FAIRCHILD™

The Power to Amaze.

Compact Power Modules for Motion Control

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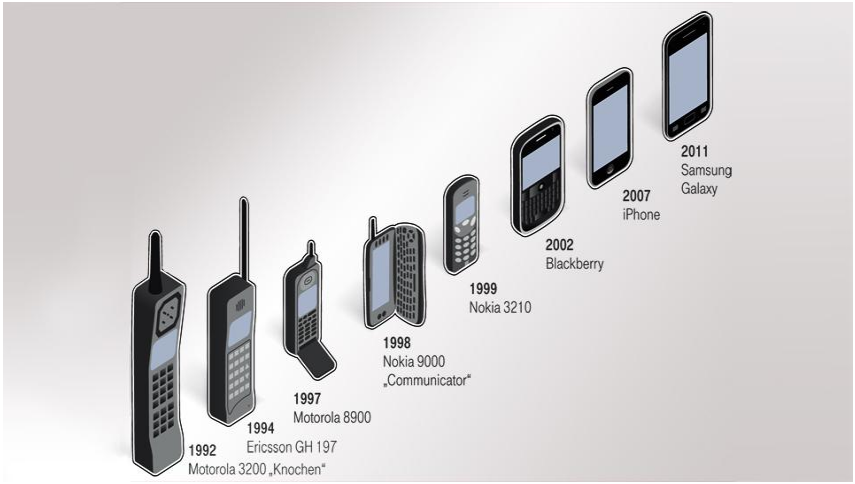
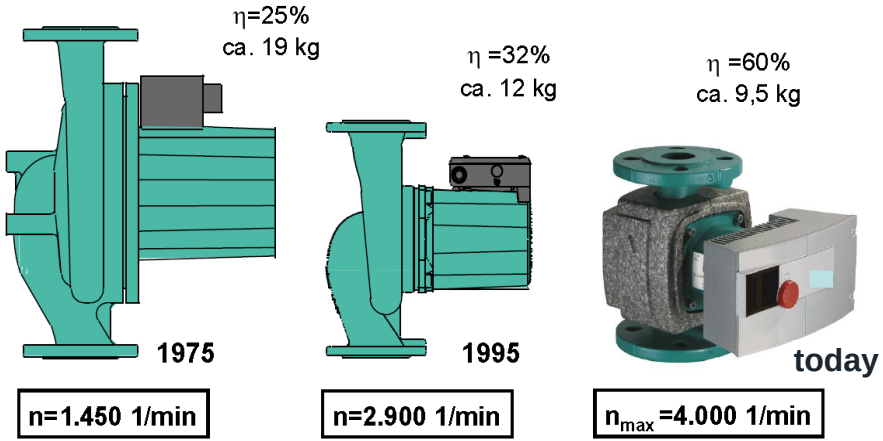
September 3, 2014

Evolution

Technical evolution

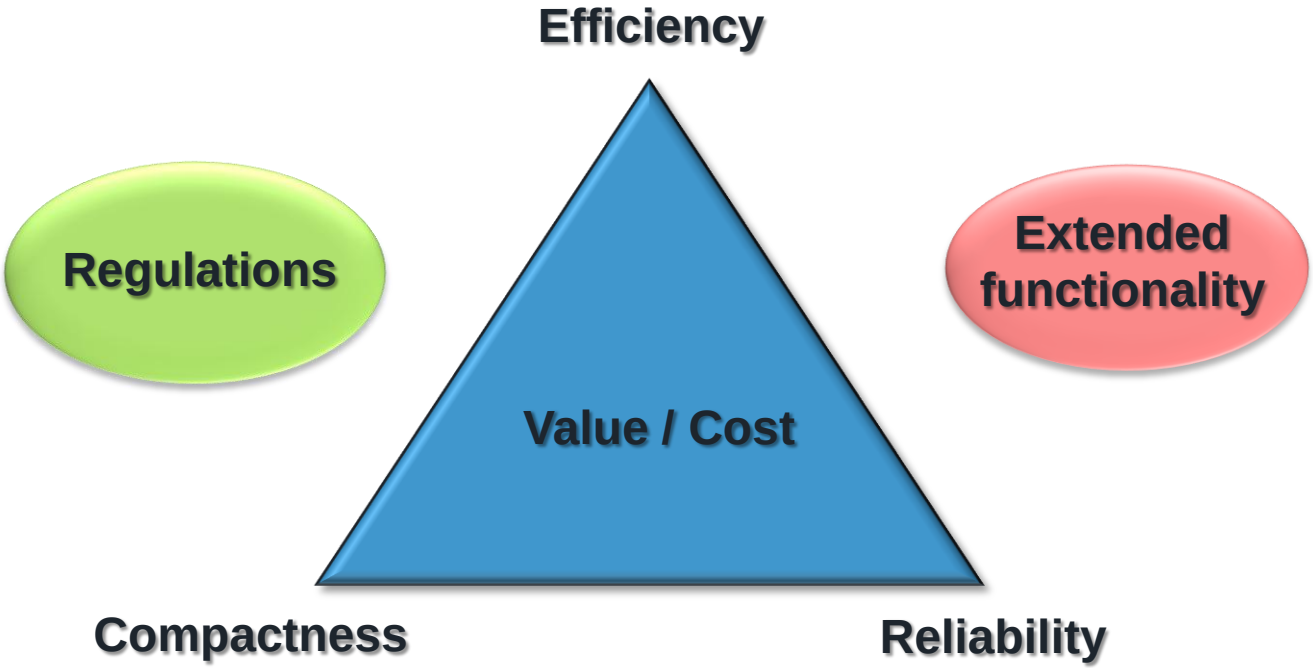


Evolution in Motion control



Example of a Circulation-Pump (Source: WILO SE)

Market Trend in Motion Control



Market Drivers

- Energy Regulations
  - Each country has been strengthening ‘Energy Efficiency Level’ for saving energy
  - Recently, this kind of inverterization trend is spreading to below 100 W wattage solution, not only big power solution.

