INSTRUCTION MANUAL

FOR

CURRENT DIFFERENTIAL SYSTEM BE1-CDS220

DISTRIBUTED NETWORK PROTOCOL (DNP3)

Publication: 9313900992
Revision: C 09/17

INTRODUCTION

This instruction manual provides detailed information about the BE1-CDS220 Current Differential System with the Distributed Network Protocol (DNP3).

First Printing: November 1999

Printed in USA

September 2017

It is not the intention of this manual to cover all details and variations in equipment, nor does this manual provide data for every possible contingency regarding installation or operation. The availability and design of all features and options are subject to modification without notice. Should further information be required, contact Basler Electric.

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REVISION HISTORY

The following information provides a historical summary of the changes made to this instruction manual (9313900992). Revisions are listed in reverse chronological order.

Manual Revision and Date	Change
C, 09/17	• Added caution box about nonvolatile memory in Section 1.
B, 10/09	• Added manual part number and revision to footers. • Updated front cover drawing.
A, 04/00	• Changed the complete manual to the DNP protocol. With ECO 8969, upped the revision level on 9313900991 and 9313900992 to Rev A. Now the 991 is for Modbus™ protocol and the 992 is for DNP protocol.
—, 11/99	• Initial release. This manual (9313900992) was initially released for the Modbus protocol. To coordinate with the AS-400 data base and the published product bulletin, the Modbus Instruction Manual publication number was changed to 9313900991.

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SECTION 1 • GENERAL INFORMATION

Introduction

This document describes the Basler Electric Distributed Network Protocol (DNP) implementation in the BE1-CDS Current Differential System. The BE1-CDS is classified as an intelligent electronic device (IED) that is capable of reacting or responding to specific requests conforming to a level two slave device, as defined in the DNP3 Subset Definitions Document. This manual contains a list of DNP data objects accessible by a master station.

CAUTION

This product contains one or more *nonvolatile memory* devices. Nonvolatile memory is used to store information (such as settings) that needs to be preserved when the product is power-cycled or otherwise restarted. Established nonvolatile memory technologies have a physical limit on the number of times they can be erased and written. In this product, the limit is 100,000 erase/write cycles. During product application, consideration should be given to communications, logic, and other factors that may cause frequent/repeated writes of settings or other information that is retained by the product. Applications that result in such frequent/repeated writes may reduce the useable product life and result in loss of information and/or product inoperability.

NOTE

This implementation of DNP3 is fully compliant with DNP3 Subset Definition Level 2, contains many Subset Level 3 features, and contains some functionality even beyond Subset Level 3.

References

- Instruction Manual for BE1-CDS Current Differential System
- DNP3 Basic 4 Document Set
- DNP Subset Definitions Document
- The DNP website (www.DNP.org)

SECTION 2 • DEVICE PROFILE DOCUMENT

Table 2-1 provides a Device Profile Document in the standard format defined in the DNP3 subset definition document. The table, in combination with the implementation table provided in Section 3 and the point list tables provided in Section 5, provide a complete application configuration guide for including the BE1-CDS DNP protocol in any DNP environment.

Table 2-1. DNP3 Device Profile Document

DEVICE PROFILE DOCUMENT

Vendor Name: Basler Electric Company

Device Name: BE1-CDS Current Differential System

Highest DNP Level Supported:	Device Function:
DNP-L2.	☐ Master ☒ Slave

Notable objects, functions, and/or qualifiers supported in addition to the highest DNP levels supported (the complete list is described in DNP3 Implementation Table):

- For static (non-change-event) object requests, request qualifier codes 00 and 01(start-stop), 07 and 08 limited quantity), and 17 and 28(index) are supported in addition to request qualifier code 06 (no range – or all points).
- Static object requests sent with qualifiers 00,01,06,07, and 08, will be responded to with qualifiers 00 or 01.
- Static object requests sent with qualifiers 17 and 28 will be responded to with qualifiers 17 or 28.
- The read function code for object 102 (8-bit unsigned integer), variation 1, is supported.
- Time period when device requires time-synchronization from the master is configurable via object 41, point 30.
- Dead band for current analog input events is configurable via object 41, point 31.

Maximum Data Link Frame Size (octets):	Maximum Application Fragment Size (octets):
Transmitted 292	Transmitted 2048
Received 292	Received 1024

Maximum Data Link Re-tries:	Maximum Application Layer Re-tries:
☒ None	☒ None
☐ Fixed at	☐ Fixed at
☐ Configurable	☐ Configurable, range _____ to _____

Requires Data Link Layer Confirmation:

☒ Never
☐ Always
☐ Sometimes If 'Sometimes', when?_____
☐ Configurable If 'Configurable', how?_____

Requires Application Layer Confirmation:

☐ Never
☐ Always (not recommended)
☒ When reporting Event Data (Slave devices only)
☒ When sending multi-fragment responses (Slave devices only)

Timeouts while waiting for:

Data Link Confirm	☐ None	☒ Fixed at 3000 ms	☐ Variable	☐ Configurable
Complete Appl. Fragment	☒ None	☐ Fixed at ____	☐ Variable	☐ Configurable
Application Confirm	☐ None	☒ Fixed at 5000 ms	☐ Variable	☐ Configurable
Complete Appl. Response	☒ None	☐ Fixed at ____	☐ Variable	☐ Configurable

DEVICE PROFILE DOCUMENT

Sends/Executes Control Operations:

WRITE Binary Outputs	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
SELECT/OPERATE	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
DIRECT OPERATE	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
DIRECT OPERATE - NO ACK	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Count > 1	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
Pulse On	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Pulse Off	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
Latch On	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Latch Off	☐ Never	☒ Always	☐ Sometimes	☐ Configurable
Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
Clear Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable

Reports Binary Input Change Events when no specific variation requested (Slave Only):
- ☐ Never
- ☒ Only time-tagged
- ☐ Only non-time-tagged
- ☐ Configurable to send both, one or the other (attach explanation)

Reports time-tagged Binary Input Change Events when no specific variation requested:
- ☐ Never
- ☒ Binary Input Change With Time
- ☐ Binary Input Change With Relative Time
- ☐ Configurable (attach explanation)

Master Expects Binary Input Change Events:
- ☐ Never
- ☐ Either time-tagged or non-time-tagged for a single event
- ☐ Both time-tagged and non-time-tagged for a single event
- ☐ Configurable (attach explanation)

Sends Unsolicited Responses (Slave Only):
- ☒ Never
- ☐ Configurable (attach explanation)
- ☐ Only certain objects
- ☐ Sometimes (attach explanation)
- ☐ ENABLE/DISABLE UNSOLICITED Function codes supported

Sends Static Data in Unsolicited Responses (Slave Only):
- ☒ Never
- ☐ When Device Restarts
- ☐ When Status Flags Change

No other options are permitted.

Default Counter Object/Variation:
- ☒ No Counters Reported
- ☐ Configurable (attach explanation)
- ☐ Default Object
  Default Variation
- ☐ Point-by-point list attached

Counters Roll Over at:
- ☒ No Counters Reported
- ☐ Configurable (attach explanation)
- ☐ 16 Bits
- ☐ 32 Bits
- ☐ Other Value:
- ☐ Point- by-point list attached

Sends Multi-Fragment Responses (Slave Only): ☒ Yes ☐ No

SECTION 3 • IMPLEMENTATION TABLE

DNP Implementation Table

Table 3-1 identifies which object variations, function codes, and qualifiers the BE1-CDS DNP supports in both request messages and in response messages.

For static (non-change-event) objects, requests sent with qualifiers 00, 01, 06, 07, or 08 will be responded to with qualifiers 00 or 01. Static object requests sent with qualifiers 17 or 28 will be responded to with qualifiers 17 or 28.

For change-event objects, qualifiers 17 and 28 are always responded.

