

HVIC

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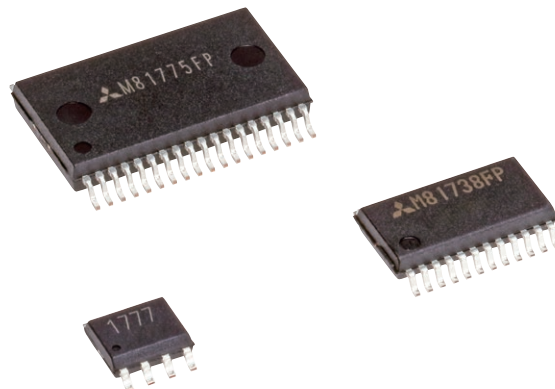
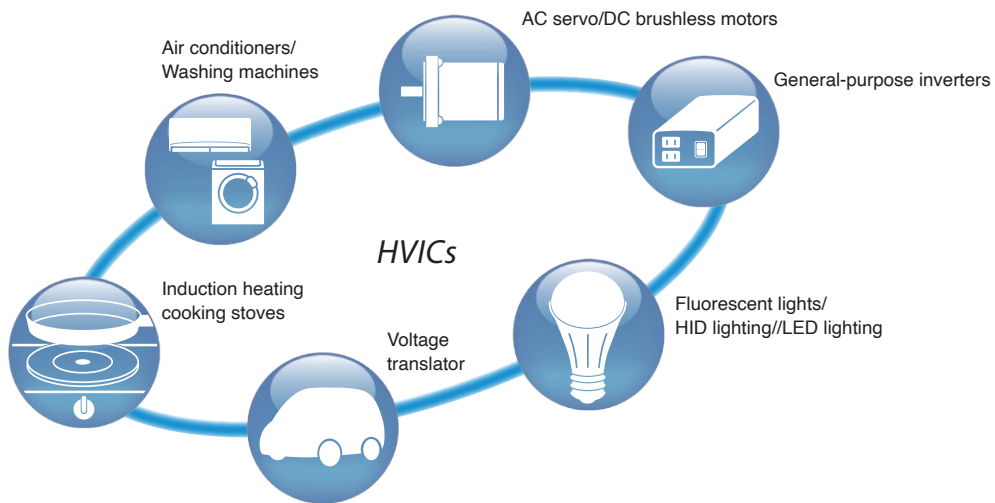
Innovative Power Devices for a Sustainable Future

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.

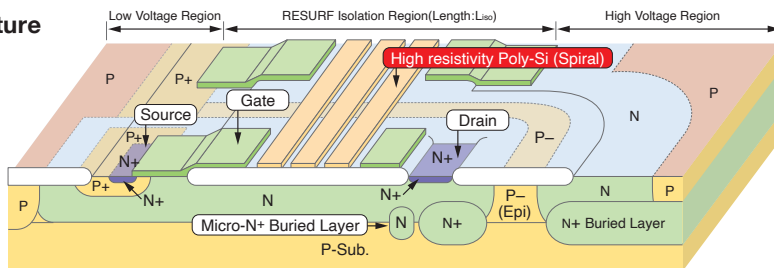
•High tolerance to switching noise helps achieve highly reliable inverter systems

- 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 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

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.



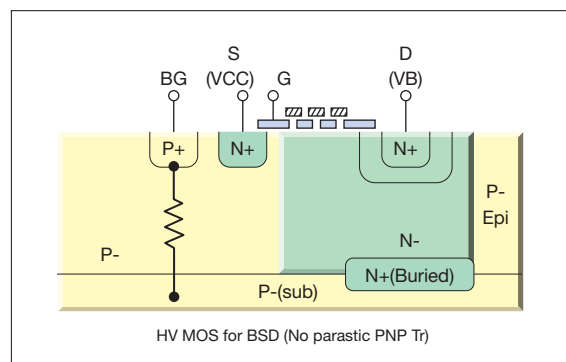
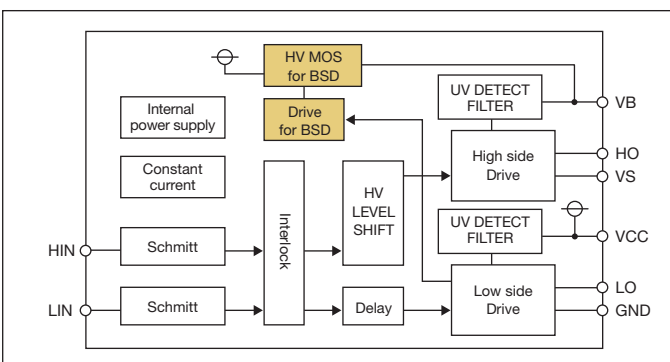
<Main Features>

