

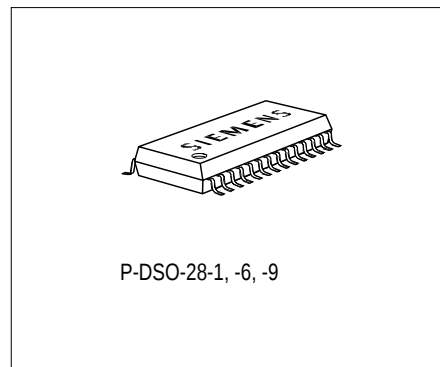
## 1-A Quad-HBD (Quad-Half-Bridge Driver)

**TLE 4208**

### Overview

#### Features

- Driver for up to 3 motors
- Delivers up to 0.8 A continuous
- Optimized for DC motor management applications
- Very low current consumption in stand-by (Inhibit) mode
- Low saturation voltage; typ.1.2 V total @ 25 °C; 0.4 A
- Output protected against short circuit
- Error flag diagnosis
- Overvoltage lockout and diagnosis
- Undervoltage lockout
- CMOS/TTL compatible inputs with hysteresis
- No crossover current
- Internal clamp diodes
- Overtemperature protection with hysteresis and diagnosis
- Enhanced power P-DSO-Package



| Type       | Ordering Code | Package    |
|------------|---------------|------------|
| TLE 4208 G | Q67007-A9335  | P-DSO-28-6 |

### Description

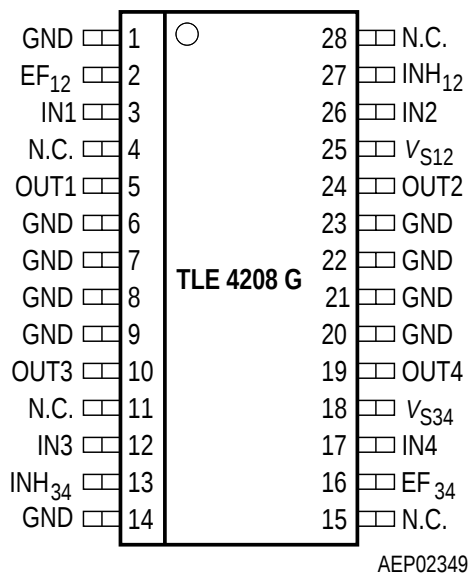
The TLE 4208 is a fully protected **Quad-Half-Bridge-Driver** designed specially for automotive and industrial motion control applications.

The part is built using the Siemens bipolar high voltage power technology DOPL.

In a cascade configuration up to three actuators (DC motors) can be connected between the four half-bridges. These four half-bridges are configured as 2 dual-half-bridges, which are supplied and controlled separately. Operation modes forward (cw), reverse (ccw), brake and high impedance are invoked from a standard interface.

The standard enhanced power P-DSO-28 package meets the application requirements and saves PCB-board space and costs.

