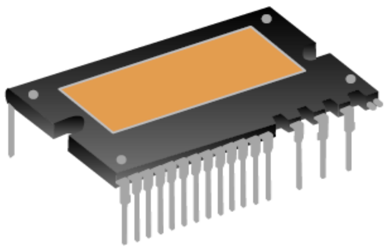
Description

CRM60GH20E4 are 3-phase Integrated Power Modules (IPM) designed for advanced appliance motor drive applications such as freezer compressor and pumps.

CRM60GH20E4 Integrated 6 low-loss IGBTs and FRDs, 3-phase full bridage drivers in a familiar package. The modules are optimized for low EMI characteristics.

Features

- 600V/20A three-phase inverter
- Works with 3.3V/5V MCU
- Integrated under-voltage protection
- High accurate over-current protection
- LVIC integrated >40μs fault duration time
- LVIC built-in temperature-sensing
- Integrated over temperature protection
- Integrated bootstrap functionality
- Isolation rating: 1500 Vrms/min



DIP-24B

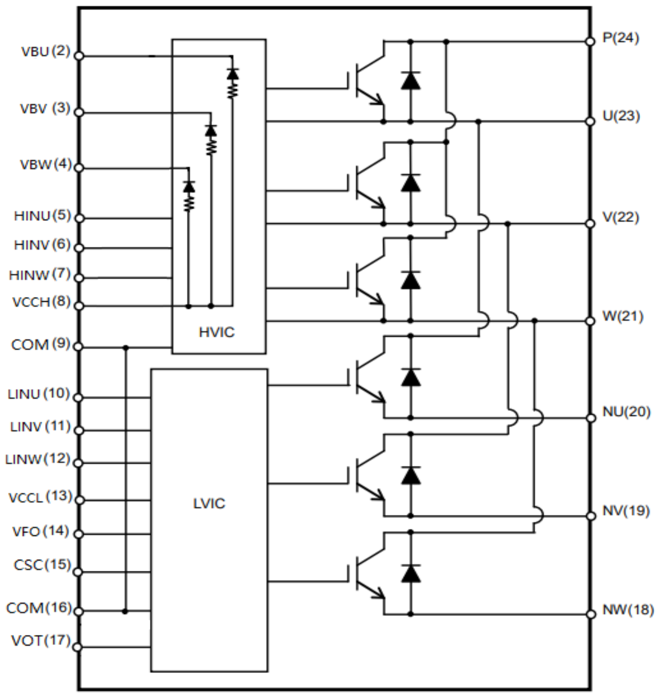
Applications

- Freezer compressor
- Air condition compressor
- Pumps

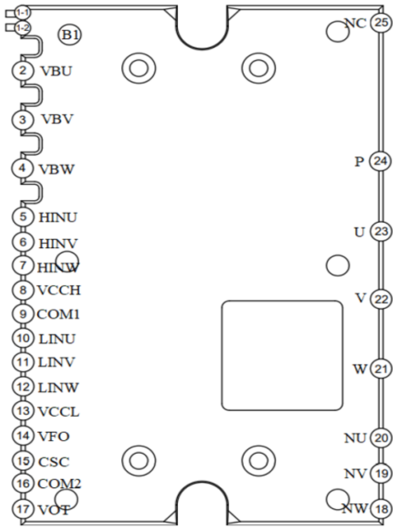
Package Marking and Ordering Information

Part #	Marking	Package	Packing	Quantity	V_{OT}
CRM60GH20E4	CRM60GH20E4	DIP-24B	Tube	360	Yes

