

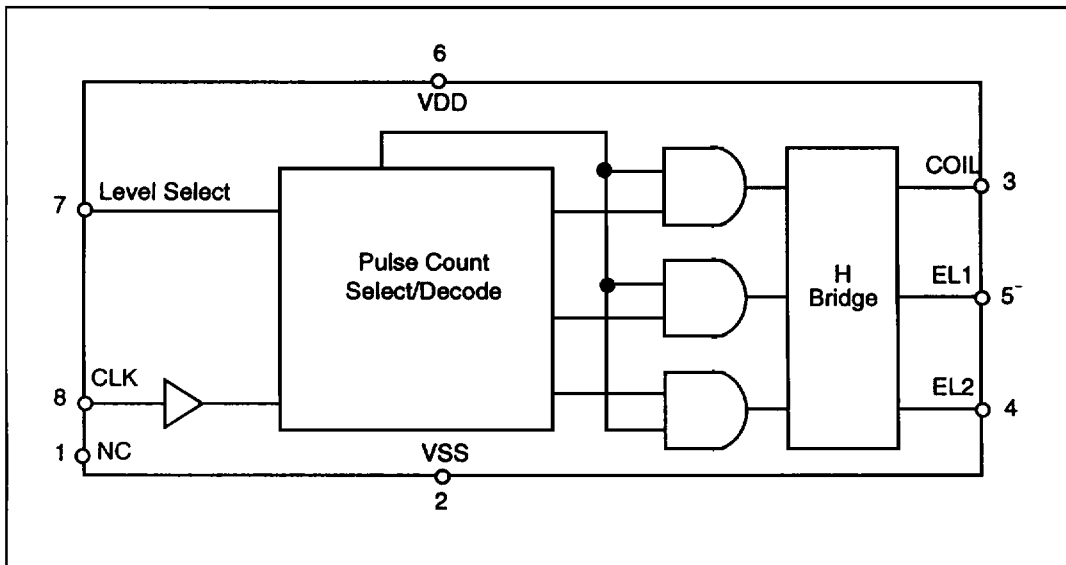
**Electroluminescent Lamp Driver  
 with Selectable Level Outputs**

- 2.2 V- 3.3 V Battery Operation
- 50 nA Maximum Standby Current
- Four Level Selectable Output
- High Voltage Output 90Vpp Typical
- High Impedance Clock Signal Conditioner



**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 microprocessor control. 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 N-SOIC package or die form.



**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.

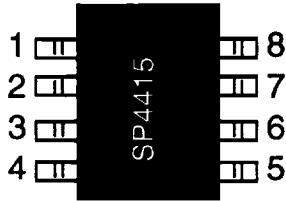
V <sub>DD</sub> .....	7.0 V
Input Voltages/Currents	
Level Select (pin 1).....	-0.5V to (V <sub>DD</sub> +0.5V)
EN (pin 3).....	80mA
Lamp Outputs.....	250Vp
Storage Temperature.....	-65°C to +150°C
Power Dissipation.....	200mW

## 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)

PARAMETERS	MIN.	TYP.	MAX.	UNIT	CONDITIONS
<b>INPUT CHARACTERISTICS</b>					
Supply Voltage	2.2	3.0	3.6	Volts	
Total Supply Current		5	20	mA	V <sub>DD</sub> = 3.0V ±5%; Level Select = Level 1
Quiescent Supply Current		10	50	nA	V <sub>DD</sub> = 3.0V ±5%; Level Select = Level 1
Clock Frequency	20,000	32,768	64,000	kHz	Typ. Osc. Input = 32,768 Hz
EN, Level Select Voltage On	V <sub>DD</sub> -0.5	V <sub>DD</sub>	V <sub>DD</sub> +0.5	Volts	
EN, Level Select Current On	1	10	40	µA	
EN, Level Select Voltage Off	0.5	0	V <sub>DD</sub> /2	Volts	
EN, Level Select Current Off		0	10	µA	Level Select = 1.5V, V <sub>DD</sub> = 3V
<b>Inductor Drive</b>					
Peak Current		10	60	mA	
Pulse Rate		8,192		Hz	Osc. Input = 32,768 Hz
Duty Cycle					
Level 1		7		pulses	
Level 2		9		pulses	
Level 3		12		pulses	
Level 4		16		pulses	
Duty Cycle		75		%	
<b>Lamp Output</b>					
Differential Voltage	130	140	160	V <sub>pp</sub>	Level Select = Level 1
Frequency		256		Hz	
Lamp Capacitance		2000		pF	Approximately 1 sq. in (6.5 sq. cm) EL lamp

