Click here for production status of specific part numbers.

MAX17701EVKITA# Evaluation Kit

Evaluates: MAX17701 in 5V Output-Voltage Application

General Description

The MAX17701EVKITA# (EV kit) provides a proven design to evaluate the MAX17701 high-efficiency, high-voltage, Himalaya synchronous step-down DC-DC supercapacitor charger controller. The EV kit provides constant current (CC) mode and constant voltage (CV) modes to charge supercapacitors. The EV kit is designed to deliver 20A CC mode current (I_{CHGMAX}) and 5V CV mode voltage (V_{OUT}) from a 9V to 60V input supply. The EV kit supports up to continuous 10A load connected in parallel to supercapacitors at the output. The EV kit is optimized for 24V nominal input voltage application. The switching frequency of the EV kit is set at 350kHz (f_{SW}) for optimum efficiency and component size. The EV kit features a safety timer (TMR) to set the maximum allowed constant current (CC) mode charging time. For more details about the IC benefits and features, refer MAX17701 IC data sheet.

Features

- Operates from a 9V to 60V Input Supply
- 20A CC Mode Charging Current
- 5V CV Mode Output Voltage
- 350kHz Switching Frequency
- Resistor-Programmable UVLO Threshold
- Input Short Protection
- CC Mode Safety Timer (TMR)
- Cycle-by-Cycle Overcurrent Limit
- External Clock Synchronization (RT/SYNC)
- Fault Monitoring Open-Drain Output ($\overline{FLG}$)
- Charging Current Monitoring (ISMON)
- Output Overvoltage Protection (OVI)
- IC Overtemperature Protection
- Proven PCB Layout
- Fully Assembled and Tested

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

Quick Start

Recommended Equipment

- MAX17701EVKITA#
- 60V, 20A DC input power supply
- 10A electronic load
- Three digital voltmeters (DVM)
- Digital ammeter (DAM)

Equipment Setup and Test Procedure

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

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

1) Set electronic load with 10A and disable the electronic load.
2) Connect the positive terminal of the electronic load to the VOUT connector and negative terminal of electronic load to the nearest PGND connector.
3) Turn on electronic load and discharge supercapacitors till the voltage across the output goes to 0V. Disconnect the electronic load.
4) Set the power supply at a voltage between 9V and 60V. Disable the power supply.
5) Verify that shunts are installed across pins 1-2 on EN/UVLO jumper (J1), pins 1-2 on ILIM jumper (J2), pins 2-3 on TMR jumper (J3). See Table 1, Table 2, and Table 3 for details.
6) Connect the positive terminal of the input power supply to the DCIN connector and the negative terminal to the nearest PGND connector.
7) Connect the positive terminal of the electronic load to the VOUT connector in series with DAM and the negative terminal to the nearest PGND connector.
8) Connect first DVM (DVM1) between the VOUT connector and nearest PGND connector. Connect the second DVM (DVM2) between the ISMON PCB pad and nearest SGND PCB pad. Connect third DVM (DVM3) between the $\overline{FLG}$ PCB pad and nearest SGND PCB pad.
9) Turn on DC power supply.
10) The charger starts in CC mode. Observe that the DVM2 displays 1.5V, translates to 20A charging current.

319-100560; Rev 0; 7/20

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11) The charger enters CV mode when V_{FB} reaches CV threshold (1.217V) and the charging current starts to fall from 20A. Observe that the voltage reading in DVM2 falls from 1.5V to 0.75V in CV mode.
12) Verify that the current reading in DAM is 10A in both CC and CV modes.
13) The charger continues to regulate the output voltage in CV mode and supercapacitors are fully charged. Verify that the DVM1 displays close to 5V.
14) During charging process, verify that the $\overline{FLG}$ voltage displays 5V on DVM3, which shows that there is no fault.
15) After testing is completed, switch off the power supply. Remove the electronic load after supercapacitor voltage is discharged to 0V.

Detailed Description

The MAX17701EVKITA# (EV kit) provides charging solution for supercapacitor with CC mode charging current of 20A and CV mode voltage of 5V from a 9V to 60V input supply. The EV kit supports a continuous load current up to 10A at the output. The EV kit features a 350kHz switching frequency for optimum efficiency and component size. The RT/SYNC PCB pad allows an external clock to synchronize the device. The EV kit includes an EN/UVLO PCB pad and J1 to enable/disable the controller. The $\overline{FLG}$ PCB pad allows to monitor the charger fault status. The ISMON PCB pad allows to monitor charging current.

Enable/Undervoltage-Lockout (EN/UVLO) Programming

The EV kit offers an adjustable input undervoltage lockout feature. The EN/UVLO pin can be used to set a desired input voltage at which the charger is enabled or disable the charger by pulling down EN/UVLO to SGND/EP. Figure 1 shows the input under voltage lockout setting on the EV kit. The EN/UVLO pin can be used as input undervoltage lockout detector with a typical hysteresis of 160mV. To disable the MAX17701, install a shunt across pins 2–3 on J1. See Table 1 for J1 settings. As shown in Figure 1, the input at which the charger controller of the IC turns on, can be set with a resistor-divider connected to EN/UVLO from DCIN to PGND. The minimum $V_{DCIN(MIN)}$ that can be set for a 5V CV mode voltage and 350kHz programmed switching frequency on the EV kit is 9V.

Choose R1 as follows:

$$R1 \le (10000 \times V_{DCIN(MIN)})$$

where $V_{DCIN(MIN)}$ is the voltage at which the device is required to turn on.

Calculate the value of R2 using the following equation:

$$R2 = \frac{V_{EN\_TH\_R} \times R1}{V_{DCIN(MIN)} - V_{EN\_TH\_R} + (I_{EN\text{-}BIAS} \times R1)}$$

where:

$I_{EN\text{-}BIAS}$ = Internal bias pullup current on the EN/ULVO pin (3µA)

$V_{EN\_TH\_R}$ = EN/UVLO pin rising threshold voltage (1.25V)

For more details about setting the undervoltage lockout level, refer to the MAX17701 data sheet.

