

Industry Online Support

NEWS

Explanation regarding Measurement -"Transmission Times for Typical RFID Configurations using SIMATIC S7".

RFID ID33

https://support.industry.siemens.com/cs/ww/en/view/82255083

Siemens Industry Online Support



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# **1** Scope of Measurement

# 1.1 Objective

The planner of an automation system with RFID component is primarily interested in how long it takes for the entire system to read data from a transponder to the S7 CPU or to write it from the S7 CPU to the transponder.

A typical system setup with SIMATIC RFID consists of any S7 CPU type to which an ASM is connected via an IO bus system and distributed I/O or centrally. The specific reader is connected to the ASM, which writes or reads the information to the corresponding transponder. The individual components are combined in a variant matrix.

In order to be able to make the right component selections in the concept phase of an automation project, or to get a general feel for the expected response times, it is important to be able to estimate the communication performance of this planned configuration.

### Important questions

- Which S7 components are best suited for the planned automation project?
- Which data transfer times can be expected for typical configurations?
- Which statistical fluctuations can occur in the process?
- How does the data communication affect the cycle (OB1) of the sending and receiving S7 controller?

### Scope of these measurements

In order to answer these questions, extensive measurements have been performed under conditions relevant to practical operation:

- With typical S7 components
- Typical parameters and configurations
- With a load program relevant to practical operation in the S7 controller
- With a typical range of quantity operations

To conveniently access the measurement results, you can set up your desired configuration using the interactive user interface.

# 1.2 Performance data provided

The following performance data or measured variables are available to you: Table 1-1

Measured variable	Definition
Transmission time for RFID Read/Write	<ul> <li>The transmission time answers the following question:</li> <li>How long does it take to transfer a data packet from the trigger at the RFID communication module to the positive acknowledgement at the same block? (RFID Read/Write)</li> <li>How does this transfer time change by varying the</li> </ul>

Measured variable	Definition
	various parameters (data length, baud rate, etc).
	<ul> <li>What statistical fluctuations occur in the process?</li> </ul>
Inventory time	The measured variable answers the questions:
	<ul> <li>How long does it take until 1n statically placed transponders have been detected by the reader's read field and are ready for read/write commands?</li> <li>How does this value spread statistically?</li> </ul>
Ovela time in the CZ CDU	
Cycle time in the S7 CPU	the sender CPUs (min, avg, max).
PN update time	The PN update time 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 <b>calculated</b> by STEP 7 and not measured.

Note

For a detailed description of the method of measurement, please refer to chapter 3.

# **1.3** Parameters of the measurement

This measurement has been performed with the following parameters: Table 1-2

Component	Parameter	Explanation
S7 controller	CPU	Selection of the CPU type
	СР	Setting of the CP type. Communication path via the integrated interface of the CPU or use of a CP
	Load due to program	Setting of the program load implemented in the sending station by an additional STEP 7 program.
Network	Network connection	Bus type with which the RFID communication modules or readers are connected to the controller.
	Additional IO load	Number an ET200 stations with digital IO
	Connection via distributed I/O	ET200 station type
Communication	Type of communication module	RFID connection module
module	Number of communication modules	
	IO link master type module	Type of IO link master connection for IO link-capable readers
Reader/TAGs	RFID reader type	Selection of RFID reader type
	Number of readers	Selection of how many readers are in an interface connection

Component	Parameter	Explanation
	Antenna mode	Selection of the RFID antenna mode (permanent on, on demand)
	Number of UHF antennas	
	TAG type	
	Number of tags in field	Only relevant for UHF inventory measurements

# **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 of validity and technical data

### Scope of validity

The measurement covers a typical range of components. The selection follows the most current and most frequently used products as of "summer 2017".

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.

The following boundary conditions apply for all measurement series:

- The configuration of the S7 CPUs and ASMs shall be carried out with default values as far as possible.
- The transponders used are incremented with a value during the write cycles in order to detect when the transponder has to be replaced after the end of the average write cycles (technical data).
- For UHF, the fastest radio profile should always be set. (as of autumn 2016 profile 37).
- The expected number of TAGs should always match the real TAGs to be read (initial Q value 1, 10, 100)
- The transmission power of the UHF readers was set to 1 watt.

