

Product Catalog 2022

# 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)

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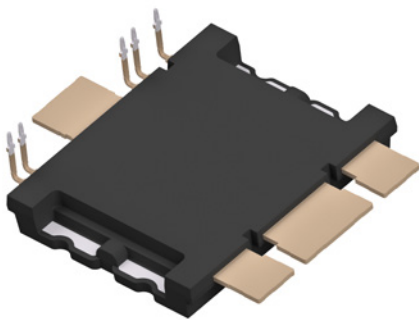
# Product outlook

## RoadPak XS

A new RoadPak with a smaller footprint for the 750 V and 1200 V classes will be available for sampling in the third quarter of 2022. 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 Q3/2022	750	2 x 440	RoadPak
1200 V phase leg MOSFET, samples available Q3/2022	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 solution that combines the IGBT and the free-wheeling diode into a single chip, the BIGT. This enables greater power cycling capability and increases current density. During 2022 Hitachi Energy will launch the BIGT2, a second generation of this chip, that delivers a 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 will deliver a StakPak with an unprecedented current rating of 5000 A.



### LoPak 1200 V, 1700 V

New 1200 V class LoPak modules are now available, completing the portfolio with high current ratings of 2 x 600 A and 2 x 900 A. Their compact size and optimized high-performance design mean they are ideal for a wide variety of applications. Further extending the existing LoPak 1700 V portfolio, a new, more powerful 1700 V module rated at 2 x 600 A, which benefits from the newly launched Trench Fine Pattern (TFP) chip technology, will be added.

#### Ratings

Availability	Voltage (V)	Current (A)	Housing
1200 V 600 A phase leg IGBT, samples available	1200	2 x 600	LoPak1
1200 V 900 A phase leg IGBT, samples available	1200	2 x 900	LoPak1
1700 V 600 A phase leg IGBT, samples available Q3 2022	1700	2 x 600	LoPak1



### 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, it 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 for more than five years. With the help of a new generation of chip, Hitachi Energy now supports current ratings of 1500 A 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.

### Ratings

Availability	Voltage (V)	Current (A)	Housing
1700 V 1000 A TFP technology, samples available Q2 2022	1700	2 x 1000	LV LinPak
1700 V 1500 A TFP technology, samples available Q2 2022	1700	2 x 1500	LV 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, samples available Q3 2022	1200	2 x 110	FlexyPak1
1200 V 220 A with SiC MOSFET, samples available Q3 2022	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) module rated at 2200 V is now fully qualified and available in volume, while the thyristor and thyristor / diode hybrid modules are available in sample quantities (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.

Target ratings 50Pak and 60Pak



Voltage ( V)	Package	Configuration TT Thy/Thy DD Dio/Dio DT Dio/Thy TD Thy/Dio
6000	60Pak	DD
5000	60Pak	DD
2200	50, 60Pak	DD
1800	50, 60Pak	TT, DD, DT, TD

## 2500 V reverse-blocking IGCT

With the introduction of the newly developed 2.5 kV reverse-blocking Integrated Gate Commutated Thyristors (RB-IGCT), another powerful device is added to the successful and well-established IGCT product line.

The RB-IGCT is optimized for the lowest conduction losses and highest turn-off current 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.

To achieve the highest turn-off current capability of 5600 A, the well known and proven HPT<sup>+</sup> platform is used. Due to its outstanding performance, efficiency and reliability, the new RB-IGCT is the ideal device for Solid State Circuit Breakers (SSCB) used in renewables, transport electrification and modern edge grids.

Rating of 2500 V, RB-IGCT



Device	Availability	Voltage (V)	Turn-off current (A)	Housing
RB-IGCT	Samples available	2500	5600	L size



# 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.





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- |   |  |
|---|--|
| <p>1 Power transmission and distribution (HVDC, FACTS, STATCOM and others)</p> <p>2 Industry (medium and low-voltage drives, soft starters, UPSs, high-power rectifiers, excitation systems and others)</p> | <p>3 Mobility (rail and subway main and auxiliary drives, trackside power supply / electrical vehicles)</p> <p>4 Renewable energy (converters for pumped hydro, wind turbines and solar)</p> |
|---|--|

# SEMIS

## Semiconductor power loss simulation tool

SEMIS is Hitachi Energy’s power loss simulation tool.

This web application enables the selection of the optimal high-power semiconductor by considering thermal losses and device utilization with various topologies, circuit parameters and control strategies to fit customer specific needs.

By selecting the topology and defining the relevant circuit and control parameters, SEMIS analyzes multiple system dependencies. Power losses as well as thermal conditions are evaluated, enabling the verification of semiconductors’ device capabilities under various conditions.

### Topologies

Available topologies are listed in the respective sub-categories DC-DC, Voltage Source and Current Source converters. Please select according to your requirement.

Voltage Source Converters

Current Source Converters

DC-DC Converters

<p>VSC IGBT 1 Ph 2L</p> <p>SEMIS0</p> <p>Simulate &gt;</p>	<p>VSC IGBT 2 Ph 3L NPC</p> <p>Simulate &gt;</p>	<p>VSC IGBT 3 Ph 2L</p> <p>Simulate &gt;</p>	<p>VSC IGBT 3 Ph 3L</p> <p>Simulate &gt;</p>
<p>VSC IGBT 2 Ph 3L</p> <p>Simulate &gt;</p>	<p>Half Bridge Multilevel Converter with IGBT</p> <p>Simulate &gt;</p>	<p>Half Bridge Multilevel Converter with IGBT</p> <p>Simulate &gt;</p>	<p>Full Bridge Multilevel Converter with IGBT</p> <p>Simulate &gt;</p>
<p>Full Bridge Multilevel FACTS with IGBT</p> <p>Simulate &gt;</p>	<p>Full Bridge Multilevel FACTS with IGBT</p> <p>Simulate &gt;</p>		

### 3 Phase 3 Level VSC

#### IGBT based

Select Topology: NPC

Converter Operation: Inverter

Ambient temperature:  °C

System Frequency:  Hz

Switching frequency:  Hz

PWM strategy: Sinusoidal PWM

Modulation Index:

DC Voltage:  V

AC Reference Parameter: AC Current

AC Side Current (RMS):  A

Power Factor:

Reactive Power Type: Inductive (Converter)

Heat Sink Thermal Resistance:  K/W

IGBT Module Type: HiPak

Voltage Rating: 6.5 kV

Module Configuration: Single IGBT

Matching IGBTs:

- 5SNA 0400J650100      400 A, 125 C
- 5SNA 0500J650300      500 A, 125 C
- 5SNA 0600G650100      600 A, 125 C
- 5SNA 0750G650300      750 A, 125 C
- 5SNA 1000G650300      1000A, 150 C

NPC Diode Selection: 6.5 kV

- 5SLD 0600J650100      2X600 A, 125 C

Simulate
Hold result

Analysis completed.

High power semiconductor applications are highly complex and, to reduce prototyping, require thermal loss evaluation prior to a detailed circuit analysis to find the best possible semiconductor for customized settings and conditions. More than 35 topologies are listed according to application fields or grouped as Voltage Source (VSC), Current Source (CSC) and DC-DC converters. By selecting the topology circuit, the list of definable settings is indicated, enabling the highest flexibility in the definition of the system parameters.

To start the simulation, circuit parameters are defined according to the user specification with significant flexibility enabling the simulations to be adapted to customer needs. With the selection of one or more Hitachi Energy products, the system is ready for analysis.

The thermal impedance path, conduction and switching losses of each element of the topology as well as the control strategy are considered for the calculation of junction temperatures. This reveals critical elements or thermal paths enabling optimizations with the initial approach.

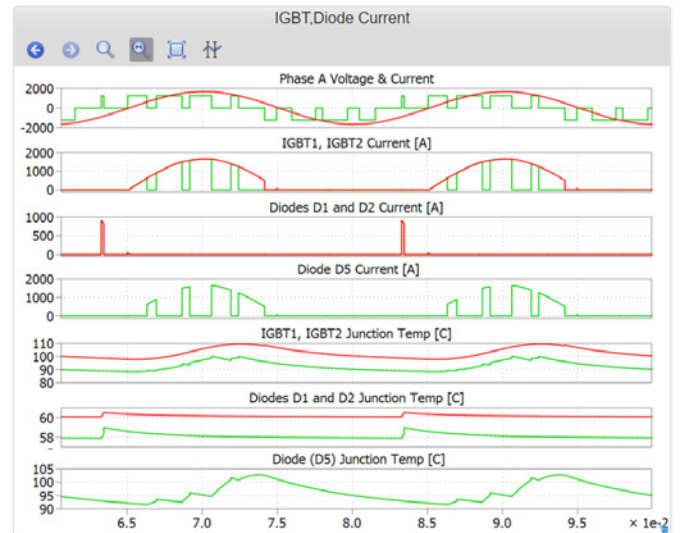
The simulator uses Jacobian steady-state analysis to calculate the on-state and dynamic power losses, as well as the resulting thermal variations of semiconductors. If junction temperatures exceed the permissible limits, alert messages are generated to ensure a safe operating area for the specific semiconductor.

Detailed results are displayed as graphs, indicating the thermodynamic and electrical static behavior of each power semiconductor. With the phase voltage and current, the combined converter output is indicated.

For detailed analysis, semiconductor specific parameters are tabulated, enabling numerical analysis of each element and parameter for conduction and switching power losses and junction temperatures. Critical elements with the highest thermal load are discovered rapidly, leading to efficient optimization in relation to cost efficiency, power losses and cooling system. For verification of the system efficiency, the converter power effectiveness and the system efficiency are indicated. This reveals the power loss influence of the applied semiconductors in combination with the control strategy. By comparing multiple products and parameter combinations, the influence of varying parameters is revealed.

By providing an efficient and reliable product analysis according to customer requirements, a tailor-made selection of Hitachi Energy products can be made with ease. For customer simulations with more specific topologies and control strategies, the model's data is available for download from Hitachi Energy's website. This enables simulation to the highest customization and adaptation of control strategies.

Simulations exceeding the capabilities of the online SEMIS tool and for simulations of higher complexity, please contact your Hitachi Energy sales agent or Hitachi Energy - Semiconductors - for further support.



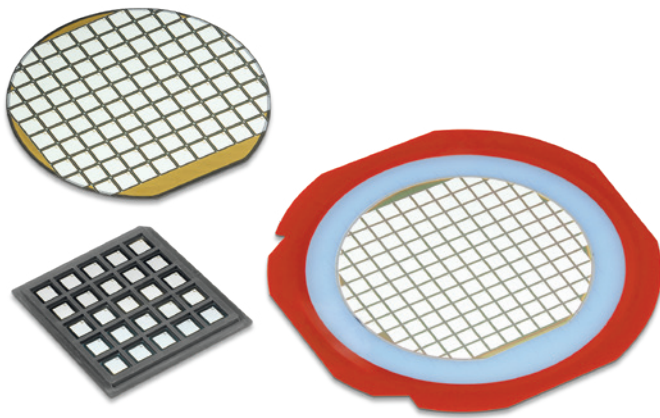
Device Losses & Temperatures						
	Switching	Conduction	Combined Losses	TvjAvg	TvjMax	TvjBLS
IGBT1	784.39 W	1.235 kW	2.020 kW	92.50 °C	100.15 °C	97.44 °C
IGBT2	79.70 W	2.345 kW	2.425 kW	102.66 °C	109.46 °C	109.46 °C
IGBT3	189.07 W	2.368 kW	2.557 kW	106.10 °C	113.66 °C	113.15 °C
IGBT4	675.45 W	1.228 kW	1.903 kW	89.31 °C	97.98 °C	95.93 °C
D1	34.09 W	22.00 W	56.09 W	58.12 °C	58.99 °C	58.05 °C
D2	0 W	22.05 W	22.05 W	60.17 °C	60.50 °C	60.24 °C
D3	0 W	26.15 W	26.15 W	61.37 °C	61.71 °C	61.70 °C
D4	5.97 W	26.16 W	32.12 W	56.35 °C	56.78 °C	56.66 °C
D5	135.20 W	1.053 kW	1.189 kW	96.10 °C	102.75 °C	102.72 °C
D6	120.13 W	1.054 kW	1.174 kW	95.43 °C	101.72 °C	101.72 °C
Converter Losses	6.07 kW	28.14 kW	34.21 kW			
% Losses			1.68 %			

Converter AC Parameters						
	Real Power	Reactive Power	Phase Voltage (RMS)	Phase Current (RMS)	Output Frequency	Power Factor
	2002 kW	1502 kVAR	707 V	1.180 kA	50 Hz	0.80

DC Parameters & Control Parameters				
	DC Power	DC Voltage	Switching Frequency	Modulation Index
	2036 kW	2.500 kV	450 Hz	0.80

# 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+ and SPT++) 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 compared to others. Additionally to these well-established planar chip technologies, starting 2022, Hitachi Energy will add 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.

Hitachi Energy’s 1700 V SPT++ chipset is the world’s first 1700 V chipset that offers an operational junction temperature of up to 175 °C. This allows the module designer to increase the power density of the IGBT modules significantly.

## Diode dies

Part number	Type	Size A x B mm	Thickness µm	$V_{PRM}$ (V)	$I_F$ (A)	$V_F$ (V) typ. 125 °C	Max. dies per wafer
1.2 kV							
<b>5SLY 86E1200</b>	SPT+	6.3 x 6.3	350	1200	50	1.85	361
<b>5SLY 86F1200</b>	SPT+	7.4 x 7.4	350	1200	75	1.85	257
<b>5SLY 86G1200</b>	SPT+	8.4 x 8.4	350	1200	100	1.85	198
<b>5SLY 86J1200</b>	SPT+	10.0 x 10.0	350	1200	150	1.85	137
<b>5SLZ 88J1200 New</b>	SPT++/FSA	11.8 x 8.7	140	1200	300	1.71	240

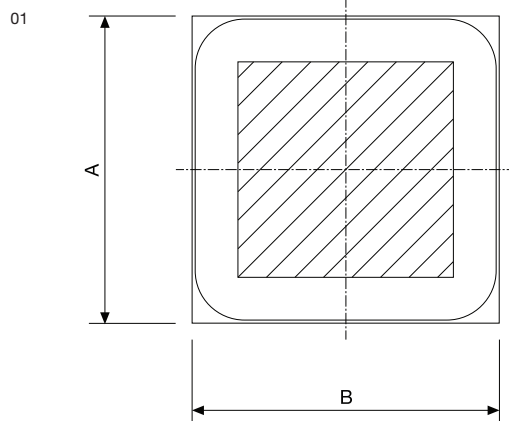
Part number	Type	Size A x B mm	Thickness $\mu\text{m}$	$V_{\text{PRM}}$ (V)	$I_{\text{F}}$ (A)	$V_{\text{F}}$ (V) typ. 125 °C	Max. dies per wafer
1.7 kV							
<b>5SLY 86E1700</b>	SPT <sup>+</sup>	6.6 x 6.6	390	1700	50	2.1	326
<b>5SLZ 86E1700</b>	SPT <sup>++</sup> /FSA	6.6 x 6.6	370	1700	50	1.75	326
<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	6.8 x 11.4	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

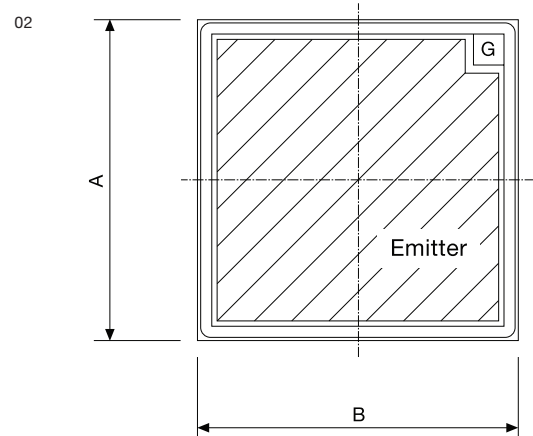
Part number	Type	Size A x B mm	Thickness $\mu\text{m}$	$V_{\text{CES}}$ (V)	$I_{\text{C}}$ (A)	$I_{\text{CM}}$ (A)	$V_{\text{CESat}}$ (V) typ. 125 °C	Max. dies per wafer
1.2 kV								
<b>5SMY 86H1280</b>	SPT <sup>+</sup>	9.1 x 9.1	140	1200	57	114	2.1	166
<b>5SMY 86J1280</b>	SPT <sup>+</sup>	10.2 x 10.2	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
<b>5SMW 88N1201 New</b>	TFP	19.1 x 11.7	130	1200	300	600	1.71	100
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 62 for part numbering structure.

