MITSUBISHI ELECTRIC
Changes for the Better

HVIC

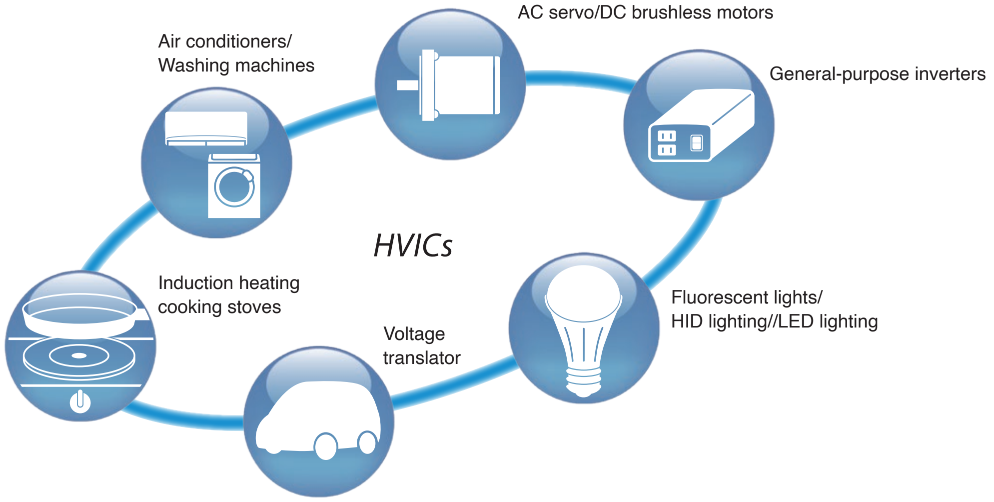
HVIC

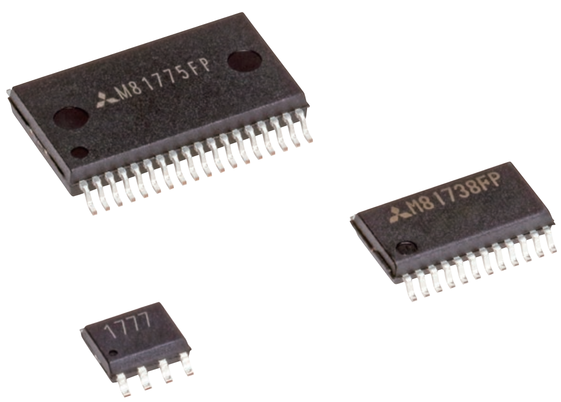
Innovative Power Devices for a Sustainable Future

Mitsubishi Electric HVICs contribute to the high reliability of various power supply equipment by equipping them with various the protection functions.

High-voltage integrated circuits (HVICs) are capable of directly driving the gates of power MOSFETs and IGBTs using signals input from microcomputers, thereby replacing power MOSFET and IGBT gate drivers that use pulse transformers and photocouplers. They are insulated by a level shift circuit inside the semiconductor chip. Since a variety of protection functions, such as power supply undervoltage, interlocking, input signal filter, and error output, are built into the IC, reliability of the power supply equipment is enhanced.
Mitsubishi Electric has many half-bridge products that are commonly used in drive circuits. Our HVIC products comply with the European Union's Restriction of Hazardous Substances Directive for electrical equipment, 2011/65/EU and 2015/863/EU.

Main Features	**High voltage floating circuit is built-in because it is a high side gate drive.** **Built-in signal transmission (level shift) function for transmitting signals to the floating circuit** **High side gate driver section has a high voltage isolation structure.** **Level shift section has a high voltage NMOS structure.**





1200V HVIC with Desaturation Detection for Power Semiconductors M81748FP

M81748FP achieves the high durability of 1200V that is suitable for AC400V inverter systems.

●High durable 1200V rating that is applicable to an industrial use like AC400V inverter systems

- The HVIC achieves low leakage current limited to a maximum 10uA of HVIC by applying a 1200V divided RESURF*1 structure to optimize its surface structure.
- PolyRFP*2 structure of chip surface greatly enhances the durability.

