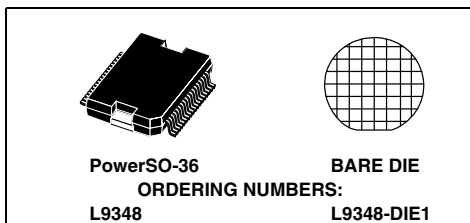


QUAD LOW SIDE DRIVER

- SUPPLY VOLTAGE RANGE: 4.8 TO 18V
- OUTPUT VOLTAGE UP TO 40V
- OUTPUT VOLTAGE CLAMP DURING RECIRCULATION OF INDUCTIVE LOADS
- OUTPUT CURRENT CAPABILITY 2 X 5A AND 2 X 3A
- LOW POWER DISSIPATION DURING RECIRCULATION OF INDUCTIVE LOADS BY INTEGRATED FREE WHEELING DIODES (3A-DRIVERS ONLY)
- LOW ON-RESISTANCE 2 X 0.2Ω , 2 X 0.35Ω (TYP.)
- OUTPUT SHORT CIRCUIT CURRENT PROTECTION
- REAL TIME DIAGNOSTIC FUNCTIONS
- OVERTEMPERATURE SHUTDOWN
- SIGNAL- AND POWER-GROUND-LOSS SHUTDOWN



- 3.3V CMOS COMPATIBLE INPUTS AND STATUS

DESCRIPTION

The L9348 is a monolithic integrated quad low side driver realized in advanced Multipower-BCD technology. It is intended to drive inductive loads (relays, electromagnetic valves) in automotive and industrial applications.

