TS33

Datasheet

Micropower high precision series voltage reference

QFN8 1.5x1.5

Maturity status link
TS33

Features

- Fixed 1.25 V,1.8 V, 2.048 V, 2.5 V, 3.0 V, 3.3 V 4.096 V, 5.0 V output voltage
- Ultra low operating current: 3.9 µA (typ.) at 25 °C
- High initial accuracy: +/-0.15 %
- Stable when used with capacitive loads
- Extended temperature range: -40 to +125 °C
- 30 ppm/°C maximum temperature coefficient
- Available in QFN8 1.5x1.5 package

Applications

- Portable equipment
- Data acquisition systems
- Instrumentation
- Medical equipment
- Test equipment

Description

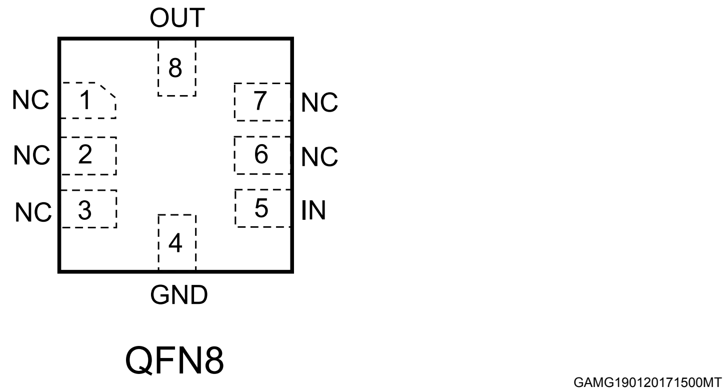
The TS33 family of low power series voltage references is capable of providing stable and precise output voltages with an initial accuracy of 0.15% over an extended temperature range (-40 to +125 °C).

The ultra low operating current is a key advantage for power-restricted designs. In addition, the TS33 is very stable over the entire operating temperature range, making it suitable for high-precision applications.

Available in QFN8 surface mount packages, the TS33 can be designed in applications where space saving is a critical issue.

1 Pin configuration

Figure 2. Pin configuration (top view)



2 Maximum ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{IN}	Maximum input voltage	-0.3 to 7	V
V_{OUT}	Maximum voltage on the output pin	-0.3 to V_{IN} +0.3	V
I_{OUT}	Output short-circuit current (sinking/sourcing)	Internally limited	mA
Pd	Power dissipation (1)	700	mW
T_{stg}	Storage temperature	-65 to +150	°C
ESD	Human body model (HBM)	4	kV
	Charged device model	1000	V
T_{lead}	Lead temperature (soldering) 10 s	260	°C
T_j	Max junction temperature	+150	°C

1. *Pd has been calculated with T_{amb} = 25 °C and T_{jmax} = 150 °C*

Note: Absolute maximum ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied.

Table 2. Thermal data

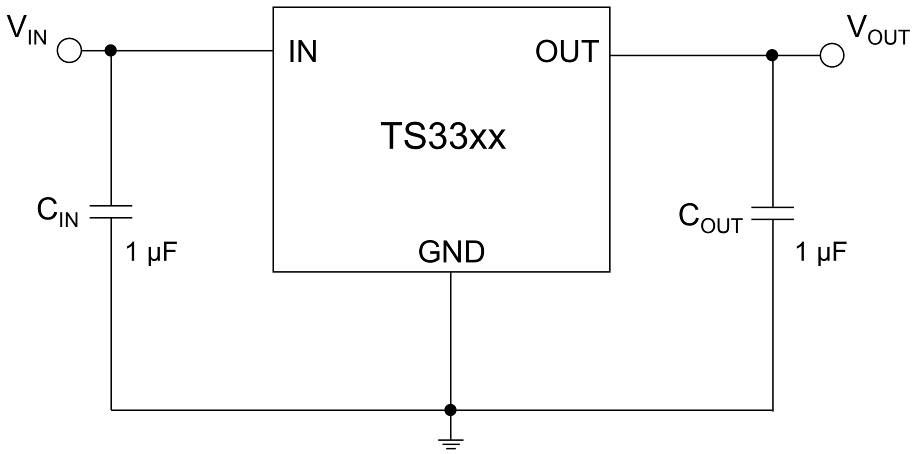
Symbol	Parameter	Value	Unit
R_{thJA}	Thermal resistance junction-ambient	159	°C/W
R_{thJC}	Thermal resistance junction-case	103	°C/W

