BLUE STAR

New High Efficiency Configured Series Air Cooled Screw Chiller

It has everything you look for in a Chiller:
Customisation; High Efficiency; Eco-friendly; Low Noise

AHRI CERTIFIED™
www.ahridirectory.org
Air-Cooled Chillers
AHRI Standard 550/590

DESIGNED FOR ENERGY EFFICIENCY STANDARD

ASHRAE 90.1 COMPLIANT

ECBC Compliant

User's Manual

First published July 2017.

Since ASHRAE standards use the FPS system, FPS nomenclature
is used in some places in this publication for convenient reference.

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BLUE STAR

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Introduction

Blue Star has been a pioneer in developing and manufacturing chillers for various applications.

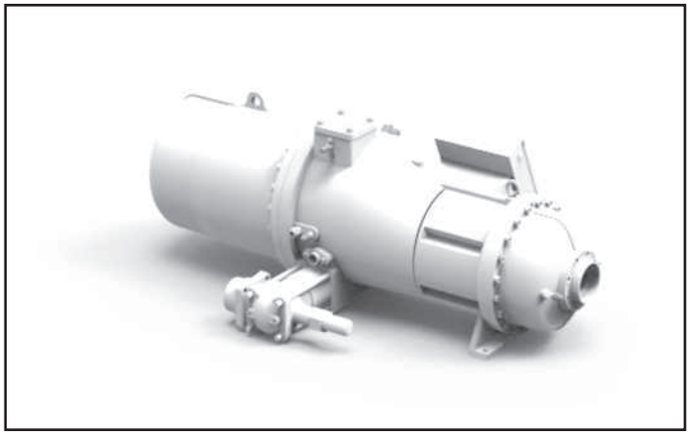
A new generation of air cooled screw chillers, flooded type with R134a refrigerant, is being added to the present range of air cooled screw chillers of R134a (DX) air cooled and water cooled screw chillers R22 (DX).

The chillers are energy-efficient and robust in construction. They are developed with state-of-the-art technology components. The chillers are fitted with R134a optimised Hanbell series semi-hermetic screw compressors, high-efficiency DX coolers and air cooled condensers. The latest generation highly efficient copper tubes are incorporated in the coolers. Electronic expansion valves and the new generation MCS Magnum controller lead to precise control of refrigerant flow and chilled water temperature. Specially developed low-noise bird-wing design fans are used for optimum airflow.

Acoustic enclosure for compressor can be offered as an optional feature to reduce noise level. Special coatings on aluminium condenser fins can also be offered for better corrosion resistance required in coastal/industrial environment.

Compressor

Compressor



Screw compressor has advantages compared to other compressors, due to its inherent design features. The compressor has only two moving parts, viz. male and female screws and slide valve. The wear and tear is thus minimum and the life of the compressor is higher. Due to its inherent characteristics, screw compressor has the highest volumetric efficiency; the derating at higher temperature is negligible.

It has stepless capacity control, usually from 35% to 100%. This feature makes it ideally suitable for varying load applications, and has better efficiency under part load conditions (condensers and evaporators are designed for 100% capacity). This capacity control also helps in limiting the starting current as the system can be started in unloaded condition (35%), and the loading is done stepless.

The screw compressor is semi-hermetic in construction, which makes it serviceable. Due to geometrically symmetrical moving parts, the compressor has extremely low vibrations. The compressor is tested in accordance with ARI standards.

Air Cooled Condenser Coils

The shell and tube evaporator has been built using imported doubly enhanced and highly efficient finned copper tubes of 19mm dia, and has been optimised for refrigerant and water velocities. The shell is manufactured from high-grade steel. The expansion of the tube is done with torque-controlled process. The cooler is fitted with refrigerant level central, sight glass and oil recovery system.

Cooler (Flooded)

The shell and tube evaporator has been built using imported doubly enhanced highly efficient inner grooved copper tubes of 19mm dia and has been optimised for refrigerant and water velocities. The shell is manufactured from high-grade steel. The expansion of the tube is done with torque controlled process. The cooler is fitted with refrigerant level central, sight glass and oil recovery system.

Oil Separator

An external oil separator is installed in the compressor discharge line to separate oil from the refrigerant. This is specially designed for low velocity of refrigerant and has demister pads for effective oil separation. This has integral oil reservoir at the bottom. Oil level switch is incorporated for the safe operation of compressor in case of fall in oil level below acceptable limit. The oil flowback to the compressor is due to differential pressure. A solenoid valve provided in the oil return line energises along with the start of compressor. The oil flow switch provided in the line as an additional safety trips the compressor in case of stoppage of oil return. Majority of the oil is recovered back whereas minute quantity of oil can travel along with refrigerant further to the system.

Oil Recovery System

In the flooded cooler, the liquid refrigerant boils in the shell and the refrigerant vapour is sucked into the compressor at low velocity. While the refrigerant boils to become vapour, the minute quantity of oil which

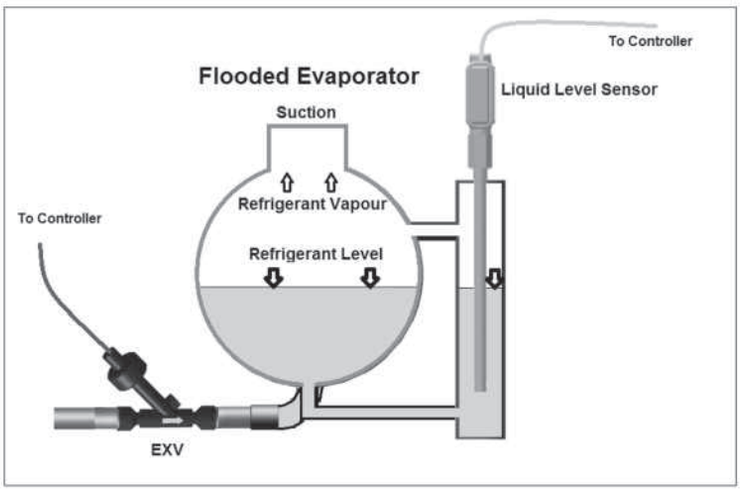
was mixed with the refrigerant can remain in the cooler which also needs to be recovered back to the compressor.

This is accomplished by the application of induced flow of oil return by providing an eductor. The eductor has three connections. One end of the eductor is connected to the condenser top at the shell side to permit flow of hot gas through the eductor, the second to the various tapping from the cooler, and the third back to the compressor.

The principal of operation of the eductor is the conversion of static to dynamic head, allowing a lower static pressure to induce flow from a cooler that is lower than the motive flow source (high pressure gas), but higher in pressure than the exit (evaporator).

Refrigerant Level Controller

Level transducer probe is installed to detect the refrigerant level in the flooded cooler to maintain the liquid refrigerant level in the cooler to the desired level. A separate vertical level column arrangement is made comprising of liquid sight glasses. The bottom and top portions of the above are connected across the cooler shell to indicate the level of refrigerant. The transducer probe is fitted at the top of this level column. The level transducer probe is normally supplied as factory pre-calibrated and tested for a specific refrigerant. The signal from the level controller through MCS Magnum enables the electronic expansion valve to maintain the desired refrigerant level in the cooler.



Fans

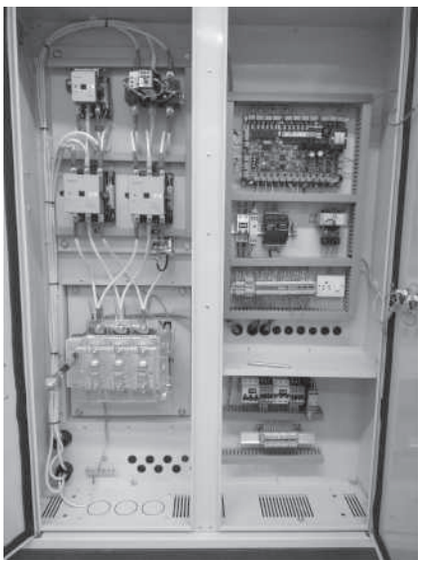
The chiller is fitted with 5-lobe, bird-wing design fans. The profile of bird-wing design fans has been arrived at, after carrying out extensive trials of airflow and noise level in Blue Star's test laboratory. This profile optimises both the noise level and power consumption against the required airflow and static pressure.

Electronic expansion valve

The screw chiller is fitted with an electronic expansion valve with its drivers, as an integral part of the MCS Magnum control panel. The algorithm is built to ensure the most appropriate operation of the expansion valve motor. This system adjusts the opening of the valve with shorter response time, against varying load conditions, resulting in optimising of power. Coupled with the stepless capacity control which is a feature of the screw compressor, the electronic expansion valve will maximise power savings.

The electronic expansion valve operates on a principle of opening and closing of valves through a stepper motor, which has 3810 steps per revolution. The signal for the stepper motor is received through the MCS Magnum control panel. Electronic expansion valves thus have advantage over normal thermostatic expansion valves, which have slower response for the changing conditions. The electronic expansion valve adjusts itself based on suction superheat and monitors the flow of refrigerant quickly and accurately, as compared to thermostatic expansion valve. This inherent feature allows the system to operate in a very narrow band of superheat, resulting in power saving.

Control Panel

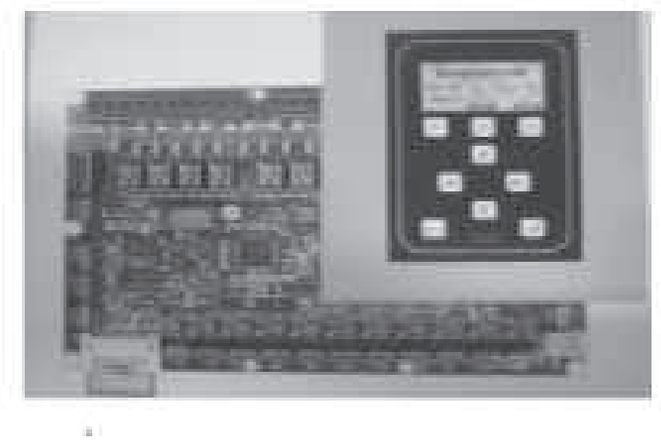


The control panel has been designed and mounted on to the chiller framework at the end. Microcontrol panel MCS Magnum, the power section and the termination sections are clearly separated out for ease of installation and servicing.

Magnum Controller

The MCS Magnum controller is a proven microprocessor-based controller designed for the hostile environment of the HVAC/R industry.

The Magnum provides flexibility with setpoints and control options that can be selected prior to commissioning a system or when the unit is live and functioning. Displays, alarms and other interfaces are accomplished in a clear and simple language that informs the user as to the status of the controller.



The MCS Magnum contains a master microcontroller along with a keypad and display. Complementing the Magnum microcontroller are MCS-I/O, MCS-RO8 and MCS-S16 expansion boards. This allows for system expansion to a maximum of 48 inputs and 48 outputs. Communication to these units occurs at 38,400 baud rate over the MCS-I/O port, which is dedicated for this purpose.

A RS-485 port is provided for communication with systems manufactured by other companies. Additionally, a built-in RS-485 to RS-232 converter allows communication over the RS-485 port via RS-232 port. An MCS portal is also available (optional) that allows communication via BACnet, Johnson N2, Automated Logic, LonWorks or the available data format to allow the user to communicate directly. In the case of Modbus, no separate MCS portal is required.

A complete software support package is available for the PC that allows system configuration, dynamic on-line display screens, remote communication, graphing and more. Temperature setting and control is in the range of ± 0.5°F. Microcontrol panel has stepless capacity control from 17.5% to 100%, non-volatile memory backup for all setpoints, automatic power failure reset, built-in time delays for compressors and condenser fans, single phase/phase reversal protection, password protection at 4 levels and in-built antifreeze and flow switch safety.

Microcontrol panel is provided with RS-232 port for direct remote computer connectivity (up to 50 feet), fault indication and status facility and RS-485 connection (up to 6000 ft). PC connection program provides both local and remote communication to microcontrol panel. The microcontrol panel automatically performs history logging and this program will graph the selected items.

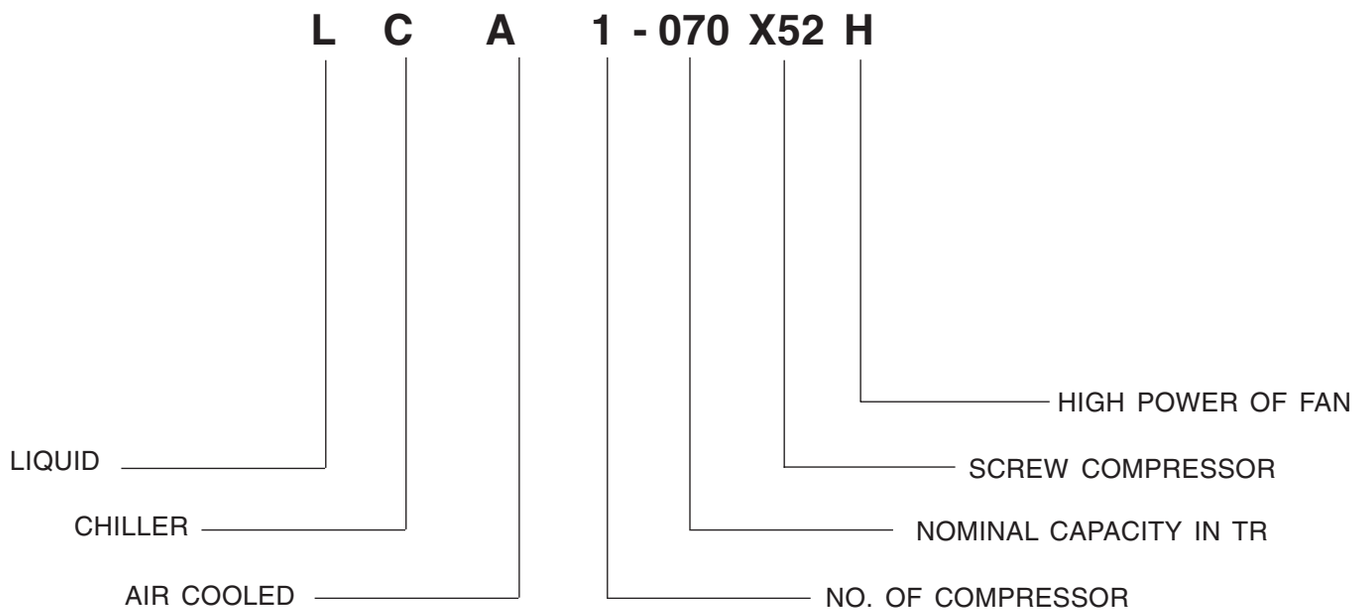
Microcontrol panel has remote monitoring and access through PC with modem and dedicated telephone line without BMS as a standard feature through RS-232 and RS-485 (PC, modem gateway for units are optional and not in the scope). Also, remote monitoring can be done with a web monitor connected to the panel and further to customer's LAN.

Two Levels of Safety

The chiller is protected with primary and secondary safety systems. This has been done to protect the chiller even in the case of failure of any of the protection device. Care has been taken to ensure that no nuisance alarms are generated. The protection device is as tabulated below:

	Primary	Secondary
Single Phasing	SPPR module and compressor motor protector	Current sensing
Reverse Phase Compressor Motor	SPPR module and compressor motor protector	Suction and discharge pressures
Motor Winding Temp.	Motor protector	Current sensing
Discharge Temp.	Compressor PTC sensor	Temperature sensor on discharge line (MCS)
Motor Overload	Current sensing	Overload relay
Starting Current	Star-delta method	Unloaded start by MCS
HP/ LP	Pressure sensors	----
Ref. Migration	Compressor discharge	----
	Check valve	
Lubrication Oil	Oil level switch	----
	Oil pressure difference (MCS)	----
	Crankcase heater	----
Antifreeze	LWT sensor	----
Water Flow	Flow switch interlock for Cooler	----
Sudden Compressor On/Off	Time delay	Anti-cycle cutout 15 min.

Nomenclature



Technical Specifications

New High Efficiency Configured Series Air Cooled Screw Chiller

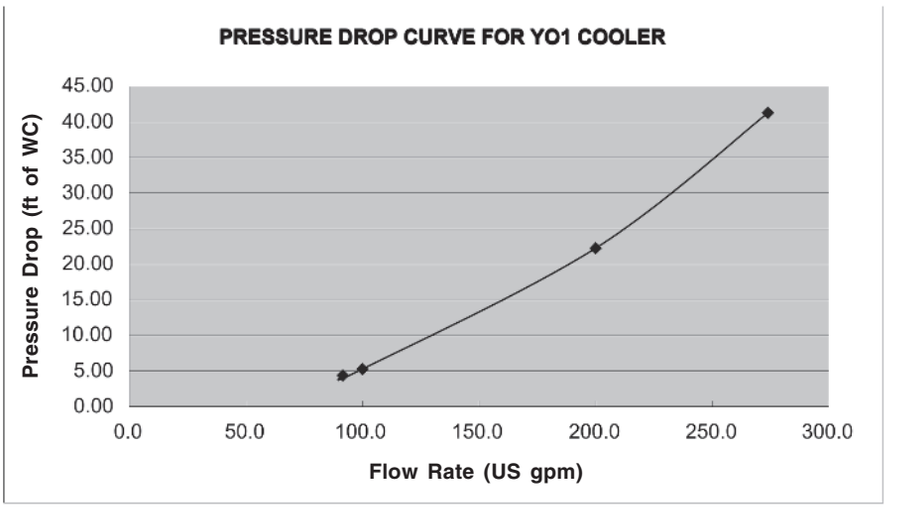
S. No.	Description	Units	LCA1-070X52H
(A)	**Cooling Capacity**	TR	69.00
(B)	**Compressor Model:**		**X52**
1	Quantity	Nos	1
2	Type		Semi-hermetic Screw
3	Motor Type		Refrigerant Cooled, 3-phase, Asynchronous Motor
4	Max. Operating Current for Chiller	A	257
5	Compressor Locked Rotor Current	A	970
6	Starting Current of Chiller	A	331
7	Operating Speed	RPM	2950
8	Oil Charge in Compressor	l/ckt	35
9	Type of Oil		HBR-B04
10	R134a Refrigerant Charge	kg	70
(C)	**Electrical Power Supply:**		415V, 3-phase, 50 Hz
(D)	**Condenser:**		
1	Model		C1
2	Tube Material		3/8" Inner Groove,.Copper
3	Type of Al Fin		Super Slit
4	Face Area	m^2	10.81
5	No of Rows	Nos	3
6	No of Coils		4
(E)	**Condenser Fan Details:**		
1	Quantity of Fans	Nos	4
2	Fan Diameter	mm	915
3	Airflow Quantity	CFM	58000
(F)	**Condenser Fan Motor Details:**		
1	Type		Totally enclosed Pad-mounted
2	Quantity	Nos	4
3	Speed	RPM	915
4	Full Load Current	A	4

Sr No.	Description	Units	LCA1-070X52H
(G)	**Flooded-Cooler**		
1	Model		Y01
2	Tube Type & Material		Both-side finned copper tube
3	Tube Outer Diameter	mm	19.05
4	Shell Inner Diameter	mm	393.6
5	No. of Pass (Water Side)	Nos	4
6	No. of Refrigerant Circuit	Nos	1
7	Copper tube length	mm	1500
(H)	**Expansion Valve**		Electronic Type
(I)	**Overall Dimensions:**		
1	Length	mm	3198
2	Width	mm	2235
3	Height	mm	2432
(J)	**Weight (Approx.):**		
1	Operating Weight (Approx.):	kg	3032

Pressure Drop Curves

COOLER Y01

Flow Rate US gpm	Pressure Drop in ft of H_2O
91.6	4.39
100.0	5.28
200.0	22.28
273.9	41.29



Electronic Expansion Valve

Controlled refrigerant flow over the entire capacity range saves energy and dollars. Cooling loads and condenser water temperatures can change constantly. The chiller is fitted with an electronic expansion valve for the accurate control of flow of refrigerant with the level transducer probe to maintain the desired liquid level in the cooler. The valves modulate by the electronically controlled rotation of a step motor. The step motor drives a gear train and lead screw to position a piston. The piston is used to modulate flow through a port, as referred in the figure. The motor is of two-phase type driven in the bi-polar mode. Two discrete sets of motor stator windings are powered in sequence to rotate the rotor 3.6 degrees per step. Polarity of the drive signal reverses for each step.

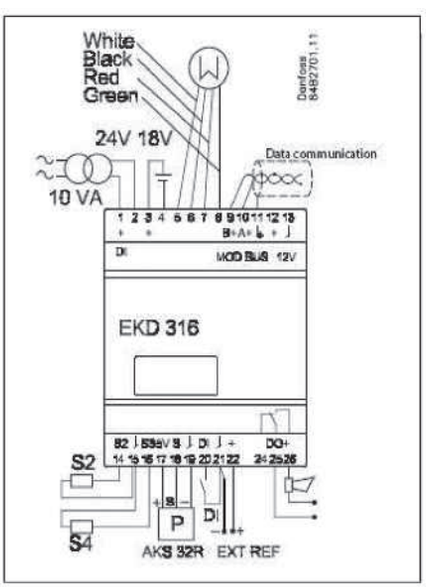
1. The benefits of using electronic expansion valves are:

- Step motor operated for precise control
- High-resolution drive assembly
- Tight seating
- Corrosion-resistant materials used throughout
- Precise positioning for optimal control of liquid injection
- ETS 250 and 400 are designed for HFC/HCFC conditions, providing 34 bar (493 psig) working pressure
- Balanced design providing bi-flow operation as well as solenoid tight shut-off function in both flow directions at MOPD 33 bar (478.6 psig)

2. EXV Driver

The controller and valve can be used where there are requirements for accurate control of superheat and temperature in connection with refrigeration.

This is where the controller receives signals from controller, after which it controls the valve's opening degree. For safety reasons the liquid flow to the evaporator must be cutoff if there is power failure. As the ETS valve is provided with step motor, it will remain open in such a situation. As the battery backup is mounted on chiller, the valve will close in the event of a power cut and safeguard the system.



Connections

Necessary connections

Terminals:

1-2 Supply voltage 24V AC.

3-4 Battery (the voltage will close the ETS valve if the controller loses its supply voltage. *The battery* voltage must be kept disconnected from terminals 1 and 2.

5-8 Supply to step motor.

9-13 Operation via data communication either EKA 164A or system unit + software. It is important that the installation of the data communication cable be done correctly. Cf. separate literature No. RC8AC.

20-21 Switch function for start/stop of regulation. If a switch is not connected, terminals 20 and 21 must be short-circuited.

Application-dependent connections

Superheat control

14-15 Pt 1000 sensor at evaporator outlet (S2)

15-16 Pt 1000 sensor for measuring air temperature (S3)

17-19 Pressure transmitter type AKS 32R (the signal cannot be shared with other controllers)

Control of the valves opening degree with analog signal

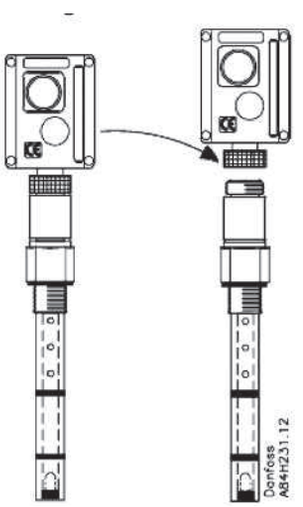
21-22 Current signal or voltage signal from other regulation (Ext. Ref.)

24-25 Alarm relay

There is connection between 24 and 25 in alarm situations and when the controller is dead.

Refrigerant level controller

Level transducer probe is installed to detect the refrigerant level in the flooded cooler to maintain the liquid refrigerant level in the cooler to the desired level. A separate vertical level column arrangement is made comprising of liquid sight glasses. The bottom and top portions of the above are connected across the cooler shell to indicate the level of refrigerant. The transducer probe is fitted at the top of this level column. The level transducer probe is normally supplied factory pre-calibrated and tested for a specific refrigerant. The signal from the level controller through Controller enables electronic expansion valve to maintain the desired refrigerant level in the cooler.

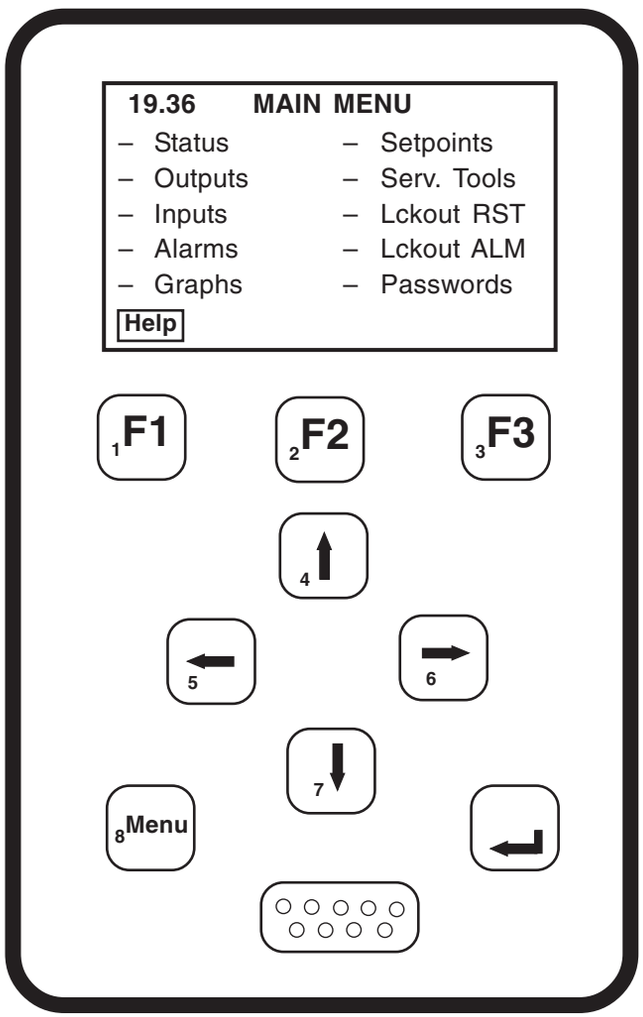


Can be separated without dismantling the standpipe.

