Invotech Application Instructions

for HFC YF135 ~ YF200

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1.Safety

1.1 Safety statements

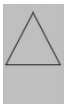
Invotech Scroll compressors are designed and manufactured according to the latest EU and US Safety Standards. They are dedicated to be installed in machines according to EU machine Directive 2006/42/EC. The compressors are in accordance with EU Low Voltage Directive 2014/35/EU and EU pressure Equipment Directive 2014/68/EU.

You are strongly advised to follow Invotech instructions which should be retained through the whole lifetime of compressor. Meanwhile other local safety rules or standard should be obeyed as well.

1.2 Safety references

In order to prevent hazards, safety reference must be strict observed. Explanation of reference icons as below:

Attention!
Instructions on preventing possible damage to equipment.



Caution!
Instructions on preventing possible minor or moderate hazard to persons.

Warning!
Instructions on preventing possible severe hazard to persons.

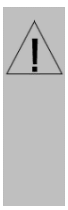
Danger!
Instructions on preventing immediate risk of serious hazard to persons.

1.3 Safety Instructions

Refrigerant compressor are only permitted to use in dedicated application, and need be caution .

All work related to compressors and refrigerant system shall be carried out only by authorized personnel which has been trained and qualified.

General instructions below against electrical shock, pressure system and burn hazards.



ELECTRICAL SHOCK HAZARD

- Turn off and disconnect power before manual operation.
- Discharge all capacitors before servicing.
- Use compressor with grounded system only.
  Strictly refer to original wiring diagrams.

PRESSURE SYSTEM HAZARD

- Safety equipment must be used due to oil and refrigerant inside system is under pressure.
- Remove refrigerant from both high and low pressure side before removing compressor.
- Use appropriate back up wrenches on shut-off valves when servicing.
- Never leave system unattended when it has no charge, a holding charge or with the service valves closed without electrical locking out.
- Use approved refrigerants and oils.

BURN HAZARD

- Do not touch compressor before it cooled down.
- Ensure components (calbe,damper, tie,etc) not touch onto high temperature areas of the compressor.
- Use caution mark during and after brazing period, in case of other people touch high temperature areas.
- Personal safety equipment must be used.

2.Instruction

Invotech YF compressors are special designed for low temperature applications, such as cold room, environmental test chamber, refrigeration display cabinet and frozen cave, etc. Along with special design of scroll, dynamic discharge valve, injection system, etc, YF compressors have very good capacity and high efficiency at low temperature condions.

2.1 Nomenclature

You can read Invotech compressor model name as Figure 1. Each letter has its own meaning which defines application, capacity at ARI rating condition (YF for evaporating / condensing temperature : -31.7/40.6℃ or -25/105℉), refrigerant and oil type, voltage & frequency, tube process type and so on.

Depending on housing diameter, Invotech compressors are divided into different platforms (3HP,5HP,10HP,30HP,50HP).We mainly focus on 30HP platform in this article.

30HP platform include model YF135~200 E** for HFC/HCFC fixed speed.

