MIC4826

Low Input Voltage, 160 V_{PP} Output Voltage, EL Driver

Features

- 1.8V to 5.5V DC Input Voltage
- 160 V_{PP} Regulated AC Output Waveform
- Independently Adjustable EL Lamp Frequency
- Independently Adjustable Boost Converter Frequency
- 0.1 µA Shutdown Current

Applications

- LCD Panel Backlight
- Cellular Phones
- PDAs
- Pagers
- Calculators
- Remote Controls
- Portable Phones

General Description

The MIC4826 is a high output voltage, DC to AC converter, designed for driving EL (Electroluminescent) lamps. The device operates from an input voltage range of 1.8V to 5.5V, making it suitable for 1-cell Li Ion and 2- or 3-cell alkaline/NiCad/NiMH battery applications. The MIC4826 converts a low voltage DC input to a 160 V_{PP} AC output signal that drives the EL lamp.

The MIC4826 is comprised of two stages: a boost stage, and an H-bridge, lamp driver, stage. The boost stage steps the input voltage up to +80V. The H-bridge stage then alternately switches the +80V output to each terminal of the EL lamp, thus creating a 160 V_{PP} AC signal to drive the EL lamp and generate light.

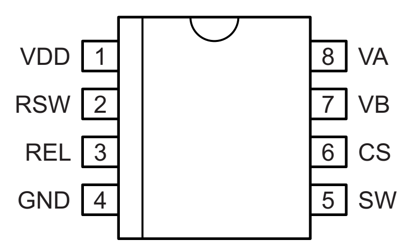
The MIC4826 features separate oscillators for the boost and H-bridge stages. External resistors independently set the operating frequency of each stage. This flexibility allows the EL lamp circuit to be optimized for maximum efficiency and brightness.

The MIC4826 uses a single inductor and a minimum number of external components, making it ideal for portable, space sensitive applications.

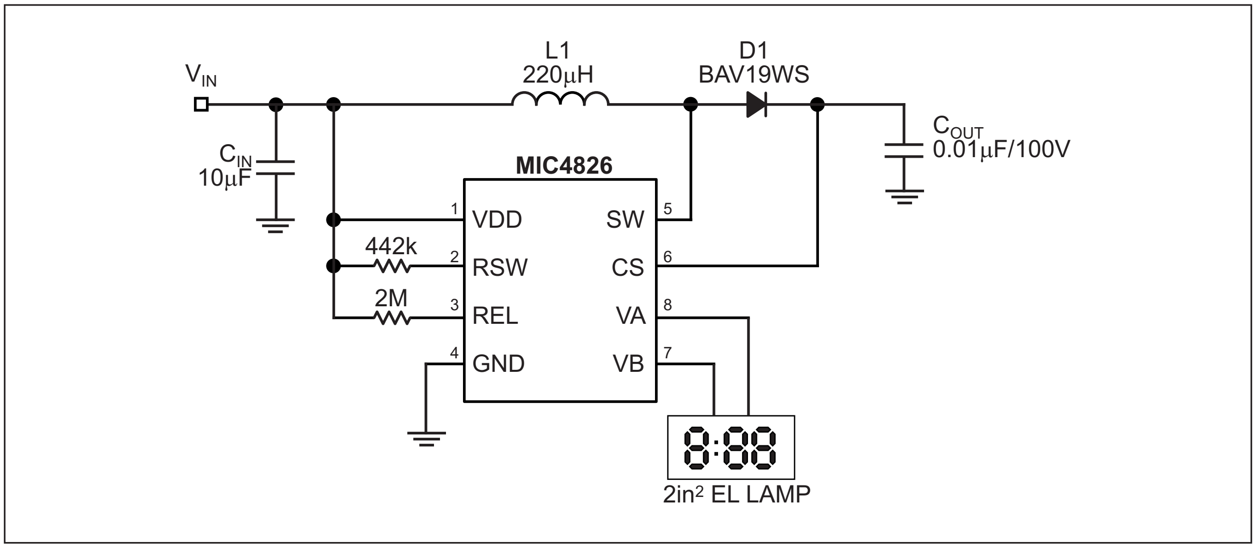
The MIC4826 is available in an 8-pin MSOP package with an ambient temperature range of –40°C to +85°C.

