Leybold

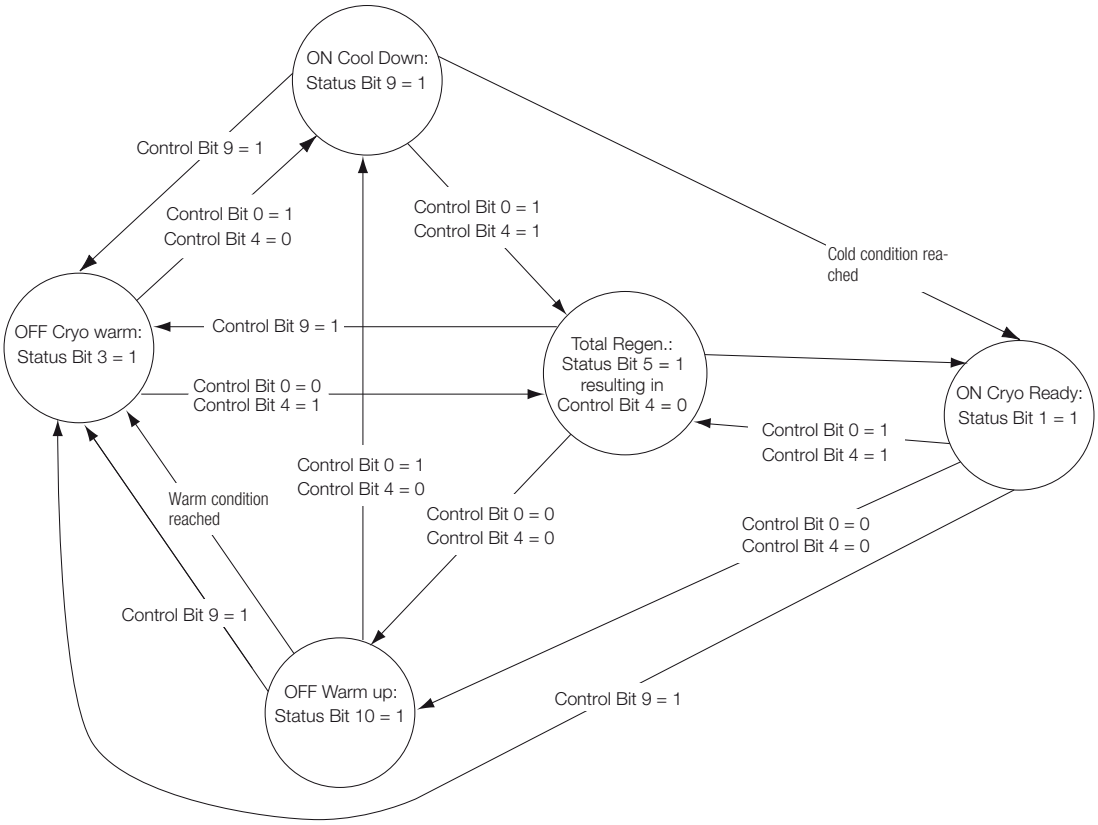
COOLVAC

ProfiBus Module

Operating Instructions 300358931_002_C1

Part Number

844000V1



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Installation and operation of the COOLVAC SC or the COOL.DRIVE is described in the Operating Instructions for the pump system, for example GA12145 for the COOLVAC ClassicLine or 300373558 for the COOLVAC iCL.
Described in these Operating Instructions is only the ProfiBus interface of the ProfiBus module.

Original operating instructions.

Obligation to Provide Information
Before installing and commissioning the COOLVAC ProfiBus module, carefully read these Operating Instructions and follow the information so as to ensure optimum and safe working right from the start.

NOTICE

The Leybold **COOLVAC ProfiBus module** has been designed for safe and efficient operation when used properly and in accordance with these Operating Instructions. It is the responsibility of the user to carefully read and strictly observe all safety precautions described in this section and throughout the Operating Instructions. The pump **must only be operated in the proper condition and under the conditions described in the Operating Instructions**. It must be operated and maintained by trained personnel only. Consult local, state, and national agencies regarding specific requirements and regulations. Address any further safety, operation and/or maintenance questions to our nearest office.

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

DANGER

WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

WARNING

CAUTION indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury.

CAUTION

NOTICE is used to notify users of installation, operation, programming or maintenance information that is important, but not hazard related.

NOTICE

We reserve the right to alter the design or any data given in these Operating Instructions. The illustrations are not binding.

Retain the Operating Instructions for further use.

Safety Information

0 Important Safety Information

0.1 Hazards in Connection with Safety-related Measures and Precautions

WARNING

1 The instrument has been developed and tested in accordance with the state-of-the-art, the European Standards EN 61000-6-2 and 61000-6-4, the EC Directive EMC (2004/108/EC) and other applicable safety engineering standards. Even so when using this instrument dangers need to be expected when the instrument is operated by personnel not qualified respectively when the instrument is improperly operated or not used in agreement with the specified conforming utilisation.

2 Comply with the information provided in these Operating Instructions in order to prevent endangering life and health of the operator or third persons, to prevent impairing functioning and quality of the instrument, as well as to prevent endangering material assets of the user.

3 Besides observing the information provided in these Operating Instructions and the binding accident prevention rulings which apply at the operating site, additionally observe the expert regulations relating to safe and professional working.

4 The operator must ensure that every person ordered with installing, respectively erecting, first-time commissioning, operating and maintenance of the instrument has read and fully understood the information provided in these Operating Instructions.

5 Conversions and modifications to the instrument not described in these Operating Instructions are prohibited for safety reasons. Such unauthorised modifications will render any manufacturer's liability void as to the therefrom resulting injury to persons and damage to property.

6 Have the instrument operated and maintained only by trained and duly authorised personnel familiarised with the instrument and instructed as to the dangers.

7 The operator must prevent unauthorised persons from operating the instrument.

8 At least once per shift the operator must inspect the instrument as to any externally apparent damage or deficiencies. The officer of the operator must be informed immediately as to any changes including the operational behaviour which are found and which impair safety.

0.2 Electric Hazards

WARNING

1 Do not disconnect any protective earth connections. By including all subassemblies in the protective earth scheme of the instrument fault currents are prevented from flowing through instrument sections in the event of a malfunction.

2 If for repair or other work protective earth connections need to be disconnected, these must be re-established immediately after having completed such work.

3 Deficiencies like loose connections, charred or corroded cables need to be repaired as soon as these are detected.

4 Have the instrument installed in an electrical cabinet and integrated within the electrical system of a vacuum system only by an expert working in agreement with VDE guidelines. Such work must only be done after the instrument and the related system have been reliably deenergised.

5 Disconnect the ProfiBus module from the mains power (at the power supply) before making any connections. Since dangerous voltages may nonetheless be encountered, the housing may only be opened by a duly qualified electrician.

0.3 Risk of Damaging the Instrument

NOTICE

1 When improperly connecting the wiring to the output of the instrument, a then occurring short-circuit may destroy the instrument.

1 ProfiBus DP

In a ProfiBus DP system, a difference is made between master and slave units. Here the master units control all traffic. They transmit data to the related slaves and request data from these. It is possible to run one or several masters in a system.

The COOlVAC ProfiBus module is a slave unit and thus respond to requests from the master, and it supply data exclusively after having received a request to do so from the master.

For more information on the ProfiBus system:
«The Rapid Way to ProfiBus»,
Manfred Popp, ProfiBus Nutzerorganisation e.V. Heid-und-Neu-Str. 7
D-76131 Karlsruhe
Germany
P/N: 4.072

1.1 Description of the Interface

At both ends of the bus a terminating resistor is required. Such a terminator can be activated in the module. The Profibus module has been prepared for installation on a hat rail.

Supplied Equipment

ProfiBus module for installation on a hat rail, RS 232 cable 3 m.

Standards

ProfiBus DP V0 corresponding to IEC 61158-2 and IEC 61784 Type 3

Protocol

In accordance with ProfiBus profile for variable fast revolving drive units Profile No.3; Version 2.0

Transmission rates and cable lengths

(see also the standards)

Transmission rate (kBit/s)	max. segment (m)
9.6-93.75	1200
187.5	1000
500	400
1500	200
3000-12000	100

The baud rate is set automatically. The following baud rates are supported:

9.6 k Baud	19.2 k Baud	45.45 k Baud	
93.75 k Baud	187.5 k Baud	500 k Baud	
1.5 M Baud	3 M Baud	6 M Baud	12 M Baud

Exterior view

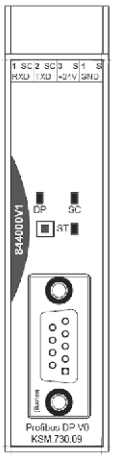

Fig. 1 Position of the LEDs on the ProfiBus module

Interior view

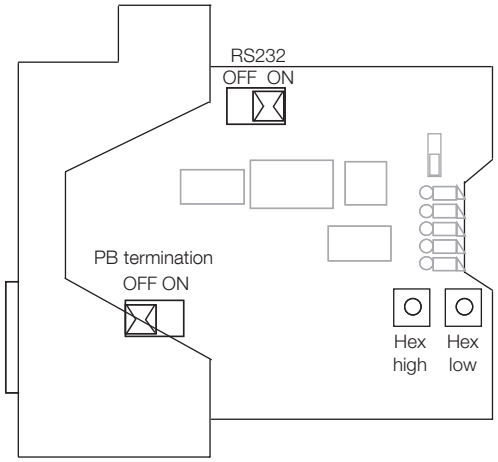

Fig. 2 Position of the addresses in the ProfiBus module
PB termination resistor to OFF, RS 232 set to ON

Address range	Hex $01 ... $7D (selectable via switch) Hex$7E software selectable
corresponding to	decimal 1 ... 126
Voltage level	see standards
Interface connection	Sub-D 9-way socket on the side of the instrument (female)
Thread	UNC4-40

The ProfiBus watchdog function has not been implemented.

