MITSUBISHI ELECTRIC

<HVIC>

M81738FP

1200V HIGH VOLTAGE HALF BRIDGE DRIVER

DESCRIPTION

M81738FP is high voltage Power MOSFET and IGBT gate driver for half bridge applications.

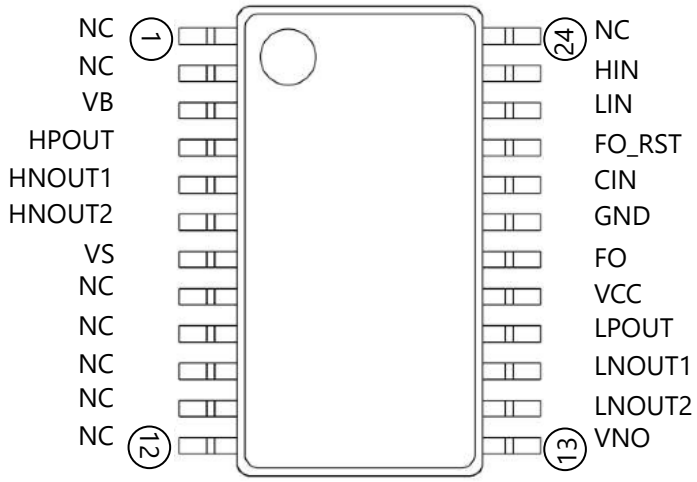
FEATURES

- ●Floating supply voltage up to 1200V
- ●Low quiescent power supply current
- ●Separate sink and source current output up to ±1A (typ)
- ●Active Miller effect clamp NMOS with sink current up to 1A (typ)
- ●Input noise filters (HIN,LIN,FO_RST,FO)
- ●Over-current detection and output shutdown
- ●High side under voltage lockout
- ●FO pin which can input and output Fault signals to communicate with controllers and synchronize the shut down with other phases
- ●Active clamp (power supply surge clamp)
- ●24-Lead SSOP PACKAGE

APPLICATIONS

Power MOSFET and IGBT gate driver for Medium and Micro inverter or general purpose.

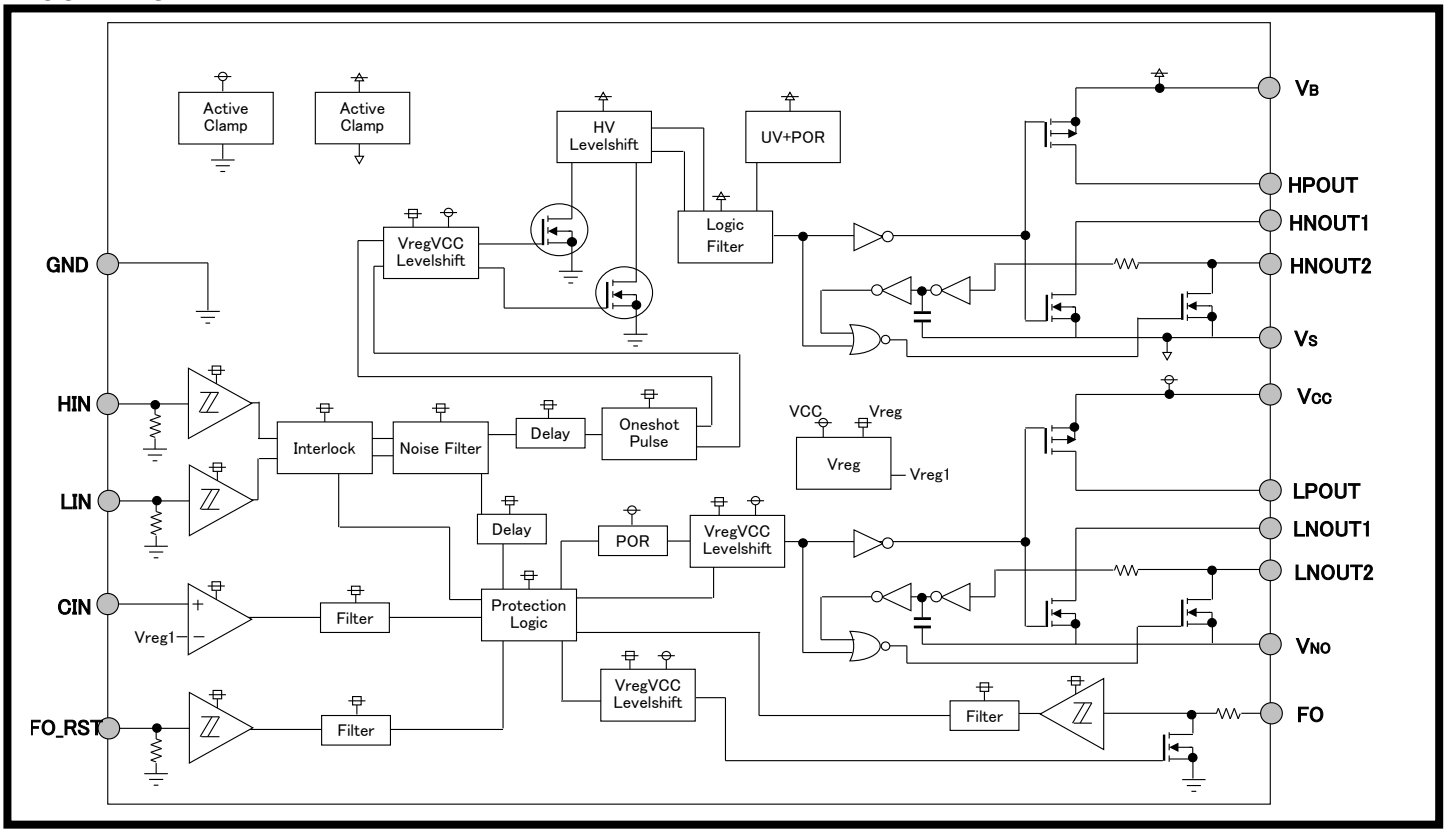
PIN CONFIGURATION (TOP VIEW)



Outline:SSOP24

NC:NO CONNECTION

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

Absolute maximum ratings indicate limitation beyond which destruction of device may occur. All voltage parameters are absolute voltage reference to GND unless otherwise specified.

