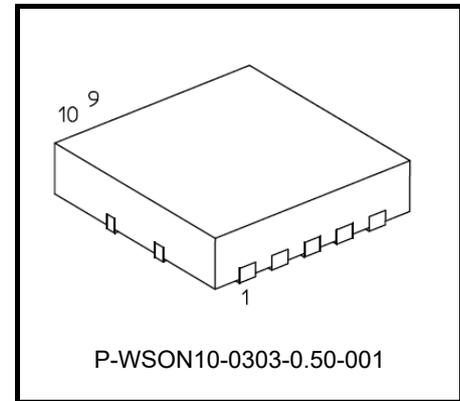


Toshiba Intelligent Power Device Silicon Monolithic Power MOS Integrated Circuit

TPD1055FA

For Motor, Solenoid and Lamp
High side power switch

TPD1055FA is a High-side switch of a P channel DMOS output. It is monolithic power IC that can be driven directly from a CMOS or TTL logic circuit (MPU etc.), and was equipped with the intelligent function of protection and diagnosis.

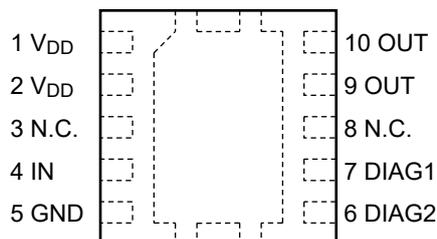


Weight:0.02g(typ.)

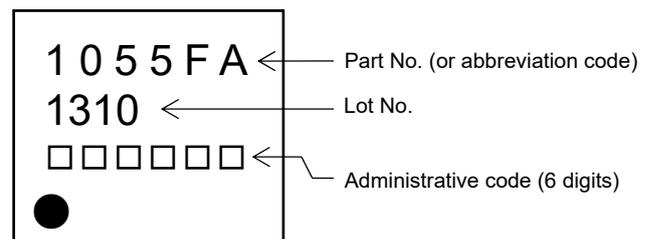
Features

- A monolithic power IC with a structure combining a control block and a power MOSFET (D-MOS) on single chip.
- One side of load can be grounded to a high-side switch.
- AEC-Q100 qualified.
- Can directly drive a power load from CMOS or TTL logic.
- Built-in protection circuits against over temperature, over current.
- Incorporates a diagnosis function that allows diagnosis output to be read externally at battery short, load short-circuiting, opening, or over temperature.
- Up to $V_{DD} - 40V$ (Min) of counter electromotive force from an inductance load can be applied.
- Low on-resistance: $R_{DS(ON)}=0.12\Omega(\text{Max})$ (@ $V_{DD} = 12V$, $T_{ch} = 25^\circ\text{C}$, $I_o = -2A$)
- WSON10 package for surface mounting that is packed in embossed tape.

Pin Assignment (top view)



