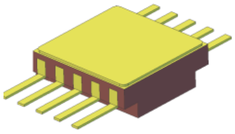
RHF100

Rad-hard, 1.2 V, precision shunt, voltage reference

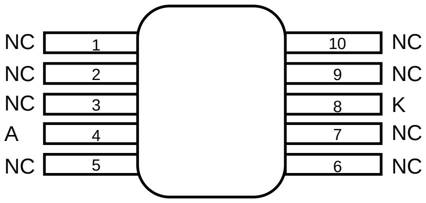
Datasheet - production data

Ceramic Flat-10



The upper metallic lid is not electrically connected to any pins, nor to the IC die inside the package

Pin connections
(top view)



Features

- Fixed shunt: 1.2 V stable on capacitive load
- High precision ±0.15 %
- Wide operating current: 40 µA to 12 mA
- 15 ppm/°C over temperature range
- 2 ppm/°C variation over 3000 hrs
- 0.02 % precision stability over 3000 hrs
- 300 krad high and low dose rate
- ELDRS-free up to 300 krad
- 0.03 % precision stability over 100 krad
- 0.08 % precision stability over 300 krad
- SEL-free up to 120 MeV.cm²/mg
- SET characterized

Applications

- Space systems
- Space data acquisition systems
- Aerospace instrumentation
- ADC references

Description

The RHF100 is a 1.2 V precision, low-power, fixed shunt, voltage reference dedicated to space applications.

Mounted in a Flat-10 hermetic ceramic package, the RHF100 uses dedicated architecture and design rules to provide the best immunity against radiation.

The very low operating current and very good stability over a wide temperature range stretching from -55 °C to 125 °C make the RHF100 particularly suitable for precision and power saving.

Table 1: Device summary

Parameter	RHF100K1	RHF100K01V
SMD pin	—	5962F14225
Quality level	Engineering model	QML-V flight
Package	Flat-10	
Lead finish	Gold	
Mass	0.50 g	
EPPL (1)	—	Target
Temp. range	-55 °C to 125 °C	

Notes:

(1)EPPL = ESA preferred part list

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1 Absolute maximum ratings and operating conditions

Table 2: Absolute maximum ratings

Symbol	Parameter	Value	Unit
I_k	Reverse breakdown cathode current	15	mA
I_f	Forward current	20	
T_{stg}	Storage temperature	-65 to +150	ºC
T_j	Maximum junction temperature	150	
R_{thja}	Thermal resistance junction (T_j) to ambient (T_a)	140	°C/W
R_{thjc}	Thermal resistance junction to case	40	
ESD	HBM: human body model (1)	2	kV
	MM: machine model (2)	200	V
	CDM: charged device model (3)	1.5	kV

Notes:

(1)Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 kΩ resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.

(2)Machine model: a 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5Ω). This is done for all couples of connected pin combinations while the other pins are floating.

(3)Charged device model: all pins and package are charged together to the specified voltage and then discharged directly to the ground through only one pin.

Table 3: Operating conditions

Symbol	Parameter	Value	Unit
$Ik_{min.}$	Minimum operating cathode current (1)	40	µA
$Ik_{max.}$	Maximum operating cathode current(1)	12	mA
T_{amb}	Operating ambient temperature range	-55 to +125	°C

Notes:

(1)Refer to *Section 5.3: "Minimum and maximum cathode current"*

2 Electrical characteristics

Tested parameters before radiation are shown in *Table 4: "Anode connected to GND (0 V), Vk referred to anode voltage, Ck = 100 nF, unless otherwise specified"*.

Table 4: Anode connected to GND (0 V), Vk referred to anode voltage, Ck = 100 nF, unless otherwise specified

Symbol	Parameter	Test conditions	Temp.	Min.	Typ.	Max.	Unit
DC performance							
V_k	Reverse breakdown voltage	I_k = 100 µA	25 °C		1.2		V
ΔV_k	Reverse breakdown voltage tolerance	I_k = 100 µA, burn in = 240 hrs	25 °C	-1.8		1.8	mV
				-0.15		0.15	%
ΔV_k	Reverse breakdown voltage tolerance	I_k = 100 µA, life test = 3000 hrs	25 °C	-2.3		2.3	mV
				-0.19		0.19	%
I_{kmin}	Minimum operating cathode current	Refer to *Section 5.3: "Minimum and maximum cathode current"*	-55 °C			40	µA
			25 °C			40	
			125 °C			40	
$\Delta V_k/\Delta T$	Average temperature coefficient $\frac{Vkmax - Vkmin}{180°C \times Vk(25°C)} \times 10^6$	I_k = 100 µA,	-55 °C to 125 °C		5	15	ppm/°C
		I_k = 10 mA			5	15	
ΔV_k vs. ΔI_k	Average reverse breakdown voltage change vs. operating current change	$I_{kmin} \leq I_k \leq 1$ mA	-55 °C		0.19	0.3	mV
			25 °C		0.2	0.31	
			125 °C		0.22	0.34	
		1 mA $\leq I_k \leq$ 12 mA	-55 °C		1.2	2.4	
			25 °C		1.5	3	
			125 °C		1.7	3.4	
R_{ka}	Equivalent reverse static resistance	$\Delta I_k = I_{kmin}$. to 10 mA	-55 °C		0.1	0.17	Ω
			25 °C		0.11	0.19	
			125 °C		0.15	0.26	
Z_{ka}	Equivalent reverse dynamic impedance	I_k = 1 mA to 1.1 mA, F ≤ 1 kHz, no capacitive load	-55 °C		0.4		
			25 °C		0.4		
			125 °C		0.5		
e_n	Spectral density voltage noise	I_k = 100 µA, F= 1 kHz	-55 °C		380		nV/√Hz
			25 °C		440		
			125 °C		490		
Kvh (1)	Vk long-term stability $\frac{Vk(0hr) - Vk(xxxxhrs)}{Vk(0hr)} \times 100$	I_k = 100 µA, 1000 hrs	25 °C		0.02		%
		I_k = 100 µA, 2000 hrs			0.019		
		I_k = 100 µA, 3000 hrs			0.018		

Symbol	Parameter	Test conditions	Temp.	Min.	Typ.	Max.	Unit
KvTc(1)	Average temperature coefficient long-term stability $\Delta V_k/\Delta T$(0 hr) - $\Delta V_k/\Delta T$(xxxx hrs)	I_k = 100 µA, I_k = 10 mA, 1000 hrs	-55 °C to 125 °C		2		ppm/°C
		I_k = 100 µA, I_k = 10 mA, 2000 hrs			2		
KvTc(1)	Average temperature coefficient long-term stability $\Delta V_k/\Delta T$(0 hr) - $\Delta V_k/\Delta T$(xxxx hrs)	I_k = 100 µA, I_k = 10 mA, 3000 hrs	-55 °C to 125 °C		2		ppm/°C

Notes:

(1) Fiability is done with a cathode current setting, I_k = 10 mA and Ta = 125 °C. 0 hr corresponds to an initial burn-in of 240 hrs.

3 Radiations

Total ionizing dose (MIL-STD-883 TM 1019)

The products guaranteed by radiation within the RHA QML-V system, fully comply with the MIL-STD-883 TM 1019 specification.

The RHF100 is RHA QML-V, tested and characterized in full compliance with the MIL-STD-883 specification, both below 10 mrad/s and between 50 and 300 rad/s.

These parameters are shown in *Table 6: "Electrical characteristics after 100 krad (high-dose and low-dose rate), anode to GND (0 V), Vk referred to anode voltage, Ck = 100 nF, (unless otherwise specified)"* after 100 krad and *Table 7: "Electrical characteristics after 300 krad (high-dose and low-dose rate), anode to GND (0 V), Vk referred to anode voltage, Ck = 100 nF, (unless otherwise specified)"*after 300 krad (both high- and low-dose rate), as follows:

- All tests are performed in accordance with MIL-PRF-38535 and the test method 1019 of the MIL-STD-883 for total ionizing dose (TID).
- The ELDRS characterization is performed in qualification only on both biased and unbiased parts, on a sample of ten units for high-dose rate and ten units for low-dose rate from two different wafer lots.
- In the frame of the wafer lot acceptance, each wafer lot is tested at high-dose rate only, in the worst bias case condition, based on the results obtained during the initial qualification.

Heavy ions

The behavior of the product when submitted to heavy ions is not tested in production. Heavy ion trials are performed on qualification lots only.

