

## High-Voltage Dimmable EL Lamp Driver

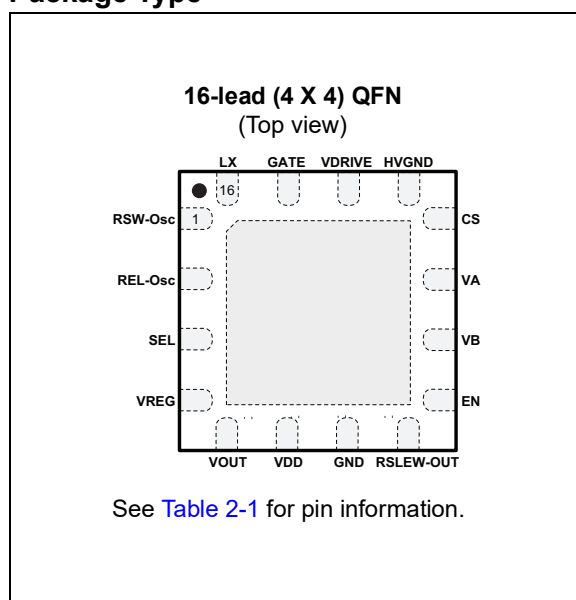
### Features

- 360 V<sub>PP</sub> Output Voltage for High Brightness
- Large Output Load Capability of up to 150 nF
- 2.7V to 5.5V Operating Supply Voltage
- Compatible with Single Lithium Ion Cell
- Adjustable Output Regulation for Dimming
- External Switching MOSFET
- Low Audible Noise
- Output Discharge Slew Rate Control
- 1.5V Logic
- Dedicated Enable Pin
- Two Electroluminescent (EL) Frequency Controls
- Independent Lamp and Converter Frequency Setting
- Split Supply Capability

### Applications

- Laptop Keyboards
- Netbook Keyboards
- Display Signs
- Portable Instrumentation Equipment
- Electronic Organizers

### Package Type



### General Description

The HV816 is a high-voltage EL lamp driver designed for driving a lamp capacitance of up to 150 nF or an area of approximately 42 square inches. It is made up of a boost converter followed by an H-bridge. The boost converter produces a regulated output voltage, which is set at a nominal value of 180V using an internal reference voltage. The H-bridge is used to produce a differential output drive, so the EL lamp will see  $\pm 180V$  (360V peak-to-peak). The HV816 has two internal oscillators—one for controlling the boost converter switching frequency and one for controlling the H-bridge switching frequency. Having separate control of each switching frequency allows flexibility in circuit design.

The operating input supply voltage is 2.7V to 5.5V, but the Enable (EN) and Select (SEL) interface to the device will accept logic high levels down to 1.5V. The EN input is for turning the device ON and OFF. The SEL input is for external logic control of the H-bridge switching frequency, if required.

The HV816 boost converter stage uses a single inductor and a minimum number of external components. The input voltage to the inductor can be different from the input voltage to the HV816 (split supply). The external inductor is connected either between the LX and V<sub>DD</sub> pins or, for split supply applications, between the LX pin and a higher voltage supply (shown as V<sub>IN</sub> in the [Functional Block Diagram](#)). An external MOSFET has to be driven by the switch oscillator to generate a high voltage. The switching frequency for this MOSFET is set by an external resistor connected between the RSW-Osc pin and the supply pin, V<sub>DD</sub>. During operation, the external switching MOSFET turns on and allows energy to be stored in the inductor. This energy is transferred into the capacitor C<sub>S</sub> when the MOSFET turns off. The voltage at the C<sub>S</sub> pin will increase with every switching cycle. Once the voltage at the C<sub>S</sub> pin reaches the desired regulation limit, nominally 180V, the external switching MOSFET is turned OFF to conserve power.

The C<sub>S</sub> capacitor is connected between the C<sub>S</sub> pin and ground. The C<sub>S</sub> pin is internally connected to the H-bridge. Energy from the boost converter stage is stored in the capacitor before being transferred to the EL lamp. Depending on the EL lamp size, a 1 nF to 15 nF capacitor should be used for C<sub>S</sub>.

