

EXD-HP1/2 Stand-alone Superheat / Economizer Controller

Technical Bulletin

EXD-HP1/2 are stand-alone universal superheat and/ or economizer controllers for heat pumps, heating units, air conditioning and precision cooling such as telecom and shelter applications.

Features

- Self-adapting superheat/economizer control in conjunction with EMERSON stepper motor driven electronic expansion Valves EXM/EXL or EXN
- Discharge hot gas temperature control by wet refrigerant vapor/vapor injection to compressor
- EXD-HP1: Controller with one EXV output
- EXD-HP2: Controller with two independent EXV outputs
- Controllers as slave with Modbus (RTU) communication capability. All data (read/write) accessible by any third-party controller having modbus communication (RTU)
- Upload/download key (accessory) for transmission of parameter settings among controllers with the same setting
- Low pressure switch and freeze protection function
- Manual positioning of valve(s)
- Limitation of evaporating pressure (MOP)
- Low/high superheat alarm
- Monitoring of sensors and sensor wiring and detection of sensor and wiring failures
- Integrated display (3-digits LEDs) and key board
- Electrical connection via plug-in type screw terminals (included with controller)
- OEM product: Box order quantities: 20 pieces (Multi-pack)



EXD-HP2

Selection table

Type	Description	Part No.	
		Multipack	Single pack
Controllers			
EXD-HP1	with 1 EXV output	807836M	-
EXD-HP2	with 2 EXV outputs	807837M	-
Valves / Coils			
EXM-B0A	Electronic expansion valve	800399M	-
EXM-B0B		800400M	-
EXM-B0D		800401M	-
EXM-B0E		800402M	-
EXM-125	Coil 12 VDC	800403M	-
EXL-B1F	Electronic expansion valve	800405M	-
EXL-B1G		800406M	-
EXL-125	Coil 12 VDC	800407M	-
EXN-B2K	Electronic expansion valve (not selectable in conjunction with R290)	-	800421
EXN-B2L		-	800422
EXN-125	Coil 12 VDC	-	800420
Temperature sensor			
ECP-P30	Temperature sensor with 3 m cable	-	804495
Pressure sensors		Suction pressure	
PT5N-07M / PT5N-07T	-0.8...7 bar	805350M / 805380M	805350 / 805380
PT5N-10FLR	-0.8...10 bar	805391M	805391
PT5N-18M / PT5N-18T	0...18 bar	805351M / 805381M	805351 / 805381
PT5N-30M / PT5N-30T	0...30 bar	805352M / 805382M	805352 / 805382
Plug and cable assembly for pressure sensors			
PT4-M15	1.5 m cable length	804803M	804803
PT4-M30	3.0 m cable length	804804M	804804
PT4-M60	6.0 m cable length	804805M	804805
PT4-M60-FLR	6.0 m cable length, 2-wire, ATEX certified	-	804806

Note: For further details of EXM/EXL, EXN and PT5N: Please see separate Technical Bulletin.

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Alarm functions - List of alarms

Condition	Delay time	Alarm relay	Valve position	Reset type	Display alarm LED
Hardware errors (sensors)	-	Triggered	Fully close	Auto	ON
Hardware errors (Stepper motor)	-	Triggered	-	Auto	ON
Low superheat	Fix: 1 min.	Triggered	Fully close	Auto/Manual	ON/Blinking
Discharge hot gas above limit	30 sec.	Triggered	Operating	Auto	ON
High superheat	Adjustable	Triggered	Operating	Auto	ON
Low pressure	Adjustable	Triggered	Operating	Auto/Manual	ON/Blinking
Freezing	Adjustable	Triggered	Fully closed	Auto/Manual	ON/Blinking

