INDUSTRIAL INTERFACE

- RS485
- CAN
- UARTS
- ISOLATION
- IND ETHERNET
- IND I/O

- AUTOMATION
- HVAC
- PLC
- MEDICAL
- E-METER
- AUTOMOTIVE
Industrial Market

- RS-485
- CAN
- UART
- USB
- Serialized I/O
- Industrial Ethernet Phy
- Digital isolation
- Isolated transceivers
- Isolated S/D modulator
- Isolated gate driver
- Programmable PLL
- Clock buffers
Communication Market

- LVDS / LVPECL
- MLVDS
- RS-485
- UART
- SerDes
- Gigabit buffers & translators
- Cross-point switches
- Equalizers
- PCIe bridges
- USB bridges
- Laser / VCSEL drivers
- TIA / PA amplifiers
- Low-jitter frequency synthesizers
- Low jitter prog. clock buffers
- Memory clocks/buffers

Equalizer Enables 4-Gbps Speed on Backplanes Designed for 1 Gbps

Laser / VCSEL drivers
Consumer & Computing Market

- USB
- 1394
- UART
- LVDS
- SerDes
- PCI Express
- HDMI switch / repeater
- DisplayPort switch
- e-SATA Mux / redriver
- Programmable PLLs
- Low power clock gen.
- Custom clocks
- Memory PLL / register

Motorola STB - 1394
Sharp Blu-ray DVD
Sharp HDTV / DVR
Apple MacBook Pro -1394
HDD
Line Cards – PCIe
Medical / Auto / Test & Meas. / Security & Surv.

- LVDS
- SerDes
- USB
- 1394
- CAN
- Digital Isolators
- Serialized I/O
- Frequency synthesizers
- Programmable PLL
- Low-jitter clock buffers
Interface & Clock Products

Communications Interface
- LVDS
- M-LVDS
- xECL
- Signal Conditioners / Equalizers
- Telecom SerDes
- Crosspoints
- Optical Module ICs

Industrial Interface
- RS-485 / RS-422
- Digital Isolation
- Ethernet PHYs
- CAN
- Industrial I/Os
- UARTs

Consumer & Computer Interface
- SuperSpeed USB 3.0 & USB 2.0
- Redrivers & Equalizers
- Digital Video Interfaces
- PCI-Express & PCI
- 1394 (Firewire)

Clock & Timing Products
- Clock Generation
- Jitter Cleaning
- Redrivers & Equalizers
- Digital Video Interfaces
- Memory Clocks

Utility Interface
- ESD / EMI
- Voltage Level Translators
- Signal Switches
- I²C
- RS-232

Clock & Timing
- Utility Interface +1

Clock & Timing Products
- Clock Generation
- Jitter Cleaning
- Redrivers & Equalizers
- Digital Video Interfaces
- Memory Clocks

Utility Interface
- ESD / EMI
- Voltage Level Translators
- Signal Switches
- I²C
- RS-232

Clock & Timing
- Utility Interface +1
Industrial Communication buses

4-20 mA (Analog current loop, < 20 Hz bandwidth)
HART (Modulated 4-20 mA)
RS-232
RS-485
Wireless (Wireless HART, ISA100.11a)
and many more….

CAN
  CAN-Open
  DeviceNet
Interbus
  RS-485-based
Modbus
  RS-232-based
  RS-485-based
ProfiBus
  RS-485-based
  IEC 1158-2-based
  Fiber-based
  and many more…

Ethernet-based
  Ethernet/IP
  Profinet
  EtherCAT
  Foundation HSE
  Ethernet Powerlink
  Modbus TCP
  DriveCliq
  Sercos III
  and more…
## Industrial Communications: TI solutions

