

EC3-X33 Stand-alone Superheat Controller Technical Data



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	Emerson PCN	Part No.
Superheat Controller	EC3-X33	097707	807 783
Terminal kit	K03-X32	097709	807 644
Temperature sensor	ECN-N60	097714	804 497
Electrical Control Valve	EX4, EX5, EX6, EX7 or EX8 *	*	*
Pressure sensor			
• for R-22/R-124/R-134a/R-404A/R-407C/R-507C	PT5-07M	097748	802 350
• for R-410A	PT5-18M	097749	802 851
• for R-744	PT4-30M	097728	802 334
Plug and cable assembly for pressure sensor	PT4-M60	097717	804 805

*For further details refer to: EX4, EX5, EX6, EX7, EX8 Electrical Control Valves datasheet FC-TD/ EX4-8

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

Description	Type	Emerson PCN	Part No.
Optional display/keypad	ECD-002	097712	807 657
Cable connection between EC3-X33 and ECD-002	ECC-N30 or any standard Cat 5 patch cord with RJ45 connectors	097713	807 861
Replacement Battery for EC3		097693	807 790

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 vapor 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

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Introduction

The EC3-X33 controls the opening of an electrical control valves according to desired superheat. As Emerson Electrical Control Valves (ECV) are able to provide positive shut-off function better than conventional solenoid valves, there will be no flow through Emerson ECV 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, as well as when the operating conditions of the evaporator change over time.

Superheat Control function

By receiving two measured values from Emerson pressure sensor PT4 and Emerson 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 between 6°F and 60°F. If low superheat alarm function is disabled, it is possible to adjust the superheat set point below 6°F down to 1°F 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. This 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 depends on the 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 the closed 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.

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 PT4 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 the event of a power failure to the entire system, a stepper motor driven valve would not be able to move. Due to the differential pressure between condenser and evaporator, the refrigerant would continue to flow through the valve if the valve is open. The compressor must be protected after power recovery against flood-back. The EC3-X33 contains an internal rechargeable battery and smart battery charge control. Optimum battery life is achieved through temperature compensated charge cycles.

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 and 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.

In addition to hardware errors, the EC3-X33 will monitor the minimum operating superheat. If the superheat drops below 1°F for a continuous period of one minute, the low superheat alarm will occur. The low superheat alarm can be disabled for applications such as a flooded evaporator, where a lower operating superheat is required.

In the case of an alarm, the EC3-X33 will close the valve, and the alarm relay will be deactivated. Alarm codes such 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 the system controller, it is possible to stop the compressor/system. The alarm relay is activated during normal operation and

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deactivated during alarm conditions such as supply power interruptions.

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 PT4 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 the type of refrigerant and system, different types of pressure sensors are needed.

- PT4-07M for evaporators operating with refrigerants R-22/R-124/R-134a/R-404A/R-407C
- PT4-18M for evaporators operating with R-410A
- PT4-30M for evaporators operating with R744

Every type of pressure sensor is calibrated in a temperature range for the above specified applications. The feature set and performance of the PT4 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.

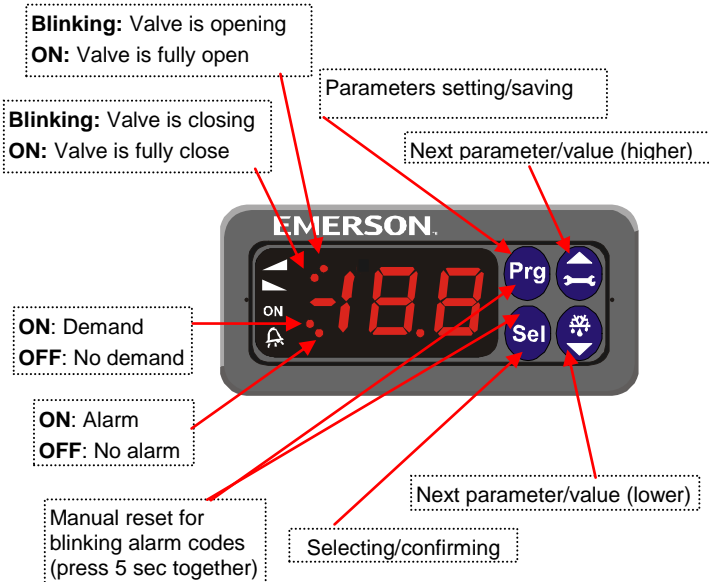
Emerson temperature sensor ECN-N60

The temperature sensor measures the refrigerant temperature at the outlet of the evaporator. It is important to use only this particular 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.

