HV861

Low-Noise Dimmable Dual EL Lamp Driver

Features

- Adjustable Output Regulation for Dimming
- Lamp Fade-in/Fade-out Capability
- Low Audible Noise
- 180 V_{PP} Output Voltage for Higher Brightness
- 1.5V Enable Input Logic High
- Single-cell Lithium Ion-compatible
- One Miniature Inductor to Power both Lamps
- Separately Adjustable Lamp and Converter Frequencies
- Split Supply Capability

Applications

- Dual Display Cellular Phones
- Keypad and LCD Backlighting
- Personal Digital Assistant (PDA)
- Handheld Wireless Communication Products
- Global Positioning Systems (GPS)

General Description

The HV861 is a low-noise dimmable high-voltage dual EL lamp driver designed for driving two electroluminescent (EL) lamps with a combined area of 5 in^2. The input supply voltage range is from 2.5V to 4.5V. Enable input logic high can go as low as 1.5V, which allows logic interface operating from typical 1.8V supplies. The device is designed to minimize audible noise emitted by the EL lamps.

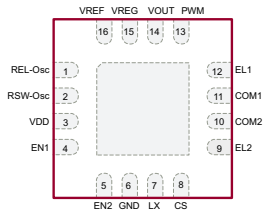
The device uses a single inductor and a minimum number of passive components. With the internal reference voltage, the regulated output voltage is at a nominal value of 90V. The EL lamps therefore see ±90V. The two EL lamps can be turned on and turned off using two CMOS logic inputs, EN1 and EN2. The driver is disabled when both EN1 and EN2 are at logic low.

The HV861 has two internal oscillators, a switching MOSFET, and two high-voltage EL lamp driver H-bridges. Each driver has its own half-bridge common output, COM1 and COM2, which significantly minimizes the DC offset seen by the EL lamp. The frequency for the switching MOSFET is set by an external resistor connected between the R_{SW-Osc} pin and the supply pin, V_{DD}. The EL lamp driver frequency is set by an external resistor connected between the R_{EL-Osc} pin and the V_{DD} pin. An external inductor is connected between the L_X and V_{DD} pins or V_{IN} for split supply applications. Depending upon the EL lamp sizes, a 1 nF to 10 nF capacitor is connected between the C_S and ground. As the switching MOSFET charges the external inductor and discharges it into the capacitor at C_S, the voltage at C_S starts to increase. Once the voltage at C_S reaches a nominal value of 90V, the switching MOSFET is turned off to conserve power.

EL lamp dimming can be accomplished by applying a PWM logic signal to the PWM pin. The EL lamp brightness will be inversely proportional to the PWM duty cycle. The HV861 can also slowly turn on or turn off the EL lamp, giving a fade on/off appearance.

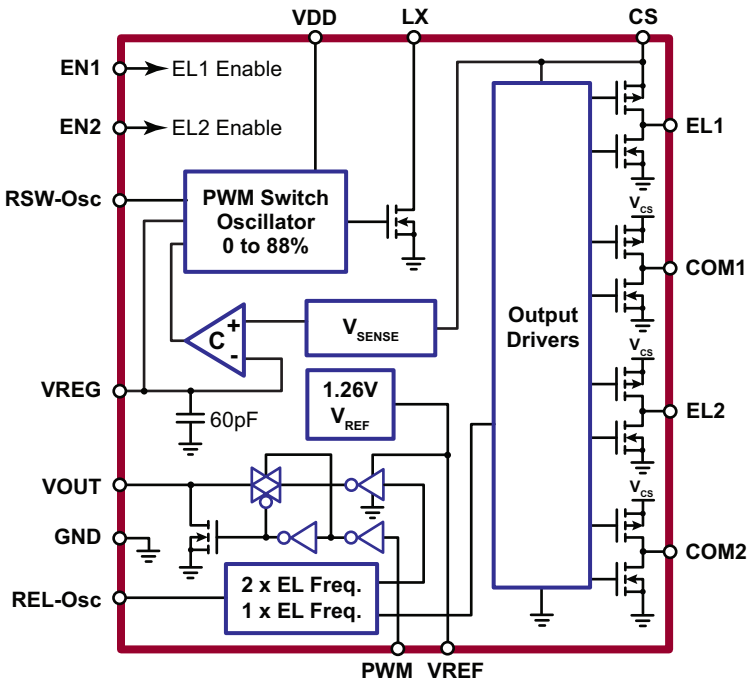
Package Type

16-lead WQFN
(Top view)