Table 3. Recommended operating conditions

Symbol	Parameter	Value	Unit
V_{IN}	Operating input voltage range	1.8 to 5.5	V
I_{OUT}	Maximum operating current	±5	mA
T_{oper}	Operating free air temperature range	-40 to +125	°C

3 Typical application

Figure 3. Typical application circuit



4 Electrical characteristics

V_{IN} = 5 V, I_{LOAD} = 0 mA, T_{amb} = 25 °C (unless otherwise specified).

Table 4. Electrical characteristics for TS3312

Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
V_{IN}	Minimum input voltage	I_{LOAD} = 0 mA T_{amb} = 25 °C	1.8			V
V_{OUT}	Output voltage	V_{IN} = 5 V I_{LOAD} = 0 mA T_{amb} = 25 °C		1.25		V
	Initial accuracy		-0.15		0.15	%
$\Delta V_{OUT}/\Delta T$	Average temperature coefficient	-40 °C < T_{amb} < +85 °C		9	30	ppm/°C
		-40 °C < T_{amb} < +125 °C		8	30	
$\Delta V_{OUT}/\Delta V_{IN}$	Line regulation	V_{IN} = 1.8 V to 5.5 V	-50	6	+50	ppm/V
		0 °C < T_{amb} < 70 °C		6		
		-40 °C < T_{amb} < +85 °C		8		
		-40 °C < T_{amb} < +125 °C		30		
$\Delta V_{OUT}/\Delta I_{LOAD}$	Load regulation	V_{IN} = 1.8 V	-50	6	+50	ppm/mA
		I_{LOAD} = ±5 mA 0 °C < T_{amb} < 70 °C		10		
		-40 °C < T_{amb} < +85 °C		20		
		-40 °C < T_{amb} < +125 °C		20		
I_{SC}	Short-circuit current sourcing/ sinking			35		mA
I_Q	Quiescent current			3.9	7	µA
		-40 °C < T_{amb} < +85 °C		4.4	7.5	
		-40 °C < T_{amb} < +125 °C		4.8	10	
C_{OUT}	Capacitive load		0.1		10	µF
T_{ON}	Turn-on settling time	to 0.1 %, C_{OUT} = 1 µF		2		ms
e_n	Noise floor	f = 0.1 Hz to 10 Hz		35		μV_{P-P}

Table 5. Electrical characteristics for TS3330

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output voltage	V_{IN} = 5 V		3.0		V
	Initial accuracy	I_{LOAD} = 0 mA T_{amb} = 25 °C	-0.15		0.15	%
$\Delta V_{OUT}/\Delta T$	Average temperature coefficient	-40 °C < T_{amb} < +85 °C		9	30	ppm/°C
		-40 °C < T_{amb} < +125 °C		8	30	
$\Delta V_{OUT}/\Delta V_{IN}$	Line regulation	V_{IN} = 3.2 V to 5.5 V	-50	6	+50	ppm/V
		0 °C < T_{amb} < 70 °C		6		
		-40 °C < T_{amb} < +85 °C		8		
		-40 °C < T_{amb} < +125 °C		30		
$\Delta V_{OUT}/\Delta I_{LOAD}$	Load regulation	V_{IN} = 3.2 V	-50	6	+50	ppm/mA
		I_{LOAD} = ±5 mA 0 °C < T_{amb} < 70 °C		10		
		-40 °C < T_{amb} < +85 °C		20		
		-40 °C < T_{amb} < +125 °C		20		
V_{DROP}	Minimum dropout voltage	V_{IN} = 3.2 V I_{LOAD} = ±5 mA		50	100	mV
		0 °C < T_{amb} < 70 °C		70		
		-40 °C < T_{amb} < +85 °C		75		
		-40 °C < T_{amb} < +125 °C		80		
		I_{LOAD} = ±2 mA -40 °C < T_{amb} < +85 °C			70	
I_{SC}	Short-circuit current sourcing/ sinking			35		mA
I_Q	Quiescent current			3.9	7	µA
		-40 °C < T_{amb} < +85 °C		4.4	7.5	
		-40 °C < T_{amb} < +125 °C		4.8	10	
C_{OUT}	Capacitive load		0.1		10	µF
T_{ON}	Turn-on settling time	to 0.1 %, C_{OUT} = 1 µF		2		ms
e_n	Noise floor	f = 0.1 Hz to 10 Hz		67		μV_{P-P}

