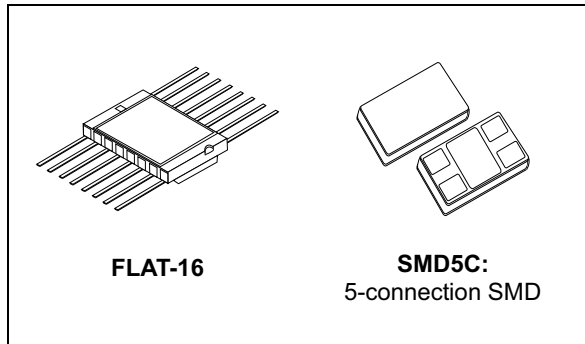


**Rad-hard adjustable positive voltage regulator**

Datasheet - production data

**Features**

- Operating input voltage from 3 V to 12 V
- Adjustable output voltage
- 3 A maximum guaranteed output current in SMD5C package, 2 A in FLAT-16
- Very low dropout voltage: 350 mV typ @ 400 mA
- Embedded overtemperature and overcurrent protection
- Adjustable overcurrent limitation
- Very low noise: 40  $\mu\text{V}_{\text{RMS}}$  (10 Hz-100 kHz)
- Output overload monitoring/signalling
- Inhibit (ON/OFF) TTL-compatible control
- Programmable output short-circuit current
- Remote sensing operation
- Low quiescent current: 1.5 mA typ @ no load, 150  $\mu\text{A}$  in shutdown
- Rad-hard: guaranteed up to 300 krad Mil Std 883E Method 1019.6 high dose rate and 0.01 rad/s in ELDRS conditions
- Heavy ion, SEL immune.

**Description**

The RHFL4913A is a high-performance adjustable positive voltage regulator, able to provide 2 A of maximum current in FLAT-16 package (3 A in the SMD5C package) from an input voltage ranging from 3 V to 12 V, with a typical dropout voltage of 350 mV.

The RHFL4913A features exceptional radiation performances. It is tested in accordance with Mil Std 883E Method 1019.6, in ELDRS conditions. The device is available in the FLAT-16 and the new SMD5C hermetic ceramic package, and the QML-V die is specifically designed for space and harsh radiation environments. It operates with an input supply of up to 12 V. The RHFL4913A is QML-V qualified, DSCC SMD #5962F02524.

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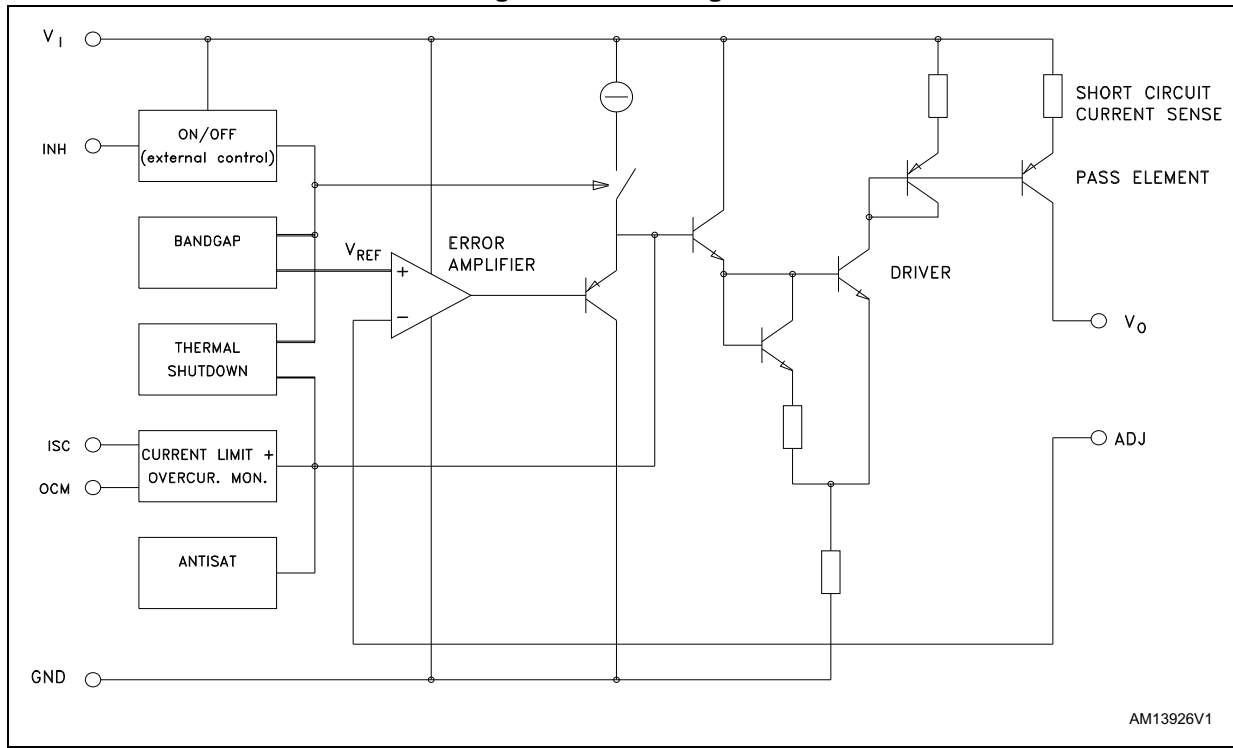
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# 1 Diagram

Figure 1. Block diagram



AM13926V1

## 2 Pin configuration

Figure 2. Pin configuration (top view for FLAT-16, bottom view for SMD5C)

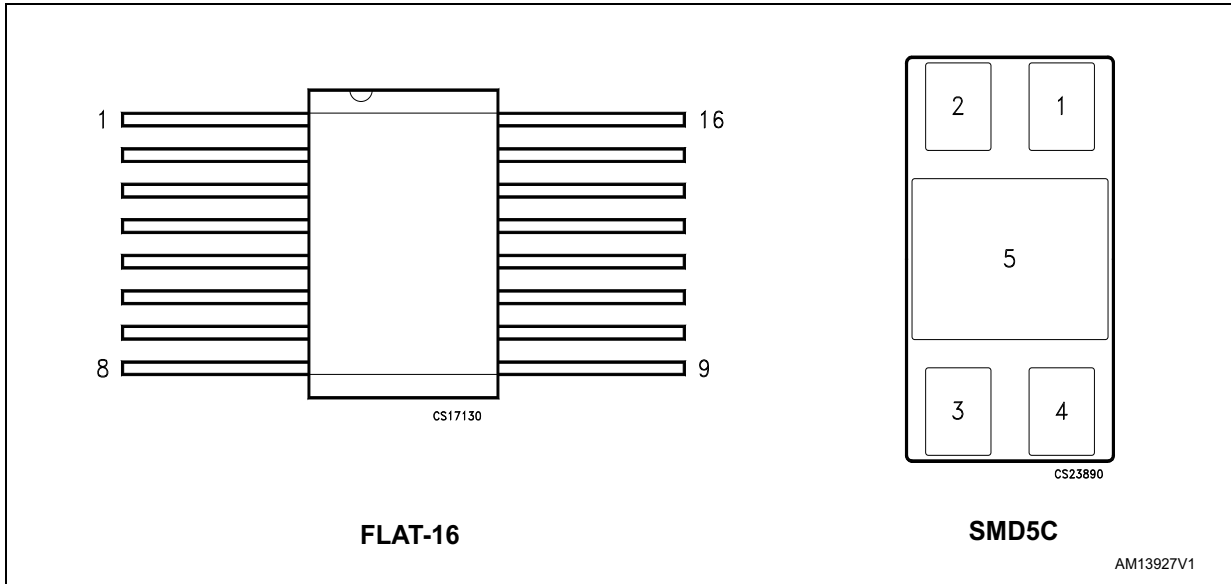


Table 1. Pin description

Pin name	FLAT-16 <sup>(1)</sup>	SMD5C <sup>(2)</sup>
V <sub>O</sub>	1, 2, 6, 7	1
V <sub>I</sub>	3, 4, 5	4
GND	13	5
I <sub>sc</sub>	8	
OCM	10	
INHIBIT	14	3
ADJ	15	2
NC	9, 11, 12, 16	

1. The upper metallic package lid and the bottom metallization are neither connected to regulator die nor to package terminals, hence electrically floating.
2. The upper metallic package lid is neither connected to regulator die nor to package terminals, hence electrically floating.

### 3 Maximum ratings

**Table 2. Recommended maximum operating ratings <sup>(1)</sup>**

Symbol	Parameter	Value	Unit
$V_I$	DC input voltage, $V_I - V_{\text{GROUND}}$	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	
$P_D$	$T_C = 25\text{ °C}$ power dissipation	15	W
$T_{\text{STG}}$	Storage temperature range	-65 to +150	°C
$T_{\text{OP}}$	Operating junction temperature range	-55 to +150	°C
ESD	Electrostatic discharge capability	Class 3	

1. Exceeding maximum ratings may damage the device.

**Table 3. Thermal data**

Symbol	Parameter	Value	Unit
$R_{\text{thJC}}$	Thermal resistance junction-case, FLAT-16 and SMD5C	8.3	°C/W
$T_{\text{SOLD}}$	Maximum soldering temperature, 10 sec.	300	°C



## 4 Electrical characteristics

$T_J = 25\text{ °C}$ ,  $V_I = V_O + 2.5\text{ V}$ ,  $C_I = C_O = 1\text{ }\mu\text{F}$ , unless otherwise specified.

**Table 4. Electrical characteristics**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_I$	Operating input voltage	$I_O = 1\text{ A}$ , $T_J = -55\text{ to }125\text{ °C}$	3		12	V
$V_O$	Output voltage	$I_O = 1\text{ A}$ for FLAT-16, 2 A for SMD5C, $V_O = V_{ADJ}$	1.19	1.23	1.27	V
		$I_O = 1\text{ A}$ for FLAT-16, 2 A for SMD5C $V_O = 9\text{ V}$	8.7		9.3	V
$I_{SHORT}$	Output current limit <sup>(1)</sup>	Adjustable by mask/external resistor	1	4.5		A
$\Delta V_O/\Delta V_I$	Line regulation	$V_I = V_O + 2.5\text{ V to }12\text{ V}$ , $I_O = 5\text{ mA}$ , $T_J = +25\text{ °C}$		0.07	0.35	%
		$V_I = V_O + 2.5\text{ V to }12\text{ V}$ , $I_O = 5\text{ mA}$ , $T_J = -55\text{ °C}$		0.05	0.4	
		$V_I = V_O + 2.5\text{ V to }12\text{ V}$ , $I_O = 5\text{ mA}$ , $T_J = +125\text{ °C}$		0.1	0.4	
		$V_I = 3\text{ V to }12\text{ V}$ , $I_O = 5\text{ mA}$ , $T_J = -55\text{ °C to }+125\text{ °C}$		0.1	0.5	
$\Delta V_O/\Delta I_O$	Load regulation	$V_I = V_O + 2.5\text{ V}$ , $I_O = 5\text{ to }400\text{ mA}$ , $T_J = +25\text{ °C}$		0.04	0.3	%
		$V_I = V_O + 2.5\text{ V}$ , $I_O = 5\text{ to }400\text{ mA}$ , $T_J = -55\text{ °C}$		0.02	0.5	
		$V_I = V_O + 2.5\text{ V}$ , $I_O = 5\text{ to }400\text{ mA}$ , $T_J = +125\text{ °C}$		0.02	0.5	
		$V_I = V_O + 2.5\text{ V}$ , $I_O = 5\text{ mA to }1\text{ A}$ , $T_J = +25\text{ °C}$		0.08	0.5	
		$V_I = V_O + 2.5\text{ V}$ , $I_O = 5\text{ mA to }1\text{ A}$ , $T_J = -55\text{ °C}$		0.05	0.6	
		$V_I = V_O + 2.5\text{ V}$ , $I_O = 5\text{ mA to }1\text{ A}$ , $T_J = +125\text{ °C}$		0.04	0.6	
		$V_I = 3\text{ V}$ , $I_O = 5\text{ mA to }1\text{ A}$ , $T_J = -55\text{ °C to }+125\text{ °C}$		0.1	0.7	
$Z_{OUT}$	Output impedance	$I_O = 100\text{ mA DC and }20\text{ mA rms}$		100		m $\Omega$

