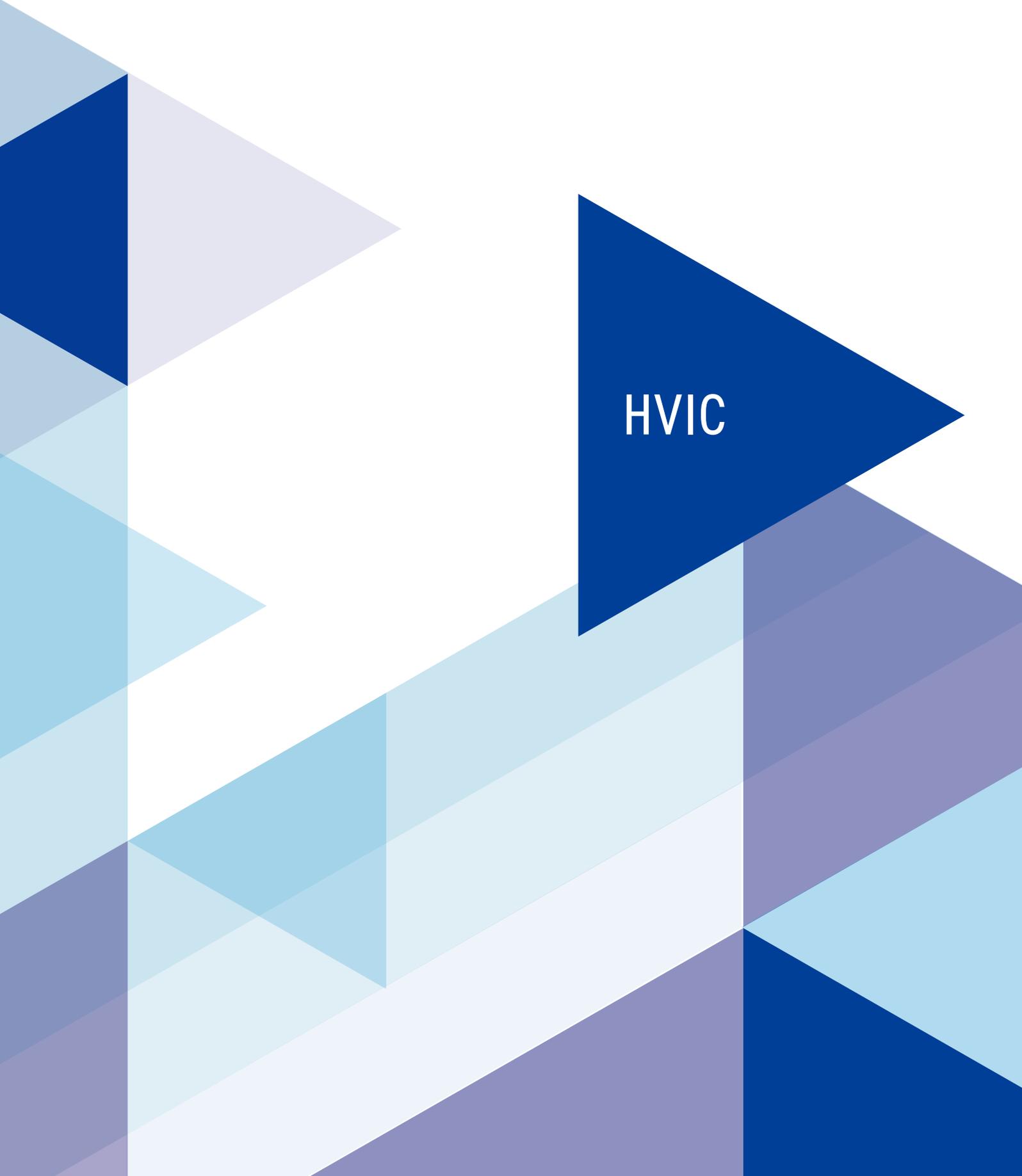


HVIC



HVIC

Innovative Power Devices for a Sustainable Future

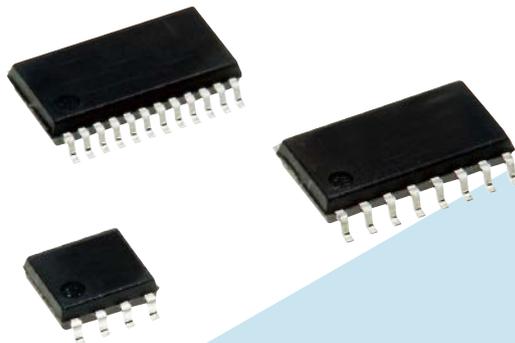
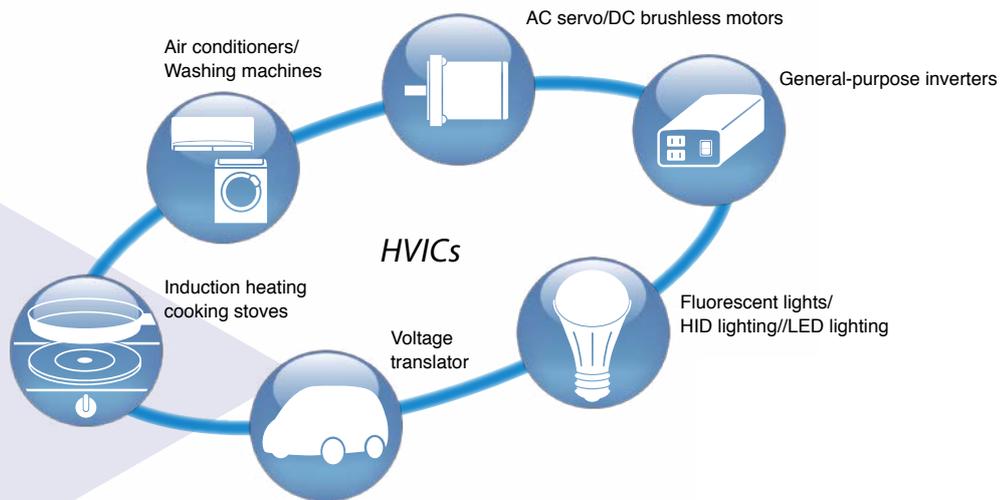
Mitsubishi Electric HVICs contribute to the high reliability of various power supply equipment by equipping them with various the protection functions.

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.



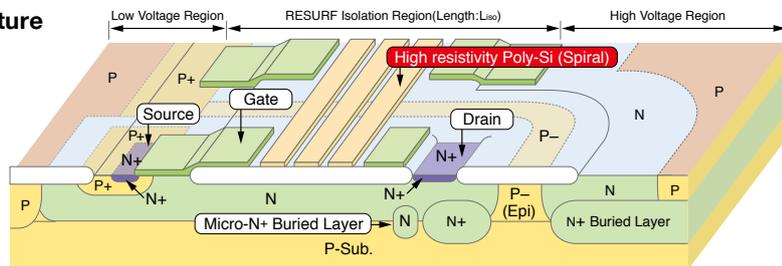
1200V HVIC with Desaturation Detection for Power Semiconductors M81748FP

M81748FP achieves the high durability of 1200V that is most 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 RESURF¹ structure to optimize its surface structure.
 - PolyRFP² 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 superior 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

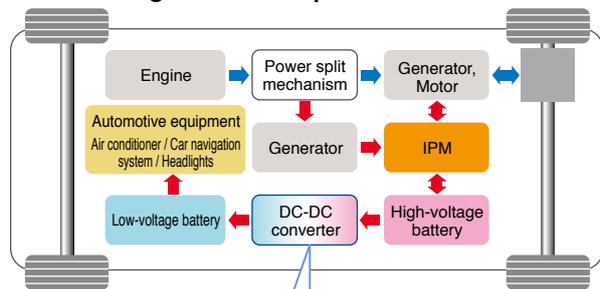
600V HVIC for Automotive Applications M81767JFP

M81767JFP contributes to the high reliability and the optimized switching control of the voltage converter and the power semiconductor for automotive applications.

