CoM4.sw

Reference Manual

Parameters

Version: v3.0
2025-03-11

Contents

List of Tables

Part I.

Parameter lists

1. Parameter: Introduction

CoM4.sw stands for "Controlled Measurements Software by TetraTec", a core application of devices from TetraTec Instruments (TTI). The CoM4.sw software can cover a large selection of tasks. CoM4.sw is embedded in the overall concept CoM4.CAL for TetraTec Instruments measuring systems.

The software is based on a further development of the TetraTec Instruments LMF software and offers an application for tasks in measuring and control technology of compressed air, flow rate and leak tests. The basic functions of the software cover the necessary physical calculations for flow metering and leak tests.

The state machines enable sequence control for the measuring processes. The sequences can be parameterized with the software. Connection of serial sensors and control of external devices are also provided in the software.

The software supports several protocols with which the controller can be operated through a higher-level control system. If the functionality is not sufficient for an application, the software can be expanded with scripts.

The CoM4.sw software consists of the actual CoM4.sw executable on the one hand and the parameters and scripts on the other hand. The CoM4.sw executable was created for many different applications, while the parameterization of CoM4.sw specifies the CoM4.sw for the specific application. The scripts expand the basic functionality of CoM4.sw with special applications.

The parameters of the CoM4.sw software are defined in **-init.dat* files. The following **-init.dat* files are available:

File	Meaning	Explanations
b-init.dat	Definition of subprograms	Parameter lists - 2 - S. 17 - *B Parameters / subprograms*
d-init.dat	Configuration of the 7-segment display	Parameter lists - 3 - S. 27 - *D Parameters / display configuration*
e-init.dat	Extension for primary elements	Parameter lists - 4 - S. 31 - *E parameters / extension of primary elements*
f-init.dat	Free float parameters	Parameter lists - 5 - S. 39 - *F parameters / freely definable float parameters*
i-init.dat	Free integer parameters	Parameter lists - 6 - S. 41 - *I parameter / freely definable integer parameters*
k-init.dat	Configuration of the hardware	Parameter lists - 7 - S. 43 - *K parameters / hardware configuration*
m-init.dat	Definition of mixed gases and mechanical elements	Parameter lists - 8 - S. 55 - *M parameters / gas mixtures and mechanical elements*
p-init.dat	Program-dependent parameters for a measurement task	Parameter lists - 9 - S. 59 - *P parameters / program-dependent configuration*
r-init.dat	Read parameters for data output	Parameter lists - 10 - S. 83 - *R parameters / read parameters*
s-init.dat	General system configuration	Parameter lists - 11 - S. 101 - *S parameters / system configuration*

File	Meaning	Explanations

Table 1.1.: Available parameter files

An example of the content of the parameter files: :

f-init.dat

```
        F0011 val=1.39339E-5
        F0106 level=$008 desc="LFE1 Upper Limit CAL  " type=1 unit=7
              min=-3.0 max=3.0 val=4.3333333E-05
```

r-init.dat

```
        # Values from the script
        R1900 type=12 unit=01 dig=3 name="Script Var 00 " ro=1
        R1901 type=11 unit=00 dig=3 name="Script Var 01 " ro=1
        R1902 type=13 unit=00 dig=3 name="Script Var 02 " ro=1
        R1903 type=11 unit=00 dig=3 name="Script Var 03 " ro=1
        R1909 type=00 unit=03 dig=1 name="Script Var 04 " ro=1
```

The parameters have the following attributes (note: only the value of the attribute `val` can be changed via the COMM interface):

Attribute	Meaning
`desc`	Description of the parameter in the editing menu
`dig`	Number of places after the decimal in the display
`level`	Assignment of the parameter to a defined user level
`max`	Maximum value that is accepted by the COMM interface
`min`	Minimum value that is accepted by the COMM interface
`ro`	read only Not possible to change parameter via COMM interface
`mustwrite`	Value will *always* be written during SAVE to *param.dat*, even if no change was made
`type`	Physical variable, see: 151
`unit`	Physical unit, see: 151
`val`	The set value of the parameter
`lastchange`	Time of the last change (seconds since 00:00 1/1/1970, integer)

Table 1.2.: Attributes of the parameters

Note:
The attributes `unit` and `dig` refer only to the representation in the display. CoM4.sw *always* calculates internally with SI units!

All parameters can be reached directly via the COMM interface. The value of the parameter attribute `val` can be queried via the parameter name. Example :

```
Input -> S0099
Output -> S0099=PA123A0
```

The value of the attribute `val` can be changed for all parameters except for the R parameters by using the commands `ACTIVATE`, `TEMP` or `SAVE`.

All parameters of the CoM4.sw program are listed in the sections that follow. The type of the parameter is also noted in the tables: Integer (*INT*), Float (*FLT*), or String (*STR*). Some parameters can contain expressions that are evaluated. In these cases it is noted whether an Integer, Float or String is expected after the evaluation. If an incorrect type is assigned, CoM4.sw generates a type mismatch error message..

2. B Parameters / subprograms

Note: An understanding of P parameters is a necessary precondition for understanding this sections, see:

- Parameter lists - 9 - S. 59 - *P parameters / program-dependent configuration*

The intent and purpose of subprograms is to switch a given set of P parameters independently of the currently selected program. This makes it possible for example to switch between two sensors automatically. The criteria for switching are freely definable.

It is possible in CoM4.sw to select one or more parameter blocks of P parameters (for example the block for differential pressure Pn010-Pn014) from a pool of 10 data records from the B parameters. This pool is in area Bnxxx. The first digit n indicates the subprogram. The structure of a Bnxxx block for a n between 0 and 9 is the same as the structure of the P parameters. Therefore the parameters for switching the primary element data apply to parameters Bn000-Bn003.

The criteria for the switching process depend on the program. The criteria are defined in the Pn6xx parameters. Each parameter set corresponds to a logical block (e.g. primary elements) and is therefore assigned to a block in the Pn6xx parameters.

Further information:

- Parameter lists - 9.17 - S. 79 - *Pn600 block: Subprogram switching*
- Parameter lists - 9.22 - S. 79 - *Blocks for subprogram switching*

The blocks of B parameters that are analogous to the P parameters in specific detail:

2.1. Bn000 Primary elements

Parameter	Bedeutung	Werte	Erläuterungen
Bn000	Number of primary element	0..39 (*INT*) 40..139 [0]	0..39 flow element from S40xx-S70xx 40..139 flow element from E00xx-E99xx

Parameter	Bedeutung	Werte	Erläuterungen
Bn001	Gas through primary element	-1013..25 [1]	-1013: Predefined mixed gas naturalL (mix) -1012: Predefined mixed gas naturalH (mix) -1011: Predefined mixed gas nitrogen monoxide NO 10% in 90% N2 -1010: Predefined mixed gas nitrogen monoxide NO 1% in 99% N2 -1009: Predefined mixed gas propene C3H6 5% in 95% N2 -1008: Predefined mixed gas lean gas 12% O2 in 88% N2 -1007: Predefined mixed gas rich gas 20% CO and 6.666% H2 in 73.334% N2 -1006: Predefined mixed gas rich gas synthetic air 20.5% O2 and 79.5% N2 -1005: Predefined mixed gas lean gas 30% H2 in 70% N2 -1004: Predefined mixed gas lean gas 20% H2 in 80% N2 -1003: Predefined mixed gas lean gas 10% H2 in 90% N2 -1002: Predefined mixed gas lean gas 5% H2 in 95% N2 -1001: Predefined mixed gas MixAirDry CIPM2007 -1000: Predefined mixed gas MixAirDry BIPM1979 Composition of the predefined mixed gas via `PREDEFGASMIX n`

Parameter	Bedeutung	Werte	Erläuterungen
Cont. Bn001	Gas through primary element	-1013..25 [1]	-9: Mixed gas 9 (see M09xx) ... -1: Mixed gas 1 (see M01xx) 0: Mixed gas 0 (see M00xx) 1: Air 2: Argon 3: Carbon dioxide 4: Carbon monoxide 5: Helium 6: Hydrogen 7: Nitrogen 8: Oxygen 9: Methane 10: Propane 11: n-butane 12: Natural gas H (outdated!) 13: Natural gas L (outdated!) 14: Laughing gas 15: Water vapor 16: Xenon 17: Nitric oxide 18: Neon 19: Krypton 20: Propene 21: Ethane 22: Ethene 23: Ammonia 24: Sulfur dioxide 25: n-pentane
Bn002	Density calculations	0..3 (*INT*) [3]	General: For air with moisture content: Limits: 0 .. 65 °C and 0 .. 80 % r.h. 0: Ideal 1: Real, virial coefficients. 2: BIPM recommendation 1979 (air only). 3: CIPM recommendation 2007 (air only).

Parameter	Bedeutung	Werte	Erläuterungen
Bn003	Viscosity calculations	0..14 (*INT*) [14]	General: Pressure range limits 0.05 to 10 bara. For air with moisture content: Limits 0 .. 65 °C and 0 .. 80 % r.h. 0: Automatic decision based on gas type For air PTB model with humidity correction according to Kestin-Whitelaw. For all other gases: Dauber & Danner model. 1: Gas type: Air (moist), model: PTB, humidity: Kestin-Whitelaw. 2: Gas type: All gases, model: Daubert & Danner. 3: Gas type: Air (dry), model: Sutherland PTB. 4: Gas type: All gases, model: Sutherland VDI/VDE 2040. 12: Gas type: Air (moist), model: Daubert & Danner, humidity: Kestin-Whitelaw. 13: Gas type: Air (moist), model: Sutherland PTB, humidity: Kestin-Whitelaw. 14: Gas type: Air (moist), model: Sutherland VDI/VDE 2040, humidity: Kestin-Whitelaw.

Table 2.1.: B parameter: Primaries

2.2. Bn010 Primary measurands

Parameter	Bedeutung	Werte	Erläuterungen
Bn011	Physical variable	0..0 (*INT*) [0]	Physical variable according to section 13, permanently set to pressure here
Bn012	Display of unit	0..17 (*INT*) [3]	For coding see section 13
Bn013	Display of places after the decimal	0..5 (*INT*) [1]	Number of places after the decimal

Parameter	Bedeutung	Werte	Erläuterungen
Bn014	KalAssi information	Expression (n.a.) [""]	Information for KalAssi -2: Deactivated -1: Fixed value 0 .. 19: Input number of the sensor 20 .. 999: Reserved for special cases 1000 .. 2097152: Bit-coded: Calculated from multiple inputs 1000 is an offset here Example: 1005: Calculated from input 0 and input 2

Table 2.2.: B parameter: Differential pressure

Parameter	Bedeutung	Werte	Erläuterungen
Bn015	Value	Expression (*FLT*) [""]	e.g. R parameters empty = switched off
Bn016	Physical quantity	0..0 (*INT*) [0]	Physical variable according to section 13, permanently set to pressure here
Bn017	Display of unit	0..17 (*INT*) [3]	For coding see section 13
Bn018	Display of places after the decimal	0..5 (*INT*) [1]	Number of places after the decimal
Bn019	KalAssi information	Expression (n.a.) [""]	Information for KalAssi -2: Deactivated -1: Fixed value 0 .. 19: Input number of the sensor 20 .. 999: Reserved for special cases 1000 .. 2097152: Bit-coded: Calculated from multiple inputs 1000 is an offset here Example: 1005: Calculated from input 0 and input 2

Table 2.3.: B parameter: Absolute pressure

Parameter	Bedeutung	Werte	Erläuterungen
Bn020	Value	Expression (*FLT*) [""]	e.g. R parameters Empty = switched off

Parameter	Bedeutung	Werte	Erläuterungen
Bn021	Physical variable	0..0 (*INT*) [5]	Physical variable according to section 13, permanently set to temperature here
Bn022	Display of unit	0..17 (*INT*) [1]	For coding see section 13
Bn023	Display of places after the decimal	0..5 (*INT*) [1]	Number of places after the decimal
Bn024	KalAssi information	Expression (n.a.) [""]	Information for KalAssi -2: Deactivated -1: Fixed value 0 .. 19: Input number of the sensor 20 .. 999: Reserved for special cases 1000 .. 2097152: Bit-coded: Calculated from multiple inputs 1000 is an offset here Example: 1005: Calculated from input 0 and input 2

Table 2.4.: B parameter: Temperature

Parameter	Bedeutung	Werte	Erläuterungen
Bn025	Value	Expression (*FLT*) [""]	e.g. R parameters Empty = switched off
Bn026	Physical variable	0..0 (*INT*) [10]	Physical variable according to section 13, permanently set to humidity here
Bn027	Display of unit	0..17 (*INT*) [1]	For coding see section 13
Bn028	Display of places after the decimal	0..5 (*INT*) [1]	Number of places after the decimal
Bn029	KalAssi information	Expression (n.a.) [""]	Information for KalAssi -2: Deactivated -1: Fixed value 0 .. 19: Input number of the sensor 20 .. 999: Reserved for special cases 1000 .. 2097152: Bit-coded: Calculated from multiple inputs 1000 is an offset here Example: 1005: Calculated from input 0 and input 2

Table 2.5.: B parameter: Humidity

2.3. Bn030 Reference measurands

Parameter	Bedeutung	Werte	Erläuterungen
Bn030	Value	Expression (*FLT*) [""]	e.g. R parameters Empty = switched off
Bn031	Physical variable	0..0 (*INT*) [0]	Physical variable according to section 13, permanently set to pressure here
Bn032	Display of unit	0..17 (*INT*) [3]	For coding see section 13
Bn033	Display of places after the decimal	0..5 (*INT*) [1]	Number of places after the decimal
Bn034	KalAssi information	Expression (n.a.) [""]	Information for KalAssi -2: Deactivated -1: Fixed value 0 .. 19: Input number of the sensor 20 .. 999: Reserved for special cases 1000 .. 2097152: Bit-coded: Calculated from multiple inputs 1000 is an offset here Example: 1005: Calculated from input 0 and input 2

Table 2.6.: B parameter: Reference absolute pressure

Parameter	Bedeutung	Werte	Erläuterungen
Bn035	Value	Expression (*FLT*) [""]	e.g. R parameters Empty = switched off
Bn036	Physical variable	0..0 (*INT*) [5]	Physical variable according to section 13, permanently set to temperature here
Bn037	Display of unit	0..17 (*INT*) [1]	For coding see section 13
Bn038	Display of places after the decimal	0..5 (*INT*) [1]	Number of places after the decimal

Parameter	Bedeutung	Werte	Erläuterungen
Bn039	KalAssi information	Expression (n.a.) [""]	Information for KalAssi -2: Deactivated -1: Fixed value 0 .. 19: Input number of the sensor 20 .. 999: Reserved for special cases 1000 .. 2097152: Bit-coded: Calculated from multiple inputs 1000 is an offset here Example: 1005: Calculated from input 0 and input 2

Table 2.7.: B parameter: Reference temperature

Parameter	Bedeutung	Werte	Erläuterungen
Bn040	Value	Expression (*FLT*) [""]	e.g. R parameters Empty = switched off
Bn041	Physical variable	0..0 (*INT*) [10]	Physical variable according to section 13, permanently set to humidity here
Bn042	Display of unit	0..17 (*INT*) [1]	For coding see section 13
Bn043	Display of places after the decimal	0..5 (*INT*) [1]	Number of places after the decimal
Bn044	KalAssi information	Expression (n.a.) [""]	Information for KalAssi -2: Deactivated -1: Fixed value 0 .. 19: Input number of the sensor 20 .. 999: Reserved for special cases 1000 .. 2097152: Bit-coded: Calculated from multiple inputs 1000 is an offset here Example: 1005: Calculated from input 0 and input 2

Table 2.8.: B parameter: Reference humidity

2.4. Bn050 Auxiliary inputs

Parameter	Bedeutung	Werte	Erläuterungen
Bn050	Value	Expression (*FLT*) [""]	e.g. R parameters Empty = switched off
Bn051	Physical quantity	0..21 (*INT*) [0]	Physical variable according to section 13
Bn052	Display of unit	0..17 (*INT*) [0]	For coding see section 13
Bn053	Display of places after the decimal	0..5 (*INT*) [1]	Number of places after the decimal
Bn054	KalAssi information	expression (n.a.) [""]	Information for KalAssi -2: Deactivated -1: Fixed value 0 .. 19: Input number of the sensor 20 .. 999: Reserved for special cases 1000 .. 2097152: Bit-coded: Calculated from multiple inputs 1000 is an offset here Example: 1005: Calculated from input 0 and input 2

Table 2.9.: B parameter: 10x auxiliary inputs 0 - 9 on Bn050 to Bn099

2.5. Bn100 Units and places after the decimal

The blocks follow with a spacing of 10: Bn100, Bn110, Bn120 to Bn190. The first blocks are preassigned with the most important variables in the standard case: Bn100: Volume flow, Bn110: Mass flow, Bn120: Time, from Bn130 additional variables can be defined.

Parameter	Bedeutung	Werte	Erläuterungen
Bn100	Physical variable	-1 .. 21 (*INT*) [1]	Physical variable: For coding see table 13.2 -1: Entry is not used With volume flow preset here
Bn101	Unit	0 .. 19 [2]	For unit coding see table 13.2
Bn102	Display of places after the decimal	0 .. 5 (*INT*) [1]	Number of places after the decimal
Bn110	Physical variable	-1 .. 21 (*INT*) [2]	Physical variable: For coding see table 13.2 -1: Entry is not used With mass flow preset here
Bn111	Unit	0 .. 19 [2]	For unit coding see table 13.2

Parameter	Bedeutung	Werte	Erläuterungen
Bn112	Display of places after the decimal	0 .. 5 (*INT*) [1]	Number of places after the decimal
Bn130	Physical variable	-1 .. 21 (*INT*) [7]	Physical variable: For coding see table 13.2 -1: Entry is not used With time preset here
Bn131	Unit	0 .. 19 [0]	For unit coding see table 13.2
Bn132	Display of places after the decimal	0 .. 5 (*INT*) [1]	Number of places after the decimal

Table 2.10.: B parameter: Units and places after the decimal

3. D Parameters / display configuration

The display will be configured in the 7-segment display with the D parameters. The structure of the D parameters is as follows:

- A display list is assigned to a display mode that usually corresponds to a main state. The COMM command `DMODE` indicates the mapping of the modes to the respective lists. See p.: 28
- A display list is filled with up to 18 individual pages. How the list `n` is filled is indicated by the COMM command `DLIST n`. See p.: 29
- 100 individual pages can be defined. How the page `n` is defined is indicated by the COMM command `DPAGE n`. See p.: 30

3.1. D0000 Block / mode assignments

The assignment is made by means of an expression which must be evaluated as an integer. In the simplest case the number of the list can be listed here.

Example:

```
D0000="I0000=0?0:1"
```

Depending on I0000, in Conti mode list 0 (if I0000 = 0) or list 1 is displayed.

Parameter	Bedeutung	Werte	Erläuterungen
D0000	CONTI	Expression (*INT*) [0]	Number for list of continuous measured values of displaying mode (State 2020, `MEASMODE = 0` and `MEASAVAIL` = 0)
D0001	POLL	Expression (*INT*) [5]	Number for POLL mode list (State 2020, `MEASAVAIL` = 1)
D0002	MEAS	Expression (*INT*) [3]	Number for MEAS list (State 2400)
D0003	FILL	Expression (*INT*) [1]	Number for FILL list (State 2100 or 2200)
D0004	CALM	Expression (*INT*) [2]	Number for CALM list (State 2300)
D0005	CAL	Expression (*INT*) [3]	Number for CAL list (State 2500)
D0006	VENT	Expression (*INT*) [4]	Number for VENT list (State 2600)
D0007	WAIT	Expression (*INT*) [5]	Number for WAIT list (State 2800)

Parameter	Bedeutung	Werte	Erläuterungen
D0008	ZERO	Expression (*INT*) [6]	Number for ZERO list (State 3200) *Caution:* D0008 was previously MeasResult in LMF-7 This display mode no longer exists now
D0009	LEAK	Expression (*INT*) [7]	Number for LEAK list (State 2400 and `MEASMODE` = 1)
D0010	LEAKResult	Expression (*INT*) [8]	Number for list of continuous measured values of displaying mode (State 2020: `MEASMODE = 1` and `MEASAVAIL` = 1
D0011	Free	Expression (*INT*) [0]	Free
D0012	Free	Expression (*INT*) [0]	Free
D0013	Free	Expression (*INT*) [0]	Free
D0014	Free	Expression (*INT*) [0]	Free
D0015	Free	Expression (*INT*) [0]	Free
D0016	Free	Expression (*INT*) [0]	Free
D0017	Free	Expression (*INT*) [0]	Free
D0018	Free	Expression (*INT*) [0]	Free
D0019	Free	Expression (*INT*) [0]	Free

Table 3.1.: D parameter: Assignment of mode to list

3.2. D0100 Block / list configuration

20 lists can be defined. The parameterization is repeated with an interval of 20: D0100, D0120, D0140...

Parameter	Bedeutung	Werte	Erläuterungen
D01n0	Number of pages in this list	0..18 (*INT*) [11]	n pages from D0102 are used for display
D01n1	Display mode	0..1 (*INT*) [1]	Display mode 0: Switch by page 1: switch by row

Parameter	Bedeutung	Werte	Erläuterungen
D01n2	page #1	0..99 (*INT*) [1]	For the number of the page from the page definition see table 3.3
D01n3	page #2	0..99 (*INT*) [11]	Number of the page from the page definition
D01n4	page #3	0..99 (*INT*) [12]	Number of the page from the page definition
D01n5	page #4	0..99 (*INT*) [13]	Number of the page from the page definition
D01n6	page #5	0..99 (*INT*) [14]	Number of the page from the page definition
D01n7	page #6	0..99 (*INT*) [15]	Number of the page from the page definition
D01n8	page #7	0..99 (*INT*) [16]	Number of the page from the page definition
D01n9	page #8	0..99 (*INT*) [17]	Number of the page from the page definition
D01n0	page #9	0..99 (*INT*) [18]	Number of the page from the page definition
D01n1	page #10	0..99 (*INT*) [19]	Number of the page from the page definition
D01n2	page #11	0..99 (*INT*) [20]	Number of the page from the page definition
D01n3	page #12	0..99 (*INT*) [0]	Number of the page from the page definition
D01n4	page #13	0..99 (*INT*) [0]	Number of the page from the page definition
D01n5	page #14	0..99 (*INT*) [0]	Number of the page from the page definition
D01n6	page #15	0..99 (*INT*) [0]	Number of the page from the page definition
D01n7	page #16	0..99 (*INT*) [0]	Number of the page from the page definition
D01n8	page#17	0..99 (*INT*) [0]	Number of the page from the page definition
D01n9	page#18	0..99 (*INT*) [0]	Number of the page from the page definition.

Table 3.2.: D parameter: Assignment of lists to pages

3.3. D1000 Block / page configuration

100 pages can be defined in blocks D1000 to D1999. The parameterization is repeated with an interval of 10: Page #0 is defined in D1000 to D1002, page #1 is defined in D1010 to D1012, etc. Defaults are already assigned to the individual pages in the software.

Parameter	Bedeutung	Werte	Erläuterungen
D1nn0	1. Display of line	-7...-1 (*INT*) 0..59999 [-1]	-12: Name of the program in MC 2 -11: Name of the program in MC 1 -10: Name of the program in MC 0 (each from Pn899, see there) -7: Evaluation from measuring circuit 2 -6: Evaluation from measuring circuit 1 -5: Evaluation from measuring circuit 0 -4: Current time -3: Current date -2: Program number of the measuring circuit -1: Empty display 0..2999: R parameters number 3000..9999: do not have assigned settings 10000..50899: P parameter number of R parameters contains thousandths place: Measuring circuit Thousandths place: R parameter type: 1xxxx: Continuous value 2xxxx: Mean value 3xxxx: Total 4xxxx: Minimum 5xxxx: Maximum
D1nn1	2. Display of line	-7...-1 (*INT*) 0..59999 [-1]	like D1nn0
D1nn2	3. Display of line	-7...-1 (*INT*) 0..59999 [-1]	like D1nn0

Table 3.3.: D parameter: Definition of pages

4. E parameters / extension of primary elements

Further information:

- Parameter lists - 11.16 - S. 117 - *S4000-S7900 Block: Linearization of primary elements*

4.1. Enn00 Primary elements

Parameter	Bedeutung	Werte	Erläuterungen
E0n00	Type of the primary element	0..1 (*INT*) 20..21 30..39 40..42 45..49 60..61 80 100..101 120 140 [0]	Type and evaluation type of the primary element 0: Standard LFE according to Hagen-Poisseuille 1: Uniflow LFE 20: Critical nozzle according to PTB 21: Critical nozzle according to CFO 30 - 39: Nozzle pools no. 0 - 9 40: Orifice with flange pressure sensing 41: Orifice with corner pressure sensing 42: Orifice with D-D/2 pressure sensing 45: Venturi nozzle 46: Venturi tube rough cast 47: Venturi tube machined 48: Venturi tube, sheet steel inlet 49: SAO nozzle 60: Accutube 61: Beta-Flow 80: Gas meter 81: Simulated gas meter 100: Direct mass flow input 101: Direct volume flow input 120: Leakage measurement (LMS) 140: No primary element

Parameter	Bedeutung	Werte	Erläuterungen
E0n01	Gas type for calibration	-1013..25 [1]	-1013: Predefined mixed gas naturalL (mix) -1012: Predefined mixed gas naturalH (mix) -1011: Predefined mixed gas nitrogen monoxide NO 10% in 90% N2 -1010: Predefined mixed gas nitrogen monoxide NO 1% in 99% N2 -1009: Predefined mixed gas propene C3H6 5% in 95% N2 -1008: Predefined mixed gas lean gas 12% O2 in 88% N2 -1007: Predefined mixed gas rich gas 20% CO and 6.666% H2 in 73.334% N2 -1006: Predefined mixed gas rich gas synthetic air 20.5% O2 and 79.5% N2 -1005: Predefined mixed gas lean gas 30% H2 in 70% N2 -1004: Predefined mixed gas lean gas 20% H2 in 80% N2 -1003: Predefined mixed gas lean gas 10% H2 in 90% N2 -1002: Predefined mixed gas lean gas 5% H2 in 95% N2 -1001: Predefined mixed gas MixAirDry CIPM2007 -1000: Predefined mixed gas MixAirDry BIPM1979 Composition of the predefined mixed gas via `PREDEFGASMIX n`

Parameter	Bedeutung	Werte	Erläuterungen
Cont. E0n01	Gas type for calibration	-1013..25 [1]	-9: Mixed gas 9 (see M09xx) ... -1: Mixed gas 1 (see M01xx) 0: Mixed gas 0 (see M00xx) 1: Air 2: Argon 3: Carbon dioxide 4: Carbon monoxide 5: Helium 6: Hydrogen 7: Nitrogen 8: Oxygen 9: Methane 10: Propane 11: n-butane 12: Natural gas H (outdated!) 13: Natural gas L (outdated!) 14: Laughing gas 15: Water vapor 16: Xenon 17: Nitric oxide 18: Neon 19: Krypton 20: Propene 21: Ethane 22: Ethene 23: Ammonia 24: Sulfur dioxide 25: n-pentane
E0n02	Calibration pressure	0.0..1.0E6 (*FLT*) [101325]	Absolute pressure in Pascal Not relevant for primaries 1, 80, 81 100, 101, 120, 140
E0n03	Calibration temperature	0.0..1.0E3 (*FLT*) [294.26]	Temperature in Kelvin Not relevant for primaries 1, 80, 81, 100, 101, 120, 140
E0n04	Calibration humidity	0.0..1.0 (*FLT*) [0.0]	Humidity (dimensionless) Not relevant for primaries 1, 80, 81, 100, 101, 120, 140
E0n05	Order	-99..99 (*INT*) [1]	Generalized polynomial order: First digit including the sign indicates the lowest exponent (in most cases 0) Second digit +1 = number of coefficients The highest exponent results from the sum of both digits including the sign Example: S2n05=-25 is the smallest exponent: −2, largest exponent: 3
E0n10 ⋮	Maximum 10 coefficients	*FLT*	

Parameter	Bedeutung	Werte	Erläuterungen
E0n19			
E0n20	X factor	(*FLT*) [0.01]	Scaling factor for polynomial input value from SI units to polynomial units
E0n21	Y factor	(*FLT*) [6.0E4]	Scaling factor for polynomial output value (flow rate) from polynomial units to SI units
E0n22	Serial number	String [""]	Serial number of the primary element
E0n23	Y correction	0.998..1.002 (*FLT*) [1.000]	Multiplicative correction factor for the output value of the polynomial
E0n25	Precondition for calculation	Expression (*INT*) [""]	Expression for precondition of the calculation Evaluation FALSE: Calculation will not be performed All dependent flow rate values will be set to Error Evaluation TRUE: Calculation will be performed The script variable `THIS` contains the measuring circuit here If there are errors in the expression, the calculation will not be performed

Table 4.1.: E parameter: Primary element

4.1.1. Enn30 Direct inputs

Parameter	Bedeutung	Werte	Erläuterungen
E0n30	Input value	Expression (*FLT*) [""]	Expression that has as its result the direct volume or mass flow.