<table>
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<tr>
<th>Customer Design Concerns</th>
<th>TI INDUSTRIAL AUTOMATION SOLUTIONS</th>
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</thead>
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<tr>
<td><strong>Interoperability</strong></td>
<td>Broad product portfolio</td>
</tr>
<tr>
<td>- Existing network installation</td>
<td>- High performance processors</td>
</tr>
<tr>
<td>- Available components</td>
<td>- Precision Analog signal chain ICs</td>
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<tr>
<td>- Future development</td>
<td>- Interface ICs</td>
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<tr>
<td><strong>Speed</strong></td>
<td>- Extensive Power products</td>
</tr>
<tr>
<td>- Signaling rate</td>
<td>- Wireless transceivers</td>
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<tr>
<td>- Data rate</td>
<td><strong>Harsh environment portfolio</strong></td>
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<tr>
<td><strong>Noise</strong></td>
<td>- Advanced Processes</td>
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<tr>
<td>- Immunity</td>
<td>- Wide Package Portfolio</td>
</tr>
<tr>
<td>- Generation</td>
<td><strong>Safety relevant solutions</strong></td>
</tr>
<tr>
<td><strong>Network length</strong></td>
<td>Energy efficiency</td>
</tr>
<tr>
<td><strong>Number of nodes</strong></td>
<td><strong>We cover the entire solution!</strong></td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td><strong>Flexibility &amp; future proof</strong></td>
</tr>
<tr>
<td>- Active dissipation</td>
<td><strong>Long product life supply policy</strong></td>
</tr>
<tr>
<td>- Low-power modes</td>
<td><strong>Interface:</strong></td>
</tr>
<tr>
<td>- Voltage supplies needed</td>
<td>Isolation, Transceivers</td>
</tr>
<tr>
<td><strong>Costs</strong></td>
<td><strong>Embedded Processors:</strong></td>
</tr>
<tr>
<td>- Electronic components</td>
<td>MPUs, MCUs</td>
</tr>
<tr>
<td>- Processing burden</td>
<td><strong>Power &amp; Analog:</strong></td>
</tr>
<tr>
<td>- Cable &amp; connectors</td>
<td>DC-DC Converters, PoE PD devices, Amplifiers</td>
</tr>
<tr>
<td><strong>Robustness</strong></td>
<td><strong>HARDWARE</strong></td>
</tr>
<tr>
<td>- Temperature</td>
<td>Evaluation Modules</td>
</tr>
<tr>
<td>- ESD protection</td>
<td>For most catalog devices</td>
</tr>
<tr>
<td>- Isolation options</td>
<td><strong>SOFTWARE</strong></td>
</tr>
<tr>
<td>- Fault detection</td>
<td>CCS - IDE</td>
</tr>
<tr>
<td></td>
<td>CoDeSys support</td>
</tr>
<tr>
<td></td>
<td><strong>SUPPORT</strong></td>
</tr>
<tr>
<td></td>
<td>TI Tina Simulation</td>
</tr>
<tr>
<td></td>
<td>300+ spice/ibis models</td>
</tr>
<tr>
<td></td>
<td><strong>Join the TI E2E™ Community</strong></td>
</tr>
<tr>
<td></td>
<td>Engineer to Engineer</td>
</tr>
<tr>
<td></td>
<td>Learn more</td>
</tr>
<tr>
<td></td>
<td><strong>Share knowledge, Explore ideas, Solve problems</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Free training, selection tools and reference designs</strong></td>
</tr>
</tbody>
</table>

**Texas Instruments**
Industrial Communication
RS-485
RS-485 (EIA-485 or TIA/EIA-485)

Most versatile communication standard
1) Connects data terminal equipment (DTE) directly without the need of modems
2) Can connect several DTE's in a network structure
3) Ability to communicate over longer distances (up to 1200m)
4) Ability to communicate at faster communication rates (up to 50Mbps)

Differential signaling and Twisted pair allow better noise immunity

Multipoint communication

RS-485 Features

<table>
<thead>
<tr>
<th>Parameter</th>
<th>RS-485</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum common-mode voltage</td>
<td>-7V to 12V</td>
</tr>
<tr>
<td>Receiver input resistance</td>
<td>12kΩ min</td>
</tr>
<tr>
<td>Receiver sensitivity</td>
<td>±200mV</td>
</tr>
<tr>
<td>Driver load</td>
<td>60Ω</td>
</tr>
<tr>
<td>Driver output short-circuit limit</td>
<td>250mA</td>
</tr>
</tbody>
</table>

Why TI RS-485?

Wide selection of offerings
Fault protection features
Industry expertise in RS-422/RS-485
Combination with isolation
Complete board solution

Link to TI RS-485 Solutions
http://focus.ti.com/paramsearch/docs/parametricsearch.tsp?family=analog&familyId=545&uiTemplateId=NODE_STRY_PGE_T
RS-485 Questions

1. Isolated or Non-isolated RS-485?
2. Half-duplex or Full-duplex?
3. Supply Voltages? (3.3V or 5V)
4. Signaling rate? (bits per second)
5. Features required?
   • Wide common-mode range
   • ±70V fault protection
   • High ESD protection
   • Cross-wire immunity
   • Low-power
# RS-485 PORTFOLIO

