Innovative Power Devices for a Sustainable Future

Mitsubishi Electric power modules are at the forefront of the latest energy innovations that seek to solve global environmental issues while creating a more affluent and comfortable society for all. Some of these innovations are photovoltaic (PV) and wind power generation from renewable energy sources, smart grids realizing efficient supply of power, hybrid/electric vehicles (HV/EVs) that take the next step in reducing carbon emissions and fuel consumption, and home appliances that achieve ground-breaking energy savings. Whether in appliances, railcars, EVs or industrial systems, our power modules are key elements in changing the way energy is used.

Focus Technology

7th-Generation 1,200V-Class IGBT Chip Technology
Cutting-edge technology realizes energy-saving inverter devices

- Latest thin-wafer processing (n-drift layer) achieves thinner wafer than 6th-generation devices
- Performance improved by combining CSTBT™ and light punch-through (LPT) structures
- Inverter system power dissipation mini-mized by its superior performance (lower VCEon and Eoff)
- CSTBT™: Mitsubishi Electric’s unique IGBT that makes use of carrier cumulative effect

A small surface mount package IPM has been newly developed for fan and low-power motor drive applications

Key Features
- Optimal pin layout realizes easier PCB wiring design and enables smaller PCB size
- New integrated interlock function in addition to conventional protection features for robust operation
- Bootstrap diode is integrated for the P-side drive power supply like conventional DIPIPM™ series, reducing the number of peripheral external parts

Modules realizing single-control power supply and photocoupler-less systems for household appliances and low-capacity inverters

Key Features
- Transfer-molded structure incorporating a high thermal conductivity insulation sheet provides heat
- High-voltage IC equipped with drive, protection and level-shift circuits for direct control via input signals from a CPU or microcomputer
- Compact board and highly reliable equipment realized through single power-supply and photocoupler-less systems
- Includes built-in bootstrap diode (BSD)

 Modules with built-in control and protection circuits for AC servo robots and PV power generation

Key Features
- Built-in protection circuits for short-circuiting, power supply undervoltage and overheating
- Highly compatible package with simplified printed circuit board (PCB) design
- Special intelligent power modules (IPMs) for power conditioners in PV power generation systems

IGBT modules for general-purpose inverters used in various applications

Key Features
- Various low-inductance packages and power chips available
- Compatible with high-frequency, high-voltage (1,700V) applications
- Large-capacity modules available for renewable energy systems

High voltage, large capacity and high reliability are realized for traction and power transmission application

Key Features
- Two types of package are realized: “std type” with large output power and “dual type” for various inverter capacity by easy parallel connection
- The abundant field experience more than 20 years especially in the application of bullet train
- High reliability due to a long lifetime design and a robust design against severe environment

Modules realizing high performance and reliability for propulsion inverters in HVs/EVs

Key Features
- Built-in temperature analog output function realizing highly reliable drive train
- High-power/temperature cycle life ensures high reliability
- Compliant with the End-of-Life Vehicles Directive, regulations relating to substances of environmental concern
- High traceability in managing materials/components throughout the entire production process for each product

- HV: Hybrid Vehicle
- EV: Electric Vehicle
- PHEV: Plug-in Hybrid Electric Vehicle

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- MISOP™: Surface mount package IPM
- DIPIPM™: Intelligent Power Modules
- IPM: Insulated Gate Bipolar Transistor Modules
- HVIGBT Modules: High-Voltage Insulated Gate Bipolar Transistor Modules
- Power Modules for Vehicles: Power Modules for EV/PHEV
Surface mount package IPM

A small Surface mount package IPM has been newly developed for fan and low-power motor drive applications.