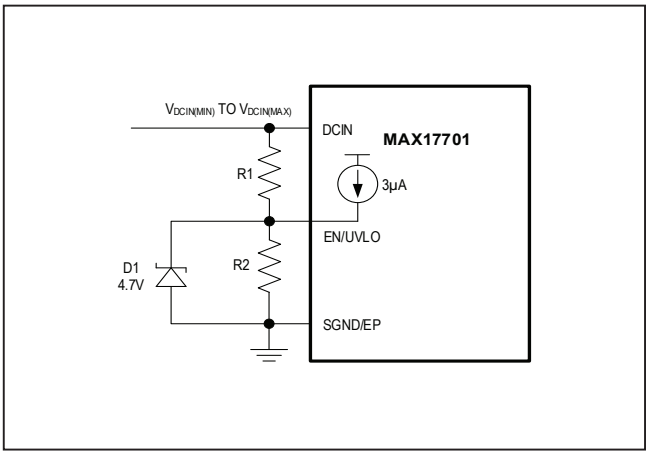


Figure 1. Setting the Input Under Voltage Lockout

Table 1. EN/UVLO Jumper (J1) Settings

JUMPER	SHUNT POSITION	EN/UVLO PIN	MAX17701 OUTPUT
J1	1-2*	Connected to the input UVLO divider midpoint	Enabled, UVLO level is set by the resistor divider from DCIN to SGND/EP
	2-3	Connected to SGND/EP	Disabled

**Default position*

CC Mode Charging Current Setting (ILIM)

The EV kit provides the CC mode charge current programming feature. The ILIM PCB pad on the EV kit supports external control of the CC mode charging current (I_{CHGMAX}). See Table 2 for J2 settings. To program the I_{CHGMAX} at 20A, install a jumper across pins 1–2 on J2. In order to control I_{CHGMAX} with an external dynamic input, install a jumper across pins 2-3 on J2 and apply a voltage (V_{ILIM}) between ILIM PCB pad and nearest SGND PCB pad. To program the I_{CHGMAX} at 10A, remove the jumper on J2. The allowable voltage range on V_{ILIM} is 0.15V–1.5V. For more details about the *CC Mode Charging Current Setting*, refer to the MAX17701 IC data sheet.

External Clock Synchronization (RT/SYNC)

The EV kit provides a RT/SYNC PCB pad to synchronize the MAX17701 to an optional external clock. The external synchronization clock frequency must be between 0.9 x f_{SW} and 1.1 x f_{SW}, where f_{SW} is the frequency of operation set by R10. In the presence of a valid external clock for synchronization for 112 cycles of internal switching clock, the MAX17701 starts to sync in with external clock. For more details about external clock synchronization, refer to the MAX17701 IC data sheet.

Fault Status Output ($\overline{FLG}$)

The EV kit provides an $\overline{FLG}$ PCB pad to indicate the status of the charger. $\overline{FLG}$ goes high when the MAX17701 is in normal operation (no faults). $\overline{FLG}$ goes low when the safety timer times out or when a hardware fault is detected.

For more details about hardware faults, refer to the MAX17701 IC data sheet.

Charger Timers (TMR)

The EV kit features safety timer to set the timeout in CC mode. The safety timer is adjusted by the value of capacitor between TMR and SGND/EP. The default programmed safety timeout on the EV kit is 118sec. If the charger doesn't enter CV mode within 118 seconds, then the charger enters blanking fault. The charger stays idle for fault blanking time of 472sec before restarting the charging.

The TMR jumper (J3) supports safety timer enable/disable feature. See Table 3 for J3 settings. In order to disable the safety timer, install a jumper across pins 1–2 on J3. To enable the safety timer setting for 118sec, install a jumper across pins 2–3 on J3. For more details about charger timers, refer to the MAX17701 IC data sheet.

Hot Plug-In and Long Input Cables

The MAX17701EVKITA# PCB layout provides an electrolytic capacitor (C15 = 68µF/100V). This capacitor limits the peak voltage at the input of the MAX17701 when the DC input source is "hot-plugged" to the EV kit input terminals (DCIN) with long input cables. The equivalent series resistance (ESR) of the electrolytic capacitor dampens the oscillations caused by interaction of the inductance of the long input cables, and the ceramic capacitors at the buck converter input (VIN). An electrolytic capacitor at DCIN prevents the DCIN voltage from being less than -0.3V during input short events by providing damping with ESR.

Table 2. ILIM Jumper (J2) Settings

JUMPER	SHUNT POSITION	ILIM PIN	I_{CHGMAX}
J2	1-2*	Connected to V_{REF}	20A
	2-3	Connected to ILIM PCB pad	13.33 x V_{ILIM}
	Not installed	Connected to ILIM resistor divider (R8 and R9) mid-point	10A

**Default position*

Table 3. TMR Jumper (J3) Settings

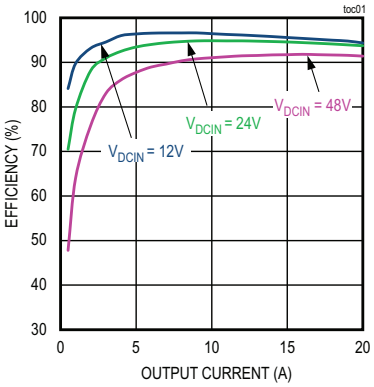
JUMPER	SHUNT POSITION	TMR PIN	SAFETY TIMER SETTING
J3	1-2	Connected to V_{REF}	Disabled
	2-3*	Connected to TMR capacitor (33nF)	Enabled and set at 118sec

**Default position*

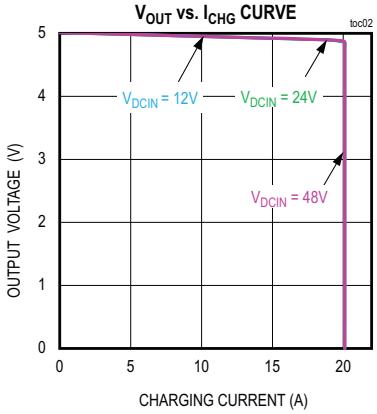
MAX17701EVKITA# Performance Report

(V_{DCIN} = 24V, V_{OUT} = 5V, I_{CHGMAX} = 20A, I_{LOAD} = 10A, f_{SW} = 350kHz, T_A = +25°C, unless otherwise noted.)

