Communication Protocol

Version 2.1.5

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Content

1 Introduction

The new communication protocol is introduced in Thyracont Smartline Devices from a specific firmware version on and is usable besides the old protocol. **But it is strongly recommended to <u>either</u> use the old or the new communication protocol and not a mixture of both.**

E. g. the old commands for *Switchpoint*, *Setpoint* and *Hysteresis* have been superseded by a unique new command *Relay* and their respective read and write commands are not compatible to each other anymore. The new protocol has a completely new syntax with a 1 byte access code (AC), 2 bytes command (CMD) and 2 bytes data field length. The new syntax is described below.

Note: VD8 compact vacuum meters use the old communication protocol V1.

2 Syntax

2.1 Package

For packages without data:

0	1	2	3	4	5	6	7	8	9
ADR			AC	CMD		LEN		CS	CR

For packages with data:

0	1	2	3	4	5	6	7	8	…	n	n+1	n+2
ADR			AC	CMD		LEN		DATA			CS	CR

The bytes are summarized by the following table:

Syntax Part	Byte (with data)	Byte (without data)	Description
Address (ADR)	0-2	0-2	Address for communication
Access Code (AC)	3	3	Access type
Command (CMD)	4-5	4-5	Character codes command
Length (LEN)	6-7	6-7	Length of data
Data (DATA)	8-n		Data to send or receive
Checksum (CS)	n+1	8	Checksum for byte 0 to 7 (without data) Checksum for byte 0 to n (with data)
Carriage Return (CR)	n+2	9	Carriage return, mandatory

2.2 Address (ADR)

The address consists of 3 bytes.

Address (ADR)	
001	RS232 or USB
001-016	RS485
100	VD12 (USB)

2.3 Access Code (AC)

The byte access code differs between read, write, factory default, error and binary mode. If you want to send a package with a read command from your master to the transmitter you must use "0" (zero) as access code. If the transmitter has executed the command it will answer and increase the access code by one. Thus, the received package has access code "1". The same applies for the write command. From master to transmitter you must use "2" for a write command, and the received feedback from the transmitter contains "3" as access code.

Factory default is an option for some commands to reset a parameter to its default value, e. g. the gas correction factor for a Pirani sensor.

If an error happens inside of any transmitter, the access code will be changed to "7" and not increased by one. The binary mode is to read and write binary data and is used for firmware update. Note: When using Binary Type of Access the length (LEN) must also be binary data of 2 bytes.

Type of Access	Access Codes for Send Sequences Master → Transmitter	Access Codes for Receive Sequences Transmitter → Master
Read	0	1
Write	2	3
Factory Default	4	5
Error	-	7
Binary	8	9

2.4 Command (CMD)

The new command is a 2 bytes case sensitive character [AA to ZZ]. A full list of valid commands is given in the next chapter.

2.5 Length (LEN)

The new part of a package is the length of DATA in bytes. If the length is lower than 10 bytes, fill up with zeros to the left. If there is no DATA (e. g. Read Commands) use "00" as length.

2.6 Checksum (CS)

Every package contains a checksum to verify the validity of the package and the calculation formula has not changed with respect to old protocol.

Package without data: build checksum from bytes 0 to 7
Package with data: build checksum from bytes 0 to n

The checksum equation:

$$DecimalNumber of CS = \left(\sum decimal numbers of characters \right) mod\, 64 + 64$$

To get the character of the checksum, convert the resulting decimal number of CS backwards into an ASCII character.

Example: Read Measurement Value (MV) at address 1

0	1	2	3	4	5	6	7	8	9
ADR			AC	CMD		LEN		CS	CR
0	0	1	0	M	V	0	0	?	CR
48	48	49	48	77	86	48	48		

1   Calculate sum: 48+48+49+48+77+86+48+48 = 452
2   Calculate decimal number of CS character: (452 mod 64) + 64 = 4 + 64 = 68
3   ASCII Character of decimal 68 is uppercase "D"
4   Insert "D" as checksum character

0	1	2	3	4	5	6	7	8	9
ADR			AC	CMD		LEN		CS	CR
0	0	1	0	M	V	0	0	D	CR

2.7 Data Source

Some commands support selecting the data source. This means the input data of this function can be set to another source of measurement data. The data source is set as an integer value corresponding to a sensor or a virtual sensor.

Sensor Type	Data Source Value
Absolute Pressure (Combination)	0 (default)
Pirani	1
Piezo	2
Hot Cathode	3
Cold Cathode	4
Ambient Pressure	6
Relative Pressure	7

3 Command Overview

3.1 Main Commands

Command	CMD	Valid Access Codes (AC)				
		Read	Write	Factory Default	Error	Binary
		0/1	2/3	4/5	7	8/9
Measurement Range	MR	X			X	
Measurement Value	MV	X			X	
Measurement Value 1 (Pirani)	M1	X			X	
Measurement Value 2 (Piezo)	M2	X			X	
Measurement Value 3 (Hot Cathode)	M3	X			X	
Measurement Value 4 (Cold Cathode)	M4	X			X	
Measurement Value 6 (Ambient P.)	M6	X			X	
Measurement Value 7 (Relative P.)	M7	X			X	
Relay 1	R1	X	X	X	X	
Relay 2	R2	X	X	X	X	
Relay 3	R3	X	X	X	X	
Relay 4	R4	X	X	X	X	
Display Unit	DU	X	X	X	X	
Display Orientation	DO	X	X	X	X	
Display Data Source	DD	X	X	X	X	
Adjust High	AH		X		X	
Adjust Low	AL		X		X	

