

Product Catalog 2024

# Power semiconductors

Our power electronics journey started in Switzerland over 100 years ago with the production of mercury-arc rectifiers. Today, we have one of the most diverse semiconductor portfolios that includes thyristors, diodes, GTOs, IGCTs, MOSFETs and IGBTs, which are manufactured at our own facilities in Lenzburg, Switzerland and Prague, Czech Republic. Our research team continues to push the boundaries of what is possible, using silicon (Si) and silicon carbide (SiC) technology to innovate the next generation of power electronics devices.

Our advanced semiconductor technology brings unprecedented control to HVDC transmission systems. We are the heart of traction converters that drive high speed trains, metros and diesel-electric locomotives. Pumps, fans, roller tables, hoist and winches found throughout industry rely on us, and the world is able to enjoy greener mobility because we power the next generation of e-vehicles.

We are Hitachi Energy – Semiconductors and with you we can shape the smarter, greener society of the future.

For more information, please contact us or visit [www.hitachienergy.com/semiconductors](http://www.hitachienergy.com/semiconductors)

# Table of contents

## **Introduction**

|            |                                       |
|------------|---------------------------------------|
| <b>004</b> | Product outlook                       |
| <b>008</b> | Applications                          |
| <b>010</b> | SEMIS – Semiconductor simulation tool |

## **IGBT dies and modules**

|            |                                     |
|------------|-------------------------------------|
| <b>012</b> | IGBT and diode dies                 |
| <b>014</b> | Medium-power IGBT modules           |
| <b>016</b> | Power IGBT/MOSFET and diode modules |

## **Diodes, thyristors, IGCTs and GTO press-packs**

|            |                                               |
|------------|-----------------------------------------------|
| <b>029</b> | Diode and thyristor modules                   |
| <b>030</b> | Diodes                                        |
| <b>040</b> | Thyristors                                    |
| <b>046</b> | Integrated gate-commutated thyristors (IGCTs) |
| <b>048</b> | Gate turn-off thyristors (GTOs)               |
| <b>050</b> | Assemblies for high power applications        |
| <b>052</b> | Test systems                                  |

## **Further information**

|            |                                              |
|------------|----------------------------------------------|
| <b>054</b> | Certificates                                 |
| <b>056</b> | Product Environmental Compliance Information |
| <b>057</b> | Symbols                                      |
| <b>058</b> | Documentation                                |
| <b>060</b> | Part numbering structure                     |

|            |                               |
|------------|-------------------------------|
| <b>064</b> | <b>Worldwide distributors</b> |
|------------|-------------------------------|

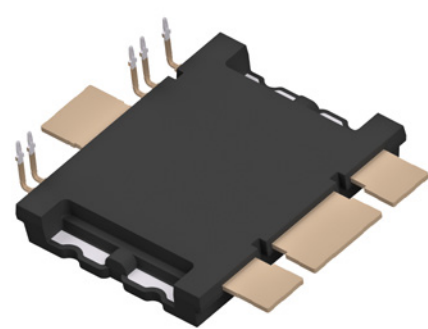
# Product outlook

## RoadPak XS

A new RoadPak with a smaller footprint for the 750 V and 1200 V classes will be available for sampling in the second quarter of 2024. It completes the RoadPak portfolio, supporting a lower current rating of 2 x 440 A and can be used in a wide range of applications due to its compact size and optimized high-performance design.

Ratings

| Availability                                       | Voltage (V) | Current (A) | Housing |
|----------------------------------------------------|-------------|-------------|---------|
| 750 V phase leg MOSFET, samples available in 2024  | 750         | 2 x 440     | RoadPak |
| 1200 V phase leg MOSFET, samples available in 2024 | 1200        | 2 x 440     | RoadPak |



## StakPak BIGT and IGBT

The Hitachi Energy StakPak is the industry standard for highest power grid infrastructure applications. It earned its place by offering unmatched reliability combined with the highest power density and mechanical robustness. At the same time, StakPak benefits from a novel semiconductor chip that combines the IGBT and the free-wheeling diode into a single chip, the BIGT. This enables greater power cycling capability, increased current, better  $R_{th}$  and increased surge current capability for the diode. Recently, Hitachi Energy has launched the BIGT2, a second generation of this chip, that delivers a further 30% improvement in current density.

To support the never-ending quest to increase the power rating and the efficiency of the HVDC stations, Hitachi Energy is developing StakPak devices with unprecedented current ratings of 5000 A and 6000 A at a blocking voltage of 4.5 kV.





**Large Fast Recovery Diode (FRD)**

Voltage Source Inverter (VSI) topology always requires a free-wheeling diode in antiparallel connection to the semiconductor switch. The free-wheeling diode is usually integrated into the housing of the switch device. To reach the highest current ratings of up to 5000 A and more, e.g. for high-end HVDC or FACTS application, a separation of the switch and free-wheeling diode is required.

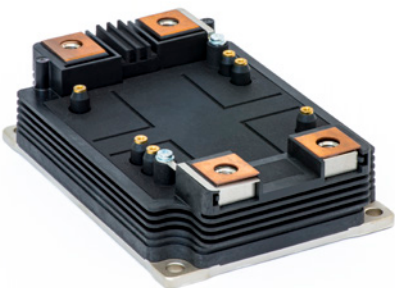
Hitachi Energy will launch a high-power large FRD platform with current rating of 5000 A that will fit our 5000 A StakPak offering or any other high-power IGCT or IGBT device.

The first device, rated 4500 V in a U-housing with a 110 mm pole piece, is available now (for more details please refer to page 33). More products will be added to the platform in the coming years.



**High-voltage LinPak**

After establishing a standard with the low-voltage LinPak, Hitachi Energy is offering a high isolation version of this module. Like its LV version, the HV version features very low stray inductance, highest current density, ideal current sharing and very good paralleling capability. The line-up expands from 3.3 kV to 6.5 kV.



| Voltage (V) | Current (A) |
|-------------|-------------|
| 3300        | 600         |
| 4500        | 450         |
| 6500        | 300         |

## Low-Voltage LinPak with new chipset

The LV 1700 V 1000 A LinPak has been deployed in trains and industrial systems since 2015. With the help of a new generation of chips, Hitachi Energy now supports current ratings of 1500 A with 1700 V in the same footprint. The chipset is based on the newly launched Trench Fine Pattern (TFP) technology, developed to enable very high current density and superior trench gate robustness. Similarly, based on TSPT<sup>+</sup> technology, a new rating, the 600 A, will be released for the 3.3 kV module.

Additionally to the 1.7 kV and the 3.3 kV, Hitachi Energy will add a new voltage class to its LV LinPak portfolio. In order to support applications that use 2-Level topologies and have DC link voltage up to 1500 V, a 2.3 kV voltage class will be released in the coming quarters.

### Ratings

| Availability                                                         | Voltage (V) | Current (A) | Housing   |
|----------------------------------------------------------------------|-------------|-------------|-----------|
| 1700 V 1000 A TFP technology, samples available Q2 2024              | 1700        | 2 x 1000    | LV LinPak |
| 1700 V 1500 A TFP technology, samples available Q2 2024              | 1700        | 2 x 1500    | LV LinPak |
| 2300 V 1400 A TFP technology, samples available Q4 2024              | 2300        | 2 x 1400    | LV LinPak |
| 3300 V 600 A TSPT <sup>+</sup> technology, samples available Q3 2024 | 3300        | 2 x 600     | LV LinPak |



## SiC LinPak in LV and HV housing

For applications where it is highly beneficial to reduce the switching losses, Hitachi Energy is offering SiC LinPak modules in LV and HV housings. For these modules, we offer both in-house manufactured SiC MOSFET chips and external chips.

### Ratings

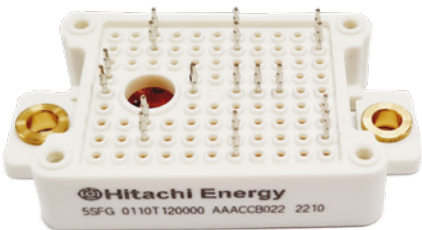
| Availability  | Voltage (V) | Current (A) | Housing   |
|---------------|-------------|-------------|-----------|
| 1700 V 900 A  | 1700        | 2 x 900     | LV LinPak |
| 1700 V 1800 A | 1700        | 2 x 1800    | LV LinPak |
| 3300 V 500 A  | 3300        | 2 x 500     | LV LinPak |
| 3300 V 1000 A | 3300        | 2 x 1000    | LV LinPak |
| 3300 V 500 A  | 3300        | 2 x 500     | HV LinPak |
| 3300 V 1000 A | 3300        | 2 x 1000    | HV LinPak |

FlexyPak

With the introduction of the FlexyPak, Hitachi Energy expands its portfolio in the lower range of high power semiconductors. The package provides unmatched internal design flexibility, allowing a variety of topologies including single, dual, chopper and Vienna to be implemented. Furthermore, the direct pin connection of the FlexyPak ensures the lowest stray inductance for a module in its class, enabling the use of novel Wide Band Gap (WBG) semiconductors in these new modules.

Ratings

| Availability                 | Voltage (V) | Current (A) | Housing   |
|------------------------------|-------------|-------------|-----------|
| 1200 V 110 A with SiC MOSFET | 1200        | 2 x 110     | FlexyPak1 |
| 1200 V 220 A with SiC MOSFET | 1200        | 2 x 220     | FlexyPak1 |



Thyristor / diode modules

All thyristor / diode modules feature industry standard housings and very low losses together with the highest operating temperatures.

Typical applications are AC motor soft starters, variable speed drives and renewable energies. Features within high-power semiconductors are also used in our thyristor/diode module product line.

The benefits of these features include highest performance, outstanding reliability, increased overload capability and many

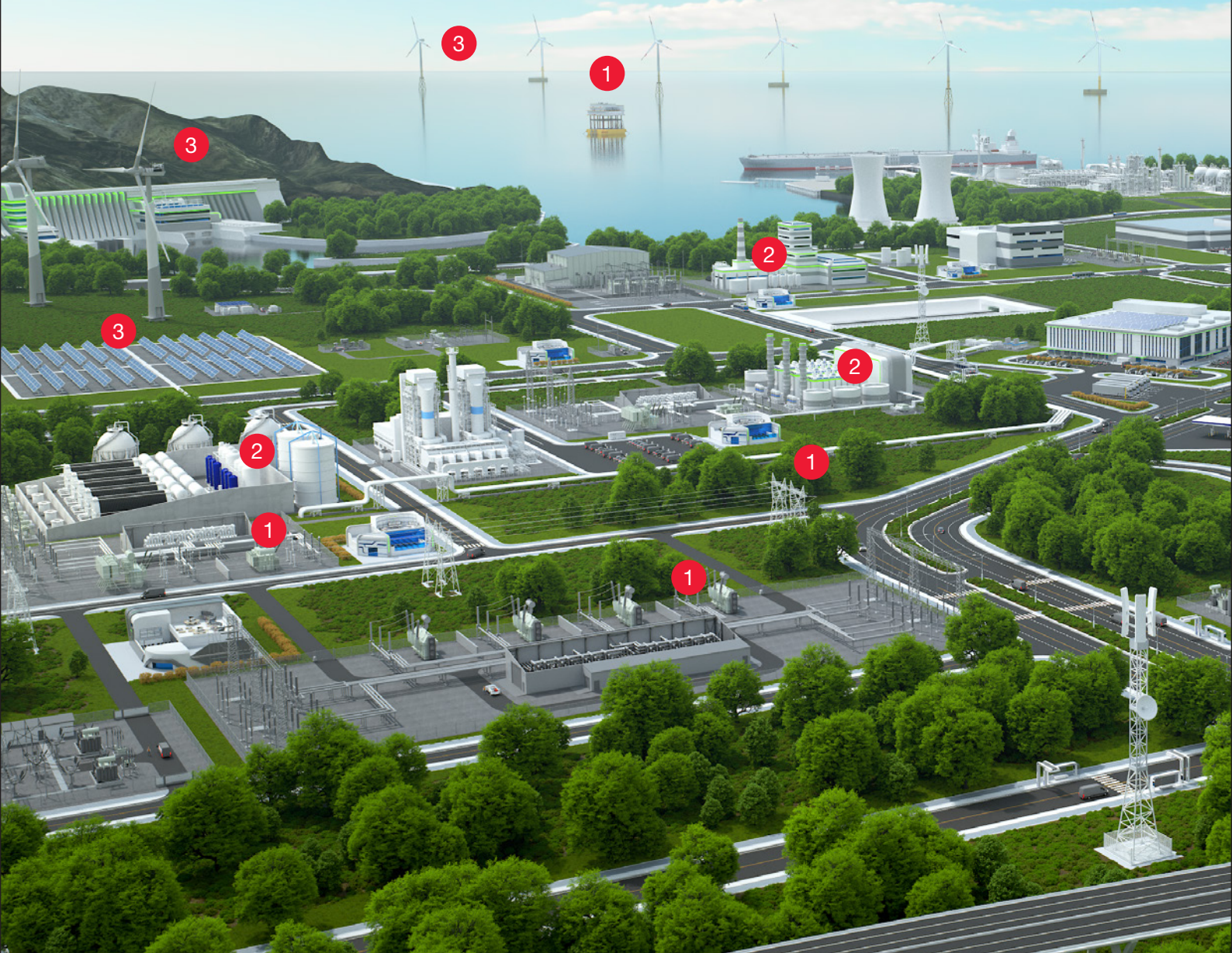
more. The 60Pak diode-diode (DD), thyristor-thyristor (TT) and hybrid thyristor / diode module (DT) rated 1800 - 2200 V are now fully qualified and available in volume (for more details see page 29). The lineup will be expanded rapidly with support for different voltages and other configurations over the next few years. In 2024 Hitachi Energy will launch a 6.5 kV high-voltage diode module with a current rating of 600 A.

Target ratings 50Pak and 60Pak

| Voltage ( V) | Package | Configuration<br>TT Thy/Thy<br>DD Dio/Dio<br>DT Dio/Thy<br>TD Thy/Dio |
|--------------|---------|-----------------------------------------------------------------------|
| 6500         | 60Pak   | DD                                                                    |
| 5000         | 60Pak   | DD                                                                    |
| 2200         | 50Pak   | DD                                                                    |
| 1800         | 50Pak   | TT, DD, DT, TD                                                        |







# Applications

Hitachi Energy's semiconductors are key components in a variety of demanding applications in markets like power transmission & distribution, industry, mobility and renewable energy. Customers rely on Hitachi Energy's high quality power semiconductor products and use them in applications in power ranges from 50 kW to 10 GW.





1

Power transmission and distribution (HVDC, FACTS, STATCOM and others)

2

Industry (medium and low-voltage drives, soft starters, UPSs, high-power rectifiers, excitation systems and others)

3

Renewable energy (converters for pumped hydro, wind turbines and solar)

4

Mobility (rail and subway main and auxiliary drives, trackside power supply / electrical vehicles)

# SEMIS 2.0

## Semiconductor simulation platform

SEMIS 2.0 is Hitachi Energy's power semiconductor simulation platform, enabling users to find optimized solutions for specific requirements.



High power semiconductor applications are very complex and, to reduce prototyping, require detailed evaluation prior to a detailed circuit analysis to find the best possible semiconductor for customized settings and conditions. Detailed thermal, power loss and switching analysis of devices based on a range of technologies enables quick, effective product evaluation, allowing engineers to bring improved energy efficiency to their customers' applications. SEMIS 2.0 makes it easy to find an optimum solution for power systems, providing a step-by-step guide to the preselection of products, data comparison and simulations.



Products can be filtered or searched based on parametric data. Filtering is based on various parameters such as housing geometry, configuration, and voltage class to refine the list of preferred products.

The table contains valuable information for primary selection of products for further investigations.

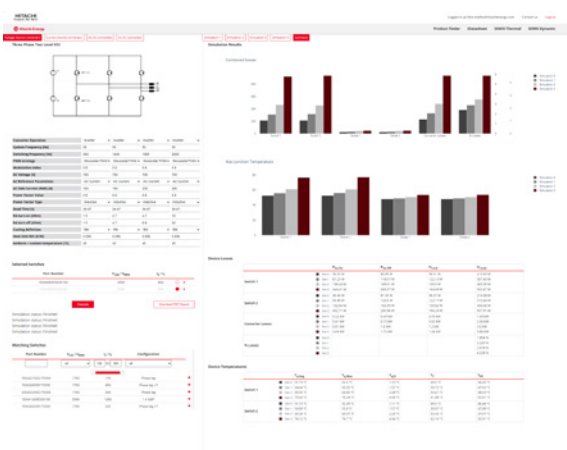
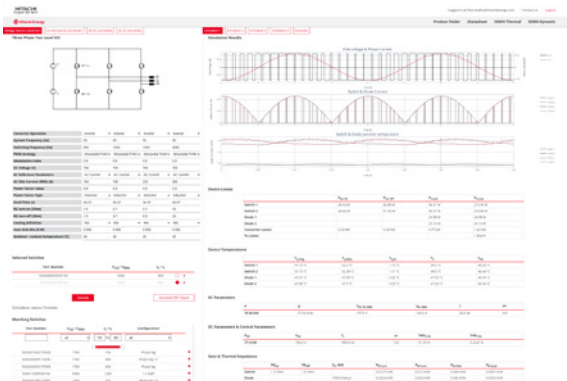
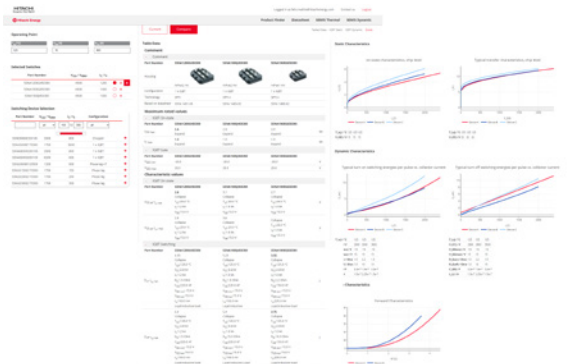
Devices can then be selected and added to the digital datasheet for further investigation. Downloadable datasheets are linked.

The SEMIS iDatasheet displays the electronic datasheet with full details of each product. Parameters are indicated with full details and conditions. The comparability enables direct assessment of parameters for multiple products by analyzing all datasheet parameters across all conditions and highlighting products with the best values. Diagrams data is plotted for comparison based on user-defined operating points. Information can be compared in real time, and the most suitable products shortlisted for further analyses with SEMIS Thermal or SEMIS Dynamic.

The comprehensive SEMIS thermal tool provides additional detailed investigation of the selected products. With more than 40 topologies, the Plecs®-based thermal simulation supports optimization of electrical, control and thermal parameters to improve energy efficiency as well as optimizing cost. With selected topologies, a selection of suitable products are indicated and are added to the simulation with one click. The combination of parameter sweeping, and the simulation of multiple products, enables comparison across a range of conditions and products to find the best product and operating efficiency.

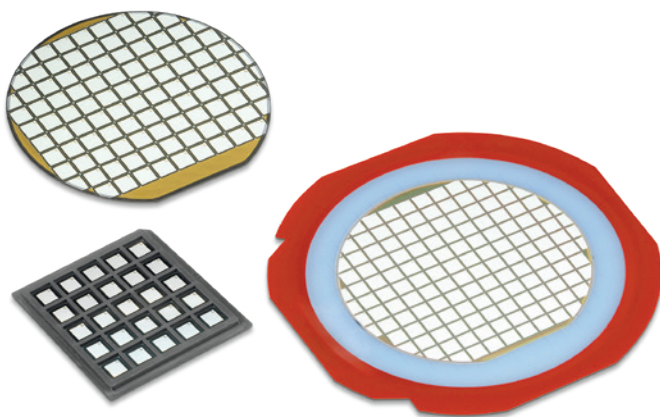
To start the simulation, circuit and control parameters are defined according to the user specification. Significant flexibility enables simulations to be adapted to customer needs. The simulation generates reliable data within seconds at a click. Using Jacobian steady-state analysis, the simulator calculates the on-state and dynamic power losses, as well as the resulting thermal variations of the semiconductors. If junction temperatures or other parameters exceed the permissible limits, alert messages are generated to ensure a safe operating area for the specific semiconductor. The detailed results are shown in tables and are plotted on charts, allowing further optimization by experienced engineers. The graphical analysis enables visual analysis of the results efficiently to reveal the optimal product immediately. The downloadable report comprises complete data, including graphical analysis that enables traceable documentation.

Based on network models, SEMIS Dynamic simulates transient switching behavior with customizable operating points and circuit definitions. Parameter specific switching times and losses as well as transient simulation are calculated. The information provided enables optimization of gate unit control and overshoot voltage to improve overall efficiency.



# IGBT and diode dies

When looking for chipsets featuring highest switching performance, ruggedness and reliability, Hitachi Energy's IGBT chips with accompanying diodes are certainly the preferred choice.



Hitachi Energy's SPT (Soft Punch Through) chipsets and their improved versions with lower losses (SPT<sup>+</sup> and SPT<sup>++</sup>) are available at 1200 V and 1700 V. They feature highest output power per rated ampere due to a moderate chip shrinkage and thus larger die area. Additionally to these well-established planar chip technologies, starting 2022, Hitachi Energy is adding a new chipset based on the recently developed Trench Fine Pattern (TFP) technology.

Typical applications for 1200 V are power converters for industrial drives, solar energy, battery backup systems (UPS) and electrical vehicles. Applications for 1700 V also include industrial power conversion & drives, wind turbines and traction converters.