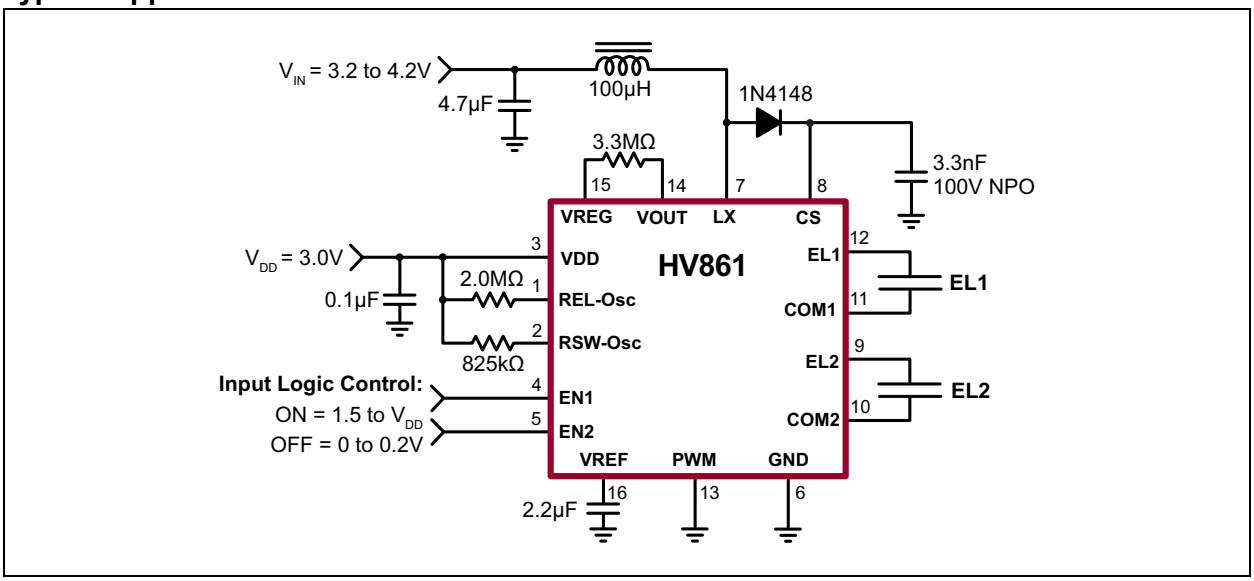


See Table 2-1 for pin information.

Functional Block Diagram



Typical Application Circuit



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings(†)

Supply Voltage, V_{DD} ..... –0.5V to 5.5V
Output Voltage, V_{CS} ..... –0.5V to +120V
Operating Ambient Temperature Range, T_A ..... –40°C to +85°C
Storage Temperature Range, T_S ..... –65°C to +150°C
Power Dissipation:
16-lead WQFN (3 X 3) 1.6W

† **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.

RECOMMENDED OPERATING CONDITIONS

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Input Voltage	V_{DD}	2.5	—	4.5	V	
Switching Frequency	f_{SW}	40	—	200	KHz	
EL Lamp Frequency	f_{EL}	150	—	500	Hz	
EL Lamp Capacitance Load	C_{LOAD}	0	—	20	nF	
Operating Ambient Temperature	T_A	–40	—	+85	°C	

ELECTRICAL CHARACTERISTICS

Electrical Specifications: Over recommended operating conditions unless otherwise specified.

