Intro to Yaskawa
Digital Networks
Yaskawa & EtherCAT
Case Study:
  High Speed Robot
Case Study:
  Plasma Cutting

• Introduction to Yaskawa
• Digital Servo Networks
• Yaskawa and EtherCAT
• Case Study – High Speed Robot
• Case Study – Plasma Cutting
Yaskawa Electric Company

- Founded: 1915
- Sales: $3.3 Billion
- Associates: 8000+
- Business Hubs: 24 countries
- Market Share:
  - #1 Globally in AC Servo and VFD

North America
- Yaskawa America Inc (YAI)
  Established 1967
- Motion, Drives, and Robotics
- IL/WI: VFD Drive, Motor, and system manufacturing
- CA: Product development and system design
- OH: Robotic systems assembly and integration
Yaskawa Product Offering

- **Full Line Servo Platform**
  - 50W to 55kW
  - 100VAC, 200VAC, 400VAC Class
  - Rotary, Direct Drive, and Linear Motors
  - Linear Motor Stages

- **Ease of Use**
  - Intuitive Install and Setup
  - Adaptive Tuning
  - Tools for Testing and Troubleshooting

- **Performance**
  - High Bandwidth
  - Advanced Auto-tuning
  - Vibration Suppression

- **Quality**
Digital Servo Network Choices

• Different networks were designed to solve the problem in different ways due to different design constraints:
  – Fastest update, Lowest Latency (Example: EtherCAT)
  – Robustness (Example: MECHATROLINK)
  – Compatibility with TCP/IP (Example: Ethernet/IP)

• Machine designers need to consider their own application requirements when choosing a network:
  – Mechanical bandwidth
  – Required noise immunity
  – Network features
  – Product compatibility
  – Cost
Yaskawa - Why EtherCAT?

• High level of interest
  – Customers investigating the technology
  – Vendors developing EtherCAT Masters and Slaves
  – Customers developing EtherCAT Masters

• Defined Specification
  – CoE = CANopen over EtherCAT
  – CiA DSP 402 Device Profile for Drives

• Yaskawa is committed to supporting all popular digital networks
  – “Network Agnostic”
  – Experience implementing each of the major digital networks since 1991
  – We work to deeply understand each network’s strengths and weaknesses
  – Yaskawa strives to be the best implementation of any given network protocol for AC servo drives
Sigma-5 EtherCAT Amplifier

- **Implementation**
  - Adaptive Auto-Tuning = No Servo gains to adjust
  - Motor auto-ID = No motor parameters to configure
  - Absolute feedback = No homing required

- **Performance**
  - High frequency response = reduced settling time
  - Anti-resonance = reduced machine noise and vibration
  - Vibration Control = increase performance of existing mechanics

- **Safety with EtherCAT**
  - EN ISO 13849-1, Cat 3
  - STO, SS1, SS2, SLS
EtherCAT at Yaskawa

- Member EtherCAT Technology Group since 2007
- Launched EtherCAT Sigma-5 amplifier in 2009
- Hosted ETG Plugfest in Waukegan, Illinois in 2010
  - Delta Tau, CMC Burny, Beckhoff, Radic Technologies, Soft Servo, National Instruments, Yaskawa America
EtherCAT at Yaskawa

Active Network Lab

- Check Third-Party Interoperability
- Assist Third-Party Master and Servo Configuration
- Run Sigma-5 Servos from Third Party Masters
- Check System Network Cycle Times
- Troubleshoot with Network Protocol Analyzer from Wireshark
- Continued Development of Firmware for EtherCAT Sigma-5
• Develop Function Blocks for Third-Party Masters

MotionWorks IEC 2

- **Y_WriteParameters**
  - bExecute
  - sNetId
  - nSlaveAddr
  - sFile
  - nErrorID

- **Y_ReadDriveParameter**
  - bExecute
  - sNetId
  - nSlaveAddr
  - sFile

- **Y_ResetAbsoluteEncoder**
  - bExecute
  - sNetId
  - nSlaveAddr

TwinCAT

- **Y_WriteParameters**
  - bExecute
  - sNetId
  - nSlaveAddr
  - sFile
  - nErrorID

