAX17039.

Quick-PWM is a trademark of Maxim Integrated Products, Inc.

Windows, Windows XP, and Windows Vista are registered trademarks of Microsoft Corp.

Features

MAX17039:

- **Intel IMVP-7 Serial VID-Compliant 25MHz Interface**
- **0 to 1.5200V Output-Voltage Range**
- **7V to 20V Input-Voltage Range**
- **Core CPU SMPS**
  - **3-Phase, Fast-Response Interleaved, Quick-PWM**
  - **Two Internal Drivers + One External Driver (MAX8791)**
  - **Transient-Suppression Feature**
  - **99A Peak Load-Current Capability (33A Each Phase)**
  - **350kHz Switching Frequency (per Phase)**
- **Core GPU SMPS**
  - **1-Phase, Fast-Response Internal Driver Quick-PWM**
  - **33A Peak Load-Current Capability**
  - **440kHz Switching Frequency**
- **Active Voltage Positioning with Adjustable Gain**
- **Power-Good (VR__READY) Outputs**
- **External Thermal-Fault Detection ($\overline{VR\_HOT}$)**
- **Output Current Monitors (IMON_)**
- **Overvoltage-, Undervoltage-, and Thermal-Fault Protections**
- **56-Pin Thin QFN Package**

MAX17000:

- **Complete DDR Supplies: VCCDDR, VTTDDR, VTTR**
- **7V to 20V Input-Voltage Range**
- **400kHz Switching Frequency**
- **10A Output Current Capability (VCCDDR)**
- **2A Output Current Capability (VTTDDR)**
- **3mA Output Current Capability (VTTR)**
- **Overvoltage Protection**
- **Power-Good Output Indicators (D15 and D16)**
- **24-Pin Thin QFN Package**

MAX17007A:

- **I/O Supplies: VTT1 and VTT2**
- **7V to 20V Input-Voltage Range**
- **300kHz Switching Frequency**
- **6A Output Current Capability (VTT1)**
- **21A Output Current Capability (VTT2)**
- **Overvoltage-, Undervoltage-, and Thermal-Fault Protections**
- **Power-Good Output Indicators (D19 and D20)**
- **28-Pin Thin QFN Package**

Ordering Information

PART	TYPE
MAX17039EVKIT+	EV Kit

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

MAX17039 Evaluation Kit

Component List

DESIGNATION	QTY	DESCRIPTION
C1–C4, C68, C69, C105, C106, C130, C131, C160–C163	14	10µF ±20%, 25V X5R ceramic capacitors (1210) Murata GRM32DR61E106K TDK C3225X7R1E106M AVX 12103D106M Taiyo Yuden TMK325BJ106MM KEMET C1210C106M3RAC
C5, C7, C8, C67, C70, C78, C89, C90, C107, C168, C169	11	470µF, 2V, 4.5mΩ low-ESR polymer capacitors (D case) Panasonic EEFSX0D471E4 or NEC TOKIN PSGV0E477M4.5
C6, C71, C108, C150, C167	0	Not installed, capacitors (D case)
C9	0	Not installed, capacitor (0805)
C10, C11	2	2.2µF ±20%, 10V X5R ceramic capacitors (0603) TDK C1608X5R1A225M or Murata GRM188R61A225M or AVX 0603ZD225MAT
C12, C19, C21, C22–C29, C74, C75, C77, C85–C88, C109, C110, C112, C114, C137–C140, C170, C171, C175, C178, C179, C181, C183	0	Not installed, capacitors (0603)
C13, C14, C73, C102, C135, C136, C165, C180	8	0.22µF ±20%, 10V X7R ceramic capacitors (0603) Murata GRM188R71A224K Taiyo Yuden LMK107BJ224MA TDK C1608X7R1C224M AVX 06033D224KAT
C15, C16, C76, C111, C144	5	0.33µF ±10%, 10V X5R ceramic capacitors (0603) Murata GRM188R61A334K TDK C1608X5R1A334K
C17, C18, C65, C113, C121, C134, C172, C182	8	1000pF ±10%, 50V X7R ceramic capacitors (0603) TDK C1608X7R1H102K or Murata GRM188R71H102K or equivalent
C20, C80, C164, C174	4	0.1µF ±10%, 25V X7R ceramic capacitors (0603) TDK C1608X7R1E104K or Murata GRM188R71E104K
C30	0	Not installed, 1000µF, 50V aluminum electrolytic capacitor (12.5mm x 25mm) SANYO 50MV1000AX
C31, C34, C39–C45, C55–C60, C64, C115–C120	25	22µF, 6.3V X5R ceramic capacitors (0805) TDK C2012X5R0J226MT Taiyo Yuden JMK212BJ226MG
C32, C33, C35–C38, C46–C54, C141, C142, C143, C145–C148, C184–C193	32	10µF ±20%, 6.3V X5R ceramic capacitors (0805) TDK C2012X5R0J106M or Taiyo Yuden AMK212BJ106MG AVX 08056D106MAT
C66	0	Not installed, capacitor (1210)
C72, C101, C132, C133, C176, C177	6	1µF ±10%, 16V X5R ceramic capacitors (0603) TDK C1608X5R1C105K Taiyo Yuden EMK107BJ683MA Murata GRM188R61C105K
C79	1	0.01µF ±10%, 50V X7R ceramic capacitor (0603) TDK C1608X7R1E103K or Murata GRM188R71E103K
C81–C84	4	470pF ±10%, 50V X7R ceramic capacitors (0603) Murata GRM188R71H471K TDK C1608X7R1H471K Taiyo Yuden UMK107B471KZ

Component List (continued)

DESIGNATION	QTY	DESCRIPTION
C149	1	330µF, 2V, 4.5mΩ low-ESR polymer capacitor (D case) Panasonic EEFSX0D331E4 or NEC TOKIN PSGV0E337M4.5
C166	1	220µF, 2.5V, 12mΩ low-ESR polymer capacitor (D case) SANYO 2R5TPE220MC
C173	1	2200pF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H222K TDK C1608X7R1H222K
C201	1	1µF ±10%, 6.3V X5R ceramic capacitor (0603) Murata GRM188R60J105K
C202–C206, C256	6	4.7µF ±10%, 6.3V X5R ceramic capacitors (0603) Murata GRM188R60J475K
C207–C210	4	47µF ±10%, 6.3V 325mΩ tantalum capacitors (Size C) KEMET B45197A1476K309
C211, C219–C223, C228–C255	34	0.1µF ±10%, 10V X5R ceramic capacitors (0402) Murata GRM155R61A104K
C212	1	0.022µF ±10%, 16V X7R ceramic capacitor (0402) Murata GRM155R71C223K
C213, C224, C225	3	0.01µF ±10%, 16V X7R ceramic capacitors (0402) Murata GRM155R71C103K
C214, C226	2	4700pF ±10%, 25V X7R ceramic capacitors (0402) Murata GRM155R71E472K
C215, C216, C227	3	2200pF ±10%, 50V X7R ceramic capacitors (0402) Murata GRM155R71H222K
C217	1	1000pF ±10%, 50V X7R ceramic capacitor (0402) Murata GRM155R71H102K
C218	1	470µF ±10%, 6.3V 100mΩ tantalum capacitor (Size E) KEMET B45197A1477K509
C257, C258	2	15pF ±5%, 50V C0G ceramic capacitors (0402) Murata GRM1555C1H150J
C259–C262	4	10pF ±5%, 50V C0G ceramic capacitors (0402) Murata GRM1555C1H100J
$\overline{\text{DRSKIP}}$, EN1, EN2, GND_SENSE, IMONA, IMONB, PGOOD1, PGOOD2, PGOODVTT1, PGOODVTT2, PWM_OUT, REFIN1, $\overline{\text{SHDN}}$, $\overline{\text{SKIP}}$, $\overline{\text{SKIPVTT}}$, $\overline{\text{STDBY}}$, VCCGT_SENSE, VCCP_SENSE, VID_SEL, VOUT_SENSE, VR_ENABLE, $\overline{\text{VR\_HOT}}$, VRA_READY, VRB_READY, VSSGT_SENSE, VSSP_SENSE, VTT_1, VTT_2	28	Test points
D1, D2, D6, DG	0	Not installed
D10, D14, D17, D18	4	3A, 30V Schottky diodes Nihon EC31QS03L Central Semi CMSH3-40M
D15, D16, D19, D20	4	Green clear SMD LEDs (0805) Lite-On LTST-C170GKT
D201	1	Green LED (0603)
D202–D205	4	Schottky barrier diodes (Mini 2P) Panasonic MA2YD1500L

Component List (continued)

DESIGNATION	QTY	DESCRIPTION
FB201–FB204	4	120 at 100MHz, 2A ferrite beads (0603) Murata BLM18PG121SN1D
JU4–JU9, JU15, JU16	8	2-pin headers
JU10, JU12, JU13	0	Not installed, 3-pin headers
J201	1	USB type-B right-angle receptacle
JU201	1	3-pin header
J202, J203	0	Not installed, dual-row (5 x 2) headers
L1, L2, L3, L4, L7	5	0.36µH, 36A, 0.82mΩ power inductors Panasonic ETQP4LR36ZFC NEC TOKIN MPC1055LR36 TOKO FDUE1040D-R36M
L5	1	0.6µH, 17A, 2.3mΩ power inductor NEC TOKIN MPC0750LR60C
L6	1	1µH, 10A, 9mΩ power inductor NEC TOKIN MPLC0730LR1R0
N1, N2, N7, N8	4	n-channel MOSFETs (PowerPAK, 8 SO) Fairchild FDMS8680 Vishay (Siliconix) SiR402DP
N3–N6, N9, N10, N12, N23	8	n-channel MOSFETs (PowerPAK, 8 SO) Fairchild FDMS8660AS Vishay (Siliconix) Si7658ADP
N11, N19, N20, N21, N22	0	Not installed
N13, N15, N17	3	n-channel MOSFETs (PowerPAK, 8 SO) Fairchild FDS6298 (SO 8) Vishay (Siliconix) SI4386DY
N14, N16, N18	3	n-channel MOSFETs (PowerPAK, 8 SO) Fairchild FDS8670 (SO 8) Vishay (Siliconix) SI4626ADY

DESIGNATION	QTY	DESCRIPTION
Q1	1	n-channel logic-level MOSFET (SOT23) Fairchild 2N7002 (Top Mark: 702) Central Semi 2N7002
R1, R15, R16, R22, R44, R46, R47, R73, R74, R76, R77, R107, R142	13	10Ω ±5% resistors (0603)
R2, R3, R57, R101, R145	5	150kΩ ±1% resistors (0603)
R4, R5, R6, R19, R24, R32, R54, R56, R59, R60, R61, R63, R71, R72, R78, R106, R120, R139	18	0Ω resistors (0603)
R7, R11, R21, R67, R149	5	1.5kΩ ±1% resistors (0603)
R8, R12, R35, R69	4	2.1kΩ ±1% resistors (0603)
R9, R13, R34, R70	4	40.2kΩ ±1% resistors (0603)
R10, R14, R36, R68, R115, R134, R148	7	10kΩ ±1% NTC thermistors, β = 3380 (0603) Murata NCP18XH103F03RB TDK NTCG163JH103F
R17	1	3.83kΩ ±1% resistor (0603)
R18, R45, R48, R49, R50, R51, R53, R55, R62, R64, R65, R66, R103, R111, R112, R117, R118, R119, R121, R131, R132, R137, R138, R150, R151, R214, R215, R217, R219	0	Not installed, resistors (0603) R18, R45, R48, R49, R51, R55, R62, R64, R65, R66, R111, R112, R119, R214, R215, R217, R219 are open; R50, R53, R103, R117, R118, R121, R131, R132, R137, R138, R150, R151 are short (PC trace)

Component List (continued)

DESIGNATION	QTY	DESCRIPTION
R20, R52, R100, R130	0	Not installed, resistors—short (PC trace) (1210)
R23	1	5.11kΩ ±1% resistor (0603)
R25, R27	2	4.87kΩ ±1% resistors (0603)
R26, R28	2	100kΩ ±5% NTC thermistors, ß = 4250 (0603) Murata NCP18WF104J03RB TDK NTCG163JF104J
R29, R31	2	115kΩ ±1% resistors (0603)
R30	1	15.4kΩ ±1% resistor (0603)
R33, R42, R43	3	332kΩ ±1% resistors (0603)
R37, R38, R41	3	169kΩ ±1% resistors (0603)
R39, R40, R156	3	200kΩ ±1% resistors (0603)
R58, R88, R102, R108, R109, R110, R144, R155	8	100kΩ ±5% resistors (0603)
R75	1	8.06kΩ ±1% resistor (0603)
R89, R90, R91	3	1.91kΩ ±1% resistors (0603)
R104, R105, R143, R154	4	1kΩ ±5% resistors (0603)
R113, R114	2	3.48kΩ ±1% resistors (0603)
R116, R147	6	20kΩ ±1% resistors (0603)
R133, R135	2	1.82kΩ ±1% resistors (0603)
R136	1	499Ω ±1% resistor (0603)
R140	1	90.9kΩ ±1% resistor (0603)
R141	1	100kΩ ±1% resistor (0603)
R146	1	1.21kΩ ±1% resistor (0603)
R152	1	4.99kΩ ±1% resistor (0603)
R153	1	10kΩ ±1% resistor (0603)
R201, R202	2	22Ω ±5% resistors (0603)
R203, R204, R205	3	25.5kΩ ±1% resistors (0603)
R206	1	78.7kΩ ±1% resistor (0603)
R207	1	54.9kΩ ±1% resistor (0603)
R208	1	12.7kΩ ±1% resistor (0603)
R209	1	510Ω ±5% resistor (0603)
R210–R213, R221	5	10kΩ ±5% resistors (0603)
R216, R218, R220	3	90.9Ω ±1% resistors (0603)

DESIGNATION	QTY	DESCRIPTION
TP201–TP204	0	Not installed, test points
U1	1	3-phase + 1-phase Quick-PWM IMVP-7 controller (56 TQFN-EP*) Maxim MAX17039GTN+
U2	1	CPU socket rPGA-989 FOXCONN PZ98927-3641-01F
U3	1	Single driver (8 TQFN-EP*) Maxim MAX8791GTA+
U4	1	DDR memory power controller (24 TQFN-EP*) Maxim MAX17000ETG+
U5	1	Dual step-down Quick-PWM controller (28 TQFN-EP*) Maxim MAX17007AGTI+
U6, U7, U8	3	500mA LDOs (8 TQFN-EP*) Maxim MAX1935ETA+
U9	1	USB microcontroller (64 QFN-EP*) Atmel AT90USB1286-16MU
U10	1	Cyclone III FPGA (144 EQFP-EP*) Altera EP3C5E144C7N
U11	1	FPGA serial configuration device (8 SO) Altera EPCS4SI8N
Y1	1	8MHz crystal Hong Kong X'tals SSL8000000E18FAE
—	1	USB high-speed A-to-B cable, 6ft
—	2	Shunts
—	1	PCB: MAX17039 EVALUATION KIT+

**EP = Exposed pad.*

MAX17039 Evaluation Kit

Component Suppliers

SUPPLIER	PHONE	WEBSITE
AVX Corporation	843-946-0238	www.avxcorp.com
Central Semiconductor Corp.	631-435-1110	www.centralsemi.com
Fairchild Semiconductor	888-522-5372	www.fairchildsemi.com
Hong Kong X'tals Ltd.	852-35112388	www.hongkongcrystal.com
KEMET Corp.	864-963-6300	www.kemet.com
Murata Electronics North America, Inc.	770-436-1300	www.murata-northamerica.com
NEC TOKIN America, Inc.	408-324-1790	www.nec-tokinamerica.com
Nihon Inter Electronics Corp.	847-843-7500	www.niec.co.jp
Panasonic Corp.	800-344-2112	www.panasonic.com
SANYO Electric Co., Ltd.	619-661-6835	www.sanyodevice.com
Taiyo Yuden	800-348-2496	www.t-yuden.com
TDK Corp.	847-803-6100	www.component.tdk.com
TOKO America, Inc.	847-297-0070	www.tokoam.com
Vishay	402-563-6866	www.vishay.com

Note: *Indicate that you are using the MAX17039 when contacting these component suppliers.*

MAX17039 EV Kit Files

FILE	DESCRIPTION
INSTALL.EXE	Installs the EV kit files on your computer
MAX17039.EXE	Application program
ATUSBHID.DLL	USB software library
UNINST.INI	Uninstalls the EV kit software

Quick Start

Recommended Equipment

- MAX17039 EV kit
- 7V to 20V, > 100W power supply, battery, or notebook AC adapter
- DC bias power supply, 5V at 1A
- Dummy load capable of sinking 99A each (CPU core)
- Dummy load capable of sinking 33A (GPU core)
- Digital multimeters (DMMs)
- 100MHz dual-trace oscilloscope
- User-supplied Windows 2000, Windows XP, or Windows Vista 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 kit software. Text in **bold and underlined** refers to items from the Windows operating system.