Table 4.2.: E parameter: Direct inputs

4.1.2. Enn40 LMS

Parameter	Bedeutung	Werte	Erläuterungen
E0n40	R parameter for pressure drop	0..2999 (*INT*) [110]	Number of the R parameter containing the pressure drop for the leakage measurement

Parameter	Bedeutung	Werte	Erläuterungen
E0n41	DUT volume	-1.0..1.0 (*FLT*) [10E-3]	DUT volume in m^3
E0n42	Reference leak	-1.0..1.0 (*FLT*) [0.0]	Leak of the reference leak in m^3/s
E0n43	Inherent leak	-1.0E4..1.0E4 (*FLT*) 1.0E2 [0.0]	Inherent leak of the system in Pa/s Pressure drop: Negative sign pressure increase: Positive sign

Table 4.3.: E parameter: LMS

4.1.3. Enn50 Critical nozzles

Parameter	Bedeutung	Werte	Erläuterungen
E0n50	Nozzle code QVtr	0.0..1.0 (*FLT*) [0.001]	QVtr in m^3/s
E0n51	Cpe correction factor	(*FLT*) [0.0]	PTB evaluation only: Correction factor for the input pressure dependency in Pa^{-1}
E0n52	Xt factor	(*FLT*) [1.0]	CFO evaluation only: Input scaling of temperature correction Xt 1.0: for polynomial in SI units 1.8: for polynomial in US units

Table 4.4.: E parameter: Critical nozzles

4.1.4. Enn60 orifices, Venturi, Beta-Flow and SAO

Parameter	Bedeutung	Werte	Erläuterungen
E0n60	Internal diameter of tube	1.0E-4..1.0 (*FLT*) [0.1]	Internal diameter of the supply line tube in m
E0n61	Diameter of the orifice	1.0E-4..1.0 (*FLT*) [0.05]	Diameter of the orifice in m
E0n62	Smallest Reynolds number	(*FLT*) [2.0E3]	If E0065 = 1 or 2: Minimum value of the Reynolds number for the iteration (dimensionless)

Parameter	Bedeutung	Werte	Erläuterungen
E0n63	Largest Reynolds number	(*FLT*) [2.0E7]	If E0065 = 1 or 2: Maximum value of the Reynolds number for the iteration (dimensionless)
E0n64	Tolerance of iteration	(*FLT*) [0.001]	End criterion: If the amount of change in the mass flow from one iteration step to the next is less than this value, the iteration ends
E0n65	Calculation method	0..2 (*INT*) [0]	0: Calculation according to DIN EN ISO 5167 1: Polynomial calculation using the differential pressure 2: Polynomial calculation using the Reynolds number*
E0n66	Conversion factor for Betaflow	(*FLT*) [775.428]	Betaflow only: The factor by which the K factor based on SI units is multiplied before it is made available in the R parameters.

Table 4.5.: E parameter: Orifices, Venturi nozzles/tubes, Betaflow and SAO nozzles

4.1.5. Enn70 Gas meters

Parameter	Bedeutung	Werte	Erläuterungen
E0n70	Input channel	0..9 (*INT*) [0]	Channel CTn on counter card
E0n71	Volume per pulse	0.0..1.0E3 (*FLT*) [0.001]	in m^3
E0n72	Number of pulses for measurement	2..1000 (*INT*) [2]	only during continuous operation: Number of pulses that will be evaluated for the current value
E0n73	Timeout time	1.0..86400.0 (*FLT*) [5.0]	Current values: If no pulse is received for the duration of timeout time, the current value is set to 0.0 until the next pulse Measurement process (state 2400 ff.) *and* S9002 = 1: While waiting in state 2410, if no pulse is received for the duration of the timeout time, the measurement is aborted by state 2480

Table 4.6.: E parameter: Gas meter

4.1.6. Enn80 Accutubes

Parameter	Bedeutung	Werte	Erläuterungen
E0n80	K: Mean value of KFlow	(*FLT*) [0.6]	
E0n81	Tube diameter D_i	1E-4…1.0 (*FLT*) [0.1]	in m
E0n82	Reference temperature	173.15…473.15 (*FLT*) [288.7]	Reference temperature for the correction of thermal expansion in Kelvin
E0n83	Thermal expansion coefficient	(*FLT*) [0.0]	The thermal expansion coefficient of the tube
E0n84	Smallest Reynolds number	(*FLT*) [2.0E3]	If E0065 = 1 or 2: Minimum value of the Reynolds number for the iteration (dimensionless)
E0n85	Largest Reynolds number	(*FLT*) [2.0E7]	If E0065 = 1 or 2: Maximum value of the Reynolds number for the iteration (dimensionless)
E0n86	Tolerance of iteration	(*FLT*) [0.001]	If the change in the mass flow in one iteration step is less than the tolerance of the iteration, the iteration ends.

Table 4.7.: E parameter: AccuTubes

5. F parameters / freely definable float parameters

F parameters F0000 to F0199 can be used for float values. These parameters have the following attributes: `level`, `type`, `unit`, `min`, `max` and `val`.

Example:

```
        F0000 val=1.39339E-5
        F0006 level=$008 desc="LFE1 Upper Limit CAL  " type=1 unit=7
              min=-3.0 max=3.0 val=4.3333333E-05
```

Only the value 1.39339E-5 is defined for parameter F0000.

Parameter F0006 has the following description: `"LFE1 Upper Limit CAL"`.
The physical variable volume flow (type = 1) with the unit $cm^3 \cdot min^{-1}$ (unit = 7) is also assigned to the numeric value 4.3333333E-05 now. The minimum value is set to -3.0 and the maximum value to 3.0 in SI.

Note:

The attributes `unit` and `dig` refer only to the representation in the display. All values that are exchanged via the Comm interface are *always* in SI units!

6. I parameter / freely definable integer parameters

Example:

```
I0011 level=$008 desc="Program preselection " min=0 max=9 val=5
```

The value 5 is defined for parameter I0011. The parameter is described as a program preselection. It must be defined in the range from 0 to 9.

7. K parameters / hardware configuration

The hardware configuration is made using K parameters. The hundredths place n of the K parameters indicates the slot of the slot card to be configured, so K00xx for slot 0, K01xx for slot 1, etc.

numbering of the ports of a slot card:
The CoM4.sw program automatically numbers the inputs and outputs depending on the type sequentially from slot 0 port 0 to slot 4 port 4..

Please note:

If the onboard sensors of a T60 module are active, the numbering of AIxx always begins with them. This means that the numbers of the regular slot cards are moved correspondingly.

A slot card can have up to 4 ports. Each port represents a separate input or output.

Example:
The slot card in Slot0 is a type 100 card with two analog inputs. The slot cards in slots 1 and 2 in this example are type 200 cards. The slot card in slot 3 is another type 100 card. The T60 module is active.

Data record K0010-14 would then define AI02, K0015-19 would define AI03, K0310-14 would define AI04 and K0315-19 would define AI05. Onboard pressure would be on AI00 and onboard temperature would be on AI01.

Notice:
All K parameters are read-only. They can be defined when *k-init.dat* is created, but can no longer be changed during ongoing operation. In addition, K parameters may only be defined in *k-init.dat*. They are not permitted in any other files (*project.dat*, etc.).

Exceptions are the PreScaler K0n62 and minimum frequency K0n63 for the type 500 input card.

7.1. K0000 General configuration

These parameters handle the general configuration of one of the 5 slot cards. The slot is defined by the 100ths place in the range from K0000 to K0400. K0000 ff. defines the card in slot 0, while K0100 ff. defines the card in slot 1. There are a total of 5 blocks.

Parameter	Bedeutung	Werte	Erläuterungen
K0n00	Type of the card	0..520 (*INT*) [0]	0: Not a slot card 100: 2x analog input 120: 4x analog input 200: 2x analog output 220: 4x analog output 310: 1x analog input, 1x analog output 500: 2x counter input s 520: 2x PWM output
K0n01	Serial number of the card	*STR* [""]	Serial number of the card in format xxxSxxx

K0n05	Configurations flag	0..1 (*INT*) [0]	Additional configuration of the card: 0: No additional configuration 1: Type 100 card with interrupt diode

Table 7.1.: General hardware configuration

7.2. K0n10 – Type 100, type 120, type 310: Configuration of analog input cards

These parameters handle the configuration of analog inputs of a type 100, type 120 or type 310 card. The block is repeated 4 times with a spacing of 5 on K0n10 ff., K0n15 ff., K0n20 ff. and K0n25 ff.

Parameter	Bedeutung	Werte	Erläuterungen
K0n10	Gain	1.0E-6..1.0E6 (*FLT*) [1.0]	Calibrated gain of the card
K0n11	Offset	(*FLT*) [0.0]	number of offset of the card
K0n12	Pregain	0..7 (*INT*) [0]	Pregain: Gain of the direct input signal in the card Generated: Value · Gain · 2^{Pregain}
K0n13	Filter	10..1000 (*FLT*) [50]	Frequency, sampling rate of the card
K0n14	CAL number	(*STR*) [""]	CAL number of calibration of the port

Table 7.2.: K parameters: Configuration of the analog inputs

Input signal	Gain	Offset
0 .. +10 volts	10.00	0.00
0 .. +5 volts	5.00	0.00
-2 .. +2 volts	2.00	0.00
-1 .. +1 volts	1.00	0.00
-500 .. +500 mV	0.50	0.00
-200 .. +200 mV	0.20	0.00
-100 .. +100 mV	0.10	0.00
0 .. +20 mA	20.00	0.00
4 .. +20 mA	20.00	0.00

Table 7.3.: Ideal values for gain and offset of the analog inputs

7.3. K0n30 – Type 200, type 220, type 310: Configuration of analog output cards

These parameters handle the configuration of analog outputs of a type 200, type 220 or type 310 card. The block is repeated 4 times with a spacing of 5 on K0n30 ff., K0n35 ff., K0n40 ff. and K0n45 ff.

Parameter	Bedeutung	Werte	Erläuterungen
K0n30	Gain	1.0E-6..1.0E6 (*FLT*) [0.5]	Calibrated gain of the card
K0n31	Offset	(*FLT*) [1.0]	Calibrated offset of the card
K0n32	CAL number	(*STR*) [""]	CAL number of calibration of the port

Table 7.4.: K parameters: Configuration of the analog outputs

Information about scaling of the analog outputs via the gain & offset parameters:

- The value that goes from CoM4 internally to the card must be scaled from -1.0 .. +1.0.
- How value -1.0 .. +1.0 is converted to an actual current or voltage signal depends entirely on how the card is fitted. This is done with the 8 dip switches for each port and in some cases by the exchangeable resistors.
- Gain and offset are used for CoM4 to scale the value from S8n01 internally to -1 .. +1 and thereby to calibrate the characteristic curve of the card.

The internal convention at TetraTec is that the expression in S8n01 must result in a value of 0.0 .. 1.0. Therefore 0.0 .. 1.0 must be mapped to -1.0 .. +1.0. The following is used for this:

- Gain = 0.5
- Offset = 1.0

To map another value such as 0.004 .. 0.02 to -1.0..+1.0, the gain & offset must be adapted accordingly.

The following formulas can be used for this 7.1 .. 7.3:

$$-1.0 = x_{\mathrm{min}} \cdot \frac{1}{\mathrm{Gain}} - \mathrm{Offset} \tag{7.1}$$

$$+1.0 = x_{\mathrm{max}} \cdot \frac{1}{\mathrm{Gain}} - \mathrm{Offset} \tag{7.2}$$

$$2.0 = (x_{\mathrm{max}} - x_{\mathrm{min}}) \cdot \frac{1}{\mathrm{Gain}} \tag{7.3}$$

Symbol	Parameters	Meaning	Unit
x_{min}	–	Minimum value in the expression of S8n01	(-)
x_{max}	–	Maximum value in the expression of S8n01	(-)
Gain	K0n30 ff.	Gain of the card	(-)
Offset	K0n31 ff.	Offset of the card	(-)

Table 7.5.: Symbols: Scaling of gain & Offset for analog output cards

Comment regarding type 220 card: The card of type 220 does not map the value range of S8n01 to -1.0..+1.0, but instead to 0.0..1.0. The following points then apply:

$$0.0 = x_{\text{min}} \cdot \frac{1}{\text{Gain}} - \text{Offset} \tag{7.4}$$

$$+1.0 = x_{\text{max}} \cdot \frac{1}{\text{Gain}} - \text{Offset} \tag{7.5}$$

$$1.0 = (x_{\text{max}} - x_{\text{min}}) \cdot \frac{1}{\text{Gain}} \tag{7.6}$$

Further information:

- Parameter lists - 11.17 - S. 128 - *S8000 block: Analog outputs*

7.4. K0n50 – Type 520 PWM output cards

These parameters handle the configuration of the PWM outputs of a type 520 card. All assignments have been made in this case.

Parameter	Bedeutung	Werte	Erläuterungen
K0n50	StopState of port 0	0..1 (*INT*) [0]	Status of the output in Stop state 0: Output of 0.0 1: Output of 1.0
K0n51	CAL number	(*STR*) [""]	CAL number of calibration of the port
K0n55	StopState of port 1	0..1 (*INT*) [0]	Status of the output in Stop state 0: Output of 0.0 1: Output of 1.0
K0n56	CAL number	(*STR*) [""]	CAL number of calibration of the port

Table 7.6.: K parameters: Configuration of PWM outputs

7.5. K0n60 – Type 500 incremental counters, pulse counters and frequency input cards

These parameters handle the configuration of the counters and frequency inputs of a type 500 card. All assignments have been made in this case.

Parameter	Bedeutung	Werte	Erläuterungen
K0n60	Mode of port 0	0..3 (*INT*) [0]	0: NoMode - not used 1: Incremental counter 2: Incremental counter two-track evaluation 3: Pulse counting
K0n61	Option - frequency of port 0	0..1 (*INT*) [0]	0: Not active 1: Frequency measurement active
K0n62	PreScaler port 0	1..8 (*INT*) [1]	PreScaler for measured pulses Possible values: 1: Prescaler 2 2: Prescaler 4 3: Prescaler 8 4: Prescaler 16 5: Prescaler 32 6: Prescaler 64 7: Prescaler 128 8: Prescaler 256
K0n63	Lowest frequency of port 0	0.0..5E7 (*FLT*) [0.0]	Lowest frequency to be measured Reciprocal of this frequency: Time for detection 0 Hz
K0n64	CAL number	(*STR*) [""]	CAL number of calibration of the port
K0n65	Mode of port 1	0..3 (*INT*) [0]	0: NoMode - not used 1: Incremental counter 2: Incremental counter two-track evaluation 3: Pulse counting
K0n66	Option - frequency of port 1	0..1 (*INT*) [0]	0: not active 1: Frequency measurement active
K0n67	PreScaler port 1	1..8 (*INT*) [1]	PreScaler for measured pulses Possible values: 1: Prescaler 2 2: Prescaler 4 3: Prescaler 8 4: Prescaler 16 5: Prescaler 32 6: Prescaler 64 7: Prescaler 128 8: Prescaler 256
K0n68	Lowest frequency of port 1	0.0..5E7 (*FLT*) [0.0]	Lowest frequency to be measured Reciprocal of this frequency: Time for detection 0 Hz
K0n69	CAL number	(*STR*) [""]	CAL number of calibration of the port

Table 7.7.: K parameters: Configuration of PWM outputs

The PreScalers and minimum frequency of the type 500 card must be parameterized correctly. Unlike all other K parameters, K0n62/K0n67 and K0n63/K0n68 can also be changed in ongoing operation.

The order of magnitude of the frequency to be measured f_{Meas} must already be known before the configuration. The minimum frequency $f_{\text{min-expected}}$ must also be known. $f_{\text{min-expected}}$ must always be greater than $f_{\text{min-phys}}$; the lowest possible frequency that can physically be measured. The reciprocal of $f_{\text{min-expected}}$ is the time after the last received pulse for which a frequency (or a flow rate or similar variable derived from it) will still be displayed before the frequency or other variable is set to 0.0 Hz.

The PreScaler that has a direct effect on the measurement must also be selected. The larger the PreScaler, the better the resolution.

The following equations apply to the type 500 card. Caution: These equations do *not* apply to the type 510 card.

$$f_{\text{Resolution}} = \frac{f_{\text{Meas}}^2}{1.0E7 \cdot \frac{1}{2} \cdot pS} \tag{7.7}$$

$$t_{\text{Meas}} = \frac{pS}{f_{\text{Meas}}} \tag{7.8}$$

$$f_{\text{min-phys}} = \frac{1E7 \cdot pS}{2^{24}} \tag{7.9}$$

$$f_{\text{min-expected}} = \text{Kn068} > f_{\text{min-phys}} \tag{7.10}$$

$$t_{\text{Zeroflowrate}} = \frac{1}{f_{\text{min-expected}}} \tag{7.11}$$

Symbol	Parameters	Meaning	Unit
$f_{\text{Resolution}}$		Resolution of the measurement	[Hz]
f_{Meas}		Frequency to be measured	[Hz]
pS	K0n62	PreScaler	[-]
t_{Meas}		Measuring time until result available	[s]
$f_{\text{min-phys}}$		Lowest frequency that can still be processed	[Hz]
$f_{\text{min-expected}}$	K0n63	Lowest frequency that it should still be possible to evaluate	[Hz]
$t_{\text{Zeroflowrate}}$		Wait time after the last signal is received after which a frequency of 0.0 Hz is generated when it has elapsed.	[s]

Table 7.8.: Symbols: Formulas for type 500 card

Some examples for configuration of the PreScaler:

Signal [Hz]	PreScaler	Measuring time [s]	Resolution [Hz]
1	2	2.00000000	0.00000010
10	2	0.20000000	0.00001000
100	2	0.02000000	0.00100000
100	256	2.56000000	0.00000781

Signal [Hz]	PreScaler	Measuring time [s]	Resolution [Hz]
1.000	4	0.00400000	0.05000000
1.000	128	0.12800000	0.00156250
10.000	64	0.00640000	0.31250000
100.000	256	0.00256000	7.81250000
1.000.000	256	0.00025600	781.250000

Table 7.9.: Examples of the correlation: Measuring time, resolution and PreScaler

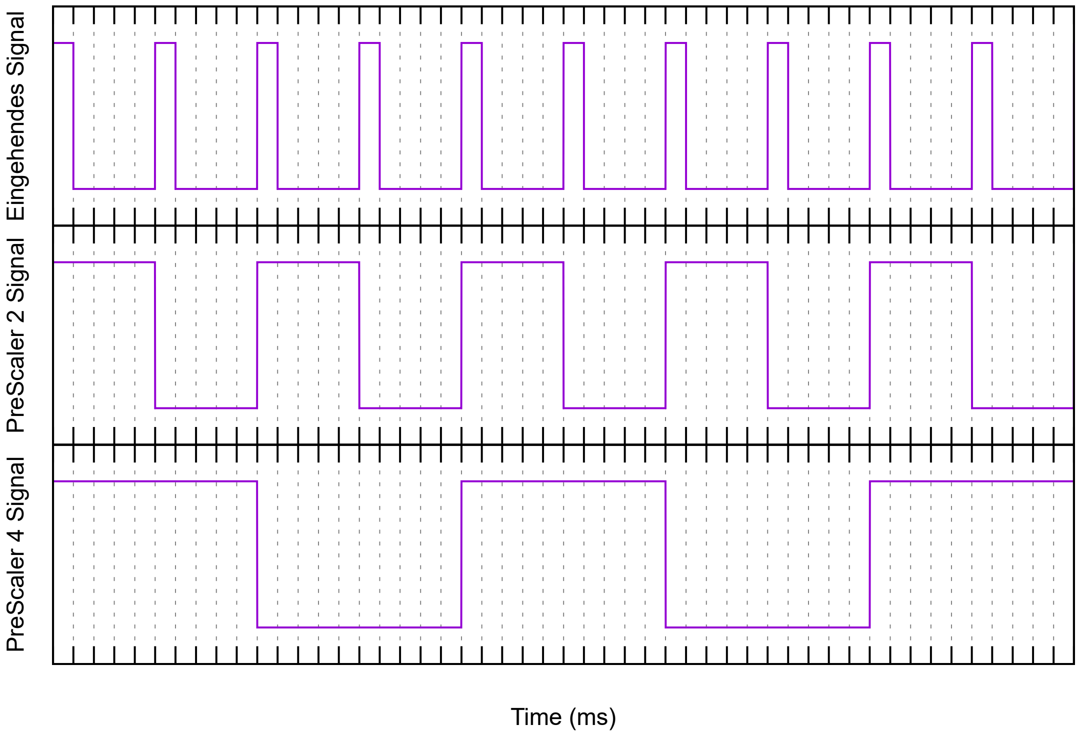

Figure 7.1.: Input signal to be measured and PreScaler signals generated from it

7.6. K0500 General properties of the controller

The mainboard has integrated pressure and temperature sensors. For the temperature sensor, note that the temperature is measured directly on the board.

- The pressure sensor generates a float from 0.0 to 1.0. The float scales with 0.0 = 0.0 mbar to 1.0 = 1100.0 mbar.
- The temperature sensor generates a float from 0.0 to 1.0. The float scales with 0.0 = 0.0 K to 1.0 = 358.15 K.

Both sensors are set up in the template file so that they generate their measured value in SI units. The pressure sensor always lands on AI00, the temperature sensor on AI01. If type 100, type 120 or type 310 cards are still being used, these AIs are moved to the range starting at AI02.

Parameter	Bedeutung	Werte	Erläuterungen
K0500	Controller serial number	String (*STR*) [""]	Serial number of the controller
K0510	Device name	Expression (*STR*) [/dev/t60]	Onboard sensors for absolute pressure and temperature " ": Deactivated `/dev/t60`: Activated
K0520	Pressure gain	-1E6..1E6 (*FLT*) [1100.0E2]	Sensor gain
K0521	Pressure offset	(*FLT*) [0.0]	Sensor offset
K0522	CAL number	(*STR*) [""]	CAL number of calibration of the port
K0525	Temperature gain	-1E6..1E6 (*FLT*) [358.15]	Sensor gain
K0526	Temperature offset	(*FLT*) [0.0]	Sensor offset
K0527	CAL number	(*STR*) [""]	CAL number of calibration of the port

Table 7.10.: K parameters: Configuration of the onboard sensors

7.7. K0600 Configuration of the serial connections

These parameters handle the configuration of the serial interfaces. 10 interfaces are possible. The block is repeated 10 times with an interval of 10: K0600 ff, K0610 ff., etc.

Parameter	Bedeutung	Werte	Erläuterungen
K06n0	Device name	Expression (*STR*) [""]	Type of the serial connection number n " ": Deactivated `/dev/ser0`: RS-232 connection to the hardware connection "ser0" for external devices or AK protocol `/dev/ser1`: RS-485 connection to the hardware connection "ser1" for serial sensors `/dev/ser2`: RS-485 connection to the hardware connection "ser2" for serial sensors
K06n1	Bit rate	0..115200 (*INT*) [9600]	Bit rate of the serial connection (Baud) 300 1200 2400 4800 9600 14400 19200 28800 38400 57600 115200
K06n2	Data bits	5..8 (*INT*) [8]	Number of data bits
K06n3	Stop bits	1..2 (*INT*) [1]	Number of stop bits
K06n4	Parity	0..4 (*INT*) [0]	Parity mode 0: None 1: Even 2: Odd 3: Space 4: Mark
K06n5	Handshake	0..2 (*INT*) [0]	Handshake used 0: None 1: RTS/CTS (only possible with RS232) 2: Xon/Xoff (software handshake)
K06n6	Echo	0..1 (*INT*) [1]	0: Echo off (default - RS232) 1: Echo on (default - RS485)
K06n7	Protocol	0..1 (*INT*) [0]	0: RS-232 1: RS-485

Table 7.11.: K parameters: Configuration of the serial connections

Note: The device drivers for Linux (e.g.: "dev/ser1") have names that refer to the hardware connections: "ser0", "ser1" and "ser2". The link of the serial connection with the hardware connection is assigned directly in the driver. Which of the 10 serial interfaces in the K0600 parameters the connections are made to is in principle freely configurable, but the following convention is recommended:

- `K0600 val="dev/ser0"`
- `K0610 val="dev/ser1"`
- `K0620 val="dev/ser2"`

7.8. K1000 Configuration of type 400 modules

These parameters handle the configuration of the type 400 modules. All assignments have been made in this case.

Parameter	Bedeutung	Werte	Erläuterungen
K1000	Device name	Expression (*STR*) [""]	Type 400 bus for digital inputs and outputs " ": Deactivated `/dev/t400`: Activated
K1001	Timeout	1.0E-3..1.0 (*FLT*) [10.0E-3]	Timeout for T400 communication in seconds.. 10 ms is the minimum allowable value.
K1005	Type 50 module	0..1 (*INT*) [1]	Flag for type 50 module 0:inactive 1:active
K1010	Submodule address 0	0..432 (*INT*) [0]	Type of the T400 submodule at address 0 0: None 412: 16x DI backpane 414: 8x DI DIN rail 422: 16x DO backplane 424: 8x DO DIN rail 432: 8xDI, 8xDO backplane 435: 4xDI, 4xDO 4xstandard button board
K1011	Submodule address 1	0..432 (*INT*) [0]	Type of the T400 submodule at address 1 see above
K1012	Submodule address 2	0..432 (*INT*) [0]	Type of the T400 submodule at address 2 see above
K1013	Submodule address 3	0..432 (*INT*) [0]	Type of the T400 submodule at address 3 see above
K1014	Submodule address 4	0..432 (*INT*) [0]	Type of the T400 submodule at address 4 see above
K1015	Submodule address 5	0..432 (*INT*) [0]	Type of the T400 submodule at address 5 see above
K1016	Submodule address 6	0..432 (*INT*) [0]	Type of the T400 submodule at address 6 see above
K1017	Submodule address 7	0..432 (*INT*) [0]	Type of the T400 submodule at address 7 see above

Parameter	Bedeutung	Werte	Erläuterungen
K1018	Submodule address 8	0..432 (*INT*) [0]	Type of the T400 submodule at address 8 see above
K1019	Submodule address 9	0..432 (*INT*) [0]	Type of the T400 submodule at address 9 see above
K1020	Submodule address 10	0..432 (*INT*) [0]	Type of the T400 submodule at address 10 see above
K1021	Submodule address 11	0..432 (*INT*) [0]	Type of the T400 submodule at address 11 see above
K1022	Submodule address 12	0..432 (*INT*) [0]	Type of the T400 submodule at address 12 see above
K1023	Submodule address 13	0..432 (*INT*) [0]	Type of the T400 submodule at address 13 see above
K1024	Submodule address 14	0..432 (*INT*) [0]	Type of the T400 submodule at address 14 see above
K1025	Submodule address 15	0..432 (*INT*) [0]	Type of the T400 submodule at address 15 see above

Table 7.12.: K parameters: Configuration of the type 400 DI and DO inputs and outputs

8. M parameters / gas mixtures and mechanical elements

8.1. M0000 Gas mixtures

Note:
Only the Daubert & Dannert and Sutherland VDI / VDE 2040 models can be used for the viscosity of the individual gas components. The viscosity of the gas mixture is determined according to the Meriam model.