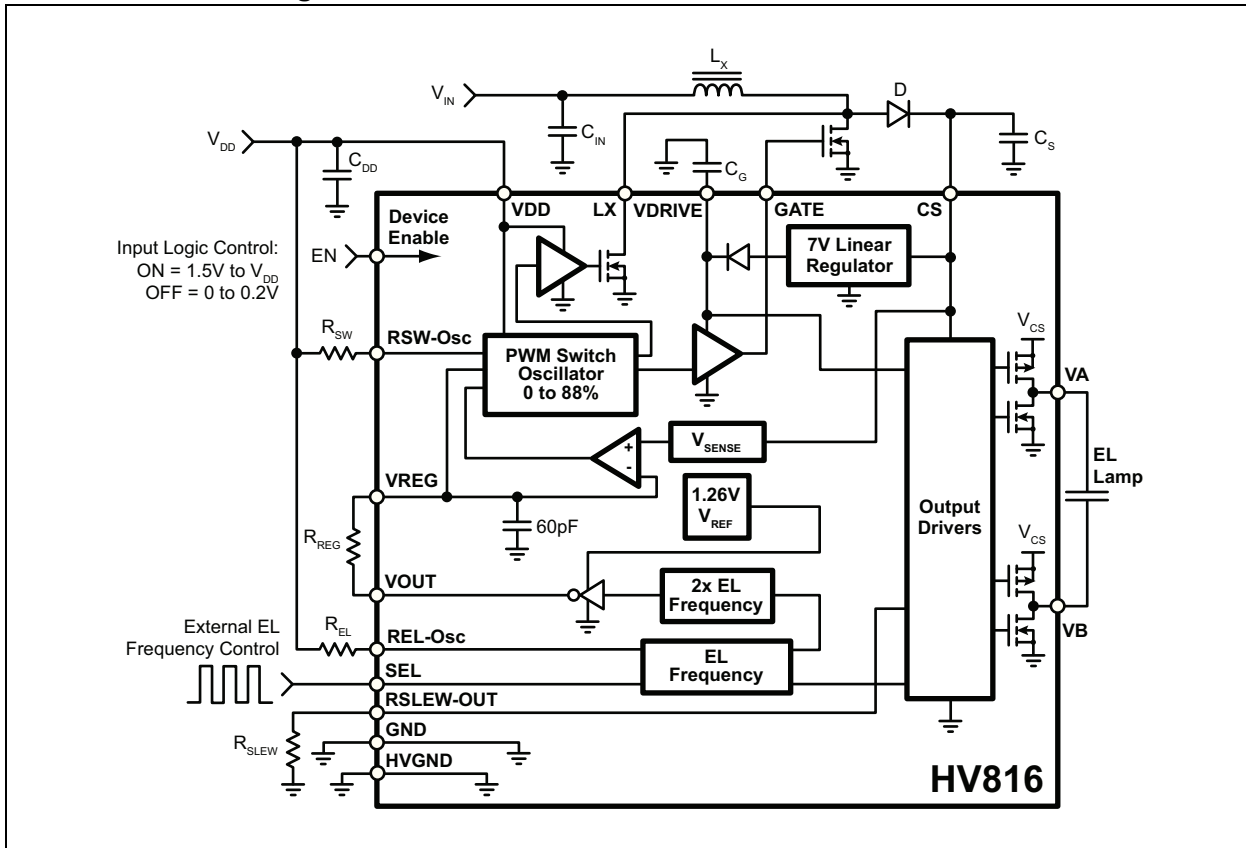
The EL lamp switching frequency can be within the range of 100 Hz to 1 Hz. This frequency can be set by either an external logic signal at the SEL pin, with a frequency that is four times the desired EL lamp switching frequency, or by an external resistor connected between the REL-Osc and V<sub>DD</sub> pins. If external frequency is input to the device at the SEL pin, the REL-Osc pin should be connected to ground.

The HV816 has the provision to control the output's discharge rate to minimize audible noise emitted by the EL lamp, which is connected between the VA and VB pins. An external resistor from the RSLEW-OUT pin to ground controls the VA, VB output discharge rate.

