3-Phase Bridge Driver IC

Features

- Compatible to very low ohmic normal level input N-Channel MOSFETs
- Seperate input for each MOSFET
- PWM frequency up to 30kHz
- Fulfils specification down to 9V supply voltage
- Low EMC sensitivity and emission
- Separate Source connection for each MOSFET
- Adjustable dead time
- Adjustable dI/dt limitation
- Short circuit protection with adjustable current limitation
- Driver undervoltage warning
- Reverse polarity protection
- Disable function
- Input with TTL characteristics
- Error flag
- Thermal overload warning for driver IC
- Shoot through protection
- Shoot through option
- Integrated bootstrap diodes

Product Summary

Turn on current	$I_{Oxx(on)}$	0.5	A
Turn off current	$I_{Oxx(off)}$	0.85	A
Supply voltage range	V_{Vs}	9...20	V
Max. Gatecharge @ 20kHz	Q_G	550	nC
Gate Voltage	V_{GS}	10	V
Temperature range	T_J	-40...+150	°C

P-DSO36-10

Application

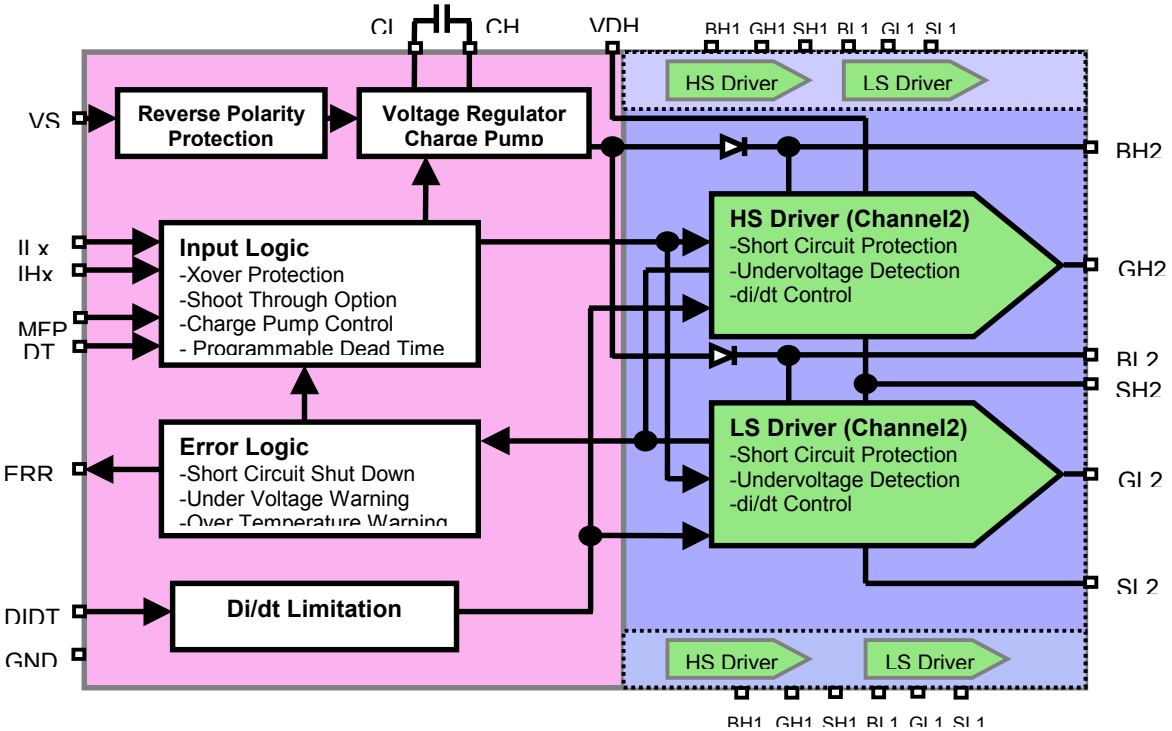
- Dedicated for 3-phase high current motor bridges in PWM control mode. This device fulfils requirements in 12V automotive applications

