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 **DQ**.

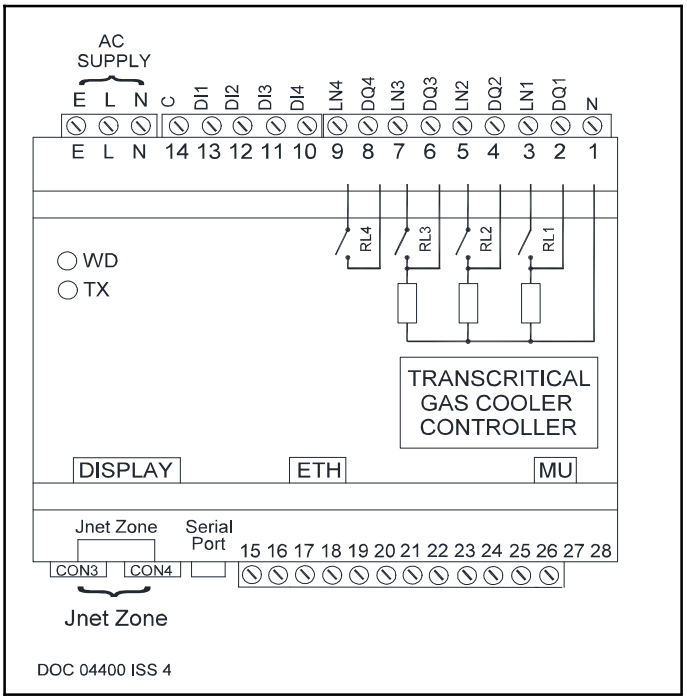
The plant inputs are electrically isolated. A volt free contact should be connected for the logical conditions stated below between the input and common **C** (14).

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				
1	LN DQ	3 2	Suppressed	Enable Adiabatic cooling
2	LN DQ	5 4	Suppressed	Enable High Pressure Valve
3	LN DQ	7 6	Suppressed	Watchdog
4	LN DQ	8 9	Unsuppressed	High Safety Interlock Pressure
Digital Inputs				
1		14 13	Volt Free	Auto
2		14 12	Volt Free	Adiabatic cooling healthy
3		14 11	Volt Free	Fans Healthy
4		14 10	Volt Free	HP Valve Healthy
Analogue OUTPUT				
1	+ -	19 20	0-10 V	Cooler Fan speed
2	+ -	17 20	4-20mA	High Pressure Valve
		26 16	0V +24v	External Supply
Analogue INPUT				
1	+ -	21 22	5k Thermistor	Cooled Gas Temperature
2	+ -	21 23	5k Thermistor	Ambient Air Temperature
	+ -	15 24	4-20 mA	Cooler Exit Pressure
	+ -	17 20	4-20mA	Cooler Inlet 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 22 press: ITEM 2 2 ENTER

To set item 50 to 650 Press:

ITEM 5 0 ENTER SET 6 5 0 ENTER

To correct errors press: CANCEL

To select next or previous items press: + and −

Initial Commissioning Settings

The controller has 1 set of data built in to its program for use during commissioning. Initialize to this data by setting item 9 to 1234. This loads into the controller a suitable set of data, adjustments should then be made as necessary.

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 MPa as selected by item 9393.

The HP350 controller drives the JTL LCD14 display using a CAB75 cable. Various cable lengths are available.

Transcritical CO2 Operation
When the external ambient reaches a certain level the CO2 becomes supercritical. At this point the CO2 gas cooling strategy has to change as the condenser changes over to being a gas cooler.

The decision to switch to supercritical control from conventional subcritical control is made using the 'adjusted ambient temperature' (item 35).

The adjusted ambient temperature is calculated by taking the difference between the CO2 gas temperature (item 31) and the ambient temperature (item 32). This difference is then limited to 10K and multiplied by a percentage factor (item 36). The result is added to the ambient temperature to produce the adjusted ambient temperature.