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
On-resistance of Switching Transistor	$R_{DS(ON)}$	—	—	7	Ω	I = 100 mA
Maximum Output Regulation Voltage	V_{CS}	80	90	100	V	V_{DD} = 2.5V to 4.5V
Output Regulation Voltage	V_{CS}	—	78	—	V	V_{DD} = 2.5V to 4.5V, V_{REG} = 1.092V
		—	62	—	V	V_{DD} = 2.5V to 4.5V, V_{REG} = 0.862V
		—	45	—	V	V_{DD} = 2.5V to 4.5V, V_{REG} = 0.632V
External Input Voltage Range	V_{REG}	0	—	1.40	V	V_{DD} = 2.5V to 4.5V
V_{REF} Output High Voltage	V_{REFH}	1.12	1.26	140	V	V_{DD} = 2.5V to 4.5V
Quiescent V_{DD} Supply Current	I_{DDQ}	—	—	150	nA	EN = Low
Average Sourcing Current from V_{REF} Pin	$I_{REF(SOURCE)}$	—	6	—	µA	V_{DD} = 2.5V to 4.5V
Average Sinking Current from V_{REF} Pin	$I_{REF(SINK)}$	—	6	—	µA	V_{DD} = 2.5V to 4.5V
Quiescent V_{DD} Supply Current	I_{DDQ}	—	—	300	nA	V_{DD} = 2.5V, EN1 = EN2 = PWM = low
		—	—	400	nA	V_{DD} = 3V, EN1 = EN2 = PWM = low
		—	—	500	nA	V_{DD} = 4.5V, EN1 = EN2 = PWM = low
Input Current going into the V_{DD} Pin	I_{DD}	—	—	250	µA	V_{DD} = 2.5V to 4.5V, R_{EL} = 2 MΩ, R_{SW} = 825 kΩ
Input Current including Inductor Current	I_{IN}	—	25	50	mA	V_{IN} = 3.2V See Figure 3-1.
EL Lamp Frequency	f_{EL}	160	190	220	Hz	R_{EL} = 2 MΩ

ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Specifications: Over recommended operating conditions unless otherwise specified.

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Switching Transistor Frequency	f_{SW}	84	100	116	kHz	R_{SW} = 825 kΩ
Switching Transistor Duty Cycle	D	—	88	—	%	
Input PWM Frequency	PWM	10	—	100	kHz	
LOGIC INPUTS						
Enable Input Logic High Voltage	V_{IH}	1.5	—	V_{DD}	V	V_{DD} = 2.5V to 4.5V
Enable Input Logic Low Voltage	V_{IL}	0	—	0.2	V	V_{DD} = 2.5V to 4.5V
Enable Input Logic High Current	I_{IH}	—	—	1	µA	V_{IH} = V_{DD} = 2.5V to 4.5V
Enable Input Logic Low Current	I_{IL}	—	—	–1	µA	V_{IL} = 0V, V_{DD} = 2.5V to 4.5V
Enable Input Capacitance	C_{IN}	—	—	15	pF	

TEMPERATURE SPECIFICATIONS

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
TEMPERATURE RANGE						
Operating Ambient Temperature Range	T_A	–40	—	+85	°C	
Storage Temperature Range	T_S	–65	—	+150	°C	
PACKAGE THERMAL RESISTANCE						
16-lead WQFN	θ_{JA}	—	33	—	°C/W	

2.0 PIN DESCRIPTION

The details on the pins of HV861 are listed in Table 2-1.
Refer to **Package Type** for the location of pins.

