

## Smart Quad Low-Side Switch

### Features

- Shorted circuit protection
- Overtemperature protection
- Overvoltage protection
- Open Load Detection
- Direct parallel control of the inputs
- Inputs high or low active programmable
- General fault flag
- Very low standby quiescent current
- Compatible with 3V microcontrollers
- **Electrostatic discharge (ESD) protection**

### Application

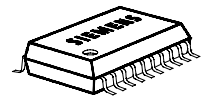
- $\mu$ C compatible power switch for 12 V applications
- Switch for automotive and industrial systems
- Line, relay or lamp driver

### General description

Quad channel Low-Side Switch in Smart Power Technology (SPT) with four separate inputs and four open drain DMOS output stages. The TLE 6225 G is protected by embedded protection functions and designed for automotive and industrial applications, to drive lines, lamps and relays.

### Product Summary

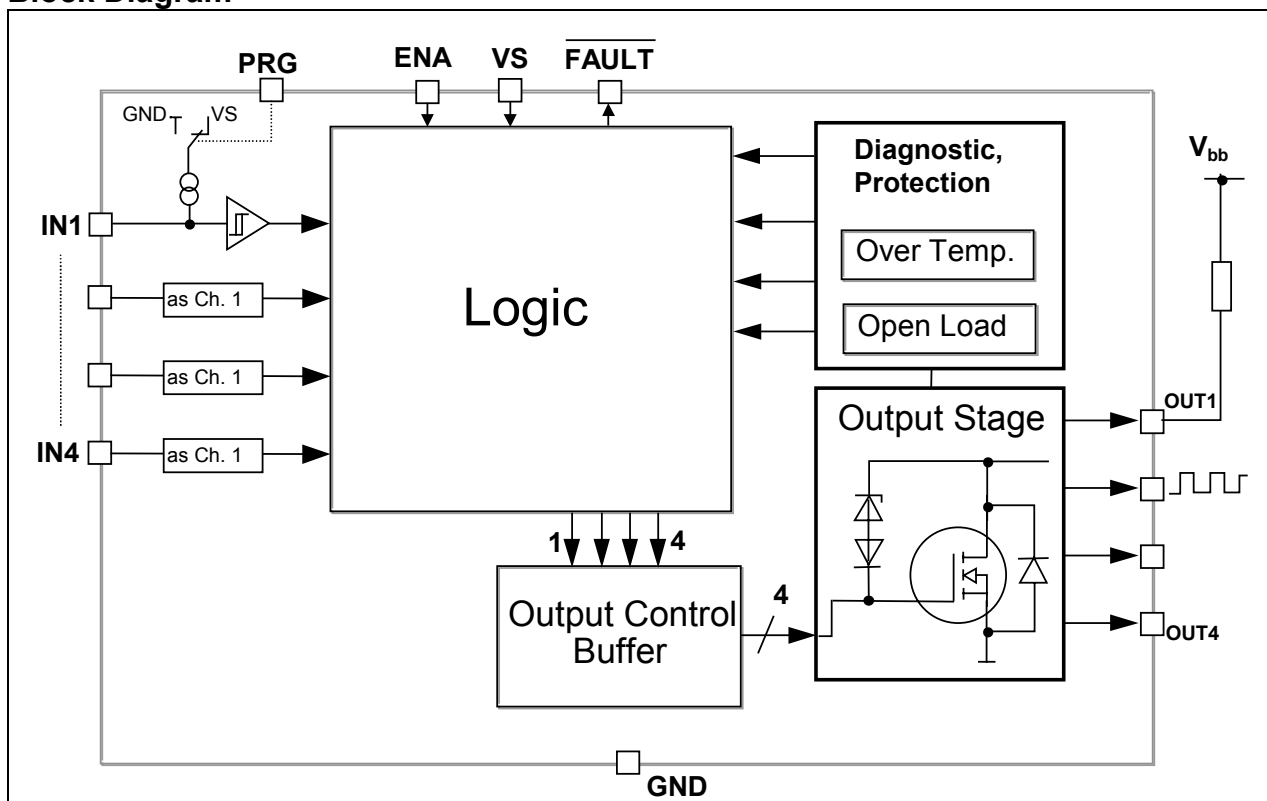
Supply voltage	$V_S$	4.5 – 32	V
Drain source voltage	$V_{DS(AZ)max}$	60	V
On resistance	$R_{ON}$	1.7	$\Omega$
Output current(each) (individ.)	$I_{D(NOM)}$	350 500	mA mA



