July 2013

FHR1200
Micro-Power, Ultra Wide Voltage Regulator

Features

- Low Operating Current: 12 µA Max.
- Option to Direct Drive Feedback Pin on PWM Controllers
- Programmable Output: 7.5 V to 100 V
- Wide Operating Temperature Range: -55°C to +150°C
- Output Voltage Accuracy: ±2%
- Excellent Output Voltage Compensation: -30 PPM/°C
- Sink Current Capability: 10 µA to 50 mA
- Small Package: SC70-6 (SOT363)

Applications

- Primary-Side Regulation in Flyback SMPS
- Secondary-Side Regulation in Flyback SMPS
- High Input Voltage SMPS
  - Smart Meter
  - Industrial Motor Control
  - Wireless Infrastructure
- Industrial and Street Lighting LED Power Supplies

Description

The FHR1200 is a high-efficiency regulator that outperforms the typical shunt regulator in the flyback power supply by offering a maximum regulation voltage of 100 V, lower bias current, and better stability over the maximum industrial temperature range, resulting in efficiency savings in Standby Mode.

In certain configurations, the efficiency savings FHR1200 can directly drive the PWM controller. This option eliminates complexity and cost of an optocoupler and additional feedback pin drive circuitry. For compatible circuits, the FHR1200 can regulate with as low as 20 µA of supply current (bias and sink stages), driving greater than a 90% power savings compared to a standard shunt regulator.

The FHR1200 is packaged in space-saving surface-mount SC70-6 (SOT363) to minimize layout space and cost.

Typical Application

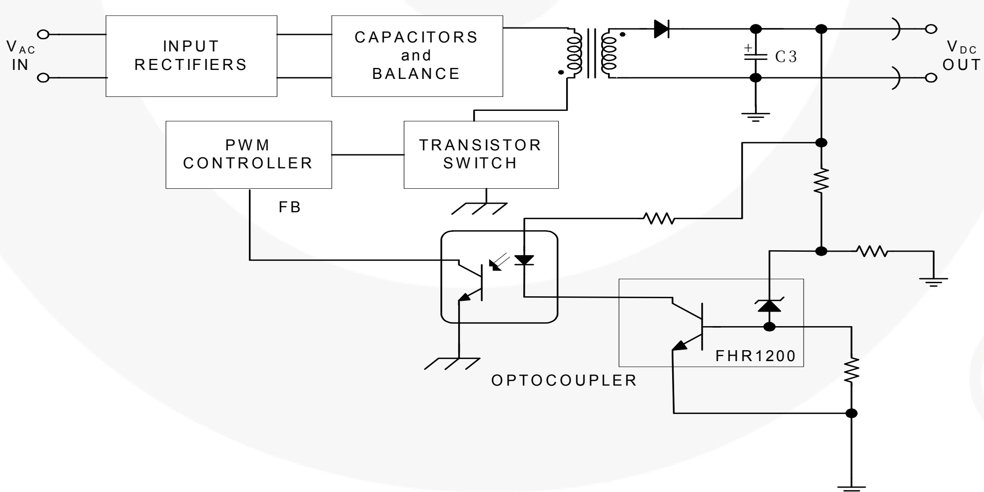

Figure1. Flyback Power Supply Secondary-Side Regulation

Ordering Information

Part Number	Top Mark	Package	Packing Method	Remarks
FHR1200	FH	SC70-6 (SOT363)	Tape and Reel	3000 pcs, Reel Size is 7"

Block Diagram

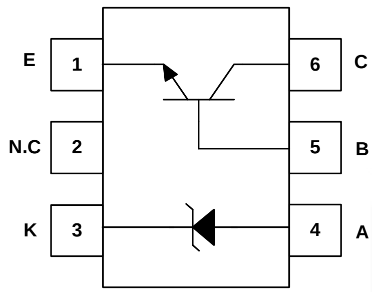

Figure 2. Internal Connection

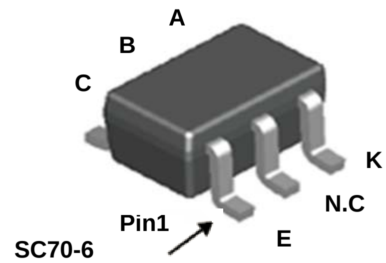

Figure 3. Device Package

Pin Definitions

Pin #	Name	Description
4	Jumper	Ref Bias Pin: Tie R4 to ground to bias; Tie cap to ground for lower noise
2	NC	No Connection
5	Jumper	Reference Bias Pin
1	GND	Ground Connection
3	Reg Input	Reference Voltage
6	Out	Regulator Output

Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only. Values are at T_A = 25°C unless otherwise noted.