TABLE 2-1: PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1	REL-Osc	External resistor from $R_{EL\text{-}Osc}$ to V_{DD} sets the EL frequency. The EL frequency is inversely proportional to the external R_{EL} resistor value. Reducing the resistor value by a factor of two results in an increase in the EL frequency by two. $$f_{EL} = \frac{2M\Omega \times 190Hz}{R_{EL}}$$
2	RSW-Osc	External resistor from $R_{SW\text{-}Osc}$ to V_{DD} sets the switch converter frequency. The switch converter frequency is inversely proportional to the external R_{SW} resistor value. Reducing the resistor value by a factor of two results in an increase in the switch converter frequency by two. $$f_{SW} = \frac{825k\Omega \times 100kHz}{R_{SW}}$$
3	VDD	Low-voltage input supply pin
4	EN1	Enable input signal for EL Lamp 1. CMOS logic input pin. (Refer to Table 3-2.)
5	EN2	Enable input signal for EL Lamp 2. CMOS logic input pin. (Refer to Table 3-2.)
6	GND	Device ground
7	LX	Drain of internal switching MOSFET. Connection for an external inductor. The inductor L_X is used to boost the low-input voltage by inductive flyback. When the internal switch is on, the inductor is being charged. When the internal switch is off, the charge stored in the inductor is transferred to the high-voltage capacitor, C_S. The energy stored in the capacitor is connected to the internal H-bridge, and therefore to the EL lamp. 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 of the inductor (controlled by R_{SW}) should be increased to avoid saturation.
8	CS	Connect a 100V capacitor between this pin and ground. This capacitor stores the energy transferred from the inductor.
9	EL2	EL Lamp 2 connection
10	COM2	Common connection for EL2 Lamp
11	COM1	Common connection for EL1 Lamp
12	EL1	EL Lamp 1 connection
13	PWM	PWM pulse input for EL lamp dimming. The duty cycle of the PWM signal is inversely proportional to the output voltage. If PWM dimming is not desired, then the PWM pin should be tied to ground.
14	VOUT	Switched internal reference voltage
15	VREG	Input voltage to set V_{CS} regulation voltage. This pin allows an external voltage source to control the V_{CS} amplitude. EL lamp dimming can be accomplished by varying the input voltage to V_{REG}. The V_{CS} voltage is approximately 71 times the voltage seen on V_{REG}. External resistor connected between V_{REG} and V_{OUT} pins controls the V_{CS} charging rate. The charging rate is inversely proportional to the resistor value.

TABLE 2-1: PIN FUNCTION TABLE (CONTINUED)

Pin Number	Pin Name	Description
16	VREF	Internal reference voltage to set the regulation voltage. Connect an external capacitor, C_{REF}, from V_{REF} to ground to slowly brighten the lamp during power-up and dim down the lamp during power-down. The size of the capacitor determines the time taken to brighten up or dim down. If fade-in and fade-out are not required, this pin should be left floating. Fade-in/fade-out time = C_{REF} x 210 x 103 seconds.

