

# 2ED2304S06F

## 650 V Half Bridge Gate Driver with Integrated Bootstrap Diode

### Feature list

- Infineon Thin-film-SOI-technology
- Fully operational to +650 V
- Floating channel designed for bootstrap operation
- Output source/sink current capability +0.36 A/-0.7 A
- Integrated Ultra-fast, low  $R_{DS(on)}$  Bootstrap Diode
- Tolerant to negative transient voltage up to -50 V (Pulse width is up 500 ns) given by SOI-technology
- 10 ns typ., 60 ns max. propagation delay matching
- $dV/dt$  immune  $\pm 50$  V
- Gate drive supply range from 10 V to 20 V
- Undervoltage lockout for both channels
- 3.3 V, 5 V and 15 V input logic compatible
- RoHS compliant

### Product summary

- $V_{OFFSET}$  = 670 V max.
- $I_{O+/-}$  (typ.) = 0.36 A/0.7 A
- $V_{OUT}$  = 10 V - 17.5 V
- Delay Matching = 60 ns max.
- Internal deadtime = 75 ns
- $t_{on/off}$  (typ.) = 310 ns/300 ns

### Package

DSO-8



### Potential applications

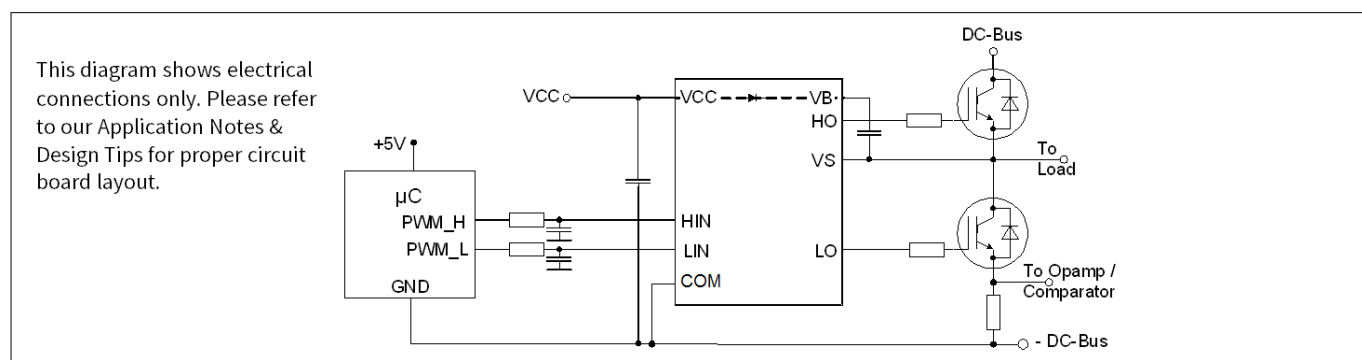
- Motor drives, General purpose inverters
- Refrigeration compressors
- Half-bridge and full-bridge converters in offline AC-DC power supplies for telecom and lighting

### Product validation

Qualified for industrial applications according to the relevant tests of JEDEC47/20/22.

### Description

The 2ED2304S06F is a 650-V half-bridge gate driver. Its Infineon thin-film-SOI technology provides excellent ruggedness and noise immunity. The Schmitt trigger logic inputs are compatible with standard CMOS or LSTTL logic down to 3.3 V. The output drivers features a high pulse current buffer stage designed for minimum driver cross-conduction. The floating channel can be used to drive an N-channel power MOSFET or IGBT in the high side configuration which operates up to 650 V. Additionally, the offline online clamping function provides an inherent protection of the parasitic turn-on by floating gate conditions when IC is not supplied.