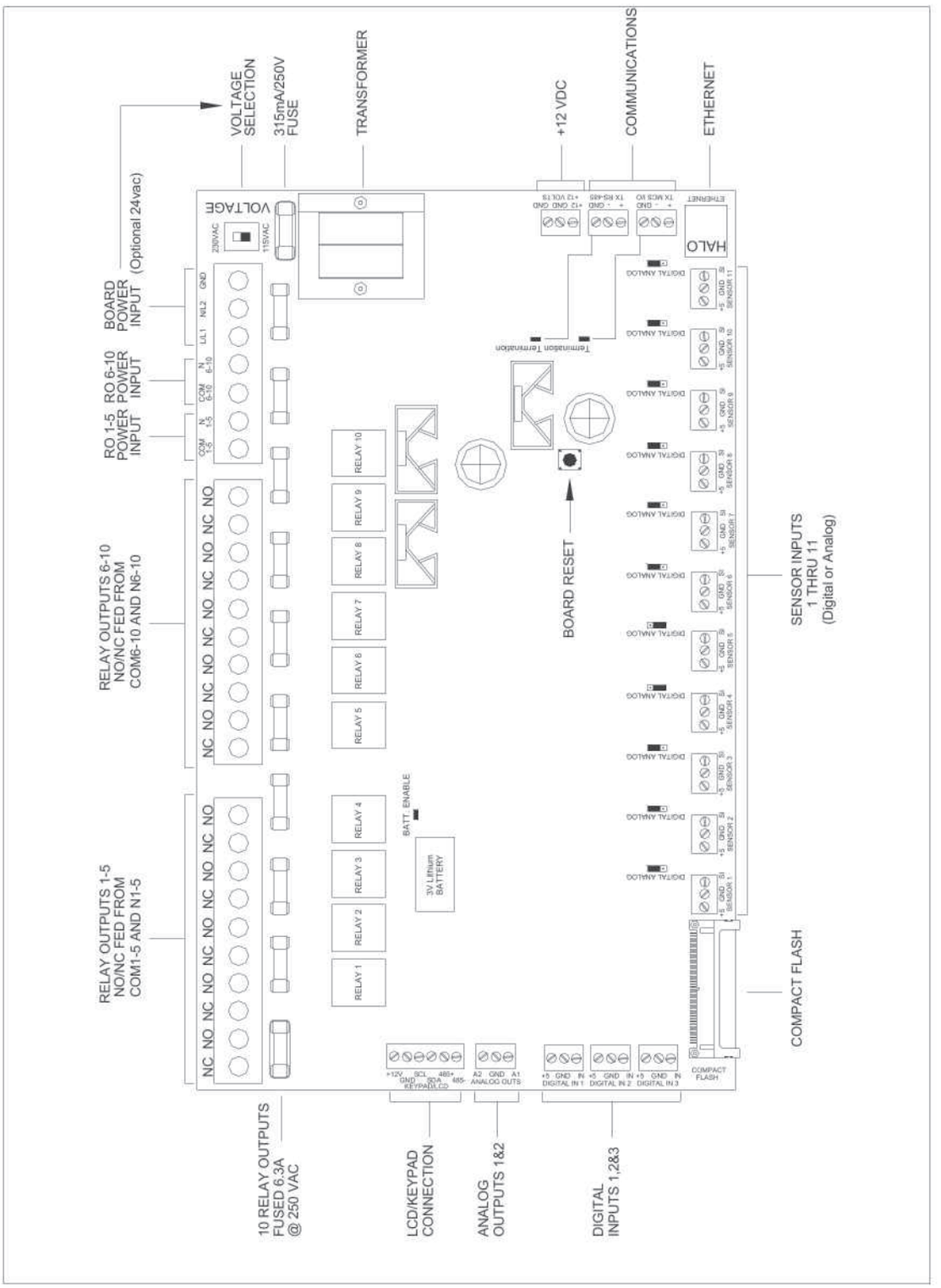
MCS Magnum Controller

The Magnum Keypad Display Quick Reference

- No authorisation is required for displaying information.
- Pressing the 'MENU' key will display the information below.
- Using the ←,↑,→,↓ position the cursor on the item you want.
- Press the ENTER key to display the item
- The bottom line of the display defines the current functions. For passwords use the numbers on the keys. (1 thru 8)
- The RS-232 connector is located at the bottom of the keypad.
- To use PC connection you need to use MCS-PC9 cable.



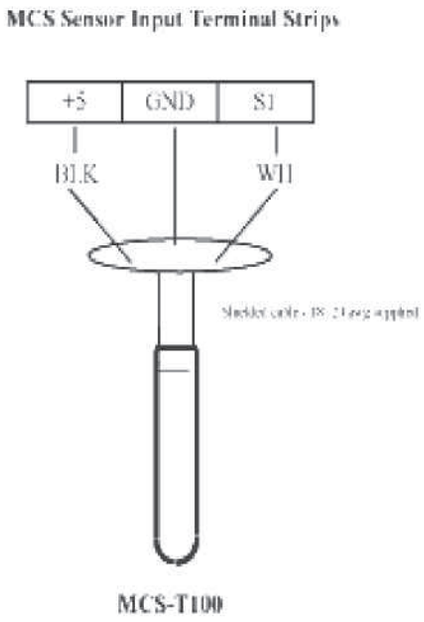
MAGNUM Hardware Quick Reference Sheet



The MCS Sensors Quick Reference Sheet (Temperature & Humidity)

MCS-100 (SI #1 through 11 on Magnum or SI 16)

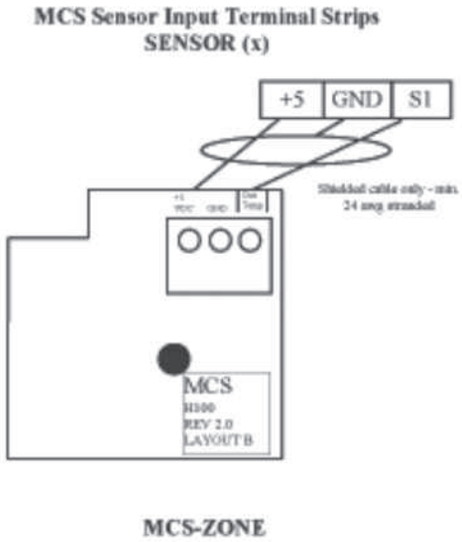
1. Connects to 1 of Magnum Sensor Inputs 1 thru 11 or SI 16
2. Shielded cable GND dran must be connected to SI 'GND'
3. Temp MCS-8 SI (inputs 1-11) jumper setting is ANALOG'



MCS-T100

MCS-ZONE (SI #1 through 11 on Magnum or SI 16)

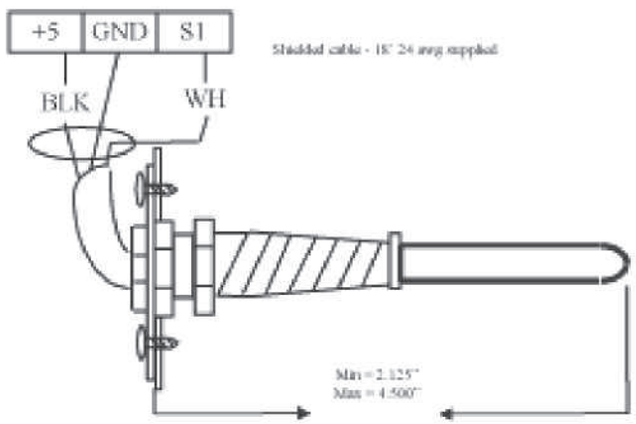
1. Connects to 1 of Magnum Sensor Inputs 1 thru 11 or SI 16
2. Shielded cable GND dran must be connected to SI 'GND'
3. Temp MCS-8 SI (inputs 1-11) jumper setting is ANALOG'



MCS-ZONE

MCS - SAIR (SI #1 through 11 on Magnum or SI 16)

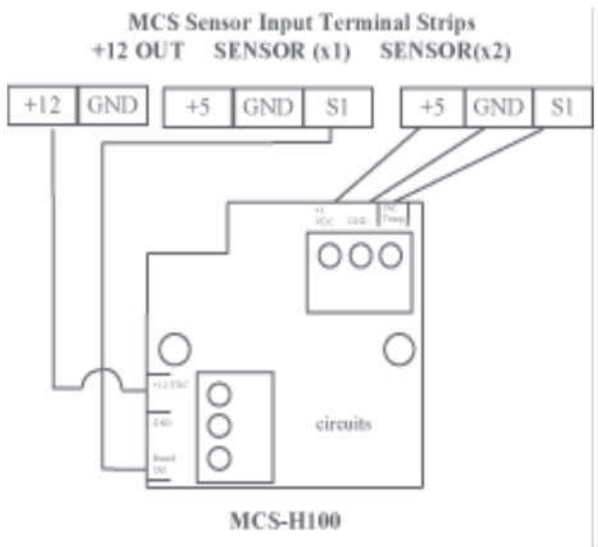
1. Connects to 1 of Magnum Sensor Inputs 1 thru 11 or SI 16
2. Shielded cable GND dran must be connected to SI 'GND'
3. Temp MCS-8 SI (inputs 1-11) jumper setting is analog'
4. Minimum extension inside duct 2.25"
5. Normal extension, as shown, 4.00".



MCS-SAIR

MCS-HUMD (SI#1 through 11 on Magnum or SI 16)

1. Connects to 2 of Magnum Sensor Inputs 1 thru 11 or SI 16
2. Humidity MCS-8 SI (input 1-8) jumper setting to analog
3. +5V DC & GND are common (only one connection required)
4. Temp. on Magnum SI (inputs 1-11) jumper setting is analog'
5. Shielded cable GND drain must be connected to SI 'GND'

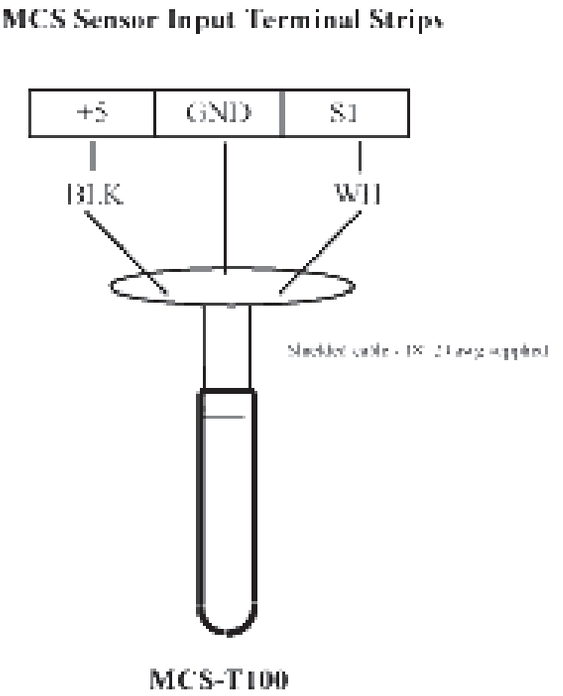


MCS-H100

MCS Sensors (Temp)

MCS-T-100 (SI #1 through 11 on Magnum or SI 16)

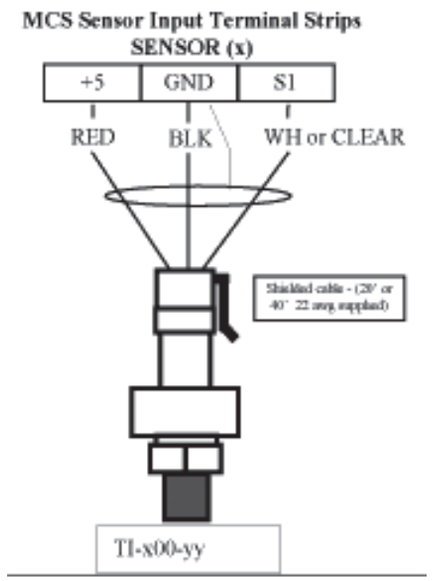
1. Connects to 1 of Magnum Sensor Inputs 1 thru 11 or SI 16
2. Shielded cable GND dran must be connected to SI 'GND'
3. Temp MCS-8 SI (inputs 1-11) jumper setting is ANALOG'



MCS Sensors (Pressure, Current)

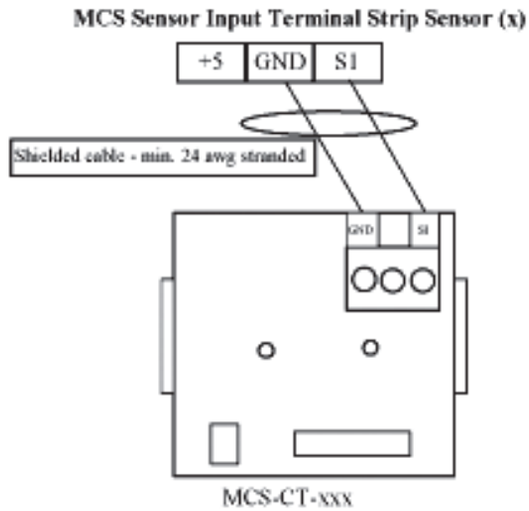
TI-200-(SP) & T1-500-(DP)XX
(SI #1 thru 11 on Magnum or SI 16)

1. TI-500-xx pressure transducer (3 wire 0-5 vde)
2. Wiring for 3 wire to SI# 1 through 11 or on SI 16
3. Jumper settings for SI is 'Analog'
4. Pressure range 0-500 psi



MCS-CT-xxx (SI #1 through 11 on Magnum or SI 16)

1. Connect to Magnum Sensor inputs 1 thru 11 or SI 16
2. The current transformer may be 100:0.5, 250:0.5, 500: 0.5
3. AMPS jumper setting is 'Analog'
4. For wiring only remove terminal block from CT.
5. Do not remove Printed Circuit Board.
6. Do not wIre +5 from Magnum or SI 16



MCS Magnum Controller

This control strategy is based upon developing a control zone and then to step the compressor(s) through their stages to maintain the control sensor reading within this zone. To accomplish this, the system will constantly monitor the control value, its rate of change and position in relationship to the control zone.

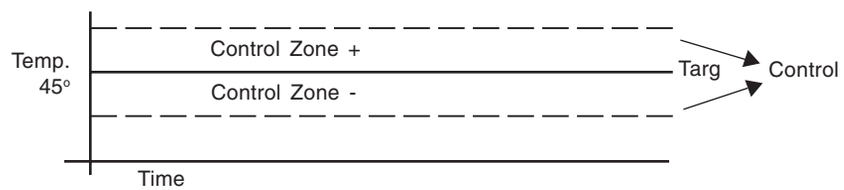
1.1 Common Definitions

1.1.1. Target

The control target is specified in setpoint 1. This will be the base of developing the control zone.

1.1.2. Control Zone

The control zone is developed by adding the setpoints for the control target (setpoint 1) and the dead band + (setpoint 2) to obtain the upper limit. The lower limit is obtained by subtracting the dead band (setpoint 3) from the control target (setpoint 1).



Once the control zone has been established, the system will attempt to keep the control sensor reading within this range.

1.1.3. Controlling Sensor

This is the sensor that has been specified in the MCS Cfg. program as providing the control value reading. It will be the leaving liquid temperature. The setpoints must be adjusted to agree with the controlling value.

1.1.4 The Rate of Change of the Control Input

The rate of change is how fast the control value is changing over a period of time. If the control value is increasing the rate will be positive, if decreasing the rate will be a negative value. How fast the input is changing, its direction and where the current input reading is in relationship to the control zone will determine what action the system will take.

1.1.5. Step Delay

The system will not attempt to take action until the Step Delay reaches zero. Setpoint 26 contains the initial value. The rate of decrement is based upon the rate of change of control input value and the sensitivity that has been specified.

1.2. MCS Magnum Control States

Consider the Magnum Controller as a state computer, that is, as decisions are made based upon setpoints, timers and sensor inputs, the controller moves from one state to another. The controller will change states to ensure the proper functioning of the chiller package.

As per review of the various states, one must remember that a chiller package consists of a number of different parts or functions: the compressors and their related items such as unloaders, evaporators and condensing functions. To control these functions the states will be divided into three sections:

1.2.1. Capacity Control States

1.2.2. Circuit Control States

1.2.3. Condenser Control States

Both the CAPACITY CONTROL STATES and CIRCUIT CONTROL STATES are displayed on the STATUS option of the LCD. To view the state of the chiller, select the STATUS option from the MENU on the keypad. One can then view the entire status by using the page up / down function keys. The information can also be accessed via the PC-Connect program under status screen by clicking on the CONTROL STATUS button.

Control Status Display from the MAGNUM Keypad

The following will be displayed:

1. The Current State of the Package and Circuits

The first display shows the current capacity of the package and duration at this level. By pressing the **PG UP** OR **PG DWN** one will get additional information of each circuit.

ACTUAL DISPLAY ***DESCRIPTION***

09.55 Unit 45/54				
Unit is unloaded				
025:42;33				
WTD	ACT	WTD%	DLY	ROC
0	0	40%	180	0.0
TARGET = 45.0 (ADJ + 0.0)				
PG PG				

HH:MM	CHILLER UNIT			LEV / ENT
CURRENT CONTROL STATE				
TIME IN CURRENT STATE				
WANTED #STEPS	ACTUAL #STEPS	WANTED% ACTUAL	DELAY NEXTCHG	SLOPE DIRECTION
TARGET SETPOINT +TARGET RESET				
PG UP		PG DWN		

09.56 CMP #1 45/54			
CMP OFF / READY			
000 : 00;30			
SUCT	DISC	OPD	MOTOR
0	0	40%	0%

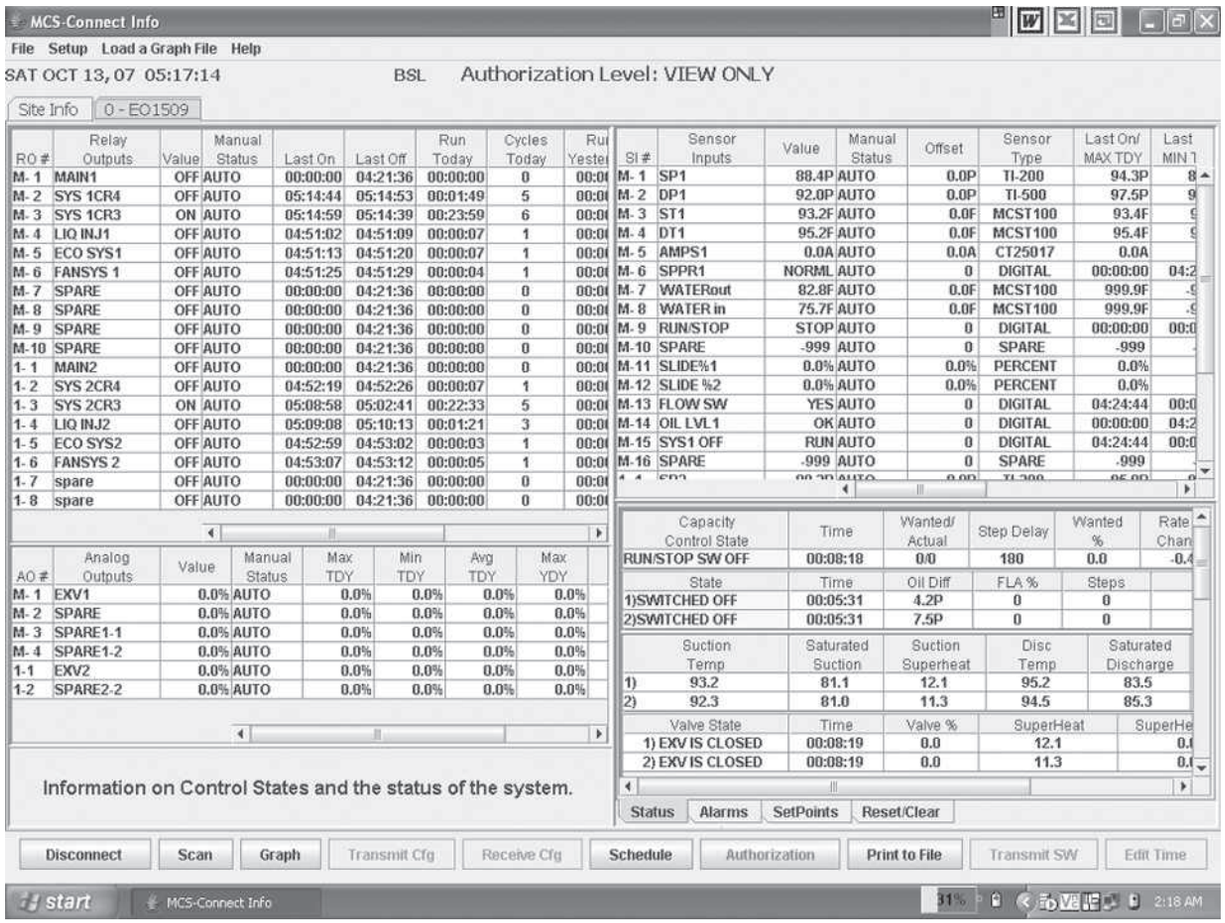
HH:MM	CIRCUIT		LEV / ENT
CURRENT CONTROL STATE			
TIME IN CURRENT STATE			
SUCTION	DISCHARGE	OIL DIFFERENTIAL	MOTOR
?	?	?	?

09:55 CMP#1 45/54			
CMP OFF / READY			
SST	SSH	SCT	DSH
38	16.9	97	79.2

HH:MM	CIRCUIT		LEV / ENT
CURRRENT CONTROL STATE			
TIME IN CURRENT STATE			
SAT SUCT. TEMP	SUCT SHEAT TEMP	SAT. COND TEMP	DISC SHEAT TEMP

1.2. STATUSX Display (from the PC-Connect program)

STATUSX is an expanded option of STATUS. The status of the CAPACITY CONTROL STATES, CIRCUIT CONTROL STATES and EXV CONTROL STATES can be viewed from the PC-Connect program by accessing the CONTROL STATUS key under status screen. The following will be displayed:



The above display is split as follows:

- The top line defines the MCS Conn. screen followed by the authorisation level
- The next line provides the Magnum address, the day of week, and time from Magnum, the company name followed by the site name
- The upper left quadrant provides the relay output data
- The upper right quadrant provides the sensor input data
- The lower left provides the analog outputs and below that the MCS Conn. notification information
- The lower right provides four screens depending on the tab selected. (Status, Alarms, Setpoints and Reset)
- The bottom tab bar provides function selection within MCS Conn

CAPACITY CONTROL STATE	TIME	WANTED/ ACTUAL	STEP DELAY	WANTED FLA%	RATE OF CHANGE	CONTROL ON	MODE
UNIT IS LOADED	12:03:06	2 / 2 OF 2	300	100%	0.0	ENT LIQ	CHILLER
CIRCUIT STATE	TIME	OIL DIFF	FLA%	SLIDE			ACCUM
1) <–CMP IS HOLDING	11:56:30	124.1P	100%				4
2) CMP IS HOLDING	01:13:42	145.4P	96%				
CIRCUIT SUCTION TEMP	SATURATED SUCTION	SUCTION SUPERHEAT	DISC TEMP	SATURATED DISCHARGE	DISC SUPERHEAT	Ref. Type is R134a	
1) 26.5	16.9	9.6	149.3	101.8	47.5		
2) 23.5	15.7	7.8	108.3	104.1	4.7		
DEFROST STATE	TIME	VALVE %	SUPER HEAT	SHEAT ROC	ADJ DELAY		
1) EXV IS HOLDING	00:21:50	35.3%	9.7	0.0	80		
2) EXV IS CLOSING	00:00:24	36.0%	7.8	0.0	56		

The Control Status portion of the STATUSX screen is shown above.

Chiller Information:

- **Capacity Control State** – State of chiller
- **Time** – Time in that state, if the state is UNIT IN POWER UP; time will decrement to zero
- **Steps Wanted on / Actual on of Total Steps** – Number of steps wanted on vs. the actual steps turned on vs. the total steps on the chiller
- **Step Delay** – Value that is counted down. The sensitivity and where the control temperature is in relationship to the control zone will determine the speed of the countdown. When the value decrements to zero, the system will determine if a change in the system's capacity is required
- **Wanted Slide %** – Wanted slide percentage
- **Rate of Chng** – Rate at which the control sensor is changing
- **Disc Temp** – Discharge Temperature.
- **Saturated Discharge** – Calculated Discharge Saturated Temperature. The Discharge Pressure is converted into temperature based upon the type of refrigerant (R22, R134a)
- **Discharge Superheat** – Available if both the Discharge Temperature and the Discharge Pressure are used. The calculation is Discharge Temp minus the Discharge Saturated Temp

1.2.1. Capacity Control States

Unit in Power Up

The unit enters this state, when the MAGNUM is powered up or the system has been reset. The system will remain in this state for the time specified in setpoint POWER DELAY, setpoint 23, or if not active for 90 seconds. In this state all points (ROs) are turned off. This is a time delay to ensure that the microcontroller has stable power before starting the algorithm.

