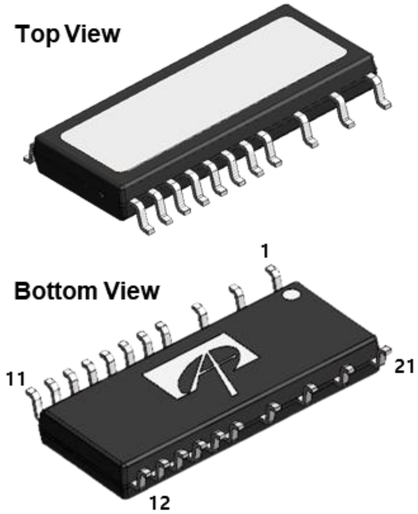
AIM7DT3AR60V3

Intelligent Power Module

External View



Size: 17.9 x 7.5 x 2.5 mm

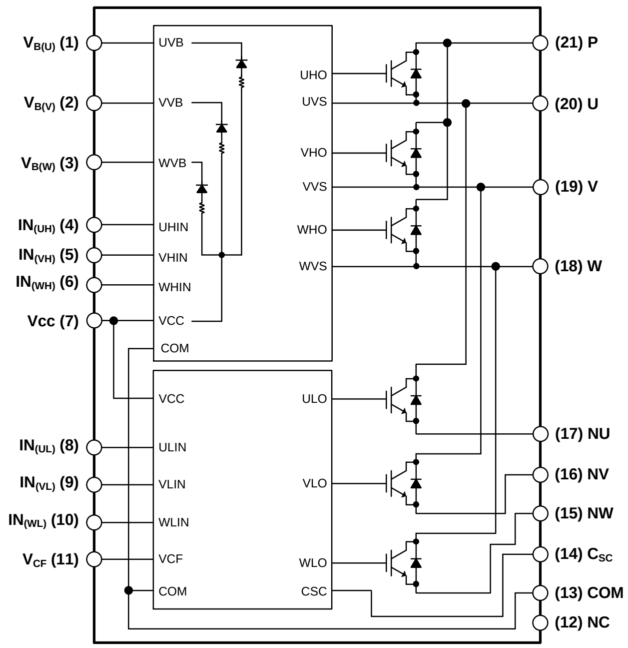
Features

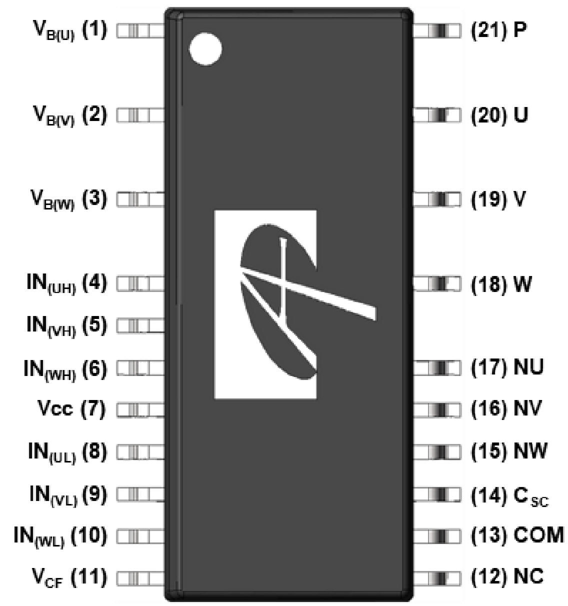
- 600V-3A
- Fully functional 3-phase IGBT-IPM
- Reverse conducting IGBT with monolithic body diode
- DBC-embedded SMD Type
- Wide input interface (3-18V) with schmitt-trigger input circuit
- Built-in bootstrap diodes with current-limiting resistor
- Control supply under-voltage lockout protection (UVLO)
- Over-temperature (OT) protection
- Short-circuit current protection (C_{SC})
- Controllable fault out signal (V_{CF}) corresponding to SC, UV, OT fault
- Isolation ratings of 1500Vrms/min

Applications

- AC 100~240Vrms class low power motor drives
- Refrigerators, Dishwashers, Drain Pumps and Fan Motors

Internal Equivalent Circuit / Pin Configuration





Ordering Information

Part Number	Package	Description
AIM7DT3AR60V3	IPM-7DT	N/A

AOS Green Products use reduced levels of Halogens, and are also RoHS compliant.
Please visit https://aosmd.com/sites/default/files/media/AOSGreenPolicy.pdf for additional information.

