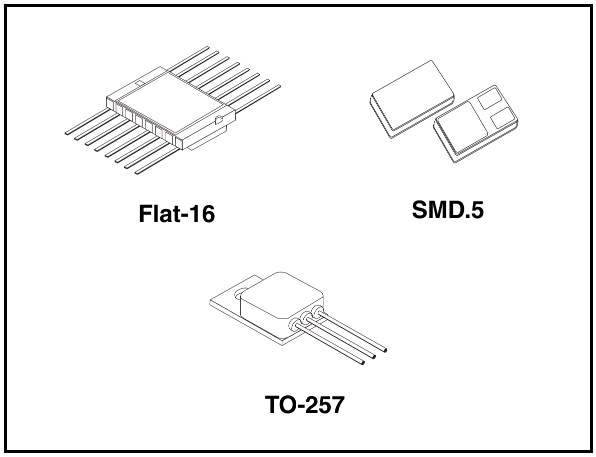
RHFL4913XX15 - RHFL4913XX25
RHFL4913XX33 - RHFL4913XX50

Rad-hard positive fixed voltage regulator

Features

- 2 and 3 A low dropout voltage
- Embedded overtemperature, overcurrent protections
- Adjustable current limitation
- Output overload monitoring/signalling
- Fixed 1.5 V, 2.5 V; 3.3 V; 5.0 V output voltages
- Inhibit (ON/OFF) TTL-compatible control
- Programmable output short-circuit current
- Remote sensing operation
- Rad-hard: tested up to 300 krad Mil Std 883E Method 1019.6 and low dose rate conditions
- Heavy ion, SEL, and SEU immune; able to sustain $2x10^{14}$ protons/cm^2 and $2x10^{14}$ neutrons/cm^2



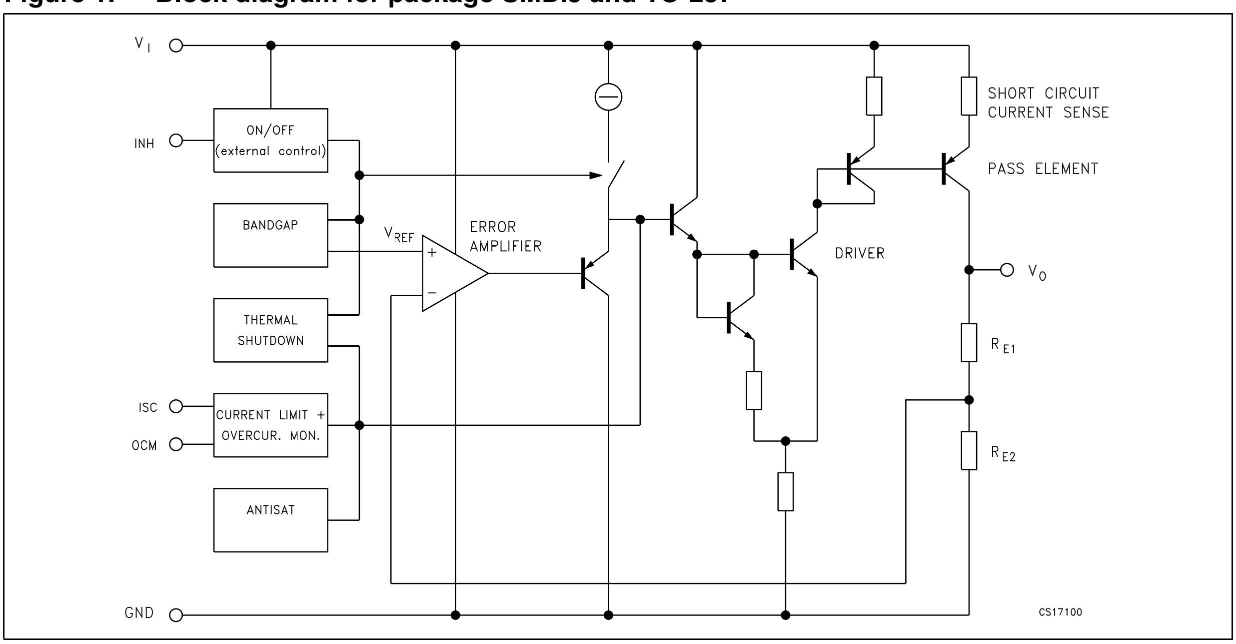
Description

The RHFL4913 fixed is a high performance Rad-hard positive voltage regulator family.