Internal Electrical Schematic



Module Pin-Out Description



Bottom view

Pin Number	Pin Name	Description
2	VBU	High Side Floating Supply Voltage U
3	VBV	High Side Floating Supply Voltage V
4	VBW	High Side Floating Supply Voltage W
5	HINU	Logic Input for High Side Gate Driver - Phase U
6	HINV	Logic Input for High Side Gate Driver - Phase V
7	HINW	Logic Input for High Side Gate Driver - Phase W
8	VCCH	High side IC supply voltage
9	COM	Logic Ground
10	LINU	Logic Input for Low Side Gate Driver - Phase U
11	LINV	Logic Input for Low Side Gate Driver - Phase V
12	LINW	Logic Input for Low Side Gate Driver - Phase W
13	VCCL	Low side IC supply voltage
14	VFO	Fault output / Temperature monitor
15	CSC	External capacitance, Over current shutdown input
16	COM	Logic Ground
17	VOT	Output for Temperature Sensing
18	NW	Phase W Low Side Source
19	NV	Phase V Low Side Source
20	NU	Phase U Low Side Source
21	W	Output - Phase W, High Side Floating Supply Offset W
22	V	Output - Phase V, High Side Floating Supply Offset V
23	U	Output - Phase U, High Side Floating Supply Offset U
24	P	DC Bus Voltage Positive
25	NC	Not Connected

Absolute Maximum Ratings

Parameter	Symbol	Maximum	Unit
Inverter			
Supply Voltage between P-NU,NV,NW	V_{PN}	450	V
Supply Voltage(surge) between P-NU,NV,NW	$V_{PN(surge)}$	500	V
Collector-Emitter Voltage	V_{CES}	600	V
DC Output Current per IGBT, T_C=25°C, T_J≤150°C	I_C	20	A
Pulsed Output Current per IGBT, T_C=25°C, T_J≤150°C, less	I_{CP}	40	A
Maximum Power Dissipation per IGBT, T_C=25°C	P_D	78	W
Control (Protection)			
Control Supply Voltage	V_{CC}	20	V
High-side Bias Voltage	V_{BS}	20	V
Input Signal Voltage	V_{IN}	-0.5~Vcc+0.5	V
Fault Output Supply Voltage	V_{FO}	-0.5~Vcc+0.5	V
Fault Output Current sink current at VFO terminal	I_{FO}	1	mA
Current Sensing Input Voltage	V_{SC}	-0.5~Vcc+0.5	V
Total System			
Self Protection Supply Voltage Limit (Short Circuit Protection	$V_{PN(PROT)}$	400	V
Operating Junction Temperature	T_J	-40~150	°C
Module Case Operation Tempertature	T_C	-20~100	°C
Storage Temperature	T_{stg}	-40~125	°C
Junction to Case Thermal Resistance, one IGBT	$R_{th(j-c)Q}$	1.6	℃/W
Junction to Case Thermal Resistance, one FRD	$R_{th(j-c)F}$	2.1	℃/W
Isolation Voltage (1min)	V_{ISO}	1500	V_{rms}

Recommended Operating Conditions

(Tj = 25 °C, unless otherwise specified)

Parameter	Symbol	Value			Unit
		min.	typ.	max.	
P-N Supply Voltage	V_{PN}	-	300	450	V
Control Supply Voltage	V_{CC}	13.5	15	16.5	V
High-Side Bias Voltage	V_{BS}	13.5	15	18.5	V
Control Voltage Fluctuations	dV_{CC}/dtd V_{BS}/dt	-1	-	1	V/μs
Input ON Threshold Voltage	$V_{IN(ON)}$	2.5	-	VCC	V
Input OFF Threshold Voltage	$V_{IN(OFF)}$	0	-	0.8	V
Deadtime Inserted	t_{dead}	1	-	-	μs
Minimum Input Pluse Width	$P_{WIN(ON)}$ $P_{WIN(OFF)}$	0.7	-	-	μs
PWM Switching Frequency	f_{PWM}	-	-	20	kH_Z
COM voltage fluctuations (COM-NU,NV,NW)	V_{COM}	-5	-	5	V

