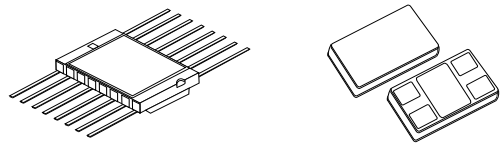
RHFL4913A

Rad-hard adjustable positive voltage regulator

Datasheet - production data



FLAT-16

SMD5C:
5-connection SMD

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 μV_{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 µA 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

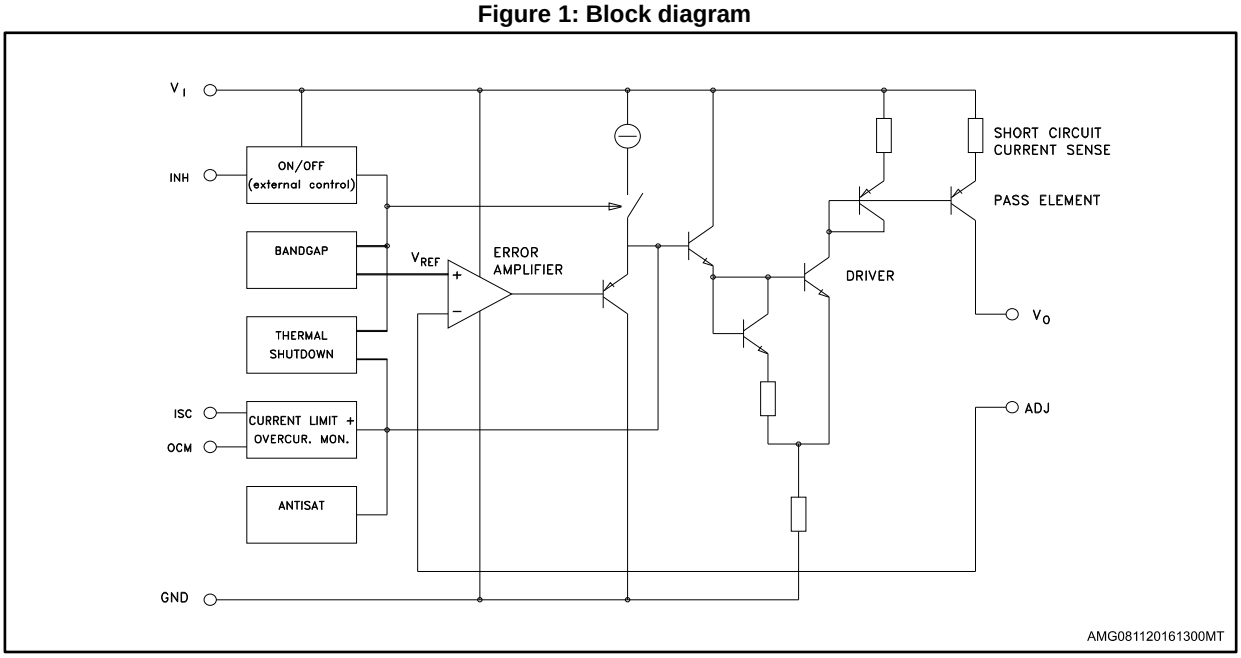
The RHFL4913A is a high-performance adjustable positive voltage regulator, able to provide 2 A of maximum current in FLAT-16 package (3 A in the SMD5C package) from an input voltage ranging from 3 V to 12 V, with a typical dropout voltage of 350 mV.

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 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.

Contents

1 Diagram

Figure 1: Block diagram



2 Pin configuration

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

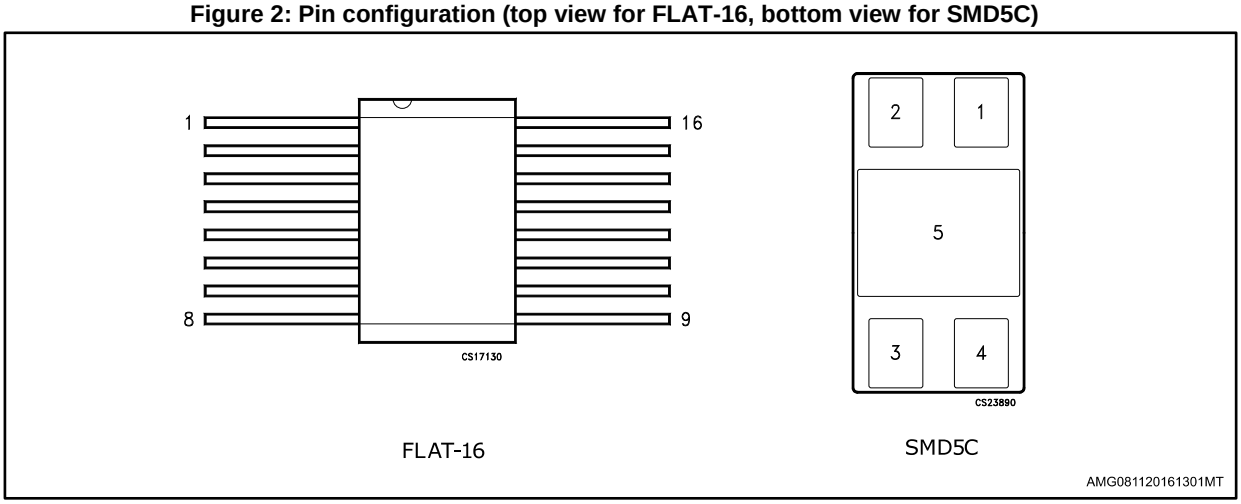


Table 1: Pin description

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

Notes:

(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

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	

Exceeding maximum ratings may damage the device.

Table 3: Thermal data

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

4 Electrical characteristics

T_J = 25 °C, $V_I = V_O + 2.5$ V, $C_I = C_O = 1$ µF, unless otherwise specified.

Table 4: Electrical characteristics

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

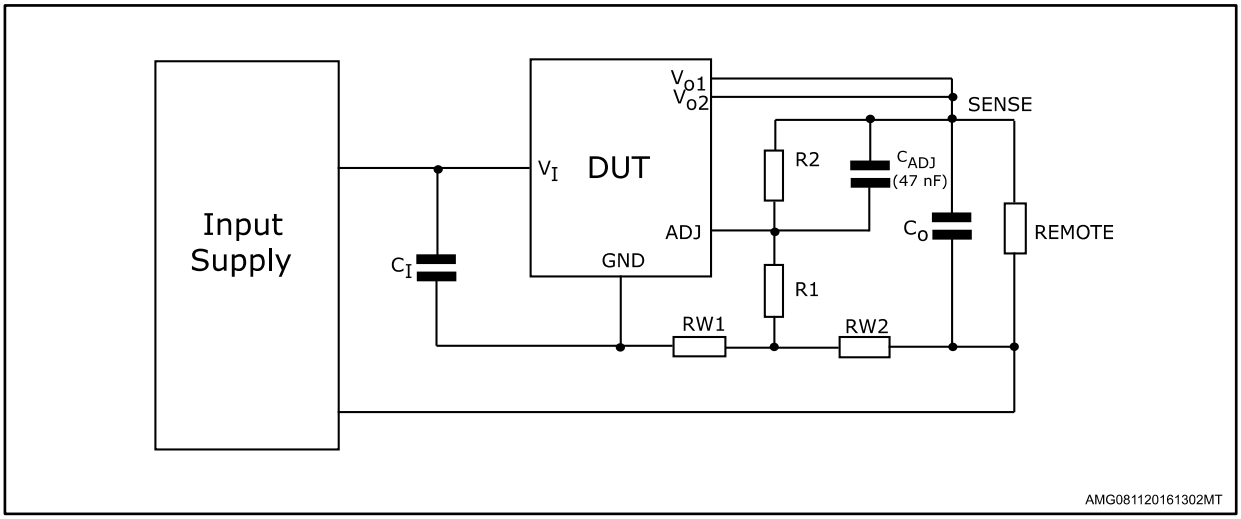
Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_q	Quiescent current	$V_I = V_O + 2.5$ V, $I_O = 5$ mA, ON mode (+25 °C)		1.5	6	mA
		$V_I = V_O + 2.5$ V, $I_O = 30$ mA, ON mode (+25 °C)		2.7	8	
		$V_I = V_O + 2.5$ V, $I_O = 300$ mA, ON mode (+25 °C)		11	25	
		$V_I = V_O + 2.5$ V, $I_O = 1$ A, ON mode (+25 °C)		32	60	
I_q	Quiescent current ON mode	$V_I = V_O + 2.5$ V, $I_O = 30$ mA, (-55 °C)		3	14	mA
		$V_I = V_O + 2.5$ V, $I_O = 300$ mA, (-55 °C)		15	40	
		$V_I = V_O + 2.5$ V, $I_O = 1$ A, (-55 °C)		52	100	
		$V_I = V_O + 2.5$ V, $I_O = 30$ mA, (+125 °C)		3	8	
		$V_I = V_O + 2.5$ V, $I_O = 300$ mA, (+125 °C)		8	20	
		$V_I = V_O + 2.5$ V, $I_O = 1$ A, (+125 °C)		20	40	
$I_{q(off)}$	Quiescent current Shutdown mode	$V_I = V_O + 2$ V, $V_{INH} = 2.4$ V, OFF mode		0.15	1	mA
V_d	Dropout voltage	$I_O = 0$ mA, $V_O = 2.5$ V to 9 V		130		mV
		$I_O = 400$ mA, $V_O = 2.5$ to 9 V, (+25 °C)		350	450	
		$I_O = 400$ mA, $V_O = 2.5$ to 9 V, (-55 °C)		300	400	
		$I_O = 400$ mA, $V_O = 2.5$ to 9 V, (+125 °C)		450	550	
		$I_O = 1$ A, $V_O = 2.5$ to 9 V, (+25 °C)		500	650	
		$I_O = 1$ A, $V_O = 2.5$ to 9 V, (-55 °C)		400	550	
		$I_O = 1$ A, $V_O = 2.5$ to 9 V, (+125 °C)		640	800	
		$I_O = 2$ A, $V_O = 2.5$ to 9 V, (+25 °C)		750		
		$I_O = 2$ A, $V_O = 2.5$ to 9 V, (+125 °C)		950		