Technical Data EXD-HP1/2

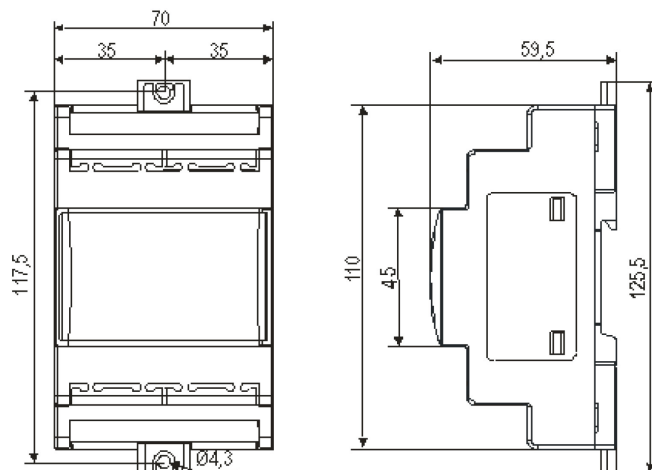
Supply voltage	24 VAC/DC $\pm 10\%$
Power consumption	EXD-HP1: Max. 15 VA EXD-HP2: Max. 20 VA
Digital inputs	EXD-HP1: Two, each potential free EXD-HP2: Three each potential free
Relay output	SPDT contacts, AgSnO Inductive (AC15) 24 VAC: 1 A Resistive: 24 VAC/DC: 4 A
Type of action	1B
Rated impulse voltage	0.5kV
Pollution Degree	2
Plug-in connector size	Removable screw version wire size 0.14...1.5 mm ²

Protection class	IP20
Housing	Self-extinguishing ABS
Mounting	DIN rail mounted
Temperatures	Storage -20...+65°C operating -10...+60°C
Relative humidity	0...85% RH non condensing
Applied directive	LVD, EMC, RoHS
Compliance with	DIN EN60335-1 DIN EN 55014-1, DIN EN 55014-2
Weight	175 g
Marking	

Input Sensors, Output Valves

Description	Specification												
Temperature input	ECP-P30 (3 meter cable length) Range: -30°C...+150°C												
Pressure sensor input	PT5N Signal: 4 ... 20 mA												
Electronic expansion valves (stepper motor) output	Note: The connection of two valves are permitted as below table: <table> <tr> <th>Circuit 1</th><th>Circuit 2</th></tr> <tr> <td>EXM</td><td>EXM</td></tr> <tr> <td>EXM</td><td>EXL</td></tr> <tr> <td>EXL</td><td>EXM</td></tr> <tr> <td>EXL</td><td>EXL</td></tr> <tr> <td>EXN</td><td>EXN</td></tr> </table> EXM/L series or EXN Series	Circuit 1	Circuit 2	EXM	EXM	EXM	EXL	EXL	EXM	EXL	EXL	EXN	EXN
Circuit 1	Circuit 2												
EXM	EXM												
EXM	EXL												
EXL	EXM												
EXL	EXL												
EXN	EXN												

Dimensions (mm)



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MOP Table & Functions

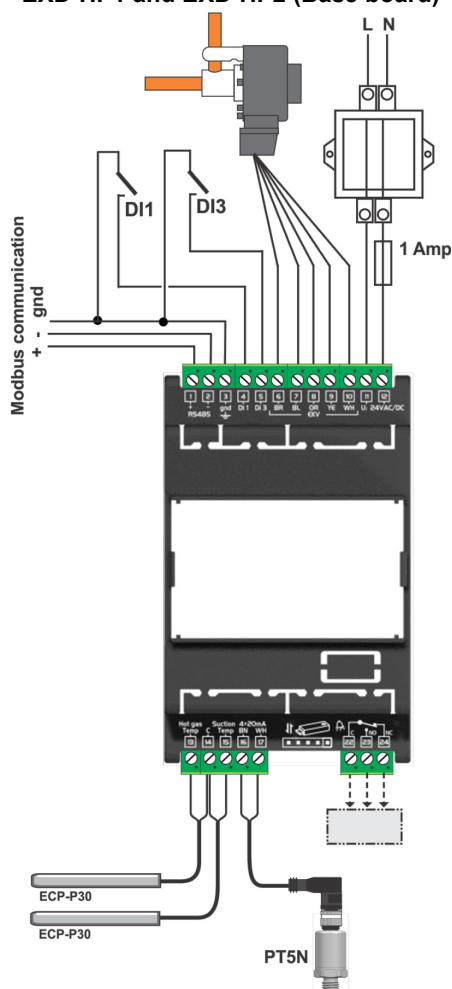
Refrigerant	Min.	Max.	Factory setting	Function	Refrigerant	Min.	Max.	Factory setting	Function
R22	-40 °C	+50 °C	+15 °C	Superheat control & Economizer control	R452A	-45 °C	+66 °C	+15 °C	Superheat control
R134a	-40 °C	+66 °C	+15 °C	Superheat control	R454A*	-57 °C	+66 °C	+10 °C	Superheat control
R410A	-40 °C	+45 °C	+15 °C	Superheat control	R454B*	-40 °C	+45 °C	+18 °C	Superheat control
R32	-40 °C	+30 °C	+15 °C	Superheat control & Economizer control	R454C*	-66 °C	+48 °C	+17 °C	Superheat control
R407C	-40 °C	+48 °C	+15 °C	Superheat control & Economizer control	R513A	-57 °C	+66 °C	+13 °C	Superheat control
R290*	-40 °C	+50 °C	+15 °C	Superheat control	R452B*	-45 °C	+66 °C	+25 °C	Superheat control
R448A	-57 °C	+66 °C	+12 °C	Superheat control	R1234ze*	-57 °C	+66 °C	+24 °C	Superheat control
R449A	-57 °C	+66 °C	+12 °C	Superheat control	R1234yf*	-52 °C	+66 °C	+15 °C	Superheat control

