Electronic Fan Speed Power Module FSP and Control Module FSE

Features FSP

- Can be used in combination with ALCO® FSE Control Module, EC2, EC3 and other electronic controllers which provide a 0...10 V output signal for condensing pressure control
- Versions for 3- and 1- phase motors approved for phase cut operation
- Paralleling of fan motors up to maximum current
- Reduced fan noise level during low ambient temperature conditions
- Energy saving due to improved cooling efficiency
- Short start impulse during partial load to overcome friction and windmilling
- Easy installation with cables for power supply and motor connection factory wired
- IP67 protection for outdoor mounting

FSE
Control Module

FSP
Power Module

Standards:

- CE per Low Voltage Directive
- CE per EMC
- FSE: UL file E183816

Selection Chart FSP

Type	Part No.	Supply Voltage	Current Range (A)	Max. Start Current max. 1sec (A)	Power Supply Cable Length (mtr)	Motor Cable Length (mtr)	Wire Diameter	Weight (g)
FSP-150	**800 370**	230V /50 Hz	0.3 - 5	15 A	1.5	0.75	3 x 1 mm²	1 050
FSP-180	**800 373**		0.3 - 8	24 A				
FSP-340	**800 376**	400V/3/50 Hz	0.3 - 4	12 A			5 x 1 mm²	1 650

Selection Chart FSE Control Modules

Type	Part No.	Refrigerants	Adjustment Range P_{cut}* (bar)	Cut-off Pressure factory set (bar)	Test Pressure	Pressure Connection	Weight (g)
FSE-01S	804 701	R134a	4 ... 12.5	7.8	30 bar	7/16"-20 UNF female	125
FSE-02S	804 706	R22, R404A, R407C, R507	10 ... 21	15.5	36 bar	7/16"-20 UNF female	125
FSE-03S	804 711	R410A	12 ... 28	20.4	50 bar	7/16"-20 UNF female	150

* Pressure at which fan is cut-off.

Selection Chart Cable Assemblies

Temperature Range -25 to 80°C / no UL		Temperature Range -50 to 80°C / UL appr.		Length (mtr.)	Weight (g)
Type	Part No.	Type	Part No.		
for connection to FSE Control Module:					
FSE-N15	804 680			1.5	80
FSE-N30	804 681			3.0	130
FSE-N60	804 682			6.0	220
for connection to EC2, EC3 and other controllers:					
		FSP-L15	804 693	1.5	
		FSP-L30	804 694	3.0	

Selection Dependent on Product Combination

Selection

1. Select a **Power Module FSP** by the total maximum operating current and phases of condenser fan motors

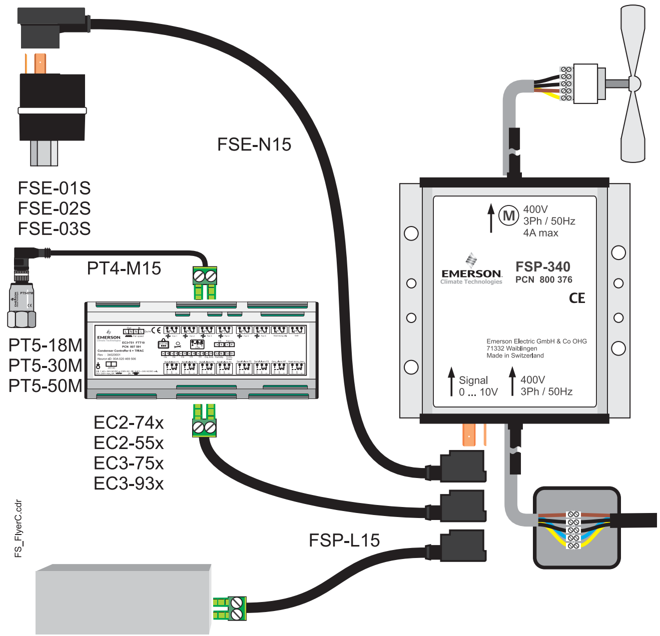
2. Select a **Control Module FSE** based on the pressure requirements of the refrigerant used:
   FSE-01S for R134a,
   FSE-02S for R22 / R404 A / R407C / R507
   FSE-03S for R410A

   - or a controller of the EC Series

   - or another electronic controller which provides a 0...10 V output signal

3. Select a **Cable Assembly**
   a) for connection of **FSE to FSP**:
   FSE-Nxx: -25 ... +80°C
   - 3 lengths: (1.5 - 3.0 - 6.0 m)

