ZSP4412A

Electroluminescent Lamp Driver

Super Low Standby Current

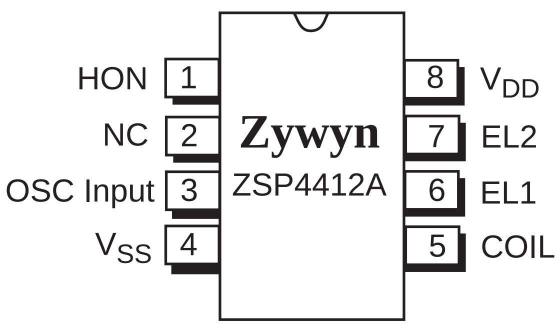
Features

- **+2.2V to +3.6V battery operation**
- **50nA maximum standby current (10nA typical)**
- **High voltage output typical 160V_{PP}**
- **External oscillator required**
- **Enable control pin**

Applications

- **Watches**
- **Pagers**
- **Backlit LCD displays**

Pin Configuration



8-Pin nSOIC/MSOP

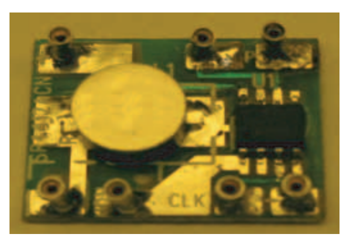
General Description

The ZSP4412A is a high voltage output DC-AC converter that can operate from a +2.2V to +3.6V power supply. The ZSP4412A is designed with our proprietary high voltage BiCMOS technology and is capable of supplying up to 250V_{PP} signals, making it ideal for driving small electroluminescent lamps. The device features 10nA (typical) standby current, for use in low power portable products. An inductor is used to generate the high voltage, and an external oscillator is needed as a clock source. The ZSP4412A is offered in an 8-pin narrow SOIC package or an 8-pin MSOP package. For delivery in die form, please consult the factory.

Ordering Information

Part Number	Temperature Range	Package Type
ZSP4412ACN	0°C to +70°C	8-Pin nSOIC
ZSP4412ACU	0°C to +70°C	8-Pin MSOP
ZSP4412ALCU	0°C to +70°C	8-Pin MSOP Green
ZSP4412ACX	0°C to +70°C	Die in Wafflepack
ZSP4412ACW	0°C to +70°C	Die in Wafer Form
ZSP4412ANEB	n/a	nSOIC Eval. Board
ZSP4412AUEB	n/a	MSOP Eval. Board

Please contact the factory for pricing, availabiliy on Tape-and-Reel, and Green Package options.



Please contact the factory for EL driver design support and availability of custom-made evaluation demo boards.

See our web site for Application Note **AN007** regarding requirements for custom-made evaluation demo boards.

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 is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

V_{DD} .... +5.0V
Input Voltages/Currents
  HON (pin 1) .... –0.5V to (V_{DD} +0.5V)
  COIL (pin 5) 60mA
Lamp Output .... $250V_{PP}$
Storage Temperature .... –65°C to +150°C
Operating Temperature .... –0°C to +70°C
Power Dissipation Per Package
  8-pin nSOIC (derate 6.14mW/°C above +70°C) .. 500mW
  8-pin µSOIC (derate 4.85mW/°C above +70°C) .. 390mW

Storage Considerations

Storage in a low humidity environment is preferred. Large high density plastic packages are moisture sensitive and should be stored in Dry Vapor Barrier Bags. Prior to usage, the parts should remain bagged and stored below 40°C and 60%RH. If the parts are removed from the bag, they should be used within 48 hours or stored in an environment at or below 20%RH. If the above conditions cannot be followed, the parts should be baked for four hours at 125°C in order remove moisture prior to soldering. Zywyn ships product in Dry Vapor Barrier Bags with a humidity indicator card and desiccant pack. The humidity indicator should be below 30%RH.

The information furnished by Zywyn has been carefully reviewed for accuracy and reliability. Its application or use, however, is solely the responsibility of the user. No responsibility of the use of this information become part of the terms and conditions of any subsequent sales agreement with Zywyn. Specifications are subject to change without the responsibility for any infringement of patents or other rights of third parties which may result from its use. No license or proprietary rights are granted by implication or otherwise under any patent or patent rights of Zywyn Corporation.