Unit in Lockout

The unit enters this state, whenever a critical situation is encountered that could cause harm to the chiller package. Items such as freeze protect and emergency stop will force the system into this state. Lockouts can be reset without authorisation from the keypad or PC-Connect program; however if the lockout condition has not been corrected, the system will again be forced into the LOCKOUT state. In this state, all ROs except ALARM RO and the oil heater RO for screws with an oil pump are turned OFF and placed in the 'LOCKOUT' state. *NOTE: If the Lockout Reset is pressed more than 6 times in a day the unit cannot be reset except through the MCS Conn. program and requires Factory authorisation.*

No Run – I/O Lost

This state will be entered whenever the MAGNUM loses communication with any of the I/O boards that are connected via the MCS I/O network. When this state is entered the system will generate an MCS I/O off-line alarm that identifies which I/O is off-line and a lost I/O shutdown alarm which locks out the unit. The lockout-reset key must be pressed to reset the system, after the lost I/O has been corrected. In this state, all ROs except ALARM RO are turned OFF.

Run/Stop SW Off

The unit enters this state, when the run/stop switch is off, in the stop position. When the chiller is in this state, the active individual circuit states are moved to the CMP IS OFF state through the normal states. One capacity STEP will be moved per second.

Scheduled Off (optional)

The unit enters this state, when the schedule is calling for the package to be off. When the chiller is in this state, the active individual circuit states are moved to the CMP IS OFF state through the normal states. One capacity STEP will be moved per second.

Off – No Evap Flow

The unit enters this state, when the evaporator flow switch is off. When the chiller is in this state, the active individual circuit states are moved to the CMP IS OFF state through the normal states. One capacity STEP will be moved per second. If the NO FLOW setpoint is active and set to Lockout the chiller will lockout on no flow.

Unit is Off

The unit enters this state, when the system has moved from a STARTUP, DISABLE, LOCKOUT or LOST I/O state. The chiller is now ready to move into an active state to meet the capacity required.

Unit is Holding

The unit enters this state, when one of three conditions exists:

1) The control sensor reading is being maintained within the control zone.
2) Control sensor reading is above the control zone but the Rate of Change is lesser than the value in the (MAX ROC-, #27) setpoint. This indicates that the temperature is decreasing towards the target at an acceptable speed. Therefore, no additional cooling is needed at this time.
3) The temperature is below the control zone but the Rate of Change is greater than the (MAX ROC+, #28) setpoint. This indicates that the temperature is increasing towards the target. Therefore, no reduction in cooling is needed at this time.

This state indicates that there is no need to adjust the cooling capacity of the chiller package. This state will be exited when more or less capacity is required.

Unit is loading

The unit enters this state, when more capacity is required. Every second an adjustment is made to the step delay. When the delay reaches zero, the counter ‘steps wanted on’ is increased by 1.

Unit is loaded

The unit enters this state, when all of the system's available capacity steps are on and the package is providing the maximum amount of cooling capacity.

Unit Unloading

The unit enters this state, when less capacity is required. Every second an adjustment is made to the step delay. When the delay reaches zero, the counter ‘steps wanted on' is decreased by 1.

Unit is Unloaded

The unit enters this state, when all of the system's available capacity steps are off. The package is providing no cooling capacity, as none is required. The system is ready to react to cooling needs.

1.2.2. Circuit Control States

Refer to the section in MCS Control States and Relay Output sequence Quick Reference for an overview of which states are active.

The actions of the circuit's control states actually result in more, less or no change in the amount of cooling capacity. The CAPACITY CONTROL STATES dictate how the individual circuits move within their states.

CMP Locked Out

The unit enters this state, when the Capacity control state is LOCKOUT or a safety setpoint for this circuit has indicated that a critical situation has been encountered. Setpoints such as (LOW SUCTION #77) or (HI DISCH PSI #81) are examples of safety setpoints. Lockouts can be reset without authorisation from the keypad or PC-Connect program; however if the lockout condition has not been corrected, the circuit will again be forced into the LOCKOUT state.

Lost IO Locked

The unit enters this state, when the Capacity Control State is LOST IO. Lockout reset key will move the circuit to the OFF state. Lockouts can be reset without authorisation from the keypad or PC-Connect program; however if the lockout condition has not been corrected, the circuit will again be forced into the LOCKOUT state.

Safety Tripped

The unit enters this state, when a safety trips but a lockout is not to be generated. An alarm is generated but the system will restart after the delay specified in the corresponding setpoint. If a second trip occurs within the time specified in the setpoint, the circuit will be placed in the CMP LOCKED OUT state.

CMP Off/Ready

The unit enters this state, when no cooling capacity is required from this circuit or the prior state was CMP ANTICYCE, LOST IO LOCKED or SWITCHED OFF. In this state the circuit is ready to provide cooling capacity if needed. The circuit will remain in this state for a minimum of 60 seconds.

CMP PMP Down

The unit enters this state, whenever the pump down switch has been turned on or if this circuit is no longer wanted on. The compressor is on and the liquid line solenoid is closed. This state is active until the suction pressure reaches the value in the setpoint 61, PMP DWN OFF or the time has exceeded the value in the setpoint 62, PMP DWN DELY. The circuit will then move to the ANTICYC state.

CMP Anticycle

The unit enters this state, when the PMP DWN state has been completed. The circuit will stay in this state with all circuit points off for the period of time contained in either setpoint 59 (ACYC OFF -> ON) or setpoint 63 (ACYC ON -> ON) whichever is longer. The circuit will then move to the OFF state. NOTE: The ACYC ON -> ON limits the number of starts per hour.

Switched Off

The unit enters this state, after the circuit has been pumped down due to the pump down switch being on or if the circuit flow switch is off. In this state the compressor, and all related points, plus the liquid line are off. The circuit will not leave this state unless the pump down switch is turned off. If the pump down switch is turned off, the circuit-state will be changed to the OFF state.

Fast Unloading

For screw compressors, this state is entered when the compressor is turned on. The system will remain in this state for 60 seconds while the “fast unloader” and unload points are on. This is to ensure that the screw is unloaded.

CMP is Loading

For infinite step compressors, this state is when the load solenoid is being pulsed to increase the cooling capacity of the circuit. The duration of the pulse is specified in the setpoint 37, LOAD PULSE and the frequency of the pulse is determined by setpoint 56, PULSE DELAY. The setpoint PULSE DELAY should be a value between 3 and 5 seconds. During loading this will allow the change to take place and the amps to reflect that change.

CMP is holding

This state only exists for infinite step compressors. In this state, the required refrigeration capacity of the system is being meant; no movement of the slide valve is required.

CMP is at 100%

The unit enters this state, when the compressor is fully loaded. In this state, the circuit is providing the maximum amount of cooling capacity.

CMP is Unloading

For infinite step compressors, this state is when the unload solenoid is being pulsed to reduce the cooling capacity of the circuit by moving the slide valve. The duration of the pulse is specified in setpoint 38, UNLOAD PULSE and the frequency of the pulse is determined by setpoint 56, PULSE DELAY. The setpoint PULSE DELAY should be a value of between 3 and 5 seconds. During unloading this will allow the refrigerant to enter the chamber slow enough not to cause oil foaming.

CMP Unloaded

For infinite step compressors, this state is when the slide is fully unloaded (indicated by unloaded input or after the unloader is pulsed for 30 seconds with no change). For fixed step compressors, this state is when the compressor is on and fully unloaded. In this state the compressor is supplying its minimum cooling capacity.

HI Disc Unload

Refer to setpoint numbers 81, HI DISCH PSI; 82, HI DISC UNLD; 83, HI DISC RELD; 87, HI DISCH TMP; 88, HI DISCH UNLD; and 89, HI DISCH RELD.

Infinite step compressors only: The capacity is being unloaded due to a high discharge pressure or high discharge temperature. The compressor will stay in this state until the pressure or temperature has dropped below the corresponding setpoint. The system will then move to the HI DISC HOLD state.

HI Disc Hold

Refer to setpoints numbers 81, HI DISCH PSI; 82, HI DISC UNLD; 83, HI DISC RELD; 87, HI DISCH TMP; 88, HI DISCH UNLD; and 89, HI DISCH RELD.

HI Disc TMP HLD

Refer to setpoints numbers 87, HI DISCH TMP; 88, HI DISCH UNLD; and 89, HI DISCH RELD.

This state is entered when a fully loaded circuit, that has more than one step, has encountered a dangerously high discharge temperature. One step of cooling capacity will be turned off. The circuit will remain in this state for a minimum of five minutes before returning to the LOADED state if the dangerous condition has been corrected.

LO Suct Unload

Refer to setpoints numbers 77, LOW SUCTION; 78, LO SUCT UNLD; and 79, LO SUCT RELD.

Infinite step compressors only: The capacity is being unloaded due to a low suction pressure. The compressor will stay in this state until the suction pressure is above the critical value. The system will then move to the LO SUCT HOLD State.

LO Suct Hold

Refer to setpoints numbers 77, LOW SUCTION; 78, LO SUCT UNLD; and 79, LO SUCT RELD.

Infinite Step Compressors

If the capacity is being held due to a low suction pressure condition, the circuit will return to its appropriate state once the suction pressure returns to a normal operating condition.

LO TMP Unload

The circuit's leaving liquid temperature has caused the system to unload. When the leaving liquid temperature gets to within 1.5°F of the freeze setpoint, the unload will occur before we hit the freeze protect safety.

LO TMP Hold

Reload from the ‘LO TMP UNL’ occurs when we are 3.0°F above the freeze setpoint. Until we reach this point the system will remain in the LO TMP HOLD state.

HI AMP Hold

Not used with infinite step compressors. This state is entered when a fully loaded circuit, that has more than one step, has encountered a dangerously high AMP draw. Refer to setpoints numbers 65 through 72 for FLA per circuit and 75 HI AMPS %. In this state, one step of cooling capacity will be turned off. The circuit will remain in this state for a minimum of five minutes before returning to the LOADED state if the dangerous condition has been corrected.

Authorisation Code:

Authorisation code is a special four-character code that enables access into the MAGNUM system. The code must be numeric with values between 1 and 8 if it is to be entered from the keypad/display. If the system is being accessed via MCS Connect program, the code may consist of any valid alpha/numeric characters. Each system can have up to 15 different authorisation codes. This provides the capability of issuing different codes to different people if desired. There are four levels of authorisation, which provide different capabilities within the system. The authorisation code and the associated level cannot be displayed or viewed in a MAGNUM system. These are established when building the configuration file in the MCS Cfg. program. The authorisation codes must be protected and remain confidential, if they are compromised unauthorised personnel can gain access to the system.

System generated alarms

The following alarms are generated to provide information; they will not cause a change in the control algorithm such as a lockout condition or a relay output being forced off.

- Power Failed
- Power Returned
- Computer Reset
- LCD Failure
- HW Date Invalid
- HW Time Invalid
- SW Date Invalid
- SW Time Invalid
- RAM Integrity
- Watchdog Reset

Alarms as a result of individual action

The following alarms indicate that an individual took action:

- Alarms Cleared
- STPT Changed
- RO Manual
- AO Manual
- SI Manual
- Point Info Clear
- Clock Set
- CFG Download

Alarms generated by the control algorithm

The following alarms indicate that the control algorithm took action:

- Rotated Lead
- Daylight Savings

MAGNUM system alarms

Alarms are generated by the MAGNUM control algorithm:

Configuration problem alarms

These alarms indicate a problem with the configuration file that has been loaded into the system. The system is not operational, a configuration must be transmitted to the unit from PC-Connect or the config chip must be replaced with a valid one.

- Invalid Config. - Check if sums are incorrect
- Invalid Config. Ver - Version number of the configurator is invalid
- Invalid Config Type - This type does not agree with software, chiller software with a home unit configuration

MCS Local Network Problem Alarms

These alarms indicate problems with the MCS local network, the system can be accessed but the system is in a lockout state, LOST I/O.

- MCS-I/O 1 Lost
- MCS-I/O 2 Lost
- MCS-I/O 3 Lost
- Lost I/O Shutdown

Key sensors problem alarms

This alarm indicates a problem with a key sensor; it is either shorted or open. The alarm will contain ALARM followed by the 8-character name of the sensor.

The following sensors related to the entire system are tested:

- Leaving liquid, if failed: lock out the chiller system
- Returning liquid, if failed: alarm only no lock out
- Ambient temperature, if failed: alarm only no lock out

The following circuit sensors are tested. If they fail that circuit only is locked out.

- Suction pressure and temperature
- Discharge pressure and temperature
- Oil pressure and temperature
- Motor temperature (if it is an analog input device)

Emergency Alarm

This alarm indicates that the emergency stop switch has been turned on. The system can be accessed but the entire system is in a lockout state.

- Emergency Stop

Setpoint safeties

For a safety function to be monitored, both the associated sensor input and the lockout setpoint must be active. If a safety trips, the alarm name will consist of the setpoint name plus additional identification such as point number or circuit number if applicable.

If a safety applies to a circuit and it is an active lockout type of a setpoint, the first time this safety trips an alarm will be generated and the circuit will be shut down and placed in a safety state. The system will attempt to reactivate this circuit after waiting the length of time specified in this setpoint, safety down time. If successful, the system will continue to run. If the same safety trips within the time specified in the lockout delay time, the circuit will be locked off and a manual intervention is required. If the lockout delay time is set to zero, the system will generate a lockout condition the first time that the safety occurs.

The time in the safety state and the time between safeties are specified in the individual setpoints. This enables the times to be unique for each lock out setpoint.

MOST SAFETIES ARE CHECKED ONLY IF THE COMPRESSOR IS RUNNING, IF THE SAFETY IS ALWAYS CHECKED IT WILL BE SO NOTED.

The following are a list of safeties that are incorporated in the standard chiller algorithm control. These safeties are checked every second. Note, for a multiple circuit system, each circuit is tested individually. If a safety condition exists, action will be taken with that circuit only, other circuits will continue to function.

Freeze Protection (SAFETY IS ALWAYS CHECKED)

If the leaving water temperature drops below the setpoint value, the system and all circuits will enter a lockout state and a freeze notification alarm will be generated.

Phase Loss Protection

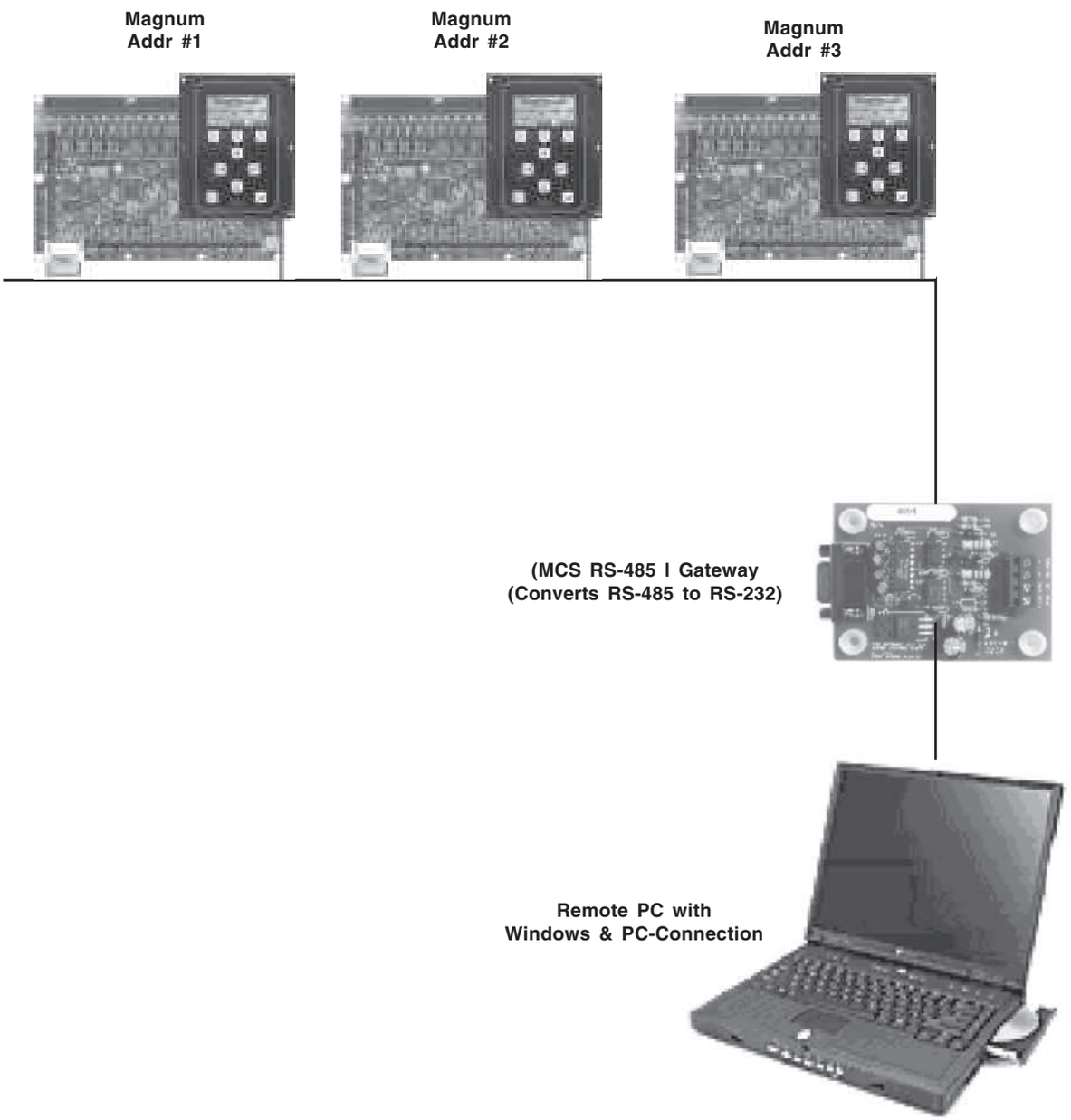
Phase loss, as indicated by the phase loss monitor, will result in the system and all circuits being locked off and a phase loss notification alarm will be generated.

Emergency Stop

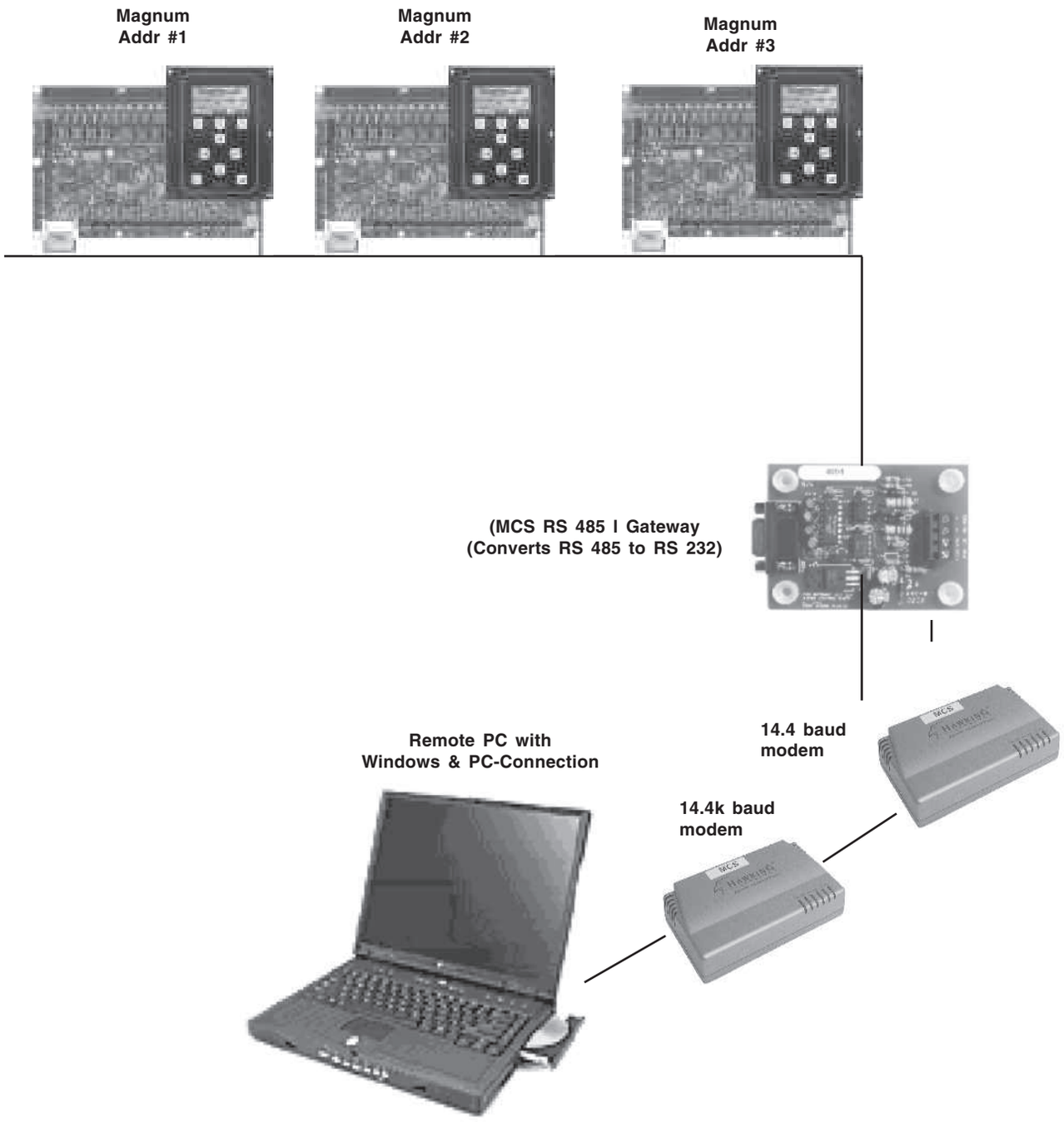
Emergency stop, as indicated by the emergency stop switch, will result in the system and all circuits being locked off and an emergency stop notification alarm will be generated. No setpoint is required.

Local & Remote Connectivity

Microcontrol Panel (MCS Magnum)



MCS 485 Network Remote PC Support Only



Requirements for PC Software

To install and run the program we suggest the following system requirements:

Front-end System Requirements

- Windows
- Pentium 166 MHz
- 10 Gigabyte hard disk with at least 25 Megabytes free
- CD Drive
- Super VGA display capable of displaying 256 colours
- 64 Megabytes of RAM or more is recommended
- 33.6k baud modem

Minimum System Required to Run Program

- Windows 2000
- Pentium 1.0 MHz or faster
- 40 Gigabyte Hard Drive
- Super VGA Display capable of displaying 256 colours
- 256 Megabytes RAM
- 56k baud modem

Magnum Control States Quick Reference

Control States tell the user the system's status; this information is critical. From the Magnum keypad/ display, press the menu key and select STATUS (The control status is the second line in the MCS Control States Quick Reference – CHLR & I 8.00 Software).

Control States tell the user the system's status; this information is critical!

The Magnum Keypad Display Quick Reference:

CAPACITY CONTROL STATES	
STATE	DESCRIPTION
UNIT IN POWER	System Reset or Power Returned (delay of 60 seconds or setpoint value)
UNIT IS OFF	System ready to run but no cooling capacity required
RUN/STOP SW OFF	Disabled: run/stop switch is off.
SCHEDULED OFF	Disabled: operating schedule is false.
OFF NO EVAP FLOW	Disabled: no evaporator flow
AMBIENT OFF	Disabled: either high or low ambient temperature.
UNIT IN LOCKOUT	Chiller locked out, all points except alarm point are OFF
NO RUN- IO LOST	Lost communication Chiller locked out
UNIT IS HOLDING	No change in capacity
UNIT UNLOADING	Reduce capacity
UNIT LOADING	Increase capacity
UNIT IS UNLOADED	Unit is unloaded, No cooling capacity is being provided.
UNIT IS LOADED	Unit is loaded, maximum cooling capacity is being provided.

CIRCUIT CONTROL STATES	
STATE	**DESCRIPTION**
CMP OFF/READY	Circuit ready but not required or has not been in this state for 60 seconds
FAST UNLOADING	Fast unload screw compressor at startup.
CMP IS LOADING	Pulsing screw load solenoid
CMP IS HOLDING	Control temperature within target control band
CMP IS UNLDING	Pulsing screw unload solenoid
HI DISC UNLOAD	Pulse screw unload solenoid because discharge temp or pressure is too high
HI DISC HOLD	Holding until discharge temp or pressure returns to normal
LO SUCT UNLOAD	Pulse screw unload solenoid or unload 1 step, suction temp or pressure is too low
LO SUCT HOLD	Holding screw slide or 1 unloader off until suction temp or pressure returns to normal
LO TEMP UNLOAD	Comp unloading, temperature less than 1.5°F above freeze point.
LO TEMP HOLD	Hold until temperature is 3.0°F above freezing point.
CMP UNLOADED	Comp ON, all unloaders OFF
CMP IS AT 100%	Circuit is fully loaded, all unloaders are OFF
CMP PUMP DOWN	Pumping down
CMP ANTICYCLE	Delay after turning off circuit
SWITCHED OFF	Pump down switch on or system state is DISABLE
SAFETY TRIPPED	Safety tripped not LOCKOUT
CMP LOCKED OUT	Safety tripped twice within half hour, circuit locked off
LOST IO LOCKED	Lost communication
HI AMP HOLD	Circuit is in hold due to high amps. Can only be unloaded.

