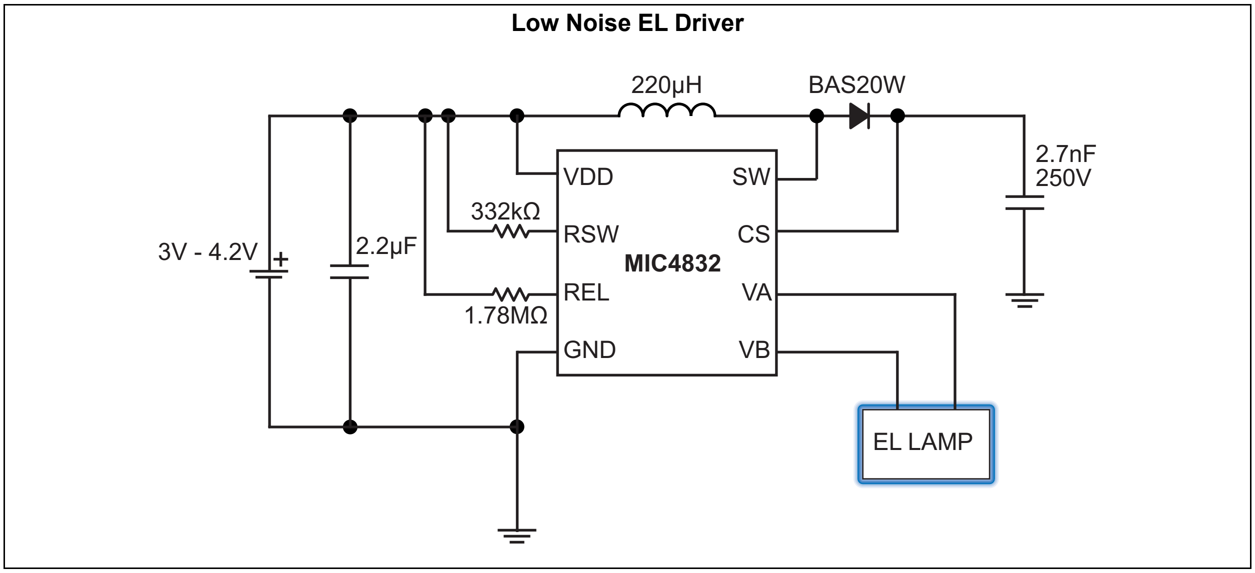
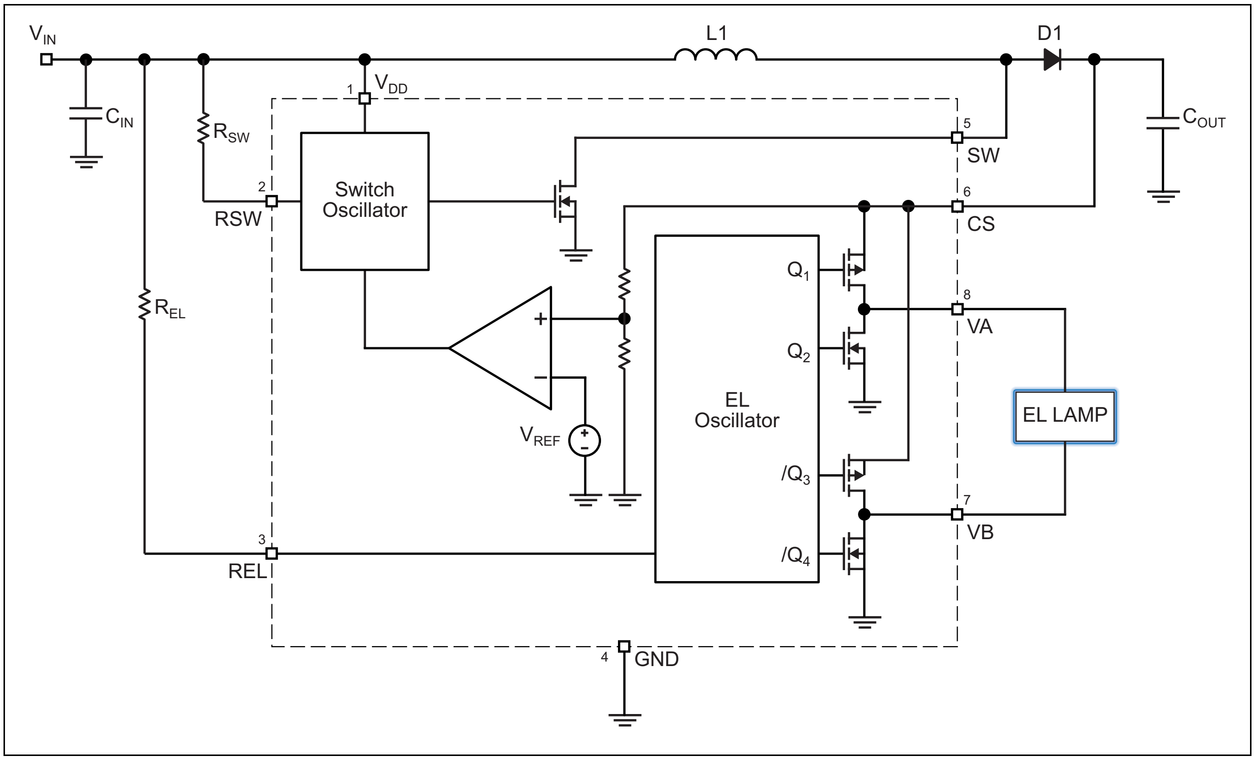
Typical Application Circuit



Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Supply Voltage (V_{DD})	–0.5V to +6V
Output Voltage (V_{CS})	–0.5V to +120V
EL Lamp Terminals (V_A, V_B)	V_{CS} + 3V
Switch Voltage (V_{SW})	–0.5V to +120V
Frequency Control Voltage (V_{RSW}, V_{REL})	–0.5V to (V_{DD} + 0.3V)
ESD Rating (Note 1)	2 kV

Operating Ratings ††

Supply Voltage (V_{DD})	+1.8V to +5.5V
Lamp Drive Frequency (f_{EL})	60 Hz to 1000 Hz
Switching Frequency (f_{SW})	65 kHz to 250 kHz

† Notice: Exceeding the absolute maximum ratings may damage the device.

†† Notice: The device is not guaranteed to function outside its operating ratings.

Note 1: Devices are ESD sensitive. Handling precautions recommended. Human body model, 1.5 kΩ in series with 100 pF.

ELECTRICAL CHARACTERISTICS

Electrical Characteristics: $V_{IN} = V_{DD} = 3.0V$, $R_{SW} = 338$ kΩ, $R_{EL} = 1.78$ MΩ. $T_A = +25°C$ unless otherwise specified. **Bold** values valid for $–40°C \le T_A \le +85°C$. Note 1

Parameter	Sym.	Min.	Typ.	Max.	Units	Conditions
On-Resistance	$R_{DS(ON)}$	—	3.8	7	Ω	I_{SW} = 100 mA
CS Voltage Variation	V_{CS}	**91**	105	**119**	V	—
Enable Input Low Voltage (Turn-Off)	V_{EN-L}	—	—	0.5	V	V_{DD} = 1.8V to 5.5V
Enable Input High Voltage (Turn-On)	V_{EN-H}	V_{DD} – 0.5	—	—	V	V_{DD} = 1.8V to 5.5V
Shutdown Current	I_{SD}	—	0.01	**0.5**	µA	R_{SW} Resistor = Low; R_{EL} Resistor = Low; V_{DD} = 5.5V
Input Supply Current	I_{VDD}	—	45	**75**	µA	R_{SW} Resistor = High; R_{EL} Resistor = High; V_{CS} = 110V; V_A, V_B = OPEN
Input Current Including Inductor	I_{CS}	—	24	—	mA	$V_{IN} = V_{DD}$ = 3.2V; R_{SW} = 338 kΩ, R_{EL} = 1.78 MΩ; L = 220 µH; R_{OUT} = 10 kΩ; Lamp = 2 in^2
$V_A – V_B$ Output Drive Frequency	f_{EL}	158	200	242	Hz	R_{EL} = 1.78 MΩ
Switching Transistor Frequency	f_{SW}	90	112	134	kHz	R_{SW} = 338 kΩ
Switching Transistor Duty Cycle	D	—	90	—	%	—

Note 1: Specification for packaged product only.

TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Storage Temperature Range	T_S	–65	—	+150	°C	—
Ambient Temperature Range	T_A	–40	—	+85	°C	—
Package Thermal Resistance						
Thermal Resistance 8-Lead DFN	θ_{JA}	—	63	—	°C/W	—
Thermal Resistance MSOP-8	θ_{JA}	—	206	—	°C/W	—

Note 1: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air (i.e., T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum +125°C rating. Sustained junction temperatures above +125°C can impact the device reliability.