Parameter	Meaning	Values	Explanations
M0000	Name of gas mixture	*STR* [""]	Name of the gas mixture
M0001	Number of gases	*INT* 1..10 [1]	Number of gases in the mixture
M0010	Gas type of gas 0	*INT* 1..25 [1]	Gas type of gas 0
M0011	Proportion of the substance (mol) in the overall quantity of substance or quantity of substance of gas 0	*FLT* 0.001..999 [1.0]	Molar proportion of gas 0 in the mixture
M0015	Gas type of gas 1	*INT* 1..25 [1]	Gas type of gas 1
M0016	Proportion of the substance (mol) in the overall quantity of substance or quantity of substance of gas 1	*FLT* 0.001..999 [1.0]	Molar proportion of gas 1 in the mixture
M0020	Gas type of gas 2	*INT* 1..25 [1]	Gas type of gas 2
M0021	Proportion of the substance (mol) in the overall quantity of substance or quantity of substance of gas 2	*FLT* 0.001..999 [1.0]	Molar proportion of gas 2 in the mixture

Parameter	Meaning	Values	Explanations
M0025	Gas type of gas 3	*INT* 1..25 [1]	Gas type of gas 3
M0026	Proportion of the substance (mol) in the overall quantity of substance or quantity of substance of gas 3	*FLT* 0.001..999 [1.0]	Molar proportion of gas 3 in the mixture
M0030	Gas type of gas 4	*INT* 1..25 [1]	Gas type of gas 4
M0031	Proportion of the substance (mol) in the overall quantity of substance or quantity of substance of gas 4	*FLT* 0.001..999 [1.0]	Molar proportion of gas 4 in the mixture
M0035	Gas type of gas 5	*INT* 1..25 [1]	Gas type of gas 5
M0036	Proportion of the substance (mol) in the overall quantity of substance or quantity of substance of gas 5	*FLT* 0.001..999 [1.0]	Molar proportion of gas 5 in the mixture
M0040	Gas type of gas 6	*INT* 1..25 [1]	Gas type of gas 6
M0041	Proportion of the substance (mol) in the overall quantity of substance or quantity of substance of gas 6	*FLT* 0.001..999 [1.0]	Molar proportion of gas 6 in the mixture
M0045	Gas type of gas 7	*INT* 1..25 [1]	Gas type of gas 7
M0046	Proportion of the substance (mol) in the overall quantity of substance or quantity of substance of gas 7	*FLT* 0.001..999 [1.0]	Molar proportion of gas 7 in the mixture
M0050	Gas type of gas 8	*INT* 1..25 [1]	Gas type of gas 8

Parameter	Meaning	Values	Explanations
M0051	Proportion of the substance (mol) in the overall quantity of substance or quantity of substance of gas 8	*FLT* 0.001..999 [1.0]	Molar proportion of gas 8 in the mixture
M0055	Gas type of gas 9	*INT* 1..25 [1]	Gas type of gas 9
M0056	Proportion of the substance (mol) in the overall quantity of substance or quantity of substance of gas 9	*FLT* 0.001..999 [1.0]	Molar proportion of gas 9 in the mixture

Table 8.1.: Configuration of the gas mixtures

8.2. M1000 Mechanical elements

The M1xxx area contains 100 definitions of mechanical elements with a spacing of 10.

Parameter	Meaning	Values	Explanations
M1000	Name of the element	(*STR*) ["Element name"]	Name of the mechanical element
M1001	Designates movement to home position	(*STR*) ["Movement to HP"]	Contains a designation of the movement to home position for display or logging purposes
M1002	Designates movement to working position	(*STR*) ["Movement to WP"]	Contains a designation of the movement to working position for display or logging purposes
M1003	Message for error during movement to home position	(*STR*) ["Error HP"]	Contains the error message for the movement to home position for display or logging purposes
M1004	Message for error during movement to working position	(*STR*) ["Error WP"]	Contains the error message for the movement to work position for display or logging purposes

Parameter	Meaning	Values	Explanations
M1005	Expression for actual state	Expression (*INT*) ["-1"]	Actual state of the element -1: Unknown 0: Home position 1: Working position
M1006	Timeout	0.02..120.0 (*FLT*) [5.0]	Timeout for the movement of the mechanical element

Table 8.2.: Configuration of the mechanical elements

9. P parameters / program-dependent configuration

By way of clarification:
In the sections that follow, the lowercase letter n in the parameter number stands for the program number. There are 10 programs with numbers 0 to 9. These programs have assigned settings depending on the application. Not all programs necessarily always have assigned settings.

9.1. Pn000 block: Primary element

The flow rate is calculated from the parameterization of the primary element in Pn000 ff., the selection of the primary element type in S4000 ff. and measurands Pn010 to Pn029.

Linked R parameters:
The parameterization in block Pn000 defines R parameters R0030 to R0041. And if correction calculation is active, also R parameters R0050 to R0054.

Parameter	Bedeutung	Werte	Erläuterungen
Pn000	Number of primary element	0..39 (*INT*) 40..139 [0]	0..39 flow element from S40xx-S70xx 40..139 flow element from E00xx-E99xx

Parameter	Bedeutung	Werte	Erläuterungen
Pn001	Gas through primary element	-1013..25 [1]	-1013: Predefined mixed gas naturalL (mix) -1012: Predefined mixed gas naturalH (mix) -1011: Predefined mixed gas nitrogen monoxide NO 10% in 90% N2 -1010: Predefined mixed gas nitrogen monoxide NO 1% in 99% N2 -1009: Predefined mixed gas propene C3H6 5% in 95% N2 -1008: Predefined mixed gas lean gas 12% O2 in 88% N2 -1007: Predefined mixed gas rich gas 20% CO and 6.666% H2 in 73.334% N2 -1006: Predefined mixed gas rich gas synthetic air 20.5% O2 and 79.5% N2 -1005: Predefined mixed gas lean gas 30% H2 in 70% N2 -1004: Predefined mixed gas lean gas 20% H2 in 80% N2 -1003: Predefined mixed gas lean gas 10% H2 in 90% N2 -1002: Predefined mixed gas lean gas 5% H2 in 95% N2 -1001: Predefined mixed gas MixAirDry CIPM2007 -1000: Predefined mixed gas MixAirDry BIPM1979 Composition of the predefined mixed gas via `PREDEFGASMIX n`

Parameter	Bedeutung	Werte	Erläuterungen
Cont. Pn001	Gas through primary element	-1013..25 [1]	-9: Mixed gas 9 (see M09xx) ... -1: Mixed gas 1 (see M01xx) 0: Mixed gas 0 (see M00xx) 1: Air 2: Argon 3: Carbon dioxide 4: Carbon monoxide 5: Helium 6: Hydrogen 7: Nitrogen 8: Oxygen 9: Methane 10: Propane 11: n-butane 12: Natural gas H (outdated!) 13: Natural gas L (outdated!) 14: Laughing gas 15: Water vapor 16: Xenon 17: Nitric oxide 18: Neon 19: Krypton 20: Propene 21: Ethane 22: Ethene 23: Ammonia 24: Sulfur dioxide 25: n-pentane
Pn002	Density calculations	0..3 (*INT*) [3]	General: For air with moisture content: Limits: 0 .. 65 °C and 0 .. 80 % r.h. 0: Ideal 1: Real, virial coefficients. 2: BIPM recommendation 1979 (air only). 3: CIPM recommendation 2007 (air only).

Parameter	Bedeutung	Werte	Erläuterungen
Pn003	Viscosity calculations	0..14 (*INT*) [14]	General: Pressure range limits 0.05 to 10 bara. For air with moisture content: Limits 0 .. 65 °C and 0 .. 80 % r.h. 0: Automatic decision based on gas type For air PTB model with humidity correction according to Kestin-Whitelaw. For all other gases: Dauber & Danner model. 1: Gas type: Air (moist), model: PTB, humidity: Kestin-Whitelaw. 2: Gas type: All gases, model: Daubert & Danner. 3: Gas type: Air (dry), model: Sutherland PTB. 4: Gas type: All gases, model: Sutherland VDI/VDE 2040. 12: Gas type: Air (moist), model: Daubert & Danner, humidity: Kestin-Whitelaw. 13: Gas type: Air (moist), model: Sutherland PTB, humidity: Kestin-Whitelaw. 14: Gas type: Air (moist), model: Sutherland VDI/VDE 2040, humidity: Kestin-Whitelaw.

Table 9.1.: P parameter: Primary element

9.2. Measurands

Linked R parameters See:

- Parameter lists - 9.2 - S. 63 - *Overview: Blocks of measurands*

Measurand	P parameters	R parameters
Differential pressure:	Pn010	Ry001
Absolute pressure:	Pn015	Ry002
Temperature:	Pn020	Ry003
Humidity:	Pn025	Ry004
Reference absolute pressure:	Pn030	Ry010
Reference temperature:	Pn035	Ry011
Reference humidity:	Pn040	Ry012
Auxiliary variable Aux0:	Pn050	Ry020
Auxiliary variable Aux1:	Pn055	Ry021

Measurand	P parameters	R parameters
Auxiliary variable Aux2:	Pn060	Ry022
Auxiliary variable Aux3:	Pn065	Ry023
Auxiliary variable Aux4:	Pn070	Ry024
Auxiliary variable Aux5:	Pn075	Ry025
Auxiliary variable Aux6:	Pn080	Ry026
Auxiliary variable Aux7:	Pn085	Ry027
Auxiliary variable Aux8:	Pn090	Ry028
Auxiliary variable Aux9:	Pn095	Ry029

Table 9.2.: Overview of the blocks of measurands and R parameters linked with them

9.3. Pn010 block: Differential pressure (Pdif)

The differential pressure is required mainly for the LFE evaluation. Other flow rate processes such as the critical nozzle do not require this variable.

Parameter	Bedeutung	Werte	Erläuterungen
Pn010	Value	Expression (*FLT*) [""]	e.g. R parameters R0820 Empty = Switched off
Pn011	Physical variable	0..0 (*INT*) [0]	Physical variable according to section 13, permanently set to pressure here
Pn012	Display	0..17 (*INT*) [3]	For coding see section 13
Pn013	Display of places after the decimal	0..5 (*INT*) [1]	Number of places after the decimal
Pn014	KalAssi information	-2..2097152 (*INT*) [-2]	Information for KalAssi -2: Deactivated -1: Fixed value 0 .. 19: Input number of the sensor 20 .. 999: Reserved for special cases 1000 .. 2097152: Bit-coded: Calculated from multiple inputs 1000 is an offset here Example: 1005: Calculated from input 0 and input 2

Table 9.3.: P parameter: Differential pressure

Example:
P0010 `val=R0820` sets linearized input in S20xx as the differential pressure. P0010 `val=R0800` would use the raw value of the input.

Further information:

- Parameter lists - 11.15 - S. 113 - *S2000/S3000 block: Linearization of inputs*
- Parameter lists - 10.1 - S. 99 - *Overview of R parameters*

9.4. Pn015 block: Absolute measuring pressure (Pabs)

The absolute pressure at the measuring point is required for every flow rate evaluation.

Note: In many cases absolute pressures (Pabs, Rpab, etc.) are calculated using the system absolute pressure from relative pressures.

Parameter	Bedeutung	Werte	Erläuterungen
Pn015	Value	Expression (*FLT*) [""]	e.g. R parameters Empty - switched off
Pn016	Physical variable	0..0 (*INT*) [0]	Physical variable according to section 13, permanently set to pressure here
Pn017	Display of unit	0..17 (*INT*) [3]	For coding see section 13
Pn018	Display of places after the decimal	0..5 (*INT*) [1]	Number of places after the decimal
Pn019	KalAssi information	-2..2097152 (*INT*) [-2]	Information for KalAssi -2: Deactivated -1: Fixed value 0 .. 19: Input number of the sensor 20 .. 999: Reserved for special cases 1000 .. 2097152: Bit-coded: Calculated from multiple inputs 1000 is an offset here Example: 1005: Calculated from input 0 and input 2

Table 9.4.: P parameter: Absolute measuring pressure

Example:
P0015 `val=R0821 + R0000` sets the total of the linearized input in S21xx (`R0821`, relative pressure) and the system absolute pressure (`R0000`) as the absolute measuring pressure of the measuring section.

Further information:

- Parameter lists - 11.15 - S. 113 - *S2000/S3000 block: Linearization of inputs*
- Parameter lists - 10.1 - S. 99 - *Overview of R parameters*

9.5. Pn020 block: Measuring temperature (Temp)

Parameter	Bedeutung	Werte	Erläuterungen
Pn020	Value	Expression (*FLT*) [""]	E.g. R parameters `R0820` Empty = Switched off
Pn021	Physical variable	5..5 (*INT*) [5]	Physical variable according to section 13, permanently set to temperature here
Pn022	Display of unit	0..17 (*INT*) [1]	For coding see section 13
Pn023	Display of places after the decimal	0..5 (*INT*) [1]	Number of places after the decimal
Pn024	KalAssi information	-2..2097152 (*INT*) [-2]	Information for KalAssi -2: Deactivated -1: Fixed value 0 .. 19: Input number of the sensor 20 .. 999: Reserved for special cases 1000 .. 2097152: Bit-coded: Calculated from multiple inputs 1000 is an offset here Example: 1005: Calculated from input 0 and input 2

Table 9.5.: P parameter: Measuring temperature

Example:
P0020 `val=R0822` sets the linearized input in S22xx (`R0822`) as the measuring temperature of the measuring section.

Further information:

- Parameter lists - 11.15 - S. 113 - *S2000/S3000 block: Linearization of inputs*
- Parameter lists - 10.1 - S. 99 - *Overview of R parameters*

9.6. Pn025 block: Measuring humidity (Hum)

Parameter	Bedeutung	Werte	Erläuterungen
Pn025	Value	Expression (*FLT*) [""]	e.g. R parameters Empty = switched off
Pn026	Physical variable	10..10 (*INT*) [10]	Physical variable according to section 13, permanently set to humidity here

Parameter	Bedeutung	Werte	Erläuterungen
Pn027	Display	0..17 (*INT*) [1]	For coding see section 13
Pn028	Display of places after the decimal	0..5 (*INT*) [1]	Number of places after the decimal
Pn029	KalAssi information	-2..2097152 (*INT*) [-2]	Information for KalAssi -2: Deactivated -1: Fixed value 0 .. 19: Input number of the sensor 20 .. 999: Reserved for special cases 1000 .. 2097152: Bit-coded: Calculated from multiple inputs 1000 is an offset here Example: 1005: Calculated from input 0 and input 2

Table 9.6.: P parameter: Measuring humidity

Example:
`P0025 val=R0823` sets the linearized input in S23xx (`R0823`) as the measuring humidity of the measuring section.

Further information:

- Parameter lists - 11.15 - S. 113 - *S2000/S3000 block: Linearization of inputs*
- Parameter lists - 10.1 - S. 99 - *Overview of R parameters*

9.7. Pn030 block: Absolute reference pressure (RPab)

To switch the result variables of the reference calculation to active:

- Blocks Pn030, Pn035 and Pn040 must be reasonably parameterized.
- The reference calculation must be activated in Pn300. See p.: 72

Parameter	Bedeutung	Werte	Erläuterungen
Pn030	Value	Expression (*FLT*) [""]	e.g. R parameters Empty = switched off
Pn031	Physical variable	0..0 (*INT*) [0]	Physical variable according to section 13, permanently set to pressure here
Pn032	Display of unit	0..17 (*INT*) [3]	For coding see section 13
Pn033	Display of places after the decimal	0..5 (*INT*) [1]	Number of places after the decimal

Parameter	Bedeutung	Werte	Erläuterungen
Pn034	KalAssi information	-2..2097152 (*INT*) [-2]	Information for KalAssi -2: Deactivated -1: Fixed value 0 .. 19: Input number of the sensor 20 .. 999: Reserved for special cases 1000 .. 2097152: Bit-coded: Calculated from multiple inputs 1000 is an offset here Example: 1005: Calculated from input 0 and input 2

Table 9.7.: P parameter: Absolute reference pressure

Example:
P0030 `val=R0824 + R0000` sets The total of the linearized input in S24xx (`R0824`, relative pressure) and the system absolute pressure (`R0000`) as the absolute measuring pressure of the measuring section.

Further information:

- Parameter lists - 11.15 - S. 113 - *S2000/S3000 block: Linearization of inputs*
- Parameter lists - 10.1 - S. 99 - *Overview of R parameters*

9.8. Pn035 block: Reference temperature (RTem)

To switch the result variables of the reference calculation to active:

- Blocks Pn030, Pn035 and Pn040 must be reasonably parameterized.
- The reference calculation in Pn300 must be activated, see p.: 72

Parameter	Bedeutung	Werte	Erläuterungen
Pn035	Value	Expression (*FLT*) [""]	e.g. R parameters `R0820` Empty = Switched off
Pn036	Physical variable	5..5 (*INT*) [5]	Physical variable according to section 13, permanently set to temperature here
Pn037	Display of unit	0..17 (*INT*) [1]	For coding see section 13
Pn038	Display of places after the decimal	0..5 (*INT*) [1]	Number of places after the decimal

Parameter	Bedeutung	Werte	Erläuterungen
Pn039	KalAssi information	-2..2097152 (*INT*) [-2]	Information for KalAssi -2: Deactivated -1: Fixed value 0 .. 19: Input number of the sensor 20 .. 999: Reserved for special cases 1000 .. 2097152: Bit-coded: Calculated from multiple inputs 1000 is an offset here Example: 1005: Calculated from input 0 and input 2

Table 9.8.: P parameter: Reference temperature

Example:
P0035 `val=R0825` sets the linearized input in S25xx (`R0825`) as the measuring temperature of the measuring section.

Further information:

- Parameter lists - 11.15 - S. 113 - *S2000/S3000 block: Linearization of inputs*
- Parameter lists - 10.1 - S. 99 - *Overview of R parameters*

9.9. Pn040 block: Reference humidity (RHum)

Note:
Usually the humidity of a measuring system is only measured centrally at one point. It is possible to calculate the humidity at the reference point if the pressure, temperature and humidity at the measuring point as well as the pressure and temperature at the reference point are available, see example.

To switch the result variables of the reference calculation to active:

- Blocks Pn030, Pn035 and Pn040 must be reasonably parameterized.
- The reference calculation in Pn300 must be activated, see p.: 72

Example:

```
P0040  val=RELHUM(R0010,R0011,XV(R0002,R0003,R0004))
```

The molar proportion of water is calculated here from the starting conditions (`R0002 - R0004`). This is a conserved quantity. At the reference point it is then converted back to a humidity with the reference conditions (`R0010` and `R0011`).

Further information:

- Parameter lists - 11.15 - S. 113 - *S2000/S3000 block: Linearization of inputs*
- Parameter lists - 10.1 - S. 99 - *Overview of R parameters*

Parameter	Bedeutung	Werte	Erläuterungen
Pn040	Value	Expression (*FLT*) [""]	e.g. R parameters Empty = switched off
Pn041	Physical variable	10..10 (*INT*) [10]	Physical variable according to section 13, permanently set to humidity here
Pn042	Display of unit	0..17 (*INT*) [1]	For coding see section 13
Pn043	Display of places after the decimal	0..5 (*INT*) [1]	Number of places after the decimal
Pn044	KalAssi information	-2..2097152 (*INT*) [-2]	Information for KalAssi -2: Deactivated -1: Fixed value 0 .. 19: Input number of the sensor 20 .. 999: Reserved for special cases 1000 .. 2097152: Bit-coded: Calculated from multiple inputs 1000 is an offset here Example: 1005: Calculated from input 0 and input 2

Table 9.9.: P parameter: Reference humidity

9.10. Pn050-Pn095 block: Auxiliary inputs (Aux0 to Aux9)

10 auxiliary inputs are available (AUX0 to AUX9). They can be freely assigned via blocks Pn050 to Pn095. The blocks are repeated with a spacing of 5 (Pn050 - AUX0, Pn055 - AUX1, etc., Pn095 - AUX9).

This is primarily an extension of the CoM4.sw software with which the additional sensor values can be integrated without predefined usage. If other measurands will be recorded for the measurement task in addition to the flow rate, even if only for documentation purposes, the corresponding sensors are routed to auxiliary inputs. Examples: Sensors for distance, force, control signal on the UUT, etc.

Parameter	Bedeutung	Werte	Erläuterungen
Pn050	Val	Expression (*FLT*) [""]	e.g. R parameters Empty = switched off
Pn051	Physical variable	0..21 (*INT*) [0]	Physical variable according to section 13, can be edited here
Pn052	Display of unit	0..17 (*INT*) [0]	For coding see section 13
Pn053	Display of places after the decimal	0..5 (*INT*) [1]	Number of places after the decimal

Parameter	Bedeutung	Werte	Erläuterungen
Pn054	KalAssi information	-2..2097152 (*INT*) [-2]	Information for KalAssi -2: Deactivated -1: Fixed value 0 .. 19: Input number of the sensor 20 .. 999: Reserved for special cases 1000 .. 2097152: Bit-coded: Calculated from multiple inputs 1000 is an offset here Example: 1005: Calculated from input 0 and input 2

Table 9.10.: P parameter: Auxiliary inputs

9.11. Pn100 -Pn200: Units and places after the decimal

The unit and places after the decimal of the output of an R parameter in the display can be defined in various places. Until R parameter RyXXX is definitively generated, its physical variable, unit and number of places after the decimal can be changed and overwritten several times. The sources of the physical variables can be found sorted by their priority in table 9.11. 1 is the highest priority and is therefore written last. Lower priorities are overwritten by higher priorities.

Source	Priority	What is defined?	Reference
p-init.dat Pn010 to Pn099 block	1	Type, unit and places after the decimal	Section 9.2
p-init.dat Pn350 to Pn399 block	1	Type, unit and places after the decimal	Section 9.14
p-init.dat Pn415 to Pn417 block Pn465 bis Pn467 Block	1	Type, unit and places after the decimal	Section 9.15
s-init.dat S2090 and S9010 Block	1	Type, unit and places after the decimal	Section 11.19
p-init.dat Pn200 block	2	Type, unit and places after the decimal	Section 9.11.2
p-init.dat Pn100 block	3	Type, unit and places after the decimal	Section 9.11.1
r-init.dat Complete	4	Type, unit and places after the decimal	Section 10
s-init.dat S9050 - S9095	Not applicable	Def. new phys. variable	Section 11.20

Table 9.11.: sources and priorities of physical variables, units and places after the decimal

9.11.1. Pn100 Units and places after the decimal of physical variables

Specific physical variables, units and places after the decimal can be assigned in blocks of 10 with parameters Pn100 to Pn199. The blocks follow with a spacing of 10: Pn100, Pn110, Pn120 to Pn190. The first blocks are preassigned with the most important variables in the standard case: Pn100: Volume flow, Pn110: Mass flow, Pn120: Time. Beginning with Pn130, additional quantities can be defined. Target quantities for the assignment are the R parameters 0 .. 799.

Parameter	Bedeutung	Werte	Erläuterungen
Pn100	Physical variable	-1 .. 21 (*INT*) [1]	Physical variable: For coding see table 13.2 -1: Entry is not used With volume flow preset here
Pn101	Unit	0 .. 19 [2]	For unit coding see table 13.2
Pn102	Display of places after the decimal	0 .. 5 (*INT*) [1]	Number of places after the decimal
Pn110	Physical variable	-1 .. 21 (*INT*) [2]	Physical variable: For coding see table 13.2 -1: Entry is not used With mass flow preset here
Pn111	Unit	0 .. 19 [2]	For unit coding see table 13.2
Pn112	Display of places after the decimal	0 .. 5 (*INT*) [1]	Number of places after the decimal
Pn130	Physical variable	-1 .. 21 (*INT*) [7]	Physical variable: For coding see table 13.2 -1: Entry is not used With time preset here
Pn131	Unit	0 .. 19 [0]	For unit coding see table 13.2
Pn132	Display of places after the decimal	0 .. 5 (*INT*) [1]	Number of places after the decimal

Table 9.12.: P parameter: Units and places after the decimal for variables

Further information:

- Parameter lists - 9.11 - S. 70 - *Sources: Units and places after the decimal*

9.11.2. Pn200 block: Units and places after the decimal for specific R parameters

Physical dimension, unit and places after the decimal can be assigned program-specifically to up to 20 R parameters for display with parameters Pn200 to Pn299. The parameter set is repeated with a spacing of 5 for Pn200, Pn205, and Pn210 to Pn290. Target quantities for the assignment are all R parameters that are written via script except for R parameters 1900 ff. The physical dimension, unit and places after the decimal are also assigned to these R parameters 1900 ff. by means of a script.

Parameter	Bedeutung	Werte	Erläuterungen
Pn200	R parameter	-1..2899 (*INT*) [-1]	Number of the R parameter -1 if the entry will not be used
Pn201	Dimension	0..24 (*INT*) [10]	Physical variable
Pn202	Unit	0..17 (*INT*) [0]	Unit: For coding see table 13.2
Pn203	Display of places after the decimal	0..5 (*INT*) [1]	Number of places after the decimal

Table 9.13.: P parameter: Units, places after the decimal for R parameters

Further information:

- Parameter lists - 9.11 - S. 70 - *Sources: Units and places after the decimal*

9.12. Pn300 Block: Reference and correction calculation

The reference calculation is used to activate R parameters R0032 (RQVa), R0093 (RDen) and R0098 (RVis).

The correction calculation is used to activate R parameters R0051 (CQVa), R0052 (CQVn), R0053 (CQVr), R0054 (CQMa) R0094 (CDen) and R0099 (CVis).

Parameters	Meaning	Values	Explanations	Pn301
Pn300	Reference calculation	0 .. 1 (*INT*) [0]	0: Not active 1: Active	
Pn301	Correction calculation	0 .. 4 (*INT*) [0]	Correction for volume and mass flows, with standardization to the reference conditions stated below 0: From 1: Speed of sound (T) 2: Orifice 3: Viscosity 4: Direct correction value (in Pn305)	
Pn302	Reference pressure	0.0 .. 2.0E06 (*FLT*) [1.0E05]	Reference pressure - fixed value in Pascal	1,2,3,4
Pn303	Reference temperature	233.15 .. 1073.15 (*FLT*) [293.15]	Reference humidity - fixed value in Kelvin	1,2,3,4
Pn304	Reference humidity	0.0 .. 1.0 (*FLT*) [0.0]	Reference humidity - fixed value 0..1	1,2,3,4

Parameters	Meaning	Values	Explanations	Pn301
Pn305	Expression depending on value in Pn301	Expression (*FLT*) [""]	Depending on the meaning of Pn301: 2 or 3: Ratio according to formula $\frac{Pdif_{Ref}}{Pdif_{Meas}}$ 4: The correction factor is defined only by the expression in Pn305	2, 3, 4

Table 9.14.: P parameters: Reference and correction calculation

9.13. Pn310 Block: Functions

The block is available 4 x and is repeated to Pn315, Pn320 and Pn325.

Block Pn310 activates the following R parameters:

- Ry110: Slope of straight line
- Ry111: Intercept of straight lines
- Ry112: Correlation coefficient
- Ry113: Standard deviation over the values
- Ry114: Mean value of the values

Parameter	Bedeutung	Werte	Erläuterungen
Pn310	Type of function	0..1 (*INT*) [0]	0: Switched off 1: Regression line
Pn311	Minimum time	0.02..3600.0 (*FLT*) [5.0]	Minimum measuring time for a valid regression
Pn312	Maximum time	0.02..3600.0 (*FLT*) [10.0]	Maximum time of the regression taken into consideration. Older measurement data is no longer included in the current regression.
Pn313	Input value of the function	0..2999 (*INT*) [1]	R parameter number Input value for the function

Table 9.15.: P parameter: Functions

9.14. Pn350 Block: Calculated R parameters

This block activates R parameters R0060, R0061, R0062, R0063, R0064 or R0260, 360 ff.

The values in block Pn350 are used to be able to assign calculated, program-dependent values to some R parameters.

A total of 5 calculated R parameters are possible. The parameters for Pn350-Pn352 are repeated to Pn360, Pn370, Pn380 and Pn390 with a spacing of 10 for this purpose. The results land accordingly in Ry061, Ry062, etc.

A separate expression is available for Pn351 and Pn352 for the total and mean value. If expressions are indicated here, the total and/or mean value of the calculated R parameter with the result of the expressions will be overwritten after the measurement is shut down.

Warning: The total and/or mean value of the calculated R parameter are not overwritten until 1 cycle after the other R parameters 200 ff! Therefore the value is not available in time for the evaluation. Having a variable calculated via Px352 and then having it evaluated via Px500=1, Px501=260 does not work!

Parameter	Bedeutung	Werte	Erläuterungen
Pn350	Calculated R parameter #0	Expression (*FLT*) [""]	Result is written to Ry060
Pn351	Total of the calculated R parameter #0	Expression (*FLT*) [""]	Result is written to Ry360
Pn352	Mean value of the calculated R parameter #0	Expression (*FLT*) [""]	Result is written to Ry260 **Warning:** The total and/or mean value of the calculated R parameter are not written until 1 cycle after the other R parameters 200 ff! Therefore the value is not available in time for the evaluation. Having a variable calculated via Px352 and then having it evaluated via Px500=1, Px501=260 does not work!
Pn353	Type of the calculated R parameter #0	0..21 (*INT*) [0]	Type of the calculated R parameter
Pn354	Unit of the calculated R parameter #0	0..17 (*INT*) [0]	Unit of the calculated R parameter
Pn355	Places after the decimal of the calculated R parameter #0	0..5 (*INT*) [1]	Places after the decimal of the calculated R parameter

Table 9.16.: P parameter: Calculated R parameters

9.15. Pn400 and Pn450 blocks: Regulation

Controller: Two numeric controllers are available for each program. There is now also one parameter block available for Pn400 and a second for Pn450. The first controller is calculated first in the cycle (for Pn400), then the second is calculated (for Pn450). This order must be taken into consideration if the controllers are *cascaded* . In this case the first controller should be used as the outer controller (= to the final regulating value) while the second controller should be used as the inner controller (to the auxiliary quantity). Both integrated PID controllers can be configured as controllers for all variables measured or calculated with CoM4.sw (e.g. pressures or volume flows). The scaling and definition of the analog output for output of the actuating variable is done in the S8nxx block.