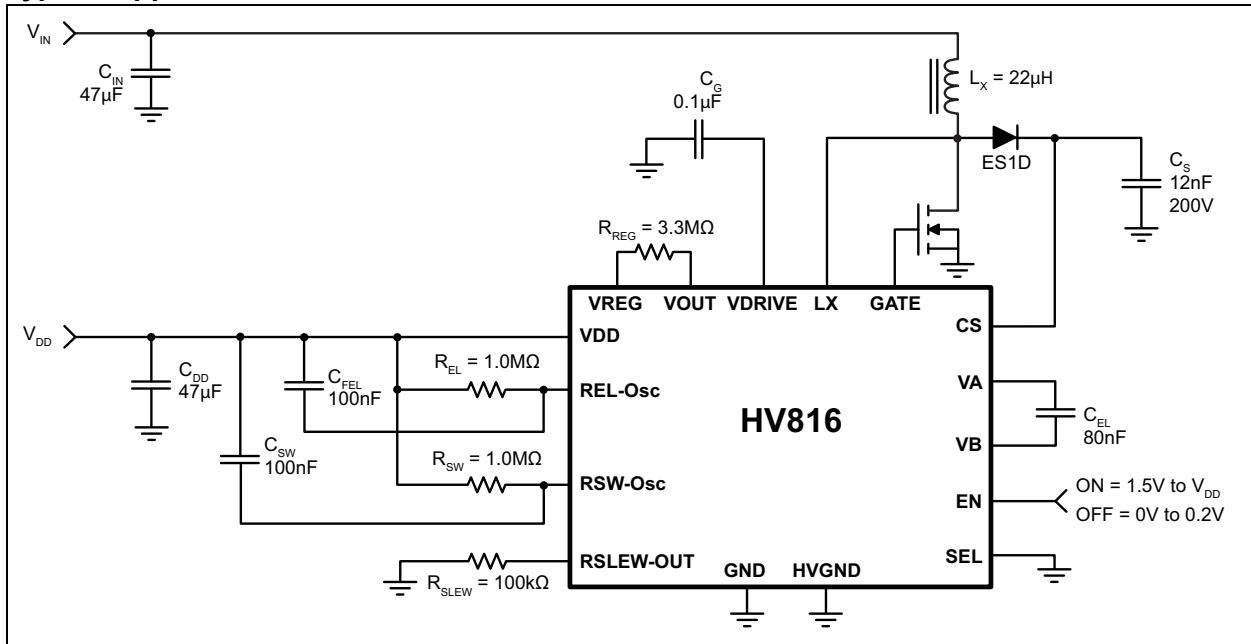
EL lamp dimming can be accomplished by changing the input voltage to the V<sub>REG</sub> pin. The V<sub>REG</sub> pin allows an external voltage source to control the V<sub>CS</sub> amplitude. The V<sub>CS</sub> voltage is approximately 143 times the voltage at the V<sub>REG</sub> pin.

# HV816

## Functional Block Diagram



## Typical Application Circuit



# HV816

## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings †

Supply Voltage, $V_{DD}$	-0.5V to 7V
Output Voltage, $V_{CS}$	-0.5V to 215V
Operating Temperature, $T_A$	-40°C to +125°C
Storage Temperature, $T_S$	-65°C to +150°C
Power Dissipation:	
16-lead QFN	1.6 Watts
ESD Rating	ESD Sensitive

† **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.

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

### RECOMMENDED OPERATING CONDITIONS

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Supply Voltage	$V_{DD}$	2.7	—	5.5	V	
Switching Frequency	$f_{SW}$	50	—	200	kHz	
EL Output Frequency	$f_{EL}$	100	—	1000	Hz	
Input for EL Output Frequency	$S_{EL}$	400	—	4000	Hz	$S_{EL} = 4 * (f_{EL})$ and 50% duty cycle
Output Discharge Slew Rate Control Resistor	$R_{SLEW}$	100	—	500	k $\Omega$	
EL Lamp Load Capacitance	$C_{EL}$	0	—	150	nF	

