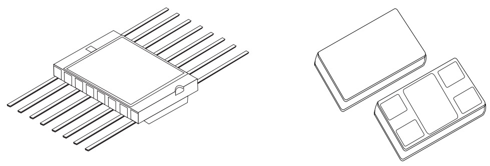
RHFL4913 ADJUSTABLE

Rad-Hard Adjustable positive voltage regulator

Features

- 3 Ampere low dropout voltage
- Embedded overtemperature, overcurrent protections
- Adjustable overcurrent limitation
- Output overload monitoring/signalling
- Adjustable output voltage
- Inhibit (ON/OFF) TTL Compatible Control
- Programmable output short circuit current
- Remote sensing operation
- RADHARD: Guaranteed up to 300krad in MIL 1019.6 High Dose Rate and 0.01Rad/sec ELDRS Conditions
- Heavy IONS SEL, SEU Immune. Sustains $2x10^{14}$ proton/cm^2, And $2x10^{14}$ neutron/cm^2



FLAT-16

SMD5C:
5 connections SMD

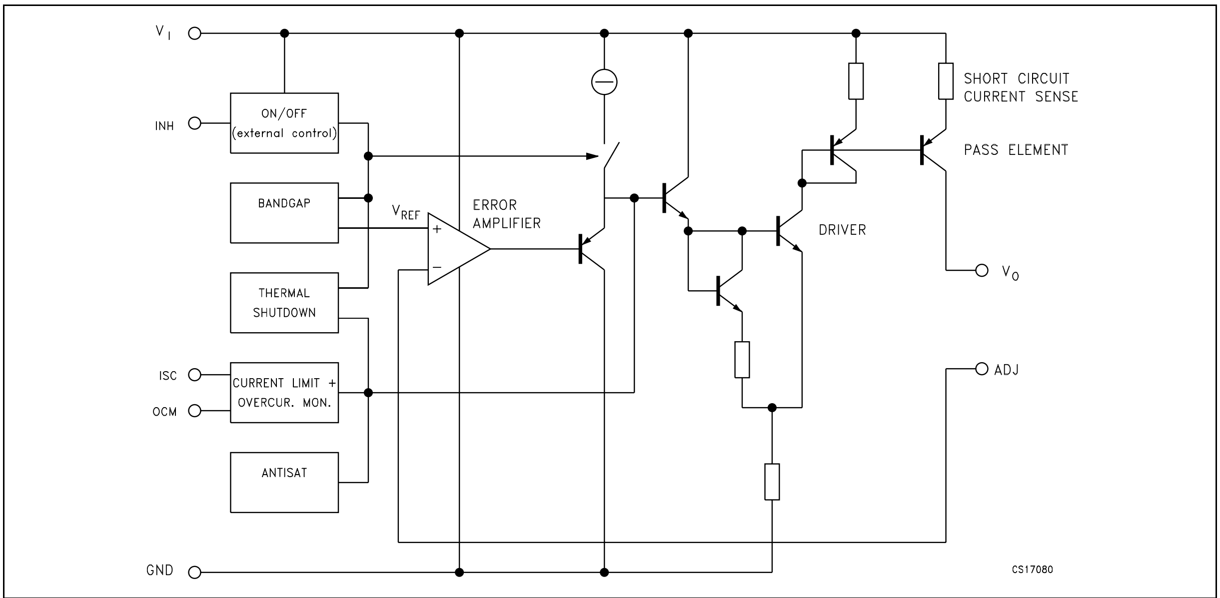
Description

The RHFL4913 ADJUSTABLE is a high performance Adjustable Positive Voltage Regulator providing exceptional radiation performances, tested in accordance with Mil Std 1019.6 ELDRS conditions.

Available in Flat-16 and new SMD5C hermetic ceramic packages and as QmlV-Die, it is specifically intended for Space and harsh radiation environments. Input supply range is up to 12 volts.

