Fairchild IGBT Module Solution

2004. 1

PD Discrete Business
Fairchild Semiconductor
1. Fairchild IGBT Technologies
2. IGBT 2-PAK Module (7PM)
3. IGBT Power Integrated Module (24PM / 25PM)
IGBT application

IGBT Module & Discrete

☞ Elevator
☞ F.A. - Inverter, AC servo, Robotics
☞ Welding machine
☞ Power Supply - UPS, SMPS
☞ Transportation - Ignition control, Battery charger

IGBT application
Examples of Application Circuit (I)

- Home appliance (IH-JAR, IH-Cooker, MWO..)
- Package Type: TO-220, TO-3P, TO-264
- Current rating: 30 ~ 80A

**SINGLE ENDED TYPE**
(V\(_{CE}\) : 900 ~ 1700V)

**HALF BRIDGE TYPE**
(V\(_{CE}\) : 600V)
Examples of Application Circuit (II)

- Industrial Equipment (Welding, UPS, IH Heater)
- Package Type: 2-PAK, 1-PAK Module
- Current Rating: 600V: 50 ~ 600A, 1200V: 50A ~ 200A

4*1-PAK IGBT MODULE
2*2-PAK IGBT MODULE

FULL BRIDGE TYPE
Examples of Application Circuit (III)

☞ 3Phase Motor Drive. (Inverter, Frequency Converter)
☞ Package Type: 6-Pak, 2-Pak, 1-Pak Module
☞ Current Rating: 600V: 50 ~ 600A, 1200V: 50A ~ 200A

3PHASE BRIDGE TYPE

- 6*Discrete CO-PAK
- 1*6-PAK IGBT MODULE
- 2*2-PAK IGBT MODULE
- 6*1-PAK IGBT MODULE
Examples of Application Circuit (IV)

DC Chopper

DC Servo (NC, ROBOT)
Examples of Application Circuit (✓)

Low Output CVCF Inverter

CVCF Inverter (UPS)

Filter
Examples of Application Circuit (VI)

VVVF Inverter (PAM)

VVVF Inverter (PWM)
PT – NPT Comparison

**PT** (Punch Through)
- Emitter
- Gate
- p base
- n-Layer
- n+ buffer
- p+ collector
- Collector

**NPT** (Non Punch Through)
- Emitter
- Gate
- p base
- n-Layer
- p+ collector
- Collector

- Good Productivity
- Cost High
- Bad to Parallel Connect
- Good SOA
- Good Productivity
- Cost Low
- Easy to Parallel Connect
- Excellent SOA
- Long Tail Current
**PT (Punch through) IGBTs**

- Material:
  - N- EPI / N+ EPI / P+ wafer
- N+ Buffer layer between N- and P+ collector
- Asymmetric Blocking Characteristic
  - \( \Rightarrow \) Forward Blocking, But No Reverse Blocking
- Lifetime Control by Heavy Dose EBI
- Low Vce(sat) , Fast Switching
- Large Leakage Current
- Negative Temperature Coefficient Characteristics
- Effective in Voltage range < 600 V
NPT (Non Punch through) IGBTs

- Material:
  - N- Wafer / P+ Diffusion
- No N+ Buffer layer between N- and P+ collector
- Symmetric Blocking Characteristic
  ⇒ Forward and Reverse Voltage Blocking
- No Lifetime Control or He$^{4+}$ Ion Irradiation
- Long Tail Current
- Small Leakage Current
- Positive Temperature Coefficient Characteristics
- Large SOA
- Effective in Voltage range > 1200V
Short Circuit Withstand Time (Tsc)

- IGBTs are need to be protected from over current caused by Motor destruction or fault by noise. Normally protection circuit has delay time (3~7μS), so IGBTs have to withstand certain time under Short circuit condition.
- Motor drive product (RUF-Series) is guaranteed at least 10μS for Tsc.

![Diagram of short circuit withstand time](image)

**Diagram:**
- SC --> Detecting abnormal condition --> Feedback --> Gate Turn-off (Over Vce(sat), DC line current)
Short Circuit Withstand Time (Tsc)

- Motor Control requires Tsc longer than 10 usec
- Large Voltage (DC Link Voltage) and Large Current (5 to 10 times larger than rated Ic) Condition
- Longer Tsc requires Larger Vth
NPT IGBT target for 1200V Module

Graph showing Eoff [μJ/A] vs. Vce,sat [V] with targets for Motor Control and IH Application.
What is Merit of NPT?

- This Advanced NPT technology has been especially designed to provide Lower Static and Dynamic Energy Loss performance, excellent short circuit withstanding capability.
- These devices are designed according to their application such as IH and Inverter application.
- This Advanced NPT technology development targets for provide a leadership position in this market area with its performance and cost competency.
1. IGBT 2-PAK Module (7PM)
New package (G Series)

- Reduced Package Internal Stray Inductance
- Optimized Switching Characteristics (Low Switching Noise)
- 3 Types of Package by Current Ratings
- UL Approval: E209204

\[ V_{GE} = V_{ge} + V_{LE} = V_{ge} + 0 = V_{ge} \]
2-PAK Module - G Series

Internal Circuit Diagram

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<thead>
<tr>
<th>DEVICE</th>
<th>BVces [V]</th>
<th>Ic [A]</th>
<th>Vce(sat) [V] typ.</th>
<th>Tf [μS] typ.</th>
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## New 2-PAK Module - G Series

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**Internal Circuit Diagram**

**7PM-HA**
600V 150/200/300A  
1200V 100/150A

**7PM-IA**
600V 300/400A  
1200V 200A
# Line-Up of Chopper Module in 7PM-GA Package

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<th>Remark</th>
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2. IGBT Power Integrated Module

(25PM / 24PM)
### 25PM-AA

- **3 Phase Rectifier + Brake + 3 Phase Inverter + NTC**

#### LINE UP

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<th>BVces [V]</th>
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- Options Available
  - 1 Phase Rectifier
  - Without Brake
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<th>Input</th>
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# Line-Up Plan of New Power Integrated Module - 25PM 1200V

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New Power Integrated Module - 24PM (type 1)

- 3 Phase Rectifier + Brake + 3 Phase Inverter + NTC

Options Available
- 1 Phase Rectifier
- Without Brake

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<tr>
<th>DEVICE</th>
<th>BVces [V]</th>
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New Power Integrated Module - 24PM (type 2)

- 3 Phase Rectifier + Brake + 3 Phase Inverter + NTC

LINE UP

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Options Available
- 1 Phase Rectifier
- Without Brake
## Line UP Plan
### of New Power Integrated Module - 24PM

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