Description

The ZXSC440 is a dedicated photoflash charger,charging an 80µF photoflash capacitor to 300V in 3.5 seconds from a 3V supply.

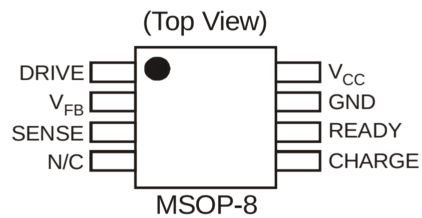
The flyback conversion efficiency is typically 75%,much higher than the commonly used discrete charging circuits.

The Charge pin enables the circuit to be initiated fromthe camera's microprocessor, using negligible current when flash is not being used.

The Ready pin signals the microprocessor when the flash is charged and ready to be fired.

A small amount of hysteresis on the voltage feedback shuts down the device as long as the capacitor remains fully charged, again using negligible current.

Pin Assignments



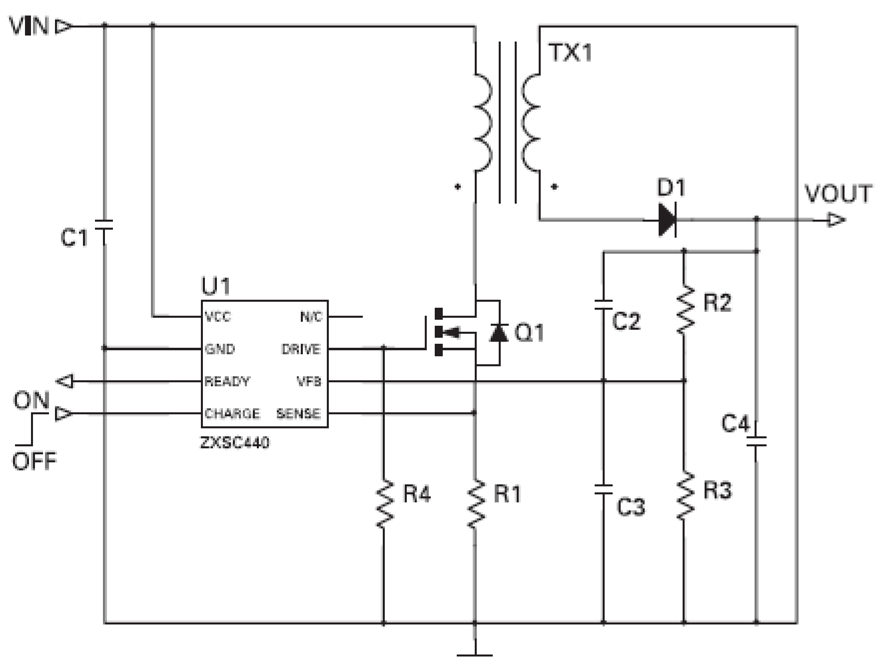
Features

- Charges a 80µF photoflash capacitor to 300V in 3.5 seconds from 3V
- Charges various value photoflash capacitors
- Over 75% flyback efficiency
- Charge and Ready pins
- Consumes only 4.5µA when not charging
- Small MSOP-8 low profile package

