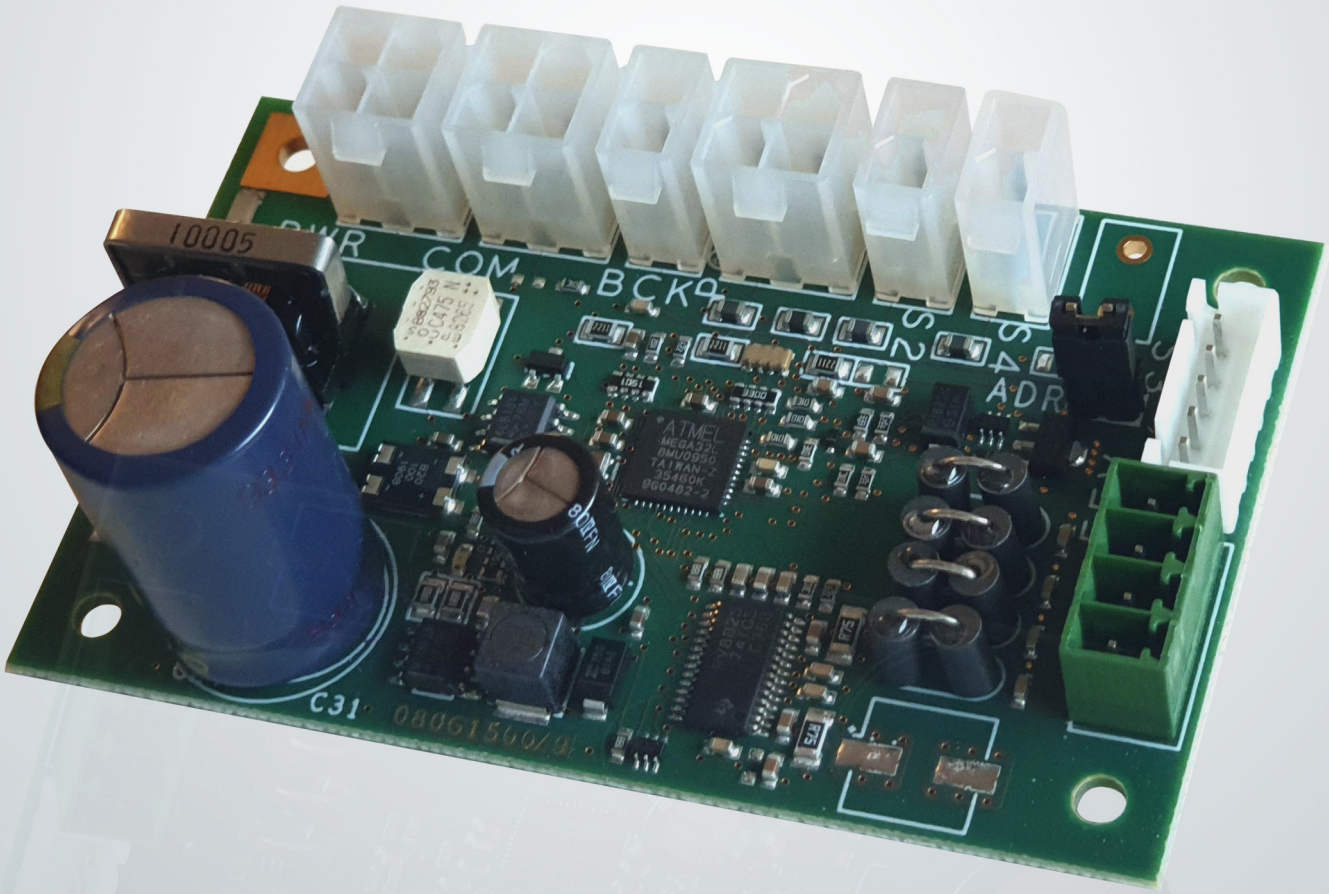
ENGINEERING
TOMORROW

User Guide

Superheat controller
Type **EIM 365 (PV01)**

For commercial air conditioning and refrigeration applications



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Introduction

EIM 365 is a superheat controller that can be used to control the superheat of the evaporator by adjusting the opening degree of a valve. It is used in applications such as air conditioning, heat pumps and refrigeration. The controller can also be used as stepper valve driver by setting the valve opening degree manually via communication Bus.

Benefits:
The evaporator is charged optimally for various load and suction pressure variations.Increase Energy Efficiency by ensuring optimum utilization of the Evaporator.It controls EEV in microsteps providing a smooth superheat curve and less noise.

Features:
- Superheat regulation
- Maximum Operating Pressure function (MOP)
- Defrost
- Compressor protection functions
- Manual control via Modbus Communication
- Loss of Charge indication (LOC).

Portfolio overview

Table 1: Portfolio overview

Features	Specifications
Supply voltage	24 V AC / DC (+ 15%), 50 / 60 Hz, 15 VA / 8 W, Class II isolation
Power Consumption	Idle: Max. 20 mA @ 24 V DC Operating: Max. 900 mA RMS @ 24 V DC
Backup battery	Yes (EKE 2U recommended)
Number of temperature sensors	2
Temperature sensor inputs	• S2: PT1000 • S4: PT1000 or Digital input from external contact
Number of Pressure sensor	1
Pressure Transmitter types	Ratiometric 0.5 – 4.5 V
Sensor Signal Sharing via ModBus	No
Valve Support	ETS 12.5, 25, 50, 100, 250, 400; ETS 6, CCMT 16-42; CTR; ETS Colibri 12-100C and User defined
Superheat Reference Mode	• MSS • LoadAp
Startup mode	• Fixed OD • P-Control
Operation	• Standalone • Modbus RS485 (not terminated internally)
User interface	Modbus to supervisor, Modbus to PC
PC suite	Koolprog
Gateway to PC suite	ICPCON RS485 to usb convertor
Display	None

Table 2: Related products

Pressure transducer	Temperature sensor	Electric Expansion valve	M12 Angle Cables
AKS 32R	AKS 21, AKS 11	ETS 6, ETS 12.5-400, ETS Colibri	Various lengths of standard M12 cable are available for connecting stepper motor valves.
			

