MICROPOWER SC70-5 & SOT23-5 LOW DROPOUT REGULATORS

ZXCL5213V25, ZXCL5213V26, ZXCL5213V28, ZXCL5213V30, ZXCL5213V33, ZXCL5213V40
ZXCL250, ZXCL260, ZXCL280, ZXCL300, ZXCL330, ZXCL400

DESCRIPTION

The ZXCL series have been designed with space sensitive systems in mind. They are available in the ultra small SC70-5 package, which is half the size of other SOT23 based regulators.

The devices can be used with all types of output capacitors including low ESR ceramics and typical dropout voltage, is only 85mV at 50mA load. Supply current is minimised with a ground pin current of only 50μA at full 150mA load. Logic control allows the devices to be shut down, consuming typically less than 10nA. These features make the device ideal for battery powered applications where power economy is critical.

For applications requiring improved performance over alternative devices, the ZXCL is also offered in the 5 pin SOT23 package with an industry standard pinout.

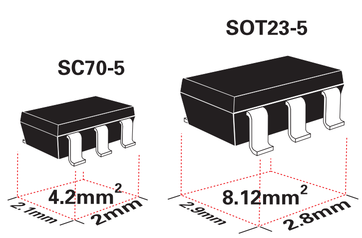
The devices feature thermal overload and over-current protection and are available with output voltages of 2.5V, 2.6V, 2.8V, 3V, 3.3V and 4V. Other voltage options between 1.5V and 4V can be provided. Contact Zetex marketing for further information.

The ZXCL series are manufactured using CMOS processing, however advanced design techniques mean that output noise is improved even when compared to other bipolar devices.

FEATURES

- 5-pin SC70 package for the ultimate in space saving
- 5-pin SOT23 industry standard pinout
- Can be used with all types of output capacitor
- Low 85mV dropout at 50mA load
- 50μA ground pin current with full 150mA load
- Typically less than 10nA ground pin current on shutdown
- 2.5, 2.6, 2.8, 3, 3.3 and 4 volts output
- Very low noise, without bypass capacitor
- Thermal overload and over-current protection
- -40 to +85°C operating temperature range
- No-load stable

PACKAGE FOOTPRINT

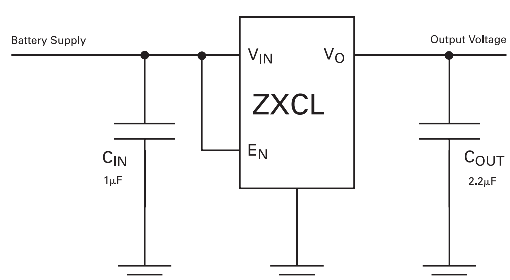


APPLICATIONS

- Cellular and Cordless phones
- Palmtop and laptop computers
- PDA
- Hand held instruments
- Camera, Camcorder, Personal Stereo
- PCMCIA cards
- Portable and Battery-powered equipment

No-Load Stability, the ZXCL device will maintain regulation and is stable with no external load. e.g. CMOS RAM applacations.

TYPICAL APPLICATION CIRCUIT



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ZETEX

ABSOLUTE MAXIMUM RATINGS

Terminal Voltage with respect to GND

V_{IN}	-0.3V to 7.0V
E_N	-0.3V to 10V
V_O	-0.3V to 5.5V

Package Power Dissipation (T_A=25°C)

SC70-5	300mW (Note 1)
SOT23-5	450mW (Note 1)

Output short circuit duration	Infinite
Continuous Power Dissipation	Internally limited
Operating Temperature Range	-40°C to +85°C
Storage Temperature Range	-55°C to +125°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

$V_{IN} = V_O + 0.5V$, all values at $T_A = 25°C$ (Unless otherwise stated)