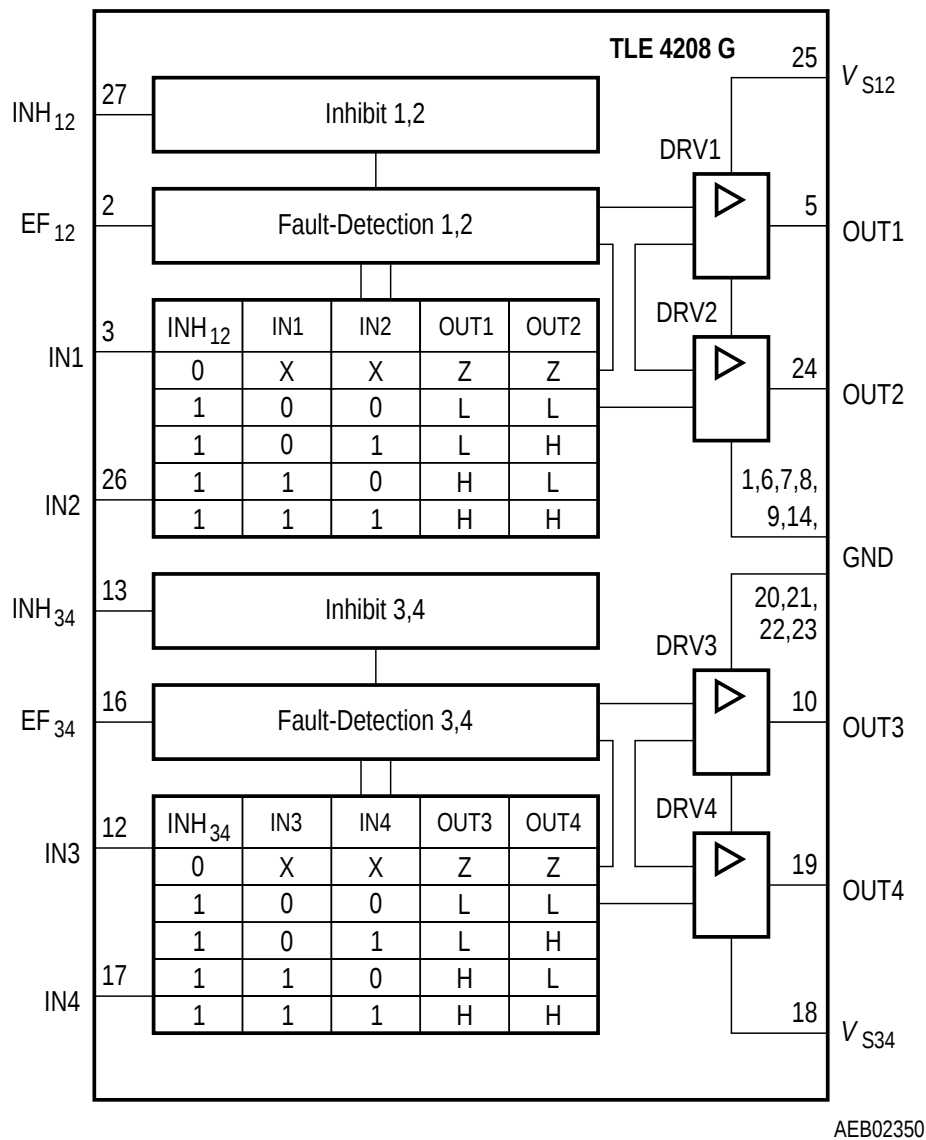
Furthermore the built-in features like diagnosis, over- and undervoltage-lockout, short-circuit protection, over-temperature protection and the very low quiescent current in stand-by mode will open a wide range of automotive and industrial applications.



**Figure 1** Pin Configuration (top view)

## Pin Definitions and Functions

| Pin No.                                 | Symbol            | Function                                                                                                    |
|-----------------------------------------|-------------------|-------------------------------------------------------------------------------------------------------------|
| 1, 6, 7, 8, 9,<br>14, 20, 21,<br>22, 23 | GND               | <b>Ground;</b><br>negative reference potential for blocking capacitor                                       |
| 2                                       | EF <sub>12</sub>  | <b>Error Flag output of half-bridges 1 and 2;</b><br>open collector; low = error                            |
| 3                                       | IN1               | <b>Input channel of half-bridge 1;</b><br>controls OUT1                                                     |
| 4, 11, 15, 28                           | N.C.              | <b>Not connected</b>                                                                                        |
| 5                                       | OUT1              | <b>Power output of half-bridge 1;</b><br>full short circuit protected; with integrated clamp diodes         |
| 10                                      | OUT3              | <b>Power output of half-bridge 3;</b><br>full short-circuit protected; with integrated clamp diodes         |
| 12                                      | IN3               | <b>Input channel of half-bridge 3;</b><br>controls OUT3                                                     |
| 13                                      | INH <sub>34</sub> | <b>Inhibit input of half-bridges 3 and 4;</b><br>low = half-bridges 3 and 4 in stand-by                     |
| 16                                      | EF <sub>34</sub>  | <b>Error Flag output of half-bridges 3 and 4;</b><br>open collector; low = error                            |
| 17                                      | IN4               | <b>Input channel of half-bridge 4;</b><br>controls OUT4                                                     |
| 18                                      | V <sub>S34</sub>  | <b>Power supply voltage of half-bridges 3 and 4;</b><br>positive reference potential for blocking capacitor |
| 19                                      | OUT4              | <b>Power output of half-bridge 4;</b><br>full short circuit protected; with integrated clamp diodes         |
| 24                                      | OUT2              | <b>Power-output of half-bridge 2;</b><br>full short circuit protected; with integrated clamp diodes         |
| 25                                      | V <sub>S12</sub>  | <b>Power supply voltage of half-bridges 1 and 2;</b><br>positive reference potential for blocking capacitor |
| 26                                      | IN2               | <b>Input channel of half-bridge 2;</b><br>controls OUT2                                                     |
| 27                                      | INH <sub>12</sub> | <b>Inhibit input of half-bridges 1 and 2;</b><br>low = half-bridges 1 and 2 in stand-by                     |



**Figure 2 Block Diagram**

## Input Logic

### Functional Truth Table of Halfbridge 1 and 2

| INH <sub>12</sub> | IN1 | IN2 | OUT1 | OUT2 | Mode     |
|-------------------|-----|-----|------|------|----------|
| 0                 | X   | X   | Z    | Z    | Stand-By |
| 1                 | 0   | 0   | L    | L    | Brake LL |
| 1                 | 0   | 1   | L    | H    | CW       |
| 1                 | 1   | 0   | H    | L    | CCW      |
| 1                 | 1   | 1   | H    | H    | Brake HH |