Pin Description

Pin Number	Pin Name	Pin Function
1	$V_{B(U)}$	High-Side Bias Voltage for U-phase IGBT Driving
2	$V_{B(V)}$	High-Side Bias Voltage for V-phase IGBT Driving
3	$V_{B(W)}$	High-Side Bias Voltage for W-phase IGBT Driving
4	$IN_{(UH)}$	Signal Input for High-Side U-phase
5	$IN_{(VH)}$	Signal Input for High-Side V-phase
6	$IN_{(WH)}$	Signal Input for High-Side W-phase
7	V_{CC}	Control Supply Voltage
8	$IN_{(UL)}$	Signal Input for Low-Side U-phase
9	$IN_{(VL)}$	Signal Input for Low-Side V-phase
10	$IN_{(WL)}$	Signal Input for Low-Side W-phase
11	V_{CF}	Controllable Fault Output
12	NC	No connection
13	COM	Common Supply Ground
14	C_{SC}	Capacitor (Low-Pass Filter) for Short-Circuit Current Detection Input
15	NW	Negative DC-Link Input for W-Phase
16	NV	Negative DC-Link Input for V-Phase
17	NU	Negative DC-Link Input for U-Phase
18	W	Output for W-phase
19	V	Output for V-phase
20	U	Output for U-phase
21	P	Positive DC-Link Input

Absolute Maximum Ratings (T_J=25°C, unless otherwise specified)

Symbol	Parameter	Conditions	Ratings	Units
Inverter				
BV_{CES}	IGBT Breakdown Voltage	T_J=25°C	600	V
I_C	IGBT Collector Current (Continuous)	T_C=25°C	3	A
		T_C=80°C	2	A
I_{CP}	IGBT Collector Current (Pulsed)	T_C=25°C, <100µs pulse width	4.5	A
P_D	Maximum Power Dissipation	T_C=25°C	23.5	W
T_J	Operating Junction Temperature		-40 to 150	°C
Control (Protection)				
V_{CC}	Control Supply Voltage	Applied between V_{CC}-COM	-0.3 ~ 20	V
V_{BS}	High-Side Control Bias Voltage	Applied between $V_{B(U)}$-U, $V_{B(V)}$-V, $V_{B(W)}$-W	-0.3 ~ 20	V
V_{IN}	Input Voltage	Applied between $IN_{(UH)}$, $IN_{(VH)}$, $IN_{(WH)}$, $IN_{(UL)}$, $IN_{(VL)}$, $IN_{(WL)}$-COM	-0.3 ~ V_{CC}+0.5	V
V_{CF}	Fault Output Supply Voltage	Applied between V_{CF}-COM	-0.3 ~ 5.5	V
Thermal Resistance				
$R_{th(j-c)}$	Junction to Case Thermal Resistance	Inverter RC-IGBT (per 1/6 module)	5.3	°C/W
Total System				
T_C	Module Case Operation Temperature		-30 to 125	°C
T_{STG}	Storage Temperature		-40 to 150	°C
V_{ISO}	Isolation Voltage	60Hz, sinusoidal, AC 1min, between connected all pins and heat sink plate	1500	V_{rms}

Recommended Operation Conditions

Symbol	Parameter	Conditions	Min.	Typ.	Max	Units
V_{PN}	Bus Supply Voltage	Applied between P-N	0	300	450	V
V_{CC}	Control Supply Voltage	Applied between V_{CC}-COM	13.5	15.0	16.5	V
V_{BS}	High-Side Bias Voltage	Applied between $V_{B(U)}$-U, $V_{B(V)}$-V, $V_{B(W)}$-W	13.5	15.0	16.5	V
dV_{CC}/dt, dV_{BS}/dt	Control Supply Variation		-1	-	1	V/us
t_{dead}	Arm Shoot-Through Blocking Time	For each input signal	1.5	-	-	µs
f_{PWM}	PWM Input Frequency	-40°C < T_J < 150°C	-	16	-	kHz
$PW_{IN(ON)}$	Minimum Input Pulse Width	(Note 1)	0.7	-	-	µs
$PW_{IN(OFF)}$			0.7	-	-	µs

Note:

1. IPM may not respond if the input pulse width is less than $PW_{IN(ON)}$, $PW_{IN(OFF)}$.

Electrical Characteristics (T_J=25°C, unless otherwise specified)

