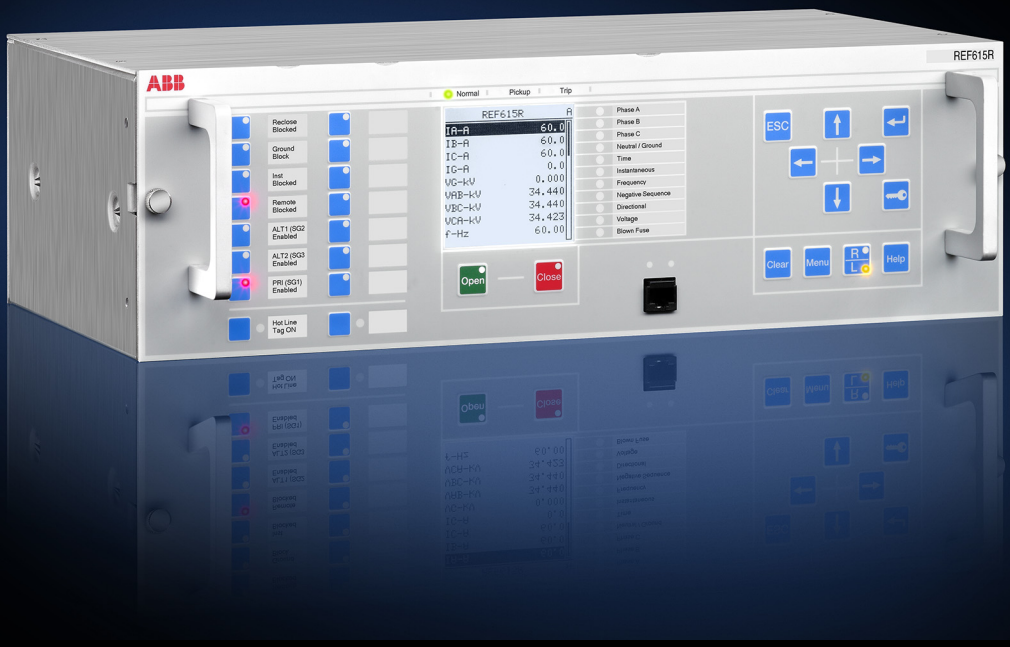

Relion® Protection and Control

REF615R

DPU2000R Modbus Point List Mitigation Manual

Power and productivity
for a better world™

Document ID: 1MRS240173-IB
Issued: 09/24/2016
Revision: B
Product version: 4.1

Copyright

Trademarks

Warranty

Please inquire about the terms of warranty from your nearest ABB representative.

ABB Inc.
Distribution Automation
4300 Coral Ridge Drive
Coral Springs, FL 33065, USA
Toll-free: 1 (800) 523-2620
Phone: +1 954-752-6700
Fax: +1 954 345-5329
http://www.abb.com/substationautomation

Disclaimer

The data, examples and diagrams in this manual are included solely for the concept or product description and are not to be deemed as a statement of guaranteed properties. All persons responsible for applying the equipment addressed in this manual must satisfy themselves that each intended application is suitable and acceptable, including that any applicable safety or other operational requirements are complied with. In particular, any risks in applications where a system failure and/or product failure would create a risk for harm to property or persons (including but not limited to personal injuries or death) shall be the sole responsibility of the person or entity applying the equipment, and those so responsible are hereby requested to ensure that all measures are taken to exclude or mitigate such risks.

This product is designed to be connected and to communicate information and data via a network interface, which should be connected to a secure network. It is sole responsibility of person or entity responsible for network administration to ensure a secure connection to the network and to establish and maintain any appropriate measures (such as but not limited to the installation of firewalls, application of authentication measures, encryption of data, installation of anti virus programs, etc) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ABB is not liable for damages and/or losses related to such security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information

This document has been carefully checked by ABB but deviations cannot be completely ruled out. In case any errors are detected, the reader is kindly requested to notify the manufacturer. Other than under explicit contractual commitments, in no event shall ABB be responsible or liable for any loss or damage resulting from the use of this manual or the application of the equipment.

Conformity

This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 2004/108/EC) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 2006/95/EC). This conformity is the result of tests conducted by ABB in accordance with the product standards EN 50263 and EN 60255-26 for the EMC directive, and with the product standards EN 60255-6 and EN 60255-27 for the low voltage directive. The protection relay is designed in accordance with the international standards of the IEC 60255 series and ANSI C37.90.

Table of contents

Table of tables

Table of figures

Section 1 Introduction

1.1 This manual

The mitigation manual compares REF615R's Modbus point list mapping with DPU2000R's. The manual should be used in conjunction with the corresponding communication point list mapping and protocol manual.

1.2 Intended audience

This manual addresses, from substituting REF615R for DPU2000R perspective, the communication system engineer or system integrator responsible for pre-engineering and engineering for communication setup in a substation.

1.3 Document revision history

Document revision/date	Product version	History
A/2/24/2014	4.0	First release
B/9/24/2016	4.1	Content update

1.4 Related documentation

Name of the document	Document ID
Feeder Protection and Control REF615R Modbus Point List Manual	1MRS240052-IB
REF615R Modbus Communication Protocol Manual	1MRS240047-IB
DPU2000/1500R/2000R Modbus / Modbus Plus Modbus TCP/IP Automation Technical Guide	TG 7.11.1.7-51
Instruction Book DPU2000R Distribution Protection Unit	1MRA587219- MIB (IB 7.11.1.7-4)

1.5 Symbols and conventions

1.5.1 Safety indication symbols

The caution icon indicates important information or warning related to the concept discussed in the text. It might indicate the presence of a hazard which could result in corruption of software or damage to equipment or property.

The information icon alerts the reader to important facts and conditions.

The tip icon indicates advice on, for example, how to design your project or how to use a certain function.

Although warning hazards are related to personal injury, it should be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process performance leading to personal injury or death. Therefore, comply fully with all warning and caution notices.

Section 2 Modbus point list mapping mitigations

2.1 Overview

Thanks to today's modern computer's fast processing speed and the price drops of the computer physical memories, data acquisition bandwidth has greatly improved and the databases sizes has drastically expanded. As a result, data management has become a new focus as a large volume of data can be acquired in a short period of time. To meet the demand, IEC61850 as an object oriented communication protocol classifies each data point of a SCADA system by its associated logical device, logical node, function names and instances, etc. In this way, it models each basic data point from the field into a unique data object on the network by a unique IEC 61850 path, and each of every attributes of the data object is modeled by a unique IEC 61850 path as well.

The DPU2000R relay was developed by ABB in the 1990s and has served the industry successfully for over a decade. As time went by, some of its hardware components and software design modules have become obsolete, restricting its use in the future power grid network communication systems.

The REF615R, as a new generation of ABB protection relay, offers much broader network communication capabilities as it implements the state-of-the-art IEC61850 protocol as its primary substation communication protocol, and on top of it, it still supports other well-respected digital communication protocols such as Modbus and DNP3.

To reduce a system integrator's efforts to remap the Modbus point list after substituting an REF615R for a DPU2000R, the REF615R has kept the majority of the Modbus register assignments the same as in DPU2000R. While the DPU2000R's Modbus server links every points' value directly from the software variables, the REF615R's Modbus server accesses data values through that data object's IEC 61850 path. The Modbus register assignments of points fundamental to the feeder protection and control task (52a, 52b, 51P, 50P-1, 51N, 50N-1, metering, etc.) are all easily inherited from DPU2000R, since each has its unique IEC 61850 path. Modbus mapping for some of the points only relevant to the DPU2000R's specific software and hardware design features are maintained by using REF615R's programmability feature since they do not have the corresponding IEC61850 paths. However, some DPU2000R design featured points have to be left out since inheriting them on the REF615R was neither necessary nor practical.

In the remainder of this document, from Section 3 to Section 5, the Modbus point list mapping of the DPU2000R and the REF615R are compared in a tabular format. The sections' sequence is the same as in the original DPU2000R's Modbus point list manual.

Modbus 6x registers are not supported in REF615R because WebHMI and PCM 600 tool can be used to make settings and logic changes.

This document does not cover the Modbus point list mapping added in the REF615R that do not exist in the DPU2000R. To view the entire Modbus point list mapping for

REF615R, please refer to the "Feeder Protection and Control REF615R Modbus Point List Manual" with Document ID: 1MRS240052-IB.

Section 3 0x registers

3.1 Function Code 1 (Read coil status)

REF615R maps status information into two types of blocks as in DPU2000R. One is single-bit block, the other one is double-bit block. The single-bit block only provides status information, and the double-bit block provides both of the status and momentary change information.

REF615R maps the output and input status in the same register assignments and sequences as in DPU2000R. For the points without IEC61850 paths and their readings can only be obtained by PCM600 tool configurations, their original register addresses in DPU2000R are reserved. Their new addresses are the addresses of those generic logic points.

Please check "Feeder Protection and Control REF615R Modbus Point List Manual", document ID: 1MRS240052-IB to find out the Modbus point list mapping of the generic logical points.

For the Modbus output and input status points in DPU2000R unable to be mapped in REF615R, their original Modbus address assignments are reversed.

Seal-in (latch) points in the logic output block are not directly mapped because they do not have IEC 61850 paths. The alternatives are either to read momentary change detect (MCD) bit from their corresponding points in the double-bit logical output block, or to use the generic set reset logic to program the seal-in point using PCM600 ACT. One example is given in Section 7.1.6, Figure 7.

3.1.1 Logical output block (Single-bit data):

REF615R maps the single-bit logical output points in the same register assignments and sequence as in DPU2000R.

Table 1: Mitigations of Modbus registers mapping for the logical output points in single-bit block

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
1	Breaker is Tripping (TRIP)	1	LD0.TRPPTRC1.Tr.general	

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
2	Breaker is Closing (Close)	2	LD0.MVGAPC8.Q3.stVal	Configured by PCM600 ACT.
3	DPU is in ALARM (ALARM)	3	LD0.LLN0.Health.stVal	Converted enum value to boolean to read ALARM as same in DPU2000R.
4	Under voltage Trip (27-1P)	4	LD0.PHPTUV1.Op.general	
5	Negative Sequence Over-current Trip (46)	5	LD0.NSPTOC1.Op.general	
6	Phase Instantaneous Over-current Trip (50P1)	6	LD0.PHHPTOC1.Op.general	
7	Neutral Instantaneous Over-current Trip (50N1)	7	LD0.EFHPTOC3.Op.general	
8	Phase Instantaneous Over-current Trip (50P2)	8	LD0.PHHPTOC2.Op.general	
9	Neutral Instantaneous Over-current Trip (50N2)	9	LD0.EFHPTOC4.Op.general	
10	Phase Instantaneous Over-current Trip (50P3)	10	LD0.PHIPTOC1.Op.general	
11	Neutral Instantaneous Over-current Trip (50N3)	11	LD0.EFIPTOC2.Op.general	
12	Phase Time Over-current Trip (51P)	12	LD0.PHLPTOC1.Op.general	
13	Neutral Time Over-current Enabled (51N)	13	LD0.EFLPTOC2.Op.general	
14	Overvoltage Trip any single phase (59-1)	14	LD0.PHPTOV1.Op.general	
15	Direct Over-current Trip Positive Sequence (67P-1)	15	LD0.DPHLPTOC1.Op.general	
16	Direct Over-current Trip Negative Sequence (67N)	16	LD0.DEFLPTOC1.Op.general	
17	Frequency Shed (1st Stage) (81S-1)	17	LD0.LSHDPTRC1.Op.general	
18	Frequency Restore (1st Stage) (81R-1)	18	LD0.LSHDPTRC1.RestLodOp.general	
19	! Phase A Target Alarm (PATA)	2332	! LD0.LEDGGIO1.ISCSO1.stVal	! Address different in REF615R
20	! Phase B Target Alarm (PBTA)	2334	! LD0.LEDGGIO1.ISCSO2.stVal	! Address different in REF615R
21	! Phase C Target Alarm (PCTA)	2336	! LD0.LEDGGIO1.ISCSO3.stVal	! Address different in REF615R
22	Trip Coil Failure Alarm (TCFA)	22	LD0.MVGAPC8.Q1.stVal	Configured by PCM600 ACT.
23	Tap Changer Cutoff (TCC)	23	LD0.DARREC1.ActRec.stVal	
24	Reclosing Disabled Alarm (79DA)			Please reference REF615R 1x address of 10034 as it is mapped for 43a.
25	Pick Up Alarm (PUA)	25	LD0.LEDPTRC1.Str.general	
26	Recloser Lock Out Alarm (79LOA)	26	LD0.DARREC1.LO.stVal	
27	Breaker Fail Alarm (BFA)	27	LD0.SSCBR1.OpnAlm.stVal	
28	Phase Demand Current Alarm (PDA)			N/A in REF615R
29	Neutral Demand Current Alarm (NDA)			N/A in REF615R