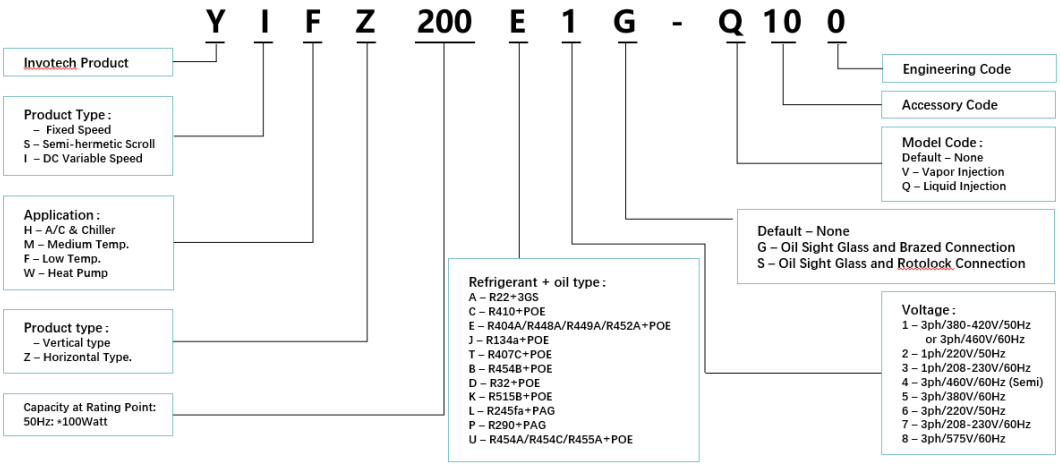


Figure 1 Nomenclature

2.2 Operation envelop

YF compressor can be used with R22, R404A and other refrigerants depending on model selected and lubricant used, and you can find operation envelop in datasheets, figure 2 as reference. Please check with Invotech application engineer if any question about suitable refrigerants.

! You must ensure compressor operate within permitted envelop.

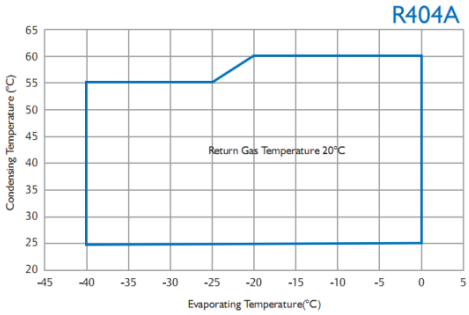


Figure 2a Envelop for R404A

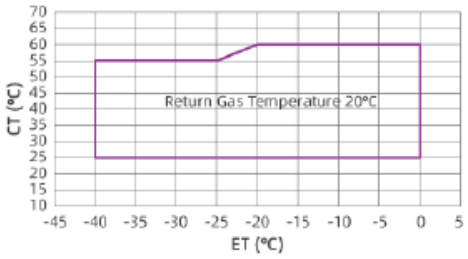


Figure 2b Envelop for R448A/R449A/R452A

3.Mounting/Installation

3.1 Compressor transport

Invotech compressors are packaged and transferred on pallet, which settled inside groove like cardboard shape. And please ensure compressor vertical for long way transportation, such as high-way, by train or by sea.

3.2 Compressor installation

Install compressor horizontally and stable by using Invotech grommet and sleeve.

! Maximum 15°inclination is permitted.

The recommended torque to tighten the mounting kits is 13±1N.m.

For outdoor installation, please take suitable measurements to protect compressor against low ambient temperature or corrosion (like seawater or aggressive atmosphere).

! Finish pipe welding asap after remove suction and discharge plug, to prevent moisture go into refrigerant system.

Scroll compressors are provided with either braze connections or rotalock adapters depending on the nomenclature selected.

Invotech scroll compressor choose different kinds of oil, to fit for varies of refrigerant. Polyol ester lubricant is provided with HFC and A2L refrigerants, mineral oil is intended with R22, PAG oil is cooperate with flammable refrigerant (A3 class).Suggest to use lubrication oil permitted by Invotech, which has already been verified.

Gloves, eye protection and other protective equipment is necessary, to prevent hazard from oil.

Don't let POE oil contact with surface or material which might be harmed by POE, including without limitation, certain polymers (e.g. PVC/CPVC and polycarbonate).

The compressor has already charged oil before delivery. You should add more oil if pipe line is too long (usually over 20m), you can refer to figure 3 recharge oil reference, judge and make correct decision according to actual system design.

Liquid Pipe OD (inch/mm)	Recharge amount (mL/m)
1/2' / F12.7	10
5/8' / F15.88	20
3/4' / F19	30
7/8' / F22	40
1' / F25.4	50

Figure 3 Recharge oil reference

Invotech Scroll compressors may be used at multiple compressor parallel rack application, which requires an oil management system to maintain proper oil level in each compressor. The sight glass connection can accommodate the oil control devices.

Unlike reciprocating compressors, scroll compressors do not have oil pump along with oil pressure safety control. Therefore an external oil level control is required.

3.3 Pipe layout

You should keep pipe unit clean and dry, bending should be designed as less as possible.

Suggest to add support for long straight pipes, in order to reduce vibration and resonance noise, figure 4 is for reference.

Pipe OD (mm)	Distance between supports (cm)
12.7	120
16	150
22	185
28.5	220

Figure 4 pipe support suggestion

Compressor should remain power off until finish all welding.
Keep pipes stress free when brazing.