## Diode dies

| Part number             | Type                   | Size A x B<br>mm | Thickness<br>μm | V <sub>PRM</sub> (V) | I <sub>F</sub> (A) | V <sub>F</sub> (V)<br>typ. 125 °C | Max. dies per wafer |
|-------------------------|------------------------|------------------|-----------------|----------------------|--------------------|-----------------------------------|---------------------|
| 1.2 kV                  |                        |                  |                 |                      |                    |                                   |                     |
| <b>5SLY 86E1200</b>     | SPT <sup>+</sup>       | 6.3 x 6.3        | 350             | 1200                 | 50                 | 1.85                              | 361                 |
| <b>5SLY 86F1200</b>     | SPT <sup>+</sup>       | 7.4 x 7.4        | 350             | 1200                 | 75                 | 1.85                              | 257                 |
| <b>5SLY 86G1200</b>     | SPT <sup>+</sup>       | 8.4 x 8.4        | 350             | 1200                 | 100                | 1.85                              | 198                 |
| <b>5SLY 86J1200</b>     | SPT <sup>+</sup>       | 10.0 x 10.0      | 350             | 1200                 | 150                | 1.85                              | 137                 |
| <b>5SLZ 88F1200 New</b> | SPT <sup>++</sup> /FSA | 10.1 x 5.6       | 140             | 1200                 | 150                | 1.71                              | 454                 |
| <b>5SLZ 88J1200 New</b> | SPT <sup>++</sup> /FSA | 11.8 x 8.7       | 140             | 1200                 | 300                | 1.71                              | 240                 |



| Part number         | Type                   | Size A x B<br>mm | Thickness<br>$\mu\text{m}$ | $V_{\text{PRM}}$ (V) | $I_{\text{F}}$ (A) | $V_{\text{F}}$ (V)<br>typ. 125 °C | Max. dies per wafer |
|---------------------|------------------------|------------------|----------------------------|----------------------|--------------------|-----------------------------------|---------------------|
| 1.7 kV              |                        |                  |                            |                      |                    |                                   |                     |
| <b>5SLY 86E1700</b> | SPT <sup>+</sup>       | 6.6 x 6.6        | 390                        | 1700                 | 50                 | 2.1                               | 326                 |
| <b>5SLZ 86E1700</b> | SPT <sup>++</sup> /FSA | 6.6 x 6.6        | 370                        | 1700                 | 50                 | 1.75                              | 326                 |
| <b>5SLY 86F1700</b> | SPT <sup>+</sup>       | 7.7 x 7.7        | 390                        | 1700                 | 75                 | 2.1                               | 237                 |
| <b>5SLZ 86F1700</b> | SPT <sup>++</sup> /FSA | 7.7 x 7.7        | 370                        | 1700                 | 75                 | 1.75                              | 237                 |
| <b>5SLY 86G1700</b> | SPT <sup>+</sup>       | 8.6 x 8.6        | 390                        | 1700                 | 100                | 2.1                               | 188                 |
| <b>5SLZ 86G1700</b> | SPT <sup>++</sup> /FSA | 8.6 x 8.6        | 370                        | 1700                 | 100                | 1.75                              | 177                 |
| <b>5SLY 86J1700</b> | SPT <sup>+</sup>       | 10.2 x 10.2      | 390                        | 1700                 | 150                | 2.1                               | 131                 |
| <b>5SLZ 86J1700</b> | SPT <sup>++</sup> /FSA | 10.2 x 10.2      | 370                        | 1700                 | 150                | 1.75                              | 131                 |
| <b>5SLZ 86L1700</b> | SPT <sup>++</sup> /FSA | 9.3 x 15.9       | 370                        | 1700                 | 225                | 1.75                              | 92                  |
| <b>5SLY 86M1700</b> | SPT <sup>+</sup>       | 13.6 x 13.6      | 390                        | 1700                 | 300                | 2.1                               | 69                  |

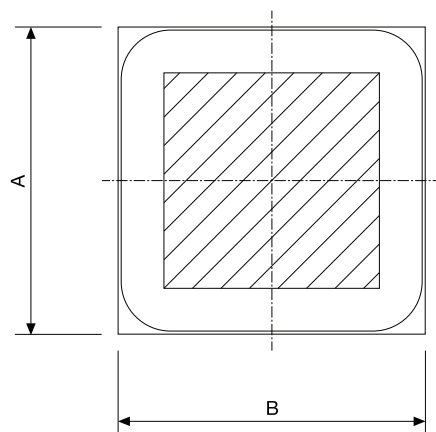
## IGBT dies

| Part number         | Type              | Size A x B<br>mm | Thickness<br>$\mu\text{m}$ | $V_{\text{CES}}$ (V) | $I_{\text{C}}$ (A) | $I_{\text{CM}}$ (A) | $V_{\text{CESat}}$ (V)<br>typ. 125 °C | Max. dies per wafer |
|---------------------|-------------------|------------------|----------------------------|----------------------|--------------------|---------------------|---------------------------------------|---------------------|
| 1.2 kV              |                   |                  |                            |                      |                    |                     |                                       |                     |
| <b>5SMY 86H1280</b> | SPT <sup>+</sup>  | 9.1 x 9.1        | 140                        | 1200                 | 57                 | 114                 | 2.1                                   | 166                 |
| <b>5SMY 86J1280</b> | SPT <sup>+</sup>  | 10.2 x 10.2      | 140                        | 1200                 | 75                 | 150                 | 2.1                                   | 130                 |
| <b>5SMY 86K1280</b> | SPT <sup>+</sup>  | 11.2 x 11.9      | 140                        | 1200                 | 100                | 200                 | 2.1                                   | 98                  |
| <b>5SMY 86M1280</b> | SPT <sup>+</sup>  | 13.5 x 13.5      | 140                        | 1200                 | 150                | 300                 | 2.2                                   | 71                  |
| 1.7 kV              |                   |                  |                            |                      |                    |                     |                                       |                     |
| <b>5SMY 86G1721</b> | SPT <sup>+</sup>  | 8.6 x 8.6        | 209                        | 1700                 | 50                 | 100                 | 3.0                                   | 186                 |
| <b>5SMY 86J1722</b> | SPT <sup>+</sup>  | 10 x 10          | 209                        | 1700                 | 75                 | 150                 | 3.0                                   | 132                 |
| <b>5SMY 86J1732</b> | SPT <sup>+</sup>  | 10 x 10          | 190                        | 1700                 | 75                 | 150                 | 2.55                                  | 132                 |
| <b>5SMY 86K1722</b> | SPT <sup>+</sup>  | 11.3 x 11.3      | 209                        | 1700                 | 100                | 200                 | 3.0                                   | 104                 |
| <b>5SMY 86K1732</b> | SPT <sup>++</sup> | 11.3 x 11.3      | 190                        | 1700                 | 100                | 200                 | 2.55                                  | 104                 |
| <b>5SMY 86L1731</b> | SPT <sup>++</sup> | 7.4 x 19.9       | 190                        | 1700                 | 120                | 240                 | 2.7                                   | 86                  |
| <b>5SMY 86M1721</b> | SPT <sup>+</sup>  | 13.6 x 13.6      | 209                        | 1700                 | 150                | 300                 | 3.0                                   | 69                  |
| <b>5SMY 86M1730</b> | SPT <sup>++</sup> | 13.6 x 13.6      | 190                        | 1700                 | 150                | 300                 | 2.55                                  | 69                  |
| <b>5SMY 86M1731</b> | SPT <sup>++</sup> | 13.9 x 14.0      | 190                        | 1700                 | 160                | 320                 | 2.55                                  | 66                  |
| <b>5SMY 86P1730</b> | SPT <sup>++</sup> | 15.9 x 16.9      | 190                        | 1700                 | 225                | 450                 | 2.55                                  | 46                  |
| <b>5SMY 86Q1731</b> | SPT <sup>++</sup> | 16.4 x 18.0      | 190                        | 1700                 | 250                | 500                 | 2.55                                  | 44                  |

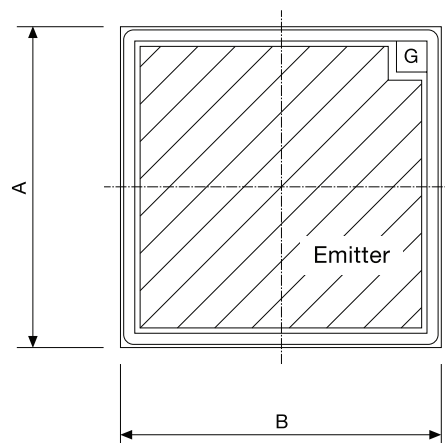
Please refer to page 60 for part numbering structure.

01  
Diode dies02  
IGBT dies

01



02



# Medium-power IGBT modules

Hitachi Energy enhances its successful IGBT module range into the medium-power segment. Starting with the 62Pak and the LoPak1, Hitachi Energy brings the proven high quality and reliability of the HiPak modules to the medium-power IGBT segment.

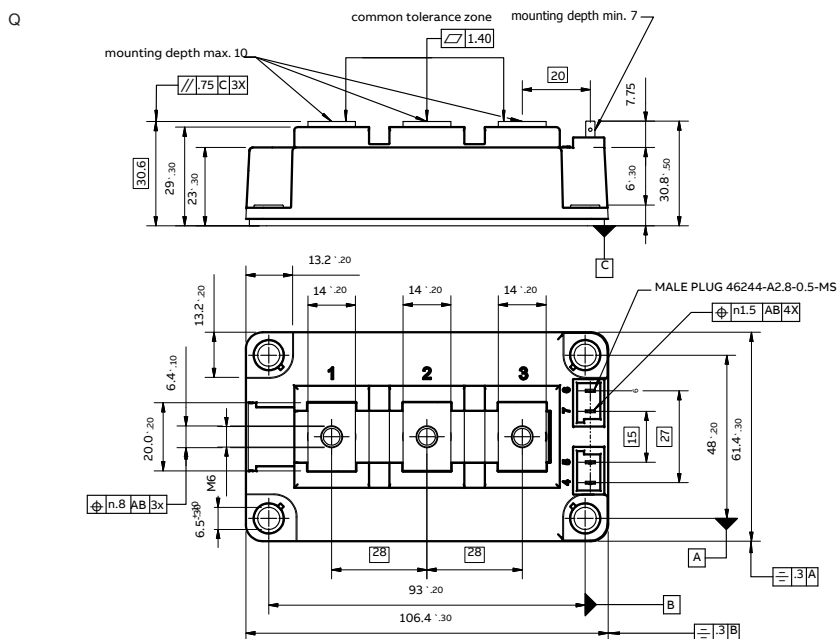


Hitachi Energy's 62Pak modules have an advanced packaging technology that leverages the performance of the latest silicon technology:

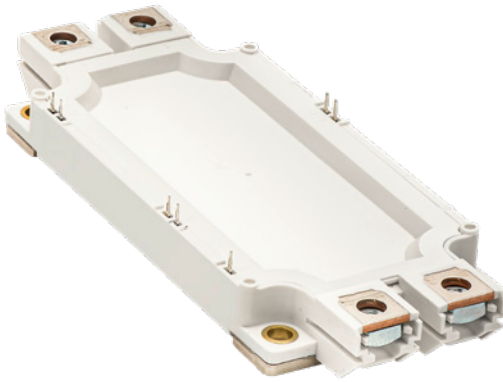
- 1700 V SPT<sup>++</sup> fast switching IGBT / diode chipset with lowest switching losses
- Full 175 °C operation temperature with full square SOA
- Best-in-class temperature cycling performance of bond-wire chip connection
- Standard package allowing drop-in replacement

| Part number<br>T <sub>vj</sub> (operational) up to 175 °C | Voltage V <sub>CES</sub> (V) | Current I <sub>C</sub> (A) | Configuration        | V <sub>CESat</sub> (V) | V <sub>F</sub> (V) | Housing |
|-----------------------------------------------------------|------------------------------|----------------------------|----------------------|------------------------|--------------------|---------|
| 1.7 kV                                                    |                              |                            |                      |                        |                    |         |
| <b>5SNG 0150Q170300</b>                                   | 1700                         | 2 x 150                    | (5) - Phase leg IGBT | 2.55                   | 1.75               | Q       |
| <b>5SNG 0200Q170300</b>                                   | 1700                         | 2 x 200                    | (5) - Phase leg IGBT | 2.55                   | 1.75               | Q       |
| <b>5SNG 0300Q170300</b>                                   | 1700                         | 2 x 300                    | (5) - Phase leg IGBT | 2.55                   | 1.75               | Q       |

Please refer to page 61 for part numbering structure.  
Configurations on page 24



Dimensions in mm



Hitachi Energy's LoPak is 100 % mechanically compatible with the Econo-type dual IGBT modules. It sets a new benchmark with full switching performance up to 175 °C. It is specifically designed for excellent internal current sharing, offering optimal thermal utilization and increased robustness.

In addition, we offer LoPak 1200 V and 1700 V with an optional feature: the pre-applied Thermal Interface Material (TIM).

The use of TIM improves the thermal conduction at the module baseplate/heatsink interface ensuring more stability over long-term operation. Typical applications include:

- Wind power converters
- Variable speed drives
- Power supplies
- Power quality
- UPS

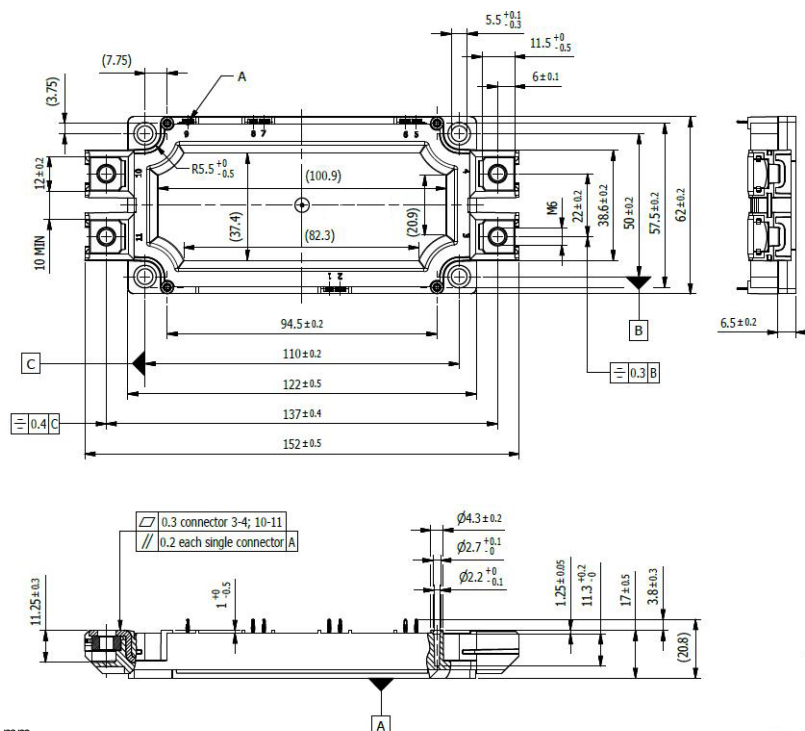
| Part number<br>T (operational) up to 175 °C | Voltage $V_{CES}$ (V) | Current $I_C$ (A) | Configuration        | $V_{CEsat}$ (V) | $V_F$ (V) | Housing     |
|---------------------------------------------|-----------------------|-------------------|----------------------|-----------------|-----------|-------------|
| 1.2 kV                                      |                       |                   |                      |                 |           |             |
| <b>5SNG 0600R120500</b>                     | 1200                  | 2 x 600           | (5) - Phase leg IGBT | 1.71            | 1.71      | R           |
| <b>5SNG 0600R120590</b>                     | 1200                  | 2 x 600           | (5) - Phase leg IGBT | 1.71            | 1.71      | R incl. TIM |
| <b>5SNG 0900R120500</b>                     | 1200                  | 2 x 900           | (5) - Phase leg IGBT | 1.71            | 1.71      | R           |
| <b>5SNG 0900R120590</b>                     | 1200                  | 2 x 900           | (5) - Phase leg IGBT | 1.71            | 1.71      | R incl. TIM |
| 1.7 kV                                      |                       |                   |                      |                 |           |             |
| <b>5SNG 0225R170300</b>                     | 1700                  | 2 x 225           | (5) - Phase leg IGBT | 2.55            | 1.75      | R           |
| <b>5SNG 0225R170390</b>                     | 1700                  | 2 x 225           | (5) - Phase leg IGBT | 2.55            | 1.75      | R incl. TIM |
| <b>5SNG 0300R170300</b>                     | 1700                  | 2 x 300           | (5) - Phase leg IGBT | 2.55            | 1.75      | R           |
| <b>5SNG 0300R170390</b>                     | 1700                  | 2 x 300           | (5) - Phase leg IGBT | 2.55            | 1.75      | R incl. TIM |
| <b>5SNG 0450R170300</b>                     | 1700                  | 2 x 450           | (5) - Phase leg IGBT | 2.55            | 1.75      | R           |
| <b>5SNG 0450R170390</b>                     | 1700                  | 2 x 450           | (5) - Phase leg IGBT | 2.55            | 1.75      | R incl. TIM |
| <b>5SNG 0750R170300*</b>                    | 1700                  | 2 x 750           | (5) - Phase leg IGBT | 2.41            | 1.99      | R           |
| <b>5SNG 0750R170390*</b>                    | 1700                  | 2 x 750           | (5) - Phase leg IGBT | 2.41            | 1.99      | R incl. TIM |

Please refer to page 61 for part numbering structure.

Configurations on page 24

\* Contact factory

R



Dimensions in mm



# Power IGBT/MOSFET and diode modules

Hitachi Energy offers three categories of high-power IGBT and diode modules: Insulated, press-pack and the newly launched SiC modules for e-mobility applications.

Insulated modules consist of the new innovative, low inductive phase leg LinPak and the well-established HiPak lineup with more than 15 years and more than 1 million modules in the field.

Press-pack modules are a range of pressure contact IGBT modules also known as StakPak. StakPaks are Hitachi Energy's flagship products with record power ratings up to 5200 V and more than 3000 A.

The new e-mobility module portfolio takes advantage of silicon carbide (SiC) technology, offering benefits like high-current rating in a small package and a with very low stray inductance.

Hitachi Energy's power IGBT and diode module families are:

- RoadPak modules page 18
- LinPak IGBT & SiC MOSFET modules page 20
- HiPak IGBT and diode modules page 22
- StakPak IGBT press-pack modules page 26





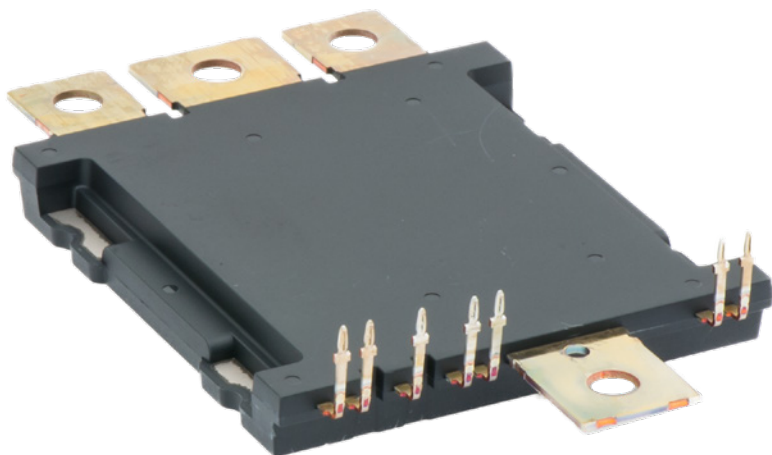


# RoadPak™ SiC e-mobility module

The RoadPak is our newest innovative solution for all e-mobility applications. It enables the design of converters with lowest overall stray inductance, thanks to the latest generation of SiC MOSFET chipset and enhanced liquid cooling performance due to its pin-fin baseplate.

RoadPak applications include amongst others main drive train for xEVs, e-trucks, e-busses, traction auxiliary converters, as well as power electronics for xEV-charging. In addition, the RoadPak allows very easy low inductive connections and supports several numbers of parallel chips, thus the current rating of the inverters can be scaled up with just one module type. This allows the use of RoadPak in a well defined converter portfolio based on various performance classes.

Thanks to its exceptional low stray inductance (5 nH), the RoadPak is the ideal package to deliver the full potential of high-power SiC devices. Additionally, Hitachi Energy offers optimized gate units for the RoadPak, as well as a cooler for three devices in a 3-phase inverter configuration. Our RoadPak modules feature the lowest switching losses, highest performance and excellent robustness, while supporting two chipsets: our own Hitachi Energy chipset and an external chipset to reduce supply chain challenges and ensure product availability.

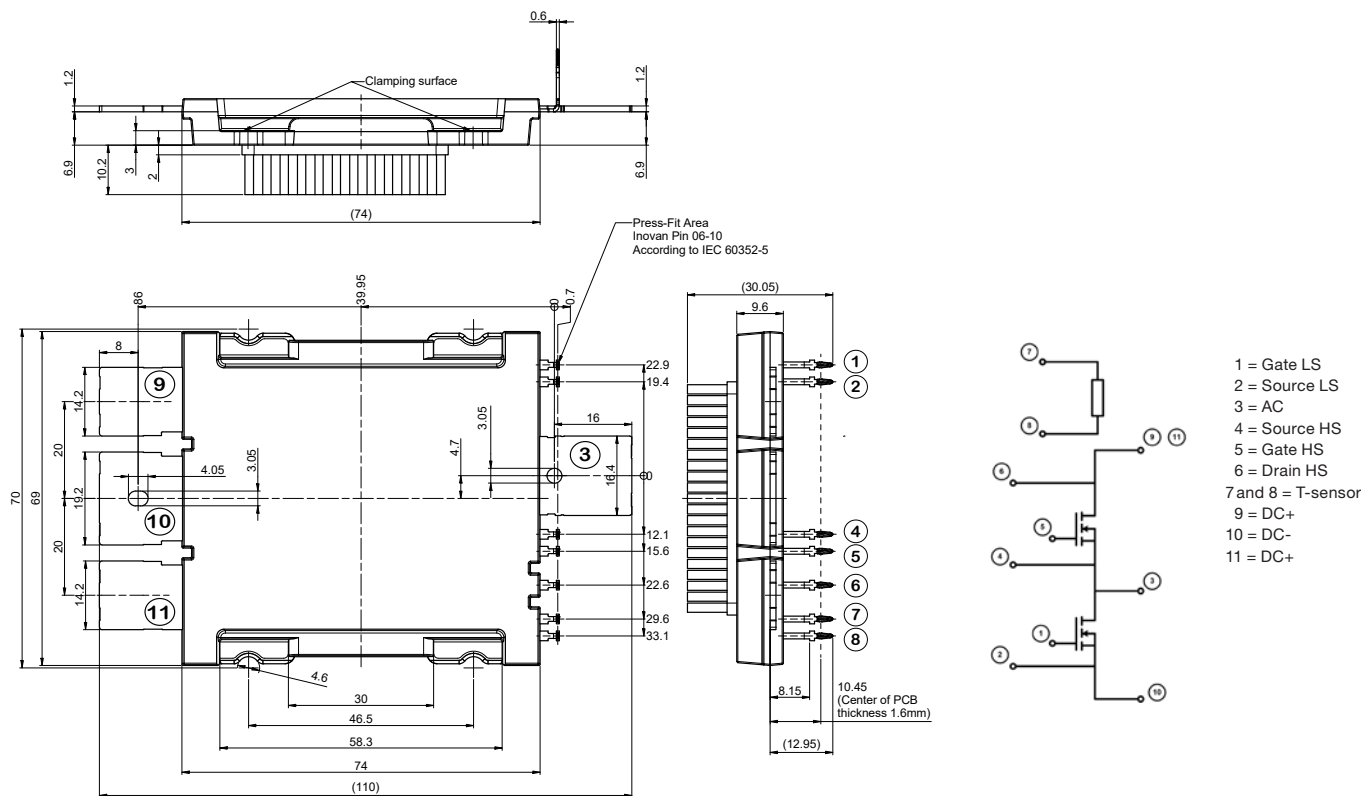


| Part number<br>$T_{vj}$ (operational) up to 175 °C | Voltage $V_{DS}$ (V) | Current $I_D$ (A) | Configuration          | $R_{DS(on)}$ (mΩ)<br>typ. 25 °C | $R_{DS(on)}$ (mΩ)<br>typ. 175 °C | Housing |
|----------------------------------------------------|----------------------|-------------------|------------------------|---------------------------------|----------------------------------|---------|
| <b>5SFG 0660B07500x</b>                            | 750                  | 2 x 660           | (5) - Phase-leg MOSFET | 2.4                             | 4.2                              | B       |
| <b>5SFG 0880B07500x</b>                            | 750                  | 2 x 880           | (5) - Phase-leg MOSFET | 1.8                             | 3.2                              | B       |
| <b>5SFG 1100B07500x</b>                            | 750                  | 2 x 1100          | (5) - Phase-leg MOSFET | 1.4                             | 2.5                              | B       |
| <b>5SFG 0580B12000x</b>                            | 1200                 | 2 x 580           | (5) - Phase-leg MOSFET | 2.9                             | 5.5                              | B       |
| <b>5SFG 0780B12000x</b>                            | 1200                 | 2 x 780           | (5) - Phase-leg MOSFET | 2.2                             | 4.1                              | B       |
| <b>5SFG 0980B12000x</b>                            | 1200                 | 2 x 980           | (5) - Phase-leg MOSFET | 1.8                             | 3.3                              | B       |

Please refer to page 61 for part numbering structure.

On request:

- Optimized gate unit
- Cooler for 3-phase inverter design



Dimensions in mm



# LinPak IGBT & SiC MOSFET modules

The LinPak is a new innovative solution for all power conversion applications. It enables the design of converters with lowest overall inductance, thus fast low switching loss chipsets can be used for the first time also in high-current applications.

These applications include amongst others traction, converters for wind turbines or other renewables, industrial drives, as well as power electronics for FACTS applications. In addition, the LinPak allows very easy parallel connection, thus the current rating of the inverters can be scaled up with just one part number.

This makes the supply chain and initial device design-in efforts significantly more efficient.

Thanks to its exceptional low stray inductance, the LinPak is the ideal package to demonstrate the performance of high-power SiC. Hitachi Energy offers a SiC demonstrator module for customers to evaluate the SiC performance.

Hitachi Energy's LinPak modules feature lowest switching losses and excellent robustness thanks to its low inductance.