PID model: Each controller can be configured as a P, PI or PID controller. Any measurand or operand from Ry000 block or a variable from the script block can be defined as a control variable. The parameters for configuring the controller are indicated in the table below. The controller parameters (Pn402-Pn405) can be determined for example based on the setting rules according to Ziegler-Nichols (see below).

Output:
The results of the numeric PID controller are generated to permanently assigned R parameters:

Parameters	Meaning
Ry150	Nominal controller value 0 (final value without ramp)
Ry151	Actual value of controller 0
Ry152	Control value of controller 0
Ry153	Absolute deviation (actual value - final nominal value) of controller 0
Ry154	Relative deviation (actual value - final nominal value)/final nominal value of controller 0
Ry155	The current nominal value of the ramp for controller 0
Ry160	Nominal value of controller value 1 (final value without ramp)
Ry161	Actual value of controller 1
Ry162	Control value of controller 1
Ry163	Absolute deviation (actual value - final nominal value) of controller 1
Ry164	Relative deviation (actual value - final nominal value)/final nominal value of controller 1
Ry165	The current nominal value of the ramp for controller 1

Table 9.17.: R parameters of the controller

Ramps:
It is possible to introduce the nominal value of a controller via a ramp. The ramp can be linear (if Pn423=1.0) or when filtered may asymptotically approximate the final nominal value PT1. The parameters for the ramp are Pn420 to Pn423. The following function can be used to restart the ramp from the script code:

```
RESET_CONTROLLER_RAMP (INT0, INT1)
```

This reinitializes the ramp of a controller. `INT0` indicates the program and `INT1` the controller. This function must always be called when there is a change to the nominal value if the controller has a ramp.

Ziegler - Nichols:
To determine the control parameters, the controller can first be defined as a simple P controller (TI = 0, TD = 0) (see also table of regulation setting parameters). KR can be calculated as an initial approximation:

$$KR = \frac{\mathsf{Pn406} - \mathsf{Pn405}}{\mathsf{Nominalvalue}_{\mathsf{Max,inSI}}} \tag{9.1}$$

The loop gain is then set to a value that leads to a stable continuous vibration of actual values, i.e. the control variable. This value for KR is designated as Kkrit. The duration of a period of the continuous vibration (Tkrit.) can now be read from a graphical display.

The values for Kkrit. and Tkrit. can be used to determine the controller parameters according to the table below 9.18. The results can then be used as values for parameters Pn401 - Pn403.

Controller	KR	TI	TD
P	$0.5 \cdot$ Kkrit		

Controller	KR	TI	TD
PI	$0.45 \cdot$ Kkrit	$0.85 \cdot$ Tkrit	
PID	$0.6 \cdot$ Kkrit	$0.5 \cdot$ Tkrit	$0.12 \cdot$ Tkrit

Table 9.18.: Determination of the controller parameters according to Ziegler - Nichols

Further information:

- Parameter lists - 11.17 - S. 128 - *S8000 block: Analog outputs*

Parameter	Bedeutung	Werte	Erläuterungen
Pn400	Control mode	Expression (*INT*) ["0"]	0: Control off 1: Control On 2: Suspended (control value is frozen, RPARs 150 remain without error codes)
Pn401	Loop gain (KR) of regulation	(*FLT*) [1]	P portion of the controller, dimensionless, as floating-point number
Pn402	Integral portion (TI) of the control	(*FLT*) [1]	I-portion of the controller in seconds If TI =0 no I component and no D-portion
Pn403	Differential component (TD) of the regulation	(*FLT*) [0]	D-portion of the controller in seconds If TD=0 no D-portion
Pn404	Time constant of the differential component	(*FLT*) [0.1]	Delay for the D-portion in seconds Must be at least as large as the cycle time
Pn405	Actuating variable restriction for lower limit	(*FLT*) [0.0]	Dimensionless floating-point number
Pn406	Actuating variable restriction for upper limit	(*FLT*) [1.0]	Dimensionless floating-point number
Pn410	Nominal value of controller	Expression (*FLT*) [""]	An expression that has as its result the nominal value of the controller
Pn411	Control variable, actual value	Expression (*FLT*) [""]	An expression that yields the actual value for the controller
Pn412	Output value after reset	Expression (*FLT*) [""]	An expression that has as its result the assumed control value of the controller at restart
Pn415	Magnitude of the nominal and actual value	0..24 (*INT*) [-1]	For coding see section
Pn416	Unit of the nominal and actual value	0..17 (*INT*) [0]	For coding see section
Pn417	Places after the decimal of the nominal and actual value	0..5 (*INT*) [1]	For coding see section

Parameter	Bedeutung	Werte	Erläuterungen
Pn420	Ramp to introduce the nominal value	0..1 (*INT*) [0]	0: Not used 1: Used
Pn421	Nominal value ramp start	Expression (*FLT*) [""]	Expression for the start value of the ramp
Pn422	Nominal value ramp slope	(*FLT*) [0.0]	Absolute slew rate in SI units of the control variable per second
Pn423	Linear portion of the ramp	0.0..1.0 (*FLT*) [1.0]	Portion of the ramp that is traversed linearly The rest of the ramp is traversed filtered by PT1
Pn425	Jitter	0..1 (*INT*) [0]	Overlap of the output signal with a jitter 0: Inactive 1: Active
Pn426	Maximum nominal/actual difference for jitter	0..1E30 (*FLT*) [0.0]	The jitter signal is only active if the nominal/actual difference is less than the value set here
Pn427	Double jitter amplitude	0..1E30 (*FLT*) [0.0]	The control value is increased or decreased in each cycle by half of the value set here
Pn428	Linearization of the control value	0..2 (*INT*) [0]	A linearization that can be made by means of the control value: 0: Deactivated 1: EXT_FUNC from Pn429 2: EWS 3/4 (Pn405 must be -1.0 here. Pn406 must be +1.0 here. The control value that is generated (Ry152 or Ry162) is then scaled by the linearization from 0.0 .. 1.0 as required for an EWS) 3: EWS 3/6 (Pn405 must be -1.0 here. Pn406 must be +1.0 here. The control value that is generated (Ry152 or Ry162) is then scaled by the linearization from 0.0 .. 1.0 as required for an EWS)
Pn429	Number of the EXT_FUNC for Pn428	0..49 (*INT*) [0]	Number of the EXT_FUNC, containing the linearization for the control value

Table 9.19.: P parameter: Control

9.16. Pn500 block: Evaluation and monitoring

4 different evaluation criteria are defined in block Pn500, each of which is used to monitor a parameter after the end of the test or continuously. The overall result is the concatenation of all activated individual evaluations. The parameters for the first evaluation criterion are shown below as an example. The block is repeated three times in Pn510, Pn520 and Pn530.

The results of the evaluation are made available in the R parameter blocks Ry170 to Ry181 and by means of the script function `res()`.

Parameter	Meaning
Ry170	Evaluated or monitored variable from Pn50x
Ry171	Lower limit for variable from Pn50x
Ry172	Upper limit for variable from Pn50x
Ry173	Evaluated or monitored variable from Pn51x
Ry174	Lower limit for variable from Pn51x
Ry175	Upper limit for variable from Pn51x
Ry176	Evaluated or monitored variable from Pn52x
Ry177	Lower limit for variable from Pn52x
Ry178	Upper limit for variable from Pn52x
Ry179	Evaluated or monitored variable from Pn53x
Ry180	Lower limit for variable from Pn53x
Ry181	Upper limit for variable from Pn53x

Table 9.20.: Output of the evaluation via R parameters

Parameter	Bedeutung	Werte	Erläuterungen
Pn500	Type of evaluation	0..2 (*INT*) [0]	0: Switched off, evaluation always good 1: Evaluate after the end of the test 2: Monitor continuously
Pn501	Variable to be monitored	0..2999 (*INT*)	Number of the R parameter to be evaluated
Pn502	Lower limit	-1E38..1E38 (*FLT*)	Lower limit value in SI units
Pn503	Upper limit	-1E38..1E38 (*FLT*)	Upper limit value in SI units
Pn504	Override for evaluation	Expression (*INT*)	Expression is assessed before the evaluation > 0 : Result of the individual evaluation is automatically "good" < 0 : Result of the individual evaluation is automatically "bad" No expression or = 0, evaluation will be performed

Table 9.21.: P parameter: Limit values

9.17. Pn600 block: Subprogram switching

The intent and purpose of subprograms is to switch a given set of P parameters independently of the currently selected program. This means it is possible for example to switch between two sensors automatically if criterion A is fulfilled or not fulfilled.

It is possible in CoM4.sw to select one or more parameter blocks of P parameters (for example the block for differential pressure P0010-P0014) from a pool of 10 data records from the B parameters.

The switching process is defined in parameter sets Pn6xx. Each parameter set corresponds to a logical block (e.g. primary elements, differential pressure...) and is therefore assigned to a block in the Pn6xx parameters 9.22. There are 20 data records with a spacing of 5: Pn600 ff. Pn605 ff. Pn610 ff., etc.

Further information:

- Parameter lists - 2 - S. 17 - *B Parameters / subprograms*

Block	Description	Correspondence in Pn6xx
Units	0: Units and places after the decimal	Pn600-Pn602
Primary	1: Primary element data Px00n	Pn605-Pn607
Unused	2: Currently not used	Pn610-Pn612
Pdif	3: Primary measurand	Pn615-Pn617
Pabs	4: Absolute pressure	Pn620-Pn622
Temp	5: Measuring temperature	Pn625-Pn627
Hum	6: Measuring humidity	Pn630-Pn632
RPabs	7: Absolute reference pressure	Pn635-Pn637
RTemp	8: Reference temperature	Pn640-Pn642
RHum	9: Reference humidity	Pn645-Pn647
Aux0	10: Auxiliary input 0	Pn650-Pn652
Aux1	11: Auxiliary input 1	Pn655-Pn657
Aux2	12: Auxiliary input 2	Pn660-Pn662
Aux3	13: Auxiliary input 3	Pn665-Pn667
Aux4	14: Auxiliary input 4	Pn670-Pn672
Aux5	15: Auxiliary input 5	Pn675-Pn677
Aux6	16: Auxiliary input 6	Pn680-Pn682
Aux7	17: Auxiliary input 7	Pn685-Pn687
Aux8	18: Auxiliary input 8	Pn690-Pn692
Aux9	19: Auxiliary input 9	Pn695-Pn697

Table 9.22.: Blocks for subprogram switching

Parameter	Brief description	Comments
Px600	Program or subprogram	0 = Bound to program, 1 = Switching between subprograms according to expression in Pn602
Px601	Wait time	Wait time until the next switching in seconds Further switching processes will be suppressed during this time
Px602	Expression	The expression must result in an integer Determines the data record number n of subprogram Bnxxx

Table 9.23.: P parameters: Switching of block - places after the decimal and units

9.18. Pn700 block: Process times

Parameter	Bedeutung	Werte	Erläuterungen
Pn700	Prefill time	0.0..86400.0 (*FLT*) [0.0]	in seconds
Pn701	Fill time	0.0..86400.0 (*FLT*) [0.0]	in seconds
Pn702	Calm time	0.0..86400.0 (*FLT*) [0.0]	in seconds
Pn703	Measuring time	0..86400.0 (*FLT*) [10.0]	in seconds
Pn704	Venting time	0.0..86400.0 (*FLT*) [0.0]	in seconds
Pn709	Number of measurement pulses	2..1E5 (*INT*) [2]	The number of measurement pulses for a gas meter according to the pulse counting method Measuring time ends after the number of pulses has elapsed (gate measurement)..

Table 9.24.: P parameter: Process times

Notes:
For measuring systems with multiple measuring circuits, the process times may be asynchronous for the measuring circuits. The end of all tests is derived from the process time of the measuring circuit that runs the longest.

Further information:

- Parameter lists - 11.37 - S. 130 - *S parameter: Special functions*

9.19. Pn800 block: Program-dependent display parameters

R parameters are assigned to a display list print program-dependently in block Pn800. The R parameter specified in Pn800 is available in the display lists with 10800. The R parameter in Pn801, in 10801, etc.

Further information:

- Parameter lists - 3 - S. 27 - *D Parameters / display configuration* .

Parameter	Bedeutung	Werte	Erläuterungen
Pn800	Display parameter #0	0..2000 (*INT*) [820]	Available in d-init as 10800
Pn801	Display parameter #1	0..2000 (*INT*) [821]	Available in d-init as 10801
Pn802	Display parameter #2	0..2000 (*INT*) [822]	Available in d-init as 10802
Pn803	Display parameter #3	0..2000 (*INT*) [823]	Available in d-init as 10803

Table 9.25.: P parameter: Display parameters

Any ticker can be defined by using the text to the right of the dividing line | in table 9.26 .

Parameter	Bedeutung	Werte	Erläuterungen
Pn899	Program name	Expression (*STR*) ["n|Prog"]	Left part of the display:: Program number n Right part of the display: Any name as running text (here Prog) Assigned to the display via *d-init.dat*: Values: -10 for MK0 -11 for MK1 -12 for MK2

Table 9.26.: P parameter: Program name

10. R parameters / read parameters

10.1. Ryxxx block: Measured results

Note:
Com4.sw can make up to 3 measuring circuits available. In the table below, the lowercase letter y in the parameter number stands for the number of the measuring circuit and can take on a value of 0, 1 or 2. R parameters are read-only and are used for data output.

During a mean value forming measurement, statistical values of the R parameters are determined. The corresponding R parameters are readily apparent in the parameter number by an offset of 100:

- Ry0xx Current value
- Ry2xx Mean value
- Ry3xx Accumulated value
- Ry4xx Minimum during the measurement
- Ry5xx Maximum during the measurement
- Ry6xx Standard deviation
- Ry7xx Change over time ($\frac{Finalvalue - startingvalue}{Time}$)

Parameter	Meaning/physical variable	Name	Addition
Ry000	System absolute pressure	Pbas	
Ry001	Differential pressure	Pdif	
Ry002	Absolute measuring pressure	Pabs	
Ry003	Measuring temperature	Temp	
Ry004	Measuring humidity	Hum	
Ry010	Absolute reference pressure [1)]	RPab	
Ry011	Reference temperature [1)]	RTem	
Ry012	Reference humidity [1)]	RHum	
Ry020	Auxiliary input 0	Aux0	
Ry021	Auxiliary input 1	Aux1	
Ry022	Auxiliary input 2	Aux2	
Ry023	Auxiliary input 3	Aux3	
Ry024	Auxiliary input 4	Aux4	

Parameter	Meaning/physical variable	Name	Addition
Ry025	Auxiliary input 5	Aux5	
Ry026	Auxiliary input 6	Aux6	
Ry027	Auxiliary input 7	Aux7	
Ry028	Auxiliary input 8	Aux8	
Ry029	Auxiliary input 9	Aux9	
Ry030	Measurement volume flow	QVac	
Ry031	Standard volume flow	QVno	
Ry032	Reference volume flow [1)]	RQVa	
Ry033	Heat output	CPwr	
Ry034	Heat quantity	HQty	
Ry035	Mass flow	QMas	
Ry036	Orifices: Reynolds number at the neck [5)]	Re_d	
Ry037	Orifices: Reynolds number in the inlet [5)]	Re_D	
Ry038	Orifices: Speed at the neck	v_d	
Ry039	Orifices: Speed in the inlet	v_D	
Ry040	K factor Betaflow	K	
Ry041	Pressure drop of LMS	dpdt	
Ry052	Correction standard volume flow [2)]	CQVn	
Ry053	Correction reference volume flow [1)] [2)]	CQVr	
Ry054	Correction mass flow [2)]	CQMa	
Ry060	Calculated R parameter from Pn350	Cal0	
Ry061	Calculated R parameter from Pn360	Cal1	
Ry062	Calculated R parameter from Pn370	Cal2	
Ry063	Calculated R parameter from Pn380	Cal3	
Ry064	Calculated R parameter from Pn390	Cal4	
Ry090	Calibration density	KDen	
Ry091	Measuring density	ADen	
Ry092	Standard density	NDen	
Ry093	Reference density [1)]	RDen	

Parameter	Meaning/physical variable	Name	Addition
Ry094	Correction density [2)]	CDen	
Ry095	Calibration viscosity	KVis	
Ry096	Measuring viscosity	AVis	
Ry097	Standard viscosity	NVis	
Ry098	Reference viscosity [1)]	RVis	
Ry099	Correction viscosity [2)]	CVis	
Ry110	Slope of function 0	FuncRes0	Func0
Ry111	Axis intercept of function 0	FuncRes1	Func0
Ry112	Correlation coefficient of function 0	FuncRes2	Func0
Ry113	Standard deviation of function 0	FuncRes3	Func0
Ry114	Mean value of function 0	FuncRes4	Func0
Ry115	Slope of function 1	FuncRes0	Func1
Ry116	Axis intercept of function 1	FuncRes1	Func1
Ry117	Coefficient of function 1	FuncRes2	Func1
Ry118	Standard deviation of function 1	FuncRes3	Func1
Ry119	Mean value of function 1	FuncRes3	Fun01
Ry120	Slope of function 2	FuncRes0	Func2
Ry121	Axis intercept of function 2	FuncRes1	Func2
Ry122	Correlation coefficient of function 2	FuncRes2	Func2
Ry123	Standard deviation of function 2	FuncRes3	Func2
Ry124	Mean value of function 2	FuncRes4	Func2
Ry125	Slope of function 3	FuncRes0	Func3
Ry126	Axis intercept of function 3	FuncRes1	Func3
Ry127	Correlation coefficient of function 3	FuncRes2	Func3
Ry128	Standard deviation of function 3	FuncRes3	Func3
Ry129	Mean value of function 3	FuncRes4	Func3
Ry130	Factor from the correction calculation (continuous) [2)]	Corr Cont	
Ry131	Factor from the correction calculation (mean value forming) [2)]	Corr Avrg	
Ry150	Regulation 0, nominal value	Set0	
Ry151	Regulation 0, actual value	Act0	

Parameter	Meaning/physical variable	Name	Addition
Ry152	Regulation 0, output actuating variable	Cor0	
Ry153	Regulation 0 deviation from abs. final nominal value (actual - nominal)	DiffAbs0	
Ry154	Regulation 0, deviation from rel. final nominal value (actual - nominal)/nominal	DiffRel0	
Ry155	Regulation 0, nominal value ramp	SetRamp0	
Ry160	Regulation 1, nominal value	Set1	
Ry161	Regulation 1, actual value	Act1	
Ry162	Regulation 1, output actuating variable	Cor1	
Ry163	Regulation 1, deviation from abs. final nominal value (actual - nominal)	DiffAbs1	
Ry164	Regulation 1, deviation from rel. final nominal value (actual - nominal)/nominal	DiffRel1	
Ry165	Regulation 1, nominal value ramp	SetRamp1	
Ry170	Evaluated or monitored variable[4)] from Pn501		
Ry171	Lower limit value from Pn502		
Ry172	Upper limit value from Pn503		
Ry173	Evaluated or monitored variable[4)] from Pn511		
Ry174	Lower limit value from Pn512		
Ry175	Upper limit value from Pn513		
Ry176	Evaluated or monitored variable[4)] from Pn521		
Ry177	Lower limit value from Pn522		
Ry178	Upper limit value from Pn523		
Ry179	Evaluated or monitored variable[4)] from Pn531		
Ry180	Lower limit value from Pn532		
Ry181	Upper limit value from Pn533		
Ry190	Number of pulses during measurement (gas meter)	pulse	
Ry191	The currently active program in measuring circuit y		
Ry194	Remaining time, prefill	PFIL	
Ry195	Remaining time, fill	FILL	
Ry196	Remaining time, calm	CALM	
Ry197	Remaining time, stabilize (ZERO)	ZERO	
Ry198	Remaining time, vent	VENT	

Parameter	Meaning/physical variable	Name	Addition
Ry199	Accumulated measuring time (MEAS, LEAK)	TMEAS	
Ry200	Mean value of basic system pressure	Pbas	Avrg
Ry201	Mean value of differential pressure	Pdif	Avrg
Ry202	Mean value of absolute measuring pressure	Pabs	Avrg
Ry203	Mean value of measuring temperature	Temp	Avrg
Ry204	Mean value of measuring humidity	Hum	Avrg
Ry210	Mean value of absolute reference pressure 1)	RPab	Avrg
Ry211	Mean value of reference temperature 1)	RTem	Avrg
Ry212	Mean value of reference humidity 1)	Rhum	Avrg
Ry220	Mean value of auxiliary input 0	Aux0	Avrg
Ry221	Mean value of auxiliary input 1	Aux1	Avrg
Ry222	Mean value of auxiliary input 2	Aux2	Avrg
Ry223	Mean value of auxiliary input 3	Aux3	Avrg
Ry224	Mean value of auxiliary input 4	Aux4	Avrg
Ry225	Mean value of auxiliary input 5	Aux5	Avrg
Ry226	Mean value of auxiliary input 6	Aux6	Avrg
Ry227	Mean value of auxiliary input 7	Aux7	Avrg
Ry228	Mean value of auxiliary input 8	Aux8	Avrg
Ry229	Mean value of auxiliary input 9	Aux9	Avrg
Ry230	Mean value of measurement volume flow	QVac	Avrg
Ry231	Mean value of standard volume flow	QVno	Avrg
Ry232	Mean value of reference volume flow 1)	RQVa	Avrg
Ry233	Mean value of heat output	CPwr	Avrg
Ry234	Mean value of heat quantity	HQty	Avrg
Ry235	Mean value of mass flow	QMas	Avrg
Ry236	Mean value of orifices: Reynolds number at the neck	Ref	Avrg
Ry237	Mean value of orifices: Reynolds number in the inlet	Ret	Avrg
Ry238	Mean value of orifices: Speed at the neck	Vf	Avrg
Ry239	Mean value of orifices: Speed in the inlet	Vt	Avrg

Parameter	Meaning/physical variable	Name	Addition
Ry240	Mean value of K factor	K	Avrg
Ry241	Mean value of pressure drop of LMS	dpdt	Avrg
Ry252	Mean value of correction standard volume flow [2]	CQvn	Avrg
Ry253	Mean value of correction reference volume flow [1] [2]	CQvr	Avrg
Ry254	Mean value of correction mass flow [2]	CQMa	Avrg
Ry260	Mean value of calculated R parameter from Pn350	Cal0	Avrg
Ry261	Mean value of calculated R parameter from Pn360	Cal1	Avrg
Ry262	Mean value of calculated R parameter from Pn370	Cal2	Avrg
Ry263	Mean value of calculated R parameter from Pn380	Cal3	Avrg
Ry264	Mean value of calculated R parameter from Pn390	Cal4	Avrg
Ry290	Mean value of calibration density	KDen	Avrg
Ry291	Mean value of measuring density	ADen	Avrg
Ry292	Mean value of standard density	NDen	Avrg
Ry293	Mean value of reference density [1]	RDen	Avrg
Ry294	Mean value of correction density [2]	CDen	Avrg
Ry295	Mean value of calibration viscosity	KVis	Avrg
Ry296	Mean value of measuring viscosity	AVis	Avrg
Ry297	Mean value of standard viscosity	NVis	Avrg
Ry298	Mean value of reference viscosity [1]	RVis	Avrg
Ry299	Mean value of correction viscosity [2]	CVis	Avrg
Ry300	Total of basic system pressure	Pbas	Sum
Ry301	Total of differential pressure	Pdif	Sum
Ry302	Total of absolute measuring pressure	Pabs	Sum
Ry303	Total of measuring temperature	Temp	Sum
Ry304	Total of measuring humidity	Hum	Sum
Ry310	Total of absolute reference pressure [1]	RPab	Sum
Ry311	Total of reference temperature [1]	RTem	Sum
Ry312	Total of reference humidity [1]	Rhum	Sum

Parameter	Meaning/physical variable	Name	Addition
Ry320	Total of auxiliary input 0	Aux0	Sum
Ry321	Total of auxiliary input 1	Aux1	Sum
Ry322	Total of auxiliary input 2	Aux2	Sum
Ry323	Total of auxiliary input 3	Aux3	Sum
Ry324	Total of auxiliary input 4	Aux4	Sum
Ry325	Total of auxiliary input 5	Aux5	Sum
Ry326	Total of auxiliary input 6	Aux6	Sum
Ry327	Total of auxiliary input 7	Aux7	Sum
Ry328	Total of auxiliary input 8	Aux8	Sum
Ry329	Total of auxiliary input 9	Aux9	Sum
Ry330	Total of measurement volume flow	QVac	Sum
Ry331	Total of standard volume flow	QVno	Sum
Ry332	Total of reference volume flow 1)	RQVa	Sum
Ry333	Total of heat output	CPwr	Sum
Ry334	Total of heat quantity	HQty	Sum
Ry335	Total of mass flow	QMas	Sum
Ry336	Total of orifices: Reynolds number at the neck	Ref	Sum
Ry337	Total of orifices: Reynolds number in the inlet	Ret	Sum
Ry338	Total of orifices: Speed at the neck	Vf	Sum
Ry339	Total of orifices: Speed in the inlet	Vt	Sum
Ry340	Total of K factor	K	Sum
Ry341	Total of pressure drop of LMS	dpdt	Sum
Ry352	Total of correction standard volume flow 2)	CQvn	Sum
Ry353	Total of correction reference volume flow 1) 2)	CQvr	Sum
Ry354	Total of correction mass flow 2)	CQMa	Sum
Ry360	Total of calculated R parameter from Pn350	Cal0	Sum
Ry361	Total of calculated R parameter from Pn360	Cal1	Sum
Ry362	Total of calculated R parameter from Pn370	Cal2	Sum
Ry363	Total of calculated R parameter from Pn380	Cal3	Sum

Parameter	Meaning/physical variable	Name	Addition
Ry364	Total of calculated R parameter from Pn390	Cal4	Sum
Ry390	Total of calibration density	KDen	Sum
Ry391	Total of measuring density	ADen	Sum
Ry392	Total of standard density	NDen	Sum
Ry393	Total of reference density [1)]	RDen	Sum
Ry394	Total of correction density [2)]	CDen	Sum
Ry395	Total of calibration viscosity	KVis	Sum
Ry396	Total of measuring viscosity	AVis	Sum
Ry397	Total of standard viscosity	NVis	Sum
Ry398	Total of reference viscosity [1)]	RVis	Sum
Ry399	Total of correction viscosity [2)]	CVis	Sum
Ry400	Minimum basic system pressure	Pbas	Min
Ry401	Minimum differential pressure	Pdif	Min
Ry402	Minimum absolute measuring pressure	Pabs	Min
Ry403	Minimum measuring temperature	Temp	Min
Ry404	Minimum measuring humidity	Hum	Min
Ry410	Minimum absolute reference pressure [1)]	RPab	Min
Ry411	Minimum reference temperature [1)]	RTem	Min
Ry412	Minimum reference humidity [1)]	Rhum	Min
Ry420	Minimum auxiliary input 0	Aux0	Min
Ry421	Minimum auxiliary input 1	Aux1	Min
Ry422	Minimum auxiliary input 2	Aux2	Min
Ry423	Minimum auxiliary input 3	Aux3	Min
Ry424	Minimum auxiliary input 4	Aux4	Min
Ry425	Minimum auxiliary input 5	Aux5	Min
Ry426	Minimum auxiliary input 6	Aux6	Min
Ry427	Minimum auxiliary input 7	Aux7	Min
Ry428	Minimum auxiliary input 8	Aux8	Min
Ry429	Minimum auxiliary input 9	Aux9	Min

Parameter	Meaning/physical variable	Name	Addition
Ry430	Minimum measurement volume flow	QVac	Min
Ry431	Minimum standard volume flow	QVno	Min
Ry432	Minimum reference volume flow [1)]	RQVa	Min
Ry433	Minimum heat output	CPwr	Min
Ry434	Minimum heat quantity	HQty	Min
Ry435	Minimum mass flow	QMas	Min
Ry436	Minimum orifices: Reynolds number at the neck	Ref	Min
Ry437	Minimum orifices: Reynolds number in the inlet	Ret	Min
Ry438	Minimum orifices: Speed at the neck	Vf	Min
Ry439	Minimum orifices: Speed in the inlet	Vt	Min
Ry440	Minimum K factor	K	Min
Ry441	Minimum pressure drop of LMS	dpdt	Min
Ry452	Minimum correction standard volume flow [2)]	CQvn	Min
Ry453	Minimum correction reference volume flow [1)] [2)]	CQvr	Min
Ry454	Minimum correction mass flow [2)]	CQMa	Min
Ry460	Minimum calculated R parameter from Pn350	Cal0	Min
Ry461	Minimum calculated R parameter from Pn360	Cal1	Min
Ry462	Minimum calculated R parameter from Pn370	Cal2	Min
Ry463	Minimum calculated R parameter from Pn380	Cal3	Min
Ry464	Minimum calculated R parameter from Pn390	Cal4	Min
Ry490	Minimum calibration density	KDen	Min
Ry491	Minimum measuring density	ADen	Min
Ry492	Minimum standard density	NDen	Min
Ry493	Minimum reference density [1)]	RDen	Min
Ry494	Minimum correction density [2)]	CDen	Min
Ry495	Minimum calibration viscosity	KVis	Min
Ry496	Minimum measuring viscosity	AVis	Min
Ry497	Minimum standard viscosity	NVis	Min
Ry498	Minimum reference viscosity [1)]	RVis	Min