Table 6. **Electrical characteristics for TS3333**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{OUT}	Output voltage	V_{IN} = 5 V		3.3		V
	Initial accuracy	I_{LOAD} = 0 mA T_{amb} = 25 °C	-0.15		0.15	%
$\Delta V_{OUT}/\Delta T$	Average temperature coefficient	-40 °C < T_{amb} < +85 °C		9	30	ppm/°C
		-40 °C < T_{amb} < +125 °C		8	30	
$\Delta V_{OUT}/\Delta V_{IN}$	Line regulation	V_{IN} = 3.5 V to 5.5 V	-50	6	+50	ppm/V
		0 °C < T_{amb} < 70 °C		6		
		-40 °C < T_{amb} < +85 °C		8		
		-40 °C < T_{amb} < +125 °C		30		
$\Delta V_{OUT}/\Delta I_{LOAD}$	Load regulation	V_{IN} = 3.5 V	-50	6	+50	ppm/mA
		I_{LOAD} = ±5 mA 0 °C < T_{amb} < 70 °C		10		
		-40 °C < T_{amb} < +85 °C		20		
		-40 °C < T_{amb} < +125 °C		20		
V_{DROP}	Minimum dropout voltage	V_{IN} = 3.5 V I_{LOAD} = ±5 mA		50	100	mV
		0 °C < T_{amb} < 70 °C		70		
		-40 °C < T_{amb} < +85 °C		75		
		-40 °C < T_{amb} < +125 °C		80		
		I_{LOAD} = ±2 mA -40 °C < T_{amb} < +85 °C			70	
I_{SC}	Short-circuit current sourcing/ sinking			35		mA
I_Q	Quiescent current			3.9	7	µA
		-40 °C < T_{amb} < +85 °C		4.4	7.5	
		-40 °C < T_{amb} < +125 °C		4.8	10	
C_{OUT}	Capacitive load		0.1		10	µF
T_{ON}	Turn-on settling time	to 0.1 %, C_{OUT} = 1 µF		2		ms
e_n	Noise floor	f = 0.1 Hz to 10 Hz		73		μV_{P-P}

5 Typical performance characteristics

The following plots are referred to the typical application circuit and, unless otherwise noted, at T_A = 25 °C, V_{OUT} = 3.0 V.

Figure 4. Output voltage vs. temperature

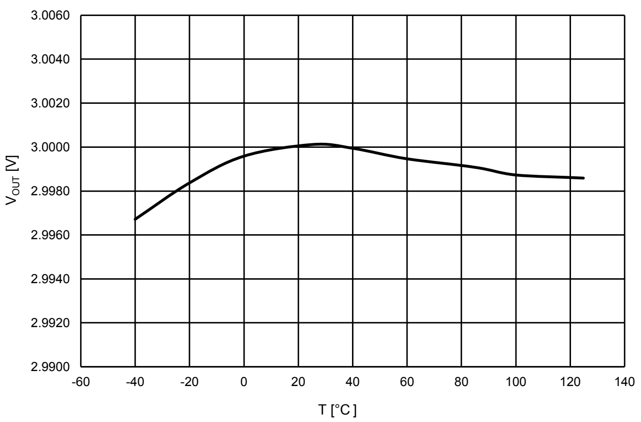


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Figure 5. Output voltage vs. input voltage

