SP4403
Electroluminescent Lamp Driver

DESCRIPTION

The **SP4403** is a high voltage output DC-AC inverter specifically designed to drive electroluminescent lamps to backlight liquid crystal displays, keypads, and backlit readouts used in battery operated portable equipment. The **SP4403** will operate from a 1.8V-6.0V power supply. The **SP4403** is capable of supplying up to more than 160 V_{pp} signals, making it ideal for driving electroluminescent lamps. One external inductor is required to generate the high voltage, and one external capacitor is used to select the oscillator frequency. The device could be used in low power portable products, such as PDA's, pagers, cellular phones, and other portable applications using LCDs in dim or low light environments. The **SP4403** is offered in die form and 8-pin SOP packages.

FEATURES

- 1.8V-6.0V Battery Operation
- High Voltage Output, Low power consumption
- Internal Oscillator
- Uses Small 680µH or 1mH Coil
- Pin-Pin replacement of Sipex SP4422A, SP4423, Functional replacement of : SP4403, IMP803, D340B, D355B

APPLICATIONS

- PDA
- Pagers
- Cellular Phones
- Remote Controls
- Handheld Computers
- Handheld GPS Units
- LCD Module

Ordering Information

PART NO.	TEMP. RANGE (°C)	PACKAGE
SP4403EM	-40 – 85 °C	8-Pin SOP
SP4403EMT	-40 – 85 °C	8-Pin TSSOP
SP4403EU	-40 – 85 °C	8-Pin MSOP
SP4403EX	-40 – 85 °C	Dice

ABSOLUTE MAXIMUM RATING

V_{DD}: 6.5V
COIL (pin3) Current: 280mA
Power Dissipation 500mW

HON (pin1): -0.3V to V_{DD}+0.3V
Lamp Output (V_{pp}): 250V

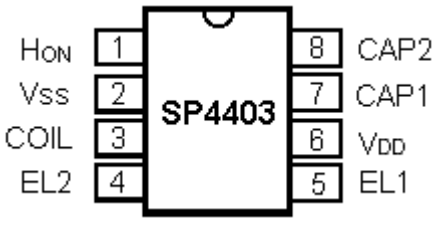
ELECTRICAL SPECIFICATIONS

(T= 25°C; V_{DD} = 3.0V, Lamp Capacitance = 10nF, Coil = 2.2mH (R = 11Ω), C_{OSC} = 270pF unless otherwise noted)

PARAMETER	MIN	TYP	MAX	UNIT	CONDITIONS
Supply Voltage, V_{DD}	1.8	3.0	6.0	V	
Supply Current, I_{COIL}+I_{DD}		20 45	30 60	mA	V_{DD} = 3.0V, V_{HON} = 3.0V V_{DD} = 6.0V, V_{HON} = 6.0V
Coil Voltage, V_{COIL}	V_{DD}		6.0	V	
HON Input Voltage, V_{HON} LOW: EL off HIGH: EL on	 -0.25 V_{DD} - 0.25	 0 V_{DD}	 0.25 V_{DD} +0.25	V	V_{DD} = 3.0V
HON Current, EL On		8	40	µA	V_{HON} =V_{DD} = 3.0V
Shutdown Current, I_{SD} =I_{COIL}+I_{DD}		0.03	1	µA	V_{DD} = 3.0V, V_{HON} = 0V
INDUCTOR DRIVE					
Coil Frequency, f_{COIL} =f_{LAMP} ×32		9.6		kHz	
Coil Duty Cycle		85		%	
EL LAMP OUTPUT					
EL Lamp Frequency, f_{LAMP}	200	350	600	Hz	V_{DD} = 3.0V
Peak to Peak	160	180		V_{pp}	V_{DD} = 3.0V