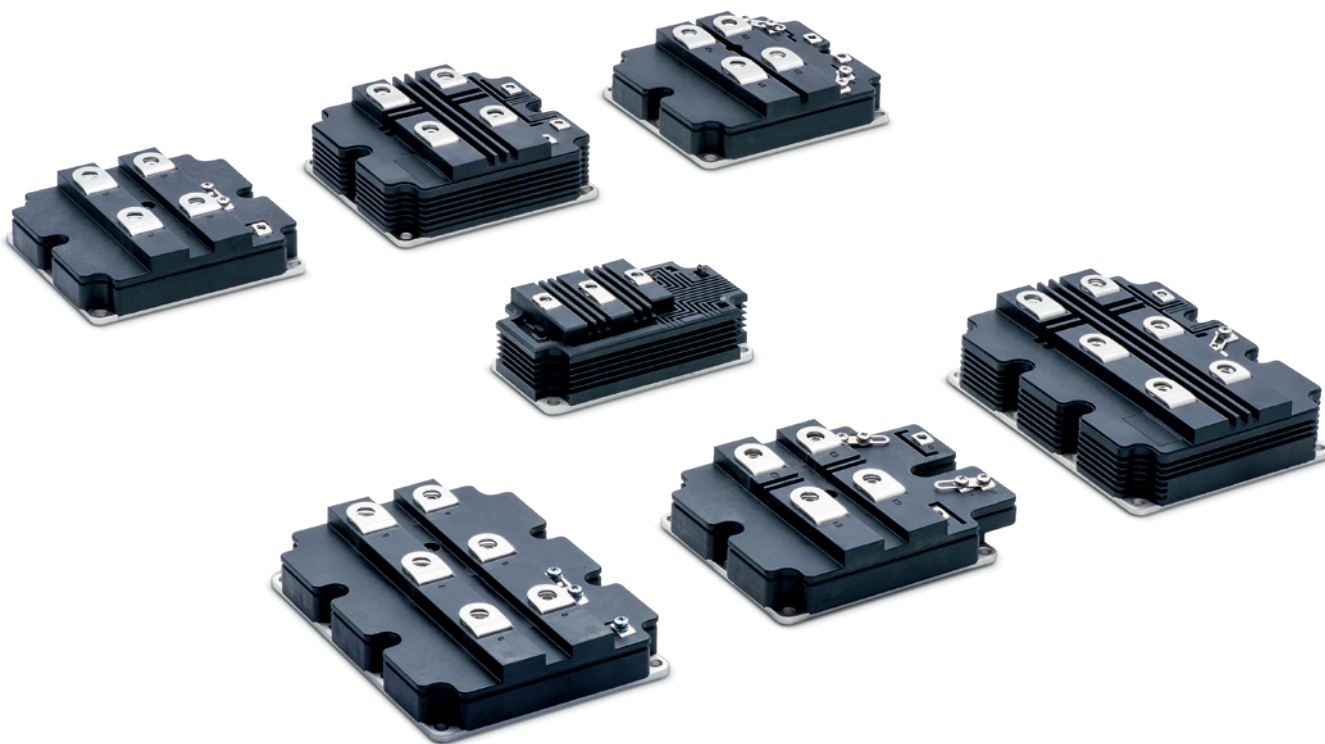


# HiPak IGBT and diode modules

Demanding high-power applications such as traction inverters, medium-voltage drives, wind turbine converters, HVDC or FACTS are looking for the highest reliability IGBT modules.

Hitachi Energy's HiPak family of IGBT modules is the best fit to demanding applications, continuing to set new standards of robustness.

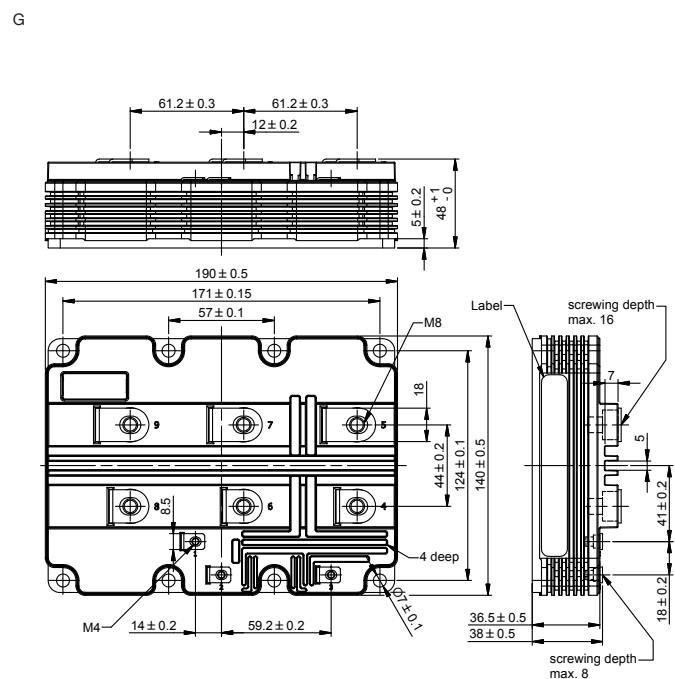
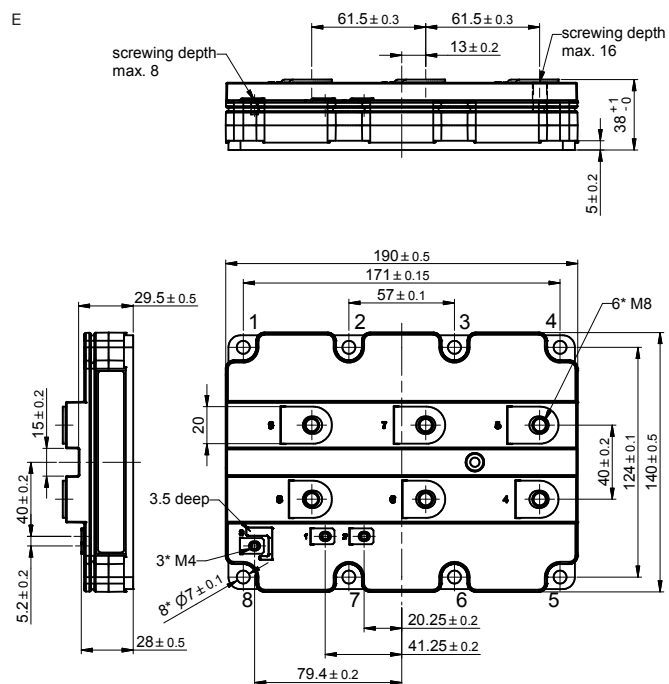
Hitachi Energy's HiPak IGBT modules are available from 1700 V to 6500 V in various configurations. They all feature low losses combined with soft-switching performance and record-breaking Safe Operating Area (SOA).





| Part number<br>$T_{vj}$ (operational) up to 125 °C | Voltage $V_{CES}$ (V) | Current $I_C$ (A) | Configuration         | $V_{CEsat}$ (V)<br>typ. 125 °C | $V_F$ (V)<br>typ. 125 °C | Housing |
|----------------------------------------------------|-----------------------|-------------------|-----------------------|--------------------------------|--------------------------|---------|
| 1.7 kV                                             |                       |                   |                       |                                |                          |         |
| <b>5SND 1200M170300</b>                            | 1700                  | 2 x 1200          | (3) – Dual IGBT       | 3.0                            | 1.95                     | M       |
| <b>5SNE 1200M170300</b>                            | 1700                  | 1200              | (2) – Chopper         | 3.0                            | 1.95                     | M       |
| <b>5SNA 1600N170300</b>                            | 1700                  | 1600              | (1) – Single IGBT     | 2.4                            | 1.67                     | N1      |
| <b>5SNE 1600E170300</b>                            | 1700                  | 1600              | (2) – Chopper         | 2.4                            | 1.67                     | E       |
| <b>5SNA 2400N170300</b>                            | 1700                  | 2400              | (1) – Single IGBT     | 3.0                            | 1.95                     | N1      |
| <b>5SNA 2400E170305</b>                            | 1700                  | 2400              | (1) – Single IGBT     | 2.4                            | 1.67                     | E       |
| <b>5SNE 2400E170300</b>                            | 1700                  | 2400              | (2) – Chopper         | 3.0                            | 1.95                     | E       |
| <b>5SLA 3600E170300</b>                            | 1700                  | 3600              | (6) – Single Diode    | –                              | 1.95                     | E       |
| <b>5SNA 3600E170300</b>                            | 1700                  | 3600              | (1) – Single IGBT     | 3.0                            | 1.95                     | E       |
| 3.3 kV                                             |                       |                   |                       |                                |                          |         |
| <b>5SNG 0250P330305</b>                            | 3300                  | 2 x 250           | (5) – Phase leg IGBT  | 3.1                            | 2.25                     | P       |
| <b>5SLG 0500P330300</b>                            | 3300                  | 2 x 500           | (7) – Phase leg Diode | –                              | 2.25                     | P       |
| <b>5SNA 0800N330100</b>                            | 3300                  | 800               | (1) – Single IGBT     | 3.8                            | 2.35                     | N1      |
| <b>5SNE 0800E330100</b>                            | 3300                  | 800               | (2) – Chopper         | 3.8                            | 2.35                     | E       |
| <b>5SNA 1000N330300</b>                            | 3300                  | 1000              | (1) – Single IGBT     | 3.1                            | 2.25                     | N1      |
| <b>5SNE 1000E330300</b>                            | 3300                  | 1000              | (2) – Chopper         | 3.1                            | 2.25                     | E       |
| <b>5SLD 1000N330300</b>                            | 3300                  | 2 x 1000          | (4) – Dual Diode      | –                              | 2.25                     | N1      |
| <b>5SNA 1200E330100</b>                            | 3300                  | 1200              | (1) – Single IGBT     | 3.8                            | 2.35                     | E       |
| <b>5SNA 1200G330100</b>                            | 3300                  | 1200              | (1) – Single IGBT     | 3.85                           | 2.35                     | G       |
| <b>5SLD 1200J330100</b>                            | 3300                  | 2 x 1200          | (4) – Dual Diode      | –                              | 2.35                     | J       |
| <b>5SNA 1200N330400</b>                            | 3300                  | 1200              | (1) – Single IGBT     | 2.9                            | 2.20                     | N       |
| <b>5SNA 1500E330305</b>                            | 3300                  | 1500              | (1) – Single IGBT     | 3.1                            | 2.25                     | E       |
| <b>5SNA 1800E330400</b>                            | 3300                  | 1800              | (1) – Single IGBT     | 2.9                            | 2.20                     | E       |
| <b>5SNA 1800G330400</b>                            | 3300                  | 1800              | (1) – Single IGBT     | 2.9                            | 2.20                     | G       |
| 4.5 kV                                             |                       |                   |                       |                                |                          |         |
| <b>5SNG 0150P450300</b>                            | 4500                  | 2 x 150           | (5) – Phase leg IGBT  | 3.5                            | 3.45                     | P       |
| <b>5SLG 0600P450300</b>                            | 4500                  | 2 x 600           | (7) – Phase leg Diode | –                              | 3.5                      | P       |
| <b>5SNA 0650J450300</b>                            | 4500                  | 650               | (1) – Single IGBT     | 3.7                            | 3.4                      | J       |
| <b>5SLD 0650J450300</b>                            | 4500                  | 2 x 650           | (4) – Dual Diode      | –                              | 3.4                      | J       |
| <b>5SNA 0800J450300</b>                            | 4500                  | 800               | (1) – Single IGBT     | 3.55                           | 3.5                      | J       |
| <b>5SNE 0800G450300</b>                            | 4500                  | 800               | (2) – Chopper         | 3.55                           | 3.5                      | G       |
| <b>5SNA 1000J450300</b>                            | 4500                  | 1000              | (1) – Single IGBT     | 3.55                           | 2.8                      | J       |
| <b>5SNA 1200G450300</b>                            | 4500                  | 1200              | (1) – Single IGBT     | 3.55                           | 3.5                      | G       |
| <b>5SNA 1200G450350</b>                            | 4500                  | 1200              | (1) – Single IGBT     | 3.55                           | 3.5                      | G       |
| <b>5SLD 1200J450350</b>                            | 4500                  | 2 x 1200          | (4) – Dual Diode      | –                              | 3.5                      | J       |
| <b>5SLD 1500J450350</b>                            | 4500                  | 2 x 1500          | (4) – Dual Diode      | –                              | 2.8                      | J       |
| <b>5SNA 1500E450300</b>                            | 4500                  | 1500              | (1) – Single IGBT     | 3.55                           | 2.8                      | E       |
| <b>5SNA 1500G450300</b>                            | 4500                  | 1500              | (1) – Single IGBT     | 3.55                           | 2.8                      | G       |
| <b>5SNA 1500G450350</b>                            | 4500                  | 1500              | (1) – Single IGBT     | 3.55                           | 2.8                      | G       |
| 6.5 kV                                             |                       |                   |                       |                                |                          |         |
| <b>5SNA 0400J650100</b>                            | 6500                  | 400               | (1) – Single IGBT     | 5.4                            | 3.4                      | J       |
| <b>5SNA 0500J650300</b>                            | 6500                  | 500               | (1) – Single IGBT     | 3.9                            | 3.4                      | J       |
| <b>5SNA 0600G650100</b>                            | 6500                  | 600               | (1) – Single IGBT     | 5.4                            | 3.4                      | G       |
| <b>5SLD 0600J650100</b>                            | 6500                  | 2 x 600           | (4) – Dual Diode      | –                              | 3.4                      | J       |
| <b>5SNA 0750G650300</b>                            | 6500                  | 750               | (1) – Single IGBT     | 3.9                            | 3.4                      | G       |
| <b>5SNA 1000G650300</b>                            | 6500                  | 1000              | (1) – Single IGBT     | 4.1                            | 3.3                      | G       |
| <b>5SLD 1000J650300 New</b>                        | 6500                  | 2 x 1000          | (4) – Dual Diode      | –                              | 3.3                      | J       |

Please refer to page 61 for part numbering structure.





# StakPak IGBT press-pack modules

To enhance reliability and reduce cost in systems that require redundancy and series connected IGBT modules, one should consider using Hitachi Energy's StakPaks.

Hitachi Energy's StakPak family uses a well proven concept in IGBT press-pack technology that:

- allows for easy mechanical and electrical series connection
- allows for easy stack design thanks to high tolerance for inhomogeneous mounting pressure
- guarantees a uniform chip pressure in multiple-device stacks
- provides a stable shorted state in case of failure
- long-term short-circuit failure mode (SCFM) available

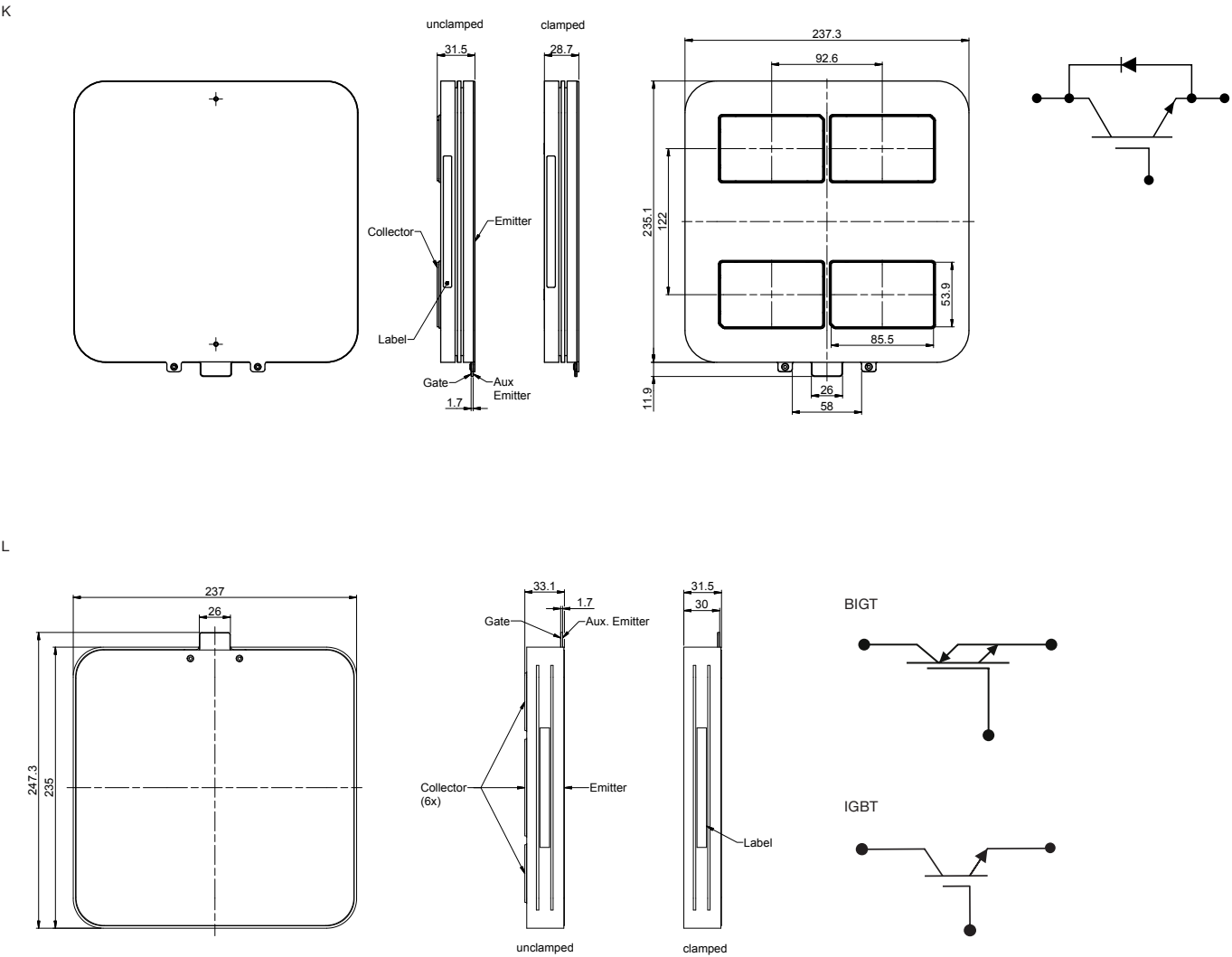
Hitachi Energy's StakPak IGBT modules are therefore a perfect match for applications like HVDC, FACTS, breakers and pulsed power.





| Part number      | Voltage $V_{CES}$ (V) | Current $I_C$ (A) | $V_{CEsat}$ (V)<br>typ. 125 °C | $V_F$ (V)<br>typ. 125 °C | IGBT-to-diode<br>ratio | Housings | SCFM<br>rating |
|------------------|-----------------------|-------------------|--------------------------------|--------------------------|------------------------|----------|----------------|
| 5SNA 1300K450300 | 4500                  | 1300              | 3.4                            | 2.4                      | 1:1                    | K        | Yes            |
| 5SNA 2000K450300 | 4500                  | 2000              | 3.4                            | 2.4                      | 1:1                    | K        | Yes            |
| 5SNA 2000K451300 | 4500                  | 2000              | 3.65                           | 3.0                      | 2:1                    | K        | Yes            |
| 5SNA 2000K452300 | 4500                  | 2000              | 3.65                           | 3.0                      | 2:1                    | K        | No             |
| 5SNA 3000K452300 | 4500                  | 3000              | 3.65                           | 3.0                      | 2:1                    | K        | No             |
| 5SMA 3000L450300 | 4500                  | 3000              | 3.1                            | –                        | 1:0                    | L        | No             |

Please refer to page 61 for part numbering structure.





# Diode and thyristor modules

## 60Pak

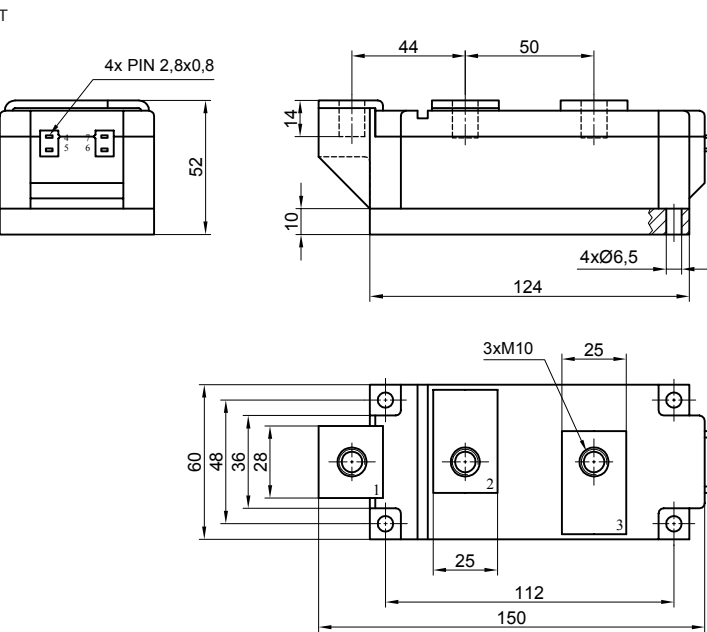
Hitachi Energy’s diode and thyristor modules feature industry standard housings and very low losses together with the highest operating temperatures.



They provide the ultimate in reliability and are the epitome of quality. Whether efficiently driving industrial motors, smoothly accelerating fans and pumps, or supply power to demanding applications. The key benefits of the new 60Pak module are highest performance, outstanding reliability and increased overload capability. All highest quality Hitachi Energy’s assets wrapped in a standard industrial housing

| Part number         | $V_{RRM}$ (V) | $I_{FAVM}$ (A) | Configuration                     | Housing |
|---------------------|---------------|----------------|-----------------------------------|---------|
| 5SET 0540T1800      | 1800          | 522            | Thyristor / Thyristor (Phase leg) | 60 mm   |
| 5SEG 0540T1820      | 1800          | 522            | Thyristor / Diode (Phase leg)     | 60 mm   |
| 5SEE 0540T1830      | 1800          | 522            | Diode / Thyristor (Phase leg)     | 60 mm   |
| 5SED 0890T2240      | 2200          | 889            | Diode / Diode (Phase leg)         | 60 mm   |
| 5SED 0890T2250* New | 2200          | 889            | Diode / diode (common anode)      | 60 mm   |
| 5SED 0890T2260* New | 2200          | 889            | Diode / diode (common cathode)    | 60 mm   |

Please refer to page 63 for part numbering structure /  
\* Contact factory



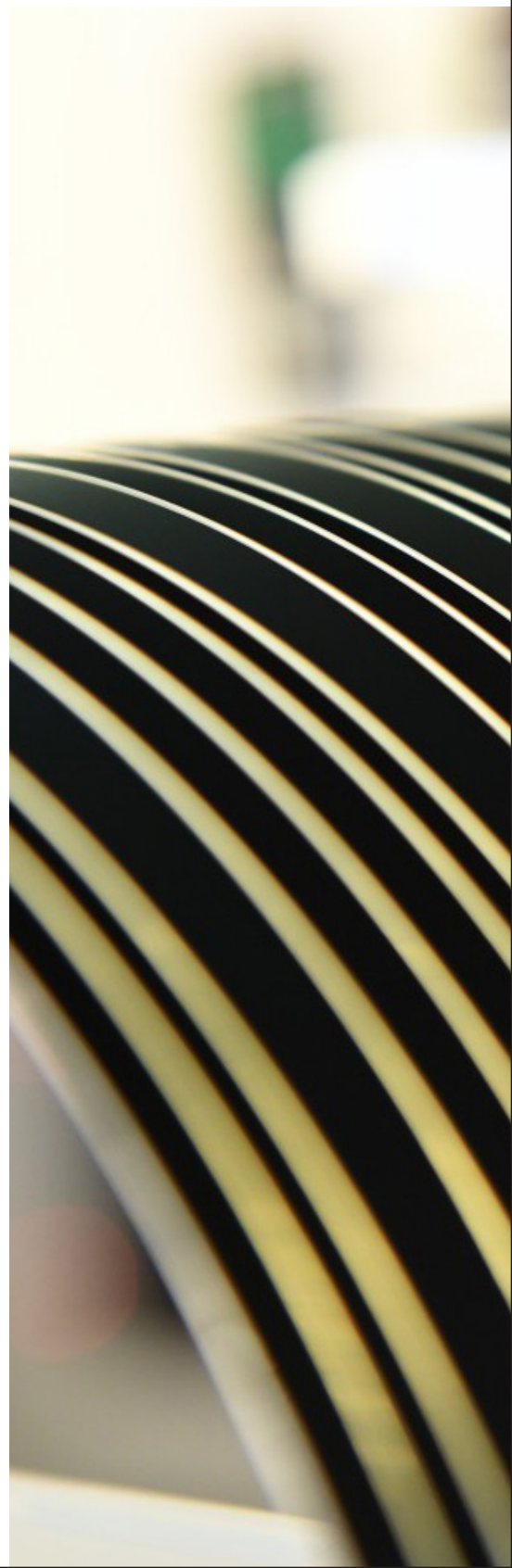
# Diodes

Diodes are used in a number of different applications. Each of these applications sets different requirements on the diodes' characteristics.

