Echelon Update
LonMark Denmark
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• LONWORKS® 2.0 overview
• Vertical Markets and Application Examples
• Application Stories and Case Studies
• New features in the NodeBuilder FX Development Tool
• FT 5000 EVB Evaluation Board
• FT 5000 Smart Transceiver/Neuron® 5000 Processor
LONWORKS 2.0
Overview
- Leader in technology for control and energy awareness
  ◦ Creator of an ISO global standard for control
  ◦ Over 80 million devices installed
  ◦ Utilized in buildings, homes, factories, utilities, and cities

- Leading the transforming of the smart electricity grid
  ◦ Smart metering technology for over 30 million homes
  ◦ Worldwide smart grid leader
  ◦ Providing AMI infrastructure utilities all over the world
LONWORKS Is Truly International

[Logos of various companies related to automation and control systems]
Echelon’s Smart Grid Vision

*When Everything Is Energy Aware*

- Save Energy
- Improve Productivity
- Reduce Maintenance
- Improve Quality
Market Awareness Has Never Been Higher

• Clean technology initiatives are gaining momentum worldwide
  ◊ New worldwide stimulus and energy incentive plans
  ◊ Significant smart grid laws (UK, US, and elsewhere)
  ◊ Government mandated efficiency (China, Japan, EU, elsewhere)

• Emphasis on smart buildings
  ◊ LEED rules weighting energy efficient controls more heavily
  ◊ Tax incentives (US) for energy efficient controls

• Control networks are in demand
  ◊ Utility driven demand response for commercial and residential
  ◊ The ‘smart grid’ is expanding to include everything that consumes electricity
  ◊ Green city movement accelerating
Design choices today need to be right for tomorrow

- Standards and longevity are more important than ever
- Proven history is a key determining factor
- Working with legacy equipment and future infrastructures is essential
- Connectivity and remote management ensures viability
  - Energy Asset Management on the rise
    - Energy Monitoring and Control
  - Smaller, lower cost, easy to deploy networks required for smaller locations
    - Previously unmonitored remote sites
Introducing the LONWORKS 2.0 Platform

• The next generation in technology for control networks

• A fully backward-compatible revolution in control
  ◊ Fully implements the ISO/IEC LONWORKS standard
  ◊ Next generation Neuron® microprocessor
  ◊ Next generation smart transceivers
  ◊ Next generation tools

• Taking advantage of the past and the future
  ◊ New tools eliminate credit fees for LONWORKS 2.0 components
  ◊ Significantly lower cost for tools and components
  ◊ Common hardware for evaluation and development tools making the device development process more cost-effective
ISO/IEC 14908 Open Data Communication in Building Automation, Controls and Building Management – Control Network Protocol

- ISO/IEC 14908-1
  Part 1: Protocol Stack
  - EN 14908-1:2005
  - GB/Z 20177.1-2006

- ISO/IEC 14908-2
  Part 2: Twisted Pair Communication
  - ANSI/CEA-709.3
  - EN 14908-2
  - GB/Z 20177.3

- ISO/IEC 14908-3
  Part 3: Power Line Channel Specification
  - ANSI/CEA-709.2
  - EN 14908-3
  - GB/Z 20177.2

- ISO/IEC 14908-4
  Part 4: IP Communication
  - ANSI/CEA-852
  - EN 14908-4
  - GB/Z 20177.4
The LONWORKS 2.0 Platform

- Cost Effective
- Easier to Use
- Advanced Technology
- Better Performance

LONWORKS 2.0
ISO/IEC 14908-x
The LONWORKS 2.0 Platform
The First Wave... (more on this later....)

- 5000 Series Components
- Evaluation and Development Tools
- Integration Tools
Vertical Markets and Application Examples
Echelon’s vertical markets

- Building automation
- Energy management
- Street lighting
- Home automation
- LED lighting
- Quick Service Restaurants
- Retail stores
- Renewable energy
- Sub Metering
- Automotive
- Industrial Automation
- Transportation
- M2M
- …
The LONWORKS Platform in BMS

- Adopted by thousands of companies
  - Honeywell, Kieback & Peter, MERTEN, Siemens, SPEGA, TAC, etc.
    - HVAC and room lighting control
    - Access control and security etc.
    - Elevators
  - Lower maintenance cost
  - Asset Management
  - Remote monitoring
  - Optimized energy efficiency
- Ideal for energy management applications
  - Monitor and Control consumption
  - Devices, Buildings, Homes, Municipalities etc.
Roppongi Hills - Japan