- Customers Demand
  - Requiring higher efficiency
  - Need solutions that help reduce PCB space
  - Want lower price Bill of Materials (BOM) costs

Low Power Motion Control Applications

Pumps:

- Dishwasher
- Washing machine
- Circulation-pump
- Small pumps

Fans:

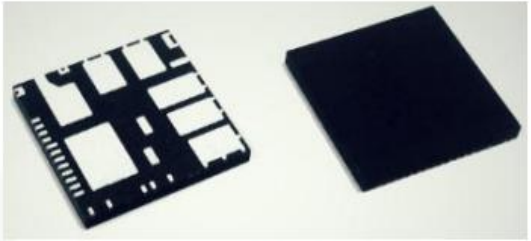
- Kitchen hood
- Ventilation unit
- Air-Conditioner(Indoor/Outdoor)
- Pedestal/Ceiling fans

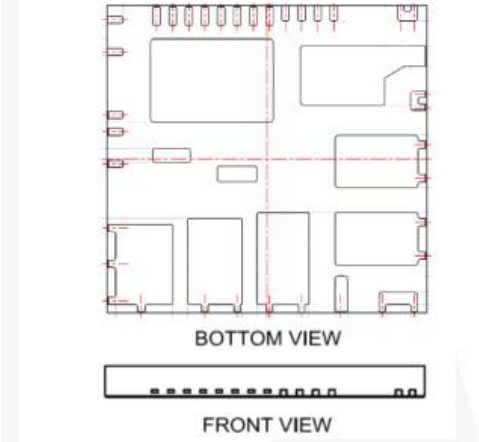




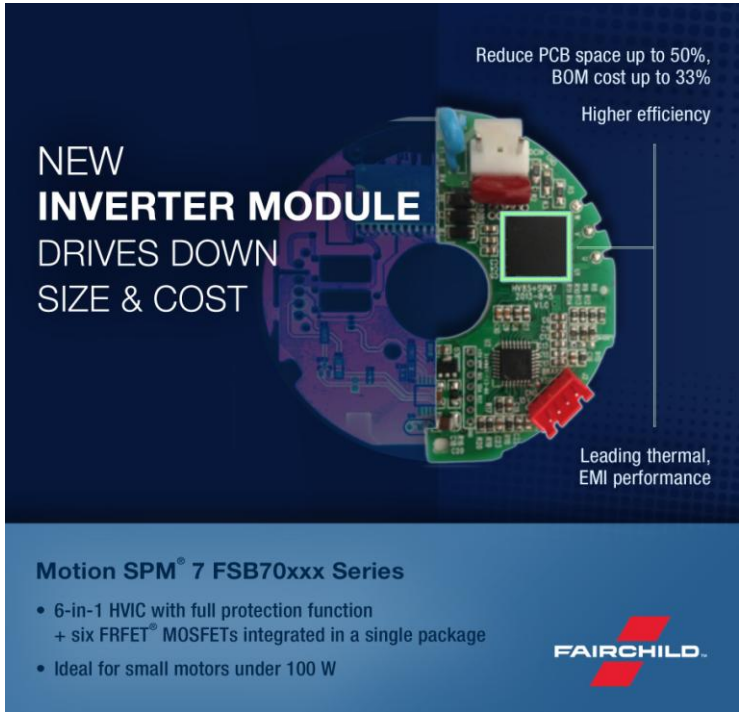



Compactness Module (SPM® 7 Series) for Low Power Motion Control



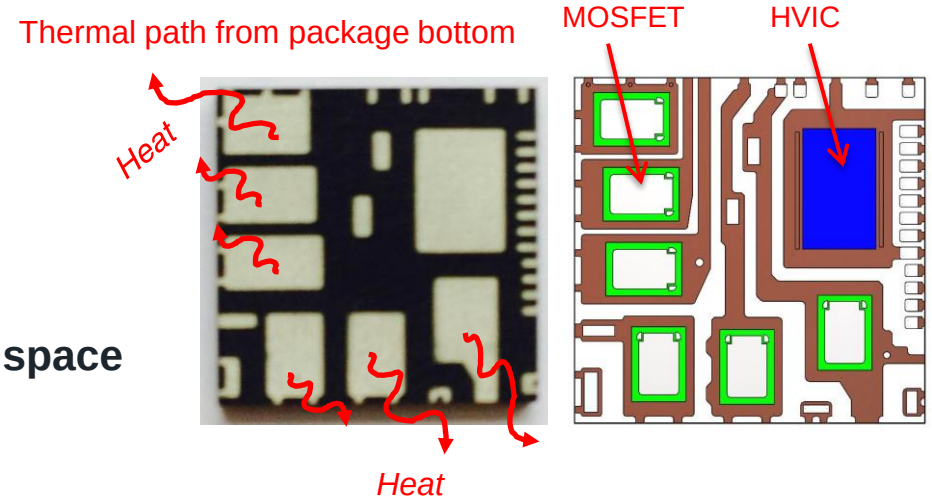


Package
12.9 x 12.9 x 1.3 [mm]
Power-QFN

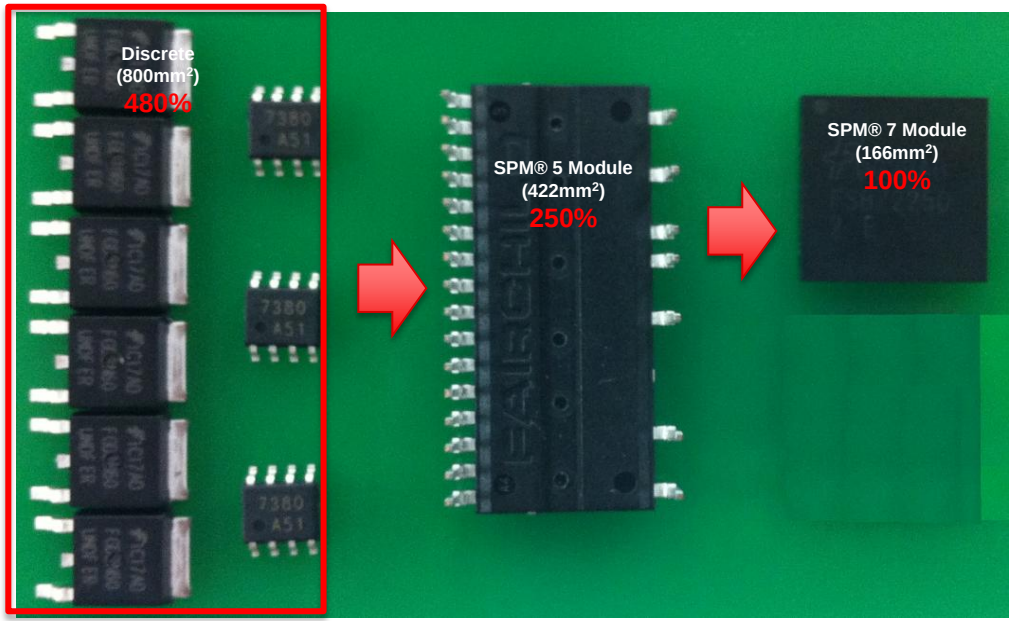


Advantages of SPM® 7 Series

- **Optimized FRFET® MOSFET**
  - New SPM® series adopted UniFET™ II FRFET® MOSFET version for 250 V / 500 V
  - Will add 600 V SuperFET® II MOSFET version
- **Lower Thermal resistance**
  - * FSB70450 : (0.8) degree/watt
- **Compact package size for minimizing PCB space**
  - Up to 50% reduction in PCB space
- **Optimized EMI performance**
  - Stable di/dt , dv/dt