*Note: Half-Bridge 1 and 2 connected to a full-bridge*

### Functional Truth Table of Half-Bridge 3 and 4

| INH <sub>34</sub> | IN3 | IN4 | OUT3 | OUT4 | Mode     |
|-------------------|-----|-----|------|------|----------|
| 0                 | X   | X   | Z    | Z    | Stand-By |
| 1                 | 0   | 0   | L    | L    | Brake LL |
| 1                 | 0   | 1   | L    | H    | CW       |
| 1                 | 1   | 0   | H    | L    | CCW      |
| 1                 | 1   | 1   | H    | H    | Brake HH |

IN: 0 = Logic LOW  
1 = Logic HIGH  
X = don't care

OUT: Z = Output in tristate condition  
L = Output in sink condition  
H = Output in source condition

*Note: Half-Bridge 3 and 4 connected to a full-bridge*

## Diagnosis

| EF <sub>12</sub> | EF <sub>34</sub> | Error                                      |
|------------------|------------------|--------------------------------------------|
| 1                | 1                | no error                                   |
| 0                | 1                | over temperature of half-bridge 1 and 2 or |
| 0                | 1                | over voltage of half-bridge 1 and 2        |
| 1                | 0                | over temperature of half-bridge 3 and 4 or |
| 1                | 0                | over voltage of half-bridge 3 and 4        |
| 0                | 0                | over temperature of all half-bridges or    |
| 0                | 0                | over voltage of all half-bridges           |

## Electrical Characteristics

### Absolute Maximum Ratings

| Parameter | Symbol | Limit Values |      | Unit | Remarks |
|-----------|--------|--------------|------|------|---------|
|           |        | min.         | max. |      |         |

### Voltages

|                                                                                   |                      |       |    |   |                                                      |
|-----------------------------------------------------------------------------------|----------------------|-------|----|---|------------------------------------------------------|
| Supply voltage                                                                    | $V_{S12}, V_{S34}$   | – 0.3 | 45 | V | –                                                    |
| Supply voltage                                                                    | $V_{S12}, V_{S34}$   | – 1   | –  | V | $t < 0.5 \text{ s}; I_{S12}, I_{S34} > -2 \text{ A}$ |
| Logic input voltages (IN1; IN2; INH <sub>12</sub> ; IN3; IN4; INH <sub>34</sub> ) | $V_i$                | – 5   | 20 | V | $0 \text{ V} < V_{S12}, V_{S34} < 45 \text{ V}$      |
| Logic output voltage (EF <sub>12</sub> ; EF <sub>34</sub> )                       | $V_{EF12}, V_{EF34}$ | – 0.3 | 20 | V | $0 \text{ V} < V_{S12}, V_{S34} < 45 \text{ V}$      |

### Currents

|                        |               |    |   |    |                    |
|------------------------|---------------|----|---|----|--------------------|
| Output current (cont.) | $I_{OUT1-4}$  | –  | – | A  | internally limited |
| Output current (peak)  | $I_{OUT1-4}$  | –  | – | A  | internally limited |
| Output current (diode) | $I_{OUT1-4}$  | –1 | 1 | A  | –                  |
| Output current (EF)    | $I_{EF12-34}$ | –2 | 5 | mA | –                  |

### Temperatures

|                      |           |      |     |    |   |
|----------------------|-----------|------|-----|----|---|
| Junction temperature | $T_j$     | – 40 | 150 | °C | – |
| Storage temperature  | $T_{stg}$ | – 50 | 150 | °C | – |

### Thermal Resistances

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

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

## Operating Range

| Parameter                                                                               | Symbol             | Limit Values  |               | Unit | Remarks                                            |
|-----------------------------------------------------------------------------------------|--------------------|---------------|---------------|------|----------------------------------------------------|
|                                                                                         |                    | min.          | max.          |      |                                                    |
| Supply voltage                                                                          | $V_{S12}, V_{S34}$ | $V_{UV\ OFF}$ | 18            | V    | After $V_{S12}, V_{S34}$ rising above $V_{UV\ ON}$ |
| Supply voltage increasing                                                               | $V_{S12}, V_{S34}$ | – 0.3         | $V_{UV\ ON}$  | V    | Outputs in tristate                                |
| Supply voltage decreasing                                                               | $V_{S12}, V_{S34}$ | – 0.3         | $V_{UV\ OFF}$ | V    | Outputs in tristate                                |
| Logic input voltages<br>(IN1; IN2; INH <sub>12</sub> ;<br>IN3; IN4; INH <sub>34</sub> ) | $V_I$              | – 2           | 18            | V    | –                                                  |
| Junction temperature                                                                    | $T_j$              | – 40          | 150           | °C   | –                                                  |

