IGBTs

IXYS Corporation
# Table Of Contents

I. IXYS IGBT Technologies

II. Product Lines

III. Latest IGBTs
I. IGBTs: Key Parameters

- Collector-emitter breakdown voltage, $V_{CES}$
- Collector current, $I_C$
- Collector-emitter saturation voltage, $V_{CE(sat)}$
- Current fall time, $t_{fi}$
- Turn-off energy loss, $E_{off}$
- Thermal resistance (junction to case), $R_{thJC}$
IXYS IGBT Technologies

- Extreme Light Punch Through (XPT™)
- BiMOSFET™ (Reverse Conducting IGBTs)
- Press-Pack IGBTs
- Punch Through (PT)
- Non Punch Through (NPT)
- Very High Voltage NPT
## IXYS IGBT Advantages and Applications

<table>
<thead>
<tr>
<th>Product Family</th>
<th>Features/Advantages</th>
<th>Applications</th>
</tr>
</thead>
</table>
| Extreme Light Punch Through (XPT™)    | ▪ Thin wafer technology  
▪ Reduced thermal resistance  
▪ Low energy losses  
▪ Fast switching  
▪ Low tail current  
▪ High current density  
▪ Positive temperature coefficient of $V_{CE(sat)}$ | ▪ Battery chargers  
▪ E-bikes  
▪ Motor drives  
▪ Power inverters  
▪ Welding machines  
▪ Power factor correction circuits  
▪ Switched-mode power supplies  
▪ Uninterruptible power supplies |
| Punch Through (PT)                    | ▪ Optimized for low switching losses  
▪ High avalanche capability  
▪ Square RBSOA  
▪ Anti-parallel ultra-fast diode  
▪ High power density  
▪ Low gate drive requirements | ▪ High frequency power inverters  
▪ Motor drives  
▪ UPS and PFC circuits  
▪ Battery chargers  
▪ Welding machines and lamp ballasts  
▪ Switched-mode power supplies |
| Non Punch Through (NPT)               | ▪ Extremely rugged  
▪ Low $V_{CE(sat)}$  
▪ High power density  
▪ Optional co-packed Sonic-FRD™ diode  
▪ International standard packages | ▪ Capacitor discharge and pulsed circuits  
▪ DC choppers  
▪ DC servo and robot drives  
▪ Uninterruptible power supplies  
▪ Switched-mode power supplies |
# IXYS IGBT Advantages and Applications

<table>
<thead>
<tr>
<th>Product Family</th>
<th>Features/Advantages</th>
<th>Applications</th>
</tr>
</thead>
</table>
| **Very High Voltage NPT** | - High peak current capability  
- Low on-state voltage $V_{CE(sat)}$  
- UL 94 V-0 Flammability qualified (molding epoxies)  
- High power density  
- Easy to mount  
- Low gate drive requirements  
- Proprietary ISOPLUS™ packages available | - Switched-mode and resonant mode power supplies  
- Capacitor discharge applications  
- Pulsed circuits  
- Uninterruptible power supplies |
| **BiMOSFETs™ (Reverse Conducting IGBTs)** | - High blocking voltages  
- Simple drive requirement (MOS-gate turn-on)  
- Low conduction losses  
- High power density  
- Easy to mount  
- International standard packages | - Laser and X-ray generators  
- Capacitor discharge circuits  
- Uninterruptible power supplies  
- Switched-mode and resonant-mode power supplies  
- Radar systems |
| **Press-Pack IGBTs**     | - Improved chipset with even lower losses  
- Even wider SOA (up to 4800A turn-off capability at 3kV DC link)  
- Fully hermetic compression bonded encapsulation  
- 47mm and 125mm poleface industry standard outlines  
- Double side cooling | - Medium Voltage Drives (marine drives, traction, wind power converters, industrial)  
- Energy Utilities (STATCOM, active VAr controllers, renewable generation) |
IXYS IGBT Structures

eXtreme-light Punch-Through (XPT™) Technology

IXYS IGBTs: Cross Sectional Views
XPT™ Technology Advantages

Advantages
- Thin wafer technology
- Reduced thermal resistance
- Low energy losses
- Fast switching
- Low tail current
- High current density
- Positive temperature coefficient of $V_{CE(sat)}$

