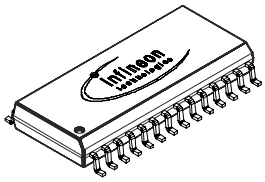
Hex-Half-Bridge / Double Six-Driver TLE 6208-6 G

Data Sheet **SPT 4**

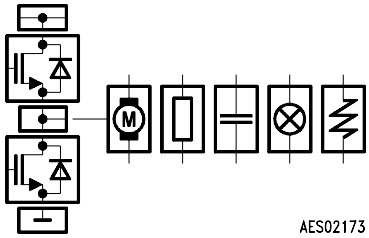
1 Overview



P-DSO-28-6
Enhanced Power

1.1 Features

- Six High-Side and six Low-Side-Drivers
- Free configurable as switch, halfbridge or H-bridge
- Optimized for DC motor management applications
- 0.6 A continuous (1 A peak) current per switch
- $R_{DS\ ON}$; typ. 0.8 Ω, @ 25 °C per switch
- Outputs fully short circuit protected with diagnosis
- Overtemperature-Protection with hysteresis and diagnosis
- Temperature prewarning
- Standard SPI-Interface
- Very low current consumption (typ. 10 µA, @ 25 °C) in stand-by (Inhibit) mode
- Over- and Undervoltage-Lockout
- CMOS/TTL compatible inputs with hysteresis
- Internal clamp diodes
- Enhanced power P-DSO-Package



Type	Ordering Code	Package
TLE 6208-6 G	Q67007-A9462	P-DSO-28-6

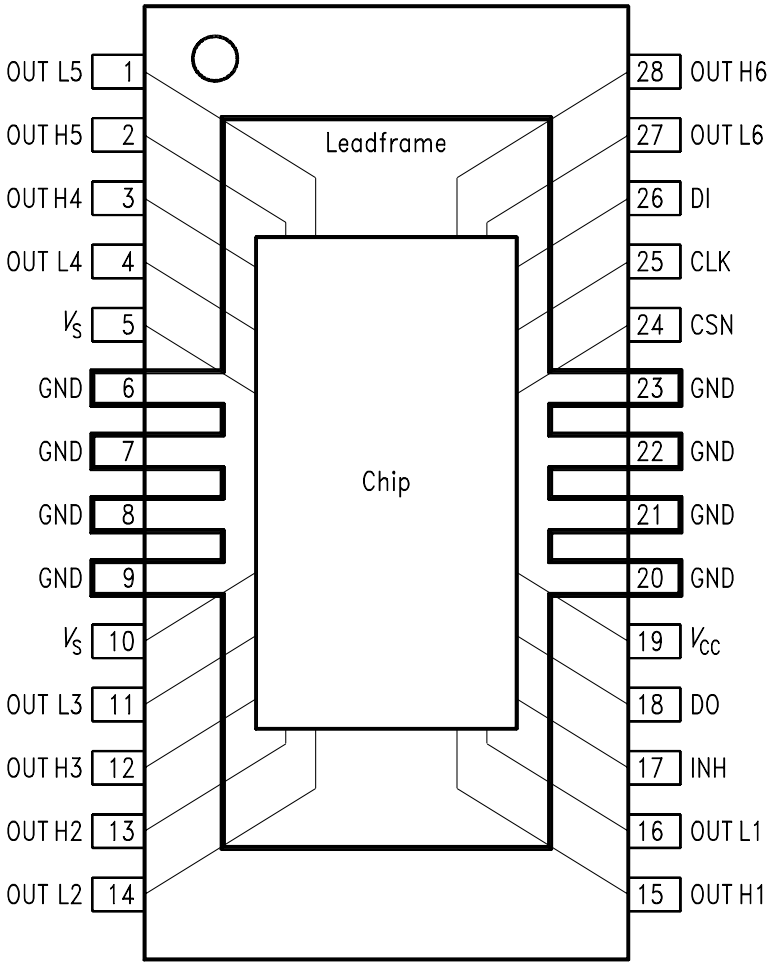
Functional Description

The TLE 6208-6 G is a fully protected **Hex**-**H**alf-**B**ridge-**D**river designed specifically for automotive and industrial motion control applications. The part is based on Infineons Smart Power Technology SPT® which allows bipolar and CMOS control circuitry in accordance with DMOS power devices existing on the same monolithic circuitry. The six low and high side drivers are freely configurable and can be controlled separately. Therefore all kind of loads can be combined. In motion control up to 5 actuators (DC-Motors) can be connected to the 6 halfbridge-outputs (cascade configuration). Operation modes forward (cw), reverse (ccw), brake and high impedance are controlled from a standard SPI-Interface. The possibility to control the outputs via software from a central logic, allows limiting the power dissipation. So the standard P-DSO-28-6-package meets the application requirements and saves PCB-Board-space and cost.

Furthermore the build-in features like Over- and Undervoltage-Lockout, Over-Temperature-Protection and the very low quiescent current in stand-by mode opens a wide range of automotive- and industrial-applications.

1.2 Pin Configuration
(top view)

P-DSO-28-6



Legend:

V_S = Power Supply Voltage
OUT = Output
L = Low
H = High
GND = Ground
V_{CC} = 5V Supply

DI = Data Input
DO = Data Output
CLK = Clock Input
CSN = Chip–Select–Not Input
INH = Inhibit Input

AEP02174

Figure 1

1.3 Pin Definitions and Functions

Pin No.	Symbol	Function
1	OUTL5	**Low-Side-Output 5**; Power-MOS open drain with internal reverse diode; no internal clamp diode or active zenering; short circuit protected and open load controlled.
2	OUTH5	**High-Side-Output 5**; Power-MOS open source with internal reverse diode; no internal clamp diode or active zenering; short circuit protected and open load controlled.
3	OUTH4	**High-Side-Output 4**; see pin2.
4	OUTL4	**Low-Side-Output 4**; see pin1.
5	V_S	**Power supply**; external connection to pin 10 necessary; needs a blocking capacitor as close as possible to GND Value: 22 µF electrolytic in parallel to 220 nF ceramic.
6, 7, 8, 9	GND	**Ground;** Reference potential; internal connection to pin 20, 21, 22 and 23; cooling tab; to reduce thermal resistance; place cooling areas on PCB close to this pins.
10	V_S	**Power Supply**; see pin 5.
11	OUTL3	**Low-Side-Output 3**; see pin1.
12	OUTH3	**High-Side-Output 3**; see pin2.
13	OUTH2	**High-Side-Output 2**; see pin2.
14	OUTL2	**Low-Side-Output 2**; see pin1.
15	OUTH1	**High-Side-Output 1**; see pin2.
16	OUTL1	**Low-Side-Output 1**; see pin1.
17	INH	**Inhibit input;** has an internal pull down; device is switched in standby condition by pulling the INH terminal low.
18	DO	**Serial-Data-Output;** this 3-state output transfers diagnosis data to the control device; the output will remain 3-stated unless the device is selected by a low on Chip-Select-Not (CSN); see **Table 2** for Diagnosis protocol.
19	V_{CC}	**Logic supply voltage**; needs a blocking capacitor as close as possible to GND; Value: 10 µF electrolytic in parallel to 220 nF ceramic.