### Components used

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

Table	1-3

Component		Туре	Article number	Version
S7 CPUs	S7-1200	CPU 1212C	6ES7212-1AE40-0XB0	V 4.2
		CPU 1217C	6ES7217-1AG40-0XB0	V 4.2
		CM 1243-5	6GK7243-5DX30-0XE0	V 1.3.4
	S7-1500	CPU 1511-1PN	6ES7511-1AK01-0AB0	V 2.1
		CPU 1516 -3PN/DP	6ES7516-3AN01-0AB0	V 2.1
		CM(P)1542-5	6GK7542-5DX00-0XE0	V1.0
		CPU 1518-4PN/DP	6ES7518-4AP00-0AB0	V 2.1
		CPU 1512SP-1 PN	6ES7512-1DK01-0AB0	V 2.1
		CPU 1515SP PC	6ES7677-2AA41-0EB0	V 2.1
		CM DP for ET 200SP CPU	6ES7545-5DA00-0AB0	V 1.0
		CPU 1516pro-2PN CM CPU 2PN	6ES7516-2PN00-0AB0 6ES7194-4AP00-0AA0	V 2.1
ET 200 Station	ET 200SP	IM 155-6 PN ST	6ES7155-6AA00-0BN0	V 3.3
		IM 155-6 DP HF	6ES7155-6BA00-0CN0	V 3.3
	ET 200pro	IM 155-6 DP ST	6ES7154-1AA01-0AB0	V 2.2
		IM 154-4 PN	6ES7154-4AB10-0AB0	V 7.1
	ET 200AL	IM 157-1 PN	6ES7157-1AB00-0AB0	V 1.0
		IM157-1 DP	6ES7157-1AA00-0AB0	V 1.0
IO-Link master	S7-1200	SM 1278 IO-Link Master	6ES7278-4BD32-0XB0	V 2.0.1
modules	ET 200SP	CM 4 X IO-LINK ST	6ES7137-6BD00-0BA0	V 2.1.1
	ET 200pro	EM 4 IO-Link HF	6ES7147-4JD00-0AB0	V 1.0
	ET 200eco	4IO-L	6ES7148-6JD00-0AB0	V 1.0
	ET 200AL	CM 4X IO-LINK	6ES7147-5JD00-0BA0	V 1.03
RFID		ASM 456	6GT2002-0ED00	V 4.0
communication module		RF 180C	6GT2002-0JD00	V 2.2
		RF 170C	6GT2002-0HD01	V 3.1
		RF 120C	6GT2002-0LA00	V 1.0
RFID reader		RF220R	6GT2821-2AC10	
		RF220R IO-Link V1.1	6GT2821-2BC32	
		RF340 R Gen2	6GT2801-2BA10	
		RF680R	6GT2811-6AA10-0AA0	
		RF680A (antenna)	6GT2812-2GB08	
RFID transponder		RF350T	6GT2800-5BD00	
		RF622L	6GT2810-4AC80	
		MDS D324	6GT2600-3AC00	This tag only has a maximum capacity of 992 bytes. But it is displayed with 1000 bytes.
		MDS D424	6GT2600-4AC00	
		MDS E611	6GT2300-0BB00	

### 1 Scope of Measurement

Component	Туре	Article number	Version
STEP 7 software	STEP 7 TIA P		V 14 SP1
IO-Link communication blocks for S7 PLCs	https://support.industry.sie mens.com/cs/en/en/view/73 565887		

# 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

	উ⊟ Choice of configuration	
Controller	Type of connection	RFID-Reader
CPU CPU 1516pro-2PN CP Load due to program	Type of connection nothing selected  Load due dec. IO	Reader Type nothing selected  Num readers per module nothing selected
nothing selected	Communication to module	Antennas
Data length [Bytes] nothing selected  RFID Access nothing selected	ET 200 Type  Communication to reader  Num communikation modules  nothing selected  Type of communication module  nothing selected  I lik k deater	Antennas nothing selected  Num ext. UHF antennas nothing selected  UHF antenna polarisation nothing selected  Antenna Mode nothing selected
	IO-LINK Master nothing selected	TAG Type nothing selected Num TAGs in field of reader 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
4	The "filter icon" indicates that at least one filter is active in the selection area.
+-	+: Expand input area -: Collapse input area
nichts ausgewählt •	These controls allow you to select components or values.
5 ms 🗙	A selection has been made by you and can be undone by clicking "X".
	Due to the selection of another control, the system has made an automatic selection for you.