## PIN DESCRIPTION

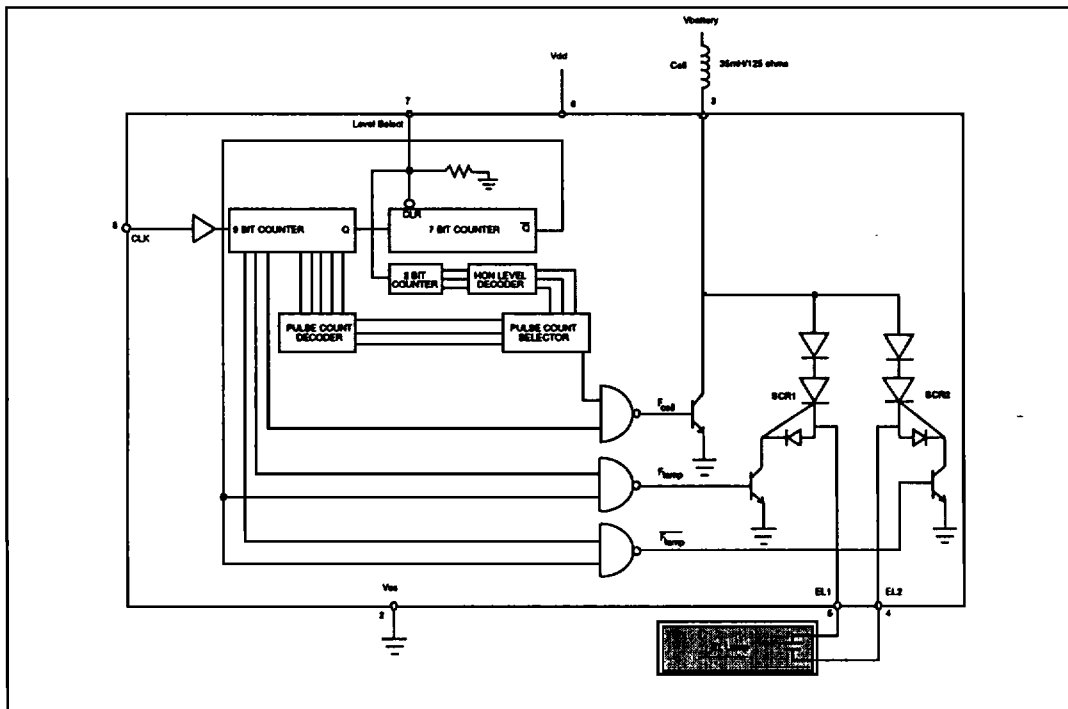


- Pin 1 – NC - Float this pin..
- Pin 2 – Vss - Ground connection
- Pin 3 – Coil - Coil input, connect coil from Vdd to Pin 5.
- Pin 4 – Lamp2- EL voltage output, connect directly to EL lamp.
- Pin 5 – Lamp1- EL voltage output, connect directly to EL lamp.
- Pin 6 – Vdd - Power supply for driver, connect to system Vdd.
- 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 MΩ), low capacitance (2.5pF) and 200mV sensitivity. The external clock should range from (Vdd-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,  $F_{coil}$  and  $F_{lamp}$ . 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  $F_{coil}$  to  $F_{lamp}$  will always equal 32.



SP4415 Schematic

The EL outputs can be enabled by driving the Level Select pin (pin 1) high.