1.2 Operation of the LEDs

LED SC

off	Ready for operation, no internal malfunction
red, steady	No RS232 link to the SC

LED ST

off	Unit is exchanging ProfiBus data
yellow, flashing	Unit is in clear mode, waiting for ProfiBus master initialisation
red, steady	Internal error
red, flashing	ProfiBus address is outside the valid range

LED DP

off	Unit is offline
green, steady	Unit is exchanging ProfiBus data

Connection

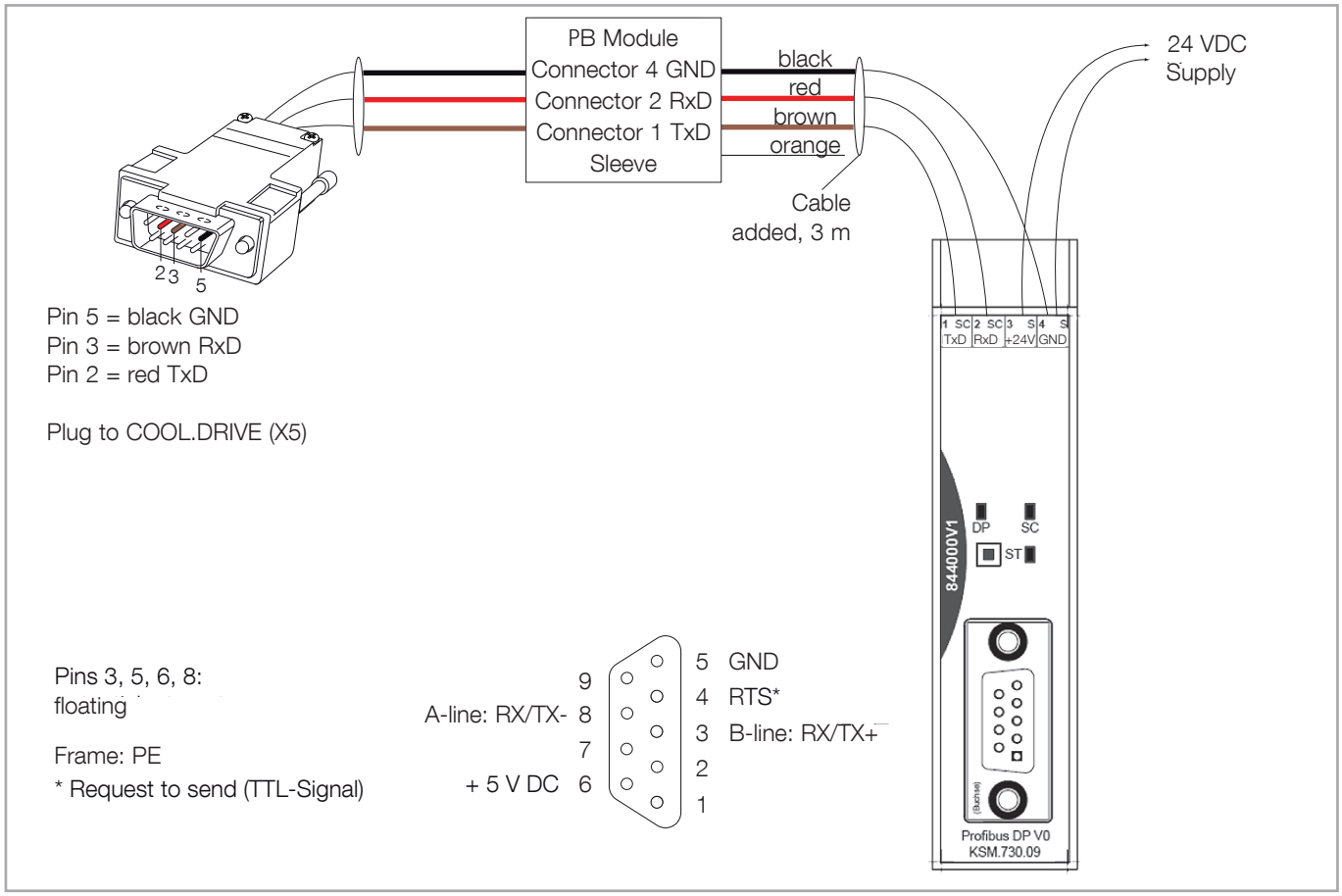

Fig. 3 Connection to COOL.DRIVE: Connections of the ProfiBus module and Assignment for the socket

2 Connection

WARNING

Disconnect the ProfiBus module and the pump control from the mains before making any connections. Since dangerous voltages may nonetheless be encountered, the housing must be opened only by a qualified electrician.

The Profibus module has been prepared for installation on a hat rail. Connect the ProfiBus via the ProfiBus module.

Line type	SIEMENS-SINEC-L2 bus line
P/N	6XV1830-0AH10

Connection to COOL.DRIVE

Connect the RS232 connection of the ProfiBus module at the COOL.DRIVE (X5) using the supplied cable.

The connection of a terminating resistor is required at the ends of the ProfiBus line. Both ProfiBus connector and ProfiBus module (cf. Fig. 2) show integrated terminating resistors. Upon delivery the terminating resistor of the ProfiBus module is switched OFF.

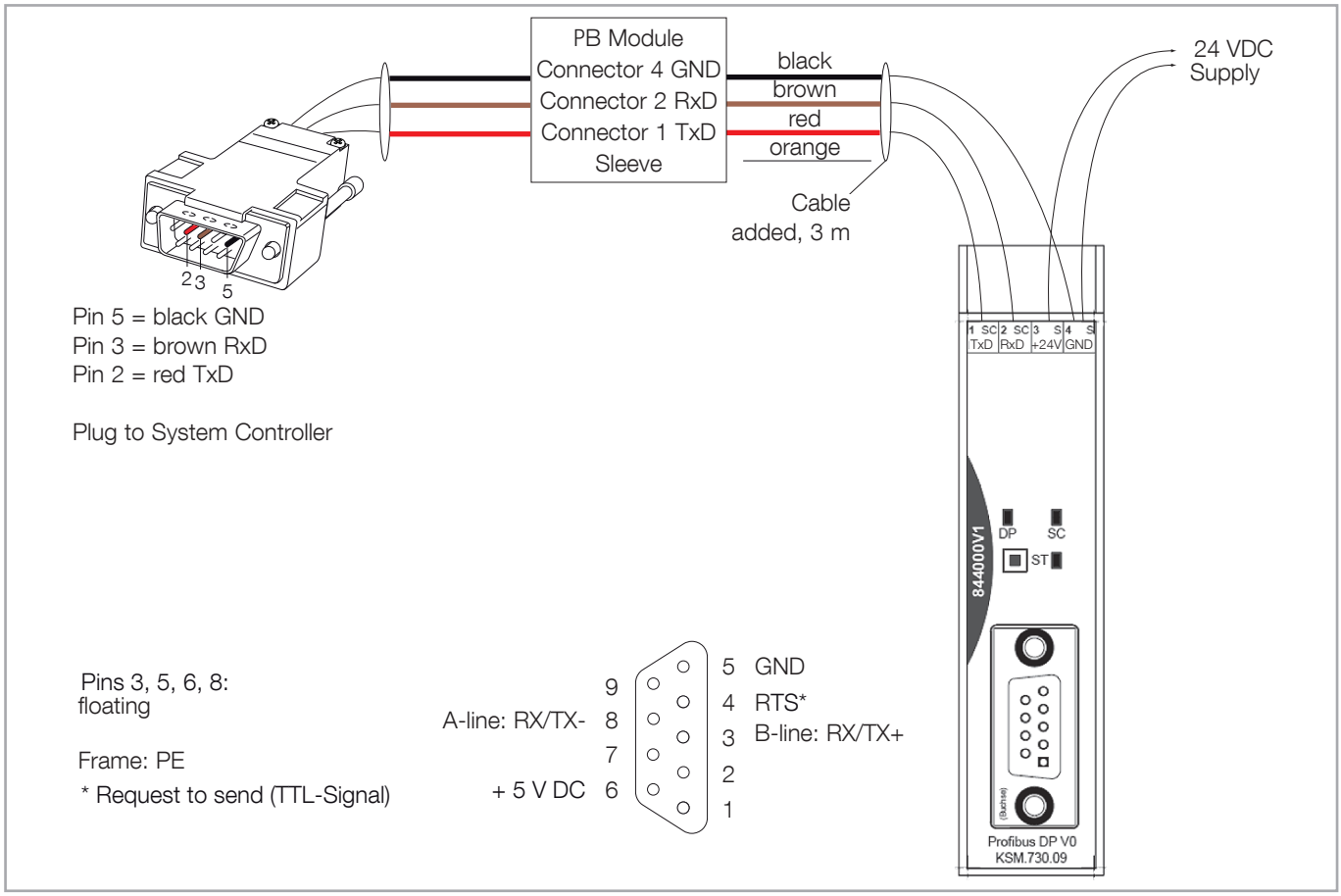

Fig. 4 Connection to System Controller SC: Connections of the ProfiBus module and Assignment for the socket

Connection to System Controller SC

Connect the RS232 connection of the ProfiBus module at the rear of the COOLVAC SC using the supplied cable.

