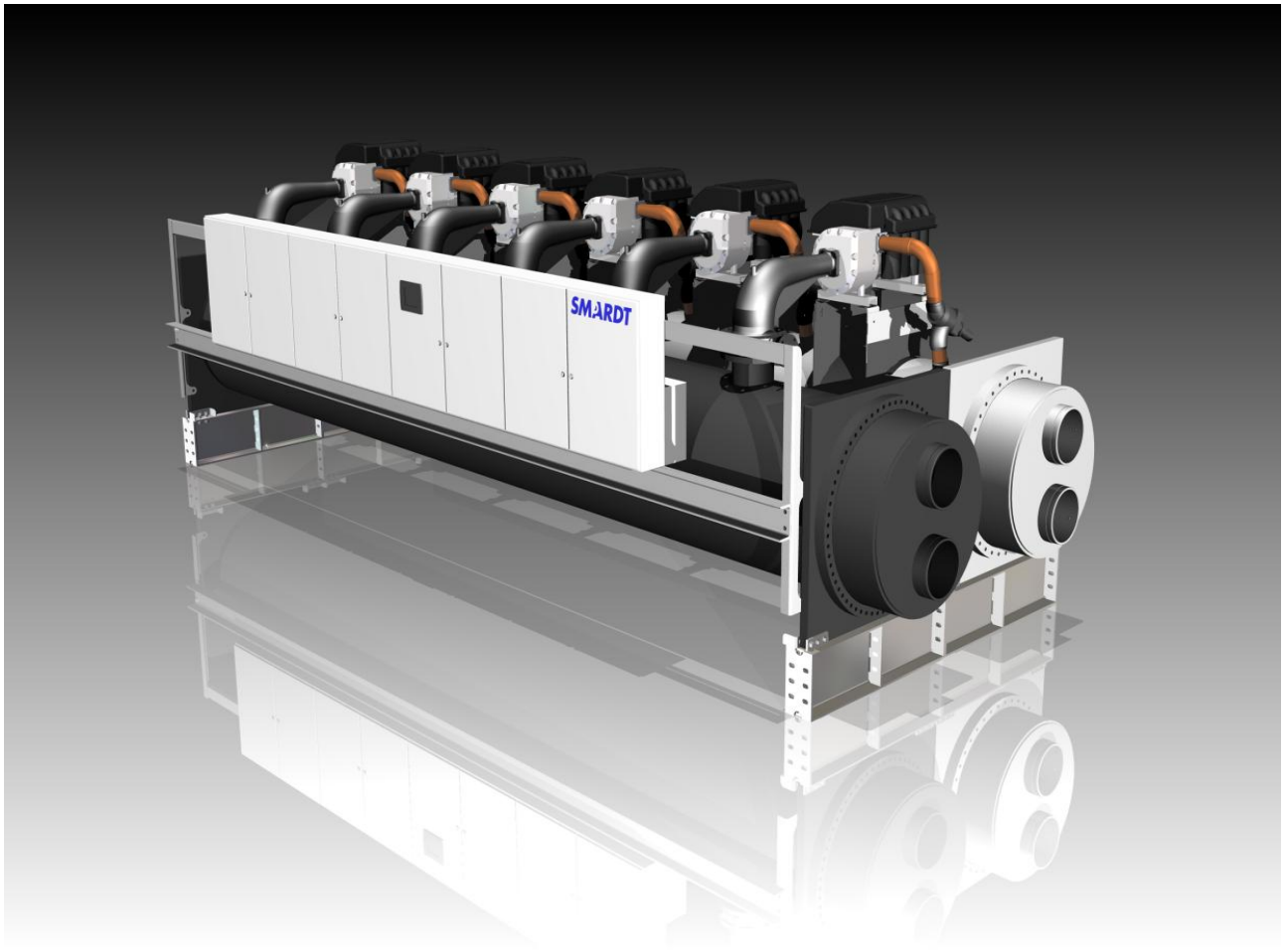
SMARDT

Water-Cooled Chiller
Manual

Oil-Free Centrifugal Chiller



Installation, Operation & Maintenance Manual

SMARDT CHILLER GROUP
IOM-WC TD0061R-C

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For product support issues, corrections, or enquiries, contact:

Product Support
productsupport@smardt.com

SMARDT CHILLER GROUP INC.
1800 Trans Canada Hwy
Dorval, QC, Canada H9P 1H7
Tel : +1 514 426 8989
Fax: +1 514 426 5757
www.smardt.com

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DOCUMENT PURPOSE

The purpose of this manual is to inform contractors, building owners, and engineers of the installation, sequence of operation and service requirements for the SMARDT oil-free Water-Cooled centrifugal chiller.

It is intended that this manual be used with the applicable installation drawings and wiring diagrams.

This manual is applicable to the complete range of SMARDT Water-Cooled chiller models.

SMARDT has an on-going policy of continuous product improvement, which at times, may impact the information contained in this manual. Revised manuals are not distributed unless recipients specifically subscribe to the revised documents.

DEFINITION OF ACRONYMS

AC	Alternating Current
AHRI	Air-Conditioning, Heating & Refrigeration Institute
ASHRAE	American Society of Heating, Refrigeration, & Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ANSI	American National Standards Institute
BAS	Building Automation System
BMS	Building Management System
CG	Center of Gravity
DC	Direct Current
EXV/EXValve	Electronic Expansion Valve
HP/LP	High Pressure / Low Pressure
HVAC	Heating, Ventilating & Air Conditioning
IGV	Inlet Guide Vane
I/O	Input / Output
kPa	Kilopascals
LCWT	Leaving Chilled Water Temperature
LWT	Leaving Water Temperature
MCA (A)	Minimum Circuit Ampacity (Amps)
MOP (A)	Maximum (Rating of) Over-Current Protective Device (Amps)
MDS (A)	Minimum Disconnect Size Rating (Amps)
MFW	Minimum Field Wiring Size
PCBs	Printed Circuit Boards
PID	Proportional Integral Derivative
psi	Pounds per Square Inch
psia	Pounds per Square Inch Absolute
psig	Pounds per Square Inch Gauge
RH	Relative Humidity
RMA	Return Merchandise Acknowledgement
RTU	Remote Terminal Unit
SH	Super Heat
SSH	Suction Super Heat
SST	Saturated Suction Temperature
VAC	Volts Alternating Current
VDC	Volts Direct Current
VFD	Variable Frequency Drive

Table 1: Definition of Acronyms

SAFETY

WARNING!

Under all circumstances, only qualified and licensed HVAC &/or refrigeration personnel should work on SMARDT chillers.

REFRIGERANT SAFETY GUIDELINES

Responsible Refrigerant Practices

SMARDT chillers use HFC-134a ozone friendly refrigerant, and SMARDT believes that responsible refrigerant practices are important to the environment, our customers, and the air conditioning industry. All handlers of refrigerants must be certified, and the US Federal Clean Air Act (Section 608) sets forth the service procedures and requirements for handling, reclaiming, recovering and recycling of certain refrigerants, and for the equipment that is used in these service procedures. In addition, some states or municipalities may have further requirements that must also be adhered to for responsible management of refrigerants. It is important to know the applicable laws, and to follow them.

SAFETY CONSIDERATIONS

Centrifugal liquid chillers are designed to provide safe and reliable service when operated within design specifications. When operating this equipment, use good judgment and good safety practices, in order to minimize the potential for equipment or property damage or increased personal risk. Make sure procedures and safety precautions contained in this manual are fully understood, and that equipment operation is within product data submittal specifications.

DANGER

DO NOT VENT refrigerant pressure relief valves within a building. Outlet from pressure relief valves must be vented outdoors in accordance with the latest edition of ANSI/ASHRAE 15 (American National Standards Institute/American Society of Heating, Refrigeration, and Air Conditioning Engineers - Safety Standard for Refrigeration Systems). Refrigerant vapor is heavier than air and reduces the amount of oxygen available for breathing. The accumulation of refrigerant in an enclosed space can displace oxygen and cause asphyxiation, it causes eye and skin irritation, and its misuse can be fatal. Be sure to provide adequate ventilation in accordance with ANSI/ASHRAE 15; especially for enclosed and low overhead spaces. Inhalation of high concentrations of vapor is harmful and may cause heart irregularities, unconsciousness, and even death in severe cases.

BECAUSE oxygen gas reacts violently with many common substances, DO NOT USE OXYGEN to purge lines or to pressurize a chiller for any purpose.

NEVER EXCEED specified test pressures: VERIFY the allowable test pressure by checking the design pressures on the equipment nameplate.

DO NOT USE air for leak testing, use only dry nitrogen.

DO NOT VALVE OFF any safety device.

BE SURE that all pressure relief devices are properly installed and functioning before operating any chiller.

PREVENT POTENTIAL RISK OF INJURY OR DEATH by electrocution. Hazardous voltage is present on main compressor leads, even when a compressor shaft is not spinning. Open the power supply disconnect before touching motor leads or terminals. Allow 15 minutes for capacitors to discharge before proceeding.

WARNING!

DO NOT WELD OR FLAMECUT any refrigerant line or vessel until all refrigerant (liquid and vapor) has been removed from the chiller. Traces of vapor should be displaced with nitrogen, and the work area should be well ventilated. Refrigerant in contact with an open flame produces toxic gases.

Only shops certified with an “R” stamp from ASME can repair vessels. Do not weld, repair or make any changes to pressure components.

DO NOT USE eyebolts or eyebolt holes to rig either chiller sections or the entire assembly.

ONLY QUALIFIED electricians should work on the equipment.

DO NOT WORK ON electrical components, including control panels, switches, or capacitors, until it is certain that ALL POWER IS OFF and no residual voltage can leak from capacitors. Allow 15 minutes for capacitors to discharge before proceeding.

LOCK OUT AND TAG ALL electrical circuits during servicing.

AVOID SPILLING liquid refrigerant on skin or getting it into the eyes. USE SAFETY GOGGLES. Wash any spills from the skin with soap and water. If liquid refrigerant enters the eyes, IMMEDIATELY FLUSH EYES with water and consult a physician.

NEVER APPLY an open flame or live steam to a refrigerant cylinder. Dangerous over pressure can result. When it is necessary to heat refrigerant, use only warm (110 F [43 C]) water.

DO NOT REUSE disposable (non-returnable) cylinders or attempt to refill them. It is DANGEROUS and is ILLEGAL. When cylinder is emptied, evacuate remaining gas pressure, loosen the collar and unscrew and discard the valve stem. DO NOT INCINERATE.

CHECK THE REFRIGERANT TYPE before adding refrigerant to the chiller. The introduction of the wrong refrigerant can cause damage or malfunction to this chiller. Only R134a refrigerant should be used.

DO NOT ATTEMPT TO REMOVE fittings, covers, etc., while chiller is under pressure or while chiller is running. Be sure pressure is at 0 psig (0 kPa) before breaking any refrigerant connection.

SMARDT provides 2 pressure relief valves per vessel, and it is important that only one is used at a time. The stem on the manifold Is to be either front seated or back seated; not in the middle.

CAREFULLY INSPECT all pressure relief devices AT LEAST ONCE A YEAR. If chiller operates in a corrosive environment, carry out these inspections at more frequent intervals.

DO NOT ATTEMPT TO REPAIR OR RECONDITION any relief device when corrosion or build-up of foreign material (rust, dirt, scale, etc.) is found within the valve body or mechanism. Replace the device.

DO NOT install pressure relief devices in series or backwards.

USE CARE when working near or in line with a pressure relief device. Sudden release of the device can cause it and objects in its path to act as projectiles.

CAUTION

DO NOT STEP on refrigerant lines. Broken lines have the potential to whip about, release refrigerant, and cause personal injury.

DO NOT climb over a chiller. Use a platform, catwalk, or staging, and follow safe practices when using a ladder.

USE MECHANICAL EQUIPMENT (crane, hoist, etc.) to lift or move inspection covers or other heavy components. Even if components are light, use mechanical equipment when there is a risk of slippage or loss of balance.

BE AWARE that certain automatic start arrangements CAN ENGAGE COMPRESSOR, PUMPS, or COOLING FANS. Open the disconnect ahead of the COMPRESSOR, PUMPS, or COOLING FANS.

USE only repair or replacement parts that meet the code requirements of the original equipment.

DO NOT VENT OR DRAIN waterboxes containing industrial brines, liquid, gases, or semisolids without the permission of your process control group.

DO NOT LOOSEN waterbox cover bolts until the waterbox has been completely drained.

DO NOT LOOSEN a packing gland nut before checking that there is no pressure on the packing gland.

PERIODICALLY INSPECT all valves, fittings, and piping for corrosion, rust, leaks, or damage.

PROVIDE A DRAIN connection in the vent line near each pressure relief device to prevent a build-up of condensate or rain water.

Waterboxes and waterbox covers are too heavy to lift or carry. Ensure that they are properly slung before removing attachment bolts.

ELECTRICAL SAFETY

WARNING!

Low voltage in electrical equipment is potentially lethal. Isolate incoming electrical power before attempting installation or service of the equipment.

When AC power is first removed from the compressor, the capacitors store enough energy to cause injury. It is essential to allow sufficient time for the capacitors to discharge before proceeding.

Wait at least 15 minutes after isolating power before opening compressor access covers.

WATER TREATMENT

CAUTION

Do not use untreated or improperly treated water. Its use may result in equipment damage. Using untreated or improperly treated water in SMARDT chillers may result in inefficient operation, potential damage to tubing, and accelerated corrosion of waterboxes.

STATIC MAGNETIC FIELDS – DTC COMPRESSORS

WARNING!

DTC compressors produce static magnetic fields. Static magnetic fields are those produced by a permanent or direct current (DC) electro-magnet and could potentially have an effect on medical devices. Most pacemakers, defibrillators, and loop recorders are designed and tested to operate normally during exposure to static magnetic fields commonly found in the work environment. DTC advises against personnel with such a medical device, from performing any disassembly of the compressor that would expose the shaft or bearings.

Measurements of the Turbocor™ compressor conducted by DTC show the highest level of static magnetic fields is 0.0009T (tesla) (9G (gauss) within 153 mm (6”) of the body of the compressor.

PRODUCT DESCRIPTION

GENERAL DESCRIPTION

The SMARDT range of chillers offer the smallest footprint, the quietest operation and among the highest operating efficiencies on the market.