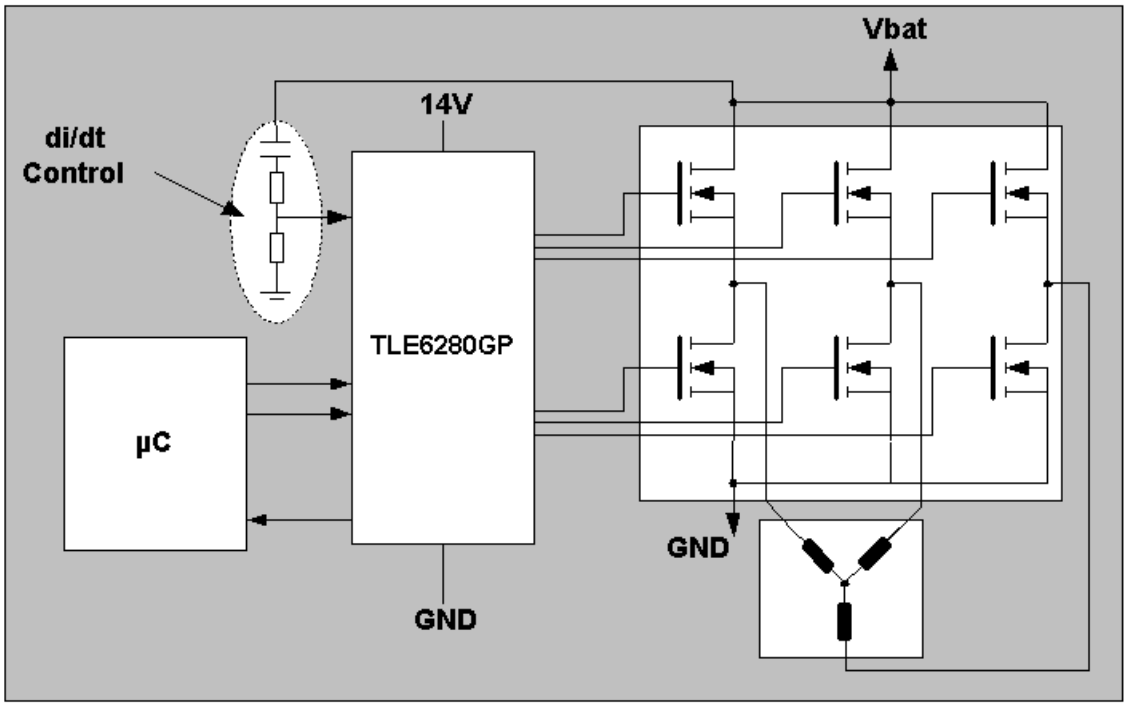
General Description

3 phase bridge driver IC for MOSFET power stages with multiple protection functions.

Block Diagram

Application Block Diagram




Vbat
14V
di/dt
Control
TLE6280GP
µC
GND
GND

Pin	Symbol		Function
1;18;19:36	GND		Logic Ground
8	VS		Voltage supply
20 21	CL CH		Charge pump - capacitor
9 11 13	IH1 IH2 IH3		Control inputs for highside switches 1 to 3 (low active)
10 12 14	IL1 IL2 IL3		Control inputs for lowside switches 1 to 3 (high active)
15	MFP		Multi function pin: a) Disable the complete device by V_{MFP}<1V b) Program pin for output voltage level under short circuit condition (V_{Gxx} –V_{Sxx} = 2xV_{MFP}) c) Enable shoot through option by V_{MFP}>4.5V
17	DT		Program pin for dead time
35	DIDT		Program pin dI/dt limitation
34	VDH		Sense pin for drain voltage of the highside MOS-FETs
16	ERR		Error flag for driver supply under voltage, overtem-perature and short circuit (open drain output)
2 28 22	BH1 BH2 BH3		Bootstrap supply high side switches 1 to 3
5 31 25	BL1 BL2 BL3		Backup capacitor connection low switches 1 to 3
3 29 23	GH1 GH2 GH3		Output to gate high side switches 1 to 3
6 32 26	GL1 GL2 GL3		Output to gate low side switches 1 to 3
4 30 24	SH1 SH2 SH3		Connection to source high side switches 1 to 3
7 33 27	SL1 SL2 SL3		Connection to source low side switches 1 to 3