Installation

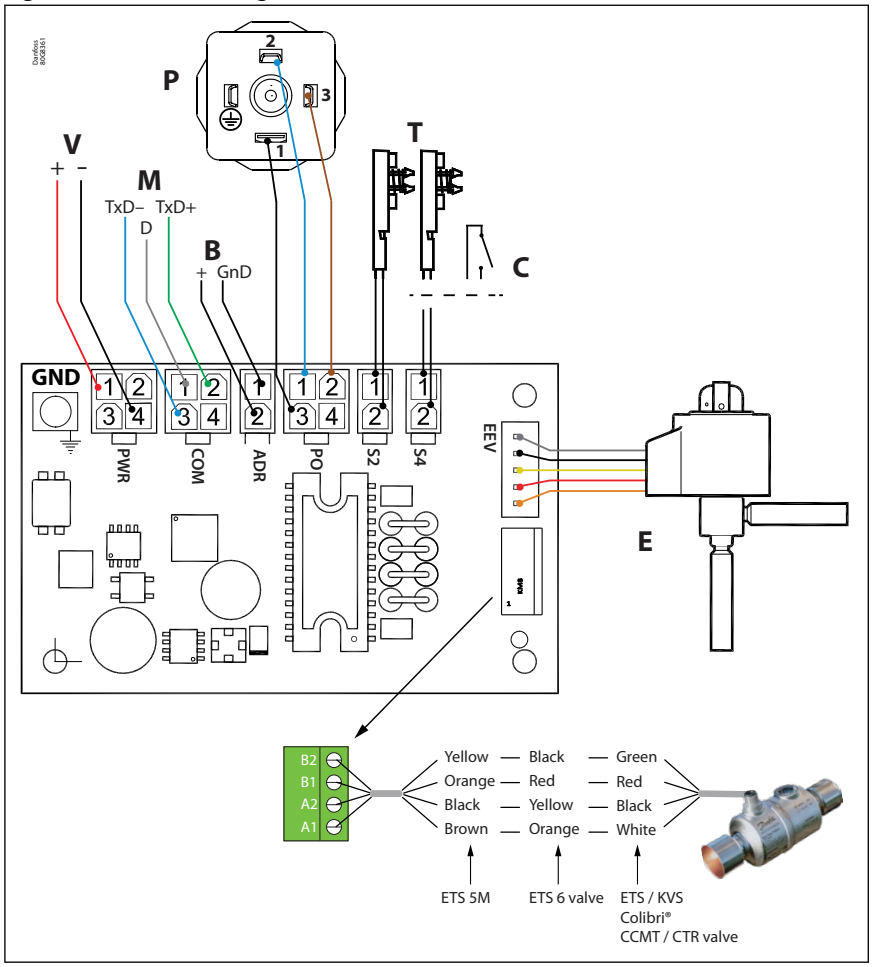
Technical specification

Table 3: Technical specification

Features	Description	
Supply voltage	24 V AC / DC (± 15%), 50 / 60 HZ Galvanically Isolated	
Power consumption	Idle: Max. 20 mA @ 24 V DC Operating: Max. 900 mA RMS @ 24 V DC	
Input signals	Po	AKS 32R (or similar Ratiometric pressure transmitter)
	S2	Measuring range: -60 – +120 °C / -76 – 248 °F
	S4	PT1000 or Digital input from external contact.
EEV Driver	Max. current 900mA RMS Supported valves: ETS 12.5, 25, 50, 100, 250, 400; ETS 6, CCMT 16-42; CTR; ETS Colibri 12-100C and User defined	
Data communication	Type	RS485 – Modbus RTU (Not terminated internally)
	Baud rate	19200
	Address settings	Selectable via Software (default 164)
	Connector	Pluggable
	Internal Termination	No
	Galvanic isolation	No
Environmental conditions	Storage	-34 °C to 71 °C / -30 °F to 160 °F
	Operating	-25 °C to 60 °C / -13 °F to 140 °F
	Humidity	<95% RH, non-condensing
Dimensions	25 × 50 × 80 mm / 0.98 × 1.97 × 3.15 inch	
Battery backup	18 – 28 V DC, > 49 VmAh (Recommend using Danfoss EKE 2U)	
Operation	Standalone or via MODBUS data communication	
Connector type	4 way Mini fit receptacle Molex 39-01-2040 or similar 2 way Mini fit receptacle Molex 39-01-2020 or similar Crimp: 24- 18 AWG Molex 39-020-0039 or similar.	
Gateway	Standard RS485 to USB convertor. (eg; ADAM-4561, ICP DAS I-7561U-G) **Note:** check compatibility of gateway tool with PC operating system	
Display	None	
PC suite	None (EIM 365 is to be connected and configured using supervisor systems).	

Dimension and Mounting

Figure 1: Connection diagram



V	Power Supply 24 V AC or DC
P	Pressure transmitter Ratiometric 0.5 – 4.5 V i.e. AKS 32R
M	Modbus to master controller
B	Battery backup
T	Temperature sensors PT 1000 i.e. AKS 11
C	Regulation control On/Off switch (enable parameter HW Main Switch to 1)
E	ETS 12.5, 25, 50, 100, 250, 400; ETS 6, CCMT 16-42; CTR; ETS Colibri 12-100C and user defined

IMPORTANT:

- The supply voltage is not galvanically separated from the input and output signals, hence it is not recommended to use shared power supply.
- No voltage should be supplied externally, if S4 terminal is setup as a Regulation on/off switch.
- Do not reverse the polarity of the power connection cables or Modbus signal cable else it could damage the terminals.
- EIM should be grounded and measures must be taken during installation to connect the board to a grounding point.

Figure 2: Modbus one to one connection

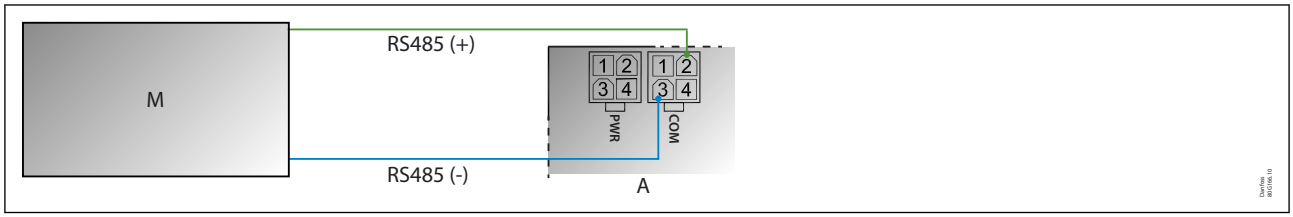
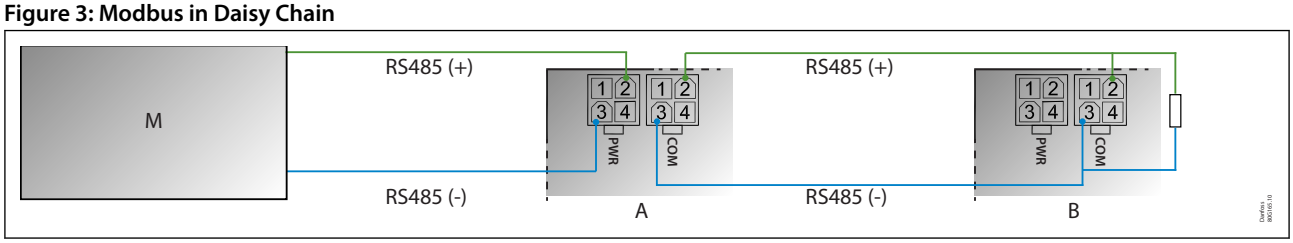


Figure 3: Modbus in Daisy Chain

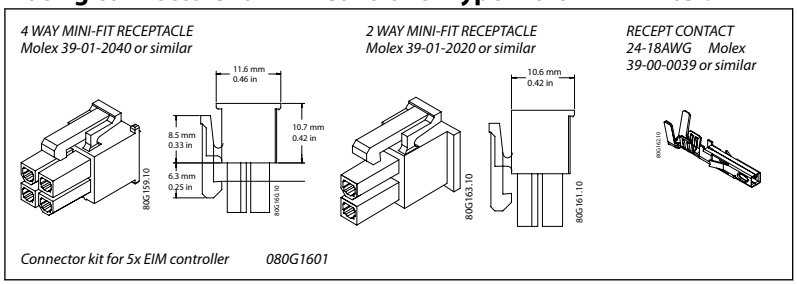


M	Master controller	**B**	EIM slave 2
A	EIM slave 1	**R**	120 Ohm min. 0.25 Watt termination

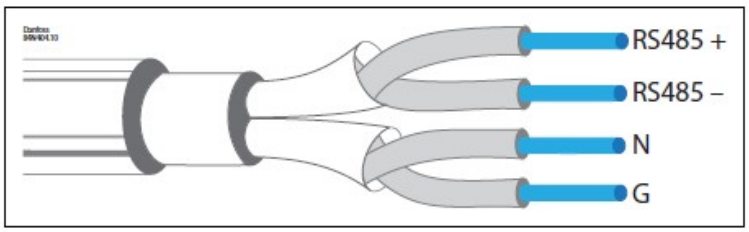
NOTE:

- Modbus transmission lines usually require termination resistors, especially for longer cable lengths.
- If two EIMs are connected remember to remove the addressing jumper on one of the EIMs. This will change the address of EIM or else change the address of second unit using Modbus.

Mating connectors for EIM Controller Type Molex Mini-Fit Jr.™



Connecting Modbus



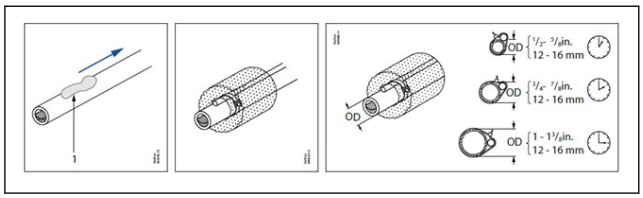
- For the Modbus cable, it is best to use 24AWG shielded twisted-pair cable with a shunt capacitance of 16 pF/ft and 100Ω impedance.
- The max. permissible number of devices simultaneously connected to RS485 output is 32. The RS485 cable is of impedance 120 Ω with maximum length of 1000 m.
- Terminal resistors 120 Ω for terminal devices are recommended for length > 1 m

N	Not in use
G	Ground

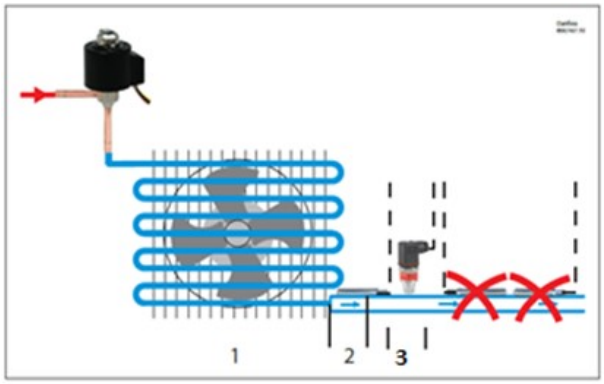
WARNING:

- Accidental damage, poor installation, or site conditions, can give rise to malfunctions of the control system, and ultimately lead to a plant breakdown.
- Every possible safeguard is incorporated into our products to prevent this. However, a wrong installation, for example could still present problems. Electronic controls are no substitute for normal, good engineering practice.
- Danfoss will not be responsible for any goods, or plant components, damaged because of the above defects. It is the installer's responsibility to check the installation thoroughly, and to fit the necessary safety devices.

