ST Offer for Power Modules

Brief Overview

March 21, 2018
Power Transistor Division
Power Product Portfolio

From Discrete to Power Modules, ST leads the innovation

Discrete & Drivers & SIP
Typical Power: 10 W ÷ 5 kW

SLLIMM™ IPM
Typical Power: 20 W ÷ 3 kW

ACEPACK™ Power Modules
Typical Power: 3 kW ÷ 30 kW

Ideal solutions for Industrial & Robotic Drives, Home Appliances, Welding, Pumps, Fans & Blowers, Air Conditioning
Module Market Trends 2016-2021

IHS Data @ Oct 2017
ACEPACK

Adaptable, Compact and Easier PACKage

The best Power Module offer for Industrial Motor Control and more

Power Modules for various applications

- Technology & Flexibility to address market needs
- 100% controlled by ST for silicon (SiC, MOSFET, IGBT and Diodes)
- Current level from 15 A to 75 A for power scalability
- 650 V and 1200 V
Features and Benefits

- Press FIT and solder pins options, configuration flexibility
- Up to 1200V breakdown voltage
- Integrated screw clamps
- All power switches in a module including NTC
- Several current ratings available

- Several configurations (CIB, 6pack, ..) available and low stray inductance
- High reliability and robustness, miniaturized power side board occupation
- Simplified and stable screwing
- Compact design and cost effective system approach
- Very high power density
ACEPACK

Technology & Flexibility to Address Market Needs

Main Features
- Compact module concept
- Configuration flexibility
- Press FIT and solder pins options
- High power density
- Reliable and easy mounting system
- Integrated temperature sensor available
- Low stray inductance module design
- PCB layout design
- High reliability and quality
- RoHS-compliant modules

ST Power Switch capability
- IGBTs
- HV MOSFETs
- Diodes
- Bridge Rectifier Diodes
- Silicon Carbide MOSFETs
- Silicon Carbide Diodes
- SCR….etc.

Main Topologies can be addressed in ACEPACK

ACEPACK 1
6-PACK 25-35A,1200V
6-pack 50A,650V
CIB 15A,1200V
- Air Conditioning
- Motor drives
- Servo drives
- UPS
- (H)EV

ACEPACK 2
6-PACK 75A,1200V
CIB 25-35A,1200VV
CIB 50A,650V
- Air Conditioning
- Motor drives
- Auxiliary Inverters
# ACEPACK Module for Motor Control

## Standard products in MP (solder and press fit pins)

### ACEPACK™ 1

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Topology</th>
<th>$BV_{CES}$</th>
<th>$I_C$ rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1P25S12M3/-F</td>
<td>Six-Pack</td>
<td>1200V</td>
<td>25A</td>
</tr>
<tr>
<td>A1P35S12M3/-F</td>
<td></td>
<td></td>
<td>35A</td>
</tr>
<tr>
<td>A1C15S12M3/-F</td>
<td>Converter Inverter Brake</td>
<td>1200V</td>
<td>15A</td>
</tr>
<tr>
<td>A1P50S65M2/-F</td>
<td>Six-Pack</td>
<td>650V</td>
<td>50A</td>
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### ACEPACK™ 2

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Topology</th>
<th>$BV_{CES}$</th>
<th>$I_C$ rating</th>
</tr>
</thead>
<tbody>
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<td>A2C25S12M3/-F</td>
<td>Converter Inverter Brake</td>
<td>1200V</td>
<td>25A</td>
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<tr>
<td>A2C35S12M3/-F</td>
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<td></td>
<td>35A</td>
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<td>A2P75S12M3/-F</td>
<td>Six-Pack</td>
<td>1200V</td>
<td>75A</td>
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<tr>
<td>A2C50S65M2/-F</td>
<td>Converter Inverter Brake</td>
<td>650V</td>
<td>50A</td>
</tr>
</tbody>
</table>
ACEPACK 2 Package
ACEPACK - Package Technology