1.3 Pin Definitions and Functions (cont'd)

Pin No.	Symbol	Function
20, 21, 22, 23	GND	**Ground**
24	CSN	**Chip-Select-Not input**; CSN is an active low input; serial communication is enabled by pulling the CSN terminal low; CSN input should only be transitioned when CLK is low; CSN has an internal active pull up and requires CMOS logic level inputs.
25	CLK	**Serial clock input**; clocks the shiftregister; CLK has an internal active pull down and requires CMOS logic level inputs.
26	DI	**Serial data input;** receives serial data from the control device; serial data transmitted to DI is an 16bit control word with the Least Significant Bit (LSB) being transferred first: the input has an active pull down and requires CMOS logic level inputs; DI will accept data on the falling edge of CLK-signal; see **Table 1** for input data protocol.
27	OUTL6	**Low-Side-Output 6**; see pin1.
28	OUTH6	**High-Side-Output 6**; see pin2.

1.4 Functional Block Diagram

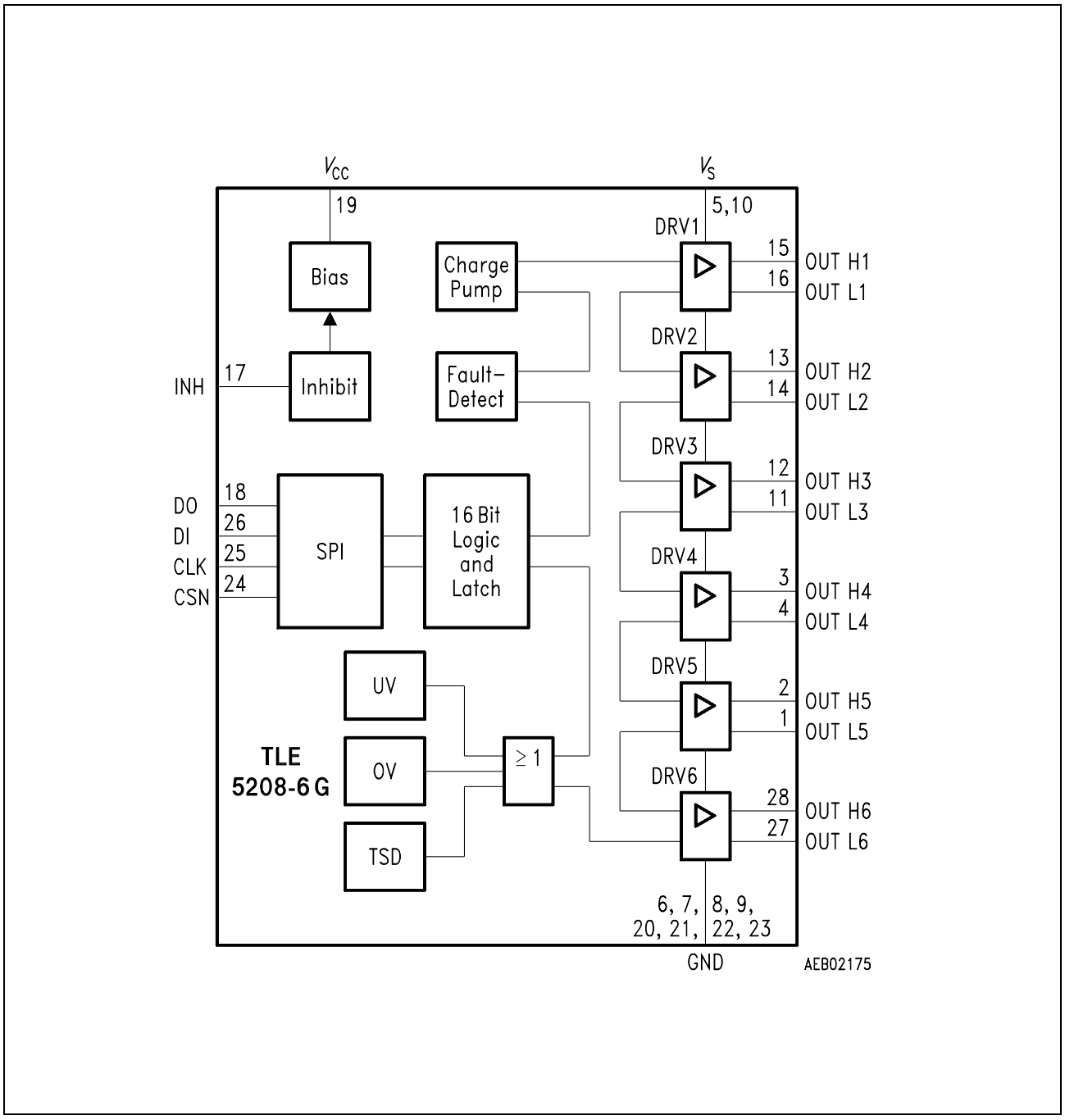


Figure 2
Block Diagram

1.5 Circuit Description

Figure 2 shows a block schematic diagram of the module.

There are 6 halfbridge drivers on the right-hand side. An HS driver and an LS driver are combined to form a halfbridge driver in each case.

The drivers communicate via the internal data bus with the logic and the other control and monitoring functions: undervoltage (UV), overvoltage (OV), overtemperature (TSD), charge pump and fault detect.

Two connection interfaces are provided for supply to the module: All power drivers are connected to the supply voltage V_S. These are monitored by overvoltage and undervoltage comparators with hysteresis, so that the correct function can be checked in the application at any time.

The logic is supplied by the V_{CC} voltage, typ. with 5 V. The V_{CC} voltage uses an internally generated Power-On Reset (POR) to initialize the module at power-on. The advantage of this system is that information stored in the logic remains intact in the event of short-term failures in the supply voltage V_S. The system can therefore continue to operate following V_S undervoltage, without having to be reprogrammed. The “undervoltage” information is stored, and can be read out via the interface. The same logically applies for overvoltage. “Interference spikes” on V_S are therefore effectively suppressed.

The situation is different in the case of undervoltage on the V_{CC} connection pin. If this occurs, then the internally stored data is deleted, and the output levels are switched to high-impedance status (tristate). The module is initialized by V_{CC} following restart (Power-On Reset = POR).

The 16-bit wide programming word or control word (see **Table 1**) is read in via the DI data input, and this is synchronized with the clock input CLK. The status word appears synchronously at the DO data output (see **Table 2**).

The transmission cycle begins when the chip is selected with the CSN input (H to L). If the CSN input changes from L to H then the word which has been read in becomes the control word. The DO output switches to tristate status at this point, thereby releasing the DO bus circuit for other uses.

The INH inhibit input can be used to cut off the complete module. This reduces the current consumption to just a few µA, and results in the loss of any data stored. The output levels are switched to tristate status. The module is reinitialized with the internally generated POR (Power-On Reset) at restart.

This feature allows the use of this module in battery-operated applications (vehicle body control applications).

Every driver block from DRV 1 to 6 contains a low-side driver and a high-side driver. The output connections have been selected so that each HS driver and LS driver pair can be combined to form a halfbridge by short-circuiting adjacent connections. The full flexibility of the configuration can be achieved by dissecting the halfbridges into “quarter-bridges”. **Table 3** shows examples of possible applications.

When commutating inductive loads, the dissipated power peak can be significantly reduced by activating the transistor located parallel to the internal freewheeling diode. A special, integrated “timer” for power ON/OFF times ensures there is no crossover current at the halfbridge.