SMARDT's Water-Cooled centrifugal chiller design consists of a shell and tube evaporator, shell and tube condenser, twin-turbine centrifugal compressor(s), compressor controller(s), load balancing valves (if specified), refrigerant level sensors, electronic expansion valves, interconnecting refrigerant piping, and safety features such as triple freeze protection. All SMARDT chillers are designed to optimize the performance of oil-free centrifugal compressors from Danfoss Turbocor™ Compressors Inc.

The chiller set is a packaged unit, requiring connection to the chilled water circuit, main electrical supply, and integration with the building automation system (BAS) if applicable. The following protocols are available on SMARDT Chillers for BAS systems: LON, BACNET, BACNET/IP, N2, and MODBUS/IP, and these interfaces are usually installed inside the SMARDT main control panel.

SMARDT chillers deliver a high level of reliability, outstanding part-load efficiency, and the lowest overall cost of ownership on the market.

SMARDT chiller performance is certified by AHRI. For details, please see the AHRI website at www.ahrinet.org .

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WATER COOLED CHILLER - PRINCIPAL COMPONENTS

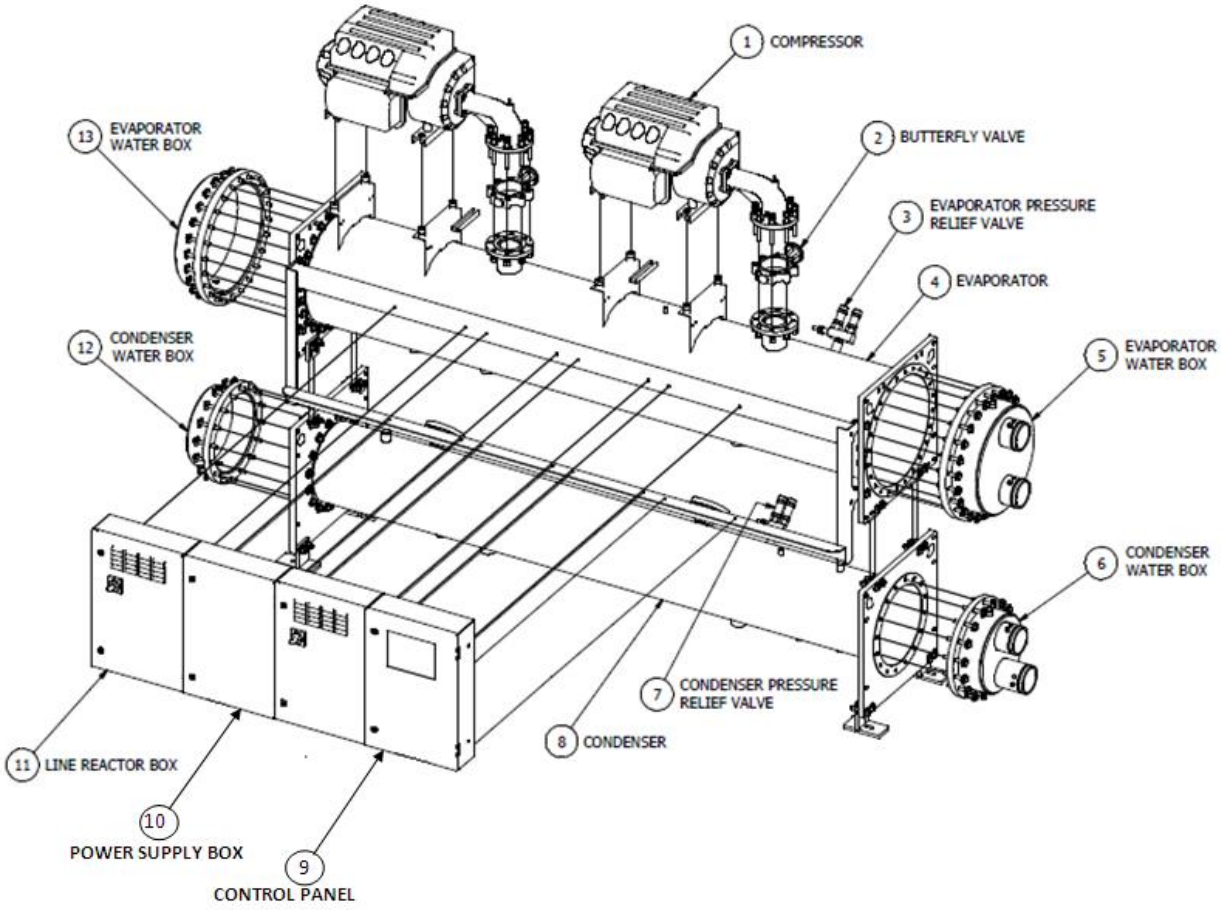

Figure 1: Exploded View - Water Cooled Chiller - Principal Components

PIPING SCHEMATIC

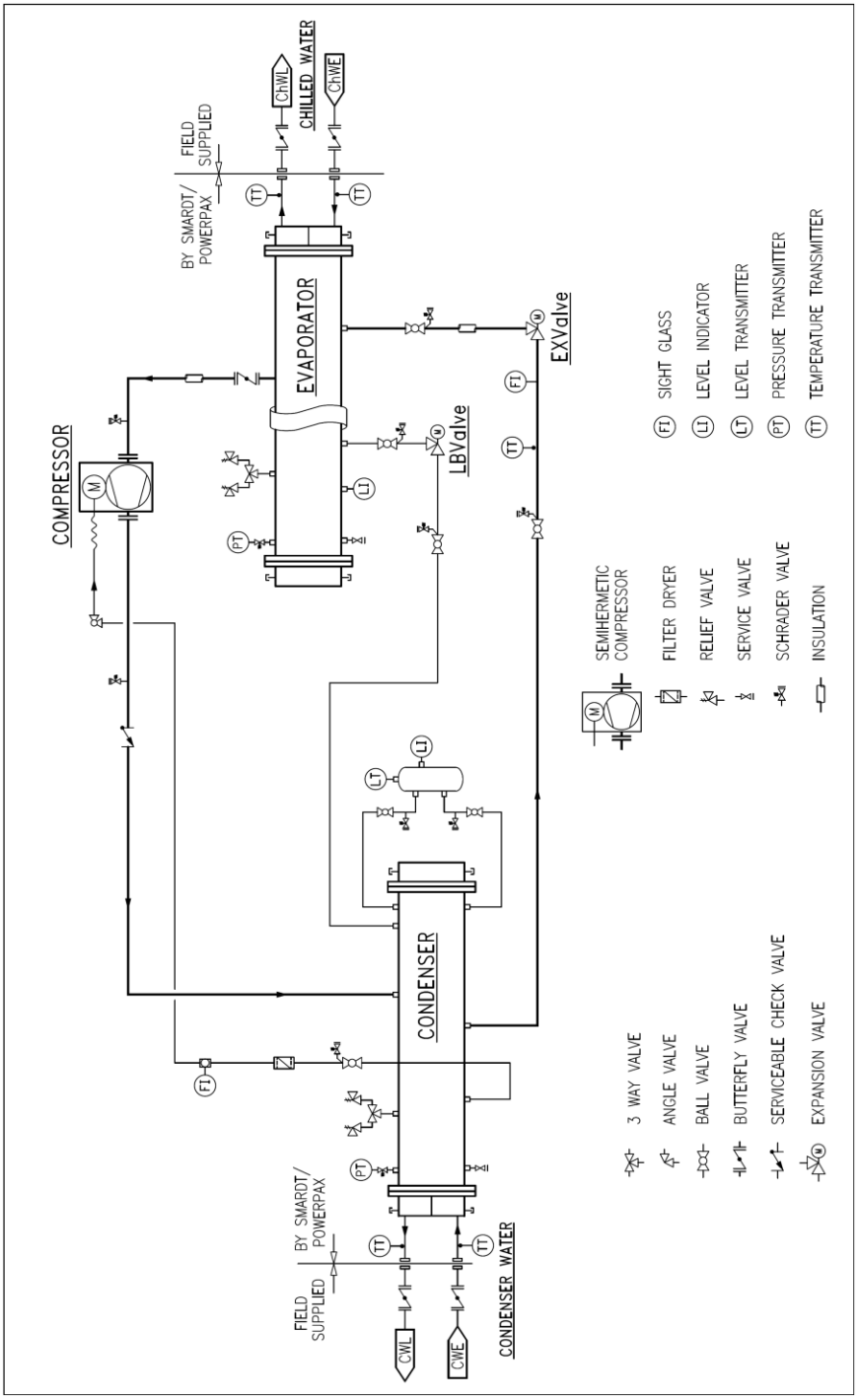

Figure 2: Piping Schematic

CHILLER NOMENCLATURE

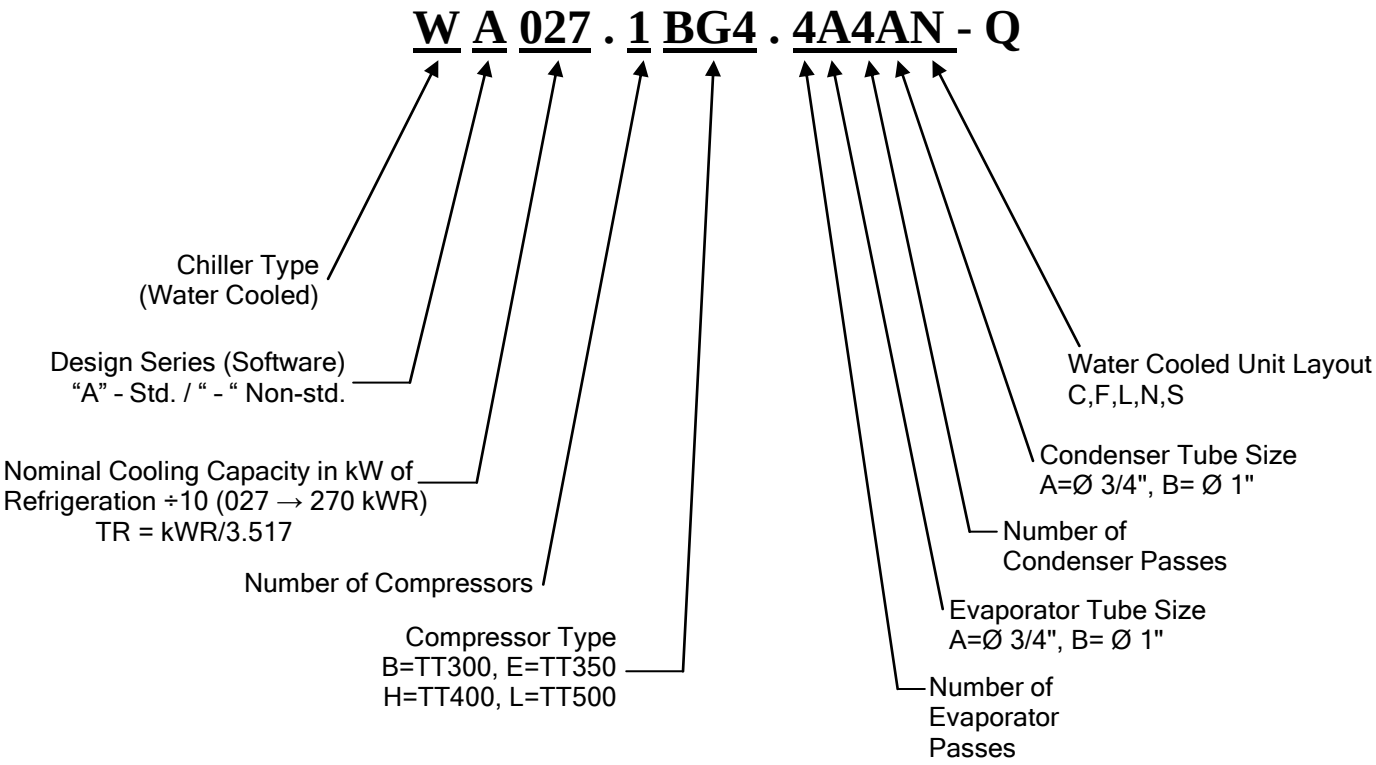

Figure 3: Chiller Nomenclature

NAMEPLATES

Nameplates are located in various locations on the chiller.

CHILLER NAMEPLATE

The chiller unit nameplate is located on the outside of the control cabinet door and contains both a model and serial number. The serial number is unique to the particular chiller and helps identify it. These numbers should be used to identify the chiller for service, parts and warranty enquiries. Verify that the information on the chiller nameplate is consistent with the chiller ordered.

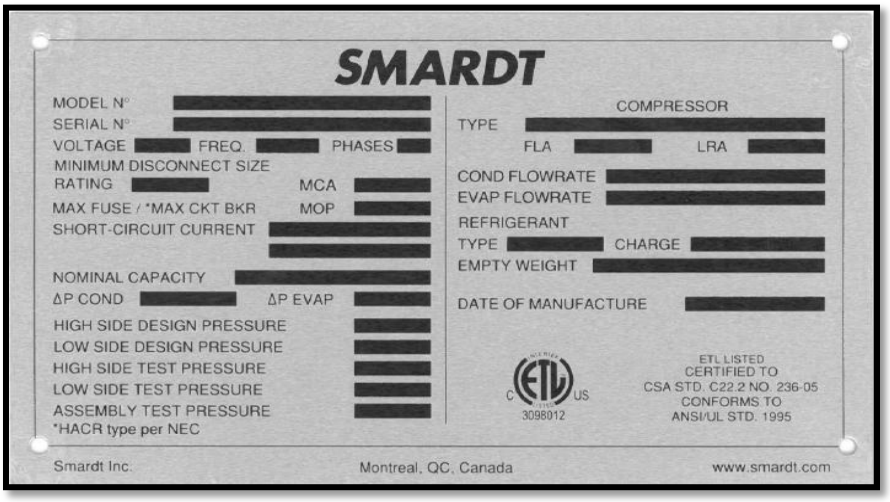

Figure 4: Chiller Nameplate

CONDENSER / EVAPORATOR NAMEPLATE

Each heat exchanger has a nameplate attached to it. This plate has a serial number which identifies the vessel, but not the entire unit. This plate also provides the year of manufacture, the rated pressures, and the operating temperature ranges of the vessel.