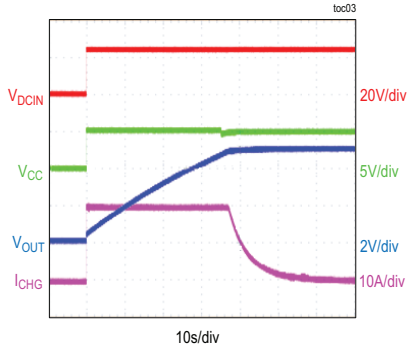
EFFICIENCY vs. OUTPUT CURRENT



V_{OUT} vs. I_{CHG} CURVE

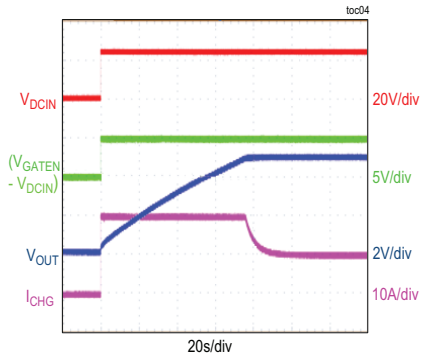


SUPERCAPACITOR CHARGING AT NO LOAD



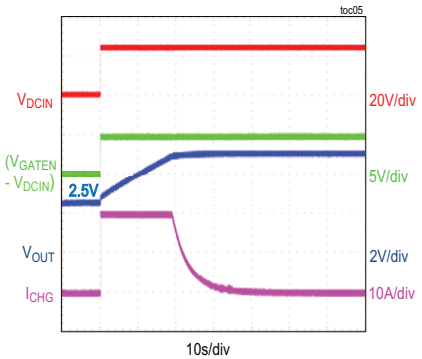
CONDITIONS: I_{CHGMAX} = 20A

SUPERCAPACITOR CHARGING AT 10A LOAD



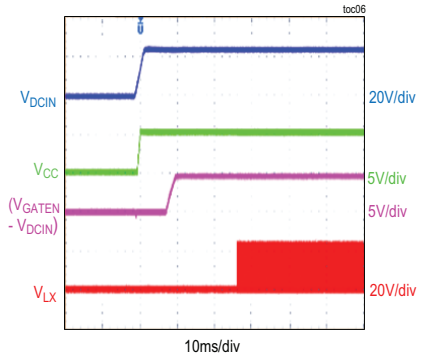
CONDITIONS: I_{CHGMAX} = 20A

SUPERCAPACITOR CHARGING WITH PRE-BIASED OUTPUT OF 2.5V



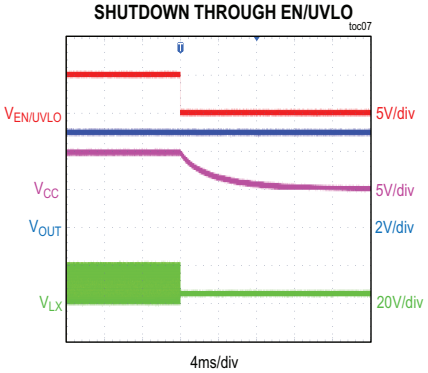
CONDITIONS: I_{CHGMAX} = 20A

DCIN STARTUP



CONDITIONS: CC MODE, I_{CHGMAX} = 20A

SHUTDOWN THROUGH EN/UVLO

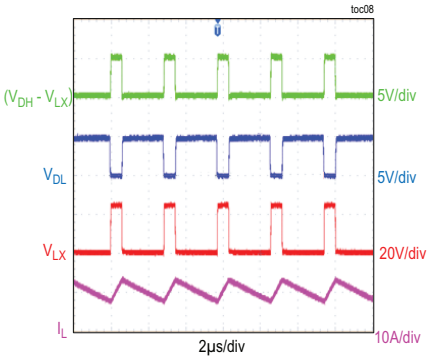


CONDITIONS: 5V OUTPUT, CV MODE, NO LOAD

MAX17701EVKITA# Performance Report (continued)

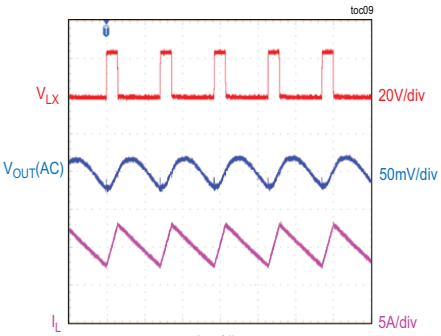
(V_{DCIN} = 24V, V_{OUT} = 5V, I_{CHGMAX} = 20A, I_{LOAD} = 10A, f_{SW} = 350kHz, T_A = +25°C, unless otherwise noted.)