Package Type

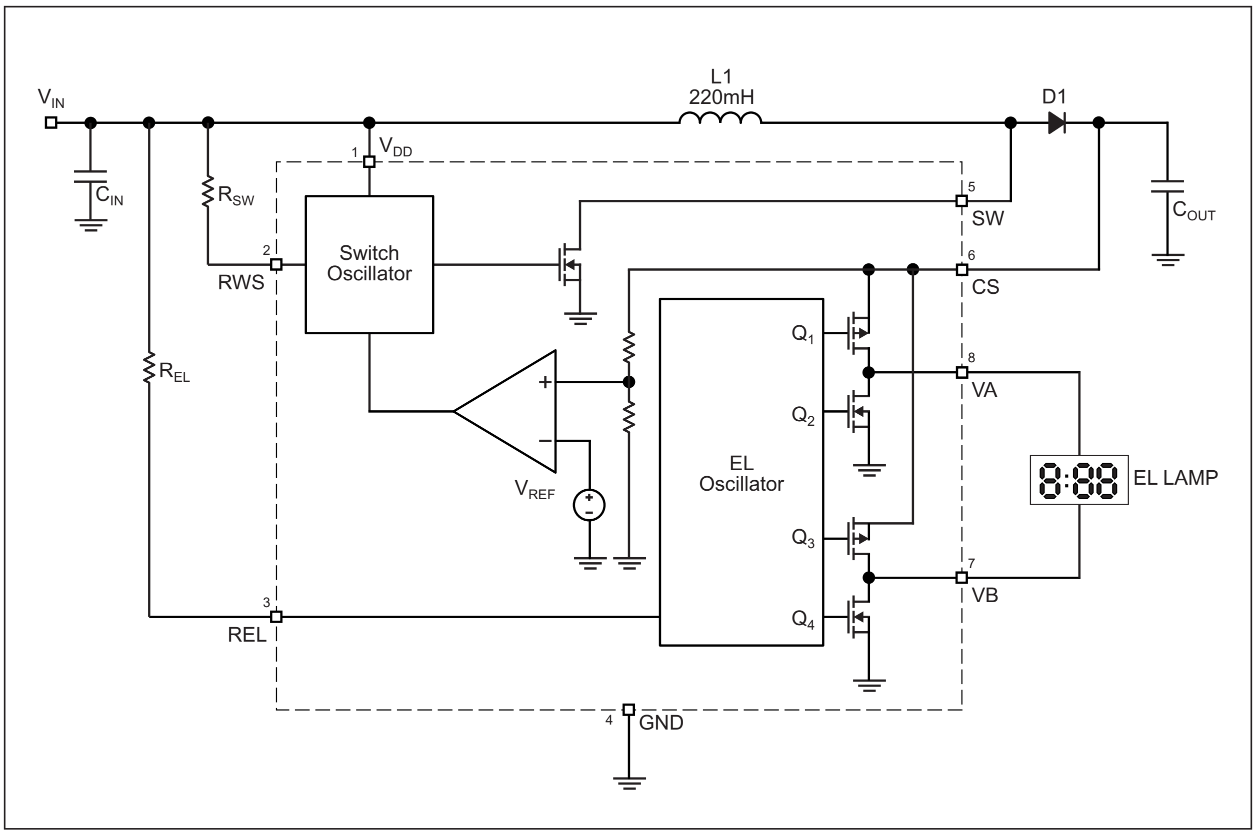
MIC4826
8-Pin MSOP (MM)



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 +100V
Frequency Control Voltage (V_{RSW}, V_{REL}) .... –0.5V to (V_{DD} +0.3V)
Power Dissipation @ T_A = 85°C .... 200 mV
Storage Temperature (T_S) .... –65°C to +150°C
ESD Rating .... (Note 1)

Operating Ratings ‡

Supply Voltage (V_{DD}) .... +1.8V to +5.5V
Lamp Drive Frequency (f_{EL}) .... 60 Hz to 1000 Hz
Switching Transistor Frequency (f_{SW}) .... 8 kHz to 200 kHz
Ambient Temperature .... –40°C to +85°C
Package Thermal Resistance ($R\theta_{(JA)}$, 8-Pin MSOP) .... 206°C/W

† Notice: Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability. Specifications are for packaged product only.

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

Note 1: Devices are ESD sensitive. Handling precautions are recommended.

ELECTRICAL CHARACTERISTICS

Electrical Characteristics: V_{IN} = V_{DD} = 3.0V, R_{SW} = 560 kΩ, R_{EL} = 1.0 MΩ.T_A = 25°C unless otherwise noted. **Bold** values indicate –40°C ≤ T_A ≤ +85°C.