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
30	Blown Fuse Alarm (BFUA)	30	LD0.SEQRFUF1.Str.general	
31	Kilo amperes Symmetrical Inverted Alarm (KSI)	31	LD0.SSCBR1.APwrAlm.stVal	
32	Recloser Counter Alarm 1 (79CA1)	32	LD0.SSCBR1.OpNumAlm.stVal	
33	High Power Factor Alarm (HPFA)			N/A in REF615R
34	Low Power Factor Alarm (LPFA)			N/A in REF615R
35	Over-current Trip Counter Alarm (OCTC)			N/A in REF615R
36	1st Instantaneous Over-current Distance Alarm (50-1D)			See Section 7.1.1 for example or explanation
37	2nd Instantaneous Over-current Distance Alarm (50-2D)			See Section 7.1.2 for example or explanation
38	Settings Table Change Alarm (STC)	38	LD0.LLN0.SetChg.stVal	
39	Zone Sequence Control Alarm (ZSC)	39	LD0.DARREC1.ProCrd.stVal	
40	Phase Over-current Disabled Alarm (PH3-D)			See Section 7.1.3 for example or explanation
41	Ground Over-current Disabled Alarm (GRD-D)			See Section 7.1.4 for example or explanation
42	PA (67P) Positive Sequence Direct Over-current Trip Alarm (32 PA)	42	LD0.DPSRDIR1.Dir.general	
43	PN (67N) Negative Sequence Direct Over-current Trip Alarm (32 NA)	43	LD0.DNZSRDIR1.Dir.general	
44	Three Phase Under voltage Trip (27-3P)			See Section 7.1.5 for example or explanation
45	3 Phase KVAR Demand Alarm (VARDA)			N/A in REF615R
46	Recloser Counter Alarm 2 (79CA2)			N/A in REF615R
! 47	A Single Phase Trip (Phase A) (TRIP A)	! 19	! LD0.LEDPTRC1.Op.phsA	! Address different in REF615R
! 48	B Single Phase Trip (Phase B) (TRIP B)	! 20	! LD0.LEDPTRC1.Op.phsB	! Address different in REF615R
! 49	C Single Phase Trip (Phase C) (TRIP C)	! 21	! LD0.LEDPTRC1.Op.phsC	! Address different in REF615R
50	Under voltage Trip (27-1 latch)			See Section 7.1.6 for example or explanation
51	Negative Sequence Over-current Trip (46 latch)			See Section 7.1.6 for example or explanation
52	Phase Instantaneous Over-current Trip (50P1 latch)			See Section 7.1.6 for example or explanation
53	Neutral Instantaneous Over-current Trip (50N1 latch)			See Section 7.1.6 for example or explanation
54	Phase Instantaneous Over-current Trip (50P2 latch)			See Section 7.1.6 for example or explanation
55	Neutral Instantaneous Over-current Trip (50N2 latch)			See Section 7.1.6 for example or explanation
56	Phase Instantaneous Over-current Trip (50P3 latch)			See Section 7.1.6 for example or explanation

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
57	Neutral Instantaneous Over-current Trip (50N3 latch)			See Section 7.1.6 for example or explanation
58	Phase Time Over-current Enabled (51P latch)			See Section 7.1.6 for example or explanation
59	Neutral Time Over-current Enabled (51N latch)			See Section 7.1.6 for example or explanation
60	Overvoltage Trip (59 latch)			See Section 7.1.6 for example or explanation
61	Direct Over-current Trip Positive Sequence (67P-1 latch)			See Section 7.1.6 for example or explanation
62	Direct Over-current Trip Negative Sequence (67N latch)			See Section 7.1.6 for example or explanation
63	Frequency Shed (1st Stage) (81S-1 latch)			See Section 7.1.6 for example or explanation
64	Frequency Restore (1st Stage) (81R-1 latch)			See Section 7.1.6 for example or explanation
65	Over frequency (1st Stage) (81O-1 latch)			See Section 7.1.6 for example or explanation
66	Three Phase Under voltage Trip (27-3P latch)			See Section 7.1.6 for example or explanation
67	TRIP A Single Phase Trip (Phase A) (TRIP A latch)			See Section 7.1.6 for example or explanation
68	TRIP B Single Phase Trip (Phase B) (TRIP B latch)			See Section 7.1.6 for example or explanation
69	TRIP C Single Phase Trip (Phase C) (TRIP C latch)			See Section 7.1.6 for example or explanation
70	User Logical Output 1 (ULO1)			N/A in REF615R
71	User Logical Output 2 (ULO2)			N/A in REF615R
72	User Logical Output 3 (ULO3)			N/A in REF615R
73	User Logical Output 4 (ULO4)			N/A in REF615R
74	User Logical Output 5 (ULO5)			N/A in REF615R
75	User Logical Output 6 (ULO6)			N/A in REF615R
76	User Logical Output 7 (ULO7)			N/A in REF615R
77	User Logical Output 8 (ULO8)			N/A in REF615R
78	User Logical Output 9 (ULO9)			N/A in REF615R
79	Positive 3 Phase KVAR Alarm (PVARA)			N/A in REF615R
80	Negative 3 Phase KVAR Alarm (NVARA)			N/A in REF615R
81	Load Current Alarm (LOADA)	81	LD0.CMMXU1.HiAlm.stVal	
82	Over frequency (1st Stage) (81O-1)	82	LD0.FRPTOF1.Op.general	
83	Over frequency (2nd Stage) (81O-2)	83	LD0.FRPTOF2.Op.general	
84	Frequency Shed (2nd Stage) (81S-2)	84	LD0.LSHDPTRC2.Op.general	
85	Frequency Restore (2nd Stage) (81R-2)	85	LD0.LSHDPTRC2.RestLodOp.general	
86	Over frequency (2nd Stage) (81O-2 latch)			See Section 7.1.6 for example or explanation
87	Frequency Shed (2nd Stage) (81S-2 latch)			See Section 7.1.6 for example or explanation

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
88	Frequency Restore (2nd Stage) (81R-2 latch)			See Section 7.1.6 for example or explanation
89	Cold Load Timer Alarm (CLTA)	89	LD0.MVGAPC8.Q2.stVal	Configured by PCM600 ACT.
90	Positive Watt Alarm 1 (Watt1)			N/A in REF615R
91	Positive Watt Alarm 2 (Watt2)			N/A in REF615R
92	Reclose Counter Alarm 1 (79CA 1 latch)			See Section 7.1.6 for example or explanation
93	Reclose Counter Alarm 2 (79CA 2 latch)			See Section 7.1.6 for example or explanation
94	Sensitive Earth Fault (SEF latch)			See Section 7.1.6 for example or explanation
95	Sensitive Earth Fault Alarm (SEF)	95	LD0.EFLPTOC4.Op.general	
96	Alarm without Sensitive Earth Fault (w/o SEF)			N/A in REF615R
97	Trip Breaker Fail Trip (BF trip)	97	LD0.CCBRBRF1.InCBFlt.stVal	
98	Retrip Breaker Fail Retrip (BF retrip)	98	LD0.CCBRBRF1.OpIn.general	
99	Trip Breaker Fail Trip (BF trip latch)			See Section 7.1.6 for example or explanation
100	Retrip Breaker Fail Retrip (BF retrip latch)			See Section 7.1.6 for example or explanation
101	Phase Power Directional Alarm (positive sequence) (32P-2)			Please reference REF615R 0x address of 42 as it is mapped for (32 PA)
102	Phase Power Directional Alarm (negative sequence) (32N-2)			Please reference REF615R 0x address of 43 as it is mapped for (32 NA)
103	Phase Power Directional Alarm (positive sequence) (32P latch)			See Section 7.1.6 for example or explanation
104	Phase Power Directional Alarm (negative sequence) (32N latch)			See Section 7.1.6 for example or explanation
105	Breaker Failure Alarm (BFA latch)			See Section 7.1.6 for example or explanation
106	Synch Check Function (25 latch)			See Section 7.1.6 for example or explanation
107	Synch Check Function Operating (25)	107	LD0.SECRSYN1.Mod.blockIn	
108	Slow Breaker Alarm (SBA)			N/A in REF615R
109	Block Low Voltage Block Reclose (79V)			N/A in REF615R
110	Reclose Initiated (Reclose Initiated)	110	LD0.DARREC1.Op.general	
111	Ground Voltage (59G)	111	LD0.ROVPTOV1.Str.general	
112	Ground Voltage Latched (59G latch)			See Section 7.1.6 for example or explanation
113	Latching Output 1 (LO1)	113	LD0.SRGAPC1.Q1.stVal	
114	Latching Output 2 (LO2)	114	LD0.SRGAPC1.Q2.stVal	

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
115	Latching Output 3 (LO3)	115	LD0.SRGAPC1.Q3.stVal	
116	Latching Output 4 (LO4)	116	LD0.SRGAPC1.Q4.stVal	
117	Latching Output 5 (LO5)	117	LD0.SRGAPC1.Q5.stVal	
118	Latching Output 6 (LO6)	118	LD0.SRGAPC1.Q6.stVal	
119	Latching Output 7 (LO7)	119	LD0.SRGAPC1.Q7.stVal	
120	Latching Output 8 (LO8))	120	LD0.SRGAPC1.Q8.stVal	
121	ON Tagging Relay ON (TR ON)			N/A in REF615R
122	OFF Tagging Relay OFF (TR OFF)			N/A in REF615R
123	TAG Tagging Relay TAGGED (TR TAG)			N/A in REF615R
124	59 3 Phase Overvoltage (3PH 59)			N/A in REF615R
125	59 3 Phase Overvoltage Latched (3PH 59-1 latch)			N/A in REF615R
126	Negative Sequence Overvoltage (47)	126	LD0.NSPTOV1.Op.general	
127	Negative Sequence Overvoltage Latched (47 latch)			See Section 7.1.6 for example or explanation
128	Instantaneous 3 phase Over-current alarm disabled (50-3D)			See Section 7.1.7 for example or explanation
129	Phase Distance Zone 1 (21P-1)			N/A in REF615R
130	Phase Distance Zone 1 Latched (21P-1 latch)			N/A in REF615R
131	Phase Distance Zone 2 (21P-2)			N/A in REF615R
132	Phase Distance Zone 2 Latched (21P-2 latch)			N/A in REF615R
133	Phase Distance Zone 3 (21P-3)			N/A in REF615R
134	Phase Distance Zone 3 Latched (21P-3 latch)			N/A in REF615R
135	Phase Distance Zone 4 (21P-4)			N/A in REF615R
136	Phase Distance Zone 4 Latched (21P-4 latch)			N/A in REF615R
137	Control Button Status (C1 (Control Button 1))	137	LD0.SPCGGIO1.SPCSO1.stVal	
138	Control Button Status (C2 (Control Button 2))	138	LD0.SPCGGIO1.SPCSO2.stVal	
139	Control Button Status (C3 (Control Button 3))	139	LD0.SPCGGIO1.SPCSO3.stVal	
140	Control Button Status (C4 (Control Button 4))	140	LD0.SPCGGIO1.SPCSO4.stVal	
141	Control Button Status (C5 (Control Button 5))	141	LD0.SPCGGIO1.SPCSO5.stVal	
142	Control Button Status (C6 (Control Button 6))	142	LD0.SPCGGIO1.SPCSO6.stVal	
143	Trip Target (TripT)	143	LD0.LEDPTRC1.Op.general	
144	Neutral Target Alarm (NTA)	144	LD0.LEDGGIO1.ISCSO4.stVal	
145	Time Target (TimeT)	145	LD0.LEDGGIO1.ISCSO5.stVal	
146	Instantaneous Target (InstT)	146	LD0.LEDGGIO1.ISCSO6.stVal	
147	Negative Sequence Target (NegSeqT)	147	LD0.LEDGGIO1.ISCSO7.stVal	
148	Frequency Target (FreqT)	148	LD0.LEDGGIO1.ISCSO8.stVal	

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
149	Directional Target (DirT)	149	LD0.LEDGGIO1.ISCSO9.stVal	
150	Voltage Target (VoltT)	150	LD0.LEDGGIO1.ISCSO10.stVal	
151	Distance Target (DistT)	151	LD0.LEDGGIO1.ISCSO11.stVal	
152	Sensitive Earth Fault Target (SEFT)			N/A in REF615R
153	User Logical Output 10 Status (ULO10)			N/A in REF615R
154	User Logical Output 11 Status (ULO11)			N/A in REF615R
155	User Logical Output 12 Status (ULO12)			N/A in REF615R
156	User Logical Output 13 Status (ULO13)			N/A in REF615R
157	User Logical Output 14 Status (ULO14)			N/A in REF615R
158	User Logical Output 15 Status (ULO15)			N/A in REF615R
159	User Logical Output 16 Status (ULO16)			N/A in REF615R
160	Live Bus Live Line Status (LBLL)	160	LD0.SECRSYN1.LLLBInd.stVal	
161	Live Bus Dead Line Status (LBDL)	161	LD0.SECRSYN1.DLLBInd.stVal	
162	Dead Bus Live Line Status (DBLL)	162	LD0.SECRSYN1.LLDBInd.stVal	
163	Dead Bus Dead Line Status (DBDL)	163	LD0.SECRSYN1.DLDBInd.stVal	
164	Negative Sequence Time Over-current Trip Alarm (46A)	164	LD0.NSPTOC2.Op.general	
165	Negative Sequence Time Over-current Trip Alarm (46A latch)			See Section 7.1.6 for example or explanation
166	Local Remote Disabled Status (REMOTE D)	166	CTRL.LLN0.LocRem.stVal	
167	Setting Active Primary Settings are Active (Prim)	167	LD0.LLN0.Act1SG.stVal	
168	Alternate Setting Group 1 is Active (ALT1)	168	LD0.LLN0.Act2SG.stVal	
169	Alternate Setting Group 2 is Active (ALT2)	169	LD0.LLN0.Act3SG.stVal	
170	TEST SHIFTER A is in Position 1 (SHIFTA-1)			N/A in REF615R
171	TEST SHIFTER A is in Position 2 (SHIFTA-2)			N/A in REF615R
172	TEST SHIFTER A is in Position 3 (SHIFTA-3)			N/A in REF615R
173	TEST SHIFTER A is in Position 4 (SHIFTA-4)			N/A in REF615R
174	TEST SHIFTER B is in Position 1 (SHIFTB-1)			N/A in REF615R
175	TEST SHIFTER B is in Position 2 (SHIFTB-2)			N/A in REF615R
176	TEST SHIFTER B is in Position 3 (SHIFTB-3)			N/A in REF615R
177	TEST SHIFTER B is in Position 4 (SHIFTB-4)			N/A in REF615R

PATA, PBTA, PCTA are mapped to different coil addresses in REF615R with those in DPU2000R.

TRIPA, TRIPB, TRIPC are mapped to different coil addresses in REF615R with those in DPU2000R.

3.1.2 Physical output block (Single-bit data)

REF615R inherits the same layout of physical I/O channels from DPU2000R. Besides DPU2000R's normal speed I/O card, REF615R offers high speed I/O cards. As a result, REF615R extends Modbus points for physical output block (single-bit data) to the coil address of 288.