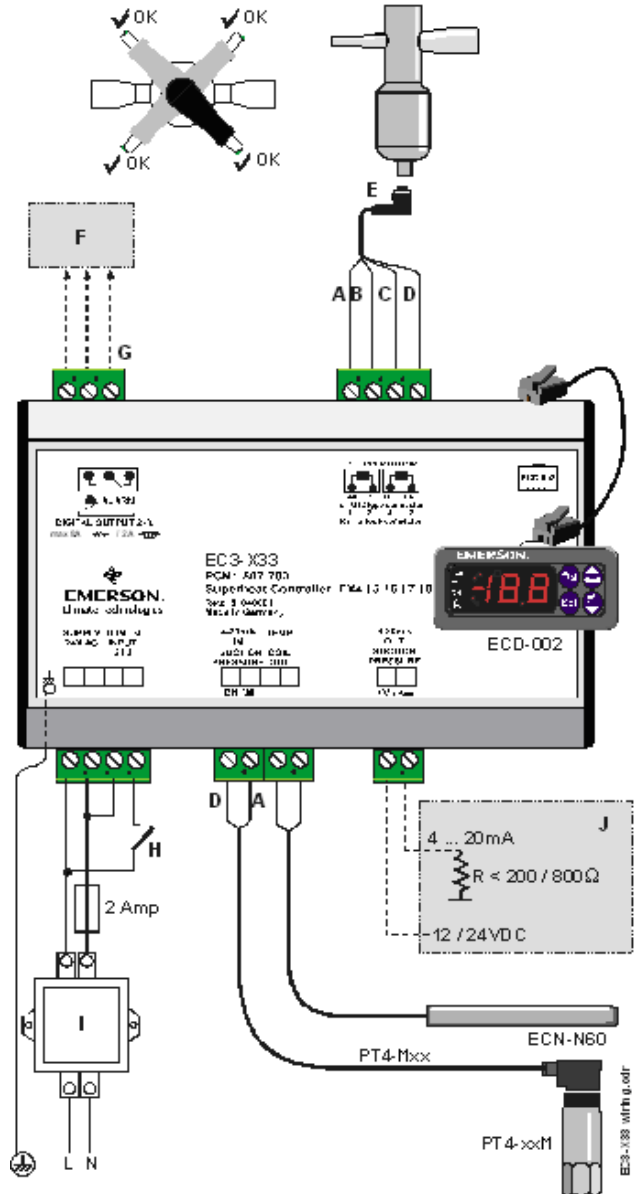
Optional ECD-002 display/keypad unit

The ECD-002 is required to set a parameter during start-up. After completion of start-up, it may be left connected or removed from EC3-X33.

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 EX5-Nxx for connection to EX4/EX5/EX6/EX7/EX8

F: Remote control panel, system controller

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

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

I: Transformer Class II, 24VAC secondary / 28VA

J: Third party controller (can use the analog output signal from 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

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Ordering, main parts

Description	Type	Part Code Nr.	
Controller EC3-X33	EC3-X33	807 783	
Terminal Kit for EC3-X33	K03-X32	807 644	
Pressure Sensors	-11.6...101.5 psi	PT4-07M	802 332
	0...261.1 psi	PT4-18M	802 333
	0...435.1 psi	PT4-30M	802 334
Cable Assembly for PT4	20 ft cable length	PT4-M60	804 805
NTC Temperature sensors	20 ft cable length	ECN-N60	804 497
Display/keypad unit (need for set-up only)		ECD-002	807 657
Connection cable EC3 to ECD-002	10 ft	ECC-N30	807 861

Ordering, accessories, spare part

Transformer	Emerson PCN	Type	Part Code Nr.
Primary:120/208/240VAC 60 Hz Secondary: 24V 40VA	097724	T2	90-T40F3

Suitable valves for connection to EC3-X33

Valve	Capacity range Tons *	Refrigerant	Capacity regulation
EX4	0.6 ... 5.7	R-22	10-100%
EX5	1.4 ... 14.2		
EX6	3.4 ... 34.1		
EX7	10 ... 93.8		
EX8	25.6 ... 250.2		
EX4	0.6 ... 6	R-407C	
EX5	1.4 ... 15.1		
EX6	3.7 ... 35.8		
EX7	10 ... 98.7		
EX8	28.4 ... 263		
EX4	0.6 ... 4.3	R-134a	
EX5	1.1 ... 11.1		
EX6	2.8 ... 26.4		
EX7	7.1 ... 72.5		
EX8	19.9 ... 193.4		
EX4	0.6 ... 4	R-404A/ R-507	
EX5	1.1 ... 10		
EX6	2.6 ... 23.9		
EX7	6.8 ... 65.4		
EX8	17.6 ... 174.3		

