Short-circuit Protection Circuit

The Short-circuit Protection Circuit monitors the drain voltage of the high side MOSFET to detect short circuits. This circuit detects a short circuit when a short circuit current flows for longer than tspoff (typically 3μs). The outputs are switched to the OFF state and the DIAG1 signal is switched HIGH. The IPM is then latched in the short-circuit protection state. This state can be released by setting the RESET input LOW and then HIGH again.

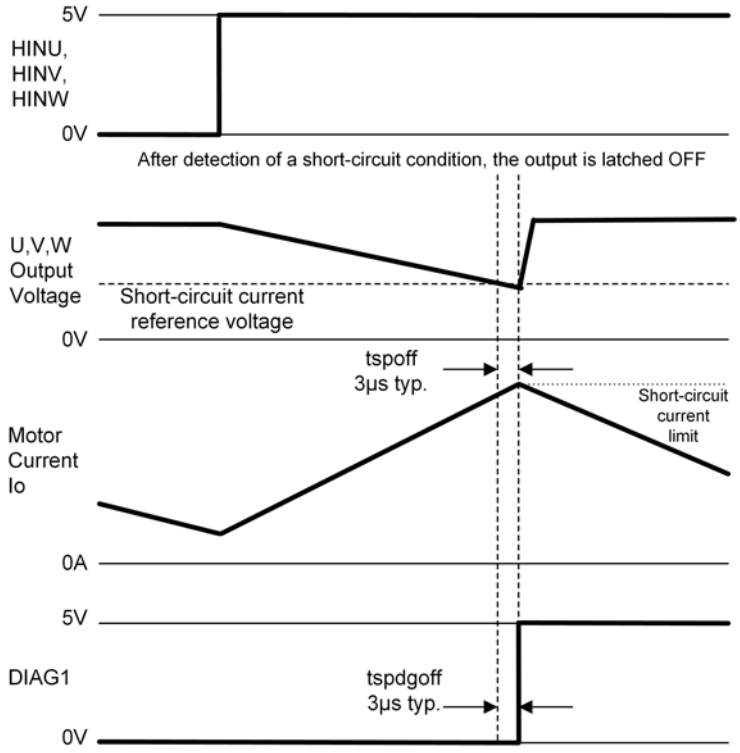


Figure 11: Timing Diagram Short-circuit Condition

Over-current Protection Circuit

The Over-current Protection Circuit monitors the drain voltage of the low-side MOSFETs to detect over currents. This circuit detects a short circuit when a short circuit current flows for longer than tocoff (typically 4.3μs). When a short circuit is detected, the outputs are switched off and the short circuit condition is flagged by switching on DIAG1. The over-current protection state is held for time t_{INT} (typically 1ms) then released. It is not latched like the short-circuit current protection mode.

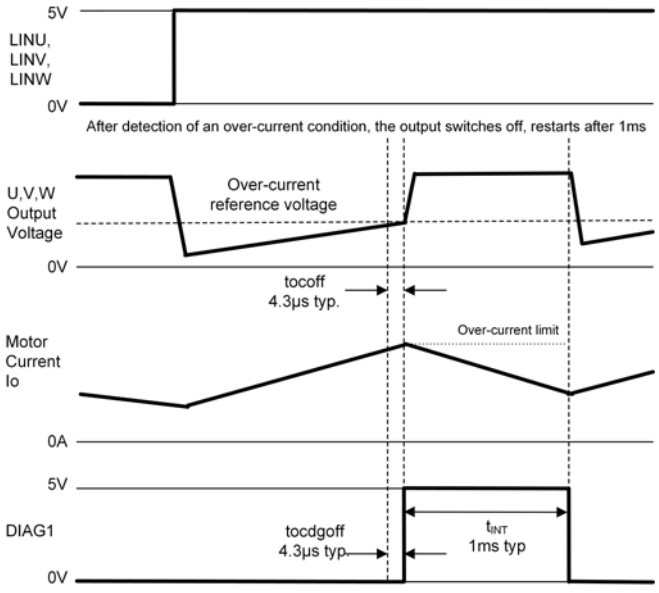


Figure 12: Timing Diagram for Over-current Protection

Undervoltage Lockout Protection Circuit

The Undervoltage Lockout Protection Circuit monitors voltages supplied to VB1 pin to detect low voltages. When the voltage on VB1 falls below the undervoltage lockout falling threshold, the outputs will be turned off. The undervoltage lockout circuit has a hysteresis. If the voltage on VB1 rises above the undervoltage lockout rising threshold, the module will return to normal operating mode.