<table>
<thead>
<tr>
<th>5V</th>
<th>Half-duplex Transceivers</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HVD3082E</td>
<td>Economical, Small packages</td>
</tr>
<tr>
<td></td>
<td>HVD3085E</td>
<td>-20 to +25 Common Mode</td>
</tr>
<tr>
<td></td>
<td>HVD3086E</td>
<td>-20 to +25 CM, Equalization</td>
</tr>
<tr>
<td></td>
<td>HVD20</td>
<td>70V Protection, Wide Common</td>
</tr>
<tr>
<td></td>
<td>HVD21</td>
<td>Toughest, IEC ESD rating, TVS</td>
</tr>
<tr>
<td></td>
<td>HVD22</td>
<td>PROFIBUS</td>
</tr>
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<td></td>
<td>HVD23</td>
<td>Cross Wire Immunity (SymPo)</td>
</tr>
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<td></td>
<td>HVD24</td>
<td>9 Channel RS-485/422</td>
</tr>
<tr>
<td></td>
<td>HVD1785</td>
<td>4kV Isolated RS-485</td>
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<tr>
<td></td>
<td>HVD1786</td>
<td>4kV Isolated PROFIBUS</td>
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<tr>
<td></td>
<td>LBC184</td>
<td>3-5V Operating Range</td>
</tr>
<tr>
<td></td>
<td>HVD1787</td>
<td>70V Protection, 3-5V VCC</td>
</tr>
<tr>
<td></td>
<td>HVD1176</td>
<td>16kV ESD, Small Packages</td>
</tr>
<tr>
<td></td>
<td>ISO3082</td>
<td>No-Enables</td>
</tr>
<tr>
<td></td>
<td>ISO3088</td>
<td>Enables</td>
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<td></td>
<td>ISO1176</td>
<td>Low Power</td>
</tr>
<tr>
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<td>ISO1176T</td>
<td>4kV Isolated RS-485</td>
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<tr>
<td></td>
<td>HVD96</td>
<td>RS-422 Quad Line Driver</td>
</tr>
<tr>
<td>3.3V</td>
<td>ISO15</td>
<td>RS-422 Quad Line Receiver</td>
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<tr>
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<td>ISO15M</td>
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<td>AM26LV31E</td>
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<td></td>
<td>AM26LV32E</td>
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<tr>
<td>3.3V</td>
<td>HVD09</td>
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<td></td>
<td>HVD10</td>
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<td>HVD11</td>
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<td></td>
<td>HVD12</td>
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<tr>
<td>3.3V</td>
<td>HVD1780</td>
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<td></td>
<td>HVD1781</td>
<td></td>
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<tr>
<td></td>
<td>HVD1782</td>
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</tr>
<tr>
<td>3.3V</td>
<td>HVD1791</td>
<td></td>
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<td></td>
<td>HVD1792</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HVD1793</td>
<td></td>
</tr>
</tbody>
</table>

**Texas Instruments**
RS-485 Applications

1. E-meter: SN65HVD3082E
2. DVR/security electronics: SN65HVD485
3. Motion control: SN65HVD3088E
4. Building automation (HVAC): SN65HVD1785
5. Factory automation: SN65HVD1176 or ISO1176T
CAN
Controller Area Network (CAN)

Highly robust serial communication standard
- Inter-module bus design
- Allows microcontrollers and devices to communicate with each other within a vehicle without a host computer.
- Excellent prioritization and arbitration capabilities
- Used in automotive, industrial, medical applications

CAN in automotive application

CAN bus logic state voltage definitions

Why TI CAN?
- Wide selection of offerings
- Synergy with automotive developments
- Synergy with Luminary CAN controllers
- Combination with isolation
- Complete board solution
CAN Questions

1. Isolated or Non-isolated CAN?
2. Supply Voltages? (uP & other)
3. Bus fault protection level (voltage level to survive shorted)?
4. Features required?
   - Number of nodes in network, length of network & desired datarate
   - TXD Dominant Time Out Protection?
   - Auto-Baud Loopback?
   - Diagnostic Loopback?
   - Low power wake up from bus?
5. Need to support any specific standards?
   - DeviceNet, CANopen, CAN Kingdom, CANaerospace, SafetyBUS p, SAEJ1939, SAEJ2284, NMEA 2000, ISO 11783
# CAN Portfolio

<table>
<thead>
<tr>
<th>FEATURES</th>
<th>ISOLATED CAN</th>
<th>±36V BUS-FAULT PROTECTION</th>
<th>-27 TO 40V BUS-FAULT PROTECTION</th>
<th>-4 TO 16V BUS-FAULT PROTECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ISO1050</strong></td>
<td>Industry's First 4kV Isolated CAN</td>
<td><strong>SN65HVD252</strong> DeviceNet CAN</td>
<td><strong>SN65HVD251</strong> Low-power Stand by</td>
<td><strong>SN65HVD250</strong> Low-power Stand by</td>
</tr>
<tr>
<td><strong>SN65HVD253</strong></td>
<td></td>
<td><strong>SN65HVD251</strong> Low-power Stand by</td>
<td><strong>SN65HVD233</strong> Diagnostic Loopback</td>
<td><strong>SN65HVD230</strong> Low-power Stand by</td>
</tr>
<tr>
<td><strong>SN55HVD251</strong></td>
<td></td>
<td><strong>SN65HVD251</strong> Low-power Stand by</td>
<td><strong>SN65HVD234</strong> Ultra Low Sleep</td>
<td><strong>SN65HVD231</strong> Ultra Low Power Sleep</td>
</tr>
<tr>
<td></td>
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<td></td>
<td><strong>SN65HVD235</strong> Auto-Baud Loopback</td>
<td><strong>SN65HVD232</strong> Ultra Low Power Sleep</td>
</tr>
</tbody>
</table>

