



## **MR2000 Series**

### **Standby Compatible Partial Resonance Power Supply IC Module with High-speed IGBT**

Shigeru Hisada - Electronic Device Div.Group Advanced Power Products Div. Device Design Dept.  
(Joined the company in 1991)

## 1

### Introduction

#### Development of the MR2000 Series

Energy conservation guidelines from the Ministry of Economy, Trade and Industry require a reduction in the standby power consumption of various types of electrical products as a means of reducing environmental CO<sub>2</sub> levels. There are strong demands for reduced power consumption in common devices such as TVs and set top boxes (STB) which remain on standby for long periods of time, and efficient operation under micro-loads is required. Furthermore, demands for integration of the various protective functions, higher functionality, and lower price are increasing to the extent that it is now difficult to satisfy such demands with existing products.

In response, a Multi Chip Module (MCM) structure, incorporating only a main switch and control IC, has been adopted in the development of the MR2000 Series of highly functional and low-cost IC modules.

## 2

### Outline

The MR2000 Series includes the 100V input and 200V/worldwide input IC modules, with a function for burst mode switching under micro-load. The 100V input MR2500 Series employs a 500V resistant MOSFET, while the 200V/worldwide input MR2900 Series employs a newly developed 900V resistant high-speed IGBT and a switching device optimized for the various input ranges. Both devices are partial resonance power supply IC modules comprising a low power consumption control IC as the control circuit.

MR2000 Series modules are contained in a fully molded MA Series package as used for previous power supply hybrid ICs with an added screw hole.

**2-1**

## Primary Features

- 1 Current consumption is reduced with use of the burst mode, promoting standby compatibility with a single converter.
- 2 The optimized switching device provides ideal partial resonance operation for high efficiency and low noise.
- 3 The 900V resistant switching device (high-speed IGBT) simplifies design of power supplies for worldwide input.
- 4 Power consumption under micro-load is extremely low (burst mode).
- 5 Use of a drain kick circuit eliminates the need for a start-up resistor.
- 6 The use of a soft drive circuit reduces noise.
- 7 Incorporates an over-current protection function (primary current detect, Ton limit).
- 8 Incorporates over-voltage protection and thermal shutdown functions.
- 9 A power supply circuit may be configured with the minimum of external components.
- 10 The use of the fully molded package is beneficial for insulation design.

**2-2**

## Product Lineup

Model	Main switch	Peak input voltage	Peak input current	Output capacity Po [W] (reference values)		
				Input voltage range AC90~132V	Input voltage range AC90~276V	Input voltage range AC180~276V
MR2520	MOSFET	500	8	100	-	-
MR2540			13	150	-	-
MR2920	High-speed IGBT	900	7	-	100	150
MR2940			10	-	150	225

Table 1 MR2000 Series Product Lineup

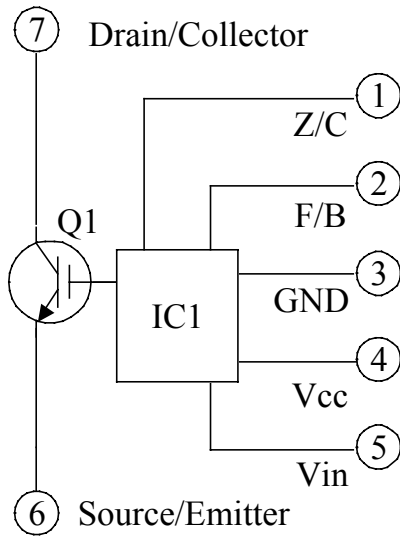


Fig.1 Equivalent Circuit



Fig.2 Appearance

## 3

## Features

## 3-1

## Main Switching Device - High-speed IGBT (MR2900 Series)

The unique (patented) structure of the Shindengen high-speed IGBT provides both high-speed switching and low saturation voltage in a single device, thus also permitting its use in switching power supplies. This newly developed high-speed IGBT is positioned between the MOSFET and the bipolar transistor (Fig.3).