P-DSO 20-6

Ordering Code:  
Q 67006 A9373

### Block Diagram



## Pin Description

Pin	Symbol	Function
1	IN1	Input Channel 1
2	IN2	Input Channel 2
3	FAULT	General Fault Flag
4	GND	Ground
5	GND	Ground
6	GND	Ground
7	GND	Ground
8	VS	Supply Voltage
9	IN3	Input Channel 3
10	IN4	Input Channel 4
11	ENA	Enable for all channels/Standby
12	OUT4	Power Output channel 4
13	OUT3	Power Output channel 3
14	GND	Ground
15	GND	Ground
16	GND	Ground
17	GND	Ground
18	OUT2	Power Output channel 2
19	OUT1	Power Output channel 1
20	PRG	Program (inputs high or low active)

## Pin Configuration (Top view)

IN1	1●	20	PRG
IN2	2	19	OUT1
FAULT	3	18	OUT2
GND	4	17	GND
GND	5	16	GND
GND	6	15	GND
GND	7	14	GND
VS	8	13	OUT3
IN3	9	12	OUT4
IN4	10	11	ENA

P-DSO-20-6

## Maximum Ratings for $T_j = -40^{\circ}\text{C}$ to $150^{\circ}\text{C}$

Parameter	Symbol	Values	Unit
Supply Voltage	$V_S$	-0.3 ... +40	V
Continuous Drain Source Voltage (OUT1...OUT4)	$V_{DS}$	-0.7 ... +45	V
Input Voltage, IN1 - IN4	$V_{IN}$	- 0.3 ... + 7	V
Input Voltage, PRG, ENA	$V_{IN}$	- 0.3 ... + 40	V
Output Load Dump Protection $V_{Load\ Dump} = U_P + U_S$ ; $U_P = 13.5\text{ V}$ With Automotive Relay Load $R_L = 70\ \Omega$ $R_l^{1)} = 2\ \Omega$ ; $t_d = 400\text{ms}$ ; IN = low or high	$V_{Load\ Dump}^{2)}$	75	V
FAULT Output Voltage	$V_{Fault}$	- 0.3 ... + 40	V
Operating Temperature Range	$T_j$	- 40 ... + 150	$^{\circ}\text{C}$
Storage Temperature Range	$T_{stg}$	- 55 ... + 150	$^{\circ}\text{C}$
Output Current per Channel (see electrical characteristics)	$I_{D(lim)}$	self limited	A
Output Clamping Energy $I_D = 0.2\text{ A}$	$E_{AS}$	10	mJ
Power Dissipation (DC) @ $T_A = 25^{\circ}\text{C}$ (on PCB $6\text{ cm}^2$ cooling area)	$P_{tot}$	2.5	W
Electrostatic Discharge Voltage (Human Body Model) according to MIL STD 883D, method 3015.7 and EOS/ESD assn. standard S5.1 - 1993	$V_{ESD}$	2000	V
DIN Humidity Category, DIN 40 040		E	
IEC Climatic Category, DIN IEC 68-1		40/150/56	
Thermal Resistance			
junction - pin	$R_{thJP}$	23	K/W
junction - ambient @ min. footprint	$R_{thJA}$	80	
junction - ambient @ $6\text{ cm}^2$ cooling area	$R_{thJA}$	45	

<sup>1)</sup>  $R_l$  = internal resistance of the load dump test pulse generator LD200

<sup>2)</sup>  $V_{LoadDump}$  is setup without DUT connected to the generator per ISO 7637-1 and DIN 40 839.