Table 5: Radiations

Type	Characteristics	Value	Unit
TID	180 krad/h high-dose rate (50 rad/sec) up to:	300	krad
	ELDRS free up to:	300	
	36 rad/h low-dose rate (0.01 rad/sec) up to:	300	
Heavy ions	SEL immunity (at 125 °C, with a particle angle of 60 °) up to:	120	MeV.cm²/mg
	SEL immunity (at 125 °C, with a particle angle of 0 °) up to:	60	
	SET (at 25 °C)	Characterized	

Table 6: Electrical characteristics after 100 krad (high-dose and low-dose rate), anode to GND (0 V), Vk referred to anode voltage, Ck = 100 nF, (unless otherwise specified)

Symbol	Parameter	Test conditions	Temp.	Min.	Typ.	Max.	Unit
DC performance							
V_k	Reverse breakdown voltage	I_k = 100 µA	25 °C		1.2		V
ΔV_k	Reverse breakdown voltage tolerance	I_k = 100 µA	25 °C		±1.8		mV
					±0.5		%

Symbol	Parameter	Test conditions	Temp.	Min.	Typ.	Max.	Unit
I_{kmin}	Minimum operating cathode current	Refer to *Section 5.3: "Minimum and maximum cathode current"*	-55 °C			40	µA
			25 °C			40	
			125 °C			40	
$\Delta V_k/\Delta T$	Average temperature coefficient $\frac{Vkmax - Vkmin}{180°C \times Vk(25°C)} \times 10^6$	I_k = 100 µA	-55 °C to 125 °C		5		ppm/°C
		I_k = 10 mA	-55 °C to 125 °C		5		
ΔV_k vs. ΔI_k	Average reverse breakdown voltage change vs. operating current change	$I_{kmin} \leq I_k \leq$ 1 mA	-55 °C		0.19		mV
			25 °C		0.2		
			125 °C		0.22		
		1 mA $\leq I_k \leq$ 12 mA	-55 °C		1.2		
			25 °C		1.5		
			125 °C		1.7		
R_{ka}	Equivalent reverse static resistance	$\Delta I_k = I_{kmin}$ to 10 mA	-55 °C		0.12		Ω
			25 °C		0.13		
			125 °C		0.2		
Z_{ka}	Equivalent reverse dynamic impedance	I_k = 1 mA to 1.1 mA, F ≤ 1 kHz, no capacitive load	-55 °C		0.4		Ω
			25 °C		0.4		
			125 °C		0.5		
Kvhd	Stability in radiation $\frac{\lvert Vk(0rad) - Vk(100krad)\rvert}{Vk(0rad)} \times 100$	I_k = 100 µA, total dose = 100 krads, dose rate = 0.01 rad/s	25 °C		0.03		%
e_n	Spectral density voltage noise	I_k = 100 µA, F= 1 kHz	-55 °C		380		nV/√ Hz
			25 °C		440		
			125 °C		490		

Table 7: Electrical characteristics after 300 krad (high-dose and low-dose rate), anode to GND (0 V), Vk referred to anode voltage, Ck = 100 nF, (unless otherwise specified)

Symbol	Parameter	Test conditions	Temp.	Min.	Typ.	Max.	Unit
DC performance							
V_k	Reverse breakdown voltage	I_k = 100 µA	25 °C		1.2		V
ΔV_k	Reverse breakdown voltage tolerance	I_k = 100 µA	25 °C	-4.2		4.2	mV
				-0.35		0.35	%
I_{kmin}	Minimum operating cathode current	Refer to *Section 5.3: "Minimum and maximum cathode current"*	-55 °C			40	µA
			25 °C			40	
			125 °C			40	
$\Delta V_k/\Delta T$	Average temperature coefficient $\frac{Vkmax - Vkmin}{180°C \times Vk(25°C)} \times 10^6$	I_k = 100 µA	-55 °C to 125 °C		5		ppm/°C
		I_k = 10 mA	-55 °C to 125 °C		5		
ΔV_k vs. ΔI_k	Average reverse breakdown voltage change vs. operating current change	$I_{kmin} \leq I_k \leq$ 1 mA	-55 °C		0.19		mV
			25 °C		0.2		
			125 °C		0.22		
		1 mA $\leq I_k \leq$ 12 mA	-55 °C		1.2		
			25 °C		1.5		
			125 °C		1.7		
R_{ka}	Equivalent reverse static resistance	$\Delta I_k = I_{kmin}$ to 10 mA	-55 °C		0.12		Ω
			25 °C		0.13		
			125 °C		0.2		
Z_{ka}	Equivalent reverse dynamic impedance	I_k = 1 mA to 1.1 mA, F ≤ 1 kHz, no capacitive load	-55 °C		0.4		Ω
			25 °C		0.4		
			125 °C		0.5		
Kvhd	Stability in radiation $\frac{\lvert Vk(0rad) - Vk(100krad) \rvert}{Vk(0rad)} \times 100$	I_k = 100 µA, total dose = 300 krads, dose rate = 0.01 rad/s	25 °C		0.08		%
e_n	Spectral density voltage noise	I_k = 100 µA, F= 1 kHz	-55 °C		380		nV/√ Hz
			25 °C		440		
			125 °C		490		

4 Electrical characteristic curves

Figure 1: Reverse breakdown voltage characteristic vs. cathode current

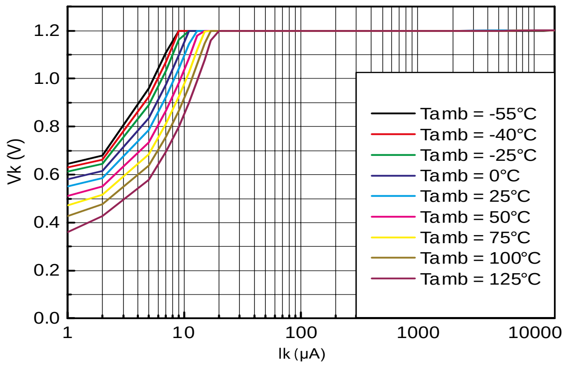


Figure 2: Zoom of reverse breakdown voltage characteristic vs. cathode current

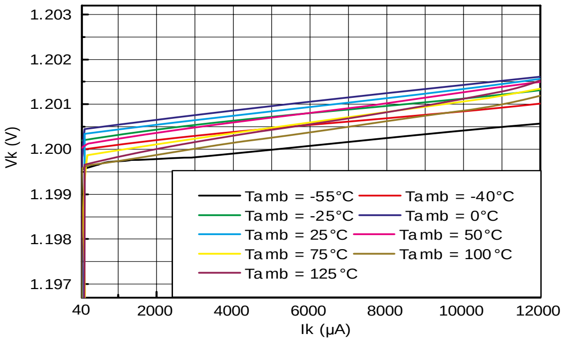


Figure 3: Reverse breakdown voltage characteristic vs. ambient temp.

