

- DC to AC Inverter for EL Backlit Display Panels
- Low Voltage, Single Battery Operation (vbat > 1.1 Vdc)
- Dual Oscillator Operation for Application Flexibility
- Low Current Standby Mode

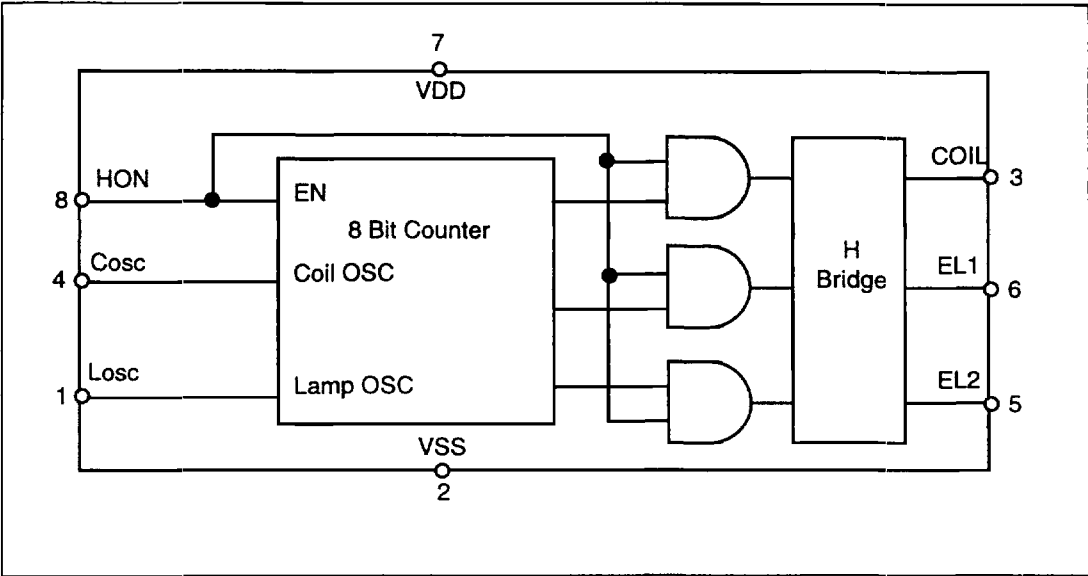


**APPLICATIONS**

- Pagers ■ Digital Watches ■ Backlit LCD Displays

**DESCRIPTION...**

The **SP4424** is a high voltage output DC-AC converter that can operate from a single 1.5 Vdc battery supply. The **SP4424** is capable of supplying up to 250 Vpp signals, making it ideal for driving electroluminescent lamps. The device features 100nA (typ) standby current, for use in low power portable products. One external inductor is required to generate the high voltage charge, and two external capacitors are used to select the oscillator and lamp frequencies. The **SP4424** is offered in both an 8 pin narrow SOIC or micro SOIC package. For delivery in die form, please consult the factory.



*Block Diagram*



## ABSOLUTE MAXIMUM RATINGS

These are stress ratings only and functional operation of the device at these ratings or any other above those indicated in the operation sections of the specifications below is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

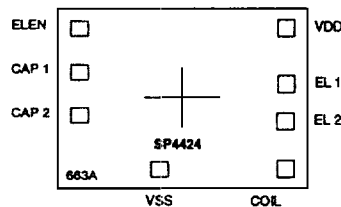
V <sub>as</sub> .....	7.0V
Input Voltages/Currents	
HON (pin1).....	-0.5V to (V <sub>as</sub> +0.5V)
COIL (pin3).....	100mA
Lamp Outputs.....	250Vpp
Storage Temperature.....	-65°C to +150°C
Power Dissipation.....	200mW

## SPECIFICATIONS

(T= 25°C; V<sub>as</sub> = 1.5V; Lamp Capacitance = 8000pF; Coil = 20 mH at 70 Ohms; Coil OSC = 220pF, Lamp OSC = 1800pF unless otherwise noted)

