



# Differences between IEC 61850-9-2, 9-2LE and IEC 61869-9

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# IEC 61850-9-2 or IEC 61850-9-2 LE?

Differences between IEC 61850-9-2, 9-2LE and IEC 61869-9

- IEC 61850-9-2 is a standard
  - Definition of different ways to structure the Process bus communication.
  - Does not allow interoperability as too much open
- IEC 61850-9-2 LE is a guideline
  - Specify very few options to structure the Process bus communication:
    - “It further clarifies uncertainties with respect to the interpretation of the standards and/or to precisely define what options to choose in case the standards permit a choice of options.”
  - Does allow communication interoperability between manufacturers, ex:
    - Fiber optic transmission system 100Base-FX full duplex with ST or MTRJ,
    - Dataset as 4 I + 4 U, 80 or 256 samples per period,
    - Operation modes,
    - Synchronization, etc...

• Does not allow interoperability as do not specify compatible contents/Data

# IEC 61869-9 1/2
















Differences between IEC 61850-9-2, 9-2LE and IEC 61869-9

The IEC 61869-9 standard:

- Replaces IEC 60044-8 digital solution.
- Provides a product standard for instrument transformers with a digital interface according to 61850.
- Includes backward compatibility for the UCA International Users Group *Implementation Guideline for Digital Interface to Instrument Transformers Using IEC 61850-9-2*.
- Uses IEC 61588 (PTP) for time synchronization, with an option for 1PPS.

# IEC 61869-9 2/2

## Differences between IEC 61850-9-2, 9-2LE and IEC 61869-9

PRODUCT FAMILY STANDARDS		PRODUCT STAND ARD	PRODUCTS	OLD STANDARD
 <b>61869-1</b> GENERAL REQUIREMENTS FOR INSTRUMENT TRANSFORMERS		 <b>61869-2</b>	ADDITIONAL REQUIREMENTS FOR CURRENT TRANSFORMERS	60044-1 60044-6
		 <b>61869-3</b>	ADDITIONAL REQUIREMENTS FOR INDUCTIVE VOLTAGE TRANSFORMERS	60044-2
		 <b>61869-4</b>	ADDITIONAL REQUIREMENTS FOR COMBINED TRANSFORMERS	60044-3
		 <b>61869-5</b>	ADDITIONAL REQUIREMENTS FOR CAPACITIVE VOLTAGE TRANSFORMERS	60044-5
	 <b>61869-6</b> ADDITIONAL GENERAL REQUIREMENTS FOR LOW POWER INSTRUMENT TRANSFORMERS	 <b>61869-7</b>	ADDITIONAL REQUIREMENTS FOR ELECTRONIC VOLTAGE TRANSFORMERS	60044-7
		 <b>61869-8</b>	ADDITIONAL REQUIREMENTS FOR ELECTRONIC CURRENT TRANSFORMERS	60044-8
		 <b>61869-9</b>	DIGITAL INTERFACE FOR INSTRUMENT TRANSFORMERS	
		 <b>61869-10</b>	ADDITIONAL REQUIREMENTS FOR LOW-POWER STAND-ALONE CURRENT SENSORS	
		 <b>61869-11</b>	ADDITIONAL REQUIREMENTS FOR LOW POWER STAND ALONE VOLTAGE SENSORS	60044-7
		 <b>61869-12</b>	ADDITIONAL REQUIREMENTS FOR COMBINED ELECTRONIC INSTRUMENT TRANSFORMER OR COMBINED STAND ALONE SENSORS	
		 <b>61869-13</b>	STAND ALONE MERGING UNIT	
		 <b>61869-14</b>	ADDITIONAL REQUIREMENTS FOR DC CURRENT TRANSFORMERS	
		 <b>61869-15</b>	ADDITIONAL REQUIREMENTS FOR DC VOLTAGE TRANSFORMERS	