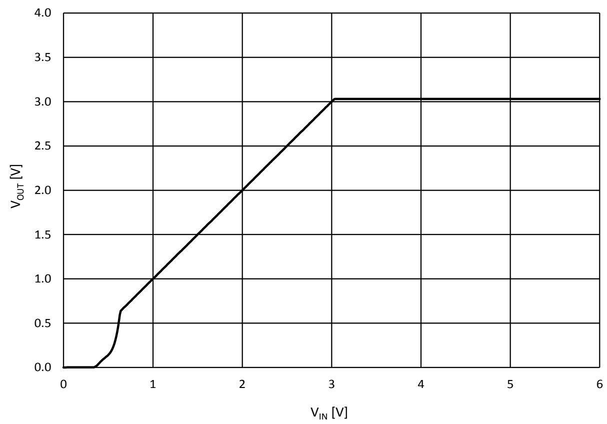

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Figure 6. Quiescent current vs. input voltage

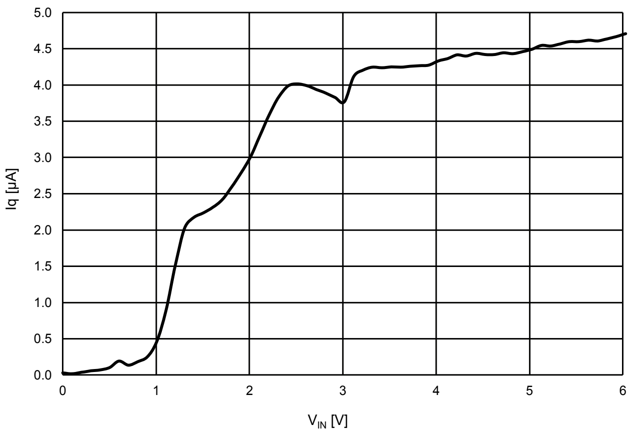

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Figure 7. Dropout voltage vs. load current