Available into various hermetic ceramic packages, it is specifically intended for space and harsh radiation environments. Input supply range is up to 12 V.

RHFL4913 fixed is QML-V qualified, DSCC SMD are 5962F02534 / 02535 / 02536.

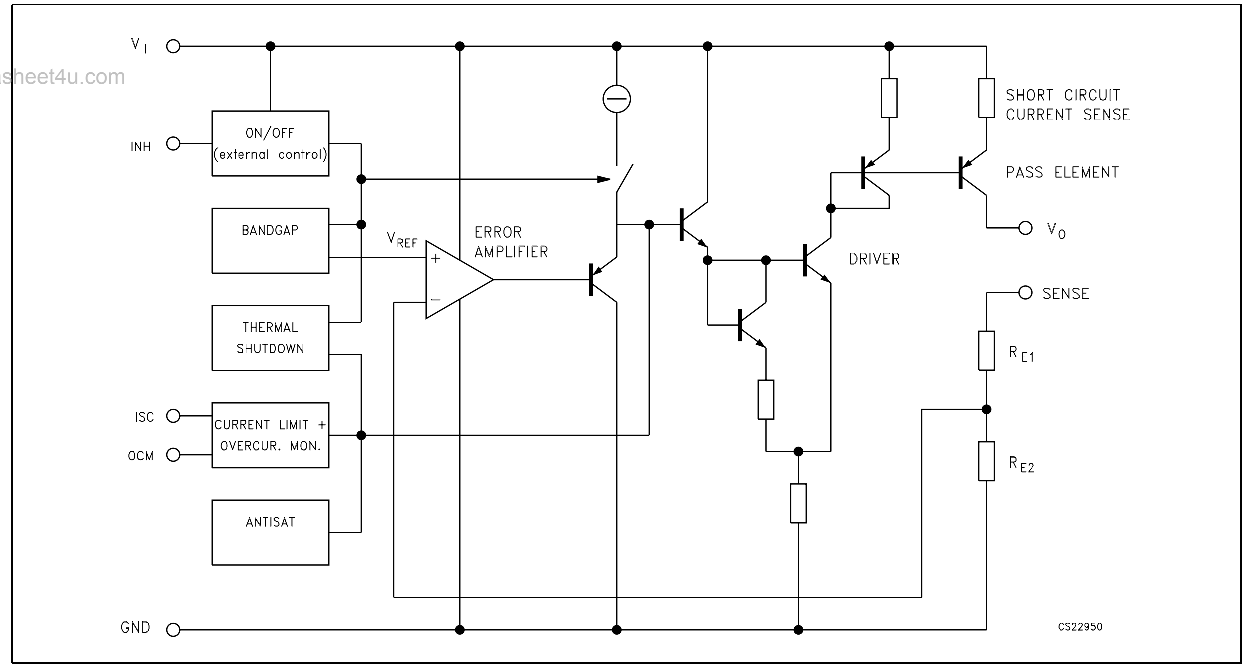
Figure 1. Block diagram for package SMD.5 and TO-257