Figure 1. Block Diagram

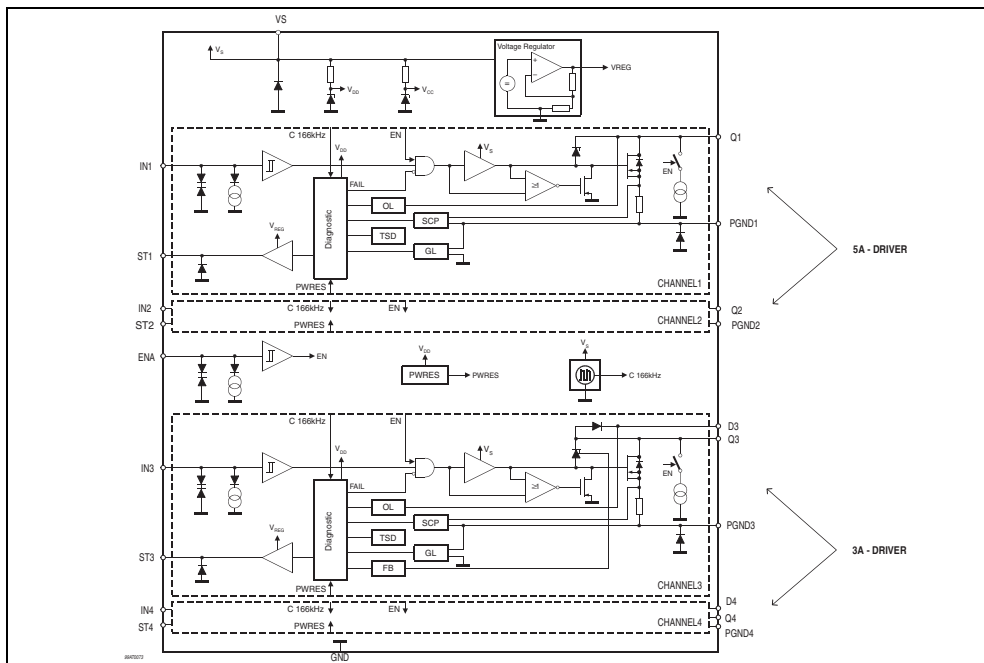


Figure 2. Pin Connection

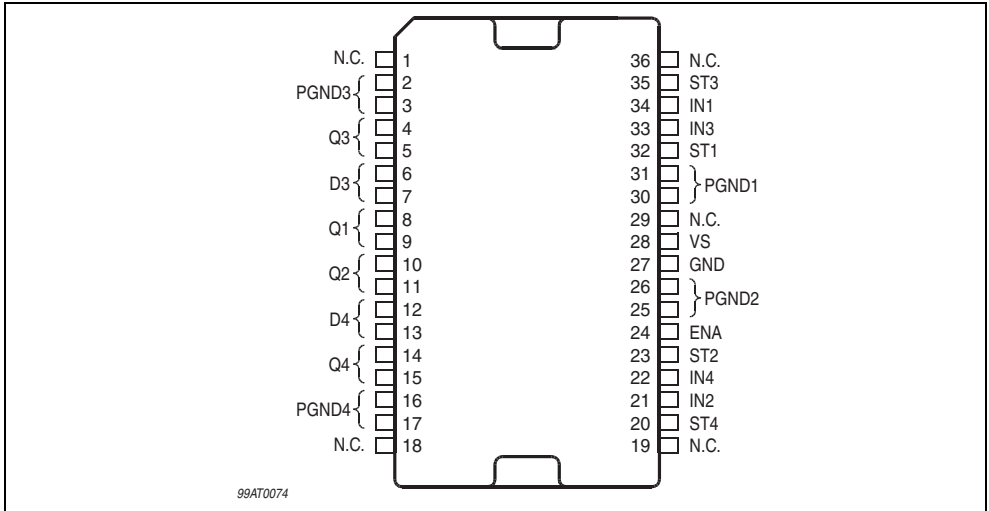


Table 1. Pin Description

| N° | Pin | Function |
|---------------|-------|------------------------------------|
| 1, 18, 19, 36 | N.C. | (GND) |
| 2, 3 | PGND3 | Power Ground Channel 3 |
| 4, 5 | Q3 | Power Output Channel 3 (3A switch) |
| 6, 7 | D3 | Recirculation Diode Channel 3 |
| 8, 9 | Q1 | Power Output Channel 1 (5A switch) |
| 10, 11 | Q2 | Power Output Channel 2 (5A switch) |
| 12, 13 | D4 | Recirculation Diode Channel 4 |
| 14, 15 | Q4 | Power Output Channel 4 (3A switch) |
| 16, 17 | PGND4 | Power Ground Channel 4 |
| 20 | ST4 | Status Output Channel 4 |
| 21 | IN2 | Control Input Channel 2 |
| 22 | IN4 | Control Input Channel 4 |
| 23 | ST2 | Status Output Channel 2 |
| 24 | ENA | Enable |
| 25, 26 | PGND2 | Power Ground Channel 2 |
| 27 | GND | Signal Ground |
| 28 | VS | Supply Voltage |
| 29 | N.C. | Not Connected |
| 30, 31 | PGND1 | Power Output Channel 3 |
| 32 | ST1 | Status Output Channel 1 |
| 33 | IN3 | Control Input Channel 3 |
| 34 | IN1 | Control Input Channel 1 |

Table 2. Thermal Data

| Symbol | Parameter | Test Conditions | Values | | | Unit |
|------------------------|--|--------------------------|--------|------|------------|----------|
| | | | Min. | Typ. | Max. | |
| T _j | Junction temperature | | -40 | | 150 | °C |
| T _{jc} | Junction temperature during clamping (life time) | Σt = 30min Σt = 15min | | | 175 190 | °C °C |
| T _{stg} | Storage temperature | | -55 | | 150 | °C |
| R _{th j-case} | Thermal resistance junction to case | | | | 2 | °C/W |

Table 3. Absolute Maximum Ratings

The absolute maximum ratings are the limiting values for this device. Damage may occur if this device is subjected to conditions which are beyond these values.

| Symbol | Parameter | Test Conditions | Value | Unit |
|-----------------------------------|--|---|------------|------|
| Voltages | | | | |
| V _S | Supply voltage range | | -0.3 to 40 | V |
| V _Q , V _D | max. static Output voltage | | 40 | V |
| V _{IN} , V _{EN} | Input voltage range (IN1 to IN4, EN) | I _I < 10mA | -1.5 to 6 | V |
| V _{ST} | Status output voltage range | I _I < 1mA | -0.3 to 6 | V |
| V _{DRmax} | max. Reverse breakdown voltage free wheeling diodes D3, D4 | I _R = 100 μA | 55 | V |
| Currents | | | | |
| I _{Q 1/2} | Output current at reversal supply for Q1, Q2 | | -4 | A |
| I _{Q 3/4} | Output current at reversal supply for Q3, Q4 | | -2 | A |
| I _{ST} | Status output current range | | -1 to 1 | mA |
| E _{Q1/2} | max. Discharging energy for inductive loads per channel Q1, Q2 | T _j = 25°C | 50 | mJ |
| | | T _j = 150°C | 30 | mJ |
| I _{FDmax} | max. load current free wheeling diodes | t < 5ms | 3 | A |
| ESD Protection | | | | |
| Supply and Signal pins | | versus GND | ±2 | kV |
| Output pins (Qx, Dx) | | versus common ground (=short of SGND with all PGND) | ±4 | kV |

Note: Human Body Model according to MIL883C. The device withstands ST1 class level.