3.0 APPLICATION INFORMATION

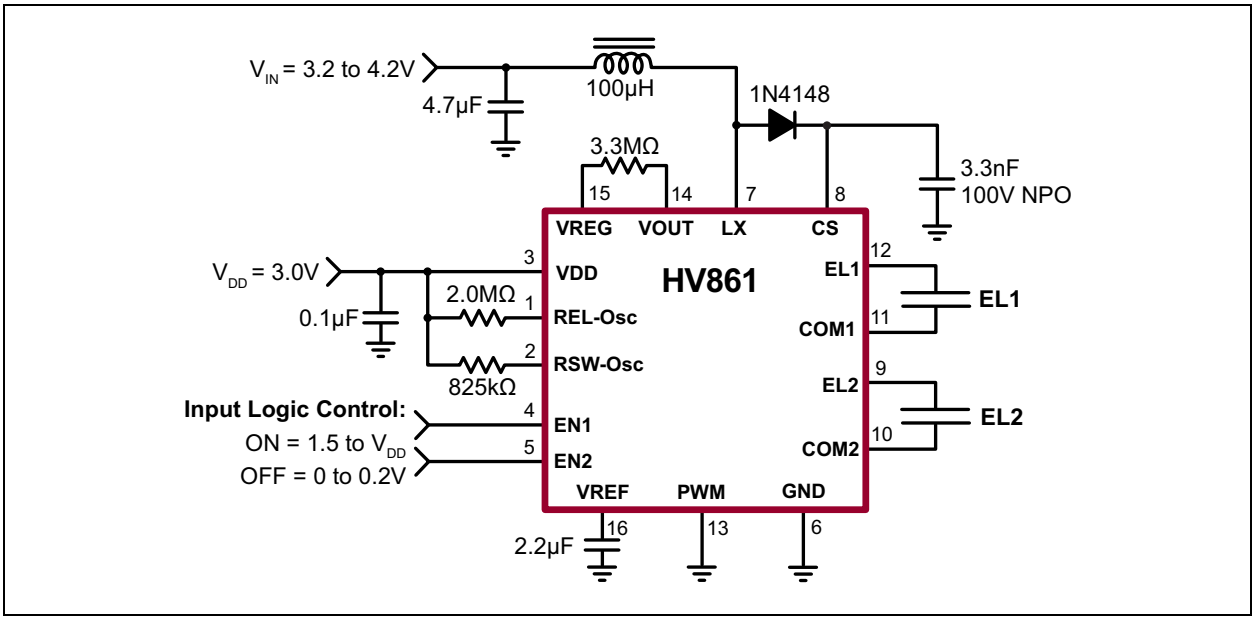


FIGURE 3-1: *Test Circuit.*

TABLE 3-1: TYPICAL PERFORMANCE (EL1 LAMP SIZE = EL2 LAMP SIZE = 3.6 IN^2)

EN1	EN2	EL1	EL2	COM1	COM2	IC
0	0	High Z	High Z	High Z	High Z	OFF
0	1	High Z	ON	High Z	ON	ON
1	0	ON	High Z	ON	High Z	ON
1	1	ON	ON	ON	ON	ON

TABLE 3-2: TRUTH FUNCTION TABLE

V_{DD} (V)	V_{IN} (V)	Lamp	I_{IN} (mA)	V_{CS} (V_{PEAK})	f_{EL} (Hz)	Lamp Brightness (cd/m^2)	
						EL1	EL2
3	4	EL1 ON	16.5	93	188	14	—
		EL2 ON	16.5			—	14
		EL1 and EL2 ON	29.8			14	14

