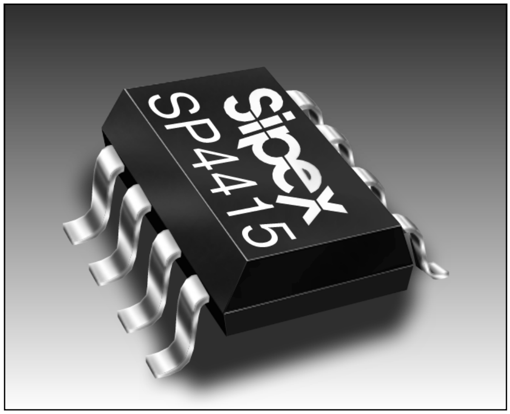
Electroluminescent Lamp Driver with Selectable Level Outputs

- 2.2 V- 3.6 V Battery Operation
- 50 nA Maximum Standby Current
- Four Level Selectable Output
- High Voltage Output 140V_{PP} Typical
- High Impedance Clock Signal Conditioner

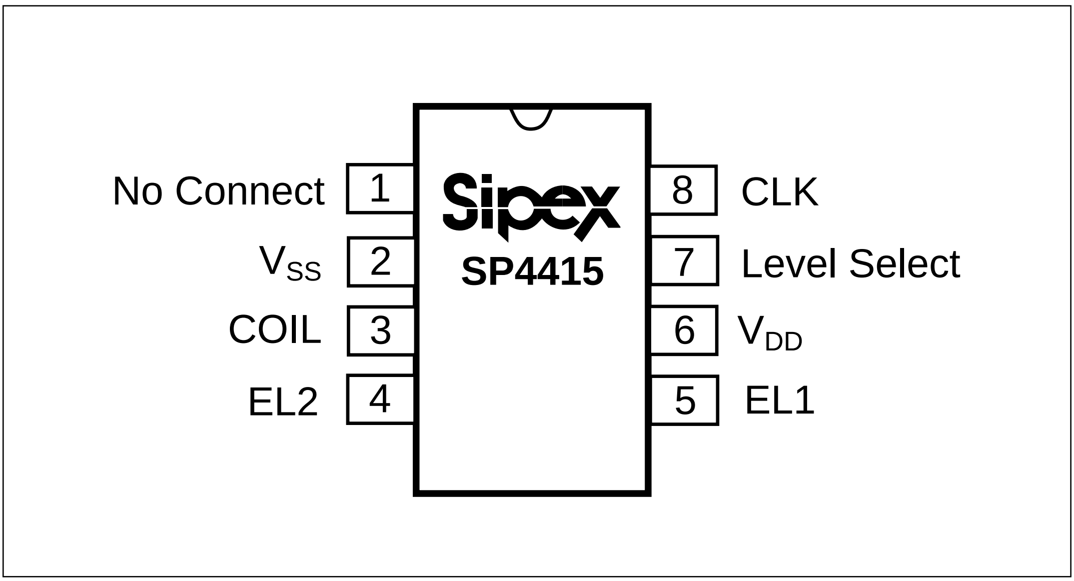


APPLICATIONS

- 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_{DD}..7.0 V
Input Voltages/Currents
Level Select (pin 1).......................................-0.5V to (V_{DD}+0.5V)
EN (pin3)...60mA
Lamp Outputs...250V_{PP}
Storage Temperature...-65˚C to +150˚C

Power Dissipation Per Package

8-pin NSOIC (derate 6.14mW/ºC above +70ºC)..................................500mW

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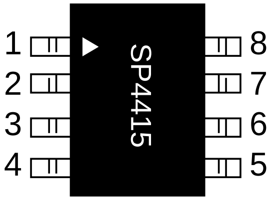
SPECIFICATIONS