SYMBOL	PARAMETER	CONDITIONS	LIMITS MIN	TYP	MAX	UNITS
V_{IN}	Input Voltage		(note2)		5.5	V
V_O	Output Voltage	I_O = 1mA				
		ZXCL250 / 5213V25	2.450	2.5	2.550	
		ZXCL260 / 5213V26	2.548	2.6	2.652	V
		ZXCL280 / 5213V28	2.744	2.8	2.856	
		ZXCL300 / 5213V30	2.940	3.0	3.060	
		ZXCL330 / 5213V33	3.234	3.3	3.366	
		ZXCL400 / 5213V40	3.920	4.0	4.080	
		I_O = 100mA $V_O + 0.5V < V_{IN} < V_{IN}$ max.				
		ZXCL250 / 5213V25	2.425		2.575	
		ZXCL260 / 5213V26	2.522		2.678	
		ZXCL280 / 5213V28	2.744		2.884	
		ZXCL300 / 5213V30	2.910		3.090	
		ZXCL330 / 5213V33	3.201		3.399	V
		ZXCL400 / 5213V40	3.880		4.120	
$\Delta V_O/\Delta T$	Output Voltage Temperature Coefficient			-15		ppm/°C
$I_{O(MAX)}$	Output Current	ZXCL250 / 5213V25 only	150 100			mA
I_{OLIM}	Over Current Limit	ZXCL250 / 5213V25 only	160 105	230	800 750	mA
I_Q	Ground pin current	No Load I_O = 150mA, I_O = 100mA,		25 50 40	50 120 100	µA µA µA

ELECTRICAL CHARACTERISTICS

$V_{IN} = V_O + 0.5V$, all values at $T_A = 25°C$ (Unless otherwise stated)

SYMBOL	PARAMETER	CONDITIONS	LIMITS			UNITS
			MIN	TYP	MAX	
V_{DO}	Dropout Voltage Note 3	**ZXCL250 / 5213v25**				
		I_O=10mA		15		
		I_O=50mA		85		mV
		I_O=100mA		163	325	
		ZXCL260 / 5213v26				
		I_O=10mA		15		mV
		I_O=50mA		85		
		I_O=100mA		155	310	
		ZXCL280 / 5213v28				
		I_O=10mA		15		
		I_O=50mA		85		mV
		I_O=100mA		140	280	
		ZXCL300 / 5213v30				
		I_O=10mA		15		
		I_O=50mA		85		mV
		I_O=100mA		140	280	
		ZXCL330 / 5213v33				
		I_O=10mA		15		
		I_O=50mA		85		mV
		I_O=100mA		140	280	
		ZXCL400 / 5213v40				
		I_O=10mA		15		
		I_O=50mA		85		mV
		I_O=100mA		140	280	
ΔV_{LNR}	Line Regulation	V_{IN}=(V_O+0.5V) to 5.5V, I_O=1mA		0.02	0.1	%/V
ΔV_{LDR}	Load Regulation	I_O=1mA to 100mA		0.01	0.04	%/mA
E_N	Output Noise Voltage	f=10Hz to 100kHz, C_O=10µF,		50		µV rms
V_{ENH}	Enable pin voltage for normal operation		2		10	V
		T_A = -40°C	2.2			
V_{ENL}	Enable pin voltage for output shutdown		0		0.8	V
V_{ENHS}	Enable pin hysteresis			150		mV
I_{EN}	Enable Pin input current	V_{EN}=5.5V			100	nA
I_{QSD}	Shutdown supply current	V_{EN}=0V			1	µA
T_{SD}	Thermal Shutdown Temperature		125		165	°C

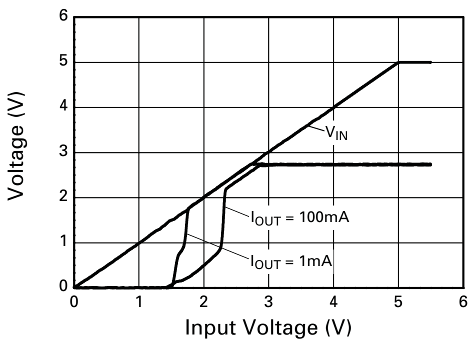
Device testing is performed at T_A=25°C. Device thermal performance is guaranteed by design.