STEADY-STATE SWITCHING



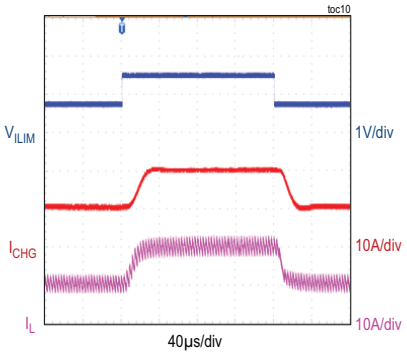
CONDITIONS: CV MODE, I_{LOAD} = 10A

STEADY-STATE PERFORMANCE



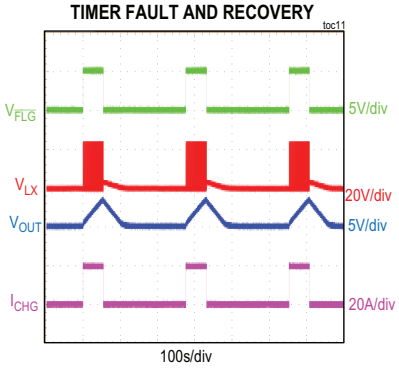
CONDITIONS: CV MODE, I_{LOAD} = 10A

ILIM TRANSIENT PERFORMANCE
V_{ILIM} IS SWITCHED BETWEEN 0.75V AND 1.5V



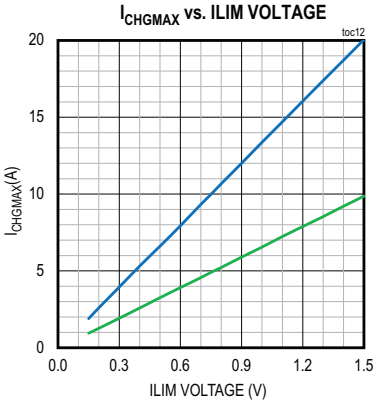
CONDITIONS: CC MODE

TIMER FAULT AND RECOVERY



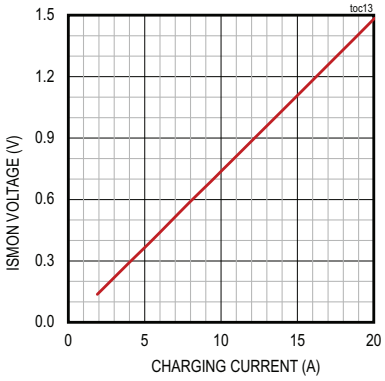
CONDITIONS: CC MODE, T_{TMR} = 55s, I_{LOAD} = 10A, I_{CHGMAX} = 20A

I_{CHGMAX} vs. ILIM VOLTAGE



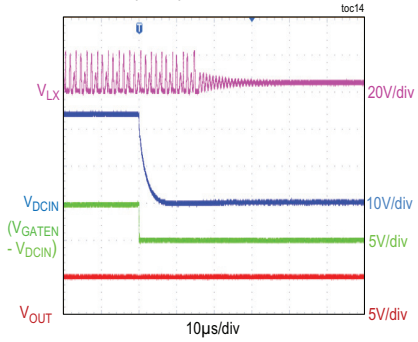
CONDITIONS: CC MODE

ISMON VOLTAGE vs. CHARGING CURRENT



CONDITIONS: CC MODE

INPUT (DCIN) SHORT PROTECTION



CONDITIONS: 5V OUTPUT, CV MODE, NO LOAD

Component Suppliers

SUPPLIER	WEBSITE
Coilcraft, Inc.	www.coilcraft.com
Murata Americas	www.murataamericas.com
Tacate Group	www.tecategroup.com
Panasonic Corp.	www.panasonic.com
TDK	www.tdk.com
Vishay	www.vishay.com
Taiyo Yuden	www.yuden.co.jp
Diodes Inc.	www.diodes.com
Yageo Corp.	www.yageo.com

Note: *Indicate that you are using the MAX17701 when contacting these component suppliers.*

Ordering Information

PART	TYPE
MAX17701EVKITA#	EV Kit

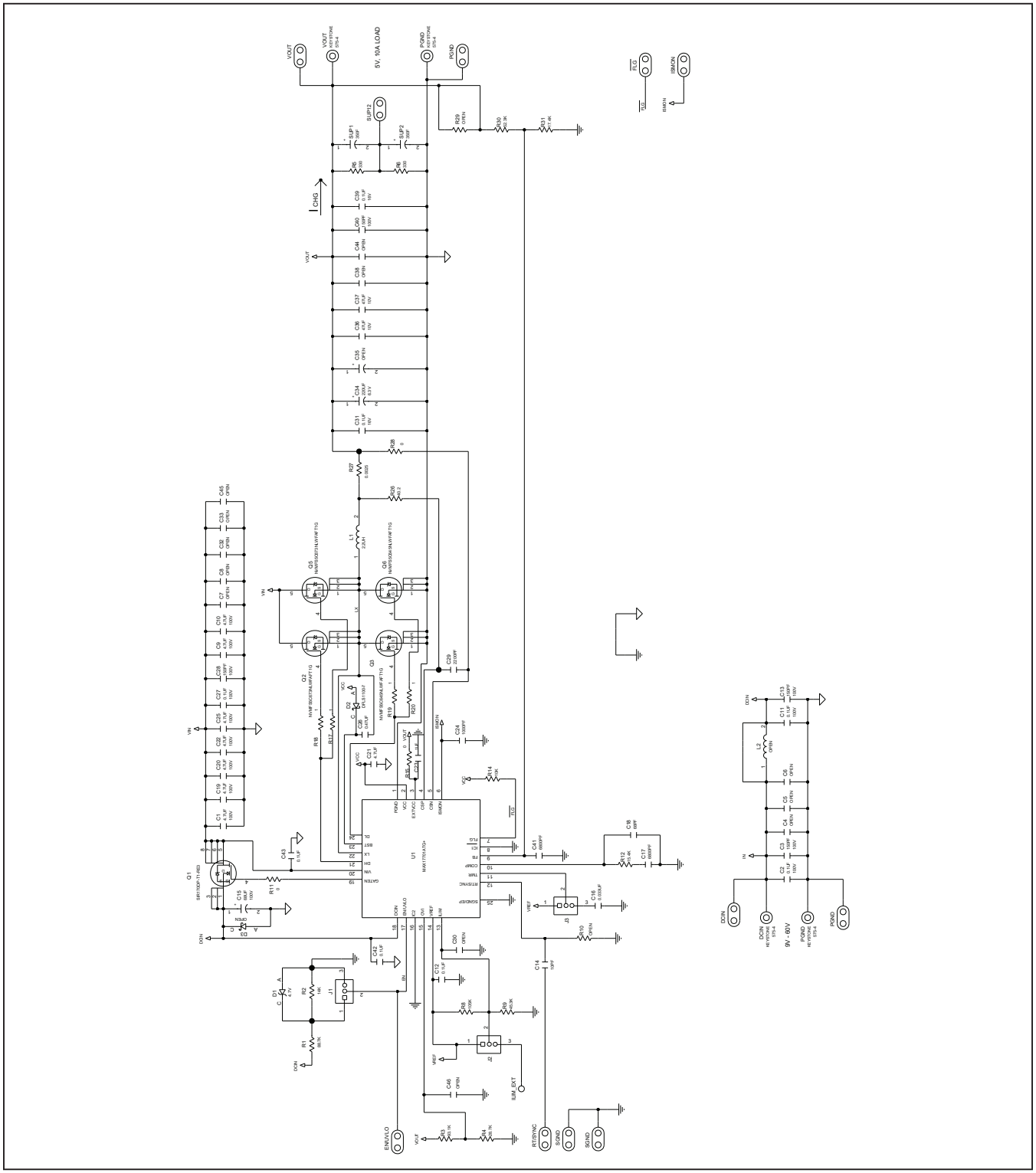
#Denotes RoHs compliance.

