DVRR-72
COMMUNICATION SPECIFICATION

(Modbus RTU mode protocol)

DAIICHI ELECTRONICS CO., LTD.

Contents

1. Communication specification

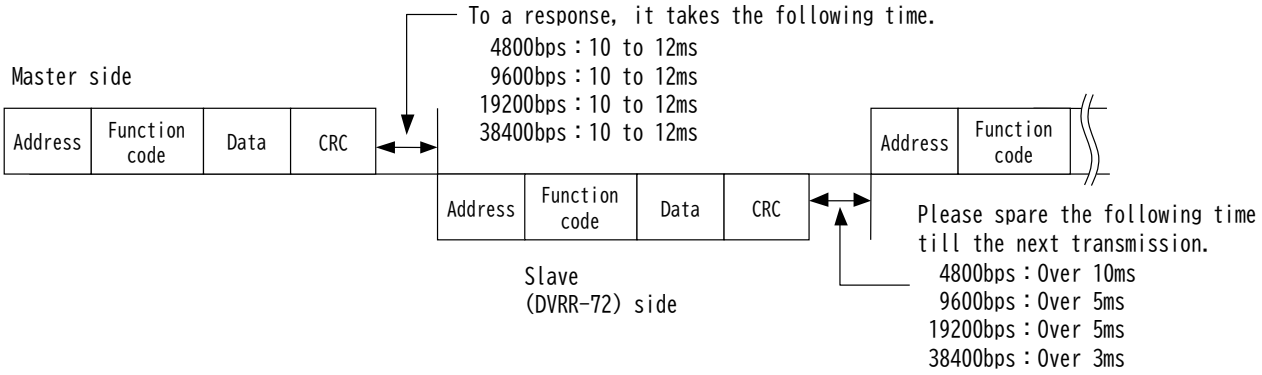
Item	Specification	Default setting
Standard	TIA-485-A (2003)	—
Protocol	Modbus protocol RTU mode	—
	Function code : 03H	
Transmission system	Half-duplex two-wire system	—
Synchronous system	Asynchronous communication method	—
Bit rate (1)	4800bps / 9600bps / 19200bps / 38400bps	19200bps
Modulation code	NRZ	—
Start bit	1 bit	—
Data length	8 bit	—
Parity (1)	NONE / Even number / Odd number	Odd number
Stop bit (1)	1 bit / 2 bit	1 bit
Cable length	1000m (The total extension)	—
Address (1)	1 to 247 (Connection is possible to 31 sets.)	1
Error detection	CRC-16 ($X^{16}+X^{15}+X^2+1$)	—
Transmission character	Binary	—

Transmission data are sent out from a bit 0.

Note(1) Settings can be changed using the switch on the front.

2. Transmission and reception protocol

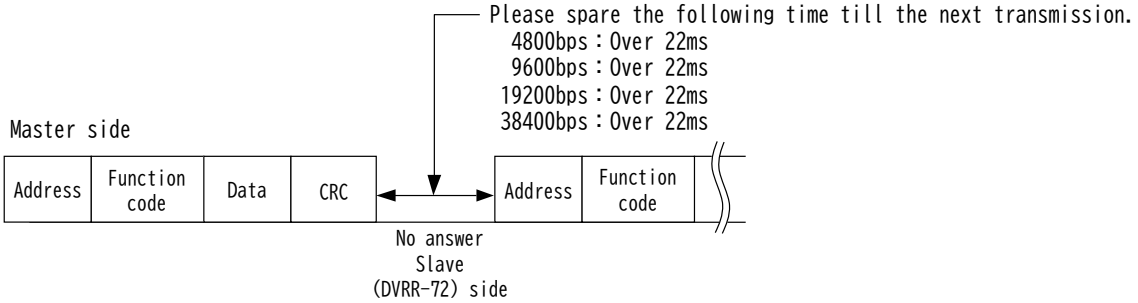
(1) Usual request (Query)



(2) Brosdcast request (Query)

