

MOSFETs Silicon N-Channel MOS

# SSM10N961L

## 1. Applications

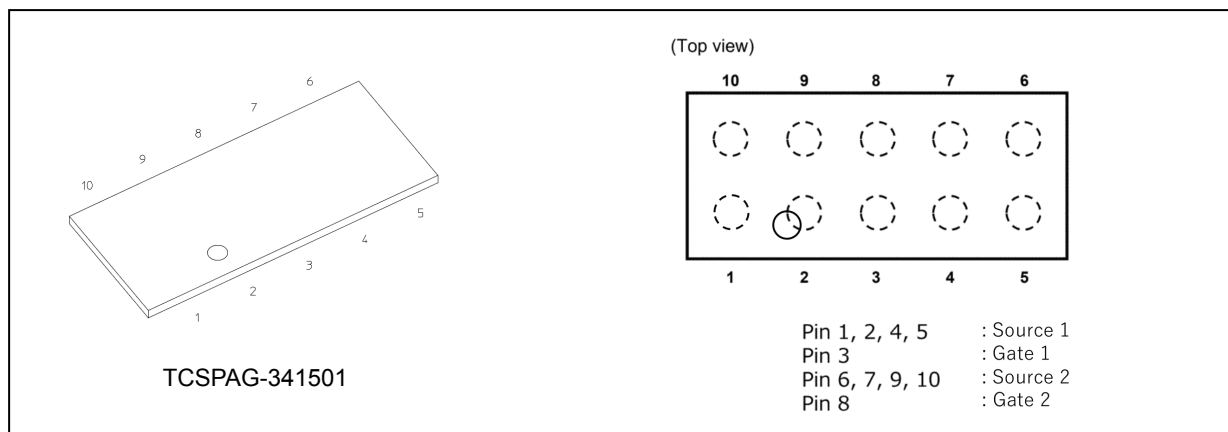
- Power Management Switches
- Battery protection circuits

## 2. Features

- (1) Low source-source on-resistance  
 :  $R_{SS(ON)} = 13.6 \text{ m}\Omega$  (typ.) (@ $V_{GS} = 4.5 \text{ V}$ )  
 :  $R_{SS(ON)} = 9.9 \text{ m}\Omega$  (typ.) (@ $V_{GS} = 10 \text{ V}$ )
- (2) RoHS Compatible (Note 1)
- (3) Halogen-free

Note 1: The RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

## 3. Packaging and Pin Assignment



Start of commercial production

2023-08

### 4. Absolute Maximum Ratings (Note) (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$ )

Characteristics	Symbol	Rating	Unit
Source-source voltage	$V_{SSS}$	30	V
Gate-source voltage	$V_{GSS}$	$\pm 20$	V
Source current (DC) (Note 1)	$I_S$	9.0	A
Source current (DC) (Note 2)		14.0	
Source current (pulsed) (Note 3)	$I_{SP}$	72	A
Power dissipation (Note 1)	$P_D$	0.88	W
Power dissipation ( $t \leq 10\text{ s}$ ) (Note 1)		1.51	
Channel temperature	$T_{ch}$	150	$^\circ\text{C}$
Storage temperature	$T_{stg}$	-55 to 150	$^\circ\text{C}$

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.

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).

Note 1: Device mounted on an 25 mm × 27.5 mm,  $t = 1.6\text{ mm}$ , Cu Pad: 18  $\mu\text{m}$ , 407 mm<sup>2</sup>, FR4 glass epoxy board

Note 2: Device mounted on an 25 mm × 27.5 mm,  $t = 1.6\text{ mm}$ , Cu Pad: 70  $\mu\text{m}$ , 687.5 mm<sup>2</sup>, FR4 glass epoxy board

Note 3: Pulse width  $\leq 10\text{ }\mu\text{s}$ , Duty  $\leq 1\%$

Note: The MOSFETs in this device are sensitive to electrostatic discharge. When handling this device, the worktables, operators, soldering irons and other objects should be protected against anti-static discharge.

Note: The channel-to-ambient thermal resistance,  $R_{th(ch-a)}$ , and the drain power dissipation,  $P_D$ , vary according to the board material, board area, board thickness and pad area. When using this device, be sure to take heat dissipation fully into account.

