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February 2014



# 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
  - o Smart Meter
  - o 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 applications where low operating power, wide temperature, and wide voltage range is important. The regulator also features better stability and faster response than many existing regulators.

Unlike the LM431 type of part, the FHR1200 can directly drive a power supply controller thus saving parts count and circuit complexity in many applications. This also makes the FHR1200 ideal for non-isolated secondary side, primary side, and floating regulation. Non-isolated secondary side regulation saves the cost of OPTOs and simplifies the power supply design.

The FHR1200 is very flexible and can be used in many diverse applications. For example: V<sub>CC</sub> regulators to >100 volts, small additional auxiliary power supplies, programmable precision zener diodes (both high and low power), plus numerous analog circuits.

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

### **Typical Application**

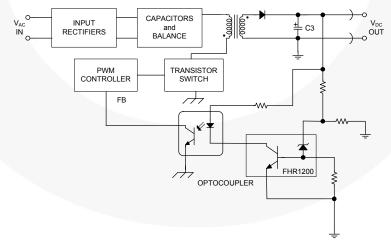


Figure 1. Flyback Power Supply Secondary-Side Regulation

### **Ordering Information**

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

1

### **Block Diagram**

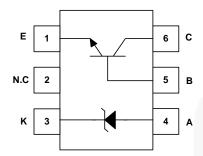


Figure 2. Internal Connection

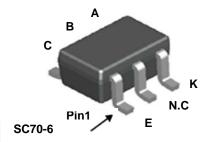


Figure 3. Device Package

### **Pin Definitions**

Pin #	Pin Name	Description
1	Е	Ground Connection
2	N.C	No Connection
3	K	Reference Voltage
4	Α	Ref Bias Pin: Tie R4 to ground to bias; Tie cap to ground for lower noise
5	В	Reference Bias Pin
6	С	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 <sub>OUT</sub>	Regulator Output		100	V
I <sub>BIAS</sub>	Cathode Current		50	mA
$P_{D}$	Power Dissipation	T <sub>A</sub> = 25°C	227	mW
T <sub>J,</sub> T <sub>STG</sub>	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
$\Psi_{JB}$	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.  $\Psi_{JB}$  test method: T-36 gauge thermocouple is soldered directly to the collector lead pin about 1 mm distance from package lead.

### **Electrical Characteristics**

Values are at T<sub>A</sub> = 25°C unless otherwise noted.