Table 2: Mitigations of Modbus registers mapping for the physical output points in single-bit block

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
257	Reserved Status	257		Normal speed BIO card
		273		High speed BIO card
258	Reserved Status	258		Normal speed BIO card
		274		High speed BIO card
259	Reserved Status	259		Normal speed BIO card
		275		High speed BIO card
260	Reserved Status	260		Normal speed BIO card
		276		High speed BIO card
261	Reserved Status	261		Normal speed BIO card
		277		High speed BIO card
262	Reserved Status	262		Normal speed BIO card
		278		High speed BIO card
263	OUT 8 (reserved) Status	263		Normal speed BIO card
		279		High speed BIO card
264	OUT 7 (reserved) Status	264		Normal speed BIO card
		280		High speed BIO card
265	OUT 6 Status	265	LD0.XUGGIO100.SPCSO6.stVal	Normal speed BIO card
		281	LD0.XBUGGIO110.SPCSO6.stVal	High speed BIO card
266	OUT 5 Status	266	LD0.XUGGIO100.SPCSO5.stVal	Normal speed BIO card
		282	LD0.XBUGGIO110.SPCSO5.stVal	High speed BIO card
267	OUT 4 Status	267	LD0.XUGGIO100.SPCSO4.stVal	Normal speed BIO card
		283	LD0.XBUGGIO110.SPCSO4.stVal	High speed BIO card
268	OUT 3 Status	268	LD0.XUGGIO100.SPCSO3.stVal	Normal speed BIO card
		284	LD0.XBUGGIO100.SPCSO3.stVal	High speed BIO card
269	OUT 2 Status	269	LD0.XUGGIO110.SPCSO2.stVal	Normal speed BIO card
		285	LD0.XBUGGIO100.SPCSO2.stVal	High speed BIO card

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
270	OUT 1 Status	270	LD0.XUGGIO110.SPCSO1.stVal	Normal speed BIO card
		86	LD0.XBUGGIO100.SPCSO1.stVal	High speed BIO card
271	CLOSE (Reserved) Status	271		Normal speed BIO card
		287		High speed BIO card
272	TRIP Status	272	LD0.XUGGIO100.SPCSO1.stVal	Normal speed BIO card
		288	LD0.XBUGGIO100.SPCSO4.stVal	High speed BIO card

3.1.3 Logical output block (Double-bit data with momentary change detection)

Like in DPU2000R, the logical output block in REF615R starts from coil address of 513 and ends with coil address of 866. The IEC61850 paths for the status points in double-bit block, if available, are the same as those in the logical output block with single-bit data. In REF615R, MCD (Momentary Change Detect) bits are implemented in the same way and mapped in the same address locations as the momentary bits in DPU2000R.

To know more about how MCD works, please read "REF615R Modbus Communication Protocol Manual", Document ID: 1MRS240047-IB.

Table 3: Mitigations of Modbus registers mapping for the logical output points in double-bit block

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
513	Breaker is Tripping (TRIP) Status	513	LD0.TRPPTRC1.Tr.general	
514	Breaker is Tripping (TRIP) Momentary	514		MCD bit of the previous point's status
515 - 866		515 - 866	Paths for the status points are the same as in the single-bit block if paths are available.	Same ACT logic as in single-bit block if solutions are available.

3.1.4 Physical output block (Double-bit data with momentary change detection)

Like in DPU2000R, the physical output block in REF615R starts from coil address of 1025 and ends with coil address of 1056 using the normal speed BIO cards. Because REF615R supports high speed BIO cards which are not available in DPU2000R, the ending coil address for this block extends to 1088.

The IEC61850 paths for the status points are the same as in the output block with single bit data. In REF615R, MCD (Momentary Change Detect) bits are implemented in the same way and mapped in the same address location as the momentary bits in DPU2000R.

Table 4: Mitigations of Modbus registers mapping for the physical output points in double-bit block

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
1025	Reserved Status	1025		Normal speed BIO card
		1057		High speed BIO card
1026	Reserved Momentary	1026		Normal speed BIO card
		1058		High speed BIO card
1027-1054		1027-1054	Paths for the status points are the same as in the single-bit block.	Normal speed BIO card
		1059-1086	Paths for the status points are the same as in the single-bit block.	High speed BIO card
1055	TRIP Status	1055	LD0.XUGGIO100.SPCSO1.stVal	Normal speed BIO card
		1087	LD0.XBUGGIO100.SPCSO4.stVal	High speed BIO card
1056	TRIP Momentary	1056		MCD bit of the previous point's status
		1088		MCD bit of the previous point's status

Section 4 1x Registers

4.1 Function code 2 (Read input status)

REF615R maps status information into two types of blocks as in DPU2000R. One is single-bit block, the other one is double-bit block. The single-bit block only provides status information, and the double-bit block provides both of the status and momentary change information.

REF615R maps the input status in the same register assignments and sequences as in DPU2000R. For the points without IEC61850 paths and their readings can only be obtained by PCM600 ACT configurations, their original register addresses in DPU2000R are reserved. Their new addresses are the addresses of those generic logic points.

Please check "Feeder Protection and Control REF615R Modbus Point List Manual", document ID: 1MRS240052-IB to find the Modbus point list mapping of the generic logical points.

For the Modbus logical input points in DPU2000R unable to be mapped in REF615R, their original Modbus address assignments are reversed.

Seal-in (latch) points in the logic input block are not directly mapped because they do not have IEC 61850 paths. The alternatives are either to read momentary change detect (MCD) bit from their corresponding points in the double-bit logical input block, or to use the generic set reset logic to program the seal-in point using PCM600 ACT. One example is given in Section 7.1.6, Figure 7.

4.1.1 Logical input block (single-bit data)

REF615R maps the single-bit logical input points in the same register assignments and sequence as in DPU2000R.

Table 5: Mitigations of Modbus registers mapping for the logical input block in single-bit block

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
10001	Breaker Status (52a = 1 52b = 0 CB Close) (52a)	10001	CTRL.CBCSWI1.PosCls.stVal	Apparatus close position

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
10002	Breaker Status (52a = 0 52b= 1 CB Open) (52b)	10002	CTRL.CBCSWI1.PosOpn.stVal	Apparatus open position
10003	Enable Reclose Function Asserted (43a)	10003	*LD0.DARREC1.AROn.stVal	Auto reclosing allowed
10004	Enable Phase Over current Protection for all Phase elements except 50P-3 (PH3)			See Section 7.2.1 for example or explanation
10005	Enable Ground Over current Protection for all Ground elements except 50N-3 (GRD)			See Section 7.2.2 for example or explanation
10006	Spring Charging Contact Function Enabled (SCC)	10006	LD0.SSCBR1.InSprCha.stVal	
10007	Single Shot Reclosing Enabled (79S)			N/A in REF615R
10008	Multiple Shot Reclosing Enabled (79M)	10008	LD0.DARREC1.InReClsOn.stVal	
10009	Trip Coil Monitoring Enabled (TCM)			N/A in REF615R
10010	Enable 50P-1 and 50N-1 (50-1)			See Section 7.2.3 for example or explanation
10011	Enable 50P-2 and 50N-2 (50-2)			See Section 7.2.4 for example or explanation
10012	Enable 50P-3 and 50N-3 (50-3)			See Section 7.2.5 for example or explanation
10013	Enable Alternate 1 Settings (ALT1)			See Section 7.2.6 for example or explanation
10014	Enable Alternate 2 Settings (ALT2)			See Section 7.2.7 for example or explanation
10015	Initiate Event Capture 1 (ECI1)			N/A in REF615R
10016	Initiate Event Capture 2 (ECI2)			N/A in REF615R
10017	Waveform Capture Initiate (WCI)		DR.RDRE1.RcdTrg.stVal	
10018	Enable Zone Sequence Coordination (ZSC)	10018	LD0.DARREC1.ProCrd.stVal	
10019	Initiate Trip Output (OPEN)	10019	CTRL.CBCSWI1.OpOpn.general	
10020	Initiate Close Output (CLOSE)	10020	CTRL.CBCSWI1.OpCls.general	
10021	Enable Negative Sequence Time Over current Function (46)	10021	LD0.NSPTOC1.Mod.blockIn	
10022	Enable Positive Sequence Directionally Controlled Phase Time Over current Function (67P-1)			N/A in REF615R
10023	Enable Negative Sequence Directionally Controlled Phase Time Over current Function (67N)			N/A in REF615R
10024	User Logical Input 1 Element Energized (ULI1)			N/A in REF615R
10025	User Logical Input 2 Element Energized (ULI2)			N/A in REF615R
10026	User Logical Input 3 Element Energized (ULI3)			N/A in REF615R
10027	User Logical Input 4 Element Energized (ULI4)			N/A in REF615R
10028	User Logical Input 5 Element Energized (ULI5)			N/A in REF615R
10029	User Logical Input 6 Element Energized (ULI6)			N/A in REF615R
10030	User Logical Input 7 Element Energized (ULI7)			N/A in REF615R
10031	User Logical Input 8 Element Energized (ULI8)			N/A in REF615R
10032	User Logical Input 9 Element Energized (ULI9)			N/A in REF615R

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
10033	Reclose and Over current Counters Cleared (CRI)			N/A in REF615R
10034	Automatic Reclose Inhibit Enabled (ARCI)	10034	LD0.DARREC1.InInhRec.stVal	Interrupts and inhibits reclosing sequence
10035	Initiate Trip and Auto Reclose Function (TARC)	10035	LD0.DARREC1.OpOpn.general	
10036	Sensitive Earth Fault Enabled (SEF TC)			N/A in REF615R
10037	External Starter Input Initiated (ExtBFI)			N/A in REF615R
10038	Breaker Fail Initiate (BFI)	10038	LD0.CCBRBRF1.InStr.stVal	
10039	User Defined Input (UDI)			N/A in REF615R
10040	Sync Check Enable (25)			N/A in REF615R
10041	Sync Check Bypass (25 Bypass)	10041	LD0.SECRSYN1.ByPss.stVal	
10042	Local Control Enabled (Local Enable)	10042	CTRL.LLN0.Loc.stVal	
10043	Target LED's Reset (TGT)			N/A in REF615R
10044	Seal In Alarm (SIA)			N/A in REF615R
10045	Latched Input 1 Set (LIS1)	10045	LD0.SRGAPC1.Set1.stVal	
10046	Latched Input 2 Set (LIS2)	10046	LD0.SRGAPC1.Set2.stVal	
10047	Latched Input 3 Set (LIS3)	10047	LD0.SRGAPC1.Set3.stVal	
10048	Latched Input 4 Set (LIS4)	10048	LD0.SRGAPC1.Set4.stVal	
10049	Latched Input 5 Set (LIS5)	10049	LD0.SRGAPC1.Set5.stVal	
10050	Latched Input 6 Set (LIS6)	10050	LD0.SRGAPC1.Set6.stVal	
10051	Latched Input 7 Set (LIS7)	10051	LD0.SRGAPC1.Set7.stVal	
10052	Latched Input 8 Set (LIS8)	10052	LD0.SRGAPC1.Set8.stVal	
10053	Latched Input 1 Reset (LIR1)	10053	LD0.SRGAPC1.Rs1.stVal	
10054	Latched Input 2 Reset (LIR2)	10054	LD0.SRGAPC1.Rs2.stVal	
10055	Latched Input 3 Reset (LIR3)	10055	LD0.SRGAPC1.Rs3.stVal	
10056	Latched Input 4 Reset (LIR4)	10056	LD0.SRGAPC1.Rs4.stVal	
10057	Latched Input 5 Reset (LIR5)	10057	LD0.SRGAPC1.Rs5.stVal	
10058	Latched Input 6 Reset (LIR6)	10058	LD0.SRGAPC1.Rs6.stVal	
10059	Latched Input 7 Reset (LIR7)	10059	LD0.SRGAPC1.Rs7.stVal	
10060	Latched Input 8 Reset (LIR8)	10060	LD0.SRGAPC1.Rs8.stVal	
10061	Tagging relay set (TR_SET)			N/A in REF615R
10062	Tagging relay reset (TR_RST)			N/A in REF615R
10063	User Logical Input 10 Status (ULI10)			N/A in REF615R
10064	User Logical Input 11 Status (ULI11)			N/A in REF615R
10065	User Logical Input 12 Status (ULI12)			N/A in REF615R
10066	User Logical Input 13 Status (ULI13)			N/A in REF615R
10067	User Logical Input 14 Status (ULI14)			N/A in REF615R
10068	User Logical Input 15 Status (ULI15)			N/A in REF615R
10069	User Logical Input 16 Status (ULI16)			N/A in REF615R

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
10070	Negative Sequence Time Over current Trip (46A)	10070	LD0.NSPTOC2.Mod.blockIn	
10071	Switch Set Test Status (SWSET)			N/A in REF615R
10072	Test Shift Register A Input Status (SHIFTA)			N/A in REF615R
10073	Test Shift Register B Input Status (SHIFTB)			N/A in REF615R

4.1.2 Physical input block (Single-bit data)

REF615R inherits the same layout of physical I/O channels from DPU2000R. Besides DPU2000R's normal speed I/O card, REF615R offers high speed I/O cards. As a result, REF615R extends Modbus points for physical input block (single-bit data) to input address of 10295.

