ST1S12XX
ST1S12XX12, ST1S12XX18

Synchronous rectification with enable, 0.7 A, 1.7 MHz fixed or adjustable step-down switching regulator in TSOT23-5L

Features

- Step-down current mode PWM (1.7 MHz) DC-DC converter
- 3% DC output voltage tolerance
- Synchronous rectification
- Fixed output voltage 1.2 V, 1.8 V, and ADJ (available on request 1.5 V, 2.5 V and 3.3 V)
- Enable function
- Internal soft start
- Typical efficiency: > 90%
- 0.7 A output current capability
- Not switching quiescent current: max 650 µA over temperature range
- R_{DSON} typ. 250 mΩ and 400 mΩ
- Uses tiny capacitors and inductors
- Operative junction temp. -40 °C to 125 °C
- Available in TSOT23-5L package

TSOT23-5L

Description

The ST1S12 is a step down DC-DC converter optimized for powering low-voltage digital cores in HDD applications and, generally, to replace the high current linear solution when the power dissipation may cause high heating of the application environment. It provides up to 0.7 A over an input voltage range of 2.5 V to 5.5 V. A high switching frequency (1.7 MHz) allows the use of tiny surface-mount components. In addition to the resistor divider to set the output voltage value, only an inductor and two capacitors are required. Moreover, a low output ripple is guaranteed by the current mode PWM topology and by the use of low ESR SMD ceramic capacitors. The device is thermally protected and the current is limited to prevent damage due to accidental short-circuit. The ST1S12 is available in the TSOT23-5L package.

Table 1. Device summary

Part numbers	Order codes	Package
ST1S12XX	ST1S12GR	TSOT23-5L
ST1S12XX12	ST1S12G12R	TSOT23-5L
ST1S12XX18	ST1S12G18R	TSOT23-5L

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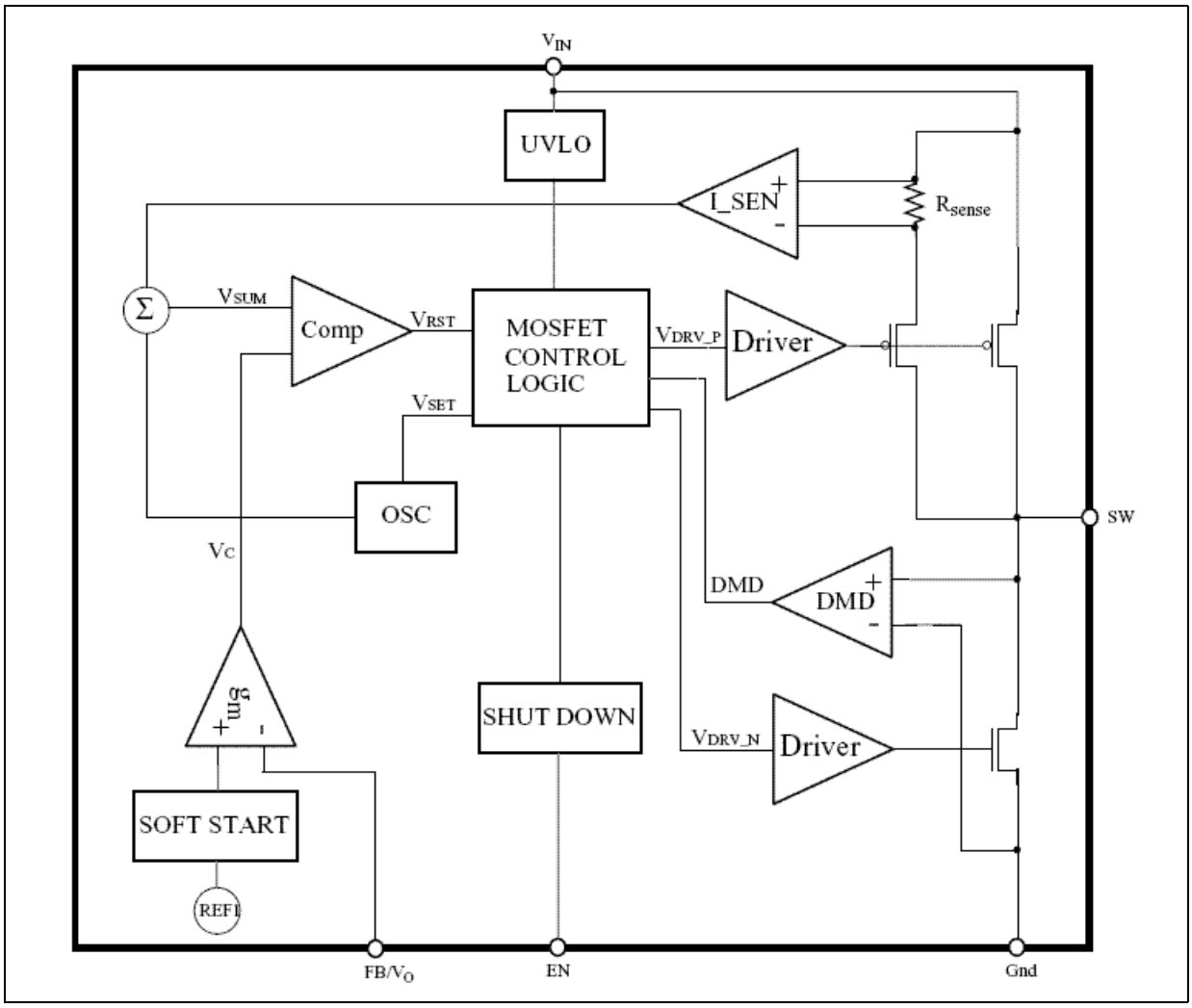
1 Schematic

Figure 1. Schematic diagram



2 Pin configuration

Figure 2. Pin connections (top view)