Note1: *) EXN not permitted

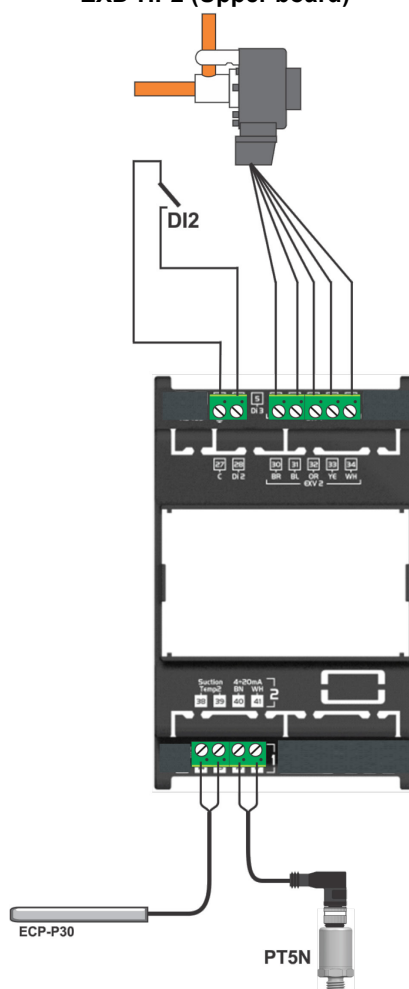
Note2: *) **Warning -Flammable refrigerants:** EXD-HP1/2 has a potential ignition source and does not comply with ATEX requirements. Installation only in non-explosive environment. For flammable refrigerants only use valves and accessories approved for it!

Wiring Diagrams

EXD-HP1 and EXD-HP2 (Base board)



EXD-HP2 (Upper board)



Notes:

- Base board for superheat control or Economizer control.
- Alarm relay, dry contact. Relay coil is not energized at alarm condition or power off and energized during normal operation
- Hot gas discharge sensor input is mandatory only for economizer control function.
- Transformer shall be class 2

Notes:

- Upper board only for superheat control
- Upper board does not need to be wired if circuit 2 of EXD-HP2 is disabled

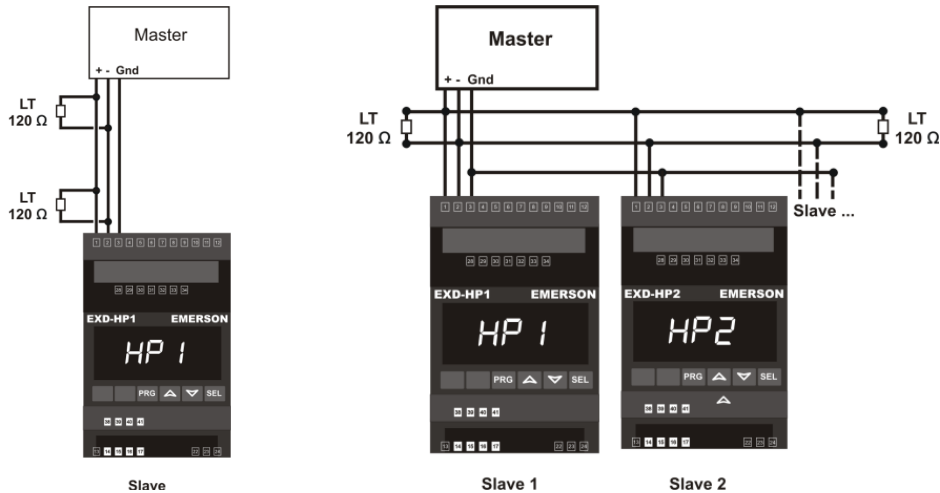
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Communication ModBus (RTU) protocol details

The use of communication is not necessary/mandatory; however, the communication is available for connection to upper level of system controller (third party controller) in order to perform data and commands transfer as well as data logging.