Electrical Characteristic

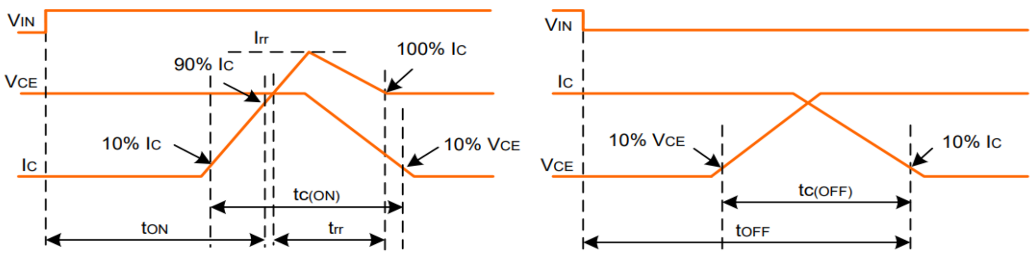
(Tj = 25 °C, unless otherwise specified)

Inverter Part

Parameter		Symbol	Value			Unit	Test Condition
			min.	typ.	max.		
Collector-Emitter Saturation Voltage		$V_{CE(SAT)}$	-	1.9	2.4	V	$V_{CC}=V_{BS}=15V, V_{IN}=5V, I_C=20A$
FRD Forward Voltage		V_{EC}	-	1.5	2.0	V	$V_{IN}=0V, I_F=20A$
Collector-Emitter Leakage Current		I_{CES}	-	-	1	mA	$V_{CE}=V_{CES}$
Switching Times (NOTE 1)	Hige side	t_{ON}	-	850	-	ns	$V_{PN}=400V$, $V_{CC}=V_{BS}=15V$, $I_C=20A$ $V_{IN}=0\sim5V$
		$t_{c(ON)}$	-	460	-	ns	
		t_{OFF}	-	660	-	ns	
		$t_{c(OFF)}$	-	100	-	ns	
		t_{rr}	-	100	-	ns	
	Low side	t_{ON}	-	900	-	ns	
		$t_{c(ON)}$	-	510	-	ns	
		t_{OFF}	-	790	-	ns	
		$t_{c(OFF)}$	-	140	-	ns	
		t_{rr}	-	120	-	ns	

NOTE 1: t_{ON} and t_{OFF} include the propagation delay time of the internal drive IC. Listed values are measured at the laboratory test condition, and they can be different according to the field applications due to the effect of different printed circuit boards and wirings. Please see Fig 3 for the switching time definition.

Switching Time Definition



(a)Turn-on (b)Turn-off

Control Part

Parameter		Symbol	Value			Unit	Test Condition	
			min.	typ.	max.			
Quiescent VCC Supply Current		I_{QCCN}	-	-	3.5	mA	V_{CC}=15V, V_{IN}=5V	VCCH-COM, VCCL-COM
		I_{QCCF}	-	-	3.5	mA	V_{CC}=15V, V_{IN}=0V	
Quiescent VBS Supply Current		I_{QBS}	-	-	150	μA	V_{BS}=15V, V_{INH}=0V	VBU-VSU, VBV-VSV, VBW-VSW
Fault Output Voltage		V_{FOH}	4.9	-	-	V	V_{SC}=0V, VFO Circuit: 10k Ω to 5V pull-up	
		V_{FOL}	-	-	0.95	V	V_{SC}=1V, I_{FO}=10mA	
Fault Output Pulse Width(2)		t_{FO}	40	-	-	μs	(Note2)	
Over-Current Trip Level(3)		$V_{CSC(ref)}$	0.455	0.48	0.505	V	VCC=15V, (Note3)	
Over Temperature Protection Trip Level		OT_t	100	120	140	°C	Trip Level	
Over Temperature Protection Reset Hysteresis		OT_{rh}	-	10	-	°C	Hysteresis of Trip-Reset	
Temperature Output		V_{OT}	0.88	1.13	1.39	V	T=25°C	
			2.63	2.77	2.91	V	T=90°C	
Supply Circuit Under-Voltage Protection	Low Side	U_{VCCT}	9.0	10.0	11.0	V	Trip Level	
		U_{VCCR}	10.0	11.0	12.0	V	Reset Level	
	High Side	U_{VBST}	9.0	10.0	11.0	V	Trip Level	
		U_{VBSR}	10.0	11.0	12.0	V	Reset Level	
ON Threshold Voltage		V_{IH}	-	2.2	2.6	V	HINU/HINV/HINW-COM	
OFF Threshold Voltage		V_{IL}	0.8	1.2	-	V	LINU/LINV/LINW-COM	

