



B5 – PROTECTION AND AUTOMATION PS 3 / INTEGRATION OF INTELLIGENCE ON SUBSTATIONS

10473_2022

Intelligent Monitoring, Testing & Diagnostics in a Process Bus Based Full Digital Substation – A Utility's Experience

Abhay CHOUDHARY, Subir SEN, Sudhir AGARWAL, Abhay KUMAR, C. P. AWASTHI, Sitesh BADERIA, Yashwant K., Ritesh KUMAR Power Grid Corporation of India Limited, INDIA

Motivation

- Towards digitalization efforts, POWERGRID commissioned its first 400kV IEC 61850 Process Bus based Full Digital Substation in December 2020 at Malerkotla in Punjab state. This substation is critical for the agricultural power requirements of the region.
- Utilized the features and technologies of IEC 61850 during all the stages of the project, thus impacting the way monitoring, auditing, testing and commissioning of a Process bus based Digital Substation is carried out.
- The standard enables the utilities to use advanced monitoring, diagnostics and online testing techniques which bring tremendous amount of visibility into the systems whilst providing flexibility during commissioning phase and operation and maintenance (O&M) phase.

Approach

a. Online Monitoring & Diagnostics

- Advanced Online Monitoring of Protection & Control system
 - Monitoring of Sampled Values (SV) alarms (Figure 1)
 - Monitoring of Generic Object Oriented Substation Events (GOOSE) communication on a dashboard in HMI (Figure 2)
 - System wide real-time diagnostics information (Figure 3)



Figure 1: Monitoring of SV Alarms (SV fail and SV Time Sync Fail)

AAATTINOTTA		I non I non I	and I am I		The Paper Annual St	
		8.0				inter failes
					and some states	and said
IOCK LEDIES AVOID					And Designed, Married	AT IN CASE OF AT AT
OCCLEMENT - BOOM BY		NAME AND ADDRESS OF TAXABLE				And Andrews and a
OCCLEMENT - Brins II		STATISTICS.				
					000 100 000 - 00 W	AND DESCRIPTION OF A
						10 (M-10) (1)
OCIC LEDNES AN AUX			-	_	-010-E 10-R0X-49-05	and the second
000 100100 411011		state and set of the local division of the	-		01010 100-000A - 02 00	
ALL REPORT OF		COLUMN AND ADDRESS - ADDRE			010 B 18 A 8 A 10 B 10 1	NOME ADDRESS AND AN
			10000.0000			ACCERTANCE IN CONTRACTOR OF
COLUMN ADDRESS ADDRESS		COMPANY AND INCOME.			*********	ACCRETATION OF ALL
000 M0180 48000		server subscription. He want the	and a state of the local division of the loc		01048340444444444	
		server serverses and server			1014 10140A- 10140	
			1000.000			ELECTRONIC ELECTRON
DOX LEDNES 41-161			1000.000			POST REPORT AND PROVIDED IN CONTRACT OF CONTRACTO OF CONTRACTO OF CONTRACTO OF CONTRACT OF CONTRACT OF CONTRACT OF CONTRACT OF CONTRACTO OF CONTRACT OF CONTRACTO OF CONTRACT.
BUILD 1 1000	_					NUMBER OF STREET, STRE
And in state			10000-0000			POINT REPORT OF T
		second second second				C COMPANY OF MOTOR
		Inclusion of the local division of the local		88.0 m	10.5 million 10.0	
	_			Martine was	BILLING BUILT	A STATE OF

Figure 2: GOOSE Alarms Dashboard

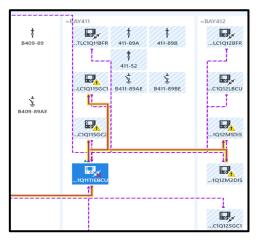


Figure 3: Diagnostics information: Example when there is loss of association between a Publisher IED and Subscriber IEDs

b. Online Testing

Intelligent Online Testing – Access to IED

	MURKTLC1Q09M1DIS • Data M	iodel • Ln] • PIRC	1	Activity Monitor		
	PTRC1 Protection trip co	nditioning		MLRKTLC1Q33BFR		
	Name		Value		4	
	🕨 🖸 Mod		on	500.146 A ∠ 0°		
	🕨 🛄 Bah		on	MisC-N Of Loris/TTRL/MOULA.cho4	.ents\FFRE_MMOULAphok	
	🕨 💽 Health		Ck	(+180/ N / v)	4	
aSet	A 🔤 Ob	4 💟 Op		600.14 A 2 -120.002"	<u> </u>	
	🛃 general	[ST]	false	.entsyTPRE_MIXAULA.phd	1	
	Aariq 🚾	(ST)	fabr		×	
	🔀 phsB	(ST)	fake	100.00 A 2 120°		
	🔀 pheC	[ST]	false	-amerta(FFRE_MUXULA enta(FFRE_MUXULA.pho	1	
	🕨 🔛 q	(ST)	good	×	a	
******	🔹 🔀 t	[ST]	13(May/201:07:01.184 PM	false 🕺 false		
	🕨 🚾 Str		fabe, unknown	C81/989/1 Optx 081/989/1 Optx	1	
	🕨 🎦 NamPit		SIDMENS		-	
				MLRKTLC1Q33M1D45	_	
6 1				false × false *		
				Int/PRCLOp		
				false false i		
				Unt/PTRCLOpphsA	1	
				false ×		
				Lut/PIRCLOpphsC		

Figure 4: Online Testing - An example to show that various parameters (measurements, protection information etc.) of an IED can be viewed using a third party tool

http://www.cigre.org





B5 – PROTECTION AND AUTOMATION PS 3 / INTEGRATION OF INTELLIGENCE ON SUBSTATIONS

10473_2022

Intelligent Monitoring, Testing & Diagnostics in a Process Bus Based Full Digital Substation – A Utility's Experience

continued

c. Specific Tests

- Merging Unit testing (Figure 5)
- Testing an IED as a subscriber to GOOSE/SV
- Monitoring SV skew at reception ports of IEDs

PPS/PTP Time synchronization unit							
Analogue Output	Merging Unit	SV Output from MU fed to Test Tool					
Current/Voltage generator (e.g., a Relay Test Kit)							
Analogue Output	Test Tool						

Figure 5: A setup for testing Merging Unit

Discussion

As all the control and protection schemes are based on high-speed information exchange, the monitoring of Network becomes important:

- Use of Local HMI and Network monitoring tools (Figure 7).
- Digital substation specific Network analyzers and recorders (Figure 6).
- Monitoring of PTP time synchronization.

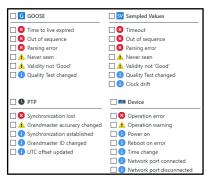


Figure 6: An example to show various monitoring and trigger options based on different system conditions

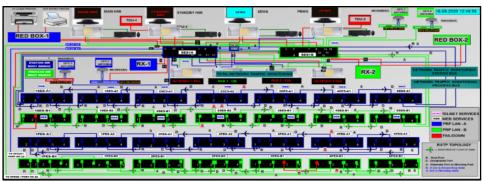


Figure 7: Network Monitoring integrated in HMI

Conclusion

IEC 61850 Process Bus based digital substations enable the utilities to implement systems with intelligent monitoring capabilities along with features for online testing and advanced diagnostics.

These capabilities and features along with the fact that these are vendor-neutral make utilities confident and encouraged to adopt Process Bus based Digital Substations.

The technology has been successfully adopted in POWERGRID and it has immensely benefitted in reliable and efficient operation of the substation. The technology has helped in quick diagnostics and faster troubleshooting.