Applications

- Digital camera flash unit
- Film camera flash unit

Typical Application Circuit

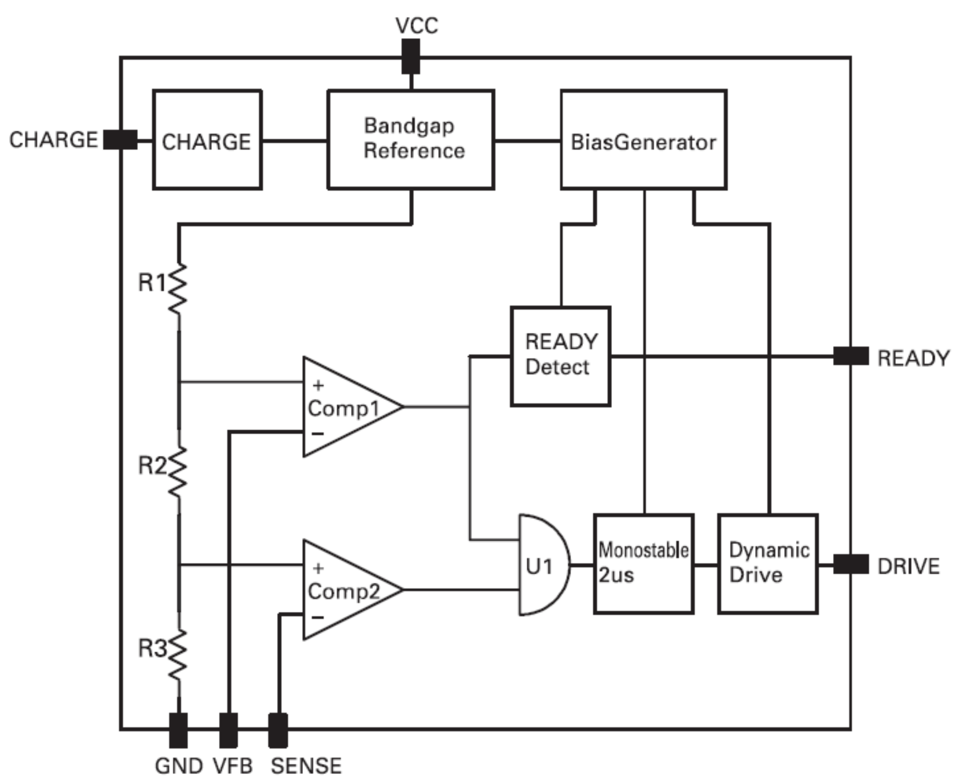


© Diodes Incorporated

Pin Descriptions

Pin Name	Pin #	Description
Drive	1	Drive output for external switching transistor. Connect to base or gate of external switching transistor
VFB	2	Reference voltage. Internal threshold set to 300mV. Connect external resistor network to set output voltage
Sense	3	Inductor current sense input. Internal threshold voltage set to 28mV. Connect external sense resistor
N/C	4	
Charge	5	Initiate photoflash capacitor charging
Ready	6	Signal to microprocessor when photoflash capacitor charged
GND	7	Ground
V_{CC}	8	Supply voltage, 1.8V to 8V

Functional Block Diagram



© Diodes Incorporated

Absolute Maximum Ratings (T_A = 25°C)

Parameter	Rating	Unit
V_{CC}	-0.3 to +10	V
Drive	-0.3 to V_{CC} +0.3	V
Ready	-0.3 to V_{CC} +0.3	V
Charge	-0.3 to The lower of (+5.0) or (V_{CC} +0.3)	V
VFB, Sense	-0.3 to The lower of (+5.0) or (V_{CC} +0.3)	V
Operating Temperature	-40 to +85	°C
Storage Temperature	-55 to +150	°C
Power Dissipation @ 25°C	450	mW

Electrical Characteristics (T_A = 25°C, Vdd = 3V; unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
V_{CC}	V_{CC} range		1.8		8	V
I_Q (Note 1)	Quiescent current	V_{CC} = 8V			220	µA
I_{STDN}	Shutdown current			4.5		µA
E_{FF} (Note 2)	Efficiency			85		%
ACC_{REF}	Reference tolerance	1.8V < V_{CC} < 8V	-3.0		3.0	%
TCO_{REF}	Reference temp co.			0.005		%/°C
T_{DRV}	Discharge pulse width	1.8V < V_{CC} < 8V		1.7		µs
F_{OSC}	Operating frequency				200	kHz
INPUT PARAMETERS						
V_{SENSE}	Sense voltage		22	28	34	mV
I_{SENSE}	Sense input current	V_{FB} = 0V; V_{SENSE} = 0V	-1	-7	-15	µA
V_{FB}	Feedback volatage		291	300	309	mV
I_{FB} (Note 2)	Feedback input current	V_{FB} = 0V; V_{SENSE} = 0V	-1.2		-4.5	µA
VIH (Note 3)	Shutdown threshold		1.5		V_{CC}	V
VIL	Shutdown threshold		0		0.55	V
dV_{LN}	Line voltage regulation			0.5		%/V
OUTPUT PARAMETERS						
I_{DRIVE}	Transistor drive current	V_{DRIVE} = 0.7V	2	3.4	5	mA
V_{DRIVE}	Transistor voltage drive		0		V_{CC}-0.4	V
C_{DRIVE}	MOSFET gate drive cpbty			300		pF
VOH_{READY}	Ready flag output high	I_{EOR} = -300nA, T_A = 25°C	2.5		V_{CC}	V
VOL_{READY}	Ready flag output low	I_{EOR} = 1mA, T_A = 25°C	0		1	V
T_{READY}		T_A = 25°C		195		µs
dI_{LD}	Load current regulation				0.01	%/mA

