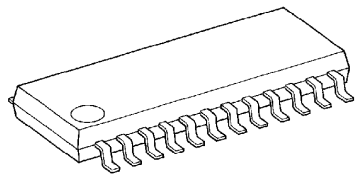
TOSHIBA INTELLIGENT POWER DEVICE SILICON MONOLITHIC POWER MOS INTEGRATED CIRCUIT

T P D 2 0 0 2 F

2-CHANNEL SQUIB DRIVER for AIR BAG

TPD2002F is an intelligent power device for a 2-channel squib driver for use with SRS electronic air bags.
The device is based on the Bi-CMOS-DMOS process.



SSOP24-P-300-1.00B

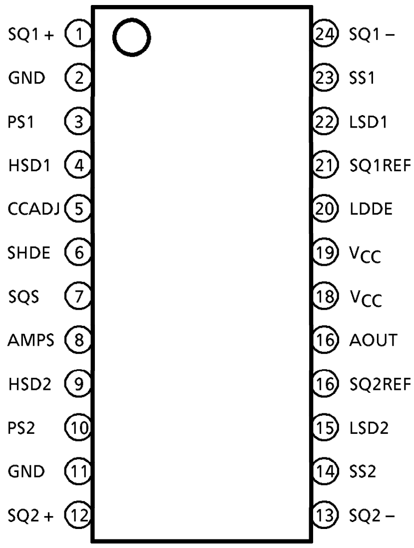
Weight : 0.29 g (Typ.)

FEATURES

- Four independent inputs control two high-side switches and two low-side switches, directly driving two squibs.
- The following diagnosis functions (analog multiplexer output) are built in:
  - Squib short-to-battery diagnosis
  - Squib short-to-ground diagnosis
  - Squib open diagnosis
  - Safing sensor on diagnosis
  - Squib short diagnosis
  - Squib driver MOS FET diagnosis
- Built-in protection for overheating.
- 24-pin SSOP for surface mounting.
- Embossed taping supported.

