Click here for production status of specific part numbers.

MAX5995B Evaluation Kit

Evaluates: MAX5995A/B/C/MAX5974D

General Description

The MAX5995 evaluation kit (EV kit) is a fully assembled and tested surface-mount circuit board featuring an Ethernet port, network powered-device (PD) interface controller circuit for -57V supply rail systems. The EV kit uses the MAX5995B IEEE® 802.3af/at/bt-compliant network PD interface controller in a 16-pin TQFN package with an exposed pad. The IC is used in Power-over-Ethernet (PoE) applications requiring DC power from an Ethernet network port for PDs such as VoIP phones, wireless access nodes, security cameras, lighting, and building automation.

The EV kit receives power from IEEE 802.3af/at/bt-compliant power-sourcing equipment (PSE). Refer to the MAX5952, MAX5965A/MAX5965B, and MAX5980 IC data sheets for PSE controllers. The PSE provides the required -36V to -57V DC power over an unshielded twisted-pair Ethernet network cable to the EV kit's RJ45 magnetic jack. The EV kit features a 1 x 1 Gigabit RJ45 magnetic jack and two active full-wave rectifiers (N101 and N102) for separating the DC power provided by an endspan or midspan Ethernet system.

The EV kit can also be powered by a wall adapter power source. The EV kit provides PCB pads to accept the output of a wall adapter power source. When a wall adapter power source is detected, it always takes precedence over the PSE source and allows the wall adapter to power the EV kit.

The EV kit demonstrates the full functionality of the IC, such as PD detection signature, PD classification signature, Multi-Event Classification (MEC), Intelligent MPS, inrush current control, input undervoltage lockout (UVLO), and DC-DC step-down converter. The step-down converter operates at a fixed 290kHz switching frequency and is configured for an isolated active-clamped forward topology with output voltage +12V DC that can deliver 5.5A of current.

Features

- IEEE 802.3af/at/bt-Compliant PD Interface Circuit
- Multi-Event Classification 0-8
- -36V to -57V Input Range
- Demonstrates a 71W PD Design with Isolated Active-Clamped Forward Topology DC-DC Converter
- +12V Output at 5.5A
- Startup Inrush Current Limit of 135mA (typ)
- Current Limit During Normal Operation
- Evaluates Endspan and Midspan Ethernet Systems
- Type 1-4 PSE Classification Indicator
- Simplified Wall Adapter Interface
- Demonstrates Sleep and Ultra-Sleep Power-Saving Modes
- Proven PCB Layout
- Fully Assembled and Tested

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

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***Warning:** The EV kit is designed to operate with high voltages. Dangerous voltages are present on this EV kit and on equipment connected to it. Users who power up this EV kit or power the sources connected to it must be careful to follow safety procedures appropriately to work with high-voltage electrical equipment.*

Under severe fault or failure conditions, this EV kit may dissipate large amounts of power, which could result in the mechanical ejection of a component or of component debris at high velocity. Operate this kit with care to avoid possible personal injury.

319-100275; Rev 0; 11/18

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Quick Start

Required Equipment

- MAX5995_EVKIT_A
- An IEEE 802.3af/at/bt compliant PSE and a Category 5e Ethernet network cable
- -48V, 3A capable DC power supply
- Voltmeter

Procedure

The 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) Use one of the following methods to power the EV kit:
   a) **If network connectivity is required:** Connect a Category 5e Ethernet network cable from the EV kit input port RJ45 connector to the corresponding PSE Ethernet LAN connection that provides power to the EV kit.
   b) **If network connectivity is not required:** Connect a -48V DC power supply between the -54V and GND PCB pads on the EV kit. Connect the power-supply positive terminal to the GND pad and the negative terminal to the -54V pad.
2) Activate the PSE power supply or turn on the external DC power supply.
3) Using a voltmeter, verify that the EV kit provides +12V across the V_{OUT} and RTN PCB pads.

Detailed Description of Hardware (or Software)

The MAX5995 EV kit features an Ethernet port and network PD interface controller circuit for -57V supply rail systems. The EV kit contains a IEEE® 802.3af/at-compliant network PD interface controller in a 16-pin TQFN-EP package. The IC is used in PoL applications for powering PDs from an unshielded twisted-pair (UTP) Ethernet Category 5e network cable and PSE port using endspan or midspan Ethernet systems.

The EV kit receives power from an IEEE 802.3af/at-compliant PSE and a UTP cable connected to the EV kit's RJ45 magnetic jack. The EV kit uses a 1 x 1 gigabit RJ45 magnetic jack and two active full-wave bridge power rectifiers to separate the -57V DC power sent by the PSE. The EV kit can accept power from an endspan or midspan PSE network configuration.

The EV kit can also accept power from a wall adapter power source. When a wall adapter power source is detected between the POWER+ and POWER- pads, the IC's internal isolation switch disconnects, which allows the wall adapter to supply power to the EV kit.

The EV kit demonstrates the full functionality of the IC such as PD detection signature, PD classification signature, Multi-Event Classification (MEC), Intelligent MPS, inrush current control, and UVLO. Resistor R101 sets the PD detection impedance. Resistors R44 and R6 set the PD classification signatures.

The EV kit's integrated DC-DC step-down converter is configured for an isolated ACTIVE-CLAMPED forward converter topology with output voltage of +12V and provides up to 5.5A at the output while achieving up to 92.5%, 92.4% and 92% efficiencies for 42V/48V/57V input, respectively. The step-down converter operates at a fixed 290kHz switching frequency.

PD Class selection by Classification resistors

By selecting the two external resistors connected to CLSA and CLSB pins, the power consumption requested by the PD can be defined. Table 1 shows the the R_{CLSA} and R_{CLSB} resistor values needed to set for PD class and the PD power consumption defined by standards. R_{CLSA} sets classification current for the 1st and 2nd class Events for 0~4 class PD complaint with IEEE 802.3af/at standard, and RCLSB set classification current for the 3rd to 5th class event for 0~8 class PD complaint with IEEE 802.3bt standard.

Table 1. PSE Type and PD Class with Classification Resistor R_{CLSA} and R_{CLSB}

PD CLASS	POWER REQUESTED BY PD	R_{CLSA}	R_{CLSB}
0	12.95W	619	OPEN
1	3.84W	118	OPEN
2	6.49W	66.5	OPEN
3	12.95W	43.2	OPEN
4	25.5W	30.9	30.9
5	38.25W	30.9	619
6	51W	30.9	118
7	61W	30.9	66.5
8	71W	30.9	43.2

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Wall Adapter Power Source (POWER+, POWER-)

The EV kit can also accept power from a wall adapter power source. Use the POWER+ (0V) and POWER- (-10V to -57V) PCB pads to connect the wall adapter power source. The wall adapter power source operating-voltage range must be within +10V to +57V for the EV kit.

When the wall adapter power source is above +10V it always takes precedence over the PSE source. Once the wall adapter power source is detected, the IC's internal isolation switch disconnects. The wall adapter power is supplied to V_{DD} through diode S210. Once it takes over, the classification process is disabled.

When the wall adapter power source is below +8V, the PSE provides power through the IC's internal isolation switch. Diode S210 prevents the PSE from back-driving the wall adapter power source when it is below +8V.

