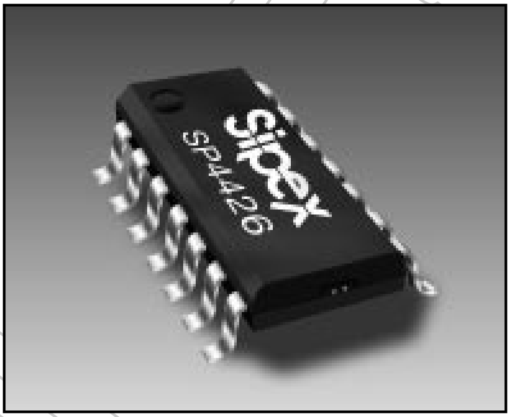
Electroluminescent Lamp Driver with High Output Drivers

- 2.2V-6.0V Battery Operation
- DC to AC Inverter for EL Backlit Display Panels
- Externally Adjustable Internal Oscillator
- Low Current Standby Mode

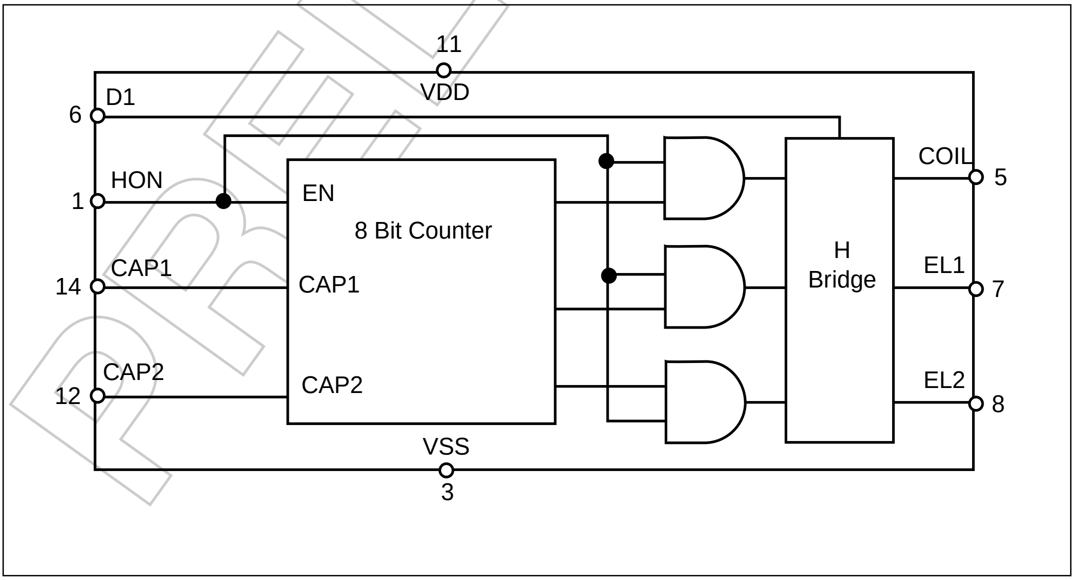


APPLICATIONS

- HPC's ■ PDA's ■ Pen Tablets
- Backlit LCD Displays

DESCRIPTION…

The **SP4426** is a high voltage output DC-AC converter that can operate from a 2.2V-6.0V power supply. The **SP4426** is capable of supplying up to 300 Vpp signals, making it ideal for driving electroluminescent lamps. The device features 100 nA (typ) standby current, for use in low power portable products. One external inductor is required to generate the high voltage charge, and one external capacitor is used to select the oscillator and Lamp frequencies. The **SP4426** is offered in a 14 pin narrow SOIC. 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.

