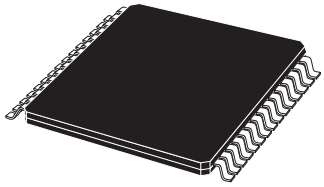
VNH2SP30-E

Automotive fully integrated H-bridge motor driver

Features

Type	$R_{DS(on)}$	I_{out}	V_{ccmax}
VNH2SP30-E	19mΩ max (per leg)	30A	41V

- Output current: 30A
- 5V logic level compatible inputs
- Undervoltage and overvoltage shut-down
- Overvoltage clamp
- Thermal shut down
- Cross-conduction protection
- Linear current limiter
- Very low stand-by power consumption
- PWM operation up to 20 kHz
- Protection against loss of ground and loss of V_{CC}
- Current sense output proportional to motor current
- Package: ECOPACK®



MultiPowerSO-30

Description

The VNH2SP30-E is a full bridge motor driver intended for a wide range of automotive applications. The device incorporates a dual monolithic high side driver and two low side switches. The high side driver switch is designed using STMicroelectronic's well known and proven proprietary VIPower™ M0 technology which permits efficient integration on the same die of a true Power MOSFET with an intelligent signal/protection circuitry.

The low side switches are vertical MOSFETs manufactured using STMicroelectronic's proprietary EHD ('STripFET™') process.

The three die are assembled in the MultiPowerSO-30 package on electrically isolated leadframes. This package, specifically designed for the harsh automotive environment offers improved thermal performance thanks to exposed die pads. Moreover, its fully symmetrical mechanical design allows superior manufacturability at board level. The input signals IN_A and IN_B can directly interface to the microcontroller to select the motor direction and the brake condition. The $DIAG_A/EN_A$ or $DIAG_B/EN_B$, when connected to an external pull-up resistor, enable one leg of the bridge. They also provide a feedback digital diagnostic signal. The normal condition operation is explained in *Table 11 on page 12*. The motor current can be monitored with the CS pin by delivering a current proportional to its value. The speed of the motor can be controlled in all possible conditions by the PWM up to 20 kHz. In all cases, a low level state on the PWM pin will turn off both the LS_A and LS_B switches. When PWM rises to a high level, LS_A or LS_B turn on again depending on the input pin state.

Order codes

Package	Tube	Tape and Reel
MultiPowerSO-30	VNH2SP30-E	VNH2SP30TR-E

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1 Device block description

Figure 1. Block diagram

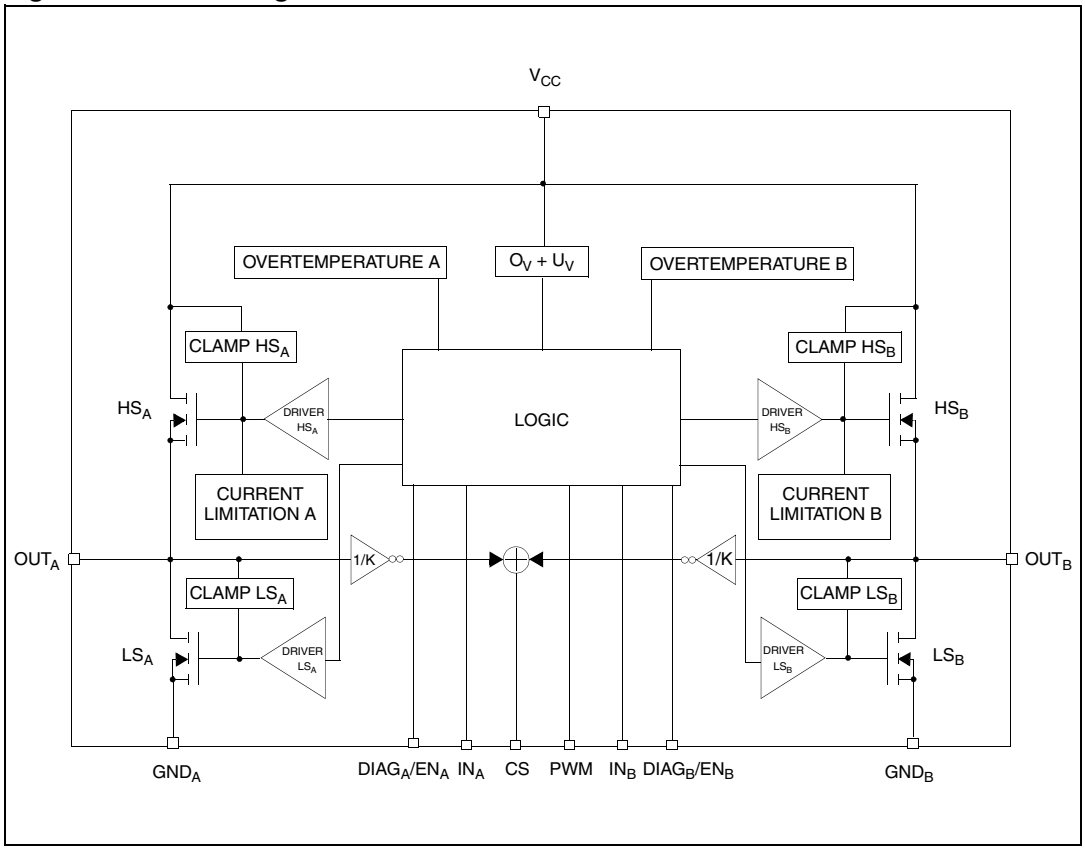


Table 1. Block description

Name	Description
Logic control	Allows the turn-on and the turn-off of the high side and the low side switches according to the truth table
Overvoltage + undervoltage	Shuts down the device outside the range [5.5V..16V] for the battery voltage
High side and low side clamp voltage	Protects the high side and the low side switches from the high voltage on the battery line in all configurations for the motor
High side and low side driver	Drives the gate of the concerned switch to allow a proper $R_{DS(on)}$ for the leg of the bridge
Linear current limiter	Limits the motor current by reducing the high side switch gate-source voltage when short-circuit to ground occurs
Overtemperature protection	In case of short-circuit with the increase of the junction's temperature, shuts down the concerned high side to prevent its degradation and to protect the die
Fault detection	Signals an abnormal behavior of the switches in the half-bridge A or B by pulling low the concerned $EN_x/DIAG_x$ pin

2 Pin-out description

Figure 2. Configuration diagram (top view)

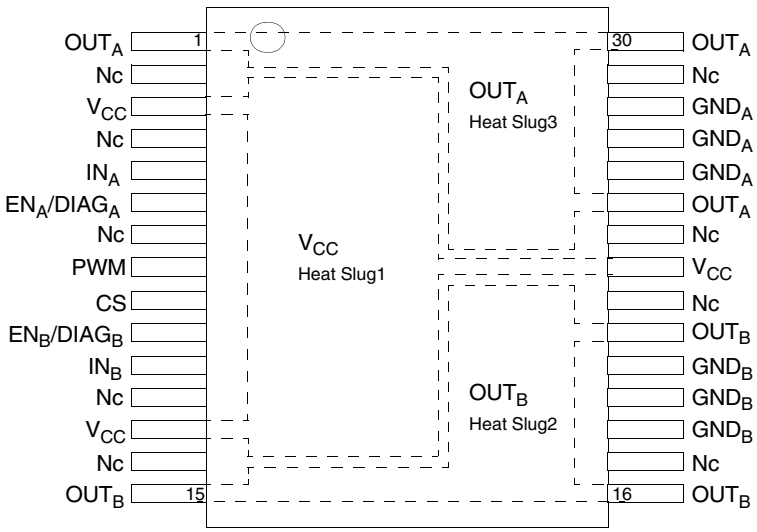


Table 2. Pin definitions and functions

Pin No	Symbol	Function
1, 25, 30	OUT_A, Heat Slug2	Source of high side switch A / Drain of low side switch A
2, 4, 7, 12, 14, 17, 22, 24, 29	NC	Not connected
3, 13, 23	V_{CC}, Heat Slug1	Drain of high side switches and power supply voltage
6	$EN_A/DIAG_A$	Status of high side and low side switches A; open drain output
5	IN_A	Clockwise input
8	PWM	PWM input
9	CS	Output of current sense
11	IN_B	Counter clockwise input
10	$EN_B/DIAG_B$	Status of high side and low side switches B; open drain output
15, 16, 21	OUT_B, Heat Slug3	Source of high side switch B / Drain of low side switch B
26, 27, 28	GND_A	Source of low side switch A(1)
18, 19, 20	GND_B	Source of low side switch B(1)

1. GND_A and GND_B must be externally connected together.

Table 3. Pin functions description

Name	Description
V_{CC}	Battery connection
GND_A, GND_B	Power grounds; must always be externally connected together

Table 3. Pin functions description (continued)

Name	Description
OUT_A, OUT_B	Power connections to the motor
IN_A, IN_B	Voltage controlled input pins with hysteresis, CMOS compatible. These two pins control the state of the bridge in normal operation according to the truth table (brake to V_{CC}, brake to GND, clockwise and counterclockwise).
PWM	Voltage controlled input pin with hysteresis, CMOS compatible. Gates of low side FETs are modulated by the PWM signal during their ON phase allowing speed control of the motor.
$EN_A/DIAG_A$, $EN_B/DIAG_B$	Open drain bidirectional logic pins. These pins must be connected to an external pull up resistor. When externally pulled low, they disable half-bridge A or B. In case of fault detection (thermal shutdown of a high side FET or excessive ON state voltage drop across a low side FET), these pins are pulled low by the device (see truth table in fault condition).
CS	Analog current sense output. This output sources a current proportional to the motor current. The information can be read back as an analog voltage across an external resistor.

3 Electrical characteristics

V_{CC} = 9V up to 16V; -40°C < T_j < 150°C, unless otherwise specified.

Table 4. Power

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{CC}	Operating supply voltage		5.5		16	V
I_S	Supply current	Off state: IN_A = IN_B = PWM = 0; T_j = 25°C; V_{CC} = 13V IN_A = IN_B = PWM = 0		12	30 60	µA µA
		On state: IN_A or IN_B = 5V, no PWM			10	mA
R_{ONHS}	Static high side resistance	I_{OUT} = 15A; T_j = 25°C			14	mΩ
		I_{OUT} = 15A; T_j = -40 to 150°C			28	
R_{ONLS}	Static low side resistance	I_{OUT} = 15A; T_j = 25°C			5	
		I_{OUT} = 15A; T_j = -40 to 150°C			10	
V_f	High side free-wheeling diode forward voltage	I_f = 15A		0.8	1.1	V
$I_{L(off)}$	High side off state output current (per channel)	T_j = 25°C; V_{OUTX} = EN_X = 0V; V_{CC} = 13V			3	µA
		T_j = 125°C; V_{OUTX} = EN_X = 0V; V_{CC} = 13V			5	
I_{RM}	Dynamic cross-conduction current	I_{OUT} = 15A (see *Figure 9*)		0.7		A

Table 5. Logic inputs (IN_A, IN_B, EN_A, EN_B)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IL}	Input low level voltage	Normal operation ($DIAG_X$/EN_X pin acts as an input pin)			1.25	V
V_{IH}	Input high level voltage		3.25			
V_{IHYST}	Input hysteresis voltage		0.5			
V_{ICL}	Input clamp voltage	I_{IN} = 1mA	5.5	6.3	7.5	
		I_{IN} = -1mA	-1.0	-0.7	-0.3	
I_{INL}	Input low current	V_{IN} = 1.25V	1			µA
I_{INH}	Input high current	V_{IN} = 3.25V			10	
V_{DIAG}	Enable output low level voltage	Fault operation ($DIAG_X$/EN_X pin acts as an output pin); I_{EN} = 1mA			0.4	V

Table 6. PWM

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{pwl}	PWM low level voltage				1.25	V
I_{pwl}	PWM pin current	V_{pw} = 1.25V	1			µA
V_{pwh}	PWM high level voltage		3.25			V
I_{pwh}	PWM pin current	V_{pw} = 3.25V			10	µA
$V_{pwhhyst}$	PWM hysteresis voltage		0.5			V
V_{pwcl}	PWM clamp voltage	I_{pw} = 1mA	V_{CC} + 0.3	V_{CC} + 0.7	V_{CC} + 1.0	
		I_{pw} = -1mA	-6.0	-4.5	-3.0	
C_{INPWM}	PWM pin input capacitance	V_{IN} = 2.5V			25	pF

Table 7. Switching (V_{CC} = 13V, R_{LOAD} = 0.87W, unless otherwise specified)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
f	PWM frequency		0		20	kHz
$t_{d(on)}$	Turn-on delay time	Input rise time < 1µs (see *Figure 7*)			250	µs
$t_{d(off)}$	Turn-off delay time	Input rise time < 1µs (see *Figure 7*)			250	
t_r	Rise time	(see *Figure 6*)		1	1.6	
t_f	Fall time	(see *Figure 6*)		1.2	2.4	
t_{DEL}	Delay time during change of operating mode	(see *Figure 5*)	300	600	1800	
t_{rr}	High side free wheeling diode reverse recovery time	(see *Figure 8*)		110		ns
$t_{off(min)}$ (1)	PWM minimum off time	9V < V_{CC} < 16V; T_j = 25°C; L = 250µH; I_{OUT} = 15A			6	µs

1. To avoid false Short to Battery detection during PWM operation, the PWM signal must be low for a time longer than 6µs.