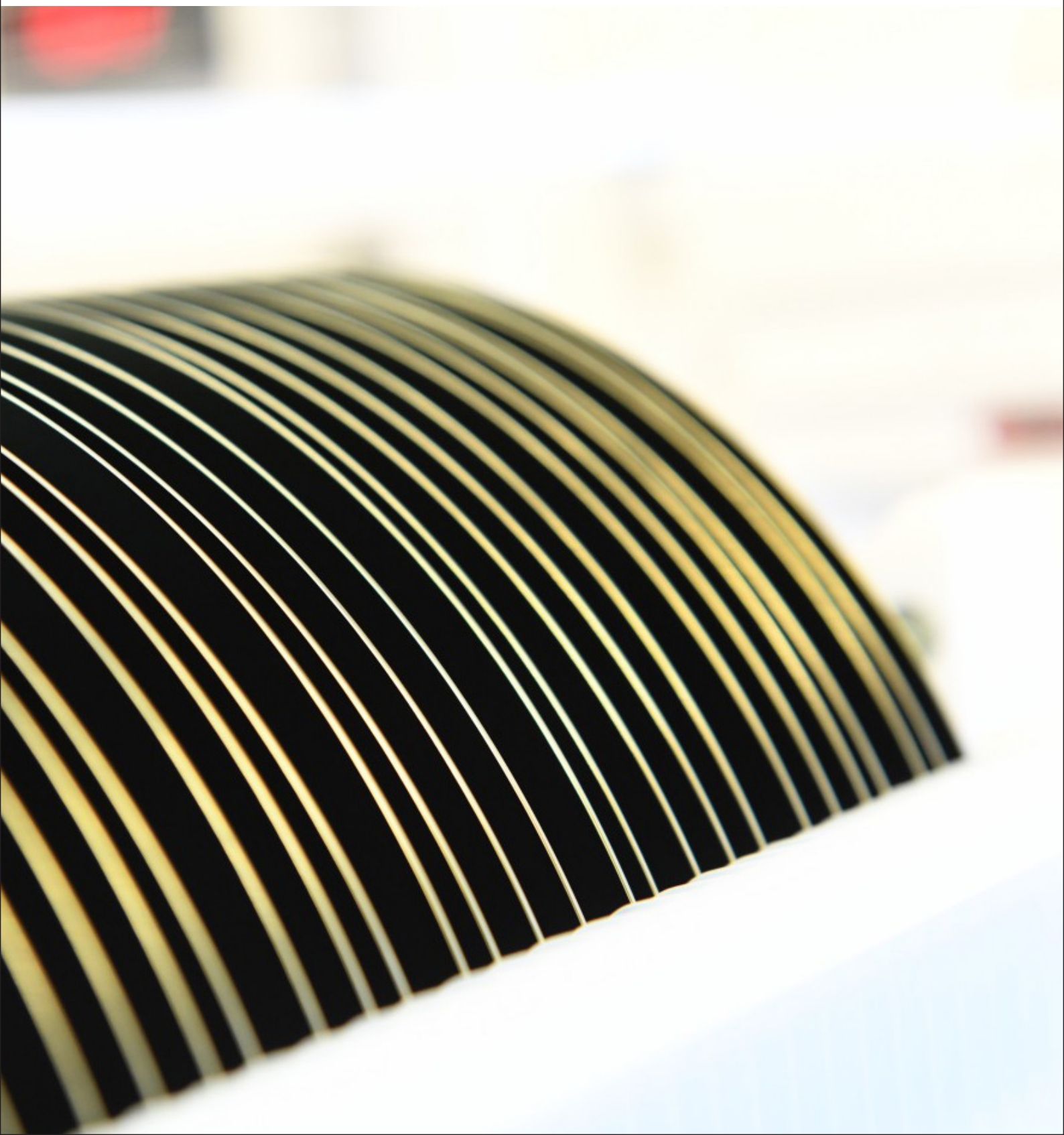
Inverter applications ask for fast recovery diodes with soft-switching characteristics, high-current rectifiers demand diodes with low on-state losses, medium-power rectifiers benefit from diodes with avalanche capability and welding rectifiers require highest current in the smallest package.

Hitachi Energy offers four press-pack diode families that meet these requirements:

- |                                           |         |
|-------------------------------------------|---------|
| • Fast recovery diodes                    | page 32 |
| • Standard rectifier and avalanche diodes | page 34 |
| • Welding diodes                          | page 38 |







# Fast recovery diodes

Hitachi Energy's comprehensive family of fast recovery diodes is optimized for enhanced Safe Operating Area (SOA) and controlled (soft) turn-off recovery. This makes these diodes very well suited for all converter applications.



The diodes are typically used in combination with IGCTs and GTOs as free-wheeling and clamp diodes, thus enabling full IGCT and GTO performance.

Our L-housing fast recovery diodes optimally match press-pack IGBT and IEGT applications where a  $di/dt$  of up to 5 kA/ $\mu$ s is required.

Fast recovery diode recommendations for various applications can be found in the application note – Applying fast recovery diodes. The latest version is available at [www.hitachienergy.com/semiconductors](http://www.hitachienergy.com/semiconductors)

## GTO free-wheeling diodes

| Part number  | $V_{RRM}$ | $V_{DC}$  | $I_{FAVM}$                         |      | $I_{FSM}$ | $V_{F0}$  | $r_F$ | $I_{rr}$                            | $Q_{rr}$ | $T_{VJM}$ | $R_{thJC}$ | $R_{thCH}$ | $F_m$ | Housing |
|--------------|-----------|-----------|------------------------------------|------|-----------|-----------|-------|-------------------------------------|----------|-----------|------------|------------|-------|---------|
|              |           |           | $T_C = 85\text{ }^{\circ}\text{C}$ | 1 ms | 10 ms     | $T_{VJM}$ |       | $di\ dt = 300\text{ A}/\mu\text{s}$ |          |           |            |            |       |         |
|              |           |           |                                    |      |           |           |       |                                     |          |           |            |            |       |         |
|              |           |           |                                    |      |           |           |       |                                     |          |           |            |            |       |         |
|              |           |           |                                    |      |           |           |       |                                     |          |           |            |            |       |         |
| $T_{VJM}$    | $T_{VJM}$ | $T_{VJM}$ |                                    |      |           |           |       |                                     |          |           |            |            |       |         |
| V            | V         | A         | kA                                 | kA   | V         | mΩ        | A     | μC                                  | °C       | K/kW      | K/kW       | kN         |       |         |
| 5SDF 13H4501 | 4500      | 2800      | 1200                               | 60.0 | 25.0      | 1.30      | 0.48  | 800                                 | 3000     | 125       | 12         | 3          | 40    | H1      |
| 5SDF 10H6004 | 6000      | 3800      | 1100                               | 44.0 | 18.0      | 1.50      | 0.60  | 1000                                | 6000     | 125       | 12         | 3          | 40    | H1      |

Drawings see page 35-37.

Please refer to page 63 for part numbering structure.

## IGBT diodes

| Part number     | $V_{RRM}$ | $V_{DC}$ | $I_{FAVM}$                         | $I_{FSM}$ | $V_{FO}$ | $r_F$     | $I_{rr}$                            | $Q_{rr}$ | $T_{VJM}$ | $R_{thJC}$ | $R_{thCH}$ | $F_m$ | Housing |
|-----------------|-----------|----------|------------------------------------|-----------|----------|-----------|-------------------------------------|----------|-----------|------------|------------|-------|---------|
|                 |           |          | $T_C = 70\text{ }^{\circ}\text{C}$ |           | 10 ms    | $T_{VJM}$ | $di/dt = 5000\text{ A}/\mu\text{s}$ |          |           |            |            |       |         |
|                 |           |          |                                    | $T_{VJM}$ |          |           | $T_{VJM}$                           |          |           |            |            |       |         |
|                 |           |          |                                    |           |          |           |                                     |          |           |            |            |       |         |
|                 | V         | V        | A                                  | kA        | V        | mΩ        | A                                   | μC       | °C        | K/kW       | K/kW       | kN    |         |
| 5SDF 20L4521    | 4500      | 2800     | 1950                               | 45.0      | 1.70     | 0.80      | 3600                                | 5300     | 140       | 6          | 3          | 40    | L2      |
| 5SDF 28L4521    | 4500      | 2800     | 2620                               | 56.0      | 1.10     | 0.47      | 4100                                | 10100    | 140       | 6          | 3          | 40    | L2      |
| 5SDF45U4521 New | 4500      | 3400     | 4400                               | 81.0      | 1.12     | 0.31      | 6500                                | 14000    | 140       | 4.3        | 1.1        | 135   | U       |

## IGCT diodes

| Part number       | V <sub>RRM</sub> | V <sub>DC</sub> | I <sub>FAVM</sub>      |      | I <sub>FSM</sub> | V <sub>FO</sub>  | r <sub>F</sub>   | I <sub>rr</sub> | di/dt | T <sub>VJM</sub> | R <sub>thJC</sub> | R <sub>thCH</sub> | F <sub>m</sub> | Housing |
|-------------------|------------------|-----------------|------------------------|------|------------------|------------------|------------------|-----------------|-------|------------------|-------------------|-------------------|----------------|---------|
|                   |                  |                 | T <sub>C</sub> = 70 °C |      | 1 ms             | 10 ms            | T <sub>VJM</sub> | max.            |       |                  |                   |                   |                |         |
|                   |                  |                 |                        |      | T <sub>VJM</sub> | T <sub>VJM</sub> |                  |                 |       |                  |                   |                   |                |         |
|                   |                  |                 | V                      | V    | A                | kA               |                  |                 | kA    |                  |                   |                   |                |         |
| 5SDF 03D4502      | 4500             | 2800            | 275                    | 10.0 | 5.0              | 2.15             | 2.80             | 355             | 300   | 115              | 40                | 8                 | 16             | D       |
| 5SDF 05F4502      | 4500             | 2800            | 435                    | 32.0 | 16.0             | 2.42             | 2.10             | 610             | 430   | 115              | 17                | 5                 | 20             | F       |
| 5SDF 10H4503      | 4500             | 2800            | 1100                   | 47.0 | 20.0             | 1.75             | 0.88             | 1520            | 600   | 125              | 12                | 3                 | 40             | H1      |
| 5SDF 20L4520      | 4500             | 2800            | 1970                   | –    | 45.0             | 1.56             | 0.80             | 2400            | 1200  | 140              | 6                 | 3                 | 40             | L2      |
| 5SDF 28L4520      | 4500             | 2800            | 2620                   | –    | 56.0             | 1.10             | 0.47             | 2800            | 1000  | 140              | 6                 | 3                 | 40             | L2      |
| 5SDF 34L4520* New | 4500             | 2800            | 2690                   | –    | 40.0             | 1.46             | 0.48             | 2690            | 1700  | 140              | 5.6               | 2.2               | 55             | L3      |
| 5SDF 45U4500* New | 4500             | 3400            | 4400                   | –    | 80.6             | 1.12             | 0.31             | 7500            | 5300  | 140              | 4.3               | 1.1               | 135            | U       |
| 5SDF 02D6004      | 5500             | 3300            | 175                    | 8.0  | 3.0              | 3.35             | 7.20             | 300             | 220   | 115              | 40                | 8                 | 16             | D       |
| 5SDF 04F6004      | 5500             | 3300            | 380                    | 22.0 | 10.0             | 2.70             | 2.80             | 600             | 340   | 115              | 22                | 5                 | 20             | F       |
| 5SDF 08H6005      | 5500             | 3300            | 585                    | 40.0 | 18.0             | 4.50             | 1.30             | 900             | 440   | 115              | 12                | 3                 | 40             | H1      |

Drawings see page 35-37.

Please refer to page 63 for part numbering structure.

\* Contact factory

# Rectifier and avalanche diodes

Hitachi Energy's two families of high-power rectifier diodes – standard rectifier diodes and avalanche diodes – are well-known for their outstanding reliability and excellent nominal and surge current capabilities.



The standard rectifier diodes are optimized for line frequency and low on-state losses. Their main applications are rectifiers for large AC drives, aluminum smelting and other metal refining as well as trackside supply.

The avalanche diodes are self-protected against transient overvoltages, offer reduced snubber requirements and feature maximum avalanche power dissipation. They are frequently used for input rectifiers in traction converters or high-voltage power rectifiers.

For safe and easy parallel or series connection, both types of diodes are available in groups of similar  $V_F$  or  $Q_{rr}$ , respectively.

## Avalanche diodes

| Part number  | V <sub>RRM</sub>       | I <sub>FAVM</sub> | I <sub>FSM</sub>          | V <sub>F0</sub>  | r <sub>F</sub>           | P <sub>RSM</sub> | T <sub>VJM</sub> | R <sub>thJC</sub> | R <sub>thCH</sub> | F <sub>m</sub> | Housing |
|--------------|------------------------|-------------------|---------------------------|------------------|--------------------------|------------------|------------------|-------------------|-------------------|----------------|---------|
|              | T <sub>C</sub> = 85 °C |                   | 10 ms<br>T <sub>VJM</sub> | T <sub>VJM</sub> | 20μs<br>T <sub>VJM</sub> |                  |                  |                   |                   |                |         |
|              | V                      | A                 | kA                        | V                | mΩ                       | kw               | °C               | K/kW              | K/kW              | kN             |         |
| 5SDA 11D1702 | 1700                   | 1310              | 15.0                      | 0.74             | 0.21                     | 50               | 160              | 40                | 10                | 11             | D       |
| 5SDA 27F2002 | 2000                   | 2700              | 31.0                      | 0.79             | 0.09                     | 100              | 160              | 20                | 5                 | 22             | F       |
| 5SDA 10D2303 | 2300                   | 1140              | 13.5                      | 0.83             | 0.30                     | 50               | 160              | 40                | 10                | 11             | D       |
| 5SDA 24F2303 | 2300                   | 2350              | 29.0                      | 0.84             | 0.13                     | 75               | 160              | 20                | 5                 | 22             | F       |
| 5SDA 09D2604 | 2600                   | 1020              | 11.5                      | 0.87             | 0.39                     | 50               | 160              | 40                | 10                | 11             | D       |
| 5SDA 08D3205 | 3200                   | 910               | 9.2                       | 0.93             | 0.52                     | 50               | 160              | 40                | 10                | 11             | D       |
| 5SDA 21F3204 | 3200                   | 2110              | 26.0                      | 0.89             | 0.17                     | 75               | 160              | 20                | 5                 | 22             | F       |
| 5SDA 07D3806 | 3800                   | 790               | 7.6                       | 1.01             | 0.72                     | 50               | 160              | 40                | 10                | 11             | D       |
| 5SDA 16F3806 | 3800                   | 1620              | 20.5                      | 1.03             | 0.32                     | 50               | 160              | 20                | 5                 | 22             | F       |
| 5SDA 06D5007 | 5000                   | 690               | 7.0                       | 1.10             | 1.01                     | 50               | 160              | 40                | 10                | 11             | D       |
| 5SDA 14F5007 | 5000                   | 1410              | 17.5                      | 1.13             | 0.44                     | 50               | 160              | 20                | 5                 | 22             | F       |

Drawings see page 35-37.

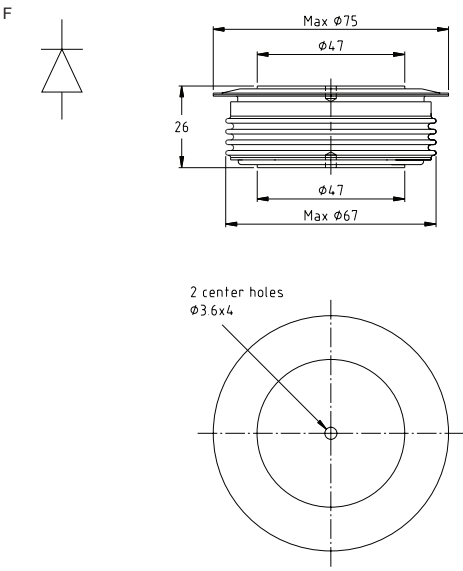
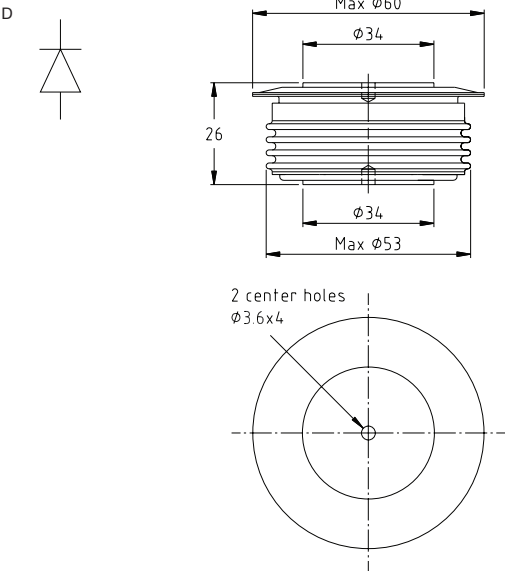
Please refer to page 63 for part numbering structure.



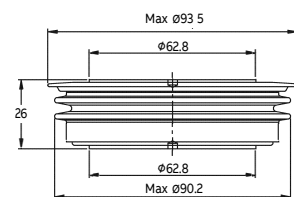
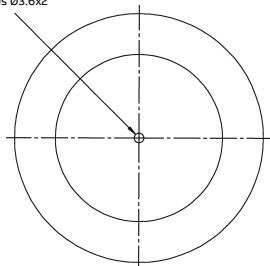
Standard rectifier diodes

| Part number       | V <sub>RSM</sub>          | V <sub>RRM</sub> | I <sub>FAVM</sub> | I <sub>FSM</sub> | V <sub>FO</sub>  | r <sub>F</sub> | T <sub>VJM</sub> | R <sub>thJC</sub> | R <sub>thCH</sub> | F <sub>m</sub> | Housing |
|-------------------|---------------------------|------------------|-------------------|------------------|------------------|----------------|------------------|-------------------|-------------------|----------------|---------|
|                   | 10 ms<br>T <sub>VJM</sub> |                  |                   |                  | T <sub>VJM</sub> |                |                  |                   |                   |                |         |
|                   | V                         | V                | A                 | kA               | V                | mΩ             | °C               | K/kW              | K/kW              | kN             |         |
| 5SDD 70H2000      | 2000                      | 2000             | 7030              | 65.0             | 0.861            | 0.046          | 190              | 8.0               | 2.5               | 50             | H2      |
| 5SDD 65H2400      | 2400                      | 2400             | 6520              | 59.0             | 0.870            | 0.057          | 190              | 8.0               | 2.5               | 50             | H2      |
| 5SDD 51L2800      | 2800                      | 2000             | 5380              | 65.0             | 0.770            | 0.082          | 175              | 8.0               | 3.0               | 70             | L1      |
| 5SDD 60N2800      | 2800                      | 2000             | 6830              | 87.0             | 0.800            | 0.050          | 160              | 5.7               | 1.0               | 90             | N       |
| 5SDD 60Q2800      | 2800                      | 2000             | 7385              | 87.0             | 0.800            | 0.050          | 160              | 5.0               | 1.0               | 90             | Q       |
| 5SDD 11T2800      | 2800                      | 2800             | 1285              | 15.0             | 0.933            | 0.242          | 160              | 32.0              | 8.0               | 10             | T       |
| 5SDD 11D2800      | 2800                      | 2800             | 1285              | 15.0             | 0.933            | 0.242          | 160              | 32.0              | 8.0               | 10             | D       |
| 5SDD 24F2800      | 2800                      | 2800             | 2596              | 30.0             | 0.906            | 0.135          | 160              | 15.0              | 4.0               | 22             | F       |
| 5SDD 48H3200      | 3200                      | 3200             | 4708              | 61.0             | 0.992            | 0.067          | 160              | 8.0               | 2.5               | 50             | H2      |
| 5SDD 54N4000      | 4000                      | 3600             | 5200              | 85.0             | 0.800            | 0.086          | 150              | 5.7               | 1.0               | 90             | N       |
| 5SDD 40H4000      | 4000                      | 4000             | 3847              | 46.0             | 0.900            | 0.133          | 160              | 8.0               | 2.5               | 50             | H2      |
| 5SDD 08D5000      | 5000                      | 5000             | 1028              | 12.0             | 0.894            | 0.487          | 160              | 32.0              | 8.0               | 10             | D       |
| 5SDD 08T5000      | 5000                      | 5000             | 1028              | 12.0             | 0.894            | 0.487          | 160              | 32.0              | 8.0               | 10             | T       |
| 5SDD 20F5000      | 5000                      | 5000             | 1978              | 24.0             | 0.940            | 0.284          | 160              | 15.0              | 4.0               | 22             | F       |
| 5SDD 38H5000      | 5000                      | 5000             | 3814              | 45.0             | 0.903            | 0.136          | 160              | 8.0               | 2.5               | 50             | H2      |
| 5SDD 36K5000      | 5000                      | 5000             | 3638              | 45.0             | 0.903            | 0.136          | 160              | 9.2               | 2.5               | 50             | K       |
| 5SDD 33L5500      | 5500                      | 5000             | 3480              | 46.0             | 0.940            | 0.147          | 150              | 7.0               | 1.5               | 70             | L1      |
| 5SDD 50N5500      | 5500                      | 5000             | 4570              | 73.0             | 0.800            | 0.107          | 150              | 5.7               | 1.0               | 90             | N       |
| 5SDD 06D6000      | 6000                      | 6000             | 662               | 10.5             | 1.066            | 0.778          | 150              | 42.0              | 8.0               | 11             | D       |
| 5SDD 10F6000      | 6000                      | 6000             | 1363              | 17.5             | 1.015            | 0.407          | 150              | 20.0              | 5.0               | 22             | F       |
| 5SDD 14F6000      | 6000                      | 6000             | 1363              | 17.5             | 1.015            | 0.407          | 150              | 20.0              | 5.0               | 22             | F       |
| 5SDD 31H6000      | 6000                      | 6000             | 3201              | 40.0             | 0.944            | 0.166          | 150              | 8.0               | 2.5               | 50             | H2      |
| 5SDD 50N6000      | 6000                      | 6000             | 4210              | 71.2             | 0.800            | 0.134          | 150              | 5.7               | 1.0               | 90             | N       |
| 5SDD 57N6500 New  | 6500                      | 6500             | 5850              | 110.0            | 0.840            | 0.09           | 160              | 4.7               | 1.0               | 90             | N       |
| 5SDD 57X6500* New | 6500                      | 6500             | 5850              | 110.0            | 0.840            | 0.098          | 160              | 4.7               | 1.0               | 90             | X       |
| 5SDD 75Y8500      | 8500                      | 8500             | 6720              | 121              | 0.945            | 0.118          | 150              | 3.0               | 0.6               | 190            | Y       |

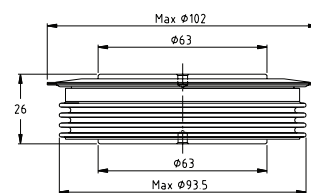
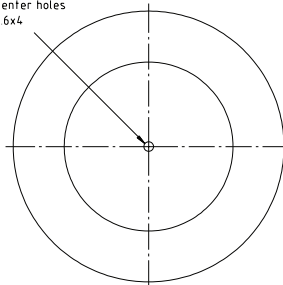
Drawings see page 35-37.  
Please refer to page 63 for part numbering structure.  
\*Contact factory



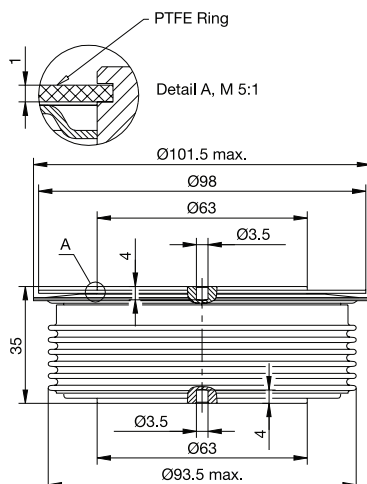
H1


2 center holes  
Ø3.6x2


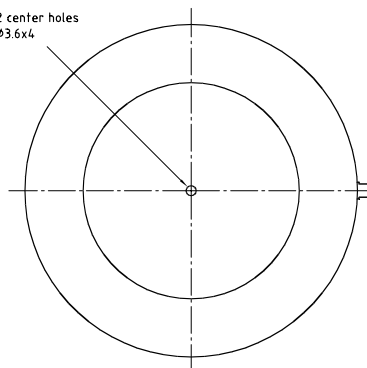
H2


2 center holes  
Ø3.6x4


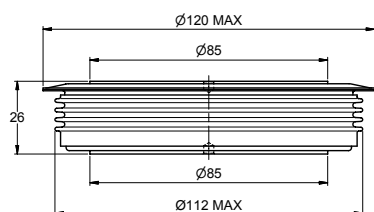
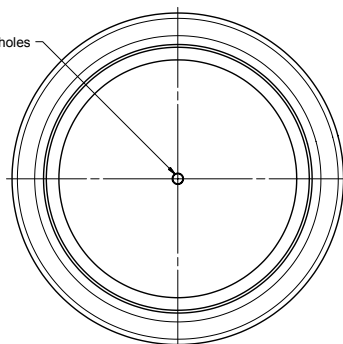
K