Symbol	Parameter	Cond	ditions	Min.	Тур.	Max.	Units
V <sub>REF</sub>	Reference Voltage (Zener + Base Emitter Voltage)	$V_{OUT} = V_{REF}$ , Fig. 4, $V_{CC} = 17.3 \text{ V}$ , $Accuracy = \pm 2\%$ , $I_Z = 25 \mu\text{A}$	R3 = 49.9 kΩ , $I_{REF}$ = 1 μA, R4 = 23.2 kΩ , $I_{CC}$ = 200 μA	7.115	7.260	7.405	٧
TCV <sub>REF</sub>	Temperature Coefficient <sup>(2)</sup>	$V_{OUT} = V_{REF}$ , $T_A = 0$ to +100°C Accuracy = $T_A = -40$ to +125°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 57		- PPM/°C
ΔV <sub>REF</sub> / ΔV <sub>OUT</sub>	Ratio of the Change in Reference Voltage to the Change in Cathode Voltage	Fig. 5, $V_{CC} = V_{OUT} + 20 \text{ V}$ , $I_Z = 25\mu\text{A}$ , $V_{OUT} = V_{REF} + 75\text{V}$ , $R5 = (3)$	$\begin{array}{l} \text{R3} = 100 \; \text{k}\Omega \; , \; \text{R2} = 53.6 \; \text{k}\Omega \; , \\ \text{R1} = 0 \;   \; 499 \; \text{k}\Omega \; , \\ \text{R4} = 23.2 \; \text{k}\Omega \; , \\ \text{I}_{\text{CC}} = 200 \; \text{\mu}\text{A} , \; \text{I}_{\text{REF}} = 150 \; \text{\mu}\text{A} \end{array}$		0.024	0.200	mV/V
I <sub>Z</sub>	Reference Input Current	$I_{CC}$ = 1.0 mA, Fig. 5, $V_{CC}$ = 1			7.7	12.0	μΑ
ΔΙ <sub>Ζ</sub> /ΔΤ	Deviation of Reference I <sub>Z</sub> Over Temperature	R1 = 10.0 k $\Omega$ , R2 = $^{\circ}$ , R3 = 100 k $\Omega$ , R4 = 499 k $\Omega$ , R5 = $^{(4)}$			5.45		μΑ/°C
ΔV <sub>REF</sub> / ΔI <sub>CC</sub>	Output Impedance	Fig. 4, $V_{OUT} = V_{REF}$ , $V_{CC} = 15.4 \mid 19.4 \text{ V}$ , $I_Z = 25 \mu\text{A}$ , $f = 0 \text{Hz}$ , $R5 = ^{(5)}$	$I_{CC}$ = 160   240 μA, R3 = 49.9 kΩ , R4 = 23.2 kΩ		154	300	Ω
		V <sub>OUT</sub> = V <sub>REF</sub> , Fig. 6,	$C_N = n/a, C_L = n/a$		141.0		μVrms
A	Output Noise Voltage <sup>(6)</sup>	$\begin{split} &I_{CC} = 1.0 \text{ mA, V}_{CC} = 17.3 \text{ V,} \\ &V_{REF} = 7.35 \text{ V, I}_Z = 25 \mu\text{A,} \\ &R3 = 15.00 \text{ k}\Omega \text{ ,} \\ &R4 = 28.7 \text{ k}\Omega \text{ ,} \\ &f = 400 \text{ Hz to } 100 \text{ KHz} \end{split}$	$C_N = 0.1  \mu F,  C_L = n/a$	1	8.1		
e <sub>n</sub>			$C_N = n/a, C_L = 0.1 \mu\text{F}$		57		
			$C_N = 0.1 \mu F, C_L = 0.1 \mu F$		8.0		
GBW (3db)	Gain Bandwidth Product	$\begin{split} &I_{CC} = 1.0 \text{ mA, } V_{CC} = 27 \text{ V}_{DC}, \text{ V}_{IN} = 2 \text{ Vp-p,} \\ &I_{B}1 = 5  \mu\text{A, } I_{Z} = 25  \mu\text{A, } C_{G}C_{L} =  , C_{N} = 0.1  \mu\text{F,} \\ &R1 = 23.2  k\Omega \text{ , } R2 = 39.2  k\Omega \text{ , } R3 = 15  k\Omega \text{ , } R4 = 28.7  k\Omega \text{ ,} \\ &R5 = 22  k\Omega \text{ , } V_{OUT} = 12 \text{ V, } I_{REF} = 200  \mu\text{A, } Gain = -1, \text{ Fig. 7} \end{split}$			4.47		MHz
SR	Slew Rate	$\begin{split} &I_{CC} = 1.0 \text{ mA},  V_{CC} = 27  V_{DC},  V_{IN} = 2  V_{P-P}, \\ &I_{B}1 = 5  \mu\text{A},  I_{Z} = 25  \mu\text{A},  C_{G}C_{L} =  ,  C_{N} = 0.1  \mu\text{F}, \\ &R1 = 23.2  k\Omega  ,  R2 = 39.2  k\Omega  ,  R3 = 15  k\Omega  ,  R4 = 28.7  k\Omega  , \\ &R5 = 22  k\Omega  ,  V_{OUT} = 12  V,  I_{REF} = 200  \mu\text{A},  Gain = -1,  Fig.  7 \end{split}$			18.8		V/µs

### Notes:

2. The deviation parameters V<sub>REF(dev)</sub> and I<sub>REF(dev)</sub> 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<sub>REF</sub>, is defined as:

$$TCV_{REF}|(\frac{ppm}{^{\circ}C}) = \frac{\left(\frac{V_{REF}(dev)}{V_{REF}(T_A=25^{\circ}C)}\right) * 10^6}{^{\wedge}T} \qquad (T_A): Ambient Temperature} V_{REF}(dev): V_{REF} deviation over full temperature range}$$

where  $\Delta T$  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.

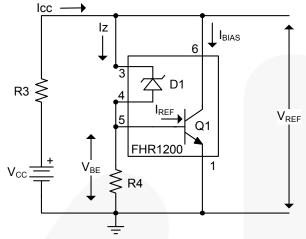
3. 
$$\frac{\Delta V_{REF}}{\Delta V_{OUT}} = ABS \left| \frac{V_{REF}1 - V_{REF}2}{V_{OUT}1 - V_{OUT}2} \right|$$

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 typical ~200; b) all resistors are metal film; c) all capacitors are plastic film.