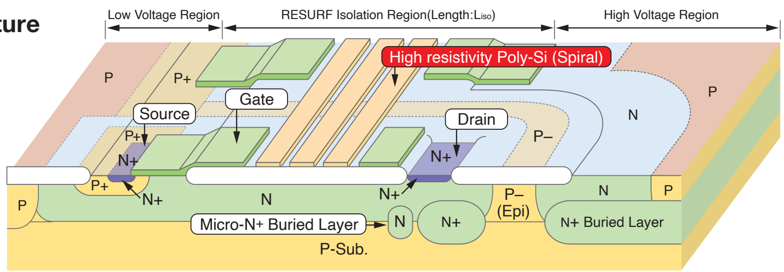
●High tolerance to switching noise helps achieve highly reliable inverter systems

- High latch-up immunity (parasitic Vertical -PNP transistor action) realized with chip's low-impedance buried layers.

●Desaturation detection for reduced power loss reduction in power semiconductors

- P-side and N-side desaturation detection prevents overcurrent thermal destruction of the power semiconductors by using 1200V P-channel MOSFET.
- The HVIC directly detects shorts and earth faults in power semiconductors on P-side and transmits fault signals to N-side, shutting down systems.
- Desaturation detection is sperior to the detection method which is used the shunt resistor for the power loss reduction in power semiconductors.

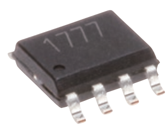
The cross section structure of 1200V Nch MOSFET that applied the divided RESURF*1 structure



*1 RESURF: REduced SUrface Field *2 PolyRFP: Polycrystalline silicon Resistor Field Plate

Half-bridge Driver High-voltage (600V) IC with BSD Function M81777FP

Built-in BSD function helps to reduce the number of parts in inverter systems.



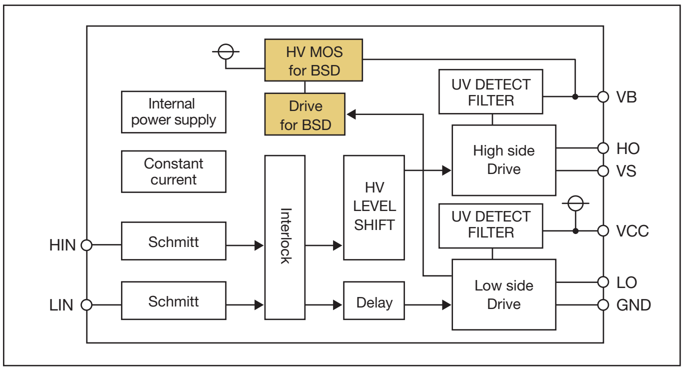
<Main Features>

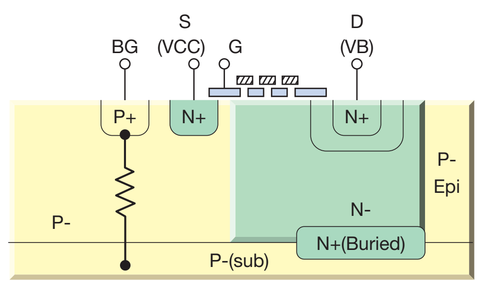
●Built-in BSD function helps to reduce the number of parts in inverter systems

- M81777FP for inverter systems is equipped with a BSD function that enables inverter systems and high-voltage wiring to be designed with fewer parts.

●BSD function's high-voltage metal oxide semiconductor (MOS) achieves high noise resistance

- Mitsubishi Electric's proprietary high-voltage MOS structure suppresses current leakage during charging.
- The MOS structure is free of parasitic elements that can cause latch-up malfunctions due to noise when switching inverters (negative potential surge noise generated in freewheel diode during reflux mode).





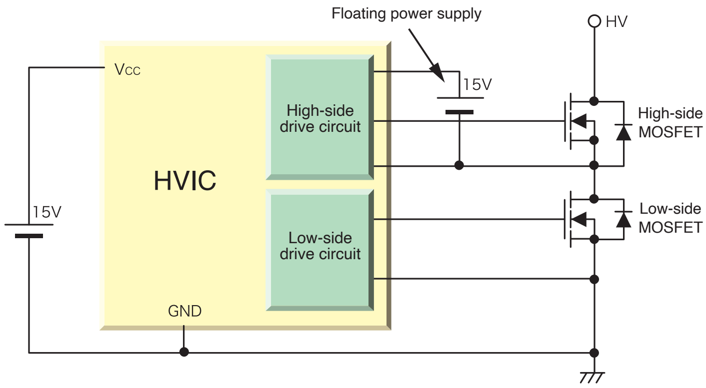
HV MOS for BSD (No parastic PNP Tr)