Note1: Maximum power dissipation is calculated assuming the device is mounted on a PCB measuring 2 inches square

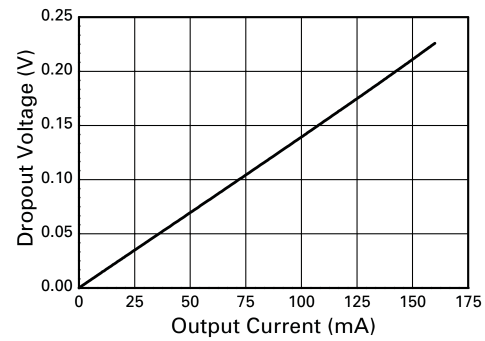
Note 2: Output Voltage will start to rise when V_{IN} exceeds a value or approximately 1.3V. For normal operation, V_{IN} (min) > V_{OUT} (nom) + 0.5V.

Note 3: Dropout voltage is defined as the difference between V_{IN} and V_O, when V_O has dropped 100mV below its nominal value. Nominal value of V_O is defined at V_{IN}=V_O+0.5V.

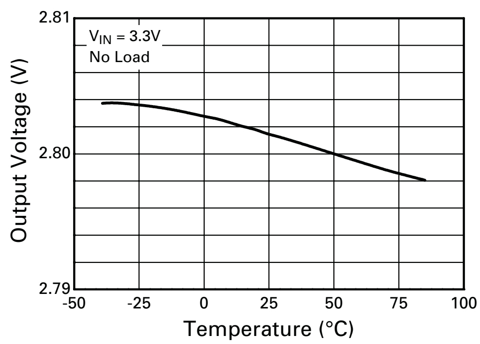
TYPICAL CHARACTERISTICS (ZXCL280 / 5213 shown)



