SATEC
Powerful Solutions

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High Performance Analyzer
PM180

IEEE C37.118.2 Synchrophasor Data Transfer Protocol

Reference Guide

Every effort has been made to ensure that the material herein is complete and accurate. However, the manufacturer is not responsible for any mistakes in printing or faulty instructions contained in this book. Notification of any errors or misprints will be received with appreciation.

For further information regarding a particular installation, operation or maintenance of equipment, contact the manufacturer or your local representative or distributor.

REVISION HISTORY

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1 General

This document describes protocol implementation features and configuring of the IEEE C37.118.2 synchrophasor data transfer protocol in the PM180 phasor measurement unit (PMU).

The PM180 PMU supports commanded client-server UDP and TCP data transmission and spontaneous UDP data transmission over IP protocol. Serial communication is not supported as obsolete and rarely used for synchrophasor data transfer.

Streaming of synchrophasor data is also available over Ethernet via the IEC 61850 protocol by mapping the IEEE C37.118.2 synchrophasor data stream to IEC 61850-9-2 sampled values service (see the PM180 IEC 61850 communication protocol reference guide for more information).

IEEE C37.118.2 reference documents:

IEEE Std C37.118.1-2011, IEEE Standard for Synchrophasor Measurements for Power Systems

IEEE Std C37.118.1a-2014, IEEE Standard for Synchrophasor Measurements for Power Systems, Amendment 1: Modification of Selected Performance Requirements

IEEE Std C37.118.2-2011, IEEE Standard for Synchrophasor Data Transfer for Power Systems

2 Protocol Implementation

The IEEE C37.118.2 protocol is implemented in the PM180 in a flexible manner. Most of IEEE C37.118.2 features are user-configurable allowing easy adaptation for use in different installations. To keep maximum interoperability with phasor data concentrators (PDC) and controlling stations, the PM180 supports all standard frame types for synchrophasor data interrogation and streaming.

The PAS configuration software supplied with the PM180 provides all necessary tools for remote configuration of the device.

See Chapter 3 for instructions on how to configure IEEE C37.118.2 options in the device for your particular installation.

See the PM180 Operation Manual for more information on configuring the meter via PAS.

The protocol implementation details are explained in the following sections.

2.1 IEEE C37.118.2 Data Communications

The PM180 PMU provides commanded client-server UDP and TCP data transmission and spontaneous UDP data transmission over IP protocol.

The synchrophasor data is transmitted at a programmable reporting rate of 1 to 60 frames per second at sub-multiples of the nominal power line frequency.

The data stream ID number you assigned to the PMU via the IEEE C37.118.2 setup uniquely identifies a synchrophasor data stream. Only requests with the matching data stream ID are responded by the PMU.

2.1.1 Unicast Commanded UDP and TCP Data Transmission

Commanded data transmission must be explicitly turned on by a command sent by a client to receive synchrophasor data via a unicast UDP or TCP connection.

Streaming Data Slots

The PM180 PMU provides 5 data streaming slots for continuous streaming synchrophasor data via unicast UDP or/and TCP connections.

Although the UDP server responds to commands from unlimited number of UDP clients and the TCP server can support up to 8 client connections, the commands to turn on data transmission on new connections after all 5 data streams are running will be ignored.

TCP Connection Timeout

An idling TCP connection is closed if there is no activity on both sides, i.e. there are no master commands received or no streaming data transmission, within a programmable connection idle timeout. You can change the TCP connection idling timeout via the device Network Setup (see the PM180 Operation Manual for details).

Uncontrollable Commanded UDP Data Flow

Unlike TCP connections, in case of the commanded UDP transmission, IEEE C37.118.2 does not provide tools for probing whether a client who initiated transmission is still alive and listening to the synchrophasor data stream.

Abnormal termination of client operations without explicit turning off the data transmission may leave the streaming slot active forever and thus limit the number of slots available for new data streams.

The PM180 provides a command you can send to the device via the IEEE C37.118.2 setup dialog (see Section 3) that stops all active commanded UDP streams and releases the corresponding data streaming slots.

You can check which data streams are currently active via the device Telnet server. Run a Telnet client on your PC, log on to the device, type "enet" on the main menu command prompt, and then type "proto". See the PM180 Operation Manual for more information on operating Telnet. The following picture shows what the active data stream list may look like.

```
Telnet 192.168.0.212                          _ □ ×
>enet

Ethernet Menu Commands
--------------------
 h        - Display this text
 net      - Current network addresses
 ip       - Network settings
 stat [net|tcp|udp|ip|icmp|arp|dns|sock] - Network statistics
 proto [c37.118] - Application protocol statistics
 stop net - Shut the network down
 run net  - Start the network
 q        - Quit menu

ENET>proto

C37.118.2 protocol statistics

Running commanded data streams:
TCP: client address 192.168.0.135 port 51828
UDP: client address 192.168.0.139 port 4713
UDP: client address 192.168.0.135 port 4713
UDP: client address 192.168.0.72 port 4713

ENET>_
```

2.1.2   Spontaneous UDP Data Transmission

Spontaneous synchrophasor data transmission is explicitly enabled and disabled by the user via the IEEE C37.118.2 setup (see Section 3 for details). The destination UDP port and IP address are configurable.

