MAX20058 Evaluation Kit

Evaluates: MAX20058

General Description

The MAX20058 EV kit is a proven design to evaluate the MAX20058 high-efficiency, high-voltage, synchronous step-down DC-DC converter in a TDFN package. The EV kit is optimized to generate a 5V output at load currents up to 1A from a 24V 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 under-voltage lockout, adjustable soft-start, adjustable switching frequency, adjustable current limit, open-drain $\overline{\text{RESET}}$ signal, and external frequency synchronization.

Features

- Operates from 6.5V to 60V at 24V 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
- Fully Assembled and Tested

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

Quick Start

Required Equipment

- MAX20058 EV kit
- Adjustable DC power supply
- Digital multimeter (DMM)
- Electronic load

Procedure

The EV kit is fully assembled and tested. Use the following 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 at a voltage to 24V. 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 pad on the EV kit. Then, connect the negative lead to the neighboring PGND PCB pad.
5) Connect the positive terminal of the electronic load to VOUT PCB pad. Then, connect the negative lead to the neighboring PGND2 PCB pad.
6) Enable the DC power supply.
7) Using the DMM, verify that the voltage across VOUT and PGND2 PCB pads is 5V.
8) Turn on the electronic load.
9) Verify that the voltage across VOUT1 and PGND PCB pads is still close to 5V after load regulation.
10) Turn off the electronic load.
11) Turn off the power supply.

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Detailed Description

The MAX20058 5V output EV kit provides a proven design to evaluate the MAX20058 high-efficiency, high-voltage, synchronous step-down DC-DC converter. The EV kit generates 5V at load currents up to 1A from a 6.5V to 60V 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 JU1 to enable the output at a desired input voltage. The RT/SYNC PCB pad allows an external clock to synchronize the device while the IC is set to FPWM through JU4 or JU5. A $\overline{\text{RESET}}$ PCB pad is available for monitoring when the converter output is in regulation.

Soft-Start Input (SS)

The device 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 EV kit) programs the soft-start time for the corresponding output voltage. The selected output capacitance (CSEL) and the output voltage (VOUT) 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.

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.*

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 3 for JU1 settings.

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

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

where VINU is the input voltage at which the MAX20058 is required to turn ON and R1 is in Ω. 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

The following table 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 power supply is reset or the IC has been disabled.

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. The resistor R4 sets the switching frequency of the part, and the EV kit is defaulted to 400kHz (105Ω). The following table shows some common frequencies and their corresponding resistor values.

The internal oscillator of the MAX20058 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
1800	23.3

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 where inductive ringing can cause the output voltage to go temporarily negative, an external R-C filter is implemented in the design. A 4.7Ω (R12) and 0.1µF (C7) are recommended.

For applications where VOUT is less than 4.5V, EXTVCC should be shorted to ground and the R-C 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 on the IC data sheet, Table 4 summarizes suggested ideal inductor values for common configurations, calculated at 0.3 inductor-to-current ratio for common VIN, VOUT, and switching frequency combinations.

Table 4. Recommended Inductor for Common Operating Conditions

NOMINAL VIN (V)	VOUT (V)	SWITCHING FREQUENCY (kHz)	RECOMMENDED INDUCTOR (µH)
48	12	400	75
48	5	400	37
24	12	400	50
24	12	1800	12
24	5	400	33
24	3.3	400	24

