Electrical Installation Requirements
Care should be taken to separate the power and signal cables to prevent electrical interference and possible damage due to inadvertent connection.

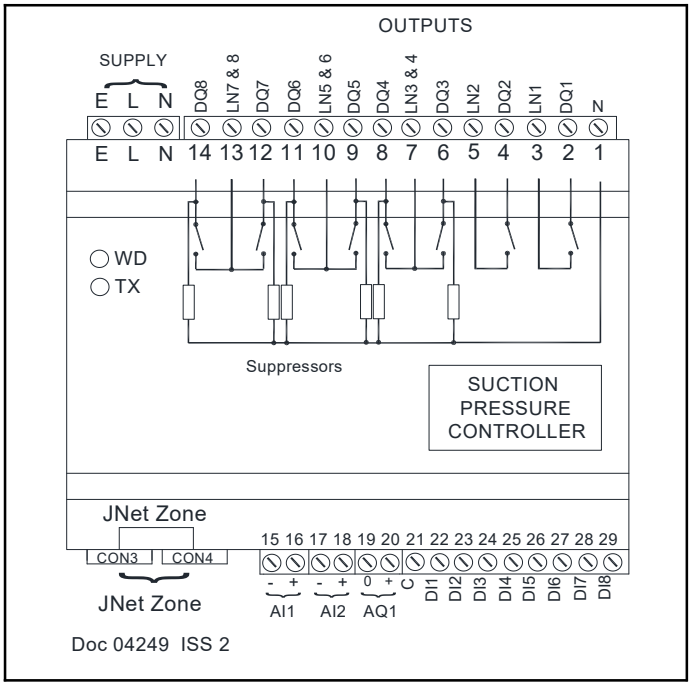
The power outputs are fitted with suppressors to protect against electrical interference when switching off solenoid valves or contactors. It is therefore essential to observe the output polarity. The line voltage should be connected to the terminals marked **LN** and the switched loads to **LD.**

The plant inputs are electrically isolated. A volt free contact should be connected for the logical conditions stated below between the input and common **C** (21).

The control supply neutral must be connected to terminal 1 for EMC operation.

CE Conformance
This unit conforms with the relevant EU standards when installed according to the JTL Installation Requirements for this product

Digital Output		
DQ1	Unsuppressed	Critical Alarm
DQ2	Unsuppressed	High Suction Pressure (Alarm)
DQ3	Suppressed	Run Compressor 1
DQ4	Suppressed	Run Compressor 2
DQ5	Suppressed	Run Compressor 3
DQ6	Suppressed	Run Compressor 4
DQ7	Suppressed	Run Inverter
DQ8	Suppressed	Watchdog
Digital Inputs		
DI1	Volt Free	Auto/Manual
DI2	Volt Free	High Discharge Pressure
DI3	Volt Free	Compressor 1 Available to Run
DI4	Volt Free	Compressor 2 Available to Run
DI5	Volt Free	Compressor 3 Available to Run
DI6	Volt Free	Compressor 4 Available to Run
DI7	Volt Free	Inverter Healthy
DI8	Volt Free	Low Liquid Level
Analogue OUTPUT		
AQ1	0-10 V	Inverter Speed
Analogue INPUT		
AI1	4-20 mA	Not used
AI2	4-20 mA	Suction Pressure



Use of Maintenance Unit
The controller can be checked and the operation adjusted using a JTL portable maintenance unit which plugs into the controller. Each item of information has an item number. The more important items are listed in the tables overleaf.
Examples:
To read item 21 press: ITEM 2 1 ENTER

To set item 41 to –4.0 press:
ITEM 4 1 ENTER SET - 0 4 0 ENTER

To correct errors press: CANCEL

To select next or previous items press: + and –

Initial Commissioning and Bitswitch Settings
The controller has 4 sets of data built in to its program for use during commissioning. These can be accessed by setting the virtual bitswitches as shown in the table overleaf. The virtual bitswitches are set using item 966. Then set item 9 to 1234. This loads into the controller a suitable set of data for the selected type of case. Adjustments should then be made as necessary. The range over which the settings can be adjusted is also defined by the bitswitch setting.

If a JTL communications network is connected to the controller then the unit number should be set on item 1.

Pressure Display
The pressure can be displayed in psi, bar or kPa as selected by item 179.

The LP310 controller drives the JTL LCD14 display using a CAB75 cable. Various cable lengths are available.