Table 8. Protection and diagnostic

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{USD}	Undervoltage shut-down				5.5	V
	Undervoltage reset			4.7		
V_{OV}	Overvoltage shut-down		16	19	22	
I_{LIM}	High side current limitation		30	50	70	A
V_{CLP}	Total clamp voltage (V_{CC} to GND)	I_{OUT} = 15A	43	48	54	V
T_{TSD}	Thermal shut-down temperature	V_{IN} = 3.25V	150	175	200	°C
T_{TR}	Thermal reset temperature		135			
T_{HYST}	Thermal hysteresis		7	15		

Table 9. Current sense (9V < V_{CC} < 16V)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
K_1	I_{OUT}/I_{SENSE}	I_{OUT} = 30A; R_{SENSE} = 1.5kW; T_j = -40 to 150°C	9665	11370	13075	
K_2	I_{OUT}/I_{SENSE}	I_{OUT} = 8A; R_{SENSE} = 1.5kW; T_j = -40 to 150°C	9096	11370	13644	
dK_1 / K_1 (1)	Analog sense current drift	I_{OUT} = 30A; R_{SENSE} = 1.5kW; T_j = -40 to 150°C	-8		+8	%
dK_2 / K_2 (1)	Analog sense current drift	I_{OUT} > 8A; R_{SENSE} = 1.5kW; T_j = -40 to 150°C	-10		+10	
I_{SENSEO}	Analog sense leakage current	I_{OUT} = 0A; V_{SENSE} = 0V; T_j = -40 to 150°C	0		65	µA

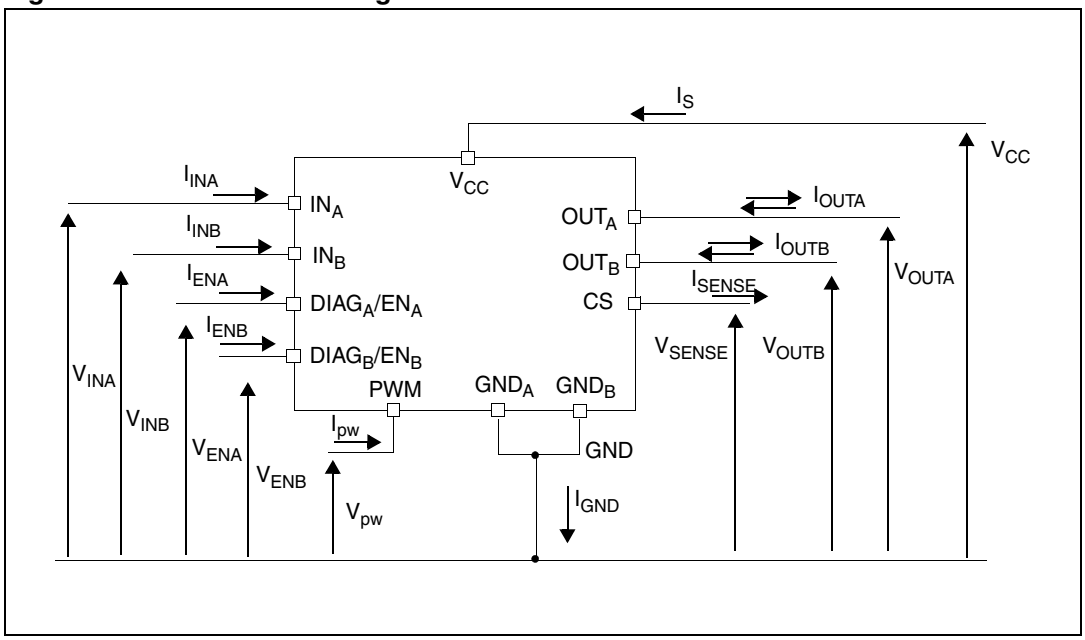
1. Analog sense current drift is deviation of factor K for a given device over (-40°C to 150°C and 9V < V_{CC} < 16V) with respect to its value measured at T_j = 25°C, V_{CC} = 13V.

3.1 Maximum ratings

Table 10. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	+41	V
I_{max}	Maximum output current (continuous)	30	A
I_R	Reverse output current (continuous)	-30	
I_{IN}	Input current (IN_A and IN_B pins)	±10	mA
I_{EN}	Enable input current ($DIAG_A/EN_A$ and $DIAG_B/EN_B$ pins)	±10	
I_{pw}	PWM input current	±10	
V_{CS}	Current sense maximum voltage	-3/+15	V
V_{ESD}	Electrostatic discharge (R = 1.5kΩ, C = 100pF) – CS pin – logic pins – output pins: OUT_A, OUT_B, V_{CC}	 2 4 5	 kV kV kV
T_j	Junction operating temperature	Internally limited	°C
T_c	Case operating temperature	-40 to 150	
T_{STG}	Storage temperature	-55 to 150	

Figure 3. Current and voltage conventions



4 Waveforms and truth table

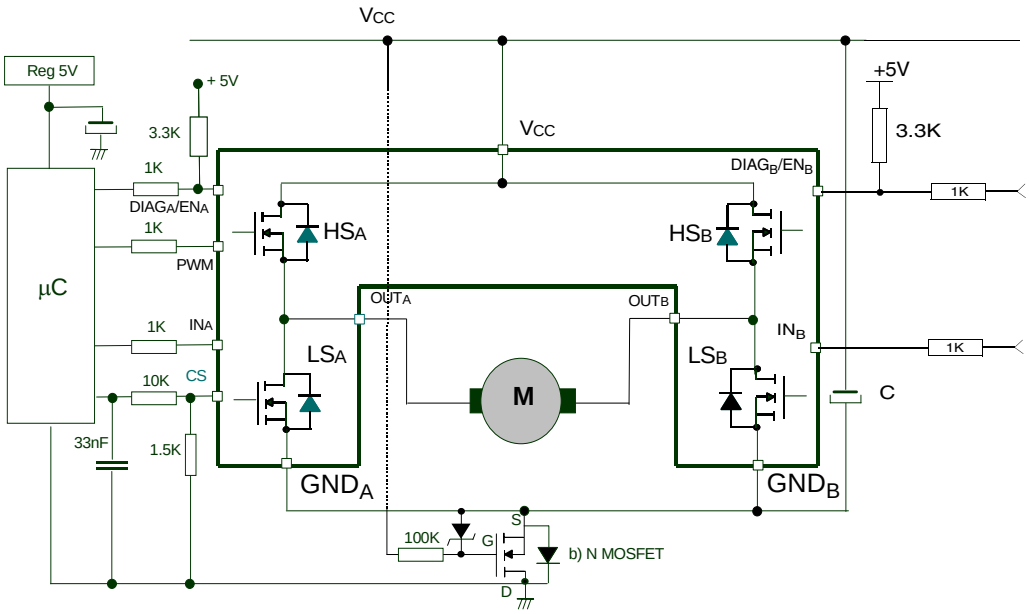
In normal operating conditions the $DIAG_X/EN_X$ pin is considered as an input pin by the device. This pin must be externally pulled high.

PWM pin usage: In all cases, a “0” on the PWM pin will turn off both LS_A and LS_B switches. When PWM rises back to “1”, LS_A or LS_B turn on again depending on the input pin state.

Table 11. Truth table in normal operating conditions

IN_A	IN_B	$DIAG_A/EN_A$	$DIAG_B/EN_B$	OUT_A	OUT_B	CS	Operating mode
1	1	1	1	H	H	High Imp.	Brake to V_{CC}
	0				L	$I_{SENSE} = I_{OUT}/K$	Clockwise (CW)
0	1			L	H		Counterclockwise (CCW)
	0				L	High Imp.	Brake to GND

Figure 4. Typical application circuit for DC to 20 kHz PWM operation short circuit protection



The value of the blocking capacitor (C) depends on the application conditions and defines voltage and current ripple onto supply line at PWM operation. Stored energy of the motor inductance may fly back into the blocking capacitor, if the bridge driver goes into tri-state. This causes a hazardous overvoltage if the capacitor is not big enough. As basic orientation, 500µF per 10A load current is recommended.

In case of a fault condition the $DIAG_X/EN_X$ pin is considered as an output pin by the device.

The fault conditions are:

- overtemperature on one or both high sides
- short to battery condition on the output (saturation detection on the low side power MOSFET)

Possible origins of fault conditions may be:

- OUT_A is shorted to ground → overtemperature detection on high side A.
- OUT_A is shorted to V_{CC} → low side power MOSFET saturation detection.

When a fault condition is detected, the user can know which power element is in fault by monitoring the IN_A, IN_B, $DIAG_A/EN_A$ and $DIAG_B/EN_B$ pins.

In any case, when a fault is detected, the faulty leg of the bridge is latched off. To turn on the respective output (OUT_X) again, the input signal must rise from low to high level.

Table 12. Truth table in fault conditions (detected on OUT_A)

IN_A	IN_B	$DIAG_A/EN_A$	$DIAG_B/EN_B$	OUT_A	OUT_B	CS
1	1	0	1	OPEN	H	High Imp.
	0				L	
0	1				H	I_{OUTB}/K
	0				L	High Imp.
X	X		0		OPEN	
	1		1		H	I_{OUTB}/K
	0				L	High Imp.
		Fault Information		Protection Action		

Note: Notice that saturation detection on the low side power MOSFET is possible only if the impedance of the short-circuit from the output to the battery is less than 100mΩ when the device is supplied with a battery voltage of 13.5V.

Table 13. Electrical transient requirements

ISO T/R - 7637/1 Test Pulse	Test Level I	Test Level II	Test Level III	Test Level IV	Test Levels Delays and Impedance
1	-25V	-50V	-75V	-100V	2ms, 10Ω
2	+25V	+50V	+75V	+100V	0.2ms, 10Ω
3a	-25V	-50V	-100V	-150V	0.1µs, 50Ω
3b	+25V	+50V	+75V	+100V	
4	-4V	-5V	-6V	-7V	100ms, 0.01Ω
5	+26.5V	+46.5V	+66.5V	+86.5V	400ms, 2Ω

ISO T/R - 7637/1 Test Pulse	Test Levels Result I	Test Levels Result II	Test Levels Result III	Test Levels Result IV
1	C	C	C	C
2				
3a				
3b				
4				
5		E	E	E

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 device.