Maximum Ratings at T_j=25°C unless specified otherwise

Parameter	Symbol	Values	Unit
Supply voltage [1]	V_S	-4 ... 45V	V
Max. Gate charge @ 20kHz	Q_G	550	nC
Operating temperature range Storage temperature range	T_j T_{stg}	-40 ...+150 -55 ...+150	°C
Max. voltage range at Ixx, MFP, DT; ERR		-0.3 ...+7	V
Max. voltage range at SLx	V_{SLx}	-7 ...+7	V
Max. voltage range at SHx	V_{SHx}	-7 ...+45	V
Max. voltage range at VDH, GHx T_j=-40 ... 150°C		 -6 ...+55	V
Max. voltage range at BHx T_j=-40 ... 150°C	V_{BHx}	 -0.3 ...+55	V
Max. voltage difference Bxx - Sxx	V_{Bxx}-V_{Sxx}	-0.3 ...+15	V
Max. voltage difference Gxx - Sxx	V_{Gxx}-V_{Sxx}	-0.3...+11	V
Max. voltage range at CL	V_{CL}	-0.3 ...+10	V
Max. voltage range at CH	V_{CH}	-0.3 ...+18	V
Max. voltage range at DIDT	V_{DIDT}	-7 ...+7	V
Power dissipation (DC) @ T_C=125°C	P_{tot}	1.2	W
Electrostatic discharge voltage (Human Body Model) according to MIL STD 883D, method 3015.7 and EOS/ESD assn. standard S5.1 - 1993	V_{ESD} [2]	2	kV
DIN humidity category, DIN 40 040		E	
IEC climatic category, DIN IEC 68-1		40/150/56	
Jedec Level		3	

Thermal resistance junction-case	R_{thJC}	≤5	K/W

Functional range

Parameter and Conditions at T_j = 25 °C, unless otherwise specified	Symbol	Values			Unit
		min	typ	max	

Parameter	Symbol	Values	Unit
Supply voltage	V_S	9 ... 20	V
Operating temperature range	T_j	-40 ...+150	°C
Duty Cycle @ 20kHz [3] [4]		0...96	%
Max. Gate charge @ 20kHz ; 0...98% duty cycle @ 20kHz ; 2...96% duty cycle	Q_G	275 550	nC
Max. voltage range at Ixx,ERR		-0.3 ...+7	V

[1] With external resistor (≥10 Ω) and capacitor
[2] All test involving Bxx pins V_{ESD}=1kV!
[3] As long as one switch is switched with the PWM frequency
[4] If the Bootstrap Capacitor is pumped up to V_{BHx}-V_{SHx}=12V, the maximum duty cycle is 100% for 500 µs

Max. voltage range at MFP[5]	V_{MFP}	-0.3 ...+5	V
Max. voltage range at SLx	V_{SLx}	-7 ...+7	V
Max. voltage range at SHx	V_{SHx}	-7 ...+45	V
Max. voltage range at VDH, GHx T_j=-40 ... 150°C		-6 ...+55	V
Max. voltage range at BHx T_j=-40 ... 150°C	V_{BHx}	-0.3 ...+55	V
Max. voltage range at DIDT	V_{DIDT}	-7 ...+7	V
PWM frequency	F_{PWM}	2...30	kHz
Min. dead time resistor[6]	R_{DT}	10	kΩ

Electrical Characteristics

Parameter and Conditions at T_j = 25 °C, unless otherwise specified and supply voltage range V_S = 9 ... 18V; f_{PWM} = 20kHz	**Symbol**	**Values**			**Unit**
		min	typ	max	
Static Characteristics					
Low level output voltage (V_{Oxx}-V_{Sxx}) @ I=10mA	ΔV_{LL}	--	50	100	mV
High level output voltage (V_{Oxx}-V_{Sxx}) @ I=-10mA	ΔV_{HL}	8	10	11	V
Supply current at VS (device disabled) @ V_{bat}= V_S =14V R_{DT}=400kΩ V_{MFP}=3V	$I_{VS(dis)}$	--	--	12	mA
Supply current at VS @ 20kHz V_{MFP}≤4V (Outputs open)	$I_{VS(open)}$	--	20	--	mA
Low level input voltage T=-40 + 150°C	$V_{IN(LL)}$	--	--	1.0	V
High level input voltage T=-40 + 150°C	$V_{IN(HL)}$	2.0	--	--	V
Input hysteresis	ΔV_{IN}	100	200		mV