- World’s largest stand-alone LonWorks enabled building project with 759,100 m²
- Four zones, 13 Buildings
  - Mori Tower; Four residential towers

**SOLUTION:**

- 16,500 LonWorks devices
- HVAC, Lighting, Access
- Over 170,000 points monitored
- Over 20% savings in energy costs
- LonWorks/IP integration using *i.LON®* servers
- Mori Building general developer/operator
  - Urban developer operating more than a hundred buildings
  - Extensive use of LonWorks planned for tallest building in Shanghai – The Shanghai World Financial Center
Coeur Défense, Paris

• Location and access
  ◊ The biggest office property complex in Europe located at the heart of the central esplanade of the Paris-La Défense business district

• The building
  ◊ Property complex with a total floor area of 182,000 m² in two towers 180 metres high (39 floors) and 3 small (8-12 floors) buildings linked to each other by a "glass cathedral".

• Building Automation System
  ◊ 15000 LONWORKS devices
  ◊ One (1) i.LON™ 100 per floor (150 floors)
US Army Corps of Engineers (USACE)

- The LONWORKS specification will be the only building control guide specification that is recognized by the Army, Navy and Air Force for all of their facilities worldwide.
- Corps District designers will use them for all building controls, although it is not mandatory.
- – UFGS 15951: Direct Digital Control for HVAC and Other Local Building Systems (‘Building level’ spec)
- – UFGS 13801: Utility Monitoring and Control System (campus-wide/base-wide spec)

It will be available at the following Corps website:

Barclays Worldwide roll-out

- 8500 buildings – retrofit & new
- Main Driver:
  ◦ energy control
  ◦ acquisition of accurate, timely data
  ◦ alarm handling
- Requirements:
  ◦ Use of proven, open technology back-up by international standards
  ◦ Globally available & supported products
  ◦ Remote control and monitoring of facilities
  ◦ Payback > 3 years
Barclays Worldwide roll-out

• **Aim**
  ◦ To provide Flat Network Topology
  ◦ Web Browsing standard application
  ◦ Industry Standard open protocols
  ◦ Product and Network Sustainability
  ◦ Lower energy consumption with 20-30%

• **The solution**
  ◦ i.Lon SmartServer
  ◦ LonWorks products; eg Distech I/O Controllers
Street Lighting

- Managed Street Lighting
  - Up to 70% reduction of energy use
  - Lower operating and maintenance costs
  - Improved security
    - Individual control of light output and meeting traffic and weather conditions (on/off and dim)
    - Brighter lights at crosswalks, accidents or other danger spots
  - Predictive maintenance and replacement of light bulbs
    - Failing bulbs use approximately 3x more electricity
    - Improved security
    - Lower maintenance costs
  - Improved city aesthetics
Home Automation

- **Comfort**
  - Central Information and control
  - Audio/Video Integration with lighting and sun blind control
  - Scheduler
    - Time, date and event
  - Easy to install (Plug & Play)

- **Energy and cost optimization**
  - Energy conservation through constant light control, sleep mode etc.
  - Energy measurement and management

- **Remote control and security**
  - Devices can be maintained remotely
  - Alarming (e.g. gas leakage)
  - Integration of security systems (access control etc.)
• Centralized monitoring and control of distributed facilities with the i.LON SmartServer…
  ◊ Energy measurement and control
  ◊ Maintenance
  ◊ Alarm diagnostic
  ◊ Asset management
• …e.g. in retail stores, branch banks, schools, kindergarten, quick service restaurants, hotels etc.
Amtrak Acela High Speed Train

- High speed tilting train service between Boston, New York, and Washington, D.C.
- Built by Bombardier, uses FT-10 free topology twisted pair channel to monitor and control propulsion, power inverters, braking, fire protection systems, ride stability, safety, and comfort.
Bellagio Hotel, Las Vegas NV

- Water fountain show
- Fountain and sprinkler systems controls
- Pump controls
- Valve controls
- Choreographed lights and music
- Leak detection
- www.wetdesign.com
**Echelon in the Utility Market**

- **Echelon is a leader in power line networking**
  - Over 30 million devices installed worldwide
  - CENELEC A-band for utility applications; C-band for in-home use
  - Echelon components power the single largest networked energy system in the world at Enel
    - Over 27M PLC-based meters, 300K concentrators successfully installed
  - Over one million NES advanced meters being deployed today