Symbol	Parameter	Conditions		Min.	Typ.	Max	Units
Inverter							
$V_{CE(SAT)}$	Collector-Emitter Saturation Voltage	V_{CC}=V_{BS}=15V, V_{IN}=5V	I_C=2A	-	1.5	1.9	V
V_F	Emitter-Collector Forward Voltage	V_{CC}=V_{BS}=15V, V_{IN}=0	I_C=2A	-	2.1	2.5	V
t_{OFF}	Switching Times	V_{PN}=300V, V_{CC}=V_{BS}=15V I_C=2A, V_{IN}=0V↔5V Inductive load (high-side)		-	980	-	ns
t_f				-	80	-	ns
t_{ON}				-	710	-	ns
t_r				-	30	-	ns
t_{rr}				-	180	-	ns
I_{CES}	Collector-Emitter Leakage Current	V_{IN}=0V, V_{CE}=600V		-	-	1	mA
Control (Protection)							
I_{QCC}	Quiescent V_{CC} Supply Current	V_{CC}=15V, $IN_{(UL, VL, WL)}$=0V	V_{CC}-COM	-	-	1.5	mA
I_{QBS}	Quiescent V_{BS} Supply Current	V_{BS}=15V, $IN_{(UH, VH, WH)}$=0V	$V_{B(U)}$-U, $V_{B(V)}$-V, $V_{B(W)}$-W	-	-	0.3	mA
UV_{CCT}	Supply Circuit Under-Voltage Protection	Trip Level		10.3	11.4	12.5	V
UV_{CCR}		Reset Level		10.8	11.9	13.0	V
UV_{BST}		Trip Level		9.0	10.0	11.0	V
UV_{BSR}		Reset Level		10.0	11.0	12.0	V
V_{SC}	Short-Circuit Trip Level	V_{CC}=15V		0.45	0.48	0.51	V
OT_T	Over-Temperature Protection (Note 2)	V_{CC}=15V, Detect LVIC Temperature	Trip Level	110	130	150	°C
OT_{HYS}			Hysteresis of Trip Reset	-	30	-	°C
V_{CFH}	Fault Output Voltage	V_N=0V		4.9	-	-	V
V_{CFL}		V_N=1V		-	-	0.5	V
V_{CF+}	CF positive going threshold			-	1.9	2.2	V
V_{CF-}	CF negative going threshold			0.8	1.1	-	V
t_{FO}	Fault Output Pulse Width (Note 3)			20	-	-	µs
I_{IN}	Input Current	V_{IN}=5V		-	650	850	µA
$V_{th(on)}$	ON Threshold Voltage	Applied between $IN_{(UH)}$, $IN_{(VH)}$, $IN_{(WH)}$, $IN_{(UL)}$, $IN_{(VL)}$, $IN_{(WL)}$ –COM		-	-	2.5	V
$V_{th(off)}$	OFF Threshold Voltage			0.8	-	-	V
Bootstrap Diode							
$V_{F(BSD)}$	Bootstrap Diode Forward Voltage	I_F=10mA including voltage drop by limiting resistor		-	3.6	-	V
R_{BSD}	Bootstrap Diode Equivalent Resistance			-	360	-	Ω

Note:

2. When the LVIC temperature exceeds OT Trip temperature level (OT_T), OT protection is triggered and fault signal outputs.
3. At SC detection, F_O pulse width has a fixed width of minimum 20µs.

Controllable Fault Output Circuit

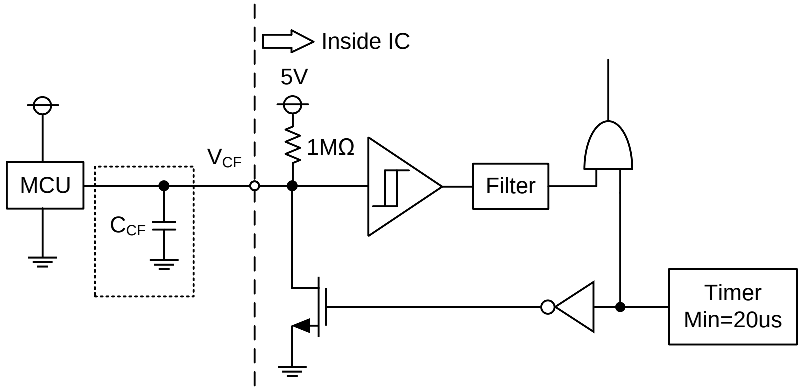


Figure 1. V_{CF} Output Circuit

(1) The V_{CF} pin provides an enable functionality that allows it to shut down the all low-side IGBTs. When the V_{CF} pin is in the high state the IPM is able to operate normally. If the V_{CF} pin is in a low state, the low-side IGBTs are turned off until the enable condition is restored.

