

Double channel high-side driver with analog current sense for automotive applications

Datasheet - production data



Features

Max transient supply voltage	V_{CC}	41 V
Operating voltage range	V_{CC}	4.5 to 28 V
Typ on-state resistance (per ch.)	R_{ON}	7.7 m Ω
Current limitation (typ)	I_{LIMH}	85 A
Off-state supply current	I_S	2 $\mu A^{(1)}$

1. Typical value with all loads connected.

- General
 - Very low standby current
 - 3.0 V CMOS compatible inputs
 - Optimized electromagnetic emissions
 - Very low electromagnetic susceptibility
 - Compliance with European directive 2002/95/EC
 - Very low current sense leakage
- Diagnostic functions
 - Proportional load current sense
 - High current sense precision for wide currents range
 - Current sense disable
 - Off-state openload detection
 - Output short to V_{CC} detection
 - Overload and short to ground (power limitation) indication
 - Thermal shutdown indication
- Protection
 - Undervoltage shutdown
 - Overvoltage clamp
 - Load current limitation
 - Self limiting of fast thermal transients

- Protection against loss of ground and loss of V_{CC}
- Overtemperature shutdown with auto restart (thermal shutdown)
- Inrush current active management by power limitation
- Reverse battery protected with self switch of the PowerMOS
- Electrostatic discharge protection

Applications

- All types of resistive, inductive and capacitive loads

Description

The VND5E008ASP-E is a double channel high-side driver manufactured using ST proprietary VIPower® M0-5 technology and housed in PowerSO-16 package. The device is designed to drive 12 V automotive grounded loads, and to provide protection and diagnostics. They also implement a 3 V and 5 V CMOS-compatible interface for the use with any microcontroller.

The device integrates advanced protective functions such as load current limitation, inrush and overload active management by power limitation, overtemperature shut-off with auto restart and overvoltage active clamp. A dedicated analog current sense pin is associated with every output channel providing enhanced diagnostic functions including fast detection of overload and short-circuit to ground through power limitation indication, overtemperature indication, short-circuit to V_{CC} diagnosis and on-state and off-state open-load detection. The current sensing and diagnostic feedback of the whole device can be disabled by pulling the CS_DIS pin high to share the external sense resistor with similar devices.

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1 Block diagram and pin description

Figure 1. Block diagram

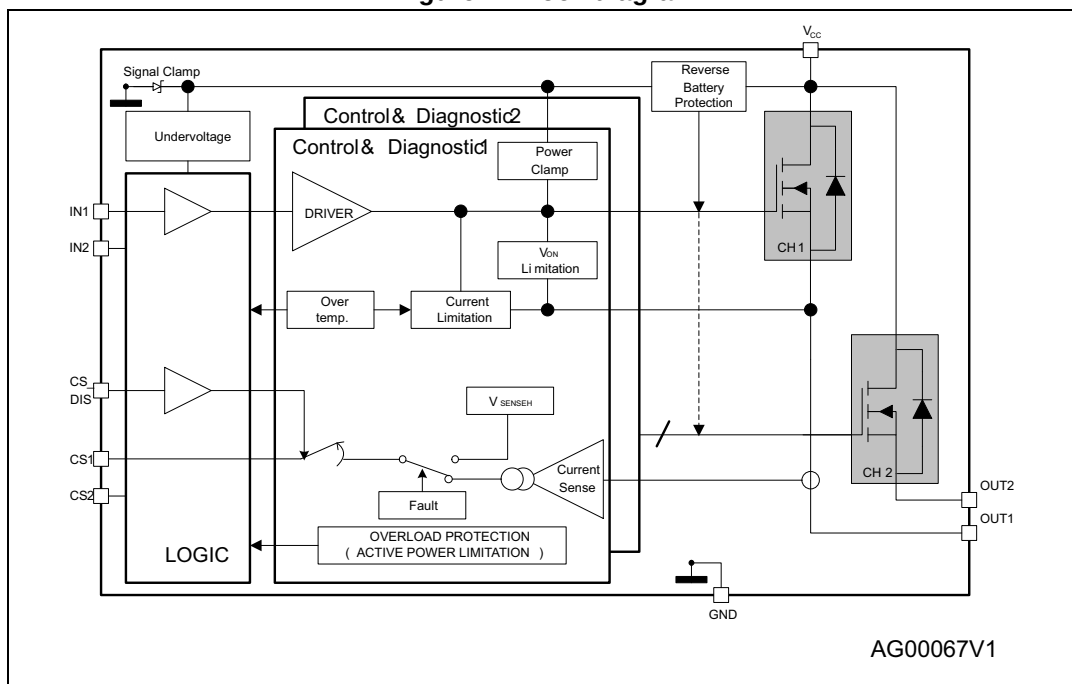


Table 1. Pin function

Name	Function
V _{CC}	Battery connection.
OUT _{1,2}	Power outputs.
GND	Ground connection.
IN _{1,2}	Voltage controlled input pins with hysteresis, CMOS compatible. They control output switch state.
CS _{1,2}	Analog current sense pins, they deliver a current proportional to the load current.
CS_DIS	Active high CMOS compatible pin, to disable the current sense pin.

Figure 2. Configuration diagram (top view)

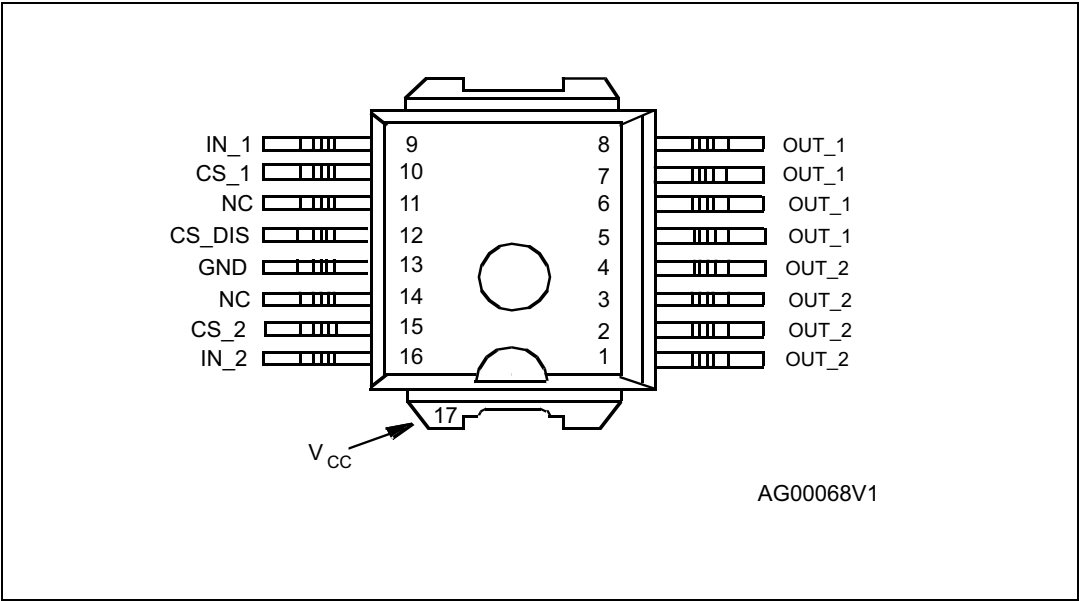


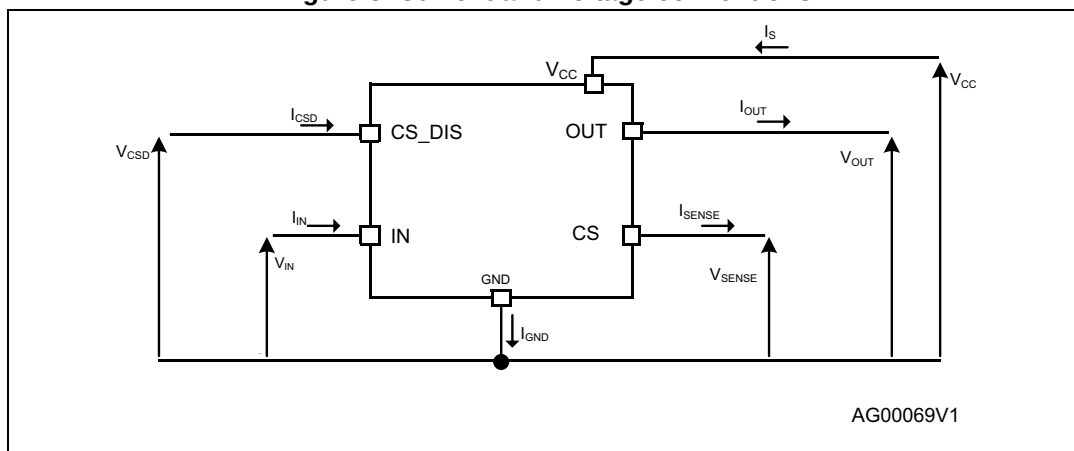
Table 2. Suggested connections for unused and not connected pins

Connection / pin	Current sense	N.C.	Output	Input	CS_DIS
Floating	Not allowed	X ⁽¹⁾	X	X	X
To ground	Through 1 KΩ resistor	X	Not allowed	Through 10 KΩ resistor	Through 10 KΩ resistor

1. X: do not care.

2 Electrical specifications

Figure 3. Current and voltage conventions



2.1 Absolute maximum ratings

Stressing the device above the ratings listed in [Table 3](#) 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 the conditions in this section for extended periods may affect device reliability.