The MCS Troubleshooting Quick Reference Sheet

PROBLEM	POTENTIAL SOLUTION
No Sensor +5V DC	Indicates a possible shorted input sensor • Remove all sensor terminal blocks. • Wait about 30 to 60 seconds. If +5V DC returns, replace one sensor wire at a time until the +5V DC is lost again. This will be the shorted sensor.
A sensor input reads -99.9	This indicates an open sensor input signal or 5V DC problem. • Check sensor wiring for missing wire or poor connection. • Check sensor for bad sensor. • Check +5V DC on sensor input to ground. If less than 5V DC is on the sensor 5V DC terminal block, the problem is with probably a shorted sensor. (A polyfuse protects the board) • Remove all sensor input terminals • Wait about 1 min. or until 5V DC is restored at sensor input. • Connect terminals 1 at a time until short reappears & fixes bad sensor.
A sensor input reads +999.9	This indicates a shorted sensor input signal. • Check sensor wiring for +5V DC shorted to signal, etc. • Check sensor for bad sensor.
Invalid reading on one sensor input.	This indicates an input problem with 1 sensor. • Verify jumper settings correct for that SI. (Analog/Digital)
MCS CONTROLLER 'INITIALISATION' on LCD display.	Indicates Microcontroller in constant reset. • Check incoming power > 105V AC or 220V AC
Top row of LCD display all bars & 2nd row blank.	Indicates software chip problem possible. • Possible U11 software version incorrect • No GAL chip • Possible bad connection or cable between LCD and MCS8
LCD blank.	Indicates bad connection. • Connector J2 on MCS not on or offset on connector. • Resistor adjustment VR1 out of adjustment.
Lost I/O	Indicates communications problem. • Verify RS485 LED blinking. • Verify termination jumper J6 only on at MAGNUM & last I/O. • Verify MAGNUM & I/O address set correctly. • Verify wiring from MAGNUM to each I/O is correct • Check 120V AC fuses on I/O units

PROBLEM	POTENTIAL SOLUTION
Changes to MCS not being made from the unit's keypad.	This indicates inability to write to chip U10. • Verify 'EEP WRITE ENABLE' jumper W6 is on. • Not authorised
Invalid authorisation	This indicates an invalid authorisation number. Follow steps below for proper authorisation: • Press SERVICE DIAGNOSTICS key until the authorisation option appears • Press the ENTER key • From the "Display Status" press keys corresponding to your authorisation number. • Press ENTER
SI from AMPS board 10 A low.	This indicates a problem with this SI only. • Jumper setting on this SI is in wrong position. • Incorrect sensor type used.
INVALID CONFIG VER	Indicates layout of CFG is incorrect. • CFG layout for different version.
INVALID CONFIG TYPE	Indicates U10 CFG is incompatible with U11 software. • Example U10 CFG for home while U11 for chiller.
INVALID CONFIG	Indicates Checksum is invalid. • Reload CFG
Sensor input believed invalid (Under Sensor Diagnostic Sub Menu)	• Verify Berg jumpers using Quick Reference Sheets. • Check board version number. • Check wiring of sensor.
Communications to MCS-485 -GATEWAY from PC-Connect not working.	• Verify if the red LED on the gateway is blinking. This indicates that the PC-Connect program is talking to the gateway. • Verify if the two-wire shielded cable has properly wired the RS-485 connector to the gateway. • Verify if the red LED (located just to the left of the RS-485 connector on the MAGNUM board) is blinking. This indicates that the MAGNUM is responding to the gateway. • If both of these LEDs are blinking, check the address of the MAGNUM and any other MAGNUMs that are on the network. Each must have a unique address. This address can be changed from the MAGNUM. Proper authorisation is required. Enter the UNIT INFORMATION screen by pressing the SERVICE DIAGNOSTIC key and scrolling to this item. Press the ENTER key and scroll to the NETWORK ADDRESS screen. Change address if needed. • Verify +12V DC to MCS-485 GATEWAY
INVALID CONFIG	Indicates Checksum invalid • Either set to factory defaults or reset settings.

Screw Compressor

1. General

Hanbell series semi-hermetic screw compressor is developed especially for applications in air conditioning and refrigeration. With high operating load design, each Hanbell compressor is of high efficiency and reliability in all operating conditions such as thermal storage, heat pump system and refrigeration. Each Hanbell compressor has the latest and advanced **5-to-6 Patented Screw Rotor Profile** designed to ensure high capacity and efficiency in all operating conditions. Each unit is carefully manufactured and inspected by high precision THREAD SCREW ROTOR GRINDING MACHINE, CNC MACHINING CENTER, and 3D COORDINATE MEASURING MACHINE. Each **Hanbell** compressor follows the **ISO 9001** quality system. This certification assures that its quality is controlled under severe quality procedures and good service to all customers.

RE series compressor is equipped with separated radial and axial bearings, liquid injection or economiser connection, PTC motor temperature thermistors, discharge temperature thermistors, a motor protector, optical oil level switch, oil pressure differential switch connector, and other accessories. The complete accessories and their new designs guarantee the compressor has the best reliability, longest bearing life during heavy-duty running and strict operating conditions.

This Technical Manual contains information about lifting, dimensions, installation, operation, applications and basic troubleshooting. It is strongly recommended that contents of this manual be referred carefully prior to lifting, installation, and commissioning of RE series compressor in order to prevent any accident or damage. Please contact Hanbell or its local distributors/agents for more information or further assistance.

2. Specifications and description of design

2.1 Compressor Specifications

MODEL	COMPRESSOR					MOTOR					LUBRICANT CHARGE	WEIGHT
	Displacement 60 / 50Hz	Rated Speed	Vi	Cap. Control (%)		Nominal Hp		Starting	Voltage (V)			
	m^3/hr	60 / 50Hz		Step	Stepless	60Hz (A/B)	50Hz (A/B)		60Hz	50Hz	L	kg
RE-230A/B	280/232	3550/2950	2.2 2.6 3.0 3.5 4.4	25, 50, 75, 100	25~100	56/76	46/63	Y-Delta PWS DOL	380 440 460 480	380 400 415	14	380
RE-260A/B	320/266					63/82	52/68				16	440
RE-300A/B	369/307					69/97	58/80				16	480
RE-420A/B	501/417					96/132	80/110				16	600
RE-480A/B	579/481					108/146	90/122				17	630
RE-550A/B	666/554					132/166	110/138				19	670
RE-620A/B	752/625					146/197	122/164	Y-Delta DOL			23	870
RE-710A/B	857/712					166/214	138/178				26	920
RE-820A/B	987/820					197/233	164/194				28	1050
RE-920A/B	1112/924					214/258	178/215				28	1135

Note:

1. Motor type: 3-phase, 2-pole, squirrel-cage, induction motor
2. Motor insulation: Class F
3. Motor protection: PTC motor temperature thermistor, Pt1000 motor temperature sensor (standard accessory), Pt100 motor temperature sensor (optional accessory)
4. Hydrostatic pressure test: 32kg/cm^{2}G

Nominal Horse Power:

All above Nominal HP are not equal to the maximum compressor HP. Please refer to the output of Hanbell selection software for the operation current, Maximum Continuous Current (MCC) according to various working conditions while selecting the switch contactor, cable, fuse and wire, etc.

2.2 Design features

Hanbell screw compressors feature simple and robust construction by elimination of some components such as pistons, piston rings, valve plates, oil pumps which are found in reciprocating compressors. Without these components, screw compressors run with low noise level, minimised vibration, high reliability, and durability. Hanbell screw compressors are of two-shaft rotary displacement design with the latest and advanced 5:6 patented screw rotors. Screw rotors are precisely installed with roller bearings, i.e. radial bearings at both the suction and discharge ends as well as angular contact ball bearings i.e. axial bearings at discharge end. A three-phase, two-pole squirrel-cage induction motor drives the compressor. The motor rotor is located on the shaft of the male screw rotor. Cooling of the motor is achieved with suction refrigerant vapour.

Compressor technical features:

Energy-efficiency Mechanism – Hanbell RE series compressor has upgraded screw rotors and optimised inner structure to achieve good and reliable working performance. Optimal volume ratio under part load reaches high working efficiency to save power consumption effectively.

Superior Capacity Control Mechanism – Optimal slide valve layout has strong support in all strokes and new internal structure for piston rod obtains additional support during capacity modulation.

Compact and Robust Structure – Combining motor casing and compression chamber in one iron casing creates compact size for easy installation. The design of ribbed casing and well-supporting feet for main body enhance compressor structure to reach high working performance.

Multinational patents of upgraded high-efficiency screw rotors – This new large-volume, upgraded high-efficiency rotor profile is designed especially for modern refrigerant characteristics to achieve less power consumption. Hanbell screw rotors are patented in Taiwan, UK, US, and China and accomplished by using precision CNC machining centres, rotor milling machines, rotor grinding machines. Strict ISO 9001 process control and the application of precise inspection equipment, such as ZEISS 3D coordinate measuring machines, ensure high-efficiency, high-quality, low-noise and low-vibration Hanbell RE series screw compressors.

High-efficiency motor – Premium grade low-loss core steel with special motor cooling slot, optimal internal casing design around the motor, and casted refrigerant guide vane pilot the cold suction refrigerant gas through the motor. The above motor features provide the highest operating efficiency, no matter how strict the operating conditions are.

Double-walled rotor housing – Double casing structure with high-strength inner ribs has been designed to minimise noise and ensure rigidity. The rotor housing is made of high-strength grey cast iron FC25 that is extremely stable, so that no expansion will occur even at high-pressure condition. These casings are machined by computer-aided machining centres and inspected by precision measuring machines to enhance reliability.

Direct flange-on oil separator – A vessel made of ductile material FCD, is specially designed to withstand high pressure and provide the highest efficiency of oil separation. Simple oil management and low-pressure-drop demister ensure the minimum refrigerant dilution in the oil and maintain high oil viscosity.

Precise capacity control – The slide valve for capacity control is located in the compressor chamber. The slide valve is actuated by injection of pressurised oil into the cylinder from the oil sump as well as bypass of oil through solenoid valves in each oil line with pressure differential.

Perceptive protection modules – RE series screw compressors are equipped with PTC thermistors and Pt1000 motor temperature sensor as standard accessories. Motor protection module monitors discharge and motor coil temperatures as well as phase sequence and phase loss. Accessories also include optical oil level switch to monitor the level of oil, pressure differential switch, and pressure relief valve for optional application.

Adaptable with additional cooling – Liquid injection system to motor and compression chamber can be built in the system with RE series screw compressors. The RE series screw compressor also has oil cooler connection port and middle pressure economiser connection port for customer's desired application.

2.3 Compression process

(A) Suction and sealing:

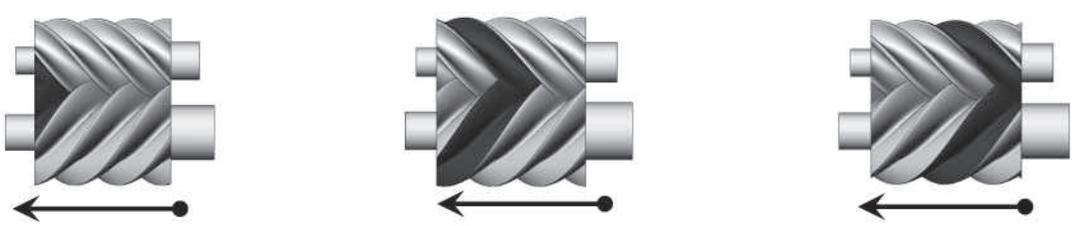
At the beginning of the compression cycle, as the male rotor and female rotor unmesh, gas from suction port fills the interlobe space (refer to the dark area below). Refrigerant at suction pressure continues to fill it, until the trailing lobe crosses the suction area and the gas is trapped inside the interlobe space.

(B) Compression:

As the male rotor and female rotor meshes, the interlobe space moves towards discharge end and its volume decreases so that gas pressure increases consequently.

(C) Discharge:

Gas is discharged from the interlobe space when the leading lobe crosses the discharge port whose volume ratio is designed differently for various applications.



(C) Discharge (B) Compression (A) Suction and sealing

Figure 1 Compression Process

2.4 Capacity Control System

The RE series screw compressors are equipped with either 4-step capacity control system or continuous (stepless) capacity control system. Both of the capacity control systems consist of a modulation slide valve, piston rod, cylinder, piston, and piston rings. The slide valve and the piston are connected by a piston rod. The principle of operation is using the oil pressure to drive the piston in the cylinder.

As seen in Figure 2, the positive pressure differential causes the piston to move in the cylinder. When the slide valve moves towards the right side, the effective compression volume increases in the compression chamber. This means the displacement of refrigerant gas also increases, as a result the refrigeration capacity also increases. However, when any one of the solenoid valves (for 4-step capacity control system) is opened, the high pressure oil in the cylinder bypasses to the suction side, which causes the piston and the slide valve to move towards the left side, and then some of the refrigerant gas bypasses from the compression chamber back to the suction end. As a result, the refrigeration capacity decreases. The modulation (stepless) solenoid valves (SV1&SV2) are controlled by the controller to modulate the piston position smoothly with stable output of capacity.

Before stopping the compressor, Hanbell strongly recommends that the unloading solenoid valve of stepless control system or 25% solenoid valve of 4-step control system should be kept opened for 60~90 seconds so that oil pressure in the cylinder could be released. When starting the compressor again, it is in minimum load position for light duty start.

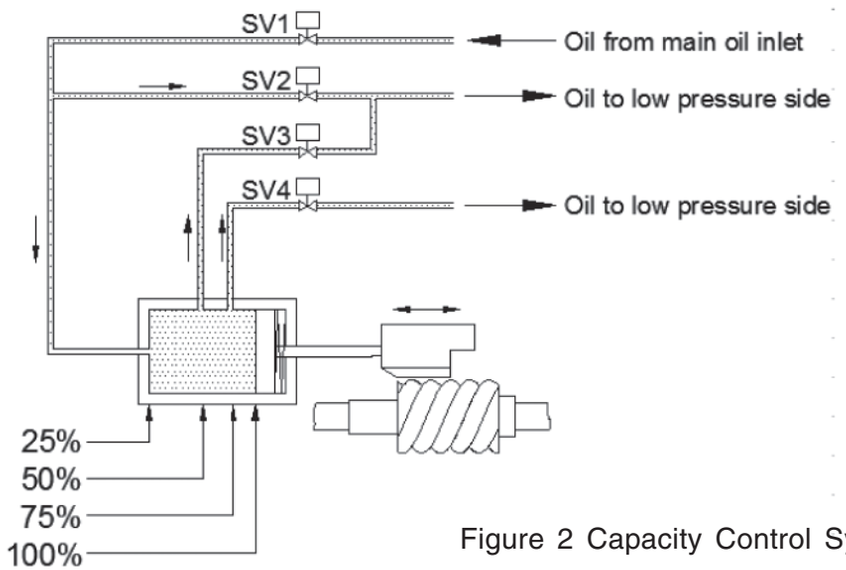
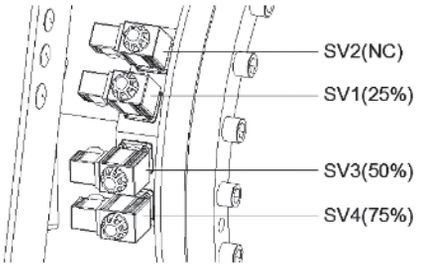


Figure 2 Capacity Control System

2.5 4-step capacity control system

There are three Normal Closed (NC) solenoid valves installed on the compressor to control capacity from minimum capacity to full load (100%). In 4-step capacity control system, it is usual to use the sequence of min.%-50%-75%-100% to load the capacity of compressor and to use the sequence of 100%-75%-50%-min% to unload the capacity. If part load running is lasting for a long time, the problem of oil return, motor cooling, high discharge temperature need to be solved by adding accessories such as optical oil level switch for monitoring the oil level, liquid injection devices for cooling motor coil and controlling discharge temperature. **Min% is recommended for start and stop only, not for long-term operation.**



Capacity system control module				
Solenoid valve	SV2	SV1	SV3	SV4
A. 4 step capacity control	—	●	●	●
B. Step-less capacity control	●	●	—	—
C. Dual capacity control	●	●	●	●

● : Installation — : No installation

4 step capacity control				
	SV2(NO)	SV1	SV3	SV4
100% load	—	△	△	△
75% load	—	△	△	▲
50% load	—	△	▲	△
25% load (For start only)	—	▲	△	△

▲: energized △: not energized

Figure 3 4-step capacity control

Note: For 4-step capacity control system, Hanbell provides Normally Closed (NC) solenoid valves as standard accessory. If Normally Opened (NO) solenoid valves are preferred instead, please specify it to Hanbell when placing the order.

a. min% capacity

When starting the compressor, SV1 25% solenoid valve is energised and the piston is in min% capacity position, so even the oil coming from the oil sump is continuously injecting into the cylinder through the internal orifice, the high-pressured oil in the cylinder bypasses directly into the suction port, and the piston is kept in its initial position.

Note: It is strongly recommended to energise SV1 25% solenoid valve for 1~3 minutes before compressor starts and for 60~90 seconds before compressor stops to ensure the slide valve is in min% position.

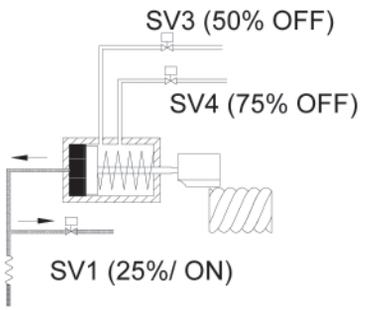


Figure 4 Min% capacity

b. 50% capacity

When SV3 50% solenoid valve is energised by pressure, temperature, or other controllers, the high-pressure oil in the oil sump flows into the cylinder due to the closing of min% valve that pushes the piston moving towards the position where a hole at exactly 50% position drains the oil back to the suction side and the piston is held in that position.

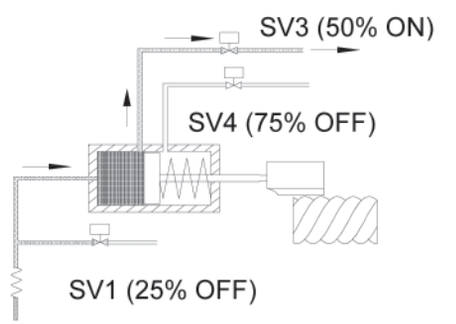


Figure 5 50% capacity

c. 75% capacity

When SV4 75% solenoid valve is energised, without the SV50% solenoid valve energised simultaneously, the high pressure oil will push the piston towards the position where a hole at exactly 75% position drains the oil back to the suction side and the piston will be held in that position.

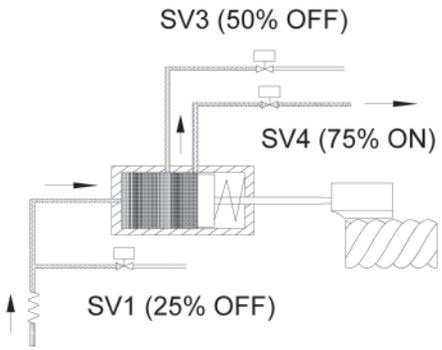


Figure 6 75% capacity

d. 100% full load

When all of three modulation solenoid valves are not energised, the high-pressured oil flows into the cylinder continuously to push the piston towards the suction side gradually until the slide valve touches the end of the compression chamber and the piston also reaches its dead end entirely whereby no bypass of compression gas occurs. Therefore, full load is achieved.

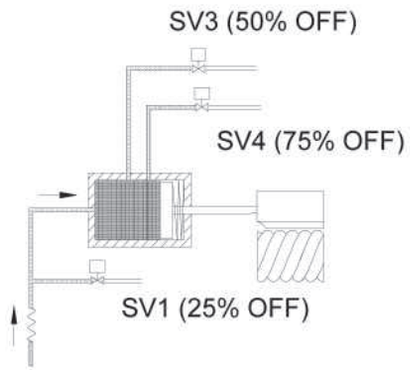


Figure 7 100% (Full load) capacity

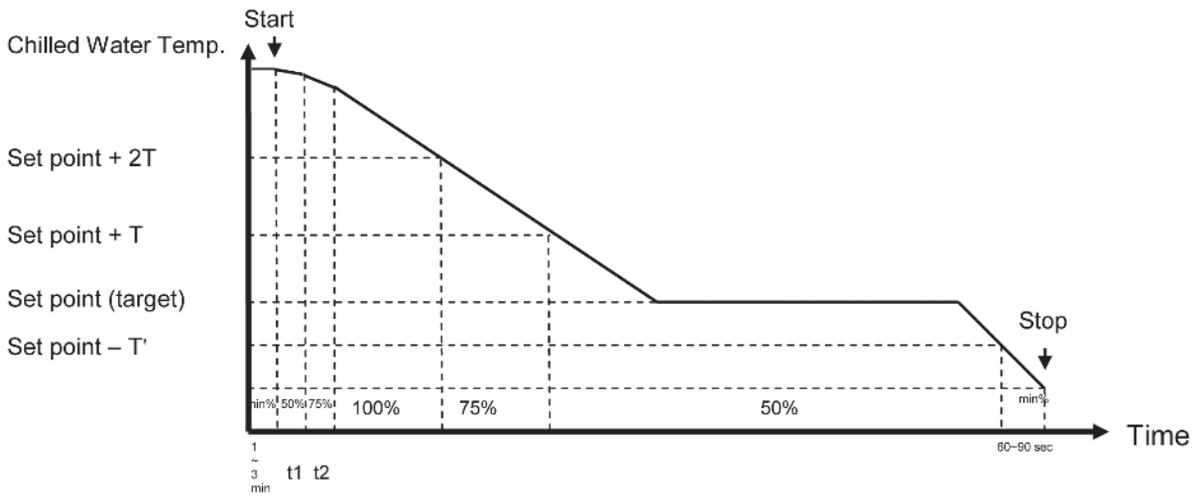


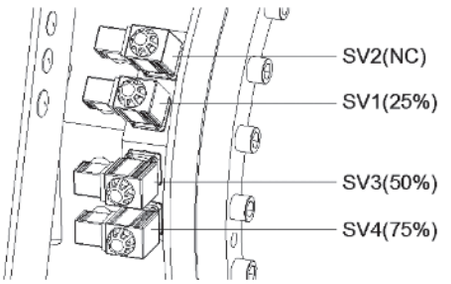
Figure 8 Start/stop sequence and temperature/modulation of single compressor

Note:

1. Above T & T' should be determined by system designer's experience and end user's application.
2. Above t1 & t2 should be longer than 60 sec as recommended.
3. Capacity control must be kept at min% capacity for 1~3 min before start and for 60~90 sec before stop.
4. Start the compressor at min% and SV3 50% can be energised right after start.

2.6 Continuous (stepless) Capacity Control System

In continuous (stepless) capacity control system, solenoid valve SV2 (for loading) and solenoid valve SV1 (for unloading) are equipped to inlet and outlet of piston cylinder respectively. These two solenoid valves are controlled by chiller temperature controller or microcontroller so that refrigeration capacity can be modulated anywhere within min% ~ 100%. Min% is recommended for start and stop only, not for long-term operation. It is very important for any controller to control loading and unloading in stable condition.



Capacity system control module				
Solenoid valve	SV2	SV1	SV3	SV4
A. 4 step capacity control	—	●	●	●
B. Stepless capacity control	●	●	—	—
C. Dual capacity control	●	●	●	●

● : Installation — : No installation

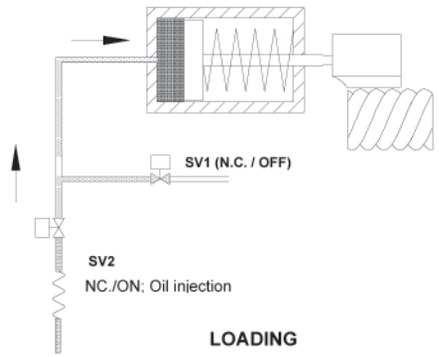
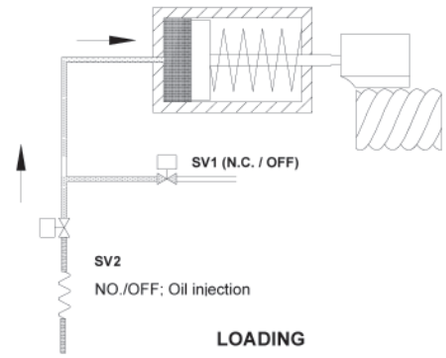
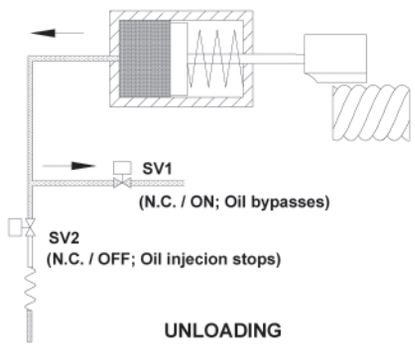
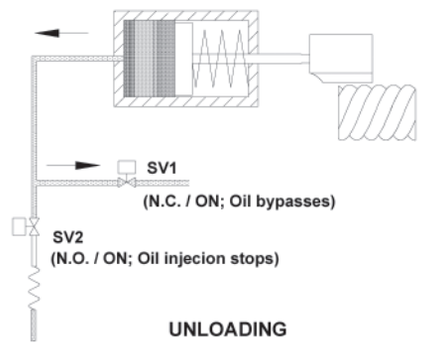
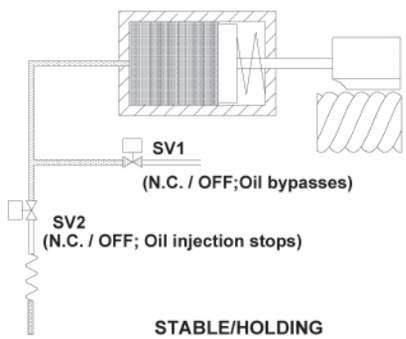
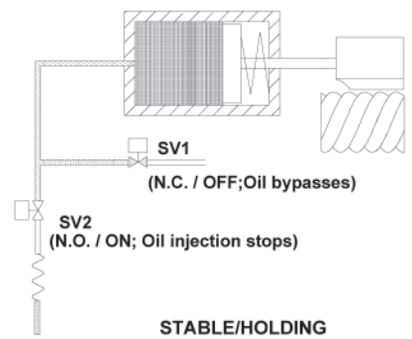
Stepless capacity control				
	SV2	SV1	SV3	SV4
Start	△	▲	—	—
Loading	▲	△	—	—
Unloading	△	▲	—	—
Stable	△	△	—	—

▲: energised △: not energised

Figure 9 Stepless capacity control

Note:

1. In continuous (stepless) capacity control system, Hanbell installs two normally closed solenoid valves as standard accessory. If it is necessary to be equipped with other type of solenoid valves, please specify it when placing orders.
2. If customers prefer to remove unloading orifice plug or equip with loading orifice plug for system applications, please specify it when placing orders
3. Normally opened solenoid valve SV2 (for loading) is optional.