Notes: 1. Excluding gate/base drive current.
2. I_{FB} is typically half of these at 3V.
3. Shutdown pin voltage must not exceed (V_{CC}+0.3V) or 5V, whichever is lower.

© Diodes Incorporated

Device Description

Bandgap Reference

All threshold voltages and internal currents are derived from a temperature compensated bandgap reference circuit with a reference voltage of 1.22V nominal. If the REF terminal is used as a reference for external devices, the maximum load should not exceed ±2µA.

Dynamic Drive Output

Depending on the input signal, the output is either "LOW" or "HIGH". In the high state a 3.4mA current source (max drive voltage = V_{CC}-0.4V) drives the base or gate of the external transistor. In order to operate the external switching transistor at optimum efficiency, both output states are initiated with a short transient current in order to quickly discharge the base or the gate of the switching transistor.

Switching Circuit

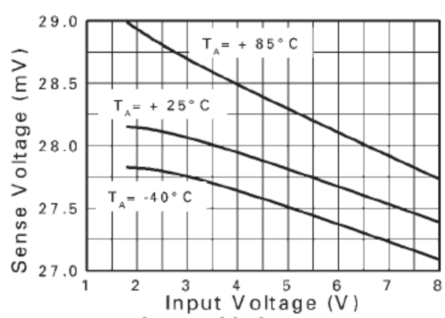
The switching circuit consists of two comparators, Comp1 and Comp2, a gate U1, a monostable and the drive output. Normally the DRIVE output is "HIGH"; the external switching transistor is turned on. Current ramps up in the inductor, the switching transistor and external current sensing resistor. This voltage is sensed by comparator, Comp2, at input SENSE. Once the current sense voltage across the sensing resistor exceeds 28mV, comparator, Comp2, through gate U1, triggers a re-triggerable monostable and turns off the output drive stage for 1.7µs. The inductor discharges into the reservoir capacitor. After 1.7µs a new charge cycle begins, thus ramping the output voltage. When the output voltage reaches the nominal value and VFB gets an input voltage of more than 300mV, the monostable is forced "on" from Comp1 through gate U1, until the feedback voltage falls below 300mV. The above action continues to maintain regulation, with slight hysteresis on the feedback threshold.

READY Detector

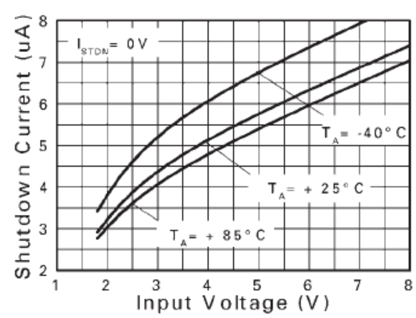
The READY circuit is a re-triggerable 195µs monostable, which is re-triggered by every down regulating action of comparator Comp1. As long as regulation takes place, output READY is "HIGH" (high impedance, 100K to V_{CC}). Short dips of the output voltage of less than 195µs are ignored. If the output voltage falls below the nominal value for more than 195µs, output READY goes "LOW". This can be used to signal to the camera controller that the flash unit has charged fully and is ready to use.