Table 3. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	DC supply voltage	28	V
V_{CCPK}	Transient supply voltage ($T < 400$ ms, $R_{LOAD} > 0.5 \Omega$)	41	V
$-V_{CC}$	Reverse DC supply voltage	16	V
I_{OUT}	DC output current	Internally limited	A
$-I_{OUT}$	Reverse DC output current	45	A
I_{IN}	DC input current	-1 to 10	mA
I_{CSD}	DC current sense disable input current	-1 to 10	mA
V_{CSENSE}	Current sense maximum voltage	$V_{CC}-41$ $+V_{CC}$	V V
E_{MAX}	Maximum switching energy (single pulse) ($T_{DEMAG} = 0.4$ ms; $T_{jstart} = 150$ °C)	280	mJ

Table 3. Absolute maximum ratings (continued)

Symbol	Parameter	Value	Unit
V _{ESD}	Electrostatic discharge (Human Body Model: R = 1.5 K Ω ; C = 100 pF)		
	– Input	4000	V
	– Current sense	2000	
	– CS_DIS	4000	
	– Output	5000	
	– V _{CC}	5000	
V _{ESD}	Charge device model (CDM-AEC-Q100-011)	750	V
T _j	Junction operating temperature	-40 to 150	°C
T _{stg}	Storage temperature	-55 to 150	°C

2.2 Thermal data

Table 4. Thermal data

Symbol	Parameter	Max. value	Unit
R _{thj-case}	Thermal resistance junction-case (MAX) (with one channel ON)	0.5	°C/W
R _{thj-amb}	Thermal resistance junction-ambient	See Figure 19	°C/W

2.3 Electrical characteristics

8 V < V_{CC} < 28 V; -40 °C < T_j < 150 °C, unless otherwise specified.

Table 5. Power section

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{CC}	Operating supply voltage		4.5	13	28	V
V_{USD}	Undervoltage shutdown			3.5	4.5	V
$V_{USDhyst}$	Undervoltage shutdown hysteresis			0.5		V
R_{ON}	On-state resistance	$I_{OUT} = 6\text{ A}$; $T_j = 25\text{ °C}$		7.7		mΩ
		$I_{OUT} = 6\text{ A}$; $T_j = 150\text{ °C}$			14.7	mΩ
		$I_{OUT} = 6\text{ A}$; $V_{CC} = 5\text{ V}$; $T_j = 25\text{ °C}$			12	mΩ
$R_{ON REV}$	Reverse battery on-state resistance	$V_{CC} = -13\text{ V}$; $I_{OUT} = -6\text{ A}$; $T_j = 25\text{ °C}$			9	mΩ
V_{clamp}	Clamp voltage	$I_S = 20\text{ mA}$	41	46	52	V
I_S	Supply current	Off-state; $V_{CC} = 13\text{ V}$; $T_j = 25\text{ °C}$; $V_{IN} = V_{OUT} = V_{SENSE} = V_{CSD} = 0\text{ V}$		2 ⁽¹⁾	5 ⁽¹⁾	μA
		On-state; $V_{CC} = 13\text{ V}$; $V_{IN} = 5\text{ V}$; $I_{OUT} = 0\text{ A}$		4.8	6.5	mA
$I_{L(off1)}$	Off-state output current ⁽²⁾	$V_{IN}=V_{OUT}=0\text{V}$; $V_{CC}=13\text{V}$; $T_j=25\text{°C}$	0	0.01	3	μA
		$V_{IN}=V_{OUT}=0\text{V}$; $V_{CC}=13\text{V}$; $T_j=125\text{°C}$	0		5	μA

1. PowerMOS leakage included.

2. For each channel.

Table 6. Switching ($V_{CC} = 13\text{ V}$; $T_j = 25\text{ °C}$)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$t_{d(on)}$	Turn-on delay time	$R_L = 2.2\text{ Ω}$ (see Figure 6)	—	28	—	μs
$t_{d(off)}$	Turn-off delay time	$R_L = 2.2\text{ Ω}$ (see Figure 6)	—	15	—	μs
$(dV_{OUT}/dt)_{on}$	Turn-on voltage slope	$R_L = 2.2\text{ Ω}$	—	0.14	—	V/μs
$(dV_{OUT}/dt)_{off}$	Turn-off voltage slope	$R_L = 2.2\text{ Ω}$	—	0.3	—	V/μs
W_{ON}	Switching energy losses during t_{won}	$R_L = 2.2\text{ Ω}$ (see Figure 6)	—	1.4	—	mJ
W_{OFF}	Switching energy losses during t_{woff}	$R_L = 2.2\text{ Ω}$ (see Figure 6)	—	0.5	—	mJ

Table 7. Logic inputs

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{IL}	Input low level voltage				0.9	V
I_{IL}	Low level input current	$V_{IN} = 0.9\text{ V}$	1			μA
V_{IH}	Input high level voltage		2.1			V
I_{IH}	High level input current	$V_{IN} = 2.1\text{ V}$			10	μA
$V_{I(hyst)}$	Input hysteresis voltage		0.25			V
V_{ICL}	Input clamp voltage	$I_{IN} = 1\text{ mA}$	5.5		7	V
		$I_{IN} = -1\text{ mA}$		-0.7		V
V_{CSDL}	CS_DIS low level voltage				0.9	V
I_{CSDL}	Low level CS_DIS current	$V_{CSD} = 0.9\text{ V}$	1			μA
V_{CSDH}	CS_DIS high level voltage		2.1			V
I_{CSDH}	High level CS_DIS current	$V_{CSD} = 2.1\text{ V}$			10	μA
$V_{CSD(hyst)}$	CS_DIS hysteresis voltage		0.25			V
V_{CSCL}	CS_DIS clamp voltage	$I_{CSD} = 1\text{ mA}$	5.5		7	V
		$I_{CSD} = -1\text{ mA}$		-0.7		V

Table 8. Protections and diagnostics⁽¹⁾

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{limH}	DC short circuit current	$V_{CC} = 13\text{ V}$	60	85	120	A
		$5\text{ V} < V_{CC} < 22\text{ V}$			120	A
I_{limL}	Short circuit current during thermal cycling	$V_{CC} = 13\text{ V}; T_R < T_j < T_{TSD}$		21		A
T_{TSD}	Shutdown temperature		150	175	200	$^{\circ}\text{C}$
T_R	Reset temperature		$T_{RS} + 1$	$T_{RS} + 5$		$^{\circ}\text{C}$
T_{RS}	Thermal reset of status		135			$^{\circ}\text{C}$
T_{HYST}	Thermal hysteresis ($T_{TSD} - T_R$)			7		$^{\circ}\text{C}$
V_{DEMAG}	Turn-off output voltage clamp	$I_{OUT} = 2\text{ A}; V_{IN} = 0; L = 6\text{ mH}$	$V_{CC} - 28$	$V_{CC} - 31$	$V_{CC} - 35$	V
V_{ON}	Output voltage drop limitation	$I_{OUT} = 0.6\text{ A}; T_j = -40\text{ }^{\circ}\text{C}$ to $150\text{ }^{\circ}\text{C}$ (see Figure 8)		25		mV

1. To ensure long term reliability under heavy overload or short circuit conditions, protection and related diagnostic signals must be used together with a proper software strategy. If the device is subjected to abnormal conditions, this software must limit the duration and number of activation cycles.

Table 9. Current sense ($8\text{ V} < V_{CC} < 18\text{ V}$)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
K_0	I_{OUT}/I_{SENSE}	$I_{OUT} = 0.5\text{ A}$; $V_{SENSE} = 0.5\text{ V}$; $T_j = -40\text{ }^{\circ}\text{C}$ to $150\text{ }^{\circ}\text{C}$	3550	6230	9350	
K_1	I_{OUT}/I_{SENSE}	$I_{OUT} = 1.2\text{ A}$; $V_{SENSE} = 0.5\text{ V}$; $T_j = -40\text{ }^{\circ}\text{C}$ to $150\text{ }^{\circ}\text{C}$	3825	5820	8315	
$dK_1/K_1^{(1)}$	Current sense ratio drift	$I_{OUT} = 1.2\text{ A}$; $V_{SENSE} = 0.5\text{ V}$; $V_{CSD} = 0\text{ V}$; $T_j = -40\text{ }^{\circ}\text{C}$ to $150\text{ }^{\circ}\text{C}$	-15		15	%
K_2	I_{OUT}/I_{SENSE}	$I_{OUT} = 6\text{ A}$; $V_{SENSE} = 4\text{ V}$; $T_j = -40\text{ }^{\circ}\text{C}$ to $150\text{ }^{\circ}\text{C}$	3300	4610	5900	
$dK_2/K_2^{(1)}$	Current sense ratio drift	$I_{OUT} = 6\text{ A}$; $V_{SENSE} = 4\text{ V}$; $V_{CSD} = 0\text{ V}$; $T_j = -40\text{ }^{\circ}\text{C}$ to $150\text{ }^{\circ}\text{C}$	-13		13	%
K_3	I_{OUT}/I_{SENSE}	$I_{OUT} = 18\text{ A}$; $V_{SENSE} = 4\text{ V}$; $T_j = -40\text{ }^{\circ}\text{C}$ to $150\text{ }^{\circ}\text{C}$	4000	4510	5000	
$dK_3/K_3^{(1)}$	Current sense ratio drift	$I_{OUT} = 18\text{ A}$; $V_{SENSE} = 4\text{ V}$; $V_{CSD} = 0\text{ V}$; $T_j = -40\text{ }^{\circ}\text{C}$ to $150\text{ }^{\circ}\text{C}$	-7		7	%
I_{SENSE0}	Analog sense leakage current	$I_{OUT} = 0\text{ A}$; $V_{SENSE} = 0\text{ V}$; $V_{CSD} = 5\text{ V}$; $V_{IN} = 0\text{ V}$; $T_j = -40\text{ }^{\circ}\text{C}$ to $150\text{ }^{\circ}\text{C}$	0		1	μA
		$V_{CSD} = 0\text{ V}$; $V_{IN} = 5\text{ V}$; $T_j = -40\text{ }^{\circ}\text{C}$ to $150\text{ }^{\circ}\text{C}$	0		2	μA
		$I_{OUT} = 6\text{ A}$; $V_{SENSE} = 0\text{ V}$; $V_{CSD} = V_{IN} = 5\text{ V}$	0		1	μA
V_{SENSE}	Max analog sense output voltage	$I_{OUT} = 18\text{ A}$; $V_{CSD} = 0\text{ V}$	5			V
$V_{SENSEH}^{(2)}$	Analog sense output voltage in fault conditions	$V_{CC} = 13\text{ V}$; $R_{SENSE} = 10\text{ K}\Omega$		8		V
$I_{SENSEH}^{(2)}$	Analog sense output current in fault conditions	$V_{CC} = 13\text{ V}$; $V_{SENSE} = 5\text{ V}$		7		mA
$t_{DSENSE1H}$	Delay response time from falling edge of CS_DIS pin	$V_{SENSE} < 4\text{ V}$; $1.2\text{ A} < I_{OUT} < 18\text{ A}$; $I_{SENSE} = 90\%$ of $I_{SENSE\text{ max}}$ (see Figure 4)		50	100	μs
$t_{DSENSE1L}$	Delay response time from rising edge of CS_DIS pin	$V_{SENSE} < 4\text{ V}$; $1.2\text{ A} < I_{OUT} < 18\text{ A}$; $I_{SENSE} = 10\%$ of $I_{SENSE\text{ max}}$ (see Figure 4)		5	20	μs
$t_{DSENSE2H}$	Delay response time from rising edge of INPUT pin	$V_{SENSE} < 4\text{ V}$; $1.2\text{ A} < I_{OUT} < 18\text{ A}$; $I_{SENSE} = 90\%$ of $I_{SENSE\text{ max}}$ (see Figure 4)		150	300	μs

Table 9. Current sense (8 V < V_{CC} < 18 V) (continued)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$\Delta t_{\text{DSENSE2H}}$	Delay response time between rising edge of output current and rising edge of current sense	$V_{\text{SENSE}} < 4\text{ V}$; $I_{\text{SENSE}} = 90\%$ of $I_{\text{SENSE max}}$; $I_{\text{OUT}} = 90\%$ of I_{OUTMAX} ; $I_{\text{OUTMAX}} = 6\text{ A}$ (see Figure 7)			300	μs
t_{DSENSE2L}	Delay response time from falling edge of INPUT pin	$V_{\text{SENSE}} < 4\text{ V}$; $1.2\text{ A} < I_{\text{OUT}} < 18\text{ A}$; $I_{\text{SENSE}} = 10\%$ of $I_{\text{SENSE max}}$; (see Figure 4)		5	20	μs

- Parameter guaranteed by design; it is not tested.
- Fault conditions includes: power limitation, overtemperature and open-load off-state detection.