Procedure

The MAX17039 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** to download the latest version of the EV kit software, 17039xx.ZIP. Save the EV kit software to a temporary folder and uncompress the ZIP file.

2) Install the EV kit software on your computer 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.

3) Ensure that the circuit is connected correctly to the supplies and dummy loads prior to applying any power.

4) Turn on the battery power before turning on the 5V bias power.

5) Verify that there is a shunt across JU15 (VTT1 = 1.05V).
6) Connect the USB cable from the PC to the EV kit board.
7) Start the EV kit software by opening its icon in the **Start | Programs** menu. The EV kit software main window should appear, as shown in Figure 1. Verify that the **Hardware: Connected** message is displayed in the bottom-left status bar.
8) Click on the **Serial VID Commands** tab.
9) In the **VR Address** combo box (Figure 2), select **1111** for the MAX17039 voltage regulator.
10) On the line for command index 02h, move the track bar to set the DAC setpoint voltage to 1.2000V (BFh) and press the **Execute** button.
11) Observe the 1.2000V output voltage on the SMPS outputs (V_{OUT} and VCCGT) with the DMM and/or oscilloscope. Look at the LX switching nodes and MOSFET gate-drive signals while varying the load current.

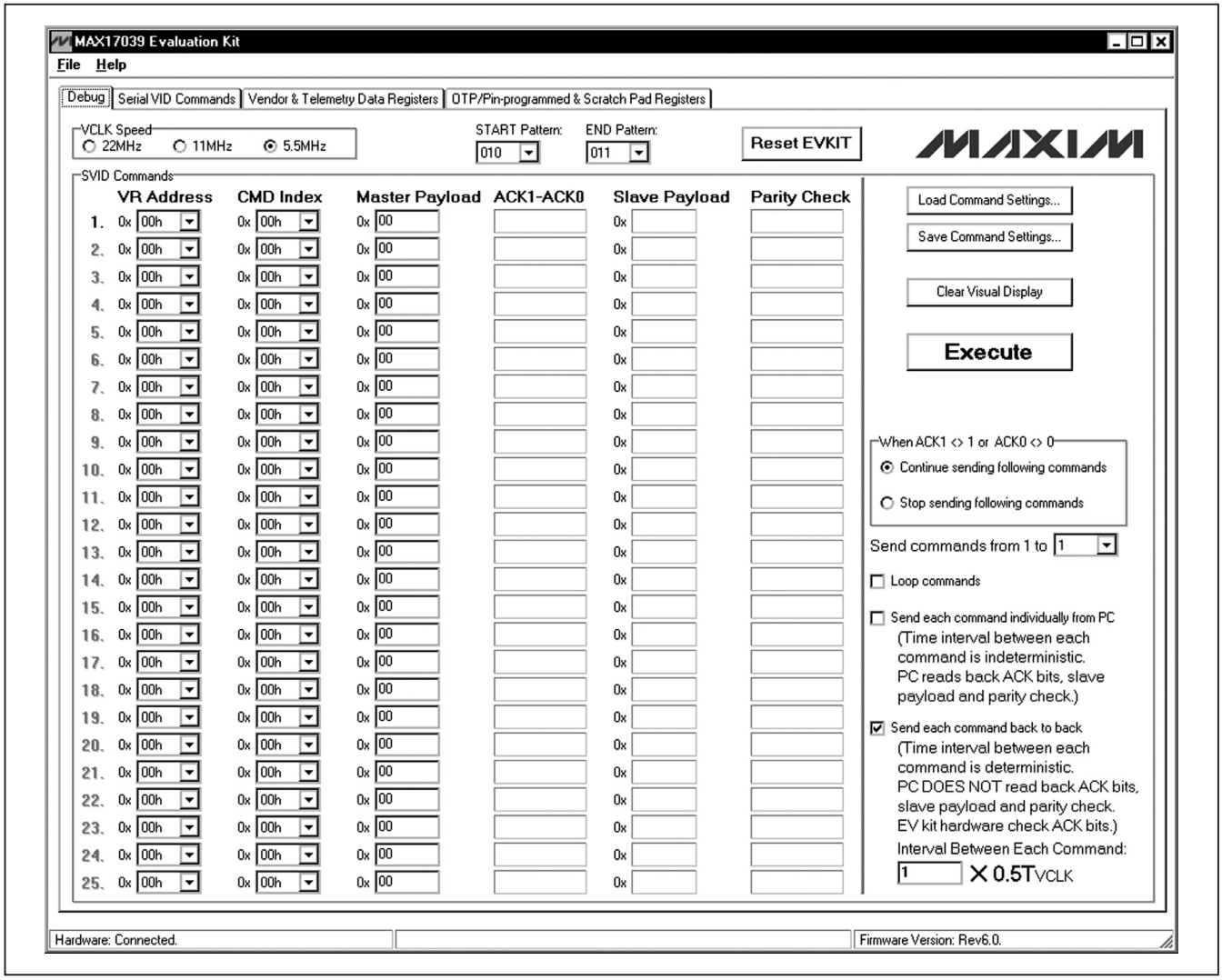

Figure 1. MAX17039 Evaluation Kit Software (Debug Tab)

Detailed Description of Software

The MAX17039 EV kit software contains four tab sheets: **Debug**, **Serial VID Commands**, **Vendor & Telemetry Data Registers**, and **OTP/Pin-programmed & Scratch Pad Registers**.

SCLK Speed Selection

By default, the VCLK speed is set to 5.5MHz on the EV kit. To select a different VCLK speed, the user should navigate to the **Debug** tab sheet and select the desired radio button in the **VCLK Speed** group box.

Debug Tab

The **Debug** tab sheet (Figure 1) has the most complete tools to evaluate the MAX17039. The controls include SVID interface clock-speed selection, protocol selection, and start and end pattern selection.

In the **SVID Commands** group box, the user can set up each individual command, send the commands to the MAX17039 one-by-one continuously, or send the commands to the MAX17039 back-to-back with configurable time intervals between each command. Up to 25 commands can be sent in one loop. The user can also control

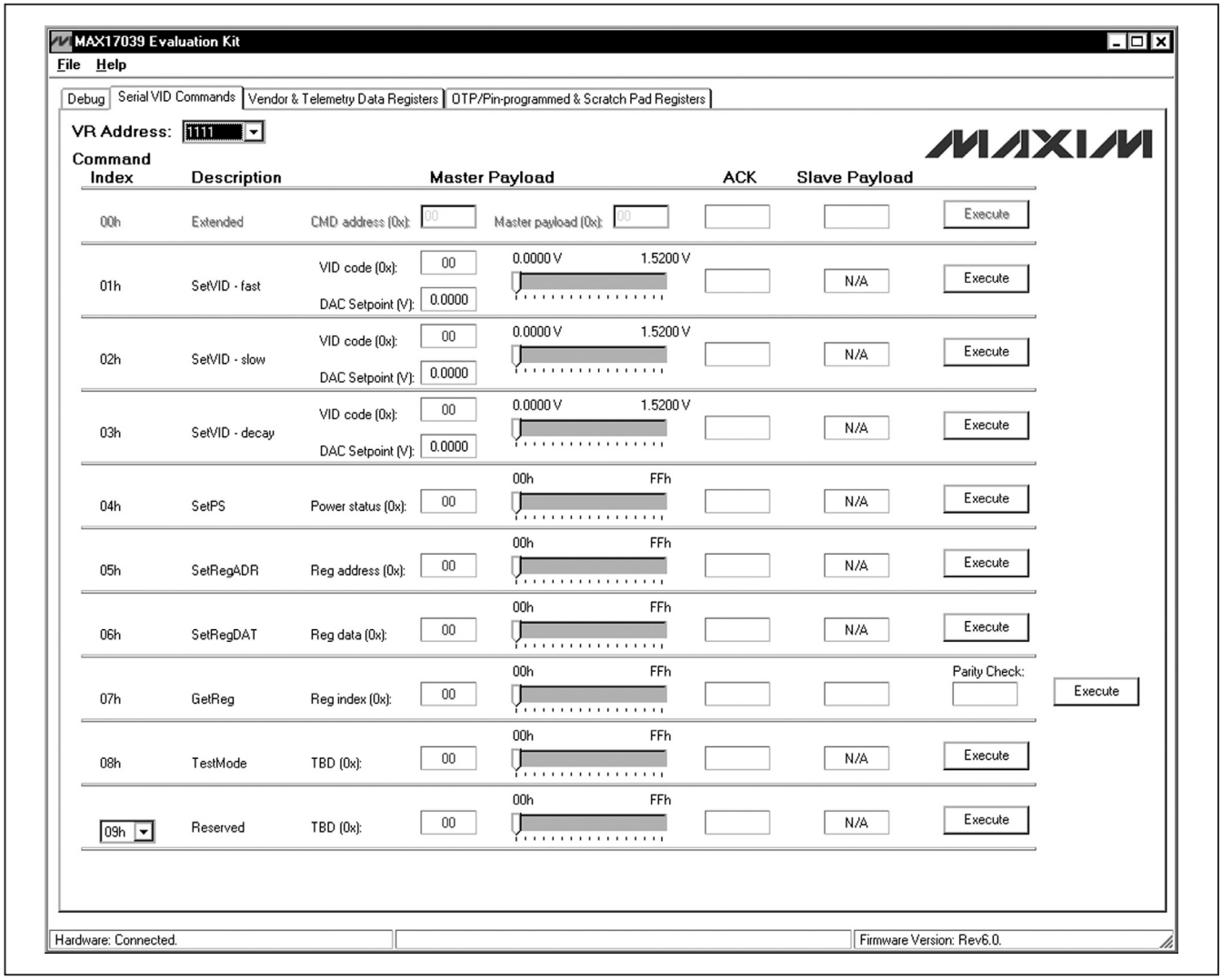

Figure 2. MAX17039 Evaluation Kit Software (Serial VID Commands Tab)

how the SVID master acts when wrong acknowledge bits are received (e.g., either continue or stop sending the commands in the queue).

Press the **Save Command Settings**… button to save the SVID command settings to a text file. Press the **Load Command Settings**… button to load SVID command settings from a text file.

Press the **Reset EVKIT** button to reset the connection between the PC and the SVID bus master. There is no effect on the voltage regulator settings.

Serial VID Commands Tab

The **Serial VID Commands** tab sheet (Figure 2) lists all 32 serial VID commands. Some commands are reserved commands for future use. Move the track bars to change the master payload. Press an **Execute** button to send the command on the same row.

Vendor & Telemetry Data Registers Tab

The **Vendor & Telemetry Data Registers** tab sheet (Figure 3) lists the vendor data registers and the telemetry data registers. Press a **Read** button to send the command on the same row.

OTP/Pin-Programmed & Scratch Pad Registers Tab

The **OTP/Pin-programmed & Scratch Pad Registers** tab sheet (Figure 4) lists the OTP/pin-programmed registers and the scratchpad registers. Press a **Read** button to send the command on the same row.

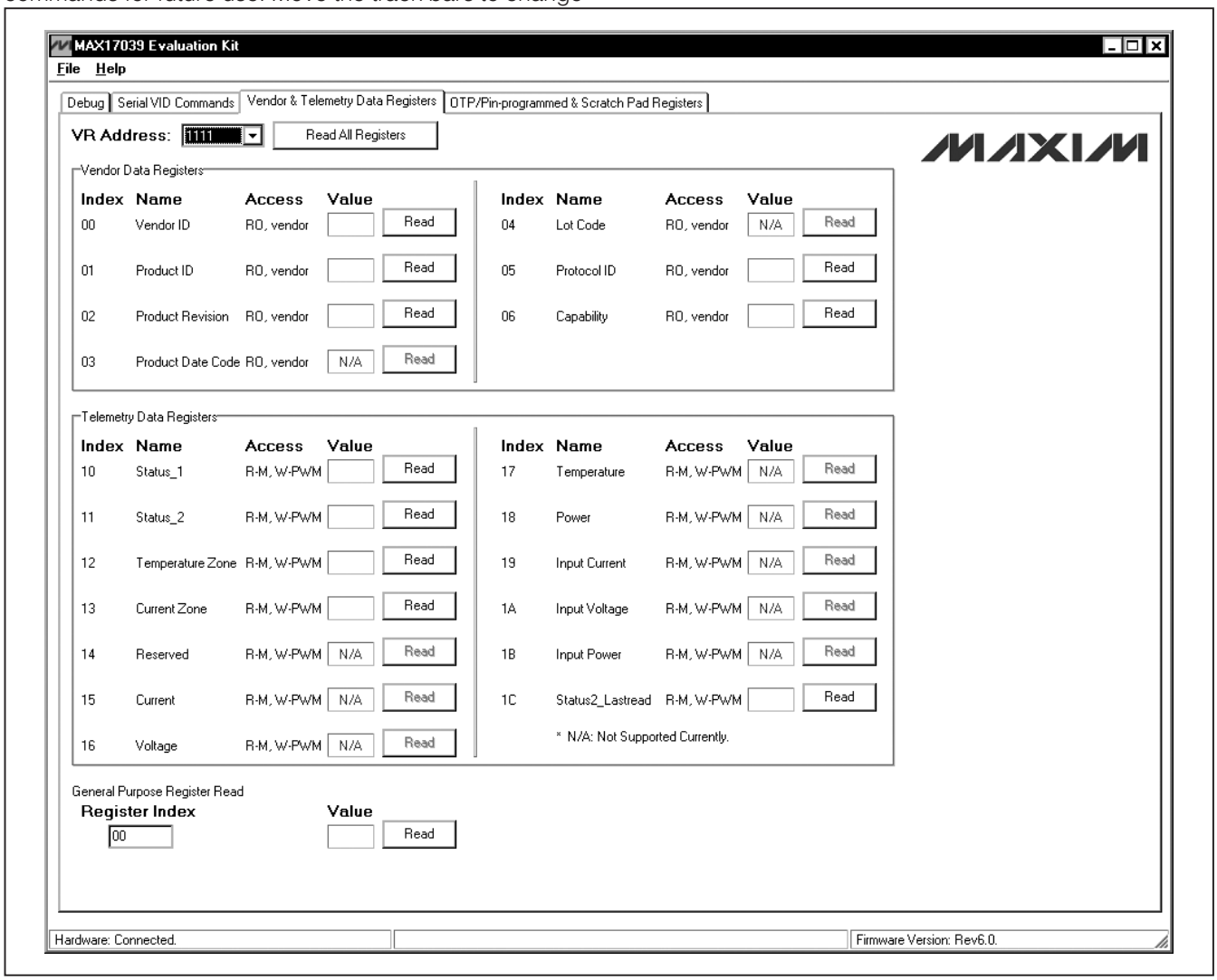

Figure 3. MAX17039 Evaluation Kit Software (Vendor & Telemetry Data Registers Tab)

Serial VID Interface (VCLK, VDIO, $\overline{ALERT}$)

The MAX17039 supports the serial VID interface. Serial VID is a 3-wire (VCLK, VDIO, $\overline{ALERT}$) serial synchronous interface used to transfer power-management information between a master (typically a microprocessor) and a slave (typically a voltage regulator controller). The link is between one master device (usually a microprocessor) and multiple slave devices (usually a VR controller) on the same bus. There is a 4-bit addressing scheme for the slave devices.

The clock is source-synchronous from the CPU. The master drives the VCLK signal with a low-voltage open-drain driver. The master can shut down the VCLK signal to save power when no data transfer is needed. The VDIO line is a low-voltage, open-drain data signal that the master and slave use to send information to each other. The $\overline{ALERT}$ line is an active-low signal driven from the slave device, indicating to the master that the status register needs to be read.

The on-board FPGA is the serial VID bus master and the MAX17039 is the slave. The bus operates at a maximum frequency of 33MHz.

