MAX20059 Evaluation Kit

Evaluates: MAX20059

General Description

The MAX20059 EV kit is a proven design to evaluate the MAX20059 high-efficiency, high-voltage, synchronous step-down DC-DC converter IC in a TDFN package. The EV kit is optimized to generate a 5V output at load currents up to 1A from a 48V input supply, and can be reconfigured to meet other system requirements. The EV kit features a 400kHz switching frequency. The EV kit can be used to monitor the IC's features, such as adjustable input undervoltage lockout, adjustable soft-start, adjustable switching frequency, adjustable current limit, open-drain $\overline{\text{RESET}}$ signal, and external frequency synchronization.

Benefits and Features

- Operates from 6.5V to 72V at 48V Nominal Input
- Meets Stringent OEM Module Power Consumption and Performance Specifications
- 5V Output Voltage at 400kHz Switching Frequency
- Up to 1A Output Current with Adjustable Peak-Current Limit
- Jumpers for Quickly Adjusting Peak-Current Limit and Mode Selection
- Auxiliary Bootstrap LDO to Improve Efficiency
- Adjustable Soft-Start Time with External Capacitor
- Optimized Application Layout and Components for Quick Design Implementation
- Proven PCB Layout
- Fully Assembled and Tested

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

Quick Start

Required Equipment

- MAX20059 EV kit
- Adjustable DC power supply
- Digital multimeter (DMM)
- Electronic load

Procedure

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

1) Verify that all jumpers are positioned to their default settings (Table 1).
2) Preset the power supply to 48V. Disable the power supply.
3) Preset the electronic load to 500mA. Disable the electronic load.
4) Connect the positive lead of the power supply to the VIN PCB pad on the EV kit.
5) Connect the negative lead to the neighboring PGND PCB pad.
6) Connect the positive terminal of the electronic load to the VOUT PCB pad.
7) Connect the negative lead to the neighboring PGND2 PCB pad.
8) Enable the DC power supply.
9) Using the DMM, verify that voltage across the VOUT and PGND2 PCB pads is 5V.
10) Turn on the electronic load.
11) Verify that the voltage across the VOUT and PGND PCB pads is still close to 5V after load regulation.
12) Turn off the electronic load.
13) Turn off the power supply.

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Detailed Description

The MAX20059 5V output EV kit provides a proven design to evaluate the MAX20059 high-efficiency, high-voltage, synchronous step-down DC-DC converter IC. The EV kit generates 5V at load currents up to 1A from a 6.5V to 72V input supply. The EV kit features a 400kHz switching frequency for optimum efficiency and component size. The EV kit includes an EN/UVLO PCB pad and jumper JU1 to enable the output at a desired input voltage. The RT/SYNC_IN PCB pad allows an external clock to synchronize the device while the IC is set to FPWM through jumper JU4 or JU5. A RESETB PCB pad is available for monitoring when the converter output is in regulation.

Soft-Start Input (SS)

The IC implements adjustable soft-start operation to reduce inrush current and to minimize output-voltage overshoot during startup. A capacitor connected from the SS pin to SGND (C6 on the EV kit) programs the soft-start time for the corresponding output voltage. The selected output capacitance (C_{SEL}) and the output voltage (V_{OUT}) determine the minimum required soft-start capacitor as follows:

$$C_{SS} \geq 30 \times 10^{-6} \times C_{SEL} \times V_{OUT}$$

The soft-start time (t_{SS}) is related to the capacitor connected at SS (C_{SS}) by the following equation:

$$t_{SS} = \frac{C_{SS}}{6.25 \times 10^{-6}}$$

For example, to program a 2ms soft-start time, a 12nF capacitor should be connected from the SS pin to SGND.

Regulator Enable/Undervoltage-Lockout Level (EN/UVLO)

The device offers an adjustable-input undervoltage-lockout level. For always-on operation, no shunt should be installed across JU1. To disable the output, install a shunt across pins 2-3 on JU1 and the EN/UVLO pin is pulled to GND. See Table 1 for JU1 default settings.