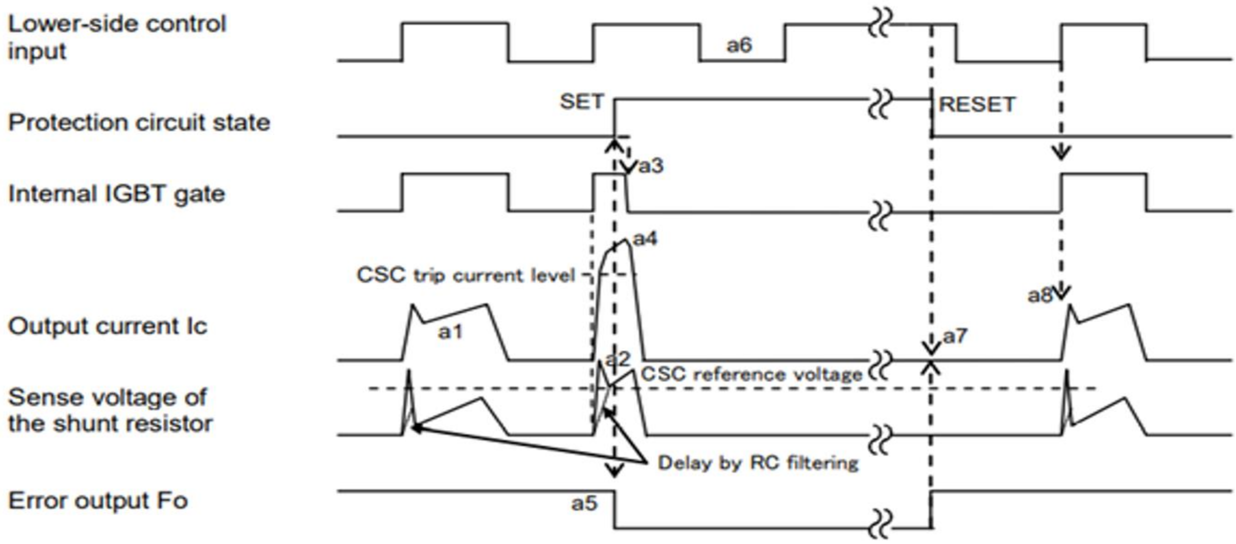
NOTE 2: Fault signal outputs when SC，UV or OT Trip Temperature level, VOT protection is triggered and fault outputs.

NOTE 3: Short-circuit protection works only for low sides.

Bootstrap Diode Part

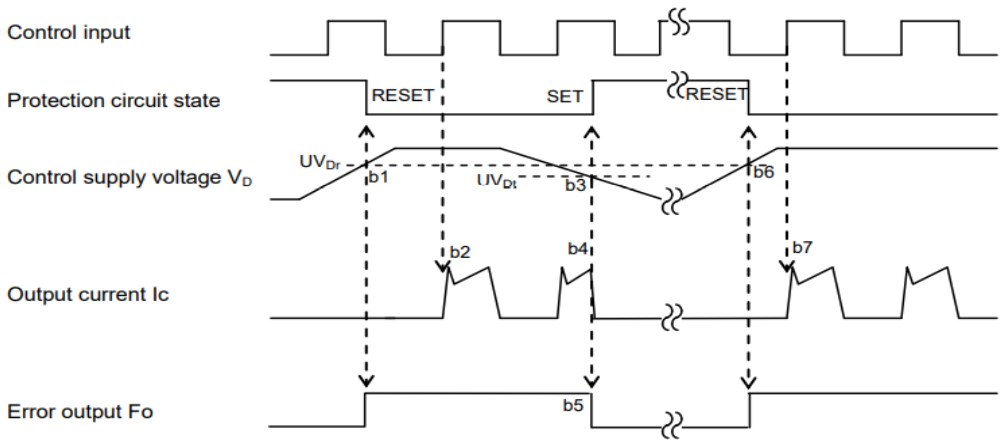
Parameter	Symbol	Value			Unit	Test Condition
		min.	typ.	max.		
Bootstrap Diode Forward Voltage	V_F	-	3	-	V	I_F = 10mA, T_C = 25°C
Bootstrap Diode Reverse Recovery Time	t_{rr}	-	80	-	ns	I_F = 10mA, T_C = 25°C
Bootstrap emulator on resistance	R_{BSD}	180	260	280	Ω	V_{CC} =15V, T_C = 25°C