**SUPPLY VOLTAGE**

- 5V
- 3.3V

**Existing** | **New** | **Roadmap**

**Texas Instruments**
CAN Applications

- Standard Data Bus PHY: SAEJ1939, SAEJ2284, NMEA 2000, ISO 11783
- CAN Data Bus (PHY): CANopen, DeviceNet, CAN Kingdom, CANaerospace, SafetyBUS p
- Industrial Automation
- Building automation
- Process control equipment
- Factory automation
- Networked sensors
- Networked actuators
- Motor Control
- Medical
- Telecom
- Robotics
- Low Power & Battery applications
- Automotive (-Q1 version)
Isolation
**ISOLATION**

**Galvanic isolation**
The ability to exchange signals between two circuits without allowing the flow of current

**Benefits of isolation in electrical systems**
- Break ground loops
- Reduce common mode noise
- Safety from high voltages

**w/o isolation**

**with isolation**

**Why TI Isolation?**
- Most stable dielectric over temp, moisture
- Highest lifetime in the industry
- Highest magnetic immunity
- Breadth of stand-alone and integrated ISO
- Complete board solution

**TI SiO₂ capacitive isolation**

**Isolation terminology**

1. **Working or Operating Voltage**: Continuous voltage across isolation (560Vpk or 890Vpk)
2. **Isolation or Transient Voltage (Vrms)**: Transient voltage across isolation (4kVpk or 6kVpk)
3. **Basic Isolation**: 560Vpk continuous, 4kVpk transient voltage
4. **Reinforced Isolation**: 890Vpk continuous, 6kVpk transient, 10kV surge voltage
   Medical needs 5kVrms transient
5. **Common Mode Transient Immunity (CMTI)**: \(\frac{d(V_1-V_2)}{dt}\) without false toggling of the o/p
6. **Creepage and Clearance**: surface-distance across isolation that may conduct if wet or polluted
Isolation Questions

1. Stand-alone isolation or integration (Transceiver, Gate-Drivers, Data-Converters)?

2. Isolation Voltage:
   Transient / Withstand: 4kVpeak, 6kVpk, 5kVrms
   Working / Continuous: 560Vpk, 1200Vpk, 1414Vpk

3. Channel-count?

4. Return channels?

5. Data Rate?
Isolation Applications

1. Motor Control: ISO7420FE, ISO7421FE, ISO5500
2. Energy Meter: ISO3082
3. Programmable Logic Controllers: ISO7241C, ISO7241M
4. DC-DC Power Supplies: ISO7420FE, ISO7421FE
5. Solar Inverters: ISO7420E
4-20mA loop/HART
4-20 mA Product Portfolio

**2-Wire Transmitter**
- **General Purpose**
  - XTR101: Precision, Low Drift, 11.6 to 40V, 2 1mA sources
  - XTR115: Current Loop, 7.5 to 36V, 2.5 V Voltage Reference
  - XTR116: Current Loop, 7.5 to 36V, 4.096V Voltage Reference
  - XTR117: Current Loop, 7.5 to 40V, 5 V Voltage Regulator

- **Bridge Conditioning**
  - XTR106: Bridge Excitation and Linearization, 7.5 to 36V, 2.5 & 5V Voltage References

- **RTD or Bridge Programmable Conditioning**
  - XTR108: Programmable w/ Signal Conditioning, 7.5 to 24V, 2 500uA Current Sources
  - XTR105: Excitation and Linearization, 7.5 to 36V, 2 800uA Current Sources
  - XTR112: Excitation and Linearization, 7.5 to 36V, 2 250uA Current Sources
  - XTR114: Excitation and Linearization, 7.5 to 36V, 2 100uA Current Sources

**3-Wire Transmitter**
- **General Purpose**
  - XTR110: V-to-I Conv/Trans, 13.5 to 40V, 10V Voltage Ref, Selectable I/O ranges
  - XTR111: V-to-I Conv/Trans, 8 to 40V, Adjustable sub-reg 3.3 to 12V, 0 to 36mA out
  - XTR300: Analog Current or Voltage Out, 10 to 40V, Error Detection, Protection

