

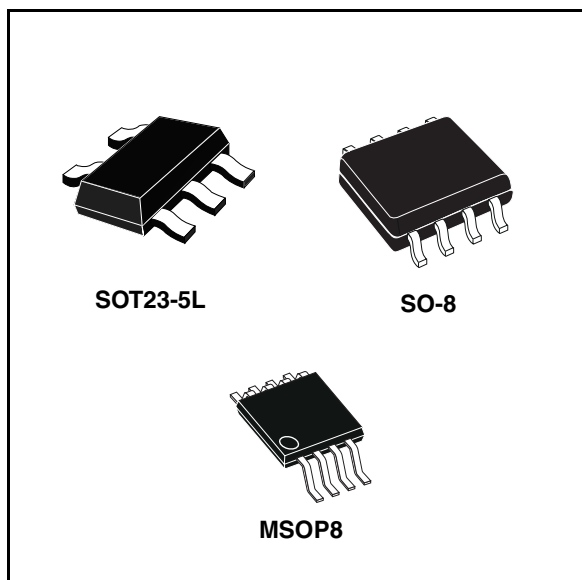


STMPS2141, STMPS2151 STMPS2161, STMPS2171

Enhanced single channel power switches

Features

- 90 mΩ high-side MOSFET switch
- 500/1000 mA continuous current
- Thermal and short-circuit protection with overcurrent logic output
- Operating range from 2.7 V to 5.5 V
- CMOS- and TTL-compatible enable inputs
- Undervoltage lockout (UVLO)
- 12 μA maximum standby supply current
- Ambient temperature range, -40°C to 85°C
- 8 kV ESD protection
- Reverse current protection
- Fault-blanking



Description

The STMPS2141, STMPS2151, STMPS2161, STMPS2171 power distribution switches are intended for applications where heavy capacitive loads and short circuits are likely to be encountered. These devices incorporate 90 mΩ N-channel MOSFET high-side power switches for power-distribution. These switches are controlled by a logic enable input.

When the output load exceeds the current-limit threshold or a short is present, the device limits the output current to a safe level by switching into a constant-current mode. When continuous heavy overloads and short circuits increase the power dissipation in the switch, causing the junction temperature to rise, a thermal protection circuit shuts the switch off to prevent damage. Recovery from a thermal shutdown is automatic once the device has cooled sufficiently. Internal circuitry ensures the switch remains off until a valid input voltage is present.

Table 1. Device summary

Order codes			Current limit (mA)	Enable
SO-8	SOT23-5L	MSOP8 ⁽¹⁾		
STMPS2141MTR	STMPS2141STR	STMPS2141TTR	500	Active low
STMPS2151MTR	STMPS2151STR	STMPS2151TTR	500	Active high
STMPS2161MTR	STMPS2161STR	STMPS2161TTR	1000	Active low
STMPS2171MTR	STMPS2171STR	STMPS2171TTR	1000	Active high

1. MSOP8 package is also known as "TSSOP8"

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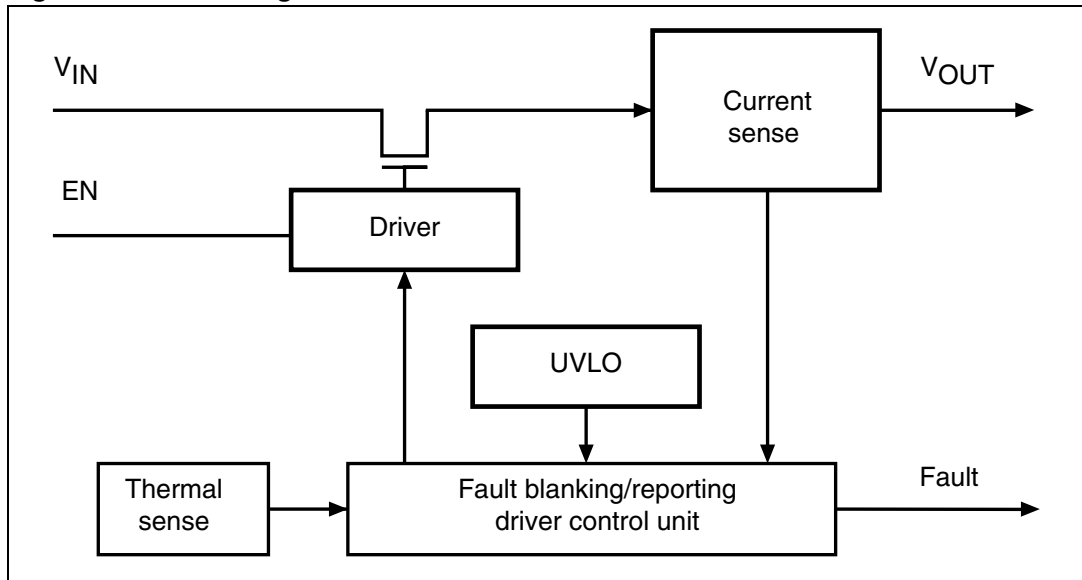
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1 Block diagram

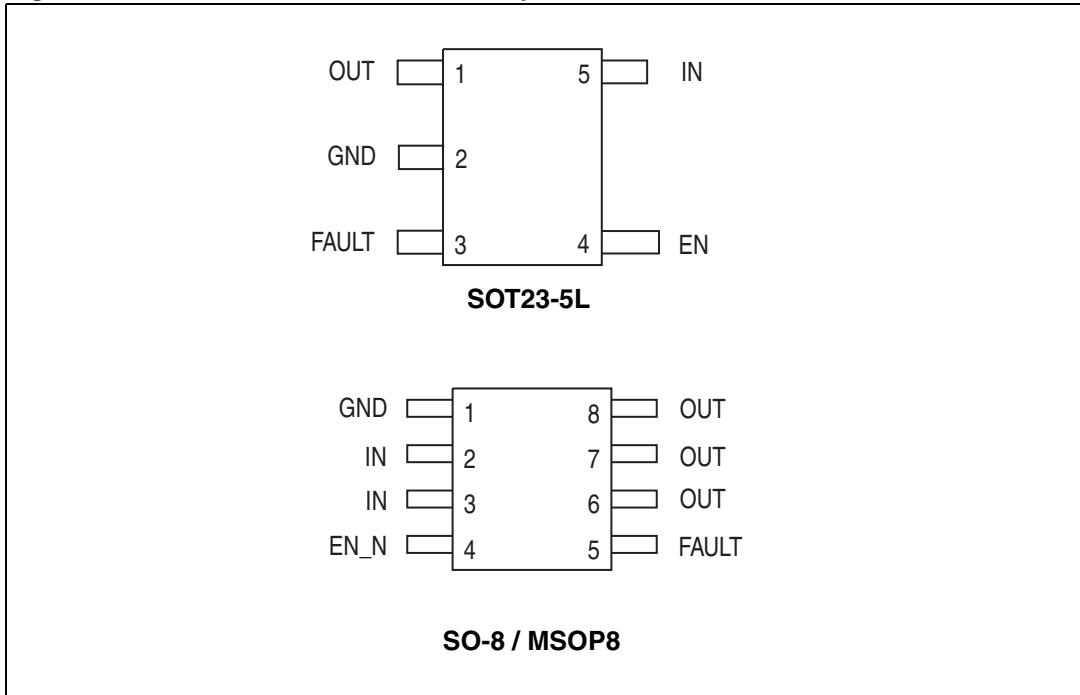
Figure 1. Block diagram



2 Pin settings

2.1 Pin connections

Figure 2. SOT23-5L, SO-8 and MSOP8 pin connections



2.2 Pin description

Table 2. Pin description

Pin number			Name	Function
SO8	MSOP8	SOT23-5L		
1	1	2	GND	Ground
2	2	5	IN	2.7 V - 5.5 V input
3	3	-	IN	2.7 V - 5.5 V input
4	4	4	EN	Enable for power switch
5	5	3	FAULT	Open drain FAULT indicator, active low
6	6	1	OUT	Output of power switch
7	7	-	OUT	Output of power switch
8	8	-	OUT	Output of power switch

3 Functional description

3.1 Fault blanking

The STMP21 devices feature a 10 ms fault blanking. Fault blanking allows current-limit faults, including momentary short-circuit faults that occur when hot-swapping a capacitive load, and also ensures that no fault is issued during power-up. When a load transient causes the device to enter current limit, an internal counter starts. If the load fault persists beyond the 10 ms fault-blanking timeout, the FAULT output asserts “low”. Load-transient faults less than 10 ms (typ.) do not cause a FAULT output assertion. Only current-limit faults are blanked. Die over-temperature faults and input voltage drops below the UVLO threshold cause an immediate fault output.

3.2 Overcurrent/over-temperature protection

In overcurrent or short-circuit condition, the switch limits the current at a value of about 120% of the rated current. If the temperature of the die goes above the limit value, the switch turns off.

3.3 FAULT conditions

In power switch applications, 4 types of FAULT conditions are common. These fault conditions and the response of the STMP21x1 power switches are described in the following [Table 3](#).

Table 3. FAULT conditions

Fault	Condition	STMP21x1 action
Short circuit	Output shorted to GND via resistance path of < 1 Ω causing a rapid current surge.	Reduces output voltage to reduce the current. Asserts FAULT pin after a blanking period
Over-current	Output connected to a load that sinks current above threshold.	Reduces output voltage to reduce the current. Asserts FAULT pin after a blanking period.
Overheating	Temperature of junction exceeds 135°C due to any reason.	Turn OFF output until temperature falls below 125°C. Asserts FAULT pin immediately.
Undervoltage	Input voltage drops below the UVLO threshold.	Turn OFF output until input voltage rises above the UVLO threshold plus hysteresis. Asserts FAULT pin immediately.

3.4 Reversed current blocking

When the switch is OFF (disabled through the EN pin), or when the STMPS device is unpowered ($V_{CC} = 0\text{ V}$) the switch behaves as an Hi-Z at the output pin, ensuring that no reverse current will flow into the device when $V_i < V_o$.

Note: In the case where the switch is ON, and a voltage higher than V_{IN} is applied to the OUT pin, a reverse current occurs. This operating condition is not allowed.

3.5 UVLO

When the input voltage drops below critical values, the power switch turns off to prevent improper operation due to low voltage.

4 Ambient temperature

In Enable operating mode, an amount of power is dissipated as heat in the power switch due to the on-resistance. The power dissipation is: $P = I^2R$.