### 5. Safety Precautions

This section lists important precautions which users of semiconductor devices (and anyone else) should observe in order to avoid injury to human body and damage to property, and to ensure safe and correct use of our products.

[Handling Precaution for MOSFET in use of Protection Circuit for Battery Pack]

Use a unit, for example PTC Thermistor, which can shut off the power supply if a short-circuit occurs. If the power supply is not shut off on the occurring short-circuit, a large short-circuit current will flow continuously, which may cause the device to catch fire ore smoke. The product listed in this document is intended for usage in Lithium Ion Battery charge and discharge control application. So it is responsible for customer when using the product in the different application.

### 6. Electrical Characteristics

#### 6.1. Static Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$ )

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Gate-source leakage current	$I_{GSS}$	$V_{SS} = 0\text{ V}, V_{GS} = \pm 20\text{ V}$	—	—	$\pm 10$	$\mu\text{A}$
Source-source current (zero-gate voltage)	$I_{SSS}$	$V_{SS} = 30\text{ V}, V_{GS} = 0\text{ V}$	—	—	1	$\mu\text{A}$
Source-source breakdown voltage	$V_{(BR)SSS}$	$I_S = 250\text{ }\mu\text{A}, V_{GS} = 0\text{ V}$	30	—	—	V
Gate threshold voltage (Note 1)	$V_{th}$	$V_{SS} = 10\text{ V}, I_S = 0.25\text{ mA}$	1.3	1.8	2.3	V
Source-source on-resistance (Note 2)	$R_{SS(ON)}$	$I_S = 7\text{ A}, V_{GS} = 10\text{ V}$	8.0	9.9	12.8	m $\Omega$
		$I_S = 7\text{ A}, V_{GS} = 4.5\text{ V}$	11.8	13.6	17.6	
Body diode forward voltage (Note 2)	$V_{F(S-S)}$	$I_F = 7\text{ A}, V_{GS} = 0\text{ V}$	—	0.8	1.2	V

Note 1: Let  $V_{th}$  be the voltage applied between gate and source that causes the source current ( $I_S$ ) to below (0.25 mA for this device). Then, for normal switching operation,  $V_{GS(ON)}$  must be higher than  $V_{th}$ , and  $V_{GS(OFF)}$  must be lower than  $V_{th}$ . This relationship can be expressed as:  $V_{GS(OFF)} < V_{th} < V_{GS(ON)}$ .

Take this into consideration when using the device.

Note 2: Pulse measurement.

#### 6.2. Dynamic Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$ )

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Switching time (turn-on delay time)	$t_{d(on)}$	$V_{DD} = 15\text{ V}, I_S = 7\text{ A},$ $V_{GS} = 0\text{ to }10\text{ V},$ $R_G = 50\text{ }\Omega, R_L = 0.6\text{ }\Omega$ Duty $\leq 1\%$ , $V_{IN}: t_r, t_f < 5\text{ ns}$ Common source, See Chapter 6.3	—	87	—	ns
Switching time (rise time)	$t_r$		—	159	—	
Switching time (turn-off delay time)	$t_{d(off)}$		—	816	—	
Switching time (fall time)	$t_f$		—	494	—	

