HV857

High-Voltage Low-Noise EL Lamp Driver IC

Features

- Patented Audible Noise Reduction
- Patented Lamp Aging Compensation
- 190 V_{PP} Output Voltage for Higher Brightness
- Patented Output Timing for High Efficiency
- Single-cell Lithium Ion-compatible
- 150 nA Shutdown Current
- 1.8V to 5V Wide Input Voltage Range
- Separately Adjustable Lamp and Converter Frequencies
- Output Voltage Regulation
- Split Supply Capability

Applications

- LCD Backlighting
- Mobile Cellular Phone
- PDAs
- Handheld Wireless Communication Devices
- Global Positioning Systems (GPS)

General Description

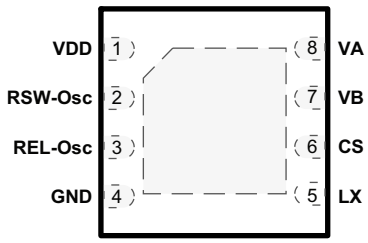
The HV857 is a high-voltage driver designed for driving Electroluminescent (EL) lamps of up to 5 in^2. The input supply voltage range is from 1.8V to 5V. The device uses a single inductor and a minimum number of passive components. The nominal regulated output voltage that is applied to the EL lamp is ±95V. The chip can be enabled and disabled by connecting the resistor on RSW-Osc to VDD/GND.

The HV857 has two internal oscillators, a switching MOSFET, and a high-voltage EL lamp driver. The frequency for the switching MOSFET is set by an external resistor connected between the RSW-Osc pin and the supply pin, VDD. The EL lamp driver frequency is set by an external resistor connected between REL-Osc pin and VDD pin. An external inductor is connected between the LX and VDD pins or V_{IN} for split supply applications. A 0.003 µF–0.1 µF capacitor is connected between CS and ground. The EL lamp is connected between VA and VB.

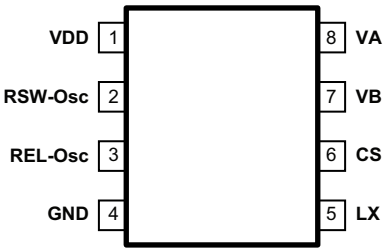
The switching MOSFET charges the external inductor and discharges it into the capacitor at CS. The voltage at CS will start to increase. Once the voltage at CS reaches a nominal value of 95V, the switching MOSFET is turned off to conserve power. The outputs VA and VB are configured as an H-bridge and are switching in opposite states to achieve ±95V across the EL lamp.

Package Types

8-lead WDFN
(Top view)

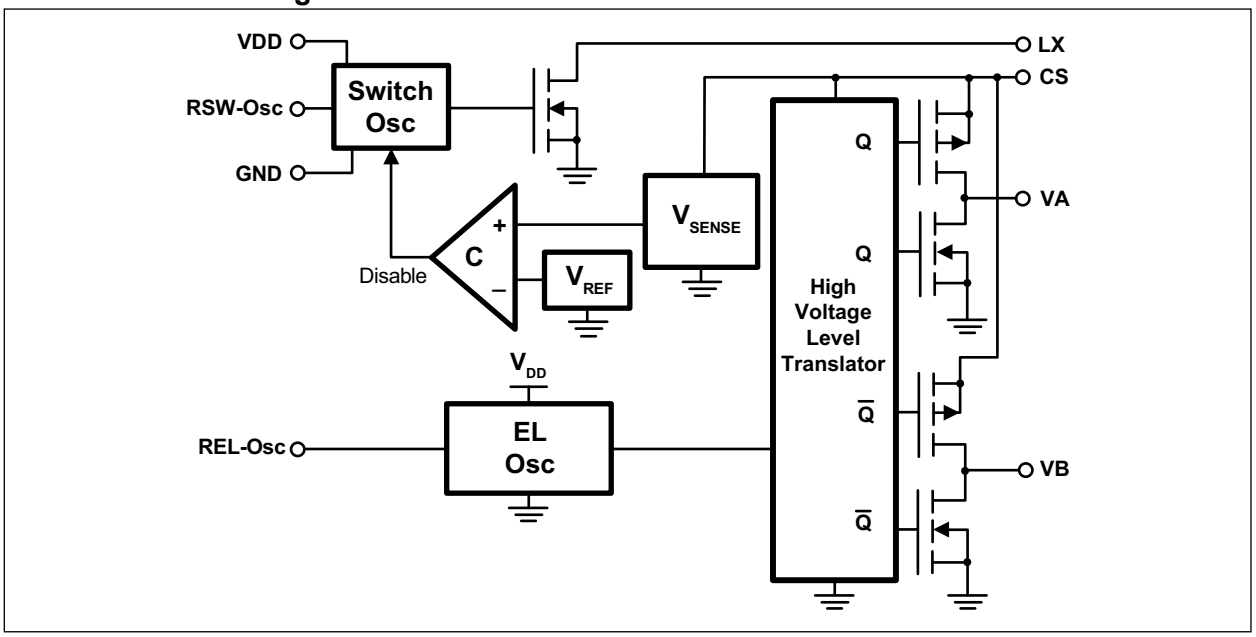


8-lead MSOP
(Top view)