Table 10. Open-load detection (8 V < V_{CC} < 18 V)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{OL}	Open-load off-state voltage detection threshold	$V_{\text{IN}} = 0\text{ V}$; $8\text{ V} < V_{\text{CC}} < 18\text{ V}$	2	—	4	V
I_{OL}	Open-load on-state current detection threshold	$V_{\text{IN}} = 5\text{ V}$; $8\text{ V} < V_{\text{CC}} < 18\text{ V}$; $I_{\text{SENSE}} = 5\text{ }\mu\text{A}$	10	—	100	mA
t_{DSTKON}	Output short circuit to V _{CC} detection delay at turn off	See Figure 5	180	—	1200	μs
$I_{\text{L(off2)}}$	Off-state output current at $V_{\text{OUT}} = 4\text{ V}$	$V_{\text{IN}} = 0\text{ V}$; $V_{\text{SENSE}} = 0\text{ V}$; V_{OUT} rising from 0 V to 4 V	-120	—	0	μA
$t_{\text{d_vol}}$	Delay response from output rising edge to V _{SENSE} rising edge in open-load	$V_{\text{IN}} = 0\text{ V}$; $V_{\text{OUT}} = 4\text{ V}$; $V_{\text{SENSE}} = 90\%$ of V_{SENSEH}		—	20	μs

Figure 4. Current sense delay characteristics

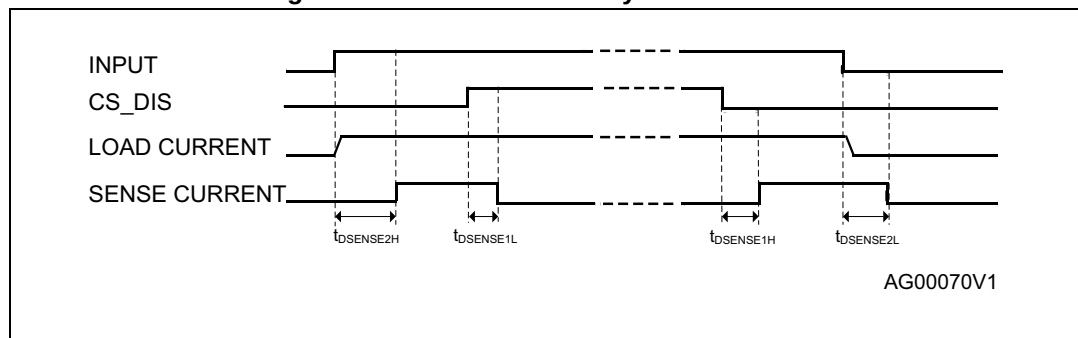


Figure 5. Open-load off-state delay timing

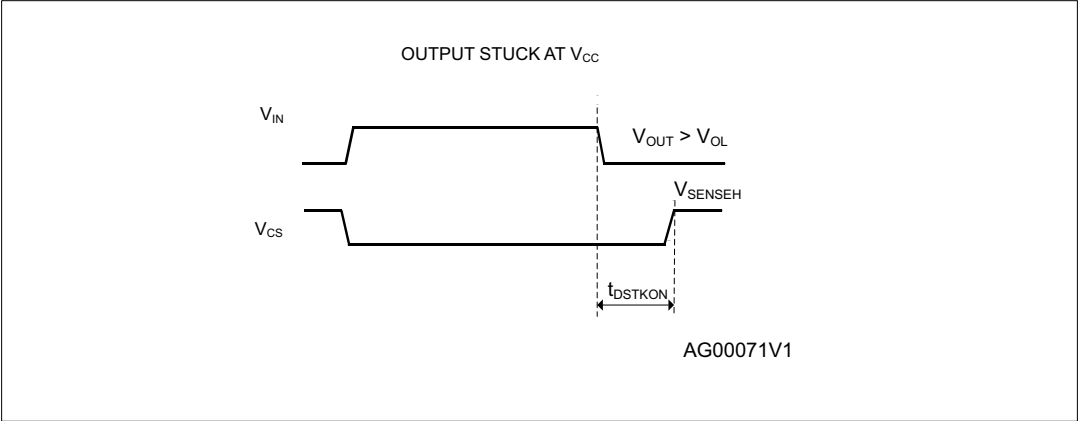


Figure 6. Switching characteristics

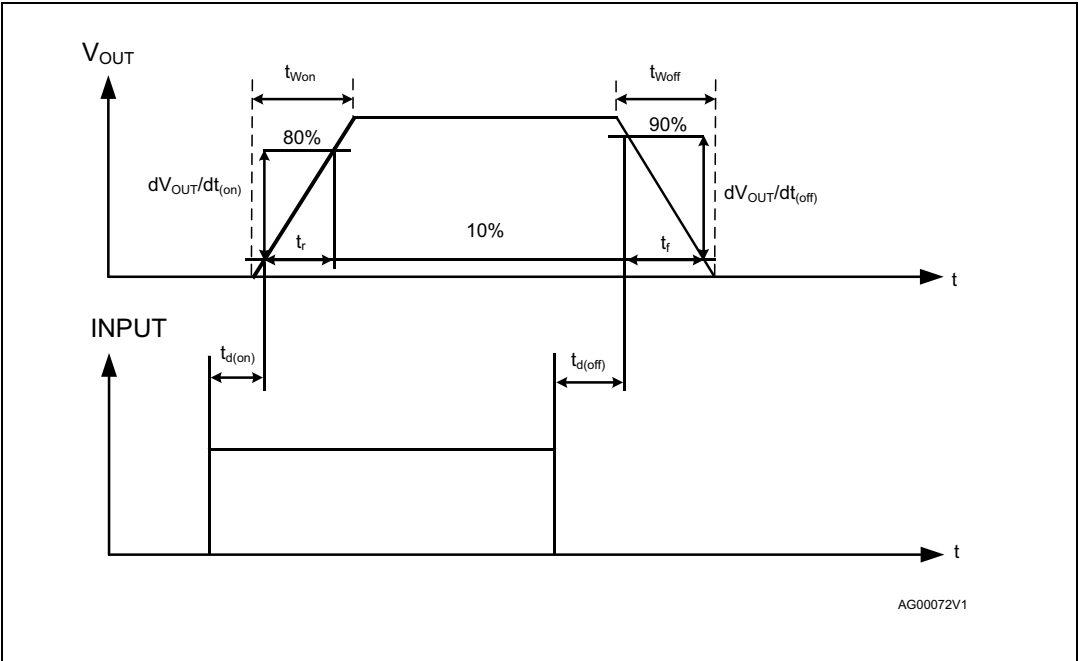


Figure 7. Delay response time between rising edge of output current and rising edge of current sense (CS enabled)