#### 6.3. Switching Time Test Circuit

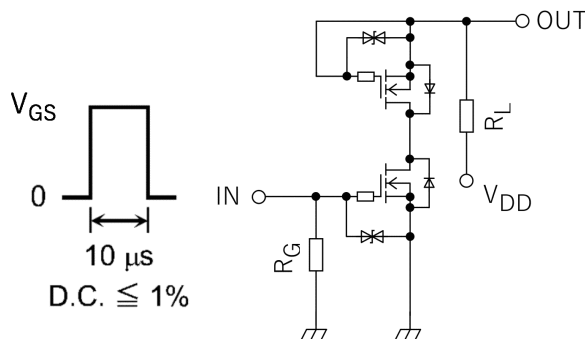


Fig. 6.3.1 Switching Time Test Circuit

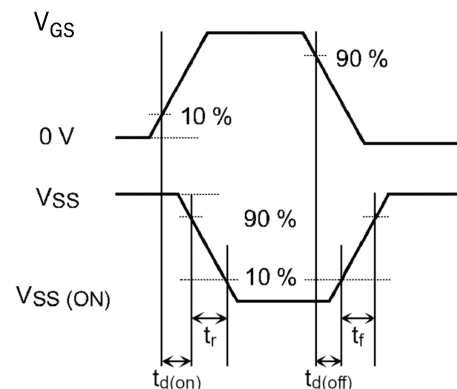


Fig. 6.3.2 Input Waveform/Output Waveform

#### 6.4. Gate Charge Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$ )

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Total gate charge (gate-source plus gate-drain)	$Q_g(4.5V)$	$V_{SS} = 15\text{ V}, I_S = 7\text{ A}, V_{GS} = 4.5\text{ V}$	—	8.8	—	nC
	$Q_g(10V)$	$V_{SS} = 15\text{ V}, I_S = 7\text{ A}, V_{GS} = 10\text{ V}$	—	17.3	—	
Gate-source charge 1	$Q_{gs1}$	$V_{SS} = 15\text{ V}, I_S = 7\text{ A}$	—	3.0	—	
Gate-drain charge	$Q_{gd}$		—	3.6	—	

## 7. Marking

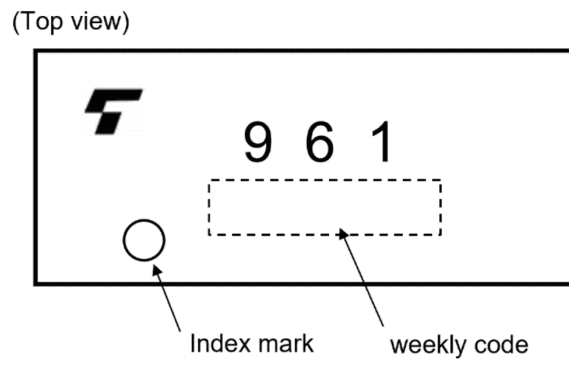
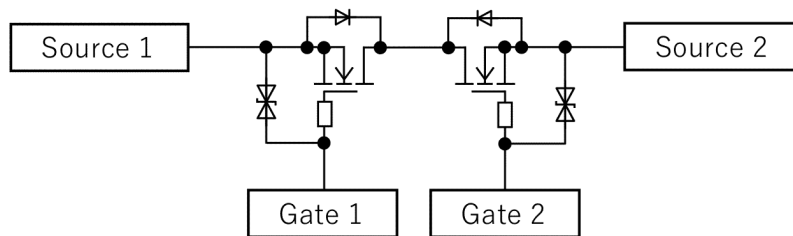
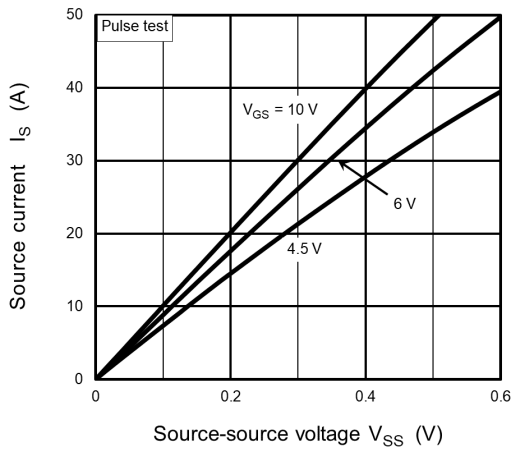