Pipes closed to compressor should incline a little, to ensure refrigerant flow towards correct direction: outlet from discharge or inlet from suction side.

Consideration must be given to sound reduction and tubing reliability. Some tubing geometry or "shock loops" may be useful to reduce vibration transferred from compressor to external tubing.

The tubes should be "flexibility" enough to allow normal compressor start and stall without over stress on the tube joints. It is desirable to design tubing with its natural frequency away from compressor frequency, to prevent resonance and tube damage. Figure 5 shows an example of acceptable tubing configuration.

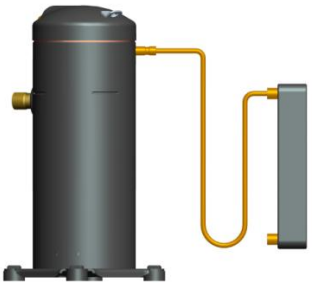


Figure 5(a) Typical line arrangement

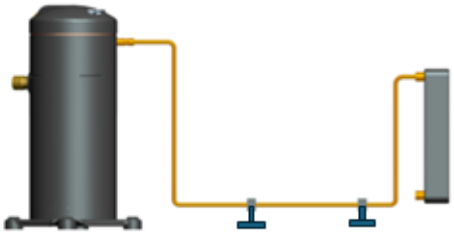


Figure 5(b) Typical line arrangement

When pipe is vertical like figure 6, with refrigerant flow from bottom to top,(such as suction line), you should add U bending every 5 meters, to ensure oil can flow back to compressor and avoid mechanical components wearing due to lack of oil.

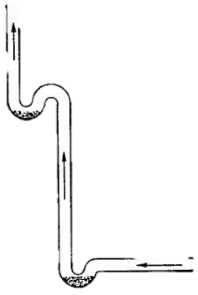


Figure 6 U bendings vertically

Don't overheat valves, switch and thermostat, etc. Suggest to cover them by wet cloth when welding.
Braze piping with nitrogen gas flow.
Don't braze joint area too long time.
Max. brazing temperature 700℃

3.4 Components

3.4.1 Accumulator

Due to the inherent ability of involute design, Invotech scroll compressors are able to handle liquid refrigerant flood back and defrost condition, therefore accumulators may not be required.

But an accumulator is required when facing a single compressor with much charging, or a system with defrost schemes or transient operations that allow prolonged and uncontrolled liquid return back to compressor.

Besides of preventing liquid refrigerant flood back, accumulator should also ensure oil back to compressor normally, but not stored inside. So the size of oil return holes should be considered.

Suggest 2mm hole for 20-25HP compressor.
Don't use too small filter mesh, no finer than 30 meshes.

3.4.2 Filter dryer

Refrigerant system is easy to be polluted by moisture or other dirty bits, so filter dryer is necessary, especially before capillary tube or expansion valve, to avoid ice or dirty block and lead to compressor defect.

Don't insert tube too deep, in case of mesh inside damaged.
45° above or vertical installation to ensure liquid refrigerant out from dryer.

3.4.3 Dampers

You can add some dampers or other heavy parts onto long direct pipe, to reduce vibration and resonance noise. But sufficient verification test is necessary to ensure dampers are useful, please don't add them arbitrarily.

4.Electrical connection

4.1 General recommendation

Invotech Scroll compressors and related electrical devices / accessories are in accordance with the Low Voltage Directive 14/35/EU. We have IP54 cover as standard accessory for 30HP platform, you can also request IP67 cover if safety needed.

You should finish electrical connection strictly according to the wiring diagram in the terminal box. Follow the safety standard EN 60204, EN 60335 and other local safety regulations.

Power leakage will cause serious human injure.
Pay special attention to flammable refrigerant application.

Danger of short circuit caused by condensing water in terminal box!
Use reliable standard cable bushing only and ensure proper sealing.

Supply power as name plate, correct voltage and frequency are mandatory.

4.2 High voltage test

Invotech Scroll compressors have already submitted to high voltage (Hi-pot) test in the factory according to EN60034-1 or UL987 with UL version. Invotech standard is 2000V AC 1s under 50 or 60Hz, leakage current ≤5mA.Since motor will be damaged if often test under high voltage, you are suggested to verify below 2000V on production line or onsite testing.

