19-2528; Rev 1; 2/03

EVALUATION KIT AVAILABLE

Wide-Input 0.6V Shunt Regulators for Isolated DC-to-DC Converters

General Description

The MAX8515A/MAX8515 shunt regulators simplify the design of voltage regulation and overvoltage protection (OVP) functions in high-accuracy isolated DC-to-DC converters with output voltages as low as 0.6V. The devices have supply voltage and feedback inputs separated from the output shunt stage, and can operate directly from the DC-to-DC converter output stage when the output voltage is 1.8V to 18V. Alternately, the MAX8515A/MAX8515 input stage can be biased from an unregulated 1.7V to 28V supply, independent of DC-to-DC converter output voltage. The MAX8515A/MAX8515 shunts 20mA when the output voltage is as low as 0.2V.

The MAX8515A features an initial output accuracy of 0.5% at +25°C and 1% from -40°C to +85°C and provides the output voltage regulation function for isolated DC-to-DC converters. The MAX8515 features initial output accuracy of 1% at +25°C and 1.8% from -40°C to +85°C and can provide an output OVP function for isolated DC-to-DC converters. High open-loop bandwidth allows design of high-bandwidth DC-to-DC converters.

Low-cost, low-dropout linear regulators can be designed with the MAX8515A/MAX8515 and an external NPN transistor for cost-conscious applications that do not require overcurrent, short-circuit, or overtemperature protection.

The MAX8515/MAX8515A are available in space-saving 5-pin SC70 and SOT23 packages and are specified over the -40°C to +85°C extended temperature range. An evaluation kit is available to speed designs.

Applications

Isolated DC-to-DC Converters

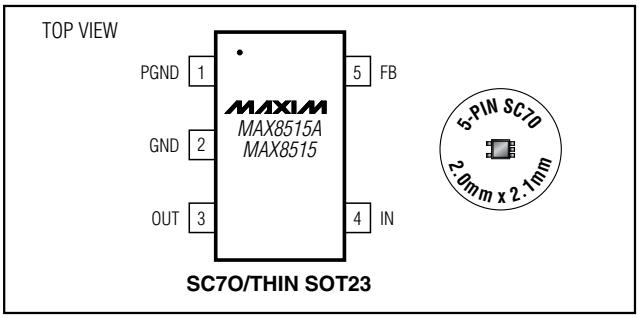
Network, Telecom, and Cellular Base Station Power Supplies

Low-Dropout Linear Regulators

Shunt Regulator

Adjustable Voltage Reference

Pin Configuration



SC7O/THIN SOT23

Features

- **MAX8515A**
  - **0.6V ±0.5% Initial Accuracy at +25°C**
  - **0.6V ±1% Accuracy from -40°C to +85°C**
- **MAX8515**
  - **0.6V ±1% Initial Accuracy at +25°C**
  - **0.6V ±1.8% Accuracy from -40°C to +85°C**
- **Sinks 20mA at 0.2V to 18V**
- **Input Voltage Range from 1.7V to 28V**
- **Directly Drives Optocouplers**
- **0.2Ω Dynamic Output Impedance**
- **Space-Saving 5-Pin SC70 or SOT23 Packages**

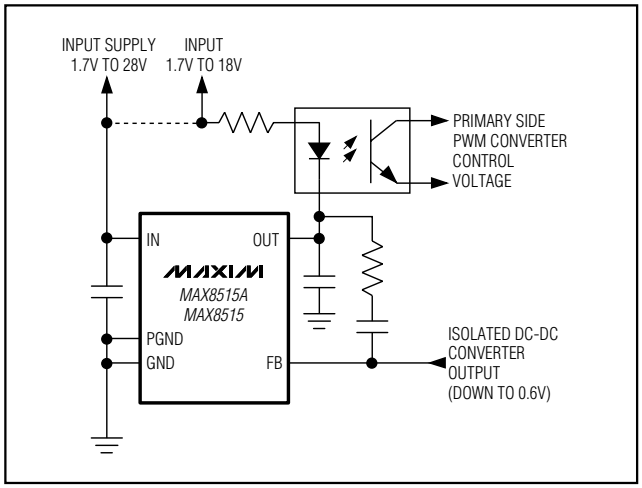
Ordering Information

PART	TEMP RANGE	PIN-PACKAGE
MAX8515AEXK-T	-40°C to +85°C	5 SC70-5
MAX8515AEZK-T	-40°C to +85°C	5 Thin SOT23-5
MAX8515EXK-T	-40°C to +85°C	5 SC70-5
MAX8515EZK-T	-40°C to +85°C	5 Thin SOT23-5

Functional Diagram appears at end of data sheet.

Selector Guide appears at end of data sheet.

