

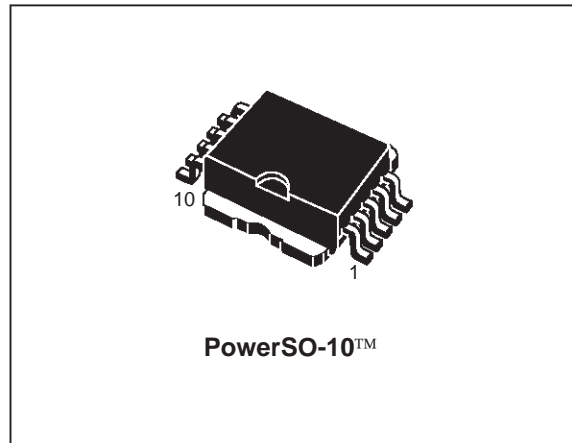


# VND670SP

## DUAL HIGH SIDE SWITCH WITH DUAL POWER MOS GATE DRIVER (BRIDGE CONFIGURATION)

TYPE	R <sub>DS(on)</sub>	I <sub>OUT</sub>	V <sub>DSS</sub>
VND670SP	30 mΩ	15 A	40 V

- OUTPUT CURRENT: 15A PER CHANNEL
- 5V LOGIC LEVEL COMPATIBLE INPUTS
- GATE DRIVE FOR TWO EXTERNAL POWER MOS
- UNDERVOLTAGE AND OVERVOLTAGE SHUT-DOWN
- OVERVOLTAGE CLAMP
- THERMAL SHUT DOWN
- CROSS-CONDUCTION PROTECTION
- CURRENT LIMITATION
- VERY LOW STAND-BY POWER CONSUMPTION
- PWM OPERATION UP TO 10 KHz
- PROTECTION AGAINST:
  - LOSS OF GROUND AND LOSS OF V<sub>CC</sub>
- REVERSE BATTERY PROTECTION (\*)

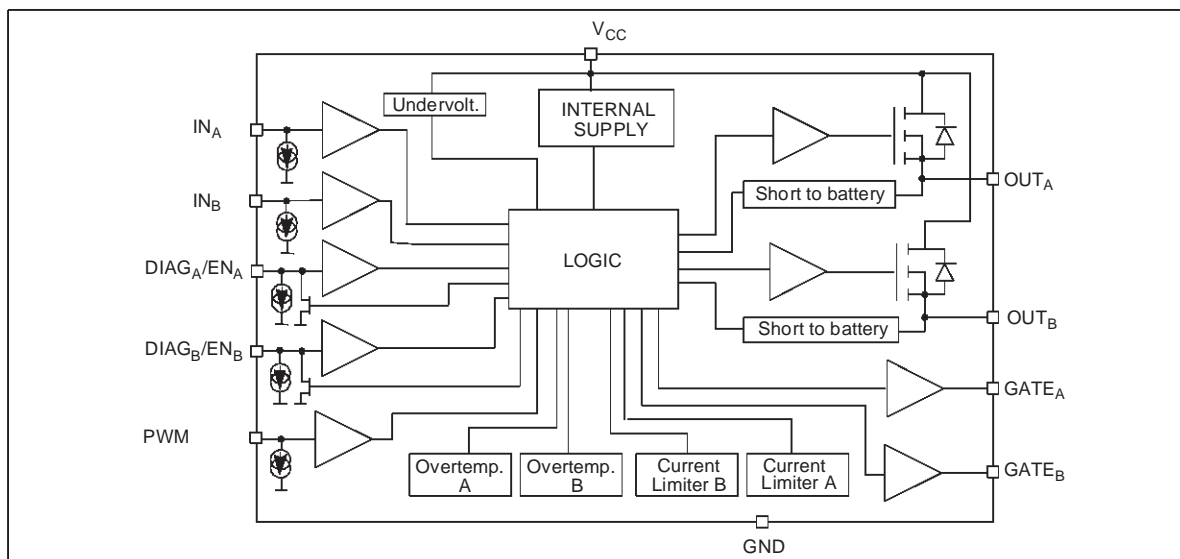


configuration. The device integrates two 30 mΩ Power MOSFET in high side configuration, and provides gate drive for two external Power MOSFET used as low side switches. IN<sub>A</sub> and IN<sub>B</sub> allow to select clockwise or counter clockwise drive or brake; DIAG<sub>A</sub>/EN<sub>A</sub>, DIAG<sub>B</sub>/EN<sub>B</sub> allow to disable one half bridge and feedback diagnostic. Built-in thermal shut-down, combined with a current limiter, protects the chip in overtemperature and short circuit conditions. Short to battery protects the external connected low-side Power MOSFET.

### DESCRIPTION

The VND670SP is a monolithic device made using STMicroelectronics VIPower technology, intended for driving motors in full bridge

