Digital Energy
Multilin

745 Transformer Protection System
Communications Guide

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Table of Contents

Digital Energy
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745 TRANSFORMER PROTECTION SYSTEM COMMUNICATIONS GUIDE

Chapter 1: Overview

Description

Protocols

The GE Multilin 745 Transformer Protection System communicates with other computerized equipment such as programmable logic controllers, personal computers, or plant master computers using either the AEG Modicon Modbus protocol or the Harris Distributed Network Protocol (DNP), Version 3.0. Following are some general notes:

- The 745 relay always act as slave devices meaning that they never initiate communications; they only listen and respond to requests issued by a master computer.
- For Modbus, a subset of the Remote Terminal Unit (RTU) format of the protocol is supported which allows extensive monitoring, programming and control functions using read and write register commands.
- For DNP, the functionality is restricted to monitoring of essential relay data and control of important relay functions. A complete description of the services available via DNP may be found in the Device Profile Document which is included in this chapter.

DNP is a complex protocol. As a consequence, it is not possible within the scope of this manual to provide a description of the protocol's operation in anything approaching the detail required to understand how to use it to communicate with the relay. It is strongly recommended that interested users contact the DNP Users Group at http://www.dnp.org to obtain further information:

Members of the DNP Users Group are eligible to receive complete descriptions of all aspects of the protocol. The Users Group also operates a website (http://www.dnp.org) where technical information and support is available.

Physical layer

Both the Modbus and DNP protocols are hardware-independent so that the physical layer can be any of a variety of standard hardware configurations including RS232, RS422, RS485, fiber optics, etc. The 745 includes a front panel RS232 port and two rear terminal RS485 ports, one of which can also be configured as RS422. Data flow is half duplex in all configurations. See the 745 instruction manual for details.

Each data byte is transmitted in an asynchronous format consisting of 1 start bit, 8 data bits, 1 stop bit, and possibly 1 parity bit. This produces a 10 or 11 bit data frame. This is important for transmission through modems at high bit rates (11 bit data frames are not supported by many modems at baud rates greater than 300).

The baud rate and parity are independently programmable for each communications port. Baud rates of 300, 1200, 2400, 4800, 9600, and 19200 are available. Even, odd, and no parity are available. See the 745 instruction manual for further details.

The master device in any system must know the address of the slave device with which it is to communicate. The 745 will not act on a request from a master if the address in the request does not match the relay's slave address (unless the address is the broadcast address -- see below).

A single setpoint selects the slave address used for all ports with the exception that for the front panel port the relay will accept any address when the Modbus protocol is used. The slave address is otherwise the same regardless of the protocol in use, but note that the broadcast address is 0 for Modbus and 65535 for DNP. The relay recognizes and processes a master request (under conditions that are protocol-specific) if the broadcast address is used but never returns a response.

DNP may be used on, at most, one of the communications ports. Any port(s) not selected to use DNP will communicate using Modbus. The **DNP PORT** setpoint is used to select which port will communicate using DNP.

The maximum time for a 745 relay to return a response to any (non-broadcast) master request never exceeds 1 second.

Digital Energy
Multilin

745 TRANSFORMER PROTECTION SYSTEM COMMUNICATIONS GUIDE

Chapter 2: Modbus Protocol

Overview

GE Multilin modbus implementation

The GE Multilin 745 Transformer Protection System implements a subset of the AEG Modicon Modbus serial communication standard. Many devices support this protocol directly with a suitable interface card, allowing direct connection of relays. The Modbus protocol is hardware-independent; that is, the physical layer can be any of a variety of standard hardware configurations. This includes RS232, RS422, RS485, fibre optics, etc. The 745 includes a front panel RS232 port and two rear terminal RS485 ports, one of which can be configured as a four-wire RS422 port. Modbus is a single-master / multiple-slave protocol suitable for a multi-drop configuration as provided by RS485/RS422 hardware. In this configuration up to 32 slaves can be daisy-chained together on a single communication channel.

The GE Multilin 745 is always a Modbus slave. It cannot be programmed as a Modbus master. The Modbus protocol exists in two versions: Remote Terminal Unit (RTU, binary) and ASCII. Only the RTU version is supported by the 745. Monitoring, programming and control functions are possible using read and write register commands.

Additional information on the Modbus protocol can be found on the Modbus website at http://www.modbus.org.

Electrical interface

The hardware or electrical interface is any of the following:

- two-wire RS485 for the rear terminal COM1 and COM2 terminals
- four-wire RS422 for the rear terminal COM1 terminals
- RS232 for the front panel connector

In a two-wire RS485 link, data flow is bidirectional. The four-wire RS422 port uses the RS485 terminal for receive lines, and two other terminals for transmit lines. In the front panel RS232 link there are separate lines for transmission and reception as well as a signal ground wire. In all configurations data flow is half duplex. That is, data is never transmitted and received at the same time.

RS485 and RS422 lines should be connected in a daisy chain configuration (avoid star connections) with terminating resistors and capacitors installed at each end of the link, i.e. at the master end and at the slave farthest from the master. The value of the terminating resistors should be equal to the characteristic impedance of the line. This is approximately

120 Ω for standard 24 AWG twisted pair wire. The value of the capacitors should be 1 nF. Shielded wire should always be used to minimize noise. Polarity is important in RS485 communications. The '+' terminal of every device must be connected together for the system to operate.

Data frame format and data rate

One data frame of an asynchronous transmission to or from a GE Multilin 745 consists of 1 start bit, 8 data bits, and 1 stop bit. This produces a 10 bit data frame. The 745 can be configured to include an additional even or odd parity bit if required, producing an 11 bit data frame.

All ports of the GE Multilin 745 Transformer Protection System support operation at 300, 1200, 2400, 9600, and 19200 baud.

Data packet format

A complete request/response sequence consists of the following bytes transmitted as separate data frames:

Master query message:	
Slave address	(1 byte)
Function code	(1 byte)
Data	(variable number of bytes depending on the function code)
CRC	(2 bytes)

Slave response message:	
Slave address	(1 byte)
Function code	(1 byte)
Data	(variable number of bytes depending on the function code)
CRC	(2 bytes)

A message is terminated when no data is received for a period of 3½ character transmission times. Consequently, the transmitting device must not allow gaps between bytes larger than this interval (about 3 ms at 9600 baud).

- **Slave address**: This is the first byte of every message. This byte represents the user-assigned address of the slave device that is to receive the message sent by the master. Each slave device must be assigned a unique address, and only the addressed slave will respond to a message that starts with its address. In a master query message the slave address represents the address of the slave to which the request is being sent. In a slave response message the slave address is a confirmation representing the address of the slave that is sending the response. A master query message with a slave address of 0 indicates a broadcast command. All slaves on the communication link will take action based on the message, but none will respond to the master. Broadcast mode is only recognized when associated with function codes 05h, 06h, and 10h. For any other function code, a message with broadcast mode slave address 0 will be ignored.
- **Function code**: This is the second byte of every message. Modbus defines function codes of 1 to 127. The 745 implements some of these functions. In a master query message, the function code tells the slave what action to perform. In a slave response message, if the function code sent from the slave is the same as the function code sent from the master then the slave performed the function as requested. If the high order bit of the function code sent from the slave is a 1 (i.e. if the function code is > 7Fh) then the slave did not perform the function as requested and is sending an error or exception response.
- **Data**: This will be a variable number of bytes depending on the Function Code. This may include actual values, setpoints, or addresses sent by the master to the slave or by the slave to the master.

- **CRC**: This is a two byte error checking code. The RTU version of Modbus includes a two-byte CRC-16 (16-bit cyclic redundancy check) with every message. The CRC-16 algorithm essentially treats the entire data stream (data bits only; start, stop and parity ignored) as one continuous binary number. This number is first shifted left 16 bits and then divided by a characteristic polynomial (1100000000000101B). The 16 bit remainder of the division is appended to the end of the message, MSByte first. The resulting message including CRC, when divided by the same polynomial at the receiver will give a zero remainder if no transmission errors have occurred. If a GE Multilin Modbus slave device receives a message in which an error is indicated by the CRC-16 calculation, the slave device will not respond to the message. A CRC-16 error indicates that one or more bytes of the message were received incorrectly and thus the entire message should be ignored in order to avoid the slave device performing any incorrect operation. The CRC-16 calculation is an industry standard method used for error detection.

CRC-16 algorithm

Once the following algorithm is completed, the working register "A" will contain the CRC value to be transmitted. Note that this algorithm requires the characteristic polynomial to be reverse bit ordered. The most significant bit of the characteristic polynomial is dropped, since it does not affect the value of the remainder. The following symbols are used in the algorithm:

- —>: data transfer
- A: 16 bit working register
- AL: low order byte of A
- AH: high order byte of A
- CRC: 16-bit CRC-16 value
- i, j: loop counters
- (+): logical exclusive or operator
- Di: i-th data byte (i = 0 to N-1)
- G: 16 bit characteristic polynomial = 1010000000000001 with the most significant bit dropped and bit order reversed
- shr(x): shift right (the least significant bit of the low order byte of x shifts into a carry flag, a '0' is shifted into the most significant bit of the high order byte of x, all other bits shift right one location

The algorithm is:

```
1. FFFF hex -> A
2. 0 -> i
3. 0 -> j
4. Di (+) AL -> AL
5. j + 1 -> j
6. shr(A)
7. is there a carry? If No, go to 8; If Yes, G (+) A -> A
8. is j = 8? If No, go to 5; If Yes, go to 9.
9. i + 1 -> i
10. is i = N? If No, go to 3; If Yes, go to 11.
11. A -> CRC
```

Message timing

Communication message synchronization is maintained by timing constraints. The receiving device must measure the time between the reception of characters. If three and one half character times elapse without a new character or completion of the message, then the communication link must be reset (i.e. all slaves start listening for a new query message from the master). Thus at 1200 baud a delay of greater than 3.5 x 1/1200 x 10 = 29.2 ms will cause the communication link to be reset. At 9600 baud a delay of greater than 3.5 x 1/9600 x 10 = 3.6 ms will cause the communication link to be reset. Most master query messages will be responded to in less than 50 ms.

Modbus functions

Supported Modbus functions

The second byte of every message is the function code. Modbus defines function codes of 01h to 7Fh. The GE Multilin SR-series Modbus protocol supports some of these functions, as summarized below.

Table 2–1: GE Multilin Modbus function codes

Function Code		Definition	Description	Substitute
Hex	Dec.			
03	3	Read actual values or setpoints	Read actual value or setpoint registers from one or more consecutive memory map registers	04h
04	4			03h
05	5	Execute operation	Perform 745 specific operations	10h
06	6	Store single setpoint	Write a specific value into a single setpoint register	10h
10	16	Store multiple setpoints	Write specific values into one or more consecutive setpoint registers	---

NOTE

Since some programmable logic controllers only support function codes 03h (or 04h) and 10h, most of the above Modbus commands can be performed by reading from or writing to special addresses in the 745 memory map using these function codes. See *Function code substitutions* on page 2–11 for details.

Read actual values or setpoints

Modbus implementation: Read holding registers
GE Multilin implementation: Read actual values or setpoints

Since some PLC Modbus implementations only support one of function codes 03h and 04h, the 745 interpretation allows either code to be used for reading one or more consecutive setpoints or actual values. The data starting address determines the data type being read. Function codes 03h and 04h are therefore identical.

The GE Multilin implementation of Modbus views "holding registers" as any setpoint or actual value register in the 745 memory map. Registers are 16 bit (two byte) values transmitted high order byte first. Thus all GE Multilin setpoints and actual values in the memory map are sent as two byte registers. This function code allows the master to read one or more consecutive setpoints or actual values from the addressed slave device.

The maximum number of values that can be read in a single message is 120.

Message format and example:

Request to read 3 register values starting from address 0200 from slave device 11.

Master query message	Example	Description
Slave address	11	query message for slave 11
Function code	03	read register values
Data starting address	02 00	data starting at address 0200
Number of registers (high, low)	00 03	3 register values = 6 bytes total
CRC (low, high)	06 E3	computed cyclic redundancy check

Slave response	Example	Description
Slave address	11	response message from slave 11
Function code	03	read register values
Byte count	06	3 register values = 6 bytes total
Data #1 (high, low)	02 2B	register value in address 0200 = 022B
Data #2 (high, low)	00 00	register value in address 0201 = 0000
Data #3 (high, low)	00 64	register value in address 0202 = 0064
CRC (low, high)	C8 BA	computed CRC code

Execute operation

Modbus implementation: Force single coil
GE Multilin implementation: Execute operation

This function allows the master to perform various operations in the 745. The two-byte value of FF00h must be sent after the operation code for the operation to be performed.

Message format and example:

Request to perform reset operation in slave device 11.

Master query message	Example	Description
Slave address	11	query message for slave 11
Function code	05	execute operation
Operation code (high, low)	00 01	remote reset
Code value (high, low)	FF 00	perform operation
CRC (low, high)	DF 6A	computed cyclic redundancy check

Slave response	Example	Description
Slave address	11	response message from slave 11
Function code	05	execute operation
Operation code (high, low)	00 01	remote reset
Code value (high, low)	FF 00	perform operation
CRC (low, high)	DF 6A	computed cyclic redundancy check

Operation code	Definition	Description
0000	No operation	Does not do anything.
0001	Remote reset	Performs the same function as the front panel RESET key.
0002	Trigger trace memory	Initiates a waveform capture of trace memory and increments the "Total Number of Trace Triggers" registers.
0003	Clear maximum demand data	Performs the same function as the **CLEAR MAX DEMAND DATA** actual values command.
0004	Clear event recorder data	Performs the same function as the **CLEAR EVENT RECORD DATA** actual values command.
0005	Clear loss-of-life data	Performs the same function as the **CLEAR LOSS-OF-LIFE DATA** setpoints command.
0006	Clear trace memory	Clears all trace memory buffers and sets the "Total number of trace triggers" register to zero.
0007	Clear energy data	Performs the same function as the **CLEAR ENERGY** actual values command.

Store single setpoint

Modbus implementation: Preset single register
GE Multilin implementation: Store single setpoint

This function code allows the master to modify the contents of a single setpoint register in the addressed slave device. The response of the slave device to this function code is an echo of the entire master query message.

Message format and example:

Request slave device 11 to write the value 00C8 at setpoint address 1100.

Master query message	Example	Description
Slave address	11	query message for slave 11
Function code	06	store single setpoint value
Data starting address (high, low)	11 00	data starting at address 1100
Data (high, low)	00 C8	data for address 1100 = 00C8
CRC (low, high)	8F F0	CRC computed by master

Slave response	Example	Description
Slave address	11	response message from slave 11
Function code	06	store single setpoint value
Data starting address (high, low)	11 00	data starting at address 1100
Data (high, low)	00 C8	data for address 1100 = 00C8
CRC (low, high)	8F F0	CRC computed by slave

Store multiple setpoints

Modbus implementation: Preset multiple registers
GE Multilin implementation: Store multiple setpoints

This function code allows the master to modify the contents of a one or more consecutive setpoint registers in the addressed slave device. Setpoint registers are 16 bit (two byte) values transmitted high order byte first. The maximum number of register values (setpoints) that can be stored in a single message is 60.

For example, request slave device 11 to write the value 00C8 at setpoint address 1100, and the value 0001 at setpoint address 1101.

Master query message	Example	Description
Slave address	11	query message for slave 11
Function code	10	store multiple setpoint values
Data starting address (high, low)	11 00	data starting at address 1100
Number of setpoints (high, low)	00 02	2 setpoint values = 4 bytes total
Byte Count	04	4 bytes of data
Data #1 (high, low)	00 C8	data for address 1100 = 00C8
Data #2 (high, low)	00 01	data for address 1101 = 0001
CRC (low, high)	27 01	CRC computed by master

Slave response	Example	Description
Slave address	11	response message from slave 11
Function code	10	store multiple setpoint values
Data starting address (high, low)	11 00	data starting at address 1100
Number of setpoints (high, low)	00 02	2 setpoint values = 4 bytes total
CRC (low, high)	46 64	CRC computed by slave

Exception responses

Programming or operation errors happen because of illegal data in a message, hardware or software problems in the slave device, etc. These errors result in an exception response from the slave. The slave detecting one of these errors sends a response message to the master consisting of slave address, function code, error code, and CRC. To indicate that the response is a notification of an error, the high order bit of the function code is set to 1.

Table 2–2: Modbus error codes

Error	Modbus definition	GE Multilin implementation
01	Illegal function	The function code of the master query message is not a function code supported by the slave.
02	Illegal data address	The address referenced in the data field of the master query message is not an address supported by the slave.
03	Illegal data value	The value referenced in the data field of the master query message is not allowable in the addressed slave location.
04	Failure in associated device	An external device connected to the addressed slave device has failed and the data cannot be sent. This response will be returned if a GE Multilin device connected to the RS485 external device port of the 745 has failed to respond to the 745.
05*	Acknowledge	The addressed slave device has accepted and is processing a long duration command. Poll for status.
06*	Busy, rejected message	The message was received without error, but the slave device is engaged in processing a long duration command. Retransmit later, when the slave device may be free.
07*	NAK - Negative Acknowledge	The message was received without error, but the request could not be performed, because this version of the 745 does not have the requested operation available.

* Some implementations of Modbus may not support these exception responses.

For example, request to slave device 11 to perform unsupported function code 39h.

Master query message	Example	Description
Slave address	11	query message for slave 11
Function code	39	unsupported function code – error
CRC (low, high)	CD F2	CRC computed by master

Slave response	Example	Description
Slave address	11	response message from slave 11
Function code	B9	return unsupported function code with high-order bit set
Error code	01	illegal function
CRC (low, high)	93	CRC computed by slave

Reading the event recorder

All event recorder data can be read from Modbus registers found in the address range 0800h to 0FFFh. The "Total number of events since last clear" register at address 0804h is incremented by one every time a new event occurs. The register is cleared to zero when the event recorder is cleared. When a new event occurs, the event is assigned an 'event number' which is equal to the incremented value of this register. The newest event will have an event number equal to the total number of events. This register can be used to determine if any new events have occurred by periodically reading the register to see if the value has changed. If the total number of events has increased, then new events have occurred.

Only the data for a single event can be read from the Modbus memory map in a single data packet. The "Event record selector index" register at address 0805h selects the event number whose data can be read from the memory map. For example, to read the data for event number 123, the value 123 must first be written to this register. All the data for event number 123 can now be read from the event recorder data registers at addresses 0830h to 086Ah. Only the last 256 events are actually stored in the relay's memory. Attempting to retrieve data for older events that are not stored will result in a Modbus exception response when writing to the "Event record selector index".

The following example illustrates how information can be retrieved from the event recorder. A SCADA system polls the total number of events register once every minute. It now reads a value of 27 from the register when previously the value was 24, which means that three new events have occurred during the last minute. The SCADA system writes a value of 25 to the event record selector index register. It then reads the data for event number 25 from the event recorder data registers and stores the data to permanent memory for retrieval by an operator. The SCADA system now writes the value 26 to the selector and then reads the data for event number 26. Finally, the SCADA system writes the value 27 to the selector and then reads the data for this event. All the data for the new events has now been retrieved by the SCADA system, so it resumes polling the total number of events register.

Reading trace memory

All trace memory data can be read from Modbus registers found in the address range 4000h to 4816h. The "Total number of trace triggers since last clear" register at address 4004h is incremented by one every time a new trace memory waveform capture is triggered. The register is cleared to zero when the trace memory is cleared. When a new trigger occurs, the captured trace memory buffer is assigned a trigger number which is equal to the incremented value of this register. The newest captured buffer will have a trigger number equal to the total number of trace triggers. This register can be used to determine if any new triggers have occurred by periodically reading the register to see if the value has changed. If the total number of trace triggers has increased, then new trace memory waveform captures have occurred.

Only the data for a single channel of a single trace memory buffer can be read from the Modbus memory map at a time. The "Trace buffer selector index" register at address 4005h selects the trace memory buffer, and the "Trace channel selector index" register at 4006h selects the trace memory channel, whose waveform data can be read from the memory map. For example, to read the waveform data for the "Winding 1 phase C current" of trace memory buffer 5, the value 5 must be written to the trace buffer selector index, and the value 2 (as per data format F65) must be written to the trace channel selector index. All the captured waveform data for buffer 5, channel "Winding 1 phase C current" can now be read from the trace memory data registers at addresses 4010h to 4416h. Only the trace memory buffers for the last three trace memory triggers are actually stored in the relay's memory. Attempting to retrieve data for older triggers that are not stored will result in a Modbus exception response when writing to the trace buffer selector index.

For example, to retrieve information from the trace memory, a SCADA system polls the total number of trace triggers register once every minute. It now reads a value of 6 from the register when previously the value was 5, indicating that one new trigger has occurred during the last minute. The SCADA system writes a value of 6 to the trace buffer selector index register. It then writes the value of 0 to the trace channel selector index register, reads the waveform data for "Winding 1 phase A current" of trace buffer 6 from the trace memory data registers, and stores the data to memory for retrieval by an operator. The SCADA system now writes the value 1 to the trace channel selector index and then reads the waveform data for "Winding 1 phase B current". The SCADA system continues by writing all other channel numbers to the trace channel selector index, each time reading the waveform data, until all channels for buffer 6 have been read. All the waveform data for the new trace memory trigger has now been retrieved by the SCADA system, so it resumes polling the total number of trace triggers register.

Accessing data via the user map

The 745 has a powerful user map feature that allows a computer to access up to 120 non-consecutive registers (setpoints or actual values) by using one Modbus read message.

It is often necessary for a master to continuously poll various values in each of the connected slave relays. If these values are scattered throughout the memory map, reading them would require numerous transmissions and would labor the communication link. The user map can be programmed to join any memory map address to one in the block of consecutive user map locations, so that they can be accessed by reading (and writing to, if joined to setpoints) these consecutive locations. The user map feature consists of:

1. User map addresses 1 to 120 (located at memory map addresses 0180h to 01F7h). These are the setpoints which store the (possibly discontinuous) memory map addresses of the values that are to be accessed.
2. User map values 1 to 120 (located at memory map addresses 0100h to 0177h). These are the access points of the remapped locations. Reading user map value 1 returns the value at the address stored in user map address 1, user map value 2 the value at user map address 2, and so on. Writing to any user map value is only possible if the address stored in the corresponding user map address is a setpoint value.

For an example of how to use the user map feature, say the master computer is required to continuously read the memory map locations shown below from slave 11. Normally, this would require at least 4 separate master query messages.

Address	Description	Type
0200h	Relay Status	actual value
0210h	Winding 3 phase time overcurrent flag	actual value
0300h	Winding 1 phase a 4th harmonic content	actual value
0301h	Winding 1 phase b 4th harmonic content	actual value
0302h	Winding 1 phase c 4th harmonic content	actual value
2002h	Percent differential pickup	setpoint

1. First, preload the addresses listed in the first column of the table to in user map addresses 1 to 6 (addresses 0180h to 0185h).

Master query message	Example	Description
Slave address	11	query message for slave 11
Function code	10	store multiple setpoint values
Data starting address (high, low)	01 80	data starting at address 0180
Number of setpoints (high, low)	00 06	6 setpoint values = 12 bytes total
Byte count	0C	12 bytes of data
Data #1 (high, low)	02 00	0200 → Relay status
Data #2 (high, low)	02 10	0210 → W3 Phase time overcurrent flag
Data #3 (high, low)	03 00	0300 → W1 ΦA 4th harmonic content
Data #4 (high, low)	03 01	0301 → W1 ΦB 4th harmonic content
Data #5 (high, low)	03 02	0302 → W1 ΦC 4th harmonic content
Data #6 (high, low)	20 02	2002 → Percent differential pickup
CRC (low, high)	2F 8A	CRC computed by master

Slave response	Example	Description
Slave address	11	response message from slave 11
Function code	10	store multiple setpoint values
Data starting address (high, low)	01 80	data starting at address 0180
Number of setpoints (high, low)	00 06	6 setpoint values = 12 bytes total
CRC (low, high)	42 8F	CRC computed by slave

2. Now that the user map addresses have been setup, the required memory map locations can be accessed via the user map values 1 to 6 (addresses 0100h to 0105h). Both actual values and setpoints may be read.

Master query message	Example	Description
Slave address	11	query message for slave 11
Function code	03	read register values
Data starting address (high, low)	01 00	data starting at address 0100
Number of registers (high, low)	00 06	6 setpoint values = 12 bytes total
CRC (low, high)	C6 A4	CRC computed by master

Slave response	Example	Description
Slave address	11	response message from slave 11
Function code	03	read register values
Byte count	0C	6 registers values = 12 bytes of data
Data #1 (high, low)	82 01	Relay status
Data #2 (high, low)	00 01	W3 Phase TOC flag = not operated
Data #3 (high, low)	00 01	W1 ΦA 4th harmonic content = 1% f_0
Data #4 (high, low)	00 01	W1 ΦB 4th harmonic content = 1% f_0
Data #5 (high, low)	00 01	W1 ΦC 4th harmonic content = 1% f_0
Data #6 (high, low)	00 1E	Percent differential pickup = 0.30 × I_d
CRC (low, high)	80 F1	CRC computed by slave

3. Setpoints may be written via the user map. In the example above, to change the value of restrained differential pickup to 0.20 x CT through the user map, transmit the following Modbus message:

Master query message	Example	Description
Slave address	11	query message for slave 11
Function code	06	store single setpoint values
Data starting address (high, low)	01 85	data starting at address 0185
Data (high, low)	00 14	0014 = 0.30 × I_d
CRC (low, high)	9B 40	CRC computed by master

Slave response	Example	Description
Slave address	11	response message from slave 11
Function code	06	store single setpoint values
Data starting address (high, low)	01 85	data starting at address 0185
Data (high, low)	00 14	0014 = 0.30 × I_d
CRC (low, high)	9B 40	CRC computed by slave

Function code substitutions

Most 745 supported Modbus commands can be performed via function codes 03h (or 04h), and 10h and special memory map addresses.

Function codes 03h and 04h are interchangeable. Both have identical message formats, and both perform the same action.

Function code 05h (execute operation) can be performed by writing the command as if it were data in the memory map. For example, to write operation code 01h (reset targets) to register 0080h, the message format and example is shown below.

Request slave device 11 to reset targets:

Master query message	Example	Description
Slave address	11	query message for slave 11
Function code	10	store multiple setpoints (substituted for function code 05h)
Data starting address (high, low)	00 80	data starting at address 0080
Number of setpoints (high, low)	00 01	1 register values = 2 bytes total
Byte count	02	2 bytes of data
Data (high, low)	00 01	0001 = operation code 0001h (reset targets)
CRC (low, high)	B5 90	CRC computed by master

Slave response	Example	Description
Slave address	11	response message from slave 11
Function code	10	store multiple setpoints
Data starting address (high, low)	00 80	data starting at address 0080
Number of setpoints (high, low)	00 01	1 setpoint values = 2 bytes total
CRC (low, high)	02 31	CRC computed by slave

Function code 06h (store single setpoint) is simply a shorter version of function code 10h (store multiple setpoints). Using function code 10h, such that the number of setpoints stored is 1, has the same effect as function code 06h. The message format and example is shown below.

Request slave device 11 to write the single setpoint value 00C8 at setpoint address 1100.

Master query message	Example	Description
Slave address	11	query message for slave 11
Function code	10	store multiple setpoints (substituted for function code 06h)
Data starting address (high, low)	11 00	data starting at address 1100
Number of setpoints (high, low)	00 01	1 setpoint values = 2 bytes total
Byte count	02	2 bytes of data
Data (high, low)	00 C8	data for address 1100 = 00C8
CRC (low, high)	6B 07	CRC computed by master

Slave response	Example	Description
Slave address	11	response message from slave 11
Function code	00	store multiple setpoint values
Data starting address (high, low)	11 00	data starting at address 1100
Number of setpoints (high, low)	00 01	1 setpoint values = 2 bytes total
CRC (low, high)	06 65	CRC computed by slave

Modbus memory map

Memory map organization

Data in the 745 that is accessible via computer communications is grouped into several sections of the memory map as shown in the table below. All memory map locations are two-byte (16-bit) values. The following section lists all memory map locations. Addresses for all locations are in hexadecimal. Consult the range, step, units, and the data format (listed after the memory map) to interpret the register values.

Table 2–3: Memory map organization

Memory map section	Address range	Description
Product ID	0000 to 007F	Identification and revision information. Read only.
Commands	0080 to 00FF	Substitute command locations. Read and write.
User map	0100 to 01FF	User map values and addresses. Read and write.
Actual values	0200 to 07FF	Read only.
Event recorder	0800 to 0FFF	Read only (except "Event record selector index" register).
Common setpoints	1000 to 1FFF	Read and write.
Setpoint group 1 to 4	2000 to 3FFF	Read and write.
Trace memory	4000 to 4186	Read only (except "Trace buffer selector index" and "Trace channel selector index" registers)
Playback memory	6000 to 680F	Read and write.

745 memory map

The Modbus memory map for the 745 Transformer Protection System is shown below. All addresses are in hexadecimal format.

Table 2–4: 745 memory map (Sheet 1 of 56)

Addr	Description	Range	Step	Units	Format	Default
Product ID (addresses 0000 to 007F, read only)						
0000	GE Multilin product device code	---	---	---	F1	33 = 745
0001	Hardware revision	---	---	---	F13	4 = D
0002	Software revision	---	---	---	F14	200
0003	Version number	000 to 999	001	---	F1	000
0004	Bootware revision	000 to 999	001	---	F14	120
0005	Installed options	---	---	---	F15	---
0006	Serial number (4 registers)	---	---	---	F33	"A0000000"
000A	Manufacture date (2 registers)	---	---	---	F23	---
000C	Reserved					
000D	Reserved					
↓	↓	↓	↓	↓	↓	↓
001F	Reserved					
Upgrade options (addresses 0020 to 002F, read/write)						
0020	New options	---	---	---	F15	---
0021	Modify passcode	---	---	---	F33	---
0022	Reserved					
0023	Reserved					
↓	↓	↓	↓	↓	↓	↓
007F	Reserved					
Commands (Addresses 0080 to 00FF) - Read / Write						
Commands						
0080	Command operation code	---	---	---	F19	---
0081	Passcode access (4 registers)	---	---	---	F33	---
0085	Change passcode (4 registers)	---	---	---	F33	---
0089	Reserved					
008A	Reserved					
↓	↓	↓	↓	↓	↓	↓
008F	Reserved					
Virtual inputs						
0090	Virtual input 1 programmed state	---	---	---	F43	0
0091	Virtual input 2 programmed state	---	---	---	F43	0
0092	Virtual input 3 programmed state	---	---	---	F43	0
0093	Virtual input 4 programmed state	---	---	---	F43	0
0094	Virtual input 5 programmed state	---	---	---	F43	0
0095	Virtual input 6 programmed state	---	---	---	F43	0
0096	Virtual input 7 programmed state	---	---	---	F43	0
0097	Virtual input 8 programmed state	---	---	---	F43	0
0098	Virtual input 9 programmed state	---	---	---	F43	0
0099	Virtual input 10 programmed state	---	---	---	F43	0
009A	Virtual input 11 programmed state	---	---	---	F43	0
009B	Virtual input 12 programmed state	---	---	---	F43	0
009C	Virtual input 13 programmed state	---	---	---	F43	0
009D	Virtual input 14 programmed state	---	---	---	F43	0

Table 2–4: 745 memory map (Sheet 2 of 56)

Addr	Description	Range	Step	Units	Format	Default
009E	Virtual input 15 programmed state	---	---	---	F43	0
009F	Virtual input 16 programmed state	---	---	---	F43	0
00A0	Reserved					
00A1	Reserved					
↓	↓	↓	↓	↓	↓	↓
00EF	Reserved					
Time/date						
00F0	Time (2 registers)	---	---	---	F22	---
00F2	Date (2 registers)	---	---	---	F23	---
00F4	Reserved					
00F5	Reserved					
↓	↓	↓	↓	↓	↓	↓
00FF	Reserved					
User map (addresses 0100 to 01FF, read/write)						
User map values						
0100	User map value #1	---	---	---	---	---
0101	User map value #2	---	---	---	---	---
0102	User map value #3	---	---	---	---	---
0103	User map value #4	---	---	---	---	---
0104	User map value #5	---	---	---	---	---
0105	User map value #6	---	---	---	---	---
0106	User map value #7	---	---	---	---	---
0107	User map value #8	---	---	---	---	---
0108	User map value #9	---	---	---	---	---
0109	User map value #10	---	---	---	---	---
010A	User map value #11	---	---	---	---	---
010B	User map value #12	---	---	---	---	---
010C	User map value #13	---	---	---	---	---
010D	User map value #14	---	---	---	---	---
010E	User map value #15	---	---	---	---	---
010F	User map value #16	---	---	---	---	---
0110	User map value #17	---	---	---	---	---
0111	User map value #18	---	---	---	---	---
0112	User map value #19	---	---	---	---	---
0113	User map value #20	---	---	---	---	---
0114	User map value #21	---	---	---	---	---
0115	User map value #22	---	---	---	---	---
0116	User map value #23	---	---	---	---	---
0117	User map value #24	---	---	---	---	---
0118	User map value #25	---	---	---	---	---
0119	User map value #26	---	---	---	---	---
011A	User map value #27	---	---	---	---	---
011B	User map value #28	---	---	---	---	---
011C	User map value #29	---	---	---	---	---
011D	User map value #30	---	---	---	---	---
011E	User map value #31	---	---	---	---	---
011F	User map value #32	---	---	---	---	---

Table 2–4: 745 memory map (Sheet 3 of 56)

Addr	Description	Range	Step	Units	Format	Default
0120	User map value #33	---	---	---	---	---
0121	User map value #34	---	---	---	---	---
0122	User map value #35	---	---	---	---	---
0123	User map value #36	---	---	---	---	---
0124	User map value #37	---	---	---	---	---
0125	User map value #38	---	---	---	---	---
0126	User map value #39	---	---	---	---	---
0127	User map value #40	---	---	---	---	---
0128	User map value #41	---	---	---	---	---
0129	User map value #42	---	---	---	---	---
012A	User map value #43	---	---	---	---	---
012B	User map value #44	---	---	---	---	---
012C	User map value #45	---	---	---	---	---
012D	User map value #46	---	---	---	---	---
012E	User map value #47	---	---	---	---	---
012F	User map value #48	---	---	---	---	---
0130	User map value #49	---	---	---	---	---
0131	User map value #50	---	---	---	---	---
0132	User map value #51	---	---	---	---	---
0133	User map value #52	---	---	---	---	---
0134	User map value #53	---	---	---	---	---
0135	User map value #54	---	---	---	---	---
0136	User map value #55	---	---	---	---	---
0137	User map value #56	---	---	---	---	---
0138	User map value #57	---	---	---	---	---
0139	User map value #58	---	---	---	---	---
013A	User map value #59	---	---	---	---	---
013B	User map value #60	---	---	---	---	---
013C	User map value #61	---	---	---	---	---
013D	User map value #62	---	---	---	---	---
013E	User map value #63	---	---	---	---	---
013F	User map value #64	---	---	---	---	---
0140	User map value #65	---	---	---	---	---
0141	User map value #66	---	---	---	---	---
0142	User map value #67	---	---	---	---	---
0143	User map value #68	---	---	---	---	---
0144	User map value #69	---	---	---	---	---
0145	User map value #70	---	---	---	---	---
0146	User map value #71	---	---	---	---	---
0147	User map value #72	---	---	---	---	---
0148	User map value #73	---	---	---	---	---
0149	User map value #74	---	---	---	---	---
014A	User map value #75	---	---	---	---	---
014B	User map value #76	---	---	---	---	---
014C	User map value #77	---	---	---	---	---
014D	User map value #78	---	---	---	---	---
014E	User map value #79	---	---	---	---	---

Table 2–4: 745 memory map (Sheet 4 of 56)