Typical Operating Characteristics

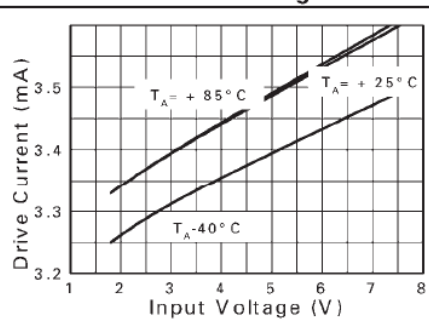
(For typical application circuit at V_{IN}=3V and T_A=25°C unless otherwise stated)



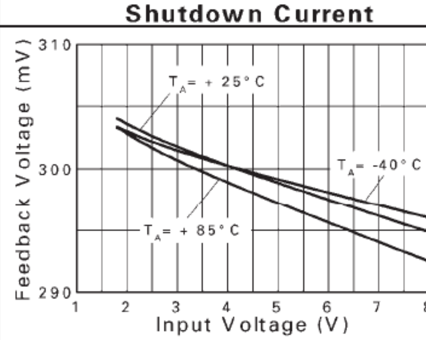
Input Voltage vs Sense Voltage



Input Voltage vs Shutdown Current



Input Voltage vs Drive Current



Input Voltage vs Feedback Voltage

© Diodes Incorporated

Application Information

Switching Transistor Selection

The choice of switching transistor has a major impact on the converter efficiency. For optimum performance, a bipolar transistor with low $V_{CE(SAT)}$ and high gain is required. The V_{CEO} of the switching transistor is also an important parameter as this sees typically three times the input voltage when the transistor is switched off. Zetex SuperSOT™ transistors are an ideal choice for this application. At input voltages above 4V, suitable Zetex MOSFET transistors will give almost the same performance with a simpler drive circuit, omitting the ZXTD6717 pre-drive stage. Using a MOSFET, the Schottky diode may be omitted, as the body diode of the MOSFET will perform the same function, with just a small loss of efficiency.

Output Rectifier Diode Selection

The diode should have a fast recovery, as any time spent in reverse conduction removes energy from the reservoir capacitor and dumps it, via the transformer, into the protection diode across the output transistor.
This seriously reduces efficiency. Two BAS21 diodes in series have been used, bearing in mind that the reverse voltage across the diode is the sum of the output voltage together with the input voltage multiplied by the step-up ratio of the transformer:

$$V_{R(DIODE)} = V_{OUT(MAX)} + (V_{IN} \times T_{URNS}\ R_{ATIO})$$

Therefore, with a 300V output, a supply of 8 volts and a 1:12 step-up transformer, there will be a 396V across the diode. This occurs during the current ramp-up in the primary, as it transforms the input voltage up by the turns ratio and the polarity at the secondary is such as to add to the output voltage already being held off by the diode.

Peak Current Definition

In general, the I_{PK} value must be chosen to ensure that the switching transistor, Q1, is in full saturation with maximum output power conditions, assuming worse-case input voltage and transistor gain under all operating temperature extremes. Once I_{PK} is decided the value of R_{SENSE} can be determined by:

$$R_{SENSE} = \frac{V_{SENSE}}{I_{PK}}$$

Sense Resistor

A low value sense resistor is required to set the peak current. Power in this resistor is negligible due to the low sense voltage threshold, V_{SENSE}. Below is a table of recommended sense resistors:

Manufacturer	Series	$R_{DC}(\Omega)$ Range	Size	Tolerance
Cyntec	RL1220	0.022 - 10	0805	±5%
IRC	LR1206	0.010 – 1.0	1206	±5%

Using a 22mΩ sense resistor results in a peak current of just over 1.2A.

Transformer Parameters

Proprietary transformers are available, for example the Pulse PAO367, Primary inductance: 24µH, Core: Pulse PAO367, Turns ratio: 1:12, see Bill of Materials below. If designing a transformer, bear in mind that the primary current may be over an amp and, if this flows through 10 turns, the primary flux will be 10 Amp. Turns and small cores will need an air gap to cope with this value without saturation. Secondary winding capacitance should not be too high as this is working at 300V and could soon cause excessive losses.

ZXSC440 Transformer Specifications

Part No.	Size (WxLxH) mm	L_{PRI} (µH)	$L_{PRI-LEAK}$ (nH)	N	R_{PRI} (mΩ)	R_{SEC} (Ω)
T-15-089	6.4x7.7x4	12	400	10:2	211	27
T-15-083	8x8.9x2	20	500	10:2	675	35
SBL-5.6-1	5.6x8.5x4	10	200	10:2	103	26
PAO367	9.1x9.1x5.1	24		12:1		

© Diodes Incorporated

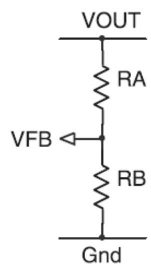
Application Information (cont.)

