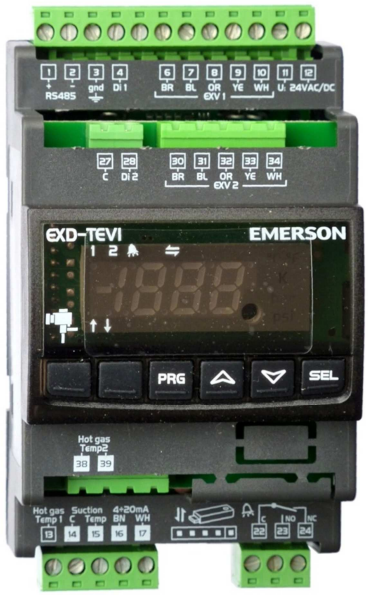
EXD-TEVI Economizer Controller for Tandem Compressors

Technical Bulletin

EXD-TEVI is a **stand-alone controller** for enhanced wet vapor injection for Copeland tandem Scroll compressors in heating applications.



EXD-TEVI

Features EXD-TEVI

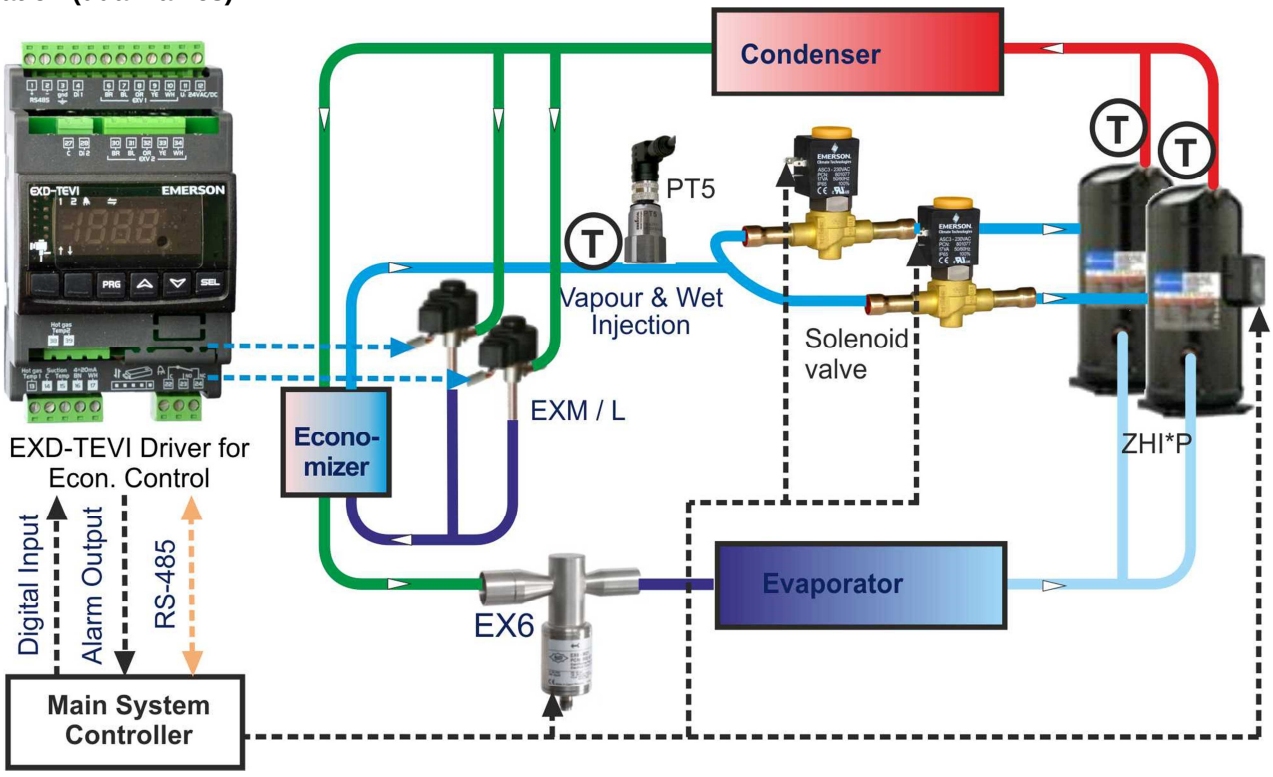
- Emerson solution for specified operating map of tandem scroll
- Two EXL valves can be driven in parallel for required wide injection capacity
- Input signals: Injection (intermediate) pressure and temperature sensor as well as two compressor discharge temperature sensors
- Two independent digital inputs for recognition of tandem compressors operation
- High discharge temperature alarm
- Monitoring of sensors and sensor wiring and detection of sensor wiring failures
- Controllers as slave with Modbus (RTU) communication capability
- Upload/download key (accessory) allows to copy parameter settings from one controller to others
- Integrated 3½ digit 7-segment display with 6 indicator LEDs
- Electrical connection via plug-in type screw terminals (included with controller)
- DIN rail mounting housing