**Figure 1** Typical connection diagram

**2ED2304S06F**  
**650 V Half Bridge Gate Driver with Integrated Bootstrap Diode**



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**Device information**

**Device information**

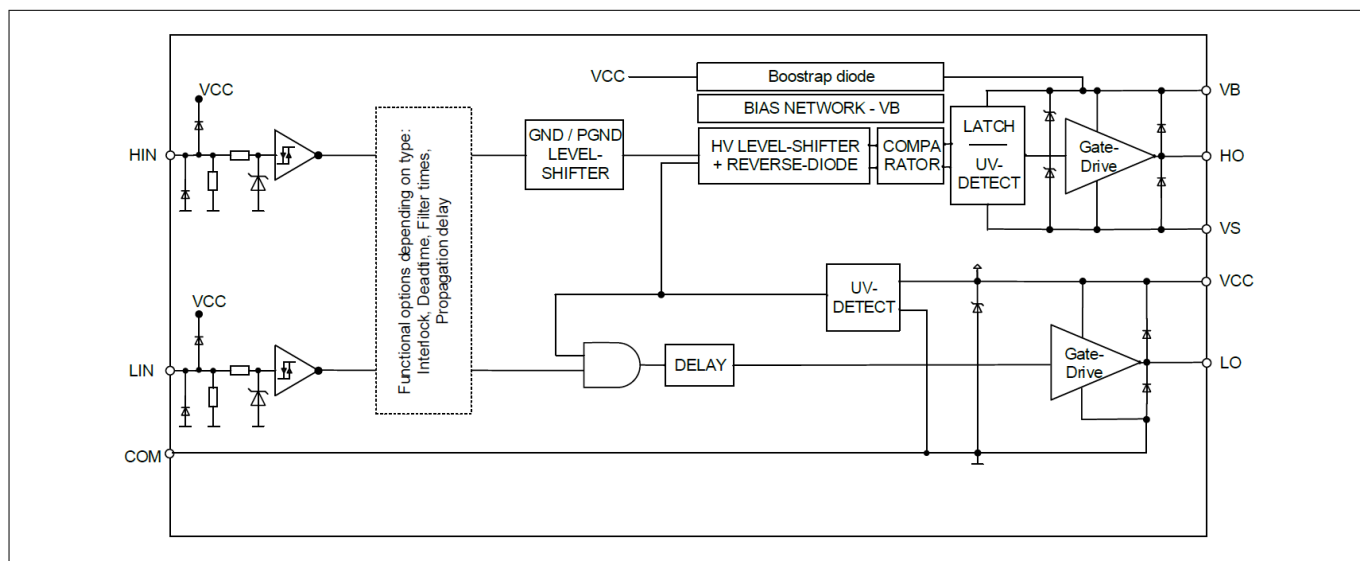
| Base Part Number | Package Type | Standard Pack |          | Orderable Part Number |
|------------------|--------------|---------------|----------|-----------------------|
|                  |              | Form          | Quantity |                       |
| 2ED2304S06F      | DSO-8        | Tube/Bulk     | 95       | 2ED2304S06FXLSA1      |
|                  |              | Tape and Reel | 2500     | 2ED2304S06FXUMA1      |

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## Block diagram

### 1 Block diagram

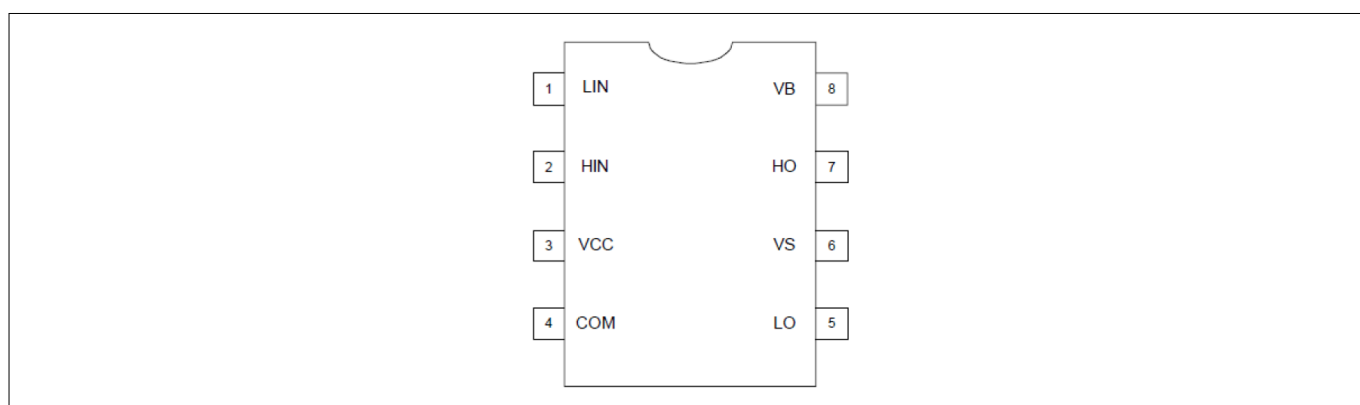


**Figure 2** Functional block diagram

### 2 Lead definitions

**Table 1** 2ED2304S06F lead definitions

| Pin | Symbol | Description                                                                                                       |
|-----|--------|-------------------------------------------------------------------------------------------------------------------|
| 1   | LIN    | Logic input for low-side gate driver output (LO), in phase. Schmitt trigger inputs with hysteresis and pull down  |
| 2   | HIN    | Logic input for high-side gate driver output (HO), in phase. Schmitt trigger inputs with hysteresis and pull down |
| 3   | VCC    | Low-side and logic supply voltage                                                                                 |
| 4   | COM    | Low-side gate drive return                                                                                        |
| 5   | LO     | Low-side driver output                                                                                            |
| 6   | VS     | High voltage floating supply return                                                                               |
| 7   | HO     | High-side driver output                                                                                           |
| 8   | VB     | High-side gate drive floating supply                                                                              |



