

MiCOM P746

Numerical Busbar Protection Relay

P746/EN PX/B11

Software Version 01 and 02

PIXIT

Note: The technical manual for this device gives instructions for its installation, commissioning, and operation. However, the manual cannot cover all conceivable circumstances or include detailed information on all topics. In the event of questions or specific problems, do not take any action without proper authorization. Contact the appropriate Schneider Electric technical sales office and request the necessary information.

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1 PROTOCOL IMPLEMENTATION EXTRA INFORMATION FOR TESTING

1.1 Introduction

This document specifies the protocol implementation extra information for testing (PIXIT) of the IEC 61850 interface in the MiCOM Px40 range of protection relays. Together with the PICS and MICS specifications the PIXIT forms the basis for conformance testing in accordance with part 10 of the IEC 61850 standard specifications.

1.2 Document Structure

Each section within this specification specifies the PIXIT for each supported ACSI service model as structured in parts 7-2 and 10 of the IEC 61850 standard specifications.

2 APPLICATION ASSOCIATION MODEL

2.1 Association Parameters

The following parameters are required to be specified when attempting to initiate an association with MiCOM Px40 relays:

Parameter	Value
Transport selector (tsel)	00 01
Session selector (ssel)	00 01
Presentation selector (psel)	00 00 00 01

The following parameters are only required for OSI based connections only and are not supported:

- AP Title
- AE Qualifier

2.2 Aborting Associations

When a client aborts its association the TCP/IP socket is not immediately closed down by the relay. This is a standard operating principle to ensure that any delayed or out-of-order frames are correctly processed before closing down the socket.

The time-out period for aborted sockets is approximately sixty (**60**) seconds. For the duration of this time-out period the socket resources are unavailable for new client association requests.

A total of 100 sockets are available but it should be noted that these resources are shared with other network tasks (for example SNTP time synchronization). If no sockets are available the relay will refuse new association requests from a client.

2.3 Maximum Client Associations

The maximum number of simultaneously connected clients supported is sixteen (**16**).

2.4 TCP Keep Alive

The TCP_KEEPALIVE function has been implemented according to part 8 of the IEC 61850 standards and the RFCs which the specification references. Acknowledgements received by the relay to keep-alive messages are not processed.

The interval between the keep-alive messages is configurable between one (1) and twenty (20) seconds, with a setting increment of one (1) second.

The default interval for TCP_KEEPALIVE messages transmitted by the relay is five (5) seconds.

2.5 Loss of Link Detection

Px40 devices support loss of network link detection. The device will automatically attempt to connect back onto the network using alternating copper or fiber interfaces. The period for alternating between interfaces is user configurable with a default period of sixty (**60**) seconds.

Any client associations will be automatically aborted if the network link is not re-established after a maximum of ninety (**90**) seconds.

The TCP_KEEPALIVE messages are transmitted for a fixed period of approximately 75 seconds following the last received keep-alive response, after which time the client association will be dropped.

2.6 Authentication

Authentication is not supported by MiCOM Px40 relays.

The default access level over the IEC 61850 interface is level 2 although actual setting changes are not supported.

2.7 MMS PDU Size

The maximum supported MMS PDU size is 8000 bytes, while the minimum supported MMS PDU size is 400 bytes.

2.8 Startup Time

The typical start-up time of basic Ethernet services, following an interruption to the power supply, is approximately 25 seconds. Full IEC 61850 services are available after an approximate start-up time of 30 seconds.

3 SERVER MODEL

3.1 Data Quality (Measurements and Status Points)

The MiCOM Px40 range of products does not support the concept of IEC 61850 quality information, as such all quality data attributes return a fixed value of zero (0) indicating the quality of data is good.

3.2 Get/Set Data Values Services

The maximum number of data values supported in one GetDataValues and SetDataValues service request is dependant upon the following elements:

- The maximum negotiated size of the MMS PDU
- The total length of all *ObjectReferences* to be included within the service request

That is to say, the total length of all *ObjectReferences* must be less than the maximum supported MMS PDU size, taking into account any relevant header information.