The connection of a terminating resistor is required at the ends of the ProfiBus line. Both, ProfiBus connector and ProfiBus module (cf. Fig. 2) show integrated terminating resistors. Upon delivery the terminating resistor of the ProfiBus module is switched OFF.

Set the COOLVAC SC (P/N 844230) to a baud rate of 9600 and the interface to “Remote” so that the communication will be directed to the ProfiBus module.

Address

A new address setting is enabled when the power is switched on again.

Example: Address 43dez. = 2Bhex.

Connection

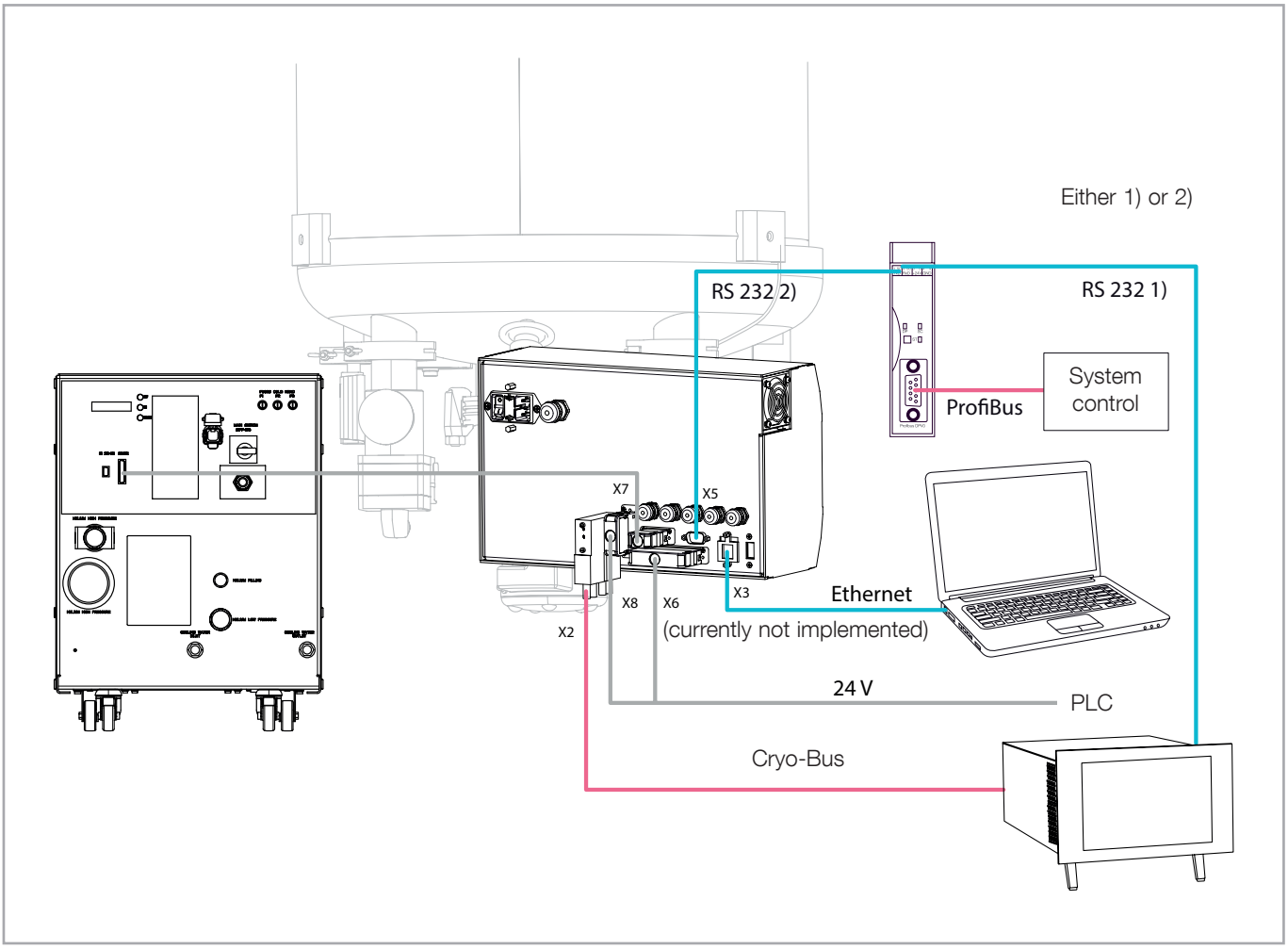

Fig. 5 Control options for one pump and one compressor unit

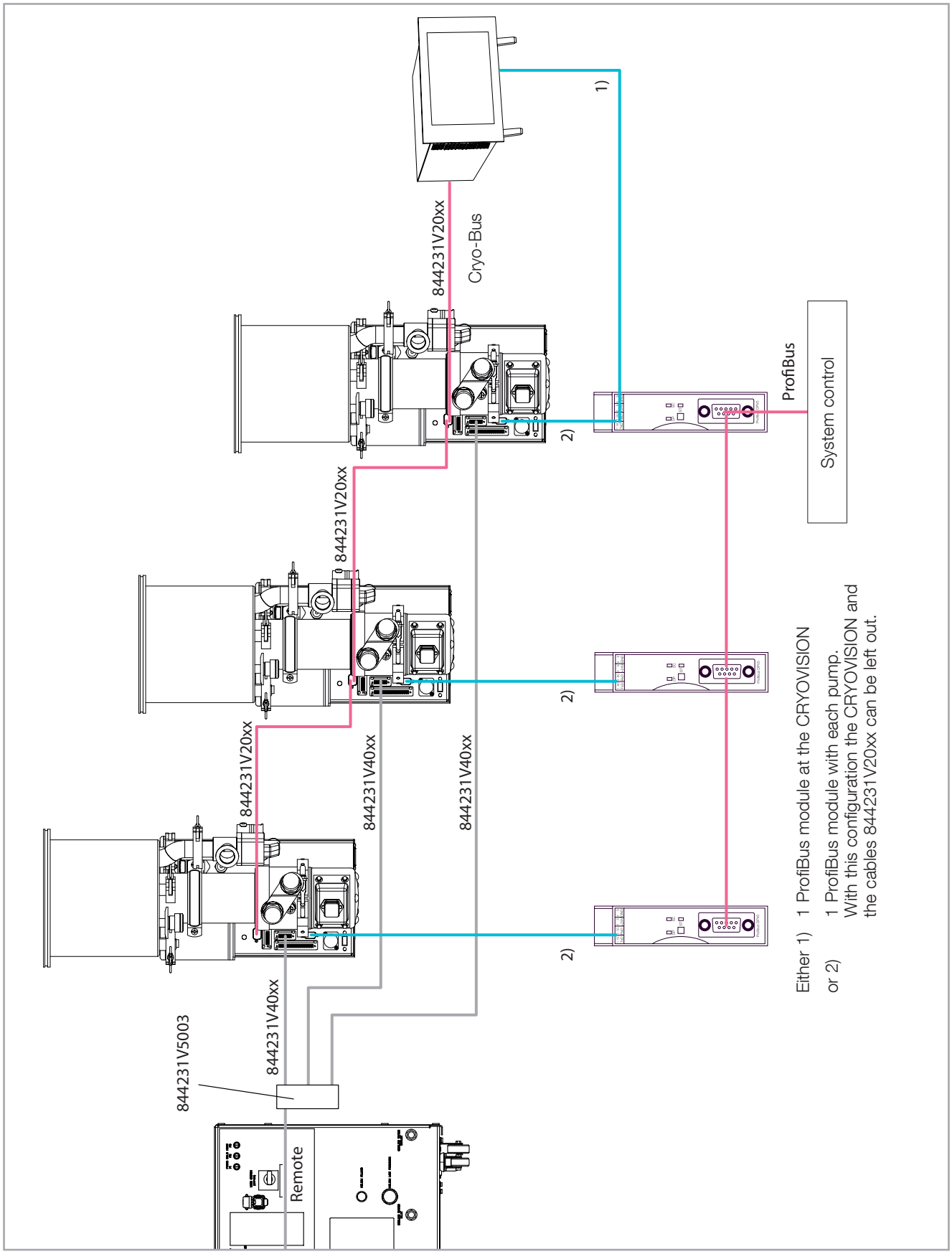

Fig. 6 Control options for several pumps each with an integrated COOL.DRIVE

Connection

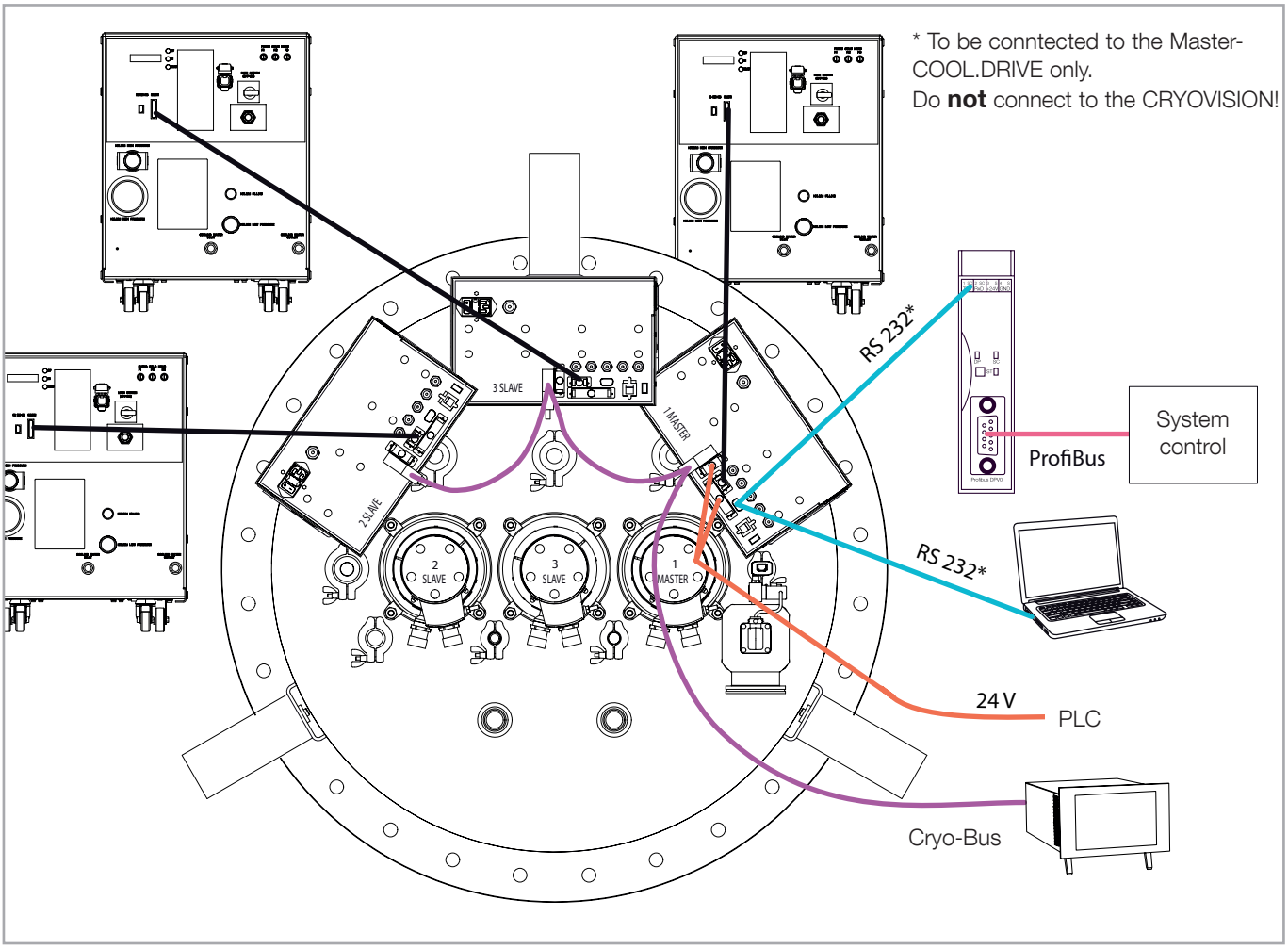

Fig. 7 Control options for a COOLVAC 30 000 iCL (COOLVAC 18 000 iCL and COOLVAC 60 000 iCL similar)

3 Description of the Telegram

Two types of protocol (PPO types) have been implemented. In the following only the payload data are described. Data which serve communication purposes (data link layer, layer 2 acc. to OSI, for example, start byte and addressing etc.) are processed automatically in the background by the ProfiBus.

3.1 PPO Type 1

Length of the payload data block: 6 words = 12 bytes = 0xF3, 0xF1 (see 3.3 GSD File)

Byte No.	Abbre-viation	Description	Read access on pump	Write access on pump	Response from COOLVAC ProfiBus
0-1	PKE	Parameter number and type of access		Value (see 4.1)	
2	IND	Parameter index	Value	Value	Value
3	–	reserved		0	
4-7	PWE	Parameter value	0	Value	Value
8-9	PZD1: ZSW STW	Status and control bits and pump address		Value (see 4.2)	
10-11	PZD2: HIW HSW	Main actual value and setpoint for temperature T1 and T2*	0	0	Value (K)

* normally HIW ≠ HSW

3.2 PPO Type 6 (Leybold-specific)

Length of the payload data block: 1 word = 2 byte identifier = 0x00, 0xF0 (see 3.3 GSD file)

Byte No.	Abbre-viation	Description	Read access on pump	Write access on pump	Response from COOLVAC ProfiBus
0-1	PZD1: ZSW STW	Status and control bits and pump address		Value (see 4.2)	

3.3 GSD File (Example)

Documented in the GSD file are the parameters of the ProfiBus DP interface. The file format has been defined in the standard so that project tools from different manufacturers can be used. The current GSD file is available from Leybold upon request or can be downloaded from the Leybold homepage. In addition the contents of the GSD file have been documented in the following.

```
;=============================================================
; Leybold Profibus Interface for Cryo Controller.
; Model : Cryo Controller