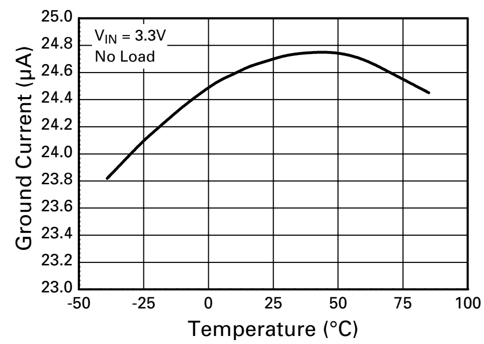
Input to Output Characteristics



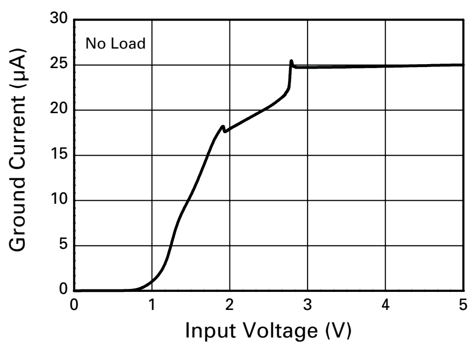
Dropout Voltage v Output Current



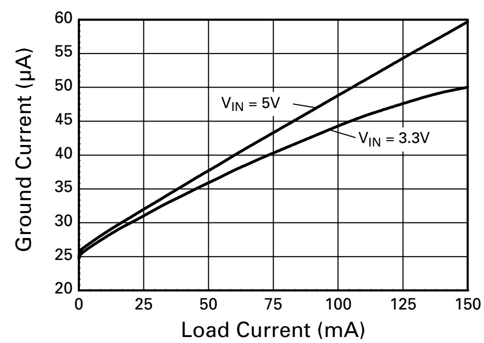
Output Voltage v Temperature



Ground Current v Temperature

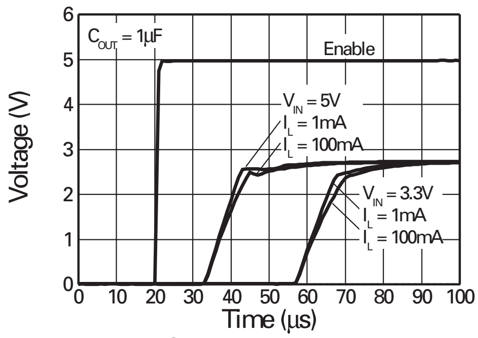


Ground Current v Input Voltage

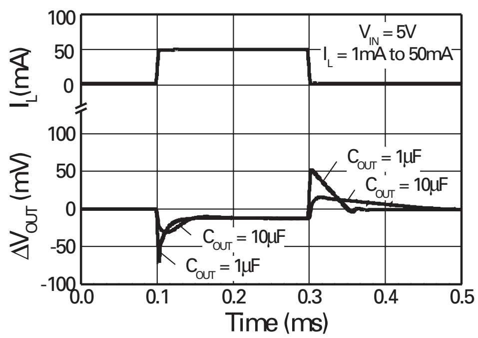


Ground Current v Load Current

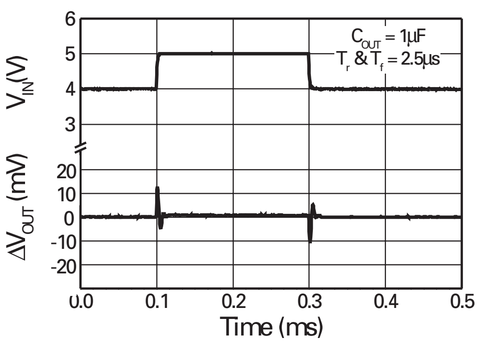
TYPICAL CHARACTERISTICS



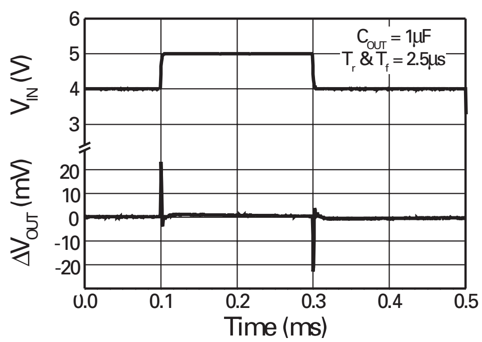
Start-Up Response



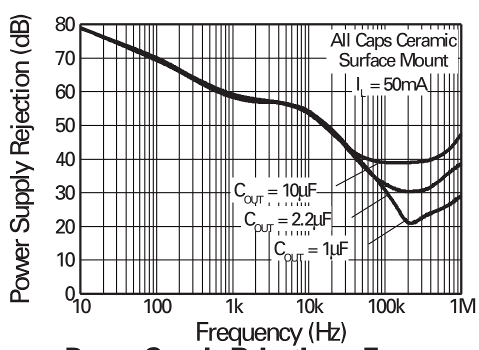
Load Response



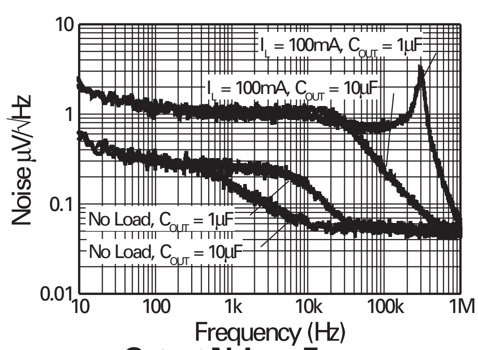
Line Rejection I_L = 1mA



Line Rejection I_L = 100mA



Power Supply Rejection v Frequency

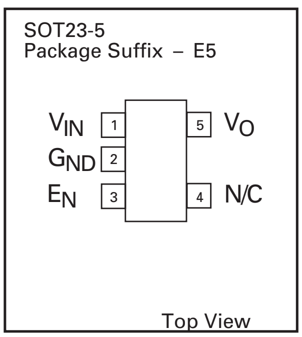


Output Noise v Frequency

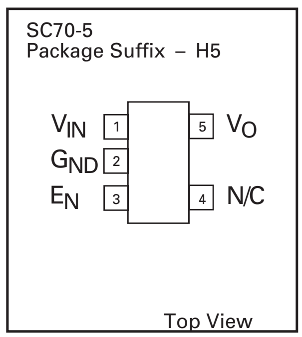
PIN DESCRIPTION

Pin Name	Pin Function
V_{IN}	Supply Voltage
G_{ND}	Ground
E_N	Active HIGH Enable input. TTL/CMOS logic compatible. Connect to V_{IN} or logic high for normal operation
N/C	No Connection
V_O	Regulator Output