### **Test Circuit**



V<sub>N</sub> C<sub>C</sub> R5 | Z | A | D1 | R3 | V<sub>OJT</sub> | V<sub>C</sub> | R4 | 1 | V<sub>C</sub> |

 $\leftarrow$ l $\infty$ 

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

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

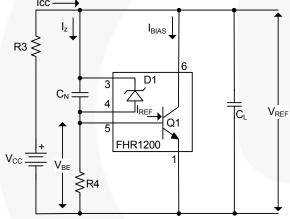


Figure 6. Test Configured:  $V_{REF} = V_{OUT}$  with Capacitance

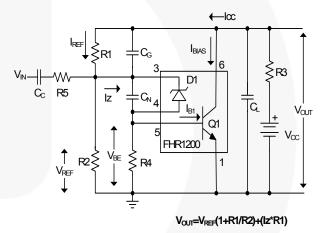


Figure 7. Test Configured:  $V_{REF} < V_{OUT}$  with Capacitance

### Typical Characteristics: V<sub>REF</sub>

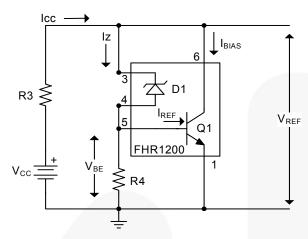


Figure 8. Test Diagram: V<sub>REF</sub> = V<sub>OUT</sub> (Fixed Value of R4)

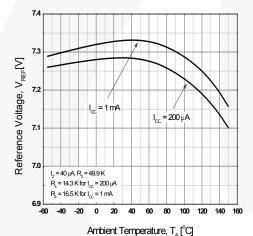


Figure 10. Reference Voltage vs. Ambient Temperature (Fixed Value R4,  $I_Z \sim 40 \,\mu\text{A}$  at 25°C)

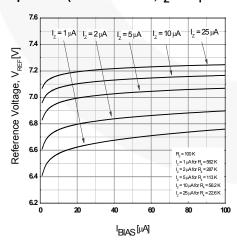


Figure 12. Minimum Cathode Current for Regulation

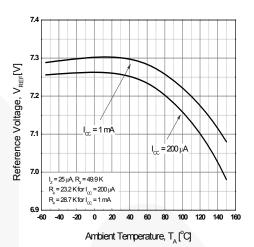


Figure 9. Reference Voltage vs. Ambient Temperature (Fixed Value R4, I<sub>Z</sub> ~ 25  $\mu$ A at 25°C)

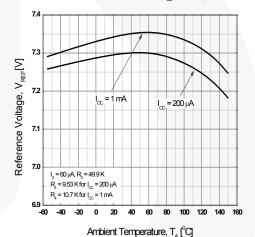
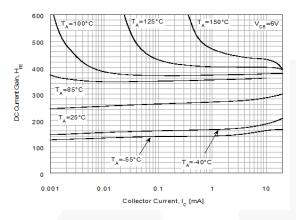


Figure 11. Reference Voltage vs. Ambient Temperature (Fixed Value R4,  $I_Z \sim 60~\mu A$  at 25°C)

### **Typical Characteristics** (Continued)



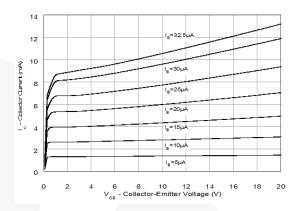
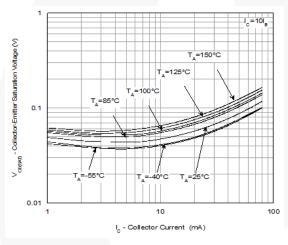


Figure 13. DC Current Gain vs. Collector Current

Figure 14. Common Emitter Output Characteristics



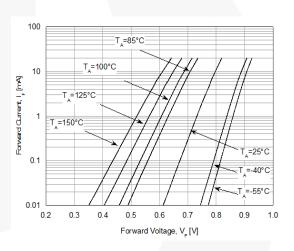
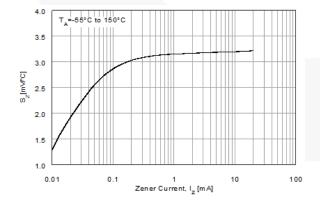