The RHFL4913 ADJUSTABLE is Qml-V Qualified, DSCC Smd is 5962F02524.

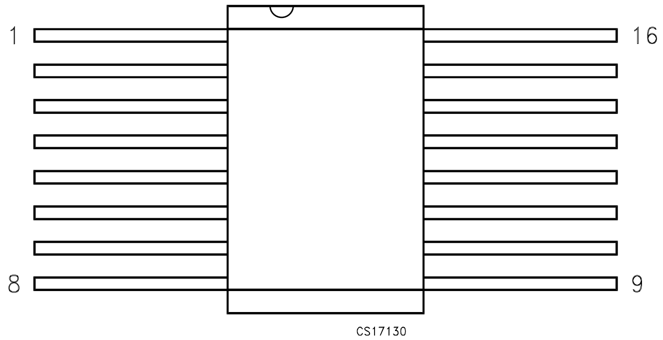
Block diagram



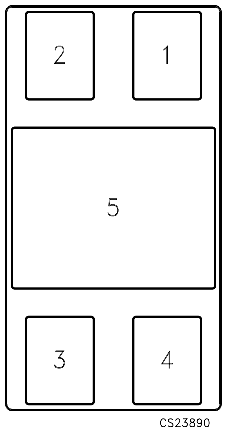
Contents

1 Pin configuration

Figure 1. Pin configuration (Top view for FLAT-16, Bottom view for SMD5C)



FLAT-16



SMD5C

Table 1. Pin description

Pin name	FLAT-16	SMD5C
V_O	1, 2, 6, 7	1
V_I	3, 4, 5	2
GND	13	5
I_{SC}	8	
OCM	10	
INHIBIT	14	4
ADJ	15	3
NC	9, 11, 12, 16	

2 Maximum ratings

Table 2. Recommended maximum operating ratings (Note)

Symbol	Parameter	Value	Unit
V_I	DC Input Voltage, V_I - V_{GROUND}	12	V
V_O	DC Output Voltage Range	1.23 to 9	V
I_O	Output Current, RHFL4913KPA	2	A
I_O	Output Current, RHFL4913SCA	3	
P_D	T_C = 25°C Power Dissipation	15	W
T_{stg}	Storage Temperature Range	-65 to +150	°C
T_{op}	Operating Junction Temperature Range	-55 to +150	°C
ESD	Electrostatic Discharge Capability	Class 3	

Note: Exceeding maximum ratings may damage the device.

Table 3. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal Resistance Junction-Case, 16pin Flat and SMD5C	8.3	°C/W
T_{SOLD}	Maximum soldering Temperature, 10sec.	300	°C

3 Electrical characteristics

Table 4. Electrical characteristics
(T_J = 25°C, $V_I = V_O$+2.5V, $C_I = C_O$ = 1µF, unless otherwise specified)