Electrical Characteristics

T_A = +25°C, V_{DD} = +3.0V, C_{LAMP} = 2000pF, Coil = 30mH at 125Ω; External Oscillator = 32,768Hz unless otherwise noted.

Symbol	Parameter	Condition	Min	Typ	Max	Units
V_{DD}	Supply Voltage		2.2	3.0	3.6	V
$I_{COIL} + I_{DD}$	Supply Current	$V_{HON} = V_{DD}$ = +3.0V		5	20	mA
V_{COIL}	Coil Voltage		V_{DD}		3.6	V
V_{HON}	HON Input Voltage LOW: EL off HIGH: EL on		 –0.25 V_{DD} – 0.25	 0 V_{DD}	 0.25 V_{DD} + 0.25	V
I_{HON}	HON Current	$V_{HON} = V_{DD}$ = +3.0V	1	10	100	µA
$I_{SD} = I_{COIL} + I_{DD}$	Shutdown Current	V_{HON} = 0V		10	50	nA
INDUCTOR DRIVE						
$f_{COIL} = f_{LAMP}$ x 32	Coil Frequency	Input Oscillator = 32768Hz		8192		Hz
	Coil Duty Cycle			75		%
$I_{PK-COIL}$	Peak Coil Current	Guaranteed by design			60	mA
EL LAMP OUTPUT						
f_{LAMP}	EL Lamp Frequency	Input Oscillator = 32768Hz		256		Hz
V_{PP}	Peak-to-Peak Output Voltage		120	160		V_{PP}

Block Diagram

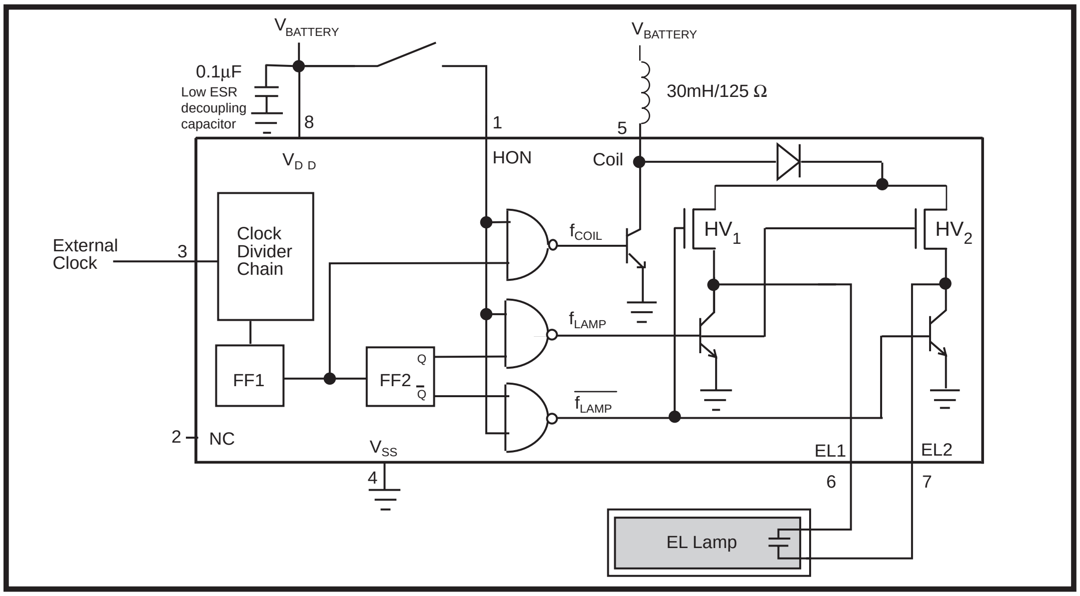
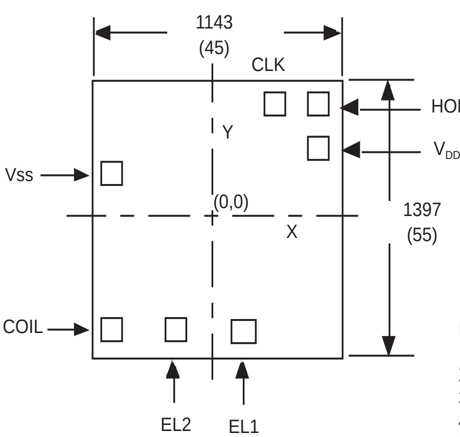


Figure 1. ZSP4412A Block Diagram

Pin Description

Pin Number	Pin Name	Pin Function
1	HON	Enable for driver operation: high = active; low = inactive.
2	NC	No connect.
3	OSC INPUT	Oscillator clock input.
4	V_{SS}	Power supply common: connect to ground.
5	COIL	Coil input: connect coil from V_{DD} to this pin.
6	EL1	Lamp driver output 1: connect to EL lamp.
7	EL2	Lamp driver output 2: connect to EL lamp.
8	V_{DD}	Positive supply.