- **Main Features**
  - Optimized pin layout realizes easier PCB wiring design and enables smaller PCB size
  - Insulation distance between pins ensured, realizing easier board mounting without coating process
  - Newly integrated interlock function in addition to conventional protection features for robust operation
  - Installing RC-IGBT simultaneously realizes compact package and low loss performance can go together
  - Bootstrap diode is integrated for the P-side drive power supply like conventional DIPIPM™ series, reducing the number of peripheral external parts

### MISOP™

<table>
<thead>
<tr>
<th>Type name</th>
<th>Rated current</th>
<th>Rated voltage</th>
<th>Chips</th>
<th>Protection</th>
<th>Shape</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP25K**</td>
<td>2A</td>
<td>600V</td>
<td>RC-IGBT, HVIC, BSD</td>
<td>UV, SC, OT</td>
<td>Surface mount package</td>
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<tr>
<td>SP35K**</td>
<td>3A</td>
<td>600V</td>
<td>RC-IGBT, HVIC, BSD</td>
<td>UV, SC, OT</td>
<td>Surface mount package</td>
</tr>
</tbody>
</table>

*1 Reverse-conducting IGBT

### Schematic drawing

### Outline Drawing

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**Featured Products**

**Surface mount package IPM**

- All-in-one intelligent power modules equipped with 3-phase converter and brake circuit in addition to inverter circuit
- Recommended for low-cost inverter and fan controller applications

**Featured Products**

**Smaller package size realized by integrating newly designed RC-IGBT**

**Recommended for low-cost inverter and fan controller applications**

**Internal circuit diagram**

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**Customer Support**

**EVA series, evaluation boards for each DIPIPM™**

- Various evaluation boards to easy support system design

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*For further information, please contact sales office.*

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**New Products**

**Surface mount package IPM MISOP™**

- SP25K, SP35K

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Line-up of DIPIPM™

### Series Matrix of 600V / 500V DIPIPM™

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>Definition of DIPIPM</th>
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<tbody>
<tr>
<td>600V</td>
<td>PSS05S92F6-AG</td>
<td>BSD: Bootstrap Diode</td>
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<td>PSS05S92E6-AG</td>
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### Series Matrix of 1200V DIPIPM™

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<th>Name</th>
<th>Definition of DIPIPM</th>
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<tbody>
<tr>
<td>1200V</td>
<td>PSS10S92F6-AG</td>
<td>BSD: Bootstrap Diode</td>
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</table>

### Type Name Definition of DIPIPM™

#### Circuit construction
- **CSTBT**: Mitsubishi Electric’s unique IGBT that makes use of the carrier cumulative effect
- **HVIC**: High Voltage ICL
- **LVIC**: Low Voltage ICL
- **BSI**: Bootstrap Diode
- **UV**: Power supply Under Voltage protection
- **CT**: Over Temperature protection
- **SC**: Short Circuit protection
- **VOC**: Analog Temperature Output
- **RoHS**: Restriction of the use of certain Hazardous Substances in electrical and electronic equipment
- **CIB**: Converter Inverter Brake
- **CI**: Converter Inverter

#### Chip type
- **SLIMDIP-S**: Mitsubishi Electric’s unique IGBT that makes use of the carrier cumulative effect
- **SLIMDIP-L**: Mitsubishi Electric’s unique IGBT that makes use of the carrier cumulative effect

#### Protective Function
- **VOT**: Over Temperature protection
- **SC**: Short Circuit protection
- **UV**: Power supply Under Voltage protection

#### Specifications
- **Active input**: High (5V)
- **Emitter pin of N-side**: High (5V)
- **Insulation voltage**: 2500Vrms
<Main Features>
- Power loss has been reduced with the introduction of the 7th-generation IGBT produced using CSTBT™ and a diode incorporating a RFC™ structure that contributes to reducing the power consumed in inverters.
- The new resin-insulated metal baseplate, originally introduced in 7th-generation IGBT modules, eliminates the solder-attached section, increasing the thermal cycle lifetime and improving inverter reliability.
- In addition to the built-in functions of the previous product, an automatic switching speed control, and error detection function contribute to lowering inverter loss and shortening design time.

- CSTBT™: Mitsubishi Electric's unique IGBT that utilizes the carrier cumulative effect
- RFC: Relaxed field cathode

*1 Represents reference is “A” package with screw terminal and straight layout (CG1A).