Table 4. Electrical characteristics (continued)

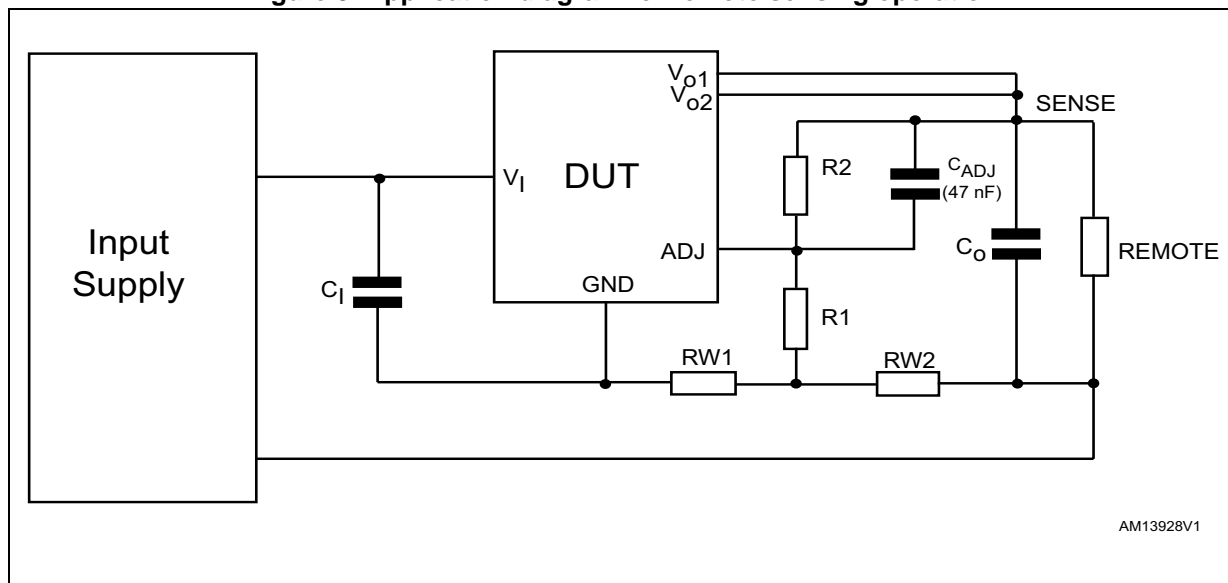
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_q$	Quiescent current	$V_I = V_O + 2.5\text{ V}$ , $I_O = 5\text{ mA}$ , ON mode (+25 °C)		1.5	6	mA
		$V_I = V_O + 2.5\text{ V}$ , $I_O = 30\text{ mA}$ , ON mode (+25 °C)		2.7	8	
		$V_I = V_O + 2.5\text{ V}$ , $I_O = 300\text{ mA}$ , ON mode (+25 °C)		11	25	
		$V_I = V_O + 2.5\text{ V}$ , $I_O = 1\text{ A}$ , ON mode (+25 °C)		32	60	
$I_q$	Quiescent current ON mode	$V_I = V_O + 2.5\text{ V}$ , $I_O = 30\text{ mA}$ , (-55 °C)		3	14	mA
		$V_I = V_O + 2.5\text{ V}$ , $I_O = 300\text{ mA}$ , (-55 °C)		15	40	
		$V_I = V_O + 2.5\text{ V}$ , $I_O = 1\text{ A}$ , (-55 °C)		52	100	
		$V_I = V_O + 2.5\text{ V}$ , $I_O = 30\text{ mA}$ , (+125 °C)		3	8	
		$V_I = V_O + 2.5\text{ V}$ , $I_O = 300\text{ mA}$ , (+125 °C)		8	20	
		$V_I = V_O + 2.5\text{ V}$ , $I_O = 1\text{ A}$ , (+125 °C)		20	40	
$I_{q(off)}$	Quiescent current Shutdown mode	$V_I = V_O + 2\text{ V}$ , $V_{INH} = 2.4\text{ V}$ , OFF mode		0.15	1	mA
$V_d$	Dropout voltage	$I_O = 0\text{ mA}$ , $V_O = 2.5\text{ V to }9\text{ V}$		130		mV
		$I_O = 400\text{ mA}$ , $V_O = 2.5\text{ to }9\text{ V}$ , (+25 °C)		350	450	
		$I_O = 400\text{ mA}$ , $V_O = 2.5\text{ to }9\text{ V}$ , (-55 °C)		300	400	
		$I_O = 400\text{ mA}$ , $V_O = 2.5\text{ to }9\text{ V}$ , (+125 °C)		450	550	
		$I_O = 1\text{ A}$ , $V_O = 2.5\text{ to }9\text{ V}$ , (+25 °C)		500	650	
		$I_O = 1\text{ A}$ , $V_O = 2.5\text{ to }9\text{ V}$ , (-55 °C)		400	550	
		$I_O = 1\text{ A}$ , $V_O = 2.5\text{ to }9\text{ V}$ , (+125 °C)		640	800	
		$I_O = 2\text{ A}$ , $V_O = 2.5\text{ to }9\text{ V}$ , (+25 °C)		750		
		$I_O = 2\text{ A}$ , $V_O = 2.5\text{ to }9\text{ V}$ , (+125 °C)		950		
$V_{INH(ON)}$	Inhibit voltage	$I_O = 5\text{ mA}$ , $T_J = -55\text{ to }+125\text{ °C}$			0.8	V
$V_{INH(OFF)}$	Inhibit voltage	$I_O = 5\text{ mA}$ , $T_J = -55\text{ to }+125\text{ °C}$	2.4			
SVR	Supply voltage rejection <sup>(1)</sup>	$V_I = V_O + 2.5\text{ V} \pm 0.5\text{ V}$ , $V_O = 3\text{ V}$ $I_O = 5\text{ mA}$	$f = 120\text{ Hz}$	60	70	dB
			$f = 33\text{ KHz}$	30	40	
$I_{SH}$	Shutdown input current	$V_{INH} = 5\text{ V}$		15		$\mu\text{A}$
$V_{OCM}$	OCM pin voltage	Sinked $I_{OCM} = 24\text{ mA}$ active low		0.38		V

Table 4. Electrical characteristics (continued)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{PLH}$ $t_{PHL}$	Inhibit propagation delay <sup>(1)</sup>	$V_I = V_O + 2.5V$ , $V_{INH} = 2.4 V$ , $I_O = 400$ mA $V_O = 3 V$	ON-OFF		20	$\mu s$
			OFF-ON		100	$\mu s$
eN	Output noise voltage <sup>(1)</sup>	$B = 10 \text{ Hz to } 100 \text{ kHz}$ , $I_O = 5 \text{ mA to } 2 \text{ A}$		40		$\mu V_{rms}$

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

Figure 3. Application diagram for remote sensing operation



## 5 Device description

The RHFL4913A adjustable voltage regulator contains a PNP type power element controlled by a signal resulting from an 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.

### 5.1 ADJ pin

The load output voltage feedback comes from an external resistor divider bridge mid-point connected to the ADJ pin (allowing all possible output voltage settings as per user requirements) established between load terminals.

### 5.2 Inhibit ON-OFF control

By setting the INHIBIT pin TTL high, the device switches off the output current and voltage. The device is ON when the INHIBIT pin is set low. Since the INHIBIT pin is pulled down internally, it can be left floating in cases where the inhibit function is not used.

### 5.3 Overtemperature protection

A temperature detector internally monitors the power element junction temperature. The device turns off when a temperature of approximately 175 °C is reached, returning to ON mode when back to approximately 135 °C. Combined with the other protection blocks, the device is protected from destructive junction temperature excursions in all load conditions. It should be noted that when the internal temperature detector reaches 175 °C, the active power element can be as high as 225 °C. Prolonged operation under these conditions far exceeds the maximum operating ratings and device reliability cannot be guaranteed.

### 5.4 Programmable overcurrent protection

An internal non fold-back short circuit limitation is set with  $I_{SHORT} > 3.8 \text{ A}$  ( $V_O$  is 0 V). This value can be decreased via an external  $R_{SH}$  resistor connected between the  $I_{SC}$  and  $V_I$  pins, with a typical value range of 10 k $\Omega$  to 200 k $\Omega$  (refer to [Figure 44.](#) and [Figure 45.](#)). To maintain optimal  $V_O$  regulation, it is necessary to set  $I_{SHORT}$  1.6 times greater than the maximum desired application  $I_O$ . When  $I_O$  reaches  $I_{SHORT} - 300 \text{ mA}$ , the current limiter overrules the regulation,  $V_O$  starts to drop and the OCM flag is raised. When no current limitation adjustment is required, the  $I_{SC}$  pin must be left unbiased (as it is in 3 pin packages).

### 5.5 OCM pin

The OCM pin goes low when the current limit becomes active, otherwise  $V_{OCM} = V_I$ . It is buffered and can sink 10 mA. The OCM pin is internally pulled up by a 5 k $\Omega$  resistor.

## 6 Application information

To adjust the output voltage, the R2 resistor must be connected between the V<sub>O</sub> and ADJ pins. The R1 resistor must be connected between ADJ and ground. Resistor values can be derived from the following formula:

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

The V<sub>ADJ</sub> is typically 1.23 V, controlled by the internal temperature-compensated band gap block.

The minimum input voltage is 3 V. The RHFL4913A adjustable is functional as soon as the V<sub>I</sub> - V<sub>O</sub> voltage difference is slightly above the power element saturation voltage. The adjust pin to ground resistor (R1) value must not be greater than 10 kΩ, in order to keep the output feedback error below 0.2%. A minimum of 0.5 mA I<sub>O</sub> must be set to ensure perfect no-load regulation. It is advisable to dissipate this current into the divider bridge resistor.

All available V<sub>I</sub> pins, as well as all available V<sub>O</sub> pins, should always be externally interconnected, otherwise the stability and reliability of the device cannot be guaranteed.

The inhibit function switches off the output current electronically, and therefore very quickly. According to Lenz's Law, external circuitry reacts with Ldi/dt terms which can be of high amplitude in case somewhere a serial coil inductance exists. Large transient voltage would develop on both device terminals. It is advisable to protect the device with Schottky diodes to prevent negative voltage excursions. In the worst case, a 14 V Zener diode could protect the device input.

Since the RHFL4913A adjustable voltage regulator is manufactured with very high speed bipolar technology (6 GHz f<sub>T</sub> transistors), the PCB layout must be designed with exceptional care, with very low inductance and low mutually coupling lines. Otherwise, high frequency parasitic signals may be picked up by the device resulting in system self-oscillation. The benefit is an SVR performance extended to far higher frequencies.

### 6.1 Output capacitor selection and stability.

The device has been designed for high stability and low dropout operation.

To ensure regulator stability, input and output capacitors with a minimum 1 μF are mandatory. When large transient currents are expected, larger value capacitors are necessary. The detailed stability plane versus output capacitance and ESR is shown in [Figure 54](#).