Output Power Calculation

This is approximately the power stored in the coil times the frequency of operation times the efficiency. Assuming a current of 1.2 amps in a 30µH primary, the stored energy will be 21.6µJ. The frequency is set by the time it takes the primary to reach 1.2 amps plus the 1.7µs time allowed to discharge the energy into the reservoir capacitor. Using 3 volts, the ramp time is 12µs, so the frequency will be 73kHz, giving an input power of about 1.6 watts. With an efficiency of 75% the output power will be 1.2 watts. An 80µF capacitor charged to 300 volts stores 3.6J, so 1.2 watts will take 3 seconds to charge it. Higher input voltages reduce the ramp time, the frequency therefore goes up and the output power is increased, resulting in shorter charging times.

Output Voltage Adjustment

The ZXSC440 are adjustable output converters allowing the end user the maximum flexibility. For adjustable operation a potential divider network is connected as follows:



The output voltage is determined by the equation:

$V_{OUT} = V_{FB}$ (1 + RA / RB),

where V_{FB}=300mV

In a circuit giving 300 volts, the "1" in the above equation becomes negligible compared to the ratio which is around 1000. It will not be exactly 1000 because of the negative input current in the feedback pin. The resistor values, RA and RB, should be maximized to improve efficiency and decrease battery drain. Optimization can be achieved by providing a minimum current of $I_{FB(MAX)}$=200nA to the V_{FB} pin. Output is adjustable from V_{FB} to the (BR)V_{CEO} of the switching transistor, Q1.

In practice, there will be some stray capacitance across RA and this will cause a lead in the feedback which can affect hysteresis (it makes the device shut down too early) and it is best to swamp this with a capacitor CA and then use a capacitor CB across RB where CB/CA = RA/RB. This is similar to the method used for compensating oscilloscope probes.

Layout Issues

Layout is critical for the circuit to function in the most efficient manner in terms of electrical efficiency, thermal considerations and noise.

For 'step-up converters' there are four main current loops, the input loop, power-switch loop, rectifier loop and output loop. The supply charging the input capacitor forms the input loop. The power-switch loop is defined when Q1 is 'on', current flows from the input through the transformer primary, Q1, R_{SENSE} and to ground. When Q1 is 'off', the energy stored in the transformer is transferred from the secondary to the output capacitor and load via D1, forming the rectifier loop. The output loop is formed by the output capacitor supplying the load when Q1 is switched back off.

To optimize for best performance each of these loops kept separate from each other and interconnected with short, thick traces thus minimizing parasitic inductance, capacitance and resistance. Also the R_{SENSE} resistor should be connected, with minimum trace length, between emitter lead of Q1 and ground, again minimizing stray parasitics.