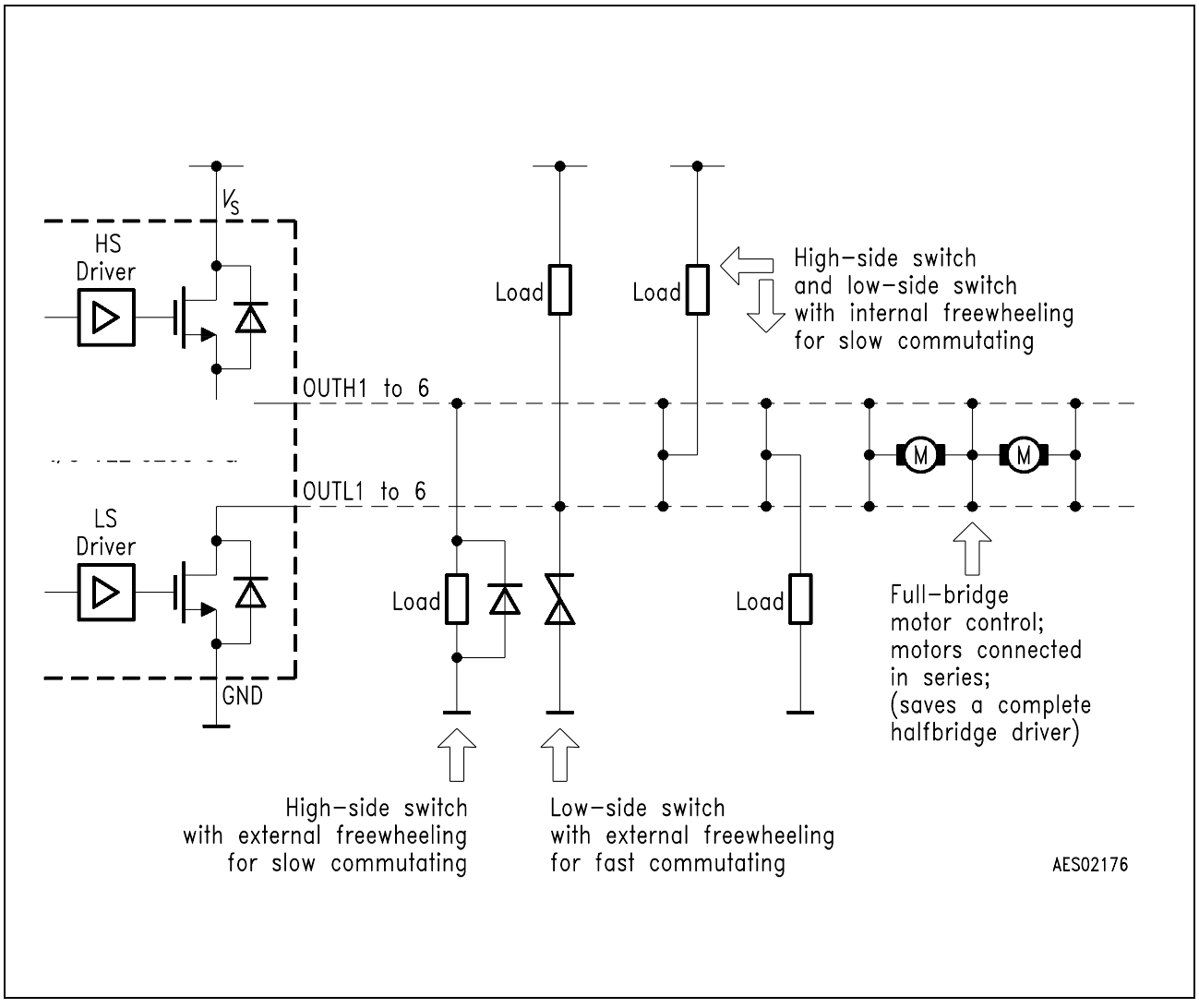


Figure 3
Configuration Examples for “Quarter Bridges” on the TLE 6208-6 G

Table 1
Input Data Protocol

BIT	
15	OVLO on/off
14	Underload SD on/off
13	Overcurrent SD on/off
12	HS-Switch 6
11	LS-Switch 6
10	HS-Switch 5
9	LS-Switch 5
8	HS-Switch 4
7	LS-Switch 4
6	HS-Switch 3
5	LS-Switch 3
4	HS-Switch 2
3	LS-Switch 2
2	HS-Switch 1
1	LS-Switch 1
0	Status Register Reset

H = ON
L = OFF

Table 2
Diagnosis Data Protocol

BIT	
15	Power supply fail
14	Underload
13	Overload
12	Status HS-Switch 6
11	Status LS-Switch 6
10	Status HS-Switch 5
9	Status LS-Switch 5
8	Status HS-Switch 4
7	Status LS-Switch 4
6	Status HS-Switch 3
5	Status LS-Switch 3
4	Status HS-Switch 2
3	Status LS-Switch 2
2	Status HS-Switch 1
1	Status LS-Switch 1
0	Temp. Prewarning

H = ON
L = OFF

Table 3
Fault Result Table

Fault	Diag.-Bit	Result
Overcurrent (load)	13	Only the failed output is switched OFF. Function and protection can be deactivated by bit No. 13.
Short circuit to GND (high-side-switch)	13	Only the failed output is switched OFF. Function and protection can be deactivated by bit No. 13.
Short circuit to V_S (low-side-switch)	13	Only the failed output is switched OFF. Function and protection can be deactivated by bit No. 13.
Temperature warning	0	Reaction of control device needed.
Temperature shut down (SD)	–	All outputs OFF.
Openload	14	Only the failed output is switched OFF. Function can be deactivated by bit No. 14.
Underload	14	Only the failed output is switched OFF. Function can be deactivated by bit No. 14.
Undervoltage lockout (UVLO)	15	All outputs OFF.
Overvoltage lockout (OVLO)	15	All outputs OFF. Function can be deactivated by bit No. 15.

H = failure;
L = no failure.

2 Electrical Characteristics

2.1 Absolute Maximum Ratings

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		
Voltages					
Supply voltage	V_S	– 0.3	40	V	–
Supply voltage	V_S	– 1	–	V	t < 0.5 s; I_S > – 2 A
Logic supply voltage	V_{CC}	– 0.3	5.5	V	0 V < V_S < 40 V
Logic input voltages (DI, CLK, CSN, INH)	V_I	– 0.3	5.5	V	0 V < V_S < 40 V 0 V < V_{CC} < 5.5 V
Logic output voltage (DO)	V_{DO}	– 0.3	V_{CC}	V	0 V < V_S < 40 V 0 V < V_{CC} < 5.5 V
Currents					
Output current (cont.), if Bit13 (OCSD) is set.	I_{OUT1-6}	–	–	A	internal limited
Output current (cont.), if Bit13 (OCSD) is deactivated.	I_{OUT1-6}	– 1.5	1.5	A	V_{DS} = 12 V
		– 0.7	0.7	A	V_{DS} = 20 V
		– 0.25	0.25	A	V_{DS} = 40 V
Output current (peak), if Bit13 (OCSD) is set.	I_{OUT1-6}	–	–	A	internal limited
Output current (peak), if Bit13 (OCSD) is deactivated. t_P < 50 ms; t = 1 s;	I_{OUT1-6}	– 2	2	A	V_{DS} = 12 V
		– 0.9	0.9	A	V_{DS} = 20 V
		– 0.3	0.3	A	V_{DS} = 40 V
Temperatures					
Junction temperature	T_j	– 40	150	°C	–
Storage temperature	T_{stg}	– 50	150	°C	–

Note: Maximum ratings are absolute ratings; exceeding any one of these values may cause irreversible damage to the integrated circuit.

