

From 61850-9-2LE to 61869-9 Changes to Sampled Values

Agenda

- Sampled Values Standards
- Differences between 61850-9-2LE and 61869-9
- Sampling Variants
- Logical Nodes, Datasets, Control Blocks
- Time Synchronization
- Simulation
- Status of Conformance Testing

Standards for Sampled Values

- IEC 61850-9-2
 - Standard for Process Bus communication
 - Very General
- UCA 61850-9-2LE (Not an IEC standard)
 - Guideline that clarifies some of the uncertainties for interoperability
 - 61850 Ed 1
- IEC 61869-9:2016
 - Provides a standard for digital interface of instrument transformers according to IEC
 - Includes backward compatibility for 9-2LE
 - Uses PTP for time synchronization

9-2LE and 61869-9 are IEC 61850-9-2 profiles (interoperable subsets)

UCA 61850-9-2LE

- Created by UCA to specify an implementation guideline
- Used a subset of IEC 61850-9-2 for process bus SV messages
- Specified MU Merging Unit Logical Device
- Specified LLN0 logical node
 - Fixed DataSet specified as PhsMeas1 with 4 Currents and 4 Voltages
 - Sampled Values Control Blocks (at least one implemented)
 - MSVCB01 – 80 samples per period
 - MSVCB02 – 256 samples per period
 - SAV Common Data Class
- Edition 1 of 61850

IEC 61869-9 (TC 38 Instrument Transformers)

- Replaces IEC 60044-8
- Uses IEC 61850-9-2:2011 for SV specific communication service mapping
- Provides a standard for a digital interface for Instrument Transformers
- Includes backward compatibility to 61850-9-2LE
- Uses IEC 61588 in accordance with IEC 61850-9-3 for time synchronization
- Defines a maximum processing delay time requirement
- Allows for multiple ASDUs in an SV message
- Consolidates sampling rate variants
- Relies on IEC 61869-6 for frequency response requirements

Comparison of 9-2LE and 61869-9

	IEC 61850-9-2 LE	IEC 61869-9
Dataset	4I + 4U	FfSsliUu
Protection sampling rate	80 samples per period	4800 Hz
Synchronization	1 pps	IEC 61588/IEC 61850-9-3
Number of Protection ASDU	1	2
Simulation	No	Yes
Time adjustment method defined	No	Yes
Holdover time	No	Yes
Max processing delay requirement	No	Yes

IEC 61869-9 Variants

- Variants defined by FfSsliUu
 - f is the digital output sample rate in samples per second
 - s is the number of ASDUs contained in an SV message
 - i is the number of current quantities in each sample
 - u is the number of voltage quantities in each sample
- Examples
 - F4800S1I4U4 4800 samples per second, 1 ASDU, 4 currents, 4 voltages
Same as MSVCB01 in a 60 Hz system for backward compatibility
 - F14400S6I4U4 14400 samples per second, 6 ASDUs, 4 currents, 4 voltages
 - F4800S2I8U0 4800 samples per second, 2 ASDUs, 8 currents, 0 voltages

IEC 61869-9 Variants

Digital output sample rates [Hz]	Number of ASDUs per frame	Digital output publishing rate [frames/s]	Notes
4 000	1	4 000	For use on 50 Hz systems backward compatible with 9-2LE guideline.
4 800	1	4 800	For use on 60 Hz systems backward compatible with 9-2LE guideline, or 50 Hz systems backward compatible with 96 samples per nominal system frequency cycle. .
4 800	2	2 400	Preferred rate for general measuring and protective applications, regardless of the power system frequency.
5 760	1	5 760	For applications on 60 Hz systems backward compatible with 96 samples per nominal system frequency cycle.
12 800	8	1 600	Deprecated, only for use on 50 Hz systems.
14 400	6	2 400	Preferred rate for quality metering applications, regardless of the power system frequency including instrument transformers for time critical low bandwidth DC control applications.
15 360	8	1 920	Deprecated, only for use on 60 Hz systems.
96 000	1	96 000	Preferred rate for instrument transformers for high bandwidth DC control applications.