Typical Operating Circuit



For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

Wide-Input 0.6V Shunt Regulators for Isolated DC-to-DC Converters

ABSOLUTE MAXIMUM RATINGS

IN to GND .....-0.3V to +30V
OUT to GND .....-0.3V to +20V
FB to GND .....-0.3V to the lower of 5.5V and (V_{IN} +0.3V)
PGND to GND .....-0.3V to +0.3V
Continuous Power Dissipation (T_A =+70°C)
5-Pin SC70 (derate 3.1mW/°C above +70°C).....246.9mW
5-Pin Thin SOT23 (derate 9.1mW/°C above +70°C)....727mW
Operating Temperature Range .....-40°C to +85°C
Junction Temperature Range .....-40°C to +150°C
Storage Temperature Range .....-65°C to +150°C
Lead Temperature (soldering, 10s) .....+300°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 rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V_{IN} = 3.3V, OUT = FB, I_{OUT} = 5mA, T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 1)

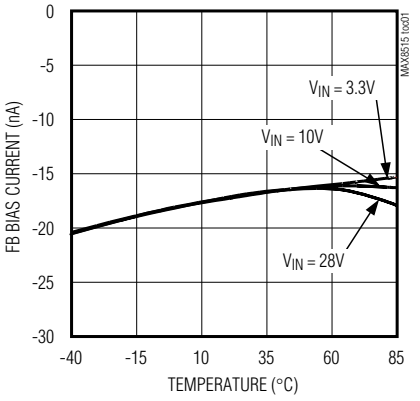
PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
IN							
IN Voltage Range	V_{IN}			1.7		28	V
IN Supply Current	I_{IN}	V_{IN} = 2V to 28V	I_{OUT} = 0.3mA		0.5	1	mA
			I_{OUT} = 10mA		2.5	4	
FB							
FB Threshold Accuracy		T_A = +25°C	MAX8515AE_K	0.597	0.6	0.603	V
			MAX8515E_K	0.594	0.6	0.606	
		T_A = 0°C to +85°C	MAX8515AE_K	0.595	0.6	0.605	
			MAX8515E_K	0.592	0.6	0.608	
		T_A = -40°C to +85°C	MAX8515AE_K	0.594	0.6	0.606	
			MAX8515E_K	0.589	0.6	0.608	
FB Load Regulation		I_{OUT} = 1mA to 20mA			3.8	6	mV
FB Line Regulation		V_{IN} = 2V to 28V			0.2	1	mV
		V_{IN} = 1.7V to 28V				1.5	
FB Output Voltage Regulation		V_{OUT} = 0.2V to 18V, I_{OUT} = 1mA			0.2	1	mV
FB Input Bias Current	$I_{FB(BIAS)}$	V_{IN} = 28V		-0.1	0.02	+0.1	µA
OUT							
OUT Voltage Range	V_{OUT}			0.2		18	V
Maximum Output Current	$I_{OUT(MAX)}$	V_{OUT} = 0.2V, V_{IN} = 2V, V_{FB} = 0.63V		20			mA
Output Leakage Current	$I_{OUT(LEAK)}$	V_{IN} = 28V, V_{OUT} = 18V, V_{FB} = 0V	T_A = +25°C		0.001	0.1	µA
			T_A = +85°C		0.03		
Dynamic Output Impedance	Z_{OUT}	I_{OUT} = 1mA to 20mA, f <1kHz			0.2	0.32	Ω

Note 1: Devices are production tested at T_A = +25°C, limits over temperature are guaranteed by design.

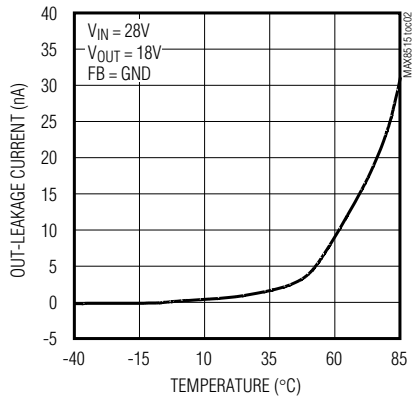
Typical Operating Characteristics

(V_{IN} = 3.3V, I_{OUT} = 5mA, FB = OUT, circuit in Figure 1, C1 = 0.1µF, C2 = 1µF, T_A = +25°C, unless otherwise specified.)