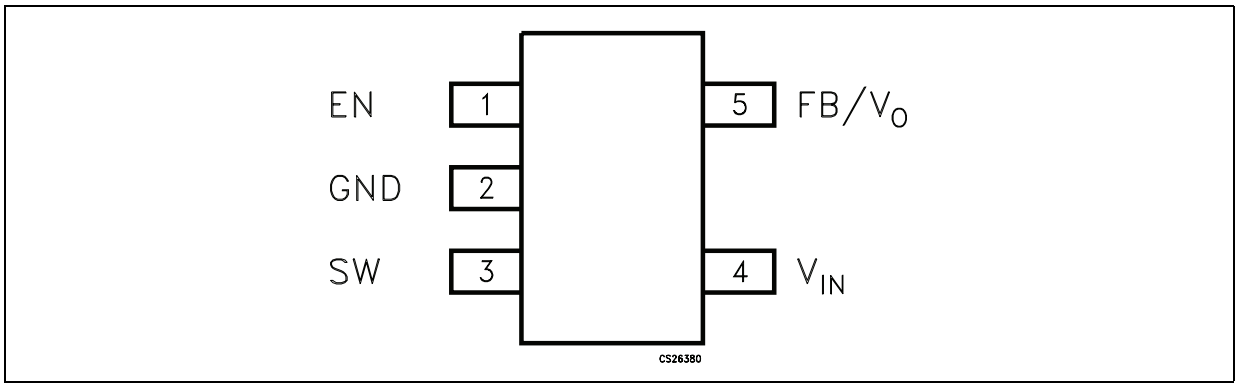


Table 2. Pin description

Pin n°	Symbol	Name and function
1	EN	Enable pin
2	GND	System ground
3	SW	Switching pin
4	V_{IN}	Input supply pin
5	FB/V_O	Feedback voltage / or output voltage

3 Maximum ratings

Table 3. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{IN}	Positive power supply voltage	-0.3 to 6.5	V
V_{EN}	Enable voltage	-0.3 to V_{IN} + 0.3	V
SWITCH Voltage	Max. voltage of output pin	-0.3 to V_{IN} + 0.3	V
V_{FB}/V_O	Feedback voltage	-0.3 to 3	V
V_O	Output voltage (for V_O > 1.6 V)	-0.3 to 6	V
T_J	Max junction temperature	-40 to 150	°C
T_{STG}	Storage temperature range	-65 to 150	°C
T_{LEAD}	Lead temperature (soldering) 10 sec	260	°C

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

Table 4. Thermal data

Symbol	Parameter	Value	Unit
R_{thJA}	Thermal resistance junction-ambient	220	°C/W
R_{thJC}	Thermal resistance junction-case	110	°C/W

Table 5. ESD performance

Symbol	Parameter	Test conditions	Value	Unit
ESD	ESD protection voltage	HBM	2	kV
		MM	0.3	kV

4 Electrical characteristics

V_{IN} = V_{EN} = 3.6 V, C_{IN} = 4.7 µF, C_O = 10 µF, L = 2.2 µH, T_J = - 40 to 125 °C (unless otherwise specified. Typical values are referred to 25 °C).

Table 6. Electrical characteristics for ST1S12G

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
FB	Feedback voltage	T_J = -40 to 125°C	582	600	618	mV
I_{FB}	V_{FB} pin bias current		-50		50	nA
V_{IN}	Minimum input voltage	I_O = 10mA to 0.7A	2.5			V
I_Q	Quiescent current	V_{IN} = V_{EN}, V_{FB} = 0.65V		500	650	µA
		V_{EN} = 0, T_J = -40°C to 85°C			1	µA
I_O	Output current	V_{IN} = 2.5V to 5.5 V (1)	0.7			A
V_{EN}	Enable threshold	Device ON, V_{IN} = 2.5V to 5.5V	1.5			V
		Device OFF			0.5	
I_{EN}	Enable pin current				1	µA
$\%V_O/\Delta V_{IN}$	Reference line regulation	V_{IN} = 2.5V to 5.5V (1)		0.05	0.1	$\%V_O/\Delta V_{IN}$
$\%V_O/\Delta I_O$	Reference load regulation	I_O = 10 mA to 700mA (1)		0.0025	0.005	$\%V_O$/mA
$PWMf_S$	PWM switching frequency		1.16	1.7	2.08	MHz
D_{MAX}	Maximum duty cycle				100	%
R_{DSON}-N	NMOS switch on resistance	I_{SW} = 100mA		0.25	0.4	Ω
R_{DSON}-P	PMOS switch on resistance	I_{SW} = 100mA		0.25	0.45	Ω
I_{SWL}	Switching current limitation	(1)		1.6		A
ν	Efficiency (1)	I_O = 10mA to 100 mA, V_O = 1.8V		80		%
		I_O = 100mA to 0.7A, V_O = 1.8V		90		
T_{SHDN}	Thermal shutdown		130	150		°C
T_{HYS}	Thermal shutdown hysteresis			15		°C
$\%V_O/\Delta I_O$	Load transient response	I_O = 100mA to 700mA, T_A = 25°C t_R = t_F ≥ 200ns, C_O=22µF (1)	-5		+5	$\%V_O$
$\%V_O/\Delta I_O$	Short circuit removal response	I_O = 10mA to I_O= short, T_A = 25°C (1)	-10		+10	$\%V_O$

1. Guaranteed by design, but not tested in production.

V_{IN} =V_{EN} = 3 V, C_{IN} = 4.7 µF, C_O =10 µF, L = 2.2 µH, T_J = -40 to 125 °C (unless otherwise specified. Typical values are referred to 25 °C).

