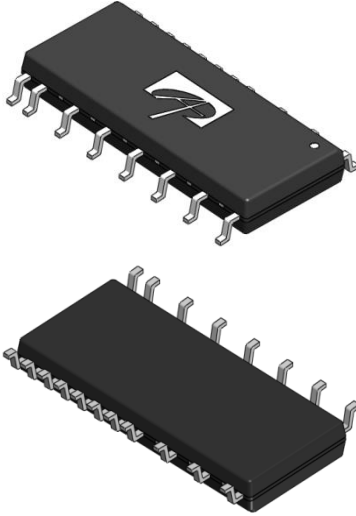


## External View



Size: 18 x 7.5 x 2.5 mm



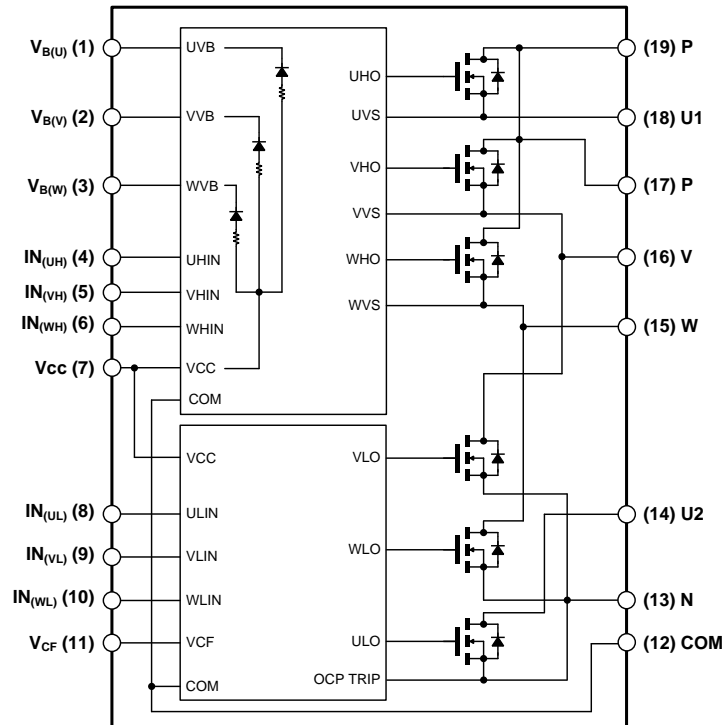
## Features

- 600V,  $R_{DS(on)} = 4.2\Omega$  (Max)
- Advanced MOSFET technology ( $\alpha$ MOS5™) for motor drives
- Low loss and EMI
- 3-phase Inverter module including HVIC drivers
- Wide input interface (3-18V), Schmitt trigger receiver circuit (Active High)
- Built-in bootstrap diodes with integrated current-limiting resistor
- Control supply under-voltage lockout protection (UVLO)
- Over-temperature (OT) protection
- Over-current protection (OCP)
- Controllable fault out signal ( $V_{CF}$ ) corresponding to OC, UV, OT fault
- Isolation ratings of 1500Vrms/min

## Applications

- AC 100~240Vrms class low power motor drives
- Fan motors

## Internal Equivalent Circuit / Pin Configuration

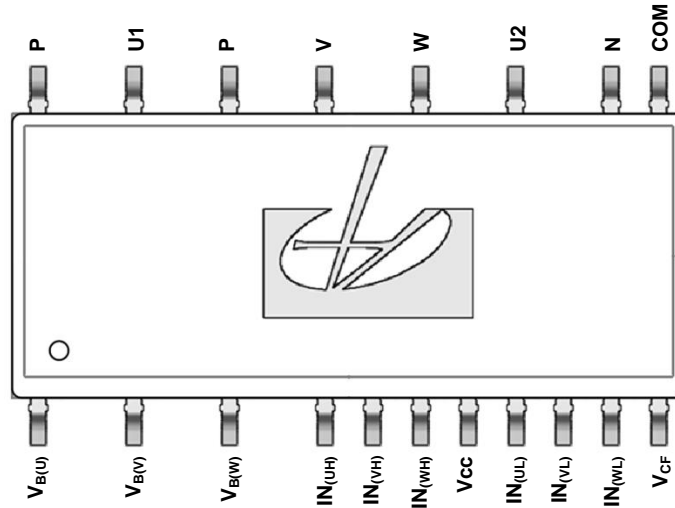


**Ordering Information**

Part Number	Temperature Range	Package	Description
AIM702S60C1	-40°C to 150°C	IPM-7	N/A