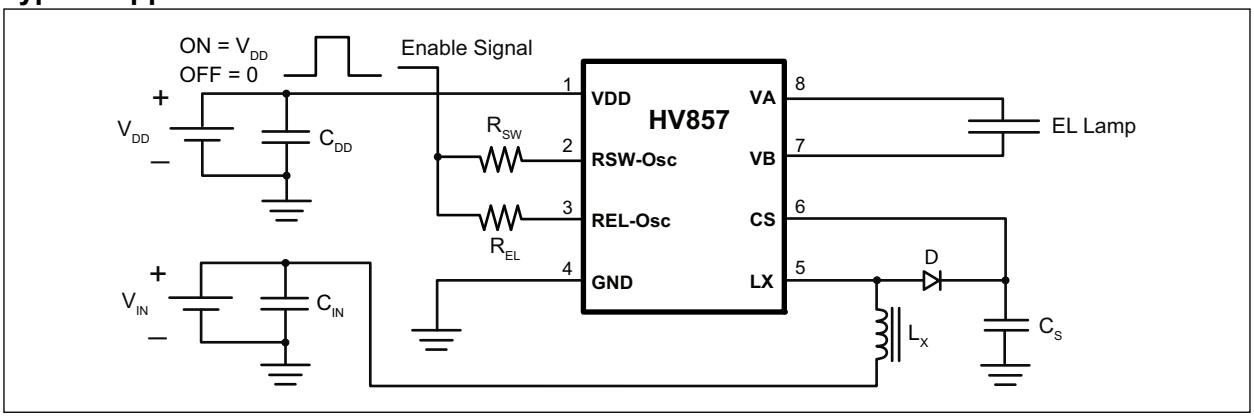


WDFN pads are at the bottom of package. Exposed center pad is at ground potential. See Table 2-1 for pin information.

Functional Block Diagram



Typical Application Circuit



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings(†)

Supply Voltage, V_{DD} ..... –0.5V to 6.5V
Output Voltage, V_{CS} ..... –0.5V to +120V
Operating Ambient Temperature, T_A ..... –40°C to +85°C
Storage Temperature, T_S ..... –65°C to +150°C
Power Dissipation:
8-lead WDFN 1.6W
8-lead MSOP ..... 300 mW

† **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
Supply Voltage	V_{DD}	1.8	—	5	V	
Operating Drive Frequency	f_{EL}	—	—	1	kHz	
Operating Temperature	T_A	–40	—	+85	°C	

DC ELECTRICAL CHARACTERISTICS

Electrical Specifications: Over recommended operating conditions unless otherwise specified, T_A = 25°C.

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
On-resistance of Switching Transistor	$R_{DS(ON)}$	—	—	6	Ω	I = 100 mA
Maximum Output Regulation Voltage	V_{CS}	85	95	105	V	V_{DD} = 1.8V to 5V
Peak-to-Peak Output Voltage	$V_A – V_B$	170	190	210	V	V_{DD} = 1.8V to 5V
Quiescent V_{DD} Supply Current	I_{DDQ}	—	—	150	nA	R_{SW-Osc} = Low
Input Current Going into the V_{DD} Pin	I_{DD}	—	—	150	µA	V_{DD} = 1.8V to 5V (See Figure 3-1.)
Input Current including Inductor Current	I_{IN}	—	20	25	mA	See Figure 3-1. (**Note 1**)
Output Voltage on V_{CS}	V_{CS}	—	84	—	V	See Figure 3-1.
EL Lamp Frequency	f_{EL}	205	240	275	Hz	See Figure 3-1.
Switching Transistor Frequency	f_{SW}	—	80	—	kHz	See Figure 3-1.
Switching Transistor Duty Cycle	D	—	88	—	%	See Figure 3-1.

Note 1: The 220 µH inductor used has a maximum DC resistance of 8.4Ω.

TEMPERATURE SPECIFICATIONS

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
TEMPERATURE RANGE						
Operating Ambient Temperature	T_A	–40	—	+85	°C	
Storage Temperature	T_S	–65	—	+150	°C	
PACKAGE THERMAL RESISTANCE						
8-lead WDFN	θ_{JA}	—	37	—	°C/W	
8-lead MSOP	θ_{JA}	—	171	—	°C/W	

Note 1: Mounted on an FR4 board, 25 mm x 25 mm x 1.57 mm.

ENABLE/DISABLE FUNCTION TABLE

Parameter	Sym.	Min.	Typ.	Max.	Unit	Conditions
Logic Input Low Voltage	EN-L	0	—	0.2	V	V_{DD} = 1.8V to 5V
Logic Input High Voltage	EN-H	V_{DD}–0.2	—	V_{DD}	V	V_{DD} = 1.8V to 5V

2.0 PIN DESCRIPTION

The details on the pins of HV857 are listed in Table 2-1.
See location of pins in **Package Types**.

TABLE 2-1: PIN FUNCTION TABLE

8-lead DFN Pin Number	8-lead MSOP Pin Number	Pin Name	Description
1	1	VDD	Power supply pin
2	2	RSW-Osc	The switching frequency of the converter is controlled via an external resistor R_{SW} between RSW-Osc and VDD of the device. The switching frequency increases as R_{SW} decreases. Given the inductor, as the switching frequency increases, the amount of current drawn from the battery decreases and the output voltage, V_{CS}, also decreases. $$f_{SW} = \frac{560k\Omega \times 80Hz}{R_{SW}}$$
3	3	REL-Osc	The EL lamp frequency is controlled via an external R_{EL} resistor connected between REL-Osc and VDD of the device. The lamp frequency increases as the R_{EL} decreases. As the EL lamp frequency increases, the amount of current drawn from the battery rises and the output voltage, V_{CS}, drops. The color of the EL lamp is dependent upon its frequency. A 2 MΩ resistor would provide a lamp frequency of 205 Hz to 275 Hz. Decreasing the R_{EL} resistor by a factor of two will increase the lamp frequency by a factor of two. $$f_{EL} = \frac{2M\Omega \times 240Hz}{R_{EL}}$$
4	4	GND	Ground pin
5	5	LX	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 connects to the EL lamp. In general, smaller value inductors, which can handle more current, are more suitable to drive larger sized lamps. As the inductor value decreases, the switching frequency of the inductor (controlled by R_{SW}) should be increased to avoid saturation. A 220 µH inductor with an 8.4Ω series DC resistance is typically recommended. For inductors with the same inductance value, but with a lower series DC resistance, a lower R_{SW} resistor value is needed to prevent high current draw and inductor saturation.
6	6	CS	A fast reverse recovery diode, BAS21 or equivalent, needs to be connected between the CS pin and LX pin. A 0.003 µF to 0.1 µF, 100V capacitor to GND is used to store the energy transferred from the inductor.