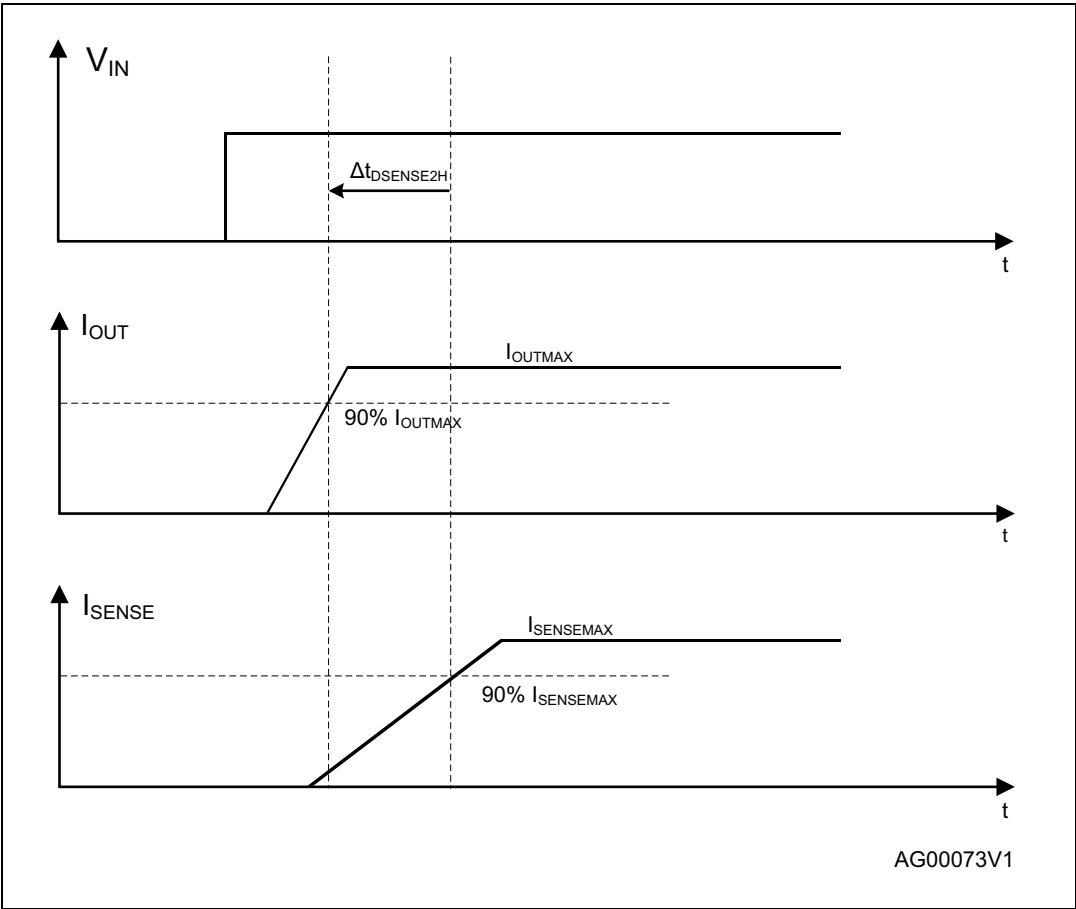


Figure 8. Output voltage drop limitation

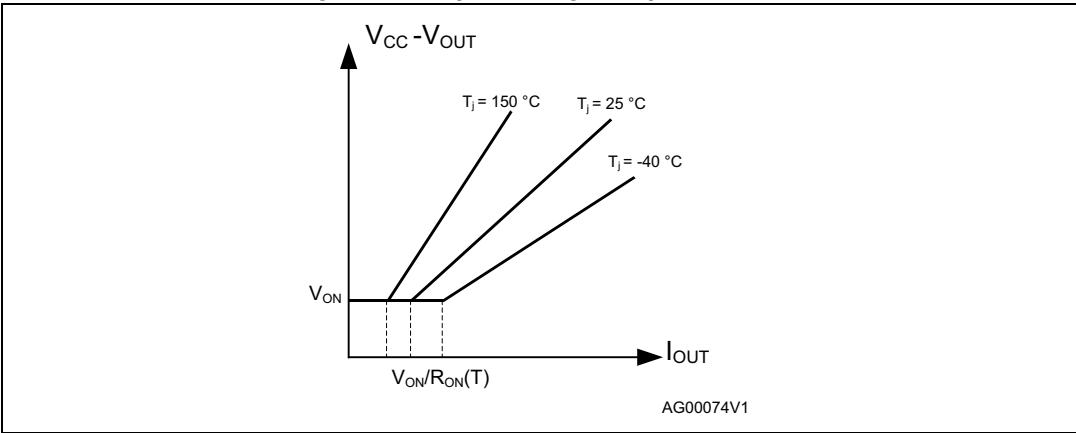


Table 11. Truth table

Conditions	Input	Output	Sense ($V_{CSD} = 0\text{ V}$) ⁽¹⁾
Normal operation	L	L	0
	H	H	Nominal
Overtemperature	L	L	0
	H	L	V_{SENSEH}
Undervoltage	L	L	0
	H	L	0
Overload	H	X (no power limitation)	Nominal
	H	Cycling (power limitation)	V_{SENSEH}
Short circuit to GND (Power limitation)	L	L	0
	H	L	V_{SENSEH}
Open-load off-state (with external pull up)	L	H	V_{SENSEH}
Short circuit to V_{CC} (external pull up disconnected)	L	H	V_{SENSEH}
	H	H	V_{SENSEH} < Nominal
Negative output voltage clamp	L	L	0

1. If the V_{CSD} is high, the SENSE output is at a high impedance, its potential depends on leakage currents and external circuit.

Table 12. Electrical transient requirements (part 1/3)

ISO 7637-2: 2004(E) Test Pulse	Test levels ⁽¹⁾		Number of pulses or test times	Burst cycle/pulse repetition time		Delays and impedance
	III	IV				
1	-75 V	-100 V	5000 pulses	0.5 s	5 s	2 ms, 10 Ω
2a	+37 V	+50 V	5000 pulses	0.2 s	5 s	50 μ s, 2 Ω
3a	-100 V	-150 V	1h	90 ms	100 ms	0.1 μ s, 50 Ω
3b	+75 V	+100 V	1h	90 ms	100 ms	0.1 μ s, 50 Ω
4	-6 V	-7 V	1 pulse			100 ms, 0.01 Ω
5b ⁽²⁾	+65 V	+87 V	1 pulse			400 ms, 2 Ω

1. The above test levels must be considered referred to $V_{CC} = 13.5$ V except for pulse 5b.
2. Valid in case of external load dump clamp: 40V maximum referred to ground. The protection strategy allows PowerMOS to be cyclically switched on during load dump, so distributing the load dump energy along the time and to transfer a part of it to the load.

Table 13. Electrical transient requirements (part 2/3)

ISO 7637-2: 2004(E) Test Pulse	Test level results ⁽¹⁾	
	III	IV
1	C	C
2a	C	C
3a	C	C
3b	C	C
4	C	C
5b ⁽²⁾⁽³⁾	C	C

1. The above test levels must be considered referred to $V_{CC} = 13.5$ V except for pulse 5b.
2. Valid in case of external load dump clamp: 40V maximum referred to ground. The protection strategy allows PowerMOS to be cyclically switched on during load dump, so distributing the load dump energy along the time and to transfer a part of it to the load.
3. Suppressed load dump (pulse 5b) is withstood with a minimum load connected as specified in [Table 3: Absolute maximum ratings](#).

Table 14. Electrical transient requirements (part 3/3)

Class	Contents
C	All functions of the device are performed as designed after exposure to disturbance.
E	One or more functions of the device are not performed as designed after exposure to disturbance and cannot be returned to proper operation without replacing the