Suction Pressure Control Strategy
The compressor capacity is controlled by measuring the suction gas pressure (item21) and attempting to maintain this at a constant set value within certain constraints. The suction pressure of the compressor pack is controlled by varying the number of steps of compression. The LP310 can control an inverter trim compressor. When the inverter trim control is available the inverter varies the compressor speed on the trim machine to maintain the pressure. Only when the inverter driven compressor is running at minimum or maximum speed will the other compressors be stopped or started as required.

When a change in compressor capacity is required the controller decides which step of capacity is to be changed. The decision is based on the following:

- The maximum number of starts per hour on an individual compressor.
- The compressor running hours are balanced.
- All machines can be run periodically.
- Unnecessary starts and stops of the compressors are avoided.
- Capacity of compressors when unequal.

The suction pressure is maintained within the deadband if sufficient capacity is available. The deadband is positioned symmetrically about the suction pressure setpoint so that for example, if the setpoint is set to 8 psi and the deadband is set to 4 psi, then the bottom of the deadband is 6 psi and the top 10 psi.

Under normal conditions when the suction pressure is within the deadband no increase or decrease in staged capacity will occur.

Suction Pressure Optimisation

When used in conjunction with a JTL suction pressure optimiser (SPO) and appropriate JTL evaporator controllers/monitors, the suction pressure can be optimised to save energy.

The optimiser monitors the evaporator conditions and sets the suction pressure to the appropriate level to maintain the evaporator at the optimiser level to achieve the desired temperatures at the lowest energy.

The allowed range of pressure is set on items 40 (minimum) and 152 (maximum) optimisation is enabled on item 150.

CAPACITY CHANGES (STAGE CONTROL)

Capacity Increase

When the suction pressure goes above the control deadband the controller will decide when and how an increase in capacity will occur. If capacity is available and the pressure does not return within the deadband a change in capacity will eventually occur.

However, the capacity change does not occur immediately the pressure goes outside the deadband. There is a minimum delay between each increase in capacity regardless of demand.

The size and duration of the difference (or error) between the desired pressure and the actual pressure is taken into account. This error is integrated with respect to time. When the integrated error is large enough a capacity increase will occur.

To put this more simply, if the pressure error is large a capacity change will occur more quickly than if the error is small.

Capacity Increase Response Time

The speed of response of the system can be adjusted using the increase gain (item 44). The larger the gain, the sooner a capacity increase occurs.

Capacity Decrease

When the suction pressure goes below the control deadband the controller program will decide when and how a decrease in capacity will occur. If the pressure does not return within the deadband a change in capacity will eventually occur.

As for the increase in capacity there is a minimum delay between each decrease in capacity and the pressure error is integrated with respect to time. When the integrated error is large enough a capacity decrease will occur.

Capacity Decrease Response Time

The speed of response of the system can be adjusted using the decrease gain (item 45). The larger the gain, the sooner a capacity decrease occurs.

The use of separate increase and decrease gains allows the compressors to unload faster than loading if desired. This feature is of particular benefit on low temperature stages to prevent the suction pressure going too low.

Change Of Pressure

The change of pressure is also considered. If the pressure is going towards the setpoint fast enough for the suction pressure to reach the deadband in an acceptable time then, no capacity change is made.

Starts Per hour

Each compressor can be programmed to have a maximum number of starts per hour. The item numbers for this selection are 219 for compressor 1, 229 for compressor 2 up to 249 for compressor 4. Once a compressor has started it is not allowed to restart again until the restart timer, which ensures the starts per hour are observed, has timed out.

Compressor Capacity

Each compressor can be programmed to have a capacity. The items for this data are 216 for compressor 1, 226 for compressor 2 up to 246 for compressor 4.

The capacity control takes account of the capacity that can be started and stopped to ensure optimum control. Where a small capacity change can be made by starting and stopping two machines to give a net change in capacity this is done. In this condition the machine to be started always starts before the machine to be stopped regardless of whether capacity is to be increased or decreased.

High Discharge Pressure

If the discharge pressure exceeds the pressure safety level (on input 2) then, the compressor capacity is reduced. There is a choice of two actions in this condition on item 197 either the reduction in capacity is controlled by the normal sequence of unloading or all compressors are stopped immediately.

When the pressure falls below the safety level the capacity is allowed to increase again according to the normal requirements of the suction pressure.

Low load Condition

When the refrigeration load is low enough for the compressors to run on 1 step only (including the trim compressor) then, to prevent the last compressor stopping unnecessarily, the deadband lower limit is automatically lowered, reducing the pressure at which the last compressor would be stopped.

In this condition the deadband lower limit is set to the 1st stage hold on pressure setpoint (item 48).

There is a very low suction pressure setting (item 196) below which, if enabled by item 195, will stop all compressors instantly.