Selection table

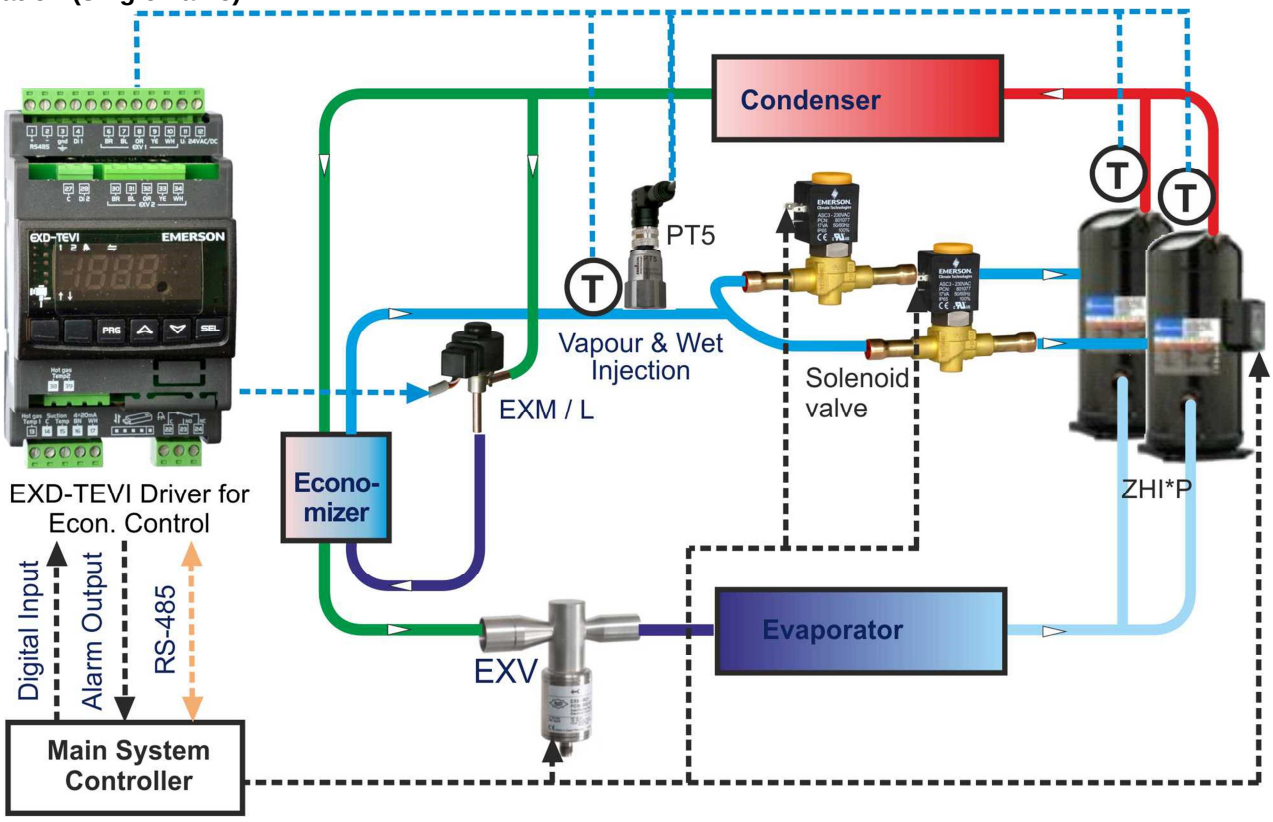
Description	Type	PCN	
		Multipack (20 pieces)	Singlepack
Controller with connectors	EXD-TEVI	807 838M	807 838
Injection line temperature sensor	ECN-N30 (3 meter cable) or ECN-N60 (6 meter cable)	- -	804 496 804 497
Injection line pressure transmitter	PT5-30M (flare connection) or PT5-30T (brazed connection)	802 352M 802 382M	802 352 802 382
Plug and cable assembly for pressure transmitters	PT4-M15 (1.5 meter cable) or PT4-M30 (3 meter cable)	804 803M 804 804M	804 803 804 804
Electronic expansion valve body	EXL-B1F	800405M	-
	EXL-B1G	800406M	-
Electronic expansion valve coil	EXL-125	800407M	-