Fig.4 shows a comparison of losses in the 900V resistant switching device in the worldwide partial resonance power supply. The loss curve is comparatively flat in relation to the wide range of input voltage, and as such the device is optimized for use with a variety of international input voltages.

Device	Symbol	Drive	ON loss	Switching loss
MOSFET		Voltage	Large	Small
High-speed IGBT		Voltage	↑	↓
IGBT		Voltage		
BJT		Current	Small	Large

Fig.3 Comparison of Switching Devices

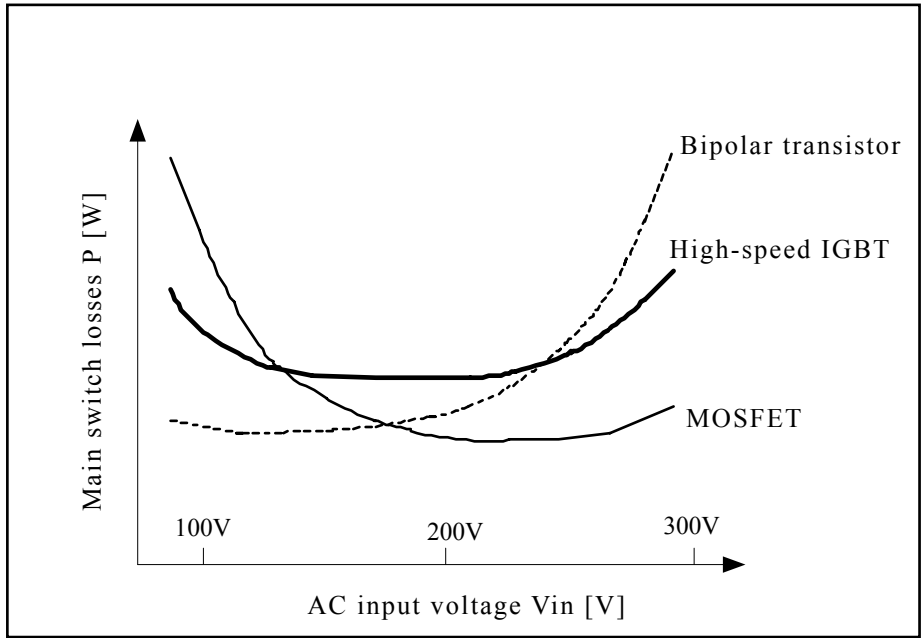


Fig.4 Comparison of Losses in 900V Resistant Switching Device

**3-2** Advantages of 900V Resistance in the High-speed IGBT (MR2900 Series)

The MR2900 Series incorporates a 900V resistant high-speed IGBT for almost ideal partial resonance operation.

Fig.5 shows a comparison between waveforms with 650V and 900V resistance. The use of the 900V resistant device allows a sufficiently small resonance condenser discharge current, with consequently reduced switching losses. This in turn allows an increase in the capacity of the resonance condenser C1, thus allowing lower noise and a power supply of higher efficiency.

The ability to maintain a sufficient margin of voltages resistance eliminates the need for a DCR snubber circuit, thus reducing the number of components required and allowing design of power supplies with superior cost-performance.