TABLE 2-1: PIN FUNCTION TABLE

8-lead DFN Pin Number	8-lead MSOP Pin Number	Pin Name	Description
7,8	7,8	VB,VA	The EL lamp terminals are connected to the VA and VB pins. Polarity is irrelevant. As the EL lamp size increases, more current will be drawn from the battery to maintain high voltage across the EL lamp. The input power (V_{IN} x I_{IN}) will also increase. If the input power is greater than the power dissipation of the package, an external resistor in series with one side of the lamp is recommended to help reduce the package power dissipation.

3.0 APPLICATION INFORMATION

3.1 Typical Application/Test Circuit

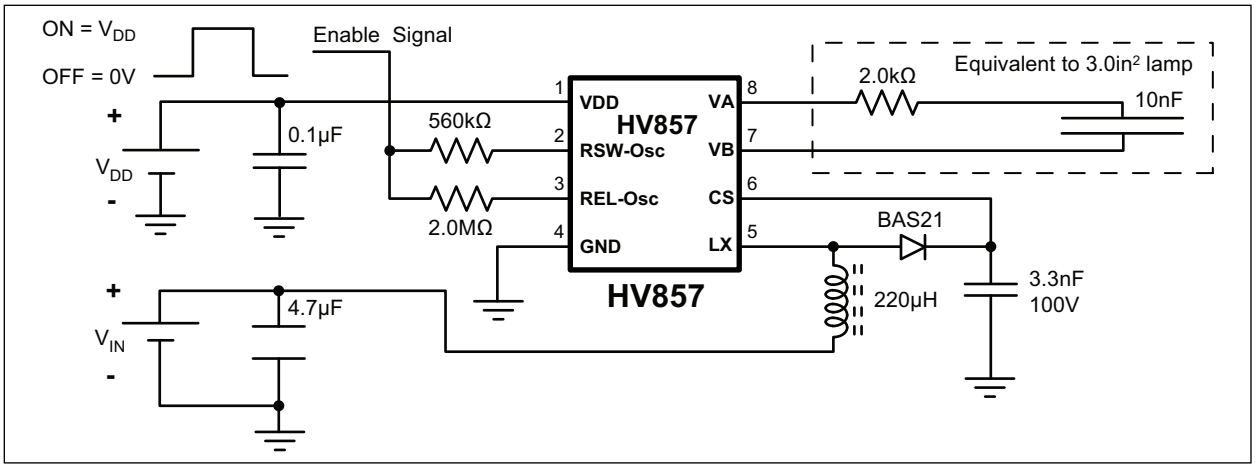


FIGURE 3-1: *Typical Application/Test Circuit.*

TABLE 3-1: TYPICAL PERFORMANCE

Device	Lamp Size	$V_{DD} = V_{IN}$	I_{IN}	V_{CS}	f_{EL}	Brightness
HV857	3 in^2	3.3V	20 mA	84V	240 Hz	6ft-lm

3.1.1 TYPICAL PERFORMANCE CURVES FOR TYPICAL APPLICATION/TEST CIRCUIT (Figure 3-1)

Note 1: 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.