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
On-Resistance of Switching Transistor	$R_{DS(ON)}$	—	3.8	**7.0**	Ω	I_{SW} = 100 mA, V_{CS} = 75V
Output Voltage Regulation	V_{CS}	75	80	85	V	V_{DD} = 1.8V to 5.5V
		73	—	**87**	V	—
Output Peak-to-Peak Voltage	V_A-V_B	150	160	170	V	V_{DD} = 1.8V to 5.5V
		146	—	**174**	V	—
Input Low Voltage (Turn Off)	V_{EN-L}	—	—	0.5	V	V_{DD} = 1.8V to 5.5V
Input High Voltage (Turn On)	V_{EN-H}	V_{DD}–0.5	—	—	V	V_{DD} = 1.8V to 5.5V
Shutdown Current (Note 2)	I_{SD}	—	0.01	0.1	µA	R_{SW} = LOW; R_{EL} = LOW V_{DD} = 5.5V
			—	**0.5**		
Input Supply Current	I_{VDD}	—	21	**75**	µA	R_{SW} = HIGH; R_{EL} = HIGH V_{CS} = 75V; V_A, V_B OPEN
Boosted Supply Current	I_{CS}	—	200	**400**	µA	R_{SW} = HIGH; R_{EL} = HIGH V_{CS} = 75V; V_A, V_B OPEN
Input Current Including Inductor Current	I_{IN}	—	28	—	mA	V_{IN} = V_{DD} = 1.8V. See (Figure 1-1)
V_A - V_B Output Drive Frequency	f_{EL}	285	360	435	Hz	—
Switching Transistor Frequency	f_{SW}	53	66	79	kHz	—
Switching Transistor Duty Cycle	D	—	90	—	%	—

Note 1: Specification for packaged product only.
2: Shutdown current is defined as the sum of current going into pin 1, 5, and 6 when the device is disabled.

TEMPERATURE SPECIFICATIONS (Note 1)

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Storage Temperature Range	T_S	–65	—	+150	°C	—
Ambient Temperature	T_A	–40	—	+85	°C	—
Package Thermal Resistances						
Thermal Resistance 8-Pin MSOP	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}).

Test Circuit

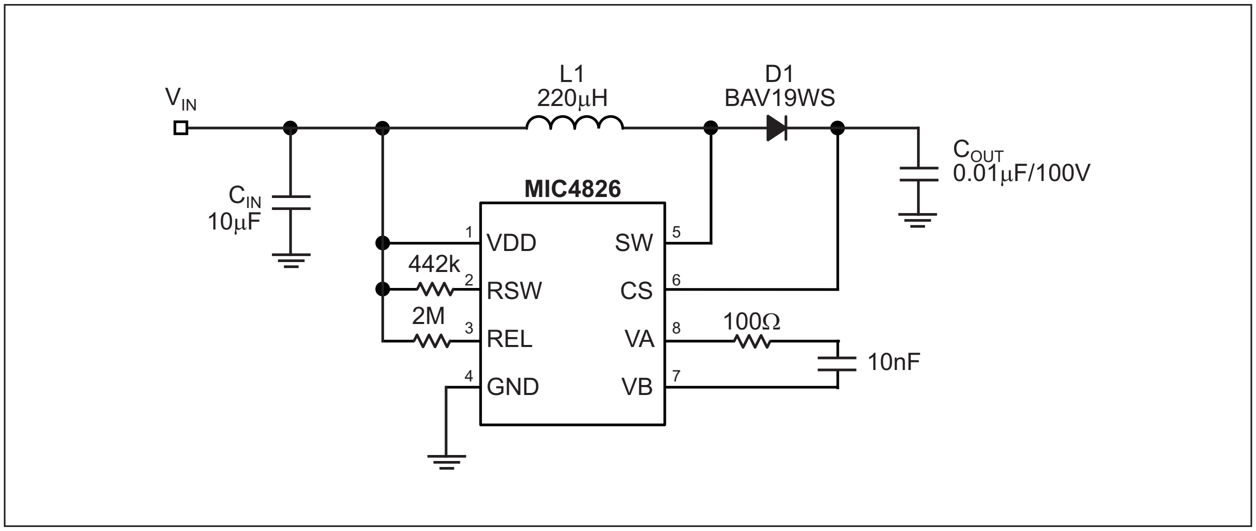


FIGURE 1-1: *MIC4826 Test Circuit.*

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.