Table 3-1. Implementation Table

OBJECT			**REQUEST** (BE1-CDS-220 will parse)		**RESPONSE** (BE1-CDS-220 will respond with)	
Object No.	Variation No.	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (hex)	Qualifier Codes (hex)
1	0	Binary Inputs – (Variation 0 is used to request default variation)	1 (read)	00,01 (start- stop) 06 (no range) 07,08 (limited qty) 17,28 (index)		
1	1 (default – see note 1)	Single-Bit Binary Input	1 (read)	00,01 (start- stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81 (response)	00,01 (start-stop) 17,28 (index)
2	0	Binary Input Change (Variation 0 is used to request default variation)	1 (read)	06 (no range) 07,08 (limited qty)		
2	1	Binary Input Change without time	1 (read)	06 (no range) 07,08 (limited qty)	81 (response)	17,28 (index)
2	2 (default – see note 1)	Binary Input Change with time	1 (read)	06 (no range) 07,08 (limited qty)	81 (response)	17,28 (index)
10	0	Binary Output – (Variation 0 is used to request default variation)	1 (read)	00,01 (start- stop) 06 (no range) 07,08 (limited qty) 17,28 (index)		
10	2 (default – see note 1)	Binary Output Status	1 (read)	00,01 (start- stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81	00,01 (start-stop) 17,28 (index)
12	1	Control Relay Output Block	3 (select) 4 (operate) 5 (direct op) 6 (dir op Noack)	00,01 (start-stop) 07,08 (limited qty) 17,28 (index)	81	echo of request
30	0	Analog Input (Variation 0 is used to request default variation)	1 (read)	00,01 (start- stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81(response)	00,01 (start-stop) 17,28 (index)
30	1	32-Bit Analog Input With Flag	1 (read)	00,01 (start- stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81	00,01 (start-stop) 17,28 (index)
30	2	16-Bit Analog Input With Flag	1 (read)	00,01 (start- stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81	00,01 (start-stop) 17,28 (index)
30	3 (default – see note 1)	32-Bit Analog Input Without Flag	1 (read)	00,01 (start- stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81	00,01 (start-stop) 17,28 (index)

OBJECT			REQUEST (BE1-CDS-220 will parse)		RESPONSE (BE1-CDS-220 will respond with)	
Object No.	Variation No.	Description	Function Codes (dec)	Qualifier Codes (hex)	Function Codes (hex)	Qualifier Codes (hex)
30	4	16-Bit Analog Input Without Flag	1 (read)	00,01 (start- stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81	00,01 (start-stop) 17,28 (index)
32	0	Analog Change Event (Variation 0 is used to request default variation)	1 (read)	06 (no range) 07,08 (limited qty)		
32	1 (default – see note 1)	32-Bit Analog Input without time	1 (read)	06 (no range) 07,08 (limited qty)	81	17,28 (index)
32	2	16-Bit Analog Input without time	1 (read)	06 (no range) 07,08 (limited qty)	81	17,28 (index)
32	3	32-Bit Analog Input with time	1 (read)	06 (no range) 07,08 (limited qty)	81	17,28 (index)
32	4	16-Bit Analog Input with time	1 (read)	06 (no range) 07,08 (limited qty)	81	17,28 (index)
40	0	Analog Output Status – (Variation 0 is used to request default variation)	1	00,01 (start-stop) 06 (no range) 07,08 (limited qty) 17,28 (index)		
40	1	32-bit Analog Output Status	1 (read)	00,01 (start-stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81	00,01 (start-stop) 17,28 (index)
40	2 (default - see note 1)	16-bit Analog Output Status	1 (read)	00,01 (start-stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81	00,01 (start-stop) 17,28 (index)
41	1	32-bit Analog Output Block	3 (select) 4 (operate) 5 (direct op) 6 (dir op noack)	00,01 (start-stop) 07,08 (limited qty) 17,28 (index)	81	echo of request
41	2	16-bit Analog Output Block	3 (select) 4 (operate) 5 (direct op) 6 (dir op noack)	00,01 (start-stop) 07,08 (limited qty) 17,28 (index)	81	echo of request
50	1	Time and Date	1 (read) 2 (write)	00,01 (start-stop) 06 (no range or all) 07 (limited qty=1) 08 (limited qty) 17,28 (index)	81	00,01 (start-stop) 17,28 (index)
60	1	Class 0 Data (Note 1) (Note 4)	1 (read)	06 (no range or all)	81	
60	2	Class 1 Data	1 (read)	06 (no range or all) 07,08 (limited qty)	81	
60	3	Class 2 Data	1 (read)	06 (no range or all) 07,08 (limited qty)	81	
60	4	Class 3 Data	1 (read)	06 (no range or all) 07,08 (limited qty)	81	
80	1	Internal Indications	2 (write)	00 (start-stop) (index must=7)		
102	1	8-Bit Unsigned Integer (Note 2)	1 (read)	00,01 (start- stop) 06 (no range) 07,08 (limited qty) 17,28 (index)	81(response)	00,01 (start-stop) 17,28 (index)
		No Object (function code only) (See Note 3)	13 (cold restart)			
		No Object (function code only) (See Note 3)	14 (warm restart)			
		No Object (function code only)	23 (delay meas)			

Notes for Table 3-1:

1. A Default variation refers to the variation responded to when variation 0 is requested and/or in class 0,1,2, or 3 scans.
2. Object 102 is not included in Class 0 poll response.
3. A cold restart is implemented as a warm restart – the DNP process is restarted.
4. In Class 0 are included all Binary Inputs (object 1), and a selected set of Analog Inputs (object 30). Binary Output Status points and Analog Output Status points are not included in Class 0.

SECTION 4 • CONFIGURATION PARAMETERS

DNP Configuration Parameters

These paragraphs describe configuration settings that may be verified/changed from the BE1-CDS front panel or using ASCII protocol commands.

Relay Style Number

BE1-CDS relays that support the DNP protocol must have a Style Number with the eighth character as a number 3. This can be verified by reading the relay Style Number via the front communication port using the RG-VER ASCII command. (Reference the BE1-CDS Instructional Manual, part number 9 3139 00 990).

Example:
>rg-ver
Model Number: BE1-CDS220
Style Number: E0EN0YY3N0R
App Program: VER 1.14.00 03/03/00
DSP Program: VER 1.13.00 06/28/99
Boot Program: VER 2.11.00 10/28/98
Serial Number: H00069997

BE1-CDS Slave Address

BE1-CDS relays support DNP through the rear RS-485 communication port, which is communication port 2 (COM2). This port supports Baud Rates: 1200, 2400, 4800, 9600, and 19200, and the default Baud Rate is 9600.

DNP Slave IED Address Range is from 0 to 65534. Address 65535 (hex FFFF) is used to broadcast messages to all devices. The communication address can be set by the SG-COM ASCII command. For more information about changing the relay parameters, refer to the BE1-CDS Instructional Manual, part number 9 3139 00 990.

Example: Set the BE1-CDS address to be 125, and baud rate to be 9600.

(In the following example, the operator's commands are in **bold**.)

>**a=<global_password>** <**enter**> //enter global password
>ACCESS GRANTED: GLOBAL
> **sg-com2=9600,a125**(**enter**)
>**exit** (**enter**)
>SAVE CHANGES (Y/N/C) ?
>**y** <**enter**>
>CHANGE COMM PARAMETERS
>
To verify port address, enter command
>**sg-com2**(**enter**)
>SG-COM2=9600, A125, P0,R1,X0

SECTION 5 • POINT LIST

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51 Phase A Trip 5-1
51 Phase B Trip 5-1
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151 Phase A Trip 5-1
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251 Phase A Trip 5-1
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SECTION 5 • POINT LIST

Binary Input Points

Binary Input changes are scanned every four milliseconds. Events are pending in the Slave application buffer until the Master device sends conformation that response with pending events was received. Table 5-1 describes the binary input points.