2.4 Waveforms

Figure 9. Normal operation

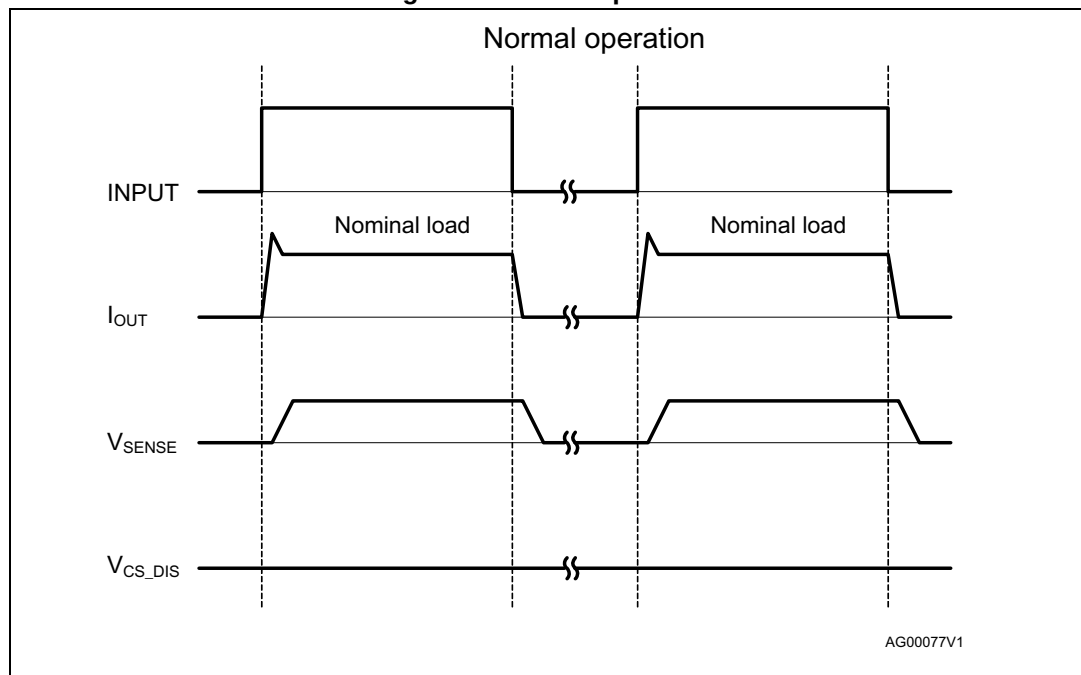


Figure 10. Overload or short to GND

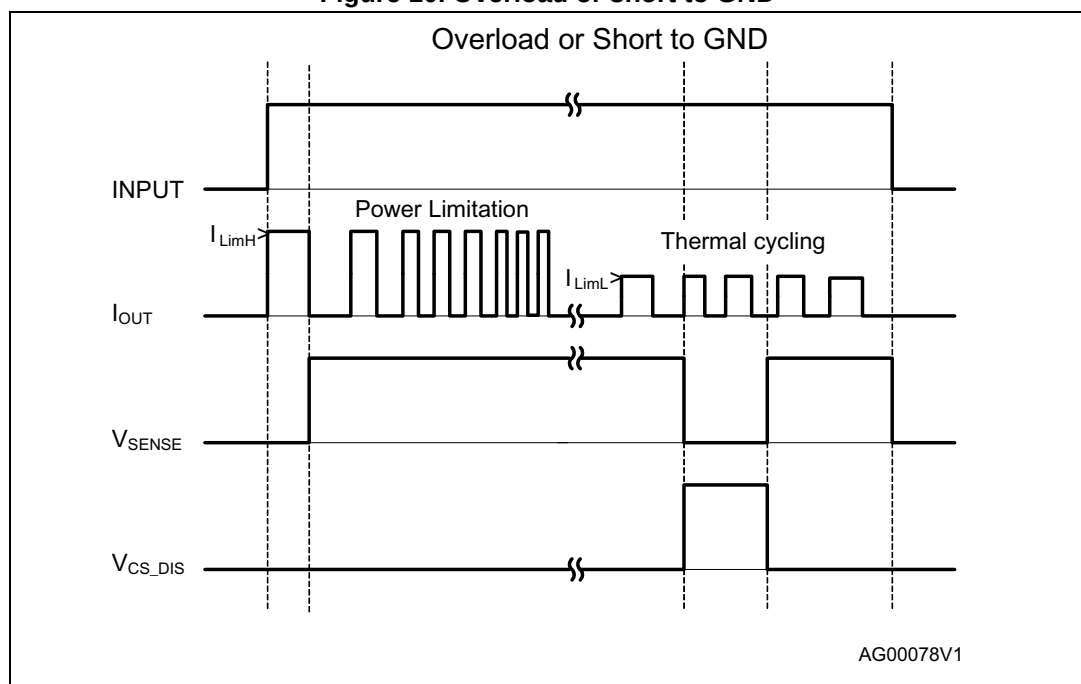


Figure 11. Intermittent overload

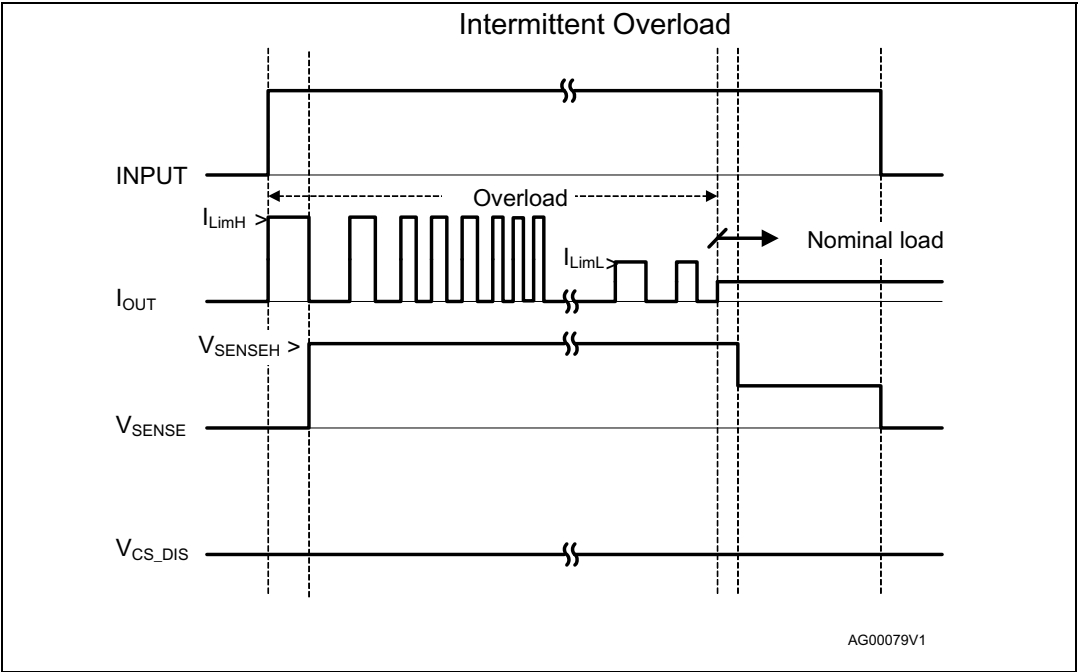


Figure 12. Off-state open-load with external circuitry

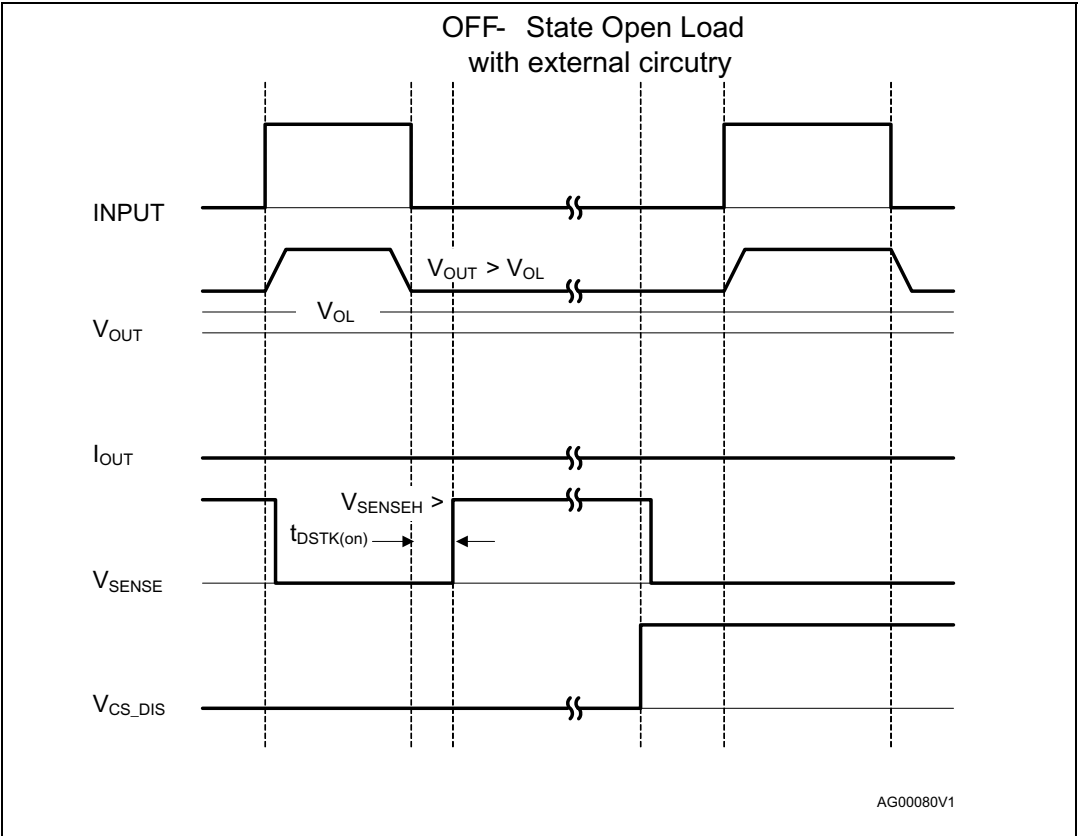


Figure 13. Short to V_{CC}

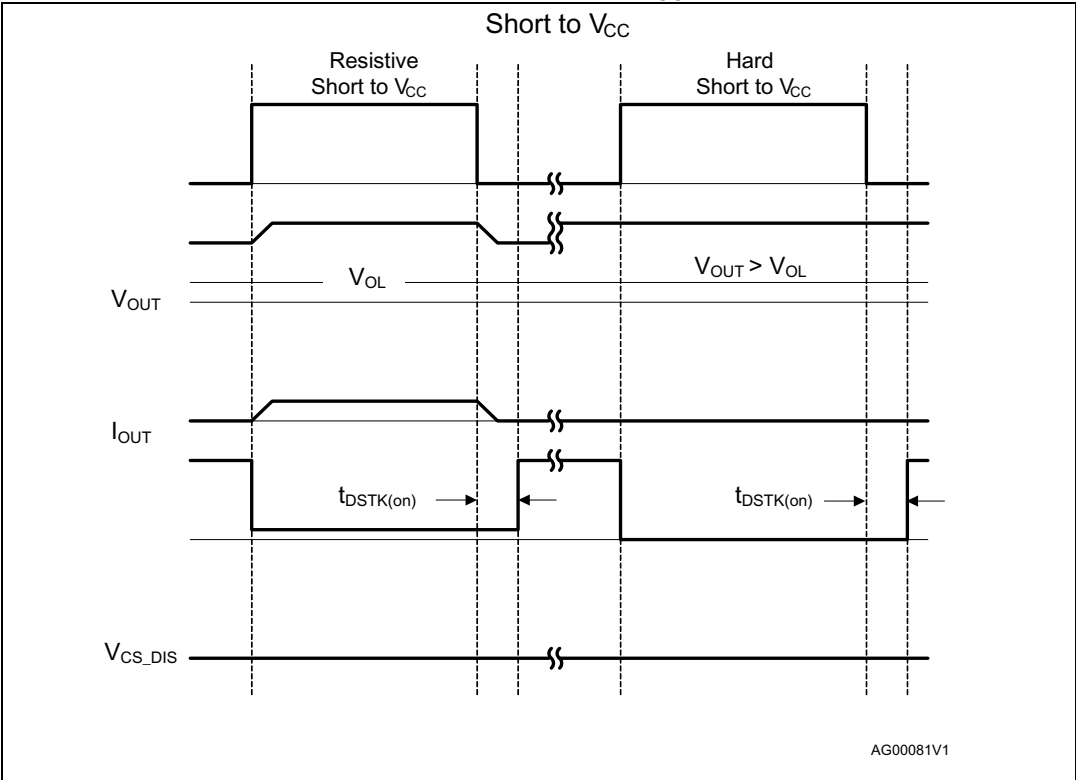
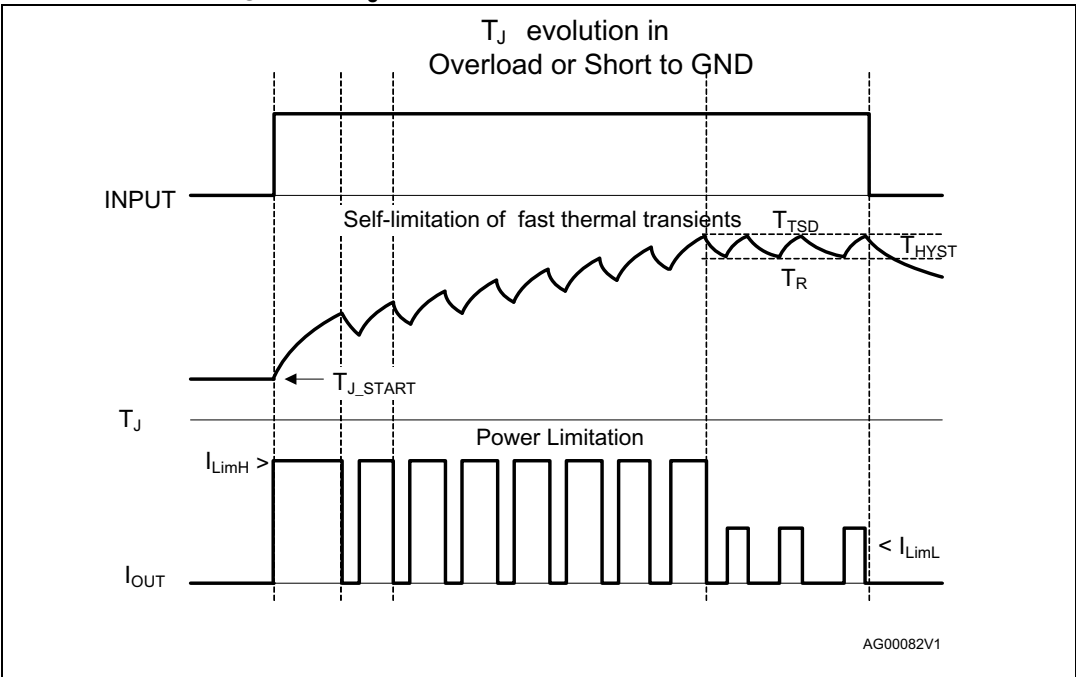
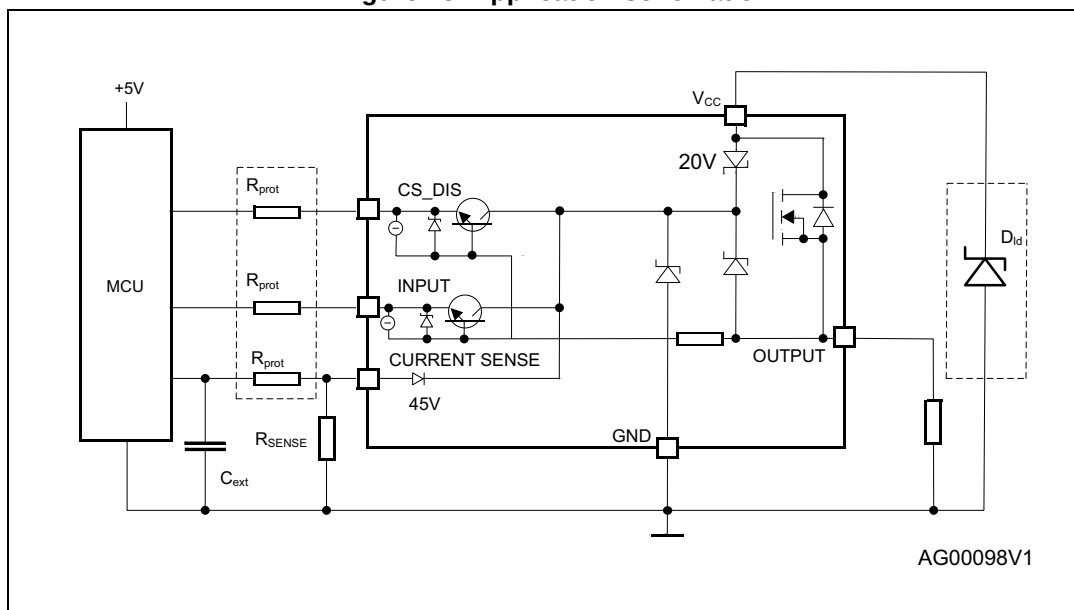