3.2 Device Parameters

Command	CMD	Valid Access Codes (AC)				
		Read	Write	Factory Default	Error	Binary
		0/1	2/3	4/5	7	8/9
Degas	DG	X	X		X	
Digital Logic	DL	X	X		X	
Sensor Transition	ST	X	X	X	X	
Cathode Status	CA	X			X	

Cathode Control	CC	X	X	X	X	
Cathode Control Mode	CM	X	X	X	X	
Filament Control	FC	X	X	X	X	
Filament Number	FN	X			X	
Filament Status	FS	X			X	
Gas Correction Factor 1 (Pirani)	C1	X	X	X	X	
Gas Correction Factor 3 (Hot Cathode)	C3	X	X	X	X	
Gas Correction Factor 4 (Cold Cathode)	C4	X	X	X	X	
Analog Output Characteristic	OC	X		X	X	
Panel Status	PS	X	X		X	
Controller Status	CS	X	X		X	

3.3   Device Information

Command	CMD	Valid Access Codes (AC)				
		Read	Write	Factory Default	Error	Binary
		0/1	2/3	4/5	7	8/9
Type of Device	TD	X			X	
Product Name	PN	X			X	
Serial Number Device	SD	X			X	
Serial Number Head	SH	X			X	
Baud Rate	BR		X		X	
Device Address	DA	X	X	X	X	
Response Delay	RD	X	X	X	X	
Version Device	VD	X			X	
Version Firmware	VF	X			X	
Version Bootloader	VB	X			X	
Device Restart	DR		X		X	
Operating Hours	OH	X			X	
Gauge Statistics	PM	X		X	X	

4 Command List

4.1 Smartline Transmitter

Name	CMD	VSR / VCR	VSL / VCL	VSP / VCP	VSH	VSM	VSI
Measurement Range	MR	X	X	X	X	X	X
Measurement Value	MV	X	X	X	X	X	X
Measurement Value 1 (Pirani)	M1	X	X	X	X	X	
Measurement Value 2 (Piezo)	M2	X	X				
Measurement Value 3 (Hot Cathode)	M3				X^2		
Measurement Value 4 (Cold Cathode)	M4					X^2	X
Measurement Value 6 (Ambient P.)	M6		X^3				
Measurement Value 7 (Relative P.)	M7		X^3				
Relay 1	R1	X	X	X	X	X	X
Relay 2	R2	X	X	X	X	X	X
Display Unit	DU	X^1	X^1	X^1	X^1	X^1	X^1
Display Orientation	DO	X^1	X^1	X^1	X^1	X^1	X^1
Display Data Source	DD	X^1	X^1	X^1	X^1	X^1	X^1
Adjust High	AH	X	X	X	X	X	
Adjust Low	AL	X	X	X	X	X	

Name	CMD	VSR / VCR	VSL / VCL	VSP / VCP	VSH	VSM	VSI
Degas	DG				X		
Digital Logic	DL		X		X	X	X
Sensor Transition	ST	X	X		X	X	
Cathode Status	CA				X	X	X
Cathode Control	CC				X	X	X
Cathode Control Mode	CM					X	X
Filament Control	FC				X		
Filament Number	FN				X		
Filament Status	FS				X		
Gas Correction Factor 1 (Pirani)	C1	X	X	X	X	X	
Gas Correction Factor 3 (Hot Cathode)	C3				X		
Gas Correction Factor 4 (Cold Cathode)	C4					X	X
Analog Output Characteristic	OC	X	X	X	X	X	X
Operating Hours	OH	X	X	X	X	X	X
Gauge Statistics	PM	X	X	X	X	X	

Name	CMD	VSR / VCR	VSL / VCL	VSP / VCP	VSH	VSM	VSI
Type of Device	TD	X	X	X	X	X	X
Product Name	PN	X	X	X	X	X	X
Serial Number Device	SD	X	X	X	X	X	X
Serial Number Head	SH	X	X	X	X	X	X
Baud Rate	BR	X	X	X	X	X	X
Response Delay	RD	X	X	X	X	X	X
Version Device	VD	X	X	X	X	X	X
Version Firmware	VF	X	X	X	X	X	X
Version Bootloader	VB	X	X	X	X	X	X
Device Restart	DR	X	X	X	X	X	X

Notes:
1) Only valid if device has an LCD display
2) Only valid if cathode is not switched off permanently
3) Only valid if device has an ambient pressure sensor

4.2 USB Transmitter and Mini Transmitter

Name	CMD	PT51S0	VSR5xUSB
Measurement Range	MR	X	X
Measurement Value	MV	X	X
Measurement Value 1 (Pirani)	M1	X	X
Measurement Value 2 (Piezo)	M2	X	X
Measurement Value 6 (Ambient P.)	M6	X[1]	
Measurement Value 7 (Relative P.)	M7	X[1]	
Adjust High	AH	X	X
Adjust Low	AL	X	X
Sensor Transition	ST	X	X
Gas Correction Factor 1 (Pirani)	C1	X	X
Analog Output Characteristic	OC	X[2]	
Gauge Statistics	PM	X	X
Type of Device	TD	X	X
Product Name	PN	X	X
Serial Number Device	SD	X	X
Serial Number Head	SH	X	X
Baud Rate	BR	X	X
Device Address	DA	X[3]	
Version Device	VD	X	X
Version Firmware	VF	X	X
Device Restart	DR	X	X

Notes:
1) Only valid if device has an ambient pressure sensor
2) Only valid if device has an analog output
3) Only valid for devices with RS485 interface

4.3 Display and Control Units

Name	CMD	VD12	VD14
Relay 1	R1	X	X
Relay 2	R2	X	X
Relay 3	R3		X
Relay 4	R4		X
Display Unit	DU	X	X
Panel Status	PS	X	X
Controller Status	CS	X	X