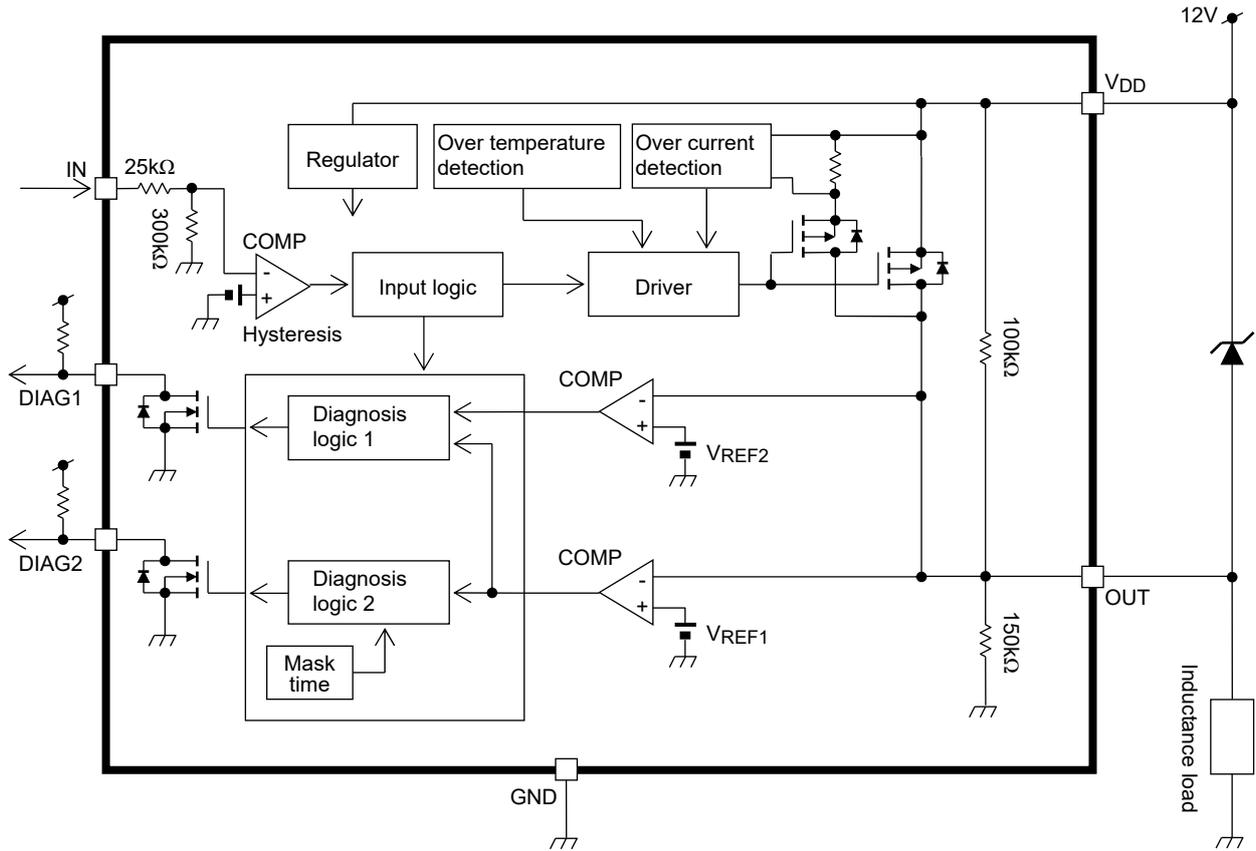
Marking



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

Start of commercial production
2013-12

Block Diagram



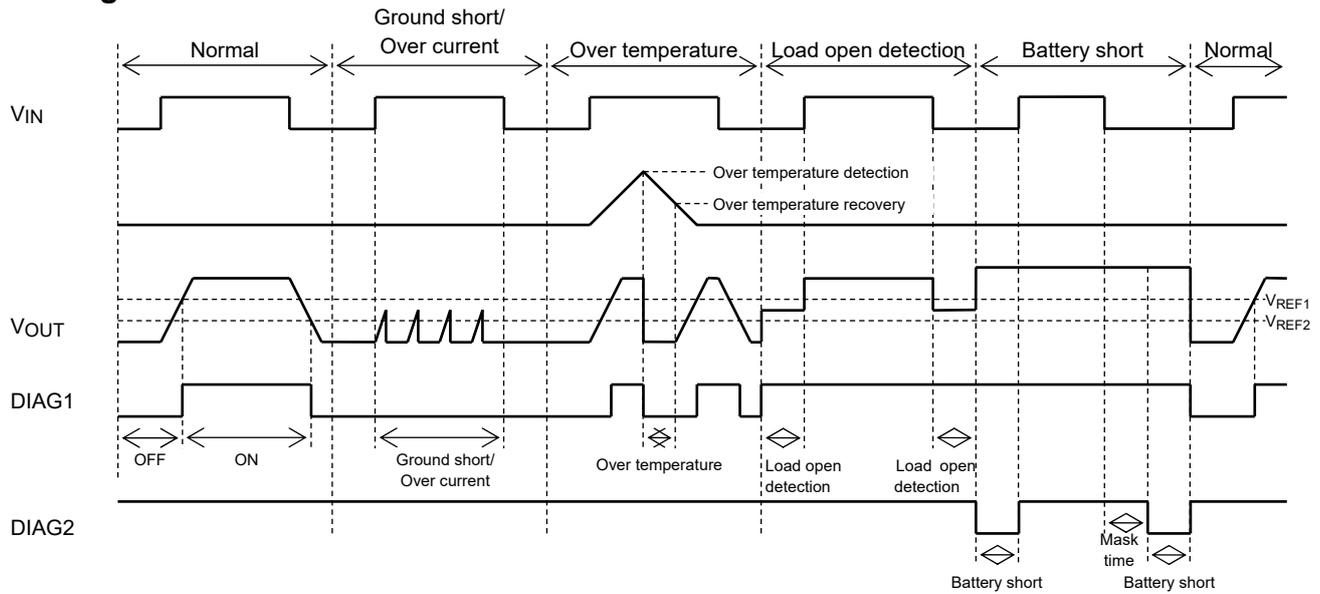
Pin Description

| Pin No | Symbol | Function |
|--------|-----------------|---|
| 1,2 | V _{DD} | Power pin. |
| 4 | IN | Input pin. Input is connected to GND pin with pull down resistor. Even if the input is open, output will not accidentally turn on. |
| 5 | GND | Ground pin. |
| 6 | DIAG2 | Self-diagnosis detection pin. It detects battery short. N-channel open drain. |
| 7 | DIAG1 | Self-diagnosis detection pin. It detects load open, overcurrent, overtemperature. N-channel open drain. |
| 9,10 | OUT | Output pin. When the load is short-circuited and current in excess of the detection current (3A min) flows to the output pin, the output automatically turns on or off. |
| 3,8 | N.C. | No-Connect pin. |

*Exposed Pad has to be connected to GND pattern because of stability operation and heat radiation.

*Please use N.C. pin in opening or GND connection.

Timing Chart



Truth Table

| Input signal VIN | Output voltage VOUT | Output state | Operating state |
|---------------------|------------------------|---------------------------|--------------------------------|
| L | L | Off | Normal |
| H | H | On | |
| L | H(Note 1) | Off | Load open detection |
| H | H | On | |
| L | H | Off | Battery short |
| H | H | On | |
| L | L | Off | Ground short / Over current |
| H | L | Current limit (Switching) | |
| L | L | Off | Over temperature |
| H | L | Off | |

Note 1: Internal voltage in TPD1055FA and external voltage decide this output voltage.

| Input signal VIN | Output voltage VOUT | Diagnosis state | | | |
|---------------------|------------------------------------|-----------------|---|--------|---------------|
| | | VDIAG1 | State | VDIAG2 | state |
| L | $V_{OUT} < V_{REF2}$ | L | Normally off | H | - |
| | $V_{REF2} \leq V_{OUT} < V_{REF1}$ | H | Load open detection | H | - |
| | $V_{REF1} \leq V_{OUT}$ | H | - | L | Battery short |
| H | $V_{REF1} \leq V_{OUT}$ | H | Normally on | H | - |
| | $V_{OUT} < V_{REF1}$ | L | Over current(Load short)/ Over temperature | H | - |

V_{REF2} : $V_{IH}=1.8V(Typ.) / V_{IL}=1.6V(Typ.)$ * Hysteresis 0.2V

V_{REF1} : $V_{IH}=V_{DD}-1.0V(Typ.) / V_{IL}=V_{DD}-1.5V(Typ.)$ * Hysteresis 0.5V

Absolute Maximum Ratings (Ta = 25°C)

| Characteristics | Symbol | Rating | Unit | Note |
|--------------------------|-------------------|---|--------------|---------------------------------------|
| Drain-source voltage | V _{DS} | 40.0 | V | P channel |
| Supply voltage | DC | V _{DD(1)} | -0.3 to 25.0 | - |
| | Pulse | V _{DD(2)} | 40.0 | Range exceeding 25.0V is within 0.3s. |
| Input voltage | V _{IN} | -0.3 to 6.0 | V | - |
| Diagnosis output voltage | V _{DIAG} | -0.3 to 6.0 | V | - |
| Output voltage | V _{OUT} | (V _{DD} -40.0) to (V _{DD} +0.3) | V | - |
| Output current | I _O | Internally Limited | A | - |
| Diagnosis current | I _{DIAG} | 5 | mA | - |
| Power dissipation | P _D | 1.84 | W | Note2 |
| Operating temperature | T _{opr} | -40 to 125 | °C | - |
| Channel temperature | T _{ch} | 150 | °C | - |
| Storage temperature | T _{stg} | -55 to 150 | °C | - |

Note: 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).