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

### 6.2 Remote sensing operation

A separate kelvin voltage sensing line provides the ADJ pin with exact load "high potential" information (see [Figure 3](#)). But variable remote load current consumption induces variable I<sub>q</sub> current (I<sub>q</sub> is roughly the I<sub>O</sub> current divided by the h<sub>FE</sub> of the internal PNP series power

element) routed through the parasitic series line resistor RW2. To compensate for this parasitic voltage, resistor RW1 can be introduced to provide the necessary compensating voltage signal to the ADJ pin.

A ceramic or polyester 47nF  $C_{ADJ}$  capacitor between ADJ and  $V_{OUT}$  pins is recommended when the remote sensing technique is implemented.

### 6.3 FPGA power supply lines

Because FPGA devices are very sensitive to  $V_{DD}$  transients beyond a few % of their nominal supply voltage (usually 1.5 V), special attention must be given by supply lines designers to mitigate possible heavy ion disturbances. The worst case heavy ion effect can be summarized as: the RHFL4913 internal control loop being cut (made open) or short-circuited for a sub-microsecond duration. During such an event, the RHFL4913 power element can either provide excessive current or current supply stoppage to the output ( $V_{OUT}$ ) for a duration of about one microsecond, after which time the RHFL4913 smoothly recovers to nominal operation.

According to the simulations, some very short SET (i.e. those having duration <100nsec) are dependent also on the stray inductances related to the PCB topology, especially those on the ground.

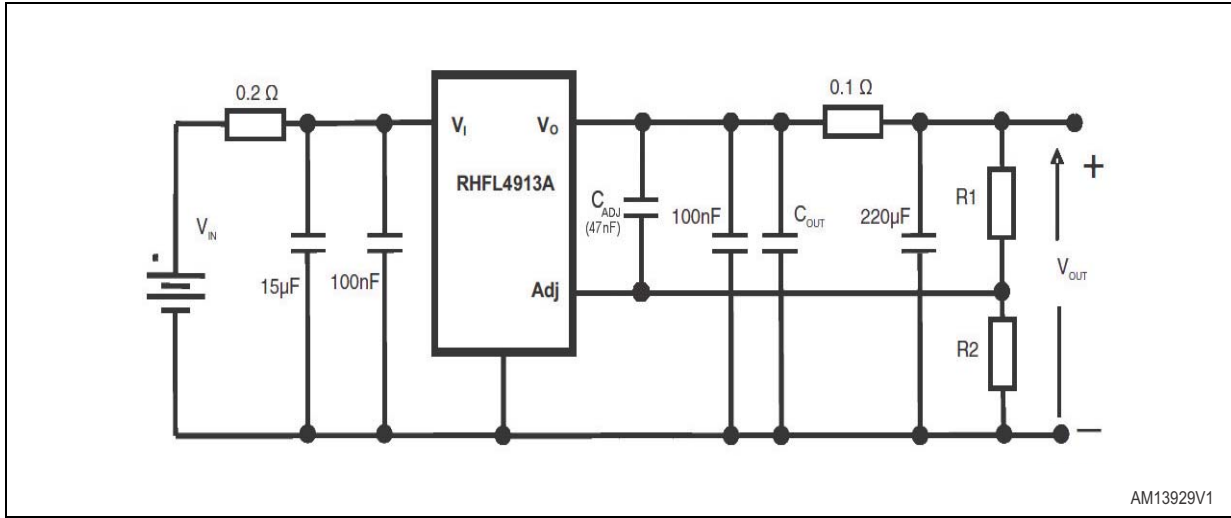
To mitigate these "transients", it is recommended to implement the RHFL4913 PCB layout as follows:

- Minimizing series/parallel parasitic inductances of the PCB path
- Using an effective grounding scheme with short connections to GND, such as a star-bus topology, whose board GND is at the GND force. The best solution is a ground plane.
- Using a low ESR 47  $\mu$ F  $C_{OUT}$  filtering capacitor, with ESR lower than 30m $\Omega$ , together with a 470 nF ceramic capacitor in parallel (to reduce dynamic ESR)
- Implementing the SET mitigation circuit, by adding additional filtering components as described in [Figure 4](#) and [Figure 5](#).

With this implementation, the ELDO simulated worst transient case shows no more than 90 mV deviation from the nominal line voltage value.

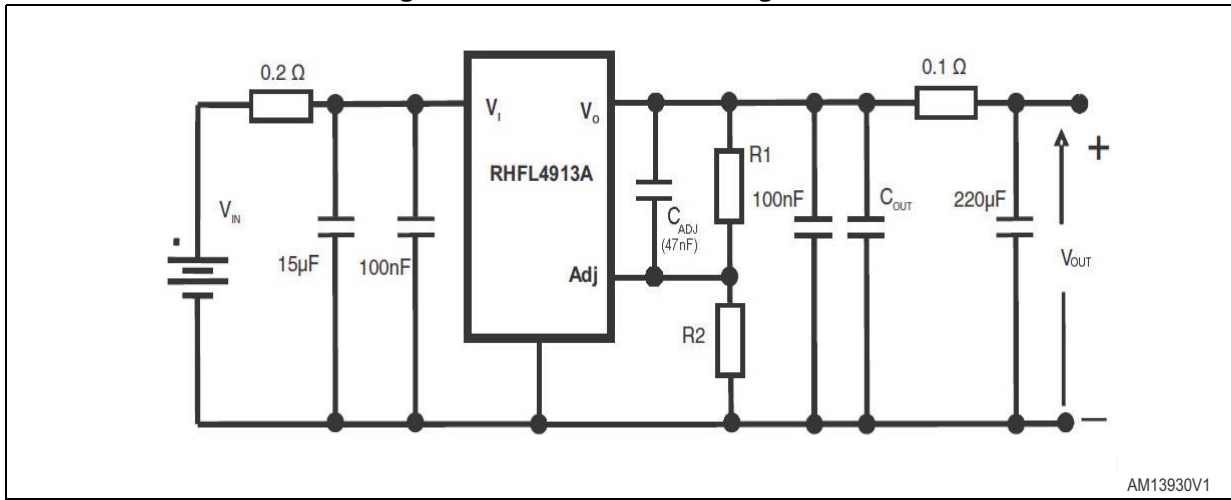
Additional details and suggestions regarding the application techniques aimed to mitigate the SET effects on a linear voltage regulator can be found in the AN2984 ("Minimizing the SET-related effects on the output of a voltage linear regulator,, available on [www.st.com](http://www.st.com)).

Figure 4. Baseline bias configuration with remote feedback



AM13929V1

Figure 5. Local feedback configuration



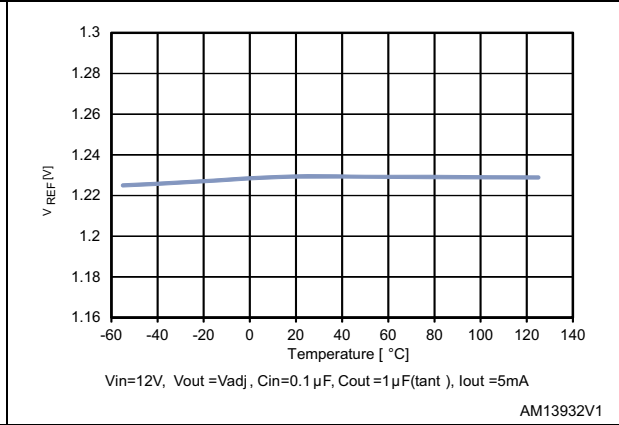
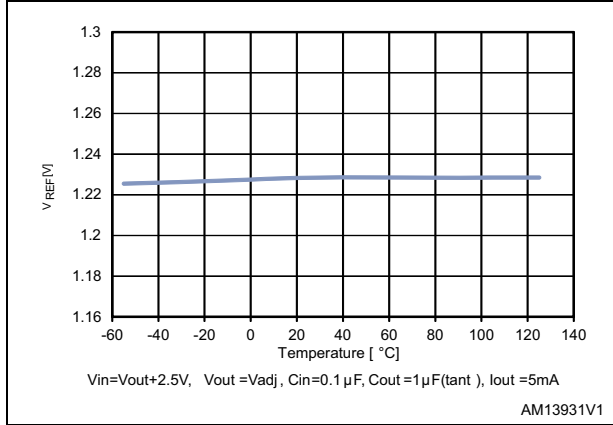
AM13930V1

## 6.4 Notes on the 16-pin hermetic package

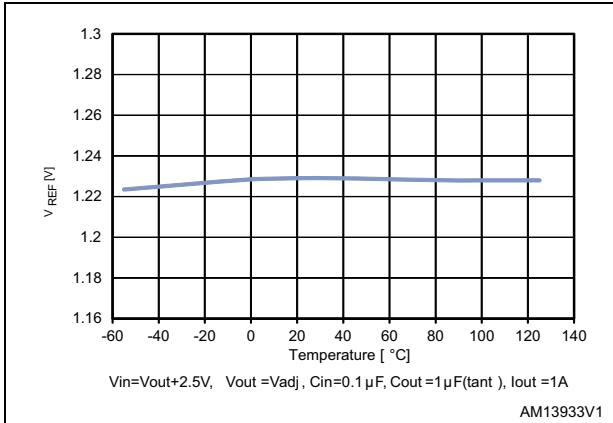
The bottom section of the 16-pin package is metallized in order to allow the user to directly solder the RHFL4913A onto PCB, no heat sink needed for enhanced heat removal.

# 7 Typical characteristics

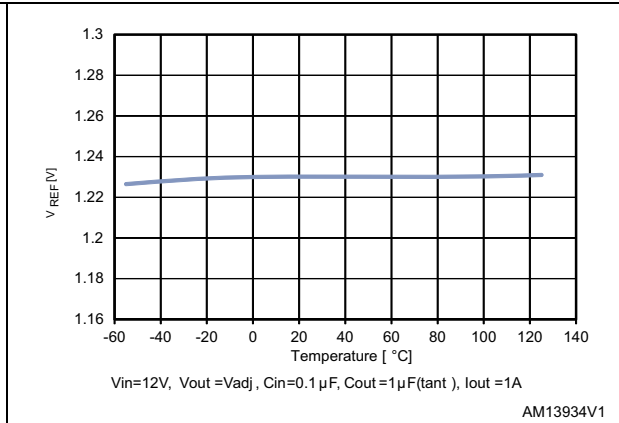
**Figure 6. Reference voltage versus temperature ( $V_{in}=V_{out}+2.5\text{ V}$ )**      **Figure 7. Reference voltage versus temperature ( $V_{in}=12\text{ V}$ )**



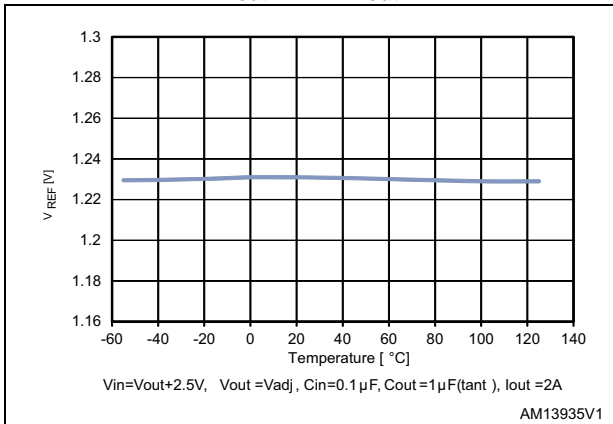
**Figure 8. Reference voltage vs temperature ( $V_{in}=V_{out}+2.5\text{ V}$ ,  $I_{out}=1\text{ A}$ )**