01  
Diode dies



02  
IGBT dies



# 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.

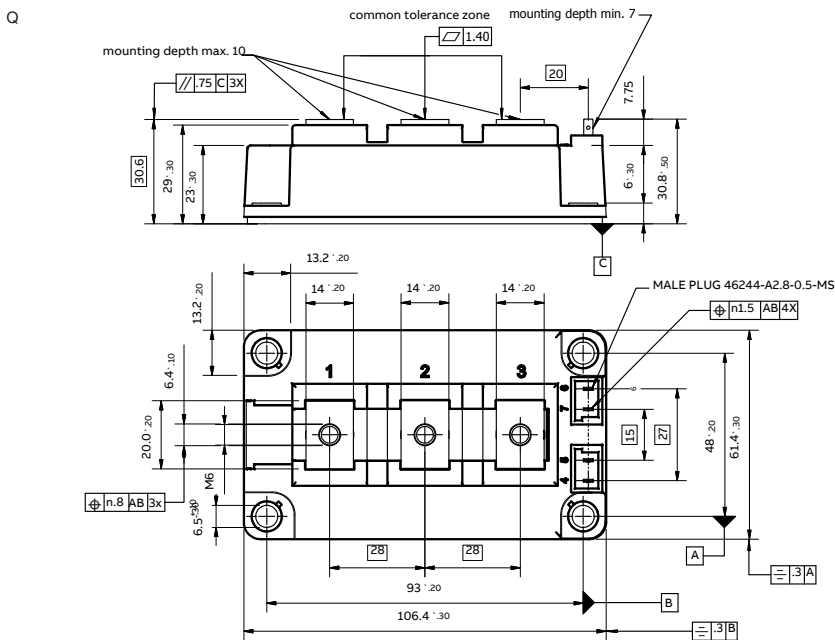


Hitachi Energy's 62Pak modules have an advanced packaging technology that leverages the performance of the latest silicon technology:

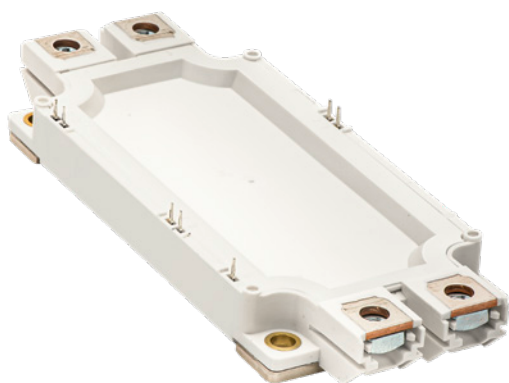
- 1700 V SPT++ fast switching IGBT / diode chipset with lowest switching losses
- Full 175 °C operation temperature with full square SOA
- Best-in-class temperature cycling performance of bond-wire chip connection
- Standard package allowing drop-in replacement

Part number <i>T<sub>vj</sub></i> (operational) up to 175 °C	Voltage <i>V<sub>CES</sub></i> (V)	Current <i>I<sub>C</sub></i> (A)	Configuration	<i>V<sub>CEsat</sub></i> (V)	<i>V<sub>F</sub></i> (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 63 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.

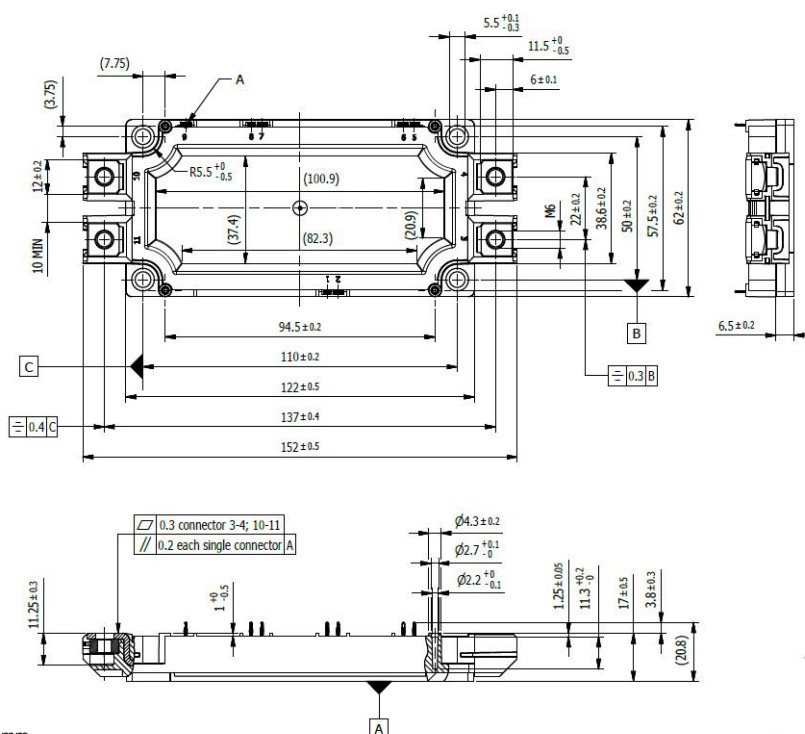
In addition, we offer LoPak 1700 V with an optional feature: the pre-applied Thermal Interface Material (TIM). The use of TIM improves the thermal conduction at the module baseplate/ heatsink interface ensuring more stability over long-term operation. Typical applications include:

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

Part number	Voltage $V_{CES}$ (V)	Current $I_C$ (A)	Configuration	$V_{CEsat}$ (V)	$V_F$ (V)	Housing
T (operational) up to 175 °C						
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

Please refer to page 63 for part numbering structure.  
Configurations on page 24

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.

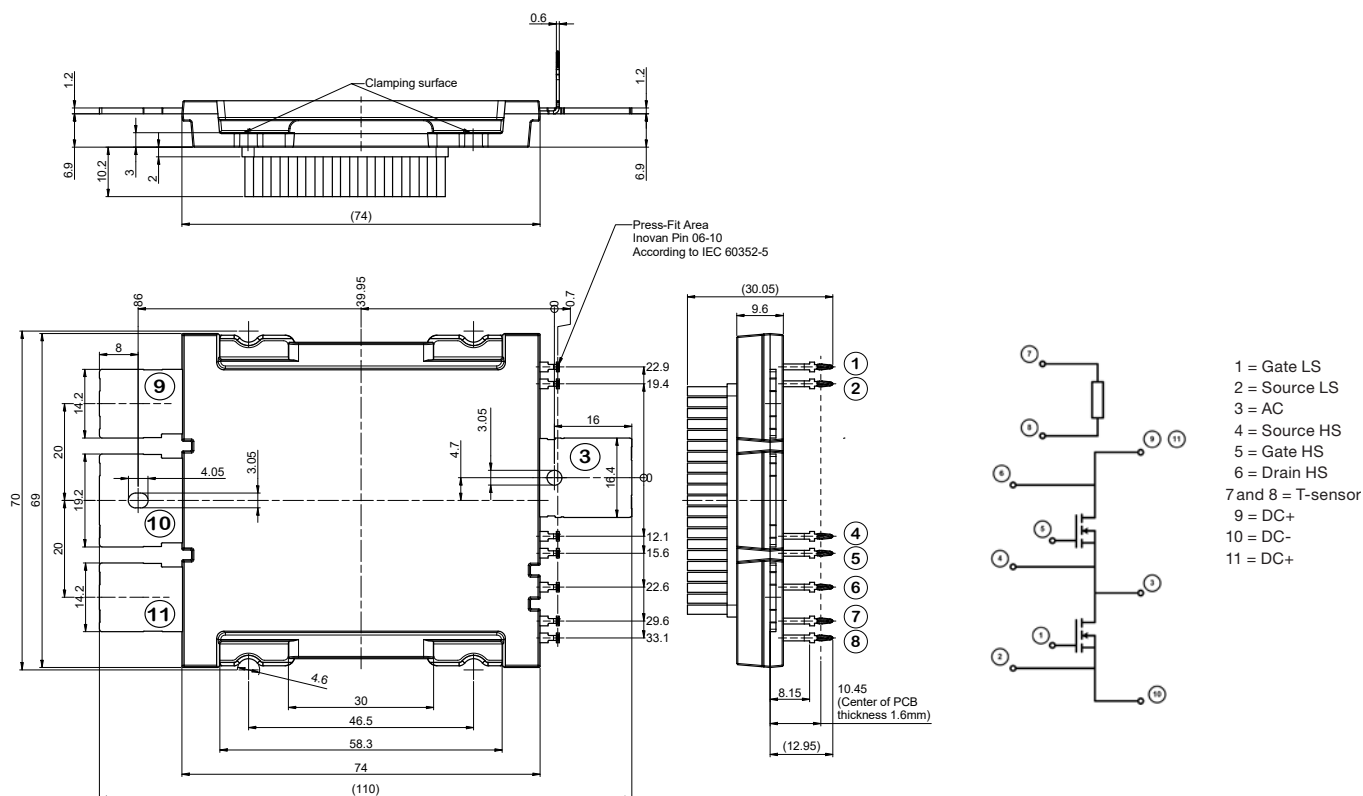


Part number $T_{vj}$ (operational) up to 175 °C	Voltage $V_{DSS}$ (V)	Current $I_D$ (A)	Configuration	$R_{DS(on)}$ (m $\Omega$ ) typ. 25 °C	$R_{DS(on)}$ (m $\Omega$ ) typ. 175 °C	Housing
<b>5SFG 0660B07500x</b>	750	2 x 660	(5) - Phase-leg MOSFET	2.4	4.2	B
<b>5SFG 0880B07500x</b>	750	2 x 880	(5) - Phase-leg MOSFET	1.4	1.9	B
<b>5SFG 1100B07500x</b>	750	2 x 1100	(5) - Phase-leg MOSFET	1.1	1.5	B
<b>5SFG 0580B12000x</b>	1200	2 x 580	(5) - Phase-leg MOSFET	2.9	5.2	B
<b>5SFG 0780B12000x</b>	1200	2 x 780	(5) - Phase-leg MOSFET	2.4	4.2	B
<b>5SFG 0980B12000x</b>	1200	2 x 980	(5) - Phase-leg MOSFET	1.9	3.2	B

Please refer to page 63 for part numbering structure.

On request:

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



# 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.



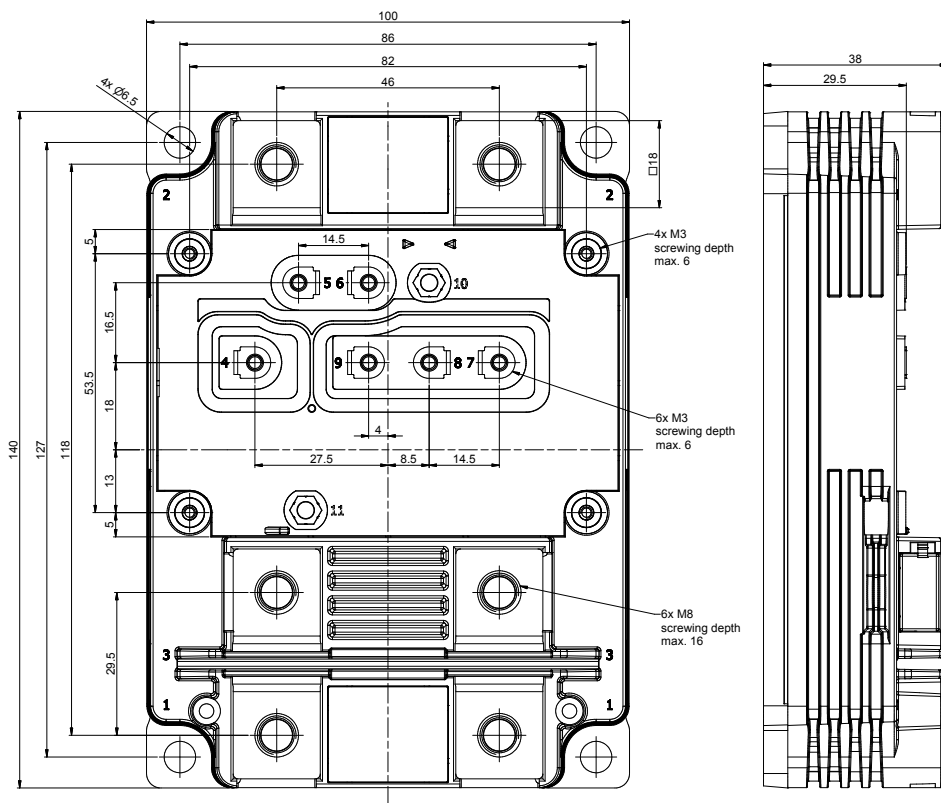
Part number $T_{vj}$ (operational) up to 175 °C	Voltage $V_{CES}$ (V)	Current $I_C$ (A)	Configuration	$V_{CEsat}$ (V) typ. 125 °C	$V_F$ (V) typ. 125 °C	Housing
<b>5SNG 1000X170300</b>	1700	2 x 1000	(5) – Phase leg IGBT	2.55	1.75	X
<b>5SNG 0450X330300</b>	3300	2 x 450	(5) – Phase leg IGBT	3.1	2.25	X

Please refer to page 63 for part numbering structure.  
Configurations on page 24

Part number	Voltage $V_{DSS}$ (V)	Current $I_D$ (A)	Configuration *	$R_{DS(on)}$ (mΩ) typ. 25 °C	$R_{DS(on)}$ (mΩ) typ. 150 °C	Housing
<b>5SFG 0900X170100 *</b>	1700	2 x 900	(5) – Phase leg MOSFET	2.8	4.8	X
<b>5SFG 1800X170100 *</b>	1700	2 x 1800	(5) – Phase leg MOSFET	1.4	2.4	X
<b>5SFG 0500X330100 *</b>	3300	2 x 500	(5) – Phase leg MOSFET	3.6	6.6	X
<b>5SFG 1000X330100 *</b>	3300	2 x 1000	(5) – Phase leg MOSFET	1.9	3.5	X