Mounting temperature sensor



- Mount sensor on a clean surface without any paints.
- Remember to put on heat conducting paste and insulate the sensor.
- Sensor mounting max. 5 cm from the outlet of the evaporator to get the precise measurements.



1	Evaporator
2	Temperature sensor mounted close to the evaporator
3	Pressure sensor

Mounting pressure transmitter

Installation of the pressure transmitter is less critical but mounting of pressure transmitter should be closer to the temperature sensor, right after the evaporator and with its head in upright position. Power supply

NOTE:

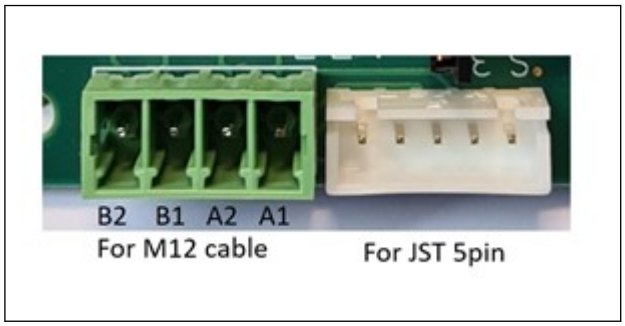
- Separate the sensor and digital input cables as much as possible (at least 3 cm) from the power cables to the loads to avoid possible electromagnetic disturbance.
- Never lay power cables and probe cables in the same conduits (including those in the electrical panels).

Mounting EIM

- Grounding of secondary (output) of transformer is not recommended.
- Do not reverse the polarity of the power connection cables and avoid ground loops (i.e. avoid connecting one field device to several controllers as this may result in short circuits and can damage your device).
- Use individual transformers for EIM 365 controller to avoid possible interference or grounding problems in the power supply.
- Use metal fasteners to place EIM board as this is important to reduce EMC and facilitate grounding.

Valve Stepper Motor Output

- All valves are driven with a 24 V supply chopped to control the current (Current driver).
- The stepper motor is connected to the “Stepper Valve” terminals (see terminal assignment) with Danfoss M12 connection cable.
- To configure stepper motor valves other than Danfoss stepper motor valves, the correct valve parameters must be set as described in the Valve configuration section (see the configuration section for details).
- The correct valve must be defined in “Valve Type”, i.e., parameter 3002.



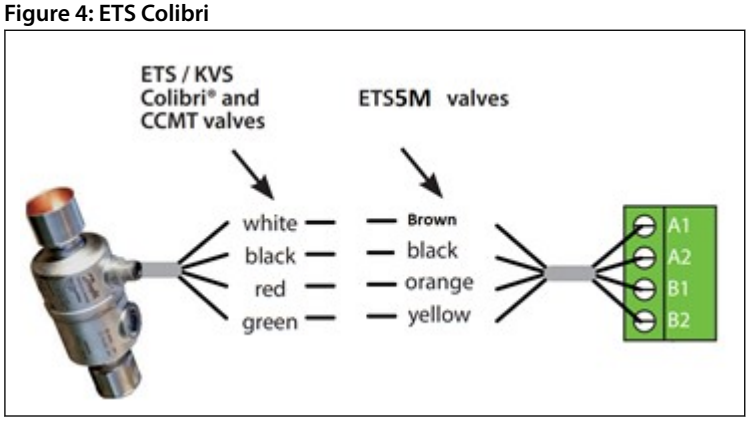
Valve Cable Connection

Table 4: ETS Colibri / KVS Colibri/ ETS / KVS / CCM / CCMT / CTR

EIM terminals	A1	A2	B1	B2
Danfoss M12 Cable	White	Black	Red	Green
ETS Colibri® / KVS Colibri / CCMT / CTR / CCM Pin number	3	4	1	2
ETS 6	Orange	Yellow	Red	Black

To be used with 4 pole terminal block.

Figure 4: ETS Colibri



NOTE:
For ETS 6 do not connect gray cable while using terminal block connection. If using JST 5pin its plug and play.

Guideline for long M12 cables on Danfoss stepper motor valves.

Long cables will lead to degradation of performance.

You can overcome this degradation by changing the settings for the valve driver.

This guideline is based on the cable type being the same type as the standard Danfoss stepper motor cable

Table 5: Recommended wire size and cable distance (twisted pair) between EIM controller and stepper motor valve

Cable length	1 m – 15 m	15 m – 30 m
Wire diameter for valve connection	0.52 / 0.33 mm2 20 / 22 AWG	Min. 0.52 mm2 20 AWG

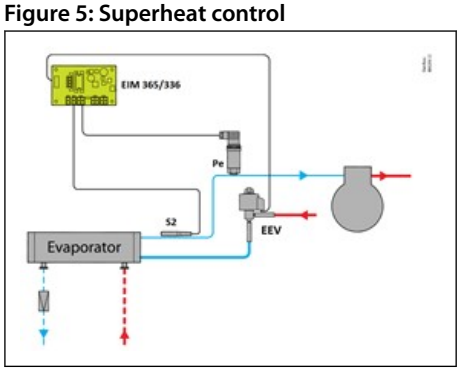
Applications

Superheat control

For superheat control, EIM implements a PI controller. The actual superheat is calculated based on temperature sensor S2 and pressure sensor Pe values, and the controller will adjust the OD of the valve to bring the superheat to the desired reference. If superheat is too low the flow in the expansion is decreased and superheat will be higher and vice versa.

The EIM 365 controller is designed to be operated via Modbus and to rely on a constant connection to the master controller of the system it is located within. In this configuration the master controller reads the readout registers from the EIM 365 and uses the parameters to change the control behavior of the EIM 365 (see parameter list).

Figure 5: Superheat control



Evaporator temperature (Te) control for de-humidifying

For applications with a need to de-humidify the evaporator, it is possible to control on the saturated evaporator temperature instead of the normal control signal.

Manual control (Stepper driver via Modbus)

In this application the EIM 365 is a stepper motor driver, where the valve can be controlled manually by setting the desired opening degree via Modbus.

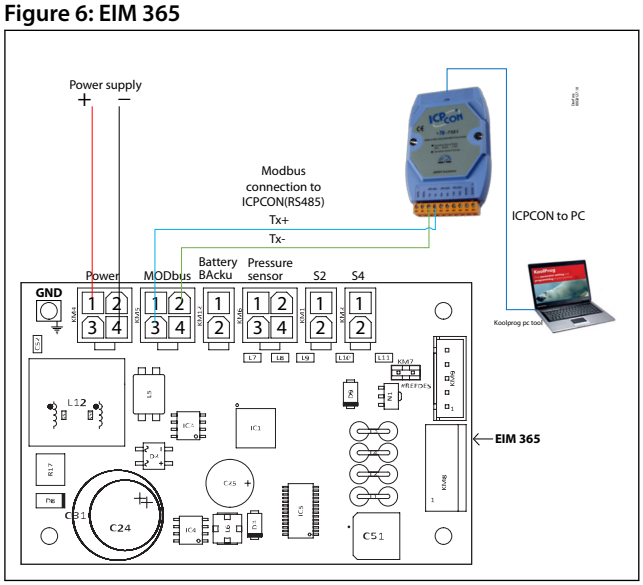
User Interface

EIM 365 is to be setup using Modbus with connection to supervisor or using Danfoss Koolprog PC suite.

In order to connect the product to Koolprog, Customer has to use modbus convertor mentioned in techincal specification.

Remember to check the PC operating system compatibility when using 3rd party convertors.

Figure 6: EIM 365



Configuration

This section represents a guide on how to configure the EIM 365 series controller for various application. Also, the configuration for other features, like startup, defrost and protection are also explained. The parameters are given in a form of a parameter table, where the most important parameters in a mode are shown and described.

The EIM 365 controller has a default configuration to be operated via Modbus and to rely on a constant connection to the master controller of the system it is located within. In this configuration the master controller reads the readout registers from the EIM 365 and uses the parameters to change the control behavior of the EIM 365 (see Parameter list).