Table 7. Electrical characteristics for ST1S12G12

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
OUT	Output feedback pin	T_J =-40 to 125°C	1.164	1.2	1.236	V
I_O	V_O pin bias current			15	20	µA
V_{IN}	Minimum input voltage	I_O= 10mA to 0.7A	2.5			V
I_Q	Quiescent current	V_{IN} =V_{EN}, V_{FB}=1.5V		500	650	µA
		V_{EN} = 0, T = -40°C to 85°C			1	µA
I_O	Output current	V_{IN} = 2.5V to 5.5V (1)	0.7			A
V_{EN}	Enable threshold	Device ON, V_{IN} = 2.5 to 5.5V	1.5			V
		Device OFF			0.5	
I_{EN}	Enable pin current				1	µA
$\%V_O/\Delta V_{IN}$	Reference line regulation	V_{IN} = 2.5V to 5.5V (1)		0.05	0.1	$\%V_O/\Delta V_{IN}$
$\%V_O/\Delta I_O$	Reference load regulation	I_O = 10mA to 700mA (1)		0.0025	0.005	$\%V_O$/mA
$PWMf_S$	PWM switching frequency		1.16	1.7	2.08	MHz
R_{DSON}-N	NMOS switch on resistance	I_{SW} = 100 mA		0.25	0.4	Ω
R_{DSON}-P	PMOS switch on resistance	I_{SW} = 100 mA		0.25	0.45	Ω
I_{SWL}	Switching current limitation	(1)		1.6		A
ν	Efficiency (1)	I_O = 10mA to 100mA		80		%
		I_O = 100mA to 0.7A		85		
T_{SHDN}	Thermal shutdown		130	150		°C
T_{HYS}	Thermal shutdown hysteresis			15		°C
$\%V_O/\Delta I_O$	Load transient response	I_O = 100mA to 700mA, T_A = 25°C $t_R = t_F \geq$ 200ns, C_O=22µF (1)	-5		+5	$\%V_O$
$\%V_O/\Delta I_O$	Short circuit removal response	I_O = 10mA to I_O = short, T_A = 25°C (1)	-10		+10	$\%V_O$

1. Guaranteed by design, but not tested in production.

V_{IN} =V_{EN} = 3.6 V, C_{IN} = 4.7 µF, C_O =10 µF, L = 2.2 µH, T_J = -40 to 125 °C (unless otherwise specified. Typical values are referred to 25 °C).

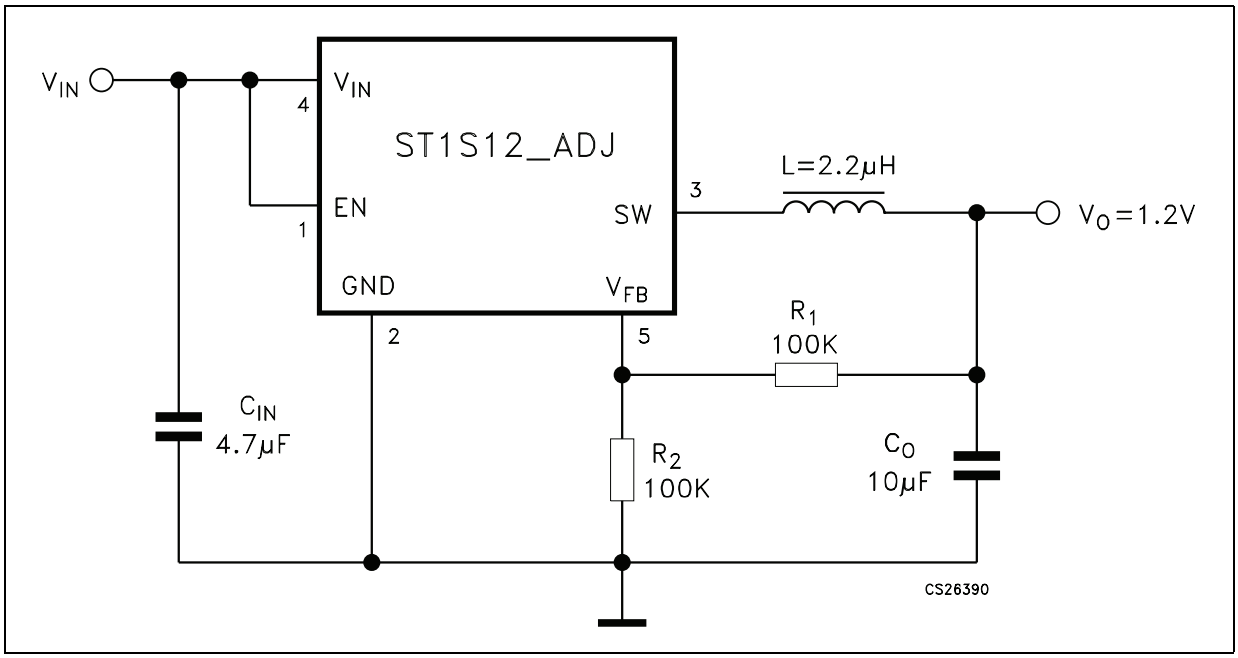
Table 8. Electrical characteristics for ST1S12G18

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
OUT	Output feedback pin	T_J =-40 to 125°C	1.746	1.8	1.854	V
I_O	V_O pin bias current			15	20	µA
V_{IN}	Minimum input voltage	I_O= 10mA to 0.7A	2.5			V
I_Q	Quiescent current	V_{IN} =V_{EN}, V_{FB}=2V		500	650	µA
		V_{EN} = 0, T_J = -40°C to 85°C			1	µA
I_O	Output current	V_{IN} = 2.5V to 5.5V (1)	0.7			A
V_{EN}	Enable threshold	Device ON, V_I = 2.5V to 5.5V	1.5			V
		Device OFF			0.5	
I_{EN}	Enable pin current				1	µA
$\%V_O/\Delta V_{IN}$	Reference line regulation	V_{IN} = 2.5V to 5.5V (1)		0.05	0.1	$\%V_O/\Delta V_{IN}$
$\%V_O/\Delta I_O$	Reference load regulation	I_O = 10mA to 700mA (1)		0.0025	0.005	$\%V_O$/mA
$PWMf_S$	PWM switching frequency		1.16	1.7	2.08	MHz
R_{DSON}-N	NMOS switch on resistance	I_{SW} = 100mA		0.25	0.4	Ω
R_{DSON}-P	PMOS switch on resistance	I_{SW} = 100mA		0.25	0.45	Ω
I_{SWL}	Switching current limitation	(1)		1.6		A
ν	Efficiency (1)	I_O = 10mA to 100mA		80		%
		I_O = 100mA to 0.7A		90		
T_{SHDN}	Thermal shutdown		130	150		°C
T_{HYS}	Thermal shutdown hysteresis			15		°C
$\%V_O/\Delta I_O$	Load transient response	I_O = 100mA to 700mA, T_A = 25°C $t_R = t_F \geq$ 200ns, C_O=22µF (1)	-5		+5	$\%V_O$
$\%V_O/\Delta I_O$	Short circuit removal response	I_O = 10mA to I_O = short, T_A = 25°C (1)	-10		+10	$\%V_O$

1. Guaranteed by design, but not tested in production.

5 Typical application

Figure 3. Application circuit



6 Application notes

The ST1S12 is an adjustable current mode PWM step-down DC-DC converter with internal 0.7 A power switch, packaged in TSOT23-5L. This device is a complete 0.7 A switching regulator, with its internal compensation eliminating the need for additional components.

