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MAX8822 Evaluation Kit

Evaluates: MAX8822

General Description

The MAX8822 evaluation kit (EV kit) is a fully assembled and tested printed-circuit board (PCB) that demonstrates the MAX8822 ultra-efficient negative charge-pump LED driver with dual LDOs. The MAX8822 drives up to four white LEDs (WLEDs) for backlighting and contains two 200mA, low-noise, high power-supply-rejection-ratio (PSRR) LDOs to power external camera modules or other loads. The EV kit includes a MAXQ2000 microcontroller circuit that provides the serial-pulse control necessary to adjust WLED brightness and LDO output voltages. Through the MAXQ2000, WLED brightness levels are sequentially incremented/decremented between 0.1mA and 24mA and shut down by pushbutton controls. Sixteen different LDO output-voltage combinations (from off to 3.3V) are selected by DIP-switch positions and latched by a pushbutton. The MAX8822 IC includes soft-start, WLED and LDO short-circuit protection, and thermal shutdown.

Features

♦ **Powers Up to 4 White LEDs**
   Independent Adaptive Voltage Supply for Each LED
   24mA to 0.1mA Dimming Range
   1% (typ) Current Accuracy and 0.3% (typ) Current Matching

♦ **Dual 200mA Low-Noise, High PSRR LDOs**
   16 Selectable LDO Output Voltage Combinations from OFF Up to 3.3V

♦ **MAXQ2000 Microprocessor Circuit for LED and LDO Serial-Pulse Control**
   Sequential UP/DOWN LED Dimming Pushbutton Control
   DIP-Selectable LDO Output Voltages

♦ **2.7V to 5.5V Input Range**

♦ **Selectable Microprocessor Circuit Power Input (IN1, IN2)**

♦ **WLED and LDO Short-Circuit and Thermal Protection**

♦ **Small, Low-Profile Components**

♦ **Lead-Free and RoHS-Compliant**

♦ **Fully Assembled and Tested**

Ordering Information

PART	TYPE
MAX8822EVKIT+	EV Kit

+Denotes lead-free and RoHS-compliant.

Component List

DESIGNATION	QTY	DESCRIPTION
C1	1	4.7µF ±10%, 6.3V X5R ceramic capacitor (0603) TDK C1608X5R0J475K or equivalent
C2, C8, C10	3	0.1µF ±10%, 10V X5R ceramic capacitors (0402) TDK C1005X5R1A104K or equivalent
C3, C4, C6, C7, C12, C13	6	1µF ±10%, 6.3V X5R ceramic capacitors (0402) TDK C1005X5R0J105K Murata GRM155R60J105K or equivalent
C5	1	2.2µF ±10%, 6.3V X5R ceramic capacitor (0603) TDK C1608X5R0J225K Murata GRM185R60J225K or equivalent

DESIGNATION	QTY	DESCRIPTION
C9, C11	2	10pF ±0.5pF, 50V C0G ceramic capacitors (0402) TDK C1005C0G1H100D or equivalent
D1–D4	4	White LEDs
D5, D6, D7	3	Green LEDs
J1	0	Not installed, 10-pin (2 x 5) header, 0.1in spacing Sullins PEC36DAAN (72-pin strip, cut to size as needed) Digi-Key S2012E-36-ND
JU1, JU2	2	2-pin headers Sullins PEC36SAAN (36-pin strip, cut to size as needed) Digi-Key S1012E-02-ND

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MAX8822 Evaluation Kit

Component List (continued)

DESIGNATION	QTY	DESCRIPTION
JU3	1	3-pin header Sullins PEC36SAAN (36-pin strip, cut to size as needed) Digi-Key S1012E-02-ND
JU4–JU8	0	Not installed, PCB connection—shorted (0402)
R1, R2	2	200kΩ ±5% resistors (0402), lead free
R3, R4, R5	3	220Ω ±5% resistors (0402), lead free
S1, S2, S3	3	Momentary pushbutton switches Panasonic EVQ-PHP03T
S4	1	4-position DIP switch CTS 206-4 or equivalent
TP1–TP4	0	Not installed, test points