The following control modes are available:

- Superheat control
- Manual Control
- Defrost
- Te Control for dehumidifying
- Protection features

Superheat Control Mode

For superheat control, one temperature sensor S2, and one pressure sensor Pe are needed. The actual superheat is calculated based on these two sensor readings, and the controller will adjust the OD of the valve to bring the superheat to the desired reference. If superheat is too low the flow in the expansion is decreased and superheat will be higher and vice versa

Table 6: Quick Guide for setting the controller in Superheat control mode

Features	Description
EnablingRegulation control ON/Off switch (optional)	HwMainSwitch= 1 (default is 0, i.e S4 sensor) Forstandalone configuration it is recommended to enable Regulation control ON/Off switch in order to control start/ stop regulation when needed, otherwise the controller will start regulating when controller is powered up.
Select Refrigerant	O30= 1 - 42 (default value is 20 i.e R407C)
Select startup method	Startup mode: 1: fixed OD, 2: P-control
Select superheat reference calculation method	n21 SH mode: 1: MSS; 2: LoadAp Note: EIM can be set to Fixed SH mode by using LoadAp and setting Max SH = Min SH
Select valve setting	n03=Valve type
Define pressure sensor rangein bar absolute (x10)	o20 = Min. Transducerpressure o21 =Max.Transducer pressure
Define min/max superheat	N09= max. superheat n10= min. superheat
Define MOP (optional)	n11= maximum operating pressure (default is 12.5 bar absolute, max. 200 = MOP off)
Set force opening of the valve (optional)	Start OD% (n17)Start Up time (n15)
To start the superheat control	Set r12= ON

NOTE:
Make sure that r12 = 0 (OFF) for changing the settings.

Configuring the superheat control

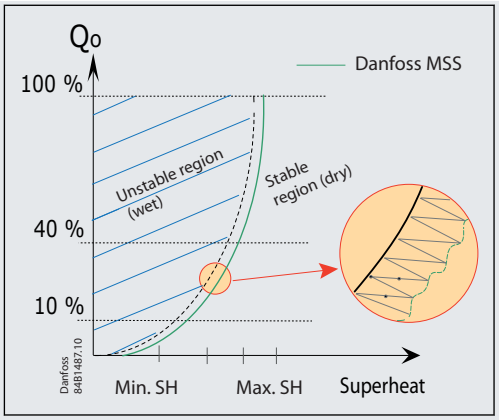
The superheat controller is a PI controller, The time constant for the superheat control can be changed by setting "Tn SH".The alpha value is the design time constant and should be in reasonable proximity to the time constant of theevaporator. A large alpha value means a slow reaction, a small alpha value means a fast reaction.If the superheat drops below "n22 SH close", the controller will close the valve faster to avoid the risk of liquid in the compressors suction line.

In superheat mode the controller will control the superheat to be stable and closer to the superheat reference. The Superheat reference is calculated based on following different methods:

Table 7: Configuring the superheat control

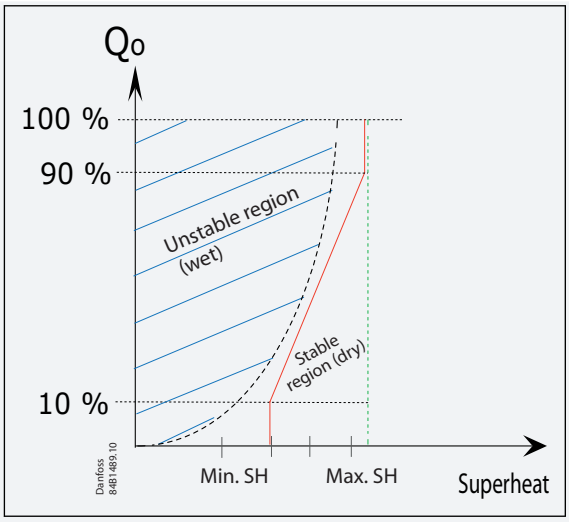
Minimum Stable Superheat (MSS):
The controller will be searching for the minimum stable superheat between an upper and lower boundary specified by the user. Then if the superheat is stable at a certain value, the controller decreases the superheat reference, if the SH gets unstable, the SH reference is raised again. The goal of this method is to search for the lowest possible superheat that can be obtained while still maintaining a stable system.

EIM	365
Applicable	✔



LoadAP:
In LoadAp application, SH reference follows a defined curve as shown in the diagram. This two-point curve is defined by SH max and SH min. These two values must be selected in such a way that the curve is situated between the MSS curve and the curve for average temperature difference ΔTm (temperature difference between media temperature and evaporating temperature). This makes the regulation more stable compared to MSS because it does not seek a usability.

EIM	365
Applicable	✔



NOTE:
A fixed superheat reference can be achieved by setting the “n10 Min SH” and “n09 Max SH” can both be set to the desired reference value. This will disable the minimum stable superheat search algorithm and the controller will instead regulate the superheat according to this reference.

Figure 7: Superheat reference tracking

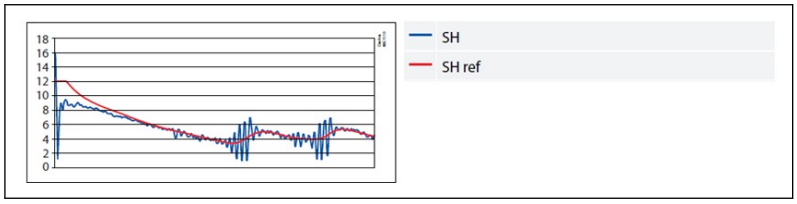
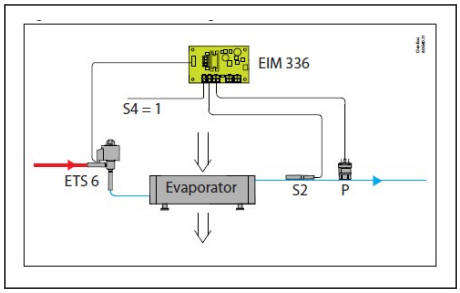


Table 8: Superheat control configuration

Symbolic name	PNU	Description
n21 SH mode	3026	1: MSS; 2: LoadAp
n09Max. SH	3015	Maximum superheat reference setting.
n10Min. SH	3021	Minimum superheat reference setting.
n20Kp T0	3025	Pressure feedback gain.
n22SH close	3027	Superheat close level. If the superheat goes below this value, the valve will close faster.
---Tn SH	3103	Integration time for superheat control
---Alpha	3111	Design time constant. A large alpha means a slow response, a small alpha mean a fast response.

Standalone configuration

The EIM 365 can be set in a standalone configuration by setting the modbus register i.e “HWMainSwitch” to 1. This will setup the S4 input to be used as a Regulation On / Off switch. Note that only external control of the EIM 365/336 in this configuration is through the Regulation On / Off switch.



NOTE:
That the only external control of the EIM 365/336 in this configuration is through the Regulation control On / Off switch. It is not possible to manually control the opening degree or change settings, and the defrost and Te control modes are not available.

Table 9: Related parameters

Symbolic name	PNU	Description
---HW Main Switch	64100	0= no external main switch 1 = regulation control On /Off switch

Manual Control

In this mode The EIM 365 is acting as stepper motor valve driver, where valve opening degrees is sent using Modbus. In this mode, no sensor is needed, and no superheat control is performed, and no safety features are present.

Table 10: Manual control

EIM	365
Applicable	✓

When setting the manual control register “o18 Manual ctrl” to 1, the controller will be in manual control. During this mode the opening degree is controlled by setting the “Manual OD%”.

NOTE:
- On using system configuration, it is necessary to read the "Ctrl Stats" register 3100 continuously, failure to do so will start the MSS regulation automatically irrespective to the different status of the regulation On /Off switch
- The manual control mode does not depend on the “r12 Main Switch” and will set the opening degree regardless of its state.
- Setting “o18 Manual ctrl.” to 0 again, the controller will go to the default control, and will open or close from the current opening degree

Table 11: Related parameters

Symbolic name	PNU	Description
o18 Manual ctrl.	2075	0 = Superheat control 1 = Manual control
o45Manual OD%	2064	Manual opening degree in %. 0 = fully closed. 100 = fully open.

