CAREL

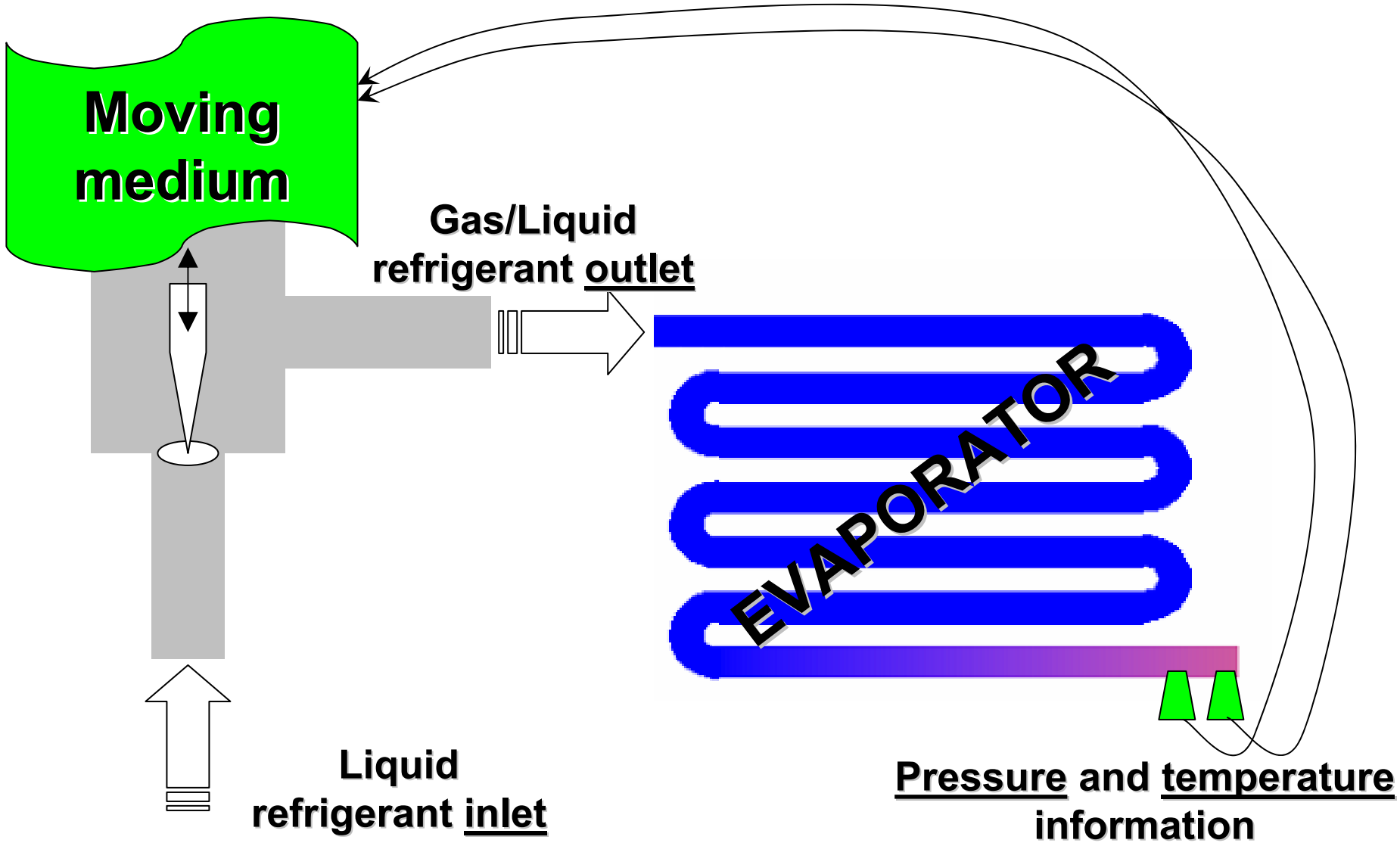
E²V training course

- E²V -

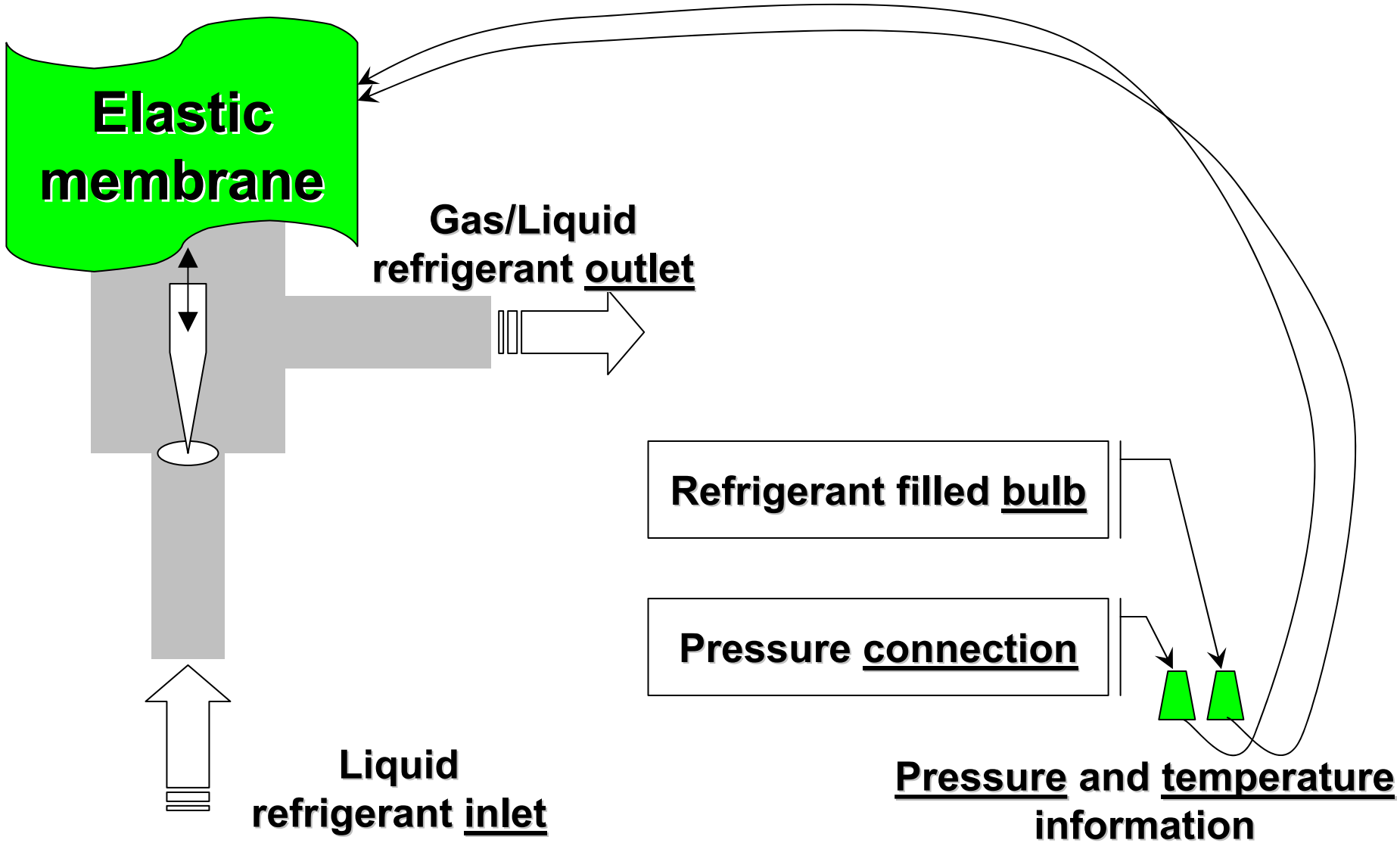
- E^2V training course -

- EV concept and operation
- EEV description
- Comparison of EEV with TEV
- E^2V main characteristics and features
- E^2V commercial and promotional issues
- E^2V installation
- E^2V sizing
- Open discussion