Thermal Resistance

| Characteristic | Symbol | Rating | Unit |
|---------------------------------------|-----------------------|--------|-------|
| Channel to ambient thermal resistance | R _{th(ch-a)} | 67.6 | °C /W |

Test conditions

Note 2:

- Glass epoxy board
- Material: FR-4(4 layer)
- Size: 76.2mm * 114.3mm * 1.6mm
- Via: ø0.3mm (2 points)

Electrical Characteristics

(Unless otherwise specified, $T_{ch} = -40$ to $125\text{ }^{\circ}\text{C}$, $V_{DD} = 5$ to 18 V)

| Characteristics | Symbol | Test circuit | Test condition | Min | Typ. | Max | Unit |
|---|---------------------------------|--------------|---|--------------|--------------------|--------------------|--------------------|
| Operating supply voltage | $V_{DD(opr)}$ | - | - | 5 | - | 18 | V |
| Negative output voltage that can be applied to output | $V_{OUT(neg)}$ | - | $V_{IN}=0\text{V}$ | $V_{DD}-40$ | - | - | V |
| Supply current | $I_{DD(off)}$ | - | $V_{IN}=0\text{V}$, Output open | - | 1.0 | 2.5 | mA |
| | $I_{DD(on)}$ | - | $V_{IN}=5\text{V}$, Output open | - | 1.2 | 3.0 | mA |
| Input voltage | V_{IH} | - | - | 2.0 | - | - | V |
| | V_{IL} | - | - | - | - | 0.8 | V |
| Input current | $I_{IN(1)}$ | - | $V_{IN}=5\text{V}$ | - | 15 | 50 | μA |
| | $I_{IN(2)}$ | - | $V_{IN}=0\text{V}$ | -1 | - | 1 | μA |
| On resistance | $R_{DS(ON)}$ | - | $V_{DD}=8$ to 18V , $I_O=-2\text{A}$, $T_{ch}=25\text{ }^{\circ}\text{C}$ | - | 0.08 | 0.12 | Ω |
| Output leakage current | I_{OL} | - | $V_{IN}=0\text{V}$, $V_{OUT}=0\text{V}$ | -500 | -120 | - | μA |
| Diagnosis output voltage | "L"-level V_{DL} | - | $I_{DIAG}=1\text{mA}$ | - | 0.15 | 0.40 | V |
| Diagnosis output current | "H"-level I_{DH} | - | $V_{DIAG}=5\text{V}$ | - | - | 10 | μA |
| Over current detection | I_{OC} | - | - | -9 | -5 | -3 | A |
| Over current off time | Short-Toff | - | $V_{DD}=12\text{V}$, $R_L=0.1\Omega$, $T_{ch}=25\text{ }^{\circ}\text{C}$ | 3.3 | 8.0 | 15.0 | ms |
| Over temperature detection | Temperature T_{OT} | - | - | 150 | 170 | 200 | $^{\circ}\text{C}$ |
| | Hysteresis ΔT_{OT} | - | - | - | 5 | - | $^{\circ}\text{C}$ |
| Load open detection resistance | R_{OP} | - | $V_{IN}=0\text{V}$ | 1 | 20 | 200 | $\text{k}\Omega$ |
| Load open detection voltage | $V_{OUT(OP)}$ | - | $V_{IN}=0\text{V}$ | - | $0.6 \cdot V_{DD}$ | $0.7 \cdot V_{DD}$ | V |
| Battery short detection voltage | Temperature V_{REF1} | - | $V_{IN}=0\text{V}$, $V_{OUT}=L$ to H | $V_{DD}-1.5$ | $V_{DD}-1.0$ | $V_{DD}-0.7$ | V |
| | Hysteresis ΔV_{REF1} | - | - | - | 0.5 | - | V |
| Battery short detection mask time | T_{mask} | - | $V_{OUT}=V_{DD}$, $V_{IN} \downarrow$ to $DIAG2 \downarrow$ | 50 | 110 | 200 | μs |
| Switching time | t_{on} | 1 | $V_{DD}=12\text{V}$, $R_L=10\Omega$, $T_{ch}=25\text{ }^{\circ}\text{C}$ | - | 20 | 50 | μs |
| | t_{off} | | | - | 20 | 50 | μs |

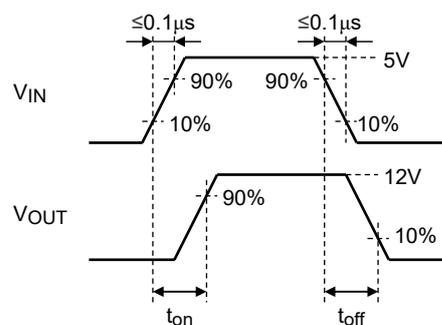
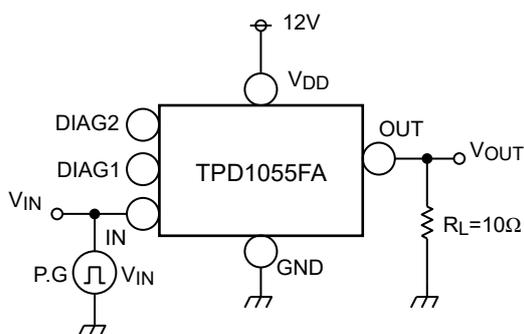
*Typical characteristic conditions are $V_{DD}=12\text{V}$, $T_{ch}=25\text{ }^{\circ}\text{C}$.

*Sink current to this IC is expressed by "+", source current from this IC is expressed by "-".

*The voltage range that can detect difference between Load open and battery short is $V_{DD} \geq 7\text{V}$.