Set the voltage at which each converter turns on with a resistive voltage-divider connected from V_{IN} to SGND. Connect the center node of the divider to the EN/UVLO pin. Choose R1 as follows:

$$R1 \leq 110000 \times V_{INU}$$

where V_{INU} is the input voltage at which the IC is required to turn on, and R1 is measured in ohms. Calculate the value of R2 as follows:

$$R2 = \frac{1.215 \times R1}{V_{INU} - 1.215 + (2.5\mu A \times R1)}$$

Current Limit and Mode-of Operation Selection

Table 2 lists the values of the resistor R5 to program PWM or PFM modes of operation and 1.6A or 1.14A peak current limits.

On the EV kit, jumpers JU2–JU5 are connected to each of the above values for easy evaluation of each mode and peak current limit. The mode of operation cannot be changed on-the-fly after power-up until the power supply is reset or the IC has been disabled.

Table 1. Default Jumper Settings

JUMPER	DEFAULT SHUNT POSITION	FUNCTION
JU1	Installed, across pins 2-3	Enable for VOUT
JU2	Open	PFM/1.6A peak ILIM
JU3	Open	PFM/1.14A peak ILIM
JU4	Installed	FPWM/1.6A peak ILIM
JU5	Open	FPWM/1.14A peak ILIM

Note: *Only 1 jumper between JU2-5 should be installed. For 3-pin connectors, pin 1 is denoted by a silkscreen circle.*

Table 2. R_{ILIM} Resistor vs. Modes of Operation and Peak Current Limit

R_{ILIM} (kΩ)	MODE OF OPERATION	PEAK CURRENT LIMIT (A)
OPEN	PFM	1.6
422	PFM	1.14
243	PWM	1.6
121	PWM	1.14

Switching-Frequency Selection and External-Frequency Synchronization

The RT/SYNC pin programs the switching frequency of the converter. Resistor R4 sets the switching frequency of the part, and the EV kit is defaulted to 400kHz (105Ω). Table 3 shows some common frequencies and their corresponding resistor values.

The internal oscillator of the MAX20059 can be synchronized to an external clock signal on the RT/SYNC pin. The external synchronization clock frequency must be between 1.15 x f_{SW} and 1.4 x f_{SW}, where f_{SW} is the frequency programmed by R4. To use the external clock, the IC must be set to PWM mode.

Table 3. Switching Frequency vs. RT Resistor

SWITCHING FREQUENCY (kHz)	R_T (kΩ)
200	210
400	105
600	69.8
2000	19.1

EXTVCC External Power Supply

The EV kit is laid out so that EXTVCC is connected to VOUT and the internal LDO can be powered more efficiently at higher input voltages. To protect the IC from short-circuit events in which inductive ringing can cause the output voltage to go temporarily negative, an external RC filter is implemented in the design. A 4.7Ω resistor (R12) and 0.1µF capacitor (C7) are recommended.

For applications in which V_{OUT} is less than 4.5V, EXTVCC should be shorted to ground and the RC filter does not need to be implemented. In this case, the internal LDO is always powered from the input voltage. To test this on the EV kit, remove R12 and then replace C7 with a 0Ω short.

Inductor Selection and Suggested Values

While the detailed inductor calculations can be found in the MAX20059 IC data sheet, Table 4 summarizes the suggested ideal inductor values for common configurations, calculated at 0.3 inductor-to-current ratio for common V_{IN}, V_{OUT}, and switching-frequency combinations.

Table 4. Recommended Inductor for Common Operating Conditions

NOMINAL V_{IN} (V)	V_{OUT} (V)	SWITCHING FREQUENCY (kHz)	RECOMMENDED INDUCTOR (µH)
48	12	400	75
48	5	400	37
48	12	2000	15

