Measurement Technology and I/O Product Update

Michael Jost
Product Manager I/O
20+ Years Bus Terminal since 1995

- 30 Bus systems
- 100 Signals
- 1000 Different products
Beckhoff | The Inventor of sliced I/O in 1995

Million slices sold
Signal types
Widest Variety of Signals > 300 EtherCAT IO Terminals

- Digital I/O
- Analog I/O
- Counters/frequencies
- Pulse train
- Measurement
- Resistance bridge
- 12/16/24 Bit
- RS232/RS485/TTY
- SSI/incremental and SinCos encoder interface
- Thermocouple/RTD
- Motion
EtherCAT Terminal – System Integration

EtherCAT Coupler

Motion terminals

1, 2, 4, 8 or 16 channels

Measurement technology, Condition Monitoring

Bus Coupler

Free mix of signals

HD EtherCAT Terminals

TwinSAFE PLC

Embedded PC with fieldbus slave

EtherCAT Plug-in modules

Fieldbus master/slave terminals
Development of Beckhoff Analog Technology

- 1994: Fist analog bus terminal 12/16 bit
- 1998: KL3xxx precise
- 2000: EtherCAT 100 MBit
- 2002: First EL3xx
- 2004: EL3356 Strain Gauge
- 2006: EL3632 IEPE/ICP
- 2008: EL32xx first factory calibration certificate
- 2010: Precise & Multi-Interface
- 2014:
- 2016:
## Analog Inputs Overview

### EL3xxx | Analog Inputs Overview

Analog inputs for EtherCAT – a selection

<table>
<thead>
<tr>
<th>Family</th>
<th>Measurement type</th>
<th>sampling rate</th>
<th>Resolution</th>
<th>Measurement fault class</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>EL30xx</td>
<td>10 V, 20 mA …</td>
<td>1 ms / 1 kSps</td>
<td>12 bit</td>
<td>±0.3 % MBE</td>
<td>Economy</td>
</tr>
<tr>
<td>EL31xx</td>
<td>10 V, 20 mA …</td>
<td>100 µs / 10 kSps</td>
<td>16 bit</td>
<td>±0.3 % MBE</td>
<td>Standard</td>
</tr>
<tr>
<td>EL3602/3612</td>
<td>10 V, 20 mA …</td>
<td>1 ms / 1 kSps</td>
<td>24 bit</td>
<td>±0.01 % MBE</td>
<td>Precise</td>
</tr>
<tr>
<td>EL3702/3712</td>
<td>10 V, 20 mA</td>
<td>10 µs / 100 kSps</td>
<td>16 bit OVS</td>
<td>±0.3 % MBE</td>
<td>Fastest</td>
</tr>
<tr>
<td>EL3356</td>
<td>Strain Gauges</td>
<td>100 µs / 10 kSps</td>
<td>24 bit</td>
<td>±0.01 % MBE</td>
<td>Quick balance</td>
</tr>
<tr>
<td>EL320x-0010</td>
<td>RTD</td>
<td>2 ms / 500 Sps</td>
<td>0.01°C / dig</td>
<td>±0.1°C</td>
<td>RTD exact</td>
</tr>
<tr>
<td>EL3314-0010</td>
<td>TC</td>
<td>20 ms / 50 Sps</td>
<td>0.001°C / dig</td>
<td>Typ K: ±1.8°C</td>
<td>TC exact</td>
</tr>
<tr>
<td>EL3773</td>
<td>230 V~ U, I</td>
<td>100 µs / 10 kSps</td>
<td>16 bit OVS</td>
<td>±0.5 % MBE</td>
<td>TrueRMS</td>
</tr>
<tr>
<td>EL34xx</td>
<td>230 V~ U, I</td>
<td>200 ms / 5 Sps</td>
<td>16 bit</td>
<td>±0.5 % MBE</td>
<td>EnergyMonitoring</td>
</tr>
<tr>
<td>EL3692</td>
<td>10 mΩ ... 10 MΩ</td>
<td>10 ms / 100 kSps</td>
<td>24 bit</td>
<td>±0.5 % MBE</td>
<td>TrueRMS</td>
</tr>
<tr>
<td>EL3632</td>
<td>IEPE / ICP</td>
<td>20 µs / 50 kSps</td>
<td>16 bit OVS</td>
<td>±0.5 % MBE</td>
<td>ConditionMonitoring</td>
</tr>
</tbody>
</table>
New: 107 % Extended Range (switchable)