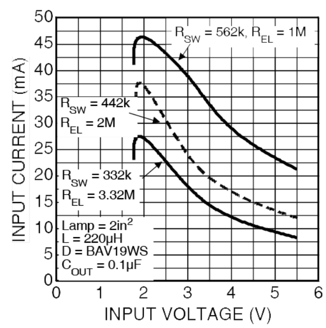


FIGURE 2-1: *Total Input Current vs. Input Voltage.*

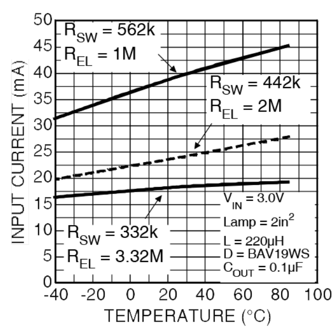


FIGURE 2-2: *Total Input Current vs. Temperature.*

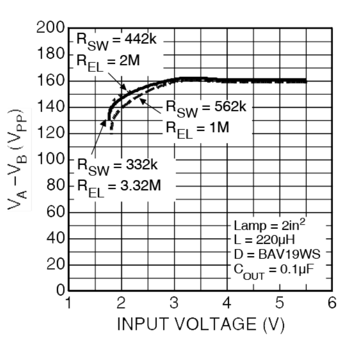


FIGURE 2-3: *Output Voltage vs. Input Voltage.*

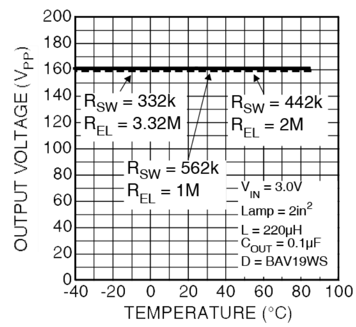


FIGURE 2-4: *Output Voltage vs. Temperature.*

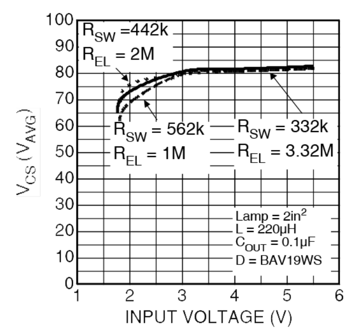


FIGURE 2-5: *CS Voltage vs. Input Voltage.*

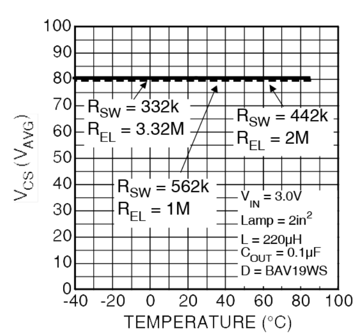


FIGURE 2-6: *CS Voltage vs. Temperature.*

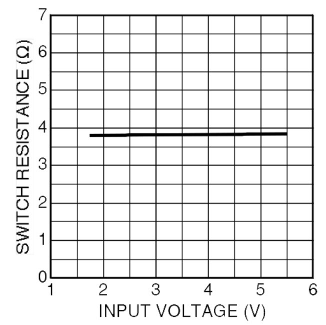


FIGURE 2-7: *Switch Resistance vs. Input Voltage.*

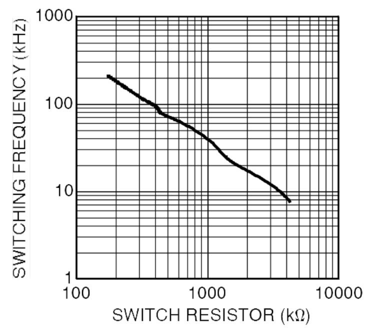


FIGURE 2-8: *Switching Frequency vs. Switch Resistor.*

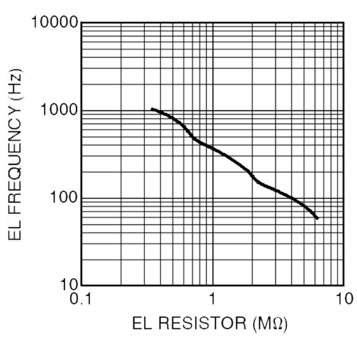


FIGURE 2-9: *EL Frequency vs. EL Resistor.*

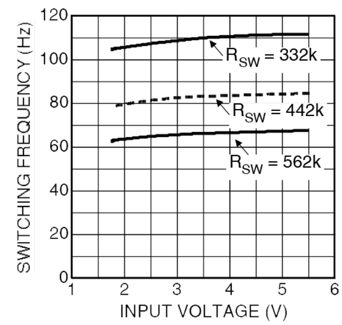


FIGURE 2-10: *Switching Frequency vs. Input Voltage.*

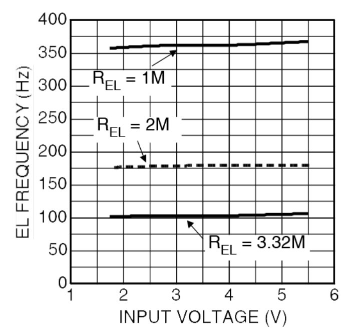


FIGURE 2-11: *EL Frequency vs. Input Voltage.*

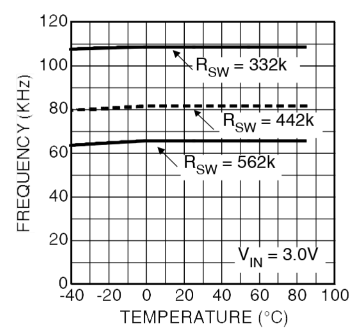


FIGURE 2-12: *Switching Frequency vs. Temperature.*

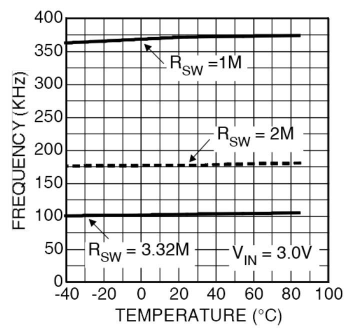


FIGURE 2-13: *EL Frequency vs. Temperature.*

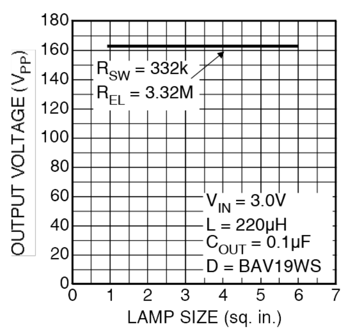


FIGURE 2-14: *Output Voltage vs. Lamp Size.*

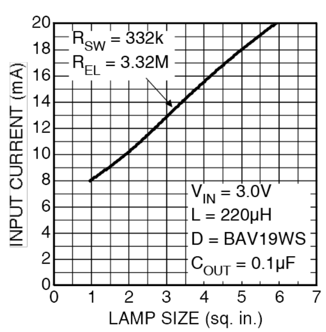


FIGURE 2-15: *Total Input Current vs. Lamp Size.*

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 V_{DD}. Connecting the external resistor to GND disables the switch oscillator and shutdown the device.
3	REL	EL Resistor (External Component): Set EL frequency of the internal H-bridge driver by connecting an external resistor to V_{DD}. Connecting the external resistor to GND disables the EL oscillator.