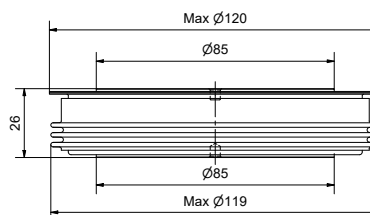
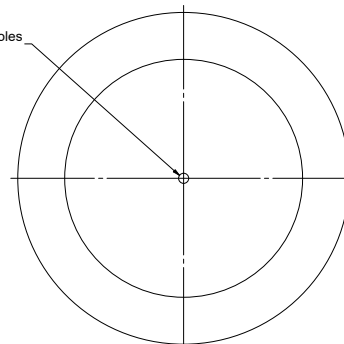
L1

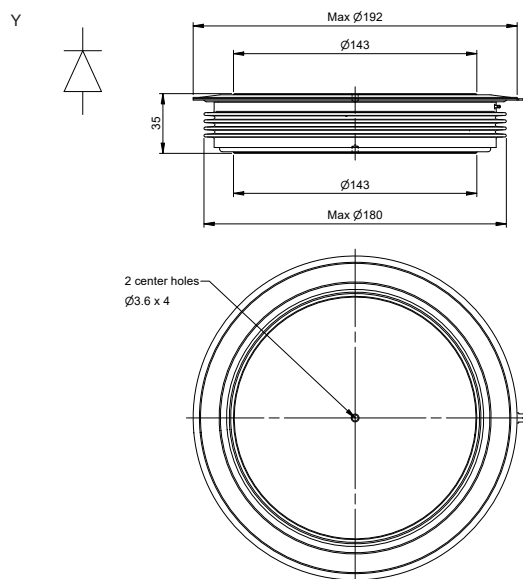
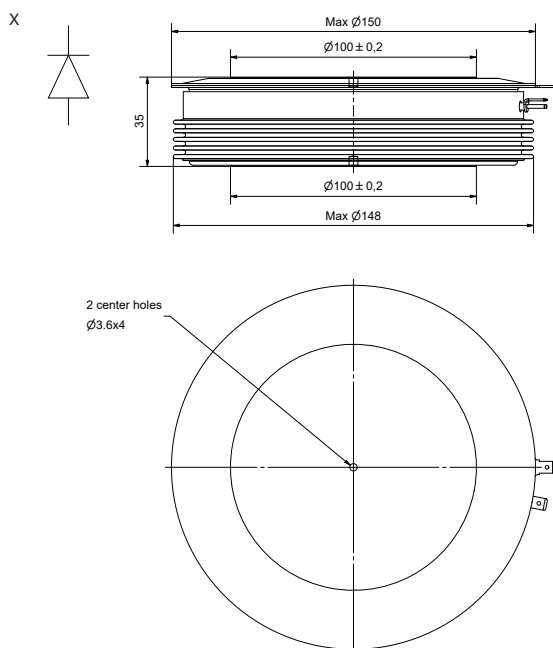
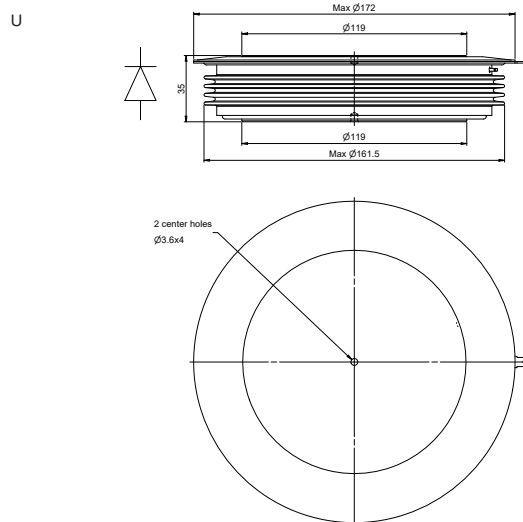
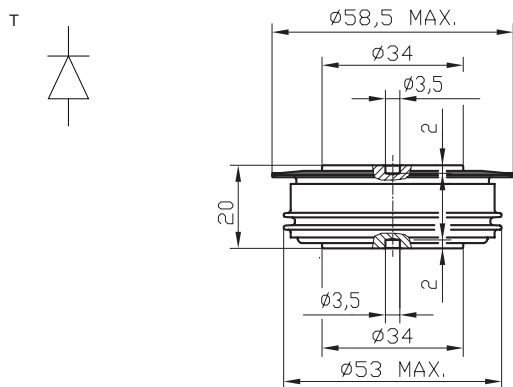
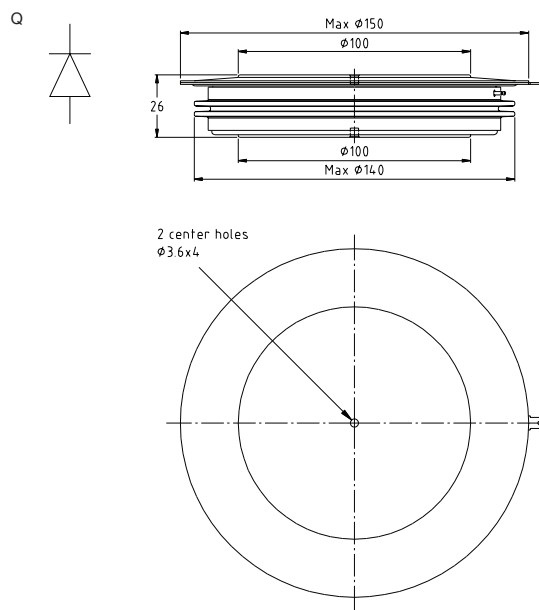
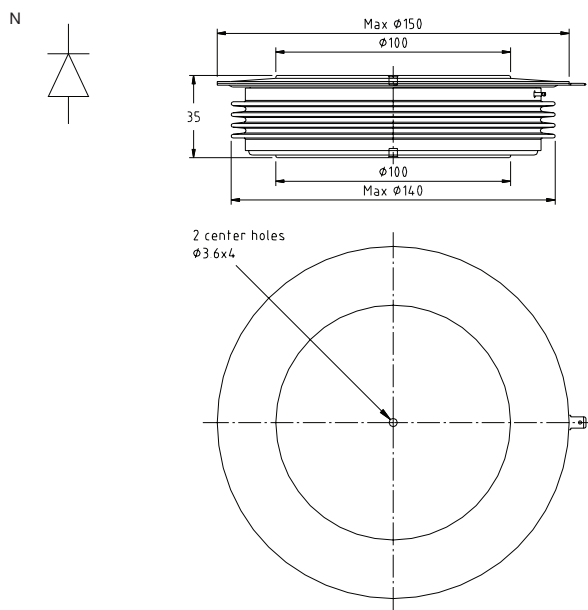

2 center holes  
Ø3.6x4


L2


2 center holes  
Ø3.6 x 3


L3


2x center holes  
Ø3.6x3




# Welding diodes

Almost every second car driving in Europe has been fabricated using Hitachi Energy welding diodes, as most of the major welding equipment manufacturers rely on Hitachi Energy's quality, reliability and performance.



Hitachi Energy's comprehensive product range offers medium frequency (up to 2 kHz) and high frequency (up to 10 kHz) welding diodes. They all feature very low on-state voltage and very low thermal resistance. In addition, they are available in light package, thin and hermetically sealed ceramic housings or even housing-less, another welcomed feature for equipment that is mounted directly on robot arms.

## Medium frequency

| Part number           | $V_{RRM}$ | $V_{Fmin}$ | $V_{FMAX}$                                                   | $I_{FAVM}$                         | $I_{FSM}$          | $V_{F0}$  | $r_F$     | $T_{VJM}$          | $R_{thJC}$ | $R_{thCH}$ | $F_m$ | Housing |
|-----------------------|-----------|------------|--------------------------------------------------------------|------------------------------------|--------------------|-----------|-----------|--------------------|------------|------------|-------|---------|
|                       |           |            | $T_j = 25\text{ }^{\circ}\text{C},$<br>$I_F = 5000\text{ A}$ | $T_C = 85\text{ }^{\circ}\text{C}$ | 10 ms<br>$T_{VJM}$ | $T_{VJM}$ | $T_{VJM}$ |                    |            |            |       |         |
|                       | V         | V          | V                                                            | A                                  | kA                 | V         | mΩ        | $^{\circ}\text{C}$ | K/kW       | K/kW       | kN    |         |
| <b>5SDD 71X0200</b>   | 200       | –          | 1.05                                                         | 7110                               | 55                 | 0.74      | 0.026     | 170                | 10.0       | 5.0        | 22    | X       |
| <b>5SDD 71B0200</b>   | 200       | –          | 1.05                                                         | 7110                               | 55                 | 0.74      | 0.026     | 170                | 10.0       | 5.0        | 22    | B       |
| <b>5SDD 0120C0200</b> | 200       | –          | 0.92 *                                                       | 11000                              | 85                 | 0.75      | 0.020     | 170                | 6.0        | 3.0        | 37.5  | C       |
| <b>5SDD 71X0400</b>   | 400       | 0.95       | 1.00                                                         | 7110                               | 55                 | 0.74      | 0.026     | 170                | 10.0       | 5.0        | 22    | X       |
| <b>5SDD 71B0400</b>   | 400       | –          | 1.05                                                         | 7110                               | 55                 | 0.74      | 0.026     | 170                | 10.0       | 5.0        | 22    | B       |
| <b>5SDD 0120C0400</b> | 400       | 0.83*      | 0.88 *                                                       | 11350                              | 85                 | 0.74      | 0.018     | 170                | 6.0        | 3.0        | 37.5  | C       |
| <b>5SDD 92Z0401</b>   | 400       | –          | 1.03 *                                                       | 9244                               | 60                 | 0.78      | 0.031     | 180                | 5.6        | 3.6        | 36    | Z1      |
| <b>5SDD 0105Z0401</b> | 400       | –          | 1.01 *                                                       | 10502                              | 70                 | 0.812     | 0.026     | 180                | 5.0        | 2.5        | 40    | Z2      |
| <b>5SDD 0135Z0401</b> | 400       | –          | 0.92 *                                                       | 13526                              | 85                 | 0.758     | 0.021     | 180                | 3.9        | 2.6        | 52.5  | Z3      |

\* at 8000 A,  $T_{VJM}$

Please refer to page 63 for part numbering structure.

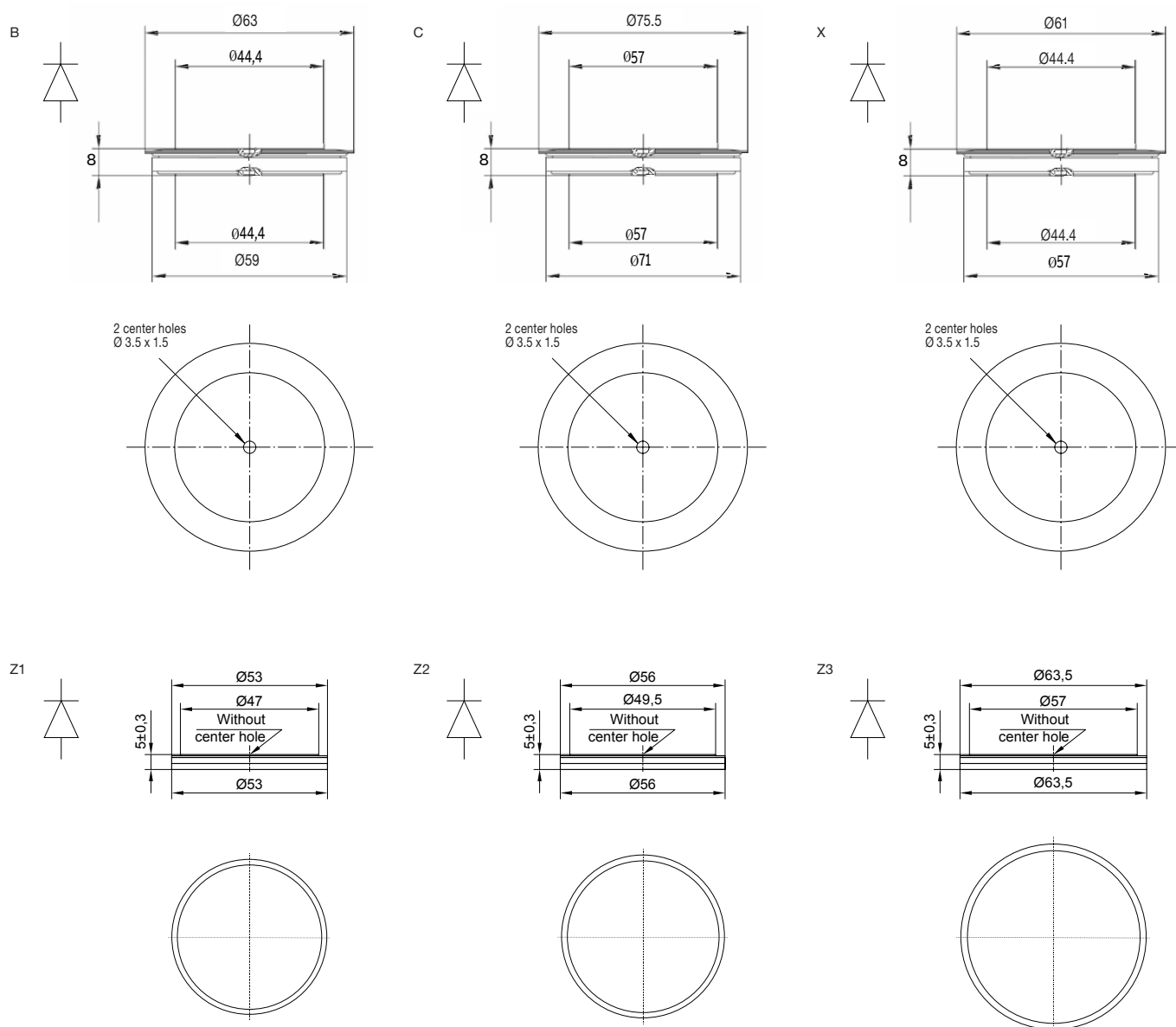


## High frequency

| Part number           | $V_{RRM}$                          | $V_{FMAX}$ | $I_{FAVM}$           | $I_{FSM}$          | $V_{FO}$  | $r_F$     | $Q_{rr}$  | $T_{VJM}$ | $R_{thJC}$ | $R_{thCH}$ | $F_m$ | Housing |
|-----------------------|------------------------------------|------------|----------------------|--------------------|-----------|-----------|-----------|-----------|------------|------------|-------|---------|
|                       | $T_{VJM}$<br>$I_F = 5000\text{ A}$ |            | $T_C = 85\text{ °C}$ | 10 ms<br>$T_{VJM}$ | $T_{VJM}$ | $T_{VJM}$ | $T_{VJM}$ |           |            |            |       |         |
|                       | V                                  | V          | A                    | kA                 | V         | mΩ        | μC        | °C        | K/kW       | K/kW       | kN    |         |
| <b>5SDF 63B0400</b>   | 400                                | 1.14       | 6266                 | 44                 | 0.962     | 0.036     | 180       | 190       | 10.0       | 5.0        | 22    | B       |
| <b>5SDF 63X0400</b>   | 400                                | 1.14       | 6266                 | 44                 | 0.962     | 0.036     | 180       | 190       | 10.0       | 5.0        | 22    | X       |
| <b>5SDF 90Z0401</b>   | 400                                | 1.13       | 9041                 | 48                 | 0.979     | 0.032     | 200       | 190       | 5.6        | 3.6        | 36.0  | Z1      |
| <b>5SDF 0102C0400</b> | 400                                | 1.14 *     | 10159                | 70                 | 0.977     | 0.022     | 300       | 190       | 6.0        | 3.0        | 37.5  | C       |
| <b>5SDF 0103Z0401</b> | 400                                | 1.20 *     | 10266                | 54                 | 0.998     | 0.027     | 230       | 190       | 5.0        | 2.5        | 40.0  | Z2      |
| <b>5SDF 0131Z0401</b> | 400                                | 1.14 *     | 13058                | 70                 | 0.977     | 0.022     | 300       | 190       | 3.9        | 2.6        | 52.5  | Z3      |

\* at 8000 A

Please refer to page 63 for part numbering structure.



Dimensions in mm

# Thyristors

High-power thyristors are used in applications ranging from 100 kW drives up to HVDC stations rated above 10 GW.

Hitachi Energy offers the following thyristor families:

- Bypass thyristor page 41
- Phase control thyristors (PCTs) page 42



# Bypass thyristor



The bypass thyristor is a new semiconductor device that offers three modes of operation:

- Normal operation: Device is blocked permanently.
- Protection mode: Device is irreversibly shorted by a surge current event ( $I_{TSM} / I^2t$ ) triggered through the gate.
- SCFM mode: Continuous stable long-term short circuit mode.

A typical application is short-circuiting faulty cells in a multilevel converter topology (MMC). The thyristor housing will not rupture when passing currents up to, or exceeding, 363 kA or 217 MA<sup>2</sup>s. After a fault, the device operates as a stable short circuit for more than a year.

| Part number  | $V_{DRM}$ (V) | $V_{DCN}$ (V) | $I_{TSM}$ (kA) | Package (mm) |
|--------------|---------------|---------------|----------------|--------------|
| 5STP 10L8500 | 8400          | 4000          | 290            | L            |

Drawings see page 43.  
Please refer to page 62 for part numbering structure.

# PCTs

## Phase control thyristors

Phase control thyristor has been the backbone of the high-power electronics industry since its introduction about 50 years ago and has set benchmark reliability records over many years.



The field of PCT applications ranges from kW drives and MW rated line commutated frequency converters and electrolysis applications such as aluminum, copper or hydrogen, to GW converters for HVDC transmission.

Hitachi Energy offers the most complete range of high-power thyristors, including 6" devices. New products continue to be developed with focus on minimizing overall losses and maximizing power ratings.

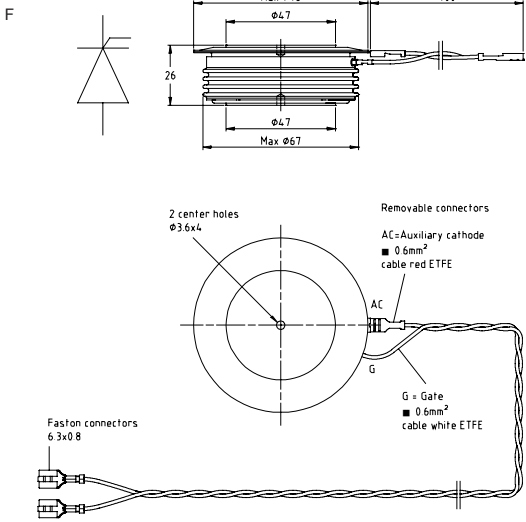
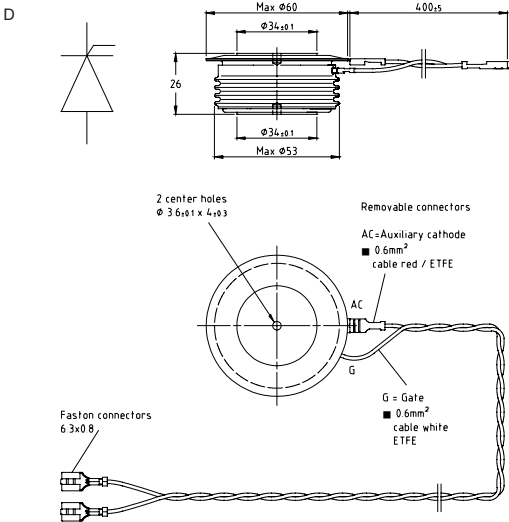
| Part number      | $V_{\text{DRM}}, V_{\text{RRM}}$ | $I_{\text{TAVM}}$                           | $I_{\text{TSM}}$         | $V_{\text{T0}}$  | $r_{\text{T}}$ | $T_{\text{VJM}}$ | $R_{\text{thJC}}$ | $R_{\text{thCH}}$ | $F_{\text{m}}$ | Housing |  |
|------------------|----------------------------------|---------------------------------------------|--------------------------|------------------|----------------|------------------|-------------------|-------------------|----------------|---------|--|
|                  | $T_{\text{VJM}}$                 | $T_{\text{C}} = 70\text{ }^{\circ}\text{C}$ | 10 ms / $T_{\text{VJM}}$ | $T_{\text{VJM}}$ |                |                  |                   |                   |                |         |  |
|                  | V                                | A                                           | kA                       | V                | mΩ             | °C               | K/kW              | K/kW              | kN             |         |  |
| 5STP 07D1800     | 1800                             | 760                                         | 9.0                      | 0.927            | 0.448          | 125              | 36.0              | 7.5               | 10             | D       |  |
| 5STP 18F1810 New | 1800                             | 1780                                        | 21.0                     | 0.923            | 0.188          | 125              | 17.0              | 4.0               | 22             | F       |  |
| 5STP 27H1800     | 1800                             | 2940                                        | 50.5                     | 0.912            | 0.096          | 125              | 10.0              | 2.0               | 50             | H       |  |
| 5STP 42L1800     | 1800                             | 4310                                        | 64.0                     | 0.81             | 0.080          | 125              | 7.0               | 1.5               | 70             | L       |  |
| 5STP 50Q1800     | 1800                             | 6100                                        | 94.0                     | 0.90             | 0.050          | 125              | 5.0               | 1.0               | 90             | Q       |  |
| 5STP 06D2800     | 2800                             | 640                                         | 8.8                      | 0.92             | 0.780          | 125              | 36.0              | 7.5               | 10             | D       |  |
| 5STP 16F2810 New | 2800                             | 1500                                        | 18.0                     | 0.956            | 0.297          | 125              | 17.0              | 4.0               | 22             | F       |  |
| 5STP 24H2800     | 2800                             | 2780                                        | 43.0                     | 0.928            | 0.141          | 125              | 10.0              | 2.0               | 50             | H       |  |
| 5STP 33L2800     | 2800                             | 3760                                        | 65.5                     | 0.929            | 0.100          | 125              | 7.0               | 1.5               | 70             | L       |  |
| 5STP 45N2800     | 2800                             | 5250                                        | 77.0                     | 0.864            | 0.069          | 125              | 5.7               | 1.0               | 90             | N       |  |
| 5STP 45Q2800     | 2800                             | 5710                                        | 77.0                     | 0.864            | 0.069          | 125              | 5.0               | 1.0               | 90             | Q       |  |
| 5STP 04D4200     | 4200                             | 500                                         | 7.1                      | 1.14             | 1.288          | 125              | 36.0              | 7.5               | 10             | D       |  |
| 5STP 12F4200     | 4200                             | 1190                                        | 17.3                     | 1.01             | 0.545          | 125              | 17.0              | 4.0               | 22             | F       |  |
| 5STP 18H4200     | 4200                             | 2170                                        | 32.0                     | 0.982            | 0.274          | 125              | 10.0              | 2.0               | 50             | H       |  |
| 5STP 28L4200     | 4200                             | 3290                                        | 54.0                     | 1.03             | 0.138          | 125              | 7.0               | 1.5               | 70             | L       |  |
| 5STP 38N4200     | 4200                             | 4090                                        | 64.5                     | 0.973            | 0.126          | 125              | 5.7               | 1.0               | 90             | N       |  |
| 5STP 38Q4200     | 4200                             | 4420                                        | 64.5                     | 0.973            | 0.126          | 125              | 5.0               | 1.0               | 90             | Q       |  |

Please refer to page 62 for part numbering structure.