(2) In addition, the V_{CF} pin can provide the fixed or adjustable pulse width of fault output signal.

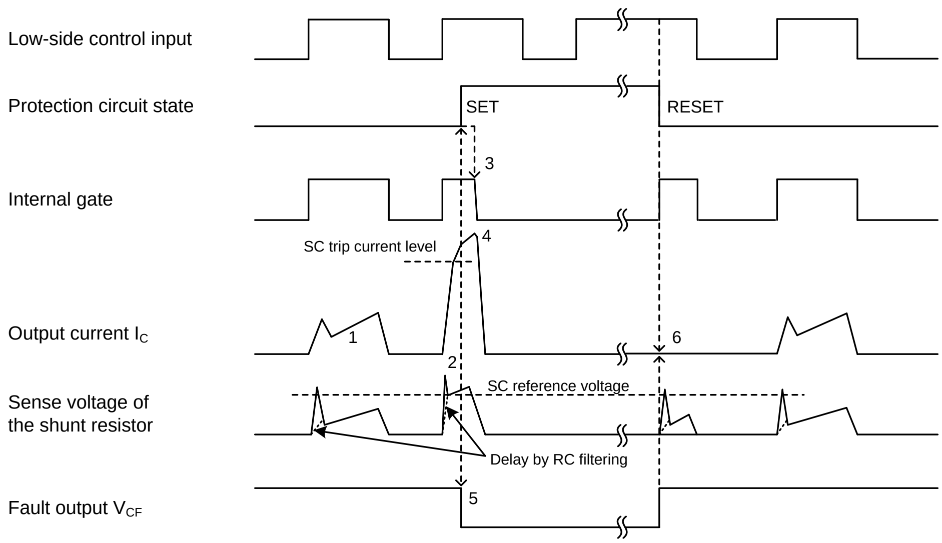
(3) If the V_{CF} pin is left, the pulse width is fixed at minimum 20us.

(4) If a capacitor is connected, the pulse width can be adjusted according to the capacitor value.

The length of pulse width is determined by the following formula;

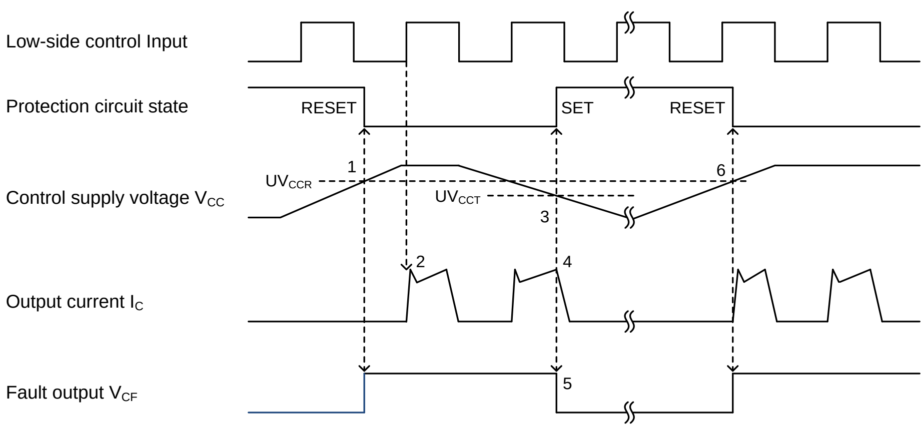
- t_{FO} = -(1MΩ*C_{CF})*ln(1-V_{CF}+/5V) + 100ns + 20us(min.)
- ex) C_{CF}=1nF, t_{FO}≈500us. Recommended parameters in the design are C_{CF} of ≤ 1nF.