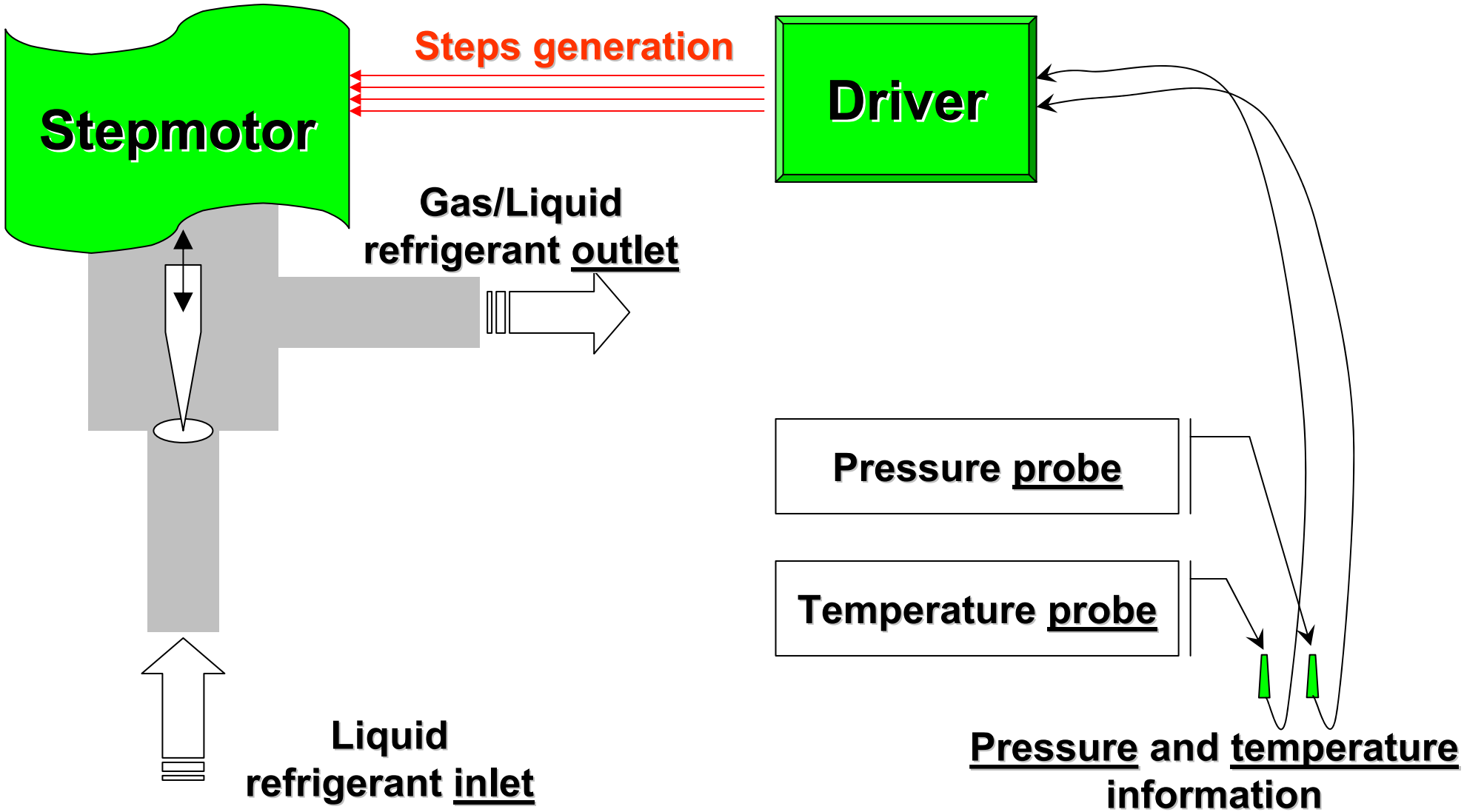
- EV concept and operation -



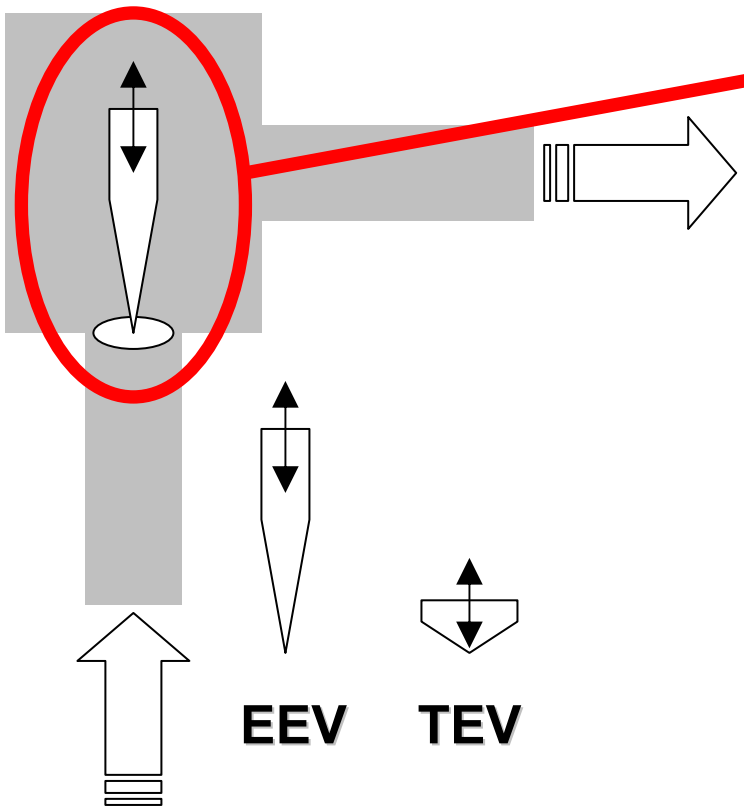
- TEV description-



- EEV description-



- TEV/EEV main differences-



Pin length

TEV usually have a pin about 1 mm long

In best EEV the pin is much longher

E^2V has a pin **15 mm long**

This means…

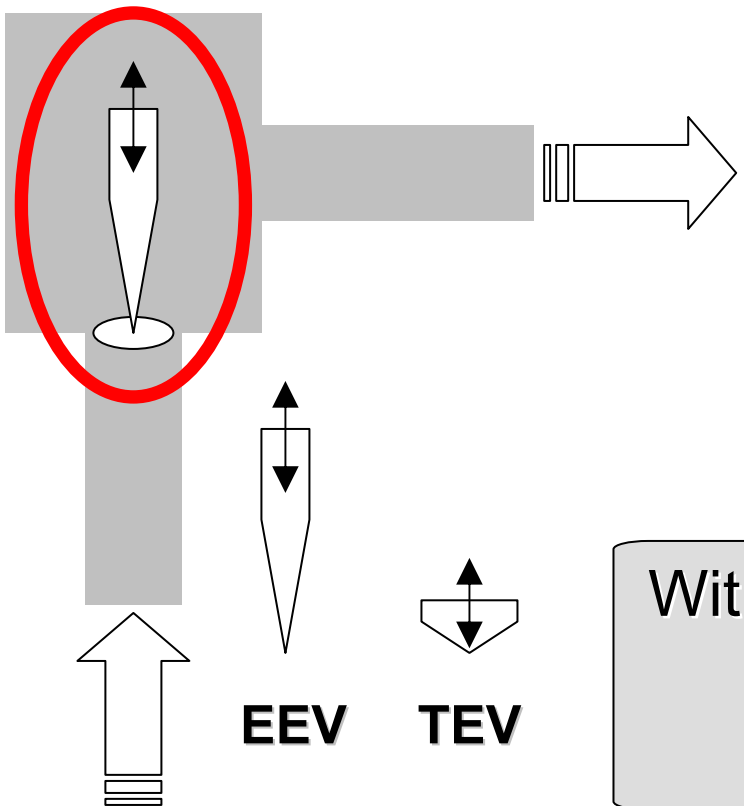
High mechanical resolution

Precise refrigerant regulation

Wide capacity modulation range

- TEV/EEV main differences-

Pin length - note on competitors steps number



E²V has **480** steps on a **15 mm** pin

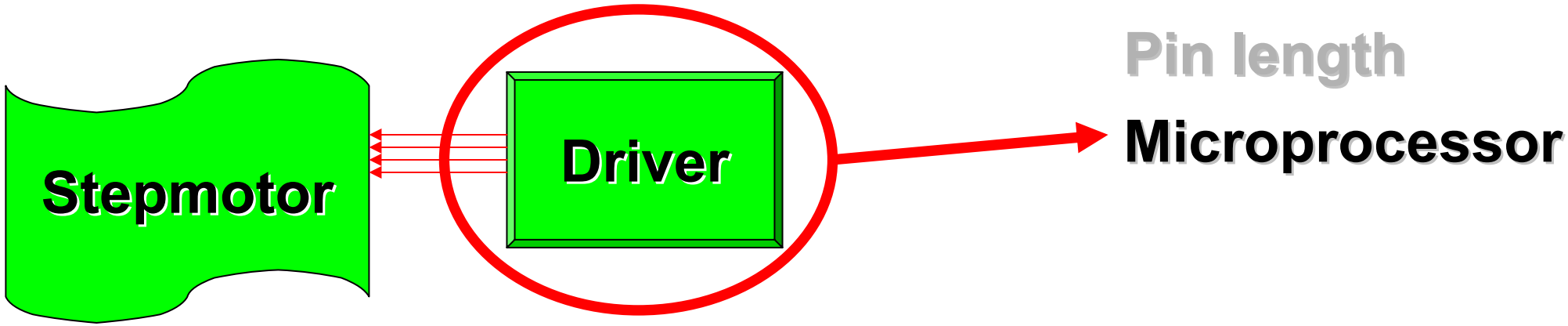
This gives a good relation between:

Theoretical resolution

Mechanical resolution

With thousands of steps on few millimeters
the single step has no effect
on refrigerant flow

- TEV/EEV main differences-



TEV Valve opening (pin position) is given by a DIRECT proportionality between "sensors"

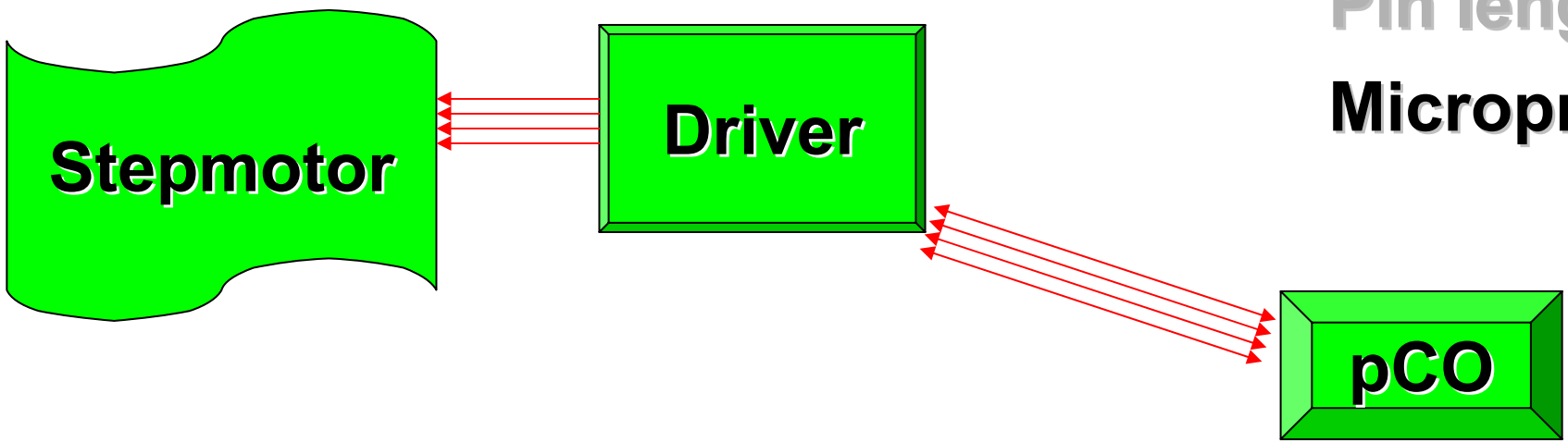
No possibility to modify or adjust TEV action

EEV Valve opening (pin position) is given by an algorithm according to application needs

EEV action is "computed" by a micorprocessor

- TEV/EEV main differences-

Microprocessor driver– note on competitors



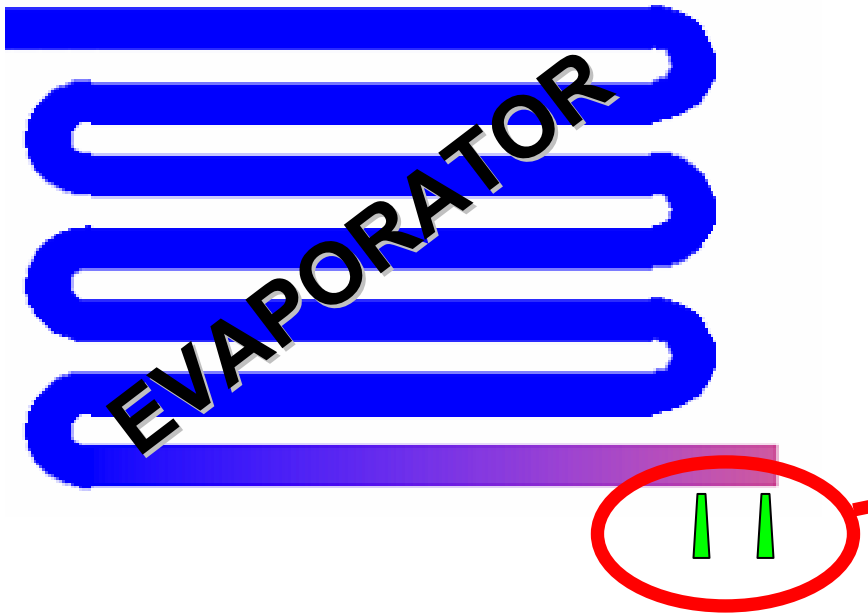
Pin length

Microprocessor

EEV algorithm *is on the Driver* but in with pCO Sistema it is possibile to *customize the EEV action*

Carel algorithm is customizable in terms of:
- Parameters
- Unit status
- Custom application

- TEV/EEV main differences-



Pin length

Microprocessor

Signals

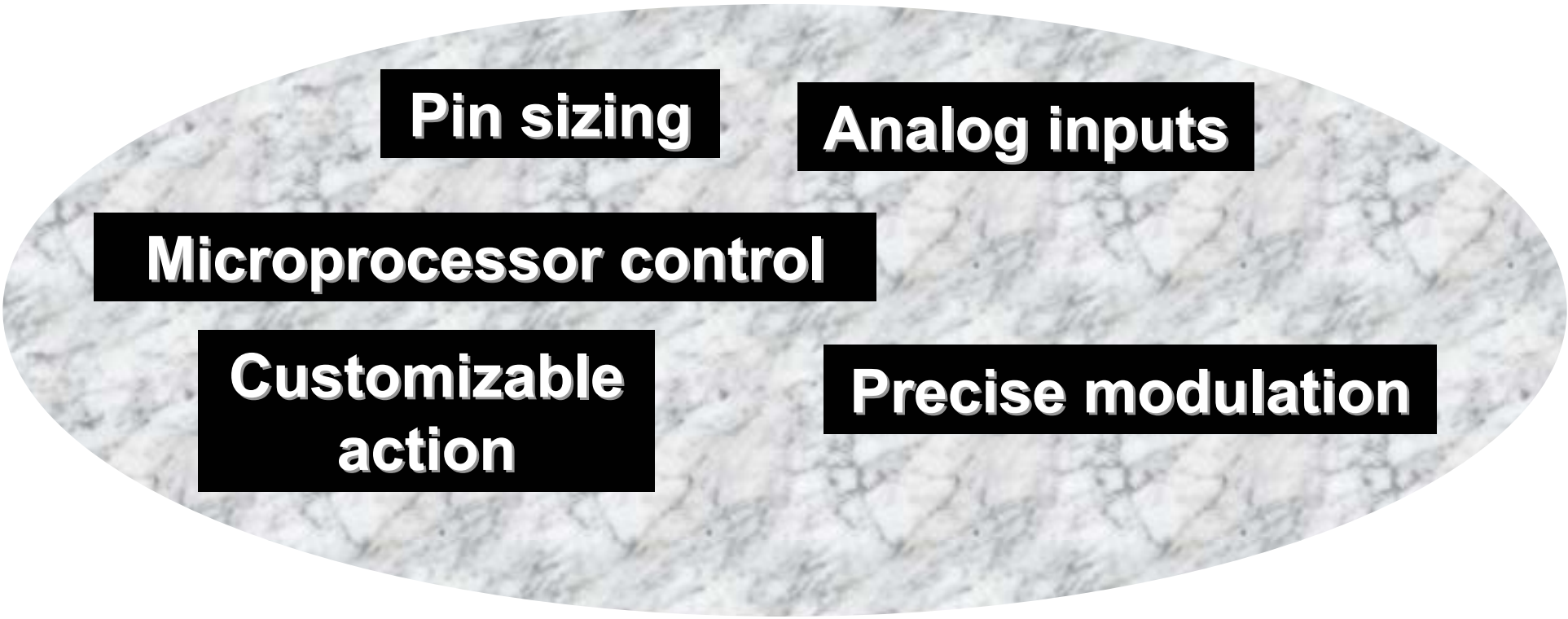
TEV Temperature and pressure information are DIRECTLY “mechanical” readings

Problems of accuracy, precision and stability

EEV Temperature and pressure information are analog inputs in a electronic instrument