Contents

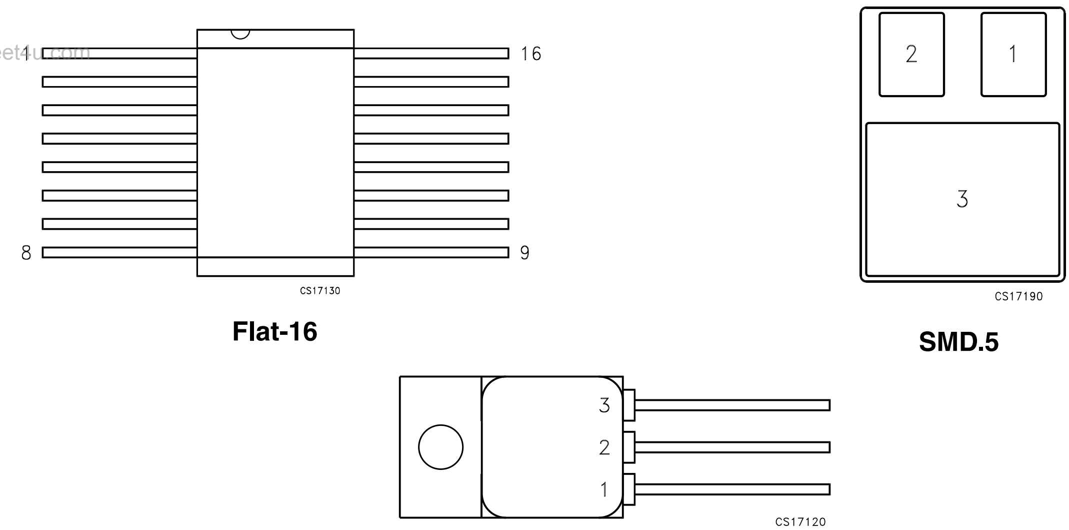
1 Diagram

Figure 2. Block diagram for package Flat-16



2 Pin configuration

Figure 3. Pin configuration (top view for Flat-16, bottom view for SMD.5)



Flat-16

SMD.5

TO-257

Table 1. Pin description

Pin name	Flat-16	SMD.5	TO-257
V_O	1, 2, 6, 7	1	3
V_I	3, 4, 5	2	1
GND	13	3	2
I_{SC}	8		
OCM	10		
INHIBIT	14		
SENSE	16		
NC	9, 11, 12, 15		

3 Maximum ratings

Table 2. Absolute maximum ratings [1]

Symbol	Parameter		Value	Unit
V_I	DC input voltage, V_I - V_{GROUND}		14	V
I_O	Output current	RHFL4913S, ESY	3	A
		RHFL4913KP	2	
P_D	T_C = 25°C power dissipation	KP, S Versions	15	W
		ESY Version	10	
T_{STG}	Storage temperature range		-65 to +150	°C
T_{OP}	Operating junction temperature range		-55 to +150	°C
T_J	Junction temperature [2]		+150	°C
ESD	Electrostatic discharge capability		Class 3	

1. Exceeding maximum ratings may damage the device.
2. Internally limited to about maximum +175 °C by thermal shutdown circuit.

Table 3. Thermal data

Symbol	Parameter	Flat-16	TO-257	SMD.5	Unit
R_{thJC}	Thermal resistance junction-case max.	8.3	12.5	8.3	°C/W
T_{SOLD}	Maximum soldering temperature, 10 sec.		300		°C

4 Electrical characteristics

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

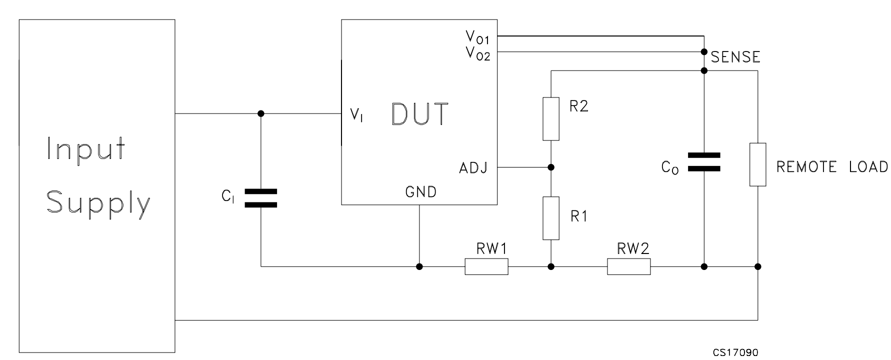
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_I	Operating input voltage	I_O = 2 A (Flat-16) or 3A (SMD.5 & TO-257)			12	V
V_O	Output voltage accuracy	$V_I = V_O$+2.5V, I_O = 5mA	-2		2	%
I_{SHORT}	Output current limit (1)	Adjustable by mask/external resistor		4.5		A
V_O	Operating output voltage	I_O = 2 A, 1.5 V output voltage	1.47		1.53	V
V_O	Operating output voltage	I_O = 2 A, 2.5 V output voltage	2.45		2.55	V
V_O	Operating output voltage	I_O = 2 A, 3.3 V output voltage	3.23		3.37	V
V_O	Operating output voltage	I_O = 2 A, 5.0 V output voltage	4.9		5.1	V
$\Delta V_O/\Delta V_I$	Line regulation	$V_I = V_O$+2.5V to 12 V, I_O = 5mA (+25°C)			0.3	%
		$V_I = V_O$+2.5V to 12 V, I_O = 5mA (-55°C)			0.4	%
		$V_I = V_O$+2.5V to 12 V, I_O = 5mA (+125°C)			0.4	%
$\Delta V_O/\Delta V_O$	Load regulation	$V_I = V_O$+2.5V, I_O = 5mA to 400 mA (+25°C)			0.2	%
		$V_I = V_O$+2.5V, I_O = 5mA to 400 mA (-55°C)			0.3	%
		$V_I = V_O$+2.5V, I_O = 5mA to 400 mA (+125°C)			0.3	%
		$V_I = V_O$+2.5V, I_O = 5mA to 1A (+25°C)			0.3	%
		$V_I = V_O$+2.5V, I_O = 5mA to 1A (-55°C)			0.4	%
		$V_I = V_O$+2.5V, I_O = 5mA to 1A (+125°C)			0.4	%
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 = 30mA, on mode			8	mA
		$V_I = V_O$+2.5V, I_O = 300mA, on mode			25	
		$V_I = V_O$+2.5V, I_O = 1A, on mode			60	
		$V_I = V_O$+2.5V, I_O = 3A, on mode (only for SMD.5 and TO-257)			150	
		$V_I = V_O$+2V, V_{INH} = 2.4V, off mode			1	
I_q	Quiescent current	$V_I = V_O$+2.5V, I_O=1A, T_J=+125°C, on mode			40	mA
		$V_I = V_O$+2.5V, I_O=1A, T_J=-55°C, on mode			100	