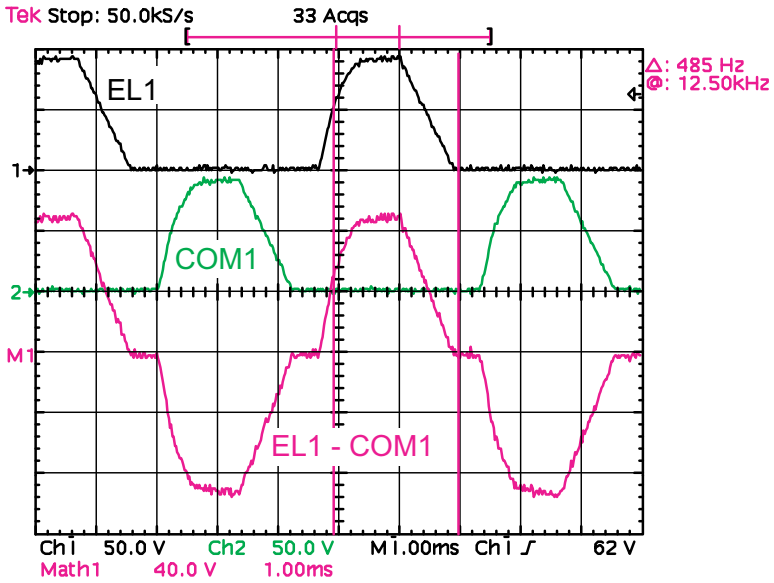


FIGURE 3-2: *Typical Waveform EL1, COM1 and Differential Waveform EL1 – COM1.*

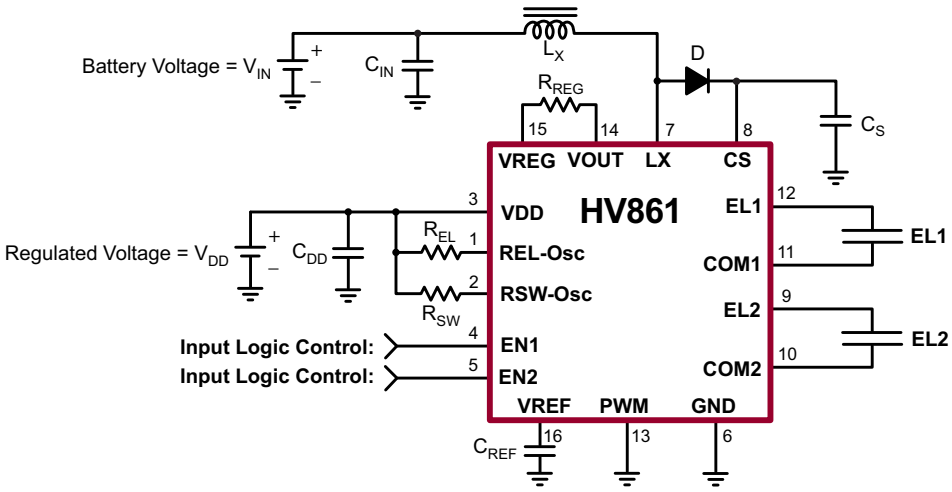


FIGURE 3-3: *Split Supply and Enable/Disable Configuration.*

3.1 Split Supply Configuration

The HV861 can also be used for handheld devices operating from a battery where a regulated voltage is available. This is shown in Figure 3-3. The regulated voltage can be used to run the internal logic of the HV861. The amount of current necessary to run the internal logic is 250 µA (maximum value). Therefore, the regulated voltage could easily provide the current without being loaded down.

3.2 Enable/Disable Configuration

The EL1 and EL2 outputs can be enabled and disabled through a logic control signal on the EN1 and EN2 pins, respectively. When EN1 is high or low, Lamp 1 (EL1) will be on or off. When EN2 is high or low, Lamp 2 (EL2) will be on or off. The control signal can be from a microprocessor.