MAX17701EVKITA# Bill of Materials

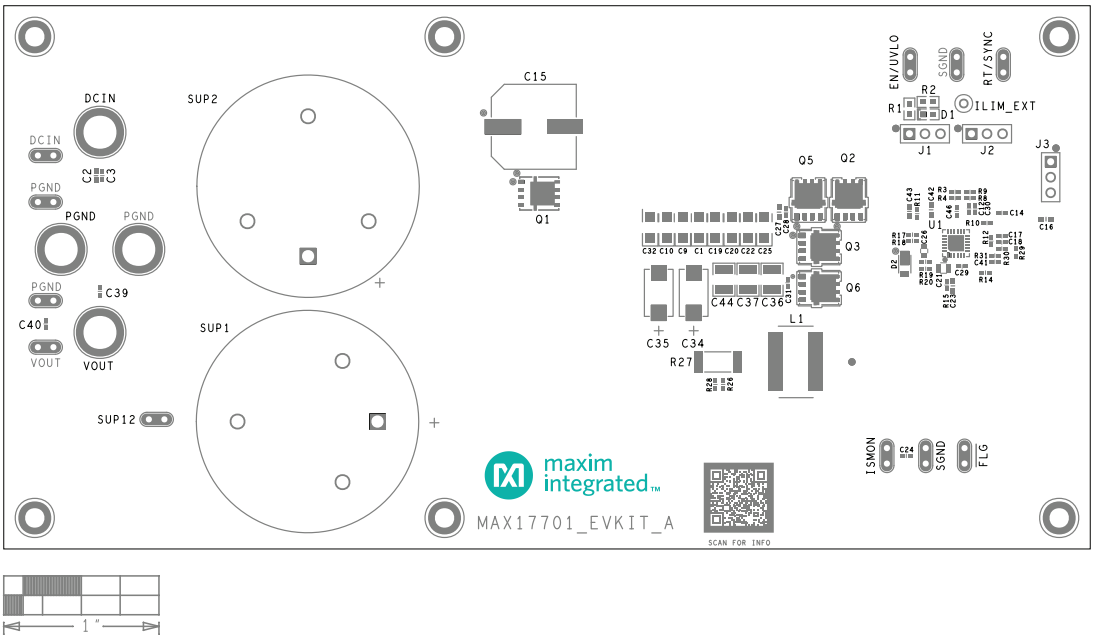
S. No	DESIGNATOR	DESCRIPTION	QUANTITY	MANUFACTURER PART NUMBER
1	C1, C9, C10, C19, C20, C22, C25	4.7µF, 10%, 100V, X7R, Ceramic capacitor (1206)	7	MURATA GRM31CZ72A475KE11
2	C2, C11, C27, C42, C43	0.1µF, 10%, 100V, X7R, Ceramic capacitor (0603)	5	TAIYO YUDEN HMK107B7104KA
3	C3, C13, C28, C40	150pF, 5%, 100V, COG, Ceramic capacitor (0402)	4	TDK C1005C0G2A151J050BA
4	C12, C31, C39	0.1µF, 10%, 16V, X7R, Ceramic capacitor (0402)	3	TAIYO YUDEN EMK105B7104KV
5	C14	10pF, 5%, 50V, COG, Ceramic capacitor (0402)	1	KEMET C0402C100J5GACTU
6	C15	ALUMINUM-ELECTROLYTIC; 68UF; 100V; TOL=20%; MODEL=EEV SERIES	1	PANASONIC EEV-FK2A680Q
7	C16	0.033µF, 10%, 50V, X7R, Ceramic capacitor (0603)	1	SAMSUNG CL10B333KB8NNNC
8	C17, C41	6800pF, 10%, 25V, X7R, Ceramic capacitor (0402)	1	YAGEO CC0402KRX7R8BB682
9	C18	68pF, 5%, 50V, C0G, Ceramic capacitor (0402)	1	KEMET C0402C680J5GAC
10	C21	4.7µF, 10%, 16V, X7R, Ceramic capacitor (0805)	1	MURATA GRM21BR71C475KE51
11	C23	1µF, 10%, 25V, X7R, Ceramic capacitor (0603)	1	TAIYO YUDEN TMK107B7105KA
12	C24	1000pF, 10%, 16V, X7R, Ceramic Capacitor (0402)	1	SAMSUNG CL05B102KO5NNN
13	C26	0.47µF, 10%, 16V, X7R, Ceramic capacitor (0603)	1	MURATA GRM188R71C474K
14	C29	2200pF, 5%, 50V, X7R, Ceramic capacitor (0402)	1	MURATA GRM155R71H222JA01
15	C34	220µF, TOL=20%, 6.3V, TANTALUM CHIP	1	PANASONIC 6TCE220MI
16	C36, C37	47µF, 10%, 10V, X7R, Ceramic capacitor (1210)	2	MURATA GRM32ER71A476KE15
17	D1	ZENER DIODE VZ=4.7V; IZ=0.005A	1	COMCHIP CZRU52C4V7
18	D2	SCHOTTKY DIODE PIV=100V; IF=1A	1	DIODES INCORPORATED DFLS1100-7
19	L1	INDUCTOR, 2.2µH, 32A (10mm x 10mm), 2.8mΩ	1	COILCRAFT XAL1010-222ME
20	Q1	N-CHANNEL POWER MOSFET(PowerPAK® SO-8) PD-(6.25W); I-(95A); V-(100V)	1	VISHAY SIR170DP-T1-RE3
21	Q2, Q5	N-CHANNEL POWER MOSFET (8-PowerTDFN, 5 Leads) PD-(3.6W); I-(50A); V-(60V)	2	ONSEMI NVMFS5C673NLWFAFT1G