Bonding Diagram

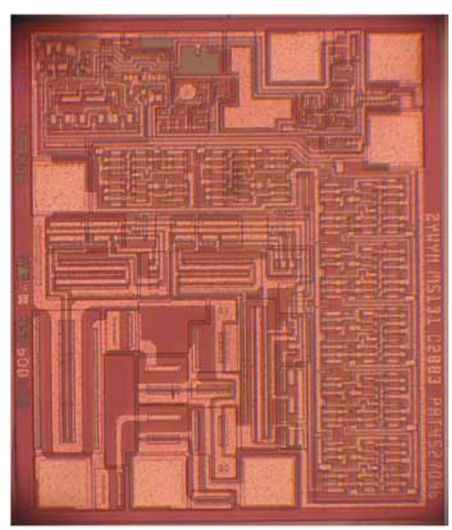


Measured from center of Pads.

PIN	X	Y
CLK	218.5	555.5
HON	418.5	555.5
V_{DD}	418.5	339.5
EL2	-178.0	-555.5
EL1	95.5	-555.5
COIL	-416.0	-555.5
V_{SS}	-416.0	219.0

NOTES:
1. Dimensions are in microns unless otherwise noted (mils).
2. Bonding pads are 125 x 125 microns typical.
3. Outside dimensions are maximum including scribe area.
4. Die thickness is 11 mils +/- 1.
5. Pad center coordinates are relative to the die center.
6. Die substrate down-bonds to Vss (GND).
7. Die mask number is MS131.
8. Die size 1143 x 1397 (45 x 55 mils).

Die Photo



Circuit Description

The ZSP4412A is made up of three basic circuit elements, a divider chain, a coil, and a switched H-bridge network. The countdown chain provides the circuit with a clock source used to control the charge and discharge phases for the coil and lamp. An external oscillator is required and is delivered to pin 3 of the SO-8 package or to the "OSC IN" pad of the bare die. If a clock frequency other than 32kHz is used, the output of the driver as well as the amount of current used, will be affected.

The suggested oscillator frequency is 32,768Hz. This clock frequency is internally divided to create two internal control signals, f_{COIL} and f_{LAMP}. The output is internally divided down by 7 flip-flops; therefore, a 32,768Hz signal will be divided into the following frequencies; 32, 16, 8, 4, 2, 1, 0.5 and 0.25kHz. The second flip flop output (8kHz) is used to drive the coil (see *Figure 4*) and the seventh 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 external clock should have a 50% duty cycle and range from V_{DD} to ground. The maximum external clock frequency is 128kHz. The coil is an external component connected from V_{BATT} to pin 5 of the ZSP4412A. Energy is stored in the coil according to the equation $E_L = 1/2(LI_P)^2$ where I_P, to the first approximation, is the product $I_P = (t_{ON})((V_{BATT} – V_{CE})/L)$, where t_{ON} is the time it takes for the coil to reach its peak current, V_{CE} is the voltage drop across the internal NPN switch transistor, and L is the inductance of the coil. When the NPN transistor switch is off, the energy is forced through an internal diode which drives the switched H-bridge network. This energy recovery is directly related to the brightness of the EL lamp output. There are many variations among coils; magnetic material differences, winding differences and parasitic capacitances. The Zywyn ZSP4412A is final tested using a 30mH/125Ω coil. For suggested coil sources see, *"Coil Manufacturers."*

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 32kHz oscillator f_{COIL} is 8kHz). During the time when the f_{COIL} signal is high, the coil is connected from V_{BATT} 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 3*).

The H-bridge consists of two proprietary low on-resistance high voltage switches. These two switches control the polarity of how the lamp is charged. The high voltage switches are controlled by the f_{LAMP} signal which is the oscillator frequency divided by 128. For a 32kHz oscillator, f_{LAMP} = 250Hz.