Symbol	Parameter	Test conditions		Min.	Typ.	Max.	Unit
$V_{INH(ON)}$	Inhibit voltage	I_O = 5 mA, T_J = -55 to +125 °C				0.8	V
$V_{INH(OFF)}$	Inhibit voltage	I_O = 5 mA, T_J = -55 to +125 °C		2.4			V
SVR	Supply voltage rejection(1)	$V_I = V_O$ + 2.5 V ± 0.5 V, V_O = 3 V, I_O = 5 mA	f = 120 Hz	60	70		dB
			f = 33 KHz	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)	$V_I = V_O$ + 2.5 V, V_{INH} = 2.4 V, I_O = 400 mA, V_O = 3 V	ON-OFF			20	µs
			OFF-ON			100	µs
eN	Output noise voltage(1)	B = 10 Hz to 100 kHz, I_O = 5 mA to 2 A			40		µVrms

Notes:

(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 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 kΩ to 200 kΩ (refer to *Figure 44: "Short circuit current vs RSH"* and *Figure 45: "Short circuit current vs RSH (zoom)"*).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 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 kΩ resistor.

6 Application information

To adjust the output voltage, the R2 resistor must be connected between the V_O 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_{ADJ} 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_I - V_O 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_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, as well as all available V_O 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_T 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: "Stability plan (Vout = Vadj)"*.

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: "Application diagram for remote sensing operation"*). 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 the parasitic series line resistor RW2. To compensate for this parasitic voltage, resistor RW1can be introduced to provide the necessary compensating voltage signal to the ADJ pin.

A ceramic or poliester 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 < 100 nsec) 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 µF C_{OUT} filtering capacitor, with ESR lower than 30 mΩ, 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: "Baseline bias configuration with remote feedback"* and *Figure 5: "Local feedback configuration"*.

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).

Figure 4: Baseline bias configuration with remote feedback

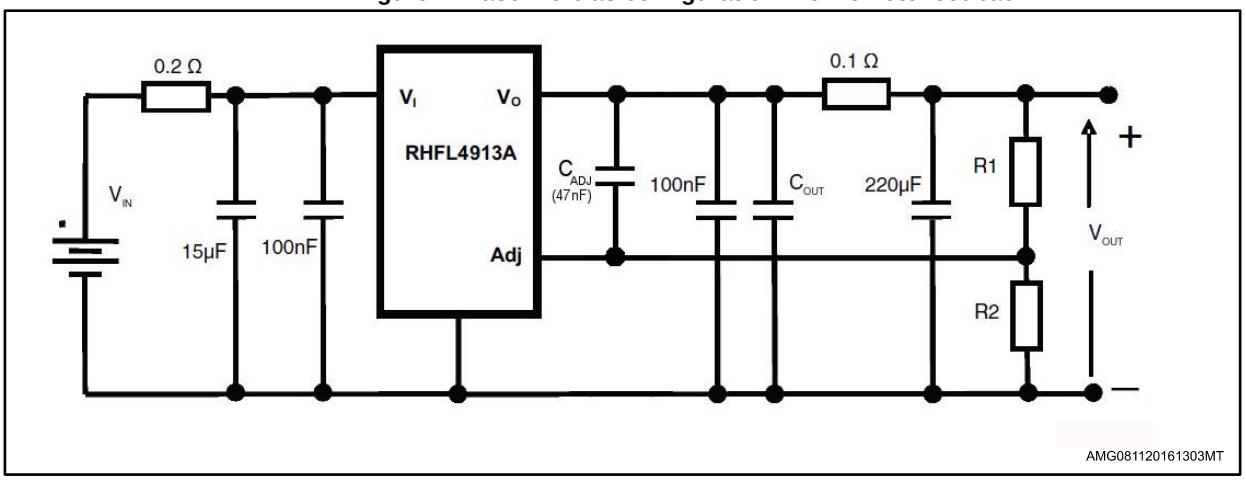
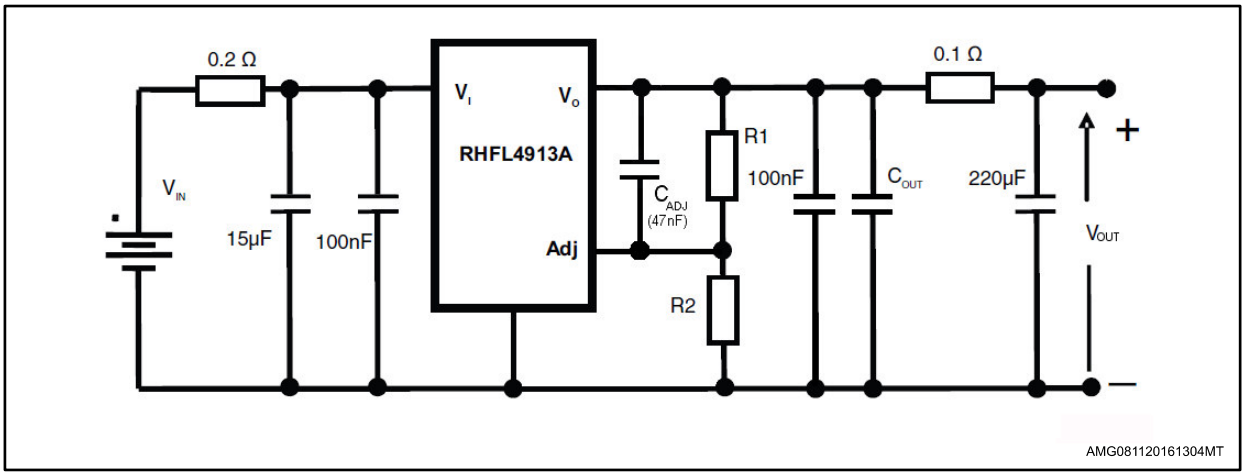


Figure 5: Local feedback configuration

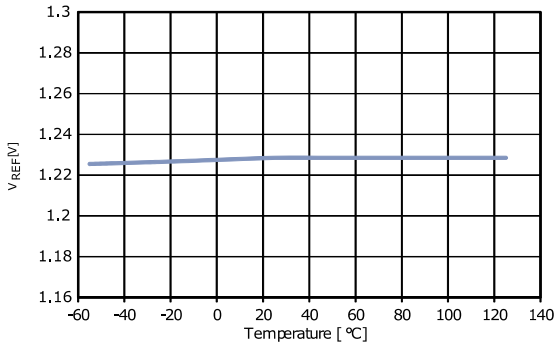


6.4 Notes on the 16-pin hermetic package

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 V)



Vin=Vout+2.5V, Vout =Vadj, Cin=0.1 µF, Cout = 1µF(tant), Iout =5mA

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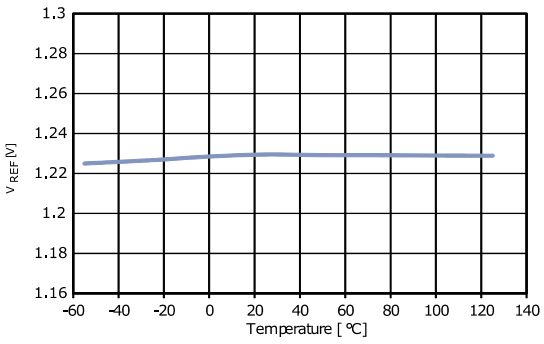
Figure 7: Reference voltage versus temperature (V_{in} = 12 V)