2.0 TYPICAL PERFORMANCE CURVES

Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

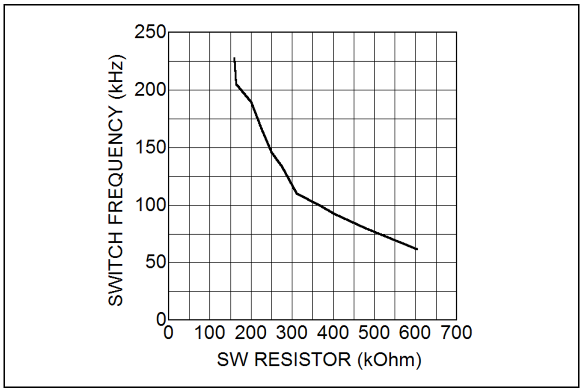


FIGURE 2-1: *Switching Frequency vs. SW Resistor.*

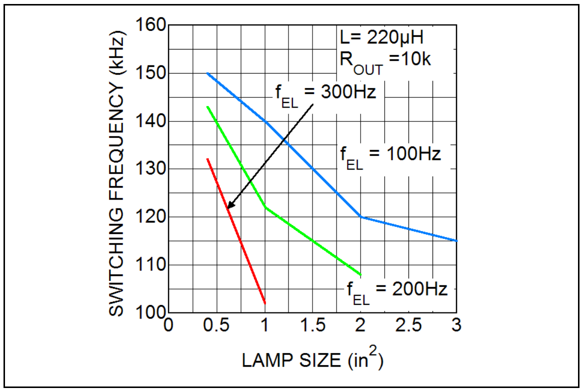


FIGURE 2-4: *Switching Frequency vs. Lamp Size.*

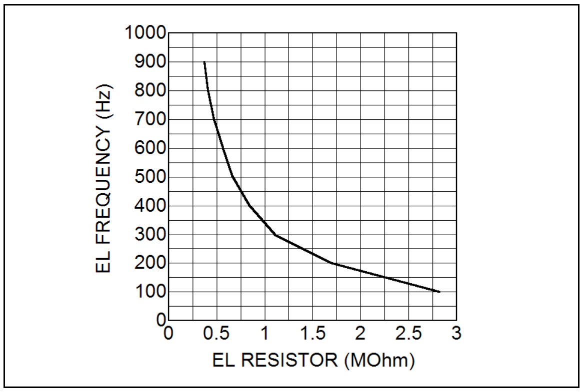


FIGURE 2-2: *EL Frequency vs. EL Resistor.*

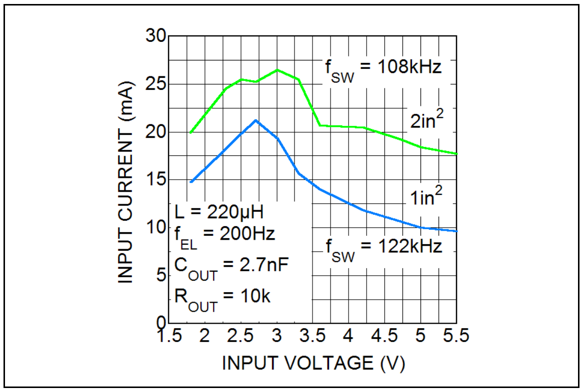


FIGURE 2-5: *Total Input Current vs. Input Voltage.*

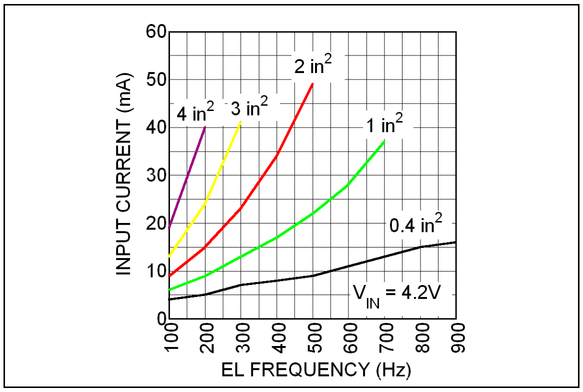


FIGURE 2-3: *Input Current vs. EL Frequency.*

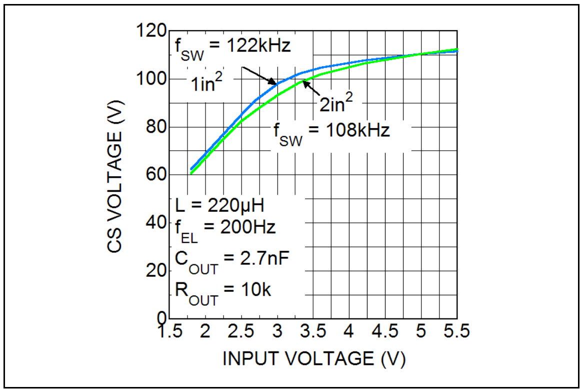


FIGURE 2-6: *Peak CS Voltage vs. Input Voltage.*

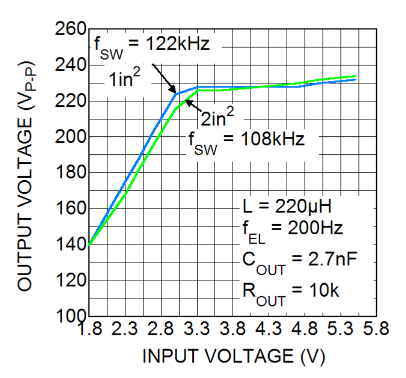


FIGURE 2-7: *Peak Output Voltage vs. Input Voltage.*

3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 3-1.