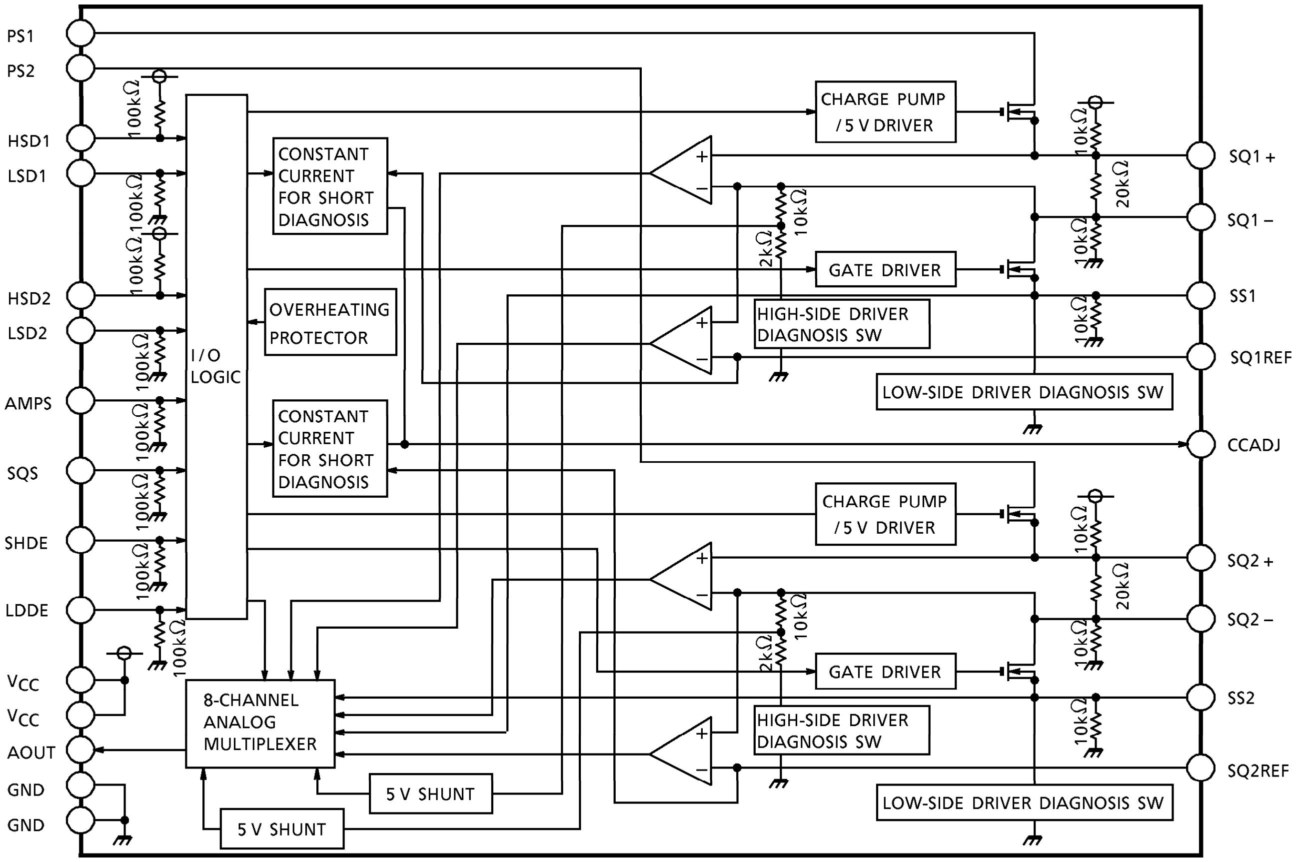
PIN ASSIGNMENT

(TOP VIEW)



(Note) : That because of its MOS structure, this product is sensitive to static electricity.

BLOCK DIAGRAM



PIN DESCRIPTION

PIN No.	SYMBOL	FUNCTION
3	PS1	Squib 1 backup power input pin (24 V)
10	PS2	Squib 2 backup power input pin (24 V)
18, 19	V_{CC}	5V power input pins (2 pins for redundancy)
2, 11	GND	Ground pins (2 pins for redundancy)
4	HSD1	Squib 1 high-side driver control input pin (pulled up)
22	LSD1	Squib 1 low-side driver control input pin (pulled down)
9	HSD2	Squib 2 high-side driver control input pin (pulled up)
15	LSD2	Squib 2 low-side driver control input pin (pulled down)
6	SHDE	Control input pin at squib short diagnosis (pulled down)
20	LDDE	Control input pin at high-side driver diagnosis (pulled down)
7	SQS	Squib switching control input pin at squib diagnosis (pulled down)
8	AMPS	Amp switching control input pin at squib short diagnosis (pulled down)
17	AOUT	Analog multiplexer output pin
1	SQ1 +	Squib 1 + output pin
24	SQ1 –	Squib 1 – output pin (also used as reference resistance pin for short diagnosis)
21	SQ1REF	Reference resistance pin for squib 1 short diagnosis
23	SS1	Squib 1 safing sensor pin
12	SQ2 +	Squib 2 + output pin
13	SQ2 –	Squib 2 – output pin (also used as reference resistance pin for short diagnosis)
16	SQ2REF	Reference resistance pin for squib 2 short diagnosis
14	SS2	Squib 2 safing sensor pin
5	CCADJ	Constant current source setting pin for short diagnosis (Connect reference resistor between this pin and GND.)

TRUTH TABLE

SQUIB 1

MODE	HSD1	LSD1	SHDE	LDDE	AMPS	SQS
Fire	L	H	L	L	L	L
Short-to-battery , short-to-ground, or open diagnosis	H	L	L	L	L	L
Safing sensor diagnosis	H	L	L	L	H	L
Short diagnosis	H	L	H	L	L / H	L
High-side driver diagnosis	L	L	L	L	L	L
Low-side driver diagnosis	H	H	L	H	L	L

SQUIB 2

MODE	HSD2	LSD2	SHDE	LDDE	AMPS	SQS
Fire	L	H	L	L	L	L
Short-to-battery, short-to-ground, or open diagnosis	H	L	L	L	L	H
Safing sensor diagnosis	H	L	L	L	H	H
Short diagnosis	H	L	H	L	L / H	H
High-side driver diagnosis	L	L	L	L	L	H
Low-side driver diagnosis	H	H	L	H	L	H

* : L / H : Switching
* : When overheating, cuts off all squib driver MOS FETs.
* : When the V_{PS} line voltage exceeds 16 V, the device may be damaged due to a dead short in high-side driver only short-to-ground mode, or in low-side driver only short-to-battery mode. However, in other than the above modes, the device will not be damaged for up to 10ms due to the overheating protection.

OPERATION

(1) Squib on mode

When 1.5 V or more is applied to the HSD pin or 3.5 V or more is applied to the LSD pin, the MOS FETs for the high-side and low-side squib drivers are turned on, entering squib on mode.

(2) Squib short-to-battery, short-to-ground, or open diagnosis / safing sensor on diagnosis

When squib is normal, outputs the voltage divided by the built-in diagnosis resistance ratio. Since the voltage is output via an analog multiplexer, squib short-to-battery, short-to-ground, open safing sensor are diagnosed using a microcontroller. When the squib is short-to-battery, a built-in shunt circuit prevents the analog multiplexer from damage.