Capacity Modulation	NC SV2 (Standard)	NO SV2 (Option)
a. Loading Standard: When NC SV2 is energised but NC SV1 is not energised, oil will be injected continuously into piston cylinder and will not bypass through NC SV1 so compressor keeps loading. Option: When both NO SV2 and NC SV1 are not energised, oil will be injected continuously into piston cylinder and will not bypass through NC SV1 so compressor keeps loading.		
b. Unloading Standard: When NC SV1 is energised but NC SV2 is not energised, oil inside piston cylinder will bypass to suction port through NC SV1. Option: When both NO SV2 and NC SV1 are energised, oil inside piston cylinder will bypass to suction port through NC SV1.		
c. Stable/Holding Standard: When both NC SV2 and NC SV1 are not energised, piston can be held in stable/holding position. Option: When NO SV2 is energised but NC SV1 is not energised, piston can be held in stable/holding position.		

Continuous/stepless capacity control principle

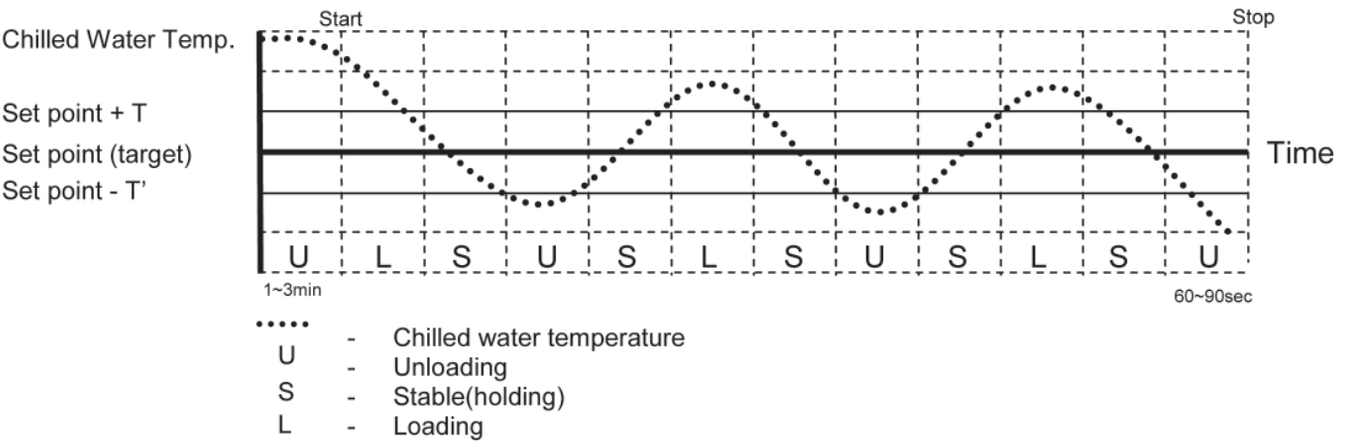
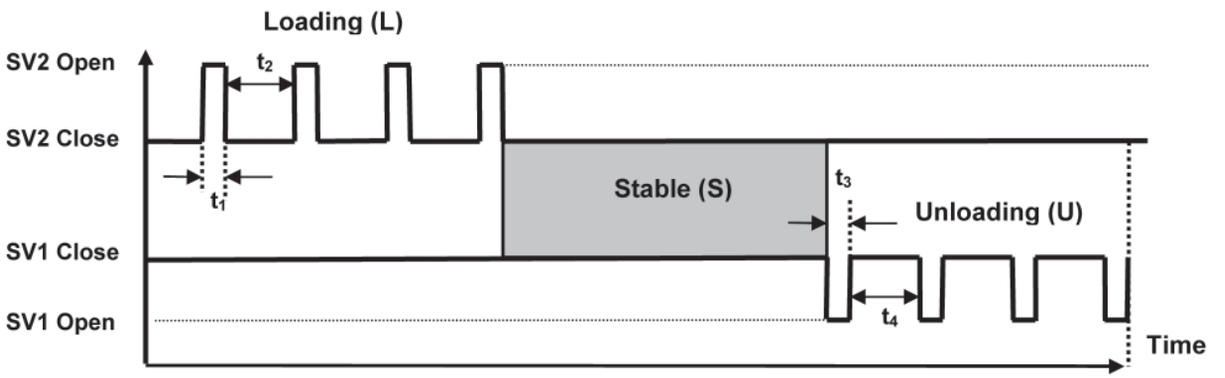


Figure 10 Continuous/stepless capacity control principle

Note:

1. Above T & T' should be determined by system designer's experience and end user's application.
2. Capacity control must be kept at unloading for 1~3 min before start and for 60~90 sec before stop.

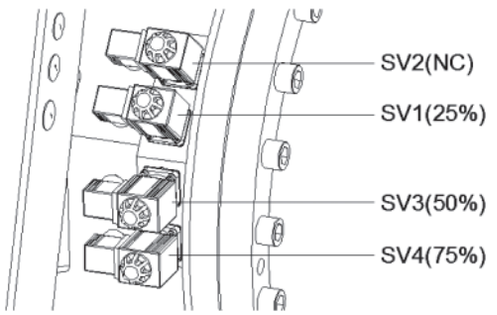
Loading/unloading functions



t_1, t_3: Pulse time 1 ~ 1.5 seconds
t_2, t_4: Pause time 15 ~ 20 seconds

Figure 11 Loading and unloading functions

2.7 Dual capacity control system (optional)



Capacity system control module				
Solenoid valve	SV2	SV1	SV3	SV4
A. 4 step capacity control	—	●	●	●
B. Stepless capacity control	●	●	—	—
C. Dual capacity control	●	●	●	●

● : Installation — : No installation

Figure 12 Dual capacity control

Hanbell can provide compressors with capacity as shown in Figure 12, and the control logic is the same as shown in chapter 2.7 and 2.8.

2.8 Compressor volume ratio (Vi)

The volume ratio (Vi) of the compressor can be defined as the ratio of suction volume to discharge volume in the compressor. The smaller the concavity of slide valve in the discharge end, the larger the volume ratio. The volume ratio directly affects the internal compression ratio (Pi). Low Vi corresponds to low Pi and high Vi corresponds to high Pi. In the equation below, in order to prevent over or under compression, the system compression ratio (CR) should be equal to compressor's internal compression ratio (Pi). Please refer to the P-V (Pressure-Volume) diagram below to figure out this relation.

CR = Pd/Ps
Pi = Vi ^{k}
Vi = Vs/Vd

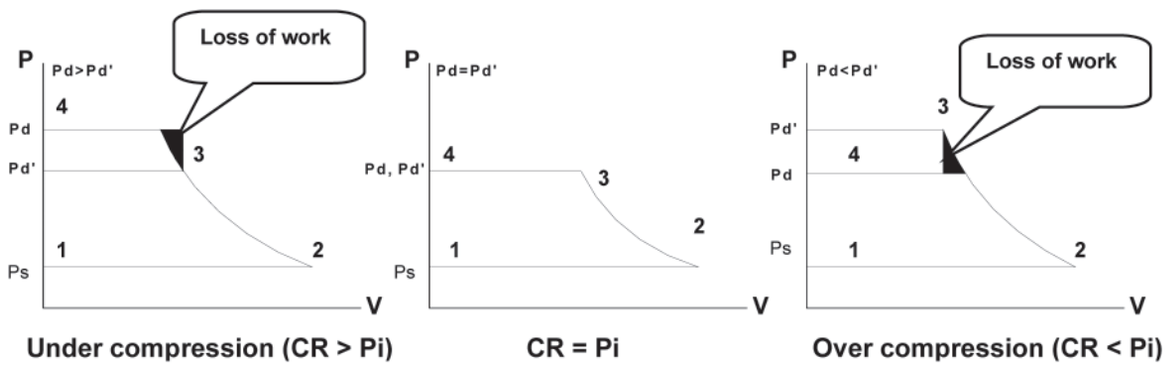
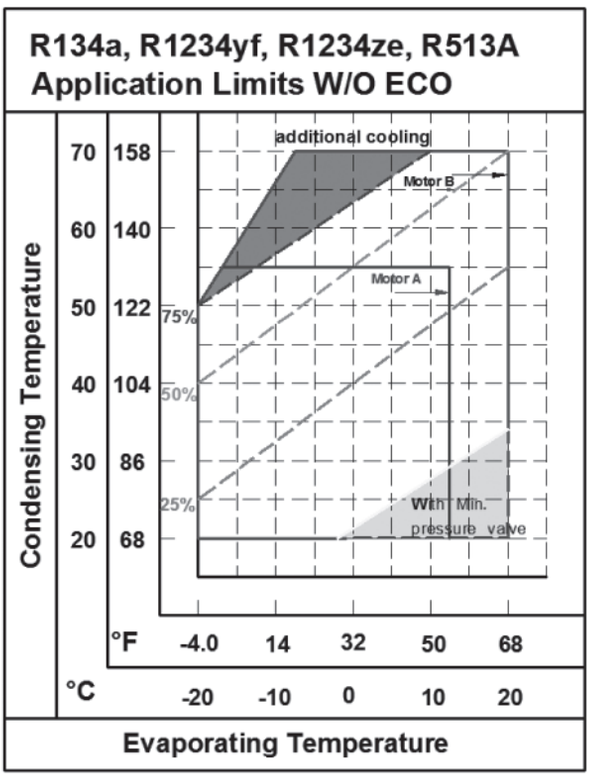


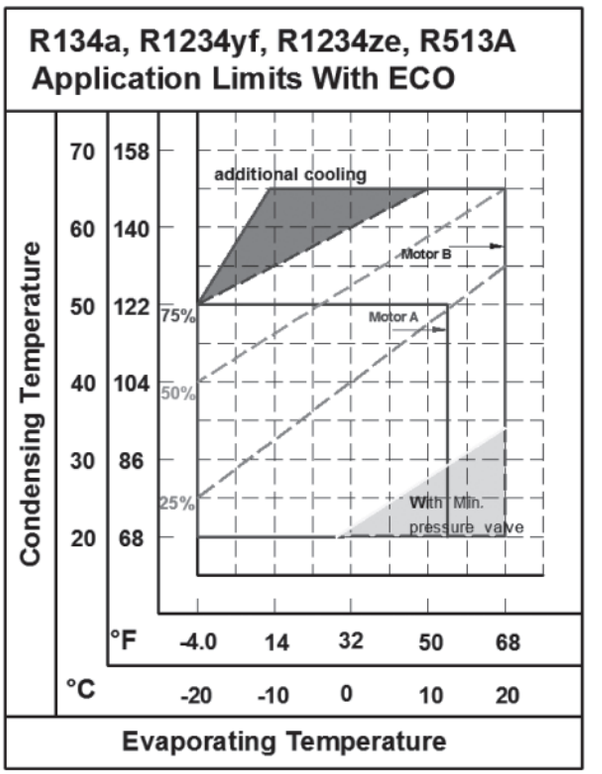
Figure 13 P-V Diagram

Where: **CR**: system compression ratio
Vi: internal volume ratio
Pd': discharge pressure (absolute pressure)
Vs: suction volume
Pi: internal compression ratio
Pd: system pressure (absolute pressure)
Ps: suction pressure (absolute pressure)
Vd: discharge volume **K**: refrigerant specific heat ratio

2.9 Application limits

Application limits of the compressor vary significantly with the type of refrigerant used. The operating limits shown below are based on saturated suction and discharge operating conditions, for continuous operation over extended periods of time. It is important to operate within these limits to maintain proper compressor life.





Note:

1. When the Hanbell screw compressor operates in partial or full load within limits, temperature of motor coil and discharge will rise concurrently. In order to keep the safe running of compressor continuously, Hanbell recommends application of the following additional cooling devices:

   (1) Oil cooler or (2) Liquid injection to chamber or (3) Liquid injection to motor.

   Please refer to the Hanbell selection software for application of additional cooling system.

   It is recommended to monitor oil-supplied pressure and maintain it at least 4 kg/cm^{2}G higher than suction pressure for adequate sealing, lubrication and capacity control or installation of oil pump or minimum pressure valve. Especially under operating conditions with low condensing temperature and high evaporating temperature like application in flooded water cooled chillers, high-low pressure difference tends to be less than 4 kg/cm^{2}G, and installation of oil pump is recommended to ensure regular oil pressure. Contact Hanbell to verify potential operating conditions outside the limits shown.
2. If compressors run continuously at partial load below 50%, failure of motor coils might happen due to insufficient cooling. Therefore, Hanbell emphasises installation of liquid injection system to motor to ensure adequate cooling of motor coils for safe running of compressors. According to EN12900, suction superheat is 10°K and liquid sub-cooling is 0°K.
3. The minimum discharge superheat is recommended to be kept 10°K higher than the condensing temperature (normally discharge superheat is around 20°K for R134a) to avoid liquid filling back to the compressor and lubrication failure.
4. Please contact Hanbell for the Application Range for R22.

3. Lubricants

The main functions of lubrication oil in screw compressors are lubrication, internal sealing, cooling and capacity control. Positive oil pressure in the cylinder pushes the piston together with the slide valve that is connected by a piston rod to move forward and backward in the compression chamber. The design of positive pressure differential lubrication system makes RE series normally omit an extra oil pump which is necessary for reciprocating compressors. However, in some special applications, it is still necessary to install an extra oil pump to screw compressors for safety. Bearings used in RE series compressors require small and steady volume of oil for lubrication. Oil injection into the compression chamber creates a film of oil for sealing in the compression housing to increase efficiency and also can dissipate part of compression heat. In order to separate oil from refrigerant gas, an external oil separator is required to ensure the least amount of oil carried into the system.

Please pay more attention to the oil temperature, which is crucial to compressor bearings' life. Oil is with much lower viscosity at high temperatures. Too low viscosity of oil will result in poor lubrication and heat dissipation in the compressor. Viscosity is recommended to be kept over 10mm^2/s at any temperatures for oil. Oil temperature in the oil sump should be kept above the saturated condensing temperature to prevent refrigerant migration into lubrication system. Oil has a higher viscosity in low ambient temperature circumstances. When viscosity is too high, slow flow speed of oil into the cylinder may result in too slow loading of the compressor. To solve this problem, use of oil heaters can warm up oil before starting.

If the compressor operates under critical operating conditions, an extra oil cooler is required – please refer Hanbell selection software for the required capacity and oil flow of the extra oil cooler. High-viscosity oil is recommended to be applied in high operating conditions because high discharge temperature will make viscosity of oil lower. Oil return from the evaporator may be insufficient in refrigeration systems, flooded chillers, etc., in which it's difficult for oil to be carried back and it may cause oil loss in the compressor. If the system encounters the oil return problem then a second oil separator is recommended to be installed between the compressor discharge side and condenser.

Each of the Hanbell RE series screw compressors has a low oil sight glass. The oil level in the compressor oil sump should be full of the sight glass when compressor is running. It is recommended to install the optical oil level switch (optional accessory) to prevent failure due to loss of oil.

3.1 Lubricants table

Applicable oil types (R134a)

SPECIFICATION		UNITS	HBR-B05	HBR-B08	HBR-B09	HBR-B04
COLOUR, ASTM			-	-	-	-
SPECIFIC GRAVITY			0.945	0.94	0.95	0.95
VISCOSITY	40°C	mm^2/s (cSt)	64	131	175	215.9
	100°C		8.9	14.53	16.5	20.8
FLASH POINT		°C	266	254	265	271
POUR POINT		°C	-43	-36.5	-30	-25
T.A.N		mg KOH/g	-	-	-	-
COPPER STRIP		100°C/3hr	-	-	-	-
MOISTURE		ppm	-	-	-	-
FLOC POINT		°C	-	-	-	-
DIELECTRIC STRENGTH (2.5mm)		kV	-	-	46.6	-

Applicable oil types (R134a)

SPECIFICATION		UNITS	HBR-B10	HBR-A02	HBR-A04	HBR-B09	HBR-B02	HBR-B01
COLOR, ASTM			1.5	L1.0	L1.0	-	-	-
SPECIFIC GRAVITY			0.883	0.914	0.925	0.95	1.01	1.05
VISCOSITY	40°C	mm^2/s (cSt)	56.0	54.5	96.5	175	168	298
	100°C		7.0	6.07	8.12	16.5	20.2	32.0
FLASH POINT		°C	220	188	198	265	290	271
POUR POINT		°C	-40	-35	-25	-30	-43	-35
T.A.N		mg KOH/g	0.01	0.00	0.01	-	-	-
COPPER STRIP		100°C/3hr	1a	1a	1a	-	-	-
MOISTURE		ppm	15	20	20	-	-	-
FLOC POINT		°C	-75	-45	-35	-	-	-
DIELECTRIC STRENGTH (2.5mm)		kV	75	50	50	46.6	-	

Note: For other applicable oil types (HFO Refrigerant), please consult Hanbell firstly for approval.

3.2 Precautions of changing oil

1. Use only qualified oil and do not mix different brands of oil together. Selection of oil should match characteristics of the refrigerant used. Some types of synthetic oil are incompatible with mineral oil. Oil that remains in the compressor should be totally cleaned up in the system before charging different brands of oil. Charge the compressor with oil for the first start and then change it into new oil again to ensure that there's no mix at all.
2. When using polyester oil for chiller systems, please make sure not to expose oil to the atmosphere for prevention of change in its property. Therefore, it is necessary to vacuum the system completely when installing the compressor.
3. In order to ensure no moisture inside the system, it is suggested to clean the system by charging it with dry Nitrogen and then vacuum it repeatedly as long as possible.
4. It is a must to change the oil in motor burned out case, because acid debris may still remain inside the system. Please follow the procedures mentioned above to change oil in the system. Check acidity of oil after 72 hours of operation and then change it again until acidity of oil becomes normal.
5. Please contact Hanbell local distributors/agents for selection of oil.

3.3 Oil change

1. Change oil periodically. Check lubrication oil every 10,000 hours of continuous running. For the first operation of the compressor, it is recommended to change the oil and clean the oil filter after running 2,000 hours. Check the system, whether clean or not, and then change oil every 20,000 hours or after 3 years' continuous running while the system operates in good condition.
2. Avoid clogging in oil filter with debris or swarf which may cause failure in bearings. An optional oil pressure differential switch is recommended to be installed. The switch will trip when the oil pressure differential between the primary and secondary sides reaches the critical point and then the compressor will automatically shut down to prevent the bearings from damage due to oil loss.

4. Compressor handling and installation

4.1 Compressor lifting

Each Hanbell screw compressor has been carefully tested at the factory and all precautionary measures have been taken to make sure that compressors will keep in perfect condition when reaching customer's works. After the compressor arrives at your warehouse, please check if its crate is kept in good condition and check all the compressor accessories with shipping documents to see if there is any discrepancy.

When lifting the compressor, it is recommended to use a steel chain or steel wire which can be used for loading capacity of 1,500kgf as shown in the figure below. Make sure that chains, cables or other lifting equipment are properly positioned to protect the compressor and its accessories from damage. Keep the compressor in horizontal position when lifting, and prevent it from crashing or falling on the ground, hitting the wall or any other accident that may damage it or its accessories.

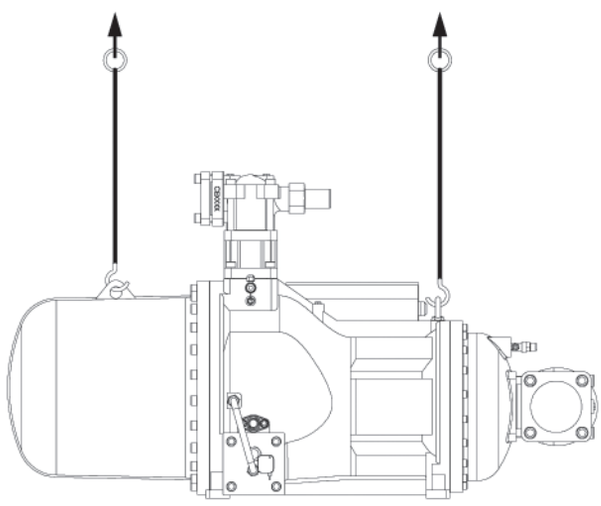


Figure 14 Lift the compressor with steel chain or steel cable

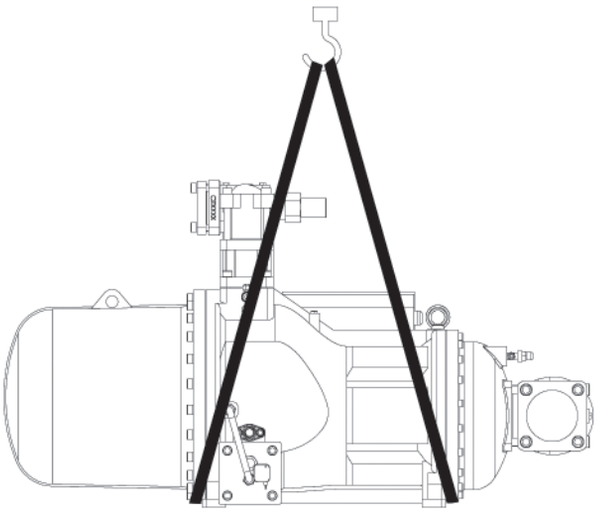


Figure 15 Lift the compressor with safety ropes

4.2 Mounting the compressor

The installation of the compressor in the refrigeration system should be accessible and make sure that the chiller base or site is far enough from heat source to prevent heat radiation. The compressor should also be installed as close as possible to the electrical power supply for easier connection and must have good ventilation with low humidity at site. Make sure that the frame or supporter is strong enough to prevent excessive vibration and noise while the compressor is running and has enough space for the compressor's future overhauling work.

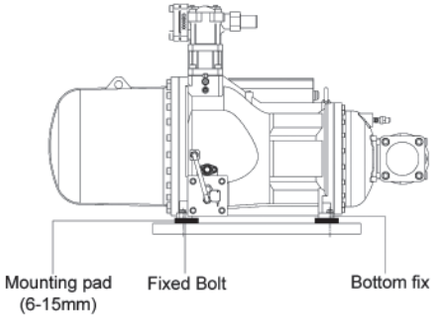


Figure 16 Installation of anti-vibration pads

The compressor must be installed horizontally and in order to prevent excessive vibration transferred by the structure and piping of the chiller while in operation, the cushion or anti-vibration pad should be installed. The installation of the anti-vibration pad is shown in Figure 16. The screws should only be tightened until slight deformation of the rubber pad is visible.

Note: It is strongly recommended to position the compressor higher than the evaporator.

Suggestions on piping works

The unsuitable piping works done to the compressor could cause abnormal vibration and noise that might damage the compressor. Take notice of the following pointers to prevent this situation from happening:

1. Cleanliness of the system should be maintained after welding the piping to avoid any swarf or debris contained inside the system as it may cause serious damage to the compressor during operation.
2. In order to reduce the vibration on the piping tubes, it is recommended to use copper tube to be the suction and discharge piping tubes. Copper tubes are better to minimise the vibration in the piping while the compressor is in operation. In case steel tubes are used in the piping system, suitable welding works are very important to avoid any stress in the piping. This inner stress can cause harmonic vibration and noise that can reduce the life of the compressor. If a large-calibre copper tube is not easily accessible and a steel tube is used instead in suction port, Hanbell also recommends the use of a copper tube in the discharge port to best minimise abnormal vibration and noise.
3. Remove the oxidised impurities, swarf or debris caused by welding in the piping tubes. If these materials fall into the compressor, the oil filter might be clogged and result in the malfunction of lubrication system, bearings and capacity control system.
4. The material of suction and discharge flange bushings is forged steel and it can be welded directly with piping connectors. After welding the flange bushing and pipes, it must be cooled down by ambient air. Do not use water to cool it down because water quenching is prohibited.