Over Current Protection



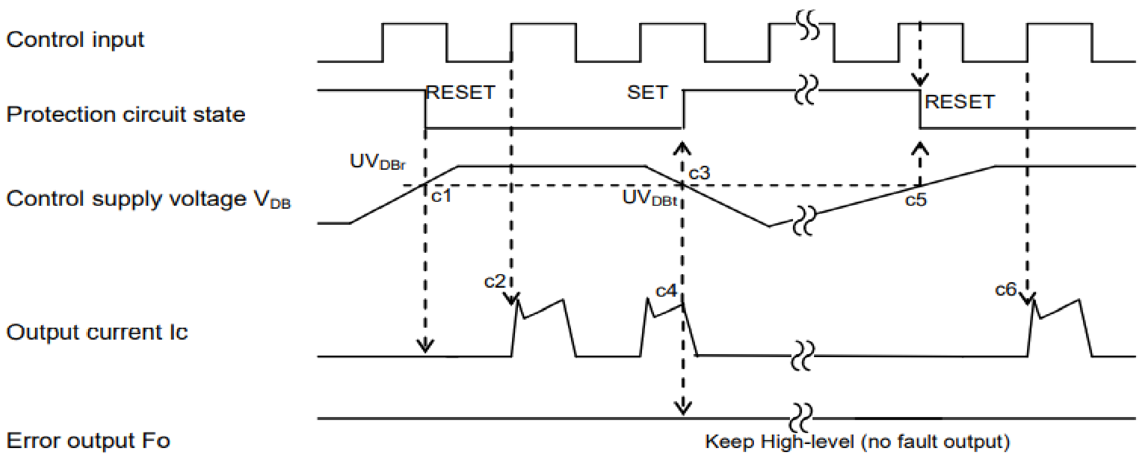
a1. Normal operation: IGBT ON and outputs current.
a2. Over current detection (CSC) (It is recommended to set RC time constant 1.5~2.0μs so that IGBT shut down within 2.0μs when over current.)
a3. All N-side IGBT's gates are hard interrupted.
a4. All N-side IGBTs turn OFF.
a5. FO outputs for tFo=minimum 40μs.
a6. Input = “L”: IGBT OFF
a7. Fo finishes output, but IGBTs don't turn on until inputting next ON signal (L→H). (IGBT of each phase can return to normal state by inputting ON signal to each phase.)
a8. Normal operation: IGBT ON and outputs current.

Under-Voltage Protection (Low-side, UV_D)