Table 5-1. Binary Input Points

Binary Input Points

Static Object Number: 1
Change Event Object Number: 2
Request Function Codes Supported: 1 (read)
Static Variation Reported When Variation 0 Requested: 1 (Binary Input Without Status)
Change Event Variation Reported When Variation 0 Requested: 2 (Binary Input Change With Time)

Point Index	Description	Change Event Assigned Class (1,2,3 or none)	Notes
0	50T Phase A Trip	1	
1	50T Phase B Trip	1	
2	50T Phase C Trip	1	
3	150T Phase A Trip	1	
4	150T Phase B Trip	1	
5	150T Phase C Trip	1	
6	250T Phase A Trip	1	
7	250T Phase B Trip	1	
8	250T Phase C Trip	1	
9	51 Phase A Trip	1	
10	51 Phase B Trip	1	
11	51 Phase C Trip	1	
12	151 Phase A Trip	1	
13	151 Phase B Trip	1	
14	151 Phase C Trip	1	
15	251 Phase A Trip	1	
16	251 Phase B Trip	1	
17	251 Phase C Trip	1	
18	87U Phase A Trip	1	
19	87U Phase B Trip	1	
20	87U Phase C Trip	1	
21	87R Phase A Trip	1	
22	87R Phase B Trip	1	
23	87R Phase C Trip	1	
24	50T Neutral Trip	1	
25	150T Neutral Trip	1	
26	250T Neutral Trip	1	

Point Index	Description	Change Event Assigned Class (1,2,3 or none)	Notes
27	50T Negative Sequence Trip	1	
28	150T Negative sequence Trip	1	
29	250T Negative sequence Trip	1	
30	51 Neutral Trip	1	
31	151 Neutral Trip	1	
32	251 Neutral Trip	1	
33	51Q Trip	1	
34	151Q Trip	1	
35	251Q Trip	1	
36	Breaker Failure Trip	1	
37	87ND Trip	1	
38	87 Restrained Trip	1	
39	87 Unrestrained Trip	1	
40	87 2nd Harmonic	1	
41	87 5th harmonic	1	
42	62	1	
43	162	1	
Active Group Status (points 44 – 47)			
44	Setting Group 0 Active	1	
45	Setting Group 1 Active	1	
46	Setting Group 2 Active	1	
47	Setting Group 3 Active	1	
Input Status (points 48 – 55)			
48	Input Contact 1 State	1	
49	Input Contact 2 State	1	
50	Input Contact 3 State	1	
51	Input Contact 4 State	1	
52	Input Contact 5 State	1	
53	Input Contact 6 State	1	
54	Input Contact 7 State	1	
55	Input Contact 8 State	1	
56	Major Alarm	1	
57	Minor Alarm	1	
58	Logic Alarm	1	
59	Output Trip Coil Monitor	1	
60	101 TRIP	1	
61	101 CLOSE	1	
62	101 SLIP CONTACT (0= Breaker Tripped, 1 = Breaker is Closed)	1	
63	43	1	
64	143	1	

Point Index	Description	Change Event Assigned Class (1,2,3 or none)	Notes
65	243	1	
66	343	1	
67	443	1	
68	543	1	
69	643	1	
70	743	1	
Hardware Output Status (points 71 - 77)			
71	Output A	1	
72	Output 1	1	
73	Output 2	1	
74	Output 3	1	
75	Output 4	1	
76	Output 5	1	
77	Output 6	1	
Relay Trouble Alarms (points 78 - 87)			
78	RAM Failure	1	
79	FLASH FAILURE	1	
80	uP Failure	1	
81	EEPROM Fatal Error	1	
82	Analog Failure	1	
83	Calibration Error	1	
84	Power Supply Error	1	
85	Default Settings Loaded	1	
86	Calibration Defaults Loaded	1	
87	DSP Failure	1	
Programmable Alarms (points 88 – 115) See Note 1			
88	Output Circuit Open Alarm	1	
89	Breaker Fail Alarm	1	
90	Differential Alarm	1	
91	Settings Changes Lost due to Access Time Out	1	
92	Breaker Alarm 1	1	
93	Breaker Alarm 2	1	
94	Breaker Alarm 3	1	
95	P Demand Maximum Exceed Alarm	1	
96	N Demand Maximum Exceed Alarm	1	
97	Q Demand Alarm	1	
98	Group Override Alarm (0=Local Control, 1= Group Override)	1	
99	Sys I/O Delay Alarm (Operating System Overload)	1	
100	Communication Error Alarm	1	
101	Clock Error Alarm	1	

Point Index	Description	Change Event Assigned Class (1,2,3 or none)	Notes
102	MPU Reset Alarm	1	
103	Settings Changed Alarm	1	
104	EEPROM Non fatal error	1	
105	An override is active in one or more outputs (Output Override Alarm)	1	
106	Loss of IRIG	1	
107	Setting Group Change Active alarm	1	
108	VO13 Logic Alarm	1	
109	VO14 Logic Alarm	1	
110	VO15 Logic Alarm	1	
111	FLT RPT(Report) Time Out	1	
112	Transformer Alarm 1	1	
113	Transformer Alarm 2	1	
114	Transformer Alarm 3	1	
115	Logic = NONE Alarm	1	
State Of Fault Trigger Logic Expression (See Note 2)			
116	Pick Up trigger expressions state (1=TRUE,0 =FALSE)	1	
117	Trip trigger logic expressions state (1=TRUE,0 =FALSE)	1	
118	Logic trigger expressions state (1=TRUE,0 =FALSE)	1	
119	1 - New Fault triggered. Fault data will be saved as the Most Recent Fault Summary Report, and available when this point becomes 0. 0 - The Most Recent Fault Summary Report available.	1	3

Notes for Table 5-1:

1. Any alarm from this Programmable Alarms group may be declared as major, minor, or logic alarm. Refer to ASCII Serial Command SG-LGC, SA-MAJ, and SA-MIN.
2. Refer to ASCII Serial Command SG-TRIGGER=<trip>,<pu>,<logic>.
3. The time stamp from transition 0 to 1 is the fault trigger time (equal to the time of the most recent Fault Summary Report).

   The time stamp from transition 1 to 0 is the time since the Fault Summary Report for the most recent fault is available (see object 30 points from 67 to 104).

   The total count of point 119 transitions from zero to one (new faults triggered) in response to a Class 1 request represents the number of faults that have occurred between two consecutive Class 1 scans. A Class 1 scan reports only the Most Recent Fault Summary Report as analog events of object 32, points 67 to 104. If there are more than one New Fault Triggered events in the Class 1 response, the previous Fault Summary Reports can be retrieved through the Select Fault Summary Report (see object 30, points 134 to 171).

Binary Output Status Points and Control Relay Output Blocks

Table 5-2 lists both the Binary Output Status Points (Object 10) and the Control Relay Output Blocks (Object 12). It is important to note that Binary Output Status Points are not included in Class 0.