- **RTD or Bridge Programmable Conditioning**
  - XTR110: V-to-I Conv/Trans, 13.5 to 40V, 10V Voltage Ref, Selectable I/O ranges
  - XTR111: V-to-I Conv/Trans, 8 to 40V, Adjustable sub-reg 3.3 to 12V, 0 to 36mA out
  - XTR300: Analog Current or Voltage Out, 10 to 40V, Error Detection, Protection

**Receiver**
- **General Purpose**
  - RCV420: Sensor Precision Current Loop Receiver 0 - 5 V

Red = New

RTD = Resistive Temperature Detector
XTR108
4-20mA, “Smart” Signal Conditioning

Features

- Complete transmitter + RTD Linearization
- Eliminated potentiometers and trimming
- Digitally calibrated

Benefits

- It is a “smart,” programmable, 4-20mA, two-wire transmitter.
- Zero, span, and linearization errors in the analog signal path can be calibrated via a standard digital serial interface, eliminating manual trimming and store in external EEPROM.

Applications

- Remote RTD transmitter
- Pressure Bridge transmitter
- Strain gauge transmitters
- SCADA remote data acquisition
- Weighing systems
- Industrial process control
**XTR117**

**4 – 20 mA Current-Loop Transmitter**

**Features**
- 5V regulator
- High accuracy:
  - Span error: 0.05%
  - Nonlinearity error: 0.003%
- Low quiescent current: 130 µA
- Current return pin

**Benefits**
- Can be used to power external circuitry
- Ensures quality performance
- Ideal for maximum power efficiency
- Assures an accurate control of the output current

**Applications**
- 2-wire, 4-20mA current loop transmitter
- Smart transmitter
- Industrial process control
- Test systems
- Current amplifier
- Voltage-to-current amplifier

Packages: QFN and MSOP
**DAC161P997**

16bit DAC with Single Wire Interface and “4-20mA” current loop drive

### Features
- 16 bit DAC
- Low Power
- Single Wire Interface (SWI), with handshake
- Programmable start up condition
- Self adjusts over wide baud rate range
- Error detection and reporting
- Programmable output Error Level
- Auxiliary HART input
- Internal Reference

### Benefits
- Fully Integrated Solution
  - Reduces design complexity as no additional high accuracy components need to be selected.
- Total power consumption below 30mW
- SWIF digital interface makes possible lowest-cost transformer coupled operation.
- Defined Start-Up Condition 3.375mA or 21.75mA & pin programmable
- Can trade off update-rate vs power consumption for different systems or even during operation
- Automatic detection of various error conditions

### Applications
- 4 -20mA loop transmitter platforms
- 2-wire sensor systems
- Process Control
- Factory automation
- Building automation

EVM PART # (July 30th 2011)
Industrial Ethernet
Industrial Ethernet

What’s different to TCP/IP-Ethernet?

- Temperature range: -40..85 (125)°C
- Low power-consumption/dissipation
- Timing requirements:
  - Low Latency
  - Deterministic Latency
- Common flavors are:

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Description</th>
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<tbody>
<tr>
<td>ProfiNet</td>
<td>Ethernet extension to Profibus</td>
</tr>
<tr>
<td></td>
<td>Profinet IO for real-time and Isochronous real-time</td>
</tr>
<tr>
<td>Ethernet/IP</td>
<td>Developed by Rockwell, ODVA and ControlNet International</td>
</tr>
<tr>
<td></td>
<td>Commercial off the shelf hardware</td>
</tr>
<tr>
<td>EtherCAT</td>
<td>Optimized for fast cycles, low jitter and determinism</td>
</tr>
<tr>
<td></td>
<td>Developed by Beckhoff</td>
</tr>
<tr>
<td>Others</td>
<td>SercosIII, Powerlink</td>
</tr>
</tbody>
</table>
TLK100 Industrial Ethernet 10/100 PHY

- Low and deterministic channel latency
- Extended cable reach to 200 m
- 16kV ESD protection on Bus pins
- IEEE802.3 Compliance
- Industry-standard MII interface to MAC
- Auto-MDI X / Auto-Negotiation / Auto-Polarity
- Flexible supply options: 3.3V or 3.3V & 1.8V & 1.1V
- Cable Diagnostics (breaks/damage/length)
- IEEE 1149.1 JTAG
- 48-pin TQFP Package

- Predictable and precise for time-critical apps
- Reliable operation over long cables
- Harsh Industrial Environments
- Communicate with all 10/100 TX Ethernet
- Easy design-in to available MACs
- Robust and reliable
- 3.3V only for simple power solution or Separate power for low power consumption
- Finds Cable faults / length within ±1m
  - Operates offline or with live traffic

-40 to 85C

- Factory automation
- Motion Control
- Industrial Networks
- IEEE1588
- EtherCAT™
- ProfiNET™
- AVB – Audio Visual Bus