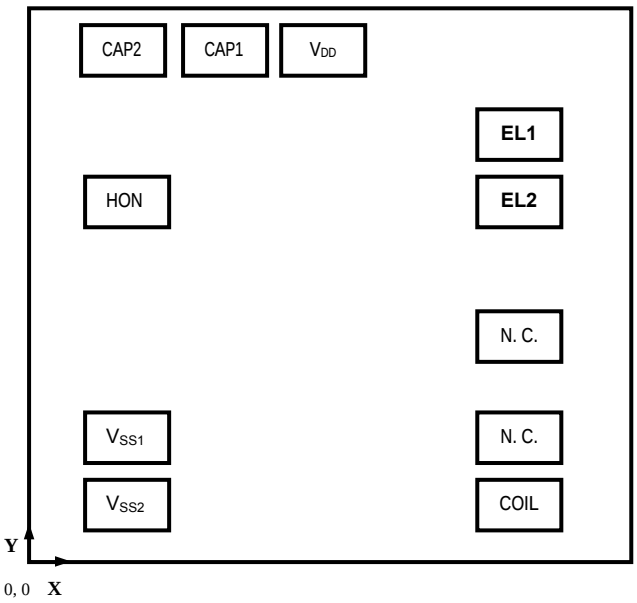
*This data sheet specifies environmental parameters, final test conditions and limits as well suggested operating conditions.

PIN DESCRIPTION



Pin 1 – HON- Enable for driver operation,
high = active; low = inactive.
Pin 2 – Vss- Power supply common, connect to ground.
Pin 3 – Coil- Coil input, connect coil from V_{DD} to pin 3.
Pin 4 – Lamp- Lamp driver output 2, connect to EL lamp.
Pin 5 – Lamp- Lamp driver output 1, connect to EL lamp.
Pin 6 – V_{DD}- Power supply for driver, connect to system V_{DD}.
Pin 7 – Cap1- Capacitor input 1, connect to C_{OSC}.
Pin 8 – Cap2- Capacitor input 2, connect to C_{OSC}.