4	GND	Ground return.
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 the other end of the EL lamp. Polarity is not important.

4.0 FUNCTIONAL DESCRIPTION

See Section 5.0, Application Information for component selection and pre-designed circuits.

4.1 Overview

The MIC4826 is a high voltage EL driver with an AC output voltage of 160V peak-to-peak capable of driving EL lamps up to 6 in^2. Input supply current for the MIC4826 is typically 21 µA with a typical shutdown current of 10 nA. 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 lamps.

4.2 Regulation

Referring to Figure 4-1, initially power is applied to V_{DD}. The internal feedback voltage is less than the reference voltage causing the internal comparator to go low which enables the switching MOSFET's oscillator. When the switching MOSFET turns on, current flows through the inductor and into the switch. The switching MOSFET will typically turn on for 90% of the switching frequency. 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 160V peak-to-peak AC output signal. The external resistor that connects to the REL pin determines the EL frequency.

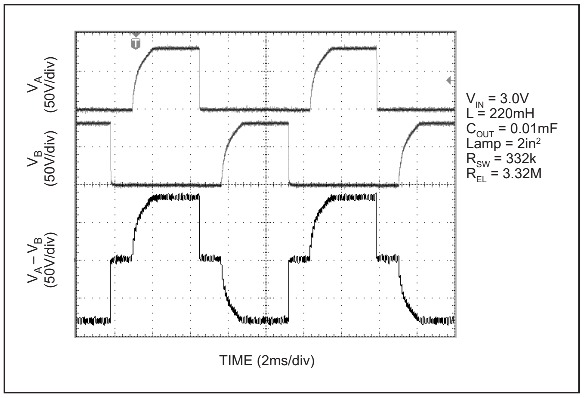


FIGURE 4-1: *108 Hz Typical Output Waveform.*

4.3 Switching Frequency

The switching frequency of the converter is controlled via an external resistor between RSW pin and VDD pin of the device. The switching frequency increases as the resistor value decreases. For resistor value selections, see Figure 2-8 or use equation Equation 4-1. The switching frequency range is 8 kHz to 200 kHz, with an accuracy of ±20%.