Addr	Description	Range	Step	Units	Format	Default
014F	User map value #80	---	---	---	---	---
0150	User map value #81	---	---	---	---	---
0151	User map value #82	---	---	---	---	---
0152	User map value #83	---	---	---	---	---
0153	User map value #84	---	---	---	---	---
0154	User map value #85	---	---	---	---	---
0155	User map value #86	---	---	---	---	---
0156	User map value #87	---	---	---	---	---
0157	User map value #88	---	---	---	---	---
0158	User map value #89	---	---	---	---	---
0159	User map value #90	---	---	---	---	---
015A	User map value #91	---	---	---	---	---
015B	User map value #92	---	---	---	---	---
015C	User map value #93	---	---	---	---	---
015D	User map value #94	---	---	---	---	---
015E	User map value #95	---	---	---	---	---
015F	User map value #96	---	---	---	---	---
0160	User map value #97	---	---	---	---	---
0161	User map value #98	---	---	---	---	---
0162	User map value #99	---	---	---	---	---
0163	User map value #100	---	---	---	---	---
0164	User map value #101	---	---	---	---	---
0165	User map value #102	---	---	---	---	---
0166	User map value #103	---	---	---	---	---
0167	User map value #104	---	---	---	---	---
0168	User map value #105	---	---	---	---	---
0169	User map value #106	---	---	---	---	---
016A	User map value #107	---	---	---	---	---
016B	User map value #108	---	---	---	---	---
016C	User map value #109	---	---	---	---	---
016D	User map value #110	---	---	---	---	---
016E	User map value #111	---	---	---	---	---
016F	User map value #112	---	---	---	---	---
0170	User map value #113	---	---	---	---	---
0171	User map value #114	---	---	---	---	---
0172	User map value #115	---	---	---	---	---
0173	User map value #116	---	---	---	---	---
0174	User map value #117	---	---	---	---	---
0175	User map value #118	---	---	---	---	---
0176	User map value #119	---	---	---	---	---
0177	User map value #120	---	---	---	---	---
0178	Reserved					
0179	Reserved					
↓	↓	↓	↓	↓	↓	↓
017F	Reserved					
User map addresses						
0180	User map address #1	0000 to FFFF	0001	hex	F1	0000 hex

Table 2–4: 745 memory map (Sheet 5 of 56)

Addr	Description	Range	Step	Units	Format	Default
0181	User map address #2	0000 to FFFF	0001	hex	F1	0000 hex
0182	User map address #3	0000 to FFFF	0001	hex	F1	0000 hex
0183	User map address #4	0000 to FFFF	0001	hex	F1	0000 hex
0184	User map address #5	0000 to FFFF	0001	hex	F1	0000 hex
0185	User map address #6	0000 to FFFF	0001	hex	F1	0000 hex
0186	User map address #7	0000 to FFFF	0001	hex	F1	0000 hex
0187	User map address #8	0000 to FFFF	0001	hex	F1	0000 hex
0188	User map address #9	0000 to FFFF	0001	hex	F1	0000 hex
0189	User map address #10	0000 to FFFF	0001	hex	F1	0000 hex
018A	User map address #11	0000 to FFFF	0001	hex	F1	0000 hex
018B	User map address #12	0000 to FFFF	0001	hex	F1	0000 hex
018C	User map address #13	0000 to FFFF	0001	hex	F1	0000 hex
018D	User map address #14	0000 to FFFF	0001	hex	F1	0000 hex
018E	User map address #15	0000 to FFFF	0001	hex	F1	0000 hex
018F	User map address #16	0000 to FFFF	0001	hex	F1	0000 hex
0190	User map address #17	0000 to FFFF	0001	hex	F1	0000 hex
0191	User map address #18	0000 to FFFF	0001	hex	F1	0000 hex
0192	User map address #19	0000 to FFFF	0001	hex	F1	0000 hex
0193	User map address #20	0000 to FFFF	0001	hex	F1	0000 hex
0194	User map address #21	0000 to FFFF	0001	hex	F1	0000 hex
0195	User map address #22	0000 to FFFF	0001	hex	F1	0000 hex
0196	User map address #23	0000 to FFFF	0001	hex	F1	0000 hex
0197	User map address #24	0000 to FFFF	0001	hex	F1	0000 hex
0198	User map address #25	0000 to FFFF	0001	hex	F1	0000 hex
0199	User map address #26	0000 to FFFF	0001	hex	F1	0000 hex
019A	User map address #27	0000 to FFFF	0001	hex	F1	0000 hex
019B	User map address #28	0000 to FFFF	0001	hex	F1	0000 hex
019C	User map address #29	0000 to FFFF	0001	hex	F1	0000 hex
019D	User map address #30	0000 to FFFF	0001	hex	F1	0000 hex
019E	User map address #31	0000 to FFFF	0001	hex	F1	0000 hex
019F	User map address #32	0000 to FFFF	0001	hex	F1	0000 hex
01A0	User map address #33	0000 to FFFF	0001	hex	F1	0000 hex
01A1	User map address #34	0000 to FFFF	0001	hex	F1	0000 hex
01A2	User map address #35	0000 to FFFF	0001	hex	F1	0000 hex
01A3	User map address #36	0000 to FFFF	0001	hex	F1	0000 hex
01A4	User map address #37	0000 to FFFF	0001	hex	F1	0000 hex
01A5	User map address #38	0000 to FFFF	0001	hex	F1	0000 hex
01A6	User map address #39	0000 to FFFF	0001	hex	F1	0000 hex
01A7	User map address #40	0000 to FFFF	0001	hex	F1	0000 hex
01A8	User map address #41	0000 to FFFF	0001	hex	F1	0000 hex
01A9	User map address #42	0000 to FFFF	0001	hex	F1	0000 hex
01AA	User map address #43	0000 to FFFF	0001	hex	F1	0000 hex
01AB	User map address #44	0000 to FFFF	0001	hex	F1	0000 hex
01AC	User map address #45	0000 to FFFF	0001	hex	F1	0000 hex
01AD	User map address #46	0000 to FFFF	0001	hex	F1	0000 hex
01AE	User map address #47	0000 to FFFF	0001	hex	F1	0000 hex
01AF	User map address #48	0000 to FFFF	0001	hex	F1	0000 hex

Table 2–4: 745 memory map (Sheet 6 of 56)

Addr	Description	Range	Step	Units	Format	Default
01B0	User map address #49	0000 to FFFF	0001	hex	F1	0000 hex
01B1	User map address #50	0000 to FFFF	0001	hex	F1	0000 hex
01B2	User map address #51	0000 to FFFF	0001	hex	F1	0000 hex
01B3	User map address #52	0000 to FFFF	0001	hex	F1	0000 hex
01B4	User map address #53	0000 to FFFF	0001	hex	F1	0000 hex
01B5	User map address #54	0000 to FFFF	0001	hex	F1	0000 hex
01B6	User map address #55	0000 to FFFF	0001	hex	F1	0000 hex
01B7	User map address #56	0000 to FFFF	0001	hex	F1	0000 hex
01B8	User map address #57	0000 to FFFF	0001	hex	F1	0000 hex
01B9	User map address #58	0000 to FFFF	0001	hex	F1	0000 hex
01BA	User map address #59	0000 to FFFF	0001	hex	F1	0000 hex
01BB	User map address #60	0000 to FFFF	0001	hex	F1	0000 hex
01BC	User map address #61	0000 to FFFF	0001	hex	F1	0000 hex
01BD	User map address #62	0000 to FFFF	0001	hex	F1	0000 hex
01BE	User map address #63	0000 to FFFF	0001	hex	F1	0000 hex
01BF	User map address #64	0000 to FFFF	0001	hex	F1	0000 hex
01C0	User map address #65	0000 to FFFF	0001	hex	F1	0000 hex
01C1	User map address #66	0000 to FFFF	0001	hex	F1	0000 hex
01C2	User map address #67	0000 to FFFF	0001	hex	F1	0000 hex
01C3	User map address #68	0000 to FFFF	0001	hex	F1	0000 hex
01C4	User map address #69	0000 to FFFF	0001	hex	F1	0000 hex
01C5	User map address #70	0000 to FFFF	0001	hex	F1	0000 hex
01C6	User map address #71	0000 to FFFF	0001	hex	F1	0000 hex
01C7	User map address #72	0000 to FFFF	0001	hex	F1	0000 hex
01C8	User map address #73	0000 to FFFF	0001	hex	F1	0000 hex
01C9	User map address #74	0000 to FFFF	0001	hex	F1	0000 hex
01CA	User map address #75	0000 to FFFF	0001	hex	F1	0000 hex
01CB	User map address #76	0000 to FFFF	0001	hex	F1	0000 hex
01CC	User map address #77	0000 to FFFF	0001	hex	F1	0000 hex
01CD	User map address #78	0000 to FFFF	0001	hex	F1	0000 hex
01CE	User map address #79	0000 to FFFF	0001	hex	F1	0000 hex
01CF	User map address #80	0000 to FFFF	0001	hex	F1	0000 hex
01D0	User map address #81	0000 to FFFF	0001	hex	F1	0000 hex
01D1	User map address #82	0000 to FFFF	0001	hex	F1	0000 hex
01D2	User map address #83	0000 to FFFF	0001	hex	F1	0000 hex
01D3	User map address #84	0000 to FFFF	0001	hex	F1	0000 hex
01D4	User map address #85	0000 to FFFF	0001	hex	F1	0000 hex
01D5	User map address #86	0000 to FFFF	0001	hex	F1	0000 hex
01D6	User map address #87	0000 to FFFF	0001	hex	F1	0000 hex
01D7	User map address #88	0000 to FFFF	0001	hex	F1	0000 hex
01D8	User map address #89	0000 to FFFF	0001	hex	F1	0000 hex
01D9	User map address #90	0000 to FFFF	0001	hex	F1	0000 hex
01DA	User map address #91	0000 to FFFF	0001	hex	F1	0000 hex
01DB	User map address #92	0000 to FFFF	0001	hex	F1	0000 hex
01DC	User map address #93	0000 to FFFF	0001	hex	F1	0000 hex
01DD	User map address #94	0000 to FFFF	0001	hex	F1	0000 hex
01DE	User map address #95	0000 to FFFF	0001	hex	F1	0000 hex

Table 2–4: 745 memory map (Sheet 7 of 56)

Addr	Description	Range	Step	Units	Format	Default
01DF	User map address #96	0000 to FFFF	0001	hex	F1	0000 hex
01E0	User map address #97	0000 to FFFF	0001	hex	F1	0000 hex
01E1	User map address #98	0000 to FFFF	0001	hex	F1	0000 hex
01E2	User map address #99	0000 to FFFF	0001	hex	F1	0000 hex
01E3	User map address #100	0000 to FFFF	0001	hex	F1	0000 hex
01E4	User map address #101	0000 to FFFF	0001	hex	F1	0000 hex
01E5	User map address #102	0000 to FFFF	0001	hex	F1	0000 hex
01E6	User map address #103	0000 to FFFF	0001	hex	F1	0000 hex
01E7	User map address #104	0000 to FFFF	0001	hex	F1	0000 hex
01E8	User map address #105	0000 to FFFF	0001	hex	F1	0000 hex
01E9	User map address #106	0000 to FFFF	0001	hex	F1	0000 hex
01EA	User map address #107	0000 to FFFF	0001	hex	F1	0000 hex
01EB	User map address #108	0000 to FFFF	0001	hex	F1	0000 hex
01EC	User map address #109	0000 to FFFF	0001	hex	F1	0000 hex
01ED	User map address #110	0000 to FFFF	0001	hex	F1	0000 hex
01EE	User map address #111	0000 to FFFF	0001	hex	F1	0000 hex
01EF	User map address #112	0000 to FFFF	0001	hex	F1	0000 hex
01F0	User map address #113	0000 to FFFF	0001	hex	F1	0000 hex
01F1	User map address #114	0000 to FFFF	0001	hex	F1	0000 hex
01F2	User map address #115	0000 to FFFF	0001	hex	F1	0000 hex
01F3	User map address #116	0000 to FFFF	0001	hex	F1	0000 hex
01F4	User map address #117	0000 to FFFF	0001	hex	F1	0000 hex
01F5	User map address #118	0000 to FFFF	0001	hex	F1	0000 hex
01F6	User map address #119	0000 to FFFF	0001	hex	F1	0000 hex
01F7	User map address #120	0000 to FFFF	0001	hex	F1	0000 hex
01F8	Reserved					
01F9	Reserved					
↓	↓	↓	↓	↓	↓	↓
01FF	Reserved					
Actual values (addresses 0200 to 07FF, read only)						
System status						
0200	Relay status	---	---	---	F20	---
0201	System status	---	---	---	F21	---
0202	Conditions	---	---	---	F35	---
0203	Operation status	---	---	---	F44	---
0204	Logic input status	---	---	---	F49	---
0205	Output relay status	---	---	---	F50	---
0206	Reserved					
0207	Reserved					
Element flags						
0208	Any element Flag	---	---	---	F52	---
0209	Any winding 1 overcurrent element flag	---	---	---	F52	---
020A	Any winding 2 overcurrent element flag	---	---	---	F52	---
020B	Any winding 3 overcurrent element flag	---	---	---	F52	---
020C	Percent differential flag	---	---	---	F52	---
020D	Instantaneous differential flag	---	---	---	F52	---
020E	Winding 1 phase time overcurrent flag	---	---	---	F52	---

Table 2–4: 745 memory map (Sheet 8 of 56)

Addr	Description	Range	Step	Units	Format	Default
020F	Winding 2 phase time overcurrent flag	---	---	---	F52	---
0210	Winding 3 phase time overcurrent flag	---	---	---	F52	---
0211	Winding 1 phase instantaneous overcurrent 1 flag	---	---	---	F52	---
0212	Winding 2 phase instantaneous overcurrent 1 flag	---	---	---	F52	---
0213	Winding 3 phase instantaneous overcurrent 1 flag	---	---	---	F52	---
0214	Winding 1 phase instantaneous overcurrent 2 flag	---	---	---	F52	---
0215	Winding 2 phase instantaneous overcurrent 2 flag	---	---	---	F52	---
0216	Winding 3 phase instantaneous overcurrent 2 flag	---	---	---	F52	---
0217	Winding 1 neutral time overcurrent flag	---	---	---	F52	---
0218	Winding 2 neutral time overcurrent flag	---	---	---	F52	---
0219	Winding 3 neutral time overcurrent flag	---	---	---	F52	---
021A	Winding 1 neutral instantaneous overcurrent 1 flag	---	---	---	F52	---
021B	Winding 2 neutral instantaneous overcurrent 1 flag	---	---	---	F52	---
021C	Winding 3 neutral instantaneous overcurrent 1 flag	---	---	---	F52	---
021D	Winding 1 neutral instantaneous overcurrent 2 flag	---	---	---	F52	---
021E	Winding 2 neutral instantaneous overcurrent 2 flag	---	---	---	F52	---
021F	Winding 3 neutral instantaneous overcurrent 2 flag	---	---	---	F52	---
0220	Winding 1 ground time overcurrent flag	---	---	---	F52	---
0221	Winding 2 ground time overcurrent flag	---	---	---	F52	---
0222	Winding 3 ground time overcurrent flag	---	---	---	F52	---
0223	Winding 1 ground instantaneous overcurrent 1 flag	---	---	---	F52	---
0224	Winding 2 ground instantaneous overcurrent 1 flag	---	---	---	F52	---
0225	Winding 3 ground instantaneous overcurrent 1 flag	---	---	---	F52	---
0226	Winding 1 ground instantaneous overcurrent 2 flag	---	---	---	F52	---
0227	Winding 2 ground instantaneous overcurrent 2 flag	---	---	---	F52	---
0228	Winding 3 ground instantaneous overcurrent 2 flag	---	---	---	F52	---
0229	Winding 1 restricted ground time overcurrent flag	---	---	---	F52	---
022A	Winding 2 restricted ground time overcurrent flag	---	---	---	F52	---
022B	Winding 3 restricted ground time overcurrent flag	---	---	---	F52	---
022C	Winding 1 restricted ground instantaneous overcurrent flag	---	---	---	F52	---
022D	Winding 2 restricted ground instantaneous overcurrent flag	---	---	---	F52	---
022E	Winding 3 restricted ground instantaneous overcurrent flag	---	---	---	F52	---
022F	Winding 1 negative-sequence time overcurrent flag	---	---	---	F52	---
0230	Winding 2 negative-sequence time overcurrent flag	---	---	---	F52	---
0231	Winding 3 negative-sequence time overcurrent flag	---	---	---	F52	---
0232	Winding 1 negative-sequence instantaneous overcurrent	---	---	---	F52	---
0233	Winding 2 negative-sequence instantaneous overcurrent	---	---	---	F52	---
0234	Winding 3 negative-sequence instantaneous overcurrent	---	---	---	F52	---
0235	Underfrequency 1 flag	---	---	---	F52	---
0236	Underfrequency 2 flag	---	---	---	F52	---
0237	Frequency decay rate 1 flag	---	---	---	F52	---
0238	Frequency decay rate 2 flag	---	---	---	F52	---
0239	Frequency decay rate 3 flag	---	---	---	F52	---
023A	Frequency decay rate 4 flag	---	---	---	F52	---
023B	Overfrequency flag	---	---	---	F52	---

Table 2–4: 745 memory map (Sheet 9 of 56)

Addr	Description	Range	Step	Units	Format	Default
023C	Fifth harmonic level flag	---	---	---	F52	---
023D	Volts-per-hertz 1 flag	---	---	---	F52	---
023E	Volts-per-hertz 2 flag	---	---	---	F52	---
023F	Winding 1 THD level flag	---	---	---	F52	---
0240	Winding 2 THD level flag	---	---	---	F52	---
0241	Winding 3 THD level flag	---	---	---	F52	---
0242	Winding 1 harmonic derating flag	---	---	---	F52	---
0243	Winding 2 harmonic derating flag	---	---	---	F52	---
0244	Winding 3 harmonic derating flag	---	---	---	F52	---
0245	Hottest-spot temperature limit flag	---	---	---	F52	---
0246	Loss-of-life limit flag	---	---	---	F52	---
0247	Analog input level 1 flag	---	---	---	F52	---
0248	Analog input level 2 flag	---	---	---	F52	---
0249	Winding 1 current demand flag	---	---	---	F52	---
024A	Winding 2 current demand flag	---	---	---	F52	---
024B	Winding 3 current demand flag	---	---	---	F52	---
024C	Transformer overload flag	---	---	---	F52	---
024D	Aging factor limit flag	---	---	---	F52	---
024E	Tap changer failure flag	---	---	---	F52	---
024F	Reserved					
0250	Reserved					
↓	↓	↓	↓	↓	↓	↓
025F	Reserved					
Input/output flags						
0260	Logic input assert flags	---	---	---	F56	---
0261	Virtual input assert flags	---	---	---	F56	---
0262	Output relay operate flags	---	---	---	F57	---
0263	Virtual output operate flags	---	---	---	F59	---
0264	Timer operate flags	---	---	---	F61	---
0265	Reserved					
0266	Reserved					
↓	↓	↓	↓	↓	↓	↓
027F	Reserved					
Winding 1 current						
0280	Winding 1 phase A current magnitude	---	---	A	F78	---
0281	Winding 1 phase A current angle	0	---	° Lag	F1	---
0282	Winding 1 phase B current magnitude	---	---	A	F78	---
0283	Winding 1 phase B current angle	0 to 359	1	° Lag	F1	---
0284	Winding 1 phase C current magnitude	---	---	A	F78	---
0285	Winding 1 phase C current angle	0 to 359	1	° Lag	F1	---
0286	Winding 1 neutral current magnitude	---	---	A	F78	---
0287	Winding 1 neutral current angle	0 to 359	1	° Lag	F1	---
0288	Winding 1 ground current magnitude	---	---	A	F81	---
0289	Winding 1 ground current angle	0 to 359	1	° Lag	F1	---
028A	Winding 1 loading	0 to 999	1	% rated	F1	---
028B	Winding 1 average phase current	---	---	A	F78	---
028C	Reserved					

Table 2–4: 745 memory map (Sheet 10 of 56)

Addr	Description	Range	Step	Units	Format	Default
028D	Reserved					
028E	Reserved					
028F	Reserved					
Winding 2 current						
0290	Winding 2 phase A current magnitude	---	---	A	F79	---
0291	Winding 2 phase A current angle	0 to 359	1	° Lag	F1	---
0292	Winding 2 phase B current magnitude	---	---	A	F79	---
0293	Winding 2 phase B current angle	0 to 359	1	° Lag	F1	---
0294	Winding 2 phase C current magnitude	---	---	A	F79	---
0295	Winding 2 phase C current angle	0 to 359	1	° Lag	F1	---
0296	Winding 2 neutral current magnitude	---	---	A	F79	---
0297	Winding 2 neutral current angle	0 to 359	1	° Lag	F1	---
0298	Winding 2 ground current magnitude	---	---	A	F82	---
0299	Winding 2 ground current angle	0 to 359	1	° Lag	F1	---
029A	Winding 2 loading	0 to 999	1	% rated	F1	---
029B	Winding 2 average phase current	---	---	A	F79	---
029C	Reserved					
029D	Reserved					
029E	Reserved					
029F	Reserved					
Winding 3 current						
02A0	Winding 3 phase A current magnitude	---	---	A	F80	---
02A1	Winding 3 phase A current angle	0 to 359	1	° Lag	F1	---
02A2	Winding 3 phase B current magnitude	---	---	A	F80	---
02A3	Winding 3 phase B current angle	0 to 359	1	° Lag	F1	---
02A4	Winding 3 phase C current magnitude	---	---	A	F80	---
02A5	Winding 3 phase C current angle	0 to 359	1	° Lag	F1	---
02A6	Winding 3 neutral current magnitude	---	---	A	F80	---
02A7	Winding 3 neutral current angle	0 to 359	1	° Lag	F1	---
02A8	Winding 3 ground current magnitude	---	---	A	F83	---
02A9	Winding 3 ground current angle	0 to 359	1	° Lag	F1	---
02AA	Winding 3 loading	0 to 999	1	% rated	F1	---
02AB	Winding 3 average phase current	---	---	A	F80	---
02AC	Reserved					
02AD	Reserved					
02AE	Reserved					
02AF	Reserved					
Sequence currents						
02B0	Winding 1 positive-sequence current magnitude	---	---	A	F78	---
02B1	Winding 1 positive-sequence current angle	0 to 359	1	° Lag	F1	---
02B2	Winding 2 positive-sequence current magnitude	---	---	A	F79	---
02B3	Winding 2 positive-sequence current angle	0 to 359	1	° Lag	F1	---
02B4	Winding 3 positive-sequence current magnitude	---	---	A	F80	---
02B5	Winding 3 positive-sequence current angle	0 to 359	1	° Lag	F1	---
02B6	Winding 1 negative-sequence current magnitude	---	---	A	F78	---
02B7	Winding 1 negative-sequence current angle	0 to 359	1	° Lag	F1	---
02B8	Winding 2 negative-sequence current magnitude	---	---	A	F79	---

Table 2–4: 745 memory map (Sheet 11 of 56)

Addr	Description	Range	Step	Units	Format	Default
02B9	Winding 2 negative-sequence current angle	0 to 359	1	° Lag	F1	---
02BA	Winding 3 negative-sequence current magnitude	---	---	A	F80	---
02BB	Winding 3 negative-sequence current angle	0 to 359	1	° Lag	F1	---
02BC	Winding 1 zero-sequence current magnitude	---	---	A	F78	---
02BD	Winding 1 zero-sequence current angle	0 to 359	1	° Lag	F1	---
02BE	Winding 2 zero-sequence current magnitude	---	---	A	F79	---
02BF	Winding 2 zero-sequence current angle	0 to 359	1	° Lag	F1	---
02C0	Winding 3 zero-sequence current magnitude	---	---	A	F80	---
02C1	Winding 3 zero-sequence current angle	0 to 359	1	° Lag	F1	---
02C2	Reserved					
02C3	Reserved					
↓	↓	↓	↓	↓	↓	↓
02CF	Reserved					
Differential current						
02D0	Phase A differential current magnitude	0.00 to 655.35	0.01	× CT	F3	---
02D1	Phase A differential current angle	0 to 359	1	° Lag	F1	---
02D2	Phase B differential current magnitude	0.00 to 655.35	0.01	× CT	F3	---
02D3	Phase B differential current angle	0 to 359	1	° Lag	F1	---
02D4	Phase C differential current magnitude	0.00 to 655.35	0.01	× CT	F3	---
02D5	Phase C differential current angle	0 to 359	1	° Lag	F1	---
Restraint current						
02D6	Phase A restraint current	0.00 to 655.35	0.01	× CT	F3	---
02D7	Phase B restraint current	0.00 to 655.35	0.01	× CT	F3	---
02D8	Phase C restraint current	0.00 to 655.35	0.01	× CT	F3	---
Ground differential current						
02D9	Winding 1 ground differential current	0.000 to 65.535	0.001	× CT	F53	---
02DA	Winding 2 ground differential current	0.000 to 65.535	0.001	× CT	F53	---
02DB	Winding 3 ground differential current	0.000 to 65.535	0.001	× CT	F53	---
02DC	Reserved					
02DD	Reserved					
02DE	Reserved					
02DF	Reserved					
2nd harmonic						
02E0	Winding 1 phase A 2nd harmonic content	0.0 to 99.9	0.1	% f_o	F2	---
02E1	Winding 1 phase B 2nd harmonic content	0.0 to 99.9	0.1	% f_o	F2	---
02E2	Winding 1 phase C 2nd harmonic content	0.0 to 99.9	0.1	% f_o	F2	---
02E3	Winding 2 phase A 2nd harmonic content	0.0 to 99.9	0.1	% f_o	F2	---
02E4	Winding 2 phase B 2nd harmonic content	0.0 to 99.9	0.1	% f_o	F2	---
02E5	Winding 2 phase C 2nd harmonic content	0.0 to 99.9	0.1	% f_o	F2	---
02E6	Winding 3 phase A 2nd harmonic content	0.0 to 99.9	0.1	% f_o	F2	---
02E7	Winding 3 phase B 2nd harmonic content	0.0 to 99.9	0.1	% f_o	F2	---
02E8	Winding 3 phase C 2nd harmonic content	0.0 to 99.9	0.1	% f_o	F2	---
02E9	Reserved					
02EA	Reserved					
↓	↓	↓	↓	↓	↓	↓
02EF	Reserved					

Table 2–4: 745 memory map (Sheet 12 of 56)

Addr	Description	Range	Step	Units	Format	Default
3rd harmonic						
02F0	Winding 1 phase A 3rd harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
02F1	Winding 1 phase B 3rd harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
02F2	Winding 1 phase C 3rd harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
02F3	Winding 2 phase A 3rd harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
02F4	Winding 2 phase B 3rd harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
02F5	Winding 2 phase C 3rd harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
02F6	Winding 3 phase A 3rd harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
02F7	Winding 3 phase B 3rd harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
02F8	Winding 3 phase C 3rd harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
02F9	Reserved					
02FA	Reserved					
↓	↓	↓	↓	↓	↓	↓
02FF	Reserved					
4th harmonic						
0300	Winding 1 phase A 4th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0301	Winding 1 phase B 4th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0302	Winding 1 phase C 4th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0303	Winding 2 phase A 4th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0304	Winding 2 phase B 4th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0305	Winding 2 phase C 4th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0306	Winding 3 phase A 4th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0307	Winding 3 phase B 4th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0308	Winding 3 phase C 4th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0309	Reserved					
030A	Reserved					
↓	↓	↓	↓	↓	↓	↓
030F	Reserved					
5th harmonic						
0310	Winding 1 phase A 5th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0311	Winding 1 phase B 5th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0312	Winding 1 phase C 5th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0313	Winding 2 phase A 5th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0314	Winding 2 phase B 5th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0315	Winding 2 phase C 5th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0316	Winding 3 phase A 5th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0317	Winding 3 phase B 5th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0318	Winding 3 phase C 5th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0319	Reserved					
031A	Reserved					
↓	↓	↓	↓	↓	↓	↓
031F	Reserved					
6th harmonic						
0320	Winding 1 phase A 6th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0321	Winding 1 phase B 6th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0322	Winding 1 phase C 6th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0323	Winding 2 phase A 6th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---

Table 2–4: 745 memory map (Sheet 13 of 56)

Addr	Description	Range	Step	Units	Format	Default
0324	Winding 2 phase B 6th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0325	Winding 2 phase C 6th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0326	Winding 3 phase A 6th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0327	Winding 3 phase B 6th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0328	Winding 3 phase C 6th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0329	Reserved					
032A	Reserved					
↓	↓	↓	↓	↓	↓	↓
032F	Reserved					
7th harmonic						
0330	Winding 1 phase A 7th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0331	Winding 1 phase B 7th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0332	Winding 1 phase C 7th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0333	Winding 2 phase A 7th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0334	Winding 2 phase B 7th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0335	Winding 2 phase C 7th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0336	Winding 3 phase A 7th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0337	Winding 3 phase B 7th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0338	Winding 3 phase C 7th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0339	Reserved					
033A	Reserved					
↓	↓	↓	↓	↓	↓	↓
033F	Reserved					
8th harmonic						
0340	Winding 1 phase A 8th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0341	Winding 1 phase B 8th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0342	Winding 1 phase C 8th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0343	Winding 2 phase A 8th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0344	Winding 2 phase B 8th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0345	Winding 2 phase C 8th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0346	Winding 3 phase A 8th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0347	Winding 3 phase B 8th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0348	Winding 3 phase C 8th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0349	Reserved					
034A	Reserved					
↓	↓	↓	↓	↓	↓	↓
034F	Reserved					
9th harmonic						
0350	Winding 1 phase A 9th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0351	Winding 1 phase B 9th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0352	Winding 1 phase C 9th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0353	Winding 2 phase A 9th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0354	Winding 2 phase B 9th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0355	Winding 2 phase C 9th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0356	Winding 3 phase A 9th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0357	Winding 3 phase B 9th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0358	Winding 3 phase C 9th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---

Table 2–4: 745 memory map (Sheet 14 of 56)

Addr	Description	Range	Step	Units	Format	Default
0359	Reserved					
035A	Reserved					
↓	↓	↓	↓	↓	↓	↓
035F	Reserved					
10th harmonic						
0360	Winding 1 phase A 10th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0361	Winding 1 phase B 10th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0362	Winding 1 phase C 10th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0363	Winding 2 phase A 10th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0364	Winding 2 phase B 10th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0365	Winding 2 phase C 10th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0366	Winding 3 phase A 10th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0367	Winding 3 phase B 10th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0368	Winding 3 phase C 10th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0369	Reserved					
036A	Reserved					
↓	↓	↓	↓	↓	↓	↓
036F	Reserved					
11th harmonic						
0370	Winding 1 phase A 11th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0371	Winding 1 phase B 11th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0372	Winding 1 phase C 11th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0373	Winding 2 phase A 11th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0374	Winding 2 phase B 11th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0375	Winding 2 phase C 11th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0376	Winding 3 phase A 11th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0377	Winding 3 phase B 11th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0378	Winding 3 phase C 11th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0379	Reserved					
037A	Reserved					
↓	↓	↓	↓	↓	↓	↓
037F	Reserved					
12th harmonic						
0380	Winding 1 phase A 12th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0381	Winding 1 phase B 12th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0382	Winding 1 phase C 12th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0383	Winding 2 phase A 12th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0384	Winding 2 phase B 12th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0385	Winding 2 phase C 12th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0386	Winding 3 phase A 12th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0387	Winding 3 phase B 12th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0388	Winding 3 phase C 12th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0389	Reserved					
038A	Reserved					
↓	↓	↓	↓	↓	↓	↓
038F	Reserved					

Table 2–4: 745 memory map (Sheet 15 of 56)

Addr	Description	Range	Step	Units	Format	Default
13th harmonic						
0390	Winding 1 phase A 13th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0391	Winding 1 phase B 13th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0392	Winding 1 phase C 13th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0393	Winding 2 phase A 13th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0394	Winding 2 phase B 13th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0395	Winding 2 phase C 13th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0396	Winding 3 phase A 13th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0397	Winding 3 phase B 13th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0398	Winding 3 phase C 13th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0399	Reserved					
039A	Reserved					
↓	↓	↓	↓	↓	↓	↓
039F	Reserved					
14th harmonic						
03A0	Winding 1 phase A 14th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03A1	Winding 1 phase B 14th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03A2	Winding 1 phase C 14th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03A3	Winding 2 phase A 14th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03A4	Winding 2 phase B 14th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03A5	Winding 2 phase C 14th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03A6	Winding 3 phase A 14th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03A7	Winding 3 phase B 14th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03A8	Winding 3 phase C 14th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03A9	Reserved					
03AA	Reserved					
↓	↓	↓	↓	↓	↓	↓
03AF	Reserved					
15th harmonic						
03B0	Winding 1 phase A 15th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03B1	Winding 1 phase B 15th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03B2	Winding 1 phase C 15th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03B3	Winding 2 phase A 15th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03B4	Winding 2 phase B 15th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03B5	Winding 2 phase C 15th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03B6	Winding 3 phase A 15th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03B7	Winding 3 phase B 15th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03B8	Winding 3 phase C 15th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03B9	Reserved					
↓	↓	↓	↓	↓	↓	↓
03BF	Reserved					
16th harmonic						
03C0	Winding 1 phase A 16th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03C1	Winding 1 phase B 16th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03C2	Winding 1 phase C 16th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03C3	Winding 2 phase A 16th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03C4	Winding 2 phase B 16th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---

Table 2–4: 745 memory map (Sheet 16 of 56)

Addr	Description	Range	Step	Units	Format	Default
03C5	Winding 2 phase C 16th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03C6	Winding 3 phase A 16th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03C7	Winding 3 phase B 16th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03C8	Winding 3 phase C 16th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03C9	Reserved					
03CA	Reserved					
↓	↓	↓	↓	↓	↓	↓
03CF	Reserved					
17th harmonic						
03D0	Winding 1 phase A 17th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03D1	Winding 1 phase B 17th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03D2	Winding 1 phase C 17th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03D3	Winding 2 phase A 17th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03D4	Winding 2 phase B 17th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03D5	Winding 2 phase C 17th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03D6	Winding 3 phase A 17th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03D7	Winding 3 phase B 17th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03D8	Winding 3 phase C 17th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03D9	Reserved					
03DA	Reserved					
↓	↓	↓	↓	↓	↓	↓
03DF	Reserved					
18th harmonic						
03E0	Winding 1 phase A 18th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03E1	Winding 1 phase B 18th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03E2	Winding 1 phase C 18th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03E3	Winding 2 phase A 18th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03E4	Winding 2 phase B 18th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03E5	Winding 2 phase C 18th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03E6	Winding 3 phase A 18th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03E7	Winding 3 phase B 18th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03E8	Winding 3 phase C 18th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03E9	Reserved					
03EA	Reserved					
↓	↓	↓	↓	↓	↓	↓
03EF	Reserved					
19th harmonic						
03F0	Winding 1 phase A 19th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03F1	Winding 1 phase B 19th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03F2	Winding 1 phase C 19th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03F3	Winding 2 phase A 19th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03F4	Winding 2 phase B 19th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03F5	Winding 2 phase C 19th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03F6	Winding 3 phase A 19th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03F7	Winding 3 phase B 19th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03F8	Winding 3 phase C 19th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
03F9	Reserved					

Table 2–4: 745 memory map (Sheet 17 of 56)

Addr	Description	Range	Step	Units	Format	Default
03FA	Reserved					
↓	↓	↓	↓	↓	↓	↓
03FF	Reserved					
20th harmonic						
0400	Winding 1 phase A 20th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0401	Winding 1 phase B 20th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0402	Winding 1 phase C 20th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0403	Winding 2 phase A 20th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0404	Winding 2 phase B 20th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0405	Winding 2 phase C 20th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0406	Winding 3 phase A 20th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0407	Winding 3 phase B 20th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0408	Winding 3 phase C 20th harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0409	Reserved					
040A	Reserved					
↓	↓	↓	↓	↓	↓	↓
040F	Reserved					
21st harmonic						
0410	Winding 1 phase A 21st harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0411	Winding 1 phase B 21st harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0412	Winding 1 phase C 21st harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0413	Winding 2 phase A 21st harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0414	Winding 2 phase B 21st harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0415	Winding 2 phase C 21st harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0416	Winding 3 phase A 21st harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0417	Winding 3 phase B 21st harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0418	Winding 3 phase C 21st harmonic content	0.0 to 99.9	0.1	% *fo*	F2	---
0419	Reserved					
041A	Reserved					
↓	↓	↓	↓	↓	↓	↓
041F	Reserved					
Total harmonic distortion						
0420	Winding 1 phase A total harmonic distortion	0.0 to 99.9	0.1	% *fo*	F2	---
0421	Winding 1 phase B total harmonic distortion	0.0 to 99.9	0.1	% *fo*	F2	---
0422	Winding 1 phase C total harmonic distortion	0.0 to 99.9	0.1	% *fo*	F2	---
0423	Winding 2 phase A total harmonic distortion	0.0 to 99.9	0.1	% *fo*	F2	---
0424	Winding 2 phase B total harmonic distortion	0.0 to 99.9	0.1	% *fo*	F2	---
0425	Winding 2 phase C total harmonic distortion	0.0 to 99.9	0.1	% *fo*	F2	---
0426	Winding 3 phase A total harmonic distortion	0.0 to 99.9	0.1	% *fo*	F2	---
0427	Winding 3 phase B total harmonic distortion	0.0 to 99.9	0.1	% *fo*	F2	---
0428	Winding 3 phase C total harmonic distortion	0.0 to 99.9	0.1	% *fo*	F2	---
0429	Reserved					
042A	Reserved					
↓	↓	↓	↓	↓	↓	↓
042F	Reserved					

Table 2–4: 745 memory map (Sheet 18 of 56)