Test Circuit 1

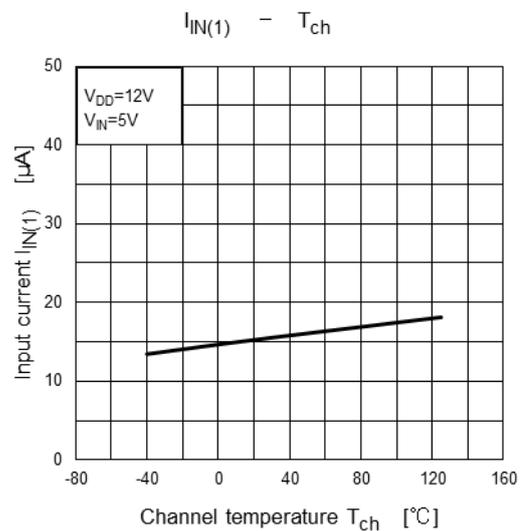
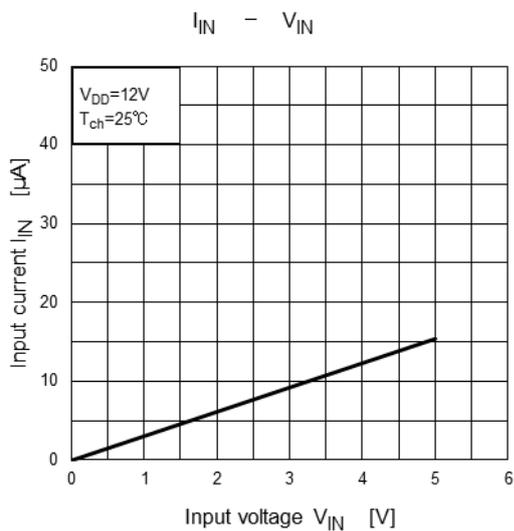
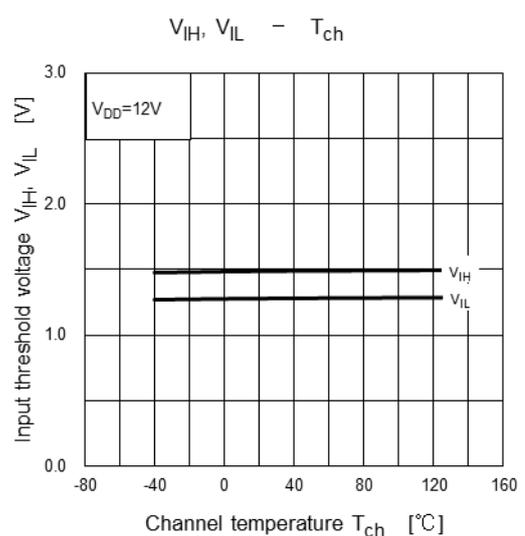
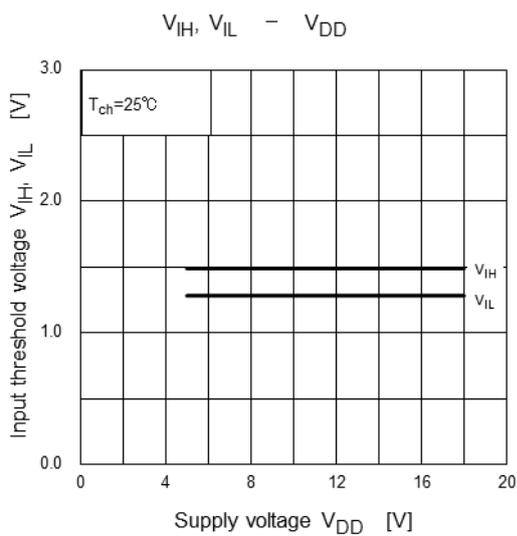
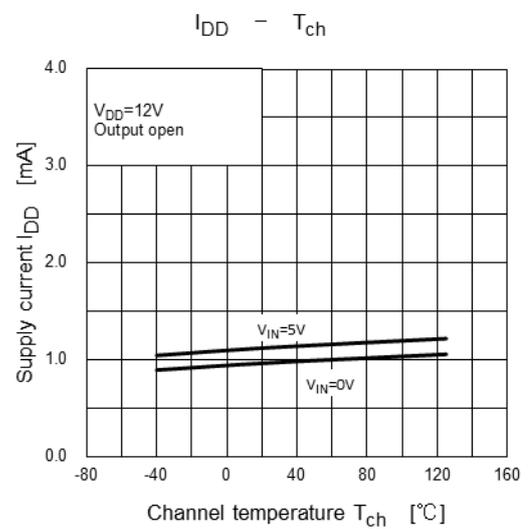
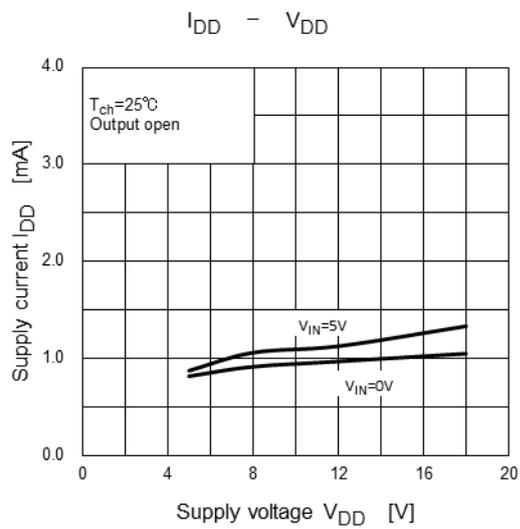
Switching times t_{on} , t_{off}