Total energy loss vs. frequency

Trade-off performance [$E_{off}$ vs. $V_{CE(sat)}$]

Lower gate charge (650V)
IGBT & BiMOSFET Switching Frequency vs Blocking Voltage

- **F_{sw}**
  - 2 MHz
  - 1 MHz
  - 500 kHz
  - 100 kHz
  - 40 kHz
  - 10 kHz
  - 5 kHz
  - 1 kHz

- **V**
  - 0
  - 50
  - 75
  - 100
  - 300
  - 600
  - 900
  - 1200
  - 1700
  - 2500
  - 4000
  - 5000

- **600V XPT™**
  - 600V-1200V NPT

- **900V PT**
  - 900V-1200V XPT™ (Planar & Trench)

- **1.6k-1.7kV BiMOSFETs™**

- **2.5k-3.6kV BiMOSFETs™**

- **4.5kV XPT™**

- **900V-1200V XPT™ (Planar & Trench)**

- **2.5k-3.6kV NPT**

- **4kV NPT**

- **600V XPT™ (Planar & Trench)**

- **300V PT**

- **600V PT**

- **1200V-1400V PT**

- **600V-1200V NPT**
Competitive Landscape: Discrete IGBTs

- Very few to no competitors above 1800V!
## II. IXYS Discrete IGBT Product Lines

<table>
<thead>
<tr>
<th>Technology</th>
<th>$V_{C\text{E}S}$ Voltage (V)</th>
<th>$I_C$ Current at 25°C (A)</th>
<th>$V_{CE(sat)}$ On-State Voltage at 25°C (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extreme Light Punch Through (XPT™)</td>
<td>600 - 4500</td>
<td>15 - 550</td>
<td>1.6 - 4</td>
</tr>
<tr>
<td>Punch Through (PT)</td>
<td>300 - 1400</td>
<td>5 - 600</td>
<td>1.15 - 5</td>
</tr>
<tr>
<td>Non Punch Through (NPT)</td>
<td>600 - 1700</td>
<td>5.5 - 170</td>
<td>2.3 - 7</td>
</tr>
<tr>
<td>Very High Voltage NPT</td>
<td>2500 - 4000</td>
<td>5.5 - 170</td>
<td>2.7 - 6</td>
</tr>
<tr>
<td>Reverse Conducting IGBTs (BiMOSFETs™)</td>
<td>1600 - 3600</td>
<td>5 - 200</td>
<td>2.5 - 7</td>
</tr>
</tbody>
</table>
III. Latest IXYS IGBTs

- 600V XPT™ Planar
- 650V XPT™ Planar
- 650V XPT™ Trench
- 900V XPT™ Planar
- 1200V XPT™ Planar
600V XPT™ IGBTs (33A-550A)

Rugged and Low Loss Extreme-Light Punch-Through IGBTs!

Features
- B3-Class, optimized for 10-30kHz hard switching operation
- C3-Class, optimized for 20-60kHz hard switching operation
- Low $V_{CE(sat)}$ and total switching energy losses $E_{ts}$
- Easy to parallel
- Square RBSOA (rated up to 600V)
- Extended FBSOA
- Avalanche rated
- Short circuit capability (10µs)
- Optional ultra-fast anti-parallel diodes (HiPerFRED™ or Sonic-FRD™)

Advantages
- High power density
- Low gate drive requirement

Applications
- Power inverters, UPS, SMPS, PFC, battery chargers, welding machines, lamp ballasts, motor drives

Part number example:
- IXK100N60B3H1
- IXXH30N60B3
- Prefix “IXX” denotes X-series XPT™ IGBT
- “B3” denotes B3-Class
- “H1” denotes co-packed diode Sonic-FRD™
650V XPT™ IGBTs
(15A-200A)