Figure 14. T_J evolution in overload or short to GND



3 Application information

Figure 15. Application schematic



Note: Channel 2 has the same internal circuit as channel 1.

3.1 Load dump protection

D_{id} is necessary (voltage transient suppressor) if the load dump peak voltage exceeds the V_{CC} max DC rating. The same applies if the device is subject to transients on the V_{CC} line that are greater than the ones shown in the ISO 7637-2 2004 (E) table.

3.2 MCU I/Os protection

When negative transients are present on the V_{CC} line, the control pins are pulled negative to approximately -1.5 V. ST suggests to insert a resistor (R_{prot}) in line to prevent the microcontroller I/O pins from latching-up.

The value of these resistors is a compromise between the leakage current of microcontroller and the current required by the HSD I/Os (Input levels compatibility) with the latch-up limit of microcontroller I/Os.

Equation 1

$$-V_{CCpeak}/I_{latchup} \leq R_{prot} \leq (V_{OH\mu C} - V_{IH}) / I_{IHmax}$$

Calculation example:

For $V_{CCpeak} = -1.5$ V and $I_{latchup} \geq 20$ mA; $V_{OH\mu C} \geq 4.5$ V

$75 \Omega \leq R_{prot} \leq 240$ k Ω .

Recommended values: $R_{prot} = 10$ k Ω , $C_{EXT} = 10$ nF.

3.3.1 Short to V_{CC} and off-state open-load detection

Short to V_{CC}

A short circuit between V_{CC} and output is indicated by the relevant current sense pin set to V_{SENSEH} during the device off-state. Small or no current is delivered by the current sense during the on-state depending on the nature of the short circuit.

Off-state open-load with external circuitry

Detection of an open-load in off mode requires an external pull-up resistor R_{PU} connecting the output to a positive supply voltage V_{PU} .

It is preferable V_{PU} to be switched off during the module standby mode in order to avoid the overall standby current consumption to increase in normal conditions, i.e. when load is connected.

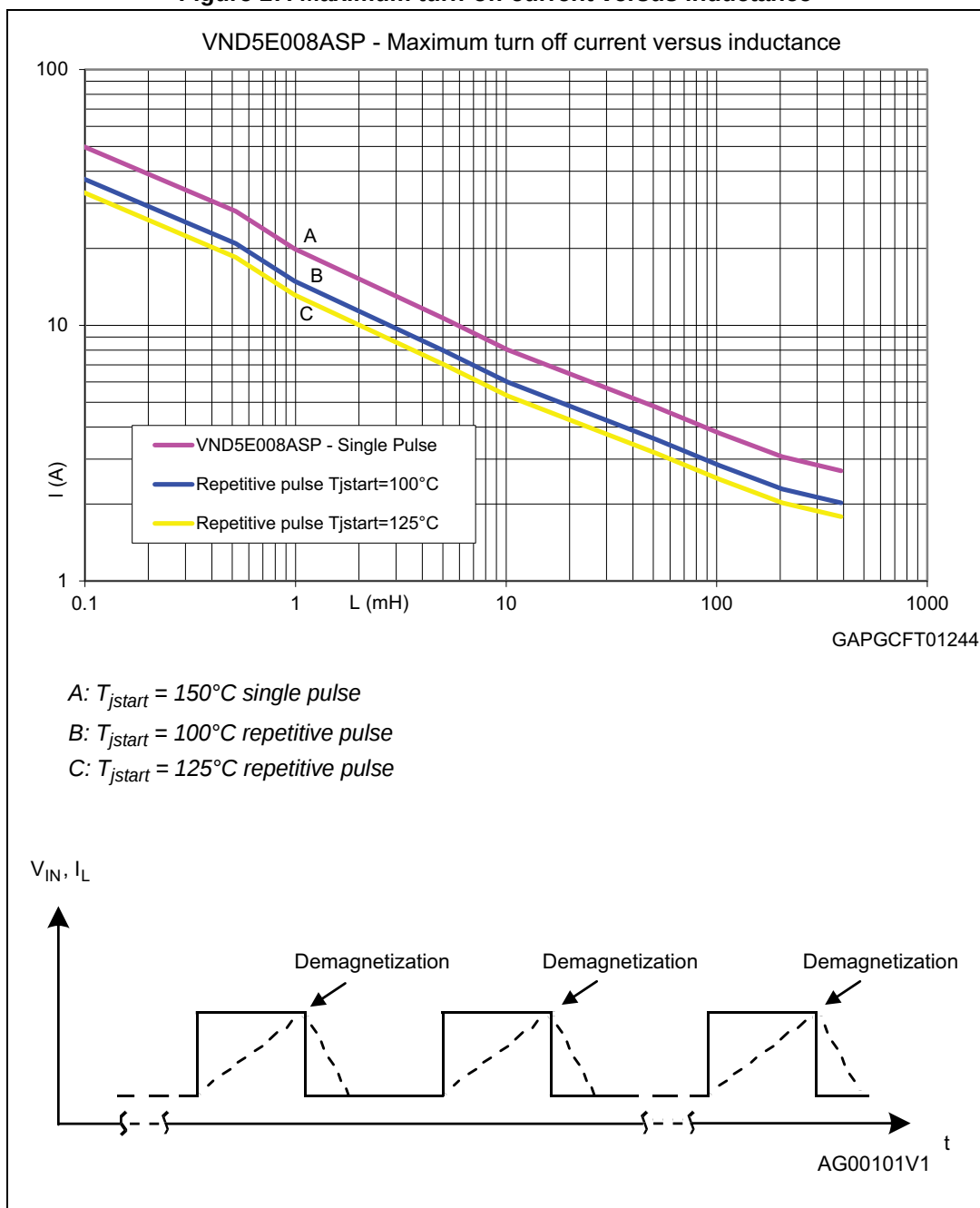
For proper open-load detection in off-state, the external pull-up resistor must be selected according to the following formula:

$$V_{OUT}|_{\text{Pull-up_ON}} = \frac{R_{PD} \cdot V_{PU} - R_{PU} \cdot R_{PD} \cdot I_{L(\text{off2})}}{R_{PU} + R_{PD}} > V_{OL\text{max}} = 4V$$

For the values of $V_{OL\text{min}}$, $V_{OL\text{max}}$, and $I_{L(\text{off2})}$ see [Table 10: Open-load detection](#) ($8V < V_{CC} < 18V$).

3.4 Maximum demagnetization energy ($V_{CC} = 16\text{ V}$)

Figure 17. Maximum turn-off current versus inductance

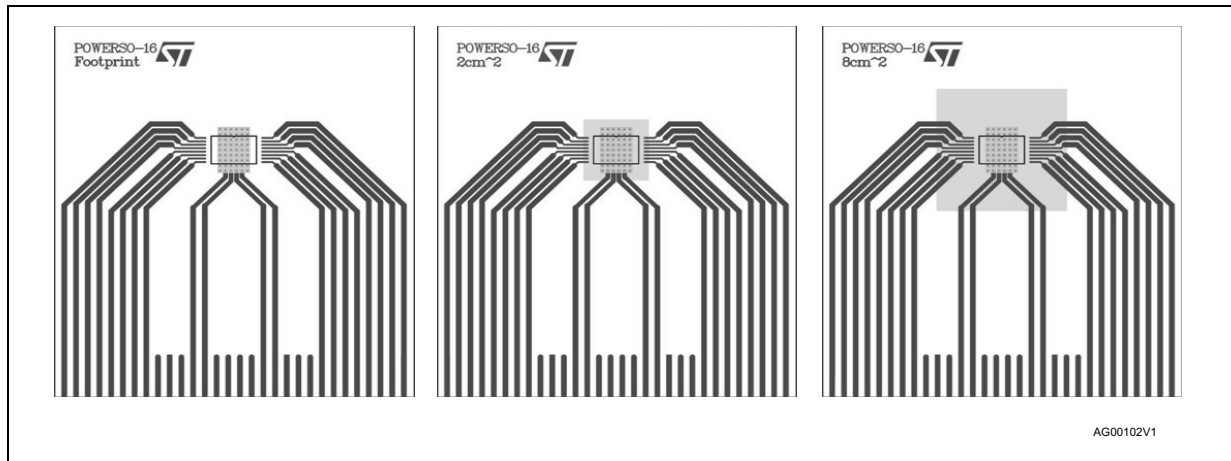


- Values are generated with $R_L = 0\ \Omega$.
In case of repetitive pulses, T_{jstart} (at the beginning of each demagnetization) of every pulse must not exceed the temperature specified above for curves A and B.

4 Package and PCB thermal data

4.1 PowerSO-16 thermal data

Figure 18. PowerSO-16 PC board



1. Layout condition of R_{th} and Z_{th} measurements (Board finish thickness 1.6 mm $\pm$ 10%; Board double layer; Board dimension 77 mm x 86 mm; Board Material FR4; Cu thickness 0.070 mm (front and back side); Thermal vias separation 1.2 mm; Thermal via diameter 0.3 mm $\pm$ 0.08 mm; Cu thickness on vias 0.025 mm).