Undervoltage Lockout (UVLO)

The EV kit operates up to a -57V supply with a turn-on UVLO threshold (V_{ON}) at -35.4V and a turn-off UVLO threshold (V_{OFF}) at -30.0V. When the input voltage is above V_{ON}, the EV kit is enabled. When the input voltage goes below V_{OFF}, the EV kit is disabled.

Sleep, Ultra-Sleep Modes and LED Operation

The EV Kit supports operating the MAX5995 in power saving modes such as the Sleep and Ultra Sleep. By using the SW3 DIP-switch, the $\overline{SL}$ pin could be driven low to enter the Sleep mode. The ultra-sleep mode could be entered by driving both $\overline{SL}$ and $\overline{ULP}$ pin to low (using DIP switch SW1, SW3). The device could be commanded to exit sleep or ultra-sleep mode by driving the $\overline{WK}$ pin low through the switch SW2.

The device features a dedicated LED pin which can be programmed to source out current when the device is in MPS, sleep or ultra-sleep modes. Diode named LED connects between LED pin and V_{SS} and lights up in green color to indicate LED current. The magnitude of the LED current can be controlled as per the value of the R105 resistor connected between the $\overline{SL}$ pin and V_{SS}.

EV Kit Compliance to MAX5995A, MAX5995C

By default, the EV kit is installed with MAX5995B IC. However, the EV kit can also be used to evaluate the MAX5995A and MAX5995C variants of the IC without any change in schematic. Do note that for evaluating MAX5995C, the duty cycle of the MPS current is selectable through the choice of the resistor R40. This resistor should not be installed while evaluating MAX5995A, MAX5995B.

Component Suppliers

SUPPLIER	WEBSITE
CoilCraft	www.coilcraft.com
Comchip	www.comchiptech.com
Diodes Incorporated	www. diodes.com
Emerson Network Power	www.vertivco.com
Fairchild Semiconductor	www.onsemi.com
Kemet	www.ir.kemet.com
Keystone	www.keyelco.com
Lite-On Electronics	www. us.liteon.com
Maxim Integrated	www.maximintegrated.com
Murata	www.murata .com
On Semiconductor	www.onsemi.com
Panasonic	www.panasonic.com
Pulse Electronics	www.pulseelectronics.com
Renesas Technology Group	www.renesas.com
Samsung Electronics	www.samsung.com
Stackpole Electronics	www.seielect.com
Sumida	www.sumida.com
Taiyo Yuden	www.yuden.co.jp
TDK	www.us.tdk.com
TE Connectivity	www.te.com
Texas Instruments	www.ti.com
Vishay Dale	www.vishay.com
Wurth Elektronik	www.we-online.com

Note: *Indicate that you are using the MAX5995 when contacting these component suppliers.*

Ordering Information

PART	TYPE
MAX5995BEVKIT#	EVKIT

#Denotes RoHS compliant.

MAX5995B EV Kit Bill of Materials

PART	QTY	DESCRIPTION
C1	1	1µF ±10%, 16V X7R ceramic capacitor (0805) Murata GRM21BR71C105KA01
C2, C11, C31, C36	4	100pF ±5%, 50V C0G ceramic capacitor (0603) Murata GRM1885C1H101JA01
C3, C5, C10	3	0.047µF ±10%, 50V X7R ceramic capacitor (0603) Tdk CGA3E2X7R1H473K080AA
C4, C32	2	0.01µF ±5%, 50V X7R ceramic capacitor (0603) Kemet C0603C103J5RAC
C6	1	1µF ±10%, 16V X7R ceramic capacitor (0603) Taiyo Yuden EMK107B7105KA
C7, C8, C13	3	2.2µF ±10%, 100V X7R ceramic capacitor (1210) Murata GRM32ER72A225KA35
C14	1	0.047µF ±10%, 500V X7R ceramic capacitor (1206) Vishay Vitramon VJ1206Y473KXEAT5Z
C15, C23, C25	3	0.1µF ±10%, 50V X7R ceramic capacitor (0603) Murata GCJ188R71H104KA12
C19	1	220pF ±10%, 250V X7R ceramic capacitor (0603) Murata GRM188R72E221K
C21, C22, C24, C33, C60	5	1000pF ±10%, 250V X7R ceramic capacitor (2211) Murata GA352QR7GF102KW01)
C26	1	100µF ±20%, 16V X7R tantalum capacitor (7343) Panasonic 16TQC100MYF
C27-C30, C34	5	22µF ±10%, 16V X5R ceramic capacitor (1206) Samsung Electronics CL31A226KOCLFN
C38	1	33µF ±20%, 100V aluminium electrolytic capacitor (Case G) Panasonic EEE-FK2A330P
C39	1	4700pF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM188R71H472KA01
C41	1	2200pF ±10%, 50V X7R ceramic capacitor (0603) Murata GRM39X7R222K50V
C45	1	2200pF ±10%, 2000V X7R ceramic capacitor (1206) Kemet C1206X222KGRAC
C56-C59	4	0.1µF ±10%, 100V X7R ceramic capacitor (0805) Murata GRM21BR72A104KAC4
C93, C105	2	0.1µF ±10%, 100V X7R ceramic capacitor (0603) Murata GCJ188R72A104KA01
C101	1	0.068µF ±5%, 100V C0G ceramic capacitor (1206) Tdk CGA5L1C0G2A683J160
D2, D3, D6, D7	4	Schottky Diode, 100V, 2A, SMB Comchip CDBB2100-G
D9, D10, D12-D15	6	Diode, 250V, 0.25A, SOD-323 Diodes Incorporated BAV21WS-7-F
D11	1	Zener Diode, 10V, 0.005A, SOD-323 Diodes Incorporated BZT52C10S-7-F
D16	1	Zener Diode, 16V, 0.005A, SOD-323 Diodes Incorporated BZT52C16S-7-F
D17, D18	2	Rectifier bridge diode, 100V, 1.5A, SMT Diodes Incorporated DF1501S
D19	1	TVS Diode, 120V, 2A, SMA Diodes Incorporated SMAJ120A-13-F
D20	1	Zener Diode, 18V, 0.05A, SOD-323 Diodes Incorporated BZT52C18S-7-F
D101	1	TVS Diode, 58V, 100A, SMB Diodes Incorporated SMBJ58A-13-F
D103	1	Schottky Diode, 100V, 2A, SMT Fairchild Semiconductor S210
D105-D108	4	Zener Diode, 12V, 0.005A, SOD-323 On Semiconductor MM3Z12VT1G
H1-H4	4	Standoff, 1/2 Inch, Female-Threaded, Hex, Aluminium Generic Part 2203
H5-H8	4	Phillips machine screw, 1/4 Inch, Stainless Steel Mcmaster-Carr; Keystone; Mcmaster-Carr 4C25MXPS; 9900;91772A106

MAX5995B EV Kit Bill of Materials (continued)