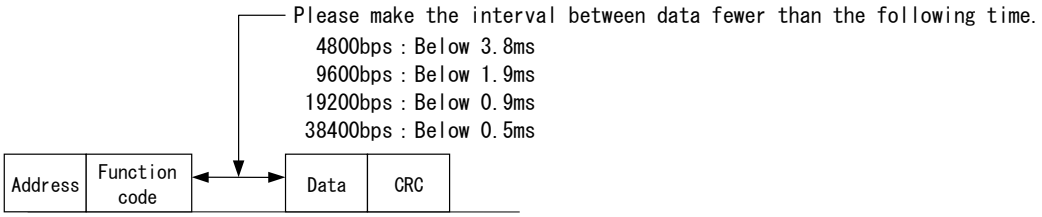
If all stations are specified in the address, it becomes a broadcast request.

At this time, the slave side becomes no answer.



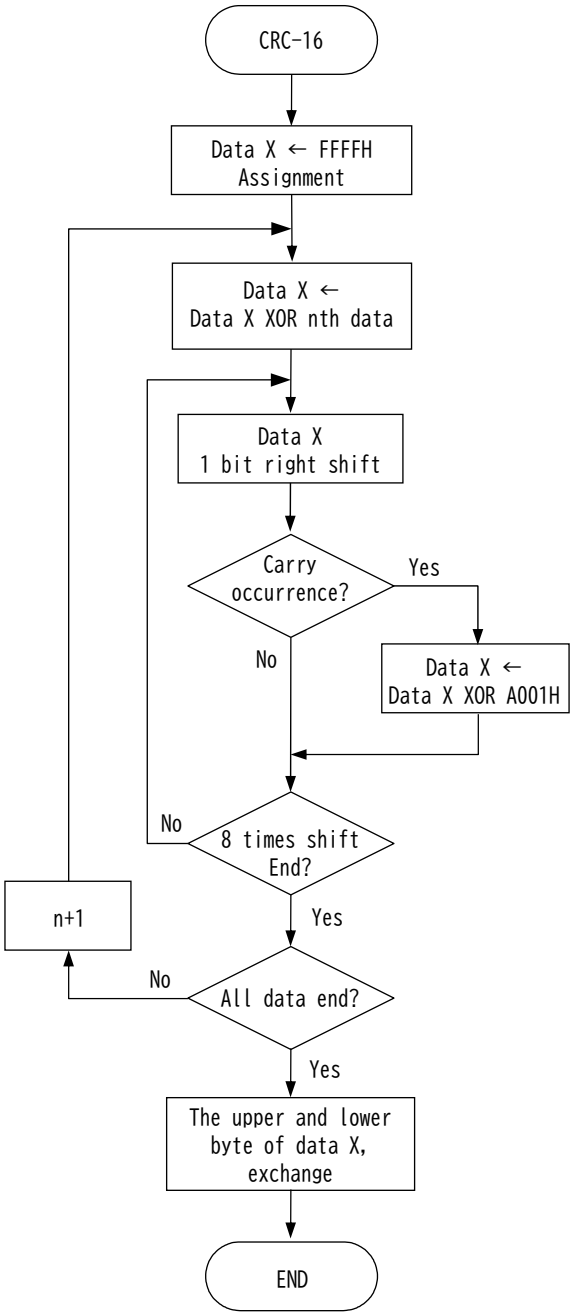
(3) The timeout between data

The interval between data must be 1.5 characters or less.



3. Calculation method of CRC-16

CRC-16 is adopted as error checking in Modbus RTU mode.
An address, a function code, and data are calculated by the following method.



(1) Arithmetic process

① 2 bytes of data-area X is secured to a CRC calculation.

② FFFFH is substituted for ① as initial value.

③ XOR of data X and the nth data (n=1) is calculated. Assign it to data X.

④ The 1-bit right shift of the data X is done.

⑤ If carry occurs in operation of ④, data X and XOR of A001H are taken.

⑥ Operation of ④,⑤ is repeated until it shifts 8 times.

⑦ The next data (n+1) and XOR of data X is calculated. Assign it to data X.

⑧ Operation of ④ to ⑦ is repeated until processing of all data is completed.