Remark: Discharge temperature sensor (86 kΩ NTC) is part of compressor delivery.

Application (dual valves)



Application (single valve)



Technical Data EXD-TEVI

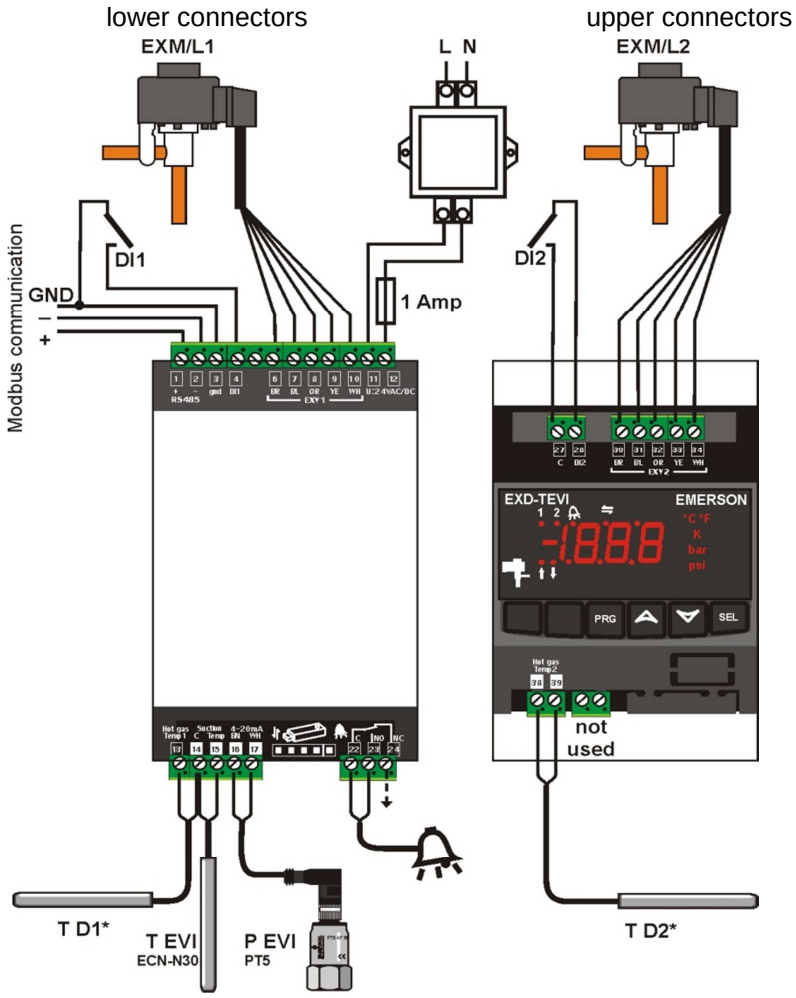
Supply voltage	24VAC/DC ±10%
Power consumption	EXD-TEVI: Max. 20VA
Digital inputs	2 (potential free)
Relay output (Alarm)	SPDT, with AgSnO contacts Inductive (AC15) 24V AC: 1A Resistive: 24 V AC/DC: 4A
Plug-in connector size	Removable screw version wire size 0.14 … 1.5 mm^2
Applied directive	LVD, EMC, RoHS,
Compliance with	DIN EN60335-1 DIN EN 55014-1, DIN EN 55014-2