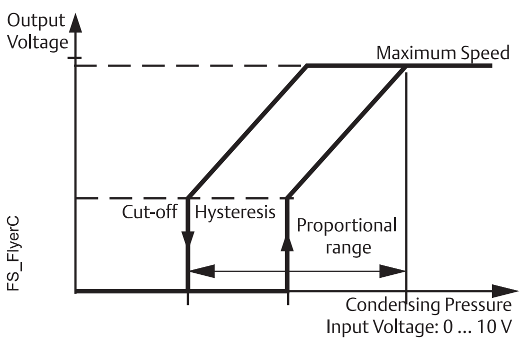
   b) or for use with an electronic controller with 0...10V signal output:
   (e.g. EC2-74x, EC2-54x ,EC3-75x, EC3-92x):
   FSP-Lxx: -50 ... +80°C
   - 2 lengths (1.5 - 3.0 m)



Control System with 0... 10 V output

Function Diagram

The behaviour of FSP together with FSE can be described by the following control diagram:



The top curve describes the fan speed at decreasing, the lower curve at rising pressure. At high condensing pressure fan is running with maximum speed (top right). In the proportional range of the curve fan speed is decreased with pressure. If the pressure falls below the specified limit the fan is cut-off.

A large hysteresis is built-in to prevent fan cycling at this point. Pressure must increase by approximately 1 bar before fan restarts. A short start pulse helps fan to overcome friction or windmilling before it supplies the proportional value.

Along the proportional range the fan speed varies between 20% and 100% for 3-phase motors and between 30% and 100% for single phase motors.

Technical Data FSP

Temperature Range Operation	-20°C to +65°C
Protection class (IEC 529 / EN 60529)	IP 67
Signal Input Voltage	0 ... 10 VDC
Mounting	Direct with screws

Technical Data FSE

Temperature Range Operation	-20°C to +65°C
Protection class (IEC 529 / EN 60529)	IP 65
Supply Voltage	10V, supplied by FSP Module
Operating Current 0 ... 10 VDC output	max. 1 mA
Medium Compatibility	HFC, HCFC, synth. / mineral oils
Pressure Connection	FSE-01S / FSE-02S brass FSE-03S stainless steel

Operating principles
Alco® Thermo®-Expansion valves control the superheat of refrigerant vapour at the outlet of the evaporator. They act as a throttle device between the high pressure and the low pressure sides of refrigeration systems and ensure that the rate of refrigerant flow into the evaporator exactly matches the rate of evaporation of liquid refrigerant in the evaporator. Thus the evaporator is fully utilized and no liquid refrigerant may reach the compressor.

Description of bulb charges
The application ranges of Thermo®-Expansion valves are heavily influenced by the charge selected.

Liquid charges
The behaviour of Thermo®-Expansion valves with liquid charges is exclusively determined by temperature changes at the bulb and not subject to any cross-ambient interference. They feature a fast response time and thus react quickly in the control circuit. Liquid charges cannot incorporate MOP functions. Maximum bulb temperatures shall not exceed 75°C.

Gas charges
The behaviour of Thermo®-Expansion valves with gas charges will be determined by the lowest temperature at any part of the expansion valve (power assembly, capillary tube or bulb). If any parts other than the bulb are subject to the lowest temperature. malfunction of the expansion valve may occur (i.e. erratic low pressure or excessive superheat). Alco® Thermo®-Expansion valves with gas charges always feature MOP functions and include ballasted bulbs. Ballast in the bulb leads to slow opening and fast closure of the valve. Maximum bulb temperature is 120°C.

Adsorption charges
These charges feature control characteristics much like MOP charges but avoid the difficulties of cross-ambient interference. Response time is slow but perfectly suitable for common refrigeration systems. Maximum bulb temperature is 130°C.

MOP (Maximum Operating Pressure)
MOP functionality is somewhat similar to the application of a crankcase pressure regulator. Evaporator pressures are limited to a maximum value to protect compressor from overload conditions. MOP selection should be within maximum allowed low pressure rating of the compressor and should be at approximately 3K above evaporating temperatures.

Practical hint: Superheat adjustments influence the MOP:

Increase of superheat: Decrease of MOP

Decrease of superheat: Increase of MOP

Static superheat
Alco® Thermo®-Expansion valves are factory preset for optimum superheat settings. This setting should be modified only if absolutely necessary.
The readjustment should be at the lowest expected evaporating temperature.

Subcooling
Subcooling generally increases the capacity of refrigeration system and may be accounted for when dimensioning an expansion valve by applying the correction factor K_t. The capacity corrections for evaporating temperature. condensing temperature and subcooling are all incorporated in K_t. These are in particular the liquid density upstream from the expansion valve, the different enthalpies of liquid and vapour phase refrigerants as well as certain part of flash gas after expansion. The percentage of flash gas differs with various refrigerants and depends on system conditions.

Heavy subcooling results in very small flash gas amounts and therefore increases expansion valve capacities. These conditions are not covered by K_t. Likewise. small flash gas amounts lead to reduced evaporator capacities and may result in substantial discrepancies between the capacities of the Thermo®-expansion valve and the evaporator. These effects must be considered during component selection when designing refrigeration circuits. In cases when subcooling exceeds 15 K, sizing of components (K_t, $K\Delta p$) should be modified accordingly. The field practice indicates the following correction factors can be used to compensate the effect of the subcooling (liquid hammering) in addition to the use of correction factors K_t, and $K\Delta p$.

