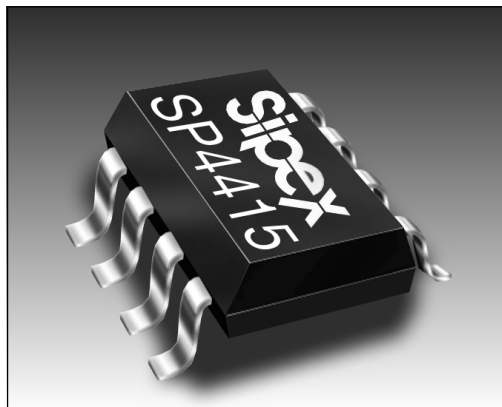


## Electroluminescent Lamp Driver with Selectable Level Outputs

- 2.2 V- 3.6 V Battery Operation
- 50 nA Maximum Standby Current
- Four Level Selectable Output
- High Voltage Output 140V<sub>pp</sub> Typical
- High Impedance Clock Signal  
Conditioner

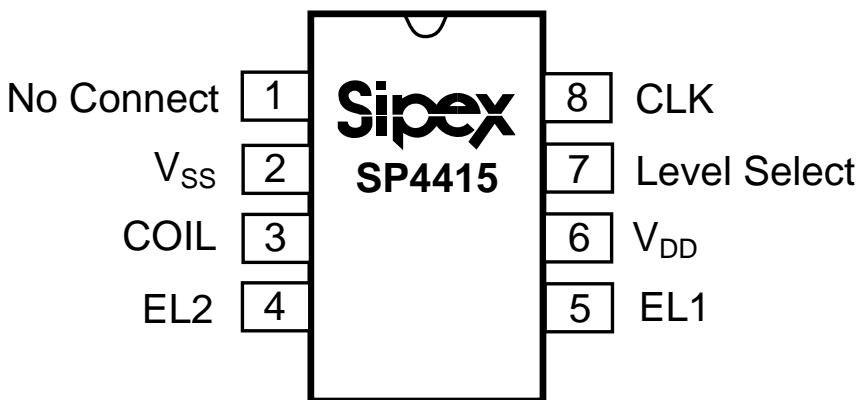
### APPLICATIONS

- Watches
- Pagers
- Backlit LCD Displays



### DESCRIPTION

The **SP4415** is a single chip DC-AC converter ideally suited for driving electroluminescent panels to four intensity levels. The **SP4415** is capable of converting DC input voltages as low as 2.2V into any of four AC voltage levels which can be set via external switch. A high impedance clock input and signal conditioner allows users to connect crystal oscillators directly to the CLK input without interfering with existing system timing, no buffering of the crystal oscillator is necessary. The **SP4415** requires only one external inductor and is offered in an 8-pin NSOIC package. For delivery in die form, please consult the factory.



**SP4415 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>DD</sub> .....	7.0 V
Input Voltages/Currents	
Level Select (pin 1).....	-0.5V to (V <sub>DD</sub> +0.5V)
EN (pin3).....	60mA
Lamp Outputs.....	.250V <sub>pp</sub>
Storage Temperature.....	-65°C to +150°C

### Power Dissipation Per Package

8-pin NSOIC (derate 6.14mW°C above +70°C).....500mW

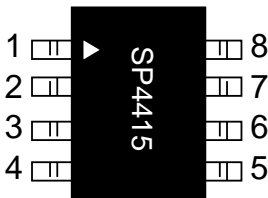
The information furnished herein by Sipex has been carefully reviewed for accuracy and reliability. Its application or use, however, is solely the responsibility of the user. No responsibility for the use of this information is assumed by Sipex, and this information shall not explicitly or implicitly become part of the terms and conditions of any subsequent sales agreement with Sipex. Specifications are subject to change without prior notice. By the sale or transfer of this information, Sipex assumes no responsibility for any infringement of patents or other rights of third parties which may result from its use. No license or other proprietary rights are granted by implication or otherwise under any patent or patent rights of Sipex Corporation.