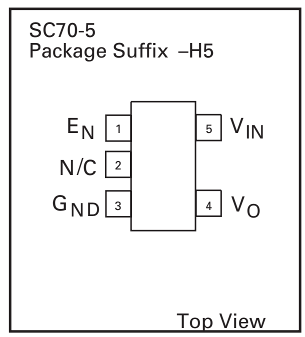
CONNECTION DIAGRAMS



ZXCLxxx

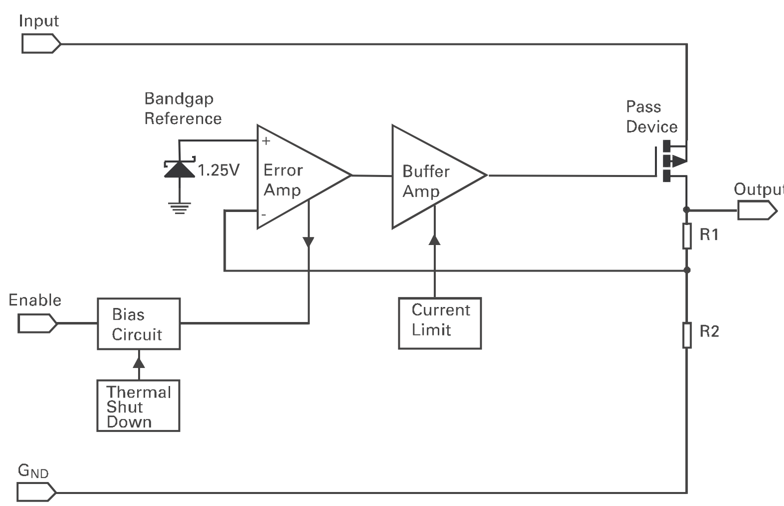


ZXCLxxx



ZXCL5213Vxx

SCHEMATIC DIAGRAM



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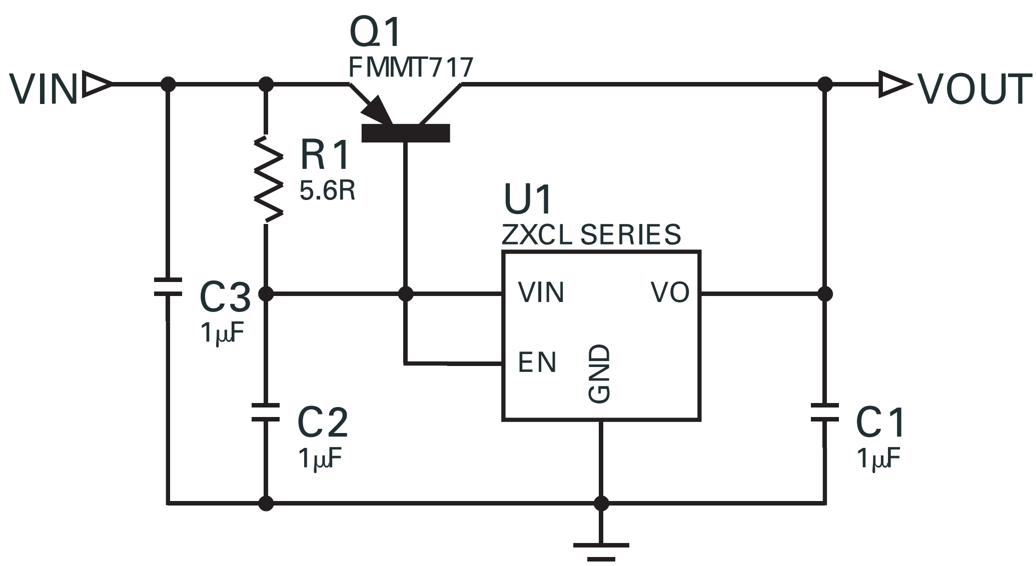
Input to Output Diode