**Figure 3** 2ED2304S06F lead assignments (DSO-8)

## Absolute maximum ratings

### 3 Absolute maximum ratings

**Table 2 Absolute maximum ratings**

Absolute maximum ratings indicate sustained limits beyond which damage to the device may occur. All voltage parameters are absolute voltages referenced to COM unless otherwise stated in the table. The thermal resistance and power dissipation ratings are measured under board mounted and still air conditions.

| Parameter                                               | Symbol     | Values                 |                | Unit                      | Note or Test Condition               |
|---------------------------------------------------------|------------|------------------------|----------------|---------------------------|--------------------------------------|
|                                                         |            | Min.                   | Max.           |                           |                                      |
| High side floating offset voltage                       | $V_B$      | $V_{CC} - 6$           | 670            | V                         | <sup>1)</sup>                        |
|                                                         |            | $V_{CC} - 50$          | –              | V                         | $t_p < 500 \text{ ns}$ <sup>1)</sup> |
| High side floating offset voltage                       | $V_S$      | $V_{CC} - V_{BS} - 6$  | 650            | V                         | –                                    |
|                                                         |            | $V_{CC} - V_{BS} - 50$ | –              | V                         | $t_p < 500 \text{ ns}$ <sup>1)</sup> |
| High side floating output voltage                       | $V_{HO}$   | $V_S - 0.5$            | $V_B + 0.5$    | V                         | –                                    |
| Floating gate drive voltage supply voltage              | $V_{BS}$   | -1                     | 20             | V                         |                                      |
| Low side supply voltage                                 | $V_{CC}$   | -1                     | 20             | V                         | –                                    |
| Low-side output voltage                                 | $V_{LO}$   | -0.5                   | $V_{CC} + 0.5$ | V                         | –                                    |
| Logic input voltage                                     | $V_{IN}$   | -0.5                   | $V_{CC} - 0.5$ | V                         | –                                    |
| Allowable $V_S$ offset supply transient relative to COM | $dV_S/dt$  | –                      | 50             | V/ns                      | <sup>2)</sup>                        |
| Package power dissipation                               | $P_D$      | –                      | 0.6            | W                         | @ $T_A \leq +25^\circ\text{C}$       |
| Thermal resistance, junction to ambient                 | $R_{thJA}$ | –                      | 195            | $^\circ\text{C}/\text{W}$ | –                                    |
| Junction temperature                                    | $T_J$      | –                      | 150            | $^\circ\text{C}$          | –                                    |
| Storage temperature                                     | $T_S$      | -40                    | 150            | $^\circ\text{C}$          | –                                    |
| Lead temperature                                        | $T_L$      | –                      | 300            | $^\circ\text{C}$          | soldering, 10 seconds                |

<sup>1)</sup> In case  $V_{CC} > V_B$  there is an additional power dissipation in the internal bootstrap diode between pins  $V_{CC}$  and  $V_B$  in case of activated bootstrap diode. Insensitivity to negative transient not subject to production test. Verified by design/characterization.

<sup>2)</sup> Not subject to production test, verified by characterization

## Recommended operating conditions

### 4 Recommended operating conditions

**Table 3 Recommended operating conditions**

For proper operation, the device should be used within the recommended conditions. All voltage parameters are absolute voltages referenced to COM unless otherwise stated in the table. The offset rating is tested with supplies of  $(V_{CC} - COM) = (V_B - V_S) = 15\text{ V}$ .

| Parameter                                     | Symbol   | Values                |              | Unit | Note or Test Condition |
|-----------------------------------------------|----------|-----------------------|--------------|------|------------------------|
|                                               |          | Min.                  | Max.         |      |                        |
| High side floating well supply voltage        | $V_B$    | $V_S + 10$            | $V_S + 17.5$ | V    | –                      |
| High side floating well supply offset voltage | $V_S$    | $V_{CC} - V_{BS} - 1$ | 650          | V    | 1)                     |
| Floating gate drive output voltage            | $V_{HO}$ | 10                    | $V_{BS}$     | V    | –                      |
| High-side supply voltage                      | $V_{BS}$ | 10                    | 17.5         | V    |                        |
| Low-side supply voltage                       | $V_{CC}$ | 10                    | 17.5         | V    | –                      |
| Low side output voltage                       | $V_{LO}$ | 0                     | $V_{CC}$     | V    | –                      |
| Logic input voltage                           | $V_{IN}$ | 0                     | $V_{CC}$     | V    | 2)                     |
| Ambient temperature                           | $T_A$    | -40                   | 125          | °C   | –                      |
| Pulse width for ON and OFF                    | $t_{IN}$ | 0.3                   | –            | μs   | 3)                     |