### BLOCK DIAGRAM

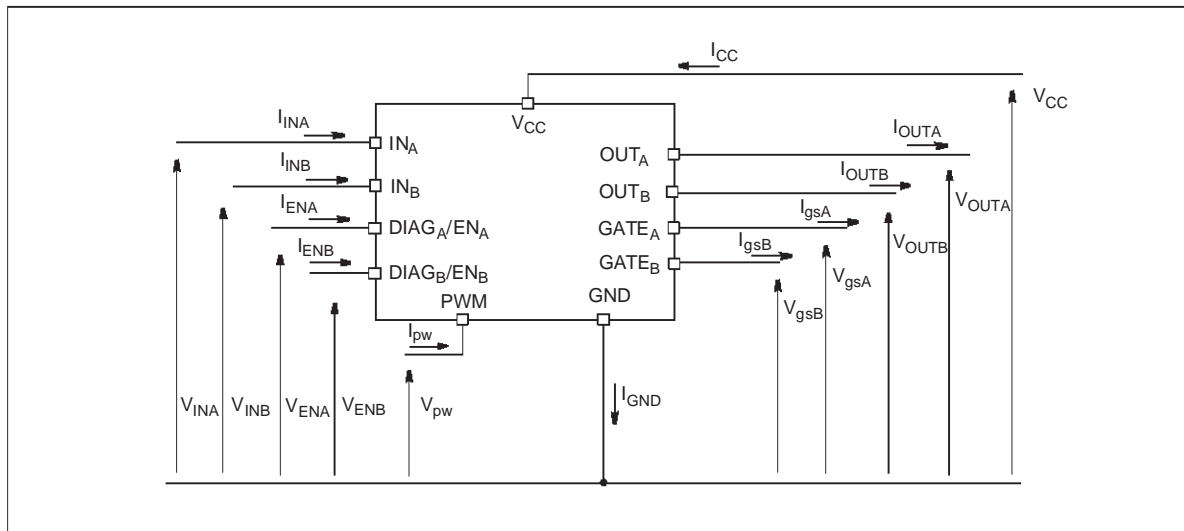


(\*) See note at page 5

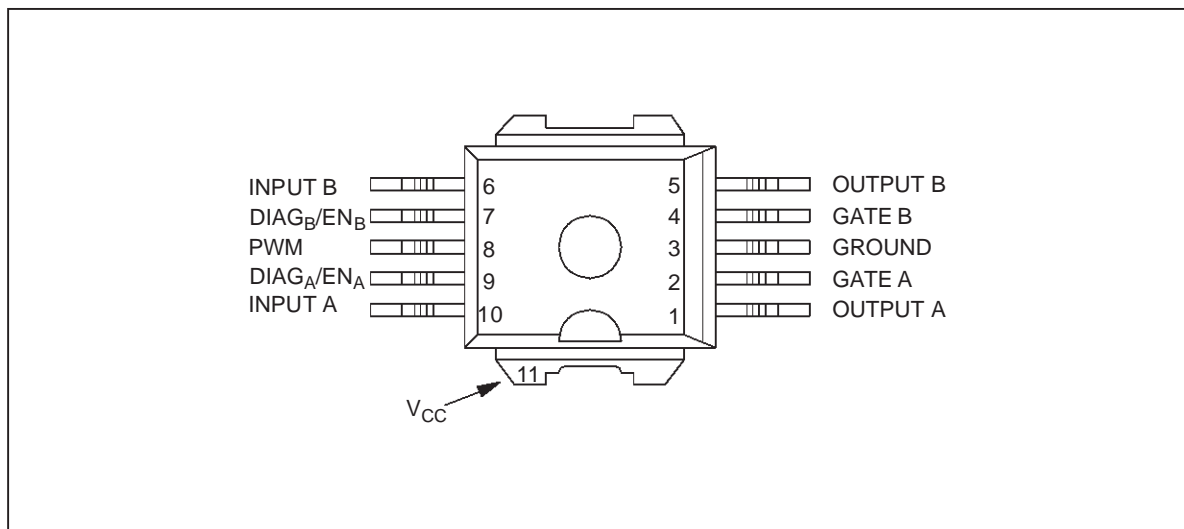
**ABSOLUTE MAXIMUM RATING**

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply voltage	-0.3 .. 40	V
$I_{max1}$	Maximum output current (continuous)	15	A
$I_{max2}$	Maximum output current (250 ms pulse duration)	20	A
$I_R$	Reverse output current (continuous)	-15	A
$I_{IN}$	Input current	+/- 10	mA
$I_{EN}$	Enable pin current	+/- 10	mA
$I_{pw}$	PWM pin current	+/- 10	mA
$I_{gs}$	Output gate current	+/- 20	mA
$V_{ESD}$	Electrostatic discharge (R=1.5kΩ, C=100pF)	2000	V
$T_j$	Junction operating temperature	-40 to 150	°C
$T_{STG}$	Storage temperature	-55 to 150	°C

**CURRENT AND VOLTAGE CONVENTIONS**



**CONNECTION DIAGRAM (TOP VIEW)**



## THERMAL DATA

Symbol	Parameter	Value	Unit
$R_{thj-case}$	Thermal resistance junction-case (per channel) (MAX)	1.4	°C/W
$R_{thj-amb}^{(*)}$	Thermal resistance junction-ambient (MAX)	50	°C/W

(\*) When mounted using the recommended pad size on FR-4 board (See AN515 Application Note).

ELECTRICAL CHARACTERISTICS ( $V_{CC}=9V$  up to 18V;  $-40^{\circ}C < T_j < 150^{\circ}C$ ; unless otherwise specified)

## POWER

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$V_{CC}$	Operating supply voltage		5.5		26	V
$R_{ON}$	On state resistance	$I_{LOAD}=12A$ $I_{LOAD}=12A; T_j=25^{\circ}C$		26	50 30	mΩ mΩ
$I_s$	Supply current	ON state OFF state			15 40	mA μA
$V_{gate}$	Gate output voltage		5.0		8.5	V
$V_{gs,cl}$	Gate output clamp voltage	$I_{gs}=-1 mA$	6.8	7.4	8.5	V

SWITCHING ( $V_{CC}=13V$ ,  $R_{LOAD}=1.1\Omega$ )

