IFE/IFM performance characterization

Technical note

Life Is On Schneider Electric

CONTENTS

1. This document

1.1. Purpose

The purpose of this document is to provide information about the performance of the Enerlin'x IFE when connected to IFMs. These results will help determine how to optimize the implementation of IFE-IFM sets for monitoring ComPact and MasterPact circuit breakers.

This document also provides guidelines for the design of groups of IFE-IFM modules and the data which can be monitored.

1.2. Prerequisites

Familiarity with the following concepts is required to understand and draw benefits from this document:

- ULP System for MasterPact and ComPact
- Modbus TCP/IP communication protocol

1.3. Reference documents

No.	Title	Reference
R1	ULP System for MasterPact and ComPact - User Guide	DOCA0093
R2	Enerlin'X IFE Ethernet Switchboard Server - User Guide	DOCA0084
R3	Enerlin'X IFM - Modbus-SL Interface for One Circuit Breaker - Instruction Sheet	NVE85393
R4	MasterPact MTZ Modbus Communication Guide	DOCA0105
R5	MasterPact NT/NW, ComPact NS Modbus Communication Guide	DOCA0091

You can download these technical publications and other technical information from our website at https://www.se.com/en/download

1.4. Glossary

Term	Description
I/O	Input / Output
IMU	Intelligent Modular Unit
iPMCC	Intelligent Power & Motor Control Center
MCCB	Molded Case Circuit Breaker
PLC	Programmable Logic Controller
RTT	Round Trip Time
ULP	Universal Logic Plug

2. Selection

2.1. Hardware

2.1.1. ULP system elements

The ULP system is composed of multiple products to help construct an electrical distribution solution which incorporates metering, communication, and operating assistance functions for circuit breakers.

For the purposes of this document, we will focus on the following products:

Description	Reference
Enerlin'X IFE switchboard server, Ethernet interface and gateway	LV434002
Enerlin'X IFM - Modbus-SL Interface for One Circuit Breaker	LV434000

Some additional components are required, such as line terminations, stacking accessories, ULP cords, etc. For more details, please refer to the ULP system guide [R1].

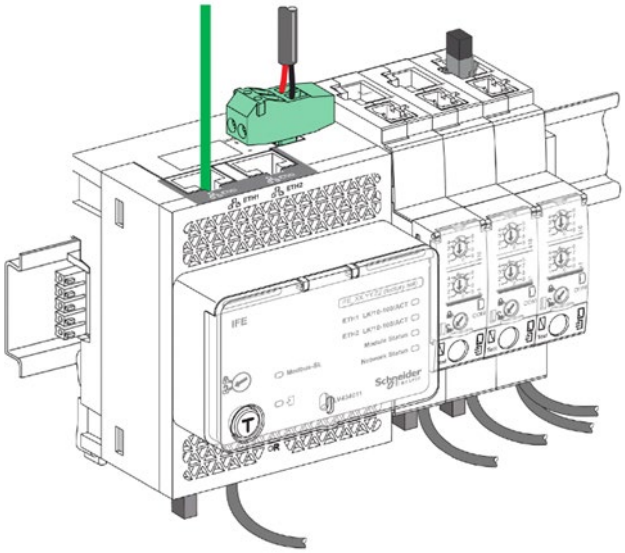

Fig 1: IFE with stacked IFMs

2.1.2. Modbus TCP client

A Modicon M580 PLC has been selected as the Modbus TCP client. This PLC is used to analyze communication with the IFE-IFM set and is composed of the following parts:

- BMEXBP400 – 4-slot Ethernet backplane
- BMEP581020 - Processor module
- BMENOC0311 - Ethernet communication module

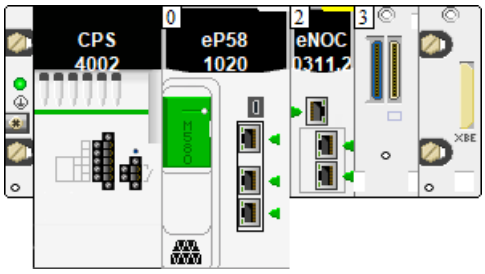

Fig 2: M580 PLC

2.2. Software

No software is required for IFE-IFM configuration as this is done through the dedicated webpages which can be accessed using a web browser (e.g. Internet Explorer).