Reverse battery protection

Three possible solutions can be considered:

1. a Schottky diode D connected to V_{CC} pin
2. an N-channel MOSFET connected to the GND pin (see *Figure 4: Typical application circuit for DC to 20 kHz PWM operation short circuit protection on page 12*)
3. a P-channel MOSFET connected to the V_{CC} pin

The device sustains no more than -30A in reverse battery conditions because of the two body diodes of the power MOSFETs. Additionally, in reverse battery condition the I/Os of VNH2SP30-E will be pulled down to the V_{CC} line (approximately -1.5V). A series resistor must be inserted to limit the current sunk from the microcontroller I/Os. If I_{Rmax} is the maximum target reverse current through µC I/Os, the series resistor is:

$$R = \frac{V_{IOs} - V_{CC}}{I_{Rmax}}$$

Figure 5. Definition of the delay times measurement

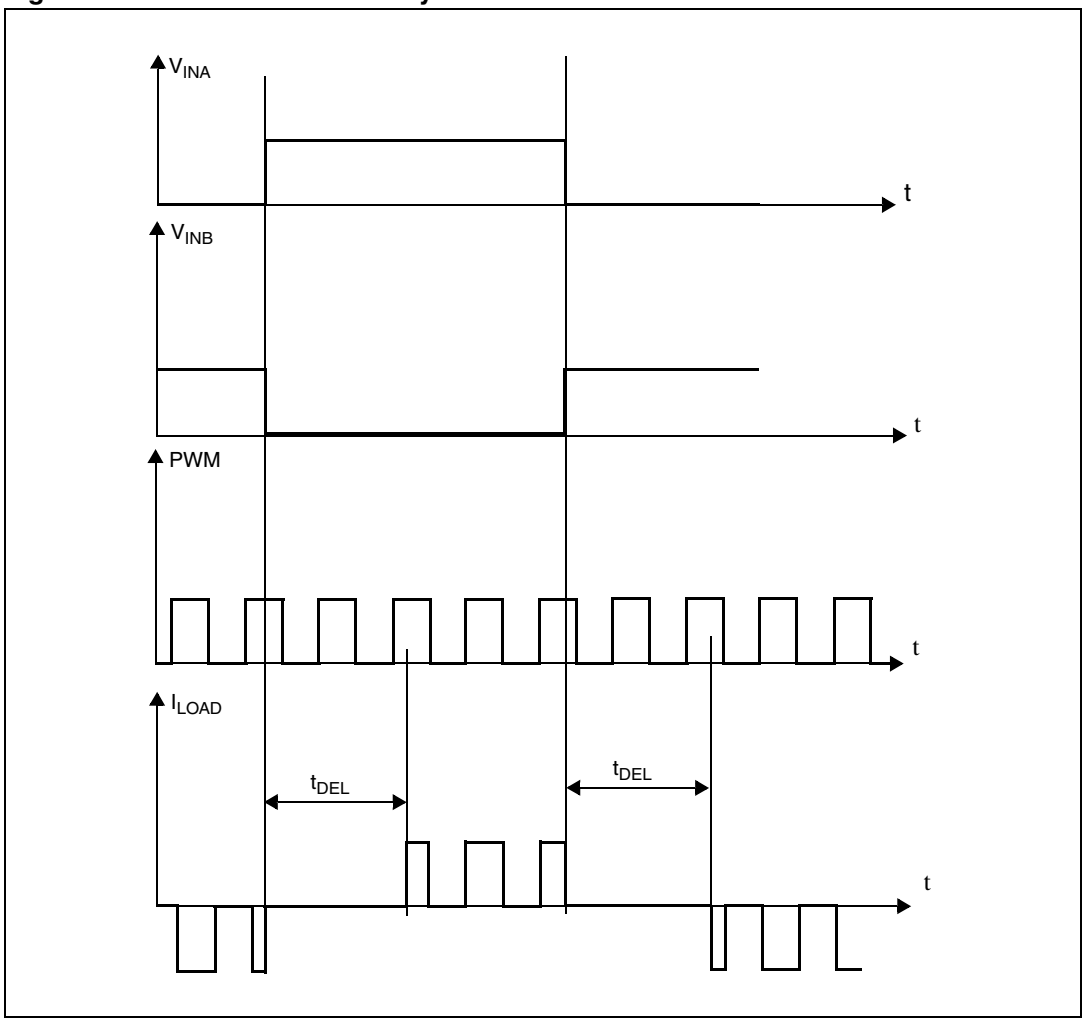


Figure 6. Definition of the low side switching times