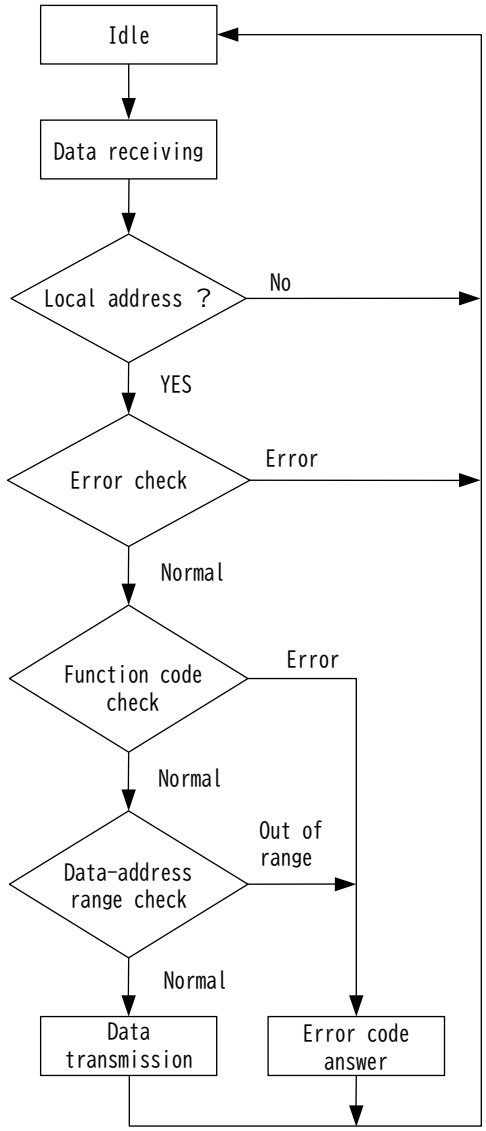
⑨ 1 byte of upper and 1 byte of lower of data-area X for a CRC calculation are exchanged.

(2) Example of calculation

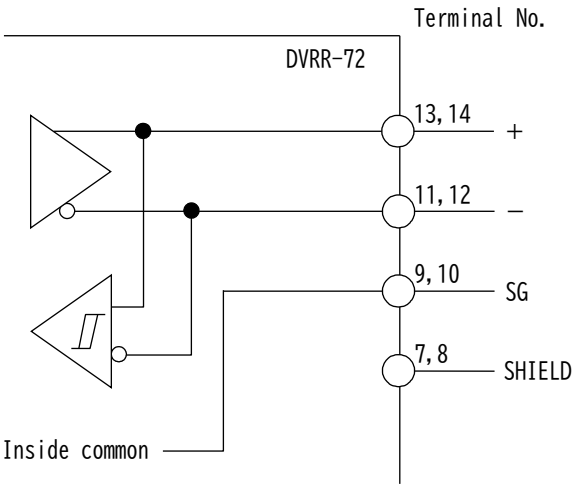
CRC Object range

1 byte	1 byte	2 byte	2 byte	2 byte
Address	Function code	Data address	Number of request data	CRC
01H	04H	00H 00H	00H 19H	31C0H

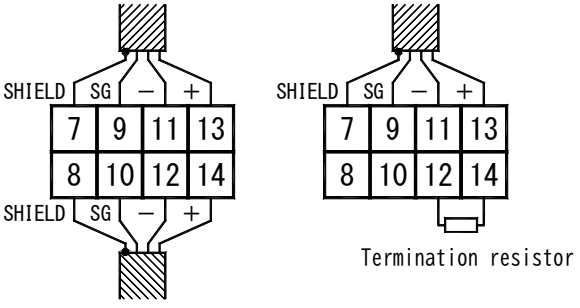
4. Communication process flow chart



5. Communication terminal arrangement



Communication output terminals 7 and 8, 9 and 10, 11 and 12, 13 and 14 are connected internally.
For daisy chain, connect as shown in the figure below.
Connect the termination resistor to the device that will be terminated in the connection form. (Refer to the figure below)



Daisy chain Terminating device

6. Modbus protocol RTU mode

6.1 Function code

This product supports the following function codes.