## Electrical Characteristics

Parameter and Conditions $V_S = 4.5$ to $32$ V ; $T_J = -40$ °C to $+150$ °C (unless otherwise specified)	Symbol	Values			Unit
		min	typ	max	

### 1. Power Supply

Supply Voltage	$V_S$	4.5		32	V
Supply Current (ENA = H, Outputs ON)	$I_{S(ON)}$		1	2	mA
Supply Current in Standby Mode (ENA = L)	$I_{S(stby)}$			10	μA

### 2. Power Outputs

ON Resistance $V_S \geq 6\text{ V}$ ; $I_D = 300\text{ mA}$	$T_J = 25^\circ\text{C}$	$R_{DS(ON)}$		1.7	2	$\Omega$
	$T_J = 150^\circ\text{C}$			3	3.6	
Output Clamping Voltage	Output OFF	$V_{DS(AZ)}$	45	50	60	V
Current Limit		$I_{D(lim)}$	500	750	1000	mA
Output Leakage Current	$V_{ENA} = L$	$I_{D(lkg)}$			5	$\mu\text{A}$
Turn-On Time	$I_D = 200\text{ mA}$ , resistive load	$t_{ON}$		5	10	$\mu\text{s}$
Turn-Off Time	$I_D = 200\text{ mA}$ , resistive load	$t_{OFF}$		5	10	$\mu\text{s}$

### 3. Digital Inputs (IN1 – IN4, ENA, PRG)

Input Low Voltage (IN1 – IN4, PRG)	$V_{INL}$	- 0.3		1	V
Input Low Voltage (ENA)	$V_{INL}$	- 0.3		0.8	V
Input High Voltage	$V_{INH}$	2.0			V
Input Voltage Hysteresis (IN1 – IN4, PRG)	$V_{INHys}$	50	100		mV
Input Voltage Hysteresis (ENA)	$V_{INHys}$	20	100		mV
Input Pull Up Current (IN1...IN4) @ PRG = L, $V_{IN} = 0V$	$I_{IN(1..4)PU}$	20	50	100	$\mu A$
Input Pull Down Current (IN1...IN4) @ PRG = H, $V_{IN} < V_S$ ; $V_{IN} < 6$	$I_{IN(1..4)PD}$	20	50	100	$\mu A$
PRG, ENA Pull Down Current $V_{IN} = 5\text{ V}$	$I_{IN(PRG,ENA)}$	20	50	100	$\mu A$
PRG, ENA Pull Down Current $V_{IN} = 14\text{ V}$	$I_{IN(PRG,ENA)}$			200	$\mu A$

### 4. Digital Output (FAULT)

FAULT Output Low Voltage	$I_{FAULT} = 1.6$ mA	$V_{FAULTL}$			0.4	V
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### 5. Diagnostic Functions

Open Load/Short to Ground Detection Voltage	$V_{DS(OL)}$	$0.4 \cdot V_S$	$0.5 \cdot V_S$	$0.6 \cdot V_S$	V
Output Pull Down Current	$I_{PD(OL)}$	20	50	200	μA
Fault Delay Time; $V_S = 12$ V	$t_{d(fault)}$	50	100	200	μs
Overtemperature Shutdown Threshold	$T_{th(sd)}$	170		200	°C
Hysteresis	$T_{hys}$		10		K

## Functional Description

The TLE 6225 G is a quad channel low-side switch with four power DMOS stages. The power transistors are protected against short to  $V_{BB}$ , overload, overtemperature and against over-voltage by zenerclamp.

The diagnostic logic recognises a fault condition which is indicated by a fault flag.

## Circuit Description

### Output Stage Control

Each output is independently controlled by an input pin and a common enable line, which enables/disables all four outputs. The parallel inputs are high or low active depending on the PRG pin. If the parallel input pins are not connected (independent of high or low activity) it is guaranteed that the outputs 1 to 4 are switched OFF. ENA - and PRG - pin itself are internally pulled down when they are not connected.

**ENA** - Enable pin.      ENA = High:      Active mode. Channels are enabled  
                                  ENA = Low (GND): Sleep mode. Channels are switched off. Less than 1  $\mu$ A current consumption.

**PRG** - Program pin.      PRG = High:      Parallel inputs Channel 1 to 4 are high active  
                                  PRG = Low (GND): Parallel inputs Channel 1 to 4 are low active.

### Power Transistors

Each of the four output stages has its own zenerclamp. This causes a voltage limitation at the power transistors when inductive loads are switched off. The outputs are provided with a current limitation set to a minimum of 500 mA.

Each output is protected by embedded protection functions. In the event of an overload or short to supply, the current is internally limited. If this operation leads to an overtemperature condition, a second protection level (about 170 °C) will turn the effected output into a PWM-mode (selective thermal shutdown with restart) to prevent critical chip temperatures. The temperature hysteresis is typically 10K.