Table 5-2. Binary Output Status Points and Control Relay Output Blocks

Binary Output Status Points:
Object Number: 10
Variations supported: 2
Request Function Codes supported: 1 (read)
Default Variation reported when variation 0 requested: 2 (Binary Output Status)

Control Relay Output Blocks
Object Number: 12
Variations supported: 1
Request Function Codes supported: 3(select), 4(operate), 5(direct operate), 6 (direct operate, noack)

Point Index	Description	Control Codes And Their Description
0	Hardware Output A State	
1	Hardware Output 1 State	
2	Hardware Output 2 State	
3	Hardware Output 3 State	
4	Hardware Output 4 State	
5	Hardware Output 5 State	
6	Hardware Output 6 State	
7	All Hardware Outputs State	
8	Hardware Output A Local Control	
9	Hardware Output 1 Local Control	
10	Hardware Output 2 Local Control	
11	Hardware Output 3 Local Control	
12	Hardware Output 4 Local Control	
13	Hardware Output 5 Local Control	
14	Hardware Output 6 Local Control	
15	All Hardware Outputs Local Control	
16	43 Selector Switch Status	
17	143 Selector Switch Status	
18	243 Selector Switch Status	
19	343 Selector Switch Status	
20	443 Selector Switch Status	
21	543 Selector Switch Status	
22	643 Selector Switch Status	
23	743 Selector Switch Status	
24	Setting Group 0	
25	Setting Group 1	
26	Setting Group 2	
27	Setting Group 3	

Point Index	Description	Control Codes And Their Description	
28	Local Setting Group Control Switch	Latch On:	Return Setting Group Control to relay local logic
29	101 Virtual Breaker Control Switch	Close:	Close Breaker (changes 101C Binary Input from 0 to 1 for 200 ms)
		Trip:	Trip Breaker (changes 101T from 0 to 1 for 200 ms)

Notes for Table 5-2:

1. Reads of Points
   - Reads of points from 0 to 6 returns the current state of corresponding hardware output points.
   - Reads of points from 8 to 14 returns 1 if corresponding hardware output is under relay Local control, or 0 if output is override.
   - Reads of points from 16 to 23 returns the current state of the corresponding x43 selector switches.
   - Reads of point 24 to 27 returns 1 if Setting Group is active. Notice that only one of these points can be active at any time.
   - Read of point 28 returns value 1 if the Setting Group Control is under relay local logic.
   - Reads of points 7, 15, and 29 always returns 0.

2- When used to control the points listed in Table 5-1, the Control Code field of object 12 is parsed as described in the following paragraphs.
   - If the Control Code is NULL, then the command will be accepted without any action being taken.
   - If Queue, and Clear sub-fields are not zero, the returned Control Status is 4 (Control operation not supported).
   - A Code sub-field of “Pulse On” (1) in combination with a value in the Trip/Close sub-field, form a Trip or Close value. A “Trip” value consists of a “PULSE ON” (1) in the Code sub-field and a 2 in the Trip/Close sub-field. This results in a value of 81(hex) in the Control Code field. A “Close” value consists of a “PULSE ON” (1) in the Code sub-field and a 1 in the Trip/Close sub-field. This results in a value of 41 (hex) in the Control Code field.

3. Valid Control Code values are:
   - 0x00 = No action will be taken.
   - 0x01 = Pulse output to opposite of current state, and then restore to previous state. Pulsed output is active 200 to 250 ms.
   - 0x03 = Latch On
   - 0x04 = Latch Off
   - 0x41 = Close (Breaker Close)
   - 0x81 = Trip (Breaker Open)

All operations not defined above are invalid and will be rejected. If the Control Code is legal, but not supported for the requested point, the Status Return value is “Control operation not supported for this point” (value 4).

- The Count, OnTime, and OffTime fields are ignored.
- Arm timer value for all Select/Operate operations is 30 seconds.

It is important to notice that any control function may be rejected because of the relay internal state. When this happens, the Status Return value is “Request not accepted because of hardware problems” (value 6). One of the reasons for the rejection may be that that point Logic Function Block has the Logic (Control) Mode disabled.

For example: Control functions for the hardware output points (points 0 to 15) will be rejected if the Output Control for all hardware outputs is disabled.

The Logic (Control) Mode of any object 12 point can be changed (enabled/disabled) via the specific point of object 41 (Analog Output Control Blocks). Refer to Analog Output Status Points and Analog Output Control Block points from 0 to 10.

Analog Inputs

The following table lists Analog Inputs (Objects 30 and 32). It is important to note that 16-bit and 32-bit variations of Analog Inputs, Analog Output Control Blocks, and Analog Output Statuses are transmitted through DNP as signed numbers. Even for analog input points that are not valid as negative values, the maximum positive representation for a 16-bit variation is $<2^{15}-1> = 32,767$. For a 32-bit variation the maximum positive representation is $<2^{31}-1> = 2,147,483,647$.

Points not assigned to any class can be read as object 30 points in any supported variation or qualifier implemented for object 30.

Change events for analog inputs are reported in CURRENT mode (when a change is detected, the report of the change contains the current value of the time of the report, not the time the change was detected.

Table 5-3. Analog Inputs

Analog Inputs

Static Object Number : 30
Change Event Object Number : 32
Request Function Codes Supported: 1 (read)
Static Variation Reported When Variation 0 Requested: 3 (32-bit Analog Input without Flag)
Change Event Variation Reported When Variation 0 Requested: 1 (32-bit Analog Change Event without Time)

Index	Description	Change Event Assigned Class (1, 2, 3, or none)	Notes
Current Magnitudes (See Note 1)			
0	Winding #1 Phase A Current Magnitude	2	1, 20
1	Winding #1 Phase B Current Magnitude	2	1, 20
2	Winding #1 Phase C Current Magnitude	2	1, 20
3	Winding #1 Neutral Current Magnitude	2	1, 20
4	Winding #1 Negative Sequence Current Magnitude	2	1, 20
5	Winding #2 Phase A Current Magnitude	2	1, 20
6	Winding #2 Phase B Current Magnitude	2	1, 20
7	Winding #2 Phase C Current Magnitude	2	1, 20
8	Winding #2 Neutral Current Magnitude	2	1, 20
9	Winding #2 Negative Sequence Current Magnitude	2	1, 20
10	Ground Current Magnitude	2	1, 20
Phase Angles			
11	Winding #1 Phase A Angle	2	7
12	Winding #1 Phase B Angle	2	7
13	Winding #1 Phase C Angle	2	7
14	Winding #1 Neutral Angle	2	7
15	Winding #2 Phase A Angle	2	7
16	Winding #2 Phase B Angle	2	7
17	Winding #2 Phase C Angle	2	7
18	Winding #2 Neutral Angle	2	7
19	Ground Angle	2	7
Differential Compensated Per Centi-Unit Currents			
20	Winding #1 Phase A Compensated Current	2	21
21	Winding #1 Phase B Compensated Current	2	21

Index	Description	Change Event Assigned Class (1, 2, 3, or none)	Notes
22	Winding #1 Phase C Compensated Current	2	21
23	Winding #1 Neutral Compensated Current	2	21
24	Winding #2 Phase A Compensated Current	2	21
25	Winding #2 Phase B Compensated Current	2	21
26	Winding #2 Phase C Compensated Current	2	21
27	Winding #2 Neutral Compensated Current	2	21
28	Ground Compensated Current	2	21
Differential Compensated Angles			
29	Winding #1 Phase A Compensated Angle	2	7
30	Winding #1 Phase B Compensated Angle	2	7
31	Winding #1 Phase C Compensated Angle	2	7
32	Winding #1 Neutral Compensated Angle	2	7
33	Winding #2 Phase A Compensated Angle	2	7
34	Winding #2 Phase B Compensated Angle	2	7
35	Winding #2 Phase C Compensated Angle	2	7
36	Winding #2 Neutral Compensated Angle	2	7
37	Ground Compensated Angle	2	7
Differential Operating Per Centi-Unit Currents			
38	Differential Operating Phase A Current	2	22
39	Differential Operating Phase B Current	2	22
40	Differential Operating Phase C Current	2	22
41	Differential Operating Ground Current	2	22
Differential Second Harmonic Centi-Percentage			
42	Phase A 2nd Harmonic Percentage	2	23
43	Phase B 2nd Harmonic Percentage	2	23
44	Phase C 2nd Harmonic Percentage	2	23
Differential Fifth Harmonic Centi-Percentage			
45	Phase A 5th Harmonic Percentage	2	23
46	Phase B 5th Harmonic Percentage	2	23
47	Phase C 5th Harmonic Percentage	2	23
48	Measured Frequency	2	17
Present Demand Currents			
49	Present Demand Current- Phase A	2	1, 20
50	Present Demand Current- Phase B	2	1, 20
51	Present Demand Current- Phase C	2	1, 20
52	Present Neutral Demand Current	2	1, 20
53	Present Negative Sequence Demand Current	2	1, 20
Breaker Duty Information			
54	Breaker Duty – Phase A	2	12
55	Breaker Duty – Phase B	2	12
56	Breaker Duty – Phase C	2	12