EXD-HP1/2 act as slave and third-party controller is master. In case of several EXD-HP1/2 connections to master, each driver needs to be addressed for proper communication.

Bus topology



ModBus Specification

- The Mode: RTU
- Modbus slave address range: 1 to 127 (parameter **Adr**)
- Baud rate: 9600 bps, 19200 bps (parameter **br**)
- Start bit: 1
- Data bits: 8
- Parity: even (default), no parity (parameter **PAr**)
- Stop bits: 1
- Master response timeout: 500 ms

Transmission Details

Modbus register address ranges

- Read-only data: Starting address: 0x0100 (256)
- Writable data: Starting address: 0x0200 (512)
- Configuration data: Starting address: 0x0300 (768)

Read Data transmission

Available through Modbus Function code 03 (0x03) Read Holding Registers

Request

Function code	1 Byte	0x03
Starting Address	2 Bytes	0x0000 to 0xFFFF
Register count	2 Bytes	1 to 125 (0x7D)

Response

Function code	1 Byte	0x03
Byte count	1 Byte	2 x N*
Holding Registers	N* x 2 Bytes	

*N = Quantity of Input Registers

Error

Error code	1 Byte	0x83
Exception code	1 Byte	01 or 02 or 03

- 01 = Function code not supported
- 02 = Starting Address or register count out of range
- 03 = Register count out of range

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Write Data transmission (single register)

Available through Modbus Function code 06 (0x06) Write Holding Register

Request

Function code	1 Byte	0x06
Starting Address	2 Bytes	0x0000 to 0xFFFF
Value	2 Bytes	0x0000 to 0xFFFF

Response

Function code	1 Byte	0x06
Starting Address	2 Bytes	0x0000 to 0xFFFF
Value	2 Bytes	0x0000 to 0xFFFF

Error

Error code	1 Byte	0x86
Exception code	1 Byte	01 or 02

01 = Function code not supported

02 = Starting address out of range

Write Data transmission (multiple registers)

Available through Modbus Function code 16 (0x10) Write Holding Registers

Request

Function code	1 Byte	0x10
Start Address	2 Bytes	0x0000 to 0xFFFF
Register count	2 Bytes	0x0001 to 0x0078
Byte count	1 Byte	2 x N
Registers values	2 x N Bytes	Value

N = register count.

Response

Function code	1 Byte	0x10
Starting Address	2 Bytes	0x0000 to 0xFFFF
Register count	2 Bytes	0x0001 to 0x0078

Error

Error code	1 Byte	0x90
Exception code	1 Byte	01 or 02 or 03

01 = Function code not supported

02 = Register Address invalid

03 = Register Value out of range

Writable variables EXD-HP1/2

Modbus address dec. / hex.	Display code	Description	Units	Remarks
512 / 0x0200	1Ho	Manual mode Circuit 1		0 = OFF 1 = ON
513 / 0x0201	1HP	Manual valve opening Circuit 1	%	Only active while manual mode is ON
514 / 0x0202		Factory default (when DI1 is Off)		1 = on (Set all parameters setting to factory default setting)
515 / 0x0203		Digital outputs		0x0001 = Alarm relay
516 / 0x0204		Manual alarm reset command		1 = Clear the alarm
517 / 0x0205	2Ho	Manual mode Circuit 2 (only EXD-HP2)		0 = OFF 1 = ON
518 / 0x0206	2HP	Manual valve opening Circuit 2 (only EXD-HP2)	%	Only active while manual mode is ON
519 / 0x0207		Discharge temperature input	1/100°C	Source for discharge temperature if parameter 1EC (0x31B) = 1 Allowed temperature range 0...160°C Minimum update rate: 2 seconds
520 / 0x0208		Discharge temp. control		0 = Discharge Temp. Control enabled 1 = Discharge Temp. Control disabled
521 / 0x0209		Demand circuit 1		0 = No demand 1 = Demand
522 / 0x020A		Demand circuit 2		0 = No demand 1 = Demand
523 / 0x020B		Manual defrost circuit 1		0 = OFF 1 = ON
524 / 0x020C		Manual defrost opening circuit 1	%	Only active while Manual defrost circuit 1 = ON
525 / 0x020D		Manual defrost circuit 2		0 = OFF 1 = ON
526 / 0x020E		Manual defrost opening circuit 2	%	Only active while Manual defrost circuit 2 = ON