When this value exceeds its setpoint (item 37) then supercritical mode control is put into operation. There is a deadband value (item 38) to control switching back to subcritical mode control.

Cooler Pressure Calculation
The cooler can have two transducers, one on the inlet and one on the exit. The exit pressure is required for the exit subcooling calculation for subcritical fan speed control.

The inlet pressure is optimal. The operational cooler pressure can be selected to be the exit, inlet or a mixture of the two pressures on item 65.

When the mixture of the pressures is chosen the proportion the two pressures is specified on item 66. 0%=exit 100%=inlet.

If the differential between the control pressure and the pressure setpoint is above a settable value (item380) then the HP valve is not allowed to close below the minimum opening (item 5155).
When the difference is less than item 380 the HP valve is allowed to close if necessary.

Cooler Pressure Control - Subcritical
In subcritical mode the cooler acts as a conventional condenser, the pressure is controlled by the high pressure valve after the condenser using PI control against an optimised pressure setpoint calculated using the external ambient temperature and the design differential temperature for the condenser.

The head pressure (item 22) is floated to give differential temperature above the ambient condition. The differential (item 363) should be set to the condenser design condition to give maximum condenser efficiency.

The outside ambient temperature (item 32) is read from sensor 2. If this is not available then it is read from the JTL network (item 899). If the outside temperature is not available then the ambient temperature is set to 15C.

The CO2 boiling point (item 365) is calculated from the cooler pressure (item 22).

The target temperature (item 364) for the condenser control is calculated from the outside air temperature plus the design differential temperature. (item 32 + item 363).

The floating pressure setpoint (item 370) is calculated from the target temperature (item 364) and the selected refrigerant (item 157).

The minimum pressure setpoint (item 50) is used when floating head is disabled or when the outside air temperature is not available.

The maximum pressure setpoint (item 350) for the condenser is used to limit the floating head pressure.

Cooler Pressure Control - Supercritical
In supercritical mode the transcritical valve is controlled by PI control against a calculated pressure set point (item 370) calculated using a formula which takes a multiple (item 63) of the external ambient temperature (item 32) and adds a constant (item 64).

Cooler Exit Temperature Control - Subcritical
In subcritical mode the cooler fans are controlled by PI control against a calculated temperature setpoint (item140) which endeavouring to maintain the liquid at a set level of subcooling (item144).

The target temperature is calculated from the condenser pressure set point.

Cooler Exit Temperature Control - Supercritical
In supercritical mode the cooler acts as a gas cooler where the fan speed is controlled by PI control against temperature setpoint calculated using a formula which takes a multiple (item 146) of the external ambient temperature and adds a constant (item 147).

Maximum Cooler Exit Temperature
The cooler exit temperature setpoint is limited to a settable maximum value (item 338).

Minimum Cooler Exit Temperature
The cooler exit temperature setpoint is limited to a minimum value calculated from the ambient temperature and a differential value set on item 143.

The cooler exit temperature is also limited to a settable minimum value (item 339).

Fan Speed Control
The controller varies frequency the speed of the fans using a 0 - 10V signal. 0 V is for minimum speed and 10 V is maximum speed.

There are maximum and minimum fan speed control settings on item 359 & 358.
If the minimum setting is set >0 then, when the minimum speed is reached the fans stay running until the pressure falls below the cut out level (item 357).

There is a separate maximum fan speed setting for nightime operation (item 368). Nightime is determined by a timer on the JTL network selected on item 369.

The fans can also be stopped or run at a minimum speed if the high pressure valve closes (item 356).

When heat reclaim boost is in operation the fan speed minimum is also changed to settable value (item 5165).

High Pressure Valve Control
The controller opens the valve using a 4-20mA signal 4mA is for valve closed and 20mA is for valve fully open.

Adiabatic Cooling
The HP380 controller can enable an adiabatic cooling system provided by others. The HP380 has the following strategy to enable the adiabatic cooling.
Adiabatic cooling must be enabled (item 5170).