DESIGNATION	QTY	DESCRIPTION
U1	1	Ultra-efficient negative charge-pump LED driver with dual LDOs (16-pin thin QFN-EP, 3mm x 3mm) Maxim MAX8822ETE+ (Top Mark: AFW)
U2	1	Low-power LCD microcontroller (68-pin QFN, 10mm x 10mm) Maxim MAXQ2000-RAX+
U3	1	Ultra-low-noise, high PSRR, LDO linear regulator (5-pin SC70) Maxim MAX8511EXK25+
Y1	1	20MHz crystal Vishay XT9S20ANA20M, lead free Citizen HC49US20.000MABJ-U
Y2	0	Not installed, crystal (1206)
—	3	Shunts, 2 position
—	1	PCB: MAX8822 Evaluation Kit+

Component Suppliers

SUPPLIER	PHONE	WEBSITE
Citizen America Corp.	310-781-1460	www.citizencrystal.com
CTS Corp.	818-842-7277	www.ctscorp.com
Digi-Key Corp.	800-344-4539	www.digikey.com
Murata Mfg. Co., Ltd.	770-436-1300	www.murata.com
Nichia Corp.	248-349-9800	www.nichia.com
Panasonic Corp.	714-373-7939	www.panasonic.com
Sullins Electronics	760-744-0125	www.sullinselectronics.com
TDK Corp.	847-803-6100	www.component.tdk.com
Vishay	402-563-6866	www.vishay.com

Note: Indicate that you are using the MAX8822 when contacting these component suppliers.

Quick Start

Required Equipment

Before beginning, the following equipment is needed:

- One variable-voltage DC power supply capable of supplying 2.7V to 5.5V at 1A
- Two digital voltmeters (DVMs)
- Two 200mA dummy loads
- One DVM to evaluate the inverting charge-pump turn-on (optional)

Procedure

The MAX8822 EV kit is fully assembled and tested. Follow the steps below to verify operation of the MAX8822 EV kit circuit (see Figure 1). **Caution: Do not turn on the power supply until all connections are completed.**

1) Ensure that a shunt is installed on jumpers JU1 and JU2 located on the EV kit.

2) Ensure that a shunt is installed between pins 1-2 of jumper JU3 located on the EV kit.

3) Turn the power supply on and preset to 4.2V.

4) Turn off the power supply. **Do not turn on the power supply until all connections are completed.**

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5) Configure connections according to Figure 1.

   a) Connect the positive terminal of the power supply to the IN1 pad located on the EV kit. Connect the negative terminal of the power supply to a GND pad located on the EV kit.

   b) Connect the positive terminal of a DVM to the LDO1 pad on the EV kit. Connect the ground terminal of that DVM to a GND pad located on the EV kit. This is the LDO1 DVM.

   c) Connect the positive terminal of the other DVM to the LDO2 pad on the EV kit. Connect the ground terminal of that DVM to a GND pad located on the EV kit. This is the LDO2 DVM.

   d) For optional charge-pump evaluation of step 15, connect the positive terminal of a DVM to the NEG pad. Connect the negative terminal of that DVM to a GND pad. This is the NEG DVM.

6) Turn on the power supply. Verify that the WLEDs are off. Verify that the LDO1 and LDO2 DVMs indicate 0V.

7) Press the UP pushbutton (S1) once. Verify that the WLEDs are illuminated at low brightness and that the green LED (D6) turns on indicating the WLEDs are enabled.

8) Press S1 a few more times. WLED brightness increases according to the dimming scheme shown in Table 1.

9) Press the DOWN pushbutton (S2). WLED brightness decreases according to the dimming scheme shown in Table 1.

10) Place the LEDs in shutdown mode by repeatedly pressing S1 or S2 until the WLEDs turn off. Verify that the green LED (D6) turns off.