### **Performance requirements**

Figure 2-2	
20 20	Performance Requirements
	Transfer times
TransTime_min[ms]	
Nothing set	-
TransTime_avg[ms]	
Nothing set	-
TransTime_max[ms]	
< 150	×

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 maximum transfer time must be under 150 ms. In addition to the filters of the selection area, this filter will now be used for the results table.

### **Configuration selected**



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 <sup>3</sup> or "---" in the specific area.

### Performance data table

Figure 2-	4					
Results: 3 of 66	94 🗋 Download	d results (*.csv)			Show column	IS
Prg-Load	DataLength	Read/Write/Inventory	TransTime_min[ms]	TransTime_avg[ms]	TransTime_max[ms]	l
5 ms	10	RFID_Read	94,4	104,7	115,6	
5 ms	100	RFID_Read	104,6	115,2	130,4	
10 ms	10	RFID_Read	114,8	125,2	135,7	
			1		▶ 1	K

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 "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			
<ul> <li>Performance data on RFID</li> </ul>	▶ Language	▶ Contact	▶ help
Controller	Choic	e of configuration	REID Pander
CPU CPU CP CP nothing selected • CP	Type of connection nothing sel Load due dec. IO nothing sel	lected •	Reader Type nothing selected • Num readers per module nothing selected •
Load due to program nothing selected	Commur	nication to module	Antennas
Data length [Bytes] nothing selected RFID Access nothing selected	ET 200 Type nothing sel Commu Num communikation nothing sel Type of communicat	Inication to reader	Antennas nothing selected  Num ext. UHF antennas nothing selected  UHF antenna polarisation nothing selected  Antenna Mode nothing selected
	IO-Link Master nothing sel	lected •	TAG Type nothing selected ▼ Num TAGs in field of reader nothing selected ▼

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 menu bar

Performance data on RFID     Language     Co	ontact ▶ help
--	---------------

Та	ble	2-2
īα	DIC	~ ~

Menu item	Description
	<ul> <li>Clicking the Performance data for the RFID opens a dialog where you can</li> <li>Restore the user interface to its initial state by clicking on the new menu item.</li> <li>View the version of the measurement and the database in the "about" area.</li> <li>Go directly to other versions of this measurement type in the "related" area.</li> </ul>
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

No.	Operator action					System response					
1.	Selec parar Exan Selec	Select a configuration by clicking on the various barameter controls and selecting a component. Example: Select a CPU in the <u>CPU</u> area					The system has applied your desired CPU (here: CPU 1516pro-2PN) and at the same time, where applicable, automatically made the next selection, the CP, for you.				
	<u>Controller</u>							Con	<u>troller</u>		}
	CPU nothing selected CPU 1212C CPU 1217C CPU 1511-1PN CPU 1516-3PN/DP CPU 15163PN/DP CPU 1515SP PC CPU 1516pro-2PN roturn a precised RFID Access The system has immediately sent a query with th					CPU CPU 1516pro-2PN × CP Load due to program nothing selected • Data length [Bytes] ne currently active filter to the database and			nd		
	Results:	450 of 6694	Download r	esults (*.csv)							, ,
	Prg-Loa	d DataLeng	th Read/Write/Inve	ntory Num Comm	Module Comm Mo	lule IO-Lii	nk Reader	Num reader	s Antenna t	ype Num An	itennas Ant p
	5 ms	10	RFID_Read	1	RF170C		RF340R Gen	21	internal	0	- 1
	5 ms	10	RFID_Read	1			RF680R	1	RF680A	1	circula
	5 ms	10	RFID_Read	1	RF170C		RF340R Gen	21	internal	o	- (
	5 ms	10	RFID_Write	1	RF170C		RF340R Gen	2 1	internal	0	}
	5 ms	100	RFID_Read	1			RF680R	1	RF680A	1	circula
	5 ms	10	RFID_Read	1	RF170C		RF340R Gen	2 1	internal	0	μ- <b>γ</b>
	5 ms	10	RFID_Read	1	RF170C		RF340R Gen	21	internal	0	}
	10 ms	10	RFID_Read	1			RF680R	1	RF680A	1	circula
	5 ms	10	RFID_Read	1	RF170C		RF220R	1	internal	0	- 7
	5 ms	100	RFID_Read	1	RF170C		RF340R Gen	2 1	Internal	0	- 3
	5 ms	10 -	RFID_Write	1	RF1/0C		RF340R Gen.	211	Internal	0	;
	In this exact been	s examp tly with t remove	ble, 450 out o his CPU. As ed from the re	of a total of 6 the send Cl esults table.	5998 measur PU has now	ed valu been p	ues are a ermanen	vailable t tly assign	hat wer ned, this	e measu s column	ured has