Symbol	Parameter		Value	Unit
V_{OUT}	Regulator Output		100	V
I_{BIAS}	Cathode Current		50	mA
P_D	Power Dissipation	T_A = 25°C	227	mW
T_J, T_{STG}	Operating and Storage Junction Temperature Range		-55 to +150	°C

Thermal Characteristics[1]

Symbol	Parameter	Value	Unit
$R_{\theta JA}$	Thermal Resistance, Junction to Air	550	°C/W
Ψ_{JB}	Junction to Board thermal characterization parameter	370	°C/W

Note:

1. PCB Board Size: FR4 76 x 114 x 0.6 T mm^3 (3.0 inch x 4.5 inch x 0.062 inch) with minimum land pattern size. Ψ_{JB} test method: T-36 guage thermocouple is soldered directly to the collector lead pin about 1 mm distance from package lead.

Electrical Characteristics

Values are at T_A = 25°C unless otherwise noted.

Symbol	Parameter	Conditions		Min.	Typ.	Max.	Units
V_{REF}	Reference Voltage (Zener + Base Emitter Voltage)	$V_{OUT} = V_{REF}$, Fig. 4, V_{CC} = 17.3 V, Accuracy = ±2%, I_Z = 25 µA	R3 = 49.9 kΩ , I_{REF} = 1 µA, R4 = 23.2 kΩ , I_{CC} = 200 µA	7.115	7.260	7.405	V
TCV_{REF}	Temperature Coefficient(2)	$V_{OUT} = V_{REF}$, Fig. 4, Accuracy = ±2%, T_A = 0 to +100°C	R3 = 49.9 kΩ , I_{REF} = 1 µA, R4 = 9.53 kΩ , I_{CC} = 200 µA, I_Z = 60 µA, V_{CC} = 10 V		29		PPM/°C
		T_A = -40 to +125°C			57		
$\Delta V_{REF}/\Delta V_{OUT}$	Ratio of the Change in Reference Voltage to the Change in Cathode Voltage	Fig. 5, $V_{CC} = V_{OUT}$ + 20 V, I_Z = 25µA, $V_{OUT} = V_{REF}$ +75V, R5 = ∞ (3)	R3 = 100 kΩ , R2 = 53.6 kΩ , R1 = 0 | 499 kΩ , R4 = 23.2 kΩ , I_{CC} = 200 µA, I_{REF} = 150 µA		0.024	0.200	mV/V
I_Z	Reference Input Current	I_{CC} = 1.0 mA, Fig. 5, V_{CC} = 17.3 V, R1 = 10.0 kΩ , R2 = ∞ , R3 = 100 kΩ , R4 = 499 kΩ , R5 = ∞ (4)			7.7	12.0	µA
$\Delta I_Z/\Delta T$	Deviation of Reference I_Z Over Temperature				5.45		µA/°C
$\Delta V_{REF}/\Delta I_{CC}$	Output Impedance	Fig. 4, $V_{OUT} = V_{REF}$, V_{CC} = 15.4 | 19.4 V, I_Z = 25 µA, f = 0 Hz, R5 = ∞ (5)	I_{CC} = 160 | 240 µA, R3 = 49.9 kΩ , R4 = 23.2 kΩ		154	300	Ω
e_n	Output Noise Voltage(6)	$V_{OUT} = V_{REF}$, Fig. 6, I_{CC} = 1.0 mA, V_{CC} = 17.3 V, V_{REF}= 7.35 V, I_Z=25 µA, R3 = 15.00 kΩ , R4 = 28.7 kΩ , f = 400 Hz to 100 KHz	C_N = n/a, C_L = n/a		141.0		µVrms
			C_N = 0.1 µF, C_L = n/a		8.1		
			C_N = n/a, C_L = 0.1 µF		57		
			C_N = 0.1 µF, C_L = 0.1 µF		8.0		
GBW (3db)	Gain Bandwidth Product	I_{CC} = 1.0 mA, V_{CC} = 27 V_{DC}, V_{IN} = 2 Vp-p, I_B1 = 5 µA, I_Z = 25 µA, C_G,C_L = ∞ , C_N = 0.1 µF, R1 = 23.2 kΩ , R2 = 39.2 kΩ , R3 = 15 kΩ , R4 = 28.7 kΩ , R5 = 22 kΩ , V_{OUT} = 12 V, I_{REF} = 200 µA, Gain = -1, Fig. 7			4.47		MHz
SR	Slew Rate	I_{CC} = 1.0 mA, V_{CC} = 27 V_{DC}, V_{IN} = 2 Vp-p, I_B1 = 5 µA, I_Z = 25 µA, C_G,C_L = ∞ , C_N = 0.1 µF, R1 = 23.2 kΩ , R2 = 39.2 kΩ , R3 = 15 kΩ , R4 = 28.7 kΩ , R5 = 22 kΩ , V_{OUT} = 12 V, I_{REF} = 200 µA, Gain = -1, Fig. 7			18.8		V/µs