- Compatible with 50+ TI
  Processors with 10/100 MAC
  - OMAP-L138 / 118 / 108
  - TMS370C64xx / C67xx
INDUSTRIAL ETHERNET

Ethernet network protocol
Used in an industrial environment
For automation and process control
Provides real-time behavior
Predictive diagnostics

Key Requirements
Deterministic and lowest latency:
• Enables real-time operation with more PHYs in daisy chain
Low link loss detection time:
• To meet EtherCAT and Sercos-III requirements
  Fiber-optics support:
  • For longer cable reach applications
  Time stamping:
  • Enables synchronization of sensors and actuators
Cable Diagnostics (Faults/Quality/length):
• Finds accurate cable damage/length and low quality
  IEC-61000-4-2 level 3 compliance:
  • Robustness in harsh conditions
High Temperature:
• To withstand extreme industrial conditions

Why TI Industrial Ethernet?
Predictable, precise and best in class channel latency
Largest cable reach in the industry
Cable diagnostics with ±1m accuracy
Highest ESD ratings
Expertise in Ethernet designs
Complete board solution
INDUSTRIAL ETHERNET PORTFOLIO

TLK100
10/100 Ethernet MII Interface
Cable Diagnostics
200m cable reach

Samples: Now
RTP: 4Q11

Future
Development
Sampling
Production

10/100 Ethernet PHYS

Released 2Q2011 3Q2011 4Q2011
Industrial Ethernet Questions

1. Need for 10/100 “fast” ethernet PHY?

2. MII (Media Independent Interface) or RMII (Reduced Media Independent Interface)?
   - TLK100: MII
   - TLK110: MII and RMII

3. Cable diagnostics capability?

4. Flexible Supply voltage options to reduce power?

5. Features:
   - ESD?
   - Cable Reach?
   - Profinet, EtherCAT, SERCOSIII, Ethernet/IP, Ethernet Powerlink, Mechatrolink III
Industrial Ethernet Applications

1. PLCs
2. Industrial PC’s
3. Drive & Motor drive units
4. Health Care
5. Robotics
6. Security
7. Operator interface
8. Industrial I/O controls
Industrial I/O
INDUSTRIAL I/O

Multi-channel signal conditioning
1) System specific diagnostics
2) Highly-efficient power reduction
3) Low heat dissipation
4) Drastic reduction in board space/BOM
5) Shortening time-to-market

Why TI Industrial I/O?
Highly-integrated
Application specific features
Robust wrt EMC standards
Complete board solution

8-Channel Module

32-Channel Module

Traditional approach

Industrial I/O approach
### INDUSTRIAL SERDES (I/O) PORTFOLIO

<table>
<thead>
<tr>
<th>Feature</th>
<th>SN65HVS880</th>
<th>SN65HVS881</th>
<th>SN65HVS882</th>
<th>SN65HVS885</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating VCC Voltage (V)</td>
<td>18V - 30V</td>
<td>10V – 34V</td>
<td>10V – 34V</td>
<td>4.5V - 5.5V</td>
</tr>
<tr>
<td>I/O Volt</td>
<td>0-30</td>
<td>0-34</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface</td>
<td></td>
<td></td>
<td></td>
<td>SPI</td>
</tr>
<tr>
<td>No. of Inputs</td>
<td></td>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>I/O max rate (kbps)</td>
<td></td>
<td></td>
<td></td>
<td>1000</td>
</tr>
<tr>
<td>Debounce times (MS)</td>
<td></td>
<td></td>
<td></td>
<td>0, 1, 3</td>
</tr>
<tr>
<td>IO Current (mA)</td>
<td></td>
<td></td>
<td></td>
<td>0.2-5.2</td>
</tr>
<tr>
<td>Low Voltage Monitor</td>
<td>Yes</td>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Parity</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Over temperature</td>
<td></td>
<td></td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Pin/Package</td>
<td></td>
<td></td>
<td>28HTSSOP</td>
<td></td>
</tr>
<tr>
<td>Operating Temp Range (C)</td>
<td>-40 to 85</td>
<td></td>
<td>-40 to 125</td>
<td></td>
</tr>
<tr>
<td>PLC Voltage range</td>
<td></td>
<td></td>
<td></td>
<td>5V VCC</td>
</tr>
<tr>
<td>Parity Bit - Error Check</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General purpose</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Applications with 5V VCC</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Industrial I/O Questions

1. How many Digital inputs in the system?
   - If more than 8, suggest cascading the HVS88X. (app note available)

2. Supply Voltages?

3. Temperature range?

4. Parity check needed?

5. Suggest ISO7241/ISO7441/ISO7541 to replace the opto-coupler used with the HVS88X device.
Industrial I/O Applications

1. PLC: SN65HVS880
2. CNC: SN65HVS880
3. Distributed I/O module: SN65HVS882
4. Industrial instrumentation: SN65HVS885
TI: Innovation in Industrial Automation Solutions

Development kits & boards

Robust Processor Roadmap

Specific 3rd Party & Partner Network

Application-specific Reference Design

Complete Signal Chain

Analog ICs

WW Support & Industrial Systems Expertise

http://www.ti.com/automation
Thank You!
PROFIBUS
PROFIBUS – Why TI?