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$t_{D(on)}$	Turn-on delay time	Input rise time $< 1\mu s$ (see fig. 1)		50	150	μs
$t_{D(off)}$	Turn-off delay time			45	135	μs
$t_r$	Output voltage rise time			50	150	μs
$t_f$	Output voltage fall time			40	120	μs
$(dV_{OUT}/dt)_{on}$	Turn-on voltage slope			160	500	V/ms
$(dV_{OUT}/dt)_{off}$	Turn-off voltage slope			230	1200	V/ms
$t_{d(ong)}$	$V_{gs}$ Turn-on delay time	$C1=4.7nF$ Break to ground configuration (see fig. 2)		0.5	2	μs
$t_{rg}$	$V_{gs}$ rise time			2.6	10	μs
$t_{d(offg)}$	$V_{gs}$ Turn-off delay time			1.0	5.0	μs
$t_{fg}$	$V_{gs}$ fall time			2.2	10	μs
$t_{del}$	External MOSFET turn-on dead time	(see fig. 3)	150	600	1800	μs

## PROTECTION AND DIAGNOSTIC

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$V_{USD}$	Undervoltage shut-down				5.5	V
$V_{OV}$	Overvoltage shut-down		36	43		V
$I_{LIM}$	Current limitation		30	45		A
$T_{TSD}$	Thermal shut-down temperature	$V_{IN}=3.25 V$	150	170	200	°C
$V_{ocl}$	Output turn-off clamp voltage	$I_{LOAD}=12A, L=6mH$	$V_{CC}-55$		$V_{CC}-41$	V
$V_{sat}$	External MOSFET saturation voltage detection threshold		2.5	4.2	5.5	V

**ELECTRICAL CHARACTERISTICS** (continued)

## PWM

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$V_{pwl}$	PWM low level voltage				1.5	V
$I_{pwl}$	PWM pin current	$V_{pw}=1.5V$	1			$\mu A$
$V_{pwh}$	PWM high level voltage		3.25			V
$I_{pwh}$	PWM pin current	$V_{pw}=3.25V$			10	$\mu A$
$V_{pwhyst}$	PWM hysteresis voltage		0.5			V
$V_{pwcl}$	PWM clamp voltage	$I_{pw} = 1 \text{ mA}$ $I_{pw} = -1 \text{ mA}$	$V_{CC}+0.3$ -5.0	$V_{CC}+0.7$ -3.5	$V_{CC}+1.0$ -2.0	V V
$V_{pwtest}$	Test mode PWM pin voltage		-3.5	-2.0	-0.5	V
$I_{pwtest}$	Test mode PWM pin current	$V_{pwtest} = -2.0 \text{ V}$	-2000	-500		$\mu A$

LOGIC INPUT ( $IN_A/IN_B$ )

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$V_{IL}$	Input low level voltage				1.5	V
$I_{INL}$	Input current	$V_{IN}=1.5 \text{ V}$	1			$\mu A$
$V_{IH}$	Input high level voltage		3.25			V
$I_{INH}$	Input current	$V_{IN}=3.25 \text{ V}$			10	$\mu A$
$V_{IHYST}$	Input hysteresis voltage		0.5			V
$V_{ICL}$	Input clamp voltage	$I_{IN}=1\text{mA}$ $I_{IN}=-1\text{mA}$	6.8 -1.0	7.4 -0.7	8.5 -0.3	V V

## ENABLE (LOGIC I/O PIN)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
$V_{ENL}$	Enable low level voltage	Normal operation (DIAG <sub>X</sub> /EN <sub>X</sub> pin acts as an input pin)			1.5	V
$I_{ENL}$	Enable pin current	$V_{EN}=1.5 \text{ V}$	1			$\mu A$
$V_{ENH}$	Enable high level voltage	Normal operation (DIAG <sub>X</sub> /EN <sub>X</sub> pin acts as an input pin)	3.25			V
$I_{ENH}$	Enable pin current	$V_{EN}=3.25 \text{ V}$			10	$\mu A$
$V_{EHYST}$	Enable hysteresis voltage	Normal operation (DIAG <sub>X</sub> /EN <sub>X</sub> pin acts as an input pin)	0.5			V
$V_{ENCL}$	Enable clamp voltage	$I_{EN}=1\text{mA}$ $I_{EN}=-1\text{mA}$	6.8 -1.0	7.4 -0.7	8.5 -0.3	V V
$V_{DIAG}$	Enable output low level voltage	Fault operation (DIAG <sub>X</sub> /EN <sub>X</sub> pin acts as an input pin)			0.4	V
		$I_{EN}=1.6 \text{ mA}$				