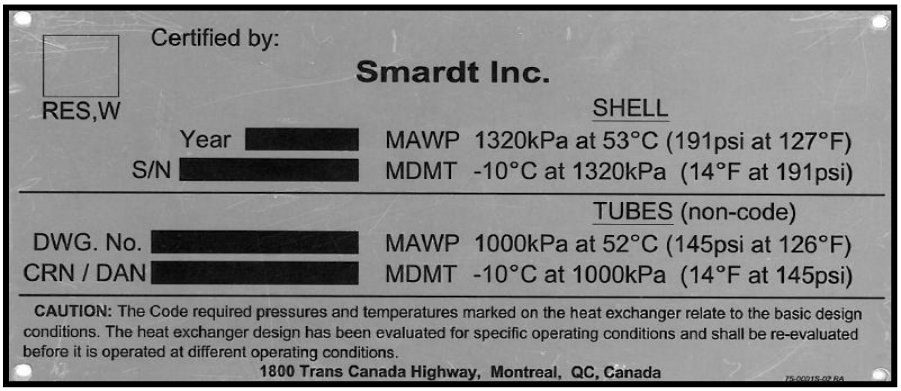

Figure 5: Condenser / Evaporator Nameplate

COMPRESSOR NAMEPLATE

Each compressor also has a nameplate. These nameplates help identify the individual compressors. The serial number on these plates should be used when identifying the compressor in question for any service, parts, or warranty enquiries.

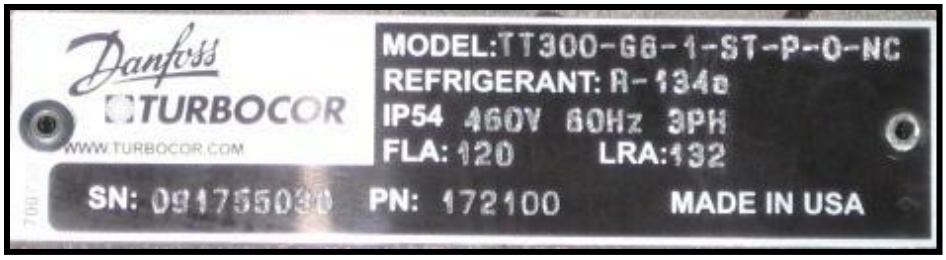

Figure 6: Compressor Nameplate

To obtain certain replacement parts, it may be necessary to quote the Model Number, Serial Number (SN), and Part Number (PN) which are found on the above three plates.

PACKING FOR TRANSPORTATION

Following SMARDT Q.A. acceptance of a completed customer unit and in order to maximize protection during transportation, the following chiller packaging procedures are carried out:

Transportation Option A

- SMARDT's standard practice, is to shrink wrap the chiller assembly as a complete unit, unless otherwise requested by the customer.
- For flatbed transportation, the complete assembly is secured to the flatbed with strapping and a weatherproof protective tarpaulin is placed over all component parts and further secured. For container transportation, the unit is either held in-situ within a custom made and suitably secured framework or braced in the container using chains and eyebolts.

Transportation Option B

Disassembly, Transportation, Reassembly

The unit is shipped partially disassembled by removing the compressor(s). There is no change to the standard evaporator & condenser build.

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- Except for the compressors, the chiller remains assembled.
- Compressors are shipped in separate packaging.
- Electrical wiring is coiled and disconnected from the compressor(s) but the electrical box remains assembled on the chiller.
- Discharge piping, which is flanged at both ends of the discharge line, is removed, as are compressor suction elbows.
- Blanking plates are provided on refrigerant piping.
- The unit ships with a nitrogen holding charge.
- The contractor is responsible for site disassembly and reassembly.
- Compressors need to be evacuated after site installation.
- The contractor is responsible for evacuation, chiller leak check, and charging.
- The refrigerant is shipped to site separately and the contractor is to provide notice of when the refrigerant is required on site, giving a lead time of not less than 2 weeks in advance of start up.

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Transportation Option C

Complete knockdown and shipping fully disassembled. Please check with SMARDT for complete details.

- All major components are shipped individually by common freight as needed.
- The discharge refrigerant line is disassembled.
- Compressors ship in separate packaging.
- Blanking plates are provided on refrigerant piping.
- Compressors must be evacuated after site installation.
- Discharge piping, which is flanged at both ends of the discharge line, is removed, as are compressor suction elbows.
- The electrical box is attached to the vessel for shipment and electrical wiring is coiled. As is needed, the contractor may remove the electrical box for rigging on-site.
- Unit ships with a nitrogen holding charge.
- The contractor is responsible for evacuation, chiller leak check, and charging.
- The refrigerant is shipped to site separately and the contractor is to provide notice of when the refrigerant is required on site, giving a lead time of not less than 2 weeks in advance of start up.

INSTALLATION

RIGGING

Care must be exercised at all times when rigging or handling the chiller set, to prevent personal injury and protect the chiller from damage.

HANDLING

Do not drop the unit or allow the unit to absorb shock. Do not push or pull on the unit. Do not let the unit fall during installation.

FOUNDATION

Before installing the chiller set, ensure that the supporting floor meets the load bearing requirements. SMARDT is not responsible for the load bearing capacity of the floor.

LIFTING METHOD

Four rigging points (two at each end) are provided on the evaporator tube sheet corners. The chiller's high center of gravity (CG) must be considered when rigging, to ensure that the chiller is secure and balanced when suspended. SMARDT recommends a spreader bar / I-beam combination be used to safely position the chiller set in its final location.

SMARDT is not responsible for the rigging and placement of the unit, and arrangements can be made through a local equipment mover.

Typical rigging details are shown in Figure 7.

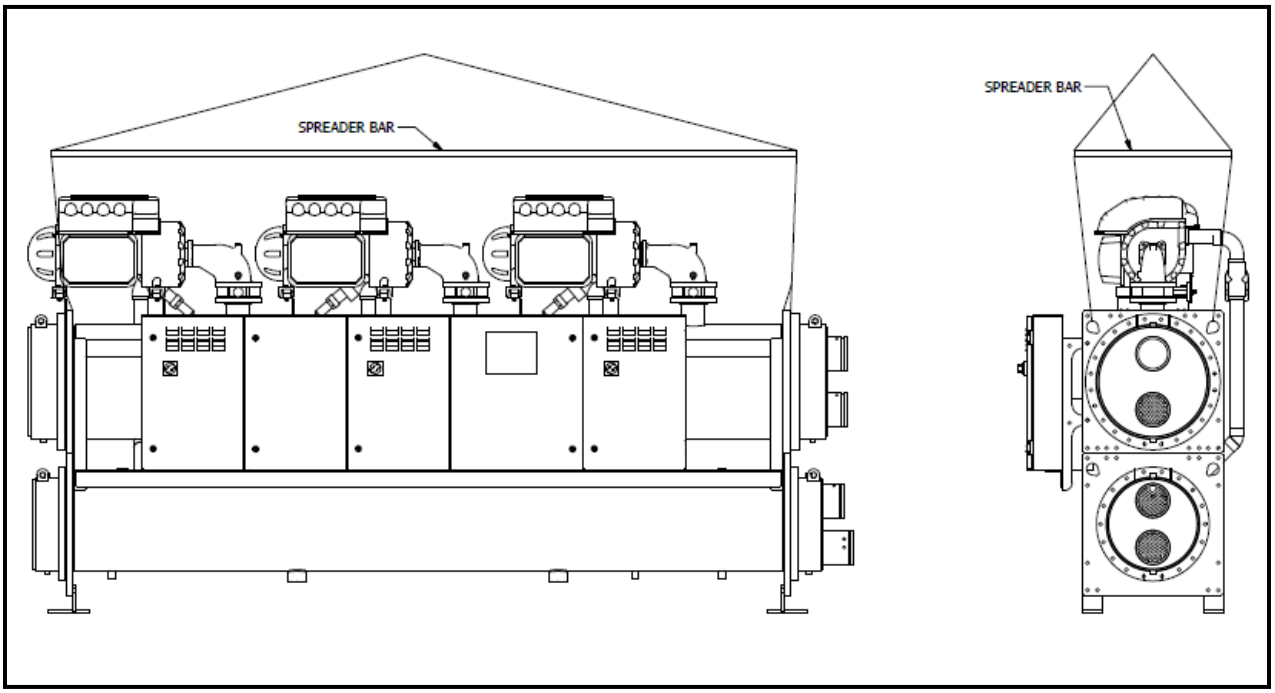
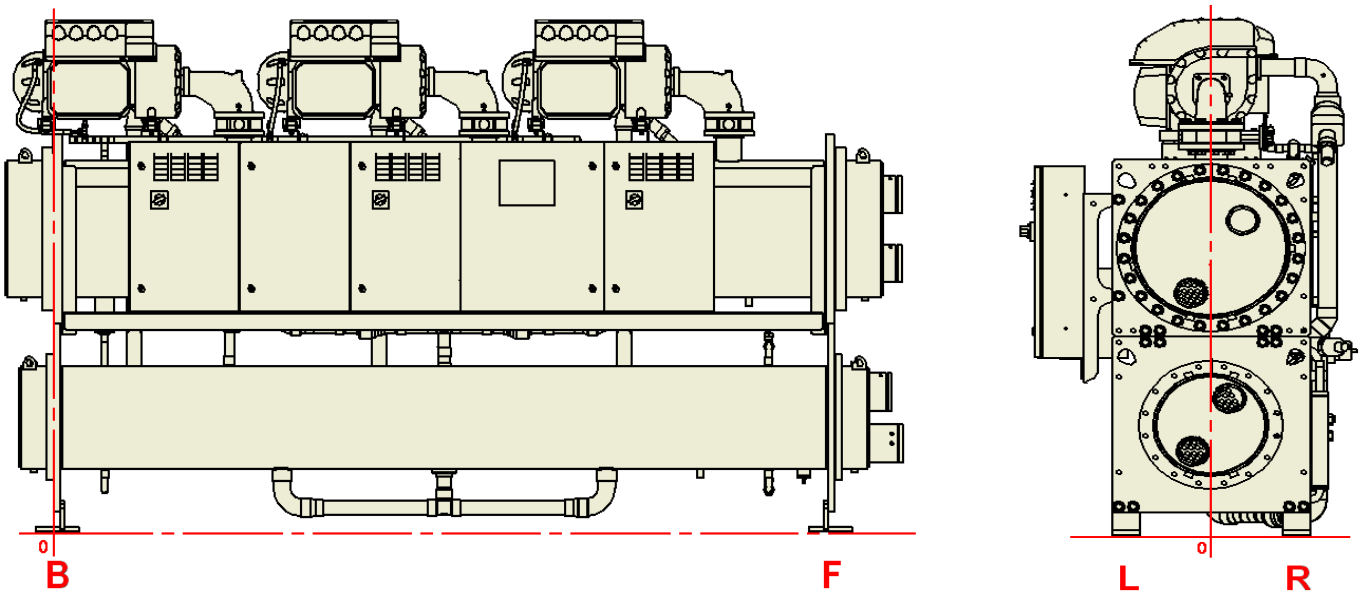


Figure 7: Rigging Diagram

CHILLER WEIGHTS



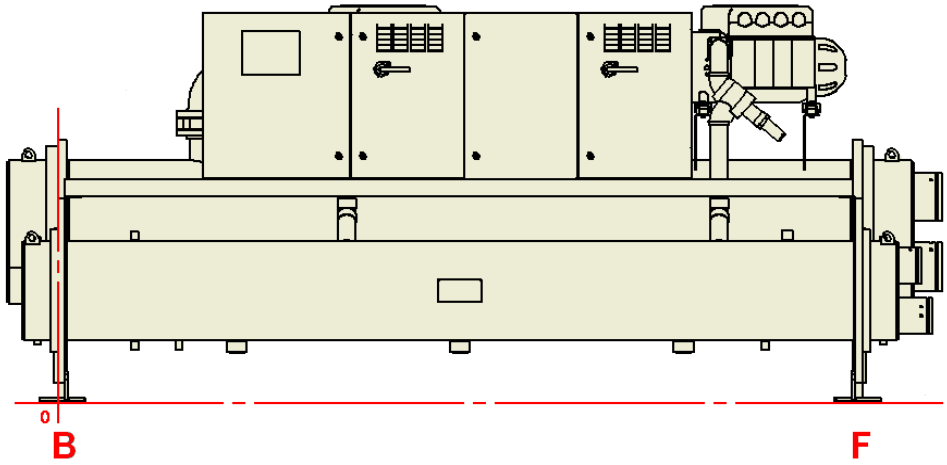
	WEIGHT kg (lbs)								CENTER OF GRAVITY mm (in.)		
	TOTAL WEIGHT		WEIGHT APPLIED TO FOOT				CONTENT WEIGHT				
Models	Empty	Operating	F-R	F-L	B-R	B-L	Refrig't	Water	Length	Width	Height
WA021.1BXX.66C	1733 (3820)	2055 (4530)	467 (1030)	517 (1139)	508 (1120)	562 (1239)	101 (223)	217 (478)	771 (30.37)	-13 (-0.51)	919 (36.18)
WA026.1BXX.44C	1656 (3650)	2005 (4420)	449 (989)	502 (1106)	498 (1098)	557 (1228)	136 (299)	212 (468)	859 (33.83)	-14 (-0.55)	900 (35.44)
WA027.1BXX.44N	1751 (3860)	2105 (4640)	568 (1031)	521 (1149)	527 (1162)	587 (1295)	130 (287)	224 (493)	937 (36.87)	-14 (-0.54)	890 (35.04)
WA030.1BXX.44C	1823 (4020)	2204 (4860)	500 (1102)	552 (1216)	549 (1210)	606 (1336)	146 (321)	238 (524)	864 (34.01)	-12.5 (-0.49)	913 (35.93)
WA030.1BXX.64C	1828 (4030)	2214 (4880)	502 (1106)	553 (1220)	549 (1211)	606 (1337)	146 (321)	238 (524)	865 (34.05)	-12.5 (-0.49)	913 (35.95)
WA031.1BXX.44N	1860 (4100)	2236 (4930)	513 (1133)	568 (1252)	548 (1208)	605 (1334)	139 (307)	235 (519)	964 (37.95)	-13 (-0.50)	914 (35.99)
WA044.2BXX.22N	2540 (5600)	3084 (6800)	656 (1454)	772 (1703)	760 (1675)	889 (1961)	241 (532)	300 (662)	1489 (58.62)	-20 (-0.77)	938 (36.92)
WA044.2BXX.32N	2540 (5600)	3084 (6800)	656 (1454)	772 (1703)	762 (1679)	892 (1966)	241 (532)	300 (662)	1487 (58.53)	-19 (-0.76)	938 (36.93)
WA044.2BXX.33N	2545 (5610)	3089 (6810)	658 (1450)	772 (1701)	763 (1683)	894 (1970)	241 (532)	300 (662)	1484 (58.44)	-19 (-0.76)	938 (36.91)
WA046.1HXX.44C	2599 (5730)	3202 (7060)	773 (1704)	847 (1867)	755 (1664)	827 (1824)	219 (483)	382 (843)	926 (36.44)	-14 (-0.54)	1334 (52.53)
WA048.1HXX.32N	2304 (5080)	2876 (6340)	662 (1460)	724 (1596)	711 (1568)	777 (1714)	271 (597)	300 (662)	1543 (60.74)	-11 (-0.42)	905 (35.64)
WA048.1HXX.33N	2309 (5090)	2876 (6340)	668 (1473)	730 (1610)	707 (1559)	773 (1704)	271 (597)	300 (662)	1555 (61.21)	-11 (-0.42)	905 (35.62)
WA050.2BXX.22N	2572 (5670)	3125 (6890)	670 (1477)	783 (1727)	770 (1697)	900 (1985)	227 (500)	327 (720)	1489 (58.64)	-19 (-0.76)	944 (37.17)
WA050.2BXX.23N	2572 (5670)	3130 (6900)	670 (1477)	799 (1726)	772 (1702)	902 (1989)	227 (500)	327 (720)	1487 (58.55)	-19 (-0.76)	944 (37.15)

