SIEMENS

Description of the measurement• 03/2016

Help and explanations of the measurement - "PROFINET IO response time measurements"

PNIO-Rea ID31

Table of Contents

1 Scope of measurement

1.1 Objective

Many applications require a quick response time via the distributed I/O. PROFINET IO is increasingly used in SIMATIC for quick and efficient data exchange between distributed I/O and S7 stations. Thanks to PROFINET IO, the Industrial Ethernet technology has now been introduced to the field level.

Typical PROFINET IO configurations consist of an IO controller with multiple IO devices. Additional loads such as programming devices (PG), operator panels or other S7 CPUs can be operated as receiving stations of larger amounts of data on the same PROFINET IO line.

Important questions

One of the most important questions arising in the course of configuration design refers to the response times to be expected (terminal-terminal response time). This issue is of particular importance when existing PROFIBUS DP systems are to be completely retrofitted for PROFINET IO:

Some typical questions with regard to the IO response times include:

- How long does it take until a distributed output responds to a distributed input when
  - processing is performed via the cyclic process image and the cyclic OB1?
  - processing is performed via a process alarm (OB40) and a partial process image?
  - processing is performed via a cyclic time interrupt (OB30)?
  - processing is performed via a clock-synchronized interrupt (OB60) in PROFINET IRT mode?
- How long does it take until a centralized output responds to a centralized input when
  - processing is performed via the cyclic process image and the cyclic OB1?
  - processing is performed via a process alarm (OB40) and a partial process image?
  - processing is performed via a cyclic time interrupt (OB30)?
- What are the effects of different load cases and line configurations on the cycle time of OB1 and the time required by the CPU operating system for internal administrative tasks?
- Which statistical fluctuations can occur at the various OB process levels?
- Do the OB process levels interact with each other in terms of their response times?

To answer these questions, Siemens Industry Automation periodically performs extensive measurements with typical PN IO systems. To conveniently access the measurement results, you can set up your desired configuration with the interactive user interface.

- Which S7 components are best suited for the planned automation project?
- Which response times have to be expected for typical configurations?
- Which statistical fluctuations can occur?
- Which effects have to be expected?

1.2 Performance data provided

The following performance data or measured variables are available to you for this measurement:

Table 1-1

<table>
<tr><th rowspan="2">Measured variable</th><th colspan="4">Processing in</th><th rowspan="2">Definition</th></tr>
<tr><th>OB1</th><th>OB3x</th><th>OB4x</th><th>OB6x</th></tr>
<tr><td>IO response time in the centralized I/O.</td><td>X</td><td>X</td><td>X</td><td>-</td><td>The response time is the period between the events 1 and 3:
1. A signal change occurs at a digital input of the centralized I/O.
2. The IO controller responds by setting an output via a program at a process level in the centralized I/O.
3. At this output, a signal change occurs again.</td></tr>
<tr><td>IO response time in the distributed I/O (I/O devices).</td><td>X</td><td>X</td><td>X</td><td>X</td><td>The response time is the period between the events 1 and 3:
4. A signal change occurs at a digital input of the centralized I/O.
5. The IO controller responds by setting an output via a program at a process level in the distributed I/O.
6. At this output, a signal change occurs again.</td></tr>
<tr><td>Cycle time in the IO controller</td><td>X</td><td colspan="3"></td><td>This is the interval between two updates of the process image in the IO controller.</td></tr>
<tr><td>Cycle control time</td><td>X</td><td colspan="3"></td><td>The cycle control time is the time required by the operating system of the CPU from the last instruction at the end of the OB1 program to the OB1 program recall with the first instruction.</td></tr>
<tr><td>PN update time</td><td colspan="4"></td><td>The PN update time is the update time calculated by STEP 7 or the update time manually set for the configured PN IO devices. It is not measured but only specified as a value from the STEP configuration.</td></tr>
</table>

Measured variable	Processing in				Definition
	OB1	OB3x	OB4x	OB6x	
PN send clock					The PN send clock is the time that, in the case of data communication via PROFINET IO, passes between two IO cycles of the IO controller. This time is **calculated** by STEP 7 and not measured.
Application Sync Time					The sync time is the value with which the user program is called in OB6x in the clock-synchronized mode. This time is **calculated** by STEP 7 and not measured.

Note For a detailed description of the measurement method, please refer to Chapter 3 Performing the measurements.

1.3 Parameters of the measurement

This measurement has been performed with the following parameters:

Table 1-2

Component	Parameter	Explanation
IO controller	CPU	Selecting the IO controller type
	CM	Setting a CM as IO controller
	Load due to program	Setting the program load by an additional STEP 7 program in the IO controller.
	Parameterized interrupt cycle time	Setting the cyclic interrupt in the IO controller.
Network	Network load	Connecting an engineering station in the "monitoring variables" mode.
Distributed I/O	I/O device type	Selecting the IO device type (ET 200SP/MP)
	Number of stations	Number of IO devices on the PN IO line
	IO bytes per station	Setting the number of input and output bytes on each IO device (e.g., 16 IO bytes mean 8 bytes DI and 8 bytes DO).
Centralized I/O	IO bytes	Setting the number of input and output bytes in the central rack of S7 CPU (e.g., 16 IO bytes mean 8 bytes DI and 8 bytes DO).

Note The value ranges that can be set for the individual parameters may vary depending on the configuration. Please note the respective displays in the user interface.

1.4 Scope and technical data

Scope of validity

The measurement covers a typical range of components. The selection is based on the latest and most frequently used products as of "mid-2015".

The measured values apply provided that the network has been configured correctly. Due to system-internal error control, an incorrect or incomplete configuration causes significantly deviating times.

Boundary conditions of the measurement

All measured values were acquired under specific boundary conditions (configuration and parameterization).

All settings essential for the measurement are listed in the following table. STEP 7 default values are used for all settings that are not listed.

Table 1-3

<table>
<tr><th>Constant</th><th>Range of values</th><th>Comment</th></tr>
<tr><td>Total number of I/O bytes</td><td>50 % I bytes and 50 % O bytes</td><td>Universal for all IO assignments in the OBs</td></tr>
<tr><td>Distribution of I/O bytes to the OB process levels</td><td>Due to the IO expansion (32, 64, 128 bytes), the additional IO bytes are distributed as evenly as possible to the OB1, OB30, OB60 process levels. The number of bytes on OB40 remains consistently small.</td><td>The exact distribution of IO bytes is output in each measurement.</td></tr>
<tr><td rowspan="2">Selecting the PN send clock/application cycle/delay times</td><td rowspan="2">The smallest possible send clock and application cycle are set for all variants with OB60(IRT).
For all variants without OB60(IRT), the value is 1 ms, if possible.</td><td>If these limits are not allowed by STEP 7, the closest possible value is to be used.
The clock-synchronized application cycle is equal to the PN IO update time /send clock. (EVA model = 1)
For the PN driver, the send clock is fixed to 32ms for Windows systems.</td></tr>
<tr><td>Selecting Ti/To times in the isochronous I/O:
The default values of the corresponding module are to be used. Fixed values are used for ET200 SP HF.</td></tr>
</table>

Input delays and pulse expansions for DIs	The smallest possible value is always selected.	The input delay can be switched off entirely for ET200 SP. The smallest possible value has been used for ET200.

Components used

The following table contains all components that were used in this measurement.

Table 1-4

Component		Type	Article no.	Version
IO controller	S7-1200	CPU-1212C	6ES7212-1AE40-0XB0	V4.0
		CPU-1217C	6ES7217-1AG40-0XB0	V4.0
	S7-1500	CPU-1513	6ES7513-1AL00-0AB0	V1.5
		CPU-1516	6ES7516-3AN00-0AB0	V1.5
		CPU-1518	6ES7518-4AP00-0AB0	V1.5
		ET 200SP CPU 1512SP-1 PN	6ES7512-1DK00-0AB0	V1.0
		CM1542-1	6GK7542-1AX00-0XE0	V1.0
	Software controller	ET 200SP Open Controller CPU 1515SP PC	6ES7677-2AA41-0FB0	V1 4GB RAM 16GB CF card WES 7P 64Bit
		CPU1507S	6ES7672-7AC00-0YA0	V1.8
		IPC 427D & CPU1507S	6AG4140-5BK04-0EB0	Core i3, 1,6 GHz, PN-IRT, 2GB + NVRAM; Win7 embedded; CFAST 16GB
		IPC 627D & CPU1507S	6AG4131-2CM20-0AX0	Celeron 2,2 GHz PN CP1616, 2MB SRAM, SSD 240GB, 4GB RAM, Win7 Ultimate
	PN Driver for Controller	IPC 427D	6ES7195-3AA00-0YA0	V1.0
IO Devices	ET 200SP	IM 155-6PN ST	6ES7155-6AA00-0BN0	V1.1
		IM155-6 PN HF	6ES7155-6AU00-0CN0	V2.2
	IO module	8 DO HF	6ES7 132-6BF00-0CA0	
		8 DI HF	6ES7 131-6BF00-0CA0	
		16 DO ST	6ES7 132-6BH00-0BA0	
		16 DI ST	6ES7 131-6BH00-0BA0	
		2 AI	6ES7 134-6HB00-0DA1	
		2 AQ	6ES7 135-6HB00-0DA1	
		CM IO Link)	6ES7 137-6BD00-0BA0	
	ET 200MP	IM155-5 PN ST	6ES7155-5AA00-0AB0	V 2.0
		IM155-5 PN HF	6ES7155-5AA00-0AC0	V 1.0
	IO module	16 DI HF	6ES7 521-1BH00-0AB0	
		16 DO ST	6ES7 522-1BH00-0AB0	
		32 DI HF	6ES7 521-1BL00-0AB0	
		32 DO ST	6ES7 522-1BL00-0AB0	
		8 x AI	6ES7 531-7NF10-0AB0	