11) Set the LDO SEL DIP switch (S4) to 0000. Press the LDO SET button (S3). Verify that the LDO1 DVM indicates approximately 2.8V and the LDO2 DVM indicates approximately 1.2V. Verify that the green LEDs (D7 and D5) turn on indicating that LDO1 and LDO2 are enabled, respectively.

12) Connect a 200mA load to LDO1. Verify that the LDO1 DVM indicates approximately 2.8V.

13) Connect a 200mA load to LDO2. Verify that the LDO2 DVM indicates approximately 1.2V.

14) Set DIP switch S4 to 1111. Press the LDO SET button (S3). Verify that both LDOs turn off. Verify that the LDO1 DVM and the LDO2 DVM indicate 0V. Verify that the green LEDs (D7 and D5) turn off.

15) Optional: To evaluate the inverting charge-pump turn-on, perform the following procedure:

   a) Set the power supply to 4.2V.

   b) Program the LEDs for full brightness by pressing the UP/DOWN pushbuttons.

   c) Verify that the NEG voltmeter indicates 0V.

   d) Reduce the power-supply voltage to 3V.

   e) Verify that the NEG DVM reads a negative voltage, indicating that the charge pump is on.

   f) Increase the power-supply voltage to 4.2V.

   g) Verify that the NEG DVM reads 0V, indicating that the charge pump is now off.
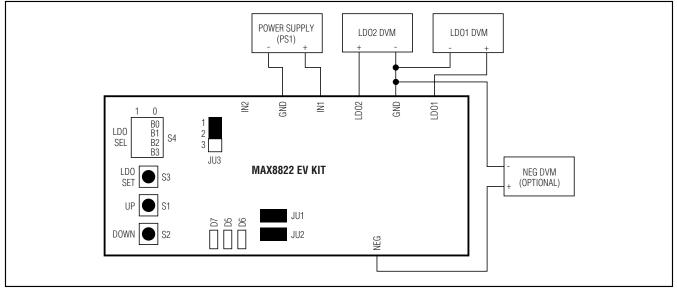

Figure 1. MAX8822 EV Kit Quick-Start Setup

MAX8822 Evaluation Kit

Detailed Description

The MAX8822 evaluation kit (EV kit) is a fully assembled and tested PCB that demonstrates the MAX8822 ultra-efficient negative charge-pump LED driver with dual LDOs. The MAX8822 drives up to four white LEDs (WLEDs) for backlighting and contains two 200mA, high power-supply-rejection-ratio (PSRR) LDOs to power external camera modules or other loads. The EV kit includes a MAXQ2000 microcontroller circuit that provides the serial-pulse control signals necessary to adjust WLED brightness and LDO output voltages. Through the MAXQ2000, WLED brightness levels are sequentially incremented/decremented between 0.1mA and 24mA and shut down by UP/DOWN pushbutton controls. Sixteen different LDO output-voltage combinations (from off to 3.3V) are selected by DIP-switch positions and latched by a pushbutton. The EV kit includes two jumpers (JU1, JU2) to manually place the WLED regulators and LDOs in shutdown mode or for configuring the WLED regulators and LDO1/LDO2 for externally supplied serial-pulse control. The MAX8822 IC includes soft-start, WLED and LDO short-circuit protection, and thermal shutdown.

LED Dimming Control

The MAX8822 EV kit utilizes a MAXQ2000 microcontroller to implement serial-pulse WLED dimming control, programming the WLED current from 0.1mA to 24mA and to place the LED regulators in shutdown mode. (Refer to the *LED Dimming Control* section of the MAX8822 IC data sheet for more details on serial-pulse dimming control.) The microcontroller uses the UP and DOWN pushbuttons (S1 and S2) to increment and decrement the WLED current in a sequential manner, according to the dimming scheme displayed in Table 1. Upon each UP/DOWN pushbutton event, the microcontroller sends the required number of serial pulses to the MAX8822 ENLED input to program the WLED current to the desired value. WLED brightness is incremented from 0.1mA to 24mA in 31 UP button presses with shutdown occurring on the 32nd press. WLED brightness is decremented from 24mA to 0.1mA in 31 DOWN button presses with shutdown occurring on the 32nd press. A green LED (D6) is illuminated when the microcontroller has programmed the WLEDS to an on state, corresponding to a V_{ENLED} high condition.