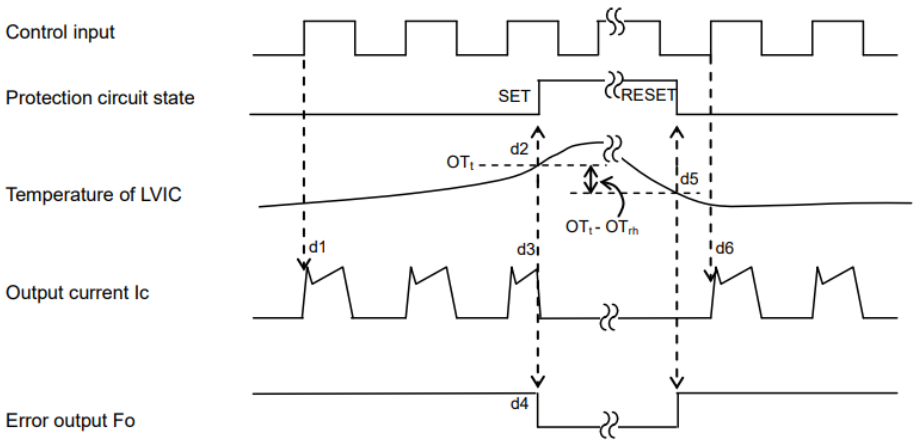
b1. Control supply voltage V_D exceeds under voltage reset level (UV_{Dr}), but IGBT turns ON by next ON signal (L→H).
(IGBT of each phase can return to normal state by inputting ON signal to each phase.)
b2. Normal operation: IGBT ON and outputs current.
b3. V_D level drops to under voltage trip level. (UV_{Dt}).
b4. All N-side IGBTs turn OFF in spite of control input condition.
b5. Fo outputs for tFo=minimum 40μs, but output is extended during V_D keeps below UV_{Dr}. b6. V_D level reaches UV_{Dr}.
b7. Normal operation: IGBT ON and outputs current.

Under-Voltage Protection (High-side, UV_{DB})



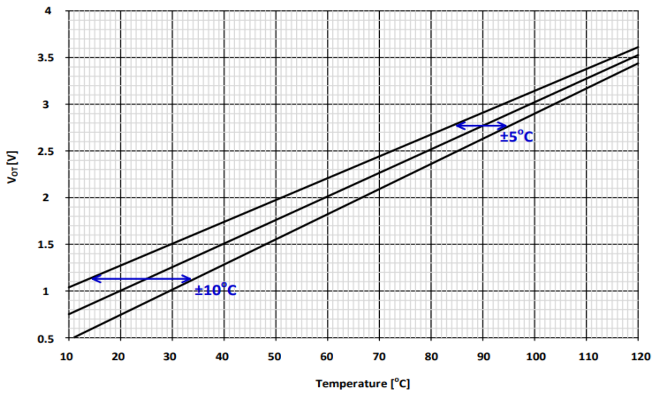
c1. Control supply voltage V_{DB} rises. After the voltage reaches under voltage reset level UV_{DBr}, IGBT turns on by next ON signal (L→H).
c2. Normal operation: IGBT ON and outputs current.
c3. V_{DB} level drops to under voltage trip level (UV_{DBt}).
c4. IGBT of the correspond phase only turns OFF in spite of control input signal level, but there is no FO signal output.
c5. V_{DB} level reaches UV_{DBr}.
c6. Normal operation: IGBT ON and outputs current.

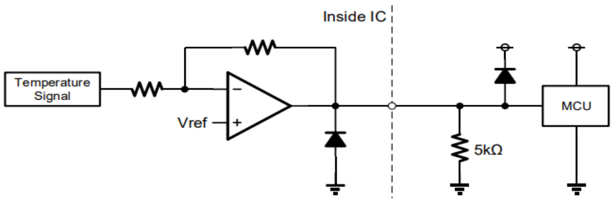
Over Temperature Protection (Low-side, Detecting LVIC temperature)



d1. Normal operation: IGBT ON and outputs current.
d2. LVIC temperature exceeds over temperature trip level(OT_t).
d3. All Low-side IGBTs turn OFF in spite of control input condition.
d4. Fo outputs for t_{Fo}=minimum 40μs, but output is extended during LVIC temperature keeps over OT_t.
d5. LVIC temperature drops to over temperature reset level.
d6. Normal operation: IGBT turns on by next ON signal (L→H).
(IGBT of each phase can return to normal state by inputting ON signal to each phase.)