**Figure 9. Reference voltage vs temperature ( $V_{in}=12\text{ V}$ ,  $I_{out}=1\text{ A}$ )**



**Figure 10. Reference voltage vs temperature ( $V_{in}=V_{out}+2.5\text{ V}$ ,  $I_{out}=2\text{ A}$ )**



**Figure 11. Reference voltage versus temperature ( $V_{in}=12\text{ V}$ ,  $I_{out}=2\text{ A}$ )**

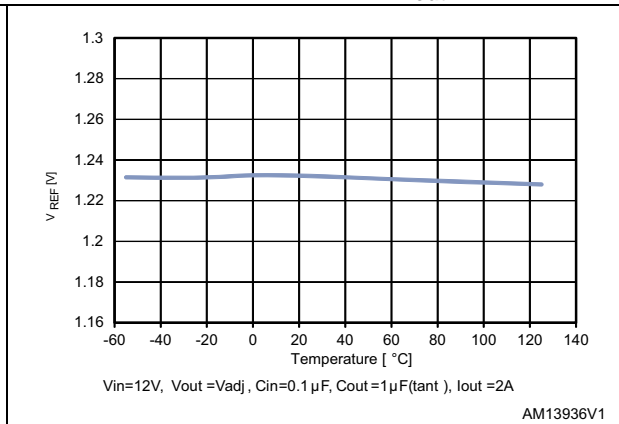




Figure 12. Line regulation vs temperature

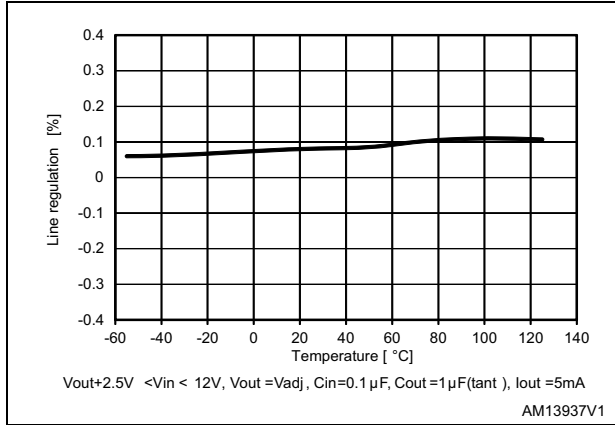


Figure 13. Load regulation vs temperature (I<sub>out</sub>=5 mA to 400 mA)

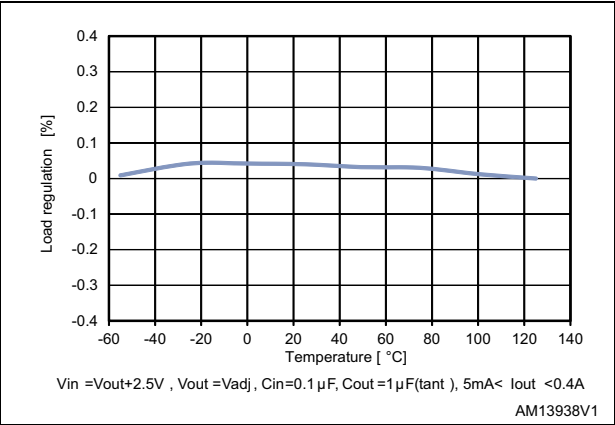


Figure 14. Load regulation vs temperature (I<sub>out</sub>=5 mA to 1 A)

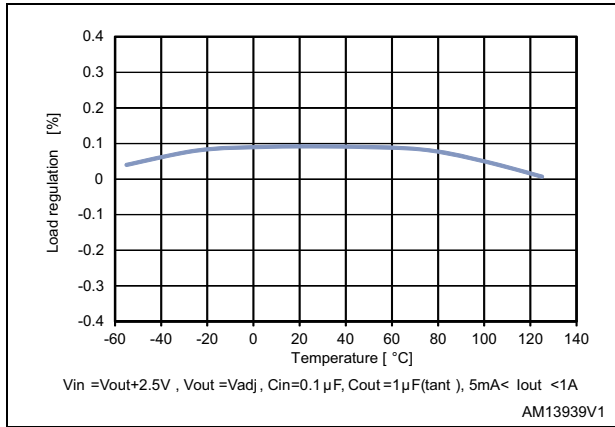


Figure 15. Inhibit threshold vs temperature

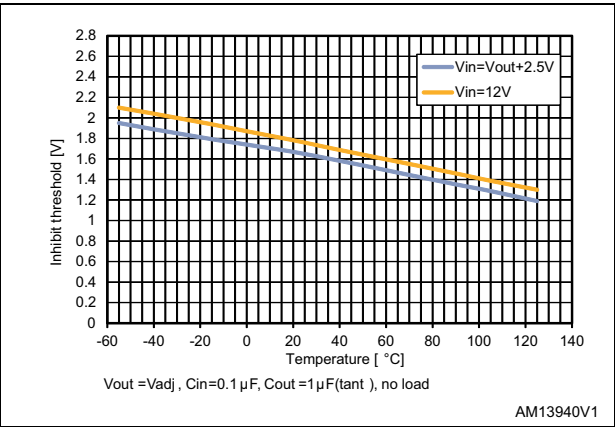


Figure 16. Output voltage vs input voltage (I<sub>out</sub>=0 mA, T=25 °C and T=125 °C)

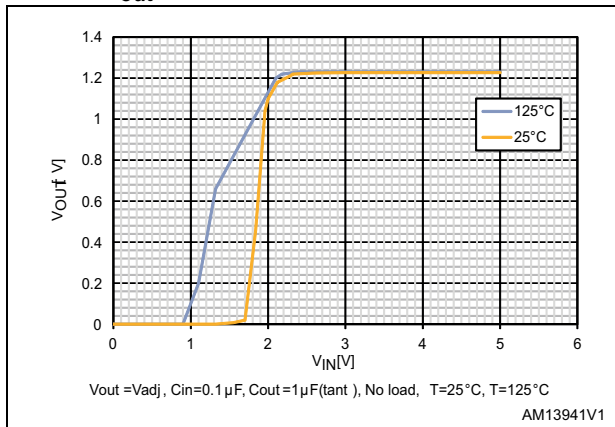


Figure 17. Output voltage vs input voltage (I<sub>out</sub>=0 mA, T=0 °C and T=-55 °C)

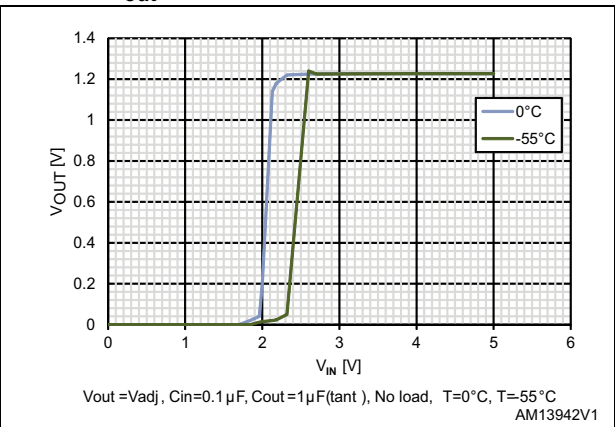


Figure 18. Output voltage vs input voltage ( $I_{out}=3\text{ A}$ ,  $T=25\text{ }^{\circ}\text{C}$  and  $T=125\text{ }^{\circ}\text{C}$ )

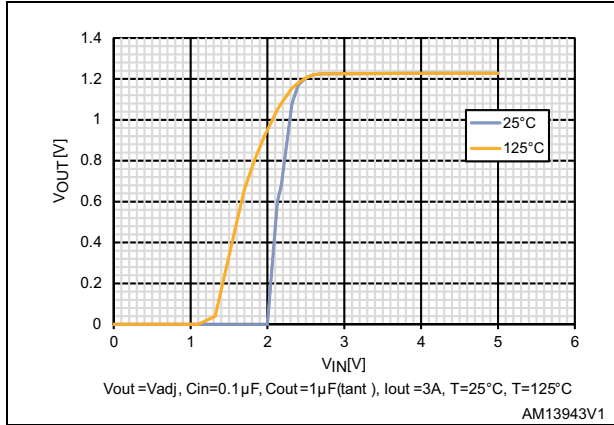


Figure 19. Output voltage vs input voltage ( $I_{out}=3\text{ A}$ ,  $T=0\text{ }^{\circ}\text{C}$  and  $T=-55\text{ }^{\circ}\text{C}$ )

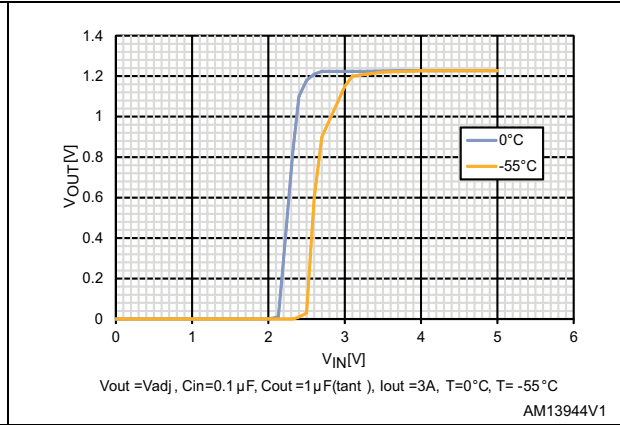


Figure 20. Quiescent current vs temperature (no load)

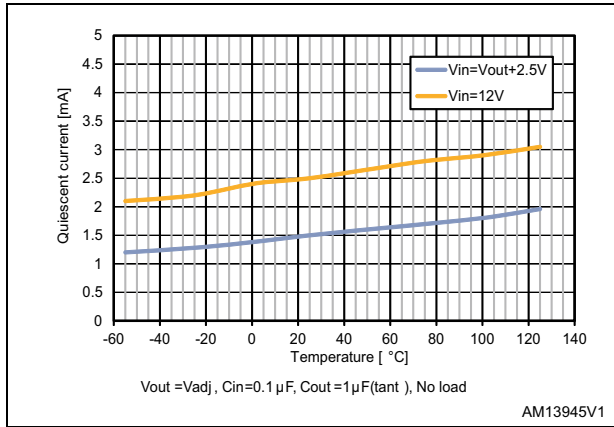


Figure 21. Quiescent current vs temperature ( $I_{out}=30\text{ mA}$ )

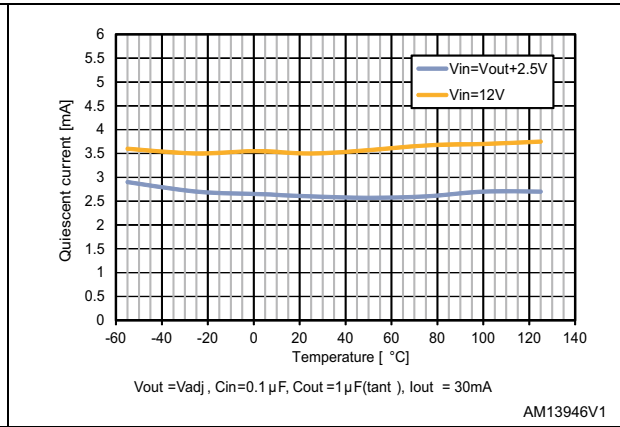


Figure 22. Quiescent current vs temperature ( $I_{out}=300\text{ mA}$ )