Vin=12V, Vout =Vadj, Cin=0.1 µF, Cout = 1µF(tant), Iout =5mA

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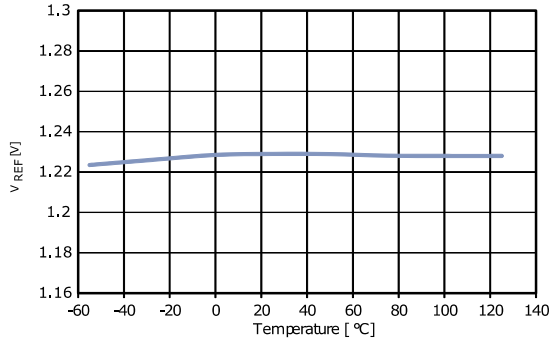
Figure 8: Reference voltage vs temperature (V_{in} = V_{out} + 2.5 V, I_{out} = 1 A)



Vin=Vout+2.5V, Vout =Vadj, Cin=0.1 µF, Cout = 1µF(tant), Iout =1A

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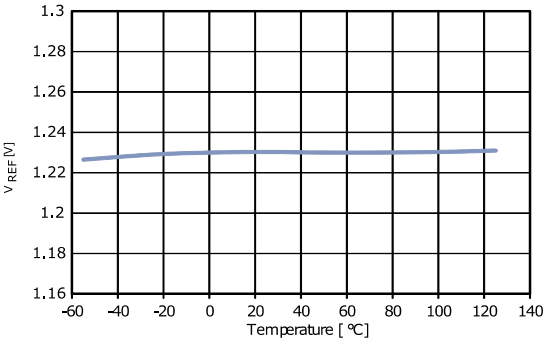
Figure 9: Reference voltage vs temperature (V_{in} = 12 V, I_{out} = 1 A)



Vin=12V, Vout =Vadj, Cin=0.1 µF, Cout = 1µF(tant), Iout =1A

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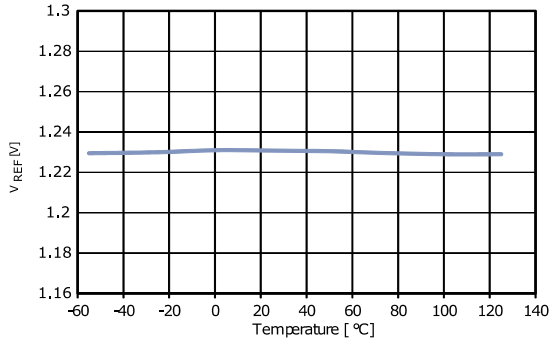
Figure 10: Reference voltage vs temperature (V_{in} = V_{out} + 2.5 V, I_{out} = 2 A)



Vin=Vout+2.5V, Vout =Vadj, Cin=0.1 µF, Cout = 1µF(tant), Iout =2A

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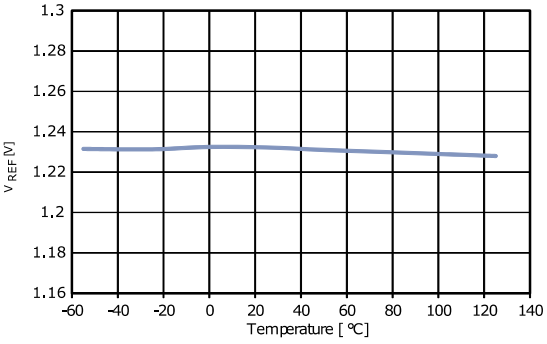
Figure 11: Reference voltage versus temperature (V_{in} = 12 V, I_{out} = 2 A)



Vin=12V, Vout =Vadj, Cin=0.1 µF, Cout = 1µF(tant), Iout =2A

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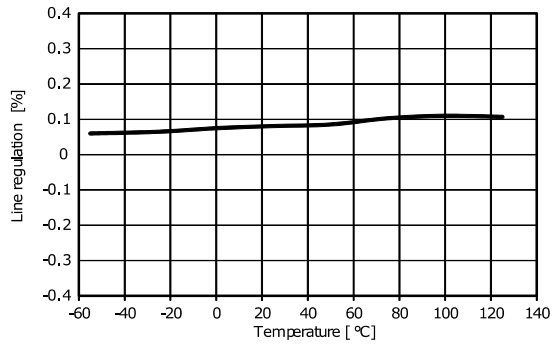
Figure 12: Line regulation vs temperature



Vout+2.5V <Vin < 12V, Vout =Vadj, Cin=0.1 µF, Cout = 1µF(tant), Iout =5mA

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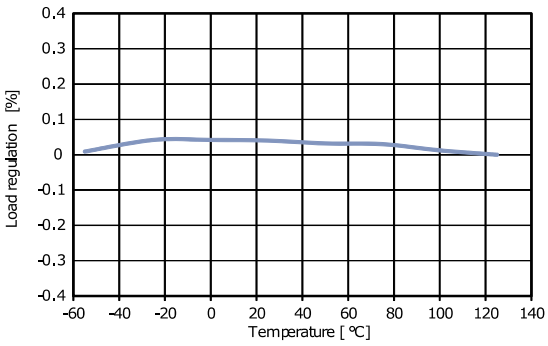
Figure 13: Load regulation vs temperature (I_{out} = 5 mA to 400 mA)



Vin =Vout+2.5V , Vout =Vadj, Cin=0.1 µF, Cout = 1µF(tant), 5mA< Iout <0.4A

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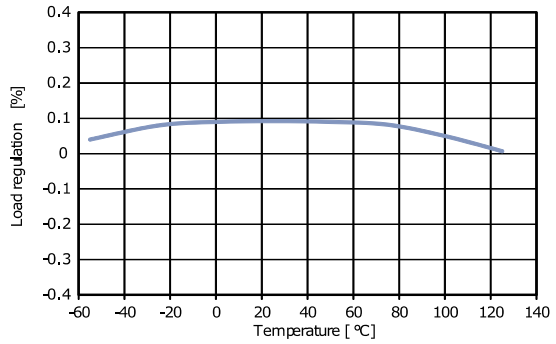
Figure 14: Load regulation vs temperature (I_{out} = 5 mA to 1 A)



Vin =Vout+2.5V , Vout =Vadj, Cin=0.1 µF, Cout = 1µF(tant), 5mA< Iout <1A

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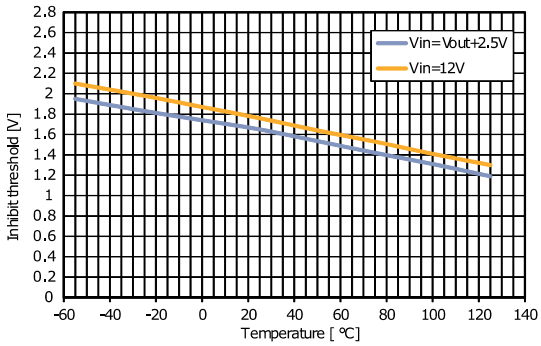
Figure 15: Inhibit threshold vs temperature



Vout =Vadj, Cin=0.1 µF, Cout =1 µF(tant), no load

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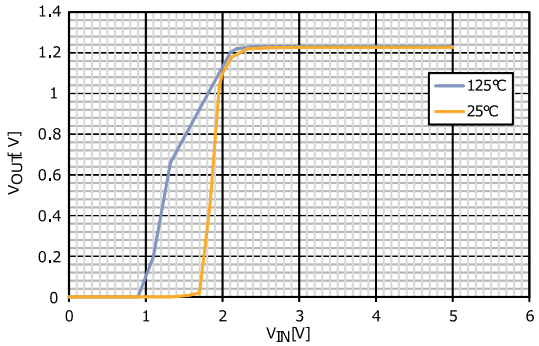
Figure 16: Output voltage vs input voltage (I_{out} = 0 mA,T = 25 °C and T = 125 °C)