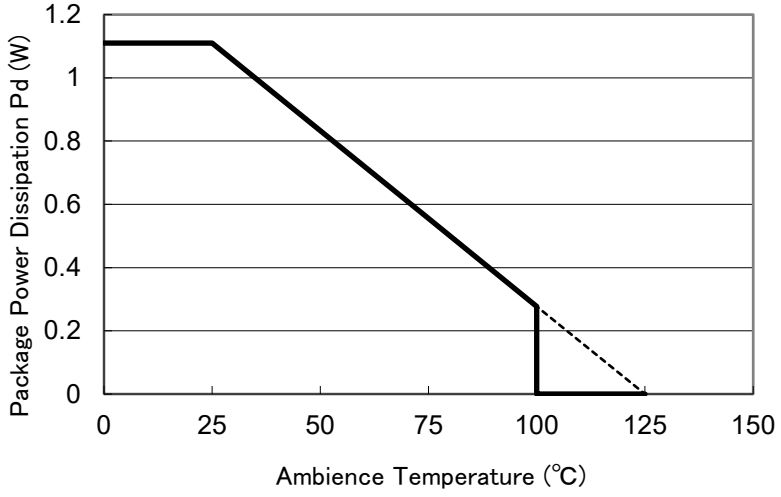
Symbol	Parameter	Test conditions	Ratings	Unit
V_B	High side floating supply absolute voltage		-0.5 ~ 1224	V
V_S	High side floating supply offset voltage		V_B -24 ~ V_B +0.5	V
V_{BS}	High side floating supply voltage	$V_{BS}=V_B-V_S$	-0.5 ~ 24	V
V_{HO}	High side output voltage		V_S -0.5 ~ V_B +0.5	V
V_{CC}	Low side fixed supply voltage		-0.5 ~ 24	V
V_{NO}	Power ground		V_{CC} -24 ~ V_{CC} +0.5	V
V_{LO}	Low side output voltage		V_{NO} -0.5 ~ V_{CC} +0.5	V
V_{IN}	Logic input voltage	HIN, LIN, FO_RST	-0.5 ~ V_{CC} +0.5	V
V_{FO}	FO input/output voltage		-0.5 ~ V_{CC} +0.5	V
V_{CIN}	CIN input voltage		-0.5 ~ V_{CC} +0.5	V
dV_S/dt	Allowable offset voltage slew rate	V_S -GND	±50	V/ns
Pd	Package power dissipation	Ta= 25°C ,On our standard PCB	~ 1.11	W
Kq	Linear derating factor	Ta≧25°C ,On our standard PCB	~ 11.1	mW/°C
Rth(j-a)	Junction-ambient air thermal resistance	On our standard PCB	~ 90	°C/W
Tj	Junction temperature		-40 ~ 125	℃
Topr	Operation temperature		-40 ~ 100	℃
Tstg	Storage temperature	On PCB	-40 ~ 150	℃
TL	Solder reflow condition	Pb-free	255:10s, max260	℃

RECOMMENDED OPERATING CONDITIONS

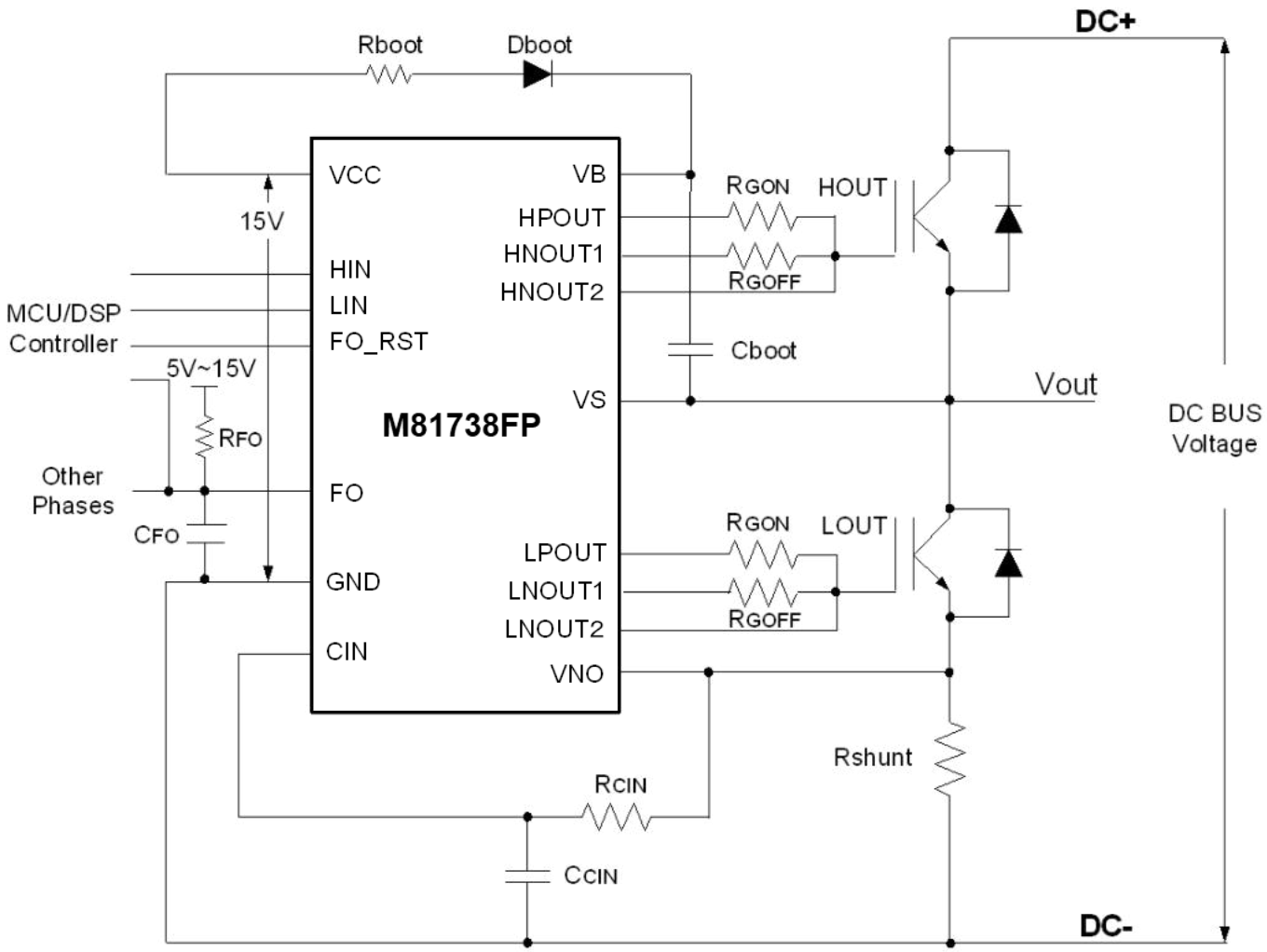
For proper operation the device should be used within the recommended conditions. All voltage parameters are absolute voltages referenced to GND unless otherwise specified.