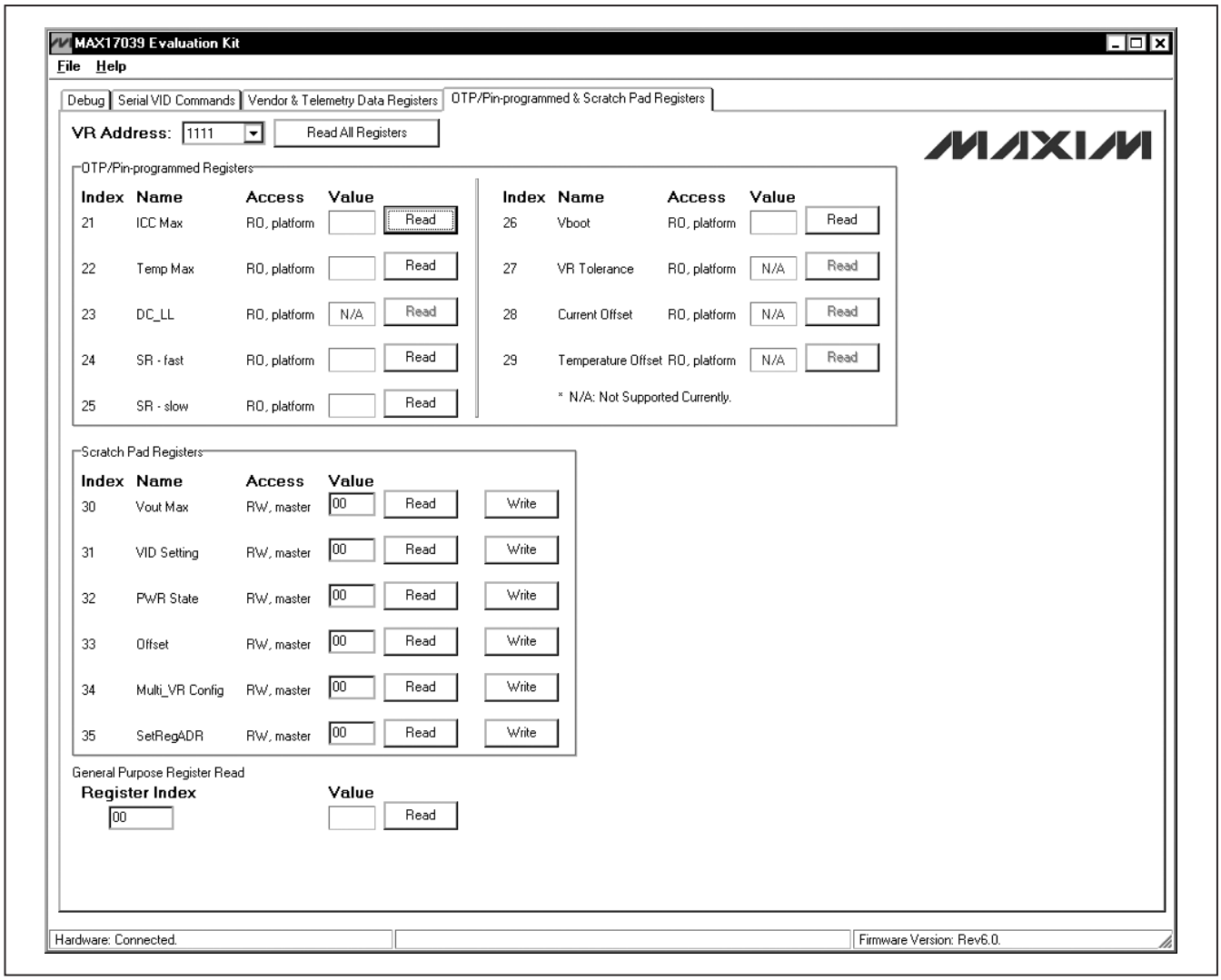

Figure 4. MAX17039 Evaluation Kit Software (OTP/Pin-programmed & Scratch Pad Registers Tab)

_Detailed Description of Hardware

The MAX17039 consists of two high-current SMPSs for the CPU and GPU cores. The CPU core SMPS buck-regulator design is optimized for a 350kHz switching frequency and output-voltage settings of approximately 1.200V. At V_{OUT} = 1.200V and V_{IN} = 12V, the inductor ripple is approximately 25% (LIR = 0.25). The MAX17039 controller interleaves all phases, resulting in 120° out-of-phase operation that minimizes the input and output filtering requirements. The MAX17039 controller shares the current between the three phases, supplying up to 33A per phase. The GPU 1-phase SMPS operates at 440kHz switching frequency and delivers up to 33A.

Setting the Output Voltages

8-Bit DAC

Both CPU and GPU cores are fully compliant with Intel's IMVP-7 serial VID communication and control specification. CPU and GPU core outputs are controlled independently by writing the appropriate data into a function-mapped register file. Output voltages are dynamically changed through a 3-wire serial VID interface (3-wire SVID: clock, data, $\overline{ALERT}$), allowing the switching regulators to be individually programmed to different voltages (Table 1). A slew-rate controller allows controlled transitions between VID codes, and controlled soft-start. SVID also allows each regulator to be individually set into a low-power pulse-skipping state. Transient-phase overlap improves the response of the pseudo fixed-frequency architecture, reducing the total output capacitance for the CPU core.

The MAX17039 includes output overvoltage protection (OVP), undervoltage protection (UVP), and thermal-fault protection. When any of these protection features detect a fault, the controller shuts down both channels. True differential current sensing improves current limit and load-line accuracy.

Table 1. MAX17039 IMVP-7 Output-Voltage SVID 8-Bit DAC Codes

LINE NO.	VID7 640mV	VID6 320mV	VID5 160mV	VID4 80mV	VID3 40mV	VID2 20mV	VID1 10mV	VID0 5mV	HEX1	HEX0	DAC SETPOINT (V)	ACCURACY (±% of VID)
0	0	0	0	0	0	0	0	0	0	0	0.0000	—
1	0	0	0	0	0	0	0	1	0	1	0.2500	35mV
2	0	0	0	0	0	0	1	0	0	2	0.2550	35mV
3	0	0	0	0	0	0	1	1	0	3	0.2600	35mV
4	0	0	0	0	0	1	0	0	0	4	0.2650	35mV
5	0	0	0	0	0	1	0	1	0	5	0.2700	35mV
6	0	0	0	0	0	1	1	0	0	6	0.2750	35mV
7	0	0	0	0	0	1	1	1	0	7	0.2800	35mV
8	0	0	0	0	1	0	0	0	0	8	0.2850	35mV
9	0	0	0	0	1	0	0	1	0	9	0.2900	35mV
10	0	0	0	0	1	0	1	0	0	A	0.2950	35mV
11	0	0	0	0	1	0	1	1	0	B	0.3000	35mV
12	0	0	0	0	1	1	0	0	0	C	0.3050	35mV
13	0	0	0	0	1	1	0	1	0	D	0.3100	35mV
14	0	0	0	0	1	1	1	0	0	E	0.3150	35mV
15	0	0	0	0	1	1	1	1	0	F	0.3200	35mV
16	0	0	0	1	0	0	0	0	1	0	0.3250	35mV
17	0	0	0	1	0	0	0	1	1	1	0.3300	35mV
18	0	0	0	1	0	0	1	0	1	2	0.3350	35mV
19	0	0	0	1	0	0	1	1	1	3	0.3400	35mV
20	0	0	0	1	0	1	0	0	1	4	0.3450	35mV
21	0	0	0	1	0	1	0	1	1	5	0.3500	35mV

Table 1. MAX17039 IMVP-7 Output-Voltage SVID 8-Bit DAC Codes (continued)

LINE NO.	VID7 640mV	VID6 320mV	VID5 160mV	VID4 80mV	VID3 40mV	VID2 20mV	VID1 10mV	VID0 5mV	HEX1	HEX0	DAC SETPOINT (V)	ACCURACY (±% of VID)
22	0	0	0	1	0	1	1	0	1	6	0.3550	35mV
23	0	0	0	1	0	1	1	1	1	7	0.3600	35mV
24	0	0	0	1	1	0	0	0	1	8	0.3650	35mV
25	0	0	0	1	1	0	0	1	1	9	0.3700	35mV
26	0	0	0	1	1	0	1	0	1	A	0.3750	35mV
27	0	0	0	1	1	0	1	1	1	B	0.3800	35mV
28	0	0	0	1	1	1	0	0	1	C	0.3850	35mV
29	0	0	0	1	1	1	0	1	1	D	0.3900	35mV
30	0	0	0	1	1	1	1	0	1	E	0.3950	35mV
31	0	0	0	1	1	1	1	1	1	F	0.4000	35mV
32	0	0	1	0	0	0	0	0	2	0	0.4050	35mV
33	0	0	1	0	0	0	0	1	2	1	0.4100	35mV
34	0	0	1	0	0	0	1	0	2	2	0.4150	35mV
35	0	0	1	0	0	0	1	1	2	3	0.4200	35mV
36	0	0	1	0	0	1	0	0	2	4	0.4250	35mV
37	0	0	1	0	0	1	0	1	2	5	0.4300	35mV
38	0	0	1	0	0	1	1	0	2	6	0.4350	35mV
39	0	0	1	0	0	1	1	1	2	7	0.4400	35mV
40	0	0	1	0	1	0	0	0	2	8	0.4450	35mV
41	0	0	1	0	1	0	0	1	2	9	0.4500	35mV
42	0	0	1	0	1	0	1	0	2	A	0.4550	35mV
43	0	0	1	0	1	0	1	1	2	B	0.4600	35mV
44	0	0	1	0	1	1	0	0	2	C	0.4650	35mV
45	0	0	1	0	1	1	0	1	2	D	0.4700	35mV
46	0	0	1	0	1	1	1	0	2	E	0.4750	35mV
47	0	0	1	0	1	1	1	1	2	F	0.4800	35mV
48	0	0	1	1	0	0	0	0	3	0	0.4850	35mV
49	0	0	1	1	0	0	0	1	3	1	0.4900	35mV
50	0	0	1	1	0	0	1	0	3	2	0.4950	35mV
51	0	0	1	1	0	0	1	1	3	3	0.5000	8mV
52	0	0	1	1	0	1	0	0	3	4	0.5050	8mV
53	0	0	1	1	0	1	0	1	3	5	0.5100	8mV
54	0	0	1	1	0	1	1	0	3	6	0.5150	8mV
55	0	0	1	1	0	1	1	1	3	7	0.5200	8mV
56	0	0	1	1	1	0	0	0	3	8	0.5250	8mV
57	0	0	1	1	1	0	0	1	3	9	0.5300	8mV
58	0	0	1	1	1	0	1	0	3	A	0.5350	8mV
59	0	0	1	1	1	0	1	1	3	B	0.5400	8mV
60	0	0	1	1	1	1	0	0	3	C	0.5450	8mV
61	0	0	1	1	1	1	0	1	3	D	0.5500	8mV
62	0	0	1	1	1	1	1	0	3	E	0.5550	8mV

Table 1. MAX17039 IMVP-7 Output-Voltage SVID 8-Bit DAC Codes (continued)

LINE NO.	VID7 640mV	VID6 320mV	VID5 160mV	VID4 80mV	VID3 40mV	VID2 20mV	VID1 10mV	VID0 5mV	HEX1	HEX0	DAC SETPOINT (V)	ACCURACY (±% of VID)
63	0	0	1	1	1	1	1	1	3	F	0.5600	8mV
64	0	1	0	0	0	0	0	0	4	0	0.5650	8mV
65	0	1	0	0	0	0	0	1	4	1	0.5700	8mV
66	0	1	0	0	0	0	1	0	4	2	0.5750	8mV
67	0	1	0	0	0	0	1	1	4	3	0.5800	8mV
68	0	1	0	0	0	1	0	0	4	4	0.5850	8mV
69	0	1	0	0	0	1	0	1	4	5	0.5900	8mV
70	0	1	0	0	0	1	1	0	4	6	0.5950	8mV
71	0	1	0	0	0	1	1	1	4	7	0.6000	8mV
72	0	1	0	0	1	0	0	0	4	8	0.6050	8mV
73	0	1	0	0	1	0	0	1	4	9	0.6100	8mV
74	0	1	0	0	1	0	1	0	4	A	0.6150	8mV
75	0	1	0	0	1	0	1	1	4	B	0.6200	8mV
76	0	1	0	0	1	1	0	0	4	C	0.6250	8mV
77	0	1	0	0	1	1	0	1	4	D	0.6300	8mV
78	0	1	0	0	1	1	1	0	4	E	0.6350	8mV
79	0	1	0	0	1	1	1	1	4	F	0.6400	8mV
80	0	1	0	1	0	0	0	0	5	0	0.6450	8mV
81	0	1	0	1	0	0	0	1	5	1	0.6500	8mV
82	0	1	0	1	0	0	1	0	5	2	0.6550	8mV
83	0	1	0	1	0	0	1	1	5	3	0.6600	8mV
84	0	1	0	1	0	1	0	0	5	4	0.6650	8mV
85	0	1	0	1	0	1	0	1	5	5	0.6700	8mV
86	0	1	0	1	0	1	1	0	5	6	0.6750	8mV
87	0	1	0	1	0	1	1	1	5	7	0.6800	8mV
88	0	1	0	1	1	0	0	0	5	8	0.6850	8mV
89	0	1	0	1	1	0	0	1	5	9	0.6900	8mV
90	0	1	0	1	1	0	1	0	5	A	0.6950	8mV
91	0	1	0	1	1	0	1	1	5	B	0.7000	8mV
92	0	1	0	1	1	1	0	0	5	C	0.7050	8mV
93	0	1	0	1	1	1	0	1	5	D	0.7100	8mV
94	0	1	0	1	1	1	1	0	5	E	0.7150	8mV
95	0	1	0	1	1	1	1	1	5	F	0.7200	8mV
96	0	1	1	0	0	0	0	0	6	0	0.7250	8mV
97	0	1	1	0	0	0	0	1	6	1	0.7300	8mV
98	0	1	1	0	0	0	1	0	6	2	0.7350	8mV
99	0	1	1	0	0	0	1	1	6	3	0.7400	8mV
100	0	1	1	0	0	1	0	0	6	4	0.7450	8mV
101	0	1	1	0	0	1	0	1	6	5	0.7500	8mV
102	0	1	1	0	0	1	1	0	6	6	0.7550	8mV
103	0	1	1	0	0	1	1	1	6	7	0.7600	8mV

Table 1. MAX17039 IMVP-7 Output-Voltage SVID 8-Bit DAC Codes (continued)

LINE NO.	VID7 640mV	VID6 320mV	VID5 160mV	VID4 80mV	VID3 40mV	VID2 20mV	VID1 10mV	VID0 5mV	HEX1	HEX0	DAC SETPOINT (V)	ACCURACY (±% of VID)
104	0	1	1	0	1	0	0	0	6	8	0.7650	8mV
105	0	1	1	0	1	0	0	1	6	9	0.7700	8mV
106	0	1	1	0	1	0	1	0	6	A	0.7750	8mV
107	0	1	1	0	1	0	1	1	6	B	0.7800	8mV
108	0	1	1	0	1	1	0	0	6	C	0.7850	8mV
109	0	1	1	0	1	1	0	1	6	D	0.7900	8mV
110	0	1	1	0	1	1	1	0	6	E	0.7950	8mV
111	0	1	1	0	1	1	1	1	6	F	0.8000	5mV
112	0	1	1	1	0	0	0	0	7	0	0.8050	5mV
113	0	1	1	1	0	0	0	1	7	1	0.8100	5mV
114	0	1	1	1	0	0	1	0	7	2	0.8150	5mV
115	0	1	1	1	0	0	1	1	7	3	0.8200	5mV
116	0	1	1	1	0	1	0	0	7	4	0.8250	5mV
117	0	1	1	1	0	1	0	1	7	5	0.8300	5mV
118	0	1	1	1	0	1	1	0	7	6	0.8350	5mV
119	0	1	1	1	0	1	1	1	7	7	0.8400	5mV
120	0	1	1	1	1	0	0	0	7	8	0.8450	5mV
121	0	1	1	1	1	0	0	1	7	9	0.8500	5mV
122	0	1	1	1	1	0	1	0	7	A	0.8550	5mV
123	0	1	1	1	1	0	1	1	7	B	0.8600	5mV
124	0	1	1	1	1	1	0	0	7	C	0.8650	5mV
125	0	1	1	1	1	1	0	1	7	D	0.8700	5mV
126	0	1	1	1	1	1	1	0	7	E	0.8750	5mV
127	0	1	1	1	1	1	1	1	7	F	0.8800	5mV
128	1	0	0	0	0	0	0	0	8	0	0.8850	5mV
129	1	0	0	0	0	0	0	1	8	1	0.8900	5mV
130	1	0	0	0	0	0	1	0	8	2	0.8950	5mV
131	1	0	0	0	0	0	1	1	8	3	0.9000	5mV
132	1	0	0	0	0	1	0	0	8	4	0.9050	5mV
133	1	0	0	0	0	1	0	1	8	5	0.9100	5mV
134	1	0	0	0	0	1	1	0	8	6	0.9150	5mV
135	1	0	0	0	0	1	1	1	8	7	0.9200	5mV
136	1	0	0	0	1	0	0	0	8	8	0.9250	5mV
137	1	0	0	0	1	0	0	1	8	9	0.9300	5mV
138	1	0	0	0	1	0	1	0	8	A	0.9350	5mV
139	1	0	0	0	1	0	1	1	8	B	0.9400	5mV
140	1	0	0	0	1	1	0	0	8	C	0.9450	5mV
141	1	0	0	0	1	1	0	1	8	D	0.9500	5mV
142	1	0	0	0	1	1	1	0	8	E	0.9550	5mV
143	1	0	0	0	1	1	1	1	8	F	0.9600	5mV
144	1	0	0	1	0	0	0	0	9	0	0.9650	5mV