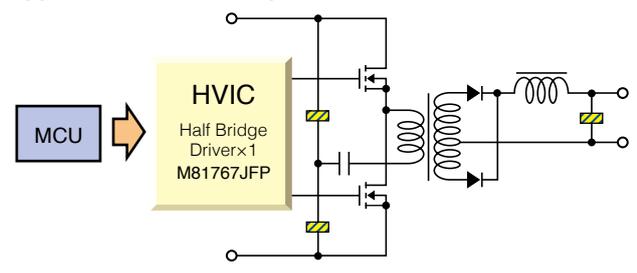


- High reliability that is applied to the requirement of automotive application**
 - Operating temperature range of -40 to +125°C.
 - UVLO (Under voltage lockout) circuit prevents power semiconductor from the destruction by the power supply voltage drop.
 - High-temperature and long-term burn-in tests assure high reliability.
 - The HVIC contributes to the downsizing of the voltage converter by reducing the peripheral parts like the comparator and photocouplers in inverter system.
- High performance supports effective control of the voltage converters**
 - The HVIC achieves low leakage current limited to a maximum 1uA of HVIC by applying a 600V divided RESURF structure to optimize its surface structure.
 - Easy to control the power semiconductors by matching the delay time of the high-voltage side and low-voltage side.

Configuration example of HEV



Application circuit examples of DC-DC converter

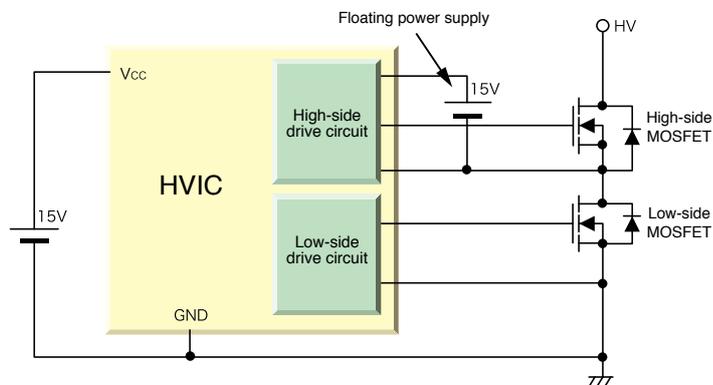


HEV: Hybrid Electric Vehicle IPM: Intelligent Power Module RESURF:REduced SURface Field

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 V_{BS} 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.

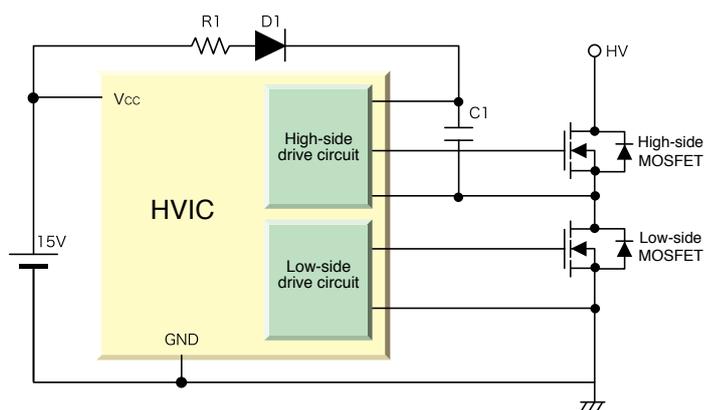
■ Floating power supply method



2 Bootstrap circuit method and basic operation

Bootstrap circuit method is used in place of the floating power supply method. The bootstrap capacitor (C1) is charged through the resistor (R1) and bootstrap diode (D1) by V_{CC}, 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.

■ 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.

■ Electrical charge and discharge current route when HVIC is operated

— Charge route
- - - Discharge route

■ 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

$$I_D = (V_{CC}/R1)e^{-t/(R1 \cdot C1)} \text{ from the initial condition } t = 0$$

$$I_D = V_{CC}/R1$$

V_{C1} is shown below. (V_F: Voltage between D1 terminals, V_{DS}: Voltage between drain and source of low-side MOSFET)