Symbol	Parameter	Test conditions	Limits			Unit
			Min.	Typ.	Max.	
V_B	High side floating supply absolute voltage		V_S+13.5	V_S+15	V_S+20	V
V_S	High side floating supply offset voltage	V_{BS}> 13.5V	-5	-	900	V
V_{BS}	High side floating supply voltage	$V_{BS}=V_B-V_S$	13.5	15	20	V
V_{HO}	High side output voltage		V_S	-	V_S+20	V
V_{CC}	Low side fixed supply voltage		13.5	15	20	V
V_{NO}	Power ground		-0.5	-	5	V
V_{LO}	Low side output voltage		V_{NO}	-	V_{CC}	V
V_{IN}	Logic input voltage	HIN, LIN, FO_RST	0	-	V_{CC}	V
V_{FO}	FO input/output voltage		0	-	V_{CC}	V
V_{CIN}	CIN input voltage		0	-	5	V

THERMAL DERATING FACTOR CHARACTERISTIC (MAXIMUM RATING)



TYPICAL CONNECTION



Note: If HVIC is working in high noise environment, it is recommended to connect a 1nF ceramic capacitor (CFO) to FO pin.

ELECTRICAL CHARACTERISTICS (Ta=25℃, VCC=VBS (=VB–VS)=15V, unless otherwise specified)

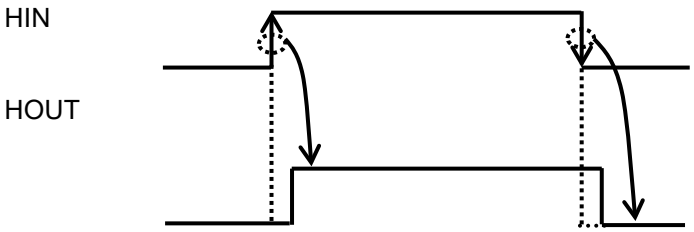
Symbol	Parameter	Test conditions	Limits			Unit
			Min.	Typ.	Max.	
I_{FS}	High side leakage current	V_B = V_S = 1200V	-	-	10	uA
I_{BS}	V_{BS} quiescent supply current	HIN = LIN = 0V	-	0.5	0.8	mA
I_{CC}	V_{CC} quiescent supply current	HIN = LIN = 0V	-	1.0	1.5	mA
V_{OH}	High level output voltage	I_O = 0A, HPOUT, LPOUT	14.5	-	-	V
V_{OL}	Low level output voltage	I_O = 0A, HNOUT1, LNOUT1	-	-	0.5	V
V_{IH}	High level input threshold voltage	HIN, LIN, FO_RST	2.2	3.0	4.0	V
V_{IL}	Low level input threshold voltage	HIN, LIN, FO_RST	0.6	1.5	2.1	V
I_{IH}	High level input bias current	V_{IN} = 5V	0.6	1.0	1.4	mA
I_{IL}	Low level input bias current	V_{IN} = 0V	0.00	0.00	0.01	mA
tFilter	Input signals filter time	HIN on-pulse	80	200	500	ns
		HIN off-pulse	80	200	500	ns
		LIN on-pulse	80	200	500	ns
		LIN off-pulse	80	200	500	ns
		FO_RST on-pulse	80	200	500	ns
		FO off-pulse	80	200	500	ns
V_{HNO2}	High side active Miller clamp NMOS input threshold voltage	V_{IN} = 0V	2.0	3.4	5.0	V
V_{LNO2}	Low side active Miller clamp NMOS input threshold voltage	V_{IN} = 0V	6.0	7.6	9.0	V
tV_{NO2}	Active Miller clamp NMOS filter time	V_{IN} = 0V	-	400	-	ns
V_{OLFO}	Low level FO output voltage	I_{FO} = 1mA	-	-	0.95	V
V_{IHFO}	High level FO input threshold voltage		2.2	3.0	4.0	V
V_{ILFO}	Low level FO input threshold voltage		0.6	1.5	2.1	V
V_{BSuvr}	V_{BS} supply UV reset voltage		10.5	11.3	12.1	V
V_{BSuvt}	V_{BS} supply UV trip voltage		10.0	10.8	11.6	V
V_{BSuvh}	V_{BS} supply UV hysteresis voltage	V_{BSuvh} = V_{BSuvr}-V_{BSuvt}	0.2	0.5	0.8	V
tV_{BSuv}	V_{BS} supply UV filter time		4	8	16	us
V_{CIN}	CIN trip voltage		0.40	0.50	0.60	V
V_{POR}	POR trip voltage		4.0	5.5	7.5	V
I_{OH}	Output high level short circuit pulsed current	HPOUT(LPOUT) = 0V, V_{IN} = 5V, PW ≦ 10us	-	1	-	A
I_{OL1}	Output low level short circuit pulsed current	HNOUT1(LNOUT1) = 15V, V_{IN} = 0V, PW ≦ 10us	-	-1	-	A
I_{OL2}	Active Miller clamp NMOS output low level short circuit pulsed current	HNOUT2(LNOUT2) = 15V, V_{IN} = 0V, PW ≦ 10us	-	-1	-	A
R_{OH}	Output high level on resistance	I_O = 1A, R_{OH} = (V_{OH}-V_O)/I_O	-	15	-	Ω
R_{OL1}	Output low level on resistance	I_O = -1A, R_{OL1} = V_O/I_O	-	15	-	Ω
R_{OL2}	Active Miller clamp NMOS output low level on resistance	I_O = -1A, R_{OL2} = V_O/I_O	-	15	-	Ω
tdLH(HO)	High side turn-on propagation delay	HPOUT short to HNOUT1 and HNOUT2, CL = 1nF	1.00	1.27	1.62	us
tdHL(HO)	High side turn-off propagation delay	HPOUT short to HNOUT1 and HNOUT2, CL = 1nF	0.90	1.21	1.47	us
tdLH(LO)	Low side turn-on propagation delay	LPOUT short to LNOUT1 and LNOUT2, CL = 1nF	1.00	1.39	1.90	us
tdHL(LO)	Low side turn-off propagation delay	LPOUT short to LNOUT1 and LNOUT2, CL = 1nF	0.90	1.19	1.70	us
tr	Output turn-on rise time	CL = 1nF	10	40	80	ns
tf	Output turn-off fall time	CL = 1nF	10	40	80	ns
DtdLH	Delay matching, high side turn-on and low side turn-off	tdLH(HO)-tdHL(LO)	-100	80	300	ns
DtdHL	Delay matching, high side turn-off and low side turn-on	tdLH(LO)-tdHL(HO)	-20	180	400	ns
V_{clamp}	Active clamp voltage	V_{cc} – GND, V_B - V_S	24	-	-	V

Note: Typ is not specified

FUNCTION TABLE (Q: Keep previous status)