(3) Squib short diagnosis

Outputs current from the built-in constant current source for diagnosis to the squib and the reference resistance, amplifies the voltage drop using an amp with the same gain, outputs the result via the analog multiplexer, enabling the squib resistance to be diagnosed using the microcontroller. The relative error of the output voltage is guaranteed as ±10%. The constant current source for diagnosis can be varied using an external resistance. Even if the setting pin is shorted, the current is limited to a maximum of 100 mA by the current limit function.

(4) Squib driver MOS FET diagnosis

When the squib driver is turned on with the safing sensor in normal status, the MOS FET drain voltages for the high-side and low-side drivers are output via the analog multiplexer. Thus, the MOS FETs are diagnosed using the microcontroller. Diagnosis switches are set to much lower than the fire energy required.

(5) Overheating protection

When firing takes place with the squib shorted, protects the output using an overheating protection (output cutoff) circuit. (When wires are shorted, protection is not possible due to too large an output device loss.)

MAXIMUM RATINGS (Ta = −40~85°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Supply Voltage	V_{PS}	30	V
	V_{CC}	7	
Input Voltage (for control)	V_{IN}	−0.5~7	V
Amp Differential Input vVltage for Short Diagnosis	V_{DEF}	5	V
Backup Capacitance	CM	1500 (25 V)	μF
Squib On Time	t_{ON}	30	ms
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

(Note) : The breakdown voltage between drain and source output for the power MOS FETs must be 30 V or higher.

ELECTRICAL CHARACTERISTICS (V_{PS} = 6~25 V, V_{CC} = 5 ± 0.25 V, Ta = −40~85°C)