Component		Type	Article no.	Version
		8 x AQ	6ES7 532-5HF00-0AB0	
Centralized S7-1200 IO	SMs	Signalboard (DI/DO)	6ES7 223-0BD30-0XB0	
		16 DI/DO SM 1223	6ES7 223-1BL30-0XB0	
		8 DI/DO SM 1223	6ES7 223-1BH32-0XB0	
		4AI/2AO SM 1234	6ES7 234-4HE32-0XB0	

2 Operating the user interface

The following chapters provide you with information on how to operate the measurement via the path user interface.

2.1 Overview of the user interface

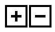
The user interface is basically divided into four areas: selection area, performance requirements, chosen topology and performance data table. All areas, except the performance data table, can be collapsed and expanded.

Selection area

Figure 2-1

In this area, you can enter your desired configuration using the appropriate operator controls. The system supports you through various automatic functions.

Table 2-1

Symbol	Explanation
	The "filter icon" indicates that at least one filter is active in the selection area.
	+: expand input area -: collapse input area
	Select a component or a value.
	By clicking the „X“ the former selection is canceled.
	The System has chosen an automatic selection due to a previous selction at another control.

Performance requirements

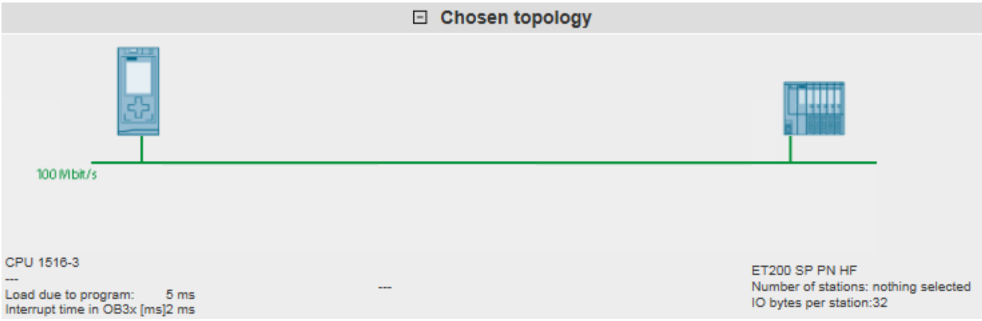
Figure 2-2

In this area, numerical filter conditions that appear when clicking on the appropriate control allow you to additionally restrict the measured values of the results table.

In this example, the minimum PN response time via the cyclic OB1 must be less than 5 ms. In addition to the filters of the selection area, this filter will now be used for the results table.

Configuration selected

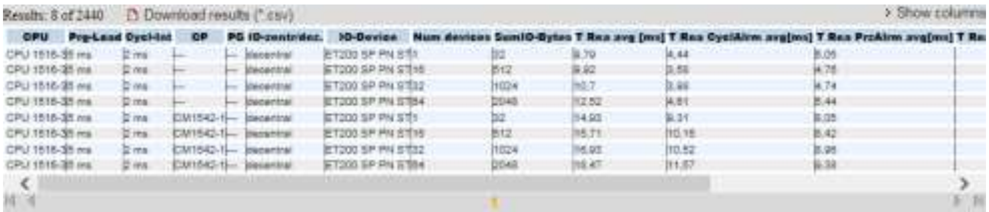
Figure 2-3



In the "Chosen topology" area, the system displays the graphical structure of your configuration. If nothing has been entered for one or more controls in the selection area, this is indicated by a question mark or „---„ in the specific area.

Performance data table

Figure 2-4


Results: 8 of 2440 Download results (*.csv) Show columns

CPU	Prg-Load	Cycl-Int	CP	PG	IO-controller	IO-Device	Num devices	SumIO-Bytes	T Res avg [ms]	T Res CyclAlrm avg[ms]	T Res PrzAlrm avg[ms]	T Re
CPU 1516-3	5 ms	2 ms	---	---	decentral	ET200 SP PN ST	1	32	9.79	4.44	5.05	
CPU 1516-3	5 ms	2 ms	---	---	decentral	ET200 SP PN ST	16	512	9.92	3.58	4.78	
CPU 1516-3	5 ms	2 ms	---	---	decentral	ET200 SP PN ST	32	1024	10.7	3.88	4.74	
CPU 1516-3	5 ms	2 ms	---	---	decentral	ET200 SP PN ST	64	2048	12.52	4.81	5.44	
CPU 1516-3	5 ms	2 ms	CM1542-1	---	decentral	ET200 SP PN ST	1	32	14.93	9.31	6.05	
CPU 1516-3	5 ms	2 ms	CM1542-1	---	decentral	ET200 SP PN ST	16	512	15.71	10.18	6.42	
CPU 1516-3	5 ms	2 ms	CM1542-1	---	decentral	ET200 SP PN ST	32	1024	16.93	10.52	6.96	
CPU 1516-3	5 ms	2 ms	CM1542-1	---	decentral	ET200 SP PN ST	64	2048	16.47	11.57	6.38	

This area displays the measured performance data with all the filters you have selected. Further columns can be shown or hidden using a dialog box by clicking on "Show columns". Clicking on "Download results (*.csv)" allows you to export the displayed selection as an Excel csv spreadsheet. This enables you to make more sorts for your applications.

2.2 How to operate the user interface

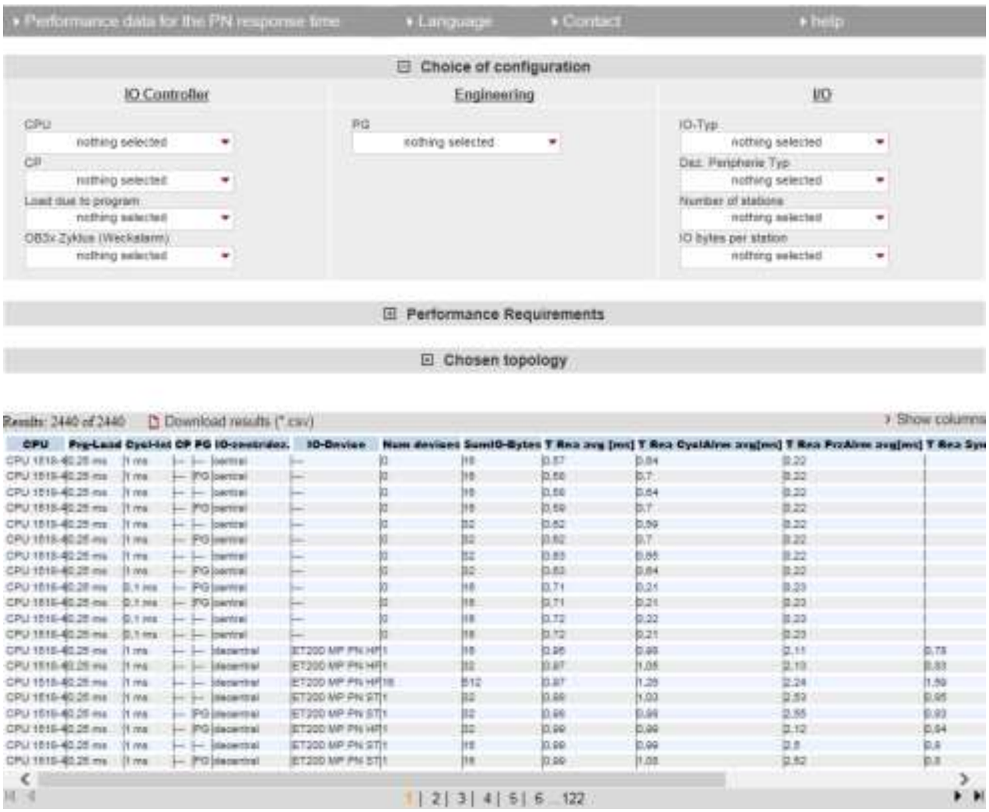
The following chapters provide you with information on how to operate the user interface:

2.2.1 Initial situation when starting the application

When calling the web application for the first time, the status of the application is as follows:

User interface

Figure 2-5



The selection area and the performance data table are always visible. The "Performance Requirements" and "Chosen topology" areas are hidden.