Code	Name	Data address	Contents	MODBUS original function
03	Measurement value request, Status information request	40201 to	The readout of measurement value and status information.	Holding register readout
08	Loopback test	—	The communication test of master and slave is performed.	Diagnosis

6.2 Abnormal response

If the message transmitted from the master is judged to be abnormal, this product does the next abnormal answer.

(1) In case it becomes a no answer.
① : In case a message transmission error occurs. (Overrun, Framing, Parity error, CRC)
② : In case the data interval of a message exceeds a regulation value (1.5 characters).
③ : In case the message frame exceeding 8 bytes is received.

(2) In case as answered in an error code.
In the error that does not correspond to (1), the following abnormal response is returned.
At this time, a code obtained by adding 80H to the code at the time of request is returned to the function code. And, the generated error code is returned as data.

Error code list

Error code	Contents
01H	The function code besides regulation is received.
02H	Data address is out of range.
03H	The data more than the number of answer data are required.

1 byte	1 byte	1 byte	2 byte
Address	Function code (+80H)	Error code	CRC
01H	84H	02H	C2C1H

6.3 Measurement value request, Status information request

Read the measurement value from this product. There is no broadcast. Function code is 03H.

(1) Data request (Query)

In case it performs setting value request, it is necessary to designate the start address of data to acquire.
If a data address is transmitted, please subtract 40001 from the address in data-address list.
Please assign the number of requested data as the number of data.

1	2	3	4	5	6	7	8
Address	Function code	Data address		Number of data		CRC	
01H	03H	00C8H		0018H		C43EH	

■ Data address list

Data address	Model			Data scaling (2)	Unit
	3P3W	1P3W	1P2W		
40201	Primary rated voltage	Primary rated voltage	Primary rated voltage	6 to 33000	V
40202	Primary rated current	Primary rated current	Primary rated current	5 to 30000	A
40203	Status information	Status information	Status information	— (3)	-
40204	Voltage (L12)	Voltage (L1N)	Voltage	0 to 32767	V
40205	Voltage (L23)	Voltage (L3N)	0000H (Fixation)	0 to 32767	
40206	Voltage (L31)	Voltage (L13)	0000H (Fixation)	0 to 32767	
40207	Current (L1)	Current (L1)	Current	0 to 32767	A
40208	Current (L2)	Current (N)	0000H (Fixation)	0 to 32767	
40209	Current (L3)	Current (L3)	0000H (Fixation)	0 to 32767	
40210	Active power	Active power	Active power	-16383 to 16383	kW
40211	Wh (Power receiving) upper	Wh (Power receiving) upper	Wh (Power receiving) upper	0 to 999999999	kWh
40212	Wh (Power receiving) lower	Wh (Power receiving) lower	Wh (Power receiving) lower	0 to 999999999	
40213	Wh (Power transmission) upper	Wh (Power transmission) upper	Wh (Power transmission) upper	0 to 999999999	
40214	Wh (Power transmission) lower	Wh (Power transmission) lower	Wh (Power transmission) lower	0 to 999999999	
40215	Reactive power	Reactive power	Reactive power	-16383 to 16383	kvar
40216	varh (Power receiving LAG) upper	varh (Power receiving LAG) upper	varh (Power receiving LAG) upper	0 to 999999999	kvarh
40217	varh (Power receiving LAG) lower	varh (Power receiving LAG) lower	varh (Power receiving LAG) lower	0 to 999999999	
40218	varh (Power receiving LEAD) upper	varh (Power receiving LEAD) upper	varh (Power receiving LEAD) upper	0 to 999999999	
40219	varh (Power receiving LEAD) lower	Varh (Power receiving LEAD) lower	varh (Power receiving LEAD) lower	0 to 999999999	
40220	Varh (Power transmission LAG) upper	Varh (Power transmission LAG) upper	Varh (Power transmission LAG) upper	0 to 999999999	
40221	Varh (Power transmission LAG) lower	Varh (Power transmission LAG) lower	Varh (Power transmission LAG) lower	0 to 999999999	
40222	Varh (Power transmission LEAD) upper	Varh (Power transmission LEAD) upper	Varh (Power transmission LEAD) upper	0 to 999999999	
40223	Varh (Power transmission LEAD) lower	Varh (Power transmission LEAD) lower	Varh (Power transmission LEAD) lower	0 to 999999999	
40224	Power factor	Power factor	Power factor	-500 to +1000 to 500	%
40225	Apparent power	Apparent power	Apparent power	0 to 16383	kVA
40226	Frequency	Frequency	Frequency	0 to 6520	Hz
40227	Maximum zero phase voltage	Maximum zero phase voltage	Maximum zero phase voltage	0 to 1200	%