No.			Operator action	I			System resp	onse	
2.	Procee parame "comm Examp Selectio	ame way to enter our choice for the to reader" and the 170C RFID reade	er the e ne reader type. er	The s	The system has applied your desired entries.				
Selection of RF170C RFID reader  Communication to reader Num communikation modules nothing selected Type of communication module RF170C IO-Link Master								x	
	Selection of the RF 340 Gen2 reader type           RFID-Reader           Reader Type           nothing selected           RF220R           RF20R           RF340R Gen2					er Type Ri readers noth	RFID-Reade		
	As in 1, therefor Results: 264	, the syster re further 4 of 6694	em has made an restricted the nu Download results (*.cs	other database umber of releva	e query wi int measu	th the a red val	advanced filter s ues.	settings and ha	S
	Prod ood	Datal enrit	Read/Write/Inventory	Num Comm Modulo	Num readere	TAG	TransTime min[ma]	TransTime average	Tra
	5 ms	10	REID Read	1	1	RE350T	99	104	113.5
	5 ms	10	RFID_Read	1	1	MDS E611	103,7	112,9	118,3
	5 ms	10	RFID Write	1	1	RF350T	103,8	113,5	123
	5 ms	10	RFID Read	1	1	MDS D424	107.7	116.9	122.31
	5 ms	10	RFID Read	1	1	MDS D324	108.3	117.9	127.75
	5 ms	100	RFID Read	1	1	RF350T	117.4	126.6	132.1
	5 ms	10	RFID Write	1	1	MDS E611	118.4	127.5	136.7
	5 ms	10	RFID Write	1	1	MDS D424	126.2	131.6	140.95
	10 me	10	REID Read	1	1	RE350T	121.8	132.7	143.51
	5 me	100	REID Read	1	1	MDS F614	131.4	140.5	150.2
	10 me	10	REID Read	1	4	MDS E614	101,4	1/3 1	143.61
	10 ms	10	REID Read	1	1	MDS D424	122 3	143.1	153.01
	10 ms	10	REID Read	1	1	MDS D324	132.6	143.3	164.3
		10	REID Write a an array	construction and a	4 ·····	RE350	Asis	1000	144
	·~~~			~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~					

### 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

No.		Operator act	ion			Syste	em response	
1.	Enter the minimum, average or maximum RFID transmission times required for your system. For a description of the different measured values, please refer to chapter 1.2, a brief explanation is available via a tooltip directly on the control. <u>Example:</u> The medial tolerable average transfer time of your application should be less than 150ms.					ystem has app	blied your desi	red entry.
				_ I		3	- Performance	Requirements
		Performance	e Requirements				Transfer ti	imes
		Transf	er times	{	TrancTir			5
	TransTime_min[m	s]		ş	THATSTI	Nothing set	-	, ,
	Nothin	ng set 🔻		2	TransTir	me avolms]	-	)
	I rans I ime_avg[m	sj		{		Nothing set	-	Ş
	TransTime maxim	ng sei 🔹		Ş	TransTime max[ms]			
	Nothin	ng set 🔹		{	< 150 ×			
	< 💙 150	X Ok		} l	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		"Low have a	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
		man her		}				
	Confirm the	input with the Ok	button					
		input with the Or	Dullon.					
	The system	has sent a query	with the now	active fill	ters to	the database	and displayed	d results in
	the performa	ance data table.						
	Results: 11 of 6694	Download results (*.cs)	/)					Snow columns
	5 ms 10	RFID Read	Num Comm Module	Num readers	RF350T	99	TransTime_avg[ms]	TransTime_max[ms] 13,5
	5 ms 10	RFID_Read	1	1	MDS E611	103,7	112,9	18,3
	5 ms 10	RFID_Write	1	1	RF350T	103,8	113,5	23
	5 ms 10	RFID_Read	1	1	MDS D424	107,7	116,9	22,3
	5 ms 100	REID Read	1	1	RE350T	117.4	126.6	32.1
	5 ms 10	RFID Write	1	1	MDS E611	118,4	127,5	36,7
	5 ms 10	RFID_Write	1	1	MDS D424	126,2	131,6	40,9
1	10 ms 10	RFID_Read	1	1	RF350T	121,8	132,7	43,5
	10 ms 10	RFID_Read	1	1	MDS E611	122	143,1	43,6
	10 ms  10	RFID_Write	1	1	RF350T	122,3	143,4	44
	14 A			1				
	With the sele default criter	ected sample filte ia.	er settings, the	e system	has fo	ound only 11 c	lata records th	at meet all