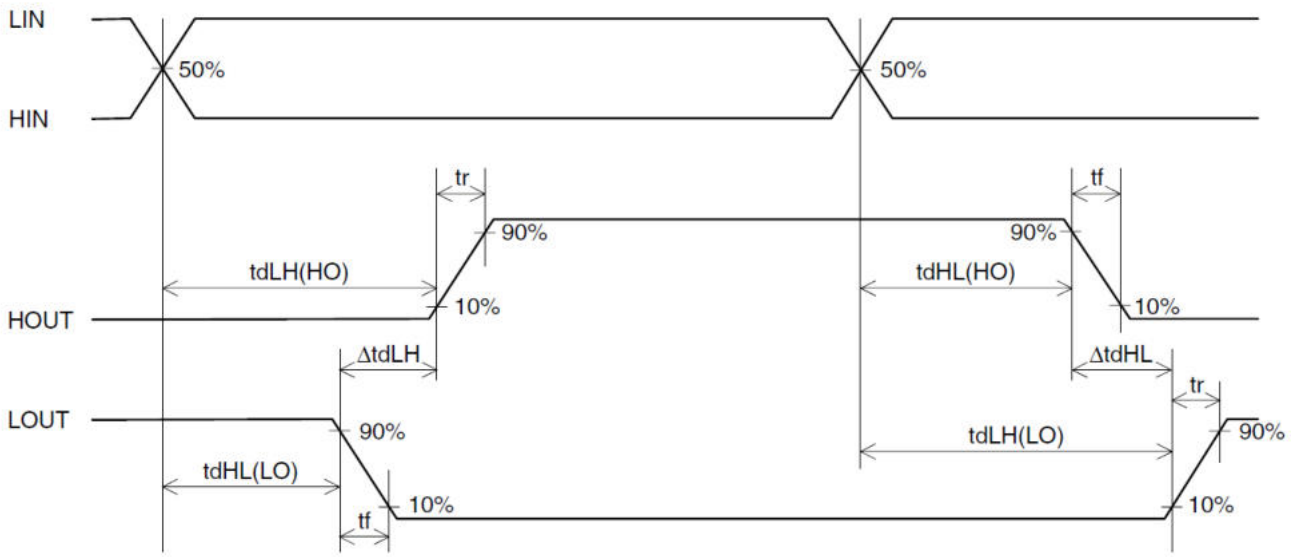
HIN	LIN	FO_RST	CIN	FO (Input)	V_{BS}/ UV・POR	V_{CC}/ POR	HOUT	LOUT	FO (Output)	Behavioral status
L	L	L	L	-	H	H	L	L	H	
L	H	L	L	-	H	H	L	H	H	
H	L	L	L	-	H	H	H	L	H	
H	H	L	L	-	H	H	Q	Q	H	Interlock active
X	H	X	H	-	X	H	L	L	L	CIN tripping when LIN = H
X	L	X	H	-	X	H	Q	Q	H	CIN not tripping when LIN = L
X	X	X	X	L	X	H	L	L	-	Output shuts down when FO = L
X	X	X	X	-	X	L	L	L	H	V_{CC} power reset
X	L	L	L	-	L	H	L	L	H	V_{BS} power reset
X	H	L	L	-	L	H	L	H	H	V_{BS} power reset is tripping when LIN = H

Note1 : “L” status of VBS/UV indicates a high side UV condition; “L” status of VCC/POR indicates a VCC power reset condition.
Note2 : In the case of both input signals (HIN and LIN) are “H”, output signals (HOUT and LOUT) keep previous status.
Note3 : X (HIN) : L→H or H→L. Other : H or L.
Note4 : Output signal (HOUT) is triggered by the edge of input signal.



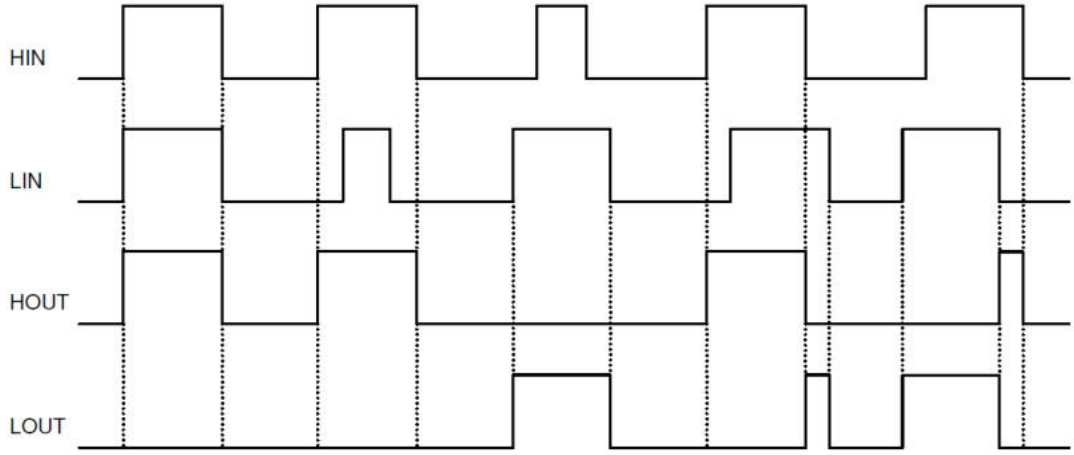
FUNCTIONAL DESCRIPTION

1. INPUT/OUTPUT TIMING DIAGRAM



2. INPUT/OUTPUT TIMING DIAGRAM

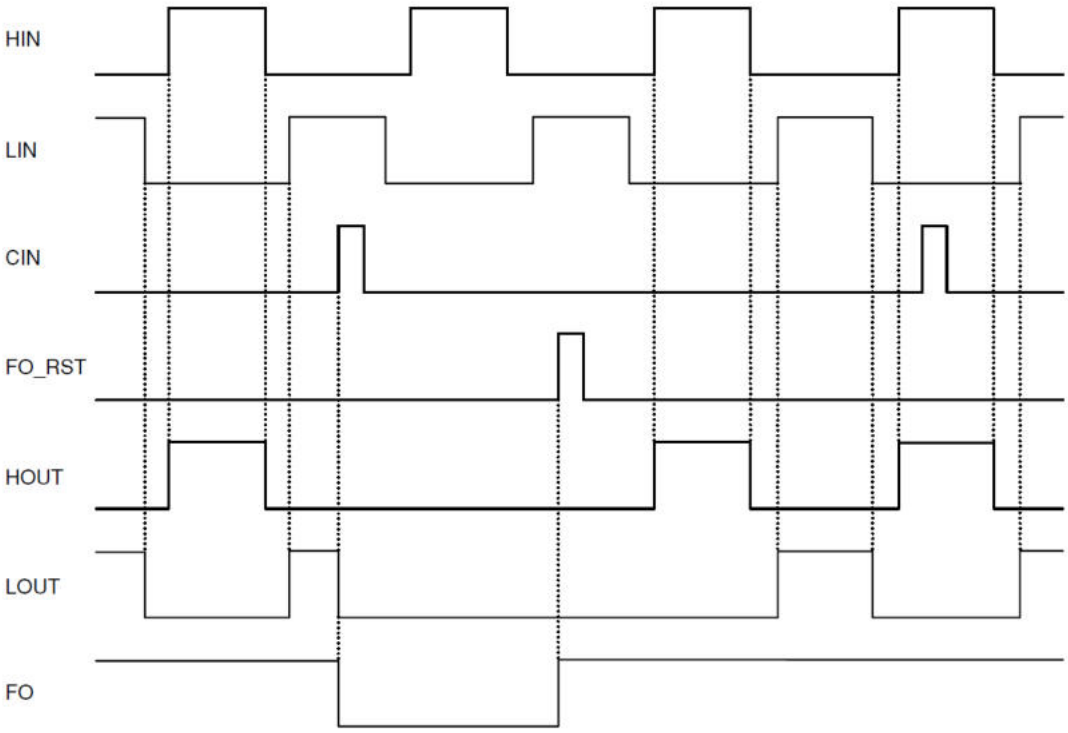
When the input signals (HIN/LIN) are high level at the same time, the outputs (HOUT/LOUT) keep their previous status.
But if signals (HIN/LIN) are going to high level simultaneously, HIN signals will get active and cause HOUT to enter “H” status.