## SPECIFICATIONS

T= 25°C; V<sub>DD</sub> = 3.0V; Lamp Capacitance = 2000pF; Coil = 30 mH at 125 Ohms; Osc = 32,768Hz (Unless otherwise noted)

PARAMETER	MIN.	TYP.	MAX.	UNITS	CONDITIONS
Supply Voltage, V <sub>DD</sub>	2.2	3.0	3.6	V	
Supply Current, I <sub>COIL</sub> +I <sub>DD</sub>		5	20	mA	V <sub>LS</sub> at Level 1
Coil Voltage, V <sub>COIL</sub>	V <sub>DD</sub>		3.6	V	
Level Select Input Voltage, V <sub>LS</sub> LOW: EL off HIGH: EL on	-0.25 V <sub>DD</sub> -0.25	0 V <sub>DD</sub>	0.25V V <sub>DD</sub> +0.25	V	
Level Select Current, I <sub>LS</sub> EL off EL on	1	10	10 40	μA	V <sub>DD</sub> =3V, 0≤V <sub>LS</sub> ≤1.5V V <sub>DD</sub> =3V, V <sub>LS</sub> =3V
Shutdown Current, I <sub>SD</sub> =I <sub>COIL</sub> +I <sub>DD</sub>			50	nA	V <sub>LS</sub> at Level 1
External Clock Frequency		32768		Hz	
Input Sensitivity		125		mV <sub>p</sub>	
<b>INDUCTOR DRIVE</b>					
Coil Frequency, f <sub>COIL</sub> =f <sub>LAMP</sub> ×32		8192		Hz	
Coil Duty Cycle		75		%	
Peak Coil Current, I <sub>PK-COIL</sub>			60	mA	Guaranteed by design.
Coil Pulses Level 1 Level 2 Level 3 Level 4		7 9 12 16		pulses	Refer to <i>SP4415 Level Select Control</i> diagrams.
<b>EL LAMP OUTPUT</b>					
EL Lamp Frequency, f <sub>LAMP</sub>		256		Hz	
Peak to Peak Output Voltage	130	140	160	V <sub>pp</sub>	V <sub>LS</sub> at Level 4

## PIN DESCRIPTION



Pin 1 – NC - Float this pin..

Pin 2 –  $V_{SS}$  - Ground connection

Pin 3 – Coil - Coil input, connect coil from  $V_{DD}$  to Pin 5.

Pin 4 – Lamp2- EL voltage output, connect directly to EL lamp.

Pin 5 – Lamp1- EL voltage output, connect directly to EL lamp.

Pin 6 –  $V_{DD}$  - Power supply for driver, connect to system  $V_{DD}$ .

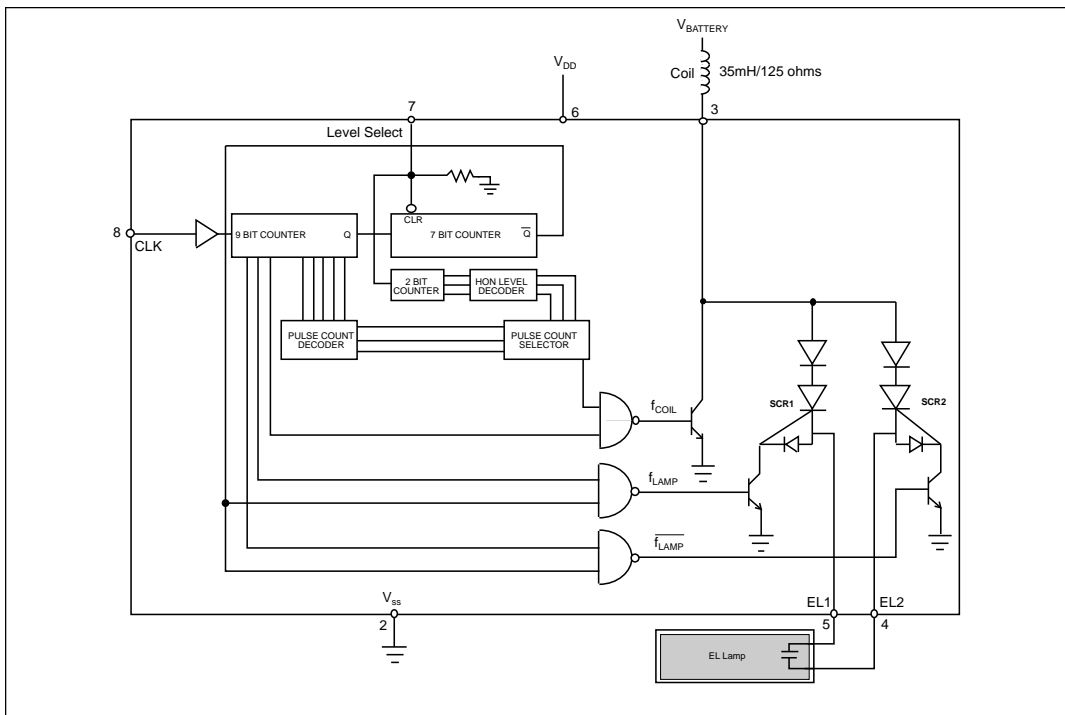
Pin 7 – Level Select - Selects the number of inductor drive pulses.