### DC ELECTRICAL CHARACTERISTICS

Electrical Specifications: Over recommended operating conditions unless otherwise indicated; $T_J = T_A = 25^\circ\text{C}$						
Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Output Regulation Voltage	$V_{CS}$	160	180	200	V	$V_{DD} = 2.7\text{V to } 5.5\text{V}$
Differential Output Voltage	$V_A - V_B$	320	360	400	V	$V_{DD} = 2.7\text{V to } 5.5\text{V}$
Quiescent $V_{DD}$ Supply Current	$I_{DDQ}$	—	—	2	$\mu\text{A}$	$V_{DD} = 5.5\text{V}$ , EN = Low
Input Current Going into the $V_{DD}$ Pin	$I_{DD}$	—	—	3	mA	$V_{DD} = 2.7\text{V to } 5.5\text{V}$ , $V_{IN} = 5\text{V}$ , $C_{EL} = 80\text{ nF}$ (See <a href="#">Typical Application Circuit.</a> )
Input Current Including Inductor Current with Load	$I_{IN-LOAD}$	—	—	380	mA	$V_{DD} = 5.5\text{V}$ , $V_{IN} = 5\text{V}$ , $R_{EL} = 1\text{ M}\Omega$ , $R_{SW} = 1\text{ M}\Omega$ (See <a href="#">Typical Application Circuit.</a> )
Input Current Including Inductor Current without Load	$I_{IN-NOLOAD}$	—	—	80	mA	$V_{DD} = 2.7\text{V to } 5.5\text{V}$ , $V_{IN} = 5\text{V}$ No Load, (See <a href="#">Typical Application Circuit.</a> )
Quiescent $V_{IN}$ (Inductor Input Voltage) Supply Current	$I_{INQ}$	—	—	10	$\mu\text{A}$	$V_{IN} = 10\text{V}$ , EN = Low (See <a href="#">Typical Application Circuit.</a> )
External Input Voltage Range	$V_{REG}$	0	—	1.33	V	$V_{DD} = 2.7\text{V to } 5.5\text{V}$
EL Lamp Frequency	$f_{EL}$	—	200	—	Hz	$R_{EL} = 1\text{ M}\Omega$
External MOSFET Switching Frequency	$f_{SW}$	—	90	—	kHz	$R_{SW} = 1\text{ M}\Omega$
External MOSFET Duty Cycle	D	—	—	88	%	
EN, SEL Logic Pins Input High Level	$V_{IH}$	1.5	—	$V_{DD}$	V	$V_{DD} = 2.7\text{V to } 5.5\text{V}$

## DC ELECTRICAL CHARACTERISTICS (CONTINUED)

**Electrical Specifications:** Over recommended operating conditions unless otherwise indicated;  $T_J = T_A = 25^\circ\text{C}$

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
EN, SEL Logic Pins Input Low Level	$V_{IL}$	0	—	0.2	V	$V_{DD} = 2.7\text{V to } 5.5\text{V}$
EN, SEL Logic Pins High Current	$I_{LOGIC}$	-1	—	1	$\mu\text{A}$	$V_{DD} = 2.7\text{V to } 5.5\text{V}$
External MOSFET Gate Voltage	$V_{GATE}$	—	8	—	V	$V_{DD} = 2.7\text{V to } 5.5\text{V}$
External MOSFET Gate Voltage Rise Time	$t_{GATE-RISE}$	—	100	200	ns	$V_{DD} = 2.7\text{V to } 5.5\text{V}, C_{LOAD} = 500\text{ pF}$
External MOSFET Gate Voltage Fall Time	$t_{GATE-FALL}$	—	—	20	ns	$V_{DD} = 2.7\text{V to } 5.5\text{V}, C_{LOAD} = 500\text{ pF}$
Output Fall Time	$t_{VA-FALL}$ or $t_{VB-FALL}$	—	180	—	$\mu\text{s}$	$C_{EL} = 150\text{ nF}, V_{CS} = 180\text{V}, R_{SLEW} = 100\text{ k}\Omega$
On-resistance of Internal N-channel MOSFET at LX Pin	$R_{ON}$	—	—	30	$\Omega$	Guaranteed by design

## TEMPERATURE SPECIFICATIONS

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
<b>TEMPERATURE RANGE</b>						
Operating Temperature	$T_A$	-40	—	+125	$^\circ\text{C}$	
Storage Temperature	$T_S$	-65	—	+150	$^\circ\text{C}$	
<b>PACKAGE THERMAL RESISTANCE</b>						
16-lead (4 X 4) QFN	$\theta_{JA}$	—	+25	—	$^\circ\text{C/W}$	

# HV816

## 2.0 PIN DESCRIPTION

The details on the pins of HV816 are listed in [Table 2-1](#). See location of pins in [Package Type](#).