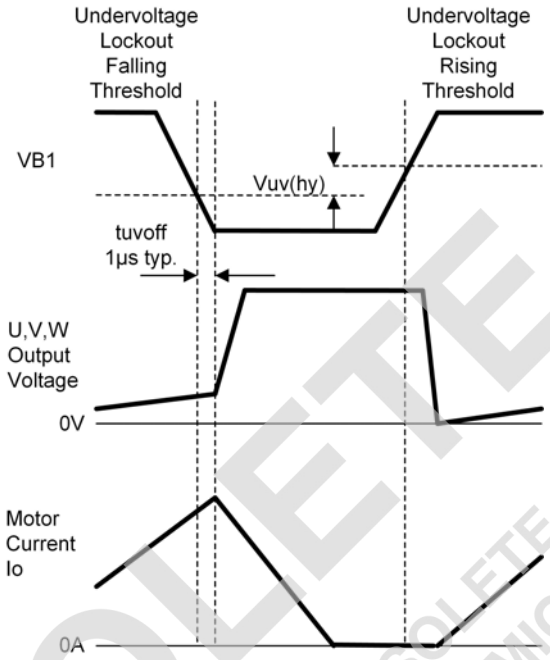


Figure 13: Timing Diagram Low Voltage Protection

Overvoltage Protection Circuit

The Overvoltage Protection Circuit monitors the voltage on VB1. If the voltage on VB1 exceeds the overvoltage protection threshold, the outputs will be switched off. The Overvoltage Protection Circuit has hysteresis. The IPM will return to normal operation when the voltage on VB1 falls below the over-voltage protection falling threshold voltage.

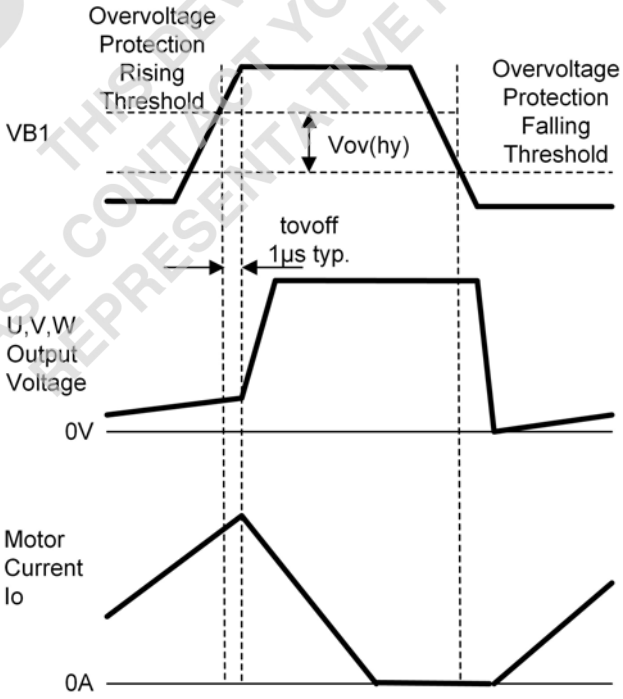


Figure 14 Timing Diagram Overvoltage Protection

Over-temperature Protection Circuit

The Over-temperature Protection Circuit monitors the circuit substrate temperature to detect excessive temperatures. When the case temperature rises above the temperature shutdown rising threshold, the outputs are switched off and the over temperature condition is flagged on output DIAG2. There is hysteresis in the over-temperature protection circuit. When the case temperature falls below the temperature shutdown falling threshold, the circuit returns to normal operation and the over-temperature condition is no longer flagged on the DIAG2 output.