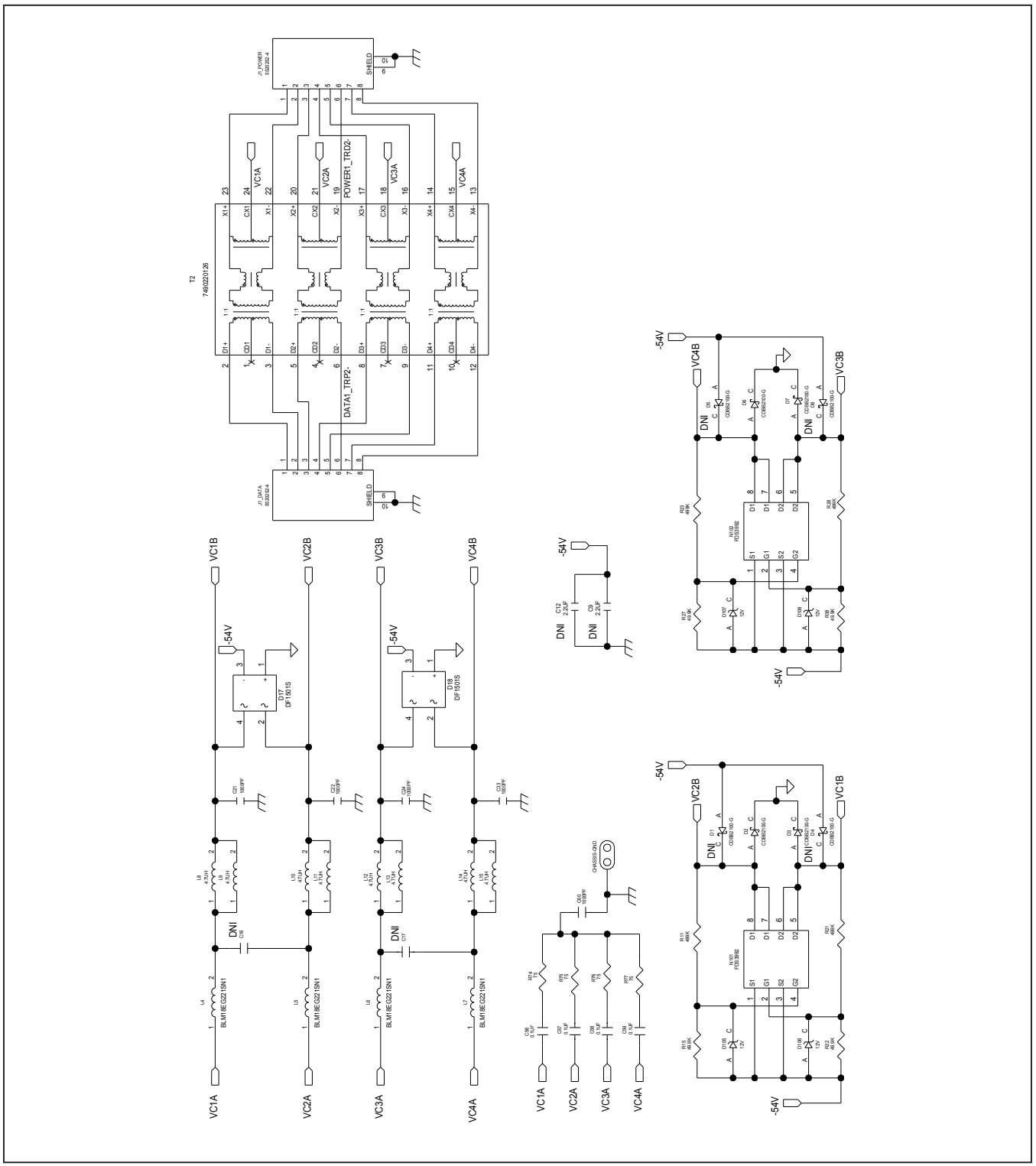
PART	QTY	DESCRIPTION
J1_DATA, J1_POWER	2	RJ45 Modular Jack Connector, Female, Through Hole, 8Pins Te Connectivity 5520252-4
L1	1	Inductor; Ferrite, 1000µH ±20%, 0.125A, SMT Coilcraft LPS4018-105MR
L2	1	Inductor, Sheilded, 2.2µH ±20%, 6.0A, SMT Sumida CDMC6D28NP-2R2MC
L3	1	Inductor, Sheilded, 4.7µH ±20%, 12.5A, SMT Sumida CDEP147NP-4R7MC-95
L4-L7	4	Inductor, Ferrite-Bead, 220, Tol = ±25%, 2A, SMT Murata BLM18EG221SN1
L8-L15	8	Inductor, Ferrite, 4.7µH ±20%, 1.10A, SMT (1008) Murata LQM2HPN4R7MG0
LED	1	LED Diode, 2.1V, 0.03A, Green, SMT (1206) Lite-On Electronics Inc. LTST-C150GKT
N7	1	MOSFET N-channel, 150V, 26A, SO-8 Vishay Siliconix SI7430DP-T1-GE3
N9, N11	2	MOSFET N-channel, 100V, 60A, SO-8 Vishay Siliconix SIR882DP-T1-GE3
N12	1	MOSFET P-channel, -150V, -8.9A, Powerpak1212-8 Vishay Siliconix SI7115DN-T1-GE3
N101, N102	2	MOSFET N-channel, 100V, 4.5A, SO-8 On Semiconductor FDS3992
Q1	1	Transistor NPN, 80V, 1A, SOT-89 Diodes Incorporated BCX5610TA
Q2	1	Transistor PNP, 40V, 0.6A, SOT-23 Fairchild Semiconductor MMBT4403
R1	1	316kΩ ±1% Resistor (0603) Vishay Dale CRCW0603316KFK
R2	1	100kΩ ±1% Resistor (0805) Panasonic ERJ-6ENF1003V
R3	1	1.5kΩ ±0.1% Resistor (0603) Panasonic ERA-3YEB152V
R4, R31, R33, R54	4	10kΩ ±0.1% Resistor (0603) Vishay Dale TNPW060310K0BE
R5, R36	2	75kΩ ±0.1% Resistor (0603) Panasonic ERJ-PB3B7502
R6	1	115Ω ±1% Resistor (0603) Vishay Dale CRCW0603115RFK
R7	1	30kΩ ±1% Resistor (0603) Vishay Dale CRCW060330K0FK
R8, R79	2	0Ω ±5% Resistor (0603) Samsung Electronics RC1608J000CS
R9, R102, R104	3	0Ω ±0% Resistor (0603) Vishay Dale CRCW06030000Z0
R10	1	51kΩ ±1% Resistor (0805) Vishay Dale CRCW080551K0FK
R11, R21, R23, R28	4	499kΩ ±1% Resistor (0402) Panasonic ERJ-2RKF4993
R13, R41-R43	4	3Ω ±1% Resistor (0603) Vishay Draloric CRCW06033R00FKEAHP
R15, R22, R27, R38	4	49.9kΩ ±1% Resistor (0402) Vishay Draloric CRCW040249K9FKEDHP
R16	1	3.6kΩ ±1% Resistor (0603) Vishay Dale RK73H1J3601F
R17, R30	2	1kΩ ±0.1% Resistor (0603) Vishay Dale TNPW06031K00BE
R18	1	42.2kΩ ±0.1% Resistor (0805) TE Connectivity RN73C2A42K2B
R19	1	200kΩ ±1% Resistor (0603) Vishay Dale CRCW06032003FK
R20	1	510Ω ±1% Resistor (0603) Vishay Dale CRCW0603510RFK
R24	1	200Ω ±1% Resistor (1206) Vishay Dale CRCW1206200RFK
R25, R29	2	200Ω ±1% Resistor (0603) Vishay Dale CRCW06032000FK
R26	1	120kΩ ±1% Resistor (0603) Vishay Dale CRCW0603120KFK
R32	1	2kΩ ±1% Resistor (0603) Stackpole Electronics Inc. RNCP0603FTD2K00
R34	1	3.3kΩ ±1% Resistor (0603) Vishay Dale CRCW06033K30FK
R35	1	13kΩ ±1% Resistor (0603) Vishay Dale CRCW060313K0FK
R37	1	10Ω ±1% Resistor (0603) Vishay Dale CRCW060310R0FK