- **Field-proven repeating technology**
  - NES data concentrators intelligently select repeaters based on sophisticated, patented algorithms, ensuring robust communications

- **Specialists in fully featured, low-cost, bi-directionally communicating electric meters**

- **Emphasis on intelligent enterprise integration and management of millions of distinct network points**
Buildings react automatically to changes in energy demand

Street lights deliver more energy efficiency, greater safety and lower maintenance cost

Utilities benefit from real-time access to energy demand, outages, tampering and theft

Consumer products react automatically to changes in energy prices

Demand Response and virtual power plants
- Utility programs and services to decrease energy use in real-time
Application Stories and Case Studies
Case Study B.O.B. Aachen / Germany

• The Balanced Office Building (BOB)
  ◊ was created as part of a low-energy construction program managed by the German Federal Ministry of Economics and Technology

• Goal:
  ◊ Create an energy-efficient office building that could be cost-effectively built and operated by employing advanced control systems
Case Study B.O.B. Aachen / Germany

• How? - Combining green building practices and smart building technologies
  ◇ Optimized thermal insulation
  ◇ Integration of solar approaches
  ◇ Use of geothermal resources
  ◇ Advanced HVAC techniques and lighting systems
Case Study B.O.B. Aachen / Germany

- LONWORKS control networks used in the B.O.B:
  - Underground probes tap stored geothermal resources for heating and cooling (heat pumps)
  - This, together with small, ventilation units, ensures ideal climate conditions in the building
  - Automatically controlled lighting systems that maximizes the use of daylight
  - **All systems are controlled by the LonWorks building management system (BMS)**
Case Study B.O.B. Aachen / Germany

- Key Benefits
  - The BMS fully integrates and automates all HVAC and lighting systems in the building—at the investment cost of a conventional building
    - Green and Smart Buildings do not mean significant higher construction costs
  - HVAC and lighting costs are **80 percent lower** than those in a similar office building
    - Quick Return On Invest
  - 97% of the tenants are satisfied with the building’s smart cooling system
    - More convenience
Statement of Christian Obst-Möllering, System and Development Engineer at Enervision, the system integrator:

“*We decided on LonWorks because only this technology could realize perfect producer-independent integration. This would not have been possible with another system.*”
Case study City of Oslo

• Oslo street lighting solution
  ◊ Outdoor lighting system account for 38% of the city’s total energy use
  ◊ A new European directive requires that new lighting systems use energy efficient electronic ballasts

• Goals:
  – Satisfy European and worldwide directives to reduce energy use and carbon dioxide emissions
  – Reduce streetlights operating costs, ensure driver and pedestrian safety, and allow remote monitoring and control
Case study City of Oslo

• The solution

◊ Replacing 55,000 mechanical ballast with electronic ballast from Selc that communicate over existing power lines using Echelon’s power line technology

– *i.LON®* SmartServer, acting as segment controllers remotely monitors and controls the lights, dimming them based on traffic, weather and available light
– Luminext’s LUMINIZER software provides the end-user with a management tool through which lamps can be remotely controlled, failures can be identified, and is used to measure and display energy consumption.
Case study City of Oslo

- Result
  - Reduced energy consumption by 70% and cut CO2 emission by 1440 tons per year
  - Better public safety
  - Lower operating costs & maintenance costs
    - Reduce maintenance materials & labor
    - Increase lamp life
Case study City of Oslo

• Result - continued
  ◦ Service level improvement
  ◦ Flexibility in customer management
  ◦ Customer satisfaction increase
  ◦ City beautification
  ◦ Oslo’s intelligent street lighting system has been cited as a “best practices” example by the C40 Cities Climate Leadership Group
Case study City of Oslo

• Tom Kristoffersen, Head of section Operation and Maintenance, at the city of Oslo:

◊ “The smart streetlight system had made an impact on every aspect of the city. The city is safer, less expensive to maintain, and all while reducing energy use and beautifying the city. The reduced carbon footprint helps us to adhere to European directives and makes us a greener city.”