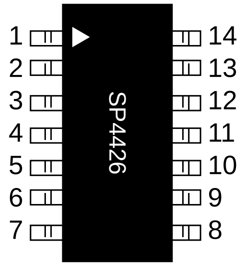
V_{dd}..........7.0V
Input Voltages/Currents
HON (pin1)..........-0.5V to (V_{dd}+0.5V)
COIL (pin3)..........60mA
Lamp Outputs..........250Vpp
Storage Temperature..........-65˚C to +150˚C
Power Dissipation..........200mW

SPECIFICATIONS

(T= 25°C; V_{dd} = 3.0V; Lamp Capacitance = 6000pF; Coil = 9 mH (R_S = 30Ω); Cosc = 150pF unless otherwise noted)

PARAMETER	MIN.	TYP.	MAX.	UNIT	CONDITIONS
INPUT CHARACTERISTICS					
Supply Voltage	2.2	3.0	6.0	Volts	
Total Supply Current		8	15	mA	Vdd= 3.0V ±5%; Hon= 3.0V
		15	50	mA	Vdd= 6.0V ±5%; Hon= 6.0V 150Ω in series with coil
Quiescent Supply Current		10	200	nA	Vdd= 3.0V ±5%; Hon= 0V
		0.3	1	µA	Vdd= 6.0V ±5%; Hon= 0V 150Ω in series with coil
Clock Frequency		76.8		kHz	Cosc=150pF; Vdd = 3.0V, (f_L x 256)
Hon Voltage On	Vdd-.5		Vdd	Volts	
Hon Current On		25	60	µA	Vdd = 3.0V
		50	120	µA	Vdd = 6.0V
Hon Voltage Off			Vdd-2	Volts	Vdd = 3.0V
			Vdd-3	Volts	Vdd = 6.0V
INDUCTOR DRIVE					
Peak Current			60	mA	
Pulse Rate		9.6		kHz	(f_L x 32)
Duty Cycle		94		%	
LAMP OUTPUT					
Differential Voltage	120	160		Vpp	
Frequency	200	300	400	Hz	Vdd = 3.0V
	225	300	450	Hz	Vdd = 6.0V
Lamp Capacitance		6000		pF	

PIN DESCRIPTION



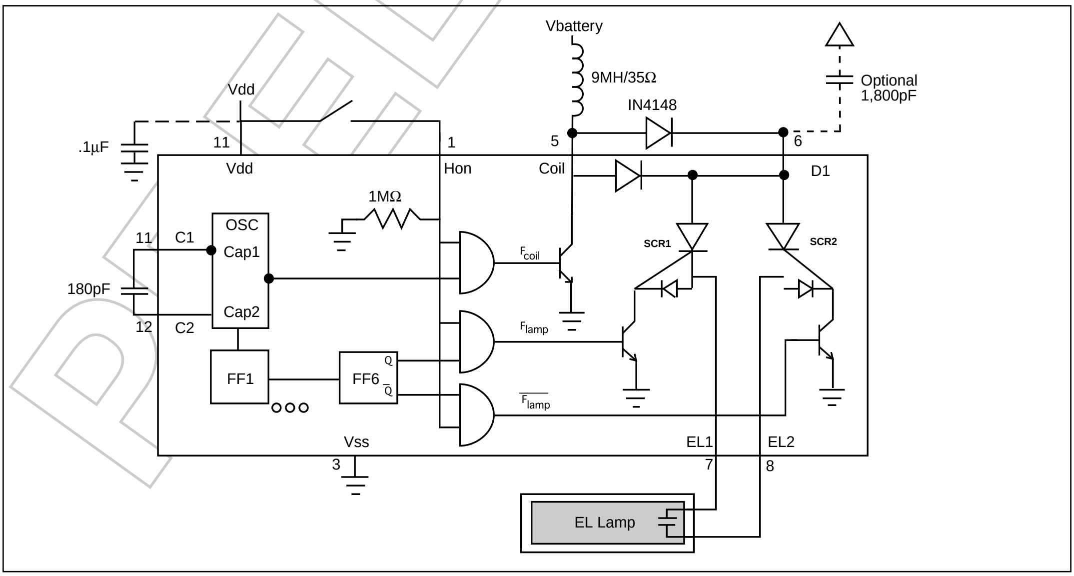
Pin 1— HON- Enable for driver operation, high=active; low=inactive
Pin 2— N/C- No connect
Pin 3— Vss- Power supply common, connect to ground.
Pin 4— N/C- No connect
Pin 5— Coil- Coil
Pin 6— D1- Diode cathode connection
Pin 7— EL1- Lamp driver output 1, connect to EL lamp
Pin 8— EL2- Lamp driver output 2, connect to EL lamp
Pin 9— N/C- No connect
Pin 10— N/C- No connect
Pin 11— Vdd- Power supply for driver, connect to system Vdd.
Pin 12— C2- Capacitor input 2, connect to Cosc
Pin 13— N/C- No connect
Pin 14— C1- Capacitor input 1, connect to Cosc