Attention points of HVIC use

1 The floating power supply method

The emitter/source potential of high-side IGBT/MOSFET referenced to GND changes to the voltage of the HV terminal from 0V when operating the application. Therefore, to drive high-side IGBT/MOSFET, the power supply of the high-side drive circuit of HVIC should have potential which is higher by VBS than the emitter/source potential of high-side IGBT/MOSFET. One of the methods to apply this voltage is the floating power supply method. Fig_right shows the example of the floating power supply method.

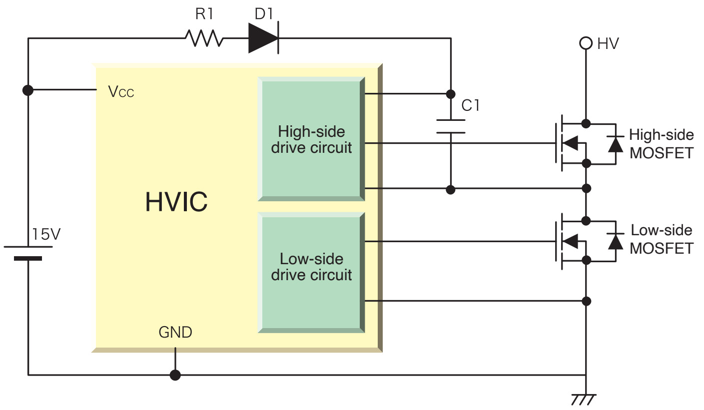
■Floating power supply method



2 Bootstrap circuit method and basic operation

Bootstrap circuit method is used in place of the folating power supply method. The bootstrap capacitor(C1) is charged through the resistor (R1) and bootstrap diode(D1) by VCC, and the high-side drive circuit of HVIC is driven by the voltage of the capacitor(C1). Fig_right shows the example of the bootstrap circuit method.
M81777FP shown in p.5 is equipped with a BSD function that enables bootstrap circuits to be designed without R1 and C1.

■Bootstrap circuit system



3 Electrical charge and discharge current route when HVIC is operated

Fig_right shows the electrical charge and discharge current route of C1 when HVIC is regularly operated.

■Setting of bootstrap capacitor (C1)

Initial charge and the voltage between bootstrap capacitor (C1)

To drive high-side MOSFET, the bootstrap capacitor is charged by turning on low-side MOSFET.
The inrush charging current is from the charging path on the right
ID=(VCC/R1)e-t/(R1･C1) from the initial condition t = 0
ID=VCC/R1

VC1 is shown below. (VF:Voltage between D1 terminals, VDS:Voltage beween drain and souce of low-side MOSFET)

VC1=VCC-VF-VDS･･･(1)

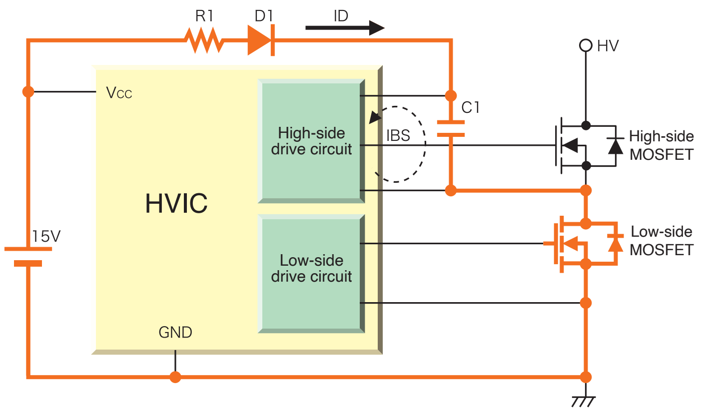
Simple calculation of bootstrap capacitor (C1)

The capacitance value C1 is shown below. (T1:Maximum on-time of high-side MOSFET, IBS:High-side drive circuit consumption current of HVIC, ΔV:Electrical discharge allowance voltage between C1 terminals)
C1 = IBS x T1 ／ ΔV + margin ･･･(2)

IBS changes depending on gate capacitance of MOSFET and carrier frequency. And (1) and (2) expression are simplified. So please set the capacitance value C1 based on evaluation of your system.