**For demanding high-speed hard-switching power conversion systems**

**Features**
- Optimized for 20kHz-60kHz switching
- Square RBSOA
- Ultra-fast anti-parallel recovery diodes (Sonic-FRD™)
- Positive thermal coefficient of $V_{CE(sat)}$
- Avalanche rated
- Short circuit capability (8µs-10µs)

**Advantages**
- High power density
- Low gate drive requirements
- Hard-switching capability
- Temperature stability of diode forward voltage $V_F$

**Applications**
- Battery chargers, E-Bikes, lamp ballasts, power inverters, power factor correction circuits, switched-mode power supplies, uninterruptible power supplies, welding machines

**Part number example:**
- IXYH30N65C3H1
- Prefix “IXY” denotes Y-series XPT™ IGBT
- “C3” denotes C3-Class
- “H1” denotes co-packed diode Sonic-FRD™

**Examples:**
- IXYP10N65C3
- IXYN100N65C3H1
- IXYH100N65C3
650V XPT™ Trench IGBTs
(65A-480A)  

Highly efficient low on-state voltage IGBTs for hard or soft switching applications

Features

- Optimized for low conduction & switching losses
- Square RBSOA
- Ultra-fast anti-parallel recovery diodes (Sonic-FRD™ or HiPerFRED™)
- Positive thermal coefficient of $V_{CE(sat)}$
- Avalanche rated
- High and very high speed types (B3 and C3 Classes) available

Advantages

- High power density
- Low gate drive requirement
- Easy to parallel

Applications

- High frequency power inverters, UPS, motor drives, SMPS, PFC circuits,
  battery chargers, welding machines, lamp ballasts.

Part number example:

IXXN110N65C4H1
Prefix “IXX” denotes X-series XPT™ IGBT
“C4” denotes C4-Class
“H1” denotes co-packed diode Sonic-FRD™

IXXH30N65B4
IXXK160N65C4
IXXX200N65B4
900V XPT™ IGBTs

(20A-310A) For energy-efficient high-speed, hard-switching power conversion applications

Features

- Optimized for 20kHz-50kHz switching
- High current handling capability
- Maximum junction temperature $T_{JM} = 175^\circ C$
- Positive thermal coefficient of $V_{CE(sat)}$
- Square RBSOA
- Ultra-fast anti-parallel diodes

Advantages

- Hard-switching capability
- High power density
- Low gate drive requirements

Applications

- E-bikes and hybrid electric vehicles, high frequency power inverters, lamp ballasts, PFC circuits, switched-mode power supplies, Uninterruptible Power Supplies (UPS), welding machines.

Part number example:

IXYA8N90C3D1
Prefix “IXY” denotes Y-series XPT™ IGBT
“C3” denotes C3-Class
“D1” denotes co-packed diode HiPerFRED™

IXY8N90C3
IXYT80N90C3
IXYK140N90C3
1200V XPT™ IGBTs
(21A-240A)  
For high-speed, hard-switching applications (up to 50kHz)

**Features**
- Optimized for low conduction & switching losses
- Square RBSOA
- Ultra-fast anti-parallel recovery diodes (Sonic-FRD™ or HiPerFRED™)
- Positive thermal coefficient of $V_{CE(sat)}$
- Avalanche rated
- B3 & C3 Classes available

**Advantages**
- High power density
- Low gate drive requirement
- Easy to parallel

**Applications**
- High frequency power inverters, UPS, motor drives, SMPS, PFC circuits,
  battery chargers, welding machines, lamp ballasts.

**Part number example:**
- IXYN82N120C3H1
- Prefix “IXY” denotes Y-series XPT™ IGBT
- “C3” denotes C3-Class
- “H1” denotes co-packed diode Sonic-FRD™

- IXYJ20N120C3D1
- IXYH40N120B3D1
- IXYK100N120B3