TABLE 3-1: PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1	VDD	Supply (Input): 1.8V to 5.5V for internal circuitry.
2	RSW	Switch Resistor (External Component): Set switch frequency of the internal power MOSFET by connecting an external resistor to VDD. Connecting the external resistor to GND disables the switch oscillator and shuts down the device.
3	REL	EL Resistor (External Component): Set EL frequency of the internal H-Bridge driver by connecting an external resistor to VDD. Connecting the external resistor to GND disables the EL oscillator.
4	GND	Ground.
5	SW	Switch Node (Input): Internal high-voltage power MOSFET drain.
6	CS	Regulated Boost Output (External Component): Connect to the output capacitor of the boost regulator and connect to the cathode of the diode.
7	VB	EL Output: Connect to one end of the EL lamp. Polarity is not important.
8	VA	EL Output: Connect to one end of the EL lamp. Polarity is not important.

4.0 FUNCTIONAL DESCRIPTION

4.1 Overview

The MIC4832 is a high-voltage EL driver with an AC output voltage of 220V peak-to-peak that's capable of driving EL lamps up to 3 in^2. Input supply current for the MIC4832 is typically 45 µA, reducing to 10 nA in shutdown. The high voltage EL driver has two internal oscillators to control the switching MOSFET and the H-Bridge driver. Both of the internal oscillators' frequencies can be individually programmed through the external resistors to maximize the efficiency and the brightness of the EL lamp.

4.2 Regulation

Referring to the Functional Block Diagram, initially power is applied to V_{DD}. The internal feedback voltage is less than the reference voltage, causing the internal comparator to go high, which then enables the switching MOSFET's oscillator. When the switching MOSFET turns on, current flows through the inductor and flows into the switch. The switching MOSFET will typically turn on for 90% of the switching period. During the on-time, energy is stored in the inductor. When the switching MOSFET turns off, current flowing into the inductor forces the voltage across the inductor to reverse polarity. The voltage across the inductor rises until the external diode conducts and clamps the voltage at V_{OUT} + V_{D1}. The energy in the inductor is then discharged into the C_{OUT} capacitor. The internal comparator continues to turn the switching MOSFET on and off until the internal feedback voltage is above the reference voltage. Once the internal feedback voltage is above the reference voltage, the internal comparator turns off the switching MOSFET's oscillator.

When the EL oscillator is enabled, V_A and V_B switch in opposite states to achieve a 220V peak-to-peak AC output signal. The external resistor that connects to the REL pin determines the EL frequency.

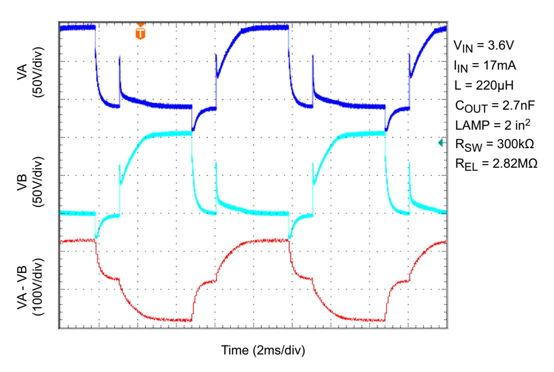


FIGURE 4-1: 100 Hz Output Waveform

4.3 Switching Frequency

The switching frequency of the converter is controlled via an external resistor between the RSW pin and VDD pin of the device. The switching frequency increases as the resistor value decreases. For resistor value selections, see Figure 2-1 or use Equation 4-1. The switching frequency range is 65 kHz to 250 kHz, with an accuracy of ±20%. In general, the lower the switching frequency, the greater the input current is drawn to deliver more power to the output. However, the switching frequency should not be so low as to allow the voltage at the switch node or the CS pin to go beyond the absolute maximum voltage of those pins.

EQUATION 4-1:

$$f_{SW}\langle kHz\rangle = \frac{36}{R_{SW}(M\Omega)}$$

4.4 EL Frequency

The EL lamp frequency is controlled via an external resistor connected between the REL pin and VDD pin of the device. The lamp frequency increases as the resistor value decreases. For resistor value selections, see Figure 2-2 or use Equation 4-2. The EL lamp frequency range is 60 Hz to 1000 Hz, with an accuracy of ±20%.

EQUATION 4-2:

$$f_{EL}(Hz) = \frac{360}{R_{EL}(M\Omega)}$$

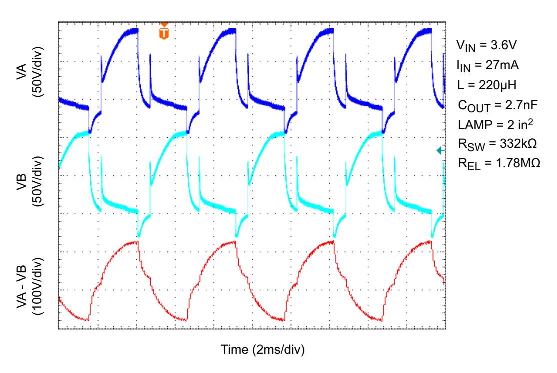


FIGURE 4-2: 200 Hz Output Waveform.

In general, as the EL lamp frequency increases, the amount of current drawn from the battery will increase. The color of the EL lamp and the intensity are dependent upon its frequency.