### Diagnostic

The  $\overline{\text{FAULT}}$  pin is an open drain output. The logic status depends on the programming pin PRG.

**$\overline{\text{FAULT}}$**  - pin.       $\overline{\text{FAULT}}$  = High      no fault @ PRG = High  
                                   $\overline{\text{FAULT}}$  = Low      no fault @ PRG = Low

## Diagnostic Table

Operating Condition	Enable Input	Program Input	Control Input	Power Output	Diagnostic Output
	ENA	PRG	IN	OUT	FAULT
Standby	L	X	X	OFF	H
Normal function	H	L	L	ON	L
	H	L	H	OFF	L
	H	H	L	OFF	H
	H	H	H	ON	H
Overtemperature	H	L	L	OFF *	H
	H	H	H	OFF *	L
Open load or short to ground	H	L	L	ON	L
	H	L	H	OFF	H
	H	H	L	OFF	L
	H	H	H	ON	H

X = not relevant

\*selective thermal shutdown for each channel at overtemperature

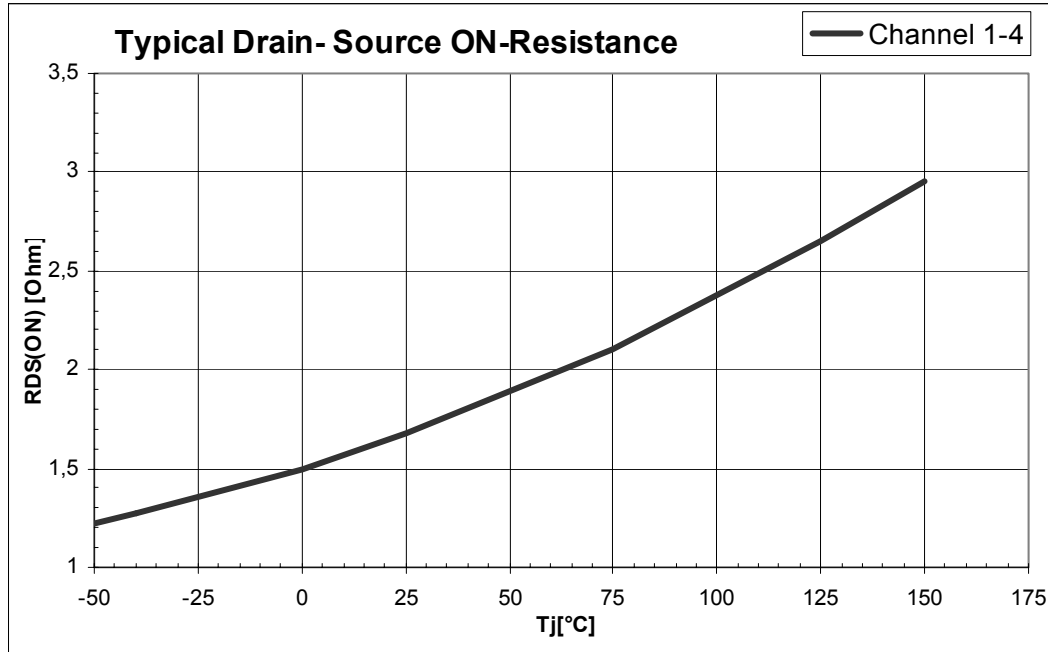
## Fault Distinction

Open load/short to ground is recognised in OFF-state. Overtemperature as a result of an overload or short to battery can only arise in ON-state. If there is only one fault at a time, it is possible to distinguish which channel is affected with which fault.