# IEC 61850-9-2 LE v.s. IEC 61869-9

## Differences between IEC 61850-9-2, 9-2LE and IEC 61869-9

- IEC 61869-9 is backward compatible with 9-2 LE communication

	IEC 61850-9-2 LE	IEC 61869-9
• Fiber optic transmission	100Base-FX full duplex	Same (+ 1Gbit/s)
•	ST or MTRJ,	Duplex LC or RJ45
• Dataset	4 I + 4 U	FfSsIiUu
• Protection sampling rate	80 samples per period	4800 Hz
• Measurement sampling rate	256 samples per period	14400 Hz
• Protection comm. ASDU	1 (≈1400 bits)	2 (≈1500 bits)*
• Measurement comm. ASDU	8	6
• Synchronization	1 pps	IEC 61588
• Nb of “Nodes” (50% of load)	7 at 60Hz/8 at 50Hz	around 14*
• Delay time* (td) (Protection)	none	2 ms
• Delay time* (td) (Quality)	none	10 ms
• Rated conformance*	none	a to d

# IEC 61869-9 definitions

## Definitions

- Delay time\* ( $t_d$ )
  - Delay time ( $t_d$ ) shall be measured as the difference between the time encoded by the SmpCnt and the time the message timestamp point appears at the digital output.
- Variants
  - To facilitate interoperability, only a limited variability is permitted for naming, message structure, sample rate, analogue signal content and scaling. **FfSsliUu**
    - $f$  is the digital output sample rate expressed in samples per second
    - $s$  is the number of ASDUs (samples) contained in a sampled value message
    - $i$  is the number of current quantities contained in each ASDU (max is 24\*)
    - $u$  is the number of voltage quantities contained in each ASDU (max is 24\*)
  - Examples:
    - F4000S1I4U4 describes the 9-2LE MSVCB01 sampled values with 50 Hz nominal system frequency.
    - F12800S8I4U4 describes the 9-2LE MSVCB02 sampled values with 50 Hz nominal system frequency.
    - F4800S2I8U0 describes sampled values with 4800 samples per second, two ASDU (samples) per message, 8 currents, and no voltages.

\*: at 100Mbit/s

# IEC 61869-9 definitions

## Conformance classes

- The conformance classes may be summarized as follows:
  - class a: the minimal set of services required to transmit MU data using sampled values;
  - class b: “class a” capabilities plus the minimal set of services required to support GOOSE messages;
  - class c: “class b” capabilities plus the implementation of the IEC 61850 series’ information model self-descriptive capabilities;
  - class d: “class c” capabilities plus services for file transfer and either one or more of un-buffered reporting and buffered reporting, or logging.