; Description : Profibus Interface based on HMS ANYBUS-IC Profibus DP Slave Interface
; Language : English
; Date : 01. February 2006
; Author : HMS Industrial Networks, M.Thiel Leybold
;
;=============================================================

#Profibus_DP

GSD_Revision        = 2

; Device identification
Vendor_Name         = «Leybold GmbH»
Model_Name          = «Cryo controller»
Revision            = «Version 0.9»
Ident_Number        = 0x1804
Protocol_Ident      = 0             ; DP protocol
Station_Type        = 0             ; Slave device
FMS_supp            = 0             ; FMS not supported
Hardware_Release    = «Version 1.02» ; HMS ABIC PDP
Software_Release    = «Version 1.00» ; HMS ABIC PDP

;Used bitmap
;Bitmap_Device      = «CL2000_0»  ; Cryo normal
;Bitmap_Diag        = «CL2000_1»  ; Cryo diagnostic
;Bitmap_SF          = «CL2000_2»  ; Cryo special case

; Supported baudrates
9.6_supp        = 1
19.2_supp       = 1
45.45_supp      = 1
93.75_supp      = 1
187.5_supp      = 1
500_supp        = 1
1.5M_supp       = 1
3M_supp         = 1
6M_supp         = 1
12M_supp        = 1

; Maximum responder time for supported baudrates
MaxTsdr_9.6     = 60
MaxTsdr_19.2    = 60
MaxTsdr_45.45   = 250
MaxTsdr_93.75   = 60
MaxTsdr_187.5   = 60
MaxTsdr_500     = 100
MaxTsdr_1.5M    = 150
MaxTsdr_3M      = 250
MaxTsdr_6M      = 450
MaxTsdr_12M     = 800

; Supported hardware features
Redundancy          = 0     ; not supported
Repeater_Ctrl_Sig   = 2     ; TTL
24V_Pins            = 0     ; not connected
Implementation_Type = «SPC3»

; Supported DP features
Freeze_Mode_supp    = 1     ; supported
Sync_Mode_supp      = 1     ; supported
Auto_Baud_supp      = 1     ; supported
Set_Slave_Add_supp  = 1     ; supported

; Maximum polling frequency
Min_Slave_Intervall = 1     ; 100 us
; Maximum supported sizes
Modular_Station     = 1     ; modular
Max_Module          = 1
Max_Input_Len       = 12
Max_Output_Len      = 12
Max_Data_Len        = 24
Modul_Offset        = 1

Fail_Safe           = 1     ; state CLEAR accepted

Slave_Family        = 0@Leybold
Max_Diag_Data_Len   = 6

; Definition of modules
Module=»PPO 1» 0xF3, 0xF1
EndModule
Module=»PPO 6» 0x00, 0xF0
EndModule
```

4 Description of PKE, IND, Control and Status Bits

4.1 PKE: Parameter Number and Type of Access / IND: Parameter index

The parameter number is sent when accessing the COOLVAC ProfiBus module and also in the response of the COOLVAC ProfiBus module.

The receiver is provided with information on the parameter value PWE: size, array value or individual value, read or write.

Some parameters (e.g. Parameter 171 - Alarm log) show depths that can be queried and (where applicable) written via the index.