2.2 Operating Range

Parameter	Symbol	Limit Values		Unit	Remarks
		min.	max.		
Supply voltage	V_S	$V_{UV\ OFF}$	40	V	After V_S rising above $V_{UV\ ON}$
Supply voltage slew rate	dV_S/dt	–	10	V/µs	–
Logic supply voltage	V_{CC}	4.75	5.50	V	–
Supply voltage increasing	V_S	– 0.3	$V_{UV\ ON}$	V	Outputs in tristate
Supply voltage decreasing	V_S	– 0.3	$V_{UV\ OFF}$	V	Outputs in tristate
Logic input voltage (DI, CLK, CSN, INH)	V_I	– 0.3	V_{CC}	V	–
SPI clock frequency	f_{CLK}	–	2	MHz	–
Junction temperature	T_j	– 40	150	°C	–

Thermal Resistances

Junction pin	$R_{thj\text{-}pin}$	–	25	K/W	measured to pin 7
Junction ambient	R_{thjA}	–	65	K/W	–

2.3 Electrical Characteristics

8 V < V_S < 40 V; 4.75 V < V_{CC} < 5.25 V; INH = High; all outputs open; – 40 °C < T_j < 150 °C; unless otherwise specified

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Current Consumption						
Quiescent current	I_S	–	10	20	µA	INH = Low; V_S = 13.2 V; T_j = 25 °C
Quiescent current	I_S	–	–	40	µA	INH = Low; V_S = 13.2 V
Supply current	I_S	–	2.0	4.0	mA	–
Logic-Supply current	I_{CC}	–	2	10	µA	INH = Low
Logic-Supply current	I_{CC}	–	1.6	3.0	mA	SPI not active
Over- and Under-Voltage Lockout						
UV-Switch-ON voltage	$V_{UV\ ON}$	–	6.5	7.0	V	V_S increasing
UV-Switch-OFF voltage	$V_{UV\ OFF}$	5.5	6.0	6.6	V	V_S decreasing
UV-ON/OFF-Hysteresis	$V_{UV\ HY}$	–	0.5	–	V	$V_{UV\ ON} - V_{UV\ OFF}$
OV-Switch-OFF voltage	$V_{OV\ OFF}$	34	37	40	V	V_S increasing
OV-Switch-ON voltage	$V_{OV\ ON}$	28	32	36	V	V_S decreasing
OV-ON/OFF-Hysteresis	$V_{OV\ HY}$	–	5.0	–	V	$V_{OV\ OFF} - V_{OV\ ON}$

2.3 Electrical Characteristics (cont'd)

8 V < V_S < 40 V; 4.75 V < V_{CC} < 5.25 V; INH = High; all outputs open; – 40 °C < T_j < 150 °C; unless otherwise specified

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Outputs OUTH1-6 and OUTL1-6						
Static Drain-Source-On Resistance						
Source (High-Side) I_{OUT} = – 0.5 A	$R_{DS\ ON\ H}$	–	0.9	1.3	Ω	8 V < V_S < 40 V T_j = 25 °C
			–	2.0	Ω	8 V < V_S < 40 V
			2.0	–	Ω	$V_{S\ OFF}$ < V_S ≤ 8 V T_j = 25 °C
			–	4.0	Ω	$V_{S\ OFF}$ < V_S ≤ 8 V
Sink (Low-Side) I_{OUT} = 0.5 A	$R_{DS\ ON\ L}$	–	0.8	1.2	Ω	8 V < V_S < 40 V T_j = 25 °C
			–	2.0	Ω	8 V < V_S < 40 V
			2.0	–	Ω	$V_{S\ OFF}$ < V_S ≤ 8 V T_j = 25 °C
			–	4.0	Ω	$V_{S\ OFF}$ < V_S ≤ 8 V
Note: Values of $R_{DS\ ON}$ for $V_{S\ OFF}$ < V_S ≤ 8 V are guaranteed by design.						
Leakage Current						
Source-Output-Stage 1 to 6	I_{QLH}	– 1	–	–	µA	$V_{OUTH1-6}$ = 0 V T_j = 25 °C
Source-Output-Stage 1 to 6	I_{QLH}	– 5	–	–	µA	$V_{OUTH1-6}$ = 0 V
Sink-Output-Stage 1 to 6	I_{QLL}	–	–	1	µA	$V_{OUTL1-6}$ = V_S T_j = 25 °C
Sink-Output-Stage 1 to 6	I_{QLL}	–	–	5	µA	$V_{OUTL1-6}$ = V_S

2.3 Electrical Characteristics (cont'd)

8 V < V_S < 40 V; 4.75 V < V_{CC} < 5.25 V; INH = High; all outputs open; – 40 °C < T_j < 150 °C; unless otherwise specified

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Overcurrent						
Source shutdown threshold	I_{SDU}	– 2.0	– 1.5	– 1.0	A	–
Sink shutdown threshold	I_{SDL}	1.0	1.5	2.0	A	–
Current limit	I_{OCL}	–	3.0	5.0	A	sink and source
Shutdown delay time	t_{dSD}	10	25	50	µs	sink and source
Open Circuit						
Detection current	I_{OCD}	15	30	50	mA	–
Delay time	t_{dOC}	200	350	600	µs	–
Delay Time from Stand-by to Data In						
Setup time	t_{set}	–	–	100	µs	–
Note: setup time is guarnteed by design						
Output Delay Times; V_S = 13.2 V; R_{Load} = 25 Ω (device not in stand-by for t > 1 ms)						
Source (high-side) ON	$t_{d\ ON\ H}$	–	7.5	12	µs	–
Source (high-side) OFF	$t_{d\ OFF\ H}$	–	3	6	µs	–
Sink (low-side) ON	$t_{d\ ON\ L}$	–	6.5	12	µs	–
Sink (low-side) OFF	$t_{d\ OFF\ L}$	–	2	5	µs	–
Dead time H to L	$t_{D\ HL}$	1.5	–	–	µs	$t_{d\ ON\ L} - t_{d\ OFF\ H}$
Dead time L to H	$t_{D\ LH}$	2.5	–	–	µs	$t_{d\ ON\ H} - t_{d\ OFF\ L}$

2.3 Electrical Characteristics (cont'd)

8 V < V_S < 40 V; 4.75 V < V_{CC} < 5.25 V; INH = High; all outputs open; – 40 °C < T_j < 150 °C; unless otherwise specified

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Output Switching Times; V_S = 13.2 V; R_{Load} = 25 Ω (device not in stand-by for t > 1 ms)						
Source (high-side) rise-time	$t_{ON\ H}$	–	4	8	µs	–
Source (high-side) fall-time	$t_{OFF\ H}$	–	2	3	µs	–
Sink (low-side) fall-time	$t_{ON\ L}$	–	1	3	µs	–
Sink (low-side) rise-time	$t_{OFF\ L}$	–	1	2	µs	–
Clamp Diodes Forward Voltage						
Upper	V_{FU}	–	0.9	1.3	V	I_F = 0.5 A
Lower	V_{FL}	–	0.9	1.3	V	I_F = 0.5 A
Inhibit Input						
H-input voltage threshold	V_{IH}	–	–	0.7	V_{CC}	–
L-input voltage threshold	V_{IL}	0.2	–	–	V_{CC}	–
Hysteresis of input voltage	V_{IHY}	50	200	500	mV	–
Pull down current	I_I	10	25	50	µA	$V_I = 0.2 \times V_{CC}$
Input capacitance	C_I	–	10	15	pF	0 V < V_{CC} < 5.25 V