Because the ST1S12 an adjustable regulator, the output voltage is determined by an external resistor divider. The desired value is derived by the following equation:

Equation 1

$V_O = V_{FB} [1 + R_1 / R_2]$

For the device to function only a few component are required: an inductor, two capacitors and the resistor divider. The inductor selected must be capable of non saturation at peak current level. Moreover, its value can be selected taking into account that a large inductor value increases efficiency at low output current and reduces output voltage ripple, while a smaller inductor can be used when it is important to reduce package size and the total cost of the application. Finally, the ST1S12 has been designed to work properly with X5R or X7R SMD ceramic capacitors both at the input and at the output. These types of capacitors, due to their very low series resistance (ESR), minimize the output voltage ripple. Other low ESR capacitors can be used according to the need of the application without compromising the correct functioning of the device.

7 Typical performance characteristics

Unless otherwise specified, refer to the typical application circuit under the following conditions: C_{IN} = 4.7 µF, C_{OUT} = 10 µF, L = 2.2 µH

Figure 4. Voltage feedback vs. temperature

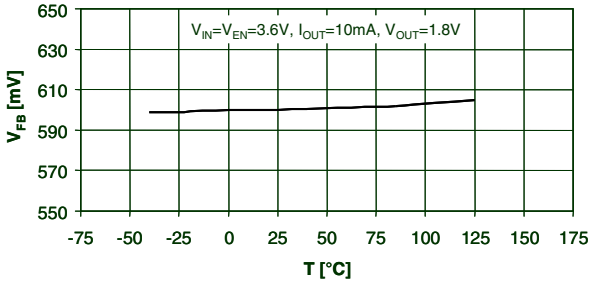


Figure 5. Drop vs. temperature

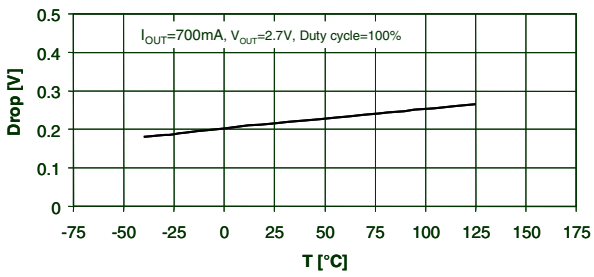


Figure 6. Oscillator frequency vs. temperature

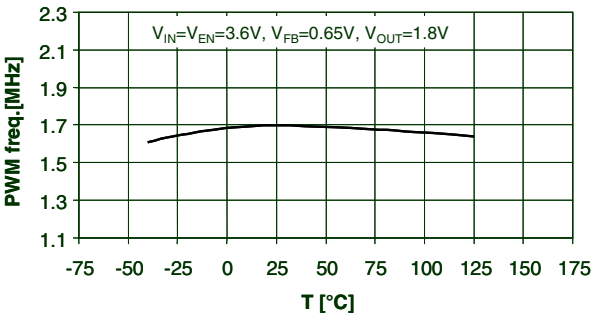


Figure 7. Efficiency vs. output current

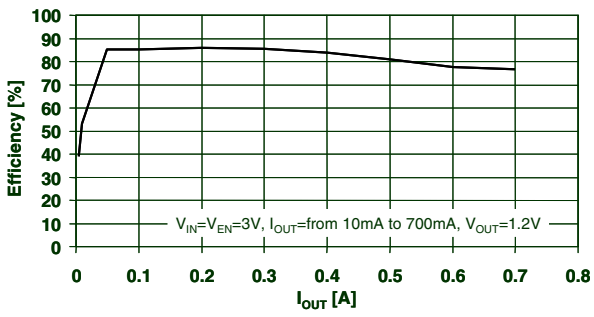


Figure 8. Efficiency vs. output current

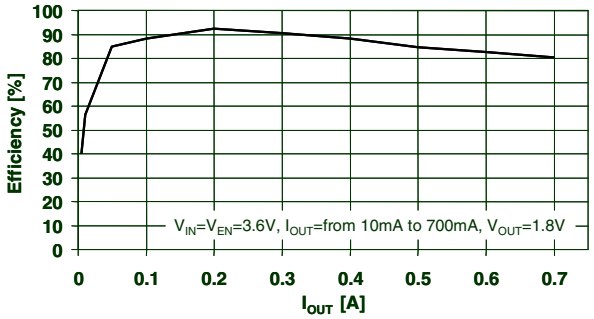


Figure 9. Efficiency vs. temperature

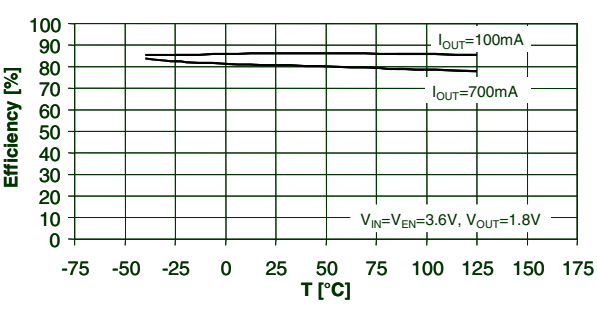


Figure 10. Efficiency vs. temperature

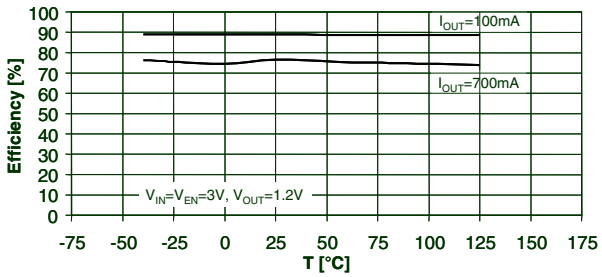


Figure 11. Supply current vs. temperature

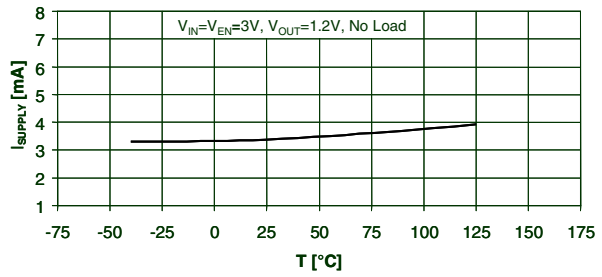


Figure 12. Quiescent current vs. temperature