Name	CMD	VD12	VD14
Type of Device	TD	X	X
Product Name	PN	X	X
Version Device	VD	X	X
Version Firmware	VF	X	X
Version Bootloader	VB	X	X
Device Restart	DR	X	X

5 Command Descriptions

5.1 Main Commands

5.1.1 Measurement Range (MR)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	MR	no data	
	Receive	1	MR	H[float]L[float]	H followed by upper limit as float [mbar] L followed by lower limit as float [mbar]
		7	MR	Error Code	See Error Messages

Example: Read Measurement Range VSR53D, Address 1

Sequence Send:

0	1	2	3	4	5	6	7	8	9
ADR			AC	CMD		LEN		CS	CR
0	0	1	0	M	R	0	0	@	CR

Sequence Receive:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
ADR			AC	CMD		LEN		DATA											CS	CR
0	0	1	1	M	R	1	1	H	1	.	2	e	3	L	1	e	-	4	w	CR

The transmitter VSR53D has a measurement range from 1.2e3 to 1e-4 mbar.

5.1.2 Measurement Value (MV)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	MV	no data	
	Receive	1	MV	float	Pressure [mbar]
		1	MV	OR	Overrange
		1	MV	UR	Underrange
		7	MV	Error Code	See Error Messages

Example: Read Current Pressure from VSR53D, Address 1

Sequence Send:

0	1	2	3	4	5	6	7	8	9
ADR			AC	CMD		LEN		CS	CR
0	0	1	0	M	V	0	0	D	CR

Sequence Receive: Pressure 973.4 mbar

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
ADR			AC	CMD		LEN		DATA							CS	CR
0	0	1	1	M	V	0	7	9	.	7	3	4	e	2	h	CR

5.1.3 Measurement Value 1, 2, 3, 4, 6, 7 (M1, M2, M3, M4, M6, M7)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	M1	no data	Pressure Pirani [mbar]
			M2	no data	Pressure Piezo [mbar]
			M3	no data	Pressure Hot Cathode [mbar]
			M4	no data	Pressure Cold Cathode [mbar]
			M6	no data	Ambient Pressure [mbar]
			M7	no data	Relative Pressure [mbar]
	Receive	1	M1/7	float	Pressure Value [mbar]
		1	M1/7	OR	Overrange
		1	M1/7	UR	Underrange
		7	M1/7	Error Code	See Error Messages

5.1.4 Relay 1, 2, 3, 4 (R1, R2, R3, R4)

The relays can be configured independently and can follow different operating modes. These modes depend on transmitter type and firmware version. It may be possible that not all modes are supported by your firmware; in that case your transmitter will return an error message and you must update the firmware first.

The following modes are possible:
- Switch by pressure (default)
- Switch on/off if Error
- Switch on/off if Underrange
- Switch on/off if Overrange
- Switch on/off if cathode is on
- Switch on/off if filament is defect
- Switch temporarily on/off

Apart from the default mode all others can be inverted by using an exclamation mark as prefix. The default mode can be inverted by switching both pressure values.

For control units it is necessary to specify the appropriate measurement channel. Therefore an additional measurement channel parameter is appended with the parameter prefix "C" in the data field.

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	R1/4	no data	
	Receive	1	R1/4	T[float]F[float]	Mode: Switch by pressure (default) T followed by pressure [mbar] F followed by pressure [mbar]
				T[float]F[float]D[int]	D (optional parameter "data source"; VSL/VCL only)
				T[float]F[float]C[int]	C (parameter "channel"; VD12/14 only)
				E	Mode: Switch on if Error
				!E	Mode: Switch off if Error
				U	Mode: Switch on if Underrange
				!U	Mode: Switch off if Underrange
				O	Mode: Switch on if Overrange (VSR/VCR, VSL/VCL, VSI only)
				!O	Mode: Switch off if Overrange (VSR/VCR, VSL/VCL, VSI only)

					C	Mode: Switch on if cathode is on (VSH, VSM/VSI only)
					!C	Mode: Switch off if cathode is on (VSH, VSM/VSI Only)
					W	Mode: Switch on if filament is defect (VSH only)
					!W	Mode: Switch off if filament is defect (VSH only)
					T0	Mode: Temporarily, relay off
					T1	Mode: Temporarily, relay on
			7	R1/4	Error Code	See Error Messages
Write	Send		2	R1/4	T[float]F[float]D[int]	Mode: Switch by pressure (default) T followed by pressure [mbar] F followed by pressure [mbar]
					T[float]F[float]D[int]	D (optional parameter "data source"; VSL/VCL only)
					T[float]F[float]C[int]	C (parameter "channel"; VD12/14 only)
					E	Mode: Switch on if Error
					!E	Mode: Switch off if Error
					U	Mode: Switch on if Underrange
					!U	Mode: Switch off if Underrange
					O	Mode: Switch on if Overrange (VSR/VCR, VSL/VCL, VSI only)
					!O	Mode: Switch off if Overrange (VSR/VCR, VSL/VCL, VSI only)
					C	Mode: Switch on if cathode is on (VSH, VSM/VSI only)
					!C	Mode: Switch off if cathode is on (VSH, VSM/VSI only)
					W	Mode: Switch on if filament is defect (VSH only)
					!W	Mode: Switch off if filament is defect (VSH only)
					T0	Mode: Temporarily, relay off
					T1	Mode: Temporarily, relay on
	Receive		3	R1/4	no data	Write successful
			7	R1/4	Error Code	See Error Messages
Factory Default	Send		4	R1/4	no data	Restore Default Mode and Default pressure values
	Receive		5	R1/4	no data	Restore Default successful
			7	R1/4	Error Code	See Error Messages