**Featured Products**

Loaded with built-in functions, contributing to inverters with enhanced energy savings

**G1 Series IPM with 7th-generation IGBT**

For the “A” package 6-in-1 (CG1A) main pin shape, select either solder pin or screw type.

For the pin layout, select either straight or L-shaped.

- **Main pin shape**
  - Solder pin: Straight, L-shaped
  - Screw: Straight, L-shaped

- **Lineup**

```
<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>Package</th>
<th>Main pin shape</th>
<th>Main pin layout</th>
<th>Code</th>
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<td>A</td>
<td>Solder pin</td>
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<tr>
<td></td>
<td></td>
<td>Solder pin</td>
<td>L-shaped</td>
<td>PM50RG1A065</td>
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<td></td>
<td></td>
<td>Screw</td>
<td>Straight</td>
<td>PM50CG1A065</td>
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<td>Screw</td>
<td>L-shaped</td>
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<td>Screw</td>
<td>L-shaped</td>
<td>PM50RG1APL065</td>
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<td>1200V</td>
<td>C</td>
<td>Solder pin</td>
<td>Straight</td>
<td>PM50CG1APL065</td>
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<td></td>
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<td>Solder pin</td>
<td>L-shaped</td>
<td>PM50RG1APL065</td>
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<td></td>
<td>Screw</td>
<td>L-shaped</td>
<td>PM50RG1APL065</td>
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Representative reference is “A” package with screw terminal and straight layout (CG1A).
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<tr>
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<th>PM50CLA060</th>
<th>PM75CLB060</th>
<th>PM200CL1A060</th>
<th>PM150CLA060</th>
<th>PM450CLA060</th>
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</thead>
<tbody>
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<td>PM75CLB120</td>
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<td>PM150CLB120</td>
<td>PM450CLB120</td>
<td>PM800CLB120</td>
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<tr>
<td>V Series</td>
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<td>PM75CLA120</td>
<td>PM200CLA120</td>
<td>PM150CLA120</td>
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<tr>
<td>S Series</td>
<td>PM50CLB120</td>
<td>PM75CLB120</td>
<td>PM200CLB120</td>
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<tr>
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<td>PM200CLA120</td>
<td>PM150CLA120</td>
<td>PM450CLA120</td>
<td>PM800CLA120</td>
</tr>
</tbody>
</table>

**Matrix of IPM Modules 1200V**

- **Emitter sensor installed Temperature sensor installed Built-in temperature sensor Built-in temperature sensor**
- **Built-in current sensor Built-in current sensor Built-in current sensor Built-in current sensor**

**Notes:**
1. PCM (Plugged Cell Merged)
2. CSTBT: Built-in current sensor
3. CSTBT: Built-in current sensor
4. CSTBT: Built-in current sensor
5. CSTBT: Built-in current sensor

**Term:**
- UV: Power supply Undervoltage protection
- SC: Short Circuit protection
- OT: Over Temperature protection
- OC: Over current protection
- RoHS: Restriction of hazardous substances in electrical and electronic equipment
**Featured Products**

Contributes to realizing smaller, energy-saving large-capacity inverters.

**Power Modules for 3-level Inverters**

- **Main Features**
  - Compatible with 3-level inverters, reducing power consumption approx. 30%*1
  - New package developed*2 contributing to lower inductance and simplified inverter circuit structure
  - IGBT specifications optimized*3 with development of new compact, low-inductance package
  - 4-in-1 and 1-in-1/2-in-1*4 lineup contributes to improved compactness and freedom in inverter design