Table 4. Operating Range.

| Symbol | Parameter | Test Conditions | Values | | | Unit |
|----------------|----------------------|-----------------|--------|------|------|------|
| | | | Min. | Typ. | Max. | |
| V _S | Supply voltage | | 4.8 | | 18 | V |
| T _j | Junction temperature | | -40 | | 150 | °C |

Table 5. Electrical Characteristics

The electrical characteristics are valid within the operating range (**Table 4**), unless otherwise specified

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|---------------------------------|--|---|------|------|------|--------------|
| Power Supply | | | | | | |
| I_S | Supply current | $V_{IN1...IN4}, ENA = H$ | | | 8 | mA |
| I_Q | Quiescent current (outputs OFF) | $V_{ENA} = L$ | | | 6 | mA |
| $I_{D3/4}$ | Quiescent current at pins D3/4 | $V_{D3/4} \leq 18V$; $V_{IN3/4} = L$ | 10 | | 400 | μA |
| Diagnostic Functions | | | | | | |
| $V_{QU1\ to\ 4}$ | Output open load voltage threshold | $V_S \geq 6.5V$ $V_{EN} = X$; $V_{IN} = L$ | 0.3 | 0.33 | 0.36 | $\times V_S$ |
| $I_{QU1\ to\ 4}$ | Output open load current threshold | $V_S \geq 6.5V$ $V_{EN} = H$; $V_{IN} = H$ | 50 | | 140 | mA |
| $I_{QO1/2}$ | Overload current threshold Q 1, 2 | $V_S \geq 6.5V$ | 5 | 7.5 | 9 | A |
| $I_{QO3/4}$ | Overload current threshold Q 3, 4 | $V_S \geq 6.5V$ | 3 | 5 | 8 | A |
| T_{th} | Overtemperature shutdown threshold | 2) | 175 | | 210 | $^{\circ}C$ |
| T_{hy} | Overtemperature hysteresis | | | 10 | | $^{\circ}C$ |
| V_{thPGL} | Power-GND-loss threshold | | 1.5 | 2.5 | 3.5 | V |
| V_{thSGL} | Signal-GND-loss threshold | | 150 | 330 | 510 | mV |
| Power Outputs (Q1 to Q4) | | | | | | |
| $R_{DS(ON)1/2}$ | Static drain-source ON-resistance Q1, Q2 | $I_Q = 1A$; $V_S \geq 9.5V$ $T_j = 25^{\circ}C$ | | 0.2 | | Ω |
| | | $T_j = 125^{\circ}C$ ³⁾ | | | 0.5 | Ω |
| | | $T_j = 150^{\circ}C$ ⁴⁾ | | | 0.5 | Ω |
| $R_{DS(ON)3,4}$ | Static drain-source ON-resistance Q3, Q4 | $I_Q = 1A$; $V_S \geq 9.5V$ $T_j = 25^{\circ}C$ | | 0.35 | | Ω |
| | | $T_j = 125^{\circ}C$ ³⁾ | | | 0.75 | Ω |
| | | $T_j = 150^{\circ}C$ ⁴⁾ | | | 0.75 | Ω |
| V_Z | Z-diode clamping voltage = threshold of flyback detection Q3/4 | $I_Q \geq 100mA$, pos. supply $V_{D3/4}$ | 45 | | 60 | V |
| V_C | Clamping voltage | $I_Q \geq 100mA$, neg. supply $V_{D3/4}$ | 4 | | 10 | V |
| I_{PD} | Output pull down current | $V_{ENA} = H$, $V_{IN} = L$ | 10 | 20 | 50 | μA |

Table 5. Electrical Characteristics

The electrical characteristics are valid within the operating range (Table 4), unless otherwise specified

| Symbol | Parameter | Test Condition | Min. | Typ. | Max. | Unit |
|---|--|--|------|------|------|------|
| I _{QIK} | Output leakage current | V _{ENA} = L, T _j = 25°C | | | 1 | μA |
| | | T _j = 125°C | | | 5 | μA |
| V _{FD3/4} | Forward voltage of free wheeling diodes D3, D4 | I _{D3/4} = -1.5A | 0.5 | | 1.75 | V |
| R _{PD0} | Gate pull down resistor for nonsupplied V _S | V _S = 0V, V _{D3/4} ≥ 6.5V | 0.3 | | 3 | kΩ |
| Timings | | | | | | |
| t _{ON} | Output ON delay time | I _Q = 1A ¹⁾ | 0 | 5 | 20 | μs |
| t _f | Output ON fall time | I _Q = 1A ¹⁾ | 0.5 | 1.5 | 8 | μs |
| t _{OFF} | Output OFF delay time | I _Q = 1A ¹⁾ | 0 | 10 | 30 | μs |
| t _r | Output OFF rise time | I _Q = 1A ¹⁾ | 0.5 | 1.5 | 5 | μs |
| t _{DSO} | Overload switch-OFF delay time | | 6 | 30 | 65 | μs |
| t _D | Output OFF status delay time | | 0.75 | 1.5 | 2.25 | ms |
| t _{filter} | error detection filter time | 2) | 5.8 | | 35 | μs |
| t _{OLOFF} | OLOFF error detection filter time | | 20 | | 70 | μs |
| Digital Inputs (IN1 to IN4, ENA) | | | | | | |
| V _{IL} | Input low voltage | | -1.5 | | 1 | V |
| V _{IH} | Input high voltage | | 2 | | 6 | V |
| V _{IHy} | Input voltage hysteresis | 2) | 50 | 100 | | mV |
| I _{IN} | Input pull down current | V _{IN} = 5V, V _S ≥ 6.5V | 8 | 20 | 40 | μA |
| Digital Outputs (ST1 to ST4) | | | | | | |
| V _{STL} | Status output voltage in low state ⁵⁾ | I _{ST} ≤ 40μA | 0 | | 0.4 | V |
| V _{STH} | Status output voltage in high state ⁵⁾ | I _{ST} ≥ -40μA | 2.5 | | 3.45 | V |
| | | I _{ST} ≥ -120μA | 2 | | 3.45 | V |
| R _{DIAGL} | R _{OUT} + R _{DSON} in low state | | 0.3 | 0.64 | 1.5 | kΩ |
| R _{DIAGH} | R _{OUT} + R _{DSON} in high state | | 1.5 | 3.2 | 7 | kΩ |