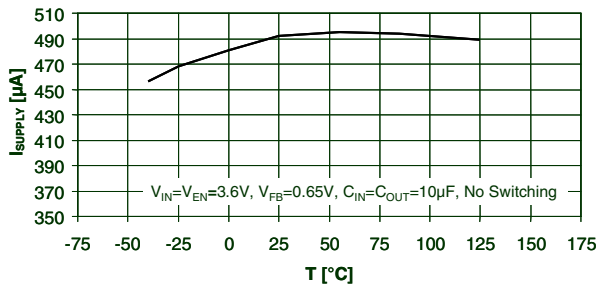


Figure 13. Enable voltage vs. temperature

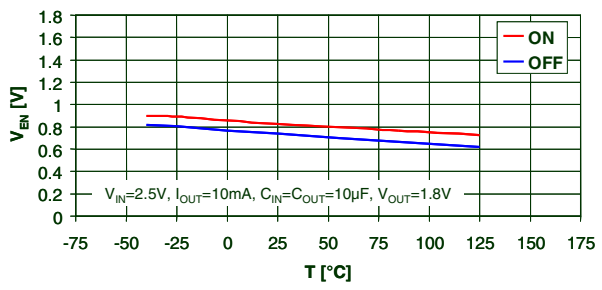


Figure 14. Enable voltage vs. temperature

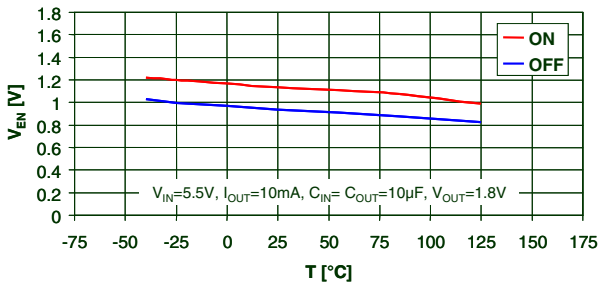


Figure 15. Reference line regulation vs. temperature

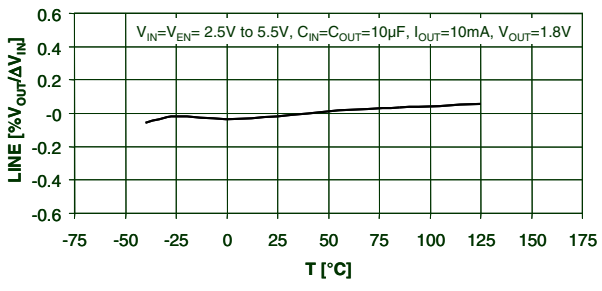


Figure 16. Reference load regulation vs. temperature

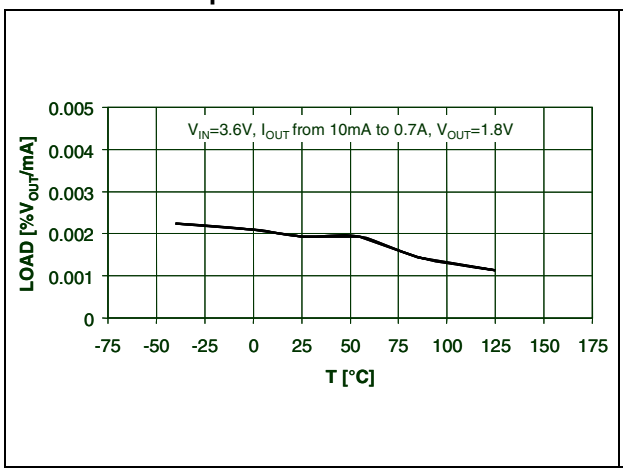


Figure 17. NMOS switch on resistance vs. temperature

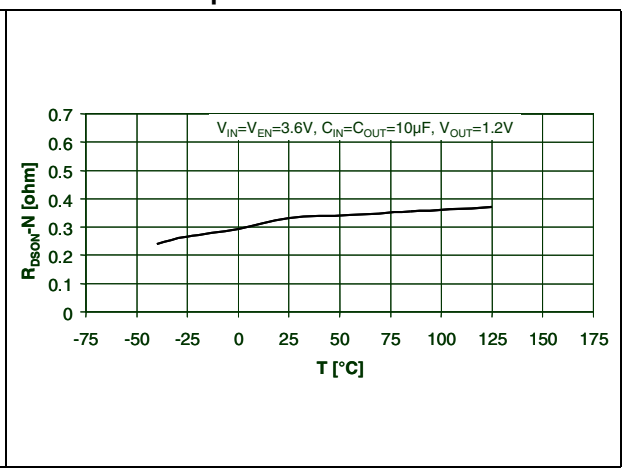


Figure 18. PMOS switch on resistance vs. temperature

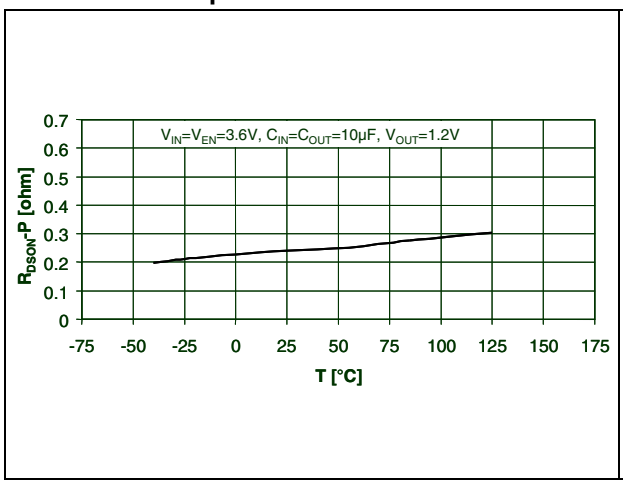


Figure 19. Switching current limitation vs. temperature

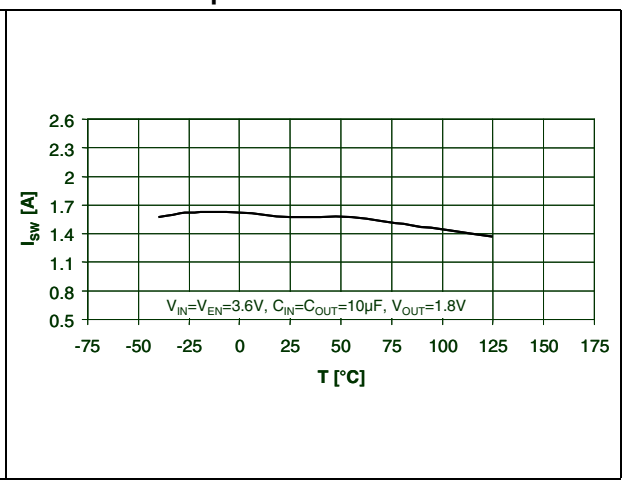


Figure 20. Switching current limitation vs. input voltage

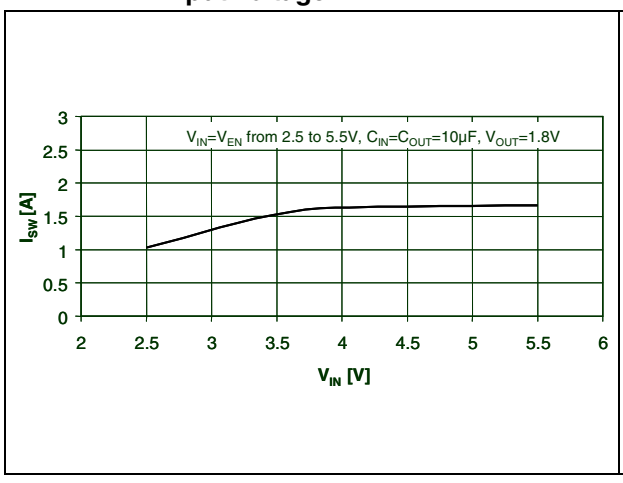


Figure 21. Output voltage vs. input voltage

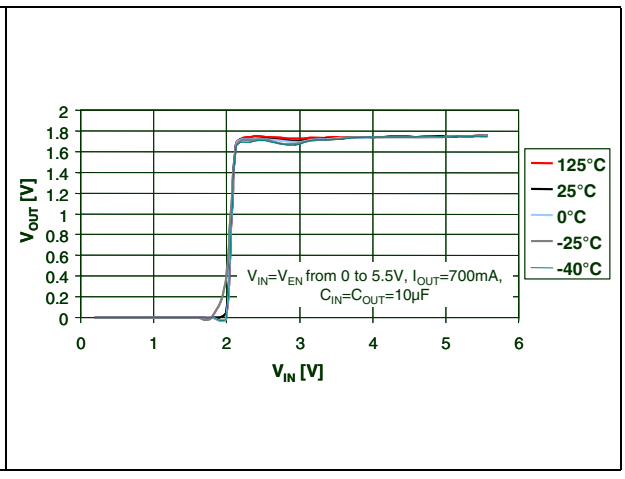
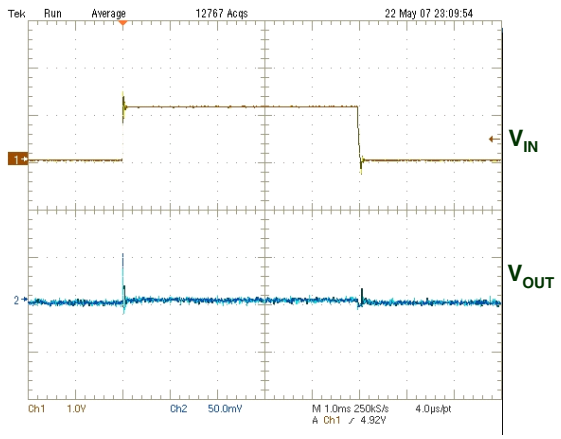
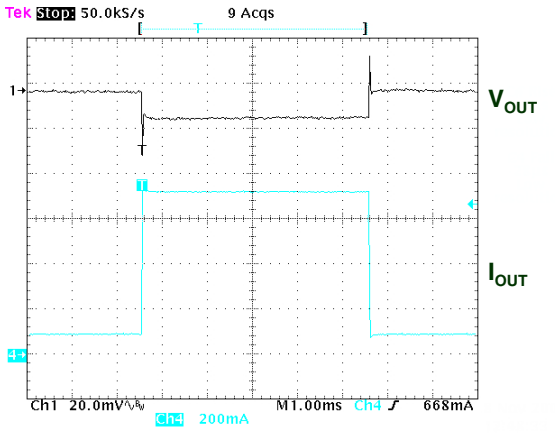