**Typical Solution**
- PROFIBUS ASIC/FPGA
- External Application Processor

**TI Solution**
- Integrated PROFIBUS with application processor
- PROFIBUS Fieldbus Data Link Layer (FDL) Implemented on PRUSS
- ARM9 runs PROFIBUS stack and user application
PROFIBUS – Available now on AM1810
Complete system solution for faster time to market

Devices
- AM335x, AM1810 (master/Slave)
- ISO1176T PROFIBUS transceiver

Features
- PROFIBUS DP (Distributed Periphery) V0 and V1
  - Profibus Slave (certified with TMG stack)
  - Profibus Master (not certified)
- 12 Mbaud/second maximum
- 11-bit minimum response time

Benefits
- Highly integrated System on Chip
- Certified PROFIBUS solution
- Lower total BOM with reduced PCB area
- Low power

Support
- TI supported firmware and development platforms
- Reference hardware available
- Pre-tested 3rd party (TMG) protocol stack

Availability
- AM1810 Production [NOW]
- Guaranteed 10+ years supply
## PROFIBUS features

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARM9 Frequency</td>
<td>Up to 375 MHz</td>
</tr>
<tr>
<td>Data Rates (baud)</td>
<td>12M, 6M, 3M, 1.5M, 500k, 187.5k, 93.75k, 19.2k, 9.6k</td>
</tr>
<tr>
<td>DP v0 Support</td>
<td>Cyclic exchange of data and diagnosis</td>
</tr>
<tr>
<td>DP v1 Support</td>
<td>Acyclic/cyclic data exchange and alarm handling</td>
</tr>
<tr>
<td>DP v2 Support</td>
<td>Not yet supported</td>
</tr>
<tr>
<td>Response Time</td>
<td>11 bit minimum TSDR Response Time</td>
</tr>
<tr>
<td>Operating System</td>
<td>Certified solution is based on Embedded Real-Time Linux, but PROFIBUS Solution in AM1810 is agnostic to OS</td>
</tr>
</tbody>
</table>
PROFIBUS software

TI Software
- Linux with RT support
- Device drivers for Linux
- PRUSS PROFIBUS Layer 2 firmware in object form

Third Party Software
- License PROFIBUS Master/Slave Stacks from TMG (TI partner) or another provider (optional if customer provides own stack)
- Evaluation version of TMG PROFIBUS stack included

Customer Software
- Industrial Application

Diagram:
- Layer 7 - Application: Industrial Application
- Layer 6 - Network: PROFIBUS DP v0/v1 Slave Stack
  - API
  - PRUSS Driver
  - PROFIBUS Driver
  - EDMA Driver
- Layer 2 - Data Link: PRUSS with PROFIBUS (FDL)
- Layer 1 - Physical: EIA-485
  - ISO1176 / ISO1176T

Customer or Third Party

Texas Instruments
PRU Subsystem on OMAP L1x/AM1x

• Two independent Programmable Real-time Units (PRU)
  – 32-Bit/200MHz RISC core
  – 1024 instructions per core
  – 512 bytes data RAM per core
  – Two registers on each PRU exported as input/output
  – Little-endian operation
  – In-built power saving through software

• Interrupt controller for system events
AM1810 overview

- ARM926EJ-S RISC core
- 10/100 Ethernet
- Integrated LCD controller
- 16-bit Flash memory interface
- 16-bit DDR2/mDDR interface
- Three 16850-type UARTs
- Industrial grade (-40 to 105°C)
- Active power 1mW/MHz

PROFIBUS
- Programmable Real-time Unit Subsystem with PROFIBUS
- UART1 or UART2 can be used for PROFIBUS

Availability
- Samples Nov 2010
- Production March 2011
- Guaranteed long-term supply
## PROFIBUS development platforms

<table>
<thead>
<tr>
<th></th>
<th>Texas Instruments, Inc.</th>
<th>Critical Link, LLC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>AM1810 EVM</td>
<td>MityARM1810 SOM and IndustrialIO Board</td>
</tr>
<tr>
<td>PROFIBUS Master Capability</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>PROFIBUS Slave Capability</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Unit Price</td>
<td>$999</td>
<td>$749</td>
</tr>
<tr>
<td>Availability*</td>
<td>11/22/2010</td>
<td>11/22/2010</td>
</tr>
<tr>
<td>* may have 4-6 week lead time</td>
<td></td>
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</table>
PROFIBUS – More information