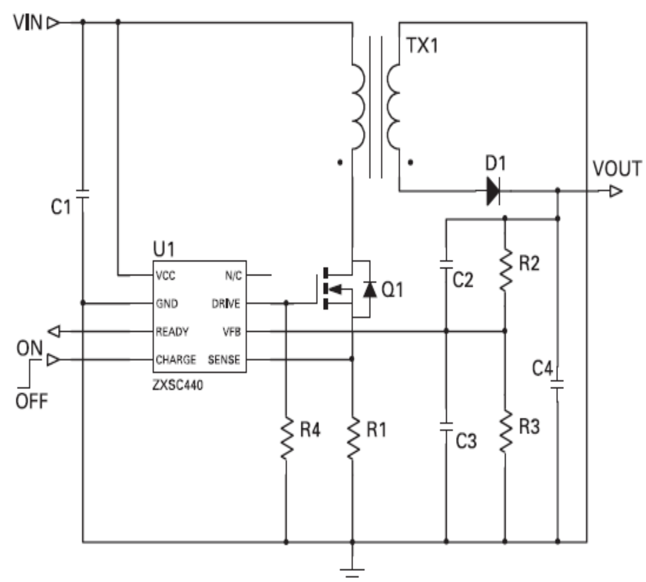
© Diodes Incorporated

APPLICATION CIRCUITS

General Camera Photoflash Charger

Specification

V_{IN} = 5V
V_{OUT} = 275V
Efficiency = 71%
Charging time = 4 seconds



Bill of Materials

Ref	Value	Package	Part Number	Manufacturer	Notes
U1		MSOP-8	ZXSC440	Diodes	
Q1		SOT23	ZXMN6A07F	Diodes	60V N-Channel
D1 (Note 5)	200V	SOT23	BAS21	Diodes	X2 200V fast rectifier diodes connected in series
Tx1				Pulse	(See Note 4)
R1	22mΩ	0805	RL1210	Cyntec	
R2	10MΩ/400V	Axial	Generic	Generic	Output voltage across resistor
R3	10kΩ	0805	Generic	Generic	
R4	100kΩ	0805	Generic	Generic	
C1	100µF/10V	0805	Generic	Murata	
C2	10pF/500V	1206	Generic	Generic	Output voltage seen across capacitor
C3	10nF/6V3	1206	Generic	Generic	
C4	120µF/300V	Radial	FW Series	Rubycon	Photoflash

Notes: 4. Transformer specification: Primary inductance: 24µH, Core: Pulse PAO367, Turns ratio: 1:12
5. Two BAS21 200V rectifier diodes are connected in series and used in place of a 400V rectifier diode to provide faster switching speeds and higher efficiency.

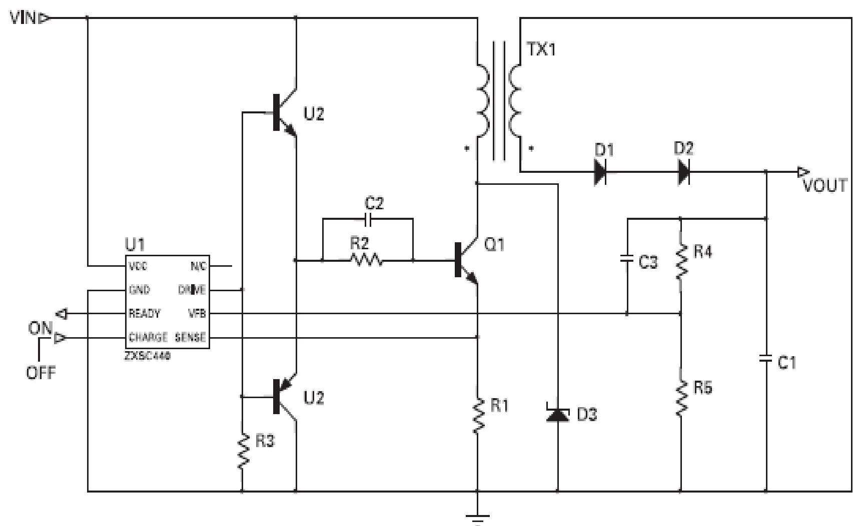
© Diodes Incorporated

APPLICATION CIRCUITS (cont.)

High Power Digital Camera Photoflash Charger

Specification

V_{IN} = 3V
V_{OUT} = 275V
Efficiency = 69%
Charging time = 5 seconds



Bill of Materials

Ref	Value	Package	Part Number	Manufacturer	Notes
U1		MSOP-8	ZXSC440	Diodes	
U2		SOT26	ZXTD6717	Diodes	NPN/PNP dual
Q1		SOT23	FMMT619	Diodes	50V NPN low sat
D1	200V	SOT23	BAS21	Diodes	200V fast rectifier
D2	200V	SOT23	BAS21	Diodes	200V fast rectifier
D3	2A	SOT26	ZLLS2000	Diodes	2A Schottky diode
Tx1			PAO367	Pulse	(See note 4)
R1	22mΩ	0805	RL1210	Cyntec	
R2	130Ω	0805	Generic	Generic	
R3	2k2Ω	0805	Generic	Generic	
R4	100MΩ/400V	Axial	Generic	Generic	Output voltage across resistor
R5	10kΩ	0805	Generic	Generic	
C1	100µF/10V	0805	Generic	Murata	
C2	220nF	0805	GRM Series	Murata	
C3	10pF/500V	1206	Generic	Generic	Output voltage seen across capacitor
C4	10nF/6V3	1206	Generic	Generic	
C5	120µF/330V	Radial	FW Series	Rubycon	Photoflash capacitor