The gas cooler exit temperature must exceed the temperature setpoint by a set amount (item 5174) for at least a set time (item 5175) AND the ambient temperature must be above a set level (item 5173).

Once the cooling is enabled it must run for a minimum set time (item 5172) and once it has stopped it must stay off for a minimum time (item 5171) before it is allowed to run again.

Adiabatic Cooling Test Facility
The HP380 provides an automatic test procedure to trigger a cooling sequence on a periodic basis. The test is specified to run at a particular time (item 5187) on a particular day (item 5181) with a period between tests in weeks (item 5180).

Note if the cooling runs for normal reasons then the this test is not run until the test period has elapsed.

Note also that this test will not run if the ambient temperature is below the minimum ambient temperature level (item 5173).
The test will run for the minimum run time. It can be programmed to repeat (item 5183) after the minimum off time.

Heat Reclaim Control
The HP380 is used in conjunction with an interface type IF67.
On the IF67 there are 4 inputs.
Pump fault
HR plant healthy
Heat reclaim required
Heat reclaim boost required.
To get the HR mode the plant must be healthy, no pump fault and heat reclaim required input. Additionally to get HR boost the HR boost input is also required.

Stage 1 - Heat Reclaim (Free Heating)
The minimum discharge pressure is raised to a fixed set value and an adjustable set rate.

The HR bypass value is controlled using a 2-10 V output on the IF67 with maximum and minimum settings to achieve the settable required water flow temperature. Maximum drive means valve fully closed.

Stage 2 - Heat Reclaim Boost
When the heating fluid flow temperature is below the setpoint then the minimum cooler pressure is raised towards a higher fixed set value and an adjustable set rate.

There is a dead zone between 70 bar and a minimum boost pressure (item 5118) which prevents the boost pressure being set around the critical point to avoid instability occurring in the pressure control.

There is an adjustable heating fluid flow temperature deadband. When the flow temperature is higher than the setpoint plus the deadband the minimum cooler pressure is lowered at the set rate to the stage 1 pressure setpoint.

When the heating fluid flow temperature is within the deadband range the minimum cooler pressure is no longer raised or lowered.

When in HR boost the gas cooler bypass valve is driven using a 2-10 V output on the IF67.

If boost pressure increase is required the cooler bypass valve is slowly opened to its maximum or until boost pressure decrease is required when it will slowly be closed.

If the pressure exceeds a set level above setpoint the cooler bypass is also slowly closed.

Heat Reclaim Features
The minimum cooler pressure will never fall below the pressure demanded by the refrigeration requirement.

In HR when the minimum cooler pressure required is higher that the stage 1 pressure the control is set into supercritical mode regardless of the refrigeration requirement.

The HP valve minimum opening should be set at a sensible value when working with heat reclaim.

Control Response
The controller uses proportional and integral control algorithms to control the outputs. These require proportional and integral gains to adjust the response of the control of outputs.

Output smoothing is available to reduce instability of the outputs where necessary.

Pressure Healthy
The HP380 can be used in conjunction with other controllers. There is an output which indicates if the discharge pressure is within acceptable limits which can be connected to other systems. The acceptable pressure level is set as item 55 and the acceptable cooler inlet pressure on item 68.

Pressure Data Sets
The cooler pressure can be broadcast via IP in up to two data sets. The set numbers are set on items 101 & 102. Setting 0 disables the broadcast.

The cooler inlet pressure can be broadcast via IP in up to two data sets. The set numbers are set on items 103 & 104. Setting 0 disables the broadcast.

Pressure Alarm
The cooler pressure is constantly monitored and compared with a high alarm level and low alarm level. Different alarm levels are available for subcritical and supercritical operation.

The cooler inlet pressure is monitored and compared with a high alarm level.

The cooler differential pressure is monitored and compared with a high alarm level.