3. Design

3.1. Network topology

As the scope of this study is limited to monitoring iPMCC breakers through an IFE-IFM set, the PLC and IFE are connected to an unmanaged Ethernet switch by Cat-5e copper cables.

For industrial installations, all the conventional Ethernet networking rules must be followed.

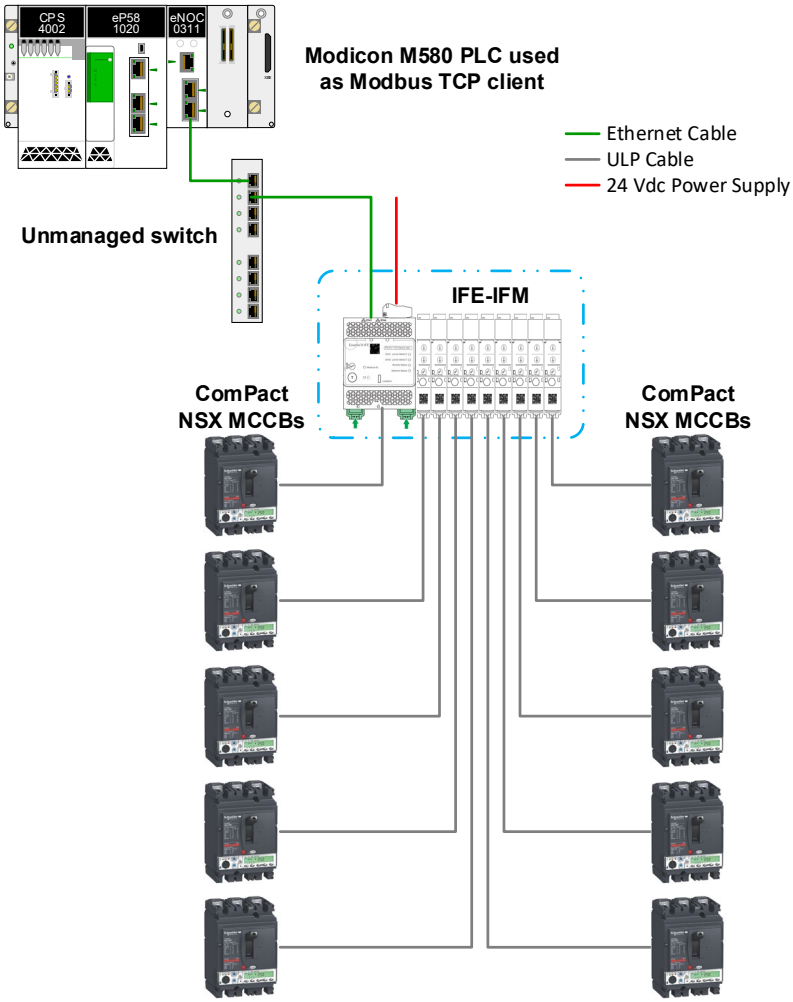

Fig 3: Network architecture

3.2. Data exchange

To determine the number of IFMs that can be connected behind an IFE, we have defined three data profiles to read, corresponding to the three performance levels of the iPMCC offer:

- Standard
- Advanced
- High-Performance

These 3 performance levels are defined as follows:

Standard performance

The “Standard” performance level refers to the usual data reporting of the installation, closed to the traditional switchboard.

The installation corresponds to the standard and simplest product use and implementation.

The data set used to monitor the installation uses the core functionality of the product installed. It is the MVP (Minimum Viable Product).

Advanced performance

The “Advanced” performance level refers to the use of additional functionality provided by the connected product or dictated by the specific working conditions or specific constraints of the installation.

This is where the requirement is to go beyond the MVP and implement additional features designed to control and monitor the installation more effectively.