<sup>1</sup> Logic operation for  $V_S$  of -8 V to +600 V

<sup>2</sup> All input pins (HIN, LIN) are internally clamped

<sup>3</sup> Input pulses may not be transmitted properly in case of LIN/HIN below 0.3 μs

## Electrical characteristics

## 5 Electrical characteristics

### 5.1 Static electrical characteristics

**Table 4 Static electrical characteristics**

( $V_{CC} - \text{COM}$ ) = ( $V_B - V_S$ ) = 15 V, and  $T_A = 25^\circ\text{C}$  unless otherwise specified. The  $V_{IL}$ ,  $V_{IH}$  and  $I_{IN}$  parameters are referenced to COM and are applicable to the respective input pins: HIN and LIN. The  $V_O$  and  $I_O$  parameters are referenced to COM/VS and are applicable to the respective output leads HO or LO. The  $V_{CCUV}$  parameters are referenced to COM. The  $V_{BSUV}$  parameters are referenced to  $V_S$ .

| Parameter                                                  | Symbol       | Values |      |      | Unit          | Note or test condition                                              |
|------------------------------------------------------------|--------------|--------|------|------|---------------|---------------------------------------------------------------------|
|                                                            |              | Min.   | Typ. | Max. |               |                                                                     |
| $V_{BS}$ supply undervoltage positive going threshold      | $V_{BSUV+}$  | 8.3    | 9.1  | 9.9  | V             | –                                                                   |
| $V_{BS}$ supply undervoltage negative going threshold      | $V_{BSUV-}$  | 7.5    | 8.3  | 9.0  | V             | –                                                                   |
| $V_{BS}$ supply undervoltage hysteresis                    | $V_{BSUVHY}$ | 0.5    | 0.9  | –    | V             | –                                                                   |
| $V_{CC}$ supply undervoltage positive going threshold      | $V_{CCUV+}$  | 8.3    | 9.1  | 9.9  | V             | –                                                                   |
| $V_{CC}$ supply undervoltage negative going threshold      | $V_{CCUV-}$  | 7.5    | 8.3  | 9.0  | V             | –                                                                   |
| $V_{CC}$ supply undervoltage hysteresis                    | $V_{CCUVHY}$ | 0.5    | 0.9  | –    | V             | –                                                                   |
| High-side floating well offset supply leakage              | $I_{LK}$     | –      | 1    | 12.5 | $\mu\text{A}$ | $V_B = V_S = 600\text{ V}$                                          |
|                                                            |              | –      | 10   | –    | $\mu\text{A}$ | <sup>1)</sup> $T_J = 125^\circ\text{C}$ , $V_S = 600\text{ V}$      |
| Quiescent $V_{BS}$ supply current                          | $I_{QBS}$    | –      | 170  | 300  | $\mu\text{A}$ | –                                                                   |
| Quiescent $V_{CC}$ supply current                          | $I_{QCC}$    | –      | 300  | 600  | $\mu\text{A}$ | –                                                                   |
| High level output voltage drop, $V_{BIAS} - V_O$           | $V_{OH}$     | –      | 0.45 | 1    | V             | $I_O = 20\text{ mA}$                                                |
| Low level output voltage drop, $V_O$                       | $V_{OL}$     | –      | 0.13 | 0.3  | V             | $I_O = 20\text{ mA}$                                                |
| Peak output current turn-on                                | $I_{O+}$     | –      | 360  | –    | mA            | <sup>1)</sup> $V_O = 0\text{ V}$ , $PW \leq 10\text{ }\mu\text{s}$  |
| Mean output current from 3 V (20%) to 6 V (40%)            | $I_{O+mean}$ | 180    | 230  | –    | mA            | $C_L = 22\text{ nF}$                                                |
| Peak output current turn-off                               | $I_{O-}$     | –      | 700  | –    | mA            | <sup>1)</sup> $V_O = 15\text{ V}$ , $PW \leq 10\text{ }\mu\text{s}$ |
| Mean output current from 12 V (80%) to 9 V (60%)           | $I_{O-mean}$ | 390    | 480  | –    | mA            | $C_L = 22\text{ nF}$                                                |
| Logic “1” input voltage                                    | $V_{IH}$     | 1.7    | 2.1  | 2.4  | V             | –                                                                   |
| Logic “0” input voltage                                    | $V_{IL}$     | 0.7    | 0.9  | 1.1  | V             | –                                                                   |
| Input bias current (HO = High)                             | $I_{IN+}$    | 15     | 35   | 60   | $\mu\text{A}$ | $V_{IN} = 3.3\text{ V}$                                             |
| Input bias current (HO = Low)                              | $I_{IN-}$    | –      | 0    | –    | $\mu\text{A}$ | $V_{IN} = 0\text{ V}$                                               |
| Bootstrap diode forward voltage between $V_{CC}$ and $V_B$ | $V_{FBS D}$  | –      | 1    | 1.2  | V             | $I_F = 0.3\text{ mA}$                                               |
| Bootstrap diode forward current between $V_{CC}$ and $V_B$ | $I_{FBS D}$  | 30     | 55   | 80   | mA            | $V_{CC} - V_B = 4\text{ V}$                                         |

