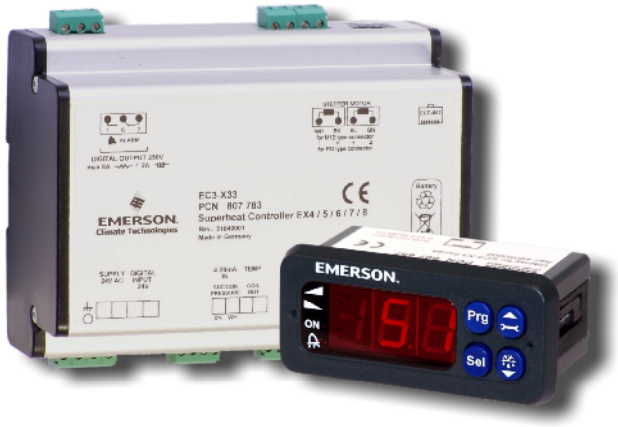
EC3-X33
Stand-alone Superheat Controller
D A T A S H E E T

EC3-X33 is a **stand-alone** universal **superheat controller** for air conditioning, refrigeration and industrial applications such as chillers, industrial process cooling, rooftops, heat pumps, package unit, close control, cold room, food process and air driers. The **optional ECD-002 Display/keypad** Unit is necessary for setup but not for operation of the controllers. ECD-002 can be connected or disconnected to EC3-X33 at any time.

Features EC3-X33

- Superheat control in conjunction with EMERSON stepper motor driven Electrical Control Valves EX4 … EX8
- Limitation of evaporating pressure (MOP)
- Low superheat alarm
- Feed through of 4…20mA signal from evaporator pressure sensor to analogue output. This may also be connected to pressure input of any other controller to avoid need for multiple pressure sensors
- Monitoring of sensors and sensor wiring and detection of sensor and wiring failures
- Intelligent alarm management in order to protect the compressor i.e fail safe operation
- Integral rechargeable battery to close Electrical Control Valve in case of power loss
- Electrical connection via plug-in type screw terminals
- Aluminum housing for DIN rail mounting



EC3-X33 with ECD-002

Features ECD-002

- 2½ digit LED display with automatic decimal point
- Indicator LEDs for valve opening/closing, external demand and alarm
- Connection to EC3 Series via ECC-Nxx or standard CAT5 patch cord with RJ45 connectors

Typical ordering package:

Description	Type	PCN
Superheat Controller	EC3-X33	807 783
Terminal kit	K03-X33	807 645
Temperature sensor	ECN-N60	804 497
Electrical Control Valve	EX4, EX5, EX6, EX7 or EX8 *	*
Pressure sensor		
• for R22/R124/R134a/R40A/R407C/R507C	PT5-07M	802 350
• for R410A	PT5-18M	802 351
• for R744	PT5-30M	802 352
• for intermediate pressure applications	PT5-18M	802 351
Plug and cable assembly for pressure sensor	PT4-M60	804 805

*For further details refer to: EX4, EX5, EX6, EX7, EX8 Electrical Control Valves datasheet EX48_35008.pdf

Accessories (required for setting at start-up only):

Description	Type	PCN
Optional display/keypad	ECD-002	807 657
Cable connection between EC3-X33 and ECD-002	ECC-N50 or any standard Cat 5 patch cord with RJ45 connectors	807 862

Application

EC3-X33 as superheat controller can be applied for the following:

- Superheat control of conventional evaporators such as shell and tube, plate heat exchanger, air coil etc.
- Superheat control of subcoolers or economizers connected to suction pressure of compressor or intermediate pressure of screw/scroll compressors having vapour or liquid injection connection
- Superheat control of intermediate gas in two stage compressors
- Superheat control of suction gas in conjunction with hot gas bypass
- Superheat control of flooded evaporators

Introduction

EC3-X33 controls the opening of electrical control valves according to desired superheat. As electrical control valves EX4 … EX8 are able to provide positive shut-off function better than conventional solenoid valves, there will be no flow through the valve as long as the compressor is not running. In the event of cooling request and compressor start-up, EC3-X33 needs to be informed. This can be achieved by a digital input. EC3-X33 will start to control the refrigerant mass flow stand alone by precise positioning of the ECV under different operating conditions such as compressor start-up, start of further compressor, high head pressure, low head pressure, high load, low load and partial load operation.