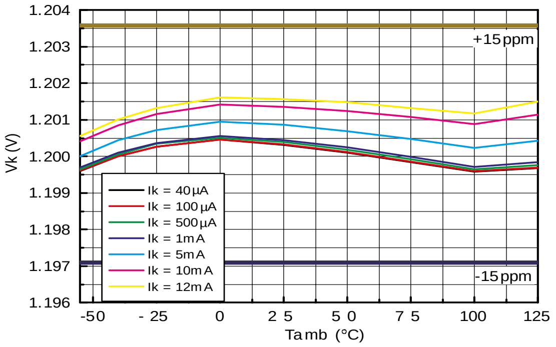


Figure 4: Average temp. coefficient vs. cathode current

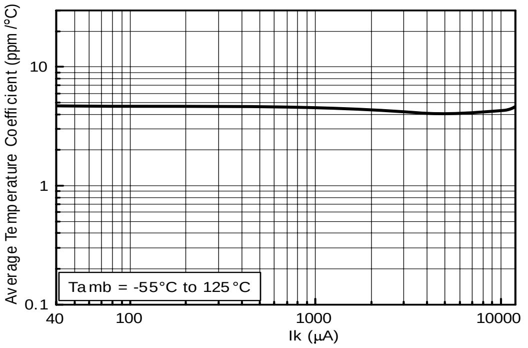


Figure 5: Output impedance vs. freq. at 25 °C, Ck = 0

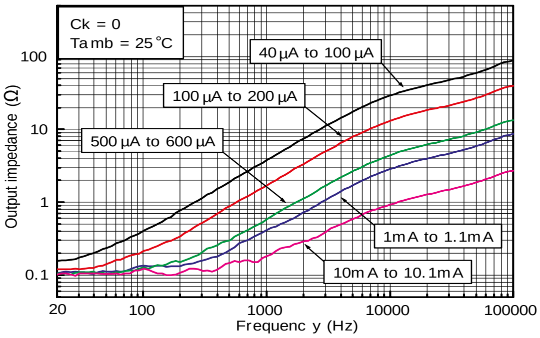


Figure 6: Output impedance vs. freq. at -55 °C, Ck = 0

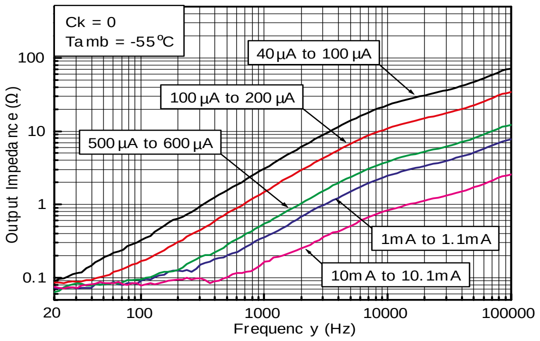


Figure 7: Output impedance vs. freq. at 125 °C, Ck = 0

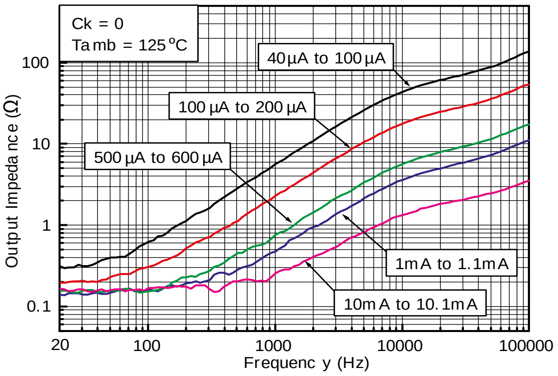


Figure 8: Output impedance vs. freq. at 25 °C, Ck = 100 nF

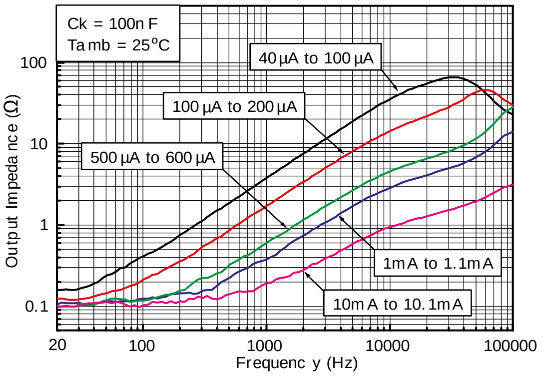


Figure 9: Output impedance vs. freq. at -55 °C, Ck = 100 nF

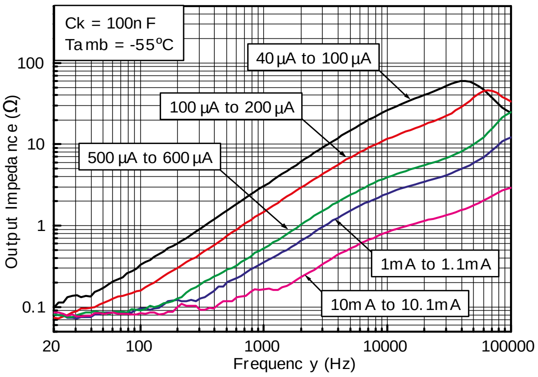


Figure 10: Output impedance vs. freq. at 125 °C, Ck = 100 nF

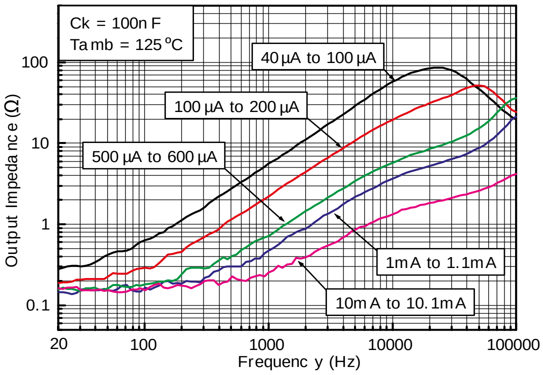


Figure 11: Output impedance vs. freq. at 25 °C, Ck = 470 nF

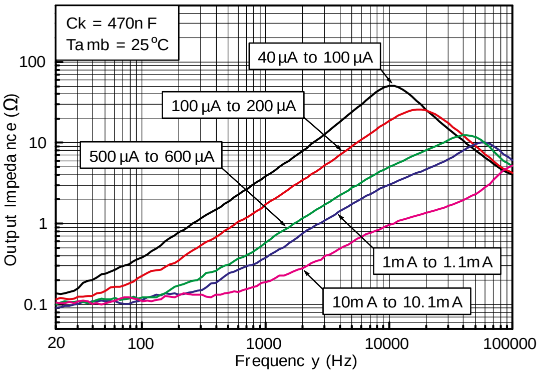


Figure 12: Output impedance vs. freq. at -55 °C, Ck = 470 nF

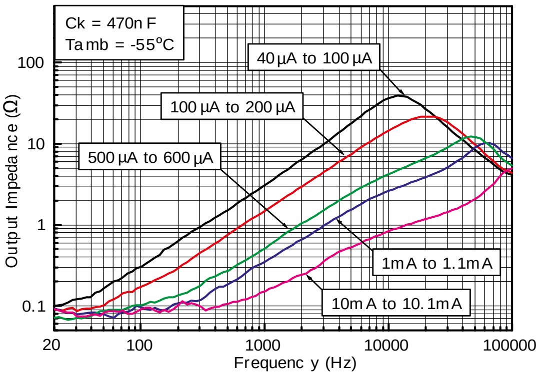


Figure 13: Output impedance vs. freq. at 125 °C, Ck = 470 nF

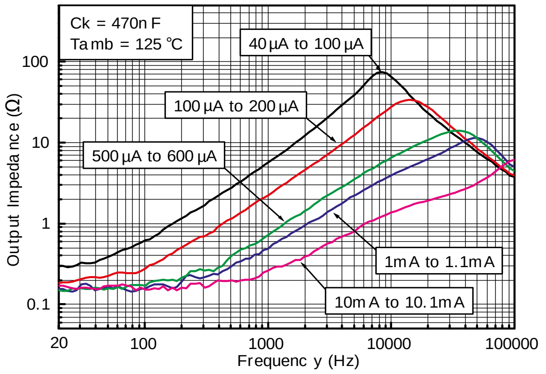


Figure 14: Spectral noise density vs. freq. at 25 °C, Ck = 0

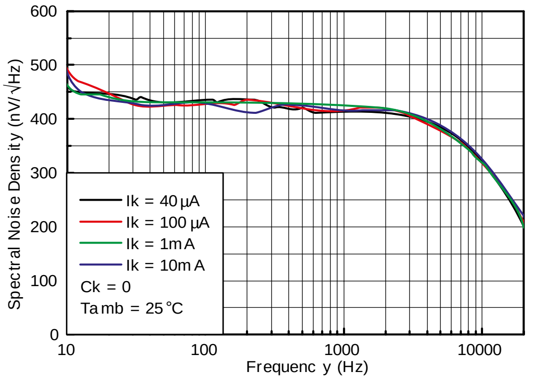


Figure 15: Spectral noise density vs. freq. at -55 °C, Ck = 0

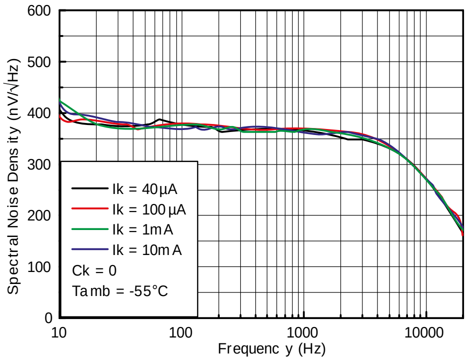


Figure 16: Spectral noise density vs. freq. at 125 °C, Ck = 0

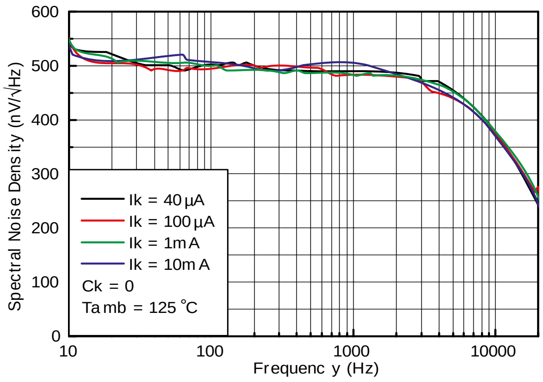


Figure 17: Spectral noise density vs. freq. at 25 °C, Ck = 100 nF

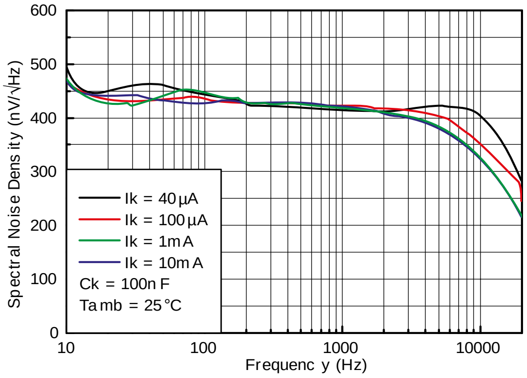


Figure 18: Spectral noise density vs. freq. at -55 °C, Ck = 100 nF

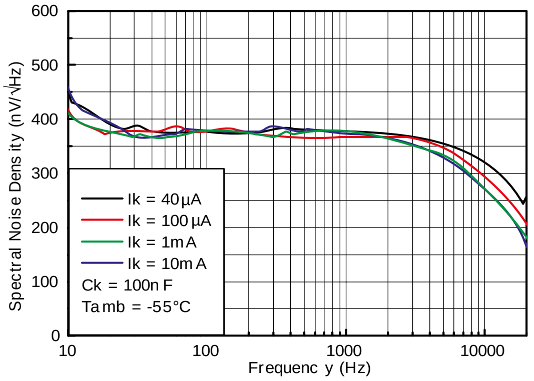


Figure 19: Spectral noise density vs. freq. at 125 °C, Ck = 100 nF

