Advances in NeSSI™ communications

An Implementation of the Generation 2 Bus
Siemens Activities

Silke Ebbing

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Portfolio Process Analytics

Continuous Gas Analytics

Laser Spectrometry

Gas Chromatography

System Integration
How to get a valid measurement???

- Reliable, robust analyzer
- Regular validation & calibration
- Representative sample
Topics

- Sample Handling Systems for Gas Chromatographs
  - Status quo
  - NeSSSI

- Siemens Implementation of Generation 2
  - A major project
  - The Maxum connection
  - Cooperation with NeSSSI component suppliers
  - Summary of key design requirements
  - Status
Traditional Sample Conditioning Systems

- Custom designed and built
- Discrete components with tubing interconnection
- Layout in cabinets or on panels
- Electrical components are minimized; pneumatic devices sometimes used
  - Valves (stream or bottle selection, atmospheric reference, other)
  - Pressure controllers or sensors
  - Flow controllers or sensors
  - Temperature controllers and sensors
- Interconnection to analyzers
Typical, Conventional “Not Smart” System

Maxum GC

Air tubing bundle to operate valves; electrical pilot valves are mounted inside GC

Sample system with mechanical components inside cabinet

High Voltage electrical power in Explosion Proof housings for heat. No automated control or sensing.

Note:
Some sampling systems mounted separately from GC.
Some systems mounted attached to GC.

Mechanical regulators, flow indicators and gauges with no electrical interface.
Conventional “Smart” System – Very Rarely Provided

Maxum GC

Air tubing bundle to operate valves; electrical pilot valves are mounted inside GC

Sample system with mechanical components inside cabinet

Wiring bundle between GC and Sampling System; Discrete I/O electronics inside GC; Wiring conforms to Explosion Proof, non-incendive methods.

NOTE:
This is rarely done because of the high expense and awkward construction techniques required.

All mechanical indicators, sensors and controllers must be replaced with electronics. All electronics must conform to Explosion Proof or non-incendive design. (NOT SHOWN in this photograph!)
NeSSI Intended Benefits

- Reduced size and cost of sampling systems
  - Standard, modular components

- Improved on-line “system availability”
  - Fewer tubing fittings, couplings
  - Opportunity for electronic maintenance monitoring

- Improved on-line performance
  - Smaller components
  - Precise electronic control
Status of NeSSI

- **Generation 1**
  - A mechanical specification is published (SP76.02)
  - Several companies now produce NeSSI standard mechanical components

- **Generation 2**
  - An electrical interface concept is published
  - No one has previously developed NeSSI interface electronics

- **Generation 3**
  - Concepts for integrated sensors and analyzers
  - Various models and prototypes have been shown
Technical Overview
NeSSI Modular Mechanical Concept

- Small, modular components
- Standardized “substrate” (or “platform”) that the components mount to
  - Substrate can be made in a variety of ways
  - Components can be made in a variety of ways
  - The interface between the substrate and the components is always the same

Conventional Sampling System
Large mechanical components.
Tube and fitting construction.

Modular Sample System (Mechanical Concept)
Small modular components.
Standard substrate interconnections.
(Actual systems typically in a cabinet.)
Technical Overview

Example NeSSI Systems

Modular components

Modular interconnection substrates.

Note:
In actual systems, the components and substrates are mounted inside a cabinet.
Technical Overview
NeSSI Illustration; Mechanical; exploded view

Substrate block
Footprint: 3.8cm x 3.8cm

Air-operated Valve

Mechanical Flow Meter

Mechanical Guage

Pro-E rendering of Swagelok system; rendering by Siemens – component representation approximate.
Major project enforced Siemens Activities for Gen 2

➢ Project
  ▶ Large petrochemical manufacturer; major plant expansion
  ▶ Several hundred analyzers with sample conditioning systems
  ▶ User desires “smart systems” implemented with NeSSI Generation 2 technology to maximize on-going system performance
  ▶ Project issues:
    • Risk mitigation; project requires proven techniques to minimize risk

➢ Problem
  ▶ No NeSSI bus standard yet existed
  ▶ Significant technical issues to be resolved with available techniques
The Siemens Solution

- Implement bus using available technology
  - Buffers and barriers for rugged I.S. environment

- Cooperate with major substrate and component suppliers to provide compatible components
  - Swagelok
  - CIRCOR Tech
  - Parker Hannifin

- Build demonstration systems for evaluation

- Complete commercial engineering and certification following go-ahead approval
Topics for bus development

