LD39020

Datasheet

200 mA very low quiescent current linear regulator IC

DFN4 1x1

SOT23-5L

Maturity status link
LD39020

Features

- Input voltage from 1.5 to 5.5 V
- Ultra low dropout voltage (200 mV typ. at 200 mA load)
- Very low quiescent current (20 µA typ at no load, 0.03 µA typ in off mode)
- Output voltage tolerance: ± 0.5 % (A version) or ± 2.0 % @ 25 °C (standard version)
- 200 mA guaranteed output current
- High PSRR (80 dB@1 kHz, 50 db@100 kHz)
- Wide range of output voltages available on request: from 0.8 V up to 5.0 V in 50 mV step
- Logic-controlled electronic shutdown
- Internal soft-start
- Optional output voltage discharge feature
- Compatible with ceramic capacitor C_{OUT} = 0.47 µF
- Internal current limit and thermal protections
- Available in DFN4 1x1 and SOT23-5L packages
- Operating temperature range: -40 °C to 125 °C

Applications

- Mobile phones
- Tablets
- Digital still cameras (DSC)
- Cordless phones and similar battery-powered systems
- Portable media players

Description

The LD39020 high accuracy voltage regulator provides 200 mA of maximum current from an input voltage ranging from 1.5 V to 5.5 V, with a typical dropout voltage of 200 mV.

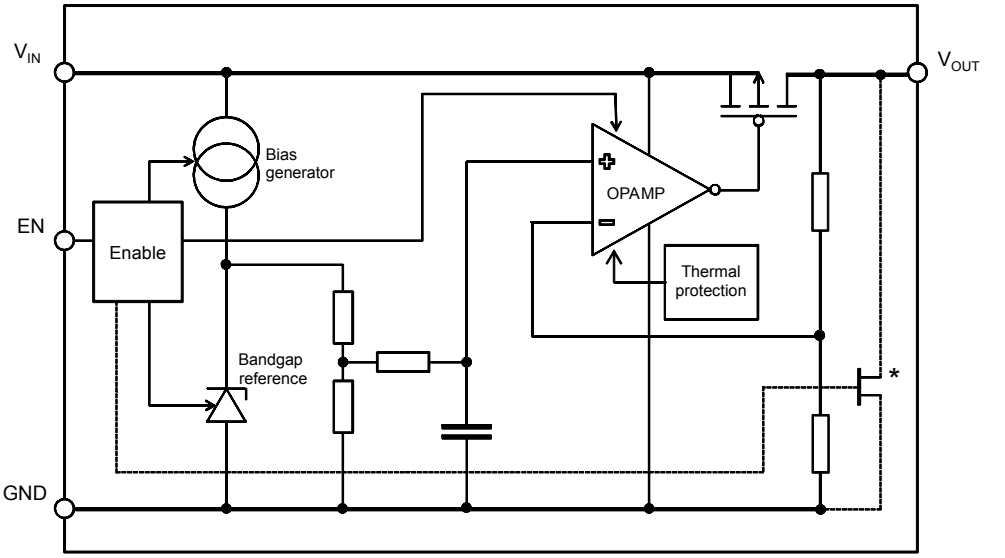
It is available in DFN4 1x1 and SOT23-5L packages, allowing the maximum space saving.

The device is stabilized with a ceramic capacitor on the output. The ultra low drop voltage, low quiescent current and low noise features, together with the internal soft-start circuit, make the LD39020 suitable for low power battery-operated applications.

An enable logic control function puts the LD39020 in shutdown mode allowing a total current consumption lower than 0.1 µA. Constant current and thermal protection are provided.

1 Diagram

Figure 1. Block diagram



Note: The output discharge MOSFET is optional.

2 Pin configuration

Figure 2. **Pin connection (top view)**

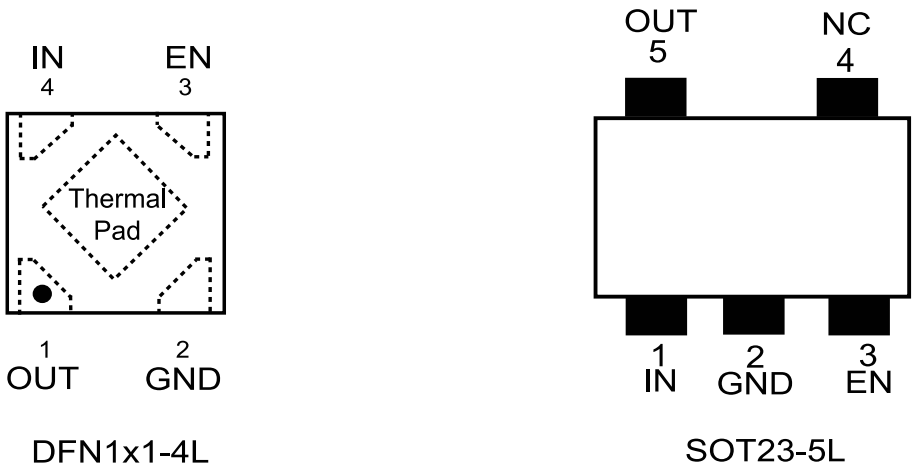
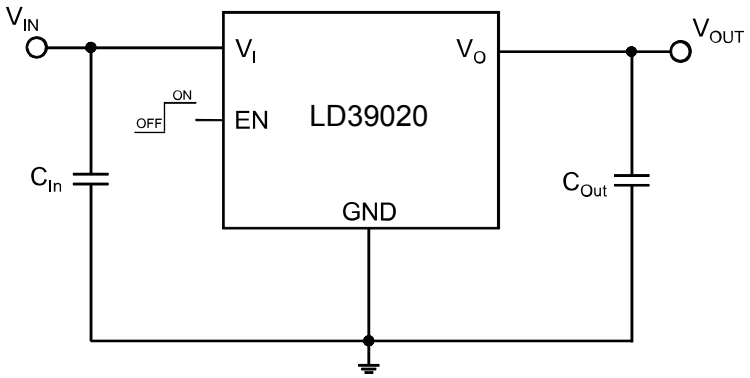


Table 1. **Pin description**

Pin DFN4 1x1	Pin SOT23-5L	Symbol	Function
1	5	OUT	Output voltage
2	2	GND	Common ground
3	3	EN	Enable pin logic input: Low = shutdown, High = active
4	1	IN	Input voltage
Thermal pad	-	GND	Connect to GND on the PCB
-	4	NC	Not internally connected

3 Typical application

Figure 3. **Typical application circuits**



4 Maximum ratings

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{IN}	Input voltage	- 0.3 to 7	V
V_{OUT}	Output voltage	- 0.3 to V_{IN} + 0.3	V
V_{EN}	Enable input voltage	- 0.3 to 7	V
I_{OUT}	Output current	Internally limited	mA
P_D	Power dissipation	Internally limited	mW
T_{STG}	Storage temperature range	- 40 to 150	°C
T_{OP}	Operating junction temperature range	- 40 to 125	°C

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

Table 3. Thermal data

Symbol	Parameter	Value	Unit
R_{thJA}	Thermal resistance junction-ambient, DFN4 1x1	250	°C/W
R_{thJC}	Thermal resistance junction-case, SOT23-5L	81	°C/W
R_{thJA}	Thermal resistance junction-ambient, SOT23-5L	255	°C/W

Table 4. ESD performance

Symbol	Parameter	Test conditions	Value	Unit
ESD	ESD Protection voltage	HBM	4	kV
		MM	400	V
		CDM	500	V

5 Electrical characteristics

T_J = 25 °C, V_{IN} = $V_{OUT(NOM)}$ + 1 V , C_{IN} = C_{OUT} = 1 µF, I_{OUT} = 1 mA, V_{EN} = V_{IN}, unless otherwise specified.