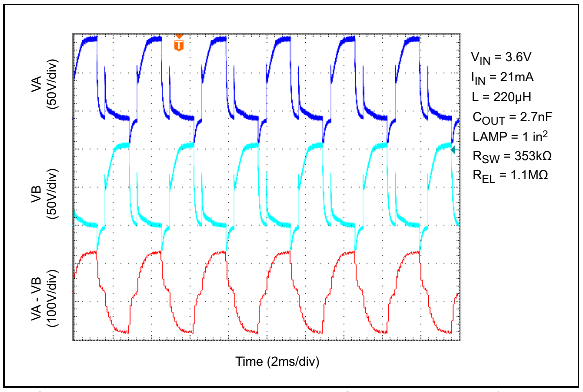


FIGURE 4-3: *300 Hz Output Waveform.*

4.5 Enable Function

The MIC4832 is disabled by connecting the external resistor (R_{SW}) to GND. This turns off the switch oscillator of the boost converter. Connecting the external resistor (R_{SW}) to VDD enables the oscillator and turns on the device. The enable voltage should rise or fall monotonically without interruption.

5.0 APPLICATION INFORMATION

5.1 Inductor

A 220 µH Murata (LQH4C221K04) inductor is recommended for most applications. Generally, inductors with smaller values can handle more current. Lowering the inductance allows the boost regulator to draw more input current to deliver more energy every cycle. As a result, a lower value inductor may be used to drive larger panels or make the current panel brighter. However, caution is required as using a low value inductor with a low switching frequency may result in voltages exceeding the absolute maximum rating of the switch node and/or the CS pin. If the application uses a low input voltage (1.8V to 3V), a lower value inductor, such as 100 µH, may be used in order to drive the EL lamp at max brightness without issue.

5.2 Diode

The diode must have a high reverse voltage (150V), because the output voltage at the CS pin can reach up to 130V. A fast switching diode with lower forward voltage and higher reverse voltage (150V), such as BAV20WS/BAS20W, can be used to enhance efficiency.

5.3 Output Capacitor

Low-ESR capacitors should be used at the regulated boost output (CS pin) of the MIC4832 to minimize the switching output ripple voltage. The larger the output capacitance, the lower the output ripple at the CS pin. The reduced output ripple at the CS pin, along with a low-ESR capacitor, improves the efficiency of the MIC4832 circuit. Selection of the capacitor value will depend upon the peak inductor current, inductor size, and the load. The MIC4832 is designed for use with an output capacitance as low as 2.2 nF. For minimum audible noise, the use of a C0G/NPO dielectric output capacitor is recommended. TDK and AVX offer C0G/NPO dielectric capacitors in capacitances up to 2.7 nF at 200V to 250V rating in 0805 size. If output ripple is a concern, a 0.01 µF/200V X7R output capacitor is recommended.

5.4 EL Lamp Terminals (VA, VB)

An EL lamp is connected from VA to VB as the load. The high voltage alternated across VA and VB by the H-Bridge cycles generate luminance. The voltage at VA and VB should not exceed the voltage at V_{CS} by more than 3V. This situation may become present when noisy enable signals such as those often generated by mechanical switches are applied to the driver's inputs. To prevent overvoltage at VA and VB, 10 kΩ resistors may be placed in series from VA to the EL panel and from VB to the EL panel. An alternative to the use of 10 kΩ resistors is to apply a diode from the CS pin to VA and VB, where the cathode of the diode is on the CS side and the anode is on the VA and VB side, respectively.