Logical Nodes

- LPHD
 - Extended to add nameplate data
 - dataNs is IEC 61869-9:2015A

LPHD class extensions for nameplate information				
Data object name	Common data class	Explanation	T	M/O/C
NamVariant	VSD	a semicolon separated list of the variant codes supported, the codes being as defined in clause 6.903.2, e.g. "F4800S114U4;F14400S614U4;F4800S210-24U0-24"		M
NamHzRtg	VSD	a semicolon separated list of the nominal frequencies (f_N) supported, in Hertz, e.g. "dc; 50; 60"		M
NamAuxVRtg	VSD	a semicolon separated list or hyphenated range of rated auxiliary power supply voltages (U_{Ar}) in volts, with indication of ac or dc where applicable, e.g. "80-300 dc;100-250 ac"		O
NamHoldRtg	VSD	the rated holdover time in seconds, e.g. "10"		M
NamMaxDIRtg	VSD	the maximum processing delay time in microseconds, e.g. "1500"		M

Logical Nodes

- TCTR
 - Instantiated for each of three current transformer phases and the neutral current measurement
 - Formatted as InnpTCTRn
 - nn is the instance number of the current measurement point
 - p is the phase identification (A,B,C or N for AC instrument transformers)
 - n is the inst of the logical node in the ICD file
 - Example I02ATCTR4
 - Current measurement point 02, phase A, instance 4

TCTR class extensions with nameplate information				
Data object name	Common data class	Explanation	T	M/O/C
NamAccRtg	VSD	the accuracy class rating in the format described in clause 5.6, e.g. "0,5S/5P20"		M
NamARtg	VSD	a semicolon separated list of the rated primary currents (I_{Pr}) in amperes, e.g. "200;400;800"		M
NamClipRtg	VSD	the ratio of the clipping limit of the instantaneous current to the rated primary current multiplied with a square root of two, e.g. "20"		M

Logical Nodes

- TCTR
 - AmpSv data object – SAV common data class (IEC 61850-7-3:2010)
 - Values are mandatory and read only

Attribute	Value
<i>AmpSv.units.SIUnit</i>	5 (code for ampere)
<i>AmpSv.units.multiplier</i>	0
<i>AmpSv.sVC.offset</i>	0
<i>AmpSv.sVC.scaleFactor</i>	0,001
<i>AmpSv.instMag.i</i>	count (of milliampere)

Logical Nodes

- TVTR
 - Instantiated for each of the three voltage transformer phases and the neutral voltage measurement
 - Formatted as UnnpTVTRn
 - nn is the instance number of the voltage measurement point
 - p is the phase identification (A,B,C, AB, BC, CA or N for AC instrument transformers)
 - n is the inst of the logical node in the ICD file
 - Example U01ATVTR1
 - Voltage measurement point 01, phase A, instance 1

TVTR class extensions with nameplate information				
Data object name	Common data class	Explanation	T	M/O/C
NamAccRtg	VSD	the accuracy class rating in the format described in clause 5.6, e.g. "0.5/3P"		M
NamVRtg	VSD	the rated primary voltage (U_{pr}) in volts, e.g. for rating of $300000/\sqrt{3}$ we will have "173000"		M
NamClipRtg	VSD	the ratio of the clipping limit of the instantaneous voltage to the rated primary voltage multiplied with a square root of two, e.g. "2"		M

Logical Nodes

- TVTR
 - VolSv data object – SAV common data class (IEC 61850-7-3:2010)
 - Values are mandatory and read only

Attribute	Value
VolSv.units.SIUnit	29 (code for volt)
VolSv.units.multiplier	0
VolSv.sVC.offset	0
VolSv.sVC.scaleFactor	0,01
VolSv.instMag.i	count (of centivolt)