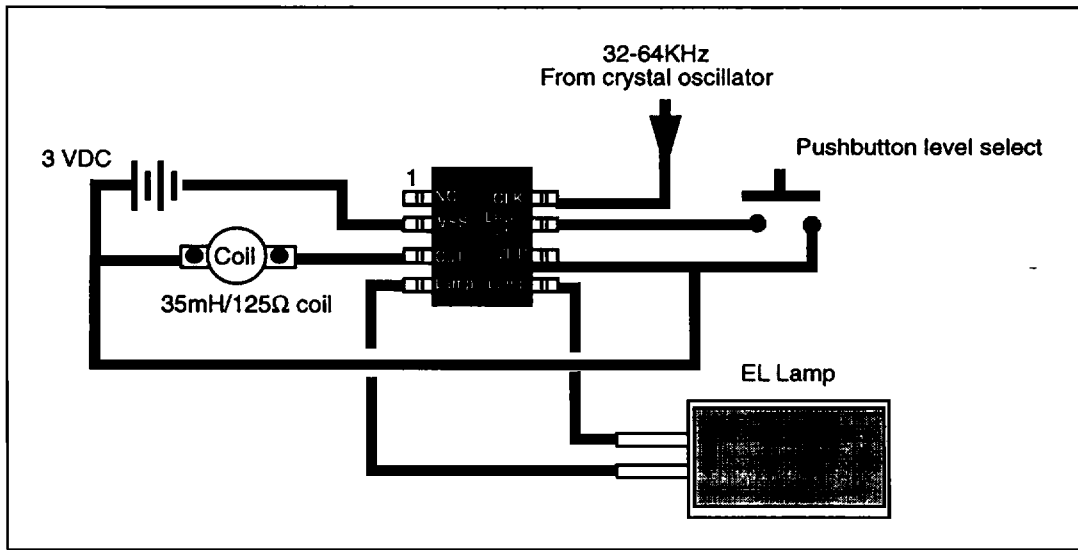
Four intensity levels can be set via the Level Select pin (pin 1). The intensity levels correspond with the number of coil pulses per bridge half cycle. The full output is represented by 16 coil pulses, levels 3, 2, 1 have 12, 9, and 7 coil pulses. The coil pulses transfer energy to the EL lamp; the 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 part 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 5 of the SP4415. Energy is developed in the coil according to the equation  $E_t = 1/2LI^2$  where the current  $I$  is defined as  $I = (V_{battery} - IR - V_{ol}) / R_T$ . 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 typ). The SP4415 itself requires less than 1mA (700 $\mu$ A typ). 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 5 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 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.

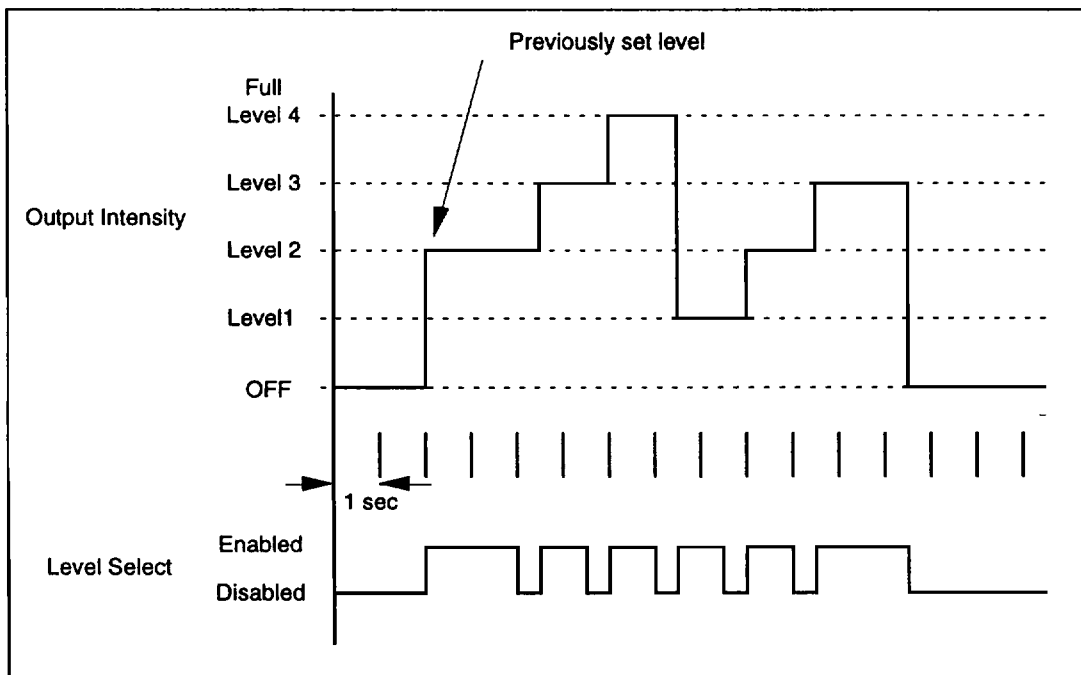
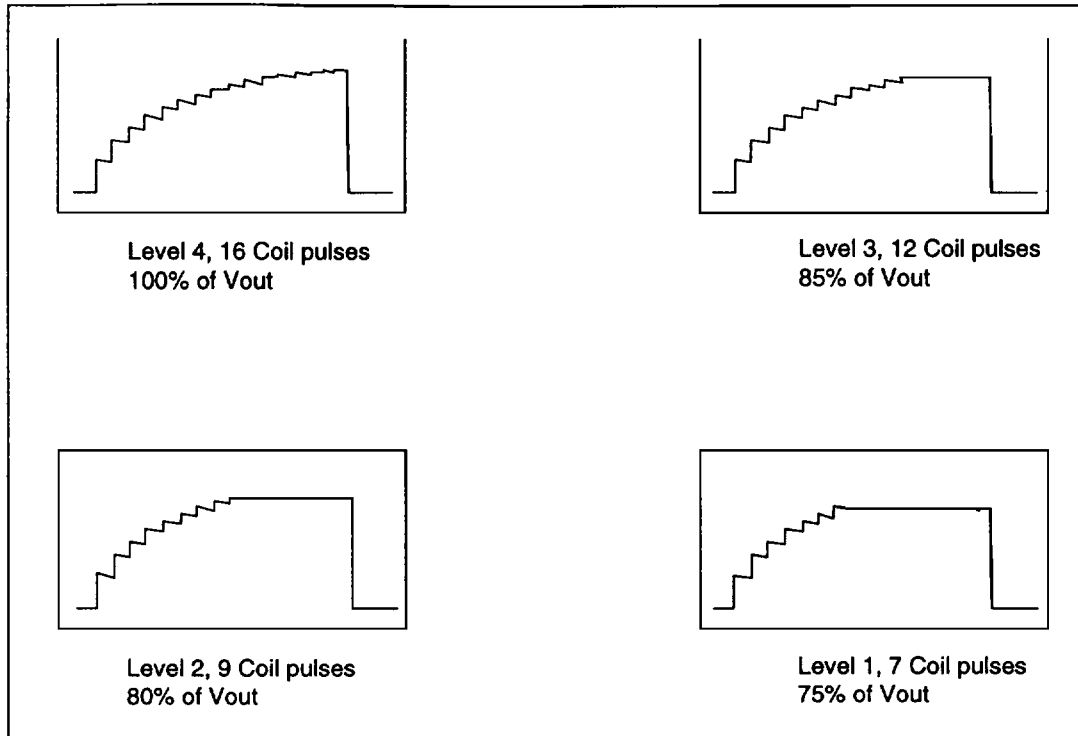
When the energy from the coil is released, a high voltage spike is created triggering the SCR switches. The direction of current flow is determined by which SCR is enabled. One full cycle of the H-bridge will create 16 voltage steps from ground to 80V (typ) on pins 6 and 7 which are 180 degrees out of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