3.3 Measurement Deadbands

MiCOM Px40 relays do not range-limit measurements, as such deadbands become impossible to specify in terms of a percentage change based on measurement limits.

For this reason, deadbands are configured based on an absolute value change with the following ranges:

Deadband setting	Comment	Impact
0	Deadbanding disabled	Deadbanded measurements follow the instantaneous measurement value
1 - 100,000	Absolute value changes of 0.001 to 100.0 respectively. Based on the formula: (Deadband setting/1000)	Deadbanded measurement will be updated when the instantaneous (absolute) value changes by more than the absolute deadband value

The main limitation of this implementation is that the maximum deadband value (100,000) may still produce data changes if the change is large enough.

4 DATA SET MODEL

4.1 Data Set Structure and Content

The structure and content of all data sets within MiCOM Px40 devices are fixed.

The number of elements in each reported data set is directly dependant upon the count of data attributes contained within the MX or ST functional constraints, as reported by the Report Control Blocks in each Logical Node instance.

None of the pre-defined data sets can be deleted.

4.2 User Definable Data Sets

MiCOM Px40 devices do not support the dynamic creation of any type of user-defined data set, either persistent or non-persistent.

5 SUBSTITUTION MODEL

5.1 Measurement and Status Point Substitution

The substitution model for measurements (MX functional constraint) and status points (ST functional constraint) is not supported in MiCOM Px40 relays.

6 SETTING GROUP CONTROL MODEL

6.1 Protection Configuration

MiCOM Px40 devices do not support on-line setting changes of protection elements over the IEC 61850 interface despite supporting multiple setting groups. As such there are no Setting Group Control Blocks (SGCB) exposed within the data model.

Only basic measurements and status point (read-only) information is provided.

Configuration of MiCOM Px40 devices is achieved through the use of the tools provided in the MiCOM S1 configuration software package.

6.2 Active Data Attribute Values

The data attribute values returned over the IEC 61850 interface to requesting clients are always taken from the active setting group of the relay.

It should be noted that there is no way of changing the active setting group using the IEC 61850 data model, however it is possible through the use of GOOSE.

7 REPORTING MODEL

7.1 Supported Report Control Block Types

MiCOM Px40 devices only support unbuffered Report Control Block (URCB) services.

7.2 Trigger Conditions

The following report trigger conditions are supported:

- Integrity
- Data change
- General interrogation

All other trigger conditions are not supported and an attempt to enable them will result in a negative response being returned by the relay.

7.3 URCB Optional Fields

The following optional fields can be included in unbuffered reports created by MiCOM Px40 devices:

- Sequence number
- Time-stamp
- Reason for inclusion
- Data set name
- Data reference
- Configuration revision

7.4 Segmented Reports

Reports will be segmented, and sent with sub-sequence numbers, if the data is too big to fit into a single MMS frame.

7.5 Multi-Client URCB Support

Each connected client will be assigned its own set of unbuffered Report Control Blocks. This allows clients to enable reporting based on their own requirements rather than having to share URCB resources with all other (connected) clients.

As each client is assigned its own URCB, the use of the reserve attribute becomes redundant although this is still supported within the control block.

7.6 Pre-Configured Attributes

The following pre-configured attributes can not be changed, either during device configuration (from SCL) or online by a connected client:

- DataSet [Data set to report]

8 LOGGING MODEL

8.1 Event Logging

MiCOM Px40 devices do not support IEC 61850 logging services, hence there are no Log Control Blocks (LCB) exposed within the data model.

The existing relay event log is used to store historical data. This is only available over the front panel user interface or legacy rear port protocols (i.e. Courier).

9 GENERIC SUBSTATION EVENTS MODEL

9.1 Supported GSE Models

MiCOM Px40 relays support IEC 61850 GOOSE. GSSE, formerly UCA2 GOOSE, is not supported.