Table 1. MAX17039 IMVP-7 Output-Voltage SVID 8-Bit DAC Codes (continued)

LINE NO.	VID7 640mV	VID6 320mV	VID5 160mV	VID4 80mV	VID3 40mV	VID2 20mV	VID1 10mV	VID0 5mV	HEX1	HEX0	DAC SETPOINT (V)	ACCURACY (±% of VID)
145	1	0	0	1	0	0	0	1	9	1	0.9700	5mV
146	1	0	0	1	0	0	1	0	9	2	0.9750	5mV
147	1	0	0	1	0	0	1	1	9	3	0.9800	5mV
148	1	0	0	1	0	1	0	0	9	4	0.9850	5mV
149	1	0	0	1	0	1	0	1	9	5	0.9900	5mV
150	1	0	0	1	0	1	1	0	9	6	0.9950	5mV
151	1	0	0	1	0	1	1	1	9	7	1.0000	0.5%
152	1	0	0	1	1	0	0	0	9	8	1.0050	0.5%
153	1	0	0	1	1	0	0	1	9	9	1.0100	0.5%
154	1	0	0	1	1	0	1	0	9	A	1.0150	0.5%
155	1	0	0	1	1	0	1	1	9	B	1.0200	0.5%
156	1	0	0	1	1	1	0	0	9	C	1.0250	0.5%
157	1	0	0	1	1	1	0	1	9	D	1.0300	0.5%
158	1	0	0	1	1	1	1	0	9	E	1.0350	0.5%
159	1	0	0	1	1	1	1	1	9	F	1.0400	0.5%
160	1	0	1	0	0	0	0	0	A	0	1.0450	0.5%
161	1	0	1	0	0	0	0	1	A	1	1.0500	0.5%
162	1	0	1	0	0	0	1	0	A	2	1.0550	0.5%
163	1	0	1	0	0	0	1	1	A	3	1.0600	0.5%
164	1	0	1	0	0	1	0	0	A	4	1.0650	0.5%
165	1	0	1	0	0	1	0	1	A	5	1.0700	0.5%
166	1	0	1	0	0	1	1	0	A	6	1.0750	0.5%
167	1	0	1	0	0	1	1	1	A	7	1.0800	0.5%
168	1	0	1	0	1	0	0	0	A	8	1.0850	0.5%
169	1	0	1	0	1	0	0	1	A	9	1.0900	0.5%
170	1	0	1	0	1	0	1	0	A	A	1.0950	0.5%
171	1	0	1	0	1	0	1	1	A	B	1.1000	0.5%
172	1	0	1	0	1	1	0	0	A	C	1.1050	0.5%
173	1	0	1	0	1	1	0	1	A	D	1.1100	0.5%
174	1	0	1	0	1	1	1	0	A	E	1.1150	0.5%
175	1	0	1	0	1	1	1	1	A	F	1.1200	0.5%
176	1	0	1	1	0	0	0	0	B	0	1.1250	0.5%
177	1	0	1	1	0	0	0	1	B	1	1.1300	0.5%
178	1	0	1	1	0	0	1	0	B	2	1.1350	0.5%
179	1	0	1	1	0	0	1	1	B	3	1.1400	0.5%
180	1	0	1	1	0	1	0	0	B	4	1.1450	0.5%
181	1	0	1	1	0	1	0	1	B	5	1.1500	0.5%
182	1	0	1	1	0	1	1	0	B	6	1.1550	0.5%
183	1	0	1	1	0	1	1	1	B	7	1.1600	0.5%
184	1	0	1	1	1	0	0	0	B	8	1.1650	0.5%
185	1	0	1	1	1	0	0	1	B	9	1.1700	0.5%

Table 1. MAX17039 IMVP-7 Output-Voltage SVID 8-Bit DAC Codes (continued)

LINE NO.	VID7 640mV	VID6 320mV	VID5 160mV	VID4 80mV	VID3 40mV	VID2 20mV	VID1 10mV	VID0 5mV	HEX1	HEX0	DAC SETPOINT (V)	ACCURACY (±% of VID)
186	1	0	1	1	1	0	1	0	B	A	1.1750	0.5%
187	1	0	1	1	1	0	1	1	B	B	1.1800	0.5%
188	1	0	1	1	1	1	0	0	B	C	1.1850	0.5%
189	1	0	1	1	1	1	0	1	B	D	1.1900	0.5%
190	1	0	1	1	1	1	1	0	B	E	1.1950	0.5%
191	**1**	**0**	**1**	**1**	**1**	**1**	**1**	**1**	**B**	**F**	**1.2000**	**0.5%**
192	1	1	0	0	0	0	0	0	C	0	1.2050	0.5%
193	1	1	0	0	0	0	0	1	C	1	1.2100	0.5%
194	1	1	0	0	0	0	1	0	C	2	1.2150	0.5%
195	1	1	0	0	0	0	1	1	C	3	1.2200	0.5%
196	1	1	0	0	0	1	0	0	C	4	1.2250	0.5%
197	1	1	0	0	0	1	0	1	C	5	1.2300	0.5%
198	1	1	0	0	0	1	1	0	C	6	1.2350	0.5%
199	1	1	0	0	0	1	1	1	C	7	1.2400	0.5%
200	1	1	0	0	1	0	0	0	C	8	1.2450	0.5%
201	1	1	0	0	1	0	0	1	C	9	1.2500	0.5%
202	1	1	0	0	1	0	1	0	C	A	1.2550	0.5%
203	1	1	0	0	1	0	1	1	C	B	1.2600	0.5%
204	1	1	0	0	1	1	0	0	C	C	1.2650	0.5%
205	1	1	0	0	1	1	0	1	C	D	1.2700	0.5%
206	1	1	0	0	1	1	1	0	C	E	1.2750	0.5%
207	1	1	0	0	1	1	1	1	C	F	1.2800	0.5%
208	1	1	0	1	0	0	0	0	D	0	1.2850	0.5%
209	1	1	0	1	0	0	0	1	D	1	1.2900	0.5%
210	1	1	0	1	0	0	1	0	D	2	1.2950	0.5%
211	1	1	0	1	0	0	1	1	D	3	1.3000	0.5%
212	1	1	0	1	0	1	0	0	D	4	1.3050	0.5%
213	1	1	0	1	0	1	0	1	D	5	1.3100	0.5%
214	1	1	0	1	0	1	1	0	D	6	1.3150	0.5%
215	1	1	0	1	0	1	1	1	D	7	1.3200	0.5%
216	1	1	0	1	1	0	0	0	D	8	1.3250	0.5%
217	1	1	0	1	1	0	0	1	D	9	1.3300	0.5%
218	1	1	0	1	1	0	1	0	D	A	1.3350	0.5%
219	1	1	0	1	1	0	1	1	D	B	1.3400	0.5%
220	1	1	0	1	1	1	0	0	D	C	1.3450	0.5%
221	1	1	0	1	1	1	0	1	D	D	1.3500	0.5%
222	1	1	0	1	1	1	1	0	D	E	1.3550	0.5%
223	1	1	0	1	1	1	1	1	D	F	1.3600	0.5%
224	1	1	1	0	0	0	0	0	E	0	1.3650	0.5%
225	1	1	1	0	0	0	0	1	E	1	1.3700	0.5%
226	1	1	1	0	0	0	1	0	E	2	1.3750	0.5%

Table 1. MAX17039 IMVP-7 Output-Voltage SVID 8-Bit DAC Codes (continued)

LINE NO.	VID7 640mV	VID6 320mV	VID5 160mV	VID4 80mV	VID3 40mV	VID2 20mV	VID1 10mV	VID0 5mV	HEX1	HEX0	DAC SETPOINT (V)	ACCURACY (±% of VID)
227	1	1	1	0	0	0	1	1	E	3	1.3800	0.5%
228	1	1	1	0	0	1	0	0	E	4	1.3850	0.5%
229	1	1	1	0	0	1	0	1	E	5	1.3900	0.5%
230	1	1	1	0	0	1	1	0	E	6	1.3950	0.5%
231	1	1	1	0	0	1	1	1	E	7	1.4000	0.5%
232	1	1	1	0	1	0	0	0	E	8	1.4050	0.5%
233	1	1	1	0	1	0	0	1	E	9	1.4100	0.5%
234	1	1	1	0	1	0	1	0	E	A	1.4150	0.5%
235	1	1	1	0	1	0	1	1	E	B	1.4200	0.5%
236	1	1	1	0	1	1	0	0	E	C	1.4250	0.5%
237	1	1	1	0	1	1	0	1	E	D	1.4300	0.5%
238	1	1	1	0	1	1	1	0	E	E	1.4350	0.5%
239	1	1	1	0	1	1	1	1	E	F	1.4400	0.5%
240	1	1	1	1	0	0	0	0	F	0	1.4450	0.5%
241	1	1	1	1	0	0	0	1	F	1	1.4500	0.5%
242	1	1	1	1	0	0	1	0	F	2	1.4550	0.5%
243	1	1	1	1	0	0	1	1	F	3	1.4600	0.5%
244	1	1	1	1	0	1	0	0	F	4	1.4650	0.5%
245	1	1	1	1	0	1	0	1	F	5	1.4700	0.5%
246	1	1	1	1	0	1	1	0	F	6	1.4750	0.5%
247	1	1	1	1	0	1	1	1	F	7	1.4800	0.5%
248	1	1	1	1	1	0	0	0	F	8	1.4850	0.5%
249	1	1	1	1	1	0	0	1	F	9	1.4900	0.5%
250	1	1	1	1	1	0	1	0	F	A	1.4950	0.5%
251	1	1	1	1	1	0	1	1	F	B	1.5000	0.5%
252	1	1	1	1	1	1	0	0	F	C	1.5050	0.5%
253	1	1	1	1	1	1	0	1	F	D	1.5100	0.5%
254	1	1	1	1	1	1	1	0	F	E	1.5150	0.5%
255	1	1	1	1	1	1	1	1	F	F	1.5200	0.5%

Reduced Power-Dissipation Voltage Positioning

The MAX17039 includes a transconductance amplifier for adding gain to the voltage-positioning sense path. The amplifier's input is generated by summing the current-sense inputs, which differentially sense the voltage across the inductor's DCR. The transconductance amplifier's output connects to the voltage-positioned feedback input (FBA), so the resistance between FBA and V_{OUT} (R17) determines the voltage-positioning gain. Resistor R17 (3.83kΩ) provides a -1.9mV/A voltage-positioning slope at the CPU output. Also, the resistance between FBB and VCCGT (R75) determines the voltage-positioning gain for the GPU output. Resistor R75 (8.06kΩ) provides a -3.9mV/A voltage-positioning slope at the GPU output. Remote output and ground sensing eliminate any additional PCB voltage drops.

Jumper JU4 Settings

Shutdown Control Input

When VR_ENABLE goes low (JU4 = GND), the MAX17039 enters the low-power shutdown mode. VRA_READY and VRB_ READY are pulled low immediately, and both output voltages ramp down at 1.2mV/µs slew rate. When the controller reaches the 0V target, the drivers are disabled (DH_ and DL_ driven low), the reference is turned off, and the IC supply currents drop to 15µA (max).

When a fault condition activates the shutdown sequence (output undervoltage lockout or thermal shutdown), the protection circuitry sets the fault latch to prevent the controller from restarting. To clear the fault latch and reactivate the MAX17039, toggle VR_ENABLE or cycle V_{DD} power.

Evaluating the MAX17000 Circuit

The MAX17039 EV kit also demonstrates the MAX17000 DDR memory-power solution circuit. The MAX17000 provides the regulated voltages required in a complete DDR memory system. The MAX17000 generates the main-memory voltage (VCCDDR), the tracking sinking/sourcing termination voltage (VTTDDR), and the reference voltage (VTTR). The MAX17000 circuit operates at 400kHz switching frequency, generates a preset 1.5V VCCDDR main-memory voltage that can source 10A from a 7V to 20V battery-input range. The termination regulator provides a 0.75V VTTDDR supply that can sink/source 2A. The termination reference buffer provides a 0.75V VTTR supply that can sink/source 3mA.

Setting the VCCDDR Output Voltage

The MAX17000 feedback input (FB) is connected to a network of resistors that set the VCCDDR output voltage. By default, the output voltage is preset to a fixed 1.5V output (R120 = 0Ω). For a fixed 1.8V output, remove R120 and install a short across resistor R51. For an adjustable VCCDDR output (1V to 2.7V), connect FB to resistive-divider R119 and R120 from the output-voltage VCCDDR. Install feedback resistors with values according to the following equation:

$$VCCDDR = VFB\left(1+\frac{R119}{R120}\right)$$

where VFB = 1V. Use 10kΩ for R120 and calculate R119 for the desired VCCDDR output voltage.

MAX17000 Standby Control Input ($\overline{STDBY}$) and Shutdown Control Input ($\overline{SHDN}$)

The MAX17000 features independent standby and shutdown controls by implementing jumpers JU5 and JU6 to control the $\overline{STDBY}$ and $\overline{SHDN}$ inputs, respectively. Jumpers JU5 and JU6 allow flexible sequencing to support all DDR operating states. The shutdown and standby control logic is illustrated in Table 3.

Table 3. JU5 ($\overline{STDBY}$) and JU6 ($\overline{SHDN}$) Functions

SHUNT POSITION		VCCDDR OUTPUT	VTTDDR	VTTR
JU5 ($\overline{STDBY}$)	JU6 ($\overline{SHDN}$)			
X	Not installed	Disabled	Disabled	Disabled
Installed*	Installed*	Enabled	Enabled	Enabled
Not installed	Installed	Enabled	Disabled	Enabled

X = Don't care.
**Default position.*

Table 2. Shutdown Mode (VR_ENABLE)

JU4 SHUNT POSITION	VR_ENABLE PIN	MAX17039 OUTPUT
Installed	Connected to GND	Shutdown mode (V_{OUT} = 0V and VCCGT = 0V)
Not installed*	Connected to VCC	Outputs enabled (V_{OUT} and VCCGT are programmed by the 3-wire serial VID interface)

**Default position.*

Evaluating the MAX17007A Circuit

The MAX17039 kit also demonstrates the MAX17007A I/O power-solution circuit.

This DC-DC converter steps down high-voltage batteries to generate low-voltage core or chipset/RAM bias supplies in notebook computers. The MAX17007A circuit generates two independent I/O voltages (VTT1 and VTT2) from a 7V to 20V battery-input range. VTT1 and VTT2 are configured for 1.05V output voltages. The VTT1 output delivers up to 6A and the VTT2 output delivers up to 21A. The VTT1 and VTT2 outputs operate at 270kHz and 330kHz switching frequencies, respectively. Both outputs can be configured for other voltages by changing resistor R140, R141, R152, and R153 values. Refer to the MAX17007A IC data sheet for more details.

The outputs can also be combined to operate as a 2-phase, high-current, single-output regulator. In this mode the output is configured for either a preset, adjustable, or dynamically adjustable output voltage using REFIN1. Refer to the *Combined-Mode Operation (FB2 = V_{CC})* section in the MAX17007A IC data sheet for more details.

The MAX17007A provides access to the device's enable control pins (EN1 and EN2) through jumpers JU15 and JU16, respectively. EN1 is used to control the VTT1 output and EN2 is used to control the VTT2 output. When in combined mode, EN1 is used for output control and EN2 must be connected to GND. Tables 4 and 5 list the options for each output-enable pin.