**WAVEFORMS AND TRUTH TABLE**

**TRUTH TABLE IN NORMAL OPERATING CONDITIONS**

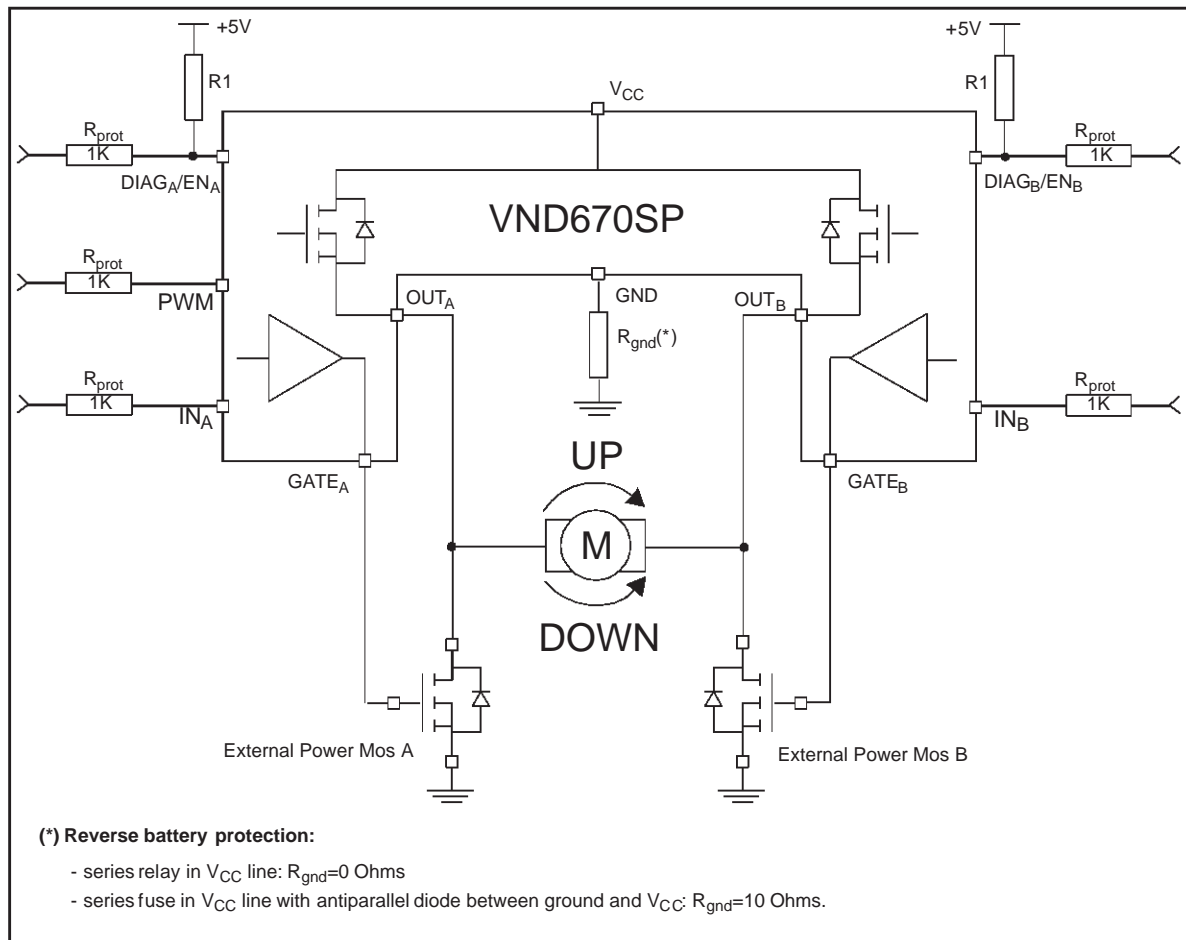
In normal operating conditions the DIAG<sub>X</sub>/EN<sub>X</sub> pin is considered as an input pin by the device. This pin must be externally pulled high.

IN <sub>A</sub>	IN <sub>B</sub>	DIAG <sub>A</sub> /EN <sub>A</sub>	DIAG <sub>B</sub> /EN <sub>B</sub>	OUT <sub>A</sub>	OUT <sub>B</sub>	GATE <sub>A</sub>	GATE <sub>B</sub>	Comment
1	1	1	1	H	H	L	L	Brake to V <sub>CC</sub>
1	0	1	1	H	OPEN	L	H	Clockwise
0	1	1	1	OPEN	H	H	L	Counter cw
0	0	1	1	OPEN	OPEN	H	H	Brake to GND
X	X	0	0	OPEN	OPEN	L	L	Stand by
1	X	1	0	H	OPEN	L	L	HS <sub>A</sub> only
0	X	1	0	OPEN	OPEN	H	L	MOS <sub>A</sub> only
X	1	0	1	OPEN	H	L	L	HS <sub>B</sub> only
X	0	0	1	OPEN	OPEN	L	H	MOS <sub>B</sub> only

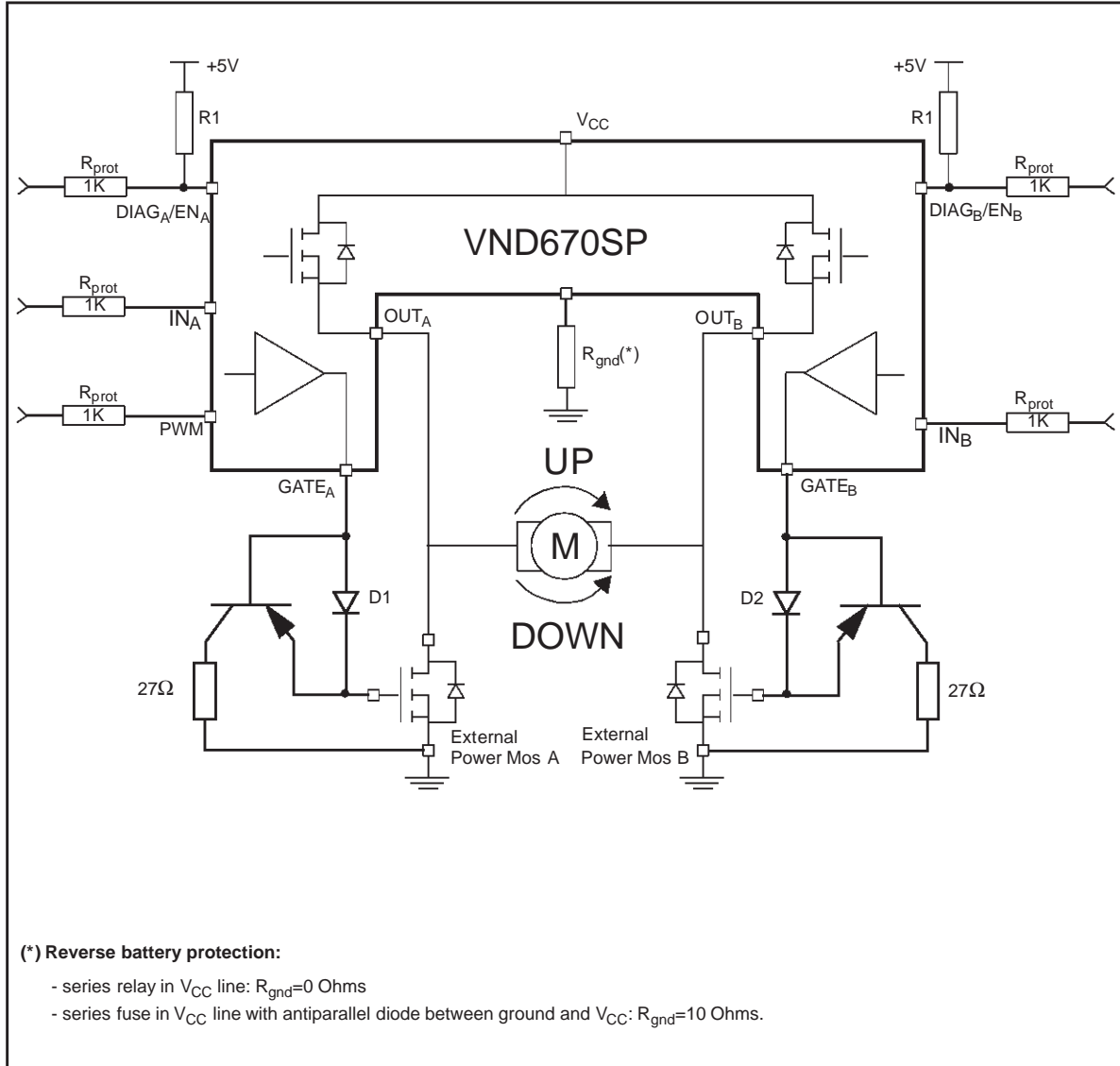
PWM pin usage:

In all cases, a "0" on the PWM pin will turn-off both GATE<sub>A</sub> and GATE<sub>B</sub> outputs. When PWM rises back to "1", GATE<sub>A</sub> or GATE<sub>B</sub> turn on again depending on the input pin state.

**TYPICAL APPLICATION CIRCUIT FOR DC TO 10KHz PWM OPERATION**



TYPICAL APPLICATION CIRCUIT FOR A 20KHZ PWM OPERATION



**WAVEFORMS AND TRUTH TABLE (CONTINUED)**

In case of a fault condition the DIAG<sub>X</sub>/EN<sub>X</sub> 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 external connected Power MOSFET).

Possible origins of fault conditions may be:

OUT<sub>A</sub> is shorted to ground ---> overtemperature detection on high side A.

OUT<sub>A</sub> is shorted to V<sub>CC</sub> ---> external Power MOSFET saturation detection (driven by GATE<sub>A</sub>).

When a fault condition is detected, the user can know which power element is in fault by monitoring the IN<sub>A</sub>, IN<sub>B</sub>, DIAG<sub>A</sub>/EN<sub>A</sub> and DIAG<sub>B</sub>/EN<sub>B</sub> pins.

In any case, when a fault is detected, the faulty half bridge is latched off. To turn-on the respective output (GATE<sub>X</sub> or OUT<sub>X</sub>) again, the input signal must rise from low to high level.

**TRUTH TABLE IN FAULT CONDITIONS (detected on OUT<sub>A</sub>)**

IN <sub>A</sub>	IN <sub>B</sub>	DIAG <sub>A</sub> /EN <sub>A</sub>	DIAG <sub>B</sub> /EN <sub>B</sub>	OUT <sub>A</sub>	OUT <sub>B</sub>	GATE <sub>A</sub>	GATE <sub>B</sub>
1	1	0	1	OPEN	H	L	L
1	0	0	1	OPEN	OPEN	L	H
0	1	0	1	OPEN	H	L	L
0	0	0	1	OPEN	OPEN	L	H
X	X	0	0	OPEN	OPEN	L	L
1	X	0	0	OPEN	OPEN	L	L
0	X	0	0	OPEN	OPEN	L	L
X	1	0	1	OPEN	H	L	L
X	0	0	1	OPEN	OPEN	L	H



Fault Information



Protection Action

**TEST MODE**

The PWM pin allows to test the load connection between two half-bridges. In the test mode (V<sub>pwm</sub>=-2V) the external Power Mos gate drivers are disabled. The IN<sub>A</sub> or IN<sub>B</sub> inputs allow to turn-on the High Side A or B, respectively, in order to connect one side of the load at V<sub>CC</sub> voltage. The check of the voltage on the other side of the load allow to verify the continuity of the load connection. In case of load disconnection the DIAD<sub>X</sub>/EN<sub>X</sub> pin corresponding to the faulty output is pulled down.