Table 4. SOT23-5L (160 °C/W)

Part number	Max current	Max R _{ON} at 5 V	Power dissipation	Temperature difference (junction and ambient)	Maximum ambient temperature (at junction temperature 125 °C)
STMPS2141	0.50 A	130 mΩ	32.5 mW	6.2	118.8
STMPS2151					
STMPS2161	1.00 A	130 mΩ	130.0 mW	24.8	100.2
STMPS2171					

Table 5. MSOP8 (220 °C/W)

Part number	Max current	Max R _{ON} at 5 V	Power dissipation	Temperature difference (junction and ambient)	Maximum ambient temperature (at junction temperature 125 °C)
STMPS2141	0.50 A	130 mΩ	32.5 mW	7.2	117.8
STMPS2151					
STMPS2161	1.00 A	130 mΩ	130.0 mW	28.6	96.4
STMPS2171					

Table 6. SO-8 (160 °C/W)

Part number	Max current	Max R _{ON} at 5 V	Power dissipation	Temperature difference (junction and ambient)	Maximum ambient temperature (at junction temperature 125 °C)
STMPS2141	0.50 A	130 mΩ	32.5 mΩ	5.2	124.8
STMPS2151					
STMPS2161	1.00 A	130 mΩ	130.0 mΩ	20.8	104.2
STMPS2171					

5 Maximum ratings

Stressing the device above the rating listed in the “absolute maximum ratings” table may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the operating sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

5.1 Absolute maximum ratings

Table 7. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_I	Input voltage range	-0.3 – 6.0	V
V_O	Output voltage range	-0.3 – ($V_I+0.3$)	V
V_{IENX}	EN Input voltage range	-0.3 – 6.0	V
I_O	Continuous output current	Internally limited	–
ESD	ESD protection level	8	kV
T_J	Junction operating temperature	-40 to 125	°C
T_{STG}	Storage temperature	-55 to 150	°C
T_R	Thermal resistance (MSOP8)	220	°C/W
T_R	Thermal resistance (SOT23-5L)	191	°C/W
T_R	Thermal resistance (SO-8)	160	°C/W

5.2 Recommended operating conditions

Table 8. Recommended operating conditions

Symbol	Parameter	Value			Unit
		Min	Typ	Max	
V_I	Input voltage	2.7	5.0	5.5	V
V_O	Output voltage	0	5.0	5.5	V
I_O (STMPS2141 STMPS2151)	Continuous output current	0	-	500	mA
I_O (STMPS2161 STMPS2171)	Continuous output current	0	-	1000	mA

6 Electrical specifications

Table 9. SOT-23-5L electrical characteristics

Symbol	Parameter	Test condition	Value			Unit
			Min	Typ	Max	
Rds on	Static drain source ON state resistance SOT23-5L package load = 500 mA (STMP2141/ STMP2151) load = 1000 mA (STMP2161/ STMP2171)	$V_I = 2.7\text{ V}; T_J = 25^\circ\text{C};$	–	120	160	mΩ
		$V_I = 5.0\text{ V}; T_J = 25^\circ\text{C};$	–	90	110	mΩ
Rds on	Static drain source ON state resistance	$V_I = 2.7\text{ V}; -40 < T_J < 125^\circ\text{C}$	–	–	200	mΩ
		$V_I = 5.0\text{ V}; -40 < T_J < 125^\circ\text{C}$	–	–	135	
Tr	Output rise time	$V_I = 5.0\text{ V } R_L = 10\ \Omega$ $C_L = 1\ \mu\text{F}$	0.05	–	2	mS

Table 10. MSO8P/SO8 electrical characteristics

Symbol	Parameter	Test condition	Value			Unit
			Min	Typ	Max	
Rds on	Static drain source ON state resistance SO-8 and MSO8 package load = 500 mA (STMP2141/ STMP2151) load = 1000 mA (STMP2161/ STMP2171)	$V_I = 2.7\text{ V}; T_J = 25^\circ\text{C}$	–	130	170	mΩ
		$V_I = 5.0\text{ V}; T_J = 25^\circ\text{C}$	–	110	125	mΩ
Rds on	Static drain source ON state resistance	$V_I = 2.7\text{ V}$ $-40 < T_J < 125^\circ\text{C}$	–	–	200	mΩ
		$V_I = 5.0\text{ V}$ $-40 < T_J < 125^\circ\text{C}$	–	–	140	
Tr	Output rise time	$V_I = 5.0\text{ V } R_L = 10\ \Omega$ $C_L = 1\ \mu\text{F}$	0.05	–	2	mS

Table 11. Current limit characteristics
($V_I = 5.5\text{ V}$, $I_O = \text{rated current}$, $T_J = 25^\circ\text{C}$, unless otherwise specified)

Symbol	Parameter	Test condition	Value			Unit
			Min	Typ	Max	
I_{OS} (STMPS2141 STMPS2151)	Overcurrent limiting threshold	$V_I = 5\text{ V}$ $V_{OUT} = 4.5\text{ V}$	0.60	0.80	1.00	A
I_{OS} (STMPS2161 STMPS2171)	Overcurrent limiting threshold		1.10	1.50	1.90	A
I_{OS} (2141,2151)	Short circuit output current	$V_I = 5\text{ V}$, OUT connected to GND, device enabled into short circuit	–	–	0.9	A
I_{OS} (2161,2171)	Short circuit output current		–	–	1.8	A

Table 12. Supply current characteristics
($V_I = 5.5\text{ V}$, $I_O = \text{rated current}$, $T_J = 25^\circ\text{C}$, unless otherwise specified)

Symbol	Parameter	Test condition	Value			Unit
			Min	Typ	Max	
I_{off}	Switch turned off	No load	–	6.0	12	μA
		No load; $-40 < T_J < 125^\circ\text{C}$	–	–	15	
I_{on}	Switch turned on	No load	–	40	60	μA
		No load; $-40 < T_J < 125^\circ\text{C}$	–	–	70	
$I_{leakage}$	Output leakage current ⁽¹⁾	Output grounded, switch is OFF	–	–	2	μA
		Output grounded, switch is OFF; $-40 < T_J < 125^\circ\text{C}$	–	–	5	
$I_{reverse}$	Reversed leakage current	Switch is off, $V_i < V_o$, output connected to 5.5 V, 25°C	–	0.5	2	μA
		Switch is off, $V_i < V_o$, output connected to 5.5 V, 125°C	–	0.5	3	

1. $I_{leakage} = I_{off-ground} - I_{off}$, where $I_{off-ground}$ = current into V_{in} when switch is off and output is grounded

Table 13. Thermal characteristics

($V_I = 5.5\text{ V}$, $I_O = \text{rated current}$, $T_J = 25^\circ\text{C}$, unless otherwise specified)

Symbol	Parameter	Test condition	Value			Unit
			Min	Typ	Max	
T1	Thermal shutdown threshold		–	–	145	°C
T2	Recovery from thermal shutdown		120	–	–	°C
Hysteresis	-		–	14	–	°C

Table 14. UVLO characteristics

($V_I = 5.5\text{ V}$, $I_O = \text{rated current}$, $T_J = 25^\circ\text{C}$, unless otherwise specified)

Symbol	Parameter	Test condition	Value			Unit
			Min	Typ	Max	
V _{UVLO}	Undervoltage lockout threshold		2.0	–	2.5	V
Hysteresis	-		40	75	110	mV

Table 15. OC pin characteristics

($V_I = 5.5\text{ V}$, $I_O = \text{rated current}$, $T_J = 25^\circ\text{C}$, unless otherwise specified)

Symbol	Parameter	Test condition	Value			Unit
			Min	Typ	Max	
OC Blanking	OCx assertion and de-assertion		4	8	15	ms
V _O	Output low voltage	$I_O = 5\text{ mA}$	–	–	0.4	V
I _{OFF}	Off current	$V_{OC} = 2.7\text{ V}, 5.5\text{ V}$ (No OC Condition)	–	–	1.0	µA

Table 16. EN pin characteristics

($V_I = 5.5\text{ V}$, $I_O = \text{rated current}$, $T_J = 25^\circ\text{C}$, unless otherwise specified)

Symbol	Parameter	Test condition	Value			Unit
			Min	Typ	Max	
V _{IH}	High level input voltage	$V_I = 2.7\text{ V to } 5.5\text{ V}$	2.0	–	–	V
V _{IL}	Low level input voltage	$V_I = 4.5\text{ V to } 5.5\text{ V}$	–	–	0.8	V
		$V_I = 2.7\text{ V to } 4.5\text{ V}$	–	–	0.4	V
I _I	Input current	$V_{IENX} = 0\text{ V or } V_I$	-0.5	–	0.5	µA
t _{ON}	Turn-ON time ⁽¹⁾	$R_L = 10\ \Omega$ $C_L = 100\text{ mF}$	–	–	5	ms
t _{OFF}	Turn-OFF time ⁽¹⁾	$R_L = 10\ \Omega$ $C_L = 100\text{ mF}$	–	–	10	ms

1. Not tested in production, specified by design

7 Detail device characteristics

7.1 STMPS2141, STMPS2151 additional electrical charts

The waveforms displayed in [Section 7.1](#) are captured with the STMPS2141 device. The STMPS2151 is expected to have the same characteristics with EN in the opposite polarity.

7.1.1 Turn on/off characteristics at $V_{OUT} = 5.0\text{ V}$

Figure 3. Voltage output turn on delay time

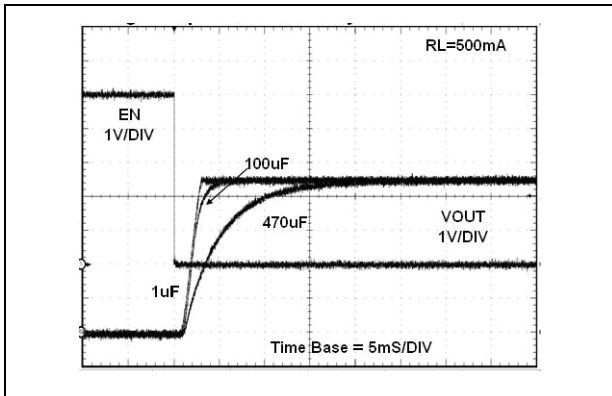


Figure 4. Voltage output turn off delay time

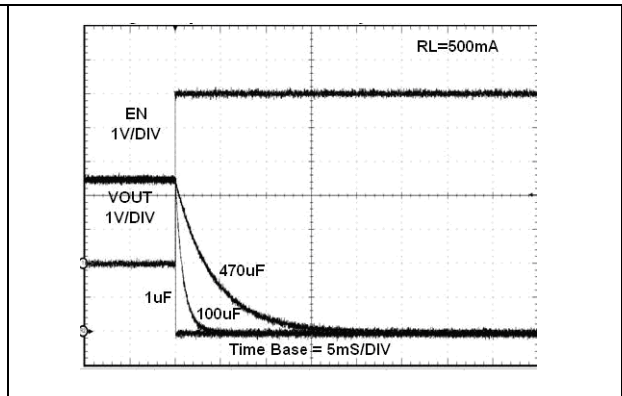


Figure 5. Current output turn on delay time

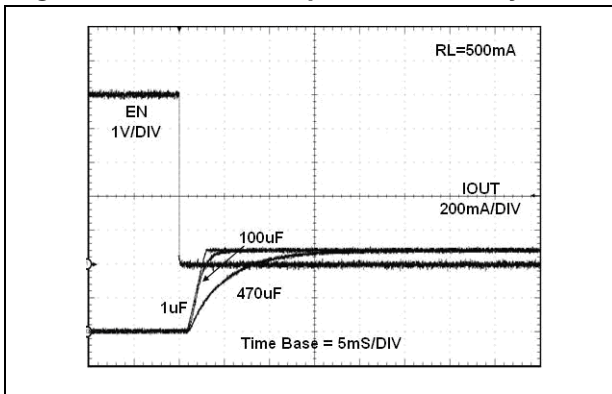
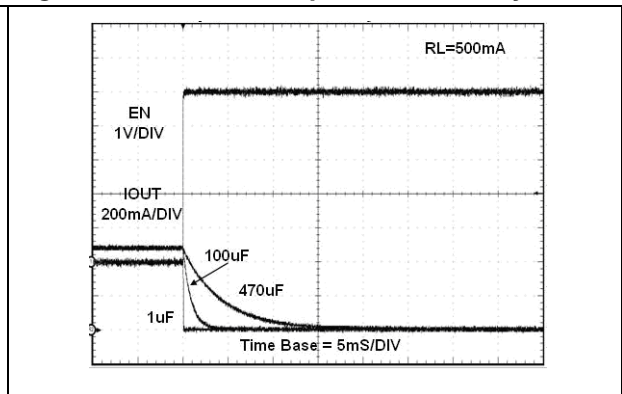