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

Symbol	Parameter	Test conditions		Min.	Typ.	Max.	Unit
V_d	Dropout voltage	I_O = 400mA, T_J = -55°C			300	400	mV
		I_O = 400mA, T_J = +25°C			350	450	
		I_O = 400mA, T_J = +125°C			450	550	
		I_O = 1A, T_J = -55°C				550	
		I_O = 1A, T_J = +25°C				650	
		I_O = 1A, T_J = +125°C				800	
		I_O = 2A, T_J = +25°C			750		
		I_O = 2A, T_J = +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			V
SVR	Supply voltage rejection (1)	$V_I = V_O$+2.5V ± 1V, 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} t_{PHL}	Inhibit propagation delay (1)	$V_I = V_O$+2.5V, V_{INH} = 2.4 V, I_O = 400 mA		on-off		20	µs
				off-on		100	µs
eN	Output noise voltage (1)	B= 10Hz to 100kHz, I_O = 5mA to 2A			40		µVrms

1. This value is guaranteed by design. For each application it's strongly recommended to comply with the maximum current limit of the package used.

Figure 4. Application diagram for remote sensing operation



5 Device description

The RHFL4913 fixed voltage contains a PNP type power element controlled by a signal resulting from amplified comparison between the internal temperature compensated band-gap cell and the fraction of the desired output voltage value. This fractional value is obtained from an internal-to-die resistor divider bridge set by STMicroelectronics. The device is protected by several functional blocks.

5.1 Low pin count package limitations

Some functions (INHIBIT, OCM, SENSE) are not available due to lack of pins. Corresponding die pads are by default connected inside silicon.

5.2 SENSE pin

The load voltage is applied by a Kelvin line connected to SENSE pin: Voltage feed-back comes from the internal divider resistor bridge. Therefore possible output voltages are set by manufacturer mask metal options. SENSE pin is not available in 3pin packages.

5.3 Inhibit ON-OFF control

By setting INHIBIT pin TTL-high, the device switches off the output current and voltage. The 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. INHIBIT pin is not available in 3pin packages.

5.4 Overtemperature protection

A temperature detector internally monitors the power element junction temperature. The device goes OFF at approx. 175 °C, returning to ON mode when back to approx. 40 °C. It is worth noting that when the internal temperature detector reaches 175 °C, the active power element can be at 225 °C: device reliability cannot be granted in case of extensive operation under these conditions.

5.5 Overcurrent protection

I_{SC} pin. An internal non-fold back short-circuit limitation is set with $I_{SHORT} > 3.8$ A (V_O is 0 V). This value can be reduced by an external resistor connected between I_{SC} pin and V_I pin, with a typical value range of 10 kΩ to 200 kΩ. This adjustment feature is not available in 3 pin packages. 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} – 300 mA, the current limiter overrules regulation and V_O starts to drop and the OCM flag is risen. When no current limitation adjustment is required, I_{SC} pin must be left unbiased (as it is in 3 pin packages).