- Nominal measurement range: 0-10 V, -10 … +10 V etc.
- New: Technical measurement range: -10.737 … +10.737 V (readable)
- Also for current input (mA) in new terminals
Class of EL31xx family:
16 bit, ± 0.3 %, 150 µs

Main features:
- 10 V / 20 mA interface internal switchable → first switchable terminal
- ± 107 % technical measurement range (extended range)
- Also NAMUR NE43 possible (3.6 … 21 mA)

Compare EP3174-0002

User:
- Lab / TestStand
- Less noise
  30 → 10 digits
Class of EL31xx family:
16 bit, ± 0.3 %, 150 µs

Main features:
- 10 V / 20 mA interface internal switchable → first switchable terminal
- ± 107 % technical measurement range (extended range)
- Also NAMUR NE43 possible (3.6 … 21 mA)
- 2.5 kV control voltage ch / ch 1 min (market leader)

Compare EP3174-0002

User:
- Battery stacks > 500 V
- Lab / sub stations
1 channel

24 bit $\Delta \Sigma$ ADC with 1.28 MHz sampling

DC synchronous

10 kSps fix $\rightarrow$ oversampling

Free downsampling until 1 Sps

Integrated drag pointer before downsampling.

2 free numerical filter with each 40 taps in CoE

$\pm 0.01\%$ MBE @ $25\pm5^\circ$C in general

Serial number, factory calibration certificate possible

Polynomial comparison

Preaged
EL3751 | Analog Multi Function Terminal

- 107 % extended range
- Internal temperature measurement
- 4 MΩ input impedance
- TrueRMS calculation
- Integrator / differentiator
- Signable comparison data

What can we measure?
### EL3751 | Analog Multi Function Terminal

<table>
<thead>
<tr>
<th>Physics</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>U</td>
<td>±30/10/5/2.5/1.25 V</td>
</tr>
<tr>
<td></td>
<td>±640/320/160/80 mV</td>
</tr>
<tr>
<td></td>
<td>±40/20/10/5 mV</td>
</tr>
<tr>
<td>I</td>
<td>±20 mA</td>
</tr>
<tr>
<td>RTD / R 2-wire</td>
<td>5 kΩ</td>
</tr>
<tr>
<td>RTD / R 3-wire</td>
<td>5 kΩ</td>
</tr>
<tr>
<td>RTD / R 4-wire</td>
<td>5 kΩ</td>
</tr>
<tr>
<td>SG ¼-bridge 2/3-wire</td>
<td>120+350 Ω</td>
</tr>
<tr>
<td>SG ½-bridge 3/5-wire</td>
<td>±16 mV</td>
</tr>
<tr>
<td>SG 1/1-bridge 4/6-wire</td>
<td>±32 mV</td>
</tr>
<tr>
<td>Poti 3/5-wire</td>
<td>From 1 kΩ</td>
</tr>
</tbody>
</table>

Completion resistors integrated

SG supply 1-5 V integrated
Control and data analysis worldwide
Connection of incremental encoders with differential outputs (RS422)

Oversampling factor \( n = 100 \)

Sampling rate max. 10 \( \mu \)s / 100 kSps

Cut-off frequency 20 mio. inc / s at 4 quadrant analysis / 5 MHz

Application:
High resolution position detection
High resolution position detection

- **EL5101:**
  100 µs cycle time

- **EL5101-0011:**
  100 kSps, 1 ms cycle time

- Exact determination of turning points

- Low CPU usage
Measuring range:
- ± 1 bar (14,5 psi)
- ± 100 mbar (1,45 psi)
- 0..7,5 bar (108,78 psi)

Pressure measurements immediately in the PLC, requires no additional converters

Simple adaption of process parameter e. g. monitoring of limiting value
Soccer World Champion 2014
World Champion 2014 – with Beckhoff Technology