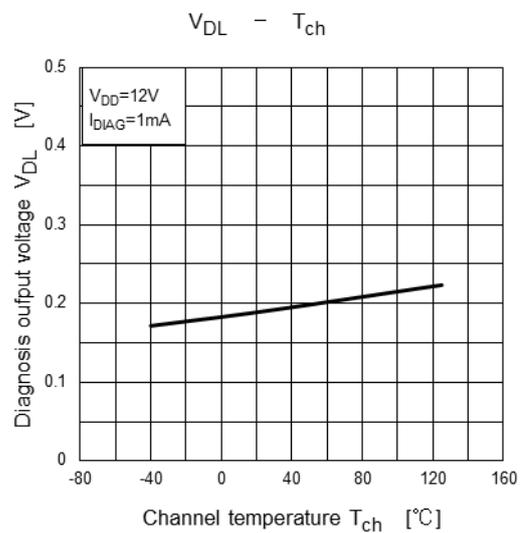
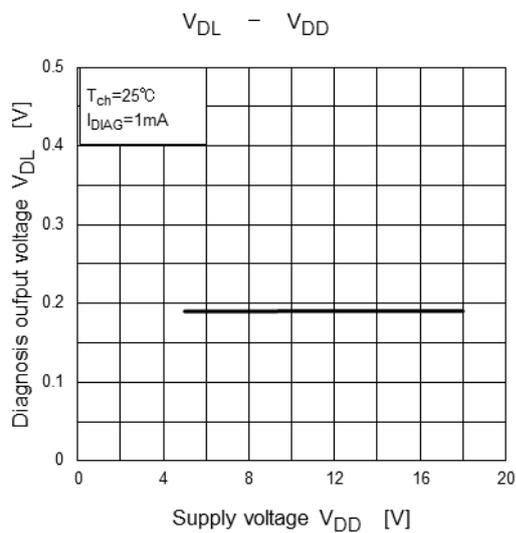
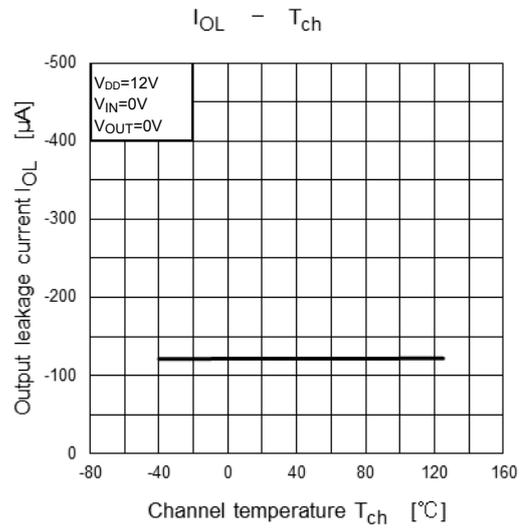
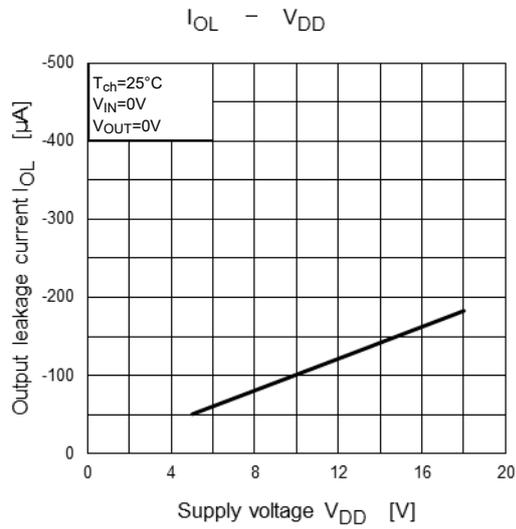
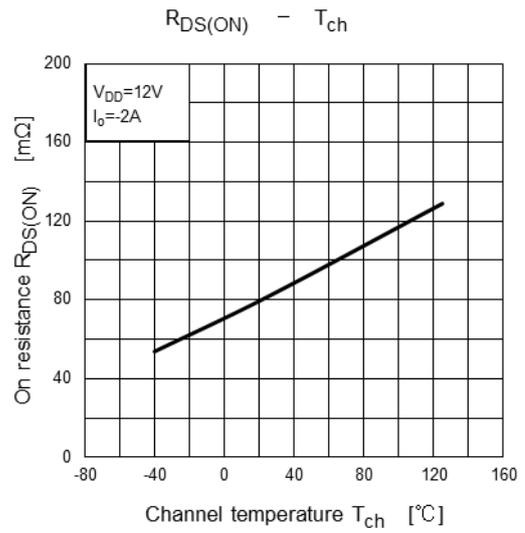
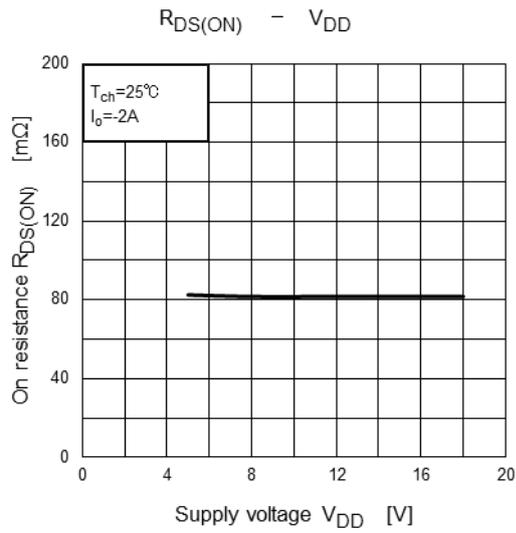