Ordering Information

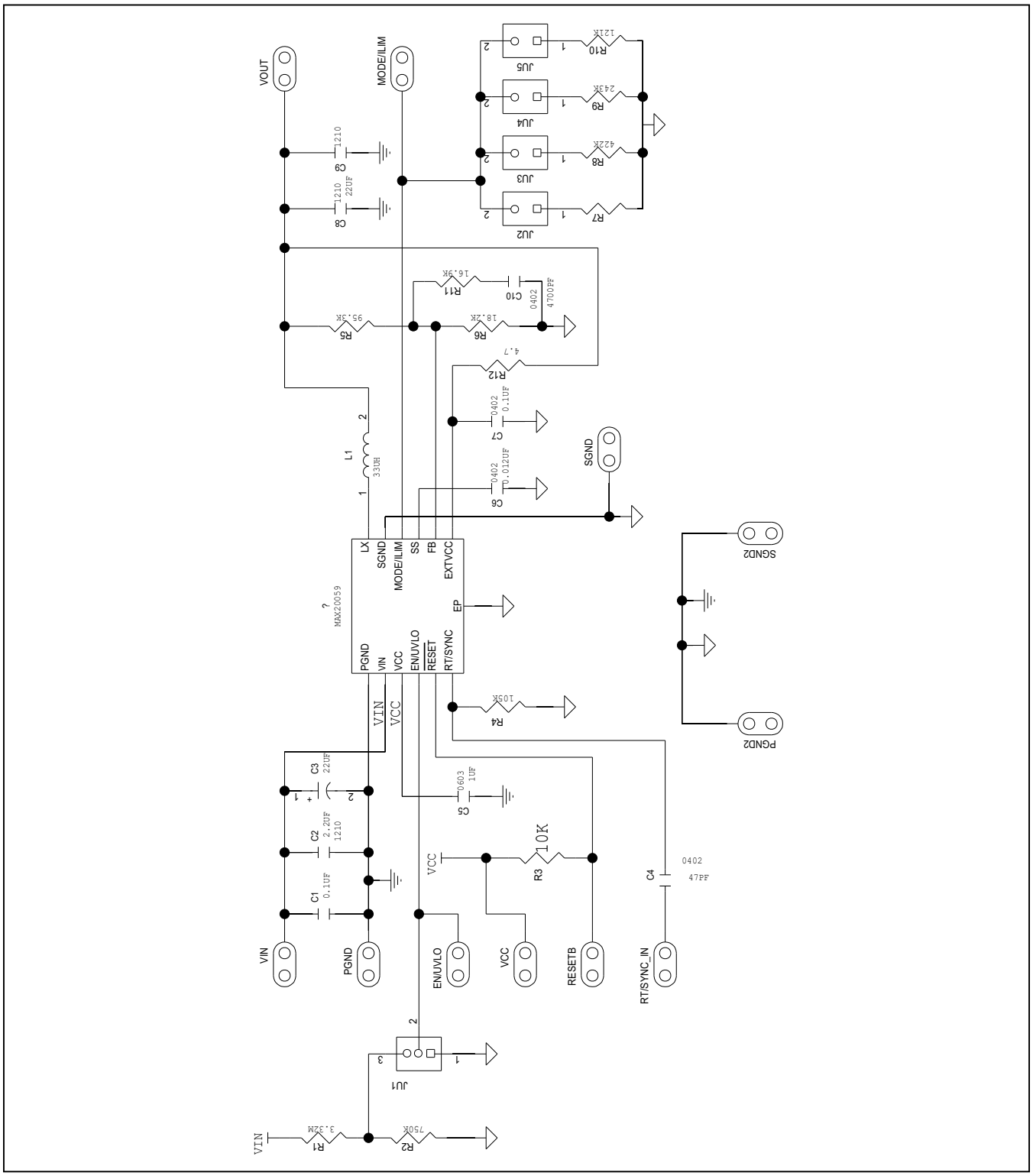
PART	TYPE
MAX20059EVKIT#	EV kit

#Denotes RoHS compliant.