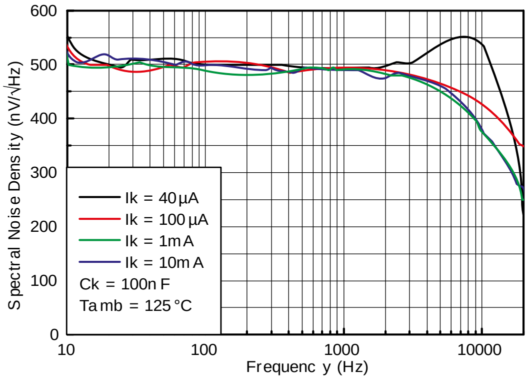


Figure 20: Spectral noise density vs. freq. at 25 °C, Ck = 470 nF

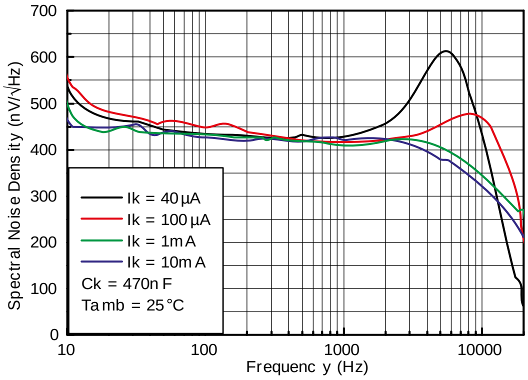


Figure 21: Spectral noise density vs. freq. at -55 °C, Ck = 470 nF

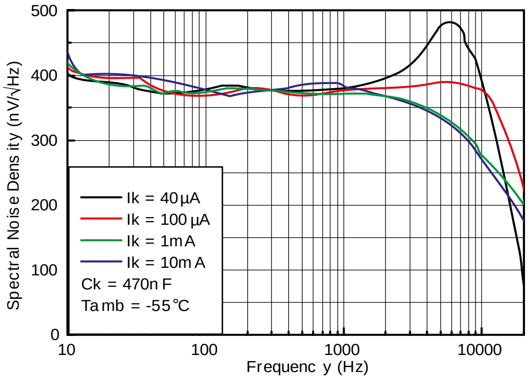


Figure 22: Spectral noise density vs. freq. at 125 °C, Ck = 470 nF

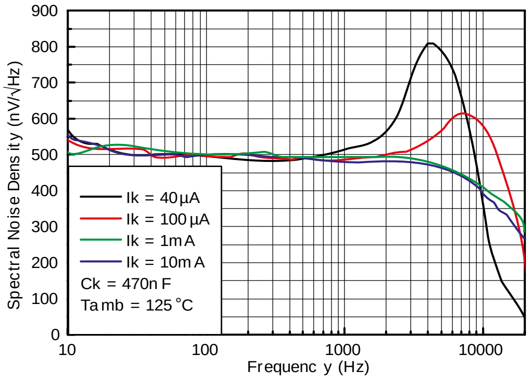
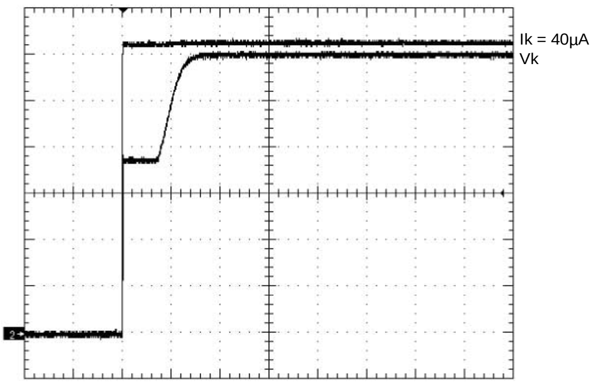
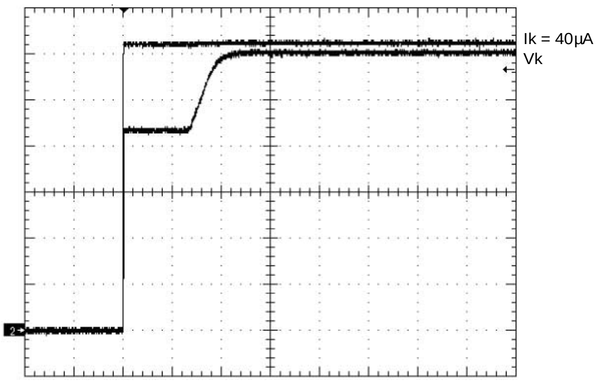


Figure 23: Cathode current step resp. at 25 °C, Ck = 0, ΔIk = 40 µA



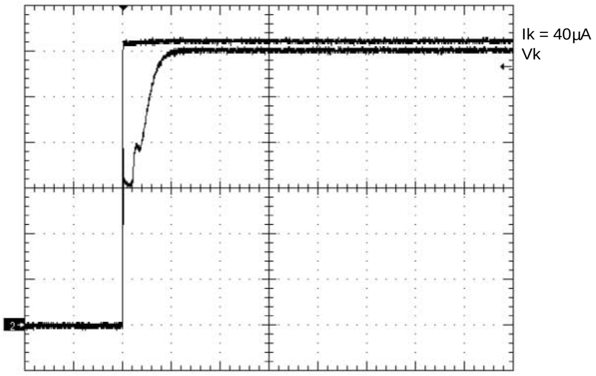
Vk = 200mV/div, 100µs/div, Ck = 0, Tamb = 25°C

Figure 24: Cathode current step resp. at -55 °C, Ck = 0, ΔIk = 40 µA



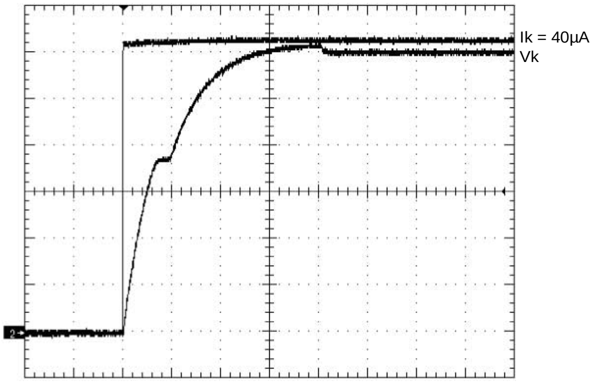
Vk = 200mV/div, 100µs/div, Ck = 0, Tamb = -55°C

Figure 25: Cathode current step resp. at 125 °C, Ck = 0, ΔIk = 40 µA



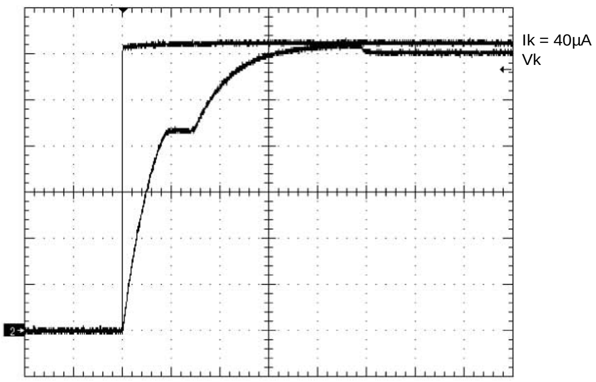
Vk = 200mV/div, 100µs/div, Ck = 0, Tamb = 125°C

Figure 26: Cathode current step resp. at 25 °C, Ck = 100 nF, ΔIk = 40 µA



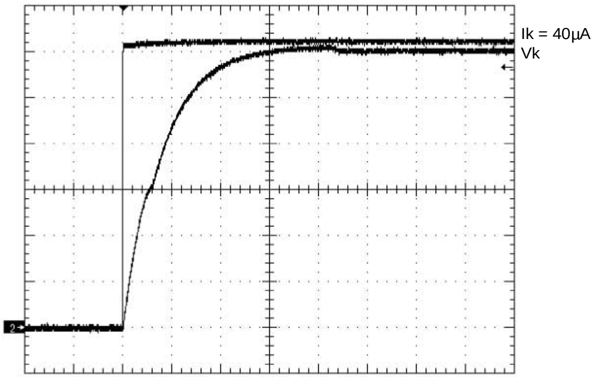
Vk = 200mV/div, 200µs/div, Ck = 100nF, Tamb = 25°C

Figure 27: Cathode current step resp. at -55 °C, Ck = 100 nF, ΔIk = 40 µA



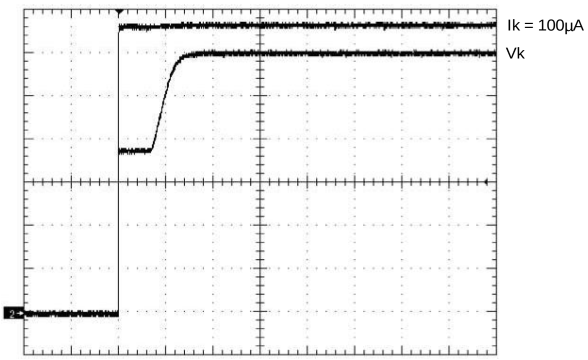
Vk = 200mV/div, 200µs/div, Ck = 100nF, Tamb = -55°C

Figure 28: Cathode current step resp. at 125 °C, Ck = 100 nF, ΔIk = 40 µA



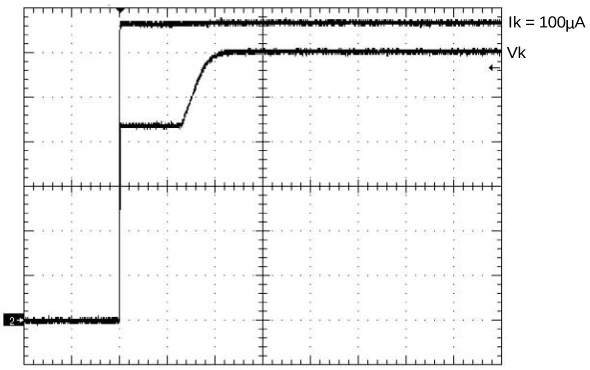
Vk = 200mV/div, 200µs/div, Ck = 100nF, Tamb = 125°C

Figure 29: Cathode current step resp. at 25 °C, Ck = 0, ΔIk = 100 µA



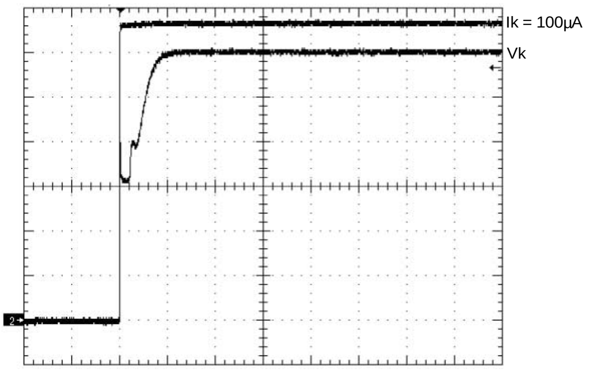
Vk = 200mV/div, 100µs/div, Ck = 0, Tamb = 25°C