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**New Features**

- New modules equipped with three-phase converter, inverter, and brake circuit(CIB), contributes to simplifying design for inverter systems
- Power loss has been reduced with the introduction of the 7th-generation IGBT produced using CSTBT™ and a diode incorporating a relaxed field of cathode (RFC) structure
- The new structure introduced eliminates the solder-attached section, increasing the thermal cycle lifetime, which contributes to improving the reliability of inverters
- The introduction of press-fit pins and PC-TIM*1 contribute to simplifying the assembly process for inverters

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**Features of IGBT Module Series**

**S Series**

- Lineup includes various package types
- 6th-generation CSTBT™ delivers low-loss performance
- Thinner package (Height: 17mm) (NX type)
- Solder attachment process eliminated
- IGBT specifications optimized for 3-level inverters, adopting CSTBT™ (Mitsubishi Electric’s unique IGBT that makes use of the carrier cumulative effect)

**NFH Series**

- High-speed CSTBT™ delivers low-loss performance
- Soft switching (resonant) turn-off function (ZVS)
- Enhanced inner wiring (skin effect)

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**New Products**

- New lineup contributes to simple design downsizing, energy-savings of industrial inverters.

**IGBT Module T/T1-Series**

- **Main Features**
  - New modules equipped with three-phase converter, inverter, and brake circuit(CIB), contributes to simplifying design for inverter systems
  - IGBT modules contribute to compact inverter systems by reducing package size by 30% compared to the Mitsubishi Electric’s existing module(CIB)
  - Power loss has been reduced with the introduction of the 7th-generation IGBT produced using CSTBT™ and a diode incorporating a relaxed field of cathode (RFC) structure
  - The new structure introduced eliminates the solder-attached section, increasing the thermal cycle lifetime, which contributes to improving the reliability of inverters
  - The introduction of press-fit pins and PC-TIM*1 contribute to simplifying the assembly process for inverters

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**IGBT Module LV100 for industrial**

- Industrial IGBT module with new standard package “LV100” for high power density inverter, have been developed for the application that high-density inverter is required.

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**Typical Circuit of 3-level Inverter**

- **T type**
  - Outline drawing
  - Isolation voltage 4kV
  - Rated current capacity
  - Soft switching (resonant) turn-off function (ZVS)
  - Enhanced inner wiring (skin effect)

- **I type**
  - Outline drawing
  - Isolation voltage 4kV
  - Rated current capacity
  - Soft switching (resonant) turn-off function (ZVS)
  - Enhanced inner wiring (skin effect)
Line-up of IGBT Modules

Matrix of IGBT Modules 1700V (No. of Outline Drawing, see page 18 to 23)

Outline Drawing of IGBT Modules

CM75, 100, 150, 200RX-12A
CM75RX-24S
CM100, 150, 200RX-12A
CM75RX-24S
CM100TX-34T
CM150TXP-34T
CM150RXL-34SA
CM300DXP-34T
CM300RXL-34SA
CM800DW-34TA
CM1200DW-34T
CM600, 1000DXL-24S
CM75, 100, 150, 200RL-12NF
CM100, 150, 200RL-24NF
CM75, 100, 150, 200RY-24NF
CM100, 150, 200RY-24AF
CM75, 100, 150, 200RY-12NF
CM100, 150, 200RY-12AF
CM75, 100, 150, 200RXL-12NF
CM100, 150, 200RXL-12AF
CM75, 100, 150, 200RXL-24NF
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CM75, 100, 150, 200RXL-12NF
CM100, 150, 200RXL-12AF
CM75, 100, 150, 200RXL-24NF
CM100, 150, 200RXL-24AF
CM75, 100, 150, 200RXL-12NF
CM100, 150, 200RXL-12AF
CM75, 100, 150, 200RXL-24NF
CM100, 150, 200RXL-24AF
Line-up of IGBT Modules

Outline Drawing of IGBT Modules

CM400DY-12NF
CM200DY-24NF
CM300DY-24A
CM600DY-24S
CM150,200DY-34A

CM600DY-12NF
CM600CY-24S
CM400DY-24NF