Pin 8 – Clk - Clock input for charge and discharge cycles.

## THEORY OF OPERATION

The **SP4415** is made up of three basic circuit elements, a clock signal conditioner, a divider chain, and a switched H-bridge network. The clock signal conditioner circuit allows users to directly connect a crystal oscillator output to the **SP4415**; no buffering is necessary. The clock input features high impedance (50 M $\Omega$ ), low capacitance (2.5pF) and 200mV sensitivity. The external clock should range from (V<sub>DD</sub>-1V) to ground. The **SP4415** is optimized for 32,768Hz clock signals and is allowed to vary from 20 kHz to 60kHz.

The externally supplied clock signal provides the circuit with a clock source used to control the charge and discharge phases for the coil and lamp. The suggested oscillator frequency is 32,768Hz . This clock frequency is internally divided to create two internal control signals,  $f_{\text{COIL}}$  and  $f_{\text{LAMP}}$ . For example a 32,768Hz signal will be divided to provide an 8,192Hz 75% duty cycle output to drive the coil and a 256Hz 50% duty cycle output to drive the lamp. Although the oscillator frequency can be varied to optimize the lamp output, the ratio of  $f_{\text{COIL}}$  to  $f_{\text{LAMP}}$  will always equal 32.



### SP4415 Schematic

The EL outputs can be enabled by driving the Level Select pin (pin 7) high.

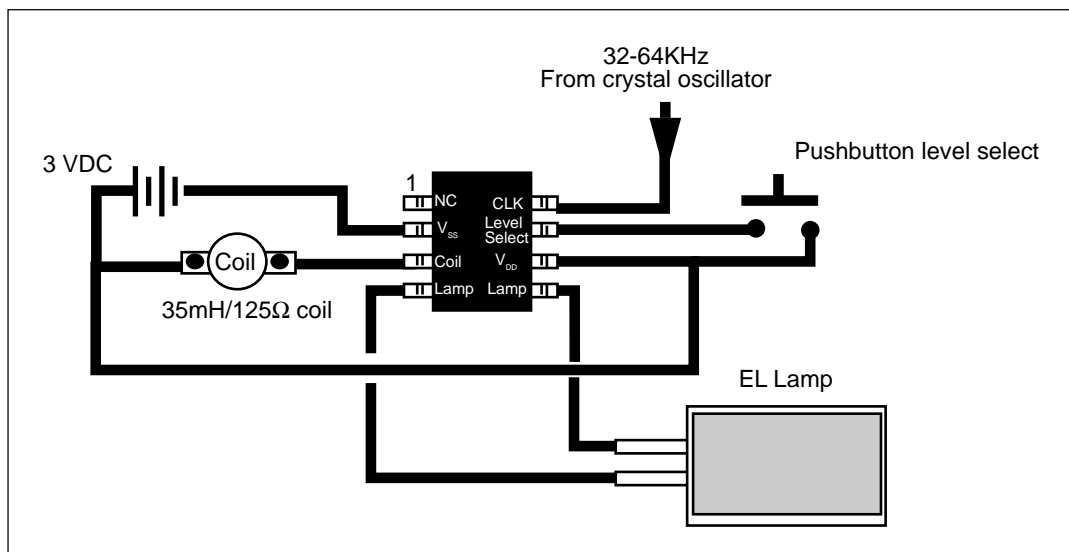
Four intensity levels can be set via the Level Select pin (pin 7). The intensity levels correspond with the number of coil pulses per bridge half cycle. The full output is represented by 16 coil pulses, levels 3, 2, 1 have 12, 9, and 7 coil pulses. The coil pulses transfer energy to the EL lamp; the more pulses per cycle, the brighter the lamp.