PARAMETER	MIN.	TYP.	MAX.	UNIT	CONDITIONS
<b>INPUT CHARACTERISTICS</b>					
Supply Voltage		1.5		Volts	
Total Supply Current			8	mA	Vdd= 1.5V ±5%; Hon= 1.5V
Quiescent Supply Current		100	200	nA	Vdd= 1.5V ±5%; Hon= 0.2V
Hon Voltage On	1.1	Vdd		Volts	Internal pulldown
Hon Current On			10	µA	
Hon Voltage Off			<Vdd/2	Volts	
<b>INDUCTOR DRIVE</b>					
Peak Current		60		mA	
Pulse Rate	3	5	6	kHz	
Duty Cycle	70	75	85	%	
<b>LAMP OUTPUT</b>					
Differential Voltage	80	110		Vpp	
Frequency	150	250	350	Hz	
Lamp Capacitance		8000		pF	

## Bonding Diagram:

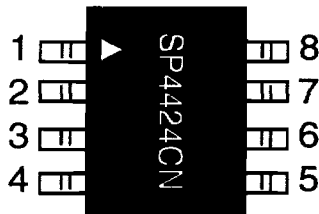


PAD	X	Y
EL1	586.0	107.0
EL2	586.0	-143.0
COIL	586.0	-376.0
VSS	80.0	-417.0
HON	562.5	-397.0
CAP2	565.0	-118.0
CAP1	562.5	114.5
VDD	588.0	417.0

## NOTES:

1. Dimensions are in Microns unless otherwise noted.
2. Bonding pads are 125x125 typ.
3. Outside dimensions are maximum, including scribe area.
4. Die thickness is 380 +/- 25 microns (15 mils +/- 1).
5. Pad center coordinates are relative to die center.
6. Die size 1498 x 1168 ( 59 x 46 mils).

## PIN DESCRIPTION



Pin 1 – Cosc- Connect Cap1 from Vss to pin 1 to set oscillator frequency.

Pin 2 – Vss- Power supply common, connect to ground.

Pin 3 – Coil- Coil input, connect coil from Vbattery to pin 3.

Pin 4 – EL2- Lamp driver output1, connect to EL lamp.

Pin 5 – EL1- Lamp driver output2, connect to EL lamp.

Pin 6 – Vdd- Power supply for driver, connect to system Vdd.

Pin 7 – HON- Enable for driver operation, high = active; low = inactive.

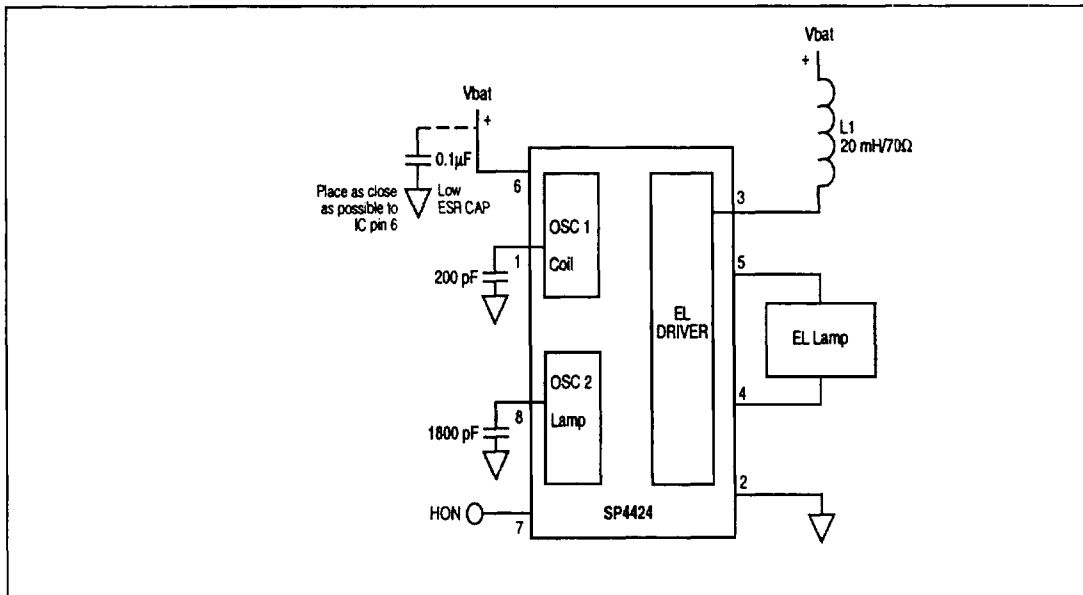
Pin 8 – Losc- connect Cap2 from Vss to pin 8 to set lamp frequency.