Time Charts of the IPM Protective Function



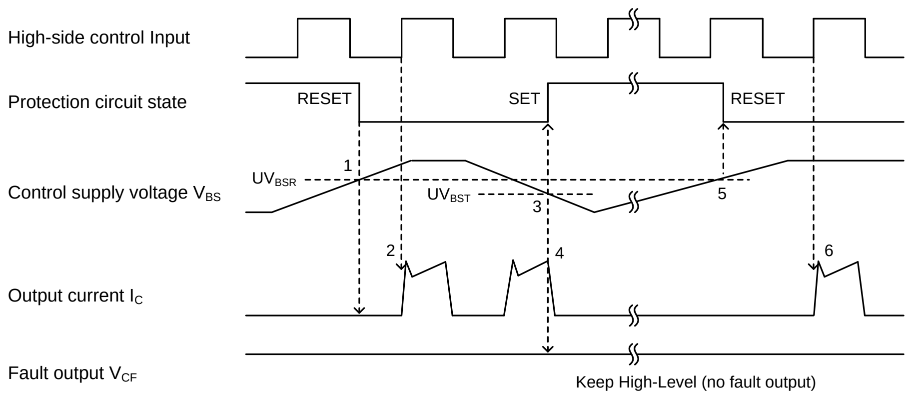
(1) Normal operation: IGBT turns on and output current.
(2) Short-circuit current detection (SC triggered).
(3) All low-side IGBTs' gate are turned off.
(4) Accordingly, all low-side IGBTs are turned off.
(5) Fault signal outputs. F_O duration time (t_{FO}) is minimum 20μs.
(6) Fault output finishes. Normal operation starts according to the input signal.

Figure 2. Short-Circuit Protection
(Low-side Operation Only with External Shunt Resistor and RC Filter)



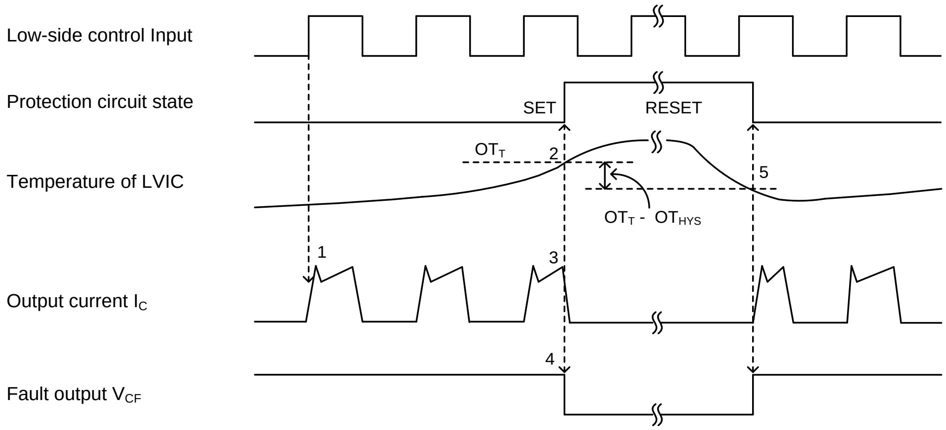
(1) Supply voltage V_{CC} becomes higher than under-voltage reset level (UV_{CCR}), and IGBTs are turned on by the next ON signal.
(2) Normal operation: IGBTs turn-on and output current.
(3) V_{CC} level drops to under-voltage trip level (UV_{CCT}).
(4) All low-side IGBTs are turned off regardless of control input condition.
(5) F_O output is generated, and F_O stays low as long as V_{CC} is below UV_{CCR}.
(6) V_{CC} level reaches UV_{CCR}. Normal operation starts according to the input signal.

Figure 3. Under-Voltage Protection (Low-side, UV_{CC})



(1) Control supply voltage V_{BS} rises. After the voltage reaches under-voltage reset level (UV_{BSR}), IGBTs are turned on by the next ON signal.
(2) Normal operation: IGBTs turn on and output current.
(3) V_{BS} level drops to under-voltage trip level (UV_{BST}).
(4) All high-side IGBTs are turned off regardless of control input condition.
(5) V_{BS} level reaches UV_{BSR}.
(6) Normal operation starts according to the input signal.

Figure 4. Under-Voltage Protection (High-side, UV_{BS})



(1) Normal operation: IGBTs turn on and output current.
(2) LVIC temperature exceeds over-temperature trip level (OT_T).
(3) All low-side IGBTs are turned off regardless of control input condition.
(4) F_O output is generated, and F_O stays low as long as LVIC temperature is over OT_T.
(5) LVIC temperature drops to over-temperature reset level (OT_T-OT_{HYS}). Normal operation starts according to the input signal.