In order to set a level, the Level Select pin should be driven high, then driven low (or released) and within the next one second, the Level Select pin should be again driven high; this sequence will increment the level selection until the highest level (level 4) is reached. The next sequence will force the output back to the lowest intensity level, level 1. The Level Select pin is equipped with a debounce circuit such that momentary ( $\leq 15$  ms) opens of the input will not result in changes to the output level.

The coil is an external component connected from  $V_{BATTERY}$  to pin 3 of the **SP4415**. Energy is developed in the coil according to the equation  $E_L = 1/2 LI^2$  where the current  $I$  is defined as  $I = (V_{BATTERY} - IR - V_{OL}) / R_L$ . In order to maximize the energy produced by the coil,  $V_{BATTERY}$  should

represent the largest voltage in the system (up to a maximum of 6.0 v );  $V_{BATTERY} = 3.0$  VDC with a 35mH/125 $\Omega$  coil is a typical example. It is not necessary that  $V_{DD} = V_{BATTERY}$ . The majority of the supply current is dissipated in the coil (10mA typical). The **SP4415** itself requires less than 1mA (700 $\mu$ A typical). Coils are also a function of the core material and winding used -- performance variances may be noticeable from different coil suppliers even though the values are the same. The **Sipex SP4415** is final tested using a 35mH/135 ohm coil. For suggested coil sources see *page 8*.

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 square wave, switching at 1/4 the oscillator frequency. For a 32,768 Hz oscillator  $f_{COIL}$  is 8,192Hz. 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 16 of these charge pulses to the lamp; each pulse increases the voltage drop across the lamp in discrete steps. As the voltage potential approaches its maximum, the steps become shorter (see *figure 1* on *page 7*).



**Typical SP4415CN Application Circuit**

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 128. For a 32,768 Hz oscillator,  $f_{LAMP}=256$  Hz.

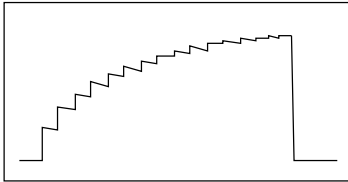
When the energy from the coil is released, a high voltage spike is created triggering the SCR switches. The direction of current flow is determined by which SCR is enabled. One full cycle of the H-bridge will create 16 voltage steps from ground to 80V (typical) on pins 6 and 7 which are 180 degrees out of phase with each other (see **figure 3** on **page 7**). A differential view of the outputs is shown in **figure 4** on **page 7**.

## ELECTROLUMINESCENT TECHNOLOGY

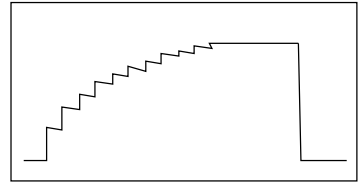
An EL lamp is basically a strip of plastic that is coated with a phosphorous material which emits light (fluoresces) when a high voltage (>40V) which was first applied across it, is removed or reversed. Long periods of DC voltages applied to the material tend to breakdown the material and reduce its 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.

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 current than LEDs or incandescent 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.

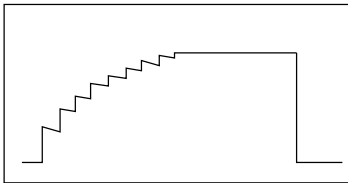
The amount of light emitted is a function of the voltage applied to the lamp, the frequency at which it is applied, the lamp material used and its size, and lastly, the inductor used. There are many variables which can be optimized for specific applications.



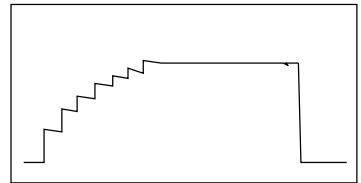
Level 4, 16 Coil pulses  
100% of  $V_{OUT}$