Table 1. LED Dimming Scheme Using UP/DOWN Pushbutton Control

UP (S1) PRESS COUNT*	DOWN (S2) PRESS COUNT*	ENLED PULSE COUNT	PROGRAMMED LED_ CURRENT (mA)	UP (S1) PRESS COUNT*	DOWN (S2) PRESS COUNT*	ENLED PULSE COUNT	PROGRAMMED LED_ CURRENT (mA)
32	0	0**	Shutdown	15	17	17	2.8
31	1	1	24.0	14	18	18	2.4
30	2	2	22.4	13	19	19	2.0
29	3	3	20.8	12	20	20	1.6
28	4	4	19.2	11	21	21	1.4
27	5	5	17.6	10	22	22	1.2
26	6	6	16.0	9	23	23	1.0
25	7	7	14.4	8	24	24	0.8
24	8	8	12.8	7	25	25	0.7
23	9	9	11.2	6	26	26	0.6
22	10	10	9.6	5	27	27	0.5
21	11	11	8.0	4	28	28	0.4
20	12	12	6.4	3	29	29	0.3
19	13	13	5.6	2	30	30	0.2
18	14	14	4.8	1	31	31	0.1
17	15	15	4.0	0	32	0**	Shutdown
16	16	16	3.2	—	—	—	—

Referenced from LED shutdown (V_{ENLED} = 0V).

**ENLED is held low.*

4 _____

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To alternatively place the WLEDs in shutdown mode, remove the shunt from jumper JU1. This pulls ENLED to GND, fulfilling the requirements to shut down the MAX8822 WLED current regulators. Placing the WLEDs in shutdown mode in this manner overrides the microcontroller, leaving D6 illuminated if the WLEDs were previously on. To bring the WLEDs out of manual shutdown, replace the shunt on jumper JU1. If D6 is illuminated (indicating that ENLED is high), WLED current is programmed to 24mA. Sequential WLED pushbutton control using the UP/DOWN pushbuttons is resumed from the last WLED current value programmed prior to manual shutdown.

To control the WLED brightness using an external serial-pulse signal, remove the shunt from jumper JU1. Apply the external serial-pulse-control signal between the ENLED pad and GND. Refer to the MAX8822 IC data sheet for WLED dimming serial-pulse-control requirements.

LDO_ Voltage Control

The MAX8822 EV kit utilizes a MAXQ2000 microcontroller to implement serial-pulse LDO voltage control, programming the output voltage of both LDOs in certain combinations from OFF to 3.3V. (Refer to the *LDO1/LDO2 Output Voltage Control* section of the MAX8822 IC data sheet for more details on LDO voltage control.) The microcontroller uses the LDO SEL DIP switch (S4) to select the LDO1/LDO2 output voltages according to the scheme displayed in Table 2. Once S4 is set to the desired DIP binary code (B3–B0), press the LDO SET pushbutton (S3) to program the LDO output voltages. Upon actuating S3, the microcontroller sends the required number of serial pulses to the MAX8822 ENLDO input to program the LDO voltages. Green LEDs (D5 and D7) indicate when LDO2 or LDO1 is programmed to a nonzero output voltage, respectively.

To place both LDOs in shutdown mode, remove the shunt from jumper JU2. This pulls ENLDO to GND, fulfilling the requirements to shut down the MAX8822 LDOs. Placing the LDOs in shutdown mode in this manner overrides the microcontroller, leaving the LDO_ enabled LEDs lit according to the LDO_ status prior to manual shutdown. To bring the LDOs out of manual shutdown, replace the shunt on jumper JU2. If D5 or D7 is illuminated (indicating that ENLDO is high) when replacing JU2, the LDOs are set to the OFF state. The LDO output voltages are then programmed according to the procedure listed above.