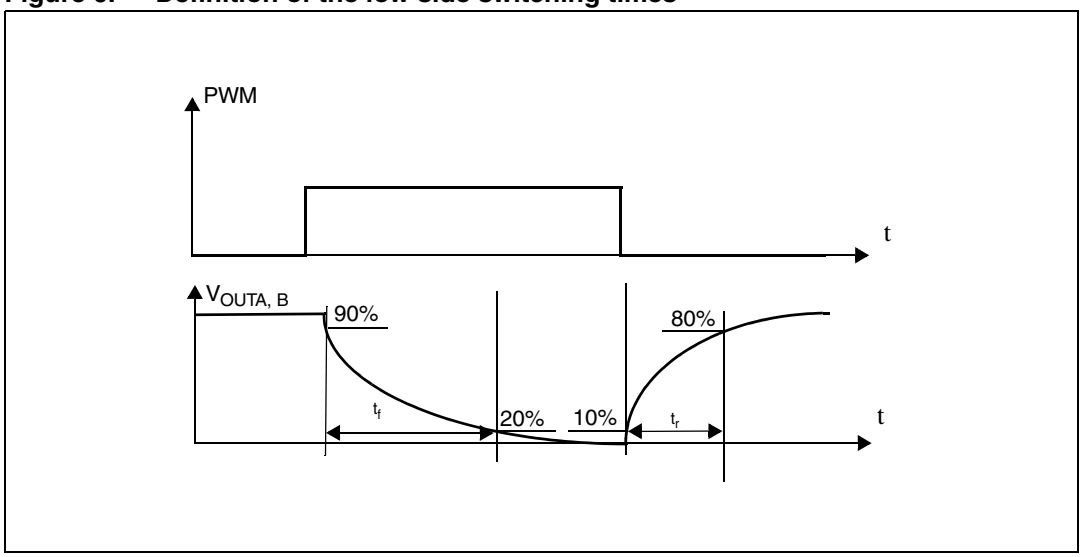


Figure 7. Definition of the high side switching times

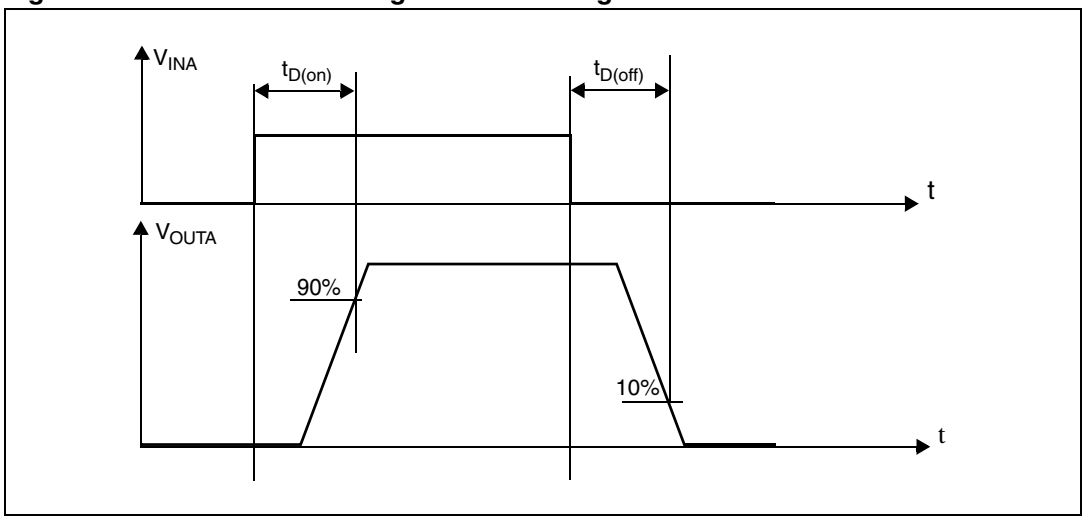


Figure 8. Definition of dynamic cross conduction current during a PWM operation

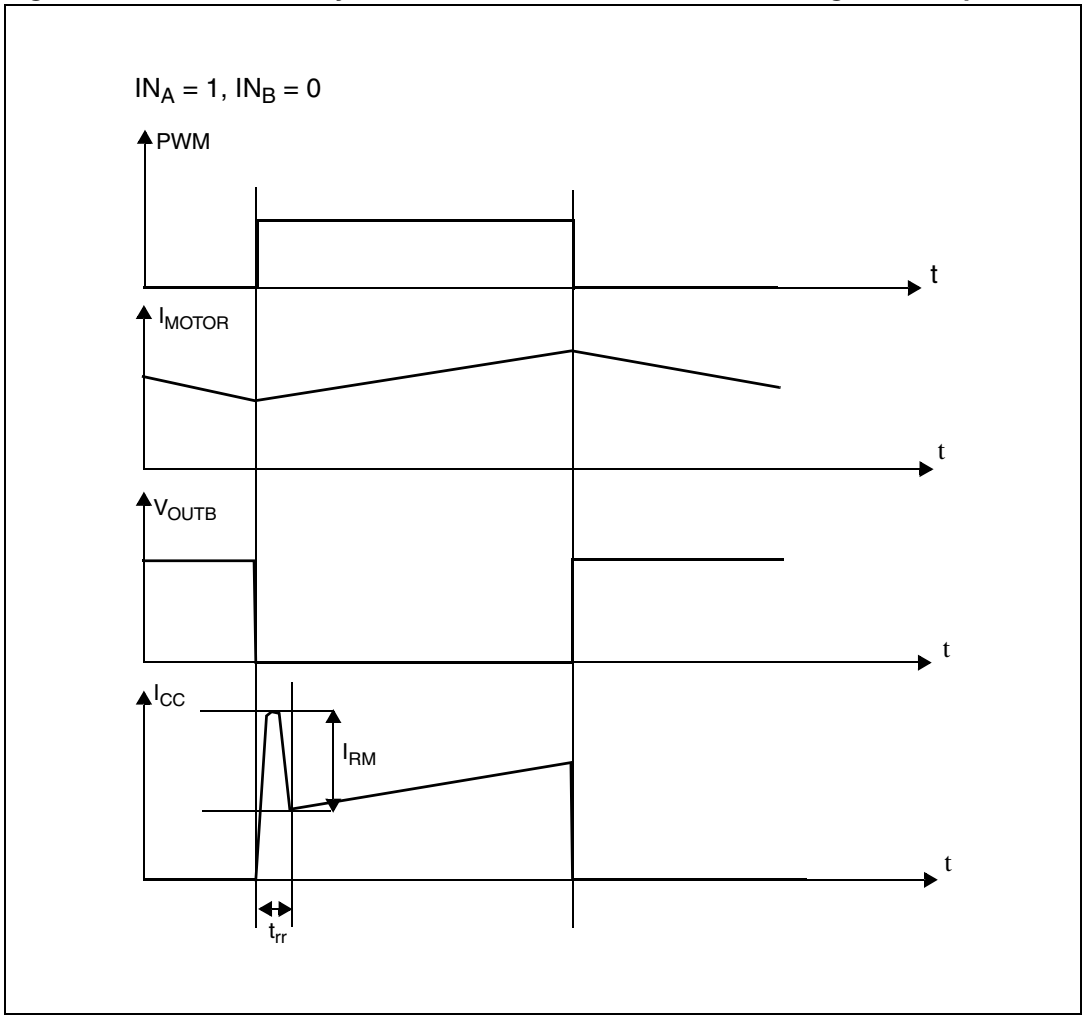


Figure 9. Waveforms in full bridge operation

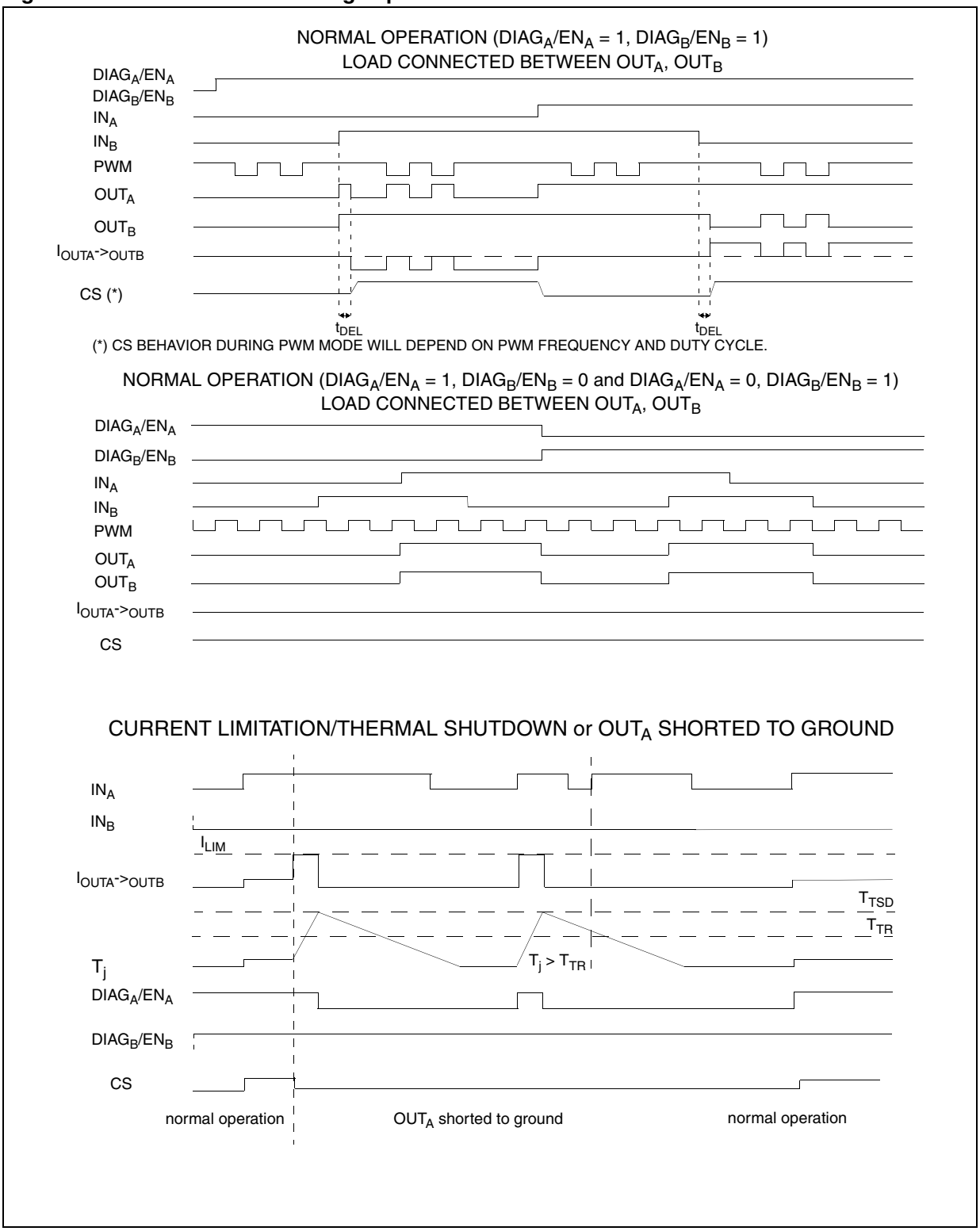
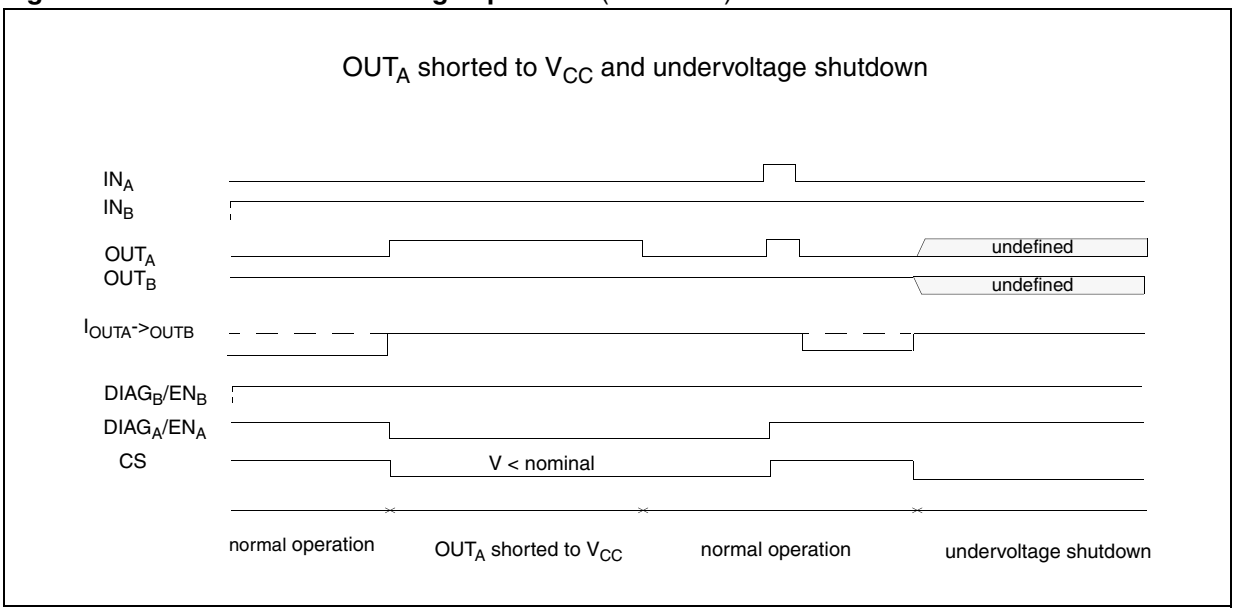
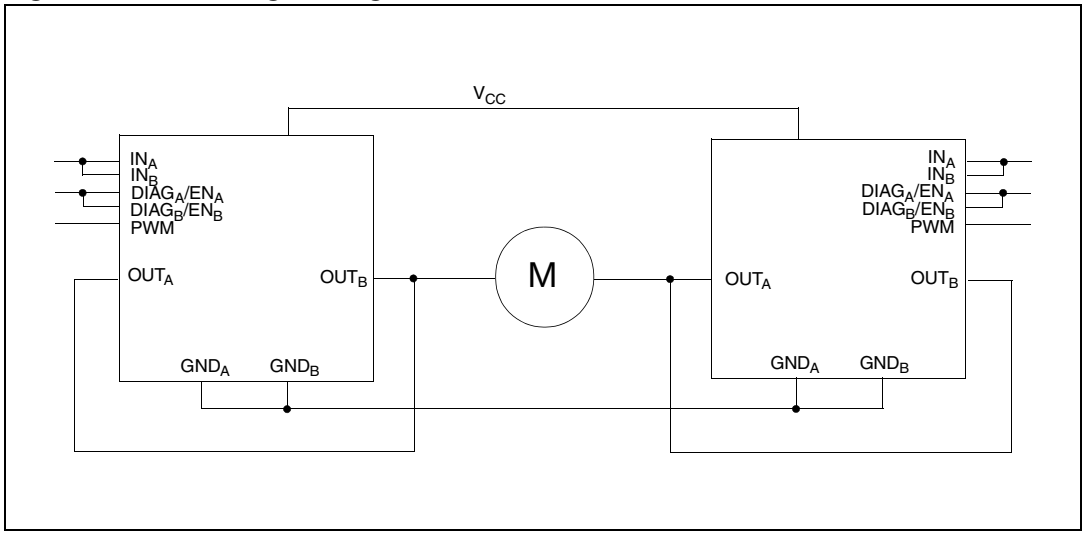


Figure 10. Waveforms in full bridge operation (continued)



The VNH2SP30-E can be used as a high power half-bridge driver achieving an On resistance per leg of 9.5mΩ. The suggested configuration is the following:

Figure 11. Half-bridge configuration



The VNH2SP30-E can easily be designed in multi-motors driving applications such as seat positioning systems where only one motor must be driven at a time. $DIAG_X/EN_X$ pins allow to put unused half-bridges in high impedance. The suggested configuration is the following:

Figure 12. Multi-motors configuration

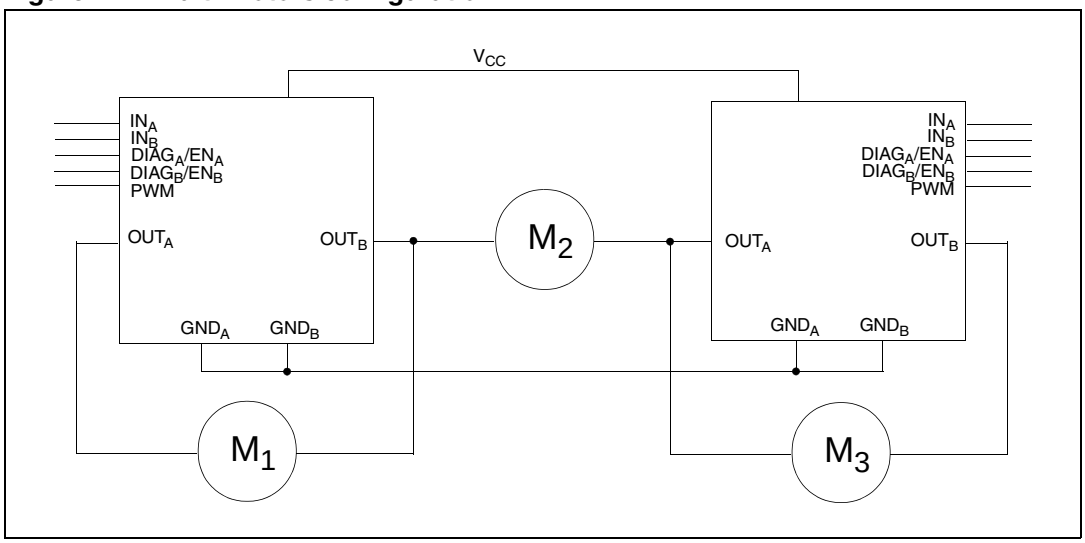


Figure 13. On state supply current

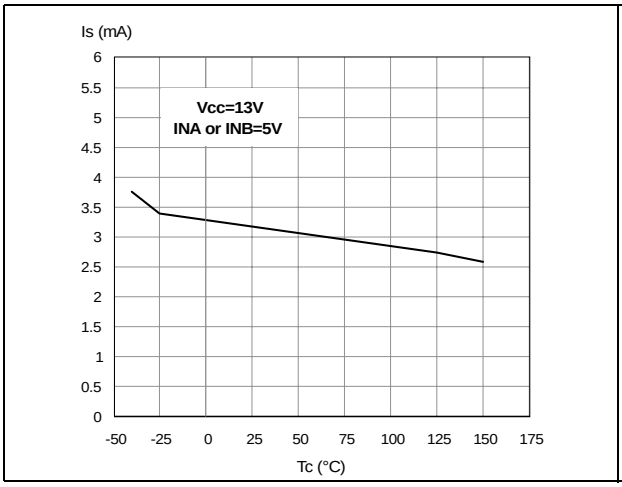


Figure 14. Off state supply current

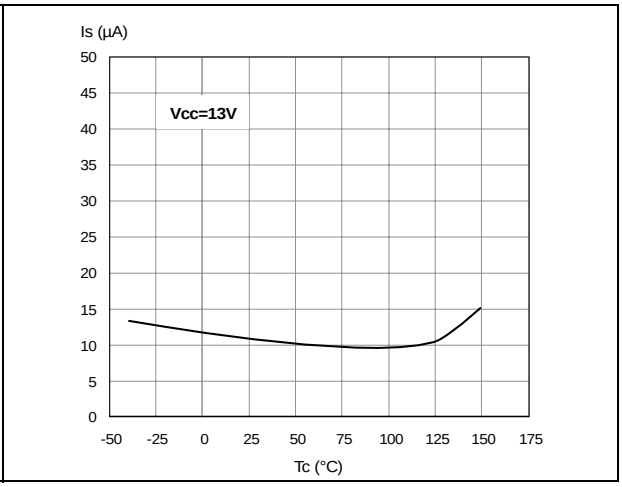


Figure 15. High level input current

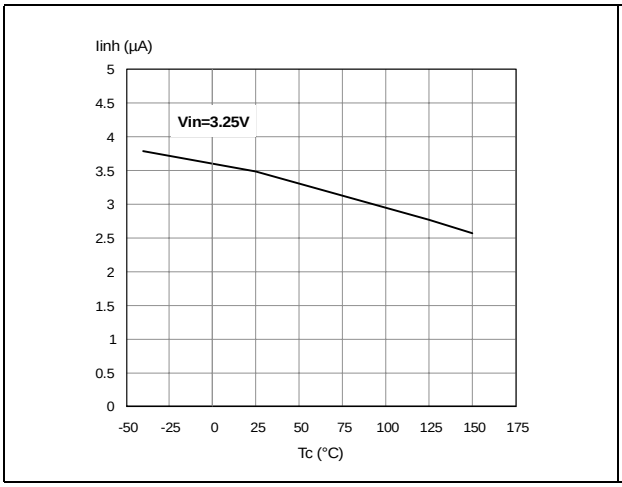


Figure 16. Input clamp voltage

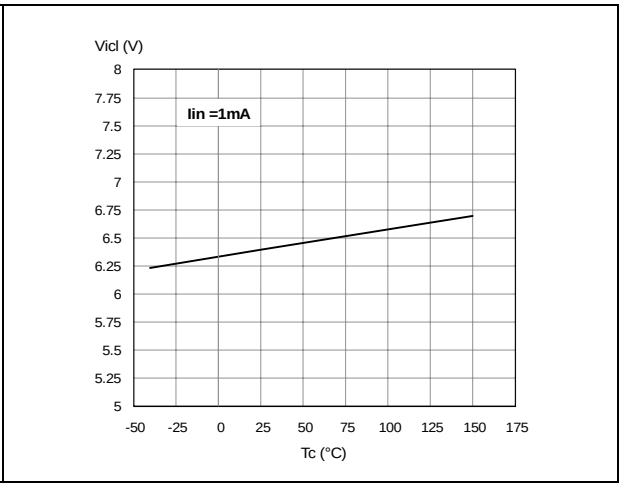


Figure 17. Input high level voltage

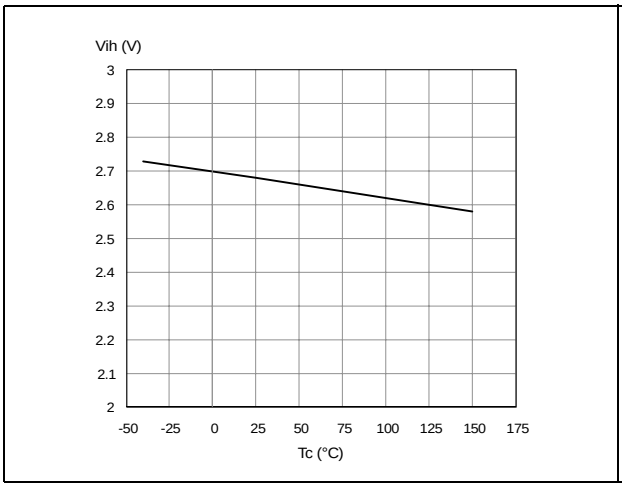


Figure 18. Input low level voltage

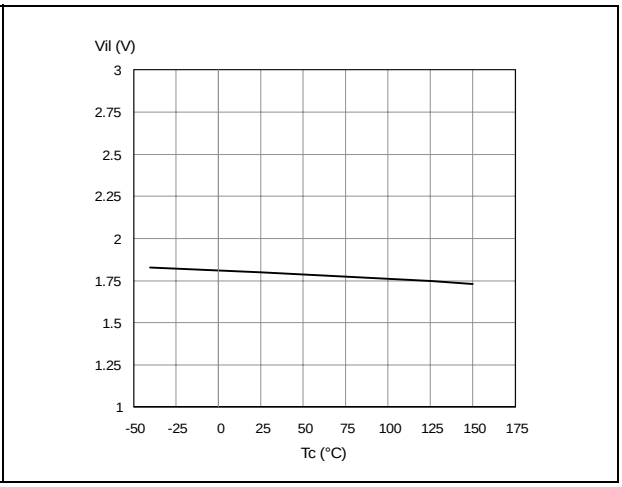


Figure 19. Input hysteresis voltage

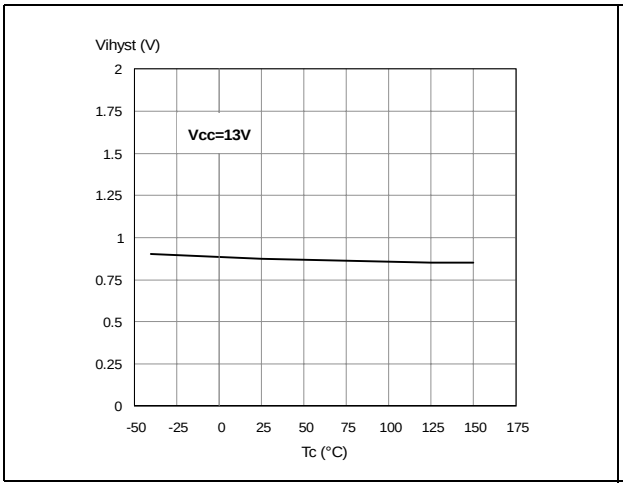


Figure 20. High level enable pin current

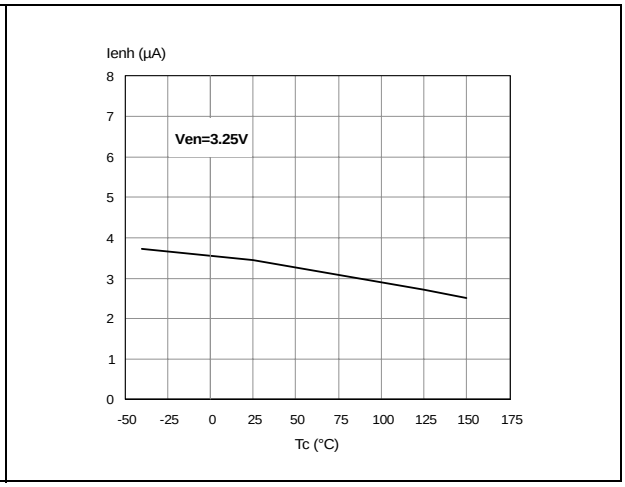


Figure 21. Delay time during change of operation mode

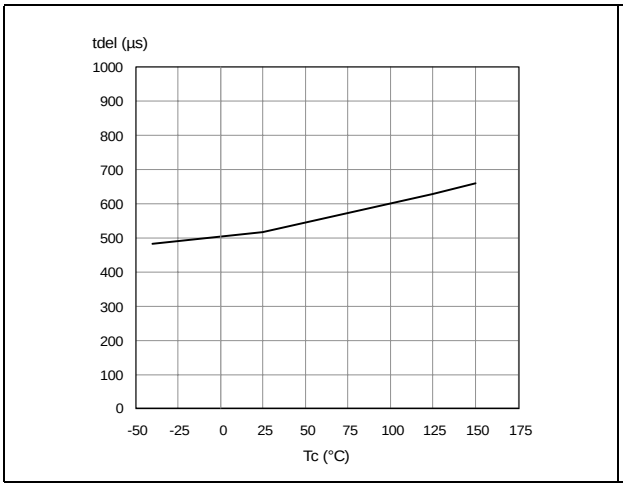


Figure 22. Enable clamp voltage

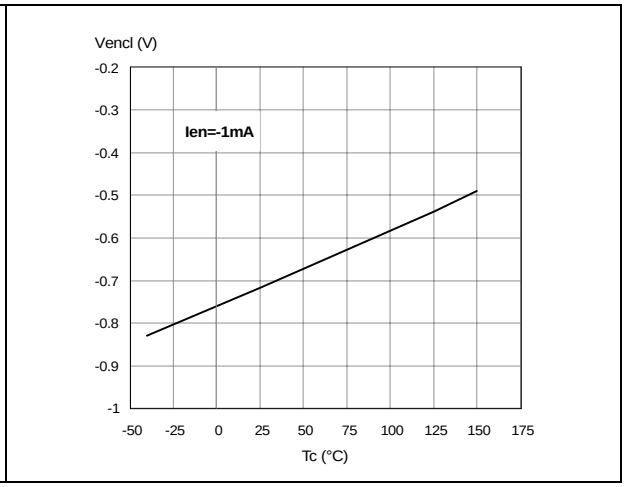


Figure 23. High level enable voltage

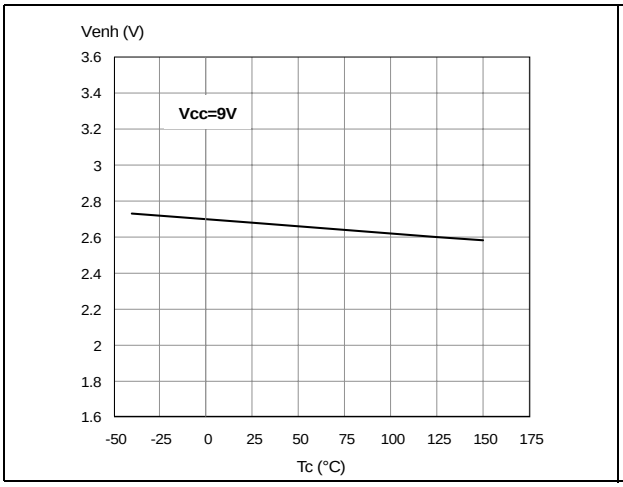


Figure 24. Low level enable voltage

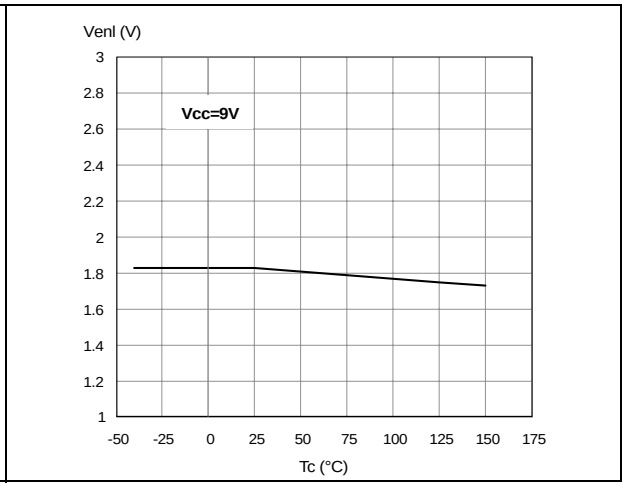


Figure 25. PWM high level voltage

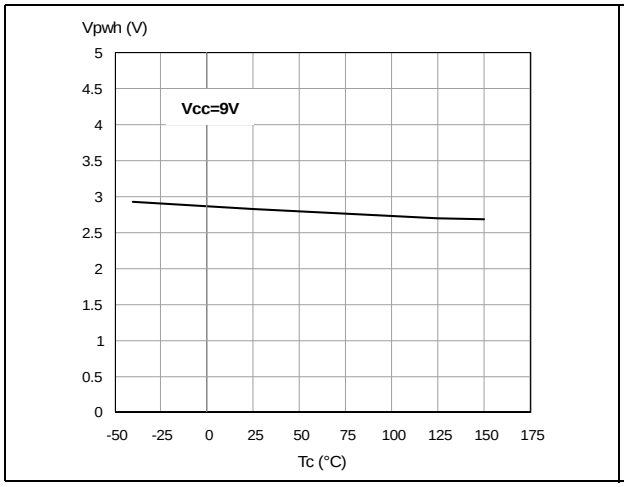