*Note: In the operating range the functions given in the circuit description are fulfilled.*

## Electrical Characteristics

$8\text{ V} < V_{S12} = V_{S34} < 18\text{ V}$ ;  $\text{INH}_{12} = \text{INH}_{34} = \text{HIGH}$ ;  $I_{\text{OUT}1-4} = 0\text{ A}$ ;  $-40\text{ }^{\circ}\text{C} < T_j < 150\text{ }^{\circ}\text{C}$ ; unless otherwise specified

| Parameter | Symbol | Limit Values |      |      | Unit | Test Condition |
|-----------|--------|--------------|------|------|------|----------------|
|           |        | min.         | typ. | max. |      |                |

## Current Consumption

$\text{INH}_{12} = \text{INH}_{34} = \text{LOW}$

|                   |       |   |    |     |               |                                                                                                            |
|-------------------|-------|---|----|-----|---------------|------------------------------------------------------------------------------------------------------------|
| Quiescent current | $I_S$ | – | –  | 100 | $\mu\text{A}$ | $I_S = I_{S12} + I_{S34}$                                                                                  |
| Quiescent current | $I_S$ | – | 20 | 40  | $\mu\text{A}$ | $I_S = I_{S12} + I_{S34}$ ;<br>$V_{S12} = V_{S34} = 13.2\text{ V}$ ;<br>$T_j = 25\text{ }^{\circ}\text{C}$ |

$\text{INH}_{12} = \text{HIGH}$  and  $\text{INH}_{34} = \text{LOW}$  or  $\text{INH}_{12} = \text{LOW}$  and  $\text{INH}_{34} = \text{HIGH}$

|                |                    |   |    |    |             |                                                                           |
|----------------|--------------------|---|----|----|-------------|---------------------------------------------------------------------------|
| Supply current | $I_{S12}, I_{S34}$ | – | 10 | 20 | $\text{mA}$ | –                                                                         |
| Supply current | $I_{S12}, I_{S34}$ | – | –  | 30 | $\text{mA}$ | $I_{\text{OUT}1/3} = 0.4\text{ A}$<br>$I_{\text{OUT}2/4} = -0.4\text{ A}$ |
| Supply current | $I_{S12}, I_{S34}$ | – | –  | 50 | $\text{mA}$ | $I_{\text{OUT}1/3} = 0.8\text{ A}$<br>$I_{\text{OUT}2/4} = -0.8\text{ A}$ |

## Over- and Under Voltage Lockout

|                       |                     |    |      |     |            |                                        |
|-----------------------|---------------------|----|------|-----|------------|----------------------------------------|
| UV Switch ON voltage  | $V_{\text{UV ON}}$  | –  | 6.5  | 7.5 | $\text{V}$ | $V_{S12}, V_{S34}$<br>increasing       |
| UV Switch OFF voltage | $V_{\text{UV OFF}}$ | 5  | 6    | –   | $\text{V}$ | $V_{S12}, V_{S34}$<br>decreasing       |
| UV ON/OFF hysteresis  | $V_{\text{UV HY}}$  | –  | 0.5  | –   | $\text{V}$ | $V_{\text{UV ON}} - V_{\text{UV OFF}}$ |
| OV Switch OFF voltage | $V_{\text{OV OFF}}$ | –  | 20   | 24  | $\text{V}$ | $V_{S12}, V_{S34}$<br>increasing       |
| OV Switch ON voltage  | $V_{\text{OV ON}}$  | 18 | 19.5 | –   | $\text{V}$ | $V_{S12}, V_{S34}$<br>decreasing       |
| OV ON/OFF hysteresis  | $V_{\text{OV HY}}$  | –  | 0.5  | –   | $\text{V}$ | $V_{\text{OV OFF}} - V_{\text{OV ON}}$ |

## Electrical Characteristics (cont'd)

8 V <  $V_{S12} = V_{S34} < 18$  V;  $INH_{12} = INH_{34} = \text{HIGH}$ ;  $I_{OUT1-4} = 0$  A;  $-40\text{ }^{\circ}\text{C} < T_j < 150\text{ }^{\circ}\text{C}$ ; unless otherwise specified

| Parameter | Symbol | Limit Values |      |      | Unit | Test Condition |
|-----------|--------|--------------|------|------|------|----------------|
|           |        | min.         | typ. | max. |      |                |