Possibility to check, filter and stabilize the P and T input

- TEV/EEV comparison-



General features of E^2V System

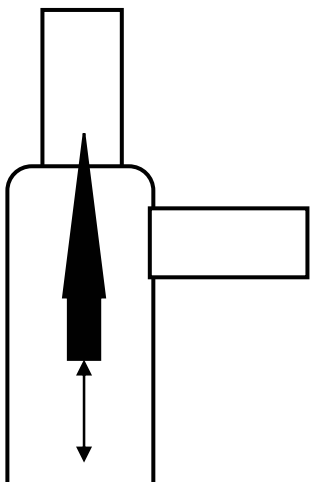
- E²V -

Details on
E²V Expansion Valve

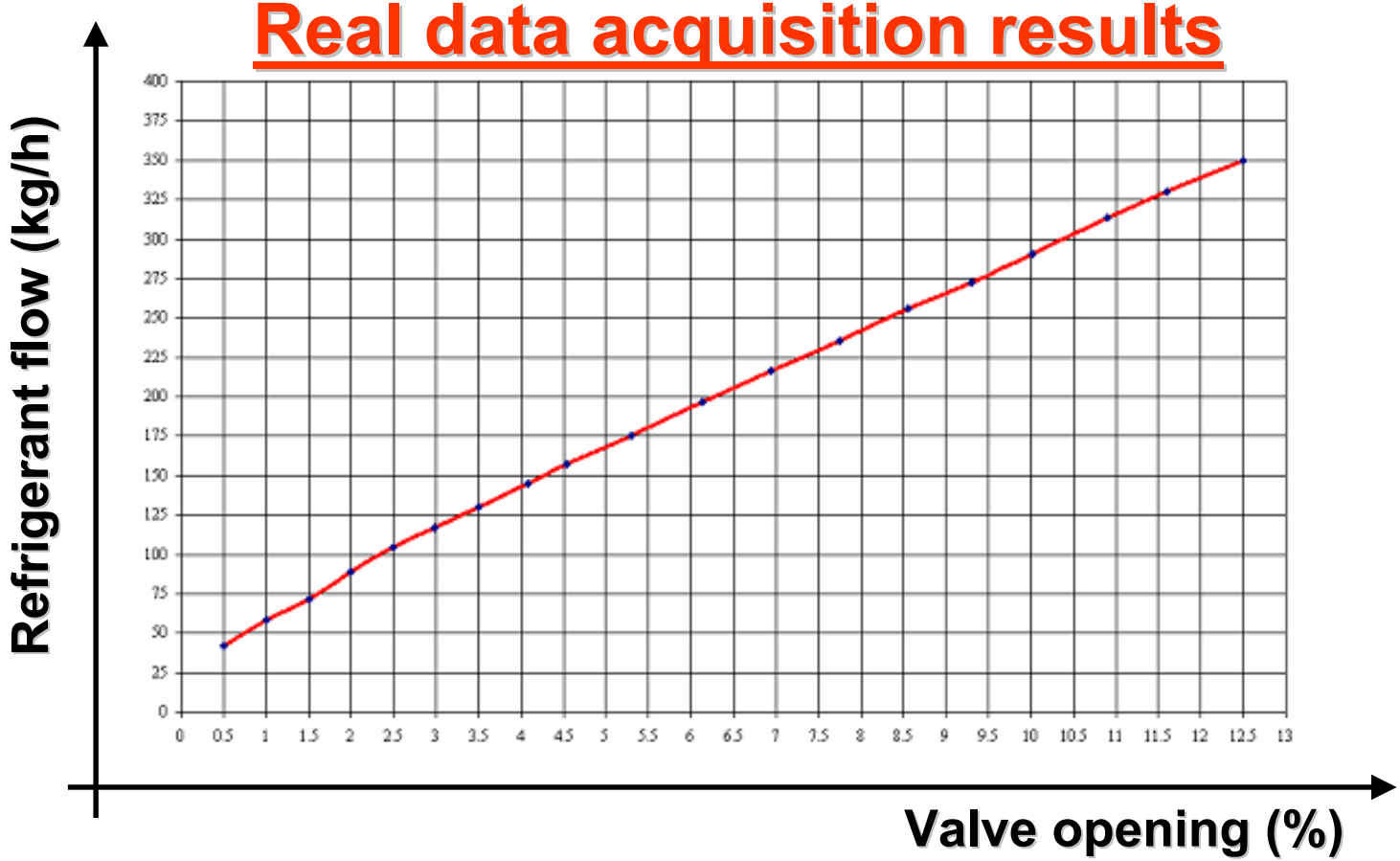
- E²V is…-

PROPORTIONAL

Axial movement of the pin gives perfect linearity in refrigerant flow



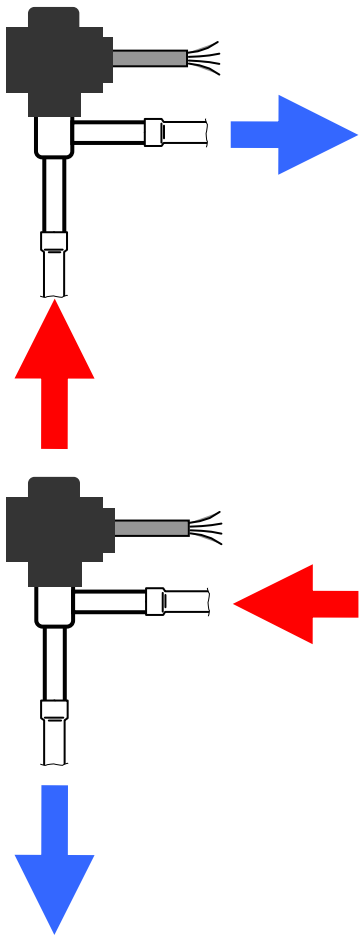
Real data acquisition results



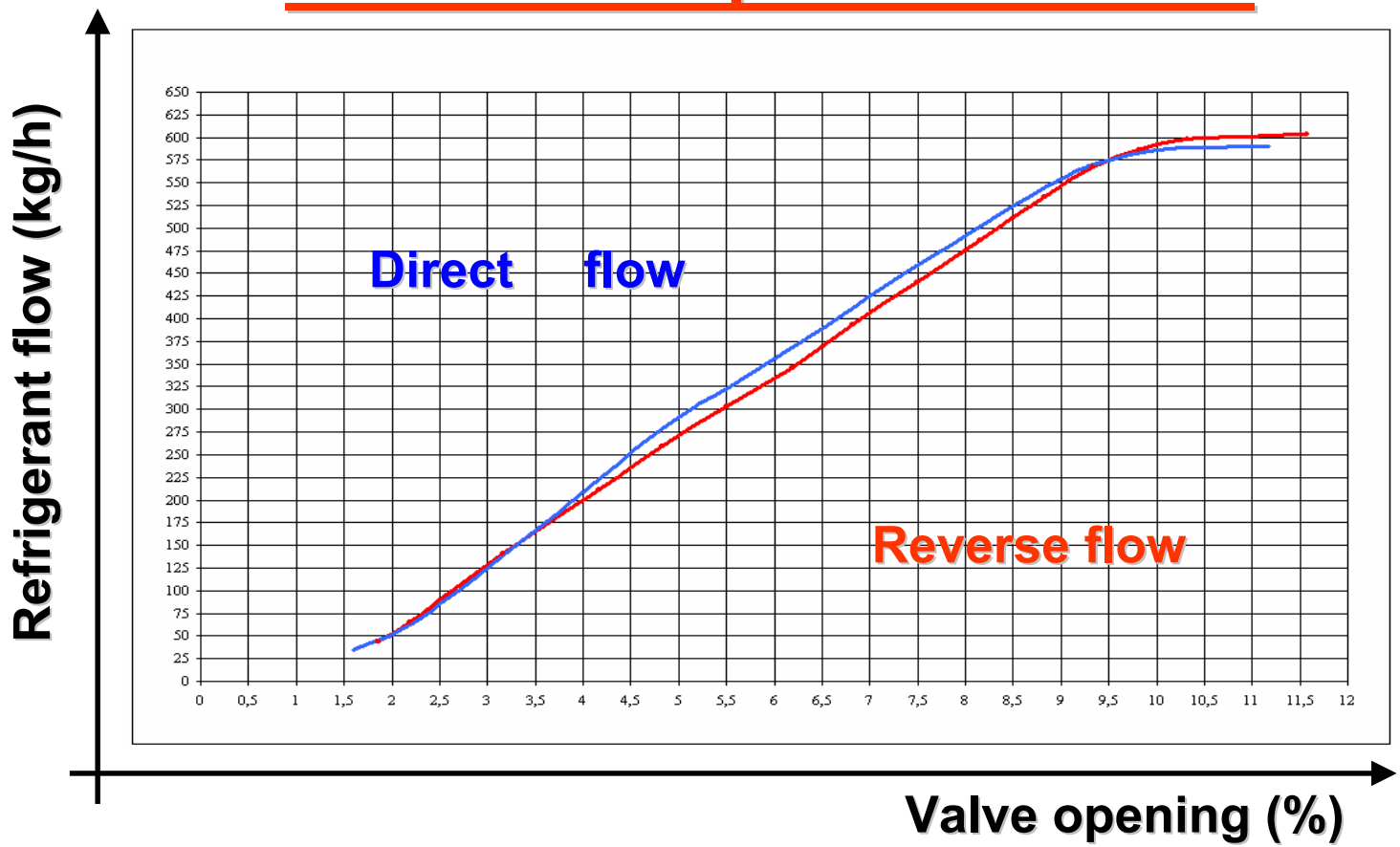
- E²V is…-

BIDIRECTIONAL

Refrigerant inlet can be both side



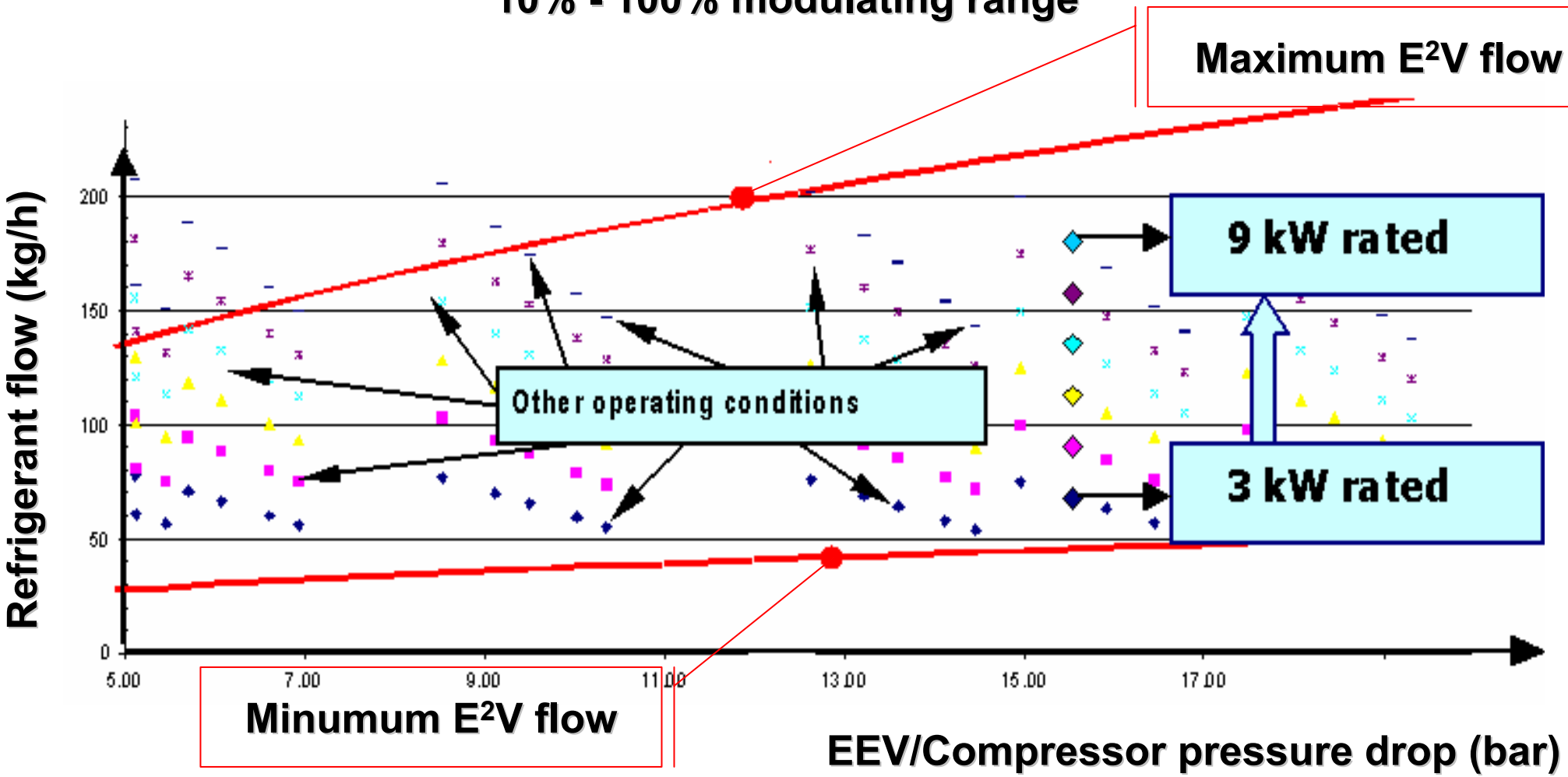
Real data acquisition results



- E²V is…-

WIDE RANGE

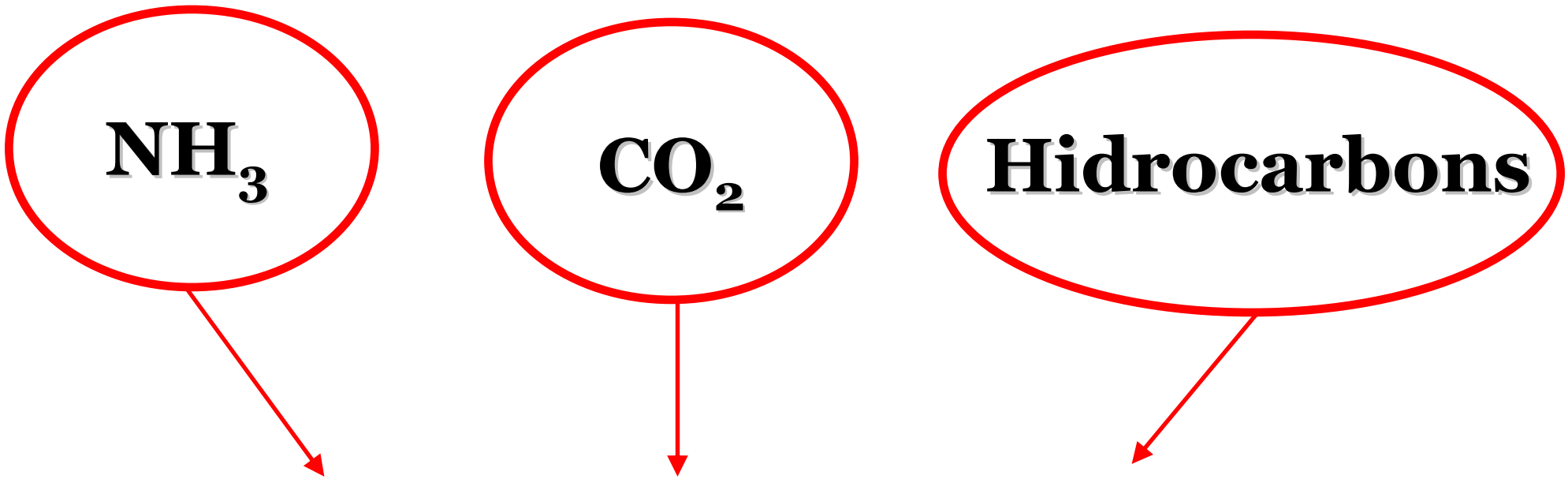
10% - 100% modulating range



- E²V is…-

STAILESS STEEL

Open compatibility with unconventional but upcoming refrigerants



The E²V valve is made with outstanding material like
AISI 316L stainless steel and PEEK polymer
but every application different from common (organic) refrigerant expansion need to be cecked for temperature and pressure range

E²V Commercial themes

Working conditions extension

Logistic simplification

Increased and stable cooling capacity

Custom functions

HP units cost reduction

Smart Pump Down

Complex units simplification

Energy saving operation

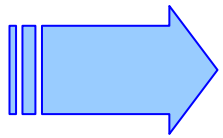
Faster and better duty achievement

Low noise operation

Smart Dehumidification

- Commercial themes-

Regulation range
+
Refrigerants Compatibilty



Same EEV

For different unit type, size, operating conditions, application,…

Logistic simplification

Maximum SIX codes

for ANY refrigerant, application and size

Display cabinets three EEV for quite all the range

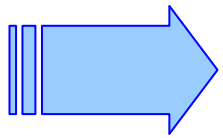
Air conditioners three EEV from 10 to 50kW

- Commercial themes-

Regulation range

+

Refrigerants Compatibilty



Same EEV

For different unit type, size, operating conditions, application,…

Working conditions extension

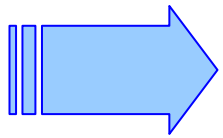
No concern of where the unit is going work and in witch conditions

- Commercial themes-

Regulation range

+

Refrigerants Compatibilty



Same EEV

For different unit type, size, operating conditions, application,…

Energy saving operation

Condensing pressure/temperature may be reduced up to UNIT operating limits: no more concern on valve capacity

Supermarket chains HUGE argument for promoting the technology, 25% energy saving per year are thousands of Euro.