Index	Description	Change Event Assigned Class (1, 2, 3, or none)	Notes
57	Breaker Operation Counter	2	13
Transformer Duty Information			
58	Transformer Phase A duty	2	15
59	Transformer Phase B duty	2	15
60	Transformer Phase C duty	2	15
61	Transformer Through Fault Operations Counter	2	16
Latched Targets Status (62 – 65)			
62	Target Status-part 1	1	18
63	Target Status-part 2	1	18
64	Target Status-part 3	1	18
65	Target Status-part 4	1	18
66	BF Status	1	19
Most Recent Fault Summary Report (67 – 104)			
67	Fault Number	1	2 ,24
68	Fault Trigger Time Stamp – part 1; days	1	3,24
69	Fault Trigger Time Stamp – part 2; ms	1	3,24
70	Active Setting Group	1	4,24
71	Trigger	1	5,24
72	System Status – Part 1	1	34
73	System Status – Part 2	1	34
74	System Status – Part 3	1	34
75	System Status – Part 4	1	34
76	System Status – Part 5	1	34
77	System Status – Part 6	1	34
78	Targets- part1	1	6,24
79	Targets- part2	1	6,24
80	Targets- part3	1	6,24
81	Targets- part4	1	6,24
82	Fault Clearing Time	1	8,24
83	Breaker Operate Time	1	9,24
84	Number of Oscillographic Reports	1	10,24
85	Winding 1 Phase A Fault Current	1	1,24
86	Winding 1 Phase B Fault Current	1	1,24
87	Winding 1 Phase C Fault Current	1	1,24
88	Winding 1 Neutral Fault Current	1	1,24
89	Winding 1 Negative Sequence Fault Current	1	1,24
90	Winding 1 Phase A Angle	1	7,24
91	Winding 1 Phase B Angle	1	7,24
92	Winding 1 Phase C Angle	1	7,24
93	Winding 1 Neutral Angle	1	7,24
94	Winding 2 Phase A Fault Current	1	1,24

Index	Description	Change Event Assigned Class (1, 2, 3, or none)	Notes
95	Winding 2 Phase B Fault Current	1	1,24
96	Winding 2 Phase C Fault Current	1	1,24
97	Winding 2 Neutral Fault Current	1	1,24
98	Winding 2 Negative Sequence Fault Current	1	1,24
99	Winding 2 Phase A Angle	1	7,24
100	Winding 2 Phase B Angle	1	7,24
101	Winding 2 Phase C Angle	1	7,24
102	Winding 2 Neutral Angle	1	7,24
103	Ground Current	1	1,24
104	Ground Angle	1	7,24
105	Phase Rotation	3	25,24
106	Winding 1 CT Ratio	3	26,24
107	Winding 2 CT Ratio	3	26,24
108	Ground CT Ratio	3	26,24
109	Winding 1 CT Connection	3	27,24
110	Winding 2 CT Connection	3	27,24
111	Winding 1 TX Connection	3	28,24
112	Winding 2 TX Connection	3	28,24
113	*Winding 1 Ground Source*	3	29,24
114	*Winding 2 Ground Source*	3	29,24
Active Logic Name			
115	1. character of Active Logic Name	3	24
116	2. character of Active Logic Name	3	24
117	3. character of Active Logic Name	3	24
118	4. character of Active Logic Name	3	24
119	5. character of Active Logic Name	3	24
120	6. character of Active Logic Name	3	24
121	7. character of Active Logic Name	3	24
122	8. character of Active Logic Name	3	24
Logic Function Block Settings			
123	Hardware Outputs' Control Mode	3	30,24
124	43 Aux Virtual Switch Logic Mode	3	31,24
125	143 Aux Virtual Switch Logic Mode	3	31,24
126	243 Aux Virtual Switch Logic Mode	3	31,24
127	343 Aux Virtual Switch Logic Mode	3	31,24
128	443 Aux Virtual Switch Logic Mode	3	31,24
129	543 Aux Virtual Switch Logic Mode	3	31,24
130	643 Aux Virtual Switch Logic Mode	3	31,24
131	743 Aux Virtual Switch Logic Mode	3	31,24
132	Setting Group Logic Mode	3	32,24
133	101 Breaker Switch Control Mode	3	33,24

Index	Description	Change Event Assigned Class (1, 2, 3, or none)	Notes
Selected Fault Summary Report (134 – 171)			
134	Fault Number	none	2
135	Fault Trigger Time Stamp – part 1; days	none	3
136	Fault Trigger Time Stamp – part 2; ms	none	3
137	Active Setting Group	none	4
138	Trigger	none	5
139	System Status – Part 1	none	34
140	System Status – Part 2	none	34
141	System Status – Part 3	none	34
142	System Status – Part 4	none	34
143	System Status – Part 5	none	34
144	System Status – Part 6	none	34
145	Targets- part1	none	6
146	Targets- part2	none	6
147	Targets- part3	none	6
148	Targets- part4	none	6
149	Fault Clearing Time	none	8
150	Breaker Operate Time	none	9
151	Number of Oscillographic Reports	none	10
152	Winding 1 Phase A Fault Current	none	1
153	Winding 1 Phase B Fault Current	none	1
154	Winding 1 Phase C Fault Current	none	1
155	Winding 1 Neutral Fault Current	none	1
156	Winding 1 Negative Sequence Fault Current	none	1
157	Winding 1 Phase A Angle	none	7
158	Winding 1 Phase B Angle	none	7
159	Winding 1 Phase C Angle	none	7
160	Winding 1 Neutral Angle	none	7
161	Winding 2 Phase A Fault Current	none	1
162	Winding 2 Phase B Fault Current	none	1
163	Winding 2 Phase C Fault Current	none	1
164	Winding 2 Neutral Fault Current	none	1
165	Winding 2 Negative Sequence Fault Current	none	1
166	Winding 2 Phase A Angle	none	7
167	Winding 2 Phase B Angle	none	7
168	Winding 2 Phase C Angle	none	7
169	Winding 2 Neutral Angle	none	7
170	Ground Current	none	1
171	Ground Angle	none	7

Index	Description	Change Event Assigned Class (1, 2, 3, or none)	Notes
	Demand Currents Historical Data		
	Peak Demand Current Since Reset		
172	**Phase A Current**	none	1
173	Phase A Time Stamp – part 1; days	none	11
174	Phase A Time Stamp – part 2; ms	none	11
175	**Phase B Current**	none	1
176	Phase B Time Stamp – part 1; days	none	11
177	Phase B Time Stamp – part 2; ms	none	11
178	**Phase C Current**	none	1
179	Phase C Time Stamp – part 1; days	none	11
180	Phase C Time Stamp – part 2; ms	none	11
181	**Neutral Current**	none	1
182	Neutral Time Stamp – part 1; days	none	11
183	Neutral Time Stamp – part 2; ms	none	11
184	**Negative Sequence**	none	1
185	Negative Sequence Time Stamp – part 1; days	none	11
186	Negative Sequence Time Stamp – part 2; ms	none	11
	Today's Peak Demand Current		
187	**Phase A Current**	none	1
188	Phase A Time Stamp – part 1; days	none	11
189	Phase A Time Stamp – part 2; ms	none	11
190	**Phase B Current**	none	1
191	Phase B Time Stamp – part 1; days	none	11
192	Phase B Time Stamp – part 2; ms	none	11
193	**Phase C Current**	none	1
194	Phase C Time Stamp – part 1; days	none	11
195	Phase C Time Stamp – part 2; ms	none	11
196	**Neutral Current**	none	1
197	Neutral Time Stamp – part 1; days	none	11
198	Neutral Time Stamp – part 2; ms	none	11
199	**Negative Sequence Current**	none	1
200	Time Stamp – part 1; days	none	11
201	Time Stamp – part 2; ms	none	11
	Yesterday's Peak Demand Current		
202	**Phase A Current**	none	1
203	Phase A Time Stamp – part 1; days of	none	11
204	Phase A Time Stamp – part 2; ms	none	11
205	**Phase B Current**	none	1
206	Phase B Time Stamp – part 1; days	none	11
207	Phase B Time Stamp – part 2; ms	none	11