BOUNDING DIAGRAM

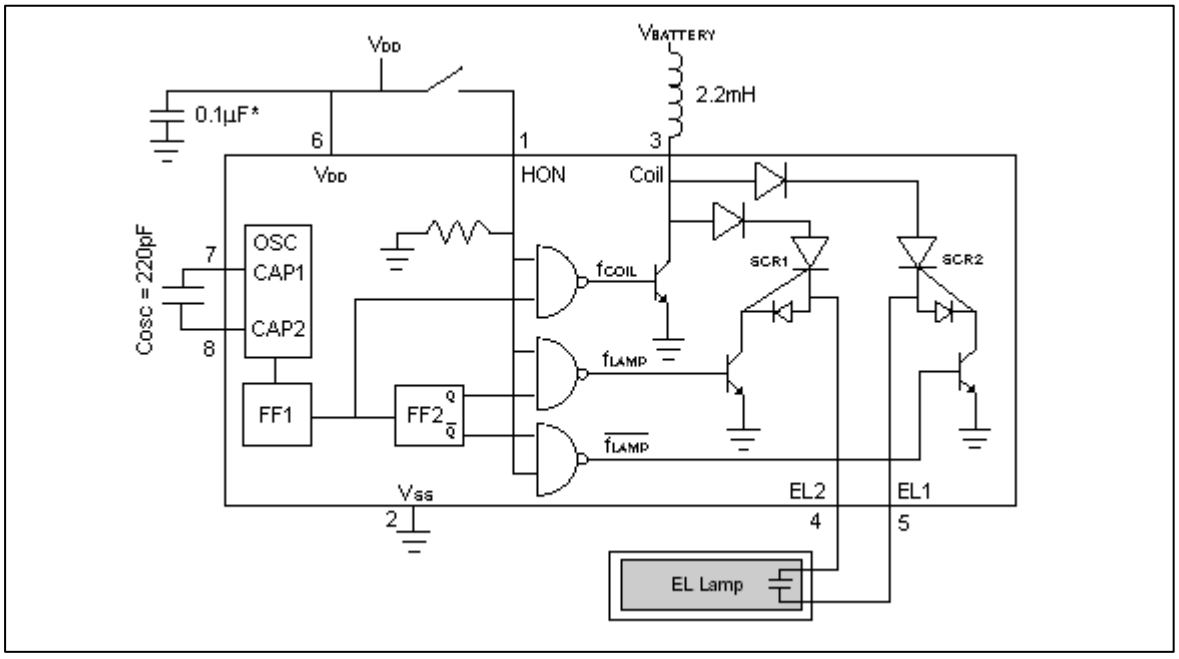


PAD LOCATION COORDINATES

Pad Name	X(μm)	Y(μm)
V_{DD}	900.5	1998.5
CAP1	476.5	1998.5
CAP2	177.5	1989.5
HON	187.5	1455.5
V_{SS1}	187.5	423.5
V_{SS2}	187.5	248.5
COIL	1778.5	248.5
N. C.		
N. C.		
EL2	1778.5	1447.5
EL1	1778.5	1638.5

NOTES:
1. Dimensions are in Microns unless otherwise noted.
2. Bonding pads are 125x125 typical
3. Outside dimensions are maximum, including scribe area.
4. Pad center coordinates are relative to die center.
5. Die size 1980 x 2160.
6. V_{SS1} and V_{SS2} are connected to V_{SS} supply on PCB.
7. N.C. -no connection.

BLOCK DIAGRAM AND TYPICAL APPLICATION



SP4403 Schematic

THEORY OF OPERATION

The **SP4403** is made up of three basic circuit elements, an oscillator, coil, and switched H-bridge network. The oscillator provides the device with an on-chip clock source used to control the charge and discharge phases for the coil and lamp. An external capacitor connected between pins 7 and 8 allows the user to vary the oscillator frequency from 32kHz to 400kHz. In general, increasing the C_{OSC} capacitor will increase the lamp output, and reduce the lamp frequency.

The suggested oscillator frequency is 64kHz. The oscillator output is internally divided to create two internal control signals, f_{COIL} and f_{LAMP}. The oscillator output is internally divided down by 8 flip flops, a 64kHz signal will be divided into 8 frequencies; 32kHz, 16kHz, 8kHz, 4kHz, 2kHz, 1kHz, 500Hz, and 250Hz. The 3rd flip flop output (8kHz) is used to drive the coil and the 8th flip flop output (250Hz) is used to drive the lamp. Although the oscillator frequency can be varied to optimize the lamp output, the ratio of f_{COIL}/f_{LAMP} will always equal 32.

The on-chip oscillator of the **SP4403** can be overdriven with an external clock source by removing the C_{OSC} capacitor and connecting a clock source to pin 8. The clock should have a 50% duty cycle and range from V_{DD}-1V to ground. An external clock signal may be desirable in order to synchronize any parasitic switching noise with the system clock. The maximum external clock frequency that can be supplied is 400kHz.

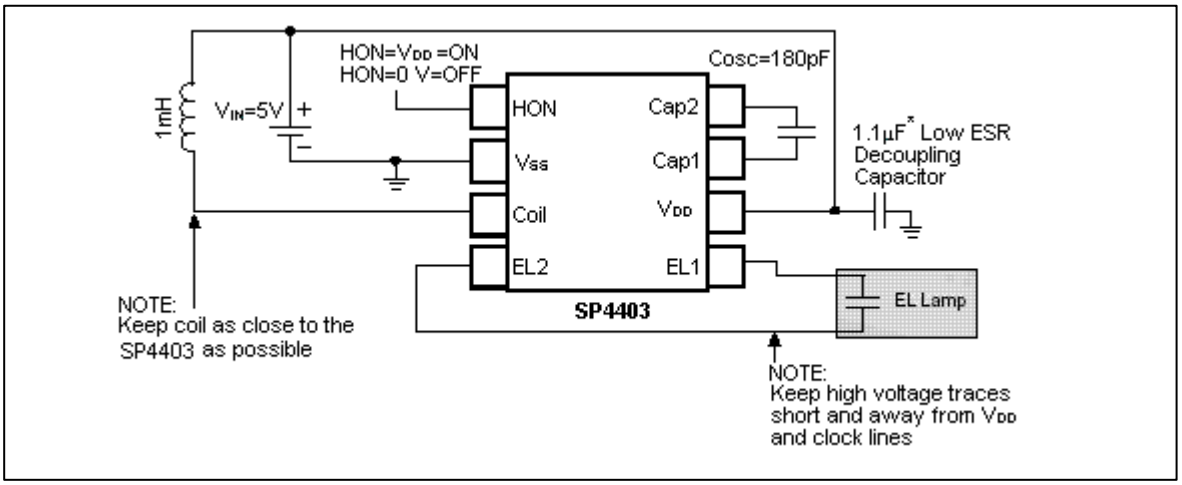
ELECTROLUMINESCENT TECHNOLOGY

What is electroluminescence?