Datasets

- Datasets specified in IEC 61850-7-2:2010
- Dataset names shall be:
 - PhsMeasx
 - Where x is the instance number of the dataset (1-99)
 - Must be unique within LLN0

Multicast sampled value control blocks

- Specified in IEC 61850-7-2:2010
- MSVCBxx
 - Where xx is the instance number (01-99)
 - Reserved for backward compatibility:
 - MSVCB01 SmpRate is 80
 - MSVCB01 SmpRate is 256

Merging unit configuration parameters

Parameter	Value Range	Details
LDName	xxxxMUnn	xxxx is the configurable IED name of the merging unit per IEC 61850-6:2009, 8.5.3. MUnn is the attribute Inst of the LDevice per IEC 61850-6:2009, 8.5.3.
MSVCBxx.SvEna	TRUE/FALSE	Repeated for each MSVCB implemented.
MSVCBxx.MsVID	see details	Should be unique within the substation. It is recommended that this field be short; set to match the hexadecimal APPID representation. NOTE some legacy devices restrict the length of this field to 10...34 characters.
DstAddress		
Addr	see comment	If DstAddress is a multicast address, the address shall be 01-0C-CD-04-xx-xx, where xx-xx needs to be configured. If DstAddress is a unicast address, the address shall be the Ethernet address of the SV subscriber.
PRIORITY	0...7	
VID	0...4095	
APPID	0x4000...0x7FFF	The value 0x4000 is the default value, indicating lack of configuration. It is strongly recommended to have unique, source orientated SV APPID within a system, in order to enable a filter on link layer. The configuration of APPID should be enforced by the configuration system.