AOS Green Products use reduced levels of Halogens, and are also RoHS compliant. Please visit [www.aosmd.com/media/AOSGreenPolicy.pdf](http://www.aosmd.com/media/AOSGreenPolicy.pdf) for additional information.



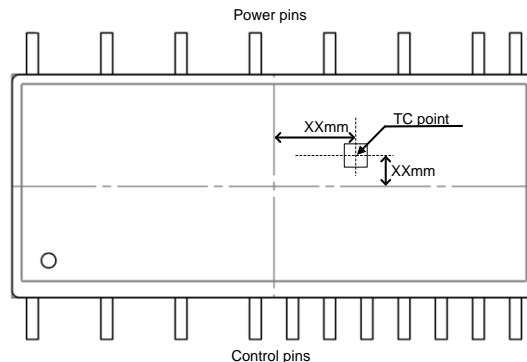
**Figure 1. Pin Configuration**

**Pin Description**

Pin Number	Pin Name	Pin Function
1	$V_{B(U)}$	High-Side Bias Voltage for U-phase MOSFET Driving
2	$V_{B(V)}$	High-Side Bias Voltage for V-phase MOSFET Driving
3	$V_{B(W)}$	High-Side Bias Voltage for W-phase MOSFET 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	COM	Common Supply Ground
13	N	Negative DC-Link Input
14	U2	Output for U-phase (connect to U1)
15	W	Output for W-phase
16	V	Output for V-phase
17	P	Positive DC-Link Input
18	U1	Output for U-phase (connect to U2)
19	P	Positive DC-Link Input

**Absolute Maximum Ratings** ( $T_J=25^\circ\text{C}$ , unless otherwise specified)

Symbol	Parameter	Conditions	Ratings	Units
<b>Inverter</b>				
$BV_{DSS}$	MOSFET Breakdown Voltage	$T_J=25^\circ\text{C}$	600	V
$I_D$	MOSFET Drain Current (Continuous)	$T_C=25^\circ\text{C}$	1.5	A
		$T_C=80^\circ\text{C}$	0.85	A
$I_{DP}$	MOSFET Drain Current (Pulsed)	$T_C=25^\circ\text{C}$ , <100 $\mu\text{s}$ pulse width	2.25	A
$P_D$	Maximum Power Dissipation	$T_C=25^\circ\text{C}$	8	W
$T_J$	Operating Junction Temperature		-40 to 150	$^\circ\text{C}$
<b>Control (Protection)</b>				
$V_{CC}$	Control Supply Voltage	Applied between $V_{CC}$ -COM	20	V
$V_{BS}$	High-Side Control Bias Voltage	Applied between $V_{B(U)}$ -U, $V_{B(V)}$ -V, $V_{B(W)}$ -W	20	V
$V_{IN}$	Input Voltage	Applied between $IN_{(UH)}$ , $IN_{(VH)}$ , $IN_{(WH)}$ , $IN_{(UL)}$ , $IN_{(VL)}$ , $IN_{(WL)}$ -COM	$V_{CC}\pm 0.5$	V
$V_{CF}$	Fault Output Supply Voltage	Applied between $V_{CF}$ -COM	$5\pm 0.5$	V
<b>Thermal Resistance</b>				
$R_{th(j-c)}$	Junction to Case Thermal Resistance	All operating condition	12.5	$^\circ\text{C/W}$
$R_{th(j-a)}$	Junction to Ambient Thermal Resistance	All operating condition	39	$^\circ\text{C/W}$
<b>Total System</b>				
$T_C$	Module Case Operation Temperature	Measurement point of $T_C$ is provided in Figure 2	-30 to 125	$^\circ\text{C}$
$T_{STG}$	Storage Temperature		-40 to 150	$^\circ\text{C}$
$V_{ISO}$	Isolation Voltage	60Hz, sinusoidal, AC 1min, between connected all pins and heat sink plate	1500	$V_{rms}$