In common with many other LDO regulators, the ZXCL device has an inherent diode associated with the output series pass transistor. This diode has its anode connected to the output and its cathode to the input. The internal diode is normally reverse biased, but will conduct if the output is forced above the input by more than a V_{BE} (approximately 0.6V). Current will then flow from Vout to Vin. For safe operation, the maximum current in this diode should be limited to 5mA continuous and 30mA peak. An external schottky diode may be used to provide protection when this condition cannot be satisfied.

Increased Output current

Any ZXCL series device may be used in conjunction with an external PNP transistor to boost the output current capability. In the application circuit shown below, a FMMT717 device is employed as the external pass element. This SOT23 device can supply up to 2.5A maximum current subject to the thermal dissipation limits of the package (625mW). Alternative devices may be used to supply higher levels of current. Note that with this arrangement, the dropout voltage will be increased by the V_{BE} drop of the external device. Also, care should be taken to protect the pass transistor in the event of excessive output current.



Scheme to boost output current to 2A

APPLICATIONS INFORMATION

Enable Control

A TTL compatible input is provided to allow the regulator to be shut down. A low voltage on the Enable pin puts the device into shutdown mode. In this mode the regulator circuit is switched off and the quiescent current reduces to virtually zero (typically less than 10nA) for input voltages above the minimum operating threshold of the device. A high voltage on the Enable pin ensures normal operation.

The Enable pin can be connected to V_{IN} or driven from an independent source of up to 10V maximum. (e.g. CMOS logic) for normal operation. There is no clamp diode from the Enable pin to V_{IN}, so the V_{IN} pin may be at any voltage within its operating range irrespective of the voltage on the Enable pin. However input voltage rise time should be kept below 5ms to ensure consistent start-up response.

Current Limit

The ZXCL devices include a current limit circuit which restricts the maximum output current flow to typically 230mA. Practically the range of over-current should be considered as minimum 160mA to maximum 800mA. The device's robust design means that an output short circuit to any voltage between ground and V_{OUT} can be tolerated for an indefinite period.

Thermal Overload

Thermal overload protection is included on chip. When the device junction temperature exceeds a minimum 125°C the device will shut down. The sense circuit will re-activate the output as the device cools. It will then cycle until the overload is removed. The thermal overload protection will be activated when high load currents or high input to output voltage differentials cause excess dissipation in the device.

Start up delay

A small amount of hysteresis is provided on the Enable pin to ensure clean switching. This feature can be used to introduce a start up delay if required. Addition of a simple RC network on the Enable pin provides this function. The following diagram illustrates this circuit connection. The equation provided enables calculation of the delay period.

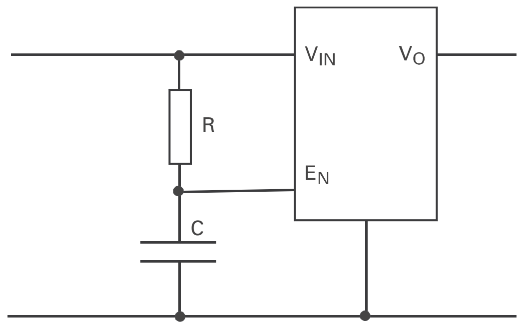


Figure 1 Circuit Connection

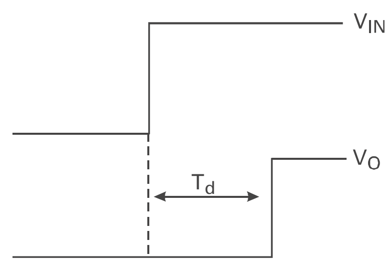


Figure 2 Start up delay (T_d)

$$T_{d(NOM)} = RC\ln\left(\frac{V_{IN}}{V_{IN} - 1.5}\right)$$

Calculation of start up delay as above

APPLICATIONS INFORMATION (Cont)