Addr	Description	Range	Step	Units	Format	Default
Harmonic derating						
0430	Winding 1 harmonic derating factor	0.00 to 1.00	0.01	---	F3	---
0431	Winding 2 harmonic derating factor	0.00 to 1.00	0.01	---	F3	---
0432	Winding 3 harmonic derating factor	0.00 to 1.00	0.01	---	F3	---
0433	Reserved					
0434	Reserved					
↓	↓	↓	↓	↓	↓	↓
043F	Reserved					
Frequency						
0440	System Frequency	0.00 to 99.99	0.01	Hz	F3	---
0441	Frequency Decay Rate	–9.99 to 9.99	0.01	Hz/s	F6	---
0442	Reserved					
0443	Reserved					
0444	Reserved					
Tap changer						
0445	Tap changer position	1 to 50	1	---	F1	---
0446	Reserved					
0447	Reserved					
0448	Reserved					
Voltage						
0449	System line-to-line voltage	0.00 to 600.00	0.01	kV	F3	---
044A	Volts-per-hertz	0.00 to 4.00	0.01	V/Hz	F3	---
044B	Line-to-neutral voltage magnitude	0.00 to 600.00	0.01	kV	F3	---
044C	Line-to-neutral voltage angle	0 to 359	1	° Lag	F1	
044D	Reserved					
044E	Reserved					
044F	Reserved					
Current demand						
0450	Demand data last clear date (2 registers)	---	---	---	F23	---
0452	Demand data last clear time (2 registers)	---	---	---	F22	---
0454	Winding 1 phase A current demand	---	---	A	F78	---
0455	Winding 1 phase B current demand	---	---	A	F78	---
0456	Winding 1 phase C current demand	---	---	A	F78	---
0457	Winding 1 maximum current demand	---	---	A	F78	0 A
0458	Winding 1 maximum current demand phase	---	---	---	F18	0 = phase A
0459	Winding 1 maximum current demand date (2 registers)	---	---	---	F23	Jan 01 1996
045B	Winding 1 maximum current demand time (2 registers)	---	---	---	F22	00:00:00.000
045D	Winding 2 phase A current demand	---	---	A	F79	---
045E	Winding 2 phase B current demand	---	---	A	F79	---
045F	Winding 2 phase C current demand	---	---	A	F79	---
0460	Winding 2 maximum current demand	---	---	A	F79	0 A
0461	Winding 2 maximum current demand phase	---	---	---	F18	0 = phase A
0462	Winding 2 maximum current demand date (2 registers)	---	---	---	F23	Jan 01 1996
0464	Winding 2 maximum current demand time (2 registers)	---	---	---	F22	00:00:00.000
0466	Winding 3 phase A current demand	---	---	A	F80	---
0467	Winding 3 phase B current demand	---	---	A	F80	---
0468	Winding 3 phase C current demand	---	---	A	F80	---

Table 2–4: 745 memory map (Sheet 19 of 56)

Addr	Description	Range	Step	Units	Format	Default
0469	Winding 3 maximum current demand	---	---	A	F80	0 A
046A	Winding 3 maximum current demand phase	---	---	---	F18	0 = phase A
046B	Winding 3 maximum current demand date (2 registers)	---	---	---	F23	Jan 01 1996
046D	Winding 3 maximum current demand time (2 registers)	---	---	---	F22	00:00:00.000
046F	Reserved					
046A	Reserved					
↓	↓	↓	↓	↓	↓	↓
0477	Reserved					
Ambient temperature						
0478	Ambient temperature	–51 to 251	1	°C	F4	---
0479	Reserved					
047A	Reserved					
↓	↓	↓	↓	↓	↓	↓
047F	Reserved					
Loss-of-life						
0480	Hottest-spot winding temperature	–50 to 300	1	°C	F4	---
0481	Total accumulated loss-of-life (2 registers)	0 to 200000	1	hours	F7	0 hours
0483	Aging factor	0.0 to 2000.0	0.1	-	F2	-
0484	Reserved					
0485	Reserved					
0486	Reserved					
0487	Reserved					
Analog input						
0488	Analog input value	0 to 65000	1	<Units>	F1	---
0489	Reserved					
048A	Reserved					
↓	↓	↓	↓	↓	↓	↓
048F	Reserved					
Power						
0490	Winding 1 real power	–32000 to 32000	---	MW	F93	---
0491	Winding 1 reactive power	–32000 to 32000	---	Mvar	F93	---
0492	Winding 1 apparent power	0 to 32000	---	MVA	F93	---
0493	Winding 1 power factor	–1.00 to 1.00	0.01	---	F6	---
0494	Winding 2 real power	–32000 to 32000	---	MW	F94	---
0495	Winding 2 reactive power	–32000 to 32000	---	Mvar	F94	---
0496	Winding 2 apparent power	0 to 32000	---	MVA	F94	---
0497	Winding 2 power factor	–1.00 to 1.00	0.01	---	F6	---
0498	Winding 3 real power	–32000 to 32000	---	MW	F95	---
0499	Winding 3 reactive power	–32000 to 32000	---	Mvar	F95	---
049A	Winding 3 apparent power	0 to 32000	---	MVA	F95	---
049B	Winding 3 power factor	–1.00 to 1.00	0.01	---	F6	---
049C	Reserved					
049D	Reserved					
049E	Reserved					
049F	Reserved					
Winding 1						
04A0	Winding 1 real power	.00001 to 32000	---	MW	F156	0

Table 2–4: 745 memory map (Sheet 20 of 56)

Addr	Description	Range	Step	Units	Format	Default
04A2	Winding 1 reactive power	.00001 to 32000	---	Mvar	F156	0
04A4	Winding 1 apparent power	.00001 to 32000	---	MVA	F156	0
Winding 2						
04A8	Winding 2 real power	.00001 to 32000	---	MW	F156	0
04AA	Winding 2 reactive power	.00001 to 32000	---	Mvar	F156	0
04AC	Winding 2 apparent power	.00001 to 32000	---	MVA	F156	0
Winding3						
04B0	Winding 3 real power	.00001 to 32000	---	MW	F156	0
04B2	Winding 3 reactive power	.00001 to 32000	---	Mvar	F156	0
04B4	Winding 3 apparent power	.00001 to 32000	---	MVA	F156	0
Energy						
0500	Energy clear date	---	---	---	F23	---
0502	Energy clear time	---	---	---	F22	---
0504	Winding 1 source watthours	---	---	MWh	F96	---
0506	Winding 1 load watthours	---	---	MWh	F96	---
0508	Winding 1 source varhours	---	---	Mvarh	F96	---
050A	Winding 1 load varhours	---	---	Mvarh	F96	---
050C	Winding 2 source watthours	---	---	MWh	F97	---
050E	Winding 2 load watthours	---	---	MWh	F97	---
0510	Winding 2 source varhours	---	---	Mvarh	F97	---
0512	Winding 2 load varhours	---	---	Mvarh	F97	---
0514	Winding 3 source watthours	---	---	MWh	F98	---
0516	Winding 3 load watthours	---	---	MWh	F98	---
0518	Winding 3 source varhours	---	---	Mvarh	F98	---
051A	Winding 3 load varhours	---	---	Mvarh	F98	---
051B	Reserved					
0513	Reserved					
↓	↓	↓	↓	↓	↓	↓
07FF	Reserved					
Event recorder (addresses 0800 to 0FFF, read only)						
Event recorder						
0800	Last clear date (2 registers)	---	---	---	F23	---
0802	Last clear time (2 registers)	---	---	---	F22	---
0804	Total number of events since last clear	0 to 65535	1	---	F1	0
0805	Event selector index (XX) [read/write]	1 to 65535	1	---	F1	1 = Event 1
0806	Reserved					
0807	Reserved					
↓	↓	↓	↓	↓	↓	↓
080F	Reserved					
Maximum event current						
0810	Maximum event winding 1 phase A current	---	---	A	F78	0 A
0811	Maximum event winding 1 phase B current	---	---	A	F78	0 A
0812	Maximum event winding 1 phase C current	---	---	A	F78	0 A
0813	Maximum event winding 1 ground current	---	---	A	F81	0 A
0814	Maximum event winding 2 phase A current	---	---	A	F79	0 A
0815	Maximum event winding 2 phase B current	---	---	A	F79	0 A
0816	Maximum event winding 2 phase C current	---	---	A	F79	0 A

Table 2–4: 745 memory map (Sheet 21 of 56)

Addr	Description	Range	Step	Units	Format	Default
0817	Maximum event winding 2 ground current	---	---	A	F82	0 A
0818	Maximum event winding 3 phase A current	---	---	A	F80	0 A
0819	Maximum event winding 3 phase B current	---	---	A	F80	0 A
081A	Maximum event winding 3 phase C current	---	---	A	F80	0 A
081B	Maximum event winding 3 ground current	---	---	A	F83	0 A
081C	Reserved					
081D	Reserved					
↓	↓	↓	↓	↓	↓	↓
082F	Reserved					
Event recorder data						
0830	Event XX date of event (2 registers)	---	---	---	F23	---
0832	Event XX time of event (2 registers)	---	---	---	F22	---
0834	Event XX cause of event	---	---	---	F24	---
0835	Event XX winding 1 phase A current magnitude	---	---	A	F78	0 A
0836	Event XX winding 1 phase A current angle	0	---	° Lag	F1	0° Lag
0837	Event XX winding 1 phase B current magnitude	---	---	A	F78	0 A
0838	Event XX winding 1 phase B current angle	0 to 359	1	° Lag	F1	0° Lag
0839	Event XX winding 1 phase C current magnitude	---	---	A	F78	0 A
083A	Event XX winding 1 phase C current angle	0 to 359	1	° Lag	F1	0° Lag
083B	Event XX winding 1 ground current magnitude	---	---	A	F81	0 A
083C	Event XX winding 1 ground current angle	0 to 359	1	° Lag	F1	0° Lag
083D	Event XX winding 1 phase A 2nd harmonic	0.0 to 99.9	0.1	% f_O	F2	0% f_O
083E	Event XX winding 1 phase B 2nd harmonic	0.0 to 99.9	0.1	% f_O	F2	0% f_O
083F	Event XX winding 1 phase C 2nd harmonic	0.0 to 99.9	0.1	% f_O	F2	0% f_O
0840	Event XX winding 1 phase A 5th harmonic	0.0 to 99.9	0.1	% f_O	F2	0% f_O
0841	Event XX winding 1 phase B 5th harmonic	0.0 to 99.9	0.1	% f_O	F2	0% f_O
0842	Event XX winding 1 phase C 5th harmonic	0.0 to 99.9	0.1	% f_O	F2	0% f_O
0843	Event XX winding 2 phase A current magnitude	---	---	A	F79	0 A
0844	Event XX winding 2 phase A current angle	0 to 359	1	° Lag	F1	0° Lag
0845	Event XX winding 2 phase B current magnitude	---	---	A	F79	0 A
0846	Event XX winding 2 phase B current angle	0 to 359	1	° Lag	F1	0° Lag
0847	Event XX winding 2 phase C current magnitude	---	---	A	F79	0 A
0848	Event XX winding 2 phase C current angle	0 to 359	1	° Lag	F1	0° Lag
0849	Event XX winding 2 ground current magnitude	---	---	A	F82	0 A
084A	Event XX winding 2 ground current angle	0 to 359	1	° Lag	F1	0° Lag
084B	Event XX winding 2 phase A 2nd harmonic	0.0 to 99.9	0.1	% f_O	F2	0% f_O
084C	Event XX winding 2 phase B 2nd harmonic	0.0 to 99.9	0.1	% f_O	F2	0% f_O
084D	Event XX winding 2 phase C 2nd harmonic	0.0 to 99.9	0.1	% f_O	F2	0% f_O
084E	Event XX winding 2 phase A 5th harmonic	0.0 to 99.9	0.1	% f_O	F2	0% f_O
084F	Event XX winding 2 phase B 5th harmonic	0.0 to 99.9	0.1	% f_O	F2	0% f_O
0850	Event XX winding 2 phase C 5th harmonic	0.0 to 99.9	0.1	% f_O	F2	0% f_O
0851	Event XX winding 3 phase A current magnitude	---	---	A	F80	0 A
0852	Event XX winding 3 phase A current angle	0 to 359	1	° Lag	F1	0° Lag
0853	Event XX winding 3 phase B current magnitude	---	---	A	F80	0 A
0854	Event XX winding 3 phase B current angle	0 to 359	1	° Lag	F1	0° Lag
0855	Event XX winding 3 phase C current magnitude	---	---	A	F80	0 A
0856	Event XX winding 3 phase C current angle	0 to 359	1	° Lag	F1	0° Lag

Table 2–4: 745 memory map (Sheet 22 of 56)

Addr	Description	Range	Step	Units	Format	Default
0857	Event XX winding 3 ground current magnitude	---	---	A	F83	0 A
0858	Event XX winding 3 ground current angle	0 to 359	1	° Lag	F1	0° Lag
0859	Event XX winding 3 phase A 2nd harmonic	0.0 to 99.9	0.1	% *fo*	F2	0% *fo*
085A	Event XX winding 3 phase B 2nd harmonic	0.0 to 99.9	0.1	% *fo*	F2	0% *fo*
085B	Event XX winding 3 phase C 2nd harmonic	0.0 to 99.9	0.1	% *fo*	F2	0% *fo*
085C	Event XX winding 3 phase A 5th harmonic	0.0 to 99.9	0.1	% *fo*	F2	0% *fo*
085D	Event XX winding 3 phase B 5th harmonic	0.0 to 99.9	0.1	% *fo*	F2	0% *fo*
085E	Event XX winding 3 phase C 5th harmonic	0.0 to 99.9	0.1	% *fo*	F2	0% *fo*
085F	Event XX phase A differential current	0.00 to 655.35	0.01	× CT	F3	0.00 × CT
0860	Event XX phase B differential current	0.00 to 655.35	0.01	× CT	F3	0.00 × CT
0861	Event XX phase C differential current	0.00 to 655.35	0.01	× CT	F3	0.00 × CT
0862	Event XX phase A restraint current	0.00 to 655.35	0.01	× CT	F3	0.00 × CT
0863	Event XX phase B restraint current	0.00 to 655.35	0.01	× CT	F3	0.00 × CT
0864	Event XX phase C restraint current	0.00 to 655.35	0.01	× CT	F3	0.00 × CT
0865	Event XX system frequency	0.00 to 99.99	0.01	Hz	F3	0.00 Hz
0866	Event XX frequency decay rate	–9.99 to 9.99	0.01	Hz/s	F6	0.00 Hz/s
0867	Event XX tap changer position	1 to 50	1	---	F1	0 = n/a
0868	Event XX volts-per-hertz	0.00 to 4.00	0.01	V/Hz	F3	0.00 V/Hz
0869	Event XX ambient temperature	–51 to 251	1	°C	F4	0 °C
086A	Event XX analog input	0 to 65000	1	<Units>	F1	0 <Units>
086B	Reserved					
086C	Reserved					
↓	↓	↓	↓	↓	↓	↓
086F	Reserved					
Communications actual values						
0870	CoBox serial number	---	---	---	F22	Unknown
0884	MAC address	---	---	---	F22	Unknown
0898	CoBox firmware version	---	---	---	F22	Unknown
08AC	Ethernet status	---	---	---	F152	---
08AD	Reserved					
08AE	Reserved					
↓	↓	↓	↓	↓	↓	↓
0FFF	Reserved					
Common setpoints (addresses 1000 to 1FFF, read/write)						
745 setup						
1000	745 setpoints	---	---	---	F29	0 = Not Prog'd
1001	Encrypted passcode (4 registers, read only)	---	---	---	F33	"AIKFBAIK"
1005	Reserved					
1006	Flash message time	0.5 to 10.0	0.5	s	F2	40 = 4.0 s
1007	Default message timeout	10 to 900	1	s	F1	300 s
1008	Reserved					
1009	Slave address	1 to 254	1	---	F1	254
100A	COM1 baud rate	---	---	---	F31	5 = 19200 Bd
100B	COM1 parity	---	---	---	F73	0 = None
100C	COM1 communication hardware	---	---	---	F17	0 = RS485
100D	COM2 baud rate	---	---	---	F31	5 = 19200 Bd
100E	COM2 parity	---	---	---	F73	0 = None

Table 2–4: 745 memory map (Sheet 23 of 56)

Addr	Description	Range	Step	Units	Format	Default
100F	Front port baud rate	---	---	---	F31	5 = 19200 Bd
1010	Front port parity	---	---	---	F73	0 = None
1011	Local reset block	---	---	---	F87	0 = Disabled
1012	Remote reset signal	---	---	---	F88	0 = Disabled
1013	IRIG-B signal type	---	---	---	F84	0 = None
1014	Active setpoint group	---	---	---	F60	0 = Group 1
1015	Edit setpoint group	---	---	---	F74	4 = Active Grp
1016	Setpoint group 2 activate signal	---	---	---	F88	0 = Disabled
1017	Setpoint group 3 activate signal	---	---	---	F88	0 = Disabled
1018	Setpoint group 4 activate signal	---	---	---	F88	0 = Disabled
1019	Clear event recorder signal	---	---	---	F88	0 = Disabled
101A	DNP port	---	---	---	F99	0=None
101B	Reserved					
101C	Reserved					
↓	↓	↓	↓	↓	↓	↓
101F	Reserved					
Default messages						
1020	Default messages selected [read only]	0 to 30	1	---	F1	1
1021	Default message #1 (2 registers)	---	---	---	F32	---
1023	Default message #2 (2 registers)	---	---	---	F32	---
1025	Default message #3 (2 registers)	---	---	---	F32	---
1027	Default message #4 (2 registers)	---	---	---	F32	---
1029	Default message #5 (2 registers)	---	---	---	F32	---
102B	Default message #6 (2 registers)	---	---	---	F32	---
102D	Default message #7 (2 registers)	---	---	---	F32	---
102F	Default message #8 (2 registers)	---	---	---	F32	---
1031	Default message #9 (2 registers)	---	---	---	F32	---
1033	Default message #10 (2 registers)	---	---	---	F32	---
1035	Default message #11 (2 registers)	---	---	---	F32	---
1037	Default message #12 (2 registers)	---	---	---	F32	---
1039	Default message #13 (2 registers)	---	---	---	F32	---
103B	Default message #14 (2 registers)	---	---	---	F32	---
103D	Default message #15 (2 registers)	---	---	---	F32	---
103F	Default message #16 (2 registers)	---	---	---	F32	---
1041	Default message #17 (2 registers)	---	---	---	F32	---
1043	Default message #18 (2 registers)	---	---	---	F32	---
1045	Default message #19 (2 registers)	---	---	---	F32	---
1047	Default message #20 (2 registers)	---	---	---	F32	---
1049	Default message #21 (2 registers)	---	---	---	F32	---
104B	Default message #22 (2 registers)	---	---	---	F32	---
104D	Default message #23 (2 registers)	---	---	---	F32	---
104F	Default message #24 (2 registers)	---	---	---	F32	---
1051	Default message #25 (2 registers)	---	---	---	F32	---
1053	Default message #26 (2 registers)	---	---	---	F32	---
1055	Default message #27 (2 registers)	---	---	---	F32	---
1057	Default message #28 (2 registers)	---	---	---	F32	---
1059	Default message #29 (2 registers)	---	---	---	F32	---

Table 2–4: 745 memory map (Sheet 24 of 56)

Addr	Description	Range	Step	Units	Format	Default
105B	Default message #30 (2 registers)	---	---	---	F32	---
105D	Reserved					
105E	Reserved					
105F	Reserved					
Message scratchpad						
1060	Scratchpad message 1 (20 registers)	---	---	---	F33	"Text 1"
1074	Scratchpad message 2 (20 registers)	---	---	---	F33	"Text 2"
1088	Scratchpad message 3 (20 registers)	---	---	---	F33	"Text 3"
109C	Scratchpad message 4 (20 registers)	---	---	---	F33	"Text 4"
10B0	Scratchpad message 5 (20 registers)	---	---	---	F33	"Text 5"
10C4	Reserved					
10C5	Reserved					
↓	↓	↓	↓	↓	↓	↓
10CF	Reserved					
DNP communications						
10D0	Port used For DNP	---	---	---	F99	0 = None
10D1	Include user map points (point mapping)	---	---	---	F30	1 = Enabled
10D2	Transmission delay	0 to 65000	1	ms	F1	0 ms
10D3	Data link confirmation mode	---	---	---	F102	0 = Never
10D4	Data link confirmation timeout	1 to 65000	1	ms	F1	1000 ms
10D5	Data link confirmation retries	0 to 100	1	---	F1	3
10D6	Select/operate arm timer duration	1 to 65000	1	ms	F1	10000 ms
10D7	Write time interval	0 to 65000	1	ms	F1	0 ms
10D8	Inhibit cold restart	---	---	---	F30	0 = Disabled
10D9	Reserved					
10DA	Reserved					
↓	↓	↓	↓	↓	↓	↓
10DF	Reserved					
Ethernet communications						
10E0	Ethernet IP address	---	---	---	F150	0
10E2	Ethernet subnet mask	---	---	---	F150	FFFFFC00
10E4	Ethernet gateway address	---	---	---	F150	0
10E6	Reserved					
10E7	Reserved					
↓	↓	↓	↓	↓	↓	↓
10EF	Reserved					
Event recorder setup						
10F0	Enable pickup event capture	---	---	---	F30	1 = Enabled
10F1	Enable operate event capture	---	---	---	F30	1 = Enabled
10F2	Enable dropout event capture	---	---	---	F30	1 = Enabled
10F3	Enable error event capture	---	---	---	F30	1 = Enabled
10F4	Enable off event capture	---	---	---	F30	1 = Enabled
10F5	Enable on event capture	---	---	---	F30	1 = Enabled
10F6	Reserved					
10F7	Reserved					
↓	↓	↓	↓	↓	↓	↓
10FF	Reserved					

Table 2–4: 745 memory map (Sheet 25 of 56)

Addr	Description	Range	Step	Units	Format	Default
Transformer						
1100	Nominal frequency	50 to 60	10	Hz	F1	60 Hz
1101	Phase sequence	---	---	---	F27	0 = ABC
1102	Transformer type	---	---	---	F28	3 = Y/d30°
1103	Rated winding temperature rise	---	---	---	F37	1 = 65°C (oil)
1104	Type of cooling: oil immersed	---	---	---	F39	0 = OA
1105	Load loss at rated load (2 registers)	1 to 20000	1	kW	F101	1250 kW
1107	No-load loss	0.1 to 2000	0.1	kW	F90	1250=125.0 kW
1108	Top oil rise over ambient (at rated load)	1 to 200	1	°C	F1	10°C
1109	Transformer thermal capacity	0.00 to 200.00	0.01	kWh/°C	F3	1.00 kWh/°C
110A	Winding time constant: oil-immersed	0.25 to 15.00	0.01	minutes	F3	200 = 2.00 min
110B	Type of cooling: dry	-	-	-	F100	0
110C	Thermal time constant: dry	0.25 to 15.00	0.01	minutes	F3	200 = 2.00 min
110D	Set initial accumulated loss of life	0 to 20000	1	hrs x 10	F1	0 hours
110E	Frequency tracking	---	---	---	F30	1 = Enabled
110F	Reserved					
1110	Reserved					
↓	↓	↓	↓	↓	↓	↓
111F	Reserved					
Transformer winding 1						
1120	Winding 1 nominal phase-to-phase voltage	1 to 20000	---	kV	F90	220.0 kV
1121	Winding 1 rated load	1 to 20000	---	MVA	F90	1000 = 100 MVA
1122	Winding 1 phase CT primary	1 to 50000	1	:1 or :5 A	F1	500 A
1123	Winding 1 ground CT primary	1 to 50000	1	:1 or :5 A	F1	500 A
1124	Winding 1 series three-phase resistance	0.001 to 50.000	0.001	ohms	F53	10700 = 10.7 Ω
1125	Winding 1 Ground Input Selection	None, G1/2, G2/3	---	---	F103	None
1126	Reserved					
1127	Reserved					
↓	↓	↓	↓	↓	↓	↓
112F	Reserved					
Transformer winding 2						
1130	Winding 2 nominal phase-to-phase voltage	1 to 20000	---	kV	F90	690 = 69.0 kV
1131	Winding 2 rated load	1 to 20000	---	MVA	F90	1000 = 100 MVA
1132	Winding 2 phase CT primary	1 to 50000	1	:1 or :5 A	F1	1500 A
1133	Winding 2 ground CT primary	1 to 50000	1	:1 or :5 A	F1	1500 A
1134	Winding 2 series three-phase resistance	0.001 to 50.000	0.001	ohms	F53	2100 = 2.100 Ω
1135	Winding 2 Ground Input Selection	None, G1/2, G2/3	---	---	F103	None
1136	Reserved					
1137	Reserved					
↓	↓	↓	↓	↓	↓	↓
113F	Reserved					
Transformer winding 3						
1140	Winding 3 nominal phase-to-phase voltage	1 to 20000	---	kV	F90	690 = 69.0 kV
1141	Winding 3 rated load	1 to 20000	---	MVA	F90	1000 = 100 MVA
1142	Winding 3 phase CT primary	1 to 50000	1	:1 or :5 A	F1	1500 A
1143	Winding 3 ground CT primary	1 to 50000	1	:1 or :5 A	F1	1500 A
1144	Winding 3 series three-phase resistance	0.001 to 50.000	0.001	ohms	F53	2100 = 2.100 Ω

Table 2–4: 745 memory map (Sheet 26 of 56)

Addr	Description	Range	Step	Units	Format	Default
1145	Winding 1 Ground Input Selection	None, G1/2, G2/3	---	---	F103	None
1146	Reserved					
1147	Reserved					
↓	↓	↓	↓	↓	↓	↓
115F	Reserved					
Onload tap changer						
1160	Winding with tap changer	---	---	---	F40	0 = None
1161	Number of tap positions	2 to 50	1	---	F1	33
1162	Minimum tap position voltage	1 to 20000	---	kV	F90	610 = 61.0 kV
1163	Voltage increment per tap	1 to 2000	---	kV	F91	50 = 0.50 kV
1164	Resistance increment per tap	10 to 500	1	ohms	F1	33 = 33 Ω
1165	Reserved					
1166	Reserved					
1167	Reserved					
Harmonics						
1168	Harmonic derating estimation	---	---	---	F30	0 = Disabled
1169	THD minimum harmonic number	---	---	---	F92	0 = 2nd
116A	THD maximum harmonic number	---	---	---	F92	19 = 21st
116B	Reserved					
116C	Reserved					
↓	↓	↓	↓	↓	↓	↓
116F	Reserved					
FlexCurve™ A						
1170	FlexCurve A delay at 1.03 × pickup	0 to 65000	1	ms	F1	0 ms
1171	FlexCurve A delay at 1.05 × pickup	0 to 65000	1	ms	F1	0 ms
1172	FlexCurve A delay at 1.10 × pickup	0 to 65000	1	ms	F1	0 ms
1173	FlexCurve A delay at 1.20 × pickup	0 to 65000	1	ms	F1	0 ms
1174	FlexCurve A delay at 1.30 × pickup	0 to 65000	1	ms	F1	0 ms
1175	FlexCurve A delay at 1.40 × pickup	0 to 65000	1	ms	F1	0 ms
1176	FlexCurve A delay at 1.50 × pickup	0 to 65000	1	ms	F1	0 ms
1177	FlexCurve A delay at 1.60 × pickup	0 to 65000	1	ms	F1	0 ms
1178	FlexCurve A delay at 1.70 × pickup	0 to 65000	1	ms	F1	0 ms
1179	FlexCurve A delay at 1.80 × pickup	0 to 65000	1	ms	F1	0 ms
117A	FlexCurve A delay at 1.90 × pickup	0 to 65000	1	ms	F1	0 ms
117B	FlexCurve A delay at 2.00 × pickup	0 to 65000	1	ms	F1	0 ms
117C	FlexCurve A delay at 2.10 × pickup	0 to 65000	1	ms	F1	0 ms
117D	FlexCurve A delay at 2.20 × pickup	0 to 65000	1	ms	F1	0 ms
117E	FlexCurve A delay at 2.30 × pickup	0 to 65000	1	ms	F1	0 ms
117F	FlexCurve A delay at 2.40 × pickup	0 to 65000	1	ms	F1	0 ms
1180	FlexCurve A delay at 2.50 × pickup	0 to 65000	1	ms	F1	0 ms
1181	FlexCurve A delay at 2.60 × pickup	0 to 65000	1	ms	F1	0 ms
1182	FlexCurve A delay at 2.70 × pickup	0 to 65000	1	ms	F1	0 ms
1183	FlexCurve A delay at 2.80 × pickup	0 to 65000	1	ms	F1	0 ms
1184	FlexCurve A delay at 2.90 × pickup	0 to 65000	1	ms	F1	0 ms
1185	FlexCurve A delay at 3.00 × pickup	0 to 65000	1	ms	F1	0 ms
1186	FlexCurve A delay at 3.10 × pickup	0 to 65000	1	ms	F1	0 ms
1187	FlexCurve A delay at 3.20 × pickup	0 to 65000	1	ms	F1	0 ms

Table 2–4: 745 memory map (Sheet 27 of 56)

Addr	Description	Range	Step	Units	Format	Default
1188	FlexCurve A delay at 3.30 × pickup	0 to 65000	1	ms	F1	0 ms
1189	FlexCurve A delay at 3.40 × pickup	0 to 65000	1	ms	F1	0 ms
118A	FlexCurve A delay at 3.50 × pickup	0 to 65000	1	ms	F1	0 ms
118B	FlexCurve A delay at 3.60 × pickup	0 to 65000	1	ms	F1	0 ms
118C	FlexCurve A delay at 3.70 × pickup	0 to 65000	1	ms	F1	0 ms
118D	FlexCurve A delay at 3.80 × pickup	0 to 65000	1	ms	F1	0 ms
118E	FlexCurve A delay at 3.90 × pickup	0 to 65000	1	ms	F1	0 ms
118F	FlexCurve A delay at 4.00 × pickup	0 to 65000	1	ms	F1	0 ms
1190	FlexCurve A delay at 4.10 × pickup	0 to 65000	1	ms	F1	0 ms
1191	FlexCurve A delay at 4.20 × pickup	0 to 65000	1	ms	F1	0 ms
1192	FlexCurve A delay at 4.30 × pickup	0 to 65000	1	ms	F1	0 ms
1193	FlexCurve A delay at 4.40 × pickup	0 to 65000	1	ms	F1	0 ms
1194	FlexCurve A delay at 4.50 × pickup	0 to 65000	1	ms	F1	0 ms
1195	FlexCurve A delay at 4.60 × pickup	0 to 65000	1	ms	F1	0 ms
1196	FlexCurve A delay at 4.70 × pickup	0 to 65000	1	ms	F1	0 ms
1197	FlexCurve A delay at 4.80 × pickup	0 to 65000	1	ms	F1	0 ms
1198	FlexCurve A delay at 4.90 × pickup	0 to 65000	1	ms	F1	0 ms
1199	FlexCurve A delay at 5.00 × pickup	0 to 65000	1	ms	F1	0 ms
119A	FlexCurve A delay at 5.10 × pickup	0 to 65000	1	ms	F1	0 ms
119B	FlexCurve A delay at 5.20 × pickup	0 to 65000	1	ms	F1	0 ms
119C	FlexCurve A delay at 5.30 × pickup	0 to 65000	1	ms	F1	0 ms
119D	FlexCurve A delay at 5.40 × pickup	0 to 65000	1	ms	F1	0 ms
119E	FlexCurve A delay at 5.50 × pickup	0 to 65000	1	ms	F1	0 ms
119F	FlexCurve A delay at 5.60 × pickup	0 to 65000	1	ms	F1	0 ms
11A0	FlexCurve A delay at 5.70 × pickup	0 to 65000	1	ms	F1	0 ms
11A1	FlexCurve A delay at 5.80 × pickup	0 to 65000	1	ms	F1	0 ms
11A2	FlexCurve A delay at 5.90 × pickup	0 to 65000	1	ms	F1	0 ms
11A3	FlexCurve A delay at 6.00 × pickup	0 to 65000	1	ms	F1	0 ms
11A4	FlexCurve A delay at 6.50 × pickup	0 to 65000	1	ms	F1	0 ms
11A5	FlexCurve A delay at 7.00 × pickup	0 to 65000	1	ms	F1	0 ms
11A6	FlexCurve A delay at 7.50 × pickup	0 to 65000	1	ms	F1	0 ms
11A7	FlexCurve A delay at 8.00 × pickup	0 to 65000	1	ms	F1	0 ms
11A8	FlexCurve A delay at 8.50 × pickup	0 to 65000	1	ms	F1	0 ms
11A9	FlexCurve A delay at 9.00 × pickup	0 to 65000	1	ms	F1	0 ms
11AA	FlexCurve A delay at 9.50 × pickup	0 to 65000	1	ms	F1	0 ms
11AB	FlexCurve A delay at 10.0 × pickup	0 to 65000	1	ms	F1	0 ms
11AC	FlexCurve A delay at 10.5 × pickup	0 to 65000	1	ms	F1	0 ms
11AD	FlexCurve A delay at 11.0 × pickup	0 to 65000	1	ms	F1	0 ms
11AE	FlexCurve A delay at 11.5 × pickup	0 to 65000	1	ms	F1	0 ms
11AF	FlexCurve A delay at 12.0 × pickup	0 to 65000	1	ms	F1	0 ms
11B0	FlexCurve A delay at 12.5 × pickup	0 to 65000	1	ms	F1	0 ms
11B1	FlexCurve A delay at 13.0 × pickup	0 to 65000	1	ms	F1	0 ms
11B2	FlexCurve A delay at 13.5 × pickup	0 to 65000	1	ms	F1	0 ms
11B3	FlexCurve A delay at 14.0 × pickup	0 to 65000	1	ms	F1	0 ms
11B4	FlexCurve A delay at 14.5 × pickup	0 to 65000	1	ms	F1	0 ms
11B5	FlexCurve A delay at 15.0 × pickup	0 to 65000	1	ms	F1	0 ms
11B6	FlexCurve A delay at 15.5 × pickup	0 to 65000	1	ms	F1	0 ms

Table 2–4: 745 memory map (Sheet 28 of 56)

Addr	Description	Range	Step	Units	Format	Default
11B7	FlexCurve A delay at 16.0 × pickup	0 to 65000	1	ms	F1	0 ms
11B8	FlexCurve A delay at 16.5 × pickup	0 to 65000	1	ms	F1	0 ms
11B9	FlexCurve A delay at 17.0 × pickup	0 to 65000	1	ms	F1	0 ms
11BA	FlexCurve A delay at 17.5 × pickup	0 to 65000	1	ms	F1	0 ms
11BB	FlexCurve A delay at 18.0 × pickup	0 to 65000	1	ms	F1	0 ms
11BC	FlexCurve A delay at 18.5 × pickup	0 to 65000	1	ms	F1	0 ms
11BD	FlexCurve A delay at 19.0 × pickup	0 to 65000	1	ms	F1	0 ms
11BE	FlexCurve A delay at 19.5 × pickup	0 to 65000	1	ms	F1	0 ms
11BF	FlexCurve A delay at 20.0 × pickup	0 to 65000	1	ms	F1	0 ms
FlexCurve™ B						
11C0	FlexCurve B delay at 1.03 × pickup	0 to 65000	1	ms	F1	0 ms
11C1	FlexCurve B delay at 1.05 × pickup	0 to 65000	1	ms	F1	0 ms
11C2	FlexCurve B delay at 1.10 × pickup	0 to 65000	1	ms	F1	0 ms
11C3	FlexCurve B delay at 1.20 × pickup	0 to 65000	1	ms	F1	0 ms
11C4	FlexCurve B delay at 1.30 × pickup	0 to 65000	1	ms	F1	0 ms
11C5	FlexCurve B delay at 1.40 × pickup	0 to 65000	1	ms	F1	0 ms
11C6	FlexCurve B delay at 1.50 × pickup	0 to 65000	1	ms	F1	0 ms
11C7	FlexCurve B delay at 1.60 × pickup	0 to 65000	1	ms	F1	0 ms
11C8	FlexCurve B delay at 1.70 × pickup	0 to 65000	1	ms	F1	0 ms
11C9	FlexCurve B delay at 1.80 × pickup	0 to 65000	1	ms	F1	0 ms
11CA	FlexCurve B delay at 1.90 × pickup	0 to 65000	1	ms	F1	0 ms
11CB	FlexCurve B delay at 2.00 × pickup	0 to 65000	1	ms	F1	0 ms
11CC	FlexCurve B delay at 2.10 × pickup	0 to 65000	1	ms	F1	0 ms
11CD	FlexCurve B delay at 2.20 × pickup	0 to 65000	1	ms	F1	0 ms
11CE	FlexCurve B delay at 2.30 × pickup	0 to 65000	1	ms	F1	0 ms
11CF	FlexCurve B delay at 2.40 × pickup	0 to 65000	1	ms	F1	0 ms
11D0	FlexCurve B delay at 2.50 × pickup	0 to 65000	1	ms	F1	0 ms
11D1	FlexCurve B delay at 2.60 × pickup	0 to 65000	1	ms	F1	0 ms
11D2	FlexCurve B delay at 2.70 × pickup	0 to 65000	1	ms	F1	0 ms
11D3	FlexCurve B delay at 2.80 × pickup	0 to 65000	1	ms	F1	0 ms
11D4	FlexCurve B delay at 2.90 × pickup	0 to 65000	1	ms	F1	0 ms
11D5	FlexCurve B delay at 3.00 × pickup	0 to 65000	1	ms	F1	0 ms
11D6	FlexCurve B delay at 3.10 × pickup	0 to 65000	1	ms	F1	0 ms
11D7	FlexCurve B delay at 3.20 × pickup	0 to 65000	1	ms	F1	0 ms
11D8	FlexCurve B delay at 3.30 × pickup	0 to 65000	1	ms	F1	0 ms
11D9	FlexCurve B delay at 3.40 × pickup	0 to 65000	1	ms	F1	0 ms
11DA	FlexCurve B delay at 3.50 × pickup	0 to 65000	1	ms	F1	0 ms
11DB	FlexCurve B delay at 3.60 × pickup	0 to 65000	1	ms	F1	0 ms
11DC	FlexCurve B delay at 3.70 × pickup	0 to 65000	1	ms	F1	0 ms
11DD	FlexCurve B delay at 3.80 × pickup	0 to 65000	1	ms	F1	0 ms
11DE	FlexCurve B delay at 3.90 × pickup	0 to 65000	1	ms	F1	0 ms
11DF	FlexCurve B delay at 4.00 × pickup	0 to 65000	1	ms	F1	0 ms
11E0	FlexCurve B delay at 4.10 × pickup	0 to 65000	1	ms	F1	0 ms
11E1	FlexCurve B delay at 4.20 × pickup	0 to 65000	1	ms	F1	0 ms
11E2	FlexCurve B delay at 4.30 × pickup	0 to 65000	1	ms	F1	0 ms
11E3	FlexCurve B delay at 4.40 × pickup	0 to 65000	1	ms	F1	0 ms
11E4	FlexCurve B delay at 4.50 × pickup	0 to 65000	1	ms	F1	0 ms