2: EL Lamp = 3 in^2, V_{DD} = 3V

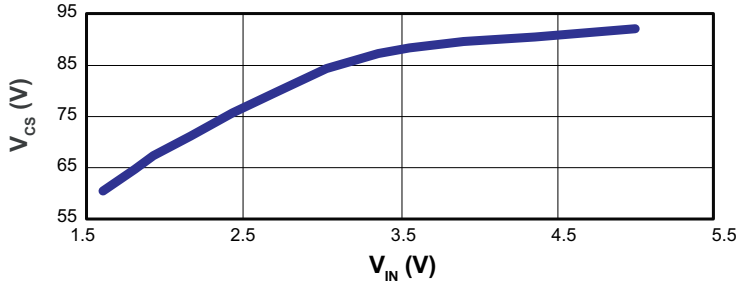


FIGURE 3-2: *V_{CS} vs. V_{IN}.*

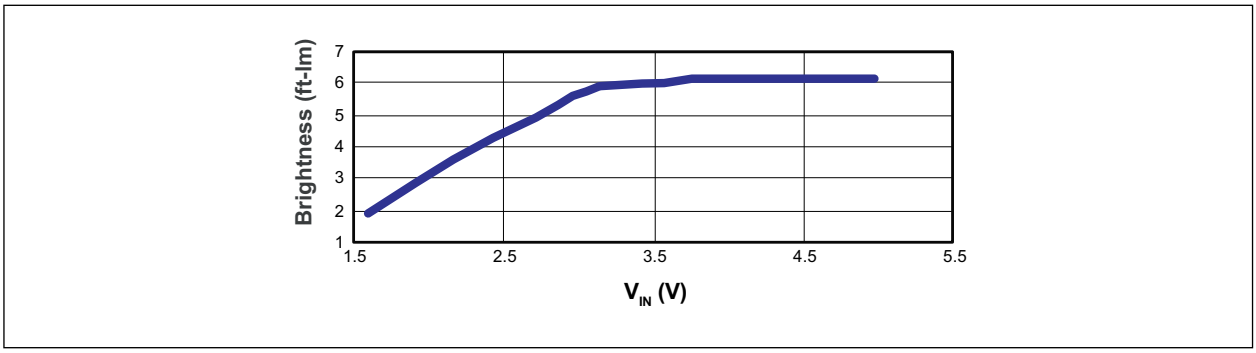


FIGURE 3-3: *Brightness vs. V_{IN}.*

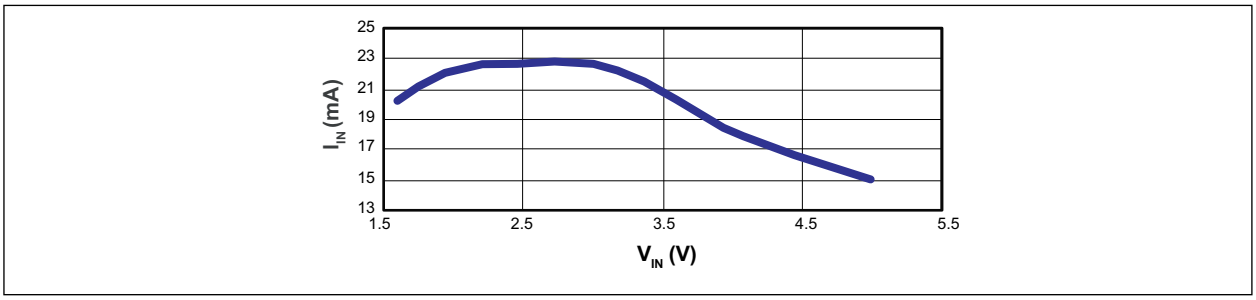


FIGURE 3-4: *I_{IN} vs. V_{IN}.*

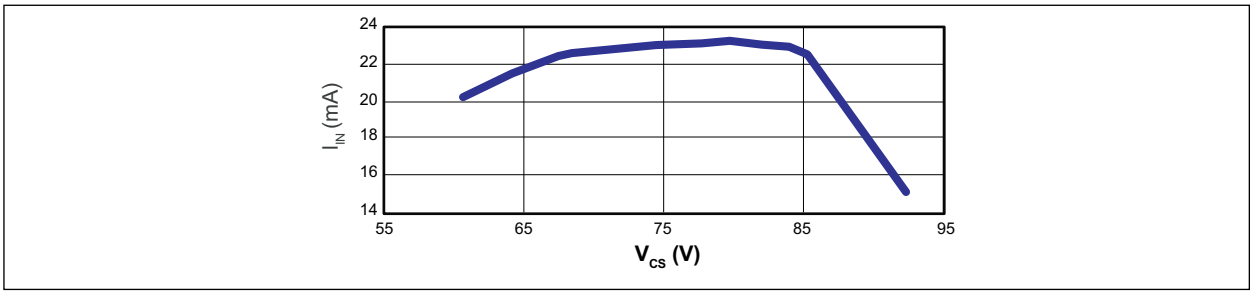


FIGURE 3-5: *I_{IN} vs. V_{CS}.*

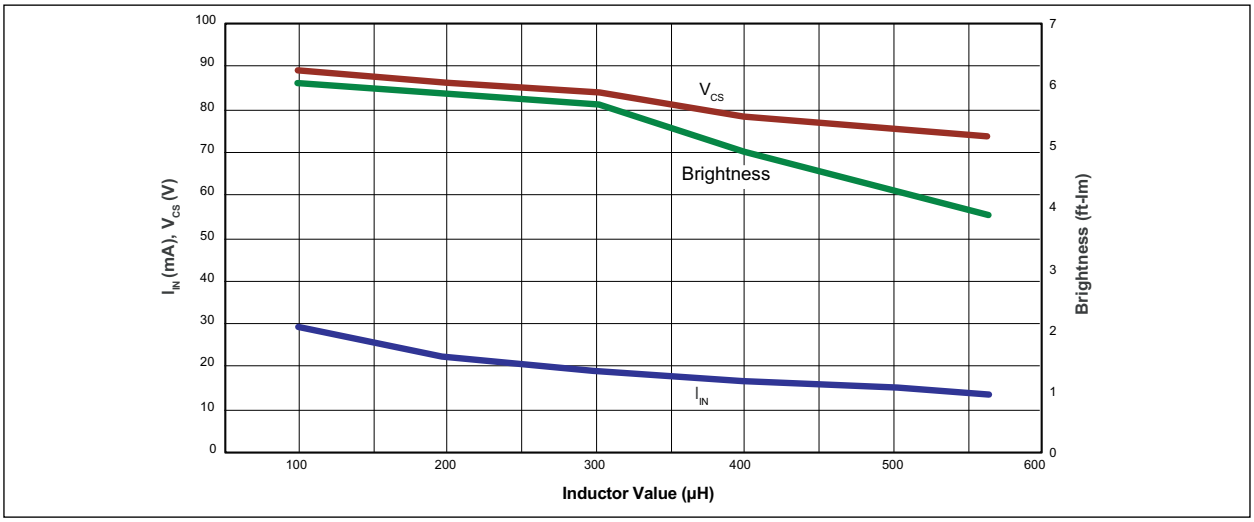


FIGURE 3-6: *I_{IN}, V_{CS}, and Brightness vs Inductor Value.*

3.2 Split Supply and Enable/Disable Configuration

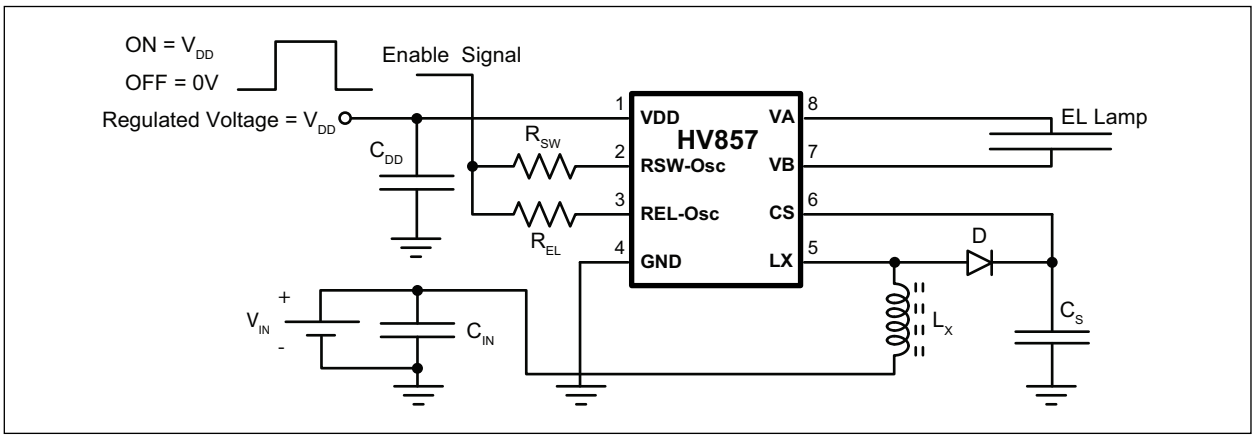


FIGURE 3-7: *Split Supply and Enable/Disable Configuration.*

3.2.1 SPLIT SUPPLY CONFIGURATION

The HV857 can also be used for handheld devices operating from a battery where a regulated voltage is available. This is shown in Figure 3-7. The regulated voltage can be used to run the internal logic of the HV857. The amount of current necessary to run the internal logic is 150 µA (maximum) at a V_{DD} of 3V. Therefore, the regulated voltage could easily provide the current without being loaded down.