• PROFIBUS white paper, application note and additional design information
  – AM1810 product page (www.ti.com/am1810)
  – PROFIBUS page (www.ti.com/profibus)

• Development tools
  – TI eStore (http://estore.ti.com)
  – Critical Link, LLC (http://www.criticallink.com)

• Support
  – E2E Forums (http://e2e.ti.com)
IO-LINK
MSP430 for IO-Link: ULP sensors

TARGET END EQUIPMENTS
- Level sensors
- Flow sensors
- Temperature sensors
- Chemical sensors

Feature set for IO-Link controllers
- **Basic IO-Link feature set**
  - Performance: 16 MIPS;
  - Flash: 32KB;
  - RAM: 1KB - 2KB RAM;
  - ADC resolution: 10-bit.
- **Extended IO-Link feature set**
  - Performance: 25MIPS;
  - Flash: 64KB;
  - RAM: 4KB RAM;
  - ADC resolution: 12-bit;
  - ADC speed: depending on application;
  - FRAM for ULP data logging;
  - Small form factor: 3mm x 3mm.

Key Attributes
- Performance: 16MIPS;
- Flash: 32KB;
- RAM: 1KB RAM;
- ADC resolution: 10-bit (12ch);
- Temperature sensor
- Industrial Temperature
- Package: 40-pin RHA

Available Now
- **MSP430 F2274**
- IO-Link MSP430 Target Devices
- **MSP430 F2370YFF**
- Available Now

Key Attributes
- Performance: 16MIPS;
- Flash: 32KB;
- RAM: 2KB RAM;
- External ADC AD1248 (24-bit)
- Comparator_A
- Industrial Temperature
- Package: 49-pin YFF (DSBGA)
  - 3,232mm x 3,232mm

IO-Link SOFTWARE
- IO-Link stack V1.0 (Development License, free of charge, Mesco)
- IO-Link stack V1.0 (Mesco, Source code)

IO-Link HARDWARE
- IO-Link Evaluation kit (F2274, IC-GF, LCD) available
- IO-Link Evaluation kit (F2370, SN6HVD101, AD1248) available Q1/2011

Texas Instruments Confidential – NDA Restriction
MSP430 for IO-Link: ULP sensors

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**IO-Link MSP430 Target Devices**

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td><strong>MSP430 F5172</strong></td>
<td><strong>MSP430 FR57xx</strong></td>
</tr>
<tr>
<td><strong>Texas Instruments</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Key Attributes**
- Performance: 25MIPS;
- Flash: 32KB;
- RAM: 2KB RAM;
- ADC resolution: 10-bit (3ch);
- 3 ch DMA, Multiplexer;
- Package: 38-pin DA (TSSOP);
  - 40-pin RHA (QFN).

**Key Attributes**
- Performance: 8/24MIPS;
- FRAM: 16KB;
- SRAM: 1KB RAM;
- ADC resolution: 10-bit (12ch);
- Comparator_A
- CRC16, 3 ch DMA, 32x32 Multi
- Package: 24/40-Pin QFN,
  - 38-Pin TSSOP

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Texas Instruments Confidential – NDA Restriction
IO-Link solution based on MSP430

IO-Link Stack V1.0

IO-Link monitor

IO-Link Starter kit

EVM 1: available

EVM 2: 2011

Source: MESCO, TI
IO-Link solution with MSP430 and SN65HVD101

**TI Solution**

- Current IO-Link implementations focus on MSP430 target devices:
  - F2274, F2370YFF, F5172, FR57xx
- Mesco-IO Link stack V1.0 available
- IO-Link EVM1 available
- External ADC: ADS1248, ADS1148
- TI IO-Link PHY: SN65HVD101 coming soon
- IO-Link Master implementation possible with OMAP-L138
SN65HVD101
IO-Link PHY

Features

- Integrated IO-Link PHY for Device Nodes
- Small package (4mm x 4mm QFN-20)
- Conforms to IO-Link Communication Spec.
- Adjustable driver output current limit
- Selectable 3.3V or 5V voltage regulator
- PWR_OK and CUR_OK diagnostic outputs

Benefits

- Reduce BOM compared to discrete solutions
- Saves board space
- Interoperable with other implementations
- Optimize operation to application needs
- Supply power to local node from 24V bus
- Smart operation during system fault conditions

Applications

- Sensors with IO-Link capability
  - Pressure
  - Temperature
  - Switches
  - Proximity
  - Flow
- Actuators with IO-Link capability
  - Pneumatics
  - Motor starters