Figure 6. Current output turn off delay time



7.1.2 Turn on/off characteristics at $V_{OUT} = 3.0\text{ V}$

Figure 7. Voltage output turn on delay time

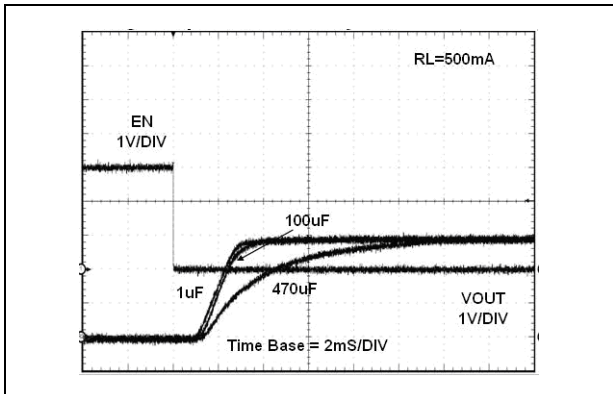


Figure 8. Voltage output turn off delay time

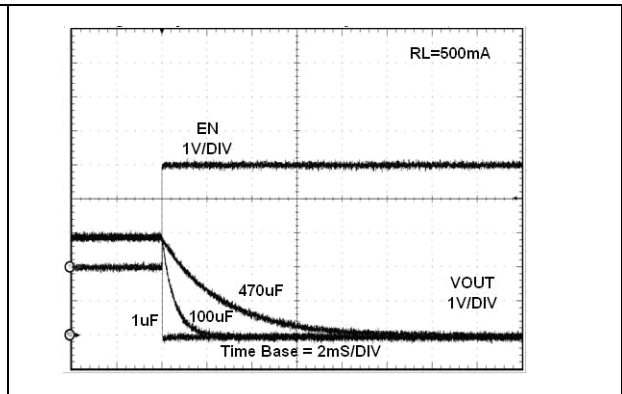


Figure 9. Current output turn on delay time

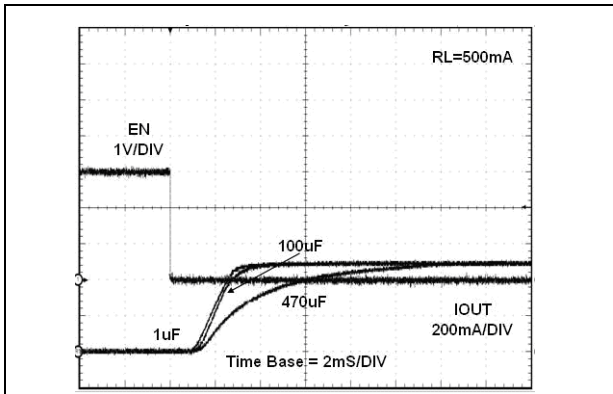
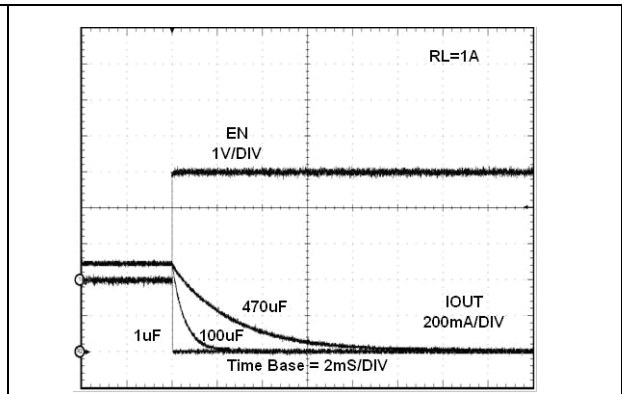


Figure 10. Current output turn off delay time



7.1.3 UVLO

Figure 11. UVLO rising

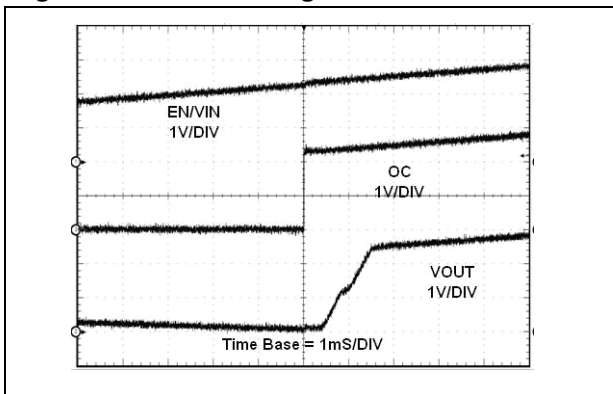
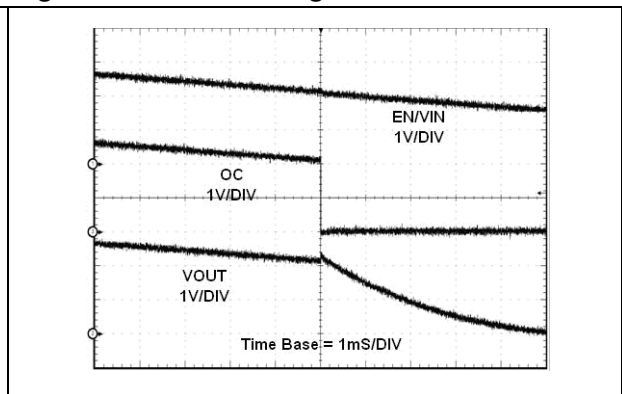


Figure 12. UVLO falling



7.1.4 OC protection characteristics

Figure 13. OC protection at $V_{OUT} = 3.0\text{ V}$

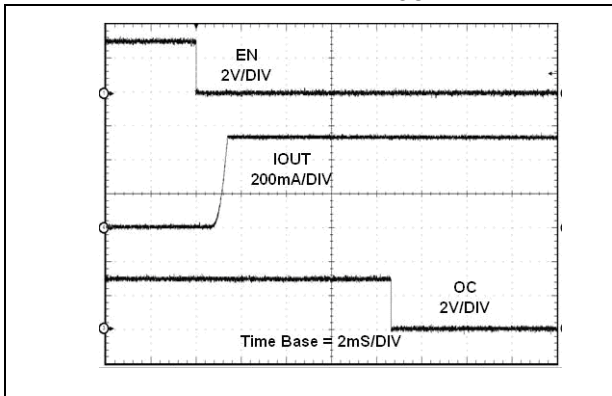


Figure 14. OC protection at $V_{OUT} = 3.0\text{ V}$

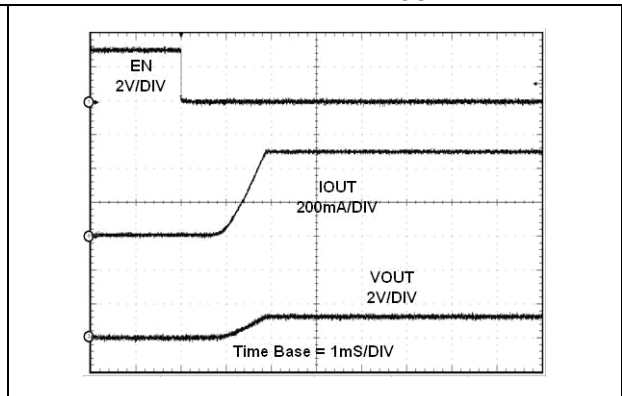


Figure 15. OC protection at $V_{OUT} = 5.0\text{ V}$

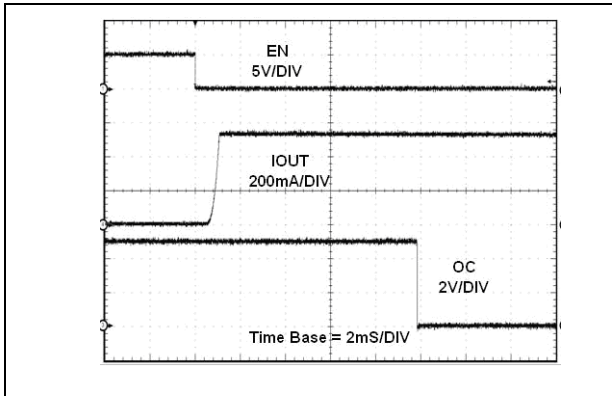
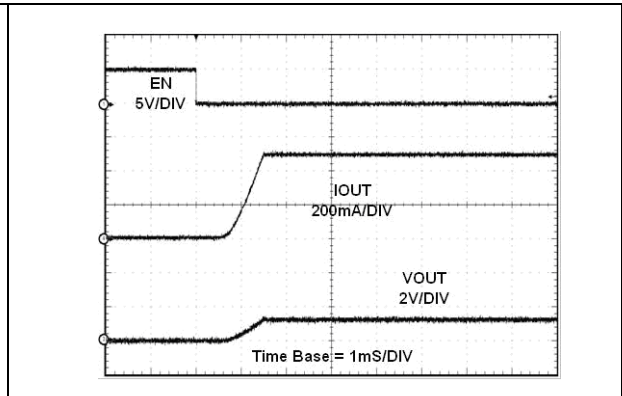


Figure 16. OC protection at $V_{OUT} = 5.0\text{ V}$



7.1.5 Other electrical characteristics

Figure 17. I_{CC} vs V_{IN} (enabled)

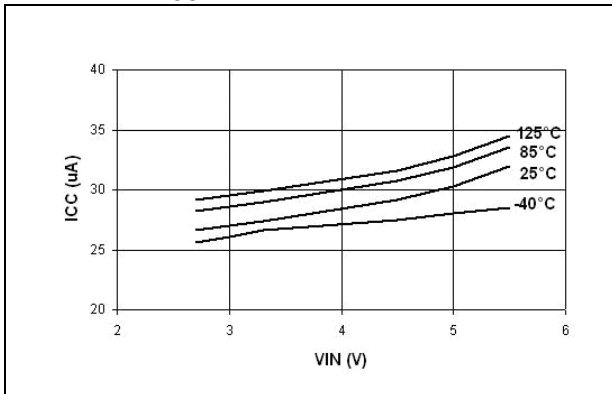


Figure 18. I_{CC} vs temperature (enabled)

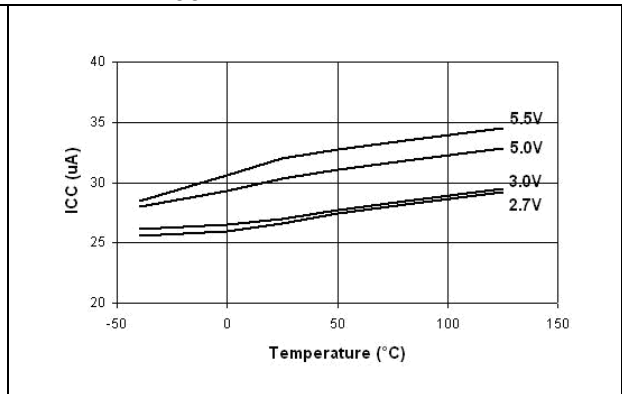


Figure 19. I_{CC} vs V_{IN} (disabled)