Example: Write "1E-1 mbar on and 1.5 mbar off" as relay 1 setting for VSP53DL, Address 2
Sequence Send:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
ADR			AC	CMD		LEN		DATA								CS	CR
0	0	2	2	R	1	0	8	T	0	.	1	F	1	.	5	I	CR

Sequence Receive:

0	1	2	3	4	5	6	7	8	9
ADR			AC	CMD		LEN		CS	CR
0	0	2	3	R	1	0	0	h	CR

Example: Write "1E-1 mbar on, 1.5 mbar off on measurement channel 1" as relay 1 setting for VD12, Address 100

Sequence Send:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
ADR			AC	CMD		LEN		DATA										CS	CR
1	0	0	2	R	1	1	0	T	0	.	1	F	1	.	5	C	1	X	CR

Sequence Receive:

0	1	2	3	4	5	6	7	8	9
ADR			AC	CMD		LEN		CS	CR
1	0	0	3	R	1	0	0	g	CR

5.1.5 Display Unit (DU)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	DU	no data	
	Receive	1	DU	mbar	Current unit is mbar (default)
				Torr	Current unit is Torr
				hPa	Current unit is hPa
		7	DU	Error Code	See Error Messages
Write	Send	2	DU	mbar	New unit is mbar (default)
				Torr	New unit is Torr
				hPa	New unit is hPa
	Receive	3	DU	no data	Write successful
		7	DU	Error Code	See Error Messages
Factory Default	Send	4	DU	no data	Restore Default
	Receive	5	DU	no data	Restore Default successful
		7	DU	Error Code	See Error Messages

Example: Write "mbar" as new display unit for VSP53DL, Address 2

Sequence Send:

0	1	2	3	4	5	6	7	8	9	10	11	12	13
ADR			AC	CMD		LEN		DATA				CS	CR
0	0	2	2	D	U	0	4	m	b	a	r	c	CR

Sequence Receive:

0	1	2	3	4	5	6	7	8	9
ADR			AC	CMD		LEN		CS	CR
0	0	2	3	D	U	0	0	~	CR

Valid units:

VSP/VCP, VSM/VSI, VSH:	mbar, Torr, hPa, Torr760
VSR/VCR, VSL/VCL:	mbar, Torr, hPa
VD12/VD14:	mbar, Torr, hPa, bar, mTorr, Pa

5.1.6 Display Orientation (DO)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	DO	no data	
	Receive	1	DO	0	Not rotated (default)
				1	Rotated by 180°
		7	DO	Error Code	See Error Messages
Write	Send	2	DO	0	Not rotated (default)
				1	Rotate by 180°
	Receive	3	DO	no data	Write successful
		7	DO	Error Code	See Error Messages
Factory Default	Send	4	DO	no data	Restore Default
	Receive	5	DO	no data	Restore Default successful
		7	DO	Error Code	See Error Messages

5.1.7 Display Data Source (DD)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	DD	no data	
	Receive	1	DD	Int	Data source (default: 0)
		7	DD	Error Code	See Error Messages
Write	Send	2	DD	Int	Data source
	Receive	3	DD	no data	Write successful
		7	DD	Error Code	See Error Messages
Factory Default	Send	4	DD	no data	Restore Default (default: 0)
	Receive	5	DD	no data	Restore Default successful
		7	DD	Error Code	See Error Messages

5.1.8 Adjust High (AH)

Mode	Sequence	AC	CMD	Data	Description
Write	Send	2	AH	no data	Adjust High for VSP/VCP, VSM, VSH Adjust Relative (VSL/VCL only)
			AH	float	Adjust High for VSR/VCR, VSL/VCL; pressure in [mbar]
	Receive	3	AH	no data	Adjust High successful
		7	AH	Error Code	See Error Messages

Example: Adjust High with 981.5 mbar for VSR53D, Address 1
Sequence Send:

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
ADR			AC	CMD		LEN		DATA					CS	CR
0	0	1	2	A	H	0	5	9	8	1	.	5	v	CR

Sequence Receive:

0	1	2	3	4	5	6	7	8	9
ADR			AC	CMD		LEN		CS	CR
0	0	1	3	A	H	0	0	m	CR

5.1.9 Adjust Low (AL)

Mode	Sequence	AC	CMD	Data	Description
Write	Send	2	AL	no data	Adjust to zero
			AL	float	Adjust Low to specific pressure Valid from 1E-4 to 1E-1 mbar (VSP/VCP only)
	Receive	3	AL	no data	Adjust Low successful
		7	AL	Error Code	See Error Messages

5.2 Sensor Parameters

5.2.1 Degas (DG)

The current pressure must be below 2E-6mbar to switch Degas on.

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	DG	no data	
	Receive	1	DG	0	Degas currently off
			DG	1	Degas currently on
		7	DG	Error Code	See Error Messages
Write	Send	2	DG	0	Switch Degas off
			DG	1	Switch Degas on
	Receive	3	DG	no data	Write successful
		7	DG	Error Code	See Error Messages

5.2.2 Digital Logic (DL)

Digital Logic (Degas Logic) is a valid command for VSH serial numbers higher than 16580300, otherwise you will get the error message NO_DEF (see Error Messages). Furthermore, it is a valid command for VSI/VSM (Cathode Control Logic), and VSL/VCL (Adjust Control Logic) transmitter.