22	Q3, Q6	N-CHANNEL POWER MOSFET (8-PowerTDFN, 5 Leads) PD-(3.7W); I-(100A); V-(60V)	2	ONSEMI NVMFS5C645NLWFAFT1G
23	R1	RESISTOR, 88.7KΩ, 1% (0603), 0.1W	1	PANASONIC ERA-3AEB8872
24	R2	RESISTOR, 14KΩ, 1% (0603), 0.1W	1	PANASONIC ERJ-3EKF1402
25	R3	RESISTOR, 93.1KΩ, 1% (0402), 0.0625W	1	VISHAY DALE CRCW040293K1FK
26	R4	RESISTOR, 28.7KΩ, 1% (0402), 0.0625W	1	VISHAY DALE CRCW040228K7FK
27	R5, R6	RESISTOR, 330Ω, 1% (0603), 0.1W	2	VISHAY DALE CRCW0603330RFK
28	R8	RESISTOR, 105KΩ, 1% (0402), 0.0625W	1	VISHAY DALE CRCW0402105KFK
29	R9	RESISTOR, 45.3KΩ, 1% (0402), 0.0625W	1	VISHAY DALE CRCW040245K3FK
30	R11, R15, R28	RESISTOR, 0Ω, 5% (0402), 0.0625W	3	YAGEO PHYCOMP RC0402JR-070RL
31	R12	RESISTOR, 15.4KΩ, 1% (0402), 0.1W	1	PANASONIC ERJ-2RKF1542
32	R14	RESISTOR, 10KΩ, 1% (0402), 0.1W	1	VISHAY DALE CRCW040210K0FK
33	R17-R20	RESISTOR, 1Ω, 1% (0402), 0.0625W	4	VISHAY DALE CRCW04021R00FK
34	R26	RESISTOR, 40.2Ω, 1% (0402), 0.0625W	1	VISHAY DALE CRCW040240R2FK
35	R27	RESISTOR, 0.0025Ω, 1% (2512), 2W	1	VISHAY WSL25122L500FEA18
36	R30	RESISTOR, 52.3KΩ, 1% (0402), 0.0625W	1	VISHAY DALE CRCW040252K3FK
37	R31	RESISTOR, 17.4KΩ, 1% (0402), 0.0625W	1	YAGEO PHYCOMP RC0402FR-0717K4L
38	SUP1, SUP2	SUPERCAPACITOR, 350F, 3V, 4mΩ	2	TECATE GROUP TPLH-3R0/350SS35X61
39	U1	SYNCHRONOUS STEP-DOWN SUPERCAPACITOR CHARGER CONTROLLER (TQFN24-EP 4mm x 4mm)	1	MAX17701ATG+
40	DCIN, PGND, PGND2, VOUT	BANANA JACK (5.2mm DIA X 5.5mm LENGTH)	4	KEY STONE 575-4
41	ILIM_EXT	TEST POINT, PIN DIA=0.1IN; TOTAL LENGTH=0.3IN;	1	KEY STONE 5000
42	J1-J3	3-pin header (0.1" centers)	3	SULLINS PEC03SAAN
43	-	SHUNTS	3	SULLINS STC02SYAN
44	C4-C8, C32, C33, C45	OPEN: CAPACITOR (1206)	0	
45	C30, C46	OPEN: CAPACITOR (0402)	0	
46	C35	OPEN: TANTALUM CAPACITOR (2917)	0	
47	C38, C44	OPEN: CAPACITOR (1210)	0	
48	L2	OPEN: INDUCTOR (10mmx10mm)	0	
49	D3	OPEN: SCHOTTKY DIODE (SMB)	0	
50	R10, R29	OPEN: RESISTOR (0402)	0	