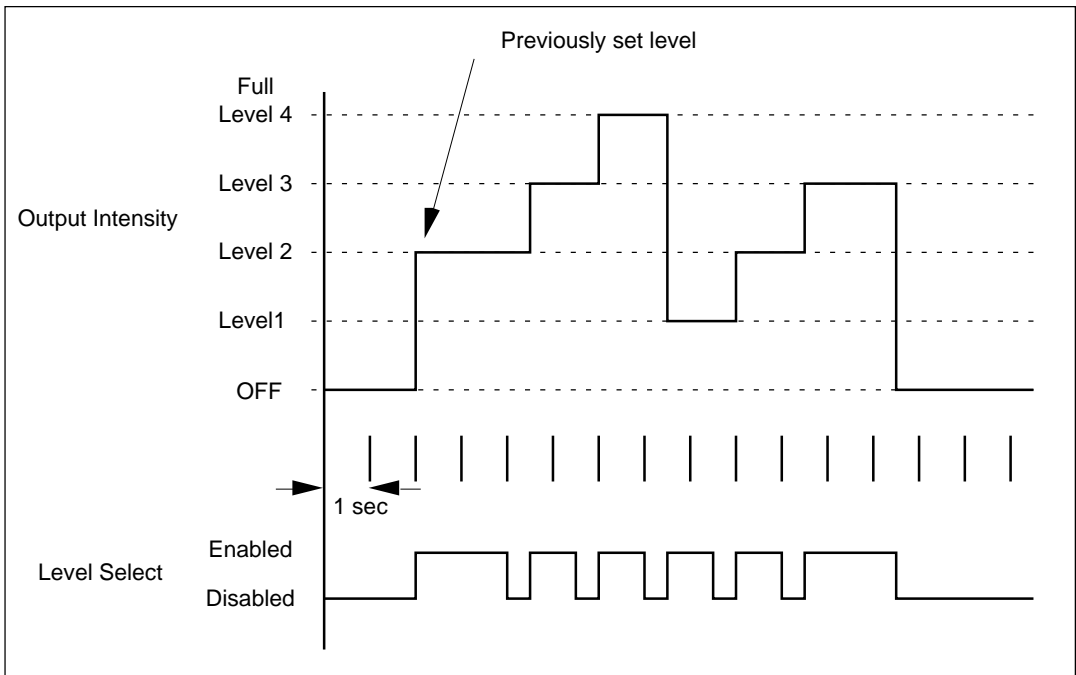
Level 3, 12 Coil pulses  
85% of  $V_{OUT}$



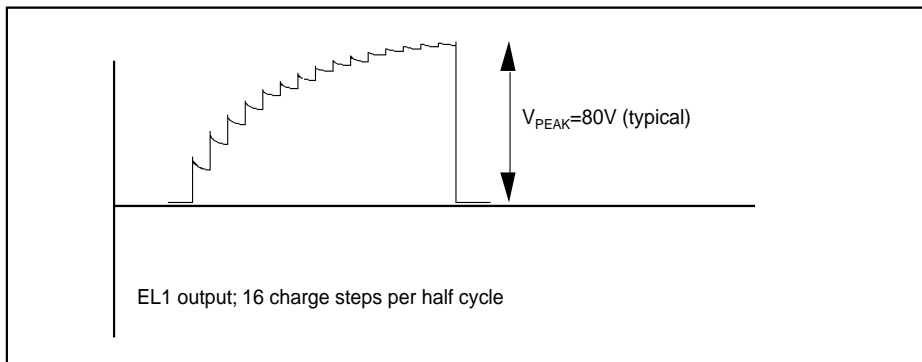
Level 2, 9 Coil pulses  
80% of  $V_{OUT}$



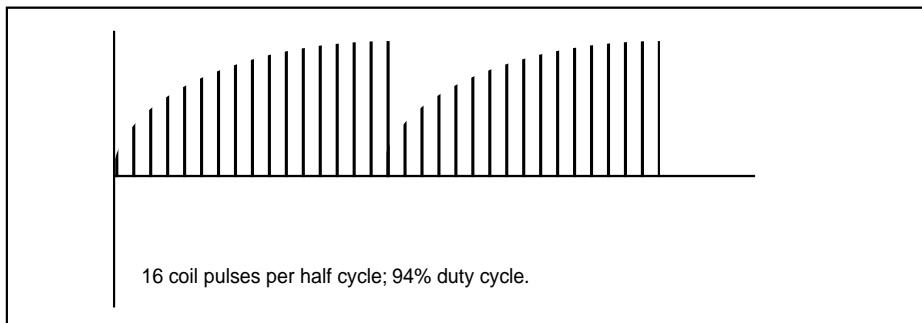
Level 1, 7 Coil pulses  
75% of  $V_{OUT}$