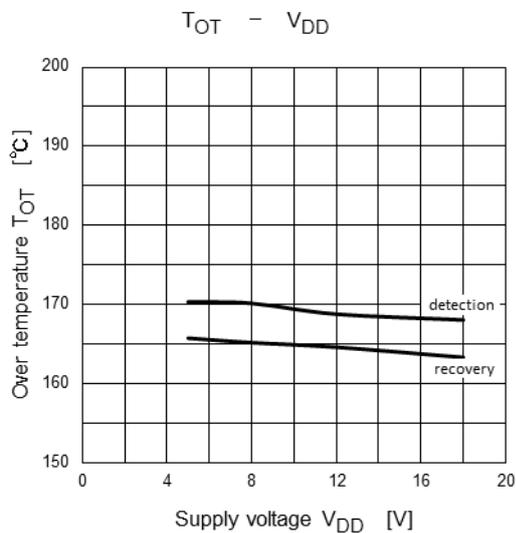
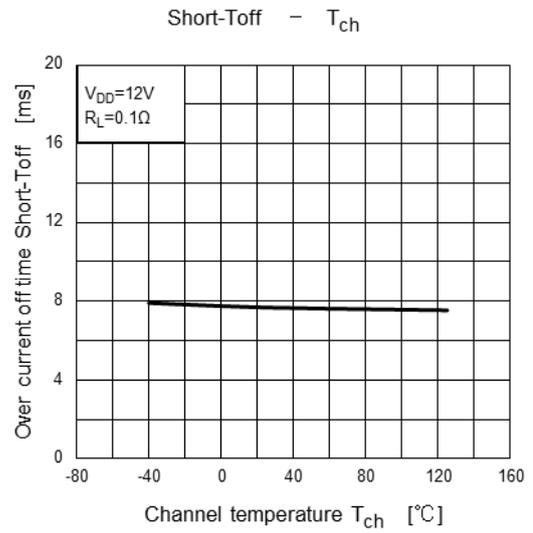
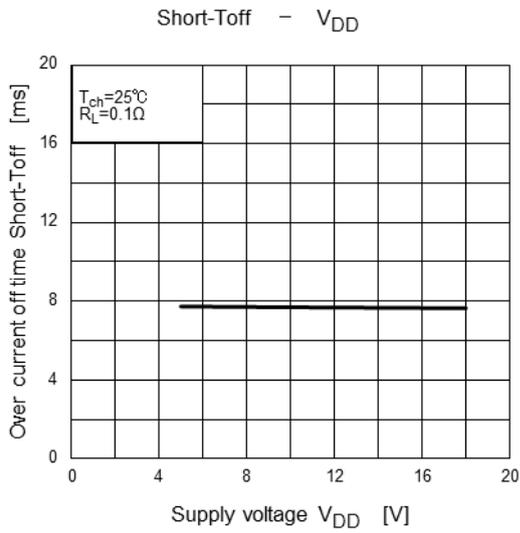
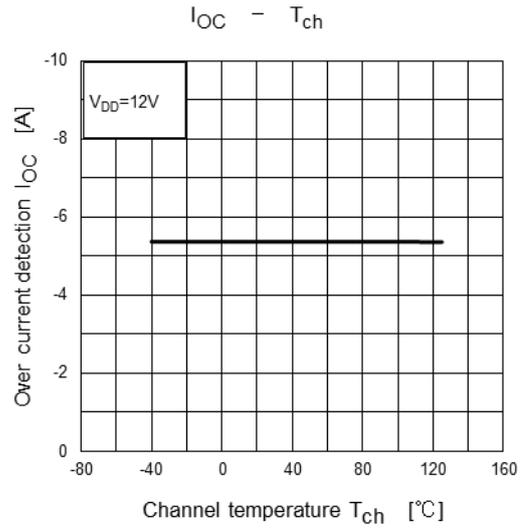
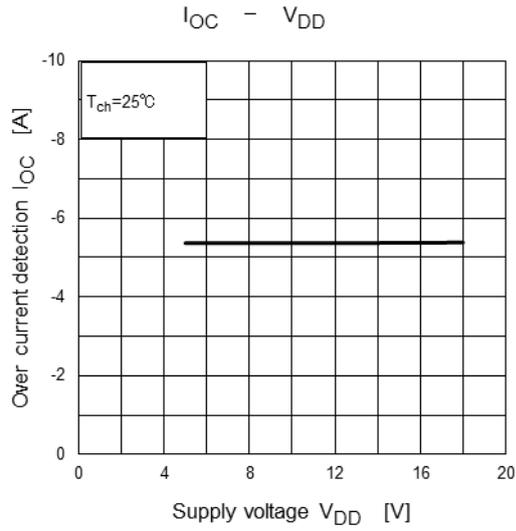
*Because TPD1055FA does not have output clamp circuit, in the case of inductance load, connect flywheel diode.