**ELECTRICAL TRANSIENT REQUIREMENTS**

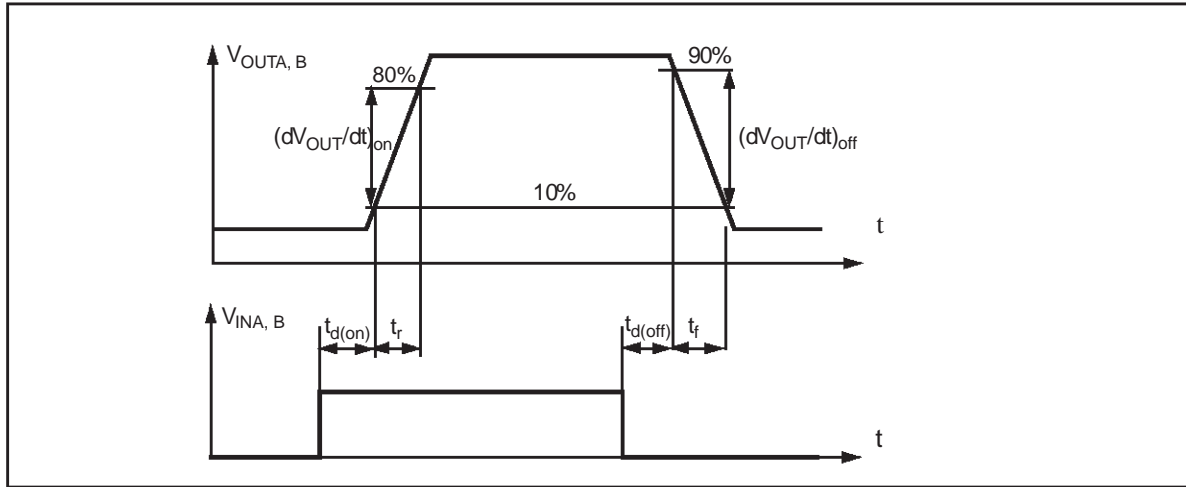
ISO T/R 7637/1 Test Pulse	Test Level I	Test Level II	Test Level III	Test Level IV	Test Levels Delays and Impedance
1	-25V	-50V	-75V	-100V	2ms, 10Ω
2	+25V	+50V	+75V	+100V	0.2ms, 10Ω
3a	-25V	-50V	-100V	-150V	0.1μs, 50Ω
3b	+25V	+50V	+75V	+100V	0.1μs, 50Ω
4	-4V	-5V	-6V	-7V	100ms, 0.01Ω
5	+26.5V	+46.5V	+66.5V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

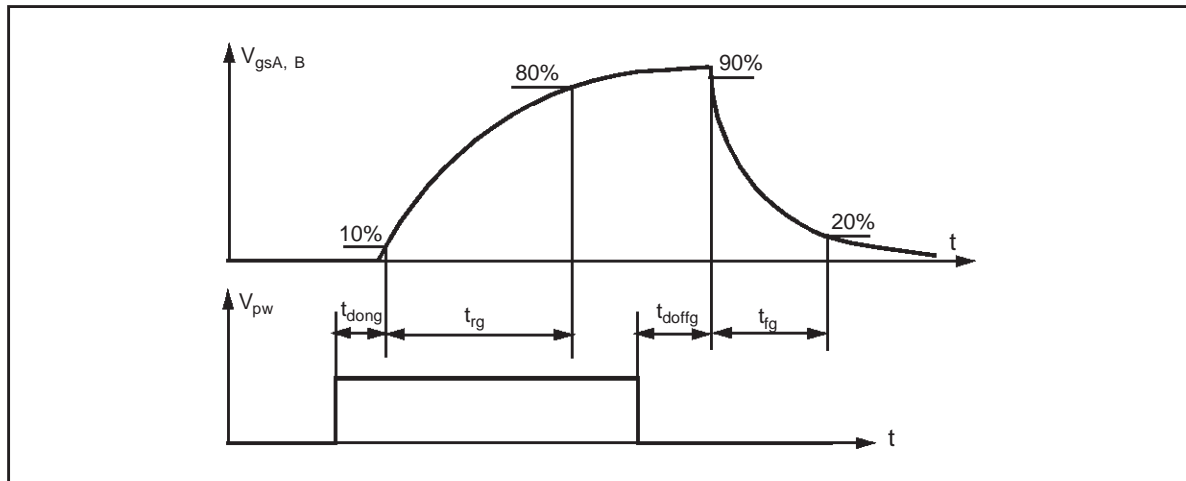
Class	Contents
C	All functions of the device are performed as designed after exposure to disturbance.
E	One or more functions of the device are not performed as designed after exposure to disturbance and cannot be returned to proper operation without replacing the device.



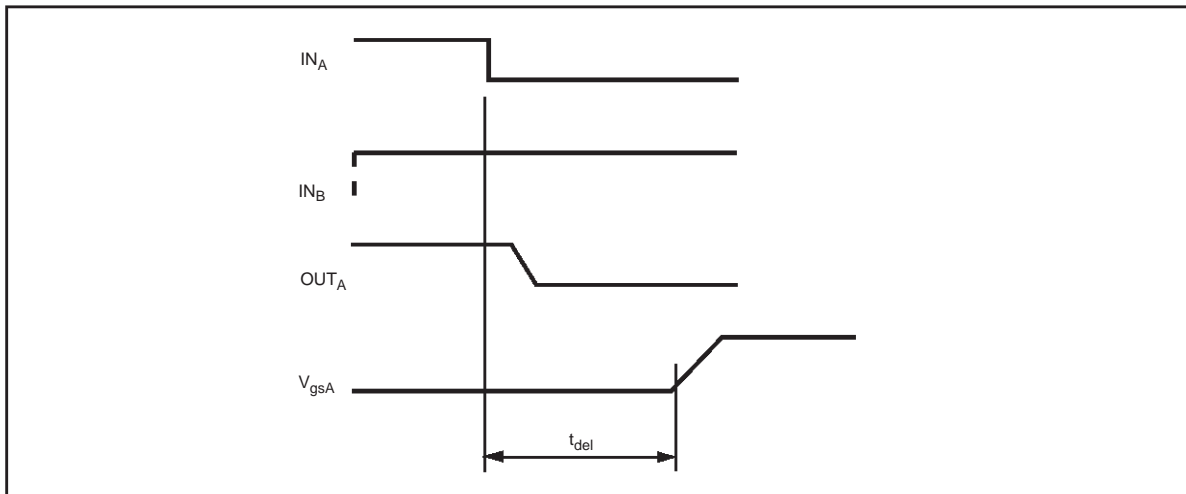
**Figure 1:** Test conditions for High Side switching times measurement.



