Combining process analyzers with smart NeSSI based sampling systems: New opportunities to improve the intelligence of the complete solution

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Brief Background

- Siemens - both manufacturer & systems integrator
  - Process Gas Chromatographs: Maxum edition 2 & MicroSAM
  - Continuous Gas Analysers: NDIR, paramagnetic O2, flame ionization, thermal conductivity, tunable diode laser

- Participation in NeSSI committee since the beginning (1990’s)
  - “Interested observer” during Generation 1 mechanical standards discussions
  - Active participant during Generation 2 bus discussions
  - Continuing strong interest in further deployment through Generation 3
What Is “NeSSI”?

An industry committee that is making standards to try to improve sample conditioning systems.

- **Part 1 – Improvement of Construction Technique**
  A modular, mechanical construction technique used for building sampling systems.

- **Part 2 – Development of a Smart Bus**
  A intrinsically safe, serial bus to permit low-cost interconnection of sensor and controls at the sampling system.

- **Part 3 – Micro Analytical**
  Implement Micro Analytical Technologies
“Traditional” Systems – The Problem: No Electronics

Maxum GC

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

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

Sample system with mechanical components inside cabinet

Mechanical regulators, flow indicators and gauges with no electrical interface.
“Traditional” Systems - More Problems:
It’s Expensive To Add Electronics

Maxum GC

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

Sample system with 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!)
Siemens Project Description

- **Objective**
  - Practical smart sampling systems
  - Suitable for flammable fluids

- **Parts**
  - Intrinsic Safety Barrier
  - Cabling system
  - Intrinsically safe power supply
  - Intrinsically safe components

- **System Interconnect**
  - I²C serial cable – made I.S.
  - No special software in GC
  - Enable remote and automatic monitoring

- **Value and Price**
  - Higher reliability
  - Easier maintenance
  - Remote diagnostics
Electrical Concept Implementation
Maxum SSSI Bus

Existing internal serial I/O linking system

Multiple channels of Oven Temperature Control

Detector Signal and Control

Maxum Electronic Section

Multiple channels of Electronic Carrier Gas Pressure Control

Multiple Solenoid Valve Controls
Practical Bus Electrical Implementation

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

NeSSI Generation 2 Bus:
- Intrinsically safe;
- Carries signal and power for devices.

Maxum GC Electronics

- New module with power drivers and intrinsic safety barriers.

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.

Smart Sampling System
Electrical Concept Implementation
Component – Link Responsibility

- Link driver and I.S. barrier by Siemens
- Software and link master protocol by Siemens
- Complete component certification as agreed.
- 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 vendor

NeSSI Substrates by: Swagelok, Parker or CIRCOR

Maxum GC
Any suitable bus option could be used: Fieldbus, Profibus, Modbus, CAN Bus, I²C, Ethernet, proprietary, other.
Component Description

- **I\(^2\)C Barrier Module (Siemens)**
  - Provides I.S. protection and buffering for I\(^2\)C

- **I\(^2\)C I/O Extender (Siemens)**
  - Provides I.S. I/O capabilities

- **Pilot Valve Module (Swagelok)**
  - 6 pilot valves for stream select, SSO, ARV

- **Multi-variable Sensor (CIRCOR Tech.)**
  - Flow, up/down stream pressure temperature

- **Pressure / Temperature Sensor (Swagelok)**
  - Sample pressure and temperature

- **Power Supply (Pepperl & Fuchs)**
  - 7 watts; intrinsically safe
  - Division 2 power supply optional

- **ALL COMPONENTS**
  - Make single connection SSSI bus
  - Intrinsically safe
  - Rated for cabinet temperatures up to 85°C
Component General Information

- **Components developed consistent with industry “NeSSI” standards**
  - Small
  - Designed explicitly for sample conditioning systems
  - High reliability, rugged, capable of mounting in severe environments

- **Components can also be used on traditional sampling systems**
  - Modular construction technique not required
  - Can be used on traditional-construction sampling systems with standard tubing

*Prototype components are shown.*
Handling Other Input Signals with Siemens Bus

- Siemens SSSI bus includes a “multi-purpose” I/O module
  - Multiple analog and digital I/O channels provided
  - Connects directly to Siemens SSSI bus
  - Mounts on DIN rail inside sampling system
  - Intrinsically safe module (may require site approval with any particular connected component)

- I/O Extension Module certified and rated for use in hazardous and rugged environments

- Module also available for use with MicroSAM to provide external I/O capability
Sampling System Example
Traditional Sampling System (2 vapor process + 1 auto-cal stream)
Sampling System Example (with notes)
Traditional Sampling System (2 vapor process + 1 auto-cal stream)

- Sample Return
- Field connection: AC power, RTD for heat trace sample lines
- Constant temperature electric traced tubing
- Block valves for maintenance on all lines
- Armored rotometers and flow adjust valves on bypass loops
- Glass rotometer for analyzer flow

- Stream 1
- Regulators and block valves at sample points
- Main Bypass filters

- Stream 2
- Insulated, electrically heated cabinet; with window for maintenance
- Double block and vent stream selection valves