9.2 GOOSE Service Support

The following GOOSE services are supported by Px40 devices:

- SendGOOSEMessage
- GetGoReference
- GetGoCBValues

The *SetGoCBValues* service is not supported, although it is possible for connected clients to change the GoEna attribute online.

9.3 Subscription to Publishing IEDs

9.3.1 Message Validation

The following elements of a GOOSE message header are checked in order to determine the messages validity prior to processing its data within the relays GOOSE scheme:

- **Destination MAC address**, but only after a valid message has been received from all subscribed publishers. Prior to this, the destination MAC address is not checked as the Ethernet card is operating in promiscuous mode.
- **Frame Ethertype**, which is filtered by the CLNP layer.
- **AppID**, which is filtered by the CLNP layer.
- **Time Allowed to Live**, which is expected to be a value greater than zero (0).
- **DatSet**, which is expected to be a valid reference as taken from the publishing devices GoCB during device configuration (from SCL) and not a NULL value.
- **GoID**, which is expected to be a valid reference as taken from the publishing devices GoCB during device configuration (from SCL) and not a NULL value.
- **ConfRev**, which is expected to match the publishing devices GoCB as set during device configuration (from SCL).
- **numDatSetEntries**, but only after an initial message from the publishing device has been received and the device has been enrolled. At this point each subsequent message must contain the same number of data set elements as the first received message.

The following elements of the GOOSE message header are not checked during validation of received messages:

- Source MAC address
- VLAN id and priority
- GoCBRef
- t
- stNum
- sqNum
- test

9.3.2 Data Processing

The data received in a GOOSE message is only processed when a change in status number (stNum), taken from the GOOSE message header, is detected. No validation checks are made to ensure the data has changed inline with the stNum increment and it is accepted and processed as per the normal procedure given below.

The data is transferred onto Boolean virtual input Programmable Scheme Logic (PSL) signals when the data subscription parameters are met:

Virtual input state		Criteria
True	On	The received data value matches the virtual inputs target value in accordance with its comparison operator.
False	Off	The received data value does not match the virtual inputs target value in accordance with its comparison operator.

MiCOM Px40 relays support thirty-two (32) virtual input signals each with their own GOOSE data set attribute index, target value and comparison operator. The following comparison operators are supported:

- GOOSE data value **EQUALS** target value
- GOOSE data value **IS NOT EQUAL TO** target value
- GOOSE data value **IS LESS THAN** target value
- GOOSE data value **IS GREATER THAN** target value

Only data attributes of a basic data-type can be decoded from the incoming GOOSE data set elements. Data objects that are a complex structure, such as the SPS Common Data Class, are not supported:

- Unsigned integer – 32bits, 16bits & 8bits
- Signed integer – 32bits, 16bits & 8bits
- Boolean
- Bit-string 2

9.3.3 Duplicated, Out-of-Order and Missed Messages

No checks are made for duplicated or out-of-order GOOSE messages. They are validated in accordance with the rules given in section 9.3.1 and the data is transferred onto the virtual inputs as per section 9.3.2.

GOOSE messages received with non-contiguous state/sequence numbers will be processed as normal.

No alarm or warning conditions are reported for any of these conditions.

9.3.4 Time Allowed to Live (TAL)

If a GOOSE message from one of the subscribed publishers is not received within the TAL taken from the last valid GOOSE message from that publisher a *GOOSE IED Absent* alarm will be raised. This alarm will self-reset as soon as a valid message from the *absent* publisher is received.

It should be noted that this single alarm provides a Logical OR of all publishing IEDs that the MiCOM Px40 relay has subscribed to. This alarm therefore remains set while there are one (1) or more publishers absent.

It is not possible from this alarm condition to identify which publishing device has exceeded its TAL and has been classed as absent.

9.3.5 Needs Commissioning and Test Flags

If a GOOSE message is received and the *NdsCom* and/or *test* flags are set the message will be accepted as valid [The TAL will be updated thus ensuring the device is classed as fully subscribed within the relays GOOSE scheme], however the message data will not be extracted nor processed within the relays GOOSE scheme logic.

