

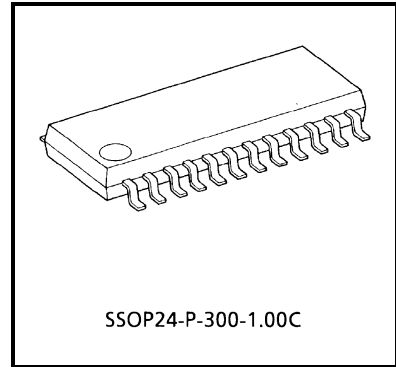
TPD2004F

2-channel Squib Driver for Air Bags

Manufactured through the Bi-CMOS-DMOS process, this 2-channel squib drive IPD is designed for use in SRS electronic system air bags.

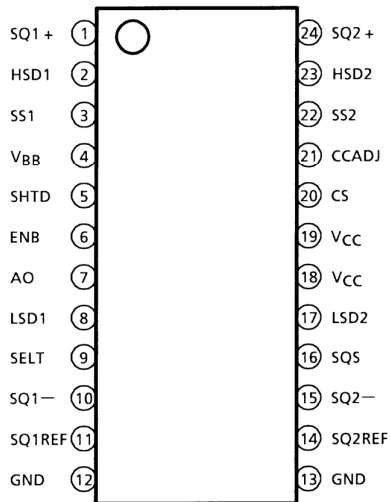
Features

- Using independent four-channel inputs, this IC controls two high-side and two low-side switches, making it possible to drive two squibs directly.
- Incorporates various diagnostic functions (analog multiplexer outputs):
 - Squib short-to-battery diagnosis
 - Squib short-to-ground diagnosis
 - Squib open-circuit diagnosis
 - Safing sensor-ON fault diagnosis
 - High-redundancy, upstream arrangement for safing sensor
 - Squib short diagnosis
 - Squib drive MOSFET diagnosis
- Chip select function allows for multi-channel structure to be materialized using minimum control lines.
- Comes in a 24-pin SSOP surface mount package.
- Supports embossed taping.

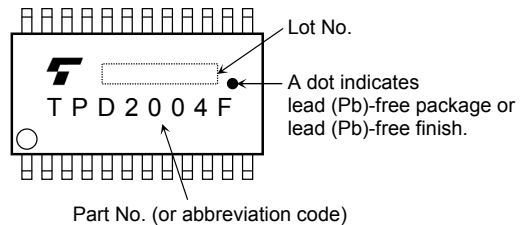


Weight: 0.29g (typ.)

Pin Assignment (top view)