Parameter	Meaning/physical variable	Name	Addition
Ry499	Minimum correction viscosity [2)]	CVis	Min
Ry500	Maximum basic system pressure	Pbas	Max
Ry501	Maximum differential pressure	Pdif	Max
Ry502	Maximum absolute measuring pressure	Pabs	Max
Ry503	Maximum measuring temperature	Temp	Max
Ry504	Maximum measuring humidity	Hum	Max
Ry510	Maximum absolute reference pressure [1)]	RPab	Max
Ry511	Maximum reference temperature [1)]	RTem	Max
Ry512	Maximum reference humidity [1)]	Rhum	Max
Ry520	Maximum auxiliary input 0	Aux0	Max
Ry521	Maximum auxiliary input 1	Aux1	Max
Ry522	Maximum auxiliary input 2	Aux2	Max
Ry523	Maximum auxiliary input 3	Aux3	Max
Ry524	Maximum auxiliary input 4	Aux4	Max
Ry525	Maximum auxiliary input 5	Aux5	Max
Ry526	Maximum auxiliary input 6	Aux6	Max
Ry527	Maximum auxiliary input 7	Aux7	Max
Ry528	Maximum auxiliary input 8	Aux8	Max
Ry529	Maximum auxiliary input 9	Aux9	Max
Ry530	Maximum measurement volume flow	QVac	Max
Ry531	Maximum standard volume flow	QVno	Max
Ry532	Maximum reference volume flow [1)]	RQVa	Max
Ry533	Maximum heat output	CPwr	Max
Ry534	Maximum heat quantity	HQty	Max
Ry535	Maximum mass flow	QMas	Max
Ry536	Maximum orifices: Reynolds number at the neck	Ref	Max
Ry537	Maximum orifices: Reynolds number in the inlet	Ret	Max
Ry538	Maximum orifices: Speed at the neck	Vf	Max
Ry539	Maximum orifices: Speed in the inlet	Vt	Max

Parameter	Meaning/physical variable	Name	Addition
Ry540	Maximum K factor	K	Max
Ry541	Maximum pressure drop of LMS	dpdt	Max
Ry552	Maximum correction standard volume flow [2)]	CQvn	Max
Ry553	Maximum correction reference volume flow [1)] [2)]	CQvr	Max
Ry554	Maximum correction mass flow [2)]	CQMa	Max
Ry560	Maximum calculated R parameter from Pn350	Cal0	Max
Ry561	Maximum calculated R parameter from Pn360	Cal1	Max
Ry562	Maximum calculated R parameter from Pn370	Cal2	Max
Ry563	Maximum calculated R parameter from Pn380	Cal3	Max
Ry564	Maximum calculated R parameter from Pn390	Cal4	Max
Ry590	Maximum calibration density	KDen	Max
Ry591	Maximum measuring density	ADen	Max
Ry592	Maximum standard density	NDen	Max
Ry593	Maximum reference density [1)]	RDen	Max
Ry594	Maximum correction density [2)]	CDen	Max
Ry595	Maximum calibration viscosity	KVis	Max
Ry596	Maximum measuring viscosity	AVis	Max
Ry597	Maximum standard viscosity	NVis	Max
Ry598	Maximum reference viscosity [1)]	RVis	Max
Ry599	Maximum correction viscosity [2)]	CVis	Max
Ry600	Standard deviation of basic system pressure	Pbas	Dev
Ry601	Standard deviation of differential pressure	Pdif	Dev
Ry602	Standard deviation of absolute measuring pressure	Pabs	Dev
Ry603	Standard deviation of measuring temperature	Temp	Dev
Ry604	Standard deviation of measuring humidity	Hum	Dev
Ry610	Standard deviation of absolute reference pressure [1)]	RPab	Dev
Ry611	Standard deviation of reference temperature [1)]	RTem	Dev
Ry612	Standard deviation of reference humidity [1)]	Rhum	Dev

Parameter	Meaning/physical variable	Name	Addition
Ry620	Standard deviation of auxiliary input 0	Aux0	Dev
Ry621	Standard deviation of auxiliary input 1	Aux1	Dev
Ry622	Standard deviation of auxiliary input 2	Aux2	Dev
Ry623	Standard deviation of auxiliary input 3	Aux3	Dev
Ry624	Standard deviation of auxiliary input 4	Aux4	Dev
Ry625	Standard deviation of auxiliary input 5	Aux5	Dev
Ry626	Standard deviation of auxiliary input 6	Aux6	Dev
Ry627	Standard deviation of auxiliary input 7	Aux7	Dev
Ry628	Standard deviation of auxiliary input 8	Aux8	Dev
Ry629	Standard deviation of auxiliary input 9	Aux9	Dev
Ry630	Standard deviation of measurement volume flow	QVac	Dev
Ry631	Standard deviation of standard volume flow	QVno	Dev
Ry632	Standard deviation of reference volume flow [1)]	RQVa	Dev
Ry633	Standard deviation of heat output	CPwr	Dev
Ry634	Standard deviation of heat quantity	HQty	Dev
Ry635	Standard deviation of mass flow	QMas	Dev
Ry636	Standard deviation of orifices:: Reynolds number at the neck	Ref	Dev
Ry637	Standard deviation of orifices: Reynolds number in the inlet	Ret	Dev
Ry638	Standard deviation of orifices: Speed at the neck	Vf	Dev
Ry639	Standard deviation of orifices: Speed in the inlet	Vt	Dev
Ry640	Standard deviation of K factor	K	Dev
Ry641	Standard deviation of pressure drop of LMS	dpdt	Dev
Ry652	Standard deviation of correction standard volume flow [2)]	CQvn	Dev
Ry653	Standard deviation of correction reference volume flow [1)] [2)]	CQvr	Dev
Ry654	Standard deviation of correction mass flow [2)]	CQMa	Dev
Ry660	Standard deviation of calculated R parameter from Pn350	Cal0	Dev
Ry661	Standard deviation of calculated R parameter from Pn360	Cal1	Dev
Ry662	Standard deviation of calculated R parameter from Pn370	Cal2	Dev
Ry663	Standard deviation of calculated R parameter from Pn380	Cal3	Dev

Parameter	Meaning/physical variable	Name	Addition
Ry664	Standard deviation of calculated R parameter from Pn390	Cal4	Dev
Ry690	Standard deviation of calibration density	KDen	Dev
Ry691	Standard deviation of measuring density	ADen	Dev
Ry692	Standard deviation of standard density	NDen	Dev
Ry693	Standard deviation of reference density 1)	RDen	Dev
Ry694	Standard deviation of correction density 2)	CDen	Dev
Ry695	Standard deviation of calibration viscosity	KVis	Dev
Ry696	Standard deviation of measuring viscosity	AVis	Dev
Ry697	Standard deviation of standard viscosity	NVis	Dev
Ry698	Standard deviation of reference viscosity 1)	RVis	Dev
Ry699	Standard deviation of correction viscosity 2)	CVis	Dev
Ry700	Change 3) in basic system pressure	Pbas	ddt
Ry701	Change 3) in differential pressure	Pdif	ddt
Ry702	Change 3) in absolute measuring pressure	Pabs	ddt
Ry703	Change 3) in measuring temperature	Temp	ddt
Ry704	Change 3) in measuring humidity	Hum	ddt
Ry710	Change 3) in absolute reference pressure 1)	RPab	ddt
Ry711	Change 3) in reference temperature 1)	RTem	ddt
Ry712	Change 3) in reference humidity 1)	Rhum	ddt
Ry720	Change 3) in auxiliary input 0	Aux0	ddt
Ry721	Change 3) in auxiliary input 1	Aux1	ddt
Ry722	Change 3) in auxiliary input 2	Aux2	ddt
Ry723	Change 3) in auxiliary input 3	Aux3	ddt
Ry724	Change 3) in auxiliary input 4	Aux4	ddt
Ry725	Change 3) in auxiliary input 5	Aux5	ddt
Ry726	Change 3) in auxiliary input 6	Aux6	ddt
Ry727	Change 3) in auxiliary input 7	Aux7	ddt
Ry728	Change 3) in auxiliary input 8	Aux8	ddt
Ry729	Change 3) in auxiliary input 9	Aux9	ddt

Parameter	Meaning/physical variable	Name	Addition
Ry730	Change [3] in measurement volume flow	QVac	ddt
Ry731	Change [3] in standard volume flow	QVno	ddt
Ry732	Change [3] in reference volume flow [1]	RQVa	ddt
Ry733	Change [3] in heat output	CPwr	ddt
Ry734	Change [3] in heat quantity	HQty	ddt
Ry735	Change [3] in mass flow	QMas	ddt
Ry736	Change [3] in orifices: Reynolds number at the neck	Ref	ddt
Ry737	Change [3] in orifices: Reynolds number in the inlet	Ret	ddt
Ry738	Change [3] in orifices: Speed at the neck	Vf	ddt
Ry739	Change [3] in orifices: Speed in the inlet	Vt	ddt
Ry740	Change [3] in K factor	K	ddt
Ry741	Change [3] in pressure drop of LMS	dpdt	ddt
Ry752	Change [3] in correction standard volume flow [2]	CQvn	ddt
Ry753	Change [3] Correction reference volume flow [1] [2]	CQvr	ddt
Ry754	Change [3] in correction mass flow [2]	CQMa	ddt
Ry760	Change [3] in calculated R parameter from Pn350	Cal0	ddt
Ry761	Change [3] in calculated R parameter from Pn360	Cal1	ddt
Ry762	Change [3] in calculated R parameter from Pn370	Cal2	ddt
Ry763	Change [3] in calculated R parameter from Pn380	Cal3	ddt
Ry764	Change [3] in calculated R parameter from Pn390	Cal4	ddt
Ry790	Change [3] in calibration density	KDen	ddt
Ry791	Change [3] in measuring density	ADen	ddt
Ry792	Change [3] in standard density	NDen	ddt
Ry793	Change [3] in reference density [1]	RDen	ddt
Ry794	Change [3] in correction density [2]	CDen	ddt
Ry795	Change [3] in calibration viscosity	KVis	ddt
Ry796	Change [3] in measuring viscosity	AVis	ddt
Ry797	Change [3] in standard viscosity	NVis	ddt
Ry798	Change [3] in reference viscosity [1]	RVis	ddt
Ry799	Change [3] in correction viscosity [2]	CVis	ddt

Parameter	Meaning/physical variable	Name	Addition
R0800	Raw input value of data record number 0	IN00	Raw
R0801	Raw input value of data record number 1	IN01	Raw
R0802	Raw input value of data record number 2	IN02	Raw
R0803	Raw input value of data record number 3	IN03	Raw
R0804	Raw input value of data record number 4	IN04	Raw
R0805	Raw input value of data record number 5	IN05	Raw
R0806	Raw input value of data record number 6	IN06	Raw
R0807	Raw input value of data record number 7	IN07	Raw
R08088	Raw input value of data record number 8	IN08	Raw
R0809	Raw input value of data record number 9	IN09	Raw
R0810	Raw input value of data record number 10	IN10	Raw
R0811	Raw input value of data record number 11	IN11	Raw
R0812	Raw input value of data record number 12	IN12	Raw
R0813	Raw input value of data record number 13	IN13	Raw
R0814	Raw input value of data record number 14	IN14	Raw
R0815	Raw input value of data record number 15	IN15	Raw
R0816	Raw input value of data record number 16	IN16	Raw
R0817	Raw input value of data record number 17	IN17	Raw
R0818	Raw input value of data record number 18	IN18	Raw
R0819	Raw input value of data record number 19	IN19	Raw
R0820	Linearized input value of data record number 0	IN00	Lin
R0821	Linearized input value of data record number 1	IN01	Lin
R0822	Linearized input value of data record number 2	IN02	Lin
R0823	Linearized input value of data record number 3	IN03	Lin
R0824	Linearized input value of data record number 4	IN04	Lin
R0825	Linearized input value of data record number 5	IN05	Lin
R0826	Linearized input value of data record number 6	IN06	Lin
R0827	Linearized input value of data record number 7	IN07	Lin
R0828	Linearized input value of data record number 8	IN08	Lin
R0829	Linearized input value of data record number 9	IN09	Lin
R0830	Linearized input value of data record number 10	IN10	Lin
R0831	Linearized input value of data record number 11	IN11	Lin

Parameter	Meaning/physical variable	Name	Addition
R0832	Linearized input value of data record number 12	IN12	Lin
R0833	Linearized input value of data record number 13	IN13	Lin
R0834	Linearized input value of data record number 14	IN14	Lin
R0835	Linearized input value of data record number 15	IN15	Lin
R0836	Linearized input value of data record number 16	IN16	Lin
R0837	Linearized input value of data record number 17	IN17	Lin
R0838	Linearized input value of data record number 18	IN18	Lin
R0839	Linearized input value of data record number 19	IN19	Lin
R0840	Raw output value of output 0	Out0	Raw
R0841	Raw output value of output 1	Out1	Raw
R0842	Raw output value of output 2	Out2	Raw
R0843	Raw output value of output 3	Out3	Raw
R0844	Raw output value of output 4	Out4	Raw
R0845	Raw output value of output 5	Out5	Raw
R0846	Raw output value of output 6	Out6	Raw
R0847	Raw output value of output 7	Out7	Raw
R0848	Raw output value of output 8	Out8	Raw
R0849	Raw output value of output 9	Out9	Raw
R0899	Cycle time actually required	Cycle time	Orig
R0900	Current state of state machine "Mainstate"		
R0901	Current phase of the process STPFIL = 1 STFILL = 2 STCALM = 3 STMEAS = 4 STCAL = 5 STVENT = 6 STWAIT = 7 STZERO = 8		
R1800	R parameters reserved for Publish-Subscribe	PubSub RPAR 00	
⋮			
R1899	R parameters reserved for Publish-Subscribe	PubSub RPAR 99	

Parameter	Meaning/physical variable	Name	Addition
R1900	R parameters RPAR_SET_VALUE(nn) reserved for Publish-Subscribe	script RPAR 00	
⋮			
R1999	R parameters RPAR_SET_VALUE(nn) reserved for Publish-Subscribe	script RPAR 99	
R2800	R parameters for nozzle pools, mass flow of an individual nozzle	QMas nozzle 0	
⋮			
R2899	R parameters for nozzle pools, mass flow of an individual nozzle	QMas nozzle 99	

Table 10.1.: Overview of R parameters

Comments on the table 10.1:

1) Reference variables are only calculated if the reference calculation in Pn300 is active, see p.: 73

2) Correction variables are only calculated if the correction calculation in Pn301 is active, see p.: 73

3) Changes are usually calculated as follows: $\frac{\Delta \text{Value}}{\Delta \text{Time}}$

4) If monitoring is active (Pn5x0 val=2), the last current value of the monitored variable is entered in Ry170 ff.

5) Reynolds numbers are only determined for primaries 40, 41, 42, 45, 46, 47, 48 and 61.

10.2. R parameter error codes

If R parameters have an error, they carry an error code and the value of the R parameters will have code NaN. This makes it necessary to intercept errors of R parameters in expressions or in the script. R parameters can have the following error codes:

Controller	Display	RERR	Meaning
EOK	[Current value]	0	Value OK
ENOPORT	noPort	1	Hardware input cannot be reached
ENOTAVAIL	noCALC	2	Value was not read in
EOFF	S-OFF	3	Sensor or calculation not active
EFAIL	S-FAIL	4	Sensor or calculation has generated an error (e.g.: Min, max violation)

Controller	Display	RERR	Meaning
EREL	C-FAIL	5	Input variable for calculation had an error (e.g..: Pdi0 for QVNo has an error)
ECONFIG	ConFiG	6	Error in the configuration

Table 10.2.: Possible error codes of R parameters

Examples: R parameter error codes

- EOK – Value can be read and is correct. If the measurement was aborted due to violated monitoring (Pn500), the result values are also EOK.
- ENOPORT – An analog input is assigned in S2x00 to an input that is not defined in the K parameters (S2x50=9). The corresponding R parameter shows ENOPORT.
- ENOTAVAIL – Measurement process is aborted during PFIL, FILL, CALM or MEAS by STOP or an error. The result variables R02xx - R07xx then indicate ENOTAVAIL.
- EOFF – An input block is deactivated: S2x00 = -2. The corresponding input R082x shows the error EOFF.
- EFAIL – Input violates its limits in S2x37/38. The corresponding R082x shows error EFAIL. Or: A sensor block is deactivated: S2x00 = -2. The corresponding sensor is assigned to the differential pressure: P0010= R0820". The differential pressure R0001 shows error EFAIL.
- EREL – A Qvno will be calculated with a sensor that violates its limits (see above). Qvno R0031 shows error EREL.
- ECONFIG – No float is assigned to the differential pressure: Pn010 = "This is a text". The differential pressure Ry001 shows the error ECONFIG.

10.3. Example *r-init.dat* Create

The standard display names of the R parameters can be overwritten in *r-init.dat* (see table 10.1). The physical variable, unit and places after the decimal can also be changed. This is especially useful for R parameters, which do not have any designation in the display yet in the standard configuration, for example R parameters R080x and R082x.

Example:

```
        # Values from the script
        R1900 type=12 unit=01 dig=3 name="Script Var 00 " ro=1
        R1901 type=11 unit=00 dig=3 name="Script Var 01 " ro=1
        R1902 type=13 unit=00 dig=3 name="Script Var 02 " ro=1
        R1903 type=11 unit=00 dig=3 name="Script Var 03 " ro=1
        R1909 type=00 unit=03 dig=1 name="Script Var 04 " ro=1
```

11. S parameters / system configuration

11.1. S0000 General sequence

Parameter	Bedeutung	Werte	Erläuterungen
S0005	Number of log messages for history	0..1000 (*INT*) [100]	Number of old log messages before the time of the request that CoM4.sw also sends to a log query on request
S0010	Mode (operating mode) [1]	0..63 (*INT*) [0]	Bit-coded value for setting the operating mode Bit 0: 1=Full sequence, 0=Partial sequence Bit 1: 1=PLC sequence, 0=Manual sequence Bit 2: 1=PLC program selection, 0=Standard program assignment Bit 3: 1=STOP aborts, 0=STOP exits Bit 4: 1= All measuring circuits continue to run separately in terms of monitoring errors, 0= An error aborts all measuring circuits

Table 11.1.: S parameter: General parameter sequence

[1] *Comments on mode/operating mode S0010:*

- The value of S0010 is bit-coded. / All / no bits can be set. A hexadecimal or binary representation can enhance readability. For example, decimal S0010=15, binary S0010=%1111 or hexadecimal S0010=$F
- Usual values:
  - S0010 = 0: Manual control
  - S0010 = 9: LMS manual control
  - S0010 = 15: Standard PLC sequence
- The value of S0010 can be seen in the script variable `SPS_MODE`.
- *Bit 0:* Partial sequence or full sequence. Partial sequence and full sequence differ as follows:
  - a) When exiting an abort state 2x80: In the full sequence, state 2x80 is always exited at VENT 2600. The partial sequence always exits the abort state 2x80 at POLL 2000.
  - b) the end of POLL in state 2090: In the partial sequence, control passes directly to 2300 CALM without the Fill phase. In the full sequence, control passes from 2090 to 2100 PFIL.
  - c) At the end of the measurement in state 2490: In the full sequence, control passes on to CAL 2500, while in the partial sequence it returns to POLL 2000.

  Therefore states 2100 PFIL, 2200 FILL, 2500 CAL and 2600 VENT are only traversed in the full sequence.

- *Bit 1:* PLC sequence and manual sequence. The main differences are:
  - a) Handling of the START signal.
  - b) Initiating a zeroing.
- *Bit 2:* PLC program selection and default program assignment.
- *Bit 3:* STOP aborts and STOP ends. The bit decides how a STOP signal will be handled by the PLC or manual control. The measurement is either aborted with the STOP signal or ended regularly with the STOP signal. In a regularly ended test, the time until the STOP signal is therefore considered to be the measuring time. In an aborted test, the result R parameters are declared to be invalid in CoM4.sw.
- *Bit 4:* Effect of monitoring in Pn500 for multiple measuring circuits: Bit active = wait until the measurement has ended in all measuring circuits or all measuring circuits have errors. Bit inactive = sequence ends with the first evaluation error in any measuring circuit. See:
  - Parameter lists - 9.16 - S. 77 - *Pn500 block: Evaluation and monitoring*
- *Note:* Bit 4 was previously used for the configuration of the abort behavior with multiple measurement traversals. The function "multiple measurement traversals" is no longer present now. The configuration of the abort behavior with multiple measuring circuits has been moved from bit 5 to its place.

11.2. S0015 General information about the LMS sequence

Parameter	Bedeutung	Werte	Erläuterungen
S0015	LDET VDET Save permanently	0..1 (*INT*) [1]	0: Apply only temporarily 1: Save permanently

Table 11.2.: S parameter: General information about the LMS sequence

11.3. S0020 Interfaces

Parameter	Bedeutung	Werte	Erläuterungen
S0020	TCP port for COMM connection	0..65535 (*INT*) [54491]	0: No COMM connection via network 1025..65535: TCP port number
S0021	List of permitted remote stations [1]	Expression (*STR*) [""]	These remote stations may set up a connection. Only relevant if remote stations are prohibited. This prohibition is overwritten with actively permitted remote stations here.
S0022	List of non-permitted remote stations [1]	Expression (*STR*) [""]	These remote stations must not set up a connection.. If nothing is prohibited, all remote stations are permitted. Will be overridden by the permitted remote stations.

Parameter	Bedeutung	Werte	Erläuterungen
S0023	Number of connections for COMM interface	1..10 (*INT*) [4]	Maximum number of permitted connections over the COMM interface
S0024	TCP KeepAlive for COMM interface	0..1 (*INT*) [1]	Activates a regular test to determine whether the COMM connection is still intact 0: Deactivated; if the remote station can no longer be reached, the COMM connection will continue to be kept open by the controller This can lead to the maximum number of connections being reached 1: Activated; if the remote station can no longer be reached, the COMM connection will be closed after 2h 11 min
S0025	TCP port for COMM connection	0..65535 (*INT*) [54490]	0: No system connection via network 1025..65535: TCP port number
S0026	List of permitted remote stations [1]	Expression (*STR*) [""]	These remote stations may set up a connection.
S0027	List of non-permitted remote stations [1]	Expression (*STR*) [""]	These remote stations must not set up a connection
S0028	Number of connections for system interface	1..10 (*INT*) [4]	Maximum number of permitted connections over the system interface
S0029	SysIF Keep Alive	0..1 (*INT*) [1]	Activation of the Keep Alive function for the SysIF interface 0: Deactivated 1: Activated
S0030	SysIF Keep Alive timeout	10.0..86400.0 (*FLT*) [20.0]	Timeout time for the Keep Alive function of the SysIF interface.

Table 11.3.: S parameter: Parameterization of the COMM and SYS-interface

1:

A list of networks separated by semicolons can be specified in the ALLOW/DENY parameters.

Notation:
Net[/Bits];Net[/Bits].
The /bits are optional and indicate the subnet mask. If /bits is not set, /32 is assumed, so only the specified IP address will apply. This makes it possible to permit/prohibit specific hosts (Net = IP address of the host) or also entire (sub) networks.

Definition of subnets:
192.0.0.0/8 refers to all 192 addresses
192.168.0.0/16 refers to all 192.168 addresses
192.168.42.0/24 refers to all 192.168.42. addresses
192.168.42.63/32 refers only to the named IP address

Examples:
2 IP addresses:
192.168.42.43; 192.168.42.44

2 networks
192.168.42.0/24;192.168.72.0/24

11.4. S0040 General parameters

Parameter	Bedeutung	Werte	Erläuterungen
S0040	Behavior of the DEFAULTS command	0..1 (*INT*) [0]	Behavior of the DEFAULTS command: 0: No confirmation prompt 1: With confirmation prompt
S0050	Flow time for pulse valves	0.02..5.0 (*FLT*) [0.04]	Duration of the flow pulses for switching the pulse valves (S1900 ff.) in seconds
S0051	Maximum number of pulse valves energized simultaneously	1..20 (*INT*) [20]	To prevent a voltage drop when switching multiple valves, which would cause a controller crash, a setting here can determine the maximum number of pulse valves that can be switched simultaneously. If more valves have to be switched, the valves beyond the maximum number will be switched with a time delay.
S0060	Number of samples for zeroing	1..250 (*INT*) [10]	Number of cycles over which the zeroing offset will be averaged during zeroing to determine the zeroing offset
S0097	Name of the template	String ["standard"]	Name and version number of the SVN tag of the template used for the measuring system software Read Only
S0098	Number of active measuring circuits	1..3 (*INT*) [1]	read only
S0099	Designation of the controller	String ["unknown"]	read only
S0100	Planned version number CoM4.sw	String [""]	The version number for CoM4.sw can be saved here while creating the software in the planning phase Read Only
S0101	Standard condition for absolute pressure	9.0E4..1.1E5 (*FLT*) [101325.0]	in pascals
S0102	Standard condition for temperature	233.15..333.15 (*FLT*) [273.15]	in Kelvin

Parameter	Bedeutung	Werte	Erläuterungen
S0103	Standard condition for humidity	0.0..1.0 (*FLT*) [0.0]	0..1 r.h.
S0301	Cycle time in normal mode	0.01..2.0 (*FLT*) [0.02]	in seconds
S0311	Display update	0.02..5.0 (*FLT*) [0.3]	Display shown only once every x seconds.

Table 11.4.: S parameter: General parameters

11.5. S0350 block: Error conditions of inputs and outputs

Block S0350 is used to configure the conditions under which error flags are set for inputs or outputs. Inputs and outputs are divided into groups for this purpose:

- Inputs
- Outputs
- Type 400 cards (digital inputs and outputs)
- Serial sensors.

As soon as errors are present in a group over a configurable time, an error flag is set. This error flag is reset as soon as no error has occurred over another (configurable) time interval. The error flag is made available to the script interpreter by way of variable FAULT and can be used for example to report the error condition via a digital output. The error flag is bit-coded and has the following meaning:

Value	Meaning
1	Error in the inputs
2	Error in the outputs
4	Error in type-400 bus
8	Error in the serial sensors

Table 11.5.: Meaning of the variable FAULT

Parameter	Bedeutung	Werte	Erläuterungen
S0350	Error handling on/off	0..1 (*INT*) [0]	0: Switched off 1: Error evaluation active
S0351	Time until error	0.02..60.0 (*FLT*) [2.0]	Time in seconds over which an error must persist permanently until the error flag is set

S0352	Time until the error flag is withdrawn	0.02..60.0 (*FLT*) [2.0]	Time in seconds that must pass without an error after the error flag is activated until the error flag is reset.

Table 11.6.: S parameter: Error conditions of inputs and outputs

Based on the same pattern:

- Block S035n parameters for inputs in S2n00
- Block S036n parameters for outputs in S8n00
- Block S037n parameters for type 400 cards
- Block S038n parameters for serial sensors

Further information:

- Exceeding a limit value for the respective input is evaluated as an error for inputs, see p.: 115
- Errors for outputs are only reported by type 200 cards in 4-20mA operation. The error is set if the power supply is interrupted.
- For the type 400 bus, a test determines whether the modules configured in the K parameters can be reached.
- The query cycle of serial sensors depends on the type and number of configured sensors. An error is triggered if there was no last query or if an error occurred during the last query. The error is triggered in each cycle until the sensor has been successfully queried.

11.6. S0500 block: User level

Parameter	Bedeutung	Werte	Erläuterungen
S0500	Name level 0	*STR* [""]	Names of the user level
S0501	Level membership	0 .. $7FFFFFFF (*INT*)	Bit-coded, each bit that is set activates membership in a level
S0502	Password for level 0	0 .. 9999 (*INT*)	Password to be entered

Table 11.7.: S parameter: User level

Parameters S0505-S0599 contain an additional 20 user definitions based on the same pattern with a spacing of 5.