Objects within a Merging Unit from IEC 61869-9 Standard

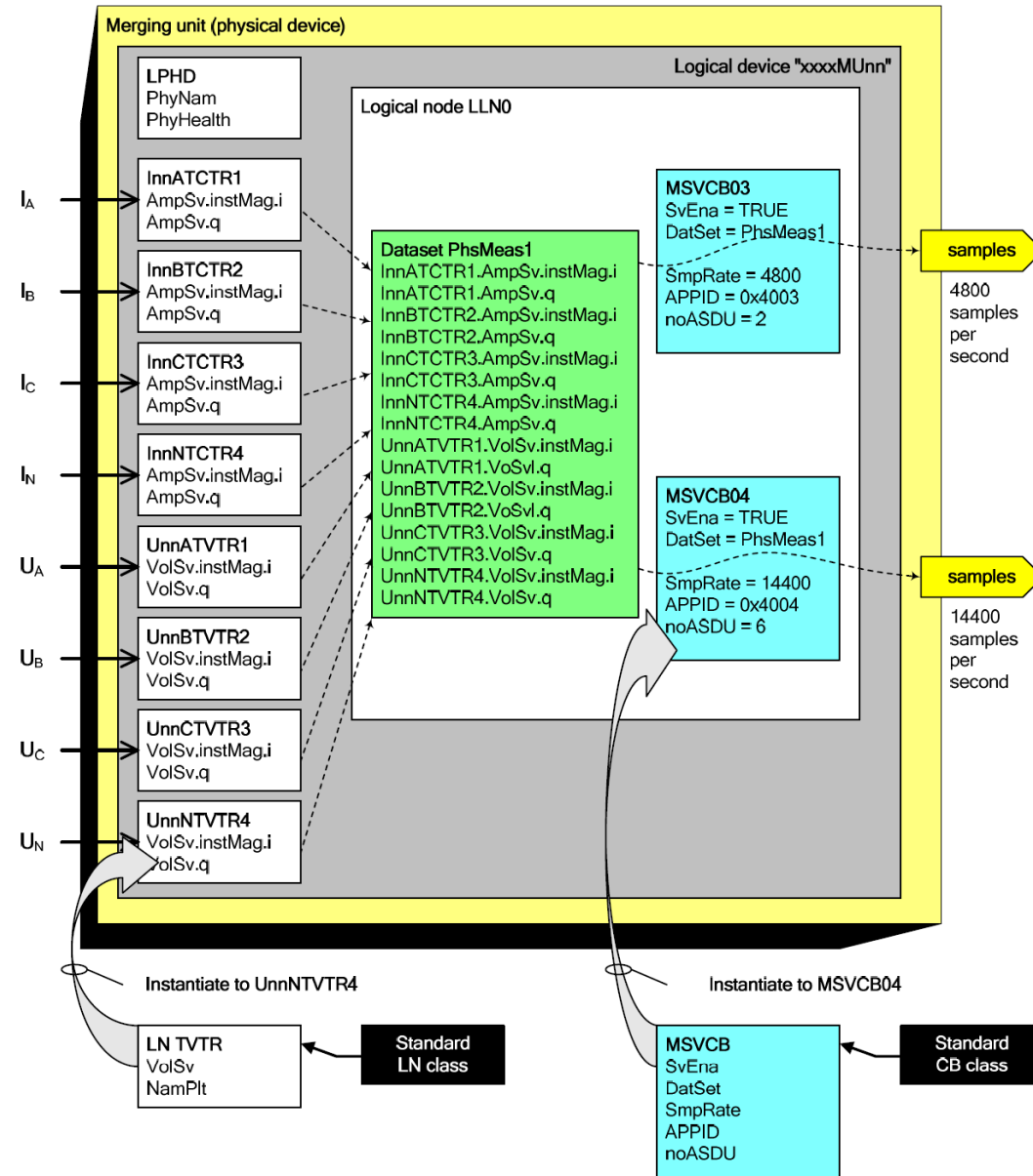


Figure 902 – General illustration of the objects within a merging unit (example)

Time Synchronization

- IEC 61588 PTP with IEC 61850-9-3 profile
- 1 PPS input is an alternative for legacy application
- Accuracy expected to be better than +/- 1 μ s
- SmpCnt field identifies the samples (Range is 0 to samples/sec. minus 1)
- At the top of second, SmpCnt is zero

Holdover time (6.904.5)

- the rated duration over which the merging unit shall continue to send samples maintaining the sample timing required for the measuring accuracy class following loss of the time signal
- During holdover, SmpSynch attribute shall remain unchanged and SmpCnt shall continue to increment and wrap as if the synchronization were present
- SmpSynch will change following the holdover time expiration
- Minimum holdover shall be 5 seconds

Free-running mode (6.904.6)