Note1 : The minimum input pulse width at HIN/LIN should be to more than 500ns (because of HIN/LIN input noise filter circuit).
Note2 : If a high-high status of input signals (HIN/LIN) is ended with only one input signal entering low level and another still being in high level, the output will enter high-low status after the delay match time (not shown in the figure above).
Note3 : Delay times between input and output signals are not shown in the figure above.

3. SHORT CIRCUIT PROTECTION TIMING DIAGRAM

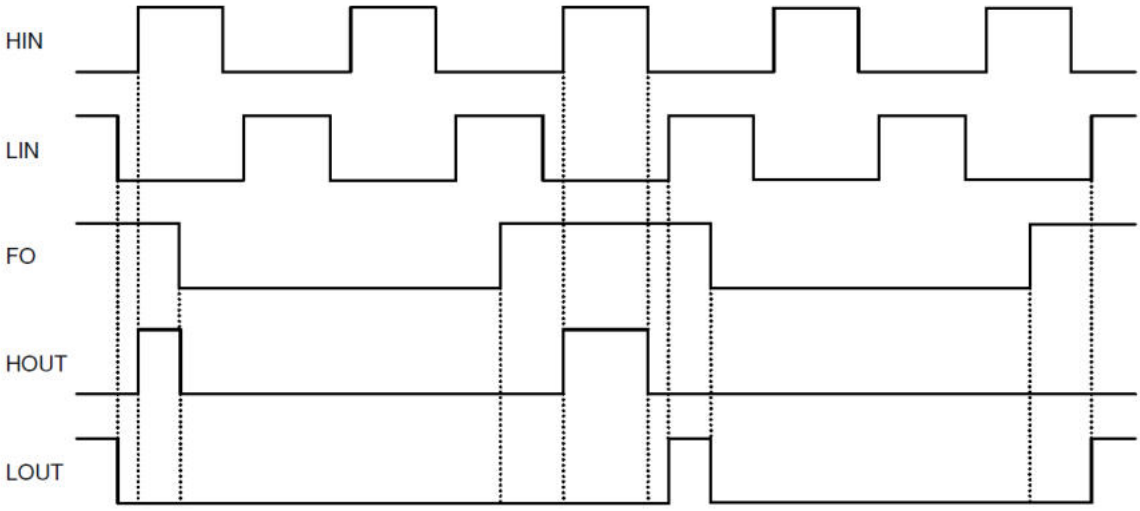
When an over-current is detected by exceeding the threshold at the CIN and LIN is at high level at the same time, the short circuit protection will get active and shutdown the outputs while FO will issue a low level (indicating a fault signal).
The fault output latch is reset by a high level signal at FO_RST pin and then FO will return to high level while the output of the driver will respond to the following active input signal.



Note1 : Delay times between input and output signals are not shown in the figure above.
Note2 : The minimum FO_RST pulse width should be more than 500ns (because of FO_RST input filter circuit).

4. FO INPUT TIMING DIAGRAM

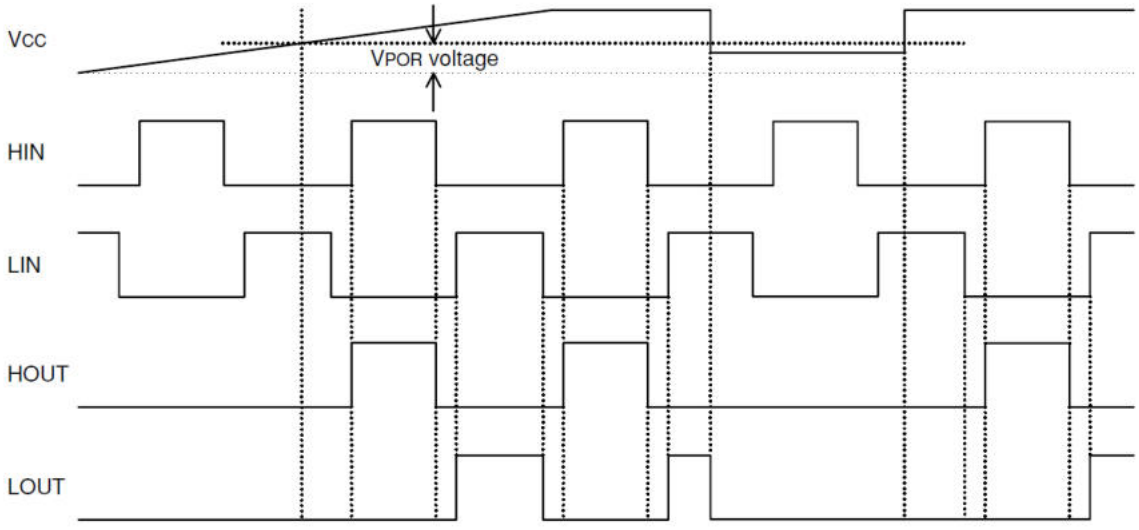
When FO is pulled down to low level in case the FO of other phases becomes low level (fault happened) or the MCU/DSP sets FO to low level, the outputs (HOUT, LOUT) of the driver will be shut down. As soon as FO goes high again, the output will respond to the following active input signal.



Note1 : Delay times between input and output signals are not shown in the figure above.
Note2 : The minimum FO pulse width should be more than 500ns (because of FO input filter circuit).