VARIABLE COMPRESSOR CAPACITY CONTROL

Inverter Frequency Control

The frequency of the inverter drive is varied using a 0-10V signal. The inverter should be set up so that 0 V is for minimum speed and 10 V is maximum speed.

Capacity Control

The controller starts and stops the inverter as required taking account of any other compressors controlled by the same suction pressure. The inverter automatically acts as a trim compressor and all the normal compressor capacity control functions are operational. The capacity of the compressor at 50Hz is programmed on item 335.

Minimum Frequency

When there are no other compressors running the inverter will stay on at minimum frequency until the minimum pressure set on item 341 is achieved.

Control Response
The controller uses proportional and integrated control algorithms to control the inverter. These require P gain (item 339) and I gain (item 340) to adjust the response of the control of variable capacity compressor.

There is also a derivative gain (item 404). This should normally be set to 0.

Frequency Output Limits
The frequency output can be limited at both maximum and minimum frequency. The settings for the limits are item 342 for maximum and item 343 for minimum frequency (in Hz). These values should match the inverter settings.

Forcing a Compressor to Run
A particular compressor may be forced to run by the maintenance unit (MU) (items 217, 227 up to 247) for compressors 1 to 4 respectively.

Any compressor may be forced off by the maintenance unit (items 218, 228 up to 248) for compressors 1 to 4 respectively.

Resulting loading and unloading of the steps of the forced compressor(s) follows all the normal rules specified above except that the controller ignores the suction pressure on the forced compressor(s).

Forced functions remain in operation for 30 minutes after the MU is unplugged, after which time the controller will reset to normal control.

Compressor Faults
The individual compressors are continuously monitored. The state of these inputs for compressor 1 is shown on item 213 of the maintenance unit. Compressor 2 is on item 223 up to compressor 4 which is shown on item 423.

The state is indicated by the following messages:

rdy	=	ready to run (no faults)
0	=	not ready (fault)

If any compressor is not ready to run then this is indicated as a compressor fault (item 97).

Pressure Alarms
The compressor suction pressure is constantly monitored and compared with the high alarm level (item 42).

If the current suction pressure goes outside the set range for a short time period then an alarm is given.

PRESSURE TRANSDUCER ALARM
The pressure transducer is constantly checked and if, after a short delay, the output goes outside the acceptable range an alarm is given (item 91).

If there is a suction pressure transducer fault, the number of compression steps is set to the maximum available. Control then reverts to the compressor LP safety switches. All normal sequencing restart delays, etc will be maintained in this mode of operation.

Low Liquid Level
An input is available to monitor low liquid level in the receiver. The input should be shorted out when there an alarm condition. An alarm is given after an adjustable delay (item 175) once the contact is closed.

ALARM DISPLAY
Various alarms are indicated on the pressure displays. Typical messages displayed are:

Hi.Sp	High suction pressure
Hi.dP	High discharge pressure
Pt.Ft	Pressure transducer fault
Lo.Li	Low level liquid
Cpr	Compressor fault - (lowest priority)

The alarm conditions are flashed alternately with the pressure. In the event of there being more than one alarm the highest priority alarm is displayed