The user levels are represented in the editing menu. When entering the editing menu, you must first select a level. A defined selection of parameters is displayed on this level.

Example:

```
        S0520 val="Level-4"
        S0521 val=$10
        S0522 val=4
        S0525 val="Level-5"
        S0526 val=$20
        S0527 val=5

        F0100 level=$10 desc="Test-1" val=15.0
```

```
        F0101 level=$20 desc="Test-2" val=24.0
        F0102 level=$30 desc="Test-3" val=35.0
```

So parameter F0100 would be available in level 4, parameter F0101 in level 5 and parameter F0102 in level 4 and level 5.

11.7. S1000 block: Program assignments

A measuring section with a set of sensors, etc. is referred to as a measuring circuit. The CoM4.sw can calculate up to three measuring circuits simultaneously. A program is assigned to each active measuring circuit and the measuring section is defined in this program.

Parameter	Bedeutung	Werte	Erläuterungen
S1000	Initial program in MK0	0..9 (*INT*)	Program assignment 0 – 9
S1001	Initial program in MK1	0..9 (*INT*)	Program assignment 0 – 9
S1002	Initial program in MK2	0..9 (*INT*)	Program assignment 0 – 9
S1010	Lowest program number MK 0	0..9 (*INT*)	Program assignment 0 – 9
S1011	Lowest program number MK 1	0..9 (*INT*)	Program assignment 0 – 9
S1012	Lowest program number MK 2	0..9 (*INT*)	Program assignment 0 – 9
S1020	Highest program number MK 0	0..9 (*INT*)	Program assignment 0 – 9
S1021	Highest program number MK 1	0..9 (*INT*)	Program assignment 0 – 9
S1022	Highest program number MK 2	0..9 (*INT*)	Program assignment 0 – 9
S1050	Perform good/bad evaluation based on block Pn500 (limit values) in measuring circuit 0	0..1 (*INT*) [0]	0: Off, no evaluation 1: On, perform evaluation
S1051	Perform good/bad evaluation based on block Pn500 (limit values) in measuring circuit 1	0..1 (*INT*) [0]	0: Off, no evaluation 1: On, perform evaluation
S1052	Perform good/bad evaluation based on block Pn500 (limit values) in measuring circuit 2	0..1 (*INT*) [0]	0: Off, no evaluation 1: On, perform evaluation

Table 11.8.: S parameter: Program Selection

Notes:
CoM4.sw does not allow switching to a program that is active in another measuring circuit. The F2 editing menu prevents the selection by not displaying the program that is used in another measuring circuit. Switching to a program that is used in another measuring circuit by means of a script results in an error message.

11.8. S1100 block: Zeroing calm times

Parameter	Bedeutung	Werte	Erläuterungen
S1100	Calm time before zeroing group 0	0.0..600.0 (*FLT*) [0.0]	Time in seconds
S1101	Calm time before zeroing group 1	0.0..600.0 (*FLT*) [0.0]	Time in seconds
S1102	Calm time before zeroing group 2	0.0..600.0 (*FLT*) [0.0]	Time in seconds

Table 11.9.: S parameter: Zeroing calm times

11.9. S1200 block: Flipflops

Up to 10 flipflops can be defined in block S1200. The output state of the flipflops can be queried with the `FF` function of the script interpreter. The flipflops are set when the set expression has a value not equal to 0. The reset is carried out according to the flipflop type:

- For type 1, if the reset output has a value <> 0.
- For types 2 and 3, after the defined hold time has elapsed.

Types 2 and 3 differ in their trigger behavior: Type 2 can be retriggered, i.e. the set expression is checked again in every cycle and the hold time is restarted if applicable. Type 3 cannot be retriggered and drops out in any case after the hold time has elapsed before the set expression is evaluated again. The new output values of the flipflops are calculated in each cycle in the order 0...9. A flipflop definition that queries the output of another flipflop therefore only reads the new value in the same cycle if the number of the queried flipflop is lower.

The table below shows only one flipflop. The parameters for the nine others follow with S1210, S1220, etc.

Parameter	Bedeutung	Werte	Erläuterungen
S1200	Type of the flag	0..3 (*INT*) [0]	0: Switched off 1: RS flipflop 2: Monostable, retriggerable 3: Monostable, non-retriggerable
S1201	Set expression	Expression (*INT*) [""]	An expression that sets the flag when it results in a value <> 0 Valid for types 1-3
S1202	Reset expression	Expression (*INT*) [""]	An expression that sets the flag when it results in a value <> 0 Valid for type 1
S1203	Hold time	0.02..86400.0 (*FLT*) [1.0]	Hold time for flags type 2 and type 3 in seconds.

Table 11.10.: S parameter: Flipflops

11.10. S1300 block: NET-IO outputs

The outputs of the NET-IO interface. 64 outputs are available. Parameters S1300 to S1363 are assigned to them with a spacing of 1.

Parameter	Bedeutung	Werte	Erläuterungen
S1300	Expression for output 0	Expression (*INT*) [""]	The expression is evaluated in every cycle if there is a connection
...	...	...	...
S1363	Expression for output 63	Expression (*INT*) [""]	The expression is evaluated in every cycle if there is a connection.

Table 11.11.: S parameter: Virtual outputs

11.11. S1400 block: PLC control inputs

Note:
All signals except for START are evaluated after the START signal is applied.

Parameter	Bedeutung	Werte	Erläuterungen
S1400	Program for measuring circuit 0	Expression (*INT*) [""]	Program selection for measuring circuit 0
S1401	Program for measuring circuit 1	Expression (*INT*) [""]	Program selection for measuring circuit 1
S1402	Program for measuring circuit 2	Expression (*INT*) [""]	Program selection for measuring circuit 2
S1403	START-Signal	Expression (*INT*) [""]	START signal, evaluated in every cycle if S0010 is set to PLC, see table 11.1
S1404	PLC-GO	Expression (*INT*) [""]	Not to be confused with the GO convention in the script If the expression is true, PFIL and FILL will be terminated or skipped The time-controlled sections of the (P)FILL phases PFIL – 2150 and FILL – 2250 are terminated regularly after the end of the first cycle (in each case 2x90)
S1405	Plc-ZERO	Expression (*INT*) [""]	ZERO preselection before the next test

Parameter	Bedeutung	Werte	Erläuterungen
S1406	LDET	Expression (*INT*) [""]	Determination of the inherent leak for an LMS primary
S1407	VDET	Expression (*INT*) [""]	Determination of volume for an LMS primary
S1408	Extension signal #0	Expression (*INT*) [""]	Project-specific PLC signal
S1409	Extension signal #1	Expression (*INT*) [""]	Project-specific PLC signal
S1410	Extension signal #2	Expression (*INT*) [""]	Project-specific PLC signal
S1411	Selection of zeroing group	*INT* [7]	Optional selection of a zeroing group. Bit-coded. Default = 7: All groups 0 to 2 will be zeroed.

Table 11.12.: S parameter: PLC control inputs

11.12. S1450 block: Button inputs

Example: `S1450 val="DIn[gc::DiForStart] = 3"`

Parameter	Bedeutung	Werte	Erläuterungen
S1450	START button	Expression (*INT*) [""]	Input value for the Start button
S1451	STOP button	Expression (*INT*) [""]	Input value for the Stop button
S1452	LEAK button	Expression (*INT*) [""]	Input value for the Leak button
S1453	ZERO button	Expression (*INT*) [""]	Input value for the Zero button

Table 11.13.: S parameter: Input/output assignments

11.13. S1800 block: Digital outputs

Block S1800 allows the assignment of up to 100 expressions for digital outputs. They are on S1800 to S1899. The digital outputs are assigned to an expression that determines the status of this output. In the table, 3 outputs are specified, for example. The expressions are reevaluated in each cycle.

Parameter	Bedeutung	Werte	Erläuterungen
S1800	Output DOut[0]	Expression (*INT*) [""]	Expression that will be evaluated to determine the state for output #0
S1801	Output DOut[1]	Expression (*INT*) [""]	Expression that will be evaluated to determine the state for output #1
S1802	Output DOut[2]	Expression (*INT*) [""]	Expression that will be evaluated to determine the state for output #2

Table 11.14.: S parameter: Digital outputs

The START, STOP, LEAK and ZERO buttons are usually on outputs DOut[0] to DOut[3].

In this case the *default assignment would be:*

```
# START button is lit during the measurement,
# if it is not a leak test.
S1800 val="MEAS && !MEASMODE"

# STOP button is lit if results are available.
S1801 val="MEASAVAIL"

# LEAK button is lit during the measurement,
# if it is a leak test.
S1802 val="MEAS && MEASMODE"

# ZERO button is lit during zeroing.
S1803 val="ST_ZERO"
```

The valves of a standard ZERO block are usually controlled as follows:

```

Differential pressure: Valve open from the beginning of
# zeroing of group 0 until the end of zeroing of group 1
S18xx val="ST_ZERO && (state < 3470)"

Relative pressure: Valve open from the beginning of
# Zeroing of group 1 until the end of zeroing of group 1:
S18xx val="ST_ZERO && (state>=3460) && (state<3470)"
```

11.14. S1900 block: Pulse valves

Block S1900 contains expressions for 40 pulse valves with a spacing of 1 from S1900 to S1939. They are selected to determine the status of the valve. The expression in S19xx determines the value of `IVALVE[xx]`. The assignment

(xx) is fixed, so S1901 defines IVALVE[01]. The nominal status of a valve can be seen in the array IVALVE for diagnostic and information purposes. The output assignment must be made separately in block S1800.

Example:
Pulse valve 0QM0 must be set to IVALVE[00] and is controlled by the digital outputs DO[08]= open and DO[09] = closed. In the script code the valve must be controlled by variable Valve0QM0.

```
project.dat
  S1808 val="IVALVE[00]==IV_OPENING"
  S1809 val="IVALVE[00]==IV_CLOSING"

  S1900 val=Valvel0QM0

code.scr
  IF state = 2200 THEN Ventil0QM0 := 1;
```

IVALVE[xx] can take on the following values:

Name	Value	Meaning
IV_UNKNOWN	0	Valve setting is unknown, e.g. after restart
IV_CLOSED	1	Generated after IV_CLOSING
IV_OPEN	2	Generated after IV_OPENING
IV_MUSTCLOSE	3	Switching of the valve requested, but number of energized valves exceeded
IV_MUSTOPEN	4	Switching of the valve requested, but number of energized valves exceeded
IV_OPENING	5	Present for the duration of the flow time (S0050)
IV_CLOSING	6	Present for the duration of the flow time (S0050)

Table 11.15.: Values and meaning of IVALVE

In the example, 2 of 40 pulse valves from S1900 to S1939.

Parameter	Bedeutung	Werte	Erläuterungen
S1900	Pulse valve 0	Expression (*INT*) [""]	Expression or variable name that determines the state of the valve This could be for example a variable in the script The expression is evaluated in each cycle
S1901	Pulse valve 1	Expression (*INT*) [""]	Expression or variable name that determines the state of the valve This could be for example a variable in the script The expression is evaluated in each cycle

Table 11.16.: S parameter: Pulse valves

11.15. S2000/S3000 block: Linearization of inputs

Structure of the parameters
The following parameters are repeated for each input. The lower-case letter n in the parameter number stands for the number of the data record. This number does not necessarily have to match the port number of a converter card. The port number is defined in parameter S2n50. The parameter block for the analog inputs is repeated 19 times with a spacing of 100 from S20xx to S39xx.

Parameter	Bedeutung	Werte	Erläuterungen
S2n00	Type of sensor	-2..4 (*INT*) [-2]	-2: Switched off -1: Fixed value from S2045 0: Integrated analog input 1: Serial sensor 2: R parameter 3: Frequency input 4: Counter
S2n01	Type of linearization	-1..2 (*INT*) [0]	-1: Without linearization / polynomial 0: Polynomial calculation 1: PT100/PT1000 linearization 2: PT100/PT1000 with polynomial
S2n05	Order	-99..99 (*INT*) [1]	Generalized polynomial order: The first digit including the sign indicates the lowest exponent (in most cases 0). The second digit +1 = number of coefficients, The highest exponent results from the sum of both digits including the sign Example: S2n05=-25 means: Lowest exponent is −2, highest is 3
S2n10	Maximum 10 coefficients (FLOAT numbers)		
⋮			
S2n19			
S2n20	X factor	(*FLT*) [1.0]	Scaling factor between sensor raw value and polynomial x-value
S2n21	Y divisor	(*FLT*) [1.0]	Divisor for scaling the output value of the polynomial
S2n22	Serial number of the sensor	String	
S2n23	Y-correction	0.998 ... 1.002 (*FLT*) [1.000]	Multiplicative correction factor for the y value of the polynomial
S2n25	Factor r0 for PT100 calculation	99.0..1010.0 (*FLT*) [100.0]	The values r0, r1, r2 and r4 are the coefficients of the PT100 polynomial according to DIN EN 60751

Parameter	Bedeutung	Werte	Erläuterungen
S2n26	Factor r1 for PT100 calculation	3.5E-3..4.5E-3 (*FLT*) [3.9083E-3]	
S2n27	Factor r2 for PT100 calculation	-6.5E-7...-5E-7 (*FLT*) -5E-7 [-5.775E-7]	
S2n28	Factor r4 for PT100 calculation	-4.8E-12...-3.5E-12 (*FLT*) -3.5E-12 [-4.183E-12]	
S2n30	Offset value	(*FLT*) [0.0]	Sensor offset in SI basic unit (also valid for PT100)
S2n31	Offset method	0..1 (*INT*) [1]	0: Compensation before characteristic curve 1: Compensation after characteristic curve
S2n32	Zeroing	0..7 (*INT*) [0]	Bitwise configuration. A bit that is set switches the function on, a bit that is not set switches it off. Bit 0: Groupwise zeroing (ZERO command, ZERO button or PLC button) off/on Bit 1: Manual zeroing on (command IZERO or test menu) off/on Bit 2: Offset check after zeroing off/on. The result of zeroing is discarded followed by switching to error state 1800 if the offset determined is not within the limits specified in S2n40/S2n41.
S2n34	Grouping for zero point adjustment	0..2 (*INT*) [0]	Sensors in the same group are zeroed together The parameter indicates the assignment to one of three possible groups
S2n36	Handling of exceeding limit values (limit values in S2n37 & S2n38)	0..4 (*INT*) [0]	0: Inactive 1: Active, check raw value and trigger sensor error in case of violation 2: Limit raw value to limit value 3: Active, check linearized value and resolve sensor error in case of violation 4: Limit linearized value to limit value
S2n37	Minimum permissible sensor value	(*FLT*) [0.0]	
S2n38	Maximum permissible sensor value	(*FLT*) [0.0]	
S2n39	Size of the ring buffer for damping	1..5 (*INT*) [1]	Form mean value of n measured values

Parameter	Bedeutung	Werte	Erläuterungen
S2n40	Lower limit for offset after zeroing	(*FLT*) [-1E30]	Only valid if bit 2 of S2n32=1
S2n41	Upper limit for offset after zeroing	(*FLT*) [+1E30]	Only valid if bit 2 of S2n32=1
S2n45	Fixed value	(*FLT*) [0.0]	Only valid if S2000=-1

Table 11.17.: S parameter: Linearization of the sensors

Parameter	Brief description	Comments
S2n00	Changed	-2: Switched off
		-1: Fixed value from S2045
		0: Integrated analog input
		1: Serial sensor
		2: R parameter
		3: Frequency input
		4: Counter
S2n45	New	Fixed value if S2000 = -1
S2n60-S2n62	Moved	to S2055
S2n70	Moved	to S2060
S2n80-S2n82	Moved	to S2065
S2n90	Moved	to S2070

Table 11.18.: S parameter: Sensor blocks

11.15.1. Extended parameter set for integrated analog inputs

Parameter	Bedeutung	Werte	Erläuterungen
S2n50	Number of the integrated analog input (hardware channel)	0..11 (*INT*)	Accesses the input with the name AInn in the configuration (nn corresponds to the number of the analog input)

Table 11.19.: S parameter: Integrated analog inputs

Note:
Input 18 (in S38nn) and input 19 (in S39nn) are assigned via the template files with the onboard sensors.

11.15.2. Extended parameter set for serial inputs

Parameter	Bedeutung	Werte	Erläuterungen
S2n55	Sensor type	0..6 (*INT*) [0]	0: Direct input, unrequested sending, e.g. RPT This can only occur once, and not in conjunction with other types 1: Meriam ZM1500 2: Not used 3: DTM 4: Meriam M1500 5: Honeywell PPT 6: Mensor 6000/6100/6180
S2n56	RS485 address	0..99 (*INT*)	RS485 address of the serial sensor
S2n57	RS485 bus	0..9 (*INT*) [1]	Number of the serial port from K06n0 to which access will be obtained Where n is the number of the serial port

Table 11.20.: S parameter: Serial inputs

11.15.3. Extended parameter set for R parameters as virtual inputs

Parameter	Bedeutung	Werte	Erläuterungen
S2n60	Number of the R parameter	0..2999 (*INT*)	Number of the R parameter that will be read to generate the value for the input.

Table 11.21.: S parameter: R parameters as inputs

11.15.4. Extended parameter set for integrated frequency inputs

Parameter	Bedeutung	Werte	Erläuterungen
S2n65	Number of the integrated frequency input	0..9 (*INT*)	Accesses the input with the name FQnn in the configuration (nn corresponds to the number of the frequency input)

Table 11.22.: S parameter: Integrated frequency inputs

11.15.5. Extended parameter set for integrated counter inputs

Parameter	Bedeutung	Werte	Erläuterungen
S2n70	Number of the integrated counter input	0..9 (*INT*)	Accesses the input with the name FQnn in the configuration (nn corresponds to the number of the frequency input).

Table 11.23.: S parameter: Integrated counter inputs

11.15.6. Extended parameter set for unit and type of R08x0er R parameters

Parameter	Bedeutung	Werte	Erläuterungen
S2n90	Type of the raw value	0..21 (*INT*) [10]	Assigns a physical variable to R parameter R080n
S2n91	Unit of the raw value	0..17 (*INT*) [0]	Assigns a unit to R parameter R080n
S2n92	Places after the decimal of the raw value	0..5 (*INT*) [1]	Assigns places after the decimal to R parameter R080n
S2n95	Type of the linearized value	0..21 (*INT*) [10]	Assigns a physical variable to R parameter R082n
S2n96	Unit of the linearized value	0..17 (*INT*) [0]	Assigns a unit to R parameter R082n
S2n97	Places after the decimal of the linearized value	0..5 (*INT*) [1]	Assigns places after the decimal to R parameter R082n

Table 11.24.: S parameter: Unit and type of R08x0 parameters

11.16. S4000-S7900 Block: Linearization of primary elements

The data of the 40 primary elements follow at intervals of 100. Parameters S4000 to S7986 are assigned.

The parameterization of the primary element is closely associated with the calculation process:

Parameter	Bedeutung	Werte	Erläuterungen
S4n00	Type of the primary element	0..1 (*INT*) 20..21 30..39 40..42 45..49 60..61 80 100..101 120 140 [0]	Type and evaluation type of the primary element 0: Standard LFE according to Hagen-Poisseuille 1: Uniflow LFE 20:Critical nozzle according to PTB 21:Critical nozzle according to CFO 30 - 39: Nozzle pools no. 0 - 9 40: Orifice with flange pressure sensing 41: Orifice with corner pressure sensing 42: Orifice with D-D/2 pressure sensing 45: Venturi nozzle 46: Venturi tube rough cast 47: Venturi tube machined 48: Venturi tube, sheet steel inlet 49: SAO nozzle 60: Accutube 61: Beta-Flow 80: Gas meter 81: Simulated gas meter 100: Direct mass flow input 101: Direct volume flow input 120: Leakage measurement (LMS) 140: No primary element

Parameter	Bedeutung	Werte	Erläuterungen
S4n01	Gas type for calibration	-1013..25 [1]	-1013: Predefined mixed gas naturalL (mix) -1012: Predefined mixed gas naturalH (mix) -1011: Predefined mixed gas nitrogen monoxide NO 10% in 90% N2 -1010: Predefined mixed gas nitrogen monoxide NO 1% in 99% N2 -1009: Predefined mixed gas propene C3H6 5% in 95% N2 -1008: Predefined mixed gas lean gas 12% O2 in 88% N2 -1007: Predefined mixed gas rich gas 20% CO and 6.666% H2 in 73.334% N2 -1006: Predefined mixed gas rich gas synthetic air 20.5% O2 and 79.5% N2 -1005: Predefined mixed gas lean gas 30% H2 in 70% N2 -1004: Predefined mixed gas lean gas 20% H2 in 80% N2 -1003: Predefined mixed gas lean gas 10% H2 in 90% N2 -1002: Predefined mixed gas lean gas 5% H2 in 95% N2 -1001: Predefined mixed gas MixAirDry CIPM2007 -1000: Predefined mixed gas MixAirDry BIPM1979 Composition of the predefined mixed gas via `PREDEFGASMIX n`

Parameter	Bedeutung	Werte	Erläuterungen
Cont. S4n01	Gas type for calibration	-10 13..25 [1]	-9: Mixed gas 9 (see M09xx) ... -1: Mixed gas 1 (see M01xx) 0: Mixed gas 0 (see M00xx) 1: Air 2: Argon 3: Carbon dioxide 4: Carbon monoxide 5: Helium 6: Hydrogen 7: Nitrogen 8: Oxygen 9: Methane 10: Propane 11: n-butane 12: Natural gas H (outdated!) 13: Natural gas L (outdated!) 14: Laughing gas 15: Water vapor 16: Xenon 17: Nitric oxide 18: Neon 19: Krypton 20: Propene 21: Ethane 22: Ethene 23: Ammonia 24: Sulfur dioxide 25: n-pentane
S4n02	Calibration pressure	0.0..1.0E6 (*FLT*) [101325]	Absolute pressure in Pascal Not relevant for primaries 1, 80, 81 100, 101, 120, 140
S4n03	Calibration temperature	0.0..1.0E3 (*FLT*) [294.26]	Temperature in Kelvin Not relevant for primaries 1, 80, 81, 100, 101, 120, 140
S4n04	Calibration humidity	0.0..1.0 (*FLT*) [0.0]	Humidity (dimensionless) Not relevant for primaries 1, 80, 81, 100, 101, 120, 140
S4n05	Order	-99..99 (*INT*) [1]	Generalized polynomial order: The first digit including the sign indicates the lowest exponent (in most cases 0), the second digit +1 = number of coefficients the highest exponent results from the sum of both digits including the sign Example: S2n05=-25 means: Lowest exponent is −2, highest is 3
S4n10 ⋮	Maximum 10 coefficients	*FLT*	

Parameter	Bedeutung	Werte	Erläuterungen
S4n19			
S4n20	X factor	(*FLT*) [0.01]	Scaling factor for polynomial input value from SI units to polynomial units
S4n21	Y factor	(*FLT*) [6.0E4]	Scaling factor for polynomial output value (flow rate) from polynomial units to SI units
S4n22	Serial number	String [""]	Serial number of the primary element
S4n23	Y correction	0.998..1.002 (*FLT*) [1.000]	Multiplicative correction factor for the output value of the polynomial
S4n25	Precondition for the calculation	Expression (*INT*) [""]	Preconditions for the calculation can be defined with this expression. If the expression evaluates to 0 (FALSE), no calculation is performed and all dependent flow rate values are incorrect. If the expression results in a value not equal to 0, the calculation is performed. The script variable THIS contains the measuring circuit as FLOAT when evaluating the expression. To use THIS directly in the evaluation, the value must previously be converted to an integer: `TRUNC(THIS)`.

Table 11.25.: S parameter: Linearization of primary elements

Info
The variables calibration pressure, temperature and humidity are correction variables. They are used to correct the conditions for calibration to the conditions at the time of the measurement. This is necessary for some models:

- Hagen-Poisseuille-LFE
- Critical nozzle PTB
- Critical nozzle CFO
- Orifices (orifice, Venturi, SAO, Betaflow)
- AccuTube

11.16.1. Extended parameter set for direct inputs

Parameter	Bedeutung	Werte	Erläuterungen
S4n30	Input value	Expression (*FLT*) [""]	Expression that has as its result the direct volume or mass flow.

Table 11.26.: S parameter: Direct inputs

11.16.2. Extended parameter set for leakage measurement (LMS)

Parameter	Bedeutung	Werte	Erläuterungen
S4n40	R parameter for pressure drop	0..2999 (*INT*) [110]	Number of the R parameter containing the pressure drop for the leakage measurement
S4n41	DUT volume	-1.0..1.0 (*FLT*) [10E-3]	DUT volume in m^3
S4n42	Reference leak	-1.0..1.0 (*FLT*) [0.0]	Leak of the reference leak in m^3/s
S4n43	Inherent leak	-1.0E4..1.0E4 (*FLT*) 1.0E2 [0.0]	Inherent leak of the system as pressure drop in Pa/s This value is applied as an offset of the measured value This means that the sign is prefixed to the pressure drop (If the pressure drops: Negative sign / If the pressure rises: Positive sign)

Table 11.27.: S parameter: LMS

11.16.3. Extended parameter set for critical nozzles

Parameter	Bedeutung	Werte	Erläuterungen
S4n50	Nozzle code QVtr	0.0..1.0 (*FLT*) [0.001]	QVtr in m^3/s
S4n51	Cpe correction factor	(*FLT*) [0.0]	PTB evaluation only: Correction factor for the input pressure dependency in Pa^{-1}
S4n52	Xt factor	(*FLT*) [1.0]	CFO evaluation only: Input scaling of temperature correction Xt 1.0: for polynomial in SI units 1.8: for polynomial in US units

Table 11.28.: S parameter: Critical nozzles

Notes on the use of nozzle pools:

A defined nozzle pool becomes active only when it is also being used as a primary element. Nozzle pool 0 has the number 30, nozzle pool 1 number 31, etc.

A nozzle pool only calculates. It does not switch any nozzles. The nozzles must be switched by scripts or other definitions.

The precondition for the calculation (S4n25 ff.) is only evaluated for the primary element of the nozzle pool, not for the individual nozzles. They are always calculated regardless of the precondition.

11.16.4. Extended parameter set for orifices, Venturi tubes, Beta-Flows and SAO nozzles

Valid for primary element types 40 to 49 and 61.

Parameter	Bedeutung	Werte	Erläuterungen
S4n60	Internal diameter of tube	1.0E-4..1.0 (*FLT*) [0.1]	Internal diameter of the supply line tube in m
S4n61	Diameter of the orifice	1.0E-4..1.0 (*FLT*) [0.05]	Diameter of the orifice in m
S4n62	Smallest Reynolds number	(*FLT*) [2.0E3]	If S4065 = 1 or 2: Minimum value of the Reynolds number for the iteration (dimensionless)
S4n63	Largest Reynolds number	(*FLT*) [2.0E7]	If S4065 = 1 or 2: Maximum value of the Reynolds number for the iteration (dimensionless)
S4n64	Tolerance of iteration	(*FLT*) [0.001]	End criterion: If the amount of change in the mass flow from one iteration step to the next is less than this value, the iteration ends
S4n65	Calculation method	0..2 (*INT*) [0]	0: Calculation according to DIN EN ISO 5167 1: Polynomial calculation using the differential pressure 2: Polynomial calculation using the Reynolds number*
S4n66	Conversion factor for Betaflow	(*FLT*) [775.428]	Betaflow only: The factor by which the K factor based on SI units is multiplied before it is made available in the R parameters.

Table 11.29.: S parameter: Orifices, Venturi tubes, Beta-Flows and SAO nozzles

Notes for S4n65=2

- In the calculation method "Polynomial via Reynolds number," the Reynolds number refers to the throttle diameter d given in S4n61.
- The start value for the iteration is the geometric mean value of the limits defined in S4n62 and S4n63.
- To ensure that the iteration works properly, polynomial CD(Re) must be strictly monotonic.
- To ensure that the iteration works properly, the polynomial must converge to the solution. Without an approach point, S4n10 can be assumed to have val=1.0 and S4n11 val=0.0.

11.16.5. Extended parameter set for gas meter

Parameter	Bedeutung	Werte	Erläuterungen
S4n70	Input channel	0..9 (*INT*) [0]	Channel CTn on counter card
S4n71	Volume per pulse	0.0..1.0E3 (*FLT*) [0.001]	in m^3
S4n72	Number of pulses for measurement	2..1000 (*INT*) [2]	only during continuous operation: Number of pulses that will be evaluated for the current flow rate value
S4n73	Timeout	1.0..86400.0 (*FLT*) [5.0]	If the amount of time between the two pulses is longer than the timeout time, the current value will be set to 0.0 If the starting pulse during a mean value forming measurement remains for longer than what is defined here, this will lead to an abort.