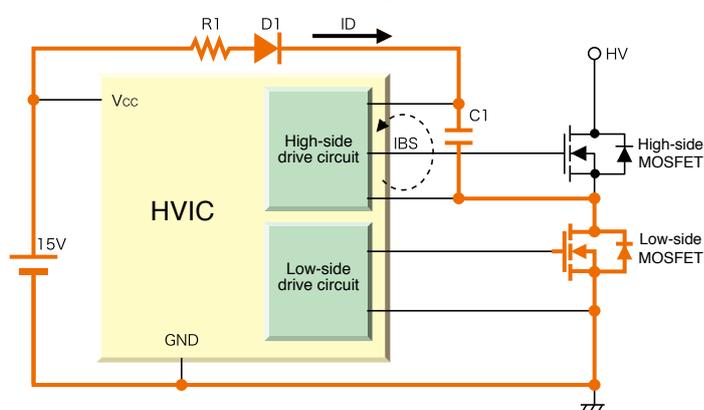
$$V_{C1} = V_{CC} - V_F - V_{DS} \dots (1)$$

Simple calculation of bootstrap capacitor (C1)

The capacitance value C1 is shown below. (T1: Maximum on-time of high-side MOSFET, I_{BS}: High-side drive circuit consumption current of HVIC, ΔV: Electrical discharge allowance voltage between C1 terminals)

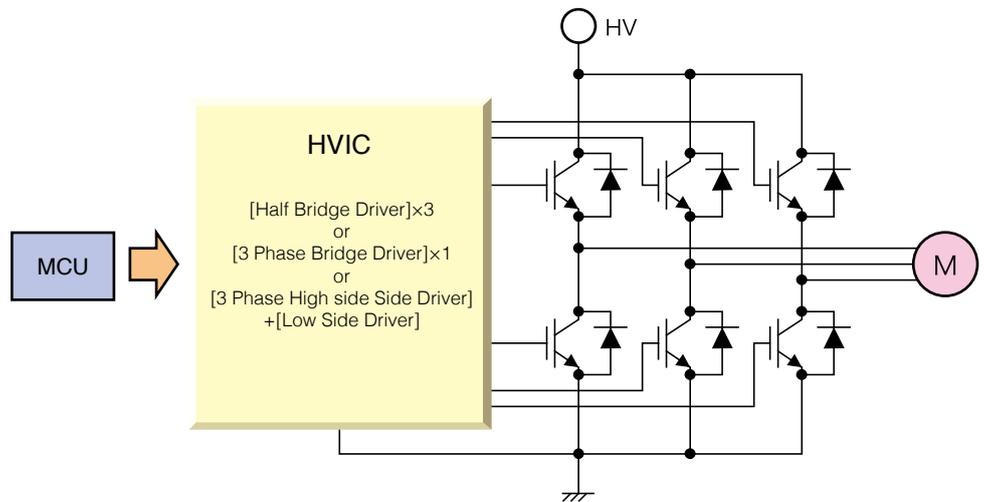
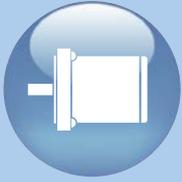
$$C1 = I_{BS} \times T1 / \Delta V + \text{margin} \dots (2)$$

I_{BS} 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.