### 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

		Chosen topology		
3	?			
100 Mbit/s				
CPU 1516-3PN/DP  Load due to program:nothing selected		?	ET 200pro PN HF RF170C Number of communication m RF340R Gen2 Number of readers	nodules:nothing selected

Components that have not been selected are indicated by a question mark icon



in the graphic and "nothing selected" or "---" in the text.

### 2.2.5 Table of performance data

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	e 2-8							
Resu <sup>*</sup>	of 6694	Download results (*.cs	SV)					Show columns
Prg-	DataLength	Read/Write/Inventory	omm Module	Num readers	TAG	TransTime_min[ms]	TransTime_averms]	TransTin 2 [ms]
5 ms	100	RFID_Read	1	1	MDS D324	159,2	168,4 5	178,2
5 ms	10	RFID_Read	1	2	RF350T	156,5	166,2	175,5
10 ms	100	RFID_Read	1	1	MDS E611	153,4	164,3	175,4
10 ms	10	RFID_Write	1	1	MDS D424	143	164,2	164,9
5 ms	10	RFID_Write	1	1	MDS D324	145,6	155,1	164,6
10 ms	10	RFID_Write	1	1	MDS E611	143,1	154	164,7
5 ms	100	RFID_Read	1	1	MDS D424	140,1	153,7	159,1
10 ms	100	RFID_Read	1	1	RF350T	142,9	153,7	154,1
10 ms	10	RFID_Write	1	1	RF350T	122,3	143,4	144
10 ms	10	RFID_Read	1	1	MDS D324	132,6	143,3	164,3
10 ms	10	RFID_Read	1	1	MDS E611	122	143,1	143,6
10 ms	10	RFID_Read	1	1	MDS D424	122,3	143,1	153,9
5 ms	100	RFID_Read	1	1	MDS E611	131,4	140,5	150,2
10 ms	10	RFID_Read	1	1	RF350T	121,8	132,7	143,5
5 ms	10	RFID_Write	1	1	MDS D424	126,2	131,6	140,9
5 ms	10	RFID_Write	1	1	MDS E611	118,4	127,5	136,7
5 ms	100	RFID_Read	1	1	RF350T	117,4	126,6	132,1
5 ms	10	RFID_Read	1	1	MDS D324	108,3	117,9	127,7
5 ms	10	RFID_Read	1	1	MDS D424	107,7	116,9	122,3
5 ms	10	RFID_Write	1	1	RF350T	8	113,5	123
14 4				1	2			▶ ₩