Figure 15. Collection-Emitter Saturation Voltage vs.
Collector Current

Figure 16. Typical Forward Voltage



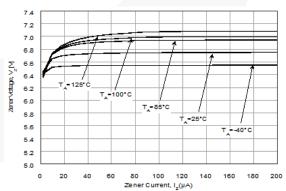


Figure 17. Typical Temperature Coefficient as Function of Working Current

Figure 18. Zener Voltage vs. Applied Current

### **Typical Characteristics** (Continued)

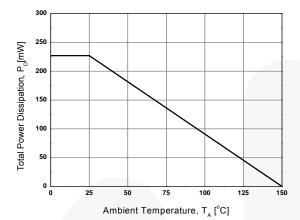


Figure 19. Power Derating

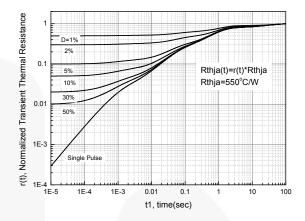


Figure 20. Transient Thermal Resistance

### Typical Applications (Continued)

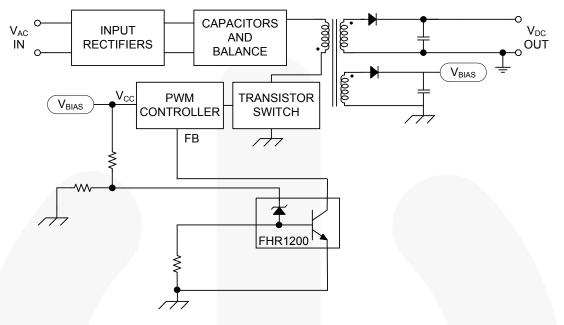


Figure 21. Flyback Power Supply Primary-Side Regulation

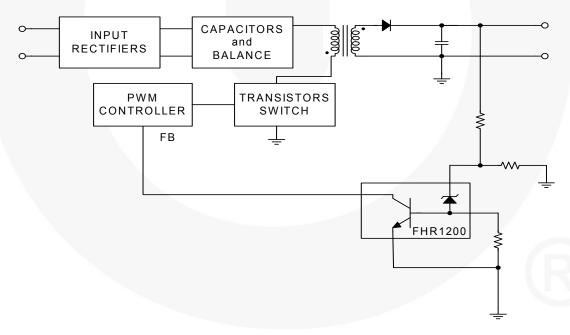


Figure 22. Flyback Power Supply Non-Isolated Secondary-Side Regulation

### **Physical Dimensions**

# SC70-6 (SOT363)

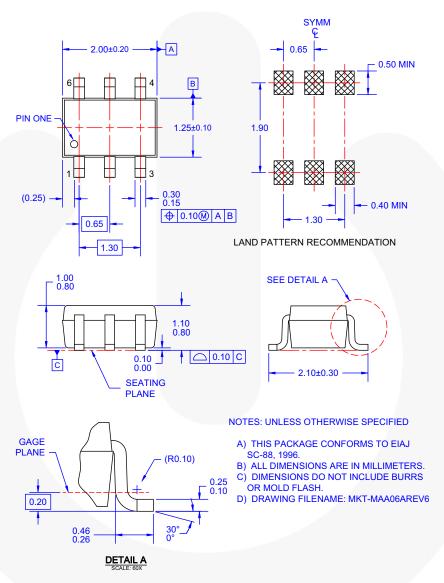


Figure 23. 6-Lead, SC-70, EIAJ SC-88, 1.25 MM WIDE

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Definition of Terms					
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Мы молодая и активно развивающаяся компания в области поставок электронных компонентов. Мы поставляем электронные компоненты отечественного и импортного производства напрямую от производителей и с крупнейших складов мира.

Благодаря сотрудничеству с мировыми поставщиками мы осуществляем комплексные и плановые поставки широчайшего спектра электронных компонентов.

Собственная эффективная логистика и склад в обеспечивает надежную поставку продукции в точно указанные сроки по всей России.

Мы осуществляем техническую поддержку нашим клиентам и предпродажную проверку качества продукции. На все поставляемые продукты мы предоставляем гарантию .

Осуществляем поставки продукции под контролем ВП МО РФ на предприятия военно-промышленного комплекса России, а также работаем в рамках 275 ФЗ с открытием отдельных счетов в уполномоченном банке. Система менеджмента качества компании соответствует требованиям ГОСТ ISO 9001.

Минимальные сроки поставки, гибкие цены, неограниченный ассортимент и индивидуальный подход к клиентам являются основой для выстраивания долгосрочного и эффективного сотрудничества с предприятиями радиоэлектронной промышленности, предприятиями ВПК и научноисследовательскими институтами России.

С нами вы становитесь еще успешнее!

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