An EL lamp is basically a strip of plastic that is coated with a phosphorous material which emits light (fluoresces) when a high voltage (>40V) which was first applied across it, is removed or reversed. Long periods of DC voltages applied to the material tend to breakdown the material and reduce its lifetime. With these considerations in mind, the ideal signal to drive an EL lamp is a high voltage sine wave. Traditional approaches to achieving this type of waveform included discrete circuits incorporating a transformer, transistors, and several resistors and capacitors. This approach is large and bulky, and cannot be implemented in most hand held equipment. SP4403 now offers low power single chip driver circuits specifically designed to drive small to medium sized electroluminescent panels. All that is required is one external inductor and capacitor.

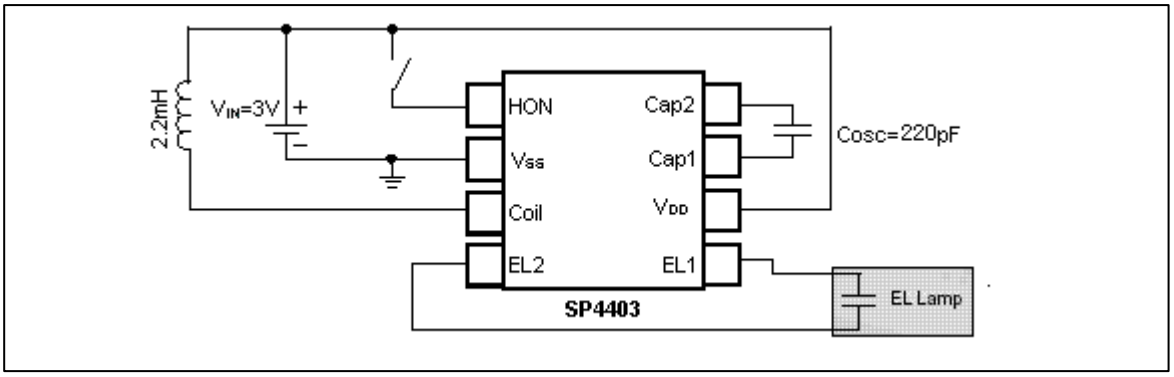
Electroluminescent backlighting is ideal when used with LCD displays, keypads, or other backlit readouts. Its main use is to illuminate displays in dim to dark conditions for momentary periods of time. EL lamps typically consume less than LEDs or bulbs making them ideal for battery powered products. Also, EL lamps are able to evenly light an area without creating "hot spots" in the display.

TYPICAL APPLICATION CIRCUIT (good result, high brightness, low current)

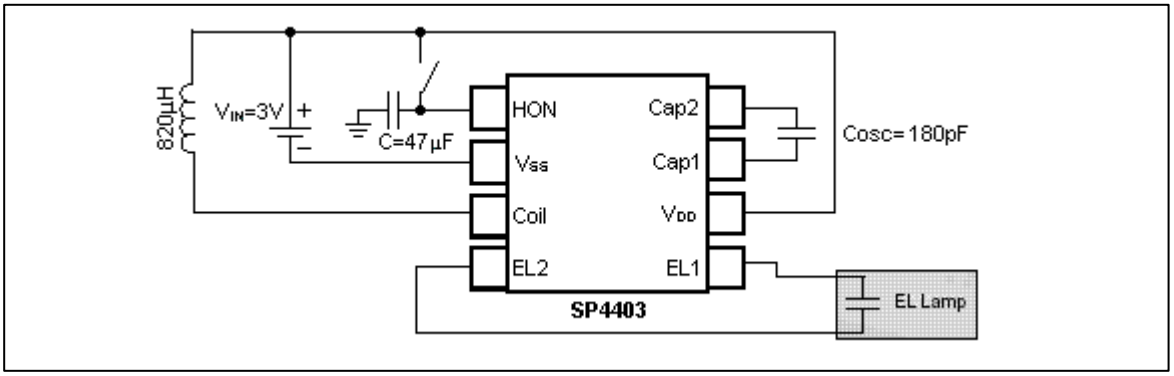


Typical SP4403 Application Circuit

APPLICATION CIRCUIT (very low power consumption when inductor and capacitor selected as indicated)