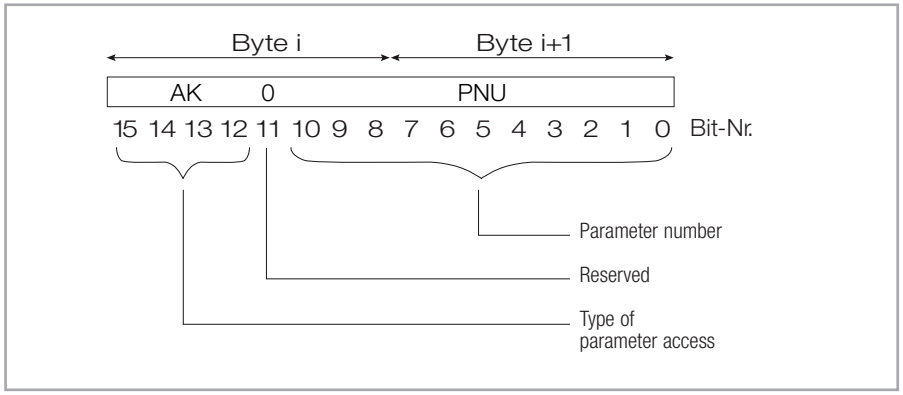

Fig. 8 PKE: parameter number and type of access (for PPO type 1 only)

PKE, IND, Bits

Type of Parameter Access to the ProfiBus module (Query Designator)					Type of Parameter Response from the ProfiBus module (Response Designator)				
Bit number					**Bit number**				
15	**14**	**13**	**12**		**15**	**14**	**13**	**12**	
0	0	0	0	No access	0	0	0	0	No response
0	0	0	1	Scalar parameter value requested (Response value 16 or 32 bit)	0	0	1	0	Parameter 32 bit value is sent
0	0	1	0	Write a 16 bit scalar parameter					
0	1	1	0	Parameter array element requested	0	1	0	1	Parameter array element 32 bit is sent
1	0	0	1	Number of array elements requested	0	1	1	0	Number of array elements is sent
					0	1	1	1	Error, Error code is sent

Error codes (Response value at Response Designator 7) – Value output in PWE

0	forbidden PNU (Parameter number not assigned)
1	parameter value not changeable (Parameter is read only)
2	lower or upper value limit exceeded (new parameter value forbidden at write command)
3	wrong sub index (sub index too big for given PNU)
4	no array (response designator is 6/9, but PNU indicates a scalar parameter or sub index ≠ 0)
5	wrong data type (response designator is 1/2, but PNU indicates an array parameter)
18	other error
19	data in cyclic traffic not legible (serial communication disturbed)
101	internal program error in gateway
102	parameter value cannot be read with this PNU (parameter is write only)
103	forbidden pump address (allowed: 0...31)
104	invalid query designator (allowed: 0/1/2/6/9)

Byte No.	0	1	2	3	4	5	6	7	8	9	10	11
Example	**Parameter identifier**		**Indices**		**Parameter value**				**Control word Status word**		**Main setpoint Main actual value**	
Description of the test	**PKE**		**IND**		**PWE**				**PZD1**		**PZD2**	
MASTER → SLAVE Main setpoint. OFF,OFF Pump #1, No Enable ProzessData, No Enabl. Main Value, read Para. 514 (T1 act, value)	0001 0010	0000 0010	0000 0000	0000 0000	0000 0000	0000 0000	0000 0000	0000 0000	0000 1000	0000 0000	0000 0000	0000 0000
Hex	12	02	00	00	00	00	00	00	08	00	00	00
SLAVE → MASTER Main act. val T1 =100k, T2 =12K Pumpe #1, Cryo Ready, Power up1Para 514 = 03E7 = 99.9K	0001 0010	0000 0010	0000 0000	0000 0000	0000 0000	0000 0000	0000 0011	1110 0111	0000 1000	0000 0011	0110 0100	0000 1100
Hex	12	02	00	00	00	00	03	E7	08	03	64	0C

4.2 Status and Control Bits (Status and Control Word) ProfiBus PPO-Type 1 and 6

Control and status bits are transmitted/received each time when being accessed.

4.2.1 Control Word (PZD1, STW) = 16 Control Bits

Is sent to the pump for each access.

Bit No.	Default status	Description
0	0	1 = Start (ON Cooldown); 0 = Stopp (OFF warm up) Start/Stop is only run, provided ■ no error is present and ■ Bit 10 is active (=1).
1	0	Reserved
2	0	PPO1 und PPO6 reserved
3	0	Reserved
4	0	1 = Start total regeneration is only run, provided ■ no error is present and ■ Bit 10 is active (=1).
5	0	1 = Start fast regeneration is only run, provided ■ no error is present and ■ Bit 10 is active (=1). With the COOL.DRIVE there is no fast regeneration, but instead a total regeneration will be started.
6	0	0 = no action 1 = Enables main setpoints T1 and T2 Setpoints from the USS telegram at PZD2 (Byte 10, 11) with rising edge will be taken over. (only, when PPO Type 1 is used) is only run, provided ■ no error is present and ■ Bit 10 is active (=1).
7	0	Error reset (after elimination some errors require an error reset, e.g. ROR error -> Warning 14)
8	0	Reserved
9		0 = no action 1 = Init (immediate jump into step 99/initial state) (with rising edge the Init will be triggered)
10	0	Enables process data (changes to bit 0, 4, 5 and 6 only accepted, provided bit 10 is set)
11		Cryopump address Bit 0
12		Cryopump address Bit 1
13		Cryopump address Bit 2
14		Cryopump address Bit 3
15		Cryopump address Bit 4

PKE, IND, Bits

4.2.2 Status Word (PZD1, ZSW) = 16 Status Bits

Is sent together with each response from the cryo pump.

Bit No.	Description
0	1 = Power up, 0 = Power reset done (depending on parameter number 513 for PPO type 1 only)
1	1 = Active operation; cryo ready
2	1 = Forevacuum is needed
3	1 = OFF Cryo warm
4*	1 = Cryo Error is pending
5	1 = Total regeneration active
6	1 = Fast regeneration active
7	1 = Communication error (cryo internal network)
8	1 = Command cannot be run
9	1 = ON Cool down
10	1 = OFF warm up
11	Cryopump address Bit 0
12	Cryopump address Bit 1
13	Cryopump address Bit 2
14	Cryopump address Bit 3
15	Cryopump address Bit 4

* Bit 4 “Cryo error” will also be present when having selected in the service mode of the COOLVAC SC a “COOLVAC reset” = step 999.

Operating Explanations

The **control right** for driving the pump via the ProfiBus interface is requested automatically upon seting Bit 10 in the control word (cf. Section 4.2.1).

The signals HIGH VACUUM VALVE CLOSED and FOREVACUUM RUNNING at the plug CUSTOMER I/O 1 are queried by the COOL.DRIVE controller during cooling down (control command ON), during warming up (control command OFF) or during a total regeneration (control command TR) and these signals must then be present.

You can ensure this by links at the input. However, we recommend that you actively control the signals HIGH VACUUM VALVE CLOSED and FOREVACUUM RUNNING at the plug CUSTOMER I/O of the COOL.DRIVE:

- The signal HIGH VACUUM VALVE CLOSED at the plug I/O 1 of the COOL.DRIVE should be present before issuing a control command (ON, OFF, TR) Otherwise a warning will be displayed.
- We additionally recommend that you also actively control the signal FOREVACUUM RUNNING at the plug Customer I/O 1 during cooling down, warming up and regeneration.

  We recommend applying the acknowledgement signal “FOREVACUUM RUNNING” to the plug CUSTOMER I/O only after having ensured that the forevacuum pump is actually running and ensuring that the forevacuum line has been evacuated up to the point of the forevacuum valve.

  Since during warming up and regeneration of the cryo pump commonly large quantities of very cold gas are released, we additionally recommend to let the forevacuum pump used to evacuate and regenerate the cryo pump, run warm already a few minutes before sending a control command (ON, OFF, TR).

At least 2 seconds must remain between sending the control commands via the USS control word.

To **turn on the pump** (starting the cooling down process) set Bit 10 (control right) and Bit 0 to 1. To turn off leave Bit 10 at 1, and set Bit 0 back to 0 (Off process).

For a second cooling down process following a total regeneration set control word‘s Bit 4 to 1 for a few seconds, then set back to 0. Bit 10 has to be set (control right), and Bit 0 has to remain set at 1.

The status of the pump can be requested via the USS status word (PZD1, ZSW; cf. Section 4.2.2). A set Bit 1 represents CRYO READY (process-ready), Bit 3 = OFF Cryo warm (pump inactive and warm), Bit 5 = Total regeneration active, Bit 9 = ON Cool down active and Bit 10 = OFF warm up active. For more information on the status word refer to Section 4.2.2 Status Word (PZD1, ZSW).

After cooling down and in the case of trouble-free operation and attaining the “CRYO READY” transition temperatures, the pump will revert to the status CRYO READY. In the status word is now Bit 1 = 1 (CRYO READY).

The current temperatures in Kelvin can be queried through the Parameters 514 (1st stage) and 515 (2nd stage; cf. Section 4.3). The current pressure in mtorr is fetched through the Parameter 516. At the COOL.DRIVE, the pressure can also be queried through Parameter 616 in mbar (float value).