Figure 5. Over-Temperature Protection (Low-side, Detecting LVIC Temperature)

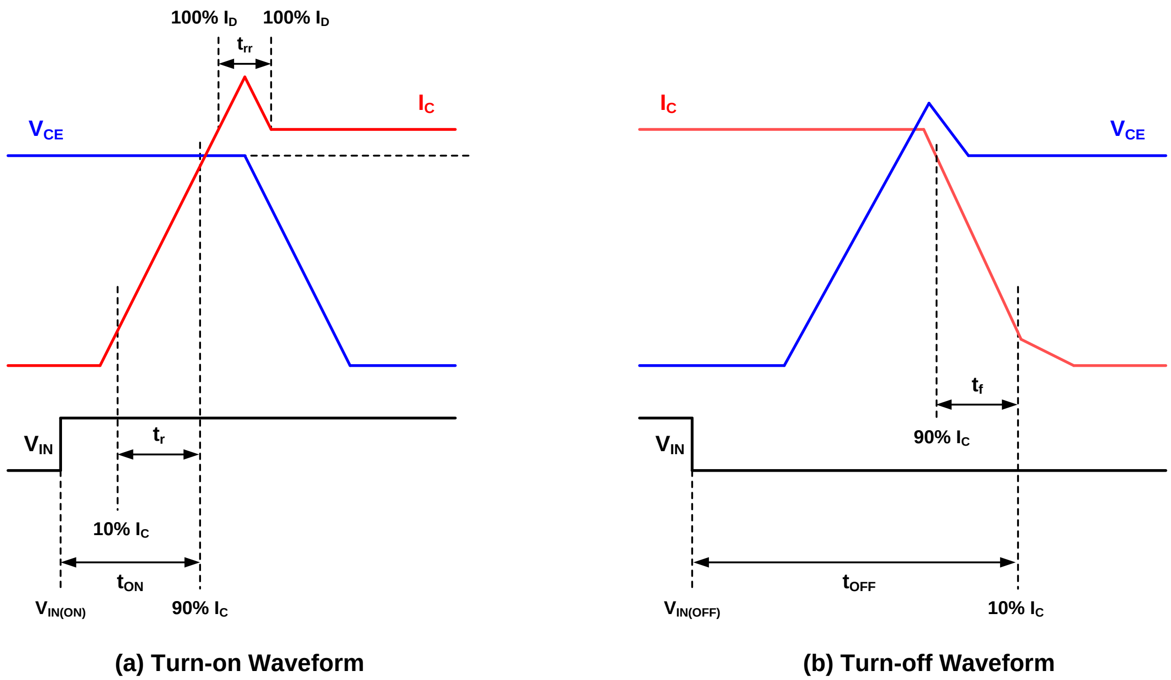
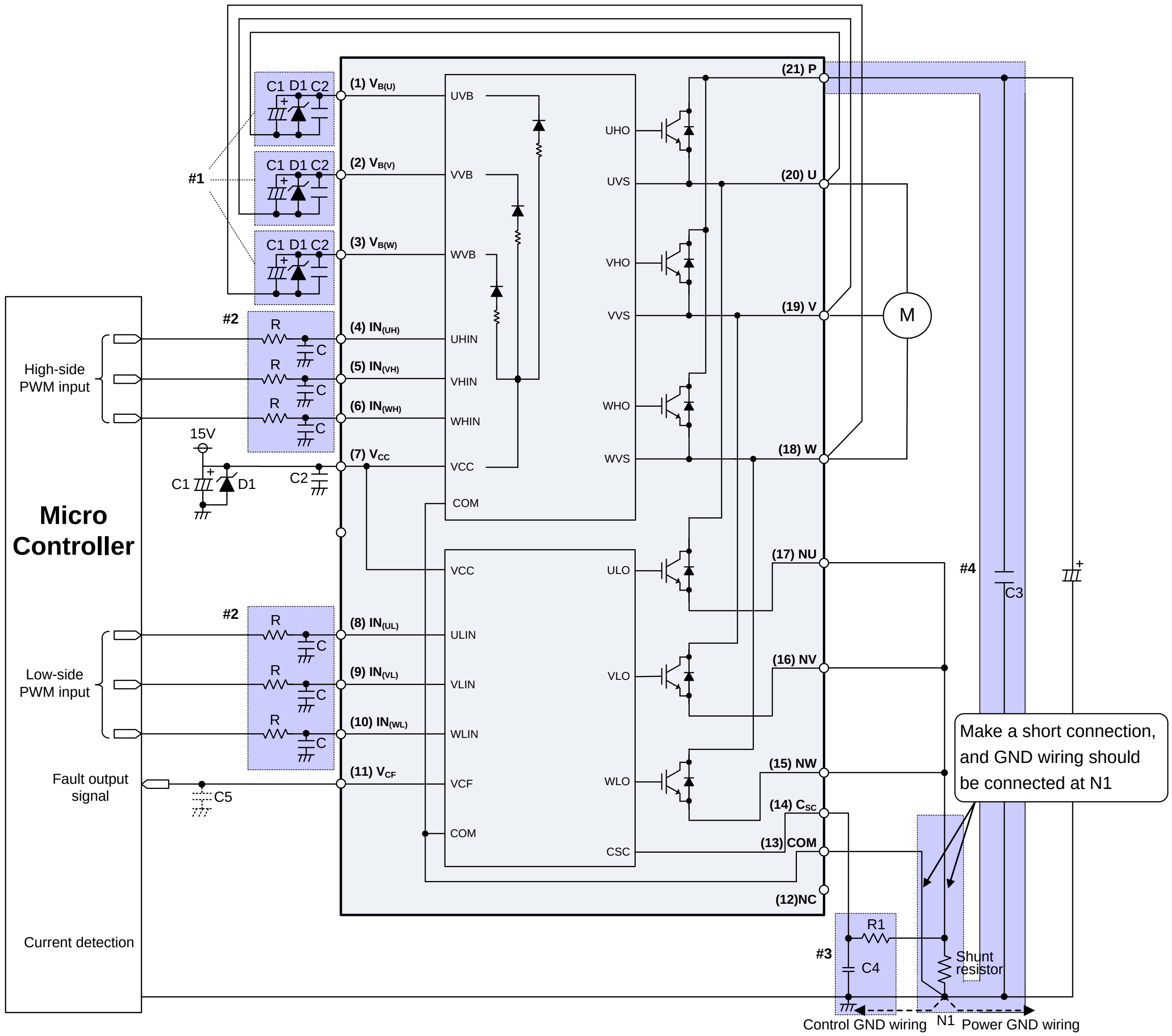