Figure 19. $R_{thj-amb}$ vs PCB copper area in open box free air condition (one channel ON)

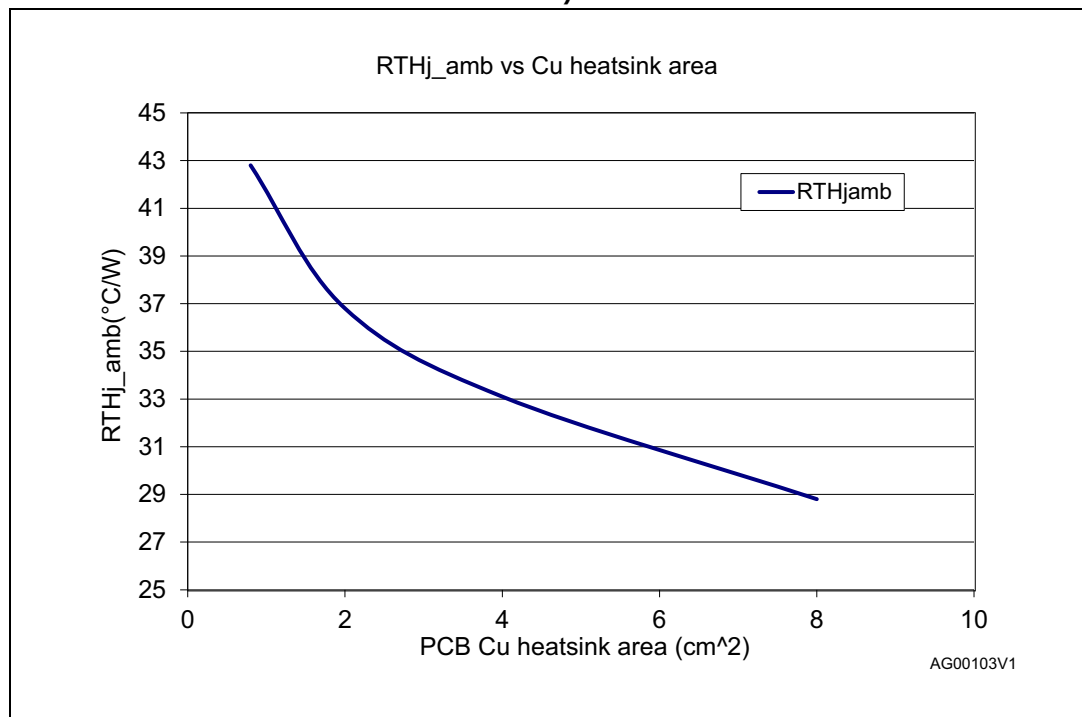


Figure 20. PowerSO-16 thermal impedance junction ambient single pulse (one channel ON)

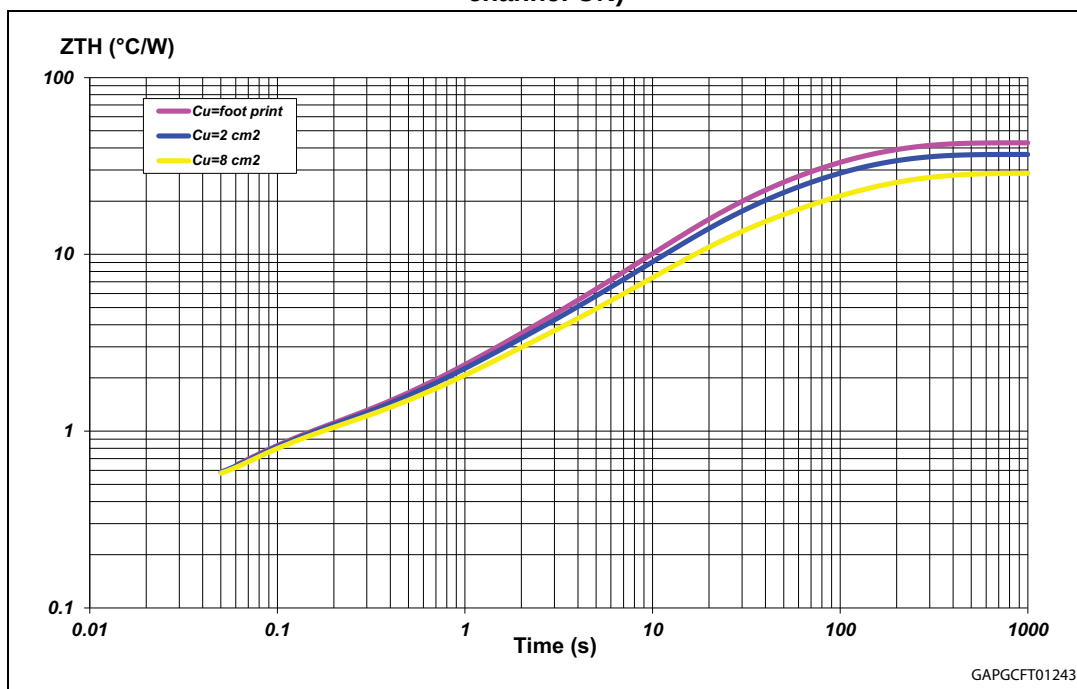
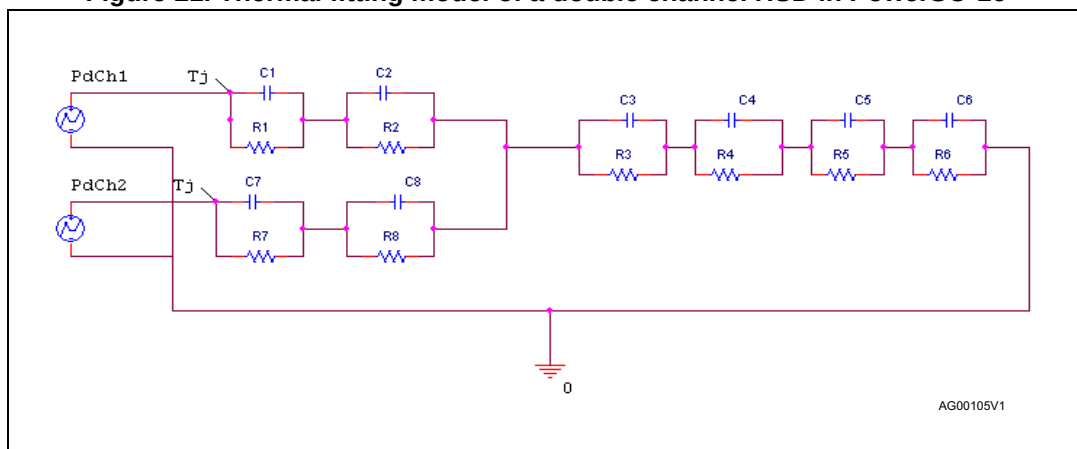


Figure 21. Thermal fitting model of a double channel HSD in PowerSO-16



1. The fitting model is a simplified thermal tool and is valid for transient evolutions where the embedded protections (power limitation or thermal cycling during thermal shutdown) are not triggered.

Equation 2: pulse calculation formula

$$Z_{TH\delta} = R_{TH} \cdot \delta + Z_{THtp}(1 - \delta)$$

where $\delta = t_p/T$

Table 15. Thermal parameters

Area/island (cm ²)	Footprint	2	8
R1=R7 (°C/W)	0.15		
R2=R8 (°C/W)	0.6		
R3 (°C/W)	1		
R4 (°C/W)	7		
R5 (°C/W)	12	10	8
R6 (°C/W)	22	18	12
C1=C7 (W.s/°C)	0.008		
C2=C8 (W.s/°C)	0.1		
C3 (W.s/°C)	1		
C4 (W.s/°C)	2		
C5 (W.s/°C)	3	4	7
C6 (W.s/°C)	5	6	12

5 Package information

5.1 ECOPACK® packages

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.