Index	Description	Change Event Assigned Class (1, 2, 3, or none)	Notes
208	**Phase C Current**	none	1
209	Phase C Time Stamp – part 1; days	none	11
210	Phase C Time Stamp – part 2; ms	none	11
211	**Neutral Current**	none	1
212	Neutral Time Stamp – part 1; days	none	11
213	Neutral Time Stamp – part 2; ms	none	11
214	**Negative Sequence Current**	none	1
215	Negative Sequence Time Stamp – part 1; days	None	11
216	Negative Sequence Time Stamp – part 2; ms	None	11

Notes for Table 5-3:

1. Current value is in primary centiamps. For example value of 123 means 1.23 Amps.

1* If the winding is set to WYE configuration, the quantities returned are IAn, IBn, ICn, INn, and Iqn where n is equal to 1 for CT circuit 1 or 2 for CT circuit 2. If the winding is set to DAB configuration, then quantities returned are IAn-IBn, IBn-ICn, ICn-IAn, INn, and Iqn where n is equal to 1 for CT circuit 1 or 2 for CT circuit 2. If the winding is set to DAC configuration, then quantities returned are IAn-ICn, IBn-IAn, ICn-IBn, Inn, and IQn where n is equal to 1 for CT circuit 1 or 2 for CT circuit 2.

2. Fault Number range is from 1 to 255. For example, after 255, fault number is going to be 1.

3. This time is a fault trigger time presented in relay's internal format: part 1 contains days (1 to 65535), and part 2 contains milliseconds (1 to 86,400,000) since January 1, 1984. This time is equal to the time of Binary Input Event "New Fault" triggered (transition from 0 to 1).

   Notice that the Binary Input Event time stamp is presented in DNP time stamp format, since January 1, 1970.

4. Active setting group at time of fault (0 or 1 or 2 or 3).

5. Event type (value is 1, 2, 4, 8, or 16) reports the classification assigned to the fault event. Fault events are classified into five categories.

   1. **Breaker Failure** (Event Type value is 1): A fault was initiated by the pickup expression and the breaker failure trip became true before fault was cleared.
   2. **Trip** (Event Type value is 2): A fault was initiated by overcurrent pickup and the relay tripped to clear the fault.
   3. **Logic** (Event Type value is 4): A fault was detected as defined by the relay logic trigger expression, but no fault was detected as defined by the pickup expression.
   4. **Pickup** (Event Type value is 8): A fault was initiated by the pickup expression but the relay never tripped indicating that the fault was cleared by some other device.
   5. **RF=TRIG** (Event Type value is 16): A Fault was triggered by the ASCII command RF=TRIGGER received via the front or rear RS-232 communication port.

6. **Targets**: are bit mapped variables. (1= TRUE, 0=FALSE).
   If Targets are Latched (points 62 to 65), Table 5-4 represents the bit position of the element at the time the reading is taken.
   If Fault Report, these targets are logged to the fault report between the time that the trip expression became true until the end of the fault.

Table 5-4. Target Status Format

BIT Mask (hex)	Part 1	Part 2	Part 3	Part 4
0001	87UA	151A	BF	150TA
0002	87UB	151B	62	150TB
0004	87UC	151C	162	150TC
0008	87RA	151N	spare	150TN
0010	87RB	151Q	spare	150TQ
0020	87RC	spare	spare	spare
0040	87ND	spare	spare	spare
0080	spare	spare	spare	spare
0100	251A	51A	250TA	50TA
0200	251B	51B	250TB	50TB
0400	251B	51C	250TC	50TC
0800	251N	51N	250TN	50TN
1000	251Q	51Q	250TQ	50TQ
2000	spare	spare	spare	spare
4000	spare	spare	spare	spare
8000	spare	spare	spare	spare

7. Unit for angle is in degrees (from 0 to 359). Delta of 1 degree deviation will cause an event.
8. Fault Clearing Time is time in milliseconds from 0 to 60,000.
9. Breaker Operate Time is time in milliseconds from 0 to 60,000.
10. The number of recorded oscillographic records per fault (read value of this point) can be 1 or 2.
11. Time presented in relay internal format: part 1 contains days (1 to 65,535) and part 2 milliseconds (1 to 86,400,000) since January 1, 1984.
12. Point represents assigned phase accumulated breaker pole duty as a centipercent of the maximum duty (DMAX) that the breaker contacts can withstand before they need service.

    Breaker Accumulated Duty for Phase A, B, and C is calculated as ΣI or ΣI^2. This is defined by the Breaker Contact Duty Operation Mode 0/1/2 entered via the ASCII protocol command SB-DUTY. DMAX is defined through the same SB-DUTY command (for more information, see the BE1-CDS Instruction Manual, Section 4, *Protection And Control*). Value range is from 0 to 20,000 where 20,000 represents 200% of DMAX. Delta of 20 centipercent will cause an event.
13. This is the number of recorded breaker operations (0 – 99,999). If the operations counter exceeds 99,999, the counter will wrap back to zero. This value can be changed via object 41, point 3 to any value from 0 to 99,999. Delta of 1 will cause an event.
14. The selected Fault Summary Report contains fault data for the fault number defined by the value of the Analog Output Status (object 40) point 29, Fault Number for Selected Fault Summary Report.
15. Point represents assigned phase accumulated transformer pole duty as a centipercent of the maximum duty (DMAX) that the transformer contacts can withstand before they need service. Transformer Duty for Phase A, B and C is calculated as ΣI or ΣI^2. This is defined by Transformer Duty Operation Mode 0/1/2 entered via ASCII protocol command ST-DUTY. DMAX is defined through the same ST-DUTY command (refer to BE1-CDS Instruction Manual). Point value range is from 0 to 20,000, where 20,000 represents 200% of DMAX. Delta of 20 centipercent will cause an event.
16. This is the number of recorded transformer through-fault operations (0 to 99,999). If the operations counter exceeds 99,999, the counter will wrap back to 0 (zero). This value can be changed via object 41, point 8 to any value from 0 to 99,999. Delta of 1 will cause an event.

17. Measured freq. value is in centihertz. For example 5506 value is 55.06 hertz. Frequency Delta of 0.01 hertz deviation will cause an event.
18. Latched Targets Status format is described in Table 5-4, under Note 6. Delta of 1 deviation will cause en event. Latched Targets can be reset via object 41, point 11.
19. BF status is a bit mapped variable with format described in Table 5-5. Delta of 1 deviation will cause an event.