THEORY OF OPERATION

The **SP4426** 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 1 and Vss allows the user to vary the oscillator frequency. The graphs on page 6 show the relationship between C_{osc} and lamp output voltage. For a given choice of coil inductance there will be an optimum C_{OSC} Cap valve that gives the maximum light output.

The suggested oscillator frequency is 20kHz (C_{osc}=180pF). 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 frequency levels; 32kHz, 16kHz, 8kHz, 4kHz, 2kHz, 1kHz, .5kHz, .25 kHz. The third flip flop output (8KHz) is used to drive the coil (see ***figure 2*** on ***page 8***) and the eighth flip flop output (256Hz) 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 **SP4426** 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%



SP4426 Schematic

duty cycle and range from Vdd-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.

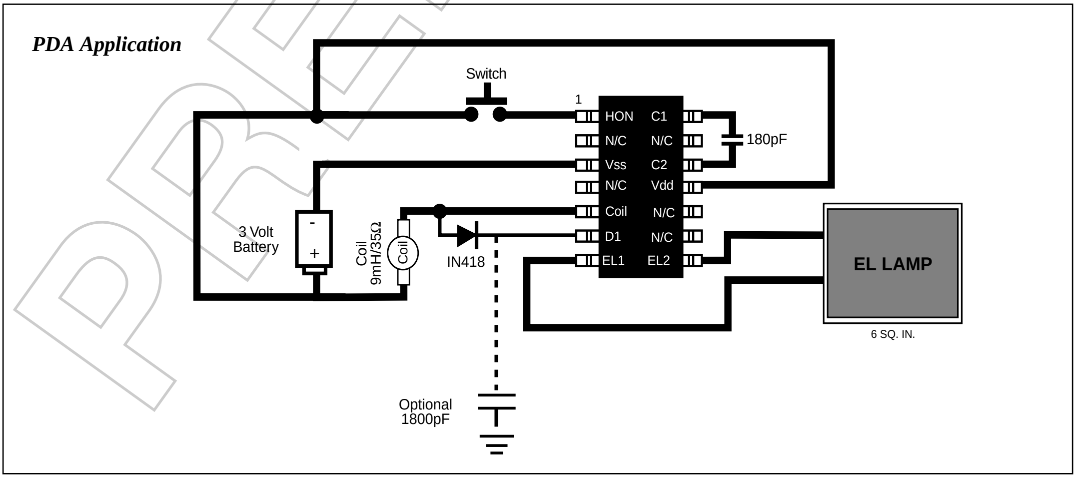
The coil is an external component connected from $V_{battery}$ to pin 9 of the **SP4426**. Energy is stored in the coil according to the equation $E_L=1/2LI^2$ where I, the the first approximation is $(V_{bat}-V_{CE})R_L$. Where V_{CE} is approximately) 0.5 volts for the internal coil driver transistor, and R_L is the series resistance of the inductor. In order to maximize the energy stored in the inductor and subsequently recovered during the switching off of the coil transistor, it is expedient to use the highest value battery, the largest inductor with the smallest series resistance that the system constraints will permit. This energy recovery is directly related to the brightness of the lamp output. There are great variations among coils; caused by magnetic material differences, winding differences and parasitic capacitance. The Sipex **SP4426** is final tested using a 9mH/35Ω coil from Hitachi. For suggested coil sources see ***page 8***.

The supply Vdd can range from 2.2 to 6.0V. It is not necessary that $Vdd=V_{battery}$. $V_{battery}$ should not exceed max coil current specification. The majority of the current goes through the coil and is typically much greater than Idd.