**Figure 2.  $T_C$  Measurement Point**
**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
$\frac{dV_{CC}}{dt}$ , $\frac{dV_{BS}}{dt}$	Control Supply Variation		-1	-	1	V/us
$t_{dead}$	Arm Shoot-Through Blocking Time	For each input signal	1.5	-	-	$\mu\text{s}$
$f_{PWM}$	PWM Input Frequency	$-40^\circ\text{C} < T_J < 150^\circ\text{C}$	-	16	-	kHz
$PW_{IN(ON)}$	Minimum Input Pulse Width <sup>(1)</sup>		0.7	-	-	$\mu\text{s}$
$PW_{IN(OFF)}$			0.7	-	-	$\mu\text{s}$

**Note:**

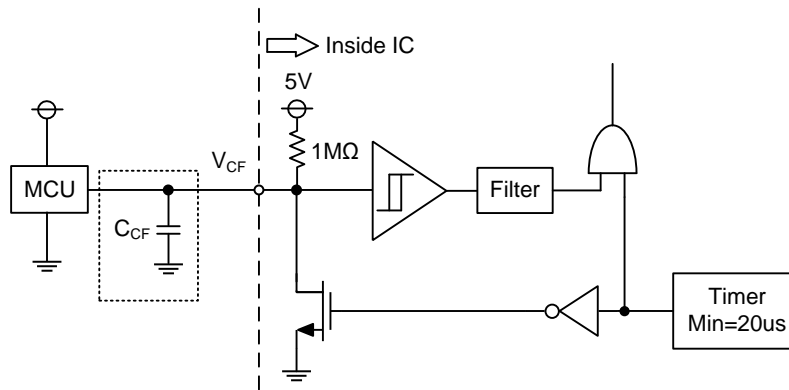
- IPM may not respond if the input pulse width is less than  $PW_{IN(ON)}$ ,  $PW_{IN(OFF)}$ .