T= 25°C; V_{DD} = 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_{DD}	2.2	3.0	3.6	V	
Supply Current, $I_{COIL}+I_{DD}$		5	20	mA	V_{LS} at Level 1
Coil Voltage, V_{COIL}	V_{DD}		3.6	V	
Level Select Input Voltage, V_{LS} LOW: EL off HIGH: EL on	 -0.25 V_{DD}-0.25	 0 V_{DD}	 0.25V V_{DD}+0.25	V	
Level Select Current, I_{LS} EL off EL on	 1	 10	 10 40	µA	 V_{DD}=3V, 0≤V_{LS}≤1.5V V_{DD}=3V, V_{LS}=3V
Shutdown Current, $I_{SD}=I_{COIL}+I_{DD}$			50	nA	V_{LS} at Level 1
External Clock Frequency		32768		Hz	
Input Sensitivity		125		mV_P	
INDUCTOR DRIVE					
Coil Frequency, $f_{COIL}=f_{LAMP}$x32		8192		Hz	
Coil Duty Cycle		75		%	
Peak Coil Current, $I_{PK-COIL}$			60	mA	Guaranteed by design.
Coil Pulses Level 1 Level 2 Level 3 Level 4		 7 9 12 16		pulses	Refer to ***SP4415 Level Select Control*** diagrams.
EL LAMP OUTPUT					
EL Lamp Frequency, f_{LAMP}		256		Hz	
Peak to Peak Output Voltage	130	140	160	V_{PP}	V_{LS} 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}.

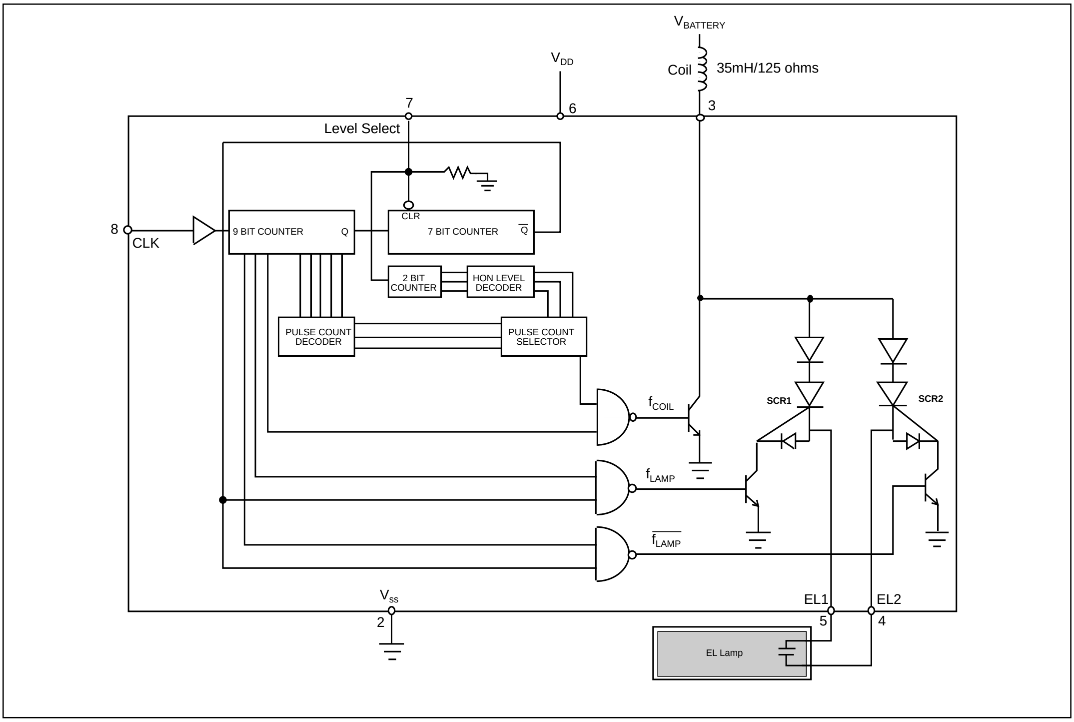
Pin 7 – Level Select - Selects the number of inductor drive pulses.