5.6 OCM pin

Goes low when current limiter starts to be active, otherwise $V_{OCM} = V_I$. It is bufferized and can sink 10 mA. OCM pin is internally pulled-up by a 5 kΩ resistor. Not available in 3 pin packages.

5.7 Alternate to

RHFL4913 fixed (& custom) voltages replace all 3-terminal industry devices, providing essential benefits

- Lower drop-out

- High radiation performance

- Better SVR

- Saving the high stability external setting resistors.

6 Application information

The RHFL4913 fixed voltage is functional as soon as V_I-V_O voltage difference is slightly above the power element saturation voltage. A minimum 0.5 mA I_O ensures perfect "no-load" regulation.

All available V_I pins must always be externally interconnected, same thing for all available V_O pins, otherwise device stability and reliability cannot be granted. All NC pins can be connected to ground. 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 some series-inductance exists. The effect would be a large transient voltage developed on both device terminals. It is necessary to protect the device with Schottky diodes preventing negative voltage excursions. In the worst case, a 14 V Zener diode shall protect the device input.

The device has been designed for high stability and low drop out operation: minimum 1 µF 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 470 nF polyester capacitors.

Being RHFL4913 fixed voltage manufactured with very high speed bipolar technology 6 GHz f_T transistors), the PCB lay-out must be performed with extreme care, very low inductance, low mutually coupling lines, otherwise high frequency parasitic signals may be picked-up by the device resulting into self-oscillation. User's benefit is a SVR performance extended to far higher frequencies.

6.1 Remote sensing operation

In case the load is located far from the regulator, it is recommended to comply with the scheme below. To obtain the best regulation, it is in addition essential to care about:

– The wire connecting R2 to the load end must not be crossed by the load current (Kelvin sense).

The noise captured by the wires between the load and the chip could bring a noisy output voltage. In case this happens, it is recommended that shielded cables are used for these connections. The external wrap must be used for connecting the ground of the chip with the load ground. It is also recommended to place 1 µF tantalum capacitors between output and ground close to the device and another next to the load.

7 Notes about Flat-16 package

The bottom of package is metallized to allow user to directly solder the voltage regulator to the equipment heater, in order to optimize heat removal performance.

7.1 Radiation performances

The RHFL4913F has been tested against: 300krad TID ELDERS in accordance with Mil-1019.6, bipolar section: post radiation parameters are within datasheet pre-rad limits. Submitted to 200MeV Iodine ions of 60.4MeV/cm2/mg LET up to 1exp(+7) ions / cm2, no SEL event has been detected.

7.2 Die information

RHFL4913 fixed is also available in die form. Space dice are electrically tested by STMicroelectronics in such a way that, when mounted in proper thermal and electrical substrate, they provide full compliance with equivalent packaged product.

- Max die dimensions: 2.794 mm by 3.861 mm or 110 mils by 152 mils

- Die thickness: 357 µm +/- 50 µm

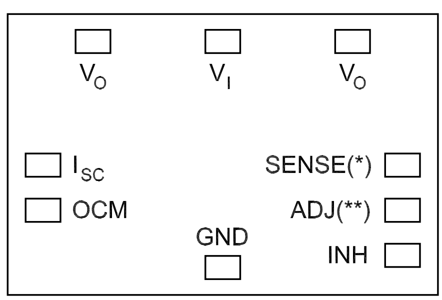
- Pad size: 184 µm by 184 µm

- Metallization: Aluminum 4% silicon alloy

- Die backside: Bare silicon

- Die backside potential: Ground

Figure 5. Die size



(*) Die SENSE pad is active in RHFL4913 fixed die. It shall not be left unbonded. It should be bonded to V_O pin.