**SP4415 Level Select Control**

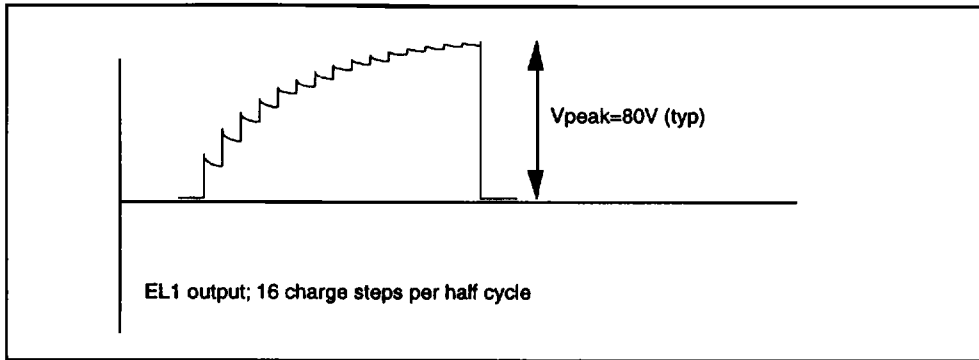


Figure 1.

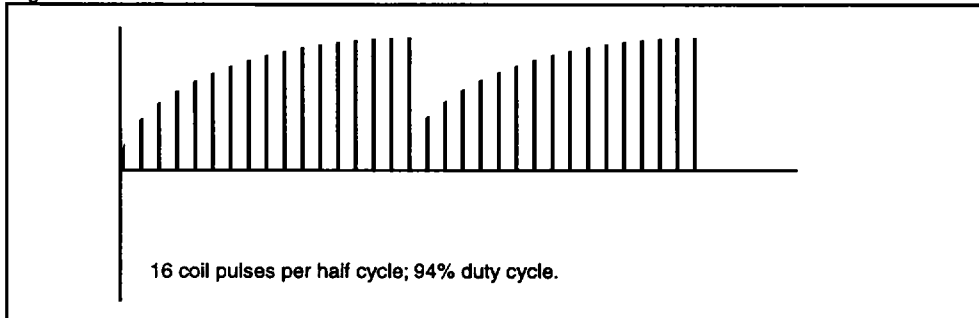


Figure 2.