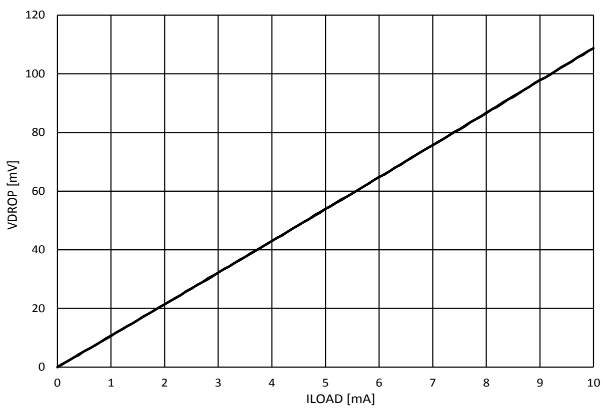

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Figure 8. SVR vs. frequency

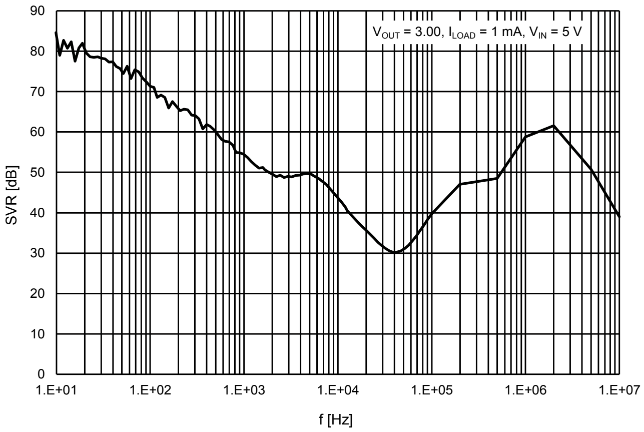

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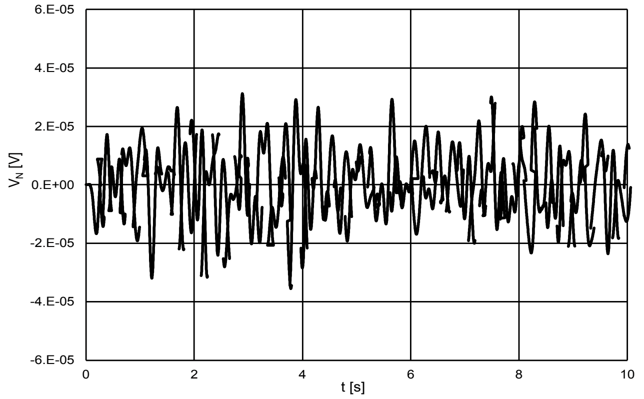
Figure 9. Low frequency noise



V_N = f(t), V_{OUT} = 3.00 V, f = 0.1 - 10 Hz

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Figure 10. Temperature drift

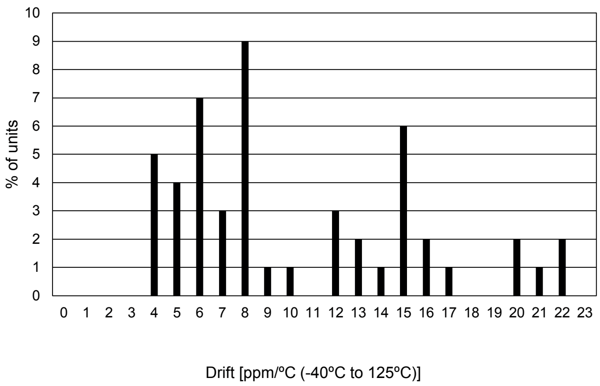

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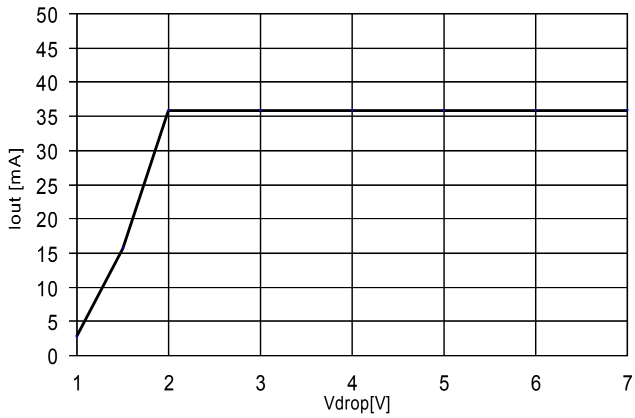
Figure 11. Short-circuit current vs. dropout voltage



T = 25 °C, Cin = 1 µF, Cout = 1 µF

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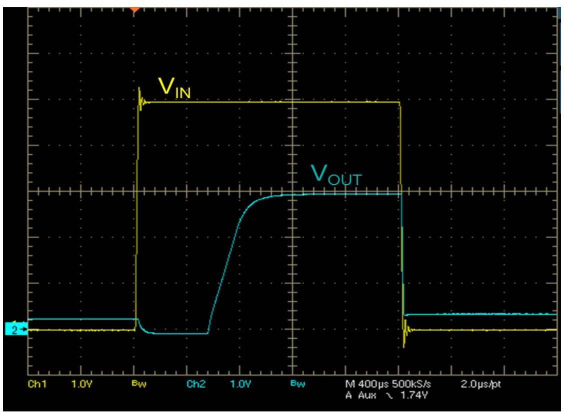
Figure 12. Startup transient (no load)



V_{IN} from 0 to 5V, V_{OUT}=3V, I_{OUT}=0mA, C_{IN}= C_{OUT}= 1µF

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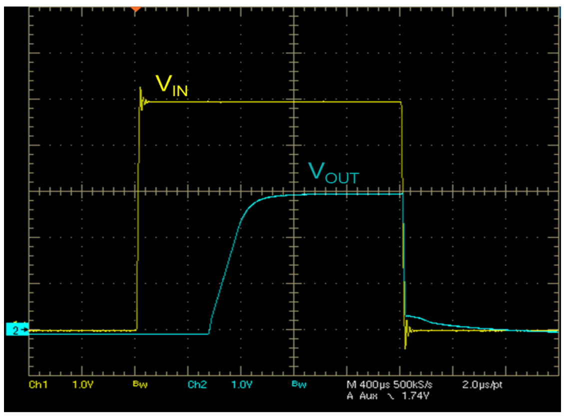
Figure 13. Startup transient (I_{OUT} = 5 mA)