Figure 30: Cathode current step resp. at -55 °C, Ck = 0, ΔIk = 100 µA



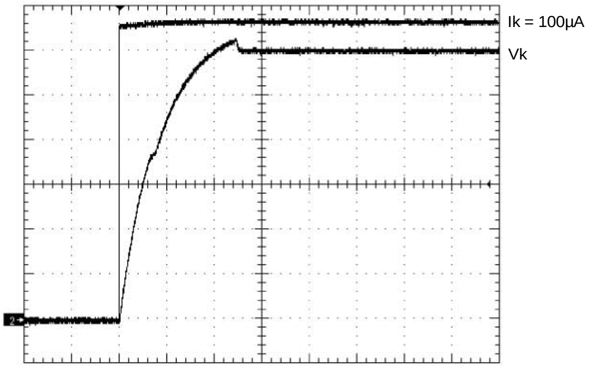
Vk = 200mV/div, 100µs/div, Ck = 0, Tamb = -55°C

Figure 31: Cathode current step resp. at 125 °C, Ck = 0, ΔIk = 100 µA



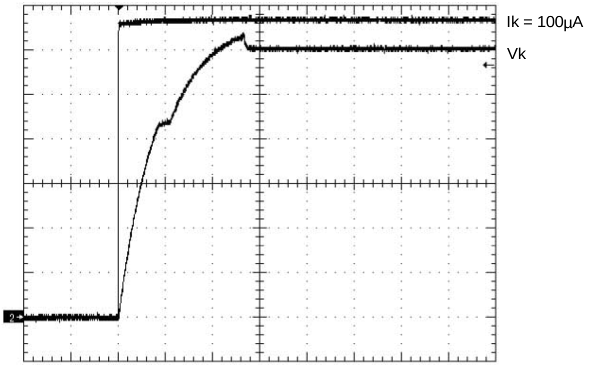
Vk = 200mV/div, 100µs/div, Ck = 0, Tamb = 125°C

Figure 32: Cathode current step resp. at 25 °C, Ck = 220 nF, ΔIk = 100 µA



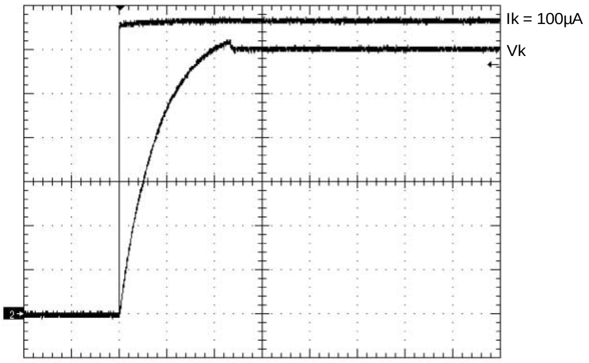
Vk = 200mV/div, 400µs/div, Ck = 220nF, Tamb = 25°C

Figure 33: Cathode current step resp. at -55 °C, Ck = 220 nF, ΔIk = 100 µA



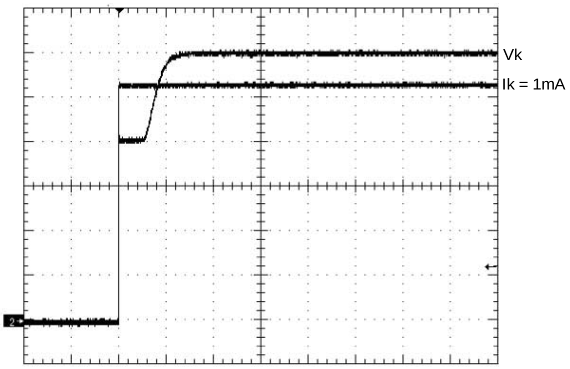
Vk = 200mV/div, 400µs/div, Ck = 220nF, Tamb = -55°C

Figure 34: Cathode current step resp. at 125 °C, Ck = 220 nF, ΔIk = 100 µA



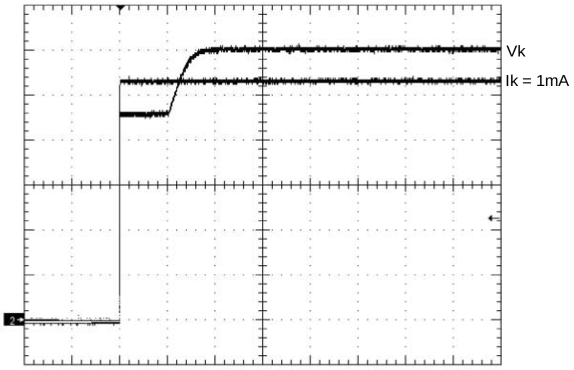
Vk = 200mV/div, 400µs/div, Ck = 220nF, Tamb = 125°C

Figure 35: Cathode current step resp. at 25 °C, Ck = 0, ΔIk = 1 mA



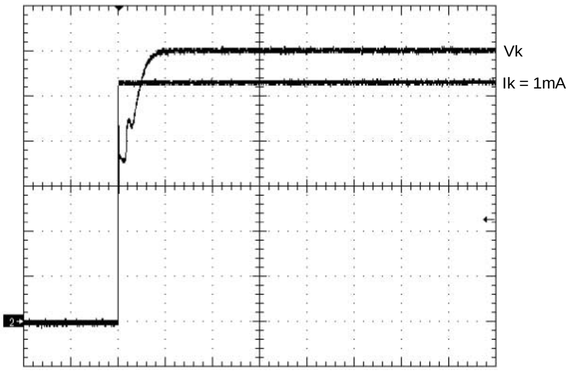
Vk = 200mV/div, 100µs/div, Ck = 0, Tamb = 25°C

Figure 36: Cathode current step resp. at -55 °C, Ck = 0, ΔIk = 1 mA



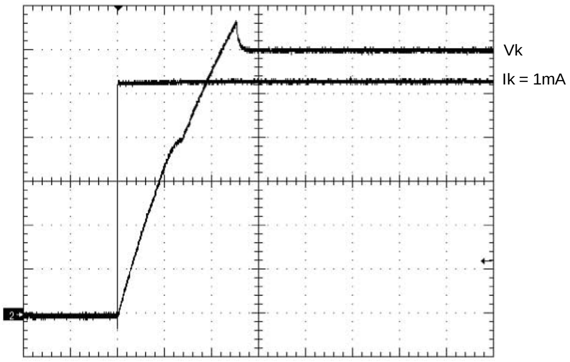
Vk = 200mV/div, 100µs/div, Ck = 0, Tamb = -55°C

Figure 37: Cathode current step resp. at 125 °C, Ck = 0, ΔIk = 1 mA



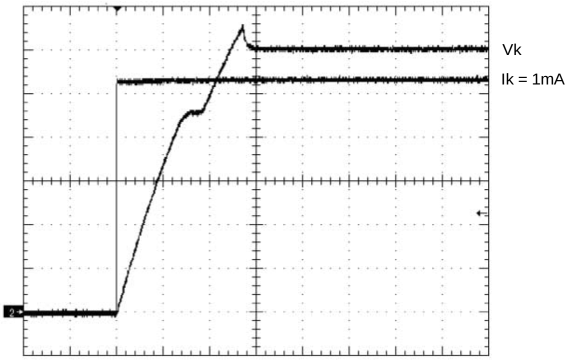
Vk = 200mV/div, 100µs/div, Ck = 0, Tamb = 125°C

Figure 38: Cathode current step resp. at 25 °C, Ck = 470 nF, ΔIk = 1 mA



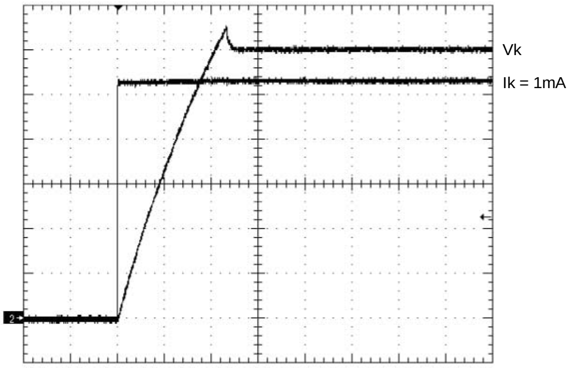
Vk = 200mV/div, 200µs/div, Ck = 470nF, Tamb = 25°C

Figure 39: Cathode current step resp. at -55 °C, Ck = 470 nF, ΔIk = 1 mA



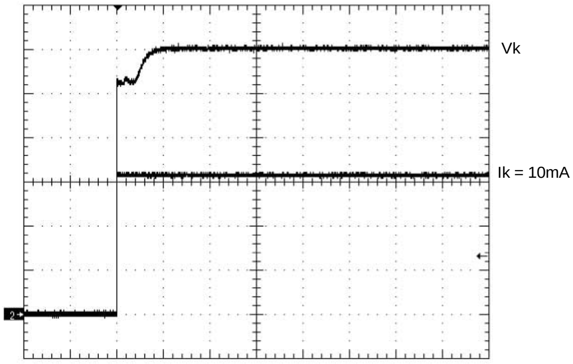
Vk = 200mV/div, 200µs/div, Ck = 470nF, Tamb = -55°C

Figure 40: Cathode current step resp. at 125 °C, Ck = 470 nF, ΔIk = 1 mA



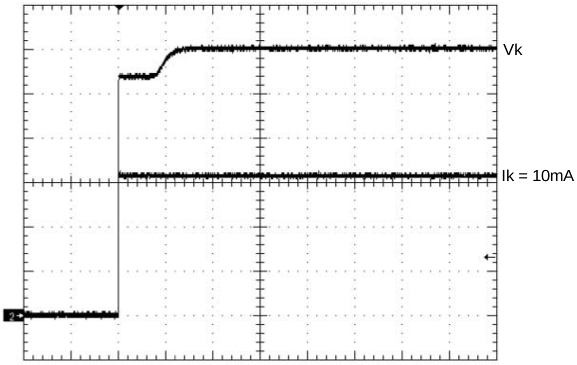
Vk = 200mV/div, 200µs/div, Ck = 470nF, Tamb = 125°C