**Electrical Characteristics** ( $T_J=25^\circ\text{C}$ , unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Units	
<b>Inverter</b>							
$V_M$	Motor Power Supply Voltage	$V_{CC}=V_{BS}=15\text{V}$ , $V_{IN}=0\text{V}$ , $T_J=25^\circ\text{C}$ All MOSFETs are off	P-N	600	-	-	V
$BV_{DSS}$	MOSFET Breakdown Voltage	$I_D=1\text{mA}$ , $V_{IN}=0\text{V}$ , $T_J=25^\circ\text{C}$		600	-	-	V
		$I_D=1\text{mA}$ , $V_{IN}=0\text{V}$ , $T_J=150^\circ\text{C}$		-	650	-	V
$I_{DSS}$	Drain-Source Leakage Current	$V_{IN}=0\text{V}$ , $V_{DS}=600\text{V}$		-	-	100	$\mu\text{A}$
$R_{DS(on)}$	Drain-Source On-State Resistance	$V_{CC}=V_{BS}=15\text{V}$ , $V_{IN}=5\text{V}$	$I_D=0.75\text{A}$	-	3.8	4.2	$\Omega$
$V_{SD}$	MOSFET Body Diode Forward Voltage	$V_{CC}=V_{BS}=15\text{V}$ , $V_{IN}=0$	$I_{SD}=0.75\text{A}$	-	1.0	1.3	V
$t_{OFF}$	Switching Times	$V_{PN}=300\text{V}$ , $V_{CC}=V_{BS}=15\text{V}$ $I_D=0.75\text{A}$ , $V_{IN}=0\text{V}\leftrightarrow 5\text{V}$ Inductive load (high-side)		-	800	-	ns
$t_f$				-	70	-	ns
$t_{ON}$				-	800	-	ns
$t_r$				-	80	-	ns
$t_{rr}$				-	160	-	ns
<b>Control (Protection)</b>							
$I_{QCC}$	Quiescent $V_{CC}$ Supply Current	$V_{CC}=15\text{V}$ , $I_{N(UH, VL, WL)}=0\text{V}$	$V_{CC-COM}$	-	-	1.5	mA
$I_{QBS}$	Quiescent $V_{BS}$ Supply Current	$V_{BS}=15\text{V}$ , $I_{N(UH, VH, WH)}=0\text{V}$	$V_{B(U)-U}$ , $V_{B(V)-V}$ , $V_{B(W)-W}$	-	-	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
$V_{OC}$	Over-Current Protection	$V_{CC}=15\text{V}$		0.9	1.0	1.1	V
$t_{OC\_blk}$	Over-Current Blanking Time	$V_{CC}=15\text{V}$		-	2	-	$\mu\text{s}$
$OT_T$	Over-Temperature Protection <sup>(2)</sup>	$V_{CC}=15\text{V}$ , Detect	Trip Level	110	130	150	$^\circ\text{C}$
$OT_{HYS}$		LVIC Temperature	Hysteresis of Trip Reset	-	30	-	$^\circ\text{C}$
$V_{CFH}$	Fault Output Voltage	$V_N=0\text{V}$		4.9	-	-	V
$V_{CFL}$		$V_N=1\text{V}$		-	-	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 <sup>(3)</sup>			20	-	-	$\mu\text{s}$
$I_{IN}$	Input Current	$V_{IN}=5\text{V}$		-	650	850	$\mu\text{A}$
$V_{th(on)}$	ON Threshold Voltage	Applied between $I_{N(UH)}$ , $I_{N(VH)}$ , $I_{N(WH)}$ , $I_{N(UL)}$ ,		-	-	2.5	V
$V_{th(off)}$	OFF Threshold Voltage	$I_{N(VL)}$ , $I_{N(WL)}-COM$		0.8	-	-	V
<b>Bootstrap Diode</b>							
$V_{RRM}$	Maximum Repetitive Reverse Voltage			600	-	-	V
$V_{F(BSD)}$	Bootstrap Diode Forward Voltage	$I_F=10\text{mA}$ including voltage drop by limiting resistor		-	5.0	-	V
$R_{BSD}$	Bootstrap Diode Equivalent Resistance			-	500	-	$\Omega$

**Note:**

- When the LVIC temperature exceeds OT Trip temperature level ( $OT_T$ ), OT protection is triggered and fault signal outputs.
- At OC detection,  $F_O$  pulse width has a fixed width of minimum 20 $\mu\text{s}$ .



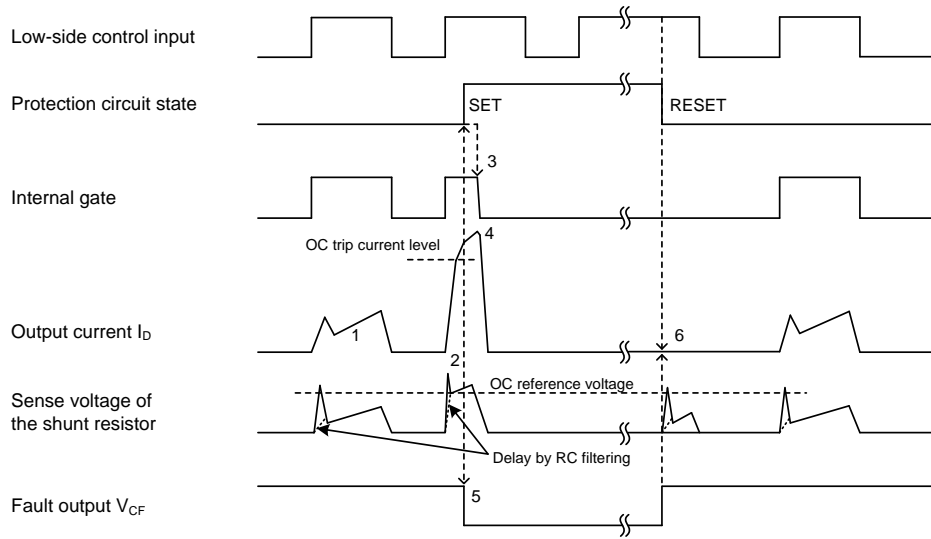
**Figure 3. V<sub>CF</sub> Output Circuit**