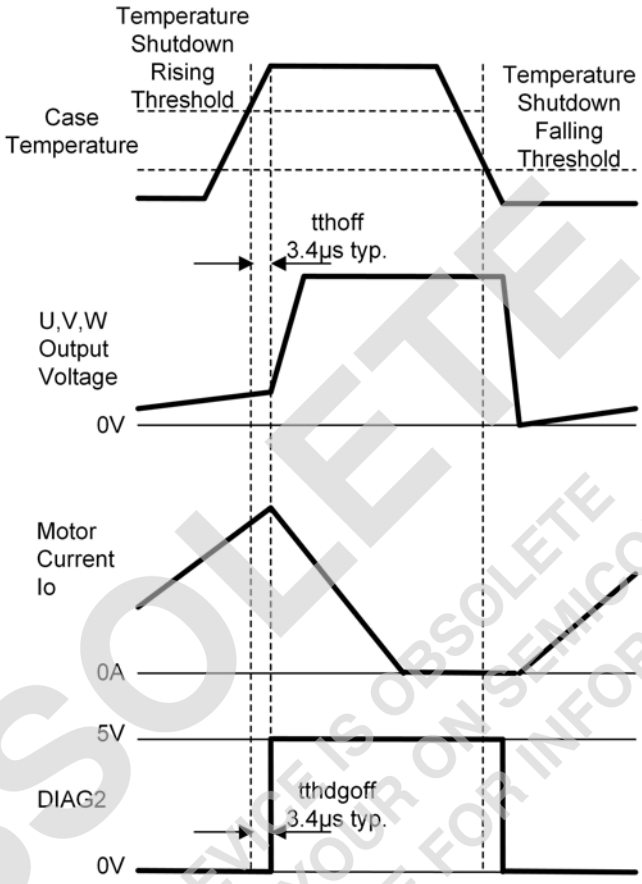


Figure 15: Timing Diagram Over-temperature Protection

Mounting Instructions

Item	Recommended Conditions
Pitch	56.0 ± 0.2mm (Please refer to Package Outline Diagram)
Screw	Diameter : M3 Screw head types: pan head, truss head, binding head
Washer	Plane washer dimensions (Figure 16) D = 7mm, d = 3.2mm and t = 0.5mm JIS B 1256
Heat sink	Material: Aluminum or Copper Warpage (the surface that contacts IPM) : −50 to 100 μm Screw holes for the heat sink must be countersunk. No contamination on the heat sink surface that contacts IPM.
Torque	Temporary tightening : 20 to 30 % of final tightening on first screw Temporary tightening : 20 to 30 % of final tightening on second screw Final tightening : 0.6 to 0.9Nm on first screw Final tightening : 0.6 to 0.9Nm on second screw
Thermal Interface	Silicone grease is recommended. Thickness : 100 to 200 μm Uniformly apply silicon grease to whole back. Thermal foils are only recommended after careful evaluation. Thickness, stiffness and compressibility parameters have a strong influence on performance.