Figure 22. Line transient



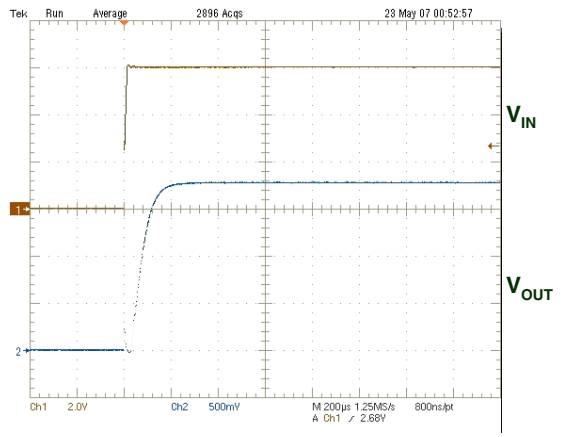
V_{IN} = V_{EN} from 4.5 V to 5.5 V, I_{OUT} = 350 mA,
C_{IN} = C_{OUT} = 10 µF, V_{OUT} = 1.8 V

Figure 23. Load transient



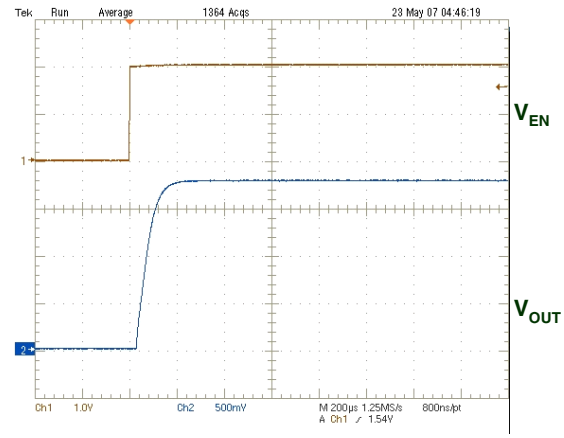
V_{IN} = V_{EN} = 3 V, I_{OUT} = 100 mA to 700 mA, t_R = t_F = 200 ns

Figure 24. Start-up transient



V_{IN} = V_{EN} from 0 V to 6 V, I_{OUT} = 350 mA,
C_{IN} = C_{OUT} = 10 µF, V_{OUT} = 1.8 V

Figure 25. Enable transient



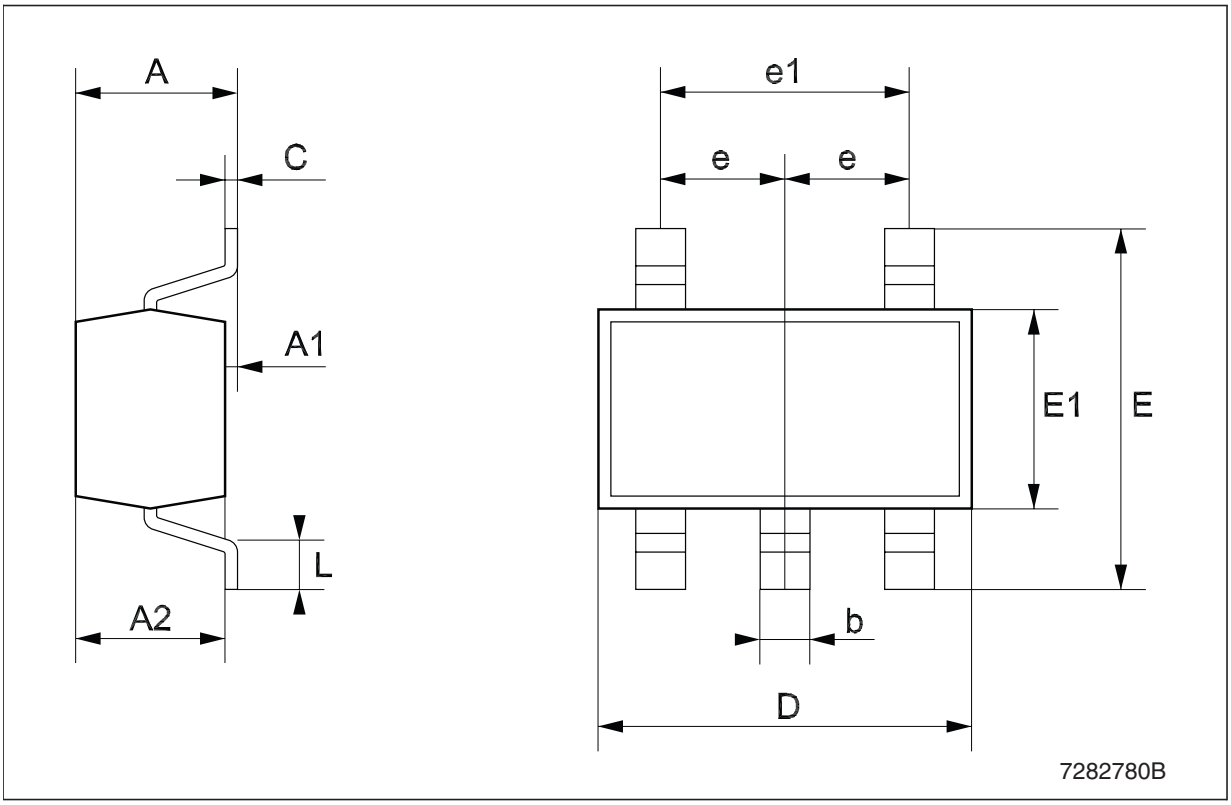
V_{IN} = 3.6, V_{EN} from 0 V to 2 V, I_{OUT} = 350 mA,
C_{IN} = C_{OUT} = 10 µF, V_{OUT} = 1.8 V

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.