Defrost Mode

EIM	365
Applicable	✓

A defrost sequence is initiated by setting the defrost activate register “Def Activate” to 1. As long as this register is kept at 1, the valve opening degree is 100%. When “Def Activate” returns to 0, the valve opening degree is kept at “Def Hold OD” for “Def Hold Ti 1” seconds. When this time expires, the valve opening degree is set to a calculated average opening degree for “Def Hold Ti 2” seconds. When this time expires the controller resumes normal operation

NOTE:
That defrost is not initiated by the EIM 365, but must be initiated by the master controller. In a standalone configuration the defrost mode is not possible. If a more dynamic control of the opening degree during defrost is required, the user should disable the “Def Hold Ti 2” by setting it to 0, and only use the “Def Hold Ti 1”.

Figure 8: Defrost Mode

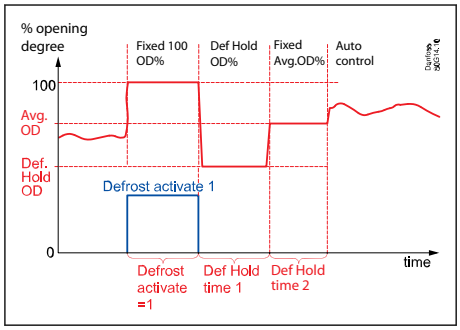


Table 12: Defrost table

Symbolic name	PNU	Description
Def Activate	50011	Defrost activating, 0 = No defrost 1 = Defrost active
Def Hold OD	50008	Opening degree during Def Hold Ti 1
Def HoldTi 1	50009	Defrost hold time 1
Def HoldTi 2	50010	Defrsot hold time 2

Te Control

EIM	365
Applicable	✓

For applications with a need to de-humidify the evaporator, it is possible to control on the saturated evaporator temperature instead of the normal control signal.

If the “Te Reference” register is set to a value above 0, Te control is activated. Te and the 'Te Reference' to calculate a new reference for the superheat control. The Te control consists of a separate PI control, which settings can be changed by setting the gain, “Kp Te” and time constant, “Tn Te”. A large Kp will lead to a large change in the output even at small changes in the evaporator temperature, but may lead to instability. A large Tn will lead to a slow reacting system, while a small Tn will lead to a fast reacting system. The MOP function is still active during Te control and it will assume control, if the evaporator is above the “MOP” limit.

Figure 9: Te Control

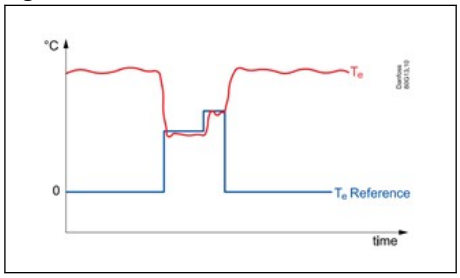


Table 13: Te Control mode

Symbolic name	PNU	Description
Kp Te	3115	Kp proportional gain while in Te control mode
Tn Te	3116	Tn integration time while in Te control mode
Te Reference	3117	Te reference while in Te control mode

Protection or Limiter features

EIM 365 has protection features and Limiter features that prevents the system from operating under bad conditions or gives indication towards it, these features are

- Superheat close
- MOP (Maximum operating pressure)
- LOC (Loss of Charge indication)

Superheat Close

EIM	365
Applicable	✓

SH close is a protection feature, When the SH values go below the SH close value, the controller will close the valve faster.

Symbolic name	PNU	Description
n22 SH close	3027	Superheat close level. If the superheat goes below this value, the valve will close faster.

Maximum operating pressure (MOP)

EIM	365
Applicable	✓

In order to reduce the current to the compressor it is possible to control the maximum operating pressure of the evaporator. If the evaporator pressure exceeds the “MOP” limit, the valve opening degree is controlled by the MOP function which will keep the pressure below the “MOP” limit. This function takes precedence over the superheat control, so during MOP control the superheat is not controlled.

The MOP function can be disabled by setting the “MOP” to the maximum value (2000 equaling 200 bar absolute). When the pressure reaches the set MOP point, an increase in OD is restricted. If the pressure reaches MOP + 0.5 Bar, an increase in OD is prohibited, and instead the OD will start to decrease. If the pressure goes below the MOP point, the controller will start to regulate the superheat normally.

The MOP controller consists of a separate PI control, which settings can be changed by setting “Kp MOP” and “Tn MOP”. A large Kp will lead to a large change in opening degree even at small changes in the evaporator pressure but may lead to instability. A large Tn will lead to a slow reacting system, while a small Tn will lead to a fast-reacting system

Figure 10: MOP controlling

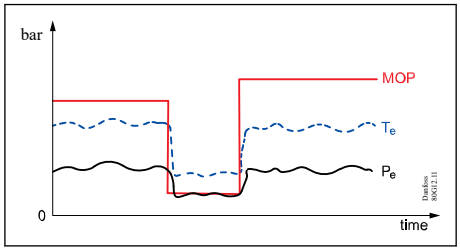
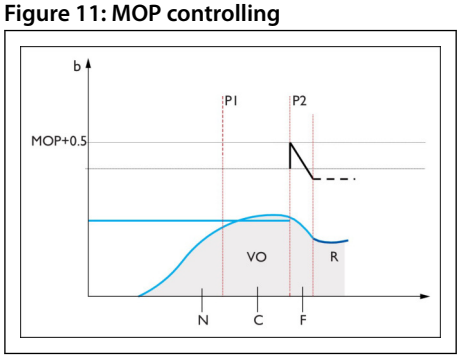


Figure 11: MOP controlling



P1	At this pressure the OD increases slower and slower.
P2	At this pressure the OD no longer increases. Beyond it the OD decreases.
Pe	pressure
VOD	Valve Opening Degree
R	Normal regulation
N	Normal OD
C	Controlled OD
F	Force closed OD

Table 14: Related parameters

Symbolic name	PNU	Description
n11 MOP	3013	Maximum operation pressure. If Pe goes above this value, the controller will control on Pe, and not on superheat.
--- Kp MOP	3113	Kp proportional gain while in MOP control mode.
--- Tn MOP	3114	Tn integration time while in MOP control mode.

LOC Indication

EIM	365
Applicable	✓

When a system loses refrigerant charge, the controller will have difficulties keeping the superheat low, even when increasing the valve opening degree. Therefore, if both the valve opening degree and the superheat are high for a long period of time, this could indicate that refrigerant charge was lost.

When the valve opening degree exceeds the trigger level "LOC Trig, and the superheat exceeds the superheat trigger level "LOC SH Trig", a timer is started.

When the timer exceeds the user defined time “LOC Timer” the “LOC Alarm” is set. If the valve opening degree drops below the user defined reset level “LOC Reset”, the timer and the alarm are reset.

The loss of charge alarm does not perform any actions, except setting the “LOC Alarm”.

Table 15: Related parameters

Symbolic name	PNU	Description
--- LOC Trig	50003	Trigger value for loss of charge
--- LOC Reset	50004	Reset value for loss of charge
--- LOC Timer	50005	Timer to trigger LOC alarm
--- LOC Alarm	50006	Loss of charge alarm flag, 0 = no alarm, 1 = LOC alarm
--- LOC SH Trig	50007	SH error trigger level for LOC alarm
--- LOC Tmr	3102	Loss Of Charge time readout displays the elapsed time since the alarm became active.

Sensor, Valve and Refrigerant Configuration

Pressure Sensor Settings

The pressure sensor input is setup by default to accept an AKS32R pressure transducer. If another sensor is to be used, it is important to note that it needs to be a 0.5 - 4.5 Vd.c. radiometric type (10% - 90% of supply voltage). The default range for the sensor is 0 to 16 bar absolute. This can be changed by setting the minimum transducer pressure “o20 MinTransPres” and the maximum transducer pressure “o21 MaxTransPres” to the new values. The values must be entered in bar absolute so a sensor with a range of -1 to 12 bar gauge, needs to be defined as 0 to 13 bar absolute.

Table 16: Pressure sensor parameters

Symbolic name	PNU	Description
o20 MinTransPres	2034	Minimumtransducer pressure (in bar absolute x 10). Example: 0 bar absolute is entered as 0
o21 MaxTransPres	2033	Maximum transducer pressure(in bar absolute x 10). Example: 13 bar absolute is entered as 130

NOTE:
BothDanfoss AKS 32R and Danfoss Saginomiya Pressure transmitter NSK-BExxx follows the relative (gauge) pressure, therefore same rules apply as explained above in converting and defining it in bar absolute in EIM controller.

Temperature sensor Settings

The temperature sensor input is setup by default to accept PT1000 temperature sensor. The values for the sensor can be adjusted to calibrate the sensor through the parameter “r09 Adjust S2”.

Table 17: Temperature sensor value offset

Symbolic name	PNU	Description
r09 Adjust S2	113	S2 Offset adjustment to correct the sensor signal due to long wires etc.