Protection class	IP 20
Housing	Self-extinguishing ABS
Mounting	DIN rail mounted
Temperatures storage operating	 -20 … +65°C -10 … +60°C
Relative humidity	0 … 85% RH non condensing
Weight	175 g
Marking	CE

Technical data: Sensors

Description	Specification
Temperature sensors	1 x 10k NTC for injection line temperature (ECN-N30 / ECN-N60) 2 x 86k NTC for discharge gas temperature (part of compressor delivery)
Pressure transmitter EVI	PT5-30M/T: 4-20 mA (Range: 0 to 30 bar)

Wiring Diagram EXD-TEVI



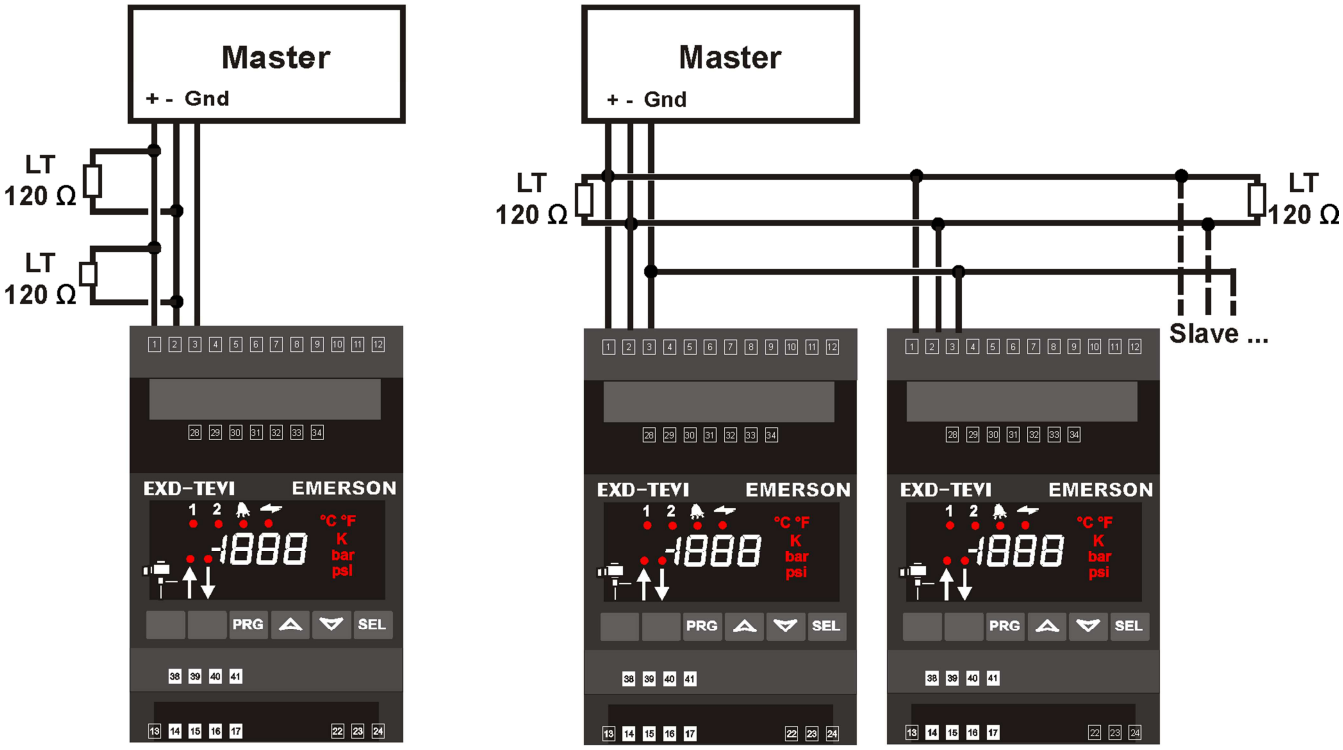
Notes:
- Alarm relay, dry contact. Relay coil is not energized at alarm condition or power off and energized during normal operation
- Transformer shall be class 2
- *The discharge temperature sensors would be part of compressor delivery