Note(2) Data can be converted to measured values using the units in the table and the data multiplying factor table on the next page. (Excluding status information data)

Note(3) Refer to the status bit assignment table.

■ Data multiplying factor table

Measurement	Judgment data	Measuring range	Multiplying factor
Voltage	Primary voltage	110.0V to 690V	×0.1
		880V to 6.60kV	×1
		11.00kV to 66.00kV	×10
		77.0kV or more	×100
Current	Primary current	5.00A to 30.00A	×0.01
		40.0A to 300.0A	×0.1
		400A to 3500A	×1
		4000A or more	×10
Active power, Reactive power, Apparent power	Full load power	0kW to less than 1.2kW	×0.0001
		1.2kW to less than 12kW	×0.001
		12kW to less than 120kW	×0.01
		120kW to less than 1200kW	×0.1
		1200kW to less than 12000kW	×1
		12000kW to less than 120000kW	×10
		120000kW to less than 1200000kW	×100
		1200000kW or more	×1000
Electric energy, Reactive energy	Full load power	0kW to less than 1kW	×0.0001
		1kW to less than 10kW	×0.001
		10kW to less than 100kW	×0.01
		100kW to less than 1000kW	×0.1
		1000kW to less than 10000kW	×1
		10000kW to less than 100000kW	×10
		100000kW to less than 1000000kW	×100
		1000000kW or more	×1000
Power factor	—	—	×0.1 fixed
Frequency	—	—	×0.01 fixed
Maximum zero phase voltage	—	—	×0.1 fixed

Calculation formula of full load power.

Full load power [kW] = (α × Primary rated voltage × Primary rated current) × 10^{-3}

Phase wire method	value of α	Note
3P3W	1.732 ($\sqrt{3}$)	Use primary rated voltage and primary rated current data.
1P3W	2	
1P2W	1	

(2) Response

If measurement value requirements are performed normally, the following response will be returned from this product side.

Example) Data address : 40201, Number of data : 24 (3-phase 3-wire)

1	2	3	4	5	6	7	8	9
Address	Function code	Answer byte count	Primary rated voltage		Primary rated current		Status information	

10	11	12	13	14	15	16	17
L12 line voltage U(L12)		L23 line voltage U(L23)		L31 line voltage U(L31)		L1 phase current I(L1)	

18	19	20	21	22	23	24	25
L2 phase current I(L2)		L3 phase current I(L3)		Active power P		Electric energy (Power receiving) Wh Upper	

26	27	28	29	30	31	32	33
Electric energy (Power receiving) Wh Lower		Electric energy (Power transmission) -Wh Upper		Electric energy (Power transmission) -Wh Lower		Reactive power var	

34	35	36	37	38	39	40	41
Reactive energy (Power receiving, LAG) varh (LAG) Upper		Reactive energy (Power receiving, LAG) varh (LAG) Lower		Reactive energy (Power receiving, LEAD) varh (LEAD) Upper		Reactive energy (Power receiving, LEAD) varh (LEAD) Lower	

42	43	44	45	46	47	48	49
Reactive energy (Power transmission, LAG) -varh (LAG) Upper		Reactive energy (Power transmission, LAG) -varh (LAG) Lower		Reactive energy (Power transmission, LEAD) -varh (LEAD) Upper		Reactive energy (Power transmission, LEAD) -varh (LEAD) Lower	

50	51	52	53
Power factor		CRC	

■ Status bit assignment table

B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0
(Uupper)															(Lower)