Figure 41: Cathode current step resp. at 25 °C, Ck = 0, ΔIk = 10 mA



Vk = 200mV/div, 100µs/div, Ck = 0, Tamb = 25°C

Figure 42: Cathode current step resp. at -55 °C, Ck = 0, ΔIk = 10 mA



Vk = 200mV/div, 100µs/div, Ck = 0, Tamb = -55°C

Figure 43: Cathode current step resp. at 125 °C, Ck = 0, ΔIk = 10 mA

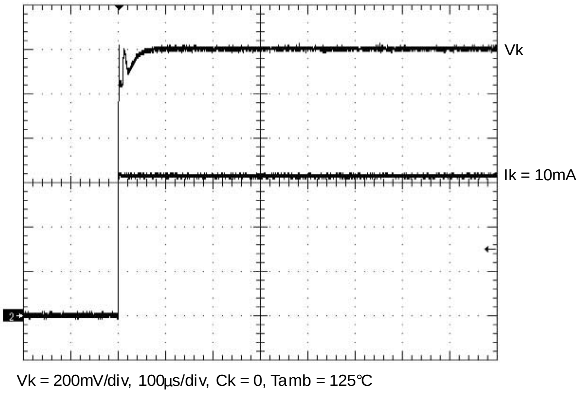


Figure 44: Cathode current step resp. at 25 °C, Ck = 4.7 µF, ΔIk = 10 mA

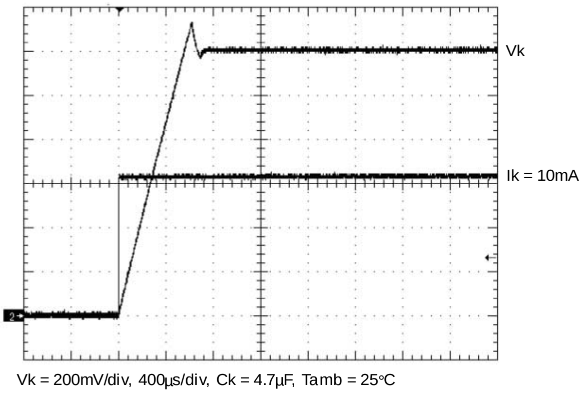


Figure 45: Cathode current step resp. at -55 °C, Ck = 4.7 µF, ΔIk = 10 mA

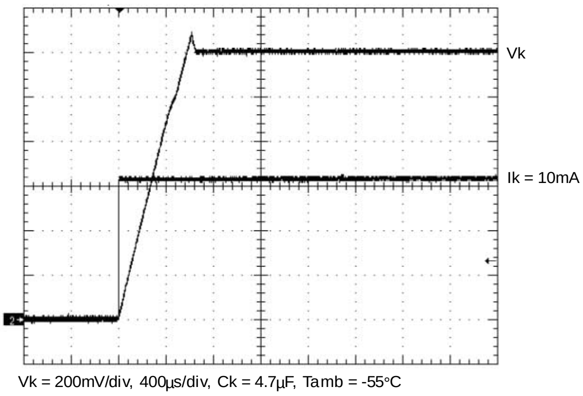


Figure 46: Cathode current step resp. at 125 °C, Ck = 4.7 µF, ΔIk = 10 mA

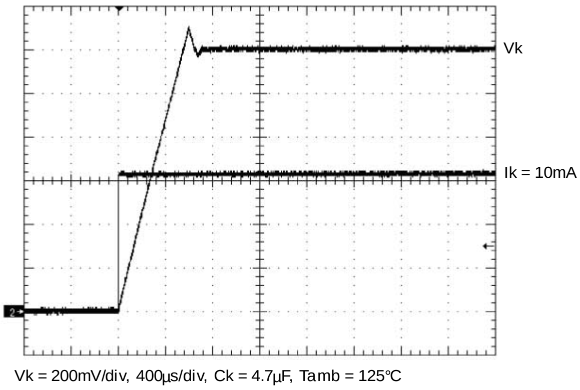


Figure 47: Vk long term stability from 0 hr to 1000 hrs

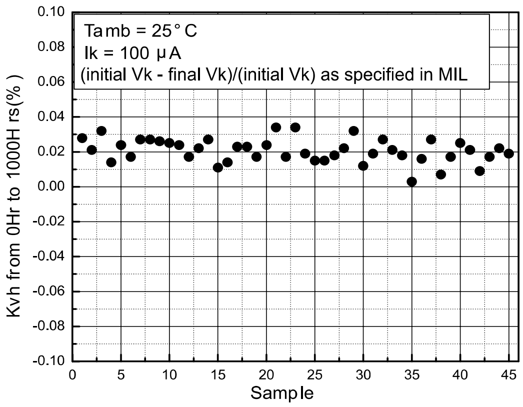


Figure 48: Vk long term stability from 0 hr to 2000 hrs

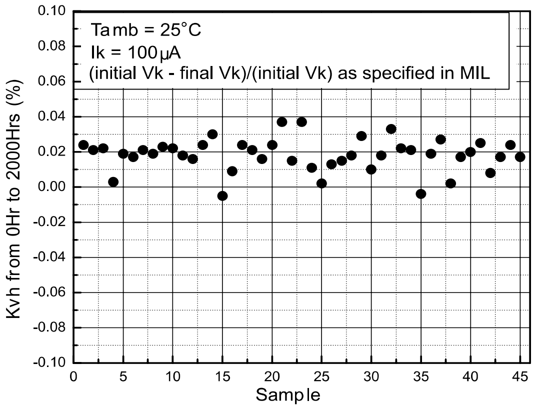


Figure 49: Vk long term stability from 0 hr to 3000 hrs

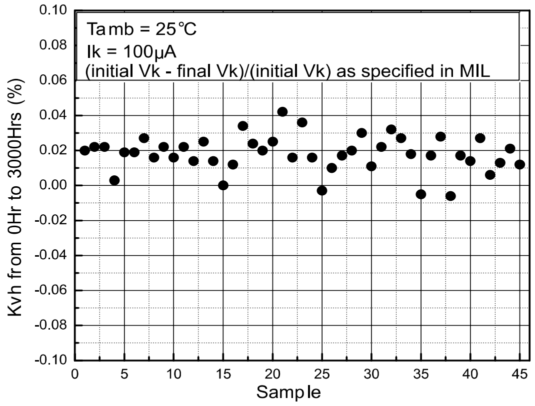


Figure 50: Vk long term stability from 1000 hrs to 2000 hrs

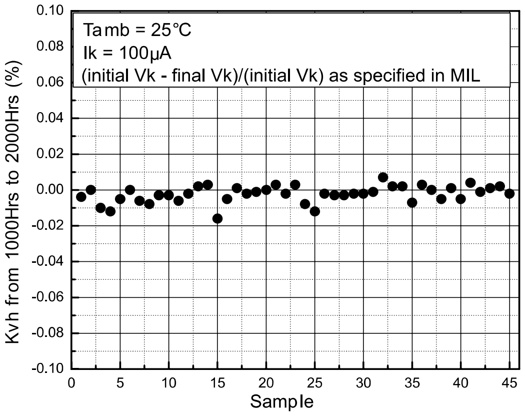


Figure 51: Vk long term stability from 2000 hr to 3000 hrs

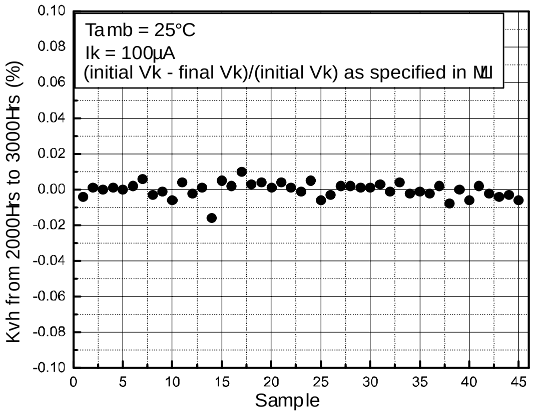


Figure 52: Average temperature coefficient at 0 hr, Ik = 100 µA

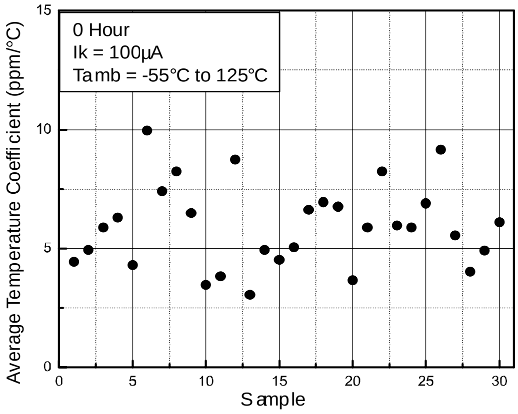


Figure 53: Average temperature coefficient at 1000 hrs, Ik = 100 µA

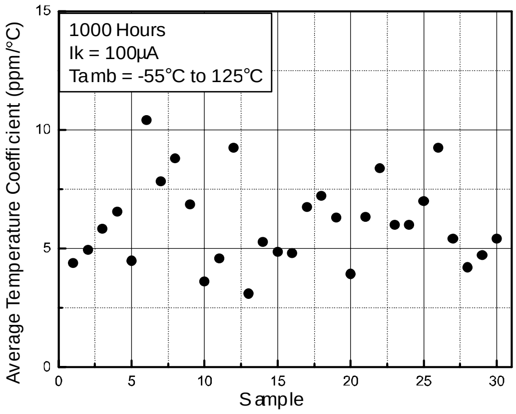


Figure 54: Average temperature coefficient at 2000 hrs, Ik = 100 µA

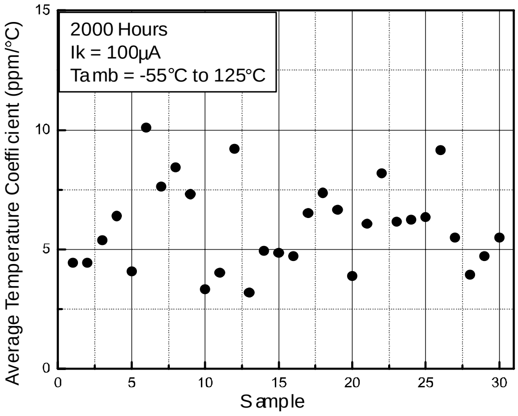


Figure 55: Average temperature coefficient at 3000 hrs, Ik = 100 µA

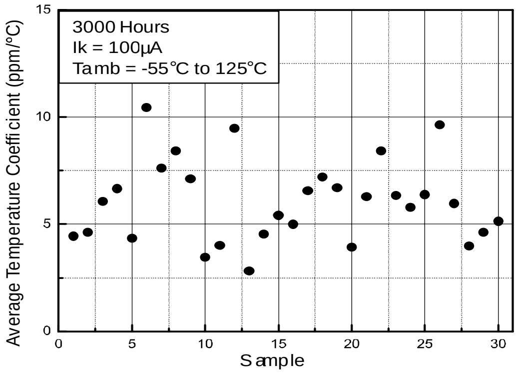