<sup>1</sup> Not subject of production test, verified by characterization

## Electrical characteristics

**Table 4 Static electrical characteristics (continued)**

( $V_{CC} - COM$ ) = ( $V_B - V_S$ ) = 15 V, and  $T_A = 25^\circ\text{C}$  unless otherwise specified. The  $V_{IL}$ ,  $V_{IH}$  and  $I_{IN}$  parameters are referenced to COM and are applicable to the respective input pins: HIN and LIN. The  $V_O$  and  $I_O$  parameters are referenced to COM/VS and are applicable to the respective output leads HO or LO. The  $V_{CCUV}$  parameters are referenced to COM. The  $V_{BSUV}$  parameters are referenced to  $V_S$ .

| Parameter                  | Symbol    | Values |      |      | Unit     | Note or test condition                        |
|----------------------------|-----------|--------|------|------|----------|-----------------------------------------------|
|                            |           | Min.   | Typ. | Max. |          |                                               |
| Bootstrap diode resistance | $R_{BSD}$ | 20     | 36   | 55   | $\Omega$ | $V_{F1} = 4\text{ V}$ , $V_{F2} = 5\text{ V}$ |

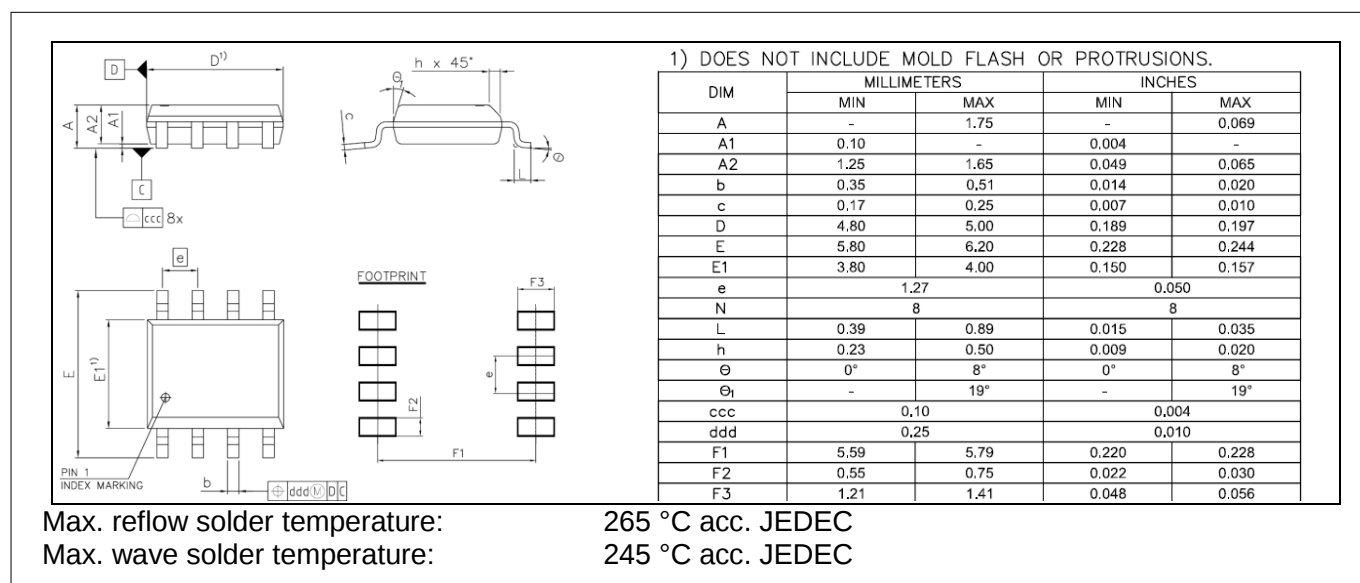
## 5.2 Dynamic electrical characteristics