Figure 26. PWM low level voltage

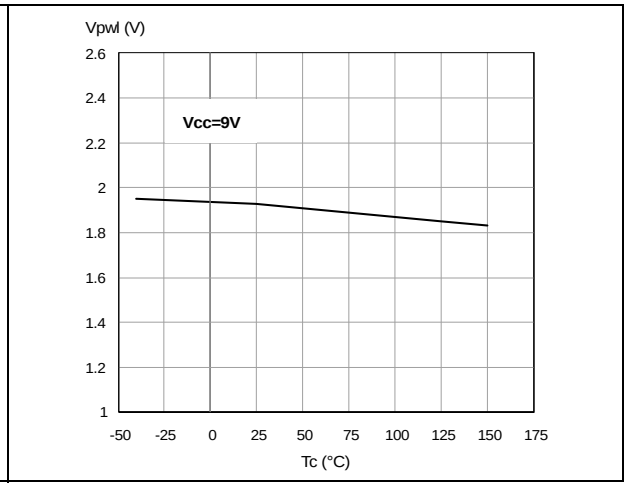


Figure 27. PWM high level current

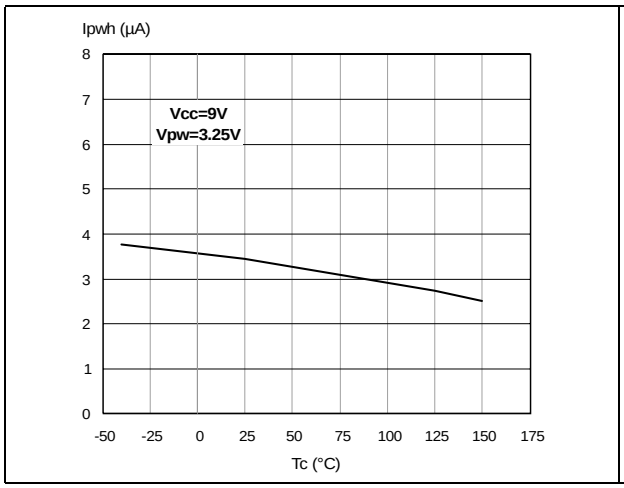


Figure 28. Overvoltage shutdown

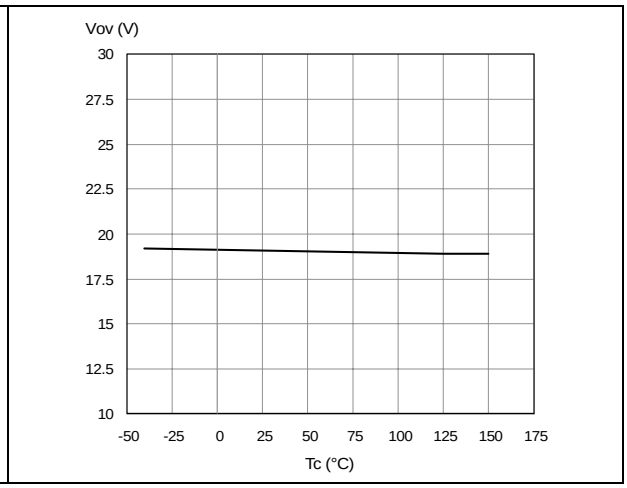


Figure 29. Undervoltage shutdown

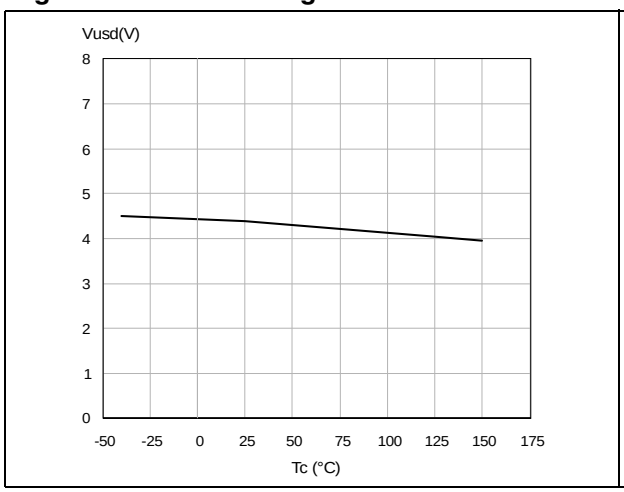


Figure 30. Current limitation

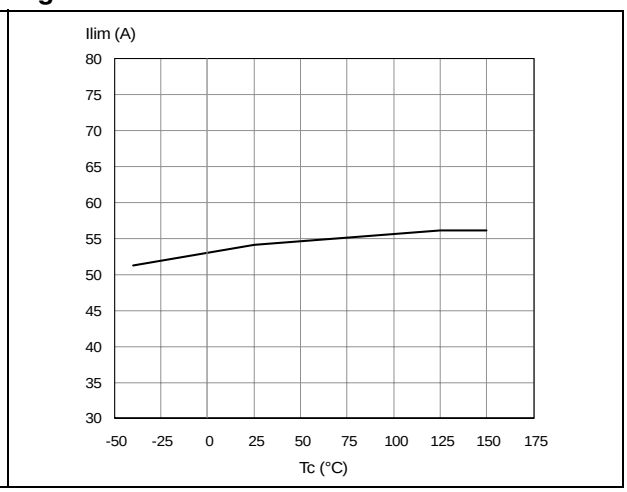


Figure 31. On state high side resistance vs T_{case}

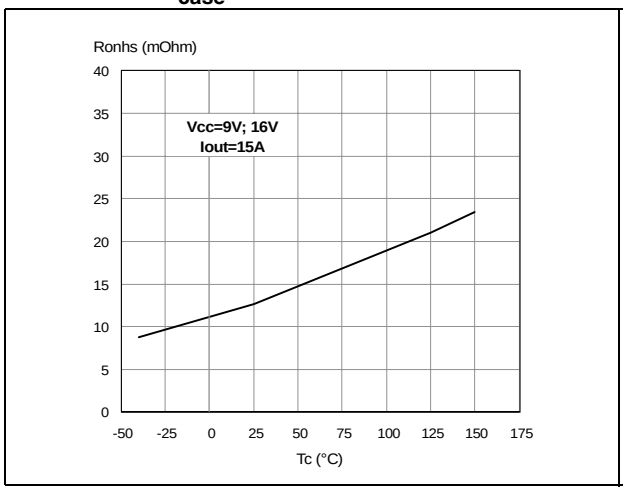


Figure 32. On state low side resistance vs T_{case}

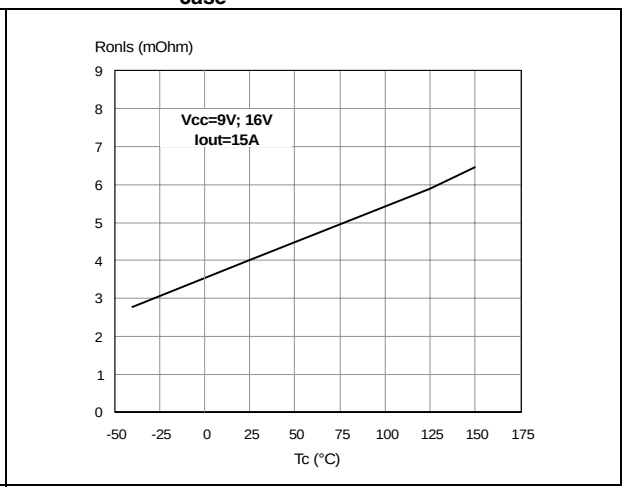


Figure 33. Turn-on delay time

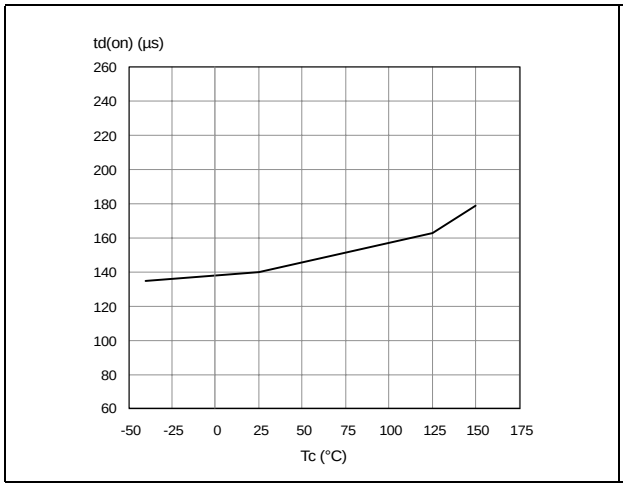


Figure 34. Turn-off delay time

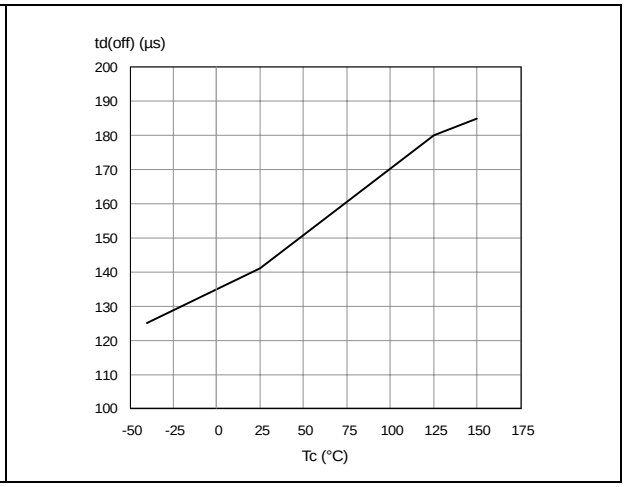


Figure 35. Output voltage rise time

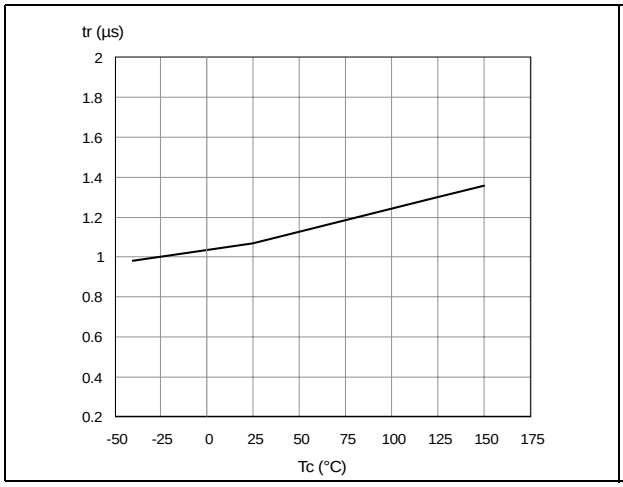
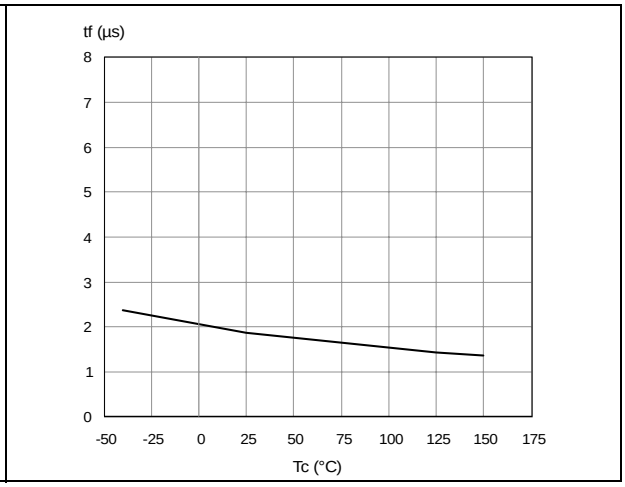
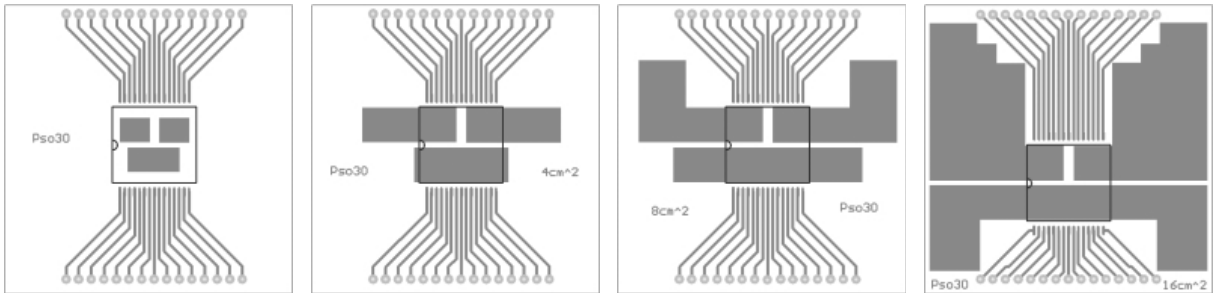


Figure 36. Output voltage fall time



5 Thermal data

Figure 37. MultiPowerSO-30™ PC board



Layout condition of R_{th} and Z_{th} measurements (PCB FR4 area = 58mm x 58mm, PCB thickness = 2mm, Cu thickness = 35µm, Copper areas: from minimum pad layout to 16cm^2).