MAX5995B EV Kit Bill of Materials (continued)

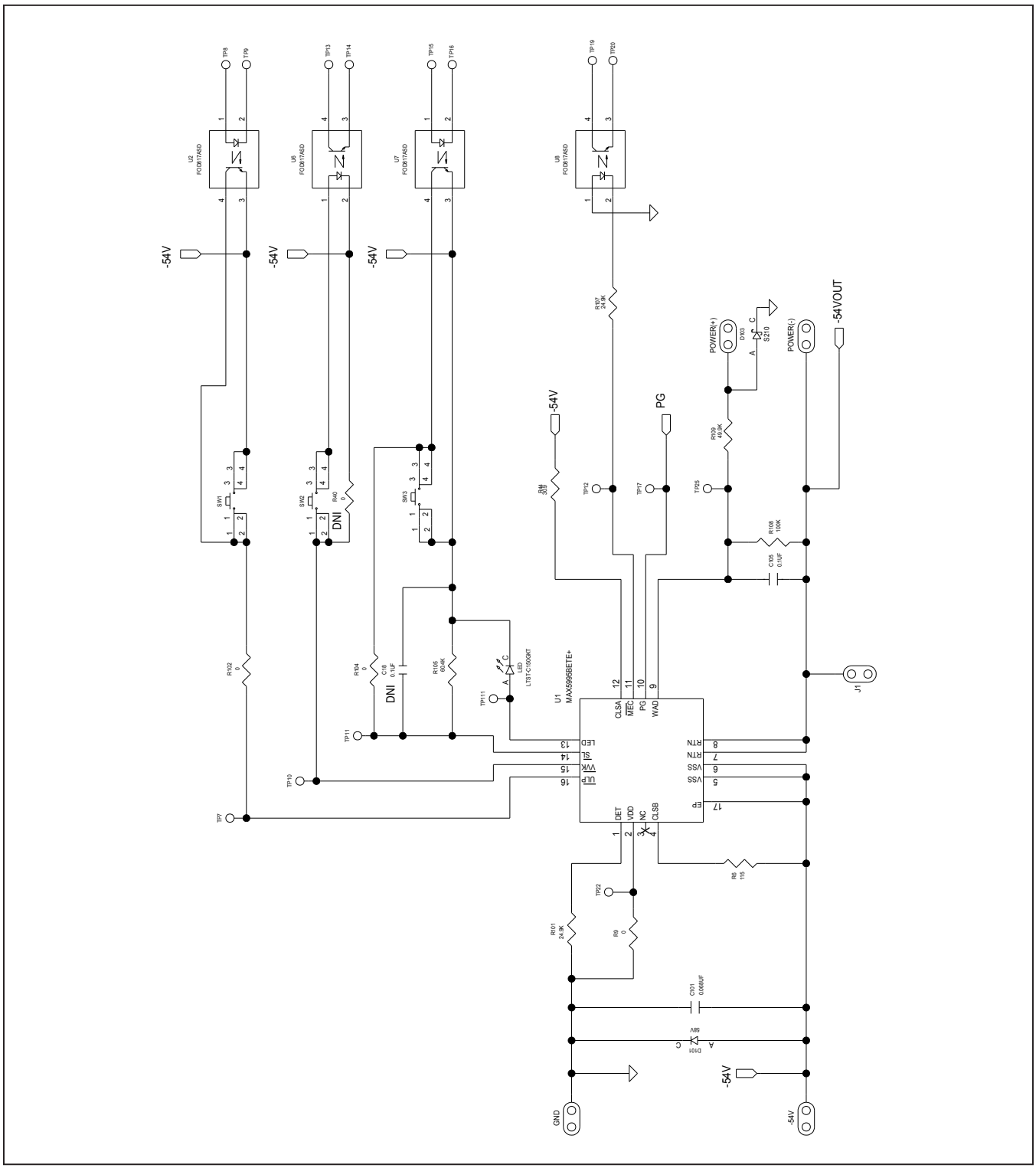
PART	QTY	DESCRIPTION
R44	1	30.9Ω ±1% Resistor (0603) Vishay Dale CRCW060330R9FK
R45, R46	2	0.04Ω ±1% Resistor (1206) Vishay Dale WSL1206R0400F
R74-R77	4	75Ω ±5% Resistor (0805) Stackpole Electronics Inc. RMCF0805JT75R0
R101	1	24.9kΩ ±1% Resistor (1206) Vishay Dale CRCW120624K9FK
R105	1	60.4kΩ ±1% Resistor (0603) Vishay Dale CRCW060360K4FK
R107	1	24.9kΩ ±1% Resistor (0603) Vishay Dale CRCW060324K9FK
R108	1	100kΩ ±1% Resistor (0603) Vishay CRCW0603100KFK
R109	1	49.9kΩ ±1% Resistor (0603) Vishay Dale CRCW060349K9FK
RTN, VOUT	2	Banana Jack Connector, Straight, 1Pin Emerson Network Power 108-0740-001
SW1-SW3	3	Surface Mount Switch SPST, 24V, 0.05A Omron B3FS-1000P
T1	1	Power Transformer, SMT-12 Pulse PA5318NL
T2	1	LAN Transformer, Turns Ratio: 1:1, 350µH, 100Khz, SMD, Wurth Elektronik 7490220126
TP1, TP3, TP22	3	Black Test Point; Dia 0.1Inch Keystone 5000
TP2, TP4	2	Red Test Point; Dia 0.1Inch Keystone 5001
TP7, TP10-TP12, TP17, TP25, TP111	7	Orange Test Point; Dia 0.1Inch Keystone 5003
TP8, TP9, TP13-TP16, TP19, TP20	8	Blue Test Point; Dia 0.1Inch Keystone 5117
U1	1	Powered Device, 802.3af/at/bt compliant, YQFN-16 Maxim MAX5995BETE+
U2, U6-U8	4	Phototransistor Optocoupler, SMT Fairchild Semiconductor FOD817ASD