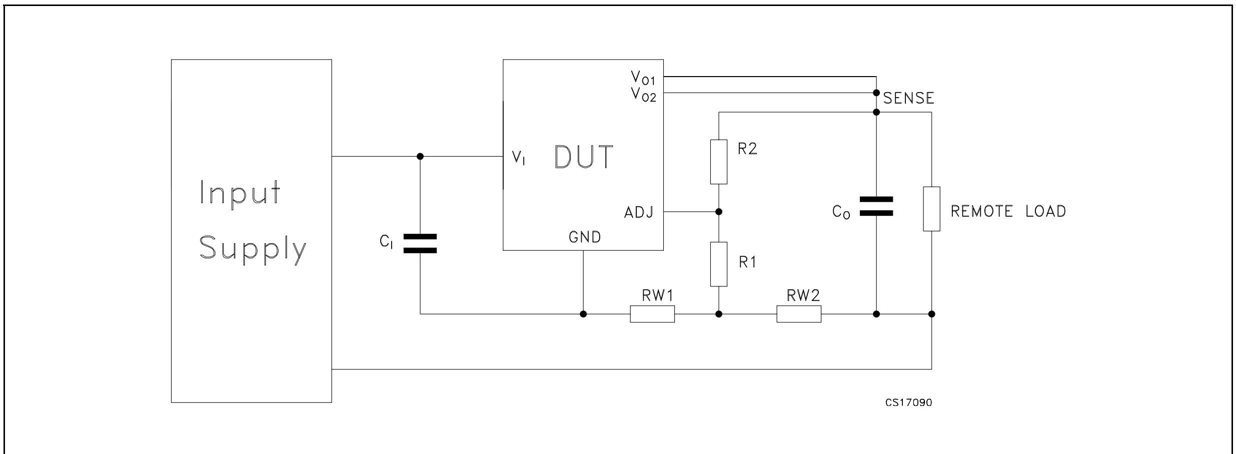
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_I	Operating input voltage	I_O = 1A, T_J= -55 to 125°C	3		12	V
V_O	Operating output voltage	I_O = 1A and or 2, V_O = 1.23 V	1.19		1.27	V
		I_O = 1A and or 2, V_O = 9 V	8.7		9.3	V
I_{SHORT}	Output current limit (1)	Adjustable by mask/external resistor	1	4.5		A
$\Delta V_O/\Delta V_I$	Line regulation	$V_I = V_O$+2.5V to 12 V, I_O = 5mA, T_J=+25°C			0.35	%
		$V_I = V_O$+2.5V to 12 V, I_O = 5mA, T_J=-55°C			0.4	
		$V_I = V_O$+2.5V to 12 V, I_O = 5mA, T_J=+125°C			0.4	
$\Delta V_O/\Delta V_O$	Load regulation	$V_I = V_O$+2.5V, I_O = 5 to 400 mA, T_J=+25°C			0.3	%
		$V_I = V_O$+2.5V, I_O = 5 to 400 mA, T_J=-55°C			0.5	
		$V_I = V_O$+2.5V, I_O = 5 to 400 mA, T_J=+125°C			0.5	
		$V_I = V_O$+2.5V, I_O = 5mA to 1A, T_J=+25°C			0.5	
		$V_I = V_O$+2.5V, I_O = 5mA to 1A, T_J=-55°C			0.6	
		$V_I = V_O$+2.5V, I_O = 5mA to 1A, T_J=+125°C			0.6	
Z_{OUT}	Output impedance	I_O = 100 mA DC and 20 mA rms		100		mΩ
I_q	Quiescent current	$V_I = V_O$+2.5V, I_O = 5mA, On Mode (+25°C)			6	mA
		$V_I = V_O$+2.5V, I_O = 30mA, On Mode (+25°C)			8	
		$V_I = V_O$+2.5V, I_O = 300mA, On Mode (+25°C)			25	
		$V_I = V_O$+2.5V, I_O = 1A, On Mode (+25°C)			60	
		$V_I = V_O$+2V, V_{INH} = 2.4VOff Mode			1	
I_q	Quiescent current ON MODE	$V_I = V_O$+2.5V, I_O = 30mA, (-55°C)			14	mA
		$V_I = V_O$+2.5V, I_O = 300mA, (-55°C)			40	
		$V_I = V_O$+2.5V, I_O = 1A, (-55°C)			100	
		$V_I = V_O$+2.5V, I_O = 30mA, (+125°C)			8	
		$V_I = V_O$+2.5V, I_O = 300mA, (+125°C)			20	
		$V_I = V_O$+2.5V, I_O = 1A, (+125°C)			40	