V_{IN} from 0 to 5V, V_{OUT}=3V, I_{OUT}=5mA, C_{IN}= C_{OUT}= 1µF

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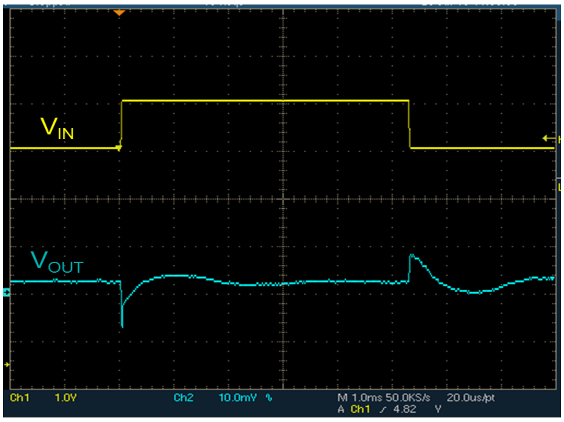
Figure 14. Line transient (no load)



V_{IN} = 5V, V_{OUT}=3V, I_{OUT}=0mA, C_{OUT}= 1µF, ΔV_{IN} = 500mV

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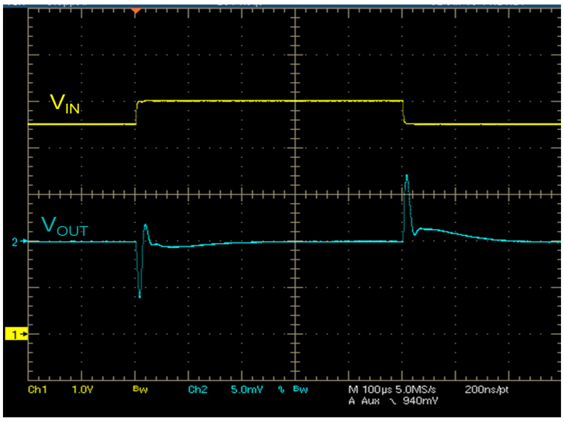
Figure 15. Line transient (I_{OUT} = 1 mA)



V_{IN} = 5V, V_{OUT}=3V, I_{OUT}=1mA, C_{OUT}= 1µF, ΔV_{IN} = 500mV

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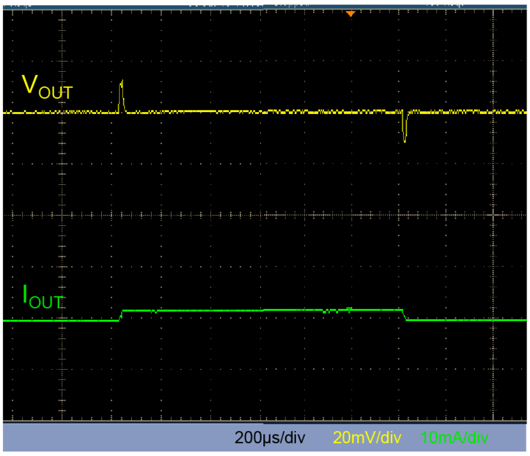
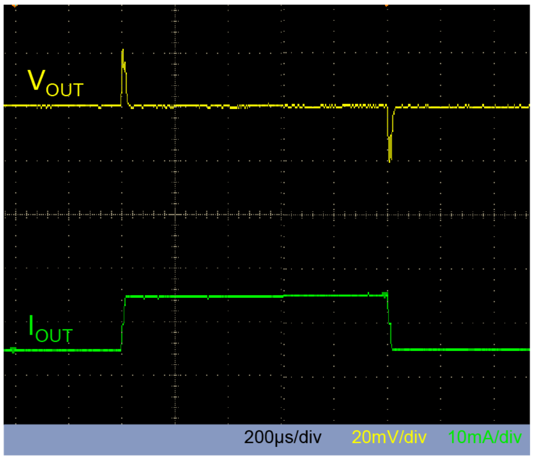
Figure 16. Load transient (I_{OUT} = +/-1 mA)