The data set provides sufficient information to perform a first level of analysis of the installation.

High performance

The “High-Performance” performance level refers to the implementation of functions providing an extended data set for full control of all parameters of the installation.

This installation is very large, complex and/or very sensitive to variations. Usually, the installation requires a high level of availability.

The data set provides all the information required to perform a detailed analysis of the installation.

For each profile, the PLC will read registers with the Modbus TCP protocol.

The set of registers will be in the legacy data set. This data set has been chosen because it is a zone which collects the most useful information in one convenient table.

3.2.1. Standard profile

In this configuration, the Standard registers are read as follows:

Description	Address	
Circuit Breaker Status Register	12000	12001
I/O Status Registers	12002	12003
Tripping Cause	12004	12005
Reserved	**12006**	**12007**
Overrun of the Protection Setpoints	12008	12012
Reserved	**12013**	**12015**
Current	12016	12022
Maximum Current Values	12023	12029
Voltage	12030	12035
Frequency	12036	12037
Power	12038	12049

To read the entire Standard data table, the PLC will use one Modbus request of 50 registers (from 12000 to 12049).

3.2.2. Advanced profile

In this configuration, the Advanced registers are read as follows:

Description	Address	
Circuit Breaker Status Register	12000	12001
I/O Status Registers	12002	12003
Tripping Cause	12004	12005
Reserved	**12006**	**12007**
Overrun of the Protection Setpoints	12008	12012
Reserved	**12013**	**12015**
Current	12016	12022
Maximum Current Values	12023	12029
Voltage	12030	12035
Frequency	12036	12037
Power	12038	12049
Energy	12050	12079
Current Demand Values	12080	12083
Power Demand Values	12084	12086
Reserved	**12087**	**12089**
Maximum Voltage Values	12090	12095
Power Factor	12096	12103
Total Harmonic Distortion (THD)	12104	12113

To read the entire Advanced data table, the PLC will use one Modbus request of 114 registers (from 12000 to 12113).

3.2.3. High-Performance profile

In this configuration, the High-Performance registers are read as follows:

Description	Address	
Circuit Breaker Status Register	12000	12001
I/O Status Registers	12002	12003
Tripping Cause	12004	12005
Reserved	**12006**	**12007**
Overrun of the Protection Setpoints	12008	12012
Reserved	**12013**	**12015**
Current	12016	12022
Maximum Current Values	12023	12029
Voltage	12030	12035
Frequency	12036	12037
Power	12038	12049
Energy	12050	12079
Current Demand Values	12080	12083
Power Demand Values	12084	12086
Reserved	**12087**	**12089**
Maximum Voltage Values	12090	12095
Power Factor	12096	12103
Total Harmonic Distortion (THD)	12104	12113
Reserved	**12114**	**12159**
Counters	12160	12163
Miscellaneous	12164	12165

To read the entire High-Performance data table, the PLC will use two Modbus requests:

- 114 registers (from 12000 to 12113)
- 6 registers (from 12160 to 12165)

4. Configuration and implementation

4.1. EcoStruxure™ Power Commissioning

The IFE and IFM firmware have been checked and upgraded where necessary with EcoStruxure™ Power Commissioning version 2.12.0.2007.

4.2. Internet Explorer

Internet Explorer version 11 is used to configure the IFE module through its web pages.

4.3. IFE & IFM

4.3.1. Modbus serial line settings

The Modbus serial line baud rate can be set to 3 different values:

- 9600 bits/s
- 19200 bits/s (default)
- 38400 bits/s

See below for details of the IFE-IFM response time at these different values:

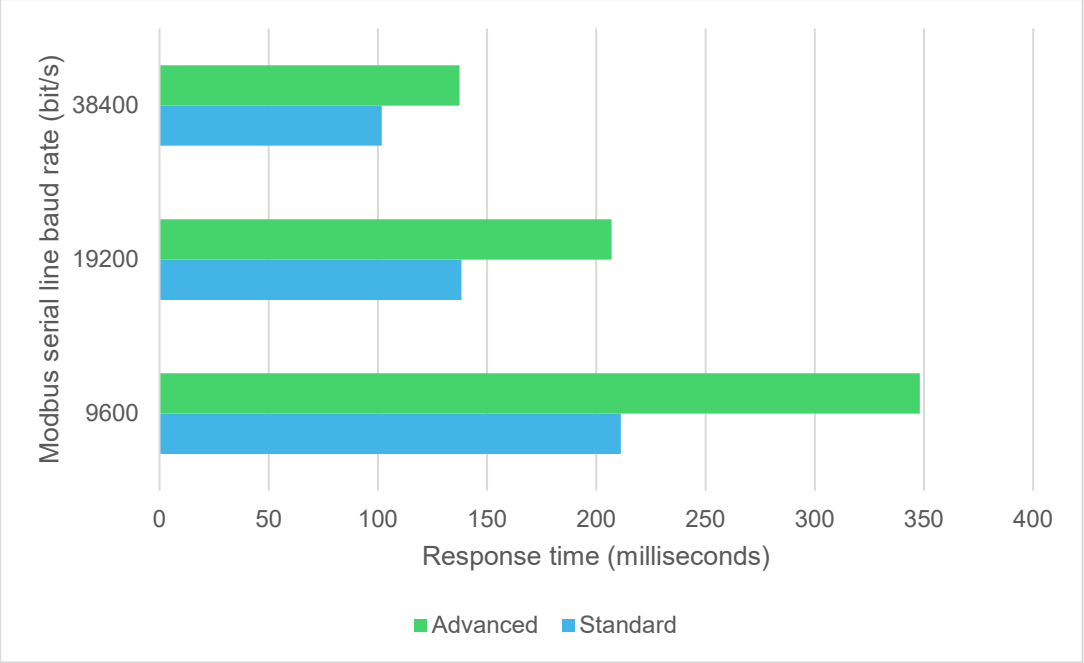

Fig 4: Modbus serial line baud rate impact

The above diagram shows that differences in the Modbus serial line baud rate setting lead to significant differences in response time.

The Modbus serial line timeout can be set from 0.1 to 10 seconds. The default value is 1 second:

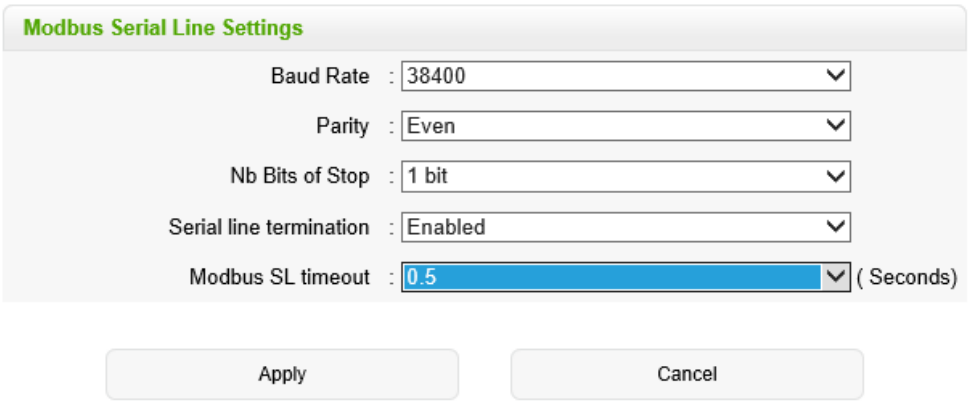

Fig 5: Timeout on serial bus

It is recommended to set a value slightly above the typical response time. This allows the Modbus TCP client to wait for a shorter time if an IFM is not functioning and decreases the impact on polling RTT.

4.3.2. Ethernet configuration

When using IO scanning with a Modicon PLC (M340 or M580), it is important to know that the PLC opens 1 connection for each frame declared in the IFE and IFM.

The IFE can support up to 8 or 16 connections. Therefore, depending of the number of IFMs connected and the data profile chosen, the right value must be set to avoid monitoring malfunction.

