TPC Bus Bar Measurement

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OUTLINE

- TPC low voltage distribution scheme
- Digital current variation
- Test Setup
- Measurements preliminary results
- Conclusion
What is the transient response of the bus bar?

**Bus bar description**
- Analogue: $4.0$ V, $60$ A stdby, $60$ A max, $100$ mm² bus bar section
- Digital: $3.3$ V, $133$ A stdby, $194$ A max, $200$ mm² bus bar section

**Wiener power supplies**
- **DIGITAL**
  - 115A max
- **DIGITAL**
  - 115A max
- **ANALOGUE**
  - 115A max

**TPC endplate**
- 121 FEE Cards
- Bus Bar pair (positive + return line)
- $L \sim 11\mu H$
- $R = 2 \times 3.4$ mΩ, $\Delta V = 1.32$ V
- $R = 2 \times 6.8$ mΩ, $\Delta V = 816$ mV
- 40m
Dynamic Digital Current Consumption

Power Supply

3.3V

100 µF

Regulator

2.5V

1 µF

ALTRO

10 × 100 nF

Current Consumption during Trigger

Current (a.u.)

Time (µs)

60A

(15A / µs)

4 µs peaking time

Standby power

0 50 100 150 200

15 April 2003 Luciano Musa
Dynamic Digital Current Consumption

Power Supply

3.3V

100 µF

Regulator

2.5V

1 µF

ALTRO

1 0 × 100 nF

Current Consumption during Trigger

60A

(0.6A / µs)

Current (a.u.)

0

50

100

150

200

Time (µs)

Standby power

100 µs peaking time

15 April 2003

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Test Configurations

Configuration A: \( R = \infty \) \( C=0 \)
Configuration B: \( R=25m\Omega \) \( C=0; \)
Configuration C: \( R=25m\Omega \) \( C=70mF \)
Configuration D: \( R = \infty \) \( C=70mF \)
Measurement 1 (configuration A)

<table>
<thead>
<tr>
<th>Test Parameters</th>
<th>(\Delta I , (A))</th>
<th>Freq (Hz)</th>
<th>(\Delta T_{HIGH} , (ms))</th>
<th>Slew rate ((A/\mu s))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60</td>
<td>100</td>
<td>4</td>
<td>10</td>
</tr>
</tbody>
</table>

A sudden interruption of the current can damage the Front End Cards!
## Measurement 2 (configuration B)

<table>
<thead>
<tr>
<th>Test Parameters</th>
<th>( \Delta I ) (A)</th>
<th>Freq (Hz)</th>
<th>( \Delta T_{\text{HIGH}} ) (ms)</th>
<th>Slew rate (A/( \mu )s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>41.6</td>
<td>100</td>
<td>4</td>
<td>10</td>
</tr>
</tbody>
</table>

A current swing of 41.6A produces a transient voltage of \( \sim 1.8V \)

Voltage drop across the bar for a current swing of 60A:

- \( \Delta V \) low load (dc) \( 0.90 \) V
- \( \Delta V \) high load (dc) \( 1.32 \) V
- \( \Delta V \) (transient) \( 3.40 \) V
Measurements 3 (configuration C)

Test Parameters

<table>
<thead>
<tr>
<th>ΔI (A)</th>
<th>Freq (Hz)</th>
<th>ΔT_{HIGH} (ms)</th>
<th>Slew rate (A/μs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>41.6</td>
<td>100</td>
<td>A</td>
<td>4 A</td>
</tr>
<tr>
<td></td>
<td>1000</td>
<td>B</td>
<td>0.1 B</td>
</tr>
</tbody>
</table>

70mF in parallel to the electronic load absorbs the large transient spikes

ALICE TPC conditions

0.95V

0.30V
# Measurements 4 (configuration D)

## Test Parameters

<table>
<thead>
<tr>
<th>$\Delta I$ (A)</th>
<th>Freq (Hz)</th>
<th>$\Delta T_{\text{HIGH}}$ (ms)</th>
<th>Slew rate (A/μs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>10</td>
<td>40</td>
<td>10</td>
</tr>
</tbody>
</table>

[Diagram showing voltage change and time intervals]
Measurements 5 (configuration A + sense wire)

The sensing feedback is not fast enough to react to the load variations.

<table>
<thead>
<tr>
<th>Test Parameters</th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta I$ (A)</td>
<td>Freq (Hz)</td>
<td>$\Delta T_{HIGH}$ (ms)</td>
<td>Slew rate (A/$\mu$s)</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>100</td>
<td>A</td>
<td>4</td>
<td>A</td>
</tr>
<tr>
<td>“</td>
<td>1000</td>
<td>B</td>
<td>0.1</td>
<td>“</td>
</tr>
</tbody>
</table>

**ALICE TPC conditions**

- $3.3V$
- $100\mu$s
- $2.5V$
- $200\mu$s
Measurements 6 (configuration C + sense wire)

The sensing feedback is not fast enough to react to the load variations

<table>
<thead>
<tr>
<th>Test Parameters</th>
<th>( \Delta I ) (A)</th>
<th>Freq (Hz)</th>
<th>( \Delta T_{\text{HIGH}} ) (ms)</th>
<th>Slew rate (A/( \mu )s)</th>
</tr>
</thead>
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<td></td>
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<td>100</td>
<td>4</td>
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1.2V

[Graph showing a waveform with 1.2V and 1.00 V markers]
The sensing feedback is not fast enough to react to the load variations

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<tbody>
<tr>
<td>ΔI (A)</td>
</tr>
<tr>
<td>41.6</td>
</tr>
</tbody>
</table>

![Graph showing test parameters and measurements](image1)

![Graph showing test parameters and measurements](image2)
Summary and Conclusions

- The distribution of the Analogue Voltage (static load) does not pose any problem.
- The distribution of the Digital Voltage (dynamic load) requires the insertion of protection capacitors.
- The protection capacitors have to be very close to the front-end cards.
- The long term reliability of large-value capacitors (10mF) has to be verified.

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Voltage (digital) on load</th>
<th>Voltage drop across bus bar</th>
<th>Required Voltage at the source</th>
</tr>
</thead>
<tbody>
<tr>
<td>No CAP</td>
<td>3.3V</td>
<td>~3.4V</td>
<td>~6.7V</td>
</tr>
<tr>
<td>70mF CAP</td>
<td>~1.2V</td>
<td>~4.5V</td>
<td></td>
</tr>
</tbody>
</table>
TPC SECTOR TEST