(1). See chapter 2.0 Timing Diagrams; resistive load condition; V_S ≥ 9V

(2). This parameter will not be tested but assured by design

(3). Wafer-measurement

(4). Measured on P-SO36 devices

(5). Short circuit between two digital outputs (one in high the other in low state) will lead to the defined result "LOW"

1.0 FUNCTIONAL DESCRIPTION

1.1 Overview

The four low-side switches are designed to drive inductive loads (relays, electromagnetic valves). For the 3A switches (Q3/4) integrated free-wheeling diodes (D3/4) are available and can be used as recirculation path for inductive loads. If either integrated nor external free-wheeling diodes are used the output voltage is clamped internally during discharge of inductive loads. The switches are controlled by CMOS compatible inputs (IN1-4) if the enable input is set to "high". The status of each switch is monitored by the related status output (ST1-4).

1.2 Input Circuits

The control and enable inputs are active high, featuring switching thresholds with hysteresis and pull-down current sources. Not connected inputs are interpreted as "LOW". If the enable input is set to "LOW" the outputs are switched off independent of the control input state (IN1-4).

1.3 Switching Stages

The four power outputs consist of DMOS-power transistors. The output stages are protected against short circuit to supply. Integrated output voltage clamp limits the output voltage in case of inductive load current flyback. Internal pull down current sources are provided at the outputs to assure a defined condition in OFF mode. They will be disconnected in the disable mode (ENA=L). If the supply of the device gets lost but the loads and D3/4 are still supplied, an internal pull down resistor discharges the gate of the DMOS-power transistor to avoid switch on due to capacitive coupling.

1.4 Status Outputs

The CMOS compatible status outputs indicate the state of the drivers (LOW-level indicates driver in OFF state, HIGH-level indicates driver in ON state). If an error occurs the status output voltage changes like described in **chapter 1.6 Error Detection**.

1.5 Protective Circuits

The outputs are protected against current overload, overtemperature, and Power-GND-loss.

1.6 Error Detection

Two main error types are distinguished in the diagnostic logic. If current overload, overtemperature, signal-GND-loss or a power-GND-loss occurs, the status output signal is inverted, an internal register is set and the driver is shutdown. The reset is done by switching off the corresponding control input or the enable input for at least the time t_D (defined to 1.5ms typ.). See also **Figure 6** in **chapter 2.0 Timing Diagrams**.

All other errors (openload, active output voltage clamp) only cause an inverted status output signal but no shutdown of the driver. An internal register is set too, but the reset is triggered automatically after the time t_D , if the error condition is no longer valid (see **Figure 7** and **Figure 8**).

Excepting the detection of the active output voltage clamp all errors are digitally filtered before they are interpreted by the diagnostic logic.

The table 6 below shows the different failure conditions monitored in ON and OFF state:

Table 6.

| | ON State ENA = HIGH, IN = HIGH | OFF State ENA = HIGH, IN = LOW | typ. Filter time | Reset done by |
|--|--------------------------------------|--------------------------------------|---------------------|--|
| Overloading of output (also shorted load to supply) | X | | 18µs | ENA or INx = "LOW" for $t \geq 1.5\text{ms}$ (typ.) |
| Open load (under voltage detection) | | X | 44µs | internal timer (1.5ms typ.) |

Table 6.

| | ON State ENA = HIGH, IN = HIGH | OFF State ENA = HIGH, IN = LOW | typ. Filter time | Reset done by |
|--|--------------------------------------|--------------------------------------|---------------------|--|
| Open load (under current detection) | X | | 18µs | internal timer (1.5ms typ.) |
| Overtemperature | X | | 18µs | ENA or INx = "LOW" for t ≥ 1.5ms (typ.) |
| Power-GND-loss | X | X | 18µs | ENA or INx = "LOW" for t ≥ 1.5ms (typ.) |
| Signal-GND-loss | X | X | 18µs | ENA or INx = "LOW" for t ≥ 1.5ms (typ.) |
| Output voltage clamp active (Q3/4 only) | | X | - | internal timer (1.5ms typ.) |

1.7 Diagnostic Output at Pulse Width Operation (PWM)

If an input is operated with a pulsed signal ($f \geq 1/t_D = 667$ Hz typ.), the status does not follow each single pulse. An internal delay t_D of typ. 1.5ms leads to a continuous status output signal (see **Figure 4** in **chapter 2.0 Timing Diagrams**).