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

The time delay is achieved by integrating the difference between the alarm level and the actual pressure over a period of 30 seconds. This means that the larger the difference the faster the alarm occurs.

Pressure Transducer Alarms
The pressure transducer is constantly checked and if, after a 15 minute time delay, the output goes outside the acceptable range an alarm is given (item 91).

If there is a pressure transducer fault, the outputs are set to a settable backup value

Ambient Temperature Tolerance Alarm
The external sensor temperature is compared to the cooler air on temperature if the difference (modulus) (item 39) is greater the tolerance for longer than 15 mins an alarm is given.

Alarm Display
Various alarms are indicated on the pressure displays. Typical messages displayed are:

P.Flt	Plant fault (auto input not present) - (highest priority)
Hi.dP	High cooler pressure
FAn	Condenser fan failure (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.

Daylight Saving
When connected to a JTL network this controller can operate by displaying daylight saving time for its time and defrost schedule. Daylight saving operation is selected by setting item 18. The connected network controller then adjusts the times automatically during the daylight saving period.

ADJUSTABLE PARAMETERS				HP380
	Item	Function	Range	Units
PRESSURE CONTROL	65	Cooler pressure calculation method	0=cooler exit 1=cooler inlet 2=mixture of both	
	66	Cooler pressure ratio	0 - 100	
	50	Pressure setpoint (minimum)	575 to 725	psi
	350	Pressure (maximum)	1200 - 1600	psi
	67	Cooler pressure safety strategy	0=cooler exit 1=cooler inlet 2=both	
	55	Cooler exit safety level	1200 -1600	psi
	68	Cooler inlet safety level	1200 -1600	psi
	73	Maximum cooler inlet pressure	1200 -1500	psi
	74	Minimum cooler exit pressure	500-600	psi
		Subcritical		
	363	Floating cooler temperature differential	5 to 15	K
		Supercritical		
	63	OAT multiplier	0 - 30	
	64	OAT constant	400 - 1400	psi
COOLER EXIT TEMPERATURE CONTROL	338	Maximum cooler exit temperature	35 - 40	°C
	339	Minimum cooler exit temperature	5 - 15	°C
		Subcritical	0.0 - 10.0	K
	144	Sub cooling setpoint		
		Supercritical		
	146	OAT multiplier	1.0 - 1.6	
	147	OAT constant	0.0 to 10.0	K
PRESSURE ALARM	52	High condensing pressure (subcritical)	725 to 1200	psi
	51	Low condensing pressure (subcritical)	300 to 600	psi
	62	High cooling pressure (transcritical)	1200 - 1600	psi
	61	Low cooling pressure (transcritical)	600 - 1200	psi
	72	High cooler inlet pressure	1200 - 1600	psi
	69	High cooler differential pressure	0 - 500	psi
PRESSURE TRANSDUCERS	122	Cooler exit transducer	0=disabled 1=enabled	
	422	Cooler exit transducer full scale (at 20 mA)	1450 - 1750	psi
	101	Cooler exit pressure data set 1	0 - 9999 (0=not used)	
	102	Cooler exit pressure data set 2	0 - 9999 (0=not used)	
	123	Cooler inlet transducer	0=Disabled 1=Enabled	
	423	Cooler inlet transducer full scale (at 20 mA)	1450 - 1750	psi
	103	Cooler inlet pressure data set 1	0 - 9999 (0=not used)	
	104	Cooler inlet pressure data set	0 - 9999 (0=not used)	
TEMPERATURES	131	Cooler exit temperature sensor	0=disabled 1=enabled	
	132	Ambient temperature sensor	0=disabled 1=enabled	
	139	Outside ambient temperature source	0-local 1-network	
	143	Minimum cooler exit differential	0 - 10	K
	36	Adjusted ambient factor	0 - 50	%
	37	Adjusted ambient setpoint	21 - 27	°C
	38	Adjusted ambient deadband	1 - 4	K
	39	Ambient temperature tolerance	3 - 10	K
	230	Discharge temperature	0=disabled 1=enabled	
	231	Heating fluid flow temperature selection	0=disabled 1=enabled	
	232	Heating fluid return temperature selection	0=disabled 1=enabled	
	233	Gas cooler bypassed temperature selection	0=disabled 1=enabled	
	234	Heat exchanger gas output temperature selection	0=disabled 1=enabled	
	235	Gas cooler in temperature selection	0=disabled 1=enabled	
	236	Air handling unit coil temperature selection	0=disabled 1=enabled	°C
	5137	Heating fluid temperature alarm level	70 - 90	