Note: Capacitances are guaranteed by design

2.3 Electrical Characteristics (cont'd)

8 V < V_S < 40 V; 4.75 V < V_{CC} < 5.25 V; INH = High; all outputs open; – 40 °C < T_j < 150 °C; unless otherwise specified

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
SPI-Interface **Delay Time from Stand-by to Data In**						
Setup time	t_{set}	–	–	100	µs	–
Logic Inputs DI, CLK and CSN						
H-input voltage threshold	V_{IH}	–	–	0.7	V_{CC}	–
L-input voltage threshold	V_{IL}	0.2	–	–	V_{CC}	–
Hysteresis of input voltage	V_{IHY}	50	200	500	mV	–
Pull up current at pin CSN	I_{ICSN}	– 50	– 25	– 10	µA	$V_{CSN} = 0.7 \times V_{CC}$
Pull down current at pin DI	I_{IDI}	10	25	50	µA	$V_{DI} = 0.2 \times V_{CC}$
Pull down current at pin CLK	I_{ICLK}	10	25	50	µA	$V_{CLK} = 0.2 \times V_{CC}$
Input capacitance at pin CSN, DI or CLK	C_I	–	10	15	pF	0 V < V_{CC} < 5.25 V
Logic Output DO						
H-output voltage level	V_{DOH}	V_{CC} – 1.0	V_{CC} – 0.7	–	V	I_{DOH} = 1 mA
L-output voltage level	V_{DOL}	–	0.2	0.4	V	I_{DOL} = – 1.6 mA
Tri-state leakage current	I_{DOLK}	– 10	–	10	µA	V_{CSN} = V_{CC} 0 V < V_{DO} < V_{CC}
Tri-state input capacitance	C_{DO}	–	10	15	pF	V_{CSN} = V_{CC} 0 V < V_{CC} < 5.25 V

Note: Capacitances are guaranteed by design

Note: Capacitances are guaranteed by design

2.3 Electrical Characteristics (cont'd)

8 V < V_S < 40 V; 4.75 V < V_{CC} < 5.25 V; INH = High; all outputs open; – 40 °C < T_j < 150 °C; unless otherwise specified

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Data Input Timing						
Clock period	t_{pCLK}	1000	–	–	ns	–
Clock high time	t_{CLKH}	500	–	–	ns	–
Clock low time	t_{CLKL}	500	–	–	ns	–
Clock low before CSN low	t_{bef}	500	–	–	ns	–
CSN setup time	t_{lead}	500	–	–	ns	–
CLK setup time	t_{lag}	500	–	–	ns	–
Clock low after CSN high	t_{beh}	500	–	–	ns	–
DI setup time	t_{DISU}	250	–	–	ns	–
DI hold time	t_{DIHO}	250	–	–	ns	–
Input signal rise time at pin DI, CLK and CSN	t_{rIN}	–	–	200	ns	–
Input signal fall time at pin DI, CLK and CSN	t_{fIN}	–	–	200	ns	–
Data Output Timing						
DO rise time	t_{rDO}	–	50	100	ns	C_L = 100 pF
DO fall time	t_{fDO}	–	50	100	ns	C_L = 100 pF
DO enable time	t_{ENDO}	–	–	250	ns	low impedance
DO disable time	t_{DISDO}	–	–	250	ns	high impedance
DO valid time	t_{VADO}	–	100	250	ns	V_{DO} < 0.2 V_{CC}; V_{DO} > 0.7 V_{CC}; C_L = 100 pF

2.3 Electrical Characteristics (cont'd)

8 V < V_S < 40 V; 4.75 V < V_{CC} < 5.25 V; INH = High; all outputs open; – 40 °C < T_j < 150 °C; unless otherwise specified

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		
Thermal Prewarning and Shutdown						
Thermal prewarning junction temperature	T_{jPW}	120	145	170	°C	–
Temperature prewarning hysteresis	ΔT	–	30	–	K	–
Thermal shutdown junction temperature	T_{jSD}	150	175	200	°C	–
Thermal switch-on junction temperature	T_{jSO}	120	–	170	°C	–
Temperature shutdown hysteresis	ΔT	–	30	–	K	–
Ratio of SD to PW temperature	T_{jSD} / T_{jPW}	1.05	1.20	–	–	–