Valve Configuration

The EIM 365 can be configured to be used with a wide range of valves ETS 12.5 or 25; ETS 50; ETS 100; ETS 250; ETS 400; USER DEFINE; Saginomiya; ETS 6; CCMT; CCMT16; CCMT24; CCMT30; CCMT42; CTR; CCMT 0; CCMT 1; ETS Colibri valve

Table 18: Valve configuration parameters

Symbolic name	PNU	Description
EIM 365 common settings		
n03 Valve type	3002	0: ETS 12.5, ETS 25, KVS 15 1: ETS 50, CCM 10, CCM 20, CCM30 2: ETS 100, CCM 40 3: ETS 250, KVS 42 4 : ETS 400 5: User defined 6: UKV, SKV, VKV, PKV 7: ETS 6 8: CCMT 2, CCMT 4, CCMT 8 9: CTM16 10: CCMT 24 11: CCMT 30 12: CMT 42 13: CTR 14: CCMT 0 15: CCMT 1 16: No valve selected 17: ETS 12C, 24C, 25C, 50C, 100C, KVS 2C, 3C, 5C

User defined valves:

Only The EIM 365 can be configured to be used with to use a valve from a different manufacturer, then these parameters must be provided by the user.

EIM	365
Applicable	✓

Table 19: User defined valve

Symbolic name	PNU	Description
n03 Valve type	3002	User defined
n37 Max steps	3032	Maximum number of steps (384 x 10 micro steps = 480 half steps)
n38 Max steps/sec	3033	Steps per second
n39 Start backlash	3034	Backlash (steps) to close in percent at startup (power on).
n40 Backlash	3035	Backlash (steps) for spindle play compensation. This is active during normal control
n42 Comp. dir.	3037	Compensation direction
n56 Motor current	3051	Motor current
Decay Mode	64321	0: Fast decay; 1: Slow decay; 2: Mixed decay

External sensor values via Modbus

In some applications, the suction pressure and/or the refrigerant temperature on the evaporator outlet, is measured by a system controller. This is often the case if the suction pressure is used to trigger low temperature/pressure alarms by the systems main controller. In these cases the sensors can be omitted from the EIM 365, and the sensor values can be received via modbus instead.

This requires that the systems main controller continuously transmits these values to the EIM 365.

If no new sensor value is received within 5 seconds of the last transmission, the sensor will revert to using the physical sensors.

The suction gas temperature S2 and the evaporator pressure Pe can be set by writing to the registers “ext S2 Temp” and “ext EvapPress P0” respectively.

NOTE:
The external evaporator pressure is received in millibar so 8.4 bar absolute must be sent as 8400.

It is possible to set the S4 temperature as an external sensor value also, but since this sensor is not used in the superheat regulation, little practical use.

Table 20: External sensor values via Modbus

Symbolic name	PNU	Description
extEvapPress P0	2643	External evaporator pressure. This value can be used instead of a sensor. This registermust be written at least every 5 second, otherwise the sensor value will be used. The entered value is in millibar
ext S2temp	2644	ExternalS2. This value can be used instead of a sensor. This register must be written at least every 5 second, otherwise the sensor value will be used.
extS4 air temp.	2646	ExternalS4. This value can be used instead of a sensor. This register must be written at least every 5 second, otherwise the sensor value will be used.

Selecting a refrigerant

The controller needs to know which refrigerant is used in order to accurately control the superheat. This can be selected by setting the “o30 Refrigerant” to the desired refrigerant as defined in the list below.

If no refrigerant is selected (“o30 Refrigerant” is set to 0 meaning the refrigerant is undefined), the “No Rfg. Sel.” alarm is set and the controller will not start regulating.

Before refrigeration can be started , the refrigerant has to be defined. You can select the following refrigerant.

Table 21: Refrigerant settings

Symbolic name	PNU	Description				
o30Refrigerant	2551	1= R12	10= R503	19= R404A	28= R744	37= R407F
		2= R22	11= R114	20= R407C	29= R1270	38= R1234ze
		3= R134a	12= R142b	21= R407A	30= R417A	39= R1234yf
		4= R502	13= User defined	22= R407B	31= R422A	40= R448A
		5= R717	14= R32	23= R410A	32= R413A	41= R449A
		6= R13	15= R227	24= R170	33= R422D	42= R452A
		7= R13b1	16= R401A	25= R290	34= R427A	

⚠ WARNING:
Wrongselection of refrigerant may cause damage to the compressor.

Startup Modes

Forced opening During startup

In some applications it is necessary to open the valve quickly when the compressor turns on, to prevent too low suction pressure. This is ensured by setting a fixed opening degree and a startup time for the controller. Note that this will give a fixed opening degree for the duration of the start time, regardless of the superheat value. Thesetting parameters are called Start OD% (n17) and StartUp time (n15).

EIM	365
Applicable	✓

Table 22: Forced opening During startup Parameters

Symbolic name	PNU	Description
Common EIM 336/ EIM 365		
n15 Startup time	3017	Time for startup state (in seconds)
n17 Startup OD	3012	Opening degree during startup state
EIM 365		
--- Startup mode	64322	1: Fixed OD; 2: P-Control Select 1 for Fixed OD

P-control

The controller is programmed for auto proportional control that will quickly Change the opening degree based onthe superheat of the system. The proportional control is active during the Minimum start time set by the user, and until the Super heat crosses the reference.

EIM	365
Applicable	✓

Table 23: P-control Parameters

Symbolic name	PNU	Description
EIM 365		
--- Startup mode	64322	1: Fixed OD; 2: P-Control Select 2 for P-control
--- Min Startup Time	64324	minimum regulation time in seconds when use P-control
n15 Startup time	3017	Time for startup state (in seconds)

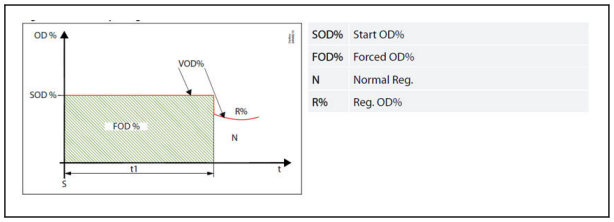
Alarms

Alarms and troubleshooting

Problems with startup

Sometimes in one-to-one applications, the valve does not open sufficiently on startup, and troublesome low pressure trips may occur. The force opening of valve function has been implemented in the EIM 336 controller. After startup, this function will provide a constant, set minimum opening degree during a set time period, regardless of the superheat value. The setting parameters are called Start OD% (n17) and StartUp time (n15).

Figure 12: Problems with startup



Low Pressure Issue due to compressor cut in and cut out

One of the features of TEX valves is the external pressure equalization making a direct and fast responding pressure connection between the compressor suction line and underside of the diaphragm in the valve. This enables the valve to open-/ close momentarily with compressor capacity cut in and out.Thesame function has been implemented into EIM 336, which is controlled by the parameter n20, KpTo. In this function. kp factor related directly to the suction pressure (To) with direct effect on the requested signal to the ETS 6 valve .Thedefault value of KpTo is set to automatic (i.e -1). If the automatic tuning is not fulfilling the desired order, Increasing the n20 setting to the fixed value will contribute to an improvement. Too high n20 will produce high fluctuation in superheat regulation.

Fluctuating superheat

When the refrigerating system has been made to work steadily, the controller's factory-set control parameters should in most cases provide a stable and relatively fast regulating system. If the system however fluctuates, this may be due to the fact that too low superheat parameters have been selected or due set of regulation parameters which are not optimal

Usually,the following parameters can be tuned in order to reach fast, stable superheat in EIM controller.

- If adaptive superheat has been selected adjust n09 and n10 parameters. For some application using fixed superheat may increase the stability. This can be done by defining n09 and n010 to the fixed value.
- To optimize the superheat regulation, most safe and direct way is to tune TnSH. For example, if a the control is too slow, define new Tn value to half (1/2 Tn), if it is still slow reduce it to another half (1/2 x 1/2 Tn= 1/4 Tn), If the control start to oscillation, then return back to (~ 3/8 Tn) ,alternatively read the time period and tune tn = 1.2 x time period.
- Keep KpT0, Alpha as default, they work for most of the cases.
- Tune parameter for force opening of the valve at start up i.e. n15 (startup OD) and n17 (start up time). These values depends on the system conditions.

NOTE:
Steps (1.) to (3.) are quite easy and safe to tune. For step (4.), caution should be taken, so as not to allow refrigerant inside the compressor.