- (1) The V<sub>CF</sub> pin provides an enable functionality that allows it to shut down the all low-side MOSFETs. When the V<sub>CF</sub> pin is in the high state the IPM is able to operate normally. If the V<sub>CF</sub> pin is in a low state, the low-side MOSFETs are turned off until the enable condition is restored.
- (2) In addition, the V<sub>CF</sub> pin can provide the fixed or adjustable pulse width of fault output signal for the OC protection.
- (3) If the V<sub>CF</sub> 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 ;

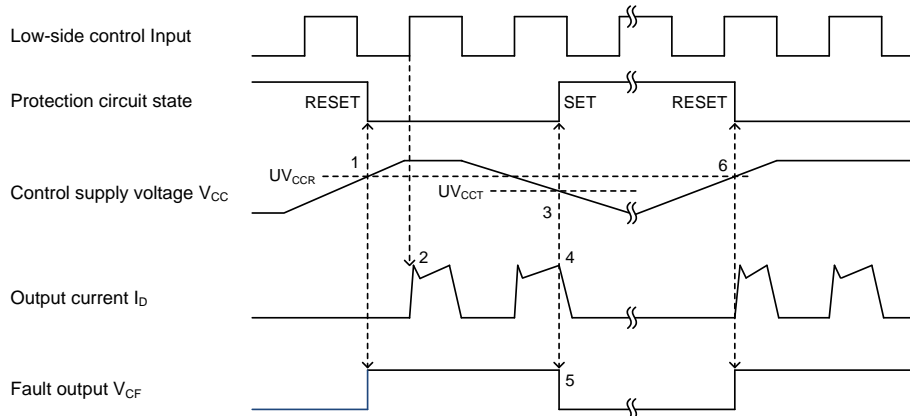
- $t_{FO} = -(1M\Omega \cdot C_{CF}) \cdot \ln(1 - V_{CF}/5V) + 100ns + 20us(\text{min.})$
- ex)  $C_{CF}=1nF$ ,  $t_{FO}=500us$ . Recommended parameters in the design are  $C_{CF}$  of  $\leq 1nF$ .

**Time Charts of the IPM Protective Function**



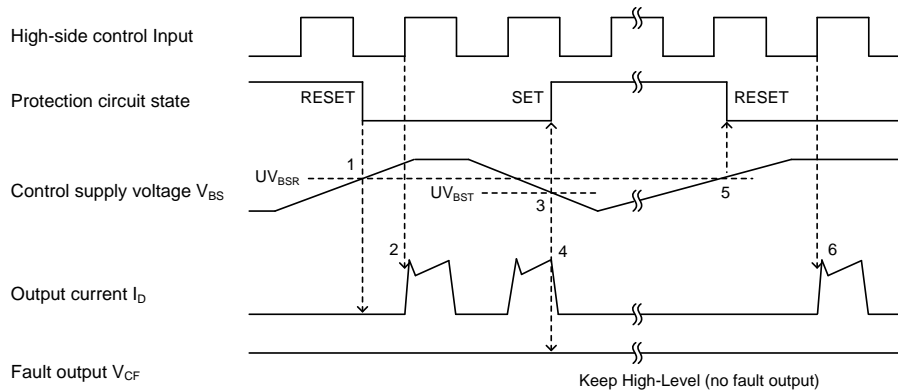
- (1) Normal operation: MOSFET turns on and output current.
- (2) Over-current detection (OCP triggered).
- (3) All low-side MOSFETs' gate are turned off.
- (4) Accordingly, all low-side MOSFETs are turned off.
- (5) Fault signal outputs.  $F_O$  duration time ( $t_{FO}$ ) is minimum 20 $\mu$ s.
- (6) Fault output finishes. Normal operation starts according to the input control signal..