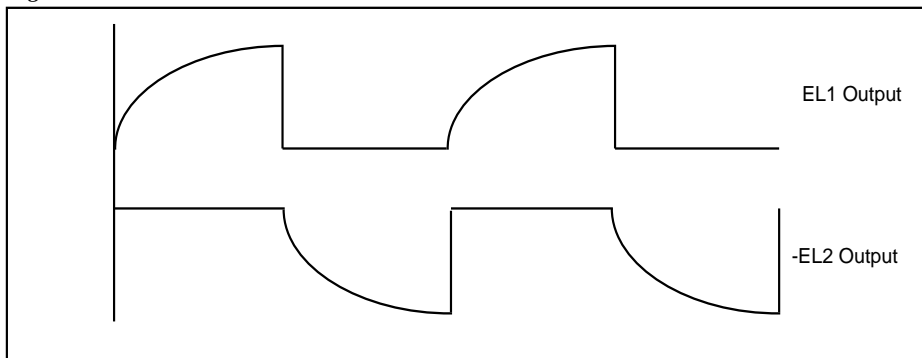
**SP4415 Level Select Control**



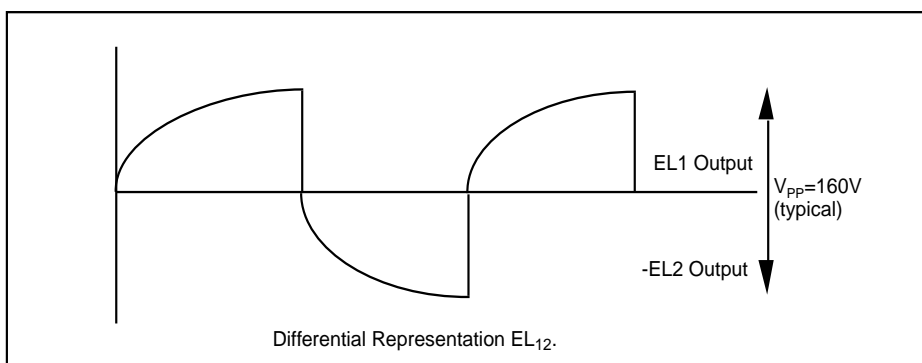
**Figure 1.**



**Figure 2.**



**Figure 3.**

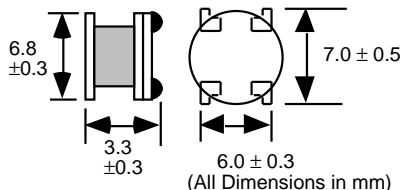


**Figure 4.**

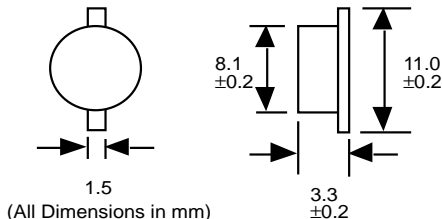
HITACHI METALS Ltd.  
Kishimoto Bldg.  
2-1, Marunouchi 2-Chome,  
Chiyoda-Ku, Tokyo Japan  
Phone: 3-3284-4936  
Fax: 3-3287-1945  
Mr. Noboru Abe  
Spec.-  
9 mH  $\pm 30\%$  42 ohm (Max)  
Model: MD 735L902B

Singapore  
Mr Stan kaiko,  
Mr. Hiroshi Kai  
Phone: 222-8077  
Fax: 222-5232  
  
Hong Kong  
Mr Mori Ota  
Phone: 2724-4188  
Fax: 2311-2095

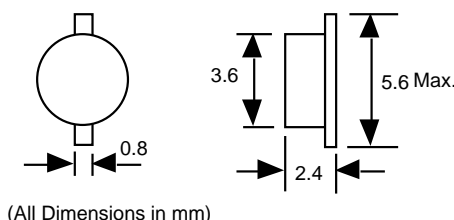
San Jose, CA  
Mr. Kent Oda  
Ph: 408 436-9505  
Fx: 408 436-9601



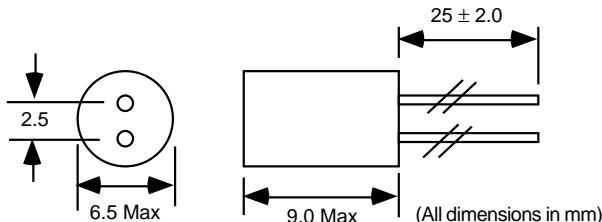
Sankyo Shoji Co. (HK)  
RM 28, 9/11 Thriving Ind. Centre  
Tsuen Wan, N.T.  
Hong Kong  
Phone: 8522 414 9268  
Fax: 8522 413 6040  
Contact: Mr. K.M. Chang  
Inductance: 29mH  $\pm 20\%$   
Resistance: 62 Ohms  $\pm 10\%$  @ 25°C  
Part Number SK-121