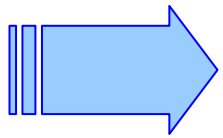
Contractors/OEM Promoting/endorsing this technology gives a plus against competitors

- Commercial themes-

Regulation range

+

Refrigerants Compatibilty



Same EEV

For different unit type, size, operating conditions, application,…

Complex units simplification

Units with multiple operating conditions to be serve do not need no more multiple circuits (TEV).

Wine industry — Chillers double water setpoint do not means no more double expansion valve and circuit.

Other applications — The limit to examples is the present low diffusion of the technology: ask Carel support for particular applications.

- Commercial themes-

Bidirectional → **Single EEV**

For reversible Heat Pumps

HP units cost reduction

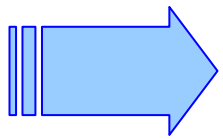
Reversible Heat pump *do not need any more two TEV*, non return valves, complex and expensive (materials/time) refrigerant piping

HP — Together with common EEV advantages like energy saving operation there is EVEN an UNIT cost reduction or at least a low cost increase for EEV use.

Any unit — Having the possibility to install the valve in virtually any position (NO UPDOWN) is “comfortable” in any unit.

- Commercial themes-

Precise superheat regulation



Stable and lower superheat

compared with TEV

Increased and stable cooling capacity

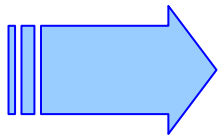
The cooling capacity increase means even an *higher efficiency* and an *higher and stable evaporation pressure*/temperature

Close control — Air Conditioner, process chiller and all the other units takes great advantage of a stable operation.

Refrigeration — Display cabinets and cold rooms increased cooling capacity means lower compressor rack energy consumption and/or lower local (regulated) temperature possible.

- Commercial themes-

Wide range
Precise operation
Microprocessor control



Faster reaching
of system stability

Faster and better duty achievement

The EEV is spread open at startup

(always taking care of superheat)

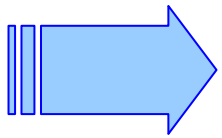
Refrigerant flow is so huge that in most unit a few minutes are enough to reach the stability of the cooled medium

AND in some application of Superheat too.

- Commercial themes-

Precise operation

Microprocessor control



Total control

of unit operation

EEV is a further and powerful hand on the system operation

The EEV movement is no more

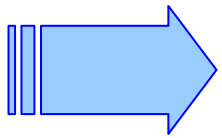
ONLY proportional to physical measurements (Temp,Press)

What the EEV does is not NECESSARY superheat regulation

The EEV position is the best to achieve the “in progress target” that may not be superheat regulation.

- Commercial themes-

Precise operation
Microprocessor control



MOP
real and efficient control

Maximum Operating Pressure

The MOP algorithm has been developed for maximum reliability and smoothness even in severe conditions (35°C chiller water inlet).

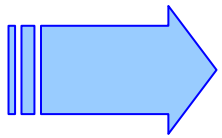
Evaporating pressure stabilized at the given maximum threshold

Possibility to monitor even the suction temperature for compressor motor overheating protection

- Commercial themes-

Precise operation

Microprocessor control



LOP

Protection control

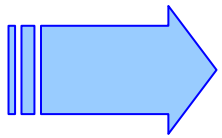
Lowest Operating Pressure

The LOP algorithm has been developed to “help” the EEV during radical change in cooling capacity (startup, staging,)

- Commercial themes-

Precise operation

Microprocessor control



Custom functions

development possibility

(pCO Sistema)

Custom functions

Like…

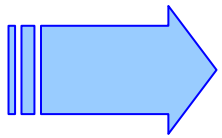
Any customization may be developed in pCO Sistema control range thanks to the Easy Tools language.

It is possible FROM the pCO to change (even runtime) setpoint, position , threshold an even the position of the valve

- Commercial themes-

Precise operation

Microprocessor control



Custom functions

development possibility

(pCO Sistema)

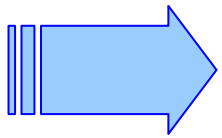
Smart Pump Down

EEV position may be “freely” decided

The pump down may be “driven” by EEV in custom solution depending on unit/application requests.

- Commercial themes-

Precise operation
Microprocessor control



Custom functions
development possibility
(pCO Sistema)

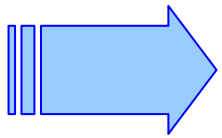
Smart Dehumidification

EEV closes more then necessary

Lower evaporator pressure/temperature
and consequently
dehumidification starts

- Commercial themes-

Precise operation
Microprocessor control



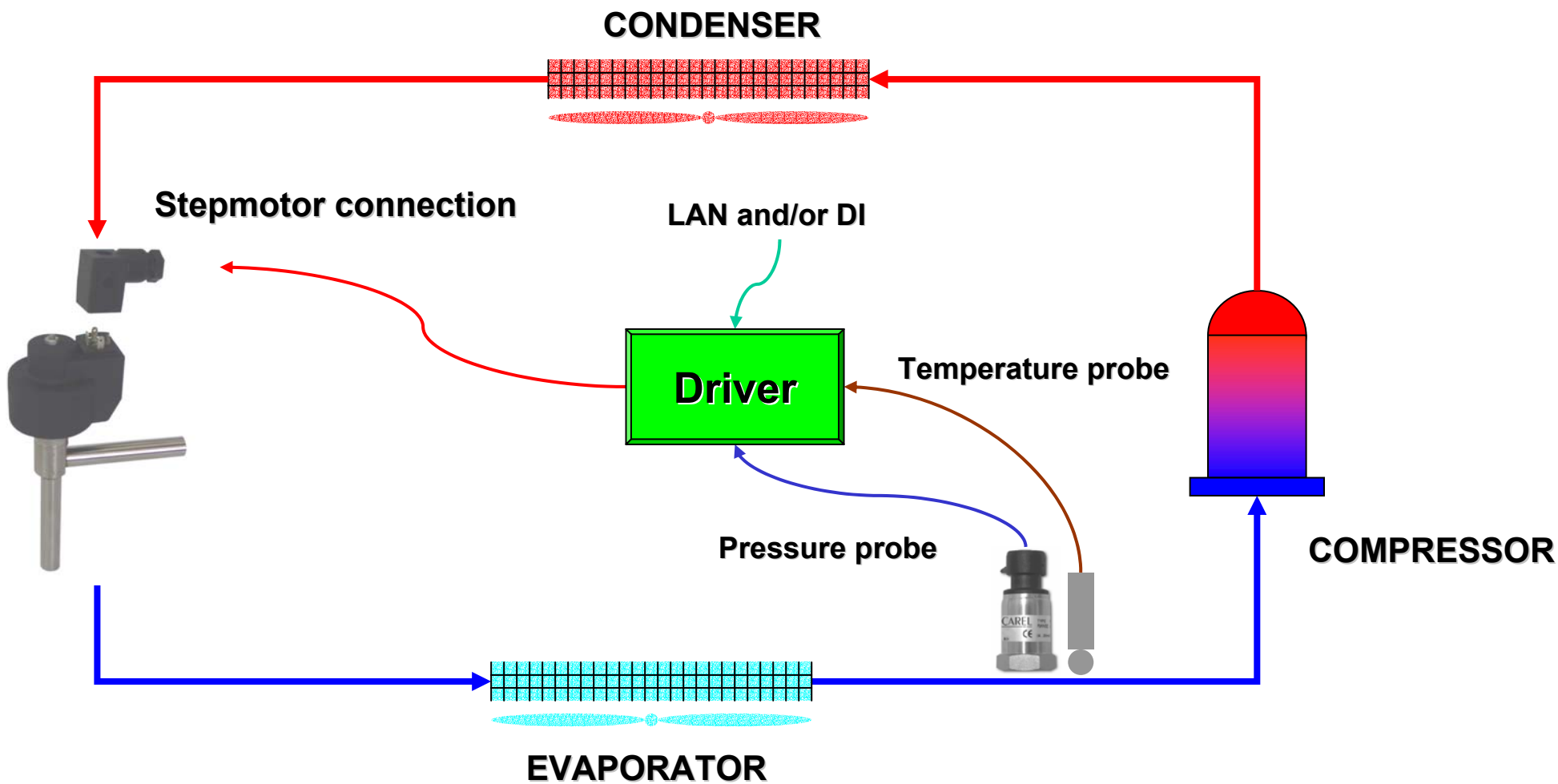
Custom functions
development possibility
(pCO Sistema)

Low noise operation

EEV closes more then necessary

Lower cooling capacity
and consequently
lower load to condenser and *lower condenser fan speed demand*