Table 2–4: 745 memory map (Sheet 29 of 56)

Addr	Description	Range	Step	Units	Format	Default
11E5	FlexCurve B delay at 4.60 × pickup	0 to 65000	1	ms	F1	0 ms
11E6	FlexCurve B delay at 4.70 × pickup	0 to 65000	1	ms	F1	0 ms
11E7	FlexCurve B delay at 4.80 × pickup	0 to 65000	1	ms	F1	0 ms
11E8	FlexCurve B delay at 4.90 × pickup	0 to 65000	1	ms	F1	0 ms
11E9	FlexCurve B delay at 5.00 × pickup	0 to 65000	1	ms	F1	0 ms
11EA	FlexCurve B delay at 5.10 × pickup	0 to 65000	1	ms	F1	0 ms
11EB	FlexCurve B delay at 5.20 × pickup	0 to 65000	1	ms	F1	0 ms
11EC	FlexCurve B delay at 5.30 × pickup	0 to 65000	1	ms	F1	0 ms
11ED	FlexCurve B delay at 5.40 × pickup	0 to 65000	1	ms	F1	0 ms
11EE	FlexCurve B delay at 5.50 × pickup	0 to 65000	1	ms	F1	0 ms
11EF	FlexCurve B delay at 5.60 × pickup	0 to 65000	1	ms	F1	0 ms
11F0	FlexCurve B delay at 5.70 × pickup	0 to 65000	1	ms	F1	0 ms
11F1	FlexCurve B delay at 5.80 × pickup	0 to 65000	1	ms	F1	0 ms
11F2	FlexCurve B delay at 5.90 × pickup	0 to 65000	1	ms	F1	0 ms
11F3	FlexCurve B delay at 6.00 × pickup	0 to 65000	1	ms	F1	0 ms
11F4	FlexCurve B delay at 6.50 × pickup	0 to 65000	1	ms	F1	0 ms
11F5	FlexCurve B delay at 7.00 × pickup	0 to 65000	1	ms	F1	0 ms
11F6	FlexCurve B delay at 7.50 × pickup	0 to 65000	1	ms	F1	0 ms
11F7	FlexCurve B delay at 8.00 × pickup	0 to 65000	1	ms	F1	0 ms
11F8	FlexCurve B delay at 8.50 × pickup	0 to 65000	1	ms	F1	0 ms
11F9	FlexCurve B delay at 9.00 × pickup	0 to 65000	1	ms	F1	0 ms
11FA	FlexCurve B delay at 9.50 × pickup	0 to 65000	1	ms	F1	0 ms
11FB	FlexCurve B delay at 10.0 × pickup	0 to 65000	1	ms	F1	0 ms
11FC	FlexCurve B delay at 10.5 × pickup	0 to 65000	1	ms	F1	0 ms
11FD	FlexCurve B delay at 11.0 × pickup	0 to 65000	1	ms	F1	0 ms
11FE	FlexCurve B delay at 11.5 × pickup	0 to 65000	1	ms	F1	0 ms
11FF	FlexCurve B delay at 12.0 × pickup	0 to 65000	1	ms	F1	0 ms
1200	FlexCurve B delay at 12.5 × pickup	0 to 65000	1	ms	F1	0 ms
1201	FlexCurve B delay at 13.0 × pickup	0 to 65000	1	ms	F1	0 ms
1202	FlexCurve B delay at 13.5 × pickup	0 to 65000	1	ms	F1	0 ms
1203	FlexCurve B delay at 14.0 × pickup	0 to 65000	1	ms	F1	0 ms
1204	FlexCurve B delay at 14.5 × pickup	0 to 65000	1	ms	F1	0 ms
1205	FlexCurve B delay at 15.0 × pickup	0 to 65000	1	ms	F1	0 ms
1206	FlexCurve B delay at 15.5 × pickup	0 to 65000	1	ms	F1	0 ms
1207	FlexCurve B delay at 16.0 × pickup	0 to 65000	1	ms	F1	0 ms
1208	FlexCurve B delay at 16.5 × pickup	0 to 65000	1	ms	F1	0 ms
1209	FlexCurve B delay at 17.0 × pickup	0 to 65000	1	ms	F1	0 ms
120A	FlexCurve B delay at 17.5 × pickup	0 to 65000	1	ms	F1	0 ms
120B	FlexCurve B delay at 18.0 × pickup	0 to 65000	1	ms	F1	0 ms
120C	FlexCurve B delay at 18.5 × pickup	0 to 65000	1	ms	F1	0 ms
120D	FlexCurve B delay at 19.0 × pickup	0 to 65000	1	ms	F1	0 ms
120E	FlexCurve B delay at 19.5 × pickup	0 to 65000	1	ms	F1	0 ms
120F	FlexCurve B delay at 20.0 × pickup	0 to 65000	1	ms	F1	0 ms
FlexCurve™ C						
1210	FlexCurve C delay at 1.03 × pickup	0 to 65000	1	ms	F1	0 ms
1211	FlexCurve C delay at 1.05 × pickup	0 to 65000	1	ms	F1	0 ms
1212	FlexCurve C delay at 1.10 × pickup	0 to 65000	1	ms	F1	0 ms

Table 2–4: 745 memory map (Sheet 30 of 56)

Addr	Description	Range	Step	Units	Format	Default
1213	FlexCurve C delay at 1.20 × pickup	0 to 65000	1	ms	F1	0 ms
1214	FlexCurve C delay at 1.30 × pickup	0 to 65000	1	ms	F1	0 ms
1215	FlexCurve C delay at 1.40 × pickup	0 to 65000	1	ms	F1	0 ms
1216	FlexCurve C delay at 1.50 × pickup	0 to 65000	1	ms	F1	0 ms
1217	FlexCurve C delay at 1.60 × pickup	0 to 65000	1	ms	F1	0 ms
1218	FlexCurve C delay at 1.70 × pickup	0 to 65000	1	ms	F1	0 ms
1219	FlexCurve C delay at 1.80 × pickup	0 to 65000	1	ms	F1	0 ms
121A	FlexCurve C delay at 1.90 × pickup	0 to 65000	1	ms	F1	0 ms
121B	FlexCurve C delay at 2.00 × pickup	0 to 65000	1	ms	F1	0 ms
121C	FlexCurve C delay at 2.10 × pickup	0 to 65000	1	ms	F1	0 ms
121D	FlexCurve C delay at 2.20 × pickup	0 to 65000	1	ms	F1	0 ms
121E	FlexCurve C delay at 2.30 × pickup	0 to 65000	1	ms	F1	0 ms
121F	FlexCurve C delay at 2.40 × pickup	0 to 65000	1	ms	F1	0 ms
1220	FlexCurve C delay at 2.50 × pickup	0 to 65000	1	ms	F1	0 ms
1221	FlexCurve C delay at 2.60 × pickup	0 to 65000	1	ms	F1	0 ms
1222	FlexCurve C delay at 2.70 × pickup	0 to 65000	1	ms	F1	0 ms
1223	FlexCurve C delay at 2.80 × pickup	0 to 65000	1	ms	F1	0 ms
1224	FlexCurve C delay at 2.90 × pickup	0 to 65000	1	ms	F1	0 ms
1225	FlexCurve C delay at 3.00 × pickup	0 to 65000	1	ms	F1	0 ms
1226	FlexCurve C delay at 3.10 × pickup	0 to 65000	1	ms	F1	0 ms
1227	FlexCurve C delay at 3.20 × pickup	0 to 65000	1	ms	F1	0 ms
1228	FlexCurve C delay at 3.30 × pickup	0 to 65000	1	ms	F1	0 ms
1229	FlexCurve C delay at 3.40 × pickup	0 to 65000	1	ms	F1	0 ms
122A	FlexCurve C delay at 3.50 × pickup	0 to 65000	1	ms	F1	0 ms
122B	FlexCurve C delay at 3.60 × pickup	0 to 65000	1	ms	F1	0 ms
122C	FlexCurve C delay at 3.70 × pickup	0 to 65000	1	ms	F1	0 ms
122D	FlexCurve C delay at 3.80 × pickup	0 to 65000	1	ms	F1	0 ms
122E	FlexCurve C delay at 3.90 × pickup	0 to 65000	1	ms	F1	0 ms
122F	FlexCurve C delay at 4.00 × pickup	0 to 65000	1	ms	F1	0 ms
1230	FlexCurve C delay at 4.10 × pickup	0 to 65000	1	ms	F1	0 ms
1231	FlexCurve C delay at 4.20 × pickup	0 to 65000	1	ms	F1	0 ms
1232	FlexCurve C delay at 4.30 × pickup	0 to 65000	1	ms	F1	0 ms
1233	FlexCurve C delay at 4.40 × pickup	0 to 65000	1	ms	F1	0 ms
1234	FlexCurve C delay at 4.50 × pickup	0 to 65000	1	ms	F1	0 ms
1235	FlexCurve C delay at 4.60 × pickup	0 to 65000	1	ms	F1	0 ms
1236	FlexCurve C delay at 4.70 × pickup	0 to 65000	1	ms	F1	0 ms
1237	FlexCurve C delay at 4.80 × pickup	0 to 65000	1	ms	F1	0 ms
1238	FlexCurve C delay at 4.90 × pickup	0 to 65000	1	ms	F1	0 ms
1239	FlexCurve C delay at 5.00 × pickup	0 to 65000	1	ms	F1	0 ms
123A	FlexCurve C delay at 5.10 × pickup	0 to 65000	1	ms	F1	0 ms
123B	FlexCurve C delay at 5.20 × pickup	0 to 65000	1	ms	F1	0 ms
123C	FlexCurve C delay at 5.30 × pickup	0 to 65000	1	ms	F1	0 ms
123D	FlexCurve C delay at 5.40 × pickup	0 to 65000	1	ms	F1	0 ms
123E	FlexCurve C delay at 5.50 × pickup	0 to 65000	1	ms	F1	0 ms
123F	FlexCurve C delay at 5.60 × pickup	0 to 65000	1	ms	F1	0 ms
1240	FlexCurve C delay at 5.70 × pickup	0 to 65000	1	ms	F1	0 ms
1241	FlexCurve C delay at 5.80 × pickup	0 to 65000	1	ms	F1	0 ms

Table 2–4: 745 memory map (Sheet 31 of 56)

Addr	Description	Range	Step	Units	Format	Default
1242	FlexCurve C delay at 5.90 × pickup	0 to 65000	1	ms	F1	0 ms
1243	FlexCurve C delay at 6.00 × pickup	0 to 65000	1	ms	F1	0 ms
1244	FlexCurve C delay at 6.50 × pickup	0 to 65000	1	ms	F1	0 ms
1245	FlexCurve C delay at 7.00 × pickup	0 to 65000	1	ms	F1	0 ms
1246	FlexCurve C delay at 7.50 × pickup	0 to 65000	1	ms	F1	0 ms
1247	FlexCurve C delay at 8.00 × pickup	0 to 65000	1	ms	F1	0 ms
1248	FlexCurve C delay at 8.50 × pickup	0 to 65000	1	ms	F1	0 ms
1249	FlexCurve C delay at 9.00 × pickup	0 to 65000	1	ms	F1	0 ms
124A	FlexCurve C delay at 9.50 × pickup	0 to 65000	1	ms	F1	0 ms
124B	FlexCurve C delay at 10.0 × pickup	0 to 65000	1	ms	F1	0 ms
124C	FlexCurve C delay at 10.5 × pickup	0 to 65000	1	ms	F1	0 ms
124D	FlexCurve C delay at 11.0 × pickup	0 to 65000	1	ms	F1	0 ms
124E	FlexCurve C delay at 11.5 × pickup	0 to 65000	1	ms	F1	0 ms
124F	FlexCurve C delay at 12.0 × pickup	0 to 65000	1	ms	F1	0 ms
1250	FlexCurve C delay at 12.5 × pickup	0 to 65000	1	ms	F1	0 ms
1251	FlexCurve C delay at 13.0 × pickup	0 to 65000	1	ms	F1	0 ms
1252	FlexCurve C delay at 13.5 × pickup	0 to 65000	1	ms	F1	0 ms
1253	FlexCurve C delay at 14.0 × pickup	0 to 65000	1	ms	F1	0 ms
1254	FlexCurve C delay at 14.5 × pickup	0 to 65000	1	ms	F1	0 ms
1255	FlexCurve C delay at 15.0 × pickup	0 to 65000	1	ms	F1	0 ms
1256	FlexCurve C delay at 15.5 × pickup	0 to 65000	1	ms	F1	0 ms
1257	FlexCurve C delay at 16.0 × pickup	0 to 65000	1	ms	F1	0 ms
1258	FlexCurve C delay at 16.5 × pickup	0 to 65000	1	ms	F1	0 ms
1259	FlexCurve C delay at 17.0 × pickup	0 to 65000	1	ms	F1	0 ms
125A	FlexCurve C delay at 17.5 × pickup	0 to 65000	1	ms	F1	0 ms
125B	FlexCurve C delay at 18.0 × pickup	0 to 65000	1	ms	F1	0 ms
125C	FlexCurve C delay at 18.5 × pickup	0 to 65000	1	ms	F1	0 ms
125D	FlexCurve C delay at 19.0 × pickup	0 to 65000	1	ms	F1	0 ms
125E	FlexCurve C delay at 19.5 × pickup	0 to 65000	1	ms	F1	0 ms
125F	FlexCurve C delay at 20.0 × pickup	0 to 65000	1	ms	F1	0 ms
1260	Reserved					
1261	Reserved					
↓	↓	↓	↓	↓	↓	↓
126F	Reserved					
Voltage input						
1270	Voltage sensing	---	---	---	F30	0 = Disabled
1271	Voltage input parameter	---	---	---	F63	0 = W1 Van
1272	Nominal VT secondary voltage	60.0 to 120.0	0.1	V	F2	1200 = 120.0 V
1273	VT ratio	1 to 5000	1	:1	F1	1000:1
1274	Reserved					
1275	Reserved					
↓	↓	↓	↓	↓	↓	↓
127F	Reserved					
Ambient temperature						
1280	Ambient temperature sensing	---	---	---	F30	0 = Disabled
1281	Ambient RTD type	---	---	---	F41	0 = 100 Ω Pt
1282	Average ambient temperature for January	–50 to 125	1	°C	F4	20°C

Table 2–4: 745 memory map (Sheet 32 of 56)

Addr	Description	Range	Step	Units	Format	Default
1283	Average ambient temperature for February	–50 to 125	1	°C	F4	20°C
1284	Average ambient temperature for March	–50 to 125	1	°C	F4	20°C
1285	Average ambient temperature for April	–50 to 125	1	°C	F4	20°C
1286	Average ambient temperature for May	–50 to 125	1	°C	F4	20°C
1287	Average ambient temperature for June	–50 to 125	1	°C	F4	20°C
1288	Average ambient temperature for July	–50 to 125	1	°C	F4	20°C
1289	Average ambient temperature for August	–50 to 125	1	°C	F4	20°C
128A	Average ambient temperature for September	–50 to 125	1	°C	F4	20°C
128B	Average ambient temperature for October	–50 to 125	1	°C	F4	20°C
128C	Average ambient temperature for November	–50 to 125	1	°C	F4	20°C
128D	Average ambient temperature for December	–50 to 125	1	°C	F4	20°C
128E	Reserved					
128F	Reserved					
Analog input						
1290	Analog input name (9 registers)	---	---	---	F33	ANALOG INPUT
1299	Analog input units (3 registers)	---	---	---	F33	"uA"
129C	Analog input range	---	---	---	F42	0 = 0-1 mA
129D	Analog input minimum value	0 to 65000	1	<Units>	F1	0 <Units>
129E	Analog input maximum value	0 to 65000	1	<Units>	F1	1000 <Units>
129F	Reserved					
12A0	Reserved					
↓	↓	↓	↓	↓	↓	↓
12BF	Reserved					
Demand metering						
12C0	Current demand meter type	---	---	---	F58	0 = Thermal
12C1	Thermal 90% response time	---	---	---	F16	2 = 15 min
12C2	Time interval	---	---	---	F16	3 = 20 min
12C3	Reserved					
↓	↓	↓	↓	↓	↓	↓
12CF	Reserved					
Analog outputs						
12D0	Analog output 1 function	---	---	---	F30	0 = Disabled
12D1	Analog output 1 value	---	---	---	F45	0 = W1 øA curr
12D2	Analog output 1 range	---	---	---	F26	2 = 4-20 mA
12D3	Analog output 1 minimum	---	---	---	---	0 A
12D4	Analog output 1 maximum	---	---	---	---	1000 A
12D5	Analog output 2 function	---	---	---	F30	0 = Disabled
12D6	Analog output 2 value	---	---	---	F45	1 = W1 øB curr
12D7	Analog output 2 range	---	---	---	F26	2 = 4-20 mA
12D8	Analog output 2 minimum	---	---	---	---	0 A
12D9	Analog output 2 maximum	---	---	---	---	1000 A
12DA	Analog output 3 function	---	---	---	F30	0 = Disabled
12DB	Analog output 3 value	---	---	---	F45	2 = W1 øC curr
12DC	Analog output 3 range	---	---	---	F26	2 = 4-20 mA
12DD	Analog output 3 minimum	---	---	---	---	0 A
12DE	Analog output 3 maximum	---	---	---	---	1000 A
12DF	Analog output 4 function	---	---	---	F30	0 = Disabled

Table 2–4: 745 memory map (Sheet 33 of 56)

Addr	Description	Range	Step	Units	Format	Default
12E0	Analog output 4 value	---	---	---	F45	9 = W1 loading
12E1	Analog output 4 range	---	---	---	F26	2 = 4-20 mA
12E2	Analog output 4 minimum	---	---	---	---	0%
12E3	Analog output 5 maximum	---	---	---	---	100%
12E4	Analog output 5 function	---	---	---	F30	0 = Disabled
12E5	Analog output 5 value	---	---	---	F45	26 = Voltage
12E6	Analog output 5 range	---	---	---	F26	2 = 4-20 mA
12E7	Analog output 5 minimum	---	---	---	---	0 = 0.00 kV
12E8	Analog output 5 maximum	---	---	---	---	14.40 kV
12E9	Analog output 6 function	---	---	---	F30	0 = Disabled
12EA	Analog output 6 value	---	---	---	F45	24 = frequency
12EB	Analog output 6 range	---	---	---	F26	2 = 4-20 mA
12EC	Analog output 6 minimum	---	---	---	---	5700 = 57.0 Hz
12ED	Analog output 6 maximum	---	---	---	---	6300 = 63.0 Hz
12EE	Analog output 7 function	---	---	---	F30	0 = Disabled
12EF	Analog output 7 value	---	---	---	F45	25 = Tap Pos.
12F0	Analog output 7 range	---	---	---	F26	2 = 4-20 mA
12F1	Analog output 7 minimum	---	---	---	---	1
12F2	Analog output 7 maximum	---	---	---	---	33
12F3	Reserved					
↓	↓	↓	↓	↓	↓	↓
12FF	Reserved					
Logic inputs						
1300	Logic input 1 function	---	---	---	F30	0 = Disabled
1301	Logic input 1 name (9 registers)	---	---	---	F33	Logic Input 1
130A	Logic input 1 asserted state	---	---	---	F75	1 = Closed
130B	Logic input 2 function	---	---	---	F30	0 = Disabled
130C	Logic input 2 name (9 registers)	---	---	---	F33	Logic Input 2
1315	Logic input 3 asserted state	---	---	---	F75	1 = Closed
1316	Logic input 3 function	---	---	---	F30	0 = Disabled
1317	Logic input 3 name (9 registers)	---	---	---	F33	Logic Input 3
1320	Logic input 3 asserted state	---	---	---	F75	1 = Closed
1321	Logic input 4 function	---	---	---	F30	0 = Disabled
1322	Logic input 4 name (9 registers)	---	---	---	F33	Logic Input 4
132B	Logic input 4 asserted state	---	---	---	F75	1 = Closed
132C	Logic input 5 function	---	---	---	F30	0 = Disabled
132D	Logic input 5 name (9 registers)	---	---	---	F33	Logic Input 5
1336	Logic input 5 asserted state	---	---	---	F75	1 = Closed
1337	Logic input 6 function	---	---	---	F30	0 = Disabled
1338	Logic input 6 name (9 registers)	---	---	---	F33	Logic Input 6
1341	Logic input 6 asserted state	---	---	---	F75	1 = Closed
1342	Logic input 7 function	---	---	---	F30	0 = Disabled
1343	Logic input 7 name (9 registers)	---	---	---	F33	Logic Input 7
134C	Logic input 7 asserted state	---	---	---	F75	1 = Closed
134D	Logic input 8 function	---	---	---	F30	0 = Disabled
134E	Logic input 8 name (9 registers)	---	---	---	F33	Logic Input 8
1357	Logic input 8 asserted state	---	---	---	F75	1 = Closed

Table 2–4: 745 memory map (Sheet 34 of 56)

Addr	Description	Range	Step	Units	Format	Default
1358	Logic input 9 function	---	---	---	F30	0 = Disabled
1359	Logic input 9 name (9 registers)	---	---	---	F33	Logic Input 9
1362	Logic input 9 asserted state	---	---	---	F75	1 = Closed
1363	Logic input 10 function	---	---	---	F30	0 = Disabled
1364	Logic input 10 name (9 registers)	---	---	---	F33	Logic Input 10
136D	Logic input 10 asserted state	---	---	---	F75	1 = Closed
136E	Logic input 11 function	---	---	---	F30	0 = Disabled
136F	Logic input 11 name (9 registers)	---	---	---	F33	Logic Input 11
1378	Logic input 11 asserted state	---	---	---	F75	1 = Closed
1379	Logic input 12 function	---	---	---	F30	0 = Disabled
137A	Logic input 12 name (9 registers)	---	---	---	F33	Logic Input 12
1383	Logic input 12 asserted state	---	---	---	F75	1 = Closed
1384	Logic input 13 function	---	---	---	F30	0 = Disabled
1385	Logic input 13 name (9 registers)	---	---	---	F33	Logic Input 13
138E	Logic input 13 asserted state	---	---	---	F75	1 = Closed
138F	Logic input 14 function	---	---	---	F30	0 = Disabled
1390	Logic input 14 name (9 registers)	---	---	---	F33	Logic Input 14
1399	Logic input 14 asserted state	---	---	---	F75	1 = Closed
139A	Logic input 15 function	---	---	---	F30	0 = Disabled
139B	Logic input 15 name (9 registers)	---	---	---	F33	Logic Input 15
13A4	Logic input 15 asserted state	---	---	---	F75	1 = Closed
13A5	Logic input 16 function	---	---	---	F30	0 = Disabled
13A6	Logic input 16 name (9 registers)	---	---	---	F33	Logic Input 16
13AF	Logic input 16 asserted state	---	---	---	F75	1 = Closed
13B0	Logic input 1 target	---	---	---	F46	0 = Self-Test
13B1	Logic input 2 target	---	---	---	F46	0 = Self-Test
13B2	Logic input 3 target	---	---	---	F46	0 = Self-Test
13B3	Logic input 4 target	---	---	---	F46	0 = Self-Test
13B4	Logic input 5 target	---	---	---	F46	0 = Self-Test
13B5	Logic input 6 target	---	---	---	F46	0 = Self-Test
13B6	Logic input 7 target	---	---	---	F46	0 = Self-Test
13B7	Logic input 8 target	---	---	---	F46	0 = Self-Test
13B8	Logic input 9 target	---	---	---	F46	0 = Self-Test
13B9	Logic input 10 target	---	---	---	F46	0 = Self-Test
13BA	Logic input 11 target	---	---	---	F46	0 = Self-Test
13BB	Logic input 12 target	---	---	---	F46	0 = Self-Test
13BC	Logic input 13 target	---	---	---	F46	0 = Self-Test
13BD	Logic input 14 target	---	---	---	F46	0 = Self-Test
13BE	Logic input 15 target	---	---	---	F46	0 = Self-Test
13BF	Logic input 16 target	---	---	---	F46	0 = Self-Test
Virtual inputs						
13C0	Virtual input 1 function	---	---	---	F30	0 = Disabled
13C1	Virtual input 1 name (9 registers)	---	---	---	F33	Virtual Input 1
13CA	Virtual input 2 function	---	---	---	F30	0 = Disabled
13CB	Virtual input 2 name (9 registers)	---	---	---	F33	Virtual Input 2
13D4	Virtual input 3 function	---	---	---	F30	0 = Disabled
13D5	Virtual input 3 name (9 registers)	---	---	---	F33	Virtual Input 3

Table 2–4: 745 memory map (Sheet 35 of 56)

Addr	Description	Range	Step	Units	Format	Default
13DE	Virtual input 4 function	---	---	---	F30	0 = Disabled
13DF	Virtual input 4 name (9 registers)	---	---	---	F33	Virtual Input 4
13E8	Virtual input 5 function	---	---	---	F30	0 = Disabled
13E9	Virtual input 5 name (9 registers)	---	---	---	F33	Virtual Input 5
13F2	Virtual input 6 function	---	---	---	F30	0 = Disabled
13F3	Virtual input 6 name (9 registers)	---	---	---	F33	Virtual Input 6
13FC	Virtual input 7 function	---	---	---	F30	0 = Disabled
13FD	Virtual input 7 name (9 registers)	---	---	---	F33	Virtual Input 7
1406	Virtual input 8 function	---	---	---	F30	0 = Disabled
1407	Virtual input 8 name (9 registers)	---	---	---	F33	Virtual Input 8
1410	Virtual input 9 function	---	---	---	F30	0 = Disabled
1411	Virtual input 9 name (9 registers)	---	---	---	F33	Virtual Input 9
141A	Virtual input 10 function	---	---	---	F30	0 = Disabled
141B	Virtual input 10 name (9 registers)	---	---	---	F33	Virtual Inpt 10
1424	Virtual input 11 function	---	---	---	F30	0 = Disabled
1425	Virtual input 11 name (9 registers)	---	---	---	F33	Virtual Input 11
142E	Virtual input 12 function	---	---	---	F30	0 = Disabled
142F	Virtual input 12 name (9 registers)	---	---	---	F33	Virtual Input 12
1438	Virtual input 13 function	---	---	---	F30	0 = Disabled
1439	Virtual input 13 name (9 registers)	---	---	---	F33	Virtual Input 13
1442	Virtual input 14 function	---	---	---	F30	0 = Disabled
1443	Virtual input 14 name (9 registers)	---	---	---	F33	Virtual Input 14
144C	Virtual input 15 function	---	---	---	F30	0 = Disabled
144D	Virtual input 15 name (9 registers)	---	---	---	F33	Virtual Input 15
1456	Virtual input 16 function	---	---	---	F30	0 = Disabled
1457	Virtual input 16 name (9 registers)	---	---	---	F33	Virtual Input 16
1460	Virtual input 1 target	---	---	---	F46	0 = Self-Reset
1461	Virtual input 2 target	---	---	---	F46	0 = Self-Reset
1462	Virtual input 3 target	---	---	---	F46	0 = Self-Reset
1463	Virtual input 4 target	---	---	---	F46	0 = Self-Reset
1464	Virtual input 5 target	---	---	---	F46	0 = Self-Reset
1465	Virtual input 6 target	---	---	---	F46	0 = Self-Reset
1466	Virtual input 7 target	---	---	---	F46	0 = Self-Reset
1467	Virtual input 8 target	---	---	---	F46	0 = Self-Reset
1468	Virtual input 9 target	---	---	---	F46	0 = Self-Reset
1469	Virtual input 10 target	---	---	---	F46	0 = Self-Reset
146A	Virtual input 11 target	---	---	---	F46	0 = Self-Reset
146B	Virtual input 12 target	---	---	---	F46	0 = Self-Reset
146C	Virtual input 13 target	---	---	---	F46	0 = Self-Reset
146D	Virtual input 14 target	---	---	---	F46	0 = Self-Reset
146E	Virtual input 15 target	---	---	---	F46	0 = Self-Reset
146F	Virtual input 16 target	---	---	---	F46	0 = Self-Reset
1470	Reserved					
1471	Reserved					
↓	↓	↓	↓	↓	↓	↓
147F	Reserved					

Table 2–4: 745 memory map (Sheet 36 of 56)

Addr	Description	Range	Step	Units	Format	Default
Output relay 1						
1480	Output relay 1 name (9 registers)	---	---	---	F33	Solid State Trip
1489	Output relay 1 operation	---	---	---	F66	0=self-resetting
148A	Output relay 1 type	---	---	---	F38	0 = Trip
148B	Output relay 1 FlexLogic™ (20 registers)	---	---	---	F47	---
149F	Reserved					
14A0	Reserved					
↓	↓	↓	↓	↓	↓	↓
14AF	Reserved					
Output relay 2						
14B0	Output relay 2 name (9 registers)	---	---	---	F33	Trip 1
14B9	Output relay 2 operation	---	---	---	F66	0=self-resetting
14BA	Output relay 2 type	---	---	---	F38	0 = Trip
14BB	Output relay 2 FlexLogic™ (20 registers)	---	---	---	F47	---
14CF	Reserved					
14D0	Reserved					
↓	↓	↓	↓	↓	↓	↓
14DF	Reserved					
Output relay 3						
14E0	Output relay 3 name (9 registers)	---	---	---	F33	Trip 2
14E9	Output relay 3 operation	---	---	---	F66	0=self-resetting
14EA	Output relay 3 type	---	---	---	F38	0 = Trip
14EB	Output relay 3 FlexLogic™ (20 registers)	---	---	---	F47	---
14FF	Reserved					
1500	Reserved					
↓	↓	↓	↓	↓	↓	↓
150F	Reserved					
Output relay 4						
1510	Output relay 4 name (9 registers)	---	---	---	F33	Volts/Hertz Trip
1519	Output relay 4 operation	---	---	---	F66	0=self-resetting
151A	Output relay 4 type	---	---	---	F38	0 = Trip
151B	Output relay 4 FlexLogic™ (20 registers)	---	---	---	F47	---
152F	Reserved					
1530	Reserved					
↓	↓	↓	↓	↓	↓	↓
153F	Reserved					
Output relay 5						
1540	Output relay 5 name (9 registers)	---	---	---	F33	Overflux Alarm
1549	Output relay 5 operation	---	---	---	F66	0=self-resetting
154A	Output relay 5 type	---	---	---	F38	1 = Alarm
154B	Output relay 5 FlexLogic™ (20 registers)	---	---	---	F47	---
155F	Reserved					
1560	Reserved					
↓	↓	↓	↓	↓	↓	↓
156F	Reserved					
Output relay 6						
1570	Output relay 6 name (9 registers)	---	---	---	F33	Frequency Trip 1

Table 2–4: 745 memory map (Sheet 37 of 56)

Addr	Description	Range	Step	Units	Format	Default
1579	Output relay 6 operation	---	---	---	F66	0=self-resetting
157A	Output relay 6 type	---	---	---	F38	0 = Trip
157B	Output relay 6 FlexLogic™ (20 registers)	---	---	---	F47	---
158F	Reserved					
1590	Reserved					
↓	↓	↓	↓	↓	↓	↓
159F	Reserved					
Output relay 7						
15A0	Output relay 7 name (9 registers)	---	---	---	F33	Frequency Trip 2
15A9	Output relay 7 operation	---	---	---	F66	0=self-resetting
15AA	Output relay 7 type	---	---	---	F38	0 = Trip
15AB	Output relay 7 FlexLogic™ (20 registers)	---	---	---	F47	---
15BF	Reserved					
15C0	Reserved					
↓	↓	↓	↓	↓	↓	↓
15CF	Reserved					
Output relay 8						
15D0	Output relay 8 name (9 registers)	---	---	---	F33	Frequency Trip 3
15D9	Output relay 8 operation	---	---	---	F66	0=self-resetting
15DA	Output relay 8 type	---	---	---	F38	0 = Trip
15DB	Output relay 8 FlexLogic™ (20 registers)	---	---	---	F47	---
15EF	Reserved					
15F0	Reserved					
↓	↓	↓	↓	↓	↓	↓
15FF	Reserved					
Trace memory						
1600	Number of pre-trigger cycles	1 to 15	1	cycles	F1	12 cycles
1601	Trace memory trigger FlexLogic™ (10 registers)	---	---	---	F47	---
160B	Reserved					
160C	Reserved					
↓	↓	↓	↓	↓	↓	↓
19FF	Reserved					
Virtual outputs						
1A00	Virtual output 1 FlexLogic™ (10 registers)	---	---	---	F47	---
1A0A	Virtual output 2 FlexLogic™ (10 registers)	---	---	---	F47	---
1A14	Virtual output 3 FlexLogic™ (10 registers)	---	---	---	F47	---
1A1E	Virtual output 4 FlexLogic™ (10 registers)	---	---	---	F47	---
1A28	Virtual output 5 FlexLogic™ (10 registers)	---	---	---	F47	---
1A32	Reserved					
1A33	Reserved					
↓	↓	↓	↓	↓	↓	↓
1D7F	Reserved					
Timers						
1D80	Timer 1 start	---	---	---	F62	0 = End
1D81	Timer 1 pickup delay	0.00 to 600.00	0.01	s	F3	0.00 s
1D82	Timer 1 dropout delay	0.00 to 600.00	0.01	s	F3	0.00 s
1D83	Timer 2 start	---	---	---	F62	0 = End

Table 2–4: 745 memory map (Sheet 38 of 56)