Fig. 7.1 Marking

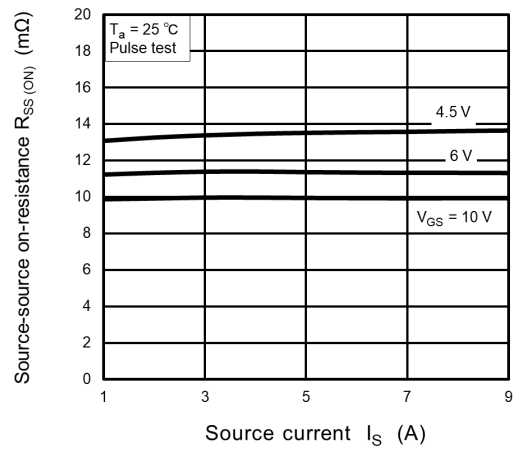
## 8. Equivalent Circuit



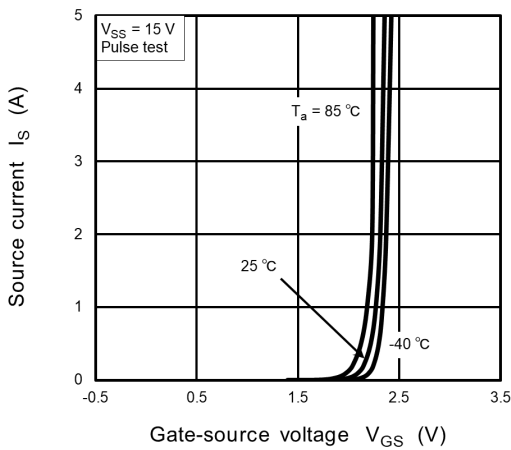
### 9. Characteristics Curves (Note)