PKE, IND, Bits

When in the cryopump the temperature CRYO READY T1 (COOL.DRIVE: P560) or CRYO READY T2 (COOL.DRIVE: P561) is exceeded, then the signal CRYO READY will disappear (Status bit 1 = 0). Even in spite of a pressure below $5 \cdot 10^{-4}$ mbar in the vacuum chamber the signal CRYO READY will no longer be present when the corresponding temperature conditions are no longer being fulfilled. For this reason this signal alone should not be used to control your process and/or the high vacuum valve.

The temperature T2 of the silicon diode should not increase above 20 K since this would release the gases collected on the cold surface of the second stage which in turn would cause a rapid and uncontrolled increase of T2. In this case run a total regeneration so as to let the cryopump return again to the status of CRYO READY.

Status bit 5 will be set after a regeneration had been started with control bit 4. Status bit 10 is set with an initiated OFF process via removing control bit 0.

A status query for the cryopump is initiated via Parameter 513 (Status word). Thus you may obtain information, for example, whether the cold head is on or off, the forevacuum valve has been triggered, or if the gauge head has been switched on (cf. Section 4.3).

During operation, the cryopump will sent a request to the forevacuum pump. This is done via the floating contact FOREVACUUM NEEDED signal to Customer I/O 1 or via Bit 22 of the status query of Parameter 551 (cf. Section 4.3). In this case the cryopump will need the backing pump and expects the signal FOREVACUUM RUNNING at the 24 V interface (release for switching the forevacuum valve). After the “pump on delay time” has elapsed the warning message 13 “Forevacuum pump not running” is output when the signal FOREVACUUM RUNNING is not present early enough (factory setting 30 seconds).

Current software steps of the COOL.DRIVE can be retrieved via parameter 552.

Additional status information for the cryopump is initiated through Parameter 551 (Status double word of the cryopump), as e.g. whether the pump is currently cooling down (Bit 4), warming up (Bit 5), has reached operational readiness („CRYO READY“) (Bit 10), is warm (Bit 16), or is currently regenerating (Bit 26).

Some errors or warnings will require a reset. USS control bit 7 serves this purpose.

Please also note all further possible USS commands given in Section 4.3.

4.3 Parameter List

Para-meter	Value, Description	Range, PB Value	Unit	Default value	Type Request	Type Answer	Access
1	Unit identifier (not a cryo controller command	0 ... 2^16	-	501	u16	u16	r
171	**COOL.DRIVE only** Alarm log Warning or error number Query of indexes in the USS index byte (Byte 2) Note: information regarding the alarm log continuing at P576 Index depth 00 … 49	00 … 999	-	-	u16	u32	r
293	**COOL.DRIVE only** Query of the ProfiBus module SW (in ASCII format) Query of indexes in the USS index byte (Byte 2) Index depth 00… 05	1 ... 2^16	-	-	-	u32 array	r
513	Status 1 Bit 0 = pump motor ON/OFF Bit 1 = rough valve Open/Close Bit 2 = purge valve (not used) Bit 3 = TC1 ON/OFF Bit 4 = TC2 (not used) Bit 5 = Power On Reset Bit 6 = always 1 Bit 7 = always 0	0 ... 255	-	-	u16	u16	r
514	Get 1st stage temperature	0 ... 3500	0.1	-	u16	u16	r
515	Get 2nd stage temperature	0 ... 3500	0.1	-	u16	u16	r
516	Get pump pressure in mtorr	0 ... 10000000	0.1	-	u32	u32	r
517	Regeneration control 0 = Abort Regen, Restart Pump 1 = Start Full Regen 2 = Start fast regeneration (with Semiline pumps only, otherwise start of total regeneration) 3 = Init (COOL.DRIVE only: immediate jump into Step 99/initial state)	0 ... 3	-	-	u16	u32	w
518	Cryo pump ON = 1 OFF = 0	0 / 1	-	-	u16	u16	w
519	Power fail recovery flag 0 = Cryo Ready 1 = Cooldown 2 = Regeneration	0 ... 2	-	-	u16	u16	r
520	Error Code 0 = No error 1 = Collective fault at Coolvac 2 = Timer overrun 3 = Regeneration manually cancelled	0 ...3	-	-	u16	u16	r

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Para-meter	Value, Description	Range, PB Value	Unit	Default value	Type Request	Type Answer	Access
521	Regeneration program step 000 = Cryo OFF warm 010 = Warm up 030 = TR rough to base 040 = FR rough to base 060 = Cool down 090 = Regeneration completed 100 = TR warm up 110 = Active warm up RP reserve 140 = TR warm up 150 = Active warmup RP not reserve 160 = TR warm up 180 = ROR 190 = Active ROR RP reserve 191 = TR ROR 192 = Active ROR RP not reserve 200 = TR rough to base 210 = TR rough to base / Wait 220 = TR cool down 220 = TR cool down 230 = Active warm up RP reserve 510 = FR rough to base 520 = FR rough to base 530 = FR switch to total regen 540 = FR cool down 560 = FR cool down 640 = FR warm up 650 = FR warm up 999 = Regen aborted	0 ... 999	0.1	-	u16	u16	r
522	Get 1st stage temp min setpoint	0 ... 3500	1	-	u16	u16	r
522	Set 1st stage temp min setpoint	0 ... 3500	1	-	u16	u16	w
523	Get 2nd stage temp min setpoint	0 ... 3500	1	-	u16	u16	r
523	Set 2nd stage temp min setpoint	0 ... 3500	1	-	u16	u16	w
527	Status 2 Bit 0 = setpoint 1 on Bit 1 = setpoint 2 on Bit 3 = 1st stage temp. Control **T1 T2 S2 (ASCII)** off off @ 65 off I off 10 R 65 10 [	0 ... 255	-	-	u16	r	r
528	Status 3 (not used) Bit 0 = pump phase 1 Bit 1 = pump phase 2	0 ... 255	-	-	u16	u16	r
529	Pump operating hours	0 ... 2^32	-	-	U32	U32	r
532	Software version of pump module	1 ... 2^16	-	-	u16	u16	r
533	Serial number for COOLVAC SC	1 ... 2^32	-	-	u16	u16	r
533	Serial number of pump (11 chars) for COOL.DRIVE, one ASCII value per index Query of indexes in the USS index byte (Byte 2) Index depth 00 … 17	0 … 127	-	-	u16	u32	r

Para-meter	Value, Description	Range, PB Value	Unit	Default value	Type Request	Type Answer	Access
537	**COOL.DRIVE only** Pump status flag Bit 0 = Status forevacuum valve (TRUE = open) Bit 4 = TRUE with changeover from fast to total regeneration Bit 5 = TRUE with active fast regeneration	64, 96, 80, 112	-	-	u16	u32	r
538	Reads remaining 3 characters of pump serial number (if any exist) at COOLVAC SC	1 ... 2^16	-	-	u16	u16	r
538	Last 3 chars of pump serial number (RS232 Tel 'VQ') with COOL.DRIVE, one ASCII value per index Query of indexes in the USS index byte (Byte 2) Index depth 00 … 17	0 … 127	-	-	u16	u32	r
548	Get h since last full regeneration	1 ... 2^16	-	-	u16	u16	r
549	Get h since last fast regeneration	1 ... 2^16	-	-	u16	u16	r
550	Get AC power status (with COOLVAC iCl irrelevant - answer always 0)	1 ... 2^16	-	-	u16	u32	r
Parameters 551 – 678 are valid for COOL.DRIVE only							
551	CoolDrive's Status double word (derived from RS232 command 'Stat') **Bit Function, Bit = 1, if ...** 0 reserved 1 reserved 2 Cold head motor running 3 Error 4 Process “CoolDown” 5 Process “WarmUp” 6 reserved 7 reserved 8 reserved 9 reserved 10 Normal operation / “Cryo Ready” 11 Pump is cold 12 PowerReset 13 Regeneration required 14 Collective warning 15 reserved 16 Pump is warm 17 Regeneration aborted 18 Init executed 19 reserved 20 Compressor required 21 Compressor switched on 22 Forevacuum required 23 Forevacuum switched on 24 Forevacuum vlave open 25 reserved 26 Regeneration running 27 High-vacuum valve open 28 reserved 29 reserved 30 Service mode is active 31 Critical gas operation active	0 … 2^32	-	-	u16	u32	r

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Para-meter	Value, Description	Range, PB Value	Unit	Default value	Type Request	Type Answer	Access
552	CoolDrive program step **Initial steps** 0 Starting status cryo warm (initial state) 99 Initial status init command was run or the network was down (initial state – init/power fail) **Prozess „cooldown“** 1 Pump cold or warm? (cryo check) 2 Baking out the active charcoal (cleaning) 3 Baking out the active charcoal (cleaning) 4 Requesting the backing pump (forevacuum needed) 5 Fore-evacuation to “P MIN CH ON“ (roughing to pressure CH on (pressure value cold head on)) 6 End fore-evacuation (roughing ended) 61 End fore-evacuation (roughing ended (forevacuum valve closed, compressor on)) 7 Start cooldown (cooldown) 8 Pump cold and ready for process (cryo ready) **Prozess „warm up“** 9 Wait for HV valve closed (warm up – close gate valve) 10 Requesting the backing pump (forevakuum needed) 11 Compressor off (warm up - compressor off) 12 Post-operation time for cold head (5 seconds (warm up - overruntime)) 13 Cold head off (warm up - coldhead off) 14 Leak test in OFF process (leak test (duration of 4 minutes)) 15 Warmup to T1 = 110 K and start the H2 controller (warm up) 16 Fore-evacuation/discharge (discharge) 17 Fore-evacuation/discharge (discharge) 18 ROR procedure (ROR (ROR-counter reset)) 181 ROR procedure (heating to T1 = 313K and T2 = 313K (ROR)) 182 ROR procedure (until time of 5 minutes has run (ROR)) 183 ROR procedure (ROR check timer of 60 s (ROR)) 184 ROR procedure (calculated ROR delta time (ROR)) 185 ROR procedure (ROR end; when ROR counter is too high, an error will be produced) (ROR) 19 Fore-evacuation (roughing) 20 Fore-evacuation end (roughing) 99 Cryo warm	0…2^32	-	-	u16	u32	r