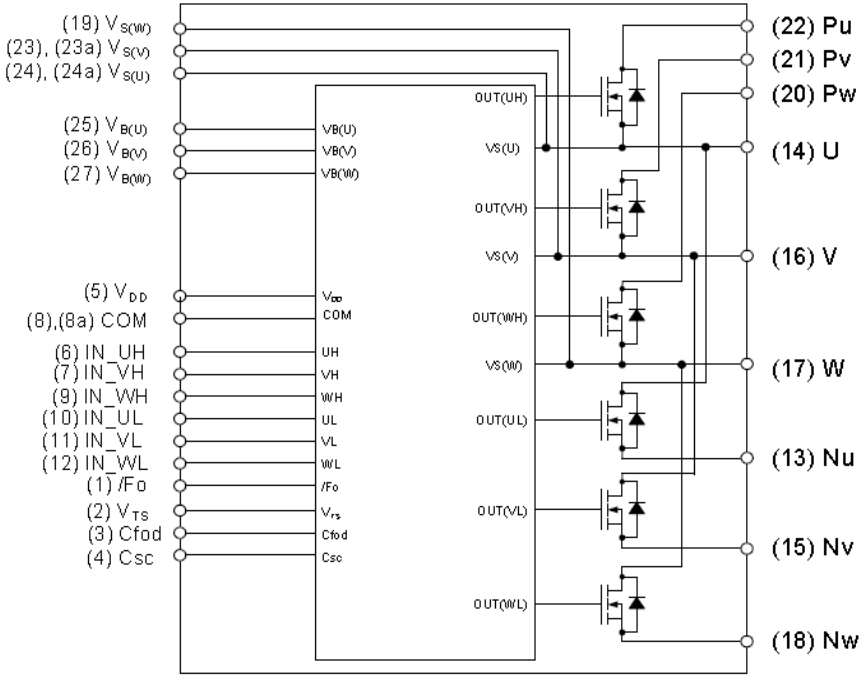


Package Size Comparison:
Discrete vs. SPM® 5 Series vs. SPM® 7 Series



Motion Control < 100W

SPM® 7 Module What's Inside?



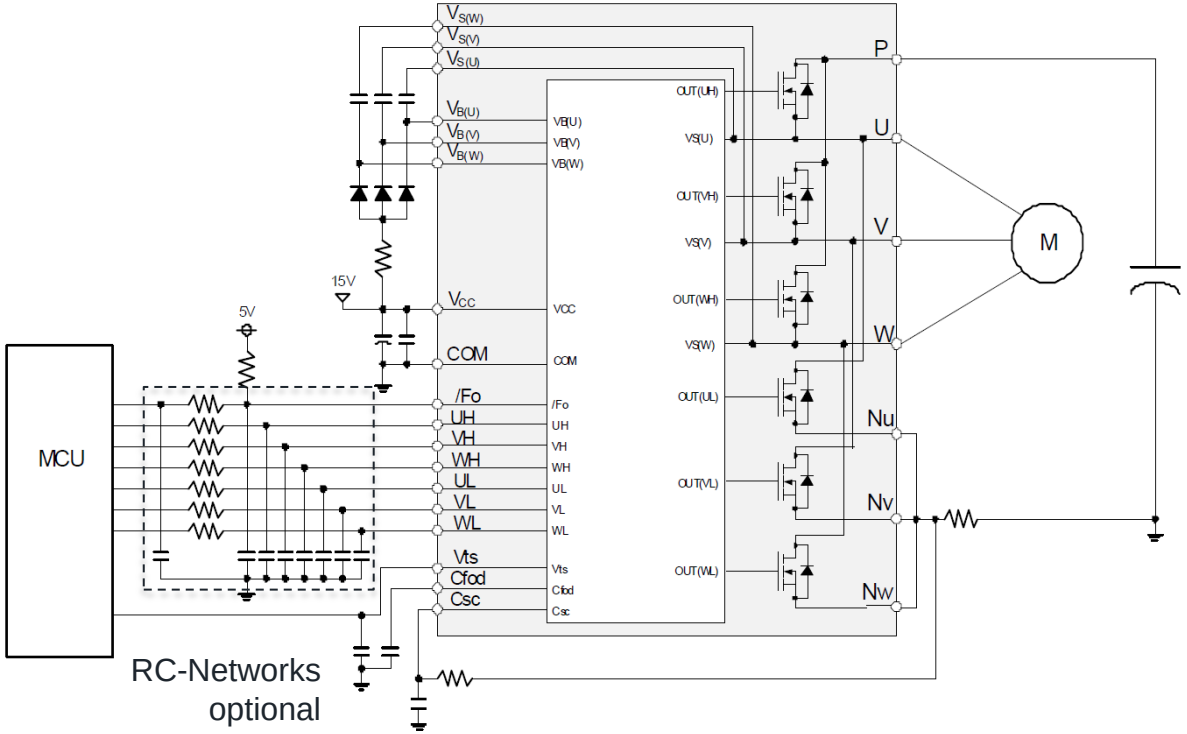
Features:

- Robust & High Efficient UniFET™ MOSFET
  - → SC withstand time is over 10us @ Worst Case
- Low EMI
  - → Reduced dv/dt
- Thermal Sensing for temperature monitoring
  - → Analog voltage output (can be sensed by MCU)
- Full Protection:
  - → High/Low side Under Voltage Lockout
  - → Overcurrent protection
  - → Interlock function
  - → "Fault out" for abnormal condition