To control the LDO_ voltage using an external signal, remove the shunt from jumper JU2. Apply the external serial-pulse control signal to the ENLDO pad. Refer to the MAX8822 IC data sheet for LDO voltage serial-pulse control requirements.

Table 2. LDO1/LDO2 Voltage Control DIP Settings

LDO SEL DIP CODE (B3–B0)	ENLDO PULSE COUNT*	PROGRAMMED LDO1 VOLTAGE**	PROGRAMMED LDO2 VOLTAGE**
0000	1	2.8V	1.2V
0001	2	3.3V	1.2V
0010	3	2.8V	1.5V
0011	4	3.3V	1.5V
0100	5	1.2V	1.8V
0101	6	1.8V	1.8V
0110	7	2.8V	1.8V
0111	8	3.3V	1.8V
1000	9	2.8V	2.8V
1001	10	0V	1.5V
1010	11	0V	1.8V
1011	12	0V	2.8V
1100	13	1.8V	0V
1101	14	2.8V	0V
1110	15	3.3V	0V
1111	16	0V	0V

*Referenced from V_{ENLDO} = high.

**Upon LDO SET (S3) button press.

MAX8822 Evaluation Kit

LDO and LED_ Thermal Shutdown

The MAX8822 includes two thermal-limit circuits that protect the IC from temperatures exceeding +160°C (typ). The first circuit monitors the internal LED_ regulator temperature and shuts down the entire IC when the temperature limit is exceeded. The second circuit monitors both of the internal LDO temperatures and shuts down only the LDOs when the temperature limit is exceeded. The thermal-shutdown condition clears after the temperature has cooled by 20°C (typ) and the LEDs and LDOs turn on with the same settings just prior to thermal shutdown.

Power-Up LED Short Detection and Open-Fault Protection

The MAX8822 contains special circuitry to detect an LED_ short-circuit condition at startup only and disables that current regulator to avoid wasting battery power. If an LED fails short-circuit after startup, that current regulator continues current-regulated operation until IC power is cycled and the short circuit is detected during the subsequent startup.

An open-circuit LED failure drives the voltage on the corresponding LED current regulator input below the switchover threshold, enabling the charge pump.

Customizing the MAX8822 EV Kit

Using Fewer than Four LEDs

As assembled, the MAX8822 EV kit powers four WLEDs, but is configurable to power fewer LEDs. To minimize power consumption, disable any unused current regulator by connecting the unused LED_ input of the MAX8822 to IN1. On the MAX8822 EV kit PCB, this is easily accomplished by shorting the anode and cathode pads of the chosen WLED(s), D1–D4. If an unused LED_ is not connected to IN, the MAX8822 operates as if an open WLED is detected. In this condition, the open-circuit LED_ drives the voltage on the corresponding LED_ output below the switchover threshold, enabling the inverting charge pump.

Measuring WLED Current

The MAX8822 EV kit includes trace jumpers that can be cut so that an ammeter can be placed in series to measure WLED current. To measure total WLED current, cut jumper JU4 and connect an ammeter in series with the pads. To measure individual D1, D2, D3, or D4 currents, cut jumpers JU5, JU6, JU7, or JU8 and place an ammeter in series with the respective jumper pads.

Evaluating Off-Board LEDs

The MAX8822 EV kit is configurable to power off-board LEDs. To power off-board LEDs, perform the following steps:

1) Cut jumper JU5 (or jumper JU6, JU7, or JU8) to remove the D1 (or D2, D3, or D4) on-board WLED from the MAX8822 EV kit circuit.

2) Connect the cathode of the off-board LED to the IC-side pad of jumper JU5 (or jumper JU6, JU7, or JU8).

3) Connect the anode of the off-board LED to IN1.

Powering the MAXQ2000 Circuit from a Separate Supply

The MAX8822 EV kit includes an additional pad to power the MAXQ2000 circuitry using a separate supply. To use a separate supply, perform the following steps:

1) Remove the shunt on jumper JU3.