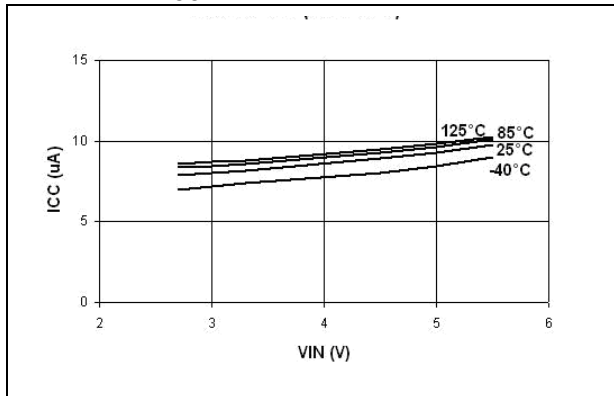


Figure 20. I_{CC} vs temperature (disabled)

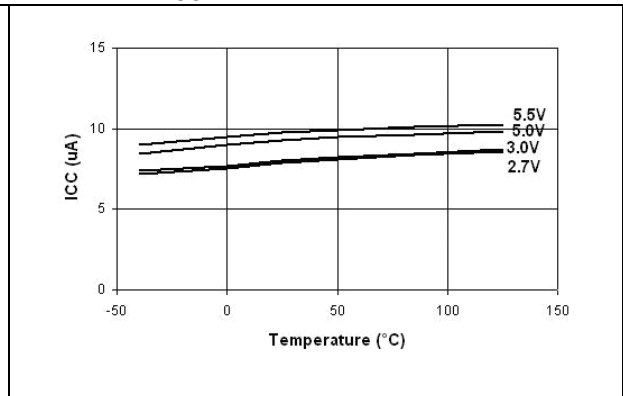


Figure 21. $R_{DS ON}$ vs V_{IN}

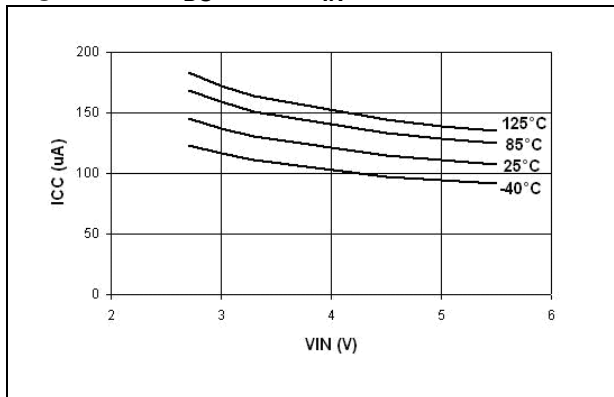


Figure 22. $R_{DS ON}$ vs temperature

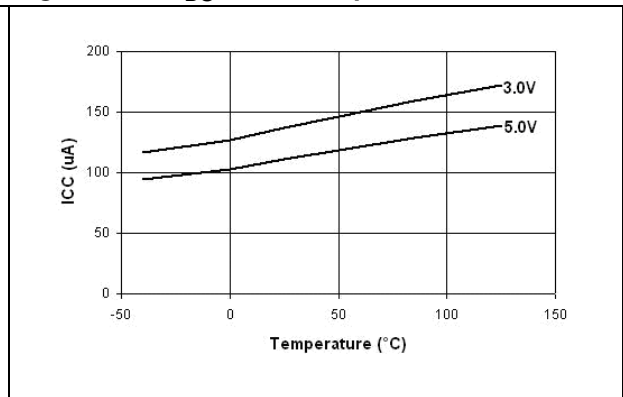


Figure 23. I_{LIMIT} vs temperature

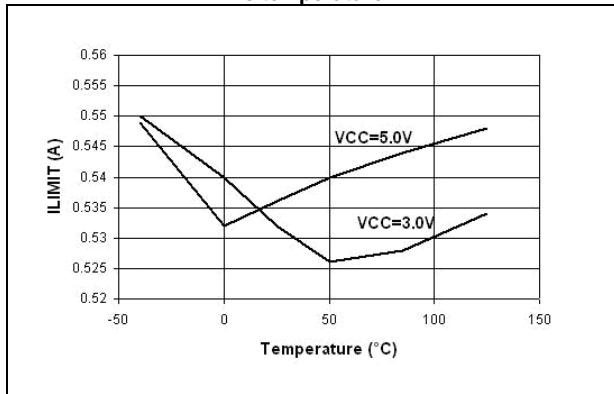


Figure 24. Switch leakage vs temperature

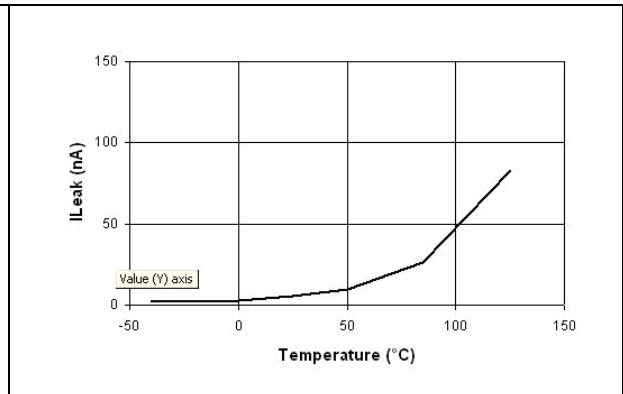


Figure 25. Output rise time vs. V_{IN}

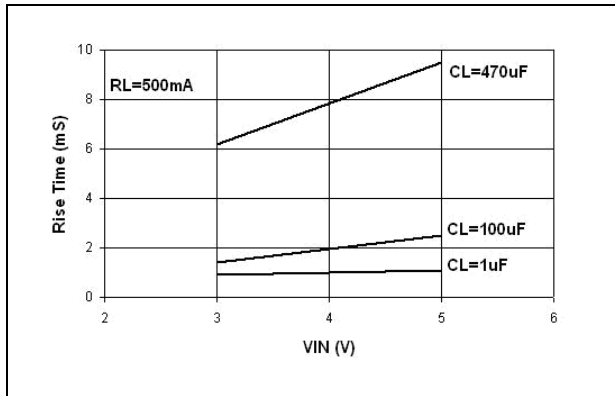


Figure 26. Output fall time vs. V_{IN}

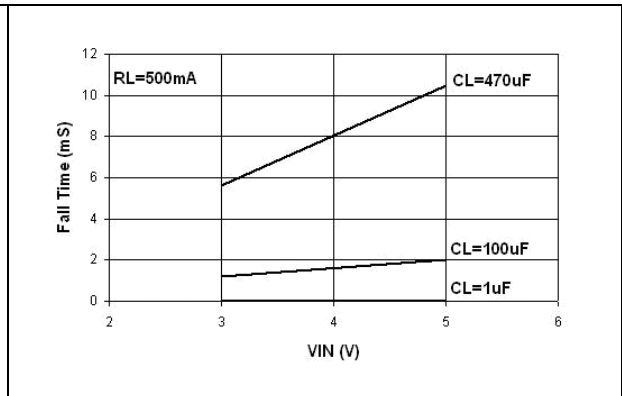
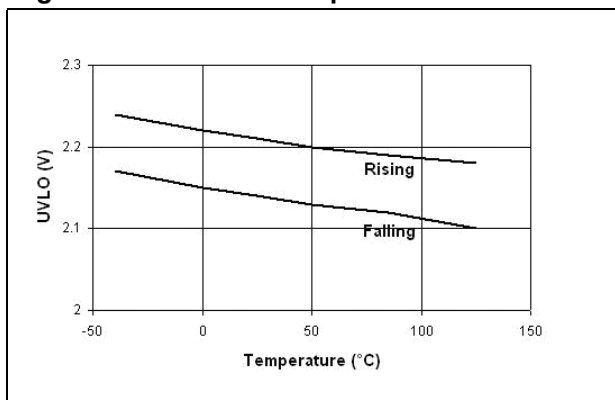


Figure 27. UVLO vs temperature



7.2 STMP2161, STMP2171 electrical charts

The waveforms displayed in [Section 7.2](#) are captured with the STMP2161 device. The STMP2171 is expected to have the same characteristics with EN in the opposite polarity.

7.2.1 Turn on/off characteristics at $V_{OUT} = 5.0\text{ V}$

Figure 28. Voltage output turn on delay time

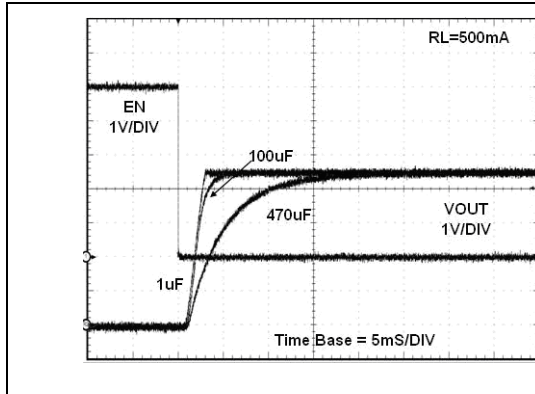


Figure 29. Voltage output turn off delay time

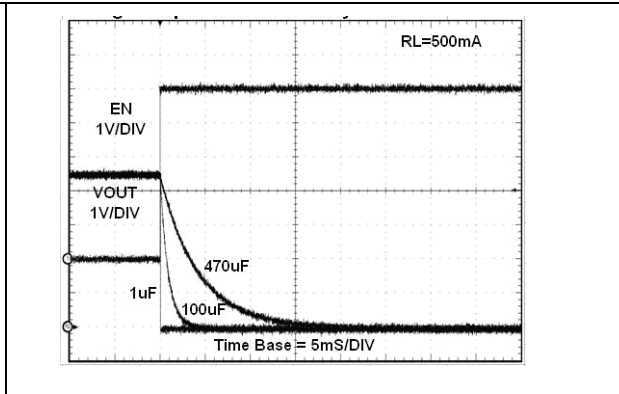


Figure 30. Current output turn on delay time

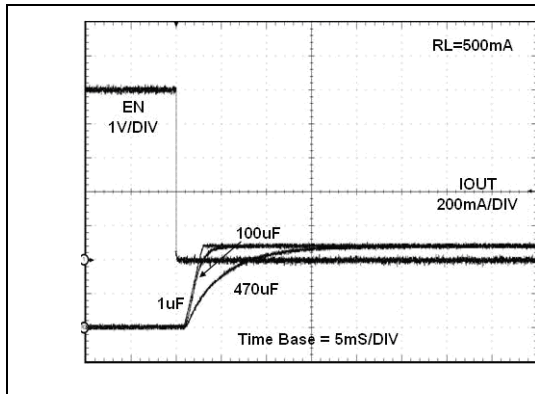
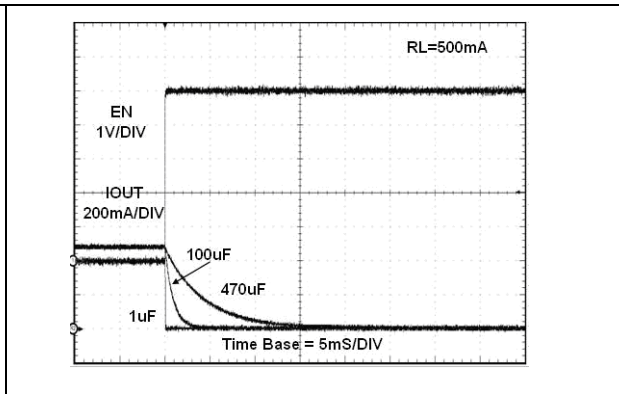