Table 4. Jumper JU15 Functions

SHUNT POSITION	EN1 PIN	VTT1 OUTPUT
Installed*	Connected to VL5	Enabled (VTT1 = 1.05V)
Not installed	Connected to GND through R144	Shutdown mode (VTT1 = 0V)

**Default position.*

Table 5. Jumper JU16 Functions

SHUNT POSITION	EN2 PIN	VTT2 OUTPUT
Installed*	Connected to V3P3	Enabled (VTT2 = 1.05V)
Not installed	Connected to GND through R155	Shutdown mode (VTT2 = 0V)

**Default position.*

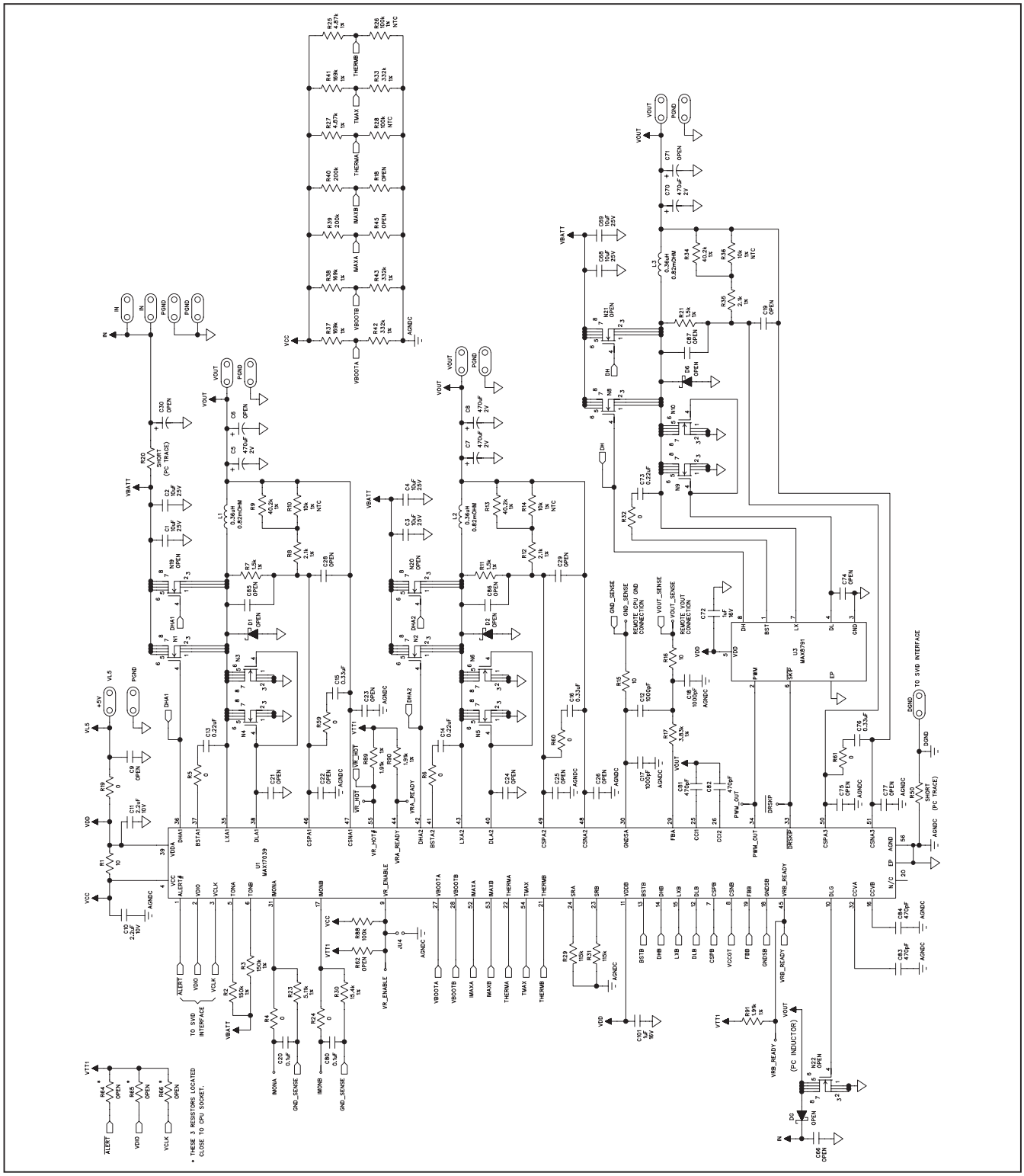

Figure 5a. MAX17039 EV Kit Schematic (Sheet 1 of 7)

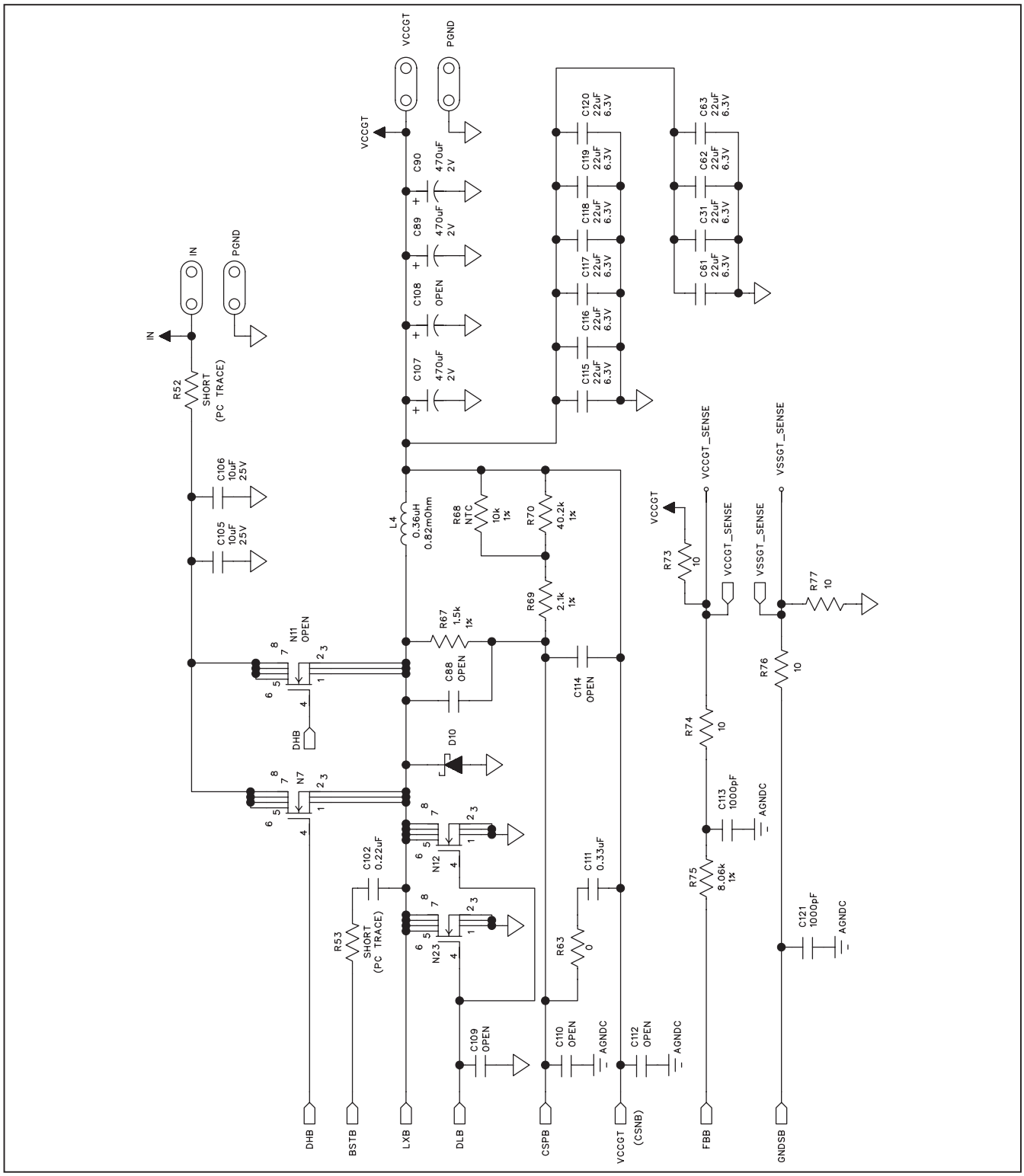

Figure 5b. MAX17039 EV Kit Schematic (Sheet 2 of 7)

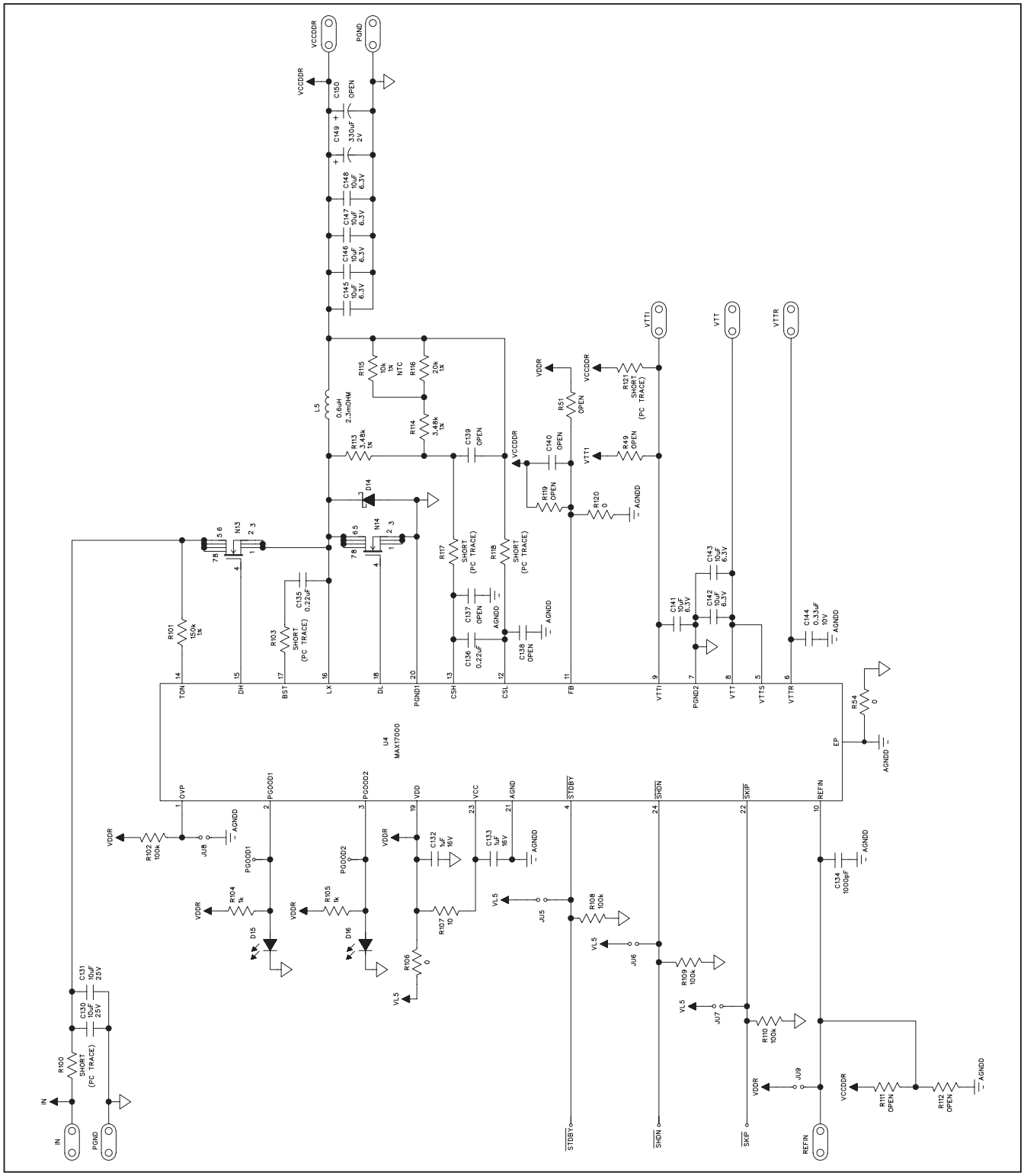

Figure 5c. MAX17039 EV Kit Schematic (Sheet 3 of 7)

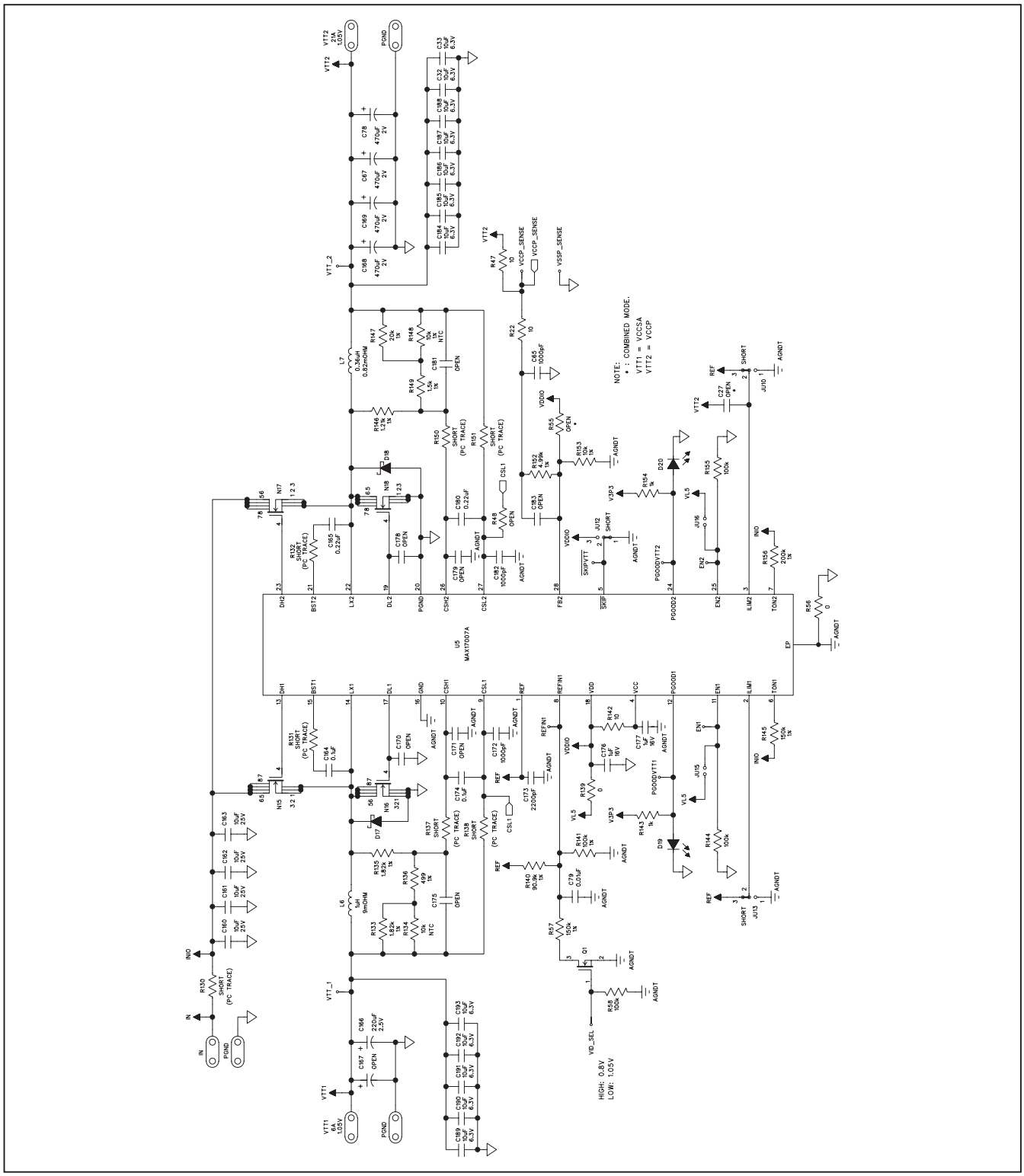

Figure 5d. MAX17039 EV Kit Schematic (Sheet 4 of 7)