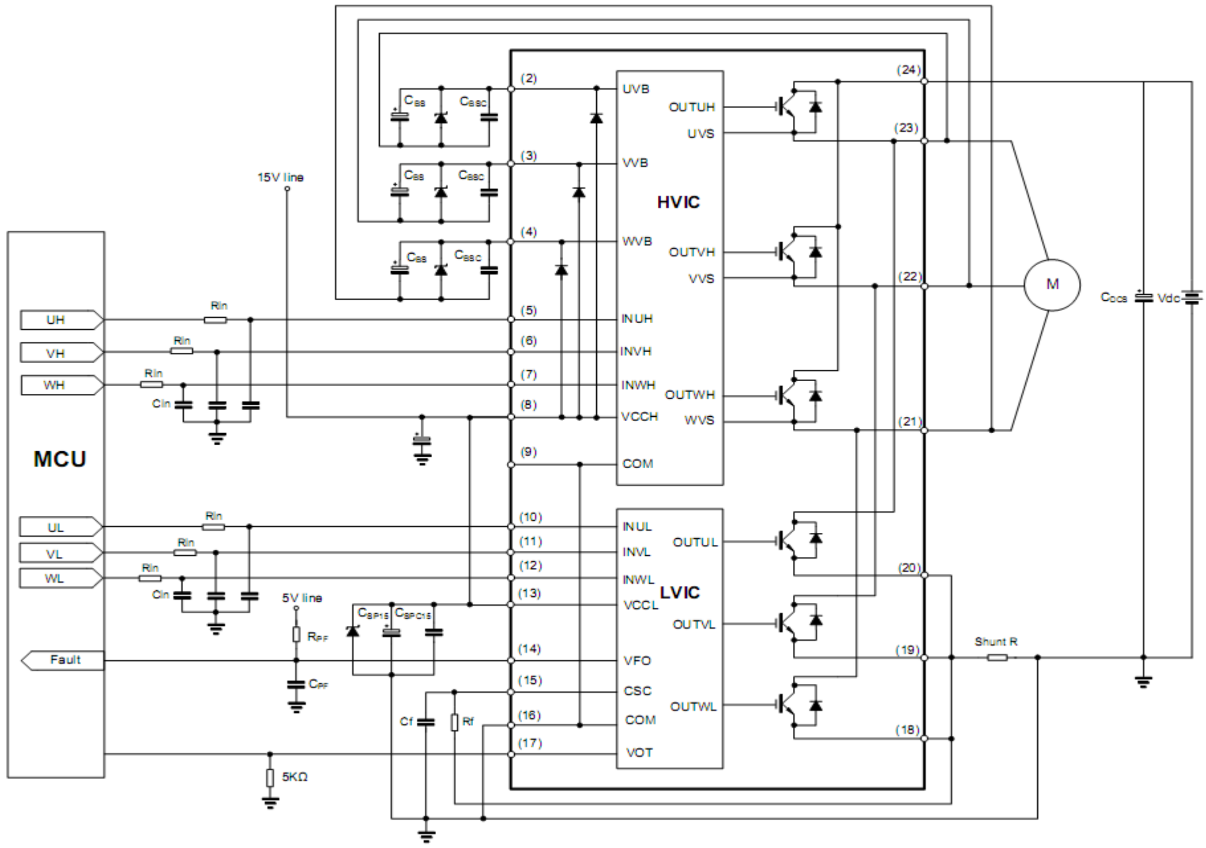
Temperature of HVIC vs. VOT output characteristics





1、 Connect 5kΩ to VOT pin if temperature monitoring function is used, and then the internal OTP function is omitted.Leave the VOT pin open (no connect) if internal over-temperature shutdown function is used. However, the VOT is also operated, but with inferior accuracy.
2、 In the case of using VOT with low voltage controller like 3.3V MCU, VOT output might exceed control supply voltage 3.3V when temperature rises excessively. If system uses low voltage controller, it is recommended to insert a clamp diode between control supply of the controller and VOT output for preventing over voltage destruction.