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	DL	no data	
	Receive	1	DL	0	Degas Logic is active low (VSH) Logic is active low (VSI/VSM, VSL/VCL)
				1	Degas Logic is active high (VSH) Logic is active high (VSI/VSM, VSL/VCL)
		7	DL	Error Code	See Error Messages
Write	Send	2	DL	0	Set Degas Logic to active low (VSH) Set Logic to active low (VSI/VSM, VSL/VCL)
				1	Set Degas Logic to active high (VSH) Set Logic to active high (VSI/VSM, VSL/VCL)
	Receive	3	DL	no data	Write successful
		7	DL	Error Code	See Error Messages
Factory Default	Send	4	DL	no data	Restore Default (active low) for VSH Restore Default (active high) for VSI/VSM, VSL/VCL
	Receive	5	DL	no data	Restore Default successful
		7	DL	Error Code	See Error Messages

5.2.3 Sensor Transition (ST)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	ST	no data	
	Receive	1	ST	0	Direct Switch VSR/VCR, VSL/VCL: 1 mbar VSH: 4E-4 mbar VSM: 1E-3 mbar
				1	Continuous Transition between VSR/VCR, VSL/VCL: 5 to 15 mbar VSH: 1E-3 to 2E-3 mbar VSM: 1E-3 to 2E-3 mbar (default)
				2	Continuous Transition between VSH: 2E-3 to 5E-3 mbar
				F[float]T[float]	Custom Continuous Transition (F)rom [float] (T)o [float], float [mbar]
				D[float]	Custom Direct Switch D[float], float in [mbar]
		7	ST	Error Code	See Error Messages
Write	Send	2	ST	0	Direct Switch VSR/VCR, VSL/VCL: 1 mbar VSH: 4E-4 mbar VSM: 1E-3 mbar
				1	Continuously Transition between VSR/VCR, VSL/VCL: 5 to 15 mbar VSH: 1E-3 to 2E-3 mbar VSM: 1E-3 to 2E-3 mbar (default)
				2	Continuously Transition between VSH: 2E-3 to 5E-3 mbar
				F[float]T[float]	Custom Continuous Transition (F)rom [float] (T)o [float], float [mbar] VSR/VCR, VSL/VCL: 1 mbar to 20 mbar VSH: 4E-4 mbar to 1E-2 mbar VSM: 4E-4 to 2E-3 mbar
				D[float]	Custom Direct Switch D[float], float in [mbar] VSR/VCR, VSL/VCL: 1 mbar to 20 mbar VSH: 4E-4 mbar to 1E-2 mbar VSM: 4E-4 to 2E-3 mbar
	Receive	3	ST	no data	Write successful
		7	ST	Error Code	See Error Messages
Factory Default	Send	4	ST	no data	Restore Default
	Receive	5	ST	no data	Restore Default successful
		7	ST	Error Code	See Error Messages

5.2.4 Cathode Status (CA)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	CA	no data	
	Receive	1	CA	0	Cathode is off
				1	Cathode is on
		7	CA	Error Code	See Error Messages

5.2.5 Cathode Control (CC)

All modifications with Cathode Control are temporary.

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	CC	no data	
	Receive	1	CC	0	Cathode is off
				1	Cathode is on (default)
		7	CC	Error Code	See Error Messages
Write	Send	2	CC	0	Cathode off
				1	Cathode on (default)
	Receive	3	CC	no data	Write successful
		7		Error Code	See Error Messages
Factory Default	Send	4	CC	no data	Restore Default
	Receive	5	CC	no data	Restore Default successful
		7	CC	Error Code	See Error Messages

5.2.6 Cathode Control Mode (CM)

All modifications with Cathode Control Mode are permanent.

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	CM	no data	
	Receive	1	CM	0	User Control (manually)
				1	Automatic Control (default)
		7	CM	Error Code	See Error Messages
Write	Send	2	CM	0	User Control (manually)
				1	Automatic Control (default)
	Receive	3	CM	no data	Write successful
		7		Error Code	See Error Messages
Factory Default	Send	4	CM	no data	Restore Default
	Receive	5	CM	no data	Restore Default successful
		7	CM	Error Code	See Error Messages

5.2.7 Filament Control (FC)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	FC	no data	
	Receive	1	FC	0	Switch to Fil. 2 if Fil. 1 is defect (default)
			FC	1	Force use Fil. 1
			FC	2	Force use Fil. 2
			FC	3	Toggle Filament if pressure > 1 mbar
		7	FC	Error Code	See Error Messages
Write	Send	2	FC	0	Switch to Fil. 2 if Fil. 1 is defect (default)
			FC	1	Force use Fil. 1
			FC	2	Force use Fil. 2
			FC	3	Toggle Filament if pressure > 1 mbar
	Receive	3	FC	no data	Write successful
		7	FC	Error Code	See Error Messages
Factory Default	Send	4	FC	no data	Restore Default
	Receive	5	FC	no data	Restore Default successful
		7	FC	Error Code	See Error Messages

5.2.8 Filament Number (FN)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	FN	no data	
	Receive	1	FN	1 or 2	Return current filament number
		7	FN	Error Code	See Error Messages

5.2.9 Filament Status (FS)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	FS	no data	
	Receive	1	FS	0	Filament 1 and 2 ok
			FS	1	Filament 1 defective
			FS	2	Filament 2 defective
			FS	3	Filament 1 and 2 defective
		7	FS	Error Code	See Error Messages