**Table 5 Dynamic electrical characteristics**

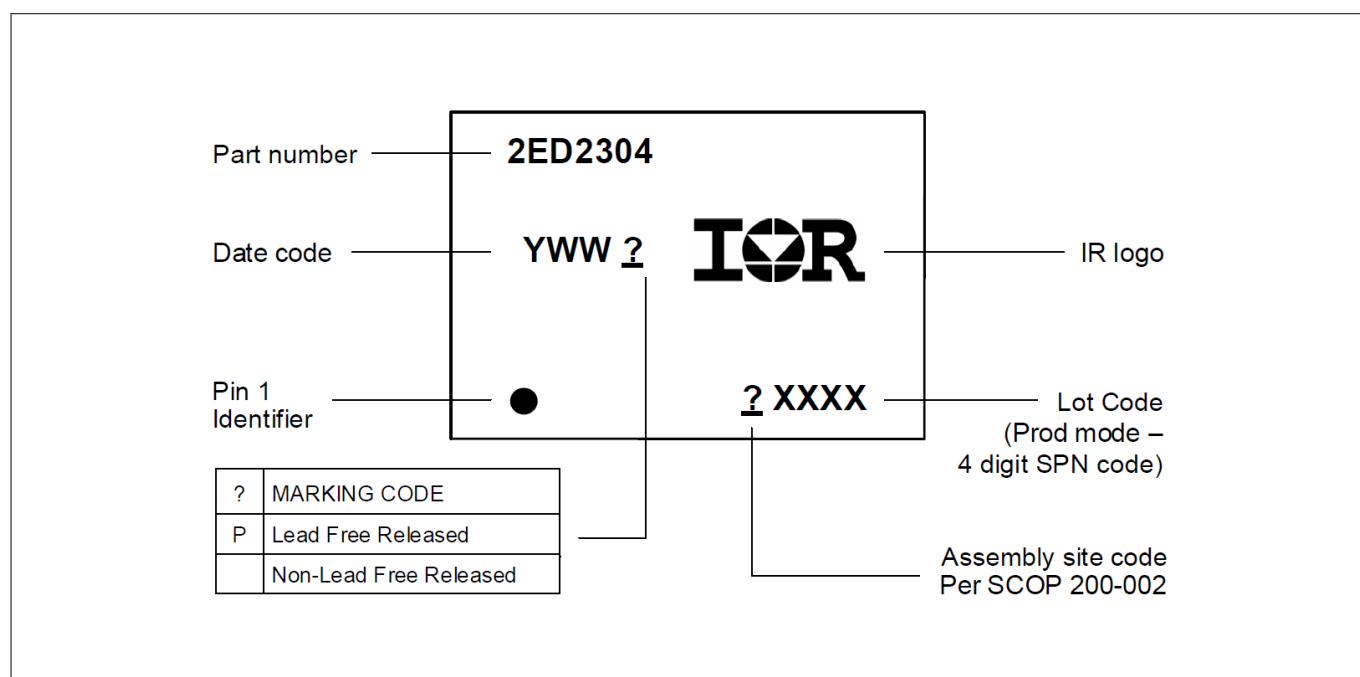
$V_{CC} = V_{BS} = 15\text{ V}$ ,  $V_{SS} = COM$ ,  $T_A = 25^\circ\text{C}$  and  $CL = 1000\text{ pF}$  unless otherwise specified.