PART	QTY	DESCRIPTION
U3	1	Current-Mode Pwm Controller, TQFN-16 Maxim MAX5974DETE+
U4	1	High Isolation Voltage Sop Photocoupler, SOP-4 Renesas Technology Corp. PS2801-1
U5	1	Adjustable Shunt Regulator, SOT-23 Texas Instruments TL432BIDBZ
-54V, CHASSIS-GND, GND, J1, POWER(+), POWER(-), RTN_PAD1, RTN_PAD2, VOUT_PAD1, VOUT_PAD2	10	WEICO wire, 20Awg, 9020 BUSS
PCB	1	Pcb: MAX5995 Maxim MAX5995
C9, C12	0	2.2µF ±10%, 100V X7R ceramic capacitor (1206) Murata KRM31KR72A225KH01
C16, C17	0	Capacitor; Smt (1210); Open; Ipc Maximum Land Pattern N/A N/A
C18	0	0.1µF ±10%, 25V X5R ceramic capacitor (0402) Murata GRM155R61E104KA87
C35, C40, C42, C43	0	Capacitor; Smt (0603); Open; Formfactor N/A N/A
C91	0	Capacitor; Smt (1206); Open; Ipc Maximum Land Pattern N/A N/A
C92	0	Capacitor; Smt (Caseg); Open; Ipc Maximum Land Pattern N/A N/A
D1, D4, D5, D8	0	Schottky Diode, 100V, 2A, SMB Comchip CDBB2100-G
R12, R39, R47, R48, R53	0	Resistor (0603) N/A N/A
R40	0	0Ω Resistor (0603) Vishay Dale CRCW06030000Z0
N101, N102	0	Transistor NPN, 100V, 3.5A, SO-8 On Semiconductor FDS89141
R5, R36	0	75kΩ ±0.1% Resistor (0603) Vishay Dale TNPW060375K0BE