Figure 31. Current output turn off delay time



7.2.2 Turn on/off characteristics at $V_{OUT} = 3.0\text{ V}$

Figure 32. Voltage output turn on delay time

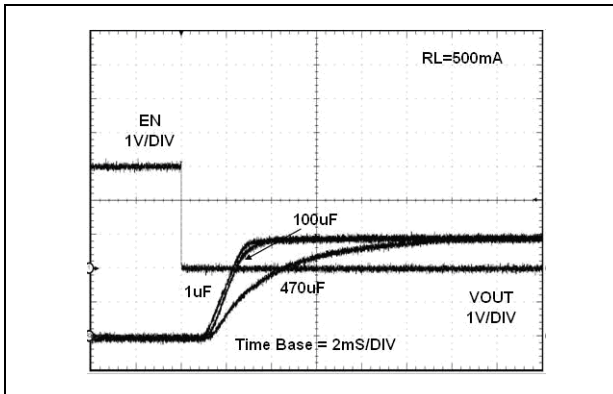


Figure 33. Voltage output turn off delay time

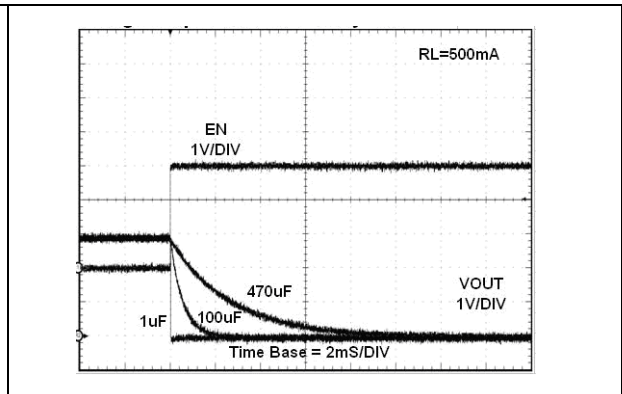


Figure 34. Current output turn on delay time

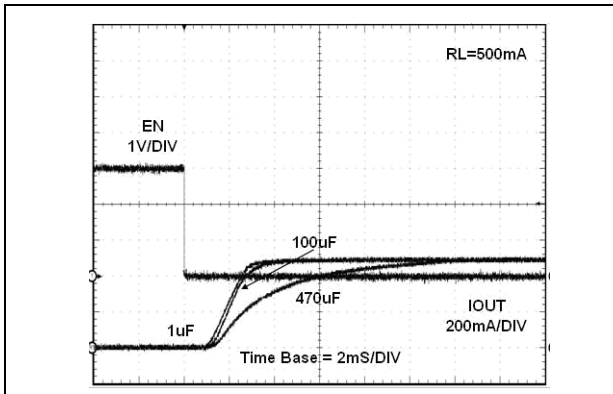
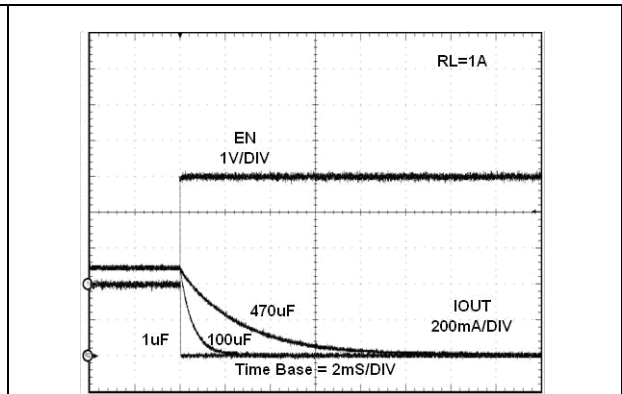


Figure 35. Current output turn off delay time



7.2.3 UVLO

Figure 36. UVLO rising

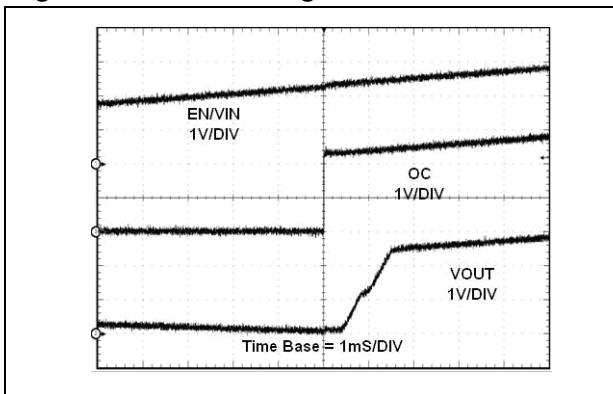
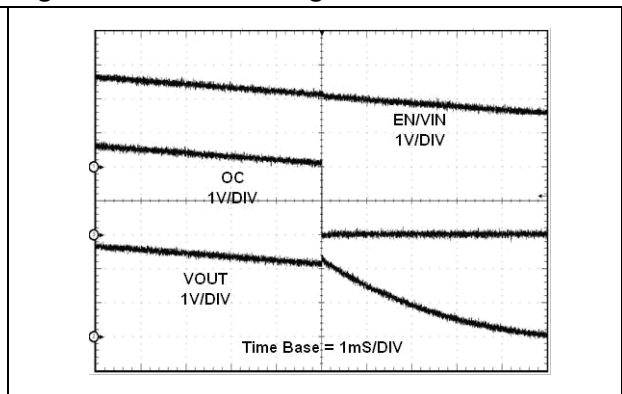


Figure 37. UVLO falling



7.2.4 OC protection characteristics

Figure 38. OC protection at $V_{OUT} = 3.0\text{ V}$

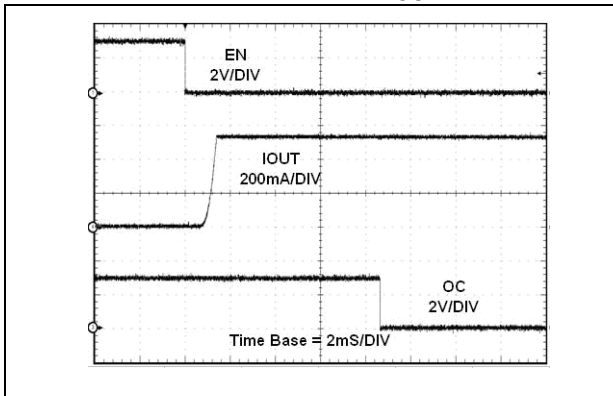


Figure 39. OC protection at $V_{OUT} = 3.0\text{ V}$

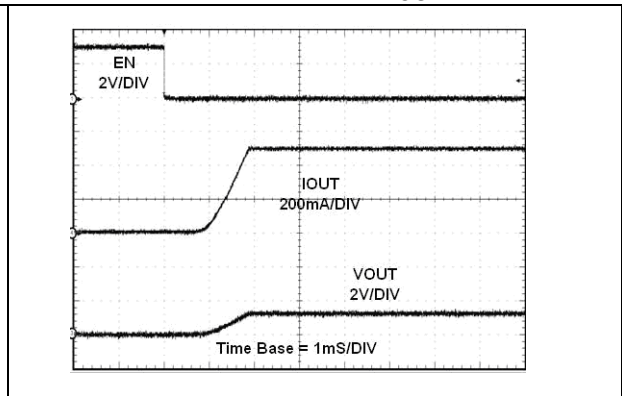


Figure 40. OC protection at $V_{OUT} = 5.0\text{ V}$

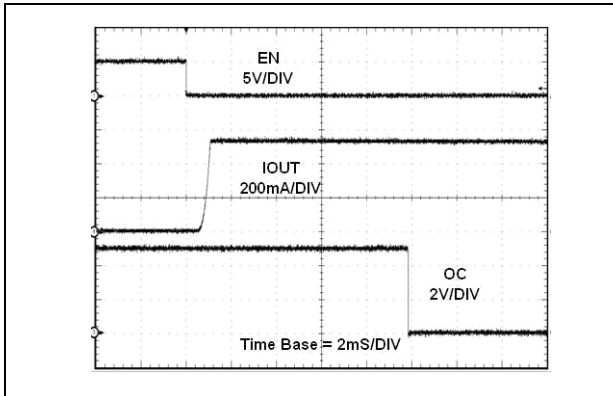
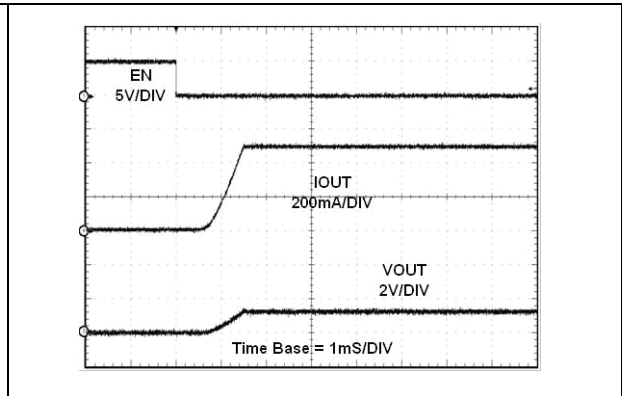


Figure 41. OC protection at $V_{OUT} = 5.0\text{ V}$



7.2.5 Other electrical characteristics

Figure 42. I_{CC} vs V_{IN} (enabled)

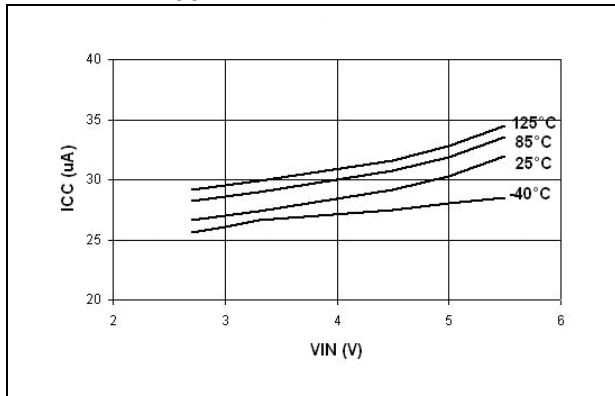


Figure 43. I_{CC} vs temperature (enabled)

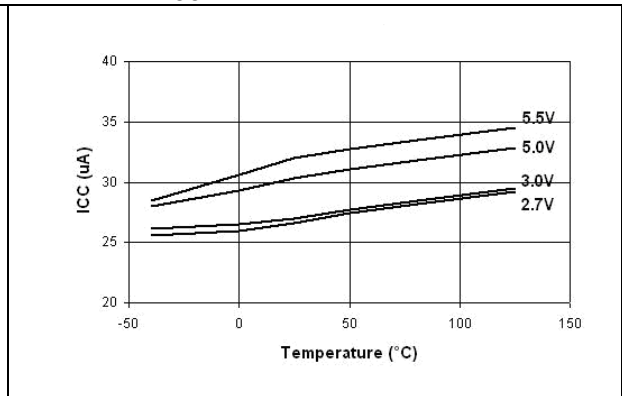


Figure 44. I_{CC} vs V_{IN} (disabled)