Notes:

2. The deviation parameters $V_{REF(dev)}$ and $I_{REF(dev)}$ are defined as the differences between the maximum and minimum values obtained over the rated temperature range. The average full-range temperature coefficient of the reference input voltage, TCV_{REF}, is defined as:

$$TCV_{REF}\left(\frac{ppm}{°C}\right) = \frac{\left(\frac{V_{REF(dev)}}{V_{REF}\ (T_A=25°C)}\right) * 10^6}{\Delta T}$$

(T_A): Ambient Temperature

V_{REF}(dev): V_{REF} deviation over full temperature range

where ΔT is the rated operating free-air temperature range of the device.
TCV_{REF} can be positive or negative, depending on whether minimum V_{REF} or maximum V_{REF}, respectively, occurs at the lower temperature.

3. $$\frac{\Delta V_{REF}}{\Delta V_{OUT}} = ABS\left|\frac{V_{REF}1 - V_{REF}2}{V_{OUT}1 - V_{OUT}2}\right|$$

4. $$I_Z = \frac{V_{REF} - V_{OUT}}{R1}$$

5. $$Z_{OUT} = \frac{V_{REF}2 - V_{REF}1}{I_{CC}2 - I_{CC}1}$$

6. For testing: a) hfe typ ~200; b) all resistors are metal film; c) all capacitors are plastic film.

Test Circuit

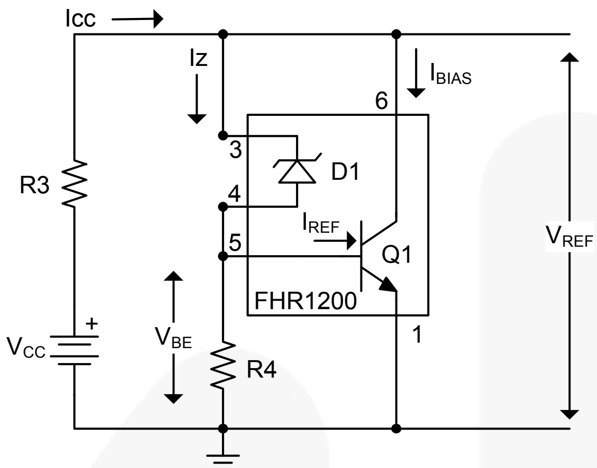

Figure 4. Test Configured: $V_{REF} = V_{OUT}$

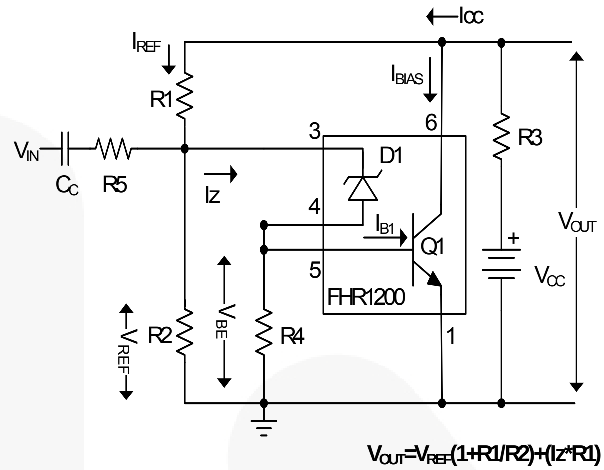

Figure 5. Test Configured: $V_{REF} < V_{OUT}$

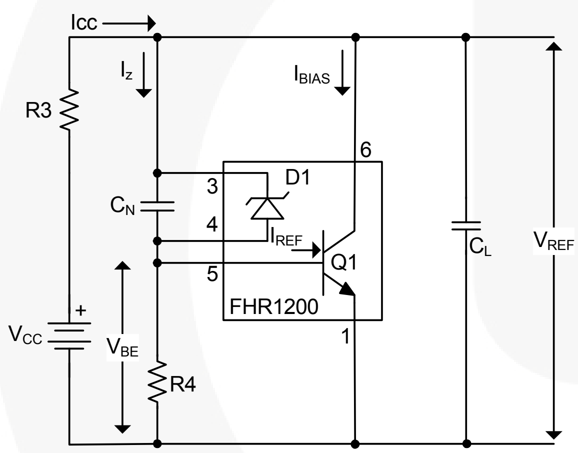

Figure 6. Test Configured: $V_{REF} = V_{OUT}$ with capacitance

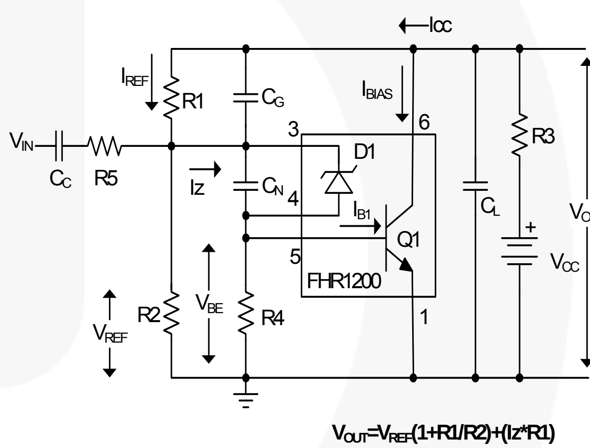

Figure 7. Test Configured: $V_{REF} < V_{OUT}$ with capacitance

Typical Characteristics: V_{REF}

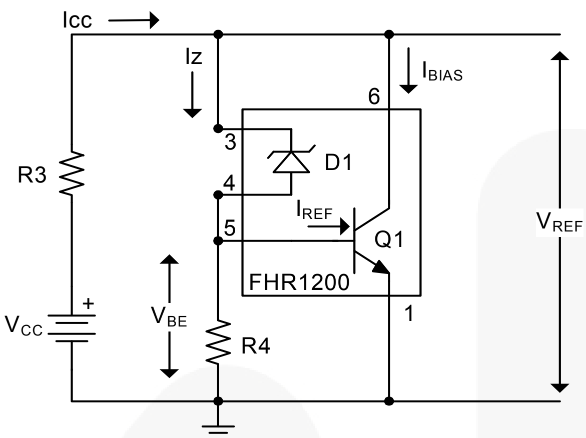

Figure 8. Test Diagram: $V_{REF} = V_{OUT}$ (Fixed Value of R4)

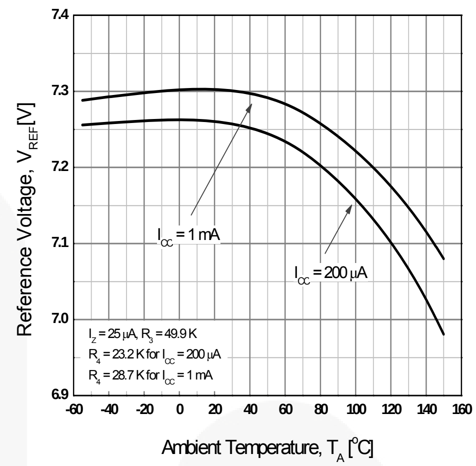

Figure 9. Reference Voltage vs. Ambient Temperature (Fixed Value R4, I_Z ~ 25 µA at 25°C)

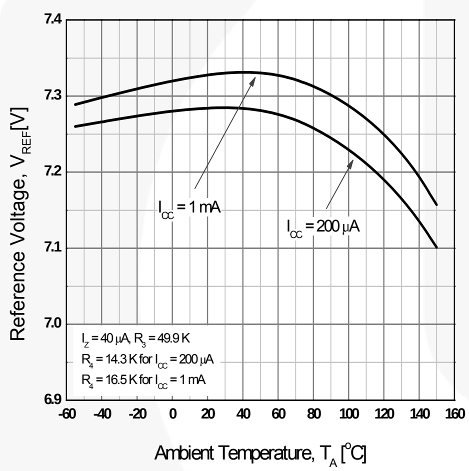

Figure 10. Reference Voltage vs. Ambient Temperature (Fixed Value R4, I_Z ~ 40 µA at 25°C)