Figure 56: Average temperature coefficient at 0 hr, Ik = 10 mA

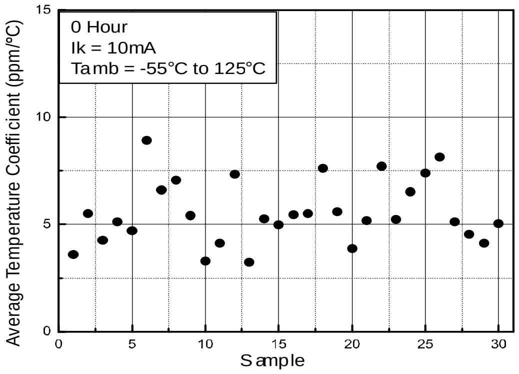


Figure 57: Average temperature coefficient at 1000 hrs, Ik = 10 mA

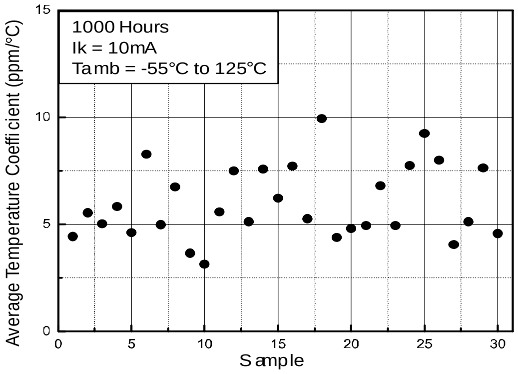


Figure 58: Average temperature coefficient at 2000 hrs, Ik = 10 mA

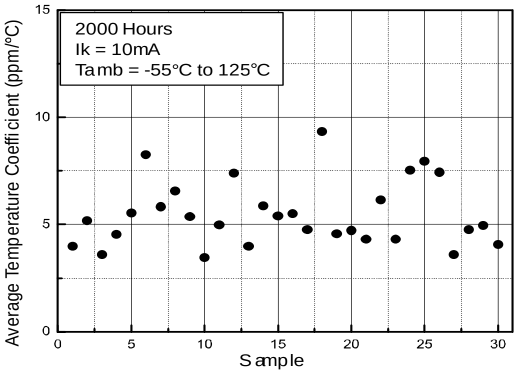


Figure 59: Average temperature coefficient at 3000 hrs, Ik = 10 mA

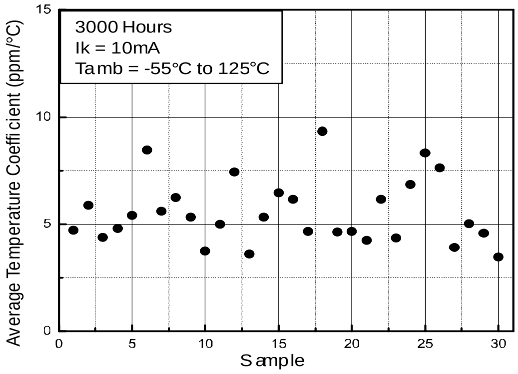


Figure 60: Reverse breakdown voltage vs. cumulated radiation dose (0.01 rad/s)

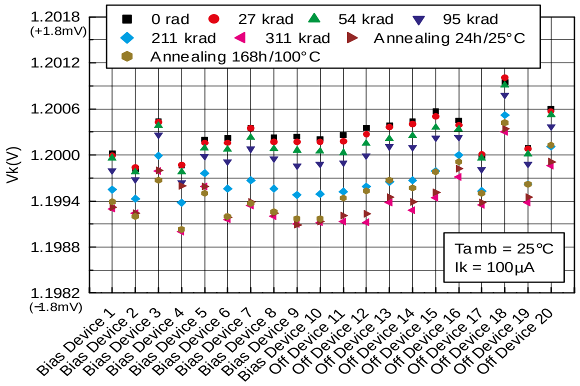
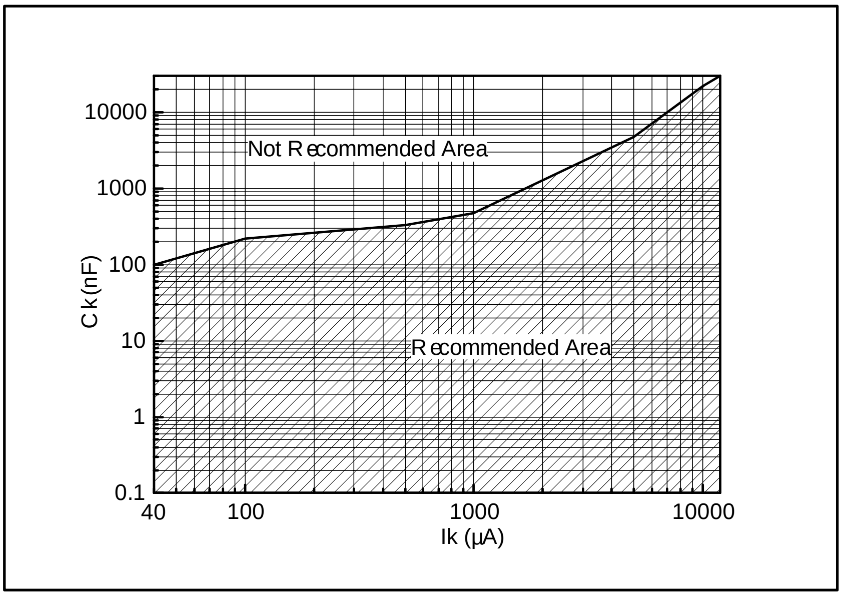


Figure 61: Recommended operating area



5 Parameters and implementation

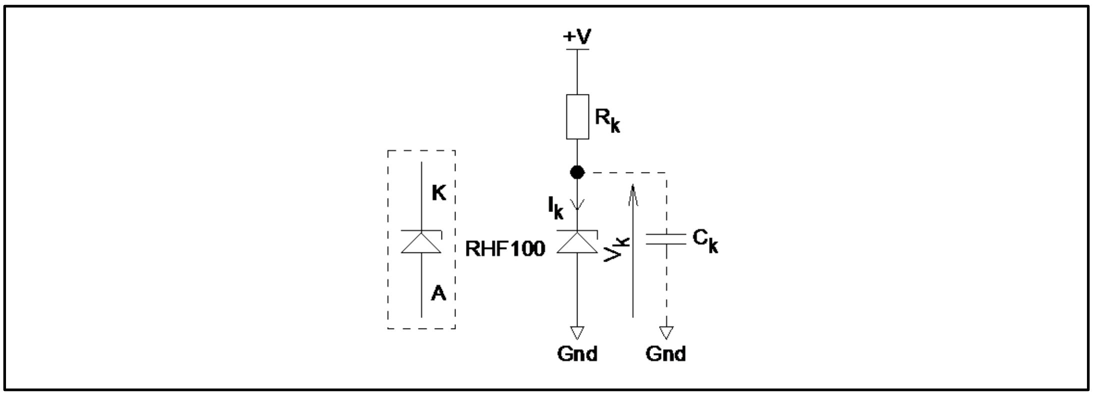
5.1 Introduction

The RHF100 is a 1.2 V, fixed voltage, shunt reference type. Its initial accuracy is ± 0.15 % and the maximum average temperature coefficient is 15 ppm/°C.

From -55 °C to 125 °C, the cathode current capability of the RHF100 ranges from 40 µA up to 12 mA.

Thanks to internal double bonding, the RHF100 has an equivalent output resistance as low as 110 mW. Consequently, the RHF100 has very good load regulation.

Figure 62: Implementation used for the test and for the characterisation



5.2 Average temperature coefficient

The RHF100 is designed with a second order compensation in temperature. This gives an S-shaped curve for the V_k variation over the temperature range.

For the RHF100, the average temperature coefficient is calculated as shown in *Equation 1*.

Equation 1

$$\text{Average temperature coefficient} = \frac{V_{kmax} - V_{kmin}}{(T_{max} - T_{min}) \times V_k(25\,°C)} \times 10^6$$

Where T_{max} = 125 °C and T_{min} = -55 °C.