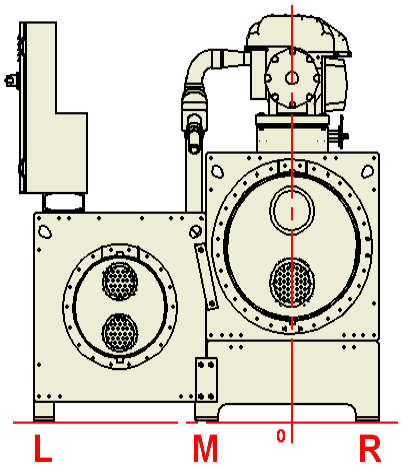
Models	Empty	Operating	F-R	F-L	B-R	B-L	Refrig't	Water	Length	Width	Height
WA050.2BXX.33N	2576 (5680)	3130 (6900)	670 (1476)	782 (1725)	774 (1706)	904 (1994)	227 (500)	327 (720)	1485 (58.47)	-19 (-0.76)	944 (37.16)
WA056.2BXX.44F	2998 (6610)	3633 (8010)	830 (1830)	981 (2162)	836 (1844)	988 (2178)	219 (483)	418 (921)	898 (35.36)	-25.5 (-1.00)	1103 (43.44)
WA059.2BXX.44F	3107 (6850)	3747 (8260)	859 (1894)	1011 (2229)	861 (1899)	1014 (2235)	199 (438)	438 (965)	989 (38.95)	-25 (-0.98)	1097 (43.20)
WA062.2BXX.22N	2749 (6060)	3393 (7480)	738 (1628)	831 (1833)	836 (1842)	967 (2131)	253 (558)	395 (870)	1502 (59.14)	-18 (-0.70)	920 (36.21)
WA062.2BXX.32N	2744 (6050)	3393 (7480)	735 (1621)	851 (1876)	836 (1844)	968 (2134)	253 (558)	392 (864)	1498 (58.97)	-18 (-0.70)	920 (36.21)
WA062.2BXX.33N	2749 (6060)	3393 (7480)	734 (1619)	850 (1873)	840 (1851)	971 (2141)	253 (558)	392 (864)	1494 (58.83)	-18 (-0.70)	919 (36.19)
WA062.2BXX.42N	2744 (6050)	3402 (7500)	740 (1631)	857 (1889)	836 (1843)	968 (2134)	269 (594)	387 (853)	1503 (59.16)	-18 (-0.70)	918 (36.13)
WA074.3BXX.22N	3084 (6800)	3778 (8330)	851 (1876)	997 (2199)	889 (1959)	1047 (2308)	288 (635)	406 (895)	1760 (69.28)	-20 (-0.79)	941 (37.03)
WA084.3BXX.22N	3198 (7050)	3915 (8630)	881 (1942)	1031 (2274)	923 (2035)	1081 (2383)	268 (591)	452 (997)	1761 (69.35)	-19.5 (-0.77)	932 (36.69)
WA088.2HXX.44F	3964 (8740)	4876 (10750)	1110 (2448)	1256 (2770)	1177 (2594)	1332 (2936)	276 (608)	634 (1397)	1209 (47.59)	-18.5 (-0.73)	1035 (40.75)
WA092.3BXX.22N	3656 (8060)	4445 (9800)	1013 (2233)	1166 (2570)	1055 (2325)	1214 (2676)	300 (662)	507 (1117)	1767 (69.58)	-21.5 (-0.84)	1438 (56.62)
WA092.3BXX.32N	3660 (8070)	4450 (9810)	1011 (2229)	1163 (2564)	1059 (2334)	1217 (2684)	300 (662)	506 (1116)	1763 (69.40)	-21.5 (-0.84)	1438 (56.62)
WA092.3BXX.33N	3706 (8170)	4491 (9900)	1019 (2247)	1173 (2582)	1070 (2360)	1229 (2710)	300 (662)	503 (1108)	1760 (69.30)	-21 (-0.83)	1430 (56.30)
WA092.3BXX.42N	3665 (8080)	4454 (9820)	1015 (2238)	1168 (2575)	1056 (2328)	1223 (2697)	300 (662)	507 (1117)	1768 (69.62)	-21 (-0.83)	1438 (56.61)
WA095.2HXX.22N	3642 (8030)	4504 (9930)	1039 (2291)	1149 (2534)	1099 (2423)	1216 (2680)	315 (695)	547 (1206)	1556 (61.26)	-15 (-0.59)	1374 (54.08)
WA095.2HXX.32N	3647 (8040)	4509 (9940)	1038 (2288)	1148 (2531)	1103 (2431)	1219 (2688)	315 (695)	547 (1206)	1552 (61.12)	-15 (-0.59)	1374 (54.08)
WA095.2HXX.33N	3651 (8050)	4513 (9950)	1036 (2285)	1147 (2528)	1106 (2438)	1347 (2696)	315 (694)	547 (1206)	1549 (60.99)	-15 -0.59	1373 (54.05)
WA096.2HXX.22N	3692 (8140)	4522 (9970)	1037 (2287)	1149 (2534)	1108 (2442)	1227 (2705)	289 (638)	537 (1186)	1745 (68.72)	-15.25 (-0.60)	1422 (55.99)
WA096.2HXX.32N	3674 (8100)	4513 (9950)	1038 (2288)	1151 (2537)	1101 (2427)	1221 (2691)	297 (655)	537 (1186)	1751 (68.95)	-15.5 (-0.61)	1422 (56.00)
WA105.4BXX.22N	4277 (9430)	5225 (11520)	1024 (2557)	1331 (2953)	1264 (2787)	1460 (3219)	354 (780)	592 (1304)	1909 (75.16)	-21.5 (-0.85)	1402 (55.20)
WA105.4BXX.32N	4282 (9440)	5225 (11520)	1158 (2553)	1342 (2948)	1267 (2794)	1464 (3227)	354 (780)	591 (1303)	1905 (75.00)	-21.5 (-0.85)	1402 (55.20)
WA120.4BXX.22N	4477 (9870)	5466 (12050)	1215 (2678)	1391 (3067)	1332 (2936)	1525 (3362)	362 (798)	623 (1375)	1904 (74.96)	-20.25 (-0.80)	1390 (54.73)
WA120.4BXX.24N	4350 (9490)	5470 (12060)	1217 (2682)	1393 (3070)	1334 (2941)	1527 (3367)	362 (798)	623 (1375)	1903 (74.94)	-20.25 (-0.80)	1389 (54.68)
WA125.3HXX.22N	4341 (9570)	5325 (11740)	1232 (2716)	1370 (3021)	1289 (2842)	1434 (3161)	362 (798)	623 (1375)	1949 (76.75)	-15.75 (-0.62)	1391 (54.77)
WA140.3HXX.22N	5307 (11700)	6595 (14540)	1530 (3373)	1670 (3682)	1622 (3577)	1771 (3904)	459 (1012)	828 (1825)	2183 (85.95)	-13 -0.51	1322 (52.04
WA150.5BFX.22F	5720 (12610)	7008 (15450)	1495 (3297)	1849 (4077)	1637 (3610)	2025 (4464)	459 (1012)	828 (1825)	2147 (84.52)	-31.5 (-1.24)	1087 (42.79)
WA180.6BFX.22F	6954 (15330)	8655 (19080)	2000 (4410)	2330 (5136)	1998 4405	2327 (5130)	622 (1371)	1082 (2385)	2503 (98.56)	-25 (-0.98)	1161 (45.69)

Note: Refer to job specific submittal for job specific product weights and dimensions.

Table 2 - Chiller Weights

Chiller Weights (cont'd)



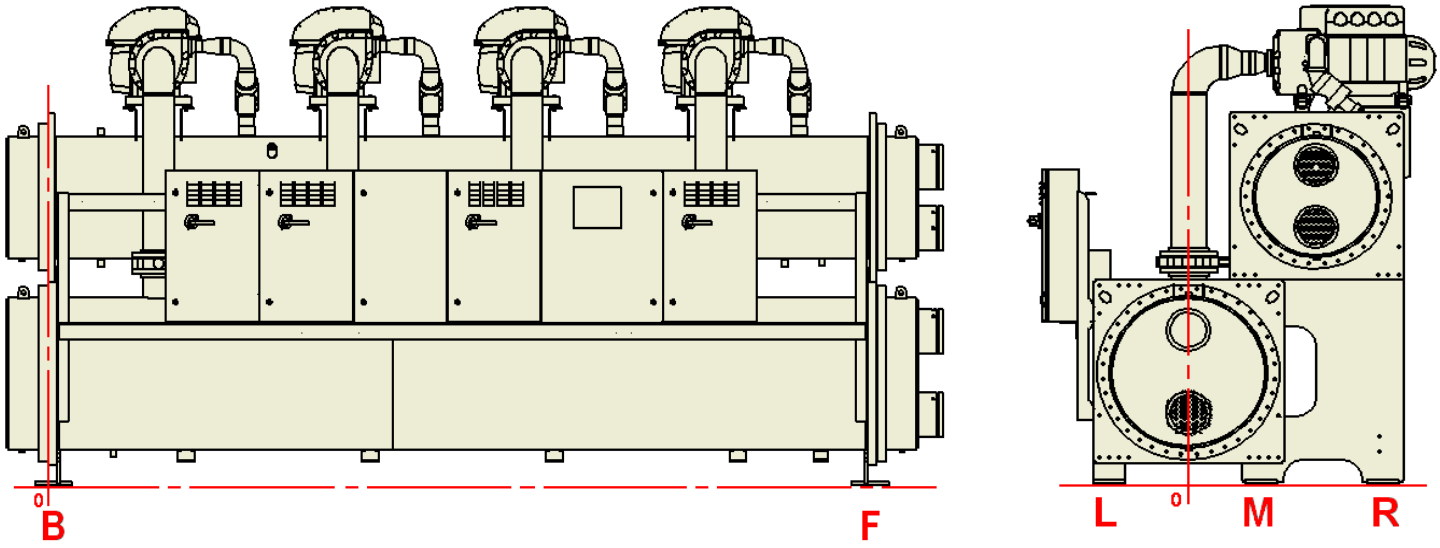


	WEIGHT kg (lbs)										CENTER OF GRAVITY mm (in.)		
	TOTAL WEIGHT		WEIGHT APPLIED TO FOOT						CONTENT WEIGHT				
Models	Empty	Oper'g	F-R	F-M	F-L	B-R	B-M	B-L	Refrig't	Water	Length	Width	Height
WA048.1HXX.32S	2422 (5340)	2994 (6600)	371 (819)	974 (2147)	201 (443)	344 (758)	924 (2037)	178 (393)	271 (597)	300 (662)	1668 (65.66)	-255 (-10.05)	628 (24.71)
WA048.1HXX.33S	2422 (5340)	2994 (6600)	371 (819)	973 (2146)	200 (442)	343 (757)	927 (2043)	180 (397)	271 (597)	300 (662)	1665 (65.56)	-256 (-10.07)	628 24.71
WA084.3BXX.22S	3316 (7310)	4023 (8870)	481 (1061)	1293 (2850)	267 (588)	435 (960)	1240 (2734)	307 (676)	256 (565)	452 (997)	1819 (71.62)	-280 (-11.01)	663 26.10
WA092.3BXX.22S	3815 (8410)	4640 (10230)	577 (1273)	1507 (3322)	265 (584)	532 (1173)	1451 (3199)	306 (674)	315 (694)	507 (1117)	1818 (71.57)	-311 (-12.23)	733 28.85
WA095.2HXX.32S	3801 (8380)	4699 (10360)	519 (1144)	1469 (3239)	293 (646)	567 (1249)	1554 (3427)	296 (653)	349 (769)	547 (1206)	1554 (61.18)	-317 (-12.49)	711 27.99
WA096.2HXX.22S	3851 (8490)	4740 (10450)	558 (1231)	1490 (3284)	249 (550)	600 (1323)	1567 (3454)	276 (609)	352 (777)	538 (1186)	1748 (68.83)	-295 (-11.63)	715 28.16
WA120.4BXX.22S	4636 (10220)	5693 (12550)	608 (1340)	1736 (3828)	377 (832)	697 (1537)	1903 (4195)	371 (819)	435 (959)	624 (1375)	1907 (75.06)	-324 (-12.75)	733 28.87
WA125.3HXX.22S	4500 (9920)	5557 (12250)	656 (1446)	1807 (3984)	355 (782)	619 (1365)	1778 (3919)	343 (756)	435 (959)	624 (1375)	2008 (79.60)	-317 (-12.48)	723 28.48
WA140.3HXX.22S	5470 (12060)	6840 (15080)	776 (1710)	2239 (4937)	472 (1041)	724 (1597)	2180 (4807)	449 (990)	543 (1197)	828 (1825)	2292 (90.25)	-333 (-13.12)	699 27.50

Note: Refer to job specific submittal for job specific product weights and dimensions.