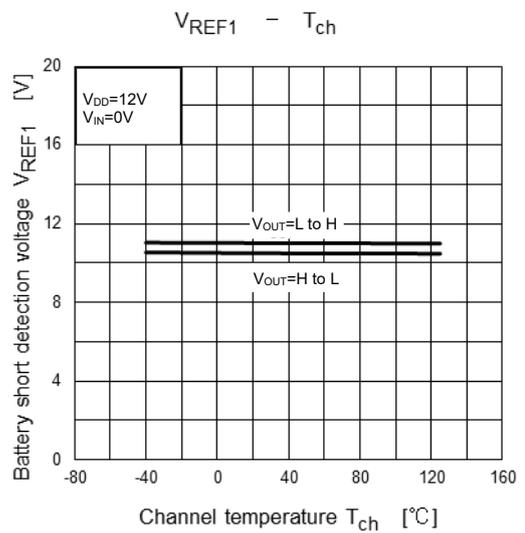
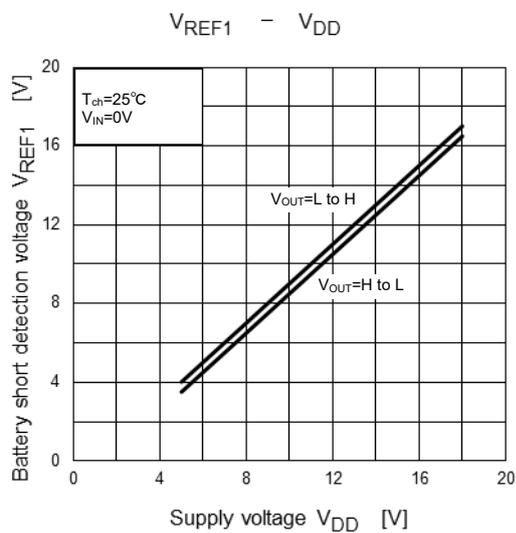
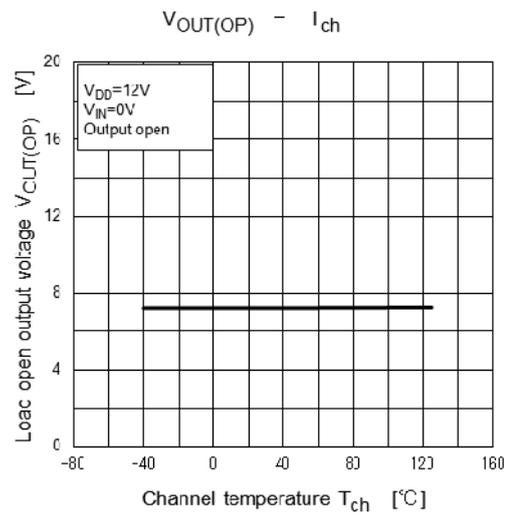
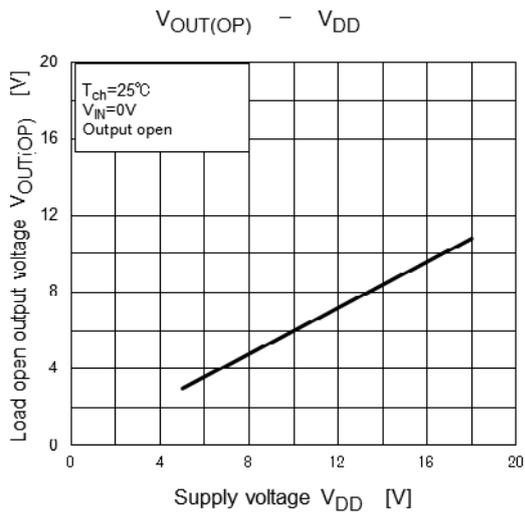
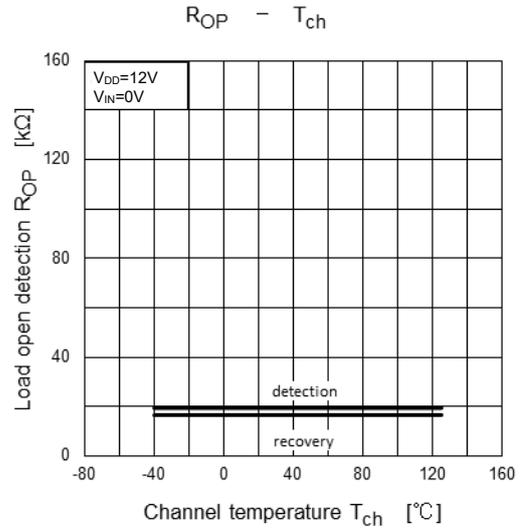
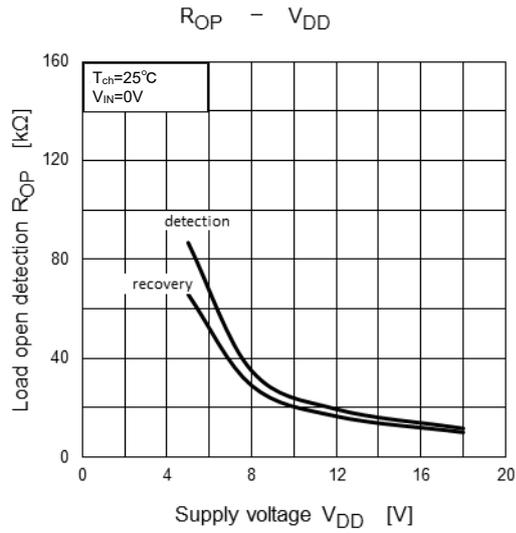
Characteristic curves

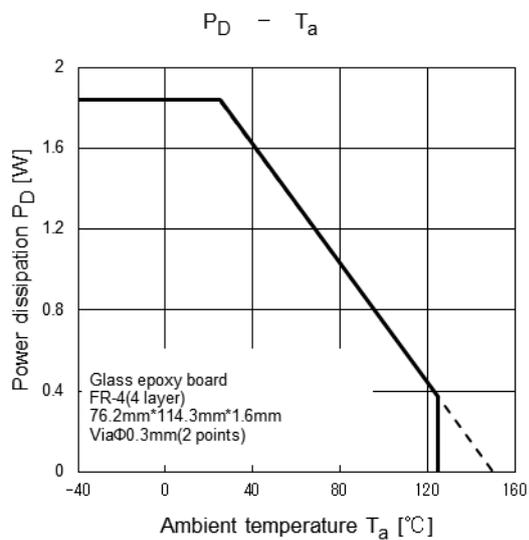
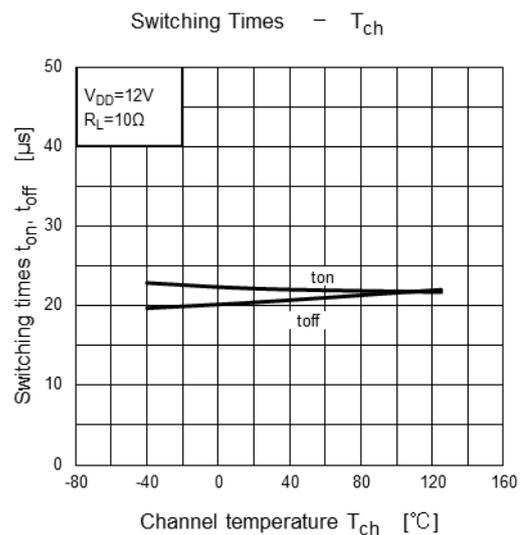
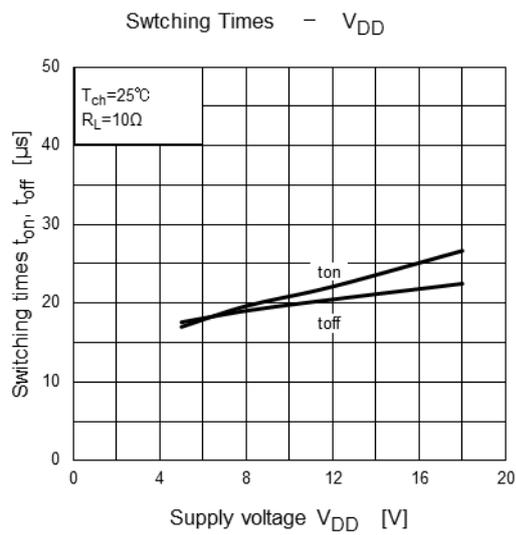
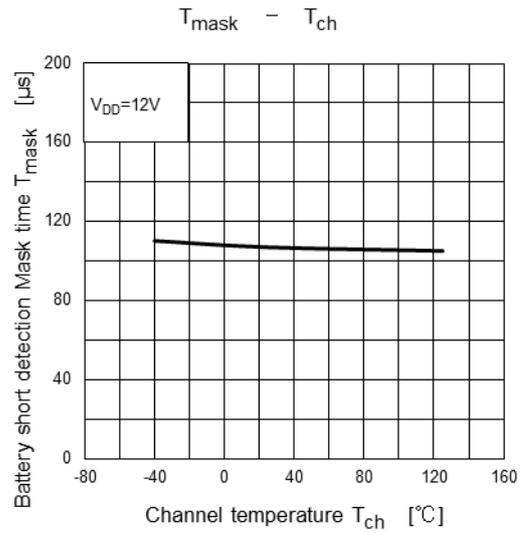
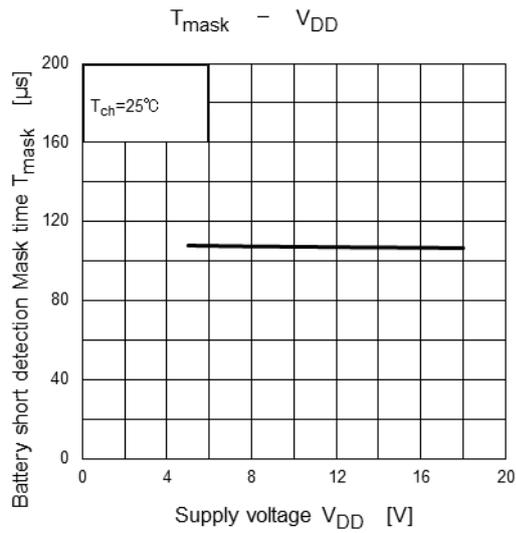
The below characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.