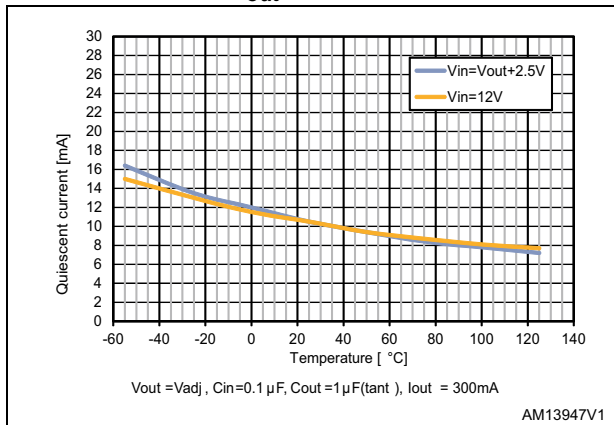


Figure 23. Quiescent current vs temperature ( $I_{out}=1\text{ A}$ )

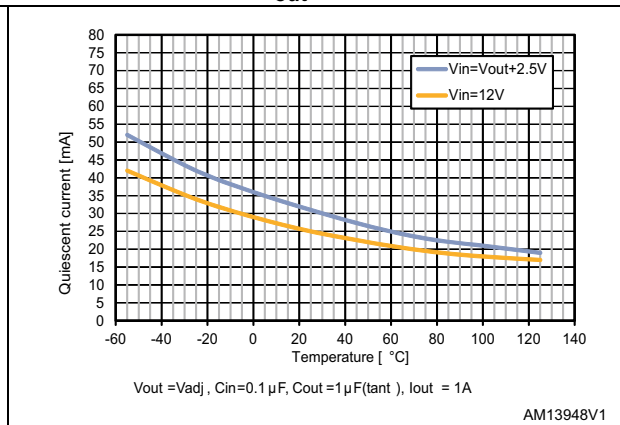


Figure 24. Quiescent current vs temperature  
( $I_{out}=2\text{ A}$ )

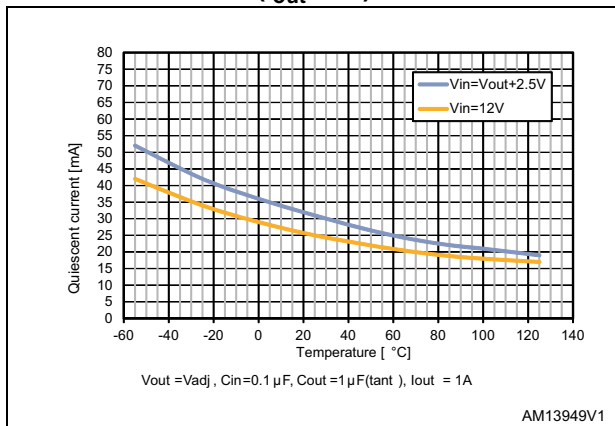


Figure 25. Quiescent current vs load current,  
( $V_{in}=V_{out}+2.5\text{ V}$ )

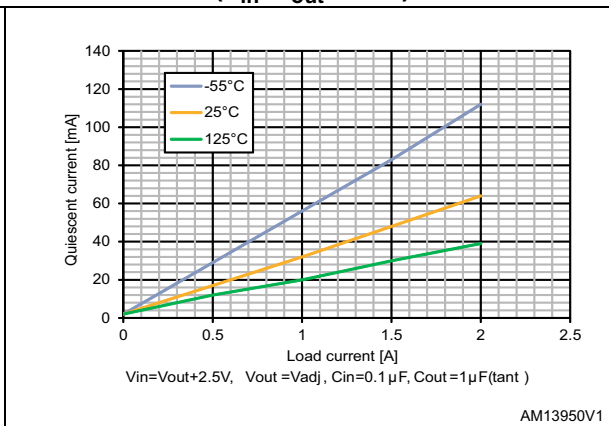


Figure 26. Quiescent current vs load current,  
( $V_{in}=12\text{ V}$ )

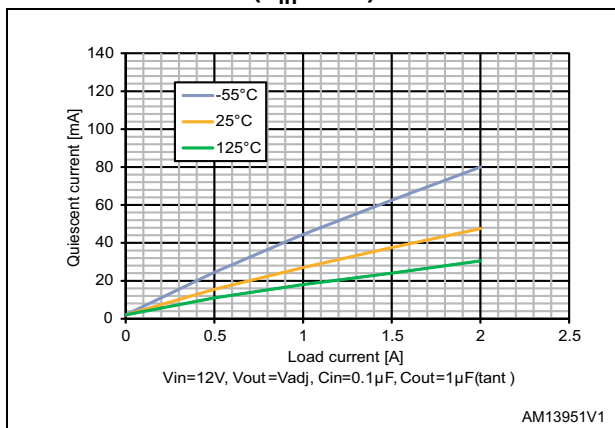


Figure 27. Dropout voltage vs temperature  
( $V_{out}=3\text{ V}$ , no load)

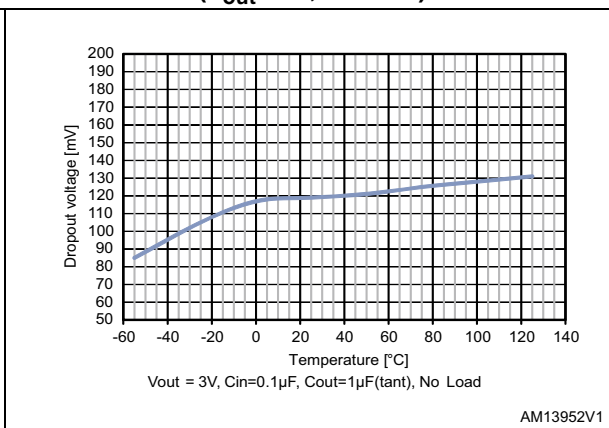


Figure 28. Dropout voltage vs temperature  
( $V_{out}=3\text{ V}$ ,  $I_{out}=400\text{ mA}$ )

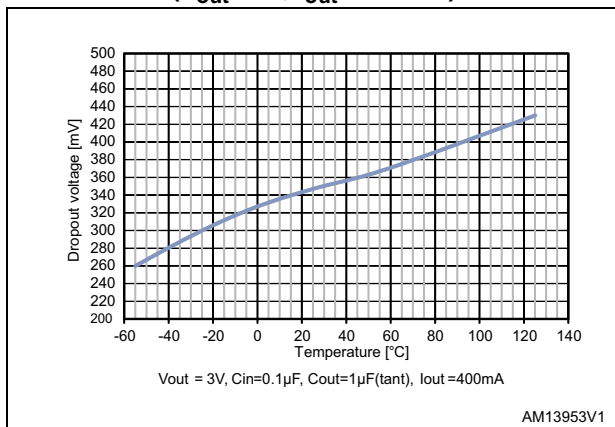


Figure 29. Dropout voltage vs temperature  
( $V_{out}=3\text{ V}$ ,  $I_{out}=1\text{ A}$ )

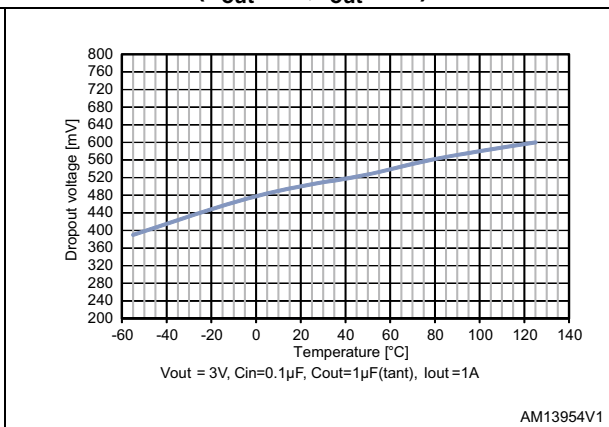


Figure 30. Dropout voltage vs temperature  
( $V_{out}=3\text{ V}$ ,  $I_{out}=2\text{ A}$ )

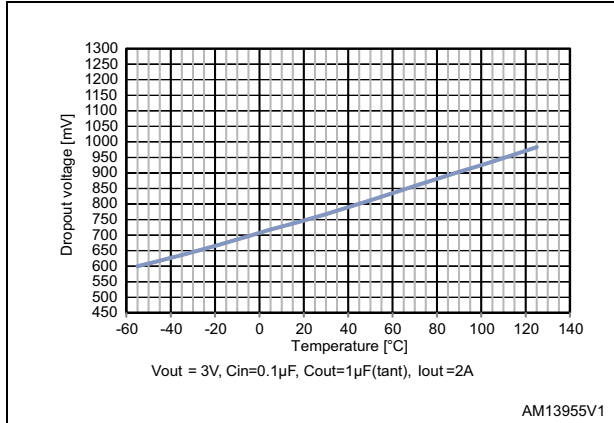


Figure 31. Dropout voltage vs temperature  
( $V_{out}=3\text{ V}$ ,  $I_{out}=3\text{ A}$ )

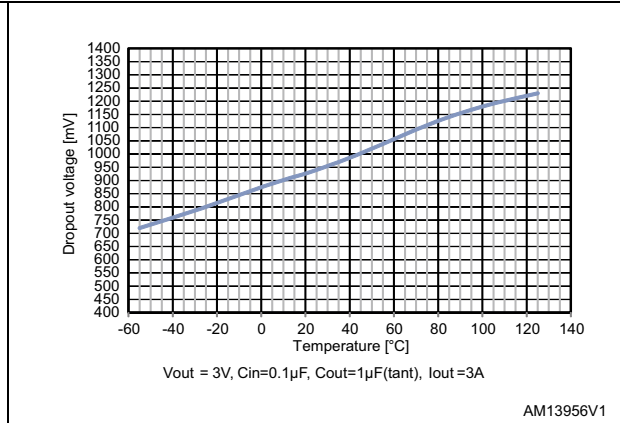


Figure 32. Dropout voltage vs load current  
( $V_{out}=3\text{ V}$ )

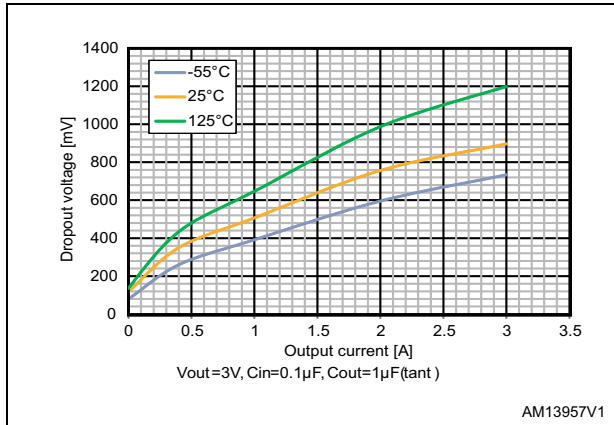


Figure 33. Dropout voltage vs load current  
( $V_{out}=9\text{ V}$ )