\* Contact factory

X



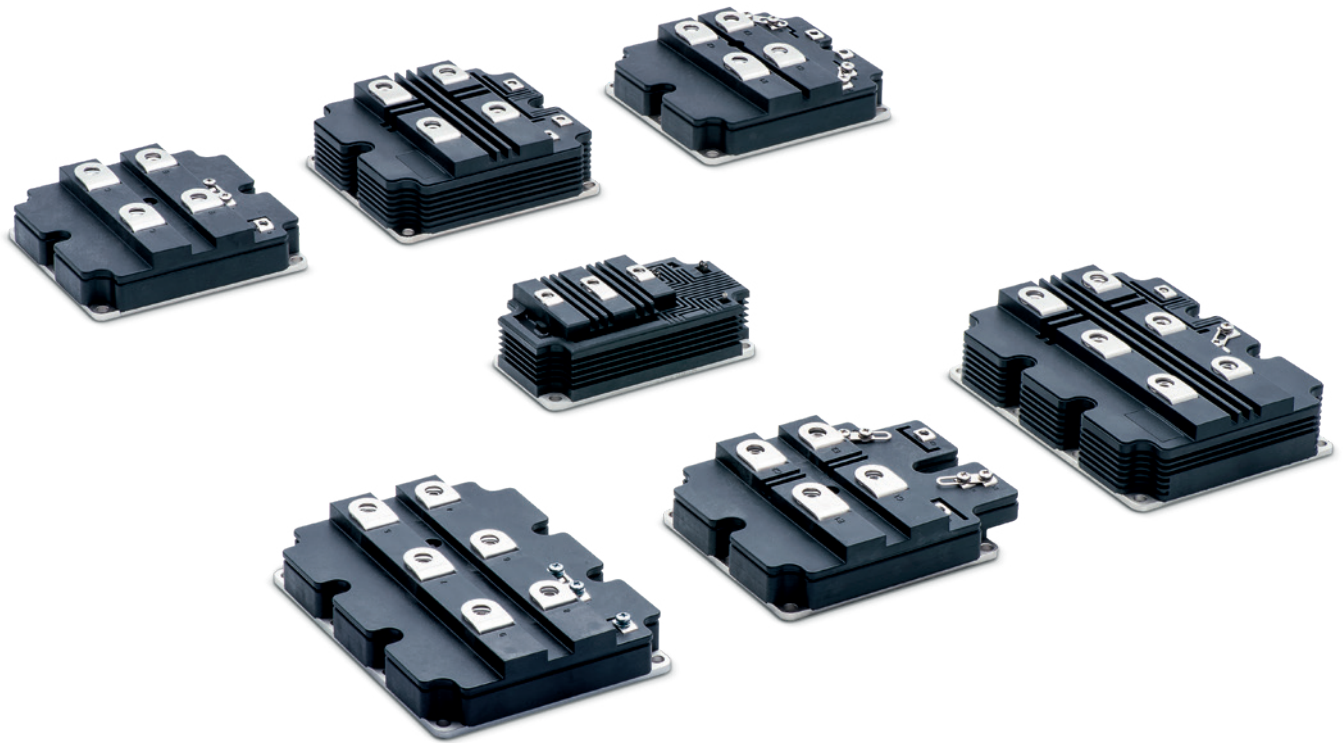
Dimensions in mm

# 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.

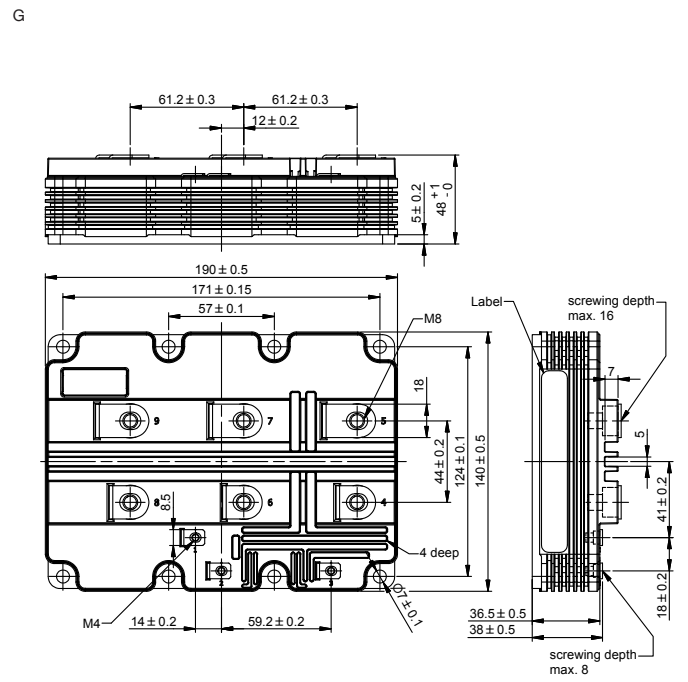
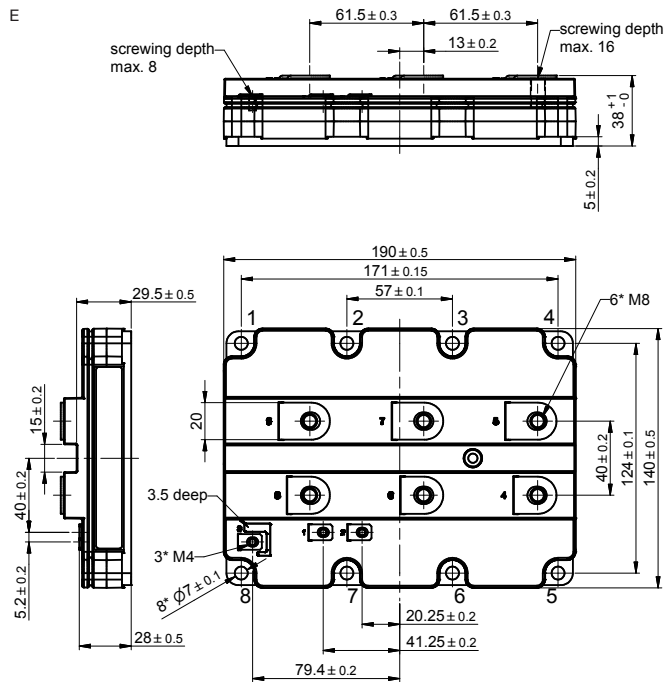
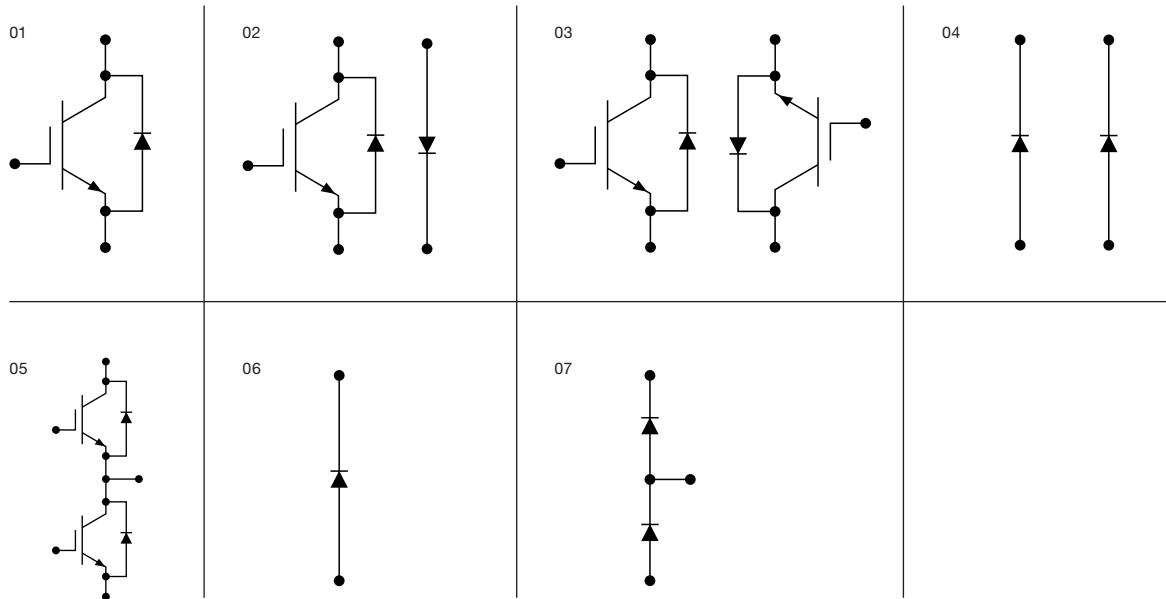
Hitachi Energy's HiPak IGBT modules are available from 1700 V to 6500 V in various configurations. They all feature low losses combined with soft-switching performance and record-breaking Safe Operating Area (SOA).



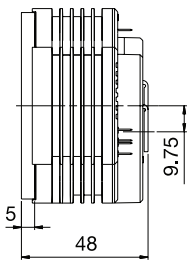
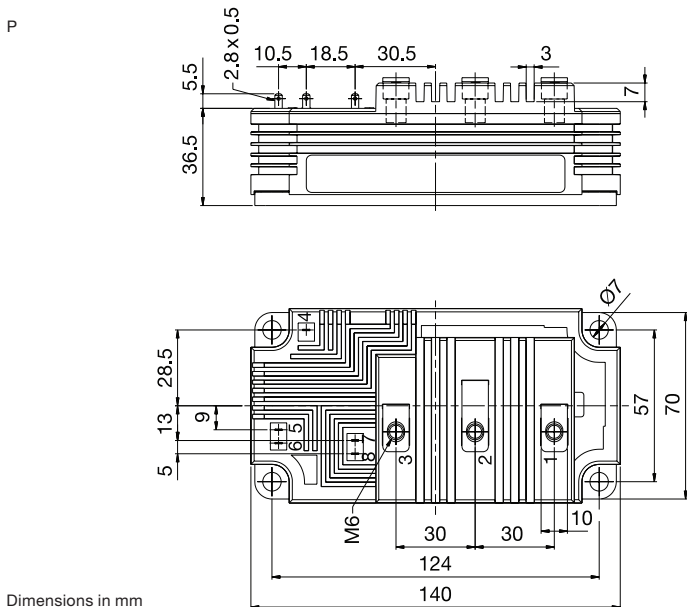
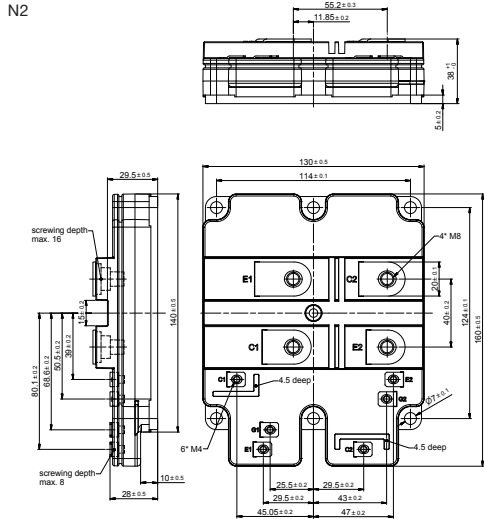
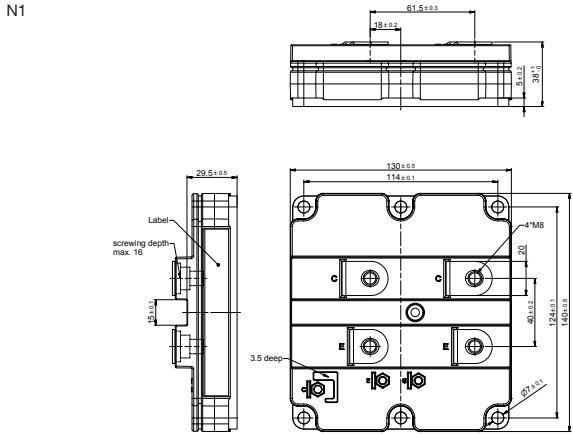
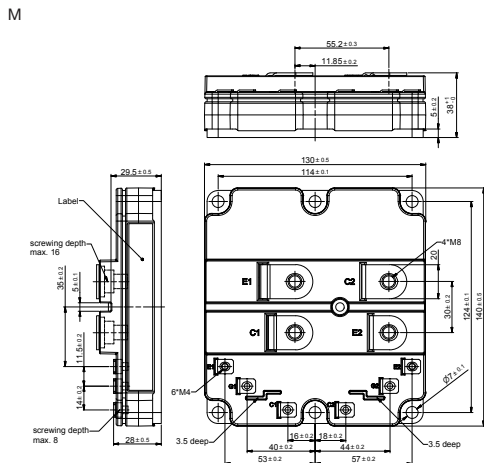
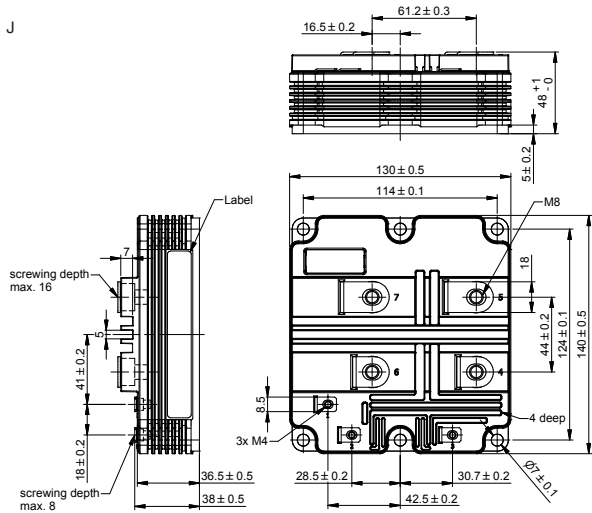
Part number $T_{vj}$ (operational) up to 125 °C	Voltage $V_{CES}$ (V)	Current $I_C$ (A)	Configuration	$V_{CEsat}$ (V) typ. 125 °C	$V_F$ (V) typ. 125 °C	Housing
1.7 kV						
<b>5SND 1200M170300 New</b>	1700	2 x 1200	(3) – Dual IGBT	3.0	1.95	M
<b>5SNE 1200M170300 New</b>	1700	1200	(2) – Chopper	3.0	1.95	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>5SND 0500N330300</b>	3300	2 x 500	(3) – Dual IGBT	3.1	2.25	N2
<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 New</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 New</b>	3300	1800	(1) – Single IGBT	2.9	2.20	E
<b>5SNA 1800G330400 New</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 New</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 1500J450300 New</b>	4500	2 x 1500	(4) – Dual Diode	–	2.8	J
<b>5SNA 1500E450300 New</b>	4500	1500	(1) – Single IGBT	3.55	2.8	E
<b>5SNA 1500G450300 New</b>	4500	1500	(1) – Single IGBT	3.55	2.8	G
<b>5SNA 1500G450350 New</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 63 for part numbering structure.

# Configurations







Dimensions in mm

# 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

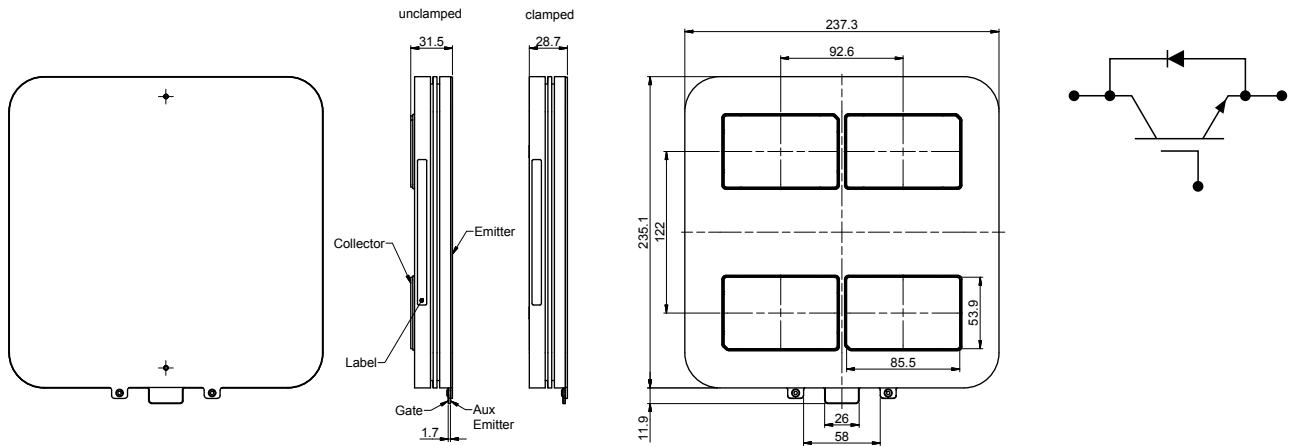
Hitachi Energy's StakPak IGBT modules are therefore a perfect match for applications like HVDC, FACTS, breakers and pulsed power.