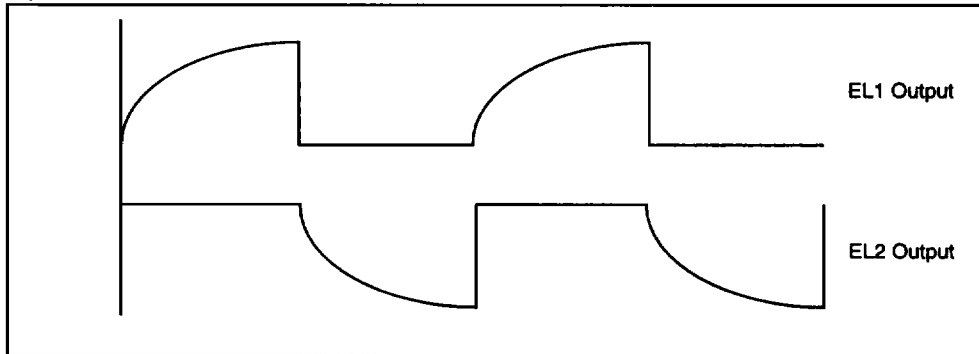


Figure 3.

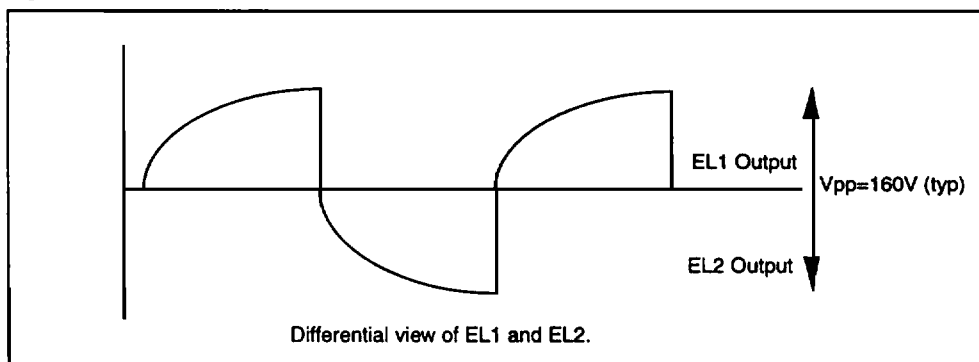


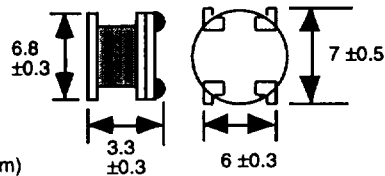
Figure 4.

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

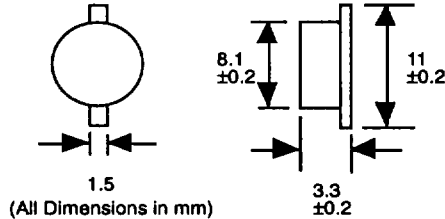
Singapore  
Mr Stan kaido,  
Mr. Hiroshi Kai  
Phone: 222-8077  
Fax: 222-5232

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

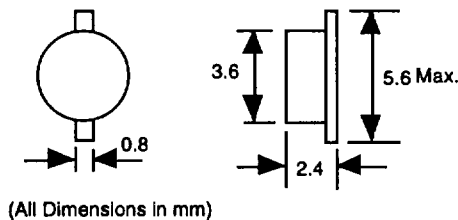
San Jose, CA  
Mr. Kent Oda  
Ph: 408 436-9505  
Fx: 408 436-9601



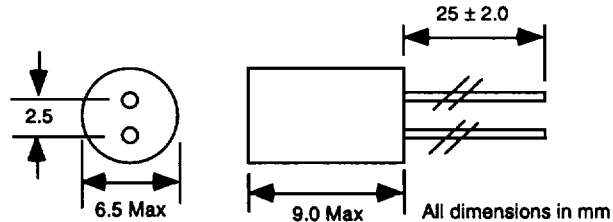
Sankyo Shoji Co. (HK)  
RM 28, 9/11 Thriving Ind. Centre  
Tsuen Wan, N.T.  
Hong Kong  
Phone: 8522 414 9268  
Fax: 8522 413 6040  
Contact: Mr. K.M. Chang  
Inductance: 29mH  $\pm 20\%$   
Resistance: 62 Ohms  $\pm 10\%$  @ 25°C  
Part Number SK-121