Description of the menu items

The following section explains the items of the application menu bar.

Figure 2-6

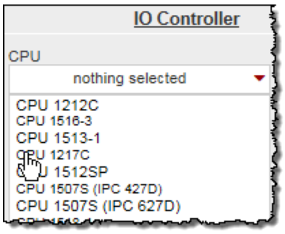
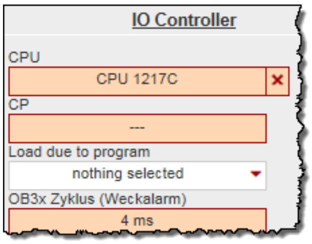
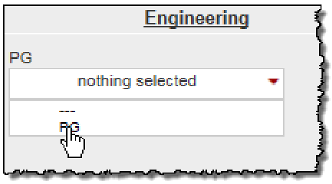
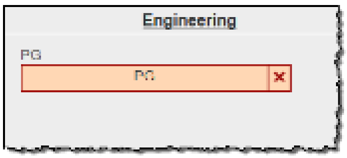
Table 2-2 to do

Menu item	Description
Performance data for the PN response time  	Click on the menu item **Performance data for response time** to open a dialog where you can • restore the user interface to its initial state by clicking on the **new** menu item. • obtain an explanation of the most important icons in the **legend** area. • view the version of the measurement and the database in the **about** area. • go directly to other versions of this measurement type in the **related** area.
Language	The user interface is implemented in German and English.
Contact	Links to Online Support
Help	Calling these help pages

2.2.2 Entering the desired configuration

In the "Selecting configuration" area, you can specify the desired hardware configuration.

Table 2-3

<table>
<tr><th>No.</th><th>Operator action</th><th>System response</th></tr>
<tr><td rowspan="2">1.</td><td>Select a configuration by clicking on the various parameter controls and selecting a component.
Example:
Selection of a CPU in the IO Controller area

</td><td>The system has applied your desired CPU (here, CPU 1217C) and at the same time, where applicable, automatically made the follow-up selection of the CP for you.

</td></tr>
<tr><td colspan="2">The system has immediately sent a query with the currently active filter to the database and displayed it in the performance data table.
Results: 28 of 2440 Download results (*.csv)
<table>
<tr><th>CPU</th><th>Prg-Load</th><th>Cycl-Int</th><th>CP</th><th>PG</th><th>IO-zentr/dez.</th><th>IO-Device</th><th>Num devices</th><th>SumIO-Bytes</th><th>T Rea avg [ms]</th><th>T Rea CyclAlrm avg[ms]</th><th>T Rea PrzAlrm</th></tr>
<tr><td>CPU 1217C</td><td>5 ms</td><td>4 ms</td><td>---</td><td>---</td><td>central</td><td>---</td><td>0</td><td>16</td><td>8,36</td><td>2,26</td><td>0,22</td></tr>
<tr><td>CPU 1217C</td><td>5 ms</td><td>4 ms</td><td>---</td><td>---</td><td>central</td><td>---</td><td>0</td><td>32</td><td>8,88</td><td>2,23</td><td>0,22</td></tr>
<tr><td>CPU 1217C</td><td>5 ms</td><td>4 ms</td><td>---</td><td>PG</td><td>central</td><td>---</td><td>0</td><td>16</td><td>9,81</td><td>1,93</td><td>0,23</td></tr>
<tr><td>CPU 1217C</td><td>5 ms</td><td>4 ms</td><td>---</td><td>PG</td><td>central</td><td>---</td><td>0</td><td>32</td><td>10,01</td><td>2,32</td><td>0,23</td></tr>
<tr><td>CPU 1217C</td><td>10 ms</td><td>4 ms</td><td>---</td><td>---</td><td>central</td><td>---</td><td>0</td><td>16</td><td>16,91</td><td>2,31</td><td>0,22</td></tr>
<tr><td>CPU 1217C</td><td>5 ms</td><td>4 ms</td><td>---</td><td>---</td><td>decentral</td><td>ET200 SP PN ST</td><td>1</td><td>16</td><td>17,16</td><td>5,11</td><td></td></tr>
<tr><td>CPU 1217C</td><td>5 ms</td><td>4 ms</td><td>---</td><td>---</td><td>decentral</td><td>ET200 SP PN ST</td><td>1</td><td>32</td><td>17,24</td><td>5,15</td><td></td></tr>
<tr><td>CPU 1217C</td><td>10 ms</td><td>4 ms</td><td>---</td><td>---</td><td>central</td><td>---</td><td>0</td><td>32</td><td>17,44</td><td>2,4</td><td>0,22</td></tr>
<tr><td>CPU 1217C</td><td>10 ms</td><td>4 ms</td><td>---</td><td>PG</td><td>central</td><td>---</td><td>0</td><td>32</td><td>18,07</td><td>2,32</td><td>0,23</td></tr>
<tr><td>CPU 1217C</td><td>10 ms</td><td>4 ms</td><td>---</td><td>---</td><td>central</td><td>---</td><td>0</td><td>64</td><td>18,54</td><td>2,27</td><td>0,22</td></tr>
<tr><td>CPU 1217C</td><td>10 ms</td><td>4 ms</td><td>---</td><td>PG</td><td>central</td><td>---</td><td>0</td><td>16</td><td>18,64</td><td>2,35</td><td>0,23</td></tr>
<tr><td>CPU 1217C</td><td>5 ms</td><td>4 ms</td><td>---</td><td>PG</td><td>decentral</td><td>ET200 SP PN ST</td><td>1</td><td>16</td><td>19,21</td><td>5,18</td><td></td></tr>
<tr><td>CPU 1217C</td><td>5 ms</td><td>4 ms</td><td>---</td><td>PG</td><td>decentral</td><td>ET200 SP PN ST</td><td>1</td><td>32</td><td>20,02</td><td>5,25</td><td></td></tr>
<tr><td>CPU 1217C</td><td>10 ms</td><td>4 ms</td><td>---</td><td>PG</td><td>central</td><td>---</td><td>0</td><td>64</td><td>20,39</td><td>2,46</td><td>0,23</td></tr>
<tr><td>CPU 1217C</td><td>10 ms</td><td>4 ms</td><td>---</td><td>---</td><td>decentral</td><td>ET200 SP PN ST</td><td>1</td><td>32</td><td>28,9</td><td>5,12</td><td></td></tr>
<tr><td>CPU 1217C</td><td>10 ms</td><td>4 ms</td><td>---</td><td>---</td><td>decentral</td><td>ET200 SP PN ST</td><td>1</td><td>16</td><td>29,68</td><td>5,35</td><td></td></tr>
</table>
In this example, 28 out of a total of 2696 measured values measured with this exact CPU are available. As the IO controller has now been permanently assigned, this column has been removed from the results table.</td></tr>
<tr><td>2.</td><td>Proceed in the same way to select the required parameters in the "Engineering" area.
Example:
Selection of a PG as an additional network load on the IO line.

</td><td>The system has applied your desired entries.

</td></tr>
</table>

No.	Operator action	System response

As in 1, the system has made another database query with the advanced filter settings and so further restricted the number of relevant measured values.

Results: 14 of 2440 Download results (*.csv)

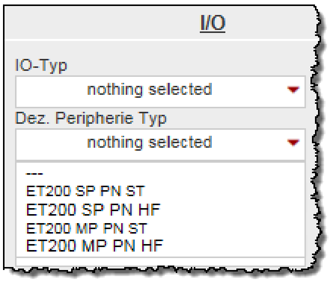
CPU	Prg-Load	Cycl-Int	CP	PG	IO-zentr/dez.	IO-Device	Num devices	SumIO-Bytes	T Rea avg [ms]	T Rea CyclAlrm avg[ms]	T Rea PrzAlrm
CPU 1217C	5 ms	4 ms	---	PG	central	---	0	16	9,81	1,93	0,23
CPU 1217C	5 ms	4 ms	---	PG	central	---	0	32	10,01	2,32	0,23
CPU 1217C	10 ms	4 ms	---	PG	central	---	0	32	18,07	2,32	0,23
CPU 1217C	10 ms	4 ms	---	PG	central	---	0	16	18,64	2,35	0,23
CPU 1217C	5 ms	4 ms	---	PG	decentral	ET200 SP PN ST	1	16	19,21	5,18	
CPU 1217C	5 ms	4 ms	---	PG	decentral	ET200 SP PN ST	1	32	20,02	5,25	
CPU 1217C	10 ms	4 ms	---	PG	central	---	0	64	20,39	2,46	0,23
CPU 1217C	10 ms	4 ms	---	PG	decentral	ET200 SP PN ST	1	16	32,91	4,98	
CPU 1217C	10 ms	4 ms	---	PG	decentral	ET200 SP PN ST	1	32	32,92	5,01	
CPU 1217C	10 ms	4 ms	---	PG	decentral	ET200 SP PN ST	1	64	34,61	5,24	
CPU 1217C	10 ms	4 ms	---	PG	decentral	ET200 SP PN ST	1	128	34,62	4,83	
CPU 1217C	50 ms	4 ms	---	PG	central	---	0	64	95,58	2,32	0,23
CPU 1217C	50 ms	4 ms	---	PG	decentral	ET200 SP PN ST	1	64	144,03	5,17	

3.