Too high fluctuating pressure signal

1. Tune parameter n20 KpT0 to lower value, if this is not working for the system disable by setting it to zero.
2. If point 1 doesn't seem to be working, then keep n20 KpT0 disable and increase para TSH (i.e Tan SH). Increase TSH (default value) by 200 and check the oscillation. If the problem seems to persist, perform the same step up to higher TSH value.

Alarms and clearing alarms

Several alarms are registered and made available on modbus. Most of these are automatically cleared when the error is no longer present. Sensor error : Temperature sensor error has a timeout of 10 minutes. This means that after the reason for a sensor error has gone, the error will remain active for 10 minutes, and then it is cleared. for the pressure sensor, the timeout is only 30 seconds.

There is an option to reset the errors externally by setting the 40075 (reset alarms) = 1.

Table 24: Related parameters

Symbolic name	PNU	Description
---Reset alarm	2046	1= Clear alarm. It is possible to clear alarms manually by setting Reset Alarms (40075). After setting this, the alarm is keptactivefor 5seconds before being cleared.
--- EKC Error	20001	Common error flag. EKC Error is SET if any other Error Alarm is ON.EKC error is auto cleared after the last active alarm has been cleared.
---S2 Error	20002	S2sensor error. If the sensor error occurs, the valve OD will be set to 80% of the Avg. opening (PNU 50021) - see. S2alarm is auto cleared after 10 min after the alarm condition has been cleared.
---S4 Error	20004	S4sensor error. If the sensor error occurs, the valve OD will be set to 80% of the Avg. opening (PNU 50021) - see. S4 alarm is auto cleared after 10 min after the alarm condition has been cleared.
---Pe inp.error	20005	Pressure transmitter out of range. If the sensor error occurs, the valve OD will be set to 80% of the Avg.opening(PNU 50021) -see . Pe alarm is auto cleared after 30 seconds.
---No Rfg. Sel.	20006	Refrigerantnot selected. NoRefrigerant selected alarm is auto cleared immediately after setting the refrigerant.
---LOC Alarm	50006	Loss of charge alarm. No action will be performed except setting the alarm.
--- CtrlStatus	3100	Bit mappped status register, see also Control status

Parameter list

Table 25: Parameter list legend

Rowtext	Explanation
PNU	The Parameter Number in the EIM 336 controller. All parameters are addressed as holding register. TheModbus PDU address correspond-sto PNU-1. If no translation table is used, this is the register number in modbus.
Min.	Minimum value
Def.	Factory default value
Max.	Maximum value
e2	Is the value stored in EEPROM
W	Is writing to the register possible
*10	The scaling of the parameter. All values are read/written as integers over modbus. Parameters need to be scaled, these are marked with acheckmark.This means that 0.1 is sent as 1 over modbus, 1.0 is sent as 10 etc.
Symbolic name	The name of the parameter
Description	Short parameter description

NOTE:
Some parameters have what is called a "config lock". This means that they can only be changed when the main switch of the EIM 336 is set to OFF (r12 = 0). This applies for instance to the type of refrigerant (o30). So if you want to change the refrigerant, the main switch (r12) must first be set to 0, then the refrigerant type (o30) can be changed.

The following parameters require the main switch (r12) to be OFF:

- n37 Max steps
- n38 Max steps/sec
- o03 Unit address
- o30 Refrigerant

Please refer to the list below. It should be possible to change all other parameters while the unit is running (regulation parameters etc.).

Main Menu

Table 26: Main Menu → Control

Label	Description	Min.	Max.	Value/ Type	Unit	RW	ADU	Description
REG	**Main Menu → Control**							
r12	Main switch	0	1	0 - OFF	Enum 1	RW	11	Start/stop of regulation. With this setting the regulation can be started and stopped. This can also be accomplished with the external hardware main switch.
o18	Manual control	0	1	0		RW	36	0 = Superheat control, 1= Manual control
o45	Manual OD %	0	100	0	%	RW	18	Manual opening degree for manual control . Used when the o18 Manual Control is set to 1. 0%/0 step = fully closed, 100%/480 step = fully open. % is chosen by default. See ADU 64309 for changing to step.
n21	SH mode	1	2	1		RW	108	1=MSS, 2=LoadAP
n15	Startup time	1	600	90	s	RW	58	Time for startup state (in seconds)
n17	Startup OD	0	100	32	%	RW	59	Opening degree during startup state
OOD	OD while OFF	0	100	0	%	RW	60	Opening degree during Off state
RAL	Reset alarm	0	1	0		RW	75	1 = clear alarm

Regulation

Table 27: Regulation → SH control

Label	Description	Min.	Max.	Value/ Type	Unit	RW	ADU	Description
SHC	**Regulation → SH control**							
n09	Max superheat	2,0	50,0	50.0	K	RW	19	Maximum superheat reference setting.
n10	Min superheat	1,0	50,0	4.0	K	RW	20	Minimum superheat reference setting.

Label	Description	Min.	Max.	Value/ Type	Unit	RW	ADU	Description
n20	KpT0	-1,0	20,0	-1.0		RW	35	Pressure feedback gain. Automatic = -1, OFF = 0 , Fixed = 1 and above
n22	SH close	0,0	16,0	2.0	K	RW	21	Superheat close level. If the superheat goes below
TSH	Tn SH	10	1800	90		RW	22	this value, the valve will close faster
SHL	SH Low	3,0	50,0	6.0	K	RW	24	Superheat close level. If the superheat goes below this value, the valve will close faster

Table 28: Regulation → MOP

Label	Description	Min.	Max.	Value/ Type	Unit	RW	ADU	Description
MOP	**Regulation → MOP**							
n11	MOP	0,0	200,0	200.0	bar	RW	23	Maximum operation pressure. If Pe goes above this value, the controller will control on Pe, and not on superheat
KpM	Kp MOP	0,5	10,0	0.5		RW	31	Kp proportional gain while in MOP control mode
TnM	Tn MOP	30	600	180		RW	32	Tn integration time while in MOP control mode
DMO	Diff MOP	-20,0	0,0	0.0	bar	RW	16	Differential MOP. A remote offset that is added to the MOP. Needs to be written every 5 seconds, else the offset is set to 0.

Table 29: Regulation → Defrost

Label	Description	Min.	Max.	Value/ Type	Unit	RW	ADU	Description
DEF	**Regulation → Defrost**							
DeA	Def Activate	0	1	0		RW	47	Defrost activating
DHO	Def Hold OD	0	100	30	%	RW	48	Defrost holding level
DH1	Def Hold Ti 1	0	32000	120	s	RW	49	Defrost holding timer 1
DH2	Def Hold Ti 2	0	32000	60	s	RW	50	Defrost holding timer 2

Table 30: Regulation → Te control

Label	Description	Min.	Max.	Value/ Type	Unit	RW	ADU	Description
TEC	**Regulation → Te control**							
KpT	Kp Te	0,5	10,0	1.0		RW	33	Kp proportional gain while in Te control mode
TnT	Tn Te	30	600	60		RW	34	Tn integration time while in Te control mode
ter	Te Reference	-200,0	200,0	0.0	C	RW	12	Te reference while in Te control mode

Table 31: Regulation → External sensors

Label	Description	Min.	Max.	Value/ Type	Unit	RW	ADU	Description
XSE	**Regulation → External sensors**							
PEV	ext. EvapPress P0	0	32000	0		RW	14	External evaporator pressure. This value can be used instead of a sensor. This register must be written at least every 5 seconds, otherwise the sensor value will be used.
TS2	ext. S2 temp	-200,0	200,0	0.0	C	RW	15	External S2. This value can be used instead of a sensor. This register must be written at least every 5 seconds, otherwise the sensor value will be used.