The direction of current flow is determined by which high voltage switch 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 5*). A differential view of the outputs is shown in *Figure 6*.

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. Zywyn now offers low power single chip driver circuits specifically designed to drive small to medium sized electroluminescent panels. All that is required is an external inductor and an external clock signal. 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.

Typical Application

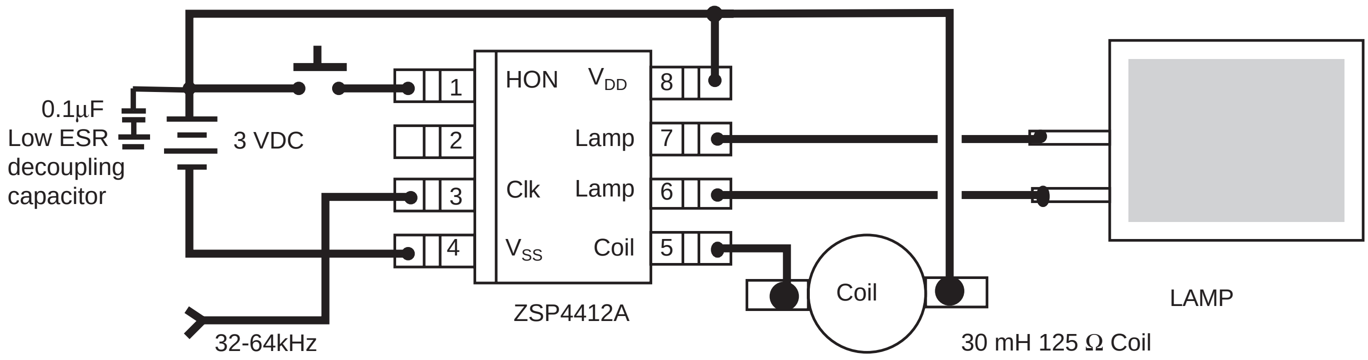


Figure 2. Typical Application Circuit

Contact factory for additional technical and application support

Waveforms

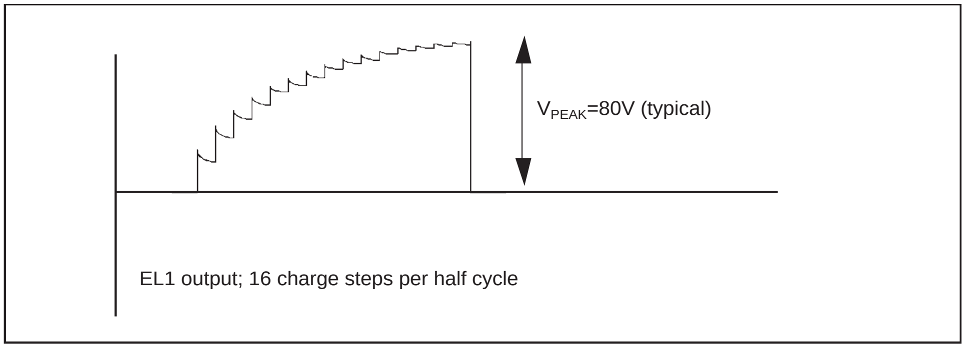


Figure 3. EL Output Voltage in Discrete Steps at EL1 Output

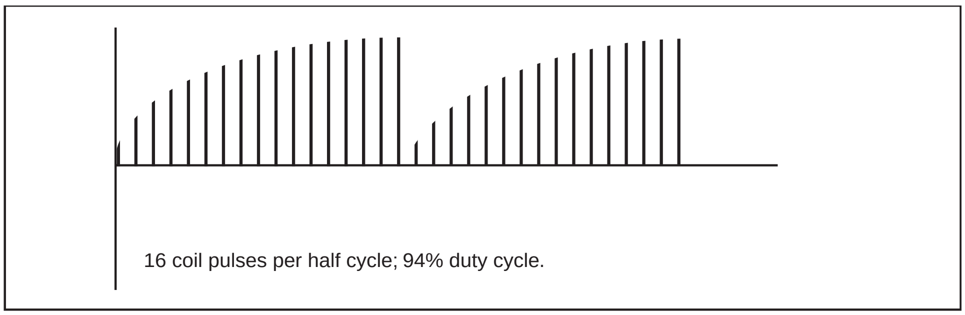


Figure 4. Voltage Pulses Released from the Coil to the EL Driver Circuitry

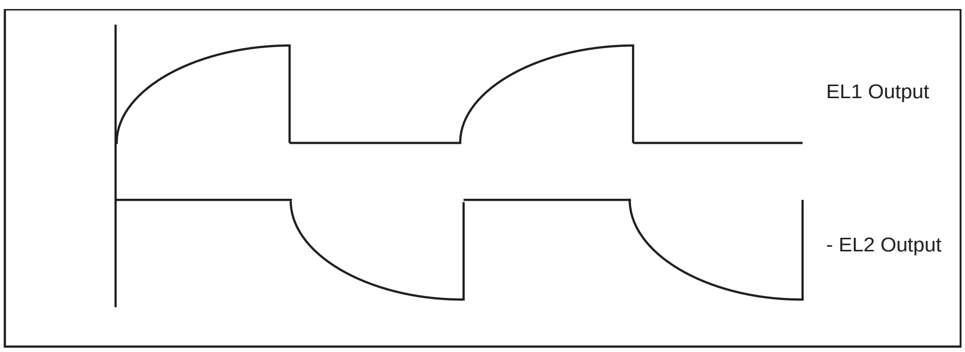


Figure 5. EL Voltage Waveforms from the EL1 and EL2 Outputs

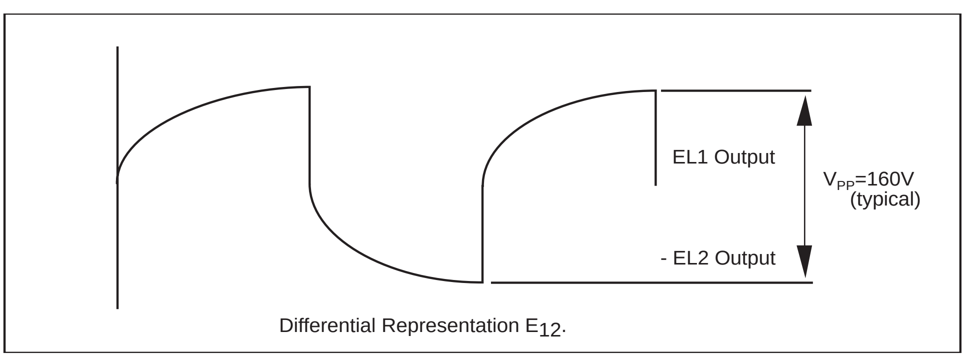


Figure 6. EL Differential Output Waveform of the EL1 and EL2 Outputs