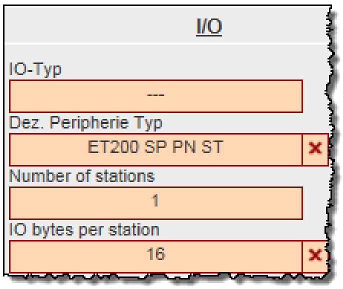
Operator action: Proceed in the same way to select the required parameters for the "IO device" area.

Example:

Successive selection of the ET200S PN HF type, with 1 station and 16 I/O bytes per station



System response: The system has applied your entries.



Once again, the system has performed a database query with the advanced filter settings and removed the now defined columns from the results table.

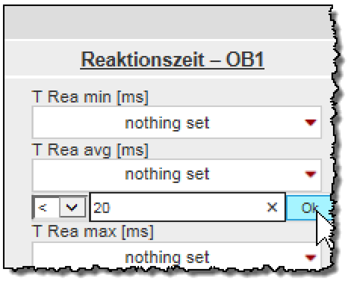
Results: 2 of 2440 Download results (*.csv) Show columns

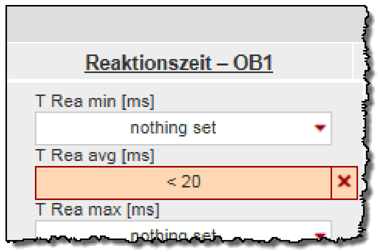
CPU	Prg-Load	Cycl-Int	CP	PG	IO-zentr/dez.	IO-Device	Num devices	SumIO-Bytes	T Rea avg [ms]	T Rea CyclAlrm avg[ms]	T Rea PrzAlrm avg[ms]	T Rea Sym
CPU 1217C	5 ms	4 ms	---	PG	decentral	ET200 SP PN ST	1	16	19,21	5,18		
CPU 1217C	10 ms	4 ms	---	PG	decentral	ET200 SP PN ST	1	16	32,91	4,98		

2.2.3 Entering the performance requirements

In addition to specifying the hardware components, you can restrict the range of tolerable message runtimes in the "Performance Requirements" filter area.

Table 2-4

<table>
<tr><th>No.</th><th>Operator action</th><th>System response</th></tr>
<tr><td rowspan="2">1.</td><td>Enter the minimum, average or maximum values required for your system. For a description of the different measured values, please refer to Chapter 1.2; a tooltip provides a brief explanation directly on the control.
<u>Example:</u>
The maximum tolerable average PN response time of your system via the process image shall be 20 ms.


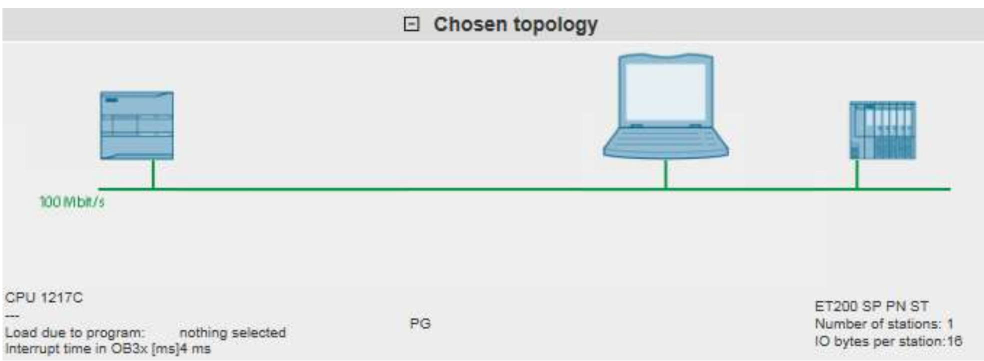
Confirm your entry by clicking on the OK button.</td><td>The system has applied your desired entry.

</td></tr>
<tr><td colspan="2">The system has sent a query with the now active filters to the database and displayed the results in the performance data table.


With the selected sample filter settings, the system has found only 1 data record that meet all default criteria.</td></tr>
</table>

2.2.4 View of the selected configuration

You can view the hardware configuration diagram for this configuration by expanding the "Chosen topology" area.

Figure 2-7



Components that have not been selected are indicated by a question mark icon  in the diagram and "nothing selected" or "---" in the text.

2.2.5 Performance data table

The performance data table shows the database contents of the respective measurement restricted by the previous filters. This area is permanently visible. By default, the table displays only a selection of the columns available in the database for this measurement. A dialog box allows you to select or deselect individual columns.

Control elements of the table

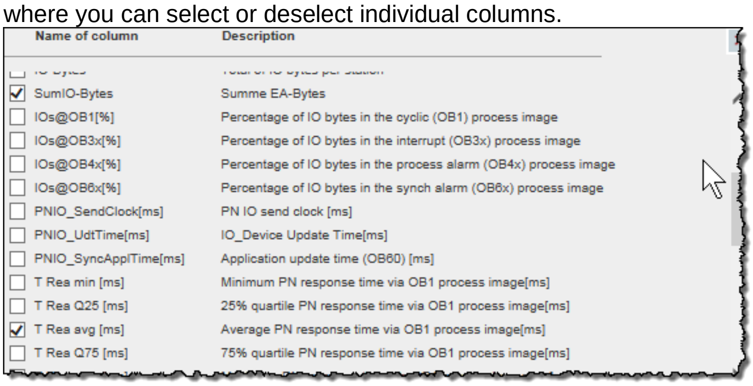
Figure 2-8

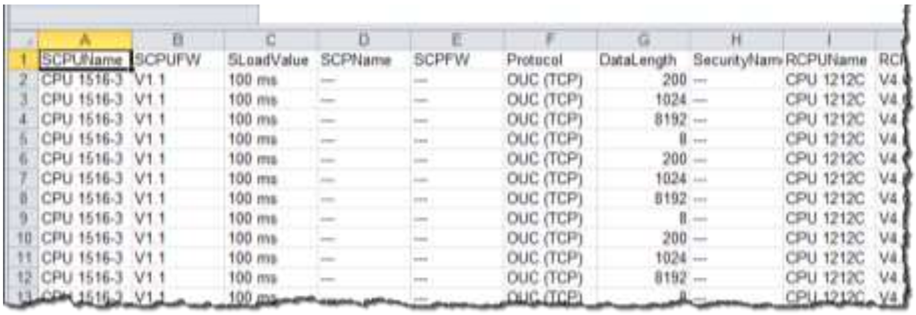
Explanation of the control elements

The following table describes the control elements shown in Figure 1-8.

Table 2-5 to do

<table>
<tr><th>No.</th><th>Explanation</th></tr>
<tr><td>1</td><td>The table control displays
the number of results
the maximum number of data records of this measurement</td></tr>
<tr><td>2</td><td>By clicking on the "> Show columns" control element, you can open a dialog box where you can select or deselect individual columns.


<table>
<tr><th></th><th>Name of column</th><th>Description</th></tr>
<tr><td>☑</td><td>SumIO-Bytes</td><td>Summe EA-Bytes</td></tr>
<tr><td>☐</td><td>IOs@OB1[%]</td><td>Percentage of IO bytes in the cyclic (OB1) process image</td></tr>
<tr><td>☐</td><td>IOs@OB3x[%]</td><td>Percentage of IO bytes in the interrupt (OB3x) process image</td></tr>
<tr><td>☐</td><td>IOs@OB4x[%]</td><td>Percentage of IO bytes in the process alarm (OB4x) process image</td></tr>
<tr><td>☐</td><td>IOs@OB6x[%]</td><td>Percentage of IO bytes in the synch alarm (OB6x) process image</td></tr>
<tr><td>☐</td><td>PNIO_SendClock[ms]</td><td>PN IO send clock [ms]</td></tr>
<tr><td>☐</td><td>PNIO_UdtTime[ms]</td><td>IO_Device Update Time[ms]</td></tr>
<tr><td>☐</td><td>PNIO_SyncApplTime[ms]</td><td>Application update time (OB60) [ms]</td></tr>
<tr><td>☐</td><td>T Rea min [ms]</td><td>Minimum PN response time via OB1 process image[ms]</td></tr>
<tr><td>☐</td><td>T Rea Q25 [ms]</td><td>25% quartile PN response time via OB1 process image[ms]</td></tr>
<tr><td>☑</td><td>T Rea avg [ms]</td><td>Average PN response time via OB1 process image[ms]</td></tr>
<tr><td>☐</td><td>T Rea Q75 [ms]</td><td>75% quartile PN response time via OB1 process image[ms]</td></tr>
</table></td></tr>
<tr><td>3</td><td>Provided that there are multiple results pages, the control bar elements of the table control allow you to select the individual results pages and go to the next, previous, last or first page.</td></tr>
<tr><td>4</td><td>When you click on "Download results (*.csv)", the web server uploads all contents of the results table to the client browser as a csv file. Depending on the browser and the installed Excel version, the data is immediately displayed in an Excel spreadsheet.