Application Circuit

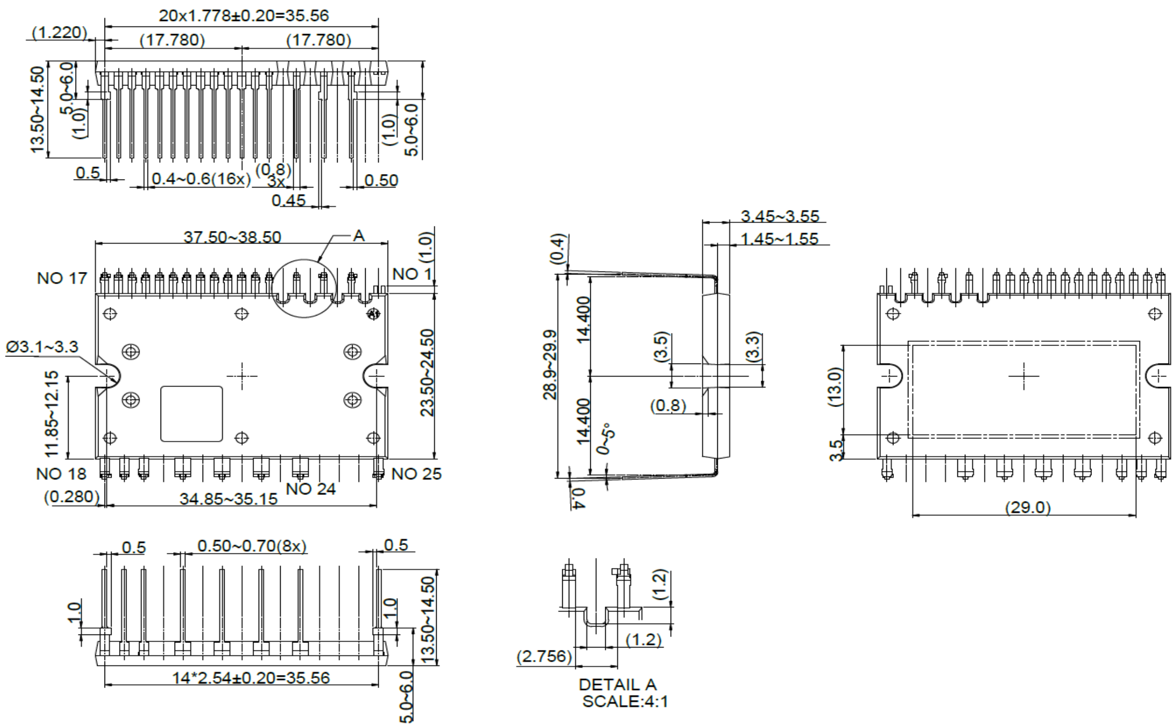


Remark:

1、To prevent malfunction, the wiring of each input should be as short as possible.
2、 Input drive is High-Active type.There is a 5kΩ（typ.）pull-down resistor integrated in the IC input circuit.And adding RC filter circuit to the input will prevent the surge noise caused by incorrect input.
3、To prevent surge damage, it is recommended to add a high-frequency non-inductive flat capacitor (0.1uF to 0.22uF)between P and N. The cable connection of the capacitor should be as short as possible.
4、The line between the current detection resistor and the IPM should be as short as possible, otherwise the large surge voltage generated by the connecting inductor may cause damage.
5、All capacitors should be mounted as close to the terminals of the IPM as possible.
6、FO output is open drain type.It should be pulled up to the positive side of 5V power supply by a resistor of about 10kΩ.
7、The time constant Rf and Cf of the protection circuit should be selected in the range of 1.5-2.0 μs.

Package Outline

DIP-24B **UNIT:mm**



Revision History

Revison	Date	Major changes
1.0	2022/5/6	Release of formal version
1.1	2023/2/3	Delete Bootstrap Diode Part

Disclaimer

Unless otherwise specified in the datasheet, the product is designed and qulified as a standard commercial product and is not intended for use in applications that require extraordinary levels of quality and reliability, such as automotive, aviation/aerospace and life-support devices or systems.

Any and all semicondutor products have certain probability to fail or malfunction, which may result in personal injury, death or property damage. Customer are solely responsible for providing adequate safe measures when design their systems.

CRM(CQ) reserves the right to improve product design, function and reliability without notice.