Vout =Vadj, Cin=0.1 µF, Cout =1 µF(tant), No load, T=25°C, T=125°C

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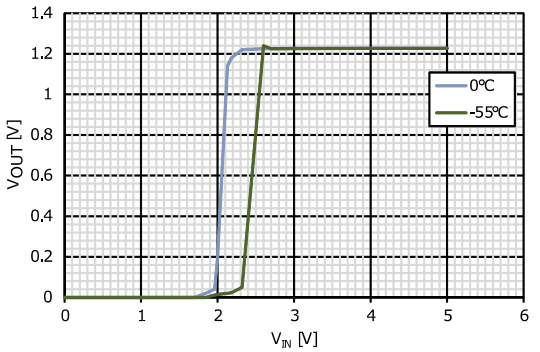
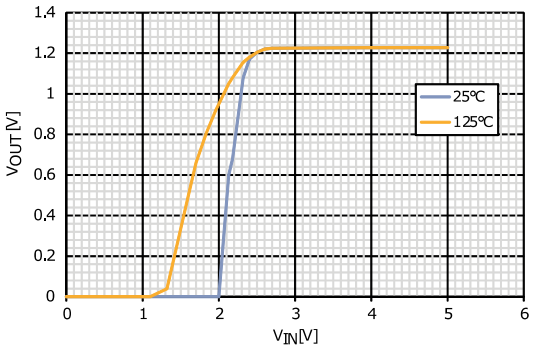
Figure 17: Output voltage vs input voltage (I_{out} = 0 mA,T = 0 °C and T = -55 °C)



Vout =Vadj, Cin=0.1 µF, Cout = 1µF(tant), No load, T=0°C, T=-55°C

AMG081120161316MT

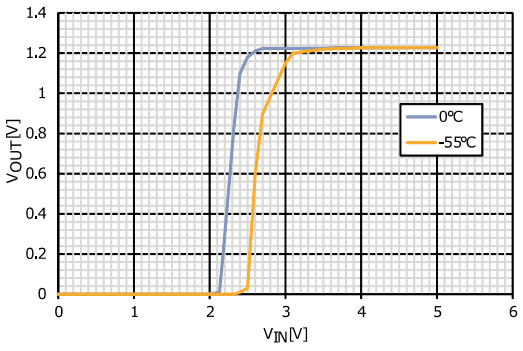
Figure 18: Output voltage vs input voltage (I_{out} = 3 A, T = 25 °C and T = 125 °C)



Vout =Vadj, Cin=0.1µF, Cout=1µF(tant), Iout =3A, T=25°C, T=125°C

AMG081120161317MT

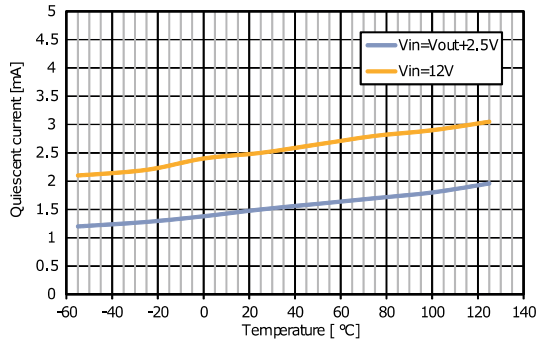
Figure 19: Output voltage vs input voltage (I_{out} = 3 A, T = 0 °C and T = -55 °C)



Vout =Vadj, Cin=0.1 µF, Cout = 1µF(tant), Iout =3A, T=0°C, T= -55°C

AMG081120161318MT

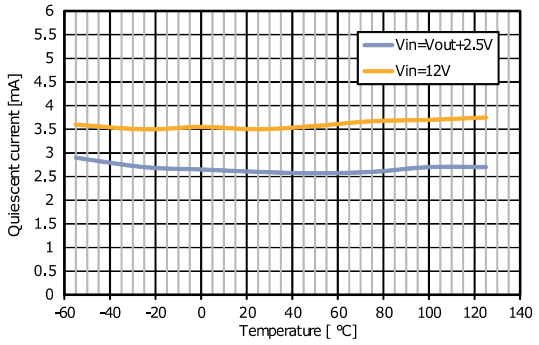
Figure 20: Quiescent current vs temperature (no load)



Vout =Vadj, Cin=0.1 µF, Cout =1µF(tant), No load

AMG081120161319MT

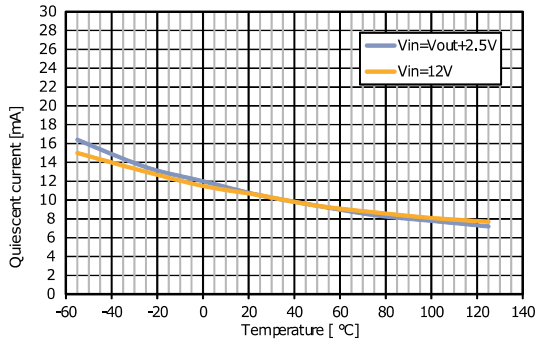
Figure 21: Quiescent current vs temperature (I_{out} = 30 mA)



Vout =Vadj, Cin=0.1 µF, Cout = 1µF(tant), Iout = 30mA

AMG081120161320MT

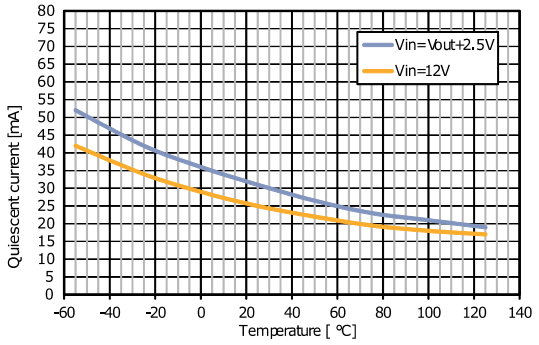
Figure 22: Quiescent current vs temperature (I_{out} = 300 mA)



Vout =Vadj, Cin=0.1 µF, Cout =1µF(tant), Iout = 300mA

AMG081120161321MT

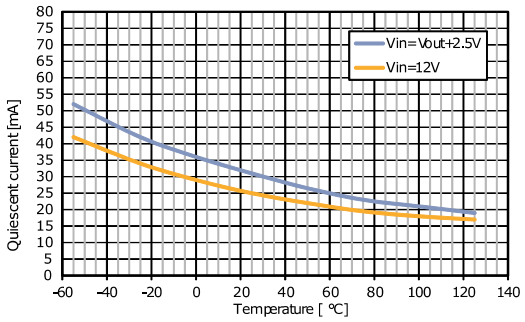
Figure 23: Quiescent current vs temperature (I_{out} = 1 A)



Vout =Vadj, Cin=0.1 µF, Cout = 1µF(tant), Iout = 1A

AMG081120161322MT

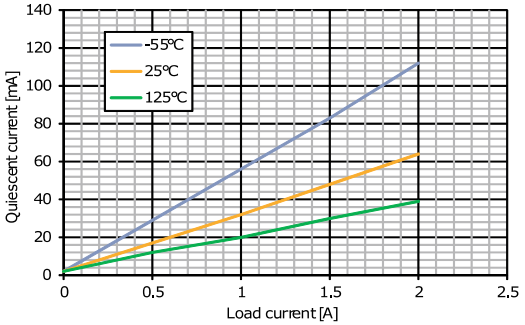
Figure 24: Quiescent current vs temperature (I_{out} = 2 A)



Vout =Vadj, Cin=0.1 µF, Cout = 1µF(tant), Iout = 1A

AMG081120161323MT

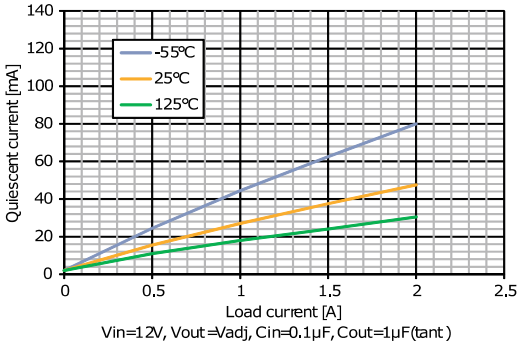
Figure 25: Quiescent current vs load current (V_{in} = V_{out} + 2.5 V)



Vin=Vout+2.5V, Vout =Vadj, Cin=0.1 µF, Cout =1µF(tant)

AMG081120161324MT

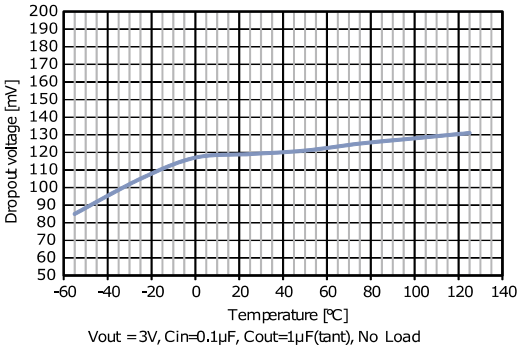
Figure 26: Quiescent current vs load current (V_{in} = 12 V)



Vin=12V, Vout =Vadj, Cin=0.1µF, Cout=1µF(tant)