Figure 6. Switching Times Definition

Example of Application Circuit



Recommended Component Values:	
(#1) C1:1~3.3µF, C2:100nF, D1:20V	(#2) R:100Ω, C:1nF
(#3) R1:1kΩ, C4:2nF	(#4) C3:0.1~0.22µF

(1) If the control GND is connected with the power GND by common broad pattern, it may cause malfunction by power GND fluctuation. It is recommended to connect the control GND and power GND at a point (N1), near the terminal of shunt resistor.

(2) A zener diode D1 (20V/1W) is recommended between each pair of control supply pins to prevent surge destruction.

(3) Prevention of surge destruction can further be improved by placing the bus capacitor as close to pin P and N1 as possible. Generally a 0.1~0.22µF snubber capacitor C3 between the P-N1 terminals is recommended.

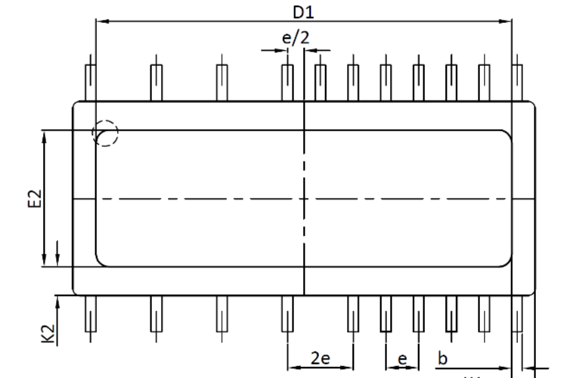
(4) Selection of the R1*C4 filter components for short-circuit protection is recommended to have tight tolerance, and is temperature-compensated type. The R1*C4 time constant should be set such that SC current is shut down within 2µs; (typically 1.5-2µs). R1 and C4 should be placed as close as possible to the C_{SC} pin. SC interrupting time may vary with layout patterns and components selections, therefore thorough evaluation in the system is necessary.

(5) It is recommended that all capacitors are mounted as close to the IPM as possible. (C1: electrolytic type with good temperature and frequency characteristics. C2: ceramic type with 0.1µF, good temperature, frequency and DC bias characteristics).