DEFAULT JUMPER TABLE	
JUMPER	**SHUNT POSITION**
J1, J2	1-2
J3	2-3

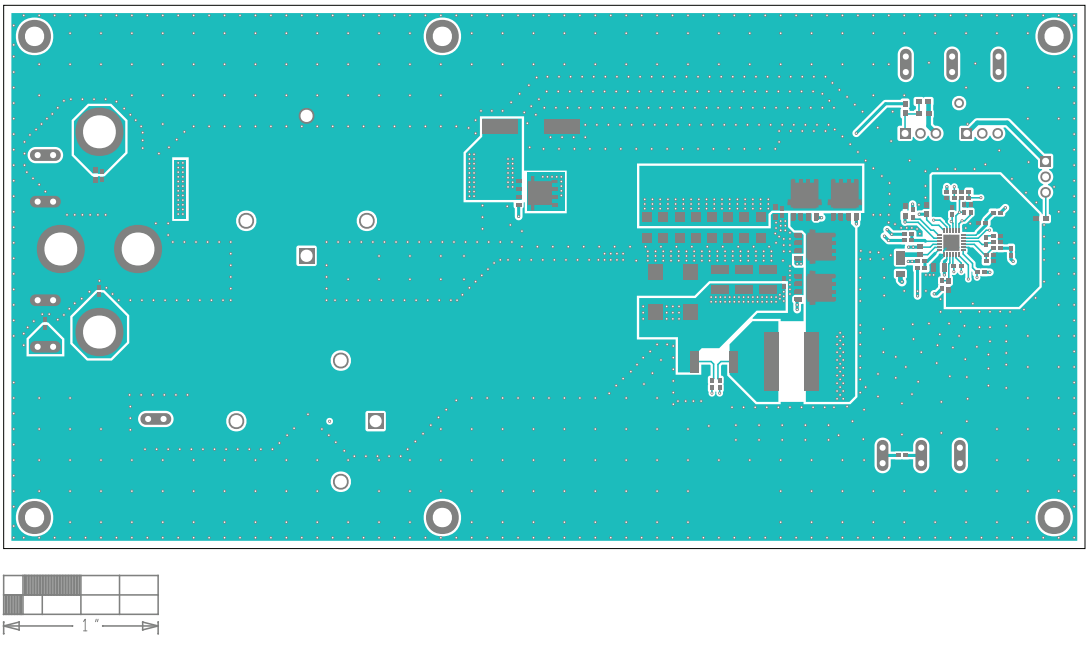
MAX17701EVKITA# Schematic



MAX17701EVKITA# PCB Layouts

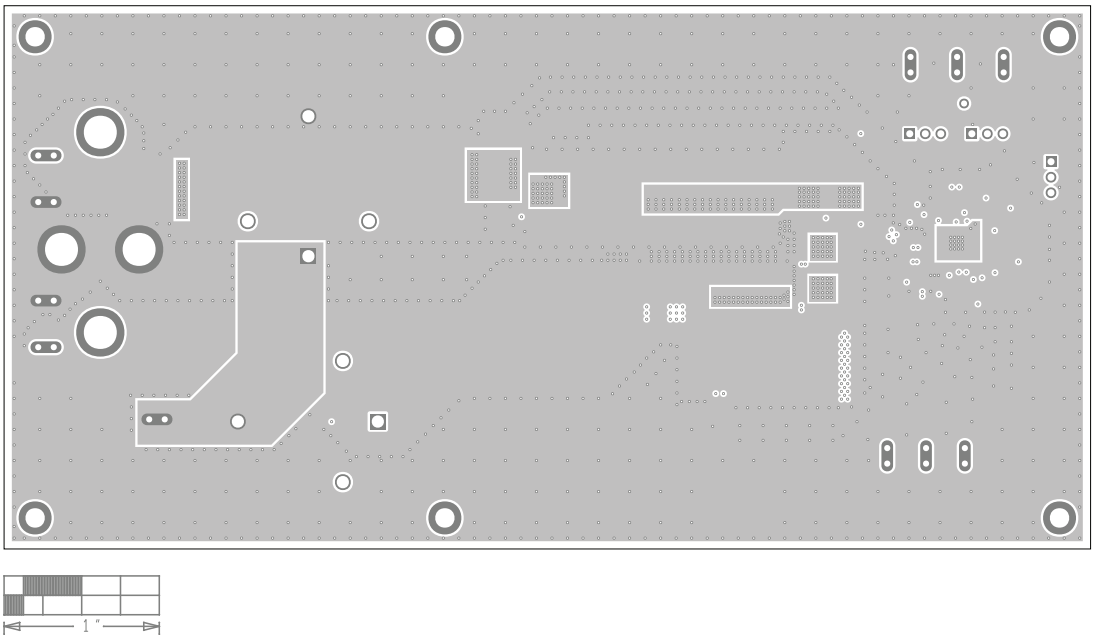


MAX17701EVKITA# EV Kit Component Placement Guide—Top Silkscreen

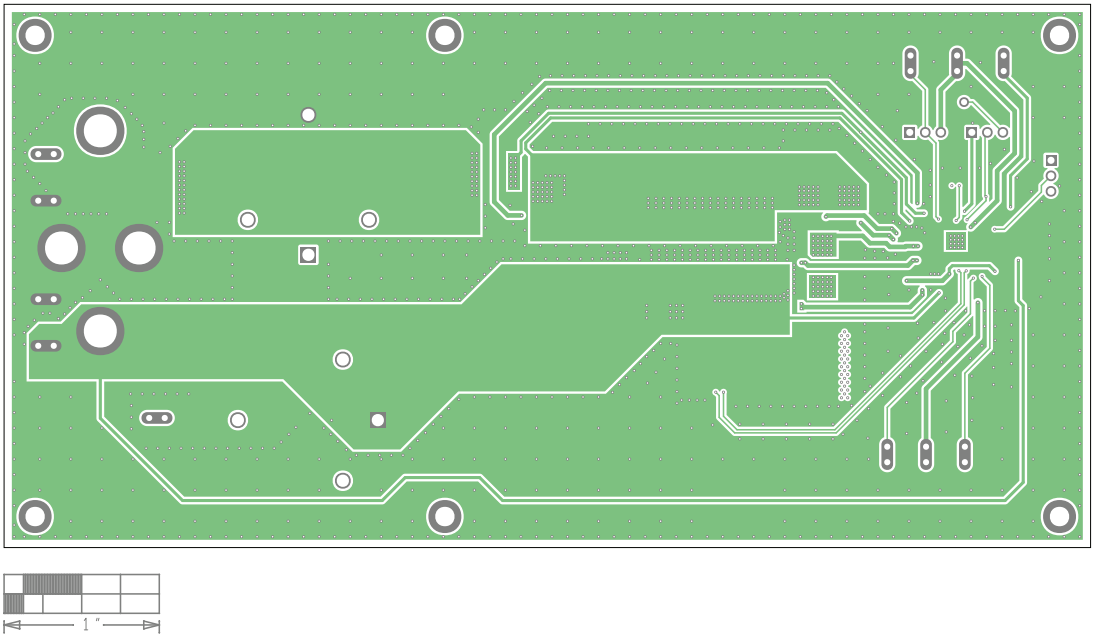


MAX17701EVKITA# EV Kit PCB Layout—Top Layer

MAX17701EVKITA# PCB Layouts (continued)