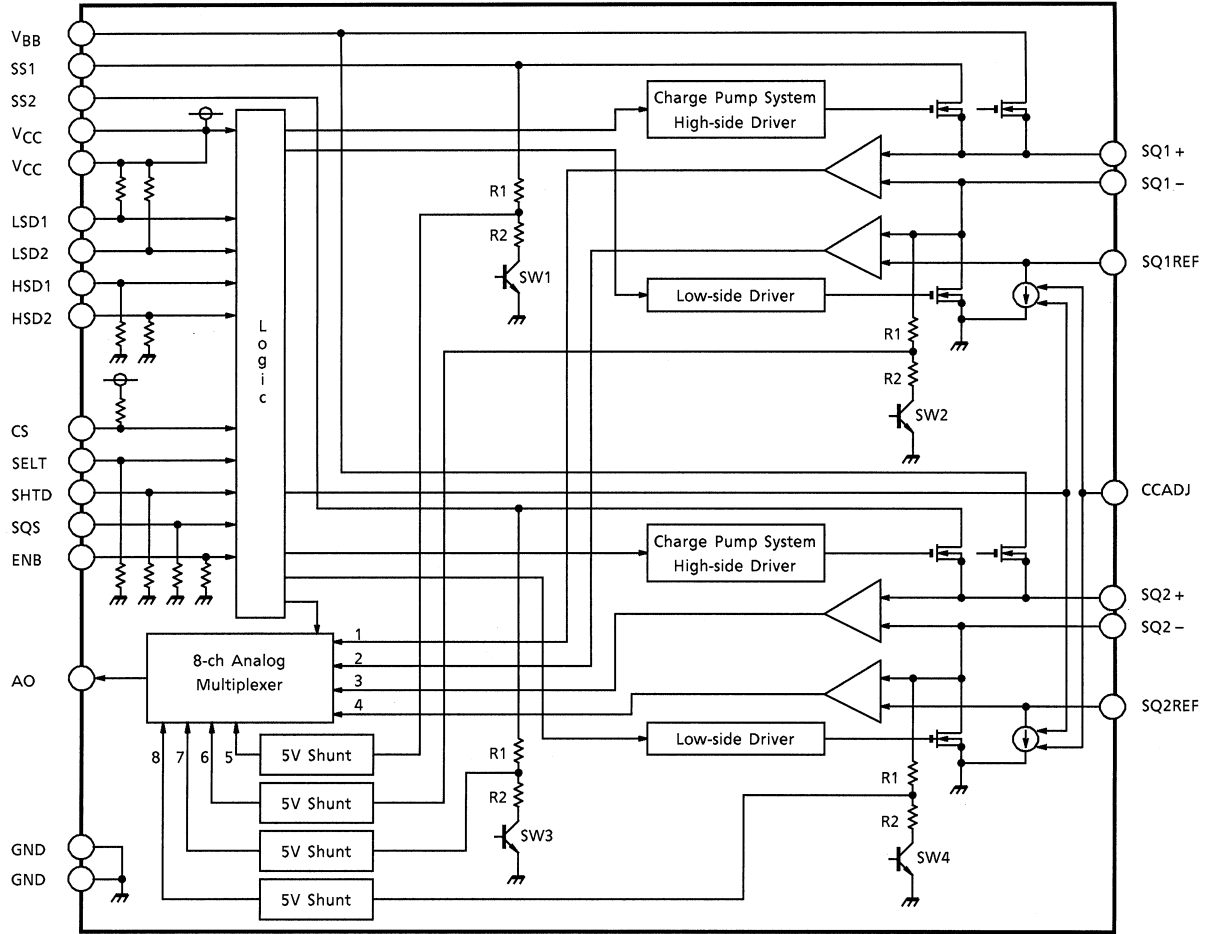


Marking



Note: Due to its MOS structure, this product is sensitive to static electricity.

Block Diagram



Pin Description

| Pin No. | Symbol | Pin Description |
|---------|-----------------|---|
| 1 | SQ1+ | Squib positive (+) side output pin for channel 1 |
| 2 | HSD1 | High-side driver control input pin for Channel 1 (pull-down) |
| 3 | SS1 | Safing sensor connect pin for channel 1 |
| 4 | V _{BB} | Backup block power supply input pin |
| 5 | SHTD | Control input pin for short diagnosis (pull-down) |
| 6 | ENB | INHIBIT input pin to inhibit ignition when this input is pulled low (pull-down) |
| 7 | AO | Analog multiplexer output pin |
| 8 | LSD1 | Low-side driver control input pin for Channel 1 (pull-up) |
| 9 | SELT | Control input pin for switching between diagnosis line and analog multiplexer (pull-down) |
| 10 | SQ1- | Squid negative (-) side output pin for channel 1 (shared with reference resistor pin for short diagnosis) |
| 11 | SQ1REF | Shorting diagnosis reference resistor pin for channel 1 |
| 12, 13 | GND | Ground pin (Two pins) |
| 14 | SQ2REF | Shorting diagnosis reference resistor pin for Channel 2 |
| 15 | SQ2- | Squib negative (-) side output pin for channel 2 (shared with reference resistor pin shorting diagnosis) |
| 16 | SQS | Squib switchover control input pin during each squib diagnosis (pull-down) |
| 17 | LSD2 | Low-side driver control input pin for Channel 2 (pull-up) |
| 18, 19 | V _{CC} | 5V block power supply input pin (two pins) |
| 20 | CS | Chip select control input pin (pull-up) |
| 21 | CCADJ | Current setup resistor connect pin for short diagnosis constant-current source (reference resistor connect pin) |
| 22 | SS2 | Safing sensor connect pin for Channel 2 |
| 23 | HSD2 | High-side driver control input pin for Channel 2 (pull-down) |
| 24 | SQ2+ | Squib positive (+) side output pin for Channel 2 |