Table 5. Electrical characteristics for LD39020T, LD39020DT

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IN}	Operating input voltage		1.5		5.5	V
V_{OUT}	V_{OUT} accuracy	I_{OUT} = 1 mA, T_J = 25 °C	-2		2	%
		I_{OUT} = 1 mA, -40 °C < T_J < 125 °C	-3		3	%
ΔV_{OUT}	Static line regulation (1)	$V_{OUT(NOM)}$ + 1 V ≤ V_{IN} ≤ 5.5 V, I_{OUT} = 10 mA		0.02		%/V
		-40 °C < T_J < 125 °C			0.2	
ΔV_{OUT}	Static load regulation	I_{OUT} = 0 mA to 200 mA		10		mV
		-40 °C < T_J < 125 °C			0.01	%/mA
V_{DROP}	Dropout voltage	I_{OUT} = 30 mA,V_{OUT} = 2.8 V		35		mV
		I_{OUT} = 200 mA, V_{OUT} = 2.8 V -40 °C < T_J < 125 °C		200	350	
e_N	Output noise voltage	10 Hz to 100 kHz, I_{OUT} = 10 mA		45		μV_{RMS}/ V_{OUT}
SVR	Supply voltage rejection	V_{IN} = $V_{OUT(NOM)}$+ 1 V +/- V_{RIPPLE} V_{RIPPLE} = 0.2 V Freq. = 1 kHz I_{OUT} = 30 mA		80		dB
		V_{IN} = $V_{OUT(NOM)}$+ 1 V +/- V_{RIPPLE}, V_{RIPPLE} = 0.2 V Freq. = 100 kHz, I_{OUT} = 30 mA		55		
I_Q	Quiescent current	I_{OUT} = 0 mA		20	40	µA
		I_{OUT} = 200 mA		100		
$I_{Standby}$	Standby current	V_{IN} input current in OFF MODE: V_{EN} = GND		0.03	1	µA
I_{SC}	Short circuit current	R_L = 0	250	350		mA
R_{ON}	Output voltage discharge MOSFET	(only on LD39020DT)		100		Ω
V_{EN}	Enable input logic low	V_{IN} = 1.5 V to 5.5 V -40 °C < T_J < 125 °C			0.4	V
	Enable input logic high	V_{IN} = 1.5 V to 5.5 V -40 °C < T_J< 125 °C	1			
I_{EN}	Enable pin input current	V_{EN} = V_{IN}			100	nA
T_{ON} (2)	Turn on time			100		µs
T_{SHDN}	Thermal shutdown			160		°C
	Hysteresis			20		

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
C_{OUT}	Output capacitor	Capacitance see Figure 17. Stability area vs. (C_{OUT}, ESR)	0.47		22	µF

1. *Not applicable for $V_{out(nom)}$ > 4.5 V*
2. *Turn-on time is time measured between the enable input just exceeding VEN high value and the output voltage just reaching 95 % of its nominal value*

T_J = 25 °C, V_{IN} = $V_{OUT(NOM)}$ + 1 V , C_{IN} = C_{OUT} = 1 µF, I_{OUT} = 1 mA, V_{EN} = V_{IN}, unless otherwise specified.

Table 6. Electrical characteristics for LD39020AT, LD39020ADT

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IN}	Operating input voltage		1.5		5.5	V
V_{OUT}	V_{OUT} accuracy	I_{OUT} = 1 mA, T_J = 25 °C	-0.5		0.5	%
		I_{OUT} = 1 mA, -40 °C < T_J < 125 °C	-1.5		1.5	%
ΔV_{OUT}	Static line regulation(1)	$V_{OUT(NOM)}$ + 1 V ≤ V_{IN} ≤ 5.5 V, I_{OUT} = 10 mA		0.02		%/V
		-40 °C < T_J < 125 °C			0.2	
ΔV_{OUT}	Static load regulation	I_{OUT} = 0 mA to 200 mA		10		mV
		-40 °C < T_J < 125 °C			0.01	%/mA
V_{DROP}	Dropout voltage	I_{OUT} = 30 mA, V_{OUT} = 2.8 V		35		mV
		I_{OUT} = 200 mA, V_{OUT} = 2.8 V -40 °C < T_J < 125 °C		200	350	
e_N	Output noise voltage	10 Hz to 100 kHz, I_{OUT} = 10 mA		45		μV_{RMS} / V_{OUT}
SVR	Supply voltage rejection	V_{IN} = $V_{OUT(NOM)}$+ 1 V +/- V_{RIPPLE} V_{RIPPLE} = 0.2 V Freq. = 1 kHz I_{OUT} = 30 mA		80		dB
		V_{IN} = $V_{OUT(NOM)}$+ 1 V +/- V_{RIPPLE}, V_{RIPPLE} = 0.2 V Freq. = 100 kHz, I_{OUT} = 30 mA		55		
I_Q	Quiescent current	I_{OUT} = 0 mA		20	40	µA
		I_{OUT} = 200 mA		100		
$I_{Standby}$	Standby current	V_{IN} input current in OFF MODE: V_{EN} = GND		0.03	1	µA
I_{SC}	Short circuit current	R_L = 0	250	350		mA
R_{ON}	Output voltage discharge MOSFET	(only on LD39020ADT)		100		Ω
V_{EN}	Enable input logic low	V_{IN} = 1.5 V to 5.5 V -40 °C < T_J < 125 °C			0.4	V

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{EN}	Enable input logic high	V_{IN} = 1.5 V to 5.5 V -40 °C < T_J < 125 °C	1			V
I_{EN}	Enable pin input current	V_{EN} = V_{IN}			100	nA
T_{ON} (2)	Turn on time			100		µs
T_{SHDN}	Thermal shutdown			160		°C
	Hysteresis			20		
C_{OUT}	Output capacitor	Capacitance see Figure 17. Stability area vs. (C_{OUT}, ESR)	0.47		22	µF

1. *Not applicable for $V_{out(nom)}$ > 4.5 V*
2. *Turn-on time is time measured between the enable input just exceeding VEN high value and the output voltage just reaching 95 % of its nominal value*

6 Application information

6.1 Soft-start function

The LD39020 has an internal soft start circuit. By increasing the startup time up to 100 µs, without the need of any external soft start capacitor, this feature is able to keep the regulator inrush current at startup under control.

6.2 Output discharge function

The LD39020 integrates a MOSFET connected between V_{OUT} and GND. This transistor is activated when the EN pin goes to low logic level and has the function to quickly discharge the output capacitor when the device is disabled by the user.

The device is available with or without auto-discharge feature.

See Section 9: Order code for more details.

6.3 Input and output capacitors

The LD39020 requires external capacitors to assure the regulator control loop stability.

Any good quality ceramic capacitor can be used but, the X5R and the X7R are suggested since they guarantee a very stable combination of capacitance and ESR overtemperature.

Locating the input/output capacitors as closer as possible to the relative pins is recommended.

The LD39020 requires an input capacitor with a minimum value of 1 µF.

This capacitor must be located as closer as possible to the input pin of the device and returned to a clean analog ground.

The control loop of the LD39020 is designed to work with an output ceramic capacitor.

This capacitor must meet the requirements of minimum capacitance and equivalent series resistance (ESR), as shown in Figure 17. Stability area vs. (C_{OUT}, ESR). To assure stability, the output capacitor must maintain its ESR and capacitance in the stable region, over the full operating temperature range.

The LD39020 shows stability with a minimum effective output capacitance of 220 nF.