3.2.2 ENABLE/DISABLE CONFIGURATION

The HV857 can be easily enabled and disabled through a logic control signal on the R_{SW} and R_{EL} resistors as illustrated in Figure 3-7. The control signal, which can be from a microprocessor, has to track the VDD supply. R_{SW} and R_{EL} are typically very high values. Therefore, only 10s of microamperes will be drawn from the logic signal when it is at a Logic High (enable) state. When the microprocessor signal is high, the device is enabled, but when the signal is low, it is disabled.

3.3 Audible Noise Reduction

This section describes a method developed to reduce the audible noise emitted by the EL lamps used in application sensitive to audible noise.

Figure 3-8 shows a general circuit schematic that uses the resistor R_{SER} connected in series with the EL lamp.

3.3.1 EFFECT OF SERIES RESISTOR ON EL LAMP AUDIBLE NOISE AND BRIGHTNESS

As EL lamp ages, its brightness is reduced and its capacitance is diminished. By using the RC model to reduce the audible noise emitted by the EL lamp, the voltage across the lamp will increase as its capacitance drops.

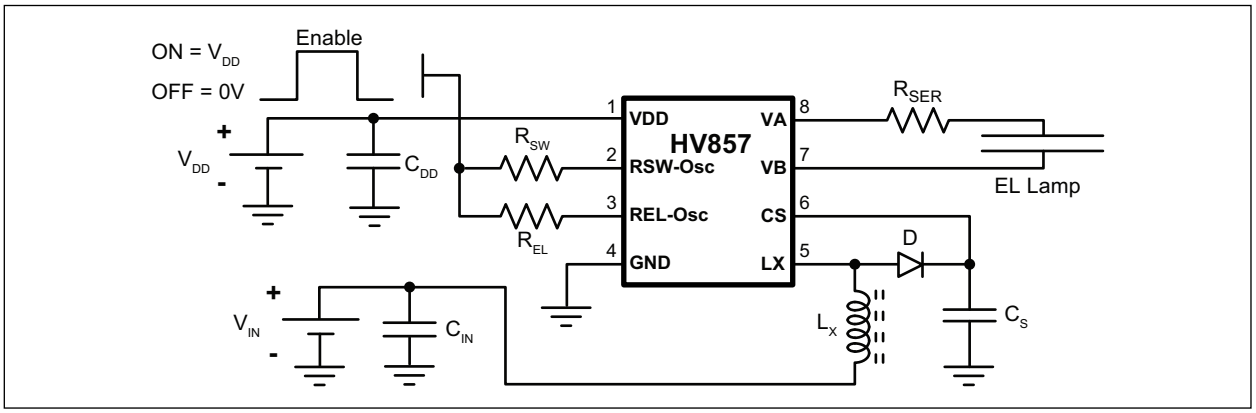


FIGURE 3-8: *Typical Application Circuit for Audible Noise Reduction.*

Hence, the increase in voltage will compensate for the reduction of the brightness. As a result, it will extend the EL lamp's half-life (half the original brightness).

Increasing the value of the series resistor with the lamp will reduce the EL lamp audible noise as well as its brightness. This is because the output voltage across the lamp will be reduced and the output waveform will have rounder edges.

3.3.2 MINIMIZATION OF EL LAMP AUDIBLE NOISE

Due to the EL lamp's construction, it emits an audible noise when lit. The noise creates a major problem for applications where the lamp is used in devices often placed close to the ear, such as cellular phones. The noisiest waveform is a square wave and the quietest waveform has been assumed to be a sine wave.

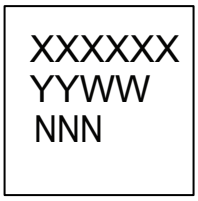
After extensive research, a waveform that is quieter than a sine wave has been developed. The waveform takes the shape of approximately 2RC time constants for rising and 2RC time constants for falling, where C is the capacitance of the EL lamp, and R is the external resistor R_{SER}, connected in series with the EL lamp. This waveform has been proven to generate less noise than a sine wave.

The audible noise from the EL lamp can be set at a desired level based on the series resistor value used with the lamp. It is important to note that use of this resistor will reduce the voltage across the lamp. Reduction of voltage across the lamp will also have another effect on the overall performance of the EL drivers and age compensation. This addresses a very important issue—EL lamp life—that most mobile phone manufacturers are concerned about.