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 94% duty cycle signal switching at the oscillator frequency. 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 lamp. F_{coil} will send 16 of these charge pulses (see ***figure 2 page 8***) 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 smaller (see ***figure 1 page 8***).

For maximum performance a fast recovery diode is recommended and should be connected between pins 5 and 6 (cathode side). The low reverse voltage capacitance of the fast recovery diode minimizes the voltage that is charged and discharged across it and this increases the energy transferred to the lamp.

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 64. For a 20kHz oscillator, F_{lamp}=300Hz.



Typical SP4426 Application Circuit

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 voltage step from ground to 80V (typ) on pins 5 and 6 which are 180 degrees out of phase with each other (see ***figure 3 page 8***). A differential view of the outputs is shown in ***figure 4 on page 8***. If Line Noise is of concern it is advisable to add a decoupling cap at Vdd.

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 if all that is required is one external inductor fast recovery diode and two capacitors.

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.

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 (see ***page 6 and 7***).

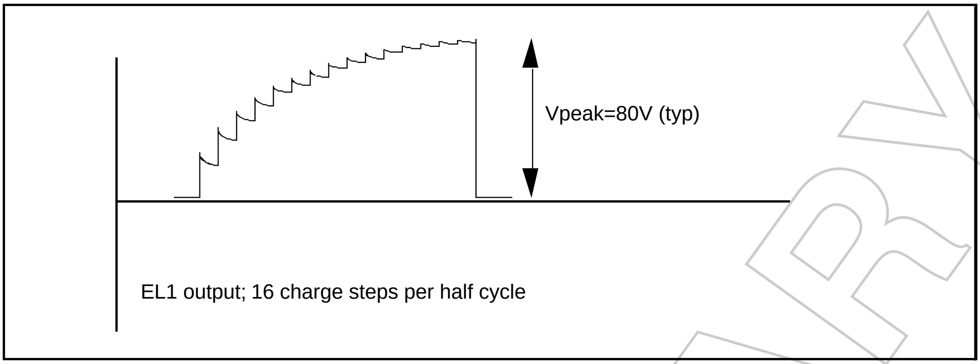


Figure 1.

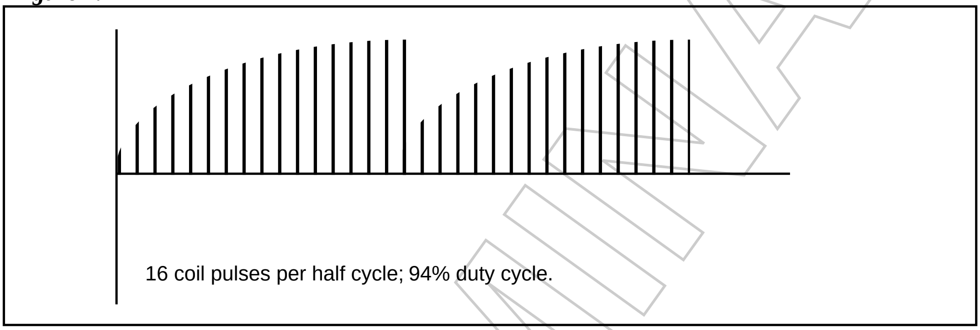


Figure 2.

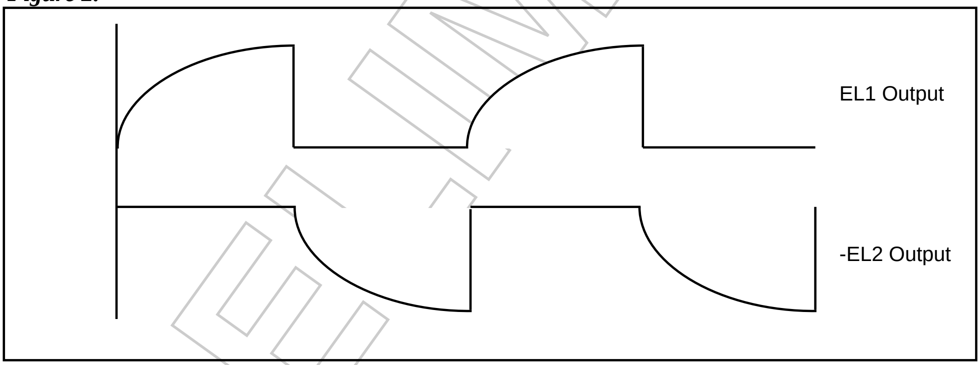


Figure 3.