<table>
<tr><th></th><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th><th>G</th><th>H</th><th>I</th><th></th></tr>
<tr><td>1</td><td>SCPUName</td><td>SCPUFW</td><td>SLoadValue</td><td>SCPName</td><td>SCPFW</td><td>Protocol</td><td>DataLength</td><td>SecurityName</td><td>RCPUName</td><td>RC</td></tr>
<tr><td>2</td><td>CPU 1516-3</td><td>V1.1</td><td>100 ms</td><td>—</td><td>—</td><td>OUC (TCP)</td><td>200</td><td>—</td><td>CPU 1212C</td><td>V4</td></tr>
<tr><td>3</td><td>CPU 1516-3</td><td>V1.1</td><td>100 ms</td><td>—</td><td>—</td><td>OUC (TCP)</td><td>1024</td><td>—</td><td>CPU 1212C</td><td>V4</td></tr>
<tr><td>4</td><td>CPU 1516-3</td><td>V1.1</td><td>100 ms</td><td>—</td><td>—</td><td>OUC (TCP)</td><td>8192</td><td>—</td><td>CPU 1212C</td><td>V4</td></tr>
<tr><td>5</td><td>CPU 1516-3</td><td>V1.1</td><td>100 ms</td><td>—</td><td>—</td><td>OUC (TCP)</td><td>8</td><td>—</td><td>CPU 1212C</td><td>V4</td></tr>
<tr><td>6</td><td>CPU 1516-3</td><td>V1.1</td><td>100 ms</td><td>—</td><td>—</td><td>OUC (TCP)</td><td>200</td><td>—</td><td>CPU 1212C</td><td>V4</td></tr>
<tr><td>7</td><td>CPU 1516-3</td><td>V1.1</td><td>100 ms</td><td>—</td><td>—</td><td>OUC (TCP)</td><td>1024</td><td>—</td><td>CPU 1212C</td><td>V4</td></tr>
<tr><td>8</td><td>CPU 1516-3</td><td>V1.1</td><td>100 ms</td><td>—</td><td>—</td><td>OUC (TCP)</td><td>8192</td><td>—</td><td>CPU 1212C</td><td>V4</td></tr>
<tr><td>9</td><td>CPU 1516-3</td><td>V1.1</td><td>100 ms</td><td>—</td><td>—</td><td>OUC (TCP)</td><td>8</td><td>—</td><td>CPU 1212C</td><td>V4</td></tr>
<tr><td>10</td><td>CPU 1516-3</td><td>V1.1</td><td>100 ms</td><td>—</td><td>—</td><td>OUC (TCP)</td><td>200</td><td>—</td><td>CPU 1212C</td><td>V4</td></tr>
<tr><td>11</td><td>CPU 1516-3</td><td>V1.1</td><td>100 ms</td><td>—</td><td>—</td><td>OUC (TCP)</td><td>1024</td><td>—</td><td>CPU 1212C</td><td>V4</td></tr>
<tr><td>12</td><td>CPU 1516-3</td><td>V1.1</td><td>100 ms</td><td>—</td><td>—</td><td>OUC (TCP)</td><td>8192</td><td>—</td><td>CPU 1212C</td><td>V4</td></tr>
<tr><td>13</td><td>CPU 1516-3</td><td>V1.1</td><td>100 ms</td><td>—</td><td>—</td><td>OUC (TCP)</td><td>8</td><td>—</td><td>CPU 1212C</td><td>V4</td></tr>
</table></td></tr>
<tr><td>5</td><td>Clicking on the column header of the measured values (in this example - TransTime_avg) triggers a sorting of the table according to this criterion. Each further click on the respective column header changes the sorting status of the column accordingly.
T Rea min [ms]   Values unsorted
T Rea min [ms]▲   Values sorted in ascending order
T Rea min [ms]▼   Values sorted in descending order

Note:
You can only sort one column at a time!</td></tr>
</table>

Meaning of the columns

Tooltips provide more detailed information on all column headers.

Table 2-6

Column name	Explanation
CPU	IO controller type
CPUFW	Firmware version CPU

Column name	Explanation
Prg-Load	Load due to program in OB1 (ms)
Cycl-Int	Interrupt time in OB3x [ms]
CP	CP/CM type (IO Controller)
CPFW	Firmware version CP/CM
PG	PG type
IO-zentr/dez	Centralized/distributed I/O
IO-Device	I/O device type
Num devices	Number of I/O device stations
IO-Bytes	Sum of IO bytes per station
SumIO-Bytes	Sum of IO bytes
IOs@OB1[%]	Percentage of IO bytes in the cyclic (OB1) process image
IOs@OB3x[%]	Percentage of IO bytes in the interrupt (OB3x) process image
IOs@OB4x[%]	Percentage of IO bytes in the process alarm (OB4x) process image
IOs@OB6x[%]	Percentage of IO bytes in the synch alarm (OB6x) process image
PNIO_SendClock[ms]	PN IO send clock [ms]
PNIO_UdtTime[ms]	IO_Device update time [ms]
PNIO_SyncApplTime[ms]	Application update time (OB60) [ms]
T Rea min [ms]	Minimum PN response time via OB1 process image[ms]
T Rea Q25 [ms]	25% quartile PN response time via OB1 process image[ms]
T Rea avg [ms]	Average PN response time via OB1 process image[ms]
T Rea Q75 [ms]	75% quartile PN response time via OB1 process image[ms]
T Rea max [ms]	Maximum PN response time via OB1 process image[ms]
T Rea CyclAlrm min[ms]	Minimum PN response time via OB4x process alarm[ms]
T Rea CyclAlrm Q25[ms]	25% quartile PN response time via OB4x process alarm[ms]
T Rea CyclAlrm avg[ms]	Typical PN response time via OB4x process alarm[ms]
T Rea CyclAlrm Q25[ms]	75% quartile PN response time via OB4x process alarm[ms]
T Rea CyclAlrm max[ms]	Maximum PN response time via OB4x process alarm[ms]
T Rea PrzAlrm min[ms]	Minimum PN response time via OB4x process alarm[ms]
T Rea PrzAlrm Q25[ms]	25% quartile PN response time via OB4x process alarm[ms]
T Rea PrzAlrm avg[ms]	Typical PN response time via OB4x process alarm[ms]
T Rea PrzAlrm Q25[ms]	75% quartile PN response time via OB4x process alarm[ms]
T Rea PrzAlrm max[ms]	Maximum PN response time via OB4x process alarm[ms]
T Rea SyncAlrm min[ms]	Minimum PN response time via OB6x clock-synchronized Alarm[ms]
T Rea SyncAlrm Q25[ms]	25% quartile PN response time via OB6x clock-synchronized Alarm[ms]
T Rea SyncAlrm avg[ms]	Typical PN response time via OB6x clock-synchronized Alarm[ms]
T Rea SyncAlrm Q25[ms]	75% quartile PN response time via OB6x clock-synchronized Alarm[ms]
T Rea SyncAlrm max[ms]	Maximum PN response time via OB6x clock-synchronized Alarm[ms]
T Cycle min[ms]	Maximum OB1 cycle time (IO controller) [ms]

Column name	Explanation
T Cycle avg[ms]	Average OB1 cycle time (IO controller) [ms]
T Cycle max[ms]	Maximum OB1 cycle time (IO controller) [ms]
T CycleBesy min[ms]	Maximum OB1 operating system time (IO controller) [ms]
T CycleBesy avg[ms]	Average OB1 operating system time (IO controller) [ms]
T CycleBesy max[ms]	Maximum OB1 operating system time (IO controller) [ms]

3 Performing the measurements

The following chapters provide information on how to perform the measurements.

3.1 Measuring method and measuring setup/sequence

Measuring sequence

The basic measurement sequence is as follows:

1. Configuring a configuration, including the download to all stations involved.
2. Measuring all measured variables (each measurement is repeated several times).
3. Evaluating the measurements and determining the statistical position parameters.

Measuring method for the performance data

- **PN response time**

  One ET200 measurement station (SP/MP) is physically connected to the PROFINET IO line. The **remaining** ET200 stations are simulated with a SIMBA PN station.
  A signal status change is periodically generated at an input of the ET200 measurement stations (DIx). The IO controller reads this input via different OB process levels, using the (partial) process image and sets a corresponding output (DAy) of the ET200 measurement station.
  The time interval between these related signal status changes is acquired with the measuring instruments and stored. Approx. 200 – 500 single measurements are performed for a measurement.

- **PN update time / PN SendClock / PN SyncAlrmTime**

  These values are the PROFINET- specific parameters. They are taken from the STEP 7 configuration and not measured.

- **Cycle times**

  The cycle time is the interval between two process image updates of the IO controller in OB1. This value is measured with system-internal functions.
  The cycle time is measured during operation. The IO controller communicates with the distributed stations or its central modules.