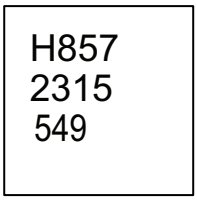
4.0 PACKAGING INFORMATION

4.1 Package Marking Information

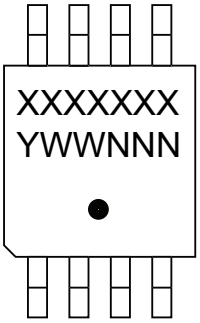
8-lead WDFN



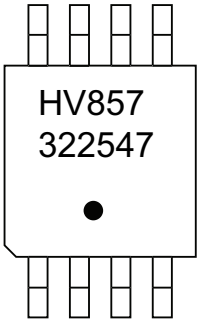
Example



8-lead MSOP



Example

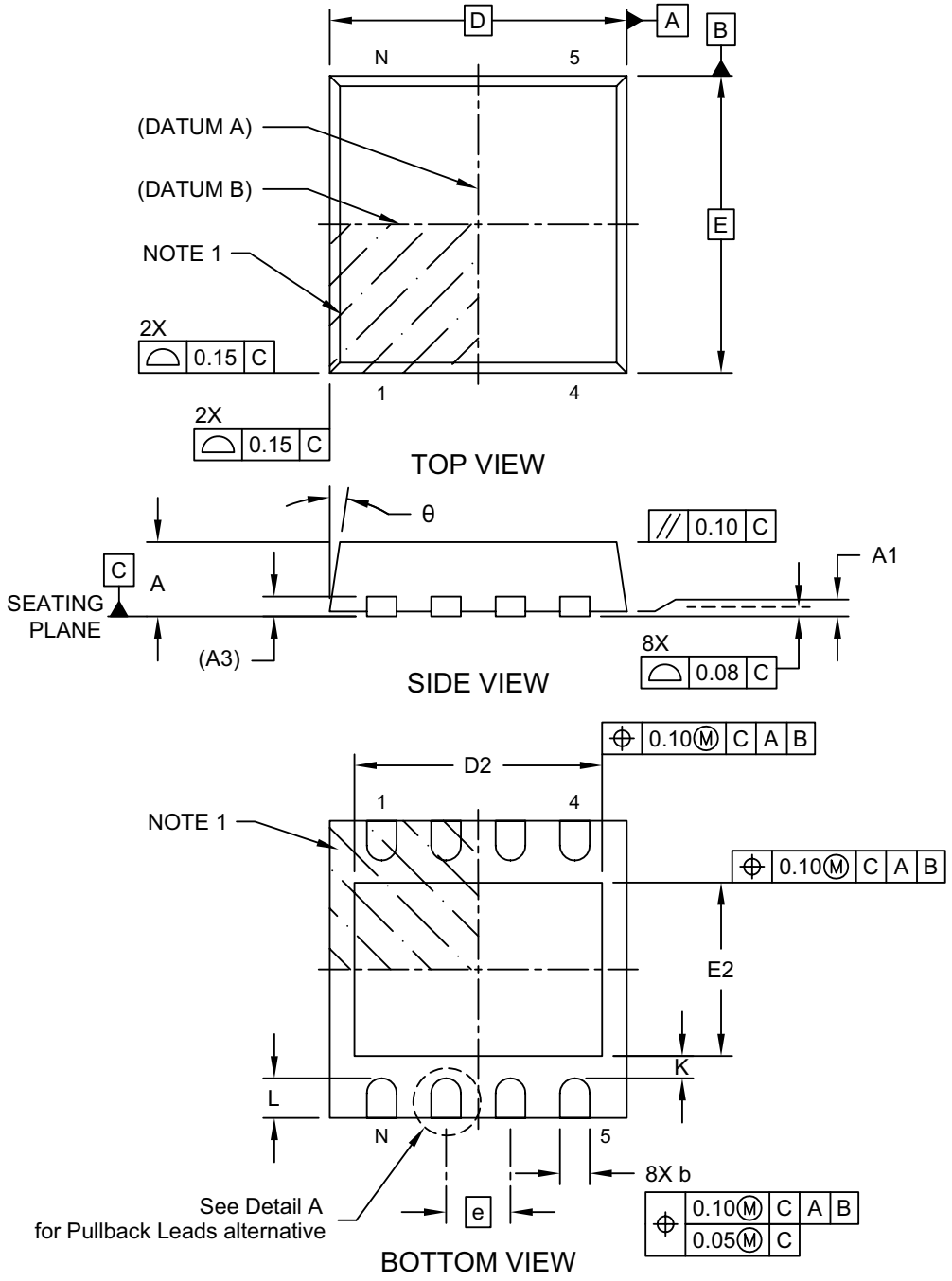


Legend:	XX...X	Product Code or Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.

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.

8-Lead Very, Very Thin Plastic Dual Flat, No Lead Package (UQ) - 3x3 mm Body [WDFN]; Supertex Legacy Package

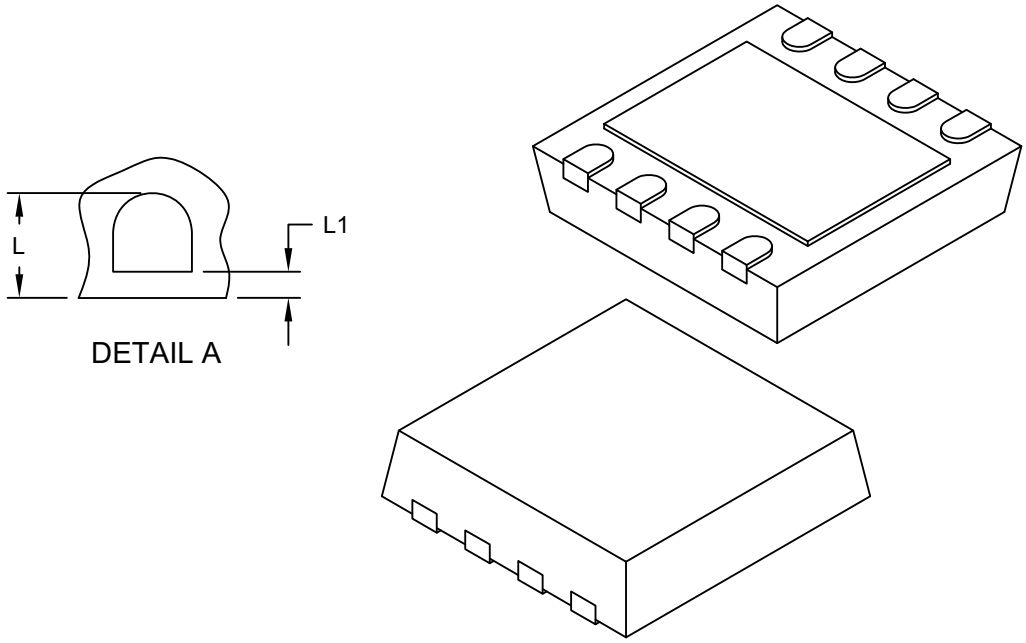
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing C04-291A Sheet 1 of 2