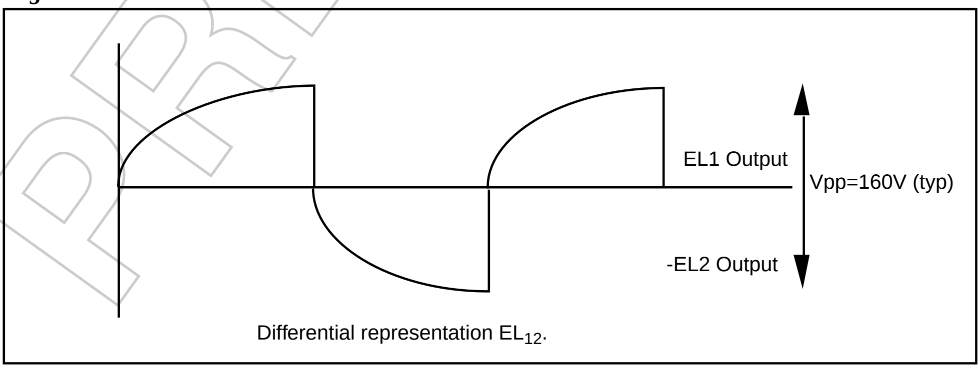


Figure 4.

Coil Manufacturers

New Coils

Coilcraft USA
Ph: (847) 639-6400
Fax: (847) 639-1469

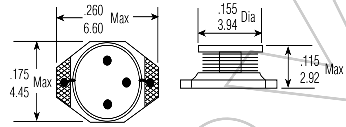
Coilcraft Europe
Ph: 44 01236 730595
Fax: 44 01236 730627

Coilcraft Taiwan
Ph: 886/2/264-3646
Fax: 886/2/270-0294

Coil Craft Singapore
Ph: 65 296-6933
Fax: 465 296-4463 #382

Coilcraft Hong Kong
Ph: 852 770-9428
Fax: 852 770-0729

Part No. DO1608C-474
470µH, 3.60 ohm



(All Dimensions in mm)

muRata USA
Ph: (770) 436-1300
Fax: (770) 436-3030

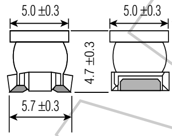
muRata Europe
Ph: 011-4991166870
Fax: 011-49116687225

muRata Taiwan Electronics
Ph: 011 88642914151
Fax: 011 88644252929

muRata Electronics Singapore
Ph: 011 657584233
Fax: 011 657536181

muRata Hong Kong
Ph: 011-85223763898
Fax: 011 852237555655

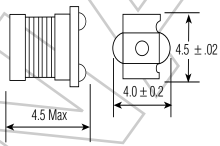
Part No. LQN4N471K04
470µH, 11.5 ohm



(All Dimensions in mm)

KOA Speer Electronics, Inc.
Ph: 814-362-5536
Fax: 814-362-8883

Part No. LPC4045TE471K
470µH, 4.55 ohm



(All Dimensions in mm)

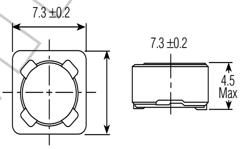
Sumida Electric Co., LTD. USA
Ph: (847) 956-0666
Fax: (847) 956-0702

Sumida Electric Co., LTD. Japan
Ph: 03-3607-5111
Fax: 03-3607-5144

Sumida Electric Co., LTD. Singapore
Ph: 2963388
Fax: 2963390

Sumida Electric Co., LTD. Hong Kong
Ph: 28806688
Fax: 25659600

Part No. CDRH74-471MC
470µH, 3.01 ohm



(All Dimensions in mm)