Table 32: Regulation → LOC

Label	Description	Min.	Max.	Value/ Type	Unit	RW	ADU	Description
LOC	**Regulation → LOC**							
LTR	LOC Trig	0	100	95	%	RW	37	Trigger value for loss of charge
LRe	LOC Reset	0	100	85	%	RW	38	Reset value for loss of charge
LTm	LOC Timer	0	7200	3600	s	RW	39	Timer to trigger LOC alarm
LST	LOC SH Trig	0,0	50,0	20.0	K	RW	40	SH error trigger level for LOC alarm

Setup

Table 33: Setup → Modbus

Label	Description	Min.	Max.	Value/ Type	Unit	RW	ADU	Description
MBU	**Setup → Modbus**							
o03	Unit Addr	1	240	165		RW	41	Primary unit address is used when jumper KM7 is mounted
UA2	Unit Addr 2	1	240	164		RW	42	Secondary unit address is used when the jumper KM7 is not mounted
MBa	MB Baud	0	2	1 - 19200	Enum 2	RW	43	Communication setting baud rate, 0=9600 , 1 = 19200, 2 = 38400
MPa	MB Parity	0	2	2 - Even parity	Enum 3	RW	44	Communication setting parity, 0 = no parity, 1 = odd parity, 2 = even
MSB	MB StopB	1	2	1 - 1 stop bit	Enum 4	RW	45	Communication setting stop bit, 1 = 1 stop bit, 2 = 2 stop bit

Table 34: Setup → Valve

Label	Description	Min.	Max.	Value/ Type	Unit	RW	ADU	Description
VAL	**Setup → Valve**							
n03	Valve type	0	17	16 - No valve selected	Enum 9	RW	110	Select the type of Danfoss stepper motor valve from the list. If you want to correct a Danfoss given valve profile. Then first select the relevant valve and then select USER DEFINE. 0 = ETS 12.5 or 25 1 = ETS 50 2 = ETS 100 3 = ETS 250 4 = ETS 400 5 = USER DEFINE 6 = Saginomiya UKV 7 = ETS 6 8 = CCMT 2 4 8 9 = CCMT16 10 = CCMT24 11 = CCMT30 12 = CCMT42 13 = CTR 14 = CCMT 0 15 = CCMT 1 16 = No valve selected 17 = ETS Colibri
n37	Max steps	100	8000	240		RW	76	Maximum number of steps (384 x 10 microsteps = 480 half steps)
n38	Max steps/sec	10	400	16		RW	77	Steps per second
n39	Start backlash	1	100	10	%	RW	78	Backlash (steps) to close in percent at startup (power on).
n40	Backlash	0	100	20	%	RW	79	Backlash (steps) for spindle play compensation. This is active during normal control
n56	Motor current	0	900	0		RW	80	Motor current
h22	Holding current	0	100	20		RW	109	Holding current
dcM	Decay mode	0	2	0 - Fast	Enum 10	RW	111	0 = Fast, 1 = Slow, 2 = Mixed

Table 35: Setup → Refrigerant

Label	Description	Min.	Max.	Value/ Type	Unit	RW	ADU	Description
REF	**Setup → Refrigerant**							
RFG	Refrigerant	0	49	0 - None	Enum 5	RW	64	Refrigerant setting. 0 = None, 1 = R12, 2 = R22, 3 = R134a, 4 = R502, 5 = R717, 6 = R13, 7 = R13b1, 8 = R23, 9 = R500, 10 = R503, 11 = R114, 12 = R142b, 13 = User, 14 = R32, 15 = R227, 16 = R401A, 17 = R507, 18 = R402A, 19 = R404A, 20 = R407C, 21 = R407A, 22 = R407B, 23 = R410A, 24 = R170, 25 = R290, 26 = R600, 27 = R600a, 28 = R744, 29 = R1270, 30 = R417A, 31 = R422A, 32 = R413A, 33 = R422D, 34 = R427A, 35 = R438A, 36 = R513A, 37 = R407F, 38 = R1234zeE, 39 = R1234yf,40 = R448A,41 = R449A, 42 = R452A, 43 = R450A, 44 = R452A, 45 = R454B, 46 = R1233zdE, 47 = R1234zeZ, 48 = R449B, 49 = R407H
RF1	Rfg. fac. A1	8000	12000	10428		RW	65	Adiabatic constant A1
RF2	Rfg. fac. A2	-4000	-1000	-2255		RW	66	Adiabatic constant A2
RF3	Rfg. fac. A3	2000	3000	2557		RW	67	Adiabatic constant A3

Table 36: Setup → Sensors

Label	Description	Min.	Max.	Value/ Type	Unit	RW	ADU	Description
SEN	**Setup → Sensors**							
r09	Adjust S2	-10,0	10,0	0.0	K	RW	17	S2 Offset adjustment to correct the sensor signal due to long wires etc.
o20	Min transducer pressure	0,0	1,0	0.0	bar	RW	62	Maximum transducer pressure (in bar absolute * 10)
o21	Max transducer pressure	1,0	200,0	16.0	bar	RW	63	Minimum transducer pressure (in bar absolute * 10)

Table 37: Setup → System

Label	Description	Min.	Max.	Value/ Type	Unit	RW	ADU	Description
SYS	**Setup → System**							
KT0	Avg KT0 Time	10	3600	180		RW	92	Average time for KT0 used as filtervalue for the average opening degree calculation when calculating the KT0
OD3	Avg OD 3hour	0,0	100,0	10.0		RW	93	Average OD, updated and saved every 3 hours. After power up the last saved average OD is used as starting average OD
HWM	HW main switch	0	1	0 - No DI main switch	Enum 6	RW	61	1 = S4 input is HW Main Switch
eMa	Manual OD as steps	0	1	0		RW	102	Enable the manual OD in o45 to be entered as halfsteps. Readouts are still in percent

Service

Table 38: Service → Alarm

Label	Description	Min.	Max.	Value/ Type	Unit	RW	ADU	Description
ReA	**Service → Alarm**							
eKe	EKC Error	0	1	0 - No alarm	Enum 7	Read	69	Common error flag. EKC Error is SET if any other Error Alarm is ON.
s2E	S2 Error	0	1	0 - No alarm	Enum 7	Read	70	S2 sensor error. If the sensor error occurs, the valve OD will be set to 80% of the Avg. opening (PNU 50021)
PeE	Pe inp.error	0	1	0 - No alarm	Enum 7	Read	72	AKS 32R out of range. If the sensor error occurs, the valve OD will be set to 80% of the Avg. opening (PNU 50021)
RfE	No Rfg. Sel.	0	1	0 - No alarm	Enum 7	Read	73	Refrigerant not selected
LAL	LOC Alarm	0	1	0 - No alarm	Enum 7	Read	10	Loss of charge alarm. No action will be performed except setting the alarm.

Table 39: Service → ReadOut

Label	Description	Min.	Max.	Value/ Type	Unit	RW	ADU	Description
ReO	**Service → ReadOut**							
u16	S4 air temp	-200,0	200,0	0.0	°C	Read	3	S4 temperature in °C measured with PT 1000 sensor connected to KM2
SHr	Superheat Ref	0,0	100,0	0.0	K	Read	7	Current superheat reference
u21	Superheat	0,0	100,0	0.0	K	Read	8	Current superheat (S2 - evaporator temperature)
u20	S2 Temp	-200,0	200,0	0.0	°C	Read	2	S2 temperature in °C measured with a PT 1000 sensor connected to KM1.
u24	Opening %	0	100	0	%	Read	9	Actual opening degree
u25	Evap Press Pe	-200,0	200,0	0.0	bar	Read	1	Evaporator pressure measured with ratiometric pressure transmitter at KM6.
u26	Evap Temp T	-200,0	200,0	0.0	°C	Read	6	Evaporator temperature (converted from evaporator pressure)
LTM	LOC Tmr	0	2000	0		Read	84	Loss Of Charge time
avo	Avg opening	0	2000	0	%	Read	85	Average opening degree. If it has never run before it will give the value of PNU 50021 at start up.

Table 40: Service → Control status

Label	Description	Min.	Max.	Value/ Type	Unit	RW	ADU	Description
Sta	**Service → Control status**							
cst	Control State	0	5	0 - Close	Enum 8	Read	83	Current state of internal control state machine.
ctr	Ctrl Status	0	20000	0		Read	5	Bit mappped status register.

Table 41: Service → Factory

Label	Description	Min.	Max.	Value/ Type	Unit	RW	ADU	Description
U2F	**Service → Factory**							
U2F	User to factory	0	1	0		RW	82	Controller will make the current settings to be its future factory default state.
F2U	Factory to user	0	1	0		RW	81	Apply defaults: On setting the original factory defaults values corresponds to its software version will be loaded. Warning: All the customized settings will be deleted and cannot be recovered on setting this value. The value will revert back to zero once the factory settings has been applied.

Ordering

Product part numbers

Table 42: Product part numbers

Description	Pack format	Code No.
EIM 365	Single pack	080G1003

Accessories

Table 43: Accessories

Description	Pack format	Code No.
Connector kit for 5x EIM Controller	Single pack	080G1601
EKE 2U battery backup	Single pack	080G5555

Certificates, declarations, and approvals

The list contains all certificates, declarations, and approvals for this product type. Individual code number may have some or all of these approvals, and certain local approvals may not appear on the list.

Some approvals may change over time. You can check the most current status at danfoss.com or contact your local Danfoss representative if you have any questions.

Table 44: Approvals

CE	089	EAC

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