Bit	Name	0	1
B0	Control output 1 (RP)	OFF	ON
B1	—	—	—
B2	RP pre-alarm	OFF	ON
B3	UV lock	No detection	Detection
B4	—	—	—
B5	Control output 2 (OVG)	OFF	ON
B6	Device error	No detection	Detection
B7	—	—	—
B8	Control input status	No input (OFF)	With input (ON)
B9	Phase wire method		
B10			
B11	—	—	—
B12	—	—	—
B13	—	—	—
B14	Phase sequence	Positive phase sequence	Negative phase sequence
B15	Mode	Normal measurement mode	Test mode

B10	B9	Phase wire method
0	0	3P3W
0	1	1P3W
1	0	1P2W

The status of B15 is 1 during test mode. The status of "—" is "0".

■ Primary rated voltage (Unit V)

Primary rating	Communication data	Primary rating	Communication data	Primary rating	Communication data
110.0V	110	880V	880	13.20kV	13200
110V	110	990V	990	13.80kV	13800
220.0V	220	1100V	1100	16.50kV	16500
220V	220	1650V	1650	18.40kV	18400
380V	380	2200V	2200	20.00kV	20000
400V	400	2.20kV	2200	22.00kV	22000
415V	415	3300V	3300	33.00kV	33000
440V	440	3.30kV	3300	66.00kV	6 (4)
460V	460	6600V	6600	77.0kV	7 (4)
480V	480	6.60kV	6600	110.0kV	10 (4)
690V	690	11.00kV	11000		

■ Primary rated current (Unit A)

Primary rating	Communication data	Primary rating	Communication data	Primary rating	Communication data
5.00A	5	120.0A	120	2000A	2000
6.00A	6	150.0A	150	2500A	2500
7.50A	7 (5)	200.0A	200	3000A	3000
8.00A	8	250.0A	250	3500A	3500
10.00A	10	300.0A	300	4000A	4000
12.00A	12	400A	400	4500A	4500
15.00A	15	500A	500	5000A	5000
20.00A	20	600A	600	6000A	6000
25.00A	25	750A	750	7500A	7500
30.00A	30	800A	800	8000A	8000
40.0A	40	900A	900	9.00kA	9000
50.0A	50	1000A	1000	10.00kA	10000
60.0A	60	1200A	1200	12.00kA	12000
75.0A	75	1500A	1500	15.00kA	15000
80.0A	80	1600A	1600	20.00kA	20000
100.0A	100	1800A	1800	30.00kA	30000

Note(4) Since it exceeds 2 bytes, the communication data is the primary rated voltage divided by 11000.
Note(5) This data is special communication data because a fraction appears.

6.4 Loopback test

The loopback test is a function to test whether the master and slave (DVRR-72) are communicating normally. Arbitrary data is returned as it is. There is no broadcast. The function code is 08H.

(1) Loopback request (Query)

When performing a loopback test, it is necessary to send data and diagnostic codes used for diagnosis. Specify 0000H as the diagnostic code. Specify any value from 0000H to FFFFH for the diagnostic data.

1	2	3	4	5	6	7	8
Address	Function code	Diagnostic code		Diagnostic data		CRC	
01H	08H	0000H		04D2H		6296H	

(2) Response

If loopback request is performed normally, the following response will be returned from this product side.

1	2	3	4	5	6	7	8
Address	Function code	Diagnostic code		Diagnostic data		CRC	

The same data sent by the master in (1) is returned as the diagnostic code and diagnostic data.

7. Test mode

Transmission data at communication output confirmation.