### Explanation of the control elements

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

2-5		
	Explanation	
The table control displa	lays	
• the number of res	sults.	
<ul> <li>the maximum num</li> </ul>	nber of data records of this measurement.	
By clicking on the "> S	Show columns" control element, you can open a dialo	a pox
where you can select of	or deselect individual columns.	5
Name of column	Description	×
CPFW	Firmware version CP	~
DataLength	Data length [Bytes]	4
Read/Write/Inventory	RFID Read/Write/Inventory	2
NetType	Net Type	- i
Num Load Stations	Num ET 200 IO stations á 64 IO-Bytes	ł
IO-Load Type	Station type of ET 200 IO Load	Ĵ
SlaveType	Connection via Distributed I/O	
Num Comm Module	Number of RFID communication modules	Ş
Comm Module	RFID Communication Module	Ş
IO-Link	IO-Link Master Type	Ş
Reader	RFID Reader Type	, ,
✓ Num readers	Number of RFID readers per module	{
Antenna type	Antenna type	
		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
When you click on "Do the results table to the	ownload results (*.csv)", the web server uploads all c	ontents of ser and the
installed Excel version	i, the data is immediately displayed in an Excel sprea	adsheet.
Datei Start Einfügen Seitenlayout Form	export.csv - microsort excer meln Daten Überprüfen Ansicht Entwicklertools PDF-XChange V6	
A1 + CPUName		N O
2 CPU 1516pro V2.0 10 ms 3 CPU 1516pro V2.0 10 ms		RF340R Gel RF340R Gel
4 CPU 1516pro V2.0 10 ms 5 CPU 1516pro V2.0 10 ms	10 RFID_Read 0 xox xox 1 RF170C 10 RFID_Read 0 xox xox 1 RF170C	RF340R Ger RF340R Ger
6 CPU 1516pro V2.0 5 ms 7 CPU 1516pro V2.0 5 ms 8 CPU 1516pro V2.0 5 ms	100 RFID_Read 0 xxx xxx 1 RF170C 100 RFID_Read 0 xxx xxx 1 RF170C 100 RFID_Read 0 xxx xxx 1 RF170C	RF340R Ger RF340R Ger
9 CPU 1516pro V2.0 5 ms 10 CPU 1516pro V2.0 5 ms	10 RFID_Read 0 xxxx xxxx 1 RF170C	RF340R Ger RF340R Ger
11 CPU 1516pro V2.0 5 ms 12 CPU 1516pro V2.0 10 ms	10 RFID_Read 0 xox xox 1 RF170C 10 RFID_Write 0 xox xox 1 RF170C	RF340R Ger RF340R Ger
13 CPU 1516pro V2.0 10 ms 14 CPU 1516pro V2.0 5 ms 15 CPU 1516pro V2.0 5 ms	10 RFID_Write 0 xxx xxx 1 RF170C 10 RFID_Write 0 xxx xxx 1 RF170C	RF340R Ger
16 CPU 1516pro V2.0 5 ms 17 CPU 1516pro V2.0 5 ms	10 RFID_Write 0 xxx xxx 1 RF170C 10 RFID_Read 0 xxx xxx 1 RF170C	RF340R Ge RF340R Ge
Olialization and the analysis		
TransTime_avg) trigge click on the respective accordingly.	ers a sorting of the table according to this example - ers a sorting of the table according to this criterion. E column header changes the sorting status of the co	ach furthe lumn
TransTime_min[ms	8] Values unsorted	
TransTime_min[ms	Values sorted in ascending order	
TransTime minIms		
transtine_mufus	values sorted in descending order	
Note:		

### Meaning of the columns

Tooltips provide more detailed information on all column headers. Table 2-6

Column name	Explanation
CPU	CPU type
CPUFW	Firmware version CPU
Prg-Load (2)	Load due to program in OB1
CP <sup>(2)</sup>	CP type
CPFW	Firmware version CP
DataLength	Data length [Bytes]
Read/Write/Inventory	Read/write RFID data/inventory
NetType	Network type
Num Load Stations	Number of ET 200 IO stations á 64 IO bytes
IO-Load Type	ET 200 IO load station type
SlaveTypeASM	Connection of the communication modules via distributed I/O
Num Comm Module	Number of RFID connection module
Comm Module	RFID communication module
IO-Link	IO-Link master type
Reader	RFID reader type
Num Reader	Number of RFID readers per connection module
Antenna type	Antenna type
Anz. Antennen	Number of external UHF antennas
Ant Polarisation	Polarization of UHF antenna
Ant-Mode	Antenna mode
Num TAGs	Number of transponders/TAGs
TAG	Transponder/TAG type
TransTime_min[ms]	Minimum transmission time [ms]
TransTime_Q25[ms]	Transmission time 25% quartile [ms]
TransTime_avg[ms]	average transmission time median [ms]
TransTime_Q75[ms]	Transmission time 75% quartile [ms]
TransTime_max[ms]	maximum transfer time [ms]
Cycle time min[ms]	maximum OB1 cycle time [ms]
Cycle time avg[ms]	average OB1 cycle time [ms]
Cycle time max[ms]	maximum OB1 cycle time [ms]
PNIO_SendClock[ms]	PN IO send clock [ms]

# **3** Performing the Measurements

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

# 3.1 Measurement setup/sequence and measurement method

### 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

### • Transmission time

How long does the mean transmission time of n bytes from the memory of the S7 CPU to the completed data transfer into the transponder (acknowledgment by the communication block used) take? For the calculation of the statistical position parameters approx. 200 single measurements are performed.