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Read-only variables EXD-HP1/2

Modbus address dec. / hex.	Description	Unit	Remarks
256 / 0x100	Valve opening - Circuit 1	1/100%	
257 / 0x101	Digital input - Circuit 1		0 = No demand 1 = Demand
258 / 0x102	Digital outputs		0x0001 = Alarm relay
259 / 0x103	Pressure sensor 1 - Circuit 1	1/100 bar	
260 / 0x104	Temperature sensor 1 - Circuit 1	1/100°C	
261 / 0x105	Temperature sensor 3 - Circuit 1	1/100°C	
262 / 0x106	Saturation temperature - Circuit 1	1/100°C	
263 / 0x107	Pressure sensor 1 failure - Circuit 1		0 = No failure 1 = Failure
264 / 0x108	Temperature sensor 1 failure - Circuit 1		0 = No failure 1 = Failure
265 / 0x109	Temperature sensor 3 failure - Circuit 1		0 = No failure 1 = Failure
266 / 0x10A	Functional alarm set Circuit 1		0x0001 = Low pressure 0x0002 = Low superheat 0x0004 = High superheat 0x0008 = Freeze protection
267 / 0x10B	Hardware alarm set		0x0001 = Valve 1 alarm 0x0002 = Valve 2 alarm (only EXD-HP2) 0x0004 = Pressure sensor 1 0x0008 = Pressure sensor 2 (only EXD-HP2) 0x0010 = Temp. sensor 1 0x0020 = Temp. sensor 2 (only EXD-HP2) 0x0040 = Temp. sensor 3
268 / 0x10C	General application state Circuit 1		0 = No demand 1 = Demand 2 = Superheat control 3 = MOP control 4 = Alarm state 5 = Discharge temperature control 6 = Manual mode
269 / 0x10D	Superheat set point - Circuit 1	1/100 K	
270 / 0x10E	Superheat measured/calculated - Circuit 1	1/100 K	
271 / 0x10F	Software revision (x104)		Hexadecimal format 1 hex digit for controller type: 1 = HP1, 2 = HP2 1 hex digit for major revision 2 hex digits for minor revision
272 / 0x110	Valve opening - Circuit 2	1/100 %	
273 / 0x111	Digital inputs - Circuit 2 (only EXD-HP2)		0 = No demand 1 = Demand
274 / 0x112	Pressure sensor 2 - Circuit 2	1/100 bar	
275 / 0x113	Temperature sensor 2 - Circuit 2	1/100 °C	
276 / 0x114	Saturation temperature 2	1/100 °C	
277 / 0x115	Pressure sensor 2 failure - Circuit 2 (only EXD-HP2)		0 = No failure 1 = Failure
278 / 0x116	Temperature sensor 2 failure - Circuit 2 (only EXD-HP2)		0 = No failure 1 = Failure
279 / 0x117	Superheat set point - Circuit 2	1/100 K	
280 / 0x118	Superheat measured/calculated - Circuit 2	1/100 K	
281 / 0x119	Digital input DI3		0 = no effect 1 = Only superheat control for economizer
282 / 0x11A	Functional alarm set Circuit 2		0x0001 = Low pressure 0x0002 = Low superheat 0x0004 = High superheat 0x0008 = Freeze protection
283 / 0x11B	General application state Circuit 2		0 = No demand 1 = Demand 2 = Superheat control 3 = MOP control 4 = Alarm state 5 = N/A 6 = Manual mode

Configuration parameters EXD-HP1/2

Modbus address dec. / hex.	Display code	Description	Unit	Default value	Range	Remarks
768 / 0x300	H5	Password		12	1 - 1999	
769 / 0x301	Adr	Modbus address		1	1 - 127	
770 / 0x302	br	Modbus baudrate		1	0 - 1	0 = 9600 baud 1 = 19200 baud
771 / 0x303	PAr	Modbus parity		0	0 - 1	0 = Parity even 1 = No parity
772 / 0x304	-C2	Circuit 2 disabled		0	0 - 1	0 = Circuit 2 enabled 1 = Circuit 2 disabled
773 / 0x306	-uC	Units conversion		0	0 - 1	0 = °C, K, barg 1 = °F, psig This parameter only affects the display on device. The units are SI-based internally as well as for MODBUS communication.
774 / 0x305	HP-	Display mode EXDHP1=0 or 1, EXDHP2=0, 1 or 2		1	0 - 2	0 = No display 1 = Circuit 1 2 = Circuit 2