## Outputs OUT1; OUT2; OUT 3; OUT 4

### Saturation Voltages

|                                                   |              |   |      |      |   |                                    |
|---------------------------------------------------|--------------|---|------|------|---|------------------------------------|
| Source (upper)<br>$I_{OUT12}, I_{OUT34} = -0.2$ A | $V_{SAT\ U}$ | – | 0.85 | 1.15 | V | $T_j = 25\text{ }^{\circ}\text{C}$ |
| Source (upper)<br>$I_{OUT12}, I_{OUT34} = -0.4$ A | $V_{SAT\ U}$ | – | 0.90 | 1.20 | V | $T_j = 25\text{ }^{\circ}\text{C}$ |
| Sink (upper)<br>$I_{OUT12}, I_{OUT34} = -0.8$ A   | $V_{SAT\ U}$ | – | 1.10 | 1.50 | V | $T_j = 25\text{ }^{\circ}\text{C}$ |
| Sink (lower)<br>$I_{OUT12}, I_{OUT34} = 0.2$ A    | $V_{SAT\ L}$ | – | 0.15 | 0.23 | V | $T_j = 25\text{ }^{\circ}\text{C}$ |
| Sink (lower)<br>$I_{OUT12}, I_{OUT34} = 0.4$ A    | $V_{SAT\ L}$ | – | 0.25 | 0.40 | V | $T_j = 25\text{ }^{\circ}\text{C}$ |
| Sink (lower)<br>$I_{OUT12}, I_{OUT34} = 0.8$ A    | $V_{SAT\ L}$ | – | 0.45 | 0.75 | V | $T_j = 25\text{ }^{\circ}\text{C}$ |

|                                              |           |   |     |     |   |                                     |
|----------------------------------------------|-----------|---|-----|-----|---|-------------------------------------|
| Total Drop<br>$I_{OUT12}, I_{OUT34} = 0.2$ A | $V_{SAT}$ | – | 1   | 1.4 | V | $V_{SAT} = V_{SAT\ U} + V_{SAT\ L}$ |
| Total Drop<br>$I_{OUT12}, I_{OUT34} = 0.4$ A | $V_{SAT}$ | – | 1.2 | 1.7 | V | $V_{SAT} = V_{SAT\ U} + V_{SAT\ L}$ |
| Total Drop<br>$I_{OUT12}, I_{OUT34} = 0.8$ A | $V_{SAT}$ | – | 1.6 | 2.5 | V | $V_{SAT} = V_{SAT\ U} + V_{SAT\ L}$ |

### Clamp Diodes

|                        |           |   |     |     |    |                             |
|------------------------|-----------|---|-----|-----|----|-----------------------------|
| Forward voltage; upper | $V_{FU}$  | – | 1   | 1.5 | V  | $I_F = 0.4$ A               |
| Upper leakage current  | $I_{LKU}$ | – | –   | 5   | mA | $I_F = 0.4$ A <sup>1)</sup> |
| Forward voltage; lower | $V_{FL}$  | – | 0.9 | 1.4 | V  | $I_F = 0.4$ A               |

Notes see page 11.

## Electrical Characteristics (cont'd)

$8\text{ V} < V_{S12} = V_{S34} < 18\text{ V}$ ;  $INH_{12} = INH_{34} = \text{HIGH}$ ;  $I_{OUT1-4} = 0\text{ A}$ ;  $-40\text{ }^{\circ}\text{C} < T_j < 150\text{ }^{\circ}\text{C}$ ; unless otherwise specified

| Parameter | Symbol | Limit Values |      |      | Unit | Test Condition |
|-----------|--------|--------------|------|------|------|----------------|
|           |        | min.         | typ. | max. |      |                |

## Input Interface

### Logic Inputs IN1; IN2; IN3; IN4

|                             |           |       |      |     |               |                    |
|-----------------------------|-----------|-------|------|-----|---------------|--------------------|
| H-input voltage             | $V_{IH}$  | –     | 2.0  | 3.0 | V             | –                  |
| L-input voltage             | $V_{IL}$  | 1.0   | 1.5  | –   | V             | –                  |
| Hysteresis of input voltage | $V_{IHY}$ | –     | 0.5  | –   | V             | –                  |
| H-input current             | $I_{IH}$  | – 2   | –    | 10  | $\mu\text{A}$ | $V_I = 5\text{ V}$ |
| L-input current             | $I_{IL}$  | – 100 | – 20 | – 5 | $\mu\text{A}$ | $V_I = 0\text{ V}$ |