8-Lead Very, Very Thin Plastic Dual Flat, No Lead Package (UQ) - 3x3 mm Body [WDFN]; Supertex Legacy Package

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		8	
Pitch	e		0.65 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	1.60	-	2.50
Overall Width	E		3.00 BSC	
Exposed Pad Width	E2	1.35	-	1.75
Terminal Width	b	0.25	0.30	0.35
Terminal Length	L	0.30	0.40	0.50
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

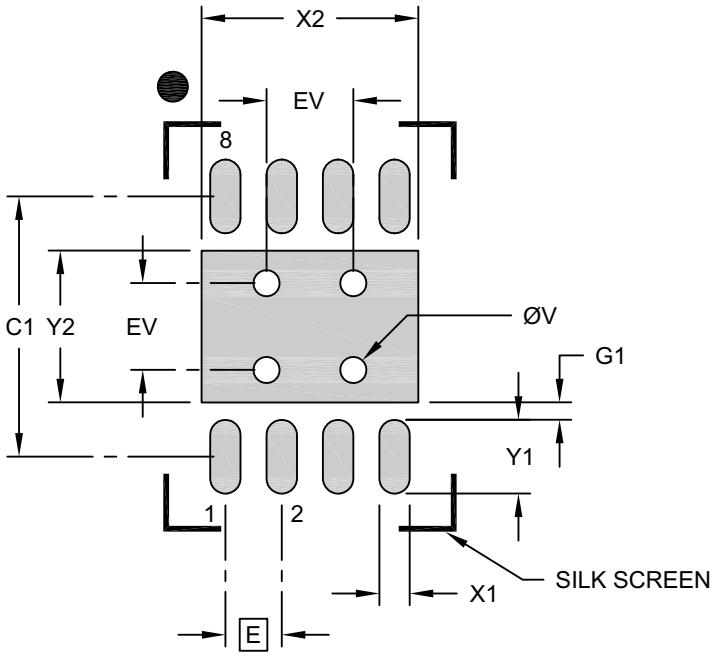
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

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

Microchip Technology Drawing C04-291A Sheet 2 of 2

8-Lead Very, Very Thin Plastic Dual Flat, No Lead Package (UQ) - 3x3 mm Body [WDFN]; Supertex Legacy Package

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	0.65 BSC		
Optional Center Pad Width	X2			2.50
Optional Center Pad Length	Y2			1.75
Contact Pad Spacing	C1		3.00	
Contact Pad Width (X8)	X1			0.35
Contact Pad Length (X8)	Y1			0.85
Contact Pad to Center Pad (X8)	G1	0.20		
Thermal Via Diameter	V		0.33	
Thermal Via Pitch	EV		1.20	

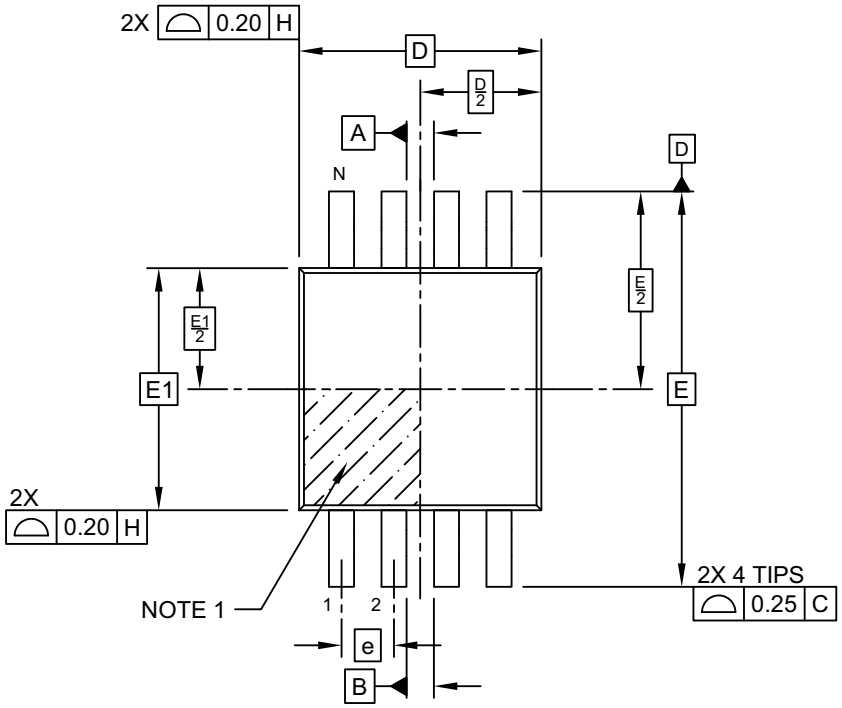
Notes:

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

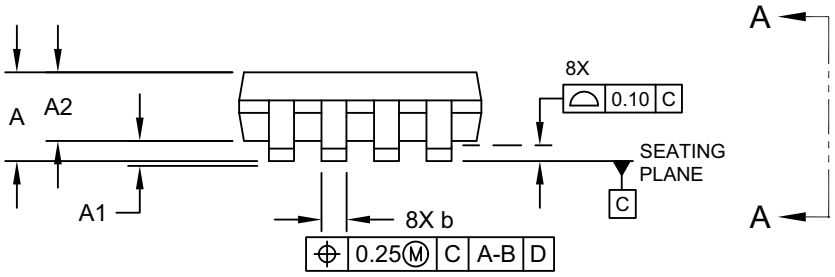
Microchip Technology Drawing C04-2291A

8-Lead Plastic Micro Small Outline Package (A3X) - 3x3 mm Body [MSOP]

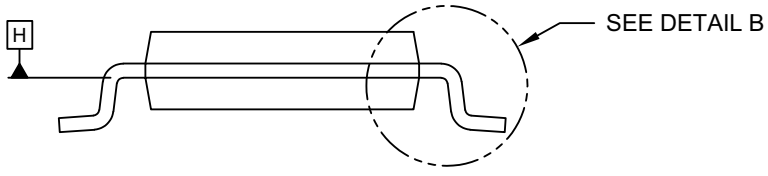
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



