PEBB-Based Converter

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• NMCT-based PEBB brassboard demonstration
  - Project Goals
  - System Requirements
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• Conclusions
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Components
- MOS Turn Off Thyristor (MTO)
- Silicon Carbide MTO
- Gate Assisted Turn Off Thyristor (GATT)
- Advanced GTO

Packaging/Accessories
- Structured Copper
- Light Weight Package
- Gate Drive Modules (MTO, GTO, GATT)
- Separately Light Triggered Thyristor (SLTT)

System/Sub-system Development
- Static Transfer Switch
- PEBB Inverter
- SSIM Inverter
- STATCON/UPS
- Static Voltage Regulator
MTO Status

53mm MTOs

4.5 kV MTOs (17) and gate drivers (27) delivered to ONR on April 30th, 97

MTO gate drivers
SPCO HPEBB modules

AC switch

Inverter switch
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SPCO HPEBB Applications

300 - 600 - 1,200 A switches
480 V - 38 kVac

Medium Voltage Transfer Switch
Static Voltage Regulator
Static Phase Shifter
Solid State Breaker
Fault Current Limiter

0.5 - 6 MVA Inverter
480 - 15 kVac
1.0 - 4.0 kHz

STATCON/UPS Inverter
Propulsion Motor Module
Active filter
DVR
The main goal of the PEBB-based Converter Project is to demonstrate N-MCT devices in a practical application.
### System Requirements

<table>
<thead>
<tr>
<th>Component</th>
<th>Voltage Conversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Phase H-Bridge Inverter</td>
<td>270 V&lt;sub&gt;dc&lt;/sub&gt; -&gt; 120 V&lt;sub&gt;ac&lt;/sub&gt; @ 60 Hz</td>
</tr>
<tr>
<td></td>
<td>750 V&lt;sub&gt;dc&lt;/sub&gt; -&gt; 450 V&lt;sub&gt;ac&lt;/sub&gt; @ 60 Hz</td>
</tr>
<tr>
<td>Three Phase Inverter</td>
<td>750 V&lt;sub&gt;dc&lt;/sub&gt; -&gt; 450 V&lt;sub&gt;ac&lt;/sub&gt; @ 60 Hz</td>
</tr>
<tr>
<td></td>
<td>750 V&lt;sub&gt;dc&lt;/sub&gt; -&gt; 450 V&lt;sub&gt;ac&lt;/sub&gt; @ 400 Hz</td>
</tr>
<tr>
<td>Three Phase Bridge Rectifier</td>
<td>450 V&lt;sub&gt;ac&lt;/sub&gt; @ 60 Hz -&gt; 750 V&lt;sub&gt;dc&lt;/sub&gt;</td>
</tr>
<tr>
<td></td>
<td>450 V&lt;sub&gt;ac&lt;/sub&gt; @ 400 Hz -&gt; 750 V&lt;sub&gt;dc&lt;/sub&gt;</td>
</tr>
<tr>
<td>Three Phase Frequency Changer</td>
<td>450 V&lt;sub&gt;ac&lt;/sub&gt; @ 60Hz -&gt; 450 V&lt;sub&gt;ac&lt;/sub&gt; @ 400Hz</td>
</tr>
<tr>
<td>DC-DC Converter</td>
<td>750 V&lt;sub&gt;dc&lt;/sub&gt; -&gt; 155 V&lt;sub&gt;dc&lt;/sub&gt;</td>
</tr>
<tr>
<td></td>
<td>750 V&lt;sub&gt;dc&lt;/sub&gt; -&gt; 270 V&lt;sub&gt;dc&lt;/sub&gt;</td>
</tr>
<tr>
<td>Switching Frequency</td>
<td>Minimum of 20 kHz</td>
</tr>
<tr>
<td></td>
<td>Target: 75 to 100 kHz</td>
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</tbody>
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**The primary challenges:**
- reconfigurability for different functions
- control algorithm execution within switching
The six phase-leg converter power circuit (excludes protective / pre-charging and reconfiguration circuits).
ARCP Phase Leg

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Diagram showing ARCP Phase Leg with components labeled as follows:
- A1
- A2
- S1
- S2
- Lr
- 2Cdc
- Vdc
- Cr/2
- +
- -
Reconfigured as DC/DC Converter

H-bridge connection using all the six phase legs.
Controls Implementation

Hardware
• AD21062 DSP - main processor
• FPGAs - PWM and soft-switching logic

Software
• Assembly algorithm - interrupt-driven control
• C - user-driven configuration / communication algorithm
Controls Task Distribution

**Interrupt-driven Process**
- read samples
- calculate control:
  - predictor algorithm
  - reference current calculation
  - control calculation
  - PWM algorithm
- write controls to FPGA

**User-driven Process**
- local user interface
- remote communications
- system diagnostics
- triggering of interrupt-driven process
- system initialization and re-configuration
Converter Control Schematic

- ADSP21062
- 18 A/D channels
- 6 Tsw, 6 bits indicating $I_{\text{load}} > I_{\text{th}}$
- FPGA
  - PWM generator
  - Logic Circuit for ARCP sequencing
  - 6-bits (i_l - i_r)
- Voltage and current signals
- 6 $I-I$ comparator outputs
- 24 gate drive commands
- Optical outputs to 24 gate drivers (6 PLMs)
- Voltages (4 AC, 2 DC)
- Currents (6 filter, 6 resonant)
Project Status

- Power Circuit
- Control Hardware
- Control Software
- Communication
- Assembly
- Testing

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Hard-Switched Test Setup Results

Tek Stop: 100kS/s

24 Acqs

C1 Freq
400.00 Hz

Ch1 200mV
Ch2 200mV
500μs
0 V
8 Apr 1997
07:35:04

Ref1 200mV
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Phase Leg Module
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Converter Cabinet
Thank you!