CM450DY-24S
CM800DY-24S

CM450DXL-34SA
CM500HA-34A
CM100,150DU-24NFH
CM200,300DU-24NFH
CM400,600DU-24NFH
CM600DXL-34SA

CM450DXL-34SA
CM100,150DU-24NFH
CM200,300DU-24NFH
CM400,600DU-24NFH
CM600DXL-34SA

CM500HA-34A
CM450DXL-34SA
CM100,150DU-24NFH
CM200,300DU-24NFH
CM400,600DU-24NFH
CM600DXL-34SA

CM100TX-24S1
CM150TX-24S1
CM150RX-24S1
CM225DX-24S1
CM300DX-24S1
CM450DX-24S1
CM600DX-24S1
Line-up of IGBT Modules

- Outline Drawing of IGBT Modules

46 CM50/75/100 MX UDP-13T/T1
CM75/100/150 MX UDP-24T/T1

47 CM75/100 MX UDP-13T/T1
CM100/150 MX UDP-24T/T1

48 CM100/150 MX UDP-13T/T1
CM150/200 MX UDP-24T/T1

HVIGBT Modules

New Products

X Series HVIGBT Modules

Existing compatible package: Standard type
Contributes to smaller, higher-capacity inverter systems by expanding lineup

- Power loss reduced by incorporating 7th-generation IGBT and RFC*1 diode
- Industry-leading power*2 for increased inverter capacity
- External size reduced 33% while maintaining the same voltage resistance and rated current as conventional products, contributing to inverter downsizing
- Optimal package internal structure realizes improved heat dissipation, humidity resistance and flame retardance, increasing product life

*1 RFC: Relaxed field of cathode
*2 3.3kV / 6.5kV (as of Apr. 5, 2018 based on Mitsubishi Electric research)
*3 Comparison of X Series CM1200H-65X and H Series CM1200H-65X

Positioning from conventional series

New common frame package: dual type
Class-leading current density contributes to increased power output in inverter systems

- Power loss reduced by incorporating 7th-generation IGBT and RFC*1 diode
- Industry's highest 3.3kV/1000A module power density of 4.57A/cm²*4 contributes to increased power output and efficiency
- Terminal layout optimized for easy paralleling and flexible inverter configurations and capacities
- New package structure offers extra reliability

*4 As of Apr. 5, 2018, based on Mitsubishi Electric research

Internal circuit diagram

New Products

X Series HVIGBT Modules

Various current ratings for optimal system design

Inverter capacities

1 parallel
2 parallel
3 parallel
4 parallel

<table>
<thead>
<tr>
<th>Inverter capacities</th>
<th>std Type</th>
<th>1.7kV</th>
<th>3.3kV</th>
<th>4.5kV</th>
<th>6.6kV</th>
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<td>1200A</td>
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Internal circuit diagram
### Line-up of HVIGBT Modules

#### Series Matrix of HVIGBT/HVIPM

<table>
<thead>
<tr>
<th><strong>Series Matrix of HVIGBT/HVIPM</strong> (No.: Number of Outline Drawing, see page 29 to 31)</th>
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<tbody>
<tr>
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<td><strong>2400A</strong></td>
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<td><strong>3600A</strong></td>
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</table>

#### Series Matrix of HVIGBT/HVIPM

<table>
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<th><strong>Series Matrix of HVIGBT/HVIPM</strong> (No.: Number of Outline Drawing, see page 29 to 31)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4500V</strong></td>
</tr>
<tr>
<td><strong>5500V</strong></td>
</tr>
</tbody>
</table>

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**Connection**

- **Type**
  - D1
  - D2
  - E2/E6
  - E4

**Notes**

- B: Cu base plate 6kV isolation
- C: AISG base plate 6kV isolation
- G: AISG base plate 10kV isolation
- **Under Development**: Under Development
- **New Product**: New Product

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**Specifications**

- **Connection**
  - H
  - E2/E6
  - E4
  - D2

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**Additional Notes**

- Under Development
- New Product
### Line-up of HVDIODE Modules

#### Series Matrix of HVDIODE Modules (No: Number of outline drawing, see page 31)

<table>