EC3-X33 is capable for diagnostics and alarm. The alarm can be received via relay output as well as optical LED/alarm code on ECD-002.

Algorithm

The superheat control algorithm is self-adapting, so that it automatically adjusts itself to the characteristics of the evaporator at regular intervals. This guarantees optimal superheat control performance for different types of evaporators and even when the operating conditions of the evaporator change over time.

Superheat Control function

By receiving two measured values from EMERSON pressure sensor PT5 and temperature sensor ECN-N60, EC3-X33 calculates the actual superheat and compares with preset superheat. EC3-X33 operates the Electrical Control Valve in order to keep superheat at desired setpoint under various operating conditions.

The superheat setpoint is adjustable in the range between 3K and 30K. If low superheat alarm function is disabled, it is possible to adjust the superheat set point below 3K down to 0.5K for special applications such as flooded evaporators.

MOP function

To avoid overload of the compressor motor, the MOP function of the EC3-X33 limits the evaporating pressure to a pre-determined value, which can be adjusted to match the safe operating envelope of the compressor. MOP setpoints are entered as saturation temperature values to match published safe operating data of compressor manufacturers and to avoid unnecessary manual conversions from temperature into pressure values. The MOP function may be totally disabled, when not needed.

Low superheat alarm

Liquid flooding may lead to serious damage of compressors and must be avoided. The built-in low superheat alarm function of the EC3-X33 detects low superheat conditions and deactivates the alarm relay. If the alarm relay is wired into the serial safety loop, the compressor will be switched off when a low superheat alarm occurs.

Digital input status

The digital input is the interface between EC3-X33 and system controller. The digital status is dependant to operation of system's compressor/thermostat.

Commander	Operating condition	Digital input status
Compressor	Compressor starts	Closed / 24V (Start)
	Compressor stops	Open / 0V (Stop)
Thermostat	Demand (compressor must be ON)	Closed / 24V (Start)
	No demand	Open / 0V (Stop)

Shut-off function

When digital input is open (0V), the EC3-X33 will drive the electrical control valve to close position. Due to the positive shut-off capabilities of the EX4/5/6/7/8 valves a separate liquid line solenoid valve is not required. The shut-off function is guaranteed in case of power loss due to built-in internal battery.

⚠ If this function is disabled, the user must ensure appropriate safety precautions are in place to protect the system against damage caused by a power failure. Refer to operating instructions.

Analogue output (4-20mA signal) function

EC3-X33 requires the outlet pressure level of the evaporator for superheat and MOP control. The output signal from PT5 is used by EC3-X33 and again provided as a 4...20mA signal (galvanized) for the connection to any other third party controller, which can receive a 4...20mA signal. Please see the wiring diagram for more details. If the system controller does not have the capability of using this signal, the terminal will not be wired to any other device.

Pump down function

EMERSON Electrical Control Valves can be driven to close position while the compressor is running for pump down function. There are two possibilities to achieve this function:

1) The valve will be driven to close position by interruption of the digital input. The compressor can be turned off by a pressure switch and / or a timer.

2) By using 4 to 20 mA analogue output connected to system controller.

In both cases, the initiation and termination of pump down is under the system controller functionality/responsibility.

Safety / internal battery function

In event of power failure to the entire system, the stepper motor driven valve would not be able to move. Due to the differential pressure between condenser and evaporator, the refrigerant could continue to flow through the valve if the valve is open. The compressor must be protected after power recovery against wet running. EC3-X32 contains an internal rechargeable battery and smart battery charge control to automatically close the valve in case of power failure.