Installing the compressor in a sloping position

Figure 17 shows a 15° limit of oblique angle for installation of compressor. In case the oblique angle is higher than the limit, compressor will be shut down easily. For special applications like the installation in ships, fishing boats, etc., where the oblique angle might exceed the limit, external oil separators, oil tanks and related accessories are recommended to be installed. Please contact Hanbell or local distributors for further layout recommendations.

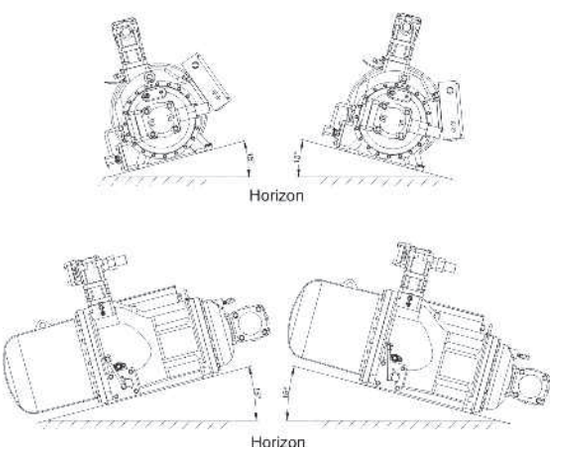


Figure 17 Limits of oblique angle for the installation of the compressor

INT69HBY diagnose control module and PTC temperature sensor

To protect the compressor, each RE series compressor has been installed with three PTC temperature sensors inside the motor coil and another one at the discharge side of compressor. These sensors are connected to an INT69HBY diagnose control module to monitor the motor and discharge temperature. If the temperature in one of the positions monitored exceeds the nominal response temperature of the respective PTC thermistor, the sensor resistance increases and the INT69HBY diagnose control module output relay trips. The module resets when the temperature drops below the response temperature by approximately 5K. The output replay provides a potential-free change-over contact and is energised as long as the nominal response temperature is not exceeded.

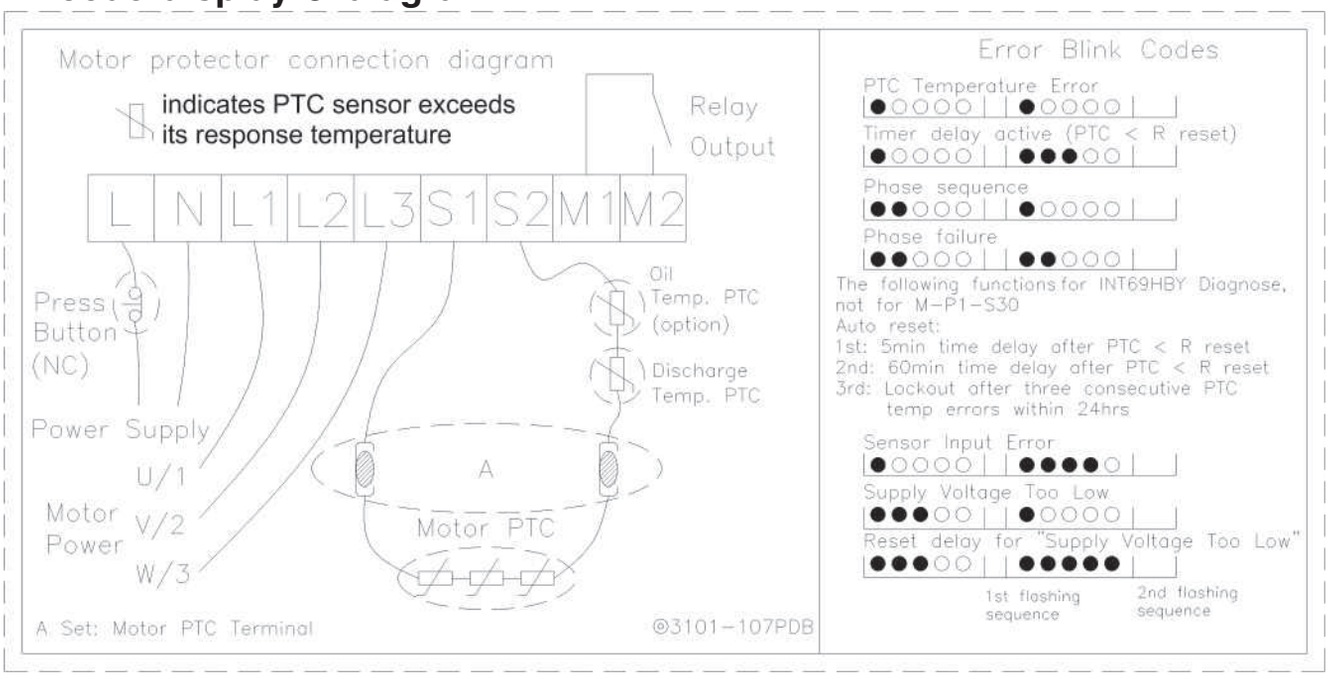
Other major functional descriptions are as follows:

1. The temperature monitoring in the motor winding is done according to the static evaluation process; the motor is switched off immediately if the nominal response temperature of the built-in AMS or PTC sensors is reached.
2. A short circuit at an AMS or PTC input also leads to a switch-off. A short cycling leads to a reset delay.
3. After cooling down or elimination of the error and a subsequent reset delay, the compressor can be restarted; restarting after locking and reset only.
4. The phase monitoring of the motor voltage is active for one second after the start of the motor. The correct phase sequence is monitored for five seconds, the phase failure is monitored for the total motor running time. If a wrong phase sequence is detected or there is a phase failure, the motor protector will lock the switch off.
5. For operation in the specified manner, the supply voltage has to be on permanently on the INT69 HBY Diagnose.
6. A dual LED (red, orange/ green) provides additional information about the motor protector and compressor status.

Technical data:

- **Supply voltage:** 115/240V±10%, 50/60Hz, 3-phase, AC
- **Relay output:** max. 240V AC, max. 2.5A, C300
- **Ambient temperature:** -30°C ~ +70°C
- **Phase monitor:** 200 ~ 690V±10%, 50/60Hz, 3 AC

Blink code display & diagram:



Oil heater

A UL-approved oil heater has been installed in every compressor as a standard accessory. Before restart of compressor after shutdown for a long time, please turn on the oil heater for at least 8 hours to make the temperature inside compressor higher than system temperature and ambient temperature to prevent condensation of refrigerant inside the oil sump of compressor which may result in liquid compression on the next start and poor lubrication due to too low viscosity of lubricant oil.

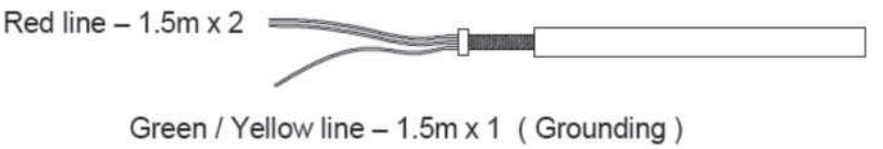


Figure 18 Oil heater

Specification: F 300W; 110V or 220V; IP 54; UL-approval

Note: If compressor is installed in low ambient temperature, it is recommended to insulate oil separator against cold ambience.

Optical oil level switch (optional accessory)

To prevent optical oil level switch trip caused by oil foaming or surging in the sump, a time delay of around 10 ~ 15 seconds is recommended before shutdown of the compressor.

Operating Power, or	AC 50/60Hz 230V
Motor Power Sense Line Voltage, or	AC 50/60Hz 230V
Ambient Temperature Range	- 30°C ...+ 85°C
Maximum temperature at prism	+ 120°C
Delay on power on	< 1 second
Delay until relay off from detection of oil loss	3 second
Relay rating data	5A/250V AC
Connection Cable	5 x 0.5mm², length=1 metre, colour coded

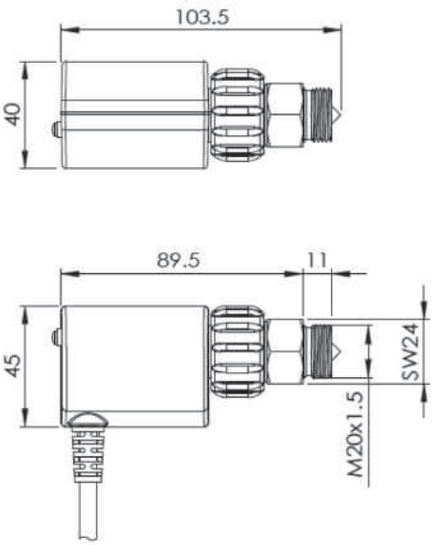


Figure 19 Optical oil level switch

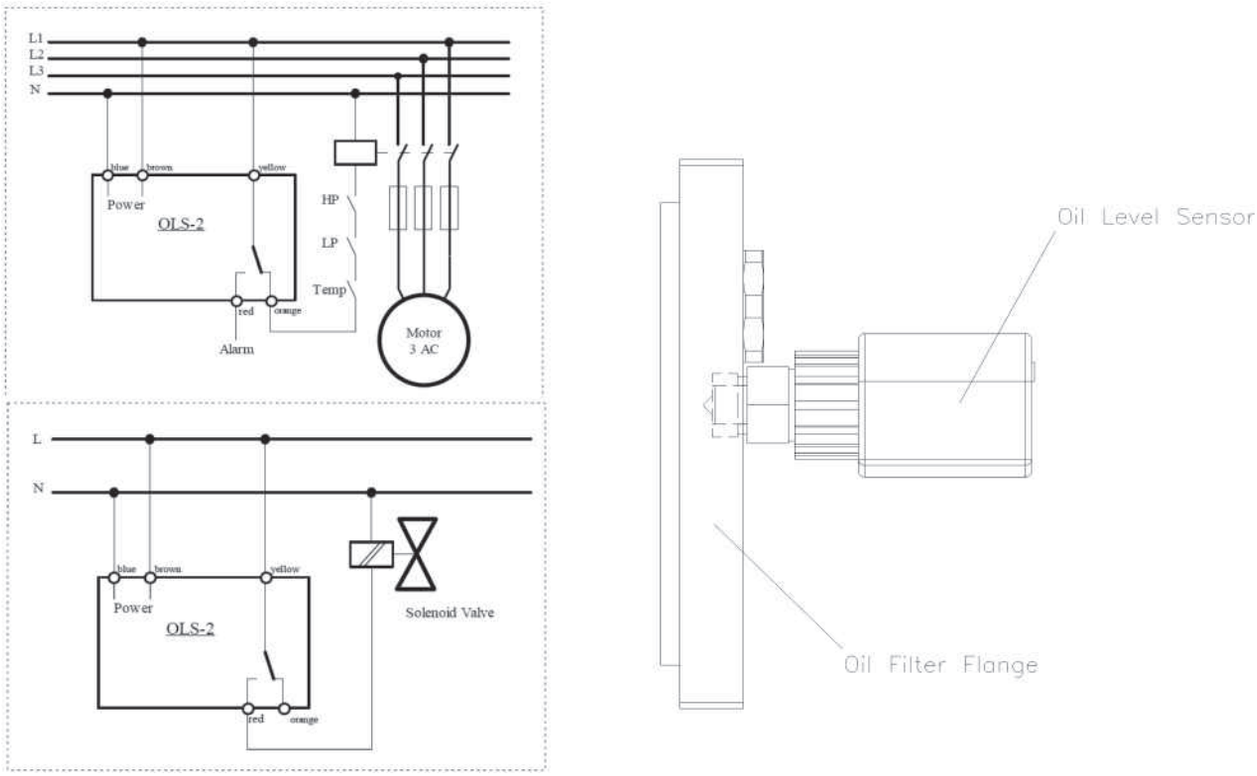


Figure 20 The installation & connection diagram of optical oil level switch

Oil drain valve

Oil drain valve is installed in compressor to drain out oil for maintenance.

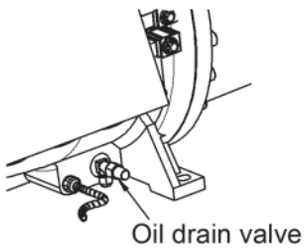


Figure 21 Oil drain valve

IP54 cable box

Hanbell designs and makes the cable box which meets the IP54 protection degree. For dimensions of cable (for motor power line and control power line) refer to the drawing below:

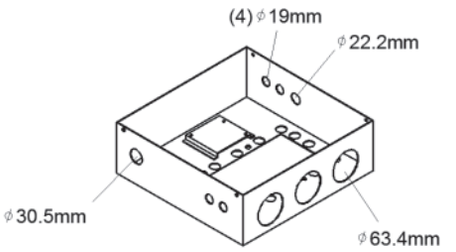


Figure 22 Cable box

Horizontal check valve installation

Horizontal check valve is standard accessory of RE series compressor. Considering limitation of clearance for installation, horizontal check valve would be the alternative to aforementioned vertical check valve for RE series compressor. Please refer to section C. For dimension of horizontal check valve. The installation drawing is as below:

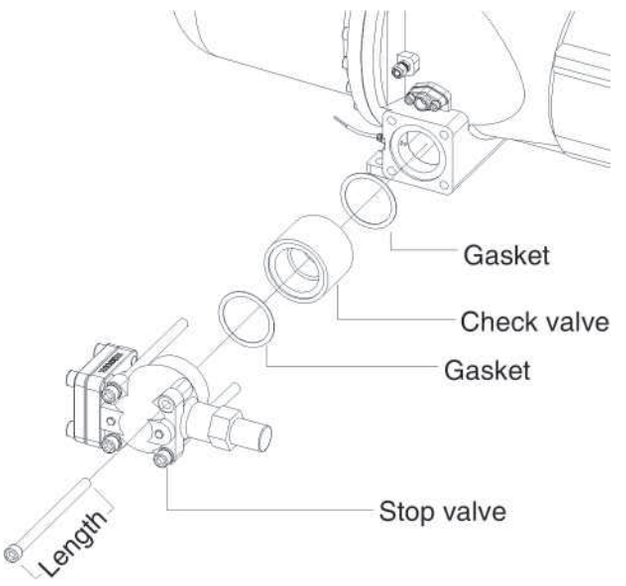
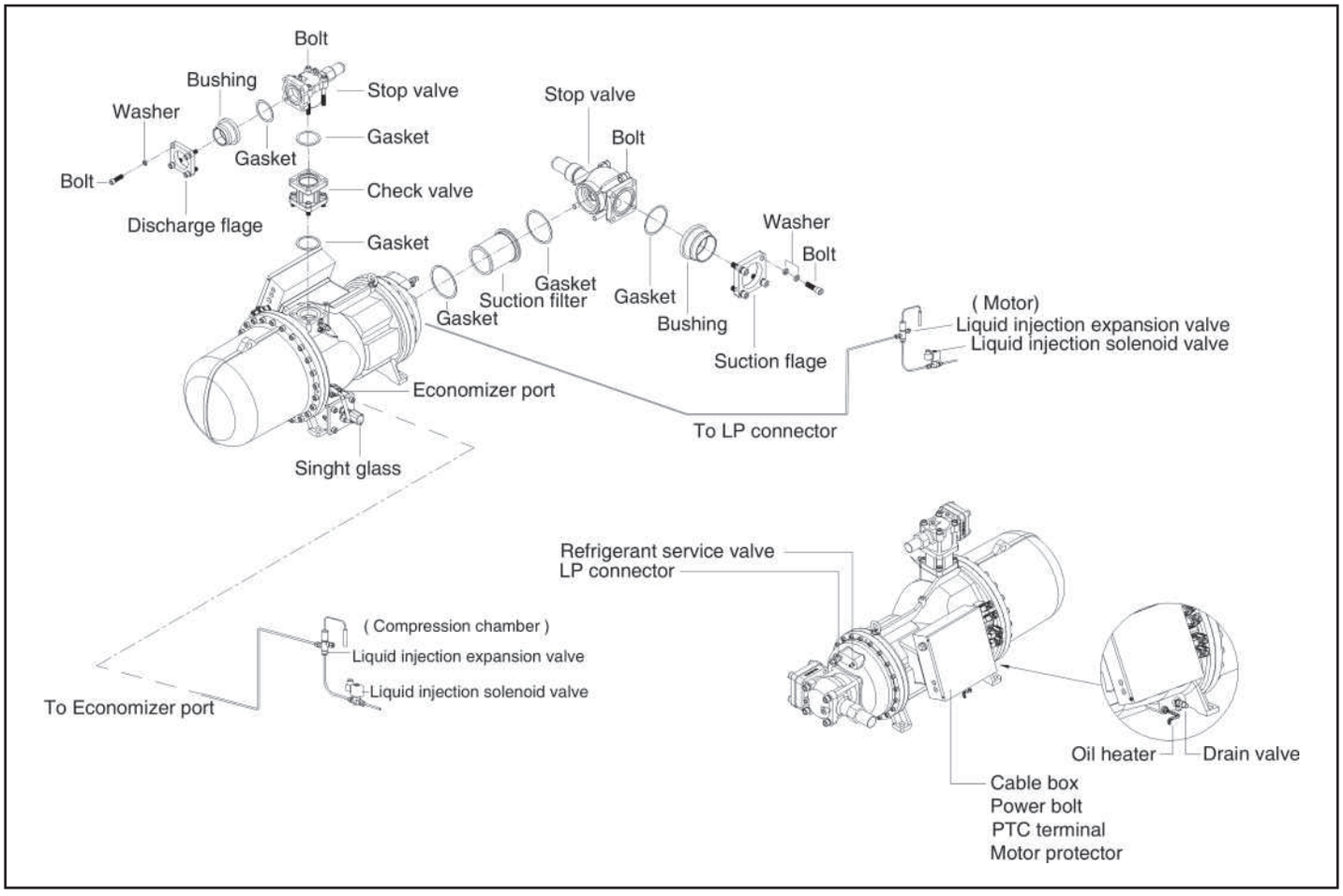


Figure 23 Installation of horizontal check valve

Installation of compressor

The diagrams below show the installation and connection of compressors:



5. Electrical data and design

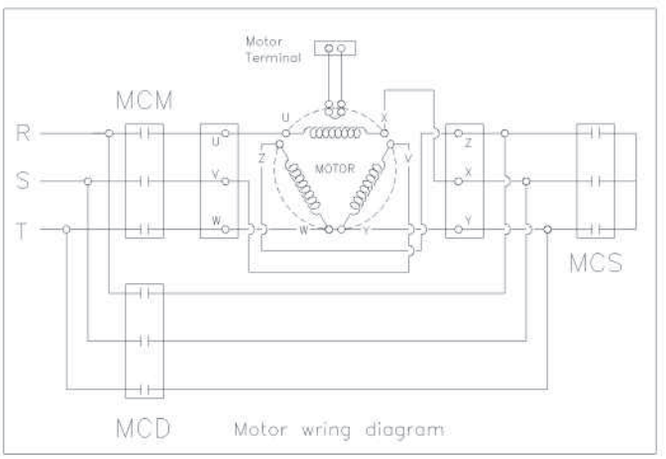
5.1 Motor design

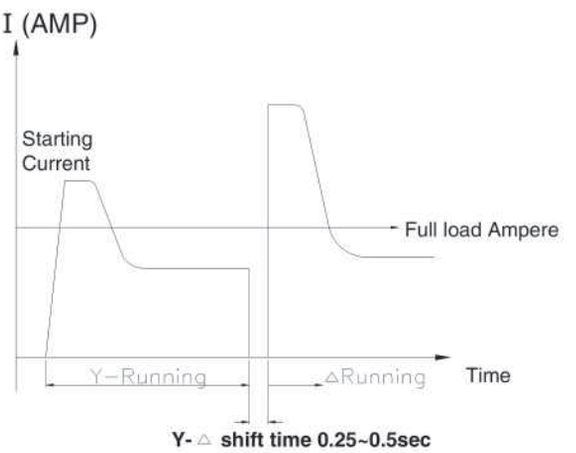
Hanbell RE series screw compressors are fitted with Y-△ motor as standard and △/△△ motor (Part Winding Starting - PWS) is also available for model RE-230~RE-550

Y-△ starting

Y-△ motor connects motor coil by Y connection during starting therefore reducing voltage on coils to 1/√3 of input voltage and reconnects motor coil by △ connection after starting. By doing so, we can decrease starting current, through voltage drop, i.e., so-called voltage-drop starting.

In Y connection, MCM and MCS are inductive while motor leads Z, X, Y are tied together as a neutral connecting as Y fashion. A few seconds later (3~5 sec is recommended), MCM and MCS become deductive. Around 0.25 sec later, MCM and MCD are inductive, leading to △ run connection.





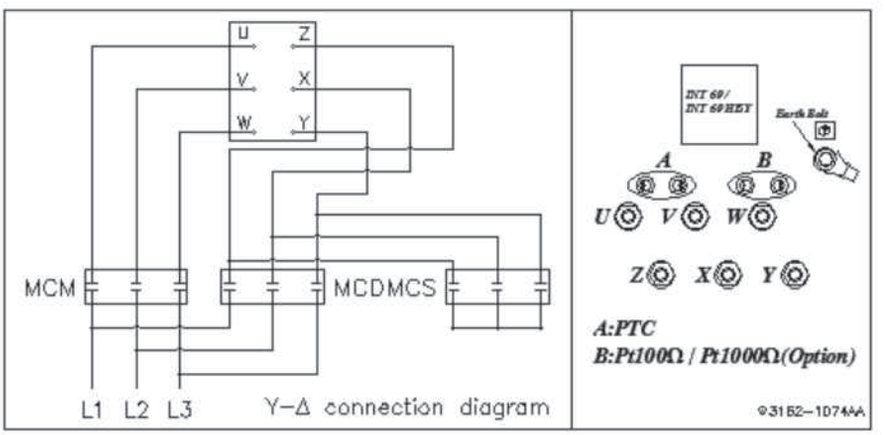


Figure 24 Y-△ Starting diagram

Attention:

After Y start, MCM and MCS are deductive for 0.25 sec and then MCM and MCD are inductive for △ run. Within as transient as 0.25 sec, pseudo short circuit might occur due to inappropriate action of contactors, causing trip of compressors.

When it occurs, we recommend usage of adjustable Y-△ dedicated timer or slightly lengthened span of time for MCM and MCS deduction – MCM and MCD reinduction from 0.25 sec to 0.5 sec directly in the microcontroller or PLC program.

Please refer to Y-△ shift time diagram for details. Because motor is not powered during Y-△ shift, shorter Y-Ä shift span is suggested to prevent second start due to decreased rotation speed. However, if Y-△ shift span is too short, the aforementioned pseudo short circuit might occur.

Characteristics of Y-△ starting

1. Starting current in Y connection is 1/3 of lock rotor ampere.
2. Starting torque in Y connection is 1/3 of lock rotor torque.
3. Acceleration of motor rotor becomes smaller at full-load starting. Therefore compressors require starting at partial load.

△/△△ (PW) starting

RE-230~RE-550 are available to be fitted with PWS motor for customer's application as an optional accessory. Please refer to the following diagram for the wiring of PWS motor.

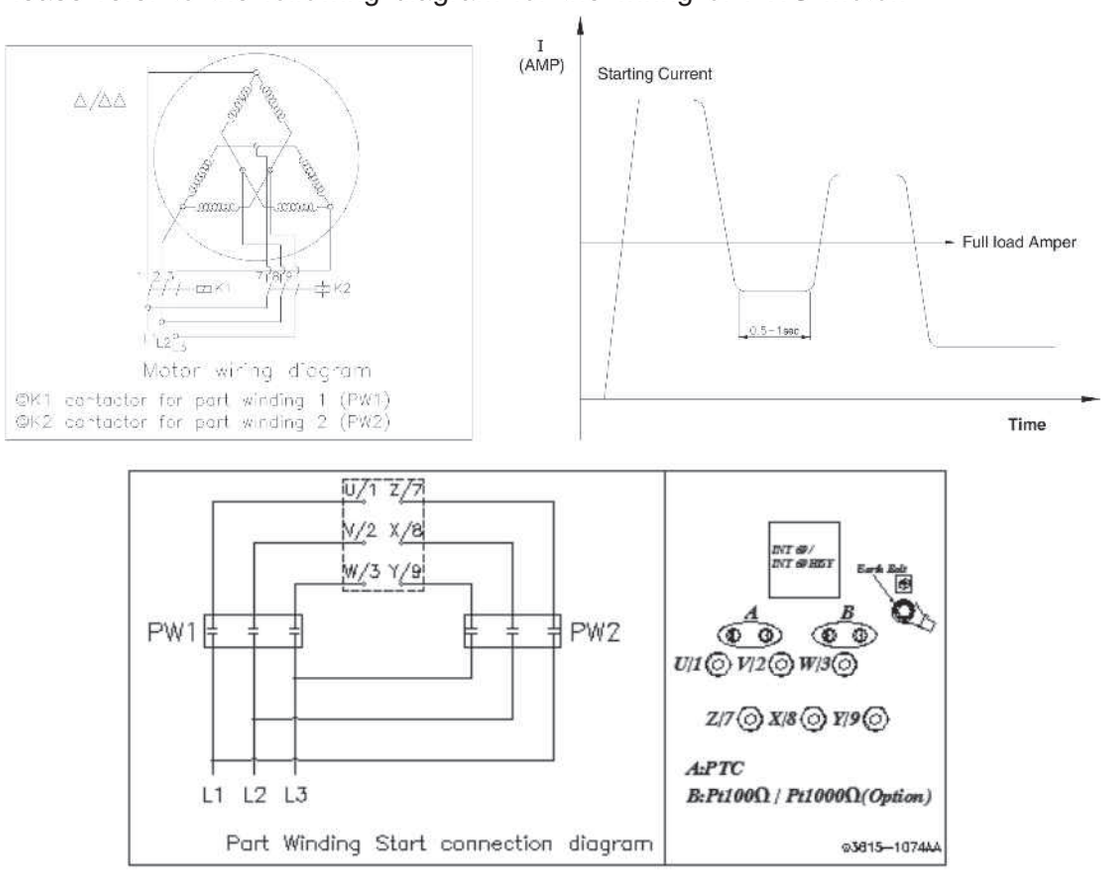


Figure 25 △/△△ (PW) starting diagram

The selection of both of each of the motor contactors (k1/k2) is for approximately 60% of the maximum running current. The recommended time delay of the switching relay k1 is to be set at 0.5 second and not more than 1 second.