Ordering Information

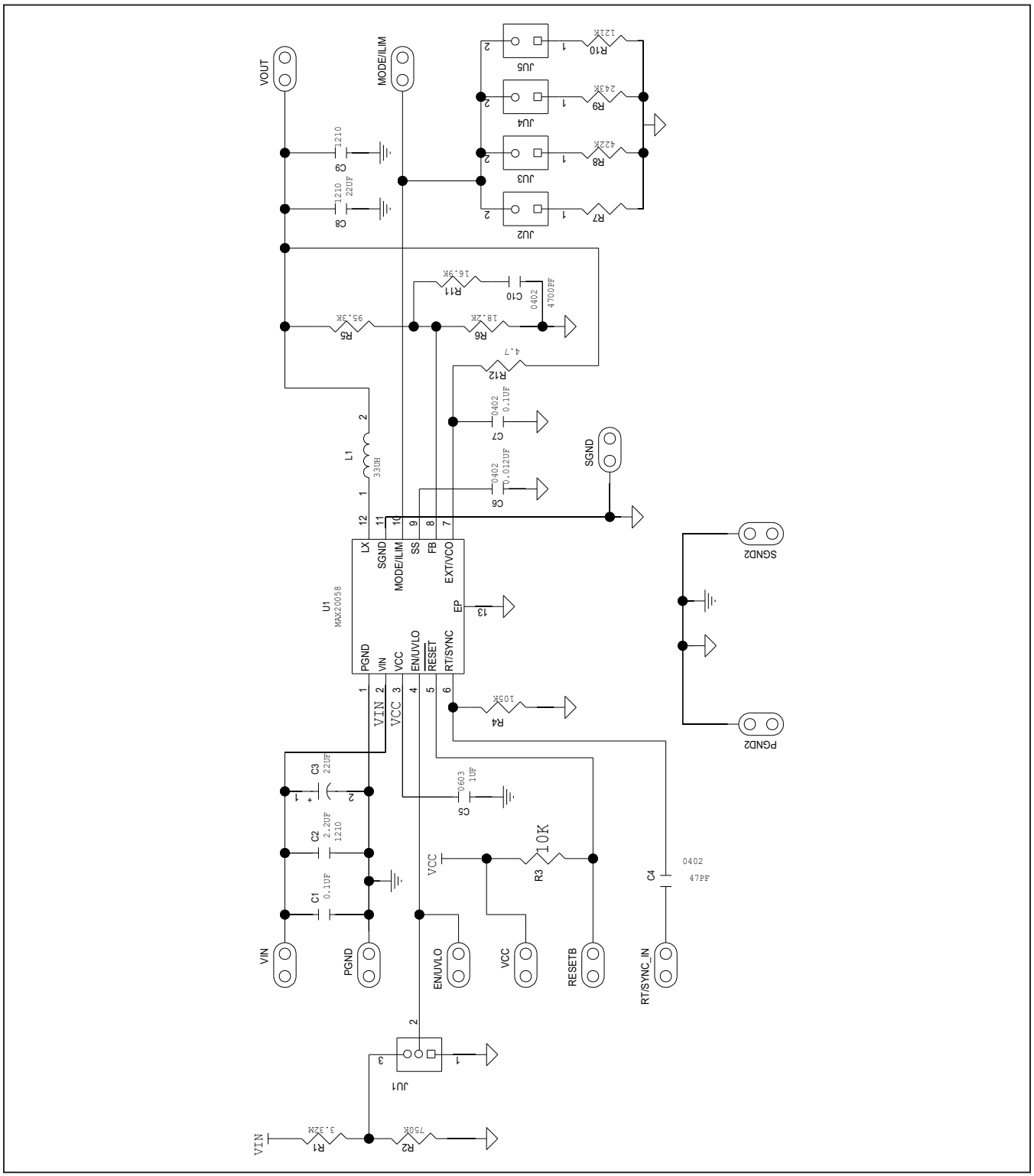
PART	TYPE
MAX20058EVKIT#	EV kit

#Denotes RoHS compliant.