FAN SPEED CONTROL	5161	Integral gain(subcritical)	0.01 - 1.00	
	5163	Integral gain (supercritical)	0.01 - 1.00	
	5160	Proportional gain (subcritical)	5.00 - 99.99	
	5162	Proportional gain (supercritical)	5.00 - 99.99	
	5045	Maximum cooler fan speed	50 - 100	%
	5044	Minimum cooler fan speed	0 - 25	%
	5165	Minimum fan speed on HR boost	0 - 20	%
	354	Upper limit for minimum fan speed	0 - 40	%
	355	Rate of change of minimum fan speed adjustment	0 - 1.0	%/4 sec
	349	Pressure differential for fan speed adjustment	15 - 75	psi
	357	Discharge pressure cut out	500 - 700	psi
	327	Minimum fan speed reduction temp (high)	0 - 25	
	328	Mnimum fan speed reduction temp (low)	-10 - 10	
	324	Compressor capacity loaded		
	325	Compressor capacity data set	0 - 9999	
	352	Compressor capacity to increase supercritical fan speed by 1%	0 - 20	kW
	329	Compressor capacity to increase subcritical fan speed by 1%	0 - 20	kW
	356	Fans strategy when transcritical valve shut	0=normal 1=stop 2=minimum speed	°C
	360	Fan speed reduction temperature	5 - 20	°C
	361	Fan speed top temperature	-5 - 10	%
	368	Maximum speed at night	50 - 100	
	369	Timer for nighttime operation	0 - 8	
	397	No of steps in backup	0 - 100	%
	389	Fan output smoothing	0 - 5 0=disabled	
	5164	Fan output voltage for zero speed	0 - 2.0	v
HIGH PRESSURE VALVE CONTROL	5151	Integral gain (subcritical)	0.01 - 1.00	
	5150	Proportional gain (subcritical)	5.00 - 99.99	
	5153	Integral gain (supercritical)	0.01 - 1.00	
	5152	Proportional gain (supercritical)	5.00 - 99.99	
	379	Valve output smoothing	0 - 5 0=disabled	
	5154	Pressure difference to allow valve to shut	15 - 75	psi
	5155	Minimum valve position	0 - 25	%
	5156	Maximum valve position	50 - 100	%
	380	Differential to allow valve to close	15 - 75	psi
ADIABATIC COOLING CONTROL	5170	Enable adiabatic cooling	0=disabled 1=enabled	
	5171	Minimum off time	2 - 10	mins
	5172	Minimum run time	5 - 30	mins
	5173	Minimum ambient to run cooling	25 - 35	°C
	5174	Gas cooler temperature error to run cooling	1 - 5	K
	5175	Adiabatic cooling trigger delay	1 - 10	mins
ADIABATIC COOLING TEST	5180	Period between tests	0 - 4 (0=disabled)	weeks
	5181	Test day	0=Sunday 1=Monday etc	
	5182	Test time of day	00:00 - 23.59	
	5183	Test repeat cycles	0 - 5	
	5186	Minimum ambient to allow testing	2 - 10	°C
HEAT RECLAIM CONTROL	5114	Heat reclaim minimum pressure set point	600 - 1100	psi
	5115	Heat reclaim boost pressure set point	1000 - 1350	psi
	5116	Rate of change of pressure on heat reclaim	0.1 - 10.0	psi/sec
	5117	Rate of change of pressure on heat reclaim boost	0.1 - 10.0	psi/sec
	5118	Minimum supercritical boost pressure	1087 - 1200	psi
	5100	Heating fluid flow water temperature set point	40.0 - 65.0	°C
	5136	Heating fluid flow temperature deadband	0.0 - 2.0	°C
HEAT EXCHANGER BYPASS VALVE	5101	Minimum bypass valve closing	0 - 25	%
	5102	Maximum bypass valve closing	25 - 100	%
	5106	Forced bypass valve output	0 - 100.0	%
	5113	Bypass valve output rate of change	0.1 - 10.0	psi/sec
GAS COOLER BYPASS VALVE	226	Gas cooler bypass	0=disabled 1=enabled	
	5051	Minimum bypass valve opening	0 - 25	%
	5052	Maximum bypass valve opening	25 - 100	%
	5056	Forced bypass valve output	0 - 100.0	%
	5086	Bypass valve output rate of change	0.1 - 10.0	psi/sec
	5087	Gas cooler bypass differential	0 - 50	psi