Whilst the battery is maintenance free, the life expectancy will depend upon the working ambient; as the temperature increases the life expectancy reduces. It is recommended to replace the battery annually to maintain the system in optimum operating condition.

⚠ If the output relays are not utilized, the user must ensure appropriate safety precautions are in place to protect the system against damage caused by a power failure

Alarm and maintenance functions

EC3-X33 provides several alarms to facilitate diagnosis as well as shut down of compressor/system if the alarm relay is wired into the serial safety loop. Built-in diagnostic routines constantly monitor battery health, sensors, the Electrical Control Valve and the associated wiring for open and short circuits. When such errors are detected, the controller goes into an alarm condition and closes the valve.

Additional to hardware errors also EC3-X33 will monitor the minimum operating superheat. If the superheat drops below 0.5K for continuous period of one minute, the low superheat alarm will occur. It can be disabled for applications such as flooded evaporator, which lower operating superheat is required.

In case of alarm, EC3-X33 will close the valve, alarm relay will be deactivated and alarm codes as well as alarm LED will be

available if the optional display/keypad ECD-002 is connected to EC3-X33.

All alarms are automatically cleared after correction. Battery alarm and low superheat alarm can be modified for manual reset.

Alarm relay function

Alarm relay contains a SPDT contact. If the relay is wired to system controller, it is possible to stop compressor/system. The alarm relay is activated during normal operation and deactivated during alarm conditions as well as supply power interruption.

Start-up configuration function

Built-in valve opening (%) at start-up for a certain period of time helps the compressor's start-up and prevents erratic low pressure cut-out for the following cases:

- Operation of systems with air cooled condensers in low ambient temperatures
- Compressor start-up after a long standby time in a low ambient environment
- Start-up of very large single stage compressor capacity

EMERSON Pressure Sensor PT5 function

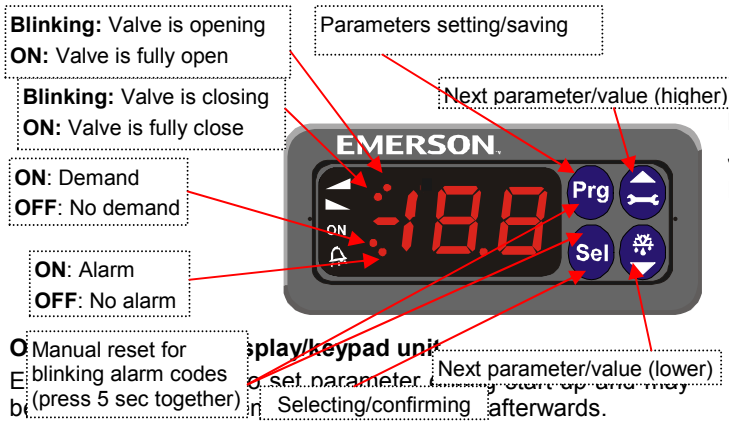
The pressure sensor measures the saturation pressure at the outlet of the evaporator. The output signal is 4 to 20 mA corresponding to a pressure range. Based on refrigerant and system, different types of pressure sensors are needed.

- PT5-07M for evaporators operating with refrigerants R22/R124/R134a/R404A/R407C
- PT5-18M for evaporators operating with R410A
- PT5-30M for evaporators operating with R744
- PT5-18M for evap. as economizers, subcoolers, which the outlet of evaporator connected to intermediate pressure of screw/scroll compressors or two stage compressors.

Every type of pressure sensor is calibrated in temperature range for above specified applications. The feature set and performance of the PT5 Series is a perfect match for the EC3-X33. Other pressure sensors are not released for use with EC3-X33 and when applied, may lead to poor performance.

EMERSON temperature sensor ECN-N60

The temperature sensor measures the refrigerant temperature at the outlet of the evaporator. It is important to use only this dedicated temperature sensor because the ECN-N60 has the right performance such as desired time constant and tolerance compensation within the specific working range. The use of other temperature sensors is not recommended. The sensor is hermetically sealed for high reliability and long lifetime and has metal housings for optimal thermal conductivity.