Build from: DCB / high current pin / plastic housing

ACEPACK assembly structure

- Plastic frame
- Pre-inserted clamps
- Lead wire
- Terminal pins
- Copper traces
- Isolated DCB
- Solder or PressFIT
- Thermal grease
- Mounting screw

DBC ‘inside’ view

Assembled module

- PCB with components
- ACEPACK™ module
- Heat sink

Housing provides best-in-class technology standards
Main Applications:
• Robotic & Industrial Drives

ACEPACK Module
650V / 1200V IGBT, 6-Pack or CiB Topology

Main Applications:
• Robotic & Industrial Drives

AE Lab as a key enabler of performance benchmarks

ACEPACK Test in ST Lab

ACEPACK Module is performing in line with the best competition

AC current and IGBT voltages

DC-load

PMSM motor

Laboratory of Traction, Czech University, Prague
A1C15S12M3-F vs. 15A/1200V competition device, $I_{\text{peak}}=14\text{A}$, $V_{\text{DC}}=500\text{V}$, $L_S=30\text{nH}$

Similar switching speed for datasheet resistors values @ application commutation inductance

$R_{\text{Gon}}=22\text{W}$
$V_{GE} \rightarrow -5\text{V}/+15\text{V}$

$R_{\text{Gon}}=39\text{W}$
$V_{GE} \rightarrow -5\text{V}/+15\text{V}$
Application Benchmarks – Motor Control

A1C15S12M3-F vs 15A/1200V competition device, $I_{\text{peak}}=14\text{A}$, $V_{\text{DC}}=500\text{V}$, $L_S=30\text{nH}$

- **ACEPACK Turn-off**
  - $E_{\text{off}}=1.55\text{mJ}$
  - $R_{\text{Goff}}=22\text{W}$
  - $V_{\text{GE}} \rightarrow -5\text{V}/+15\text{V}$

- **Competitor Turn-off**
  - $E_{\text{off}}=1.7\text{mJ}$
  - $R_{\text{Goff}}=39\text{W}$
  - $V_{\text{GE}} \rightarrow -5\text{V}/+15\text{V}$

ST module shows higher switching speed with datasheet resistors values @ application commutation inductance.
Application Benchmarks – Simulations

A2C35S12M3-F vs. 35A/1200V competition device, Pout=12.5kW

Simulation Conditions

- $V_{DC}=700V$
- $I_{RMS}=18A$
- $R_{Gon}=R_{Goff}=15W$ (different $dI/dt$)
- $\cos\phi=0.93$
- $m=1$
- $T_j=135^\circ C$
- $L_s=100nH$

Simulation Outcome

For same gate resistor $R_g$ the ST module has ~ 7.5W less losses per switch. In total ST modules saves 45W of losses per module.

Competition losses are 395W. ST saves ~ 11% of losses.

More power or better efficiency or lower $T_j$ (4,5°C) with ST module is possible.
In application conditions, the module case temperature remains similar for ST and the competitor product. Here relatively low mechanical power was measured.
**ACEPACK™ & Design-in Tools**

**STEVAL-CTM002V1 board enables quick ACEPACK™ evaluation**

- Complete board ready to test with AC motor
- 3-phase input and output
- Overvoltage and Overload protection
- Full compatibility with MC STM32 ecosystem
- RS232 and CAN connection

Board includes: A2C35S12M3-F, STGAP1S, STM32F303, DC/DC module…
The dynamic electro-thermal simulation software dedicated to ST power devices

**Developed for**
- SLLIMM, ACEPACK, Discrete*
- Several Applications
- Windows, MAC OS X*, Android* and iOS*

**Powerful and flexible**
- Dynamic load sim. (up to 10 steps)
- Long mission profile duration of hours
- Several thermal setup