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  $\pm 15\text{mH}$   
Resistance: 270 Ohms  $\pm 15\%$  @ 25°C  
Part Number SK-80



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



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

Midori Mark Ltd.  
1-5 Komagata 2-Chome  
Taita-Ku 111-0043 Japan  
Phone: 81-03-3848-2011

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

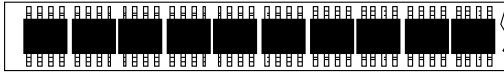
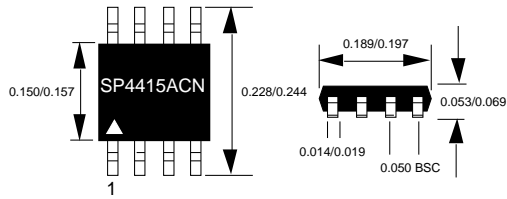
Seiko Precision  
Shuzo Abe  
1-1, Taihei 4-Chome,  
Sumida-ku, Tokyo, 139 Japan  
Phone: (03) 5610-7089  
Fax: (03) 5610-7177

Gunze Electronics  
2113 Wells Branch Parkway  
Austin, TX 78728  
Phone: (512) 752-1299  
Fax: (512) 252-1181

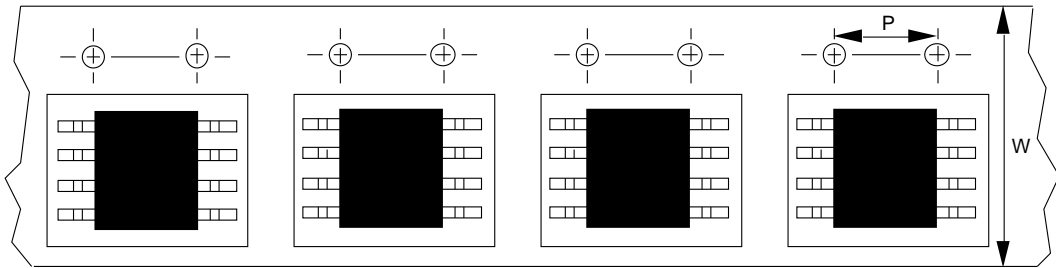


All package dimensions in inches

# 8-pin NSOIC



95 SP4415ACN per tube.



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

## ORDERING INFORMATION

Model	Temperature Range	Package Type
SP4415CN .....	0°C to +70°C .....	8-Pin NSOIC

Please consult the factory for pricing and availability on a Tape-On-Reel option.



SIGNAL PROCESSING EXCELLENCE

### Sipex Corporation

#### Headquarters and Sales Office

22 Linnell Circle  
Billerica, MA 01821  
TEL: (978) 667-8700  
FAX: (978) 670-9001  
e-mail: sales@sipex.com

#### Sales Office

233 South Hillview Drive  
Milpitas, CA 95035  
TEL: (408) 934-7500  
FAX: (408) 935-7600

### European Sales Offices:

#### ENGLAND:

Sipex Corporation  
2 Linden House  
Turk Street  
Alton Hampshire GU34 1AN  
England  
TEL: 44-1420-549527  
FAX: 44-1420-542700  
e-mail: mikeb@sipex.co.uk

#### GERMANY:

Sipex GmbH  
Gautinger Strasse 10  
82319 Starnberg  
TEL: 49.81.51.89810  
FAX: 49.81.51.29598  
e-mail: sipex-starnberg@t-online.de

### Far East:

#### JAPAN:

Nippon Sipex Corporation  
Yahagi No. 2 Building  
3-5-3 Uchikanda, Chiyoda-ku  
Tokyo 101  
TEL: 81.3.3256.0577  
FAX: 81.3.3256.0621

Sipex Corporation reserves the right to make changes to any products described herein. Sipex does not assume any liability arising out of the application or use of any product or circuit described herein; neither does it convey any license under its patent rights nor the rights of others.