• http://www.c40cities.org/
Case Study McDonalds

- Smart Kitchen
- 30,000 restaurants in 120 countries
- Goal:
  - Meet requirements of the food-safety regulations in an efficient way - HACCP (Hazard Analysis & Critical Control Point)
  - Optimize business processes – lower operational costs
  - Increase revenue
  - Lower energy consumption
Area’s for improvement

- **Kitchen equipment**
  - Not networked
  - Independent and manual set-up for each piece of equipment
  - High costs of programming in new “recipes” in each piece of equipment

- **Restaurant**
  - Multiple, independent systems for HVAC, Lighting & Access

- **Very little visibility / limited possibilities**
  - in business process & efficiency of different pieces of equipment
  - No system information
  - No ability to consolidate the data
  - No multi-site comparison
McDonald’s *LonWorks* Connected Kitchen

### In-Store Applications
- Food Production Management
- Product Quality Monitoring
- Equipment Configuration
- Crew Management
- Customer Interface

### Enterprise Applications
- Operations Management
- Inventory Management
- Product Development
- Equipment Performance
- Remote Diagnostics & Repair

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**Store Ethernet / IP LAN**

- **.LON 100**
- **.LON SmartServer**
- **FT-10 / PL-20 Router**

**Embedded Production Supervisor**
- Production Alarm Management
- Operations Scheduler
- Data Logging

**Echelon Products**
- LNS Server
- .LON SmartServer
- .LON 100
- LonWorks Router Firmware
- PL Smart Transceivers
- Pyxos

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**HVAC**

**Lighting**

**Refrigeration**

**Signage**

**Drive-thru Control**

**Kitchen Equipment**
Case Study McDonalds - The solution

• Investigated & not chosen
  ◊ NAFEN – North American Association of Food Equipment Manufacturers
  ◊ Wireless

• Echelon LonWorks solution
  ◊ Powerline communication
  ◊ i.Lon100 interface for one & multiple locations
  ◊ LNS Platform
Benefits for McDonalds

- **Inventory Management**
  - Real-time information & trends
- **Preventive & Faster maintenance**
  - Based on usage & energy consumption
  - Alarm notifications & improvement of “first time fix” %
- **Food Safety**
  - HACCP reports
- **Asset Management**
  - Where
  - Software upgrades - central
- **Energy Management**
  - Scheduled turn on - not automatic turn on of some equipment
  - Automatic adjustments of set-points
Energy Savings

Energy savings of 22.9%
WELCOME to the IPC Eco-Store monitoring site.
The purpose of this site is to allow simple comparisons between the ECO-STORE with a standard SUBWAY® store the same physical size, both located in Kissimmee, Florida.

SUBWAY®—Calypso Commons
3260 Vineland Road
Kissimmee, Fl. 34746
ECO (LEED) Store

SUBWAY®—Kissimmee Commons
4372 West Vine Street
Kissimmee, Fl. 34746
Standard Store

Contact: Brad Davis
IPC, Equipment Manager
(305) 670-0041
Email: bdavis@ipcoop.com
Floor Plans
Environmental Data
# Electric Usage Data

## Power Usage - Page 1

<table>
<thead>
<tr>
<th>Device</th>
<th>Value</th>
<th>Units</th>
<th>Datalog/Chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baking Oven</td>
<td>0</td>
<td>Amps</td>
<td></td>
</tr>
<tr>
<td>Freezer</td>
<td>0</td>
<td>Amps</td>
<td></td>
</tr>
<tr>
<td>Turbo Chef</td>
<td>0</td>
<td>Amps</td>
<td></td>
</tr>
<tr>
<td>Refrigerator</td>
<td>0</td>
<td>Amps</td>
<td></td>
</tr>
<tr>
<td>Electric Hot Water Heaters</td>
<td>0</td>
<td>Amps</td>
<td></td>
</tr>
<tr>
<td>Ice Machine</td>
<td>0</td>
<td>Amps</td>
<td></td>
</tr>
<tr>
<td>Exhaust Hood</td>
<td>0</td>
<td>Amps</td>
<td></td>
</tr>
<tr>
<td>Inside Lighting Ckt#1</td>
<td>0</td>
<td>Amps</td>
<td></td>
</tr>
<tr>
<td>Inside Lighting Ckt#2</td>
<td>0</td>
<td>Amps</td>
<td></td>
</tr>
<tr>
<td>Inside Lighting Ckt#3</td>
<td>0</td>
<td>Amps</td>
<td></td>
</tr>
<tr>
<td>Inside Lighting Ckt#4</td>
<td>0</td>
<td>Amps</td>
<td></td>
</tr>
</tbody>
</table>
Total Energy Management with EnerNOC
(Cumulative Savings)