Figure 38. Chipset configuration

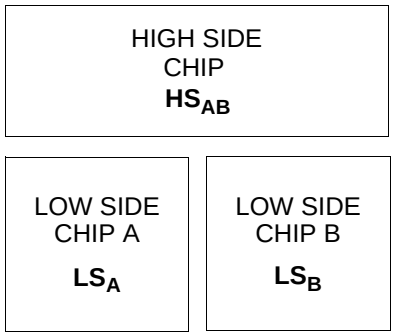
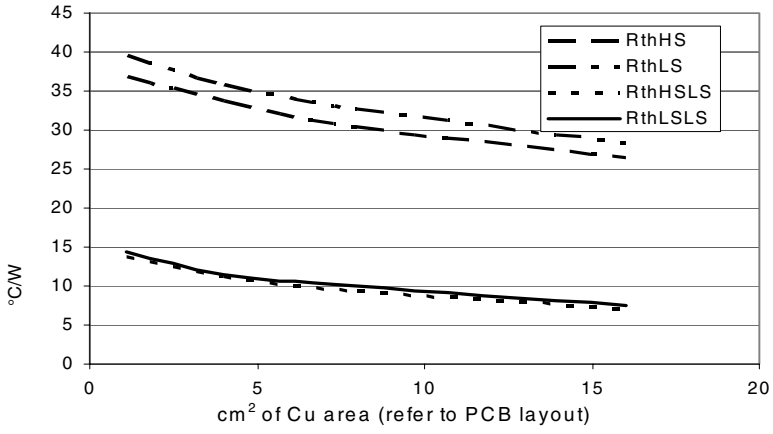


Figure 39. Auto and mutual $R_{thj-amb}$ vs PCB copper area in open box free air condition



(See definitions in *Section 5.1 on page 25*)

5.1 Thermal calculation in clockwise and anti-clockwise operation in steady-state mode

Table 14. Thermal calculation in clockwise and anti-clockwise operation in steady-state mode

HS_A	HS_B	LS_A	LS_B	T_{jHSAB}	T_{jLSA}	T_{jLSB}
ON	OFF	OFF	ON	$P_{dHSA} \times R_{thHS} + P_{dLSB} \times R_{thHSLS} + T_{amb}$	$P_{dHSA} \times R_{thHSLS} + P_{dLSB} \times R_{thLSLS} + T_{amb}$	$P_{dHSA} \times R_{thHSLS} + P_{dLSB} \times R_{thLS} + T_{amb}$
OFF	ON	ON	OFF	$P_{dHSB} \times R_{thHS} + P_{dLSA} \times R_{thHSLS} + T_{amb}$	$P_{dHSB} \times R_{thHSLS} + P_{dLSA} \times R_{thLS} + T_{amb}$	$P_{dHSB} \times R_{thHSLS} + P_{dLSA} \times R_{thLSLS} + T_{amb}$

5.1.1 Thermal resistances definition (values according to the PCB heatsink area)

R_{thHS} = R_{thHSA} = R_{thHSB} = High Side Chip Thermal Resistance Junction to Ambient (HS_A or HS_B in ON state)

R_{thLS} = R_{thLSA} = R_{thLSB} = Low Side Chip Thermal Resistance Junction to Ambient

R_{thHSLS} = $R_{thHSALSB}$ = $R_{thHSBLSA}$ = Mutual Thermal Resistance Junction to Ambient between High Side and Low Side Chips

R_{thLSLS} = $R_{thLSALSB}$ = Mutual Thermal Resistance Junction to Ambient between Low Side Chips

5.1.2 Thermal calculation in transient mode[(a)]

T_{jHSAB} = $Z_{thHS} \times P_{dHSAB} + Z_{thHSLS} \times (P_{dLSA} + P_{dLSB}) + T_{amb}$

T_{jLSA} = $Z_{thHSLS} \times P_{dHSAB} + Z_{thLS} \times P_{dLSA} + Z_{thLSLS} \times P_{dLSB} + T_{amb}$

T_{jLSB} = $Z_{thHSLS} \times P_{dHSAB} + Z_{thLSLS} \times P_{dLSA} + Z_{thLS} \times P_{dLSB} + T_{amb}$

5.1.3 Single pulse thermal impedance definition (values according to the PCB heatsink area)

Z_{thHS} = High Side Chip Thermal Impedance Junction to Ambient

Z_{thLS} = Z_{thLSA} = Z_{thLSB} = Low Side Chip Thermal Impedance Junction to Ambient

Z_{thHSLS} = $Z_{thHSABLSA}$ = $Z_{thHSABLSB}$ = Mutual Thermal Impedance Junction to Ambient between High Side and Low Side Chips

Z_{thLSLS} = $Z_{thLSALSB}$ = Mutual Thermal Impedance Junction to Ambient between Low Side Chips

a. Calculation is valid in any dynamic operating condition. P_d values set by user.

5.1.4 Pulse calculation formula

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

where $\delta = t_p / T$

Figure 40. MultiPowerSO-30 HSD thermal impedance junction ambient single pulse

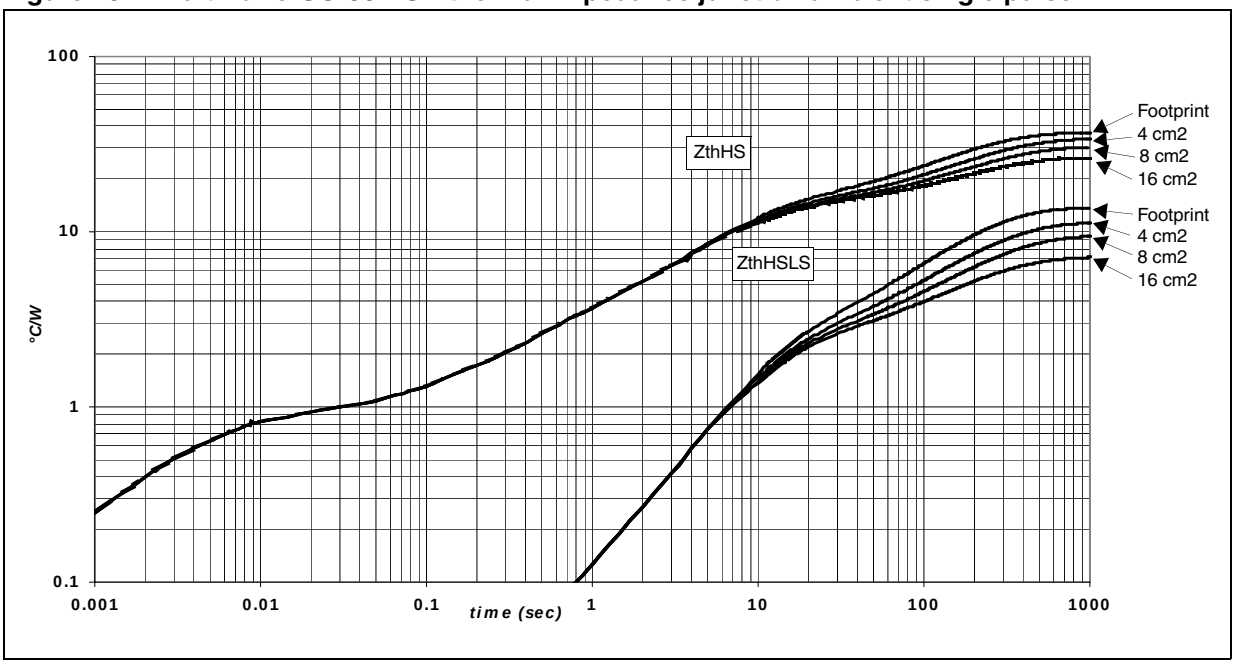


Figure 41. MultiPowerSO-30 LSD thermal impedance junction ambient single pulse

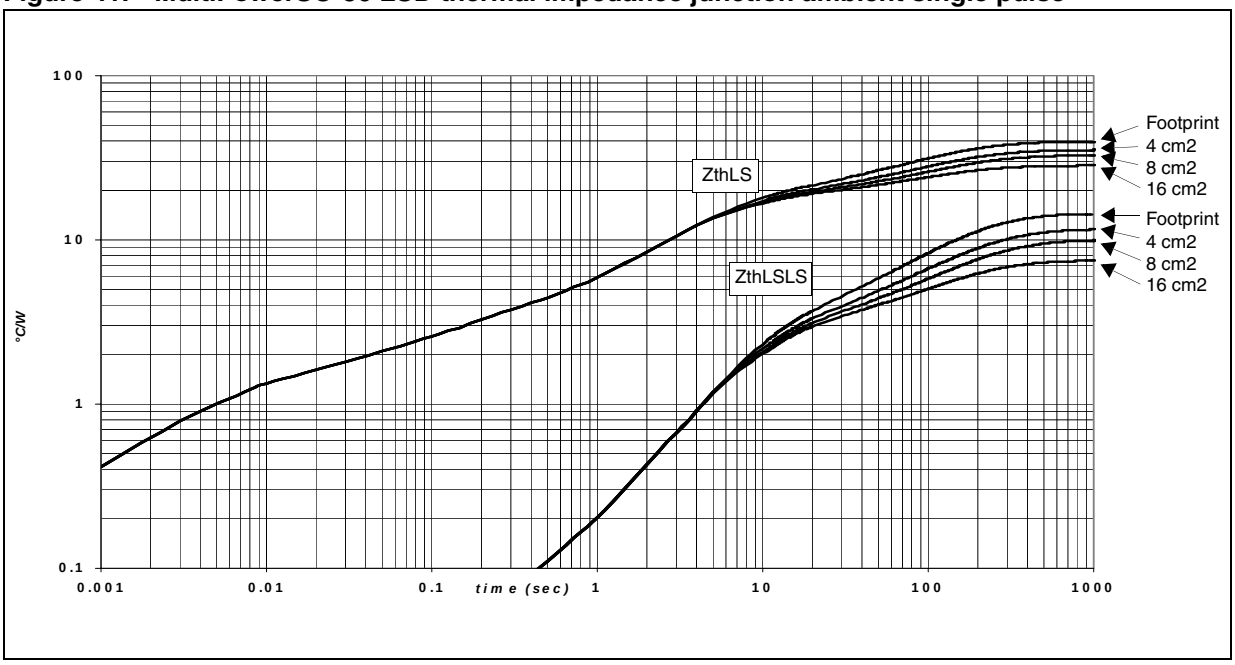


Figure 42. Thermal fitting model of an H-bridge in MultiPowerSO-30

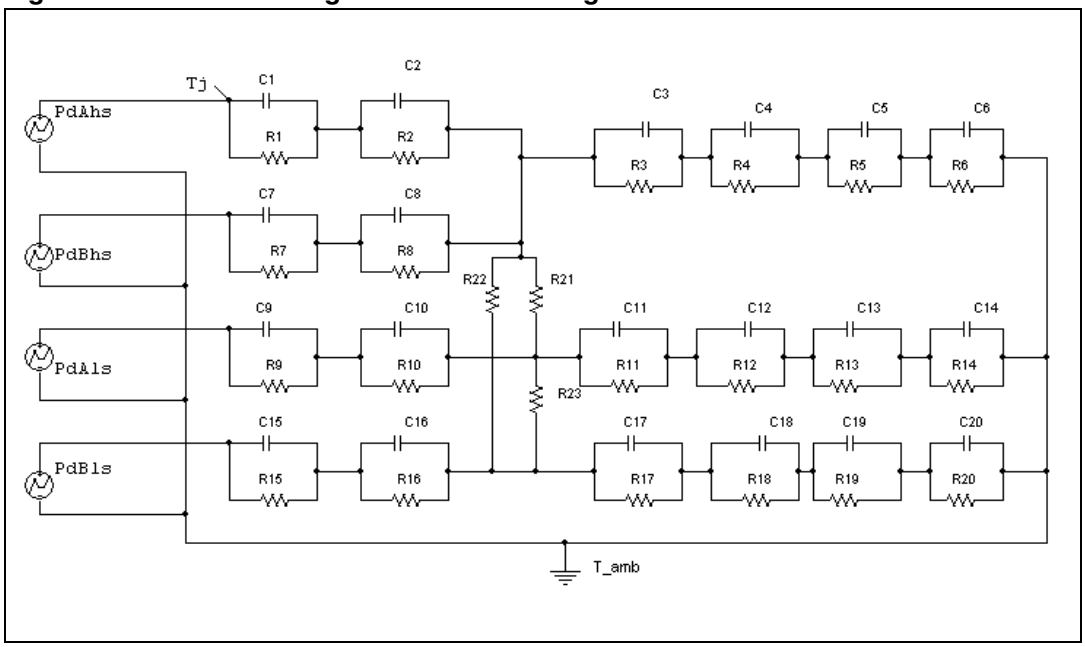


Table 15. Thermal parameters(1)