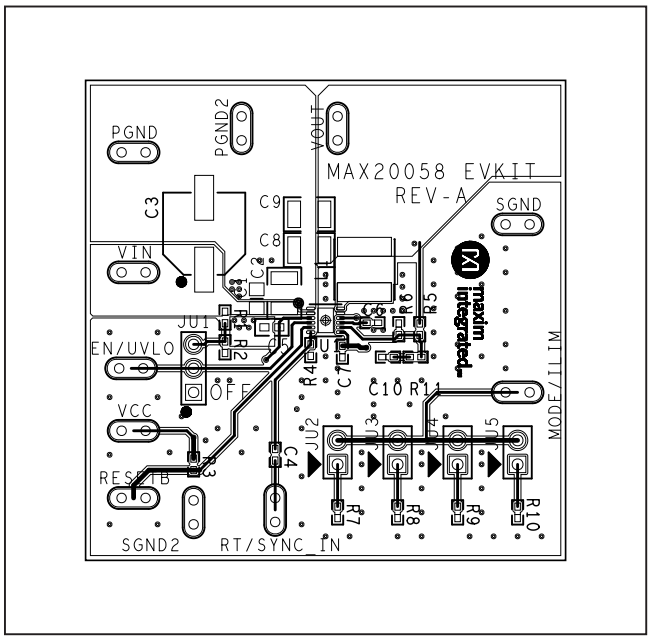
MAX20058 EV Kit Bill of Materials

ITEM	QTY	REF DES	MFG PART #	MANUFACTURER	VALUE	DESCRIPTION	TEMP_RANGE
1	1	C1	CGA4J2X7R2A104K125AA	TDK	0.1UF	CAPACITOR; SMT (0805); CERAMIC CHIP; 0.1UF; 100V; TOL = 10%; TG = -55°C TO +125°C; TC = X7R; AUTO	-55 °C TO +125 °C
2	1	C2	GRM32ER72A225KA35; CGA6N3X7R2A225K230	MURATA/TDK	2.2UF	CAPACITOR; SMT (1210); CERAMIC CHIP; 2.2UF; 100V; TOL = 10%; MODEL = GRM SERIES; TG = -55°C to +125°C; TC = X7R	-55 °C TO +125 °C
3	1	C3	EEE-TG2A220UP	PANASONIC	22UF	CAPACITOR; SMT (CASE_F); ALUMINUM-ELECTROLYTIC; 22UF; 100V; TOL = 20%; MODEL = TG SERIES; TG = -40 °C TO +125 °C	-40 °C TO +125 °C
4	1	C4	CGA2B2C0G1H470J	MURATA	47PF	CAPACITOR; SMT (0402); CERAMIC CHIP; 47PF; 50V; TOL = 5%; TG = -55°C TO +125°C; TC=C0G; AUTO	-55 °C TO +125 °C
5	1	C5	GCM188R71C105KA64; CGA3E1X7R1C105K080AC	MURATA; TDK	1UF	CAPACITOR; SMT (0603); CERAMIC CHIP; 1UF; 16V; TOL = 10%; TG = -55°C TO +125°C; TC = X7R; AUTO	-55 °C TO +125 °C
6	1	C6	GRM155R71H123KA12	MURATA	0.012UF	CAPACITOR; SMT (0402); CERAMIC CHIP; 0.012UF; 50V; TOL = 10%; TG = -55°C TO +125°C; TC = X7R	-55 °C TO +125 °C
7	1	C7	CGA2B3X7R1V104K050BB	TDK	0.1UF	CAPACITOR; SMT (0402); CERAMIC CHIP; 0.1UF; 35V; TOL = 10%; TG = -55°C TO +125°C; TC = X7R; AUTO	-55 °C TO +125 °C
8	2	C8	CGA6P1X7R1C226M	TDK	22UF	CAPACITOR; SMT (1210); CERAMIC CHIP; 22UF ; 16V; TOL = 20%; TG = -55°C TO +125°C; TC = X7R; AUTO	-55 °C TO +125 °C
9	1	C10	C0402C472J5RAC	KEMET	4700PF	CAPACITOR; SMT; 0402; CERAMIC; 4700pF; 50V; 5%; X7R; -55°C to +125°C; 0 ±15%°C MAX.	-55°C to +125°C
11	1	JU1	PEC03SAAN	SULLINS	PEC03SAAN	CONNECTOR; MALE; THROUGH HOLE; BREAKAWAY; STRAIGHT; 3PINS; NOTE: SET TO OBSOLETE DUE TO FOOTPRINT UPDATE	-65 °C TO +125 °C
12	4	JU2,JU3, JU4,JU5	TSW-102-07-T-S	SAMTEC	TSW-102-07-T-S	CONNECTOR; THROUGH HOLE; TSW SERIES; SINGLE ROW; STRAIGHT; 2PINS; -55°C TO +105°C	-55 °C TO +125 °C
13	1	L1	74404064330	WURTH ELECTRONICS INC	33UH	INDUCTOR; SMT; FERRITE CORE; 33UH; TOL = ±20%; 1.45A	-40 °C TO +125 °C
14	1	R1	CRCW04023M32FK	VISHAY DALE	3.32M	RESISTOR; 0402; 3.32MΩ; 1%; 100PPM; 0.063W; METAL FILM	-55 °C TO +155 °C
15	1	R2	CRCW0402750KFK	VISHAY DALE	750K	RESISTOR; 0402; 750KΩ; 1%; 100PPM; 0.063W; METAL FILM	-55 °C TO +155 °C
16	1	R3	ERJ-2RKF1002	PANASONIC	10K	RESISTOR; 0402; 10KΩ; 1%; 100PPM; 0.10W; THICK FILM	-55 °C TO +155 °C
17	1	R4	CRCW0402105KFK	VISHAY DALE	105K	RESISTOR; 0402; 105KΩ; 1%; 100PPM; 0.063W ; THICK FILM	-55 °C TO +155 °C
18	1	R5	CRCW040295K3FK	VISHAY DALE	95.3K	RESISTOR; 0402; 95.3KΩ; 1%; 100PPM; 0.0625W; THICK FILM	-55 °C TO +155 °C
19	1	R6	CR0402-16W-1822FT; CRCW040218K2FK	VENKEL LTD./ VISHAY DALE	18.2K	RESISTOR; 0402; 18.2KΩ; 1%; 100PPM; 0.063W; THICK FILM	-55 °C TO +155 °C
21	1	R8	CRCW0402422KFK	VISHAY DALE	422K	RESISTOR; 0402; 422KΩ; 1%; 100PPM; 0.063W; METAL FILM	-55 °C TO +155 °C
22	1	R9	ERJ-2RKF2433X	PANASONIC	243K	RESISTOR; 0402; 243KΩ; 1%; 100PPM; 0.10W; THICK FILM	-55 °C TO +125 °C
23	1	R10	ERJ-2RKF1213	PANASONIC	121K	RESISTOR; 0402; 121KΩ; 1%; 100PPM; 0.1W; THICK FILM	-55 °C TO +155 °C
24	1	R11	CRCW040216K9FK	VISHAY DALE	16.9K	RESISTOR; 0402; 16.9KΩ; 1%; 100PPM; 0.1W; THICK FILM	-55 °C TO +155 °C
20	2	R12	ERJ-2GEJ4R7X	PANASONIC	4.7	RESISTOR; 0402; 4.7Ω; 5%; 200PPM; 0.10W; THICK FILM	-55 °C TO +155 °C
25	1	U1	MAX20058ATCA/VY+	MAXIM	MAX20058	60V, 1A, Automotive Synchronous Step-Down DC-DC Converter	-40 °C TO +125 °C
10	10	EN/UVLO, MODE/ILIM,PGND, PGND2,RESETB, RT/SYNC_IN, SGND,SGND2, VIN, VOUT	9020 BUSS	WEICO WIRE	MAXIMPAD	EVK KIT PARTS; MAXIM PAD; WIRE; NATURAL; SOLID; WEICO WIRE; SOFT DRAWN BUS TYPE-S; 20AWG	N/A