5.2.10 Gas Correction Factor 1, 3, 4 (C1, C3, C4)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	C1	no data	
			C3	no data	
			C4	no data	
	Receive	1	C1	float (2 decimals)	Factor for Pirani
			C3	float (2 decimals)	Factor for Hot Cathode
			C4	float (2 decimals)	Factor for Cold Cathode
		7	C1 C3/4	Error Code	See Error Messages
Write	Send	2	C1	float	New factor for Pirani (0.2 to 8.0)
			C3	float	New factor for Hot Cathode (0.2 to 8.0)
			C4	float	New factor for Cold Cathode (0.2 to 8.0)
	Receive	3	C1	no data	Write successful
		7	C3/4	Error Code	See Error Messages
Factory Default	Send	4	C1	no data	Restore Default Factor for Pirani
			C3	no data	Restore Default Factor for Hot Cathode
			C4	no data	Restore Default Factor for Cold Cathode
	Receive	5	C1	no data	Restore successful
		7	C3/4	Error Code	See Error Messages

5.2.11 Panel Status (PS)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	PS	no data	
	Receive	1	PS	0	Panel unlocked
				1	Panel locked
		7	PS	Error Code	See Error Messages
Write	Send	2	PS	0	Unlock Panel
				1	Lock Panel
	Receive	3	PS	no data	Write successful
		7	PS	Error Code	See Error Messages

5.2.12 Controller Status (CS)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	CS	no data	
	Receive	1	CS	0	Controller is off
				1	Controller is on
		7	CS	Error Code	See Error Messages
Write	Send	2	CS	0	Switch Controller off
				1	Switch Controller on
	Receive	3	CS	no data	Write successful
		7	CS	Error Code	See Error Messages

5.3 Transmitter Parameter

5.3.1 Type of Device (TD)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	TD	no data	
	Receive	1	TD	string	Identification string of the device
		7	TD	Error Code	See Error Messages

5.3.2 Product Name (PN)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	PN	no data	
	Receive	1	PN	string	Product Name, e. g. VSP53D
		7	PN	Error Code	See Error Messages

5.3.3 Serial Number Device (SD)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	SD	no data	
	Receive	1	SD	string	Serial Number of Device
		7	SD	Error Code	See Error Messages

5.3.4 Serial Number Head (SH)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	SH	no data	
	Receive	1	SH	string	Serial Number of Sensor Head
		7	SH	Error Code	See Error Messages

5.3.5 Baud Rate (BR)

Mode	Sequence	AC	CMD	Data	Description
Write	Send	2	BR	[baud rate]	Use baud rate as data 9600, 14400, 19200, 28800, 38400, 57600, 115200
	Receive	3	BR	no data	Write successful
		7	BR	Error Code	See Error Messages

Note: If no error, the new baud will be activated after the receive sequence.

5.3.6 Device Address (DA)

Mode	Sequence	AC	CMD	Data	Description
Write	Send	2	DA	[address]	Valid address range 1 - 16
	Receive	3	DA	no data	Write successful
		7	DA	Error Code	See Error Messages

Note: If no error, the new address will be activated after the receive sequence.

5.3.7 Response Delay (RD)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	RD	no data	
	Receive	1	RD	int	Response delay in µs
		7	RD	Error Code	See Error Messages
Write	Send	2	RD	int	New response delay in µs (Valid values from 1 to 99999µs)
	Receive	3	RD	no data	Write successful
		7	RD	Error Code	See Error Messages

Note: The change of the response delay is always temporarily. After switching the device on/off or sending a Device Restart (DR) command the device will use the default value again.

5.3.8 Version Device (VD)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	VD	no data	
	Receive	1	VD	string	Version Device
		7	VD	Error Code	See Error Messages

5.3.9 Version Firmware (VF)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	VF	no data	
	Receive	1	VF	string	Version Firmware
		7	VF	Error Code	See Error Messages

5.3.10 Version Bootloader (VB)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	VB	no data	
	Receive	1	VB	string	Version Bootloader
		7	VB	Error Code	See Error Messages

5.3.11 Device Restart (DR)

Mode	Sequence	AC	CMD	Data	Description
Write	Send	2	DR	no data	
	Receive	3	DR	no data	
		7	DR	Error Code	See Error Messages

Note: If no error, device will restart after the receive sequence.

5.3.12 Analog Output Characteristic (OC)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	OC	no data	
	Receive	1	OC	Data String	See Description Data String
		7	OC	Error Code	See Error Messages
Write	Send	2	OC	Data String	See Description Data String
	Receive	3	OC	no data	Write successful
		7	OC	Error Code	See Error Messages
Factory Default	Send	4	OC	no data	Restore Default
	Receive	5	OC	no data	Restore Default successful
		7	OC	Error Code	See Error Messages

Description Data String:

The data string for the analog output characteristic has a mutable length and is divided into eight sub data contents. The order of sub data is mandatory.

Data	Sub Term	Sub Data	Description
DATA	TYPE	Log	Logarithmic Output
		Lin	Linear Output
	GAIN	G[float]	Gain shortcut "G" followed by float
	OFFSET	O[float]	Offset shortcut "O" followed by voltage float in [V]
	LOW. L.	L[float]	Lower Limit shortcut "L" followed by voltage float in [V]
	UPP. L.	L[float]	Upper Limit shortcut "L" followed by voltage float in [V]
	UNDER.	U[float]	Underrange shortcut "U" followed by voltage float in [V]
	OVER.	O[float]	Overrange shortcut "O" followed by voltage float in [V]
	FAULT	F[float]	Fault shortcut "F" followed by voltage float in [V]
	Data Source	D[int]	Optional data source

For table function:

Data	Sub Term	Sub Data	Description
DATA	Type	Tab	Logarithmic Output
	Size	S[int]	Table size count, maximum is 64
	UNDER.	U[float]	Underrange shortcut "U" followed by voltage float in [V]
	OVER.	O[float]	Overrange shortcut "O" followed by voltage float in [V]
	FAULT	F[float]	Fault shortcut "F" followed by voltage float in [V]
	Data Source	D[int]	Optional data source