## Typical electrical Characteristics

### Drain-Source on-resistance

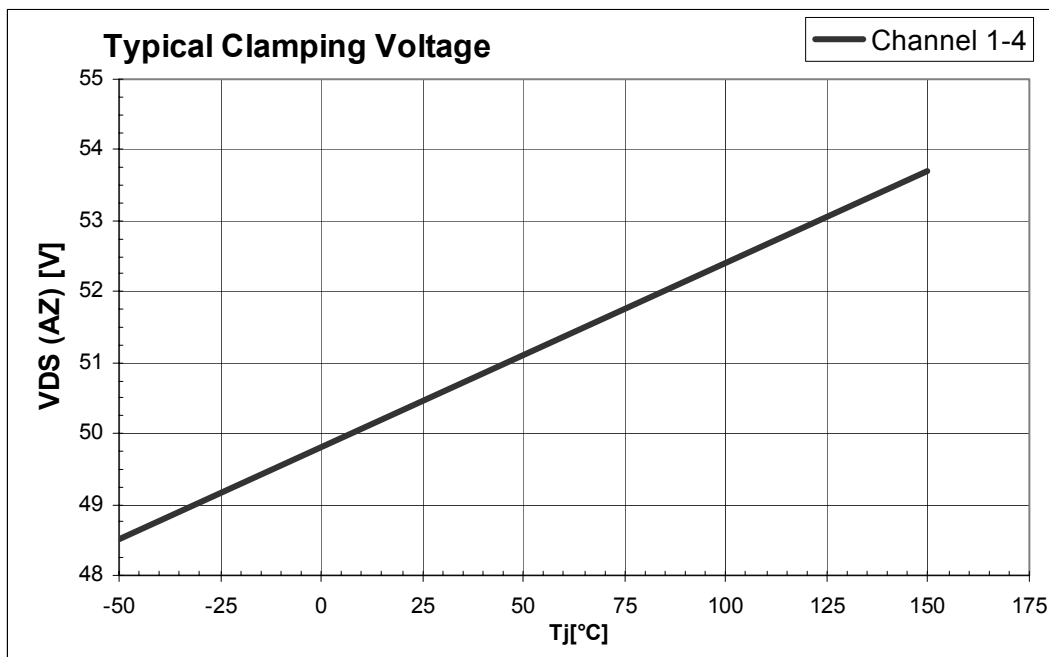
$$R_{DS(ON)} = f(T_j) ; V_s = 5V$$



**Figure 6 :** Typical ON Resistance versus Junction-Temperature  
Channel 1-4

### Output Clamping Voltage

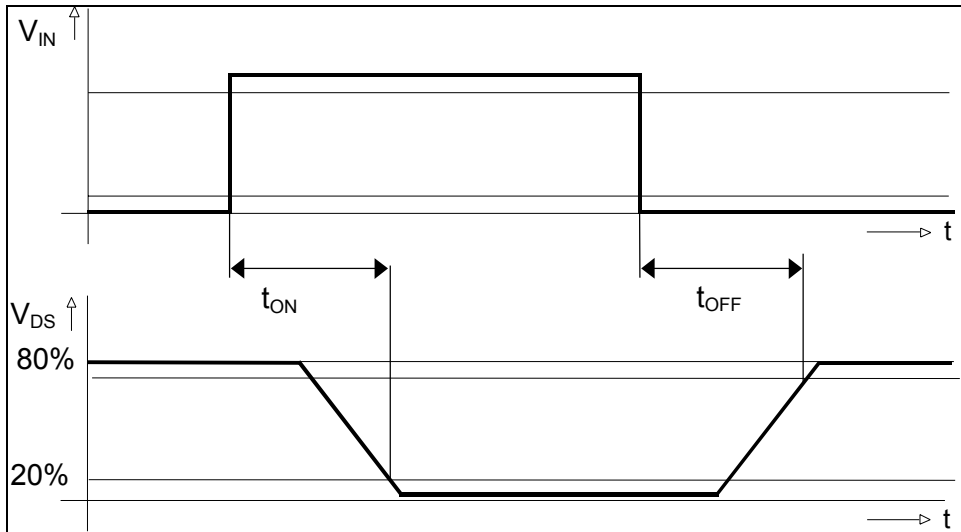
$$V_{DS(AZ)} = f(T_j) ; V_s = 5V$$



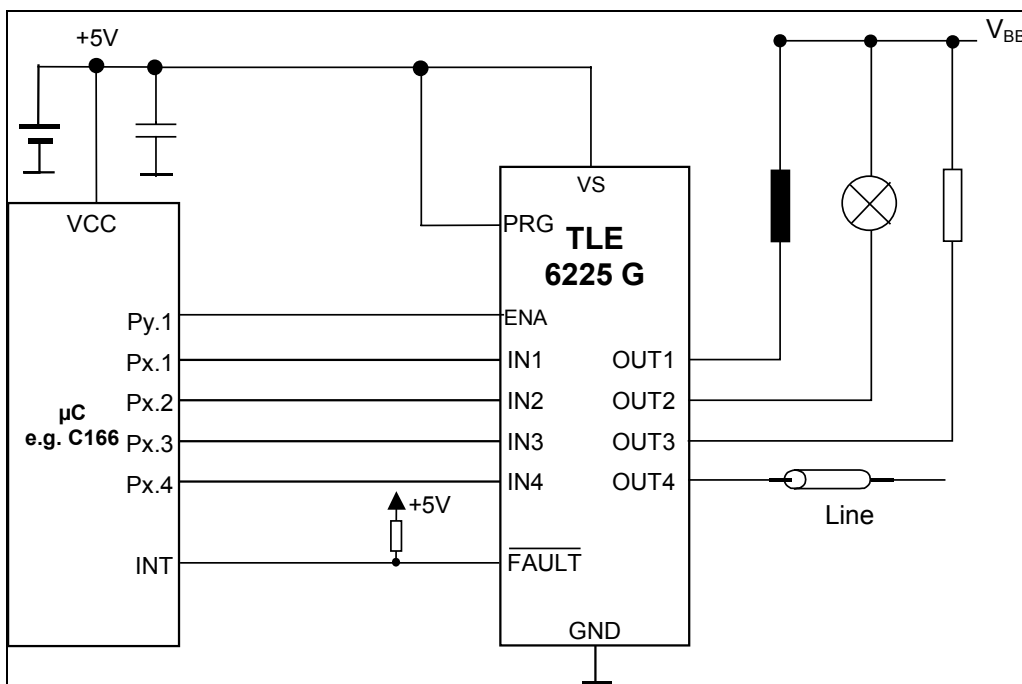
**Figure 7 :** Typical Clamp Voltage versus Junction-Temperature  
Channel 1-4