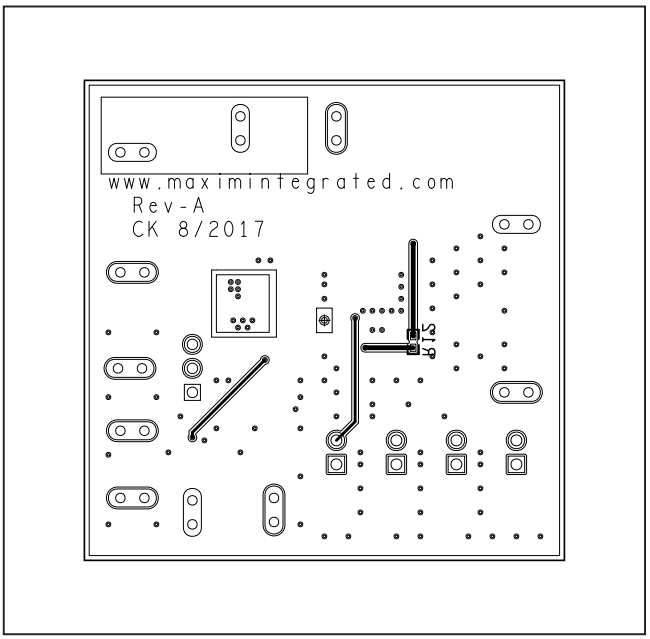
MAX20058 EV Schematic



MAX20058 EV PCB Layout



Component Placement Guide—Top



Component Placement Guide—Bottom

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	6/18	Initial release	—

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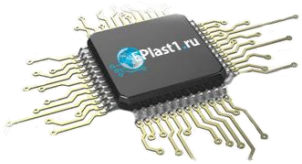

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