- **Cycle control time**

  The cycle control time is the time required by the operating system of the CPU from the last instruction at the end of the OB1 program to the OB1 program recall with the first instruction. This value is measured with internal functions.

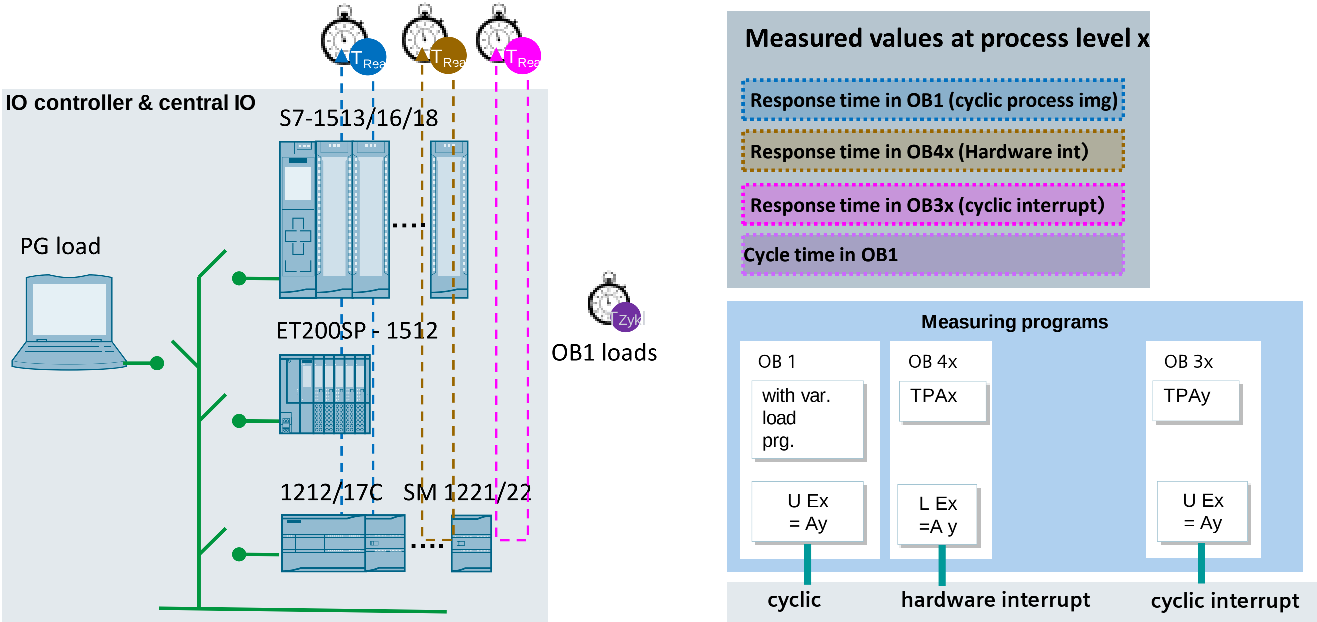
3.2 Measurement setup

The following figures show the principle of the centralized and distributed measuring setup. It does not show components (e.g., I/O modules) and signals for the dial indicators (e.g., ready signals) used only to perform the measurement.

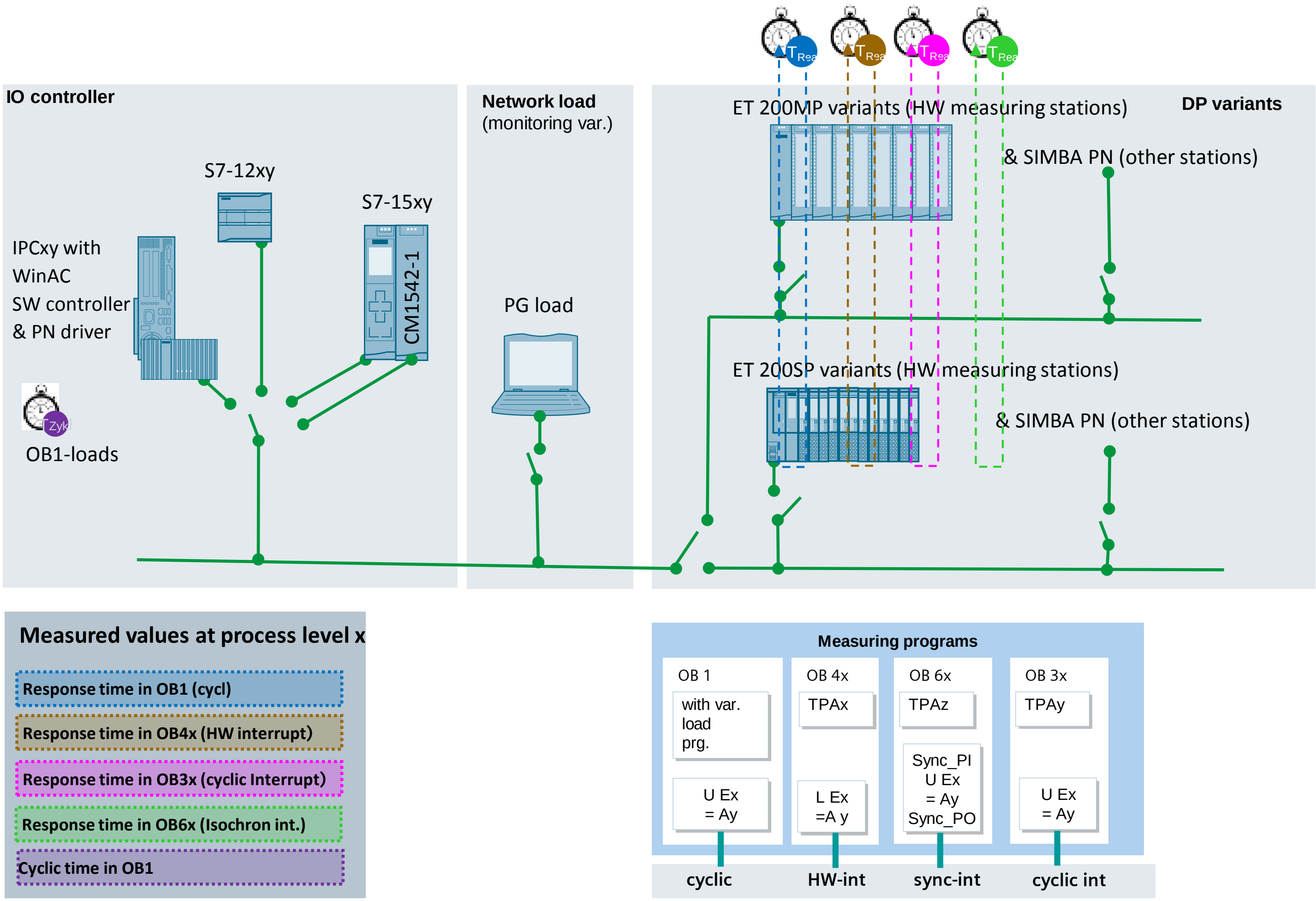
The measurement always takes place under the following boundary conditions:

- The communication program in the sending station and in the receiving station is called cyclically in OB1 of the S7 controller.
- Exactly one connection is established to each receiving station.
- A complete data block is always sent with a call.
- Source and destination of the data are each located in a data block.

Centralized measurement setup



Distributed measuring setup



3.3 Measuring the response times

Principle of measuring process in distributed PN IO measurement

ET200 stations with different configurations are connected via PROFINET IO to different SIMATIC IO controllers, using a physically wired PROFINET IO network.

The IO controller is networked directly with a real ET200SP/MP station.

All other ET200 stations configured for this measurement are simulated.

Simultaneously running dial indicators connected to the real ET200 measurement station simultaneously record the different response times (response time in OB1, response time in OB40, response time in OB30, response time in OB61) as follows:

Table 3-1

No.	Description
1.	The dial indicator sets the corresponding digital inputs in the ET200 measurement station that has been configured for the respective OBx process level.
2.	Via the real ET200 measurement station, the distributed input is detected by the IO controller interconnected accordingly (using the process image, partial process image (TPA), process alarm, TPA interrupt or TPA clock-synchronized interrupt).
3.	In response, the STEP7 program sets one distributed output in each IO controller (via OB1 cycle, OB40, OB30 or OB61).
4.	The dial indicator records the elapsed time with a resolution of +/- 3 µs.

The reading and writing of the distributed IO by the IO controller take place via the various OB process levels according to a fixed distribution rule.

Due to the IO configuration expansion (32, 64, 128 bytes), the additional IO bytes are distributed **as evenly** as possible to the OB1, OB30, OB60 process levels. The number of bytes in OB40 remains consistently small. The exact distribution of IO bytes is output in the results column in each measurement.

Principle of measuring sequence in centralized PN IO measurement

In real centralized stations with different configurations, the various SIMATIC controllers are equipped with their centralized IO modules.