Table 6: Mitigations of Modbus registers mapping for the physical input block in single-bit block

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
10257	IN13 (Reserved)	10257		Normal speed BIO card
		10273		High speed BIO card
10258	IN12 (Reserved)	10258		Normal speed BIO card
		10274		High speed BIO card
10259	IN11 (Reserved)	10259		Normal speed BIO card
		10293	LD0.XAUGGIO130.Ind11.stVal	High speed BIO card
10260	IN10 (Reserved)	10260		Normal speed BIO card
		10294	LD0.XAUGGIO130.Ind10.stVal	High speed BIO card
10261	IN9 (Reserved)	10261		Normal speed BIO card
		10295	LD0.XAUGGIO130.Ind9.stVal	High speed BIO card
10262	IN8	10262	LD0.XUGGIO110.Ind8.stVal	Normal speed BIO card
		10278	LD0.XBUGGIO110.Ind8.stVal	High speed BIO card
10263	IN7	10263	LD0.XUGGIO110.Ind7.stVal	Normal speed BIO card
		10279	LD0.XBUGGIO110.Ind7.stVal	High speed BIO card
10264	IN6	10264	LD0.XUGGIO110.Ind6.stVal	Normal speed BIO card
		10280	LD0.XBUGGIO110.Ind6.stVal	High speed BIO card
10265	IN5	10265	LD0.XUGGIO110.Ind5.stVal	Normal speed BIO card
		10281	LD0.XBUGGIO110.Ind5.stVal	High speed BIO card
10266	IN4	10266	LD0.XUGGIO110.Ind4.stVal	Normal speed BIO card
		10282	LD0.XBUGGIO110.Ind4.stVal	High speed BIO card
10267	IN3	10267	LD0.XUGGIO110.Ind3.stVal	Normal speed BIO card
		10283	LD0.XBUGGIO110.Ind3.stVal	High speed BIO card
10268	IN2	10268	LD0.XUGGIO110.Ind2.stVal	Normal speed BIO card
		10284	LD0.XBUGGIO110.Ind2.stVal	High speed BIO card

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
10269	IN1	10269	LD0.XUGGIO110.Ind1.stVal	Normal speed BIO card
		10285	LD0.XBUGGIO110.Ind1.stVal	High speed BIO card
10270	43a (reserved) status	10270		Normal speed BIO card
		10286		High speed BIO card
10271	52b (reserved) status	10271		Normal speed BIO card
		10287		High speed BIO card
10272	52a (reserved) status	10272		Normal speed BIO card
		10288		High speed BIO card

4.1.3 Logical Input Block (Double-bit data with momentary change detection)

Like in DPU2000R, the logical input block in REF615R starts from 1x address of 10513 and ends with 1x address of 10658. The IEC61850 path for the status points are the same as in the logical input block with single bit data. In REF615R, MCD (Momentary Change Detect) bits are implemented and mapped in the same way and same address locations as the momentary bits in DPU2000R.

Table 7: Mitigations of Modbus registers mapping for the logical input block in double bit block

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
10513	Breaker Status (52a = 1 52b = 0 CB Close) (52a)	10513	CTRL.CBCSWI1.PosCls.stVal	
10514	Breaker Status (52a = 1 52b = 0 CB Close) (52a) Momentary	10514		MCD bit of the previous point's status
10515	Breaker Status (52a = 0 52b = 1 CB Open) (52b)	10515	CTRL.CBCSWI1.PosOpn.stVal	
10516	Breaker Status (52a = 0 52b = 1 CB Open) (52b) Momentary	10516		MCD bit of the previous point's status
10517	Enable Reclose Function Asserted (43a)	10517	LD0.DARREC1.AROn.stVal	
-	-	-	-	-
10579	Automatic Reclose Inhibit Enabled (ARCI)	10579	LD0.DARREC1.InInhRec.stVal	
10519-10577 and 10581 to 10658			Paths for the status points are the same as in the single bit block.	

4.1.4 Physical input block (Double-bit data with momentary change detection)

Like in DPU2000R, the physical input block in REF615R starts from 1x address of 11025 and ends with 1x address of 11056 using the normal speed BIO cards. Because REF615R supports high speed BIO cards which are not available in DPU2000R, the ending 1x address for this block extends to 11102.

The IEC61850 path for the status points are the same as in the physical input block with single bit data. In REF615R, MCD (Momentary Change Detect) bits are implemented and mapped in the same way and same address locations as the momentary bits in DPU2000R.

Table 8: Mitigations of Modbus registers mapping for the physical input block in double-bit block

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
11025	IN13 (Reserved) status	11025		
11026	IN13 (Reserved) momentary	11026		
11027-11056		11027-11102	Paths for the status points are the same as in the single bit block.	

Section 5 4x Registers

5.1 Function Code 3 (Read holding register)

5.1.1 User programmable register block (UDR)

Table 9: Mitigations of Modbus user defined registers (UDR)

	DPU2000R	REF615R
Number of user defined registers	32	127
Register's starting address	40001	40001
Register's ending address	40032	40127
Configuration method	6x area registers	PCM600 CMT tool

In REF615R, only the signals having IEC61850 paths can be re-assigned to the user defined registers.

5.1.1.1 Example of remapping a discrete signal to a UDR

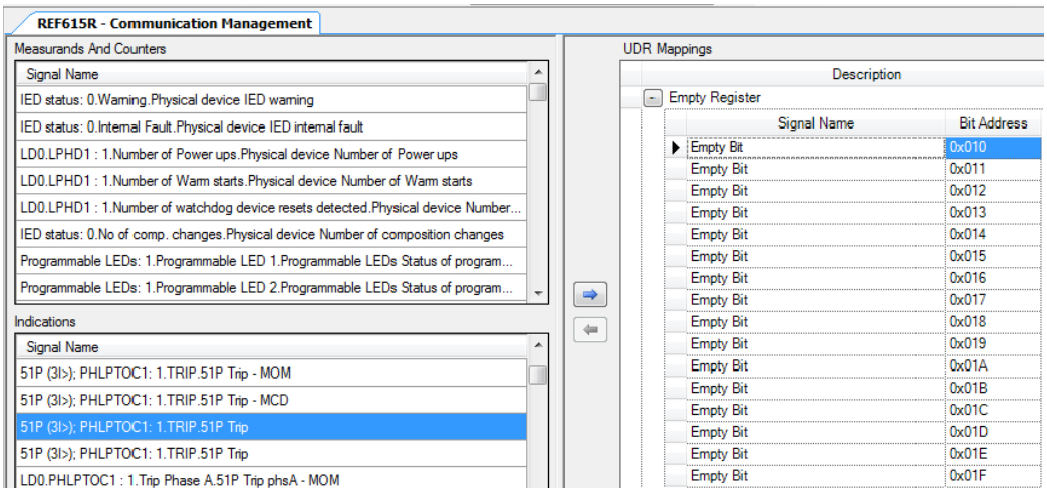

Figure 1: Snapshot of CMT in UDR view

In REF615R, user can reassign the signal to its new bit address using CMT UDR tool. As Figure 1 shows, user can highlight the signal of "51P (3I>): PHLPTOC1: 1 Trip 51P Trip" from the left pane, then expand the "Empty Register" from the right pane. In this example,

UDR 40001 is chosen. (Bit address 0x010 means 40001:00, and 0x1F means 40001:15, and 0x20 means 40002:00 etc). Select the first bit address, and click on the “Go to right” button  between the two panes, the signal will be remapped to the right pane as Figure 2 shows.

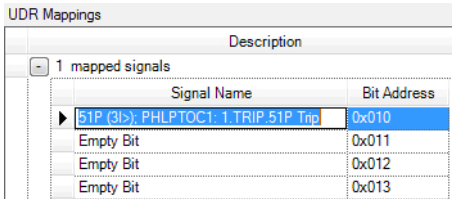

Figure 2: Snapshot of 51P remapped to 40001:00

Please note at the left pane, signal "51P (3I>): PHLPTOC1: 1 Trip 51P Trip" appears three times as Table 10 shows, it is because the signal is mapped three times at coil address: 12, 535 and 40897:4:

Table 10: Example and explanation of one digital signal (51P) in UDR view

item	Snapshot from PCM600 CMT UDR view left pane	Modbus addresses of the signals
1	51P (3I>); PHLPTOC1: 1.TRIP.51P Trip - MOM 51P (3I>); PHLPTOC1: 1.TRIP.51P Trip - MCD	Double-bit with MCD, address coil 535 for status (MOM bit), and coil 536 for change detect (MCD bit).
2	51P (3I>); PHLPTOC1: 1.TRIP.51P Trip	Single-bit, either coil address 12 or 4x address of 40897:4
3	51P (3I>); PHLPTOC1: 1.TRIP.51P Trip	Single-bit, either coil address 12 or 4x address of 40897:4

To remap the signal with double bits to UDR, one can pick up the signal with name containing "MOM". To map the signal with single bit to UDR, one can pick up the signal from either of the other two options.

The discrete signals packed into a UDR do not have to be in the same sequence as in theoriginal register. Moreover, the UDR can be packed with different discrete signals than what the original register contains.

5.1.1.2 Example of remapping an analog register to UDR

The purposes of remapping the analog measurement signals are often to change the scaling, and the offset, or to shift or clamp the data values, etc.

REF615R PCM600/CMT/UDR offers four scaling options: No scaling, Ratio scaling, Multiplicative scaling and Divisor scaling.

5.1.1.2.1 No scaling

The UDR will simply inherit its original register's scaling factor.

5.1.1.2.2 Ratio scaling

The description of how to apply ratio scaling can be found from "REF615R Modbus Communication Protocol Manual" document ID 1MRS240047-IB

5.1.1.2.3 Multiplicative scaling

The multiplicative scaling will multiply a scale factor on top of the original register's scale factor. It makes convert readings between primary, secondary and per unit very easy.

On the right pane of the PCM600/CMT UDR view, click on the "Scaling" pull down menu, and pick up "Multiplicative" option. Fill in the scale factor in the "Min in" column.

Example of converting phase A current reading from per unit to primary ampere is as following:

a. From the left pane of the UDR view, highlight the signal of "CMMXU1: 1. IA-A IA IB IC IA Amplitude magnitude of instantaneous value"

b. Pick up an available address from the right pane, and click on “Go to right” button  to move the signal to the right pane.

c. If the primary CT rating is 600A and if the original signal's scale factor keeps default value of 100, user only needs to fill in number of six into the "Min In" column. Eventually 600 will be UDR's effective multiplicative scaling.

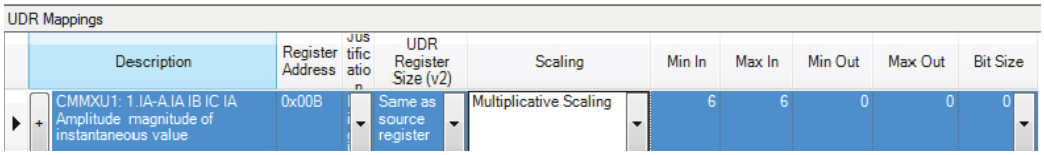

Figure 3: UDR multiplicative scaling factor for "LD0.CMMXU1.A.phsA.instCVal.mag.f"

5.1.1.2.4 Divisor scaling

The divisor scaling will divide a scale factor from original register's scale factor. It makes convert readings between primary, secondary and per unit very easy.

On the right pane of the PCM600/CMT UDR view, click on the "Scaling" pull down menu, and pick up "Divisor Scaling" option. Fill in the scale factor in the "Min in" column.

Example of converting phase A voltage reading from per unit to primary voltage is as following:

a. From the left pane of the UDR view, highlight the signal of "VMMXU1: 1.V_INST_A.VA VB VC VA Amplitude magnitude of instantaneous value."

b. Pick up an available address from the right pane, and click on “Go to Right” button  to move the signal to the right pane.

c. If the primary PT rating is 20KV, to get the primary voltage reading in KV, fill in five into the "Min In" column. It is because the original signal's scale factor is already 100. Thus, 20 (1/5*100 = 20) will be UDR's value's effective scaling. (It eventually multiplies voltage per unit reading by 20).

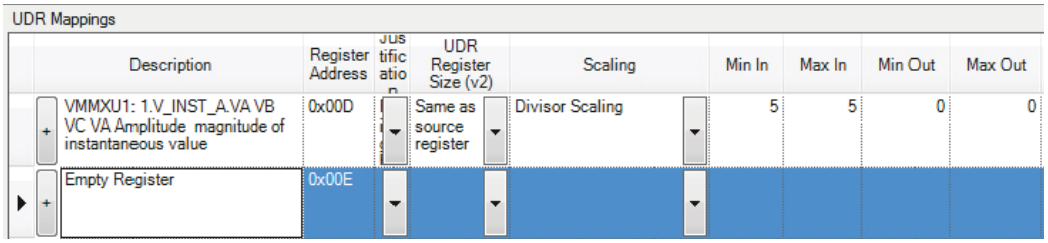

Figure 4: UDR divisor scaling factor to convert a voltage reading from pu to primary KV

If the original signal is mapped into 32 bit, the UDR shall keep it as 32 bit register by leaving the next register as "Empty Register".

5.1.2 System Status/Configuration Block

REF615R keeps as many status registers in DPU2000R as possible for the purpose of self diagnostics. The mappings for some registers without direct IEC 61850 paths, such as "heart beat", are implemented by software. Some registers in DPU2000R mapped for its obsolete hardware or device configurations are reserved as blanks.