- Implementation with an existing bus used in Siemens analyzers
  - Existing hardware, software and bus protocol for proven reliability in similar applications
  - Enhanced with standard circuitry for robustness in Intrinsic Safety
  - Tested for conformance with CE and IEC specification for immunity and avoidance of EMI and RFI

- Siemens provides:
  - Bus technology including circuit design and Intrinsic Safety design parameters
  - Intrinsic Safety implementation technology plus design assistance and certification support
  - Project management and point of overall responsibility for implementation
  - Specialized Human Interface to facilitate field maintenance

- Component vendors provide:
  - Bus compatible components including component-specific electronics
  - Integration of component-specific electronics and Siemens bus interface electronics
  - Point of responsibility for component I.S. certification
Note:
Sampling system components are never directly accessed by System Bus above. This data is always provided via the analyzer / SAM which controls the sampling system.
Continuous Gas Analyzers with system control and network integration provided by Siemens Network Access Unit (NAU) with integrated NeSSI Generation 2 Bus Control capability.

Ethernet Communications Network

Intrinsically safe, Generation 2 Bus

Sampling systems built with substrates and smart, Generation 2- compatible components.

SAM functionality is external to the analyzer.
System Concept Implementation

Ethernet Network

Intrinsically Safe NeSSI Bus

Sample to Analyzers

SAM Embedded in Controllers

Specialized HMI Software

Intrinsically Safe NeSSI Bus

Specialized HMI Software

Sample to Analyzers

Intrinsically Safe NeSSI Bus

Sample to Analyzers

Intrinsically Safe NeSSI Bus

Sample to Analyzers

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Sample to Analyzers
Technical Overview
NeSSI Electrical Concept

Intrinsically Safe Bus; provides:
- Signal for sensors and valve control
- Power for sensors and valve electrical pilots

Actual components mounted inside a cabinet creating a Division 1 or Zone 1 environment.

Input: Manifold air for valves

Input: Electrical power for high wattage heaters

Illustration courtesy of CIRCOR Tech.
Maxum currently uses an internal serial I/O linking system to manage devices required for the Chromatograph.

- Multiple channels of Oven Temperature Control
- Detector Signal and Control
- Multiple Solenoid Valve Controls
- Multiple channels of Electronic Carrier Gas Pressure Control
Bus Electrical Implementation

Existing I/O link connected to new module.

New module with power drivers and Intrinsic Safety Barriers.

NeSSI Generation 2 Bus; Intrinsically safe; carries signal and power for devices.

Maxum GC Electronics

• Existing I/O link used for control of GC Inputs and Outputs.
• Existing protocol supports several hundred I/O channels.

• Pepperl-Fuchs Intrinsically Safe Power supply: 9.5v at 1 Amp.
• Powers I/O link and components.
• Use additional power supplies as needed for large numbers of components.
Component Electrical Implementation

- **Software and I/O link master protocol by Siemens**
- **Link driver and I.S. barriers by Siemens**
- **Chip with I/O link slave software; Intrinsic Safety barriers; and Standardized interface to component electronics by Siemens**
- **Proprietary component-specific electronics by component vendor**
- **Proprietary mechanical NeSSI component by component vendors**
- **Certification of the complete component by component vendor.**
Key Physical and Functional Requirements

Analyzer House (typical)

Sampling System
Sampling System
Sampling System

Analyzer
Analyzer
Analyzer

Analyzer may be up to 10m from sampling system. Total cable length <=20m

Number of bus “instances” to be limited to simplify analyzer control and reduce cost; <= 2 instances preferred, excluding power sources.

Bus to support very large number of participating component suppliers (unlimited ~ >1000’s)
Key Physical and Functional Requirements

Bus to provide for sensing and control of: valves, pressure, flow, temperature.

Capability for the standard functions to be implemented in a variety of ways.

Any single physical device should be able to represent itself as using multiple device types.

Bus to be I.S.; components to mount in Div. 1 / Zone 1 hazardous area.

Design goal for flammability ignition temperature to be T4 (135°C) with minimum at least T3 (200°C).

Must support power loading and control of power permitted by I.S. bus: Start-up, minimum, maximum, abnormal, other power-management issues.

Component ambient temperature to be >=70°C

Interior of cabinet is considered hazardous due to leakage of flammable gases in a closed area.

Mounting area may be hazardous or not.
Key Physical and Functional Requirements

- Sampling system to be capable of supporting at least 30 separate streams
- Bus to provide for control of high-power components that do not draw power from the bus itself (e.g., heaters)
- Bus to support replacement of components while live without interruption of bus operation
- Systems are not *ad hoc*. Device function does not change while live. Device recognition during application is useful.
- Interchangeability requires that the system be able to confirm that a replacement device is of comparable type to device being replaced
Key Physical and Functional Requirements

Distance to analyzer \( \leq 20 \text{m} \)

Components must be scanned every 10 to 30 seconds.