•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

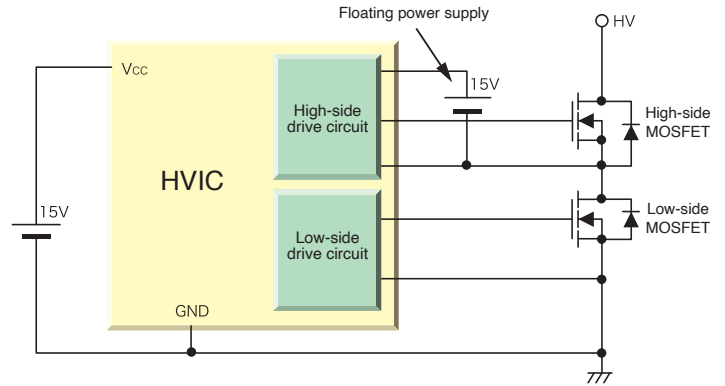
- Mitsubishi Electric's proprietary high-voltage MOS structure suppresses current leakage during charging.
- The MOS structure is free of parasitic elements that can cause latch-up malfunctions due to noise when switching inverters (negative potential surge noise generated in freewheel diode during reflux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



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

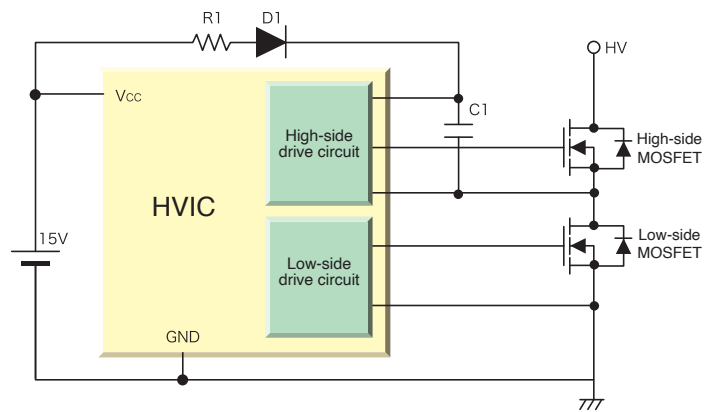


2 Bootstrap circuit method and basic operation

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.

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
 $I_D = (V_{CC}/R1)e^{-t/(R1 \cdot C1)}$ 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)

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

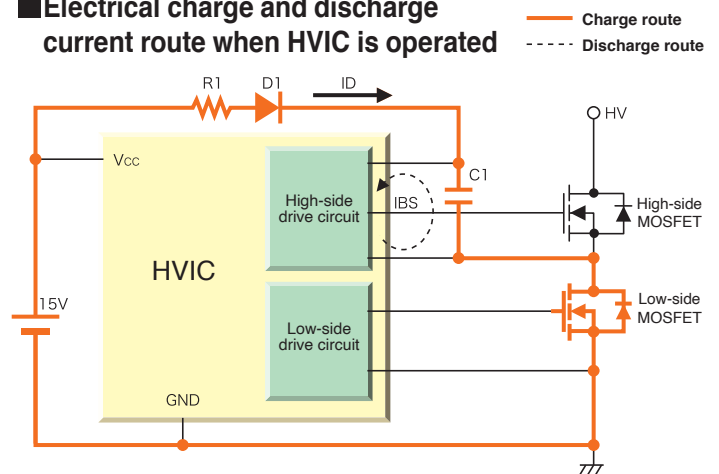
Simple calculation of bootstrap capacitor (C1)

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)