Table 11: Mitigations of Modbus system status/configuration block

DPU2000R register addr.	DPU 2000R description	Scale	REF615R register addr.	Scale	IEC 61850 path	Comments on REF615R Modbus points mapping
40129:0	Self test status		40129:0			Self test status
40129:1	contact input changed		40129:1			contact input changed
40129:2	local settings changed					N/A in REF615R
40129:3	remote edit disable		40129:3			remote edit disable
40129:4	Alternate 1 Settings Active		40129:4			Alternate 1 Settings Active
40129:5	Alternate 2 Settings Active		40129:5			Alternate 2 Settings Active
40129:6	New Fault Recorded		40129:6			New Fault Recorded
40129:7	Control Power Cycled		40129:7			Control Power Cycled
40129:8	New Operation recorded		40129:8			New Operation recorded
40129:9	New peak demand value		40129:9			New peak demand value
40129:10	New minimum demand value		40129:10			New minimum demand value
40129:11	Momentary changes		40129:11			Momentary changes

DPU2000R register addr.	DPU 2000R description	Scale	REF615R register addr.	Scale	IEC 61850 path	Comments on REF615R Modbus points mapping
40129:12-40129:15	Spare		40129:12-40129:15			Spare
40130	Spare		40130			Spare
40131:0	CPU RAM FAILURE					Check register 40192, 80 = RAM error;
40131:1	CPU EPROM FAILURE					N/A in REF615R
40131:2	CPU NVRAM FAILURE					N/A in REF615R
40131:3	CPU EEPROM FAILURE					Check register 40192, 82 = EEPROM error;
40131:4	Spare					Spare
40131:5	Spare					Spare
40131:6	Spare					Spare
40131:7	Spare					Spare
40131:8	DSP ROM FAILURE					N/A in REF615R
40131:9	DSP INT RAM FAILURE					N/A in REF615R
40131:10	DSP EXT RAM FAILURE					N/A in REF615R
40131:11	DSP ADC FAILURE					N/A in REF615R
40131:12	DSP +/15v FAILURE					N/A in REF615R
40131:13	DSP +/-15V FAILURE					N/A in REF615R
40131:14	DSP +5V FAILURE					N/A in REF615R
40131:15	DSP COP FAILURE					N/A in REF615R
40132:15-40132:2	Spare					
40132:1	0=kWhr/kVARhr; 1=MWhr/MVARhr		40132:1			0=kWhr/kVARhr; 1=MWhr/MVARhr
40132:0	0=Wye PT; 1=Delta PT		40132:0			0=Wye PT; 1=Delta PT
40133-142	Catalog Number		40133-141		LD0.LPHD1.PhyNam.eOrdNum	replaced by order code.
40143	CPU software version number	100	40142:15-40142:8	1		delimiter
40144	Analog/DSP Software Version Number	10	40142:7 - 40143:7	1	LD0.LPHD1.PhyNam.swRev	replaced by CPU software version number
40145	Front Panel Controller Software Version Number	10	40144:15-40144:8	1		delimiter
40146	Auxiliary Communication Software Version Number	10	144:07 - 40151:(15-8)	1	LD0.IHMI1.EEName.swRev	replaced by Front Panel Controller Software Version Number
40147-148	Serial Number					Check device info. register at 49000
40149-157	Unit Name					Check device info. register at 49000
40158	Phase CT Ratio		40158			Phase CT Ratio
40159	Neutral CT Ratio		40159			Neutral CT Ratio
40160	PT Ratio		40160			PT Ratio
40161	Last Power Fail Timestamp Year		40161			Last Power Fail Timestamp Year

DPU2000R register addr.	DPU 2000R description	Scale	REF615R register addr.	Scale	IEC 61850 path	Comments on REF615R Modbus points mapping
40162	Last Power Fail Timestamp Month		40162			Last Power Fail Timestamp Month
40163	Last Power Fail Timestamp Day		40163			Last Power Fail Timestamp Day
40164	Last Power Fail Timestamp Hours		40164			Last Power Fail Timestamp Hours
40165	Last Power Fail Timestamp Minutes		40165			Last Power Fail Timestamp Minutes
40166	Last Power Fail Timestamp Seconds		40166			Last Power Fail Timestamp Seconds
40167	Last Power Fail Timestamp Hundredths of Seconds		40167			Last Power Fail Timestamp Hundredths of Seconds
40168	Last Power Fail Type		40168			Last Power Fail Type
40169	Last Power Fail State Machine Current State					N/A in REF615R
40170:15 - 40170:8	Heart Beat Counter		40170:15 - 40170:8			Heart Beat Counter
40170:7	Spare					Spare
40170:6	1=One or More Unreported Operations Records		40170:6			1=One or More Unreported Operations Records
40170:5 - 40170:0	Division code = 00101 binary					N/A in REF615R
40171:15 - 40171:10	Product Code = 001110 binary					N/A in REF615R
40171:9 - 40171:8	Spare					N/A in REF615R
40171:7 - 40171:6	Reserved for Corporate Status					N/A in REF615R
40171:5	Reserved for Local Operator Action					N/A in REF615R
40171:4 - 40171:0	Spare					N/A in REF615R
40172	Last communication error comm. Port type					N/A in REF615R
40173	Last communications error command					N/A in REF615R
40174	Last communications error register					N/A in REF615R
40175	Last communication error type					N/A in REF615R
40176-177	editor write mask 1					N/A in REF615R
40178-179	editor write mask 2					N/A in REF615R
N/A	N/A		40192		LD0.LPHD2.PhyHealth2.stVal	REF615R physical device internal fault, not available in DPU2000R

REF615R provides another set of 6 system status registers (SSR1, SSR2, SSR3, SSR4, SSR5, SSR6). REF615R also provides device information registers. Please check "Feeder Protection and Control REF615R Modbus Point List Manual", document ID1MRS240052-IB, and "REF615R Modbus Communication Protocol Manual", document ID 1MRS240047-IB to find out more information.

5.1.3 RMS Load Current/Angular Values Block

REF615R has mapped the majority of load current/angular value registers the same as in DPU2000R. The default scaling of the current and voltage readings are 100 as default, it is because different from providing primary value in ampere or KV as DPU2000R Modbus server did, REF615R Modbus server provides current and voltage readings as per unit.

To change the scaling of the default measurement readings in per unit to primary readings, one can use PCM600 CMT tool to configure the scaling factors.

For example as shown in Figure 5, to read primary ampere of load current A at address 40257, one can change the signal's default scaling to 600 after finding out the CT's primary ampere rating is 600A.

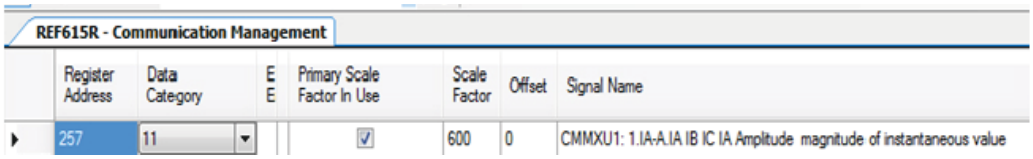

Figure 5: Snapshot on scaling load current A from CMT to read primary current in ampere.

Another way is to remap the register for "Load Current-A" to a UDR as described in Section 5.1.1.2.3 and Section 5.1.1.2.4.

Table 12: Mitigations of Modbus mappings for RMS load current/angular values block

DPU2000R register addr.	DPU 2000R description	Scale	REF615R register addr.	Scale	IEC 61850 path	Comments on REF615R Modbus points mapping
40257	Load Current A	1	40257	100	LD0.CMMXU1.A.phsA.instCVal.mag.f	reading per unit value by default
40258	Load Current A Angle	1	40258	1	LD0.CMMXU1.A.phsA.instCVal.ang.f	
40259	Load Current B	1	40259	100	LD0.CMMXU1.A.phsB.instCVal.mag.f	reading per unit value by default
40260	Load Current B Angle	1	40260	1	LD0.CMMXU1.A.phsB.instCVal.ang.f	
40261	Load Current C	1	40261	100	LD0.CMMXU1.A.phsC.instCVal.mag.f	reading per unit value by default
40262	Load Current C Angle	1	40262	1	LD0.CMMXU1.A.phsC.instCVal.ang.f	
40263	Load Current N	1	40263	100	LD0.RESCMMXU1.A.res.instCVal.mag.f	reading per unit value by default
40264	Load Current N Angle	1	40264	1	LD0.RESCMMXU1.A.res.instCVal.ang.f	

DPU2000R register addr.	DPU 2000R description	Scale	REF615R register addr.	Scale	IEC 61850 path	Comments on REF615R Modbus points mapping
40265-266	Voltage VAN	1	40265-266	100	LD0.VMMXU1.PhV.phsA.cVal.mag.f	reading per unit value by default
40267	Voltage VAN Angle	1	40267	1	LD0.VMMXU1.PhV.phsA.cVal.ang.f	
40268-269	Voltage VBN	1	40268-269	100	LD0.VMMXU1.PhV.phsB.cVal.mag.f	reading per unit value by default
40270	Voltage VBN Angle	1	40270	1	LD0.VMMXU1.PhV.phsB.cVal.ang.f	
40271-272	Voltage VCN	1	40271-272	100	LD0.VMMXU1.PhV.phsC.cVal.mag.f	reading per unit value by default
40273	Voltage VCN Angle	1	40273	1	LD0.VMMXU1.PhV.phsC.cVal.ang.f	
40274-275	Voltage VAB	1	40274-275	100	LD0.VMMXU1.PPV.phsAB.instCVal.mag.f	reading per unit value by default
40276	Voltage VAB Angle	1	40276	1	LD0.VMMXU1.PPV.phsAB.instCVal.ang.f	
40277-278	Voltage VBC	1	40277-278	100	LD0.VMMXU1.PPV.phsBC.instCVal.mag.f	reading per unit value by default
40279	Voltage VBC Angle	1	40279	1	LD0.VMMXU1.PPV.phsBC.instCVal.ang.f	
40280-281	Voltage VCA	1	40280-281	100	LD0.VMMXU1.PPV.phsCA.instCVal.mag.f	reading per unit value by default
40282	Voltage VCA Angle	1	40282	1	LD0.VMMXU1.PPV.phsCA.instCVal.ang.f	
40283-284	kWatts A	1	40283-284	1	LD0.SPEMMXU1.W.phsA.instCVal.mag.f	
40285-286	kWatts B	1	40285-286	1	LD0.SPEMMXU1.W.phsB.instCVal.mag.f	
40287-288	kWatts C	1	40287-288	1	LD0.SPEMMXU1.W.phsC.instCVal.mag.f	
40289-290	3 Phase kWatts	1	40289-290	1	LD0.PEMMXU1.TotW.instMag.f	
40291-292	kVARs A	1	40291-292	1	LD0.SPEMMXU1.VAr.phsA.instCVal.mag.f	
40293-294	kVARs B	1	40293-294	1	LD0.SPEMMXU1.VAr.phsB.instCVal.mag.f	
40295-296	kVARs C	1	40295-296	1	LD0.SPEMMXU1.VAr.phsC.instCVal.mag.f	
40297-298	3 Phase kVARs	1	40297-298	1	LD0.PEMMXU1.TotVAr.instMag.f	
40299-300	kWatt Hours A	1	40299-300	1	LD0.SPEMMTR1.DmdWhA.actVal	active energy (demand)
			40364-365	1	LD0.SPEMMTR1.SupWhA.actVal	active energy (supply)
40301-302	kWatt Hours B	1	40301-302	1	LD0.SPEMMTR1.DmdWhB.actVal	active energy (demand)
			40366-367	1	LD0.SPEMMTR1.SupWhB.actVal	active energy (supply)
40303-304	kWatt Hours C	1	40303-304	1	LD0.SPEMMTR1.DmdWhC.actVal	active energy (demand)
			40368-369	1	LD0.SPEMMTR1.SupWhC.actVal	active energy (supply)
40305-306	kWatt Hours 3 Phase (demand)	1	40305-306	1	LD0.PEMMTR1.DmdWh.actVal	active energy (demand)
			40370 - 371	1	LD0.PEMMTR1.SupWh.actVal	active energy (supply)
40307-308	kVAR Hours A	1	40307-308	1	LD0.SPEMMTR1.DmdVArhA.actVal	reactive energy (demand)
			40372-373	1	LD0.SPEMMTR1.SupVArhA.actVal	reactive energy (supply)

DPU2000R register addr.	DPU 2000R description	Scale	REF615R register addr.	Scale	IEC 61850 path	Comments on REF615R Modbus points mapping
40309-310	kVAR Hours B	1	40309-310	1	LD0.SPEMMTR1.DmdVArhB.actVal	reactive energy (demand)
			40374-375	1	LD0.SPEMMTR1.SupVArhB.actVal	reactive energy (supply)
40311-312	kVAR Hours C	1	40311-312	1	LD0.SPEMMTR1.DmdVArhC.actVal	reactive energy (demand)
			40376-377	1	LD0.SPEMMTR1.SupVArhC.actVal	reactive energy (supply)
40313-314	kVAR Hours 3 Phase(demand)	1	40313-314	1	LD0.PEMMTR1.DmdVArh.actVal	reactive energy (demand)
			40378 - 379	1	LD0.PEMMTR1.SupVArh.actVal	reactive energy (supply)
40315	Zero Sequence Current (computed)	1				N/A in REF615R
40316	Zero Sequence Current Angle (computed)	1				N/A in REF615R
40317	Positive Sequence Current	1	40317	100	LD0.CSMSQI1.SeqA.c1.instCVal.mag.f	reading per unit value by default
40318	Positive Sequence Current Ang1e	1	40318	1	LD0.CSMSQI1.SeqA.c1.instCVal.ang.f	
40319	Negative Sequence Current	1	40319	100	LD0.CSMSQI1.SeqA.c2.instCVal.mag.f	reading per unit value by default
40320	Negative Sequence Current Angle	1	40320	1	LD0.CSMSQI1.SeqA.c2.instCVal.ang.f	
40321-322	Positive Sequence Voltage Magnitude	1	40321-322	100	LD0.VSMSQI1.SeqV.c1.instCVal.mag.f	reading per unit value by default
40323	Positive Sequence Voltage Angle	1	40323	1	LD0.VSMSQI1.SeqV.c1.instCVal.ang.f	
40324-325	Negative Sequence Voltage Magnitude	1	40324-325	100	LD0.VSMSQI1.SeqV.c2.instCVal.mag.f	reading per unit value by default
40326	Negative Sequence Voltage Angle	1	40326	1	LD0.VSMSQI1.SeqV.c2.instCVal.ang.f	
40327	System Frequency	100	40327	100	LD0.FMMXU1.Hz.instMag.f	
40328	Power Factor	1	40328	100	LD0.PEMMXU1.TotPF.instMag.f	
40329-330	Zero Sequence Current Mag. (measured)	1	40329-330	100	LD0.CSMSQI1.SeqA.c3.instCVal.mag.f	reading per unit value by default
40331	Zero Sequence Current Angle (measured)	1	40331	1	LD0.CSMSQI1.SeqA.c3.instCVal.ang.f	
40332-333	Zero Sequence Voltage Mag (measured)	1	40332-333	100	LD0.VSMSQI1.SeqV.c3.instCVal.mag.f	reading per unit value by default
40334	Zero Sequence Voltage Angle (measured)	1	40334	1	LD0.VSMSQI1.SeqV.c3.instCVal.ang.f	
40335	Power Factor	1	40335	100	LD0.PEMMXU1.TotPF.instMag.f	
40336	Power Factor Status	1	40336	1	LD0.PEMMXU1.TotPF.instMag.f	
40337-338	KVA-3	1	40337-338	1	LD0.PEMMXU1.TotVA.instMag.f	

DPU2000R register addr.	DPU 2000R description	Scale	REF615R register addr.	Scale	IEC 61850 path	Comments on REF615R Modbus points mapping
40339	Fault Distance	1	40339	1	LD0.DRFLO1.FltDisKm.mag.f	
40340-341	Vbus to Vline Voltage Difference	1	40340-341	100	LD0.SECRSYN1.DifVClc.mag.f	reading per unit value by default
40342	Vbus to Vline Angle Difference	1	40342	1	LD0.SECRSYN1.DifAngClc.mag.f	
40343	Sync Check Slip Frequency	1	40343	1000	LD0.SECRSYN1.DifHzClc.mag.f	
40344-345	Zero Sequence Voltage Mag (Derived)	1				N/A in REF615R
40346	Zero Sequence Voltage Ang (Derived)	1				N/A in REF615R
40347	substation battery (Vdc)	1				N/A in REF615R

5.1.4 RMS Demand Current/Real and Reactive Power Values Block

REF615R maps all the registers in this block in the same way as in DPU2000R except some scaling factor difference. Please see Section 5.1.3 on how to change the default scaling factors.