Truth Table

| State | SQUIB | HSD1 | HSD2 | LSD1 | LSD2 | SELT | SHTD | SQS | ENB | CS | MULTI LEXER ch | DIVIDING VOLTAGE SW |
|---|-------|------|------|------|------|------|------|-----|-----|----|----------------------|---------------------------|
| Ignition | SQ1 | H | * | L | * | * | * | * | H | * | — | — |
| | SQ2 | * | H | * | L | * | * | * | H | * | — | — |
| Short Diagnosis | SQ1 | L | L | H | H | L | H | L | H | L | 1 | — |
| | SQ1 | L | L | H | H | H | H | L | H | L | 2 | — |
| | SQ2 | L | L | H | H | L | H | H | H | L | 3 | — |
| | SQ2 | L | L | H | H | H | H | H | H | L | 4 | — |
| SS1 Potential Diagnosis (Not Divided) | SQ1 | L | L | H | H | H | L | L | L | L | 5 | — |
| SS2 Potential Diagnosis (Not Divided) | SQ2 | L | L | H | H | H | L | H | L | L | 7 | — |
| SS1 Potential Diagnosis (Divided) | SQ1 | L | L | H | H | H | L | L | H | L | 5 | SW1 |
| SS2 Potential Diagnosis (Divided) | SQ2 | L | L | H | H | H | L | H | H | L | 7 | SW3 |
| SQ-1 Potential Diagnosis (Not Divided) | SQ1 | L | L | H | H | L | L | L | H | L | 6 | — |
| SQ-2 Potential Diagnosis (Not Divided) | SQ2 | L | L | H | H | L | L | H | H | L | 8 | — |
| SQ-1 Potential Diagnosis (Divided) | SQ1 | L | L | H | H | L | L | L | L | L | 6 | SW2 |
| SQ-2 Potential Diagnosis (Divided) | SQ2 | L | L | H | H | L | L | H | L | L | 8 | SW4 |
| High-side Driver Diagnosis | SQ1 | H | L | H | H | L | L | L | H | L | 6 | SW2 |
| | SQ2 | L | H | H | H | L | L | H | H | L | 8 | SW4 |
| Low-side Driver Diagnosis | SQ1 | L | L | L | H | L | L | L | H | L | 6 | — |
| | SQ2 | L | L | H | L | L | L | H | H | L | 8 | — |

*: Don't Care

Note: When ENB input is pulled low, ignition is inhibited.

Note: When CS is high, the diagnostic inputs SELT, SHTD, and SQS are ignored (in logic) and the AO pin is placed in the high-impedance state.

Note: If ignited under shorted condition, the device may break down.

Functional Description

- (1) 2-channel squib drive function
Using independent four-channel inputs, this IC controls two high-side and two low-side switches, making it possible to drive two squibs directly.
- (2) Squib line short-to-battery, short-to-ground and open-circuit diagnostic function (diagnostic voltage output)
When the squib is in normal state, by an external diagnostic resistor, the device outputs a voltage derived from V_{CC} by dividing it according to the resistance ratio. Because this voltage is output via the analog multiplexer, it is possible to diagnose short-to-battery, short-to-ground and open-circuit in the squib line using a microcomputer. Also, the device contains a shunt circuit to prevent the analog multiplexer from breaking down when the squib is short-to-battery.
- (3) Squib short diagnostic function (diagnostic voltage output)
A diagnostic current is flowed from the internal constant-current source to the squib and reference resistor, and the voltage drop in each is amplified by an internal amp whose gain is the same for both. These voltages are output via the analog multiplexer, so that the squib resistance value can be diagnosed by a microcomputer. Also, the relative accuracy of the output voltages is guaranteed to be within $\pm 10\%$.
- (4) Squib driver MOSFET diagnostic function (diagnostic voltage output)
When the squib driver is turned on while the safing sensor is in normal state, the drain voltage of the MOSFET is output via the analog multiplexer, making it possible to diagnose the state of the MOSFET using a microcomputer.
- (5) Diagnostic chip select function
Since the device has a chip select function, the diagnostic control bits can be minimized when the application circuit is configured with multiple chips. Furthermore, when a chip is not selected, the diagnostic output pin AO is placed in the high-impedance state; therefore it is possible to diagnose multiple chips using a 1-channel CPU A/D port. (Ignition operates irrespective of CS.)
- (6) Input INHIBIT function
The purpose of this function is to prevent erroneous ignition due to a fault in the microcomputer or the system power supply. It allows for ignition to be inhibited by pulling the ENB pin low.

Absolute Maximum Rating (Ta = -40~85°C)

| Characteristics | Symbol | Rating | Unit |
|-----------------------------------|------------------|------------|------|
| Power Supply Voltage | V _{BB} | 30 | V |
| | V _{CC} | 10 | |
| Input Voltage | SS | 30 | V |
| | V _{IN} | -0.5~7 | |
| Backup Capacitor Capacitance | CM | 1500 (1ch) | μF |
| Backup Capacitor Charging Voltage | CV | 25 | V |
| Squib ON-Time | t _{ON} | 15 | ms |
| Squib Driver Current (channel) | I _{SQ} | 10 | A |
| Power Dissipation | P _D | 0.8 | W |
| Operating Temperature | T _{opr} | -40~85 | °C |
| Junction Temperature | T _j | 150 | °C |
| Storage Temperature | T _{stg} | -55~150 | °C |

Note1: The squib driver uses a 60V tolerant output device. However, this does not guarantee that the squib tolerates 60V because this varies with the withstand voltages of peripheral circuits.