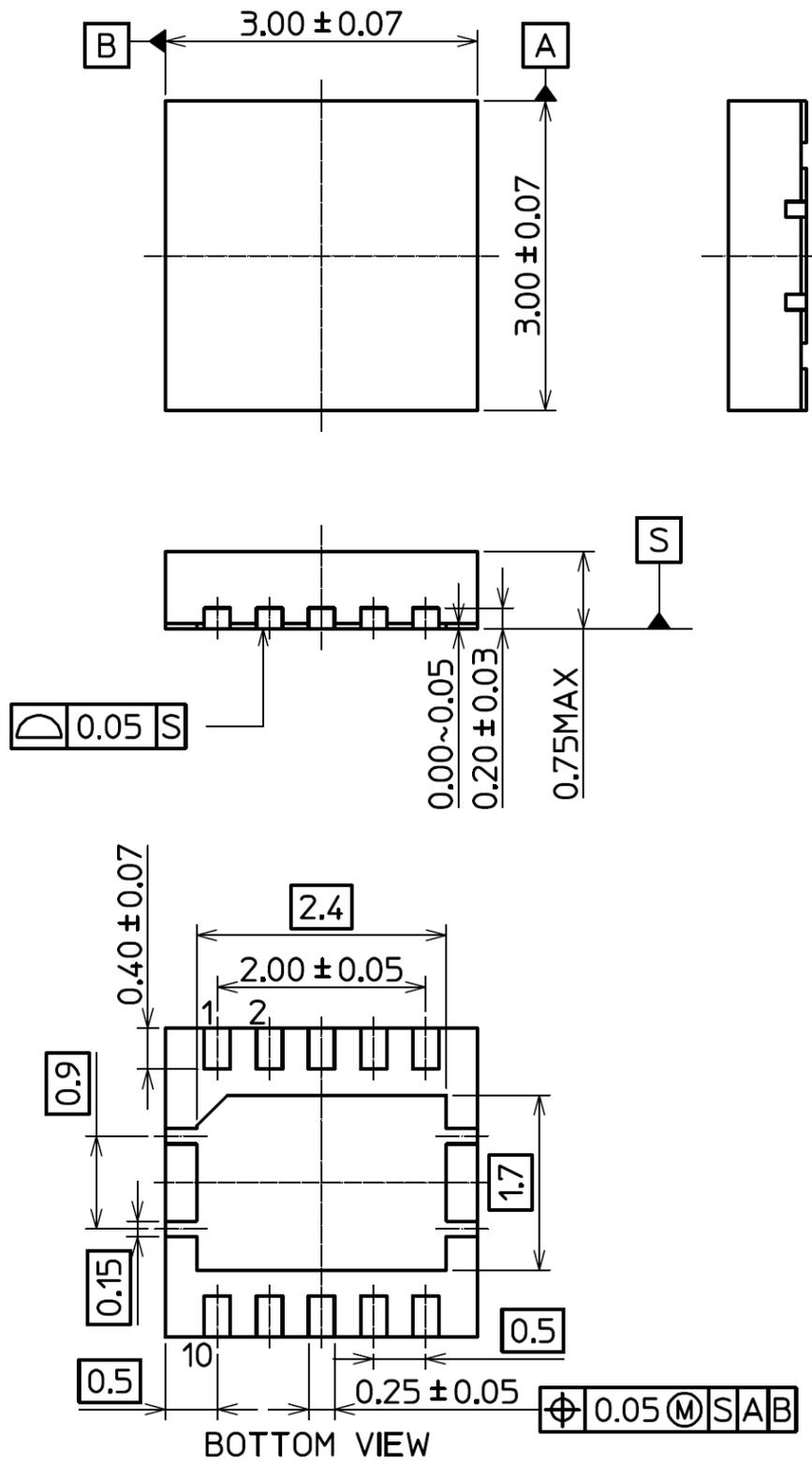






Package Dimensions

Unit: mm



Weight: 0.02g(typ.)

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