6.0 APPLICATION CIRCUIT

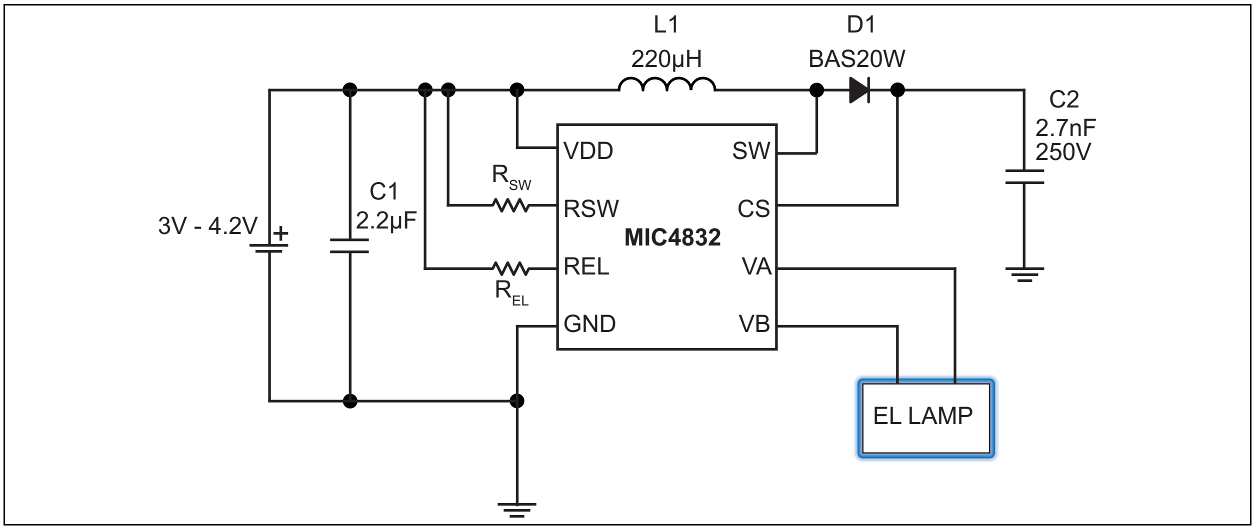


FIGURE 6-1: *Typical Li-Ion Powered MIC4832 Circuit.*

TABLE 6-1: RECOMMENDED R_{SW} & R_{EL} VALUES FOR VARIOUS PANEL SIZES

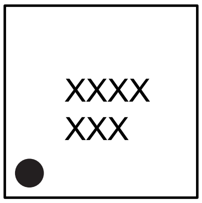
Size	Cap.	Lamp Freq.	100 Hz	200 Hz	300 Hz	400 Hz	500 Hz	600 Hz	700 Hz	800 Hz	900 Hz
—	—	R_{EL}	2.82 MΩ	1.69 MΩ	1.1 MΩ	0.837 MΩ	0.665 MΩ	0.562 MΩ	0.471 MΩ	0.409 MΩ	0.369 MΩ
0.4 in^2	2 nF	R_{SW}	240 kΩ	252 kΩ	273 kΩ	281 kΩ	257 kΩ	269 kΩ	281 kΩ	—	—
		f_{SW}	150 kHz	143 kHz	132 kHz	128 kHz	116 kHz	105 kHz	98 kHz	—	—
1 in^2	5 nF	R_{SW}	257 kΩ	295 kΩ	353 kΩ	—	—	—	—	—	—
		f_{SW}	140 kHz	122 kHz	102 kHz	—	—	—	—	—	—
2 in^2	10 nF	R_{SW}	300 kΩ	333 kΩ	—	—	—	—	—	—	—
		f_{SW}	120 kHz	108 kHz	—	—	—	—	—	—	—
3 in^2	15 nF	R_{SW}	313 kΩ	—	—	—	—	—	—	—	—
		f_{SW}	115 kHz	—	—	—	—	—	—	—	—

Table 6-1 applies to the circuit shown in Figure 6-1.

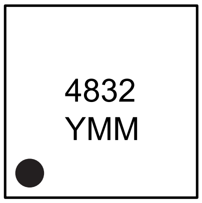
7.0 PACKAGING INFORMATION

7.1 Package Marking Information

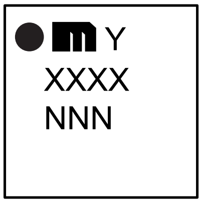
8-Lead MSOP*



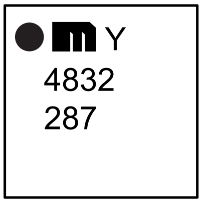
Example



8-Lead DFN*



Example



Legend:	XX...X	Product code or customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
	e3	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator (e3) can be found on the outer packaging for this package.
	●, ▲, ▼	Pin one index is identified by a dot, delta up, or delta down (triangle mark).