EQUATION 4-1:

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

4.4 EL Frequency

The EL lamp frequency is controlled via an external resistor connected between REL pin and VDD pin of the device. As the lamp frequency increases, the resistor value decreases. For resistor value selections, see Figure 2-9 or use equation Equation 4-2. The EL frequency range is 60 Hz to 1000 Hz, with an accuracy of ±20%.

EQUATION 4-2:

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

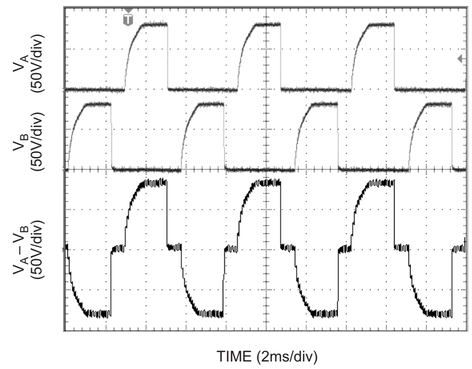


FIGURE 4-2: *180 Hz Output Waveform.*

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.

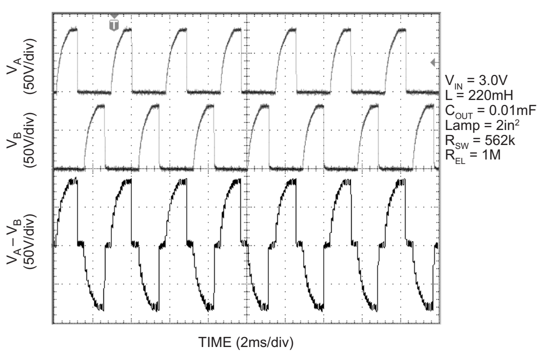


FIGURE 4-3: *360 Hz Output Waveform.*

4.5 Enable Function

The enable function of the MIC4826 is implemented by switching the R_{SW} and R_{EL} resistor between ground and V_{DD}. When R_{SW} and R_{EL} are connected to ground, the switch and the EL oscillators are disabled; therefore the EL driver becomes disabled. When these resistors connect to V_{DD}, both oscillators will function and the EL driver is enabled.

5.0 APPLICATION INFORMATION

5.1 Inductor

In general, smaller value inductors, which can handle more current, are more suitable to drive larger size lamps. As the inductor value decreases, the switching frequency (controlled by R_{SW}) should be increased to avoid saturation or the input voltage should be increased. Typically, inductor values ranging from 220 µH to 560 µH can be used. Murata offers the LQH3C series up to 560µH and LQH4C series up to 470 µH, with low DC resistance. A 220 µH Murata (LQH4C221K04) inductor is recommended for driving a lamp size of 3 square inches. It has a maximum DC resistance of 4.0Ω.

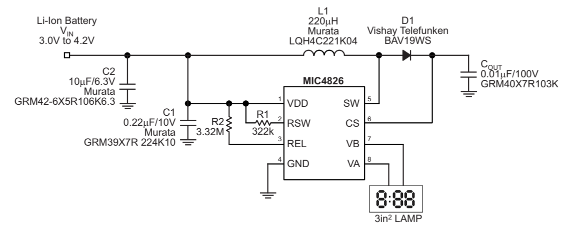
5.2 Diode

The diode must have a high reverse voltage (100V) since the output voltage at the CS pin can reach up to 100V. A fast switching diode with lower forward voltage and higher reverse voltage (100V), such as BAV19WS, 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 MIC4826 to minimize the switching output ripple voltage. Selection of the capacitor value will depend upon the peak inductor current, inductor size, and the load. MuRata offers the GRM40 series with up to 0.015 µF at 100V, with a X7R temperature coefficient in 0805 surface mount package. Typically, values ranging from 0.01 µF to 0.1 µF at 100V can be used for the regulated boost output capacitor.

5.4 Pre-Designed Application Circuits



V_{IN}	I_{IN}	V_A-V_B	F_{EL}	Lamp Size
3.3V	20 mA	$160V_{PP}$	100 Hz	$3in^2$

FIGURE 5-1: *100 Hz EL Driver for 3in² Lamp.*

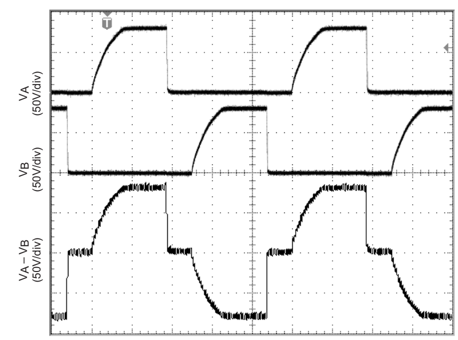
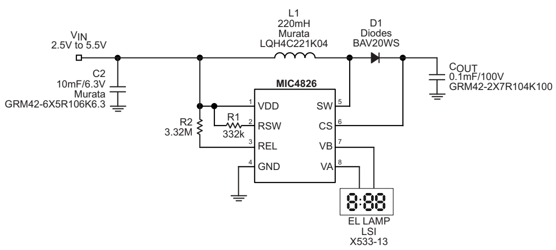