Any Virtual Input that is driven by the incoming GOOSE message (flagged as *NdsCom* or *test*) will revert to its configured default value.

9.3.6 Absent Publishing Devices

If a GOOSE message isn't received from a publishing device that the relay has subscribed to, or a message is received that is syntactically incorrect, a *GOOSE IED Absent* alarm condition will be raised.

The alarm condition will be reset when valid messages from all publishing devices that are subscribed in the relays GOOSE scheme are received.

9.3.7 Data Set Reconfiguration

Under normal circumstances a change to the data set published in a GOOSE message will result in an increment of the GoCB *ConfRev* attribute.

If the relay has subscribed to a device that changes its published data set without incrementing the *ConfRev* attribute, it will attempt to extract and decode the data as normal. If successful the data will be processed as described in section 9.3.2 however it should be noted that it will be a different data set element that is now driving the virtual input PSL signal. No alarm or warning conditions are reported for this situation.

If the relay is unable to extract and decode the data then the GOOSE message will be considered invalid and will be discarded.

9.3.8 Default Values

For the following conditions, a virtual inputs value will be forced to its configured *default value*:

- The publishing device is absent (for example, no GOOSE messages are received).
- The received GOOSE message does not pass the validation criteria given in section 9.3.1.
- The received GOOSE message has the *test* flag set.
- The received GOOSE message has the *NdsCom* flag set.

9.4 Publication

9.4.1 Pre-Configured Attributes

The following pre-configured attributes of the GOOSE Control Block (GoCB) can not be changed, either during device configuration (from SCL) or online by a connected client:

- *DatSet* [Data set to transmit]
- *NdsCom* [Needs commissioning]

The *DstAddress* (Destination Address) data object of the GoCB is configurable from SCL but can not be changed online by a connected client.

9.4.2 Commissioning

The data set assigned to the GOOSE Control Block is pre-configured and can not be modified at system configuration time or by a connected client. As such the *NdsCom* attribute is fixed to FALSE.

9.4.3 Transient Data Attributes

MiCOM Px40 relays will publish both state-transitions (Off->On, On->Off) of transient or pulsed data attribute values (e.g. a trip).

10 TRANSMISSION OF SAMPLED VALUES MODEL

10.1 Modes of Operation

MiCOM Px40 relays do not support transmission of sampled value services using any modes of operation (multicast or unicast). As such there are no Multicast Sample Value Control Blocks (MSVCB) or Unicast Sample Value Control Blocks (USVCB) exposed within the data model.

11 CONTROL MODEL

11.1 Modes of Operation

MiCOM Px40 relays do not support any of the control model services:

- Direct control with normal security
- SBO control with normal security
- Direct control with enhanced security
- SBO control with enhanced security

All control information within the data model is presented as status only.

12 TIME AND TIME SYNCHRONIZATION

12.1 Time Quality

Historical data logged by MiCOM Px40 relays do not include any quality information with respect to timestamps. For this reason none of the time quality bits are supported and are fixed at a value of zero (0) for all timestamp attributes.

12.2 Time Accuracy

The time accuracy of MiCOM Px40 relays is to ten (**10**) significant bits of the *FractionOfSecond* attribute. This equates to approximately one (**1**) millisecond, meeting the requirements of performance class T1 as defined in part 5 of the IEC 61850 standards.

12.3 External Synchronization

MiCOM Px40 relays can be configured with two (2) external time synchronization servers, of which only 1 is ever the active time synchronization source.

If an external source fails to respond to a client synchronization request, or responds with an invalid/unsupported message, the relay will automatically switch to the unused source, if configured.

When no configured external time source is available the relay will alternately send requests to all configured sources every five (5) seconds. This occurs until a valid response is received.

The status of SNTP time synchronization is given by a Courier data cell in the "Date & Time" column.

12.4 SNTP Server Operation

MiCOM Px40 relays are not intended to be used as an external time synchronization source.