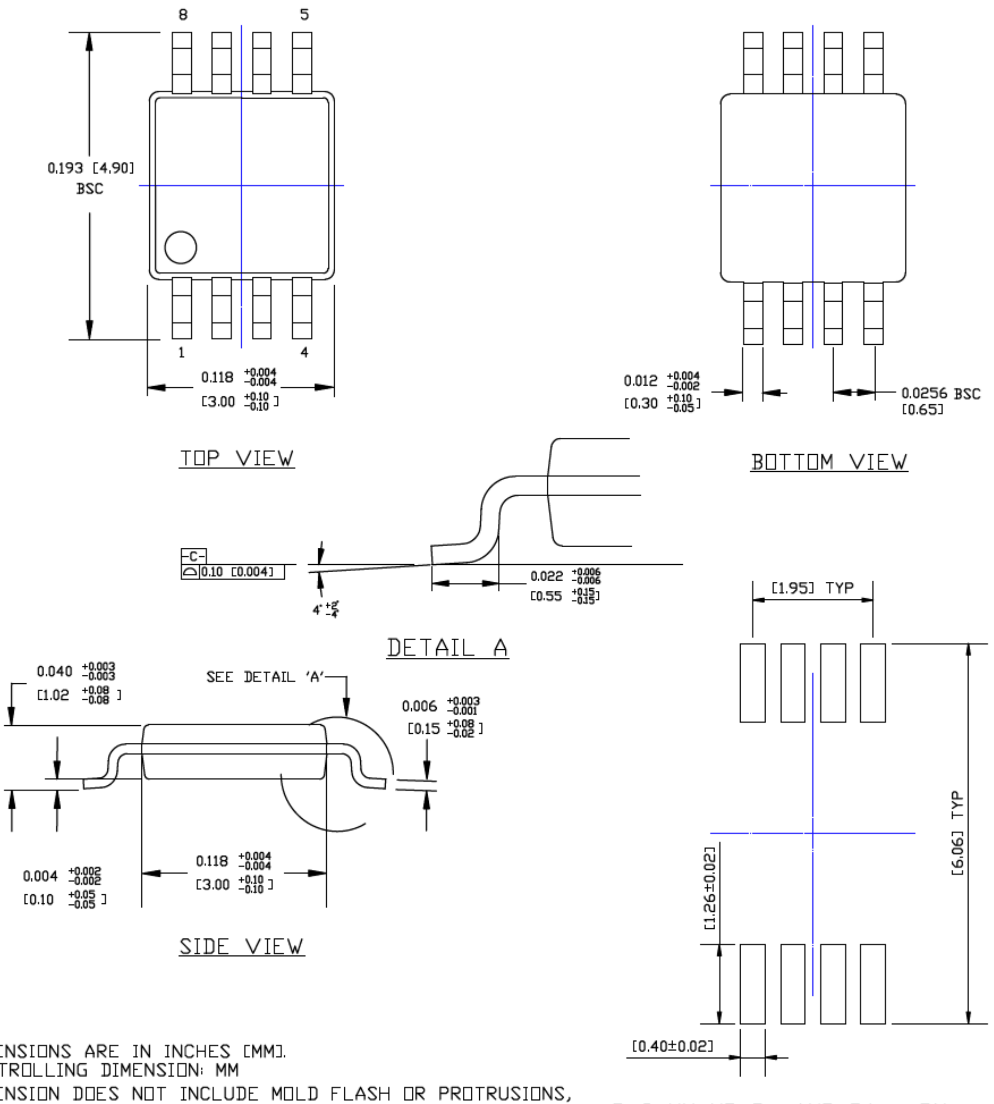
Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.

Underbar (_) and/or Overbar (‾) symbol may not be to scale.

TITLE

8 LEAD MSOP PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	MSOP-8LD-PL-1	**UNIT**	INCH [MM]



NOTES:

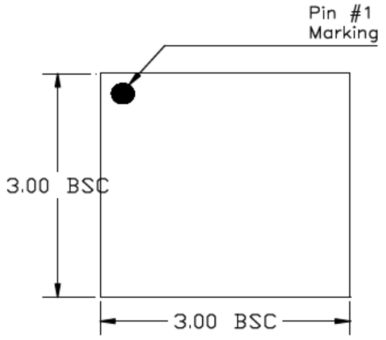
1. DIMENSIONS ARE IN INCHES [MM].
2. CONTROLLING DIMENSION: MM
3. DIMENSION DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS, EITHER OF WHICH SHALL NOT EXCEED 0.008 [0.20] PER SIDE.

Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

TITLE

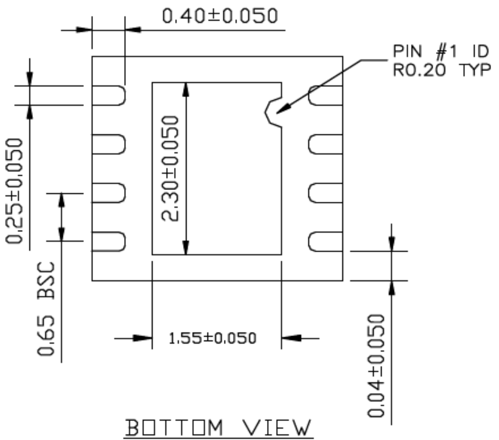
8 LEAD DFN 3x3mm PACKAGE OUTLINE & RECOMMENDED LAND PATTERN