**Connectivity**
- Multilanguage (English, Chinese*, Japan*, …)
- Quick link with st.com documents
- PDF Output Report

* Available in the next releases
### Die Oriented Tests

<table>
<thead>
<tr>
<th>Test</th>
<th>PC</th>
<th>Std ref.</th>
<th>Conditions</th>
<th>SS</th>
<th>Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEST</td>
<td></td>
<td>User spec.</td>
<td>All qualification parts tested per the requirements of the appropriate device specification.</td>
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<tr>
<td>External visual</td>
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<td>JESD22 A-108</td>
<td>Tj = 125°C, BIAS = 960V</td>
<td>25</td>
<td>1000 h</td>
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<tr>
<td></td>
<td></td>
<td>JESD22 A-108</td>
<td>Tj = 125°C, BIAS = 520V</td>
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</tr>
<tr>
<td>HTRB</td>
<td>N</td>
<td>JESD22 A-108</td>
<td>Tj = 125°C, BIAS = 30V</td>
<td>25</td>
<td>1000 h</td>
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<tr>
<td>HTGB</td>
<td>N</td>
<td>JESD22 A-108</td>
<td>TA = 125°C</td>
<td>25</td>
<td>1000 h</td>
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<tr>
<td>HTSL</td>
<td>N</td>
<td>JESD22 A-102</td>
<td>TA = 125°C</td>
<td>25</td>
<td>1000 h</td>
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</table>

### Package oriented test

<table>
<thead>
<tr>
<th>Test</th>
<th>PC</th>
<th>Std ref.</th>
<th>Conditions</th>
<th>SS</th>
<th>Steps</th>
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</thead>
<tbody>
<tr>
<td>H3TRB</td>
<td>N</td>
<td>JESD22 A-101</td>
<td>TA=85°C ; RH=85% BIAS = 100V</td>
<td>35</td>
<td>1000 h</td>
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<tr>
<td>AC</td>
<td>N</td>
<td>JESD22 A-102</td>
<td>Pa=2Atm / Ta=121°C</td>
<td>35</td>
<td>96 h</td>
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<tr>
<td>TC</td>
<td>N</td>
<td>JESD22 A-104</td>
<td>Ta = -40°C to 125°C</td>
<td>50</td>
<td>500 cy</td>
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<tr>
<td>PwCy</td>
<td>N</td>
<td>Mil-Std 750D Method 1037</td>
<td>ΔTj≥100°C, Lmax=75A (A2P75S12), Lmax=35A (A1P35S12), Lmax=15A (A1C15S12)</td>
<td>15</td>
<td>200Kcy</td>
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<tr>
<td>IOL</td>
<td>N</td>
<td>ESDA-JEDEC JES-001 ANSI-ESD S5.3.1</td>
<td>ΔTc=60°C (ΔTj≥100°C), Lmax=75A, T=1sec / toff=39sec</td>
<td>15</td>
<td>10Kcy</td>
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<tr>
<td>ESD</td>
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<td></td>
<td>HBM</td>
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<tr>
<td>Vibration Test</td>
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<td>VIBRATION: a=3g; f=5/500Hz; 4’ x 3 orientat. x 4cycles</td>
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</tbody>
</table>
Future Semiconductors and Topologies

Selected topologies and ST semiconductors

Variety of possible topologies

- 3-phase bridges with rectifiers (CIB)
- 3-phase bridges (PACK)
- Half-Bridge
- 3-level T and I types
- booster multi-phase
- …

Variety of semiconductors

- IGBT, 650V, 1200V (variety of types)
- Si diodes, 650V, 1200V (variety of types)
- Silicon Carbide MOSFETs
- Silicon Carbide Diodes
- HV MOSFETS
- SCR and rectifier diodes
- …

Semiconductors and package ownership makes ST offer unique
Grazie
감사합니다
謝謝
Merci
Danke
Thanks

For additional information, please visit:

http://www.st.com/content/st_com/en/products/power-modules/acepack-power-modules.html