Danger of insulation damage and motor burn-out.
Don't repeat hi-pot test in same way!

4.3 Three-phase rotate direction

Scroll compressor are rotation directional dependent, they can only compress in one rotational direction. On single phase compressor, there is no difference when mis-connect "L" and "N" wire, but three phase scrolls will rotate in either direction depending on the phase sequence of power supplied. So 50% chance of wrong connection. Contractors should be warned of this. Appropriate instructions or notices should be provided by the Original Equipment Manufacturer.

If reversed rotation happened, the compressor would be very noisy and no suction and discharge pressure difference, current draw is substantially reduced compared with tabulated values. Then you should choose either 2 pin and exchange connection.

4.4 Protection devices

The compressors and refrigerant system are equipped with various of protection devices. You should realize and use correct settings to ensure reliable system operation.

4.4.1 Motor protector

YF 30HP compressors have external motor protectors, which could cut-off motor when motor temperature or current is high. You can get detail protection value from datasheets or contact

Invotech application engineer.

4.4.2 IPR valve

All Invotech three phase scroll compressors have internal pressure relief valves, which will open when the pressure gap between discharge and suction is high (figure 7).

Refrigerant	Pressure Gap
R404A/R448A/ R449A/R452A	2.76-3.10 MPa

Figure 7 IPR Pressure Gap

If the IPR valve is active, hot gas in discharge shell will flow into suction side, and motor protector will be tripped from circuit. Meanwhile there will bring whistler noise as well, which is normal and no damage to compressors.

IPR valve are only exist in three phase compressors. There is no IPR valves for single phase compressors,.

4.4.3 Discharge temperature protector

Discharge temperature protector is suggested for refrigeration system. Its cut out temperature setting should be lower than 125℃. The temperature sensor should be installed about 150mm away from to the discharge port and should be insulated well.

! If protector automatic reset more than 5 times per hour, you should lock system and find root cause.

4.4.4 Pressure Limiters (HP & LP)

Both high and low pressure switches are recommended, to protect compressor and other system component from inadmissible operation conditions.

According to different series of compressor used in different application , suggested cut-out setting points (Unit: PSIG) as below Figure 8:

Control Type	R404A	R448A/ R449A	R452A
Low (min)	0	-3	-1
High (max)	430	400	430

Figure 8 Pressure Switch setpoint (PSIG)

4.4.5 DTC valve

Invotech YF**** Q/ V*** compressor can provide liquid or vapor injection function, which could increase capacity and COP. The basic logic is as figure 9 and 10.

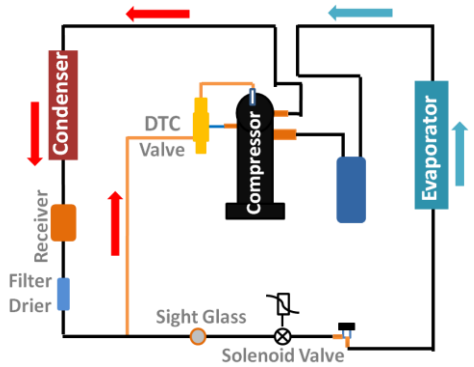


Figure 9 Liquid injection

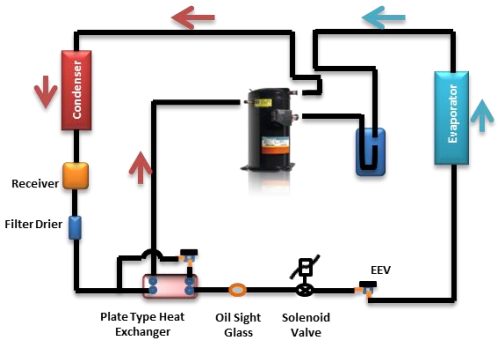


Figure 10 Vapor injection

YF**Q*** compressors are delivered with a TXV type valve to realize liquid injection. This special type of TXV valve is called DTC valve, like yellow in figure 9.The valve will open when discharge temperature reached setting point (90℃ as default) ,considering the influence of ambient temperature and sensing deviation, the actual operation temperature may be varied in a small range.