Coil Manufacturers

Hitachi Metals
Material Trading Division
2101 S. Arlington Heights Road,
Suite 116
Arlington Heights, IL 60005-4142
Phone: 1-800-777-8343 Ext. 12
(847) 364-7200 Ext. 12
Fax: (847) 364-7279

Hitachi Metals Ltd. Europe
Immernannstrasse 14-16, 40210
Dusseldorf, Germany
Contact: Gary Loos
Phone: 49-211-16009-0
Fax: 49-211-16009-29

Hitachi Metals Ltd.
Kishimoto Bldg. 2-1, Marunouchi
2-chome, Chiyoda-Ku, Tokyo,
Japan
Contact: Mr. Noboru Abe
Phone: 3-3284-4936
Fax: 3-3287-1945

Hitachi Metals Ltd. Singapore
78 Shenton Way #12-01,
Singapore 079120
Contact: Mr. Stan Kaiko
Phone: 222-8077
Fax: 222-5232

Hitachi Metals Ltd. Hong Kong
Room 1107, 11/F., West Wing,
Tsim Sha. Tsui Center 66
Mody Road,Tsimshatsui East,
Kowloon, Hong Kong
Phone: 2724-4188
Fax: 2311-2095

Murata
2200 Lake Park Drive, Smyrna
Georgia 30080 U.S.A.
Phone: (770) 436-1300
Fax: (770) 436-3030

Murata European
Holbeinstrasse 21-23, 90441
Numberg, Postfachanschrift 90015
Phone: 011-4991166870
Fax: 011-49116687225

Murata Taiwan Electronics
225 Chung-Chin Road, Taichung,
Taiwan, R.O.C.
Phone: 011 88642914151
Fax: 011 88644252929