Para-meter	Value, Description	Range, PB Value	Unit	Default value	Type Request	Type Answer	Access
553	Regeneration necessary? 1 = Regeneration should be performed 0 = Regeneration not necessary	0 … 1	-	-	u16	u32	r
554	Error reset (writes value > 0)	0 … 2^16	-	-	u16	u32	w
555	Default reset (writes value > 0) Note: control must be switched off and on again	0 … 2^16	-	-	u16	u32	w
556	„P MIN CH ON" in mbar (min. pressure to switch on cold head – adjustable from 0.03 mbar – 1 mbar): pressure value * 1,000 (mbar)»	30 … 1000	mbar, resolution 0.1mbar	100 (equals 0.1 mbar)	u16	u32	r/w
557	Counted ROR cycles	0 … 2^16	-	-	u16	u32	r
558	Sets/reads the "max pressure delta" of ROR process (Default=0.01mbar); adj. from 0.001 – 0.099 mbar Pressure value x 1,000 (mbar)»	1 … 99	mbar resolution 0.001	10 (equals 0.1 mbar)	u16	u32	r/w
559	Max. permitted ROR cycles; adj. from 1 – 99	1 … 99	-	10	u16	u32	r/w
560	Temperature transition conditions for Cryo Ready with stage 1 Temperature value x 10 (Kelvin)	1000 … 1500	K resolution 0.1	1300 (equals 130 K)	u16	u32	r/w
561	Temperature transition conditions for Cryo Ready with stage 2 Temperature value x 10 (Kelvin)	150 … 300	K resolution 0.1	170 (equals 17 K)	u16	u32	r/w
562	Reads temperature of stage 1 with COOLVAC iCL 18 000 or larger Temperature value x 10 (Kelvin) Query with pump address value in the USS index byte (Byte 2)	0 … 3500	K resolution 0.1	-	u16	u32	r
563	Reads temperature of stage 2 with COOLVAC iCL 18 000 or larger Temperature value x 10 (Kelvin) Query with pump address value in the USS index byte (Byte 2)	0 … 3500	K resolution 0.1	-	u16	u32	r

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Para-meter	Value, Description	Range, PB Value	Unit	Default value	Type Request	Type Answer	Access
564	**Error number** (currently pending) 00 No error [1] 01 Frequency converter of the cold head indicates an error [1] 02 PLC detects the failure of one cold head motor phase [1] 03 PLC detects a failure of more than one phase [1] 04 PLC detects a communication fault relating the frequency converter [1] 05 Frequency conv. is needed, but is not running [1] 06 Forevacuum valve does not open [1] 07 Forevacuum valve does not close [1] 08 Temperature at heating stage 1 does not increase although being driven [1] 09 48 VDC output driving voltage at heating stage 1 not present [2] 10 Temperature at heating stage 2 does not increase although being driven [1] 11 48 VDC output driving voltage at heating stage 2 not present [2] 12 Heating stage 1: temperature increases above a value of 325 Kelvin (shutdown of both stages via safety relay) [2] 13 Heating stage 2: temperature increases above a value of 325 Kelvin (shutdown of both stages via safety relay) [2] 14 Sensor heating stage 1 (Pt 100): temperature rises to a value above 320K [1] 15 Sensor heating stage 1 (Pt 100): contact open [1] 16 Sensor heating stage 1 (Pt 100): sensor element short-circuited [1] 17 Sensor heating stage 2 (Si diode): temperature rises to a value above 320 K [1] 18 Sensor heat. stage 2 (Si diode): contact open[1] 19 Sensor heating stage 2 (Si diode): sensor element short-circuited [1] 20 Internal error: expansion subassembly on PLC can't be started or has failed during operation [2] 21 Internal error: Si diode PCB cannot be started or has failed during operation (also none of the LEDs indicate anything any more) [2] 23 Compressor is needed, but is off / Compressor is not needed, but is ON [1] 24 Compressor is on and cold head is off or compressor is off and cold head is on; in the case of several pumps connected to a compressor this error detection type should be switched off [1] 25 Pressure sensor error: identity not detected [1] 26 Pressure sensor error: measured value is outside the valid range [1] 27 External error [5] 99 Internal error **Error reset:** [1] The error is automatically reset after having been remedied [2] Please switch the Cool.Drive off and remedy the error [5] Depending on parameter settings (applies to the input External error – currently not yet provided)	0 … 999	-	-	u16	u32	r

Parameter	Value, Description	Range, PB Value	Unit	Default value	Type Request	Type Answer	Access
565	**Warning number** (currently pending) 00 No warning 01 Heating stage 1: temperature rises above a delta K, although this stage is not being driven[2] 02 Heating stage 2: temperature rises above a delta K, although this stage is not being driven[2] 03 Sensor stage 1 (Pt 100): sensor is not behaving normally (temperature jumps) [1] 04 Sensor stage 2 (Si-Diode): sensor is not behav ing normally (temperature jumps) [1] 05 Warmup process takes too long (timer expired)[1] 06 Cooling down process takes too long (timer expired) [1] 07 Stage 1 too cold: temperature has dropped below the value for “Cryo min” [1] 08 Stage 2 too cold: temperature has dropped below the value for “Cryo min” [1] 09 Fore-evacuation (roughing) takes too long (timer expired) [1] 10 Compressor is needed, but is off / Compressor is not needed, but is ON [1] 11 Pressure is too high: pressure value exceeds the expected level in step [1] 12 High vacuum valve not closed [1] 13 Backing pump not running [1] 14 ROR cycle counter overflow [3] 15 Critical operating condition [1] 16 Mains power failure of system was detected [4] 99 Internal warning **Error reset:** [1] The error is automatically reset after having been remedied [2] Pls. switch the Cool.Drive off and remedy the error [3] An error reset is necessary [RS232: ‚eRES‘; Customer IO: input “Error reset”] (overflow of the ROR cycle counter - Warning 14 - is also reset in the course of a renewed regeneration run“] [4] Is reset upon attaining normal operation or in the event of a user command (Start/Stop/Regeneration)	0 … 999	-	-	u16	u32	r
566	“Compressor and cold head conditions differ“ error monitoring (1 = activated (default), 0 = deactivated); (should be deactivated with multi-pump-single-compressor environments!)	0 … 1	-	1	u16	u32	r/w
567	“Power fail recovery“ mode (1 = Mode active [control recovers the last process in case of mains failures]; 0 = Mode deactivated [system falls back into Step 99/initial state in case of mains failures])	0 … 1	-	1	u16	u32	r/w
568	Activates / deactivates Service Mode	0 … 1	-	0	u16	u32	r/w
569	Status of the forevacuum valve in Service Mode: (0 = FV valve closed, 1 = FV valve open)»	0 … 1	-	-	u16	u32	r/w

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Para-meter	Value, Description	Range, PB Value	Unit	Default value	Type Request	Type Answer	Access
570	Status of signal “Forevacuum pump necessary“ in Service Mode: (0 = “Forevacuum pump necessary“ OFF, 1 = “Forevacuum pump necessary“ ON)»	0 … 1	-	-	u16	u32	r/w
571	“Valve on delaytime“ - switching time of FV valve in seconds (delay between signal reception “Forevacuum running“ and opening the FV valve)	0 … 999	sec, resolution 1	5	u16	u32	r/w
572	“Critical Gas“ for applications using critical gases in the Cryo pump’s vacuum chamber. Before utilising critical gases pls. consult with Leybold!	0 … 1	-	0	u16	u32	r/w
573	Master Parameter for Big Cryo pumps (COOLVAC iCL 18 000 or larger) Control is set as Master	0 … 1	-	0	u16	u32	r/w
574	Reads error number of pump address xx with COOLVAC iCL 18 000 or larger Query w/ pump address value in the USS index byte (Byte 2) (for error numbers refer to Parameter 564)	0 … 999	-	-	u16	u32	r
575	Reads warning number of pump address xx with COOLVAC iCL 18 000 or larger Query w/ pump address value in the USS index byte (Byte 2) (for error numbers refer to Parameter 565)	0 … 999	-	-	u16	u32	r
576	Alarm log: status and type 0x00000031 = warning occurred 0x00000033 = warning resolved 0x00000041 = error occurred 0x00000043 = error resolved Query with log entry number in the USS index byte (Byte 2) Index depth 00 … 49	0x31 … 0x43	-	-	u16	u32	r
577	Alarm log: entry date The date is hex-coded into the DWORD, for evaluation display in Hex: 20.01.2000 (20 = 0x14, 01 = 0x01, 2000 = 0x07d0) 0x yyyy mm dd = 0x07d00114hex (= 131072276dez) Query with log entry number in the USS index byte (Byte 2) Index depth 00 … 49	0 … 2^32	-	-	u16	u32	r
578	Alarm log: entry time The time is hex-coded into the DWORD, for evaluation display in Hex: 22:59:46 (22=0x16, 59=0x3B, 46=0x2E) 0x hh mm ss = 0x163B2Ehex (=1456942dez) Query with log entry number in the USS index byte (Byte 2) Index depth 00 … 49	0 … 2^32	-	-	u16	u32	r