[5] V_{MFP} up to 7V allowed up to 500ms
[6] Otherwise the supply current level $I_{VS(DIS)}$ will be increased

Dynamic characteristics

Turn on current @ V_{Gxx} -V_{Sxx} = 0V; T_j=25°C	$I_{Gxx(on)}$	--	0.5	--	A
@ V_{Gxx} -V_{Sxx} = 4V; T_j=125°C		--	0.8	--	
Turn off current @ V_{Gxx} -V_{Sxx} = 10V; T_j=25°C	$I_{Oxx(off)}$	--	0.85	--	A
@ V_{Gxx} -V_{Sxx} = 4V; T_j=125°C		--	0.6	--	
Dead time (adjustable) @ R_{DT} = 1 kΩ[7]	t_{DT}	--	0.1	--	µs
@ R_{DT} = 10 kΩ			0.24		
@ R_{DT} = 50 kΩ			0.9		
@ R_{DT} = 200 kΩ			2.6		
@ R_{DT} = 400 kΩ			3.8		
@ R_{DT} > 1 MΩ			1.9		
Rise time @ C=22nF	t_{rise}	--	300	880	ns
Fall time @ C=22nF	t_{fall}	--	300	440	ns
Disable propagation time	$t_{P(DIS)}$	--	tbd	1000	ns
Input propagation time (low on)	$t_{P(ILN)}$	--	300	500	ns
Input propagation time (low off)	$t_{P(ILF)}$	--	350	500	ns
Input propagation time (high on)	$t_{P(IHN)}$	--	330	500	ns
Input propagation time (high off)	$t_{P(IHF)}$	--	300	500	ns
Input propagation time difference	$t_{P(Diff)}$	--	tbd	50	ns

Diagnosis and Protection Functions

Undervoltage warning at ERR	V_{Bxx}-V_{Sxx}	8	9.2	--	V
Overtemperature warning	$T_{J(OV)}$	150	170	tbd	°C
Hysteresis for overtemperature warning	$\Delta T_{J(OV)}$		20		°C
Short circuit protection shut down time delay	$t_{SCP(off)}$		12		µs
Short circuit criteria (V_{DS} of Mosfets) @ V_{MFP}=3V[8]	$V_{DS(SCP)}$		1.5		V
Factor between V_{MFP} and max. V_{GXX} @ 2V < V_{MFP} < 4V	V_{GxxMax}/V_{MFP}		2		
Disable input level [9]	$V_{MFP(DIS)}$	1.1	tbd	1.7	V
Disable input hysteresis	$\Delta V_{MFP(DIS)}$	--	250	--	mV
Error level @ 1.6mA I_{ERR}	V_{ERR}	--	--	1.0	V

dI /dt limitation

Non reaction level for dI/dt limitation (100% gate driver capability)	V_{DIDT}	2	--	tbd	V
Full reaction level for dI/dt limitation (Gate output current < 5mA)	V_{DIDT}	tbd	5	tbd	V

[7] With increased $I_{VS(DIS)}$
[8] aperiodic short circuit condition will be detected within several cycles, if the duty cycle is more than 10%
[9] If the device is reset after disable, the slope of $dU_{(VMFP)}/dt$ has to be higher than 3.5V/50µs

Shoot through option					
Enable level for shoot through option together with all Mosfets switched on	V_{MFP}	4	--	4.5	V

Remarks:

Default status of input pins:

To asure a defined status of all input pins in case if disconnection, these pins are internally secured by pull up / pull down current sources with approx. 10µA.
The following table shows the default status of each input pin.