# IEC 61869-9 definitions

## Digital Output Standard Sample Rates

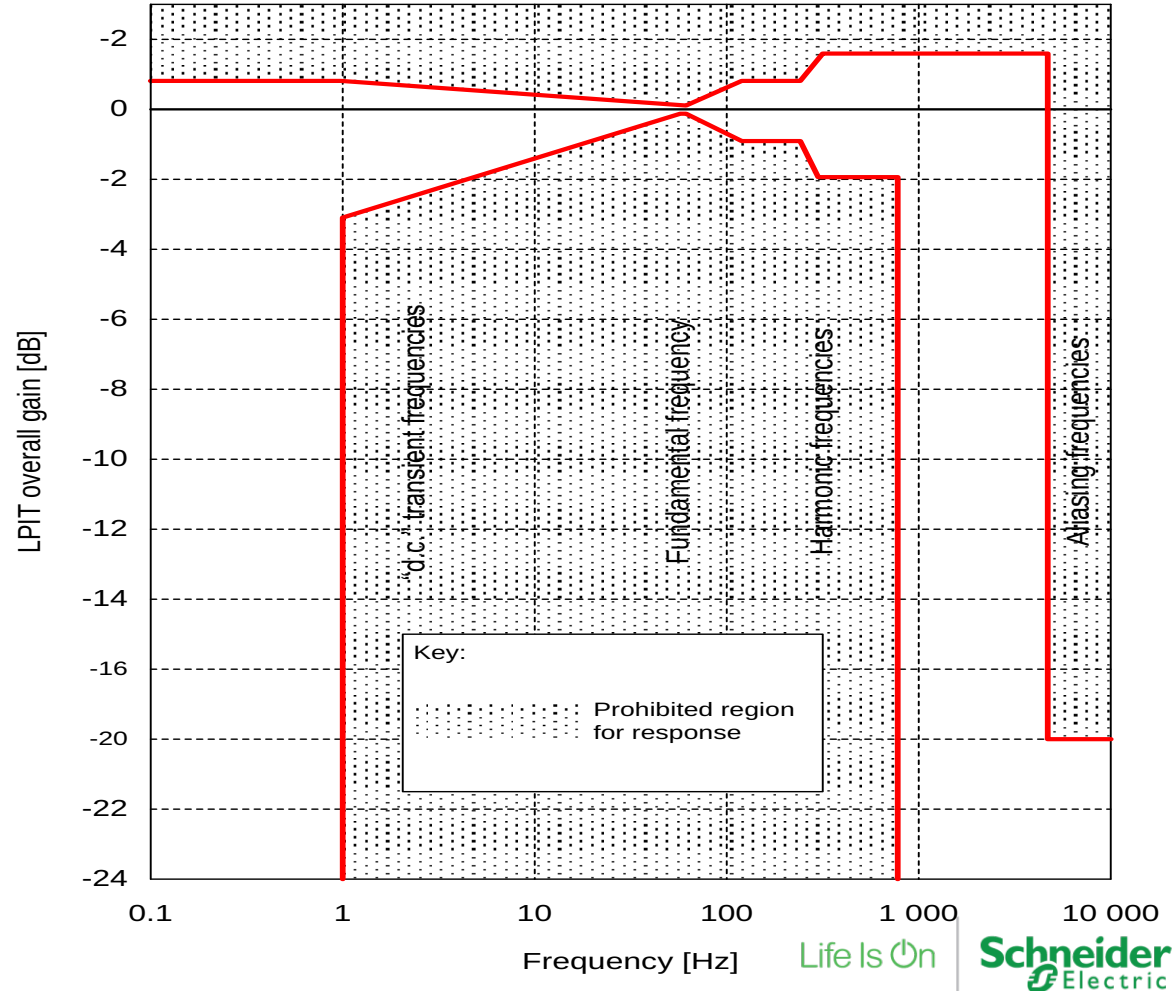
Digital output sample rates [Hz]	Number of ASDUs per frame	Digital output publishing rate [frames/s]	Notes
4 000	1	4 000	Legacy, for use on 50 Hz systems.
<b>4 800</b>	<b>2</b>	<b>2 400</b>	<b>Preferred rate for general measuring and protective accuracy classes, regardless of the power system frequency</b>
4 800	1	4 800	Legacy, for use on 60 Hz systems, or 50 Hz systems with 96 samples per nominal system frequency cycle
5 760	1	5 760	Legacy, for applications on 60 Hz systems with 96 samples per nominal system frequency cycle
12 800	8	1 600	Deprecated, only for use on 50 Hz systems
<b>14 400</b>	<b>6</b>	<b>2 400</b>	<b>Preferred rate for quality metering accuracy class, regardless of the power system frequency</b>
15 360	8	1 920	Deprecated, only for use on 60 Hz systems
96 000	1	96 000	Preferred rate for HV DC applications <sup>[VS3]</sup>



# IEC 61869 definitions

## Frequency response

- Frequency response
  - Frequency response mask for metering accuracy class1 and SAMU  
( $f_r = 60 \text{ Hz}$ ,  $f_s = 4800 \text{ Hz}$ )



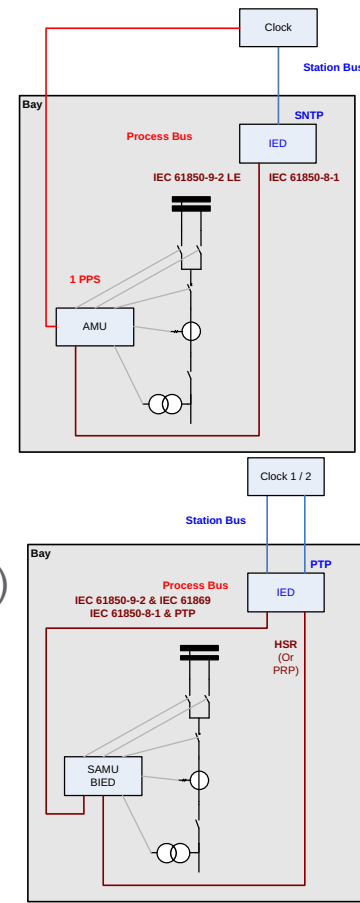
# Questions?