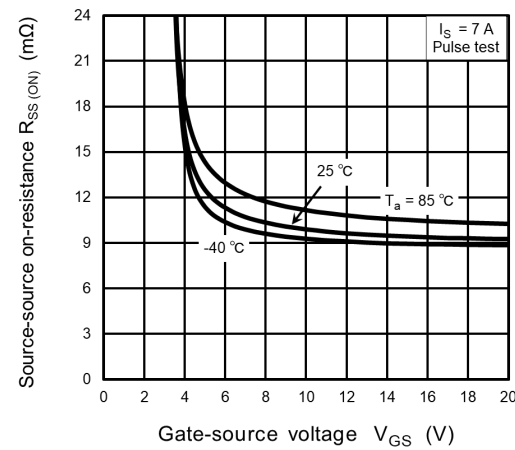
**Fig. 9.1  $I_S - V_{SS}$**



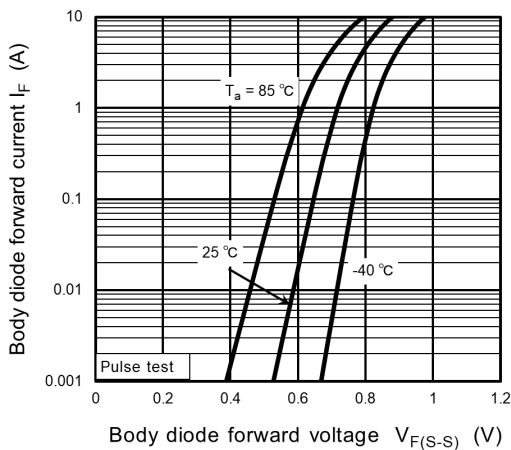
**Fig. 9.2  $R_{SS(ON)} - I_S$**



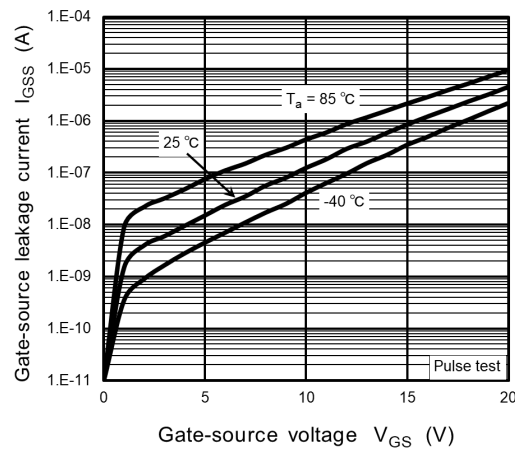
**Fig. 9.3  $I_S - V_{GS}$**



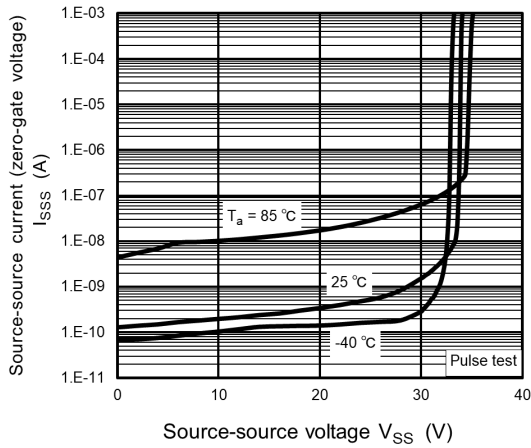
**Fig. 9.4  $R_{SS(ON)} - V_{GS}$**



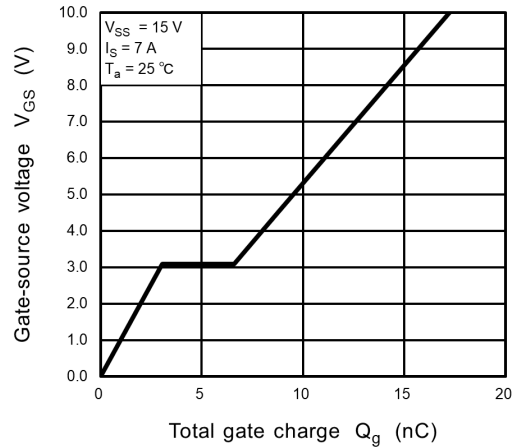
**Fig. 9.5  $I_F - V_{F(S-S)}$**



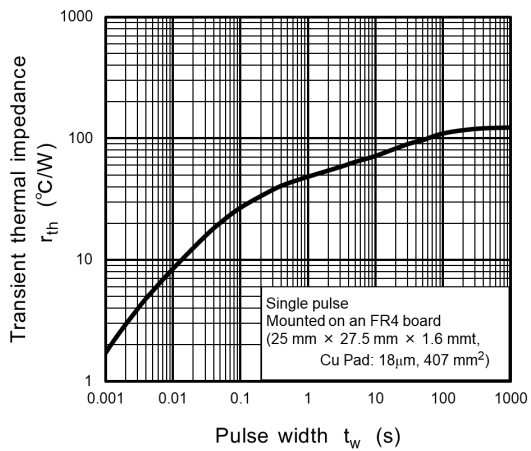
**Fig. 9.6  $I_{GS} - V_{GS}$**



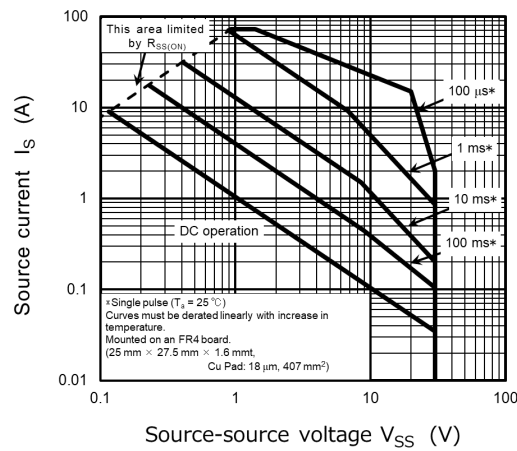
**Fig. 9.7**  $I_{SSS} - V_{SS}$



**Fig. 9.8** Dynamic Input Characteristics



**Fig. 9.9**  $r_{th} - t_w$



**Fig. 9.10** Safe Operating Area

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

10. Land Pattern Dimensions (for reference only)

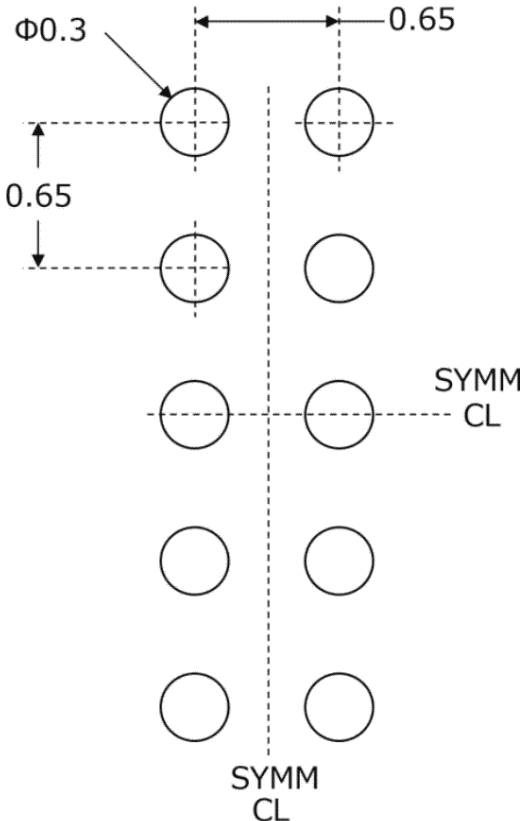


Fig. 10.1 Land Pattern Dimensions for Reference Only (Unit: mm)





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