5. LOW SIDE VCC SUPPLY POWER RESET SEQUENCE

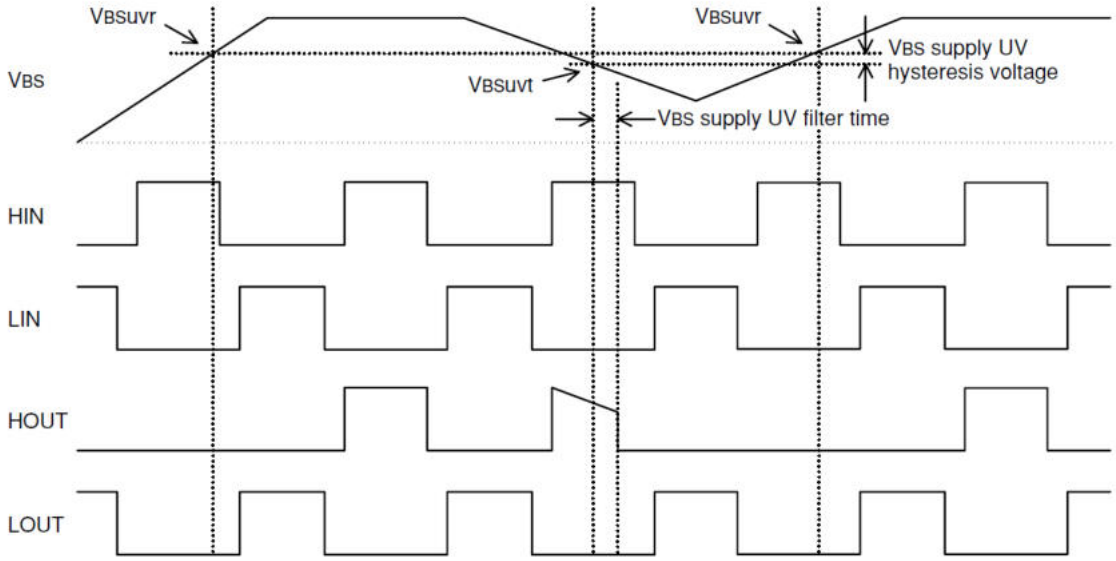
When the VCC supply voltage is lower than power reset trip voltage, the power reset gets active and the outputs (HOUT/LOUT) become “L”. As soon as the VCC supply voltage goes higher than the power reset trip voltage, the outputs will respond to the following active input signals.



Note1 : Delay times between input and output signals are not shown in the figure above

6. HIGH SIDE VBS SUPPLY UNDER VOLTAGE LOCKOUT SEQUENCE

When VBS supply voltage drops below the VBS supply UV trip voltage and the duration in this status exceeds the VBS supply UV filter time, the output of the high side is locked. As soon as the VBS supply voltage rises above the VBS supply UV reset voltage, the output will respond to the following active HIN signal.

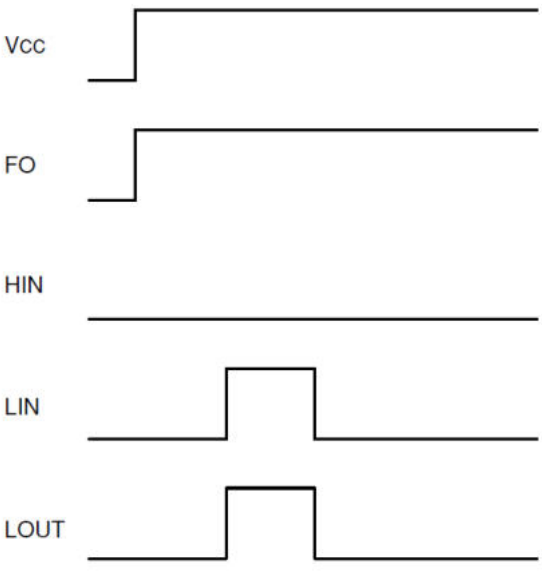


Note1 : Delay times between input and output signals are not shown in the figure above.

7. POWER START-UP SEQUENCE

At power supply start-up the following sequence is recommended when bootstrap supply topology is used.

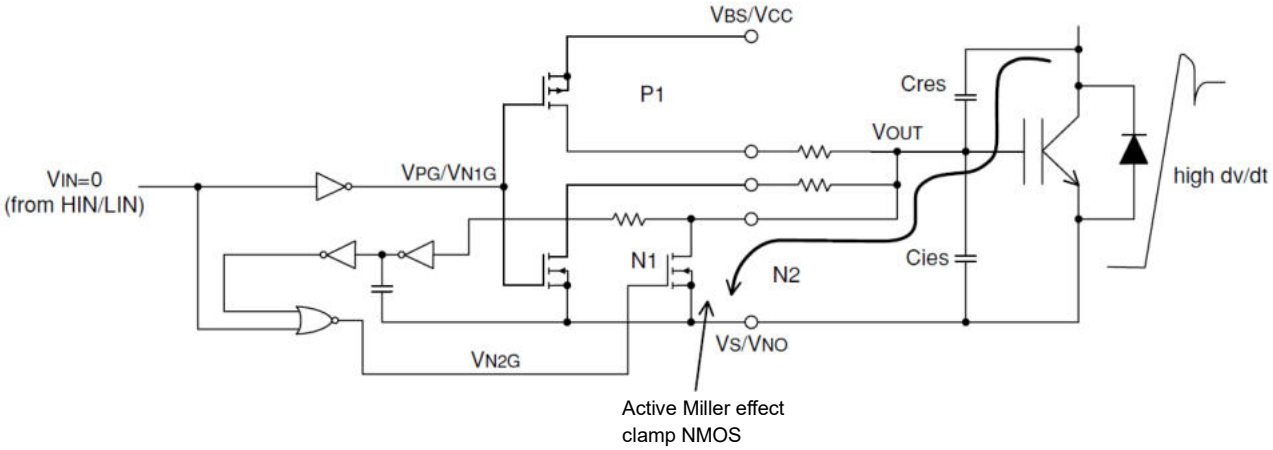
① Apply VCC.
② Make sure that FO is at high level.
③ Set LIN to high level and HIN to low level so that bootstrap capacitor could be charged.
④ Set LIN to low level.