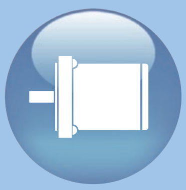
■Electrical charge and discharge current route when HVIC is operated

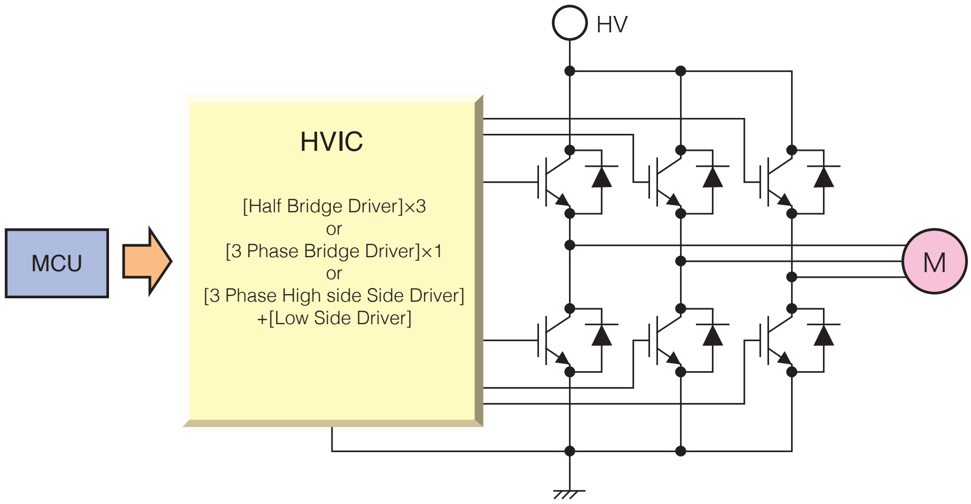
Charge route
Discharge route



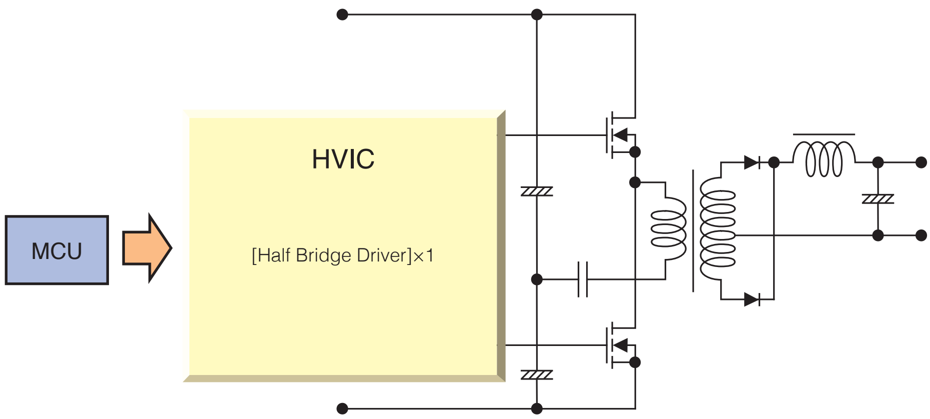
Application circuit examples

Configuration example of gate driver for motor

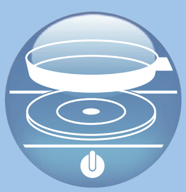


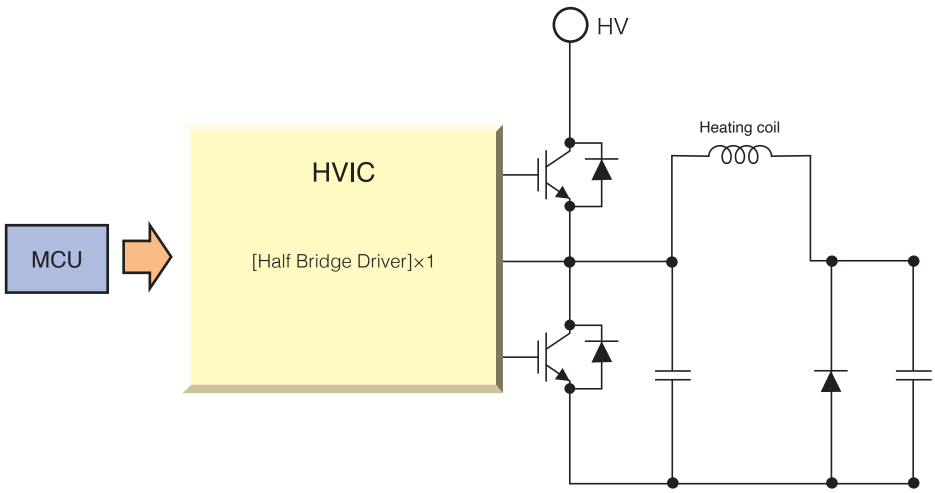


Configuration example of gate driver for DC-DC converter



Configuration example of gate driver for IH cooking heater





Line-up of HVIC

■1200V floating supply voltage

Device drive system	Number of input signals	Generation	Type name	Floating supply voltage[V]	Output current [A](typ)	Dead time control	Internal function	Package outline			
								Package type	Number of terminals	Package dimension width x length (Unit:mm)	Lead pitch (mm)
Half Bridge	2	3rd	M81738FP	1200	±1.0	Input Signal	UV,IL,NF,SC,FO, FORST,FOIN	SSOP	24	5.3×10.1	0.8
			M81748FP	1200	±2.0	Input Signal	UV,IL,NF,DESAT, FO,CFO,FOIN,SS	SSOP	24	5.3×10.1	0.8

■600V floating supply voltage

Device drive system	Number of input signals	Generation	Type name	Floating supply voltage[V]	Output current [A](typ)	Dead time control	Internal function	Package outline			
								Package type	Number of terminals	Package dimension width x length (Unit:mm)	Lead pitch (mm)
3 Phase	2×3Φ	4th	M81749FP	600	+0.2/-0.35	Input Signal	UV,IL,SC, FO,CFO	SSOP	24	5.3×10.1	0.8
			M81775FP	600	+0.2/-0.5	Input Signal	UV,IL,NF	SSOP	36	8.4×15	0.8