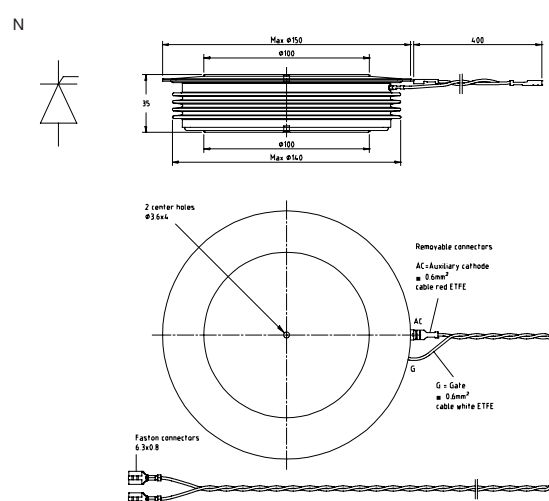
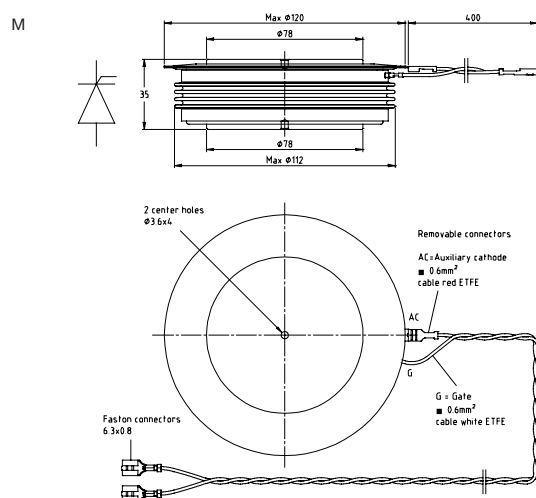
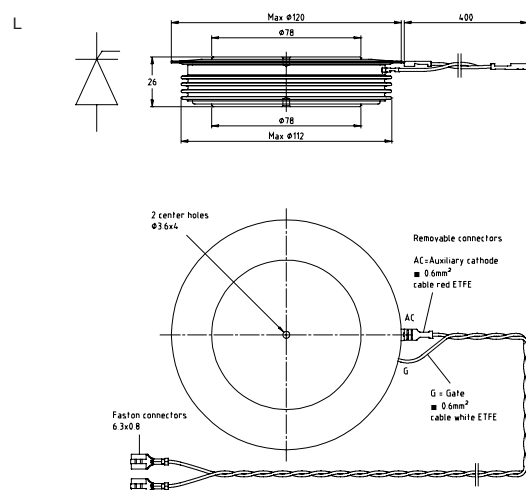
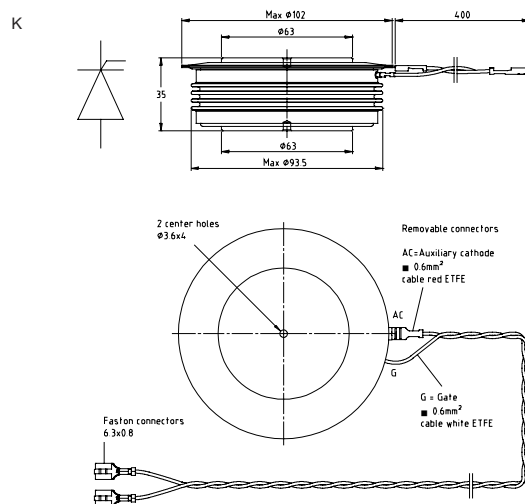
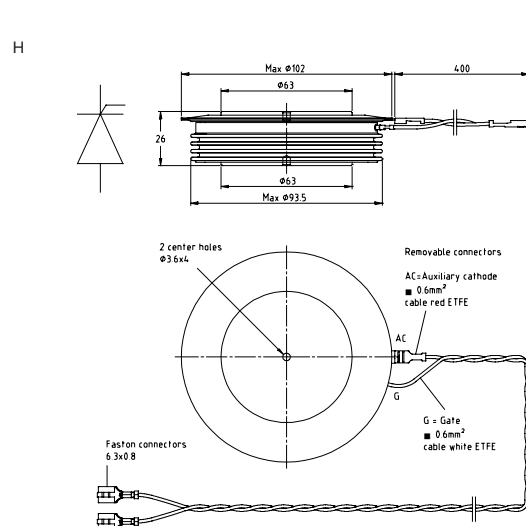
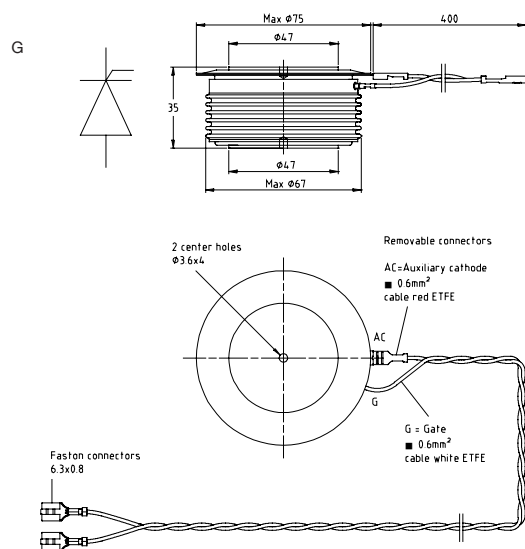


| Part number       | $V_{DRM}, V_{RRM}$ | $I_{TAVM}$                         | $I_{TSM}$         | $V_{TO}$  | $r_T$ | $T_{VJM}$ | $R_{thJC}$ | $R_{thCH}$ | $F_m$ | Housing |
|-------------------|--------------------|------------------------------------|-------------------|-----------|-------|-----------|------------|------------|-------|---------|
|                   | $T_{VJM}$          | $T_C = 70\text{ }^{\circ}\text{C}$ | 10 ms / $T_{VJM}$ | $T_{VJM}$ |       |           |            |            |       |         |
|                   | V                  | A                                  | kA                | V         | mΩ    | °C        | K/kW       | K/kW       | kN    |         |
| 5STP 04D5200      | 5200               | 420                                | 6.1               | 1.29      | 1.917 | 125       | 36.0       | 7.5        | 10    | D       |
| 5STP 17H5200      | 5200               | 1970                               | 34.0              | 0.994     | 0.343 | 125       | 10.0       | 2.0        | 50    | H       |
| 5STP 25L5200      | 5200               | 2830                               | 50.5              | 0.99      | 0.237 | 125       | 7.0        | 1.5        | 70    | L       |
| 5STP 25M5200      | 5200               | 2400                               | 50.5              | 0.99      | 0.237 | 125       | 9.0        | 1.5        | 70    | M       |
| 5STP 34N5200      | 5200               | 3450                               | 63.0              | 0.96      | 0.194 | 125       | 5.7        | 1.0        | 90    | N       |
| 5STP 34Q5200      | 5200               | 3720                               | 63.0              | 0.96      | 0.194 | 125       | 5.0        | 1.0        | 90    | Q       |
| 5STP 52U5200      | 5200               | 5200                               | 99.0              | 1.04      | 0.115 | 125       | 4.0        | 0.8        | 135   | U       |
| 5STP 03D6500      | 6500               | 340                                | 4.7               | 1.20      | 2.300 | 125       | 36.0       | 7.5        | 10    | D       |
| 5STP 03X6500      | 6500               | 390                                | 4.7               | 1.20      | 2.300 | 125       | 45.0       | 7.5        | 10    | X       |
| 5STP 08F6500      | 6500               | 850                                | 15.1              | 1.20      | 1.046 | 125       | 17.0       | 4.0        | 22    | F       |
| 5STP 08G6500      | 6500               | 730                                | 15.1              | 1.20      | 1.046 | 125       | 22.0       | 4.0        | 22    | G       |
| 5STP 12K6500      | 6500               | 1430                               | 31.5              | 1.15      | 0.647 | 125       | 11.0       | 2.0        | 50    | K       |
| 5STP 18M6500      | 6500               | 1830                               | 47.5              | 1.21      | 0.431 | 125       | 9.0        | 1.5        | 70    | M       |
| 5STP 26N6500      | 6500               | 2880                               | 65.0              | 1.12      | 0.290 | 125       | 5.7        | 1.0        | 90    | N       |
| 5STP 40N6500 New  | 6500               | 3780                               | 75.0              | 1.140     | 0.255 | 135       | 4.8        | 1.0        | 90    | N       |
| 5STP 42U6500      | 6500               | 4300                               | 86.0              | 1.17      | 0.181 | 125       | 4.0        | 0.8        | 135   | U       |
| 5STP 40X6500* New | 6500               | 3780                               | 65.0              | 1.140     | 0.259 | 135       | 4.8        | 1.0        | 90    | X1      |
| 5STP 48Y7200      | 7200               | 5040                               | 92.0              | 0.983     | 0.128 | 110       | 3.0        | 0.6        | 190   | Y       |
| 5STP 27N8500      | 8500               | 2660                               | 64.0              | 1.13      | 0.394 | 125       | 5.7        | 1.0        | 90    | N       |
| 5STP 27Q8500      | 8500               | 2870                               | 64.0              | 1.13      | 0.394 | 125       | 5.0        | 1.0        | 90    | Q       |
| 5STP 45Y8500      | 8500               | 4450                               | 90.0              | 1.06      | 0.168 | 110       | 3.0        | 0.6        | 190   | Y       |

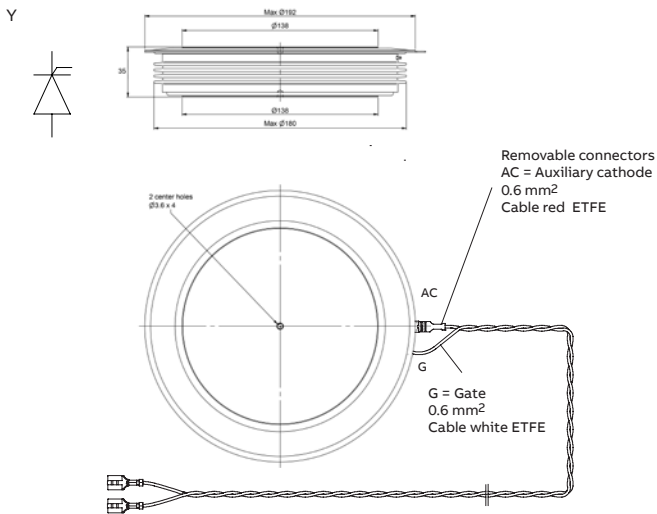
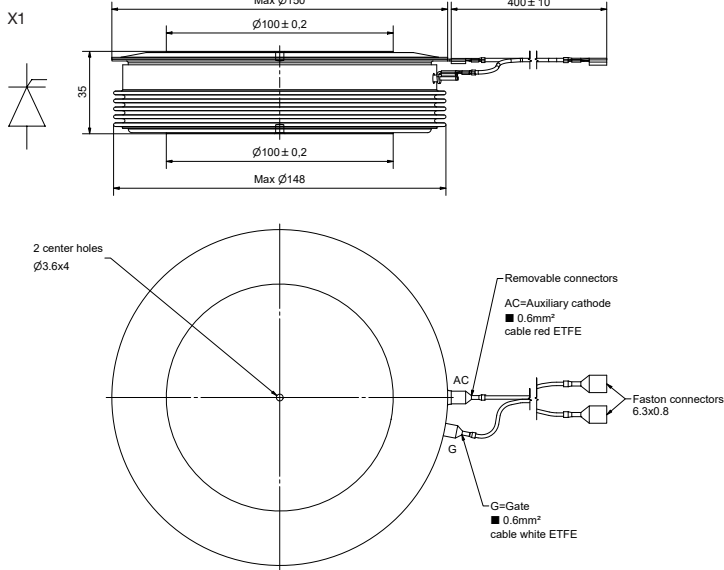
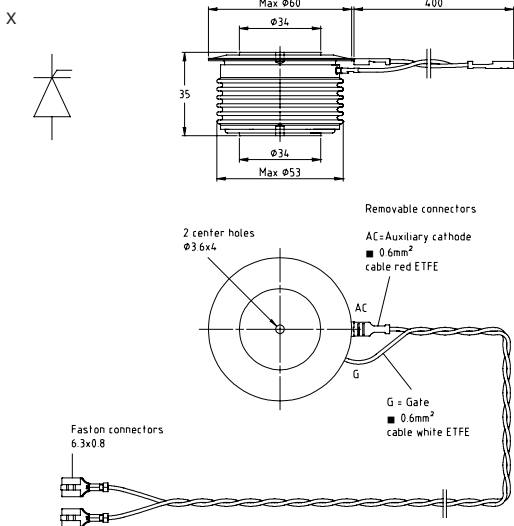
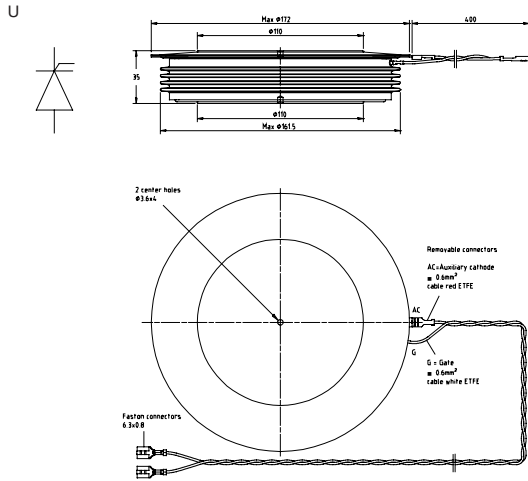
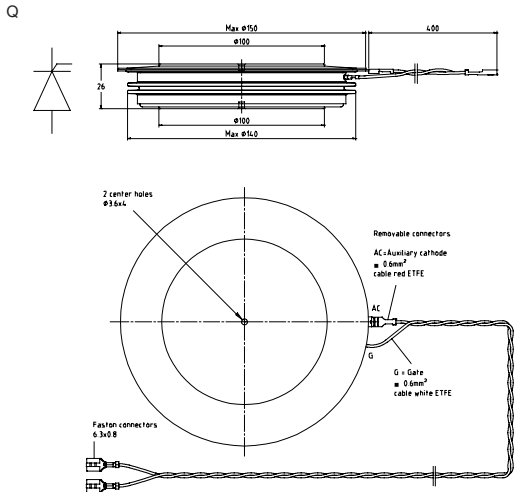
Please refer to page 62 for part numbering structure.  
\*Contact factory







Dimensions in mm



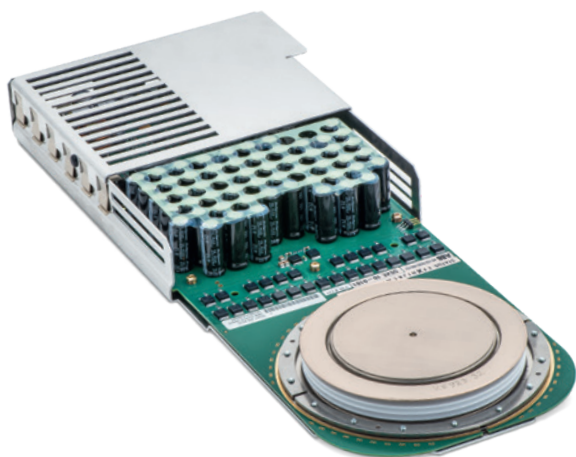
# IGCTs

## Integrated gate-commutated thyristors

Within 25 years of its introduction, the IGCT has established itself as the semiconductor of choice for high-power frequency converters by meeting the requirements of today's demanding applications.

Hitachi Energy's IGCTs are used in a multitude of applications due to their versatility, efficiency and cost-effectiveness. With their low on-state voltage, they achieve the lowest running costs by reaching inverter efficiencies of 99.6 percent and more.

Single inverters of over 15 MVA can be realized without series or parallel connection, thus achieving the highest inverter power densities in the industry.



The number of applications featuring IGCTs are many: off-shore wind generation, medium-voltage drives (MVDs), static frequency converters (SFC), marine drives, pulse power (PP) and STATCOMs, to name just a few.

With the introduction of the newly developed Reverse-Blocking Integrated Gate Commutated Thyristors (RB-IGCT), another powerful device is added to Hitachi Energy's well-established IGCT product line. The RB-IGCT is optimized for the lowest conduction losses and highest current turn-off capability. The conduction losses are reduced to less than 1000 W at 1000 A, a record low value for a power semiconductor device in this class.

Due to its outstanding performance, efficiency and reliability, the new RB-IGCT is the ideal device for Solid State Circuit Breakers (SSCBs) used in renewables, transport electrification and modern edge grids.

An example of the remarkable performance using IGCTs was achieved with the world's most powerful frequency converter (100 MVA) for a variable speed pumped hydropower application installed in the Grimsel 2 power plant in the Swiss Alps.

### Asymmetric IGCTs

| Part number      | $V_{\text{DRM}}$ | $V_{\text{DC}}$ | $V_{\text{RRM}}$ | $I_{\text{TGDM}}$ | $I_{\text{TAVM}}$                           | $I_{\text{TSM}}$         | $V_{\text{T}}$            | $V_{\text{TO}}$            | $r_{\text{T}}$   | $T_{\text{VJM}}$ | $R_{\text{thJC}}$ | $R_{\text{thCH}}$ | $F_{\text{m}}$ | $V_{\text{GIN}}$ | Outline |        |
|------------------|------------------|-----------------|------------------|-------------------|---------------------------------------------|--------------------------|---------------------------|----------------------------|------------------|------------------|-------------------|-------------------|----------------|------------------|---------|--------|
|                  |                  |                 |                  |                   | $T_{\text{C}} = 85\text{ }^{\circ}\text{C}$ | 3 ms<br>$T_{\text{VJM}}$ | 10 ms<br>$T_{\text{VJM}}$ | 4000 A<br>$T_{\text{VJM}}$ | $T_{\text{VJM}}$ | $T_{\text{VJM}}$ |                   |                   |                |                  |         |        |
|                  | V                | V               | V                | A                 | A                                           | kA                       | kA                        | V                          | V                | mΩ               | °C                | K/kW              | K/kW           | kN               |         | V      |
| 5SHY 35L4520     | 4500             | 2800            | 17               | 4000              | 1700                                        | 50                       | 32                        | 2.70                       | 1.40             | 0.33             | 125               | 8.5               | 3              | 40               | 28-40   | Fig. 1 |
| 5SHY 35L4522     | 4500             | 2800            | 17               | 4000              | 2100                                        | 56                       | 35                        | 2.00                       | 1.15             | 0.21             | 125               | 8.5               | 3              | 40               | 28-40   | Fig. 1 |
| 5SHY 45L4520     | 4500             | 2800            | 17               | 4500              | 1430                                        | 39                       | 28                        | 2.60*                      | 1.70             | 0.45             | 125               | 8.5               | 3              | 40               | 28-40   | Fig. 1 |
| 5SHY 55L4500     | 4500             | 2800            | 17               | 5000              | 1870                                        | 50                       | 33                        | 2.35                       | 1.22             | 0.28             | 125               | 8.5               | 3              | 40               | 28-40   | Fig. 1 |
| 5SHY 65L4521 New | 4500             | 2800            | 17               | 6500              | 2760                                        | –                        | 40.4                      | 2.30                       | 1.12             | 0.294            | 125               | 6.8               | 2.4            | 60               | 28-40   | Fig. 1 |
| 5SHY 65L4522 New | 4500             | 2800            | 17               | 6000              | 2320                                        | –                        | 38.6                      | 2.95                       | 1.39             | 0.390            | 125               | 6.8               | 2.4            | 60               | 28-40   | Fig. 1 |
| 5SHY 50L5500     | 5500             | 3300            | 17               | 3600              | 1290                                        | 40                       | 26                        | 4.10                       | 1.66             | 0.62             | 125               | 8.5               | 3              | 40               | 28-40   | Fig. 1 |
| 5SHY 42L6500     | 6500             | 4000            | 17               | 3800              | 1290                                        | 40                       | 26                        | 4.10                       | 1.88             | 0.56             | 125               | 8.5               | 3              | 40               | 28-40   | Fig. 1 |

- Optimized for snubberless turn-off

- Contact factory for series connection

\* at 2000 A

## Reverse conducting IGCTs

| Part number               | $V_{\text{DRM}}$ | $V_{\text{DC}}$ | $I_{\text{TGQM}}$ | $I_{\text{TAVM}}/I_{\text{FAVM}}$   | $I_{\text{TSM}}/I_{\text{FSM}}$ | $V_{\text{T}}/V_{\text{F}}$ | $V_{\text{T0}}/V_{\text{F0}}$ | $r_{\text{T}}/r_{\text{F}}$ | $T_{\text{VJM}}$ | $R_{\text{thJC}}$ | $F_{\text{m}}$ | $V_{\text{GIN}}$ | Outline |
|---------------------------|------------------|-----------------|-------------------|-------------------------------------|---------------------------------|-----------------------------|-------------------------------|-----------------------------|------------------|-------------------|----------------|------------------|---------|
|                           |                  |                 |                   | $T_{\text{C}} = 85^{\circ}\text{C}$ | 10 ms                           | $T_{\text{VJM}}$            | $T_{\text{VJM}}$              |                             |                  |                   |                |                  |         |
|                           | V                | V               | A                 | A                                   | kA                              | V                           | V                             | mΩ                          | °C               | K/kW              | kN             | V                |         |
| <b>5SHX 26L4520 GCT</b>   | 4500             | 2800            | 2200              | 1010                                | 17.0                            | 2.95                        | 1.80                          | 0.53                        | 125              | 13                |                | 28-40            | Fig. 1  |
| Diode part                |                  |                 |                   | 390                                 | 10.6                            | 5.40                        | 2.70                          | 1.24                        | 125              | 26                | 44             | 28-40            | Fig. 1  |
| <b>5SHX 19L6020 GCT</b>   | 5500             | 3300            | 1800              | 840                                 | 18.0                            | 3.45                        | 1.90                          | 0.90                        | 125              | 13                |                | 28-40            | Fig. 1  |
| Diode part                |                  |                 |                   | 340                                 | 7.7                             | 6.40                        | 2.70                          | 2.23                        | 125              | 26                | 44             | 28-40            | Fig. 1  |
| <b>5SHX 36L4520** New</b> | 4500             | 2800            | 3600              | 1040                                | 15.0                            | 2.70                        | 1.59                          | 0.74                        | 125              | 11                |                | 28-40            | Fig. 1  |
| Diode part                |                  |                 |                   | 730                                 |                                 | 3.60                        | 1.88                          | 1.15                        | 125              | 14                | 44             | 28-40            | Fig. 1  |
| <b>5SHX 36L4521** New</b> | 4500             | 2800            | 3600              | 1280                                | 20.0                            | 2.00                        | 1.24                          | 0.51                        | 125              | 11                |                | 28-40            | Fig. 1  |
| Diode part                |                  |                 |                   | 910                                 | 20.0                            | 2.60                        | 1.46                          | 0.76                        | 125              | 14                | 44             | 28-40            | Fig. 1  |

- Monolithically integrated free-wheeling diode optimized for snubberless turn-off

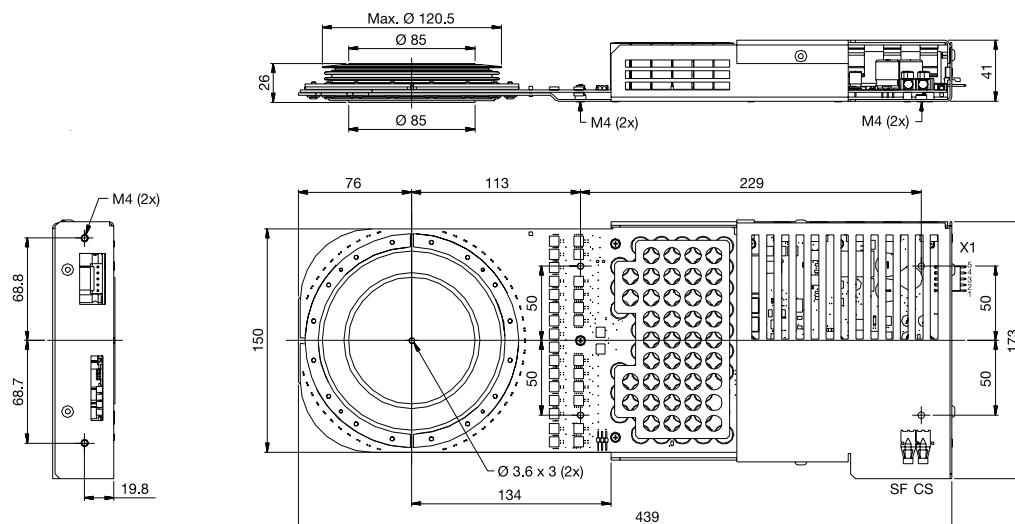
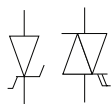
\*\*Contact factory

## Reverse blocking (symmetric) IGCTs

| Part number         | $V_{\text{DRM}}$ | $V_{\text{DC}}$ | $V_{\text{RRM}}$ | $I_{\text{TGQM}}$ | $I_{\text{TAVM}}$                   | $I_{\text{TSM}}$ | $V_{\text{T}}$ | $V_{\text{T0}}$  | $r_{\text{T}}$   | $T_{\text{VJM}}$ | $R_{\text{thJC}}$ | $R_{\text{thCH}}$ | $F_{\text{m}}$ | $V_{\text{GIN}}$ | Outline |
|---------------------|------------------|-----------------|------------------|-------------------|-------------------------------------|------------------|----------------|------------------|------------------|------------------|-------------------|-------------------|----------------|------------------|---------|
|                     |                  |                 |                  |                   | $T_{\text{C}} = 85^{\circ}\text{C}$ | 10 ms            | 1000 A         | $T_{\text{VJM}}$ | $T_{\text{VJM}}$ |                  |                   |                   |                |                  |         |
|                     | V                | V               | V                | A                 | A                                   | kA               | V              | V                | mΩ               | °C               | K/kW              | K/kW              | kN             | V                |         |
| <b>5SHZ 60L2500</b> | 2500             | 1250            | 2500             | 5600              | 3600                                | 49.7             | 0.93           | 0.781            | 0.146            | 125              | 8.5               | 3                 | 44             | 28-40            | Fig. 1  |

Please refer to page 62 for part numbering structure.