Valve	Capacity range Tons*	Refrigerant	Capacity regulation
EX4	0.9 ... 6.5	R-410A	10 to 100%
EX5	1.7 ... 16.5		
EX6	4 ... 39.8		
EX7	11.4 ... 109.5		
EX8**	28.4 ... 292		
EX4	1.1 ... 11.7	R-744	
EX5	2.8 ... 29		
EX6	7.1 ... 69.4		
EX7	19.9 ... 190.8		
EX8**	51.2 ... 508.7		
EX4	0.3 ... 3.1	R-124	
EX5	0.9 ... 8		
EX6	1.7 ... 19.1		

*) Nominal rating conditions:

Refrigerant	Evaporating Temperature	Condensing Temperature
R-22, R-134a, R-404A, R-407C, R-410A	+39.2°F	+100.4°F
R-23	-76°F	-13°F
R-744	-40°F	14°F
R-124	68°F	176°F

***) MWP: 508 psi

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Technical Data

EC3-X33

Supply voltage	24VAC ±10%, 50/60Hz
Digital input	24V AC ±10%, 50-60HZ 24V 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 12-20 AWG
Ground connection	1/4 in 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	-4 ... +149°F +32 ... +140°F
Humidity	0 ... 80% r.h. non condensing
Protection class	IP20
Weight	~28.2oz
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	-4 ... +149°F +32 ... +140°F
Humidity	0 ... 80% r.h. non condensing
Protection class	IP 65 (front protection with gasket)
Weight	~ 1.8oz
Mounting	Panel mount (2.8 x 1.1 in cutout)

Input and Output, EC3-X33 Controller

Description	Specification
Temperature input	ECN-N60 10kΩ @ +77 °F, Range: -58 ... +122 °F
Pressure sensor input	PT4-07M/18M 24VDC, 4 ... 20mA
Analog output (evaporating pressure fed-through signal)	4 20mA Requires 12 or 24 VDC
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

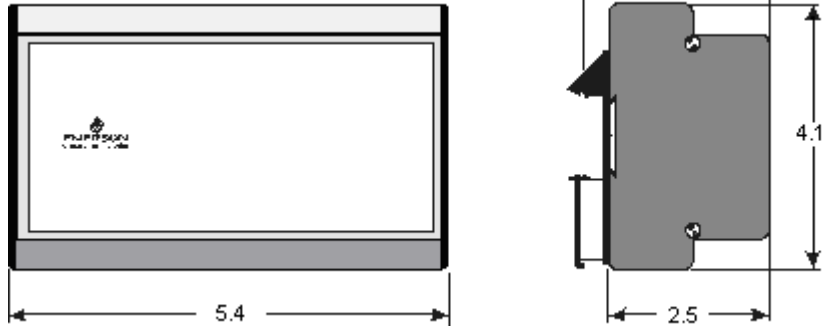
- Superheat set point
- Low superheat function
- MOP function and set point
- Type of refrigerant and required pressure sensor
- Type of Electrical Control Valve
- Valve start opening and duration
- Unit conversion
- Value to display
- Battery error management
- Password

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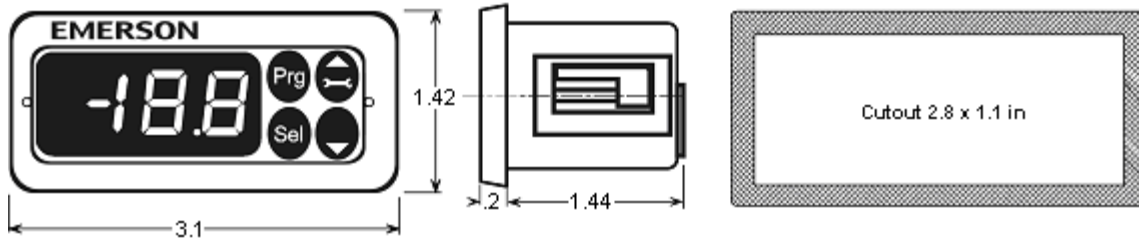


Dimensions (in)

EC3-X33 Controller



ECD-002 Display Unit



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This document replaces all earlier versions.