Notes: 4. Transformer specification: Primary inductance: 24µH, Core: Pulse PAO367, Turns ratio: 1:12

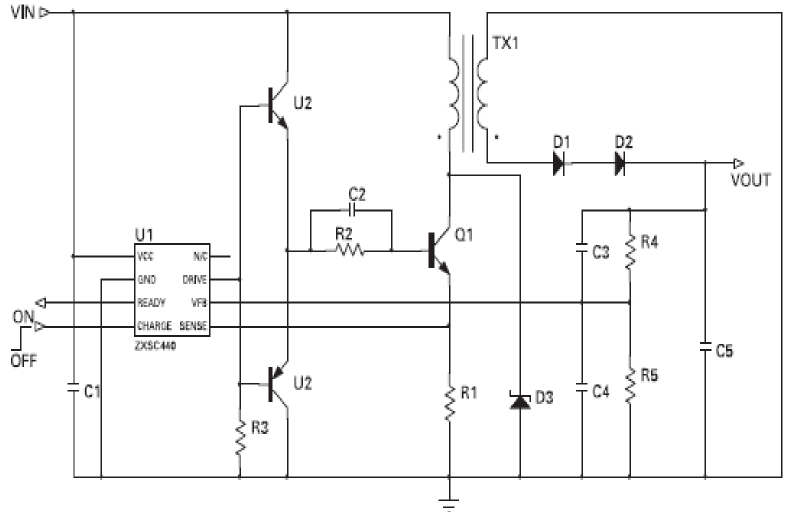
© Diodes Incorporated

APPLICATION CIRCUITS (cont.)

Low Power Digital Camera Photoflash Charger

Specification

V_{IN} = 3V
V_{OUT} = 275V
Efficiency = 58%
Charging time = 6.8 seconds



Bill of Materials

Ref	Value	Package	Part Number	Manufacturer	Notes
U1		MSOP-8	ZXSC440	Diodes	
U2		SOT26	ZXTD6717	Diodes	NPN/PNP dual
Q1		SOT23	FMMT619	Diodes	50V NPN low sat
D1	200V	SOT23	BAS21	Diodes	200V fast rectifier
D2	200V	SOT23	BAS21	Philips	200V fast rectifier
D3	2A	SOT26	ZLLS2000	Diodes	2A Schottky diode
Tx1			PAO367	Pulse	(See note 4)
R1	22mΩ	0805	RL1210	Cyntec	
R2	130Ω	0805	Generic	Generic	
R3	2k2Ω	0805	Generic	Generic	
R4	100MΩ/400V	Axial	Generic	Generic	Output voltage across resistor
R5	10kΩ	0805	Generic	Generic	
C1	100µF/10V	0805	Generic	Murata	
C2	220nF	0805	GRM Series	Murata	
C3	10pF/500V	1206	Generic	Generic	Output voltage seen across capacitor
C4	10nF/6V3	1206	Generic	Generic	
C5	120µF/330V	Radial	FW Series	Rubycon	Photoflash capacitor

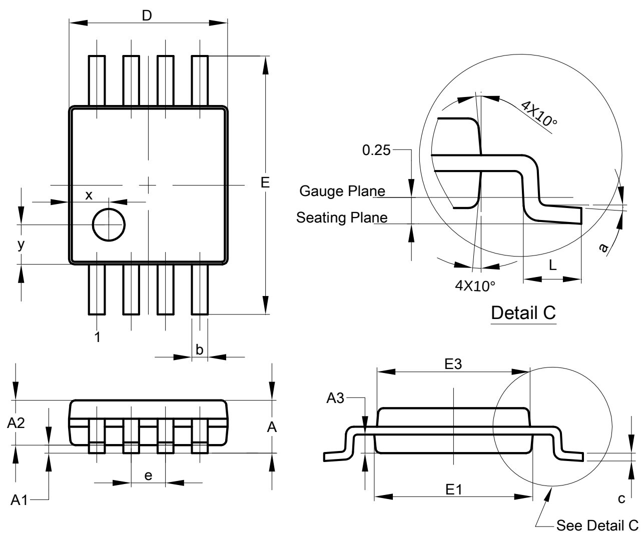
Notes: 4. Transformer specification: Primary inductance: 24µH, Core: Pulse PAO367, Turns ratio: 1:12