Measurement	Transmission data in test mode			
	Seq : Sequence number	100%	50%	0%
Voltage (RS)	1000	By primary rated voltage		0
Voltage (ST)	1100			
Voltage (TR)	1200			
Current (R)	1300	By primary rated current		0
Current (S)	1400			
Current (T)	1500			
Active power	1600	By primary rated voltage and primary rated current		0
Electric energy (Power receiving)	111111111	999999999	555555555	0
Electric energy (Power transmission)	222222222	999999999	555555555	0
Reactive power	1700	By primary rated voltage and primary rated current		0
Reactive energy (Power receiving LAG)	333333333	999999999	555555555	0
Reactive energy (Power receiving LEAD)	444444444	999999999	555555555	0
Reactive energy (Power transmission LAG)	555555555	999999999	555555555	0
Reactive energy (Power transmission LEAD)	666666666	999999999	555555555	0
Power factor	100	1000	500	0
Apparent power	1800	By primary rated voltage and primary rated current		0
Frequency	1900	6500	5500	4500
Maximum zero phase voltage	200	1000	500	0

【Example】 100% data for 3P3W, primary rated voltage 6600V and primary rated current 100A.

Voltage : 6600×15÷11 = 9000

Current : 1000

Active power (Reactive power)

: Calculate from the primary rated voltage data, primary rated current data, multiplier data.

Calculation formula

{(Primary rated voltage ÷ 110) × (Primary rated current ÷ 5)} ÷ Multiplier data

= {(6600 ÷ 110) × (100 ÷ 5)} ÷ 0.1 = 12000

Appendix table 1. Voltage Scaling Table

Primary rating	Communication data		Measurement value × Multiplying factor
	Measurement value	Multiplying factor	
110.0V	1100	0.1	110.0
110V	1100	0.1	110.0
220.0V	2200	0.1	220.0
220V	2200	0.1	220.0
380V	3800	0.1	380.0
400V	4000	0.1	400.0
415V	4150	0.1	415.0
440V	4400	0.1	440.0
460V	4600	0.1	460.0
480V	4800	0.1	480.0
690V	6900	0.1	690.0
880V	880	1	880
990V	990	1	990
1100V	1100	1	1100
1650V	1650	1	1650
2200V	2200	1	2200
2.20kV	2200	1	2200
3300V	3300	1	3300
3.30kV	3300	1	3300
6600V	6600	1	6600
6.60kV	6600	1	6600
11.00kV	1100	10	11000
13.20kV	1320	10	13200
13.80kV	1380	10	13800
16.50kV	1650	10	16500
18.40kV	1840	10	18400
20.00kV	2000	10	20000
22.00kV	2200	10	22000
33.00kV	3300	10	33000
66.00kV	6600	10	66000
77.0 kV	770	100	77000
110.0 kV	1100	100	110000

Appendix table 2. Current Scaling Table

Primary rating	Communication data		Measurement value × Multiplying factor
	Measurement value	Multiplying factor	
5.00A	500	0.01	5.00
6.00A	600	0.01	6.00
7.50A	750	0.01	7.50
8.00A	800	0.01	8.00
10.00A	1000	0.01	10.00
12.00A	1200	0.01	12.00
15.00A	1500	0.01	15.00
20.00A	2000	0.01	20.00
25.00A	2500	0.01	25.00
30.00A	3000	0.01	30.00
40.0A	400	0.1	40.0
50.0A	500	0.1	50.0
60.0A	600	0.1	60.0
75.0A	750	0.1	75.0
80.0A	800	0.1	80.0
100.0A	1000	0.1	100.0
120.0A	1200	0.1	120.0
150.0A	1500	0.1	150.0
200.0A	2000	0.1	200.0
250.0A	2500	0.1	250.0
300.0A	3000	0.1	300.0
400A	400	1	400
500A	500	1	500
600A	600	1	600
750A	750	1	750
800A	800	1	800
900A	900	1	900
1000A	1000	1	1000
1200A	1200	1	1200
1500A	1500	1	1500
1600A	1600	1	1600
1800A	1800	1	1800
2000A	2000	1	2000
2500A	2500	1	2500
3000A	3000	1	3000
3500A	3500	1	3500
4000A	400	10	4000
4500A	450	10	4500
5000A	500	10	5000
6000A	600	10	6000
7500A	750	10	7500
8000A	800	10	8000
9.00kA	900	10	9000
10.00kA	1000	10	10000
12.00kA	1200	10	12000
15.00kA	1500	10	15000
20.00kA	2000	10	20000
30.00kA	3000	10	30000

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DATE：February 13, 2025