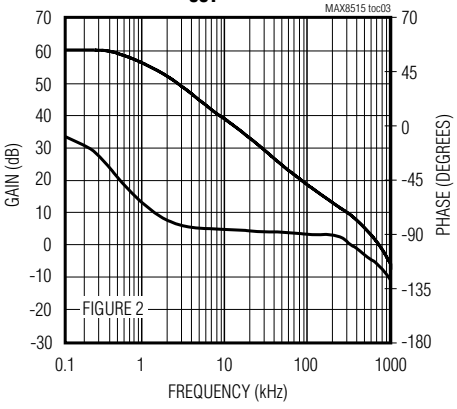
FB BIAS CURRENT vs. TEMPERATURE



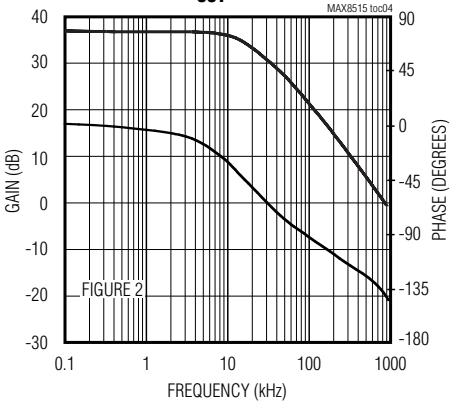
OUT-LEAKAGE CURRENT vs. TEMPERATURE



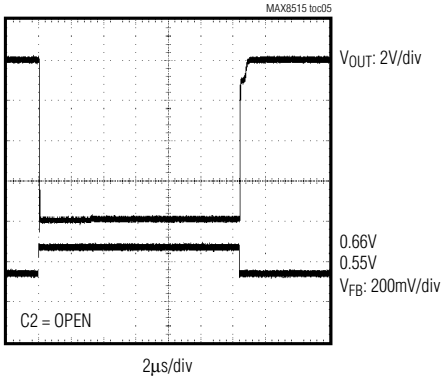
GAIN AND PHASE vs. FREQUENCY VOUT = 0.6V



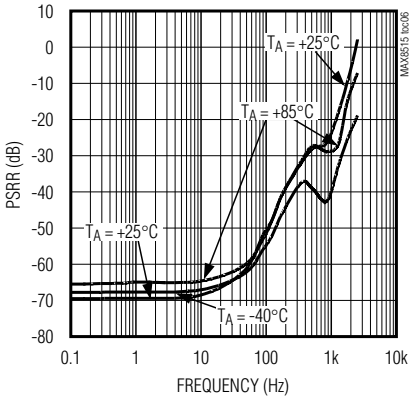
GAIN AND PHASE vs. FREQUENCY VOUT = 6V



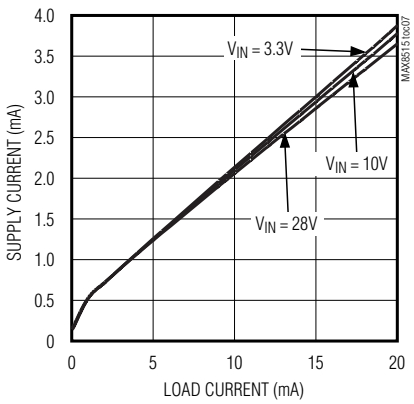
OUTPUT VOLTAGE SLEW RATE



POWER-SUPPLY REJECTION RATIO vs. FREQUENCY



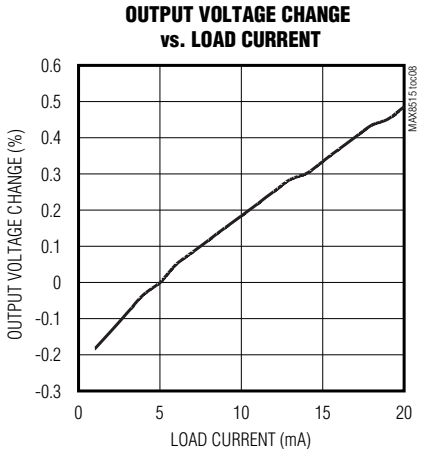
SUPPLY CURRENT vs. LOAD CURRENT

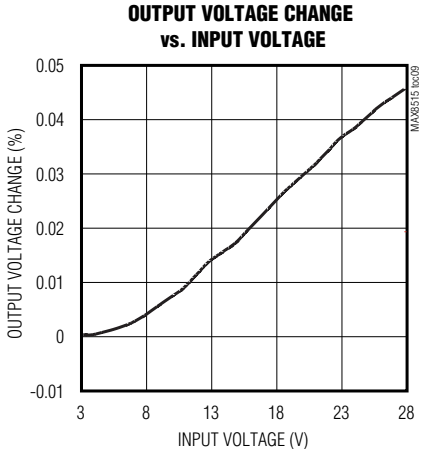


Wide-Input 0.6V Shunt Regulators for Isolated DC-to-DC Converters

Typical Operating Characteristics (continued)

(V_{IN} = 3.3V, I_{OUT} = 5mA, FB = OUT, circuit in Figure 1, C1 = 0.1µF, C2 = 1µF, T_A = +25°C, unless otherwise specified.)





Pin Description

PIN	NAME	FUNCTION
1	PGND	Power Ground. Connect PGND and GND together.
2	GND	Analog Ground. Connect GND and PGND together.
3	OUT	Output. Connect a ceramic capacitor from OUT to GND. See the *Applications Information* section.
4	IN	Supply Input. Connect a 0.1µF capacitor to GND.
5	FB	Feedback Input. Regulates to 600mV.

Detailed Description

The MAX8515A/MAX8515 adjustable shunt regulators feature isolated supply inputs and outputs, ideal for isolated power-supply applications using an optocoupler in the feedback path. The MAX8515A/MAX8515 sink 20mA with V_{OUT} at 0.2V. The wide input supply range allows the device to operate from 1.7V to 28V. The MAX8515A/MAX8515 compare the FB input to a precision 600mV reference. If the FB input is low, OUT sinks no current. If FB rises above 600mV, OUT sinks up to 20mA.