Table 4. Electrical characteristics
(T_J = 25°C, V_I = V_O+2.5V, C_I = C_O = 1µF, unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
V_d	Dropout voltage	I_O = 400mA, V_O = 2.5 to 9 V, (+25°C)		350	450	mV
		I_O = 400mA, V_O = 2.5 to 9 V, (-55°C)		300	400	
		I_O = 400mA, V_O = 2.5 to 9 V, (+125°C)		450	550	
		I_O = 1A, V_O = 2.5 to 9 V, (+25°C)			650	
		I_O = 1A, V_O = 2.5 to 9 V, (-55°C)			550	
		I_O = 1A, V_O = 2.5 to 9 V, (+125°C)			800	
		I_O = 2A, V_O = 2.5 to 9 V, (+25°C)		900		
		I_O = 2A, V_O = 2.5 to 9 V, (+125°C)		950		
$V_{INH(ON)}$	Inhibit voltage	I_O = 5mA, T_J=-55 to +125°C			0.8	V
$V_{INH(OFF)}$	Inhibit voltage	I_O = 5mA, T_J=-55 to +125°C	2.4			
SVR	Supply voltage rejection (1)	V_I = V_O+2.5V ±0.5V, V_O = 3V I_O = 5mA; f = 120Hz	60	70		dB
		f = 33KHz	30	40		
I_{SH}	Shutdown input current	V_{INH} = 5 V		15		µA
V_{OCM}	OCM Pin Voltage	Sinked I_{OCM} = 24 mA active low		0.38		V
t_{PLH}	Inhibit propagation delay (1)	V_I = V_O+2.5V, V_{INH} = 2.4 V, I_O = 400 mA V_O = 3V	ON-OFF		20	µS
t_{PHL}			OFF-ON		100	µS
eN	Output noise voltage (1)	B= 10Hz to 100KHz, I_O = 5mA to 2A		40		µVrms

1. These values are guaranteed by design. For each application it's strongly recommended to comply with the maximum current limit of the package used.

Figure 2. Application diagram for remote sensing operation



4 Device description

The RHFL4913 Adjustable contains a PNP type power element controlled by a signal resulting from amplified comparison between the internal temperature compensated Band-Gap and the fraction of the desired Output Voltage value obtained from an external resistor divider bridge. The device is protected by several functional blocks.

4.1 ADJ Pin

The Load output voltage feed-back comes from an external divider resistor bridge middle point connected to ADJ pin (allowing all possible output voltage settings as per User's desire) established between Load terminals.

4.2 INHIBIT ON-OFF Control

By setting INHIBIT pin TTL-High, the Device switches off the Output Current and Voltage. Device is ON when INHIBIT pin is set Low. Since INHIBIT pin is internally pulled down, it can be left floating in case Inhibit function is not utilized.

4.3 Overtemperature protection

A temperature detector internally monitors the power element junction temperature. The Device goes OFF when approx. 175°C are reached, returning to ON mode when back to approx. 40°C. Combined with other protection blocks, it protects the Device from destructive junction temperature excursions in all load conditions. It is worth noting that when internal temperature detector reaches 175°C, the active power element can be at 225°C: Extensive operation under these conditions far exceeds Maximum Operation Ratings and Device reliability cannot be granted.

4.4 Overcurrent protection

An internal non-fold back Short-Circuit limitation is set with I_{SHORT} > 3.8A (V_O is 0V). This value can be downward modified by an external resistor connected between I_{SC} and V_I pins, with a typical value range of 10kΩ to 200kΩ To keep excellent V_O regulation, it is necessary to set I_{SHORT} 1.6 times greater than the maximum desired application I_O. When I_O reaches I_{SHORT} – 300mA, the current limitor overrules Regulation and V_O starts to drop and OCM flag is risen. When no current limitation adjustment is required, I_{SC} pin must be left unbiased (as it is in 3pin packages).

4.5 OCM pin

Goes Low when current limit starts to be active, otherwise $V_{OCM} = V_I$. It is buffered and can sink 10mA. OCM pin is internally pulled-up by a 5 kΩ resistor.

4.6 Alternates to

RHFL4913 is recommended to replace all Industry Positive Regulators due to its exceptional Radiation performance. To replace 3-terminal Industry devices, use RHFL4913 Fixed Voltage versions.