Toko America Inc. USA
Ph: (847) 297-0070
Fax: (847) 699-7864

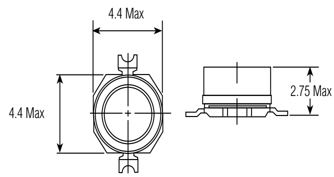
Toko Inc. Europe
Ph: (0211) 680090
Fax: (0211) 679-9567

Toko Inc. Japan
Ph: 03 3727 1161
Fax: 03 3727 1176

Toko Inc. Singapore
Ph: (255) 4000
Fax: (250) 8134

Toko Inc. Hong Kong
Ph: 2342-8131
Fax: 2341-9570

Part No. 667MA471N
470µH, 1.90 ohm



(All Dimensions in mm)

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

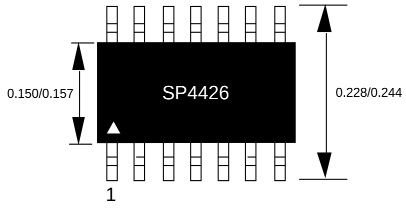
Nippon Graphite
Peter J. Opdahl
123 NW 13th Street #308
Boca Raton, FL 33432
Phone: (407) 392-2555
Fax: (407) 392-0807

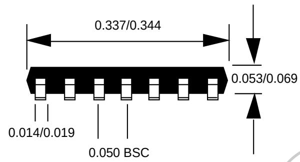
Luminescent Systems inc. (LSI)
101 Etna Road
Lebanon, NH. 03766-9004
Phone: (603) 448-3444
Fax: (603) 448-33452

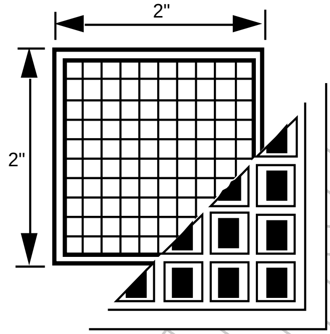
NEC Corporation
Yumi Saskai
7-1, Shiba 5 Chome, Minato-ku,
Tokyo 108-01, Japan
Phone: (03) 3798-9572
Fax: (03) 3798-6134

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

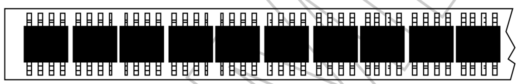
MKS
7 N. Industrial Blvd
Bridgeton, NJ. 08302
Phone: (609) 451-5545
Fax: (609) 451-9096



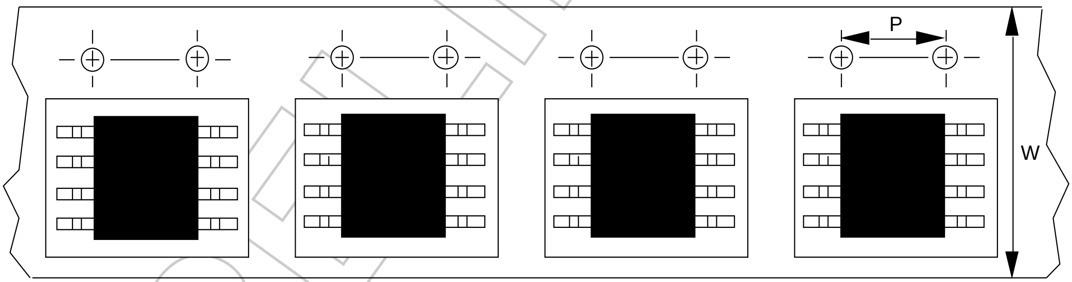




100 SP4426 die per waffle pack



50 SP4426 per tube, no minimum quantity



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

ORDERING INFORMATION

Model	Temperature Range	Package Type
SP4426CN	0˚C to +70˚C	14-Pin NSOIC
SP4426CN/TR	0˚C to +70˚C	14-Pin NSOIC
SP4426CX	0˚C to +70˚C	Die
SP4426NEB		NSOIC Evaluation Board

Sipex Corporation

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
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