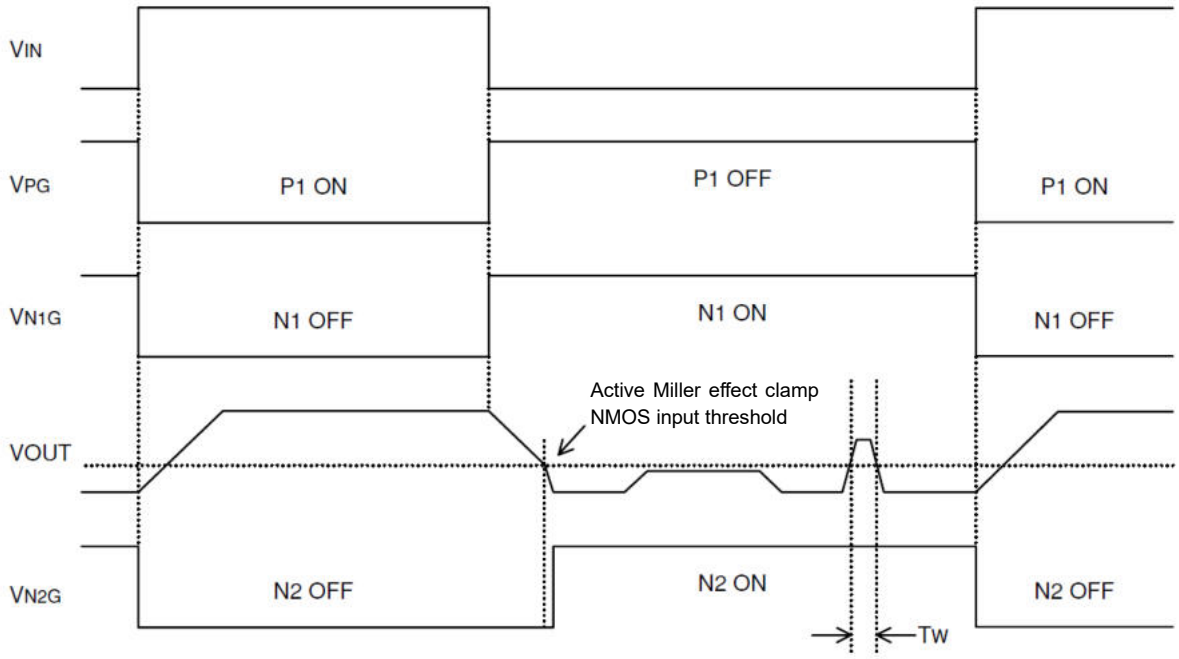
Note : If two power supply are used for supplying VCC and VBS individually, it is recommended to set VCC first and then set VBS.

8. ACTIVE MILLER EFFECT CLAMP NMOS OUTPUT TIMING DIAGRAM

The structure of the output driver stage is shown in following figure. This circuit structure employs a solution for the problem of the Miller current through Cres in IGBT switching applications. Instead of driving the IGBT gate to a negative voltage to increase the safety margin, this circuit structure uses a NMOS to establish a low impedance path to prevent the self-turn-on due to the parasitic Miller capacitor in power switches.

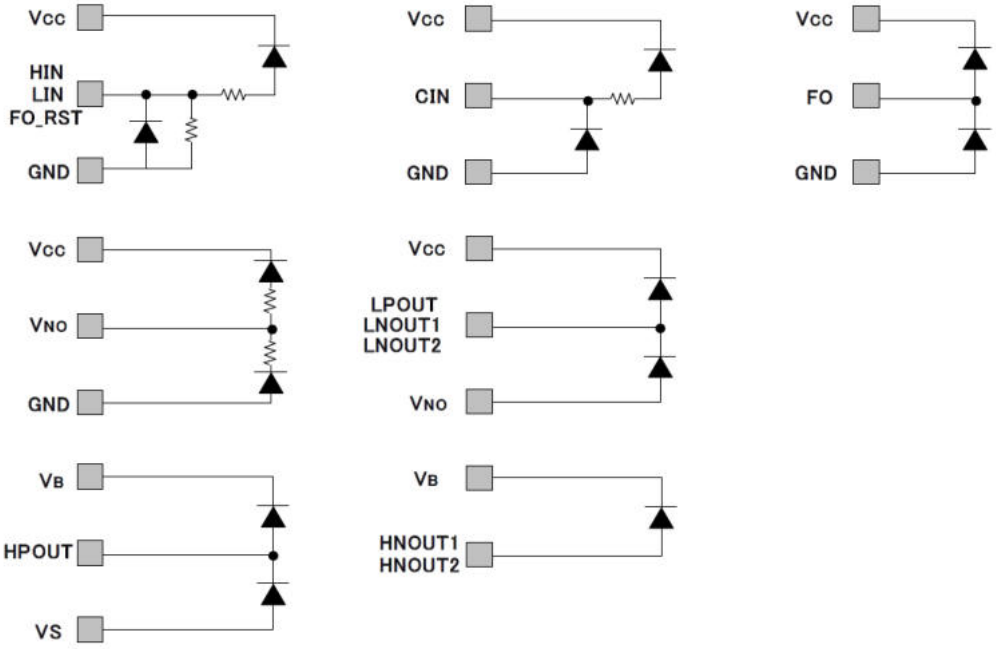


When HIN/LIN is at low level and the voltage of the VOUT (IGBT gate voltage) is below active Miller effect clamp NMOS input threshold voltage, the active Miller effect clamp NMOS is being turned on and opens a low resistive path for the Miller current through Cres.



Active Miller effect clamp NMOS keeps turn-on if TW does not exceed active Miller clamp NMOS filter time

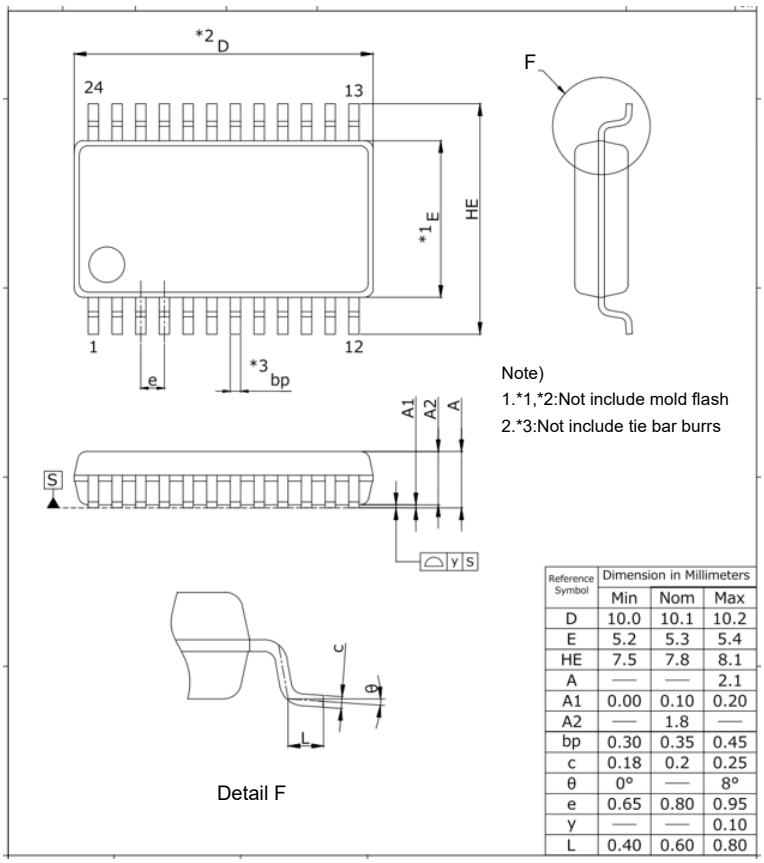
INTERNAL DIODE CLAMP CIRCUITS FOR INPUT AND OUTPUT



ENVIRONMENTAL CONSCIOUSNESS

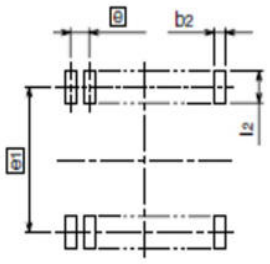
M81738FP is compliant with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) directive 2011/65/EU+(EU)2015/863.