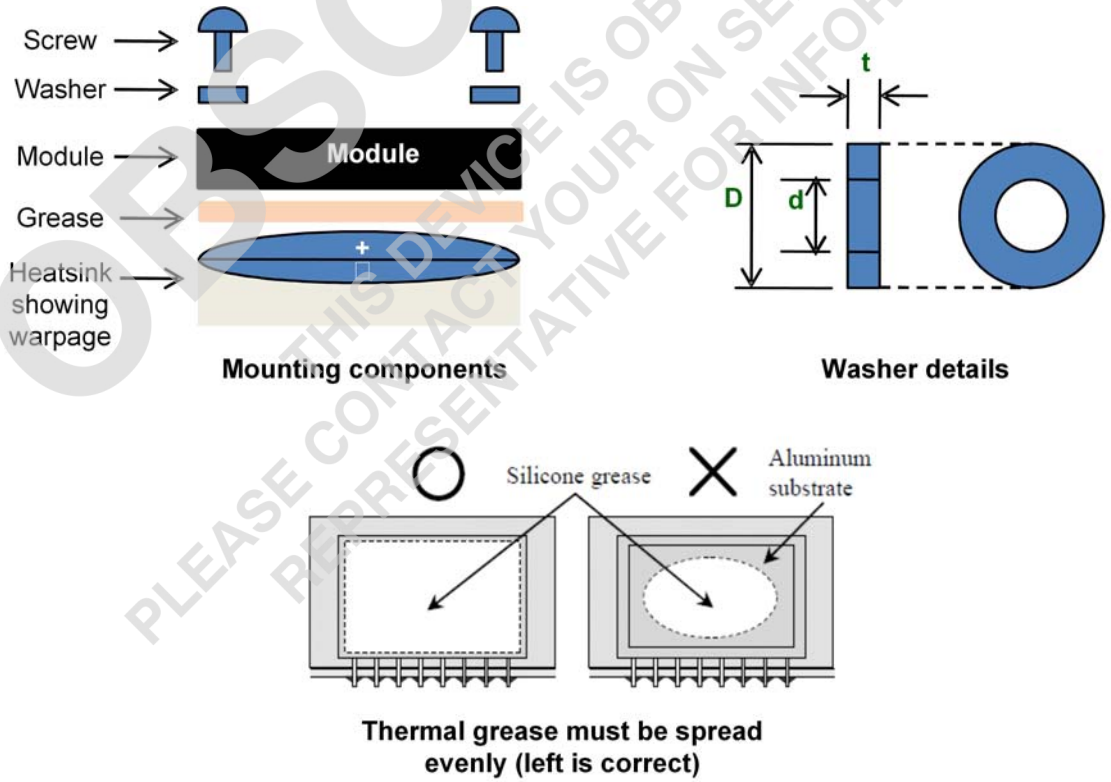


Figure 16: Module Mounting details: components; washer drawing; need for even spreading of thermal grease

Reliability Specification

Ta=25°C±5°C, Relative humidity 65%±20% unless otherwise specified

Parameter		Test Conditions	Evaluation Time	Evaluation Method	Test Time
Mechanical Strength	Free-Fall	High = 75cm, drop on a woodblock Woodblock : maple 30×30×3cm Conform to JIS C 7021 A-8	Drop Time = 3 times	Electrical Characteristics	N = 5
	Vibration Fatigue	Vibration Frequently f = 10HZ to 55HZ Logarithmic Sweep Total Amplitude = 1.5+0.2mm	X, Y, Z Each direction 2hr	Electrical Characteristics Visual Inspection	N = 11
Environmental Test	Thermal Shock (Vapor Tank)	Ta = −40°C↔125°C (30min. each) Elapsed time after the test =2hr	1000 Cycles	Electrical Characteristics Visual Inspection Solder Junction	N = 11
	Pressure Cooker	Ta = 121°C, RH=100%, 2 air pressure	48hr	Electrical Characteristics	N = 11
Life Test	High-Temperature Storage	Ta = 125°C Elapsed time after the test = 3hr Conform to JIS C 7201 B-10	1000hr	Electrical Characteristics	N = 11
	Low-Temperature Storage	Ta = −40°C Elapsed time after the test=3hr Conform to JIS C 7021 B-12	1000hr	Electrical Characteristics	N = 11
	High Temperature High Humidity Bias	Ta = 85°C±2°C, RH = 85%±5% VB1, VB2 = 70% of Maximum Rating	1000hr	Electrical Characteristics	N = 11

Table 7: Reliability Specification

Test Circuits

■ VDS(sat) measurement (Pulse Measurement)

Pin No

Measured Phase	U	V	W	UN	VN	WN
M	21	21	21	13	15	17
N	13	15	17	19	19	19
m	4	5	6	7	8	9