Data	Sub Term	Sub Data	Description
DATA	Type	Tab	Logarithmic Output
	Entry	E[int]	Entry index
	Pressure	P[float]	Pressure shortcut "P" followed by pressure float in [mbar/hPa]
	Voltage	U[float]	Voltage shortcut "U" followed by voltage float in [V]

Data Package Syntax for Analog Output Characteristic:

8	9	10	11	…	…	…	…	…	…	…	…	…	…	…	n
DATA															
TYPE			GAIN		OFFSET		LOW. L.		UPP. L.		UNDER.		OVER.		FAULT	
L	o	g	G	float	O	float	L	float	L	float	U	float	O	float	F	float
L	i	n	G	float	O	float	L	float	L	float	U	float	O	float	F	float

Example: Read Analog Output Characteristic
Sequence Send:

0	1	2	3	4	5	6	7	8	9
ADR			AC	CMD		LEN		CS	CR
0	0	1	0	O	C	0	0	s	CR

For a table entry:

0	1	2	3	4	5	6	7	8	9	10	11
ADR			AC	CMD		LEN		Type	Index	CS	CR
0	0	1	0	O	C	0	2	E	1	k	CR

Sequence Receive:

0	1	2	3	4	5	6	7	8	…	n	n+1	n+2
ADR			AC	CMD		LEN		DATA			CS	CR
0	0	1	1	O	C	3	7	37 Byte			I	CR

The content of DATA will be:

8	9	10	11	…	…	…	…	…	…	…	…	…	…	…	n
DATA															
TYPE			GAIN		OFFSET		LOW. L.		UPP. L.		UNDER.		OVER.		FAULT	
L	o	g	G	1.0	O	5.5	L	0.0	L	10.5	U	0.9	O	9.2	F	0.4

5.3.13 Operating Hours (OH)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	OH	no data	Operating hours
	Receive	1	OH	int	Operating hours in 15 minutes interval (VSR/VCR, VSL/VCL, VSP/VCP)
				[int]C[int]	Operating hours of device and cathode, each in 15 minutes interval (VSH, VSM/VSI)
		7	OH	Error Code	See Error Messages

Example: Operating hours for VSR53D, Address 1
Sequence Receive:

	0	1	2	3	4	5	6	7	8	9	10	11
	ADR			AC	CMD		LEN		DATA		CS	CR
	0	0	1	1	O	H	0	2	8	5	h	CR

Operating hours device: 85/4 = 21.25

Example: Operating Hours for VSM77D, Address 1
Sequence Receive:

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	ADR			AC	CMD		LEN		DATA					CS	CR
	0	0	1	1	O	H	0	5	4	2	C	3	6	P	CR

Operating hours device: 42/4 = 10.5
Operating hours cold cathode: 36/4 = 9

5.3.14 Gauge Statistics (PM)

Mode	Sequence	AC	CMD	Data	Description
Read	Send	0	PM	1	Data Pirani sensor
				3	Data hot cathode
	Receive	1	PM	W[int]A[int]	Data Pirani sensor: W[int], Pirani wear in percent - Negative: Corrosion - Positive: Contamination A[int], Time since last Pirani zero adjustment in 15 minutes interval
				F[int]S[int]	Data hot cathode: F[int]: Wear filament 1 in percent S[int]: Wear filament 2 in percent
		7	PM	_LOGIC Error Code	Data not available See Error Messages
Factory Default	Send	4	PM	1	Reset data Pirani sensor
	Receive	5	PM	no data	Restore Default successful
		7	PM	Error Code	See Error Messages

6   Warnings and Error Messages

If any error occurs, you will receive a feedback from the device with access code 7 and a short message in DATA to explain what kind of error happened.

DATA	Description
NO_DEF	Command is not valid (not defined) for the device, e. g. Degas (DG) for VSR
_LOGIC	Access Code is not valid or execution of command is not logical
_RANGE	Error if any data value in send sequence is out of range, e. g. value too high for a gas correction factor
ERROR1	Sensor is defect or stacked out
SYNTAX	Command is valid, but the syntax in data is wrong or the selected mode in data is not valid for your device
LENGTH	Command is valid, but the length of data is out of expected range
_CD_RE	Calibration Data Read Error
_EP_RE	EEPROM Read Error
_UNSUP	Unsupported Data, e. g. no valid value for baud rate
_SEDIS	Sensor element disabled, e. g. read measurement of cathode if cathode is disabled