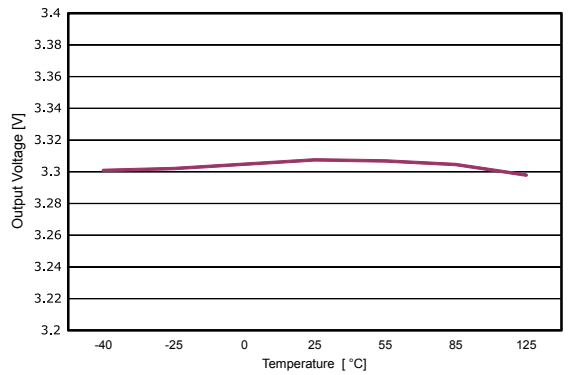
However, to keep stability in all operating conditions (temperature, input voltage and load variations), a minimum output capacitor of 0.47 µF is recommended.

The suggested combination of 1 µF input and output capacitors offers a good compromise among the stability of the regulator, optimum transient response and total PCB area occupation.

7 Typical characteristics

(C_{IN} = C_{OUT} = 1 µF, V_{EN} to V_{IN}, T_J = 25 °C unless otherwise specified)

Figure 4. Output voltage vs. temperature (I_{OUT} = 1 mA)



V_{IN} = 4.3 V, I_{OUT} = 1 mA

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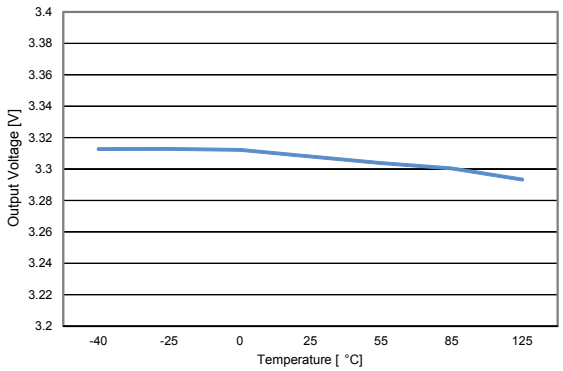
Figure 5. Output voltage vs. temperature (I_{OUT} = 200 mA)



V_{IN}=4.3V, I_{OUT}=200mA

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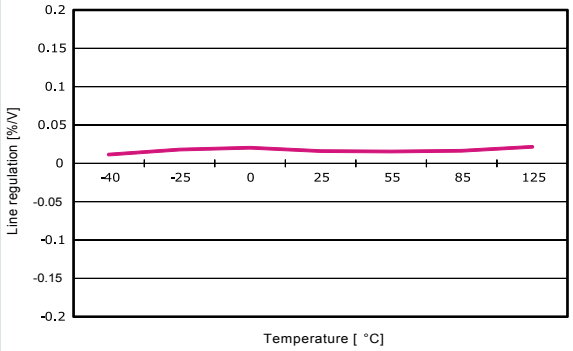
Figure 6. Line regulation vs. temperature



V_{IN} = 4.3 V to 5.5 V, I_{OUT} = 10 mA

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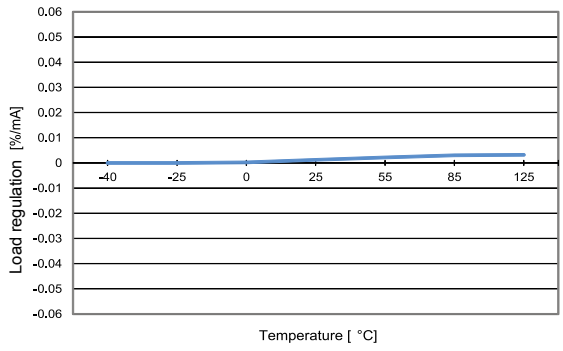
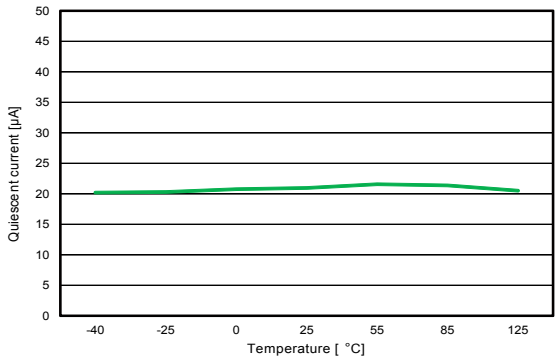
Figure 7. Load regulation vs. temperature



V_{IN}=4.3V, I_{OUT}= 0 to 200mA

AM13858V1

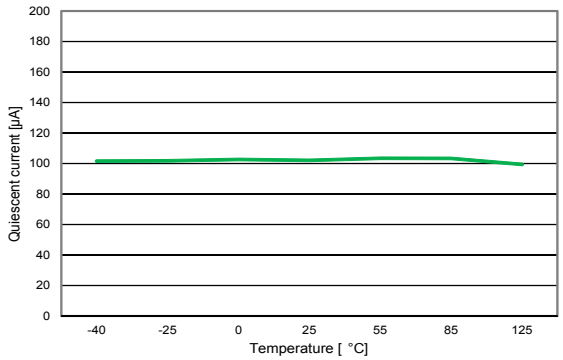
Figure 8. Quiescent current vs. temperature (I_{OUT} = 0 mA)



V_{IN} = 4.3 V, I_{OUT} = 0 mA

AM13859V1

Figure 9. Quiescent current vs. temperature (I_{OUT} = 200 mA)



V_{IN}=4.3V, I_{OUT}= 200mA

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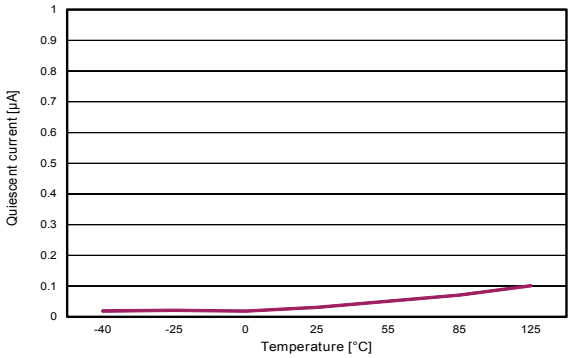
Figure 10. Shutdown current vs. temperature



V_{IN} = 4.3 V, V_{EN} = GND

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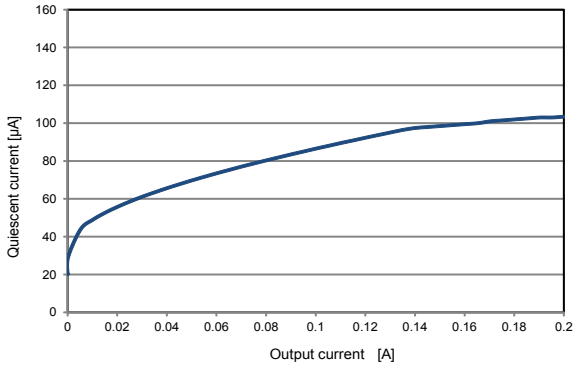
Figure 11. Quiescent current vs. load current



V_{IN}=2V, V_{OUT}=1V

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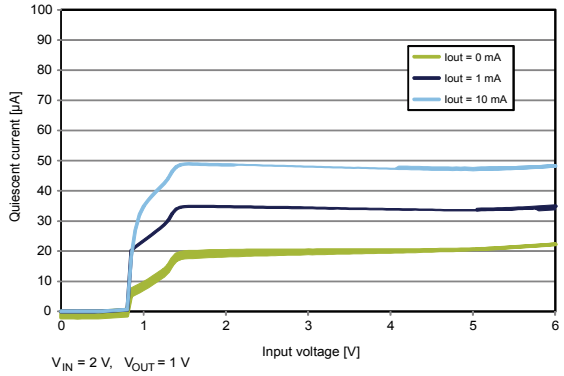
Figure 12. Quiescent current vs. input voltage



V_{IN} = 2 V, V_{OUT} = 1 V

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Figure 13. Dropout voltage vs. temperature