Table 5-5. Breaker Status Format

Value / Bit Mask (hex)	Description
0001	Breaker Operation Control State: {1=Breaker Operation Enabled; 0= Breaker Operation Disabled }
0002	Breaker State { 1=Breaker Opened ; 0= Breaker Closed }

20. Current analog input point generates an analog event if the current value is greater than the previous current value plus the dead band, or less than previous current value minus the dead band. The dead band for an analog event is configurable via Analog Output point 31, Current Dead band. The default value for dead band is set to be ±2.5% of the primary nominal current. For more information about dead band configuration see the paragraphs under *Analog Output Status and Control Points*, point 31, Note 16.
21. Differential Compensated Current is expressed as differential compensated per unit current multiplied by TAP. Read of this point returns differential compensated per centiunit current (value from 0 to 10,000). For example, if the return read value is 27 it means that the differential compensated current is equal to 27 times 0.01 times TAP which is equal to 0.27 time TAP. Delta of 10 per centiunit deviation will cause en event.
22. Differential operating current is expressed as differential operating per unit current multiplied by TAP. Read of this point returns differential operating per centiunit current (value from 0 to 10,000). For example, if the return read value is 40 it means that the differential operating current is equal to 40 times 0.01 times TAP which is equal to 0.40 times TAP. Delta of 10 per centiunit deviation will cause an event.
23. Differential 5^{TH} and 2^{nd} harmonic currents are expressed as a percentage of the operating current. Read of this point returns centipercent value (value from 0 to 10,000) of the operating current. For example, if the return read value is 1400, it means that the harmonic current is equal to 14 percent of IOP. Delta of 10 centipercent deviation will cause an event.
24. Delta of 1 bit (any change) will cause an event.
25. Read value of phase rotation is 1 for ABC and 2 for ACB.
26. Read value presents ratio in turns.
27. Read values for CT Connection is 0 =WYE , 1=DAB, 2=DAC and 3=NA (Not Available).
28. Read values for TX Connection is 0 =WYE , 1=DAB, 2=DAC and 3=NA (Not Available).
29. Read values for Ground Source is 0=NO, 1=YES, and 2=NA.
30. Read values for Hardware Output Control is 1 = Enabled, and 0=Disabled.
31. Logic Mode of AUX x43 switch can be 0(disable), 1(enable), 2(on/off), and 3 (off/momentary on). (See ASCII command SL-43x in Instruction Manual for the BE1-CDS.)
32. Read values for Setting Group Mode are 0=Disabled, 1=discrete select, and 2= binary select. Setting group can be controlled via DNP object 12 if value is 1 or 2.
33. Read values for 101 Breaker Control Switch Mode is 0=Disabled and 1=Enabled.
34. The BE1-CDS relay system status is represented as six, 16-bit mapped variables (see Table 5-6).

Table 5-6. Relay Status

BIT Mask (hex)	Part 1	Part 2	Part 3	Part 4	Part 5	Part 6
0001	50TPT	151 QT	VO A	IN 1	50TPPU	151QPU
0002	150TPT	251 QT	VO 1	IN 2	150TPPU	251QPU
0004	250TPT	BFT	VO 2	IN 3	250TPPU	BFPU
0008	50TNT	87NDT	VO 3	IN 4	50TNPU	87NDPU
0010	150TNT	87RT	VO 4	IN 5	150TNPU	87RPU
0020	250TNT	87UT	VO 5	IN 6	250TNPU	spare
0040	50TQT	2NDHAR	VO 6	IN 7	50TQPU	ARST KEY
0080	150TQT	5THHAR	VO 7	IN 8	150TQPU	TRST KEY
0100	250TQT	spare	VO 8	spare	250TQPU	43
0200	51PT	62	VO 9	ALMMAJ	51PPU	143
0400	151PT	162	VO 10	ALMMIN	151PPU	243
0800	251PT	SG0	VO 11	ALMLGC	251PPU	343
1000	51NT	SG1	VO 12	CKTMON	51NPU	443
2000	151NT	SG2	VO 13	101T	151NPU	543
4000	251NT	SG3	VO 14	101C	251NPU	643
8000	51QT	LOGIC 0 (always 0)	VO 15	101SC	51QPU	743

Analog Output Status Points and Control Blocks

Table 5-7 lists both the Analog Status Points (Object 40) and the Analog Output Control Blocks (Object 41). It is important to note that Analog Output Status Points are not included into Class 0.

The Return Status Value for object 41 for all control operations may be 6 (hardware problem) due to a value out of range, or a relay internal state. One of the reasons for rejection may be if another communication port or front panel HMI is actively programming. For more information, see the BE1-CDS Instructional Manual, Section 7, *Communications, Command Descriptions, Changing Settings Through the Serial Port*.

Table 5-7. Analog Output Status Points and Control Blocks

Analog Output Status Points
Object Number: 40
Variations Supported: 1, 2
Request Function Codes supported: 1 (read)
Default Variation Reported When Variation 0 Requested: 2 (16-Bit Analog Output Status)

Analog Output Blocks
Object Number: 41
Variations Supported: 1, 2
Request Function Codes supported: 3(select), 4(operate), 5(direct operate), 6 (direct operate, noack)

Index	Description	Notes
0	Hardware Output Logic Control Mode	1,2
1	43 AUX Virtual Switch Logic Mode	1,3
2	143 AUX Virtual Switch Logic Mode	1,3
3	243 AUX Virtual Switch Logic Mode	1,3
4	343 AUX Virtual Switch Logic Mode	1,3

Index	Description	Notes
5	443 AUX Virtual Switch Logic Mode	1,3
6	543 AUX Virtual Switch Logic Mode	1,3
7	643 AUX Virtual Switch Logic Mode	1,3
8	743 AUX Virtual Switch Logic Mode	1,3
9	Active Setting Group Control Mode	1,4
10	101 Breaker Control Switch Mode	1,5
11	Target Status Reset	6
12	Major Alarms Reset	7
13	Minor Alarms Reset	7
14	Logic Alarms Reset	7
15	Relay Trouble Alarms Reset	8
16	Breaker Accumulated Duty for Phase A	9
17	Breaker Accumulated Duty for Phase B	9
18	Breaker Accumulated Duty for Phase C	9
19	Breaker Operation Counter	10
20	Transformer Accumulated Duty for Phase A	11
21	Transformer Accumulated Duty for Phase B	11
22	Transformer Accumulated Duty for Phase C	11
23	Transformer Through Fault Operation Counter	12
24	Peak Demand Current Since Reset - Phase A	13
25	Peak Demand Current Since Reset - Phase B	13
26	Peak Demand Current Since Reset - Phase C	13
27	Peak Demand Current Since Reset - Neutral	13
28	Peak Demand Current Since Reset - Negative Sequence	13
29	Fault Number for Selected Fault Summary Report	14
30	Synchronization Time Period	15
31	Current Dead Band	16

Notes for Table 5-7:

1. Note that this data is a setting, and as such, it takes effect after being saved to a non-volatile memory.

   The procedure for saving data to a non-volatile memory is performed only once per request for all points requested to be changed through function Operate(4), Direct Operate(5) or Direct Operate No Ack (6).

   Saving to a non-volatile memory is not implemented on a per point basis because it would significantly prolong requested message processing time and cause response time-out. It is important to note that object 12 (Binary Output Status) points from 0 to 21 can be successfully controlled only if the function blocks mode are enabled at the time of parsing. This is the reason that in **the same request**, with FC= 5 or 6, specific Binary Output Status points **cannot** be first Enabled via the Mode point of object 41, and controlled immediately after that (object 12).

   For example: To control any 43 Aux Control Relay Output Block, Master should do the following steps:

   1. Enable control of x43 Aux Switch(s) via request(s) with FC=(3, 4) or 5 or 6 for specific point(s) of object 41.
   2. Control Binary Output Status point(s) (object 12) with via next request(s).

2. Hardware Output Logic Control Mode can be 0 (Disable) or 1(Enable). If hardware outputs are to be controlled via object 12 (Control Relay Output Blocks), their control must be Enabled through this point. (See ASCII command CS/CO-OUT=ENA/DIS in Instruction Manual for the BE1-CDS.)
3. Logic Mode of AUX x43 switch can be 0(disable), 1(enable), 2(on/off), and 3 (off/momentary on). (See ASCII command SL-43x in Instruction Manual for the BE1-CDS.) Depending on the Logic Mode value, AUX x43 Switch can or cannot be successfully controlled via the Control Relay Output Block x43.
4. Setting Group Mode can be 0(disable), 1 (discrete select) or 2 (binary select). If the Setting Group is to be switched via object 12 (Control Relay Output Block), it must be first Enabled via this point. (See ASCII command SL-GROUP in Instruction Manual for the BE1-CDS.)
5. Logic Mode of the 101 Breaker Control Switch can be 0(disable) or 1(enable). Depending on this point value, the 101 Virtual Breaker Control Switch can or cannot be successfully controlled via Control Relay Output Block point for 101 Virtual Breaker Control Switch. (See ASCII command SL-101 in Instruction Manual for the BE1-CDS.)
6. Target Status Reset Control can only be reset with write value equal zero. A read of this point returns 1 if there are active targets, or 0 if targets are not active. Targets Status can be read as Analog Input objects (object 30) points 62, 63, 64, and 65.
7. Major, Minor, and Logic Alarms are 32 bit mapped variables as described in Table 5-8. Writing value 0 will reset the alarms. Note that only latched alarms will be cleared.