PWS starting features

The starting current is around 40% ~ 70% of full-winding Locked Rotor Current. It depends on the design and motor size, and low starting torque.

Direct-online features

The starting equipment consists of only a main contactor and thermal or electronic overload relay. During a direct-online (DOL) start, the starting torque is very high, and is higher than necessary for most applications. The disadvantage with this method is that it gives the highest possible starting current. Please refer to the following diagram for the wiring of DOL starting.

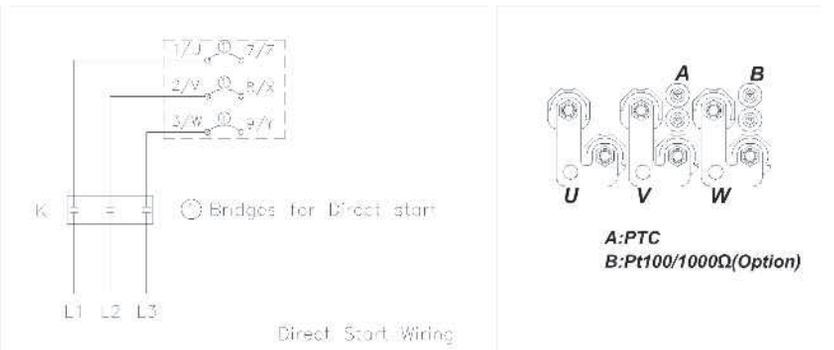


Figure 26 DOL starting diagram

Soft starting features

A soft starter is different from other starting methods in characteristics. It has thyristors in the main circuit, and the motor voltage is regulated with a printed circuit board. The soft starter's advantage is that when the motor voltage is low during start, the starting current and starting torque is also low. Please refer to the following diagram for wiring of soft starting.

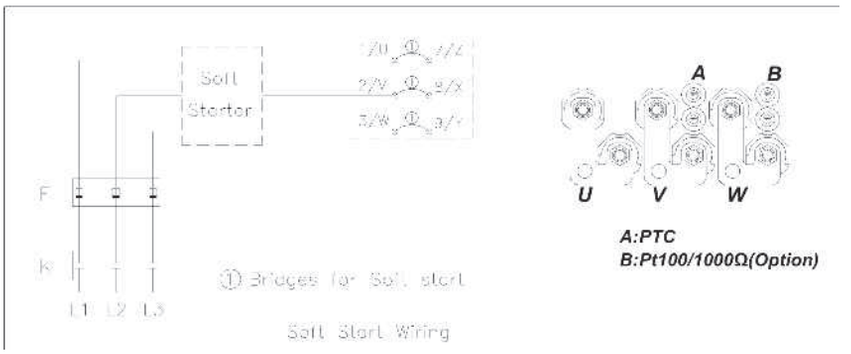


Figure 27 Soft starting diagram

Besides Y-△ and PWS start, if there is any inquiry of direct-online start, soft start, inverter start or series reactance reduced voltage start, please contact Hanbell for further information.

Attention:
Ensure the power supply wiring and output motor wiring are connected to the correct terminals. Any mistake could cause catastrophic failure of compressor motor.

5.2 Compressor protection devices

The table below shows the list of protection devices which are essential to protect the compressor and operate safely. Follow the protection devices listed in the below table to ensure the compressor is running under normal condition.

Protection device	Setpoint	Remark
Motor wiring temperature protector (PTC sensor)	Trip at 110°C, 100°C*	Standard
Discharge temperature protector (PTC sensor)	Trip at 110°C, 100°C*	Standard
Phase reversal protector (INT69HBY)		Standard
Phase failure protector (INT69HBY)		Standard
Oil temperature sensor	Cutin 100°C, cutout 90°C (Air cooled, heat pump, or refrigeration system) Cutin 80°C, cutout 70°C (Water cooled or flooded system)	Optional
Optical oil level switch	Time delay setting: 10~15 seconds	Optional
Oil filter pressure differential switch	Trip at 1.5 kg/cm^{2}g	Optional
Oil pressure differential switch	Oil inlet pressure should be 4 kg/cm^{2}g higher than the suction pressure. When it is not 4kg/cm^{2}g higher than the suction pressure, it is necessary to add a minimum pressure valve or an oil pump to ensure proper oil supply	Optional
Oil flow switch	Time delay setting: 10~15 seconds	Optional
Pt1000 (standard) or Pt100 (optional) for liquid injection to motor chamber.	Depends on customer's application. Suggest cutin 60°C, cutout 50°C	Standard/ Optional

*Manual reset suggested

Motor thermistors and discharge thermistors are temperature sensors with quick response while the temperature approaches the setpoint; thermistors must be connected in series to a controller (INT69HBY) in terminal box as a guardian to protect compressor. Alarm lamp for this protector is required to be embedded on control panel as indicator. Any intention to short controllers for starting of compressors is prohibited. It is beyond Hanbell warranty for compressors if any of the above mentioned actions are found.

Note:

When any protection device trips, please do troubleshooting and reset manually. Do not let the compressor reset automatically after abnormal trip.

5.3 Power supply

1. Limitation of power supply

a. Voltage limitation

Long-term running: rated voltage ±5%

Instant running: rated voltage ±10%

b. Frequency:

Rated frequency ±2%

Note:

In the region where the electricity power is unstable, install an additional hi-low voltage protector with ± 5% tolerance of normal voltage to ensure safe operating of the compressor.

2. Unbalanced voltages:

Unbalanced voltages usually occur because of variations in the load. When the loading on one or more of the phases are different from the others, unbalanced voltages will appear. This can be due to different impedances, type, and value of loading in each phase. Unbalanced voltages may cause serious problems, particularly to the motor.

NEMA defines voltage unbalance as follows:

$$\text{Percent voltage unbalance} = 100 \times \frac{\text{(Maximum voltage deviation from average voltage)}}{\text{(Average voltage)}}$$

NEMA states that polyphase motors shall operate successfully under running conditions at rated load when voltage unbalance at the motor terminals does not exceed 1%. Furthermore, operation of a motor with over 5% unbalance is not recommended for it probably results in motor damage.

Unbalanced voltages at motor terminals cause phase current unbalance ranging from 6 to 10 times the percent of voltage unbalance for a fully loaded motor. This causes motor overcurrent resulting in excessive heat that shortens motor life, and hence, eventual motor burnout. If the voltage unbalance is significant enough, the reduced torque capability might not be adequate for the application and the motor will not attain rated speed.

Some of the common causes of unbalanced voltage are:

- Unbalanced incoming utility supply
- Open delta connected transformer banks
- Large single phase distribution transformer in the system
- Open phase on the primary 3-phase transformer in the distribution system
- Blown fuse on 3-phase bank of power factor improvement capacitors
- Unequal impedance in conductors of power supply wiring
- Unbalanced distribution of single phase loads such as lighting
- Unequal transformer tap settings
- Faults or grounds in power transformer
- Heavy reactive single phase loads such as welders

A 3-phase unbalanced voltage protector is provided upon request as optional accessory. Please contact Hanbell for more details.

5.4 Grounding

There is a grounding terminal inside cable box. Please accurately connect it to grounding of control panel of the system.

Suggestions:

a. The regular setting of electric leak protection should be greater than 50mA; for a humid location, 25mA is better.

b. Grounding voltage of casing should be no greater than 50V; for a humid location, the limit is 25V.

c. Grounding resistance should be no greater than 500 Ohm.

d. Air Cut Board (ACB) is regularly equipped with electric leak protection. Please refer to related settings for its normal action.

e. If electric leak protection is active, please check if insulation of equipment is normal and if its wiring and setting are correct.

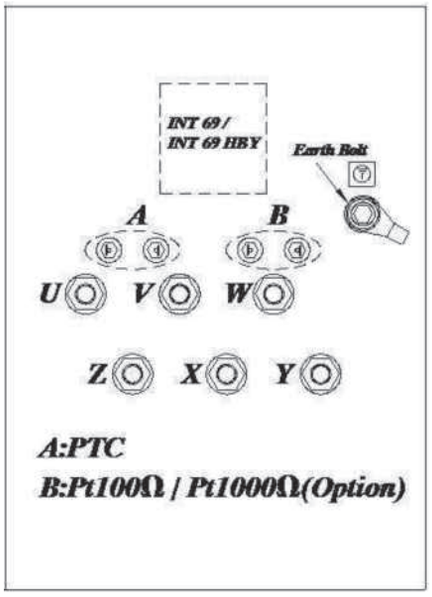


Figure 28 Grounding Terminal

Note:

Please make sure nothing is wrong before turning on the power. If there are any questions, please contact the supplier of equipment.

Rigging Storage and Installation

Rigging

When the chiller arrives at warehouse/site, proper rigging and handling is mandatory during unloading and loading the unit into position.

Care must be taken to keep the unit upright during rigging. Avoid unnecessary jerking or rough handling. Rigging labels are provided on the base frame near lifting slots. Ensure hooks are placed at the specified positions only during rigging.

Proper hoisting straps (nylon flat rope) and spreader bars (as shown in the figure) must be used when rigging. Care must be exercised to avoid twisting/crushing of the equipment.

Storage

In case the site is not ready to install the chiller, proper care should be taken to store the chiller, preferably in a covered space. Chiller is supplied with full tarpaulin cover. Do not remove covers till connecting the chiller with chilled water piping.

Check the pressure of the unit when received. If the system is not holding the pressure, the system should be pressure tested immediately; repair the leakages, if any, and charge the system with nitrogen. Never keep the system without pressure.

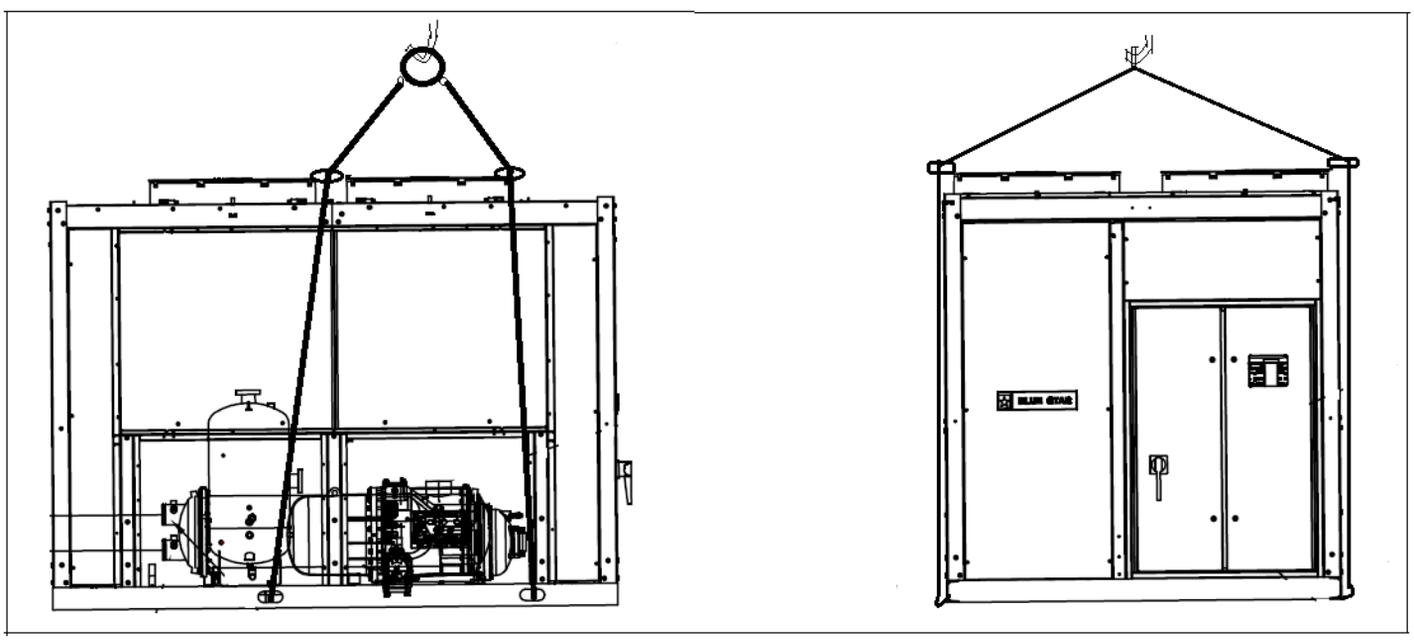


Figure 29 Rigging

Installation

Proper care should be taken to make the foundation for the chiller. In case the chiller is located on rooftop, ensure that the same is located in such a way that the load of the same is transferred to the columns and not to the slab directly. The foundation should be properly levelled. Install the chiller on the foundation/ pedestal by using vibration isolators supplied with the unit as per positions shown in GA Drawings.

The unit should not be located near to any heat source or any high tension line running above. Adequate space around the chiller, as recommended in the GA Drawing, should be made available for maintenance purpose.

The chilled water piping connections to the cooler should be terminated preferably with flexible connections to avoid transmission of vibration, if any. The piping shall be supported external to the unit as per the recommended practice.

Use recommended size of power cable to be terminated to the isolation switch of the electrical panel of the unit. Use 3½ core aluminium/copper cable along with double earthing and terminate through proper lugs. Avoid any sharp bend for the cable at the termination point. The cable shall be adequately supported.

Canopy Extension Procedure

Canopy arrangement is provided on top of the electrical box. Sliding extension panel is supplied in folded condition to avoid overhang during transportation and handling. Pull the extension panel out of main canopy and support the same with two brackets provided on canopy side panels as shown in figure.

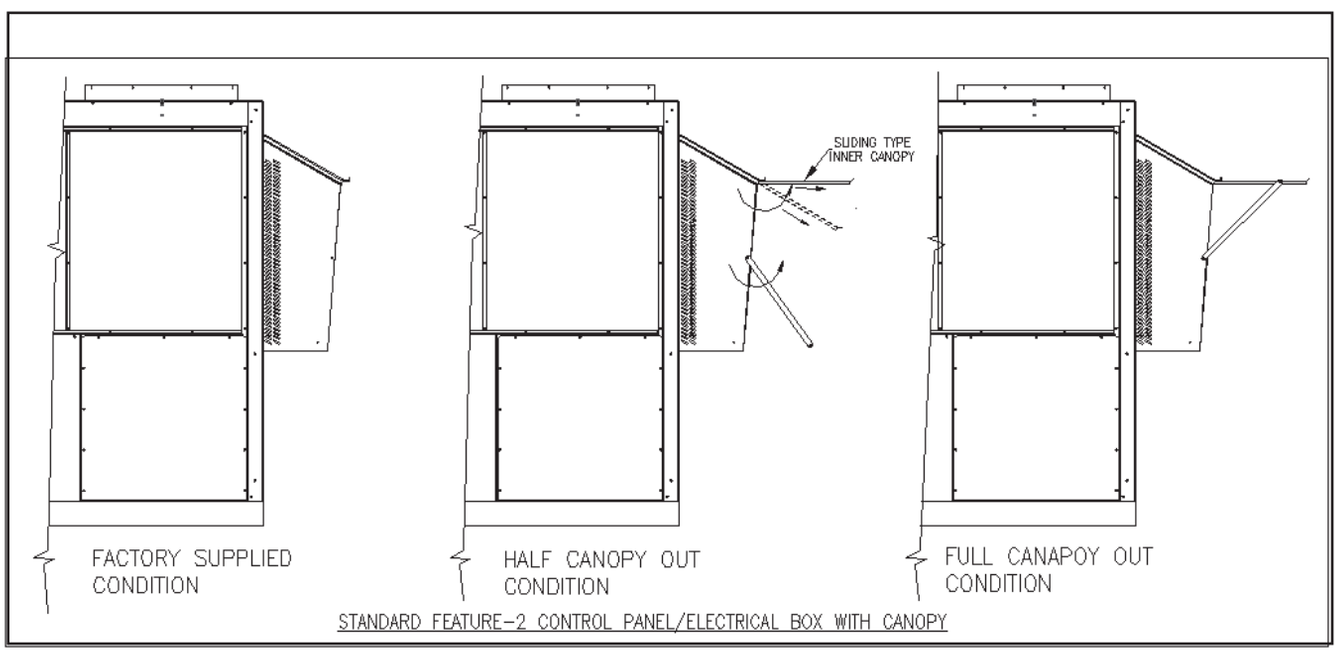


Figure 30 Canopy Extension Procedure

Pre-start Checklist

Before starting the chiller check the following:

Items	Things to be checked	Standard Values
1. Refrigeration System	1. Compressor Oil level	1. Visible oil level in sight glass
	2. Compressor Oil heater	2. Should be kept energised at least 8 hours before starting.
	3. System Valves status	3. Opened
	4. Solenoid Valves	4. Firmly fixed on spindle
	5. System pressure	5. Under positive refrigerant pressure
	6. Sensors & Transducers	6. Firmly mounted at respective locations.
2. Electrical System	1. Voltage of main power	1. Electricity voltage should be kept within 5% of the rated voltage, instant maximum voltage drop while starting should be less than 10% of the rated voltage.
	2. Voltage of control circuit.	2. Standard voltage is 230V±10%.
	3. Insulation resistance value of the motor – phase to phase and phase to ground.	3. Insulation resistance value should be above 2MW.
	4. Power terminals and wire cables terminal block are well insulated.	4. Power terminals are firmly fixed on keep wire cables away from heat source and sharp metal edges.
	5. Earthing.	5. As per Local Electrical guidelines.
	6. Capacity of electrical cables & accessories (external to chiller)	6. Properly selected as per Electrical Ratings.
3. Chilled Water Piping system	1. Chilled water connection	1. Fixed firmly at cooler outlet and supported externally.
	2. Leakage test	2. No leakage
	3. Insulation on piping	3. Insulated properly.
4. Safety Interlocks	1. Water flow switch	1. Provided in chilled water oulet piping & connection as per wiring diagram.
	2. Emergency switch, if required	2. Connection as per wiring diagram

Operation of the MCS – Magnum Controller for the New High Efficiency Configured Series Air Cooled Screw Chiller

MCS – Magnum control circuit for the New High Efficiency Configured Series Air Cooled Screw Chiller comprises of analog sensor inputs such as suction pressure(s), discharge pressure(s), entering and leaving water temperatures, current transducer, etc. and digital sensor inputs such as water line flow switch, oil line flow switch, oil level switch, SP/PR faults; etc. It consists of relay outputs that drive the compressor(s), Load/ Unload solenoid valves, etc. Analog output (0-10V DC) is used to drive the Electronic Expansion Valves.

Before switching ON the screw chillier, ensure that the flow switch is connected between points 7 & 8 (and 7A & 8A for twin cooler models) in the wiring diagram and there is sufficient water flow. The crankcase heater provided on oil separator reservoir should be ON for a minimum period of 8 hours.

In the OFF state, the condition of the outputs is as follows (provided incoming power supply is ON):

Relay output	Condition
Main1/2	OFF
Loadsol1/2	OFF
Unloadsol1/2	ON
Economiser 1/2	OFF
CondFan	OFF

• Starting Sequence

1. Switch on power supply through Rotary Switch (mounted in control section). The unit goes in power up mode. System stays in this mode for a time period as specified in MCS setpoint 23 *(factory set=90s)*. In this state, all relay outputs are turned OFF. Controller will initialise and monitor power supply stability for 90 seconds. Switch ON individual system toggle switches (mounted in control section) to enable demand from MCS for respective compressors.
2. After the power up delay, the system goes in ON state. Controller checks for any anti-cycle (fault) timer leftovers and then generates demand for the first compressor (or as per Run Time equalisation logic explained in point 10) based on setpoint and actual chilled water temperature.
3. Compressor starts with 'Fast Unload' logic. Condition of the relay outputs is as follows:

Relay output	Condition
Main1	ON
Loadsol1	OFF
Unloadsol1	ON
Economiser	OFF
CondFan	OFF

4. One bank of condenser fans goes ON with corresponding compressor

5. Depending on difference between the leaving water temperature and setpoint, the system shall load or unload. The operation of the load or unload solenoid valve is as under:

	Unload – SV1	Load – SV2
Start	OFF	ON
Loading	ON	Pulsing
Unloading	Pulsing	ON
Stable	ON	ON

6. When compressor-1 is at 100% load (or unable to load further due to safety hold), demand for the second system is generated to meet further load.
7. The first compressor is unloaded to minimum slide position and second compressor is started as per the sequence given in steps 3 to 4.
8. Thereafter both compressors are loaded/unloaded simultaneously to match the load approximately at the same percentage (unless any of the compressors goes in safety hold).
9. To completely shutdown chiller, switch off rotary switch provided in panel. To switch OFF a particular compressor, respective toggle switch should be switched off.
10. During normal shutdown through controller, compressor runs for preset time to enable unloading of slide to minimum position before switching OFF.
11. MCS has 'minimum run time equalisation' logic option (setpoint 103 should be 0 and setpoint 104 should be 1). Compressor which runs for minimum time shall start first during next operation cycle.
12. Refrigerant flow in the flooded cooler is maintained by controlling the Electronic Expansion Valve(s) to maintain preset level of refrigerant in flooded cooler.

During normal running of compressor(s) following safety parameters are monitored:*

Sr. No.	Setpoint Description	Trip Delay (Seconds)	Default Setting
1	Hi amps	2	110%
2	Low amps	5	15%
3	Low suction	120	27 psig
4	Low gas / LSV FLT	10	15 psig
5	High discharge Pr.	2	250 psig
6	Low discharge Pr.	90	80 psig
7	Low oil differential	180	44 psig
8	Unsafe Oil	4	10 psig
9	Antifreeze*	5	39°F
10	Oil flow and oil level switch	30	---

* In case of Antifreeze, all the circuits of the entire chiller are locked out.

To avoid nuisance tripping during compressor startup, initial bypass/time delay adjustment procedure is observed.

Setpoint Description	Bypass	Time Delay Adjustment *
Hi amps	For first 3 seconds	—
Low amps	For first 3 seconds	—
Low suction	During pump down	2 minutes 45 seconds, for first 5 minutes of compressor running.
Low gas/LSV FLT	—	4 seconds, for first 5 minutes of compressor running.
Low oil differential	First 5 seconds	12.5 psig for next 30 seconds.
Oil flow and oil level switch	—	15 seconds after compressor start

• Operating Specifications

The following are the operating specifications and default setpoints:

1. Leaving water temperature is set at 45°F with a tolerance of ±1°F.
2. The delay between the Star and Delta connections is preset at 3 seconds.
3. One bank of condenser fans switches ON at discharge pressure 135 psig and turns OFF at 110 psig.
4. Second bank of condenser fans switches ON at discharge pressure 160 psig and turns OFF at 120 psig
6. Low-pressure setting is at 15 psig and High-pressure setting is at 250 psig.
7. Antifreeze Thermostat setting is at 39°F.

Troubleshooting

The table below lists problems that might occur in the jobsite during commissioning or upon operation of compressor. This table will only serve as a guide for the Engineer to understand the situation after occurrence of problem at site.

PROBLEMS	PROBABLE CAUSES	REMEDY / CORRECTIVE ACTION
Sudden trip of motor thermistor/ sensor	Low suction pressure causes low refrigerant flow rate	Check compressor working unloaded for a long period
	Refrigerant shortage	Charge refrigerant
	Suction filter clogged	Clean filter
	High suction temperature	Check refrigerant liquid level
	High suction superheat	Adjust the superheat to less than 10K
	Unstable electrical system or failure	Check electrical power supply
	Motor overload	Check and rectify
	Bad motor coil causing temperature to rise rapidly	Check and rectify
Compressor unable to load	Low ambient temperature or high oil viscosity.	Turn on the oil heater before compressor start.
	Capillary clogged.	Clean or replace capillary
	Modulation solenoid valve clogged or solenoid valve coil burnt.	Clean/purge solenoid valve core or replace the solenoid valve coil
	Internal built-in oil line clogged.	Check and clean the compressor oil circuit
	Piston stuck-up.	Change piston or piston ring
	Oil filter cartridge clogged.	Clean oil filter (replace if needed)
	Too small high-low pressure differential.	Minimum pressure differential is 4 bar. Consider to install an oil pump.
Compressor unable to unload	Modulation solenoid valve clogged or burnt.	Clean or replace the solenoid valve
	Piston rings worn off or broken, or cylinder damaged, resulting in leakage.	Change piston (if cylinder is damaged severely, change the cylinder)
	Lubrication oil insufficient.	Check the oil level of the compressor add some oil if necessary
	Leakage at internal discharge cover plate end.	Check or replace the gasket and tighten the bolts.
	Solenoid valve voltage misused.	Check the control voltage
	Piston stuck up.	Change the piston set, and check the cylinder and slide valve.