AMG081120161325MT

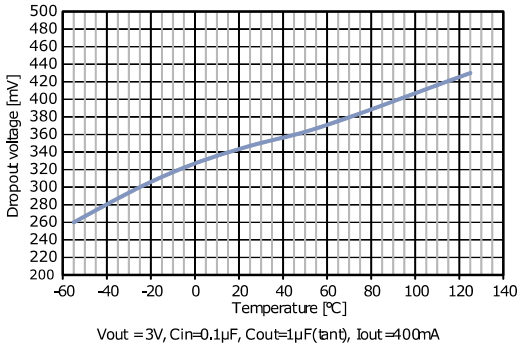
Figure 27: Dropout voltage vs temperature (V_{out} = 3 V, no load)



Vout = 3V, Cin=0.1µF, Cout=1µF(tant), No Load

AMG081120161326MT

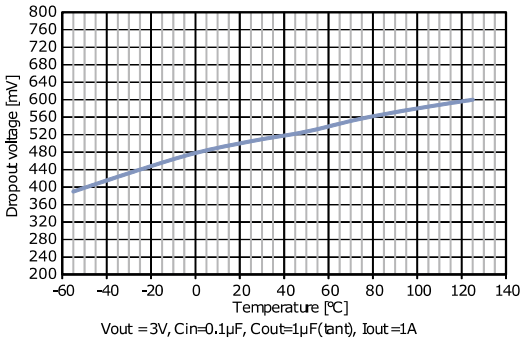
Figure 28: Dropout voltage vs temperature (V_{out} = 3 V, I_{out} = 400 mA)



Vout = 3V, Cin=0.1µF, Cout=1µF(tant), Iout =400mA

AMG081120161327MT

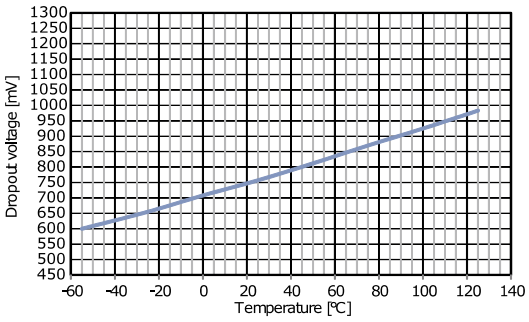
Figure 29: Dropout voltage vs temperature (V_{out} = 3 V, I_{out} = 1 A)



Vout = 3V, Cin=0.1µF, Cout=1µF(tant), Iout =1A

AMG081120161328MT

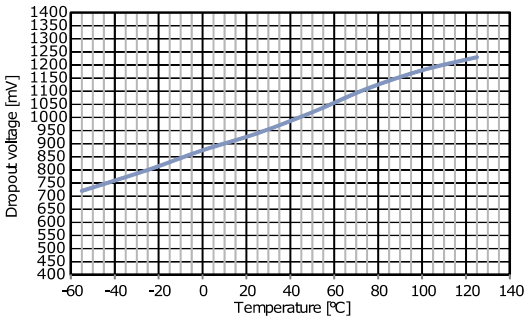
Figure 30: Dropout voltage vs temperature (V_{out} = 3 V, I_{out} = 2 A)



Vout =3V, Cin=0.1µF, Cout=1µF(tant), Iout=2A

AMG081120161329MT

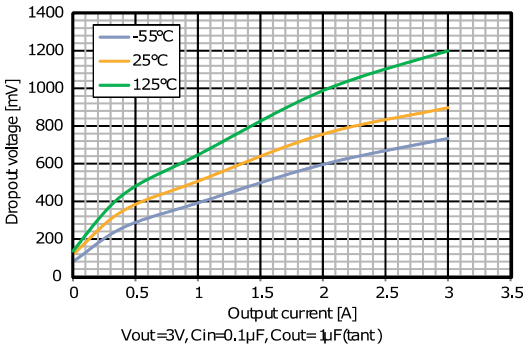
Figure 31: Dropout voltage vs temperature (V_{out} = 3 V, I_{out} = 3 A)



Vout =3V, Cin=0.1µF, Cout=1µF(tant), Iout=3A

AMG081120161330MT

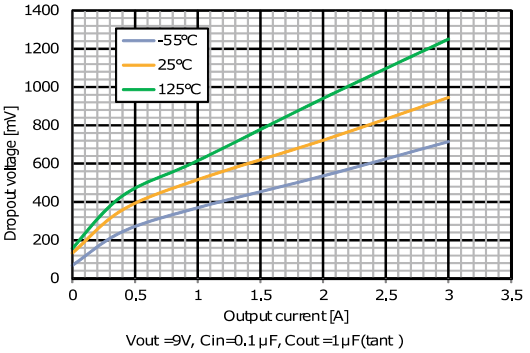
Figure 32: Dropout voltage vs load current (V_{out} = 3 V)



Vout=3V, Cin=0.1µF, Cout= 1µF(tant)

AMG081120161331MT

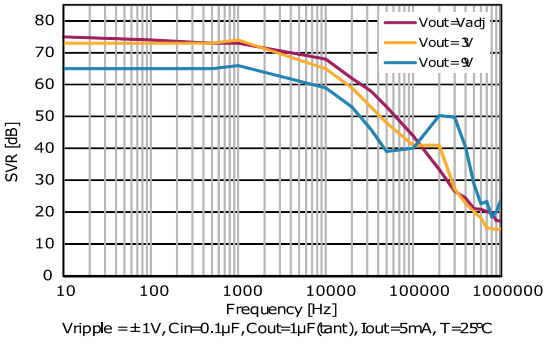
Figure 33: Dropout voltage vs load current (V_{out} = 9 V)



Vout =9V, Cin=0.1 µF, Cout =1µF(tant)

AMG081120161332MT

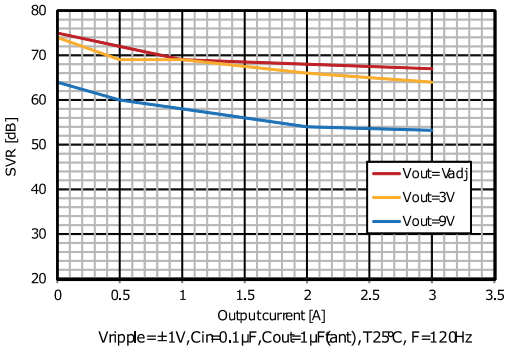
Figure 34: SVR vs frequency



Vripple =±1V, Cin=0.1µF, Cout=1µF(tant), Iout=5mA, T=25°C

AMG081120161333MT

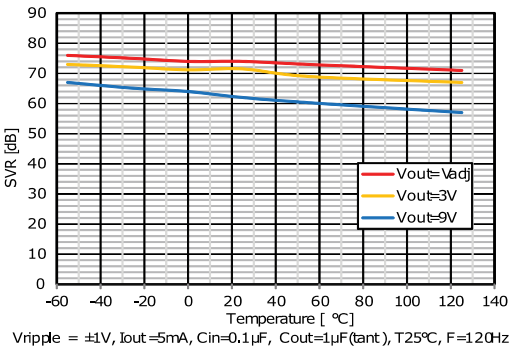
Figure 35: SVR vs load current



Vripple=±1V, Cin=0.1µF, Cout=1µF(tant), T25°C, F=120Hz

AMG081120161334MT

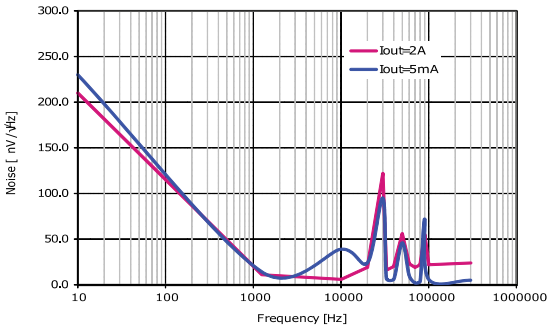
Figure 36: SVR vs temperature



Vripple = ±1V, Iout=5mA, Cin=0.1µF, Cout=1µF(tant), T25°C, F=120Hz

AMG081120161335MT

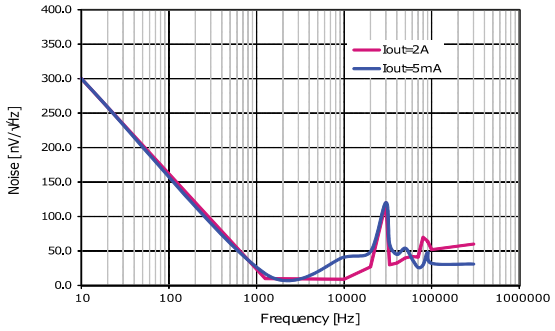
Figure 37: Output noise spectum (V_{out} = V_{adj})



V_{IN}=3.5V, V_{OUT}=V_{ADJ}, C_{IN}=220µF, C_{OUT}=220µF tantalum+0.47µF ceramic