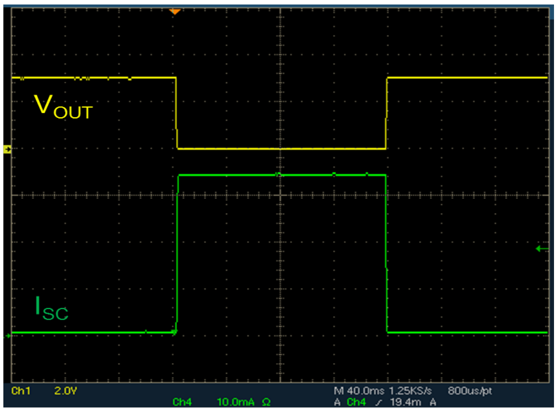
V_{OUT}=3V, I_{OUT}= ± 1mA, C_{IN}=C_{OUT}=1µF

Figure 17. Load transient (I_{OUT} = +/-5 mA)



V_{OUT}=3V, I_{OUT}= ± 5mA, C_{IN}=C_{OUT}=1µF

Figure 18. **Short-circuit response**



V_{IN}=5V, T=25°C, C_{IN}=1µF, C_{OUT}=1µF

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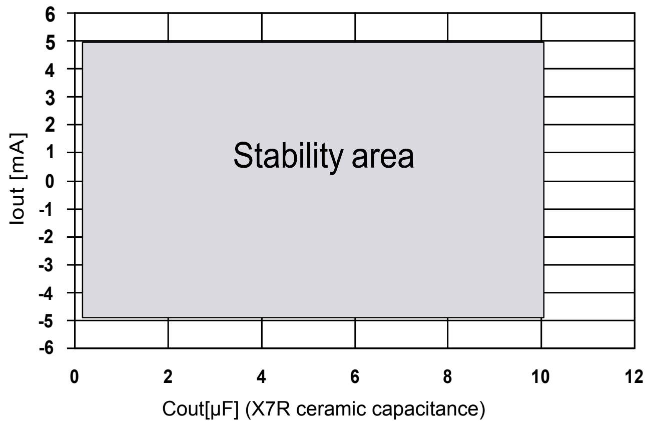
Figure 19. **Stability plan**



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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 QFN8 package information