**TABLE 2-1: PIN FUNCTION TABLE**

Pin Number	Pin Name	Description
1	RSW-Osc	External resistor $R_{SW}$ from the RSW-Osc to $V_{DD}$ pins 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 switching frequency by a factor of two. A $C_{SW}$ capacitor is recommended from RSW-Osc to the VDD pin to shunt any switching noise that may couple into the RSW-Osc pin. A $C_{SW}$ capacitor with a value of 100 nF is typically recommended.
2	REL-Osc	External resistor $R_{EL}$ from the REL-Osc to $V_{DD}$ pins 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 lamp frequency by a factor of two. The SEL pin should be connected to ground if the $R_{EL}$ resistor is used to set the EL frequency. A $C_{FEL}$ capacitor is recommended from the REL-Osc to $V_{DD}$ pins to shunt any switching noise that may couple into the REL-Osc pin. A $C_{FEL}$ capacitor with a value of 100 nF is typically recommended.
3	SEL	External logic signal input to set the EL frequency. The REL-Osc pin should be connected to ground to use this pin. The output EL frequency is $\frac{1}{4}$ of the frequency input at this pin. This pin, if not used, should be connected to ground. Input logic high is 1.5V to $V_{DD}$ . Input logic low is 0V to 0.2V.
4	VREG	Input voltage to set $V_{CS}$ regulation voltage. This pin allows an external voltage source to control the $V_{CS}$ amplitude. The $V_{CS}$ voltage = $(143 \pm 5\%) \times V_{REG}$ . An external resistor, $R_{REG}$ , connected between the $V_{REG}$ and $V_{OUT}$ pins controls the $V_{CS}$ charging rate. The charging rate is inversely proportional to the $R_{REG}$ resistor value.
5	VOUT	Switched internal reference voltage
6	VDD	Device low voltage input supply pin
7	GND	Device ground
8	RSLEW-OUT	An external resistor $R_{SLEW}$ from this pin to ground controls the slew rate of VA and VB output discharge. The output discharge slew rate is inversely proportional to the $R_{SLEW}$ resistor value. The VA, VB output discharge time is given by the equation: $t_{VA-fall} \text{ or } t_{VB-fall} = \frac{(R_{SLEW} \times C_{EL}) \text{ sec}}{43.73}$
9	EN	Enable logic pin to turn the device ON/OFF. Input logic high is 1.5V to $V_{DD}$ . Input logic low is 0V to 0.2V.
10	VA	Lamp connections. The polarity is irrelevant. The EL load capacitance is up to 150 nF.
11	VB	
12	CS	High-voltage regulated output. Connection for an external high-voltage capacitor to ground. A 0.001 $\mu$ F to 0.015 $\mu$ F 200V capacitor can be used to store the energy transferred from the inductor.
13	HVGND	High-voltage ground. Connect it to device ground.
14	VDRIVE	Drive voltage pin. An external capacitor of 0.1 $\mu$ F, $C_G$ , is required at this pin to ground. VDRIVE represents internal regulated voltage to supply internal circuits including GATE drivers.

**TABLE 2-1: PIN FUNCTION TABLE**

Pin Number	Pin Name	Description
15	GATE	Gate control pin for the switching MOSFET. Connection for an external MOSFET. The external MOSFET is used to boost the low input voltage by inductive flyback. When the MOSFET is ON, the inductor is being charged. When the MOSFET is OFF, the charge stored in the inductor will be transferred to the high-voltage capacitor $C_S$ . The energy stored in the capacitor is transferred to the internal H-bridge, and therefore to the EL lamp. In general, low $R_{ON}$ MOSFETs, which can handle more current, are more suitable to drive larger size lamps. Also, a small value inductor should be used. But as the $R_{ON}$ value and the inductor value decrease, the switching frequency of the inductor (controlled by $R_{SW}$ ) should be increased to avoid inductor saturation. The inductor input voltage ( $V_{IN}$ ) is recommended to be minimum 4.5V to get the 180V output regulation voltage with 150 nF EL load.
16	LX	Drain of the internal N-channel MOSFET. The internal MOSFET is used to generate the GATE pin voltage at startup.