Table 5-8. Major, Minor, and Alarms Status Format

Bit Mask (hex)	Name	Bit Mask (hex)	Name
00000001	Output Circuit Open	00010000	EE NON –FATAL ERR
00000002	Breaker Fail	00020000	OUTPUT OVERRIDE
00000004	Differential	00040000	LOSS OF IRIG
00000008	Access Lost	00080000	Setting Group Change Alarm Active
00000010	Breaker Alarm #1	00100000	VO13 LOGIC ALARM
00000020	Breaker Alarm #2	00200000	VO14 LOGIC ALARM
00000040	Breaker Alarm #3	00400000	VO15 LOGIC ALARM
00000080	P Demand	00800000	FLT RPT TIMEOUT
00000100	N Demand	01000000	TRANSFORMER ALARM 1
00000200	Q Demand	02000000	TRANSFORMER ALARM 2
00000400	Group Override	04000000	TRANSFORMER ALARM 3
00000800	SYS I/O Delay	08000000	LOGIC=NONE
00001000	Comm Error	10000000	spare
00002000	Clock Error	20000000	spare
00004000	uP Reset	40000000	spare
00008000	Settings Changed	80000000	spare

8. Relay Trouble Alarms can be reset by writing value 0 to this point. This is a 16-bit mapped variable and is described in Table 5-9. Only alarms with an asterisk (*) are implemented and can be read as Binary Input (object 1) points. (For more detailed information, see Section 6 *Reporting and Alarm Functions, Relay Trouble Alarms,* in the BE1-CDS Instruction Manual.)

Table 5-9. Relay Trouble Alarm Format

Bit Mask (hex)	Name	Bit Mask (hex)	Name
0001	RAM FAILURE	0100	SET DFLT LOADED
0002	ROM FAILURE	0200	CAL DFLT LOADED
0004	uP FAILURE	0400	DSP FAILURE
0008	EEPROM FATAL ERROR *	800	Spare
0010	ANALOG FAILURE *	1000	Spare
0020	CALIBRATION ERR *	2000	Spare
0040	PWR SUPPLY ERR	4000	Spare
0080	WATCHDOG FAILURE	8000	Spare

9. This point represents assigned phase accumulated breaker pole duty as a centipercent of the maximum duty (DMAX) that the breaker contacts can withstand before they need service. Breaker Accumulated Duty for Phase A, B, and C is calculated as ΣI or ΣI^2. This is defined by Breaker Contact Duty Operation Mode 0/1/2 entered via ASCII protocol command SB-DUTY. DMAX is defined through the same SB-DUTY command (refer to Instruction Manual for BE1-CDS).

   Allowed value range is from 0 to 20000, where 20000 represents 200% of DMAX.

   Example: To change accumulated breaker duty for Phase B to 134 % of DMAX, set point 17 using the appropriate control function(s) code, with value 13400. A read of point 17 will return a value of 13400 (134% of DMAX)

10. Read value of this point is a number of recorded breaker operations (0 – 99999). If the operations counter exceeds 99999, the counter will wrap back to 0 (zero). It acts as a counter, but is implemented as analog object so that the initial value can be set or current value changed to any value from 0 to 99999.

11. This point represents assigned phase accumulated transformer pole duty as a centipercent of the maximum duty (DMAX) the transformer contacts can withstand before they need service. Transformer Duty for Phase A, B, and C is calculated as ΣI or ΣI^2. This is defined by Transformer Duty Operation Mode 0/1/2 entered via ASCII protocol command ST-DUTY. DMAX is defined through the same ST-DUTY command (refer to the Instruction Manual for BE1-CDS-220). Example: To change accumulated transformer duty for Phase B to 134 % of DMAX, set point 21 via object 41, variation 1 or 2, using appropriate control function(s), with value 13400. To read the value of Accumulated Transformer Duty for Phase B, Read point 21, Obj 40, variation 1 or 2. The returned value of 13400 means 134% of DMAX.

12. Read value of point 23 is a number of recorded transformer through fault operations (0 – 99999). If the operations counter exceeds 99999, the counter will wrap back to 0 (zero). It acts as a counter, but is implemented as analog object so that the initial value can be set, or the current value changed to any value from 0 to 99999.

13. Peak Demand currents, points 24 to 28, can only be set to value 0 (Reset). Point read value presents Peak Demand current in centiamps. For Example: 670 represents 6.7 amperes.

14. Fault Number for Selected Fault Summary Report. This point value range is from 1 to 255. The Fault Summary Report for this selected fault number will be available as analog objects from point 134 to 171. If the Fault Summary Report for the Selected Fault does not exist in the relay at that time, the Return Status Value for object 41 will be 6 (hardware problem).

15. Time period, in milliseconds, when the relay (slave) sets “NEED TIME” bit in first octet of the Application Response Header Internal Indication. When time is set by the Master via object 50 (write function), the relay resets this bit. Relay sets this bit again, periodically, if the time period is not zero. Default value on Cold and Warm Restarts is 0. This means that on Cold and Warm Restarts, this bit will never be set. Allowed value is from 0 to 2^{31}-1 = 2,147,483,647 milliseconds.

16. Change Event Dead band is programmable via this point. Point value must be entered as a percentage of primary nominal current multiplied by 10. Allowed range is from 10 to 100 in steps of 1. This represents 1 to 10% in steps of 0.1%. The Default value is 25 (2.5%).

    Example: To configure Current Change Event Dead Band to 4% of primary nominal current, enter for point 31 the value 40. Relay converts this percentage into an ampere value. For a 5 ampere relay, and CT1 ratio =120 turns, dead band value in amperes for winding 1 current is 5 times 120 times 4 times 0.01 = 24 primary A (2400 centiamps).

Current threshold for winding 1 = previous current value ±24 amps.

If the CT2 ratio = 60 turns, dead band value in amperes for winding 2 current is 0.04 times 60 times 5 = 12 primary amperes (1200 centiamps). Current threshold for winding 2 = previous current value ±12 amps.

If the CT ratio for ground is 12, then utilized dead band for ground current is 0.04 times 12 times 5 = 2.4 primary amperes (240 centiamps). Ground threshold = previous ground current value ±2.4 amps.

8-Bit Unsigned Integer, Object 102

Table 5-10 is the point list for Object 102, and lists the 8-Bit Unsigned Integer Points. Note that this object has only variation 1 and cannot be requested with default variation 0.

Table 5-10. Object 102, 8-Bit Unsigned Integer Points

8-Bit Unsigned Integer
Object Number: 102
Variations Supported: 1
Request Function Codes supported: 1 (read)

Index	Description
0 - 9	Model Number
10 - 28	Application Software Version Number and Date
29 - 47	DSP Software Version Number and Date
48 - 66	Boot Software Version Number and Date
67 - 80	Serial Number
81 - 102	Style Number
103 - 118	Part Number
119 - 150	Relay ID
151 - 182	Station ID
183 - 214	User ID #1
215 - 246	User ID #2

Explanation:

Each point represents one character of a particular string.
Example: To read the Model Number, which is BE1-CDS220, the returned read values for points 0 to 9 are:

Point	0	1	2	3	4	5	6	7	8	9
Read Value in ASCII format	B	E	1	-	C	D	S	2	2	0

Object 102 is not included in Class 0 poll response.

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