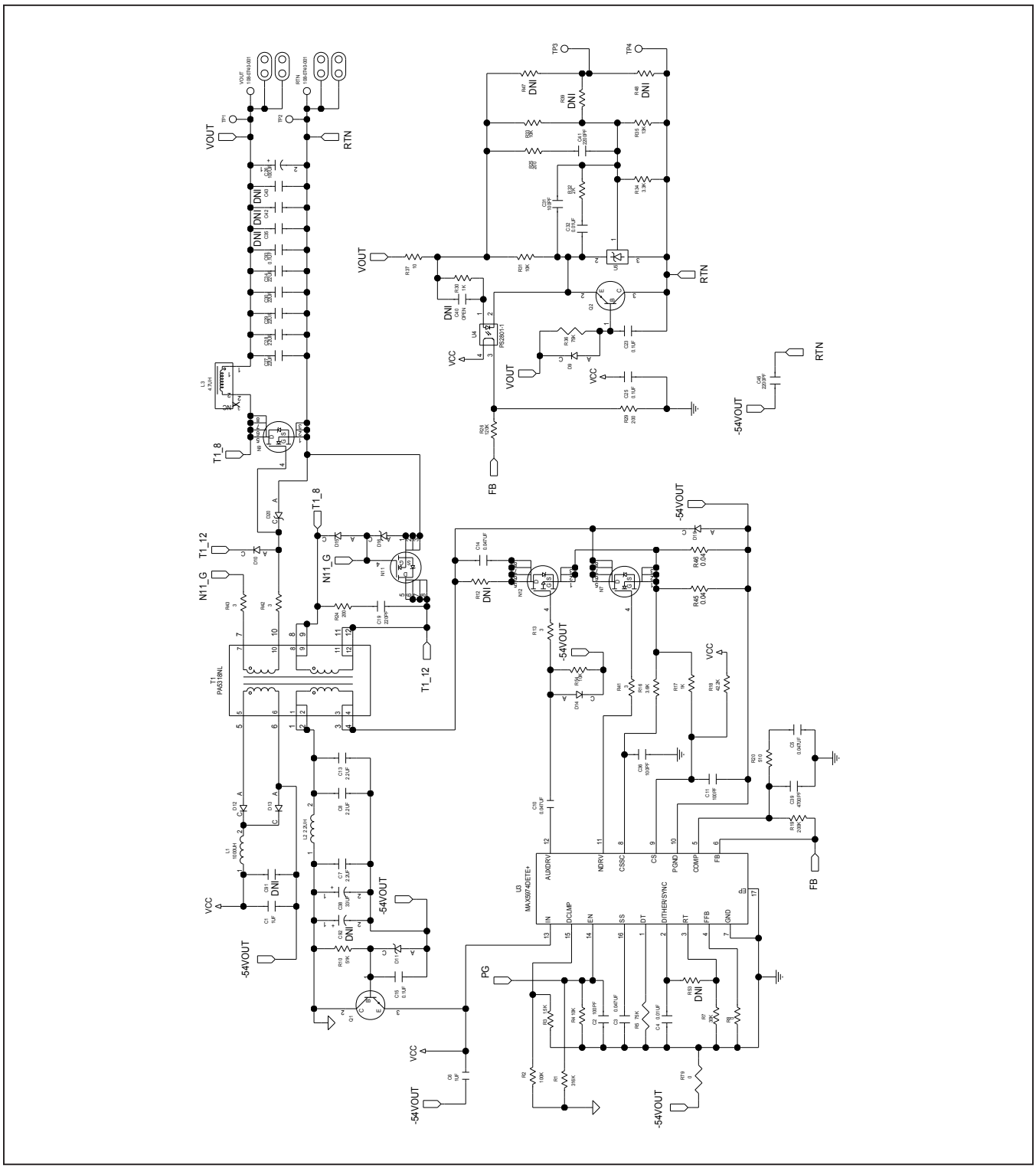
MAX5995B EV Kit Schematics



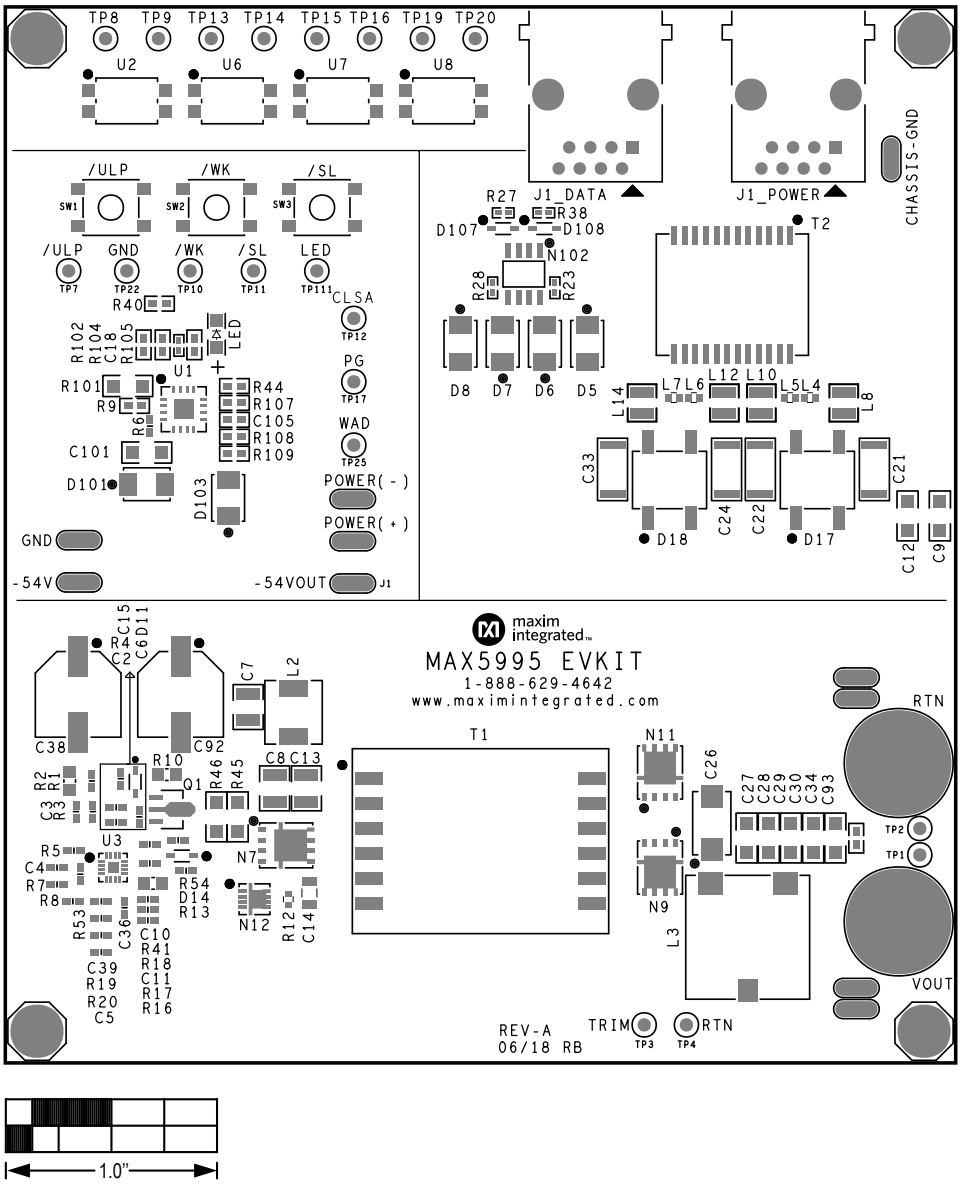
MAX5995B EV Kit Schematics (continued)



MAX5995B EV Kit Schematics (continued)