Table 3 - Chiller Weights

Chiller Weights (cont'd)



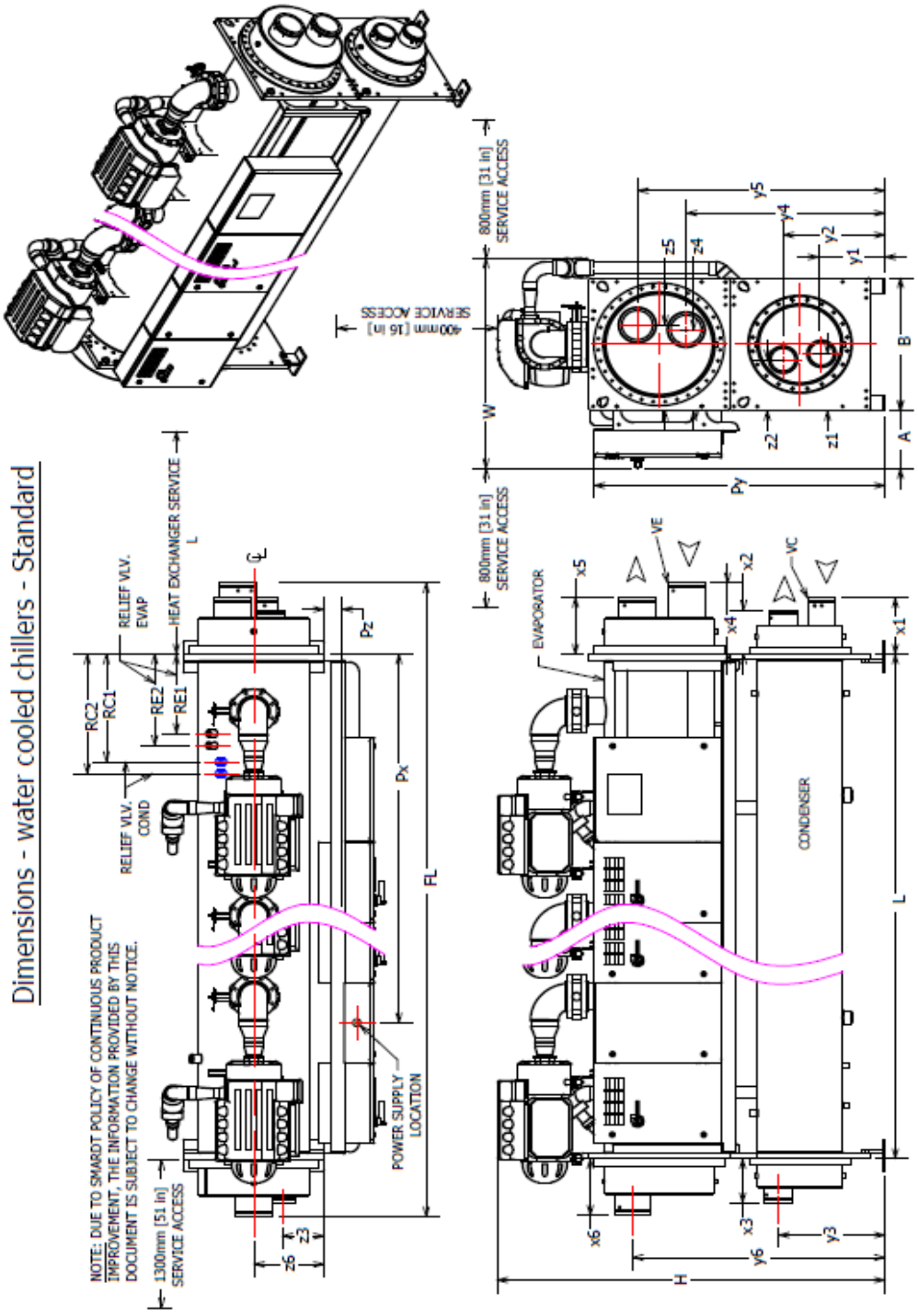
	WEIGHT kg (lbs)										CENTER OF GRAVITY mm (in.)		
	TOTAL WEIGHT		APPLY TO FOOT						CONTENT WEIGHT				
Models	Empty	Operat'g	F-R	F-M	F-L	B-R	B-M	B-L	Refrig't	Water	Length	Width	Height
WA190.4HXX.22L	6500 (14330)	8147 (17960)	463 (1020)	2730 (6019)	839 (1849)	487 (1074)	623 (6119)	852 (1879)	622 (1371)	1023 (2256)	2225 (87.59)	266 (10.47)	1021 (40.19)
WA240.5HXX.22L	7648 (16860)	9662 (21300)	609 (1342)	3226 (7112)	960 (2117)	623 (1373)	3296 (7267)	949 (2092)	738 (1628)	1278 (2818)	2483 (97.75)	279 (11.00)	1041 (40.98)

Note: Refer to job specific submittal for job specific product weights and dimensions.

Table 4 Chiller Weights

CHILLER DIMENSIONS & CLEARANCES

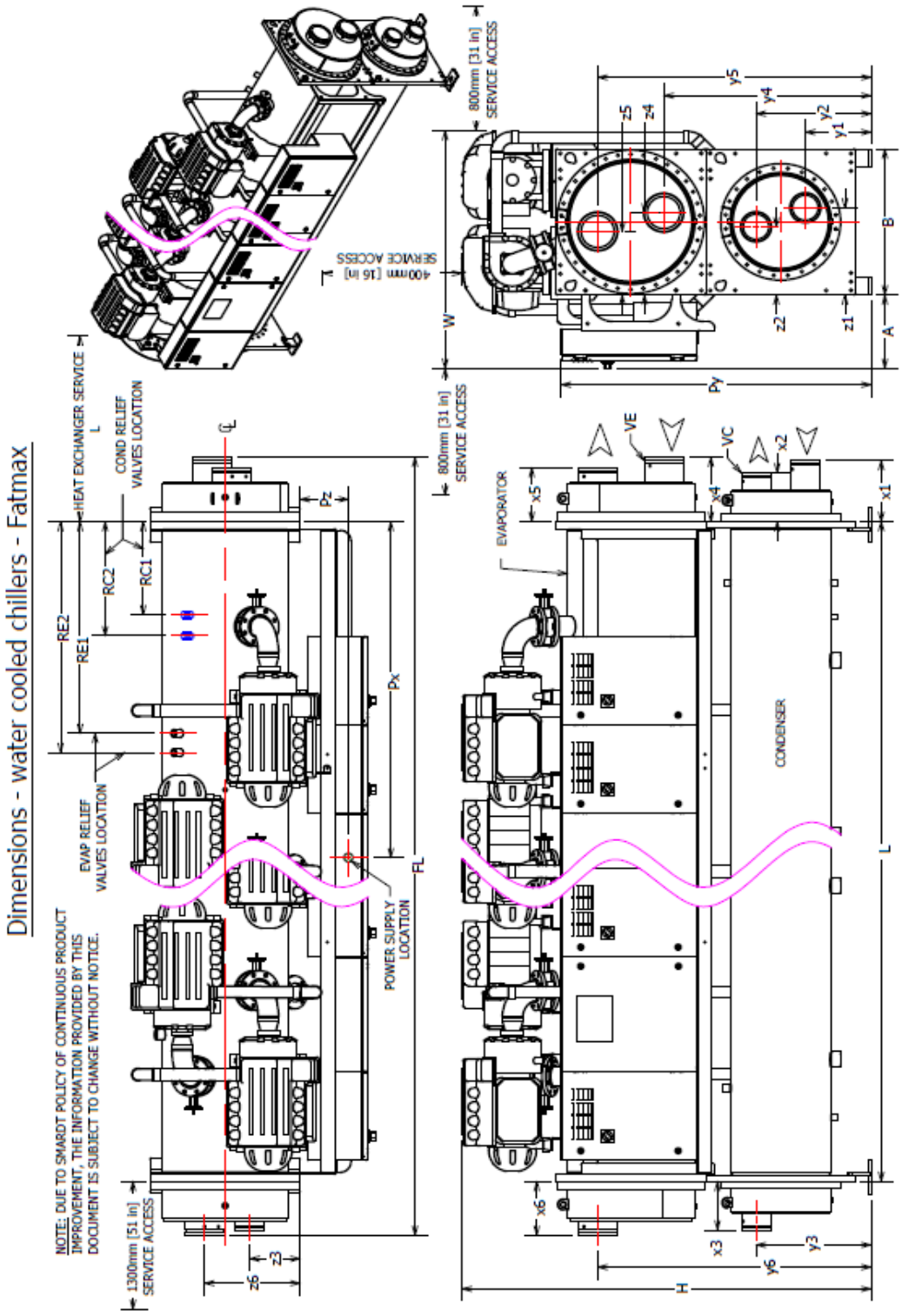
STANDARD MODEL



Note: Refer to job specific submittal for job specific product dimensions & clearances

Figure 8: Chiller Dimensions & Clearances

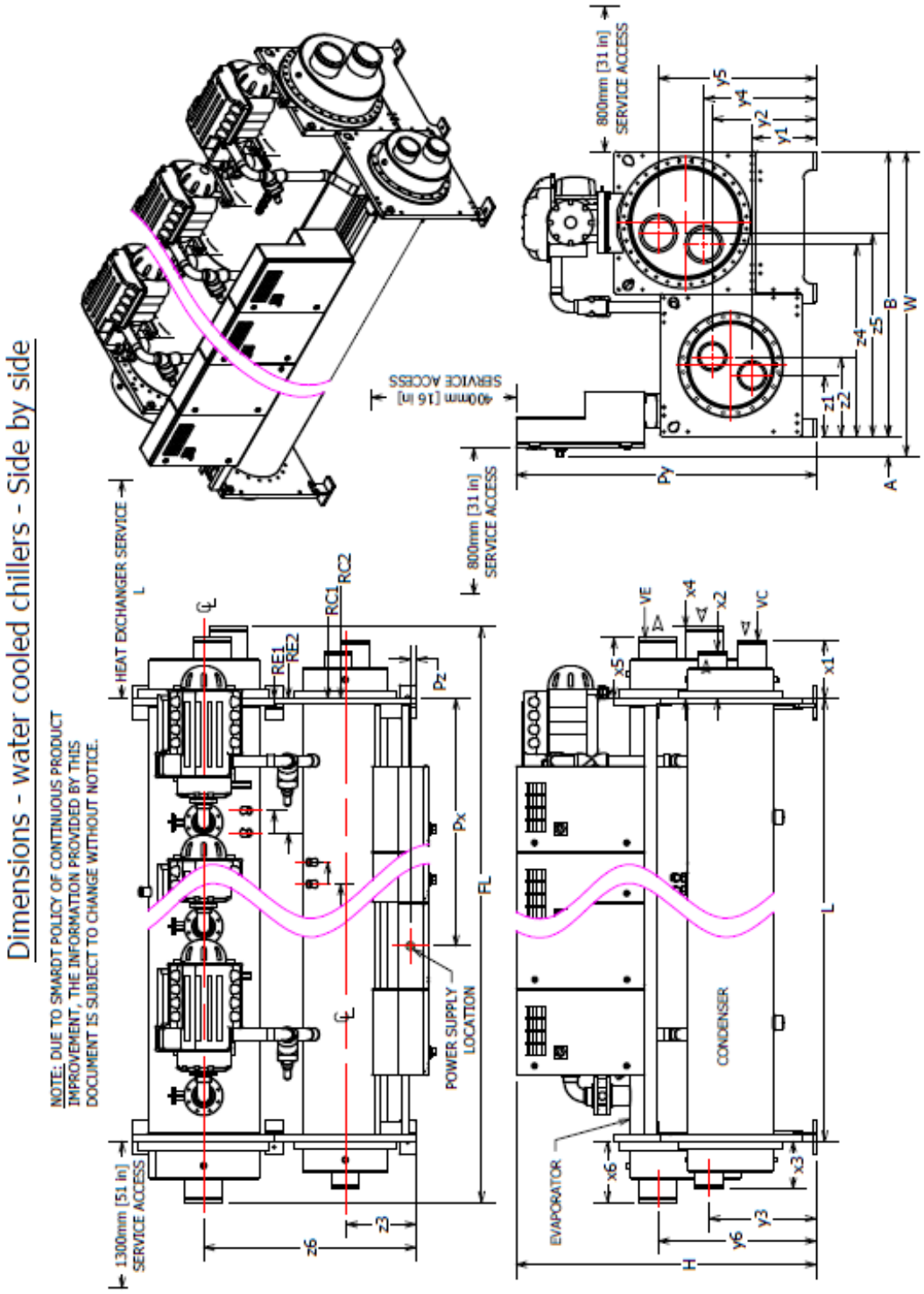
FAT MAX MODEL



Note: Refer to job specific submittal for job specific product dimensions & clearances