Note2: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/Derating Concept and Methods) and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Electrical Characteristics (T_j = -40~85°C)

| Characteristics | | Symbol | Test Condition | Min | Typ. | Max | Unit | |
|---|--|-------------------------|---|------------------------------------|------|------------------------|------|----|
| Operating Supply Voltage | | V _{BB} | — | 4 | — | 25 | V | |
| | | V _{CC} | — | 4.75 | — | 5.25 | | |
| Supply Current | | I _{BB} | V _{BB} = 24V, when diagnosed, CC _{Ref} = 20kΩ | — | 35 | 100 | mA | |
| | | | V _{BB} = 24V, when not diagnosed | — | 0.1 | 1 | | |
| | | I _{CC} | V _{CC} = 5.25V, when diagnosed | — | 5 | 10 | | |
| | | | V _{CC} = 5.25V, when not diagnosed | — | 3 | 6 | | |
| Input Voltage | | V _{IL} | INPUT "L" | — | — | V _{CC} × 0.3 | V | |
| | | V _{IH} | INPUT "H" | V _{CC} × 0.7 | — | — | | |
| Input Current | | I _{IL} | V _{IN} = 0V (Pull-down) | — | — | ±10 | μA | |
| | | | V _{IN} = 0V (Pull-up) | — | -50 | -200 | | |
| | | I _{IH} | V _{IN} = V _{CC} (Pull-down) | — | 50 | 200 | | |
| | | | V _{IN} = V _{CC} (Pull-up) | — | — | ±10 | | |
| Squib Driver ON-Resistance | | R _{DS (ON)} SQ | V _{BB} = 9V, V _{CC} = 4.75V, I _D = 1A | — | 0.6 | 1 | Ω | |
| | | | V _{BB} = 9V, V _{CC} = 4.75V, I _D = 3A | — | 0.7 | 1.2 | | |
| Squib Driver Output Leakage Current | | High Side | I _{OLSQ (H)} | V _{OUT} = 25V | — | — | 0.1 | mA |
| | | Low Side | I _{OLSQ (L)} | V _{OUT} = V _{CC} | — | — | 0.1 | |
| | | | | | | V _{OUT} = 25V | — | — |
| Diagnostic Amp Amplification Factor | | AMPGAIN | V _{CC} = 4.75V, AMPV _{COMM} = 3V, T _j = 25°C | 18 | 20 | 22 | | |
| Diagnostic Amp Offset Voltage | | AMPOFFSET | V _{CC} = 4.75V, AMPV _{COMM} = 3V, T _j = 25°C | — | — | ±10 | mV | |
| Diagnostic Amp Differential Input Voltage Range | | AMPVDEF | V _{CC} = 4.75V, I _{SH} = 100mA, AMPV _{COMM} = 3V, T _j = 25°C | 200 | — | — | mV | |
| Diagnostic Amp In-phase Input Voltage Range | | AMPVCOMM | — | 3.0 | — | — | V | |
| Diagnostic Amp Output Saturation Voltage | | V _{AMPSAT} | — | V _{CC} -1 | — | — | V | |
| Diagnostic Constant-current Source | | I _{SHDIAGCC} | CC _{Ref} = 20kΩ | 28 | 35 | 45 | mA | |
| Diagnostic Output Voltage | | V _{DIAGSQ} | R _{SQ} = 2Ω, I _{SH} = 35mA, I _{AO} = 5μA | 900 | 1400 | 1900 | mV | |
| | | V _{DIAGREF} | R _{REF} = 2Ω, I _{SH} = 35mA, I _{AO} = 5μA | 900 | 1400 | 1900 | | |
| Diagnostic Output Relative Accuracy | | V _{DIAGDEV} | R _{SQ} = R _{REF} = 2Ω, I _{SH} = 35mA, I _{AO} = 5μA | -10 | 0 | 10 | % | |