E²V Installation



- E²V System electrical installation -

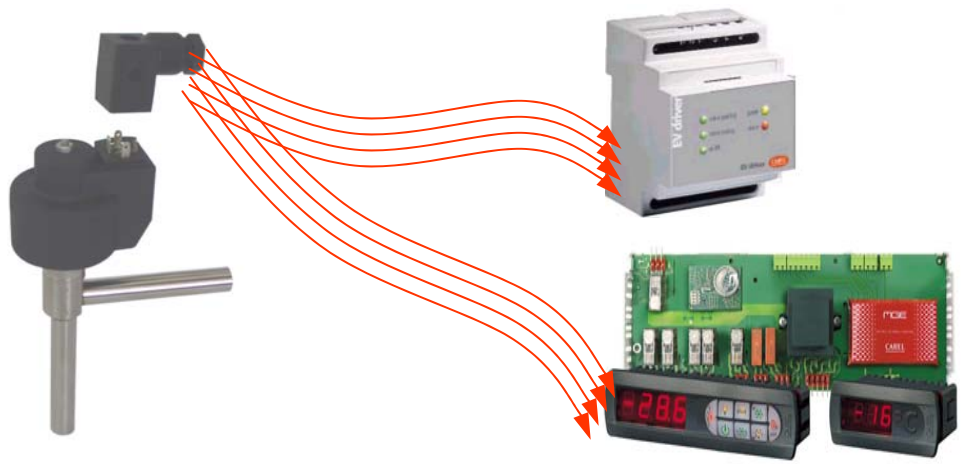
Stepmotor

EVD1 → E²V 1

EVD2 → E²V 2

EVD3 → E²V 3

EVD4 → E²V 4 (T)



EVD External

EVD Built-in

- E²V System electrical installation -

Pressure probe

4-20mA

Power → +24V (Pressure probe)

Signal → Signal (Pressure probe)

0.5-4.5V

Power → Vp (Pe)

Signal → P (Pe)

Ground → G (Pe)

EVD External

EVD Built-in

- E²V System electrical installation -

Temperature probe

EVD External

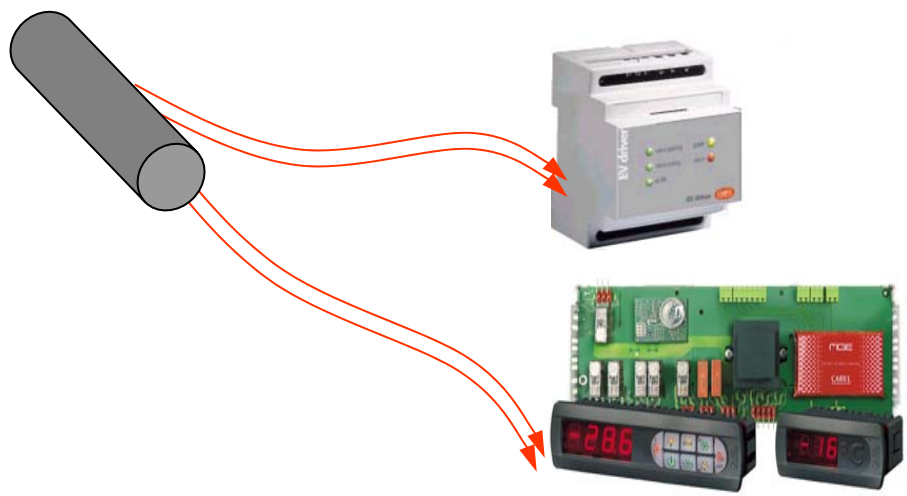
Wire1 → NTC

Wire2 → NTC

EVD Built-in

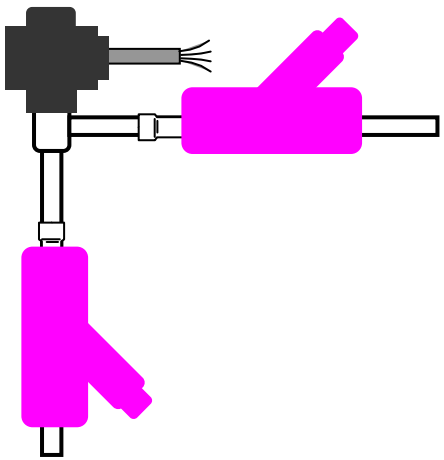
Wire1 → Tsh (NTC sh)

Wire2 → G (NTC sh)



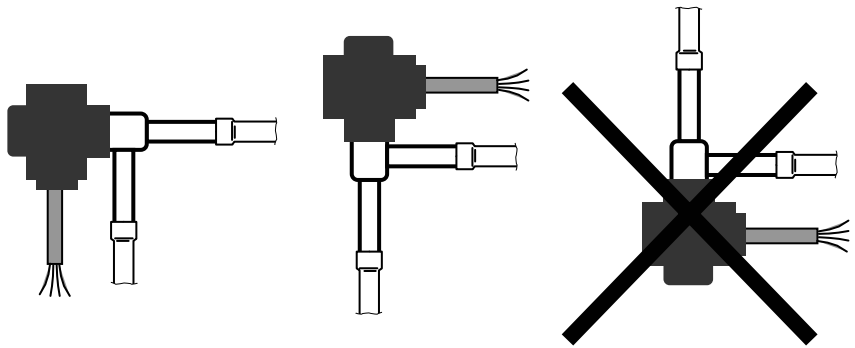
- E²V System installation -

FILTER



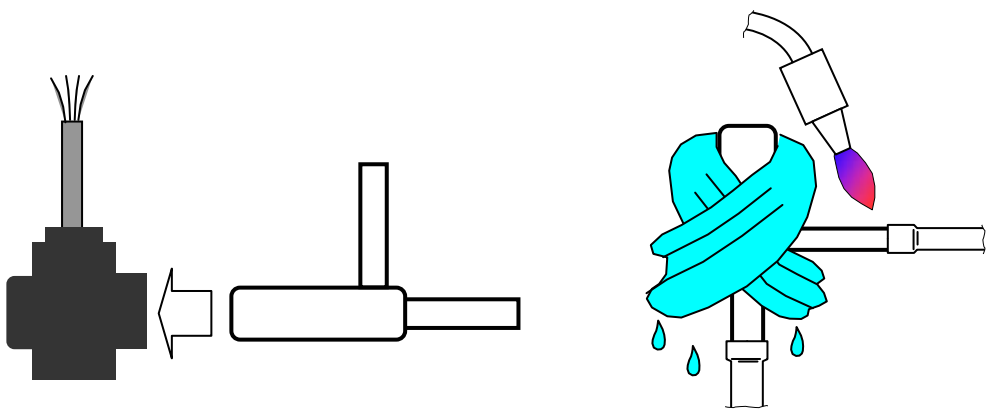
It is strongly recommended the use of a *removable filter* in the liquid line before EEV refrigerant inlet <u>especially</u> in *Supermarket application*