12.5 IRIG-B

If IRIG-B is enabled and a valid signal is being received by the relay, SNTP server responses will be ignored as IRIG-B is deemed to be the primary source of time synchronization.

If IRIG-B becomes unavailable during normal operating conditions, SNTP will become the active time synchronization source until such time that IRIG-B becomes available once again.

13 FILE TRANSFER MODEL

13.1 File Transfer Mode

MiCOM Px40 relays use MMS file transfer services for the transfer of disturbance records. The File Transfer Protocol (FTP), as defined by the Internet Engineering Task Force (IETF), is not supported.

13.2 Directory and File Structure

The following directory structure is presented by MiCOM Px40 relays:

Device Root/

COMTRADE/

dr/

dr_unextracted/

LD/

{IEDNAME}Control/

{IEDNAME}Measurements/

{IEDNAME}Protection/

{IEDNAME}Records/

{IEDNAME}System/

With the exception of the following, all directories will be empty:

- COMTRADE/
- dr/

These folders contain all disturbance records held in non-volatile memory, in an ASCII comtrade format (*.cfg and *.dat)

- dr_unextracted/

This folder contains disturbance records that have not been downloaded from the relay by a client. A record is classed as downloaded (or extracted) when the *.dat file has been transferred.

Once extracted, disturbance records are removed from this directory. However it should be noted that these records are still available from the two (2) folders mentioned above.

13.3 Directory Separator

MiCOM Px40 relays use a file system based on the UNIX directory separator character '/'.

The use of MS-DOS directory separator characters ('\') will return a positive result to the file transfer MMS service requests but with no data elements (directory or filenames).

13.4 Maximum Filename Length

Disturbance record filenames are based around the following fixed format giving a maximum filename length of twenty eight (**28**) characters:

yyyymmdd_HHMMSS_xxx_rNNN.*

Where:

- yyyy = The year, i.e. 2006
- mm = The month, i.e. 03 (for March)
- dd = The day of month, i.e. 15th
- HH = Hours in 24hr format, i.e. 12
- MM = Minutes, i.e. 59
- SS = Seconds, i.e. 59
- xxx = Milli-seconds, i.e. 999
- r = A literal 'r' character
- NNN = Disturbance record number, i.e. 001
- * = The file type, either cfg or dat

Taking into account the directory structure presented in section 13.2, this gives a maximum, fully qualified, filename length of forty four (**44**) characters.

13.5 Filename Case Sensitivity

Directory and filenames are both case sensitive.

13.6 Maximum File Size

The maximum file size is not restricted over the MMS file transfer interface, however it is dependant upon the configuration of the disturbance recorder.

The longer the recording time, the larger the comtrade file will be. The maximum recording time for MiCOM Px40 relays is 10.5 seconds, which equates to an approximate file size of **1.7MB**.

14 SUB-STATION CONFIGURATION LANGUAGE

14.1 Conformance Level

MiCOM Px40 relays are conformant to **SCL.1** as defined by part 8 of the IEC 61850 standards; annex D.

ICD template files are available within the MiCOM S1 IED Configurator application.

14.2 Private Data

MiCOM Px40 ICD files contain private SCL data. This is required by the IED configurator tool in order to correctly extract, process and configure a relay.

Any tool that imports Px40 ICD files is required to preserve the private data in accordance with part 6 of the IEC 61850 standards.

14.3 IED Name

The Sub-station Configuration Language (SCL) allows customizable IED names. MiCOM Px40 relays support user-definable IED names however these are restricted to a maximum of **eight** (8) characters in length.

15 IED CONFIGURATOR

15.1 Configuration Banks

MiCOM Px40 relays support two (2) configuration banks for holding IED configurations taken from SCD or CID Substation Configuration Language (SCL) files. This includes IP configuration, SNTP, GOOSE publishing/subscription parameters etc.

The IED Configurator tool only allows a configuration to be downloaded to the inactive bank. This bank can then be made active through the use of a Courier command cell at any time.



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