Table 13: Mitigation of Modbus mappings for RMS demand current/real and reactive power values block

DPU2000R register addr.	DPU2000R description	Scale	REF615R register addr.	Scale	IEC61850 path	Comments on REF615R Modbus points mapping
40385	Demand Current-A	1	40385	100	LD0.CMSTA1.AvAmpsA.mag.f	reading per unit value by default
40386	Demand Current-B	1	40386	100	LD0.CMSTA1.AvAmpsB.mag.f	reading per unit value by default
40387	Demand Current-C	1	40387	100	LD0.CMSTA1.AvAmpsC.mag.f	reading per unit value by default
40388	Demand Current-N	1	40388	100	LD0.RESCMSTA1.AvAmps.mag.f	reading per unit value by default
40389-390	Demand kWatts-A	1	40389-390	1	LD0.SPEMSTA1.AvWPhsA.mag.f	
40391-392	Demand kWatts-B	1	40391-392	1	LD0.SPEMSTA1.AvWPhsB.mag.f	
40393-394	Demand kWatts-C	1	40393-394	1	LD0.SPEMSTA1.AvWPhsC.mag.f	
40395-396	3 Phase Demand kWatts	1	40395-396	1	LD0.PEMSTA1.AvW.mag.f	
40397-398	Demand kVARs-A	1	40397-398	1	LD0.SPEMSTA1.AvVArPhsA.mag.f	
40399-400	Demand kVARs-B	1	40399-400	1	LD0.SPEMSTA1.AvVArPhsB.mag.f	
40401-402	Demand kVARs-C	1	40401-402	1	LD0.SPEMSTA1.AvVArPhsC.mag.f	
40403-404	3 Phase Demand kVARs	1	40403-404	1	LD0.PEMSTA1.AvVAr.mag.f	

5.1.5 RMS Peak Demand Current/Real, Reactive Power Values and Time Stamps Block

REF615R maps all the registers in this block in the same way as in DPU2000R except some scaling factor differences. Please see Section 5.1.3 on how to change the default scaling factors.

Table 14: Mitigation of Modbus mappings for peak demand current/real, reactive power values and time stamps blocks

DPU2000R register addr.	DPU2000R description	Scale	REF615R register addr.	Scale	IEC61850 path	Comments on REF615R Modbus points mapping
40513	Peak Demand Current-A	1	40513	100	LD0.CMSTA1.MaxAmpsA.mag.f	reading per unit value by default
40514	Peak Demand Current-A Year, Month		40514		LD0.CMSTA1.MaxAmpsA.t	Year, Month
40515	Peak Demand Current-A Day, Hour		40515			Day, Hour
40516	Peak Demand Current-A Minute		40516			Minute
40517	Peak Demand Current-B	1	40517	100	LD0.CMSTA1.MaxAmpsB.mag.f	reading per unit value by default
40518	Peak Demand Current-B Year, Month		40518		LD0.CMSTA1.MaxAmpsB.t	Year, Month
40519	Peak Demand Current-B Day, Hour		40519			Day, Hour
40520	Peak Demand Current-B Minute		40520			Minute
40521	Peak Demand Current-C	1	40521	100	LD0.CMSTA1.MaxAmpsC.mag.f	reading per unit value by default
40522	Peak Demand Current-C Year, Month		40522		LD0.CMSTA1.MaxAmpsC.t	Year, Month
40523	Peak Demand Current-C Day, Hour		40523			Day, Hour
40524	Peak Demand Current-C Minute		40524			Minute
40525	Peak Demand Current-N	1	40525	100	LD0.RESCMSTA1.MaxAmps.mag.f	reading per unit value by default
40526	Peak Demand Current-N Year, Month		40526		LD0.RESCMSTA1.MaxAmps.t	Year, Month
40527	Peak Demand Current-N Day, Hour		40527			Day, Hour
40528	Peak Demand Current-N Minute		40528			Minute
40529	Peak Demand KWatts-A	1	40529	1	LD0.SPEMSTA1.MaxWPhsA.mag.f	
40531	Peak Demand KWatts-A Year, Month		40531		LD0.SPEMSTA1.MaxWPhsA.t	Year, Month
40532	Peak Demand KWatts-A Day, Hour		40532			Day, Hour
40533	Peak Demand KWatts-A Minute		40533			Minute
40534	Peak Demand KWatts-B	1	40534	1	LD0.SPEMSTA1.MaxWPhsB.mag.f	
40536	Peak Demand KWatts-B Year, Month		40536		LD0.SPEMSTA1.MaxWPhsB.t	Year, Month
40537	Peak Demand KWatts-B Day, Hour		40537			Day, Hour

DPU2000R register addr.	DPU2000R description	Scale	REF615R register addr.	Scale	IEC61850 path	Comments on REF615R Modbus points mapping
40538	Peak Demand KWatts-B Minute		40538			Minute
40539	Peak Demand KWatts-C	1	40539	1	LD0.SPEMSTA1.MaxWPhsC.mag.f	
40541	Peak Demand KWatts-C Year, Month		40541		LD0.SPEMSTA1.MaxWPhsC.t	Year, Month
40542	Peak Demand KWatts-C Day, Hour		40542			Day, Hour
40543	Peak Demand KWatts-C Minute		40543			Minute
40544	3 Phase Peak Demand KWatts	1	40544	1	LD0.PEMSTA1.MaxW.mag.f	
40546	3 Phase Peak Demand KWatts Year, Month		40546		LD0.PEMSTA1.MaxW.t	Year, Month
40547	3 Phase Peak Demand KWatts Day, Hour		40547			Day, Hour
40548	3 Phase Peak Demand KWatts Minute		40548			Minute
40549	Peak Demand KVARs-A	1	40549	1	LD0.SPEMSTA1.MaxVArPhsA.mag.f	
40551	Peak Demand KVARs-A Year, Month		40551		LD0.SPEMSTA1.MaxVArPhsA.t	Year, Month
40552	Peak Demand KVARs-A Day, Hour		40552			Day, Hour
40553	Peak Demand KVARs-A Minute		40553			Minute
40554	Peak Demand KVARs-B	1	40554	1	LD0.SPEMSTA1.MaxVArPhsB.mag.f	
40556	Peak Demand KVARs-B Year, Month		40556		LD0.SPEMSTA1.MaxVArPhsB.t	Year, Month
40557	Peak Demand KVARs-B Day, Hour		40557			Day, Hour
40558	Peak Demand KVARs-B Minute		40558			Minute
40559	Peak Demand KVARs-C	1	40559	1	LD0.SPEMSTA1.MaxVArPhsC.mag.f	
40561	Peak Demand KVARs-C Year, Month		40561		LD0.SPEMSTA1.MaxVArPhsC.t	Year, Month
40562	Peak Demand KVARs-C Day, Hour		40562			Day, Hour
40563	Peak Demand KVARs-C Minute		40563			Minute
40564	3 Phase Peak Demand KVARs	1	40564	1	LD0.PEMSTA1.MaxVAr.mag.f	
40566	3 Phase Peak Demand KVARs Year, Month		40566		LD0.PEMSTA1.MaxVAr.t	Year, Month
40567	3 Phase Peak Demand KVARs Day, Hour		40567			Day, Hour
40568	3 Phase Peak Demand KVARs Minute		40568			Minute

5.1.6 RMS Minimum Demand Current/Real, Reactive Power Values and Time Stamps

REF615R maps all the registers in this block in the same way as in DPU2000R. Please see Section 5.1.3 on how to change the default scaling factors.

Table 15: Mitigation of Modbus mappings for minimum demand current/real, reactive power values and time stamps block

DPU2000R register addr.	DPU2000R description	Scale	REF615R register addr.	Scale	IEC61850 path	Comments on REF615R Modbus points mapping
40641	Minimum Demand Current-A	1	40641	100	LD0.CMSTA1.MinAmpsA.mag.f	reading per unit value by default
40642	Minimum Demand Current-A Year, Month		40642		LD0.CMSTA1.MinAmpsA.t	Year, Month
40643	Minimum Demand Current-A Day, Hour		40643			Day, Hour
40644	Minimum Demand Current-A Minute		40644			Minute
40645	Minimum Demand Current-B	1	40645	100	LD0.CMSTA1.MinAmpsB.mag.f	reading per unit value by default
40646	Minimum Demand Current-B Year, Month		40646		LD0.CMSTA1.MinAmpsB.t	Year, Month
40647	Minimum Demand Current-B Day, Hour		40647			Day, Hour
40648	Minimum Demand Current-B Minute		40648			Minute
40649	Minimum Demand Current-C	1	40649	100	LD0.CMSTA1.MinAmpsC.mag.f	reading per unit value by default
40650	Minimum Demand Current-C Year, Month		40650		LD0.CMSTA1.MinAmpsC.t	Year, Month
40651	Minimum Demand Current-C Day, Hour		40651			Day, Hour
40652	Minimum Demand Current-C Minute		40652			Minute
40653	Minimum Demand Current-N	1	40653	100	LD0.RESCMSTA1.MinAmps.mag.f	reading per unit value by default
40654	Minimum Demand Current-N Year, Month		40654		LD0.RESCMSTA1.MinAmps.t	Year, Month
40655	Minimum Demand Current-N Day, Hour		40655			Day, Hour
40656	Minimum Demand Current-N Minute		40656			Minute
40657	Minimum Demand KWatts-A	1	40657	1	LD0.SPEMSTA1.MinWPhsA.mag.f	
40659	Minimum Demand KWatts-A Year, Month		40659		LD0.SPEMSTA1.MinWPhsA.t	Year, Month
40660	Minimum Demand KWatts-A Day, Hour		40660			Day, Hour
40661	Minimum Demand KWatts-A Minute		40661			Minute
40662	Minimum Demand KWatts-B	1	40662	1	LD0.SPEMSTA1.MinWPhsB.mag.f	
40664	Minimum Demand KWatts-B Year, Month		40664		LD0.SPEMSTA1.MinWPhsB.t	Year, Month
40665	Minimum Demand KWatts-B Day, Hour		40665			Day, Hour
40666	Minimum Demand KWatts-B Minute		40666			Minute
40667	Minimum Demand KWatts-C	1	40667	1	LD0.SPEMSTA1.MinWPhsC.mag.f	
40669	Minimum Demand KWatts-C Year, Month		40669		LD0.SPEMSTA1.MinWPhsC.t	Year, Month
40670	Minimum Demand KWatts-C Day, Hour		40670			Day, Hour

DPU2000R register addr.	DPU2000R description	Scale	REF615R register addr.	Scale	IEC61850 path	Comments on REF615R Modbus points mapping
40671	Minimum Demand KWatts-C Minute		40671			Minute
40672	3 Phase Minimum Demand KWatts	1	40672	1	LD0.PEMSTA1.MinW.mag.f	
40674	3 Phase Minimum Demand KWatts Year, Month		40674		LD0.PEMSTA1.MinW.t	Year, Month
40675	3 Phase Minimum Demand KWatts Day, Hour		40675			Day, Hour
40676	3 Phase Minimum Demand KWatts Minute		40676			Minute
40677	Minimum Demand KVARs-A	1	40677	1	LD0.SPEMSTA1.MinVArPhsA.mag.f	
40679	Minimum Demand KVARs-A Year, Month		40679		LD0.SPEMSTA1.MinVArPhsA.t	Year, Month
40680	Minimum Demand KVARs-A Day, Hour		40680			Day, Hour
40681	Minimum Demand KVARs-A Minute		40681			Minute
40682	Minimum Demand KVARs-B	1	40682	1	LD0.SPEMSTA1.MinVArPhsB.mag.f	
40684	Minimum Demand KVARs-B Year, Month		40684		LD0.SPEMSTA1.MinVArPhsB.t	Year, Month
40685	Minimum Demand KVARs-B Day, Hour		40685			Day, Hour
40686	Minimum Demand KVARs-B Minute		40686			Minute
40687	Minimum Demand KVARs-C	1	40687	1	LD0.SPEMSTA1.MinVArPhsC.mag.f	
40689	Minimum Demand KVARs-C Year, Month		40689		LD0.SPEMSTA1.MinVArPhsC.t	Year, Month
40690	Minimum Demand KVARs-C Day, Hour		40690			Day, Hour
40691	Minimum Demand KVARs-C Minute		40691			Minute
40692	3 Phase Minimum Demand KVARs	1	40692	1	LD0.PEMSTA1.MinVAr.mag.f	
40694	3 Phase Minimum Demand KVARs Year, Month		40694		LD0.PEMSTA1.MinVAr.t	Year, Month
40695	3 Phase Minimum Demand KVARs Day, Hour		40695			Day, Hour
40696	3 Phase Minimum Demand KVARs Minute		40696			Minute

5.1.7 Counters Block

REF615R maps the counter block in DPU2000R's as Table 16 shows.

Table 16: Mitigation of Modbus mappings for counter block

DPU2000R register addr.	DPU2000R description	Scale	REF615R register addr.	Scale	IEC61850 path	Comments on REF615R Modbus points mapping
40769	unread operation counter	1	40769	1		unread operation counter
40770	unread fault counter	1	40770	1		unread fault counter
40771	Sum of fault current A	1				Read addr. 42010 for reference.