AMG081120161336MT

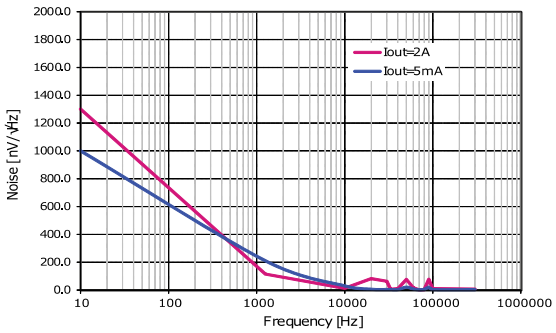
Figure 38: Output noise spectum (V_{out} = V_{adj}, C_{out} = 1 µF)



V_{IN}=3.5V, V_{OUT}=V_{ADJ}, C_{IN}=220µF, C_{OUT}=1µF tantalum

AMG081120161337MT

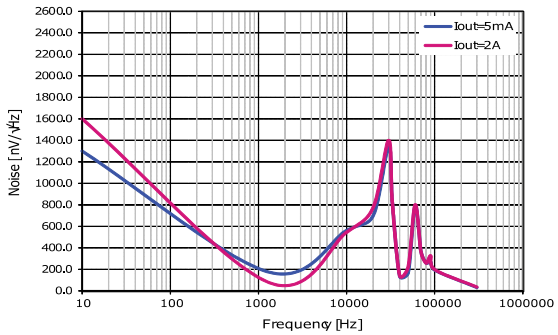
Figure 39: Output noise spectum (V_{out} = 9 V)



V_{IN}=11.5V, V_{OUT}=9V, C_{IN}=220µF, C_{OUT}=220µF tantalum+0.47µF ceramic

AMG081120161338MT

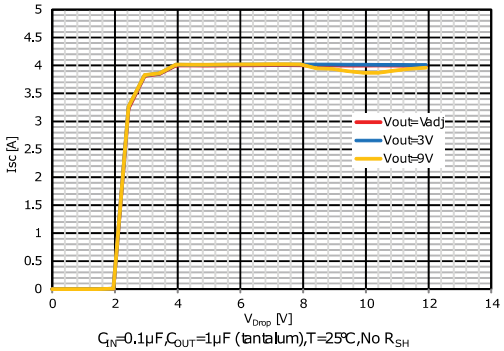
Figure 40: Output noise spectum (V_{out} = 9 V, C_{out} = 1 µF)



V_{IN}=11.5V, V_{OUT}=9V, C_{IN}=220µF, C_{OUT}=1µF tantalum

AMG081120161339MT

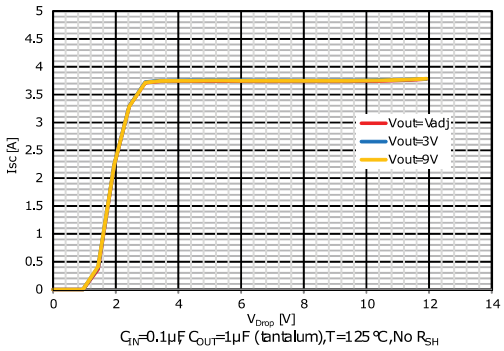
Figure 41: Short circuit current vs dropout voltage (T = 25 °C)



C_{IN}=0.1µF, C_{OUT}=1µF (tantalum), T=25°C, No R_{SH}

AMG081120161340MT

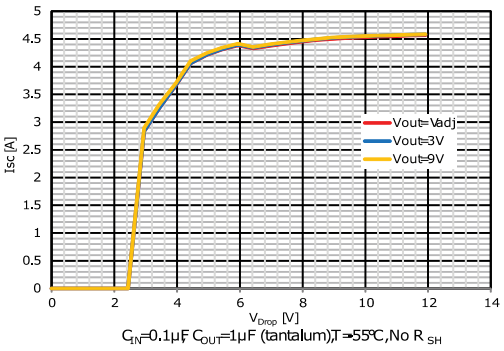
Figure 42: Short circuit current vs dropout voltage (T = 125 °C)



C_{IN}=0.1µF C_{OUT}=1µF (tantalum),T=125 °C,No R_{SH}

AMG081120161341MT

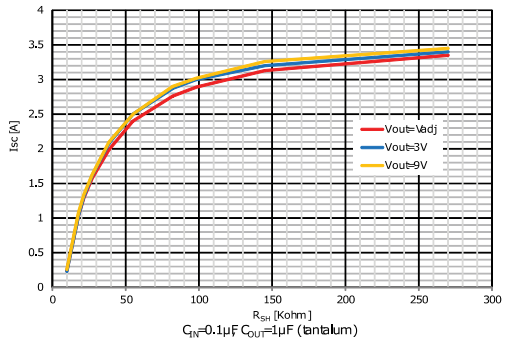
Figure 43: Short circuit current vs dropout voltage (T = -55 °C)



C_{IN}=0.1µF C_{OUT}=1µF (tantalum),T=-55°C,No R_{SH}

AMG081120161342MT

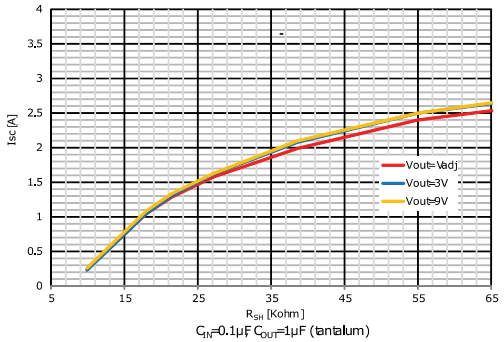
Figure 44: Short circuit current vs RSH



C_{IN}=0.1µF C_{OUT}=1µF (tantalum)

AMG081120161343MT

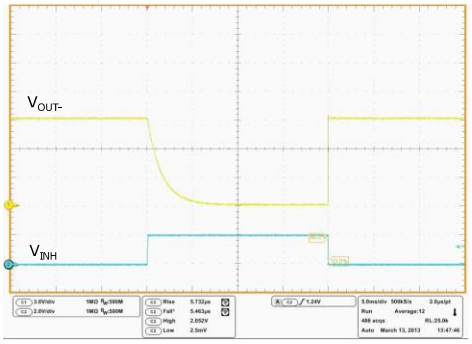
Figure 45: Short circuit current vs RSH (zoom)



C_{IN}=0.1µF C_{OUT}=1µF (tantalum)

AMG081120161344MT

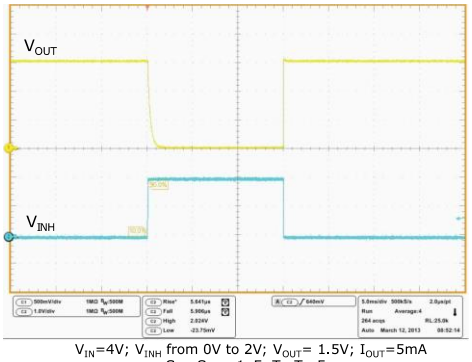
Figure 46: Enable turn-on/off (V_{out} = 9 V)



V_{IN}=12V; V_{INH} from 0V to 2V; V_{OUT}= 9V; I_{OUT}=5mA
C_{IN}=C_{OUT}=1µF; T_r=T_f=5µs

AMG081120161345MT

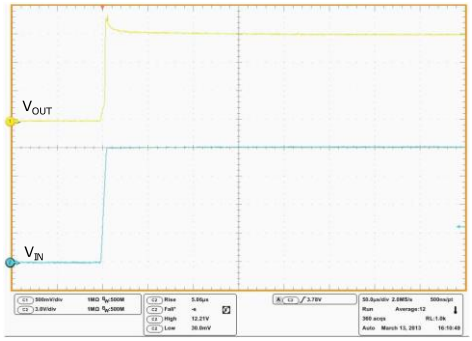
Figure 47: Enable turn-on/off (V_{out} = 1.5 V)



V_{IN}=4V; V_{INH} from 0V to 2V; V_{OUT}= 1.5V; I_{OUT}=5mA
C_{IN}=C_{OUT}=1µF; T_r=T_f=5µs

AMG081120161346MT

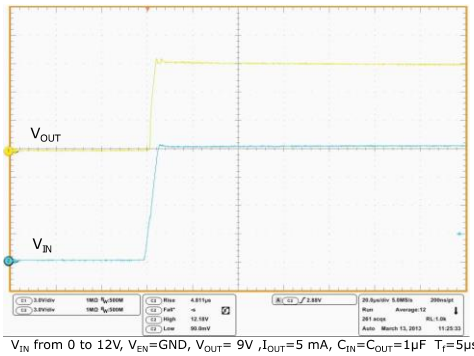
Figure 48: Turn-on time (V_{out} = 1.5 V)