O **play/keypad unit**

E

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set parameter

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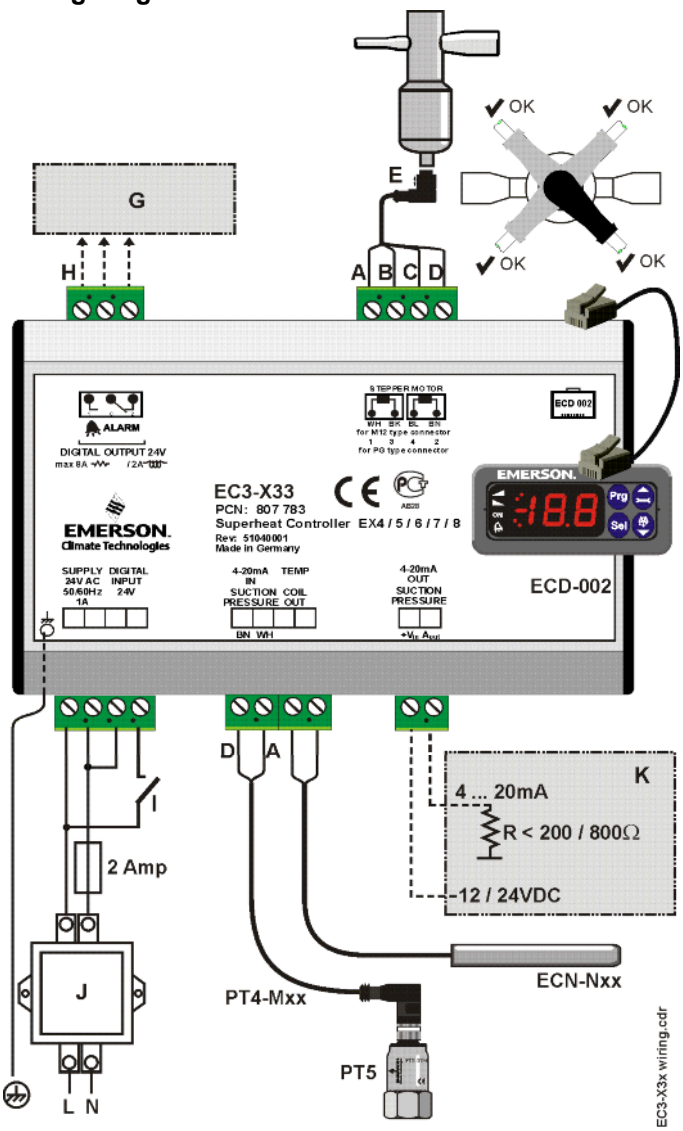
Ordering, main parts

The display unit can be switched from K/bar/°C to R/psig/°F. Indicator LEDs show the status of valve opening, valve closing, demand and alarm.

Wiring Diagram



A: White wire **B**: Black wire **C**: Blue wire **D**: Brown wire

E: Plug cable assembly EXV-Mxx for connection to EX4 .. EX8

G: Remote control panel, system controller

H: Alarm relay, dry contact. Relay coil is not energized at alarm condition or power off

⚠ The use of the relay is essential to protect the system in case of power failure if the communications interface or the ECD-002 are not utilized

I: Digital input (0V/open = Stop; 24V/closed = Start)

J: Transformer Class II, 24VAC secondary / 25VA

K: Third party controller (can use analog output signal of EC3)

Note: The internal resistor of a third party controller must fulfill the following conditions:

Supply voltage 12VDC: R ≤ 200Ω

Supply voltage 24VDC: R ≤ 800Ω

Description		Type	Part Code Nr.
Controller EC3-X33		EC3-X33	807 783
Terminal Kit for EC3-X33		K03-X33	807 645
Pressure Sensors	-0.8…7bar	PT5-07M	802 350
	0…18bar	PT5-18M	802 351
	0…30bar	PT5-30M	802 352
Cable Assembly for PT5	1.5m cable length	PT4-M15	804 803
	3.0m cable length	PT4-M30	804 804
	6.0m cable length	PT4-M60	804 805
NTC Temperature sensors	3m cable length	ECN-N30	804 496
	6m cable length	ECN-N60	804 497
	12m cable length	ECN-N99	804 499
Display/keypad unit (need for set-up only)		ECD-002	807 657
Connection cable EC3 to ECD-002	1,0 m	ECC-N10	807 860
	3,0 m	ECC-N30	807 861
	5,0 m	ECC-N50	807 862

Ordering, accessories, spare part

Transformer 230VAC Input, 24V output, Din rail mounting		Type	Part Code Nr.
For one set of controller and valve	25VA	ECT-323	804 424
For two sets of controllers and valves	60VA	ECT-623	804 421
Replacement battery kit EC3			807 790

Suitable valves for connection to EC3-X33

Valve	Capacity range kW *	Refrigerant	Capacity regulation
EX4	2 ... 20	**R22**	10-100%
EX5	5 ... 50		
EX6	12 ... 120		
EX7	35 ... 330		
EX8	90 ... 880		
EX4	2 ... 21	**R407C**	
EX5	5 ... 53		
EX6	13 ... 126		
EX7	35 ... 347		
EX8	100 ... 925		
EX4	2 ... 15	**R134a**	
EX5	4 ... 39		
EX6	10 ... 93		
EX7	25 ... 255		
EX8	70 ... 680		
EX4	2 ... 14	**R404A/ R507**	
EX5	4 ... 35		
EX6	9 ... 84		
EX7	24 ... 230		
EX8	62 ... 613		

Valve	Capacity range kW *	Refrigerant	Capacity regulation
EX4	3 ... 23	**R 410A**	10 to 100%
EX5	6 ... 58		
EX6	14 ... 140		
EX7	40 ... 385		
EX8**	100 ... 1027		
EX4	4 ... 41	**R 744**	
EX5	10 ... 102		
EX6	25 ... 244		
EX7	70 ... 671		
EX8**	180 ... 1789		
EX4	1 ... 11	**R124**	
EX5	3 ... 28		
EX6	6 ... 67		

*) Nominal rating conditions:

Refrigerant	Evaporating temperature	Condensing temperature
R22, R134a, R404A, R407C, R410A	+4°C	+38°C
R23	-60°C	-25°C
R744	-40°C	-10°C
R124	+20°C	+80°C

**) PS:35bar

Technical Data

EC3-X33

Supply voltage	24VAC ±10%, 50/60Hz
Digital input	24 V AC ±10%, 50-60HZ 24 V DC ±10%
Power consumption	25VA max. including connected ECV and display/keyboard
Internal battery charging time	Approximately 2 hours if battery is fully empty
Plug-in connector size	Removable screw version wire size 0.14 … 1.5mm^2
Ground connection	6.3mm spade earth connector
Applied directive EMC LVD RoHS	 EN 61326, EN 50081, EN 61000-6-2, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6, EN 61000-4-11
Marking	CE
Protection class	IP 20
Vibration	4g, 10-1000Hz
Temperatures storage operating	 -20 … +65°C 0 … +60°C 1… +25°C for optimum battery life
Humidity	0 … 80% r.h. non condensing
Protection class	IP20
Weight	~ 800g
Mounting	DIN rail mounted

ECD-002 Display Unit

Supply	From EC3 Series Controller via connecting cable
LED indicators	Valve opening, valve closing, alarm, demand
Display LED	Numeric segmental display, 2½-digits, red, with automatic decimal point betw. ±19.9, switchable between °C and °F
Connecting cable	ECC-Nxx or standard CAT5 patch cord with RJ45 connectors
Temperature storage operating	 -20 … +65°C 0 … +60°C
Humidity	0 … 80% r.h. non condensing
Protection class	IP 65 (front protection with gasket)
Weight	~ 52g
Mounting	Panel mount (71 x 29 mm cutout)