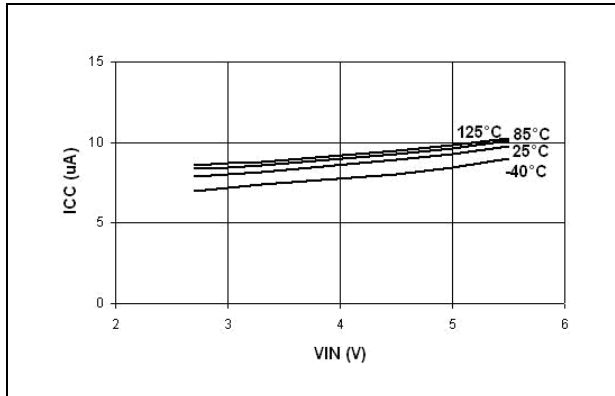


Figure 45. I_{CC} vs temperature (disabled)

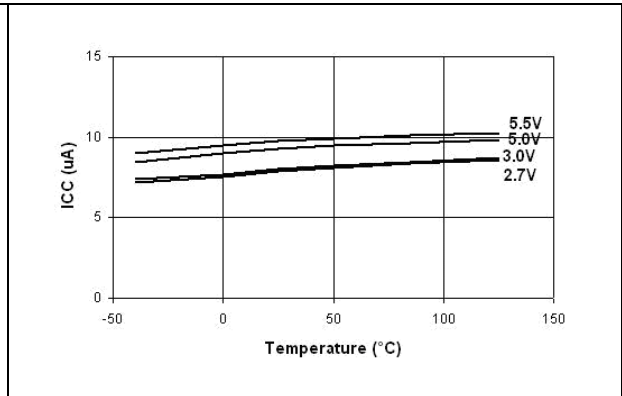


Figure 46. $R_{DS ON}$ vs V_{IN}

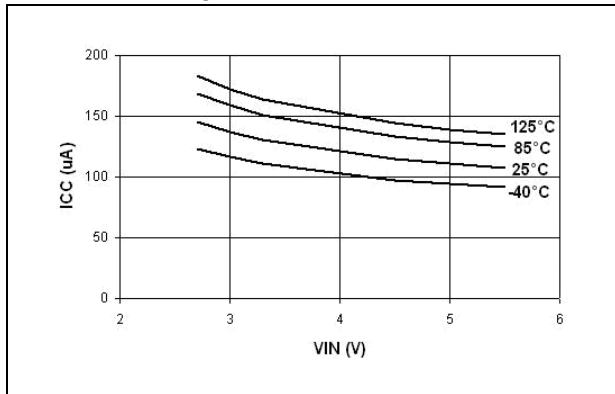


Figure 47. $R_{DS ON}$ vs temperature

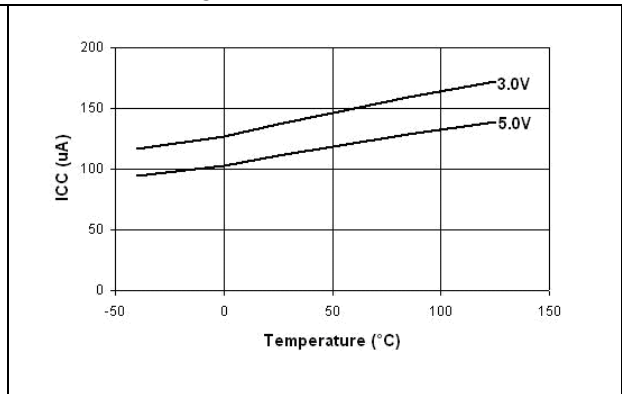


Figure 48. ILIMIT vs temperature

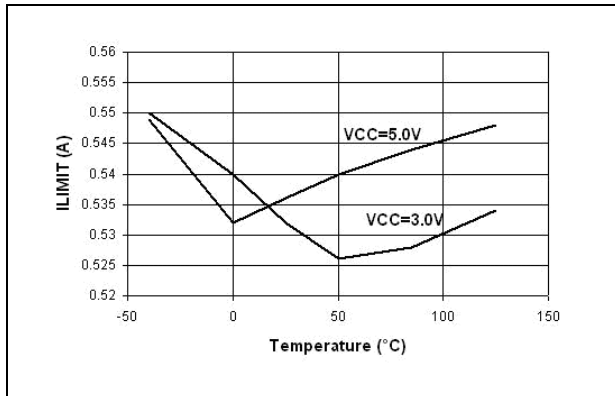


Figure 49. Switch leakage vs temperature

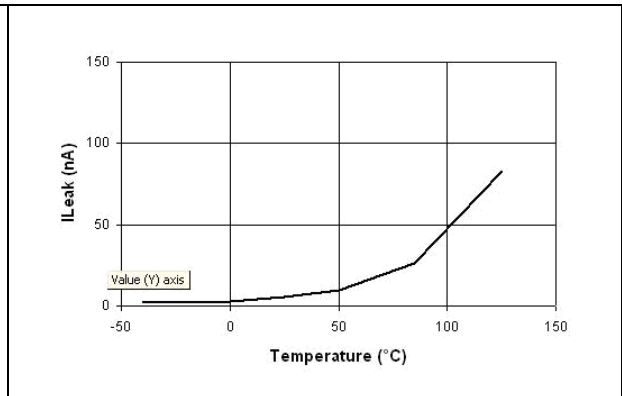


Figure 50. Output rise time vs. VIN

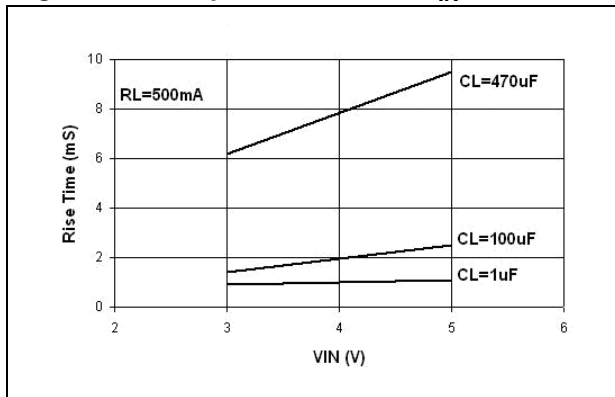


Figure 51. Output fall time vs. VIN

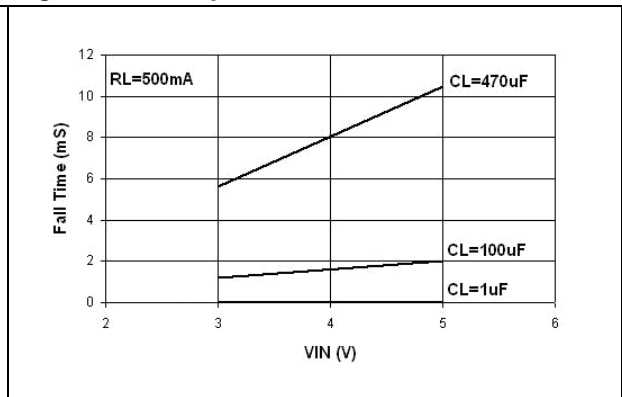
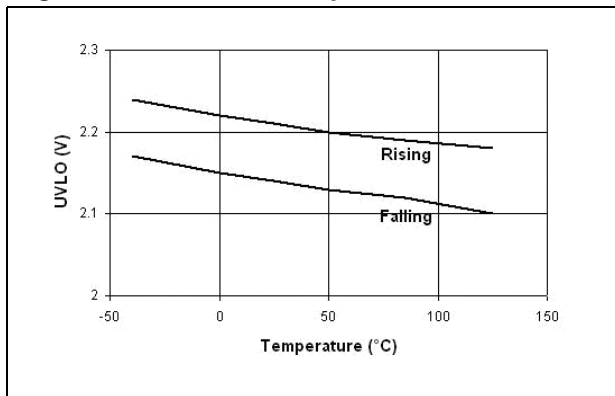


Figure 52. UVLO vs temperature



8 Package mechanical data

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

Figure 53. SOT23-5L package outline

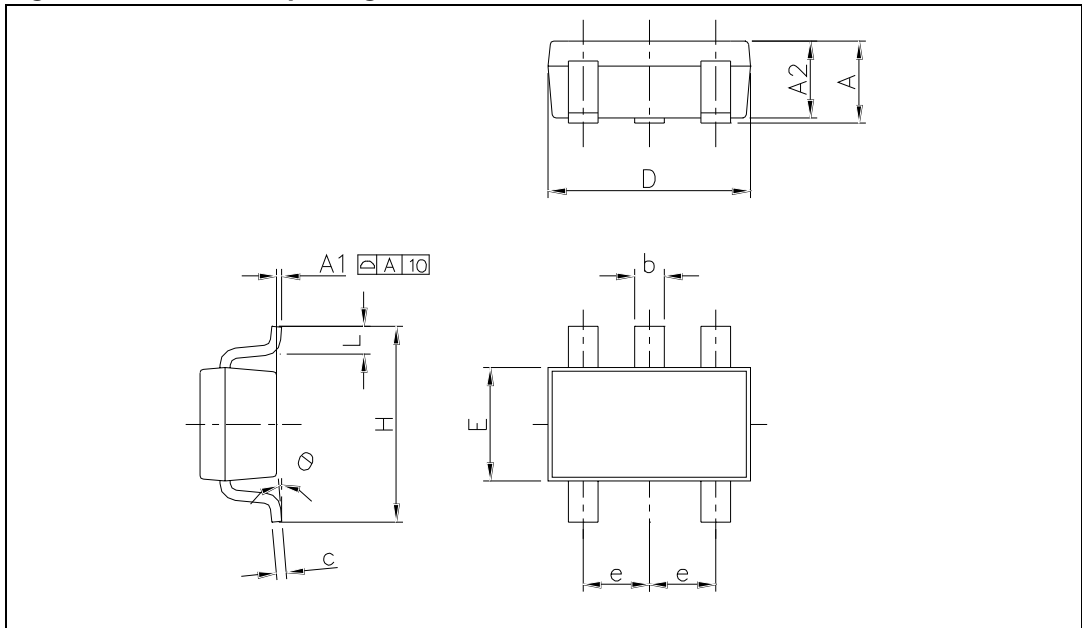


Table 17. SOT23-5L mechanical data

Symbol.	Millimeters			Inches		
	Min	Typ	Max	Min	Typ	Max
A	0.90	—	1.45	35.4	—	57.1
	—	—	—	—	—	—
A1	0.00	—	0.10	0.0	—	3.9
A2	0.90	—	1.30	35.4	—	51.2
b	0.35	—	0.50	13.7	—	19.7
C	0.09	—	0.20	3.5	—	7.8
D	2.80	—	3.00	110.2	—	118.1
E	1.50	—	1.75	59.0	—	68.8
e	—	0.95	—	—	37.4	—
H	2.60	—	3.00	102.3	—	118.1
L	0.10	—	0.60	3.9	—	23.6