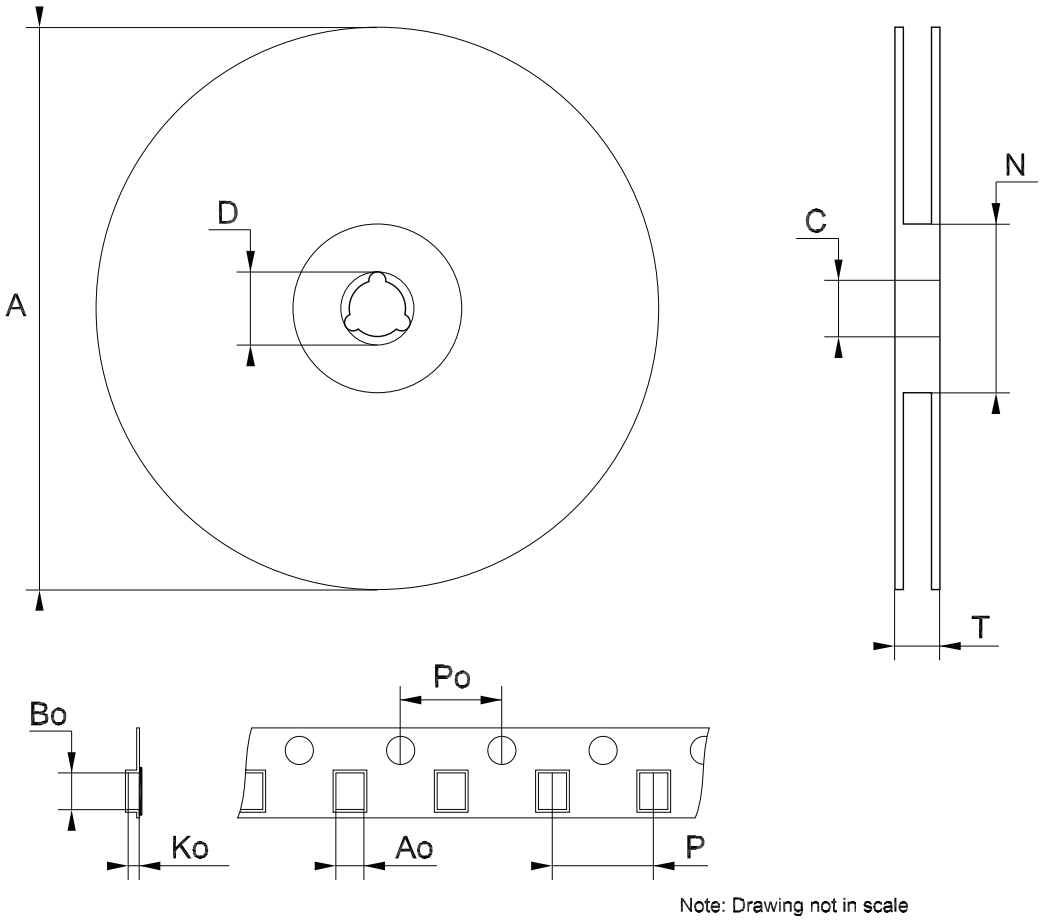
TSOT23-5L mechanical data

Dim.	mm.			mils.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.1			43.3
A1	0		0.1			3.9
A2	0.7		1.0	27.6		39.4
b	0.3		0.5	11.8		19.7
C	0.08		0.2	3.1		7.9
D		2.9			114.2	
E		2.8			110.2	
E1		1.6			63.0	
e		0.95			37.4	
e1		1.9			74.8	
L	0.3		0.6	11.8		23.6



Tape & reel TSOT23-5L mechanical data

Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			180			7.086
C	12.8	13.0	13.2	0.504	0.512	0.519
D	20.2			0.795		
N	60			2.362		
T			14.4			0.567
Ao	3.13	3.23	3.33	0.123	0.127	0.131
Bo	3.07	3.17	3.27	0.120	0.124	0.128
Ko	1.27	1.37	1.47	0.050	0.054	0.0.58
Po	3.9	4.0	4.1	0.153	0.157	0.161
P	3.9	4.0	4.1	0.153	0.157	0.161



Note: Drawing not in scale

Figure 26. TSOT23-5L footprint recommended data

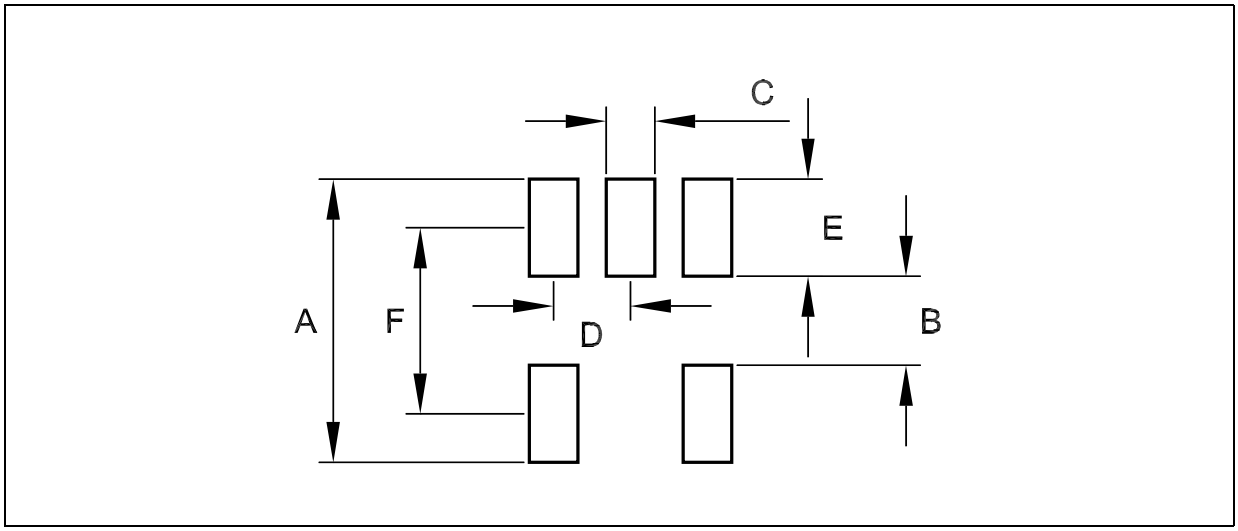


Table 9. Footprint data

Values		
	mm.	inch.
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

9 Revision history

Table 10. Document revision history

Date	Revision	Changes
10-Jan-2008	1	Initial release.
01-Feb-2008	2	Modified: *Figure 3 on page 9*.
23-Feb-2010	3	Modified: V_{IN} value*Table 3 on page 5*.
23-Jun-2011	4	Modified: FB unit *Table 6 on page 6*.
17-Feb-2012	5	Modified: quiescent current max value 600 ==> 650 *Table 6 on page 6*, *Table 7 on page 7* and *Table 8 on page 8*.