APPLICATION CIRCUIT (Hold delay, high brightness when inductor and capacitor selected as indicated)



Layout Considerations

The **SP4403** circuit board layout must observe careful analog precautions. For applications with noisy voltage power supplies a 1.1μF low ESR decoupling capacitor must be connected from V_{DD} to ground. Any high voltage traces should be isolated from any digital clock traces or enable lines. A solid ground plane connection is strongly recommended. All traces to the coil or to the high voltage outputs should be kept as short as possible to minimize capacitive coupling to digital clock lines and to reduce EMI emissions.

Selection of the optimum circuit configuration (the testing data comes from following curves. EL lamp: 25cm^2, V_{DD}=5V)

Result	Coil	Capacitor	Brightness (Lux)	Current (mA)	EL frequency	Efficiency (brightness/Current)
Good (high brightness, low current	1mH	180pF	72	55	~ 320Hz	1.3
Very low current (normal brightness)	2.2mH	220pF	40	30	~ 300Hz	1.3
	2.2mH	240pF	44	33	~ 270Hz	1.3
	2.2mH	270pF	50	37	~ 220Hz	1.4
Very high light	820μH	180pF	79	62	~ 320Hz	1.3

As for special requirement, the selection of coil (inductor) and capacitor please refer to the following performance curves. The guide line: the brightness high enough to meet the requirement, to reduce the supply current (lower power consumption). The EL brightness is depending on both EL lamp frequency and IC output voltage. If frequency of white EL lamp is much high, the light will move to slight blue color.

The amount of light emitted is a function of the voltage applied to the lamp, the frequency at which it is applied, the lamp material used and its size, and lastly, the inductor used. There are many variables which can be optimized for specific applications. SP4403 supplies characterization charts to aid the designer in selecting the optimum circuit configuration.

EL lamp: There are two kinds of EL lamp material: normal light and high light, it's better to use high light EL lamp.

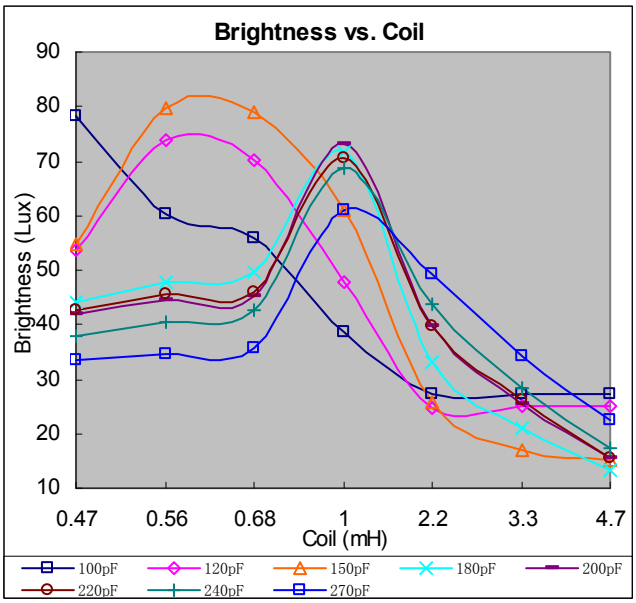
Capacitor (C_{OSC}): The smaller the C_{OSC} value, the higher EL lamp frequency. Suggest value: 100 – 270pF.