4.0 PACKAGING INFORMATION

4.1 Package Marking Information

16-lead WQFN

```
XXXXX
YYWW
NNN
```

Example

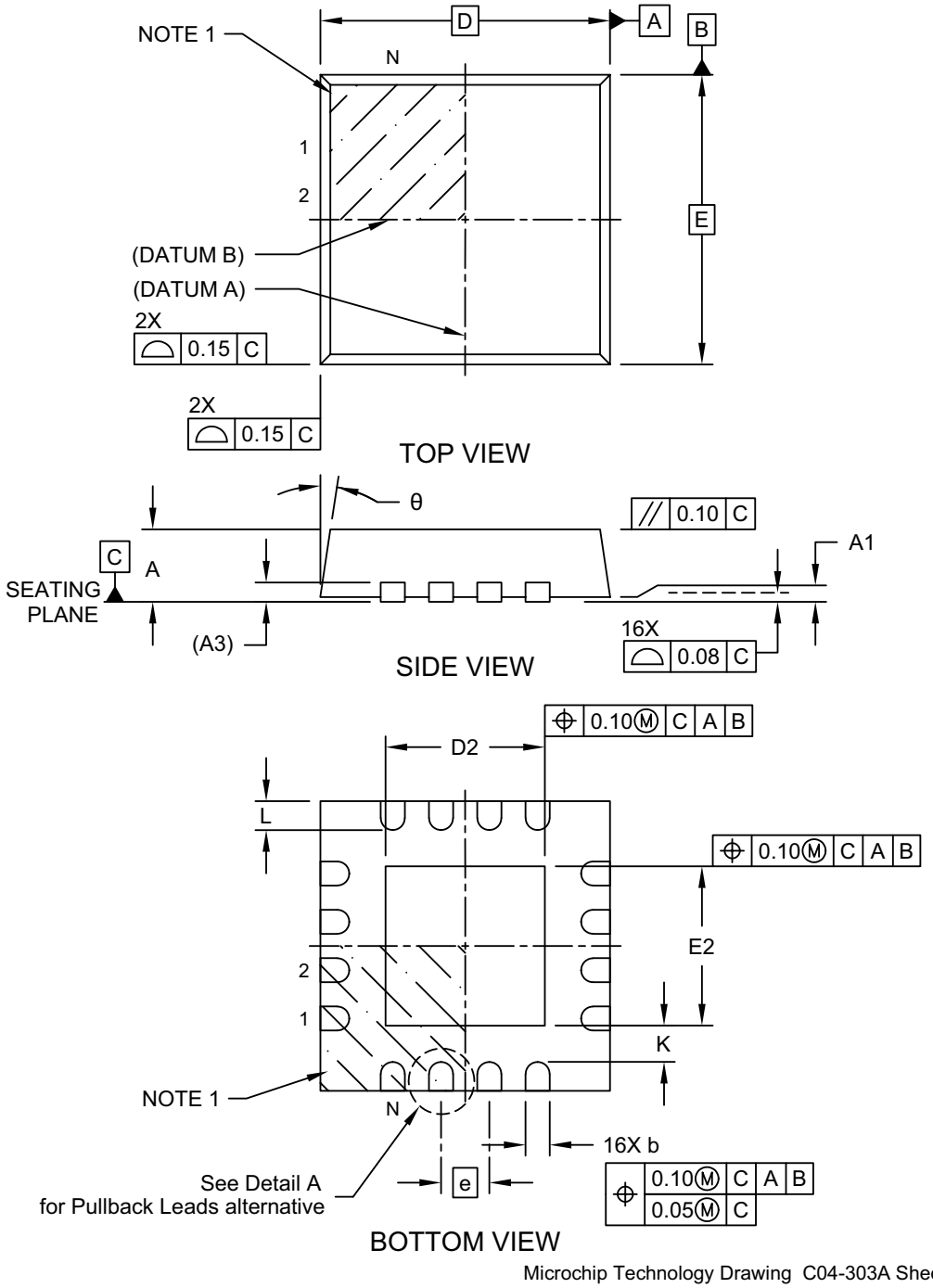
```
H861
2325
394
```

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.

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 product code or customer-specific information. Package may or not include the corporate logo.

16-Lead Very, Very Thin Plastic Quad Flat, No Lead Package (3P) - 3x3 mm Body [WQFN]; Supertex Legacy Package K7

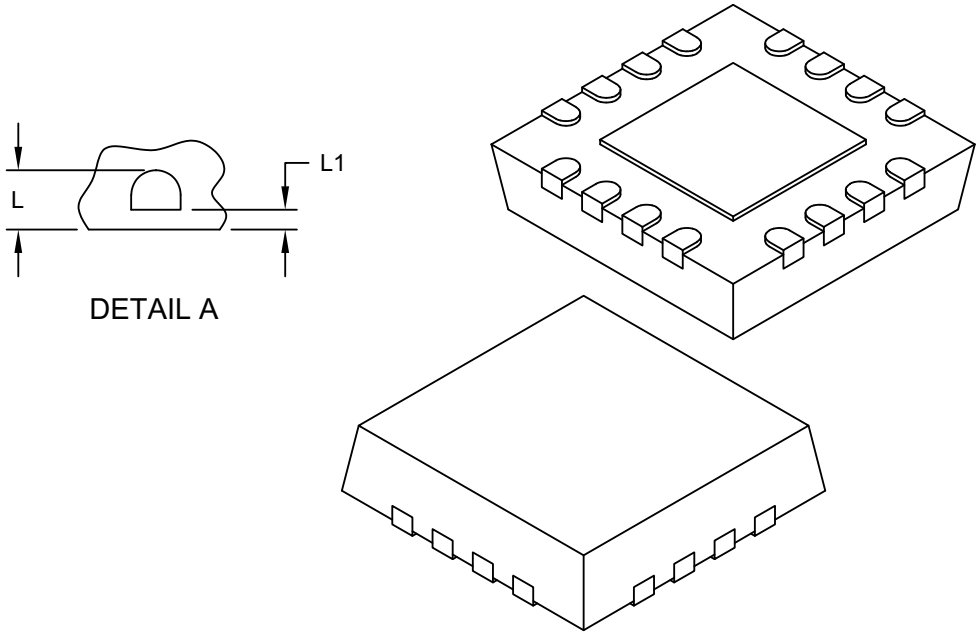
Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing C04-303A Sheet 1 of 2

16-Lead Very, Very Thin Plastic Quad Flat, No Lead Package (3P) - 3x3 mm Body [WQFN]; Supertex Legacy Package K7