Input and Output, EC3-X33 Controller

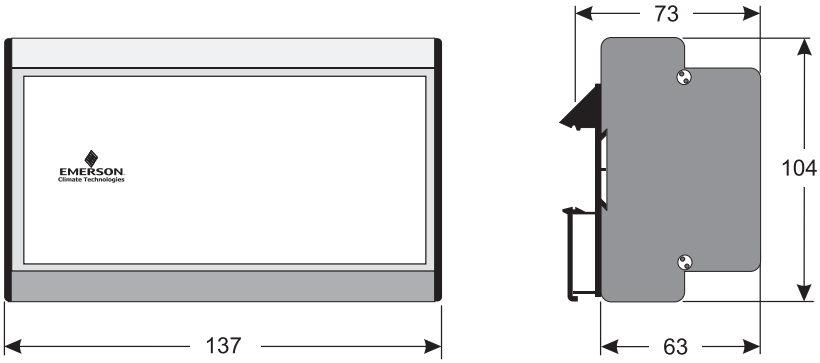
Description	Specification
Temperature input	ECN-Nxx 10kΩ @ 25 °C, Range: -50 … 50 °C
Pressure sensor input	PT5-07M/18M/30M 24VDC, 4 … 20mA
Analog output (evaporating pressure fed-through signal) Deviation from input signal	4 … 20mA Requires 12 or 24 VDC ±8% max
Digital input	0/24 VAC/DC
Output relay	SPDT contacts, AgCdO , 24VAC/DC Inductive 2Amp, Resistive 8 Amp
Stepper motor output	For EX4 … EX8 Electrical Control Valves
Connection to ECD-002	RJ45

List of Adjustable Parameters

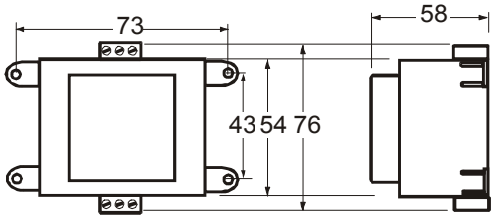
- Superheat set point
- Low superheat function
- MOP function and set point
- Type of refrigerant and required pressure sensor
- Type of Electrical Control Valve
- Valve start opening and duration
- Unit conversion
- Value to display
- Battery error management
- Password

Dimensions (mm)

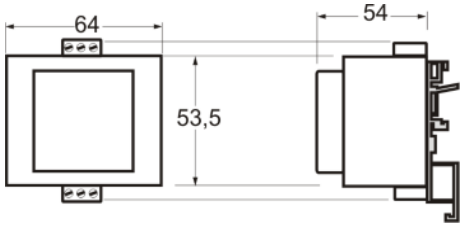
EC3-X33 Controller



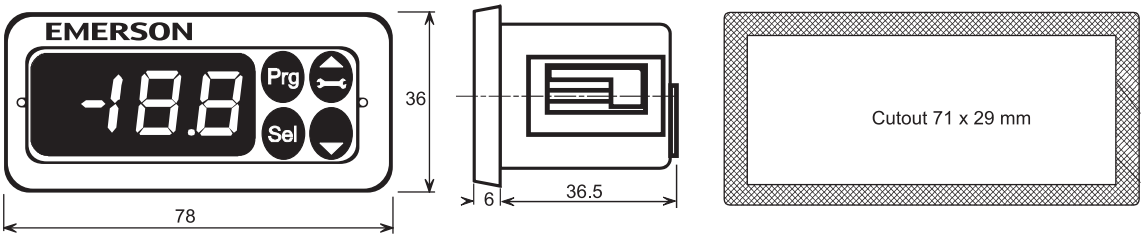
ECT-623 Transformer



ECT-323 Transformer



ECD-002 Display Unit



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