# HV816

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## 3.0 PACKAGING INFORMATION

### 3.1 Package Marking Information

16-lead QFN

XX XXXXX ⒺYYWW NNN
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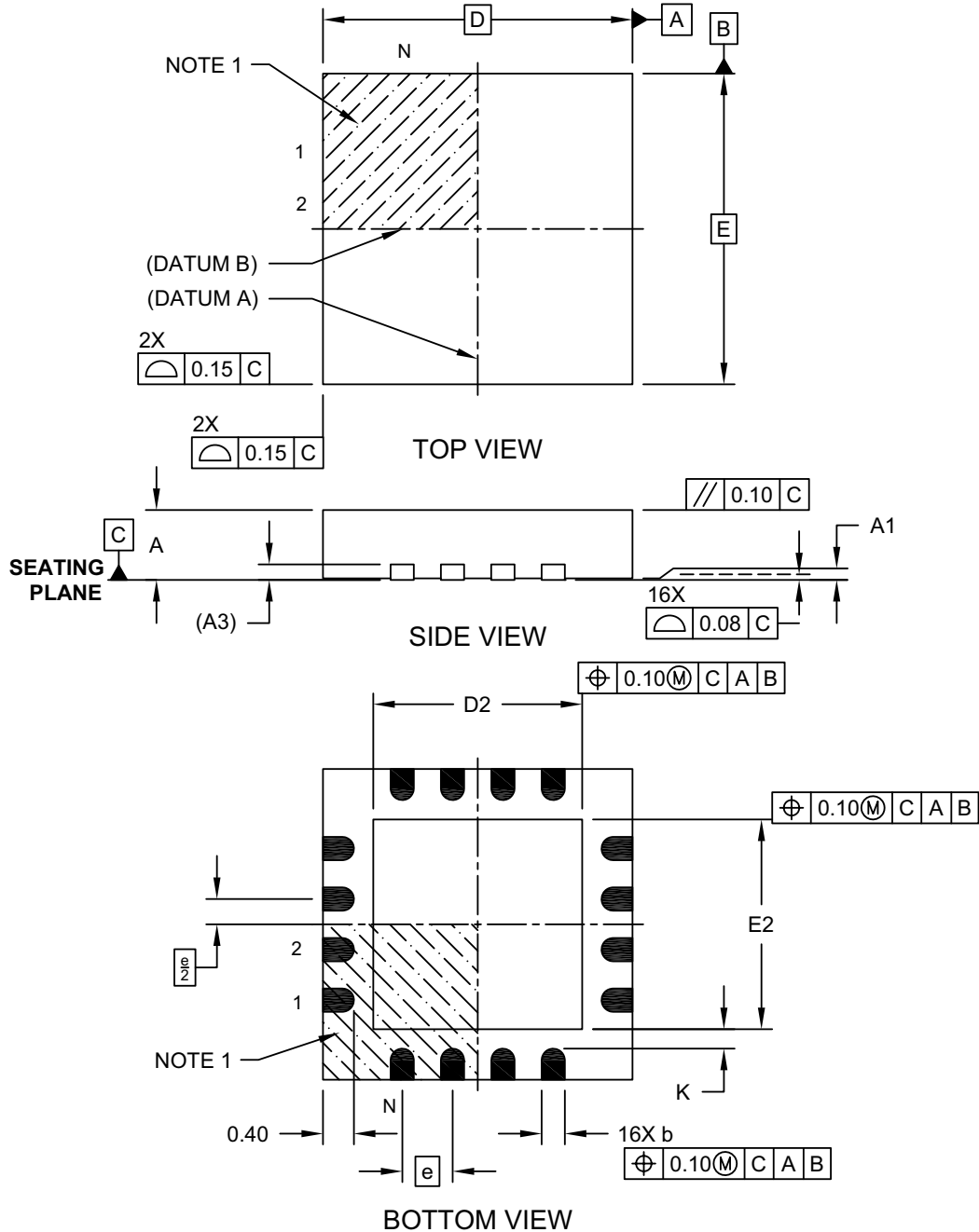
Example

HV 816K6 Ⓔ2317 658
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<b>Legend:</b>	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
	Ⓔ	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator (Ⓔ) can be found on the outer packaging for this package.
<b>Note:</b>	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 Plastic Quad Flat, No Lead Package (ML) - 4x4x0.9mm Body [QFN]