5 Application information

Adjusting Output Voltage: R2 resistor must be connected between V_O and ADJ pins. R1 resistor must be connected between ADJ and Ground. Resistor values can be derived from the following formula:

$V_O = V_{ADJ}$ (R1+ R2) / R1

V_{ADJ} is 1.23V, controlled by the internal temperature compensated Band Gap block.

The minimum Output voltage is therefore 1.22V and minimum Input voltage is 3V.

The RHFL4913 Adjustable is functional as soon as V_I - V_O voltage difference is slightly above the power element saturation voltage. The Adjust pin to Ground resistor must not be bigger than 10kΩ to keep the output feed-back error below 0.2%. A minimum 0.5mA I_O must be set to ensure perfect “no-load” regulation. It is advisable to dissipate this current into the divider bridge resistor. All available V_I pins shall always be externally interconnected, same thing for all available V_O pins, otherwise Device stability and reliability cannot be granted. The INHIBIT function switches off the output current in an electronic way, that is very quickly. According to Lenz’s Law, external circuitry reacts with LdI/dt terms which can be of high amplitude in case somewhere an inductance exists. Large transient voltage would develop on both Device terminals. It is advisable to protect the Device with Schottky diodes preventing negative voltage excursions. In the worst case, a 14V Zener diode shall protect the Device Input. The Device has been designed for high stability and low drop out operation: Minimum 1µF input and output tantalum capacitors are therefore mandatory. Capacitor ESR range is from 0.5 Ω to over 20 Ω. Such range turns out to be useful when ESR increases at low temperature. When large transient currents are expected, larger value capacitors are necessary.

In case of high current operation with expected short-circuit events, caution must be considered relatively to capacitors. They must be connected as close as possible to device terminals. As some tantalum capacitors may permanently fail when submitted to high charge-up surge currents, it is recommended to decouple them with 470nF polyester capacitors.

Being RHFL4913 Adjust manufactured with very high speed bipolar technology (6GHz f_T transistors), the PCB layout must be performed with exceptional care, very low inductance, low mutually coupling lines, otherwise high frequency parasitic signals may be picked-up by the Device resulting into system self-oscillation. The benefit is an SVR performance extended to far higher frequencies.