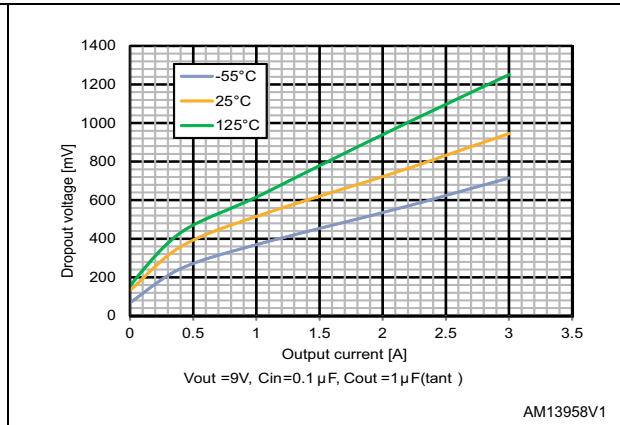


Figure 34. SVR vs frequency

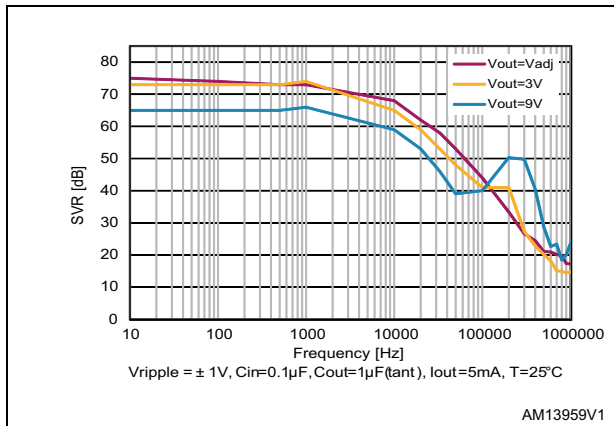


Figure 35. SVR vs load current

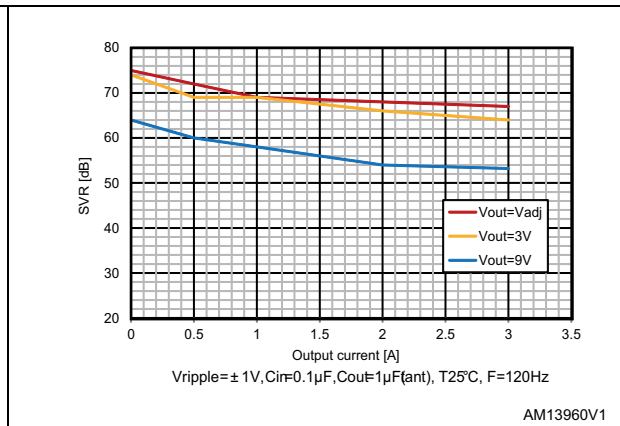


Figure 36. SVR vs temperature

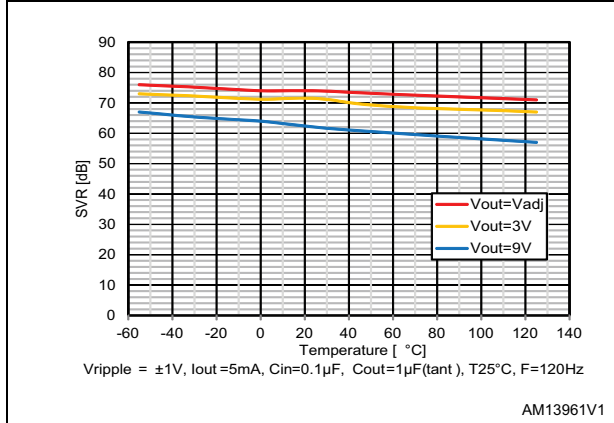


Figure 37. Output noise spectrum ( $V_{out}=V_{adj}$ )

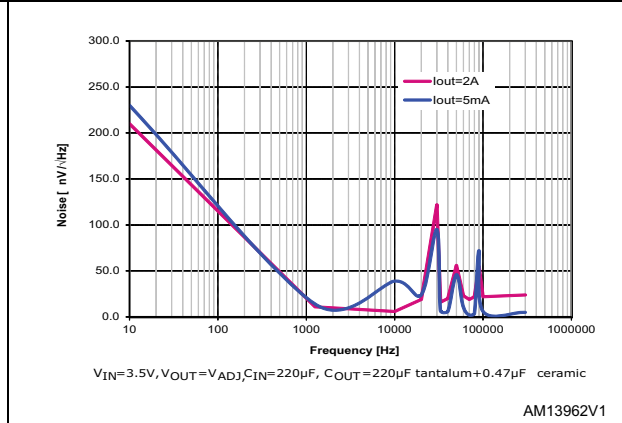


Figure 38. Output noise spectrum ( $V_{out}=V_{adj}$ ,  $C_{out}=1\ \mu F$ )

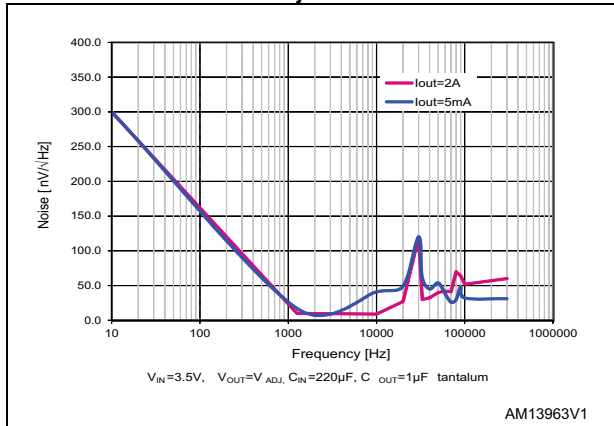


Figure 39. Output noise spectrum ( $V_{out}=9\ V$ )

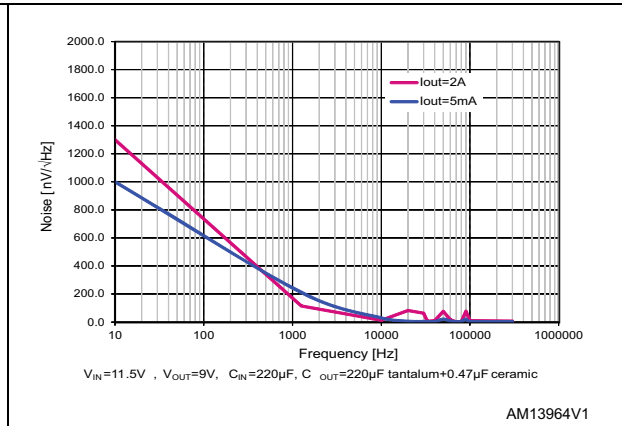


Figure 40. Output noise spectrum ( $V_{out}=9\ V$ ,  $C_{out}=1\ \mu F$ )

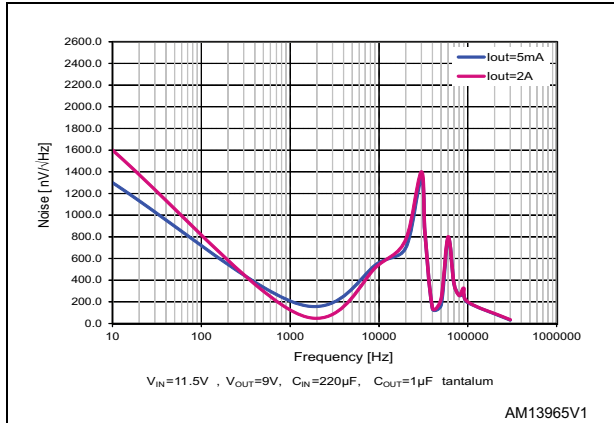


Figure 41. Short circuit current vs dropout voltage ( $T=25\ ^\circ C$ )

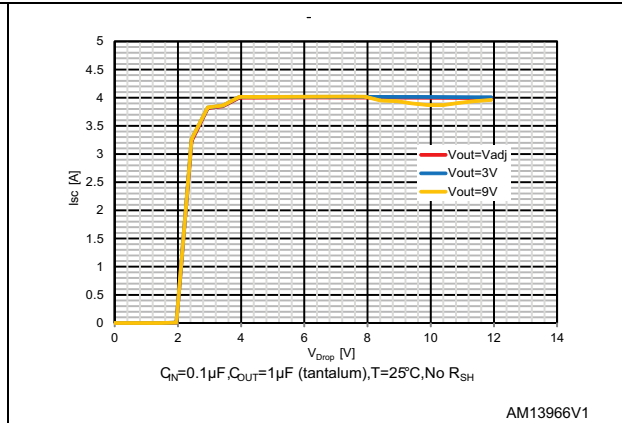


Figure 42. Short circuit current vs dropout voltage (T=125 °C)

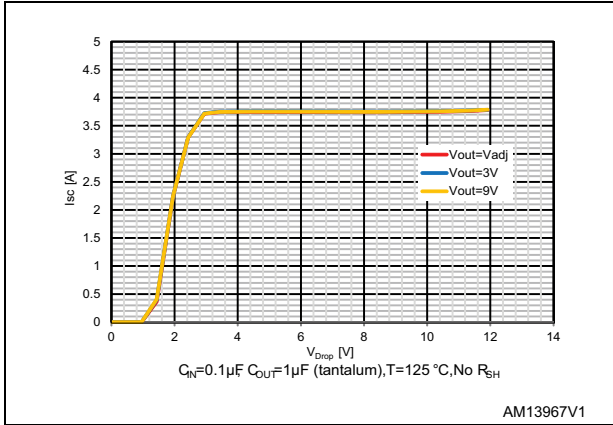


Figure 43. Short circuit current vs dropout voltage (T=-55 °C)

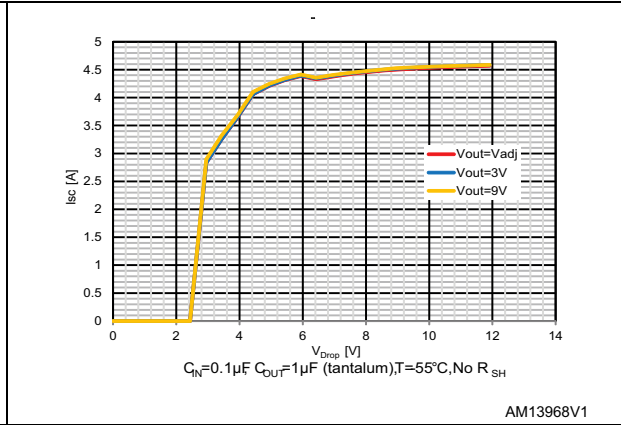


Figure 44. Short circuit current vs R\_SH

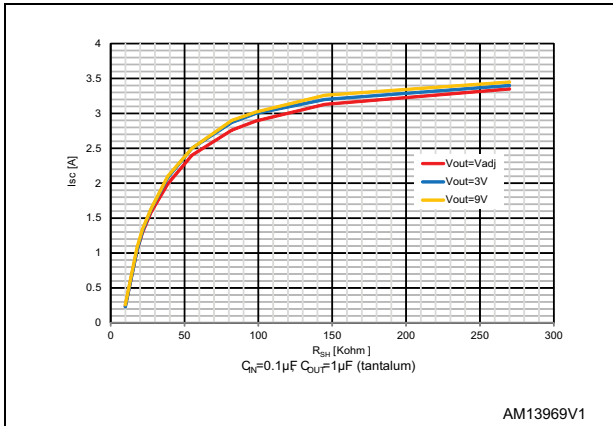


Figure 45. Short circuit current vs R\_SH (zoom)

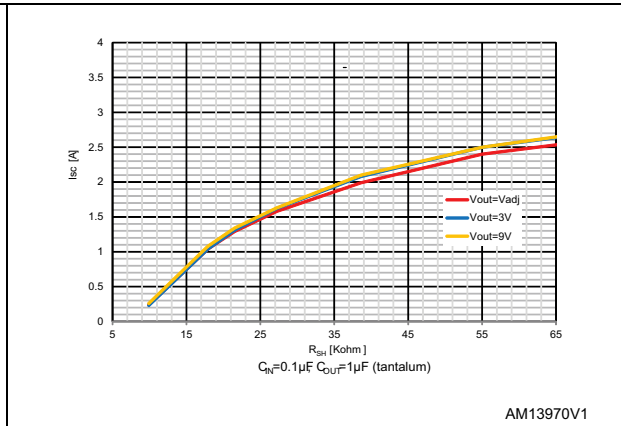


Figure 46. Enable turn-on/off (V\_OUT=9 V)