## Timing Diagrams

### Power Outputs



### Application Circuit





## Package and ordering code

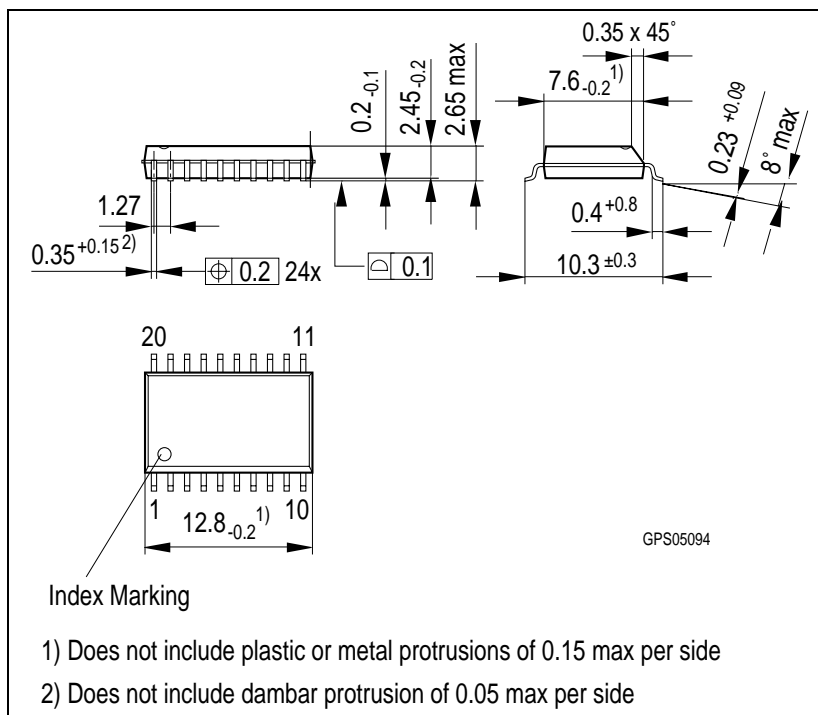
all dimensions in mm

**P - DSO - 20 - 6**

Ordering code

TLE 6225 G

Q 67006 A9373



**Published by**  
**Infineon Technologies AG,**  
**Bereichs Kommunikation**  
**St.-Martin-Strasse 76,**  
**D-81541 München**  
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