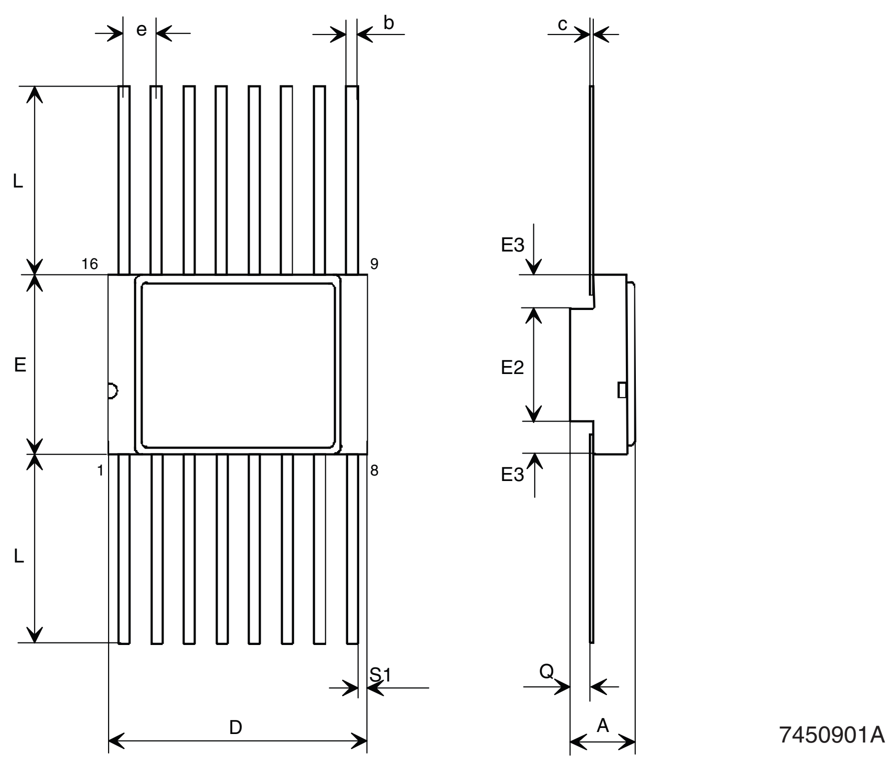
(**) Die adjust pad is available in the die lay-out but is not electrically connected to the IC. It shall be left unconnected during hybrid bonding.

8 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. These packages have a lead-free second level interconnect. The category of second Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: www.st.com.