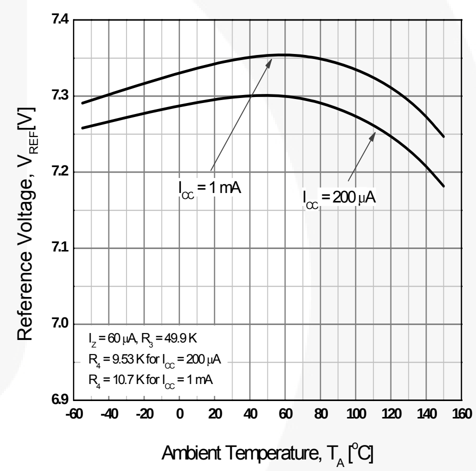

Figure 11. Reference Voltage vs. Ambient Temperature (Fixed Value R4, I_Z ~ 60 µA at 25°C)

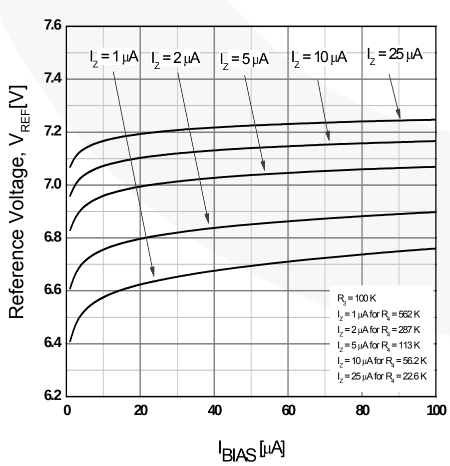

Figure 12. Minimum Cathode Current for Regulation

Typical Characteristics (Continued)