## THEORY OF OPERATION

The **SP4424** is made up of three basic circuit elements: an oscillator, coil, and switched H-bridge network. The oscillator portion of the circuit is divided into two precision oscillators. The oscillators set the coil and lamp frequencies independently. This allows for the arbitrary setting of the coil/lamp frequency ratio. The coil frequency can be selected for maximum energy transfer per cycle for a given external coil value. The coil oscillator is set at 75% duty cycle and the lamp oscillator is set at 50% duty cycle for minimum DC offset across the EL lamp.

An external capacitor connected between pin 8 and  $V_{ss}$  allows the user to vary the lamp oscillator frequency from 75Hz to 350Hz. Likewise, an external capacitor connected between pin 1 and  $V_{ss}$  allows the user to vary the coil oscillator frequency from 3.5kHz to 50kHz. The graphs on page 6 show the relationship between oscillators ( $L_{osc}$  and  $C_{osc}$ ) and their respective capacitor values.

The coil is an external component connected from  $V_{battery}$  to pin 3 of the **SP4424**. Energy is developed in the coil according to the equation  $E_L = I^2/2L$  where the current  $I$  is defined as  $I = (V_{battery} - IR_{OL})/R_T$ . In order to maximize the energy produced by the coil  $V_{battery}$  should represent the largest



**SP4424 Schematic**

voltage in the system (up to the maximum tolerance of the coil) and the coil should have low resistance and high inductance;  $V_{battery} = 1.5$  VDC with a 20mH/70Ω coil are typical. The majority of the current goes through the coil and typically less than 1mA is required for Vdd of the SP4424. Vdd can range from 1.1V to 5V; it is not necessary that  $V_{dd} = V_{battery}$ . Coils are also a function of the core material and winding used -- performance variances may be noticeable from different coil suppliers. The Sipex SP4424 is final tested using a 20mH/70Ω coil from CTC. For suggested coil sources see page 7.

The  $F_{coil}$  signal controls a switch that connects the end of the coil at pin 3 to ground or to open circuit. The  $F_{coil}$  signal is a 75% duty cycle signal. During the time when the  $F_{coil}$  signal is high, the coil is connected from  $V_{battery}$  to ground and a charged magnetic field is created in the coil. During the low part of  $F_{coil}$ , the ground connection is switched open, the field collapses and the energy in the inductor is forced to flow toward the high voltage H-bridge switches.  $F_{coil}$  will send as many charge pulses as possible in 1 Lamp Cycle. {Number of Coil pulses in 1 lamp cycle =  $\frac{Coil\ Freq}{Lamp\ Freq(2)}$ } (see figure 2 page 6). Each pulse increases the voltage drop across the lamp in discrete steps. As the voltage potential approaches its maximum, the steps become smaller (see figure 1 page 6).

The H-bridge consists of two SCR structures that act as high voltage switches. These two switches control the polarity of how the lamp is charged. The SCR switches are controlled by the  $F_{lamp}$  signal which is the oscillator frequency divided by 256. For a 64kHz oscillator,  $F_{lamp} = 256$ Hz.