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 MΩ), low capacitance (2.5pF) and 200mV sensitivity. The external clock should range from (V_{DD}-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

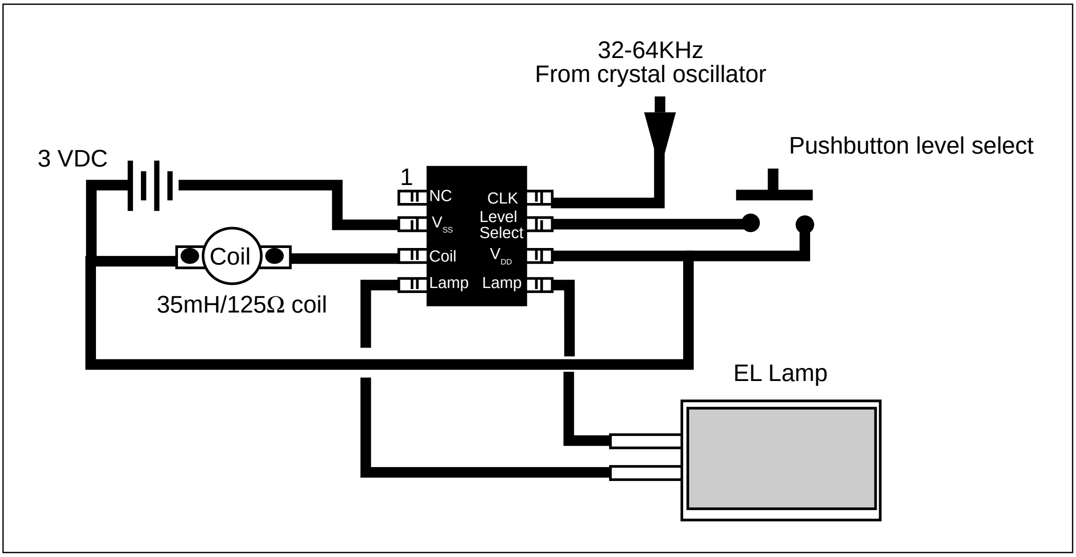
The EL outputs can be enabled by driving the Level Select pin (pin 7) high.

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 (≤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 $E_L=1/2LI^2$ 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/125Ω 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 (700µA 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.

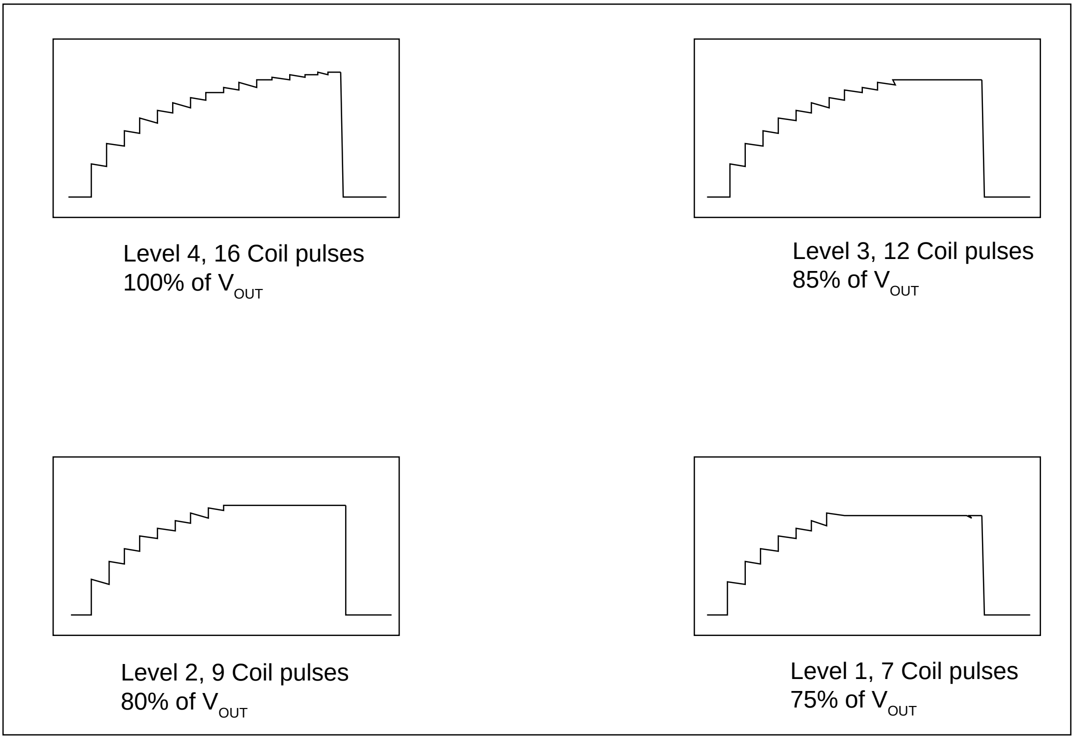
When the energy from the coil is released, a high voltage spike is created triggering the SCR switches. The direction of current flow is determined by which SCR is enabled. One full cycle of the H-bridge will create 16 voltage steps from ground to 80V (typical) on pins 6 and 7 which are 180 degrees out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