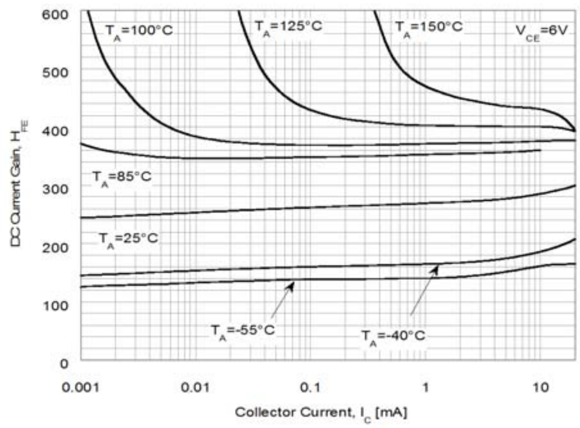

Figure 13. DC Current Gain vs. Collector Current

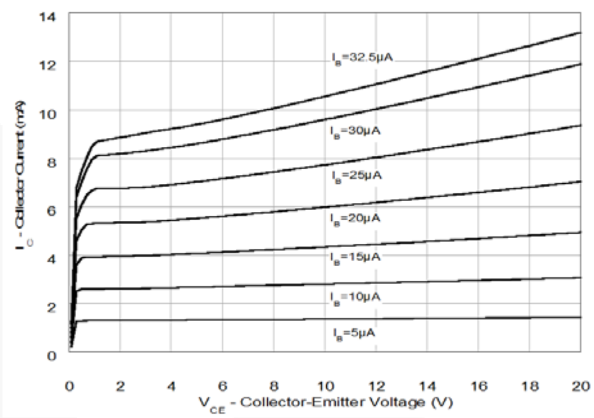

Figure 14. Common Emitter Output Characteristics

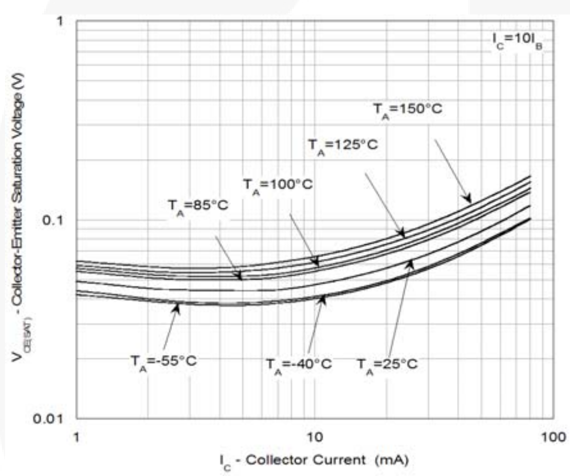

Figure 15. Collection-Emitter Saturation Voltage vs. Collector Current

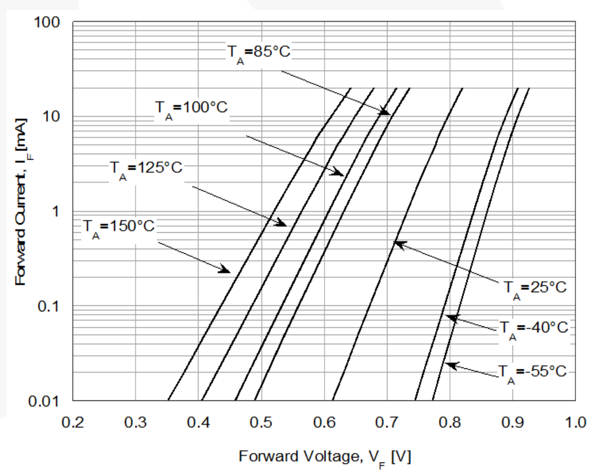

Figure 16. Typical Forward Voltage

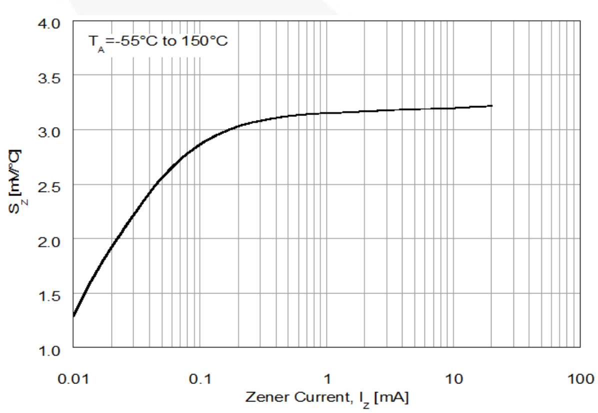

Figure 17. Typical Temperature Coefficient as Function of Working Current

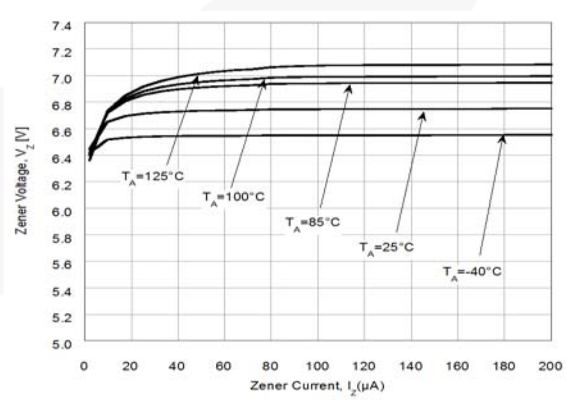

Figure 18. Zener Voltage vs. Applied Current

Typical Characteristics (Continued)