- **Energy Procurement**: 25%+ Bill Savings
- **Conservation and Efficiency**: 10% to 20% Bill Savings
- **Energy Analysis**: 5% to 10% Bill Savings
- **Demand Response**: 2% to 5% Bill Savings
- **Advanced Metering**: You Can't Manage What You Don't Measure
EnerNOC – The Video
FT 5000 Smart Transceiver/
Neuron 5000 Processor
FT 5000 Smart Transceiver
Node Cost

Node Cost:
- Neuron chip
- Transceiver
- Transformer
- Memory

FTT-10A
FT 31x0
FT 5000

~50% Reduction

199x
2002
2009
5000 Series Positioning

FT 31x0
5V chip
62 NVs

FT 5000
3.3V chip
254 NVs

FT XL
FPGA based
4096 NVs
The LONWORKS 2.0 Platform
5000 Series – One Core to Rule Them All

31x0 Series Components
FT 3120 + FT 3150
Neuron 3120 + Neuron 3150

5000 Series Components
FT 5000
Neuron 5000
The LONWORKS 2.0 Platform
Series 5000

- Advanced technology brings new functionality

- Variety of higher performance features
  - Supports 254 network variables and 127 alias network variables
  - Supports user interrupts
  - Hardware multiplier and divider on-chip

- Increases memory space for application and data

- Uses cost-effective and easily sourced external serial memory

- Low power design (3.3V)

- Significantly reduced form factor (7mm X 7mm) for less board space
• Better performance
  ◦ Up to 16x effective clock speed increase over previous designs

• Simpler and cost effective installation
  ◦ Eliminates LonMaker credit fees
  ◦ Eliminates LNS credit fees

• Dramatic reduction in device cost
  ◦ Up to a 50% node cost reduction related to control networking for devices using FT Smart Transceivers
    ▪ Node cost includes FT 5000 Smart Transceiver, memory, and transformer
The LONWORKS 2.0 Platform

*FT 5000 Smart Transceiver*

- Superior solution to RS-485 designs at low cost
  - Superior noise immunity
  - Free-topology
  - Polarity insensitive
- Backward compatibility with current TP/FT-10 channel
  - Fully backwards compatible
  - FT 5000 Smart Transceiver combines the functionality of the FT 3120/3150 into a single part

[Diagram of the FT 5000 Smart Transceiver IC and its components: Serial EEPROM (2KB or larger), Serial SPI Flash (optional), I/O, FT 5000 Smart Transceiver IC, FT-X3 Communication Transformer, Crystal (10 MHz), Power Source, LONWorks TP/FT-10 Channel]
# The LONWORKS 2.0 Platform

## Series 5000 versus Series 3100

<table>
<thead>
<tr>
<th>Specification</th>
<th>Series 3100</th>
<th>Series 5000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3120 Core</td>
<td>3150 Core</td>
</tr>
<tr>
<td>Supply Voltage</td>
<td>5.0V</td>
<td>3.3V</td>
</tr>
<tr>
<td>External Memory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interface</td>
<td>None</td>
<td>Parallel</td>
</tr>
<tr>
<td>Pricing (64KB NVM)</td>
<td>N/A</td>
<td>$1 - $2</td>
</tr>
<tr>
<td>Packages</td>
<td>N/A</td>
<td>32 PLCC</td>
</tr>
<tr>
<td>Internal memory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RAM</td>
<td>2KB</td>
<td>64KB</td>
</tr>
<tr>
<td>ROM</td>
<td>12KB</td>
<td>None</td>
</tr>
<tr>
<td>NVM</td>
<td>4KB</td>
<td>0.5KB</td>
</tr>
<tr>
<td>Performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal clock speed (max)</td>
<td>20MHz</td>
<td>10MHz</td>
</tr>
<tr>
<td>Interrupts</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Hardware Multiplier</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Package</td>
<td>32 SOIC</td>
<td>64 TQFP</td>
</tr>
</tbody>
</table>

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Key Features of the FT 5000 Smart Transceiver and Neuron 5000 Processors

- 3.3V chip

- New memory architecture
  - External serial NVM for non-volatile data
    - (application code/data, configuration data)
  - Less expensive
  - Easily sourced from multiple vendors
  - Enables faster chip operation
  - 64KB on-chip RAM
  - No non-volatile memory (NVM) on-chip for Series 5000 chips