Figure 54. SOT23-5L footprint recommendations

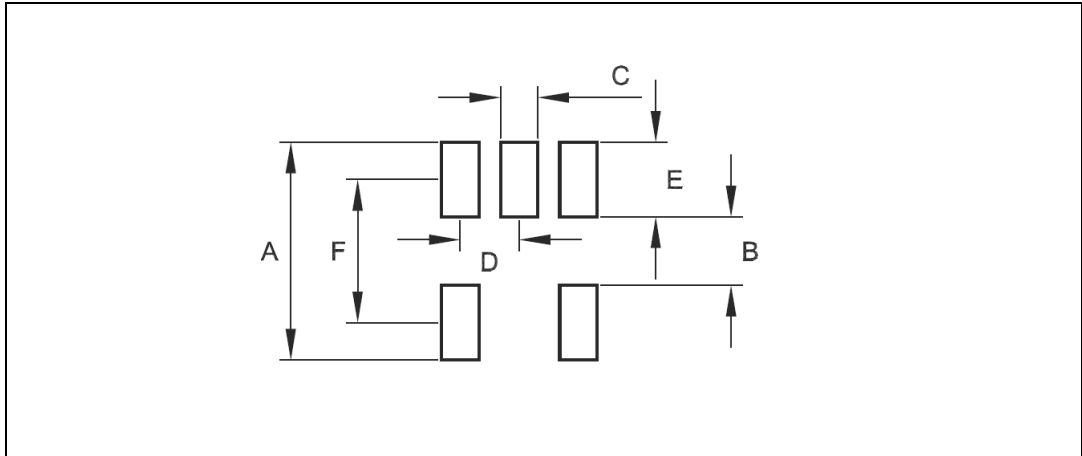


Table 18. SOT23-5L footprint dimensions

Footprint data		
Symbol	Millimeters	Inches
A	3.50	0.138
B	1.10	0.043
C	0.60	0.024
D	0.95	0.037
E	1.20	0.047
F	2.30	0.090

Figure 55. SOT23-5L carrier tape

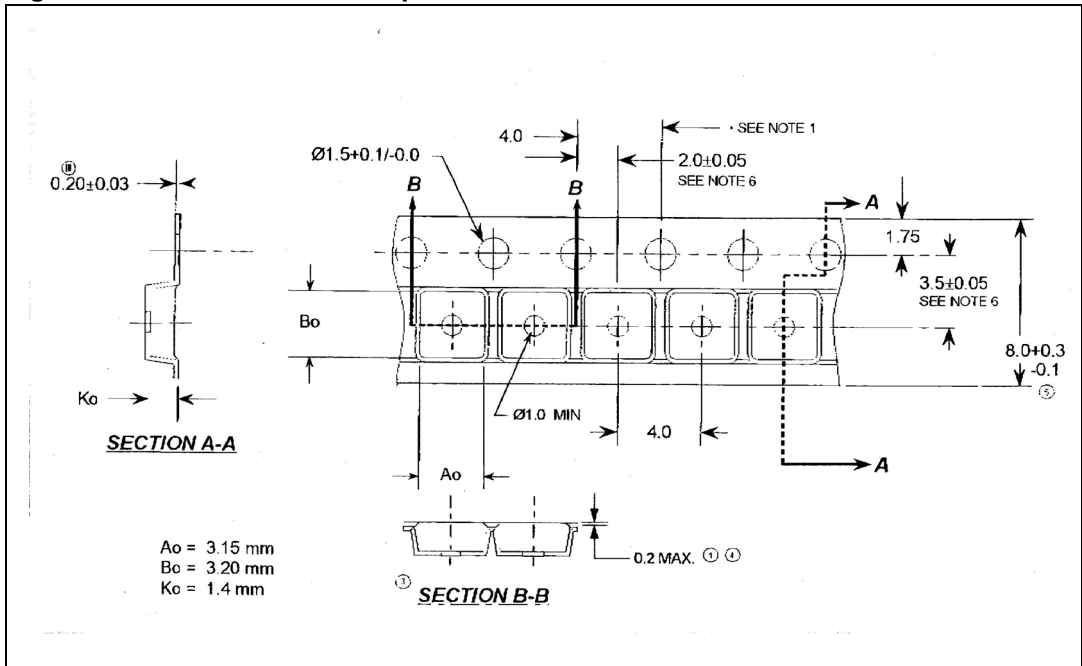


Figure 56. SOT23-5L reel information

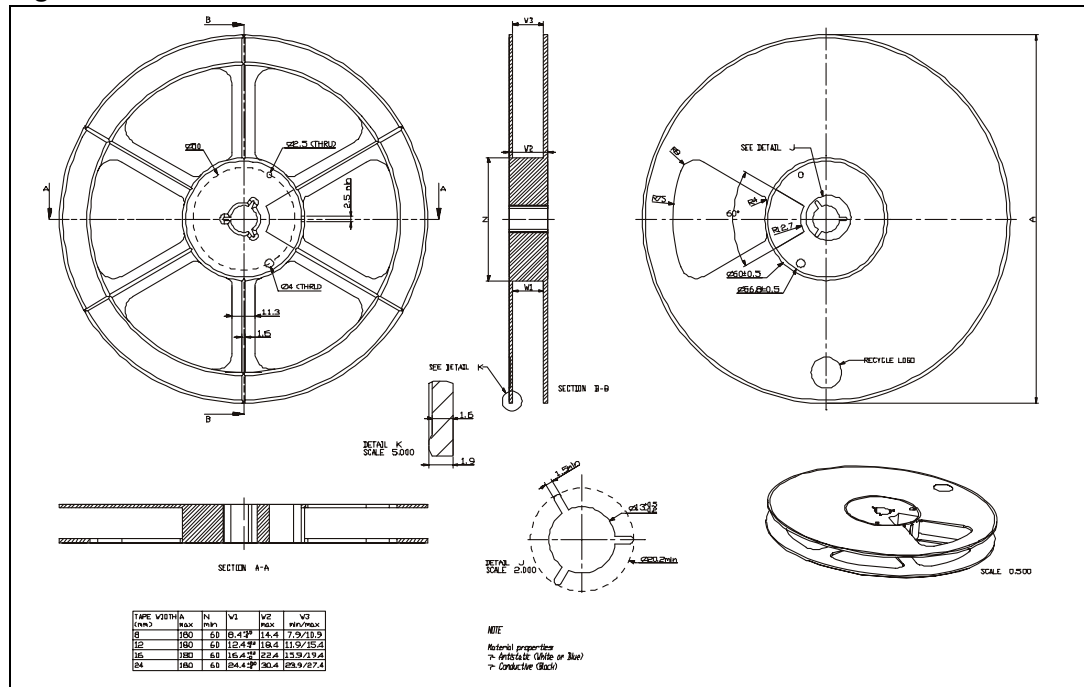
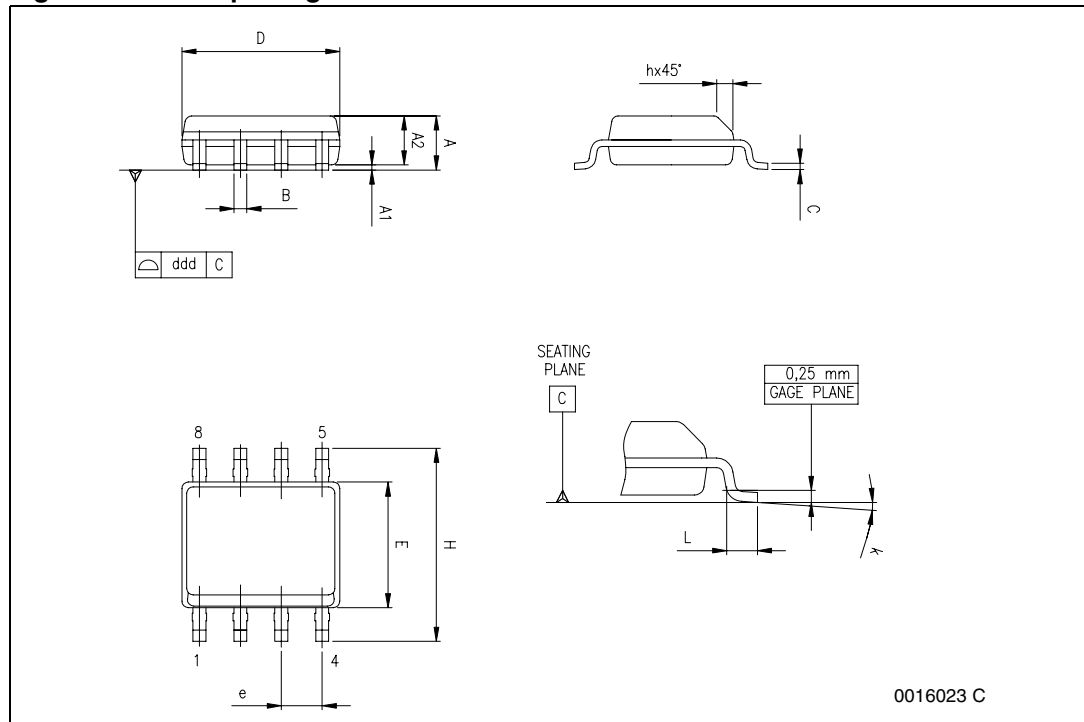


Figure 57. SO-8 package outline



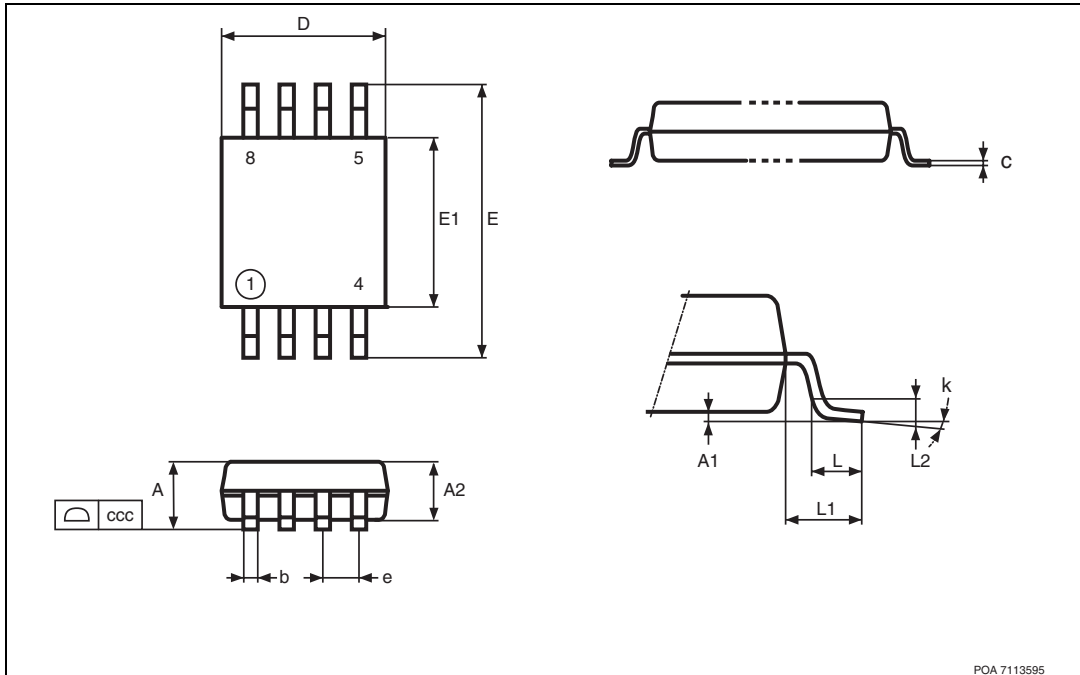
1. Drawing not to scale

Table 19. SO-8 mechanical data

Symbol	millimeters			inches		
	Min	Typ	Max	Min	Typ	Max
A	1.35	—	1.75	0.053	—	0.069
	—	—	—	—	—	—
A1	0.10	—	0.25	0.004	—	0.010
A2	1.10	—	1.65	0.043	—	0.065
B	0.33	—	0.51	0.013	—	0.020
C	0.19	—	0.25	0.007	—	0.010
D ⁽¹⁾	4.80	—	5.00	0.189	—	0.197
E	3.80	—	4.00	0.15	—	0.157
e	—	1.27	—	—	0.050	—
H	5.80	—	6.20	0.228	—	0.244
h	0.25	—	0.50	0.010	—	0.020
L	0.40	—	1.27	0.016	—	0.050
k	0° (min.), 8° (max.)					
ddd	—	—	0.10	—	—	0.004

1. Dimension D does not include mold flash, protrusions or gate burrs. Mold flash, protrusions or gate burrs shall not exceed 0.15mm (.006inch) in total (both sides).