The valve sensor must be installed in the well on top cap to adequately control scroll discharge temperature. And the valve should be tightened on the injection fitting with a torque of 25 - 28 N·m. A 90° orientation of valve is recommended, even though it will operate properly in any orientation. The capillary tube connecting the valve with sensor should be positioned well, which would not contact compressor shell during operation. Do not bend the capillary tube within 30mm at both ends.

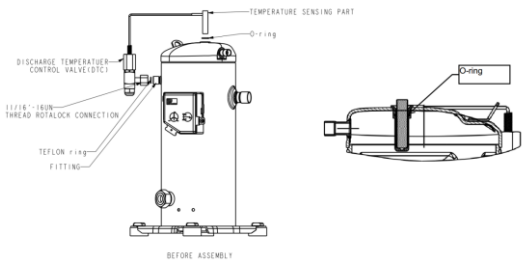


Figure 11 DTC installation Sketch

4.4.6 Crankcase heater

Crankcase heater is suggested to be installed on bottom of compressors for refrigeration applications. Suggested crankcase heater selection as figure 12.

Compressor	Max. Ref. Charge	Heater Power
13-15HP	7.5kg	90W
20-25HP	13kg	120W

Figure 12 Crankcase Heater power

Crankcase heater should be powered on 12 hours before the initial start or restart after long time off duration, to avoid refrigerant migration.

5.Commisioning

5.1 Vacuuming

Before vacuuming, you should ensure system dry and clean, test for leaks by detector or foaming, and under pressure with holding charge (N2) for 12h above.

Never do pressure test by using Oxygen or other industrial gas

Don't add refrigerant regarding as leakage test gas.
Never vacuum system by using compressors.

Vacuum from both high and low pressure sides at same time, ensure all valves are open. Suggest to vacuum until 30 Pa (500μm Hg) below.

If vacuum is not sufficient, system will show high discharge temperature and condensing pressure in future.

5.2 Charging

Only approved refrigerant is permitted to charge into compressor. Check oil level before charging. Low side charging port should be located between evaporator and accumulator, it is preferred between expansion valve and evaporator.

Use scale to ensure exact charging amount. A liquid drier is recommended to connect between refrigerant cylinder and manifold to prevent moisture into system. You should invert refrigerant tank upside down, to ensure liquid refrigerant charged into system. Charge from both high and low pressure sides of system. Power on compressor and charge from suction side is only permitted after 70% amount has been charged inside compressor.

Never power on when compressor is under vacuum state.
High voltage test is strictly prohibited before charging.

If charge too much:

Danger of wet operation, liquid flood back and cause inadequate lubrication and bearing wear, finally compressor will be damaged.
If high voltage test with liquid inside compressor, it will show high leakage current.
Explosion risk of components and pipelines by hydraulic over pressure.

If charge insufficient:

System will show low suction pressure and high superheat. (observe operating limits)

5.3 Check before starting

You should check and ensure all settings of system are correct before starting compressor.

Check list as below reference:

- Safety issue around system.
- Clean around unit, ventilation is good
- Supplied voltage and frequency.
- Wire connection, no rotate direction issue for three-phase.
- External oil cycle. Already recharge oil or not?
- Settings and function of safety and protection devices.
- Settings of time relays
- Settings of high and low pressure switch
- Status of valves, open or close?
- Oil temperature or shell temperature, avoid refrigerant migration
- Cross contact between pipe-pipe or cable-pipe, vibration noise?
- Pump down system (especially if evaporator is warmer than suction line)
- Thermal couple suitable or not?

5.4 Data recorder

Now it's time for you to qualify the compressor and system. You are appreciated to record below data, which would be helpful to evaluate compressor and analyse system, so that you can make a decision about how to optimize system for further step:

- Evaporating pressure / temperature.
- Condensing pressure / temperature.
- Discharge temperature.
- Suction temperature
- Evaporator in/mid/out temperature
- Condenser in/mid/out temperature
- Compressor temperature.
- Superheat
- Subcooling
- Bypass (EVI) temperature
- Wind inlet/outlet temperature
- Ambient and actual sensor temperature
- Setting temperature
- Defrost settings
- Current data
- Input voltage and frequency
- Power consumption
- Oil level

! 3 minutes time delay is suggested to prevent frequent start/stop.
10 minutes at least for one continuous operation cycle
A low-pressure controller is required for protection against vacuum operation.
Avoid liquid flood back.
Never use compressor to evacuate refrigerant.
Lowest suction pressure test is prohibited, due to no suction valve inside compressor and it will lead to damage.