- Performance enhancement
  - 80MHz maximum internal clock frequency (can be scaled down for power savings)
    - Up to 16x faster than FT 31x0 clock frequency
  - Hardware multiplier and divider on chip
  - User interrupts supported

- Significant reduction in node cost
  - Up to a 50% node cost reduction related to control networking for devices using FT Smart Transceivers

- Small 7mm x 7mm QFN package
Key Features (continued)

- Backward compatibility with:
  - Communication channels
  - Instruction set
  - I/O support

- Increased performance of serial I/O models
  - Hardware support for SPI and SCI/UART serial interfaces
  - 16-entry FIFO at input and output

- FT 5000 Smart Transceiver combines the functionality of FT 3120 and 3150 Smart Transceivers

- Same or less board space consumed by (FT 5000 Smart Transceiver + serial memory + FT-X3) compared to 32 pin FT 3120 chip based solutions
Benefits

• Cost reduction
  ◊ 3.3V chip
    ■ Less interface circuitry and/or on-board power supplies
  ◊ Significant node cost reduction
    ■ Up to a 50% node cost reduction related to control networking devices using FT Smart Transceivers
    ■ Node includes FT 5000 Smart Transceiver, memory, and transformer price

• Smaller and lower power designs
  ◊ 3.3V chip
    ■ Less interface circuitry and/or on-board power supplies
  ◊ Small QFN package
  ◊ Uses easily sourced small external memories (8-pin SOIC packages)

• New functionality
  ◊ Using a variety of higher performance features
  ◊ Increases memory space for application and data

• Simpler and cost effective installation
  ◊ Eliminates LonMaker credit fees
  ◊ Eliminates LNS credit fees
New Memory Architecture

- Neuron 3120+ core
  - Internal NVM (4KB only)
- Neuron 3150+ core
  - External parallel flash/EEPROM
  - Performance limited by external memory access time
- Neuron 5000+ core
  - External serial flash/EEPROM
  - External memory image copied into internal RAM to execute the application
- Performance NOT limited by external memory access time

+ Used in Neuron Chips and Smart Transceivers
- **16KB ROM**  
  ◦ Holds system firmware image

- **64KB RAM**  
  ◦ Shadows entire memory space for fast CPU operation  
  ◦ 44KB user accessible

- **No on-chip non-volatile memory**  
  ◦ Except to store Neuron ID
Using External Serial Memory

- Serial interfaces supported
  - I²C (Inter-Integrated Circuit)
  - SPI (Serial Peripheral Interface)
- Types of serial memories supported
  - EEPROM (can use either I²C or SPI interface)
  - Flash (SPI interface)
- Any EEPROM device that supports the SPI or I²C protocol can be used
- Qualified flash devices
  - Atmel® AT25F512B 512-Kilobit 2.7-volt Minimum SPI Serial Flash Memory
  - Numonyx™ M25P05-A 512-Kbit, serial flash memory, 50 MHz SPI bus interface
  - Silicon Storage Technology SST25VF512A 512 Kbit SPI Serial Flash

Note: The I²C and SPI interfaces are dedicated to external serial memory and do not consume any of the 12 I/O pins.
Series 5000 devices require at least 2KB of external serial EEPROM, and it can optionally contain external serial flash memory. There is no on-chip non-volatile memory provided for the application.

- **Note**: The drivers for different flash devices consume varying amounts of EEPROM. For example, the SST driver takes 40 bytes more of EEPROM than the other two supported flash devices which take approximately 240 bytes.

The system image resides in on-chip ROM. The application image and the system image are copied from non-volatile memory into the on-chip RAM at chip startup and reset.

- The system firmware is responsible for copying any writes that are directed towards external non-volatile memory.

- Future upgrade of System firmware is possible by programming new firmware into external memory and copying into on-chip RAM at reboot.