How long does the mean transmission time of n bytes from the transponder into the memory of the S7 CPU to the completed data transfer (acknowledgment by the communication block used) take? For the calculation of the statistical position parameters approx. 200 single measurements are performed.

How long does it take until 1..n transponders have been detected by the reader's read field and are ready for read/write commands? For the calculation of the statistical position parameters approx. 150 single measurements are performed.

### • Cycle time

In the S7 CPU, the cycle time is determined via the start functions (S7-1500). The cycle time (approx. 200 to 500 cycles) is acquired when communication to the reader is active.

### • PN-IO update time

If PN IO is selected as the transmission protocol, the data is transferred to the device via the PROFINET mechanism. The values are from the configuration by STEP 7 and are not measured. Here, the configured PN IO update time is the same as the PN IO send clock.

# 3.2 Measurement setup



The figure below shows the principle of the measurement setup.

RFID ID33 Entry ID: 82255083, ID 33, 04/2018

# 3.3 Measurement: Transmission time

### Principle

The transmission time in the mode "Read/write RFID data" indicates how long it takes until n bytes from the memory of the S7 CPU are saved into the transponder, or are read from it and have completely arrived in the S7 CPU.

### **Measurement period**

The transmission time is acquired in a gauge according to the following scheme:

- 1. The measuring variants are read by the automatic measuring device from a data base. Each data record corresponds to a HW/SW variant.
- 2. The measuring setup is modified according to the variant to be measured.
- 3. The automatic measuring device loads the corresponding S7 project into the S7 CPU.
- 4. The gauge triggers the read/write process in the S7 CPU via DI/DO.
- 5. The measuring program in the S7 CPU triggers the RFID read/write process.
- 6. When the data has been completely read into the S7 CPU or when the data is complete in the transponder (acknowledgment by the corresponding communication blocks), the S7 CPU acknowledges this to the dial gauge via DI/DO.
- 7. The gauge saves the measured time value and starts another cycle until the maximum number of measurements per variant has been reached.
- 8. The array of measured values is transferred back to the automatic measuring device for statistical evaluation and for saving into the data base.

The following functional model explains the method of measurement:



### Evaluation

The measurement is repeated several times for each configuration (measurement setup) ( $\Delta$ T1..  $\Delta$ Tn). The most important statistical position parameters are determined from this (see chapter 3.5.).

## 3.4 Measurement: Cycle time

### Principle

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

### Measurement period

- From triggering the data transmission
- Until the end of data transmission

### Evaluation

From a maximum of 500 single measurements, the dial gauge calculates the statistical position parameters of the measured values. (See chap. 3.7 Measured variables and statistics)

# 3.5 Measurement: PN IO update time

### **Principle**

The "PN IO update time" displayed in the result table is determined by STEP 7.

### 3.6 Measurement of inventory time

### Principle

The transmission time in the inventory mode indicates how long it takes to acquire all transponders in RF600 systems. This is where the time from the trigger at the inventory RFID communication module to the positive acknowledgement at the same module is determined.

The measurement differs from the RFID read and write time in so far that

- There are up to 100 TAGs in the antenna field.
- The matrix arrangement of the TAGs is dynamically moved on a turntable at a constant speed of rotation of 15 revolutions/min.
- In order to minimize incorrect measurements, the "observ\_lost\_counter" parameter was set to 200.
- The transmission power was set to 1 watt for all measurements
- For the UHF RF600 system configurations the TAGs were written in a way that the information bits were always inverted during each write cycle in order to force complete writing. This prevents the reader from optimizing the read/write processes.