Note: Temperatures are guaranteed by design

3 Timing Diagrams

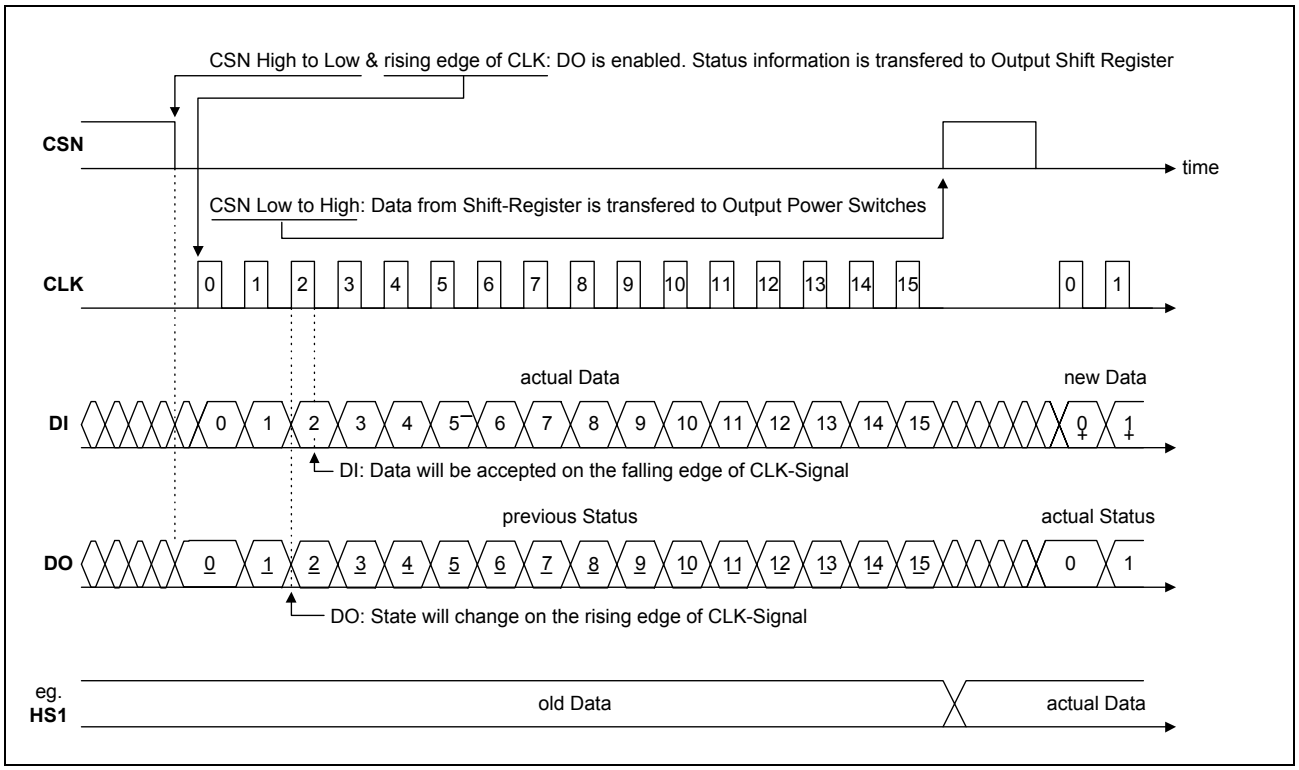


Figure 4
Standard Data Transfer Timing

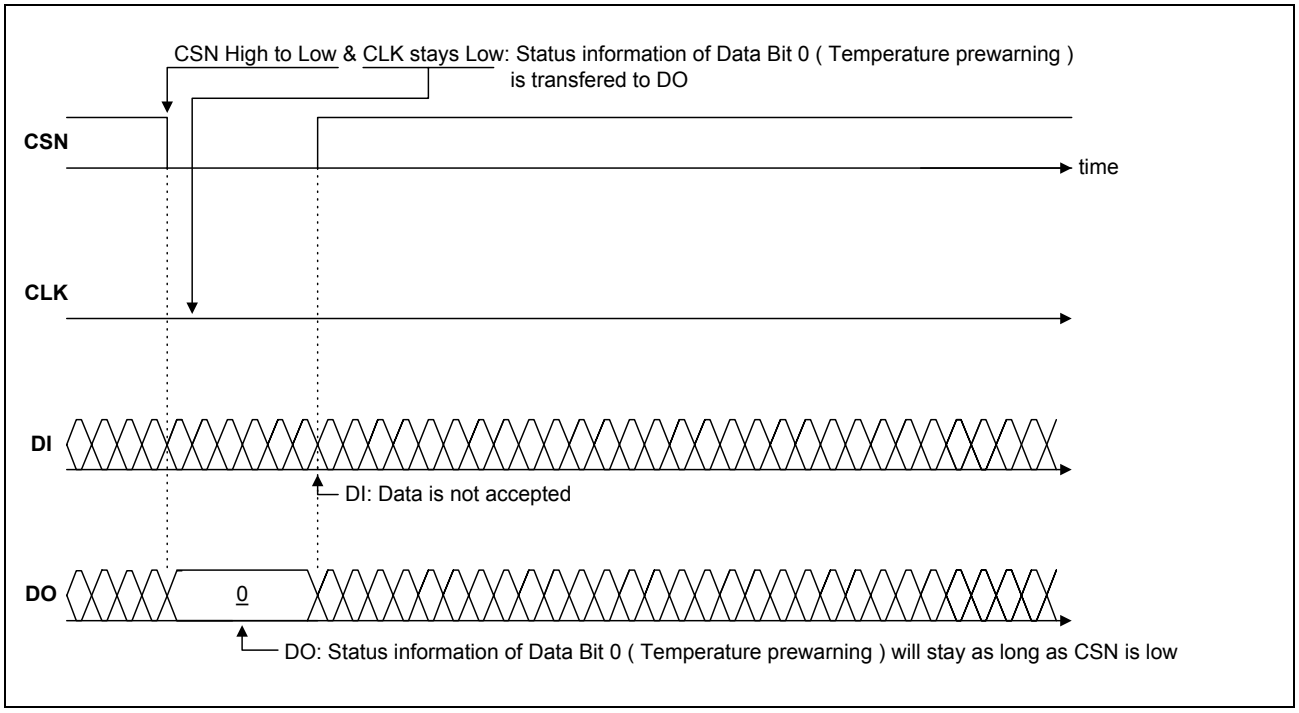


Figure 5
Timing for Temperature Prewarning only

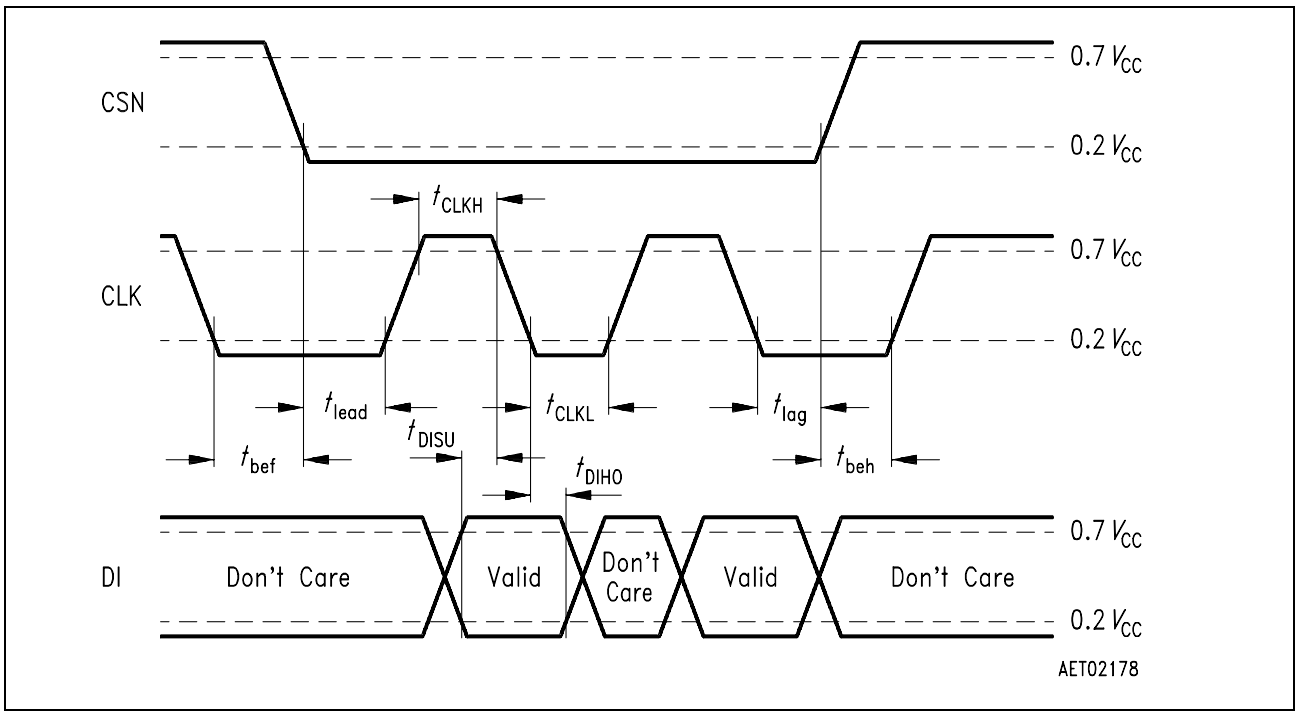


Figure 6
SPI-Input Timing

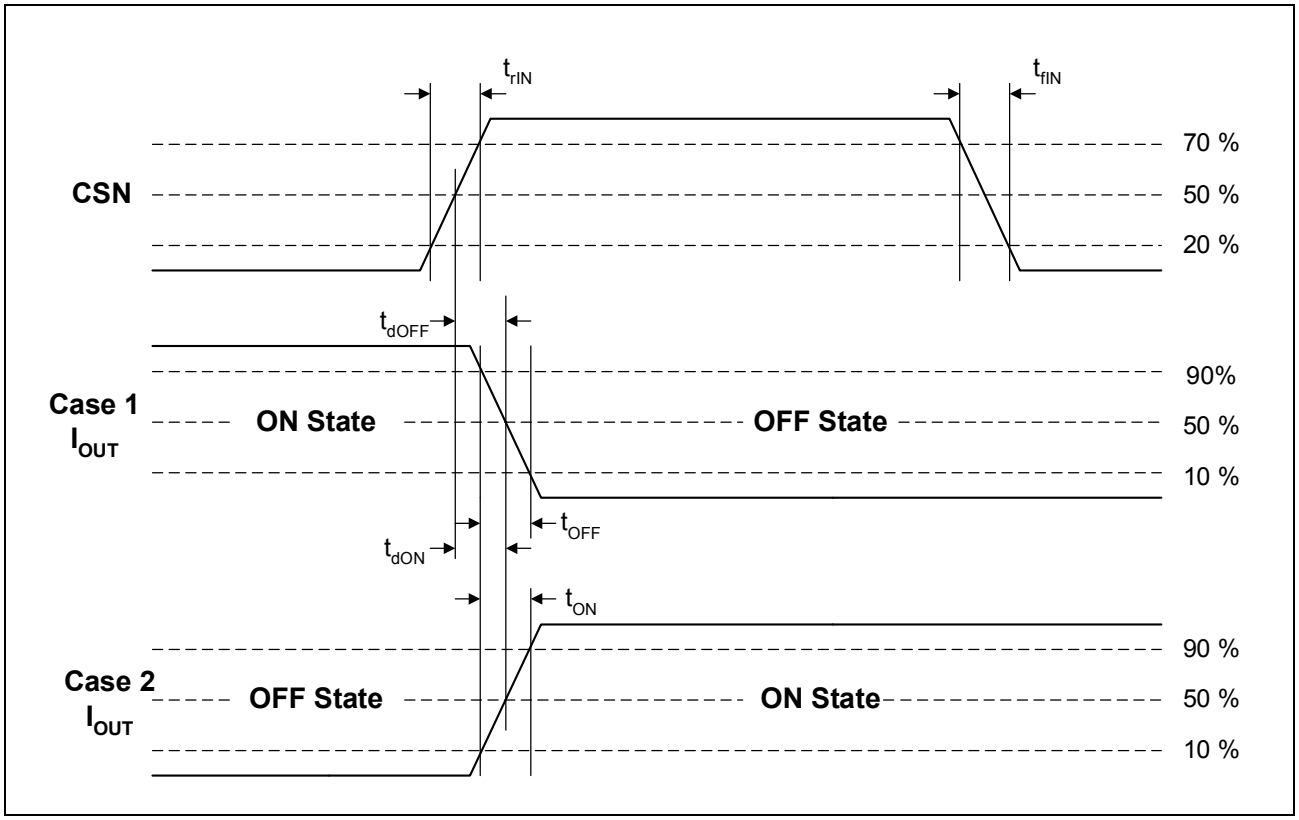