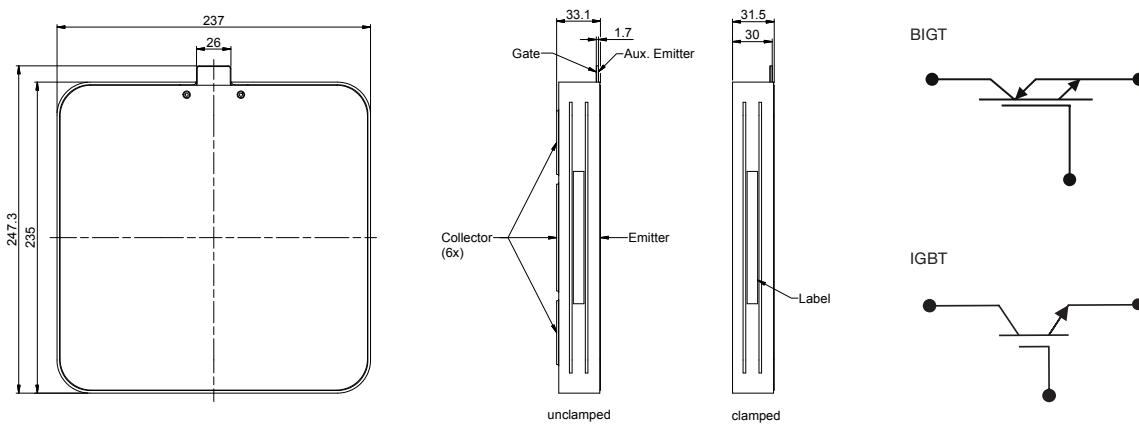
Part number	Voltage $V_{CES}$ (V)	Current $I_C$ (A)	$V_{CEsat}$ (V) typ. 125 °C	$V_F$ (V) typ. 125 °C	IGBT-to-diode ratio	Housings	SCFM rating
<b>5SNA 1300K450300</b>	4500	1300	3.4	2.4	1:1	K	Yes
<b>5SNA 2000K450300</b>	4500	2000	3.4	2.4	1:1	K	Yes
<b>5SNA 2000K451300</b>	4500	2000	3.65	3.0	2:1	K	Yes
<b>5SNA 2000K452300</b>	4500	2000	3.65	3.0	2:1	K	No
<b>5SNA 3000K452300</b>	4500	3000	3.65	3.0	2:1	K	No
<b>5SMA 3000L450300</b>	4500	3000	3.1	–	1:0	L	No
<b>5SJA 3000L520300</b>	5200	3000	3.1	2.5	1:1 (BIGT)	L	No

Please refer to page 63 for part numbering structure.

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# 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.

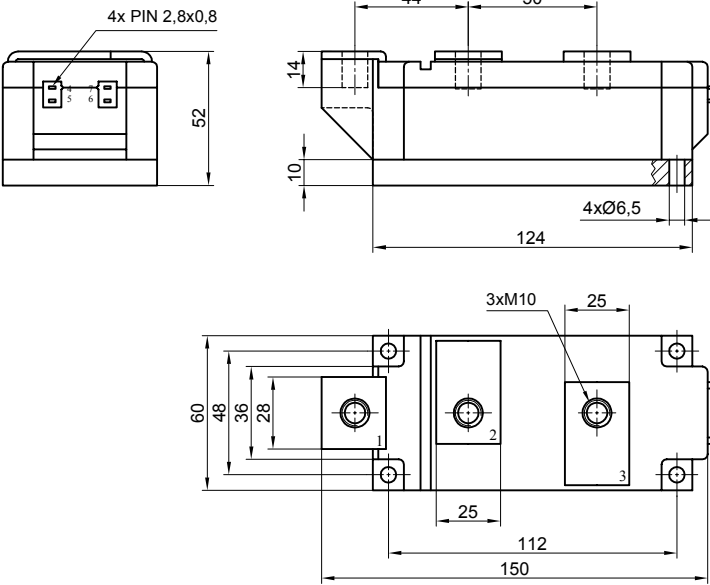


They provide the ultimate in reliability and are the epitome of quality. Whether efficiently driving industrial motors, smoothly accelerating fans and pumps, or supply power to demanding applications. The key benefits of the new 60Pak module are highest performance, outstanding reliability and increased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

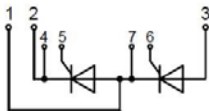
Part number	$V_{RRM}$ (V)	$I_{FAVM}$ (A)	Configuration	Housing
<b>5SET 0540T1800 New</b>	1800	522	Thyristor / Thyristor (Phase leg)	60 mm
<b>5SEE 0540T1820 New</b>	1800	522	Thyristor / Diode (Phase leg)	60 mm
<b>5SEE 0540T1830 New</b>	1800	522	Diode / Thyristor (Phase leg)	60 mm
<b>5SED 0890T2240</b>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

Please refer to page 65 for part numbering structure /  
\* Contact factory

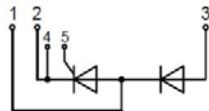
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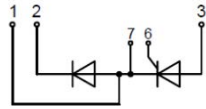
5SET 0540T1800



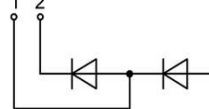
5SEG 0540T1820



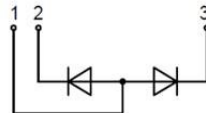
5SEE 0540T1830



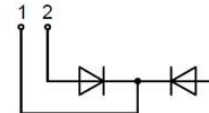
5SED 0890T2240



5SED 0890T2250



5SED 0890T2260



# Diodes

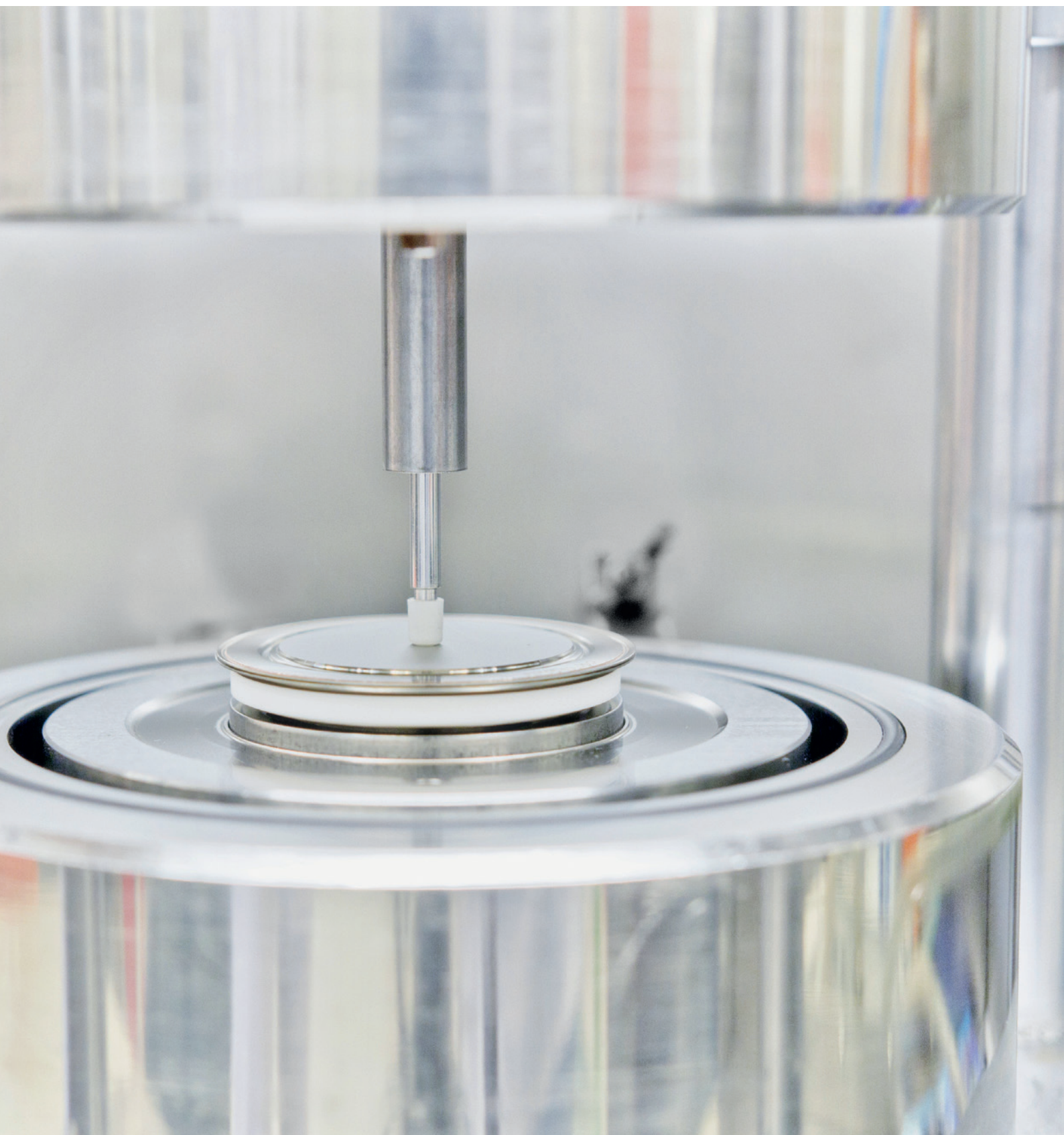
Diodes are used in a number of different applications. Each of these applications sets different requirements on the diodes' characteristics.

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
			$T_C = 85^\circ\text{C}$	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	$m\Omega$	A	$\mu\text{C}$	$^\circ\text{C}$	K/kW	K/kW	kN
<b>5SDF 13H4501</b>	4500	2800	1200	60.0	25.0	1.30	0.48	800	3000	125	12	3	40	H1
<b>5SDF 10H6004</b>	6000	3800	1100	44.0	18.0	1.50	0.60	1000	6000	125	12	3	40	H1

Drawings see page 36/37.

Please refer to page 65 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							
														$T_C = 70\text{ °C}$		10 ms		$T_{VJM}$	di/dt=5000 A/μs	
																$T_{VJM}$		$T_{VJM}$		
														V	V	A	kA	V	mΩ	A
<b>5SDF 20L4521</b>	4500	2800	1950	45.0	1.70	0.80	3600	5300	140	6	3	40	L2							
<b>5SDF 28L4521</b>	4500	2800	2620	56.0	1.10	0.47	4100	10100	140	6	3	40	L2							

## IGCT diodes

Part number	$V_{RRM}$	$V_{DC}$	$I_{FAVM}$	$I_{FSM}$	$V_{FO}$	$r_F$	$I_{rr}$	di/dt	$T_{VJM}$	$R_{thJC}$	$R_{thCH}$	$F_m$	Housing						
														$T_C = 70\text{ °C}$		1 ms	10 ms	$T_{VJM}$	max.
																$T_{VJM}$	$T_{VJM}$		
														V	V	A	kA	kA	V
<b>5SDF 03D4502</b>	4500	2800	275	10.0	5.0	2.15	2.80	355	300	115	40	8	16	D					
<b>5SDF 05F4502</b>	4500	2800	435	32.0	16.0	2.42	2.10	610	430	115	17	5	20	F					
<b>5SDF 10H4503</b>	4500	2800	1100	47.0	20.0	1.75	0.88	1520	600	125	12	3	40	H1					
<b>5SDF 20L4520</b>	4500	2800	1970	–	45.0	1.56	0.80	2400	1200	140	6	3	40	L2					
<b>5SDF 28L4520</b>	4500	2800	2620	–	56.0	1.10	0.47	2800	1000	140	6	3	40	L2					
<b>5SDF 34L4520* New</b>	4500	2800	2690	–	40.0	1.46	0.48	2680	1700	140	5.6	2.2	55	L3					
<b>5SDF 02D6004</b>	5500	3300	175	8.0	3.0	3.35	7.20	300	220	115	40	<sup>8</sup>	16	D					
<b>5SDF 04F6004</b>	5500	3300	380	22.0	10.0	2.70	2.80	600	340	115	22	5	20	F					
<b>5SDF 08H6005</b>	5500	3300	585	40.0	18.0	4.50	1.30	900	440	115	12	3	40	H1					

Drawings see page 36/37.

Please refer to page 65 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	$V_{RRM}$	$I_{FAVM}$	$I_{FSM}$	$V_{FO}$	$r_F$	$P_{RSM}$	$T_{VJM}$	$R_{thJC}$	$R_{thCH}$	$F_m$	Housing
	$T_C = 85\text{ °C}$		10 ms	$T_{VJM}$	m $\Omega$	20 $\mu$ s	°C	K/kW	K/kW	kN	
	V	A	kA			V					
<b>5SDA 11D1702</b>	1700	1310	15.0	0.74	0.21	50	160	40	10	11	D
<b>5SDA 27F2002</b>	2000	2700	31.0	0.79	0.09	100	160	20	5	22	F
<b>5SDA 10D2303</b>	2300	1140	13.5	0.83	0.30	50	160	40	10	11	D
<b>5SDA 24F2303</b>	2300	2350	29.0	0.84	0.13	75	160	20	5	22	F
<b>5SDA 09D2604</b>	2600	1020	11.5	0.87	0.39	50	160	40	10	11	D
<b>5SDA 08D3205</b>	3200	910	9.2	0.93	0.52	50	160	40	10	11	D
<b>5SDA 21F3204</b>	3200	2110	26.0	0.89	0.17	75	160	20	5	22	F
<b>5SDA 07D3806</b>	3800	790	7.6	1.01	0.72	50	160	40	10	11	D
<b>5SDA 16F3806</b>	3800	1620	20.5	1.03	0.32	50	160	20	5	22	F
<b>5SDA 06D5007</b>	5000	690	7.0	1.10	1.01	50	160	40	10	11	D
<b>5SDA 14F5007</b>	5000	1410	17.5	1.13	0.44	50	160	20	5	22	F

Drawings see page 36/37.

Please refer to page 65 for part numbering structure.