- Under LNS FX it will be possible to upgrade the System Firmware over the network just the same as for series 3100 based devices.
# Allowed Memory Configurations

<table>
<thead>
<tr>
<th>Configuration</th>
<th>EEPROM</th>
<th>Flash</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I2C</td>
<td>SPI</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td><img src="check.png" alt="check" /></td>
<td></td>
<td>→ A single I2C EEPROM memory device, from 2 KB to 64 KB in size</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPI</td>
<td>→ No flash memory device</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td><img src="check.png" alt="check" /></td>
<td>→ A single SPI EEPROM memory device, from 2 KB to 64 KB in size</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>→ No flash memory device</td>
</tr>
<tr>
<td>3</td>
<td><img src="check.png" alt="check" /></td>
<td><img src="check.png" alt="check" /></td>
<td>→ One I2C EEPROM (at least 2 KB in size, up to 64 KB in size, but the system uses only the first 2 KB of the EEPROM memory)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>→ One SPI flash memory device</td>
</tr>
<tr>
<td>4</td>
<td><img src="check.png" alt="check" /></td>
<td><img src="check.png" alt="check" /></td>
<td>→ One SPI EEPROM (at least 2 KB in size, up to 64 KB in size, but the system uses only the first 2 KB of the EEPROM memory)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>→ One SPI flash memory device</td>
</tr>
</tbody>
</table>
• 6 Pins dedicated for external serial memory interfaces

<table>
<thead>
<tr>
<th>Pin Name</th>
<th>Used For</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS0~</td>
<td>SPI</td>
<td>SPI slave select 0 (CS0~active low)</td>
</tr>
<tr>
<td>SDA_CS1~</td>
<td>SPI, I²C</td>
<td>I²C: serial data (SDA)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SPI: slave select 1 (CS1~, active low)</td>
</tr>
<tr>
<td>SCL</td>
<td>I²C</td>
<td>I²C: serial clock (SCL)</td>
</tr>
<tr>
<td>MISO</td>
<td>SPI</td>
<td>SPI master input, slave output</td>
</tr>
<tr>
<td>SCK</td>
<td>SPI</td>
<td>SPI serial clock</td>
</tr>
<tr>
<td>MOSI</td>
<td>SPI</td>
<td>SPI master output, slave input</td>
</tr>
</tbody>
</table>
FT-X3 Transformer

- Surface mount
  - Not pin compatible with FT-X2
- Same magnetic noise immunity as FT-X1 or FT-X2 communication transformer
- Can be used both with FT 5000 Smart Transceivers and FT 3120/FT 3150 Smart Transceivers
- Sold by Echelon

<table>
<thead>
<tr>
<th>Name</th>
<th>Pin Number</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NETP</td>
<td>1</td>
<td>Input</td>
<td>NETP connection from FT 5000 Smart Transceiver</td>
</tr>
<tr>
<td>CTP2</td>
<td>2</td>
<td>Ground</td>
<td>Center tap 2</td>
</tr>
<tr>
<td>CTS1</td>
<td>3</td>
<td>Output</td>
<td>Center tap 1</td>
</tr>
<tr>
<td>NETB</td>
<td>4</td>
<td>Ground</td>
<td>NETB connection to LONWORKS network</td>
</tr>
<tr>
<td>CTP1</td>
<td>5</td>
<td>Ground</td>
<td>Center tap 1</td>
</tr>
<tr>
<td>NETN</td>
<td>6</td>
<td>Input</td>
<td>NETN connection from FT 5000 Smart Transceiver</td>
</tr>
<tr>
<td>NETA</td>
<td>7</td>
<td>Ground</td>
<td>NETA connection to LONWORKS network</td>
</tr>
<tr>
<td>CTS2</td>
<td>8</td>
<td>Output</td>
<td>Center tap 2</td>
</tr>
</tbody>
</table>
The LONWORKS 2.0 Platform
The First Wave…. (continued)

• Development and Evaluation Tools
  ◊ Mini FX
    ■ Evaluation tool for LONWORKS 2.0 developers
  ◊ NodeBuilder FX
    ■ Development environment for LONWORKS 2.0 developers

• Integration Tools
  ◊ LNS ® FX
    ■ Network operating system for LONWORKS 2.0 tools and applications
  ◊ LonMaker ® FX
    ■ Installation tool for LONWORKS 2.0 integrators
New Features in the NodeBuilder FX Development Tool
New Features in the NodeBuilder FX Development Tool

- Series 5000 processor support
- Neuron C Version 2.2 enhancements
- Enhanced Hardware Template Editor
- Enhanced Code Wizard template
- Enhanced Neuron C debugger
- New LNS Plug-in Framework Developer’s Kit
Series 5000 Processor Support