HEAT RECLAIM	200	Heat reclaim enable	0=disabled 1=enabled	
	227	Heat reclaim boost enable	0=disabled 1=enabled	
	241	Timer for heat recovery enable	0 - 8	
	242	Timer for energy reduction	0 - 8	
	5132	Coolant specific heat (x1000)	700 - 1000	m3/hr
	5133	Coolant specific gravity (x1000)	1000 - 1200	
	5134	Coolant pump flow at max	10 - 200	
	5119	Rate of change of pressure on return to normal refrigeration	0.1 - 10.0	psi/sec
	5138	Bypass valve slew rate on return to normal refrigeration	0.1 - 10.0	%/sec
	5139	Heat reclaim supercritical temperature constant	2.0 - 10.0	°C
DISPLAY	9393	Display units - pressure	0 - MPa 1 - psi, 2 - bar, 3 - hPa, 4 - barA	
	9392	Display units - temperature	0 - Celsius 1 =Fahrenheit	
	189	Backlight control	0 - off 1 - on 2 - off flashes alarm 3 - on flashes alarm	
JNET FUNCTIONS	1	Unit number	0.1 - 899.7	
	18	Daylight saving operation	0= standard time, 1 daylight saving time	

OTHER USEFUL ITEMS

Item	Function	Item	Function	Item	Function
	PRESSURE		FAN SPEED CONTROL		TEMPERATURES
22	Cooler Pressure	353	Current minimum speed	899	Outside ambient
23	Cooler inlet pressure	391	Speed (%)	35	Adjusted ambient
24	Cooler exit pressure	5046	Outside Temperature	820	Met Office temperature
148	Average cooler pressure (1hr)		HP VALVE CONTROL	5120	Ambient temperature
370	Active pressure setpoint	324	Compressor capacity loaded	5121	Heating fluid flow temperature
364	Cooler target temperature	371	Output (%)	5122	Heating fluid return temperature
5021	Refrigerant boiling point	372	Forced output (%)	5123	Gas cooler bypassed temperature
			HEAT RECLAIM	5124	Heat exchanger gas output temperature
		5109	Heat exchanger bypass valve position (%)	5125	Gas cooler in temperature
		5059	Gas cooler bypass valve position (%)	5126	Air handling unit coil temperature
				5128	Gas cooler exit temperature
				5129	Discharge temperature (Heat exchanger gas input temperature)

Relay Output Rating

2A resistive

Supply Requirements
85-265 Vac 47-440Hz 5VA maximum
85-265 Vac

24 Vac (optional)

Applicable Documentation

Item Numbers	Firmware Variations	Connections Diagram
Doc No. 05363	Doc No. 05364	Doc No. 05358

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

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

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