Fig. 1



### Fast recovery diode recommendation

For all asymmetric and reverse conducting IGCTs, Hitachi Energy offers matching free-wheeling, neutral point (NPC) and clamp diodes.

The actual choice of the diode depends on the specific application. Please see application note 5SYA 2064, Applying fast recovery diodes, on [www.hitachienergy.com/semiconductors](http://www.hitachienergy.com/semiconductors).

# GTOs

## Gate turn-off thyristors

One might be assuming that the rapid advance of the IGBT would spell an equally rapid end to the GTO era. The demand for these devices, however, is still strong today.



Hitachi Energy offers a broad portfolio of asymmetric GTOs with proven field reliability in various traction and industrial applications.

Asymmetric GTOs are divided in two categories: Fine pattern and standard. Fine pattern GTOs with buffer layer have exceptionally low on-state and dynamic losses and are optimized for fast switching.

### Asymmetric GTOs

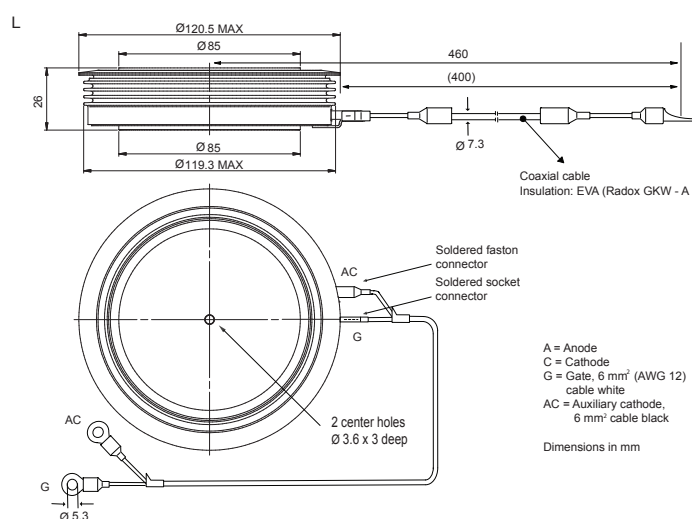
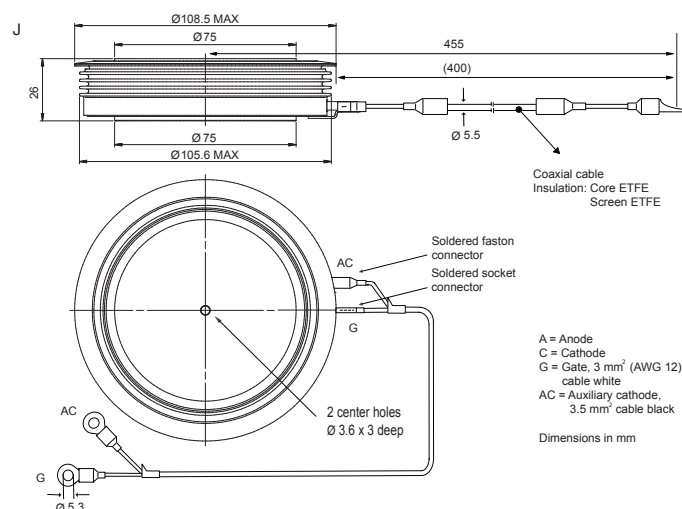
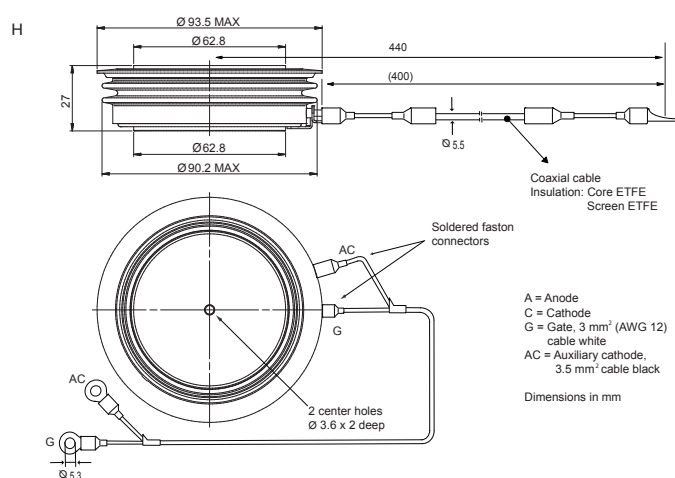
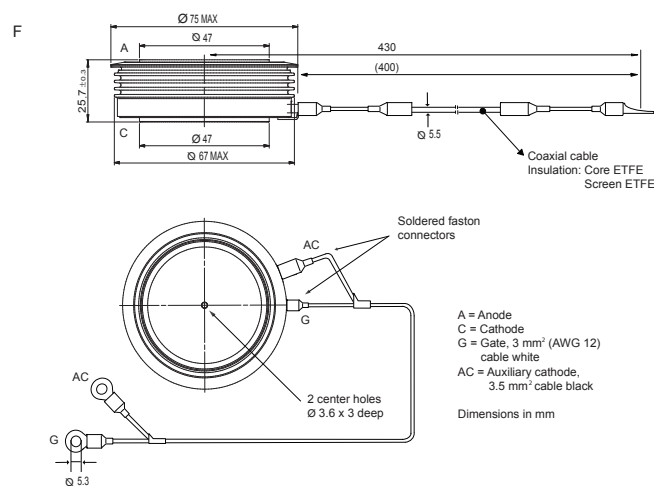
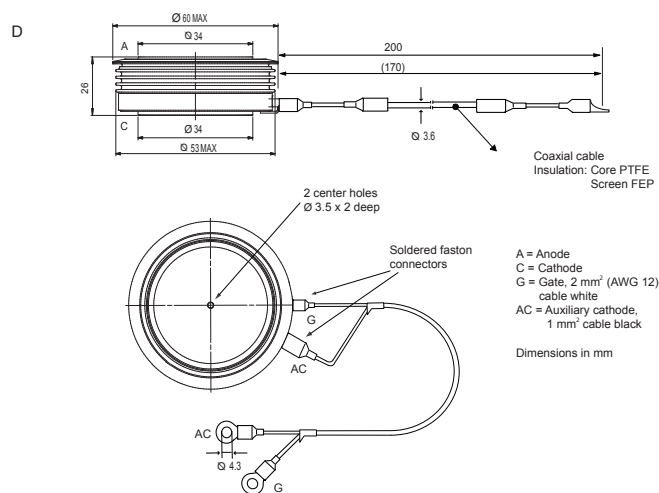
| Part number         | $V_{DRM}$ | $V_{DC}$ | $V_{RRM}$ | $I_{TGM}$ at $C_S$ |         | $I_{TAVM}$           | $I_{TSM}$          | $V_T$                  | $V_{TO}$  | $r_T$      | $T_{VJM}$ | $R_{thJC}$ | $R_{thCH}$ | $F_m$ | Outline |
|---------------------|-----------|----------|-----------|--------------------|---------|----------------------|--------------------|------------------------|-----------|------------|-----------|------------|------------|-------|---------|
|                     |           |          |           |                    |         |                      |                    |                        |           |            |           |            |            |       |         |
|                     |           |          |           |                    |         |                      |                    |                        |           |            |           |            |            |       |         |
|                     |           |          |           |                    |         | $T_C = 85\text{ °C}$ | 10 ms<br>$T_{VJM}$ | $I_{TGM}$<br>$T_{VJM}$ | $T_{VJM}$ |            |           |            |            |       |         |
|                     | V         | V        | V         | A                  | $\mu F$ | A                    | kA                 | V                      | V         | m $\Omega$ | °C        | K/kW       | K/kW       | kN    |         |
| <b>5SGA 15F2502</b> | 2500      | 1400     | 17        | 1500               | 3       | 570                  | 10.0               | 2.80                   | 1.45      | 0.90       | 125       | 27         | 8          | 15    | F       |
| <b>5SGA 20H2501</b> | 2500      | 1400     | 17        | 2000               | 4       | 830                  | 16.0               | 2.80                   | 1.66      | 0.57       | 125       | 17         | 5          | 20    | H       |
| <b>5SGA 25H2501</b> | 2500      | 1400     | 17        | 2500               | 6       | 830                  | 16.0               | 3.10                   | 1.66      | 0.57       | 125       | 17         | 5          | 20    | H       |
| <b>5SGA 30J2501</b> | 2500      | 1400     | 17        | 3000               | 5       | 1300                 | 30.0               | 2.50                   | 1.50      | 0.33       | 125       | 12         | 3          | 40    | J       |
| <b>5SGA 06D4502</b> | 4500      | 2800     | 17        | 600                | 1       | 210                  | 3.0                | 4.00                   | 1.90      | 3.50       | 125       | 50         | 8          | 11    | D       |
| <b>5SGA 20H4502</b> | 4500      | 2200     | 17        | 2000               | 4       | 710                  | 13.0               | 3.50                   | 1.80      | 0.85       | 125       | 17         | 5          | 20    | H       |
| <b>5SGA 30J4502</b> | 4500      | 2800     | 17        | 3000               | 6       | 930                  | 24.0               | 4.00                   | 2.20      | 0.60       | 125       | 12         | 3          | 40    | J       |
| <b>5SGA 40L4501</b> | 4500      | 2800     | 17        | 4000               | 6       | 1000                 | 25.0               | 4.40                   | 2.10      | 0.58       | 125       | 11         | 3          | 40    | L       |

### Asymmetric fine pattern GTOs with buffer layer

|                     |      |      |    |      |   |      |      |      |      |      |     |    |   |    |   |
|---------------------|------|------|----|------|---|------|------|------|------|------|-----|----|---|----|---|
| <b>5SGF 30J4502</b> | 4500 | 3000 | 17 | 3000 | 3 | 960  | 24.0 | 3.90 | 1.80 | 0.70 | 125 | 12 | 3 | 33 | J |
| <b>5SGF 40L4502</b> | 4500 | 2800 | 17 | 4000 | 6 | 1180 | 25.0 | 3.80 | 1.20 | 0.65 | 125 | 11 | 3 | 33 | L |

Please refer to page 62 for part numbering structure.





### Fast recovery diode recommendation

For all GTO types, Hitachi Energy offers matching free-wheeling and snubber diodes. The actual choice of the diode depends on the specific application. Please see application note 5SYA 2064, Applying fast recovery diodes, on [www.hitachienergy.com/semiconductors](http://www.hitachienergy.com/semiconductors).

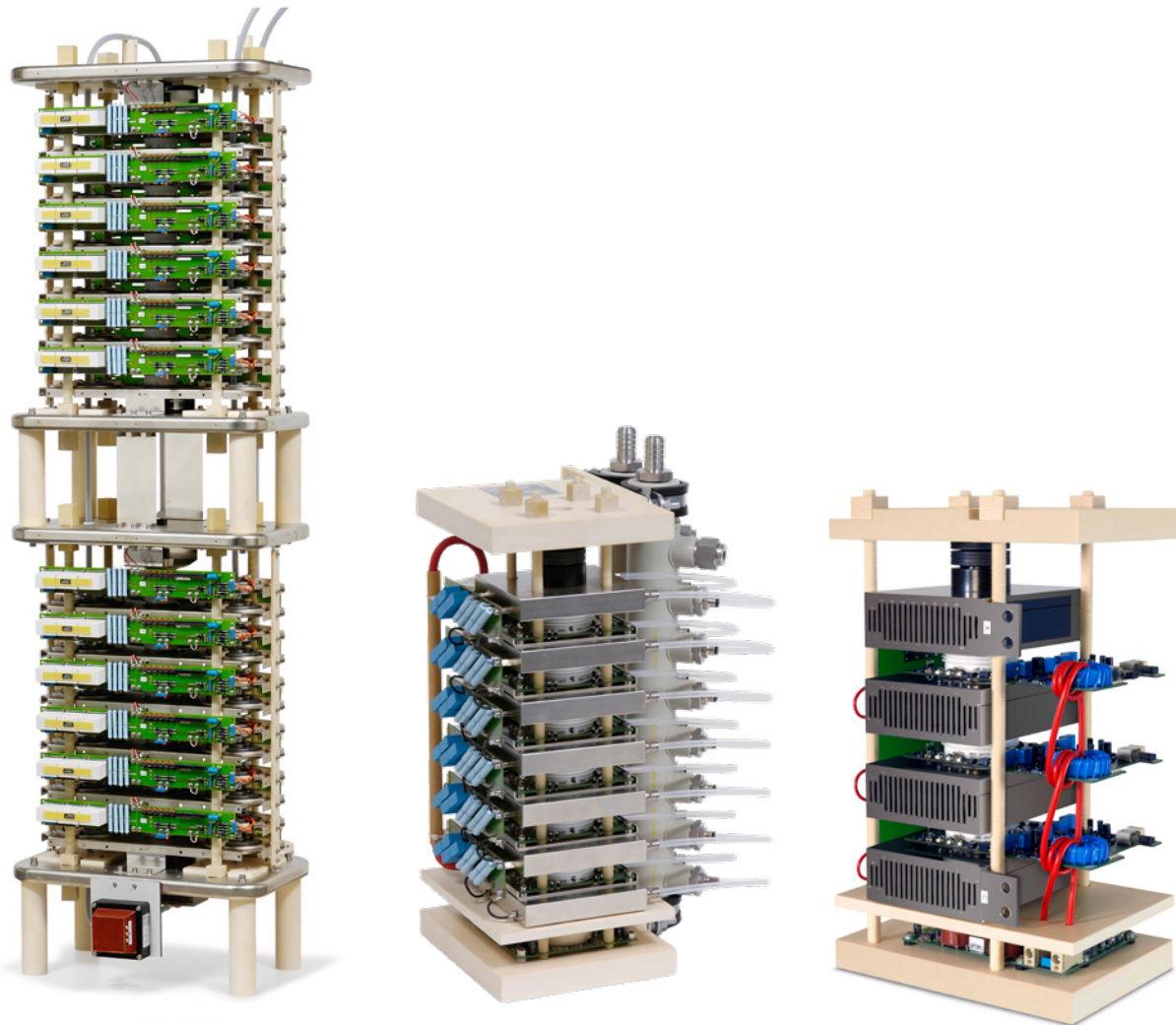
# Assemblies for high power applications

Hitachi Energy designs and produces complete solid-state assemblies containing the semiconductor device, driving circuit, triggering, mechanical clamping and cooling, ensuring performance with application-specific testing.

Hitachi Energy offers assemblies for a variety of applications from research & development and laboratory use to production. The semiconductor devices are designed to switch currents with very fast rise times (high  $di/dt$ ) for pulse power applications. They feature rapid turn-on, very high current ratings and high blocking voltages.

Due to higher reliability and lower maintenance costs, Hitachi Energy's optimized assemblies are increasingly replacing thyratrons and ignitrons.

We offer assemblies rated up to 120 kV and 200 kA using series and parallel connections. Custom build assemblies are available on request.



## Closing Switches

### Applications:

- Radar power supply switches
- Food sterilisation
- Rock blasting
- DgNOx/DeSOx dust precipitation
- Laser power supplies

| Part number           | Technology       | Cooling | Max. Voltage<br>[kV] | dl/dt<br>[kA/μs] | I <sub>max</sub><br>[kA] | Pulse width<br>[μs] | Rep. Rate<br>[Hz] |
|-----------------------|------------------|---------|----------------------|------------------|--------------------------|---------------------|-------------------|
| <b>5SVC 032700E00</b> | High dl/dt IGCTs | Air     | 5.6                  | 6                | 1.2                      | 2                   | 1350              |
| <b>5SVC 083600E00</b> | High dl/dt IGCTs | Water   | 20                   | 10               | 12.6                     | 12                  | 300               |
| <b>5SVC 163500E00</b> | High dl/dt IGCTs | Water   | 40                   | 4                | 4.0                      | 1000                | 25                |

## Modulator Switches

### Applications:

- Modulators
- Particle beam accelerators
- Oceanic research fish barriers

| Part number           | Technology | Cooling | Max. Voltage<br>[kV] | dl/dt<br>[kA/μs] | I <sub>max</sub><br>[kA] | Pulse width<br>[μs] | Rep. Rate<br>[Hz] |
|-----------------------|------------|---------|----------------------|------------------|--------------------------|---------------------|-------------------|
| <b>5SVG 073500E00</b> | Turn Off   | Water   | 10                   | 0.5              | 3.2                      | 2000                | 30                |
| <b>5SVG 031400E00</b> | IGCTs      | Air     | 4.4                  | 0.02             | 3.7                      | 2000                | 5                 |
| <b>5SVI 071700E00</b> | IGBTs      | Water   | 20                   | 3                | 2.6                      | 10                  | 1000              |

## Crowbars

### Applications:

- Crowbars for Gytrons

| Part number           | Technology | Cooling | Max. Voltage<br>[kV] | dl/dt<br>[kA/μs] | I <sub>max</sub><br>[kA] | Pulse width<br>[μs] | Rep. Rate<br>[Hz] |
|-----------------------|------------|---------|----------------------|------------------|--------------------------|---------------------|-------------------|
| <b>5SVT 360000D00</b> | Thyristors | Air     | 120                  | 1.2              | 14                       | 100                 | *SP               |

Single Pulse

## Diodes

### Applications:

- HV rectifiers

| Part number           | Technology | Cooling | Max. Voltage<br>[kV] | dl/dt<br>[kA/μs] | I <sub>max</sub><br>[kA] | Pulse width<br>[μs] | Rep. Rate<br>[Hz] |
|-----------------------|------------|---------|----------------------|------------------|--------------------------|---------------------|-------------------|
| <b>5SVD 091200B00</b> | Diodes     | Air     | 30                   | 0.260            | 50                       | 1000                | 0.02              |

## Pulse Rectifiers

### Applications:

- Test Equipment

| Part number           | Technology | Cooling | Max. Voltage<br>[kV] | I <sub>max</sub><br>[kA] | Pulse width<br>[μs] | Rep. Rate<br>[Hz] |
|-----------------------|------------|---------|----------------------|--------------------------|---------------------|-------------------|
| <b>5SVT 011500D00</b> | Thyristors | Air     | 1.6 kVAC             | 25                       | 15000               | 50                |

# Test systems for high-power semiconductors

Hitachi Energy designs, manufactures and offers CE compliant customized power semiconductor test systems.

Hitachi Energy offers test systems for various environments like research & development, laboratory, production or failure analysis. Highest quality assurance, safe handling, as well as remote or on-site service capability are guaranteed.

## High-power semiconductor test systems

Hitachi Energy offers static and dynamic production test systems for most types of power semiconductor devices like diodes, PCTs, BCTs, GTOs, IGCTs and IGBTs. They can handle dies, substrates, submodules, modules, wafers and press-pack devices. Also reliability test systems for high temperature reverse bias, intermittent operating life or surge current tests are available. Auxiliary tester parts include clamping, capacitor discharge, pre-heating, data acquisition and parameter extraction units as well as programmable IGBT and thyristor gate units.

## Parameters

The Hitachi Energy test systems cover up to 14 kV and 10 kA range and use an adjustable low stray inductance. During testing, the clamped device under test (DUT) can be precisely heated up to 185 °C for production systems or cooled down to -40 °C in an environmental chamber for engineering systems. The clamping units can handle devices up to 240 mm in diameter and can apply a clamping force of up to 240 kN.

## Automation

Our test systems are designed for easy integration into automated handling equipment. The test system's software is compatible to commercial control systems such as manufacturing execution systems (MES) and computer-aided quality assurance (CAQ).

|                                                                    | Blocking voltage AC or DC | Gate characteristics | On-state, forward voltage | Reverse recovery charge | Critical dV/dt | Circuit-commutated turn-off time | $V_{\text{ce(sat)}} / V_{\text{pnd-off}}$ | Turn-on / turn-off | Flatness baseplates |
|--------------------------------------------------------------------|---------------------------|----------------------|---------------------------|-------------------------|----------------|----------------------------------|-------------------------------------------|--------------------|---------------------|
| BiPolar test systems                                               |                           |                      |                           |                         |                |                                  |                                           |                    |                     |
| <b>Thyristor and diode static / dynamic</b>                        | X                         | X                    | X                         | X                       | X              | X                                |                                           |                    |                     |
| <b>GTO and diode static</b>                                        | X                         | X                    | X                         |                         |                |                                  |                                           | X                  |                     |
| <b>GTO and diode dynamic</b>                                       | X                         |                      |                           | X                       |                |                                  |                                           | X                  |                     |
| IGBT & SiC MOSFET test systems                                     |                           |                      |                           |                         |                |                                  |                                           |                    |                     |
| <b>IGBT &amp; SiC MOSFET and diode dies static</b>                 | X                         | X                    |                           |                         |                |                                  | X                                         |                    |                     |
| <b>IGBT &amp; SiC MOSFET and diode substrates static / dynamic</b> | X                         | X                    |                           | X                       |                |                                  | X                                         | X                  |                     |
| <b>IGBT &amp; SiC MOSFET and diode modules static</b>              | X                         | X                    |                           |                         |                |                                  | X                                         |                    |                     |
| <b>IGBT &amp; SiC MOSFET and diode modules dynamic</b>             |                           |                      |                           | X                       |                |                                  |                                           | X                  |                     |
| <b>IGBT &amp; SiC MOSFET mechanical properties</b>                 |                           |                      |                           |                         |                |                                  |                                           |                    | X                   |

## Reliability test systems

- High temperature reverse bias
- Intermittent operating life / Power cycling
- Surge current
- Frequency tester

## Auxiliary unit

- Clamping unit
- Capacitor discharge unit
- Pre-heating unit
- Programmable IGBT and thyristor gate units
- Data acquisition and parameter extraction units







# Further information

## Certificates

Hitachi Energy is committed to the highest ethical, environmental and business standards. The company has been awarded the ISO certifications for manufacturing, design and development of high-power semiconductor devices and modules (ISO 9001 and 14001).

Certificate DE21/819945151

The management system of  
**Hitachi Energy AG**

Fabrikstrasse 3, CH 5600 Lenzburg  
has been assessed and certified as meeting the requirements of  
**ISO 9001:2015**

For the following activities  
Design, development, manufacturing, marketing and sales of power semiconductor devices and modules. Design, development, manufacturing, marketing and sales of test systems for power semiconductors.

This certificate is valid from 24 November 2023 until 24 June 2024 and remains valid subject to satisfactory surveillance audits.  
Issue 5. Certified since 13 April 2023  
Organization certified since 11 January 2010 and first certified by SGS on 13 April 2023.

*D. Willemin*  
Authorized by  
Daniel Willemin  
SGS Société Générale de Surveillance SA  
Technoparkstrasse 1, 8005, Zurich, Switzerland  
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SGS

IAF

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Page 1 / 1

Certificate  
for  
**Hitachi Energy Ltd.**  
Fabrikstrasse 3, 5600 Lenzburg / Switzerland

Bureau Veritas Certification hereby confirms that the management system of the above-mentioned organization has been assessed and complies with the requirements set out in the following standards/regulations.