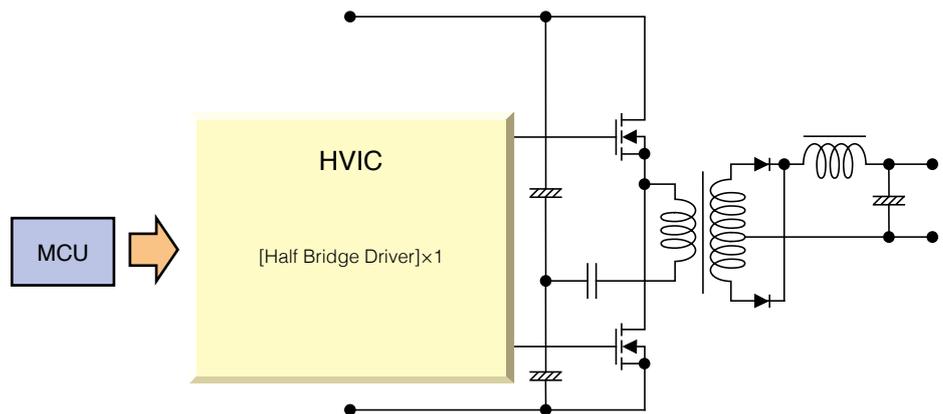


Application circuit examples

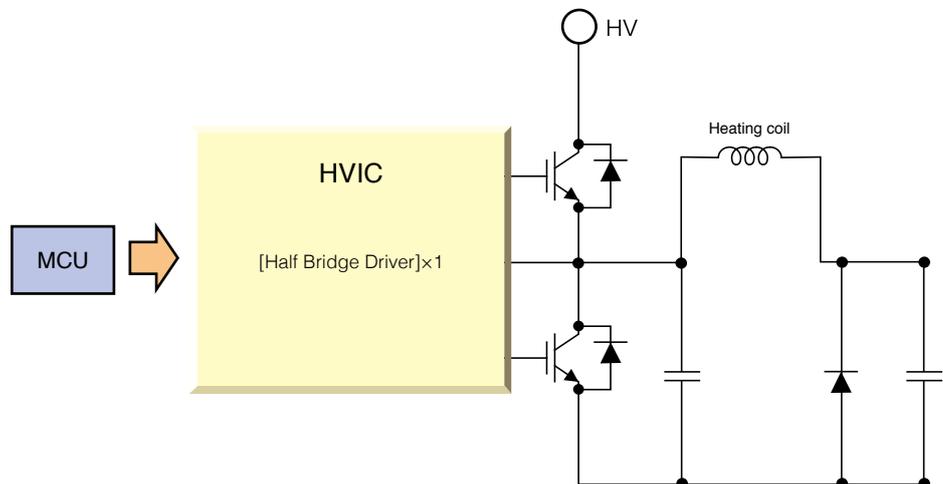
Configuration example of gate driver for motor



Configuration example of gate driver for DC-DC converter



Configuration example of gate driver for IH cooking heater



Line-up of HVIC

★★-Under Development

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	Column gap of mount pad (mil)	Lead pitch (mm)
Half Bridge	2	3rd	M81738FP	1200	1.0	Input Signal	UV,IL,NF,SC,FO, FORST,FOIN	SSOP	24	300	0.8
			M81748FP	1200	2.0	Input Signal	UV,IL,NF,DESAT, FO,CFO,FOIN,SS	SSOP	24	300	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	Column gap of mount pad (mil)	Lead pitch (mm)
3 Phase	2×3Φ	4th	M81749FP	600	0.2/-0.35	Input Signal	UV,IL,SC, FO,CFO	SSOP	24	300	0.8
			M81775FP	600	0.2/-0.5	Input Signal	UV,IL,NF	SSOP	36	450	0.8
Half Bridge	2	4th	M81736FP	600	0.2/-0.35	Input Signal	UV,IL	SOP	8	225	1.27
			M81776FP★★	600	0.2/-0.35	Input Signal	UV,IL	SOP	8	225	1.27
			M81747FP	600	0.2/-0.35	Input Signal	UV,IL,NF	SOP	8	225	1.27
			M81735FP	600	0.5	Input Signal	UV,IL	SOP	16	300	1.27
			M81774FP	600	1.0	Input Signal	UV,NF,SC,FO, FORST,FOIN	SSOP	24	300	0.8
			M81770FP	600	2.5	Input Signal	UV,IL,SD	SOP	16	300	1.27
			M81767FP	600	3.5	Input Signal	UV,NF	SOP	8	225	1.27
			M81747JFP (for automotive)	600	0.2/-0.35	Input Signal	UV,IL,NF	SOP	8	225	1.27
		M81767JFP (for automotive)	600	3.5	Input Signal	UV,IL,NF	SOP	8	225	1.27	
		1	4th	M81734FP	600	0.5	Internal	UV	SOP	8	225
M81740FP	600			3.25	Internal	UV,SD	SOP	8	225	1.27	
Dual High Side	1×2	4th	M81737FP	600	0.2	Input Signal	UV	SOP	16	300	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	Column gap of mount pad (mil)	Lead pitch (mm)
Single Low Side	1	4th	M81764FP	24	1.75/-0.8	—	High active UV,SC,FO,CFO	SOP	8	225	1.27
Dual Low side	1×2	4th	M81762FP	24	1.75/-0.8	—	High active UV,SC(×2),FO,CFO	SOP	16	300	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

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

Mitsubishi Electric Semiconductors & Devices Website

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for a greener tomorrow

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