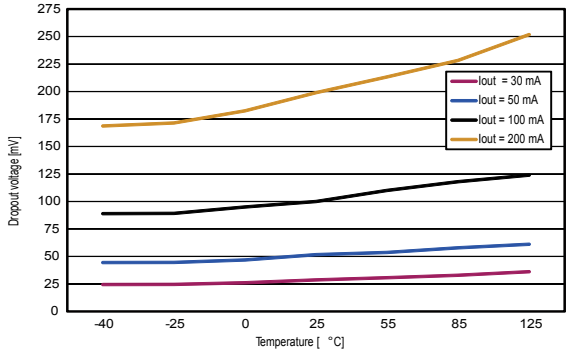

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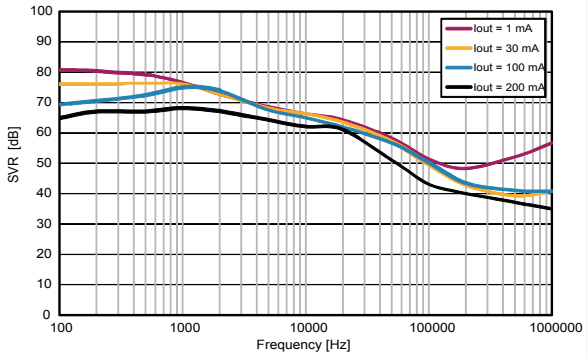
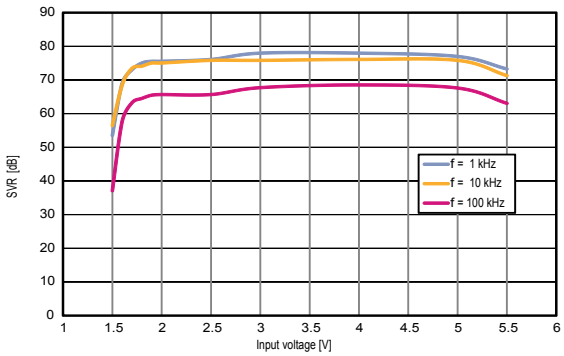
Figure 14. Supply voltage rejection vs. frequency



V_{IN}= 2 V+/-200 mV, V_{OUT}= 1 V, C_{OUT} = 1 µF

AM13865V1

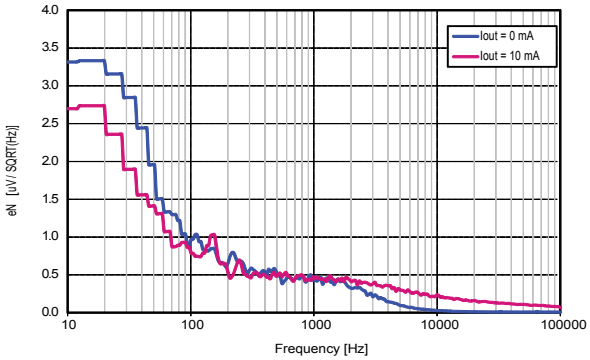
Figure 15. Supply voltage rejection vs. input voltage



I_{OUT} = 30mA, V_{OUT} = 1 V, C_{OUT} = 1 µF

AM13866V1

Figure 16. Output noise spectral density



V_{IN} = 2.0 V, V_{OUT} =1.0 V, C_{IN} = C_{OUT} = 1 µF

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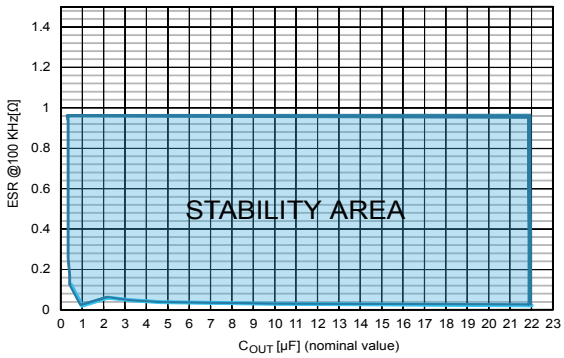
Figure 17. Stability area vs. (C_{OUT}, ESR)



V_{IN} from 2 to 5.5 V, I_{OUT} from 0 to 300 mA, C_{IN} = 1 µF

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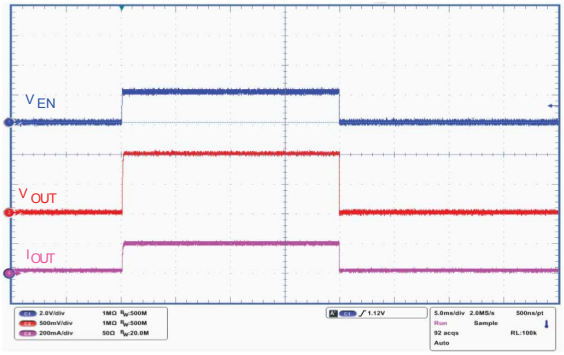
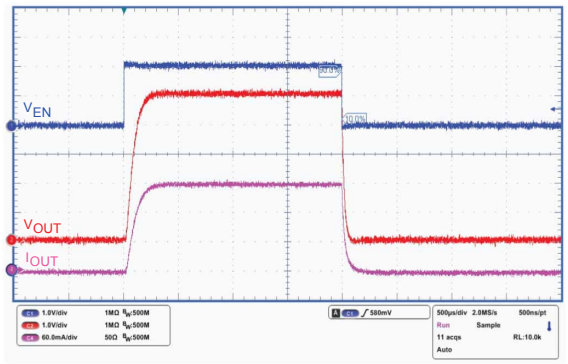
Figure 18. Enable startup (V_{OUT} = 1 V)



V_{IN} = 2 V, V_{EN} = 0 V to V_{IN}, I_{OUT} = 0.2 A, V_{OUT} = 1 V, T_r = 5 µs

AM13869V1

Figure 19. Enable startup (V_{OUT} = 5 V)



V_{IN} = 5.5 V, V_{EN} = 0 V to 2 V, I_{OUT} = 0.2 A, V_{OUT} = 5 V, T_r = 5 µs

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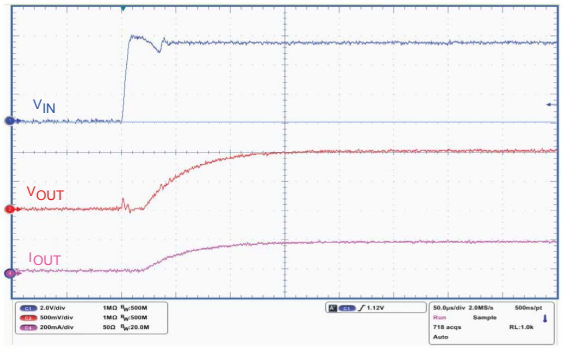
Figure 20. Turn-on time (V_{OUT} = 1 V)



V_{IN} = V_{EN} = from 0 V to 5.5 V, I_{OUT} = 0.2 A, V_{OUT} = 1 V, T_r = 5 µs

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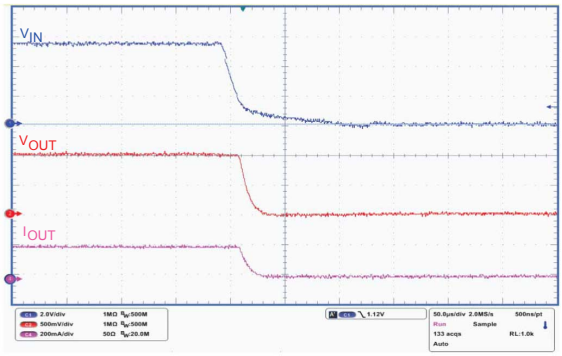
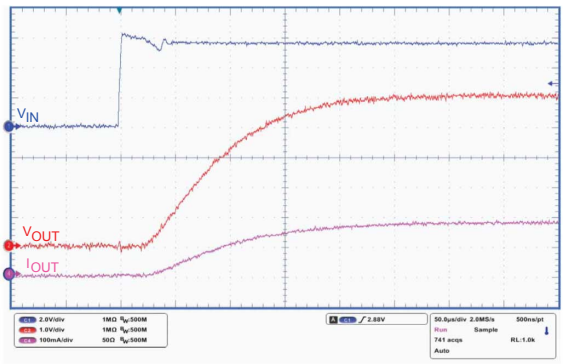
Figure 21. Turn-off time (V_{OUT} = 1 V)