<thead>
<tr>
<th>No.</th>
<th>Type</th>
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**Note:** Under Development

#### Evolution of HVIGBT Module Series

- **1.7kV**
  - H Series
  - N Series
  - S Series
  - X Series
- **2.3kV**
  - H Series
  - S Series
- **3.3kV**
  - H Series
  - R Series
  - X Series
- **4.5kV**
  - H Series
  - F Series
  - X Series

#### Evolution of HVDIODE Module Series

- **1.7kV**
  - S Series
  - X Series
- **3.3kV**
  - S Series
  - F Series
  - X Series

#### Type Name Definition of IGBT Modules

- **CM 1800 H C - 66 X**
  - Series name
  - Voltage class
  - Connection type
  - Prime mark

- **CM 1200 DC-34S**
- **CM 1200 DB/DC-34**

#### Outline Drawing of HVIGBT Modules

- **CM600DY-34H**
- **CM600E2Y-34H**
- **CM600HZ-34H**
- **CM800DZ-34H**
- **CM800DZB-34N**
- **CM1200DB-34N**
- **CM1800,2400HC-34N**
- **CM1800,2400HC-34H**
- **CM1200HC/HC-50H,-66H**
- **CM800HC-34H**
- **CM900HC-90H**
- **CM400HG-66H**
- **CM200HG-130H**
- **CM1000HC-90R**
- **CM1200HG-66H**
- **CM900HG-90H**
New Products

Package with 6-in-1 connection and integrated water-cooled fin contributes to more compact, high-power inverters for EVs/HEVs

**High Power J1 Series Power Modules for EVs/HEVs**

CT1000CJ1B060, CT600CJ1B120

**Main Features**
- Integrated direct water-cooling structure with cooling fins and 6-in-1 connection contribute to more compact, high-power inverters for EVs/HEVs
- Direct lead bonding (DLB) structure ensures high reliability
- Loss further reduced by incorporating 7th-generation IGBT built with a CSTBT™️ structure
- Completely lead-free, conforms to RoHS directives (2011/65/EU)
- Suitable for a variety of electric and hybrid vehicle inverters

CSTBT™️ stands for Cresset’s unique IGBT that utilize the carrier cancellation effect

### Features

**Common**
- Long power/temperature cycle life
- High-precision on-chip temperature sensor
- High traceability in managing materials/components for each product throughout the entire production process

**J Series T-PM (Transfer-molded Power Module)**
- Structure incorporates transfer molding and original direct lead bonding (DLB) technique
- DLB structure reduces internal wiring resistance and inductance
- Completely Pb-free (including the pins)

**J1 Series (6-in-1)**
- Cooling fin integrated direct water-cooled structure and 6-in-1 configuration contribute to minimize the automobile inverter
- DLB structure realizes high reliability
- Installation of the 7th generation IGBT adapting the CSTBT™️ structure realizes a further reduction in loss
- On-chip current sensor that enables high-speed current-cutoff protection is installed

### Matrix of 650V Power Modules

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>Power Module with pin fin</th>
<th>J Series</th>
<th>Series Name and Structure</th>
<th>Type Name Definition of Power Modules for Electric and Hybrid Vehicles</th>
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<td>300</td>
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<td>CT300CJ1A120</td>
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<td>CT700CJ1A060</td>
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<td>CT1000CJ1B120</td>
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</table>

**Type Name Definition of Power Modules for Electric and Hybrid Vehicles**

**CT 600 C J1B 120**
- **Voltage class**
- **Series name and structure**
- **Connection type**
- **Rating current class**
- **CT IGBT**

**Outline Drawing of Power Modules for Electric and Hybrid Vehicles**

- **01** CT600CJ1A060 CT700CJ1A060 CT300CJ1A120
- **02** CT300DJG060
- **03** CT1000CJ1B060 CT600CJ1B120

**NOTE**
- In case of CT1000CJ1B060 and CT600CJ1B120, each pair of arms is not connected internally.
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<thead>
<tr>
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