Applications Information

Shunt Regulator/Adjustable Voltage Reference

Figure 1 shows the MAX8515A/MAX8515 configured as a shunt regulator. Connect FB to OUT for an output voltage of 0.6V. Connect a 1.0µF capacitor from OUT to GND when the output voltage is 0.6V. A resistor-divider connected from OUT to GND produces higher output voltages and allows for a smaller output capacitor. The value of the output capacitor is inversely proportional to the output voltage:

$$V_{OUT} = 0.6 \times \left(1 + \frac{R1}{R2}\right)$$

$$C_{OUT} = 1\mu F \times \left(\frac{0.6}{V_{OUT}}\right)$$

Set the current limit with a resistor connected from IN to OUT. This type of shunt regulator is limited to low-current applications. The MAX8515A/MAX8515 can typically sink up to 20mA in this application.

Figure 2 shows the test circuits for gain and phase plots.

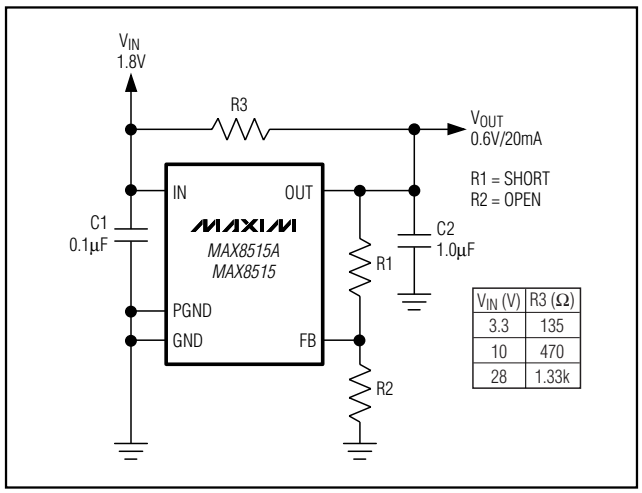


Figure 1. MAX8515A/MAX8515 Typical Application Circuit, Shunt Regulator/Adjustable Voltage Reference

Optical Feedback

Setting V_{OUT}

Figure 3 displays an application circuit using the MAX8515A/MAX8515 in an opto-isolated feedback circuit. The maximum bias current for the photodiode is set with R1. The isolated DC-to-DC converter compensation circuit is formed with R2, C3, and C4. Resistors R3 and R4 set the isolated DC-to-DC converter output voltage. C1 decouples the input supply and C2 is needed to stabilize the MAX8515A/MAX8515. Calculate V_{REG} with the following equation:

$$V_{REG} = 0.6 \times \left(1 + \frac{R3}{R4}\right)$$

Set R4 to 10kΩ and calculate R3 by:

$$R3 = \left(\frac{V_{OUT}}{V_{FB}} - 1\right) \times R4$$

For example, given a regulator output voltage of 1.8V and R4 = 10kΩ, R3 is found to be 20kΩ.

Compensation Circuit

A typical compensation scheme is depicted in Figure 3. C3 provides an integrator function that minimizes output regulation error.

R2 provides additional phase compensation at the zero frequency f_Z:

$$f_Z = \frac{1}{2\pi \times R2 \times C3}$$

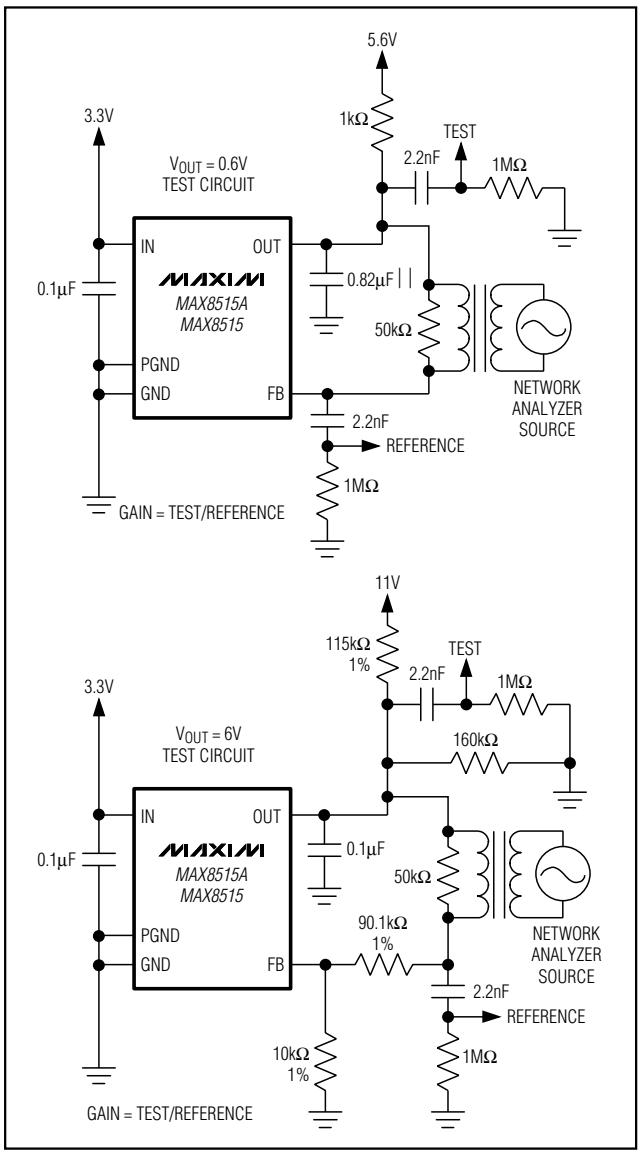


Figure 2. Test Circuits for Gain and Phase Plots

The midband gain is given by:

$$A = \frac{R2}{R3}$$

Add C4 for high-frequency noise rejection. Determine R2 based on the midband gain required by the isolated power supply. Choose f_Z based on the power supply small-signal transfer function. Calculate C3 once f_Z is known.

Wide-Input 0.6V Shunt Regulators for Isolated DC-to-DC Converters

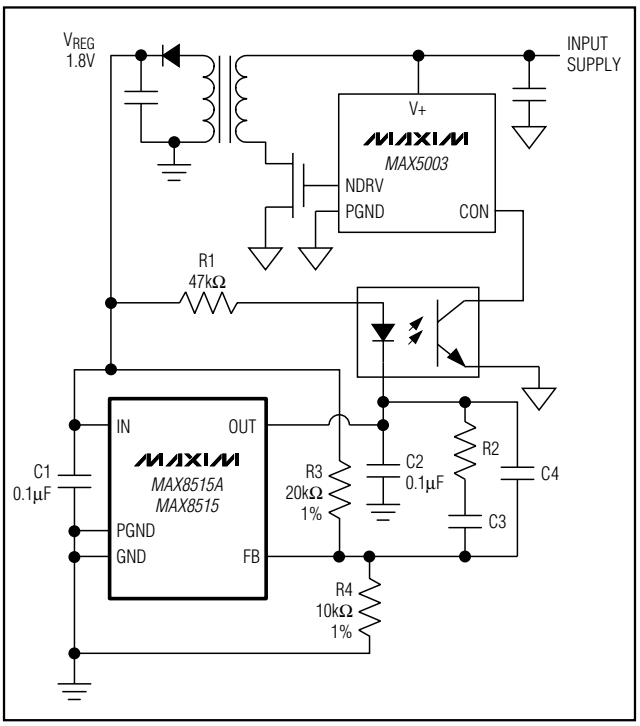


Figure 3. MAX8515A/MAX8515 Typical Application Circuit, Opto-Feedback Circuit

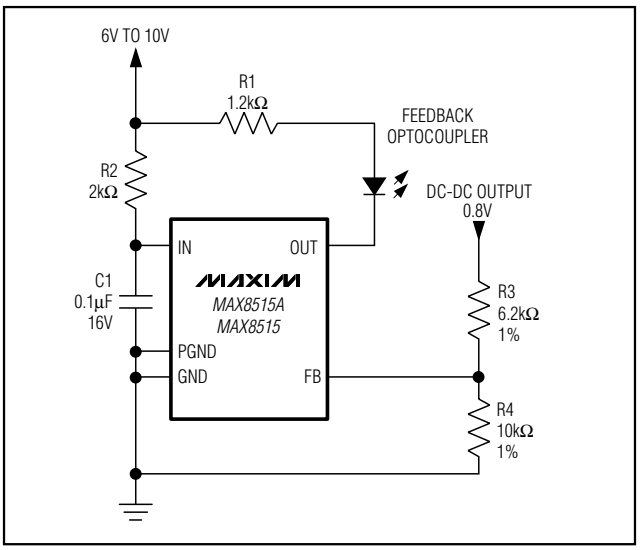


Figure 4. MAX8515A/MAX8515 Typical Application Circuit, OVP Circuit (Set to 1V OVP Threshold for 0.8V Nominal Output)

Overvoltage Protection

Figure 4 shows an isolated OVP circuit. R1 limits the current supplied to the photodiode. R2 limits the MAX8515A/MAX8515 input current. R3 and R4 set the trip threshold for the OVP. C1 is the input supply decoupling capacitor.

Values for R3 and R4 are chosen based on the needed OVP threshold. For example, a trip threshold of 25% above the rated output voltage is needed for an OVP circuit. The values of R3 can be determined from the following equation once R4 is chosen; 10kΩ is recommended for R4. Then, R3 = 6.2kΩ.

$$R3 = \left(\frac{V_{OVP}}{V_{FB}} - 1 \right) \times R4$$

where V_{OVP} = 0.8V x 1.25 for the given example.