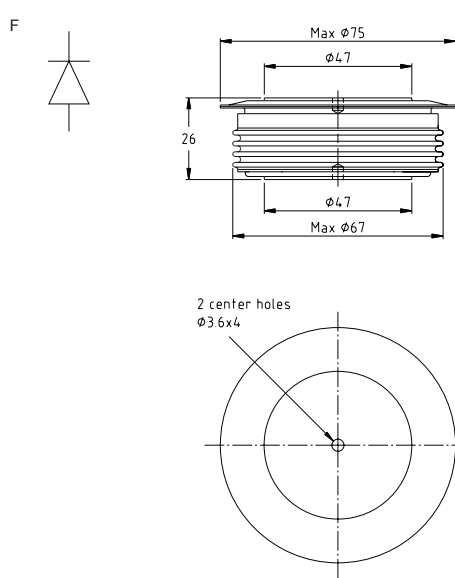
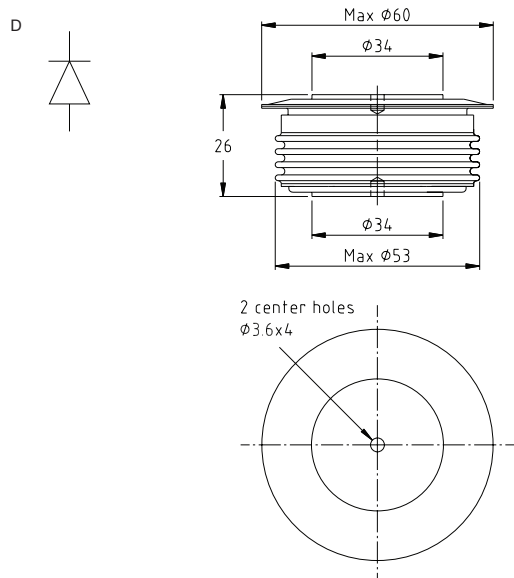
Standard rectifier diodes

Part number	$V_{RSM}$	$V_{RRM}$	$I_{FAVM}$	$I_{FSM}$	$V_{FO}$	$r_F$	$T_{VJM}$	$R_{thJC}$	$R_{thCH}$	$F_m$	Housing
			10 ms $T_{VJM}$		$T_{VJM}$						
	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	0.840	0.098	160	4.7	1.0	90	N
5SDD 57X6500* New	6500	6500	5850	110	0.840	0.098	160	4.7	1.0	90	X
5SDD 75Y8500 New	8500	8500	6720	121	0.945	0.118	150	3.0	0.6	190	Y

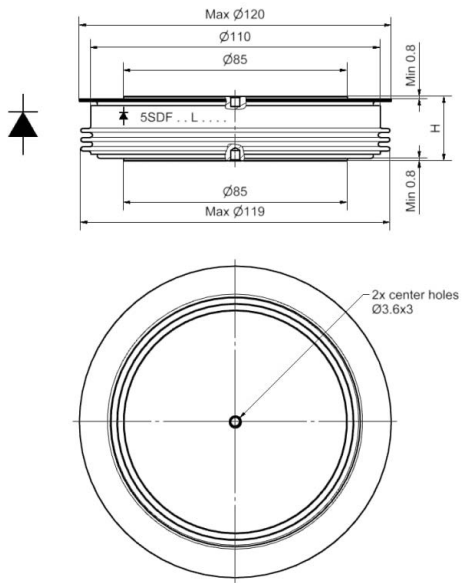
Drawings see page 35/37.

Please refer to page 65 for part numbering structure.

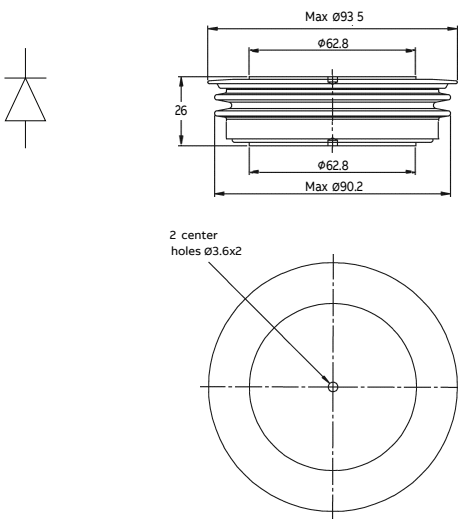
\*Contact factory



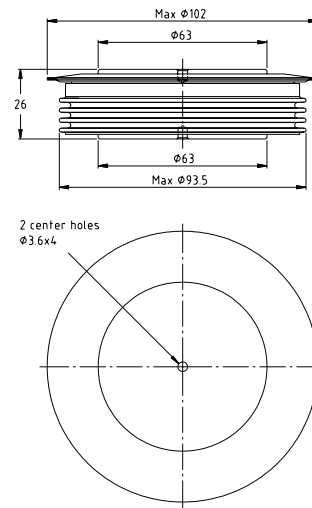
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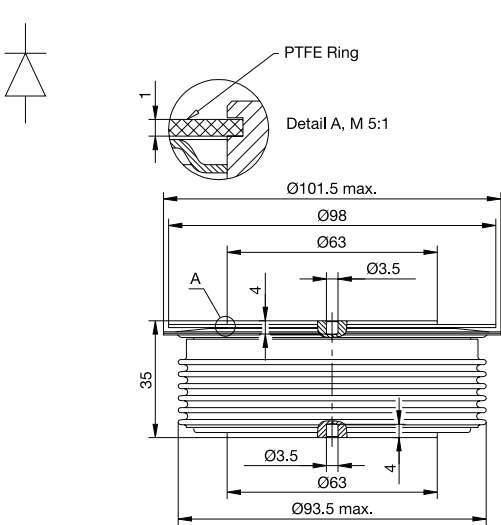
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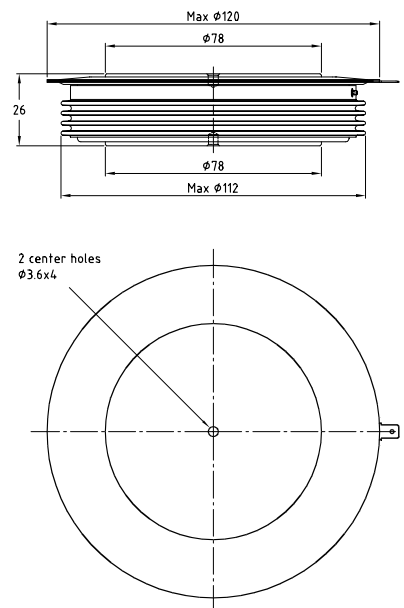
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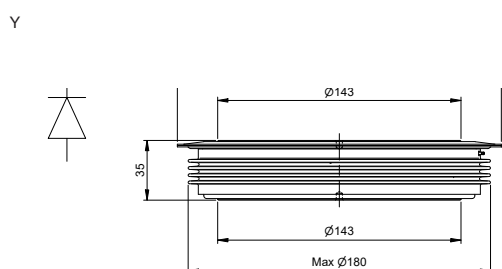
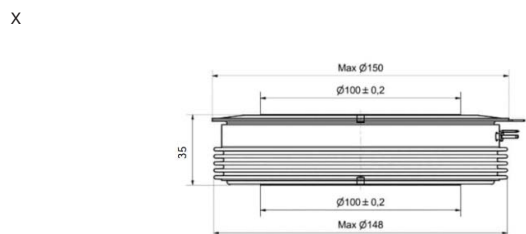
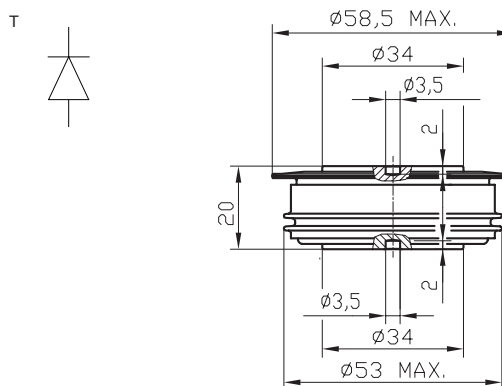
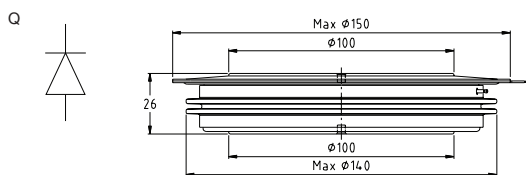
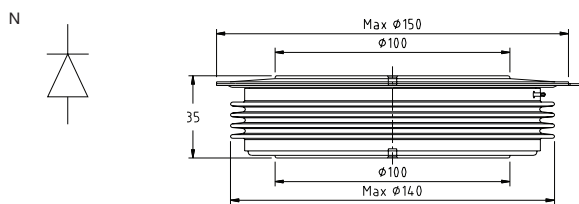
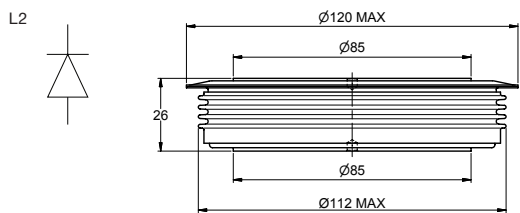


K



L1





# 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
	V	V	V	A	kA	V	m $\Omega$	$^{\circ}\text{C}$	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,  $T_{VJM}$

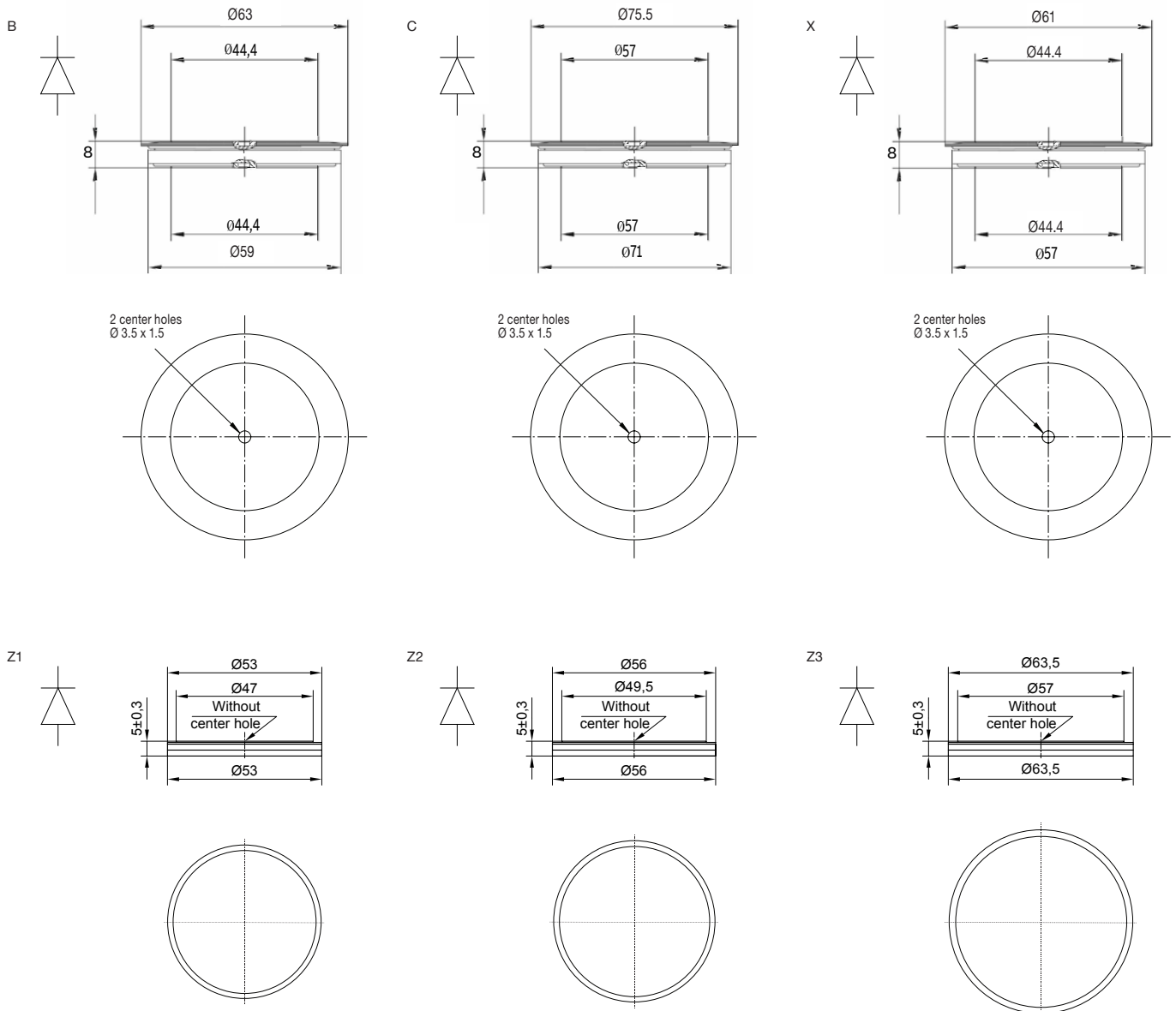
Please refer to page 65 for part numbering structure.

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
	$T_{VJM}$ $I_F = 5000\text{ A}$		$T_C = 85\text{ °C}$		$10\text{ ms}$ $T_{VJM}$		$T_{VJM}$	$T_{VJM}$	$T_{VJM}$			
	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 65 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.

Since many applications use antiparallel connected thyristors, we introduced the bi-directionally controlled thyristor (BCT), which consists of two integrated antiparallel thyristor functions on one silicon wafer.

Hitachi Energy offers the following thyristor families:

- Bypass thyristor page 41
- Phase control thyristors (PCTs) page 42
- Bi-directionally controlled thyristors (BCTs) page 46





# 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)
<b>5STP 10L8500</b>	8400	4000	290	L

Drawings see page 44.

Please refer to page 64 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.

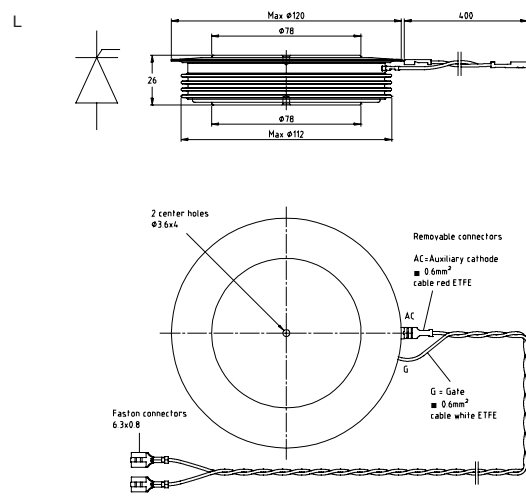
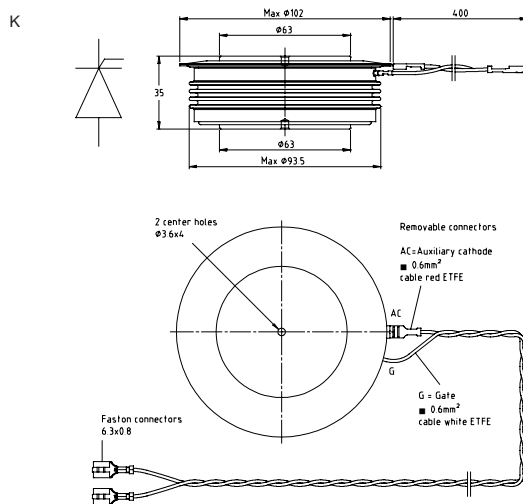
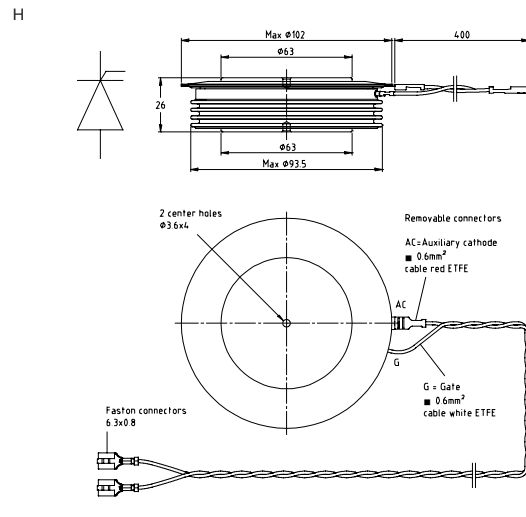
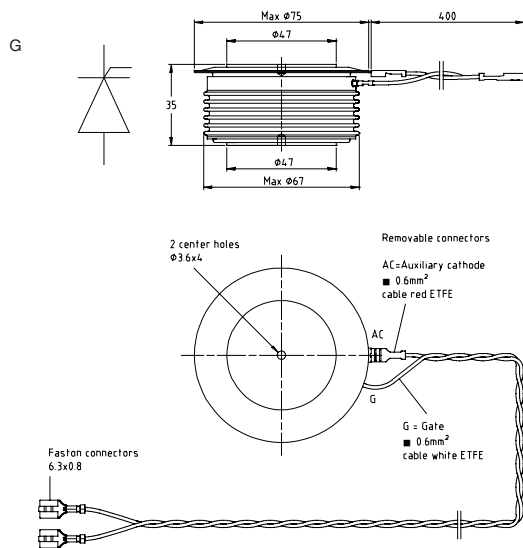
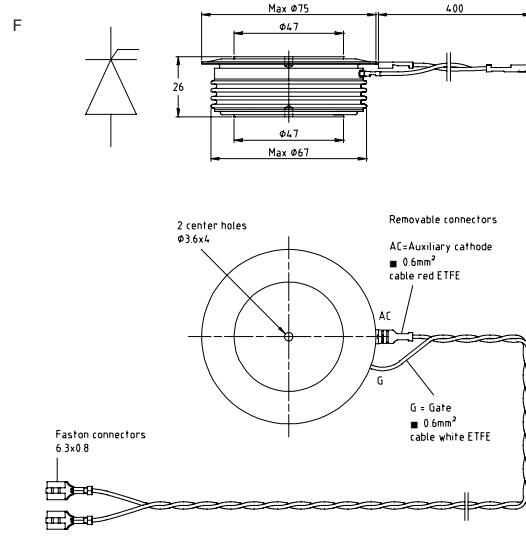
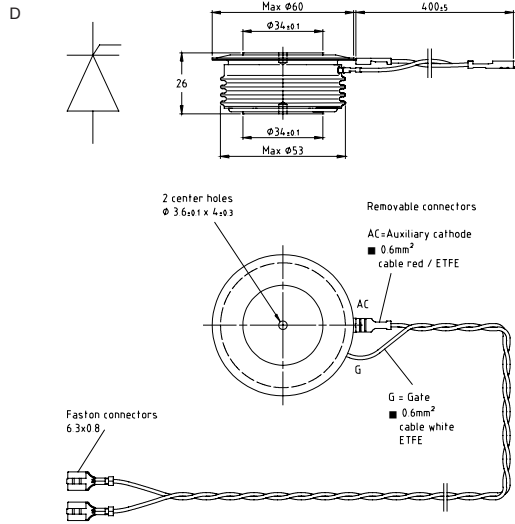
Hitachi Energy offers the most complete range of high-power thyristors, including 6" devices. New products continue to be developed with focus on minimizing overall losses and maximizing power ratings.