Simultaneously running dial indicators connected to the real IO simultaneously record the different response times (response time in OB1, response time in OB40, response time in OB30) as follows:

Table 3-2

No.	Description
1.	The dial indicator sets the corresponding digital inputs in the centralized IO that has been configured for the respective OBx process level.
2.	The centralized input is detected by the corresponding IO controller via the real IO (using the process image, partial process image (TPA), process alarm or TPA interrupt).
3.	In response, the STEP7 program sets one centralized output in each IO controller (via OB1 cycle, OB40 or OB30).
4.	The dial indicator records the elapsed time with a resolution of +/- 3 µs.

The reading and writing of the centralized IO by the IO controller take place via various OB process levels according to a fixed distribution rule.

Due to the IO **expansion** (32, 64, 128 bytes), the additional IO bytes are distributed **as evenly as possible** to the OB1, OB30, OB60 process levels. The number of bytes in OB40 remains consistently small. The exact distribution of IO bytes is output in the results column in each measurement.

Evaluations

From a maximum of 500 single measurements, the dial indicator calculates the statistical position parameters of the measured values. (See Chapter 3.5 Measured variables and statistics)

3.4 Cycle time /cycle control time measurement

Principle

The cycle time in the sending and receiving stations is determined via system functions (S7-1500) and separate measuring programs (S7-1200). The S7 controller automatically determines the statistical position parameters of the cycle time on the basis of the repeated measurements.

Measurement period

- From the start of the PN IO response time measurement
- To the end of the PN IO response time measurement with X repetitions

Evaluation

From a maximum of 500 single measurements, the dial indicator calculates the statistical position parameters of the measured values. (See Chapter 3.5 Measured variables and statistics)

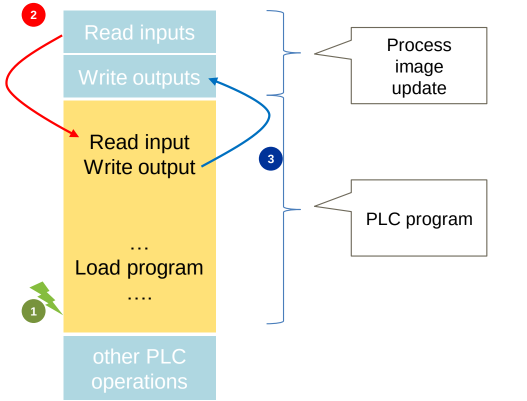
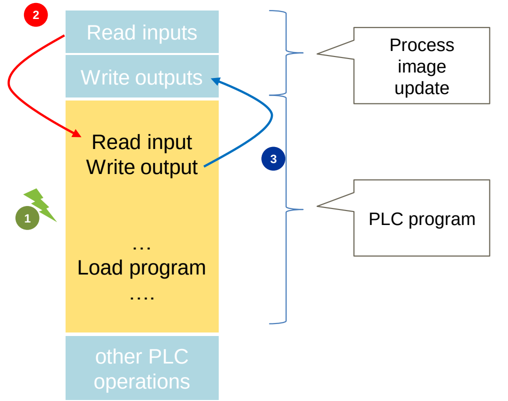
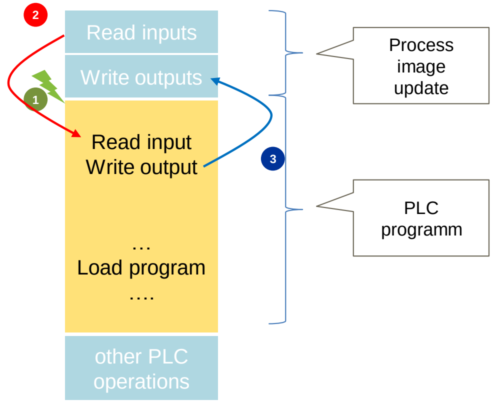
3.5 Measured variables and statistics

3.5.1 Interpretation of the measured values using the example of the response time in OB1

Determination of the response times was deliberately based on configurations that are often used in practical operation. Particular attention was paid to ensure that not only the mere "signal transit times" were measured. This means that the response times reflect the complete system, including the PLC program, and not just the individual components.

To be able to classify the measurement results correctly, the next section provides an interpretation of the "PN response time" measured variable. The table below illustrates the structure of the minimum, typical and maximum PN response time:

Table 3-3

	Minimum PN response time	**Typical PN response time**	**Maximum response time**
T-Rea with load program 10ms	12 ms	18 ms	24 ms
Position of the input signal in relation to the cycle			
Explanation	1. The input signal occurs shortly before the cycle change. 2. The inputs are copied to the process input image (within the update time). 3. The read signals are written to the process output image. In the subsequent cycle, the system writes the process image to the outputs. **Consequence:** The input signal can be directly detected, and the mirrored signal can be output at the beginning of the next cycle.	1. The input signal occurs approx. in the middle of the cycle. 2. After half a cycle has elapsed, the inputs are copied to the process input image (within the update time). These signals are read in the user program. The read signals are written to the process output image. 3. In the subsequent cycle, the system writes the process image to the outputs. **Consequence:** The input signal can only be detected half a cycle later, and the mirrored signal is then also output later.	1. The input signal occurs shortly after the cycle change and after the system has read the inputs. 2. After a complete cycle has elapsed, the inputs are copied to the process input image (within the update time). These signals are read in the user program. 3. The read signals are written to the process output image. In the subsequent cycle, the system writes the process image to the outputs. **Consequence:** The input signal can only be detected after the current cycle has been completed. The mirrored signal can thus only be output after the end of the second cycle or before the beginning of the third cycle.

Structure of the time measured	Time = approx. load program + transmission time of the system (*)	Time = approx. (time_min + time_max)/2	Time = 2 * load program + transmission time of the system (*)
Conclusion	This time indicates the best response time to be expected (best case).	This time indicates the average (typical) response time to be expected.	This time indicates the worst response time to be expected (worst case). Yet statistical outliers of the system can be added to this value.

(*)

If "reading the inputs" and "writing to the outputs" last longer than the load program, at least one "load program duration" has to be added!

Although the values actually measured are always statistically distributed between the extreme values, an ideal equal distribution cannot be assumed. Outliers and additional loads on the bus move the position parameters accordingly.

Position parameters

To make statements on the stability and probability of the average value (median), the further statistical position parameters should also be taken into consideration. For this purpose, all measured variables are measured multiple times (up to 500 individual measurements). From all measured values, the measurement system calculates the following statistical values that can then be selected by the user in the results table (by default, however, these position parameters are hidden).

Table 3-4

Position parameters	Definition
T Rea min	The minimum measured PN response time via the OB1 process image.
T Rea Q25	The first quartile (**Q25**) states that 25% of the measured values are below this number
T Rea avg	The **median** (**Q50**) indicates the measured value that divides the number of sorted measured values into two halves of equal size. This position parameter is the most important one in the measured value table and always shown by default in the results table.
T Rea Q75	The third quartile (**Q75**) states that 75% of the measured values are below this number.
T Rea max	the maximum measured PN response time via the OB1 process image.
T Rea CyclAlrm min	minimum PN response time via OB4x process alarm.
T Rea CyclAlrm Q25	25% quartile PN response time via OB4x process alarm.
T Rea CyclAlrm avg	typical PN response time via OB4x process alarm.
T Rea CyclAlrm Q25	75% quartile PN response time via OB4x process alarm.
T Rea CyclAlrm max	maximum PN response time via OB4x process alarm.
T Rea PrzAlrm min	minimum PN response time via OB4x process alarm.
T Rea PrzAlrm Q25	25% quartile PN response time via OB4x process alarm.
T Rea PrzAlrm avg	typical PN response time via OB4x process alarm.
T Rea PrzAlrm Q25	75% quartile PN response time via OB4x process alarm.
T Rea PrzAlrm max	maximum PN response time via OB4x process alarm.
T Rea SyncAlrm min	minimum PN response time via OB6x clock-synchronized alarm
T Rea SyncAlrm Q25	25% quartile PN response time via OB6x clock-synchronized alarm
T Rea SyncAlrm avg	typical PN response time via OB6x clock-synchronized alarm
T Rea SyncAlrm Q25	75% quartile PN response time via OB6x clock-synchronized alarm
T Rea SyncAlrm max	maximum PN response time via OB6x clock-synchronized alarm
T Cycle min	maximum OB1 cycle time (IO controller)
T Cycle avg	average OB1 cycle time (IO controller)
T Cycle max	maximum OB1 cycle time (IO controller)

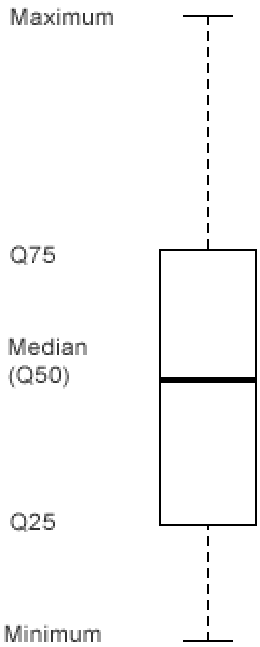
Position parameters	Definition
T CycleBesy min	maximum OB1 operating system time (IO controller)
T CycleBesy avg	average OB1 operating system time (IO controller)
T CycleBesy max	maximum OB1 operating system time (IO controller)

50% of all measured values are in the **interquartile range** (IQR), i.e., the range between XY_Q25 and XY_Q75. This range enables the user to derive information on spread and reliability of the mean value (median).