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

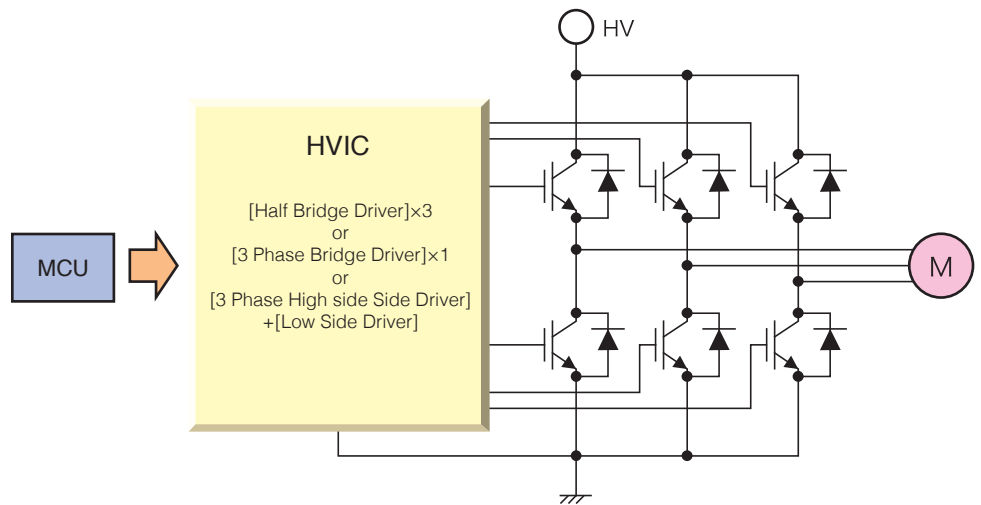
I_{BS} changes depending on gate capacitance of MOSFET and carrier frequency. And (1) and (2) expression are simplified. So please set the capacitance value C1 based on evaluation of your system.

■ Electrical charge and discharge current route when HVIC is operated

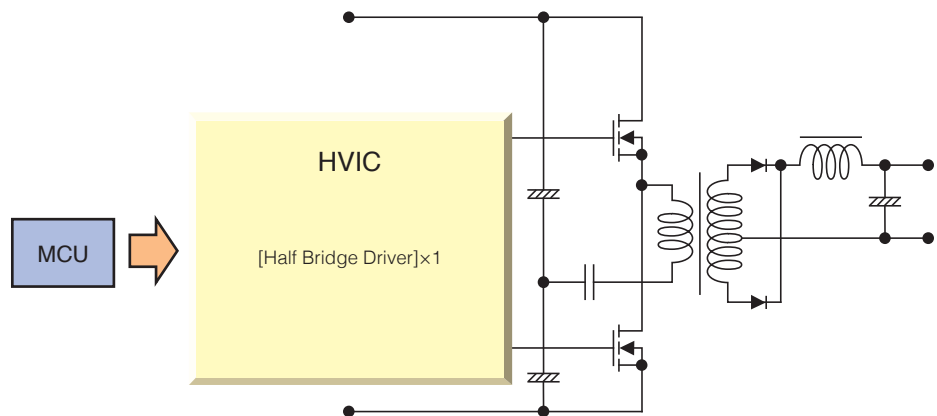


Application circuit examples

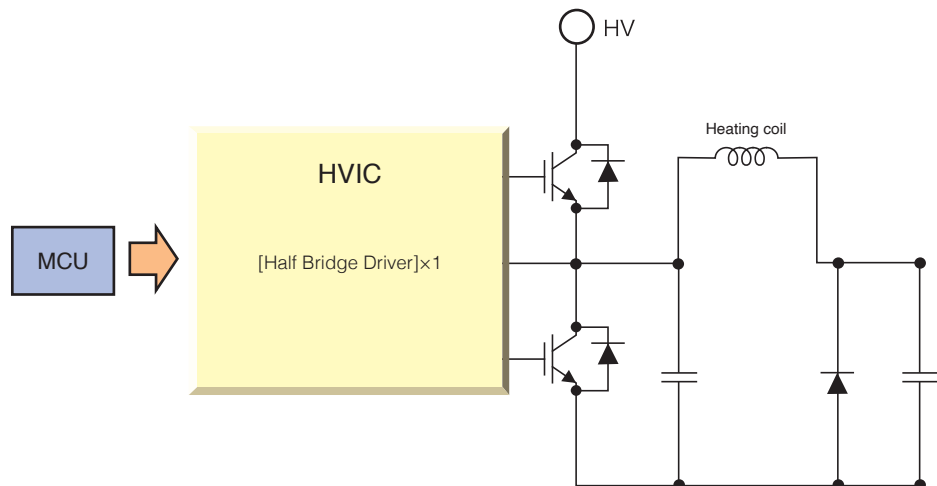
Configuration example of gate driver for motor



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 : Boot Strap 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/



Keep safety first in your circuit designs!

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