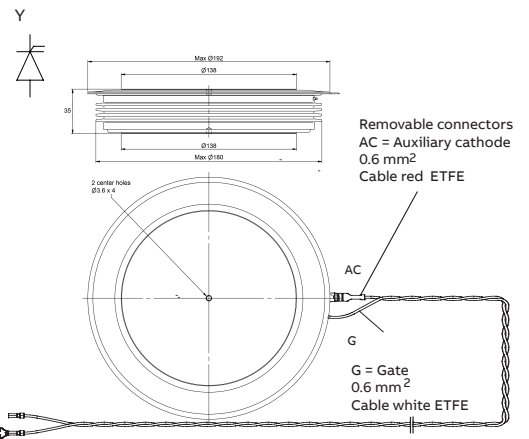
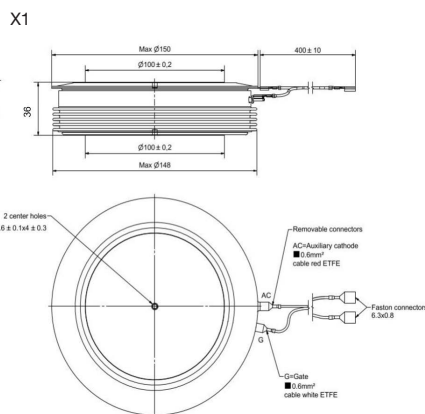
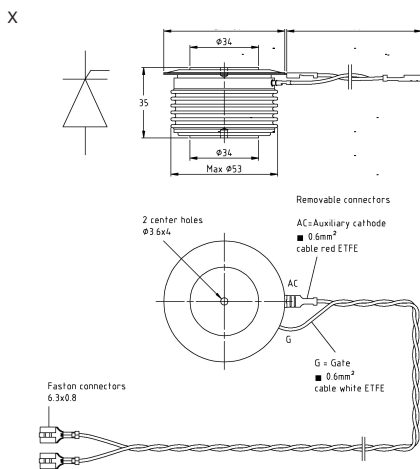
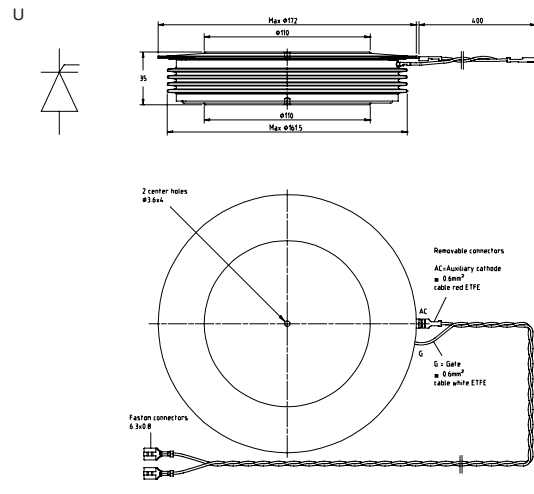
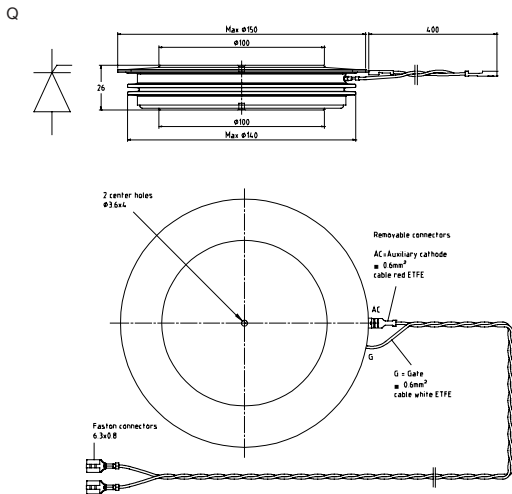
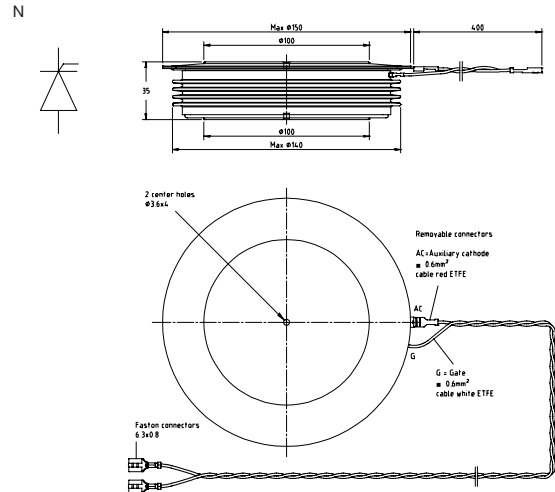
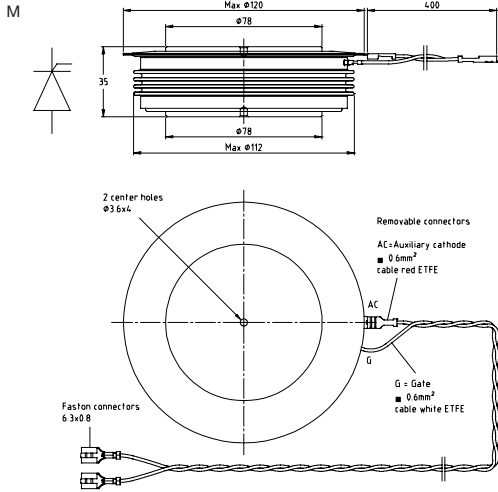
Applications using two antiparallel thyristors can take advantage of Hitachi Energy's innovative bi-directionally controlled thyristors (BCTs) that incorporate two antiparallel thyristors in a single housing (see page 46).

Part number	$V_{DRM}, V_{RRM}$	$I_{TAVM}$	$I_{TSM}$	$V_{TO}$	$r_T$	$T_{VJM}$	$R_{thJC}$	$R_{thCH}$	$F_m$	Housing
	$T_{VJM}$	$T_C = 70\text{ °C}$	10 ms / $T_{VJM}$	$T_{VJM}$						
	V	A	kA	V	mΩ	°C	K/kW	K/kW	kN	
<b>5STP 07D1800</b>	1800	760	9.0	0.927	0.448	125	36.0	7.5	10	D
<b>5STP 18F1800</b>	1800	1780	21.0	0.923	0.188	125	17.0	4.0	22	F
<b>5STP 18F1810 New</b>	1800	1780	21.0	0.923	0.188	125	17.0	4.0	22	F
<b>5STP 27H1800</b>	1800	2940	50.5	0.912	0.096	125	10.0	2.0	50	H
<b>5STP 42L1800</b>	1800	4310	64.0	0.81	0.080	125	7.0	1.5	70	L
<b>5STP 50Q1800</b>	1800	6100	94.0	0.90	0.050	125	5.0	1.0	90	Q
<b>5STP 06D2800</b>	2800	640	8.8	0.92	0.780	125	36.0	7.5	10	D
<b>5STP 16F2800</b>	2800	1500	18.0	0.956	0.297	125	17.0	4.0	22	F
<b>5STP 16F2810 New</b>	2800	1500	18.0	0.956	0.297	125	17.0	4.0	22	F
<b>5STP 24H2800</b>	2800	2780	43.0	0.928	0.141	125	10.0	2.0	50	H
<b>5STP 33L2800</b>	2800	3760	65.5	0.929	0.100	125	7.0	1.5	70	L
<b>5STP 45N2800</b>	2800	5250	77.0	0.864	0.069	125	5.7	1.0	90	N
<b>5STP 45Q2800</b>	2800	5710	77.0	0.864	0.069	125	5.0	1.0	90	Q
<b>5STP 04D4200</b>	4200	500	7.1	1.14	1.288	125	36.0	7.5	10	D
<b>5STP 12F4200</b>	4200	1190	17.3	1.01	0.545	125	17.0	4.0	22	F
<b>5STP 18H4200</b>	4200	2170	32.0	0.982	0.274	125	10.0	2.0	50	H
<b>5STP 28L4200</b>	4200	3290	54.0	1.03	0.138	125	7.0	1.5	70	L
<b>5STP 38N4200</b>	4200	4090	64.5	0.973	0.126	125	5.7	1.0	90	N
<b>5STP 38Q4200</b>	4200	4420	64.5	0.973	0.126	125	5.0	1.0	90	Q
<b>5STP 04D5200</b>	5200	420	6.1	1.29	1.917	125	36.0	7.5	10	D
<b>5STP 17H5200</b>	5200	1970	34.0	0.994	0.343	125	10.0	2.0	50	H
<b>5STP 25L5200</b>	5200	2830	50.5	0.99	0.237	125	7.0	1.5	70	L
<b>5STP 25M5200</b>	5200	2400	50.5	0.99	0.237	125	9.0	1.5	70	M
<b>5STP 34N5200</b>	5200	3450	63.0	0.96	0.194	125	5.7	1.0	90	N
<b>5STP 34Q5200</b>	5200	3720	63.0	0.96	0.194	125	5.0	1.0	90	Q
<b>5STP 52U5200</b>	5200	5200	99.0	1.04	0.115	125	4.0	0.8	135	U
<b>5STP 03D6500</b>	6500	340	4.7	1.20	2.300	125	36.0	7.5	10	D
<b>5STP 03X6500</b>	6500	390	4.7	1.20	2.300	125	45.0	7.5	10	X
<b>5STP 08F6500</b>	6500	850	15.1	1.20	1.046	125	17.0	4.0	22	F
<b>5STP 08G6500</b>	6500	730	15.1	1.20	1.046	125	22.0	4.0	22	G
<b>5STP 12K6500</b>	6500	1430	31.5	1.15	0.647	125	11.0	2.0	50	K
<b>5STP 18M6500</b>	6500	1830	47.5	1.21	0.431	125	9.0	1.5	70	M
<b>5STP 26N6500</b>	6500	2880	65.0	1.12	0.290	125	5.7	1.0	90	N
<b>5STP 40N6500 New</b>	6500	3780	65.0	1.140	0.259	135	4.8	1.0	90	N
<b>5STP 42U6500</b>	6500	4300	86.0	1.17	0.181	125	4.0	0.8	135	U
<b>5STP 40X6500* New</b>	6500	3780	65.0	1.140	0.259	135	4.8	1.0	90	X1
<b>5STP 48Y7200</b>	7200	5040	92.0	0.983	0.128	110	3.0	0.6	190	Y
<b>5STP 27N8500</b>	8500	2660	64.0	1.13	0.394	125	5.7	1.0	90	N
<b>5STP 27Q8500</b>	8500	2870	64.0	1.13	0.394	125	5.0	1.0	90	Q
<b>5STP 45Y8500</b>	8500	4450	90.0	1.06	0.168	110	3.0	0.6	190	Y

Please refer to page 64 for part numbering structure.

\*Contact factory





# BCTs

## Bi-directionally controlled thyristors

Improved volume consumption and reduced part count for SVC, 4-quadrant DC-drive or soft starter equipment in the magnitude of 25 percent compared with equally rated PCT-solutions are possible with Hitachi Energy's BCTs – without jeopardizing reliability and performance.

Hitachi Energy's innovative bi-directionally controlled thyristor (BCT) features two monolithically integrated antiparallel thyristors in a single housing. The two thyristor halves are individually triggered and have a separation region enabling the design of high-voltage devices with the dynamic capability of discrete devices.

The BCT is designed, manufactured and tested using the same philosophy, technology and equipment as the well-established PCT (page 42), thus reaching the same levels of performance and reliability.