| Characteristics | | Symbol | Test Condition | Min | Typ. | Max | Unit | | |
|---|--|----------------------------|--|------------------|---|------|------|-----|----|
| Diagnostic Resistance Value | | R1 | — | 40 | 80 | 280 | kΩ | | |
| | | R2 | — | 10 | 20 | 70 | | | |
| Diagnostic Voltage Dividing Ratio | | V _{DIV} | — | 0.17 | 0.2 | 0.23 | — | | |
| Diagnostic Resistance Relative Accuracy | | R _{DEV} | (Measured between SS1, SQ1-, SS2, SQ2-) | -5 | 0 | 5 | % | | |
| Switching Time (High-side SW) | | T _{PLH} | V _{BB} = 25V, R _{load} , I _D = 3A | — | 100 | 200 | μs | | |
| | | T _{PHL} | | — | 10 | 50 | | | |
| Switching Time (Low-side SW) | | T _{PLH} | | — | 10 | 50 | | | |
| | | T _{PHL} | | — | 10 | 50 | | | |
| Diagnosis Switchover Time | | High-side Driver Diagnosis | | T _{DLH} | V _{BB} = 25V, R _{load} , R = 2Ω | — | 120 | 250 | μs |
| | | | | T _{DHL} | | — | 50 | 100 | |
| | | Low-side Driver Diagnosis | | T _{DLH} | | — | 20 | 80 | |
| | | | | T _{DHL} | | — | 40 | 80 | |
| | | Other Diagnosis | | T _{DLH} | | — | 30 | 60 | |
| | | | | T _{DHL} | | — | 50 | 100 | |

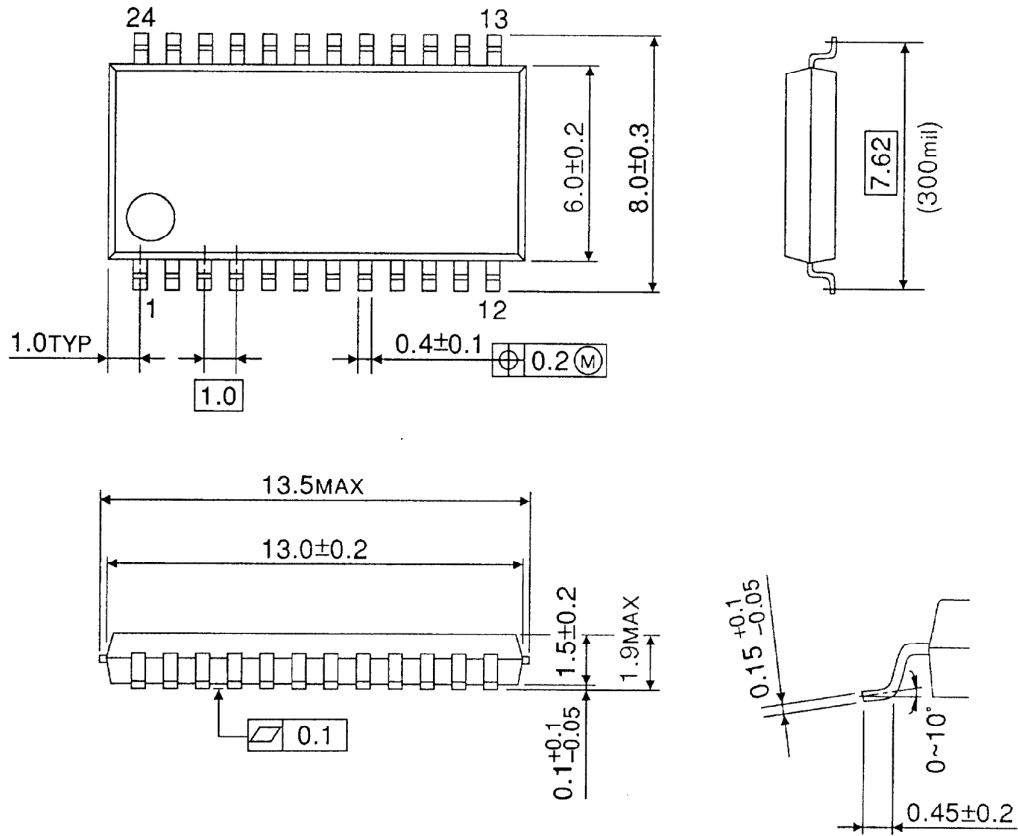
Note: The short diagnosis monitor current in cases when the CCADJ pin is shorted to GND is 100mA (max) (at all temperatures).

Note: Short diagnosis must be completed within 15ms.

Package Dimensions

SSOP24-P-300-1.00C

Unit : mm



Weight: 0.29g (typ.)

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20070701-EN

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