7   ASCII Table

Dec	Hex	ASC	Dec	Hex	ASC	Dec	Hex	ASC	Dec	Hex	ASC	Dec	Hex	ASC	Dec	Hex	ASC
0	00	NUL	22	16	SYN	44	2C	,	66	42	B	88	58	X	110	6E	n
1	01	SOH	23	17	ETB	45	2D	-	67	43	C	89	59	Y	111	6F	o
2	02	STX	24	18	CAN	46	2E	.	68	44	D	90	5A	Z	112	70	p
3	03	ETX	25	19	EM	47	2F	/	69	45	E	91	5B	[	113	71	q
4	04	BOT	26	1A	SUB	48	30	0	70	46	F	92	5C	\	114	72	r
5	05	ENQ	27	1B	ESC	49	31	1	71	47	G	93	5D	]	115	73	s
6	06	ACK	28	1C	FS	50	32	2	72	48	H	94	5E	^	116	74	t
7	07	BEL	29	1D	GS	51	33	3	73	49	I	95	5F	_	117	75	u
8	08	BS	30	1E	RS	52	34	4	74	4A	J	96	60	`	118	76	v
9	09	TAB	31	1F	US	53	35	5	75	4B	K	97	61	a	119	77	w
10	0A	LF	32	20	SP	54	36	6	76	4C	L	98	62	b	120	78	x
11	0B	VT	33	21	!	55	37	7	77	4D	M	99	63	c	121	79	y
12	0C	FF	34	22	„	56	38	8	78	4E	N	100	64	d	122	7A	z
13	0D	CR	35	23	#	57	39	9	79	4F	O	101	65	e	123	7B	{
14	0E	SOH	36	24	$	58	3A	:	80	50	P	102	66	f	124	7C		
15	0F	SI	37	25	%	59	3B	;	81	51	Q	103	67	g	125	7D	}
16	10	DLE	38	26	&	60	3C	<	82	52	R	104	68	h	126	7E	~
17	11	DC1	39	27	,	61	3D	=	83	53	S	105	69	i	127	7F	DEL
18	12	DC2	40	28	(	62	3E	>	84	54	T	106	6A	j			
19	13	DC3	41	29	)	63	3F	?	85	55	U	107	6B	k			
20	14	DC4	42	2A	*	64	40	@	86	56	V	108	6C	l			
21	15	NAK	43	2B	+	65	41	A	87	57	W	109	6D	m			

8   Command comparison between old and new protocol

Old Protocol	New Protocol	Compatibility of Data	Description
Type (T)	Type of Device (TD)	Yes	
Measurement (M)	Measurement Value (MV)	No	old: 6 Byte fixed, coded new: float value
Setpoint (S,s) Hysteresis (H,h)	Relay 1,2,3,4 (R1,R2,R3,R4)	No	Complete overhaul, see command description
Parameter Set (P,p)			not supported anymore
Correction Factor (C,c)	Gas Correction Factor 1,3,4 (C1, C3, C4)	No	old: integer multiplied by 100 new: float value and distinction between hot and cold cathode possible
Adjustment (j)	Adjust High (AH) Adjust Low (AL)	No	Complete overhaul, see command description
Start/Stop Control (A,a)	Controller Status (CS)	Yes	
Lock Keyboard (K,k)	Panel Status (PS)	Yes	
Degas (D,d)	Degas (DG)	Yes	
Filament Number (F)	Filament Number (FN)	No	old: 0=Fil. 1, 1=Fil. 2 new: 1=Fil. 1, 2=Fil. 2
Sensor Transition (W,w)	Sensor Transition (ST)	partly	Complete overhaul, see command description
Cold Cathode (I,i)	Cathode Control (CC)	Yes	
Display Unit (U,u)	Display Unit (DU)	No	Complete overhaul, see command description

9   Document History

Date	Version	Author	Changes
12.04.2016	2.0.0	SJ	first public release
18.04.2016	2.0.1	SJ	Update Sensor Transition (ST) Custom Continuous Transition and Custom Direct Switch Added: Valid Pressure Ranges for VSR, VSH and VSM
			Update Gas Correction Factor 1, 3, 4 (C1, C3, C4) Fixed: Write Command, wrong sensor principle for C3 and C4 Added: Valid Factor Ranges for C1, C3 and C4
26.04.2016	2.0.2	SJ	Update Response Delay (RS) Added: Valid Value Range for RS
28.06.2016	2.0.3	SJ	Added: Degas Logic (DL)
			Fixed some typing errors in these commands: Adjust Low (AL) Device Restart (DR) Analog Output Characteristic (OC)
			Added: Adjust Low (AJ), Write with float as data to adjust low to a specific pressure
16.09.2016	2.0.4	SJ	Changed parameter descriptions with [hPa] to [mbar]. However, the value itself will not change, but mbar is the default unit: Changes done in: Measurement Range (MR) Measurement Value (MV) Measurement Value 1, 2, 3, 4 (M1, M2, M3, M4) Adjust High (AH) Adjust Low (AL) Relay 1, 2, 3, 4 (R1, R2, R3, R4) Sensor Transition (ST) Filament Control (FC)
			Update Response Delay (RD) Fixed typing error, changed "99999µ" to "99999µs"
12.10.2016	2.0.5	SJ	Update Display Unit (DU) Existing Access Code "Factory Default" wasn't documented
17.10.2016	2.0.6	SJ	Update Degas (DG) and DeGas Logic (DL) Added some information to both commands.
			Removed Version Head (VH) from valid command list for Smartline Transmitter
03.04.2017	2.0.7	SJ	Added: Cathode Control Mode (CM) Read, Write and Factory Default
			Added: Display Orientation (DO) Read, Write and Factory Default
			Added Overrange and Underrange Message to Command Measurement Value (MV) and Measurement Value 1,2,3,4 (M1/4)
			Reorganization of Command Overview section into Main Commands, Sensor Parameter and Device Information
25.07.2017	2.0.8	MN	Added: VD14
04.08.2017	2.0.9	MN	Added: VSM Digital Logic "DL"
16.10.2017	2.1.0	MN	Added: valid display units
13.11.2017	2.1.1	MN	Added: Analog Output Characteristic Table Function
21.12.2018	2.1.2	MN	Added: Measurement Value M6, M7 Added: Display Data Source

			Added: Data Source Parameter for R1, R2, OC
19.12.2019	2.1.3	WS	Fixed: Typos
			Update: Adjust functions, parameter DL
			Added: Operating Hours (OH)
-	2.1.4	WS	Added: VCR, VCL
			Added: Cathode Status (CA), Gauge Statistics (PM)
13.10.2021	2.1.5	MN	Added: PT51S0, VSR5xUSB
			Added: Command "Device Address"