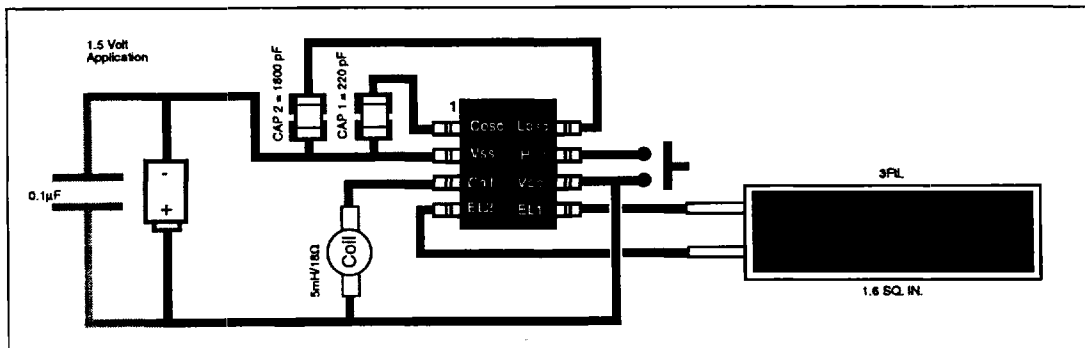
When the energy from the coil is released, a high voltage spike is created triggering the SCR switches. The direction of current flow is determined by which SCR is enabled. One full cycle of the H-bridge will create a number of voltage steps from ground to 55V (typ) on pins 4 and 5 which are 180 degrees out of phase with each other (see figure 3 page 6). A differential view of the outputs is shown in figure 4 on page 6. If Line Noise is of concern it is advisable to add a decoupling cap at Vdd (low ESR type).

## 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. Sipex 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



Typical SP4424CN Application Circuit

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.

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. Sipex supplies characterization charts to aid the designer in selecting the optimum circuit configuration.

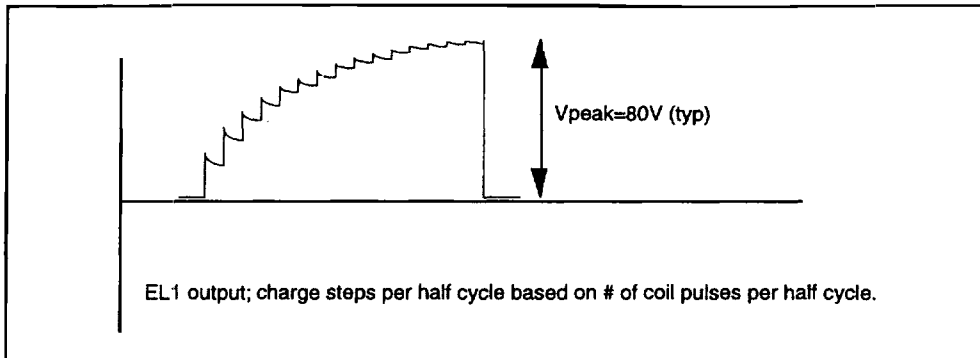


Figure 1.

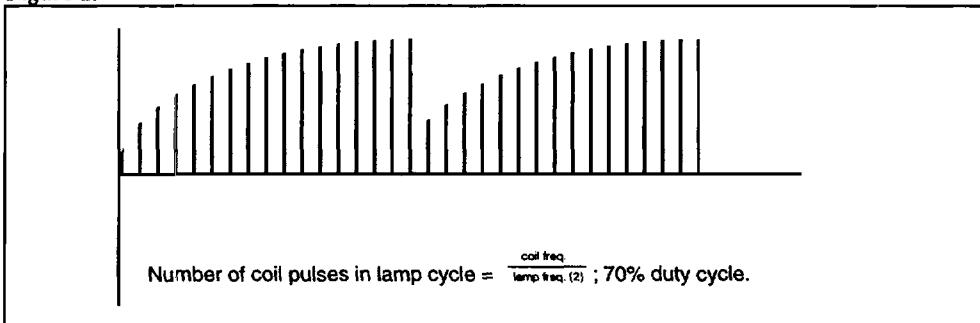


Figure 2.