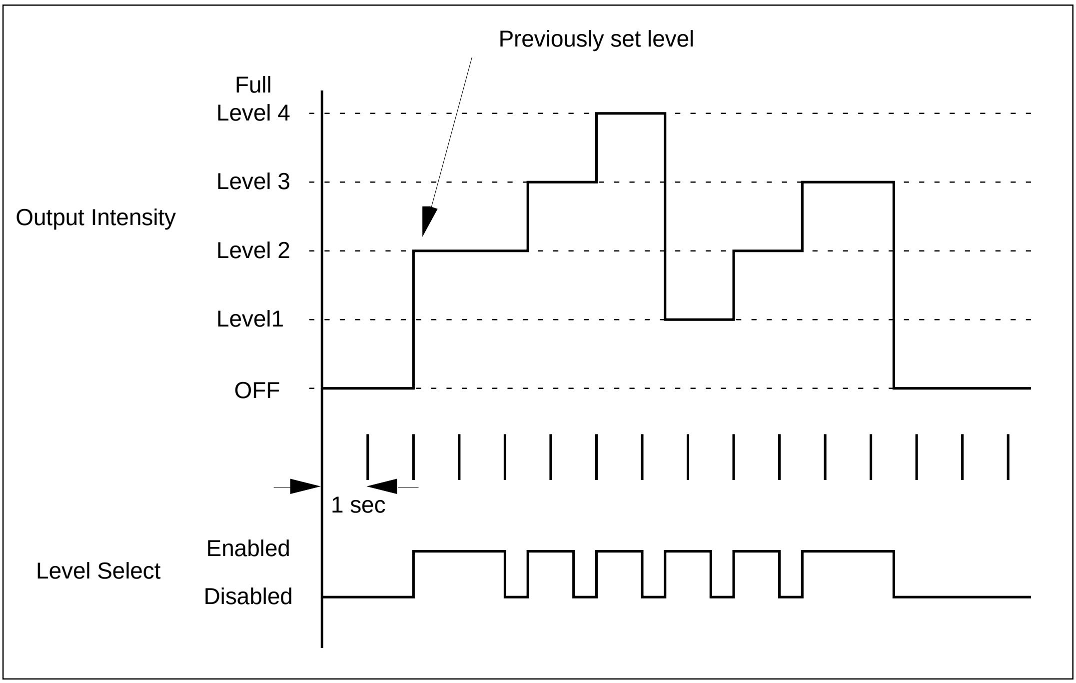
ELECTROLUMINESCENT TECHNOLOGY

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.





SP4415 Level Select Control

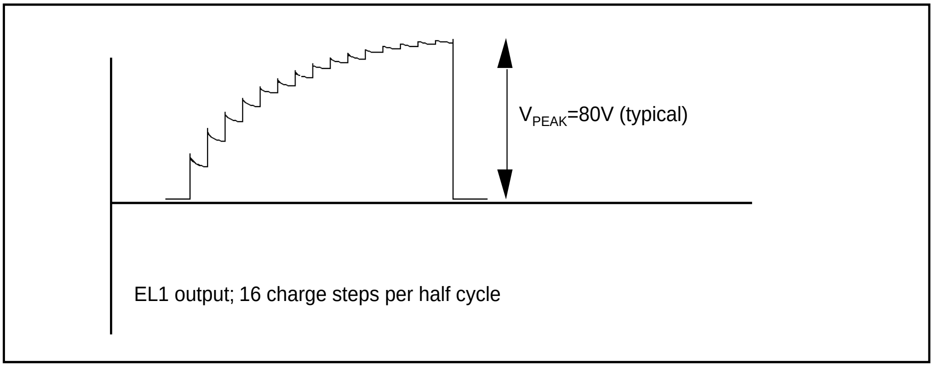


Figure 1.