The maximum numbers of permissible connections can be set in the Modbus TCP/IP Filtering menu of the IFE webpages:

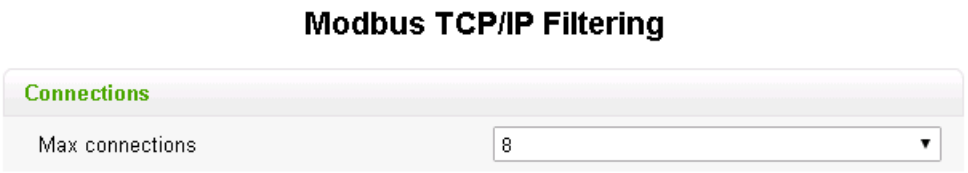

Fig 6: Maximum connections setting

If the number of frames to one IFE is more than 16, the read functions must be programmed by an alternative method to IO Scanning, such as using the elementary READ_VAR function.

5. Conclusion

Below are two tables showing the response time in the nominal case depending on:

- The Modbus serial line speed
- The data profile (Standard, Advanced or High-Performance)
- The number of IFMs stacked after the IFE

If you want your system to withstand 1 or more faulty IFMs, increase the polling time by the number of faulty IFMs x Modbus serial line timeout.

The first table shows the results with a Modbus serial line baud rate set at 19200 (default value):

Total response time in milliseconds												
Data profile	Number of IFM modules											
	1	2	3	4	5	6	7	8	9	10	11	12
Standard	195	375	555	735	915	1095	1275	1455	1635	1815	1995	2175
Advanced	275	535	795	1055	1315	1575	1835	2095	2355	2615	2875	3135
High-Perf.	415	815	1215	1615	2015	2415	2815	3215	3615	4015	4415	4815

Fig 7: Response time with IFE-IFM sets at 19200 bits/s

For applications requiring the use of an IO module connected to the IFE, the response time will be increased by 400 ms.

The second table shows the results with a Modbus serial line baud rate set at 38400:

Total response time in milliseconds												
Data profile	Number of IFM modules											
	1	2	3	4	5	6	7	8	9	10	11	12
Standard	145	275	405	535	665	795	925	1055	1185	1315	1445	1575
Advanced	185	355	525	695	865	1035	1205	1375	1545	1715	1885	2055
High-Perf.	285	555	825	1095	1365	1635	1905	2175	2445	2715	2985	3255

Fig 8: Response time with IFE-IFM sets at 38400 bits/s

For applications requiring the use of an IO module connected to the IFE, the response time will be increased by 270 ms.

6. Application example

In this example, the aim is to determine the polling time to set for an architecture composed of 1 IFE and 10 IFMs. In this calculation, we have assumed the following:

- The data model used is “Advanced” (see §3.2.2)
- The Modbus serial bus baud rate is set at 38400 (see §4.3.1)

With these parameters, the results are as follows:

- IFE response time is **15 ms**
- IFM response time is **170 ms**

As explained in §4.3.1, the Modbus serial line timeout (communication between IFE and IFMs) should be set at **300 ms**.

Assuming that the IFE, the 10 IFMs and a Modbus TCP client such as a Modicon PLC are used, this will require 11 connections. Therefore, the maximum number of connections should be set at 16 (see §4.3.2).

When all the above elements are applied, the expected response time will be as follows:

- Nominal case will be: **15 ms** + (10 x **170 ms**) = 1715 ms
- In case of 1 faulty IFM: **15 ms** + (9 x **170 ms**) + (1 x **300 ms**) = 1845 ms
- In case of 2 faulty IFMs: **15 ms** + (8 x **170 ms**) + (2 x **300 ms**) = 1975 ms

Setting a polling time of 1975 ms will guarantee that the data for the Advanced profile will be available in less than 2 s even with 2 faulty IFMs.

Schneider Electric Industries SAS

35, rue Joseph Monier
CS 30323
92506 Rueil Malmaison Cedex (France)

RCS Nanterre 954 503 439
Capital social 896 313 776 €
www.se.com