Table 11.30.: S parameter: Gas meter

Simulated gas meter:
Any input frequency can be assigned to the simulated gas meter by means of the writable array GCFREQ [3]. The 3 elements of the array stand for the 3 possible measuring circuits. The gas meter must be assigned to a program and a measuring circuit via Pn000. Hence no frequency input card is necessary, nor is parameterization of a card in the K parameters required to simulate a gas meter.

11.16.6. Notes about the gas meter

Correction polynomial
The correction polynomial has been corrected compared to the older software products (from LMF-6). The polynomial now behaves the same as the correction polynomials of all other primary elements, i.e. following points apply:

$$\text{QVac} = f(\text{QVac}_{\text{input}}) \tag{11.1}$$

Pulses during continuous measurement (S4n72):
A ring buffer with 250 entries is used for the calculation of the continuous measured values for the gas meter. The counter of the card is read in each timer signal, every 5 ms. If it is the first value, or if the counter value does not correspond to the last one, a tuple is placed in the buffer consisting of counter value and time stamp. After 1000 values, the oldest are overwritten. Note that for extremely high-frequency gas meters, more than one pulse may also be counted in 5 ms. The entries in the ring buffer would then be for example: 7 pulses at t=5 ms, 14 pulses at t=10 ms, etc.

For the calculation of the continuously updated mean value, a search is conducted in the buffer back from the current value until at least the number of pulses set in S4n72 have been found. Then the volume flow is calculated from the two time stamps and the number of pulses.

This leads to several problems:

- If the difference in pulses between the oldest counter value and the most recent counter value is less than the number set in *S4n72* and the *buffer is not full yet*, no value is calculated. The R parameter for the volume flow is set to NOTAVAIL noCALC. It is possible to wait longer until the most recent value - oldest value is $\geqslant$ S4n72 until the buffer is full.

- If the difference between the oldest counter value and the most recent counter value is less than the number set in *S4n72*, but the *buffer is already full*, no value can be calculated. If the volume flow or speed of the counter is consistent, this status is continuous, i.e. it remains in effect. The R parameter for the volume flow is set to EFAIL or S-FAIL in this case. This effect may occur if the number set in S4n72 is too large for the buffer or pulse frequency.

  Example:

  - The internal buffer contains 1000 entries.
  - The timer writes a value to the buffer every 5 ms.
  - The buffer is full after 5000 ms.
  - S4n72 $\geqslant$ 5000.
  - The gas meter generates a frequency of 1000 Hz.
  - For each timer signal, an average of 5 pulses is determined (every 5 ms).
  - The first value is written at time 0 s: 5 pulses
  - The last value is written at time 5000 ms – pulses 5005
  - Final value - the start value for these 5000 ms is 5000 pulses.
  - The value in S4n72 is greater than these 5000 pulses. In this situation a continuous value can never be calculated.
  - Rule of thumb: Values for S4n72 $\geqslant$ 1000 are only meaningful if the frequency of the input signal is above that of the timer ticker under all conditions (i.e. 200 Hz). If the input frequencies are lower, the error behavior described above will occur.

- If the gas meter is not generating any more pulses, for example because there is no more flow rate, no new counter value/time stamp tuple will be written to the buffer. The continuous calculation always uses the values present in the buffer in this state, which however do not change after this. Although there is actually no more flow rate present, a flow rate is still displayed. Parameter *S4n73* is used to detect this state. If no pulses are received within the time parameterized in S4n73, the flow rate is set to 0.0 until the next pulse is received.

Averaging measurement:
In the mean value forming measurement, the algorithm described above is *not* used with the ring buffer. Instead the time of the start and end of the measurement are determined with the aid of the timer ticker, accurate to within 5 ms, and the pulses that occur in this interval are counted. More than one pulse can also be counted per 5 ms. The current volume over time (Qvac) that has flowed through the gas meter, indicated as volume per pulse, is determined from the time that has elapsed and the number of pulses. The end of the measurement is determined by parameter Pn703 (assigned measuring time) or Pn709 (assigned number of points to be measured), whichever event occurs first.

Synchronization of the gas meter measurement:

For measurements in which a gas meter is involved, there is the option of synchronizing the measuring time with the starting pulse for the gas meter.

Why synchronization of the gas meter measurement may be necessary:
In the mean value forming gas meter measurement, pulses are counted between the start condition and the stop condition for the gas meter to determine the volume flow over time.

Let's consider the start condition first. The start condition for the gas meter measurement is the first pulse that is received in state 2420. However, the start condition for all other variables of this measuring circuit is *entering* into state 2420. Since some time may pass between entry into state 2420 and the first pulse of the gas meter, especially with low-frequency gas meters, the other variables of the measuring circuit are already averaged previously.

Now let's consider the stop condition. The stop condition for the gas meter can be determined by parameter Pn703 (assigned measuring time) or Pn709 (assigned number of points to be measured), whichever event occurs first.

In the case where the assigned number of pulses determines the end, the measurement of all variables of this measuring circuit ends at the same time. In the case where the assigned measuring time determines the end, a significant amount of time may pass between the last pulse of the gas meter that is received and the actual end of the measurement. Only the time from the first until the last pulse is used for the evaluation of the gas meter. The other variables are averaged over a longer time in this case.

Notice: For a measuring circuit with a gas meter, the measuring time in Ry199 is always the time of the gas meter evaluation, so it may be shorter than the assigned measuring time in Pn703!

The result of the situation described above is that even in a system with only one measuring circuit, the time periods over which the measurands are averaged may differ. This is especially relevant for determining the measuring density from the absolute pressure, temperature and humidity during the measurement. The measuring density is used to convert the current volume flow QVac from the gas meter measurement into a mass flow QMas or standard volume flow QVno. For example, if the temperature is not stable during the measurement, instead exhibiting a behavior proportional to time, a significant systematic error may be incorporated into the flow rate measurement of QMas or QVno.

Synchronization via S9002:
To eliminate the systematic error, synchronization can be activated for the gas meter measurement. This is done with parameter S9002. S9002 only has any meaning if there is a gas meter in a measuring circuit that is currently active. Otherwise the value of S9002 is irrelevant. S9002 = 1 in an active gas meter has two effects:

- 1) The system waits in state 2410 until the first pulse is received from the gas meter. Then all measuring times begin synchronously. This means: All measurands in the measuring circuit of the gas meter as well as all other measurands in the other optional measuring circuits start with the first pulse of the gas meter.
- 2) If more than one measuring circuit is parameterized, the measurement in *all* measuring circuits ends when the criterion for the end of the measurement of the measuring circuit with the gas meter occurs. By way of clarification: *Only* the measuring circuit with a gas meter can end the measuring time in other measuring circuits.

The effect of S9002 is illustrated by some examples below:

- *Case 1:* Synchronization *not active*, only one measuring circuit with a gas meter, end of the measurement is defined by the measuring time in Pn703. Measuring time for the gas meter is shorter than the measuring time for all other variables. There is a systematic error.
- *Case 2:* Synchronization *not active*, only one measuring circuit with a gas meter, end of the measurement is defined by the number of pulses in Pn709. Measuring time for the gas meter is still shorter than the measuring time for all other variables. The end is synchronous but the beginning is not. There is a systematic error.
- *Case 3:* Synchronization *is active*, only one measuring circuit with a gas meter, end of the measurement is defined by the measuring time in Pn703. The measurement of all variables starts synchronously, but the end is not synchronized. There is a systematic error.
- *Case 4:* Synchronization *is active*, only one measuring circuit with a gas meter, end of the measurement is defined by the number of pulses in Pn709. The measurement of all variables starts synchronously and the end is also synchronous. There is no systematic error.
- *Case 5:* Synchronization *not active*, two measuring circuits without gas meter. Measuring time of measuring circuit 0 = 5 s. Measuring time of measuring circuit 1 = 10 s. The measurands in measuring circuit 0 are averaged over 5 s. The measurands in measuring circuit 1 are averaged over 10 s. Measuring circuit 0 waits in state 2420 until measuring circuit 1 is ready, then the measurement is exited to state 2430. No systematic error within the individual measuring circuits. However, the two measuring circuits are evaluated over different times.
- *Case 6:* Synchronization *is active*, two measuring circuits without gas meter. Measuring time of measuring circuit 0 = 5 s. Measuring time of measuring circuit 1 = 10 s. The measurands in measuring circuit 0 are averaged over 5 s. The measurands in measuring circuit 1 are averaged over 10 s. Measuring circuit 0 waits in state 2420 until measuring circuit 1 is ready, then the measurement is exited to state 2430. No systematic error within the individual measuring circuits. However, the two measuring circuits are evaluated over different times.

- *Case 7:* Synchronization *is active*, two measuring circuits, one of the measuring circuits with gas meter. End of the gas meter measurement is defined by the measuring time in Pn703. Measuring time of measuring circuit 0 with gas meter = 5 s. Measuring time of measuring circuit 1 without gas meter = 10 s. Both measuring circuits start the averaging of all of their measurands with the first pulse of the gas meter. The measurement in both measuring circuits is ended after 5 s. The end of the measurement of the gas meter is not synchronous with the rest. There is a systematic error.
- *Case 8:* Synchronization *is active*, two measuring circuits, one of the measuring circuits with gas meter. End of the gas meter measurement is defined by the measuring time in Pn703. Measuring time of measuring circuit 0 with gas meter = 10 s. Measuring time of measuring circuit 1 without gas meter = 5 s. Both measuring circuits start the averaging of all of their measurands with the first pulse of the gas meter. The measurement in measuring circuit 1 ends after 5 s. Measuring circuit 1 waits in state 2420 for the end of the measurement in measuring circuit 0. After 10 s the measurement is exited to state 2430. The end of the measurement of the gas meter is not synchronous with the rest. There is a systematic error.
- *Case 9:* Synchronization *is active*, two measuring circuits, one of the measuring circuits with gas meter. End of the gas meter measurement is defined by the number of pulses in Pn709. Measuring time of measuring circuit 0 with gas meter = 20 pulses (in the example this lasts 5 s). Measuring time of measuring circuit 1 without gas meter = 10 s. Both measuring circuits start the averaging of all of their measurands with the first pulse of the gas meter. The measurement in both measuring circuits is ended after 5 s with the 20th pulse of the gas meter. The end of the measurement of the gas meter is synchronous with the rest. . No systematic error within the individual measuring circuits. However, the two measuring circuits are evaluated over different times.
- *Case 10:* Synchronization *is active*, two measuring circuits, one of the measuring circuits with gas meter. End of the gas meter measurement is defined by the number of pulses in Pn709. End of measurement of measuring circuit 0 with gas meter after 80 pulses (in the example this should last exactly 10 s). Measuring time of measuring circuit 1 without gas meter = 5 s. Both measuring circuits start the averaging of all of their measurands with the first pulse of the gas meter. The measurement in measuring circuit 1 ends after 5 s. Measuring circuit 1 waits in state 2420 for the end of the measurement in measuring circuit 0. After 80 pulses (= 10 s) the measurement is exited to state 2430. The end of the measurement of the gas meter is synchronous with the rest. There is no systematic error.
- *Case 11:* Synchronization *not active*, two measuring circuits, one of the measuring circuits with gas meter. End of the gas meter measurement is defined by the number of pulses in Pn709. End of measurement of measuring circuit 0 with gas meter after 20 pulses (in the example this should last exactly 5 s). Measuring time of measuring circuit 1 without gas meter = 10 s. The gas meter starts counting its pulses with a time offset for averaging all other measurands with its first pulse. The measurement in measuring circuit 0 is ended with the 20th pulse after 5 s. Measuring circuit 0 waits in state 2420 for the end of measuring circuit 1. Measuring circuit 1 ends its measurement after 10 s. The measurement of the gas meter is not synchronous with the rest either at the beginning or at the end. There is a systematic error.
- *Case 12:* Synchronization *not active*, two measuring circuits, one of the measuring circuits with gas meter. End of the gas meter measurement is defined by the number of pulses in Pn709. End of measurement of measuring circuit 0 with gas meter after 80 pulses (in the example this should last exactly 10 s). Measuring time of measuring circuit 1 without gas meter = 5 s. The gas meter starts counting its pulses with a time offset for averaging all other measurands with its first pulse. The measurement in measuring circuit 1 ends after 5 s. Measuring circuit 1 waits in state 2420 for the end of measuring circuit 0. The measurement in measuring circuit 0 is ended with the 80th pulse after 10 s. The process continues with state 2430. The measurement of the gas meter is not synchronous with the rest. There is a systematic error.

11.16.7. Extended parameter set for Accutubes

Parameter	Bedeutung	Werte	Erläuterungen
S4n80	K: Mean value of KFlow	(*FLT*) [0.6]	
S4n81	Tube diameter D_i	1E-4…1.0 (*FLT*) [0.1]	in m
S4n82	Reference temperature	173.15…473.15 (*FLT*) [288.7]	Reference temperature for the correction of thermal expansion in Kelvin
S4n83	Thermal expansion coefficient	(*FLT*) [0.0]	The thermal expansion coefficient of the tube
S4n84	Smallest Reynolds number	(*FLT*) [2.0E3]	If S4065 = 1 or 2: Minimum value of the Reynolds number for the iteration (dimensionless)
S4n85	Largest Reynolds number	(*FLT*) [2.0E7]	If S4065 = 1 or 2: Maximum value of the Reynolds number for the iteration (dimensionless)
S4n86	Tolerance of Iteration	(*FLT*) [0.001]	End criterion: If the amount of change in the mass flow from one iteration step to the next is less than this value, the iteration ends.

Table 11.31.: S parameter: AccuTubes

11.17. S8000 block: Analog outputs

Up to 10 analog outputs can be parameterized. The outputs are at n=0..9 on blocks S8nXX.

Comment

The value range from S8001 must be scaled in the K parameters to -1.0 .. +1.0. The respective output card determines how the electrical signal is forwarded. CoM4.SW has no information about this.

Parameter	Bedeutung	Werte	Erläuterungen
S8n00	Type of the output	-1..3 (*INT*) [-1]	-1: Switched off 0: Integrated analog output 1: Frequency output 2: PWM output
S8n01	Value for output	Expression (*FLT*)	Expression that determines the value for output

Parameter	Bedeutung	Werte	Erläuterungen
S8n02	Behavior in case of errors	0..1 (*INT*)) [1]	If errors occur during the evaluation of the expression in S8n01, the response will be as follows: 0: Old value remains in effect 1: Value from S8n03 will be generated
S8n03	Fixed value for output	0.0..1.0 (*FLT*) [0.0]	If the expression in S8n01 results in errors and S8n02 = 1, this value is generated to the output

Table 11.32.: S parameter: Analog outputs

11.17.1. Extended parameter set for integrated analog outputs

Parameter	Bedeutung	Werte	Erläuterungen
S8n10	Number of the analog port	0..9 (*INT*) [n]	Port AOxx in the hardware configuration.

Table 11.33.: S parameter: Integrated analog outputs

11.17.2. Extended parameter set for integrated frequency outputs

Parameter	Bedeutung	Werte	Erläuterungen
S8n20	Number of the frequency output	0..9 (*INT*) [n]	Port FOxx in the hardware configuration
S8n21	Pulse width	0.0 .. 1.0 (*FLT*) [0.5]	Pulse width modulation, i.e. the pulse /pause ratio of the output signal.

Table 11.34.: S parameter: Integrated frequency outputs

11.17.3. Extended parameter set for integrated PWM outputs

Parameter	Bedeutung	Werte	Erläuterungen
S8n30	Number of the PWM output	0..9 (*INT*) [n]	Port FOxx in the hardware configuration
S8n31	Frequency	0.1..1E5 (*FLT*) [1.0E3]	Frequency of the output signal.

Table 11.35.: S parameter: Integrated PWM outputs

11.17.4. Extended parameter set for units of the outputs

Parameter	Bedeutung	Werte	Erläuterungen
S8n90	Type of the output	0..21 (*INT*) [10]	Physical variable of the output
S8n91	Unit of the output	0..17 (*INT*) [0]	Unit of the output
S8n92	Places after the decimal of the output	0..5 (*INT*) [1]	Places after the decimal of the output
S8n93	Scaling of the output for the display	(*FLT*) [1.0]	Scaling for the display
S8n94	Offset of the output for the display	(*FLT*) [0.0]	Offset for the display

Table 11.36.: S parameter: Units of the outputs

11.18. S9000 block: Special functions

Parameter	Bedeutung	Werte	Erläuterungen
S9000	Measuring time for the system leak test	0..9.72E4 (*FLT*) [10.0]	in seconds
S9001	Calm time before the system leak test	0..300 (*FLT*) [0.0]	in seconds
S9002	Synchronize gas meter [1]	0..1 (*INT*) [0]	0: Not active 1: Active, only has an effect if a gas meter has been created under S4n00 ff. and selected as primary

Table 11.37.: S parameter: Special functions

Synchronization of the gas meter measurement:

For measurements in which a gas meter is involved, there is the option of synchronizing the measuring time with the starting pulse for the gas meter.

Why synchronization of the gas meter measurement may be necessary:
In the mean value forming gas meter measurement, pulses are counted between the start condition and the stop condition for the gas meter to determine the volume flow over time.

Let's consider the start condition first. The start condition for the gas meter measurement is the first pulse that is received in state 2420. However, the start condition for all other variables of this measuring circuit is *entering* into state 2420. Since some time may pass between entry into state 2420 and the first pulse of the gas meter, especially with low-frequency gas meters, the other variables of the measuring circuit are already averaged previously.

Now let's consider the stop condition. The stop condition for the gas meter can be determined by parameter Pn703 (assigned measuring time) or Pn709 (assigned number of points to be measured), whichever event occurs first. In the case where the assigned number of pulses determines the end, the measurement of all variables of this measuring circuit ends at the same time. In the case where the assigned measuring time determines the end, a significant amount of time may pass between the last pulse of the gas meter that is received and the actual end of the measurement. Only the time from the first until the last pulse is used for the evaluation of the gas meter. The other variables are averaged over a longer time in this case.

Notice: For a measuring circuit with a gas meter, the measuring time in Ry199 is always the time of the gas meter evaluation, so it may be shorter than the assigned measuring time in Pn703!

The result of the situation described above is that even in a system with only one measuring circuit, the time periods over which the measurands are averaged may differ. This is especially relevant for determining the measuring density from the absolute pressure, temperature and humidity during the measurement. The measuring density is used to convert the current volume flow QVac from the gas meter measurement into a mass flow QMas or standard volume flow QVno. For example, if the temperature is not stable during the measurement, instead exhibiting a behavior proportional to time, a significant systematic error may be incorporated into the flow rate measurement of QMas or QVno.

Synchronization via S9002:
To eliminate the systematic error, synchronization can be activated for the gas meter measurement. This is done with parameter S9002. S9002 only has any meaning if there is a gas meter in a measuring circuit that is currently active. Otherwise the value of S9002 is irrelevant. S9002 = 1 in an active gas meter has two effects:

- 1) The system waits in state 2410 until the first pulse is received from the gas meter. Then all measuring times begin synchronously. This means: All measurands in the measuring circuit of the gas meter as well as all other measurands in the other optional measuring circuits start with the first pulse of the gas meter.
- 2) If more than one measuring circuit is parameterized, the measurement in *all* measuring circuits ends when the criterion for the end of the measurement of the measuring circuit with the gas meter occurs. By way of clarification: *Only* the measuring circuit with a gas meter can end the measuring time in other measuring circuits.

The effect of S9002 is illustrated by some examples below:

- *Case 1:* Synchronization *not active*, only one measuring circuit with a gas meter, end of the measurement is defined by the measuring time in Pn703. Measuring time for the gas meter is shorter than the measuring time for all other variables. There is a systematic error.
- *Case 2:* Synchronization *not active*, only one measuring circuit with a gas meter, end of the measurement is defined by the number of pulses in Pn709. Measuring time for the gas meter is still shorter than the measuring time for all other variables. The end is synchronous but the beginning is not. There is a systematic error.
- *Case 3:* Synchronization *is active*, only one measuring circuit with a gas meter, end of the measurement is defined by the measuring time in Pn703. The measurement of all variables starts synchronously, but the end is not synchronized. There is a systematic error.
- *Case 4:* Synchronization *is active*, only one measuring circuit with a gas meter, end of the measurement is defined by the number of pulses in Pn709. The measurement of all variables starts synchronously and the end is also synchronous. There is no systematic error.
- *Case 5:* Synchronization *not active*, two measuring circuits without gas meter. Measuring time of measuring circuit 0 = 5 s. Measuring time of measuring circuit 1 = 10 s. The measurands in measuring circuit 0 are averaged over 5 s. The measurands in measuring circuit 1 are averaged over 10 s. Measuring circuit 0 waits in state 2420 until measuring circuit 1 is ready, then the measurement is exited to state 2430. No systematic error within the individual measuring circuits. However, the two measuring circuits are evaluated over different times.
- *Case 6:* Synchronization *is active*, two measuring circuits without gas meter. Measuring time of measuring circuit 0 = 5 s. Measuring time of measuring circuit 1 = 10 s. The measurands in measuring circuit 0 are averaged over 5 s. The measurands in measuring circuit 1 are averaged over 10 s. Measuring circuit 0 waits in state 2420 until measuring circuit 1 is ready, then the measurement is exited to state 2430. No systematic error within the individual measuring circuits. However, the two measuring circuits are evaluated over different times.
- *Case 7:* Synchronization *is active*, two measuring circuits, one of the measuring circuits with gas meter. End of the gas meter measurement is defined by the measuring time in Pn703. Measuring time of measuring circuit 0 with gas meter = 5 s. Measuring time of measuring circuit 1 without gas meter = 10 s. Both measuring circuits start the averaging of all of their measurands with the first pulse of the gas meter. The measurement in both measuring circuits is ended after 5 s. The end of the measurement of the gas meter is not synchronous with the rest. There is a systematic error.

- *Case 8:* Synchronization *is active*, two measuring circuits, one of the measuring circuits with gas meter. End of the gas meter measurement is defined by the measuring time in Pn703. Measuring time of measuring circuit 0 with gas meter = 10 s. Measuring time of measuring circuit 1 without gas meter = 5 s. Both measuring circuits start the averaging of all of their measurands with the first pulse of the gas meter. The measurement in measuring circuit 1 ends after 5 s. Measuring circuit 1 waits in state 2420 for the end of the measurement in measuring circuit 0. After 10 s the measurement is exited to state 2430. The end of the measurement of the gas meter is not synchronous with the rest. There is a systematic error.
- *Case 9:* Synchronization *is active*, two measuring circuits, one of the measuring circuits with gas meter. End of the gas meter measurement is defined by the number of pulses in Pn709. Measuring time of measuring circuit 0 with gas meter = 20 pulses (in the example this lasts 5 s). Measuring time of measuring circuit 1 without gas meter = 10 s. Both measuring circuits start the averaging of all of their measurands with the first pulse of the gas meter. The measurement in both measuring circuits is ended after 5 s with the 20th pulse of the gas meter. The end of the measurement of the gas meter is synchronous with the rest. . No systematic error within the individual measuring circuits. However, the two measuring circuits are evaluated over different times.
- *Case 10:* Synchronization *is active*, two measuring circuits, one of the measuring circuits with gas meter. End of the gas meter measurement is defined by the number of pulses in Pn709. End of measurement of measuring circuit 0 with gas meter after 80 pulses (in the example this should last exactly 10 s). Measuring time of measuring circuit 1 without gas meter = 5 s. Both measuring circuits start the averaging of all of their measurands with the first pulse of the gas meter. The measurement in measuring circuit 1 ends after 5 s. Measuring circuit 1 waits in state 2420 for the end of the measurement in measuring circuit 0. After 80 pulses (= 10 s) the measurement is exited to state 2430. The end of the measurement of the gas meter is synchronous with the rest. There is no systematic error.
- *Case 11:* Synchronization *not active*, two measuring circuits, one of the measuring circuits with gas meter. End of the gas meter measurement is defined by the number of pulses in Pn709. End of measurement of measuring circuit 0 with gas meter after 20 pulses (in the example this should last exactly 5 s). Measuring time of measuring circuit 1 without gas meter = 10 s. The gas meter starts counting its pulses with a time offset for averaging all other measurands with its first pulse. The measurement in measuring circuit 0 is ended with the 20th pulse after 5 s. Measuring circuit 0 waits in state 2420 for the end of measuring circuit 1. Measuring circuit 1 ends its measurement after 10 s. The measurement of the gas meter is not synchronous with the rest either at the beginning or at the end. There is a systematic error.
- *Case 12:* Synchronization *not active*, two measuring circuits, one of the measuring circuits with gas meter. End of the gas meter measurement is defined by the number of pulses in Pn709. End of measurement of measuring circuit 0 with gas meter after 80 pulses (in the example this should last exactly 10 s). Measuring time of measuring circuit 1 without gas meter = 5 s. The gas meter starts counting its pulses with a time offset for averaging all other measurands with its first pulse. The measurement in measuring circuit 1 ends after 5 s. Measuring circuit 1 waits in state 2420 for the end of measuring circuit 0. The measurement in measuring circuit 0 is ended with the 80th pulse after 10 s. The process continues with state 2430. The measurement of the gas meter is not synchronous with the rest. There is a systematic error.

11.19. S9010 block: Basic system pressure

The ambient pressure is often measured at only one point and then used as the basis of calculation for several absolute pressures in the system. This pressure is referred to as the basic system pressure.

This has several advantages:

- In contrast to absolute pressure sensors, a zero adjustment is usually relatively simple for relative pressure sensors.
- The ambient pressure does not usually change very quickly or greatly, so fewer hysteresis, offset or other loading effects may be expected on the absolute pressure sensor.
- The ambient pressure is available as an additional measured value that not infrequently already needs to be archived together with the other measurement conditions.

Parameter	Bedeutung	Werte	Erläuterungen
S9010	System absolute pressure	Expression (*FLT*) [""]	e.g. R parameters R0820 Empty = switched off
S9011	Physical variable	0..0 (*INT*) [0]	Physical variable according to section 13
S9012	Display of unit	0..17 (*INT*) [3]	For coding see section 13
S9013	Display of places after the decimal	0..5 (*INT*) [0]	Number of places after the decimal
S9014	KalAssi information	-2..2097152 (*INT*) [-2]	Information for KalAssi -2: Deactivated -1: Fixed value 0 .. 19: Input number of the sensor 20 .. 999: Reserved for special cases 1000 .. 2097152: Bit-coded: Calculated from multiple inputs 1000 is an offset here Example: 1005: Calculated from input 0 and input 2

Table 11.38.: S parameter: System absolute pressure

11.20. S9050 block: User-defined physical dimensions and units

10 blocks are also defined from S9050 to S9095 with spacing of 5. These blocks make it possible to configure up to 10 user-defined units for a variable with type code 17. These can also be used like the predefined units. Restrictions are:

- The first unit is always implicitly assumed to be an SI unit. The factor and offset a0 for S9050 are therefore always 1.0 and 0.0 respectively and cannot be changed.
- The maximum string length for the display is 7 characters. Longer strings are truncated for the display. There is no error message.

The final value is determined in SI units by subtracting the offset and dividing by the specified factor:

$$(\mathsf{Eng} - a0) \cdot \mathsf{Factor} = \mathsf{SI} \tag{11.2}$$

If the scaling factor is 0, a runtime error will therefore be generated.

Parameter	Bedeutung	Werte	Erläuterungen
S9050	Name of the unit	String (*STR*) [""]	Maximum 7 characters Up to 4 characters are displayed directly. For longer entries, the display switches between characters 0-3 and the rest

Parameter	Bedeutung	Werte	Erläuterungen
S9051	Scaling factor	Float (*FLT*) [1.0]	Factor for conversion from SI to ENG
S9052	Offset	Float (*FLT*) [0.0]	Offset a0 for conversion from SI to ENG

Table 11.39.: S parameter: User-defined physical dimensions and units

11.21. S9100 block: Log print

Log print functions are defined in block S9100. At the end of the MEAS phase of a measurement process, a string can optionally be generated with results of the measurement process via one of the available interfaces or to a file.