V_{IN} = V_{EN} = from 5.5 V to 0 V, I_{OUT} = 0.2 A, V_{OUT} = 1 V, T_f = 5 µs

AM13872V1

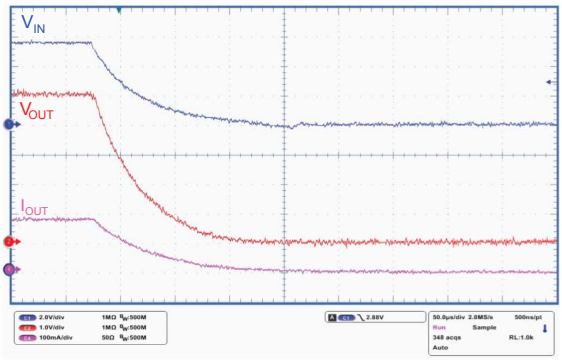
Figure 22. Turn-on time (V_{OUT} = 5 V)



V_{IN} = V_{EN} = from 0 V to 5.5 V, I_{OUT} = 0.2 A, V_{OUT} = 5 V, T_r = 5 µs

AM13873V1

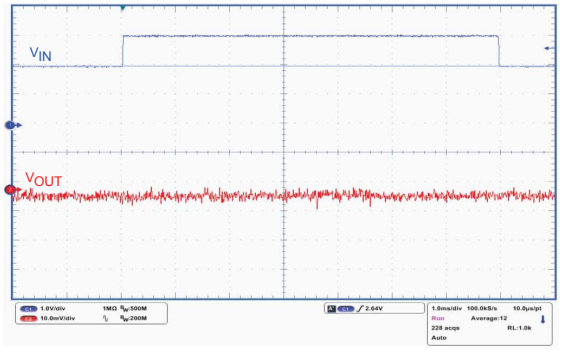
Figure 23. Turn-off time (V_{OUT} = 5 V)



V_{IN} = V_{EN} = from 5.5 V to 0 V, I_{OUT} = 0.2 A, V_{OUT} = 5 V, T_f = 5 µs

AM13874V1

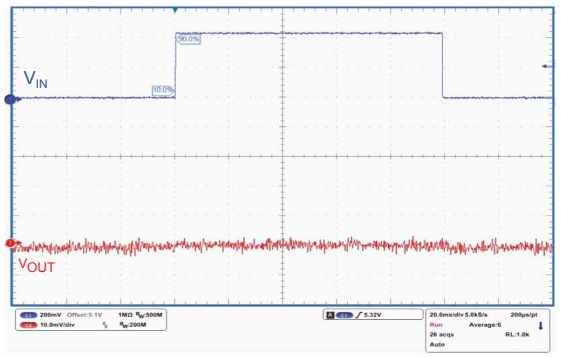
Figure 24. Line transient (V_{OUT} = 1 V)



V_{IN} = V_{EN} = from 2 V to 3 V, I_{OUT} = 10 mA, V_{OUT} = 1 V, T_r = T_f = 5 µs

AM13875V1

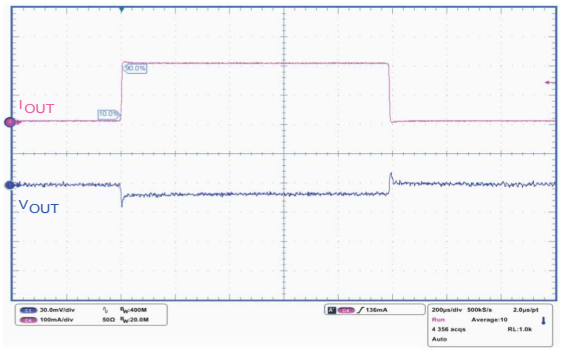
Figure 25. Line transient (V_{OUT} = 5 V)



V_{IN} = V_{EN} = from 5.1 V to 5.5 V, I_{OUT} = 10 mA, V_{OUT} = 5 V, T_r = T_f = 5 µs

AM13876V1

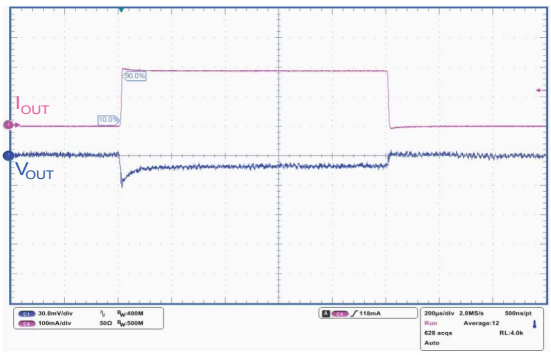
Figure 26. Load transient (V_{OUT} = 1 V)



V_{IN} = V_{EN} = 2 V, I_{OUT} = from 0 to 0.2 A, V_{OUT} = 1 V, t_r = t_f = 5 µs

AM13877V1

Figure 27. Load transient (V_{OUT} = 5 V)



V_{IN} = V_{EN} = 5.5 V, I_{OUT} = from 0 to 0.2 A, V_{OUT} = 5 V, t_r = t_f = 5 µs

AM13878V1

8 Package information

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.