### Logic Inputs $INH_{12}$ ; $INH_{34}$

|                             |           |      |     |     |               |                        |
|-----------------------------|-----------|------|-----|-----|---------------|------------------------|
| H-input voltage             | $V_{IH}$  | –    | 2.7 | 3.5 | V             | –                      |
| L-input voltage             | $V_{IL}$  | 1.0  | 2.0 | –   | V             | –                      |
| Hysteresis of input voltage | $V_{IHY}$ | –    | 0.7 | –   | V             | –                      |
| H-input current             | $I_{IH}$  | –    | 100 | 250 | $\mu\text{A}$ | $V_{INH} = 5\text{ V}$ |
| L-input current             | $I_{IL}$  | – 10 | –   | 10  | $\mu\text{A}$ | $V_{INH} = 0\text{ V}$ |

### Error-Flags $EF_{12}$ ; $EF_{34}$

|                        |            |   |     |     |               |                                    |
|------------------------|------------|---|-----|-----|---------------|------------------------------------|
| L-output voltage level | $V_{EFL}$  | – | 0.2 | 0.4 | V             | $I_{EF} = 2\text{ mA}$             |
| Leakage current        | $I_{EFLK}$ | – | –   | 10  | $\mu\text{A}$ | $0\text{ V} < V_{EF} < 7\text{ V}$ |

## Electrical Characteristics (cont'd)

$8\text{ V} < V_{S12} = V_{S34} < 18\text{ V}$ ;  $\text{INH}_{12} = \text{INH}_{34} = \text{HIGH}$ ;  $I_{\text{OUT}1-4} = 0\text{ A}$ ;  $-40\text{ }^{\circ}\text{C} < T_j < 150\text{ }^{\circ}\text{C}$ ; unless otherwise specified

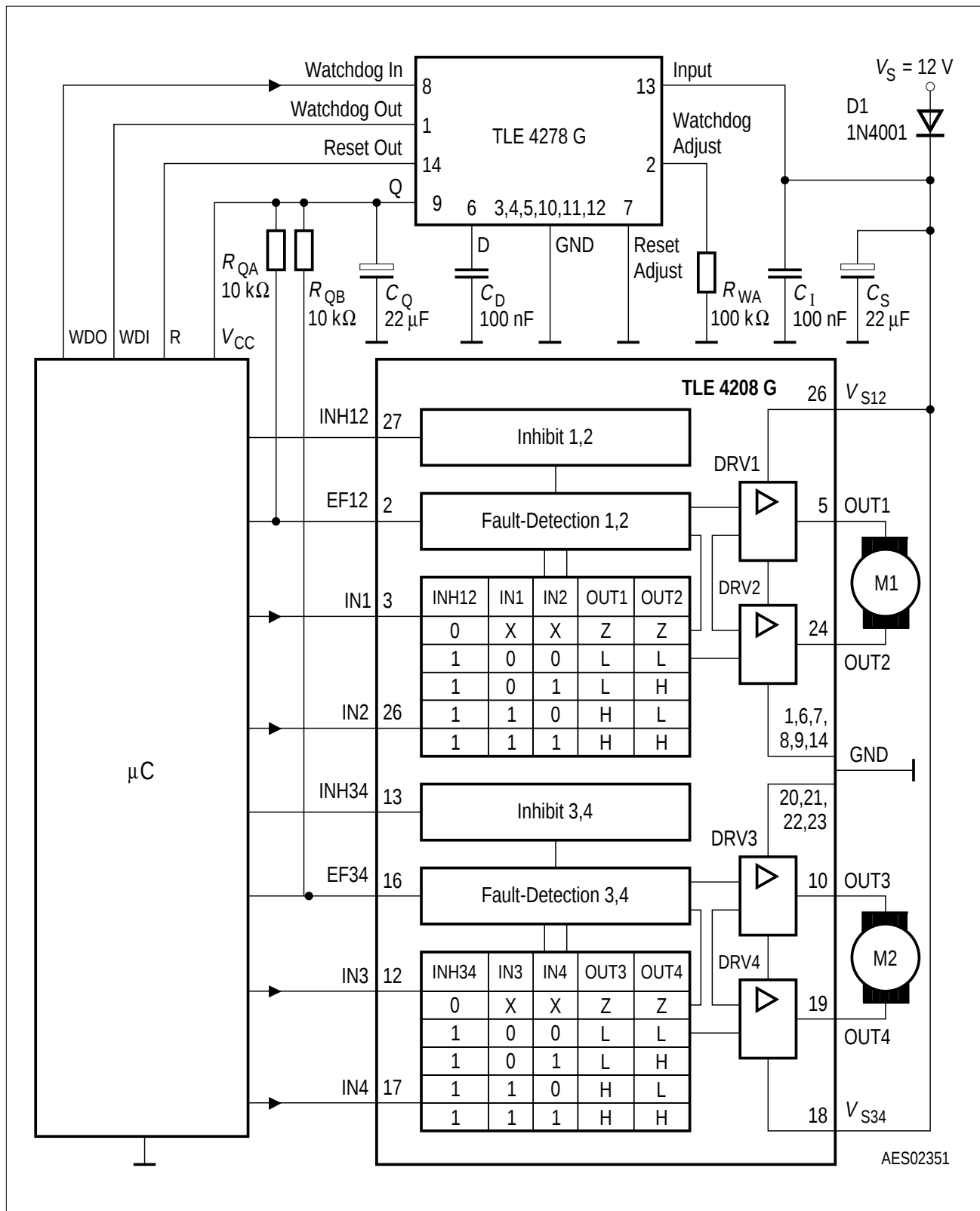
| Parameter | Symbol | Limit Values |      |      | Unit | Test Condition |
|-----------|--------|--------------|------|------|------|----------------|
|           |        | min.         | typ. | max. |      |                |