DPU2000R register addr.	DPU2000R description	Scale	REF615R register addr.	Scale	IEC61850 path	Comments on REF615R Modbus points mapping
40772	Sum of fault current B	1				Read addr. 42012 for reference.
40773	sum of fault current C	1				Read addr. 42014 for reference.
40774	Over current trip counter	1				See Section Section 7 for example or explanation
40775	breaker operations counter	1	40775	1	LD0.SSCBR1.OpCnt.stVal	
40776	Recloser Counter 1	1	40776	1	LD0.DARREC1.FrqOpCnt.stVal	
40777	Recloser Counter 2	1	40777	1		N/A in REF615R
40778	State 1 Reclose Counter	1	40778	1	LD0.DARREC1.OpCnt1.stVal	
40779	State 2 Reclose Counter	1	40779	1	LD0.DARREC1.OpCnt2.stVal	
40780	State 3 Reclose Counter	1	40780	1	LD0.DARREC1.OpCnt3.stVal	
40781	State 4 Reclose Counter	1	40781	1	LD0.DARREC1.OpCnt4.stVal	
40782	State 5 Reclose Counter	1	40782	1	LD0.DARREC1.OpCnt5.stVal	
40771	Sum of fault current A	1	42010	100	LD0.SSCBR1.AccAPwrPhA.mag.f	Can be used for Sum of fault current A
40772	Sum of fault current B	1	42012	100	LD0.SSCBR1.AccAPwrPhB.mag.f	Can be used for Sum of fault current B
40773	Sum of fault current C	1	42014	100	LD0.SSCBR1.AccAPwrPhC.mag.f	Can be used for Sum of fault current C

5.1.8 Physical and Logical Input / Output state Block

REF615R maps the 4x registers with packed bits in the same address locations as in DPU2000R. The table 17 gives an example of packed bits in 40897.

Table 17: Mitigation of Modbus physical and logical input/output state block

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
40897:15	Breaker is Tripping (TRIP)	40897:15	LD0.TRPPTRC1.Tr.general	
40897:14	Breaker is Closing (Close)	40897:14	LD0.MVGAPC8.Q3.stVal	Configured by PCM600 tool.
40897:13	DPU is in ALARM (ALARM)	40897:13	LD0.LLN0.Health.stVal	Converted enum value to boolean to read ALARM status
40897:12	Under voltage Trip (27-1P)	40897:12	LD0.PHPTUV1.Op.general	
40897:11	Negative Sequence Over-current Trip (46)	40897:11	LD0.NSPTOC1.Op.general	
40897:10	Phase Instantaneous Over-current Trip (50P1)	40897:10	LD0.PHHPTOC1.Op.general	
40897:9	Neutral Instantaneous Over-current Trip (50N1)	40897:9	LD0.EFHPTOC3.Op.general	
40897:8	Phase Instantaneous Over-current Trip (50P2)	40897:8	LD0.PHHPTOC2.Op.general	
40897:7	Neutral Instantaneous Over-current Trip (50N2)	40897:7	LD0.EFHPTOC4.Op.general	

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
40897:6	Phase Instantaneous Over-current Trip (50P3)	40897:6	LD0.PHIPTOC1.Op.general	
40897:5	Neutral Instantaneous Over-current Trip (50N3)	40897:5	LD0.EFIPTOC2.Op.general	
40897:4	Phase Time Over-current Trip (51P)	40897:4	LD0.PHLPTOC1.Op.general	
40897:3	Neutral Time Over-current Enabled (51N)	40897:3	LD0.EFLPTOC2.Op.general	
40897:2	Overvoltage Trip any single phase (59-1)	40897:2	LD0.PHPTOV1.Op.general	
40897:1	Direct Over-current Trip Positive Sequence (67P-1)	40897:1	LD0.DPHLPTOC1.Op.general	
40897:0	Direct Over-current Trip Negative Sequence (67N)	40897:0	LD0.DEFLPTOC1.Op.general	
40898 to 40926		40898 to 40926	Paths for the status points are the same as in the corresponding single bit block if paths are available.	Same ACT logic as in the corresponding single bit block if solutions are available.

5.2 Function code 16 (Preset multiple register)

5.2.1 Control mask block (read and write)

5.2.1.1 Control command format change

In DPU2000R, different types of control commands have different formats of control blocks. REF615R provides uniformed control block formats as Table 18 shows:

Table 18: Uniformed control command format in REF615R

	register 1	register 2	register 3	register 4	register 5
REF615R control command	Execute Register	password first word	password second word	Bit_x = 1	Bit_x = 1 (confirm)

5.2.1.2 Control command addresses change

Because of the control command format changes, addresses of the commands able to be mapped in REF615R are changed, as shown in Table 19.

Table 19: Mitigation of Modbus mapping for control mask block (read and write)

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
41153	Security Mask			REF615R uses WebHMI or LHMI to configure if control command passwords are required or not.
41154	Execute on initiate input registers	41154		In REF615R, it is mapped for the execute register for the control structure 1.
41155	Password character 1 & 2	41155		In REF615R, it is mapped for the password 1 for the control structure 1.

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
41156	Password character 3 & 4	41156		In REF615R, it is mapped for the password 2 for the control structure 1.
41157	Spare	41157		In REF615R, this register is mapped to control open or close the circuit breaker. Please see the rows below.
41158	Change initiate input mask	41158		In REF615R, it is mapped for the confirmation register for the control structure 1.
41159:14	Control button 6 (C6)	41187:10	LD0.SPCGGIO3.SPCSO6.Oper.ctlVal	Control button 6 (C6) set
		41187:11		Control button 6 (C6) reset
41159:13	Toggle SCADA Redi			N/A in REF615R.
41159:12	Reset energy meters	41162:10	LD0.SPEMMTR1.SupDmdRs.Oper.ctlVal	Reset energy meters single phase
		41162:12	LD0.PEMMTR1.SupDmdRs.Oper.ctlVal	Reset energy meters in 3 phase
41159:11	Reset relay status			N/A. In REF615R, status automatically resets for the Modbus client who reads the status register.
41159:10	Reset Min/Max demands	41162:6	LD0.LLN0.MtrRecRs.Oper.ctlVal	
41159:9	Reset Alarms	41162:8	LD0.LLN0.LEDRs1.Oper.ctlVal	
41159:8	Reset LED Targets	41162:9	LD0.LLN0.LEDRs2.Oper.ctlVal	
41159:7	Control button 5 (C5)	41187:8	LD0.SPCGGIO3.SPCSO5.Oper.ctlVal	Control button 5 (C5) set
		41187:9		Control button 5 (C5) reset
41159:6	Control button 4 (C4)	41187:6	LD0.SPCGGIO3.SPCSO4.Oper.ctlVal	Control button 4 (C4) set
		41187:7		Control button 4 (C4) reset
41159:5	Close Initiate (Independent of 43A)	41157:1	CTRL.CBCSWI1.Pos.Oper.ctlVal	“Close” command in SBO-with-enhanced-security mode. (Relay needs to be set at Remote mode at first).
		41157:2		“Cancel” command in SBO-with-enhanced-security mode. Send this command within 15 seconds delay after sending the “Close” command to cancel the “Close” command.
		41157:3		“Select” command in SBO-with-enhanced-security mode. Send this command within 15 seconds delay after sending the “Close” command to confirm the “Close” command.
		41157:5		“Close” command in direct-with-normal-security mode. (Relay needs to be set at Remote mode at first).
41159:4	Control button 3 (C3)	41187:4	LD0.SPCGGIO3.SPCSO3.Oper.ctlVal	Control button 3 (C3) set
		41187:5		Control button 3 (C3) reset
41159:3	Control button 2 (C2)	41187:2	LD0.SPCGGIO3.SPCSO2.Oper.ctlVal	Control button 2 (C2) set
		41187:3		Control button 2 (C2) reset
41159:2	Control button 1 (C1)	41187:0	LD0.SPCGGIO3.SPCSO1.Oper.ctlVal	Control button 1 (C1) set
		41187:1		Control button 1 (C1) reset

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
41159:1	Close Initiate (Based on 43a)			N/A in REF615R
41159:0	Trip Initiate	41157:0	CTRL.CBCSWI1.Pos.Oper.ctlVal	“Open” command in SBO-with-enhanced-security mode. (Relay needs to be set at Remote mode at first).
		41157:2		“Cancel” command in SBO-with-enhanced-security mode. Send this command within 15 seconds delay after sending the “Open” command to cancel execute the “Open” command.
		41157:3		“Select” command in SBO-with-enhanced-security mode. Send this command within 15 seconds delay after sending the “Open” command to confirm execute the “Open” command.
		41157:4		“Open” command in direct-with-normal-security mode. (Relay needs to be set at Remote mode at first).
41160-41166	Force physical input			N/A in REF615R
41167-41173	Force physical output			Check momentary output contact controls in test mode
41174-41183	Force logical input command			N/A in REF615R
41184-41195	Set/Reset command registers	41214-41223	LD0.SRGAPC1-2.Rs1-8.Oper.ctlVal and LD0.SRGAPC3-4.Rs1-8.Oper.ctlVal	Totally 2 blocks of set reset control commands. Each block has 16 control points.
41189	ULOx controls			N/A in REF615R
41196	Execute on momentary output contact registers			Password 2 for control structure 9.
41197	Password character 1 & 2	41197:0-15	LD0.SPCRGGIO1.SPCSO(1to8).Oper.ctlVal	This address is mapped for different points in REF615R than in DPU2000R.
41198	Password character 3 & 4	41198		Confirmation register for control block 9.
41199	Spare	41199		Execute register for control bock 10.
41200	Momentary output contact state mask	41200		Password 1 for control block 10.
41201	Confirmation momentary output contact state mask	41201		Password 2 for control block 10.
41201:7	OUT6	41207:10	LD0.XUGGIO100.SPCSO6.Oper.ctlVal	Normal speed BIO card, need to set relay in test mode and remote mode
		41212:10	LD0.XBUGGIO100.SPCSO6.Oper.ctlVal	High speed BIO card, need to set relay in test mode and remote mode

DPU2000R register addr.	DPU 2000R description	REF615R register addr.	IEC 61850 path	Comments on REF615R Modbus points mapping
41201:6	OUT5	41207:8	LD0.XUGGIO100.SPCSO5.Oper.ctlVal	Normal speed BIO card, need to set relay in test mode and remote mode
		41212:8	LD0.XBUGGIO100.SPCSO5.Oper.ctlVal	High speed BIO card, need to set relay in test mode and remote mode
41201:5	OUT4	41207:6	LD0.XUGGIO100.SPCSO4.Oper.ctlVal	Normal speed BIO card, need to set relay in test mode and remote mode
		41212:6	LD0.XBUGGIO100.SPCSO4.Oper.ctlVal	High speed BIO card, need to set relay in test mode and remote mode
41201:4	OUT3	41207:4	LD0.XUGGIO100.SPCSO3.Oper.ctlVal	Normal speed BIO card, need to set relay in test mode and remote mode
		41212:4	LD0.XBUGGIO100.SPCSO3.Oper.ctlVal	High speed BIO card, need to set relay in test mode and remote mode
41201:3	OUT2	41207:2	LD0.XUGGIO110.SPCSO2.Oper.ctlVal	Normal speed BIO card, need to set relay in test mode and remote mode
		41212:2	LD0.XBUGGIO110.SPCSO2.Oper.ctlVal	High speed BIO card, need to set relay in test mode and remote mode
41201:2	OUT1	41207:0	LD0.XUGGIO110.SPCSO1.Oper.ctlVal	Normal speed BIO card, need to set relay in test mode and remote mode
		41212:0	LD0.XBUGGIO110.SPCSO1.Oper.ctlVal	High speed BIO card, need to set relay in test mode and remote mode
41201:1	Close(reserved)			
41201:0	Trip	41207:12	LD0.XUGGIO100.SPCSO1.Oper.ctlVal	Normal speed BIO card, need to set relay in test mode and remote mode
		41212:12	LD0.XBUGGIO100.SPCSO1.Oper.ctlVal	High speed BIO card, need to set relay in test mode and remote mode

Modbus client controlling physical contacts only works when the REF615R protection relay is set at both remote and test mode.

Totally there are 15 control blocks in REF615R. Please check "REF615R Modbus Communication Protocol Manual", Document ID: 1MRS240047-IB, section 3.3.6 for more details on how to use control blocks. REF615R has added several control commands which are not available in DPU2000R. To find out entire REF615R control commands, please check "Feeder Protection and Control REF615R Modbus Point List Manual" document ID: 1MRS240052-IB, the table of Control Structures.

5.3 Function code 23 (Read/write 4x registers)

5.3.1 Fault Record

REF615R maps the fault records format and contents as close as possible to those in DPU2000R.