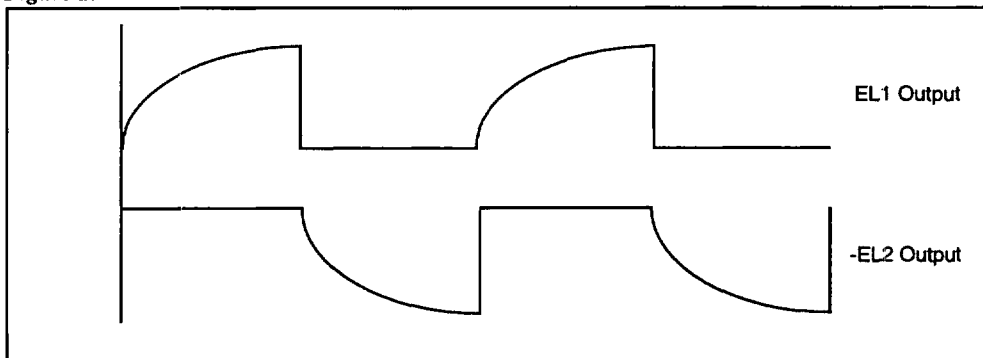


Figure 3.

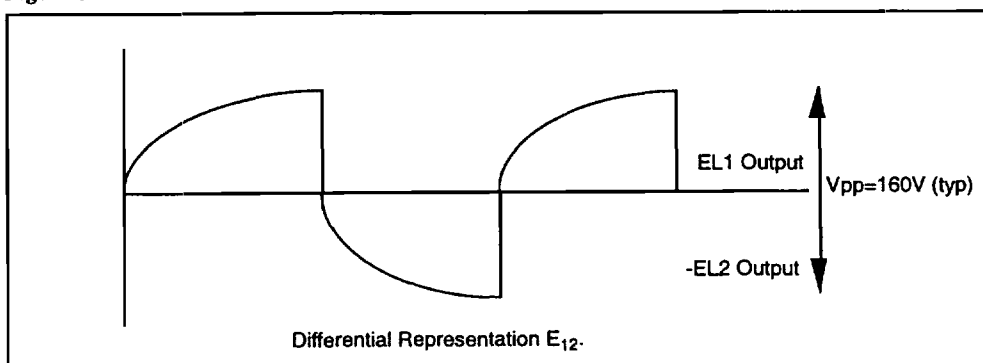


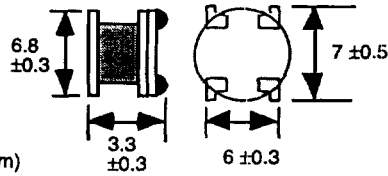
Figure 4.

HITACHI METALS Ltd.  
Kishimoto Bldg.  
2-1, Marunouchi 2-Chome,  
Chiyoda-Ku, Tokyo Japan  
Phone: 3-3284-4936  
Fax: 3-3287-1945  
Mr. Noboru Abe  
Spec.-  
9 mH  $\pm 30\%$  42 ohm (Max)  
Model: MD 735L902B

Singapore  
Mr Stan kaiko,  
Mr. Hiroshi Kai  
Phone: 222-8077  
Fax: 222-5232

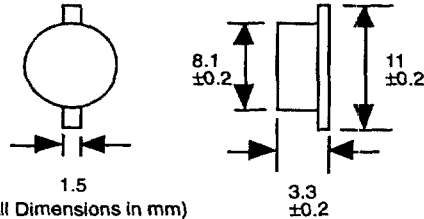
Hong Kong  
Mr Mori Ota  
Phone: 2724-4188  
Fax: 2311-2095

San Jose, CA  
Mr. Kent Oda  
Ph: 408 436-9505  
Fx: 408 436-9601



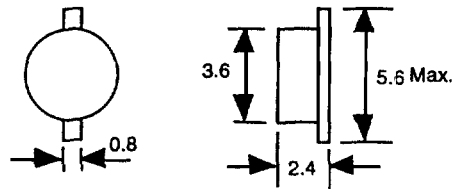
(All Dimensions in mm)