**Figure 4. Over-Current Protection  
(Low-side Operation Only with External Shunt Resistor and RC Filter)**



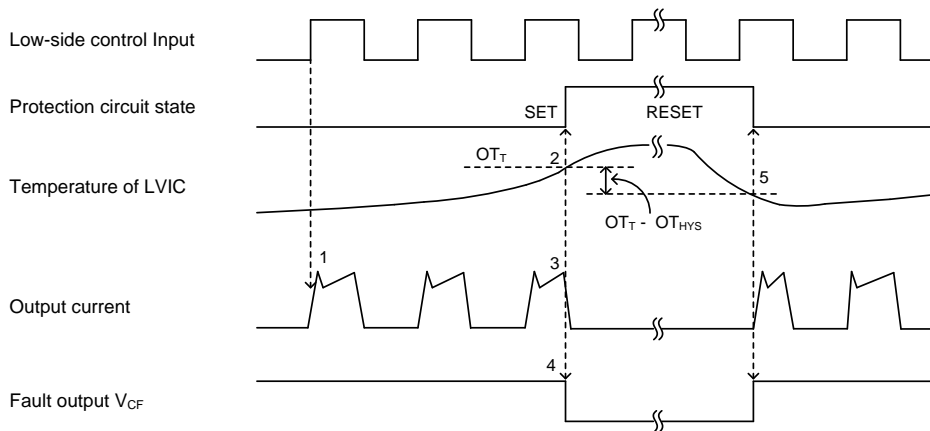
- (1) Supply voltage  $V_{CC}$  becomes higher than under-voltage reset level ( $UV_{CCR}$ ), and MOSFETs are turned on by the next ON signal.
- (2) Normal operation: MOSFETs turn-on and output current.
- (3)  $V_{CC}$  level drops to under-voltage trip level ( $UV_{CCT}$ ).
- (4) All low-side MOSFETs 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 control signal.

**Figure 5. Under-Voltage Protection (Low-side,  $UV_{CC}$ )**



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

**Figure 6. Under-Voltage Protection (High-side,  $UV_{BS}$ )**



- (1) Normal operation: MOSFETs turn on and output current.
- (2) LVIC temperature exceeds over-temperature trip level ( $OT_T$ ).
- (3) All low-side MOSFETs 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 control signal.