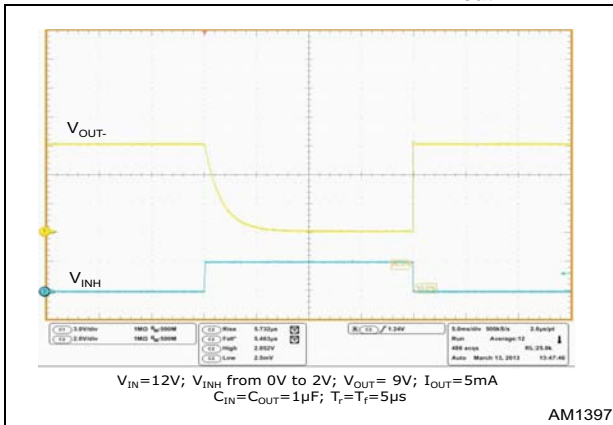


Figure 47. Enable turn-on/off (V\_OUT=1.5 V)

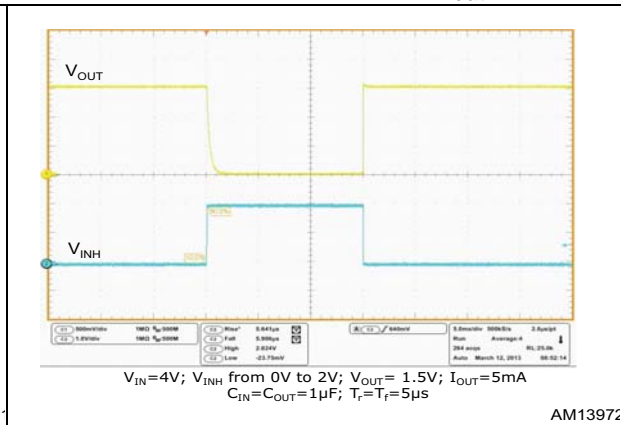


Figure 48. Turn-on time ( $V_{out}=1.5\text{ V}$ )

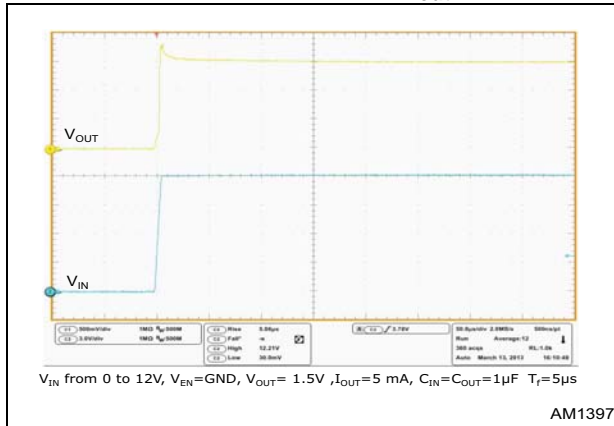


Figure 49. Turn-on time ( $V_{out}=9\text{ V}$ )

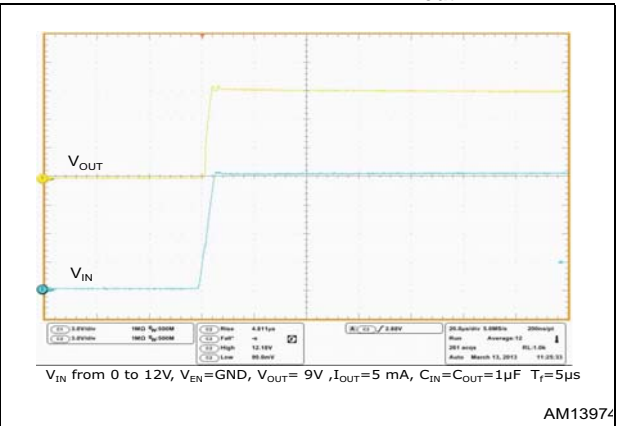


Figure 50. Inhibit propagation delay (Lo-Hi)

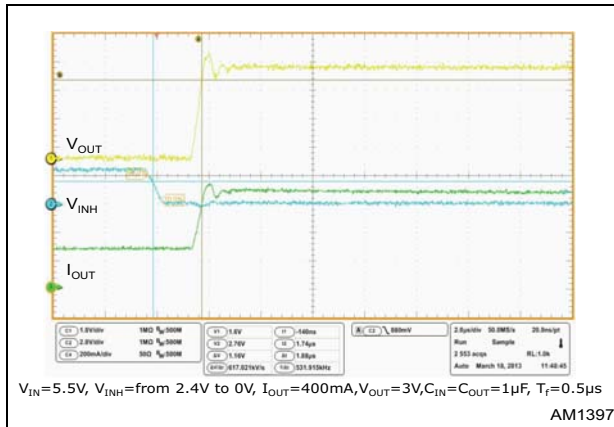


Figure 51. Inhibit propagation delay (Hi-Lo)

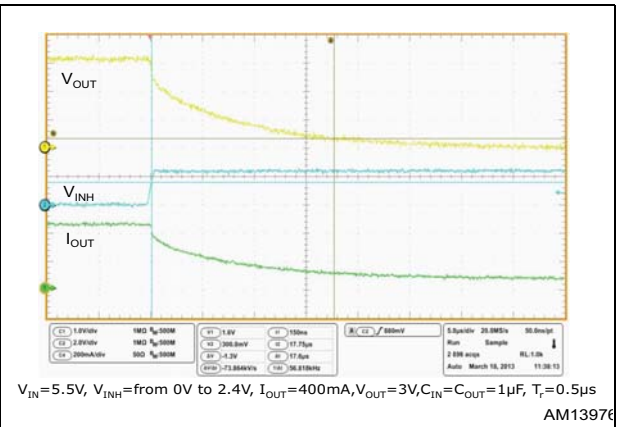


Figure 52. Line transient

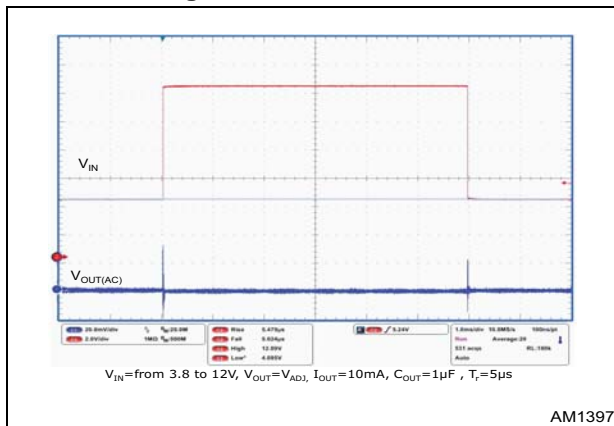


Figure 53. Load transient

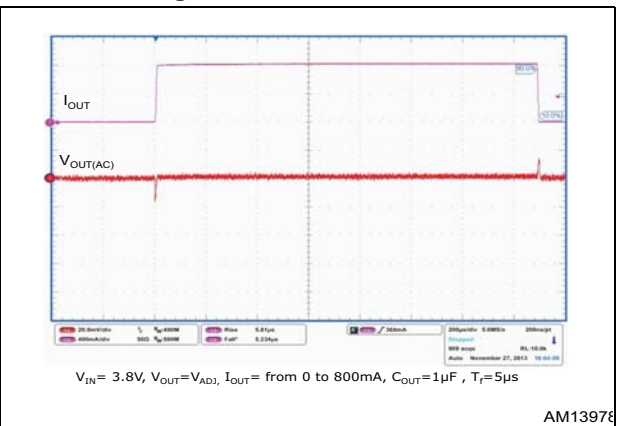
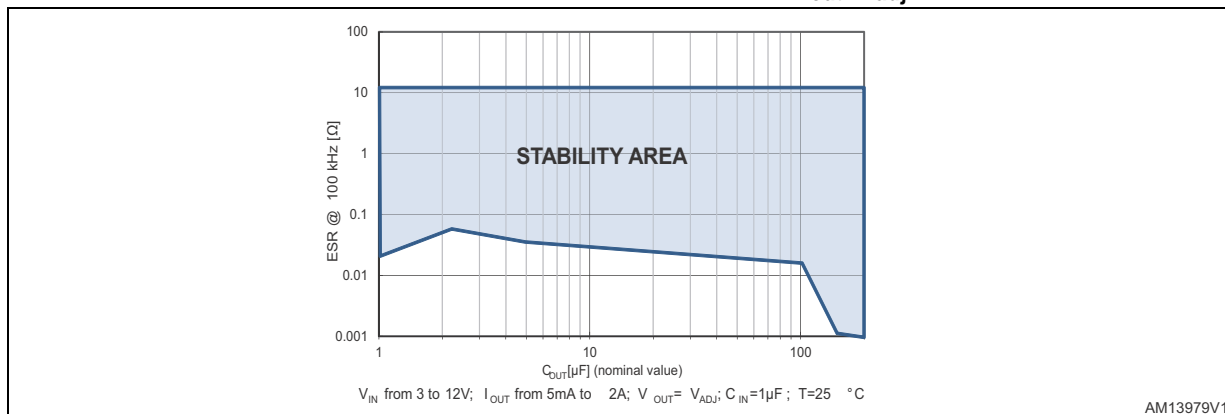


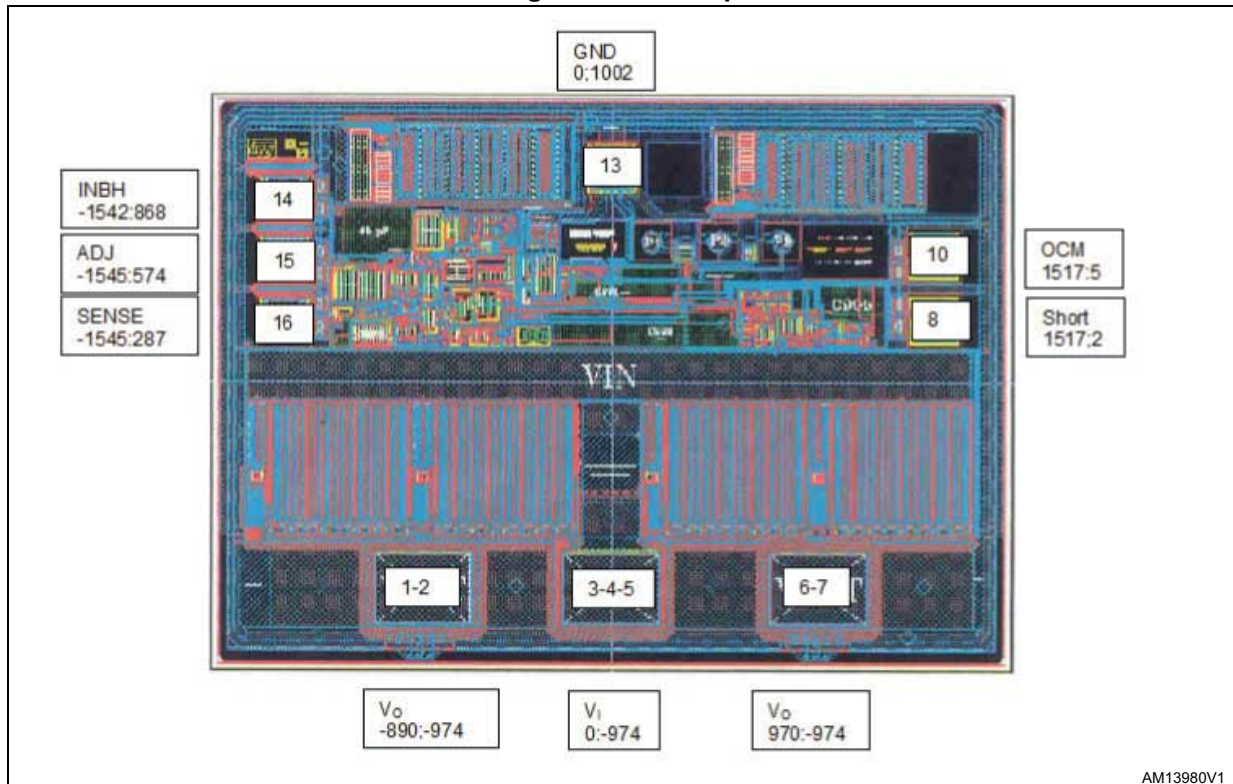
Figure 54. Stability plan ( $V_{out}=V_{adj}$ )