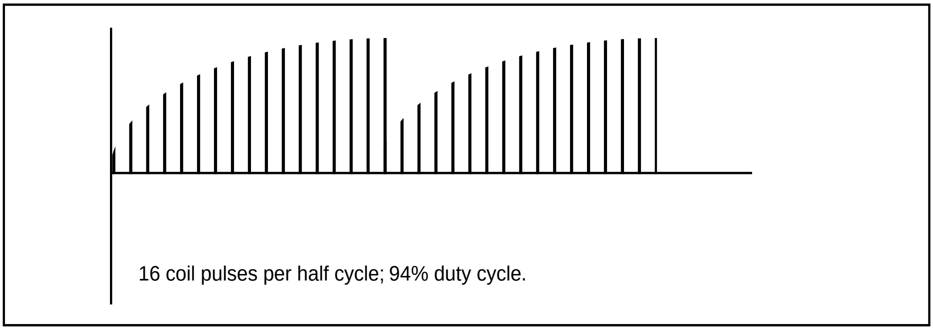


Figure 2.

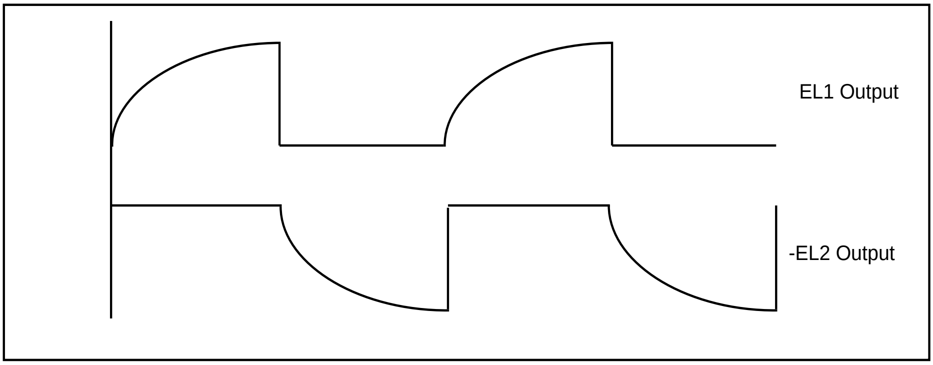


Figure 3.

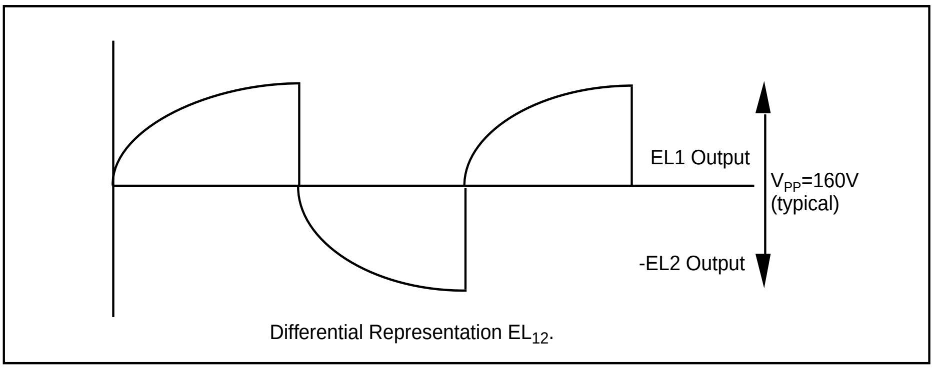


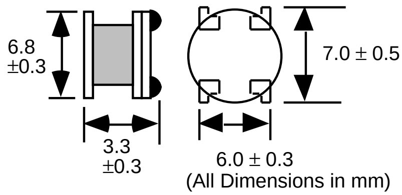
Figure 4.