Figure 20. QFN8 package outline

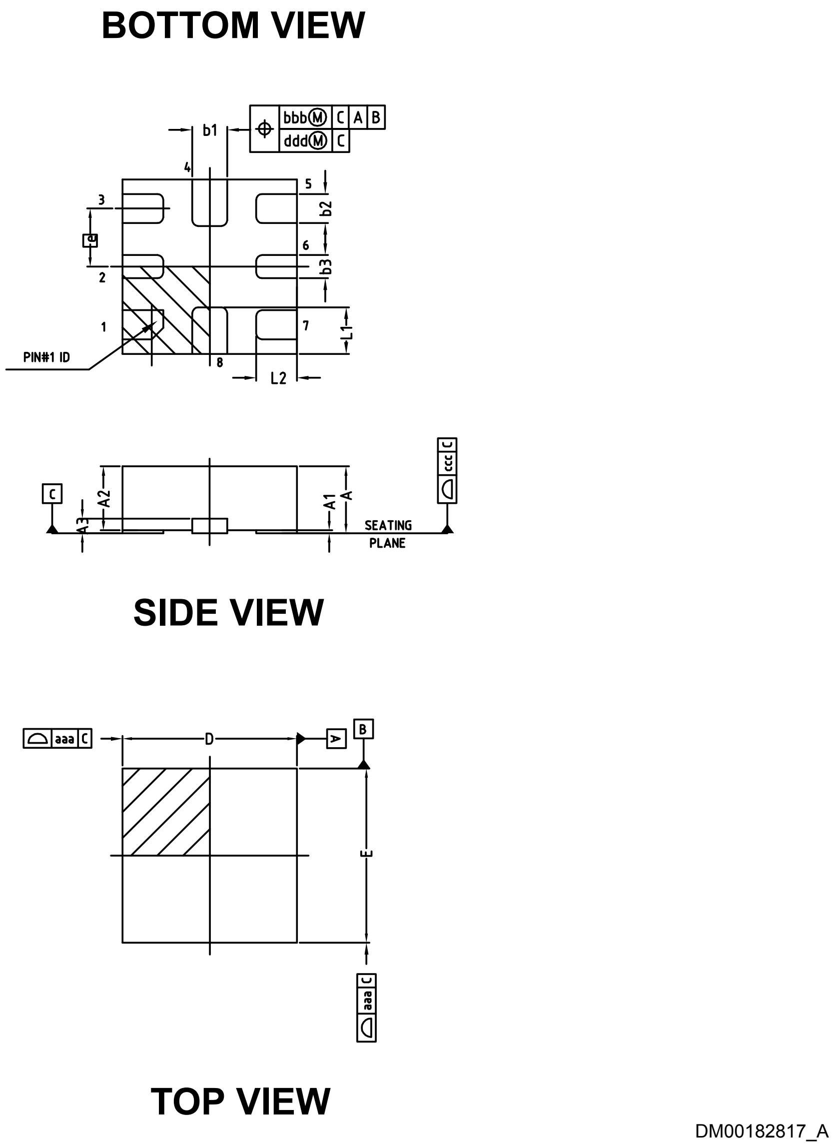


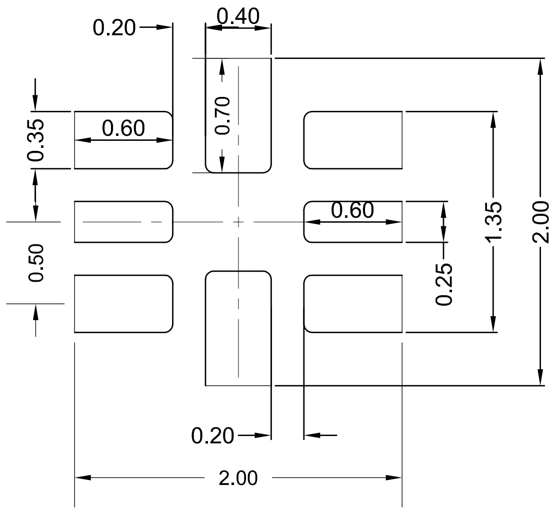
Table 7. QFN8 mechanical data

Dim.	mm			Note
	Min.	Typ.	Max.	
A	0.40	-	0.55	4
A1	0.00	-	0.05	12
A2	0.33	0.43	0.53	4
A3		-		4
b1	0.25	0.3	0.35	4.9
b2	0.20	0.25	0.30	
b3	0.15	0.20	0.25	
D	1.40	1.50	1.60	4
e		0.50		4
E	1.40	1.50	1.60	4
L1	0.30	0.40	0.50	4
L2	0.25	0.35	0.45	4
N	8			15

Table 8. QFN8 tolerance of form and position

Symbol	Tolerance of form and position
aaa	0.15
bbb	0.10
ccc	0.08
ddd	0.05
eee	0.10

Figure 21. QFN8 recommended footprint



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7 Ordering information

Table 9. **Order codes**

Part number	Output voltage (V)	Precision	Package	Temperature range
TS3312AQPR	1.25	±0.15 %	QFN8	-40 to +125 °C
TS3325AQPR [1]	2.5			
TS3330AQPR	3.0			
TS3333AQPR	3.3			

1. *In development.*

Revision history

Table 10. Document revision history

Date	Revision	Changes
05-Sep-2017	1	Initial release.
26-Sep-2018	2	Added new order codes TS3325AQPR and TS3333AQPR in Table 9. Order codes.

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