ModBus Connection

EXD-TEVI has a slave ModBus (RTU) communication capability and can be connected to an upper level controller having a master ModBus (RTU) communication capability. The Master has full control for all commands (write, read) and store data.

Bus topology for single and multiple slaves

MOD Bus must be terminated at the beginning and at the end with a 120 Ω resistor. See drawings below for one slave (left) and multiple slaves (right).



ModBus Communication

ModBus protocol details

Mode:	RTU
Modbus slave address range:	1 to 127 (parameter **Adr**)
Baud rate:	9600 bps (default), 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

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 or 03

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

Read-only variables

Modbus address dec.	Modbus address hex.	Description	Unit	Remarks Read
256	0x100	Valve opening 1	1/100 %	
257	0x101	Digital inputs		0x0000 = no demand
				0x0001 = demand compressor 1
				0x0010 = demand compressor 2
				0x0011 = demand compressor 1 + 2
258	0x102	Digital outputs		0x0001 = Alarm relay
259	0x103	EVI Pressure	1/100 bar	
260	0x104	EVI Suction Temp 1	1/100 °C	measured
261	0x105	Hot gas temp 1	1/100 °C	
262	0x106	EVI Saturation Temp 1	1/100 °C	calculated from EVI pressure
263	0x107	Pressure sensor failure, circuit 1		0 = No failure
				1 = Failure
264	0x108	EVI Suction Temp 1 sensor failure		0 = No failure
				1 = Failure
265	0x109	Hot gas temp 1 sensor failure		0 = No failure
				1 = Failure

Read-only variables (continued)

Modbus address dec.	Modbus address hex.	Description	Unit	Remarks Read
266	0x10A	Functional Alarm set		0x0001 = na
				0x0002 = na
				0x0004 = na
				0x0008 = na
				0x0010 = High discharge temp 1
				0x0020 = High discharge temp 2
267	0x10B	Hardware alarm set		0x0001 = Valve 1 alarm
				0x0002 = Valve 2 alarm
				0x0004 = Pressure 1 sensor
				0x0008 = na
				0x0010 = Suction Temp
				0x0020 = Hot gas temp2 sensor
				0x0040 = Hot gas temp1 sensor
268	0x10C	General application state*		0 = No demand
				1 = N/A
				2 = Superheat control
				3 = EVI disabled
				4 = Alarm state
				5 = Discharge temp control
				6 = Manual mode
269	0x10D	Superheat setpoint	1/100 K	
270	0x10E	Superheat	1/100 K	
271	0x10F	Software revision		Hexadecimal format 2 hex digits for major revision, 2 hex digits for minor revision.
272	0x110	Valve opening 2	1/100 %	
273	0x111	Not used		
274	0x112	Not used		
275	0x113	Hot gas temp 2	1/100 °C	
276	0x114	Not used		
277	0x115	Not used		
278	0x116	Hot gas temp 2 sensor failure		0 = No failure
				1 = Failure
279	0x117	Not used		
280	0x118	Not used		
295	0x127	Valve opening 1&2	1/100 %	Total valve opening in % of valve 1 and 2; Valve opening 1&2 = (Valve opening1 + Valve opening2) / 2