Figure 9: Chiller Dimensions & Clearances

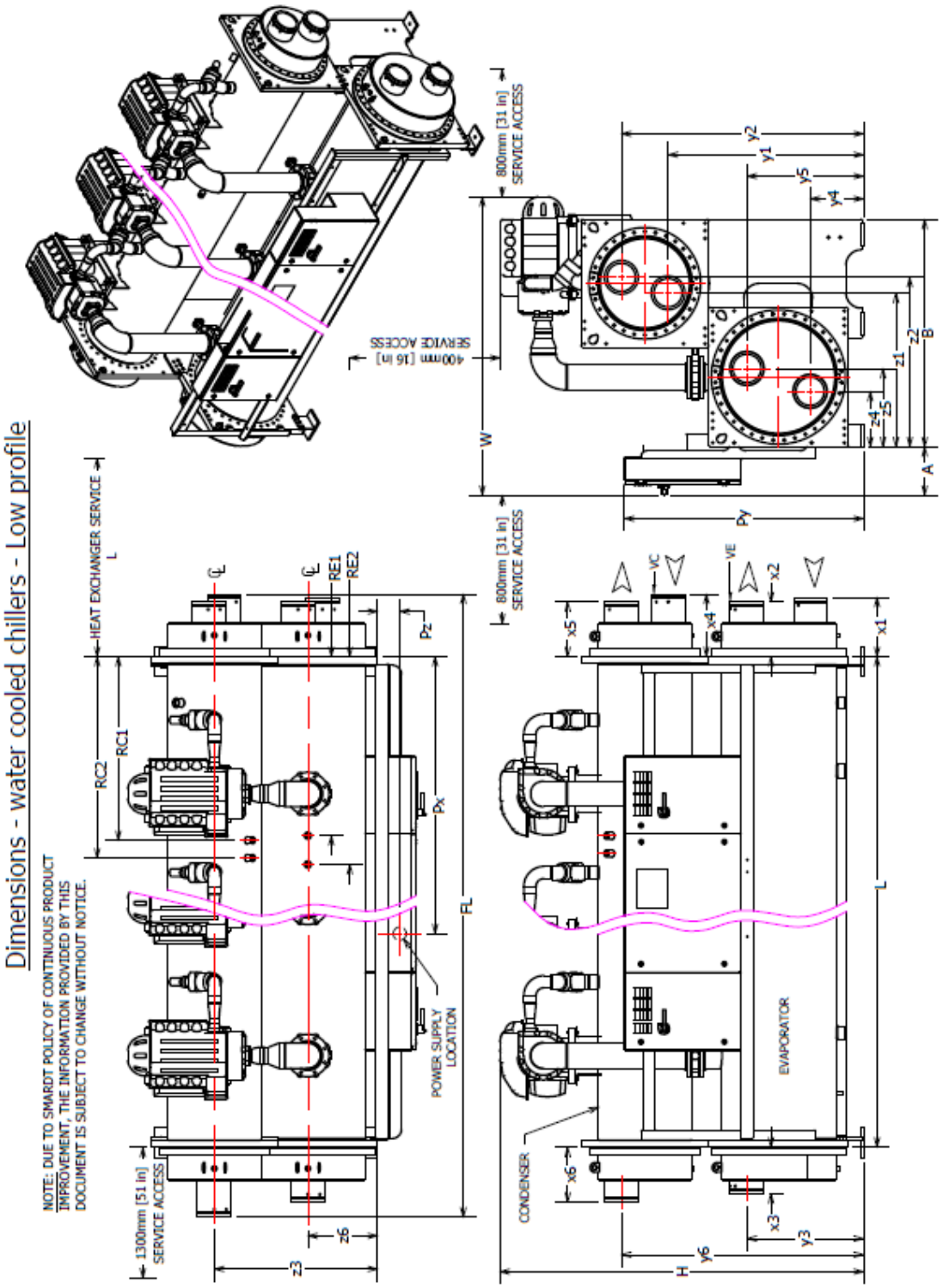
SIDE BY SIDE MODEL



Note: Refer to job specific submittal for job specific product dimensions & clearances

Figure 10: Chiller Dimensions & Clearances

LOW PROFILE MODEL



Note: Refer to job specific submittal for job specific product dimensions & clearances

Figure 11: Chiller Dimensions & Clearances

CHILLER DIMENSIONS BY MODEL

MODEL	WATER COOLED CHILLER DIMENSIONS								
	DIMENSIONS (mm/in)								
	FL	W	H	L	A	B	VC	x1	y1
WA021.1BXX.66C	2062/81.2	1145/45.1	2049/80.7	1600/63	321/12.7	700/27.6	4" dia	263/10.4	331/13
WA026.1BXX.44C	2262/89.1	1145/45.1	2024/79.7	1800/70.9	321/12.7	700/27.6	4" dia	263/10.4	346/13.6
WA027.1BXX.44N	2462/96.9	1145/45.1	2024/79.7	2000/78.7	321/12.7	700/27.6	4" dia	263/10.4	346/13.6
WA030.1BXX.44C	2262/89.1	1145/45.1	2049/80.7	1800/70.9	321/12.7	700/27.6	4" dia	263/10.4	346/13.6
WA030.1BXX.64C	2262/89.1	1145/45.1	2049/80.7	1800/70.9	321/12.7	700/27.6	4" dia	263/10.4	346/13.6
WA031.1BXX.44N	2462/96.9	1145/45.1	2049/80.7	2000/78.7	321/12.7	700/27.6	4" dia	263/10.4	346/13.6
WA044.2BXX.22N	3701/145.7	1145/45.1	2049/80.7	3200/126	321/12.7	700/27.6	5" dia	316/12.4	335/13.2
WA044.2BXX.32N	3795/149.4	1145/45.1	2049/80.7	3200/126	321/12.7	700/27.6	5" dia	316/12.4	335/13.2
WA044.2BXX.33N	3754/147.8	1145/45.1	2049/80.7	3200/126	321/12.7	700/27.6	5" dia	263/10.4	343/13.5
WA046.1HXX.44C	2364/93.1	1332/52.5	2314/91.1	1800/70.9	369/14.5	840/33.1	5" dia	330/13	401/15.8
WA047.1HXX.44C	2559/100.7	1332/52.5	2314/91.1	2000/78.7	369/14.5	840/33.1	5" dia	330/13	401/15.8
WA048.1HXX.32N	3793/149.3	1214/47.8	2054/80.9	3200/126	343/13.5	700/27.6	5" dia	316/12.4	335/13.2
WA048.1HXX.32S	3791/149.3	1540/60.6	1637/64.5	3200/126	140/5.5	1400/55.1	5" dia	316/12.4	335/13.2
WA048.1HXX.33N	3754/147.8	1214/47.8	2054/80.9	3200/126	343/13.5	700/27.6	5" dia	263/10.4	343/13.5
WA048.1HXX.33S	3754/147.8	1540/60.6	1637/64.5	3200/126	140/5.5	1400/55.1	5" dia	263/10.4	343/13.5
WA050.2BXX.22N	3701/145.7	1145/45.1	2049/80.7	3200/126	321/12.7	700/27.6	5" dia	316/12.4	335/13.2
WA050.2BXX.23N	3740/147.2	1145/45.1	2049/80.7	3200/126	321/12.7	700/27.6	5" dia	263/10.4	343/13.5
WA050.2BXX.33N	3754/147.8	1145/45.1	2049/80.7	3200/126	321/12.7	700/27.6	5" dia	263/10.4	343/13.5
WA056.2BXX.44F	2638/103.9	1382/54.4	2293/90.3	1800/70.9	436/17.1	840/33.1	5" dia	330/13	401/15.8
WA059.2BXX.44F	2838/112.9	1382/54.4	2293/90.3	2000/78.7	436/17.1	840/33.1	5" dia	330/13	401/15.8
WA062.2BXX.22N	3701/145.7	1145/45.1	2049/80.7	3200/126	321/12.7	700/27.6	6" dia	316/12.4	321/12.7
WA062.2BXX.32N	3701/145.7	1145/45.1	2049/80.7	3200/126	321/12.7	700/27.6	6" dia	316/12.4	321/12.7
WA062.2BXX.33N	3760/148	1145/45.1	2049/80.7	3200/126	321/12.7	700/27.6	6" dia	266/10.5	331/13
WA062.2BXX.42N	3715/146.3	1145/45.1	2049/80.7	3200/126	321/12.7	700/27.6	6" dia	316/12.4	321/12.7
WA074.3BXX.22N	4101/161.5	1145/45.1	2049/80.7	3600/141.7	321/12.7	700/27.6	6" dia	316/12.4	321/12.7
WA084.3BXX.22N	4104/161.6	1145/45.1	2049/80.7	3600/141.7	321/12.7	700/27.6	6" dia	316/12.4	321/12.7
WA088.2HXX.44F	3040/119.7	1393/54.8	2297/90.4	2500/98.4	445/17.5	840/33.1	6" dia	310/12.2	386/15.2
WA092.3BXX.22N	4141/163	1240/48.8	2284/89.9	3600/141.7	347/13.7	840/33.1	6" dia	316/12.4	391/15.4
WA092.3BXX.22S	4141/163	1800/70.9	1777/70	3600/141.7	120/4.7	840/33.1	6" dia	316/12.4	391/15.4
WA092.3BXX.33N	4220/166.1	1241/48.8	2284/89.9	3600/141.7	347/13.7	840/33.1	6" dia	266/10.5	401/15.8
WA092.3BXX.42N	4141/163	1241/48.8	2284/89.9	3600/141.7	347/13.7	840/33.1	6" dia	316/12.4	391/15.4
WA095.2HXX.32N	3820/150.4	1332/52.5	2314/91.1	3600/141.7	369/14.5	840/33.1	6" dia	280/11	378/14.9
WA095.2HXX.32S	3820/150.4	1820/71.7	1777/70	3200/126	140/5.5	1680/66.1	6" dia	270/10.6	378/14.9
WA095.2HXX.33N	3820/150.4	1297/51.1	2314/91.1	3200/126	369/14.5	840/33.1	6" dia	280/11	391/15.4

Note: Refer to job specific submittal for job specific product dimensions.

Table 5: Chiller Dimensions By Model

MODEL	WATER COOLED CHILLER DIMENSIONS								
	DIMENSIONS (mm/in)								
	FL	W	H	L	A	B	VC	x1	y1
WA096.2HXX.22N	4188/164.9	1335/52.5	2314/91.1	3600/141.7	369/14.5	840/33.1	6" dia	316/12.4	391/15.4
WA096.2HXX.22S	4188/164.9	1820/71.7	1777/70	3600/141.7	140/5.5	1680/66.1	6" dia	316/12.4	391/15.4
WA096.2HXX.32N	4226/166.4	1335/52.5	2314/91.1	3600/141.7	369/14.5	840/33.1	6" dia	316/12.4	391/15.4
WA105.4BXX.22N	4535/178.5	1240/48.8	2284/89.9	4000/157.5	347/13.7	840/33.1	6" dia	280/11	378/14.9
WA105.4BXX.32N	4620/181.9	1240/48.8	2284/89.9	4000/157.5	347/13.7	840/33.1	6" dia	280/11	378/14.9
WA120.4BXX.22N	4588/180.6	1241/48.8	2310/90.9	4000/157.5	347/13.7	840/33.1	6" dia	280/11	378/14.9
WA120.4BXX.22S	4588/180.6	1798/70.8	1777/70	4000/157.5	118/4.6	840/33.1	6" dia	280/11	378/14.9
WA120.4BXX.24N	4588/180.6	1241/48.8	2310/90.9	4000/157.5	347/13.7	840/33.1	6" dia	330/13	401/15.8
WA125.3HXX.22N	4588/180.6	1335/52.5	2314/91.1	4000/157.5	369/14.5	840/33.2	6" dia	280/11	378/14.9
WA125.3HXX.22N	4588/180.6	1820/71.7	1777/70	4000/157.5	140/5.5	1680/66.1	6" dia	280/11	378/14.9
WA140.3HXX.22N	5035/198.2	1335/52.5	2340/92.1	4500/177.2	369/14.5	840/33.2	6" dia	280/11	368/14.5
WA140.3HXX.22S	5035/198.2	1820/71.7	1777/70	4500/177.2	140/5.5	1680/66.1	6" dia	280/11	368/14.5
WA150.5BXX.22F	5035/198.2	1369/53.9	2293/90.3	4500/177.2	423/16.7	840/33.2	6" dia	280/11	368/14.5
WA180.5BXX.22F	5585/219.9	1434/56.5	2427/95.6	5000/196.9	423/16.7	914/36	8" dia	360/14.2	390/15.4
WA190.4HXX.22L	5085/200.2	1956/77	2384/93.9	4500/177.2	318/12.5	1491/58.7	8" dia	360/14.2	350/13.8
WA240.5HXX.22L	5585/219.9	1956/77	2409/94.8	5000/196.9	318/12.5	1491/58.7	8" dia	360/14.2	350/13.8

Note: Refer to job specific submittal for job specific product dimensions.