2) Install the shunt from pins 2-3 on jumper JU3.

3) Connect the positive terminal of a 2.7V to 5.5V alternate supply to the IN2 pad located on the MAX8822 EV kit. Connect the ground terminal of the alternate supply to a GND pad located on the MAX8822 EV kit.
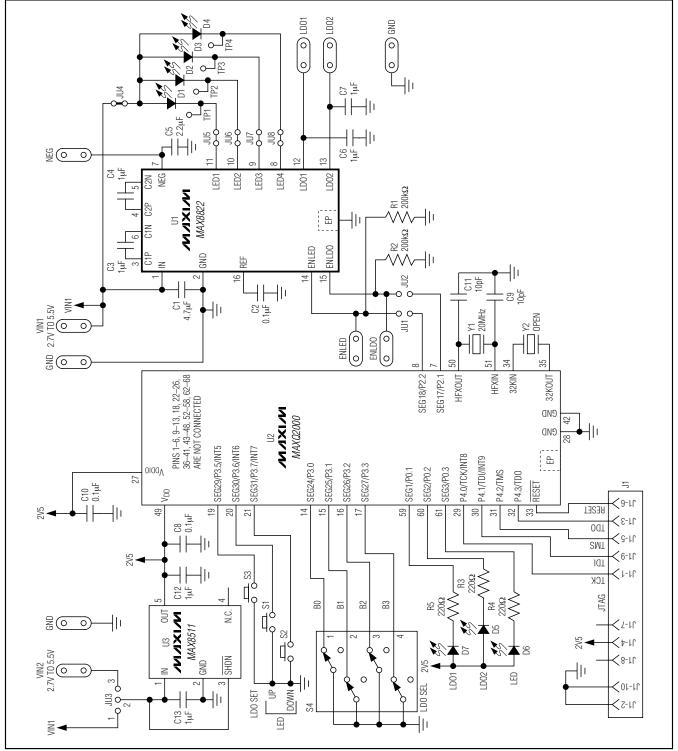
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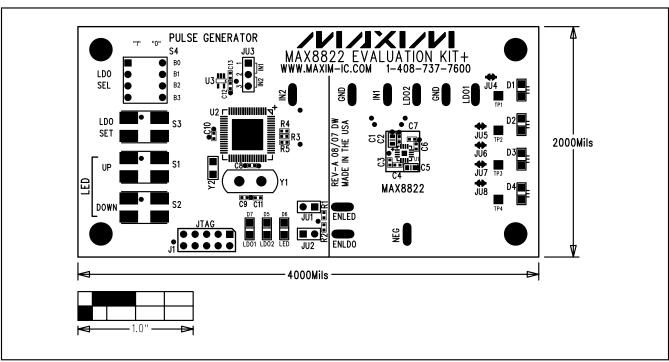Figure 2. MAX8822 EV Kit Schematic

MAX8822 Evaluation Kit

Figure 3. MAX8822 EV Kit Component Placement Guide—Top Silkscreen
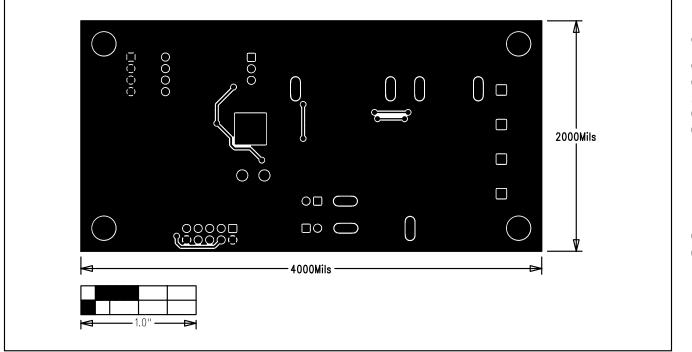

Figure 4. MAX8822 EV Kit PCB Layout—Component Side

Figure 5. MAX8822 EV Kit PCB Layout—Solder Side