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  $\pm 15\%$   
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

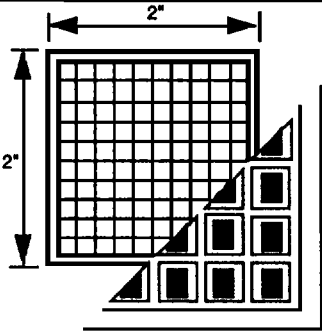
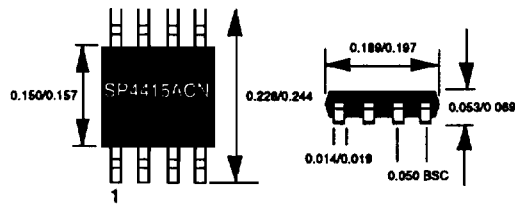
Nippon Graphite  
Peter J. Opdahl  
123 NW 13th Street #308  
Boca Raton, FL 33432  
Phone: (407) 392-2555  
Fax: (407) 392-0807

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

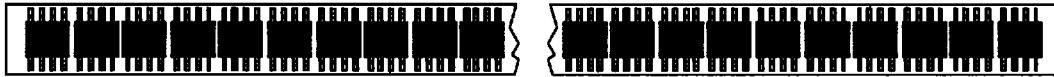
NEC Corporation  
Yumi Saskal  
7-1, Shiba 5 Chome, Minato-ku,  
Tokyo 108-01, Japan  
Phone: (03) 3798-9572  
Fax: (03) 3798-6134

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

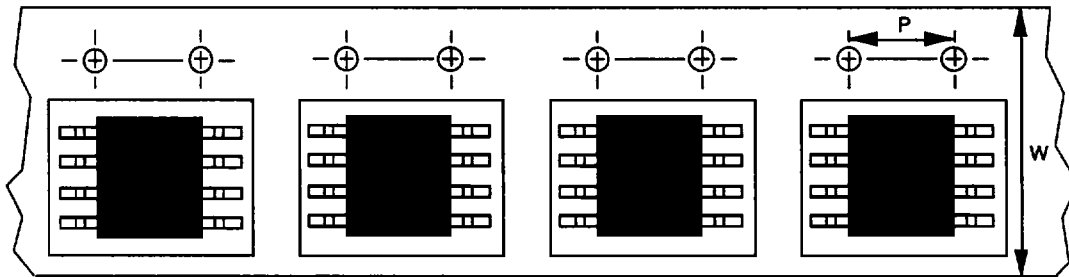
MKS  
7 N. Industrial Blvd  
Bridgeton, NJ. 08302  
Phone: (609) 451-5545  
Fax: (609) 451-9096



100 SP4415A die per waffle pack



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	1500	2500

## ORDERING INFORMATION

Model	Temperature Range	Package Type
SP4415CN . . . . .	0°C to +70°C . . . . .	8-Pin NSOIC
SP4415CN/TR . . . . .	0°C to +70°C . . . . .	8-Pin NSOIC
SP4415CX . . . . .	0°C to +70°C . . . . .	Die



SIGNAL PROCESSING EXCELLENCE

**Sipex Corporation**

22 Linnell Circle  
 Billerica, MA 01821  
 TEL: (508) 667-8700  
 FAX: (508) 670-9001

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

**US Regional Sales Offices:**

22 Linnell Circle  
 Billerica, MA 01821

**EASTERN U.S.:**  
 TEL: (508) 667-8700  
 FAX: (508) 670-9001

**WESTERN U.S.:**  
 TEL: (508) 667-8700  
 FAX: (508) 670-9001

**European Sales Offices:**

**GERMANY:**  
 Sipex GmbH  
 Gautinger Strasse 10  
 82319 Starnberg  
 TEL: 49.81.51.89810  
 FAX: 49.81.51.29598

**FRANCE:**  
 Sipex  
 30 Rue du Morvan, SILIC 525  
 94633 Rungis Cedex  
 TEL: 33.1.4687.8336  
 FAX: 33.1.4560.0784

**Far East:**

**JAPAN:**  
 Nippon Sipex Corporation  
 Haibara Building  
 2-3-7 Sotokanda Chiyoda-ku  
 Tokyo 101  
 TEL: 81.3.3254.5822  
 FAX: 81.3.3254.5824

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