Addr	Description	Range	Step	Units	Format	Default
1D84	Timer 2 pickup delay	0.00 to 600.00	0.01	s	F3	0.00 s
1D85	Timer 2 dropout delay	0.00 to 600.00	0.01	s	F3	0.00 s
1D86	Timer 3 start	---	---	---	F62	0 = End
1D87	Timer 3 pickup delay	0.00 to 600.00	0.01	s	F3	0.00 s
1D88	Timer 3 dropout delay	0.00 to 600.00	0.01	s	F3	0.00 s
1D89	Timer 4 start	---	---	---	F62	0 = End
1D8A	Timer 4 pickup delay	0.00 to 600.00	0.01	s	F3	0.00 s
1D8B	Timer 4 dropout delay	0.00 to 600.00	0.01	s	F3	0.00 s
1D8C	Timer 5 start	---	---	---	F62	0 = End
1D8D	Timer 5 pickup delay	0.00 to 600.00	0.01	s	F3	0.00 s
1D8E	Timer 5 dropout delay	0.00 to 600.00	0.01	s	F3	0.00 s
1D8F	Timer 6 start	---	---	---	F62	0 = End
1D90	Timer 6 pickup delay	0.00 to 600.00	0.01	s	F3	0.00 s
1D91	Timer 6 dropout delay	0.00 to 600.00	0.01	s	F3	0.00 s
1D92	Timer 7 start	---	---	---	F62	0 = End
1D93	Timer 7 pickup delay	0.00 to 600.00	0.01	s	F3	0.00 s
1D94	Timer 7 dropout delay	0.00 to 600.00	0.01	s	F3	0.00 s
1D95	Timer 8 start	---	---	---	F62	0 = End
1D96	Timer 8 pickup delay	0.00 to 600.00	0.01	s	F3	0.00 s
1D97	Timer 8 dropout delay	0.00 to 600.00	0.01	s	F3	0.00 s
1D98	Timer 9 start	---	---	---	F62	0 = End
1D99	Timer 9 pickup delay	0.00 to 600.00	0.01	s	F3	0.00 s
1D9A	Timer 9 dropout delay	0.00 to 600.00	0.01	s	F3	0.00 s
1D9B	Timer 10 start	---	---	---	F62	0 = End
1D9C	Timer 10 pickup delay	0.00 to 600.00	0.01	s	F3	0.00 s
1D9D	Timer 10 dropout delay	0.00 to 600.00	0.01	s	F3	0.00 s
1D9E	Reserved					
1D9F	Reserved					
↓	↓	↓	↓	↓	↓	↓
1DFF	Reserved					
Force output relays						
1E00	Force output relays function	---	---	---	F30	0 = Disabled
1E01	Force output relay 1	---	---	---	F34	0=De-energized
1E02	Force output relay 2	---	---	---	F34	0=De-energized
1E03	Force output relay 3	---	---	---	F34	0=De-energized
1E04	Force output relay 4	---	---	---	F34	0=De-energized
1E05	Force output relay 5	---	---	---	F34	0=De-energized
1E06	Force output relay 6	---	---	---	F34	0=De-energized
1E07	Force output relay 7	---	---	---	F34	0=De-energized
1E08	Force output relay 8	---	---	---	F34	0=De-energized
1E09	Force self-test relay	---	---	---	F34	0=De-energized
1E0A	Reserved					
1E0B	Reserved					
↓	↓	↓	↓	↓	↓	↓
1E0F	Reserved					
Force analog outputs						
1E10	Force analog outputs function	---	---	---	F30	0 = Disabled

Table 2–4: 745 memory map (Sheet 39 of 56)

Addr	Description	Range	Step	Units	Format	Default
1E11	Force analog output 1	0 to 100	1	%	F1	0%
1E12	Force analog output 2	0 to 100	1	%	F1	0%
1E13	Force analog output 3	0 to 100	1	%	F1	0%
1E14	Force analog output 4	0 to 100	1	%	F1	0%
1E15	Force analog output 5	0 to 100	1	%	F1	0%
1E16	Force analog output 6	0 to 100	1	%	F1	0%
1E17	Force analog output 7	0 to 100	1	%	F1	0%
1E18	Reserved					
1E19	Reserved					
↓	↓	↓	↓	↓	↓	↓
1E1F	Reserved					
Simulation setup						
1E20	Simulation function	---	---	---	F48	0 = Disabled
1E21	Block operation of outputs	---	---	---	F67	255 = 12345678
1E22	Start fault mode signal	---	---	---	F88	0 = Disabled
1E23	Start playback mode signal	---	---	---	F88	0 = Disabled
1E24	Reserved					
1E25	Reserved					
1E26	Reserved					
1E27	Reserved					
Simulation prefault values						
1E28	Prefault winding 1 phase A/B/C current magnitudes	0.0 to 40.0	0.1	× CT	F2	10 = 1.0 × CT
1E29	Prefault winding 2 phase A/B/C Current magnitudes	0.0 to 40.0	0.1	× CT	F2	10 = 1.0 × CT
1E2A	Prefault winding 3 phase A/B/C Current magnitudes	0.0 to 40.0	0.1	× CT	F2	10 = 1.0 × CT
1E2B	Prefault voltage input magnitude	0.0 to 2.0	0.1	× VT	F2	10 = 1.0 × VT
1E2C	Reserved					
1E2D	Reserved					
1E2E	Reserved					
1E2F	Reserved					
Simulation fault values						
1E30	Fault winding 1 phase A current magnitude	0.0 to 40.0	0.1	× CT	F2	10 = 1.0 × CT
1E31	Fault winding 1 phase A current angle	---	---	°	F1	0°
1E32	Fault winding 1 phase B current magnitude	0.0 to 40.0	0.1	× CT	F2	10 = 1.0 × CT
1E33	Fault winding 1 phase B current angle	0 to 359	1	° Lag	F1	120° Lag
1E34	Fault winding 1 phase C current magnitude	0.0 to 40.0	0.1	× CT	F2	10 = 1.0 × CT
1E35	Fault winding 1 phase C current angle	0 to 359	1	° Lag	F1	240° Lag
1E36	Fault winding 1 ground current magnitude	0.0 to 40.0	0.1	× CT	F2	0.0 × CT
1E37	Fault winding 1 ground current angle	0 to 359	1	° Lag	F1	0° Lag
1E38	Fault winding 2 phase A current magnitude	0.0 to 40.0	0.1	× CT	F2	10 = 1.0 × CT
1E39	Fault winding 2 phase A current angle	0 to 359	1	° Lag	F1	0° Lag
1E3A	Fault winding 2 phase B current magnitude	0.0 to 40.0	0.1	× CT	F2	10 = 1.0 × CT
1E3B	Fault winding 2 phase B current angle	0 to 359	1	° Lag	F1	120° Lag
1E3C	Fault winding 2 phase C current magnitude	0.0 to 40.0	0.1	× CT	F2	10 = 1.0 × CT
1E3D	Fault winding 2 phase C current angle	0 to 359	1	° Lag	F1	240° Lag
1E3E	Fault winding 2 ground current magnitude	0.0 to 40.0	0.1	× CT	F2	0.0 × CT
1E3F	Fault winding 2 ground current angle	0 to 359	1	° Lag	F1	0° Lag
1E40	Fault winding 3 phase A current magnitude	0.0 to 40.0	0.1	× CT	F2	10 = 1.0 × CT

Table 2–4: 745 memory map (Sheet 40 of 56)

Addr	Description	Range	Step	Units	Format	Default
1E41	Fault winding 3 phase A current angle	0 to 359	1	° Lag	F1	330° Lag
1E42	Fault winding 3 phase B current magnitude	0.0 to 40.0	0.1	× CT	F2	10 = 1.0 × CT
1E43	Fault winding 3 phase B current angle	0 to 359	1	° Lag	F1	90° Lag
1E44	Fault winding 3 phase C current magnitude	0.0 to 40.0	0.1	× CT	F2	10 = 1.0 × CT
1E45	Fault winding 3 phase C current angle	0 to 359	1	° Lag	F1	210° Lag
1E46	Fault winding 3 ground current magnitude	0.0 to 40.0	0.1	× CT	F2	0.0 × CT
1E47	Fault winding 3 ground current angle	0 to 359	1	° Lag	F1	0° Lag
1E48	Fault voltage input magnitude	0.0 to 2.0	0.1	× VT	F2	10 = 1.0 × VT
1E49	Fault voltage input angle	0 to 359	1	° Lag	F1	0° Lag
1E4A	Fault frequency	45.00 to 60.00	0.01	Hz	F3	60.00 Hz
1E4B	Reserved					
1E4C	Reserved					
↓	↓	↓	↓	↓	↓	↓
1FFF	Reserved					
Setpoint groups 1 to 4 (addresses 2000 to 3FFF, read/write)						
Percent differential						
2000	Percent differential function	---	---	---	F30	1 = Enabled
2001	Percent differential target	---	---	---	F46	1 = Latched
2002	Percent differential pickup	0.05 to 1.00	0.01	× CT	F3	30 = 0.30 × CT
2003	Percent differential slope 1	15 to 100	1	%	F1	25%
2004	Percent differential break point	1.0 to 20.0	0.1	× CT	F2	20 = 2.0 × CT
2005	Percent differential slope 2	50 to 100	1	%	F1	100%
2006	Percent differential block	---	---	---	F87	0 = Disabled
2007	Percent differential relays	1 to 8	---	---	F153	None
Harmonic inhibit						
2008	Harmonic inhibit function	---	---	---	F30	1 = Enabled
2009	Harmonic inhibit parameters	---	---	---	F64	0 = 2nd
200A	Harmonic averaging	---	---	---	F30	0 = Disabled
200B	Harmonic inhibit level	0.1 to 65.0	0.1	% fo	F2	200 = 20.0% fo
200C	Reserved					
Energization inhibit						
200D	Energization inhibit function	---	---	---	F30	1 = Enabled
200E	Energization inhibit parameters	---	---	---	F64	0 = 2nd
200F	Energization inhibit harmonic averaging	---	---	---	F30	1 = Enabled
2010	Energization inhibit level	0.1 to 65.0	0.1	% fo	F2	200 = 20.0% fo
2011	Energization inhibit duration	0.05 to 600.00	0.01	s	F1	10 = 0.10 s
2012	Energization sensing by current	---	---	---	F30	1 = Enabled
2013	Minimum energization current	0.10 to 0.50	0.01	× CT	F3	10 = 0.10 × CT
2014	Energization sensing by voltage	---	---	---	F30	0 = Disabled
2015	Minimum energization voltage	0.50 to 0.99	0.01	× VT	F3	85 = 0.85 × VT
2016	Breakers are open signal	---	---	---	F88	0 = Disabled
2017	Parallel transformer breaker close signal	---	---	---	F88	0 = Disabled
2018	Reserved					
Fifth harmonic inhibit						
2019	Fifth harmonic inhibit function	---	---	---	F30	0 = Disabled
201A	Fifth harmonic averaging	---	---	---	F30	0 = Disabled
201B	Fifth harmonic inhibit level	0.1 to 65.0	0.1	% fo	F2	100 = 10.0% fo

Table 2–4: 745 memory map (Sheet 41 of 56)

Addr	Description	Range	Step	Units	Format	Default
201C	Reserved					
201D	Reserved					
201E	Reserved					
201F	Reserved					
Instantaneous differential						
2020	Instantaneous differential function	---	---	---	F30	1 = Enabled
2021	Instantaneous differential target	---	---	---	F46	1 = Latched
2022	Instantaneous differential pickup	3.00 to 20.00	0.01	× CT	F3	800 = 8.00 × CT
2023	Instantaneous differential block	---	---	---	F87	0 = Disabled
2024	Instantaneous differential relays	1 to 8	---	---	F153	None
2025	Reserved					
↓	↓	↓	↓	↓	↓	↓
203F	Reserved					
Winding 1 phase time overcurrent						
2040	Winding 1 phase time overcurrent function	---	---	---	F30	1 = Enabled
2041	Winding 1 phase time overcurrent target	---	---	---	F46	1 = Latched
2042	Winding 1 phase time overcurrent pickup	0.05 to 20.00	0.01	× CT	F3	120 = 1.20 × CT
2043	Winding 1 phase time overcurrent shape	---	---	---	F36	0 = Ext Inverse
2044	Winding 1 phase time overcurrent multiplier	0.00 to 100.00	0.01	---	F3	100 = 1.00
2045	Winding 1 phase time overcurrent reset	---	---	---	F68	1 = Linear
2046	Winding 1 phase time overcurrent block	---	---	---	F87	0 = Disabled
2047	Winding 1 harmonic derating correction	---	---	---	F30	0 = Disabled
2048	Winding 1 phase time overcurrent relays	1 to 8	---	---	F153	None
2049	Reserved					
↓	↓	↓	↓	↓	↓	↓
204F	Reserved					
Winding 2 phase time overcurrent						
2050	Winding 2 phase time overcurrent function	---	---	---	F30	1 = Enabled
2051	Winding 2 phase time overcurrent target	---	---	---	F46	1 = Latched
2052	Winding 2 phase time overcurrent pickup	0.05 to 20.00	0.01	× CT	F3	120 = 1.20 ¥× CT
2053	Winding 2 phase time overcurrent shape	---	---	---	F36	0 = Ext Inverse
2054	Winding 2 phase time overcurrent multiplier	0.00 to 100.00	0.01	---	F3	100 = 1.00
2055	Winding 2 phase time overcurrent reset	---	---	---	F68	1 = Linear
2056	Winding 2 phase time overcurrent block	---	---	---	F87	0 = Disabled
2057	Winding 2 harmonic derating correction	---	---	---	F30	0 = Disabled
2058	Winding 2 phase time overcurrent relays	1 to 8	---	---	F153	None
2059	Reserved					
↓	↓	↓	↓	↓	↓	↓
205F	Reserved					
Winding 3 phase time overcurrent						
2060	Winding 3 phase time overcurrent function	---	---	---	F30	1 = Enabled
2061	Winding 3 phase time overcurrent target	---	---	---	F46	1 = Latched
2062	Winding 3 phase time overcurrent pickup	0.05 to 20.00	0.01	× CT	F3	120 = 1.20 × CT
2063	Winding 3 phase time overcurrent shape	---	---	---	F36	0 = Ext Inverse
2064	Winding 3 phase time overcurrent multiplier	0.00 to 100.00	0.01	---	F3	100 = 1.00
2065	Winding 3 phase time overcurrent reset	---	---	---	F68	1 = Linear
2066	Winding 3 phase time overcurrent block	---	---	---	F87	0 = Disabled

Table 2–4: 745 memory map (Sheet 42 of 56)

Addr	Description	Range	Step	Units	Format	Default
2067	Winding 3 harmonic derating correction	---	---	---	F30	0 = Disabled
2068	Winding 3 phase time overcurrent relays	1 to 8	---	---	F153	None
2069	Reserved					
↓	↓	↓	↓	↓	↓	↓
206F	Reserved					
Winding 1 phase instantaneous overcurrent 1						
2070	Winding 1 phase instantaneous overcurrent 1 function	---	---	---	F30	1 = Enabled
2071	Winding 1 phase instantaneous overcurrent 1 target	---	---	---	F46	1 = Latched
2072	Winding 1 phase instantaneous overcurrent 1 pickup	0.05 to 20.00	0.01	x CT	F3	1000=10.00xCT
2073	Winding 1 phase instantaneous overcurrent 1 delay	0 to 60000	1	ms	F1	0 ms
2074	Winding 1 phase instantaneous overcurrent 1 block	---	---	---	F87	0 = Disabled
2075	Winding 1 phase instantaneous overcurrent 1 relays	1 to 8	---	---	F153	None
2076	Reserved					
↓	↓	↓	↓	↓	↓	↓
207F	Reserved					
Winding 2 phase instantaneous overcurrent 1						
2080	Winding 2 phase instantaneous overcurrent 1 function	---	---	---	F30	1 = Enabled
2081	Winding 2 phase instantaneous overcurrent 1 target	---	---	---	F46	1 = Latched
2082	Winding 2 phase instantaneous overcurrent 1 pickup	0.05 to 20.00	0.01	x CT	F3	10.00 x CT
2083	Winding 2 phase instantaneous overcurrent 1 delay	0 to 60000	1	ms	F1	0 ms
2084	Winding 2 phase instantaneous overcurrent 1 block	---	---	---	F87	0 = Disabled
2085	Winding 2 phase instantaneous overcurrent 1 relays	1 to 8	---	---	F153	None
2086	Reserved					
↓	↓	↓	↓	↓	↓	↓
208F	Reserved					
Winding 3 phase instantaneous overcurrent 1						
2090	Winding 3 phase instantaneous overcurrent 1 function	---	---	---	F30	1 = Enabled
2091	Winding 3 phase instantaneous overcurrent 1 target	---	---	---	F46	1 = Latched
2092	Winding 3 phase instantaneous overcurrent 1 pickup	0.05 to 20.00	0.01	x CT	F3	1000=10.00xCT
2093	Winding 3 phase instantaneous overcurrent 1 delay	0 to 60000	1	ms	F1	0 ms
2094	Winding 3 phase instantaneous overcurrent 1 block	---	---	---	F87	0 = Disabled
2095	Winding 3 phase instantaneous overcurrent 1 relays	1 to 8	---	---	F153	None
2096	Reserved					
↓	↓	↓	↓	↓	↓	↓
209F	Reserved					
Winding 1 phase instantaneous overcurrent 2						
20A0	Winding 1 phase instantaneous overcurrent 2 function	---	---	---	F30	1 = Enabled
20A1	Winding 1 phase instantaneous overcurrent 2 target	---	---	---	F46	1 = Latched
20A2	Winding 1 phase instantaneous overcurrent 2 pickup	0.05 to 20.00	0.01	x CT	F3	1000=10.00xCT
20A3	Winding 1 phase instantaneous overcurrent 2 delay	0 to 60000	1	ms	F1	0 ms
20A4	Winding 1 phase instantaneous overcurrent 2 block	---	---	---	F87	0 = Disabled
20A5	Winding 1 phase instantaneous overcurrent 2 relays	1 to 8	---	---	F153	None
20A6	Reserved					
↓	↓	↓	↓	↓	↓	↓
20AF	Reserved					
Winding 2 phase instantaneous overcurrent 2						
20B0	Winding 2 phase instantaneous overcurrent 2 function	---	---	---	F30	1 = Enabled

Table 2–4: 745 memory map (Sheet 43 of 56)

Addr	Description	Range	Step	Units	Format	Default
20B1	Winding 2 phase instantaneous overcurrent 2 target	---	---	---	F46	1 = Latched
20B2	Winding 2 phase instantaneous overcurrent 2 pickup	0.05 to 20.00	0.01	x CT	F3	1000=10.00xCT
20B3	Winding 2 phase instantaneous overcurrent 2 delay	0 to 60000	1	ms	F1	0 ms
20B4	Winding 2 phase instantaneous overcurrent 2 block	---	---	---	F87	0 = Disabled
20B5	Winding 2 phase instantaneous overcurrent 2 relays	1 to 8	---	---	F153	None
20B6	Reserved					
↓	↓	↓	↓	↓	↓	↓
20BF	Reserved					
Winding 3 phase instantaneous overcurrent 2						
20C0	Winding 3 phase instantaneous overcurrent 2 function	---	---	---	F30	1 = Enabled
20C1	Winding 3 phase instantaneous overcurrent 2 target	---	---	---	F46	1 = Latched
20C2	Winding 3 phase instantaneous overcurrent 2 pickup	0.05 to 20.00	0.01	x CT	F3	1000=10.00xCT
20C3	Winding 3 phase instantaneous overcurrent 2 delay	0 to 60000	1	ms	F1	0 ms
20C4	Winding 3 phase instantaneous overcurrent 2 block	---	---	---	F87	0 = Disabled
20C5	Winding 3 phase instantaneous overcurrent 2 relays	1 to 8	---	---	F153	None
20C6	Reserved					
↓	↓	↓	↓	↓	↓	↓
20CF	Reserved					
Winding 1 neutral time overcurrent						
20D0	Winding 1 neutral time overcurrent function	---	---	---	F30	1 = Enabled
20D1	Winding 1 neutral time overcurrent target	---	---	---	F46	1 = Latched
20D2	Winding 1 neutral time overcurrent pickup	0.05 to 20.00	0.01	x CT	F3	85 = 0.85 x CT
20D3	Winding 1 neutral time overcurrent shape	---	---	---	F36	0 = Ext Inverse
20D4	Winding 1 neutral time overcurrent multiplier	0.00 to 100.00	0.01	---	F3	100 = 1.00
20D5	Winding 1 neutral time overcurrent reset	---	---	---	F68	1 = Linear
20D6	Winding 1 neutral time overcurrent block	---	---	---	F87	0 = Disabled
20D7	Winding 1 neutral time overcurrent relays	1 to 8	---	---	F153	None
20D8	Reserved					
↓	↓	↓	↓	↓	↓	↓
20DF	Reserved					
Winding 2 neutral time overcurrent						
20E0	Winding 2 neutral time overcurrent function	---	---	---	F30	0 = Disabled
20E1	Winding 2 neutral time overcurrent target	---	---	---	F46	1 = Latched
20E2	Winding 2 neutral time overcurrent pickup	0.05 to 20.00	0.01	x CT	F3	85 = 0.85 x CT
20E3	Winding 2 neutral time overcurrent shape	---	---	---	F36	0 = Ext Inverse
20E4	Winding 2 neutral time overcurrent multiplier	0.00 to 100.00	0.01	---	F3	100 = 1.00
20E5	Winding 2 neutral time overcurrent reset	---	---	---	F68	1 = Linear
20E6	Winding 2 neutral time overcurrent block	---	---	---	F87	0 = Disabled
20E7	Winding 2 neutral time overcurrent relays	1 to 8	---	---	F153	None
20E8	Reserved					
↓	↓	↓	↓	↓	↓	↓
20EF	Reserved					
Winding 3 neutral time overcurrent						
20F0	Winding 3 neutral time overcurrent function	---	---	---	F30	0 = Disabled
20F1	Winding 3 neutral time overcurrent target	---	---	---	F46	1 = Latched
20F2	Winding 3 neutral time overcurrent pickup	0.05 to 20.00	0.01	× CT	F3	85 = 0.85 × CT
20F3	Winding 3 neutral time overcurrent shape	---	---	---	F36	0 = Ext Inverse

Table 2–4: 745 memory map (Sheet 44 of 56)

Addr	Description	Range	Step	Units	Format	Default
20F4	Winding 3 neutral time overcurrent multiplier	0.00 to 100.00	0.01	---	F3	100 = 1.00
20F5	Winding 3 neutral time overcurrent reset	---	---	---	F68	1 = Linear
20F6	Winding 3 neutral time overcurrent block	---	---	---	F87	0 = Disabled
20F7	Winding 3 neutral time overcurrent relays	1 to 8	---	---	F153	None
20F8	Reserved					
↓	↓	↓	↓	↓	↓	↓
20FF	Reserved					
Winding 1 neutral instantaneous overcurrent 1						
2100	Winding 1 neutral instantaneous overcurrent 1 function	---	---	---	F30	1 = Enabled
2101	Winding 1 neutral instantaneous overcurrent 1 target	---	---	---	F46	1 = Latched
2102	Winding 1 neutral instantaneous overcurrent 1 pickup	0.05 to 20.00	0.01	× CT	F3	1000=10.00×CT
2103	Winding 1 neutral instantaneous overcurrent 1 delay	0 to 60000	1	ms	F1	0 ms
2104	Winding 1 neutral instantaneous overcurrent 1 block	---	---	---	F87	0 = Disabled
2105	Winding 1 neutral instantaneous overcurrent 1 relays	1 to 8	---	---	F153	None
2106	Reserved					
↓	↓	↓	↓	↓	↓	↓
210F	Reserved					
Winding 2 neutral instantaneous overcurrent 1						
2110	Winding 2 neutral instantaneous overcurrent 1 function	---	---	---	F30	0 = Disabled
2111	Winding 2 neutral instantaneous overcurrent 1 target	---	---	---	F46	1 = Latched
2112	Winding 2 neutral instantaneous overcurrent 1 pickup	0.05 to 20.00	0.01	× CT	F3	1000=10.00×CT
2113	Winding 2 neutral instantaneous overcurrent 1 delay	0 to 60000	1	ms	F1	0 ms
2114	Winding 2 neutral instantaneous overcurrent 1 block	---	---	---	F87	0 = Disabled
2115	Winding 2 neutral instantaneous overcurrent 1 relays	1 to 8	---	---	F153	None
2116	Reserved					
↓	↓	↓	↓	↓	↓	↓
211F	Reserved					
Winding 3 neutral instantaneous overcurrent 1						
2120	Winding 3 neutral instantaneous overcurrent 1 function	---	---	---	F30	0 = Disabled
2121	Winding 3 neutral instantaneous overcurrent 1 target	---	---	---	F46	1 = Latched
2122	Winding 3 neutral instantaneous overcurrent 1 pickup	0.05 to 20.00	0.01	× CT	F3	1000=10.00×CT
2123	Winding 3 neutral instantaneous overcurrent 1 delay	0 to 60000	1	ms	F1	0 ms
2124	Winding 3 neutral instantaneous overcurrent 1 block	---	---	---	F87	0 = Disabled
2125	Winding 3 neutral instantaneous overcurrent 1 relays	1 to 8	---	---	F153	None
2126	Reserved					
↓	↓	↓	↓	↓	↓	↓
212F	Reserved					
Winding 1 neutral instantaneous overcurrent 2						
2130	Winding 1 neutral instantaneous overcurrent 2 function	---	---	---	F30	0 = Disabled
2131	Winding 1 neutral instantaneous overcurrent 2 target	---	---	---	F46	1 = Latched
2132	Winding 1 neutral instantaneous overcurrent 2 pickup	0.05 to 20.00	0.01	× CT	F3	1000=10.00×CT
2133	Winding 1 neutral instantaneous overcurrent 2 delay	0 to 60000	1	ms	F1	0 ms
2134	Winding 1 neutral instantaneous overcurrent 2 block	---	---	---	F87	0 = Disabled
2135	Winding 1 neutral instantaneous overcurrent 2 relays	1 to 8	---	---	F153	None
2136	Reserved					
↓	↓	↓	↓	↓	↓	↓
213F	Reserved					

Table 2–4: 745 memory map (Sheet 45 of 56)

Addr	Description	Range	Step	Units	Format	Default
Winding 2 neutral instantaneous overcurrent 2						
2140	Winding 2 neutral instantaneous overcurrent 2 function	---	---	---	F30	0 = Disabled
2141	Winding 2 neutral instantaneous overcurrent 2 target	---	---	---	F46	1 = Latched
2142	Winding 2 neutral instantaneous overcurrent 2 pickup	0.05 to 20.00	0.01	× CT	F3	1000=10.00×CT
2143	Winding 2 neutral instantaneous overcurrent 2 delay	0 to 60000	1	ms	F1	0 ms
2144	Winding 2 neutral instantaneous overcurrent 2 block	---	---	---	F87	0 = Disabled
2145	Winding 2 neutral instantaneous overcurrent 2 relays	1 to 8	---	---	F153	None
2146	Reserved					
↓	↓	↓	↓	↓	↓	↓
214F	Reserved					
Winding 3 neutral instantaneous overcurrent 2						
2150	Winding 3 neutral instantaneous overcurrent 2 function	---	---	---	F30	0 = Disabled
2151	Winding 3 neutral instantaneous overcurrent 2 target	---	---	---	F46	1 = Latched
2152	Winding 3 neutral instantaneous overcurrent 2 pickup	0.05 to 20.00	0.01	× CT	F3	1000=10.00×CT
2153	Winding 3 neutral instantaneous overcurrent 2 delay	0 to 60000	1	ms	F1	0 ms
2154	Winding 3 neutral instantaneous overcurrent 2 block	---	---	---	F87	0 = Disabled
2155	Winding 3 neutral instantaneous overcurrent 2 relays	1 to 8	---	---	F153	None
2156	Reserved					
↓	↓	↓	↓	↓	↓	↓
215F	Reserved					
Winding 1 ground time overcurrent						
2160	Winding 1 ground time overcurrent function	---	---	---	F30	1 = Enabled
2161	Winding 1 ground time overcurrent target	---	---	---	F46	1 = Latched
2162	Winding 1 ground time overcurrent pickup	0.05 to 20.00	0.01	× CT	F3	85 = 0.85 × CT
2163	Winding 1 ground time overcurrent shape	---	---	---	F36	0 = Ext Inverse
2164	Winding 1 ground time overcurrent multiplier	0.00 to 100.00	0.01	---	F3	100 = 1.00
2165	Winding 1 ground time overcurrent reset	---	---	---	F68	1 = Linear
2166	Winding 1 ground time overcurrent block	---	---	---	F87	0 = Disabled
2167	Winding 1 ground time overcurrent relays	1 to 8	---	---	F153	None
2168	Reserved					
↓	↓	↓	↓	↓	↓	↓
216F	Reserved					
Winding 2 ground time overcurrent						
2170	Winding 2 ground time overcurrent function	---	---	---	F30	0 = Disabled
2171	Winding 2 ground time overcurrent target	---	---	---	F46	1 = Latched
2172	Winding 2 ground time overcurrent pickup	0.05 to 20.00	0.01	× CT	F3	85 = 0.85 × CT
2173	Winding 2 ground time overcurrent shape	---	---	---	F36	0 = Ext Inverse
2174	Winding 2 ground time overcurrent multiplier	0.00 to 100.00	0.01	---	F3	100 = 1.00
2175	Winding 2 ground time overcurrent reset	---	---	---	F68	1 = Linear
2176	Winding 2 ground time overcurrent block	---	---	---	F87	0 = Disabled
2177	Winding 2 ground time overcurrent relays	1 to 8	---	---	F153	None
2178	Reserved					
↓	↓	↓	↓	↓	↓	↓
217F	Reserved					
Winding 3 ground time overcurrent						
2180	Winding 3 ground time overcurrent function	---	---	---	F30	0 = Disabled
2181	Winding 3 ground time overcurrent target	---	---	---	F46	1 = Latched

Table 2–4: 745 memory map (Sheet 46 of 56)

Addr	Description	Range	Step	Units	Format	Default
2182	Winding 3 ground time overcurrent pickup	0.05 to 20.00	0.01	x CT	F3	85 = 0.85 x CT
2183	Winding 3 ground time overcurrent shape	---	---	---	F36	0 = Ext Inverse
2184	Winding 3 ground time overcurrent multiplier	0.00 to 100.00	0.01	---	F3	100 = 1.00
2185	Winding 3 ground time overcurrent reset	---	---	---	F68	1 = Linear
2186	Winding 3 ground time overcurrent block	---	---	---	F87	0 = Disabled
2187	Winding 3 ground time overcurrent relays	1 to 8	---	---	F153	None
2188	Reserved					
↓	↓	↓	↓	↓	↓	↓
218F	Reserved					
Winding 1 ground instantaneous overcurrent 1						
2190	Winding 1 ground instantaneous overcurrent 1 function	---	---	---	F30	0 = Disabled
2191	Winding 1 ground instantaneous overcurrent 1 target	---	---	---	F46	1 = Latched
2192	Winding 1 ground instantaneous overcurrent 1 pickup	0.05 to 20.00	0.01	x CT	F3	1000=10.00xCT
2193	Winding 1 ground instantaneous overcurrent 1 delay	0 to 60000	1	ms	F1	0 ms
2194	Winding 1 ground instantaneous overcurrent 1 block	---	---	---	F87	0 = Disabled
2195	Winding 1 ground instantaneous overcurrent 1 relays	1 to 8	---	---	F153	None
2196	Reserved					
↓	↓	↓	↓	↓	↓	↓
219F	Reserved					
Winding 2 ground instantaneous overcurrent 1						
21A0	Winding 2 ground instantaneous overcurrent 1 function	---	---	---	F30	0 = Disabled
21A1	Winding 2 ground instantaneous overcurrent 1 target	---	---	---	F46	1 = Latched
21A2	Winding 2 ground instantaneous overcurrent 1 pickup	0.05 to 20.00	0.01	x CT	F3	1000=10.00xCT
21A3	Winding 2 ground instantaneous overcurrent 1 delay	0 to 60000	1	ms	F1	0 ms
21A4	Winding 2 ground instantaneous overcurrent 1 block	---	---	---	F87	0 = Disabled
21A5	Winding 2 ground instantaneous overcurrent 1 relays	1 to 8	---	---	F153	None
21A6	Reserved					
↓	↓	↓	↓	↓	↓	↓
21AF	Reserved					
Winding 3 ground instantaneous overcurrent 1						
21B0	Winding 3 ground instantaneous overcurrent 1 function	---	---	---	F30	0 = Disabled
21B1	Winding 3 ground instantaneous overcurrent 1 target	---	---	---	F46	1 = Latched
21B2	Winding 3 ground instantaneous overcurrent 1 pickup	0.05 to 20.00	0.01	x CT	F3	1000=10.00xCT
21B3	Winding 3 ground instantaneous overcurrent 1 delay	0 to 60000	1	ms	F1	0 ms
21B4	Winding 3 ground instantaneous overcurrent 1 block	---	---	---	F87	0 = Disabled
21B5	Winding 3 ground instantaneous overcurrent 1 relays	1 to 8	---	---	F153	None
21B6	Reserved					
↓	↓	↓	↓	↓	↓	↓
21BF	Reserved					
Winding 1 ground instantaneous overcurrent 2						
21C0	Winding 1 ground instantaneous overcurrent 2 function	---	---	---	F30	0 = Disabled
21C1	Winding 1 ground instantaneous overcurrent 2 target	---	---	---	F46	1 = Latched
21C2	Winding 1 ground instantaneous overcurrent 2 pickup	0.05 to 20.00	0.01	x CT	F3	1000=10.00xCT
21C3	Winding 1 ground instantaneous overcurrent 2 delay	0 to 60000	1	ms	F1	0 ms
21C4	Winding 1 ground instantaneous overcurrent 2 block	---	---	---	F87	0 = Disabled
21C5	Winding 1 ground instantaneous overcurrent 2 relays	1 to 8	---	---	F153	None
21C6	Reserved					

Table 2–4: 745 memory map (Sheet 47 of 56)

Addr	Description	Range	Step	Units	Format	Default
↓	↓	↓	↓	↓	↓	↓
21CF	Reserved					
Winding 2 ground instantaneous overcurrent 2						
21D0	Winding 2 ground instantaneous overcurrent 2 function	---	---	---	F30	0 = Disabled
21D1	Winding 2 ground instantaneous overcurrent 2 target	---	---	---	F46	1 = Latched
21D2	Winding 2 ground instantaneous overcurrent 2 pickup	0.05 to 20.00	0.01	× CT	F3	1000=10.00xCT
21D3	Winding 2 ground instantaneous overcurrent 2 delay	0 to 60000	1	ms	F1	0 ms
21D4	Winding 2 ground instantaneous overcurrent 2 block	---	---	---	F87	0 = Disabled
21D5	Winding 2 ground instantaneous overcurrent 2 relays	1 to 8	---	---	F153	None
21D6	Reserved					
↓	↓	↓	↓	↓	↓	↓
21DF	Reserved					
Winding 3 ground instantaneous overcurrent 2						
21E0	Winding 3 ground instantaneous overcurrent 2 function	---	---	---	F30	0 = Disabled
21E1	Winding 3 ground instantaneous overcurrent 2 target	---	---	---	F46	1 = Latched
21E2	Winding 3 ground instantaneous overcurrent 2 pickup	0.05 to 20.00	0.01	× CT	F3	1000=10.00xCT
21E3	Winding 3 ground instantaneous overcurrent 2 delay	0 to 60000	1	ms	F1	0 ms
21E4	Winding 3 ground instantaneous overcurrent 2 block	---	---	---	F87	0 = Disabled
21E5	Winding 3 ground instantaneous overcurrent 2 relays	1 to 8	---	---	F153	None
21E6	Reserved					
↓	↓	↓	↓	↓	↓	↓
21EF	Reserved					
Winding 1 restricted ground fault						
21F0	Winding 1 restricted ground fault function	---	---	---	F30	0 = Disabled
21F1	Winding 1 restricted ground fault target	---	---	---	F46	1 = Latched
21F2	Winding 1 restricted ground fault pickup	0.02 to 20.00	0.01	× CT	F3	8 = 0.08 × CT
21F3	Winding 1 restricted ground fault slope	0 to 100	1	%	F1	10%
21F4	Winding 1 restricted ground fault delay	0.00 to 600.00	0.01	s	F3	10 = 0.10 s
21F5	Winding 1 restricted ground fault block	---	---	---	F87	0 = Disabled
21F6	Winding 1 restricted ground fault relays	1 to 8	---	---	F153	None
21F7	Reserved					
↓	↓	↓	↓	↓	↓	↓
21FF	Reserved					
Winding 2 restricted ground fault						
2200	Winding 2 restricted ground fault function	---	---	---	F30	0 = Disabled
2201	Winding 2 restricted ground fault target	---	---	---	F46	1 = Latched
2202	Winding 2 restricted ground fault pickup	0.02 to 20.00	0.01	× CT	F3	8 = 0.08 × CT
2203	Winding 2 restricted ground fault slope	0 to 100	1	%	F1	10%
2204	Winding 2 restricted ground fault delay	0.00 to 600.00	0.01	s	F3	10 = 0.10 s
2205	Winding 2 restricted ground fault block	---	---	---	F87	0 = Disabled
2206	Winding 2 restricted ground fault relays	1 to 8	---	---	F153	None
2207	Reserved					
↓	↓	↓	↓	↓	↓	↓
220F	Reserved					
Winding 3 restricted ground fault						
2210	Winding 3 restricted ground fault function	---	---	---	F30	0 = Disabled
2211	Winding 3 restricted ground fault target	---	---	---	F46	1 = Latched

Table 2–4: 745 memory map (Sheet 48 of 56)