6.Operation/Maintenance

6.1 Regular checklist

Examine regularly in the field according to national standard or regulations when facing unexpected status. The following points should also be checked.

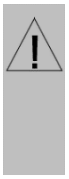
- Check compressor housing cleaness and corrosion
- Analysis operation data (chapter 5.4)
- Check protection devices status
- Update protocol
- Check cable connection
- Check color of oil.
- Check refrigerant amount, tightness test

You can judge root cause according to detail failure mode, if any questions, please refer to Invotech trouble shooting guidebook or contact Invotech application engineer.

6.2 Remove Compressor

If compressor failure is confirmed, and you should change a new compressor, please follow below steps to remove a compressor:

1. Cut off power supply, remove power cable and put safety mark accordingly.
2. Release all refrigerant from both high and low sides .
3. Check high and low pressure via pressure gauge to make sure no pressure in system.
4. Cut tube near compressor suction and discharge side, instead of weld out soldering port.
5. Remove mounting screws from base plate, and take out compressor, a hoisting tool is needed if possible.


Compressor is under pressure, severe injuries possible.
Release all refrigerant before welding, avoid refrigerant contact with fire, especially for flammable refrigerant.
Wear safety goggles!

If a compressor is failed, It is recommended to replace DTC valve and filter dryer together.

6.3 Reconnect Compressor

When a new compressor is willing to be installed ,you should follow below rules:

- Recommended brazing materials - Silfos with minimum 5% silver or silver braze material with flux.
- Round off the tube after cutting or soldering, and reinsert tubing fitting.
- Heat tube uniformly around copper tube, move slowly to the joint area. Apply solder when joint reaches brazing temperature.
- Heat joint uniformly circumferentially to let solder flow completely around the joint.
- Slowly move torch in fitting to draw braze material into the joint.
- Tightness test again, and vacuum and recharge.
- Power on compressor again for operation.


Wear goggles!
Don't overheat joint.
Don't let fire contact other components, especially for some flammable materials.

6.4 Dispose Compressor

The removed compressor and waste oil should be disposed properly. If you need further tear down and analysis of compressor, please seal the compressor to prevent moisture into, try to investigate and record failure mode as detail as possible (refer to Appendix - Faulty Compressor Information), so that you or Invotech engineer can analyse towards correct direction and find out root cause.

7. Acknowledgment

Thanks very much for using Invotech compressors, we are always your reliable backup and support, not only for compressor but also refrigerant system applications.

Welcome to visit and find technical literature on our website (https://invotech.cn). Any question need our support, please feel free to contact related application engineer or sales manager, we'll try our best to support you!

Appendix

Faulty Compressor Information

Date:

Feedback Provider		Contact Name		Contact Number	
Compressor User		Contact Name		Contact Number	
Installation Company		Date of Starting use		Date of Claim	
Filed Address					
Compressor Model		Serial No.		Refrigerant	
Application selection	Cold Room / Showcase / Industrial Cooling / Heat Pump / AC / Chiller / Refrigeration Dryer / Others				

Failure Mode:

Stuck		Starting failure		Frequent on/off	
Noisy/Vibration		Reverse Rotation Noise when stop		Leakage	
Capacity Low		Preesure Abnormal		Current High	
Motor Burnt		Low Insulation Resistance		Short Circuit to Ground	

Onsite Investigation:

Recharge Oil Type			Winding UV/CR Resistance		Ohm	Cold Room / Cabinet Temp.		℃
Recharge Oil Amount		Kg	Winding UW/CS Resistance		Ohm	Cold Room / Cabinet Size		m^3
Pump Down or not?			Winding VW/RS Resistance		Ohm	Have Oil Separator?		
First Failure or not?			Discharge Pressure		Bar	Have Accumulator?		
First Failure Date			Suction Pressure		Bar	Fan Evaporator?		
Last Sevice Date						Coil Evaporator?		

Other Description :

Faulty Compressor Information Investigation

Appendix

30HP external protector kit