Subcooling	20K	30K	40K	50K	60K
Correction factor	0.8	0.7	0.6	0.5	0.4

Emerson Climate Technologies will be happy to assist you. Please contact application engineering department.

Dimensioning
To correctly select a Thermo®-Expansion valve on a system, the following design conditions must be available:
- Cooling capacity Q_O
- Effective pressure differential across Thermo®-Expansion valve Δp
- Evaporating temperature/pressure
- Lowest possible condensing temperature/pressure
- Liquid temperature
- Type of refrigerant

As opposed to single substances (e.g. R22. R134a etc.) where the phase change takes place at a constant temperature/pressure, the evaporation and condensation of **zeotropic blend R407C** is in a gliding form (e.g. at a constant pressure the temperature varies within a certain range) through evaporators and condensers.
The evaporating/condensing pressure must be determined at saturated temperatures (bubble/dew points) for dimensioning of Thermo®-Expansion valves.

To facilate valve dimensioning for other than the standard conditions Emerson Climate Technologies offers an Excel based Alco® Selection Tool. This can be ordered from all Emerson sales offices. See www.emersonclimate.eu for contact addresses. email or phone numbers.

Example

Cooling capacity of a system:	18 kW
Refrigerant:	R407C
Condensing temperature (saturated liquid):	+35°C
(Condensing pressure will be 15.5 bar)	
See appendix page 251 for	
Evaporating temperature (saturated vapour):	0°C
(Evaporating pressure will be 4.61 bar)	
Subcooling:	1 K
Pressure drops through liquid line:	2.2 bar
Pressure drops through evaporator:	0.3 bar
Required type of Thermo®-Expansion valve:	T-series

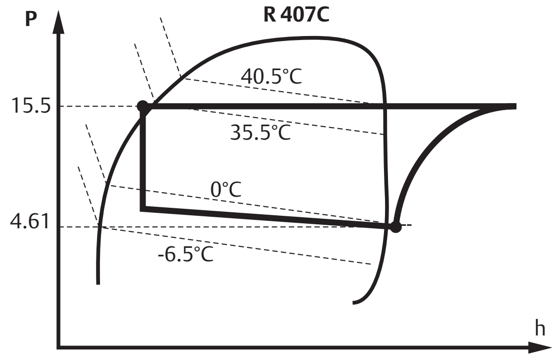
To calculate the nominal capacity the following formula has to be used:

Cooling capacity x Kt x KΔp = Nominal capacity

1. Selected **Kt-factor** according to refrigerant, liquid and evaporating temperature from table on page 182.
Kt = 0.98 (for this example)

2. Determine pressure differential across the Thermo®-Expansion valve using condensing pressure. subtract evaporating pressure and all other possible pressure losses (pressure drops in evaporator. drier. solenoid valve. liquid distribution...).

For this example:
Δp = 15.5 - (4.61 +2.2 + 0.3) = 8.39 bar
Select **KΔp** factor from table on page 182:
KΔp = 1.15 (for this example)



3. Multiply cooling capacity with **Kt** and **KΔp**. to find nominal capacity for Thermo®-Expansion valve.

Qn = 18 x 0.98 x 1.15 = 20.29 kW

Select Thermo®-Expansion Valve from table on page 178: TCLE 550 NW (for this example).

Please note that all evaporating/condensing temperatures in this catalogue are based on saturated vapour/liquid temperatures.

Selection Guide for Expansion Valves

Series	Selection Criteria				Catalogue Page
	Capacity Range kW (R 404A)	Evaporating Temp. Range °C	Main Application	Features	
TI	0.5 to 14.2	+20 to -45	Refrig./Air-Cond. Heat Pumps	Interchangeable Orifices	166
TX3	0.8 to 15.0	+20 to -45	Refrig./Air-Cond. Heat Pumps	Hermetic. Superheat adjustable. optional with check valve	174
TX6	13.3 to 57.0	+20 to -45	Air-Cond. Heat Pumps	Hermetic Superheat adjustable	176
T	2 to 209	+30 to -45	Refrig./Air-Cond. Heat Pumps	Interchangeable Orifices. ower-Assembly and Flange	178
ZZ	1.9 to 81.2	-45 to -120	Low Temperature Application	Interchangeable Orifices. Power-Assembly and Flange	183
L	2 to 154	+30 to -50	Liquid Injection Superheat Control	Interchangeable Orifices. Power-Assembly and Flange	186
935	5.2 to 43.5	+30 to -45	Liquid Injection Temperature Control	Interchangeable Orifices. Power-Assembly and Flange	188