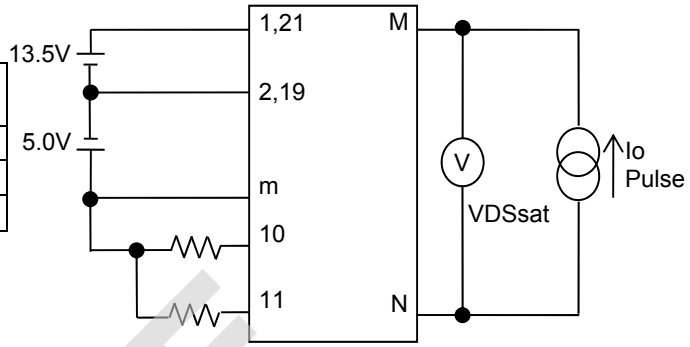


Figure 17 VDS Measurement Circuit

■ ICC Measurement

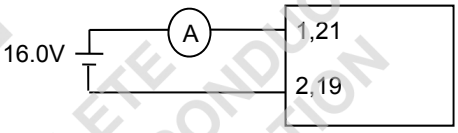


Figure 18 ICC Measurement Circuit

■ ISD Measurement

Pin No

Measured Phase	Short-Circuit Threshold			Overcurrent Threshold		
	U	V	W	UN	VN	WN
M	19	19	19	13	15	17
N	13	15	17	21	21	21
m	4	5	6	7	8	9

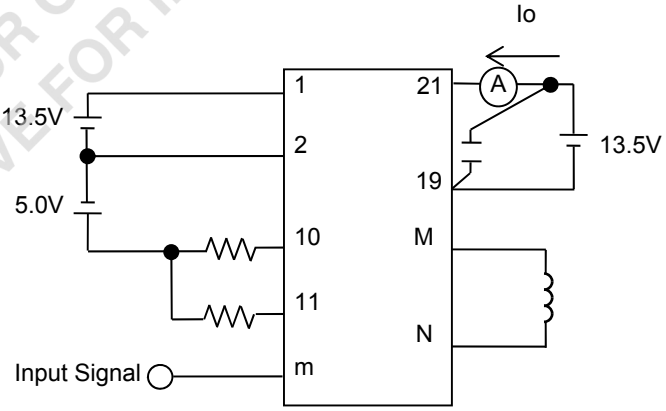


Figure 19 ISD Measurement Circuit

■ Measurement of rise, fall and delay times

Pin No

Measured Phase	U	V	W	UN	VN	WN
M	19	19	19	13	15	17
N	13	15	17	21	21	21
m	4	5	6	7	8	9