Figure 58. MSOP8 package outline



1. Drawing not to scale.

Table 20. MSOP8 package mechanical data

Symbol	Millimeters			Inches		
	Min	Typ	Max	Min	Typ	Max
A	—	—	1.10	—	—	0.043
A1	0.05	—	0.15	0.002	0.004	0.006
A2	0.75	0.85	0.95	0.031	0.034	0.037
b	0.25	—	0.40	0.010	0.013	0.016
c	0.13	—	0.23	0.005	0.007	0.009
D	2.90	3.00	3.10	0.114	0.118	0.122
E	4.65	4.90	5.15	0.187	0.193	0.199
E1	2.90	3.00	3.10	0.114	0.118	0.122
e	—	0.65	—	—	0.026	—
L	0.40	0.55	0.70	0.016	0.022	0.028
L1	—	0.95	—	—	0.037	—
K	0°	—	6°	0°	—	6°
ccc	—	—	0.10	—	—	0.004

Figure 59. SO-8 carrier tape

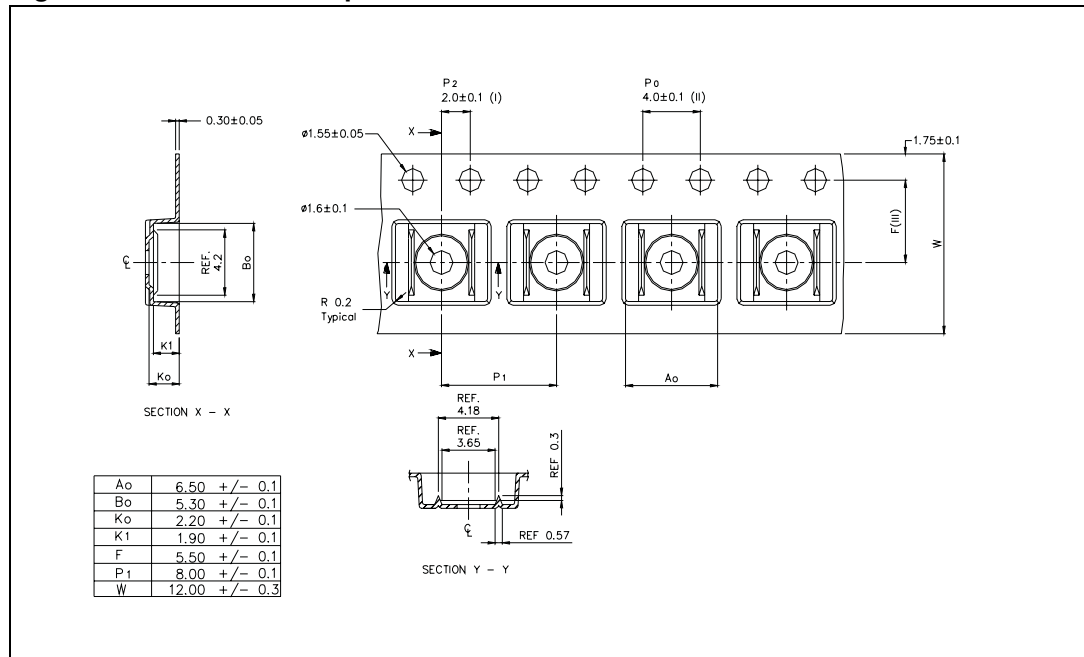
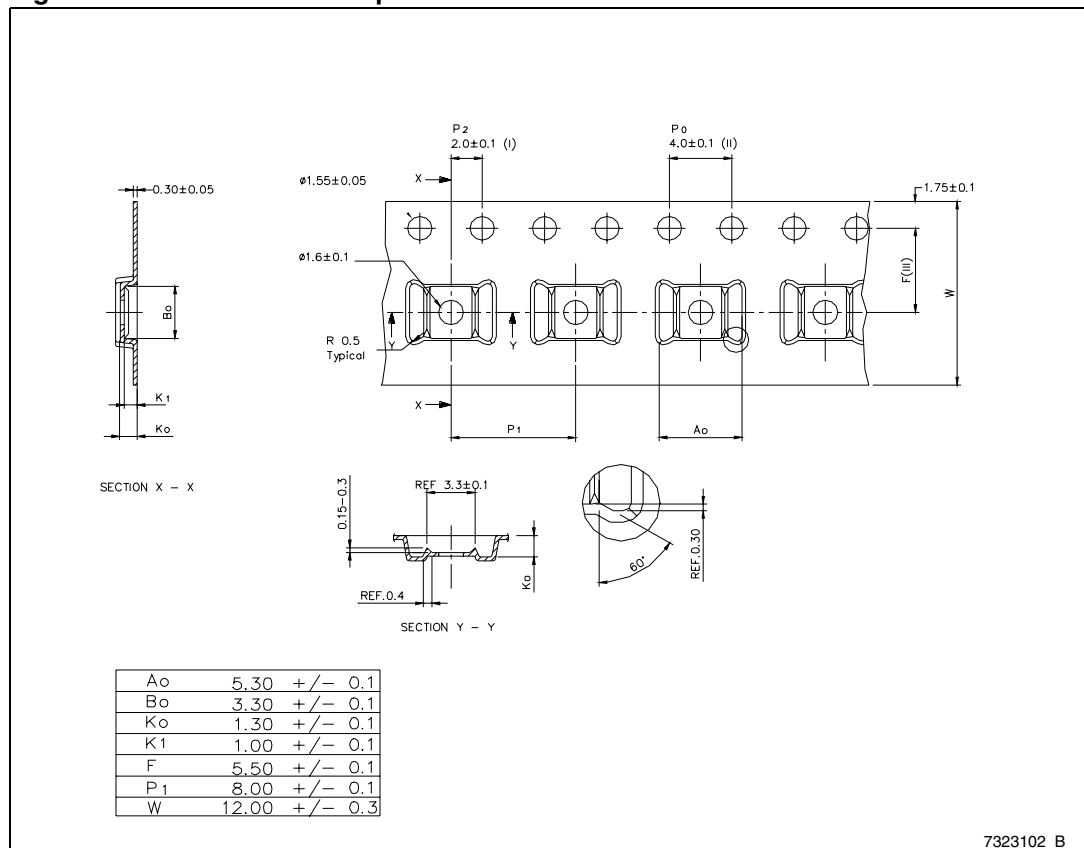


Figure 60. MSOP8 carrier tape



7323102_B

Figure 61. Reel information

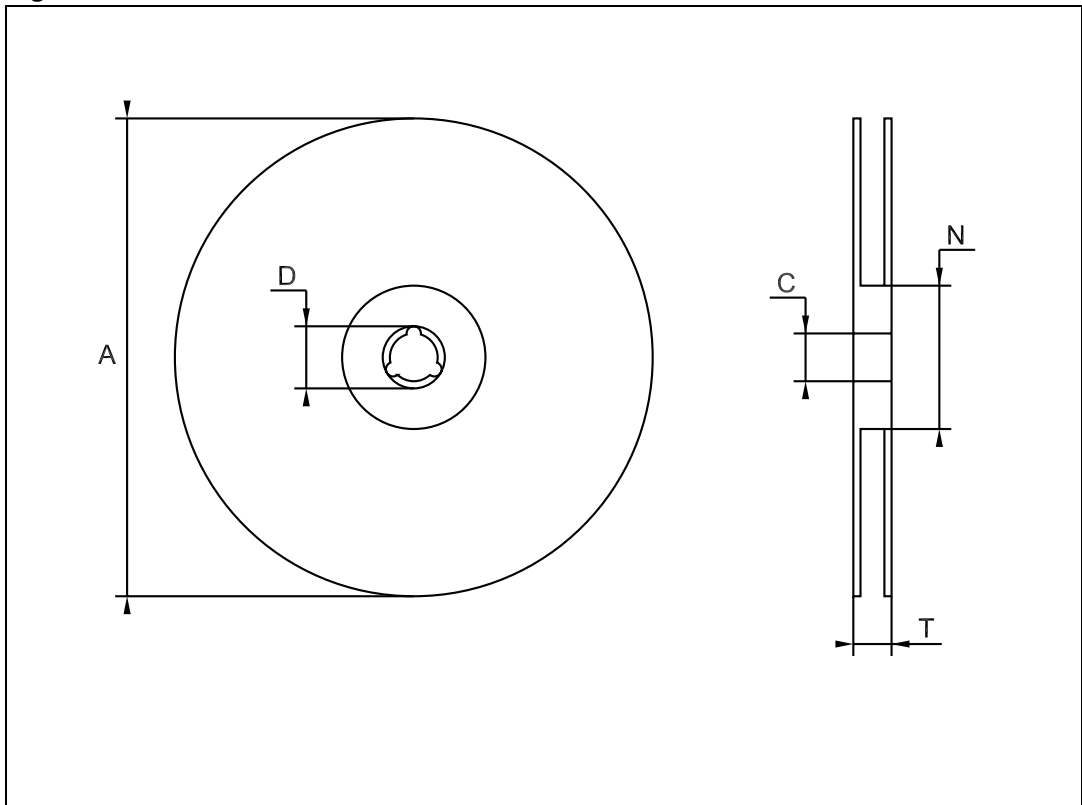


Table 21. Reel mechanical data

Symbol	Millimeters		
	Min	Typ	Max
A	–	–	330
C	12.8	–	13.2
D	20.2	–	–
N	60	–	–
T	–	v	22.4

9 Revision history

Table 22. Document revision history

Date	Revision	Changes
01-Aug-2007	1	Initial release.
18-Dec-2007	2	Minor text changes, updated Figure 53 on page 26 , added Section 7: Detail device characteristics on page 16 .
24-Jan-2008	3	Footnote added in Table 1 on page 1 , replaced Figure 58 on page 30 and Table 20 on page 30 , TSSOP8 package name replaced with MSOP8.
17-Jul-2009	4	Updated Chapter 3 , test conditions modified for $I_{reverse}$ in Table 12 on page 14 and Chapter 7 . Added: Figure 55 , Figure 56 , Figure 59 , Figure 60 and Figure 61 .

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