Parameter	Value, Description	Range, PB Value	Unit	Default value	Type Request	Type Answer	Access
579	Alarm log for COOLVAC iCL 18 000 or larger warning or error number Query with log entry number in the USS index byte (Byte 2) Index depth 00 … 49	00 … 999	-	-	u16	u32	r
580	Alarm log for COOLVAC iCL 18 000 or larger: status and type 0x00000031 = warning occurred 0x00000033 = warning resolved 0x00000041 = error occurred 0x00000043 = error resolved 0x00000040 = no error Query with log entry number in the USS index byte (Byte 2) Index depth 00 … 199	0x31 … 0x43	-	-	u16	u32	r
581	Alarm log for COOLVAC iCL 18 000 or larger: entry date The date is hex-coded into the DWORD, for evaluation display in Hex: 20.01.2000 (20 = 0x14, 01 = 0x01, 2000 = 0x07d0) 0x yyyy mm dd = 0x07d00114hex (= 131072276dez) Query with log entry number in the USS index byte (Byte 2) Index depth 00 … 199	0 … 2^32	-	-	u16	u32	r
582	Alarm log for COOLVAC iCL 18 000 or larger: entry time The time is hex-coded into the DWORD, for evaluation display in Hex: 22:59:46 (22=0x16, 59=0x3B, 46=0x2E) 0x hh mm ss = 0x163B2Ehex (=1456942dez) Query with log entry number in the USS index byte (Byte 2) Index depth 00 … 199	0 … 2^32	-	-	u16	u32	r
616	Pressure in mbar	1.18x10^-38 … 3.4x10^38	mbar resolution 1	-	u16	u32 (float)	r
678	Alarm log for COOLVAC iCL 18 000 or larger: Pump address Query with log entry number in the USS index byte (Byte 2) Index depth 00 … 199	0 … 99	-	-	u16	u32	r

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4.4 Examples for 16 Bit Control Words (PPO-Typ 1 and 6)

Deci - mal- value	Hexa- decimal- value	Bit No. 15	to		0	Description
0	0000h	0000	0000	0000	0000	No control through this interface, all other bits disabled
3072	0c00h	0000	1100	0000	0000	Control pump adr. 01 through this interface,, no start
3073	0c01h	0000	1100	0000	0001	Control pump adr. 01 through this interface,, ON cool down
3089	0c11h	0000	1100	0001	0001	Control pump adr. 01 through this interface, pump ON, total regeneration ON
2051	0803h	0000	1000	0000	0011	Pump adr. 01, ON cryo ready, power up with parameter 513 not yet confirmed.
10276	2824h	0010	1000	0010	0100	Pump adr. 05, total regeneration active, forevacuum needed
14361	3819h	0011	1000	0001	1001	Pump adr. 07, pump with error, status OFF cryo warm, power up with parameter 513 not yet confirmed.
18578	4892h	0100	1000	1001	0010	Pump adr. 09, pump with error, status cryo ready, power up with parameter 513 already confirmed..

Is sent to the ProfiBus module during each access.

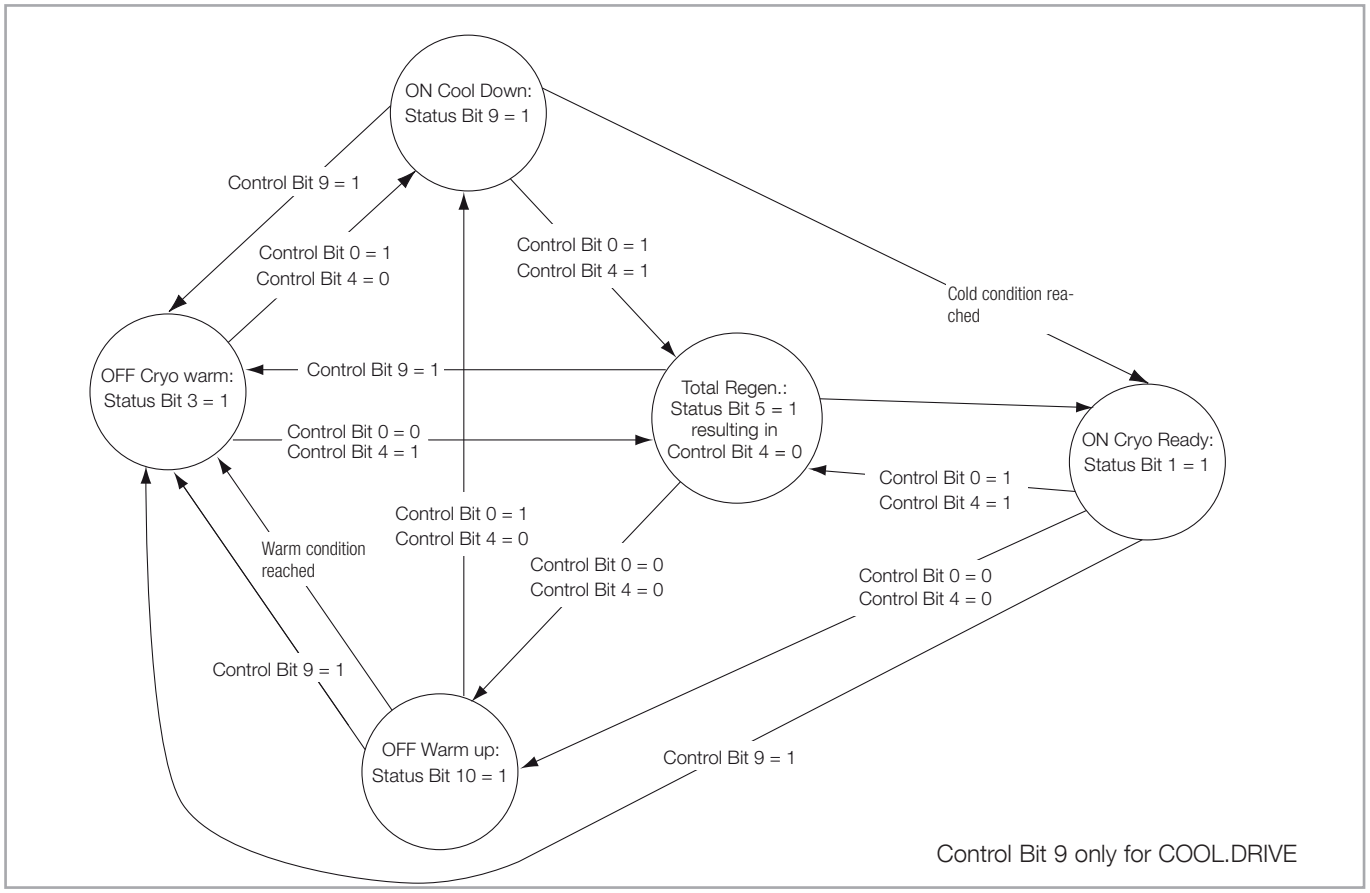

Fig. 9 Status diagram of the pump control arrangement

PZD2 Main Setpoint (HSW)
(PPO Type 1 or Parameter 522 and 523 as well)
Temperature Thresholds T1 and T2

Decimal-value	Hexadecimal-value	Bit No. 15		to	0	Description
T1min = 35K T2min = OFF	2300h	0010	0011	0000	0000	Main setpoint T1min and T2min from Master to Slave

PZD2 Hauptistwert (HIW)
(PPO Type 1 or Parameter 514 and 515 as well)
Temperature measurement data T1 and T2

Decimal-value	Hexadecimal-value	Bit No. 15		to	0	Description
T1 = >255K T2 = 119	FF77h	1111	1111	0111	0111	Main setpoint T1 and T2 from Slave to Master (range 0 - 255K!)

Leybold

CE

EU Declaration of Conformity

(Translation of original Declaration of Conformity)

The manufacturer:

Leybold GmbH
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herewith declares that the products specified and listed below which we have placed on the market, comply with the applicable EU Directives. This declaration becomes invalid if modifications are made to the product without agreement of Leybold GmbH.

Product designation: COOLVAC SC Profibus – RS232 Konverter

Part numbers: 844000V1

The products comply with the following Directives:

Electromagnetic Compatibility (2014/30/EU)

RoHS-Directive (2011/65/EU)

The following harmonized standards have been applied:

EN 61000-6-2:2005/AC:2005	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments
EN 61000-6-4:2007/A1:2011	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
EN 50581:2012	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

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