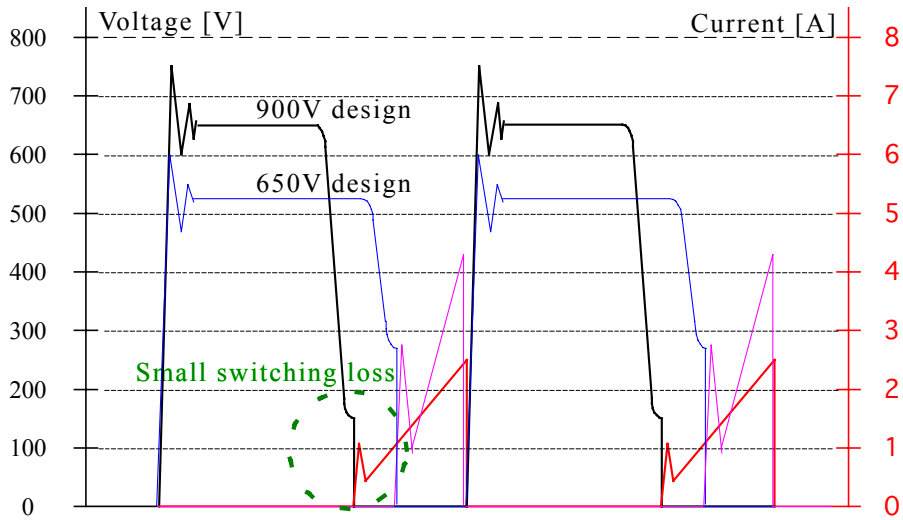


Fig.5 Comparison between Waveforms with 650V and 900V Resistance

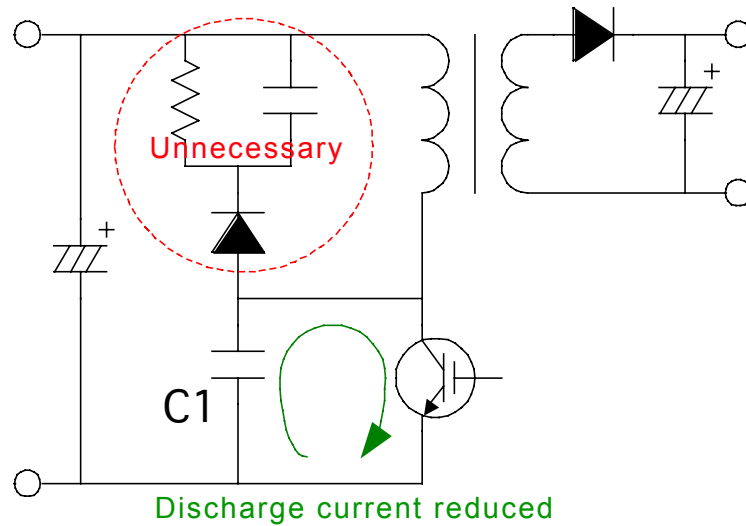


Fig.6 Resonance Condenser Discharge Current at ON

### 3-3 Protection Circuits

1

#### Load-Shorting Protection

Inclusion of a load current reduction circuit enables reduction in heating under load and alleviates stress on the device.

2

#### Protection Against Malfunction at ON

The Leading Edge Blank (LEB) prevents malfunctions in the over-current detect circuit due to discharge current in the partial resonance condenser at ON.

3

#### Protection Against Malfunction at OFF

Inclusion of the ON-dead timer prevents malfunctions at OFF.

This function ensures that resonant oscillation due to the leakage inductance and the resonance condenser at OFF, are recognized as trigger signals, and trigger input is then masked to prevent switching ON again.

4

#### Over-current Protection

Over-current protection for the device consists of pulse-by-pulse over-current protection to detect primary current, and a limitation on the ON width.

**5** Latch Halt Function for Over-voltage Protection

**6** Thermal Shutdown (TSD) to Halt Latch at Overheating

The onboard protection circuits described above reduce the number of components required and thus simplify design.

**3-4** Standby Function

The standby mode is selected by simply dropping the voltage at the Z/C ((1) pin) to 3.5V or less.

The MR2000 Series supports an ideal standby mode employing a method developed by Shindengen based on the use of small intermittent output ripples. Fig.7 and Fig.8 show the input voltage  $P_{in}$ , and the waveform at  $P_o = 1.1W$  (11V, 0.1A), for a worldwide input  $P_o = 100W$  power supply for TV applications.