EXD-HP1/2 Stand-alone Superheat / Economizer Controller

Configuration parameters EXD-HP1/2

Modbus address dec. / hex.	Display code	Description	Unit	Default value	Range	Remarks
Parameters Circuit 1						
775 / 0x307	1uE	Function		1	0 - 1	0 = Superheat control 1 = Economizer control (only R410A, R32, R407C)
776 / 0x308	1u4	Control mode circuit 1		0	0 - 4	0 = Standard control coil heat exchanger 1 = Slow control coil heat exchanger 2 = fixed PID 3 = fast control plate heat exchanger 4 = Standard plate heat exchanger
777 / 0x309	1u0	Refrigerant circuit 1		2	0 - 15	0 = R22 1 = R134a 2 = R410A 3 = R32 4 = R407C 5 = R290* 6 = R448A 7 = R449A 8 = R452A 9 = R454A* 10 = R454B* 11 = R454C* 12 = R513A 13 = R452B* 14 = R1234ze* 15 = R1234yf * *) (EXN not permitted)
778 / 0x30A	1uP	Pressure sensor 1 - type		2	0 - 3	0 = PT5N-07... 1 = PT5N-18... 2 = PT5N-30... 3 = PT5N-10P-FLR
779 / 0x30B	1uu	Start opening valve1	%	20	10 - 100	
780 / 0x30C	1u9	Start opening duration valve 1	Sec.	5	1 - 30	
781 / 0x30D	1uL	Low superheat alarm mode circuit 1		1	0 - 2	0 = Disabled 1 = Enabled auto-reset 2 = Enabled manual reset
782 / 0x30E	1u5	Superheat setpoint circuit 1	1/10 K	6		Range = 3-30K with 1uL = 1,2 Range = 0.5-30K with 1uL = 0
783 / 0x30F	1u2	MOP mode circuit 1		1	0 - 1	0 = Disabled 1 = Enabled
784 / 0x310	1u3	MOP sat. temp. limit circuit1		1/10°C		See MOP table
785 / 0x311	1P9	Low pressure alarm mode circuit1		0	0 - 2	0 = Disabled 1 = Enabled auto-reset 2 = Enabled manual reset
786 / 0x312	1PA	Low pressure alarm cut-out circuit1	1/10 bar	0	-0.8 - 17.7	
787 / 0x313	1Pb	Low pressure alarm delay circuit1	Sec.	5	5 - 199	
788 / 0x314	1Pd	Low pressure alarm cut-in circuit1	1/10 bar	0.5	0.5 - 18	
789 / 0x315	1P4	Freeze alarm mode circuit1		0	0 - 2	0 = Disabled 1 = Enabled auto-reset 2 = Enabled manual reset
790 / 0x316	1P2	Freeze alarm cut-out circuit1	1/10°C	0	-20 - 5	
791 / 0x317	1P5	Freeze alarm delay circuit1	Sec.	30	5 - 199	
792 / 0x318	1P-	Superheat control circuit1 fixed PID Kp factor	1/10	1.0	0.1 - 10	Display 1/10K
793 / 0x319	1i-	Superheat control circuit1 fixed PID Ti factor		100	1 - 350	
794 / 0x31A	1d-	Superheat control circuit1 fixed PID Td factor	1/10	3.0	0.1 - 30	Display 1/10K
795 / 0x31B	1EC	Discharge temp. source		0	0 - 1	0 = Hot Gas temperature input 1 = ModBus command
796 / 0x31C	1PE	Economizer control Circuit 1 fixed PID Kp	1/10	2.0	0.1 - 10	Display 1/10K
797 / 0x31D	1iE	Economizer control Circuit 1 fixed PID Ti		100	1 - 350	
798 / 0x31E	1dE	Economizer control Circuit 1 fixed PID Td	1/10	1.0	0.1 - 30	Display 1/10K
799 / 0x31F	1uH	High superheat alarm mode circuit 1		0	0 - 1	0 = Disabled 1 = Enabled auto-reset
800 / 0x320	1uA	High superheat alarm setpoint circuit 1	1/10 K	30	16 - 40	
801 / 0x321	1ud	High superheat alarm delay circuit 1	Min.	3	1-15	
802 / 0x322	1E2	Discharge Temp. correction	1/10 K	0	0 - 10	Positive correction to the discharge temperature to take the sensor location in account.