8.1 DFN4 1x1 package info

Figure 28. **DFN4 1x1 package outline**

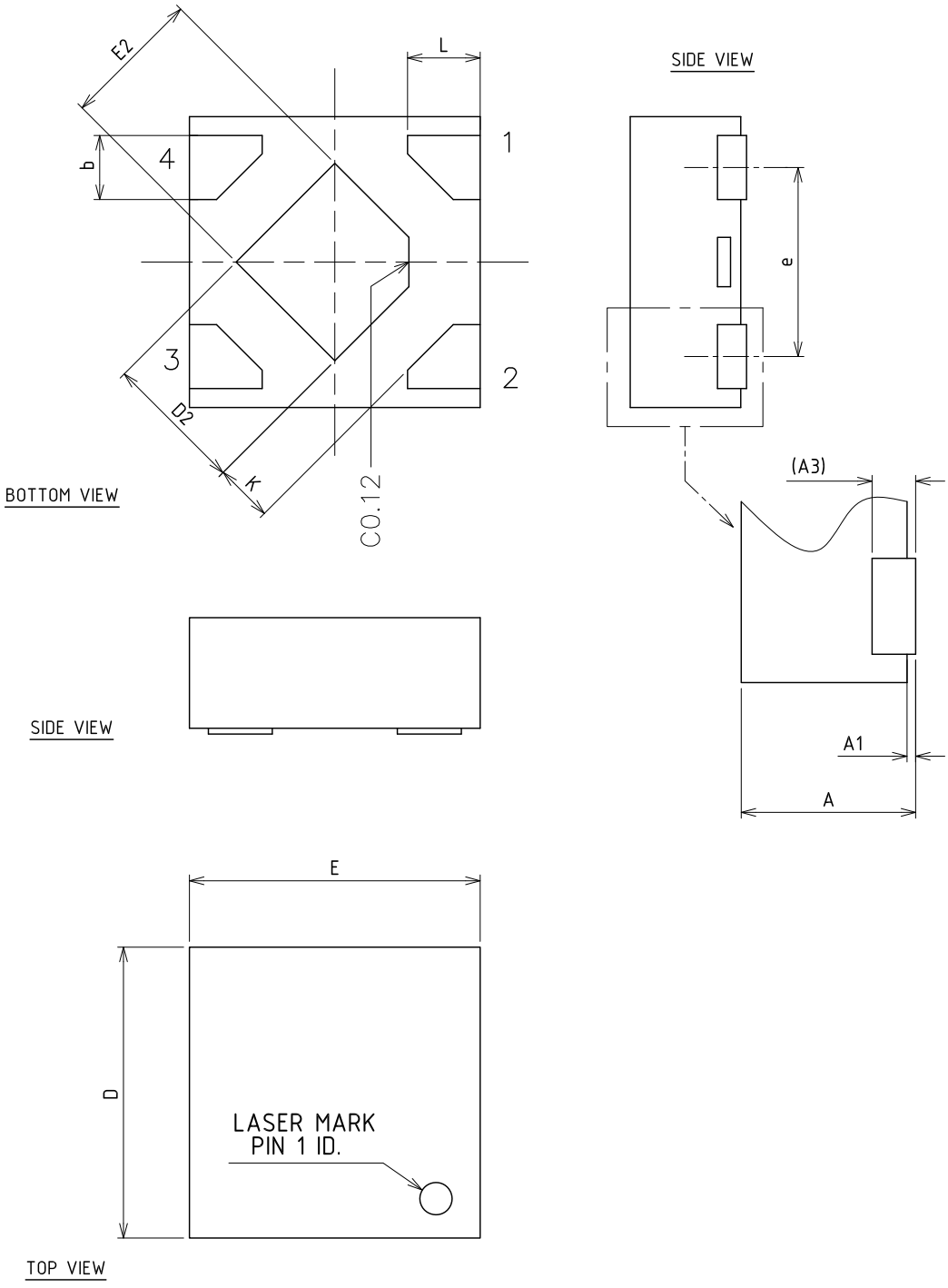
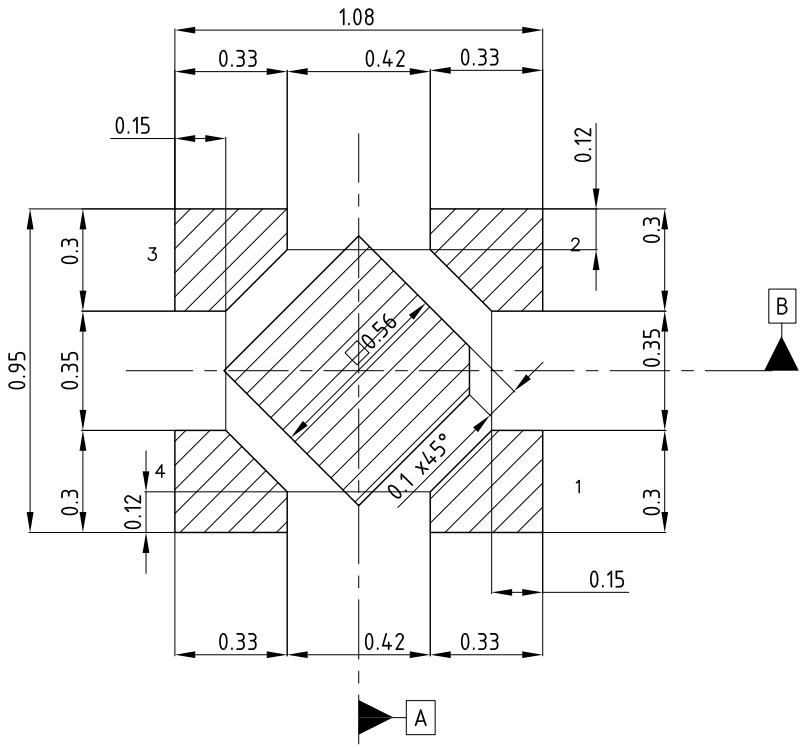


Table 7. **DFN4 1x1 mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	0.34	0.37	0.40
A1	0	0.02	0.05
A3		0.10	
b	0.17	0.22	0.27
D	0.95	1.00	1.05
D2	0.43	0.48	0.53
E	0.95	1.00	1.05
E2	0.43	0.48	0.53
e		0.65	
L	0.20	0.25	0.30
K	0.15		

Figure 29. **DFN4 1x1 recommended footprint**



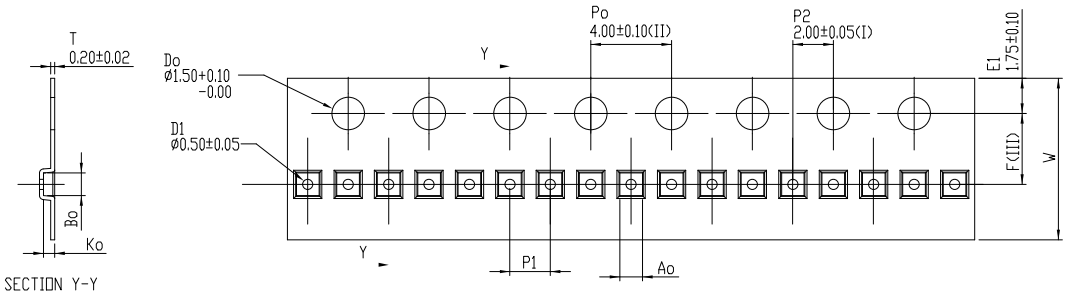
Notes:

1) This footprint is able to ensure insulation up to 10 Vrms (according to CEI IEC 664-1)

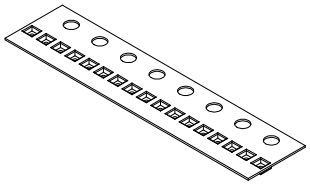
2) The device must be positioned within ⌖ 0.02 A B

8405587_A

Figure 30. **DFN4 1x1 tape outline**



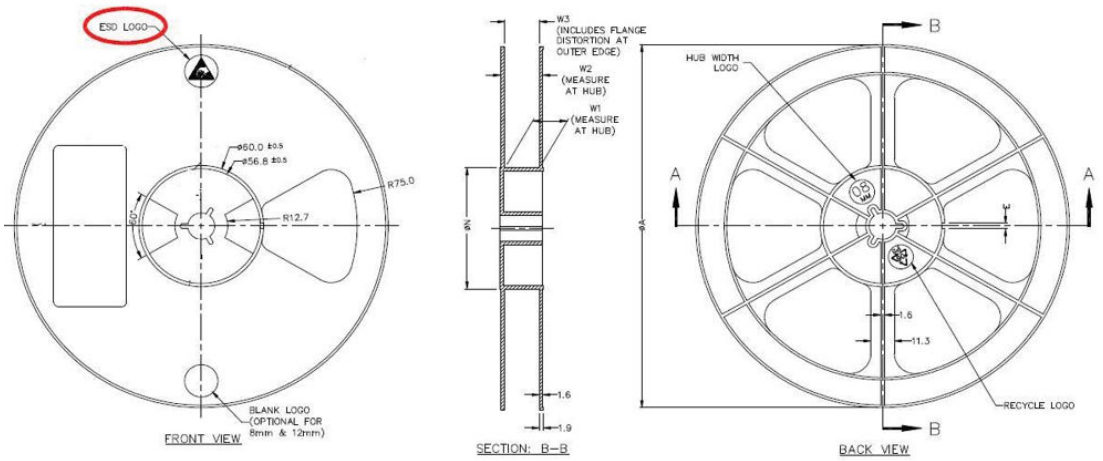
Ao	1.16	+/- 0.05
Bo	1.16	+/- 0.05
Ko	0.50	+/- 0.05
F	3.50	+/- 0.05
P 1	2.00	+/- 0.10
W	8.00	+/- 0.10

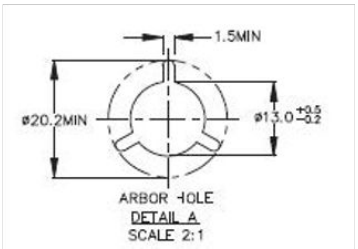


(I) Measured from centreline of sprocket hole to centreline of pocket.
(II) Cumulative tolerance of 10 sprocket holes is ± 0.20 .
(III) Measured from centreline of sprocket hole to centreline of pocket.
(IV) Other material available.

ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.

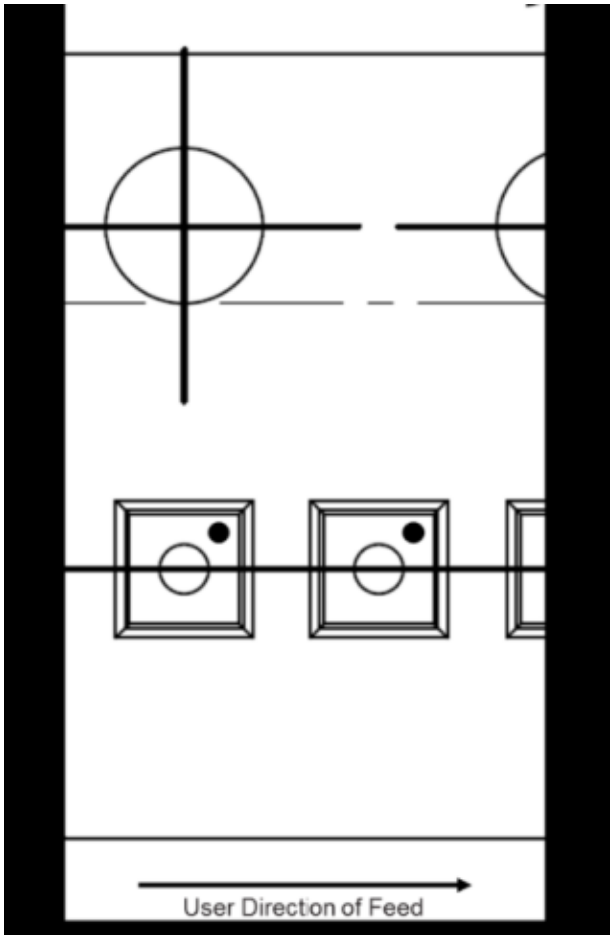
Figure 31. **DFN4 1x1 reel outline**





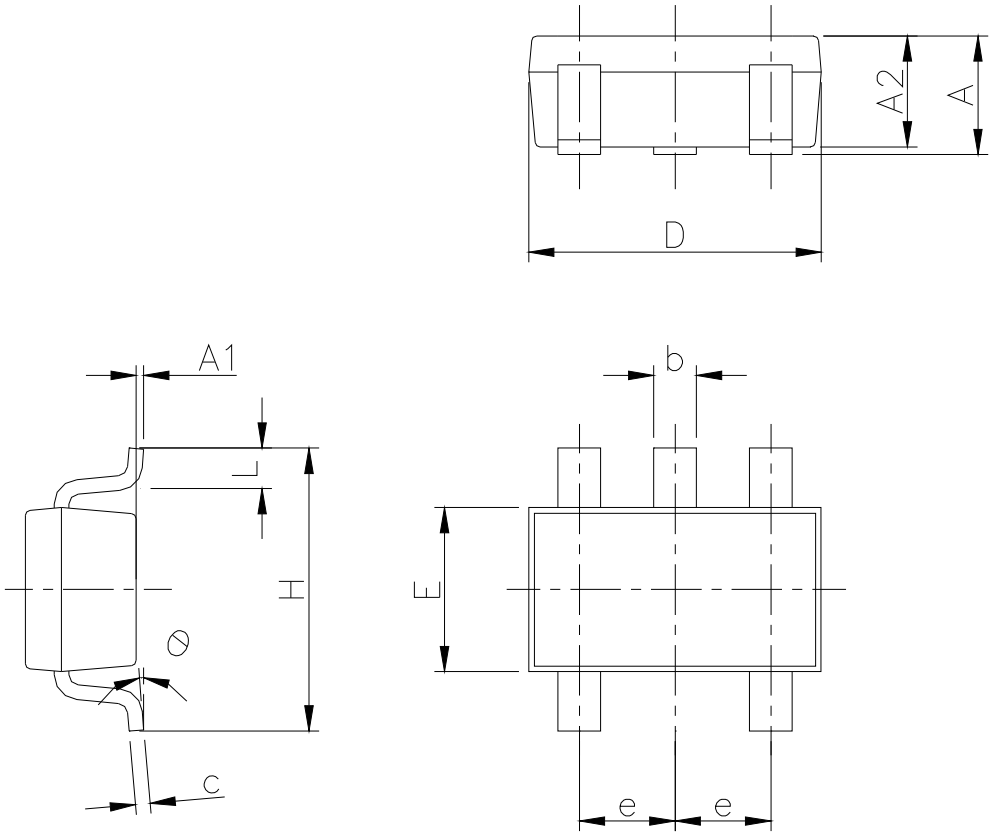
Tape width (mm)	A max.	N min.	W1 max.	W2 max.	W3 min. / max.
8	180	60	8.4	14.4	7.9 / 10.9

Figure 32. **DFN4 1x1 orientation**



8.2 SOT23-5L mechanical data

Figure 33. **SOT23-5L package outline**

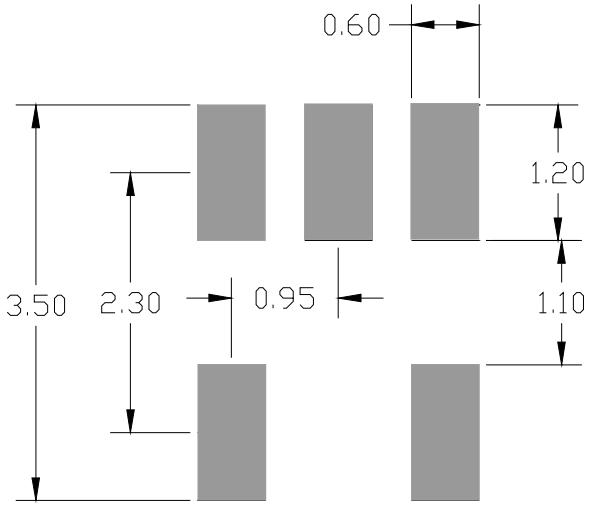


7049676_k

Table 8. **SOT23-5Lpackage mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A	0.90		1.45
A1	0		0.15
A2	0.90		1.30
b	0.30		0.50
c	0.09		0.20
D		2.95	
E		1.60	
e		0.95	
H		2.80	
L	0.30		0.60
θ	0°		8°