Linear Regulator

Use an external pass transistor in conjunction with the MAX8515A/MAX8515 to create a linear regulator as shown in Figure 5. Determine the output voltage of the regulator by:

$$V_{REG} = 0.6V \times \left(1 + \frac{R2}{R3} \right)$$

Choose R1 to maintain load regulation up to a 2A load. Use the following equation:

$$R1 = \frac{V_{IN_MIN} - V_{REG} - V_{BE}}{I_{O_MAX}} \times \beta$$

where I_{O_MAX} is the rated maximum output current, which is 2A in this application circuit. V_{REG} is the output voltage of the linear regulator. V_{BE} is the base-to-emitter forward voltage of Q1, and β is the minimum current gain of Q1 at rated load current. V_{IN} is the minimum input voltage at IN. For the typical application circuit, V_{IN_MIN} = 2.375V, V_{REG} = 1.0V, V_{BE} = 0.65V, and β = 180. Choose R1 = 15Ω for fast transient response. C1 is the input decoupling capacitor and C2 is the compensation capacitor. Use a 1µF, 6.3V capacitor for this application. Figure 6 shows a typical load-regulation curve for the circuit in Figure 5. This circuit does not provide short-circuit, overcurrent, or overtemperature protection.

Wide-Input 0.6V Shunt Regulators for Isolated DC-to-DC Converters

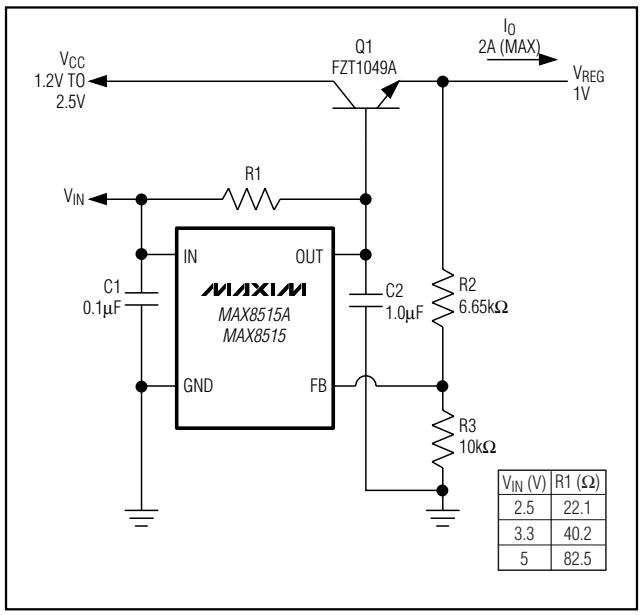


Figure 5. MAX8515A/MAX8515 Typical Application Circuit, Linear Regulator

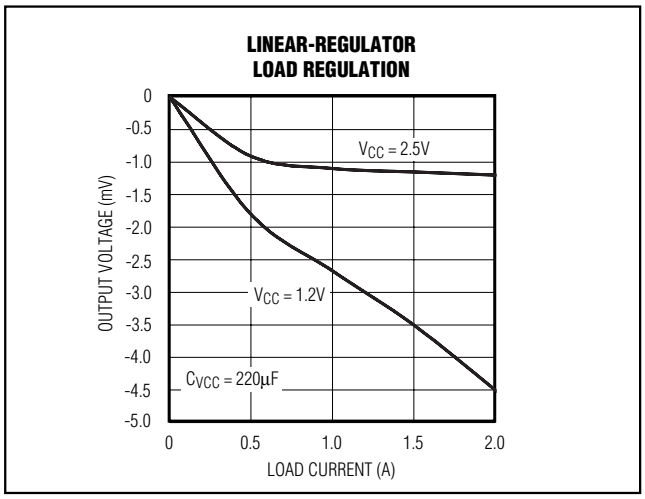
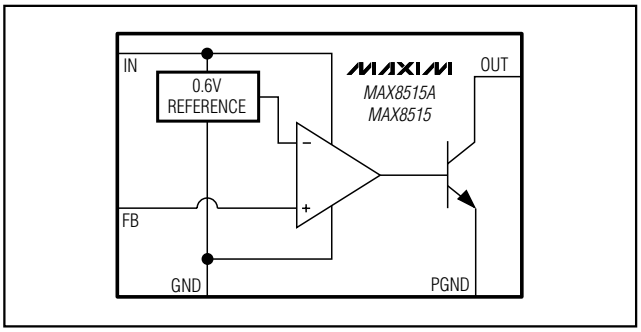


Figure 6. Load Regulation of Linear-Regulator Circuit

Functional Diagram



Selector Guide

PART	INITIAL ACCURACY	TOP MARKS
MAX8515AEXK-T	0.6V, 0.5% feedback	ADX
MAX8515AEZK-T	0.6V, 0.5% feedback	ADRK
MAX8515EXK-T	0.6V, 1% feedback	ADY
MAX8515EZK-T	0.6V, 1% feedback	ADRL