**Figure 7. Over-Temperature Protection (Low-side, Detecting LVIC Temperature)**

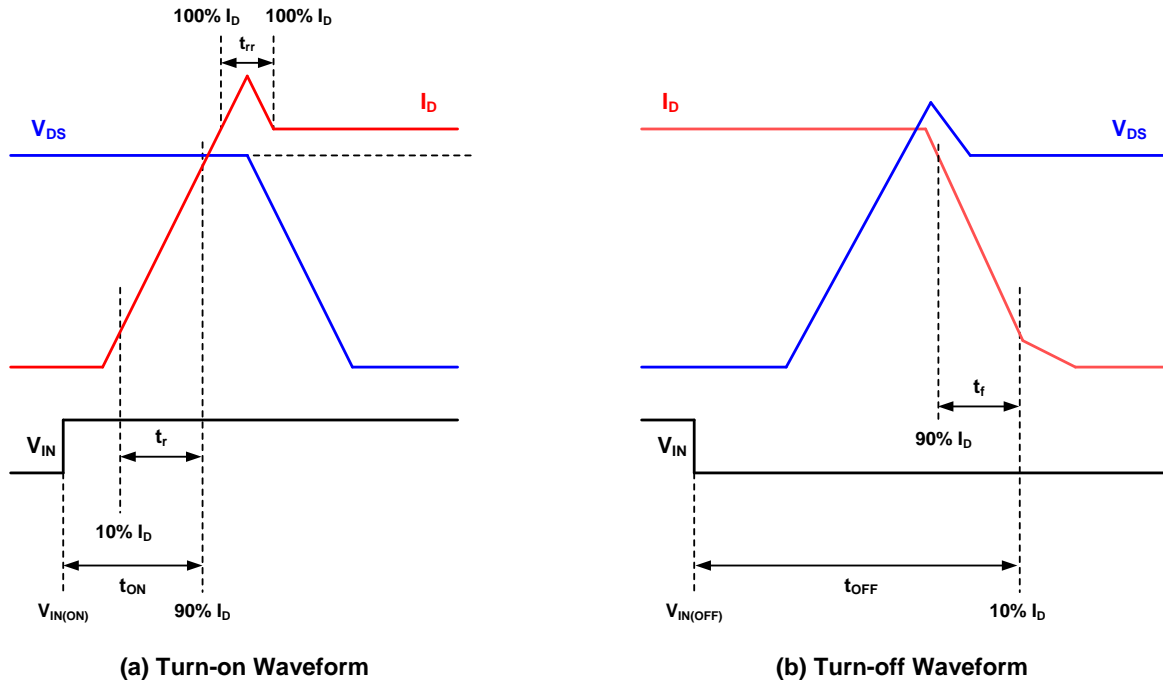
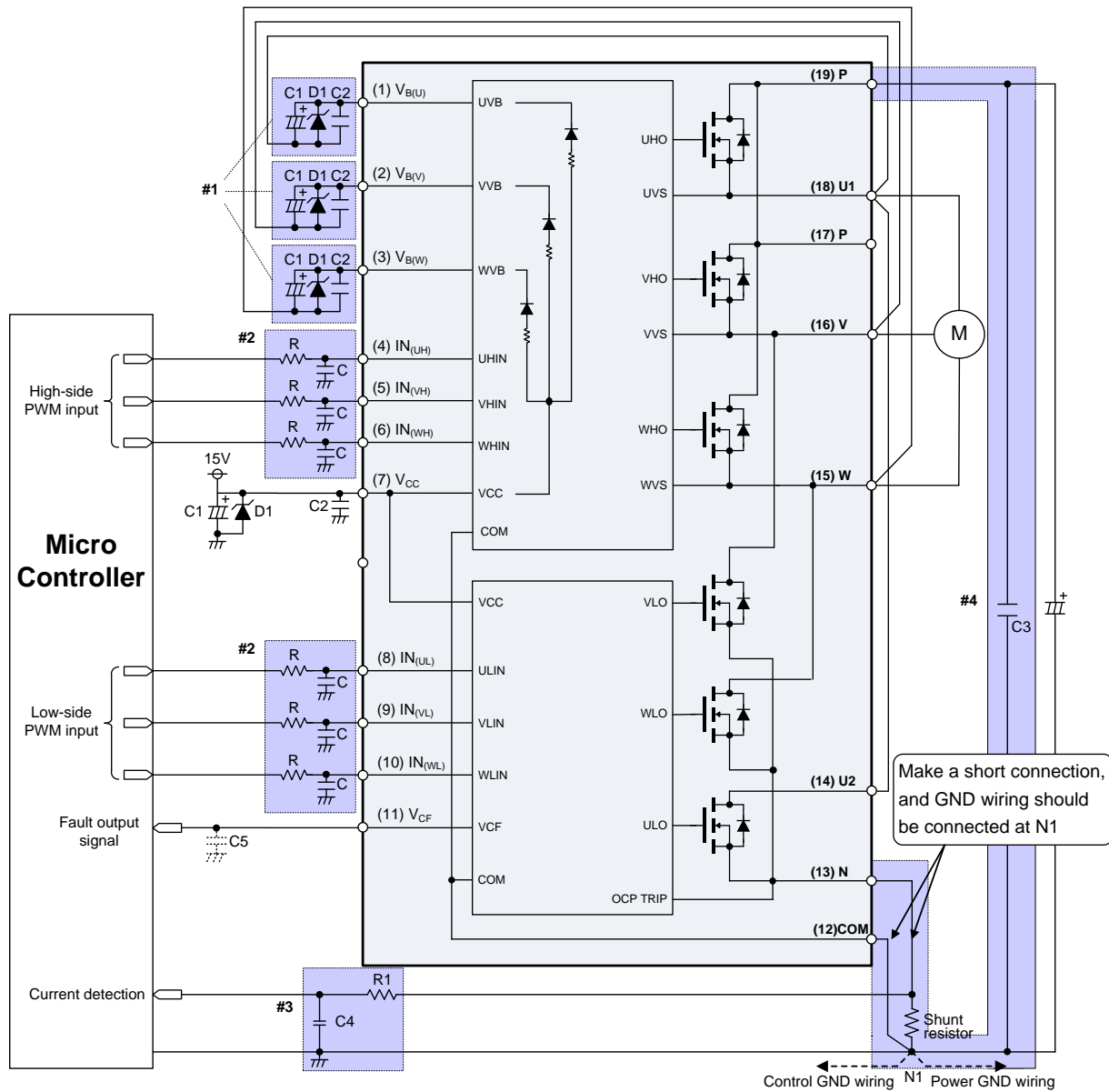