# Process Bus

Why it did not commercially work?

The **technical issues** to be solved were:

- The ~~time~~ **synchronization of measurements**:
  - 1 PPS additional link per SAMU AND from a unique clock (less availability)
  - Now solved with **doubled PTP** clocks (IEEE 1588/IEC 61588) through Eth.
- The **Ethernet communication**:
  - 1 Ethernet link per IED AND through “single” switch (decrease of availability)
  - Now solved via redundancy through IEC 62439 **PRP or HSR**
- The harmonized degree of **accuracy of the Sampled Values**
  - 9-2 LE was not standardizing the value sent (no interoperability)
  - Soon solved by **IEC 61869-13** (expected for 2019).



# Process Bus

## Takeaway

### 1. The technical issues to be solved were:

- The ~~time~~ synchronization of the measurements, now solved with PTP (IEC 61588)
- The communication redundancy need, now solved by IEC 62439 PRP (or HSR)
- The harmonized degree of accuracy of the Sampled Values soon solved by IEC 61869 full series.

### 2. The Process Bus is made of Ethernet networks either single or redundant, through which the following frames flow:

- IEC 61850-9-2 Sampled Values (following IEC 61869 behavior)
- IEC61850-8-1 GOOSE messages (mainly Binary but Analog is allowed),
- PTP (IEC 61588) time synchronization.

# Process Bus

## Takeaway

3. These Ethernet networks can be either virtual or physical networks
  - But the availability, the operators understanding of the application and the maintenance provided by physical segregation is much higher than a common network supporting multiple VLANs.
4. **Time** synchronization is not an issue if SAMUs are rightly connected.
5. Except for busbar protection with more than 7 CTs per busbar, the 100Mbits/s Process Bus fits most of the applications.
6. The optimum solution would be 100Mbit/s “PRP Process Bus” or a 1Gbit/s “HSR Process Bus” to link all the feeders of a substation.

# List of standards

## List

1. IEC 61588 (PTP)
2. IEC 61850-8-1 and -9-2
3. IEC 61869-6 and -9 and -13
4. IEC 62271-3 (BIED/SIED)
5. IEC 62439 (PRP or HSR)

# Questions?

# Process Bus protocols

What is flowing through Ethernet?

- IEC 61850-9-2 (not IEC 61850-9-2 LE) for Sampled Values “SV”
  - Samples of Current measurements (CT)
  - Samples of Voltage measurements (VT)
- It is also possible to send measurements via “Analog” GOOSE
  - Example: Voltage phase angles and magnitudes for synchrocheck
- IEC 61850-8-1 “GOOSE” messaging service for Digital I/Os
  - Status position of Switch disconnector (SW)
  - Status position of Circuit Breaker (CB)
  - Trip signals from protections to CBs (Trp)
  - Commands from DCS (open, close)
  - Others (monitoring status reports, health...)



# Process Bus protocols

What is flowing through Ethernet

- Precise Time Protocol (PTP) (IEEE 1588/IEC 61588) for Ethernet based time sync.
  - (Time) synchronization (to get 1us or 5us accurate time tagged samples)
  - IEC 62439 Time sync for HSR/PRP redundant networks
- IEC 62439-4 for Ethernet communication redundancy
  - PRP: Parallel Redundancy Protocol (Double star)
  - HSR: High-availability Seamless Redundancy (Ring)
- IEC 61869-9 and IEC 61869-13 for Mainly Differential protection algorithm interoperability
  - 9-2 LE described the Ethernet frame definition, not the sampled Values definition
  - 9-2 LE is already superseded by IEC 61869-9

A smiling man with glasses on his head, wearing a pink shirt, is sitting at a desk in an office. He is looking towards the left. In the background, there are office cubicles, a blue filing cabinet, and a pen holder. The text "THANK YOU." is overlaid in the center of the image.

THANK YOU.

Life Is On



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