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



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Terminals	N		16	
Pitch	e		0.50 BSC	
Overall Height	A	0.70	0.75	0.80
Standoff	A1	0.00	0.02	0.05
Terminal Thickness	A3		0.20 REF	
Overall Length	D		3.00 BSC	
Exposed Pad Length	D2	1.50	1.65	1.80
Overall Width	E		3.00 BSC	
Exposed Pad Width	E2	1.50	1.65	1.80
Terminal Width	b	0.18	0.25	0.30
Terminal Length	L	0.20	0.30	0.45
Pullback	L1	-	-	0.15
Mold Angle	θ	0°	7°	14°
Terminal-to-Exposed-Pad	K	**0.20**	**-**	**-**

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package is saw singulated
3. Dimensioning and tolerancing per ASME Y14.5M

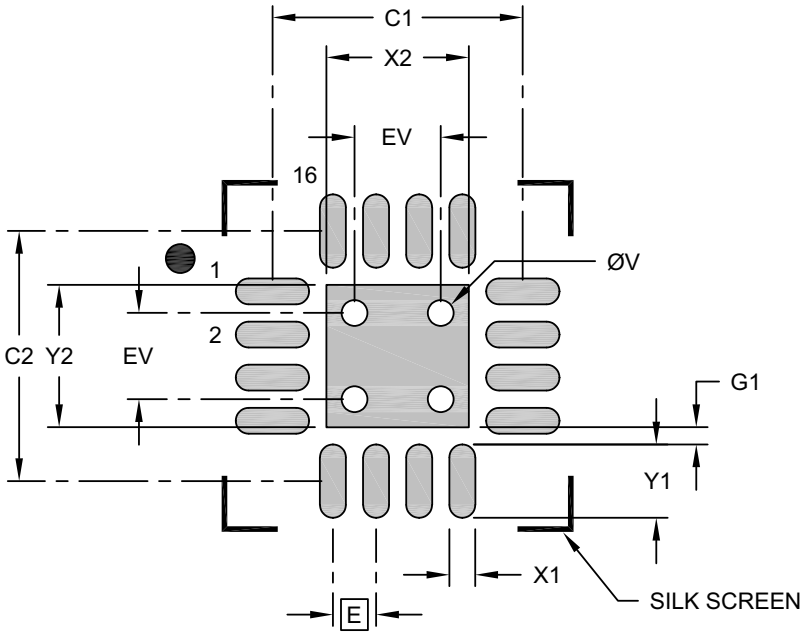
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-303A Sheet 2 of 2

16-Lead Very, Very Thin Plastic Quad Flat, No Lead Package (3P) - 3x3 mm Body [WQFN]; Supertex Legacy Package K7

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



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E		0.50 BSC	
Optional Center Pad Width	X2			1.65
Optional Center Pad Length	Y2			1.65
Contact Pad Spacing	C1		2.90	
Contact Pad Spacing	C2		2.90	
Contact Pad Width (X16)	X1			0.30
Contact Pad Length (X16)	Y1			0.85
Contact Pad to Center Pad (X16)	G1	0.20		
Thermal Via Diameter	V		0.30	
Thermal Via Pitch	EV		1.00	

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.
2. For best soldering results, thermal vias, if used, should be filled or tented to avoid solder loss during reflow process

Microchip Technology Drawing C04-2303A

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (June 2023)

- Converted Supertex Doc# DSFP-HV861 to Microchip DS20005911A
- Changed the package marking format
- Changed the quantity of the 16-lead WQFN Package from 3000/Reel to 3300/Reel to align packaging specifications with the actual BQM
- Made minor text changes throughout the document

PRODUCT IDENTIFICATION SYSTEM

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

PART NO.	XX	-	X	-	X
Device	Package Options		Environmental		Media Type

Device:	HV861	=	Low-Noise Dimmable Dual EL Lamp Driver
Package:	K7	=	16-lead WQFN (3 X 3)
Environmental:	G	=	Lead (Pb)-free/RoHS-compliant Package
Media Type:	(blank)	=	3300/Reel for a K7 Package

Example:

a) HV861K7-G: Low-Noise Dimmable Dual EL Lamp Driver, 16-lead WQFN (3 X 3), 3300/Reel

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