Sankyo Shoji Co. (HK)  
RM 28, 9/11 Thriving Ind. Centre  
Tsuen Wan, N.T.  
Hong Kong  
Phone: 8522 414 9268  
Fax: 8522 413 6040  
Contact: Mr. K.M. Chang  
Inductance: 29mH  $\pm 20\%$   
Resistance: 62 Ohms  $\pm 10\%$  @ 25°C  
Part Number SK-121



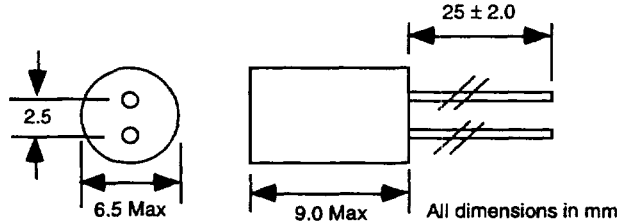
(All Dimensions in mm)

Sankyo Shoji Co. (HK)  
RM 28, 9/11 Thriving Ind. Centre  
Tsuen Wan, N.T.  
Hong Kong  
Phone: 8522 414 9268  
Fax: 8522 413 6040  
Contact: Mr. K.M. Chang  
Inductance: 65mH  $\pm 15\%$   
Resistance: 270 Ohms  $\pm 15\%$  @ 25°C  
Part Number SK-80



(All Dimensions in mm)

CTC Coils LTD (HK)  
Flat L-M 14 Fl, Haribest Ind'l Bldg.  
45-47 Au Pul Wan Street  
Fo Tan Shatin, N.T., Hong Kong  
Phone: 85 2695 4889  
Fax: 85 2695 1842  
Contact: Alfred Wong cc Marine Au  
Inductance: 20 mH  $\pm 10\%$   
Resistance: 65 Ohms Max  
Model Number: CH5070AS-203K-006  
Sipex No. S51208-M-1021-Sipex



All dimensions in mm

Mark Technology: North American stocking distributor for Sankyo and CTC  
Phone: 905-891-0165 FAX: 905-891-8534.

### EL polarizers/transflector manufacturers

Nitto Denko  
Yoshi Shinozuka  
56 Nicholson Lane  
San Jose, CA. 432-5480

Top Polarizer- NPF F1205DU  
Bottom - NPF F4225  
or (F4205) P3 w/transflector

Transflector Material  
Astra Products  
Mark Bogin  
P.O. Box 479  
Baldwin, NJ 11510  
Phone (516)-223-7500  
Fax (516)-868-2371

### EL Lamp manufacturers

Leading Edge Ind. Inc.  
11578 Encore Circle  
Minnetonka, MN 55343  
Phone 1-800-845-6992

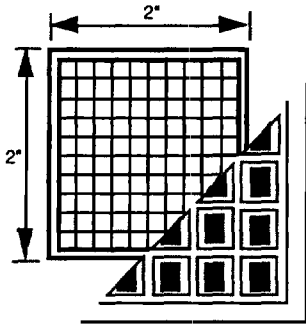
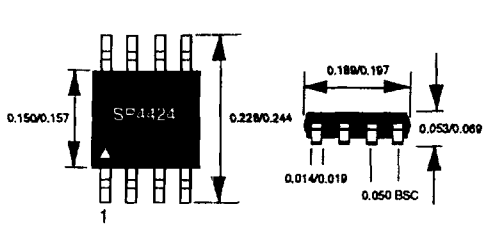
Nippon Graphite  
Peter J. Opdahl  
123 NW 13th Street #308  
Boca Raton, FL 33432  
Phone: (407) 392-2555  
Fax: (407) 392-0807

Luminescent Systems inc. (LSI)  
101 Etna Road  
Lebanon, NH. 03766-9004  
Phone: (603) 448-3444  
Fax: (603) 448-33452