- E²V System installation -



NO UPDOWN POSITION

Every other positions are allowed



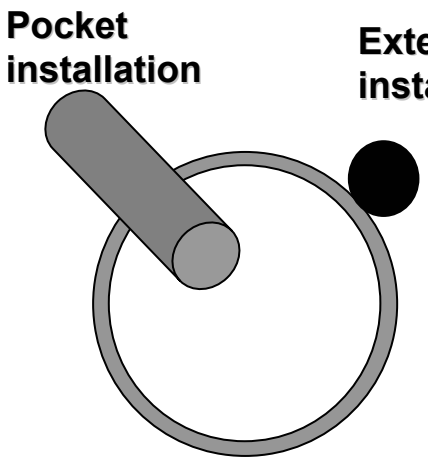
REMOVE THE COIL

before brazing

USE A WET TOWEL

while brazing

- E²V System installation -



TEMPERATURE PROBE

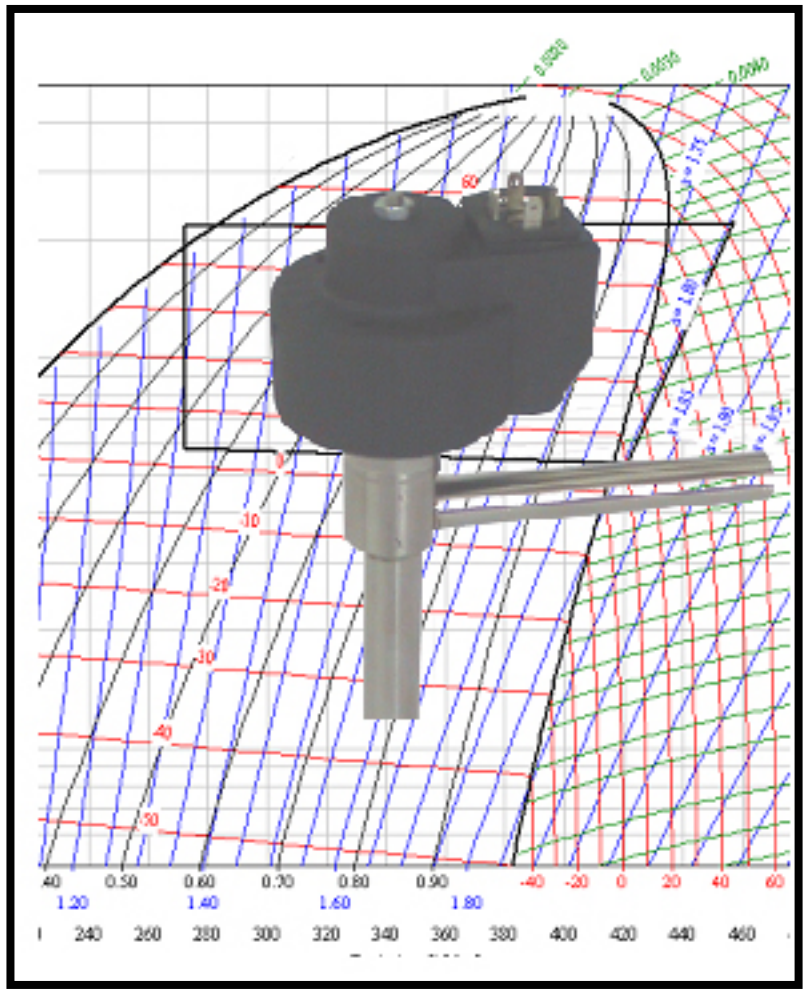
- As close as possible to evaporator outlet
- Use conductive paste and thermal insulation
- Use an internal pocket (gt.Φ4.2mm) if possible
- At 330° or 30° and before vertical lines if any

PRESSURE PROBE

- As close as possible to temperature probe
- With or without capillary tube
- Chose the minimum possible range

- E²V -

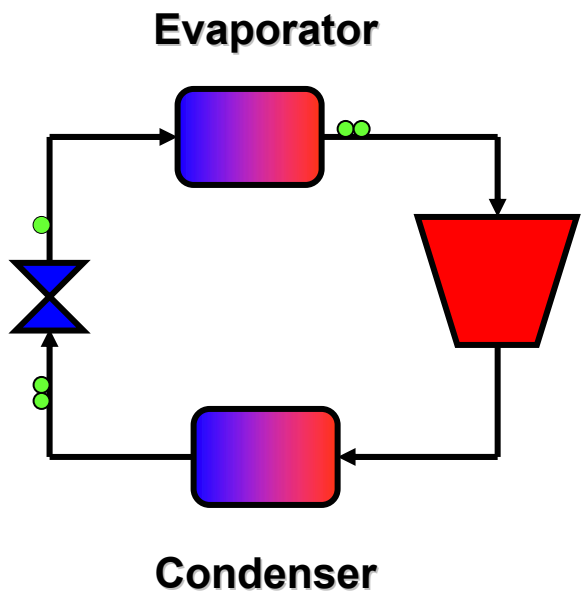
Sizing the E²V Expansion Valve



- E²V Sizing-

- Refrigerant type
- Evaporating temperature/pressure
- Condensing temperature/pressure
- Liquid temperature
- Evaporator pressure drop
- Condenser pressure drop

→ EEV pressure drop



- E²V Sizing-

What is necessary to properly size an E²V electronic expansion valve?

E²V Cooling capacity datasheet → E2V cooling cpacity

Refrigerant	→	**Page**
Cooling capacity **Evaporating and condensing temperature**	→	**Table Row**
Total pressure drop (gas+liquid) **Subcooling**	→	**Coefficients**
Repeat calculation in other conditions	→	**Capacity check**

- E²V Sizing-

Example 1

Refrigerant: R407c

Capacity: 12kW

Nominal evaporating: 5°C

Nominal condensing: 45°C

Necessary data

Tc	Te = 5 °C						Correction for soobcooling		
	E²V-09	E²V-11	E²V-14	E²V-18	E²V-24	E²V-30	$K_{5°C}$	$K_{10°C}$	$K_{15°C}$
20	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-
28	2.7	4.0	6.2	10.1	17.6	27.1	1.00	1.11	1.17
32	2.9	4.3	6.7	10.9	19.0	29.3	1.00	1.12	1.18
36	3.1	4.5	7.1	11.5	20.1	31.0	1.00	1.13	1.19
40	3.2	4.7	7.4	12.0	21.0	32.3	1.00	1.13	1.20
44	3.3	4.9	7.6	12.4	21.6	33.3	1.00	1.14	1.21
48	3.4	5.0	7.8	12.7	22.0	34.0	1.00	1.15	1.23
52	3.4	5.0	7.9	12.8	22.2	34.3	1.00	1.16	1.24
56	3.4	5.0	7.9	12.8	22.2	34.2	1.00	1.18	1.26
60	3.4	4.9	7.8	12.6	22.0	33.8	1.00	1.19	1.29

Facultative data

SBC: 5°C

Pressure drop before EEV
from compressor discharge to EEV inlet: 0.3bar

Pressure drop after EEV
from EEV outlet to compressor suction: 0.7bar

Bar	0.5	1.0	1.5	2.0	2.5
J	0.97	0.93	0.89	0.85	0.80

12/0.93=12.9!

- E²V Sizing-

Example 2

Refrigerant: R404a

Capacity: 3.5kW

Nominal evaporating: -40°C

Nominal condensing: 50°C down to 20°C

Necessary data

Facultative data

SBC: 10°C

Pressure drop before EEV from compressor discharge to EEV inlet: 0.5bar

Pressure drop after EEV from EEV outlet to compressor suction: 1bar

	Te = -40 °C						Correction for soobcooling		
Tc	E²V-09	E²V-11	E²V-14	E²V-18	E²V-24	E²V-30	$K_{5°C}$	$K_{10°C}$	$K_{15°C}$
20	2.2	3.2	5.0	8.2	14.2	21.9	1.00	1.17	1.26
24	2.2	3.2	5.0	8.1	14.1	21.7	1.00	1.19	1.28
28	2.2	3.1	4.9	8.0	13.9	21.4	1.00	1.20	1.30
32	2.1	3.0	4.8	7.8	13.5	20.9	1.00	1.22	1.33
36	2.0	2.9	4.6	7.5	13.1	20.1	1.00	1.24	1.36
40	1.9	2.8	4.4	7.2	12.5	19.2	1.00	1.27	1.40
44	1.8	2.6	4.1	6.7	11.7	18.0	1.00	1.31	1.46
48	1.7	2.4	3.8	6.2	10.8	16.6	1.00	1.36	1.53
52	1.5	2.2	3.4	5.5	9.6	14.8	1.00	1.43	1.64
56	1.3	1.9	2.9	4.8	8.3	12.8	1.00	1.55	1.80
60	1.0	1.5	2.4	3.8	6.7	10.3	1.00	1.73	2.08

Bar	0.5	1.0	1.5	2.0	2.5
J	0.97	0.93	0.89	0.85	0.80

- E²V Sizing-

Example 3

Refrigerant: R407c

Capacity: 20kW

Nominal evaporating: 0°C

Nominal condensing: 58°C down to 23°C

Necessary data

Facultative data

SBC: 5°C

Pressure drop before EEV from compressor discharge to EEV inlet: 0.2bar

Pressure drop after EEV from EEV outlet to compressor suction: 0.3bar

	Te = 0 °C						Correction for soobcooling		
Tc	E²V-09	E²V-11	E²V-14	E²V-18	E²V-24	E²V-30	$K_{5°C}$	$K_{10°C}$	$K_{15°C}$
20	-	-	-	-	-	-	-	-	-
24	2.7	4.0	6.2	10.1	17.6	27.1	1.00	1.11	1.17
28	2.9	4.3	6.7	10.9	18.9	29.2	1.00	1.12	1.17
32	3.1	4.5	7.1	11.5	20.0	30.9	1.00	1.12	1.18
36	3.2	4.7	7.4	12.0	20.9	32.2	1.00	1.13	1.19
40	3.3	4.9	7.6	12.4	21.6	33.3	1.00	1.13	1.20
44	3.4	5.0	7.8	12.7	22.1	34.0	1.00	1.14	1.21
48	3.5	5.0	7.9	12.8	22.4	34.5	1.00	1.15	1.23
52	3.5	5.1	7.9	12.9	22.4	34.6	1.00	1.17	1.25
56	3.5	5.0	7.9	12.8	22.3	34.4	1.00	1.18	1.27
60	3.4	4.9	7.8	12.6	22.0	33.8	1.00	1.20	1.29

Bar	0.5	1.0	1.5	2.0	2.5
J	0.97	0.93	0.89	0.85	0.80

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