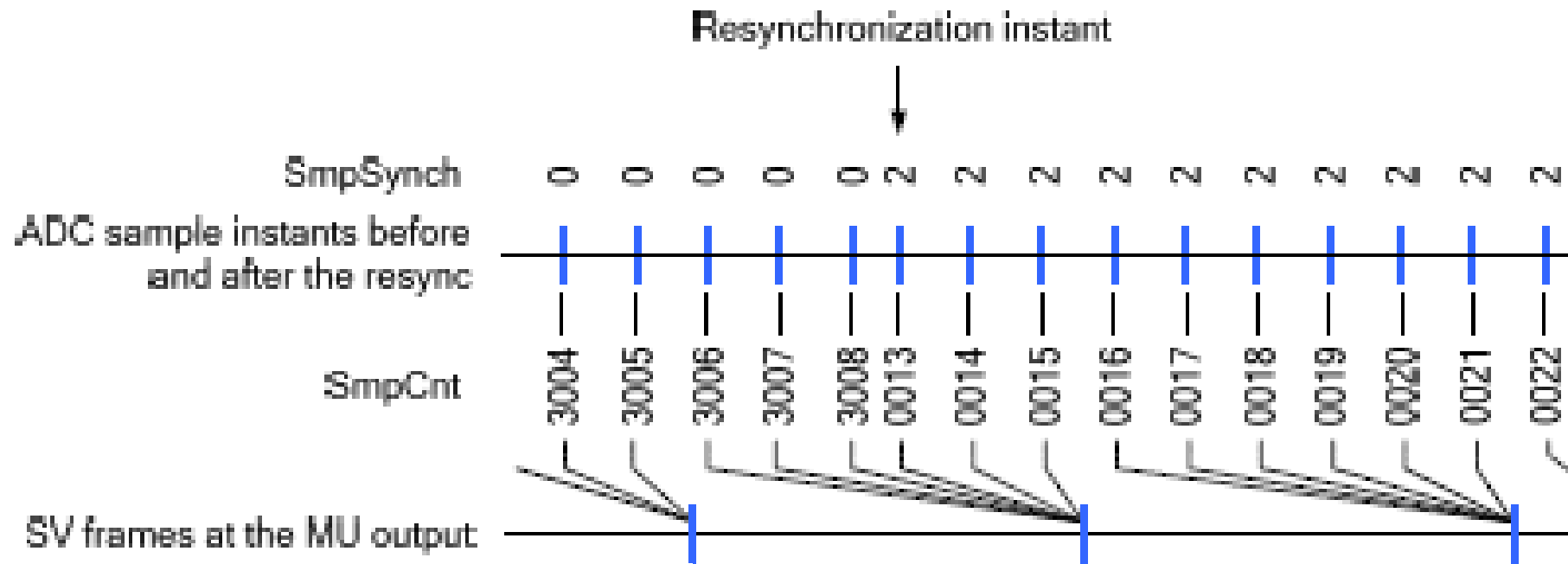
- When Merging Unit is not synchronized, Sampled Values shall be sent with sampling rate whose maximum deviation from nominal sampling rate is not more than ± 100 ppm.
- In free-running mode, SmpSynch shall be zero.
- In free-running mode, SmpCnt shall increment and wrap as if synchronized.
- Sampled values from the same merging unit shall be synchronized to each other.

Time adjustments (6.904.7)

When synchronization changes, there may be an offset between time before and after the event. Time adjustments shall occur as follows:

- Sampling shall jump from old time to new time between consecutive samples.
- Sample interval over jumps shall be no more than $\frac{1}{2}$ * nominal interval and no shorter than $\frac{1}{2}$ * nominal interval.
- SmpCnt is discontinuous over the jump
- SmpCnt continuous for samples prior to and immediately following the adjustment.
- SV subscribers are expected to cope with this transition.

Time adjustments (6.904.7)



Sampled Values Frame

A.1 ISO/IEC 8802-3 frame format

See Figures A.1, A.2 and A.3.

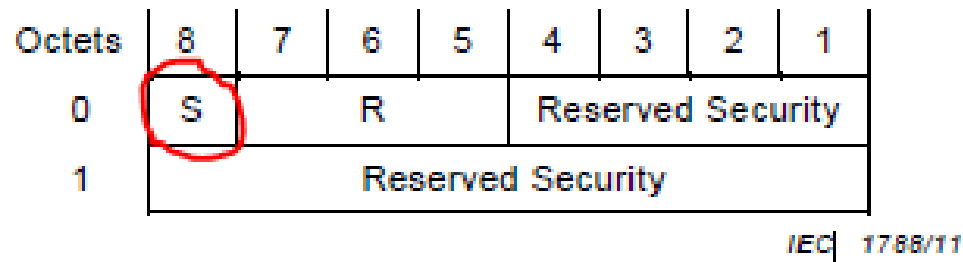
Octets	8	7	6	5	4	3	2	1	Notes
0									
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

16									
17									
18	Length Start								
19									
20									
21									
22									
23									
24									
25									
26									
.									
m + 26									
.									
≤1517									
.									
.									
≤1521									

IEC 1790/11

Figure A.1 – ISO/IEC 8802-3 frame format – No link redundancy

Simulation Bit (MU must be edition 2)