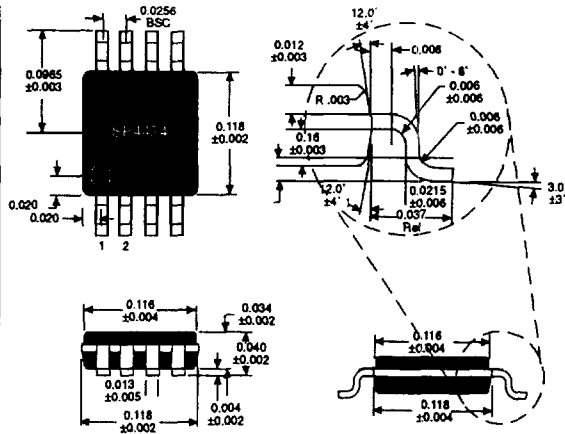
NEC Corporation  
Yumi Saskai  
7-1, Shiba 5 Chome, Minato-ku,  
Tokyo 108-01, Japan  
Phone: (03) 3798-9572  
Fax: (03) 3798-6134

Seiko Precision  
Shuzo Abe  
1-1, Taihei 4-Chome,  
Sumida-ku, Tokyo, 139 Japan  
Phone: (03) 5610-7089  
Fax: (03) 5610-7177

MKS  
7 N. Industrial Blvd  
Bridgeton, NJ. 08302  
Phone: (609) 451-5545  
Fax: (609) 451-9096



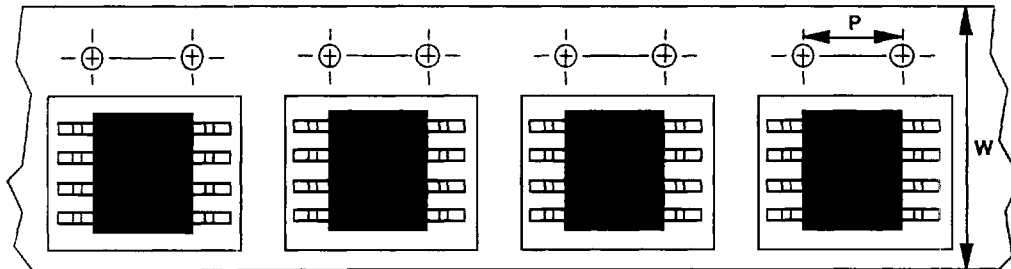
100 SP4424 die per waffle pack



95 SP4424 per tube, no minimum quantity



50 SP4424 per tube



NSOIC-8 13" reels: P=8mm, W=12mm		Standard qty per reel	Maximum qty per reel
	Minimum qty per reel		
CN	500	1500	2500
CU	500	1500	3000



**ORDERING INFORMATION**

<b>Model</b>	<b>Temperature Range</b>	<b>Package Type</b>
SP4424CN .....	0°C to +70°C .....	8-Pin NSOIC
SP4424CN/TR .....	0°C to +70°C .....	8-Pin NSOIC
SP4424CX .....	0°C to +70°C .....	Die
SP4424CU .....	0°C to +70°C .....	8-Pin USOIC
SP4424CU/TR .....	0°C to +70°C .....	8-Pin USOIC
SP4424NEB .....		NSOIC Evaluation Board
SP4424UEB .....		USOIC Evaluation Board



SIGNAL PROCESSING EXCELLENCE

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 Billerica, MA 01821  
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 FAX: (508) 670-9001

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 Milpitas, CA 95035  
 TEL: (408) 945-9080  
 FAX: (408) 946-6191

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 FAX: (508) 670-9001

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 FAX: (508) 670-9001

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 Gautinger Strasse 10  
 82319 Starnberg  
 TEL: 49.81.51.89810  
 FAX: 49.81.51.29598

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 30 Rue du Morvan, SILIC 525  
 94833 Rungis Cedex  
 TEL: 33.1.4687.8336  
 FAX: 33.1.4560.0784

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 Yahagi No. 2 Building  
 3-5-3 Uchikanda, Chiyoda-ku  
 Tokyo 101, Japan  
 TEL: 011.81.3.3256.0577  
 FAX: 011.81.3.3256.0621

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