Input pin	Default status
ILx	Low
Ihx	High
DIDT	Pull down with approx. 150Ω
DT	2µs dead time
MFP	Disable (pull down)

Shoot through option:

In order to avoid uncontrolled currents in the motor in short circuit case, it is possible to override the short circuit protection and by setting the ILx to “high”, the IHx to “low” and MFP to a level above 4.5V.

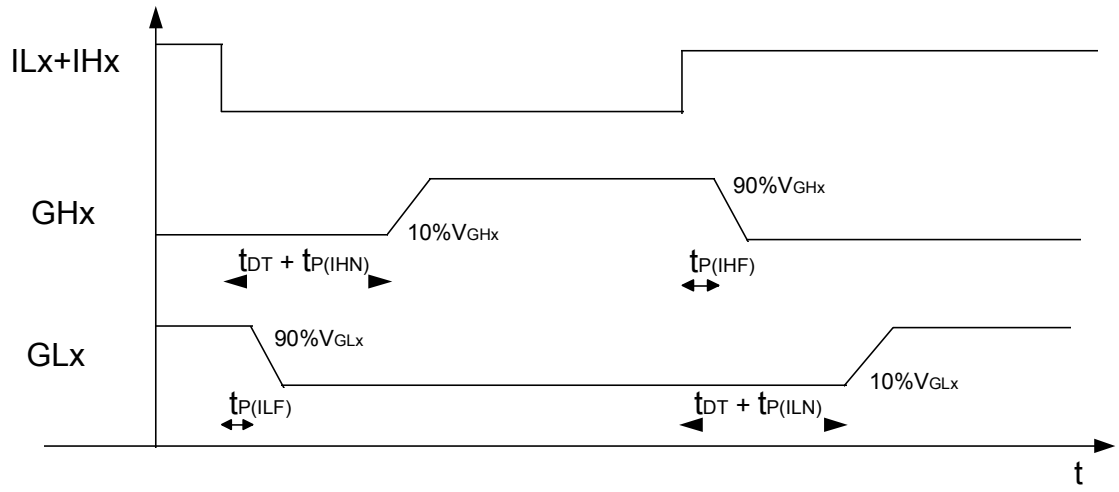
Reset:

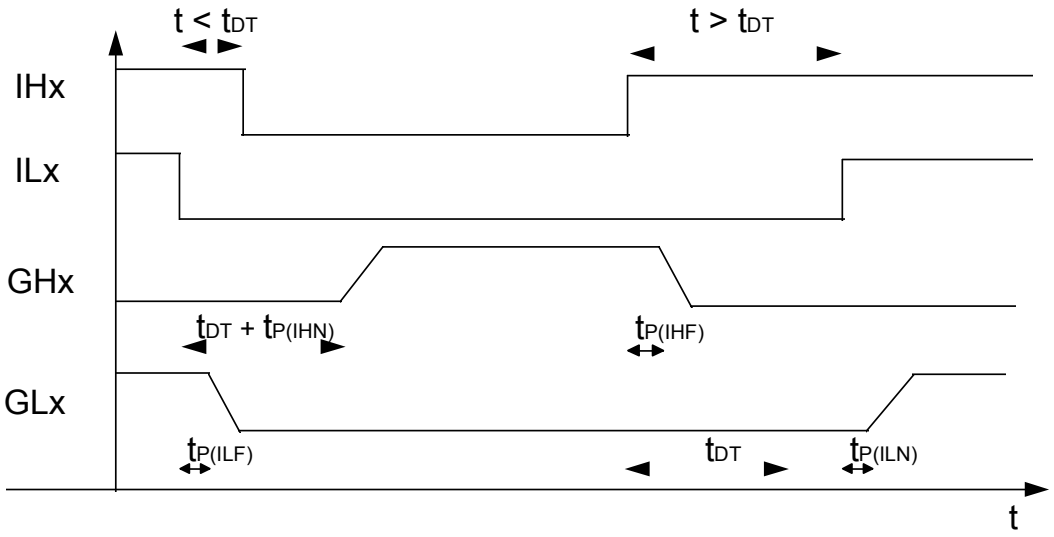
To reset the driver, the device has to be disabled for more than 1 µs