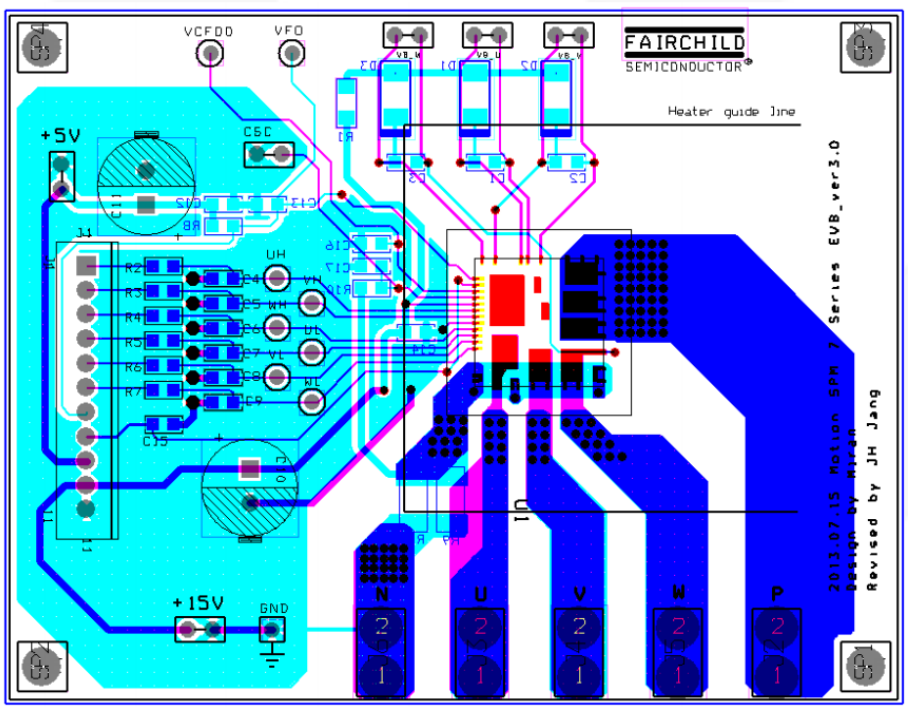
Product Line up : *FSB70625* - 250V/ 0.8Ωmax.
FSB70325 - 250V/ 1.4Ωmax.
FSB70550 - 500V/ 1.85Ωmax.
FSB70450 - 500V/ 2.2Ωmax.
FSB70250 - 500V/ 3.4Ωmax.

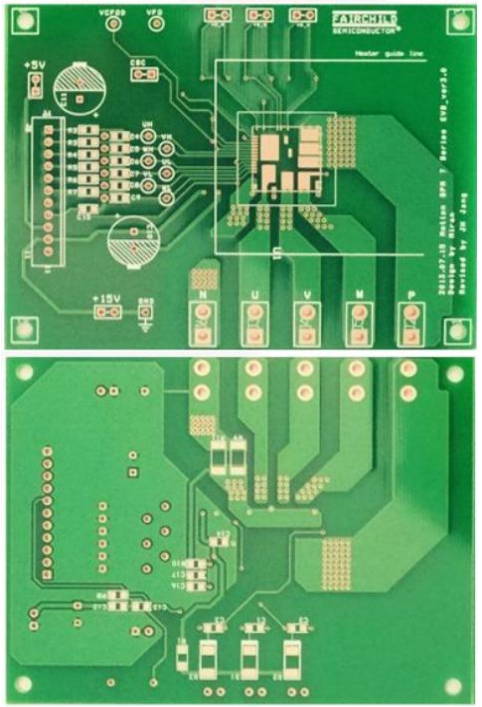
Motion Control < 100W

Application Schematic SPM® 7 Module

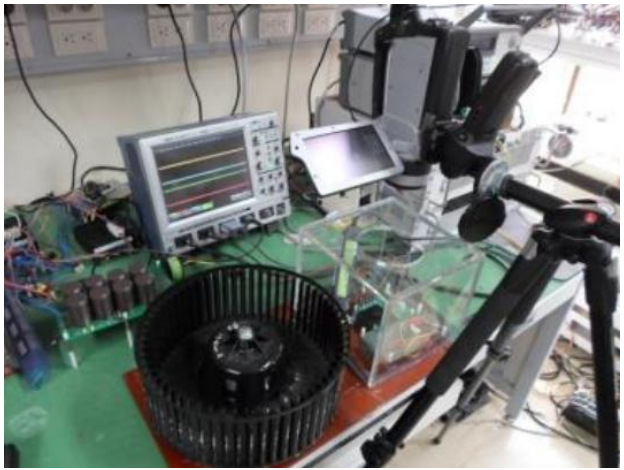


PCB Layout Example for SPM® 7 Series





Thermal Characteristics by Cu Thickness of PCB



Test Condition

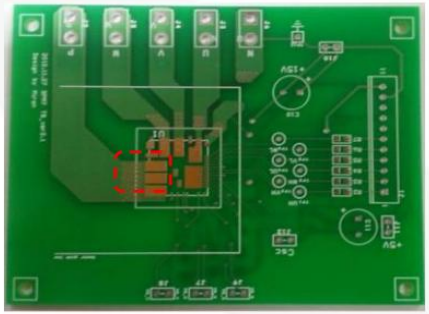
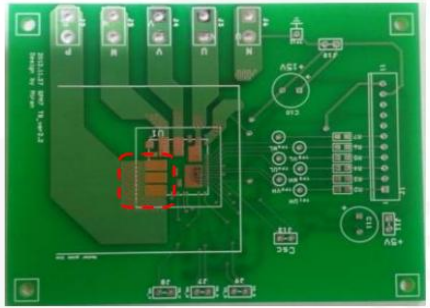
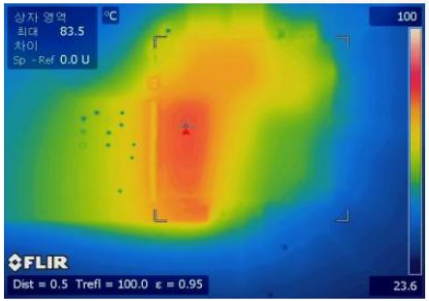
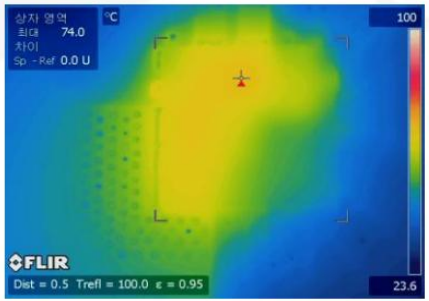
- V_{DC} = 300 V, V_{DD} = V_{BS} = 15 V, f_{SW} = 16.6 kHz
- PWM method: SVPWM
- Output current = 0.3/0.4/0.5 Arms
- No heat sink
- Test board: FR4, 2 layer, 1 oz & 2 oz.