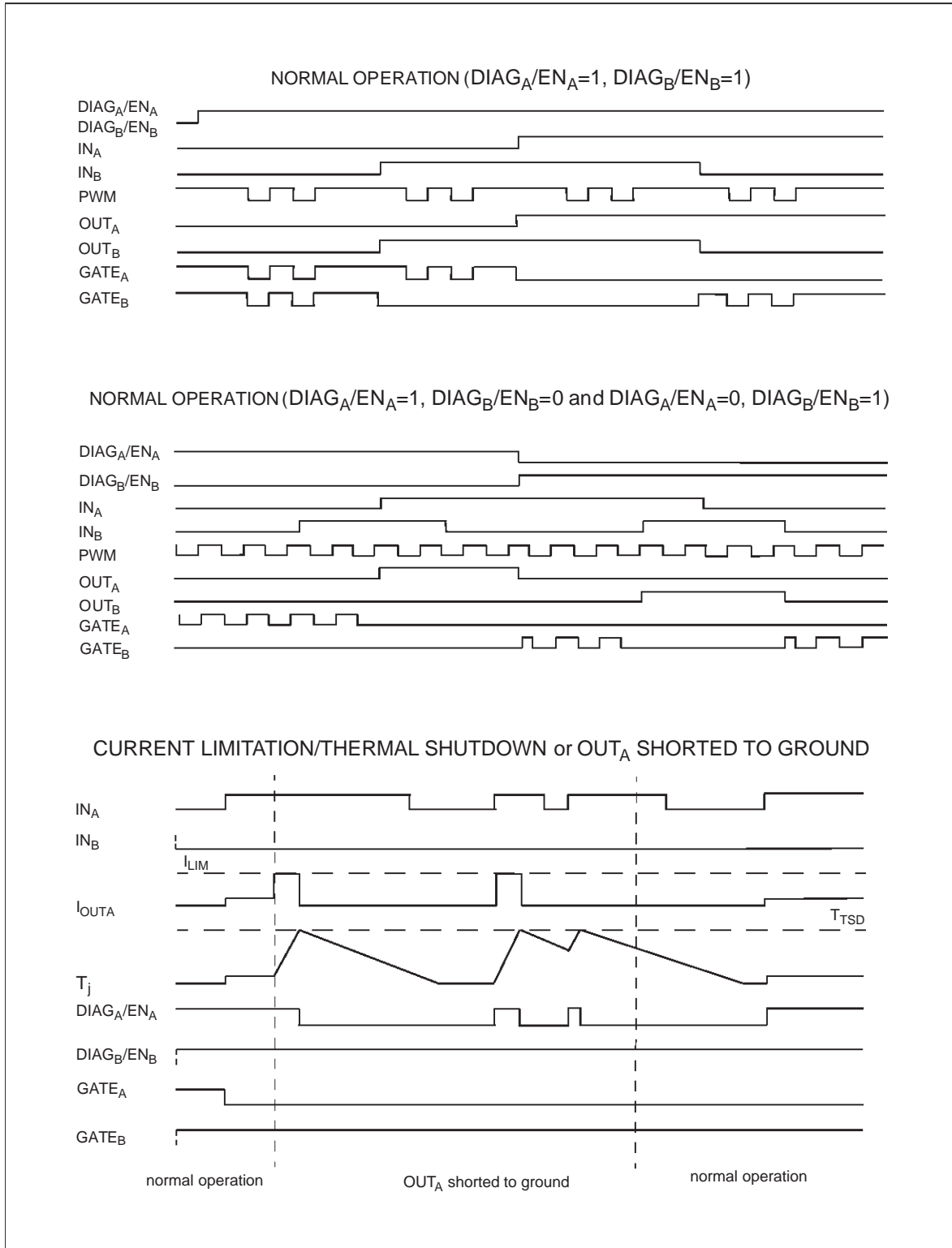
**Figure 2:** Test conditions for external Power MOSFET switching times measurement.