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 ±30% 42 ohm (Max)
Model: MD 735L902B

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

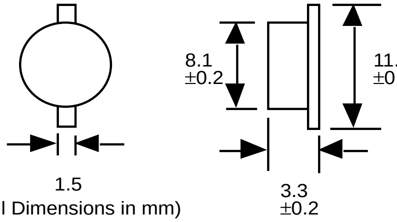
Hong Kong
Mr Mori Ota
Phone: 2724-4188
Fax: 2311-2095

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



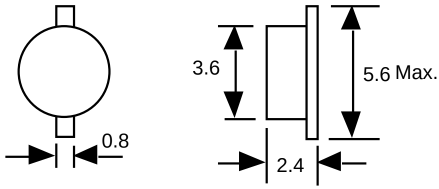
(All Dimensions in mm)

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



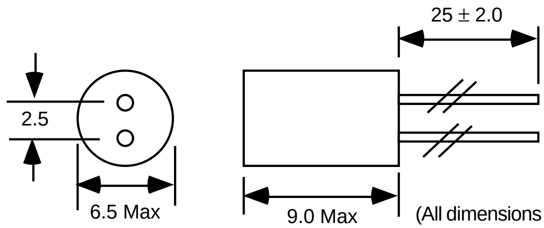
(All Dimensions in mm)

Sankyo Shoji Co. (HK)
RM 28, 9/il Thriving Ind. Centre
Tsuen Wan, N.T.
Hong Kong
Phone: 8522 414 9268
Fax: 8522 413 6040
Contact: Mr. K.M. Chang
Inductance: 65mH ±15mH
Resistance: 270 Ohms ±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 ±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

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

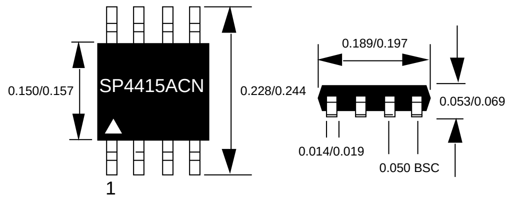
NEC Corporation
Yumi Saskai
7-1, Shiba 5 Chome, Minato-ku,
Tokyo 108-01, Japan
Phone: (03) 3798-9572
Fax: (03) 3798-6134

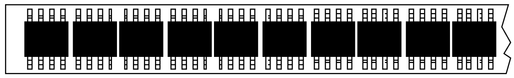
Seiko Precision
Shuzo Abe
1-1, Taihei 4-Chome,
Sumida-ku, Tokyo, 139 Japan
Phone: (03) 5610-7089
Fax: (03) 5610-7177

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

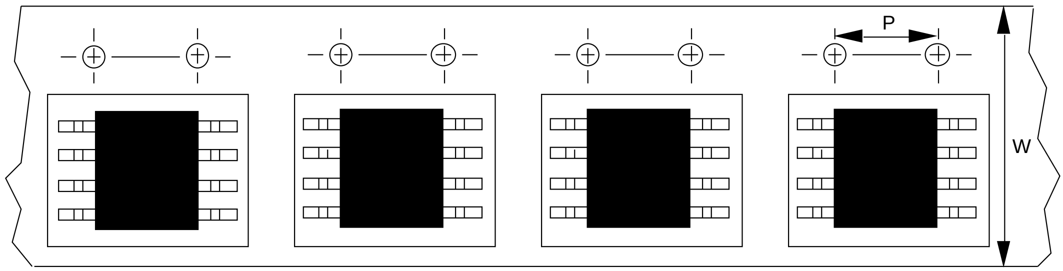
All package dimensions in inches

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.

Sipex Corporation

SIGNAL PROCESSING EXCELLENCE

Sipex Corporation

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FAX: (978) 670-9001
e-mail: sales@sipex.com

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Milpitas, CA 95035
TEL: (408) 934-7500
FAX: (408) 935-7600

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ENGLAND:
Sipex Corporation
2 Linden House
Turk Street
Alton Hampshire GU34 IAN
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

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