V_{IN} from 0 to 12V, V_{EN}=GND, V_{OUT}= 1.5V ,I_{OUT}=5 mA, C_{IN}=C_{OUT}=1µF T_f=5µs

AMG081120161347MT

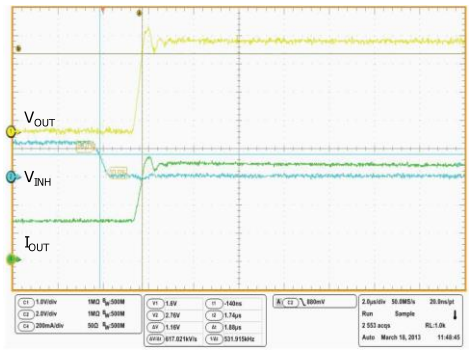
Figure 49: Turn-on time (V_{out} = 9 V)



V_{IN} from 0 to 12V, V_{EN}=GND, V_{OUT}= 9V ,I_{OUT}=5 mA, C_{IN}=C_{OUT}=1µF T_f=5µs

AMG081120161348MT

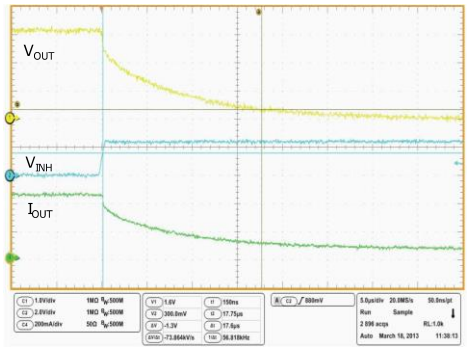
Figure 50: Inhibit propagation delay (Lo-Hi)



V_{IN}=5.5V, V_{INH}=from 2.4V to 0V, I_{OUT}=400mA,V_{OUT}=3V,C_{IN}=C_{OUT}=1µF, T_f=0.5µs

AMG081120161349MT

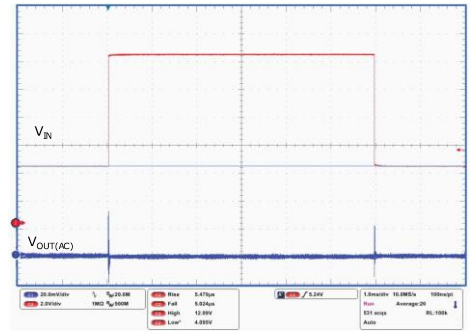
Figure 51: Inhibit propagation delay (Hi-Lo)



V_{IN}=5.5V, V_{INH}=from 0V to 2.4V, I_{OUT}=400mA,V_{OUT}=3V,C_{IN}=C_{OUT}=1µF, T_r=0.5µs

AMG081120161350MT

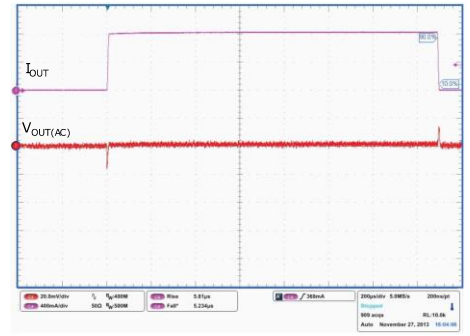
Figure 52: Line transient



V_{IN}=from 3.8 to 12V, V_{OUT}=V_{ADJ}, I_{OUT}=10mA, C_{OUT}=1µF , T_r=5µs

AMG081120161351MT

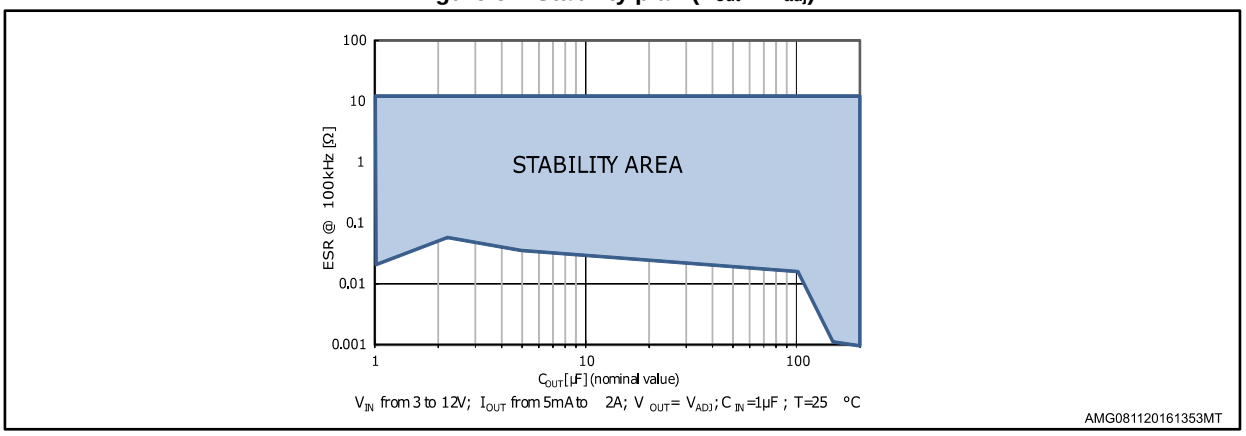
Figure 53: Load transient



V_{IN}= 3.8V, V_{OUT}=V_{ADJ}, I_{OUT}= from 0 to 800mA, C_{OUT}=1µF , T_f=5µs

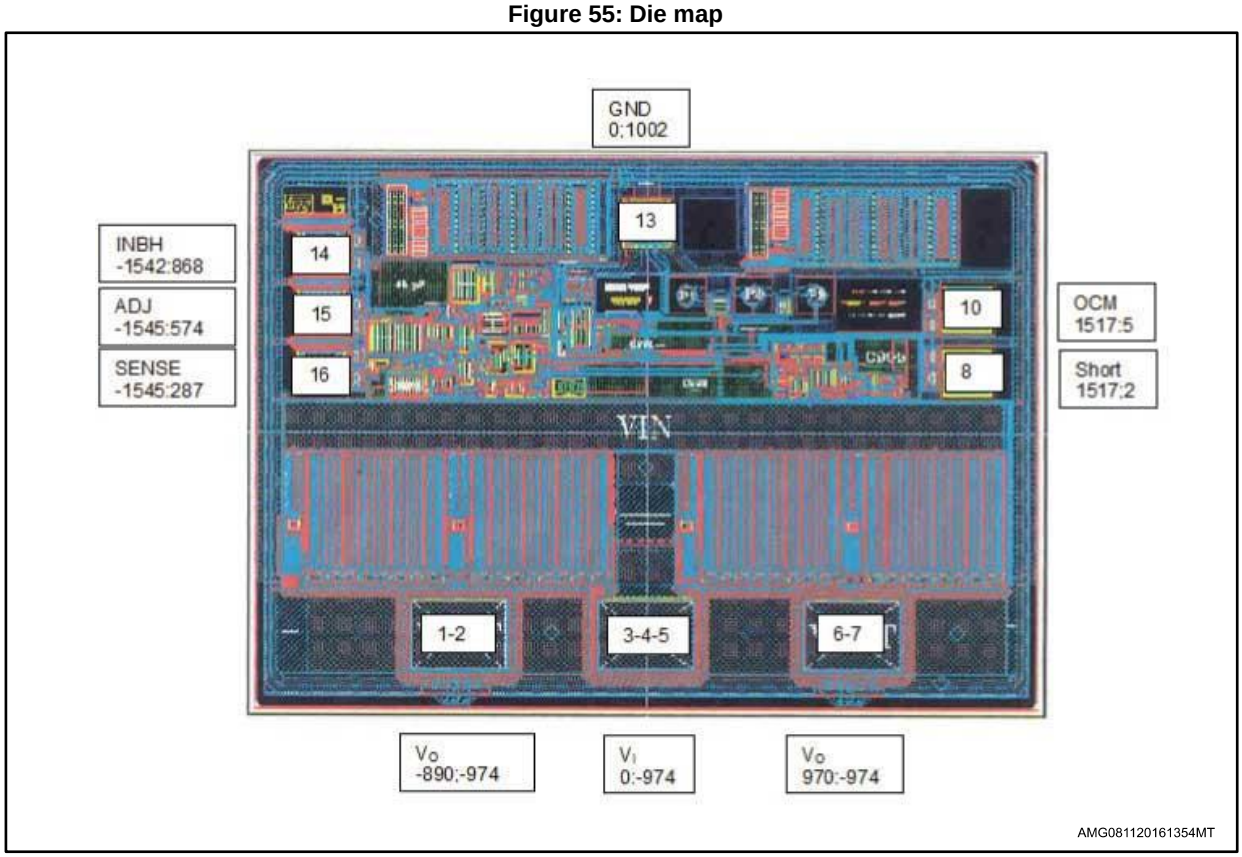
AMG081120161352MT

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



8 Die information

Figure 55: Die map



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 µm ± 25 µm (14.8 mils ± 1 mil)

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

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

Interface materials:

- Top metallization: Al/Si/Cu, 1.05 µm ± 0.15 µm
- Backside metallization: none

Glassivation:

- Type: p. vapox + nitride
- Thickness: 0.6 µm ± 0.1 µm + 0.6 µm ± 0.08 µm

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 information

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***. ECOPACK® is an ST trademark.