DRAWING #	DFN33-8LD-PL-1	**UNIT**	MM



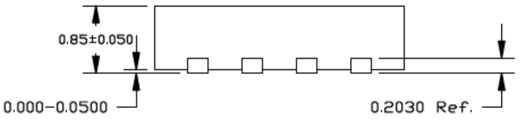
TOP VIEW

NOTE: 1, 2, 3



BOTTOM VIEW

NOTE: 1, 2, 3



SIDE VIEW

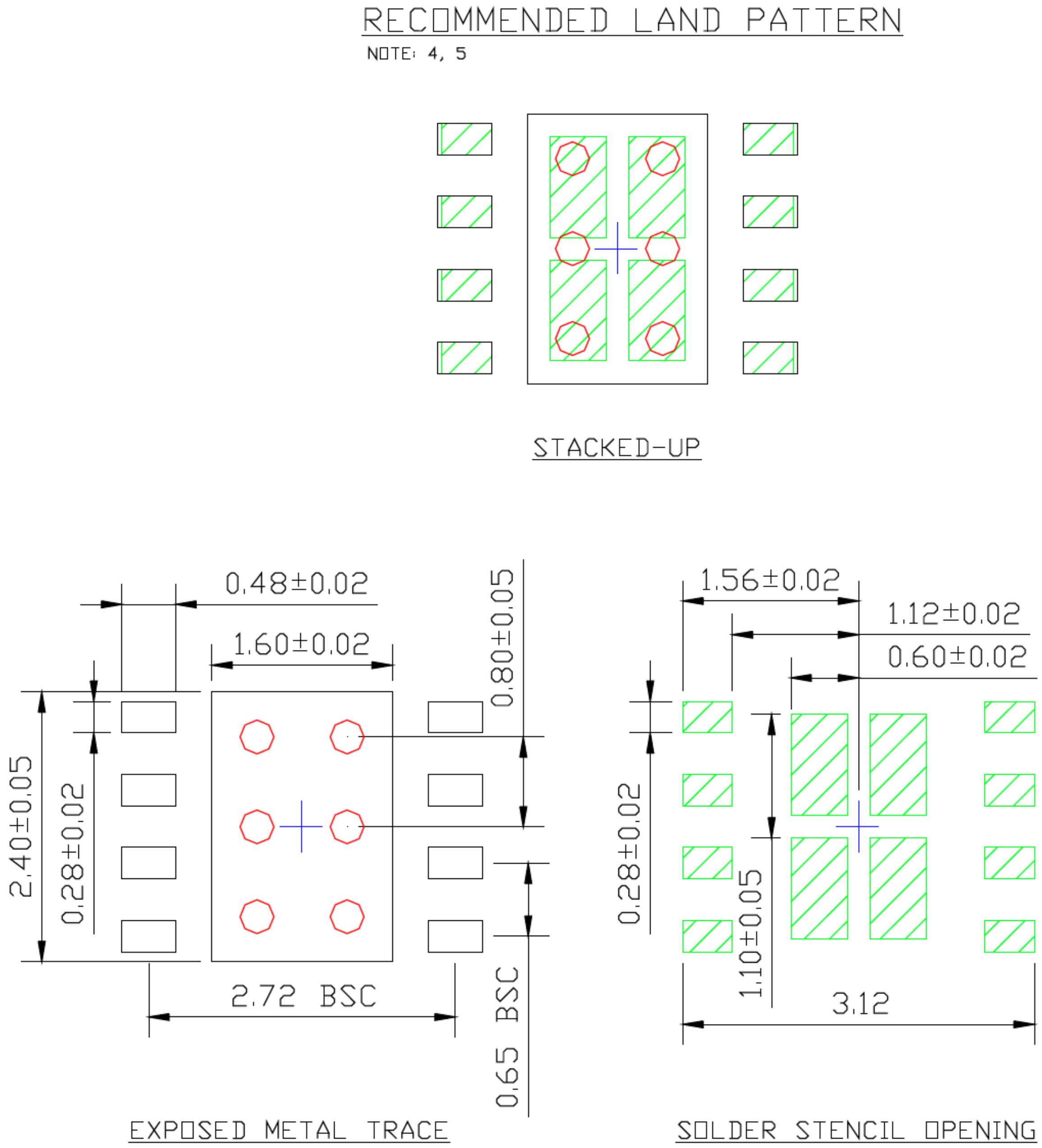
NOTE: 1, 2, 3

NOTE:

1. MAX PACKAGE WARPAGE IS 0.05 MM
2. MAX ALLOWABLE BURR IS 0.076MM IN ALL DIRECTIONS
3. PIN #1 IS ON TOP WILL BE LASER MARKED
4. RED CIRCLE IN LAND PATTERN INDICATE THERMAL VIA. SIZE SHOULD BE 0.30-0.35 MM IN DIAMETER AND SHOULD BE CONNECTED TO GND FOR MAX THERMAL PERFORMANCE
5. GREEN RECTANGLES (SHADED AREA) INDICATE SOLDER STENCIL OPENING ON EXPOSED PAD AREA. SIZE SHOULD BE 0.50x0.90 MM IN SIZE, 0.20 MM SPACING.

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

POD-Land Pattern drawing #DFN33-8LD-PL-1



Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging.

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (March 2019)

- Converted Micrel document MIC4832 to Microchip data sheet template DS20006163A.
- Minor grammatical text changes throughout.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

Device	**X**	**XX**	**-XX**
Part No.	Junction Temp. Range	Package	Media Type

Device:	MIC4832:	Low Noise 220V$_{PP}$ EL Driver
Junction Temperature Range:	Y =	–40°C to +85°C, Industrial
Package:	MM = ML =	8-Lead MSOP 8-Lead 3 mm x 3 mm DFN
Media Type:	<blank>= TR = TR =	100/Tube (MM Package) 2,500/Reel (MM Package) 5,000/Reel (ML Package)

Examples:

a) MIC4832YMM:	MIC4832, –40°C to +85°C Temperature Range, 8-Lead MSOP, 100/Tube
b) MIC4832YMM-TR:	MIC4832, –40°C to +85°C Temperature Range, 8-Lead MSOP, 2,500/Reel
c) MIC4832YML-TR:	MIC4832, –40°C to +85°C Temperature Range, 8-Lead 3 mm x 3 mm DFN, 5,000/Reel

Note 1: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

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