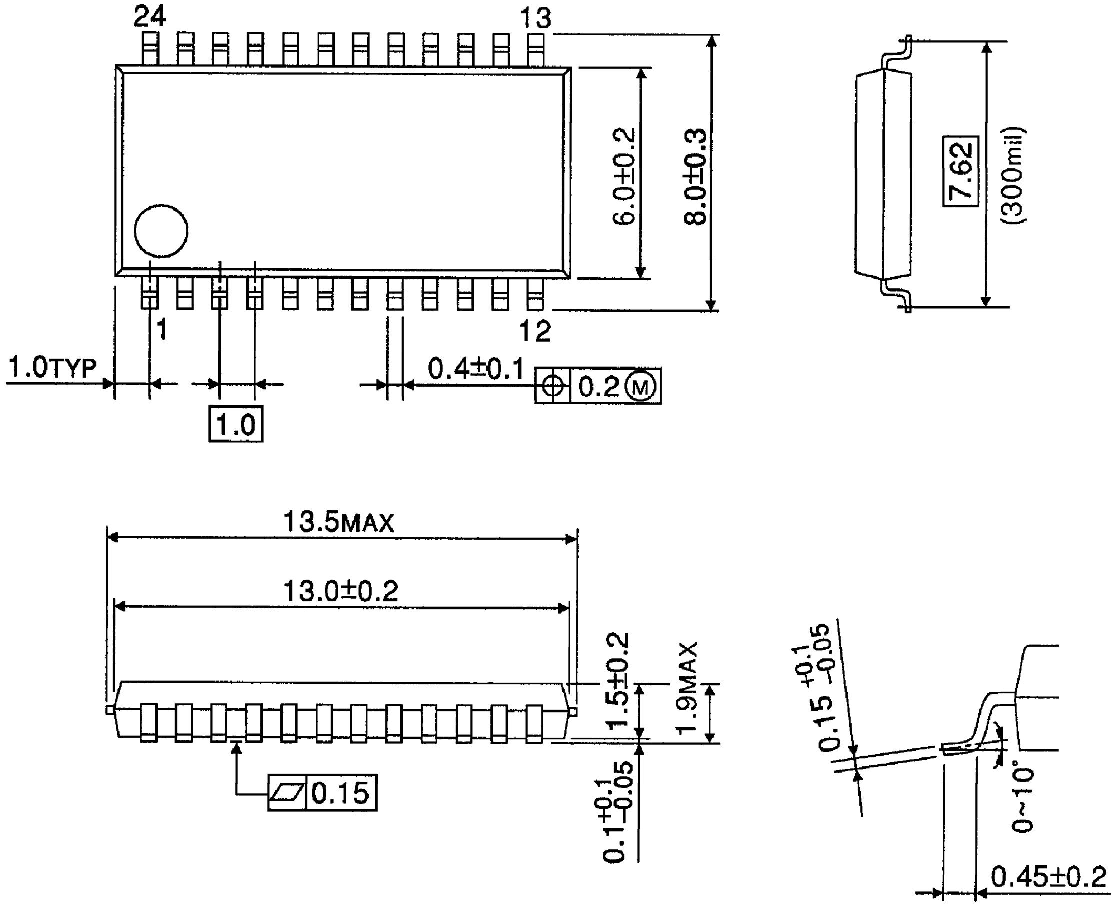
CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN	TYP.	MAX	UNIT
Operating Voltage		V_{PS}	—	—	6	—	25	V
		V_{CC}	—	—	4.75	—	5.25	
Current Dissipation		I_{PS}	—	V_{PS} = 25 V, V_{CC} = 5.25 V, at diagnosis	—	—	100	mA
			—	V_{PS} = 25 V, V_{CC} = 5.25 V, at non-diagnosis	—	—	2	
		I_{CC}	—	V_{PS} = 25 V, V_{CC} = 5.25 V, at diagnosis	—	—	10	
			—	V_{PS} = 25 V, V_{CC} = 5.25 V, at non-diagnosis	—	—	10	
Input Voltage		V_{IL}	—	INPUT "L"	—	—	1.5	V
		V_{IH}	—	INPUT "H"	3.5	—	—	
Input Current		I_{IL}	—	V_{IN} = V_{CC} (Pulled-up pin) V_{IN} = 0 V (Pulled-down pin)	—	—	± 10	μA
		I_{IH}	—	V_{IN} = 0 V (Pulled-up pin) V_{IN} = V_{CC} (Pulled-down pin)	—	50	200	
High-side Driver On Resistance		$R_{DS (ON) HS}$	—	V_{PS} = 20 V, V_{CC} = 4.75V, I_D = 1 A	—	—	1	Ω
			—	V_{PS} = 20 V, V_{CC} = 4.75 V, I_D = 3 A	—	—	1.2	
Low-side Driver On Resistance		$R_{DS (ON) LS}$	—	V_{PS} = 20 V, V_{CC} = 4.75 V, I_D = 1 A	—	—	1	Ω
			—	V_{PS} = 20 V, V_{CC} = 4.75 V, I_D = 3 A	—	—	1.2	
			—	V_{PS} = 6 V, V_{CC} = 4.75 V, I_D = 1 A	—	—	1.5	
High-side Driver Output leakage current		I_{OLH}	—	V_{OUT} = 25 V	—	—	100	μA
Low-side Driver Output Leakage Current		I_{OLL}	—	V_{OUT} = 25 V	—	—	100	μA
Short Diagnosis Output Voltage		VDIAGSQ	—	V_{PS} = 8~25 V, RCCADJ = 18 kΩ RSQ = RREF = 2 Ω, IAO = 5 μA	900	1400	1800	mV
		VDIAGREF	—		900	1400	1800	
Diagnosis Output Relative Deviation		VDIAGDEV	—	V_{PS} = 8~25 V, RCCADJ = 18 kΩ RSQ = RREF = 2 Ω, IAO = 5 μA $V_{DIAGDEV} = \{V_{DIAGSQ} / (V_{DIAGREF} - V_{DIAGSQ})\} \times 100$	− 10	0	10	%
Amp Saturation Voltage		VAMPSAT	—	V_{CC} = 4.75 V, IAO = 5 μA	3.75	—	—	V
Overheating Protection Level		T_{SD}	—	—	150	170	200	°C
Switching Time (High-side driver)		T_{PLH}	—	V_{PS} = 25 V, V_{CC} = 4.75 V, R load, R = 2 Ω	—	100	200	μs
		T_{PHL}	—		—	10	50	
Switching Time (Low-side driver)		T_{PLH}	—		—	10	50	μs
		T_{PHL}	—		—	10	50	
Diagnosis Switching Time	High-side Driver Diagnosis	T_{DLH}	—	V_{PS} = 25 V, V_{CC} = 4.75 V, R load, R = 2 Ω A_{OUT} = 1000 pF SQ + = 0.01 μF SQ − = 0.01 μF	—	—	500	μs
		T_{DHL}	—		—	—	500	
	Low-side Driver Diagnosis	T_{DLH}	—		—	—	200	
		T_{DHL}	—		—	—	500	
	Other Diagnosis	T_{DLH}	—		—	—	200	
		T_{DHL}	—		—	—	500	

(Note) : When the CCADJ pin is short-to-ground, the maximum constant current must be 100 mA (at all temperatures).

OUTLINE DRAWING

SSOP24-P-300-1.00B

Unit : mm



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