PMBus™ adaption over various transport protocols

Chris Jones
Artesyn Embedded Technologies
APEC - March 2018
Outline

• Why stray from Serial Bus I2C ?
• Popular Transport Methods
• Actual Adoption today in AC-DC Supplies
  – Power Supply Examples
• Future Plans
• Internet Cloud and On Line Control
  – How we implement it
Serial I²C Bus limitation

- Reliable communication distance is not much more than 3m
- Speed range from 100kbps to 3.4Mbps
- In the communication protocol world, I²C is often considered as ‘little’ communication protocols.
- Ethernet, USB, PCI-Express and others, present throughput in the x100 megabit to gigabit per second range.
- We must not forget what each protocol is meant for. Ethernet, USB, SATA are meant for ‘outside the box communications’ and data exchanges between whole systems.
- When there is a need to implement a communication between integrated circuit such as a microcontroller and a set of relatively slow peripheral, there is no point at using any excessively complex protocols.
### Serial Protocol Comparison

<table>
<thead>
<tr>
<th>Name</th>
<th>Sync/Async</th>
<th>Type</th>
<th>Duplex</th>
<th>Max Devices</th>
<th>Max Speed (Kbps)</th>
<th>Max Distance (Kbps)</th>
<th>Pin Count(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RS-232</td>
<td>async</td>
<td>peer</td>
<td>full</td>
<td>2</td>
<td>20(2)</td>
<td>30(3)</td>
<td>2(4)</td>
</tr>
<tr>
<td>RS-422</td>
<td>async</td>
<td>multi-drop</td>
<td>half</td>
<td>10(5)</td>
<td>10,000</td>
<td>4,000</td>
<td>1(6)</td>
</tr>
<tr>
<td>RS-485</td>
<td>async</td>
<td>multi-point</td>
<td>half</td>
<td>32(5)</td>
<td>10,000</td>
<td>4,000</td>
<td>2</td>
</tr>
<tr>
<td>I²C</td>
<td>sync</td>
<td>multi-master</td>
<td>half</td>
<td>-7</td>
<td>3,400</td>
<td>&lt;=</td>
<td>2</td>
</tr>
<tr>
<td>SPI</td>
<td>sync</td>
<td>multi-master</td>
<td>full</td>
<td>-7</td>
<td>&gt;=1,000</td>
<td>&lt;=</td>
<td>3+1(8)</td>
</tr>
<tr>
<td>Microwire</td>
<td>sync</td>
<td>master/slave</td>
<td>full</td>
<td>-7</td>
<td>&gt;=625</td>
<td>&lt;=</td>
<td>3+1(8)</td>
</tr>
<tr>
<td>1-Wire</td>
<td>async</td>
<td>master/slave</td>
<td>half</td>
<td>-7</td>
<td>16</td>
<td>1,000</td>
<td>1s</td>
</tr>
</tbody>
</table>

**Notes**

- **1** Not including ground.
- **2** Faster speeds available but not specified.
- **3** Dependent on capacitance of the wiring.
- **4** Software handshaking. Hardware handshaking requires additional pins.
- **5** Device count given in unit loads (UL). More devices are possible if fractional-UL receiv
- **6** Unidirectional communication only. Additional pins needed for each bidirectional commu
- **7** Limitation based on bus capacitance and bit rate.
- **8** Additional pins needed for every slave if slave count is more than one.

---

*John Patrick is an embedded software engineer for L-3*
Industrial Ethernet Protocols

Fieldbus: 48% (58)
Annual growth: 4% (7)

Wireless: 6% (4)
Annual growth: 32% (30)

EtherCAT 7%
Modbus-TCP 4%
POWERLINK 4%
Other Ethernet 9%
Other Wireless 1%
Bluetooth 1%

PROFINET 11%
EtherNet/IP 11%
DeviceNet 4%
CAN/CanOpen 5%
CC-Link 6%
Modbus-RTU 6%
PROFIBUS DP 14%
WLAN 4%
Other Fieldbus 13%

Industrial Ethernet: 46% (38)
Annual growth: 22% (20)
Existing I2C implementation – Server Power Supply

- Local control within the Server System
- High Speed reporting not required
- Facility management
  - Power system health reporting and monitoring
  - Thermal management
  - Protection of power system
- Rack-level management
  - Server-level power reporting and monitoring
  - Fault management and logging
  - Power budgeting
- System level optimization for optimizing power losses at different conditions
• High-end multi output current source for Bend Magnet control of Cancer Radiation Treatment system
• System requires <5mSec read accuracy
• Medical systems already uses secure internal Ethernet
Legacy Requirements for Different Communication Protocols

- Military System for Fire Control (AEGIS)
- Standard Multi Output Volts and Amps
- Requires adaptation to RS485 communication
New Application Solutions foster Different Transport Systems

• Direct Drive of Luminaires
• Support Grow programs with High Level Ethernet allowing On line monitoring

Centralized Power with Distributed Lighting using 250Vdc String in Parallel Configuration

- I = 12A →
- 250Vdc

IHP capability: 180-620VVac / 1Ω or 3Ω
12Vdc to 1,000Vdc in 3KW increments

Artesyn

- 250Vdc / 600W Driverless LED Luminaires
- 250Vdc / 600W Driverless LED Luminaires
- 250Vdc / 600W Driverless LED Luminaires
- 250Vdc / 600W Driverless LED Luminaires

March 8, 2018
New Application Solutions Foster Different Transport Systems

- Support Grow programs Dashboard
Future Plans

• Hardware expansion to provide a Bridge for:
  – EtherCAT
  – PROFINET
  – MODBUS
  – DeviceNet
Future Application Example

- IC Fab system requiring high precision heating profile
- System requires <10mSec read, process, set timing
- Customer requires all systems to operate on EtherCat
• All Artesyn Digital AC-DC power supplies communicate via I2C or Ethernet UDP
• Each type of supply has a different set of PMBus Commands that it supports
• A “config file” is uploaded to a program in the cloud
• A high level dashboard is created in the cloud and can be downloaded or operated on line through a hardware bridge
• The bridge translates the various input transport protocols and outputs I2C or UDP to the power supply
Implementation Details

**PowerPro GUI**

- Platform independent. It can be used on Windows, Linux, MAC PC, and on Android, IOS mobile devices
- Highly configurable using widgets and powerful scripting interface
- Will work on online (remote access) and offline (local) mode
- User management
- PSU configuration file and firmware database
- Adaptable to any protocol
If you can connect to the internet, you can control your power
All Commands are standard PMBus
Powerful Scripting
Thank You
Questions?

Power Management. Defined.