Figure 7
Turn OFF/ON Time

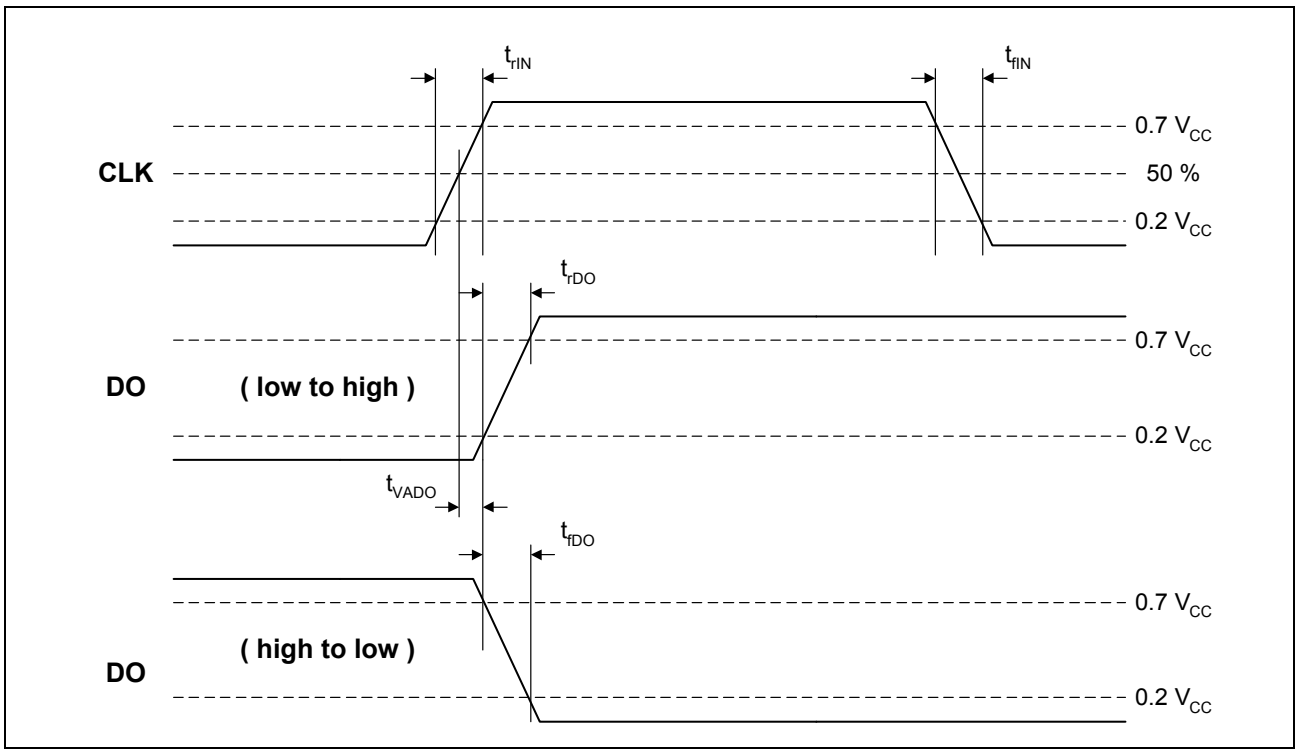


Figure 8
DO Valid Data Delay Time and Valid Time

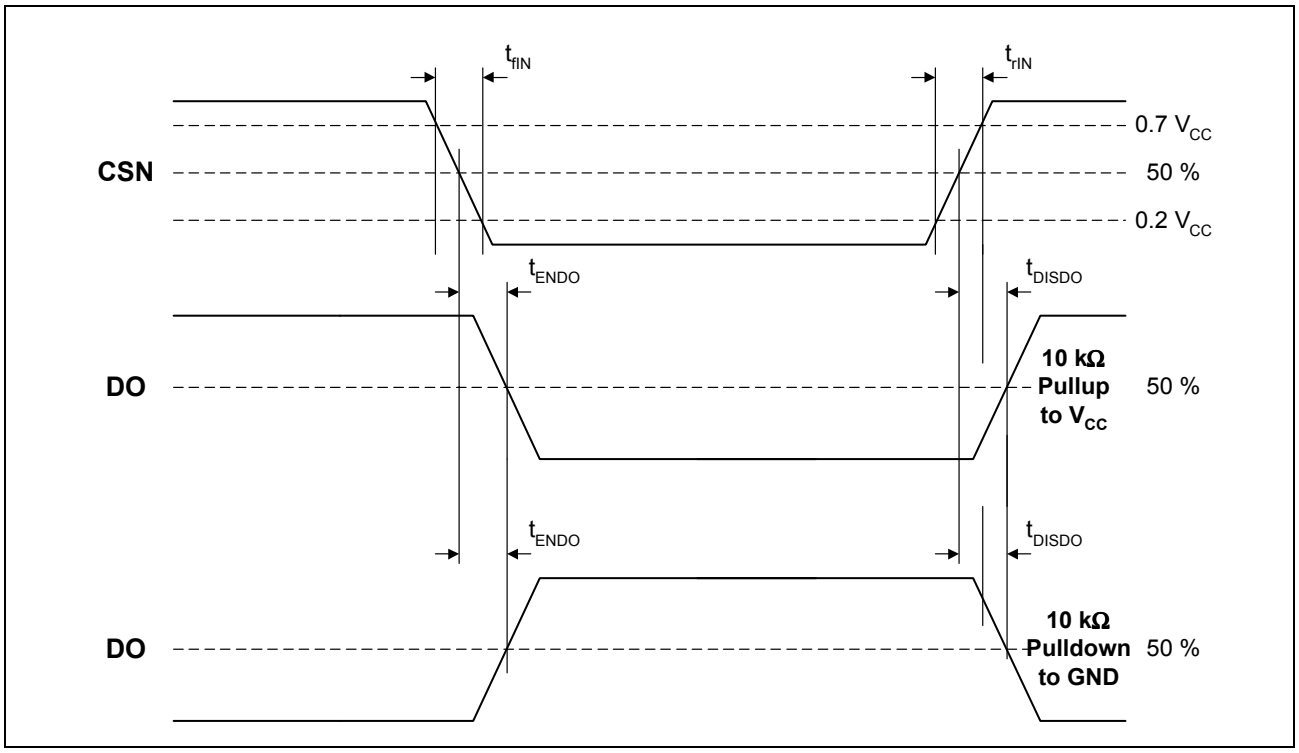


Figure 9
DO Enable and Disable Time

4 Application

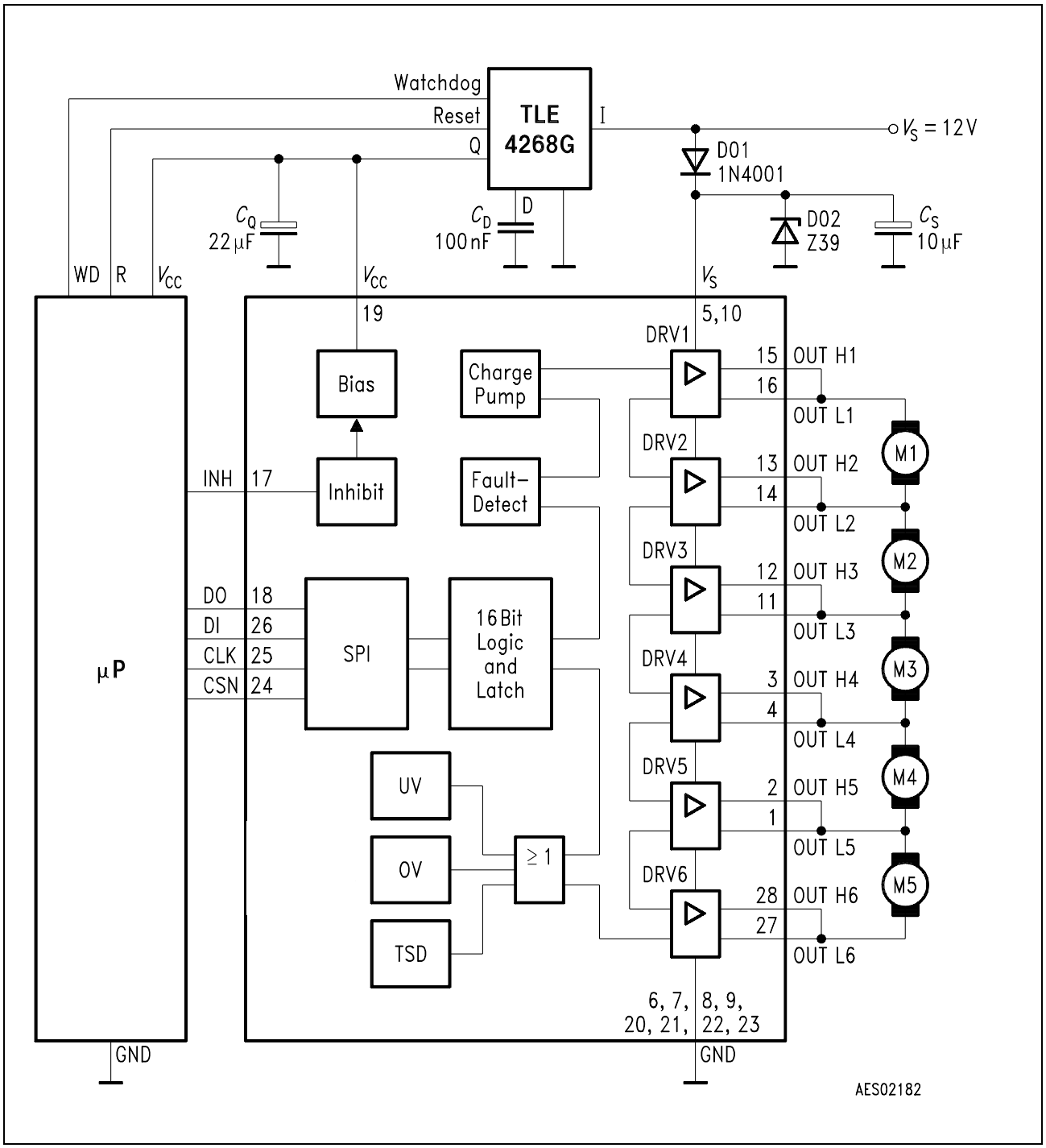
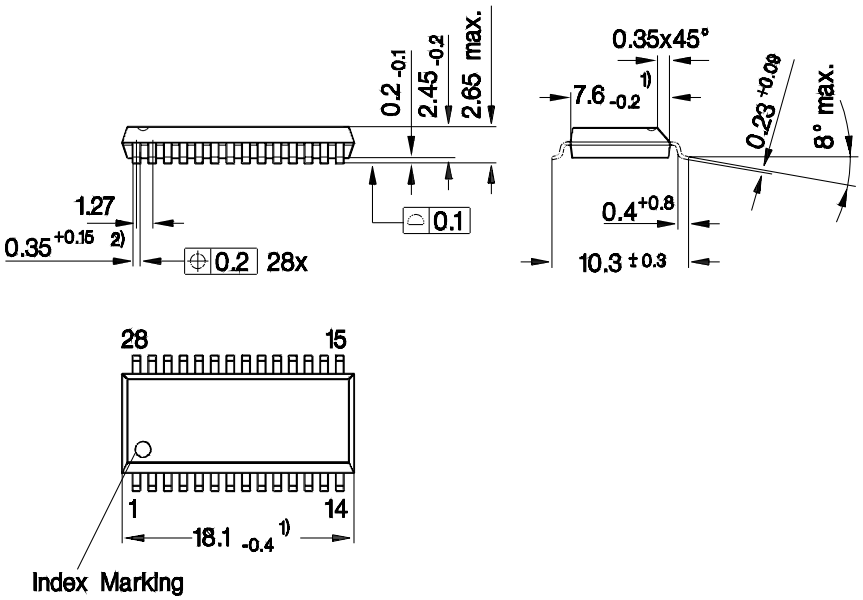


Figure 10
Application Circuit

5 Package Outlines

P-DSO-28-6
(Plastic Dual Small Outline Package)



1) Does not include plastic or metal protrusion of 0.15 max. per side
2) Does not include dambar protrusion

GPS05123

Sorts of Packing
Package outlines for tubes, trays etc. are contained in our Data Book “Package Information”.
SMD = Surface Mounted Device

Dimensions in mm