Spontaneous UDP data transmission operates in unicast, multicast or broadcast mode depending on the destination IP address you specified.

If the UDP clients have an ability to join a multicast group, you can select one from the multicast address range of 225.0.0.0 through 239.255.255.255.

For broadcast transmission within your local network, set the host part of the network address to 255 as shown in the default IP address example. Use a routable broadcast address to expand the broadcast transmission beyond your local network.

2.2   IEEE C37.118.2 Message Frames

2.2.1   Data Frames

Synchrophasor data frames transmit a time stamped set of measurements that include three voltage and three current phasors, frequency deviation from the nominal power line frequency and the rate of change of frequency.

The IEEE C37.118.2 data frame format is user configurable. You can specify the PMU station name, data stream ID number, data representation format, and data transmission rate via the IEEE C37.118.2 setup (see Section 3 for details).

The complex phasors values can be sent in a rectangular coordinates format (real and imaginary) or in polar coordinates (magnitude and angle). The phasor and frequency data can be represented in 32-bit IEEE floating-point format or as 16-bit scaled integer numbers. In case of using integer format, the data conversion factors are provided via the IEEE C37.118.2 configuration frames.

2.2.2   Configuration Frames

IEEE C37.118.2 configuration frames provide information about a synchrophasor data stream in binary format. The PM180 PMU supports two mandatory configuration frames CFG-1 and CFG-2. The optional CFG-3 frame introduced by IEEE C37.118.2-2011 is not implemented.

The configuration frame contents correspond to the specification given by IEEE C37.118.2.

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In case of transmission data in floating point format, the data conversion factors will be given as 1 and should be ignored.

2.2.3   Header Frame

A header frame gives information about a synchrophasor data stream in human-readable format. An example of the header frame is shown below.

Station Name: My Station
ID Code: 7000
UTC Time: 2019-06-03 05:31:51.786
Time Quality: Locked
Time Base: 1000000
Revision Count: 4
Data Rate: 50
Total Phasors: 6
Total Analogs: 0
Total Digitals: 0
Phasor Coordinate Format: Rectangular
Phasor Data Format: Integer
Frequency Data Format: Integer
VA Conversion Factor: 5.05387
VB Conversion Factor: 5.05387
VC Conversion Factor: 5.05387
IA Conversion Factor: 0.61037
IB Conversion Factor: 0.61037
IC Conversion Factor: 0.61037
Angle Conversion Factor: 0.0001
Frequency Conversion Factor: 0.001
df/dt Conversion Factor: 0.01
Nominal Frequency: 50 Hz

3 Configuring IEEE C37.118.2

Use PAS configuration software provided with your device to configure IEEE C37.118.2 options. See the PM180 Operation Manual for more information on installation and operating PAS on your computer.

To configure the IEEE C37.118.2 options:

1. Ensure that the selected connection protocol to communicate with your device is set to Modbus RTU or Modbus ASCII.

2. Select Communications Setup from the Meter Setup menu and then click on the IEEE C37.118.2 Setup tab.

3. Select desired options.

4. Click Save as… to store your setup in the device site database, and click Send to send the setup to the device.

See the following table for available options.

Parameter	Options	Default	Description
IEEE C37.118.2 Setup			
Station Name	Up to 16 ASCII characters	station_name	Identifies the station
Data Stream ID Number	1-65534	7000	Identifies the data stream

Parameter	Options	Default	Description
Phasor Coordinate Format	Rectangular = phasor real and imaginary, Polar = magnitude and angle	Rectangular	Selects the representation format for phasor vector
Phasor/Frequency Data Format	16-bit integer, 32-bit IEEE floating point	32-bit IEEE floating point	Selects the data format for phasor and frequency data
Data Rate, frames/s	1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 25, 30, 50, 60	10	Rate of data transmission.
Configuration Change Count	0-65535	0	
Client-server UDP/TCP Transmission			
Local UDP Port	1024-49151	4713	Local UDP port number for commanded client-server UDP operation.
Local TCP Port	1024-49151	4712	Local TCP port number for client-server TCP operation.
Stop UDP Streams	NO, YES	NO	Stops all active commanded UDP streams. Can be used to stop uncontrollable UDP streams in case of an abnormal client disconnection.
Spontaneous UDP Transmission			
Transmission Enabled	Disabled, Enabled	Disabled	Enables spontaneous data transmission.
Destination UDP Port	1024-49151	4713	Destination port number for spontaneous data transmission.
Destination IP Address (unicast/multicast)		192.168.0.255	Destination IP address for spontaneous data transmission. Can be unicast, multicast or broadcast address.

NOTES:

1. Configure the synchrophasor data frame properties and local port settings before turning on the data transmission. Changing either invalidates all active data streams and stops data transmission in progress.

2. Changing the local TCP port causes closing all active connections and restarting the network services. If you make changes via an Internet connection, wait a couple of seconds until the network is ready for operation before sending a new connection request.

3. The selected data rate is automatically rounded up to the nearest sub-multiple of the nominal frequency. In case of using both IEEE C37.118.2 and IEC 61850 synchrophasor data communications, the new data rate is applied to both protocols.

4. Changing the synchrophasor data frame properties advances the configuration change count. You can set it to any desired number by explicit writing the count value.