### **UHF** measurement setup

The 1 .. 100 UHF transponders are mounted in a three-dimensional grid in an array with a distance of approx. 10 cm to each other which moves on a controllable turntable with approx. 15 revolutions/min of the antenna arrangement.

The up to 4 antennas are placed at a distance of approx. 1m from the transponder array. The antennas opposite each other are slightly shifted in such a way that they cover a larger area.



### **Measurement period**

Die transmission time is acquired just as shown in chap. 3.3.

# 3.7 Measured variables and statistics

### **Position parameter**

In order to be able to make statements regarding the mean value (median), other statistical position parameters also have to be considered. For this purpose, all measured variables are measured several times (up to 200 individual measurements). The measuring system calculates the following statistical values from all the measured values, which can then be selected by the user in the result table (but these position parameters are hidden by default).

Position parameter	Definition
TransTime_min	The smallest measured value in the series of measurements.
TransTime_Q25	The first quartile ( <b>Q25</b> ) states that 25% of the measured values are below this number
TransTime_avg	The <b>median</b> (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.
TransTime_Q75	The third quartile ( <b>Q75</b> ) indicates that 75% of the measured values are below this number.
TransTime_max	The largest measured value in the series of measurements.

50% of all measured values are in the so-called **interquartile range** (IQR), i.e., the range between TransTime\_Q25 and TransTime\_Q75. This range enables the user to derive information on spread and reliability of the mean value (median).

Statistical outliers are not explicitly marked as such in this measurement, but are characterized by a more or less strongly shifted TransTime\_max value.

### Interpretation

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

Table 3-2

Box Plot		Position parameter	Interpretation
Maximum	-	Here, the maximum of the measured values is slightly asymmetric to the rest.	In this measurement, there is a slight upward deviation.
Q75 Median (Q50)		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) is relatively symmetrical in the IRQ range.	50% of all measured values are spread relatively widely, i.e., the entire IRQ range is more likely for this measurement.
Q25			
Maximum	_		
Q75 Median (Q50) Q25	-	50% of all measured values are in the IQR range (Q25 to Q75). Compared to the first example, this measurement is much narrower.	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.
Minimum	-		

# 3.8 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.

### 3.8.1 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.

Table 3-3 Measuring program in the S7 PLC

Measuring program		Purpose	Execution in the S7 CPU
Measuring Control program program		Signals via central or distributed I/O to change and acquire the defined time of RFID read/write/inventory commands via the gauges.	All measurements are made in the cyclic OB1
	RFID communication program	Control of the communication interface to the RFID interfaces.	Use of the function commands based on the ident profile in OB1
	Acquisition program	Acquisition and evaluation of measured values.	In all series of measurements. Concerns only the <b>cycle time</b> .
Load program			Load S7 controller (in OB1)

### **RFID** communication program

The following table shows the most important commands from the library for this measurement.

lable	94	
_		

Function	RF120C	RF180C/ASM456	RF68x	IO-Link <sup>1</sup>	Serial <sup>2</sup>
Reset Reader	Reset Reader	Reset_RF300	Reset_Reader	-	RESET, INIT
Antenna on/off	Set_ant_RF300	Set_ant_RF300	Set Ant_RF600	IOL_ANT	ANT
Read Data	Read	Read	Read	IOL_READ	READ
Write Data	Write	Write	Write <sup>3</sup>	IOL_WRITE	WRITE
Inventory	-	-	Inventory	-	

<sup>1</sup>: The commands for controlling the IO-Link reader are carried out via the blocks from SIOS <u>https://support.industry.siemens.com/cs/en/en/view/73565887</u>

### 3.8.2 Load program

The load program does not perform specific tasks. It is only used for defined enlargement (extension) of the STEP 7 program in the S7 CPU. The load program synchronizes itself before each measurement to the desired idle cycle time (without communicating to the RFID connections).

### Selecting the "cycle time without communication"

For this measurement, the length of the load program was always selected in a way so that there is an idle cycle time ("cycle time without communication") of **5ms** (low CPU load due to control tasks) or **50/100ms** (high CPU load due to 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.

# 4 Version

Tabl	е	4-	1
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Version Measurement	Measurement setup	Publication	Description
V 2.0	2017	April 2018	Repeated measurement
V 1.0	2012/2013	October 2013	First measurement