Chip Information

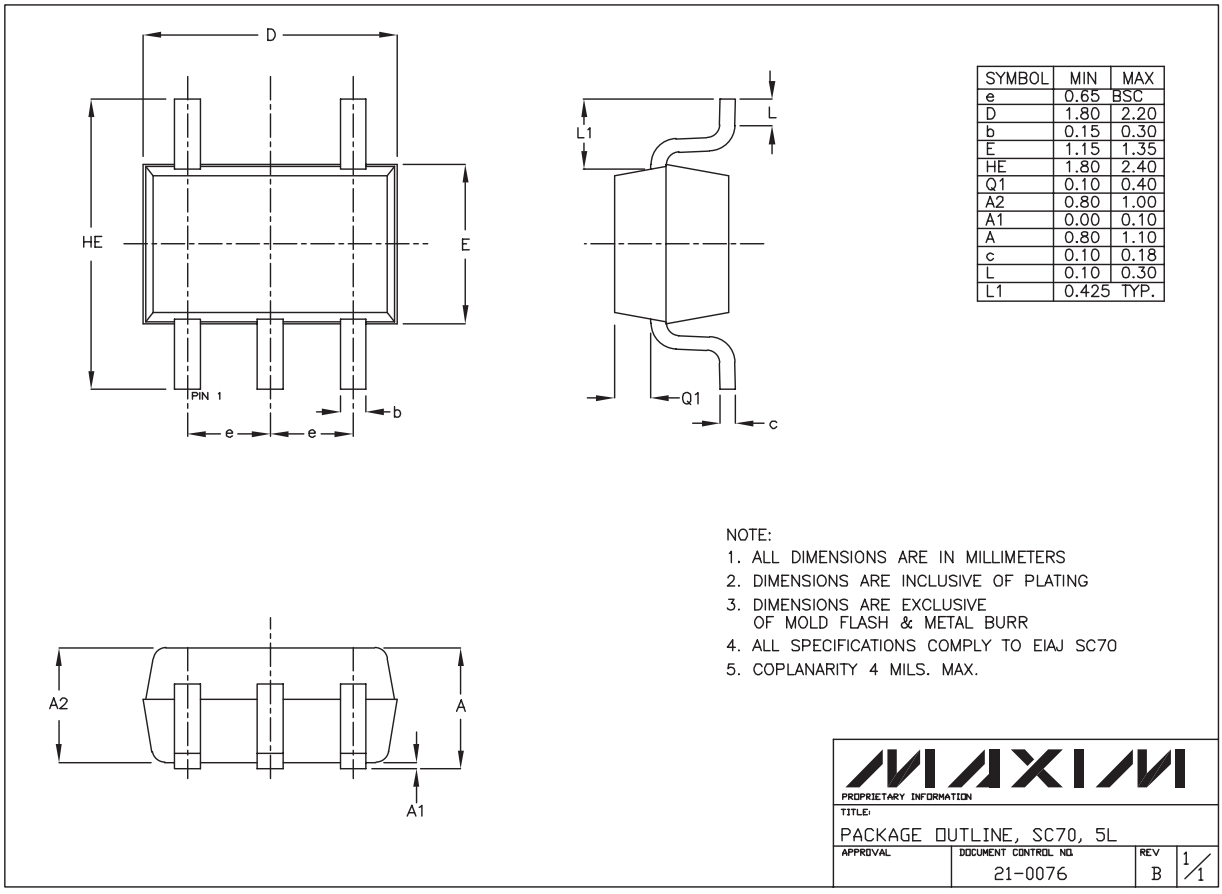
TRANSISTOR COUNT: 50

PROCESS: BiCMOS

Wide-Input 0.6V Shunt Regulators for Isolated DC-to-DC Converters

Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)



SYMBOL	MIN	MAX
e	0.65 BSC	
D	1.80	2.20
b	0.15	0.30
E	1.15	1.35
HE	1.80	2.40
Q1	0.10	0.40
A2	0.80	1.00
A1	0.00	0.10
A	0.80	1.10
c	0.10	0.18
L	0.10	0.30
L1	0.425 TYP.	

NOTE:
1. ALL DIMENSIONS ARE IN MILLIMETERS
2. DIMENSIONS ARE INCLUSIVE OF PLATING
3. DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH & METAL BURR
4. ALL SPECIFICATIONS COMPLY TO EIAJ SC70
5. COPLANARITY 4 MILS. MAX.