MAX17039 Evaluation Kit

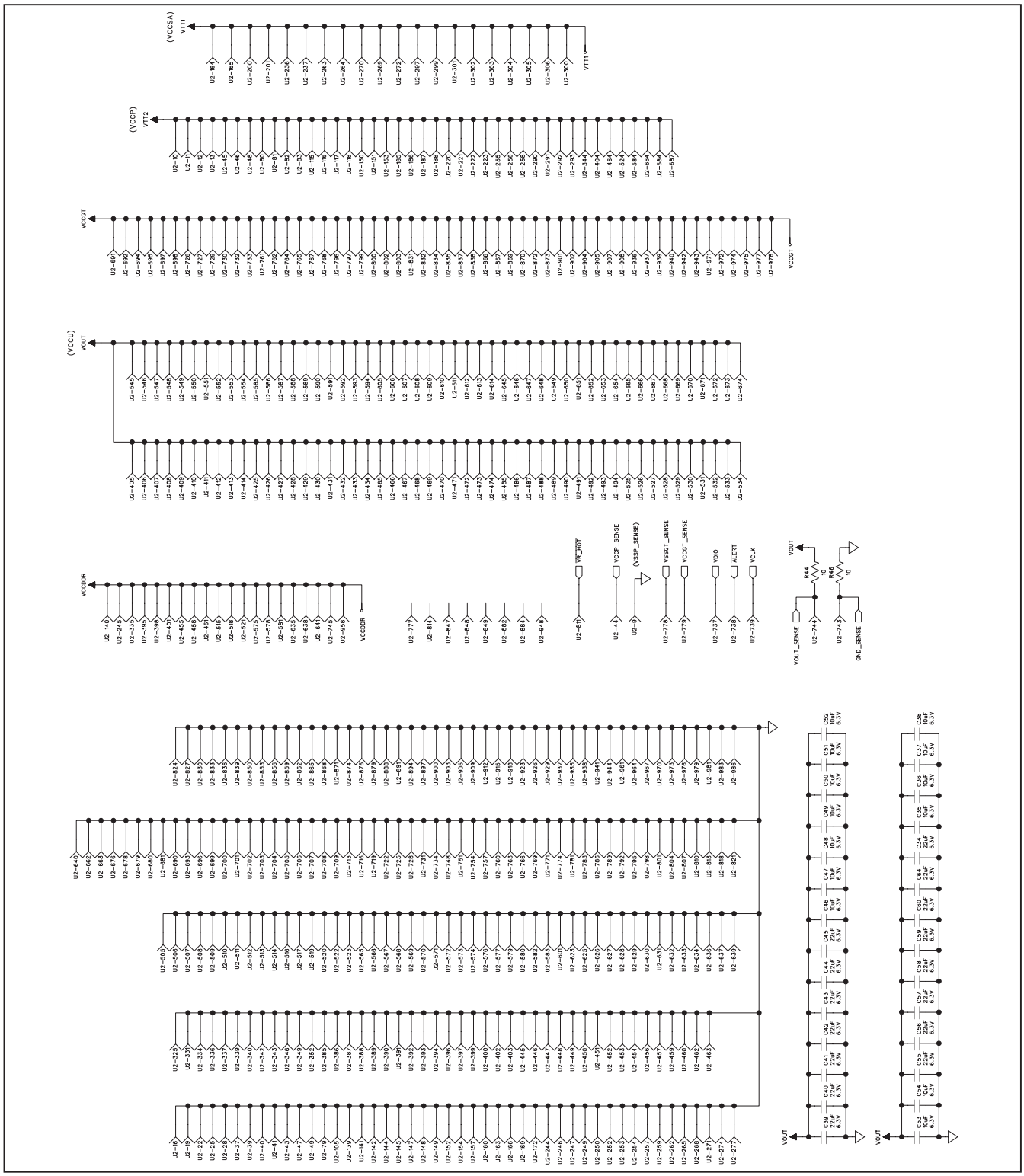

Figure 5e. MAX17039 EV Kit Schematic (Sheet 5 of 7)

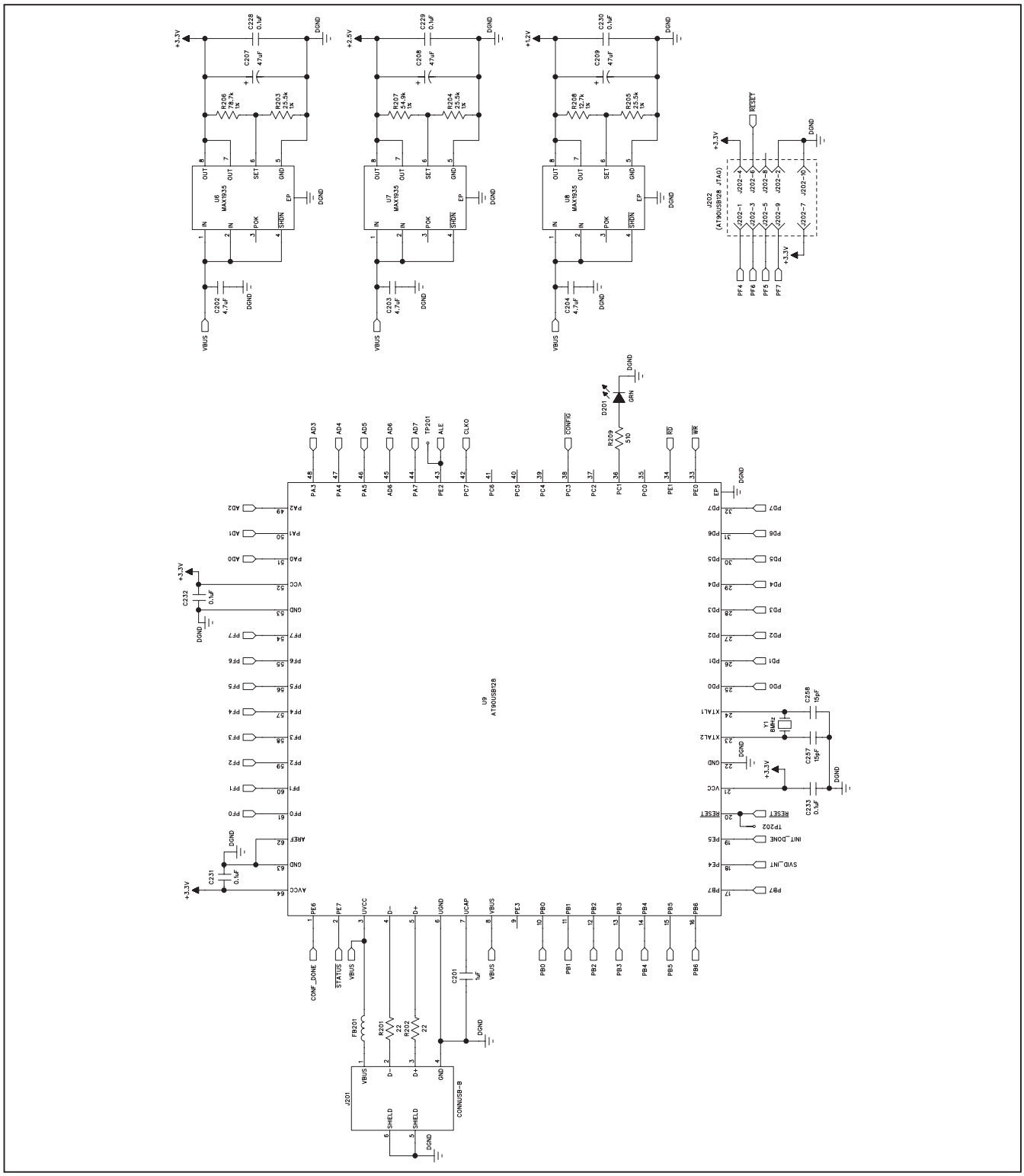

Figure 5f. MAX17039 EV Kit Schematic (Sheet 6 of 7)

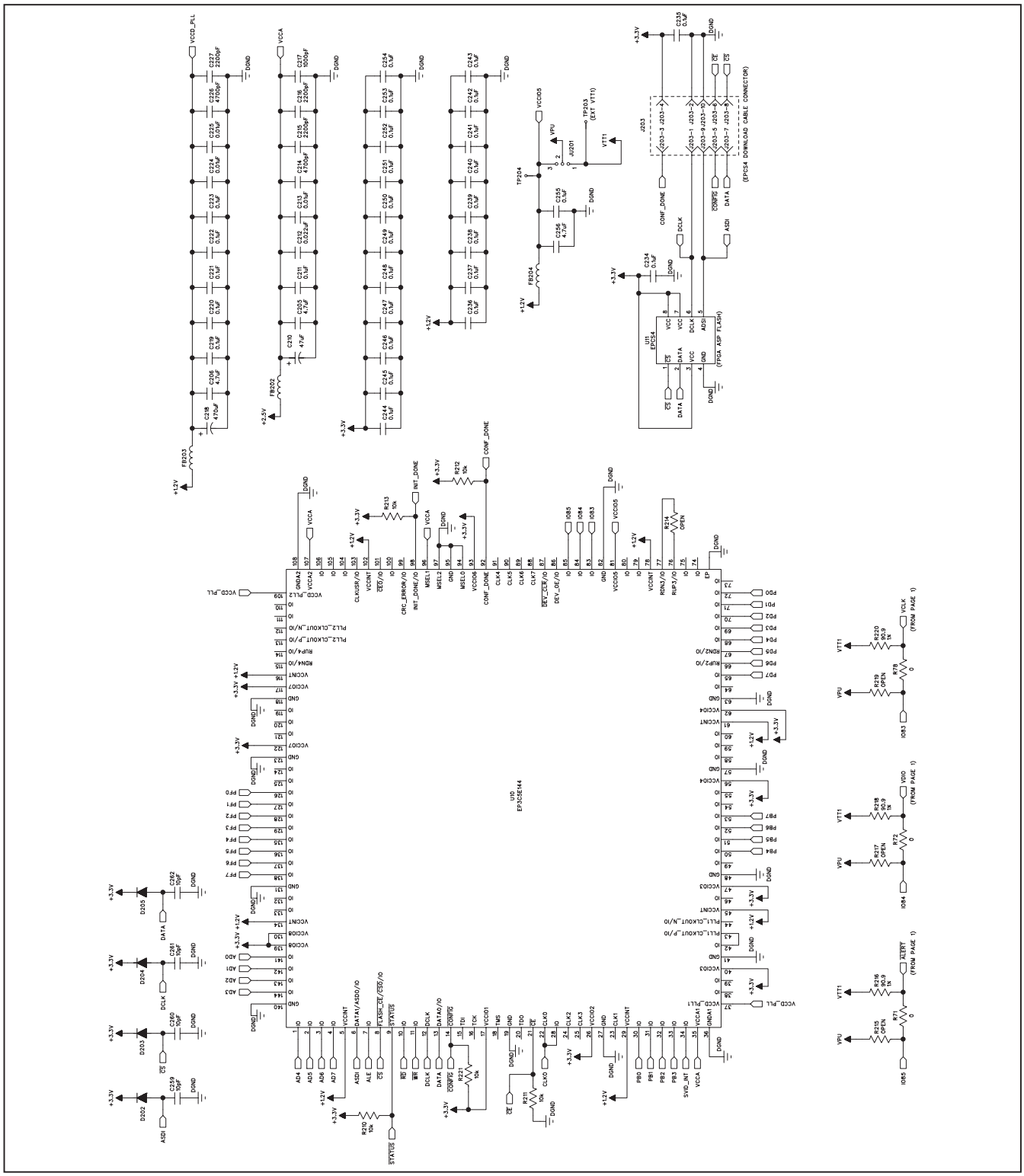

Figure 5g. MAX17039 EV Kit Schematic (Sheet 7 of 7)