- NodeBuilder FX supports:
  - Neuron 5000 Processor
  - FT 5000 Smart Transceiver
  - Series 3100 processors and Smart Transceivers

- Version 18 firmware
  - Previous versions still supported for Series 3100 processors and Smart Transceivers
Neuron C 2.2 Enhancements

- 254 NV and 127 NV alias support
- Interrupt support
- I/O model enhancements
- New and enhanced compiler directives
- Non-constant device-specific configuration property support
- Backward-compatible
254 NV and 127 Alias Support

- Supported for both Series 5000 and Series 3100 chips
  - 3120 chips typically limited by on-chip EEPROM
- Minimum Neuron firmware version 16 required
Interrupt Support

• Series 5000 chips support hardware application interrupts
• Three interrupt sources:
  ◦ I/O pins
  ◦ Timer/counters
  ◦ System timer
• Neuron C changes for interrupts
  ◦ Interrupt tasks
  ◦ Semaphores
• Interrupt tasks are executed in a fourth processor
  ◦ Only three processors used with a 5HMz or 10MHz system clock
• New compiler keywords and functions:
  ◦ __lock
  ◦ interrupt_control(), io_iena() and io_isdis()
I/O Model Enhancements

• Serial Peripheral Interface (SPI) and Serial Communication Interface (SCI) enhancements
  ◊ Series 5000 Chips hardware UART includes an increased FIFO (16 bytes)
  ◊ Software-configurable parity generation and validation (odd, even, none)

• Stretched triac I/O
  ◊ Improves performance for triac devices used with inductive loads

• New compiler keywords and functions:
  ◊ __slow, __fast, and __parity
  ◊ New non-reserved keywords (in context): odd, even, non (within the parity modifier for the SCI I/O model)
  ◊ io_set_terminal_count(),
• The new LNS Plug-in Framework Developer’s Kit facilitates writing LNS device plug-ins in .NET programming languages such as C# and Visual Basic .NET

• The LNS Plug-in Framework Developer’s Kit allows plug-ins to function in the .NET environment and interoperate with COM-based directors

• It includes:
  ◊ The components needed for interfacing with the COM-based LNS API in the .NET environment
  ◊ A set of example software and framework assemblies that let you efficiently develop plug-ins with the latest .NET programming tools and re-distribute your plug-ins
• For more information on writing LNS device plug-ins and the LNS Plug-in API, see the *LNS Plug-in Programmer’s Guide*

• The LNS Plug-in Wizard, which generated code for Microsoft Visual Basic 6.0, is no longer included, but may be downloaded
FT 5000 EVB Evaluation Board
FT 5000 EVB Evaluation Board

• Features a variety of I/O
  ◦ 4 x 20 character LCD display
  ◦ 4-way joystick with center push button
  ◦ 2 push-button inputs
  ◦ 2 LED outputs
  ◦ Light sensor
  ◦ Temperature sensor
  ◦ RS-232 interface
    ■ Can be used with the ShortStack Developer’s Kit
• I²C/SPI interface provides fast application downloads for programming the external non-volatile memory of the Neuron 5000 Processor
  ◦ Ideal for validating downloads when mass-producing production devices
  ◦ Can be used to recover devices
• Three Neuron C example applications for the FT 5000 EVB Evaluation Board are included with all NodeBuilder FXs
LonWorks 2.0 Platform Installation Tools
The LONWORKS 2.0 Platform

Installation Tools

• Streamlined, simple network installation and management
  ◊ Streamlined installation eliminating LNS and LonMaker credit fees for the Series 5000 components

• Faster, more efficient field installation
  ◊ Easy network application development with the LNS FX Network Operating System
  ◊ Easy and fast network installation with the new LonMaker FX Integration Tool

• Expected Availability
  ◊ LNS FX - Summer 2010
  ◊ LonMaker FX - 2010
With the LonWorks 2.0 Platform

Control Networks Get More Powerful, Capable, Valuable

- Building intelligence goes deeper into more devices
  ◦ Demand response better ‘tuned’ to occupants

- Process automation gets more integrated
  ◦ More devices added to the manufacturing network
  ◦ Simple network architectures

- Next generation smart products get smarter
  ◦ Increased functionality at lower cost
  ◦ Expansion of energy aware products

- New markets emerge
  ◦ Intelligent quick-service restaurants
  ◦ Automated small building systems
Series 5000 Processor Application Development

Version 2.0
Discussion

Q&A