PACKAGE OUTLINE



Note)
1.*1,*2:Not include mold flash
2.*3:Not include tie bar burrs

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	10.0	10.1	10.2
E	5.2	5.3	5.4
HE	7.5	7.8	8.1
A	—	—	2.1
A1	0.00	0.10	0.20
A2	—	1.8	—
bp	0.30	0.35	0.45
c	0.18	0.2	0.25
θ	0°	—	8°
e	0.65	0.80	0.95
y	—	—	0.10
L	0.40	0.60	0.80



Recommended Mount Pad

SYMBOLS	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
e1	—	7.62	—
l2	1.27	—	—
e	—	0.8	—
b2	—	0.5	—

The above is one example.
Please design the mount pad with your evaluation.

Main Revision for this Edition

Rev.	Date	Revision	
		Pages	Points
A	10 Jan. 2012	-	New making
B	3 Dec. 2014	- 2 10	"PRELIMINARY" is deleted. "TL" is added. "ENVIRONMENTAL CONSCIOUSNESS" is added.
C	19 Jun. 2019	4	Change V_{BSuvr} for V_{BSuvt}
D	28 Apr. 2021	-	Update format
E	26 Jul. 2022	4	Change "W" to "Ω" about the unit of R_{OH}, R_{OL1} and R_{OL2}

Important Notice

The information contained in this datasheet shall in no event be regarded as a guarantee of conditions or characteristics. This product has to be used within its specified maximum ratings, and is subject to customer's compliance with any applicable legal requirement, norms and standards.

Except as otherwise explicitly approved by Mitsubishi Electric Corporation in a written document signed by authorized representatives of Mitsubishi Electric Corporation, our products may not be used in any applications where a failure of the product or any consequences of the use thereof can reasonably be expected to result in personal injury.

In usage of power semiconductor, there is always the possibility that trouble may occur with them by the reliability lifetime such as Thermal Cycle or others, or when having assembling stress (e.g. high temperature of reflow process, or rinse after the reflow), or when used under special operating conditions (e.g. rise/fall time of the power supply voltage, or excessive voltage/current injection), or when used under special circumstances (e.g. condensation, high humidity, dusty, salty, highlands, environment with lots of organic matter / corrosive gas / explosive gas, or situations which terminals of semiconductor products receive strong mechanical stress). Therefore, please pay sufficient attention to such circumstances. Further, depending on the technical requirements, our semiconductor products may contain environmental regulation substances, etc. If there is necessity of detailed confirmation, please contact our nearest sales branch or distributor.

The contents or data contained in this datasheet are exclusively intended for technically trained staff. Customer's technical departments should take responsibility to evaluate the suitability of Mitsubishi Electric Corporation product for the intended application and the completeness of the product data with respect to such application. In the customer's research and development, please evaluate it not only with a single semiconductor product but also in the entire system, and judge whether it's applicable. As required, pay close attention to the safety design by installing appropriate fuse or circuit breaker between a high voltage/large current power supply and power semiconductor products(e.g. IGBT, MOSFET) to prevent secondary damage. Please also pay attention to the application note and the related technical information.

Keep safety first in your circuit designs!

Mitsubishi Electric Corporation puts the maximum effort into making semiconductor products better and more reliable, but there is always the possibility that trouble may occur with them. Trouble with semiconductors may lead to personal injury, fire or property damage. Remember to give due consideration to safety when making your circuit designs, with appropriate measures such as (i) placement of substitutive, auxiliary circuits, (ii) use of non-flammable material or (iii) prevention against any malfunction or mishap.

Notes regarding these materials

- These materials are intended as a reference to assist our customers in the selection of the Mitsubishi semiconductor product best suited to the customer's application; they do not convey any license under any intellectual property rights, or any other rights, belonging to Mitsubishi Electric Corporation or a third party.
- Mitsubishi Electric Corporation assumes no responsibility for any damage, or infringement of any third-party's rights, originating in the use of any product data, diagrams, charts, programs, algorithms, or circuit application examples contained in these materials.
- All information contained in these materials, including product data, diagrams, charts, programs and algorithms represents information on products at the time of publication of these materials, and are subject to change by Mitsubishi Electric Corporation without notice due to product improvements or other reasons. It is therefore recommended that customers contact Mitsubishi Electric Corporation or an authorized Mitsubishi Semiconductor product distributor for the latest product information before purchasing a product listed herein.
  The information described here may contain technical inaccuracies or typographical errors. Mitsubishi Electric Corporation assumes no responsibility for any damage, liability, or other loss rising from these inaccuracies or errors.
  Please also pay attention to information published by Mitsubishi Electric Corporation by various means, including the Mitsubishi Semiconductor home page (http://www.MitsubishiElectric.com/).
- When using any or all of the information contained in these materials, including product data, diagrams, charts, programs, and algorithms, please be sure to evaluate all information as a total system before making a final decision on the applicability of the information and products. Mitsubishi Electric Corporation assumes no responsibility for any damage, liability or other loss resulting from the information contained herein.
- Mitsubishi Electric Corporation semiconductors are not designed or manufactured for use in a device or system that is used under circumstances in which human life is potentially at stake. Please contact Mitsubishi Electric Corporation or an authorized Mitsubishi Semiconductor product distributor when considering the use of a product contained herein for any specific purposes, such as apparatus or systems for transportation, vehicular, medical, aerospace, nuclear, or undersea repeater use.
- The prior written approval of Mitsubishi Electric Corporation is necessary to reprint or reproduce in whole or in part these materials.
- If these products or technologies are subject to the Japanese export control restrictions, they must be exported under a license from the Japanese government and cannot be imported into a country other than the approved destination.
  Any diversion or re-export contrary to the export control laws and regulations of Japan and/or the country of destination is prohibited.
- Please contact Mitsubishi Electric Corporation or an authorized Mitsubishi Semiconductor product distributor for further details on these materials or the products contained therein.