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

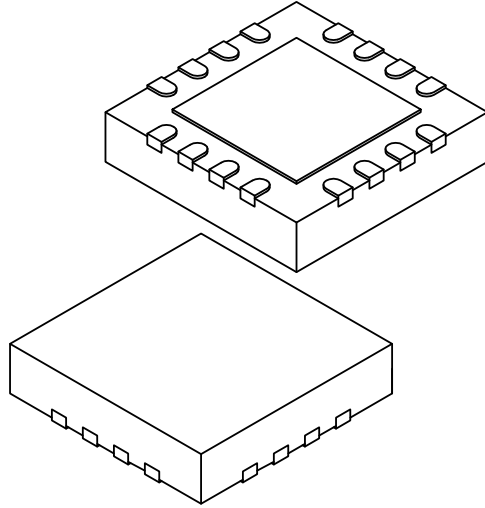


Microchip Technology Drawing C04-127D Sheet 1 of 2

# HV816

## 16-Lead Plastic Quad Flat, No Lead Package (ML) - 4x4x0.9mm Body [QFN]

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



Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Number of Pins	N	16		
Pitch	e	0.65 BSC		
Overall Height	A	0.80	0.90	1.00
Standoff	A1	0.00	0.02	0.05
Contact Thickness	A3	0.20 REF		
Overall Width	E	4.00 BSC		
Exposed Pad Width	E2	2.50	2.65	2.80
Overall Length	D	4.00 BSC		
Exposed Pad Length	D2	2.50	2.65	2.80
Contact Width	b	0.25	0.30	0.35
Contact Length	L	0.30	0.40	0.50
Contact-to-Exposed Pad	K	0.20	-	-

**Notes:**

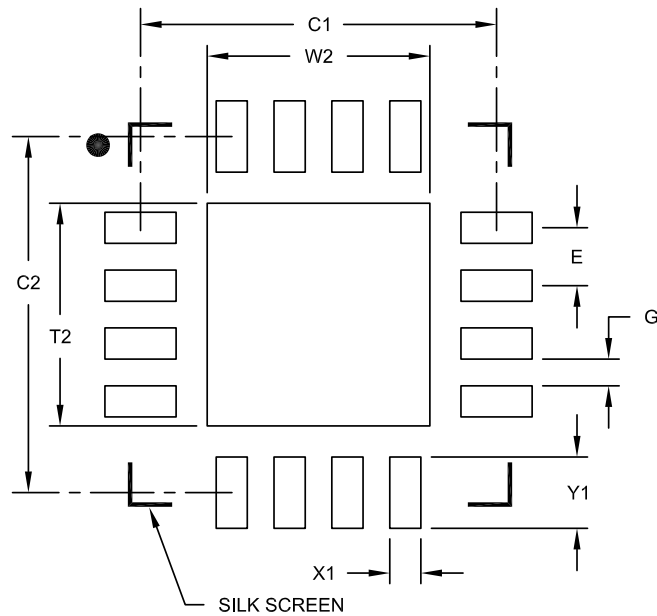
1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package is saw singulated
3. Dimensioning and tolerancing per ASME Y14.5M

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

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

Microchip Technology Drawing C04-127D Sheet 2 of 2

## 16-Lead Plastic Quad Flat, No Lead Package (ML) - 4x4x0.9mm Body [QFN]



RECOMMENDED LAND PATTERN

Dimension	Units	MILLIMETERS		
		MIN	NOM	MAX
Contact Pitch	E	0.65 BSC		
Optional Center Pad Width	W2			2.50
Optional Center Pad Length	T2			2.50
Contact Pad Spacing	C1		4.00	
Contact Pad Spacing	C2		4.00	
Contact Pad Width (X28)	X1			0.35
Contact Pad Length (X28)	Y1			0.80
Distance Between Pads	G	0.30		

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

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

Microchip Technology Drawing No. C04-2127A

# HV816

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NOTES:

## APPENDIX A: REVISION HISTORY

### Revision A (July 2023)

- Converted Supertex Doc# DSFP-HV816 to Microchip DS20005633A
- Changed the quantity of the K6 package from 3000/Reel to 3300/Reel to align packaging specifications with the actual BQM
- Made minor text changes throughout the document

# HV816

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<u>PART NO.</u>	<u>XX</u>	-	<u>X</u>	-	<u>X</u>
Device	Package Options		Environmental		Media Type
Device:	HV816	=	High-Voltage Dimmable EL Lamp Driver		
Packages:	K6	=	16-lead (4 X 4) QFN		
Environmental:	G	=	Lead (Pb)-free/RoHS-compliant Package		
Media Type:	(blank)	=	3300/Reel for a K6 Package		

**Example:**

a) HV816K6-G: High-Voltage Dimmable EL Lamp Driver, 16-lead (4 X 4) QFN Package, 3300/Reel

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