- **Y_StoreParameters**
  - bExecute
  - sNetId
  - nSlaveAddr
  - sFile

- **Y_AbsoluteEncoderReset**
  - bExecute
  - sNetId
  - nSlaveAddr

October 2011
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### EtherCAT at Yaskawa

- Network Lab Interoperability Check

<table>
<thead>
<tr>
<th>Master</th>
<th>* Compatible</th>
</tr>
</thead>
<tbody>
<tr>
<td>BECKHOFF TwinCAT</td>
<td>✔</td>
</tr>
<tr>
<td>TRIO MC464 with Motion Perfect</td>
<td>✔</td>
</tr>
<tr>
<td>NATIONAL INSTRUMENTS LabView</td>
<td>✔</td>
</tr>
<tr>
<td>Soft Servo SMP 450</td>
<td>✔</td>
</tr>
<tr>
<td>RADiC KPA Studio</td>
<td>✔</td>
</tr>
</tbody>
</table>

* Yaskawa has tested basic functionality of EtherCAT Sigma-5 with these EtherCAT masters

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**Case Study:**
- High Speed Robot
- Plasma Cutting

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**Intro to Yaskawa**

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**Digital Networks**

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**Yaskawa & EtherCAT**

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High-Speed Plastics Robot

• Robotic Mechanism removes parts at high speed from mold

• Previously used Beckhoff control with Sercos II

• Issues with current servo supplier
  – Over-heating, product availability

• Moved to EtherCAT instead of Sercos III,
  – Wanted to stay with Beckhoff control.
  – Customer perceived that EtherCAT gave them more choices in suppliers
Application Challenge

Customer Challenge:

- Maintain or reduce machine cycle time
  - Extend 5 feet and retract in just over 250 ms

- Reduce Energy consumption
  - Almost no dwell between moves
  - 24/7 operation

- Show application video
Sigma-5 EtherCAT Solution

- EtherCAT interoperability enabled fast commissioning of new servo solution
- EtherCAT position mode allowed implementation of adaptive auto-tuning at the amplifier
  - No tuning required
  - 800+ in/sec at 30 g accel
- Yaskawa provided far greater peak torque capability than previous servo supplier, allowing for much smaller motors to be used
Sigma-5 EtherCAT Solution

- Machine Cycle time reduced by 30%
  - Index in 143 ms

- Annual energy savings of $1400
  - Through use of Yaskawa RC5 Line Regen module
Plasma Cutting
Plasma Cutting

- Multi-axis plasma cutting gantry

- Chose Beckhoff for CNC control package
  - As a differentiator from Fanuc and Siemens
Application Challenge

- Machine vibration impacts quality of cuts
  - Plasma cutting process has no contact with material
  - Lack of contact makes tuning difficult, no mechanical damping
Sigma-5 EtherCAT Solution

- EtherCAT interoperability enabled fast commissioning of new servo solution

- EtherCAT position mode allowed implementation of advanced servo features in the amplifier
  - Sigma-5 Advanced Auto-Tuning
  - Vibration Suppression
  - Notch Filters Used
Sigma-5 EtherCAT Solution

Before Sigma-5 Vibration Suppression

With Sigma-5 Vibration Suppression
Intro to Yaskawa ✓
Digital Networks ✓
Yaskawa & EtherCAT ✓
Case Study: High Speed Robot ✓
Case Study: Plasma Cutting

Sigma-5 EtherCAT Results

Before

After
Sigma-5 EtherCAT Results

• Complete commissioning of new servo system in 5 days

• System tuning time reduced from one week to one day

• Cutting performance drastically improved with minimal system changes
  – No mechanical redesign
  – No software programming changes
Thank You

- Questions?
- Please see our MP2000 EtherCAT I/O module and A1000 Inverter at our Display Table
- We Welcome Your Challenge
- Thank You