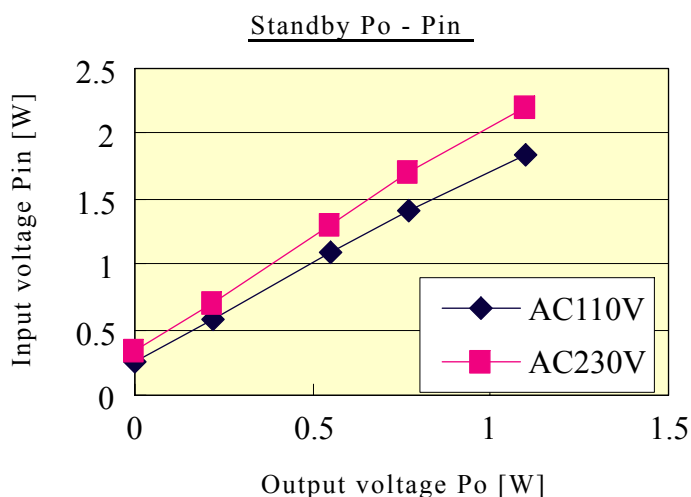


Fig.7 Input Voltage in Standby Mode

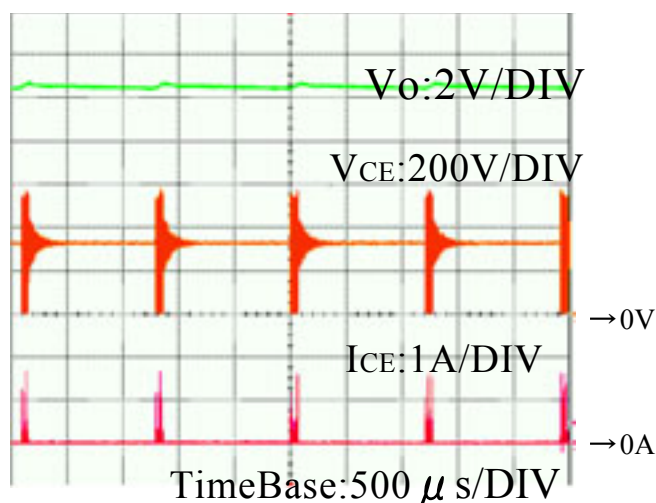


Fig.8 Waveform in Standby Mode

The functions described above considerably simplify design of peripheral circuits.

Collector current detect resistor, a maximum ON width setting resistor, and adjustment with three or four ON timing CRs is sufficient for basic design.

With worldwide input, the F/B pin ON width control is used to add a droop compensation circuit.

The table below describes the name and the function of each pin.

Pin number	Pin name	Function
①	Z/C	Set ON timing. The signal from the control coil is set with the CR time constant. The burst mode is selected by connecting a photocoupler to the Z/C pin.
②	F/B	Controls ON width with pin voltage. A resistor to set the maximum ON width, and a feedback photocoupler, are connected to this pin.
③	GND	GND pin
④	Vcc	Supplies power from the control coil.
⑤	Vin	The AC voltage rectified in the start-up circuit is input directly. Current is supplied to Vcc only at start-up, and is automatically decoupled following start-up.
⑥	Emitter/OCL	Current detect resistor connected to emitter (source)/OCL pin.
⑦	Collector	Main switch collector (drain) pin

Items in brackets refer to MR2500 Series.

Table 2 Pin Names and Functions

## 4

### Conclusion

This article has introduced the features of an IC module which is both compatible with worldwide input, and supports burst mode switching under micro-load.

The MR2000 Series is a high-functionality and low-cost IC module developed through a program of joint research between the Shindengen Semiconductor Division and the Functional Devices Division. As such, it is optimized for control ICs as well as main switching devices in partial resonance power supplies. Its characteristics permit high efficiency, low noise, and low cost over a wide range of markets in such electronic products as TVs, CRT and TFT monitors, STBs, and DVDs, as well as in a variety of office automation equipment.

Further development in terms of applications, and development of new models to suit market requirements, is scheduled.