TOP VIEW



SIDE VIEW

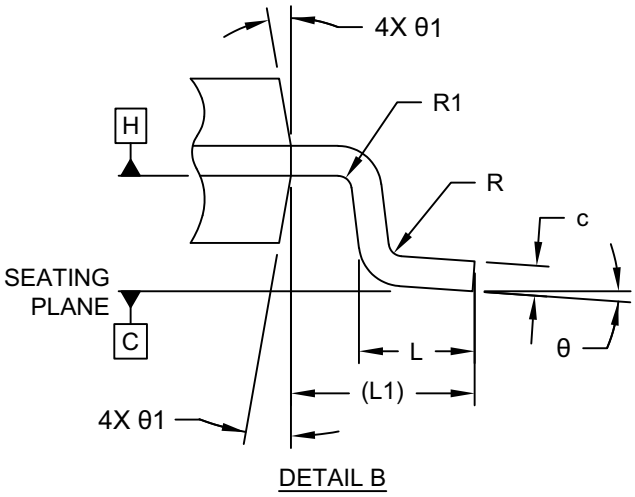


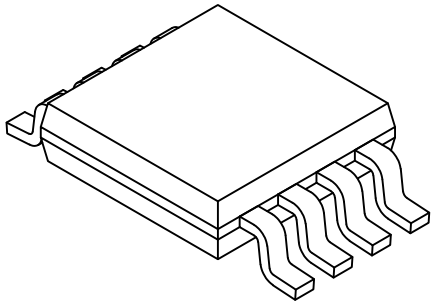
VIEW A–A

Microchip Technology Drawing C04-111-A3X Rev F Sheet 1 of 2

8-Lead Plastic Micro Small Outline Package (A3X) - 3x3 mm Body [MSOP]

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		8	
Pitch	e		0.65 BSC	
Overall Height	A	–	–	1.10
Standoff	A1	0.00	–	0.15
Molded Package Thickness	A2	0.75	0.85	0.95
Overall Length	D		3.00 BSC	
Overall Width	E		4.90 BSC	
Molded Package Width	E1		3.00 BSC	
Terminal Width	b	0.22	–	0.40
Terminal Thickness	c	0.08	–	0.23
Terminal Length	L	0.40	0.60	0.80
Footprint	L1		0.95 REF	
Lead Bend Radius	R	0.07	–	–
Lead Bend Radius	R1	0.07	–	–
Foot Angle	θ	0°	–	8°
Mold Draft Angle	θ1	5°	–	15°

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15mm per side.
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.

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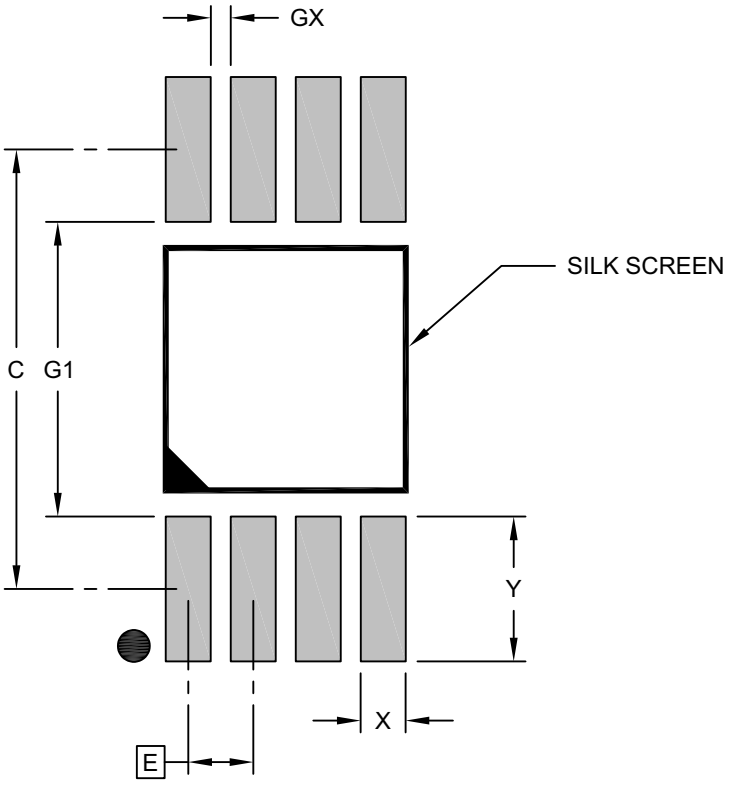
8-Lead Plastic Micro Small Outline Package (A3X) - 3x3 mm Body [MSOP]

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	0.65 BSC		
Contact Pad Spacing	C		4.40	
Contact Pad Width (X8)	X			0.45
Contact Pad Length (X8)	Y			1.45
Contact Pad to Contact Pad (X4)	G1	2.95		
Contact Pad to Contact Pad (X6)	GX	0.20		

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

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

Microchip Technology Drawing C04-2111-A3X Rev F

APPENDIX A: REVISION HISTORY

Revision A (September 2023)

- Converted Supertex Doc# DSFP-HV857 to Microchip DS20005683A
- Changed the packaging quantity of the 8-lead WDFN K7 from 3000/Reel to the 3300/Reel to align packaging specifications with the actual BQM
- Updated package outline drawings
- 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:	HV857	=	High-Voltage Low-Noise EL Lamp Driver IC
Packages:	K7	=	8-lead WDFN
	MG	=	8-lead MSOP
Environmental:	G	=	Lead (Pb)-free/RoHS-compliant Package
Media Type:	(blank)	=	3300/Reel for a WDFN Package 2500/Reel for an MSOP Package

Examples:

a) HV857K7-G: High-Voltage Low-Noise EL Lamp Driver IC, 8-lead WDFN Package, 3300/Reel

b) HV857MG-G: High-Voltage Low-Noise EL Lamp Driver IC, 8-lead MSOP Package, 2500/Reel

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