Parameter	Bedeutung	Werte	Erläuterungen
S9100	Log print function after the end of the test	Integer (*INT*) 0..3 [0]	0: inactive 1: Output via COMM interface 2: Output to file in folder */tmp*. Caution: Will not be retained through a power failure 3: Output via TCP/IP
S9101	Filename	Expression (*STR*) [""]	Name of the file for the output if S9100 = 2
S9102	Port number	Integer (*INT*) [54492]	Port number for TCP/IP output if S9100 = 3
S9110	Format string #0	Expression (variable) [""]	See below
S9111	Format string #1	Expression (variable) [""]	See below
S9112	Format string #2	Expression (variable) [""]	See below
S9113	Format string #3	Expression (variable) [""]	See below
S9120	Expression #0	Expression (variable) [""]	Expression that will be used for placeholder in S9110, S9111,S9112 or S9113
S9121	Expression #1	Expression (variable) [""]	Expression that will be used for placeholder in S9110, S9111,S9112 or S9113

Parameter	Bedeutung	Werte	Erläuterungen
S9122	Expression#2	Expression (variable) [""]	Expression that will be used for placeholder in S9110, S9111,S9112 or S9113
S9123	Expression#3	Expression (variable) [""]	Expression that will be used for placeholder in S9110, S9111,S9112 or S9113
S9124	Expression#4	Expression (variable) [""]	Expression that will be used for placeholder in S9110, S9111,S9112 or S9113
S9125	Expression#5	Expression (variable) [""]	Expression that will be used for placeholder in S9110, S9111,S9112 or S9113
S9126	Expression#6	Expression (variable) [""]	Expression that will be used for placeholder in S9110, S9111,S9112 or S9113
S9127	Expression#7	Expression (variable) [""]	Expression that will be used for placeholder in S9110, S9111,S9112 or S9113
S9128	Expression#8	Expression (variable) [""]	Expression that will be used for placeholder in S9110, S9111,S9112 or S9113
S9129	Expression#9	Expression (variable) [""]	Expression that will be used for placeholder in S9110, S9111,S9112 or S9113

Table 11.40.: S parameter: Log print

Comment on S911n parameters

Example of a standard assignment of the log print:

```
S9110 val="%9$s;P;%0$d;Pdif;%1$s;Prel0;%2$s;Prel1;%3$s;Prel2;%4$s; ...
           PReg;%5$s;RQVa;%6$s;QVac;%7$s;"

# Program
S9120 val="PROG[0]"
# Pdif
S9121 val="FORMAT('%$5.2f;mbar',0.01*R0201)"
# Aux 0
S9122 val="FORMAT('%$5.1f;mbar',0.01*R0220)"
# Aux 1
S9123 val="FORMAT('%$5.1f;mbar',0.01*R0221)"
# Aux 2
S9124 val="FORMAT('%$5.1f;mbar',0.01*R0222)"
# Aux 3
S9125 val="FORMAT('%$5.1f;mbar',0.01*R0223)"
# RQva
S9126 val="FORMAT('%$5.2f;l/min',6E4*R0232)"
```

```
# QVac
S9127 val="FORMAT('%$5.2f;l/min',6E4*R0230)"
# Date-time-stamp
S9129 val="TimeToStr(GetTime())"
```

%n ist dabei der Platzhalter für die einzelnen Einträge ins S911n. $ ist dabei die Formatanweisung: s = String, d = Integer, e = Float mit Exponent, f = Float ohne Exponent, b = Integer Binärzahl, X = Integer Hexadezimalzahl.

In the expressions in S911n, possible errors must be intercepted. See example:

```
S9110 val="RPAR(201)" # This is FALSE
{ The R parameter can have an error, in which case the output of S9110
  would not be defined. The program ends with an error. }

S9110 val="R0201"  # This is correct
{ The R parameter can have an error, in which case the value of
  R0152 also has the code NaN (Not a Number). }

S9110 val="RERR(201)?0.0:R0201  # This is also possible
{ If the R parameter has an error, the value 0.0 is generated.}

{ In addition:
  In the init files, double apostrophe must be escaped: }

S9110 val="FORMAT(\"%$5.2f;mbar\",0.01*R0201)"
```

11.22. S9150 block: Type editor

The installed type editor can only be used with script code. First the type editor must be called specifically with an external script, then the list of available types must be generated with a script. After that the display can be influenced by script code in S9150/S9151.

Parameter	Bedeutung	Werte	Erläuterungen
S9150	init – Expression for filling in the list	Expression (*STR*) [""]	Expression for calling a function to fill in the list
S9151	display – Expression for displaying an individual list entry	Expression (*STR*) [""]	Expression for calling a function to display the entry
S9152	select – Expression for selecting an entry	Expression (*STR*) [""]	Expression for calling a function to select the entry

Table 11.41.: S parameter: Type editor

Example for use:

```

s-init.dat:
```

```
S9150 val="TypeMenuInit()"
S9151 val="TypeMenuDisplay()"
S9152 val="TypeMenuSelect()"

code.scr:

FUNCTION TypeMenuInit();
VAR Err : INT;
BEGIN
  Err := TM_ADD_DIR("www/", ".typ");
  #Err := TM_ADD_FILE("types.txt", 1);
  IF (Err <> 0) THEN BEGIN
    WRITELN(TOLOG, FORMAT("TypeMenu - init error: %$d", Err));
  END;
END;

FUNCTION TypeMenuDisplay();
BEGIN
  TM_SET_DISPLAY("    " + StrCut(TM_GET_TEXT(),0,2),StrCut(TM_GET_TEXT(),3,255));
END;

FUNCTION TypeMenuSelect();
BEGIN
  WRITELN(TOLOG, FORMAT("TypeMenu - selected: www/%$s.type", TM_GET_TEXT()));
END;
```

11.23. S9170 block: Serial display

Block S9170 contains parameters for the module for control of a serial display.

Parameter	Bedeutung	Werte	Erläuterungen
S9170	Interface	-1..9 (*INT*) [-1]	-1: Deactivates the interface 0: Serial interface from block K0600 1: Serial interface from block K0610 2: Serial interface from block K0620 ...
S9171	Number of lines	1..16 (*INT*) [4]	Number of display lines
S9172	Characters per line	20..80 (*INT*) [20]	Number of characters per line in the display

Table 11.42.: S parameter: Serial display

11.24. S9200 block: Subscribe

Four blocks of S parameters with a spacing of 50 from S9200 (or S9250, S9300 and S9350) are used to configure "Subscribe". Data from another controller can be subscribed with each block. The example below shows the block at S9200. It is repeated three times with a spacing of 50.

The parameters from S9210 (or S9260, S9310 and S9360) are used to configure how the received data should appear and where it should be written. The first parameter indicates the number of data items that follow, while the subsequent parameters define the data that will be added to the subscribe data block. The first of these parameters is shown below.

Parameter	Bedeutung	Werte	Erläuterungen
S9200	Host name or serial number	Expression (*STR*) [""]	Depending on the value in S9202, this parameter contains either the name/IP address or the serial number of the controller from which data will be obtained
S9201	UDP Port	1025..65535 (*INT*) [54491]	Number of the UDP port from which data will be obtained Must correspond to S9400 of the remote station Ports 0 to 1024 are not available
S9202	Meaning of S9200	0..1 (*INT*) [0]	0: Detection of the remote station via the name or IP address 1: Detection of the remote station via the serial number Then the IP address will be defined automatically If the remote station is LMF-6 or LMF-7, at least SPELLOS 6.0.7 must be running
S9203	Version of the Publish controller	0..1 (*INT*) [1]	Version of the Publish controller: 0: LMF-6 or 7 1: CoM4.sw
S9204	Data record number	0..99 (*INT*) [0]	Number of the Publish data record to which the subscription refers; see table 11.44 and table 11.45
S9205	Offset data	0..18 (*INT*) [0]	Indicates the parameter of the block set up in the Publish controller from which the transfer will be taken
S9210	Number of data items	0..19 (*INT*) [0]	Indicates how many of the following parameters are valid for the block definition

Parameter	Bedeutung	Werte	Erläuterungen
S9211 ... S9229	Parameter #0 ... Parameter #18	*-559..82999* (*INT*) [0]	Defines data value 0 in the user-defined Subscribe data block: *-559..-500*: A value is received that is interpreted as an integer and written to an I variable in `SUBIVAR[x]` and thereby made available Example -510 in `SUBIVAR[10]` *Caution*: If it is not an integer, a runtime error with type mismatch is generated. *11800..11899*: The received value is interpreted as an R parameter and written to an R parameter with error code and numeric value in TMS format *21800..21899*: The received value is interpreted as an R parameter and written to an R parameter with complete information (unit, places after the decimal, display, etc.) Written in TMS format *41800..41899*: The received value is interpreted as an R parameter and written to an R parameter with error code and numeric value in IEEE format *51800..51899*: The received value is interpreted as an R parameter and written to an R parameter with complete information (unit, places after the decimal, display, etc.) om IEEE format *71800..71899*: The received value is interpreted as an R parameter and written to an R parameter with numeric value and error code in IEEE format with 64 bits *81800..81899*: The received value is interpreted as an R parameter and written to an R parameter with complete information (unit, places after the decimal, display, etc.) in IEEE format with 64 bits

Table 11.43.: S parameter: Subscribe

Data record number	Description
0	Zeroth block, user-defined Publish (see S9420 ff)
1	First block, user-defined Publish (see S9440 ff)
2	Second block, user-defined Publish (see S9460 ff)

Table 11.44.: Publish data records of LMF-7 and CoM4.sw

Note:
If a complete R parameter is selected for transfer, the string in attribute `name` is limited to 20 characters to remain compatible with LMF.

Data record number	Description
0	R parameters R0800 to R0839 (raw and linearized input values)
1	20 script integer variables (array `I[]`)
2	20 script float variables, simultaneously R parameters R2800-R2819
3	R parameters Ry150-Ry162
5	Selection of R parameters from measuring circuit 0
6	Selection of R parameters from measuring circuit 1
7	Selection of R parameters from measuring circuit 2
10	First block of user-defined Publish data (see S92xx)
11	Second block of user-defined Publish data (see S92xx)
12	Third block of user-defined Publish data (see S92xx)

Table 11.45.: Publish data records of LMF-6

Further information

- Parameter lists - 11.25 - S. 140 - *S9400 block: Publish*

11.25. S9400 block: Publish

If several controllers are connected by a network, each controller can access a partial range of the data of the other controllers, provided it is made available. This data exchange is only practical in a trusted environment and the data structures must also be mutually compatible. Each controller provides several data records for other authorized nodes (see parameters S9401 and S9402), but does not initially bring about any network activity. The data records are not actively sent off ("Publish") until another controller requests certain partial ranges of these provided data records ("Subscribe"). The number of recipients is limited only by the available storage space.

The S parameters at S9400 are used to configure "Publish":

Parameter	Bedeutung	Werte	Erläuterungen
S9400	UDP port	0..65535 (*INT*) [54491]	Number of the UDP port on which the controller receives queries A value of 0 switches the feature off Ports 0 to 1024 are not available

Parameter	Bedeutung	Werte	Erläuterungen
S9401	List of permitted remote stations [1]	Expression (*STR*) [""]	These remote stations may subscribe to data. Will only be queried when setting up a new connection
S9402	List of non-permitted remote stations [1]	Expression (*STR*). [""]	These remote stations may not subscribe to data. Will only be queried when setting up a new connection.
S9403	Minimum time between two updates	0.0..2.4 (*FLT*) [0.2]	Value in seconds. The time between two updates is never less than the time set here.
S9404	Update mode	0..1 (*INT*) [0]	Determines whether an update will always be sent after the minimum time has expired, or only if there have been changes to the data. 0: Send only if changes have been made. 1: Always send.

Table 11.46.: S parameter: Publish

1:

A list of networks separated by semicolons can be specified in the ALLOW/DENY parameters.

Notation:
Net[/Bits];Net[/Bits].
The /bits are optional and indicate the subnet mask. If /bits is not set, /32 is assumed, so only the specified IP address will apply. This makes it possible to permit/prohibit specific hosts (Net = IP address of the host) or also entire (sub) networks.

Definition of subnets:
192.0.0.0/8 refers to all 192 addresses
192.168.0.0/16 refers to all 192.168 addresses
192.168.42.0/24 refers to all 192.168.42. addresses
192.168.42.63/32 refers only to the named IP address

Examples:
2 IP addresses:
192.168.42.43; 192.168.42.44

2 networks
192.168.42.0/24;192.168.72.0/24

3 blocks / data records of Publish data can be configured with the parameters for S9420 (see also table 11.44). 20 parameters are available for each of these blocks. The first one indicates the number of data items that follow, while the subsequent parameters define the data that will be added to the publish data block. The example below shows the parameter block at S9420. It is repeated two more times at S9440 and S9460.

Further information:

- Parameter lists - 11.24 - S. 137 - *S9200 block: Subscribe*

Parameter	Bedeutung	Werte	Erläuterungen
S9420	Number of data items	0..19 (*INT*) [0]	Indicates how many of the following parameters are valid for the block definition
S9421 ... S9439	Parameter #0 ... Parameter #18	-559..82999 (*INT*) [0]	Defines data value 0 in the user-defined Publish data block: *-559..-500*: The value of an integer is transferred The integer can be written in the script via the CoM4.sw-Variable `PUBIVAR[x]` Example `PUBIVAR[4]` will be transferred with -504 and contains a 32-bit integer *-499..-400:* The value of a NET-IO output *-399..-300*: The value of a NET-IO input *-299.-200*: The value of a digital output (index in S1800 ff.) *-199..-100*: The value of a digital input *-6*: Net-IO64 output upper (32-bit) *-5*: Net-IO64 output lower (32-bit) *-4*: Net-IO32 input (32-bit) *-3*: A counter that is incremented every time the respective Publish block is reconfigured *-2*: The current controller time in ticks *-1*: The current Mainstate *10000..12999*: Error code and numeric value of the respective R parameter in TMS format *20000..22999*: Complete R parameters in TMS format *40000..42999*: Error code and numeric value of the respective R parameter in IEEE format *50000..52999*: Complete R parameters in IEEE format *70000..72999*: Error code and numeric value of the respective R parameter in IEEE format with 64 bits *80000..82999*: Complete R parameters in IEEE format with 64 bits

Table 11.47.: S parameter: Publish additional information

11.26. S9500 block: NET-IO interface

The system can make the result of the expressions defined in block S13xx available via a network connection. Also available via this network connection are the virtual inputs that can be queried either with `NI[x]` (value of bit `x`) or with `NI32` (decimal representation of all NET-IO inputs). The following block specifies the connection parameters for the network connection.

Parameter	Bedeutung	Werte	Erläuterungen
S9500	TCP port	0..65535 (*INT*) [0]	0: No system connection via network 1025..65535: TCP port number at which the controller waits for incoming connections Default value when NET-IO interface is set up: 54488 (previously 54492)
S9501	List of permitted remote stations [1]	Expression (*STR*) [""]	These remote stations may set up a connection. Only relevant if remote stations are prohibited. This prohibition is overwritten with actively permitted remote stations here.
S0502	List of non-permitted remote stations [1]	Expression (*STR*) [""]	These remote stations must not set up a connection.. If nothing is prohibited, all remote stations are permitted. Will be overwritten by the permitted remote stations.
S9505	Timeout for virtual inputs	0.0..86400.0 (*FLT*) [0]	Value in seconds. If no input is received for longer than the set time, the system aborts the connection. A value of 0 switches the timeout off.
S9506	Timeout for virtual outputs	0.0..86400.0 (*FLT*) [0]	Value in seconds . If no output value is delivered for longer than the set time because there are no changes, the send is coerced. A value of 0 switches the timeout off.
S9507	Format of the output	Expression (*STR*)	A string that indicates the format in which the output data will be sent. Standard according to TTI-convention: `"NO %1$8.8Xh %0$8.8Xh\r\n"` for 64-bit. `"NO %0$8.8Xh\r\n"` for 32-bit. Other formats are also possible.

Table 11.48.: S parameter: Virtual inputs and outputs

1:

A list of networks separated by semicolons can be specified in the ALLOW/DENY parameters.

Notation:
Net[/Bits];Net[/Bits].
The /bits are optional and indicate the subnet mask. If /bits is not set, /32 is assumed, so only the specified IP address will apply. This makes it possible to permit/prohibit specific hosts (Net = IP address of the host) or also entire (sub) networks.

Definition of subnets:
192.0.0.0/8 refers to all 192 addresses
192.168.0.0/16 refers to all 192.168 addresses

192.168.42.0/24 refers to all 192.168.42. addresses
192.168.42.63/32 refers only to the named IP address

Examples:
2 IP addresses:
192.168.42.43; 192.168.42.44

2 networks
192.168.42.0/24;192.168.72.0/24

Further information

- Parameter lists - 11.11 - S. 109 - *S parameter: Virtual outputs*

11.27. S9600 block: AK interface

The system has an AK protocol that serves as an interface via TCP/IP and can be configured with the following parameters.

Parameter	Bedeutung	Werte	Erläuterungen
S9600	Connection settings	-1..65535 (*INT*) [-1]	Distinction between serial or TCP/IP: -1: Deactivates the interface 0: Serial interface from block K0600 1: Serial interface from block K0610 2: Serial interface from block K0620 ... > 10: TCP/IP interface active, S9600 specifies the port number. Port number must be in the range 1025..65535.
S9601	List of permitted remote stations [1]	Expression [""]	These remote stations may set up a connection
S9602	List of non-permitted remote stations [1]	Expression [""]	These remote stations must not set up a connection
S9610	Start code	1..255 (*INT*) [2]	Messages begin with this code, default: STX (ASCII 2)
S9611	End code	1..255 (*INT*) [3]	Messages end with this code, default: ETX (ASCII 3)
S9612	Don't Care Byte	1..255 (*INT*) [32]	Value for the "Don't Care" byte, default: Blank (ASCII 32)
S9620	Expression for error	Expression (integer)	Error status of the system FALSE = no error
S9621	Expression for PLC inputs	Expression (integer)	The value determined here can forward the following status lines. Default: Bit 0: SPS_READY Bit 1: SPS_END Bit 2: Not assigned Bit 3: SPS_Fail

Parameter	Bedeutung	Werte	Erläuterungen
S9622	User-defined value for ASTZ0	Expression (STRING)	Expressions that generate any string can be used for output to the higher-level control system, see AK protocol
S9623	User-defined value for ASTZ1	Expression (STRING)	Expressions that generate any string can be used for output to the higher-level control system, see AK protocol
S9624	User-defined value for ASTZ2	Expression (STRING)	Expressions that generate any string can be used for output to the higher-level control system, see AK protocol
S9625	User-defined value for ASTZ3	Expression (STRING)	Expressions that generate any string can be used for output to the higher-level control system, see AK protocol
S9626	User-defined value for ASTZ4	Expression (STRING)	Expressions that generate any string can be used for output to the higher-level control system, see AK protocol

Table 11.49.: S parameter: Configuration of AK interface

1:

A list of networks separated by semicolons can be specified in the ALLOW/DENY parameters.

Notation:
Net[/Bits];Net[/Bits].
The /bits are optional and indicate the subnet mask. If /bits is not set, /32 is assumed, so only the specified IP address will apply. This makes it possible to permit/prohibit specific hosts (Net = IP address of the host) or also entire (sub) networks.

Definition of subnets:
192.0.0.0/8 refers to all 192 addresses
192.168.0.0/16 refers to all 192.168 addresses
192.168.42.0/24 refers to all 192.168.42. addresses
192.168.42.63/32 refers only to the named IP address

Examples:
2 IP addresses:
192.168.42.43; 192.168.42.44

2 networks
192.168.42.0/24;192.168.72.0/24

11.28. S9700 block: Sequence control

Example:

```
S9700 val=2020
```

```
S9701 val="MainState2020()"
```

Block S9700 contains 50 script assignments. The parameters at S9700 and S9701 are repeated fifty times with a spacing of 2.

Parameter	Bedeutung	Werte	Erläuterungen
S9700	State script: Machine status	0..9999 (*INT*) [0]	Machine status with which the script will be coupled in S9701
S9701	State script: Call	Expression (*STR*) [""]	Expression for calling the state function E.g.: `S9701 val=‘‘State2020()’’`
S9702	State script: Machine status	0..9999 (*INT*) [0]	Machine status with which the script will be coupled in S9701
S9703	State script: Call	Expression (*STR*) [""]	Expression for calling the state function E.g.: `S9703 val=‘‘State2030()’’`

Table 11.50.: S parameter: Sequence control

11.29. S9800 block: UBI function

Example:

`S9800 val="ubi()"`

Block S9800 contains a reference to a script that is executed depending on an expression.

Parameter	Bedeutung	Werte	Erläuterungen
S9800	Ubi function: Call	Expression (*STR*) [""]	Expression for calling the Ubi function The Ubi function is the function that is traversed in the background during every cycle

Table 11.51.: S parameter: Script code ubi

11.30. S9810 block: Command functions

Block S9810-S9895 contains references to up to 18 functions that are executed by the COMM interface. The example below shows the first block at S9810. It is repeated 18 times with a spacing of 5 (S9815 ff., S9820 ff.).

Beginning with CoM4.sw, v2.1.0 arguments can also be passed to the command functions..

Parameter	Bedeutung	Werte	Erläuterungen
S9810	Command function: Command	Expression (*STR*) [""]	Command for the COMM interface e.g.: `S9810 val=PLOT`
S9811	Command function: Call	Expression (*STR*) [""]	Expression for calling the command function e.g. `S9811 val=plot()`

Parameter	Bedeutung	Werte	Erläuterungen
S9812	Option for command with argument 0..1 (*INT*) [0]	0 : The expression in S9811 is applied 1: A search is conducted in file *code.scr* (only in this file!) for a function with the same name as in S9810. This function can then have arguments as well.	

Table 11.52.: S parameter: Script code COMM

12. T parameters / Freely definable string parameters

Freely definable T parameters can be used in expressions or scripts. Changes do not take effect until after ACTIVATE, TEMP or SAVE SAVE!. Parameters T0000 - T0099 are available.

Example:

```
        T0000 val="Hello world"
        T0001 level=$008 val="Foo"
```

13. Physical variables and their units

List of physical variables available in CoM4.sw. Several units are possible for each physical variable

Physical variable	Type code
For user-defined S9050 ff. see section Parameter lists - 11.20 - S. 133 - *S9050 block: User-defined physical dimensions and units*	17
Acceleration	16
Density	3
Dimensionless	10
Torque	22
Pressure	0
Pressure change per unit of time	6
Area	24
Energy	19
Frequency	21
Speed	15
Force	18
Power	20
Mass	9
Mass flow	2
Voltage	11
Current	12
Temperature	5
Viscosity	4
Volume	8
Volume flow	1
Distance	14
Resistance	13
Angle	23
Time	7

Table 13.1.: Overview of the physical variables, alphabetical

Unit	Unit code	Display on screen
Pressure: *Type code 0*		
Pascals	0	Pa
Hectopascals	1	hPa
Kilopascals	2	kPa
Millibar	3	mbar
Bar	4	bar
Techn. atmosphere	5	at
Phys. atmosphere	6	atm
Inches of mercury column @0°C	7	inHG
Inches of water column @4°C	8	inWC
PSI / pounds/in^2	9	lbi2
Pounds/ft^2	10	lbf2
mm mercury column @0°C	11	mmHG
mm water column @4°C	12	mmWC
PSI / pounds /in^2	13	psi
Torr	14	Torr
mm of water @20° C	15	mmWC
Inches of water col. @20°C	16	inWC
Megapascals	17	MPA
Volume flow: *Type code 1*		
m^3/sec	0	m3/s
m^3/min	1	m3/m
m^3/hour	2	m3/h
Liters/sec	3	L/s
Liters/min	4	L/m
Liters/hour	5	L/h
cm^3/sec	6	cm3s
cm^3/min	7	cm3m
cm^3/hour	8	cm3/h
ft^3/sec	9	CFS
ft^3/min	10	CFM

Unit	Unit code	Display on screen
ft^3/hour	11	CFH
$Inches^3$/sec	12	CIS
$Inches^3$/min	13	CIM
$Inches^3$/h	14	CIH
cm^3/sec	15	ml/s
cm^3/min	16	ml/m
cm^3/hour	17	ml/h
mm^3/sec	18	ul/s
mm^3/min	19	ul/m
mm^3/hour	20	ul/h
Mass flow: Type code 2		
kg/sec	0	kg/s
kg/min	1	kg/m
kg/hour	2	kg/h
g/sec	3	g/s
g/min	4	g/m
g/hour	5	g/h
lb/sec	6	PPS
lb/min	7	PPM
lb/hour	8	PPH
mg/s	9	mg/s
mg/min	10	mg/m
mg/h	11	mg/h
Density: Type code 3		
kg/m^3	0	kgm3
g/m^3	1	g/m3
lb/ft^3	2	lbcf
$lb/inch^3$	3	lbci
Viscosity: Type code 4		

Unit	Unit code	Display on screen
Pascal-sec.	0	Pa · s
Micropoises	1	uPoi
Centipoises	2	cPoi
Pounds / (in · s)	3	lto
Temperature: Type code 5		
Kelvin	0	K
Celsius	1	"C
Fahrenheit	2	"F
Rankine	3	"R
milli Kelvin	4	mK
Pressure change per unit of time: Type code 6		
Pascal/sec.	0	Pa/s
Pascal/min.	1	Pa/m
Pascal/h	2	Pa/h
Millibar/sec	3	mb/s
Millibar/min	4	mb/m
Millibar/hour	5	mb/h
Bar/sec	6	b/s
Bar/min	7	b/m
Bar/hour	8	b/h
Pounds /in²/sec	9	PSIs
Pounds /in²/min	10	PSIm
Pounds /in²/hour	11	PSIh
Time: Type code 7		
Seconds (s)	0	sec
Minutes (min)	1	min
Hours (h)	2	hour
Days	3	day

Unit	Unit code	Display on screen
Milliseconds	4	msec
Microseconds	5	usec
Volume: *Type code 8*		
m^3	0	m3
Liters	1	Lit
cm^3	2	cm3
ft^3	3	CF
$inch^3$	4	CI
mm^3	5	mm3
ml	6	ml
Mass: *Type code 9*		
kg	0	kg
g	1	g
lb	2	lb
t	3	t
Dimensionless: *Type code 10*		
Factor 1	0	-
Percent %	1	%
Kilo	2	E+03
Mega	3	E+06
Milli	4	E-03
Micro	5	E-06
Nano	5	E-09
Femto	5	E-12
Pico	5	E-15
Voltage: *Type code 11*		
Volts	0	V

Unit	Unit code	Display on screen
Millivolts	1	mV
Microvolts	2	uV
Current: *Type code 12*		
Amperes	0	A
Milliamperes	1	mA
Microamperes	2	uA
Resistance: *Type code 13*		
Ohms	0	ohm
Milliohms	1	mOhm
Kiloohms	2	kOhm
Megaohms	3	MOhm
Distance: *Type code 14*		
Meters (m)	0	m
Centimeters (cm)	1	cm
Millimeters (mm)	2	mm
Kilometers (m)	3	km
Feet (ft)	4	feet
Inches (in)	5	inch
Yards (yd)	6	yard
Miles (mil)	7	mile
Micrometers (μ)	8	mu
Speed: *Type code 15*		
Meters/second (m/s)	0	m/s
Meters/minute (m/min)	1	m/min
Kilometers/hour (km/h)	2	km/h
Kilometers/second (km/s)	3	km/s
Inches/second (in/s)	4	in/s

Unit	Unit code	Display on screen
Feet/second (ft/sec)	5	ft/s
Yards/second (yd/s)	6	yd/s
Miles/second (mil/s)	7	mps
Miles/minute (mil/min)	8	mpm
Miles/hour (mil/h)	9	mph
Knots	10	knot
Centimeters/second	11	CMPS
Millimeters/second	12	MMPS
Acceleration: *Type code 16*		
Meters/second^2 (m/s^2)	0	m/s2
Feet/second^2 (ft/s^2)	1	fts2
User-defined: *Type code 17*		
SI unit	0	Defined in S9050 - S9095
Unit 1	1	Defined in S9050 - S9095
Unit 2	2	Defined in S9050 - S9095
Unit 3	3	Defined in S9050 - S9095
Unit 4	4	Defined in S9050 - S9095
Unit 5	5	Defined in S9050 - S9095
Force: *Type code 18*		
Newton	0	N
Dyn	1	dyne
Kilonewton	2	kN
Pound force	3	lbf
Poundel	4	pdl
Energy: *Type code 19*		
Joules	0	J
Watt-seconds	1	Ws

Unit	Unit code	Display on screen
Watt-hours	2	Wh
Kilowatt hours	3	kWh
Megawatt hours	4	MWh
Calories	5	cal
Kilocalories	6	kcal
British Thermal Units	7	btu
Power: *Type code 20*		
Watts	0	W
Kilowatts	1	kW
Megawatts	2	MW
Calories/second	3	c/s
Kilocalories/hour	4	kc/h
BTU/minute	5	btum
BTU/hour	6	btuh
Frequency: *Type code 21*		
Hertz	0	Hz
Kilohertz	1	kHz
Megahertz	2	MHz
1/minute	3	1/m
1/hour	4	1/h
Torque: *Type code 22*		
nm	0	-
lbft	1	-
Angle: *Type code 23*		
Rad	0	-
Deg	1	-

Unit	Unit code	Display on screen
Area: *Type code 24*		
m^2	0	-
cm^2	1	-
mm^2	2	-

Table 13.2.: Overview of physical variables and units