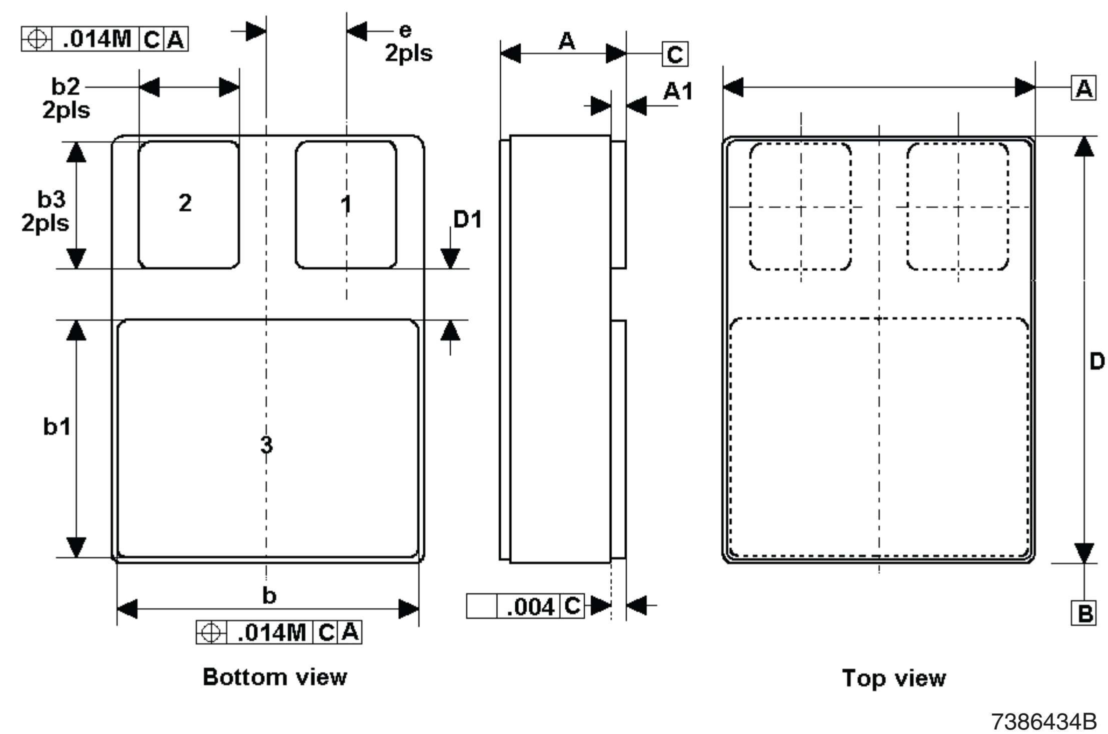
Flat-16 (MIL-STD-1835) mechanical data

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		



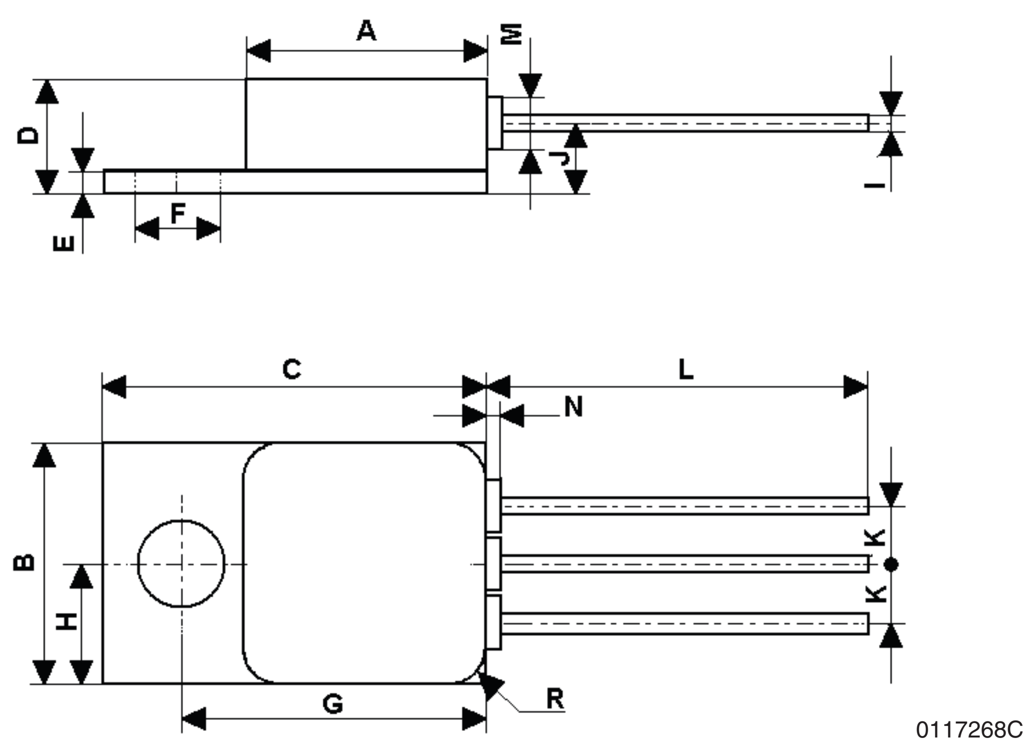
SMD.5 mechanical data

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	5.58	5.72	5.84	0.220	0.225	0.230
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	10.03	10.16	10.28	0.395	0.400	0.405
D1	0.76			0.030		
E	7.39	7.52	7.64	0.291	0.296	0.301
e		1.91			0.075	



TO-257 mechanical data

Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		10.54			0.415	
B		10.54			0.415	
C		16.64			0.655	
D	4.7		5.33	0.185		0.210
E		1.02			0.40	
F	3.56	3.68	3.81	0.140	0.145	0.150
G		13.51			0.532	
H		5.26			0.207	
I		0.76			0.030	
J		3.05			0.120	
K		2.54			0.100	
L	15.2		16.5	0.598		0.650
M		2.29			0.090	
N			0.71			0.028
R		1.65			0.065	