Figure 8. Switching Times Definition



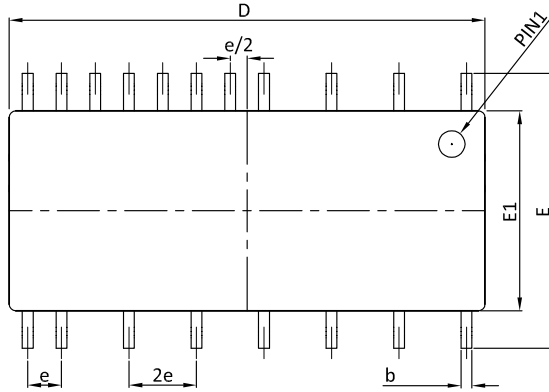
**Example of Application Circuit**



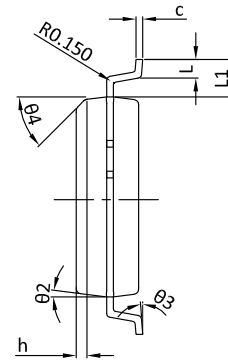
Recommended Component Values:	
(#1) C1:1~3.3μF, C2:100nF, D1:20V	(#2) R:100Ω, C:1nF
(#3) R1:1kΩ, C4:2nF	(#4) C3:0.1~0.22μF

- (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) When the current detection function is utilized by using the shunt resistor, the RC filter (R1 and C4) needs to be inserted to avoid the voltage spike noise in the current detection circuit. C4 should be placed as close to the controller as possible.
- (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<sub>CF</sub> pin can provide the fault output signal with the fixed or adjustable pulse width for the OC protection. If the V<sub>CF</sub> 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 3.

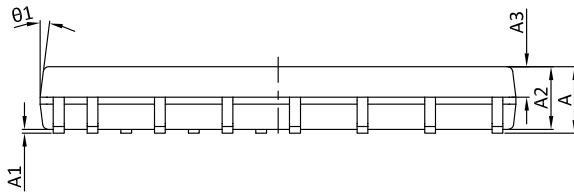
**Package Dimensions, IPM-7**



TOP VIEW

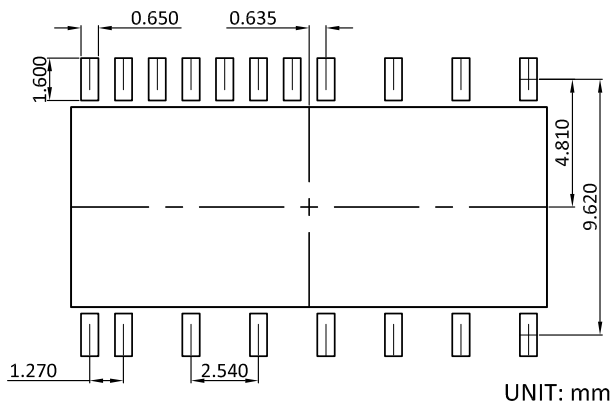


SIDE VIEW



SIDE 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	0.050	0.150	0.250	0.002	0.006	0.010
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
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
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
e	1.270TYP.			0.050TYP.		
b	0.410TYP.			0.016TYP.		
c	0.254TYP.			0.010TYP.		
$\theta_1$	7°TYP.			7°TYP.		
$\theta_2$	7°TYP.			7°TYP.		
$\theta_3$	0°	---	8°	0°	---	8°
$\theta_4$	45°TYP.			45°TYP.		
h	0.381TYP.			0.015TYP.		

**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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2. A critical component in any component of a life support, device, or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.