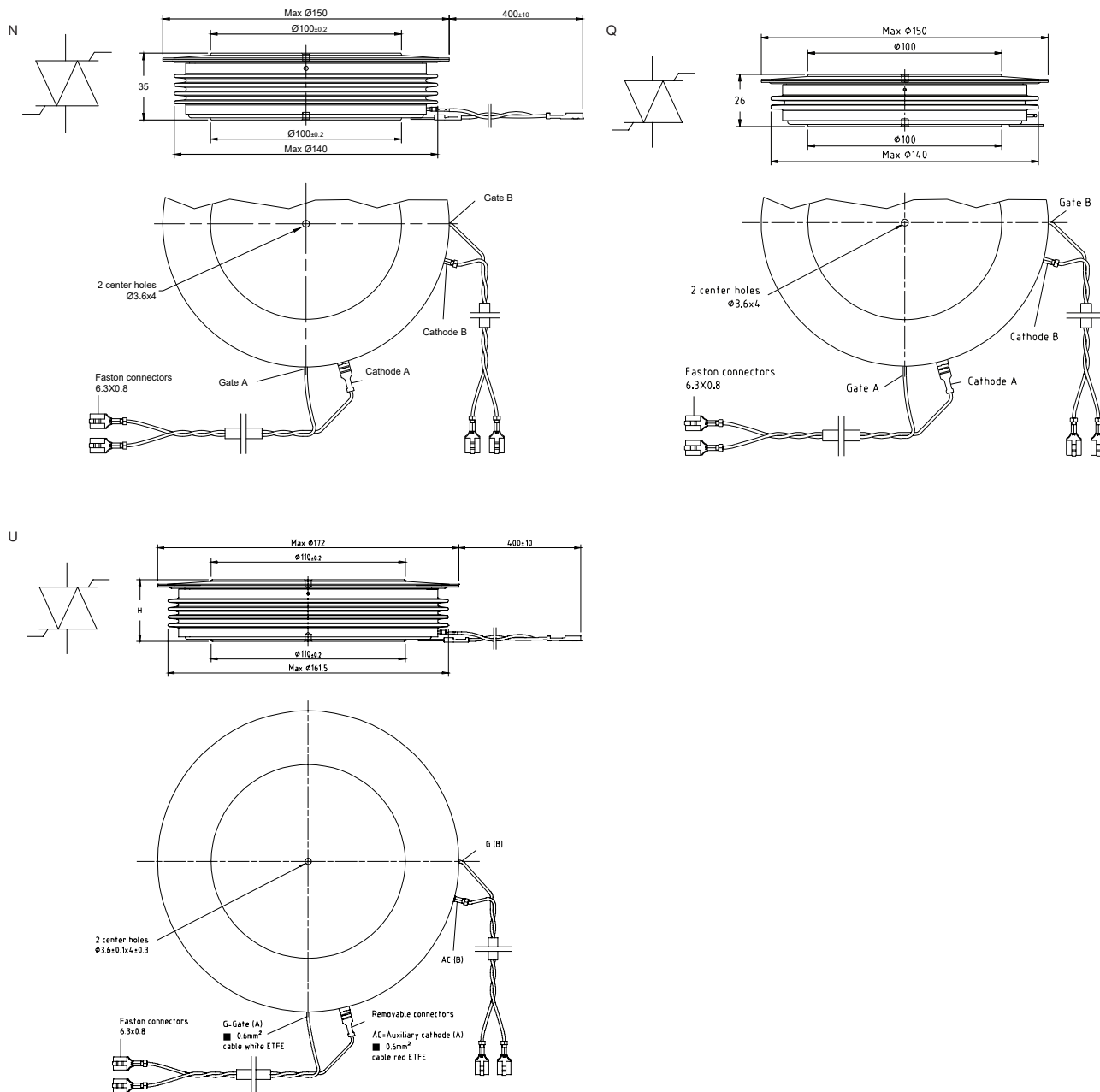
A table of replacement of PCTs by BCTs is given in the BCT application note which can be found at [www.hitachienergy.com/semiconductors](http://www.hitachienergy.com/semiconductors).



Part number	$V_{RM}$	$I_{TRMS}^*$	$I_{TAVM}$	$I_{TSM}$	$V_{TO}$	$r_T$	$T_{VJM}$	$R_{thJC}$	$R_{thCH}$	$F_m$	Housing
	$T_{VJM}$	$T_C = 70\text{ }^\circ\text{C}$	$T_C = 70\text{ }^\circ\text{C}$	10 ms	$T_{VJM}$						
	V	A	A	kA	V	m $\Omega$	$^\circ\text{C}$	K/kW	K/kW	kN	
<b>5STB 24N2800</b>	2800	5400	2430	43.0	0.85	0.160	125	11.4	2.0	90	N
<b>5STB 24Q2800</b>	2800	5840	2630	43.0	0.85	0.160	125	10.0	2.0	90	Q
<b>5STB 18N4200</b>	4200	4260	1920	32.0	0.96	0.285	125	11.4	2.0	90	N
<b>5STB 17N5200</b>	5200	4000	1800	29.0	1.02	0.320	125	11.4	2.0	90	N
<b>5STB 25U5200</b>	5200	4400	1980	42.0	1.06	0.219	110	8.5	1.6	135	U
<b>5STB 13N6500</b>	6500	3120	1405	22.0	1.20	0.600	125	11.4	2.0	90	N
<b>5STB 18U6500</b>	6500	3510	1580	29.7	1.20	0.458	110	8.5	1.6	135	U

\* AC full-wave

Please refer to page 64 for part numbering structure.



Dimensions in mm

# IGCTs

## Integrated gate-commutated thyristors

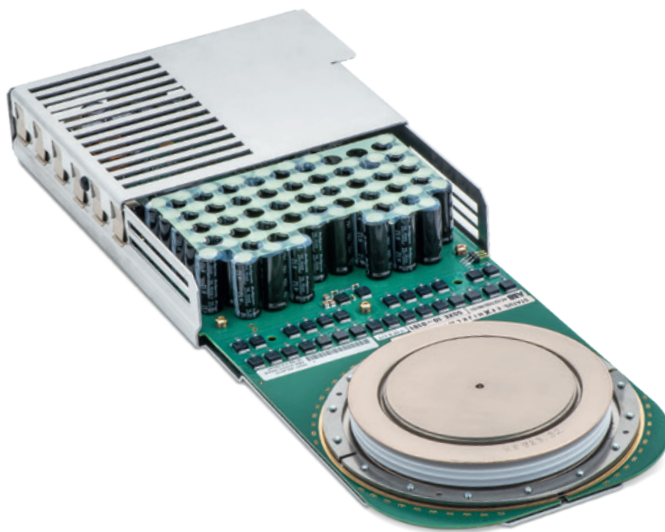
Within 20 years of its introduction, the IGCT has established itself as the semiconductor of choice for high-power frequency converters by meeting the requirements of today's demanding applications.

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 is manifold: off-shore wind generation, medium-voltage drives (MVDs), static frequency converters (SFC), marine drives, co-generation, pulse power (PP) and STATCOMs, to name just a few.

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





Asymmetric IGCTS

Part number	$V_{DRM}$	$V_{DC}$	$V_{RRM}$	$I_{TGOM}$	$T_C = 85\text{ }^\circ\text{C}$			$V_T$	$V_{T0}$	$r_T$	$T_{VJM}$	$R_{thJC}$	$R_{thCH}$	$F_m$	$V_{GIN}$	Outline
					$I_{TAVM}$	$I_{TSM}$										
					$T_{VJM}$	$T_{VJM}$	$T_{VJM}$									
	V	V	V	A	A	kA	kA	V	V	mΩ	°C	K/kW	K/kW	kN	V	
<b>5SHY 35L4520</b>	4500	2800	17	4000	1700	50	32	2.70	1.40	0.33	125	8.5	3	40	28-40	Fig. 1
<b>5SHY 35L4522</b>	4500	2800	17	4000	2100	56	35	2.00	1.15	0.21	125	8.5	3	40	28-40	Fig. 1
<b>5SHY 45L4520</b>	4500	2800	17	4500	1430	39	28	2.60*	1.70	0.45	125	8.5	3	40	28-40	Fig. 1
<b>5SHY 55L4500</b>	4500	2800	17	5000	1870	50	33	2.35	1.22	0.28	125	8.5	3	40	28-40	Fig. 1
<b>5SHY 65L4521 New</b>	4500	2800	17	6500	2660	–	36	2.30	1.11	0.297	125	6.8	2.2	60	28-40	Fig. 1
<b>5SHY 65L4522 New</b>	4500	2800	17	6000	2260	–	32,5	2.95	1.29	0.414	125	6.8	2.2	60	28-40	Fig. 1
<b>5SHY 50L5500</b>	5500	3300	17	3600	1290	40	26	4.10	1.66	0.62	125	8.5	3	40	28-40	Fig. 1
<b>5SHY 42L6500</b>	6500	4000	17	3800	1290	40	26	4.10	1.88	0.56	125	8.5	3	40	28-40	Fig. 1

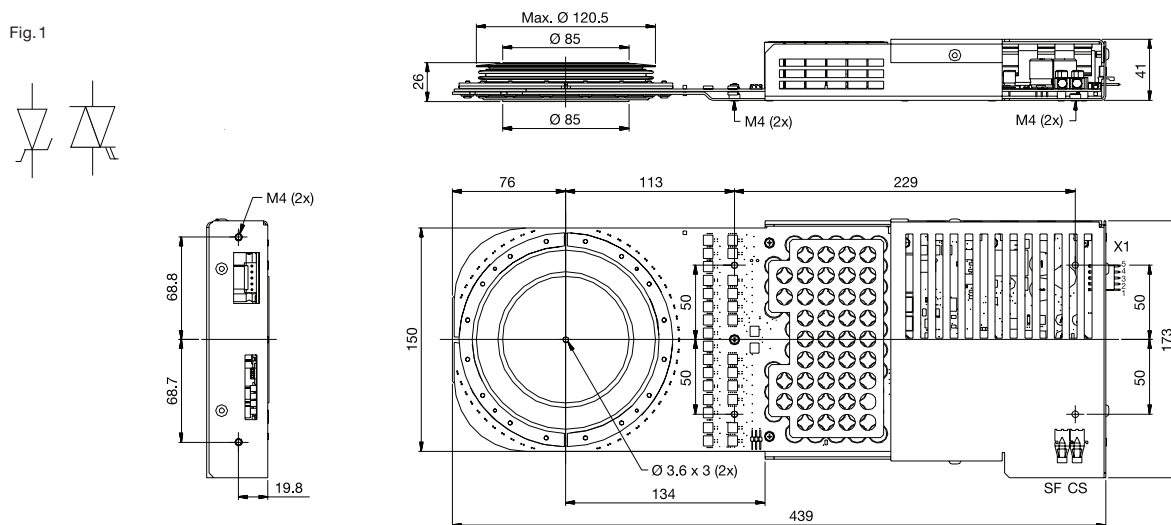
- Optimized for snubberless turn-off  
 - Contact factory for series connection  
 \* at 2000 A

Reverse conducting IGCTS

Part number	$V_{DRM}$	$V_{DC}$	$I_{TGOM}$	$T_C = 85\text{ }^\circ\text{C}$		$V_T/V_F$	$V_{T0}/V_{F0}$	$r_T/r_F$	$T_{VJM}$	$R_{thJC}$	$F_m$	$V_{GIN}$	Outline
				$I_{TAVM}/I_{FAVM}$	$I_{TSM}/I_{FSM}$								
				$T_{VJM}$	$T_{VJM}$								
	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
<b>Diode part</b>				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
<b>Diode part</b>				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
<b>Diode part</b>				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
<b>Diode part</b>				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  
 Please refer to page 64 for part numbering structure.  
 \*\*Contact factory

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.

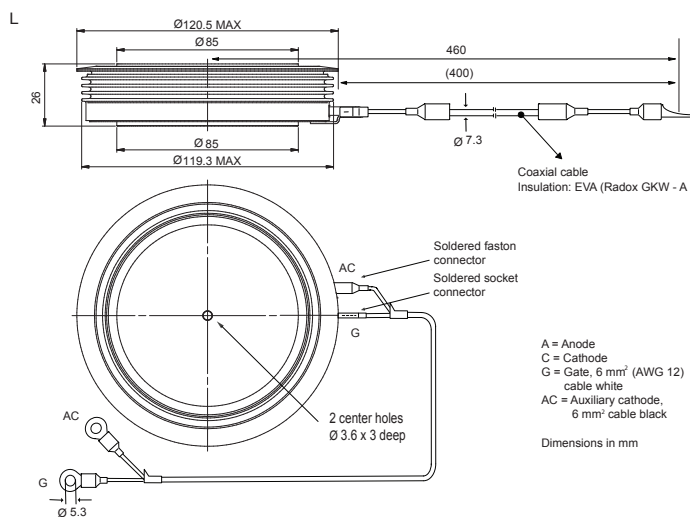
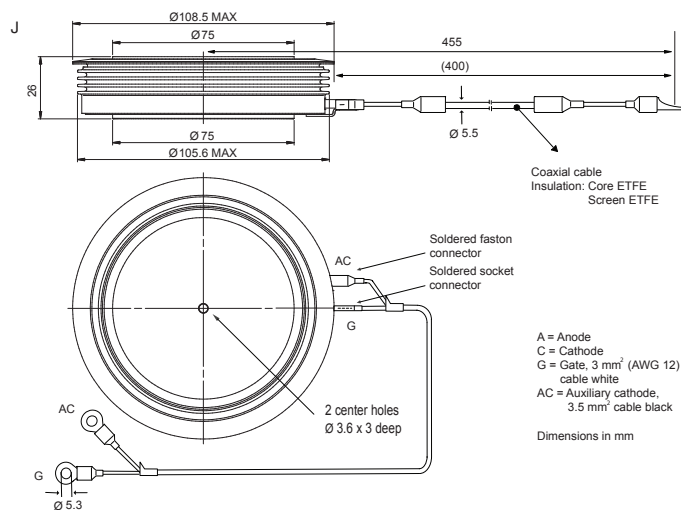
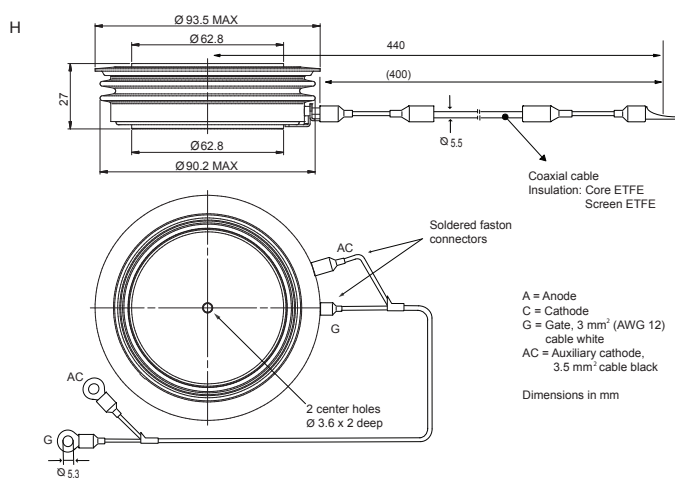
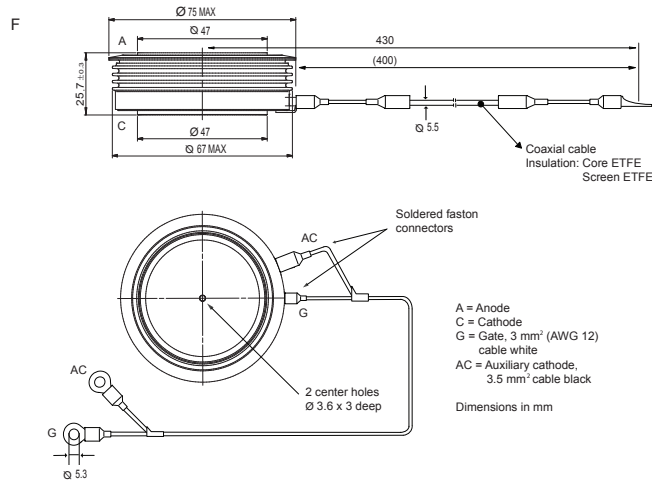
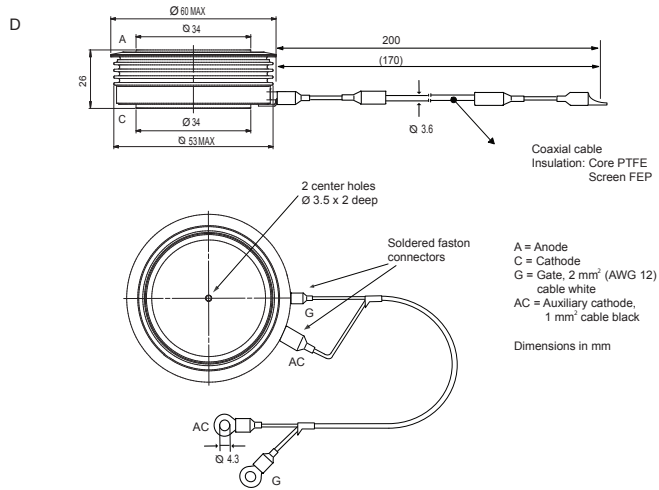
### Asymmetric GTOs

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				
																$T_C = 85\text{ °C}$		$I_{TGM}$	$T_{VJM}$
																A	$\mu\text{F}$		
<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 64 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).