Valves must operate within 0.5 sec.

At least 4 valves may be active simultaneously

Bus must meet Zone 1 and EMI/RFI requirements.

Number of components on bus:
- Typical: 5-15
- Common: 20-30
- Maxum: 200
  
  (Note: not all are shown connected in this illustration.)

Cabling must connect in available “footprint” of 3.8cm x 3.8cm

Bus must provide signal AND power. Components not large enough to permit 2 cable connections.

Power Requirements:
- Sensors: 10-40mA
- Controllers: 20-70mA
- Valve pilots: 80-350mA

Pro-E rendering of Swagelok system; rendering by Siemens – component representation approximate.
Status of Siemens Implementation

- **Analyzer and software**
  - Communications Software / Protocol: *existing proprietary, complete*

- **External bus**
  - Buffer / drivers and I.S. barriers: *testing complete; production design in progress*
  - I.S. certification: *preliminary review complete*
  - EMI / RFI testing: *bus validation tests complete*
  - Robustness, bit error rate testing: *bus validation tests complete*

- **Components**
  - Bus interface chip and circuitry: *Version 1 operating in test*
  - Component interface and software: *in test*
  - I.S. certification: *pending*
  - Component functions: *in test*

- **Compatibility with NeSSI Vision**
  - Direct implementation of NeSSI concept; meets all key requirements
  - Architecture consistent with other Bus technologies currently being considered (CAN, Fieldbus, Profibus)
Questions?
What Is NeSSI?

- New Sampling System Initiative
- User group – committee
  - Hosted by CPAC
    - Center for Process Analytical Chemistry; University of Washington; Seattle
  - End users and vendors
  - Meeting for about 8 year

Rationale of NeSSI

- Process analyzers require sample conditioning systems
- Sampling systems account for a high portion of total system maintenance
- There has been no development or significant improvement in process sampling systems in many years
- A group of end users began meeting 8 years ago to address this topic

Goals

- Publish related specifications
- Encourage and enable standardization and enhanced designs
NeSSI Committee
(New Sampling System Initiative)

➢ Major customer participants
   ▶ Dow
   ▶ ExxonMobil
   ▶ ConocoPhillips
   ▶ Shell
   ▶ BP
   ▶ Others

➢ Major analyzer supplier participants
   ▶ Siemens
   ▶ ABB
   ▶ Emerson-Rosemount

➢ Major component supplier participants
   ▶ Swagelok
   ▶ CIRCOR Tech
   ▶ Parker / Hannifin
The Traditional Analyzer System

System Communication Network

Dumb Analyzer
- Air
- Power
- Sampling System Controller
- HMI
- Process
- Air
- Power

Smart Analyzer
- Air
- Power
- HMI
- Discrete Electrical and / or pneumatic connections.
- Process
- Air
- Power
The NeSSI Vision
NeSSI Electrical Concept

System Communication Network

Dumb Analyzer

SAM

HMI

Smart Analyzer

Air

Power

Serial electrical bus.

Process
Key Bus Design Requirements
The Old Way

- Stream Select
- Bypass Flow
- Filters
- Analyzer Flow

Stream 1, Stream 2, Stream 3, Stream 4, Stream 5, Stream 6

Analyzer Flow

- Flow / Pressure Adjust

Siemens NeSSI Update.ppt
Representative Test System Design
An Introduction to NeSSI Bus Design Requirements

Active Bus Components:
- 3 selector valves
- Sample Shut off valve
- Atmospheric reference valve
- 2 pressure transmitters
- 2 flow transmitters (optioned)
FISCO Power Delivery Curves from W39

- Process Gas Chromatography
- Siemens NeSSI Update.ppt
Cabling Issues

- Cable size, bend radius, height
- Connection methods and system design
- Jacket materials
- Cost
Representative 4-wire Bus Design

Ax

Driver

Barrier

IS PS

Components

Signal

Power
Design Topics and Issues

- Bus Software
- Component Physical Issues
- EMI / RFI and Robust Design
- I.S. Design Issues
- Cabling
Location of electrical boards required to provide discrete analog and digital I/O to interface sensors.

(Locations for additional pilot valves if required.)

Pilot valves to control air-operated valves in GC and Sampling System.

To sampling system
Maxum Detail

ProE Illustration of Module on location in Maxum GC.

Bus Driver Module
Maxum and NAU Detail

P&F I.S. Power Supply

Bus Interface Module (prototype) in Maxum Network Access Unit

Example component electronics - bus interface