PROBLEMS	PROBABLE CAUSES	REMEDY / CORRECTIVE ACTION
Poor insulation of motor	Capacity control logic unsuitable.	Check
	1. Bad compressor motor coil. 2. Motor power terminal or bolt wet or frosty. 3. Motor power terminal or bolt bad or dusty. 4. Bad insulation of magnetic contactors. 5. Acidified internal refrigeration system. 6. Motor coil running for a time continuously under high temperature. 7. Compressor restart counts too many times.	Check the coil or change the motor stator
Compressor starting failure or Y-△ starter shifting failure	Slide valve piston unable to go back to its lowest % original position.	Check if the unloading SV is energised once the compressor shutsdown. Unload the compressor before shutsdown.
	Voltage incorrect.	Check the power supply
	Voltage drop too big when starting the compressor or magnetic contactor failure or phase failure.	Check the power supply and the contactor.
	Motor broken down	Change the motor
	Motor thermistor sensor trip.	See “sudden trip of motor sensor” above
	Incorrect power supply connection.	Check and reconnect
	Y-△ timer failure.	Check or replace.
	Discharge or suction stop valve closed.	Open the stop valve
	Improper connection between node terminals of Y-△ wiring.	Check and reconnect the wiring
	Rotor locked	Check and repair
	Earth fault	Check and repair
	Protection device trip	Check
Abnormal vibration and noise of compressor	Damaged bearings.	Change bearing.
	Phenomenon of liquid compression.	Adjust proper suction superheat
	Friction between rotors or between rotor and compression chamber.	Change screw rotors or/and compression chamber.
	Insufficient lubrication oil.	Check the oil level of the compressor add some oil if necessary.
	Loose internal parts.	Dismantle the compressor and change the damaged parts.
	Electromagnetic sound of the solenoid valve.	Check and repair/replace
	System harmonic vibration caused by improper piping system.	Check the piping system and if, possible, improve it using copper pipe.
	External debris fallen into the compressor.	Dismantle the compressor and check the extent of the damage.
	Friction between slide valve and rotors.	Dismantle the compressor and change the damaged parts.
	Motor rotor rotation imbalance.	Check and repair.

PROBLEMS	PROBABLE CAUSES	REMEDY / CORRECTIVE ACTION
Compressor does not run	Motor line open	Check
	Tripped overload	Check the electrical connection
	Screw rotors seized	Replace screw rotors, bearings, etc.
	Motor broken	Change motor.
High discharge temperature	Insufficient refrigerant.	Check for leaks. Charge additional refrigerant and adjust suction superheat to less than 10K
	Improper heat exchange due to condenser problem.	Check and clean condenser
	Refrigerant overcharge.	Reduce the refrigerant charge
	Air/moisture in the refrigerant system	Recover and purify refrigerant and vacuum system
	Improper expansion valve.	Check and adjust proper suction superheat
	Insufficient lubrication oil.	Check the oil level and add oil.
	Damaged bearings.	Stop the compressor and change the bearings and other damaged parts.
	Improper Vi value.	Change the slide valve.
	No system additional cooling (Liquid injection or oil cooler)	Install additional system cooling (liquid injection or oil cooling or both, based on working condition limitation)
Compressor loses oil	Lack of refrigerant	Check for leaks. Charge additional refrigerant.
	Improper system piping	Check and correct the piping or install an external oil separator
	Refrigerant fills back	Maintain suitable suction superheat at compressor
Low suction pressure	Lack of refrigerant	Check for leaks. Charge additional refrigerant.
	Evaporator dirty or iced	Defrost or clean coil
	Clogged liquid line filter drier	Clean liquid line filter drier
	Clogged suction line or compressor suction strainer	Clean or change suction strainer
	Expansion valve malfunctioning	Check and reset for proper superheat
	Condensing temperature too low	Check means for regulating condensing temperature

PROBLEMS	PROBABLE CAUSES	REMEDY / CORRECTIVE ACTION
High Suction Pressure	1. Cooler water flow rate is higher than the rated flow rate	Maintain the rated flow rate.
	2. Cooler water inlet temperature is higher than rated.	Supply the rated temperature cooling water at cooler inlet.
	3. System is overcharged	Remove the excess refrigerant.
High Suction Temperature	1. High water inlet temperature	Ensure that correct water temperature is available
	2. System is undercharged	Charge refrigerant
	3. Expansion valve malfunctioning	Check and rectify

Note: The replacement of internal parts in the compressor should be performed only by a qualified/certified service technician with full knowledge of Hanbell screw compressor or it should be performed by a Service Engineer from Blue Star.

Important Note on Applications of Compressor

1. Pump Down

Do not pump down the compressor on the chiller as a routine operation except only for temporary maintenance or a long-term shutdown because pump down will cause extremely high temperature in the compression chamber and overheat of the motor as well as less amount of refrigerant in the suction side. When doing the pump down, be sure to take notice of the items listed below:

a. Hanbell recommends that whenever doing the pumping down of the compressor, the compressor is also run at 100% capacity.

b. Pump down should be done once each time, as it may be dangerous to the compressor, compression chamber for pumping down repeatedly.

c. The minimum suction pressure when doing the pump down should be over 0.5kg/cm^{2}G

d. The allowable length of time for pumping down a compressor should not be over 15 seconds.

e. When doing the pump down of compressor, take notice that the high discharge temperature should not exceed 110°C.

f. Take notice of high/low pressure reading of the oil level of the compressor and the noise of running as well. If there is any abnormal value or situation, then immediately stop the pump down.

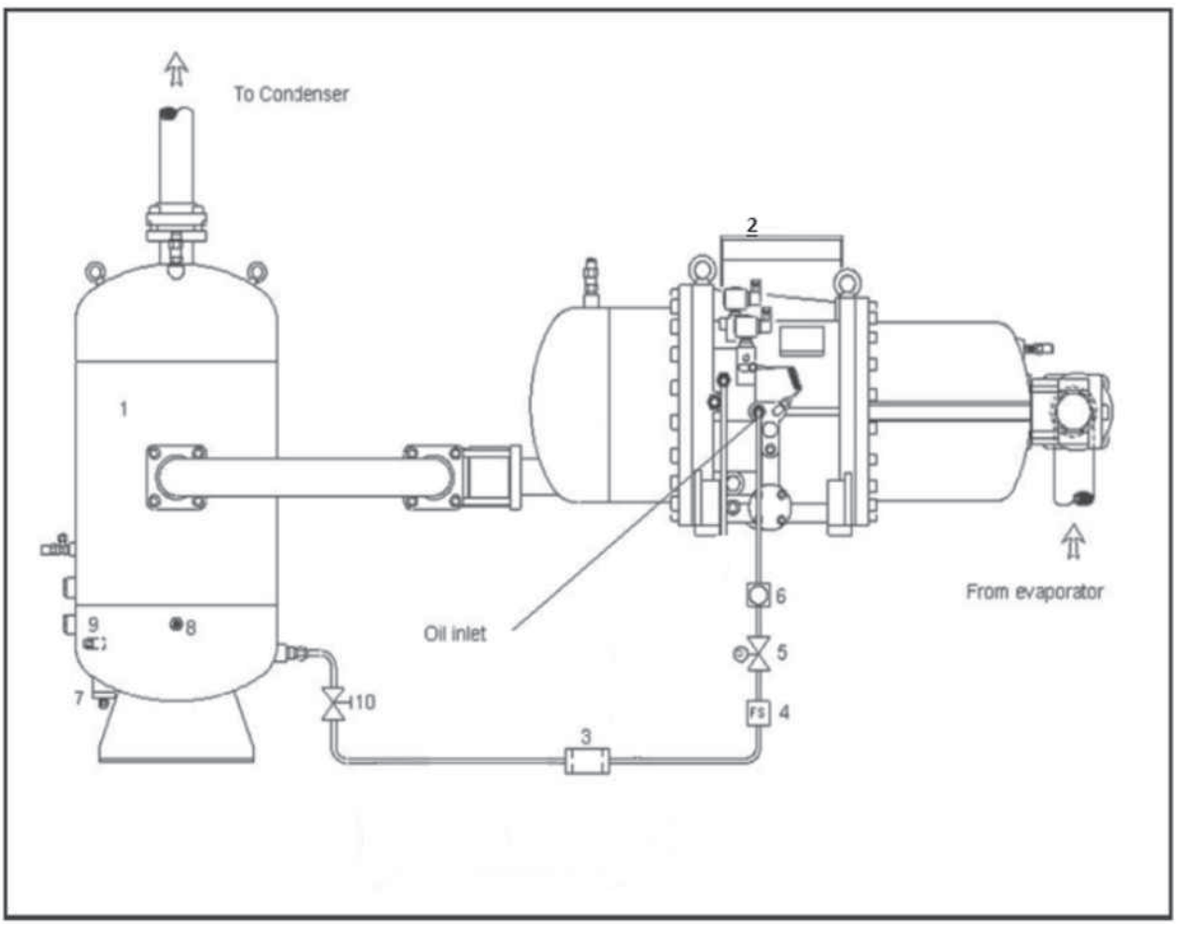
2. Long-term Partial Load Operation

If compressors have to run at partial load of below 50% continuously, though maybe within operating limits, under such operating conditions and with temperature of motor below trip setting for overheating, insufficient dissipation of heat in motor will occur due to lower flow rate of suction gas at partial load. If compressors operate under high temperature for a long time, insulation of motor will deteriorate gradually at risk of serious motor damage finally. In such severe operating conditions, Hanbell strongly recommends installation of liquid injection system to cool motor coil and use of PT100 or PT1000 sensor, as described in chapter 4.4-s, to effectively control temperature of motor while running. It is suggested to switch on liquid injection when temperature of motor coil is higher than 80°C and turn off liquid injection when it is lower than 65°C.

Installation of Lubricant Circuit

To obtain high oil filtering efficiency, low pressure drop loss and non-interruption with lubricant supply system, the oil separator is built outside the compressor. The installation of lubricant circuit is a very important issue during the whole procedure. So, before starting, please make sure to read all the instructions of this manual carefully and ensure each step is carried out in accordance with the specifications.

In the lubricant circuit, installing oil solenoid valve in proper place is very important. As the compressor is shut down, lubricant will automatically inject into compressor due to pressure differential.



1. External oil separator	5. Sight glass
2. Compressor	6. Oil level switch
3. Lubricant flow switch	7. Oil temperature sensor
4. Oil solenoid valve	8. Oil heater

Figure 31 Illustration of compressor and its external oil separator and accessories

Maintenance Schedule

Maintain the chiller periodically in accordance with the schedule shown in table below:

New High Efficiency Configured Series
Air Cooled Screw Chiller Maintenance Schedule

Checkpoints	Daily	Weekly	Monthly	Quarterly	Annually
General					
Log parameters	X				
Check water level in expansion tank	X				
Check water level in cooling tower	X				
Check for any refrigerant leaks through flare joints, valve glands, etc			X		
Check and clean refrigerant strainer				X	
Check condition of refrigerant drier				X	
Clean cooling tower sump				X	
Clean water line strainers				X	
Check quality of water					X
Check healthy operation of safety devices				X	
Check tightness of all electrical terminations				X	
Top up grease for all motors				X	
Apply thermal paste on the temperature sensors				X	
Check for any abnormal noise and vibration	X				
Check liquid line sight glass/moisture indicator	X				
Check water pressure drop in cooler		X			
Check water pressure drop in condenser		X			
Analyse oil sample					X
Check suction superheat	X				
Check crankcase heater		X			
MCS Panel					
Check program settings				X	
Check fault history				X	
Check load/unload function				X	
Check pump down function				X	
Check fan control function				X	
Check clock				X	

Maintenance Schedule: Compressor

Check Points	Time period							
Compressor	**1000 hours**	**2500 hours**	**5000 hours**	**10000 hours**	**15000 hours**	**20000 hours**	**25000 hours**	**30000 hours**
Electrical insulation				X		X		X
Oil filter cartridge				X		X		X
Suction filter								X
Capacity control piston rings								R
Oil level	X	X	X	X	X	X	X	X
Motor thermal protector			X	X	X	X	X	X
Bearings				X		X		X

X Check or Clean

R Replace

Note: If acidity of oil measured is lower than pH 6, replace the oil

Field Feedback Form

Field Feedback Card on Receipt of Chiller at Site		
Return to: Manufacturing Unit - Thane		
Product : **New High Efficiency Configured Series Air Cooled Screw Chiller**		
Chiller Model :		
Sr. No. :		
Customer Name :		Location :
Date :		
Observation	**Comments**	**Details of Defects**
Quality of Packing	Ok / Damaged	
Receipt of Documents		
- Packing List	Yes / No	
- Test Report	Yes / No	
- Truck No.		
Condition of Parts :		
- Framework	Ok /	
- Compressor	Ok /	
- Condenser	Ok /	
- Cooler	Ok /	
- Electrical Panel	Ok /	
- Refrigerant Piping	Ok /	
- Controls	Ok /	
- Idle Pressure	Ok /	
Remarks :		
Checked by:		
For Factory Use:		
- Date of Receipt :		- Action By :
- Comments :		

The field feedback card as per the format below shall be sent to factory after commisioning of the chiller

Field Feedback Card - Commissioning of Chiller at Site		
Product : **New High Efficiency Configured Series Air Cooled Screw Chiller**		
Chiller Model :		
Sr. No. :		
Customer Name :		Location :
Engineer's Name :		
Observation	**Comments**	**Details Of Defects**
Installation / Precommissioning Checks:		
- Unit Installed and levelled	Ok /	
- Installation	Ok /	
- Condenser water connection terminated properly with required isolation		
- Chilled water connection terminated properly with required isolation	Ok /	
- Electrical connection with earthing terminated properly	Ok /	
- Condenser water and chilled water system properly flushed	Ok /	
- Water Quality checked	Ok /	
- Meggering of Cabling done	Ok /	
- Condenser water and chilled water pump commissioned	Ok /	
Water flow adjusted to the design flow by checking pressure drop	Ok /	
Water flow switches connected with electrical panel	Ok /	
Check Voltage	Ok /	Starting 400V ± 10% Running 400V ± 10%
Commission the Chiller	Ok /	
Noise Level	Ok /	
Vibration	Ok /	
Check Current	Ok /	
Testing done at site	Ok /	
Performance data as per format	Ok /	
- Commissioning Date		
- Commissioning By		
Remarks:		
Note: Warranty will be valid only after receipt of this card at the factory		
For Factory Use:		
- Date of Receipt:		- Action By :
- Comments:		

Commissioning and Handing Over

Hand over the Chiller to the Customer as per the format and establish Warranty

COMMISSIONING & HANDING OVER REPORT

BLUE STAR LIMITED	**Our Ref:**			Date:	
	Cust. Ref.				
	PURCHASE ORDER			Date:	
				Date:	
	Equipment:	Blue Star make Air Cooled Screw Chillers			
	Model:				
	Sl.Nos.				
Customer Name & Address					
Equipment location					
COMMISSIONING					

Service rendered

Supplied, installed, tested and commissioned Blue Star make Air Cooled Screw Chillers and they are put into regular operation. The Model No. & Serial Nos. of the units are given below :

CHILLER MODEL:

SERIAL NO. OF MACHINE NO.1:

SERIAL NO. OF MACHINE NO.2:

The chillers are handed over to the customer for the beneficial use.

Equipment warranty expires on:	**Attended by:** Blue Star Ltd. **Signature:**	
For office use:	The above equipment has been installed and commissioned to our satisfaction.	
	Other comments (if any).	
	Date: **Customer's Stamp & Signature**	

Water Quality

Recommended Water Quality Standards

Test items	Chilled Water Quality	Cooling Tower Water Quality	Makeup Water Quality
pH	7.2 - 8.5	7.2 - 8.5	6.0 - 8.0
Total hardness ($CaCo_3$) ppm	Max. 80	Less than 200	Max. 50
Total alkalinity ($CaCo_3$) ppm	Less than 100	Less than 100	Less than 80
Chloride ion (ppm)	Less than 50	Less than 200	Less than 50
Total ion (Fe) ppm	Less than 0.3	Less than 1.0	Less than 0.3
Silica (SiO_2) ppm	Less than 30	Less than 50	Less than 30
Ammonium ion ppm	Less than 0.2	Less than 1.0	Less than 0.2

Log Report

After commissioning of the chiller at site, maintain Log Report as per the format:

Customer's Name:

Date:

			Time				
S.No	**Description**	**Units**	10.00	12.00	14.00	16.00	18.00
1	Voltage R-Y	V					
	Voltage Y-B	V					
	Voltage R-B	V					
2	Current - R	A					
	Current - Y	A					
	Current - B	A					
3	Supply Frequency	Hz					
4	Suction Pressure Compressor	psig					
5	Discharge Pressure Compressor	psig					
6	Compressor Current	A					
7	Cooler Entering Water Temperature	°F					
8	Cooler Leaving Water Temperature	°F					
9	Cooler Pressure Drop	psig					
10	Cooler Water Flow Rate	US GPM					
11	Condenser Entering Air Temperature	°F					
12	Condenser Leaving Water Temperature	°F					
13	Condenser Pressure Drop	psig					
14	Condenser Water Flow Rate	USGPM					
15	Refri. System Temperature - Discharge	°F					
16	Refri. System Temperature - Liquid	°F					
17	Superheat (suction)	°F					
18	Discharge Superheat	°F					

WARRANTY CLAIM FORM

for Blue Star's New High Efficiency Configured Series Air Cooled Screw Chiller

A copy of this form is to be filled in case of chiller failure, by BSL Engineer)

Location (City) ..... Date .....

Chiller Model No:	Chiller Serial No.
Date of despatch	Date of commissioning
Warranty commencing date	Warranty expiry date
Application in which equipment is used	

Customer's Name and Address	Dealer's Name and Address

Starting Problem	☐ Yes	☐ No
Noise at Starting	☐ Yes	☐ No
Noise while Running	☐ Yes	☐ No

Compressor: ☐ High Noise ☐ Vibration ☐ Condenser/Oil Cooler ☐ Unbalanced

Fan: ☐ High Noise ☐ Vibration ☐ Shaft Bend

Any mounting bolts loose: ☐ Yes ☐ No

Electrical Problem	☐ Yes	☐ No
Voltage	☐ Yes	☐ No

Insulation resistance (Megger test)..... ohms

Motor ☐ Jammed Bearing noise ☐ Burnt out ☐

Any leakage in the condenser coil	☐ Yes	☐ No
Any vibration in piping	☐ Yes	☐ No
Less cooling in cooler	☐ Yes	☐ No
Checked water flow rate	☐ Yes	☐ No
Checked compressor working in full load	☐ Yes	☐ No
High ambient temperature	☐ Yes	☐ No
Operating pressure checked	☐ Yes	☐ No
Shortage of refrigerant	☐ Yes	☐ No
Air cooled condenser coils clogged	☐ Yes	☐ No
All the fans working	☐ Yes	☐ No

Signature & Seal of Customer
Date .....

Signature & Seal of BSL Engineer
Date .....

(For factory use only)

Claim settled ☐ Credit advice No. ..... Claim rejected ☐

Reasons for rejection .....

Settlement authorised by: ..... Date .....

Warranty

Blue Star's screw chillers carry a warranty for a period of 12 months from the data of commissioning or 15 months from the date of delivery, whichever is earlier, unless stated otherwise in the contract of sales.

Terms of Warranty

Blue Star extends a comprehensive warranty on its systems, which entitles the customer to the following:

1. Repair/reconditioning, by BSL/BSL Dealer through whom the machine has been purchased, of any part of the equipment found defective within 12 months from the date of commissioning or 15 months from the date of despatch, whichever is earlier.

2. The warranty is valid only if:

2.1. Installation and commissioning is taken care of by BSL/its authorised persons.

2.2. The equipment is operated as per the Company's operating instructions.

3. The warranty does not cover the following:

3.1 Any leakage of Refrigerant due to improper operations

4. This warranty is not valid if any repair and/or modifications are carried out by the customer himself or his representative without written concurrence from Blue Star Limited.

5. The warranty extended herein is in lieu of all implied conditions/warranties under the law and is confined to the repair or replacement of defective parts and does not cover any consequential or resulting liability damage or loss arising from such defect. Furthermore, the warranty in no case, shall extend to the payment or any monetary consideration whatsoever of the replacement or return of the screw chiller as a whole.

6. Any repair/replacement shall not extend the overall warranty period as specified above.

7. The cost of transportation of material and of persons beyond municipal jurisdiction shall be borne by the customer.

8. This warranty may be read in conjunction with any other warranty on the installation as a whole, if the screw chiller is supplied as part of a project.

24x7 Customer Care

Phone : 1860 266 6666/1800 209 1177
SMS : "Service" to 57575
Email : customerservice@bluestarindia.com

EAST

BHUVANESHAWAR
3A, Satya Nagar, 2nd Floor,
Bhubaneswar - 751 007
Phone: (91) (674) 2572403 / 2573670

GUWAHATI
Oasis Plaza, 1st Floor,
Dr. B. Barooah Road, Ulubari, Kamrup,
Guwahati - 781 007
Phone: (0361) 2468496

KOLKATA
7, Hare Street, Kolkata - 700 001
Phone: (91) (33) 2213 4000

PATNA
Ambition Business Centre, Laxmikant
Niketan Parisar, 4th floor, 'B' Block, Room No
405, Jamal Road, Patna - 800 001

NORTH

CHANDIGARH
Adarsh Mall, 4th Floor, Plot No 50,
Industrial & Business Park, Phase - II,
Chandigarh - 160 002
Phone: (91) (172) 502 4000

GHAZIABAD
C 53A, Third Floor, Raj Nagar
District Center (RDC), Raj Nagar,
Ghaziabad - 201 001. Uttar Pradesh
Phone: (91) (120) 282 1400

JAIPUR
A-19, First Floor, Main Sahakar Path,
Near Sahakar Bhavan, Jaipur
Phone: (91) (141) 4141100/ 2744033/ 35

LUCKNOW
177/4, Faizabad Road,
Lucknow - 226 007
Phone: (91) (522) 403 4000

LUDHIANA
Fortune Chambers, 3rd Floor,
SCO 16, 17, Feroze Gandhi Market,
Ludhiana - 141 001
Phone: (91) (161) 500 1404

NEW DELHI
Elegance Tower, 1st Floor, Jasola District
Centre, New Delhi - 110 025
Phone: (91) (11) 4149 4000

SOUTH

BENGALURU
Anjuman Kay Arr Tower, No 28, Ward No 77,
Mission Road, Bengaluru - 560 027
Phone: (91) (80) 4185 40000

CHENNAI
KRM Plaza, No 2, Harrington Road,
Chetpet, Chennai - 600 031
Phone: (91) (44) 4244 4000

KOCHI
Millenium Plaza, Alinchuvadu,
MKK Nair Road, Near Palarivattom Junction,
Kochi - 682 024
Phone: (91) (484) 449 9000

SECUNDERABAD
Ashoka Raghupati Chambers,
No 1-10-60 to 64, 4th Floor, S P Road,
Begumpet, Hyderabad,
Telangana 500 016, India.
Phone: (91) (40) 4400 4000

THIRUVANANTHAPURAM
TC IV/962, Chandrika, Sree Chitra Nagar,
Pipe line Road, Kawdiar,
Thiruvananthapuram - 695 003
Phone: (91) (471) 243 5025

VIJAYAWADA
No 40-1-62, Nagas Hafeez Plaza,
Opposite to grand modern supermarket,
Near BENZ Circle, MG. Road,
Vijayawada - 520 010
Phone: (91) (866) 248 4004

VISAKHAPATNAM
D. No 49-24-65/1, Resapuvani Palem Village,
Madhura Nagar Mandal,
Near Sankarmattam Road,
Vishakapatnam - 530 016
Phone: (91) (891) 274 8405

WEST

AHMEDABAD
Abhishree Avenue, 3rd Floor,
Near Nehru, Nagar Cross Roads,
Ambawadi Road,
Ahmedabad - 380 015
Phone: (91) (79) 4022 4000

INDORE
1st Floor, Shri Krishna, Classic,
139, Fadnis Colony, A B Road,
Indore - 452 010
Phone: (91) (731) 4001211/4001311

GOA
210, 2nd Floor, Gera's Imperium I,
Patto, Panjim, Goa - 403 001
Phone: (91) (832) 2438171/2437287

MUMBAI
Blue Star House, 9A, Ghatkopar,
Link Road, Sakinaka,
Mumbai - 400 072
Phone: (91) (22) 6668 4000

NAGPUR
219 Bajaj Nagar, 1st Floor,
South Ambazari Road,
Nagpur - 440 010
Phone: (91) (712) 662 4000

PUNE
201/A, Nityanand Complex,
247/A Bund Garden Road,
Pune - 411 011
Phone: (91) (20) 4104 4000

RAIPUR
Alaska Corporates, 3rd Floor,
Opp VIP Road, Jivan Vihar Colony,
G E Road, Raipur,
Chattisgarh - 492 006

VADODARA
Ramkrishna Chambers,
Productivity Road, Alkapuri,
Vadodara
Phone: (91) (265) 661 4000

For any assistance, CALL:

Blue Star Service:

Ph: .....

Cell: .....

Blue Star Dealer:

Ph: .....

Cell: .....

Blue Star Regional Manager:

Ph: .....

Fax: .....

Blue Star's/Dealer's engineer to fill above details before handing over this Manual to customer.

BLUE STAR

PCPD/ACSC/UM//V1/07, 2017