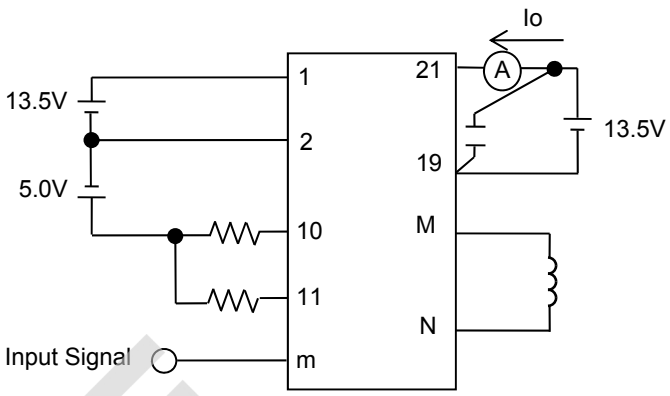


Figure 20 Switch Time Measurement Circuit

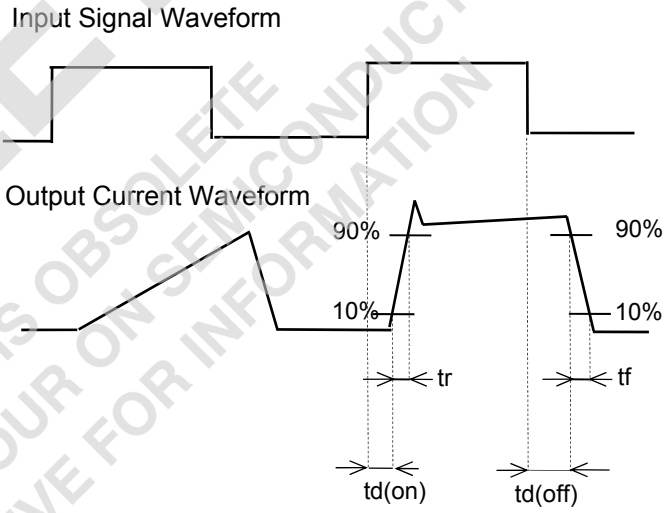
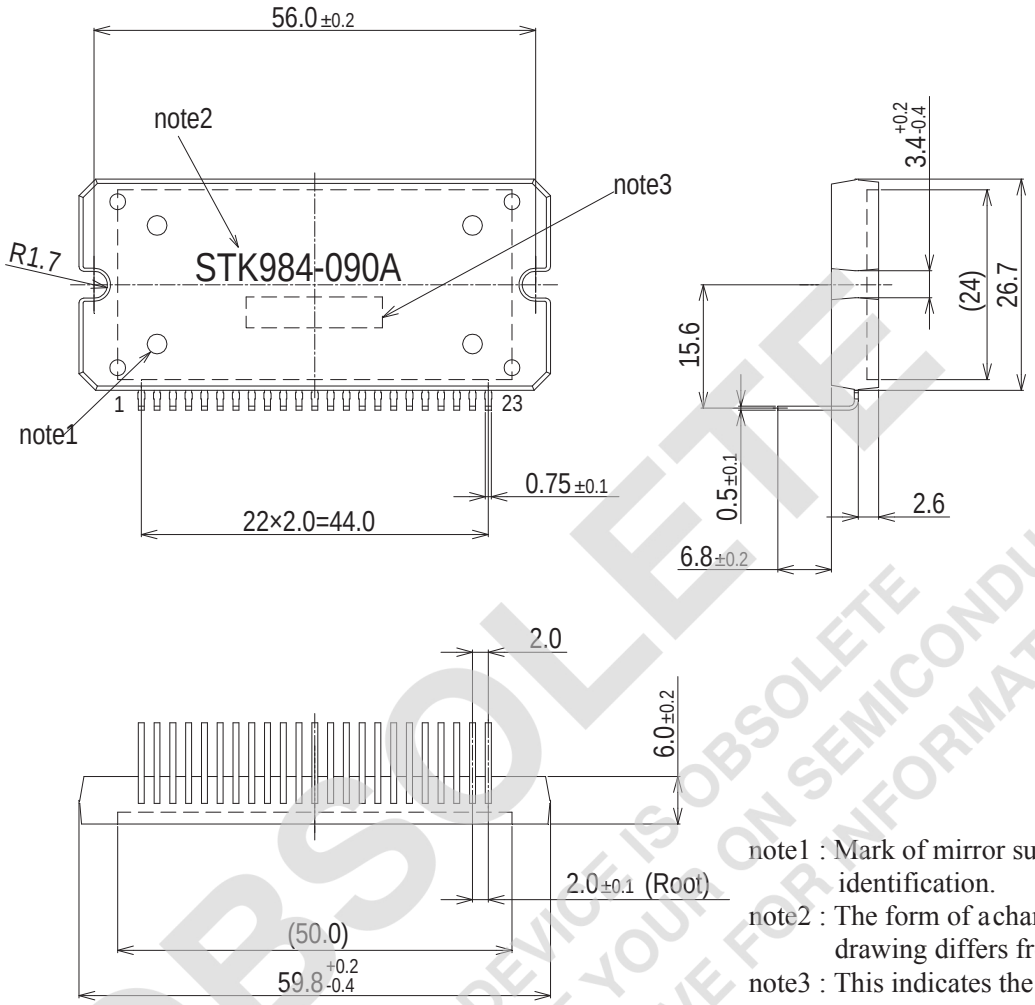


Figure 21 Switch Time Definitions

PACKAGE DIMENSIONS
unit : mm



note1 : Mark of mirror surface for No.1 pin identification.
note2 : The form of a character in this drawing differs from that of IPM.
note3 : This indicates the lot code. The form of a character in this drawing differs from that of IPM.