Effect of Cu Thickness

Copper Thickness	0.3 Arms	0.4 Arms	0.5 Arms
1 oz	69.2°C	91.5°C	
2 oz	58.8°C	75.3°C	100°C

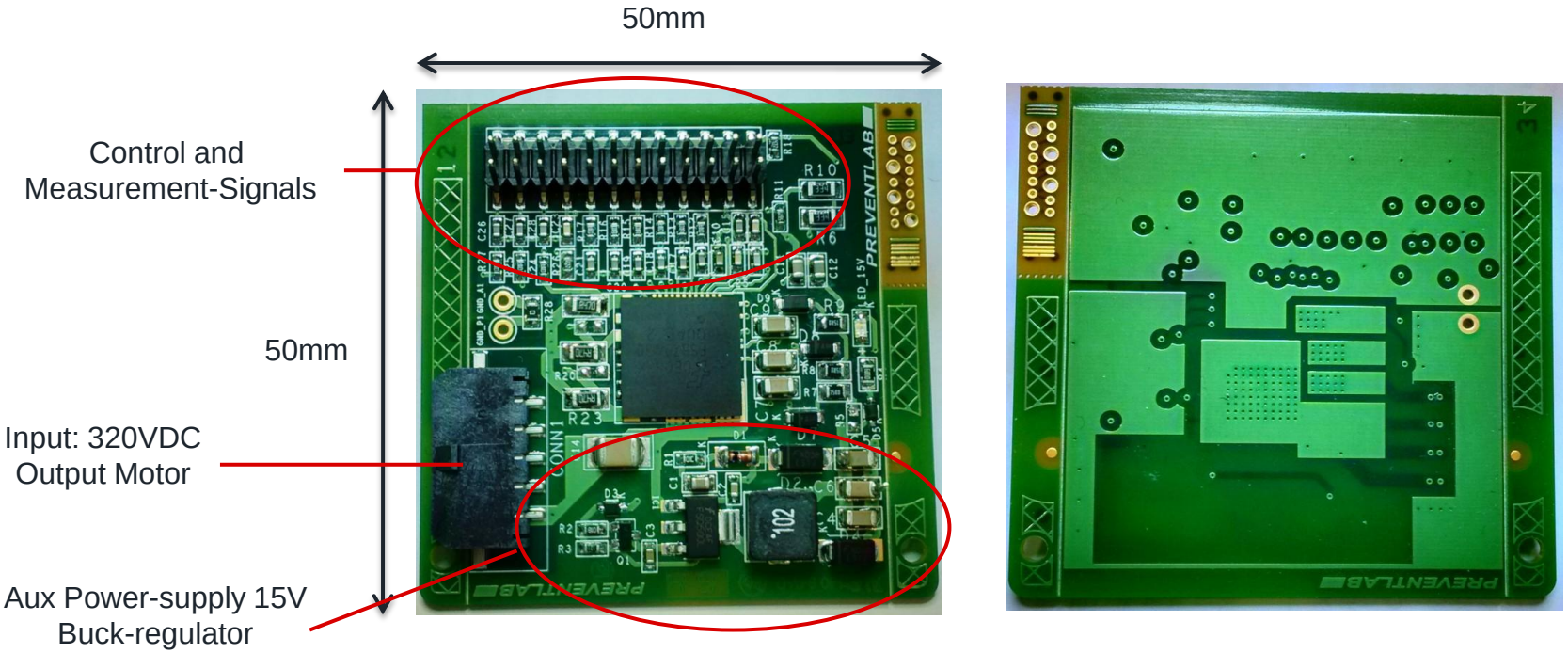
Thermal Characteristics by PCB Pattern Width

Effect of Pattern width at I_{rms} = 400 mA, 1 oz, T_A=21°C

Narrow Width (10 mm)	Wide Width (20 mm)
83.5°C	74°C
	
	

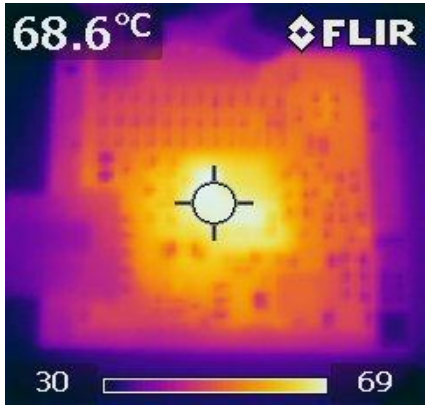
- V_{DC} = 300 V, V_{DD} = V_{BS} = 15 V, f_{SW} = 16.6 kHz
- PWM method: SVPWM
- Output current = 0.4 Arms
- No heat sink
- Test board: FR4, 2 layer, 1 oz

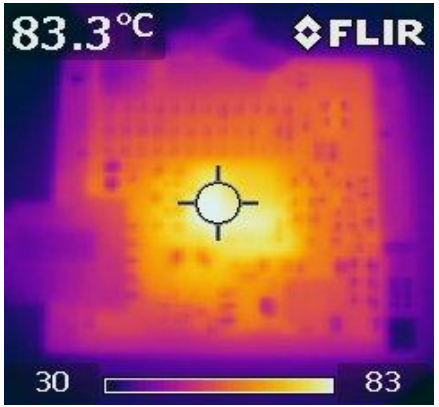
Test Results with FSB70450 Demo-Board

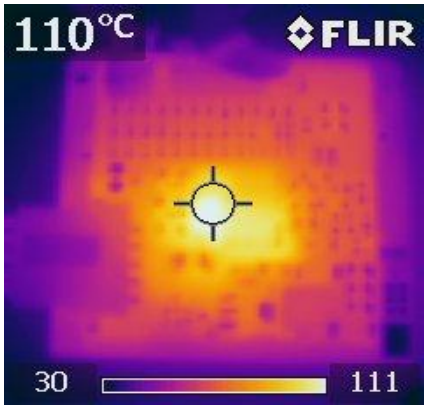


PCB: Standard 4 Layer 35um Cu

Demo-board with FSB70450
(No heatsink, Ta=20℃)