FIGURE 5-2: *Typical Characteristics for 100 Hz EL Driver for 3in² Lamp.*



V_{IN}	I_{IN}	V_A-V_B	F_{EL}	Lamp Size
3.3V	14 mA	$160V_{PP}$	100 Hz	$2in^2$

FIGURE 5-3: *100 Hz EL Driver for $2in^2$ Lamp.*

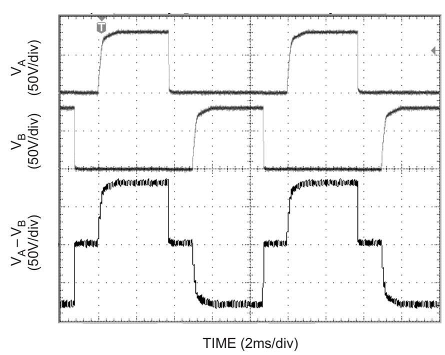
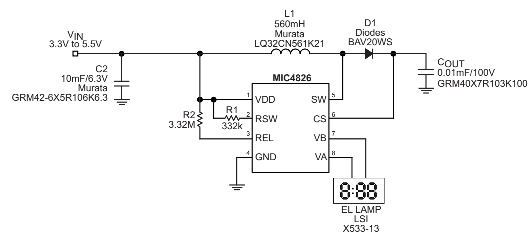


FIGURE 5-4: *Typical Characteristics for EL Driver for $2in^2$ Lamp with C_S = 0.1 µF.*



V_{IN}	I_{IN}	V_A-V_B	F_{EL}	Lamp Size
3.3V	13.2 mA	$160V_{PP}$	100 Hz	$2in^2$

FIGURE 5-5: *EL Driver for $2in^2$ Lamp with 560 µF.*

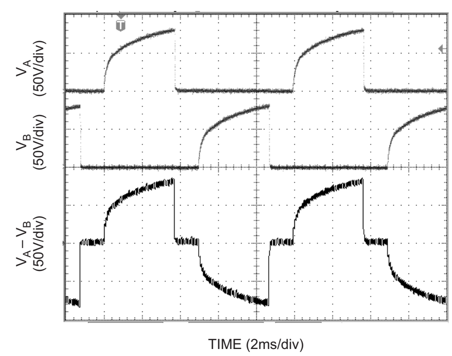
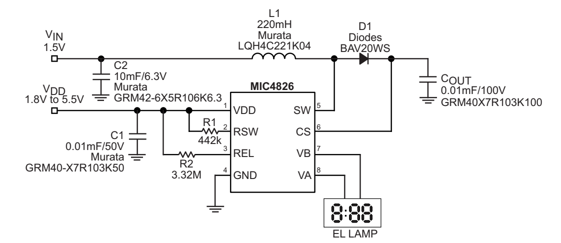


FIGURE 5-6: *Typical Characteristics for EL Driver for $2in^2$ Lamp with 560 µH Inductor.*



V_{IN}	I_{IN}	V_{DD}	I_{DD}	V_A-V_B	F_{EL}	Lamp Size
1.5V	22 mA	3.0V	36 µA	$160V_{PP}$	100 Hz	$1.6in^2$

FIGURE 5-7: *Typical for Split Power Supplies Applications.*

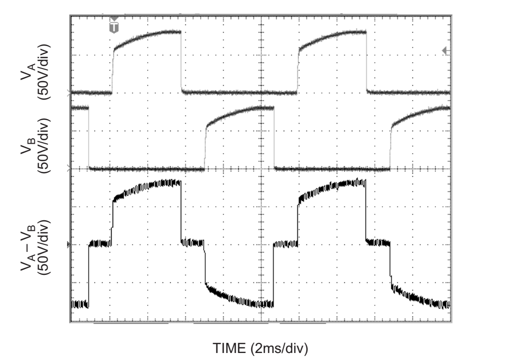
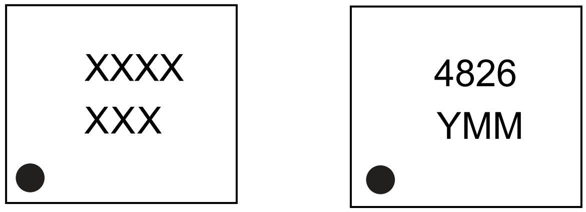


FIGURE 5-8: *Typical Characteristics for Split Power Supplies Applications.*

6.0 PACKAGING INFORMATION

6.1 Package Marking Information

8-Lead MSOP* 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).