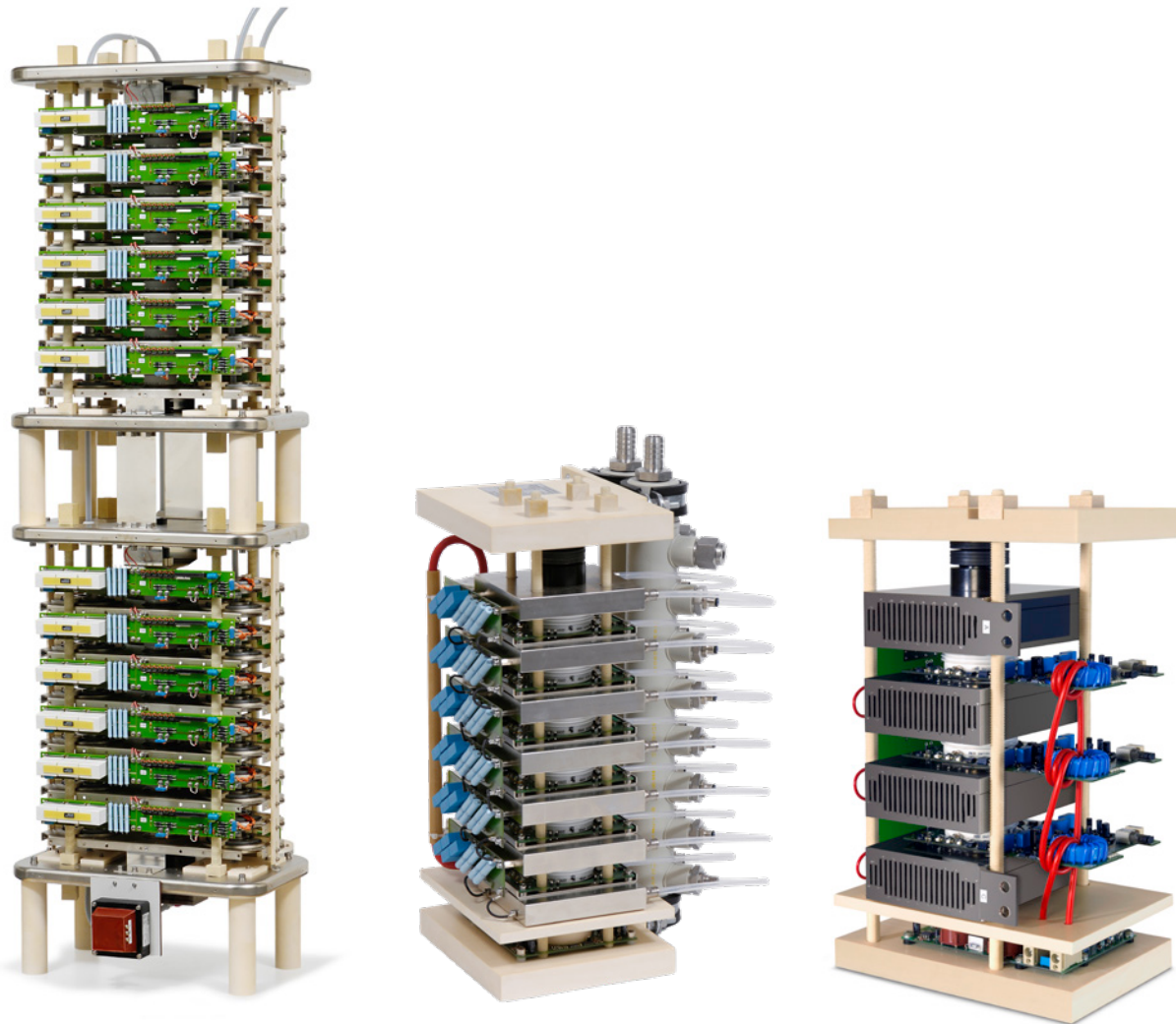
# Assemblies for high power applications

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 [kV]	di/dt [kA/μs]	I <sub>max</sub> [kA]	Pulse width [μs]	Rep. Rate [Hz]
<b>5SVC 032700E00</b>	High di/dt IGCTs	Air	5.6	6	1.2	2	1350
<b>5SVC 083600E00</b>	High di/dt IGCTs	Water	20	10	12.6	12	300
<b>5SVC 163500E00</b>	High di/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 [kV]	di/dt [kA/μs]	I <sub>max</sub> [kA]	Pulse width [μs]	Rep. Rate [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 [kV]	di/dt [kA/μs]	I <sub>max</sub> [kA]	Pulse width [μs]	Rep. Rate [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 [kV]	di/dt [kA/μs]	I <sub>max</sub> [kA]	Pulse width [μs]	Rep. Rate [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 [kV]	I <sub>max</sub> [kA]	Pulse width [μs]	Rep. Rate [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 the range of up to 14 kV and 10 kA and use configurable stray inductances down to 60 nH. During testing, the clamped device under test (DUT) can be precisely heated up to 200 °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	$V_{\text{cassat}} / V_{\text{pn-ch-off}}$	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

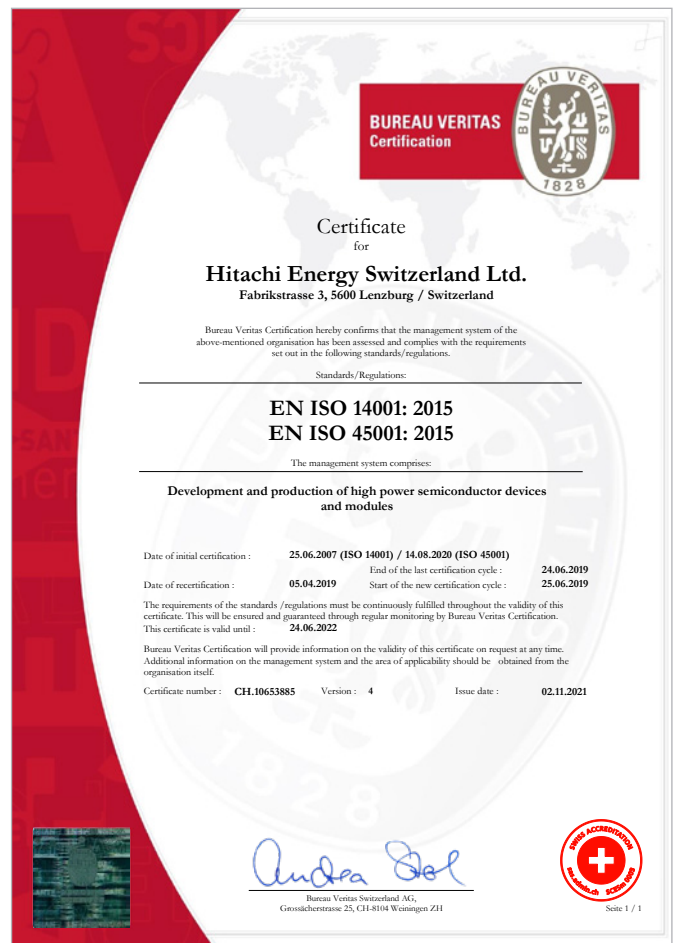
- Clamping unit
- Capacitor discharge unit
- Pre-heating unit
- Programmable IGBT and thyristor gate units
- Data acquisition and parameter extraction units



# 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).







**THE INTERNATIONAL CERTIFICATION NETWORK**  
**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: 2021 - 11 - 01  
First issued on: 2010 - 08 - 23  
Expires on: 2022 - 08 - 13

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

Registration Number: CZ - 2104/2019




Alex Stoichitoiu  
President of IQNet



Tomáš Hruška  
President of CQS



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

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- Design, development and manufacturing of:
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- high power semiconductor devices and modules

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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  
**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: 2021 - 11 - 01  
First issued on: 2010 - 08 - 23  
Expires on: 2022 - 08 - 13

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Alex Stoichitoiu  
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Tomáš Hruška  
President of CQS



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CQC China CQM China CQS Czech Republic Crt Cert Croatia DQS Holding GmbH Germany FCAV Brazil  
FONDONORMA Venezuela ICONTEC Colombia Inspecta Sertifiointi Oy Finland INTECO Costa Rica  
IRAM Argentina JQA Japan KPC Korea MIRTEC Greece MSZT Hungary Nemko AS Norway NSAI Ireland  
NYCE-SIGE Mexico PCBC Poland Quality Austria Austria RB Russia SII Israel SIQ Slovenia  
SIRIM QAS International Malaysia SQS Switzerland SRAC Romania TEST St Petersburg Russia TSE Turkey YUQS Serbia  
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# 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 Switzerland Ltd., Semiconductors and/or Hitachi Energy Czech Republic s.r.o. do not intentionally release any substance or preparation (mixtures);
- Hitachi Energy Switzerland 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 Switzerland 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 Switzerland Ltd., Semiconductors

# Further information

## Symbols

Symbol	Description
$di/dt_{\text{max}}$	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

### 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

### 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<sup>+</sup> and SPT<sup>++</sup> / Z = Enhanced trench / FSA, FCE diode / W = TFP

**Type**

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

**Die size in mm<sup>2</sup>**

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**



## 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**

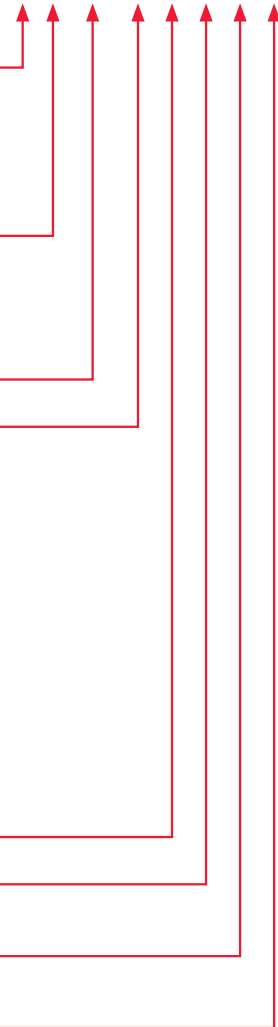
A = RoadPak A-Sample  
 B = RoadPak B-Sample  
 E = HiPak2, 40 mm  
 G = HiPak2 HV, 44 mm  
 H = Press-pack  
 J = HiPak1 HV, 44 mm  
 K = Press-pack  
 L = Press-pack  
 M = HiPak1, 30 mm  
 N1 & N2 = HiPak1, 40 mm  
 P = HiPak0  
 Q = 62Pak  
 R = LoPak1 (thermal paste/TIM)  
 S = LoPak3  
 X = LinPak

**Blocking voltage (V/100)****Package variation**

0 = Standard

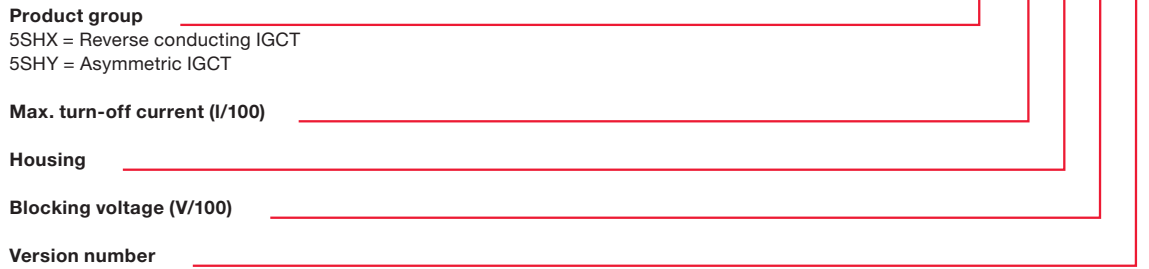
**Technology variation**

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

**Version number**

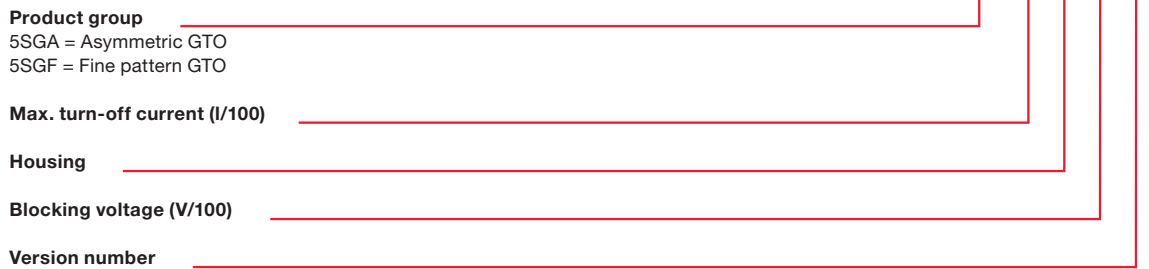
IGCT

5SHY 35 L 45 20



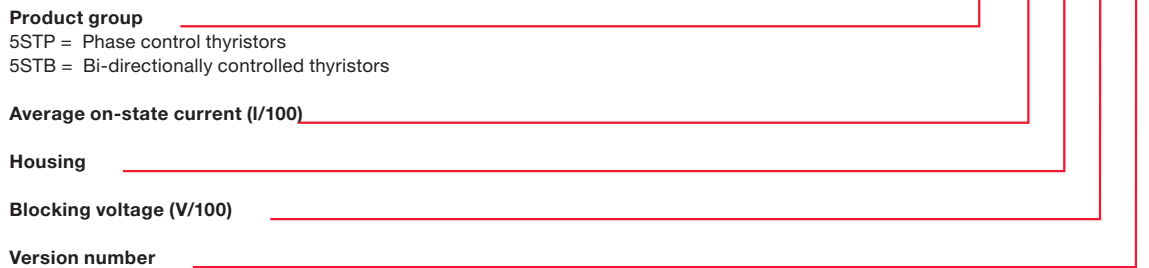
GTO

5SGA 20 H 25 01



Phase control thyristors

5STP 26 N 65 00





Diodes

5SDA 14 F 50 07

**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**

BiPolar Power modules

5SE D 0890 T 22 4 0

**Product group**

5SE

**Configuration**

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

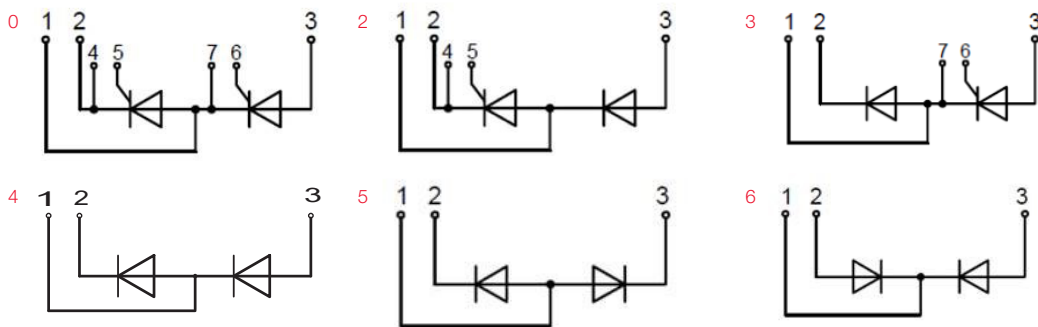
**Average on-state current (I/100)**

**Housing**

T ... 60Pak

**Blocking voltage (V/100)**

**Connection**



**Version number**

# Further information

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Web [www.richardsonrfpd.com/  
Supplier/Index/Hitachi\\_\\_Energy](http://www.richardsonrfpd.com/Supplier/Index/Hitachi__Energy)

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