Table 5: Chiller Dimensions By Model (cont'd)

MODEL	WATER COOLED CHILLER DIMENSIONS								
	DIMENSIONS (mm/in)								
	z1	x2	y2	z2	x3	y3	z3	VE	x4
WA021.1BXX.66C	285/11.2	263/10.4	541/21.3	415/13.3	N/A	N/A	N/A	4" dia	277/10.9
WA026.1BXX.44C	282/11.1	263/10.4	526/20.7	282/11.1	N/A	N/A	N/A	4" dia	277/10.9
WA027.1BXX.44N	282/11.1	263/10.4	526/20.7	282/11.1	N/A	N/A	N/A	4" dia	277/10.9
WA030.1BXX.44C	282/11.1	263/10.4	526/20.7	282/11.1	N/A	N/A	N/A	4" dia	277/10.9
WA030.1BXX.64C	282/11.1	263/10.4	526/20.7	282/11.1	N/A	N/A	N/A	4" dia	277/10.9
WA031.1BXX.44N	282/11.1	263/10.4	526/20.7	282/11.1	N/A	N/A	N/A	4" dia	277/10.9
WA044.2BXX.22N	350/13.8	263/10.4	537/21.2	350/13.8	N/A	N/A	N/A	5" dia	277/10.9
WA044.2BXX.32N	350/13.8	263/10.4	537/21.2	350/13.8	N/A	N/A	N/A	5" dia	280/11
WA044.2BXX.33N	350/13.8	N/A	N/A	N/A	263/10.4	529/20.8	350/13.8	5" dia	280/11
WA046.1HXX.44C	325/12.8	277/10.9	621/24.4	343/13.5	N/A	N/A	N/A	5" dia	311/12.2
WA047.1HXX.44C	325/12.8	277/10.9	621/24.4	343/13.5	N/A	N/A	N/A	5" dia	311/12.2
WA048.1HXX.32N	350/13.8	263/10.4	537/21.2	350/13.8	N/A	N/A	N/A	5" dia	277/10.9
WA048.1HXX.32S	350/13.8	263/10.4	537/21.2	350/13.8	N/A	N/A	N/A	5" dia	277/10.9
WA048.1HXX.33N	350/13.8	N/A	N/A	N/A	263/10.4	529/20.8	350/13.8	5" dia	277/10.9
WA048.1HXX.33S	350/13.8	N/A	N/A	N/A	263/10.4	529/20.8	350/13.8	5" dia	277/10.9
WA050.2BXX.22N	350/13.8	263/10.4	537/21.2	350/13.8	N/A	N/A	N/A	5" dia	277/10.9
WA050.2BXX.23N	350/13.8	N/A	N/A	N/A	263/10.4	529/20.8	350/13.8	5" dia	277/10.9
WA050.2BXX.33N	350/13.8	N/A	N/A	N/A	263/10.4	529/20.8	350/13.8	5" dia	277/10.9
WA056.2BXX.44F	325/12.8	277/10.9	621/24.4	343/13.5	N/A	N/A	N/A	5" dia	311/12.2
WA059.2BXX.44F	325/12.8	277/10.9	621/24.4	343/13.5	N/A	N/A	N/A	5" dia	311/12.2
WA062.2BXX.22N	350/13.8	266/10.5	551/21.7	350/13.8	N/A	N/A	N/A	6" dia	280/11
WA062.2BXX.32N	350/13.8	266/10.5	551/21.7	350/13.8	N/A	N/A	N/A	6" dia	280/11
WA062.2BXX.33N	350/13.8	N/A	N/A	N/A	266/10.5	541/21.3	350/13.8	6" dia	280/11
WA062.2BXX.42N	350/13.8	266/10.5	551/21.7	350/13.8	N/A	N/A	N/A	6" dia	330/13
WA074.3BXX.22N	350/13.8	266/10.5	551/21.7	350/13.8	N/A	N/A	N/A	6" dia	280/11
WA084.3BXX.22N	350/13.8	266/10.5	551/21.7	350/13.8	N/A	N/A	N/A	6" dia	277/10.9
WA088.2HXX.44F	308/12.1	310/12.2	626/24.6	308/12.1	N/A	N/A	N/A	5" dia	311/12.2
WA092.3BXX.22N	420/16.5	266/10.5	621/24.4	420/16.5	N/A	N/A	N/A	6" dia	310/12.2
WA092.3BXX.22S	420/16.5	266/10.5	621/24.4	420/16.5	N/A	N/A	N/A	6" dia	310/12.2
WA092.3BXX.33N	420/16.5	N/A	N/A	N/A	266/10.5	611/24.1	420/16.5	6" dia	310/12.2
WA092.3BXX.42N	420/16.5	266/10.5	621/24.4	420/16.5	N/A	N/A	N/A	5" dia	307/12.1
WA095.2HXX.32N	420/16.5	280/11	634/25	420/16.5	N/A	N/A	N/A	6" dia	310/12.2
WA095.2HXX.32S	420/16.5	270/10.6	634/25	420/16.5	N/A	N/A	N/A	6" dia	310/12.2
WA095.2HXX.33N	420/16.5	N/A	N/A	N/A	280/11	621/24.4	420/16.5	6" dia	310/12.2
WA096.2HXX.22N	420/16.5	266/10.5	621/24.4	420/16.5	N/A	N/A	N/A	8" dia	359/14.1

Note: Refer to job specific submittal for job specific product dimensions.

Table 5: Chiller Dimensions By Model (cont'd)

MODEL	WATER COOLED CHILLER DIMENSIONS								
	DIMENSIONS (mm/in)								
	z1	x2	y2	z2	x3	y3	z3	VE	x4
WA096.2HXX.22S	420/16.5	266/10.5	621/24.4	420/16.5	N/A	N/A	N/A	8" dia	359/14.1
WA096.2HXX.32N	420/16.5	266/10.5	621/24.4	420/16.5	N/A	N/A	N/A	6" dia	310/12.2
WA105.4BXX.22N	420/16.5	280/11	634/25	420/16.5	N/A	N/A	N/A	6" dia	310/12.2
WA105.4BXX.32N	420/16.5	280/11	634/25	420/16.5	N/A	N/A	N/A	6" dia	310/12.2
WA120.4BXX.22N	420/16.5	280/11	634/25	420/16.5	N/A	N/A	N/A	8" dia	359/14.1
WA120.4BXX.22S	420/16.5	280/11	634/25	420/16.5	N/A	N/A	N/A	8" dia	359/14.1
WA120.4BXX.24N	420/16.5	277/10.9	621/24.4	420/16.5	N/A	N/A	N/A	8" dia	359/14.1
WA125.3HXX.22N	420/16.5	280/11	634/25	420/16.5	N/A	N/A	N/A	8" dia	359/14.1
WA125.3HXX.22N	420/16.5	280/11	634/25	420/16.5	N/A	N/A	N/A	8" dia	359/14.1
WA140.3HXX.22N	420/16.5	280/11	644/25.4	420/16.5	N/A	N/A	N/A	8" dia	310/12.2
WA140.3HXX.22S	420/16.5	280/11	644/25.4	420/16.5	N/A	N/A	N/A	8" dia	310/12.2
WA150.5BXX.22F	420/16.5	280/11	644/25.4	420/16.5	N/A	N/A	N/A	8" dia	310/12.2
WA180.5BXX.22F	457/18	360/14.2	696/27.4	457/18	N/A	N/A	N/A	8" dia	358/14.1
WA190.4HXX.22L	457/18	360/14.2	764/30.1	457/18	N/A	N/A	N/A	8" dia	360/14.2
WA240.5HXX.22L	457/18	360/14.2	764/30.1	457/18	N/A	N/A	N/A	8" dia	360/14.2

Note: Refer to job specific submittal for job specific product dimensions.

Table 5: Chiller Dimensions By Model (cont'd)

MODEL	WATER COOLED CHILLER DIMENSIONS								
	DIMENSIONS (mm/in)								
	y4	z4	x5	y5	z5	x6	y6	z6	Px
WA021.1BXX.66C	958/37.7	280/11.0	277/10.9	1246/49.1	460/18.1	N/A	N/A	N/A	1168/45.6
WA026.1BXX.44C	986/38.8	427/16.8	277/10.9	1286/50.6	350/13.8	N/A	N/A	N/A	1265/49.8
WA027.1BXX.44N	986/38.8	427/16.8	277/10.9	1286/50.6	350/13.8	N/A	N/A	N/A	1368/53.9
WA030.1BXX.44C	989/38.9	440/17.3	277/10.9	1236/48.7	440/17.3	N/A	N/A	N/A	1268/49.9
WA030.1BXX.64C	958/37.7	280/11.0	277/10.9	1246/49.1	460/18.1	N/A	N/A	N/A	1268/49.9
WA031.1BXX.44N	976/38.4	270/10.6	277/10.9	1296/51	270/10.6	N/A	N/A	N/A	1368/53.9
WA044.2BXX.22N	976/38.4	350/13.8	277/10.9	1296/51	350/13.8	N/A	N/A	N/A	1855/73
WA044.2BXX.32N	974/38.3	350/13.8	N/A	N/A	N/A	280/11	1298/51.1	350/13.8	1855/73
WA044.2BXX.33N	974/38.3	350/13.8	N/A	N/A	N/A	280/11	1298/51.1	350/13.8	1855/73
WA046.1HXX.44C	1156/45.5	515/20.3	311/12.2	1486/58.5	560/22	N/A	N/A	N/A	1158/45.6
WA047.1HXX.44C	1156/45.5	515/20.3	311/12.2	1486/58.5	560/22	N/A	N/A	N/A	1258/49.5
WA048.1HXX.32N	974/38.3	350/13.8	N/A	N/A	N/A	277/10.9	1298/51.1	350/13.8	2365/93.1
WA048.1HXX.32S	533/21	1050/41.3	N/A	N/A	N/A	277/10.9	857/33.7	1050/41.3	1286/50.6
WA048.1HXX.33N	974/38.3	350/13.8	N/A	N/A	N/A	277/10.9	1298/51.1	350/13.8	2365/93.1
WA048.1HXX.33S	533/21	350/13.8	N/A	N/A	N/A	277/10.9	1298/51.1	350/13.8	1286/50.6
WA050.2BXX.22N	976/38.4	350/13.8	277/10.9	1296/51	350/13.8	N/A	N/A	N/A	1855/73
WA050.2BXX.23N	976/38.4	350/13.8	277/10.9	1296/51	350/13.8	N/A	N/A	N/A	1855/73
WA050.2BXX.33N	974/38.3	350/13.8	N/A	N/A	N/A	277/10.9	1298/51.1	350/13.8	1855/73
WA056.2BXX.44F	1142/45	305/12	311/12.2	1476/58.1	305/12	N/A	N/A	N/A	875/34.4
WA059.2BXX.44F	1142/45	305/12	311/12.2	1476/58.1	305/12	N/A	N/A	N/A	868/34.2
WA062.2BXX.22N	998/39.3	350/13.8	280/11	1274/50.2	350/13.8	N/A	N/A	N/A	1855/73
WA062.2BXX.32N	985/38.8	350/13.8	N/A	N/A	N/A	280/11	1287/50.7	350/13.8	1855/73
WA062.2BXX.33N	985/38.8	350/13.8	N/A	N/A	N/A	280/11	1287/50.7	350/13.8	1855/73
WA062.2BXX.42N	1016/40	270/10.6	280/11	1256/49.4	270/10.6	N/A	N/A	N/A	1855/73
WA074.3BXX.22N	998/39.3	350/13.8	280/11	1274/50.2	350/13.8	N/A	N/A	N/A	2463/97
WA084.3BXX.22N	998/39.3	350/13.8	277/10.9	1274/50.2	350/13.8	N/A	N/A	N/A	2469/97.2
WA088.2HXX.44F	1142/45	305/12	311/12.2	1476/58.1	305/12	N/A	N/A	N/A	1536/60.5
WA092.3BXX.22N	1193/47	420/16.5	310/12.2	1499/59	420/16.5	N/A	N/A	N/A	2487/97.9
WA092.3BXX.22S	622/24.5	1260/49.6	310/12.2	928/36.5	1260/49.6	N/A	N/A	N/A	2465/97
WA092.3BXX.33N	1181/46.5	420/16.5	N/A	N/A	N/A	310/12.2	1511/59.5	420/16.5	2487/97.9
WA092.3BXX.42N	1173/46.2	325/12.8	307/12.1	1466/57.7	300/11.8	N/A	N/A	N/A	2487/97.9
WA095.2HXX.32N	1154/45.4	420/16.5	N/A	N/A	N/A	310/12.2	1538/60.6	420/16.5	2109/83
WA095.2HXX.32S	583/23	1680/66.1	N/A	N/A	N/A	310/12.2	967/38.1	1680/66.1	1142/44.9
WA095.2HXX.33N	1154/45.4	420/16.5	N/A	N/A	N/A	310/12.2	1538/60.6	420/16.5	2109/83
WA096.2HXX.22N	1186/46.7	420/16.5	359/14.1	1506/59.3	420/16.5	N/A	N/A	N/A	2487/97.9

Note: Refer to job specific submittal for job specific product dimensions.

Table 5: Chiller Dimensions By Model (cont'd)

MODEL	WATER COOLED CHILLER DIMENSIONS								
	DIMENSIONS (mm/in)								
	y4	z4	x5	y5	z5	x6	y6	z6	Px
WA096.2HXX.22S	615/24.2	1260/49.6	359/14.1	935/36.8	1260/49.6	N/A	N/A	N/A	1528/60.2
WA096.2HXX.32N	1154/45.4	420/16.5	N/A	N/A	N/A	310/12.2	1538/60.6	420/16.5	2487/97.9
WA105.4BXX.22N	1193/47	420/16.5	310/12.2	1499/59	420/16.5	N/A	N/A	N/A	3130/123.2
WA105.4BXX.32N	1181/46.5	420/16.5	N/A	N/A	N/A	310/12.2	1511/59.5	420/16.5	3130/123.2
WA120.4BXX.22N	1186/46.7	420/16.5	359/14.1	1506/59.3	420/16.5	N/A	N/A	N/A	3130/123.2
WA120.4BXX.22S	615/24.2	1260/49.6	359/14.1	935/36.8	1260/49.6	N/A	N/A	N/A	2846/112.1
WA120.4BXX.24N	1186/46.7	420/16.5	359/14.1	1506/59.3	420/16.5	N/A	N/A	N/A	3130/123.2
WA125.3HXX.22N	1186/46.7	420/16.5	359/14.1	1506/59.3	420/16.5	N/A	N/A	N/A	3130/123.2
WA125.3HXX.22N	615/24.2	1260/49.6	359/14.1	935/36.8	1260/49.6	N/A	N/A	N/A	2396/94.3
WA140.3HXX.22N	1161/45.7	420/16.5	310/12.2	1531/60.3	420/16.5	N/A	N/A	N/A	1935/76.2
WA140.3HXX.22S	590/23.2	1260/49.6	310/12.2	960/37.8	1260/49.6	N/A	N/A	N/A	2396/94.3
WA150.5BXX.22F	1161/45.7	420/16.5	310/12.2	1531/60.3	420/16.5	N/A	N/A	N/A	1936/76.2
WA180.5BXX.22F	1250/49.2	457/18	358/14.1	1664/65.5	457/18	N/A	N/A	N/A	2078/81.8
WA190.4HXX.22L	1281/50.4	1071/42.2	360/14.2	1587/62.5	1071/42.2	N/A	N/A	N/A	2590/102
WA240.5HXX.22L	1274/50.2	1071/42.2	360/14.2	1594/62.8	1071/42.2	N/A	N/A	N/A	3267/128.6

Note: Refer to job specific submittal for job specific product dimensions.