9.1 FLAT-16 package information

Figure 56: FLAT-16 package outline

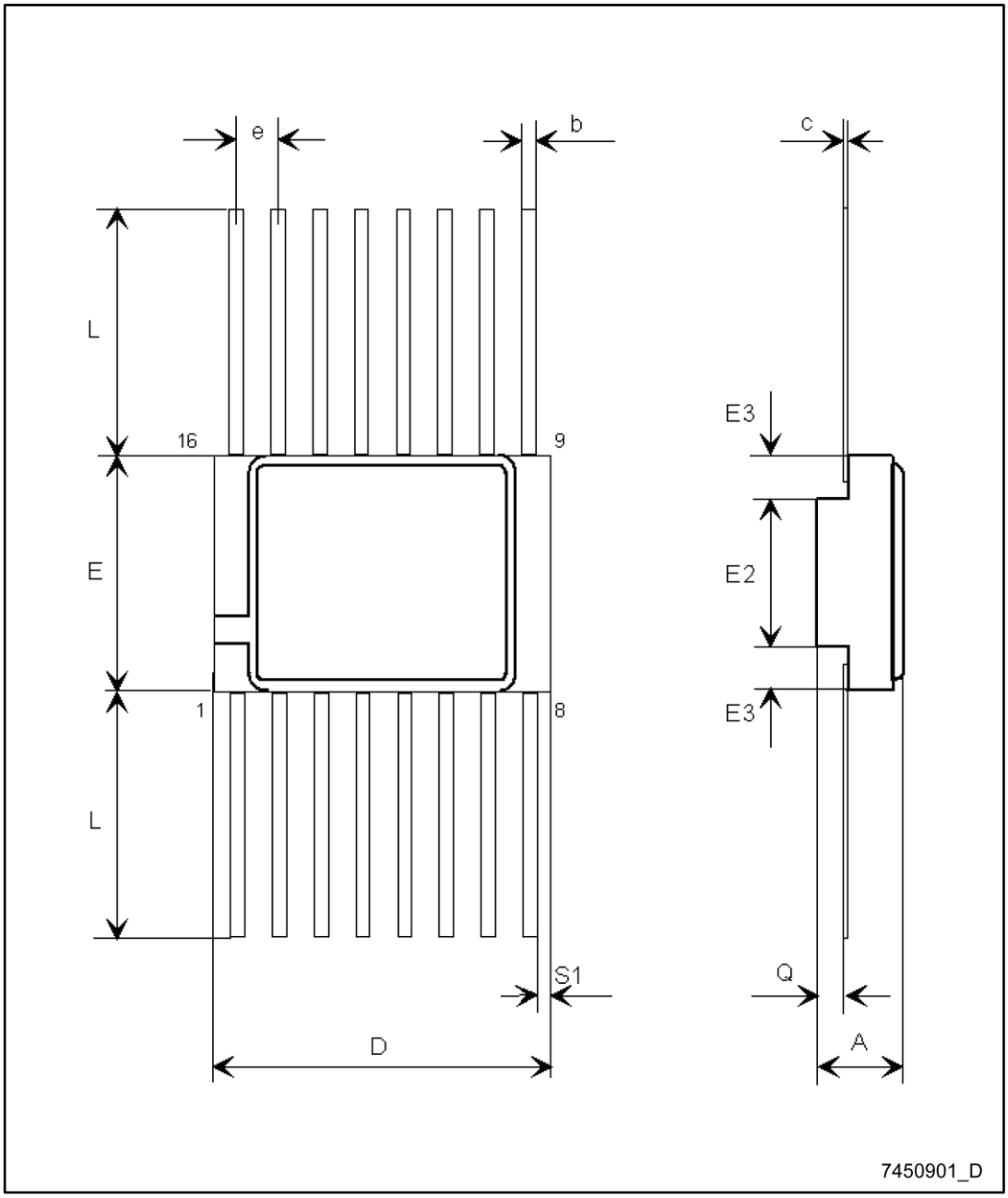


Table 5: FLAT-16 package mechanical data

Dim.	mm		
	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		

9.2 SMD5C package information

Figure 57: SMD5C package outline

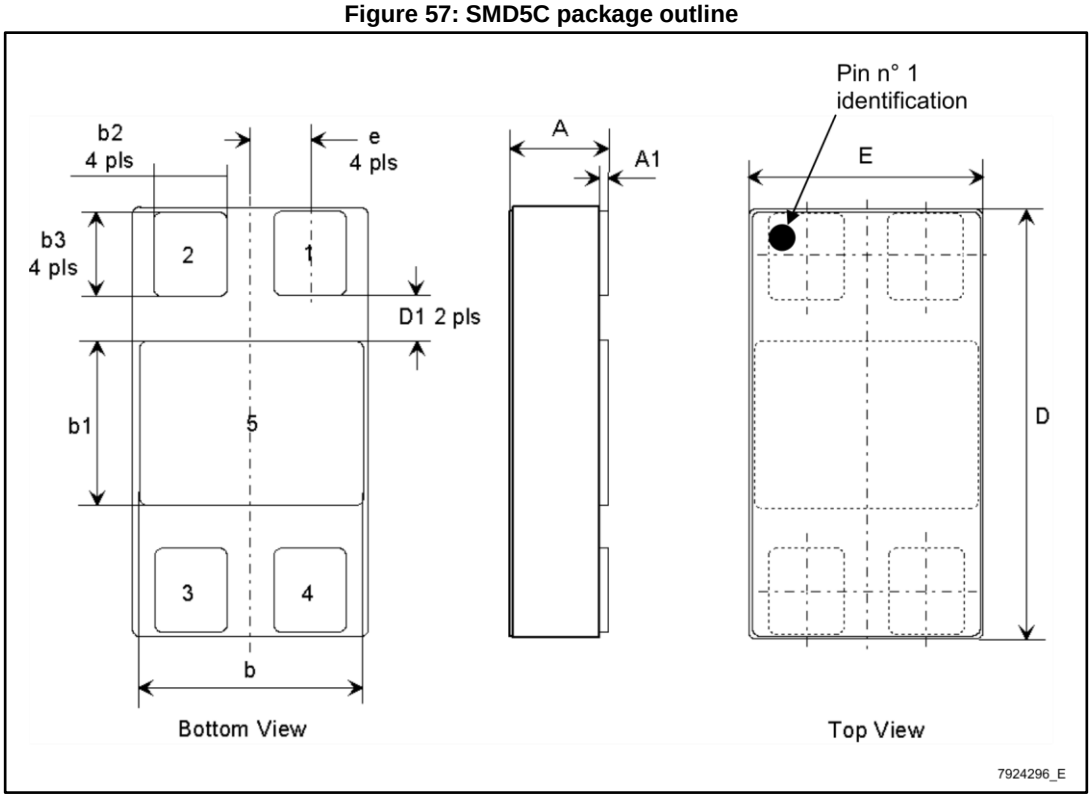


Table 6: SMD5C package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.99	3.15	3.30
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 Table 1; added section 6.3: FPGA power supply lines on page 10. Minor text changes.
22-Sep-2008	9	Modified Application information on page 9.
17-Nov-2008	10	Modified Table 8 on page 26.
21-Jan-2010	11	Modified Table 7 on page 26.
18-Oct-2010	12	Modified Section 6.2 on page 9.
07-Feb-2011	13	Added: note Table 1 on page 3.
07-Dec-2011	14	Removed the note under Table 1 on page 3 and added footnotes 1 and 2.
20-Aug-2012	15	Order code updated in Table 7 on page 26 about the SMD5C package
15-Jan-2014	16	Updated Features in cover page. Added Section 7: Typical characteristics. Modified Table 4: Electrical characteristics. Updated Section 9: Package mechanical data and Section 10: Ordering information. Minor text changes.
05-May-2014	17	Updated Figure 18: Output voltage vs input voltage (I_{out}=3 A, T=25 °C and T=125 °C). Minor text changes.
22-Nov-2016	18	Updated description in cover page. Updated *Section 9: "Package information"*. Minor text changes.

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