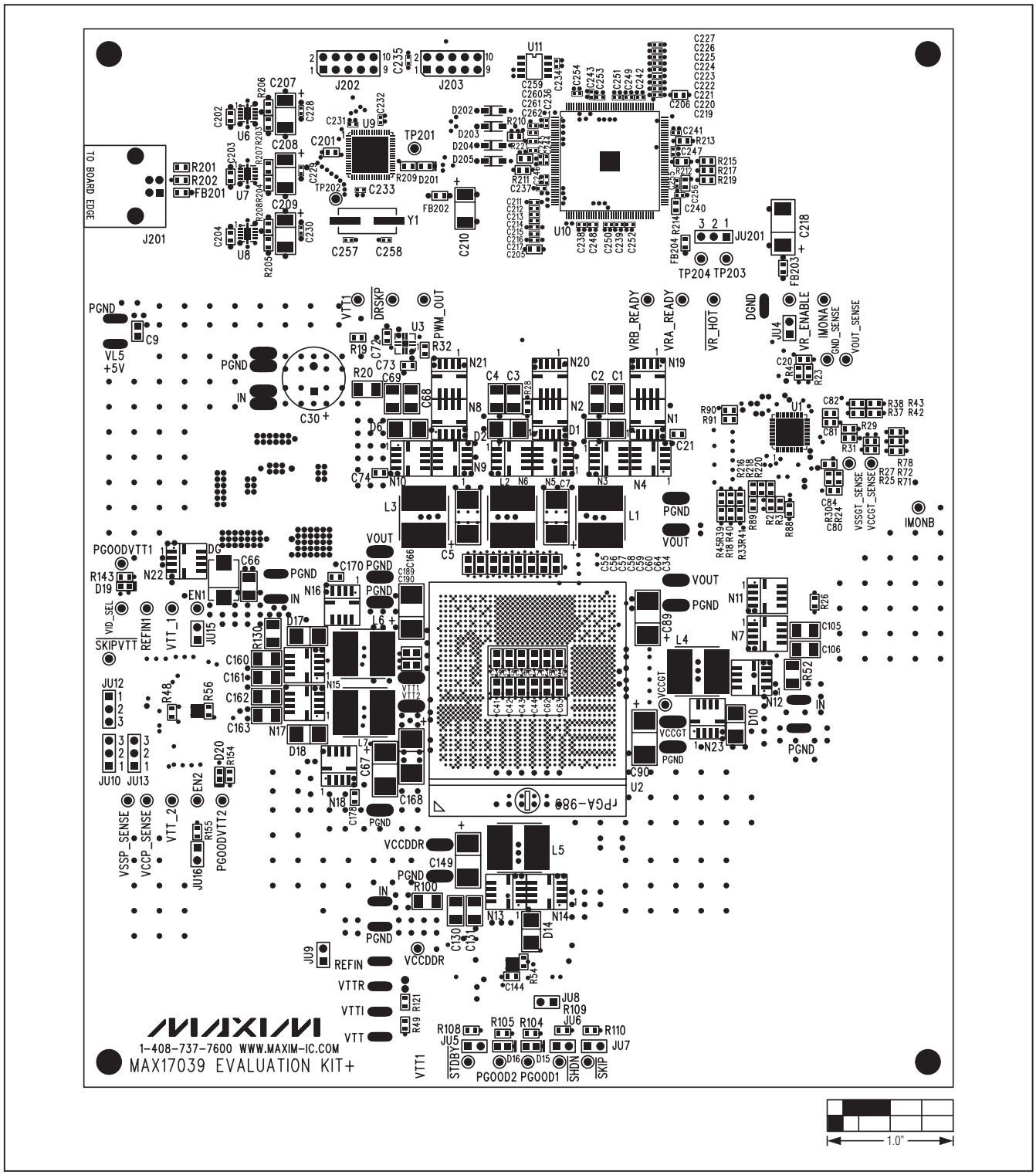

Figure 6. MAX17039 EV Kit Component Placement Guide—Component Side

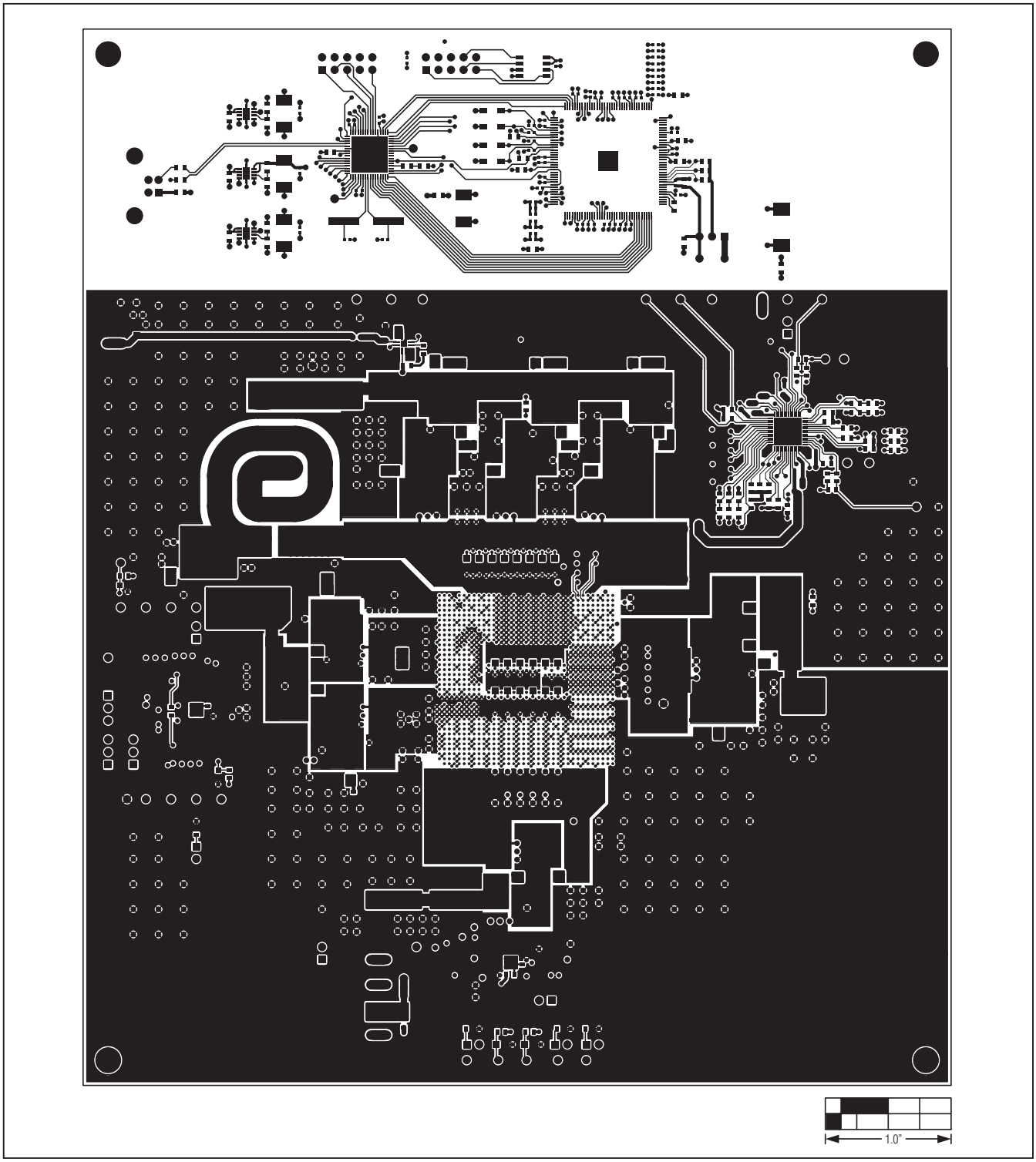

Figure 7. MAX17039 EV Kit PCB Layout—Component Side

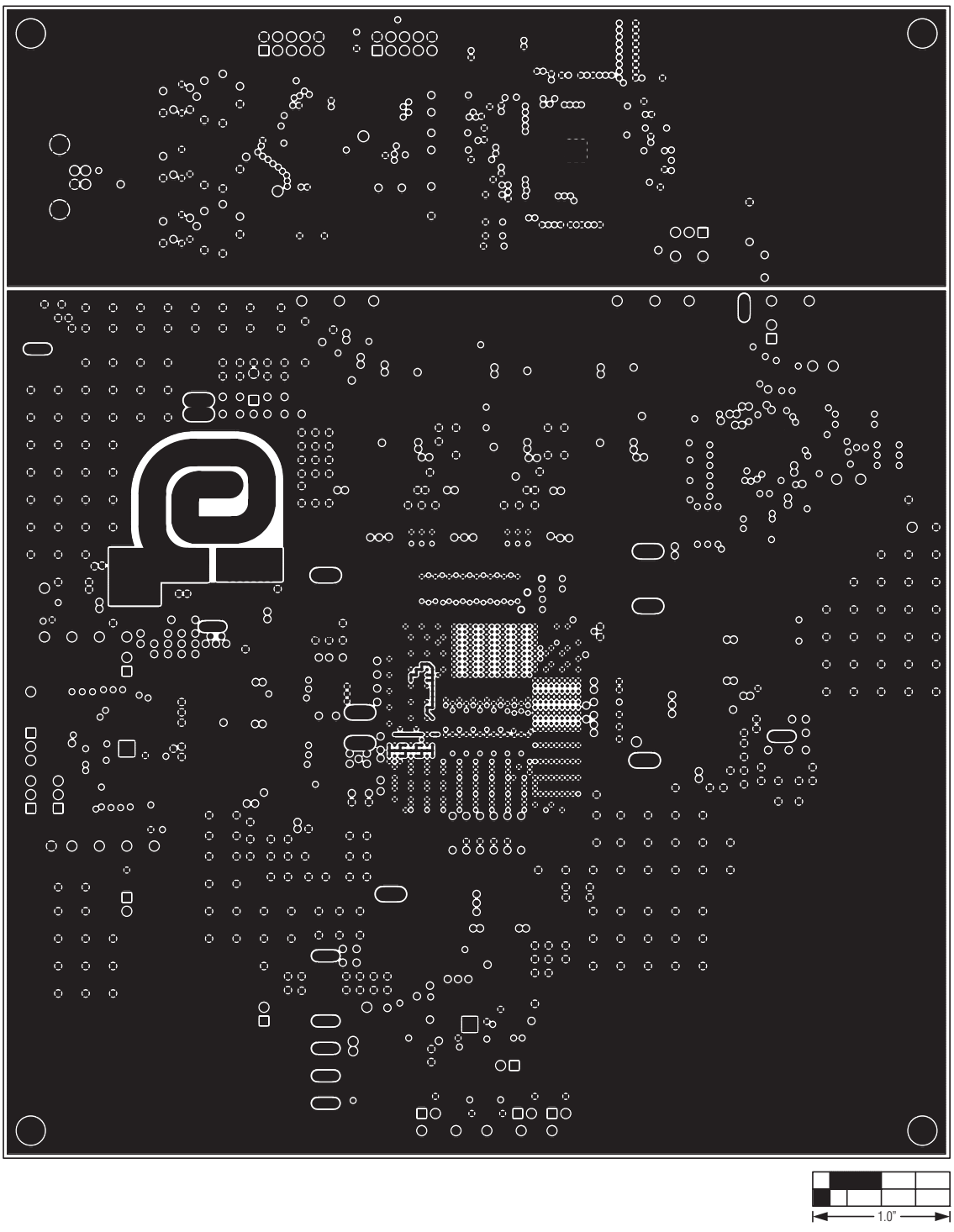

Figure 8. MAX17039 EV Kit PCB Layout—Internal Layer 2 (PGND Plane)

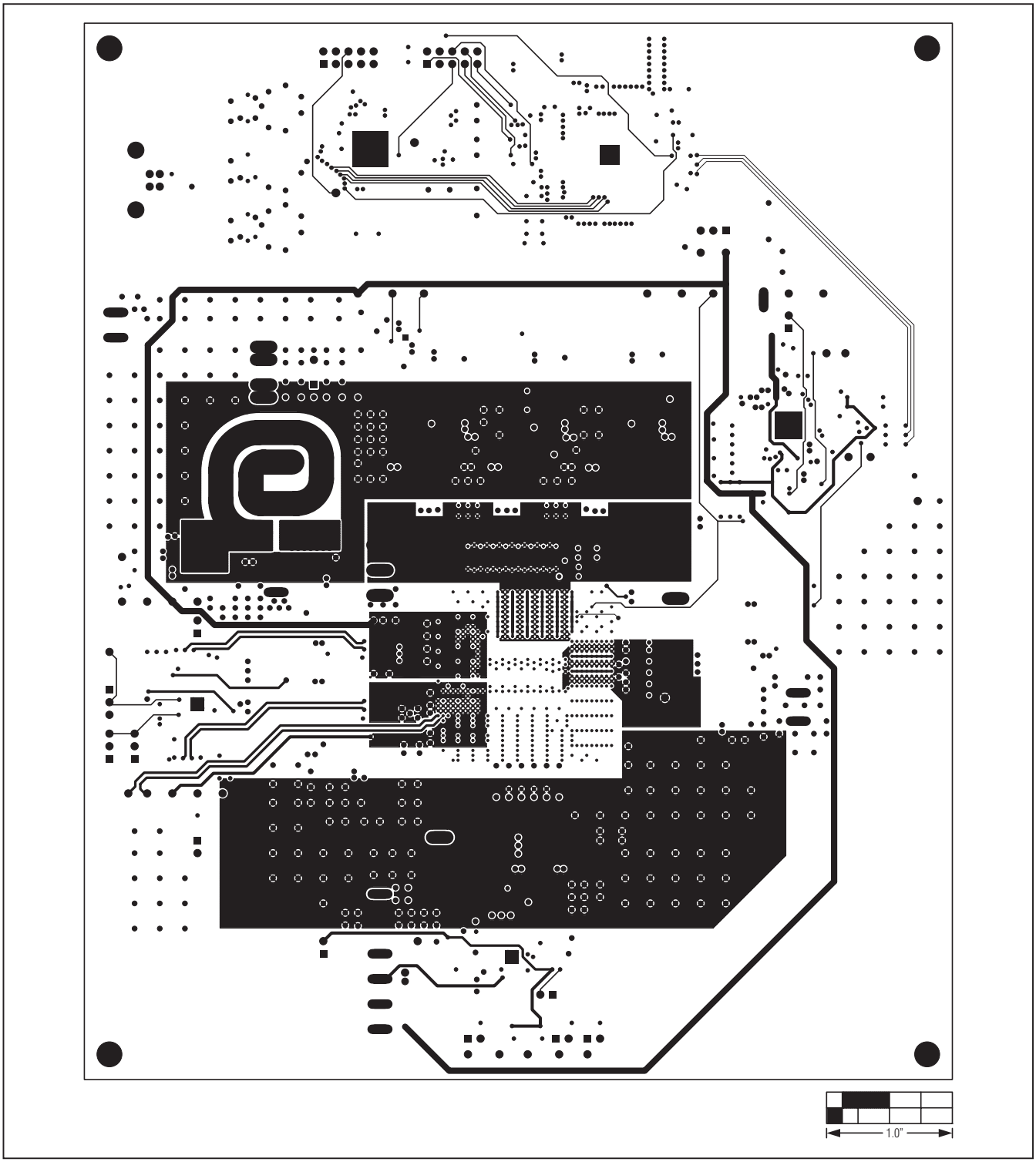

Figure 9. MAX17039 EV Kit PCB Layout—Internal Layer 3 (Signal Layer)

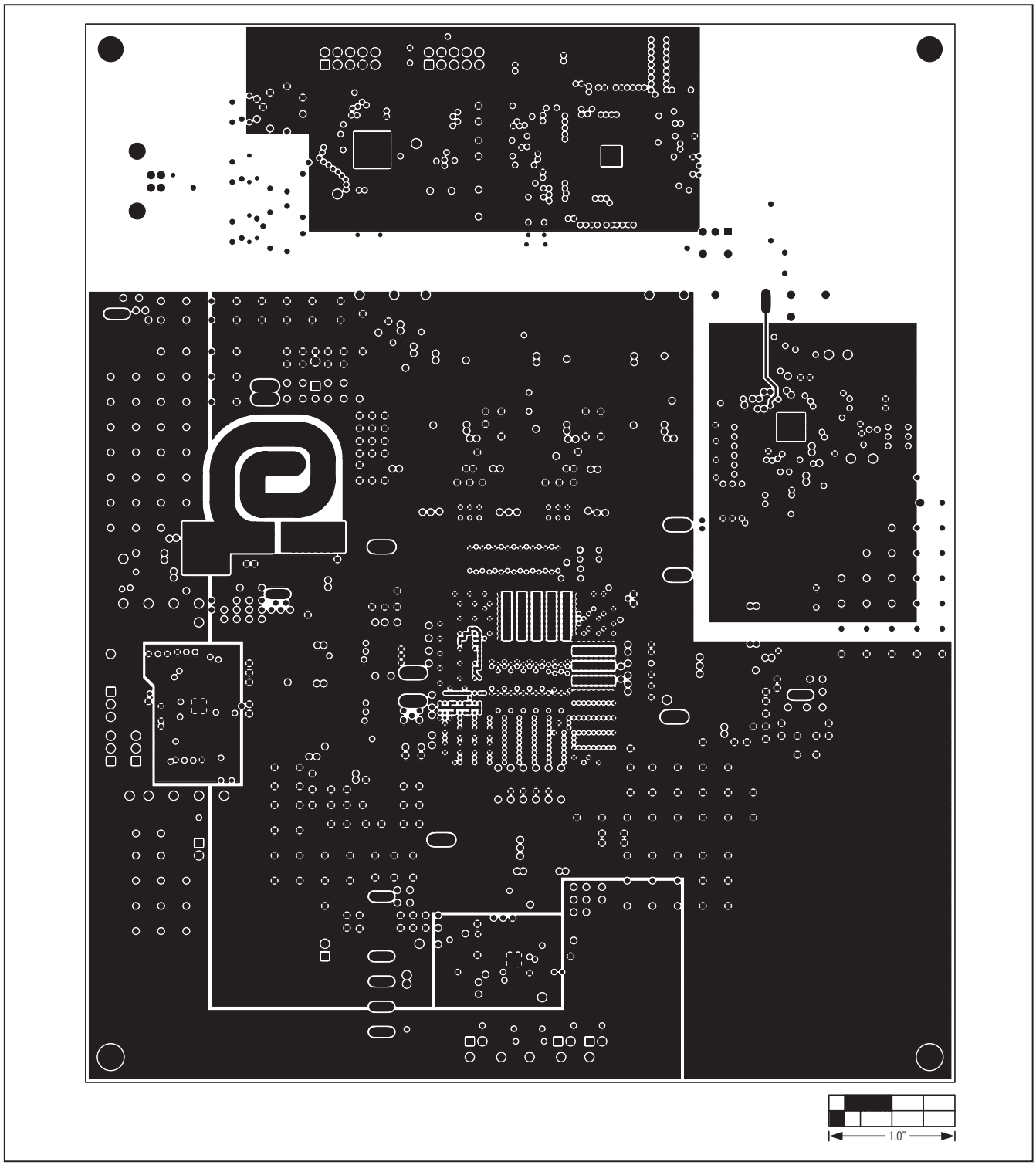

Figure 10. MAX17039 EV Kit PCB Layout—Internal Layer 4 (AGND/PGND Layer)

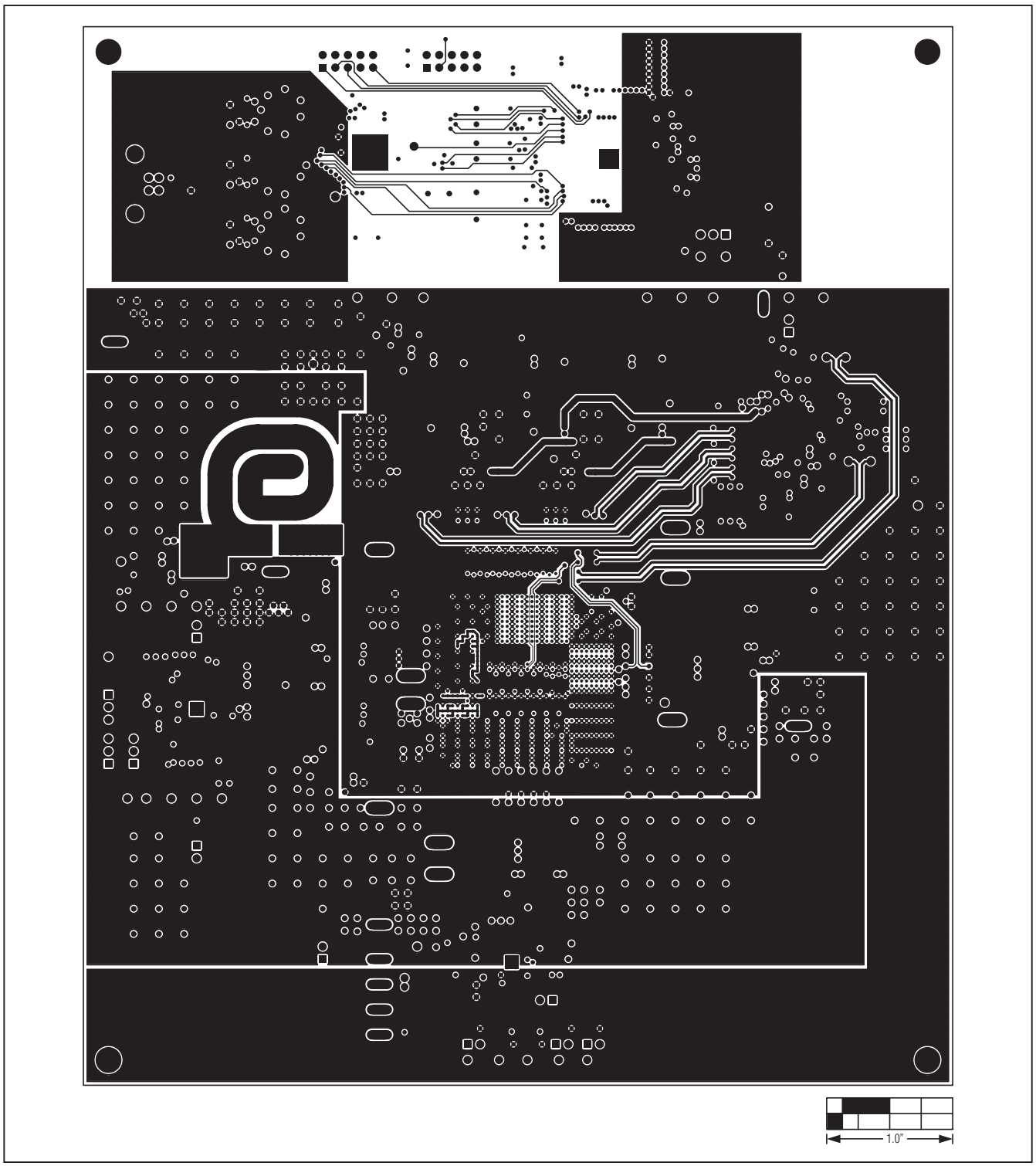

Figure 11. MAX17039 EV Kit PCB Layout—Internal Layer 5 (PGND Layer)