Power Dissipation

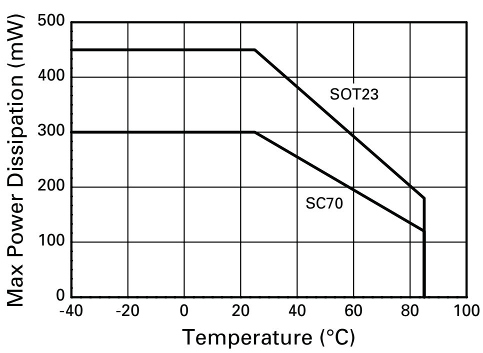
The maximum allowable power dissipation of the device for normal operation (Pmax), is a function of the package junction to ambient thermal resistance (θja), maximum junction temperature (Tjmax), and ambient temperature (Tamb), according to the expression:

$P_{max} = (Tj_{max} - T_{amb}) / \theta_{ja}$

The maximum output current (I_{max}) at a given value of Input voltage (V_{IN}) and output voltage (V_{OUT}) is then given by

$I_{max} = P_{max} / (V_{IN} - V_{OUT})$

The value of θja is strongly dependent upon the type of PC board used. Using the SC70 package it will range from approximately 280 °C/W for a multi-layer board to around 450°C/W for a single sided board. It will range from 180°C/W to 300°C/W for the SOT23-5 package. To avoid entering the thermal shutdown state, Tj_{max} should be assumed to be 125°C and I_{max} less than the over-current limit,(I_{OLIM}). Power derating for the SC70 and SOT23-5 packages is shown in the following graph.



Derating Curve

Capacitor Selection and Regulator Stability

The device is designed to operate with all types of output capacitor, including tantalum and low ESR ceramic. For stability over the full operating range from no load to maximum load, an output capacitor with a minimum value of 1µF is recommended, although this can be increased without limit to improve load transient performance. Higher values of output capacitor will also reduce output noise. Capacitors with ESR less than 0.5Ω are recommended for best results.

The dielectric of the ceramic capacitance is an important consideration for the ZXCL Series operation over temperature. Zetex recommends minimum dielectric specification of X7R for the input and output capacitors. For example a ceramic capacitor with X7R dielectric will lose 20% of its capacitance over a -40°C to 85°C temperature range, whereas a capacitor with a Y5V dielectric loses 80% of its capacitance at -40°C and 75% at 85°C.

An input capacitor of 1µF (ceramic or tantalum) is recommended to filter supply noise at the device input and will improve ripple rejection.

The input and output capacitors should be positioned close to the device, and a ground plane board layout should be used to minimise the effects of parasitic track resistance.

Dropout Voltage

The output pass transistor is a large PMOS device, which acts like a resistor when the regulator enters the dropout region. The dropout voltage is therefore proportional to output current as shown in the typical characteristics.

Ground Current

The use of a PMOS device ensures a low value of ground current under all conditions including dropout, start-up and maximum load.

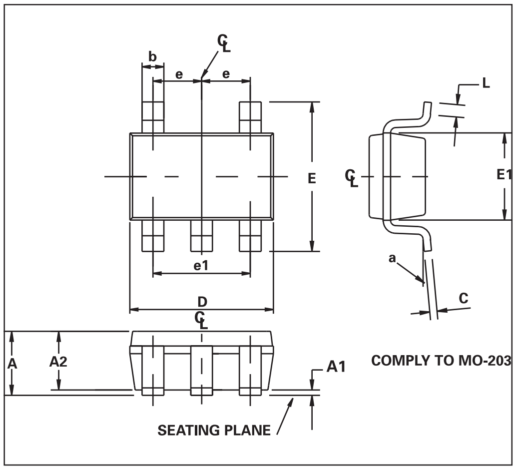
Power Supply Rejection and Load Transient Response

Line and Load transient response graphs are shown in the typical characteristics.