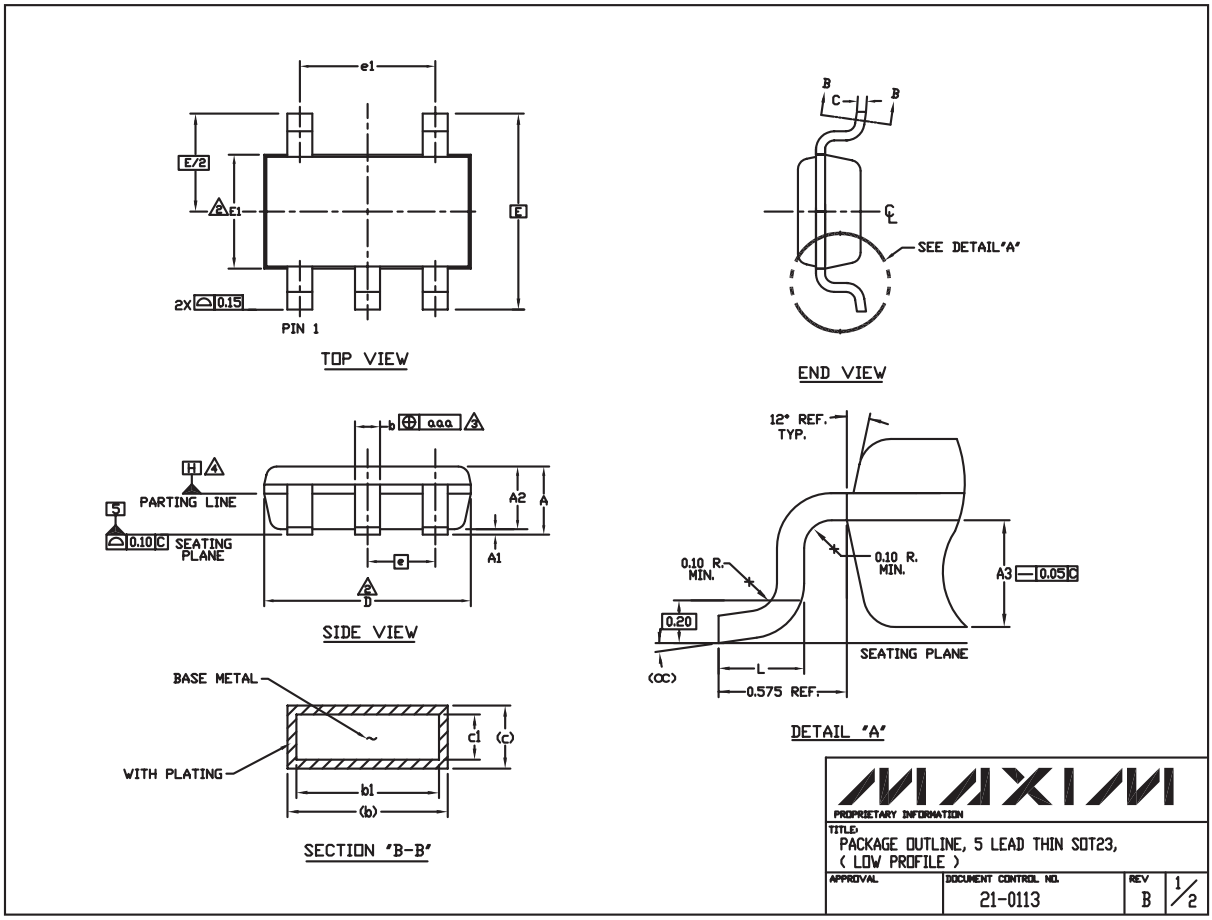
MAXIM
PROPRIETARY INFORMATION

TITLE: PACKAGE OUTLINE, SC70, 5L			
APPROVAL	DOCUMENT CONTROL NO. 21-0076	REV B	1/1

Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)

THIN SOT23.EPS



Wide-Input 0.6V Shunt Regulators for Isolated DC-to-DC Converters

Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS.

2. "D" AND "E1" ARE REFERENCE DATUM AND DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS, AND ARE MEASURED AT THE BOTTOM PARTING LINE. MOLD FLASH OR PROTRUSION SHALL NOT EXCEED 0.15mm ON "D" AND 0.25mm ON "E" PER SIDE.

3. THE LEAD WIDTH DIMENSION DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.07mm TOTAL IN EXCESS OF THE LEAD WIDTH DIMENSION AT MAXIMUM MATERIAL CONDITION.

4. DATUM PLANE "H" LOCATED AT MOLD PARTING LINE AND COINCIDENT WITH LEAD, WHERE LEAD EXITS PLASTIC BODY AT THE BOTTOM OF PARTING LINE.

5. THE LEAD TIPS MUST LINE WITHIN A SPECIFIED TOLERANCE ZONE. THIS TOLERANCE ZONE IS DEFINED BY TWO PARALLEL LINES. ONE PLANE IS THE SEATING PLANE, DATUM [-C-]; AND THE OTHER PLANE IS AT THE SPECIFIED DISTANCE FROM [-C-] IN THE DIRECTION INDICATED. FORMED LEADS SHALL BE PLANAR WITH RESPECT TO ONE ANOTHER WITH 0.10mm AT SEATING PLANE.

6. THIS PART IS COMPLIANT WITH JEDEC SPECIFICATION MO-193 EXCEPT FOR THE "e" DIMENSION WHICH IS 0.95Mmm INSTEAD OF 1.00mm. THIS PART IS IN FULL COMPLIANCE TO EIAJ SPECIFICATION SC-74.

SYMBOLS			
	MIN	NOM	MAX
A	-	-	1.10
A1	0.05	0.075	0.10
A2	0.85	0.88	0.90
A3		0.50 BSC	
b	0.30	-	0.45
b1	0.25	0.35	0.40
c	0.15	-	0.20
c1	0.12	0.127	0.15
D	2.80	2.90	3.00
E		2.75 BSC	
E1	1.55	1.60	1.65
L	0.30	0.40	0.50
e1		1.90 BSC	
e		0.95 BSC	
∝	0°	4°	8°
aaa		0.20	

MAXIM
PROPRIETARY INFORMATION

TITLE: PACKAGE OUTLINE, 5 LEAD THIN SOT23, (LOW PROFILE)

APPROVAL	DOCUMENT CONTROL NO.	REV	
	21-0113	B	2/2

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