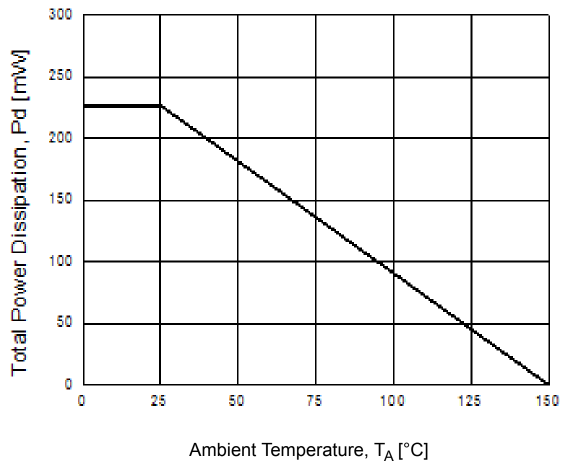

Figure 19. Power Derating

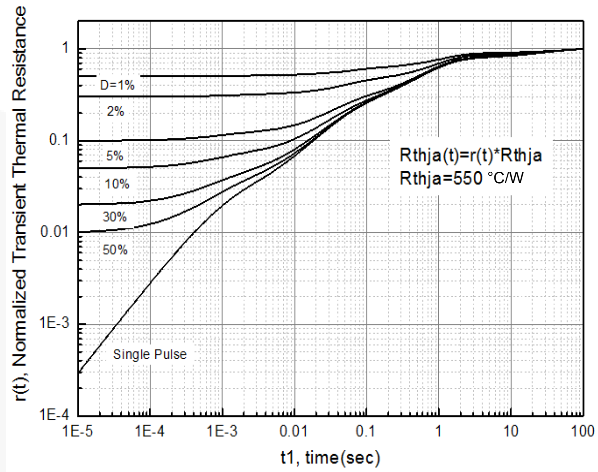

Figure 20. Transient Thermal Resistance

Typical Applications (Continued)