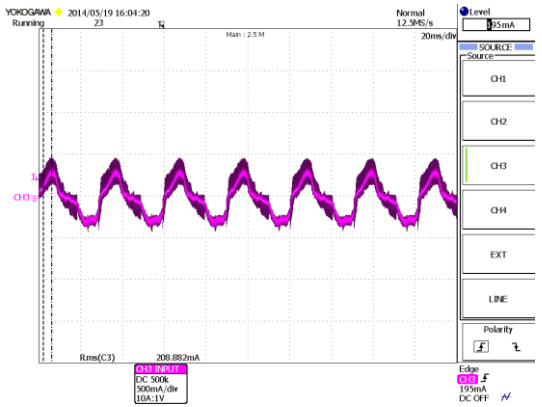




Vin=320VDC
I_motor = 200mArms
Pout= ca. 60W
Fsw=15kHz
Tmax=68,6°C

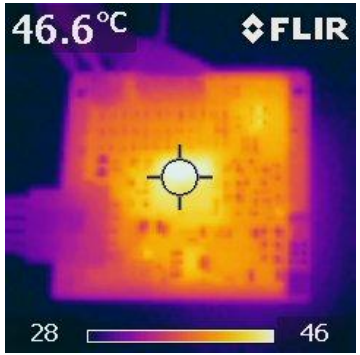
Vin=320VDC
I_motor = 300mArms
Pout= ca. 90W
Fsw=15kHz
Tmax=83,3°C

Vin=320VDC
I_motor = 400mArms
Pout= ca. 120W
Fsw=15kHz
Tmax=110°C

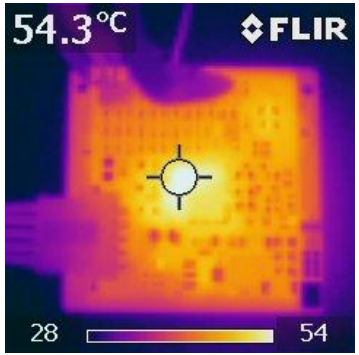


Current waveform

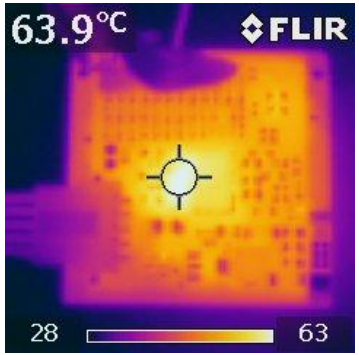
Demo-board with FSB70450
(With heatsink, Ta=20℃)



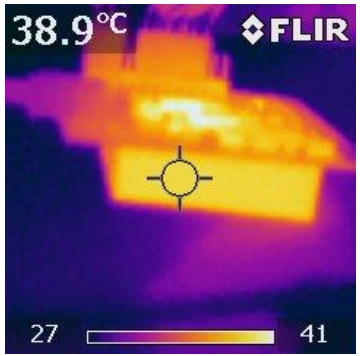
200mA (60W)

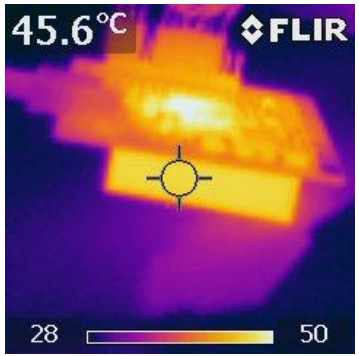


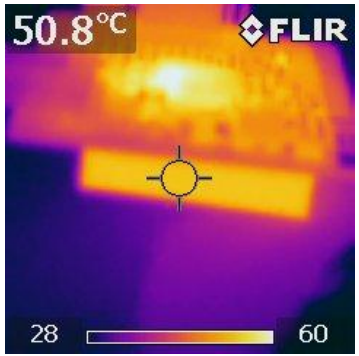
300mA (90W)

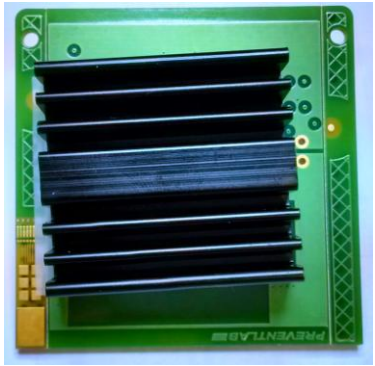


400mA (120W)