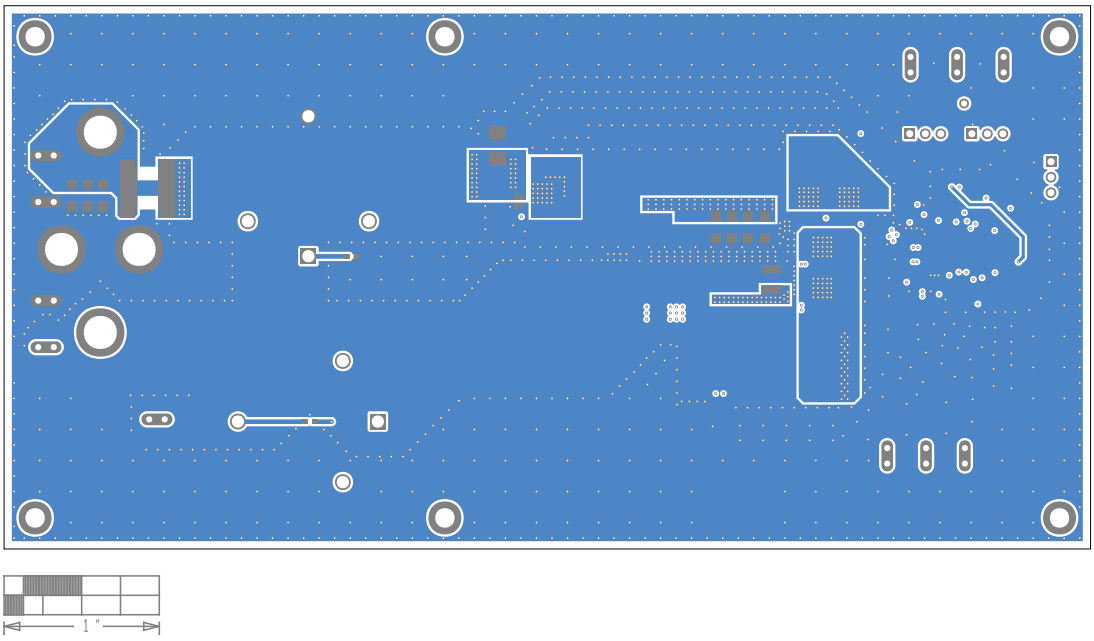


MAX17701EVKITA# EV Kit PCB Layout—Layer 2

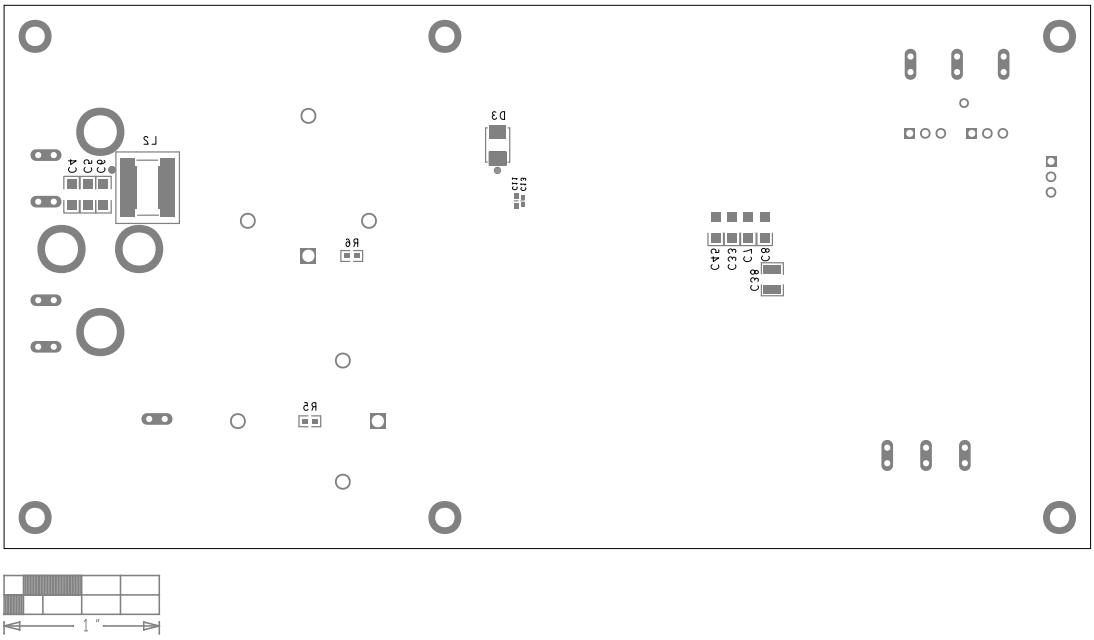


MAX17701EVKITA# EV Kit PCB Layout—Layer 3

MAX17701EVKITA# PCB Layouts (continued)



MAX17701EVKITA# EV Kit PCB Layout—Bottom Layer



MAX17701EVKITA# EV Kit Component Placement Guide—Bottom Silkscreen

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	7/20	Initial release	—