Writable variables

Modbus address dec.	Modbus address hex.	Display code	Description	Unit	Remarks
512	0x0200	**1Ho**	Manual mode Circuit		0 = off, 1 = on Full manual mode regardless of any alarms. Valve close is performed when leaving manual mode. General application state = Manual mode
513	0x0201	**1HP**	Manual valve opening	%	only active while manual mode = on
514	0x0202		Factory default		1 = on (causes a controller reset)
515	0x0203		Digital outputs		0x0001 = Alarm relay only active while manual mode = on
516	0x0204		Reset command		1 = Resets the controller
521	0x0209		Compressor 1		0 = stopped, 1 = running **
522	0x020A		Compressor 2		0 = stopped, 1 = running **
523	0x020B		Disable EVI		0 = enable EVI (default after reset) 1 = disable EVI, causes a valve close This function is to be used if Vapour/Liquid injection is not required under certain system conditions. Enabling the EVI after disabling it, behaves like a controller start (Start opening followed by Superheat / Discharge control) Modbus commands are allowed to be repeated at regular intervals. General application state = EVI disabled

**Remark: Either Digital inputs or Modbus is supposed to be used.
In case both (Digital input and Modbus) are to be used, controller will inject refrigerant in the compressor in event of one of those input is activated (value '1'). The table below further elaborates the same:

Input	Output
'0' from Digital Input; '0' from Modbus	controller will not inject refrigerant in the compressor
'0' from Digital Input; '1' from Modbus	controller will inject refrigerant in the compressor
'1' from Digital Input; '0' from Modbus	controller will inject refrigerant in the compressor
'1' from Digital Input; '1' from Modbus	controller will inject refrigerant in the compressor

***Displayed Value:**

General application state	Display value
0 = No demand	Text "OFF"
1 = N/A	N/A
2 = Superheat control	Superheat
3 = EVI disabled	Text "OFF"
4 = Alarm state	Alarm code
5 = Discharge temp control	Discharge temperature
6 = Manual mode	Discharge temperature when DT high else superheat.

Configuration parameters

Modbus address dec.	Modbus address 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	**tAn**	Single / Tandem Operation		2	1 - 2	1 = single compressor 2 = tandem compressor
773	0x305	**1u4**	Control mode 1 0 - 2				0 = standard control 1 = slow control 2 = fixed PID
777	0x309	**1uu**	Start opening	%	15	5 - 100	
778	0x30A	**1u9**	Start opening duration	s	5	1 - 30	
779	0x30B	**1u5**	Superheat setpoint	1/10 K	7	0.5 - 30	
780	0x30C		Future use				Future use
781	0x30D	**1PE**	EVI control fixed PID Kp	1/10	2.0	0.1 - 10	
782	0x30E	**1IE**	EVI control fixed PID Ti		100	1 - 350	
783	0x30F	**1dE**	EVI control fixed PID Td	1/10	1.0	0.1 - 30	
784	0x310	**1uC**	Units conversion		0	0 - 1	0 = °C, K, barg 1 = °F, psig
785	0x311	**1dt**	Discharge temp. limit	1/100 °C	135	100-140	
786	0x312	**1Lo**	Load shedding valve offset	1	18	10 - 20	Valve opening change by adding/ removing compressors. 10 is no offset, 20 is 50% of current valve opening as offset
787	0x313	**dAd**	Discharge temp. alarm delay	s	60	10-60	
788	0x314	**EC0**	Expansion valve count		1	1-2	Second Valve added
791	0x317	**t2E**	Threshold start second valve	%	30	0-50	This is the value (based on Valve opening 1&2) after which the second valve opens in addition to the first valve. Example: In case when the default value is 30%; this indicates that the Total Valves opening 1&2 is 30%. Hence the second valve would begin to open only after the first valve is 60% open.

Dimensions [mm]

EXD-TEVI Economizer Controller