- Calibration - Validation Standard
- Armored rotometers and flow adjust valves on bypass loops
- Glass rotometer for analyzer flow

- Analyzer
- Guard filter
- Flow adjust valve for sample loop

- Thermostat in cabinet
- Heater

- Vent / Drain
Smart Sampling System Example
Smart System With Siemens Sensors and SSSI Bus

1. Stream 1
2. Stream 2
3. Calibration - Validation Standard
4. Cabinet window eliminated!
5. Bus P.S.

Sample Return
Pilot Valve Module
Vent / Drain

Smart Sampling System Example
Smart System With Siemens Sensors and SSSI Bus

- Sample Return
- Stream 1
- Stream 2
- Calibration - Validation Standard
- Multi-Variable Sensors
- Pressure-Temperature Sensors
- Pilot Valve Module
- Insulated, electrically heated cabinet
- Vent / Drain
- Analyzer
- SSSI Bus
- Bus P.S.
Smart Sampling System Example
Smart System With Siemens Sensors and SSSI Bus

Sample Return

- Multi-Variable Sensors
- Diagnosis of sample & cal.gas line blockage incl. valves (PFPT)
- Diagnosis of heat tracing and fast loop line (PT)
- SSO, ARV and stream select inside cabinet

Stream 1
Stream 2

- Calibration - Validation Standard
- Checked by inline pressure sensor PT
- Diagnosis of cabinet heater by inline temperature sensor PT

Analyzer

- Pilot Valve Module
- Air
- Insulated, electrically heated cabinet
What’s Going On…?

What changed?

- Rotometers eliminated; replaced with Flow-Pressure-Temperature Sensors
- Thermometer eliminated; replaced with Temperature Sensor
- Pressure Sensors added to standard bottle inlet and inlet to analyzer
- SVCM in analyzer eliminated; replaced with Pilot Valve Module
- Cabinet window eliminated; all sensors can be read from outside and remote
- All new Sensors and Pilot Valve Module connected to analyzer by single I.S. bus cable

How does it work?

- Any blockage of bypass loops diagnosed by in-line flow and pressure sense
- Heat tracing and speed loop temperature diagnosed by in-line temperature sense on each process gas
- Main stream filters diagnosed by differential pressure across filter to selected stream
- Blockage of analyzer loop in SV or other valves diagnosed by in-line sample flow and inlet and outlet pressures
- Fluctuations of return point pressure diagnosed by in-line Pressure Sensor
- Calibration-Validation bottle checked by inline pressure sensor
- SSO, ARV and Stream Select valves switched inside cabinet
- Cabinet heater diagnosed by Temperature Sensor

Air Monitor: Practical Installation

- Analysis of atmosphere for VCM
- Parallel analysis of 2 points at once
- 15 process streams per GC
- Plus 1 to 3 calibration / validation inputs
- Need to validate flowing sample into GC sample loop

- ISSUE: Extensive and expensive field installation for controls and sensors

Typical: 15 pneumatic controls

2 flow sense measurements related to 2 parallel sampling paths

Pneumatic operators internal

Large cabinet enclosure; 2 doors, single interior zone

Typical: 15 sample points plus 1 to 3 reference points
Air Monitor: Improved with NeSSI

- Typical: 15 sample points plus 1 to 3 reference points
- P&F I.S. Power Supply
- Single I.S. cable for all interconnects to GC
- Swagelok valve control modules: 3 each; 6 pilots per module
- Circor DMT flow-pressure-temperature sensor: 2 each; 1 per concurrent sample loop
- Large cabinet enclosure: 2 doors, single interior zone
Extended System

Signal cable to GC

Pilot valve module

Multi variable sensor

PFPT
Why? Benefits To the User

System enables remote & automated monitoring of key operating parameters for sampling components

- **Personnel safety**
  - All flow and pressure sensors are high-pressure safe and suitable for toxic samples
  - Mechanical security; cabinet simplified by elimination of window
  - Lock-out practical because maintenance inspection does not require internal access

- **Reduced installation and engineering cost**
  - Stream select tubing to SVCM in GC is eliminated
  - Any analog electrical connections to GC are eliminated

- **Maintenance cost reduction**
  - Elimination of periodic human walk-by inspection
  - Capability for preventative and predictive maintenance
    - Example: decreasing flow measurement can indicate filter degradation whereas simple flow loss alarms occur only when failure has already occurred
  - When maintenance is required, personnel know maintenance situation, parts and tools required before going out to system
Why? Benefits To the User
System Enables Remote, Automated Monitoring of Key Operating Parameters

- Improved measurement validity and reliability
  - Continuous monitoring of system automatically versus periodic spot check by human walk-by
  - Validity assured during upsets, bad weather or storm conditions, holidays and other times of lowered maintenance
  - Continuous data validation possible on critical or quality-mandated measurements using Comprehensive Analyser Management Tools like Analyser System Manager

SCS = Sample Conditioning System
Discussion and Questions ?