1.8 Diagnostic Table

In general the diagnostic follows the input signal in normal operating conditions. If any error is detected the diagnostic is inverted.

Table 7.

| Operating Condition | Enable Input ENA | Control Input IN | Power Output Q | Status Output ST |
|---|------------------------|------------------------|----------------------|------------------------|
| Normal function | L | L | OFF | L |
| | L | H/PWM | OFF | L |
| | H | L | OFF | L |
| | H | H/PWM | ON | H |
| Open load or short to ground | L | L | OFF | X |
| | L | H/PWM | OFF | X |
| | H | L | OFF | H |
| | H | H/PWM | ON | L |
| Overload or short to supply Latched overload | H | H/PWM | OFF | L |
| | H | H/PWM | OFF | L |
| | H → L | X | OFF | L |
| | Reset latch | H | H/PWM → L | OFF |
| Overtemperature Latched overtemperature | H | H/PWM | OFF | L |
| | H | H/PWM | OFF | L |
| | H → L | X | OFF | L |
| | Reset latch | H | H/PWM → L | OFF |

2.0 TIMING DIAGRAMS

Figure 3. Output slope with Resistive Load

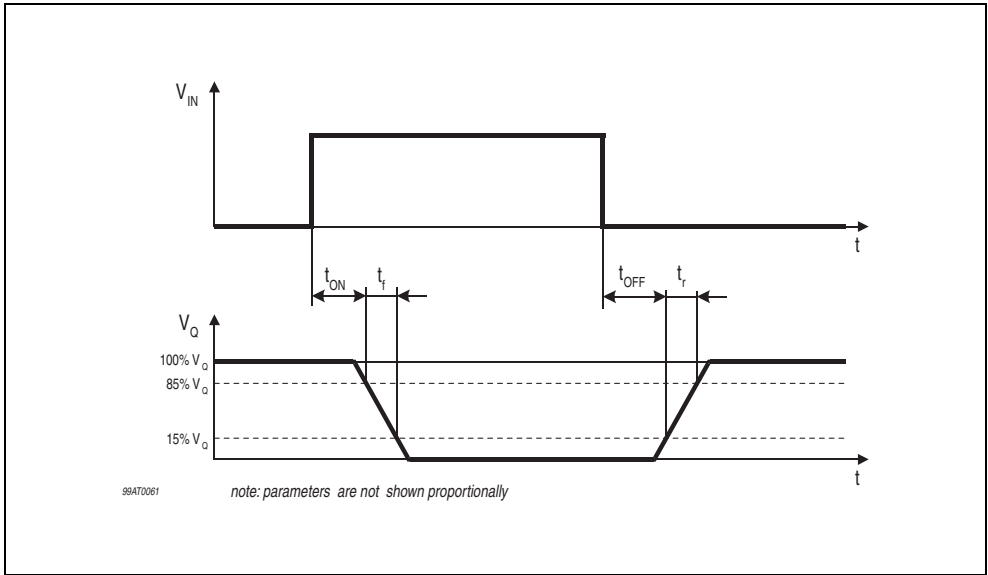


Figure 4. Diagnostic Output at PWM operation

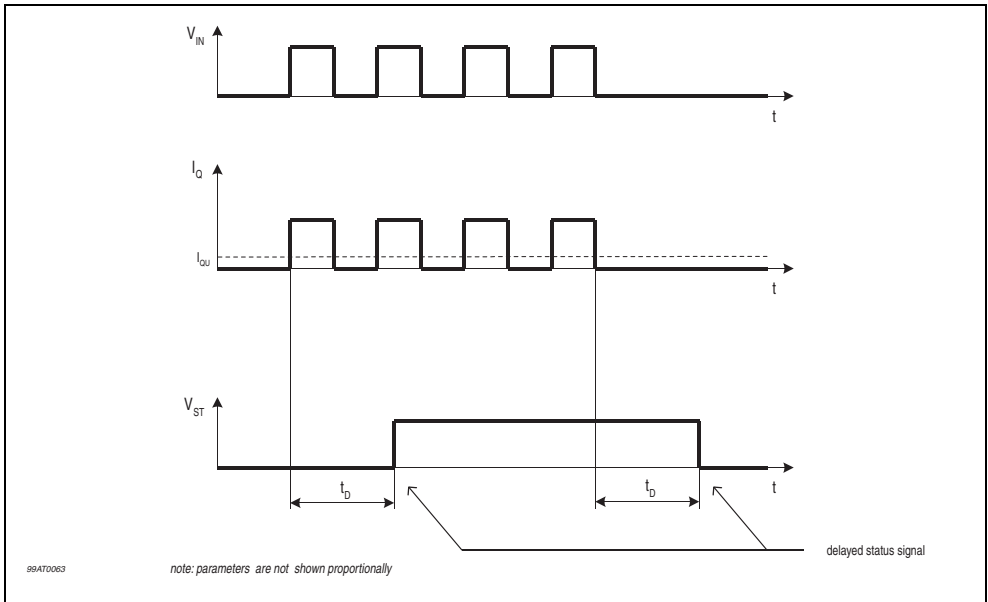


Figure 5. Overload Detection

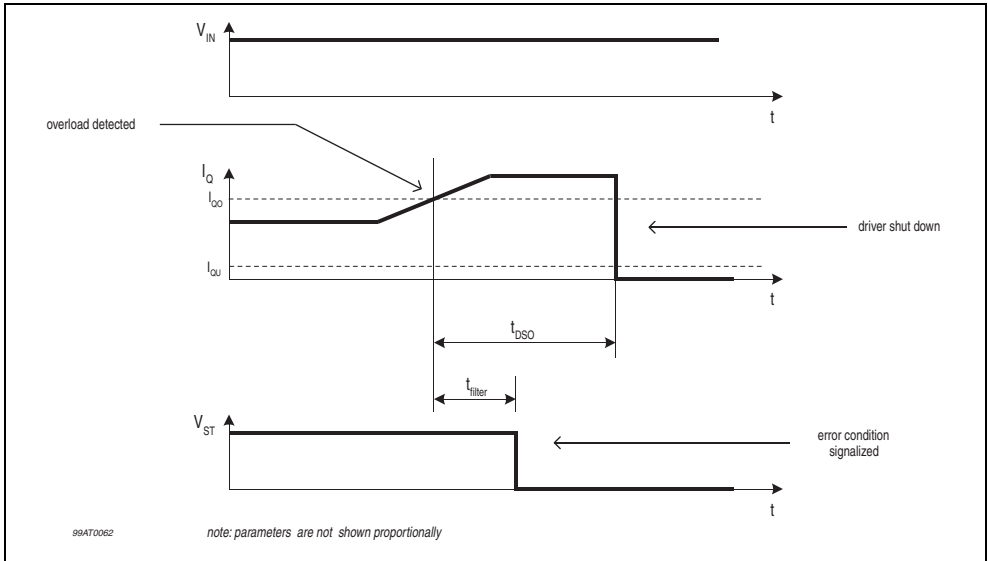


Figure 6. Driver Shut Down in Case of Overload

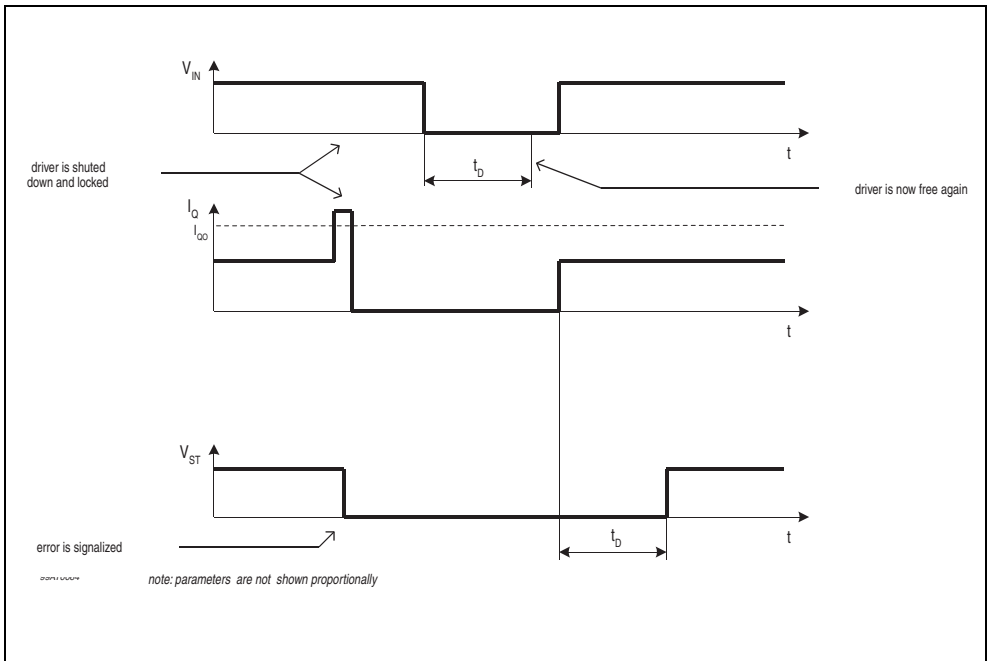


Figure 7. Under Current Condition

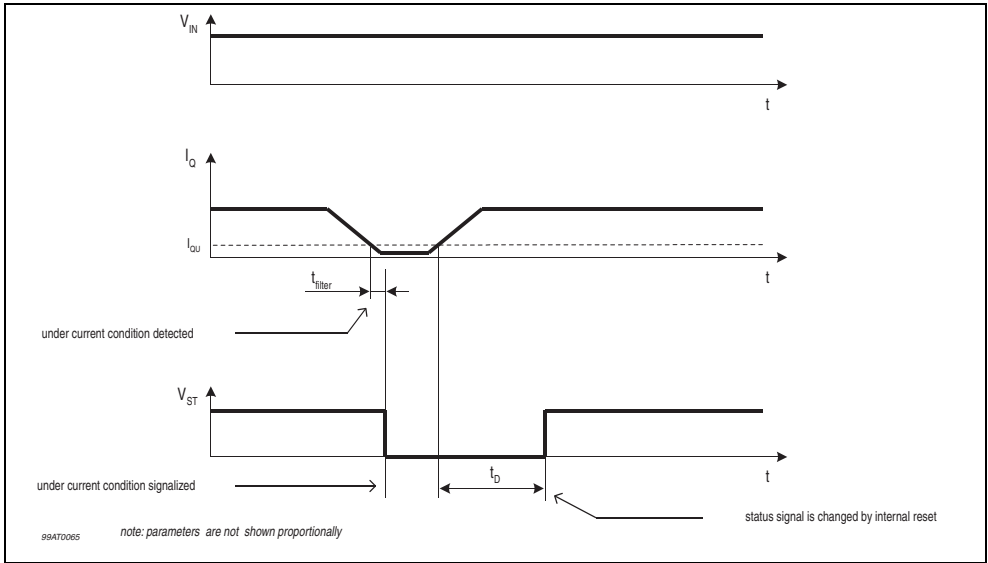


Figure 8. Open Load Condition in Off State

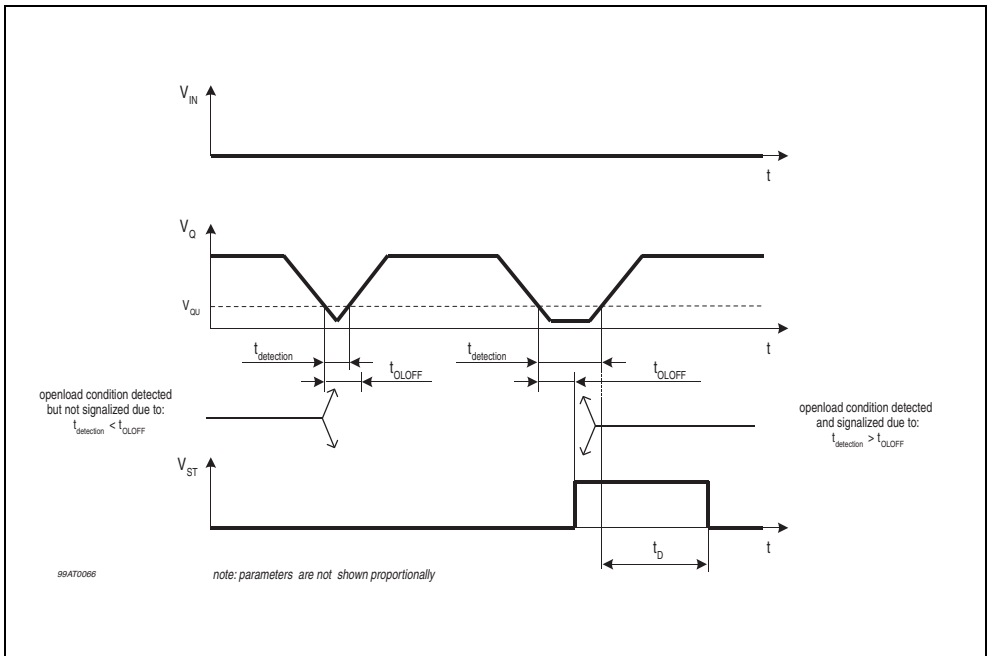
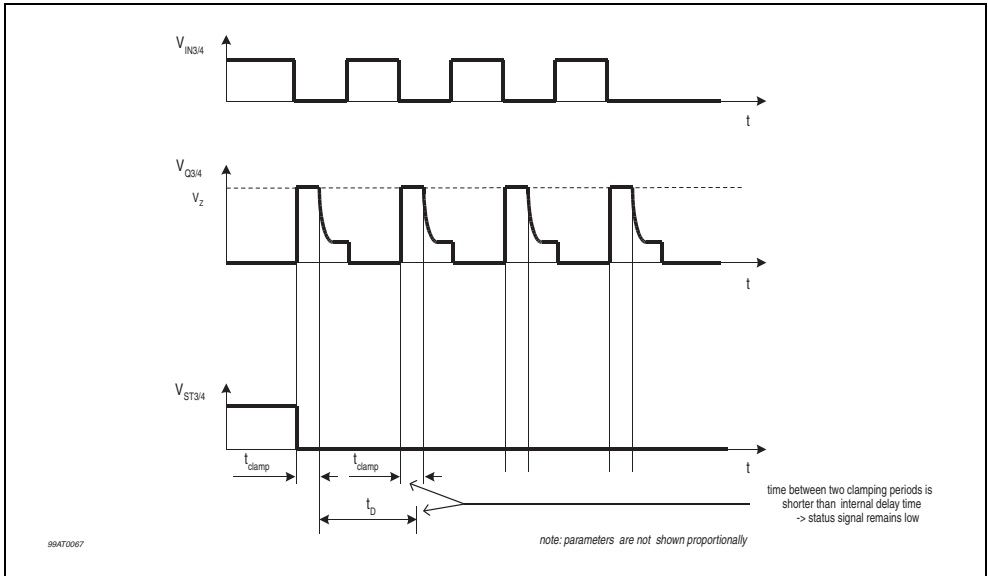