5.1 Notes about 16pin hermetic package

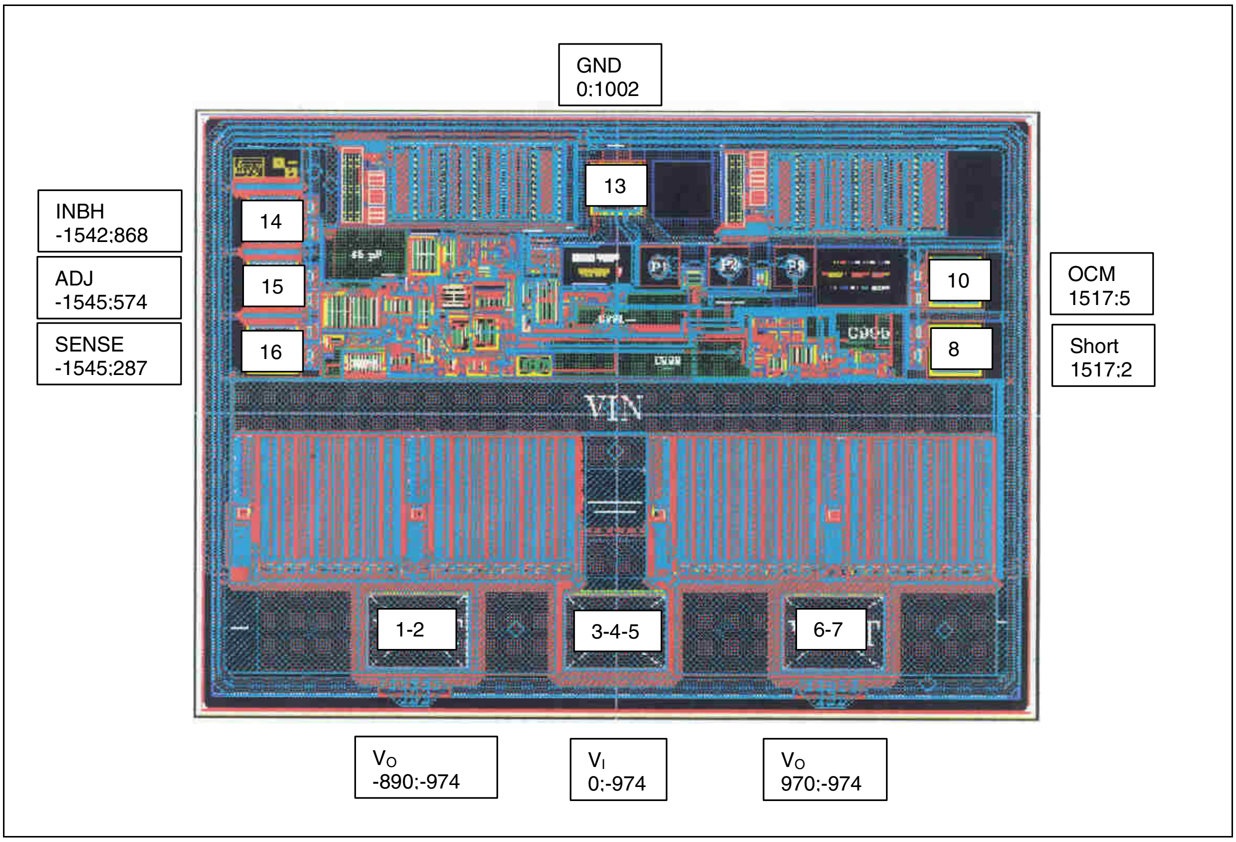
The bottom section of 16pin packages is metallized in order to allow User to directly solder the RHFL4913A on the equipment heat sink for enhanced heat removal.

5.2 Remote sensing operation

See *Figure 2.* A separate Kelvin Voltage sensing line provides ADJ pin with exact Load "high potential" information. But variable remote Load current consumption induces variable Iq current (Iq is roughly the I_O current divided by the h_{FE} of the internal PNP series power element) routed through parasitic series line resistor symbolized as RW2. To compensate this parasitic voltage, the Resistor RW1 introduced on purpose provides the necessary compensating voltage signal to ADJust pin.

6 DIE Information

Figure 3. Die map



Note: Pad numbers reflect terminal numbers when placed in case FLAT 16.

6.1 Die bonding pad locations and electrical functions.

Die physical dimensions.

Die size: 150mils x 110mils (3.81mm by 2.79mm)

Die thickness: 375µm ±25µm (14.8 mils ± 1 mil)

Pad size: V_{IN}, V_{OUT} pads: 450µm x 330µm (17.7mils by 13mils)

Control pads: 184µm x 184µm (7.25mils square)

Interface materials.

Top metallization: Al/Si/Cu, 1.05µm ± 0.15µm

Backside metallization: None

Glassivation.