Standards/Regulations:

**EN ISO 14001: 2015**  
**ISO 45001: 2018**

The management system comprises:

**Design, development, manufacturing, marketing and sales of power semiconductor devices and modules.**  
**Design, development, manufacturing, marketing and sales of test systems for power semiconductors.**

Date of initial certification : 25.06.2007 (ISO 14001)  
14.08.2020 (ISO 45001)

Date of recertification : 22.03.2022

End of the last certification cycle : 24.06.2022  
Start of the new certification cycle : 25.06.2022

The requirements of the standards /regulations must be continuously fulfilled throughout the validity of this certificate. This will be ensured and guaranteed through regular monitoring by Bureau Veritas Certification.

This certificate is valid until : 24.06.2025

Bureau Veritas Certification will provide information on the validity of this certificate on request at any time. Additional information on the management system and the area of applicability should be obtained from the organization itself.

Certificate number : 13316742 Version : 2 Issue date : 23.11.2023

*MAB*

Bureau Veritas Switzerland AG,  
Grossschäferstrasse 25, CH-8104 Weingarten ZH

Seite 1 / 1



Building  
trust  
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# Certificate

CQS has issued an IQNET recognized certificate that the organization:

**Hitachi Energy Czech Republic s.r.o.**  
Průmyslová 137, Dolní Staré Město, 541 01 Trutnov, Czech Republic

Local product group Semiconductors  
Novodvorská 1768/138a, 142 21 Praha 4, Czech Republic

has implemented and maintains a  
**Quality Management System**

for the following scope:  
Design, development and manufacturing of:  
- silicon single crystals, wafers and special products  
- high power semiconductor devices and modules

which fulfils the requirements of the following standard:

**ISO 9001:2015**

Issued on: 2022 - 08 - 14  
First issued on: 2010 - 08 - 23  
Expires on: 2025 - 08 - 13

Registration Number: **CZ - 2109/2022**

Alex Stoichitoiu  
President of IQNET

Tomáš Hruška  
President of CQS



This attestation is directly linked to the IQNET Member's original certificate and shall not be used as a stand-alone document.

**IQNET Members:**  
AENOR Spain, AFNOR Certification France, APCER Portugal, CCC Cyprus, CISO Italy, CQC China, COM China, COS Czech Republic, CRO Cert Croatia, DQS Holding GmbH Germany, EAGLE Certification Group USA, FCAB Brazil, FONDONORMA Venezuela, ICONTEC Colombia, ICS Bosnia and Herzegovina, Inspecta Sertifointi Oy Finland, INTECO Costa Rica, IRAM Argentina, JQA Japan, KFO Korea, LSQA Uruguay, MIRTEC Greece, MSZT Hungary, Nemko AS Norway, NSAI Ireland, NYCE-SIGE Mexico, PCBC Poland, Quality Austria Austria, SII Israel, SIQ Slovenia, SIRIM QAS International Malaysia, SGS Switzerland, SRAC Romania, TSE Türkiye, YUGOS Serbia

\*The list of IQNET Members is valid at the time of issue of this certificate. Updated information is available under [www.iqnet-certification.com](http://www.iqnet-certification.com)



Building  
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# Certificate

CQS has issued an IQNET recognized certificate that the organization:

**Hitachi Energy Czech Republic s.r.o.**  
Průmyslová 137, Dolní Staré Město, 541 01 Trutnov, Czech Republic

Local product group Semiconductors  
Novodvorská 1768/138a, 142 21 Praha 4, Czech Republic

has implemented and maintains an  
**Environmental Management System**

for the following scope:  
Design, development and manufacturing of:  
- silicon single crystals, wafers and special products  
- high power semiconductor devices and modules

which fulfils the requirements of the following standard:

**ISO 14001:2015**

Issued on: 2022 - 08 - 14  
First issued on: 2010 - 08 - 23  
Expires on: 2025 - 08 - 13

Registration Number: **CZ - 133/2022**

Alex Stoichitoiu  
President of IQNET

Tomáš Hruška  
President of CQS



This attestation is directly linked to the IQNET Member's original certificate and shall not be used as a stand-alone document.

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\*The list of IQNET Members is valid at the time of issue of this certificate. Updated information is available under [www.iqnet-certification.com](http://www.iqnet-certification.com)



Building  
trust  
together.

# Certificate

CQS has issued an IQNET recognized certificate that the organization:

**Hitachi Energy Czech Republic s.r.o.**  
Průmyslová 137, Dolní Staré Město, 541 01 Trutnov, Czech Republic

Local product group Semiconductors  
Novodvorská 1768/138a, 142 21 Praha 4, Czech Republic

has implemented and maintains an  
**Occupational Health and Safety Management System**

for the following scope:  
Design, development and manufacturing of:  
- silicon single crystals, wafers and special products  
- high power semiconductor devices and modules

which fulfils the requirements of the following standard:

**ISO 45001:2018**

Issued on: 2022 - 08 - 14  
First issued on: 2010 - 08 - 23  
Expires on: 2025 - 08 - 13

Registration Number: **CZ - 134/2022**

Alex Stoichitoiu  
President of IQNET

Tomáš Hruška  
President of CQS



This attestation is directly linked to the IQNET Member's original certificate and shall not be used as a stand-alone document.

**IQNET Members:**  
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\*The list of IQNET Members is valid at the time of issue of this certificate. Updated information is available under [www.iqnet-certification.com](http://www.iqnet-certification.com)

# Further information

## Product Environmental Compliance Information

With reference to the Regulation (EC) N° 1907/2006, issued by the European Union for the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH), please be aware that:

- During normal and reasonably foreseeable conditions of use, products and related accessories, which are articles according to REACH, manufactured by Hitachi Energy Ltd., Semiconductors and/or Hitachi Energy Czech Republic s.r.o. do not intentionally release any substance or preparation (mixtures);
- Hitachi Energy Ltd., Semiconductors and/or Hitachi Energy Czech Republic s.r.o. continuously assess their products for content of Substances of Very High Concern (SVHC), as included in the "Candidate List" by the European Chemicals Agency (ECHA);
- Hitachi Energy Ltd., Semiconductors and/or Hitachi Energy Czech Republic s.r.o. continuously undertake communications throughout their supply chain in order to collect information about suppliers' compliance with REACH Regulation.

For further information about product specific environmental compliance information, please contact us.

Hitachi Energy Ltd., Semiconductors

# Further information

## Symbols

| Symbol         | Description                                                                                                                       |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------|
| $di/dt_{\max}$ | Maximum rate of rise or decline of on-state current                                                                               |
| $dV/dt$        | Maximum rate of rise of off-state voltage                                                                                         |
| $F_m$          | Mounting force                                                                                                                    |
| $I_C$          | DC collector current                                                                                                              |
| $I_D$          | DC drain current                                                                                                                  |
| $I_{CM}$       | Peak collector current                                                                                                            |
| $I_F$          | Diode nominal mean forward current                                                                                                |
| $I_{FAVM}$     | Max. average forward current (180° sine wave)                                                                                     |
| $I_{FSM}$      | Max. surge peak forward current for a 180° sine wave; no voltage reapplied after surge                                            |
| $I_{RM}$       | Max. peak avalanche current for a single 180° sine wave pulse                                                                     |
| $I_{RMS}$      | Max. rms on-state current (AC full wave)                                                                                          |
| $I_{rr}$       | Max. (typ. for IGBT diode) reverse recovery current                                                                               |
| $I_T$          | On-state current thyristor                                                                                                        |
| $I_{TAVM}$     | Max. average on-state current (180° sine wave)                                                                                    |
| $I_{TGQM}$     | Max. turn-off current                                                                                                             |
| $I_{TSM}$      | Max. surge peak on-state current for a 180° sine wave; no voltage reapplied after surge                                           |
| $P_{RSM}$      | Max. surge avalanche power dissipation (single pulse)                                                                             |
| $Q_{rr}$       | Max. reverse recovery charge                                                                                                      |
| $R_{DS(on)}$   | Drain-source on resistance                                                                                                        |
| $r_F$          | Forward slope resistance                                                                                                          |
| $r_T$          | On-state slope resistance                                                                                                         |
| $R_{thCH}$     | Thermal resistance case to heatsink                                                                                               |
| $R_{thJC}$     | Thermal resistance junction to case                                                                                               |
| $R_{thJH}$     | Thermal resistance junction to heatsink                                                                                           |
| $T_C$          | Case temperature                                                                                                                  |
| $t_q$          | Turn-off time                                                                                                                     |
| $T_{VJ}$       | Junction temperature                                                                                                              |
| $T_{VJM}$      | Max. junction temperature                                                                                                         |
| $V_{CES}$      | IGBT collector-emitter voltage                                                                                                    |
| $V_{CESat}$    | Collector-emitter saturation voltage                                                                                              |
| $V_{DC}$       | Max. DC voltage rating for 100 FIT, 100 percent duty                                                                              |
| $V_{DRM}$      | Max. repetitive peak forward blocking voltage                                                                                     |
| $V_{DSS}$      | Drain-source voltage                                                                                                              |
| $V_F$          | Forward voltage drop                                                                                                              |
| $V_{F0}$       | Forward threshold voltage                                                                                                         |
| $V_{Fmax}$     | Max. forward voltage drop                                                                                                         |
| $V_{Fmin}$     | Min. forward voltage drop                                                                                                         |
| $V_{GIN}$      | Input voltage of IGCT gate drive                                                                                                  |
| $V_R$          | Symmetrical peak avalanche voltage at a sinusoidal current pulse with 20 A peak, 10 µs pulse width and 60 °C junction temperature |
| $V_{RM}$       | Max. repetitive peak blocking voltage                                                                                             |
| $V_{RRM}$      | Max. repetitive peak reverse blocking voltage                                                                                     |
| $V_{RSM}$      | Max. surge peak reverse blocking voltage                                                                                          |
| $V_T$          | On-state voltage drop                                                                                                             |
| $V_{T0}$       | On-state threshold voltage                                                                                                        |

# Further information

## Documentation

### MOSFET, IGBT dies and modules

| Document title                                                                              | Document number |
|---------------------------------------------------------------------------------------------|-----------------|
| Mounting instructions for StakPaks                                                          | 5SYA 2037       |
| Mounting instructions for HiPak modules                                                     | 5SYA 2039       |
| Failure rates of IGBT due to cosmic rays                                                    | 5SYA 2042       |
| Load-cycling capability of HiPak IGBT modules                                               | 5SYA 2043       |
| Thermal runaway during blocking                                                             | 5SYA 2045       |
| Voltage ratings of high-power semiconductors                                                | 5SYA 2051       |
| Applying IGBTs                                                                              | 5SYA 2053       |
| IGBT diode safe operating area                                                              | 5SYA 2057       |
| Surge currents for IGBT diodes                                                              | 5SYA 2058       |
| Applying IGBT and diode dies                                                                | 5SYA 2059       |
| Thermal design and temperature ratings of IGBT modules                                      | 5SYA 2093       |
| IGBT short circuit safe operating area (SOA) capability and testing                         | 5SYA 2095       |
| Paralleling of IGBT modules                                                                 | 5SYA 2098       |
| Mounting Instructions for 62Pak                                                             | 5SYA 2106       |
| Use and installation instructions for LoPak1 modules – Thermal paste                        | 5SYA 2113       |
| Use and installation instructions for LoPak1 – Pre-applied Thermal Interface Material (TIM) | 5SYA 2142       |
| Mounting and applying RoadPak modules                                                       | 5SYA 2159       |

### Diodes

| Document title                                                                     | Document number |
|------------------------------------------------------------------------------------|-----------------|
| High-current rectifier diodes for welding applications                             | 5SYA 2013       |
| Design of RC snubbers for phase control applications                               | 5SYA 2020       |
| High-power rectifier diodes                                                        | 5SYA 2029       |
| Mechanical clamping of press-pack high-power semiconductors                        | 5SYA 2036       |
| Field measurements on high-power press-pack semiconductors                         | 5SYA 2048       |
| Voltage ratings of high-power semiconductors                                       | 5SYA 2051       |
| Failure rates of fast recovery diodes due to cosmic rays                           | 5SYA 2061       |
| Applying fast recovery diodes                                                      | 5SYA 2064       |
| Parameter selection of high-power semiconductor for series and parallel connection | 5SYA 2091       |

### Thyristors

| Document title                                                                          | Document number |
|-----------------------------------------------------------------------------------------|-----------------|
| Bi-directionally controlled thyristors                                                  | 5SYA 2006       |
| Design of RC snubbers for phase control applications                                    | 5SYA 2020       |
| Gate-drive recommendations for phase control and bi-directionally controlled thyristors | 5SYA 2034       |
| Mechanical clamping of press-pack high-power semiconductors                             | 5SYA 2036       |
| Field measurements on high-power press-pack semiconductors                              | 5SYA 2048       |
| Voltage definitions for phase control and bi-directionally controlled thyristors        | 5SYA 2049       |
| Voltage ratings of high-power semiconductors                                            | 5SYA 2051       |
| Switching losses for phase control and bi-directionally controlled thyristors           | 5SYA 2055       |
| Parameter selection of high-power semiconductor for series and parallel connection      | 5SYA 2091       |
| Surge currents for phase control thyristors                                             | 5SYA 2102       |



IGCTs

| Document title                                              | Document number |
|-------------------------------------------------------------|-----------------|
| Applying IGCT gate units                                    | 5SYA 2031       |
| Applying IGCTs                                              | 5SYA 2032       |
| Mechanical clamping of press-pack high-power semiconductors | 5SYA 2036       |
| Failure rates of IGCTs due to cosmic rays                   | 5SYA 2046       |
| Field measurements on high-power press-pack semiconductors  | 5SYA 2048       |
| Voltage ratings of high-power semiconductors                | 5SYA 2051       |

GTOs

| Document title                                              | Document number |
|-------------------------------------------------------------|-----------------|
| Mechanical clamping of press-pack high-power semiconductors | 5SYA 2036       |
| Field measurements on high-power press-pack semiconductors  | 5SYA 2048       |
| Voltage ratings of high-power semiconductors                | 5SYA 2051       |

Environmental specifications

| Document title                                                             | Document number |
|----------------------------------------------------------------------------|-----------------|
| General Environmental Conditions For High Power Semiconductors             | 5SZK 9118       |
| Handling, packing and storage conditions for sawn wafer dies and bare dies | 5SZK 9114       |

# Further information

## Part numbering structure

IGBT and diode dies

5SM Y 86 M 12 80

**Product group**

5SM = IGBT  
5SL = Diode

**Technology**

X = SPT / Y = SPT+ and SPT++ / Z = Enhanced trench / FSA, FCE diode / W = TFP

**Type**

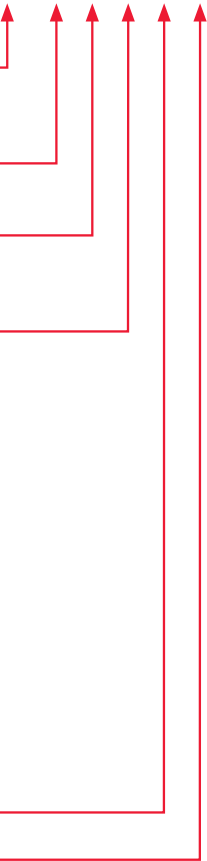
76 = Unsaun wafer die / 86 = Sawn wafer die  
12 = Picked die (waffle pack)

**Die size in mm2**

|   |     |   |                        |
|---|-----|---|------------------------|
| A | 4   | - | 8.99 mm <sup>2</sup>   |
| B | 9   | - | 15.99 mm <sup>2</sup>  |
| C | 16  | - | 24.99 mm <sup>2</sup>  |
| D | 25  | - | 35.99 mm <sup>2</sup>  |
| E | 36  | - | 48.99 mm <sup>2</sup>  |
| F | 49  | - | 63.99 mm <sup>2</sup>  |
| G | 64  | - | 80.99 mm <sup>2</sup>  |
| H | 81  | - | 99.99 mm <sup>2</sup>  |
| J | 100 | - | 120.99 mm <sup>2</sup> |
| K | 121 | - | 143.99 mm <sup>2</sup> |
| L | 144 | - | 168.99 mm <sup>2</sup> |
| M | 169 | - | 195.99 mm <sup>2</sup> |
| N | 196 | - | 224.99 mm <sup>2</sup> |
| O | 225 | - | 255.99 mm <sup>2</sup> |
| P | 256 | - | 288.99 mm <sup>2</sup> |
| Q | 289 | - | 323.99 mm <sup>2</sup> |
| R | 324 | - | 360.99 mm <sup>2</sup> |
| S | 361 | - | 399.99 mm <sup>2</sup> |

**Blocking voltage (V/100)**

**Version number**



MOSFET, IGBT and diode modules

5SN D 0800 M 17 0 1 00

Product group

- 5SF = SiC MOSFET
- 5SJ = BIGT
- 5SL = Diode
- 5SM = IGBT
- 5SN = IGBT and diode

Configuration

- A = Single device (can include diode)
- D = Dual switch in one package
- E = Chopper, switch on low side
- G = Phase leg

Nominal collector current rating (A)

Housing

- A = RoadPak A-Sample
- B = RoadPak B-Sample
- C = RoadPak C-Sample
- E = HiPak2, 40 mm
- G = HiPak2 HV, 44 mm
- H = Press-pack
- J = HiPak1 HV, 44 mm
- K = Press-pack
- L = Press-pack
- M = HiPak1, 30 mm
- N1 & N2 = HiPak1, 40 mm
- P = HiPak0
- Q = 62Pak
- R = LoPak1 (thermal paste/TIM)
- S = LoPak3
- X = LinPak

Blocking voltage (V/100)

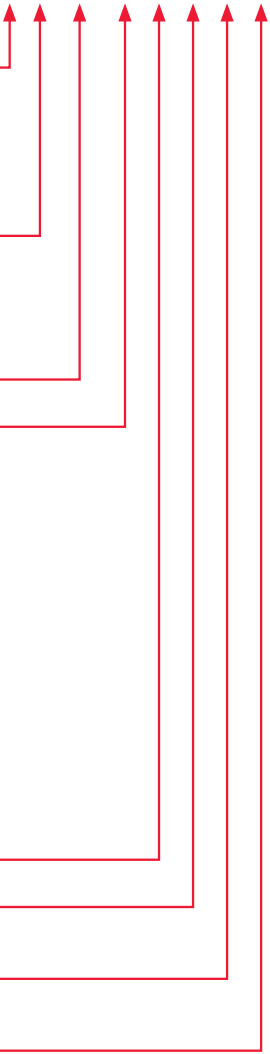
Package variation

- 0 = Standard

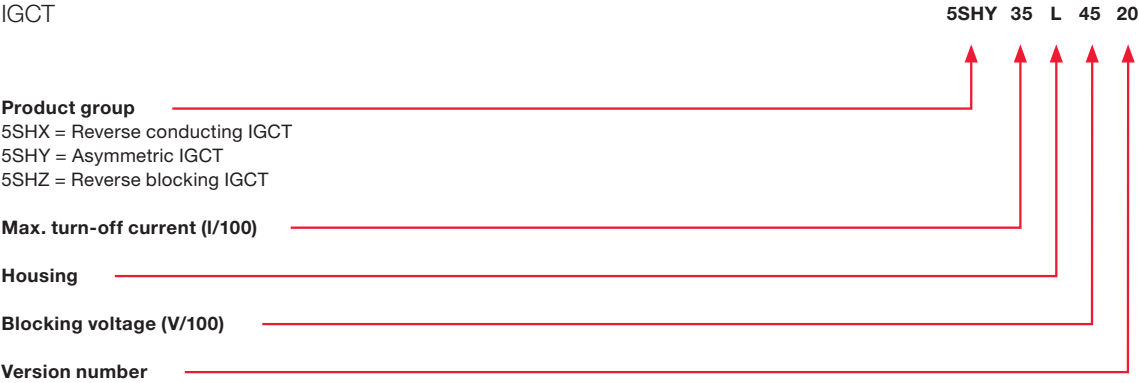
Technology variation

- 1 = SPT / 3 = SPT<sup>+</sup> and SPT<sup>++</sup> / 4 = TSPT<sup>+</sup> (Enhanced trench cell technology)

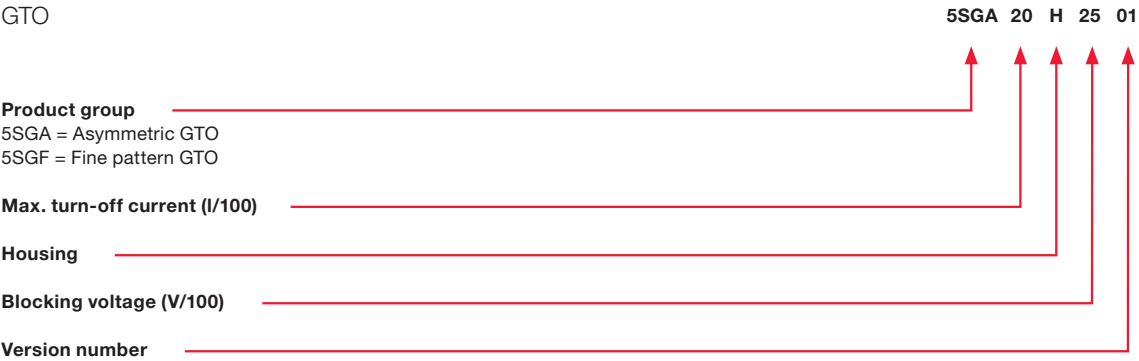
Version number



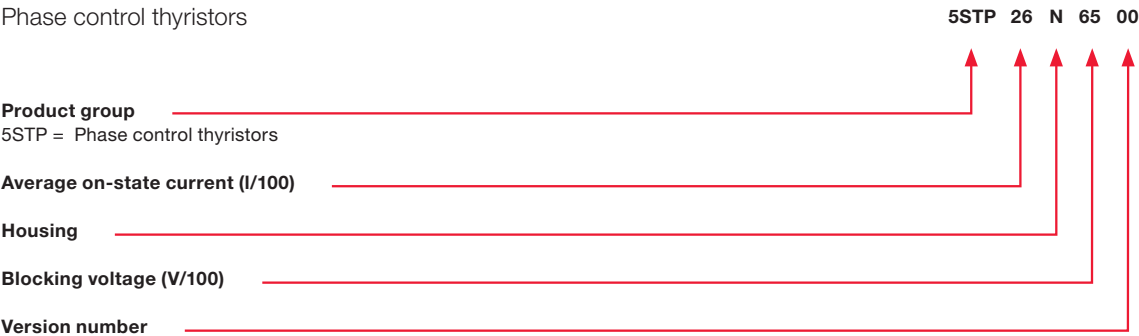
IGCT



GTO



Phase control thyristors



Diodes

Product group

5SDA = Avalanche rectifier diode  
5SDD = Rectifier diode  
5SDF = Fast recovery diode

Average on-state current (I/100)

Housing

Blocking voltage (V/100)

Version number

5SDA 14 F 50 07

BiPolar Power modules

Product group

5SE

Configuration

D = Diode / diode  
G = Thyristor / diode  
E = Diode / thyristor  
T = Thyristor / thyristor

Average on-state current (I/100)

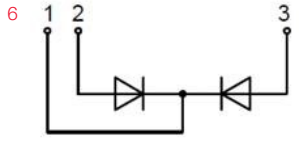
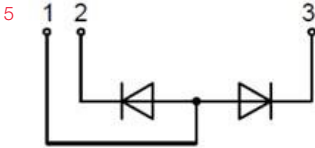
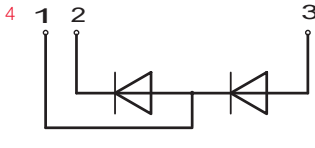
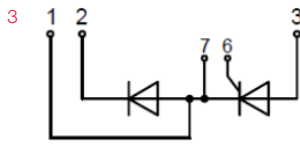
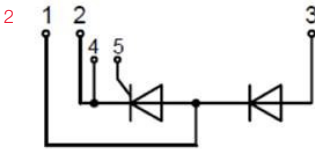
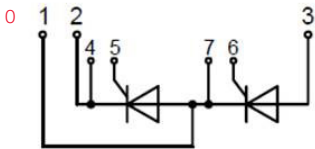
Housing

T ... 60Pak

Blocking voltage (V/100)

Connection

5SE D 0890 T 22 4 0



Version number



# Further information

## Worldwide distributors

### Global supplier

Richardson RFPD (Headquarters) 1950 S.  
Batavia Avenue  
Suite 100, Geneva, IL 60134, USA  
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