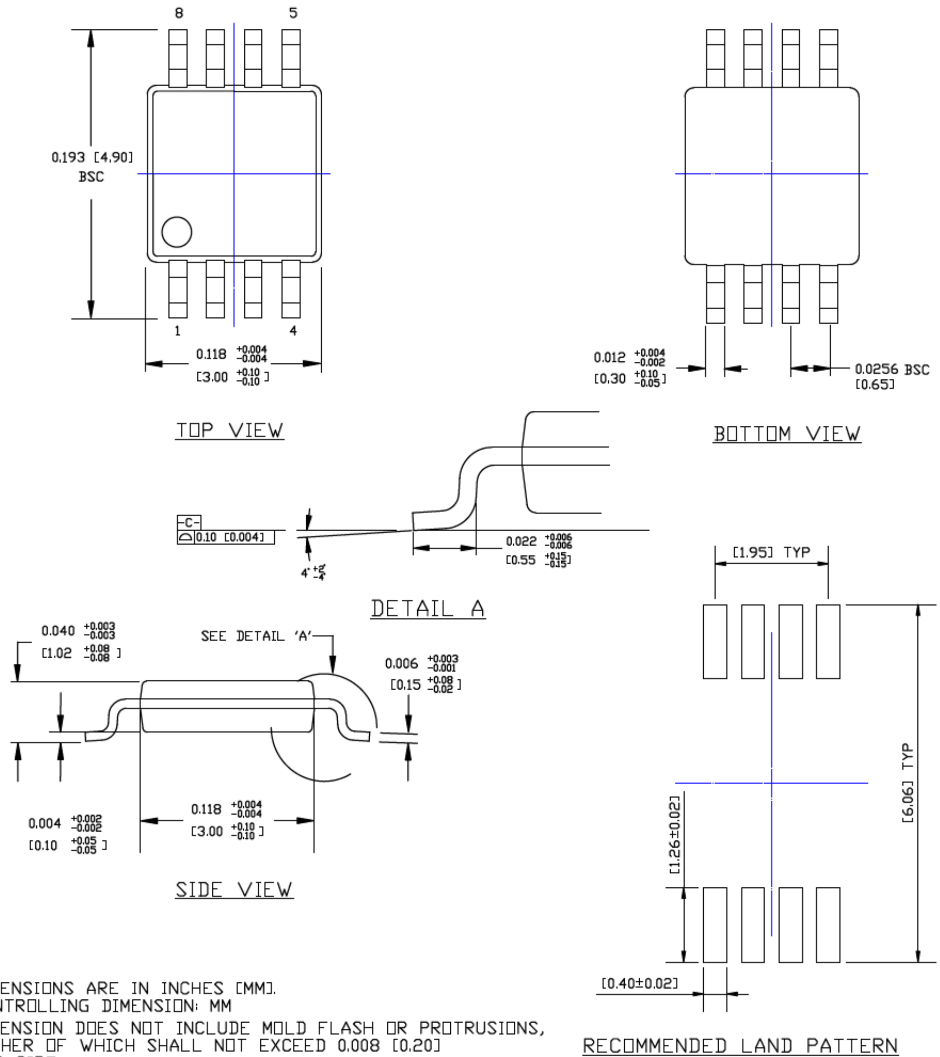
Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.

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

8-Lead MSOP Package Outline and Recommended Land Pattern

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.

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (January 2019)

- Converted Micrel document MIC4826 to Microchip data sheet DS20006134A.
- Minor 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.

PART NO.	X	XX	–XX
Device	Junction Temperature Range	Package	Media Type

Device:	MIC4826:	Low Input Voltage, 160 V_{PP} Output Voltage, EL Driver
Junction Temperature Range:	Y =	–40°C to +85°C
Package:	MM =	8-Lead MSOP
Media Type:	Blank =	100/Tube
	TR =	2,500/Reel

Examples:

a) MIC4826YMM: Low Input Voltage, 160 V_{PP} Output Voltage, EL Driver, –40°C to +85°C Temperature Range, 8-Lead MSOP Package, 100/Tube

b) MIC4826YMM-TR: Low Input Voltage, 160 V_{PP} Output Voltage, EL Driver, –40°C to +85°C Temperature Range, 8-Lead MSOP Package, 2,500/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.

NOTES:

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

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