Murata Electronics Singapore
200 Yishun Ave. 7, Singapore
2776, Republic of Singapore
Phone: 011 657584233
Fax: 011 657536181

Murata Hong Kong
Room 709-712 Miramar Tower, 1
Kimberly Road, Tsimshatsui,
Kowloon, Hong Kong
Phone: 011-85223763898
Fax: 011-85223755655

Panasonic.
6550 Katella Ave
Cypress, CA 90630-5102
Phone: (714) 373-7366
Fax: (714) 373-7323

Sumida Electric Co., LTD.
5999, New Wilke Road,
Suite #110
Rolling Meadows, IL,60008 U.S.A.
Phone: (847) 956-0666
Fax: (847) 956-0702

Sumida Electric Co., LTD.
4-8, Kanamachi 2-Chrome,
Katsushika-ku, Tokyo 125 Japan
Phone: 03-3607-5111
Fax: 03-3607-5144

Sumida Electric Co., LTD.
Block 15, 996, Bendemeer Road
#04-05 to 06, Singapore 339944
Republic of Singapore
Phone: 2963388
Fax: 2963390

Sumida Electric Co., LTD.
14 Floor, Eastern Center, 1065
King's Road, Quarry Bay,
Hong Kong
Phone: 28806688
Fax: 25659600

Polarizers/Transflector Manufacturers

Nitto Denko
Yoshi Shinozuka
Bayside Business Park 48500
Fremont, CA. 94538
Phone: 510 445 5400
Fax: 510 445-5480

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

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

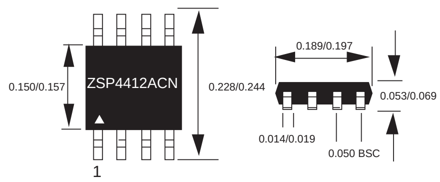
Seiko Precision
Shuzo Abe
1-1, Taihei 4-Chome,
Sumida-ku, Tokyo, 139 Japan
Phone: (03) 5610-7089
Fax: (03) 5610-7177

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

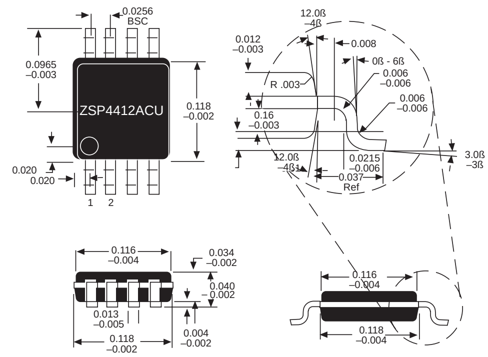
Package Information

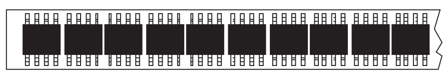
All package dimensions in inches

8-pin nSOIC

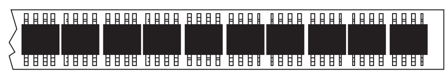


8-pin MSOP

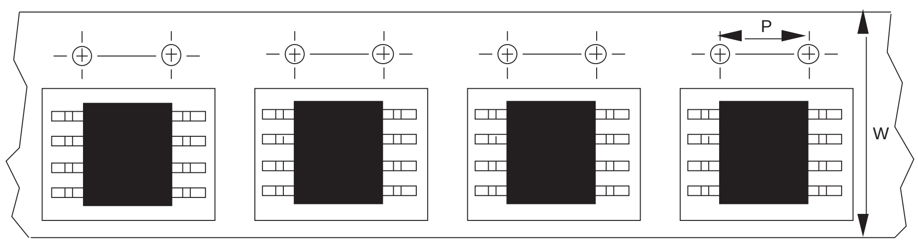




95 ZSP4412ACN per tube



50 ZSP4412ACU per tube



nSOIC-8 13" reels: P=8mm, W=12mm MSOP-8 13" reels: P=8mm, W=12mm			
Pkg.	Minimum qty per reel	Standard qty per reel	Maximum qty per reel
ACN and ACU	500	2500	3000

400 ZSP4412ACX die per wafflepack

Waffle tray size = 1996 x 1996 mils

Waffle pocket size cavity = 50 x 60 mils

Waffle depth size cavity = 25 mils

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