Addr	Description	Range	Step	Units	Format	Default
2212	Winding 3 restricted ground fault pickup	0.02 to 20.00	0.01	× CT	F3	8 = 0.08 × CT
2213	Winding 3 restricted ground fault slope	0 to 100	1	%	F1	10%
2214	Winding 3 restricted ground fault delay	0.00 to 600.00	0.01	s	F3	10 = 0.10 s
2215	Winding 3 restricted ground fault block	---	---	---	F87	0 = Disabled
2216	Winding 3 restricted ground fault relays	1 to 8	---	---	F153	None
2217	Reserved					
↓	↓	↓	↓	↓	↓	↓
224F	Reserved					
Winding 1 negative-sequence time overcurrent						
2250	Winding 1 negative-sequence time overcurrent function	---	---	---	F30	0 = Disabled
2251	Winding 1 negative-sequence time overcurrent target	---	---	---	F46	1 = Latched
2252	Winding 1 negative-sequence time overcurrent pickup	0.05 to 20.00	0.01	× CT	F3	25 = 0.25 × CT
2253	Winding 1 negative-sequence time overcurrent shape	---	---	---	F36	0 = Ext Inverse
2254	Winding 1 negative-sequence time overcurrent multiplier	0.00 to 100.00	0.01	---	F3	100 = 1.00
2255	Winding 1 negative-sequence time overcurrent reset	---	---	---	F68	1 = Linear
2256	Winding 1 negative-sequence time overcurrent block	---	---	---	F87	0 = Disabled
2257	Winding 1 negative-sequence time overcurrent relays	1 to 8	---	---	F153	None
2258	Reserved					
↓	↓	↓	↓	↓	↓	↓
225F	Reserved					
Winding 2 negative-sequence time overcurrent						
2260	Winding 2 negative-sequence time overcurrent function	---	---	---	F30	0 = Disabled
2261	Winding 2 negative-sequence time overcurrent target	---	---	---	F46	1 = Latched
2262	Winding 2 negative-sequence time overcurrent pickup	0.05 to 20.00	0.01	× CT	F3	25 = 0.25 × CT
2263	Winding 2 negative-sequence time overcurrent shape	---	---	---	F36	0 = Ext Inverse
2264	Winding 2 negative-sequence time overcurrent multiplier	0.00 to 100.00	0.01	---	F3	100 = 1.00
2265	Winding 2 negative-sequence time overcurrent reset	---	---	---	F68	1 = Linear
2266	Winding 2 negative-sequence time overcurrent block	---	---	---	F87	0 = Disabled
2267	Winding 2 negative-sequence time overcurrent relays	1 to 8	---	---	F153	None
2268	Reserved					
↓	↓	↓	↓	↓	↓	↓
226F	Reserved					
Winding 3 negative-sequence time overcurrent						
2270	Winding 3 negative-sequence time overcurrent function	---	---	---	F30	0 = Disabled
2271	Winding 3 negative-sequence time overcurrent target	---	---	---	F46	1 = Latched
2272	Winding 3 negative-sequence time overcurrent pickup	0.05 to 20.00	0.01	× CT	F3	25 = 0.25 × CT
2273	Winding 3 negative-sequence time overcurrent shape	---	---	---	F36	0 = Ext Inverse
2274	Winding 3 negative-sequence time overcurrent multiplier	0.00 to 100.00	0.01	---	F3	100 = 1.00
2275	Winding 3 negative-sequence time overcurrent reset	---	---	---	F68	1 = Linear
2276	Winding 3 negative-sequence time overcurrent block	---	---	---	F87	0 = Disabled
2277	Winding 3 negative-sequence time overcurrent relays	1 to 8	---	---	F153	None
2278	Reserved					
↓	↓	↓	↓	↓	↓	↓
227F	Reserved					
Winding 1 negative-sequence instantaneous overcurrent						
2280	Winding 1 negative-sequence inst. overcurrent function	---	---	---	F30	0 = Disabled
2281	Winding 1 negative-sequence inst. overcurrent target	---	---	---	F46	1 = Latched

Table 2–4: 745 memory map (Sheet 49 of 56)

Addr	Description	Range	Step	Units	Format	Default
2282	Winding 1 negative-sequence inst. overcurrent pickup	0.05 to 20.00	0.01	× CT	F3	1000=10.00xCT
2283	Winding 1 negative-sequence inst. overcurrent delay	0 to 60000	1	ms	F1	0 ms
2284	Winding 1 negative-sequence inst. overcurrent block	---	---	---	F87	0 = Disabled
2285	Winding 1 negative-sequence inst. overcurrent relays	1 to 8	---	---	F153	None
2286	Reserved					
↓	↓	↓	↓	↓	↓	↓
228F	Reserved					
Winding 2 negative-sequence instantaneous overcurrent						
2290	Winding 2 negative-sequence inst. overcurrent function	---	---	---	F30	0 = Disabled
2291	Winding 2 negative-sequence inst. overcurrent target	---	---	---	F46	1 = Latched
2292	Winding 2 negative-sequence inst. overcurrent pickup	0.05 to 20.00	0.01	× CT	F3	1000=10.00xCT
2293	Winding 2 negative-sequence inst. overcurrent delay	0 to 60000	1	ms	F1	0 ms
2294	Winding 2 negative-sequence inst. overcurrent block	---	---	---	F87	0 = Disabled
2295	Winding 2 negative-sequence inst. overcurrent relays	1 to 8	---	---	F153	None
2296	Reserved					
↓	↓	↓	↓	↓	↓	↓
229F	Reserved					
Winding 3 negative-sequence instantaneous overcurrent						
22A0	Winding 3 negative-sequence inst. overcurrent function	---	---	---	F30	0 = Disabled
22A1	Winding 3 negative-sequence inst. overcurrent target	---	---	---	F46	1 = Latched
22A2	Winding 3 negative-sequence inst. overcurrent pickup	0.05 to 20.00	0.01	× CT	F3	1000=10.00xCT
22A3	Winding 3 negative-sequence inst. overcurrent delay	0 to 60000	1	ms	F1	0 ms
22A4	Winding 3 negative-sequence inst. overcurrent block	---	---	---	F87	0 = Disabled
22A5	Winding 3 negative-sequence inst. overcurrent relays	1 to 8	---	---	F153	None
22A6	Reserved					
↓	↓	↓	↓	↓	↓	↓
22AF	Reserved					
Underfrequency 1						
22B0	Underfrequency 1 function	---	---	---	F30	0 = Disabled
22B1	Underfrequency 1 target	---	---	---	F46	0 = Self-reset
22B2	Underfrequency 1 minimum operating current	0.05 to 1.00	0.01	× CT	F3	20 = 0.20 × CT
22B3	Underfrequency 1 pickup	45.00 to 59.99	0.01	Hz	F3	5900 = 59.0 Hz
22B4	Underfrequency 1 delay	0.00 to 600.00	0.01	s	F3	100 = 1.00 s
22B5	Underfrequency 1 block	---	---	---	F87	0 = Disabled
22B6	Underfrequency 1 current sensing	---	---	---	F30	1 = Enabled
22B7	Underfrequency 1 minimum operating voltage	0.10 to 0.99	0.01	× VT	F3	50 = 0.50 × VT
22B8	Underfrequency 1 relays	1 to 8	---	---	F153	None
22B9	Reserved					
↓	↓	↓	↓	↓	↓	↓
22BF	Reserved					
Underfrequency 2						
22C0	Underfrequency 2 function	---	---	---	F30	0 = Disabled
22C1	Underfrequency 2 target	---	---	---	F46	1 = Latched
22C2	Underfrequency 2 minimum operating current	0.05 to 1.00	0.01	× CT	F3	20 = 0.20 × CT
22C3	Underfrequency 2 pickup	45.00 to 59.99	0.01	Hz	F3	5880 = 58.8 Hz
22C4	Underfrequency 2 delay	0.00 to 600.00	0.01	s	F3	10 = 0.10 s
22C5	Underfrequency 2 block	---	---	---	F87	0 = Disabled

Table 2–4: 745 memory map (Sheet 50 of 56)

Addr	Description	Range	Step	Units	Format	Default
22C6	Underfrequency 2 current sensing	---	---	---	F30	1 = Enabled
22C7	Underfrequency 2 minimum operating voltage	0.01 to 0.99	0.01	× VT	F3	50 = 0.50 × VT
22C8	Underfrequency 2 relays	1 to 8	---	---	F153	None
22C9	Reserved					
↓	↓	↓	↓	↓	↓	↓
22CF	Reserved					
Frequency decay						
22D0	Frequency decay function	---	---	---	F30	0 = Disabled
22D1	Frequency decay target	---	---	---	F46	1 = Latched
22D2	Frequency decay minimum operating current	0.05 to 1.00	0.01	× CT	F3	20 = 0.20 × CT
22D3	Frequency decay threshold	45.00 to 59.99	0.01	Hz	F3	5950 = 59.5 Hz
22D4	Frequency decay rate 1	0.1 to 5.0	0.1	Hz/s	F2	4 = 0.4 Hz/s
22D5	Frequency decay rate 2	0.1 to 5.0	0.1	Hz/s	F2	10 = 1.0 Hz/s
22D6	Frequency decay rate 3	0.1 to 5.0	0.1	Hz/s	F2	20 = 2.0 Hz/s
22D7	Frequency decay rate 4	0.1 to 5.0	0.1	Hz/s	F2	40 = 4.0 Hz/s
22D8	Frequency decay block	---	---	---	F87	0 = Disabled
22D9	Frequency decay current sensing	---	---	---	F30	1 = Enabled
22DA	Frequency decay minimum operating voltage	0.10 to 0.99	0.01	× VT	F3	50 = 0.50 × VT
22DB	Frequency decay delay	0.00 to 600.00	0.01	s	F3	0 = 0.00 s
22DC	Frequency decay relays	1 to 8	---	---	F153	None
22DD	Reserved					
22DE	Reserved					
22DF	Reserved					
Overfrequency						
22E0	Overfrequency function	---	---	---	F30	0 = Disabled
22E1	Overfrequency target	---	---	---	F46	1 = Latched
22E2	Overfrequency minimum operating current	0.05 to 1.00	0.01	× CT	F3	20 = 0.20 × CT
22E3	Overfrequency pickup	50.01 to 65.00	0.01	Hz	F3	6050 = 60.5 Hz
22E4	Overfrequency delay	0.00 to 600.00	0.01	s	F3	500 = 5.00 s
22E5	Overfrequency block	---	---	---	F87	0 = Disabled
22E6	Overfrequency current sensing	---	---	---	F30	1 = Enabled
22E7	Overfrequency minimum operating voltage	0.10 to 0.99	0.01	× VT	F3	50 = 0.50 × VT
22E8	Overfrequency relays	1 to 8	---	---	F153	None
22E9	Reserved					
↓	↓	↓	↓	↓	↓	↓
22EF	Reserved					
Fifth harmonic level						
22F0	5th harmonic level function	---	---	---	F30	0 = Disabled
22F1	5th harmonic level target	---	---	---	F46	0 = Self-reset
22F2	5th harmonic level minimum operating current	0.03 to 1.00	0.01	× CT	F3	10 = 0.10 × CT
22F3	5th harmonic level pickup	0.1 to 99.9	0.1	% fo	F1	100 = 10.0% fo
22F4	5th harmonic level delay	0 to 60000	1	s	F1	10 s
22F5	5th harmonic level block	---	---	---	F87	0 = Disabled
22F6	5th harmonic level relays	1 to 8	---	---	F153	None
22F7	Reserved					
↓	↓	↓	↓	↓	↓	↓
22FF	Reserved					

Table 2–4: 745 memory map (Sheet 51 of 56)

Addr	Description	Range	Step	Units	Format	Default
Volts per hertz 1						
2300	Volts-per-hertz 1 function	---	---	---	F30	0 = Disabled
2301	Volts-per-hertz 1 target	---	---	---	F46	0 = Self-reset
2302	Volts-per-hertz 1 minimum operating voltage	0.10 to 0.99	0.01	× VT	F3	10 = 0.10 × VT
2303	Volts-per-hertz 1 pickup	1.00 to 4.00	0.01	V/Hz	F3	236 = 2.36 V/Hz
2304	Volts-per-hertz 1 shape	---	---	---	F86	0 = Def. Time
2305	Volts-per-hertz 1 delay	0.00 to 600.00	0.01	s	F3	200 = 2.00 s
2306	Volts-per-hertz 1 reset	0.0 to 6000.0	0.1	s	F2	0.0 s
2307	Volts-per-hertz 1 block	---	---	---	F87	0 = Disabled
2308	Volts-per-hertz 1 relays	1 to 8	---	---	F153	None
2309	Reserved					
↓	↓	↓	↓	↓	↓	↓
230F	Reserved					
Volts per hertz 2						
2310	Volts-per-hertz 2 function	---	---	---	F30	0 = Disabled
2311	Volts-per-hertz 2 target	---	---	---	F46	1 = Latched
2312	Volts-per-hertz 2 minimum operating voltage	0.10 to 0.99	0.01	× VT	F3	10 = 0.10 × VT
2313	Volts-per-hertz 2 pickup	1.00 to 4.00	0.01	V/Hz	F3	214 = 2.14 V/Hz
2314	Volts-per-hertz 2 shape	---	---	---	F86	0 = Def. Time
2315	Volts-per-hertz 2 delay	0.00 to 600.00	0.01	s	F3	4500 = 45.00 s
2316	Volts-per-hertz 2 reset	0.0 to 6000.0	0.1	s	F2	0.0 s
2317	Volts-per-hertz 2 block	---	---	---	F87	0 = Disabled
2318	Volts-per-hertz 2 relays	1 to 8	---	---	F153	None
2319	Reserved					
↓	↓	↓	↓	↓	↓	↓
231F	Reserved					
Winding 1 THD level						
2320	Winding 1 THD level function	---	---	---	F30	0 = Disabled
2321	Winding 1 THD level target	---	---	---	F46	0 = Self-reset
2322	Winding 1 THD level minimum operating current	0.03 to 1.00	0.01	× CT	F3	10 = 0.10 × CT
2323	Winding 1 THD level pickup	0.1 to 50.0	0.1	% fo	F2	500 = 50.0%
2324	Winding 1 THD level delay	0 to 60000	1	s	F1	10 s
2325	Winding 1 THD level block	---	---	---	F87	0 = Disabled
2326	Winding 1 THD level relays	1 to 8	---	---	F153	None
2327	Reserved					
↓	↓	↓	↓	↓	↓	↓
232F	Reserved					
Winding 2 THD level						
2330	Winding 2 THD level function	---	---	---	F30	0 = Disabled
2331	Winding 2 THD level target	---	---	---	F46	0 = Self-reset
2332	Winding 1 THD level minimum operating current	0.03 to 1.00	0.01	× CT	F3	10 = 0.10 × CT
2333	Winding 2 THD level pickup	0.1 to 50.0	0.1	% fo	F2	500 = 50.0%
2334	Winding 2 THD level delay	0 to 60000	1	s	F1	10 s
2335	Winding 2 THD level block	---	---	---	F87	0 = Disabled
2336	Winding 2 THD level relays	1 to 8	---	---	F153	None
2337	Reserved					
↓	↓	↓	↓	↓	↓	↓

Table 2–4: 745 memory map (Sheet 52 of 56)

Addr	Description	Range	Step	Units	Format	Default
233F	Reserved					
Winding 3 THD level						
2340	Winding 3 THD level function	---	---	---	F30	0 = Disabled
2341	Winding 3 THD level target	---	---	---	F46	0 = Self-reset
2342	Winding 3 THD level minimum operating current	0.03 to 1.00	0.01	× CT	F3	10 = 0.10 × CT
2343	Winding 3 THD level pickup	0.1 to 50.0	0.1	% *f*o	F2	500 = 50.0%
2344	Winding 3 THD level delay	0 to 60000	1	s	F1	10 s
2345	Winding 3 THD level block	---	---	---	F87	0 = Disabled
2346	Winding 3 THD level relays	1 to 8	---	---	F153	None
2347	Reserved					
↓	↓	↓	↓	↓	↓	↓
234F	Reserved					
Winding 1 harmonic derating						
2350	Winding 1 harmonic derating function	---	---	---	F30	0 = Disabled
2351	Winding 1 harmonic derating target	---	---	---	F46	0 = Self-reset
2352	Winding 1 harmonic derating minimum operating current	0.03 to 1.00	0.01	× CT	F3	10 = 0.10 × CT
2353	Winding 1 harmonic derating pickup	0.01 to 0.98	0.01	---	F3	90 = 0.90
2354	Winding 1 harmonic derating delay	0 to 60000	1	s	F1	10 s
2355	Winding 1 harmonic derating block	---	---	---	F87	0 = Disabled
2356	Winding 1 harmonic derating relays	1 to 8	---	---	F153	None
2357	Reserved					
↓	↓	↓	↓	↓	↓	↓
235F	Reserved					
Winding 2 harmonic derating						
2360	Winding 2 harmonic derating function	---	---	---	F30	0 = Disabled
2361	Winding 2 harmonic derating target	---	---	---	F46	0 = Self-reset
2362	Winding 2 harmonic derating minimum operating current	0.03 to 1.00	0.01	× CT	F3	10 = 0.10 × CT
2363	Winding 2 harmonic derating pickup	0.01 to 0.98	0.01	---	F3	90 = 0.90
2364	Winding 2 harmonic derating delay	0 to 60000	1	s	F1	10 s
2365	Winding 2 harmonic derating block	---	---	---	F87	0 = Disabled
2366	Winding 2 harmonic derating relays	1 to 8	---	---	F153	None
2367	Reserved					
↓	↓	↓	↓	↓	↓	↓
236F	Reserved					
Winding 3 harmonic derating						
2370	Winding 3 harmonic derating function	---	---	---	F30	0 = Disabled
2371	Winding 3 harmonic derating target	---	---	---	F46	0 = Self-reset
2372	Winding 3 harmonic derating minimum operating current	0.03 to 1.00	0.01	× CT	F3	10 = 0.10 × CT
2373	Winding 3 harmonic derating pickup	0.01 to 0.98	0.01	---	F3	90 = 0.90
2374	Winding 3 harmonic derating delay	0 to 60000	1	s	F1	10 s
2375	Winding 3 harmonic derating block	---	---	---	F87	0 = Disabled
2376	Winding 3 harmonic derating relays	1 to 8	---	---	F153	None
2377	Reserved					
↓	↓	↓	↓	↓	↓	↓
237F	Reserved					

Table 2–4: 745 memory map (Sheet 53 of 56)

Addr	Description	Range	Step	Units	Format	Default
Hottest- spot limit						
2380	Hottest-spot limit function	---	---	---	F30	0 = Disabled
2381	Hottest-spot limit target	---	---	---	F46	0 = Self-reset
2382	Hottest-spot limit pickup	50 to 300	1	° C	F1	150° C
2383	Hottest-spot limit delay	0 to 60000	1	min	F1	10 min
2384	Hottest-spot limit block	---	---	---	F87	0 = Disabled
2385	Hottest-spot limit relays	1 to 8	---	---	F153	None
2386	Reserved					
↓	↓	↓	↓	↓	↓	↓
238F	Reserved					
Loss-of-life limit						
2390	Loss-of-life limit function	---	---	---	F30	0 = Disabled
2391	Loss-of-life limit target	---	---	---	F46	0 = Self-reset
2392	Loss-of-life limit pickup	0 to 20000	1	hrs x 10	F1	160000 hrs.
2393	Loss-of-life limit block	---	---	---	F87	0 = Disabled
2394	Loss-of-life limit relays	1 to 8	---	---	F153	None
2395	Reserved					
↓	↓	↓	↓	↓	↓	↓
239F	Reserved					
Analog input level 1						
23A0	Analog input level 1 function	---	---	---	F30	0 = Disabled
23A1	Analog input level 1 target	---	---	---	F46	0 = Self-reset
23A2	Analog input level 1 pickup	1 to 65000	1	<Units>	F1	10 <Units>
23A3	Analog input level 1 delay	0 to 60000	1	s	F1	50 s
23A4	Analog input level 1 block	---	---	---	F87	0 = Disabled
23A5	Analog input level 1 relays	1 to 8	---	---	F153	None
23A6	Reserved					
↓	↓	↓	↓	↓	↓	↓
23AF	Reserved					
Analog input level 2						
23B0	Analog input level 2 function	---	---	---	F30	0 = Disabled
23B1	Analog input level 2 target	---	---	---	F46	0 = Self-reset
23B2	Analog input level 2 pickup	1 to 65000	1	<Units>	F1	100 <Units>
23B3	Analog input level 2 delay	0 to 60000	1	s	F1	100 s
23B4	Analog input level 2 block	---	---	---	F87	0 = Disabled
23B5	Analog input level 2 relays	1 to 8	---	---	F153	None
23B6	Reserved					
↓	↓	↓	↓	↓	↓	↓
23BF	Reserved					
Winding 1 current demand						
23C0	Winding 1 current demand function	---	---	---	F30	0 = Disabled
23C1	Winding 1 current demand target	---	---	---	F46	0 = Self-reset
23C2	Winding 1 current demand pickup	---	---	A	F78	100 A
23C3	Winding 1 current demand block	---	---	---	F87	0 = Disabled
23C4	Winding 1 current demand relays	1 to 8	---	---	F153	None
23C5	Reserved					
↓	↓	↓	↓	↓	↓	↓

Table 2–4: 745 memory map (Sheet 54 of 56)

Addr	Description	Range	Step	Units	Format	Default
23CF	Reserved					
Winding 2 current demand						
23D0	Winding 2 current demand function	---	---	---	F30	0 = Disabled
23D1	Winding 2 current demand target	---	---	---	F46	0 = Self-reset
23D2	Winding 2 current demand pickup	---	---	A	F79	400 A
23D3	Winding 2 current demand block	---	---	---	F87	0 = Disabled
23D4	Winding 2 current demand relays	1 to 8	---	---	F153	None
23D5	Reserved					
↓	↓	↓	↓	↓	↓	↓
23DF	Reserved					
Winding 3 current demand						
23E0	Winding 3 current demand function	---	---	---	F30	0 = Disabled
23E1	Winding 3 current demand target	---	---	---	F46	0 = Self-reset
23E2	Winding 3 current demand pickup	---	---	A	F80	400 A
23E3	Winding 3 current demand block	---	---	---	F87	0 = Disabled
23E4	Winding 3 current demand relays	1 to 8	---	---	F153	None
23E5	Reserved					
↓	↓	↓	↓	↓	↓	↓
23EF	Reserved					
Transformer overload						
23F0	Transformer overload function	---	---	---	F30	0 = Disabled
23F1	Transformer overload target	---	---	---	F46	0 = Self-reset
23F2	Transformer overload pickup	50 to 300	1	% rated	F1	208% rated
23F3	Transformer overload delay	0 to 60000	1	s	F1	10 s
23F4	Transformer overload block	---	---	---	F87	0 = Disabled
23F5	Transformer overtemperature alarm signal	---	---	---	F88	0 = Disabled
23F6	Transformer overload relays	1 to 8	---	---	F153	None
23F7	Reserved					
↓	↓	↓	↓	↓	↓	↓
23FF	Reserved					
Aging factor limit						
2400	Aging factor limit function	---	---	---	F30	0 = Disabled
2401	Aging factor limit target	---	---	---	F46	0 = Self-reset
2402	Aging factor limit pickup	1.1 to 10.0	0.1	--	F2	20 = 2.0
2403	Aging factor limit delay	0 to 60000	1	minutes	F1	10 minutes
2404	Aging factor limit block	---	---	---	F87	0 = Disabled
2405	Aging factor limit relays	1 to 8	---	---	F153	None
2406	Reserved					
↓	↓	↓	↓	↓	↓	↓
240F	Reserved					
Tap changer failure						
2410	Tap changer failure function	---	---	---	F30	0 = Disabled
2411	Tap changer failure target	---	---	---	F46	0 = Self-reset
2412	Tap changer failure delay	0 to 600.00	0.01	s	F3	500 = 5.00 s
2413	Tap changer failure block	---	---	---	F87	0 = Disabled
2414	Tap changer failure relays	1 to 8	---	---	F153	None
2415	Reserved					

Table 2–4: 745 memory map (Sheet 55 of 56)

Addr	Description	Range	Step	Units	Format	Default
↓	↓	↓	↓	↓	↓	↓
3FFF	Reserved					
Trace memory (addresses 4000 to 47FF, read only)						
4000	Trace memory last clear date (2 registers)	---	---	---	F23	---
4002	Trace memory last clear time (2 registers)	---	---	---	F22	---
4004	Total trace triggers since last clear	0 to 65535	1	---	F1	---
4005	Trace buffer selector index (XX) [r/w]	1 to 65535	1	---	F1	---
4006	Trace channel selector index (YY) [r/w]	---	---	---	F65	---
4007	Reserved					
4008	Reserved					
↓	↓	↓	↓	↓	↓	↓
400F	Reserved					
4010	Selected trace buffer trigger date (2 registers)	---	---	---	F23	---
4012	Selected trace buffer trigger time (2 registers)	---	---	---	F22	---
4014	Selected trace buffer trigger cause	---	---	---	F85	---
4015	Selected trace buffer trigger sample index	0 to 1023	1	---	F1	---
4016	Selected trace buffer system frequency	2.00 to 65.00	0.01	Hz	F3	---
4017	Selected trace buffer channel YY sample 0	---	---	---	F70	---
4018	Selected trace buffer channel YY sample 1	---	---	---	F70	---
4018	Selected trace buffer channel YY sample 2	---	---	---	F70	---
↓	↓	↓	↓	↓	↓	↓
4816	Selected trace buffer channel YY sample 2047	---	---	---	F70	---
4817	Reserved					
↓	↓	↓	↓	↓	↓	↓
5FFF	Reserved					
Playback memory (addresses 6000 to 680F, read/write)						
Playback memory samples						
6000	Playback channel selector index (XX)	---	---	---	F69	---
6001	Reserved					
6002	Reserved					
↓	↓	↓	↓	↓	↓	↓
600F	Reserved					
6010	Selected playback channel sample 0	---	---	---	F70	---
6011	Selected playback channel sample 1	---	---	---	F70	---
6012	Selected playback channel sample 2	---	---	---	F70	---
↓	↓	↓	↓	↓	↓	↓
680F	Selected playback channel sample 2047	---	---	---	F70	---
6810	Reserved					
6811	Reserved					
↓	↓	↓	↓	↓	↓	↓
815F	Reserved					
Analog output D/A counts						
8160	Force analog output 1 D/A count	0 to 4095	1	---	F1	0
8161	Force analog output 2 D/A count	0 to 4095	1	---	F1	0
8162	Force analog output 3 D/A count	0 to 4095	1	---	F1	0
8163	Force analog output 4 D/A count	0 to 4095	1	---	F1	0
8164	Force analog output 5 D/A count	0 to 4095	1	---	F1	0

Table 2–4: 745 memory map (Sheet 56 of 56)

Addr	Description	Range	Step	Units	Format	Default
8165	Force analog output 6 D/A count	0 to 4095	1	---	F1	0
8166	Force analog output 7 D/A count	0 to 4095	1	---	F1	0
8167	Reserved					
8168	Reserved					
↓	↓	↓	↓	↓	↓	↓
819F	Reserved					
Calibration sample data						
81A0	Winding 1 phase A current sample	---	---	---	F70	---
81A1	Winding 1 phase B current sample	---	---	---	F70	---
81A2	Winding 1 phase C current sample	---	---	---	F70	---
81A3	Winding 1/2 ground current sample	---	---	---	F70	---
81A4	Winding 2 phase A current sample	---	---	---	F70	---
81A5	Winding 2 phase B current sample	---	---	---	F70	---
81A6	Winding 2 phase C current sample	---	---	---	F70	---
81A7	Winding 2/3 ground current sample	---	---	---	F70	---
81A8	Winding 3 phase A current sample	---	---	---	F70	---
81A9	Winding 3 phase B current sample	---	---	---	F70	---
81AA	Winding 3 phase C current sample	---	---	---	F70	---
81AB	Voltage sample	---	---	---	F70	---
81AC	Reserved					
81AD	Reserved					
81AE	Reserved					
81AF	Reserved					
Calibration ground currents						
81B0	Winding 1/2 ground current RMS magnitude	---	---	A	F81 / F82	---
81B1	Winding 2/3 ground current RMS magnitude	---	---	A	F82 / F83	---
81B2	Reserved					
81B3	Reserved					
↓	↓	↓	↓	↓	↓	↓
81BF	Reserved					

Memory map data formats

F1: Unsigned value (16 bits)
Example: 1234 stored as 1234

F2: Unsigned value, 1 decimal place (16 bits)
Example: 123.4 stored as 1234

F3: Unsigned value, 2 decimal places (16 bits)
Example: 12.34 stored as 1234

F4: Two's-complement signed value (16 bits)
Example: –1234 stored as –1234

F5: Two's-complement signed value, 1 decimal place (16 bits)
Example: –123.4 stored as –1234

F6: Two's-complement signed value, 2 decimal places (16 bits)
Example: –12.34 stored as –1234

F7: Unsigned long value (32 bits)
First block of 16 bits: high-order word of long value
Second block of 16 bits: low-order word of long value
Example: 123456 stored as 123456

F8: Unsigned long value, 1 decimal place (32 bits)
First block of 16 bits: high-order word of long value
Second block of 16 bits: low-order word of long value
Example: 12345.6 stored as 123456

F9: Unsigned long value, 2 decimal places (32 bits)
First block of 16 bits: high-order word of long value
Second block of 16 bits: low-order word of long value
Example: 1234.56 stored as 123456

F10: Two's-complement signed long value (32 bits)
First block of 16 bits: high-order word of long value
Second block of 16 bits: low-order word of long value
Example: –123456 stored as –123456

F11: Two's-complement signed long value, 1 decimal place (32 bits)
First block of 16 bits: high-order word of long value
Second block of 16 bits: low-order word of long value
Example: –12345.6 stored as –123456

F12: Two's-complement signed long value, 2 decimal places (32 bits)
First block of 16 bits: high-order word of long value
Second block of 16 bits: low-order word of long value
Example: –1234.56 stored as –123456

F13: Hardware revision (16-bit enumeration)

Value	Description
1	Hardware revision A
2	Hardware revision B
3	Hardware revision C
4	Hardware revision D
5	Hardware revision E

Value	Description
6	Hardware revision F
7	Hardware revision G
8	Hardware revision H
9	Hardware revision I
10	Hardware revision J

F14: Software revision (16 bits)

First block of four bits (0000 ---- ----- ----): not used

Second block of four bits (---- 0000 ---- ----): major revision number, 0 to 9 in steps of 1

Third block of four bits (---- ---- 0000 ----): minor revision, 0 to 9 in steps of 1

Fourth block of four bits (---- ---- ---- 0000): ultra-minor revision, 0 to 9 in steps of 1

Example: 2.83 stored as 0283 hex (643 decimal)

F15: Installed options (16-bit bitmask)

Bitmask	Description
---- ---- ---- ---0 ---- ---- ---- ---1	Two windings per phase Three windings per phase
---- ---- ---- --0- ---- ---- ---- --1-	Phase current inputs winding 1 rating = 1 A Phase current inputs winding 1 rating = 5 A
---- ---- ---- -0-- ---- ---- ---- -1--	Phase current inputs winding 2 rating = 1 A Phase current inputs winding 2 rating = 5 A
---- ---- ---- 0--- ---- ---- ---- 1---	Phase current inputs winding 3 rating = 1 A Phase current inputs winding 3 rating = 5 A
---- ---- ---0 ---- ---- ---- ---1 ----	Ground current inputs winding 1/2 rating = 1 A Ground current inputs winding 1/2 rating = 5 A
---- ---- --0- ---- ---- ---- --1- ----	Ground current inputs winding 2/3rating = 1 A Ground current inputs winding 2/3 rating = 5 A
---- ---- -0-- ---- ---- ---- -1-- ----	Low control power (0 to 60 V DC) High control power (90 to 300 V DC; 70 to 265 V AC)
---- ---- 0--- ---- ---- ---- 1--- ----	No analog inputs/outputs installed Analog inputs/outputs installed
---- ---0 ---- ---- ---- ---1 ---- ----	No loss-of-life option installed Loss-of-life option installed
---- --0- ---- ---- ---- --1- ---- ----	No restricted ground fault option installed Restricted ground fault option installed
---- -0-- ---- ---- ---- -1-- ---- ----	No Enhanced Display Enhanced Display is installed
---- 0--- ---- ---- ---- 1--- ---- ----	No Ethernet option Ethernet option is installed
---0 ---- ---- ---- ---1 ---- ---- ----	Regular environment option Harsh environment option

F16: Demand interval response (16-bit enumeration)

Value	Demand interval
0	5 minutes
1	10 minutes
2	15 minutes
3	20 minutes
4	30 minutes
5	60 minutes

F17: Communications hardware (16-bit enumeration)

Value	Communications port
0	RS485
1	RS422

F18: Maximum demand phase (16-bit enumeration)

Value	Maximum demand
0	in phase A
1	in phase B
2	in phase C

F19: Command operation code (16-bit enumeration)

Value	Command
0	No operation
1	Remote reset
2	Trigger trace memory
3	Clear maximum demand data

Value	Command
4	Clear event recorder
5	Not used
6	Clear trace memory
7	Clear energy data

F20: Relay status (16-bit bitmask)

Bitmask	Description
---- ---- ---- ---1	Relay in service
---- ---- ---- --1-	One or more self-test errors
---- ---- ---- -1--	Test mode enabled
---- ---- ---- 1---	Differential blocked
---- ---- ---1 ----	Not used
---- ---- --1- ----	Not used
---- ---- -1-- ----	Local mode on
---- ---- 1--- ----	One or more active diagnostic messages

F21: System status (16-bit bitmask)

Bitmask	Description
---- ---- ---- ---1	Transformer de-energized
---- ---- ---- --1-	Transformer overload
---- ---- ---- -1--	Load limit reduced
---- ---- ---- 1---	Not used
---- ---- ---1 ----	Setpoint group 1 active
---- ---- --1- ----	Setpoint group 2 active
---- ---- -1-- ----	Setpoint group 3 active
---- ---- 1--- ----	Setpoint group 4 active

F22: Time (32 bits)

First block of eight bits (0000 0000 ---- ---- ---- ---- ----- ----): hours, 0 to 23 in steps of 1

Second block of eight bits (---- ---- 0000 0000 ---- ---- ---- ----): minutes, 0 to 59 in steps of 1

Third and fourth block of four bits (---- ---- ---- ---- 0000 0000 0000 0000): seconds in format SS.SSSS (0 to 59999 in steps of 1). For example, 2.220 seconds stored as 2220.

Note: if the time has never been set, then all bits will be set to 1.

F23: Date (32 bits)

First block of eight bits (0000 0000 ---- ---- ---- ---- ----- ----): month, 0 to 12 in steps of 1

Second block of eight bits (---- ---- 0000 0000 ---- ---- ---- ----): day, 0 to 31 in steps of 1

Third and fourth block of four bits (---- ---- ---- ---- 0000 0000 0000 0000): year, 1990 to 2089 in steps of 1.

Note: if the date has never been set, then all bits will be set to 1.