9 Ordering information

Table 5. Order codes

DIE	Flat-16	SMD.5	TO-257	Terminal finish	Out. volt.	Q.ty level
	RHFL4913KP15-01V	RHFL4913S15-03V	RHFL4913ESY1505V	GOLD	1.5 V	
	RHFL4913KP15-02V	RHFL4913S15-04V	RHFL4913ESY1506V	SOLDER	1.5 V	
	RHFL4913KP151	RHFL4913S151	RHFL4913ESY151	GOLD	1.5 V	EM1
	RHFL4913KP152	RHFL4913S152	RHFL4913ESY152	GOLD	1.5 V	EM1=EM2 +48h B.I.
L491315DIE2V				NA	1.5 V	
L491315DIE2S				NA	1.5 V	EM1
	RHFL4913KP25-01V	RHFL4913S25-03V	RHFL4913ESY2505V	GOLD	2.5 V	QML-V
	RHFL4913KP25-02V	RHFL4913S25-04V	RHFL4913ESY2506V	SOLDER	2.5 V	QML-V
	RHFL4913KP251	RHFL4913S251	RHFL4913ESY251	GOLD	2.5 V	EM1
	RHFL4913KP252	RHFL4913S252	RHFL4913ESY252	GOLD	2.5 V	EM1=EM2 +48h B.I.
L491325DIE2V				NA	2.5 V	QML-V
L491325DIE2S				NA	2.5 V	EM1
	RHFL4913KP33-01V	RHFL4913S33-03V	RHFL4913ESY3305V	GOLD	3.3 V	QML-V
	RHFL4913KP33-02V	RHFL4913S33-04V	RHFL4913ESY3306V	SOLDER	3.3 V	QML-V
	RHFL4913KP331	RHFL4913S331	RHFL4913ESY331	GOLD	3.3 V	EM1
	RHFL4913KP332	RHFL4913S332	RHFL4913ESY332	GOLD	3.3 V	EM1=EM2 +48h B.I.
L491333DIE2V				NA	3.3 V	QML-V
L491333DIE2S				NA	3.3 V	EM1
	RHFL4913KP50-01V	RHFL4913S50-03V	RHFL4913ESY5005V	GOLD	5.0 V	QML-V
	RHFL4913KP50-02V	RHFL4913S50-04V	RHFL4913ESY5006V	SOLDER	5.0 V	QML-V
	RHFL4913KP501	RHFL4913S501	RHFL4913ESY501	GOLD	5.0 V	EM1
	RHFL4913KP502	RHFL4913S502	RHFL4913ESY502	GOLD	5.0 V	EM1=EM2 +48h B.I.
L491350DIE2V				NA	5.0 V	QML-V
L491350DIE2S				NA	5.0 V	EM1

Table 6. Part number - SMD equivalent

ST part number	SMD part number
RHFL4913KP15-02V	
RHFL4913KP25-01V	5962F0253401VXC
RHFL4913KP25-02V	5962F0253401VXA
RHFL4913KP33-01V	5962F0253501VXC
RHFL4913KP33-02V	5962F0253501VXA
RHFL4913KP50-01V	5962F0253601VXC
RHFL4913KP50-02V	5962F0253601VXA
RHFL4913S25-03V	5962F0253402VYC
RHFL4913S25-04V	5962F0253402VYA
RHFL4913S33-03V	5962F0253502VYC
RHFL4913S33-04V	5962F0253502VYA
RHFL4913S50-03V	5962F0253602VYC
RHFL4913S50-04V	5962F0253602VYA
RHFL4913ESY2505V	5962F0253402VZC
RHFL4913ESY2506V	5962F0253402VZA
RHFL4913ESY3305V	5962F0253502VZC
RHFL4913ESY3306V	5962F0253502VZA
RHFL4913ESY5005V	5962F0253602VZC
RHFL4913ESY5006V	5962F0253602VZA
L491325DIE2V	5962F0253402V9A
L491333DIE2V	5962F0253502V9A
L491350DIE2V	5962F0253602V9A

Note: 3 V version is available on request.

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 300 krad at 0.55 rad/s	8	ppm/krad
Output voltage radiation drift	From 0 krad to 300 krad, Mil Std 883E Method 1019.6	6	ppm/krad

10 Revision history

Table 8. Document revision history

Date	Revision	Changes
05-May-2004	4	Mistake in pin description SMD.5 on table 3.
28-Oct-2004	5	New order codes added - tables 4 and 5.
27-May-2005	6	The features, tables 4, 5 and the figures 1, 2 updated.
08-Jun-2005	7	Modified: P_D on table 1, the R_{thJC} for TO-257 on table 2 and the tables 6 and 7, added DIE information.
26-Aug-2008	8	Added new output 1.5 V, modified: *Table 4 on page 6*, *Table 5 on page 16* and *Table 6 on page 17*.