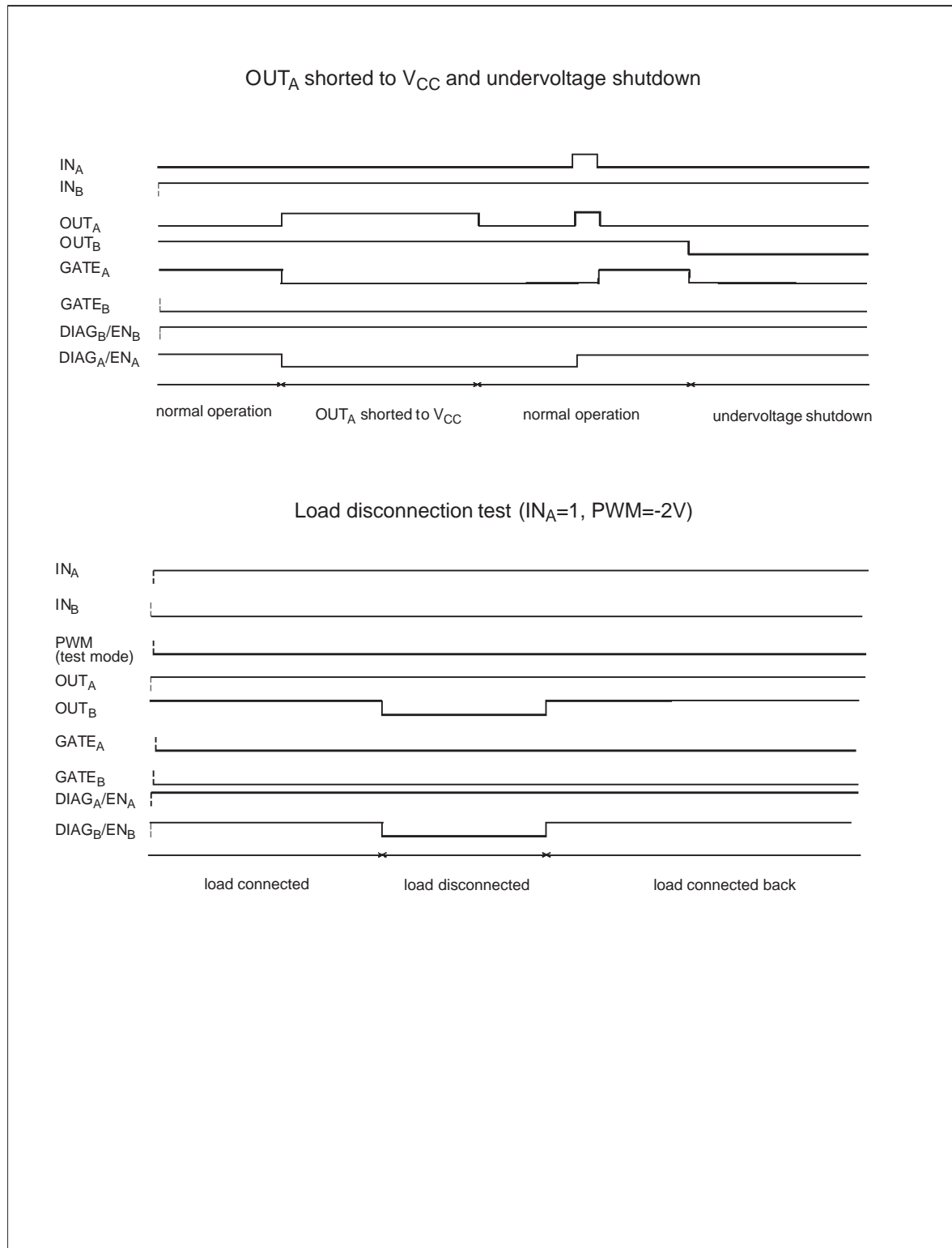
**Figure 3:** Definition of the external Power MOSFET turn-on dead time  $t_{del}$



Waveforms

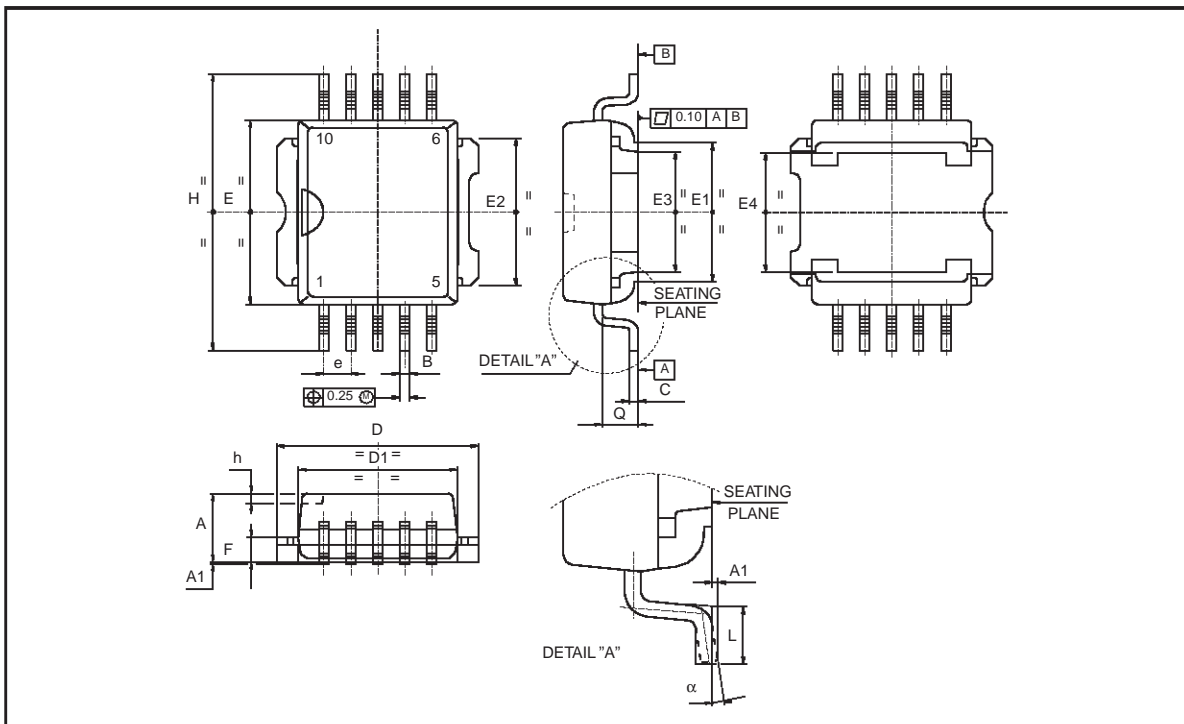


Waveforms (Continued)



**PowerSO-10™ MECHANICAL DATA**

DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	3.35		3.65	0.132		0.144
A1	0.00		0.10	0.000		0.004
B	0.40		0.60	0.016		0.024
c	0.35		0.55	0.013		0.022
D	9.40		9.60	0.370		0.378
D1	7.40		7.60	0.291		0.300
E	9.30		9.50	0.366		0.374
E1	7.20		7.40	0.283		0.291
E2	7.20		7.60	0.283		0.300
E3	6.10		6.35	0.240		0.250
E4	5.90		6.10	0.232		0.240
e		1.27			0.050	
F	1.25		1.35	0.049		0.053
H	13.80		14.40	0.543		0.567
h		0.50			0.002	
L	1.20		1.80	0.047		0.070
Q		1.70			0.067	
α	0°		8°			



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