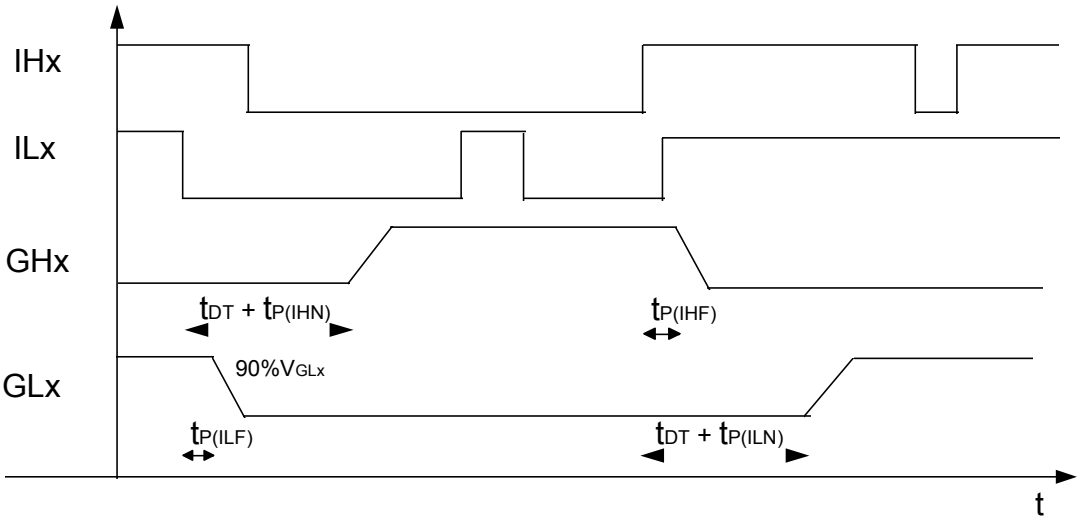
External components:

It is recomended to dimension the bootstrap and bypass ceramic capacitors according the rule C = total gate charge of the mosfet / 0.5V.
The charge pump capacitor should be 6 times higher than the bootstrap / bypass capacitors.

Dead time diagrams:




t < tDT
t > tDT
IHx
ILx
GHx
tDT + tP(IHN)
tP(IHF)
GLx
tP(ILF)
tDT
tP(ILN)
t


IHx
ILx
GHx
tDT + tP(IHN)
tP(IHF)
GLx
90%VGLx
tP(ILF)
tDT + tP(ILN)
t

Truth Table

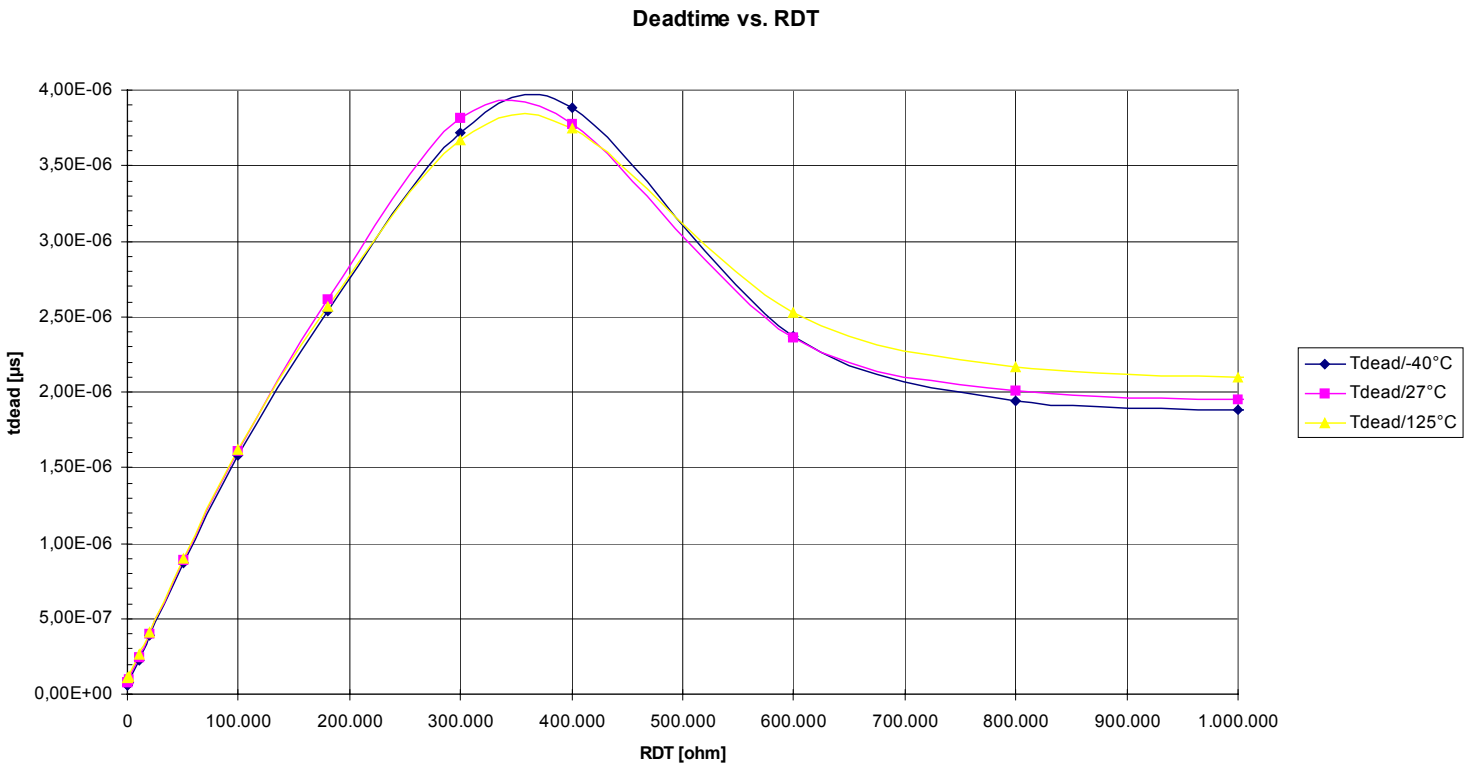
Input				Conditions			Output		
ILx	IHx	DT	MFP	UV	OT	SC	GLx	GHx	ERR
1	1	D	>1.7V	0	0	0	1	0	5V
0	0	D	>1.7V	0	0	0	0	1	5V
1	0	D	1.7-4.5V	0	0	0	A	A	5V
0	1	D	>1.7V	0	0	0	0	0	5V
0	0	D	>1.7V	1	0	0	0	1	0V
1	1	D	>1.7V	1	0	0	1	0	0V
1	0	D	1.7-4.5V	1	0	0	A	A	0V
0	1	D	>1.7V	1	0	0	0	0	0V
0	0	D	>1.7V	0	1	0	0	1	0V
1	1	D	>1.7V	0	1	0	1	0	0V
1	0	D	1.7-4.5V	0	1	0	A	A	0V
0	1	D	>1.7V	0	1	0	0	0	0V
X	X	D	>1.7V	0	0	1	0	0	B
X	X	D	<1.1V	0	0	X	0	0	5V
X	X	D	<1.1V	1	0	X	0	0	0V
X	X	D	<1.1V	0	1	X	0	0	0V
X	X	D	<1.1V	1	1	X	0	0	0V
C	C	D	>4.5V	X	X	X	1	1	0V

A) stays in the condition before the shoot throught condition occurs (see also dead time diagrams)
B) ERR=0V and stays latched until reset
C) All 3 ILx=1 AND all 3 IHx=0
D) No influence on static results
X) Can be 0 or 1

Definition:

In this datasheet a duty cycle of 98% means, that the GLx pin is 2% of the PWM period in high condition.
Remark: Please consider the influence of the dead time for your input duty cycle

Diagram “Deadtime vs. R_{DT}”



Package and Ordering Code

(all dimensions in mm)

Package Code	Ordering Code
P-DSO 36-10	**Q67007-A9406**