Type: P. Vapox + Nitride

Thickness: 0.6µm ± 0.1µm + 0.6µm ± 0.08µm

Substrate: bare Silicon

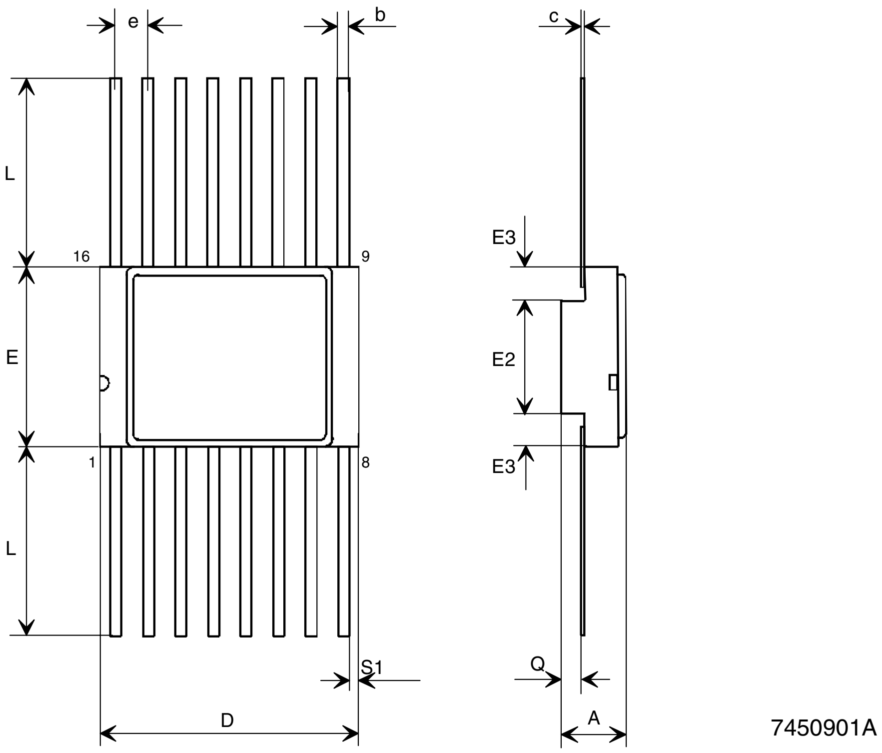
Assembly related information.

Substrate potential: Floating recommended to be tied to Ground

Special assembly instructions: "Sense" pad not used, not internally connected to any part of the IC. Can be connected to Ground when space anti-static electricity rules apply.

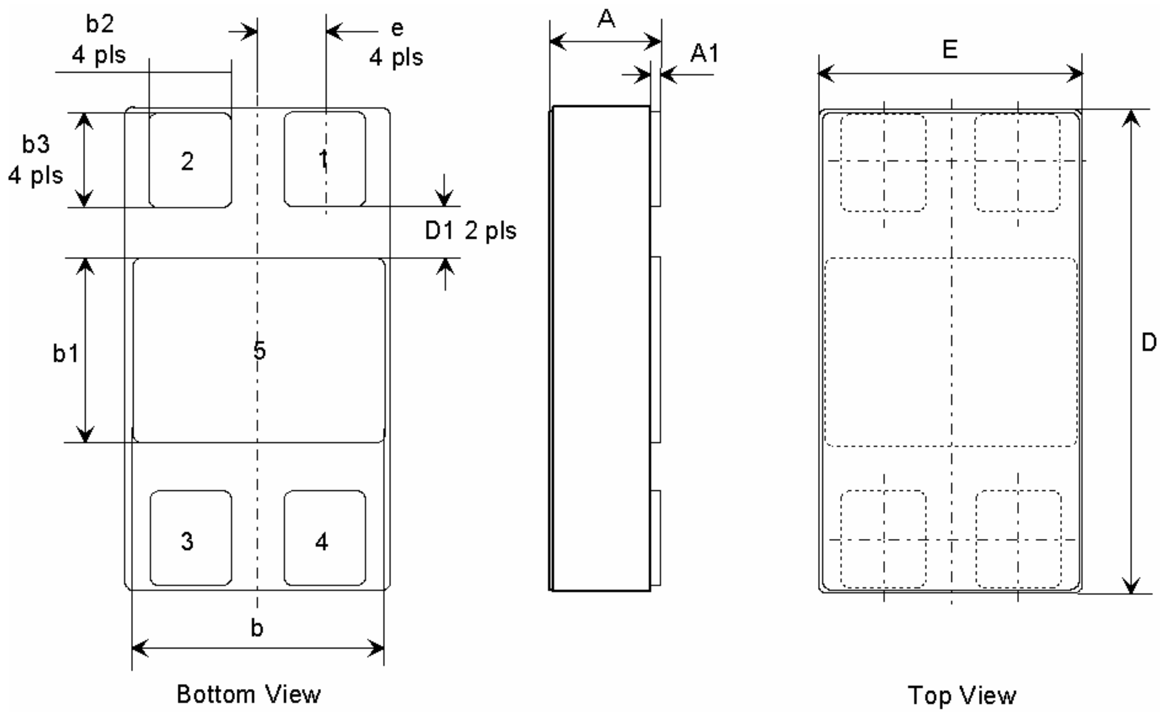
FLAT-16 (MIL-STD-1835) MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	2.16		2.72	0.085		0.107
b		0.43			0.017	
c		0.13			0.005	
D		9.91			0.390	
E		6.91			0.272	
E2		4.32			0.170	
E3	0.76			0.030		
e		1.27			0.050	
L		6.72			0.265	
Q	0.66		1.14	0.026		0.045
S1	0.13			0.005		