Interpretation of the measured values

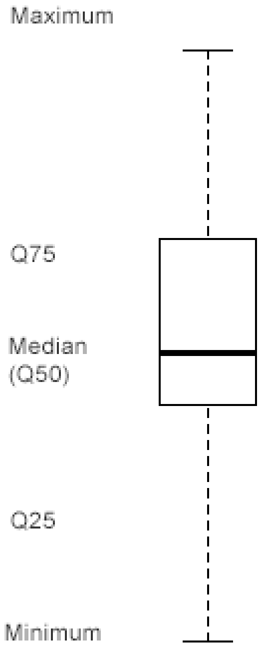
The spread of the measured values can be detected via the standardized statistical box plot representation.

Table 3-5

<table>
<tr><th>Box plot</th><th>Position parameter</th><th>Interpretation</th></tr>
<tr><td>
</td><td>Here, the maximum of the measured values is slightly asymmetric to the rest.

50% of all measured values are in the IQR range (Q25 to Q75). In this example, this range is relatively large compared to the second example.

The median (Q50 value) lies fairly symmetrical in the IRQ range.</td><td>In this measurement, there is a slight upward deviation.

50% of all measured values are spread relatively widely, i.e., the entire IRQ range is more likely for this measurement.</td></tr>
<tr><td>
</td><td>50% of all measured values are in the IQR range (Q25 to Q75). Compared to the first example, this measurement is much narrower.</td><td>50% of all measured values are spread relatively narrowly. For this configuration, the results and the value of the median are very meaningful and likely.</td></tr>
</table>

3.6 Explanatory notes on the STEP 7 program

The STEP 7 program directly affects the measured values. The following chapters provide an overview of the STEP 7 program on which the measured values are based.

Overview of the STEP 7 programs

The table below shows the function of the individual program components. During a measurement, all program components are loaded.

The user program contains primarily STEP 7 blocks for the automation of measurement and for communication with the distributed stations.

Table 3-6

STEP 7 program component		Task in the S7 controller
User program	Function program	Program components that have nothing to do with the actual acquisition of measuring values (e.g., call of communication blocks, HMI program, etc.)
	Acquisition program	Program components exclusively used to acquire the measured values and to generate the control signals. • Acquiring the measurement start signal • Measuring the cycle time
Load program		The load program fulfills no specific tasks and has no specific function. It is merely used to increase the size of the STEP 7 program and thus to extend the cycle time.

3.6.1 User program

The task of the acquisition program within the user program is primarily to mirror the configured IOs at the corresponding OB process levels. Depending on the HW configuration, IO mirroring is performed in parallel at up to 4 OB process levels. Each acquisition program interrupts the cyclic OB1 of lower priority, which results in a corresponding response time extension.

I/O program in OB1 (main)

The measuring signal is read at the digital input x of the centralized or distributed IO and output at the digital output y of the same station. The IO controller reads the signal via the **process image** assigned to OB1 and outputs it via the process image:

<u>Schematic program fragment:</u>

```
A  %Ix.y
 = %Qx.y
```

I/O program in OB40 (hardware interrupt)

The measuring signal is read at a digital input x configured with interrupt capability of the centralized or distributed IO and output at the digital output y of the same station. The IO controller reads the signal in the OB4x program (HW-Int) via the

process image assigned to the process level and immediately outputs it at the output y.

Schematic program fragment:

A %Iu.v

= %Qu.v

Note:

The interrupt rate at which OB1 is interrupted by OB40 is approx. two interrupts/sec.

I/O program in OB61 (synchronous cycle)

The start signal and measuring signal are read at the digital input x of the IRT-capable ET200 measurement station and output at the output y of the same station. The IO controller reads the corresponding bytes via the assigned clock-synchronized process image in the OB61 program, processes it and outputs it clock-synchronized via the same route to a digital output module with the corresponding configuration of the same station:

Schematic program fragment:

CALL Sync_PI

A %Im.n

= %Qm.n

CALL Sync_PO

I/O program in OB3x (Cyclic Interrupt)

The measuring signal is read at the digital input x of the centralized or distributed IO and output at the digital output y of the same station. The IO controller reads the signal via the **partial process image** assigned to OB3x and outputs it via the same process image:

Schematic program fragment:

A %Ix.y

= %Qx.y

3.6.2 Load program

The load program is part of the STEP 7 program in the S7 controller. The size (length) of the load program is selected such that it results in a default "cycle time without communication" in the S7 controller.

Definition of "cycle time without communication"

The "cycle time without communication" is the cycle time set in the S7 controller when the S7 controller is **not** subject to influences of the communication. For the

S7 controller, this means that no data is sent and no communication blocks are processed.

Defining a "cycle time without communication"

To be able to define the "cycle time without communication", a load program is downloaded to the S7 controller. This load program can be used to simulate the practice-relevant case of communication and other control tasks being simultaneously performed in the S7 controller. The load program is implemented with a simple loop which does not have any influence on the remaining program. The variation of the loops can be used to set the "cycle time without communication".

Selecting the "cycle time without communication"

For this measurement, the length of the load program has always been selected such that there is a no-load cycle time ("cycle time without communication") of **250us** (low CPU load caused by control tasks) up to **50ms** (high CPU load caused by control tasks). This implies that the length of the load program varies per S7 controller to ensure that the desired no-load cycle time is set.

Setup of the load program:

The load program consists of a combination of different types of STEP 7 instructions. The number of STEP 7 instructions of a type is selected in such a way that this type has a defined percentage of the total execution time of the load program.

Table 3-7

Type of STEP 7 assignment	Percentage of the execution time	e.g, in the case of cycle time = 10 ms
Binary instructions	approx. 60%	approx. 6ms
Time / counter instructions	approx. 20%	approx. 2ms
Data word commands	approx. 10%	approx. 1ms
Floating-point arithmetic	approx. 10%	approx. 1ms

3.6.3 The PG load

To detect the effect of an "engineering load" (PG load) on response times / cycle times, a programming device with STEP 7 V13 can be connected to the S7 controller via the "monitoring variables" function.

For this purpose, different variables (see Figure 3-1) are cyclically monitored in the S7 CPU memory on the PG. This affects primarily the cycle time of the S7 controller.

Figure 3-1 Watch table

Last

	Name	Datentyp	Startwert	R
1	Static			
2	Bool_1	Bool	false	
3	Byte_2	Byte	16#0	
4	Word_3	Word	16#0	
5	DWord_4	DWord	16#0	
6	Real_5	Real	0.0	
7	DInt_6	DInt	0	
8	counter	Int	0	
9	Feld	Array[0..23] of Byte		
10	Feld[0]	Byte	16#0	
11	Feld[1]	Byte	16#0	
12	Feld[2]	Byte	16#0	
13	Feld[3]	Byte	16#0	
14	Feld[4]	Byte	16#0	
15	Feld[5]	Byte	16#0	
16	Feld[6]	Byte	16#0	
17	Feld[7]	Byte	16#0	
18	Feld[8]	Byte	16#0	
19	Feld[9]	Byte	16#0	
20	Feld[10]	Byte	16#0	
21	Feld[11]	Byte	16#0	
22	Feld[12]	Byte	16#0	
23	Feld[13]	Byte	16#0	
24	Feld[14]	Byte	16#0	
25	Feld[15]	Byte	16#0	
26	Feld[16]	Byte	16#0	
27	Feld[17]	Byte	16#0	
28	Feld[18]	Byte	16#0	
29	Feld[19]	Byte	16#0	
30	Feld[20]	Byte	16#0	
31	Feld[21]	Byte	16#0	
32	Feld[22]	Byte	16#0	
33	Feld[23]	Byte	16#0	

4 Version

Table 4-1

Measurement version	Measurement setup	Publication	Description
V 9.0 (ID31)	Mid-2015	April 2016	Repeated measurement with new S7 controllers
V 8.1 (ID28)	Mid-2012	December 2012	Remeasurement with S7-1200 controller
V 8.0 (ID23)	Mid-2011	April 2012	Repeated measurement
V 7.0 (ID19)	Mid-2009	February 2010	Repeated measurement + New-Web Appearance
V 6.0 (ID16)	Mid-2008	January 2009	Repeated measurement + New-Web Appearance
V 4.0 (ID14)	Late 2007	July 2008	Remeasurement
V 3.0 (ID11)	Early 2007	July 2007	Repeated measurement
V 2.0.1.0 (ID7)	Mid-2004	June 2005	Adjustment of the user interface
V 2.0	Mid-2004	October 2004	Repeated measurement
V 1.1	Mid-2001	December 2001	First measurement