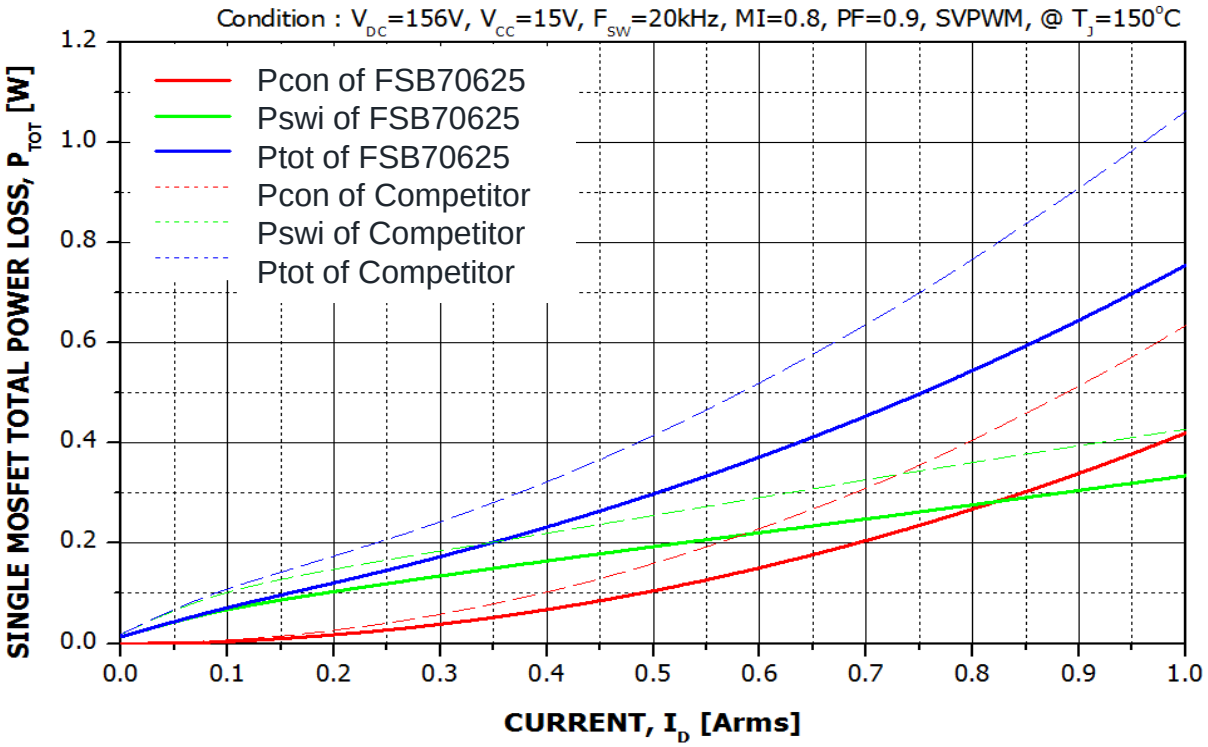




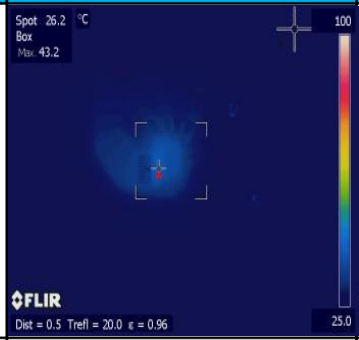
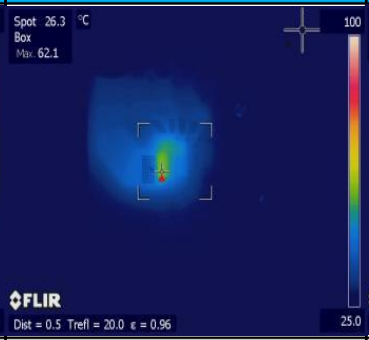
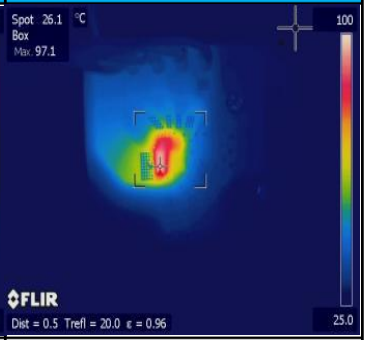
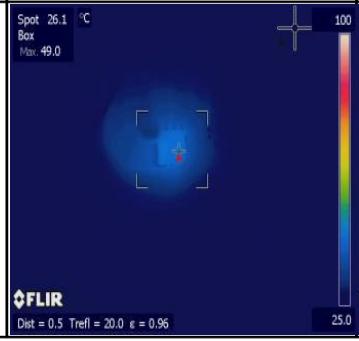
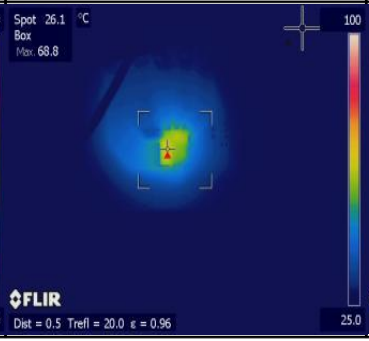
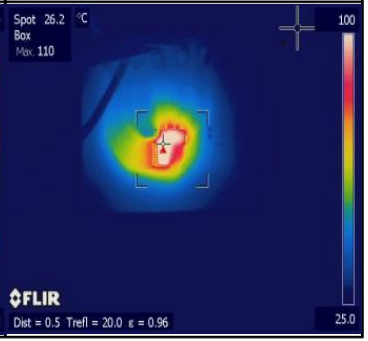




Total Loss Simulation Result



Module Temperature Performance

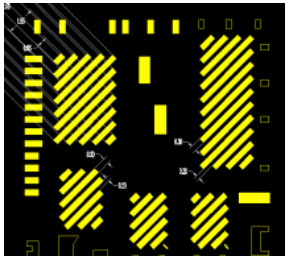
	0.2 Arms	0.4 Arms	0.6 Arms
FSB70625			
Competitor			

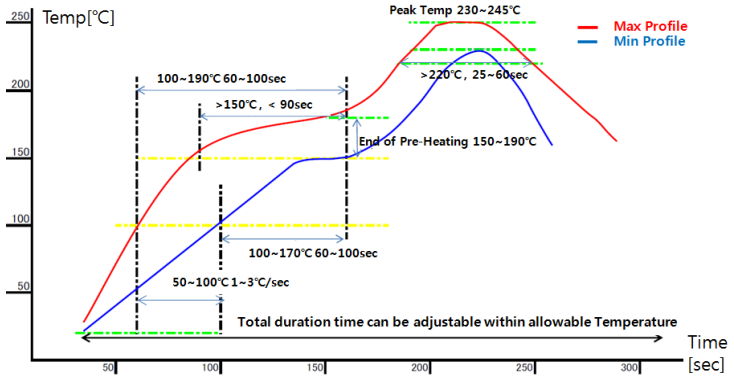
Test condition ; Vdc=156 V, Vcc=15 V, Fsw=20 KHz, Control Method = Sine-wave current control

What about manufacturability ?

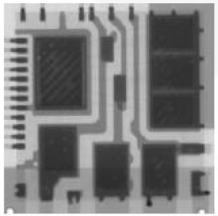
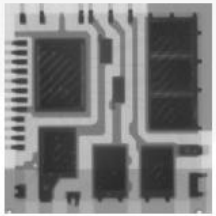
Recommendations to:

- Solder-paste type
- Stencil-Design
- Solder-profile
- X-ray-Inspection





X-ray-Analysis of different options

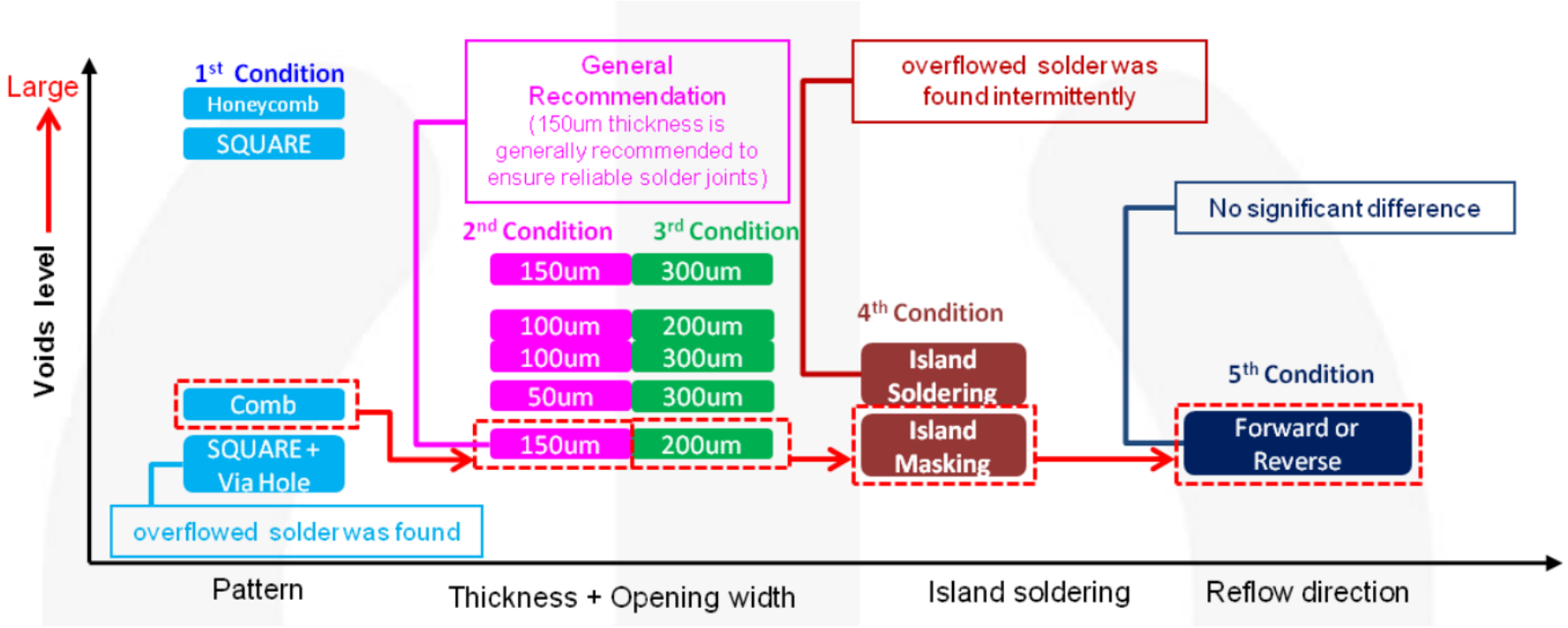
Condition	X-Ray	
100 µm Thickness, 200 µm Opening Width	 Void Level ≈ 19%	 Void Level ≈ 20%

Application Note Available on the web

AN-9078 Surface Mount Guidelines for Motion SPM® 7 Series

Recommended conditions

AN-9078 Surface Mount Guidelines for Motion SPM® 7 Series



Why Choose Our SPM® Modules

- The widest breadth of packaging for motor control applications (below 10 HP)
- Optimized packaging for thermal performance, high-power density, and robust assembly
- Compactness for low/mid-power industrial applications
- Wide range of guaranteed junction temperature: -40℃ to +150℃
- Packages with more creepage/clearance distance
- Better ruggedness, optimized conduction losses and switching losses

Highly Integrated Solution from Fairchild:

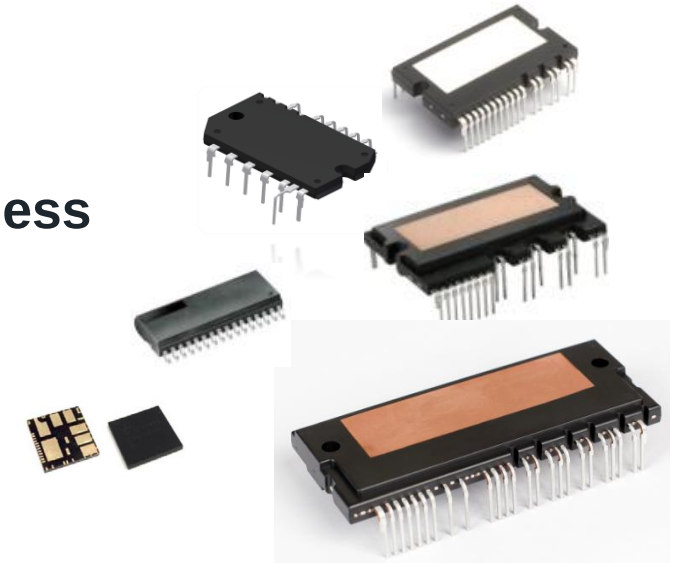
SPM® Smart Power Modules up to 10kW

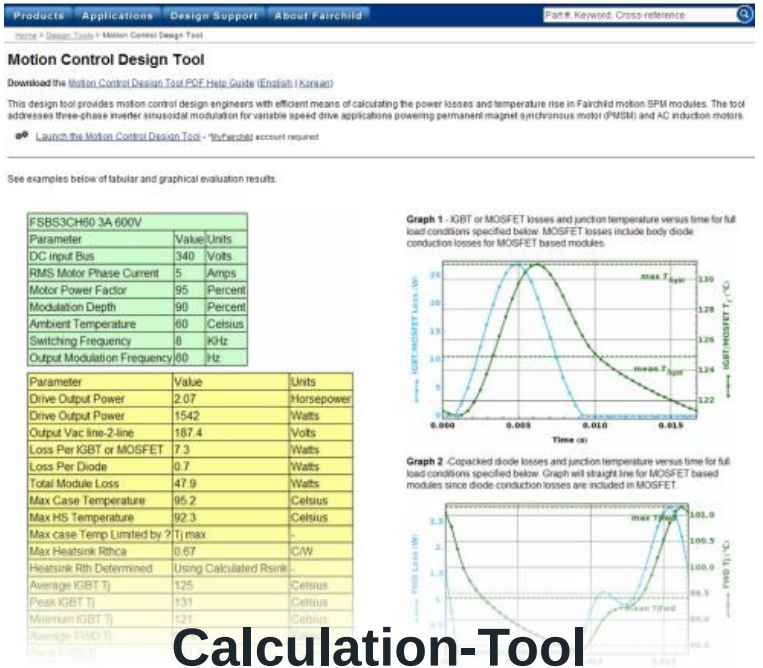
Provide:

-Efficiency

-Compactness

-Reliability





Calculation-Tool

* Motion Control Design Tool *

http://www.fairchildsemi.com/support/design-tools/motion-control-design-tool/

Related Documents & Tool

- Datasheet

FSB70625 - 250V/ 0.8Ωmax.
FSB70325 - 250V/ 1.4Ωmax.
FSB70550 - 500V/ 1.85Ωmax.
FSB70450 - 500V/ 2.2Ωmax.
FSB70250 - 500V/ 3.4Ωmax.

- Application notes & Reference Design

AN-9077 Motion SPM® 7 Series User's Guide
AN-9078 Surface Mount Guidelines for Motion SPM® 7 Series
RD-356 Reference Design RD-356

- Design Tool

Motion Control Design Tool

THANK YOU