F24: Event type and cause (16-bit enumeration)

First block of four bits (0000 ---- ---- ----): type of event, enumerated as follows:

Value	Bit arrangement	Event type
0	0000 ---- ---- ----	None
1	0001 ---- ---- ----	Off
2	0010 ---- ---- ----	On
3	0011 ---- ---- ----	Pickup
4	0100 ---- ---- ----	Operate
5	0101 ---- ---- ----	Dropout
6	0110 ---- ---- ----	Error

Second block of twelve bits (---- 0000 0000 0000): cause of event, enumerated as follows:

Value	Bit arrangement	Cause of event
0	---- 0000 0000 0000	No event
1	---- 0000 0000 0001	Percent differential
2	---- 0000 0000 0010	Instantaneous differential
3	---- 0000 0000 0011	Winding 1 phase time overcurrent
4	---- 0000 0000 0100	Winding 2 phase time overcurrent
5	---- 0000 0000 0101	Winding 3 phase time overcurrent
6	---- 0000 0000 0110	Winding 1 phase instantaneous overcurrent 1
7	---- 0000 0000 0111	Winding 2 phase instantaneous overcurrent 1
8	---- 0000 0000 1000	Winding 3 phase instantaneous overcurrent 1
9	---- 0000 0000 1001	Winding 1 phase instantaneous overcurrent 2
10	---- 0000 0000 1010	Winding 2 phase instantaneous overcurrent 2
11	---- 0000 0000 1011	Winding 3 phase instantaneous overcurrent 2
12	---- 0000 0000 1100	Winding 1 neutral time overcurrent
13	---- 0000 0000 1101	Winding 2 neutral time overcurrent
14	---- 0000 0000 1110	Winding 3 neutral time overcurrent
15	---- 0000 0000 1111	Winding 1 neutral instantaneous overcurrent 1
16	---- 0000 0001 0000	Winding 2 neutral instantaneous overcurrent 1
17	---- 0000 0001 0001	Winding 3 neutral instantaneous overcurrent 1
18	---- 0000 0001 0010	Winding 1 neutral instantaneous overcurrent 2
19	---- 0000 0001 0011	Winding 2 neutral instantaneous overcurrent 2
20	---- 0000 0001 0100	Winding 3 neutral instantaneous overcurrent 2
21	---- 0000 0001 0101	Winding 1 ground time overcurrent
22	---- 0000 0001 0110	Winding 2 ground time overcurrent
23	---- 0000 0001 0111	Winding 3 ground time overcurrent
24	---- 0000 0001 1000	Winding 1 ground instantaneous overcurrent 1
25	---- 0000 0001 1001	Winding 2 ground instantaneous overcurrent 1
26	---- 0000 0001 1010	Winding 3 ground instantaneous overcurrent 1
27	---- 0000 0001 1011	Winding 1 ground instantaneous overcurrent 2
28	---- 0000 0001 1100	Winding 2 ground instantaneous overcurrent 2
29	---- 0000 0001 1101	Winding 3 ground instantaneous overcurrent 2
30	---- 0000 0001 1110	Winding 1 restricted ground fault
31	---- 0000 0001 1111	Winding 2 restricted ground fault
32	---- 0000 0010 0000	Winding 3 restricted ground fault
33	---- 0000 0010 0001	Winding 1 restricted ground trend
34	---- 0000 0010 0010	Winding 2 restricted ground trend

Value	Bit arrangement	Cause of event
35	---- 0000 0010 0011	Winding 3 restricted ground trend
36	---- 0000 0010 0100	Winding 1 negative-sequence time overcurrent
37	---- 0000 0010 0101	Winding 2 negative-sequence time overcurrent
38	---- 0000 0010 0110	Winding 3 negative-sequence time overcurrent
39	---- 0000 0010 0111	Winding 1 negative-sequence instantaneous overcurrent
40	---- 0000 0010 1000	Winding 2 negative-sequence instantaneous overcurrent
41	---- 0000 0010 1001	Winding 3 negative-sequence instantaneous overcurrent
42	---- 0000 0010 1010	Underfrequency 1
43	---- 0000 0010 1011	Underfrequency 2
44	---- 0000 0010 1100	Frequency decay 1
45	---- 0000 0010 1101	Frequency decay 2
46	---- 0000 0010 1110	Frequency decay 3
47	---- 0000 0010 1111	Frequency decay 4
48	---- 0000 0011 0000	Overfrequency
49	---- 0000 0011 0001	Fifth harmonic level
50	---- 0000 0011 0010	Volts per hertz 1
51	---- 0000 0011 0011	Volts per hertz 2
52	---- 0000 0011 0100	Winding 1 THD level
53	---- 0000 0011 0101	Winding 2 THD level
54	---- 0000 0011 0110	Winding 3 THD level
55	---- 0000 0011 0111	Winding 1 harmonic derating
56	---- 0000 0011 1000	Winding 2 harmonic derating
57	---- 0000 0011 1001	Winding 3 harmonic derating
58	---- 0000 0011 1010	Hottest-spot limit
59	---- 0000 0011 1011	Loss-of-life limit
60	---- 0000 0011 1100	Analog input level 1
61	---- 0000 0011 1101	Analog input level 2
62	---- 0000 0011 1110	Winding 1 current demand
63	---- 0000 0011 1111	Winding 2 current demand
64	---- 0000 0100 0000	Winding 3 current demand
65	---- 0000 0100 0001	Transformer overload
66	---- 0000 0100 0010	Logic input 1
67	---- 0000 0100 0011	Logic input 2
68	---- 0000 0100 0100	Logic input 3
69	---- 0000 0100 0101	Logic input 4
70	---- 0000 0100 0110	Logic input 5
71	---- 0000 0100 0111	Logic input 6
72	---- 0000 0100 1000	Logic input 7
73	---- 0000 0100 1001	Logic input 8
74	---- 0000 0100 1010	Logic input 9
75	---- 0000 0100 1011	Logic input 10
76	---- 0000 0100 1100	Logic input 11
77	---- 0000 0100 1101	Logic input 12
78	---- 0000 0100 1110	Logic input 13
79	---- 0000 0100 1111	Logic input 14
80	---- 0000 0101 0000	Logic input 15
81	---- 0000 0101 0001	Logic input 16

Value	Bit arrangement	Cause of event
82	---- 0000 0101 0010	Virtual input 1
83	---- 0000 0101 0011	Virtual input 2
84	---- 0000 0101 0100	Virtual input 3
85	---- 0000 0101 0101	Virtual input 4
86	---- 0000 0101 0110	Virtual input 5
87	---- 0000 0101 0111	Virtual input 6
88	---- 0000 0101 1000	Virtual input 7
89	---- 0000 0101 1001	Virtual input 8
90	---- 0000 0101 1010	Virtual input 9
91	---- 0000 0101 1011	Virtual input 10
92	---- 0000 0101 1100	Virtual input 11
93	---- 0000 0101 1101	Virtual input 12
94	---- 0000 0101 1110	Virtual input 13
95	---- 0000 0101 1111	Virtual input 14
96	---- 0000 0110 0000	Virtual input 15
97	---- 0000 0110 0001	Virtual input 16
98	---- 0000 0110 0010	Output relay 1
99	---- 0000 0110 0011	Output relay 2
100	---- 0000 0110 0100	Output relay 3
101	---- 0000 0110 0101	Output relay 4
102	---- 0000 0110 0110	Output relay 5
103	---- 0000 0110 0111	Output relay 6
104	---- 0000 0110 1000	Output relay 7
105	---- 0000 0110 1001	Output relay 8
106	---- 0000 0110 1010	Self-test relay
107	---- 0000 0110 1011	Virtual output 1
108	---- 0000 0110 1100	Virtual output 2
109	---- 0000 0110 1101	Virtual output 3
110	---- 0000 0110 1110	Virtual output 4
111	---- 0000 0110 1111	Virtual output 5
112	---- 0000 0111 0000	Setpoint group 1
113	---- 0000 0111 0001	Setpoint group 2
114	---- 0000 0111 0010	Setpoint group 3
115	---- 0000 0111 0011	Setpoint group 4
116	---- 0000 0111 0100	Test mode
117	---- 0000 0111 0101	Simulation disabled
118	---- 0000 0111 0110	Simulation prefault
119	---- 0000 0111 0111	Simulation fault
120	---- 0000 0111 1000	Simulation playback
121	---- 0000 0111 1001	Logic input reset
122	---- 0000 0111 1010	Front panel reset
123	---- 0000 0111 1011	Communications port reset
124	---- 0000 0111 1100	Manual trace trigger
125	---- 0000 0111 1101	Automatic trace trigger
126	---- 0000 0111 1110	Control power
127	---- 0000 0111 1111	Logic input power
128	---- 0000 1000 0000	Analog output power

Value	Bit arrangement	Cause of event
129	---- 0000 1000 0001	Unit not calibrated
130	---- 0000 1000 0010	EEPROM memory
131	---- 0000 1000 0011	Real time clock
132	---- 0000 1000 0100	Not used
133	---- 0000 1000 0101	Emulation software
134	---- 0000 1000 0110	Internal temperature
135	---- 0000 1000 0111	FlexLogic™ equation
136	---- 0000 1000 1000	DSP processor
137	---- 0000 1000 1001	Bad transformer settings
138	---- 0000 1000 1010	IRIG-B signal
139	---- 0000 1000 1011	Setpoint access denied
140	---- 0000 1000 1100	Aging factor limit
141	---- 0000 1000 1101	Ambient temperature
142	---- 0000 1000 1110	Tap changer failure

Example: 302Ah = 12230 decimal = 0011 0000 0010 1010 = Underfrequency 1 pickup, since 0011 (first four bits) indicates a pickup event and 0000 0010 1010 (next 12 bits) indicate an underfrequency 1 cause of event.

F25: Two's-complement signed value, 3 decimal places (16 bits)

Example: –1.234 stored as –1234

F26: Analog output range (16-bit enumeration)

Value	Output range
0	0 to 1 mA
1	0 to 5 mA
2	4 to 20 mA
3	0 to 20 mA
4	0 to 10 mA

F27: Phase sequence (16-bit enumeration)

Value	Output range
0	ABC sequence
1	ACB sequence

F28: Transformer type (16-bit enumeration)

Val.	Type	Val.	Type	Val.	Type	Val.	Type
0	2W (extn correction)	30	Y/y0°/d210°	60	D/d0°/d0°	90	D/d240°/y210°
1	Y/y0°	31	Y/y0°/d330°	61	D/d0°/d60°	91	D/d300°/d0°
2	Y/y180°	32	Y/y180°/d30°	62	D/d0°/d120°	92	D/d300°/d180°
3	Y/d30°	33	Y/y180°/d150°	63	D/d0°/d180°	93	D/d300°/d300°
4	Y/d150°	34	Y/y180°/d210°	64	D/d0°/d240°	94	D/d300°/y150°
5	Y/d210°	35	Y/y180°/d330°	65	D/d0°/d300°	95	D/d300°/y330°
6	Y/d330°	36	Y/d30°/y0°	66	D/d0°/y30°	96	D/y30°/d0°
7	D/d0°	37	Y/d30°/y180°	67	D/d0°/y150°	97	D/y30°/d60°
8	D/d60°	38	Y/d30°/d30°	68	D/d0°/y210°	98	D/y30°/d240°
9	D/d120°	39	Y/d30°/d150°	69	D/d0°/y330°	99	D/y30°/y30°
10	D/d180°	40	Y/d30°/d210°	70	D/d60°/d0°	100	D/y30°/y210°
11	D/d240°	41	Y/d30°/d330°	71	D/d60°/d60°	101	D/y150°/d0°
12	D/d300°	42	Y/d150°/y0°	72	D/d60°/d240°	102	D/y150°/d120°
13	D/y30°	43	Y/d150°/y180°	73	D/d60°/y30°	103	D/y150°/d180°
14	D/y150°	44	Y/d150°/d30°	74	D/d60°/y210°	104	D/y150°/d300°
15	D/y210°	45	Y/d150°/d150°	75	D/d120°/d0°	105	D/y150°/y150°
16	D/y330°	46	Y/d150°/d210°	76	D/d120°/d120°	106	D/y150°/y330°
17	Y/z30°	47	Y/d150°/d330°	77	D/d120°/d180°	107	D/y210°/d0°
18	Y/z150°	48	Y/d210°/y0°	78	D/d120°/y150°	108	D/y210°/d60°
19	Y/z210°	49	Y/d210°/y180°	79	D/d120°/y330°	109	D/y210°/d240°
20	Y/z330°	50	Y/d210°/d30°	80	D/d180°/d0°	110	D/y210°/y30°
21	D/z0°	51	Y/d210°/d150°	81	D/d180°/d120°	111	D/y210°/y210°
22	D/z60°	52	Y/d210°/d210°	82	D/d180°/d180°	112	D/y330°/d0°
23	D/z120°	53	Y/d210°/d330°	83	D/d180°/d300°	113	D/y330°/d120°
24	D/z180°	54	Y/d330°/y0°	84	D/d180°/y150°	114	D/y330°/d180°
25	D/z240°	55	Y/d330°/y180°	85	D/d180°/y330°	115	D/y330°/d300°
26	D/z300°	56	Y/d330°/d30°	86	D/d240°/d0°	116	D/y330°/y150°
27	3W (extn correction)	57	Y/d330°/d150°	87	D/d240°/d60°	117	D/y330°/y330°
28	Y/y0°/d30°	58	Y/d330°/d210°	88	D/d240°/d240°	118	Y/z30°/z30°
29	Y/y0°/d150°	59	Y/d330°/d330°	89	D/d240°/y30°	119	Y/y0°/y0°

F29: 745 operation (16-bit enumeration)

Value	Operation state
0	Not programmed
1	Programmed

F29: Enabled/disabled state (16-bit enumeration)

Value	State
0	Disabled
1	Enabled

F31: Baud rate (16-bit enumeration)

Value	Baud rate
0	300 baud
1	1200 baud
2	2400 baud
3	4800 baud
4	9600 baud
5	19200 baud

F32: Default message (32 bits)

Internally defined

F33: ASCII text characters (16 bits)

First block of eight bits: first ASCII character, 0 to 255 in steps of 1

Second block of eight bits: second ASCII character, 0 to 255 in steps of 1

Example: "AN" stored as 414Eh = 16718 decimal

F34: Relay energization state (16-bit enumeration)

Value	Relay state
0	De-energized
1	Energized

F35: Relay conditions (16-bit bitmask)

Bitmask	Description
---- ---- ---- ---1	Active trip condition
---- ---- ---- --1-	Active alarm condition(s)
---- ---- ---- -1--	Pickup condition
---- ---- ---1 ----	Phase A fault
---- ---- --1- ----	Phase B fault
---- ---- -1-- ----	Phase C fault
---- ---- 1--- ----	Ground fault

F36: Overcurrent curve shape (16-bit enumeration)

Value	Curve shape
0	IEEE extremely inverse
1	IEEE very inverse
2	IEEE normally inverse
3	IEEE moderately inverse
4	Definite time
5	IEC curve A
6	IEC curve B
7	IEC curve C

Value	Curve shape
8	IEC short inverse
9	IAC extremely inverse
10	IAC very inverse
11	IAC inverse
12	IAC short inverse
13	FlexCurve™ A
14	FlexCurve™ B
15	FlexCurve™ C

F37: Rated winding temperature rise (16-bit enumeration)

Value	Temperature rise
0	55°C (oil)
1	65°C (oil)
2	80°C (dry)
3	115°C (dry)
4	150°C (dry)

F38: Output type (16-bit enumeration)

Value	Output type
0	Trip
1	Alarm
2	Control

F39: Cooling type for oil-filled transformers (16-bit enumeration)

Value	Output type
0	OA
1	FA
2	Non-directed FOA/FOW
3	Directed FOA/FOW

F40: Winding selection (16-bit enumeration)

Value	Winding
0	None
1	Winding 1
2	Winding 2
3	Winding 3

F41: RTD type (16-bit enumeration)

Value	RTD type
0	100 ohm Platinum
1	120 ohm Nickel
2	100 ohm Nickel
3	Monthly average

F42: Analog input range (16-bit enumeration)

Value	Range
0	0 to 1 mA
1	0 to 5 mA
2	4 to 20 mA
3	0 to 20 mA

F43: Asserted / not asserted selection (16-bit enumeration)

Value	State
0	Not asserted
1	Asserted

F44: Operation status (16-bit bitmask)

Bitmask	Status
---- ---- ---- ---0 ---- ---- ---- ---1	Code programming mode disabled Code programming mode enabled
---- ---- ---- --0- ---- ---- ---- --1-	Setpoint access jumper disabled Setpoint access jumper enabled
---- ---- ---- -0-- ---- ---- ---- -1--	Factory service mode disabled Factory service mode enabled
---- ---- ---- 0--- ---- ---- ---- 1---	Communication port passcode access is read and write Communication port passcode access is read only

F45: Analog output value (16-bit enumeration)

Value	Analog output
0	Winding 1 phase A current
1	Winding 1 phase B current
2	Winding 1 phase C current
3	Winding 2 phase A current
4	Winding 2 phase B current
5	Winding 2 phase C current
6	Winding 3 phase A current
7	Winding 3 phase B current
8	Winding 3 phase C current
9	Winding 1 loading
10	Winding 2 loading
11	Winding 3 loading
12	Winding 1 phase A THD
13	Winding 1 phase B THD
14	Winding 1 phase C THD
15	Winding 2 phase A THD
16	Winding 2 phase B THD
17	Winding 2 phase C THD
18	Winding 3 phase A THD
19	Winding 3 phase B THD
20	Winding 3 phase C THD
21	Winding 1 derating
22	Winding 2 derating
23	Winding 3 derating
24	Frequency
25	Tap position
26	Voltage
27	Winding 1 phase A demand
28	Winding 1 phase B demand
29	Winding 1 phase C demand
30	Winding 2 phase A demand
31	Winding 2 phase B demand
32	Winding 2 phase C demand
33	Winding 3 phase A demand
34	Winding 3 phase B demand
35	Winding 3 phase C demand
36	Analog input
37	Maximum event winding 1 Ia
38	Maximum event winding 1 Ib
39	Maximum event winding 1 Ic
40	Maximum event winding 1 Ig
41	Maximum event winding 2 Ia
42	Maximum event winding 2 Ib
43	Maximum event winding 2 Ic
44	Maximum event winding 2 Ig
45	Maximum event winding 3 Ia
46	Maximum event winding 3 Ib
47	Maximum event winding 3 Ic
48	Maximum event winding 3 Ig

F46: Target types (16-bit enumeration)

Value	Target
0	Self-reset
1	Latched
2	None

F47: FlexLogic™ equation (16-bit enumeration)

First block of eight or sixteen bits: FlexLogic™ token, enumerated as follows:

Bit arrangement	Token
0000 0000 0000 0000	END
0000 0001 0000 0000	OFF
0000 0010 0000 0000	ON
0000 0011 0000 0000	NOT gate
0000 0100 ---- ----	OR gate
0000 0101 ---- ----	AND gate
0000 0110 ---- ----	NOR gate
0000 0111 ---- ----	NAND gate
0000 1000 ---- ----	XOR gate
0000 1001 ---- ----	Element pickup
0000 1010 ---- ----	Element operated
0000 1011 ---- ----	Logic input asserted
0000 1100 ---- ----	Virtual input asserted
0000 1101 ---- ----	Output relay operated
0000 1110 ---- ----	Virtual output operated
0000 1111 ---- ----	Timer operated

Second block of eight bits (---- ---- 0000 0000): applicable to OR, AND, NOR, NAND, and XOR gate tokens, enumerated as follows:

Value	Bit arrangement	Cause of event
2	---- ---- 0000 0010	2-input gate
3	---- ---- 0000 0011	3-input gate
4	---- ---- 0000 0100	4-input gate
5	---- ---- 0000 0101	5-input gate
6	---- ---- 0000 0110	6-input gate
7	---- ---- 0000 0111	7-input gate
8	---- ---- 0000 1000	8-input gate
9	---- ---- 0000 1001	9-input gate
10	---- ---- 0000 1010	10-input gate
11	---- ---- 0000 1011	11-input gate
12	---- ---- 0000 1100	12-input gate
13	---- ---- 0000 1101	13-input gate
14	---- ---- 0000 1110	14-input gate
15	---- ---- 0000 1111	15-input gate
16	---- ---- 0001 0000	16-input gate
17	---- ---- 0001 0001	17-input gate
18	---- ---- 0001 0010	18-input gate
19	---- ---- 0001 0011	19-input gate

Second block of eight bits (---- ---- 0000 0000): applicable to element pickup and element operated tokens, enumerated as follows:

Value	Bit arrangement	Element pickup / element operated
0	---- ---- 0000 0000	Any element
1	---- ---- 0000 0001	Any winding 1 overcurrent
2	---- ---- 0000 0010	Any winding 2 overcurrent
3	---- ---- 0000 0011	Any winding 3 overcurrent
4	---- ---- 0000 0100	Percent differential
5	---- ---- 0000 0101	Instantaneous differential
6	---- ---- 0000 0110	Winding 1 phase time overcurrent
7	---- ---- 0000 0111	Winding 2 phase time overcurrent
8	---- ---- 0000 1000	Winding 3 phase time overcurrent
9	---- ---- 0000 1001	Winding 1 phase instantaneous overcurrent 1
10	---- ---- 0000 1010	Winding 2 phase instantaneous overcurrent 1
11	---- ---- 0000 1011	Winding 3 phase instantaneous overcurrent 1
12	---- ---- 0000 1100	Winding 1 phase instantaneous overcurrent 2
13	---- ---- 0000 1101	Winding 2 phase instantaneous overcurrent 2
14	---- ---- 0000 1110	Winding 3 phase instantaneous overcurrent 2
15	---- ---- 0000 1111	Winding 1 neutral time overcurrent
16	---- ---- 0001 0000	Winding 2 neutral time overcurrent
17	---- ---- 0001 0001	Winding 3 neutral time overcurrent
18	---- ---- 0001 0010	Winding 1 neutral instantaneous overcurrent 1
19	---- ---- 0001 0011	Winding 1 neutral instantaneous overcurrent 1
20	---- ---- 0001 0100	Winding 1 neutral instantaneous overcurrent 1
21	---- ---- 0001 0101	Winding 1 neutral instantaneous overcurrent 2
22	---- ---- 0001 0110	Winding 1 neutral instantaneous overcurrent 2
23	---- ---- 0001 0111	Winding 1 neutral instantaneous overcurrent 2
24	---- ---- 0001 1000	Winding 1 ground time overcurrent
25	---- ---- 0001 1001	Winding 2 ground time overcurrent
26	---- ---- 0001 1010	Winding 3 ground time overcurrent
27	---- ---- 0001 1011	Winding 1 ground instantaneous overcurrent 1
28	---- ---- 0001 1100	Winding 2 ground instantaneous overcurrent 1
29	---- ---- 0001 1101	Winding 3 ground instantaneous overcurrent 1
30	---- ---- 0001 1110	Winding 1 ground instantaneous overcurrent 2
31	---- ---- 0001 1111	Winding 2 ground instantaneous overcurrent 2
32	---- ---- 0010 0000	Winding 3 ground instantaneous overcurrent 2
33	---- ---- 0010 0001	Winding 1 restricted ground fault
34	---- ---- 0010 0010	Winding 2 restricted ground fault
35	---- ---- 0010 0011	Winding 3 restricted ground fault
36	---- ---- 0010 0100	Winding 1 restricted ground trend
37	---- ---- 0010 0101	Winding 2 restricted ground trend
38	---- ---- 0010 0110	Winding 3 restricted ground trend
39	---- ---- 0010 0111	Winding 1 negative-sequence time overcurrent
40	---- ---- 0010 1000	Winding 2 negative-sequence time overcurrent
41	---- ---- 0010 1001	Winding 3 negative-sequence time overcurrent
42	---- ---- 0010 1010	Winding 1 negative-sequence instantaneous overcurrent
43	---- ---- 0010 1011	Winding 2 negative-sequence instantaneous overcurrent
44	---- ---- 0010 1100	Winding 3 negative-sequence instantaneous overcurrent

Value	Bit arrangement	Element pickup / element operated
45	---- ---- 0010 1101	Underfrequency 1
46	---- ---- 0010 1110	Underfrequency 2
47	---- ---- 0010 1111	Frequency decay 1
48	---- ---- 0011 0000	Frequency decay 2
49	---- ---- 0011 0001	Frequency decay 3
50	---- ---- 0011 0010	Frequency decay 4
51	---- ---- 0011 0011	Overfrequency
52	---- ---- 0011 0100	Fifth harmonic level
53	---- ---- 0011 0101	Volts per hertz 1
54	---- ---- 0011 0110	Volts per hertz 2
55	---- ---- 0011 0111	Winding 1 THD level
56	---- ---- 0011 1000	Winding 2 THD level
57	---- ---- 0011 1001	Winding 3 THD level
58	---- ---- 0011 1010	Winding 1 harmonic derating
59	---- ---- 0011 1011	Winding 2 harmonic derating
60	---- ---- 0011 1100	Winding 3 harmonic derating
61	---- ---- 0011 1101	Hottest-spot temperature limit
62	---- ---- 0011 1110	Loss-of-life limit
63	---- ---- 0011 1111	Analog input level 1
64	---- ---- 0100 0000	Analog input level 2
65	---- ---- 0100 0001	Winding 1 current demand
66	---- ---- 0100 0010	Winding 2 current demand
67	---- ---- 0100 0011	Winding 3 current demand
68	---- ---- 0100 0100	Transformer overload
69	---- ---- 0100 0101	Aging factor limit
70	---- ---- 0100 0110	Tap changer failure

Second block of eight bits (---- ---- 0000 0000): applicable to logic input asserted and virtual input asserted tokens, enumerated as follows:

Value	Bit arrangement	Logic input / virtual input
0	---- ---- 0000 0010	Logic input 1 / virtual input 1
1	---- ---- 0000 0010	Logic input 2 / virtual input 2
2	---- ---- 0000 0010	Logic input 3 / virtual input 3
3	---- ---- 0000 0011	Logic input 4 / virtual input 4
4	---- ---- 0000 0100	Logic input 5 / virtual input 5
5	---- ---- 0000 0101	Logic input 6 / virtual input 6
6	---- ---- 0000 0110	Logic input 7 / virtual input 7
7	---- ---- 0000 0111	Logic input 8 / virtual input 8
8	---- ---- 0000 1000	Logic input 9 / virtual input 9
9	---- ---- 0000 1001	Logic input 10 / virtual input 10
10	---- ---- 0000 1010	Logic input 11 / virtual input 11
11	---- ---- 0000 1011	Logic input 12 / virtual input 12
12	---- ---- 0000 1100	Logic input 13 / virtual input 13
13	---- ---- 0000 1101	Logic input 14 / virtual input 14
14	---- ---- 0000 1110	Logic input 15 / virtual input 15
15	---- ---- 0000 1111	Logic input 16 / virtual input 16

Second block of eight bits (---- ---- 0000 0000): applicable to output relay operated token, enumerated as follows:

Value	Bit arrangement	Output relay
0	---- ---- 0000 0010	Output relay 1 operated
1	---- ---- 0000 0010	Output relay 2 operated
2	---- ---- 0000 0010	Output relay 3 operated
3	---- ---- 0000 0011	Output relay 4 operated
4	---- ---- 0000 0100	Output relay 5 operated
5	---- ---- 0000 0101	Output relay 6 operated
6	---- ---- 0000 0110	Output relay 7 operated
7	---- ---- 0000 0111	Output relay 8 operated

Second block of eight bits (---- ---- 0000 0000): applicable to virtual output operated token, enumerated as follows:

Value	Bit arrangement	Virtual output
0	---- ---- 0000 0010	Virtual output 1 operated
1	---- ---- 0000 0010	Virtual output 2 operated
2	---- ---- 0000 0010	Virtual output 3 operated
3	---- ---- 0000 0011	Virtual output 4 operated
4	---- ---- 0000 0100	Virtual output 5 operated

Second block of eight bits (---- ---- 0000 0000): applicable to timer operated token, enumerated as follows:

Value	Bit arrangement	Timer
0	---- ---- 0000 0010	Timer 1 operated
1	---- ---- 0000 0010	Timer 2 operated
2	---- ---- 0000 0010	Timer 3 operated
3	---- ---- 0000 0011	Timer 4 operated
4	---- ---- 0000 0100	Timer 5 operated
5	---- ---- 0000 0101	Timer 6 operated
6	---- ---- 0000 0110	Timer 7 operated
7	---- ---- 0000 0111	Timer 8 operated
8	---- ---- 0000 1000	Timer 9 operated
9	---- ---- 0000 1001	Timer 10 operated

F48: Simulation function (16-bit enumeration)

Value	Simulation
0	Disabled
1	Prefault mode
2	Fault mode
3	Playback mode

F49: Input states (16-bit bitmask)

Bitmask	Input state
---- ---- ---- ---x	Input 1 (0 = open, 1 = closed)
---- ---- ---- --x-	Input 2 (0 = open, 1 = closed)
---- ---- ---- -x--	Input 3 (0 = open, 1 = closed)
---- ---- ---- x---	Input 4 (0 = open, 1 = closed)
---- ---- ---x ----	Input 5 (0 = open, 1 = closed)
---- ---- --x- ----	Input 6 (0 = open, 1 = closed)
---- ---- -x-- ----	Input 7 (0 = open, 1 = closed)
---- ---- x--- ----	Input 8 (0 = open, 1 = closed)
---- ---x ---- ----	Input 9 (0 = open, 1 = closed)
---- --x- ---- ----	Input 10 (0 = open, 1 = closed)
---- -x-- ---- ----	Input 11 (0 = open, 1 = closed)
---- x--- ---- ----	Input 12 (0 = open, 1 = closed)
---x ---- ---- ----	Input 13 (0 = open, 1 = closed)
--x- ---- ---- ----	Input 14 (0 = open, 1 = closed)
-x-- ---- ---- ----	Input 15 (0 = open, 1 = closed)
x--- ---- ---- ----	Input 16 (0 = open, 1 = closed)

F50: Output relay states (16-bit bitmask)

Bitmask	Output state
---- ---- ---- ---x	Output relay 1 (0 = de-energized, 1 = energized)
---- ---- ---- --x-	Output relay 2 (0 = de-energized, 1 = energized)
---- ---- ---- -x--	Output relay 3 (0 = de-energized, 1 = energized)
---- ---- ---- x---	Output relay 4 (0 = de-energized, 1 = energized)
---- ---- ---x ----	Output relay 5 (0 = de-energized, 1 = energized)
---- ---- --x- ----	Output relay 6 (0 = de-energized, 1 = energized)
---- ---- -x-- ----	Output relay 7 (0 = de-energized, 1 = energized)
---- ---- x--- ----	Output relay 8 (0 = de-energized, 1 = energized)
---- ---x ---- ----	Self-test relay (0 = de-energized, 1 = energized)

F51: DSP diagnostic flags (16-bit bitmask)

Bitmask	Diagnostic flag
---- ---- ---- ---x	A/D virtual ground (0 = OK, 1 = out of tolerance)
---- ---- ---- --x-	A/D subsystem (0 = OK, 1 = not responding)

F52: Logic flags (16-bit bitmask)

Bitmask	Logic flag
---- ---- ---- ---x	Pickup flag (0 = not picked up, 1 = picked up)
---- ---- ---- --x-	Operated flag (0 = not operated, 1 = operated)
---- ---- ---- -x--	Latched flag (0 = not latched, 1 = latched)
---- ---- ---- x---	Self-test flag (0 = no error, 1 = error)
---- ---- ---x ----	Not used
---- ---- --x- ----	Not used
---- ---- -x-- ----	Not used
---- ---- x--- ----	Not used
---- ---x ---- ----	Phase A flag (0 = no fault, 1 = fault)
---- --x- ---- ----	Phase B flag (0 = no fault, 1 = fault)
---- -x-- ---- ----	Phase C flag (0 = no fault, 1 = fault)
---- x--- ---- ----	Ground flag (0 = no fault, 1 = fault)

F53: Unsigned value, 3 decimal places (16 bits)

Example: 1.234 stored as 1234

F54: Force LED state (16-bit bitmask)

Bitmask	LED state
---- ---- ---- ---1	LED #1 on (top)
---- ---- ---- --1-	LED #2 on
---- ---- ---- -1--	LED #3 on
---- ---- ---- 1---	LED #4 on
---- ---- ---1 ----	LED #5 on
---- ---- --1- ----	LED #6 on
---- ---- -1-- ----	LED #7 on
---- ---- 1--- ----	LED #8 on (bottom)

F55: Front panel keypress (16-bit enumeration)

Value	Key
0	"0"
1	"1"
2	"2"
3	"3"
4	"4"
5	"5"
6	"6"
7	"7"

Value	Key
8	"8"
9	"9"
10	Decimal
11	Message up
12	Message down
13	Message left
14	Message right
15	Value up

Value	Key
16	Enter
17	Reset
18	Menu
19	Escape
20	Value down
21	Help

F56: Input assert flags (16-bit bitmask)

Bitmask	Input flag
---- ---- ---- ---x	Input 1 (0 = not asserted, 1 = asserted)
---- ---- ---- --x-	Input 2 (0 = not asserted, 1 = asserted)
---- ---- ---- -x--	Input 3 (0 = not asserted, 1 = asserted)
---- ---- ---- x---	Input 4 (0 = not asserted, 1 = asserted)
---- ---- ---x ----	Input 5 (0 = not asserted, 1 = asserted)
---- ---- --x- ----	Input 6 (0 = not asserted, 1 = asserted)
---- ---- -x-- ----	Input 7 (0 = not asserted, 1 = asserted)
---- ---- x--- ----	Input 8 (0 = not asserted, 1 = asserted)
---- ---x ---- ----	Input 9 (0 = not asserted, 1 = asserted)
---- --x- ---- ----	Input 10 (0 = not asserted, 1 = asserted)
---- -x-- ---- ----	Input 11 (0 = not asserted, 1 = asserted)
---- x--- ---- ----	Input 12 (0 = not asserted, 1 = asserted)
---x ---- ---- ----	Input 13 (0 = not asserted, 1 = asserted)
--x- ---- ---- ----	Input 14 (0 = not asserted, 1 = asserted)
-x-- ---- ---- ----	Input 15 (0 = not asserted, 1 = asserted)
x--- ---- ---- ----	Input 16 (0 = not asserted, 1 = asserted)

F57: Output relay operate flags (16-bit bitmask)

Bitmask	Output state
---- ---- ---- ---x	Output relay 1 (0 = not operated, 1 = operated)
---- ---- ---- --x-	Output relay 2 (0 = not operated, 1 = operated)
---- ---- ---- -x--	Output relay 3 (0 = not operated, 1 = operated)
---- ---- ---- x---	Output relay 4 (0 = not operated, 1 = operated)
---- ---- ---x ----	Output relay 5 (0 = not operated, 1 = operated)
---- ---- --x- ----	Output relay 6 (0 = not operated, 1 = operated)
---- ---- -x-- ----	Output relay 7 (0 = not operated, 1 = operated)
---- ---- x--- ----	Output relay 8 (0 = not operated, 1 = operated)
---- ---x ---- ----	Self-test relay (0 = not operated, 1 = operated)

F58: Demand meter type (16-bit enumeration)

Value	Demand
0	Thermal
1	Block interval
2	Rolling demand

F59: Virtual output operate flags (16-bit bitmask)

Bitmask	Output state
---- ---- ---- ---x	Virtual output 1 (0 = not operated, 1 = operated)
---- ---- ---- --x-	Virtual output 2 (0 = not operated, 1 = operated)
---- ---- ---- -x--	Virtual output 3 (0 = not operated, 1 = operated)
---- ---- ---- x---	Virtual output 4 (0 = not operated, 1 = operated)
---- ---- ---x ----	Virtual output 5 (0 = not operated, 1 = operated)

F60: Active setpoint group (16-bit enumeration)

Value	Setpoint group
0	Group 1
1	Group 2
2	Group 3
3	Group 4

F61: Timer operate flags (16-bit bitmask)

Bitmask	Timer state
---- ---- ---- ---x	Timer 1 (0 = not operated, 1 = operated)
---- ---- ---- --x-	Timer 2 (0 = not operated, 1 = operated)
---- ---- ---- -x--	Timer 3 (0 = not operated, 1 = operated)
---- ---- ---- x---	Timer 4 (0 = not operated, 1 = operated)
---- ---- ---x ----	Timer 5 (0 = not operated, 1 = operated)
---- ---- --x- ----	Timer 6 (0 = not operated, 1 = operated)
---- ---- -x-- ----	Timer 7 (0 = not operated, 1 = operated)
---- ---- x--- ----	Timer 8 (0 = not operated, 1 = operated)
---- ---x ---- ----	Timer 9 (0 = not operated, 1 = operated)
---- --x- ---- ----	Timer 10 (0 = not operated, 1 = operated)

F62: FlexLogic™ equation, no gates (16 bits)

Format F47 for tokens 0000 0111 and greater (that is, with no gates)

F63: Voltage input parameters (16-bit enumeration)

Value	Voltage input
0	Winding 1 Van
1	Winding 1 Vbn
2	Winding 1 Vcn
3	Winding 1 Vab
4	Winding 1 Vbc
5	Winding 1 Vca

Value	Voltage input
6	Winding 2 Van
7	Winding 2 Vbn
8	Winding 2 Vcn
9	Winding 2 Vab
10	Winding 2 Vbc
11	Winding 2 Vca

Value	Voltage input
12	Winding 3 Van
13	Winding 3 Vbn
14	Winding 3 Vcn
15	Winding 3 Vab
16	Winding 3 Vbc
17	Winding 3 Vca

F64: Harmonic parameters (16-bit enumeration)

Value	Harmonic
0	2nd harmonic
1	2nd + 5th harmonic

F65: Trace memory channel (16-bit enumeration)

Value	Channel
0	Winding 1 Ia
1	Winding 1 Ib
2	Winding 1 Ic
3	Winding 2 Ia
4	Winding 2 Ib

Value	Channel
5	Winding 2 Ic
6	Winding 3 Ia
7	Winding 3 Ib
8	Winding 3 Ic
9	Winding 1/2 Ig

Value	Channel
10	Winding 2/3 Ig
11	Voltage
12	Logic inputs
13	Output relays

F66: Output operation (16-bit enumeration)

Value	Operation
0	Self-resetting
1	Latched

F67: Block operation of outputs (16-bit bitmask)

Bitmask	Output operation state
---- ---- ---- ---x	Output relay 1 (0 = allow operation, 1 = block operation)
---- ---- ---- --x-	Output relay 2 (0 = allow operation, 1 = block operation)
---- ---- ---- -x--	Output relay 3 (0 = allow operation, 1 = block operation)
---- ---- ---- x---	Output relay 4 (0 = allow operation, 1 = block operation)
---- ---- ---x ----	Output relay 5 (0 = allow operation, 1 = block operation)
---- ---- --x- ----	Output relay 6 (0 = allow operation, 1 = block operation)
---- ---- -x-- ----	Output relay 7 (0 = allow operation, 1 = block operation)
---- ---- x--- ----	Output relay 8 (0 = allow operation, 1 = block operation)

F68: Output operation (16-bit enumeration)

Value	Operation
0	Instantaneous
1	Linear

F69: Playback memory channel (16-bit enumeration)

Value	Channel
0	Winding 1 Ia
1	Winding 1 Ib
2	Winding 1 Ic
3	Winding 2 Ia

Value	Channel
4	Winding 2 Ib
5	Winding 2 Ic
6	Winding 3 Ia
7	Winding 3 Ib

Value	Channel
8	Winding 3 Ic
9	Winding 1/2 Ig
10	Winding 2/3 Ig
11	Voltage

F70: Playback memory channel (16 bits)

For trace/playback channel selector index from 0 to 11 (that is, any current input or voltage), F70 is a two's-complement signed value. For example, 1.000 × CT is stored as 500; –0.500 × VT is stored as –250.