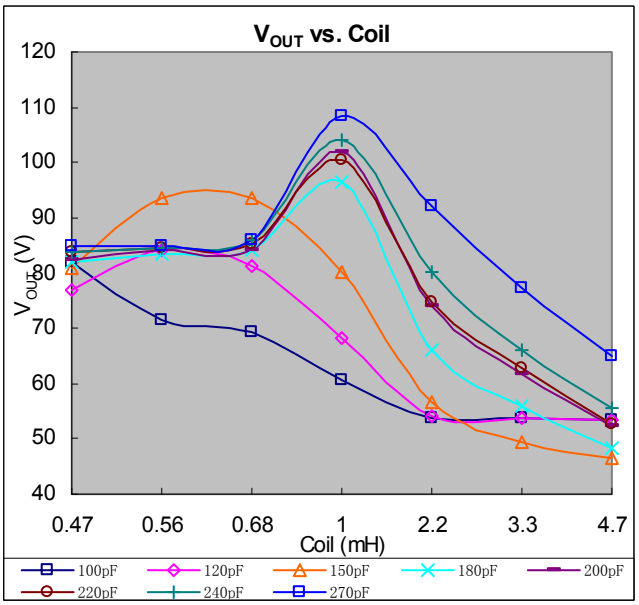
Coil (inductor): The selection of coil is very important for EL driver. Energy is stored in the coil. It's not the same coil for different size EL lamp. Generally speaking, if coil is bigger value, the total working current is lower. The resistance of coil is lower, the EL driver can get better result, brightness is higher. Suggest value: 680μH –3.3 mH.

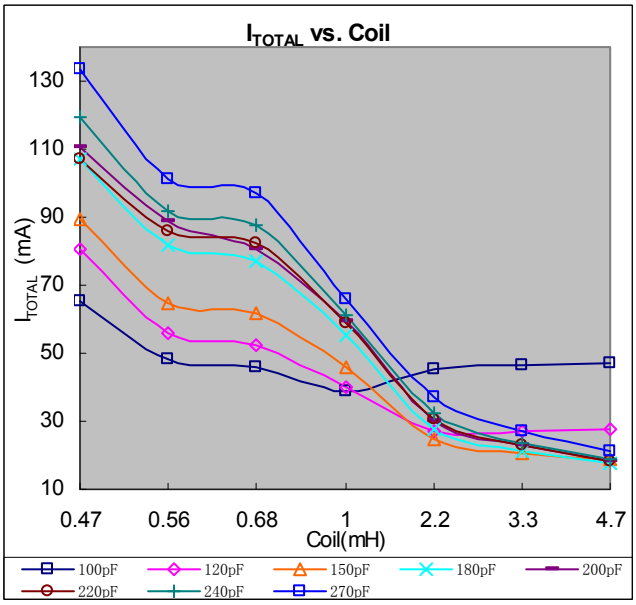
Voltage Vin: High input voltage will result high brigntness of EL lamp.

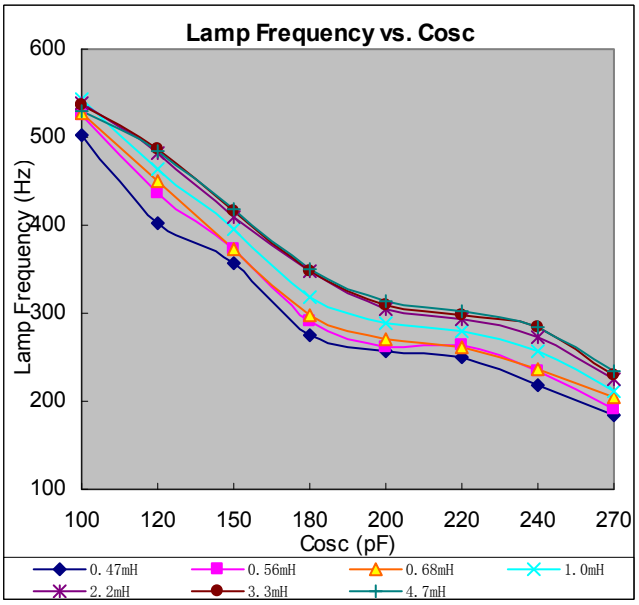
TYPICAL PERFORMANCE CURVES

The following performance curves are intended to give the designer a relative scale from which to optimizespecific applications. Absolute measurements may vary depending upon the brand of components chosen (the size of EL lamp: 25cm^2, input voltage: V_{DD}=5V).