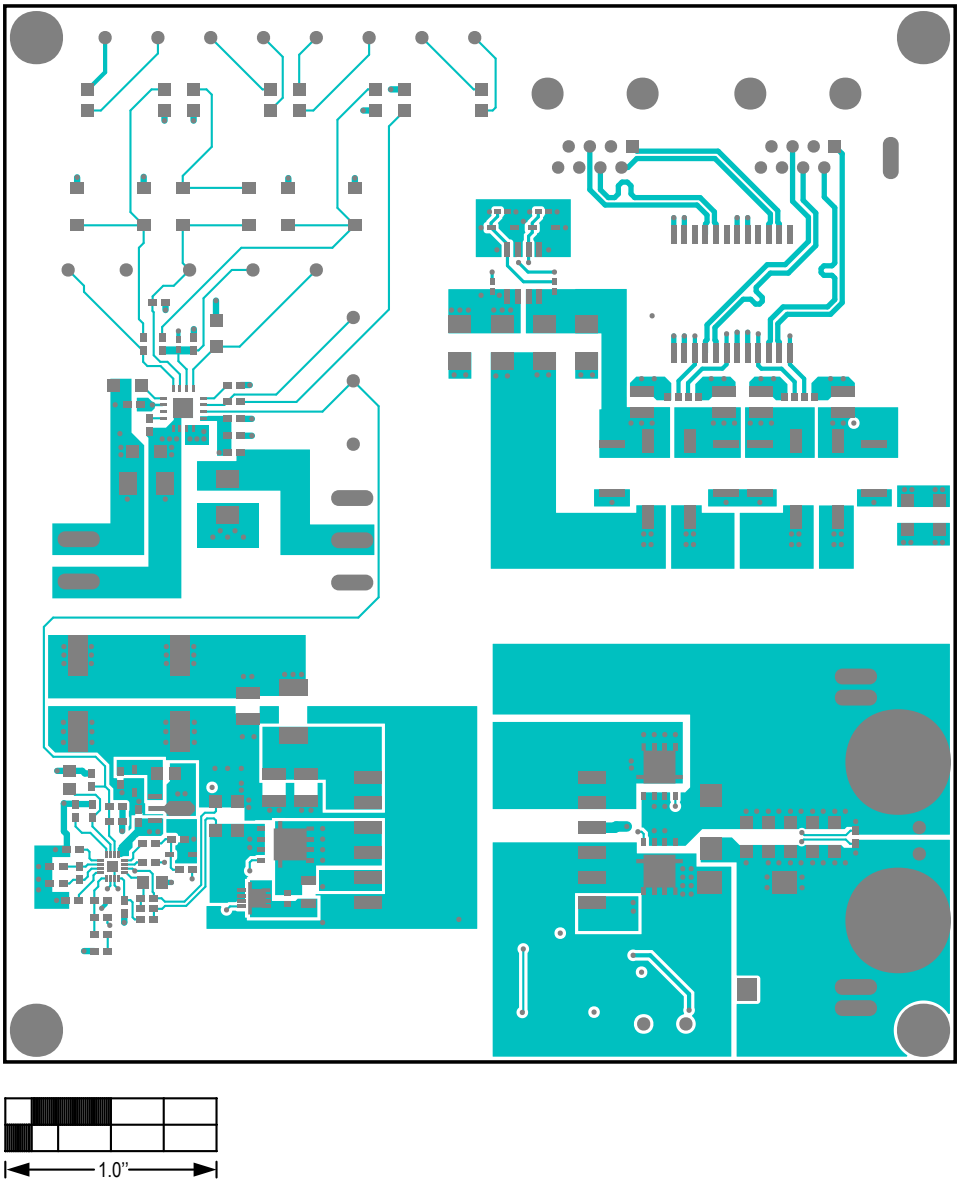


MAX5995B EV Kit PCB Layout Diagrams



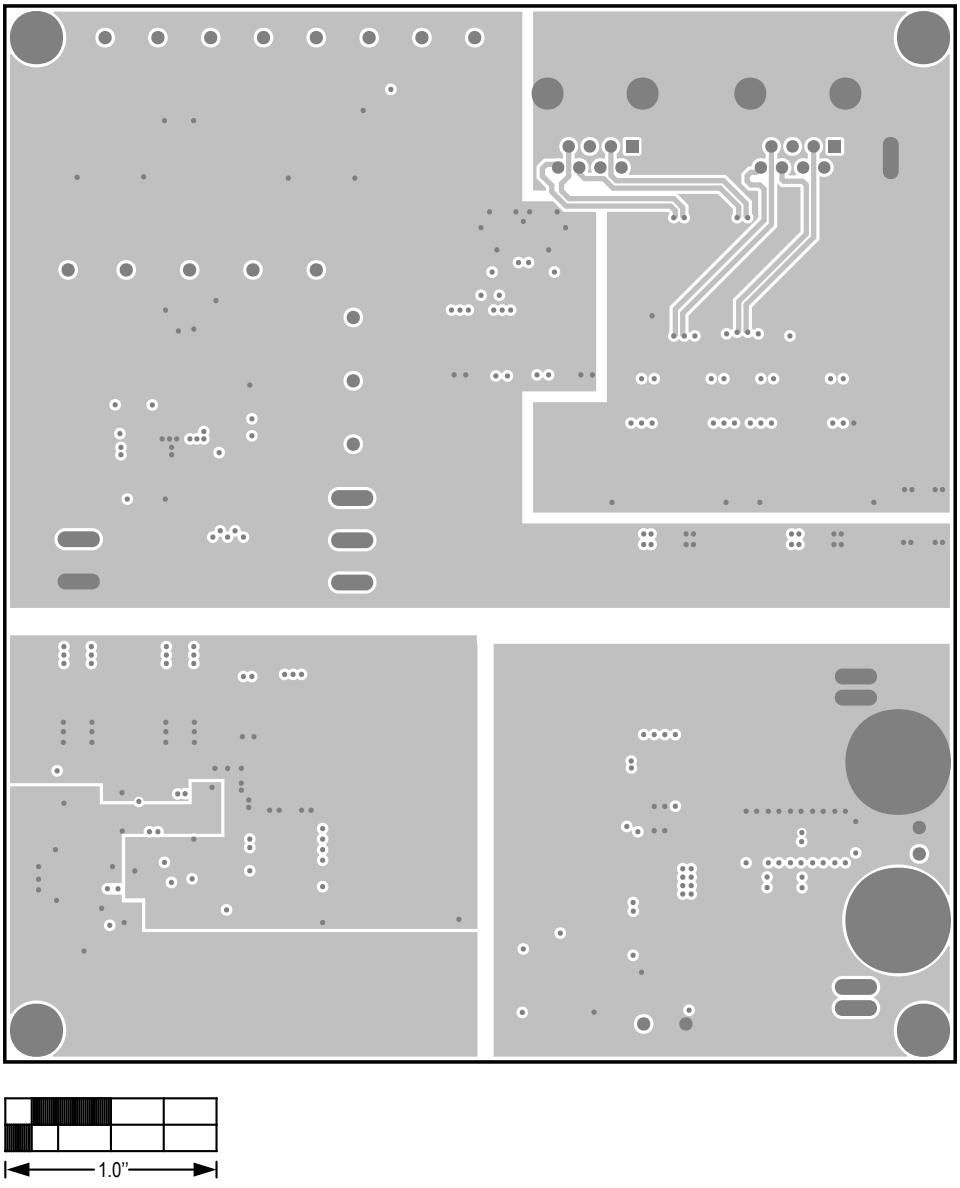
MAX5995 EV—Top Silkscreen

MAX5995B EV Kit PCB Layout Diagrams (continued)



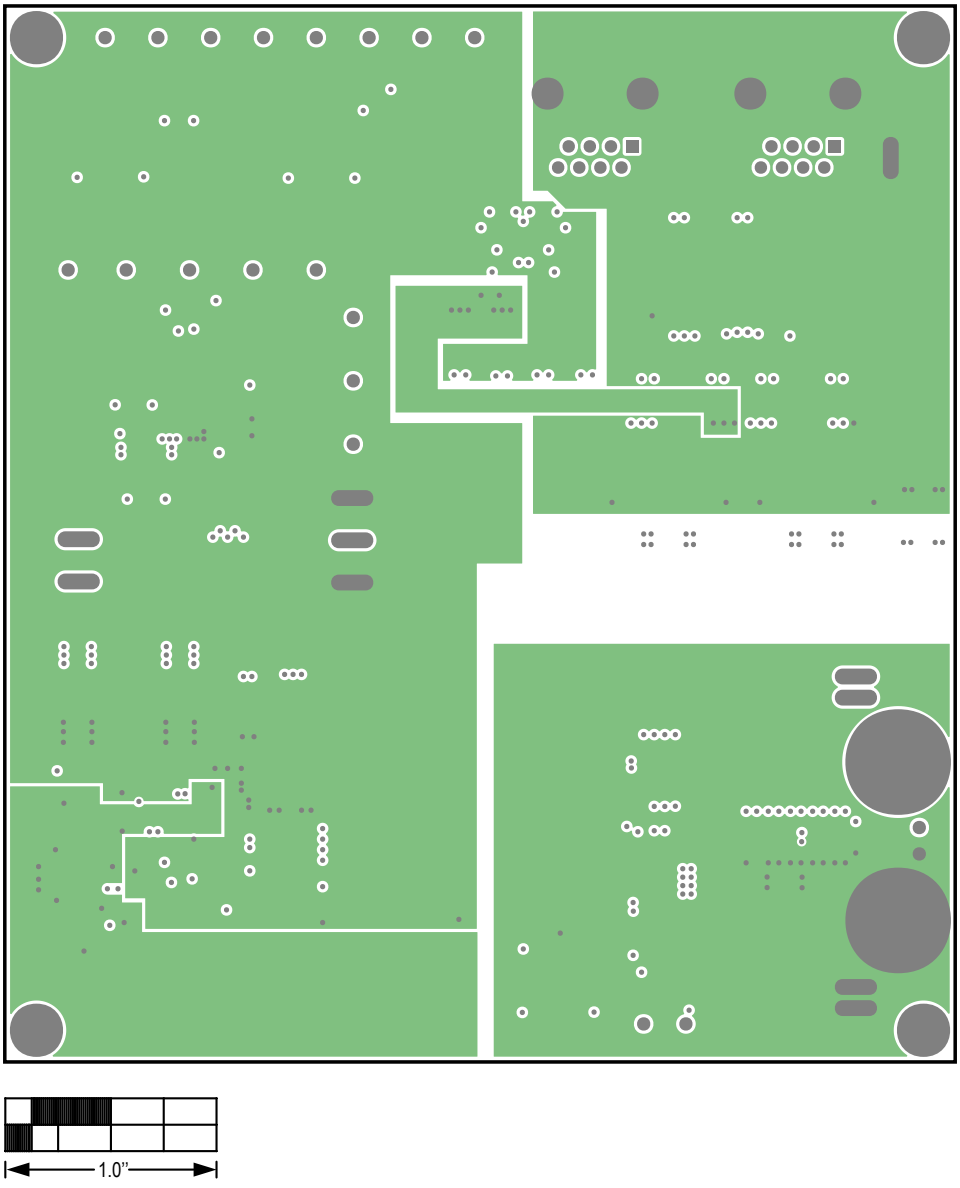
MAX5995 EV—Top View

MAX5995B EV Kit PCB Layout Diagrams (continued)