Figure 34. **SOT23-5L recommended footprint**



Note: Dimensions are in mm

8.3 SOT23-5L packing information

Figure 35. **SOT23-5L tape and reel outline**

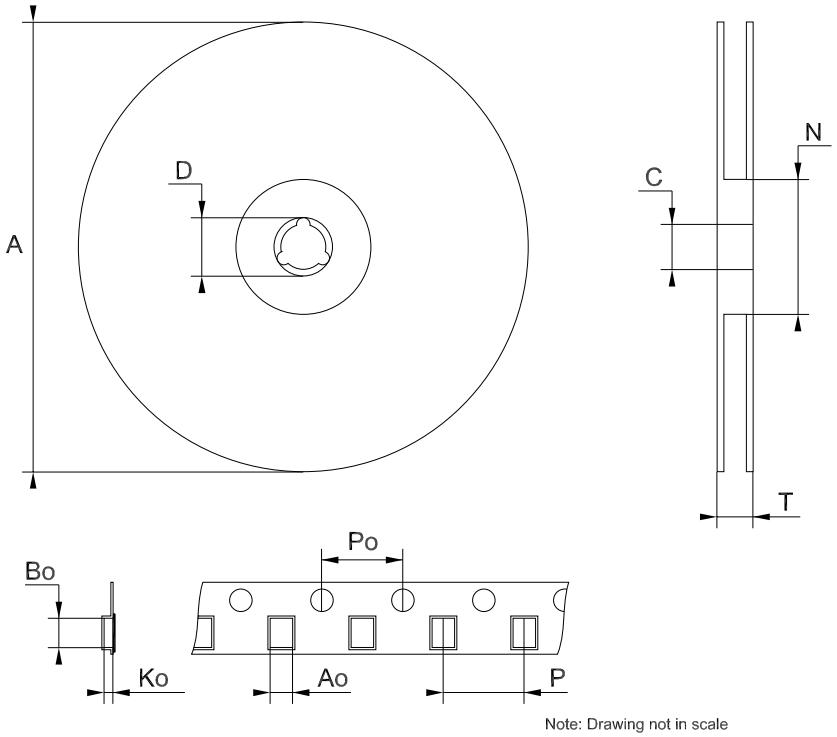


Table 9. **SOT23-5L tape and reel mechanical data**

Dim.	mm		
	Min.	Typ.	Max.
A			180
C	12.8	13.0	13.2
D	20.2		
N	60		
T			14.4
Ao	3.13	3.23	3.33
Bo	3.07	3.17	3.27
Ko	1.27	1.37	1.47
Po	3.9	4.0	4.1
P	3.9	4.0	4.1

9 Order code

Table 10. **DFN4 1x1 order code**

Order code	Output voltage (V)	Auto-discharge	Tolerance (%)	Marking
LD39020DTPU08R	0.8	Yes	2	08
LD39020DTPU11R	1.1	Yes	2	11
LD39020DTPU13R	1.3	Yes	2	13
LD39020DTPU15R	1.5	Yes	2	15
LD39020ADTPU18R	1.8	Yes	0.5	A7
LD39020DTPU18R			2	18
LD39020ATPU185R	1.85	No	0.5	BR
LD39020TPU185R			2	CR
LD39020ADTPU21R	2.1	Yes	0.5	A9
LD39020DTPU21R(1)			2	21
LD39020ADTPU25R	2.5	Yes	0.5	AA
LD39020DTPU25R			2	25
LD39020ADTPU27R(1)	2.7	Yes	0.5	AB
LD39020DTPU27R(1)			2	27
LD39020ADTPU28R	2.8	Yes	0.5	AC
LD39020DTPU28R(1)			2	28
LD39020ADTPU30R	3	Yes	0.5	AF
LD39020DTPU30R			2	30
LD39020ADTPU31R(1)	3.1	Yes	0.5	AG
LD39020DTPU31R			2	31
LD39020ATPU32R	3.2	No	0.5	BH
LD39020TPU32R			2	CH
LD39020ADTPU33R	3.3	Yes	0.5	AJ
LD39020DTPU33R			2	33
LD39020ATPU33R		No	0.5	BJ
LD39020TPU33R			2	CJ
LD39020ADTPU40R(1)	4	Yes	0.5	AL
LD39020DTPU40R			2	40
LD39020ADTPU47R(1)	4.7	Yes	0.5	AM
LD39020DTPU47R			2	47

1. *Available on request.*

Table 11. **SOT23-5L order code**

Order code	Output voltage (V)	Auto-discharge	Tolerance (%)	Marking
LD39020ADM30R	3.0	Yes	0.5	AD30

Revision history

Table 12. **Document revision history**

Date	Revision	Changes
04-Dec-2013	1	Initial release.
02-Apr-2014	2	Updated Table 10: "DFN4 1x1 order codes"..
05-Jun-2015	3	Added SOT23-5L package. Modified features and description in cover page. Updated Section 7: "Pin configuration" and Table 3: "Thermal data". Added Section 13.2: "SOT23-5L package information" and Section 13.3: "SOT23-5L packing information". Minor text changes.
03-Jul-2015	4	Updated package name from DFN1x1-4L to DFN4 1x1. Updated note in Table 11: "SOT23-5L order code". Minor text changes.
07-Jan-2019	5	Added Added Figure 31. DFN4 1x1 tape outline, Figure 32. DFN4 1x1 reel outline and Figure 33. DFN4 1x1 orientation. Updated Section 9 Order code.
17-Jun-2025	6	Updated Table 10. DFN4 1x1 order code.

Contents

1 Diagram 2
2 Pin configuration 3
3 Typical application 4
4 Maximum ratings 5
5 Electrical characteristics 6
6 Application information 9
6.1 Soft-start function 9
6.2 Output discharge function 9
6.3 Input and output capacitors 9
7 Typical characteristics 10
8 Package information 15
8.1 DFN4 1x1 package info 16
8.2 SOT23-5L mechanical data 21
8.3 SOT23-5L packing information 22
9 Order code 24
Revision history 25

List of tables

Table 1. Pin description . . . 3
Table 2. Absolute maximum ratings . . . 5
Table 3. Thermal data . . . 5
Table 4. ESD performance . . . 5
Table 5. Electrical characteristics for LD39020T, LD39020DT . . . 6
Table 6. Electrical characteristics for LD39020AT, LD39020ADT . . . 7
Table 7. DFN4 1x1 mechanical data . . . 17
Table 8. SOT23-5Lpackage mechanical data . . . 21
Table 9. SOT23-5L tape and reel mechanical data . . . 23
Table 10. DFN4 1x1 order code . . . 24
Table 11. SOT23-5L order code . . . 24
Table 12. Document revision history . . . 25

List of figures

Figure 1. Block diagram . . . 2
Figure 2. Pin connection (top view) . . . 3
Figure 3. Typical application circuits . . . 4
Figure 4. Output voltage vs. temperature (I_{OUT} = 1 mA) . . . 10
Figure 5. Output voltage vs. temperature (I_{OUT} = 200 mA) . . . 10
Figure 6. Line regulation vs. temperature . . . 10
Figure 7. Load regulation vs. temperature . . . 10
Figure 8. Quiescent current vs. temperature (I_{OUT} = 0 mA) . . . 11
Figure 9. Quiescent current vs. temperature (I_{OUT} = 200 mA) . . . 11
Figure 10. Shutdown current vs. temperature . . . 11
Figure 11. Quiescent current vs. load current . . . 11
Figure 12. Quiescent current vs. input voltage . . . 11
Figure 13. Dropout voltage vs. temperature . . . 11
Figure 14. Supply voltage rejection vs. frequency . . . 12
Figure 15. Supply voltage rejection vs. input voltage . . . 12
Figure 16. Output noise spectral density . . . 12
Figure 17. Stability area vs. (C_{OUT}, ESR) . . . 12
Figure 18. Enable startup (V_{OUT} = 1 V) . . . 12
Figure 19. Enable startup (V_{OUT} = 5 V) . . . 12
Figure 20. Turn-on time (V_{OUT} = 1 V) . . . 13
Figure 21. Turn-off time (V_{OUT} = 1 V) . . . 13
Figure 22. Turn-on time (V_{OUT} = 5 V) . . . 13
Figure 23. Turn-off time (V_{OUT} = 5 V) . . . 13
Figure 24. Line transient (V_{OUT} = 1 V) . . . 13
Figure 25. Line transient (V_{OUT} = 5 V) . . . 13
Figure 26. Load transient (V_{OUT} = 1 V) . . . 14
Figure 27. Load transient (V_{OUT} = 5 V) . . . 14
Figure 28. DFN4 1x1 package outline . . . 16
Figure 29. DFN4 1x1 recommended footprint . . . 18
Figure 30. DFN4 1x1 tape outline . . . 19
Figure 31. DFN4 1x1 reel outline . . . 19
Figure 32. DFN4 1x1 orientation . . . 20
Figure 33. SOT23-5L package outline . . . 21
Figure 34. SOT23-5L recommended footprint . . . 22
Figure 35. SOT23-5L tape and reel outline . . . 22

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