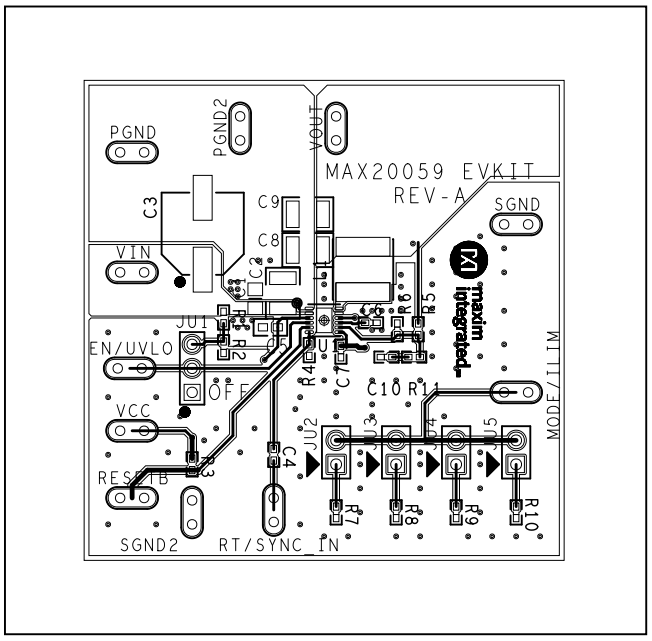
MAX20059 EV Kit Bill of Materials

QTY	REF DES	VALUE	DESCRIPTION	TEMP_RANGE	MFG PART #	MANUFACTURER
1	C1	0.1UF	CAPACITOR; SMT (0805); CERAMIC CHIP; 0.1UF; 100V; TOL=10%; TG=-55 ° TO +125 °; TC=X7R; AUTO	-55 ° TO +125 °	CGA4J2X7R2A104K125AA	TDK
1	C2	2.2UF	CAPACITOR; SMT (1210); CERAMIC CHIP; 2.2UF; 100V; TOL=10%; MODEL=GRM SERIES; TG=-55 ° to +125 °; TC=X7R	-55 ° TO +125 °	CGA6N3X7R2A225K230	TDK
1	C3	22UF	CAPACITOR; SMT (CASE_F); ALUMINUM-ELECTROLYTIC; 22UF; 100V; TOL=20%; MODEL=TG SERIES; TG=-40 ° TO +125 °	-40 ° TO +125 °	EEE-TG2A220UP	PANASONIC
1	C4	47PF	CAPACITOR; SMT (0402); CERAMIC CHIP; 47PF; 50V; TOL=5%; TG=-55 ° TO +125 °; TC=C0G; AUTO	-55 ° TO +125 °	CGA2B2C0G1H470J	MURATA
1	C5	1UF	CAPACITOR; SMT (0603); CERAMIC CHIP; 1UF; 16V; TOL=10%; TG=-55 ° TO +125 °; TC=X7R; AUTO	-55 ° TO +125 °	CGA3E1X7R1C105K080AC	TDK
1	C6	0.012UF	CAPACITOR; SMT (0402); CERAMIC CHIP; 0.012UF; 50V; TOL=10%; TG=-55 ° TO +125 °; TC=X7R	-55 ° TO +125 °	GRM155R71H123KA12	MURATA
1	C7	0.1UF	CAPACITOR; SMT (0402); CERAMIC CHIP; 0.1UF; 35V; TOL=10%; TG=-55 ° TO +125 °; TC=X7R; AUTO	-55 ° TO +125 °	CGA2B3X7R1V104K050BB	TDK
2	C8	22UF	CAPACITOR; SMT (1210); CERAMIC CHIP; 22UF ; 16V; TOL=20%; TG=-55 ° TO +125 °; TC=X7R; AUTO	-55 ° TO +125 °	CGA6P1X7R1C226M	TDK
	C9	**DNP**	**DO NOT POPULATE**	—	—	—
1	C10	4700PF	CAPACITOR; SMT; 0402; CERAMIC; 4700pF; 50V; 5%; X7R; -55° to + 125°; 0 +/-15% ° MAX.	-55° to +125°	C0402C472J5RAC	KEMET
1	JU1	PEC03SAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT; 3PINS; NOTE: SET TO OBSOLETE DUE TO FOOTPRINT UPDATE	-65 ° TO +125 °	PEC03SAAN	SULLINS
4	JU2, JU3, JU4, JU5	TSW-102-07-T-S	CONNECTOR; THROUGH HOLE; TSW SERIES; SINGLE ROW; STRAIGHT; 2PINS; -55 ° TO +105 °	-55 ° TO +125 °	TSW-102-07-T-S	SAMTEC
1	L1	33UH	INDUCTOR; SMT; FERRITE CORE; 33UH; TOL=+/-20%; 1.45A	-40 ° TO +125 °	74404064330	WURTH ELECTRONICS INC
1	R1	3.32M	RESISTOR; 0402; 3.32M OHM; 1%; 100PPM; 0.063W; METAL FILM	-55 ° TO +155 °	CRCW04023M32FK	VISHAY DALE
1	R2	750K	RESISTOR; 0402; 750K OHM; 1%; 100PPM; 0.063W; METAL FILM	-55 ° TO +155 °	CRCW0402750KFK	VISHAY DALE
1	R3	10K	RESISTOR; 0402; 10K OHM; 1%; 100PPM; 0.10W; THICK FILM	-55 ° TO +155 °	ERJ-2RKF1002	PANASONIC
1	R4	105K	RESISTOR; 0402; 105K OHM; 1%; 100PPM; 0.063W ; THICK FILM	-55 ° TO +155 °	CRCW0402105KFK	VISHAY DALE
1	R5	95.3K	RESISTOR; 0402; 95.3K; 1%; 100PPM; 0.0625W; THICK FILM	-55 ° TO +155 °	CRCW040295K3FK	VISHAY DALE
1	R6	18.2K	RESISTOR; 0402; 18.2K OHM; 1%; 100PPM; 0.063W; THICK FILM	-55 ° TO +155 °	CRCW040218K2FK	VISHAY DALE
	R7	**DNP**	**DO NOT POPULATE**	—	—	—
1	R8	422K	RESISTOR; 0402; 422K OHM; 1%; 100PPM; 0.063W; METAL FILM	-55 ° TO +155 °	CRCW0402422KFK	VISHAY DALE
1	R9	243K	RESISTOR; 0402; 243K OHM; 1%; 100PPM; 0.10W; THICK FILM	-55 ° TO +125 °	ERJ-2RKF2433X	PANASONIC
1	R10	121K	RESISTOR; 0402; 121K OHM; 1%; 100PPM; 0.1W; THICK FILM	-55 ° TO +155 °	ERJ-2RKF1213	PANASONIC
1	R11	16.9K	RESISTOR; 0402; 16.9K OHM; 1%; 100PPM; 0.1W; THICK FILM	-55 ° TO +155 °	CRCW040216K9FK	VISHAY DALE
2	R12	4.7	RESISTOR; 0402; 4.7 OHM; 5%; 200PPM; 0.10W; THICK FILM	-55 ° TO +155 °	ERJ-2GEJ4R7X	PANASONIC
1	U1	—	MAX20059 72V, 1A, Automotive Synchronous Step-Down DC-DC Converter	-40 ° TO +125 °	MAX20059ATCA/VY+	MAXIM
1	—	—	PCB: MAX20059 EVKIT	—	MAX20059EVKIT#	MAXIM
10	EN/UVLO, MODE/ILIM, PGND, PGND2, RESETB, RT/SYNC_IN, SGND, SGND2, VIN, VOUT	MAXIMPAD	EVK KIT PARTS; MAXIM PAD; WIRE; NATURAL; SOLID; WEICO WIRE; SOFT DRAWN BUS TYPE-S; 20AWG	N/A	9020 BUSS	WEICO WIRE