SMD5C MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	2.84	3.00	3.15	0.112	0.118	0.124
A1	0.25	0.38	0.51	0.010	0.015	0.020
b	7.13	7.26	7.39	0.281	0.286	0.291
b1	4.95	5.08	5.21	0.195	0.200	0.205
b2	2.28	2.41	2.54	0.090	0.095	0.100
b3	2.92	3.05	3.18	0.115	0.120	0.125
D	13.71	13.84	13.97	0.540	0.545	0.550
D1	0.76			0.030		
E	7.39	7.52	7.65	0.291	0.296	0.301
e		1.91			0.075	



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7 Packaging

RHFL4913 Adjustable is available in high thermal dissipation 16pin hermetic Flat package, which bottom flange is metallized to allow direct soldering to heat sink (efficient thermal conductivity). It is also available in SMD5C hermetic ceramic package.

8 Order code

Table 5. Order code

DIE	FLAT-16	SMD5C	Terminal finish	Out. volt.	Q.TY LEVEL
	RHFL4913KPA-01V	RHFL4913SCA-01V	GOLD	ADJ	QML-V
	RHFL4913KPA-02V		SOLDER	ADJ	QML-V
	RHFL4913KPA1	RHFL4913SCA1	GOLD	ADJ	EM1
	RHFL4913KPA2	RHFL4913SCA2	GOLD	ADJ	EM2=EM1+48hours B.I.
L4913ADIE2V				ADJ	QML-V die
L4913ADIES				ADJ	EM1 die

Table 6. Part number - SMD Equivalence

ST PART NUMBER	SMD PART NUMBER
RHFL4913KPA-01V	5962F0252401VXC
RHFL4913KPA-02V	5962F0252401VXA
L4913ADIE2V	5962F0252401V9A

Table 7. Environmental characteristics

Parameter	Conditions	Value	Unit
Output Voltage thermal drift	-55°C to +125°C	40	ppm/°C
Output Voltage radiation drift	From 0 kRad to 300k Rad at 0.55rad/sec	8	ppm/kRad
Output Voltage radiation drift	From 0 kRad to 300 kRad, MIL1019.5	6	ppm/kRad

9 Revision history

Table 8. Revision history

Date	Revision	Changes
29-Oct-2004	3	New Order Codes added - Tables 4 and 5.
27-May-2005	4	The Features, Tables 4, 5 and the Figure 1 has been updated. Add the Mechanical Data SOC-16.
08-Jun-2005	5	Mistake on Table 4 (Q.ty Level), Table 7 has been updated and add DIE Information.
30-Jan-2006	6	Added new Package SMD5C and Removed old Package SOC-16.
26-Jan-2007	7	DIE Information and DIE Pad has been updated par. 6, pages 9 and 10.