For a trace/playback channel selector index of 12 (that is, any logic inputs), F70 is formatted as per format code F49. For example, "logic inputs 1 and 3 closed" is stored as 0005 hex.

For a trace/playback channel selector index of 13 (that is, any output relays), F70 is formatted as per format code F50. For example, "output relays 2 and 4 energized" is stored as 000A hex.

F71: Factory service commands (16-bit enumeration)

Value	Command
0	Clear any pending commands
1	Load factory default setpoints
2	Load default calibration data
3	Clear diagnostic data
4	Clear RMS minimum/maximum data

F72: Force other hardware (16-bit bitmask)

Bitmask	Force hardware
---- ---- ---- ---x	LEDs (0 = normal, 1 = use LED force codes)
---- ---- ---- --x-	Not used
---- ---- ---- -x--	External watchdog (0 = normal, 1 = stop updating)
---- ---- ---- x---	Internal watchdog (0 = normal, 1 = stop updating)

F73: Parity (16-bit enumeration)

Value	Parity
0	None
1	Odd
2	Even

F74: Edit setpoint group (16-bit enumeration)

Value	Setpoint group
0	Group 1
1	Group 2
2	Group 3
2	Group 4
2	Active group

F75: Virtual input programmed state (16-bit enumeration)

Value	State
0	Open
1	Closed

F76: FlexLogic™ equation error (16-bit enumeration)

Value	Error
0	None
1	Output relay 1
2	Output relay 2
3	Output relay 3
4	Output relay 4
5	Output relay 5
6	Output relay 6
7	Output relay 7

Value	Error
8	Output relay 8
9	Trigger trace memory
10	Virtual output 1
11	Virtual output 2
12	Virtual output 3
13	Virtual output 4
14	Virtual output 5

F77: Bad transformer settings error (16-bit enumeration)

Value	Error
0	None
1	W1-W2 ratio mismatch
2	W2-W3 ratio mismatch
3	Load loss
4	Winding 1 eddy current loss

Value	Error
5	Winding 2 eddy current loss
6	Winding 3 eddy current loss
7	Winding 1 rated load
8	Winding 2 rated load
9	Winding 3 rated load

F78: Unsigned value, auto-ranging based on winding 1 phase CT primary value (16 bits)

For winding 1 phase CT primary ≤ 2 A, F78 is an unsigned value with three decimal places. For example, 1.234 is stored as 1234.

For 2 A < winding 1 phase CT primary ≤ 20 A, F78 is an unsigned value with two decimal places. For example, 12.34 is stored as 1234.

For 20 A < winding 1 phase CT primary ≤ 200 A, F78 is an unsigned value with one decimal place. For example, 123.4 is stored as 1234.

For 200 A < winding 1 phase CT primary ≤ 2000 A, F78 is a standard unsigned value. For example, 1234 is stored as 1234.

For winding 1 phase CT primary > 2000 A, F78 is a standard unsigned value scaled by 10. For example, 12340 is stored as 1234.

F79: Unsigned value, auto-ranging based on winding 2 phase CT primary value (16 bits)

For winding 2 phase CT primary ≤ 2 A, F79 is an unsigned value with three decimal places. For example, 1.234 is stored as 1234.

For 2 A < winding 2 phase CT primary ≤ 20 A, F79 is an unsigned value with two decimal places. For example, 12.34 is stored as 1234.

For 20 A < winding 2 phase CT primary ≤ 200 A, F79 is an unsigned value with one decimal place. For example, 123.4 is stored as 1234.

For 200 A < winding 2 phase CT primary ≤ 2000 A, F78 is a standard unsigned value. For example, 1234 is stored as 1234.

For winding 2 phase CT primary > 2000 A, F78 is a standard unsigned value scaled by 10. For example, 12340 is stored as 1234.

F80: Unsigned value, auto-ranging based on winding 3 phase CT primary value (16 bits)

For winding 3 phase CT primary ≤ 2 A, F80 is an unsigned value with three decimal places. For example, 1.234 is stored as 1234.

For 2 A < winding 3 phase CT primary ≤ 20 A, F80 is an unsigned value with two decimal places. For example, 12.34 is stored as 1234.

For 20 A < winding 3 phase CT primary ≤ 200 A, F80 is an unsigned value with one decimal place. For example, 123.4 is stored as 1234.

For 200 A < winding 3 phase CT primary ≤ 2000 A, F78 is a standard unsigned value. For example, 1234 is stored as 1234.

For winding 3 phase CT primary > 2000 A, F78 is a standard unsigned value scaled by 10. For example, 12340 is stored as 1234.

F81: Unsigned value, auto-ranging based on winding 1 ground CT primary (16 bits)

For winding 1 ground CT primary ≤ 2 A, F81 is an unsigned value with three decimal places. For example, 1.234 is stored as 1234.

For 2 A < winding 1 ground CT primary ≤ 20 A, F81 is an unsigned value with two decimal places. For example, 12.34 is stored as 1234.

For 20 A < winding 1 ground CT primary ≤ 200 A, F81 is an unsigned value with one decimal place. For example, 123.4 is stored as 1234.

For winding 1 ground CT primary > 200 A, F81 is a standard unsigned value. For example, 1234 is stored as 1234.

F82: Unsigned value, auto-ranging based on winding 2 ground CT primary (16 bits)

For winding 2 ground CT primary ≤ 2 A, F82 is an unsigned value with three decimal places. For example, 1.234 is stored as 1234.

For 2 A < winding 2 ground CT primary ≤ 20 A, F82 is an unsigned value with two decimal places. For example, 12.34 is stored as 1234.

For 20 A < winding 2 ground CT primary ≤ 200 A, F82 is an unsigned value with one decimal place. For example, 123.4 is stored as 1234.

For winding 2 ground CT primary > 200 A, F82 is a standard unsigned value. For example, 1234 is stored as 1234.

F83: Unsigned value, auto-ranging based on winding 3 ground CT primary (16 bits)

For winding 3 ground CT primary ≤ 2 A, F83 is an unsigned value with three decimal places. For example, 1.234 is stored as 1234.

For 2 A < winding 3 ground CT primary ≤ 20 A, F83 is an unsigned value with two decimal places. For example, 12.34 is stored as 1234.

For 20 A < winding 3 ground CT primary ≤ 200 A, F83 is an unsigned value with one decimal place. For example, 123.4 is stored as 1234.

For winding 3 ground CT primary > 200 A, F83 is a standard unsigned value. For example, 1234 is stored as 1234.

F84: IRIG-B signal type (16-bit enumeration)

Value	IRIG-B signal
0	None
1	DC shift
2	Amplitude modulated

F85: Trace memory trigger cause (16-bit enumeration)

Value	Trigger
0	No trigger
1	Manual trigger
2	Automatic trigger

F86: Volts per hertz curve shapes (16-bit enumeration)

Value	Curve shape
0	Definite time
1	Inverse curve 1
2	Inverse curve 2
3	Inverse curve 3

F87: Block signal (16-bit enumeration)

Value	Block signal
0	None
1	Logic input 1
2	Logic input 2
3	Logic input 3
4	Logic input 4
5	Logic input 5
6	Logic input 6
7	Logic input 7
8	Logic input 8
9	Logic input 9
10	Logic input 10
11	Logic input 11
12	Logic input 12
13	Logic input 13
14	Logic input 14
15	Logic input 15
16	Logic input 16
17	Virtual input 1
18	Virtual input 2
19	Virtual input 3
20	Virtual input 4
21	Virtual input 5
22	Virtual input 6
23	Virtual input 7

Value	Block signal
24	Virtual input 8
25	Virtual input 9
26	Virtual input 10
27	Virtual input 11
28	Virtual input 12
29	Virtual input 13
30	Virtual input 14
31	Virtual input 15
32	Virtual input 16
33	Output relay 1
34	Output relay 2
35	Output relay 3
36	Output relay 4
37	Output relay 5
38	Output relay 6
39	Output relay 7
40	Output relay 8
41	Self-test relay
42	Virtual output 1
43	Virtual output 2
44	Virtual output 3
45	Virtual output 4
46	Virtual output 5

F88: Assert signal (16-bit enumeration)

Value	Assert signal
0	Disabled
1	Logic input 1
2	Logic input 2
3	Logic input 3
4	Logic input 4
5	Logic input 5
6	Logic input 6
7	Logic input 7
8	Logic input 8

Value	Assert signal
9	Logic input 9
10	Logic input 10
11	Logic input 11
12	Logic input 12
13	Logic input 13
14	Logic input 14
15	Logic input 15
16	Logic input 16

F89: Low voltage winding rating (16-bit enumeration)

Value	Rating
0	above 5 kV
1	1 to 5 kV
2	below 1 kV

F90: Unsigned value, auto-ranging voltage / rated load / minimum tap voltage (16 bits)

For low voltage winding rating ≥ 5 kV, F90 is an unsigned value with one decimal place. For example, 123.4 is stored as 1234.

For 1 kV ≤ low voltage winding rating < 5 kV, F90 is an unsigned value with two decimal places. For example, 12.34 is stored as 1234.

For low voltage winding rating < 1 kV, F90 is an unsigned value with three decimal places. For example, 1.234 is stored as 1234.

F91: Unsigned value, auto-ranging voltage increment per tap (16 bits)

For low voltage winding rating ≥ 5 kV, format F91 is an unsigned value with two decimal places. For example, 12.34 is stored as 1234.

For 1 kV ≤ low voltage winding rating < 5 kV, format F91 is an unsigned value with three decimal places. For example, 1.234 is stored as 1234.

For low voltage winding rating < 1 kV, format F91 is an unsigned value with four decimal places. For example, 0.1234 is stored as 1234.

F92: Harmonic number (16-bit enumeration)

Value	Harmonic
0	2nd harmonic
1	3rd harmonic
2	4th harmonic
3	5th harmonic
4	6th harmonic
5	7th harmonic
6	8th harmonic

Value	Harmonic
7	9th harmonic
8	10th harmonic
9	11th harmonic
10	12th harmonic
11	13th harmonic
12	14th harmonic
13	15th harmonic

Value	Harmonic
14	16th harmonic
15	17th harmonic
16	18th harmonic
17	19th harmonic
18	20th harmonic
19	21st harmonic

For the following three Format Codes - F93, F94, and F95 - a "Low MVA Transformer" is defined as shown in the table below:

Low Voltage Winding Rating	Low MVA Transfomer defined as less than:
<1 kV	0.1 MVA
1 to 5 kV	1.0 MVA
>5 kV	10.0 MVA

F93: Two's-complement, signed value, auto-ranging based on winding 1 phase CT primary (16 bits)

Winding 1 phase CT primary ["W1"]	Is W1 Rated Load a Low MVA Transformer?	Signed Value stored with:	Example
W1≤ 2A	No	3 decimal places	1.234 stored as 1234
2A<W1≤20A	No	2 decimal places	12.34 stored as 1234
20A<W1≤200A	No	1 decimal place	123.4 stored as 1234
W1>200A	No	Standard signed value	1234 stored as 1234
W1≤ 2A	Yes	5 decimal places	0.01234 stored as 1234
2A<W1≤20A	Yes	4 decimal places	0.1234 stored as 1234
20A<W1≤200A	Yes	3 decimal place	1.234 stored as 1234
W1>200A	Yes	2 decimal place	12.34 stored as 1234

F94: Two's-complement, signed value, auto-ranging based on winding 2 phase CT primary (16 bits)

Winding 2 phase CT primary ["W2"]	Is W2 Rated Load a Low MVA Transformer?	Signed Value stored with:	Example
W2≤ 2A	No	3 decimal places	1.234 stored as 1234
2A<W2≤20A	No	2 decimal places	12.34 stored as 1234
20A<W2≤200A	No	1 decimal place	123.4 stored as 1234
W2>200A	No	Standard signed value	1234 stored as 1234
W2≤ 2A	Yes	5 decimal places	0.01234 stored as 1234
2A<W2≤20A	Yes	4 decimal places	0.1234 stored as 1234
20A<W2≤200A	Yes	3 decimal place	1.234 stored as 1234
W2>200A	Yes	2 decimal place	12.34 stored as 1234

F95: Two's-complement, signed value, auto-ranging based on winding 3 phase CT primary (16 bits)

Winding 3 phase CT primary ["W3"]	Is W3 Rated Load a Low MVA Transformer?	Signed Value stored with:	Example
W3≤ 2A	No	3 decimal places	1.234 stored as 1234
2A<W3≤20A	No	2 decimal places	12.34 stored as 1234
20A<W3≤200A	No	1 decimal place	123.4 stored as 1234
W3>200A	No	Standard signed value	1234 stored as 1234
W3≤ 2A	Yes	5 decimal places	0.01234 stored as 1234
2A<W3≤20A	Yes	4 decimal places	0.1234 stored as 1234
20A<W3≤200A	Yes	3 decimal place	1.234 stored as 1234
W3>200A	Yes	2 decimal place	12.34 stored as 1234

F96: Unsigned value, auto-ranging based on winding 1 phase CT primary (32 bits)

For winding 1 phase CT primary ≤ 2 A, format F96 is an unsigned value with three decimal places. For example, 1.234 is stored as 1234.

For 2 A < winding 1 phase CT primary ≤ 20 A, format F96 is an unsigned value with two decimal places. For example, 12.34 is stored as 1234.

For 20 A < winding 1 phase CT primary ≤ 200 A, format F96 is an unsigned value with one decimal place. For example, 123.4 is stored as 1234.

For 200 A < winding 1 phase CT primary ≤ 2000 A, format F96 is a standard unsigned value. For example, 1234 is stored as 1234.

For winding 1 phase CT primary > 2000 A, format F96 is an unsigned value scaled by 10. For example, 12340 is stored as 1234.

F97: Unsigned value, auto-ranging based on winding 2 phase CT primary (32 bits)

For winding 2 phase CT primary ≤ 2 A, format F97 is an unsigned value with three decimal places. For example, 1.234 is stored as 1234.

For 2 A < winding 2 phase CT primary ≤ 20 A, format F97 is an unsigned value with two decimal places. For example, 12.34 is stored as 1234.

For 20 A < winding 2 phase CT primary ≤ 200 A, format F97 is an unsigned value with one decimal place. For example, 123.4 is stored as 1234.

For 200 A < winding 2 phase CT primary ≤ 2000 A, format F97 is a standard unsigned value. For example, 1234 is stored as 1234.

For winding 2 phase CT primary > 2000 A, format F97 is an unsigned value scaled by 10. For example, 12340 is stored as 1234.

F98: Unsigned value, auto-ranging based on winding 3 phase CT primary (32 bits)

For winding 3 phase CT primary ≤ 2 A, format F98 is an unsigned value with three decimal places. For example, 1.234 is stored as 1234.

For 2 A < winding 3 phase CT primary ≤ 20 A, format F98 is an unsigned value with two decimal places. For example, 12.34 is stored as 1234.

For 20 A < winding 3 phase CT primary ≤ 200 A, format F98 is an unsigned value with one decimal place. For example, 123.4 is stored as 1234.

For 200 A < winding 3 phase CT primary ≤ 2000 A, format F98 is a standard unsigned value. For example, 1234 is stored as 1234.

For winding 3 phase CT primary > 2000 A, format F98 is an unsigned value scaled by 10. For example, 12340 is stored as 1234.

F99: Port used for DNP communications (16-bit enumeration)

Value	Port
0	None
1	COM1
2	COM2
3	Front panel port

F100: Cooling type for dry transformer (16-bit enumeration)

Value	Cooling type
0	Sealed self-cooled
1	Vented self-cooled
2	Forced cooled

F101: Unsigned value, auto-ranging load loss at rated load (16 bits)

For low voltage winding rating ≥ 5 kV, format F101 is a standard unsigned value. For example, 1234 is stored as 1234.

For 1 kV ≤ low voltage winding rating < 5 kV, format F101 is an unsigned value with one decimal place. For example, 123.4 is stored as 1234.

For low voltage winding rating < 1 kV, format F101 is an unsigned value with two decimal places. For example, 12.34 is stored as 1234.

F102: Data link confirmation mode (16-bit enumeration)

Value	Confirmation mode
0	Never
1	Sometimes
2	Always

F103: Ground input selection (16-bit enumeration)

Value	Port
0	None
1	G1/2
2	G2/3

F150: IP address (unsigned 32-bit integer)

Each byte in this register represents one octet in an IP address. For example, 015EDA1F hex indicates IP address 1.94.218.31.

F152: Ethernet status (16-bit bitmask)

Bitmask	Status
---- ---- ---- ---1	Diagnostic status on
---- ---- ---- --1-	Connection status on
---- ---- ---- -1--	Not used
---- ---- ---- 1---	Ethernet link status on

F153: Output relay flags (16-bit bitmask)

Bitmask	Output Selection
---- ---- ---- ---1	Output relay 1 (0 = Not Assigned; 1 = Assigned)
---- ---- ---- --1-	Output relay 2 (0 = Not Assigned; 1 = Assigned)
---- ---- ---- -1--	Output relay 3 (0 = Not Assigned; 1 = Assigned)
---- ---- ---- 1---	Output relay 4 (0 = Not Assigned; 1 = Assigned)
---- ---- ---1 ----	Output relay 5 (0 = Not Assigned; 1 = Assigned)
---- ---- --1- ----	Output relay 6 (0 = Not Assigned; 1 = Assigned)
---- ---- -1-- ----	Output relay 7 (0 = Not Assigned; 1 = Assigned)
---- ---- 1--- ----	Output relay 8 (0 = Not Assigned; 1 = Assigned)

F156: floating point (32 bits)

IEEE 754 single precision binary floating-point format: binary32.

The first modbus address contains the sign bit, exponent, and 7 most significant bits of the fraction. The second modbus address contains the 16 least significant bits of the fraction.

Reference: http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=4610935

Digital Energy
Multilin

745 TRANSFORMER PROTECTION SYSTEM COMMUNICATIONS GUIDE

Chapter 3: DNP Protocol

Overview

Device profile document

The communications port configured as a DNP slave port must support the full set of features listed in the Level 2 DNP V3.00 Implementation (DNP-L2) described in Chapter 2 of the subset definitions. See the DNP protocol website at http://www.dnp.org for details.

DNP 3.0: DEVICE PROFILE DOCUMENT	
Vendor Name: GE Multilin Inc.	
Device Name: 745 Transformer Protection System	
Highest DNP Level Supported: For Requests: Level 2 For Responses: Level 2	Device Function: ❒ Master ☒ Slave
Notable objects, functions, and/or qualifiers supported in addition to the Highest DNP Levels Supported (the complete list is described in the attached table): Binary Input (Object 1, variations 1 and 2) Binary Output (Object 10, variation 2) Analog Input (Object 30, variations 1, 2, 3, and 4) Analog Input Change (Object 32, variations 1, 2, 3, and 4) Warm Restart (Function Code 14)	
Maximum Data Link Frame Size (octets): Transmitted: 292 Received: 292	Maximum Application Fragment Size (octets): Transmitted: 2048 Received: 2048
Maximum Data Link Re-tries: ❒ None ❒ Fixed ☒ Configurable (note 1)	Maximum Application Layer Re-tries: ☒ None ❒ Configurable
Requires Data Link Layer Confirmation: ❒ Never ❒ Always ❒ Sometimes ☒ Configurable (note 1)	
Requires Application Layer Confirmation: ❒ Never ❒ Always ☒ When reporting Event Data ❒ When sending multi-fragment responses ❒ Sometimes ❒ Configurable	

DNP 3.0: DEVICE PROFILE DOCUMENT (Continued)

Timeouts while waiting for:

Data Link Confirm	☐ None	☐ Fixed	☐ Variable	☒ Configurable
Complete Appl. Fragment	☒ None	☐ Fixed	☐ Variable	☐ Configurable
Application Confirm	☒ None	☐ Fixed	☐ Variable	☐ Configurable
(fixed value is 5000 milliseconds				
Complete Appl. Response	☒ None	☐ Fixed	☐ Variable	☐ Configurable
Others (None)				

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
Trip/Close	☐ Never	☐ Always	☒ Sometimes	☐ Configurable
See *Binary output / control relay output block* on page 3–4 for explanation of above.				
Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable
Clear Queue	☒ Never	☐ Always	☐ Sometimes	☐ Configurable

Reports Binary Input Change Events when no specific variations requested:
- ☐ Never
- ☒ Only time-tagged
- ☐ Only non-time-tagged
- ☐ Configurable to send both, one or the other

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

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

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

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

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

Sends Multi-Fragment Responses: ☐ Yes ☒ No

Table notes:

1. The data link layer confirmation mode, confirmation timeout, and number of retries are all configurable. Refer to the 745 instruction manual for further details.

Implementation table

The following table gives a list of all objects recognized and returned by the relay. Additional information is provided on the following pages including a list of the default variations returned for each object and lists of defined point numbers for each object.

Implementation table notes:

1. For this object, the quantity specified in the request must be exactly 1 as there is only one instance of this object defined in the relay.
2. All static input data known to the relay is returned in response to a request for Class 0. This includes all objects of type 1 (binary input), type 10 (binary output) and type 30 (analog input).
3. The point tables for binary input and analog input objects contain a field which defines to which event class the corresponding static data has been assigned.
4. For this object, the qualifier code must specify an index of 7 only.

Table 3–1: DNP implementation table

Object			Request		Response	
Obj	**Var**	**Description**	**Func codes**	**Qual codes (Hex)**	**Func codes**	**Qual codes (Hex)**
1	0	Binary Input - All Variations	1	06		
1	1	Binary Input	1	00, 01, 06	129	00, 01
1	2	Binary Input With Status (Note 6)	1	00, 01, 06	129	00, 01
2	0	Binary Input Change - All Variations	1	06, 07, 08		
2	1	Binary Input Change Without Time	1	06, 07, 08	129	17, 28
2	2	Binary Input Change With Time	1	06, 07, 08	129	17, 28
10	0	Binary Output - All Variations	1	06		
10	2	Binary Output Status	1	00, 01, 06	129	00, 01
12	1	Control Relay Output Block	3, 4, 5, 6	17, 28	129	17, 28
30	0	Analog Input - All Variations	1	06		
30	1	32-Bit Analog Input With Flag	1	00, 01, 06	129	00, 01
30	2	16-Bit Analog Input With Flag	1	00, 01, 06	129	00, 01
30	3	32-Bit Analog Input Without Flag	1	00, 01, 06	129	00, 01
30	4	16-Bit Analog Input Without Flag	1	00, 01, 06	129	00, 01
32	0	Analog Input Change - All Variations	1	06, 07, 08		
32	1	32-Bit Analog Input Change without Time	1	06, 07, 08	129	17, 28
32	2	16-Bit Analog Input Change without Time	1	06, 07, 08	129	17, 28
32	3	32-Bit Analog Input Change with Time	1	06, 07, 08	129	17, 28
32	4	16-Bit Analog Input Change with Time	1	06, 07, 08	129	17, 28
50	1	Time and Date	1, 2	07 (Note 1)	129	07
60	1	Class 0 Data (Note 2)	1	06	129	
60	2	Class 1 Data (Note 3)	1	06, 07, 08	129	
60	3	Class 2 Data (Note 3)	1	06, 07, 08	129	
60	4	Class 3 Data (Note 3)	1	06, 07, 08	129	
80	1	Internal Indications	2	00 (Note 4)	129	
		No object - Cold Start	13			
		No object - Warm Start	14			
		No object - Delay Measurement	23			

1, 2, 3, 4: see the IMPLEMENATION TABLE NOTES above.

The following table specifies the default variation for all objects returned by the relay. These are the variations that will be returned for the object in a response when no specific variation is specified in a request.

Object	Description	Default variation
1	Binary input - single bit	1
2	Binary input change with time	2
10	Binary output status	2
30	16-bit analog input without flag	4
32	16-bit analog input change without time	2

DNP point lists

Binary input / binary input change

The point list for binary input (object 01) and binary input change (object 02) is shown below.

Table 3–2: Binary input points

Index	Description	Event class assigned to
0	Logic input 1 operated	Class 1
1	Logic input 2 operated	Class 1
2	Logic input 3 operated	Class 1
3	Logic input 4 operated	Class 1
4	Logic input 5 operated	Class 1
5	Logic input 6 operated	Class 1
6	Logic input 7 operated	Class 1
7	Logic input 8 operated	Class 1
8	Logic input 9 operated	Class 1
9	Logic input 10 operated	Class 1
10	Logic input 11 operated	Class 1
11	Logic input 12 operated	Class 1
12	Logic input 13 operated	Class 1
13	Logic input 14 operated	Class 1
14	Logic input 15 operated	Class 1
15	Logic input 16 operated	Class 1
16	Output relay 1 energized	Class 1
17	Output relay 2 energized	Class 1
18	Output relay 3 energized	Class 1
19	Output relay 4 energized	Class 1
20	Output relay 5 energized	Class 1
21	Output relay 6 energized	Class 1
22	Output relay 7 energized	Class 1
23	Output relay 8 energized	Class 1
24	Self-test relay energized	Class 1
25	Setpoint group 1 active	Class 1
26	Setpoint group 2 active	Class 1
27	Setpoint group 3 active	Class 1
28	Setpoint group 4 active	Class 1

NOTE

Any detected change in the state of any point will cause the generation of an event object.

Binary output / control relay output block

The following restrictions should be observed when using object 12 to control the points listed in the above table.

1. The *Count* field is checked first. If it is zero, the command will be accepted but no action will be taken. If this field is non-zero, the command will be executed exactly once regardless of its value.
2. The *Control code* field of object 12 is then inspected:

- The Queue and Clear sub-fields are ignored.
- For point 0, the valid *control code* values are "Pulse On" (1 hex), "Latch On" (03h), or "Close - Pulse On" (41h). Any of these may be used to initiate the function (reset) associated with the point
- Virtual inputs may be set (i.e. asserted) via a *Control code* value of "Latch On" (3 hex), "Close - Pulse On" (41h), or "Close - Latch On" (43h), A control code value of "Latch Off" (04h), "Trip Pulse - On" (81h), or "Trip - Latch On" (83h) may be used to clear a virtual input.
- Any value in the *control code* field not specified above is invalid and will be rejected.

3. The *On time* and *Off time* fields are ignored. Since all controls take effect immediately upon receipt, timing is irrelevant.
4. The *Status* field in the response will reflect the success or failure of the control attempt thus:
   - A status of "Request Accepted" (0) will be returned if the command was accepted.
   - A status of "Request not Accepted due to Formatting Errors" (3) will be returned if the *control code* field was incorrectly formatted.
   - If select/operate was used, a status of "Arm Timeout" (1) or "No Select" (2) is returned if the associated failure condition is detected.

An operate of the reset point may fail to clear active targets (although the response to the command will always indicate successful operation) due to other inputs or conditions (e.g. blocks) existing at the time. To verify the success or failure of an operate of this point, it is necessary to examine the associated binary input(s) after the control attempt is performed.

When using object 10 to read the status of a binary output, a read of point 0 will always return zero. For other points, the current state of the corresponding virtual input will be returned.

Table 3–3: Binary output points

Index	Description
0	Reset
1	Virtual Input 1
2	Virtual Input 2
3	Virtual Input 3
4	Virtual Input 4
5	Virtual Input 5
6	Virtual Input 6
7	Virtual Input 7
8	Virtual Input 8
9	Virtual Input 9
10	Virtual Input 10
11	Virtual Input 11
12	Virtual Input 12
13	Virtual Input 13
14	Virtual Input 14
15	Virtual Input 15
16	Virtual Input 16

Analog input / analog input change

In the following table, the entry in the *Format* column indicates that the format of the associated data point can be determined by looking up the entry in *Memory map data formats* on page 2–69. For example, an "F1" format is described in that section as a 16-bit unsigned value without any decimal places. Therefore, the value read should be interpreted in this manner.

Table 3–4: Analog input DNP points (Sheet 1 of 2)

Index when point mapping is		For-mat	Description	Event class	Notes
Disabled	Enabled				
n/a	0	-	User map value 1	---	---
n/a	1	-	User map value 2	---	---
n/a	2	-	User map value 3	---	---
↓	↓	↓	↓	---	---
n/a	118	-	User map value 119	---	---
n/a	119	-	User map value 120	---	---
0	120	F1	Winding 1 phase CT primary	Class 1	2, 6
1	121	F1	Winding 2 phase CT primary	Class 1	2, 7
2	122	F1	Winding 3 phase CT primary	Class 1	2, 5,8
3	123	F1	Winding 1 ground CT primary	Class 1	2, 9
4	124	F1	Winding 2 ground CT primary	Class 1	2, 10
5	125	F1	Winding 3 ground CT primary	Class 1	2, 5, 11
6	126	F78	Winding 1 phase A current magnitude	Class 1	6
7	127	F78	Winding 1 phase B current magnitude	Class 1	6
8	128	F78	Winding 1 phase C current magnitude	Class 1	6
9	129	F78	Winding 1 neutral current magnitude	Class 1	6
10	130	F81	Winding 1 ground current magnitude	Class 1	5, 9
11	131	F1	Winding 1 loading	Class 1	
12	132	F78	Winding 1 average phase current magnitude	Class 1	6
13	133	F79	Winding 2 phase A current magnitude	Class 1	7
14	134	F79	Winding 2 phase B current magnitude	Class 1	7
15	135	F79	Winding 2 phase C current magnitude	Class 1	7
16	136	F79	Winding 2 neutral current magnitude	Class 1	7
17	137	F82	Winding 2 ground current magnitude	Class 1	5, 10
18	138	F1	Winding 2 loading	Class 1	
19	139	F79	Winding 2 average phase current magnitude	Class 1	7
20	140	F80	Winding 3 phase A current magnitude	Class 1	5, 8
21	141	F80	Winding 3 phase B current magnitude	Class 1	5, 8
22	142	F80	Winding 3 phase C current magnitude	Class 1	5, 8
23	143	F80	Winding 3 neutral current magnitude	Class 1	5, 8
24	144	F83	Winding 3 ground current magnitude	Class 1	5, 11
25	145	F1	Winding 3 loading	Class 1	5
26	146	F80	Winding 3 average phase current magnitude	Class 1	5, 8
27	147	F78	Winding 1 positive-sequence current magnitude	Class 1	6
28	148	F79	Winding 2 positive-sequence current magnitude	Class 1	7
29	149	F80	Winding 3 positive-sequence current magnitude	Class 1	5, 8
30	150	F78	Winding 1 negative-sequence current magnitude	Class 1	6

Table 3–4: Analog input DNP points (Sheet 2 of 2)

Index when point mapping is		For-mat	Description	Event class	Notes
Disabled	Enabled				
31	151	F79	Winding 2 negative-sequence current magnitude	Class 1	7
32	152	F80	Winding 3 negative-sequence current magnitude	Class 1	5,8
33	153	F78	Winding 1 zero-sequence current magnitude	Class 1	6
34	154	F79	Winding 2 zero-sequence current magnitude	Class 1	7
35	155	F80	Winding 3 zero-sequence current magnitude	Class 1	5,8
36	156	F3	Phase A differential current magnitude	Class 1	
37	157	F3	Phase B differential current magnitude	Class 1	
38	158	F3	Phase C differential current magnitude	Class 1	
39	159	F53	Winding 1 ground differential current	Class 1	5
40	160	F53	Winding 2 ground differential current	Class 1	5
41	161	F53	Winding 3 ground differential current	Class 1	5
42	162	F2	Winding 1 phase A THD	Class 1	
43	163	F2	Winding 1 phase B THD	Class 1	
44	164	F2	Winding 1 phase C THD	Class 1	
45	165	F2	Winding 2 phase A THD	Class 1	
46	166	F2	Winding 2 phase B THD	Class 1	
47	167	F2	Winding 2 phase C THD	Class 1	
48	168	F2	Winding 3 phase A THD	Class 1	5
49	169	F2	Winding 3 phase B THD	Class 1	5
50	170	F2	Winding 3 phase C THD	Class 1	5
51	171	F3	System frequency	Class 1	3
52	172	F1	Tap changer position	Class 1	
53	173	F3	System line-to-line voltage	Class 1	5
54	174	F3	Volts-per-hertz	Class 1	5
55	175	F3	Line-to-neutral voltage magnitude	Class 1	5
56	176	F4	Ambient temperature	Class 1	5
57	177	F4	Hottest-spot winding temperature	Class 1	5
58	178	F2	Insulation aging factor	Class 1	5
59	179	F7	Total accumulated loss of life	Class 1	5, 12
60	180	F1	Analog input	Class 1	5
61	181	F93	Winding 1 real power	Class 1	5,6
62	182	F93	Winding 1 reactive power	Class 1	5,6
63	183	F93	Winding 1 apparent power	Class 1	5,6
64	184	F6	Winding 1 power factor	Class 1	5
65	185	F94	Winding 2 real power	Class 1	5,7
66	186	F94	Winding 2 reactive power	Class 1	5,7
67	187	F94	Winding 2 apparent power	Class 1	5,7
68	188	F6	Winding 2 power factor	Class 1	5
69	189	F95	Winding 3 real power	Class 1	5, 8
70	190	F95	Winding 3 reactive power	Class 1	5, 8
71	191	F95	Winding 3 apparent power	Class 1	5, 8
72	192	F6	Winding 3 power factor	Class 1	5

Table notes:

1. Unless otherwise specified, an event object will be generated for a point if the current value of the point changes by an amount greater than or equal to two percent of its previous value.
2. An event object is created for these points if the current value of a point is in any way changed from its previous value.
3. An event object is created for the system frequency point if the system frequency changes by 0.04 Hz or more from its previous value.
4. The data returned by a read of the user map value points is determined by the values programmed into the corresponding user map address registers (which are only accessible via Modbus). Refer to *Accessing data via the user map* on page 2–9 for more information. Changes in user map value points never generate event objects. Because of the programmable nature of the user map, it cannot be determined at read time if the source value is signed or unsigned. For this reason, the data returned in a 32-bit variation is never sign-extended even if the source value is negative.
5. Depending upon the configuration and/or programming of the 745, this value may not be available. Should this be the case, a value of zero will be returned.
6. Points with format F78 and F93 are scaled based upon the value of the **WINDING 1 PHASE CT PRIMARY** setpoint (point 0). It is necessary to read point 0 and refer to the descriptions of these formats (see *Memory map data formats* on page 2–69) to determine the scale factor.
7. As for Note 6, except the affected formats are F79 and F94 and the scaling is determined by the value from Point 1.

1. As for Note 6 except the affected formats are F80 and F95 and the scaling is determined by the value from Point 2.
2. As for Note 6 except the affected format is F81 and the scaling is determined by the value read from Point 3.
3. As for Note 6 except the affected format is F82 and the scaling is determined by the value read from Point 4.
4. As for Note 6 except the affected format is F83 and the scaling is determined by the value read from Point 5.
5. The total accumulated loss of life is a 32-bit, unsigned, positive value. As a consequence, a master performing 16-bit reads cannot be guaranteed to be able to read this point under all conditions. When this point's value exceeds 65535 (FFFFh), a 16-bit read will return FFFFh and the over-range bit in the flag returned with the data will be set. Because of this possibility of over-range, the default variation for this object is 2 (that is, 16-bit analog input with flag).
6. There are two defined maps for analog output points. The map used is specified by the setting of the “point mapping” setpoint at Modbus address 10D1h. This setpoint may be set to a value of “Disabled” or “Enabled”. When “Disabled”, only the preassigned analog output points are available at indices 0 through 72.

   When “Enabled”, the user map values are assigned to points 0 through 119 with the preassigned analog outputs following beginning with point index 120. The value read from points 0 through 119 will depend upon the value programmed into the corresponding user map address setpoint (programming these setpoints can only be accomplished via Modbus). Refer to *Accessing data via the user map* on page 2–9 for more information.

Please note that changes in user map values never generate event objects.

Index

F

G

H

I

L

M

N

O

P

R

S

T

U

V

W