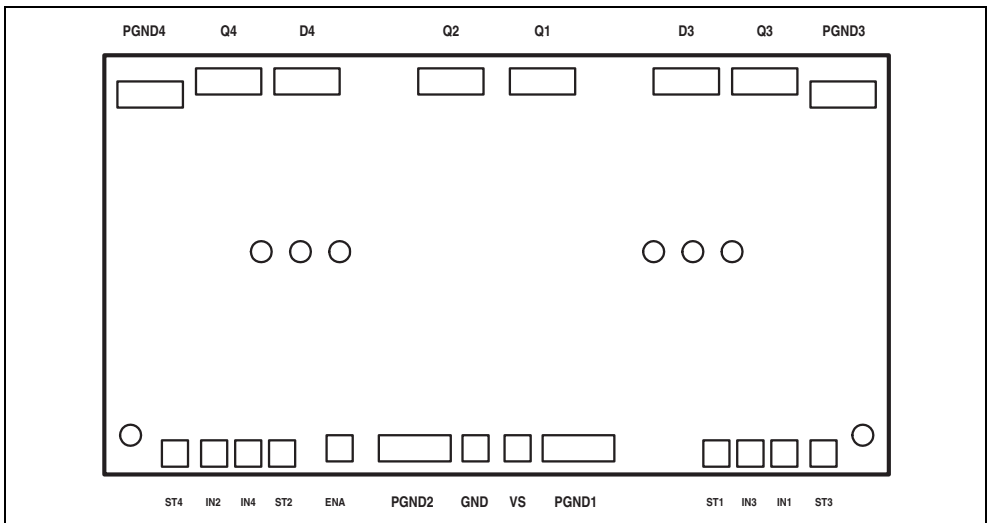
Figure 9. Output Voltage Clamp Detection



3.0 PAD POSITIONS

Chip Size: 5.17 x 2.76 mm²

Figure 10.



Please Read Carefully:

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

ST PRODUCTS ARE NOT DESIGNED OR AUTHORIZED FOR USE IN: (A) SAFETY CRITICAL APPLICATIONS SUCH AS LIFE SUPPORTING, ACTIVE IMPLANTED DEVICES OR SYSTEMS WITH PRODUCT FUNCTIONAL SAFETY REQUIREMENTS; (B) AERONAUTIC APPLICATIONS; (C) AUTOMOTIVE APPLICATIONS OR ENVIRONMENTS, AND/OR (D) AEROSPACE APPLICATIONS OR ENVIRONMENTS. WHERE ST PRODUCTS ARE NOT DESIGNED FOR SUCH USE, THE PURCHASER SHALL USE PRODUCTS AT PURCHASER'S SOLE RISK, EVEN IF ST HAS BEEN INFORMED IN WRITING OF SUCH USAGE, UNLESS A PRODUCT IS EXPRESSLY DESIGNATED BY ST AS BEING INTENDED FOR "AUTOMOTIVE, AUTOMOTIVE SAFETY OR MEDICAL" INDUSTRY DOMAINS ACCORDING TO ST PRODUCT DESIGN SPECIFICATIONS. PRODUCTS FORMALLY ESCC, QML OR JAN QUALIFIED ARE DEEMED SUITABLE FOR USE IN AEROSPACE BY THE CORRESPONDING GOVERNMENTAL AGENCY.

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2013 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Philippines - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com



Компания «ЭлектроПласт» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов;
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



Как с нами связаться

Телефон: 8 (812) 309 58 32 (многоканальный)

Факс: 8 (812) 320-02-42

Электронная почта: org@eplast1.ru

Адрес: 198099, г. Санкт-Петербург, ул. Калинина, дом 2, корпус 4, литера А.