EXD-HP1/2 Stand-alone Superheat / Economizer Controller

Configuration parameters (only for EXD-HP2)

Modbus address dec. / hex.	Display code	Description	Unit	Default value	Range	Remarks
Parameters Circuit 2						
803 / 0x323	2u4	Control mode circuit 2		0	0 - 4	0 = Standard control coil heat exchanger 1 = Slow control coil heat exchanger 2 = fixed PID 3 = fast control plate heat exchanger 4 = Standard plate heat exchanger
804 / 0x324	2u0	Refrigerant circuit 2		2	0 - 15	0 = R22 1 = R134a 2 = R410A 3 = R32 4 = R407C 5 = R290* 6 = R448A 7 = R449A 8 = R452A 9 = R454A* 10 = R454B* 11 = R454C* 12 = R513A 13 = R452B* 14 = R1234ze* 15 = R1234yf * *) (EXN not permitted)
805 / 0x325	2uP	Pressure sensor 2: type		1	0 - 3	0 = PT5N-07... 1 = PT5N-18... 2 = PT5N-30... 3 = PT5N-10P-FLR
806 / 0x326	2uu	Start opening valve 2	%	20	10 - 100	
807 / 0x327	2u9	Start opening duration valve 2	Sec.	5	1 - 30	
808 / 0x328	2uL	Low superheat alarm mode circuit 2		1	0 - 2	0 = Disabled 1 = Enabled auto-reset 2 = Enabled manual reset
809 / 0x329	2u5	Superheat setpoint circuit 2	1/10 K	6		Range = 3-30K with 2uL = 1,2 Range = 0.5-30K with 2uL = 0
810 / 0x32A	2u2	MOP mode circuit 2		1	0 - 1	0 = Disabled 1 = Enabled
811 / 0x32B	2u3	MOP sat. temp. circuit 2	1/10 °C			See MOP table
812 / 0x32C	2P9	Low pressure alarm mode circuit 2		0	0 - 2	0 = Disabled 1 = Enabled auto-reset 2 = Enabled manual reset
813 / 0x32D	2PA	Low pressure alarm cut-out circuit 2	1/10 bar	0	-0.8 - 17.7	
814 / 0x32E	2Pb	Low pressure alarm delay circuit 2	Sec.	5	5 - 199	
815 / 0x32F	2Pd	Low pressure alarm cut-in circuit 2	1/10 bar	0.5	0.5 - 18	
816 / 0x330	2P4	Freeze alarm mode circuit 2		0	0 - 2	0 = Disabled 1 = Enabled auto-reset 2 = Enabled manual reset
817 / 0x331	2P2	Freeze alarm cut-out circuit 2	1/10 °C	0	-20 - 5	
818 / 0x332	2P5	Freeze alarm delay circuit 2	Sec.	30	5 - 199	
819 / 0x333	2P-	Superheat control circuit 2 fixed PID Kp factor	1/10	1.0	0.1 - 10	Display 1/10K
820 / 0x334	2i-	Superheat control circuit 2 fixed PID Ti factor		100	1 - 350	
821 / 0x335	2d-	Superheat control circuit 2 fixed PID Td factor	1/10	3.0	0.1 - 20	Display 1/10K
822 / 0x336	2uH	High superheat alarm mode circuit 2		0	0 - 1	0 = Disabled 1 = Enabled auto-reset
823 / 0x337	2uA	High superheat alarm setpoint circuit 2	1/10 K	30	16 - 40	
824 / 0x338	2ud	High superheat alarm delay circuit 2	Min.	3	1-15	

Configuration parameters EXD-HP1/2 & Discharge Temperature Control

Modbus address dec. / hex.	Display code	Description	Unit	Default value	Range	Remarks
825 / 0x339	Et	Valve type for HP1 & HP2	0-1		0	0 = EXM/L 1 = EXN (see notes page 2) EXD-HP2 can drive two similar valves i.e. both valves must be either EXM/EXL or EXN.
831 / 0x33F	1E3	Discharge Temperature Setpoint		85	70-140	Start Setpoint
832 / 0x340	1E4	Discharge Temperature Control band		20	2-25	
833 / 0x341	1E5	Discharge Temperature limit	100	120	100-150	

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