ADJUSTABLE PARAMETERS				LP32x
	Item	Function	Range LT(HFC), HT(HFC), LT(CO2, HT(CO2)	Units
Pressure Control	40	Suction pressure setpoint (minimum)	0 to 20, 5 to 100, 100 to 250, 300 to 550	psi
	150	Suction optimisation	0=Disabled 1=Enabled	
	152	Suction pressure (maximum)	5 to 20, 15 to 60, 175 to 225, 300 to 700	psi
	43	Deadband	0 to 5, 0 to 15, 0 to 20, 0 to 100	
	44	Increase gain	0 to 99	
	45	Decrease gain	0 to 99	
	48	1st stage and fast unload set point	-5 to 20, 0 to 60, 100 to 150, 250 to 450	psi
	195	Low suction pressure safety	0=Disabled 1=Enabled	
	196	Low suction pressure safety level	-8 to 10, 10 to 40, 50 to 150, 100 to 400	psi
	197	Instant high discharge pressure shutdown	0=Disabled 1=Enabled	
Pressure Alarm	42	High suction pressure	10 to 50, 25 to 110, 200 to 300, 450 to 650	psi
	41	Low suction pressure	-5 to 15, 5 to 60, 100 to 150, 200 to 450	psi
Pressure Transducer	121	Transducer	0=Disabled 1=Enabled	
	421	Transducer full scale (at 20mA)	50 to 200, 300 to 900, 300 to 950	psi
	426	Transducer zero scale (at 4mA)	-15 to 0	psi
Compressor Common	200	Number of compressors	0 to 4	
	205	Maximum allowed to run	1 to 4	
	208	Minimum stop time	1 to 240	sec
Compressor (where X is compressor)	2x5	Owner scope	0= not in use 1= in use	
	2x6	Capacity	1-100	kW
	2x0	Control	0= Not stage controlled. 1= Stage controlled, 2= Inverter control (compressor 1 only)	
	2x9	Starts per hour	4- 20	
	210	Compressor 1 arrangement	0=Not controlled, 1=Step controlled, 2=Inverter Control	
	2x0	Compressor 2-4 arrangement	0=Not controlled, 1=Step controlled	
Variable Capacity Compressor	330	Select	0=Disabled 1=Enabled	
	341	Minimum pressure	-8 to 10, 10 to 60, 50 to 150, 100 to 100	psi
	340	Integral gain	0 to 99	
	339	Proportional gain	0 to 99	
	404	Derivative gain	0 to 99	
	343	Minimum frequency	0 to 50	Hz
	342	Maximum frequency	40 to 100	Hz
	335	Capacity at 50Hz	1 - 100	kW
Display	179	Display units	1 - psi, 2 - bar, 3- kPa, 4 - bar absolute	
Compressor Alarms	206	Fault alarm delay	0 - 10	min
	158	Fault alarm repeat delay	00:01 - 24:00 (00:00 off)	hr:min
	175	Low refrigerant alarm delay	15 - 240	min
JNET Functions	1	Unit number	0.1 - 899.7	
	18	Daylight saving operation	0= standard time, 1 daylight saving time	
Broadcast Data sets	690	Suction pressure 1	0 - 9999	
	691	Suction pressure 2	0 - 9999	
	5066	Suction pressure 3	0 - 9999	
	5067	Current suction pressure setpoint	0 - 9999	
	5060	Current compressor capacity loaded	0 - 9999	
	5065	Enable non-legacy pressure set broadcasting	0 -off 1 - on	

Virtual Bitswitch	966	Bitswitch Selection	0=LT (HFC) 1=HT (HFC) 2= LT(CO2) 3= HT(CO2) Where 0-3 is the virtual bitswitch setting on item 966.	

OTHER USEFUL ITEMS

Item	Function	Item	Function	Item	Function
	PRESSURE		**COMPRESSOR DATA (WHERE x IS COMPRESSOR NO.)**		**VARIABLE CAPACITY COMPRESSOR**
21	Pressure			345	Current proportional term
146	Average pressure (1hr)	2x3	Status	346	current integral term
	CONTROL	2x2	Run hours (10 s of hours)	331	Frequency (Hz)
151	Optimised LT setpoint	37x	Run time (last 24 hours)	332	Run hours (10s of hours)
153	Optimised HT setpoint	2x4	Restart timer	333	inverter/ compressor status
191	Integrated pressure error	35x	Average starts per hour (last 24 hours)		
181	Next increase site (kW)	45x	Compressor availability	344	Capacity loaded (kW)
182	Next decrease step (kW)	5x5	Compressor ok input status		
	PACK DATA	5x6	Capacity loaded (kW)		
201	No. of steps on load				
202	No. of compressors running				
203	Loaded capacity (kW)				

OUTPUT & FUNCTION					
MODE	RL1 CRITICAL ALARM	RL2 HIGH SUCTION PRESSURE ALARM	RL3-6 RUN COMPRESSORS 1 - 4	RL7 RUN INVERTER	RL8 WATCHDOG
NORMAL	CRITICAL ALARM PRESENT	ENERGISED WHEN PRESSURE IS HIGH	STAGE AS REQUIRED	RUN AS REQUIRED	ENERGISED WHEN ELECTRONICS HEALTHY
BACKUP			OFF	OFF	
FORCED			ON /OFF AS FORCED	ON /OFF AS FORCED	

Relay Output Rating
2A resistive

Supply Requirements
230 V ac 48-62 Hz Supply 6 VA maximum inputs
2 mA maximum

24 Vac (optional)

CE This unit conforms with the relevant EU standards when fitted in accordance with its installation instructions.

Applicable Documentation

Item Numbers	Firmware Variations	Connections Diagram
Doc No. 04220	Doc No. 04217	Doc No. 04104

Installation Information
Doc:04256

Note: The information contained in this document applies to the current version of the unit supplied with it. Full operating manuals, item number and software variation information can be obtained from the supplier JTL Systems.

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