Area/island (cm^2)	Footprint	4	8	16
R1 = R7 (°C/W)	0.05			
R2 = R8 (°C/W)	0.3			
R3 (°C/W)	0.5			
R4 (°C/W)	1.3			
R5 (°C/W)	14			
R6 (°C/W)	44.7	39.1	31.6	23.7
R9 = R15 (°C/W)	0.2			
R10 = R16 (°C/W)	0.4			
R11 = R17 (°C/W)	0.8			
R12 = R18 (°C/W)	1.5			
R13 = R19 (°C/W)	20			
R14 = R20 (°C/W)	46.9	36.1	30.4	20.8
R21 = R22 = R23 (°C/W)	115			
C1 = C7 (W.s/°C)	0.005			
C2 = C8 (W.s/°C)	0.008			
C3 = C11 = C17 (W.s/°C)	0.01			
C4 = C13 = C19 (W.s/°C)	0.3			
C5 (W.s/°C)	0.6			
C6 (W.s/°C)	5	7	9	11
C9 = C15 (W.s/°C)	0.003			
C10 = C16 (W.s/°C)	0.006			
C12 = C18 (W.s/°C)	0.075			
C14 = C20 (W.s/°C)	2.5	3.5	4.5	5.5

1. The blank space means that the value is the same as the previous one.

6 Package characteristics

In order to meet environmental requirements, ST offers these devices in ECOPACK® packages. ECOPACK® packages are lead-free. The category of Second Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label.

ECOPACK is an ST trademark. ECOPACK specifications are available at www.st.com.

6.1 MultiPowerSO-30 package mechanical data

Figure 43. MultiPowerSO-30 package outline

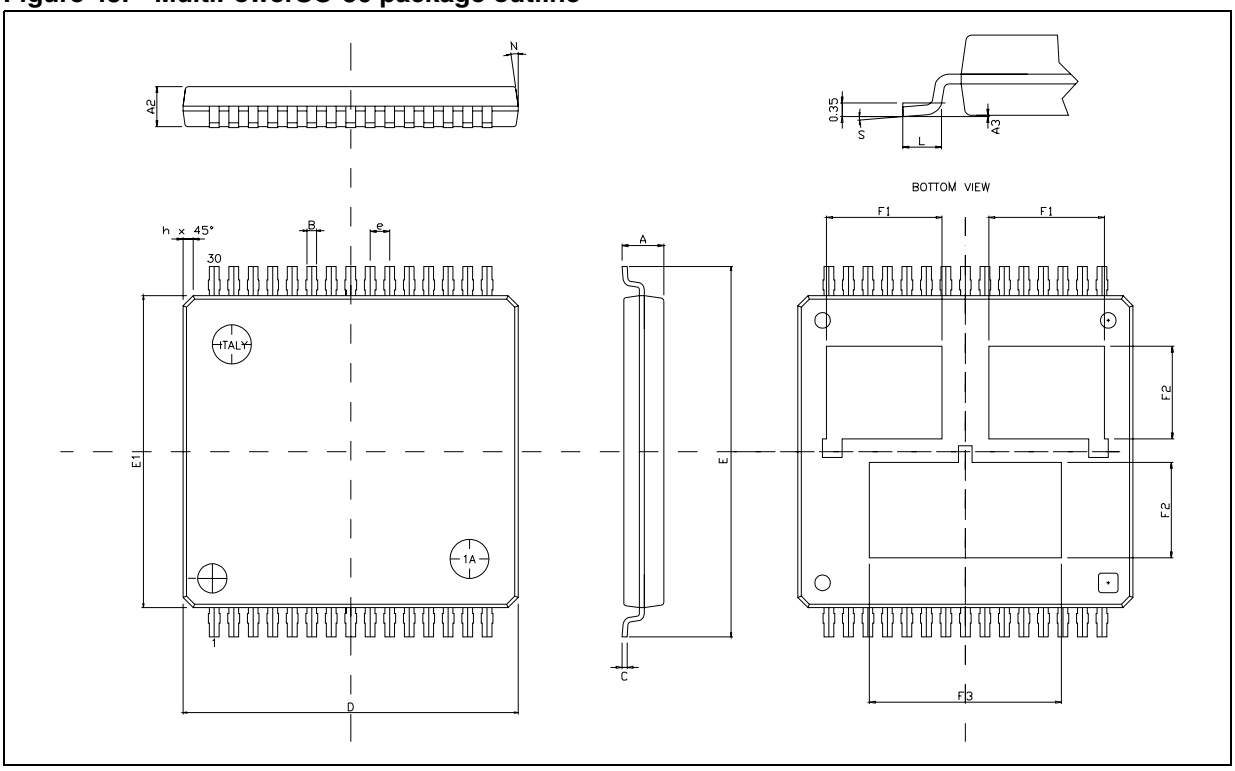


Table 16. MultiPowerSO-30 mechanical data

Symbol	Millimeters		
	Min	Typ	Max
A			2.35
A2	1.85		2.25
A3	0		0.1
B	0.42		0.58
C	0.23		0.32
D	17.1	17.2	17.3
E	18.85		19.15

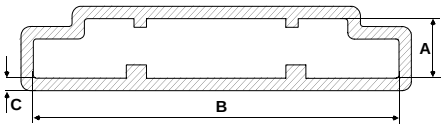
Table 16. MultiPowerSO-30 mechanical data (continued)

Symbol	Millimeters		
	Min	Typ	Max
E1	15.9	16	16.1
e		1	
F1	5.55		6.05
F2	4.6		5.1
F3	9.6		10.1
L	0.8		1.15
N			10deg
S	0deg		7deg

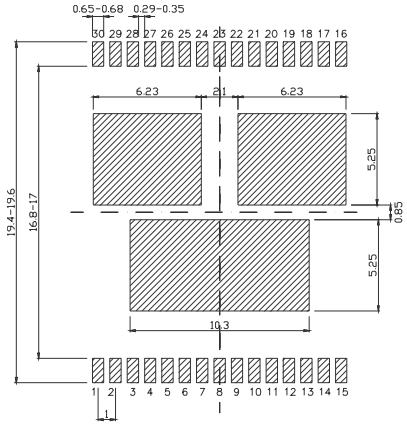
7 Packaging information

7.1 SO-28 tube shipment

Figure 44. MultiPowerSO-30 suggested pad layout and tube shipment (no suffix)

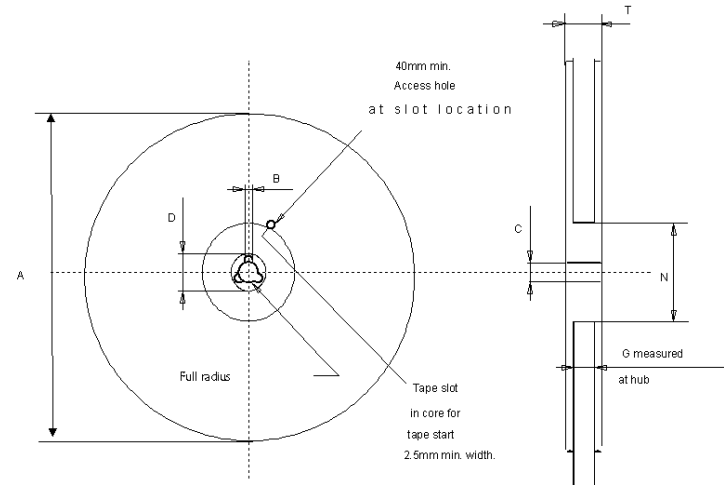


Dimension	mm
Base Q.ty	29
Bulk Q.ty	435
Tube length (± 0.5)	532
A	3.82
B	23.6
C (± 0.13)	0.8



7.2 Tape and reel shipment

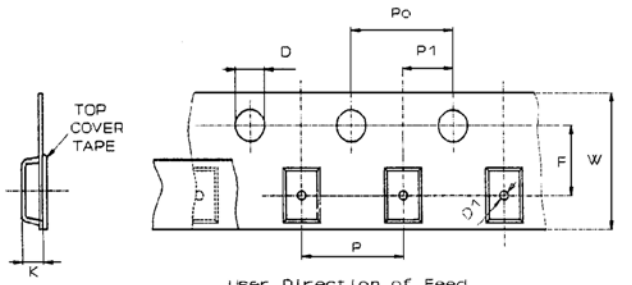
Figure 45. MultiPowerSO-30 tape and reel shipment (suffix “TR”)



Reel dimensions

SO-28 tube shipment (no suffix)

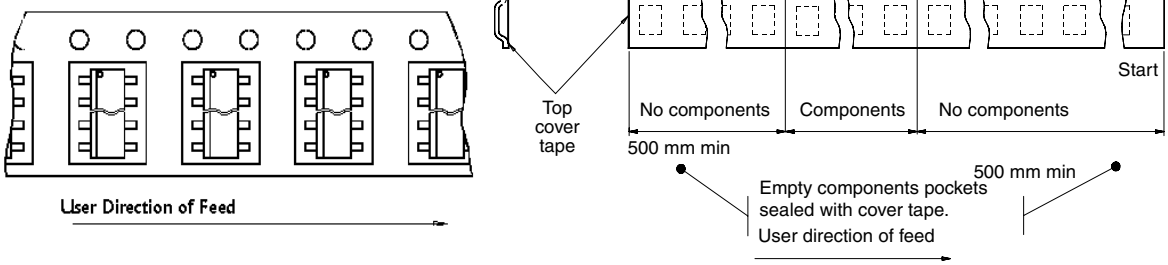
Dimension	mm
Base Q.ty	1000
Bulk Q.ty	1000
A (max)	330
B (min)	1.5
C (± 0.2)	13
D (min)	20.2
G (+ 2 / -0)	32
N (min)	100
T (max)	38.4



Tape dimensions

According to Electronic Industries Association (EIA) Standard 481 rev. A, Feb 1986

Description	Dimension	mm
Tape width	W	32
Tape Hole Spacing	P0 (± 0.1)	4
Component Spacing	P	24
Hole Diameter	D (± 0.1/-0)	1.5
Hole Diameter	D1 (min)	2
Hole Position	F (± 0.1)	14.2
Compartment Depth	K (max)	2.2
Hole Spacing	P1 (± 0.1)	2



8 Revision history

Table 17. Document revision history

Date	Revision	Description of changes
Sep-2004	1	First issue
Dec- 2004	2	Inserted $t_{off(min)}$ test condition modification and note Modified I_{RM} figure number
Feb-2005	3	Minor changes
Apr-2005	4	Public release
01-Sep-2006	5	Document converted into new ST corporate template Added table of contents, list of tables and list of figures Removed figure number from package outline *on page 1* Changed *Features on page 1* to add ECOPACK® package Added *Section 1: Device block description on page 5* Added *Section 2: Pin-out description on page 6* Added *Section 3: Electrical characteristics on page 8* Added “low” and “high” to parameters for I_{INL} and I_{INH} in *Table 5 on page 8* Added *Section 4: Waveforms and truth table on page 12* Changed first of two fault conditions in *Section 4 on page 12* Inserted note in *Figure 4 on page 12* Added vertical limitation line to left side arrow of $t_{D(off)}$ to *Figure 7 on page 16* Added *Section 5: Thermal data on page 24* Added *Section 6: Package characteristics on page 28* Added *Section 7: Packaging information on page 30* Updated disclaimer (last page) to include a mention about the use of ST products in automotive applications

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