## Thermal Shutdown

|                                        |            |     |     |     |                    |   |
|----------------------------------------|------------|-----|-----|-----|--------------------|---|
| Thermal shutdown junction temperature  | $T_{jSD}$  | 150 | 175 | 200 | $^{\circ}\text{C}$ | — |
| Thermal switch-on junction temperature | $T_{jSO}$  | 120 | —   | 170 | $^{\circ}\text{C}$ | — |
| Temperature hysteresis                 | $\Delta T$ | —   | 30  | —   | K                  | — |

<sup>1)</sup> Guaranteed by design.

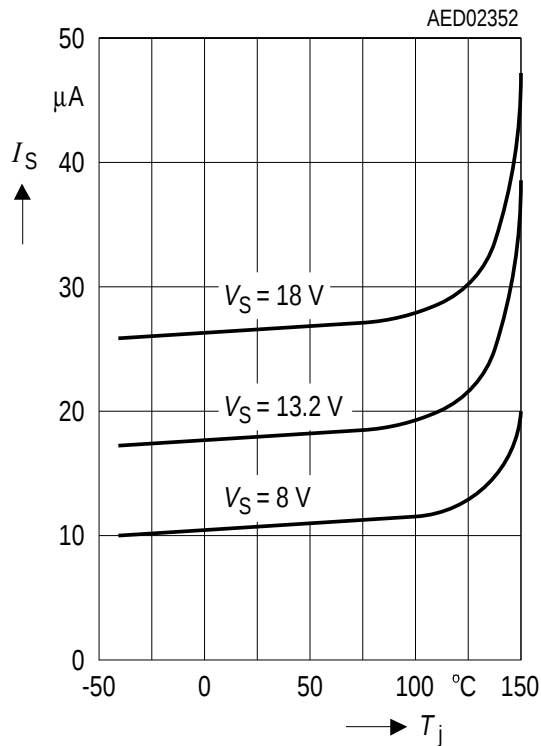
*Note: The listed characteristics are ensured over the operating range of the integrated circuit. Typical characteristics specify mean values expected over the production spread. If not otherwise specified, typical characteristics apply at  $T_A = 25^{\circ}\text{C}$  and the given supply voltage.*



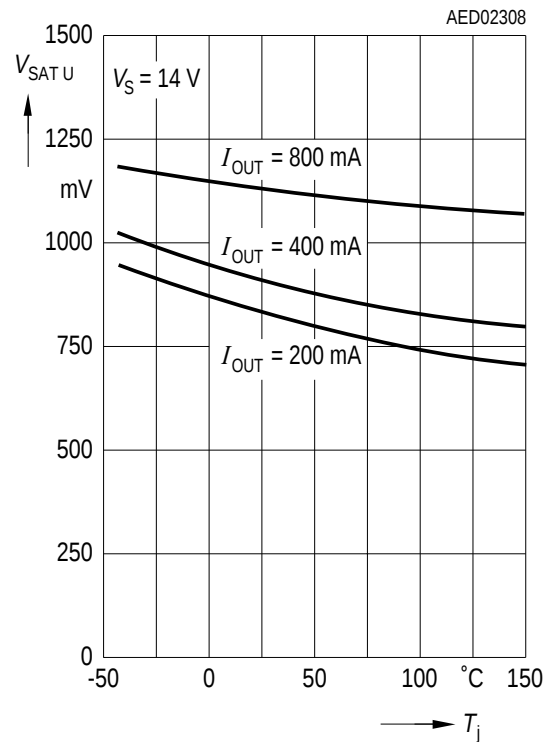
**Figure 3 Application Circuit 1 (Device is Used as Dual-Full-Bridge-Driver)**