Half Bridge	2	4th	M81776FP	600	+0.2/-0.35	Input Signal	UV,IL	SOP	8	3.9×4.85	1.27
			M81777FP	600	+0.2/-0.35	Input Signal	UV,IL,BSD	SOP	8	3.9×4.85	1.27
			M81747FP	600	+0.2/-0.35	Input Signal	UV,IL,NF	SOP	8	3.9×4.85	1.27
			M81774FP	600	±1.0	Input Signal	UV,NF,SC,FO, FORST,FOIN	SSOP	24	5.3×10.1	0.8
			M81770FP	600	±3.25	Input Signal	UV,IL,SD	SSOP	24	5.3×10.1	0.8
			M81767FP	600	±3.5	Input Signal	UV,NF	SOP	8	3.9×4.85	1.27
			M81767JFP (for automotive)	600	+0.2/-0.35	Input Signal	UV,IL,NF	SOP	8	3.9×4.85	1.27
			M81747JFP (for automotive)	600	±3.5	Input Signal	UV,IL,NF	SOP	8	3.9×4.85	1.27
	1	4th	M81734FP	600	±0.5	Internal	UV	SOP	8	3.9×4.85	1.27

■24V floating supply voltage

Device drive system	Number of input signals	Generation	Type name	Floating supply voltage[V]	Output current [A](typ)	Dead time control	Internal function	Package outline			
								Package type	Number of terminals	Package dimension width x length (Unit:mm)	Lead pitch (mm)
Single Low Side	1	4th	M81764FP	24	+1.75/-0.8	—	UV,SC,FO,CFO	SOP	8	3.9×4.85	1.27

<Term> UV : Under Voltage, IL : Inter Lock, NF : Input Noise Filter, SC : Short Current, SD : Shut Down, SS: Soft Shutdown, FO : Failure Output, FOIN : FO Input, FORST : FO Reset, CFO : Capacitor FO, DESAT: Desaturation, BSD: BootStrap Diode

For details of internal functions and package outline, please refer to the data sheet of each product.

Mitsubishi Electric Semiconductors & Devices Website

www.MitsubishiElectric.com/semiconductors/

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