5.2 PowerSO-16 mechanical data

Figure 22. PowerSO-16 package dimensions

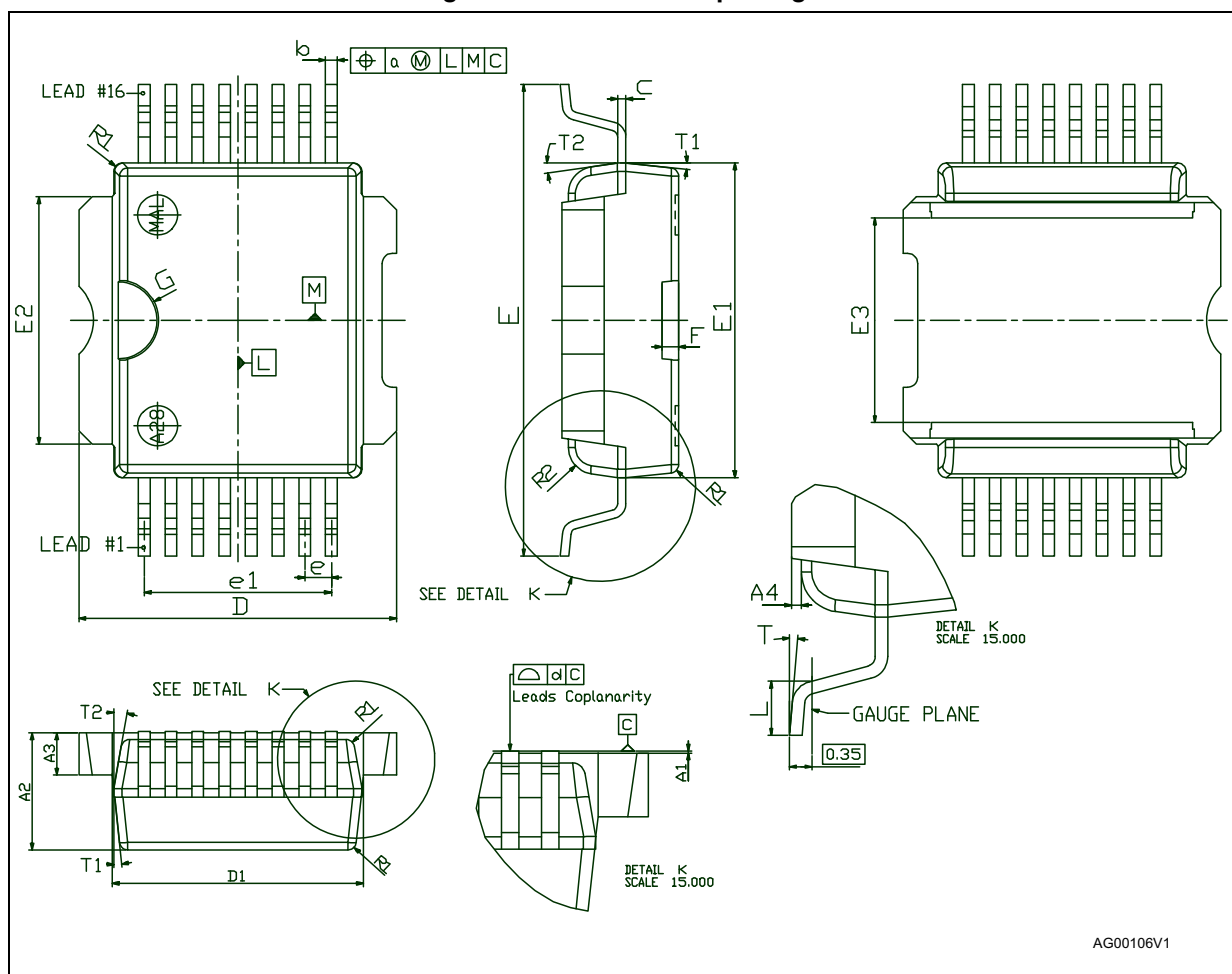


Table 16. PowerSO-16 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A1	0	0.05	0.1
A2	3.4	3.5	3.6
A3	1.2	1.3	1.4
A4	0.15	0.2	0.25
a		0.2	
b	0.27	0.35	0.43
c	0.23	0.27	0.32
D	9.4	9.5	9.6
D1	7.4	7.5	7.6
d	0	0.05	0.1
E (1)	13.85	14.1	14.35
E1	9.3	9.4	9.5
E2	7.3	7.4	7.5
E3	5.9	6.1	6.3
e		0.8	
e1		5.6	
F		0.5	
G		1.2	
L	0.8	1	1.1
R1			0.25
R2		0.8	
T	2°	5°	8°
T1	6° (typ.)		
T2	10° (typ.)		

5.3 Packing information

Figure 23. PowerSO-16 tube shipment (no suffix)

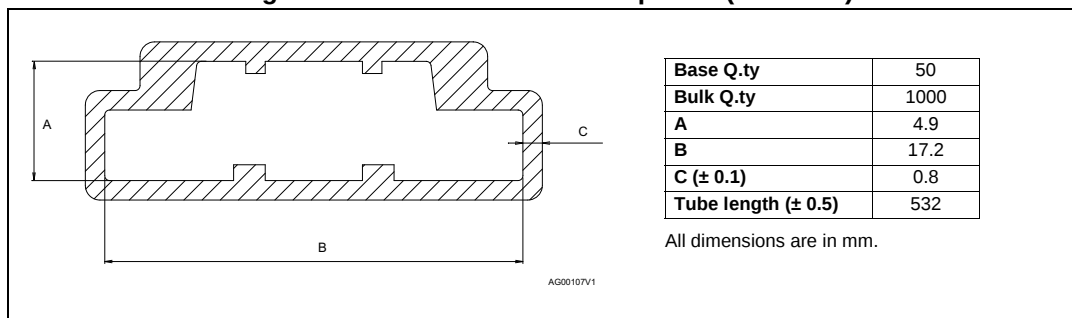


Figure 24. PowerSO-16 tape and reel shipment (suffix "TR")

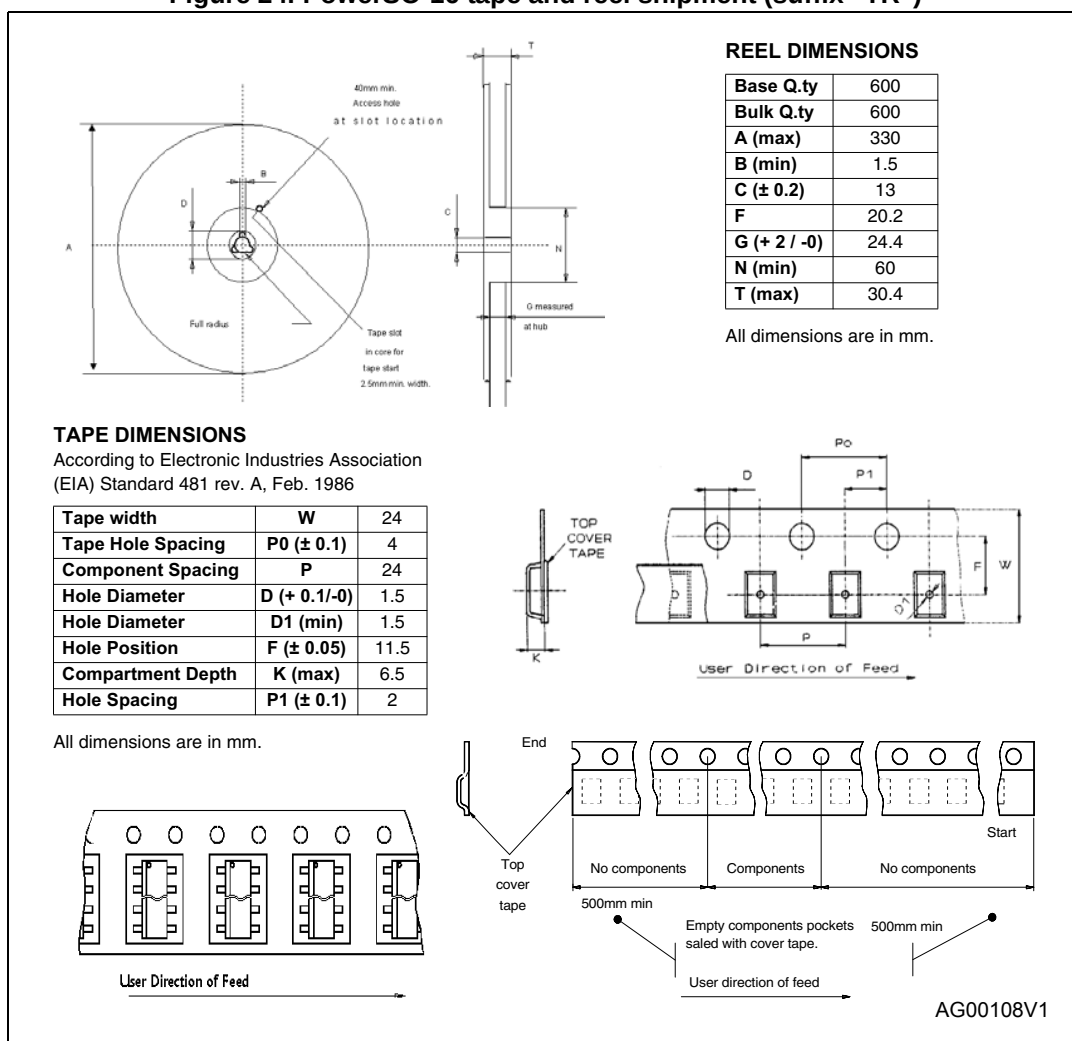
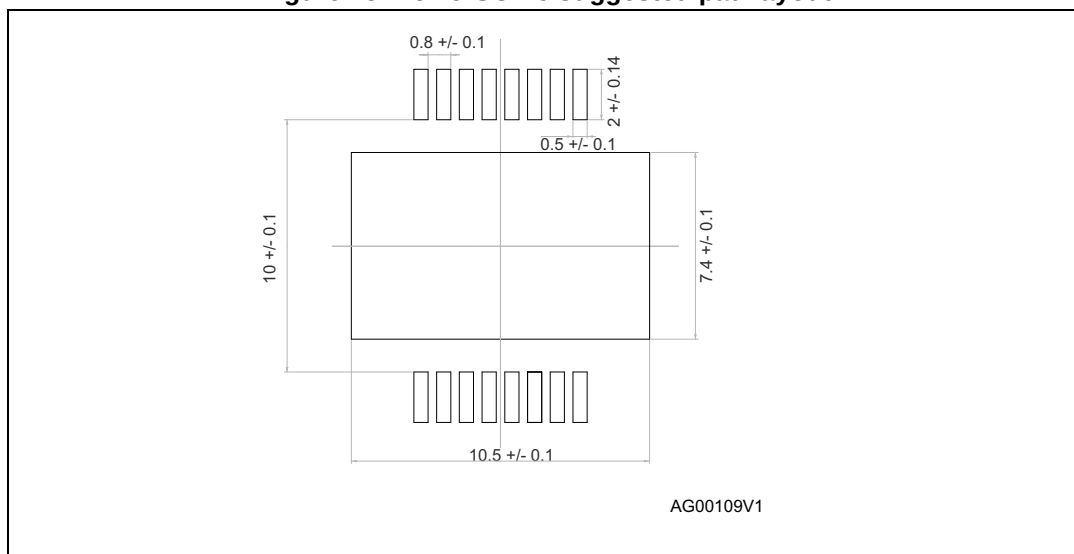


Figure 25. PowerSO-16 suggested pad layout



6 Order codes

Table 17. Device summary

Package	Order codes	
	Tube	Tape and reel
PowerSO-16	VND5E008ASP-E	VND5E008ASPTR-E

7 Revision history

Table 18. Document revision history

Date	Revision	Changes
19-Oct-2012	1	Initial release.
04-Apr-2013	2	Table 3: Absolute maximum ratings: – E_{MAX}: updated parameter and value Table 4: Thermal data: – $R_{thj-case}$: updated value Table 5: Power section: – R_{ON}, I_S: updated values Updated Table 6: Switching ($V_{CC} = 13\text{ V}$; $T_j = 25\text{ °C}$) Table 9: Current sense ($8\text{ V} < V_{CC} < 18\text{ V}$): – dK_1/K_1, K_2, dK_2/K_2, K_3, dK_3/K_3, $t_{DSENSE2H}$, $t_{DSENSE2L}$: updated values Table 10: Open-load detection ($8\text{ V} < V_{CC} < 18\text{ V}$): – I_{OL}: updated values Added Section 3.4: Maximum demagnetization energy ($V_{CC} = 16\text{ V}$) Updated Chapter 4: Package and PCB thermal data
17-Sep-2013	3	Updated disclaimer.
24-Oct-2013	4	Updated footnote 2 into the Table 12: Electrical transient requirements (part 1/3) and Table 13: Electrical transient requirements (part 2/3) .

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