## Diagrams

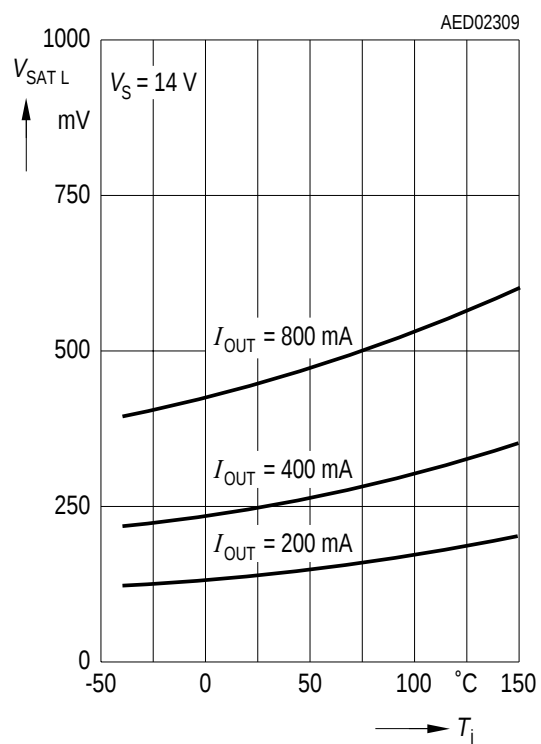
### Quiescent current $I_S$ over Temperature



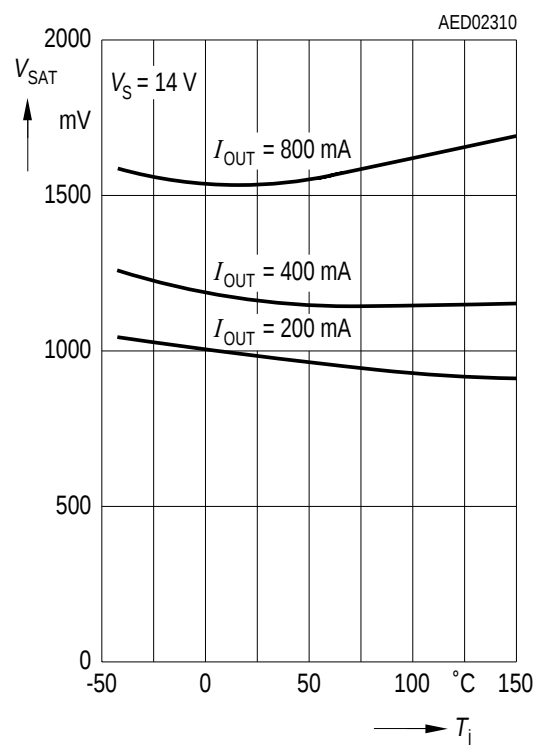
### Saturation Voltage of Source $V_{SAT U}$ over Temperature



### Saturation Voltage of Sink $V_{SAT L}$ over Temperature



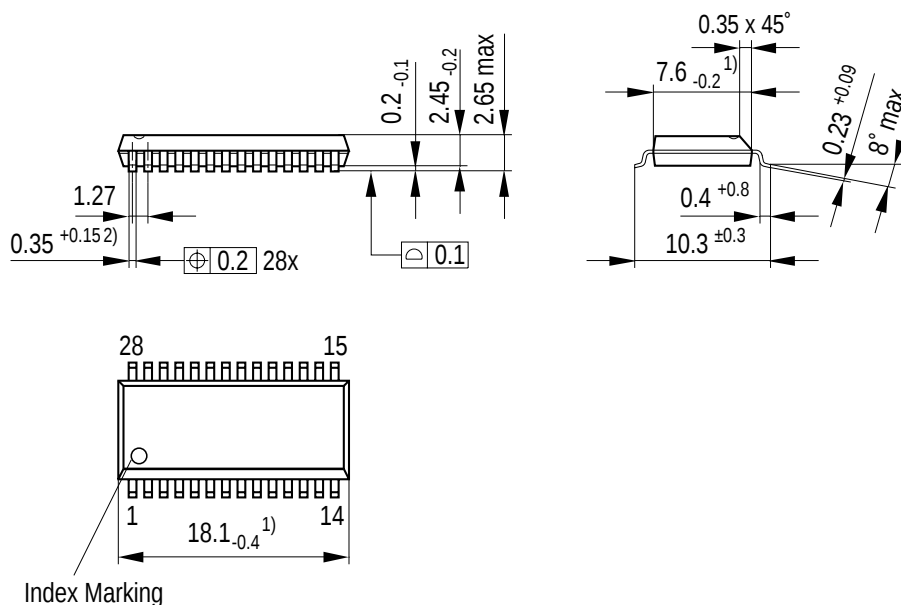
### Total Drop at outputs $V_{SAT}$ over Temperature



## Package Outlines

### P-DSO-28-6

(Plastic Dual Small Outline Package)



Index Marking

- 1) Does not include plastic or metal protrusions of 0.15 max per side
- 2) Does not include dambar protrusion of 0.05 max per side

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