These show both the DC and dynamic shift in the output voltage with step changes of input voltage and load current, and how this is affected by the output capacitor.

If improved transient response is required, then an output capacitor with lower ESR value should be used. Larger capacitors will reduce over/undershoot, but will increase the settling time. Best results are obtained using a ground plane layout to minimise board parasitics.

S70-5 PACKAGE OUTLINE

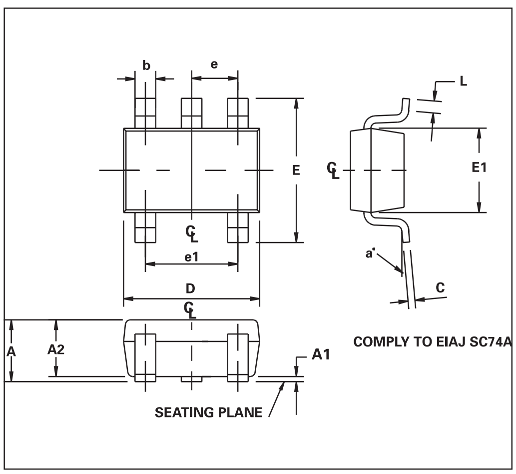


CONTROLLING DIMENSIONS IN MILLIMETRES
APPROX CONVERTED DIMENSIONS IN INCHES

SC70-5 PACKAGE DIMENSIONS

DIM	MILLIMETRES		INCHES	
	MIN	MAX	MIN	MAX
A	—	1.00	—	0.0393
A1	—	0.10	—	0.0039
A2	0.70	0.90	0.0275	0.0354
b	0.15	0.30	0.006	0.0118
C	0.08	0.25	0.0031	0.0098
D	2.0 BSC		0.0787 BSC	
E	2.10 BSC		0.0826 BSC	
E1	1.25 BSC		0.0492 BSC	
e	0.65 BSC		0.0255 BSC	
e1	1.30 BSC		0.0511 BSC	
L	0.26	0.46	0.0102	0.0181
a	0°	8°	0°	8°

SOT23-5 PACKAGE INFORMATION



CONTROLLING DIMENSIONS IN MILLIMETRES
APPROX CONVERTED DIMENSIONS IN INCHES

SOT23-5 PACKAGE DIMENSIONS

DIM	MILLIMETRES		INCHES	
	MIN	MAX	MIN	MAX
A	0.90	1.45	0.0354	0.0570
A1	0.00	0.15	0.00	0.0059
A2	0.90	1.3	0.0354	0.0511
b	0.20	0.50	0.0078	0.0196
C	0.09	0.26	0.0035	0.0102
D	2.70	3.10	0.1062	0.1220
E	2.20	3.20	0.0866	0.1181
E1	1.30	1.80	0.0511	0.0708
e	0.95 REF		0.0374 REF	
e1	1.90 REF		0.0748 REF	
L	0.10	0.60	0.0039	0.0236
a°	0	30	0	30

ORDERING INFORMATION

Device	Output Voltage V	Package	Partmarking
ZXCL250H5	2.5	SC70	L25A
ZXCL260H5	2.6	SC70	L26A
ZXCL280H5	2.8	SC70	L28A
ZXCL300H5	3.0	SC70	L30A
ZXCL330H5	3.3	SC70	L33A
ZXCL400H5	4.0	SC70	L40A
ZXCL5213V25H5	2.5	SC70	L25C
ZXCL5213V26H5	2.6	SC70	L26C
ZXCL5213V28H5	2.8	SC70	L28C
ZXCL5213V30H5	3.0	SC70	L30C
ZXCL5213V33H5	3.3	SC70	L33C
ZXCL5213V40H5	4.0	SC70	L40C
ZXCL250E5	2.5	SOT23-5	L25B
ZXCL260E5	2.6	SOT23-5	L26B
ZXCL280E5	2.8	SOT23-5	L28B
ZXCL300E5	3.0	SOT23-5	L30B
ZXCL330E5	3.3	SOT23-5	L33B
ZXCL400E5	4.0	SOT23-5	L40B

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