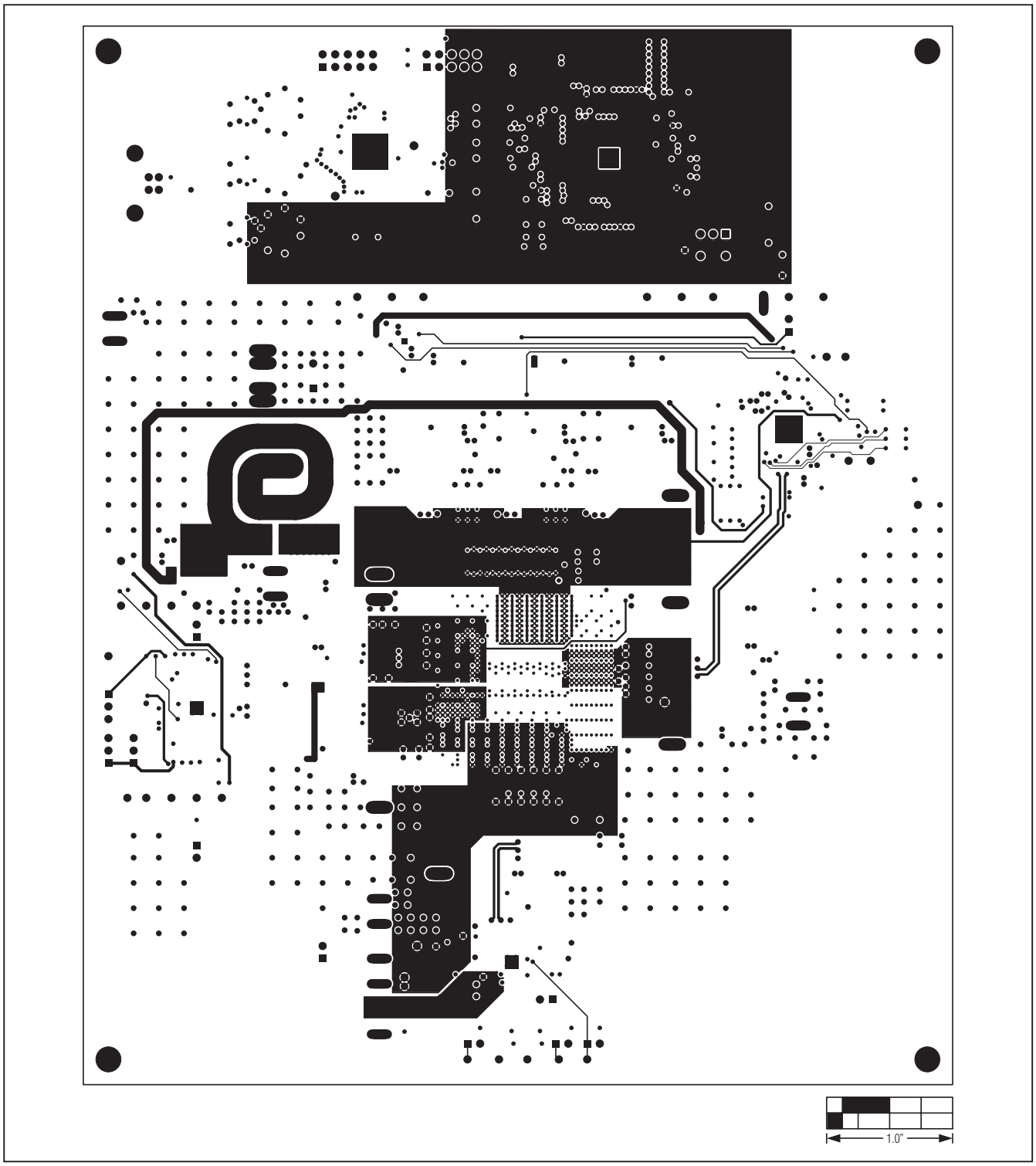

Figure 12. MAX17039 EV Kit PCB Layout—Internal Layer 6 (Signal Layer)

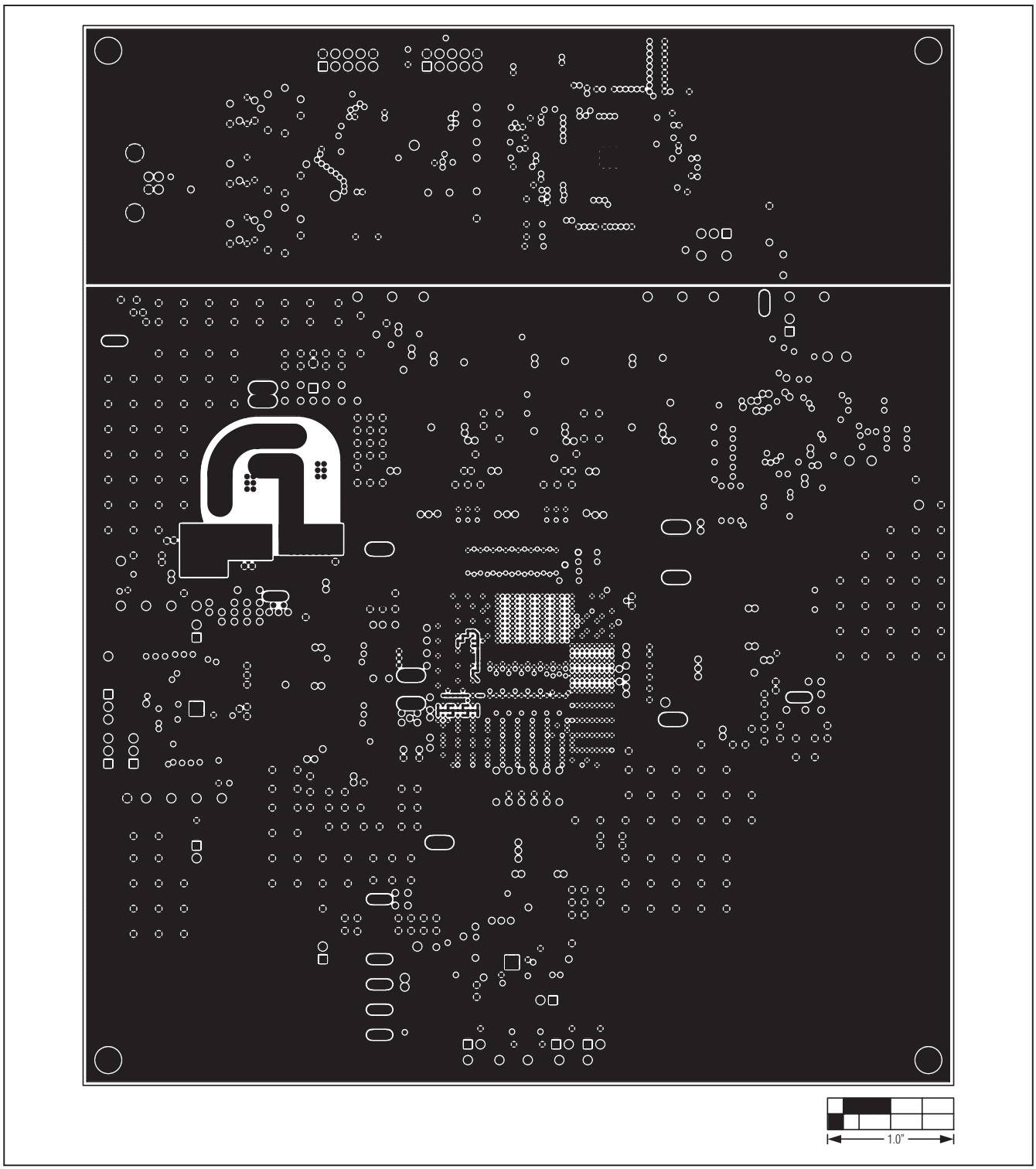

Figure 13. MAX17039 EV Kit PCB Layout—Internal Layer 7 (PGND Layer)

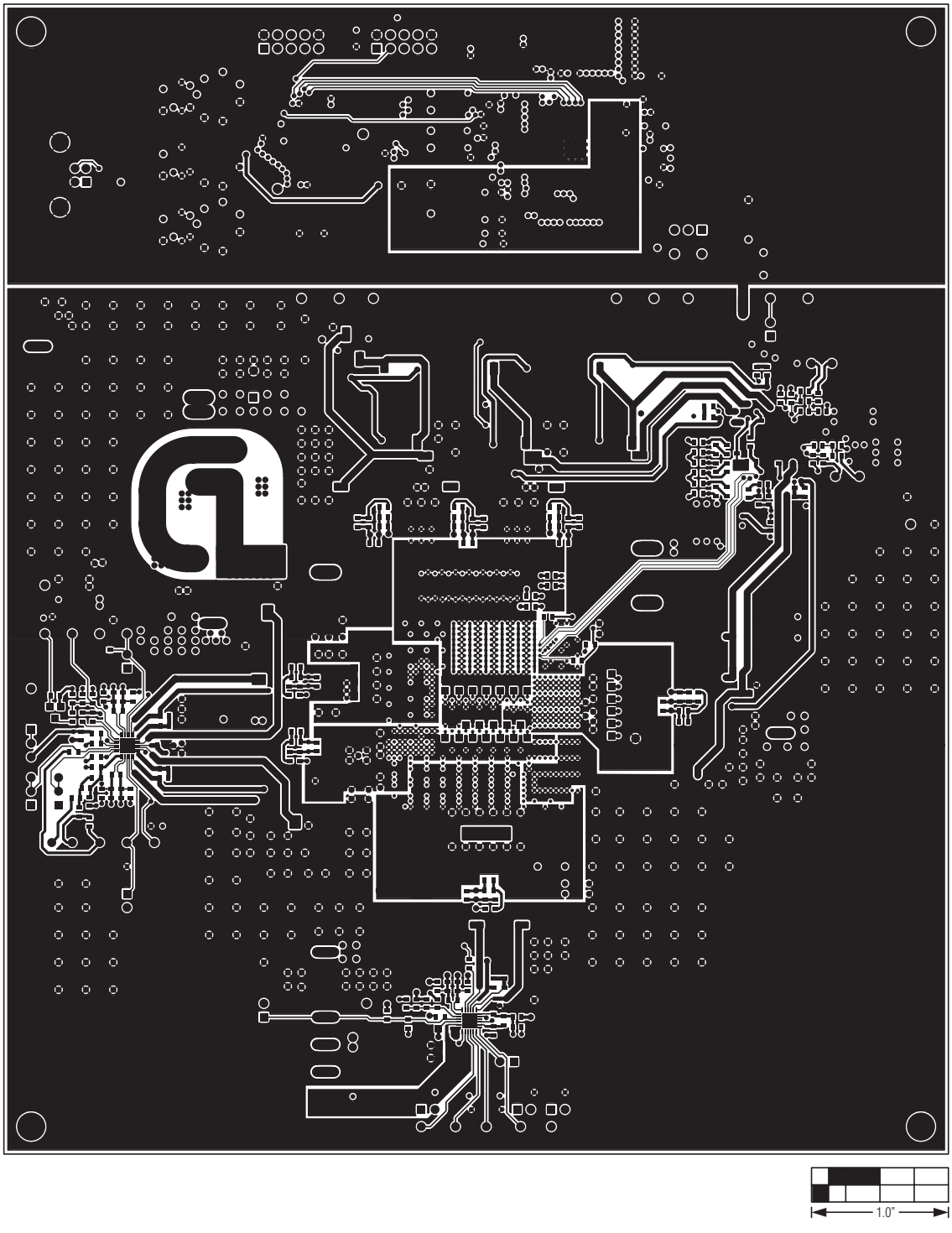

Figure 14. MAX17039 EV Kit PCB Layout—Solder Side

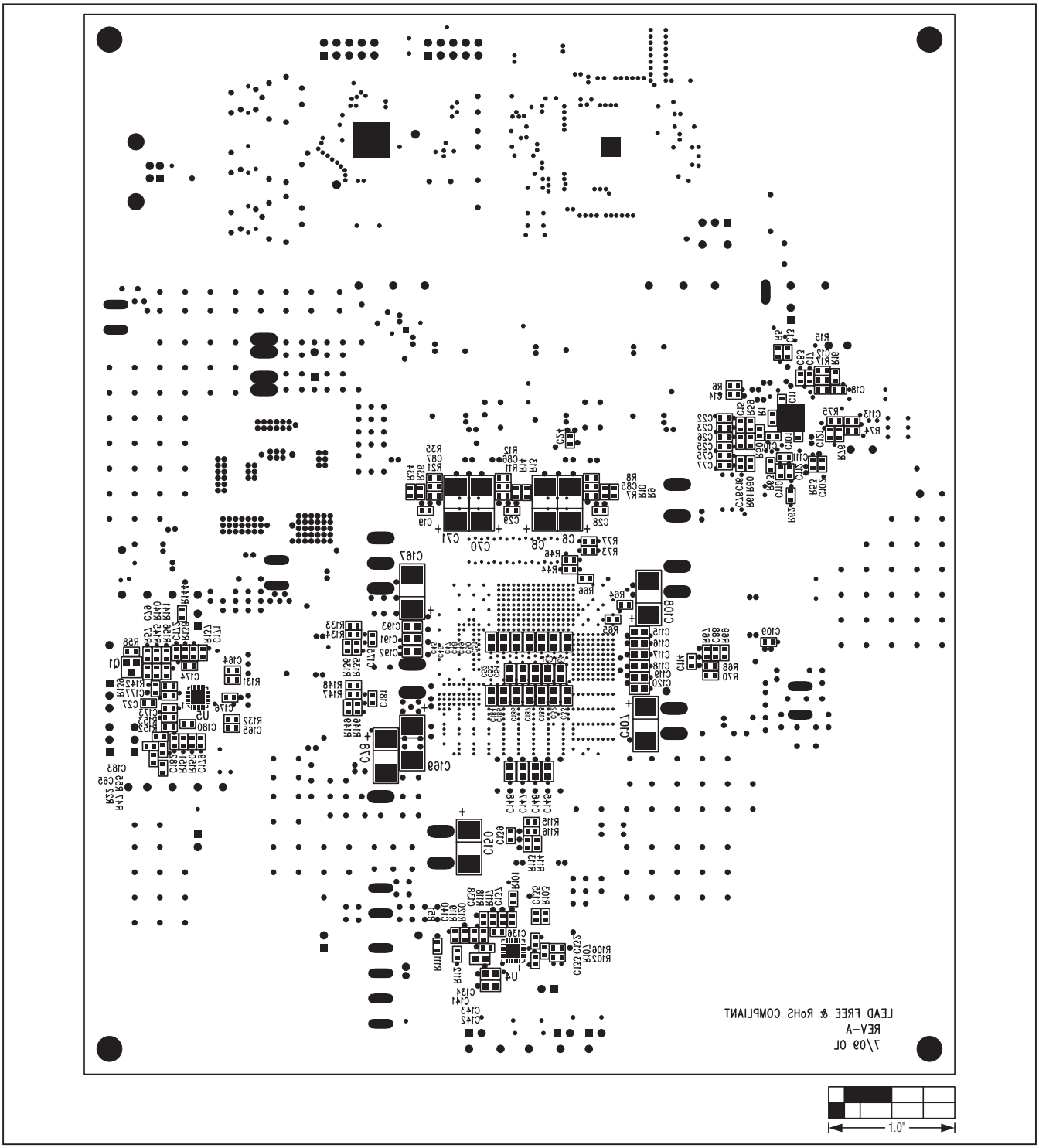

Figure 15. MAX17039 EV Kit Component Placement Guide—Solder Side