ABB’s innovative BiPolar offerings

Christian Winter, Product Manager, ABB Semiconductors, Switzerland
Content

- ABB Semiconductors product overview
- IGCTs
  - New 4.5 kV Reverse conducting device
  - IGCT Reliability
- Thyristors
  - Large size, high-voltage platform
- Diode
  - 6 Inch HV device
  - Welding diode platform

This presentation can be downloaded:
abb.com/semiconductors link to PCIM
ABB Semiconductors - Product portfolio

Full range of high power semiconductors

**IGBTs and diodes**
- IGBT chips
- Insulated modules (HiPak and LinPak)
- Press-pack modules (StakPak)

**Medium power segment (IGBT)**
- 62Pak
- LoPak

**BiPolar offerings**
- Phase controlled and bi-directional thyristors (PCT and BCT)
- Gate turn-off thyristors (GTO)
- Integrated gate-commutated thyristors (IGCT)
- Diodes

Voltage ratings from 200 to 8,500 V
Current ratings from 150 to 12,000 A
ABB’s innovative BiPolar offerings
## IGCT overview

In addition:
- Most complete Asymmetric GTO portfolio fully available
- Introduced >20 years ago by ABB.
- Various sizes and voltage classes.
- Three device variants.
- Used in wide application range.

<table>
<thead>
<tr>
<th>Voltage classes, V</th>
<th>Reverse Conducting (RC)</th>
<th>Assymetric</th>
<th>Reverse Blocking (RB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6500</td>
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<tr>
<td>5500</td>
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<td>4500</td>
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<tr>
<td>2500</td>
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<td></td>
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</tr>
<tr>
<td>F / H</td>
<td>L</td>
<td>Y</td>
<td>L</td>
</tr>
<tr>
<td>47/63</td>
<td>85</td>
<td>138</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>L</td>
<td>63</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Housing / Pole-piece diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Sample</td>
</tr>
</tbody>
</table>
New 4.5 kV 3600 A reverse conducting IGCT

New Gen 3 4.5 kV Reverse-Conducting IGCT platform in L housing (85 mm) is ready for sampling now.

Devices are available in two variants, one optimized for medium switching frequency application, such as MVD and wind power converter, the second optimized for low switching frequency intended for use in Multi-Level Modular Converter (MMC) for e.g. Static synchronous compensators (STATCOMs) or Pumped Hydro plants.

The turn-off current of 3600 A is a record value in its class. For the converter manufacturer, it means a significantly compact converter design than previously.
New 4.5 kV 3600 A reverse conducting IGCT

Design features

- Retain the current outer dimensions for compatibility with the application and integrated gate unit.
- Gen 3 optimization focus: turn-off and thermal performance:
  - Increased device diameter through efficient use of raw silicon wafer.
  - Minimal gate-circuit impedance – achieved by using a gate contact infrastructure at the device’s periphery and by routing the gate contact through the housing.
  - Turn-off current increased by adjusting doping profile.
New 4.5 kV 3600 A reverse conducting IGCT

Mechanical setup

**Previous**
- Ring gate
- Two part cathode side Molybdenum disk
- Symmetric anode and cathode side pole-piece thickness

**New**
- Outer ring gate
- Monolithic Molybdenum disk
- Asymmetric anode and cathode side pole-piece thickness

Improved thermal design for more performance and improved reliability
New 4.5 kV 3600 A reverse conducting IGCT

Two product variants
- Two variants available optimized for medium and low switching frequency applications.
- Turn-off current 3600 A.
- On-state characteristics showing the flexibility in tuning the IGCT for different switching frequencies (left).
- Trade-off between static and dynamic losses for both low Fs and high Fs variants (right).
- Different lifetime tuning technologies enables element optimization depending on the application’s needs.
- Converter designer to select the device best suited to the application (i.e. low or high switching frequency).
Field reliability “Gotthard lift”

- Devices removed from Sedrun, Gotthard lift application.
- 15 years heavy duty operation in lift drive. Known load profile and number of cycles.
- 28,200,000 tons excavated gravel with lift.
- Traces of wear-out were found but degradation was low. Example shows the minimal degradation of the cathode metallization.

Field Failure Rate (FIT) of GCT and gate unit [1]

Field reliability of IGCTs is state-of-the-art and constantly improving over time


Field failure rate FIT: Device failure of specific customers are monitored. \( r \) reported field failures per reporting year

Device failures are analyzed: Number \( N \) of devices in this application known. Uptime per year estimated to \( T = 6000 \text{h/ year} \)

Field failure rate is calculated in FIT (device failure in \( 10^9 \) device hours). Field failure rate = \( (r \times 10^9) / (N \times T) \)
Thyristor overview

In addition:
- Bi-directionally controlled thyristors (BCTs) in N, Q and U housing.
- Crowbar and fast-thyristors.

- Most complete portfolio consisting of small size low voltage up to large size and high voltage devices.
- Highest performance and reliability, lowest losses.
- Wide application range.
New large size high voltage industrial Thyristors

New large size high voltage thyristors from ABB are in mass production now. The new devices are optimized for industrial application offer benchmark performance in their class. The rugged design concept assures a reliable operation in most demanding industrial applications.

The new generation devices are based on our latest HVDC technology platform offering lowest losses, highest reliability and surge current capability. Junction temperature ranges up to 125 °C.
New large Size high voltage industrial Thyristors

Design optimization

- ABB approach: Further development of ABB’s leading HVDC thyristor portfolio, On-state ($V_T$) reduction and junction temperature increase.
- Main features: Device thinning, Si increase size, Shallow junction, Hammer gate, Snowflake.

>20% more forward current, >30% more surge current, 15% less losses for N housing 8.5 kV device
**Diode overview**

In addition:
- More housing types available.
- Wide fast recovery diodes portfolio available e.g. 5SDF 20/28L4520.

<table>
<thead>
<tr>
<th>Rated voltage, V</th>
<th>Product</th>
<th>Sample</th>
</tr>
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<tbody>
<tr>
<td>8500</td>
<td>Rectifier diodes</td>
<td></td>
</tr>
<tr>
<td>6000</td>
<td>Rectifier diodes</td>
<td></td>
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<tr>
<td>5000/5500</td>
<td>Rectifier diodes</td>
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<tr>
<td>3800/4000</td>
<td>Rectifier diodes</td>
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<tr>
<td>2600-3200</td>
<td>Welding diodes</td>
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<tr>
<td>1700-2400</td>
<td>Welding diodes</td>
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<tr>
<td>200/400</td>
<td>Welding diodes</td>
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<tr>
<th>B</th>
<th>C</th>
<th>X</th>
<th>Z</th>
<th>D</th>
<th>F</th>
<th>H/K</th>
<th>L</th>
<th>N/Q</th>
<th>Y</th>
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<tr>
<td>44</td>
<td>57</td>
<td>44</td>
<td>53-64</td>
<td>34</td>
<td>47</td>
<td>63</td>
<td>78</td>
<td>100</td>
<td>143</td>
</tr>
</tbody>
</table>

*Housing / Pole-piece diameter (mm)*
Diodes from ABB - leading in resistance welding and rectifier applications

**Welding diodes**

- Benchmark in industry.
- Standard and housing less configuration for medium and high frequency applications.
- Load cycle capability of millions of cycles, corresponding to years of device operation, is achieved.
- Continuous improvement activities keep the portfolio in leading position.

**6 Inch 8.5 kV record high-power rectifier diode**

- New 6 Inch 8.5 kV high-power diode is in sampling stage now.
- Optimized for low on-state.
- Designed for high surge current values