| Parameter                                 | Symbol      | Values |      |      | Unit | Note or test condition                                          |
|-------------------------------------------|-------------|--------|------|------|------|-----------------------------------------------------------------|
|                                           |             | Min.   | Typ. | Max. |      |                                                                 |
| Turn-on propagation delay                 | $t_{on}$    | 210    | 310  | 460  | ns   | $V_{LIN/HIN} = 0\text{ or }3.3\text{ V}$                        |
| Turn-off propagation delay                | $t_{off}$   | 200    | 300  | 440  | ns   | $V_{LIN/HIN} = 0\text{ or }3.3\text{ V}$                        |
| Turn-on rise time                         | $t_r$       | –      | 48   | 80   | ns   | $V_{LIN/HIN} = 0\text{ or }3.3\text{ V}$<br>$C_L = 1\text{ nF}$ |
| Turn-off fall time                        | $t_f$       | –      | 24   | 40   | ns   | $V_{LIN/HIN} = 0\text{ or }3.3\text{ V}$<br>$C_L = 1\text{ nF}$ |
| Input filter time                         | $t_{FILIN}$ | 100    | 150  | 250  | ns   | $V_{LIN/HIN} = 0\text{ \& }3.3\text{ V}$                        |
| Delay matching time (HS & LS turn-on/off) | MT          | –      | 10   | 60   | ns   | ext. dead time > 500 ns                                         |
| Dead time                                 | DT          | 30     | 75   | 140  | ns   | $V_{LIN/HIN} = 0\text{ \& }3.3\text{ V}$                        |
| Dead time matching time                   | MDT         | –      | 10   | 50   | ns   | ext. dead time 0 ns                                             |

## 6 Package information DSO-8

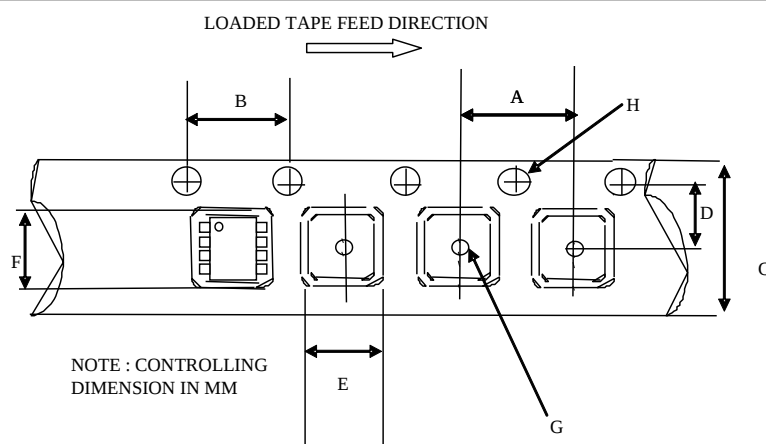


**Figure 4 Package outline PG-DSO-8**



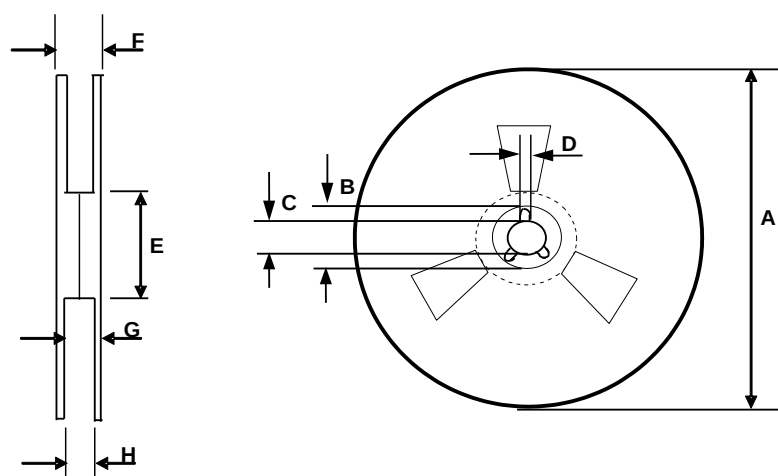
**Figure 5 Marking information PG-DSO-8 (2ED2304S06F)**

**Package information DSO-8**



**CARRIER TAPE DIMENSION FOR 8SOICN**

| Code | Metric |       | Imperial |       |
|------|--------|-------|----------|-------|
|      | Min    | Max   | Min      | Max   |
| A    | 7.90   | 8.10  | 0.311    | 0.318 |
| B    | 3.90   | 4.10  | 0.153    | 0.161 |
| C    | 11.70  | 12.30 | 0.46     | 0.484 |
| D    | 5.45   | 5.55  | 0.214    | 0.218 |
| E    | 6.30   | 6.50  | 0.248    | 0.255 |
| F    | 5.10   | 5.30  | 0.200    | 0.208 |
| G    | 1.50   | n/a   | 0.059    | n/a   |
| H    | 1.50   | 1.60  | 0.059    | 0.062 |