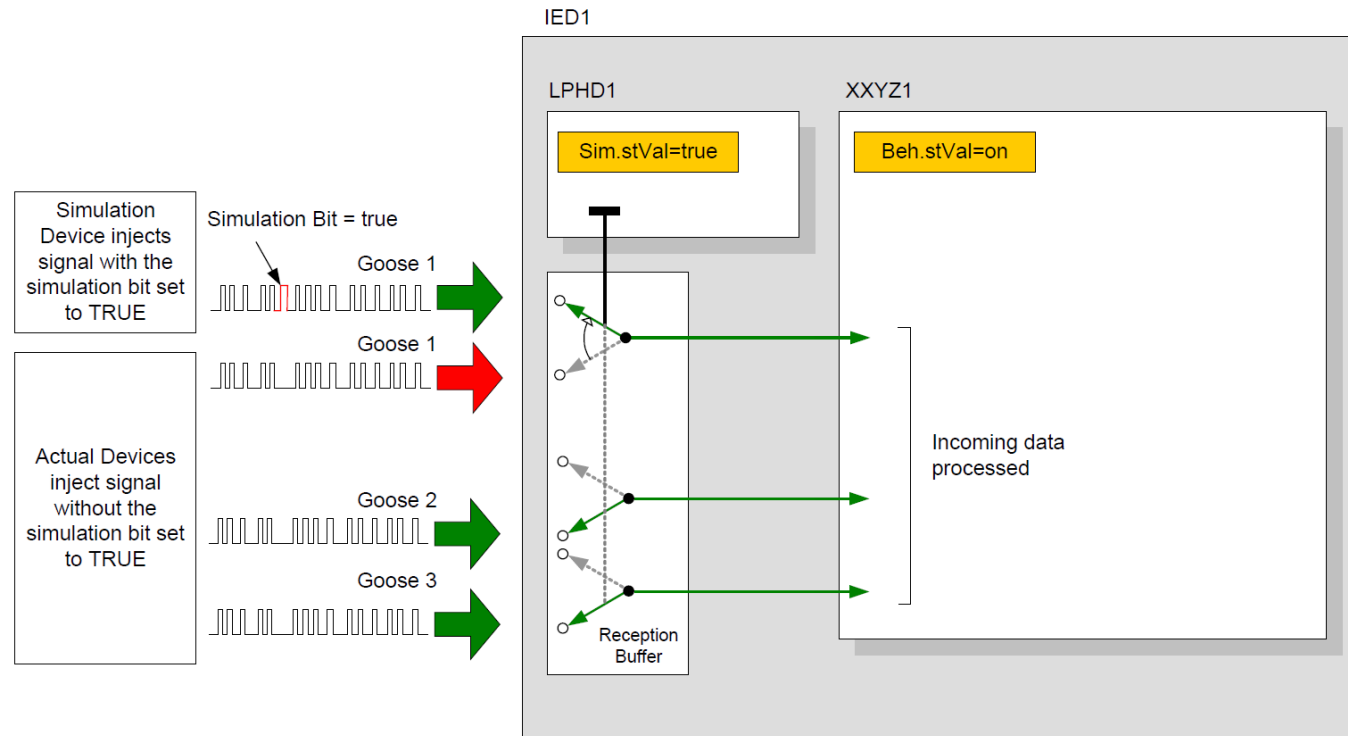


S: Simulate. When this flag is set, the SampledValue telegram has been issued by a publisher located in a test device and not by the publisher as specified in the configuration file of the device.

Simulation (61850-7-1)

7.8.2 Multicast signals used for simulation

Figure 40 shows an IED (IED1) receiving simultaneously simulation and actual signals.



IEC 1441/11

Figure 40 – Data used for receiving simulation signals

Conformance testing for SV

- Currently only conformance tests for 61850-9-2LE Publisher
- UCA IUG developing test procedures for:
 - Sampled Values Publishers according to IEC 61869-9
 - Sampled Values Subscribers according to IEC 61869-9
 - The IEC 61869-9 test procedures will be integrated in Ed2 Amd1 server conformance test procedures

THANK YOU!