© Diodes Incorporated

Ordering Information

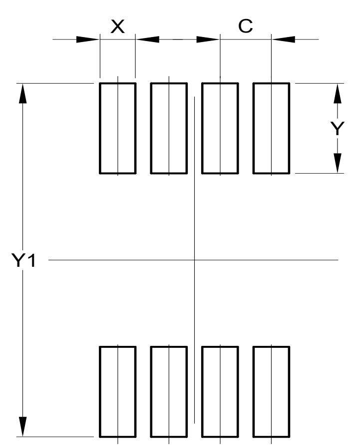
Device	Package Code	Packaging	7" Tape & Reel	
			Quantity	Part Number Suffix
ZXSC440X8TA	X8	MSOP-8	1000/Tape & Reel	TA

Package Outline Dimensions (All Dimensions in mm)



MSOP-8			
Dim	Min	Max	Typ
A	-	1.10	-
A1	0.05	0.15	0.10
A2	0.75	0.95	0.86
A3	0.29	0.49	0.39
b	0.22	0.38	0.30
c	0.08	0.23	0.15
D	2.90	3.10	3.00
E	4.70	5.10	4.90
E1	2.90	3.10	3.00
E3	2.85	3.05	2.95
e	-	-	0.65
L	0.40	0.80	0.60
a	0°	8°	4°
x	-	-	0.750
y	-	-	0.750
All Dimensions in mm			

Suggested Pad Layout



Dimensions	Value (in mm)
C	0.650
X	0.450
Y	1.350
Y1	5.300

© Diodes Incorporated

IMPORTANT NOTICE

DIODES INCORPORATED MAKES NO WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, WITH REGARDS TO THIS DOCUMENT, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION).

Diodes Incorporated and its subsidiaries reserve the right to make modifications, enhancements, improvements, corrections or other changes without further notice to this document and any product described herein. Diodes Incorporated does not assume any liability arising out of the application or use of this document or any product described herein; neither does Diodes Incorporated convey any license under its patent or trademark rights, nor the rights of others. Any Customer or user of this document or products described herein in such applications shall assume all risks of such use and will agree to hold Diodes Incorporated and all the companies whose products are represented on Diodes Incorporated website, harmless against all damages.

Diodes Incorporated does not warrant or accept any liability whatsoever in respect of any products purchased through unauthorized sales channel.
Should Customers purchase or use Diodes Incorporated products for any unintended or unauthorized application, Customers shall indemnify and hold Diodes Incorporated and its representatives harmless against all claims, damages, expenses, and attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized application.

Products described herein may be covered by one or more United States, international or foreign patents pending. Product names and markings noted herein may also be covered by one or more United States, international or foreign trademarks.

LIFE SUPPORT

Diodes Incorporated products are specifically not authorized for use as critical components in life support devices or systems without the express written approval of the Chief Executive Officer of Diodes Incorporated. As used herein:

A. Life support devices or systems are devices or systems which:

1. are intended to implant into the body, or
2. support or sustain life and whose failure to perform when properly used in accordance with instructions for use provided in the labeling can be reasonably expected to result in significant injury to the user.

B. A critical component is any component in a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or to affect its safety or effectiveness.

Customers represent that they have all necessary expertise in the safety and regulatory ramifications of their life support devices or systems, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of Diodes Incorporated products in such safety-critical, life support devices or systems, notwithstanding any devices- or systems-related information or support that may be provided by Diodes Incorporated. Further, Customers must fully indemnify Diodes Incorporated and its representatives against any damages arising out of the use of Diodes Incorporated products in such safety-critical, life support devices or systems.

Copyright © 2012, Diodes Incorporated

www.diodes.com