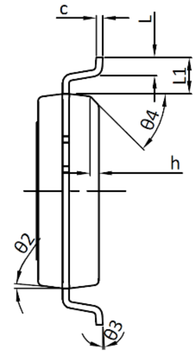
(6) To prevent malfunction, the layout to each input should be as short as possible. When using the RC coupling circuit (R: 100Ω, C: 1nF), place it as close to the IPM input pins as possible, and make sure the input signal levels meet the required turn-on and turn-off threshold voltages.

(7) The V_{CF} pin can provide the fault output signal with the fixed or adjustable pulse width. If the V_{CF} pin is left, the pulse width is fixed at minimum 20us. If a capacitor C5 is connected, the pulse width can be adjusted according to the capacitor value. For the design guide, please refer to the Figure 1.

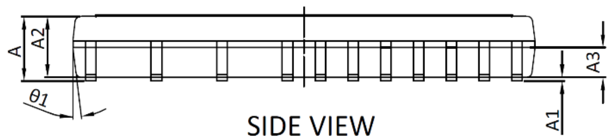
Package Dimensions, IPM-7DT



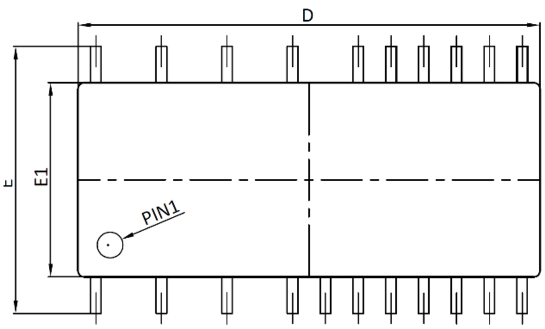
TOP VIEW



SIDE VIEW

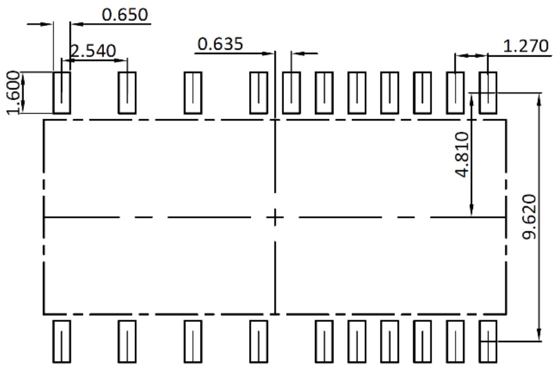


SIDE VIEW



BOTTOM VIEW

LAND PATTERN RECOMMENDATIONS



SYMBOLS	DIMENSION IN MILLIMETRES			DIMENSION IN INCHS		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	2.304	2.504	2.704	0.091	0.099	0.106
A1	0.025	---	0.150	0.001	---	0.006
A2	2.254	2.354	2.454	0.089	0.093	0.097
A3	1.050	1.150	1.250	0.041	0.045	0.049
D	17.800	17.900	18.000	0.701	0.705	0.709
D1	16.000	16.100	16.200	0.630	0.634	0.638
E	10.140	10.340	10.540	0.399	0.407	0.415
E1	7.420	7.520	7.620	0.292	0.296	0.300
E2	5.200	5.300	5.400	0.205	0.209	0.213
L	0.505	0.705	0.905	0.020	0.028	0.036
L1	1.210	1.410	1.610	0.048	0.056	0.063
K1	0.700	0.900	1.100	0.028	0.035	0.043
K2	0.910	1.110	1.310	0.036	0.044	0.052
e	1.270TYP.			0.050TYP.		
b	0.410TYP.			0.016TYP.		
c	0.254TYP.			0.010TYP.		
θ1	7°TYP.			7°TYP.		
θ2	7°TYP.			7°TYP.		
θ3	0°	---	8°	0°	---	8°
θ4	45°TYP.			45°TYP.		
h	0.381TYP.			0.015TYP.		

UNIT: mm

NOTES

1. PACKAGE BODY SIZES EXCLUDE MOLD FLASH AND GATE BURRS, MOLD FLASH SHOULD BE LESS THAN 6 MIL.
2. TOLERANCE 0.100 MILLIMETERS UNLESS OTHERWISE SPECIFIED.
3. CONTROLLING DIMENSION IS MILLIMETER, CONVERTED INCH DIMENSIONS ARE NOT NECESSARILY EXACT.

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