## 8 Die information

Figure 55. Die map



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

### 8.1 Die bonding pad locations and electrical functions

Die physical dimensions:

- Die size: 150 mils x 110 mils (3.81 mm by 2.79 mm)
- Die thickness: 375  $\mu\text{m}$   $\pm$  25  $\mu\text{m}$  (14.8 mils  $\pm$  1 mil)

Pad size: V<sub>IN</sub>, V<sub>OUT</sub> pads: 450  $\mu\text{m}$  x 330  $\mu\text{m}$  (17.7 mils by 13 mils)

- Control pads: 184  $\mu\text{m}$  x 184  $\mu\text{m}$  (7.25 mils square)

Interface materials:

- Top metallization: Al/Si/Cu, 1.05  $\mu\text{m}$   $\pm$  0.15  $\mu\text{m}$
- Backside metallization: none

Glassivation:

- Type: p. vapox + nitride
- Thickness: 0.6  $\mu\text{m}$   $\pm$  0.1  $\mu\text{m}$  + 0.6  $\mu\text{m}$   $\pm$  0.08  $\mu\text{m}$

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.

## 9 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK® is an ST trademark.

Figure 56. FLAT-16 mechanical drawing

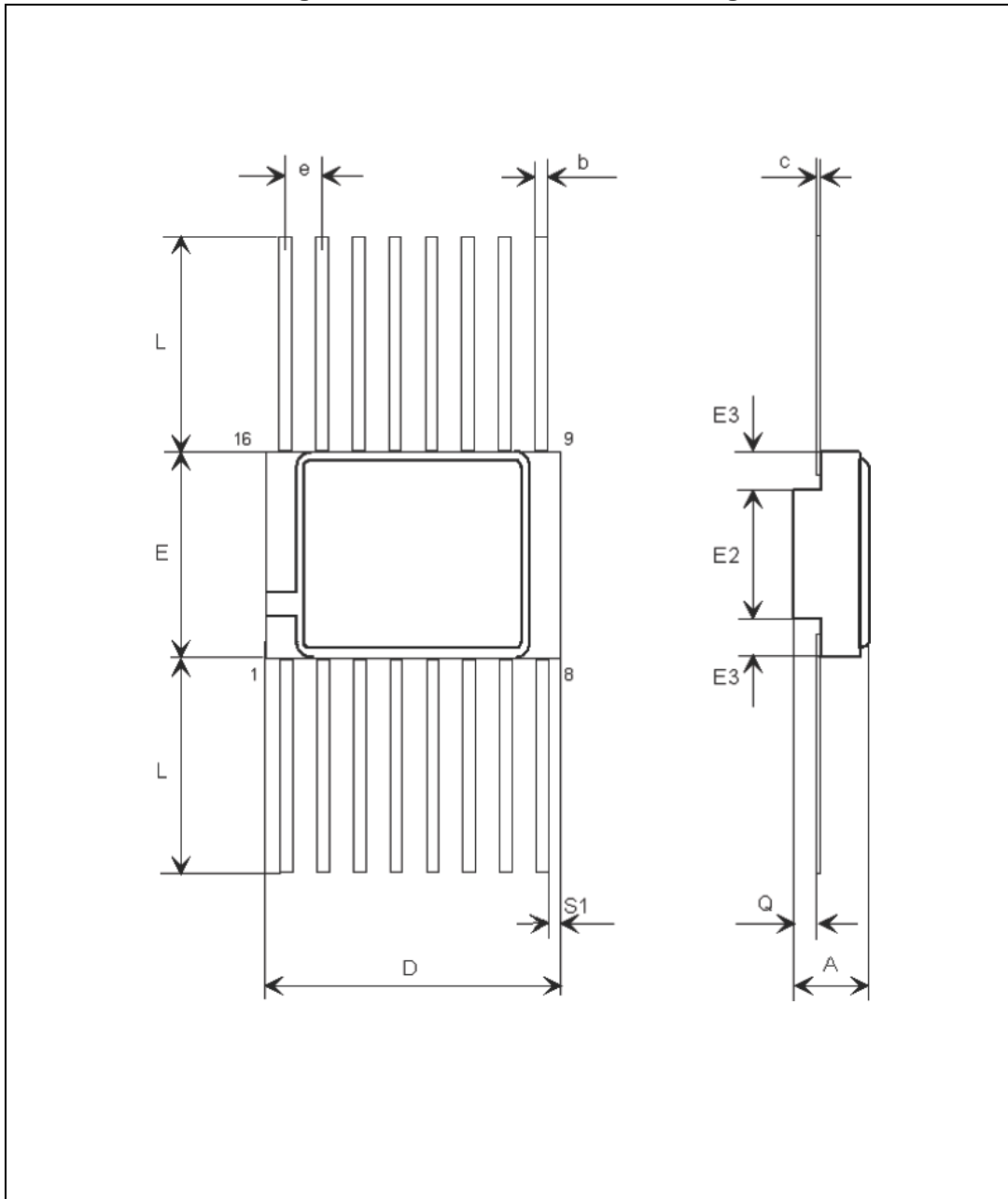
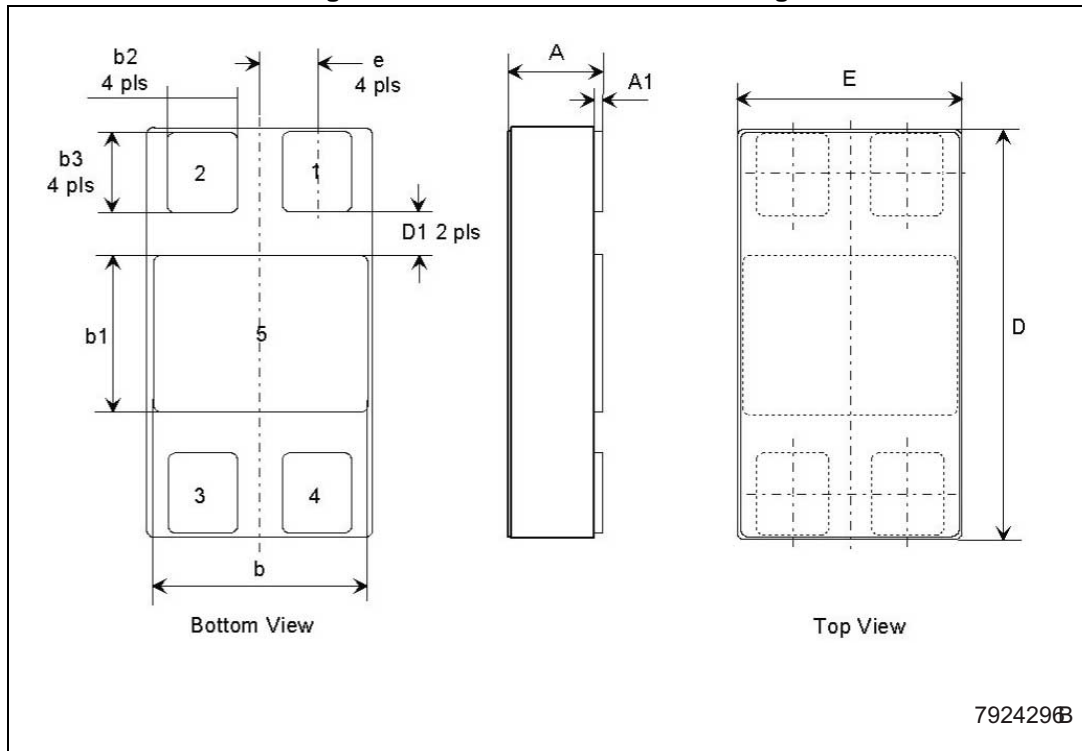


Table 5. FLAT-16 mechanical data

Symbol	Dimensions		
	Min.	Typ.	Max.
A	2.42		2.88
b	0.38		0.48
c	0.10		0.18
D	9.71		10.11
E	6.71		7.11
E2	3.30	3.45	3.60
E3	0.76		
e		1.27	
L	6.35		7.36
Q	0.66		1.14
S1	0.13		

Figure 57. SMD5C mechanical drawing



792429B

Table 6. SMD5C mechanical data

Symbol	Dimensions		
	Min.	Typ.	Max.
A	2.84	3.00	3.15
A1	0.25	0.38	0.51
b	7.13	7.26	7.39
b1	4.95	5.08	5.21
b2	2.28	2.41	2.54
b3	2.92	3.05	3.18
D	13.71	13.84	13.97
D1	0.76		
E	7.39	7.52	7.65
e		1.91	

## 10 Ordering information

**Table 7. Order codes**

Die	FLAT-16	SMD5C	Terminal finish	Output voltage	Quality level
	RHFL4913KPA-01V	RHFL4913SCA07V	Gold	Adj	QML-V
	RHFL4913KPA-02V		Solder	Adj	QML-V
	RHFL4913KPA1	RHFL4913SCA1	Gold	Adj	EM1
L4913ADIE2V				Adj	QML-V die
L4913ADIES				Adj	EM1 die

**Table 8. Part numbers - SMD equivalent**

ST part number	SMD part number
RHFL4913KPA-01V	5962F0252401VXC
RHFL4913KPA-02V	5962F0252401VXA
RHFL4913SCA07V	5962F0252403VUC
L4913ADIE2V	5962F0252401V9A

**Table 9. 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

# 11 Revision history

**Table 10. Document revision history**

Date	Revision	Changes
29-Oct-2004	3	New order codes added - Tables 4 and 5.
27-May-2005	4	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.
23-Nov-2007	8	Pin information for the SMD5C package updated in <a href="#">Table 1</a> ; added section <a href="#">6.3: FPGA power supply lines on page 14</a> . Minor text changes.
22-Sep-2008	9	Modified <a href="#">Application information on page 13</a> .
17-Nov-2008	10	Modified <a href="#">Table 8 on page 30</a> .
21-Jan-2010	11	Modified <a href="#">Table 7 on page 30</a> .
18-Oct-2010	12	Modified <a href="#">Section 6.2 on page 13</a> .
07-Feb-2011	13	Added: note <a href="#">Table 1 on page 7</a> .
07-Dec-2011	14	Removed the note under <a href="#">Table 1 on page 7</a> and added footnotes 1 and 2.
20-Aug-2012	15	Order code updated in <a href="#">Table 7 on page 30</a> about the SMD5C package
15-Jan-2014	16	Updated Features in cover page. Added <a href="#">Section 7: Typical characteristics</a> . Modified <a href="#">Table 4: Electrical characteristics</a> . Updated <a href="#">Section 9: Package mechanical data</a> and <a href="#">Section 10: Ordering information</a> . Minor text changes.
05-May-2014	17	Updated <a href="#">Figure 18: Output voltage vs input voltage (<math>I_{out}=3\text{ A}</math>, <math>T=25\text{ °C}</math> and <math>T=125\text{ °C}</math>)</a> . Minor text changes.

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