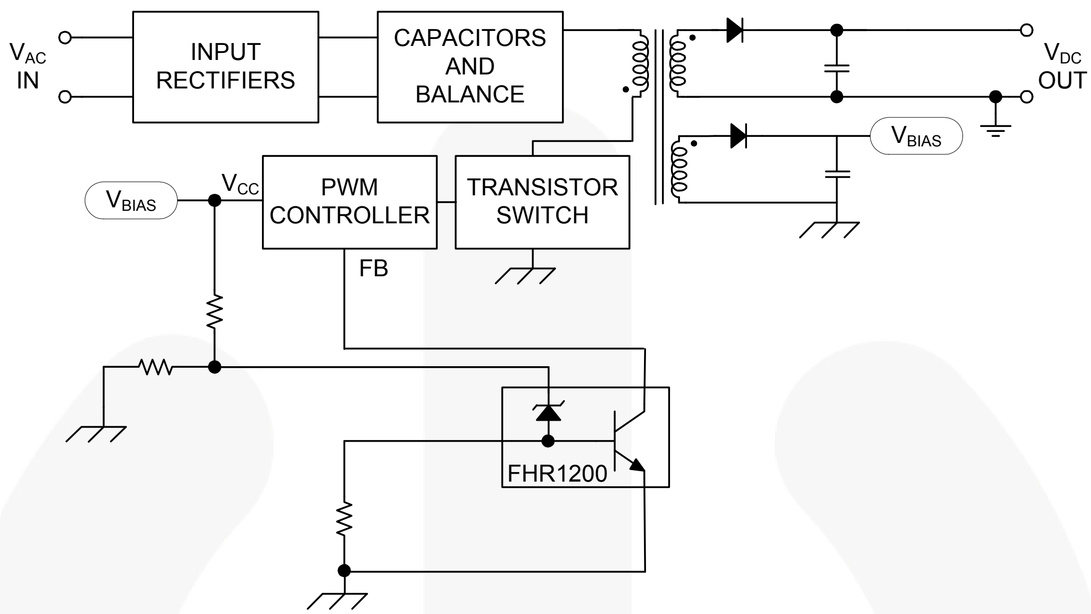

Figure 21. Flyback Power Supply Primary-Side Regulation

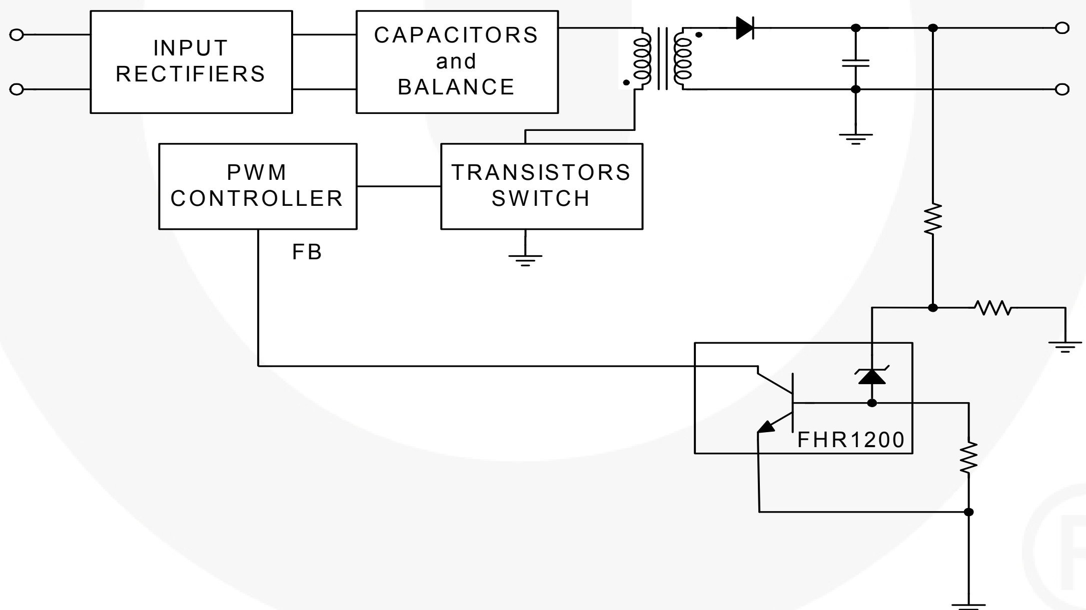

Figure 22. Flyback Power Supply Non-Isolated Secondary-Side Regulation

Physical Dimensions

SC70-6 (SOT363)

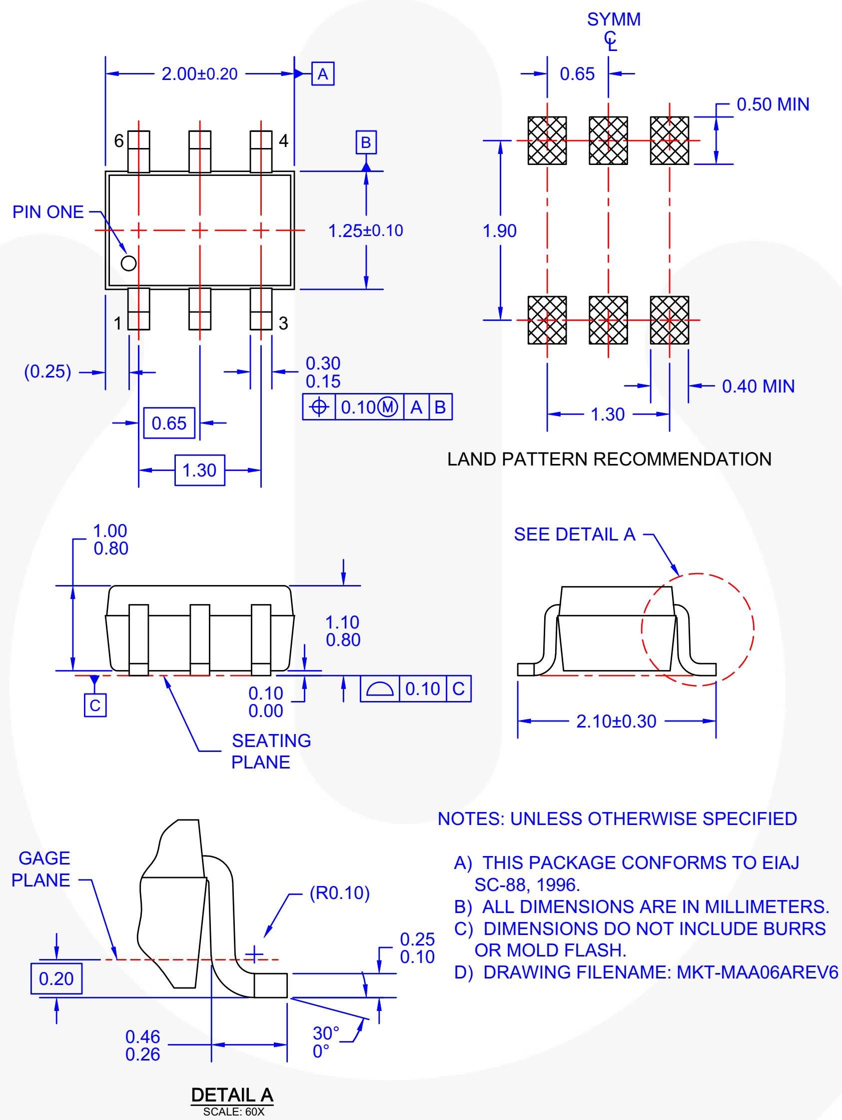

Figure 23. 6-Lead, SC-70, EIAJ SC-88, 1.25 MM WIDE

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