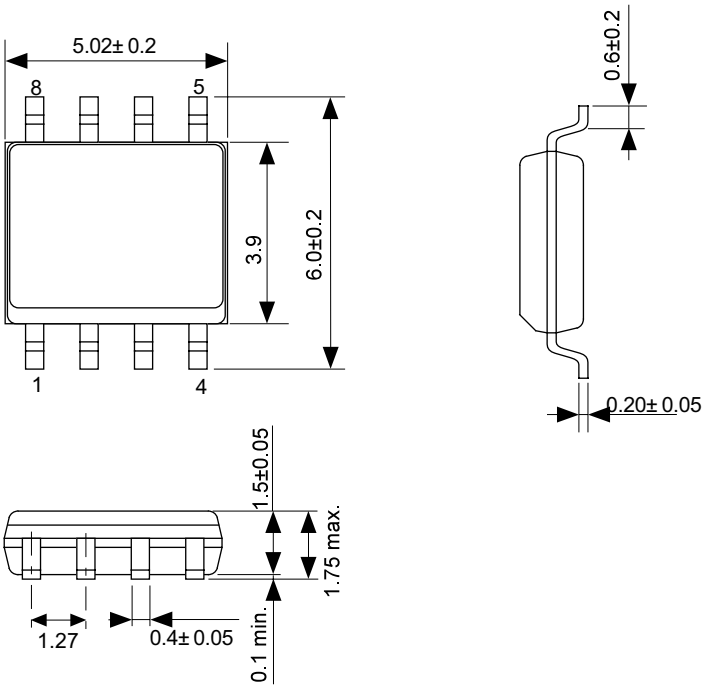




PACKAGE

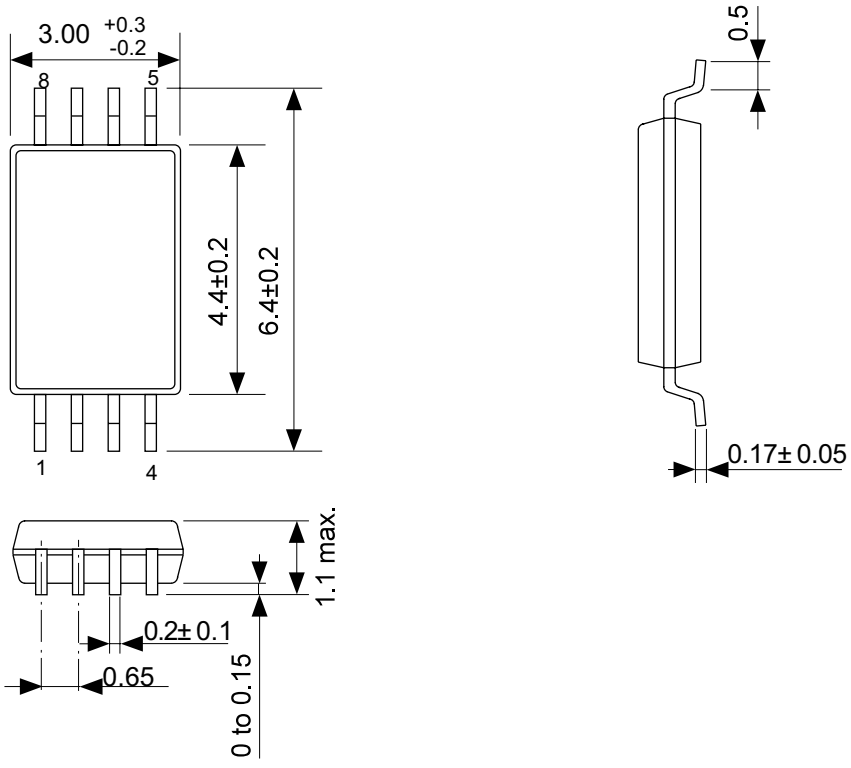
8-Pin SOP

Unit: mm



8-Pin TSSOP

Unit: mm



PACKAGE (continued)

8-Pin MSOP

Unit: mm