Table 20: Mitigation of Modbus mapping for fault records block

DPU2000R register addr.	DPU 2000R description	Scale	REF615R register addr.	Scale	IEC 61850 path	Comments on REF615R Modbus points mapping
41409	Data Control 1=First record; 2=Next record; 3=Oldest Unreported record	1	41409	1		Data Control 1=First record; 2=Next record; 3=Oldest Unreported record
41410	Fault type element	1	41410	1	LD0.FLTMSTA1.ProFcn.stVal	Protection function, see table 7.1 from “Feeder Protection and Control REF615R Modbus Point List Manual” (1MRS240052-IB)
41411	Active set and recl. Seq.	1	41463	1	LD0.FLTMSTA1.ActSG.stVal	Active setting group
			41464	1	LD0.FLTMSTA1.ShotPntr.stVal	Auto reclosing shot pointer value Au
41412	Fault number	1	41412	1		Fault number after device powers up, it does not count fault records saved before power up.
41413	Year	1	41413	1		Year
41414	Month	1	41414	1		Month
41415	Day	1	41415	1		Day
41416	Hours	1	41416	1		Hours
41417	Minutes	1	41417	1		Minutes
41418	Seconds	1	41418	1		Seconds
41419	Hundredths of Seconds	1	41419	1		Hundredths of Seconds
41420	Ia (Scale at register 41424)	1	41420	100	LD0.FLTMSTA1.AmpsA.mag.f	reading per unit value by default
41421	Ib (Scale at register 41424)	1	41421	100	LD0.FLTMSTA1.AmpsB.mag.f	reading per unit value by default
41422	Ic (Scale at register 41424)	1	41422	100	LD0.FLTMSTA1.AmpsC.mag.f	reading per unit value by default
41423	In (Scale at register 41424)	1	41423	100	LD0.FLTMSTA1.AmpsN.mag.f	reading per unit value by default
41424	Current (I) Scale x	1	41424	1		100 by default
41425	Ia Angle	1				N/A in REF615R
41426	Ib Angle	1				N/A in REF615R
41427	Ic Angle	1				N/A in REF615R
41428	In Angle	1				N/A in REF615R
41429	Zero Seq I (Mag)	1				
41430	Pos Seq I (Mag)	1	41430	100	LD0.FLTMSTA1.AmpsPsSeq.mag.f	
41431	Neg Seq I (Mag)	1	41431	100	LD0.FLTMSTA1.AmpsNgSeq.mag.f	
41432	Zero Seq I (Ang)	1				N/A in REF615R
41433	Pos Seq I (Ang)	1				N/A in REF615R
41434	Neg Seq I (Ang)	1				N/A in REF615R

DPU2000R register addr.	DPU 2000R description	Scale	REF615R register addr.	Scale	IEC 61850 path	Comments on REF615R Modbus points mapping
41435	KVab/ KVan (Mag)	100	41435	100	LD0.FLTMSTA1.VoltsAB.mag.f	KVab in per unit
			41453	100	LD0.FLTMSTA1.VoltsA.mag.f	KVan in per unit
41436	KVbc / KVbn (Mag)	100	41436	100	LD0.FLTMSTA1.VoltsBC.mag.f	KVbc in per unit
			41454	100	LD0.FLTMSTA1.VoltsB.mag.f	KVbn in per unit
41437	KVca / KVcn (Mag)	100	41437	100	LD0.FLTMSTA1.VoltsCA.mag.f	KVca in per unit
			41455	100	LD0.FLTMSTA1.VoltsC.mag.f	KVcn in per unit
41438	Vab / Van (Ang)	1				N/A in REF615R
41439	Vbc / Vbn (Ang)	1				N/A in REF615R
41440	Vca / Vcn (Ang)	1				N/A in REF615R
41441	Pos Seq KV (Mag)	100	41441	100	LD0.FLTMSTA1.VPsSeq.mag.f	in per unit
41442	Neg Seq KV (Mag)	100	41442	100	LD0.FLTMSTA1.VNgSeq.mag.f	in per unit
41443	Pos Seq V (Ang)	1				N/A in REF615R
41444	Neg Seq V (Ang)	1				N/A in REF615R
41445	Fault Location	10	41445		LD0.FLTMSTA1.FltDisKm.mag.f	Distance to fault measured in pu
41446-41447	fault impedance, real	1000	41446-41448	1000	LD0.FLTMSTA1.FltZ.cVal.mag.f	41446-41447 mapped for impedance magnitude, 41448 mapped for angle.
41448-41449	breaker operate time	1000	41449-41450	1000	LD0.FLTMSTA1.OpTm.mag.f	
41450-41451	Relay operate time	1000				N/A in REF615R
41452	Record status		41452			Record status

REF615R Modbus protocol only reads the fault records generated after the device powers up.WebHMI can be used to read entire set of fault records saved in the relay.

To find out the entire set of fault records in REF615R, please check "Feeder Protection and Control REF615R Modbus Point List Manual" with Document ID: 1MRS240052-IB.

5.3.2 Operation records

REF615R substitutes Modbus events for the operation records in DPU2000R

REF615R Modbus server only provides Modbus events generated after the device powers up. WebHMI or ftp tool can be used to upload a complete set of event records stored in the flash memory.

Table 21: Mitigation of Modbus mapping for operation records

DPU2000R register addr.	DPU 2000R description	Scale	REF615R register addr.	Scale	Comments on REF615R Modbus points mapping
N/A			41536		Number of Events to Read per polling, read max.10 events at the same time, not available in DPU2000R
41537	Data Control 1=First record; 2=Next record; 3=Oldest Unreported record	1	41537	1	Data Control 1=First record; 2=Next record; 3=Oldest Unreported record
41538	Year	1	41538	1	Year
41539	Month	1	41539	1	Month
41540	Day	1	41540	1	Day
41541	Hours	1	41541	1	Hours
41542	Minutes	1	41542	1	Minutes
41543	Seconds	1	41543	1	Seconds
41544	Hundredths of Seconds	1	41544	1	Hundredths of seconds
41545	Message #	1	41545	1	Sequence number after device powers up, it does not count fault records saved before power up.
41546	Value	1	41546	1	Value (high word)
41547	Operation Number	1	41547	1	Value (low word)
N/A			41548	1	Area of the Register on which the event happened (0 = coil; 1= input, 4 = 4x)
N/A			41549	1	Register address on which the event happened

Different from decoding the operation number to find out event type as in DPR2000R, REF615R reads the Modbus addresses associated with the event.

In one case, for example, the operation record has the following readings as shown in Table 22.

Table 22: One example of Modbus event record value

Event records addresses	values	meaning
41546	0	Higher word value is 0
41547	1	Lower word value is 1
41548	1	Register area is 1, it is a 1x register
41549	513	Register address is 513

User needs to check "Feeder Protection and Control REF615R Modbus Point List Manual", document ID: 1MRS240052-IB to find out 10513 is mapped to IEC61850 path of "CTRL.CBCSWI1.PosOpn.stVal" and its description is "52-1 Apparatus open position", and understands value of 1 means "breaker open" as status value is set as 1.

By default, some Modbus registers do not generate event upon value changes. To make them generate events, user can use PCM600 / CMT tool to enable event from "rising edge" or "both edge" of the signal's status change. On the other hand, user can disable generate default event from PCM6000 / CMT by simply checking off the event enable bit as shown in Figure 6.

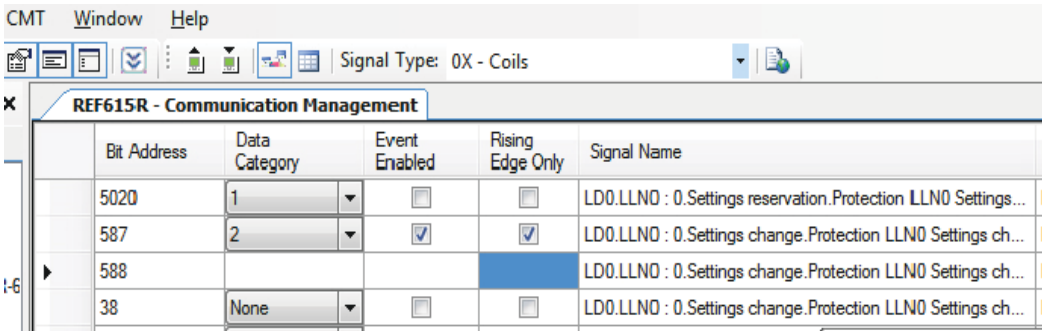

Figure 6: *Snapshot of using CMT to enable Modbus event on coil address 587.*

Only configure points with double-bits for event configurations using PCM600 CMT. It is because Modbus server only generates events on addresses from double-bit block in order not to duplicate event records.

Section 6 6x Registers

6x registers are not available in REF615R. REF615R provides WebHMI and PCM600 CMT tools to make settings and logic changes.

Section 7 Selected PCM ACT logic examples or explanations

7.1 Logical output points:

7.1.1 1st Instantaneous Over-current Distance Alarm (50-1D):

N/A in the current release. But the solution may be provided in the future release by either adding more Modbus mapping points to read function behavior status for each of every protection functions or by reading the status of the blocking signals which are configured from the PCM600 ACT logics to block the certain protection functions.

7.1.2 2nd Instantaneous Over-current Distance Alarm (50-2D):

N/A in the current release. But the solution may be provided in the future release by either adding more Modbus mapping points to read function behavior status for each of every protection functions or by reading the status of the blocking signals which are configured from the PCM600 ACT logics to block the certain protection functions. .

7.1.3 Phase Over-current Disabled Alarm (PH3-D):

N/A in the current release. But the solution may be provided in the future release by either adding more Modbus mapping points to read function behavior status for each of every protection functions or by reading the status of the blocking signals which are configured from the PCM600 ACT logics to block the certain protection functions.

7.1.4 Ground Over-current Disabled Alarm (GRD-D):

N/A in the current release. But the solution may be provided in the future release by either adding more Modbus mapping points to read function behavior status for each of every protection functions or by reading the status of the blocking signals which are configured from the PCM600 ACT logics to block the certain protection functions.

7.1.5 Three Phase Under voltage Trip (27-3P)

N/A in the current release. But the solution may be provided in the future release by either adding more Modbus mapping points to read function behavior status for each of every protection functions or by reading the status of the blocking signals which are configured from the PCM600 ACT logics to block the certain protection functions.

7.1.6 The seal in points (latch) using SRGAPC give on example:

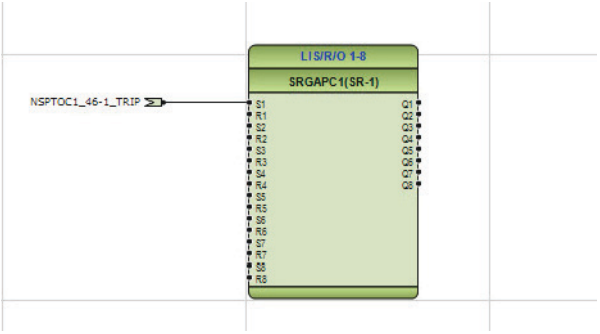

Figure 7: Example of create seal in point for 46-1 trip

Read LD0.SRGAPC1.Q1.stVal (for 46-1 trip latch status)

*Use control command of LD0.SRGAPC1.Rs1.Oper.ctlVal to reset the 46-1 trip latch. Please read "Feeder Protection and Control REF615R Modbus Point List Manual", Document ID: 1MRS240052-IB to find out the Modbus control command address.

7.1.7 Instantaneous 3 phase Over-current alarm disabled (50-3D):

N/A in the current release. But the solution may be provided in the future release by either adding more Modbus mapping points to read function behavior status for each of every protection functions or by reading the status of the blocking signals which are configured from the PCM600 ACT logics to block the certain protection functions.

7.2 Logical input ACT logic selected examples

7.2.1 Enable phase over current protection for all phase elements except 50P3 (PH3):

N/A in the current release. But the solution may be provided in the future release by either adding more Modbus mapping points to read function behavior status for each of every protection functions or by reading the status of the blocking signals which are configured from the PCM600 ACT logics to block the certain protection functions.

7.2.2 Enable ground over current protection for all ground elements except 50N-3(GRD):

N/A in the current release. But the solution may be provided in the future release by either adding more Modbus mapping points to read function behavior status for each of every protection functions or by reading the status of the blocking signals which are configured from the PCM600 ACT logics to block the certain protection functions.

7.2.3 Enable 50P-1 and 50N-1 (50-1):

N/A in the current release. But the solution may be provided in the future release by either adding more Modbus mapping points to read function behavior status for each of every protection functions or by reading the status of the blocking signals which are configured from the PCM600 ACT logics to block the certain protection functions.

7.2.4 Enable 50P-2 and 50N-2 (50-2):

N/A in the current release. But the solution may be provided in the future release by either adding more Modbus mapping points to read function behavior status for each of every protection functions or by reading the status of the blocking signals which are configured from the PCM600 ACT logics to block the certain protection functions.

7.2.5 Enable 50P-3 and 50N-3 (50-3):

N/A in the current release. But the solution may be provided in the future release by either adding more Modbus mapping points to read function behavior status for each of every protection functions or by reading the status of the blocking signals which are configured from the PCM600 ACT logics to block the certain protection functions.

7.2.6 Enable Alternate 1 Settings (ALT1):

User can write to holding register 41300 to change active setting groups, and then read from coil address of 847, which is mapped for LD0.LLN0.Act2SG.stVal, for the value.

7.2.7 Enable Alternate 2 Settings (ALT2):

User can write to holding register 41300 to change active setting groups, and then read from coil address of 849, which is mapped for LD0.LLN0.Act3SG.stVal, for the value.

Section 8 Glossary

ACT	Application Configuration Tool from PCM600
AFL	Application function block library
ANSI	American National Standards Institute
AR	Autoreclosing
BIO	Binary Input Output
CB	Circuit breaker
CMT	Communication Management tool in PCM600
CT	Current transformer
CTRL	Control logical device
DFR	Digital fault recorder
DNP3	A distributed network protocol originally developed by Westronic. The DNP3 Users Group has the ownership of the protocol and assumes responsibility for its evolution.
DPC	Double-point control
DPS	Double-point status
DR	Disturbance recorder
EMC	Electromagnetic compatibility
HMI	Human-machine interface
I/O	Input/output
ID	Identifier or identification
IEC 61850	International standard for substation communication and modelling
protection relay	Intelligent electronic device
LD0	Logical device zero (0)
LED	Light-emitting diode
LHMI	Local human-machine interface
LLN0	Logical node zero (0)
MCD	Momentary change detect

Modbus	A serial communication protocol developed by the Modicon company in 1979. Originally used for communication in PLCs and RTU devices.
MOM	Momentary position
PCM600	Protection and Control Protection Relay Manager
PLC	Programmable logic controller
PST	Parameter Setting tool in PCM600
REF615R	Wire-alike replacement option for DPU2000R with the same form factor
SBO	Select-before-operate
SSR1	System status register for device health
SSR2	System status register for device mode
SSR3	System status register for data available 1
SSR4	System status register for data available 2
SSR5	System status register for device alive counter
SSR6	System status register for last command result
stVal	Status value
SW	Software
UDR	User-definable register
UTC	Coordinated universal time
Val	Value
WHMI	Web human-machine interface

Contact us

ABB Inc.
Distribution Automation
4300 Coral Ridge Drive
Coral Springs, FL 33065, USA
Phone:+1 (800) 523-2620
Phone:+1 954-752-6700
Fax:+1 954 345-5329
www.abb.com/substationautomation

Power and productivity
for a better world™