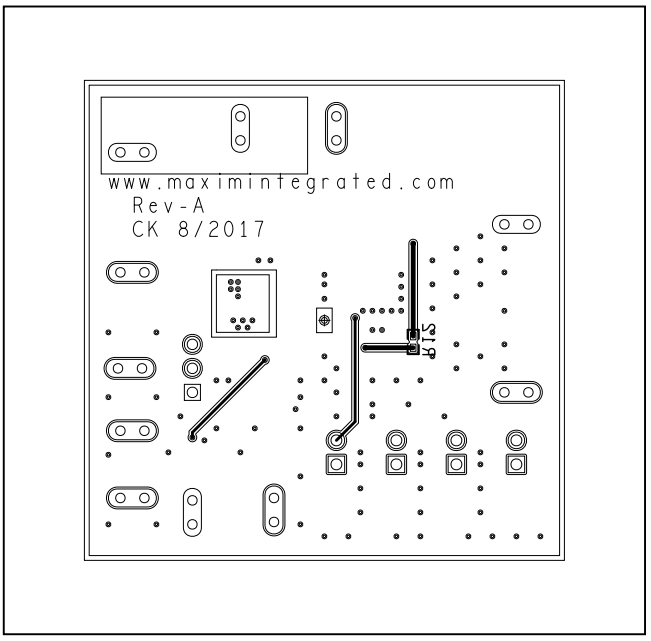
MAX20059 EV Kit Schematic



MAX20059 EV Kit PCB Layouts



MAX20059 EV Kit Component Placement Guide—Top



MAX20059 EV Kit Component Placement Guide—Bottom

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	10/18	Initial release	—

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