For each sample, use *Equation 1* and the procedure below:

- Set a cathode current (I_k)
- Measure V_k at I_k with an ambient temperature of 25 °C
- Measure V_k at I_k with the following ambient temperatures: -55 °C, -15 °C, 75 °C, and 125°C.
- For the above five temperature measurements, find the V_k maximum and minimum
- Apply *Equation 1*

The average temperature coefficient is evaluated during product qualification on the above five temperature measurements and is guaranteed on production tests with three temperature measurements: -55 °C, 25 °C, and 125 °C.

5.3 Minimum and maximum cathode current

5.3.1 Minimum operating cathode current

The minimum operating cathode current ($I_{kmin.}$) is a combination of parameters (such as reference voltage, stability, noise, and process drift) that are taken over the ambient temperature range. For the RHF100, $I_{kmin.}$ is 40 µA.

$I_{kmin.}$ is guaranteed over the ambient temperature range by *Equation 2*.

Equation 2

$$V_k(I_k = 40\ \mu A) \geq V_k(I_k = 100\ \mu A, 25\ °C) - 100\ \mu V$$

5.3.2 Maximum operating cathode current (Ikmax.)

The maximum operating cathode current ($I_{kmax.}$) is limited by the output ballast current capabilities and process drift. For the RHF100, $I_{kmax.}$ is 12 mA.

$I_{kmax.}$ is guarantee by the ΔV_k vs. ΔI_k parameter (see *Table 4: "Anode connected to GND (0 V), Vk referred to anode voltage, Ck = 100 nF, unless otherwise specified"*) and by *Equation 3* (at T_{amb} = 25 °C).

Equation 3

$$V_k(I_k = 12\ mA) \leq V_k(I_k = 100\ \mu A, 25\ °C) + 3\ mV$$

5.4 Capacitive load considerations

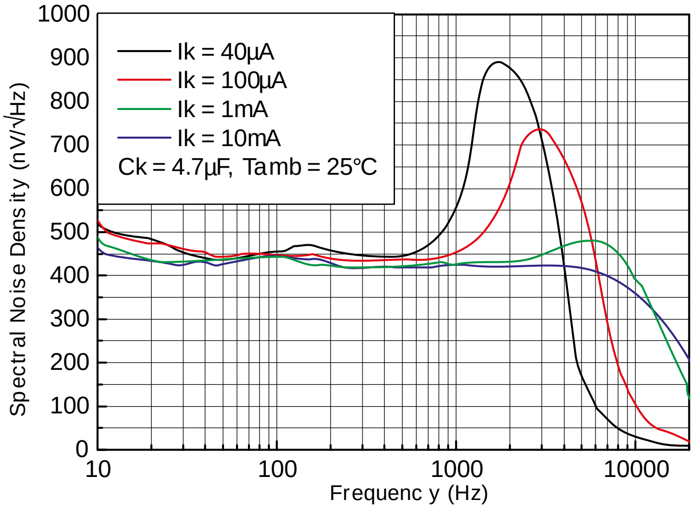
The RHF100 is designed to be stable with any capacitive load (C_k) over the cathode current range (40 µA to 12 mA) and ambient temperature range (-55 °C to 125 °C).

If an oscillation amplitude less than 2 mVrms is acceptable, this device can be considered usable with any capacitive load.

However, if no oscillation is required, it is important to follow the recommendations given in *Figure 60: "Reverse breakdown voltage vs. cumulated radiation dose (0.01 rad/s)"*.

Figure 63: "Spectral noise density vs. frequency" shows the spectral noise density measurements vs. frequency. For example, with a capacitive load of 4.7 µF and I_k = 40 µA, there is a noise peak at about 1800 Hz. For the reverse breakdown voltage (V_k), this peaking corresponds to a micro-oscillation, with jitter, centered at 1800 Hz.

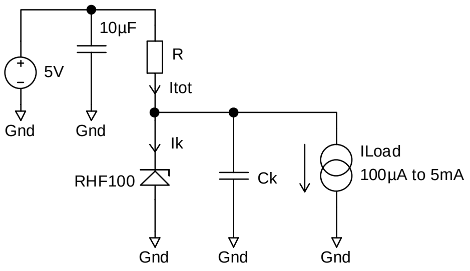
Figure 63: Spectral noise density vs. frequency



5.4.1 Design example with a variable output current load

Figure 64: "Example 1" shows how the output current load can vary from 100 µA to 5 mA. To bias the RHF100 correctly, we have to take into consideration that the cathode current varies in the opposite way to the load current.

Figure 64: Example 1



In *Figure 64: "Example 1"*, for a current load of 5 mA, the RHF100 has to be biased by 40 µA minimum.

If I_k = 100 µA, I_{tot} = 5.1 mA and the bias resistor value R can be calculated using *Equation 4*.

Equation 4

$$R = (5\text{ V} - 1.2\text{ V}) / 5.1\text{ mA}$$

In this case, R = 745 Ω. The closest normalized value is 750 Ω.

When current load = 5 mA, I_k = (5 V - 1.2 V)/750 - 5 mA = 66 µA which is higher than $I_{kmin.}$ = 40 µA.

When the current load = 100 µA, I_k = (5 V - 1.2 V)/750 - 100 µA = 4.96 mA which is lower than $I_{kmax.}$ = 12 mA.

Referring to *Figure 60: "Reverse breakdown voltage vs. cumulated radiation dose (0.01 rad/s)"*, the decoupling capacitor must not be higher than 150 nF ($I_{k\ min.}$ = 66 µA).

6 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.

6.1 Ceramic Flat-10 package information

Figure 65: Ceramic Flat-10 package mechanical drawing

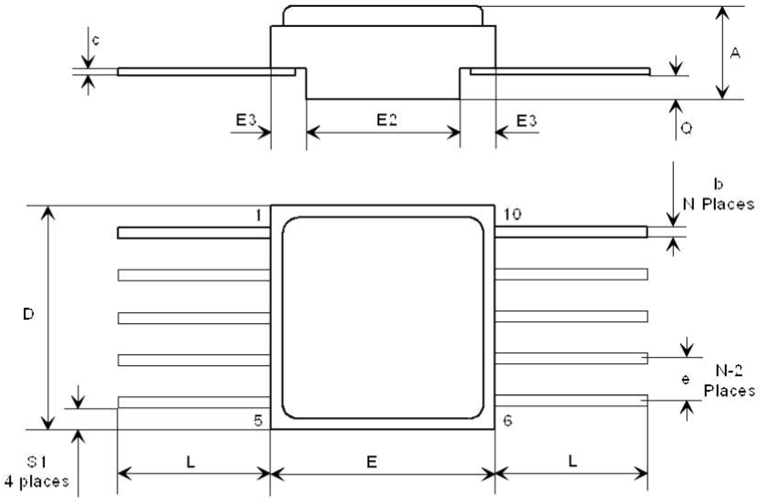


Table 8: Ceramic Flat-10 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.26	2.44	2.62	0.089	0.096	0.103
b	0.38	0.43	0.48	0.015	0.017	0.019
c	0.10	0.13	0.15	0.004	0.005	0.006
D	6.35	6.48	6.60	0.250	0.255	0.260
E	6.35	6.48	6.60	0.250	0.255	0.260
E2	4.32	4.45	4.58	0.170	0.175	0.180
E3	0.88	1.01	1.14	0.035	0.040	0.045
e		1.27			0.050	
L	6.35		9.40	0.250		0.370
Q	0.66	0.79	0.92	0.026	0.031	0.036
S1	0.16	0.48	0.81	0.006	0.019	0.032
N	10					

The upper metallic lid is not electrically connected to any pins, nor to the IC die inside the package. Connecting unused pins or the metal lid to ground or V_{CC} does not affect the electrical characteristics.

7 Ordering information

Table 9: Order codes

Order code	Description	Temp. range	Package	Marking (1)	Packing
RHF100K1	Engineering model	-55 °C to 125 °C	Flat-10	RHF100K1	Strip pack
RHF100K01V	QML-V flight			5962F1422501VXC	

Notes:

(1)Specific marking only. Complete marking includes the following: SMD pin (for QML flight only), ST logo, Date code (date the package was sealed) in YYWWA (year, week, and lot index of week), QML logo (Q or V), Country of origin (FR = France)

Contact your ST sales office for information regarding the specific conditions for products in die form and QML-Q versions.

8 Other information

8.1 Date code

The date code is structured as shown below:

- Engineering model: EM xyywwz
- QML flight model: FM yywwz

Where:

x (EM only): 3, assembly location Rennes (France)

yy: last two digits year

ww: week digits

z: lot index in the week

8.2 Documentation

Table 10: Documentation provided for QMLV flight

Quality level	Documentation
Engineering model	—
QML-V flight	• Certificate of conformance with Group C (reliability test) and group D (package qualification) reference • Precap report • PIND[(1)] test summary (test method conformance certificate) • SEM[(2)] report • X-ray report • Screening summary • Failed component list (list of components that have failed during screening) • Group A summary (QCI[(3)] electrical test) • Group B summary (QCI mechanical test) • Group E (QCI wafer lot radiation test)

Notes:

(1)PIND = particle impact noise detection

(2)SEM = scanning electron microscope

(3)QCI = quality conformance inspection

9 Revision history

Table 11: Document revision history

Date	Revision	Changes
06-Dec-2013	1	Initial release
19-Sep-2014	2	Added new Features to first page. Table 1: "Device summary" and Table 9: "Order codes": added SMD reference and flight model marking; removed footnote describing RHF100K01V as not being in full production. Updated 100 krad with 300 krad except in Table 6 Table 4: added ΔVk for 3000 hrs Table 5: updated for 300 krad Table 6: modified Kvhd Added Table 7 Added Figure 60
06-Nov-2017	3	Added comment: (initial Vk - final Vk)/(initial Vk). as specified in MIL" from Figure 47 to 51.

IMPORTANT NOTICE – PLEASE READ CAREFULLY