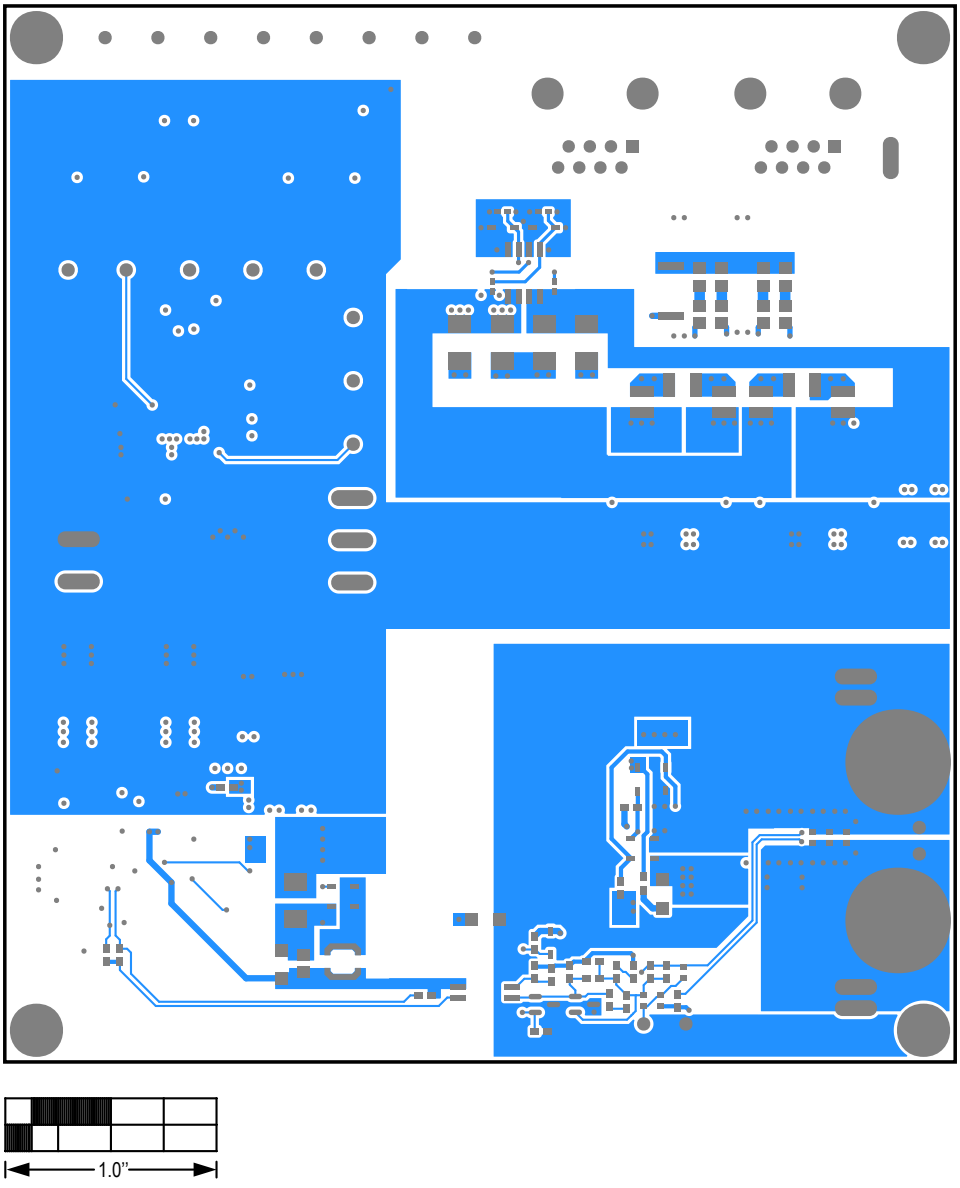
MAX5995 EV—Level GND

MAX5995B EV Kit PCB Layout Diagrams (continued)



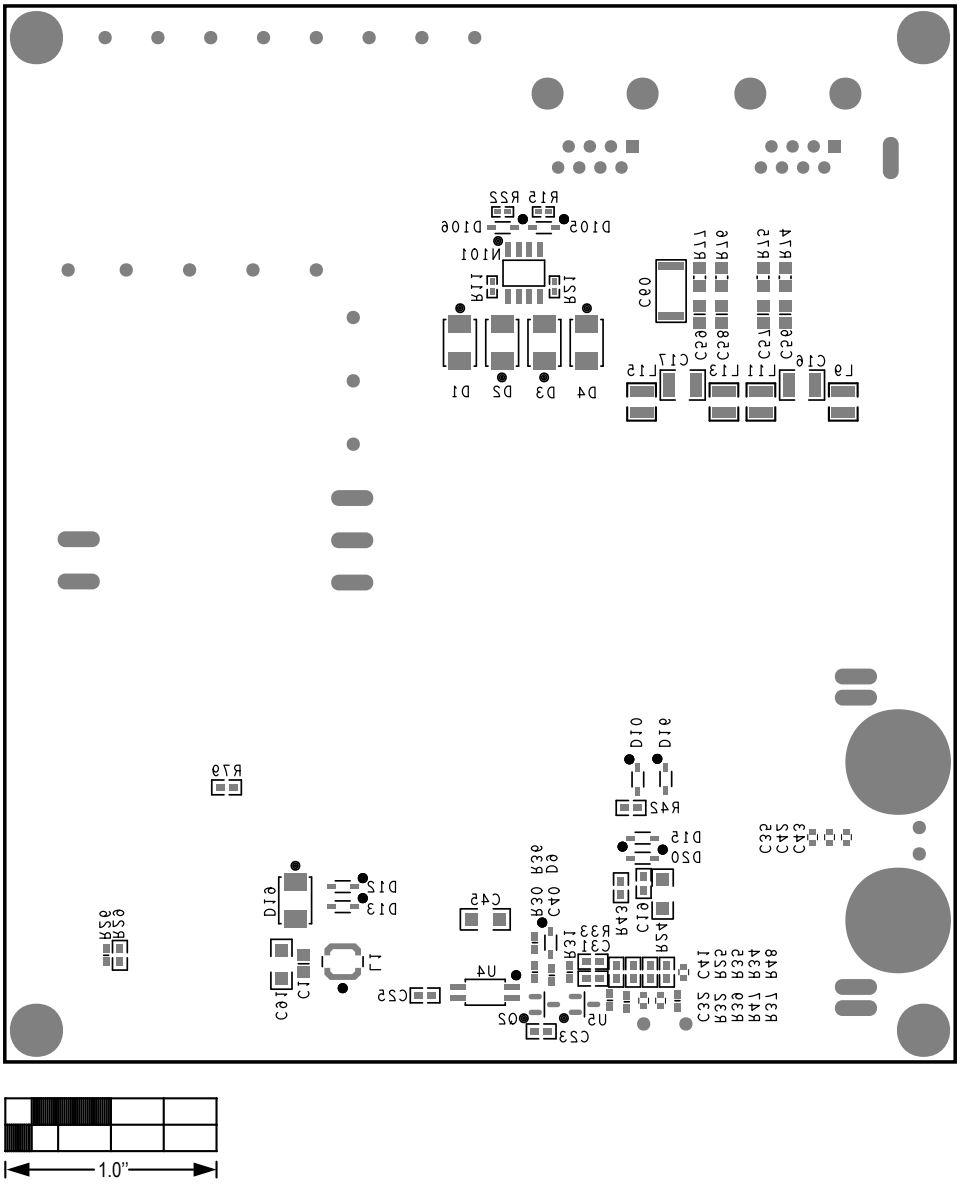
MAX5995 EV—Level PWR

MAX5995B EV Kit PCB Layout Diagrams (continued)



MAX5995 EV—Bottom View

MAX5995B EV Kit PCB Layout Diagrams (continued)



MAX5995 EV—Bottom Silkscreen

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	11/18	Initial release	—