**REEL DIMENSIONS FOR 8SOICN**

| Code | Metric |        | Imperial |        |
|------|--------|--------|----------|--------|
|      | Min    | Max    | Min      | Max    |
| A    | 329.60 | 330.25 | 12.976   | 13.001 |
| B    | 20.95  | 21.45  | 0.824    | 0.844  |
| C    | 12.80  | 13.20  | 0.503    | 0.519  |
| D    | 1.95   | 2.45   | 0.767    | 0.096  |
| E    | 98.00  | 102.00 | 3.858    | 4.015  |
| F    | n/a    | 18.40  | n/a      | 0.724  |
| G    | 14.50  | 17.10  | 0.570    | 0.673  |
| H    | 12.40  | 14.40  | 0.488    | 0.566  |

**Figure 6 Tape and reel details PG-DSO-8**

## Qualification information

# 7 Qualification information

**Table 6** Qualification information <sup>1)</sup>

|                                   |                      |                                                                                                                                                                   |                                                          |
|-----------------------------------|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|
| <b>Qualification Level</b>        |                      | Industrial <sup>2)</sup>                                                                                                                                          |                                                          |
|                                   |                      | <i>Note: This family of ICs has passed JEDEC's Industrial qualification. Consumer qualification level is granted by extension of the higher Industrial level.</i> |                                                          |
| <b>Moisture Sensitivity Level</b> |                      | DSO-8                                                                                                                                                             | MSL2 <sup>3)</sup> , 250 °C<br>(per IPC/JEDEC J-STD-020) |
| <b>ESD</b>                        | Human Body Model     | Class 1C (>1.5 kV)<br>(per JEDEC standard JESD22-A114)                                                                                                            |                                                          |
|                                   | Charged Device Model | Class C3 (> 1.0 kV)<br>(per JESD22-C101)                                                                                                                          |                                                          |
| <b>IC Latch-Up Test</b>           |                      | Class II Level A<br>(per JESD85)                                                                                                                                  |                                                          |
| <b>RoHS Compliant</b>             |                      | Yes                                                                                                                                                               |                                                          |

<sup>1)</sup> Qualification standards can be found at Infineon's web site [www.infineon.com](http://www.infineon.com)

<sup>2)</sup> Higher qualification ratings may be available should the user have such requirements. Please contact your Infineon sales representative for further information.

<sup>3)</sup> Higher MSL ratings may be available for the specific package types listed here. Please contact your Infineon sales representative for further information.

## Related products

## 8 Related products

**Table 7**      **Related products**

| Product                     | Description                                                                                                                                                                                                                                                     |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Gate Driver ICs</b>      |                                                                                                                                                                                                                                                                 |
| 6EDL04I06 /<br>6EDL04N06    | 600 V, 3 phase level shift thin-film SOI gate driver with integrated high speed, low $R_{DS(on)}$ bootstrap diodes with over-current protection (OCP), 240/420 mA source/sink current drive, Fault reporting, and Enable for MOSFET or IGBT switches.           |
| 2EDL23I06 /<br>2EDL23N06    | 600 V, Half-bridge thin-film SOI level shift gate driver with integrated high speed, low $R_{DS(on)}$ bootstrap diode, with over-current protection (OCP), 2.3/2.8 A source/sink current driver, and one pin Enable/Fault function for MOSFET or IGBT switches. |
| <b>Power Switches</b>       |                                                                                                                                                                                                                                                                 |
| IKD04N60R / RF              | 600 V TRENCHSTOP™ IGBT with integrated diode in PG-TO252-3 package                                                                                                                                                                                              |
| IKD06N65ET6                 | 650 V TRENCHSTOP™ IGBT with integrated diode in DPAK                                                                                                                                                                                                            |
| IPD65R950CFD                | 650 V CoolMOS CFD2 with integrated fast body diode in DPAK                                                                                                                                                                                                      |
| IPN50R950CE                 | 500 V CoolMOS CE Superjunction MOSFET in PG-SOT223 package                                                                                                                                                                                                      |
| <b>iMOTION™ Controllers</b> |                                                                                                                                                                                                                                                                 |
| IRMCK099                    | iMOTION™ Motor control IC for variable speed drives utilizing sensor-less Field Oriented Control (FOC) for Permanent Magnet Synchronous Motors (PMSM).                                                                                                          |
| IMC101T                     | High performance Motor Control IC for variable speed drives based on field oriented control (FOC) of permanent magnet synchronous motors (PMSM).                                                                                                                |

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**Revision history**

## **Revision history**

| <b>Document version</b> | <b>Date of release</b> | <b>Description of changes</b>   |
|-------------------------|------------------------|---------------------------------|
| 0                       | 2016-07-12             | Datasheet creation              |
| 1.0                     | 2018-02-07             | First Release Version           |
| 1.1                     | 2018-07-13             | Updated the marking information |

## Trademarks

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