Table 5: Chiller Dimensions By Model (cont'd)

MODEL	WATER COOLED CHILLER DIMENSIONS DIMENSIONS (mm/in)					
	Py	Pz	RC1	RC2	RE1	RE2
WA021.1BXX.66C	1462/57.6	170/6.7	383/15.1	N/A	288/11.3	N/A
WA026.1BXX.44C	1462/57.6	170/6.7	438/17.2	N/A	238/9.4	N/A
WA027.1BXX.44N	1462/57.6	170/6.7	538/21.1	N/A	238/9.4	N/A
WA030.1BXX.44C	1462/57.6	170/6.7	438/17.2	N/A	338/13.3	N/A
WA030.1BXX.64C	1462/57.6	170/6.7	438/17.2	N/A	338/13.3	N/A
WA031.1BXX.44N	1462/57.6	170/6.7	438/17.2	N/A	238/9.4	N/A
WA044.2BXX.22N	1462/57.6	170/6.7	805/31.7	N/A	805/31.7	N/A
WA044.2BXX.32N	1462/57.6	170/6.7	805/31.7	N/A	805/31.7	N/A
WA044.2BXX.33N	1462/57.6	170/6.7	805/31.7	N/A	805/31.7	N/A
WA046.1HXX.44C	1736/68.3	195/7.7	482/19	N/A	343/13.5	N/A
WA047.1HXX.44C	1736/68.3	195/7.7	482/19	N/A	343/13.5	N/A
WA048.1HXX.32N	1462/57.6	170/6.7	1010/39.8	N/A	805/31.7	N/A
WA048.1HXX.32S	1637/64.5	33/1.3	2035/80.1	N/A	2392/94.2	N/A
WA048.1HXX.33N	1462/57.6	170/6.7	1010/39.8	N/A	805/31.7	N/A
WA048.1HXX.33S	1637/64.5	33/1.3	2035/80.1	N/A	2392/94.2	N/A
WA050.2BXX.22N	1462/57.6	170/6.7	805/31.7	N/A	805/31.7	N/A
WA050.2BXX.23N	1462/57.6	170/6.7	805/31.7	N/A	805/31.7	N/A
WA050.2BXX.33N	1462/57.6	170/6.7	805/31.7	N/A	805/31.7	N/A
WA056.2BXX.44F	1736/68.3	284/11.2	1407/55.4	N/A	1457/57.4	N/A
WA059.2BXX.44F	1736/68.3	284/11.2	1543/60.7	N/A	1543/60.7	N/A
WA062.2BXX.22N	1462/57.6	170/6.7	805/31.7	N/A	805/31.7	N/A
WA062.2BXX.32N	1462/57.6	170/6.7	805/31.7	N/A	805/31.7	N/A
WA062.2BXX.33N	1462/57.6	170/6.7	805/31.7	N/A	805/31.7	N/A
WA062.2BXX.42N	1462/57.6	170/6.7	805/31.7	N/A	805/31.7	N/A
WA074.3BXX.22N	1462/57.6	170/6.7	562/22.1	N/A	701/27.6	N/A
WA084.3BXX.22N	1462/57.6	170/6.7	568/22.4	N/A	701/27.6	N/A
WA088.2HXX.44F	1736/68.3	272/10.7	355/14	N/A	355/14	N/A
WA092.3BXX.22N	1736/68.3	196/7.7	562/22.1	N/A	690/27.2	N/A
WA092.3BXX.22S	1736/68.3	31/1.2	2093/82.4	N/A	2062/81.2	N/A
WA092.3BXX.33N	1736/68.3	196/7.7	562/22.1	N/A	690/27.2	N/A
WA092.3BXX.42N	1736/68.3	196/7.7	562/22.1	N/A	690/27.2	N/A
WA095.2HXX.32N	1736/68.3	196/7.7	538/21.2	N/A	343/13.4	N/A
WA095.2HXX.32S	1777/70	33/1.3	2652/104.4	N/A	2857/112.5	N/A
WA095.2HXX.33N	1736/68.3	196/7.7	538/21.2	N/A	343/13.4	N/A
WA096.2HXX.22N	1736/68.3	196/7.7	962/37.9	N/A	943/37.1	N/A

Note: Refer to job specific submittal for job specific product dimensions.

Table 5: Chiller Dimensions By Model (cont'd)

MODEL	WATER COOLED CHILLER DIMENSIONS					
	DIMENSIONS (mm/in)					
	Py	Pz	RC1	RC2	RE1	RE2
WA096.2HXX.22S	1777/70	33/1.3	2738/107.8	N/A	2657/104.6	N/A
WA096.2HXX.32N	1736/68.3	196/7.7	962/37.9	N/A	943/37.1	N/A
WA105.4BXX.22N	1736/68.3	196/7.7	1097/43.2	N/A	1347/53	N/A
WA105.4BXX.32N	1736/68.3	196/7.7	1097/43.2	N/A	1347/53	N/A
WA120.4BXX.22N	1736/68.3	196/7.7	1097/43.2	N/A	1147/45.2	N/A
WA120.4BXX.22S	1777/70	33/1.3	1097/43.2	N/A	793/31.2	N/A
WA120.4BXX.24N	1736/68.3	196/7.7	1097/43.2	N/A	1147/45.2	N/A
WA125.3HXX.22N	1736/68.3	196/7.7	652/25.7	N/A	643/25.3	N/A
WA125.3HXX.22N	1777/70	33/1.3	3562/140.2	N/A	3357/132.2	N/A
WA140.3HXX.22N	1736/68.3	196/7.7	588/23.1	N/A	445/17.5	250/9.8
WA140.3HXX.22S	1777/70	33/1.3	3652/143.8	N/A	3855/151.8	4155/163.6
WA150.5BXX.22F	1736/68.3	272/10.7	545/21.5	795/31.3	545/21.5	795/31.3
WA180.5BXX.22F	1884/74.2	272/10.7	1651/65	1951/76.8	1353/53.5	1651/65
WA190.4HXX.22L	1568/61.7	145/5.7	3277/129	3577/140.8	3247/127.8	3497/137.7
WA240.5HXX.22L	1568/61.7	145/5.7	3012/118.6	3812/150.1	3047/120	3897/153.4

Note: Refer to job specific submittal for job specific product dimensions.

Table 5: Chiller Dimensions By Model (cont'd)

UNIT PLACEMENT

The SMARDT chiller should be protected from both excessive ground or pipe borne vibration and vibration from external sources such as pumps. Site location installation should take place using suitable anti-vibration mounting, ideally incorporating both vibration eliminators and steel plates positioned at each corner of the chiller. However, in that SMARDT chillers are virtually vibration free, the use of waffle pads are considered an acceptable alternative method of mounting.

Once installed, remove the rigging equipment and check for longitudinal and transverse alignment. Add shims, if necessary, to level the unit along both axes.

CLEARANCES

Adequate clearance around the chiller set is essential to facilitate maintenance and service.

Make sure that sides and service clearances are respected.

The condenser and evaporator connections are either flanged or grooved-type stubs (Victaulic®, Shurjoint®, or other equivalent) for interconnection to the external water circuits. All external piping must be adequately supported and aligned to prevent strain and distortion on the chiller headers and couplings.

INSTALLATION REQUIREMENTS AND RESPONSIBILITIES

For convenience, Table 4 details responsibilities that are associated with the installation of a SMARDT Water Cooled Chiller.

Requirement	SMARDT Supplied, SMARDT Installed	SMARDT Supplied, Field-Installed	Field Supplied, Field Installed
Delivery Inspection			Shall be performed by the purchaser of the chiller.
Rigging			Safety chains, Clevis connectors, Lifting beam equipment, skates, rollers, cranes…….ETC
Isolation			Isolation pads, Spring isolators
Electrical	Differential pressure transmitters (optional)	Graphical touch panel interface	3ph power to chiller, Circuit breakers, fused disconnect, Ground wiring, BAS call for cooling wiring, External BAS temperature reset input, BAS communications wiring, Chilled water pump contactor, control voltage and motor controls. BAS demand limit wiring High speed internet connection for remote monitoring.
Water piping	Entering and leaving chilled water temperature sensors Flow switches		Chiller isolation valves, Differential pressure gauge with shutoffs, Vent and drain lines, Pressure relief valves (water side) if required, Pipe thermometers and wells, Pipe insulation, Balancing valves, Strainers
Pressure relief valves	Pressure relief valves x2 mounted on changeover manifold		Vent lines, Flexible connections Pressure gauges across chiller barrels (to measure pressure drop)
Refrigerant		(optional) Refrigerant	

Table 6: Installation Requirements and Responsibilities

For additional information please refer to the electrical and mechanical sections of this manual.

(Installation Requirements and Responsibilities (Cont'd)

1. Locate and group all parts shipped loose, and join together with packing slip provided with the chiller. Parts shipped loose may be – touch screen control panel, temperature sensors, refrigerant and spare parts that may have been specified at time of order. Loose parts are generally shipped inside the power entry electrical panel or strapped between the line reactor panels and the chiller.

2. Fully inspect the chiller before accepting delivery from the shipping company. Detail any damage that may have occurred during shipping. Advise SMARDT Inc immediately of any shipping damage and make sure this is noted on the transport company delivery sheets.

3. Before opening any refrigerant valves, fit a set of refrigerant gauges to the evaporator and condenser of the chiller and make sure there is pressure in both heat exchangers. If no pressure, this may indicate a possible leak situation has developed during transportation. If no pressure is recorded on one of the heat exchangers, leave both isolated and investigate the source of the leak.

4. Verify the chiller foundations are correct for the unit size and weight; use a level indicator to check that the condensing unit foundation is level to within 1/4" pitch in any direction.

5. Install the chiller and any field supplied vibration/spring mounts in place, in accordance with SMARDT's unit placement guidelines.

6. Install water piping to the chiller, supply temperature wells for visual thermometers, supply and install chiller isolation valves, drain and vent lines, and install differential pressure gauge.

7. Connect electrical power to the chiller in accordance with local electrical codes and regulations.

8. Connect building automation wiring to the chiller.

9. Inspect all electrical wiring on the chiller for correctness and terminal torque.

10. Supply and install refrigerant relief piping vent lines.

11. Evacuate the chiller to 500 microns or less and hold there for at least 2 hours.

12. Charge the chiller with refrigerant using proper refrigerant practices and to the quantity as indicated on the unit nameplate. Note: In order to avoid possible freezing or rupturing of tubes, it is always advisable to run water through the chiller while charging.

13. If possible, interlock pump starters auxiliary contact with flow switch for extra protection.

Note: Piping connections made to and from the chiller water connections and the pressure relief valves, must be made in such a way that weight and strain is removed from the chiller connections. All chilled water piping connected to the chiller, should be adequately insulated. Strainers with 20mesh filters should be installed upstream of the evaporator and condenser. Adequate valving should be supplied to permit draining of water from the evaporator and condenser, as well as allowing for cleaning of the strainers.

(Installation Requirements and Responsibilities (Cont'd)

SMARDT Inc also recommends that the installing piping contractor leave at least 3ft between the pre-installed water piping and the chiller grooved connections. This is to allow, upon placement of the chiller, for proper fitting of piping to the chiller water box.

14. Each water box incorporates a threaded unplugged vent port (top) and a threaded unplugged drain cock port (bottom).

15. Vent port plugs are SMARDT supplied, and should be installed in each water box, before introducing water into the chiller.

16. Supply and install drain cocks in each water box drain cock port, before introducing water into the chiller.

17. Introduce water into the chiller and check for any possible leaks.

18. Once the new SMARDT unit is fully and satisfactorily installed, the pre-commissioning, request for start-up, commissioning, and warranty initiation process can then be instigated.

19. For SMARDT Pre-Commissioning Form - Request for Start-Up, and Commissioning and Warranty Initiation Form details – contact SMARDT Product Support.

INSTALLATION, ELECTRICAL

FIELD WIRING

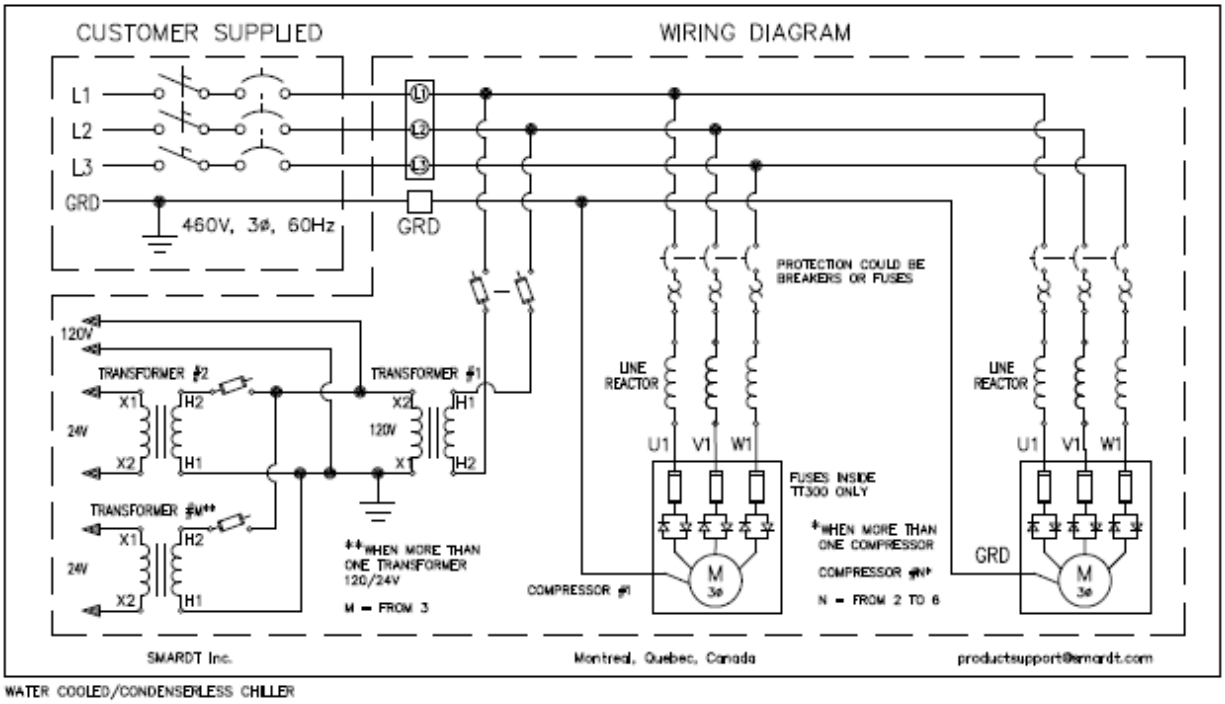


Figure 12: Field Wiring for 460V Water Cooled Chiller

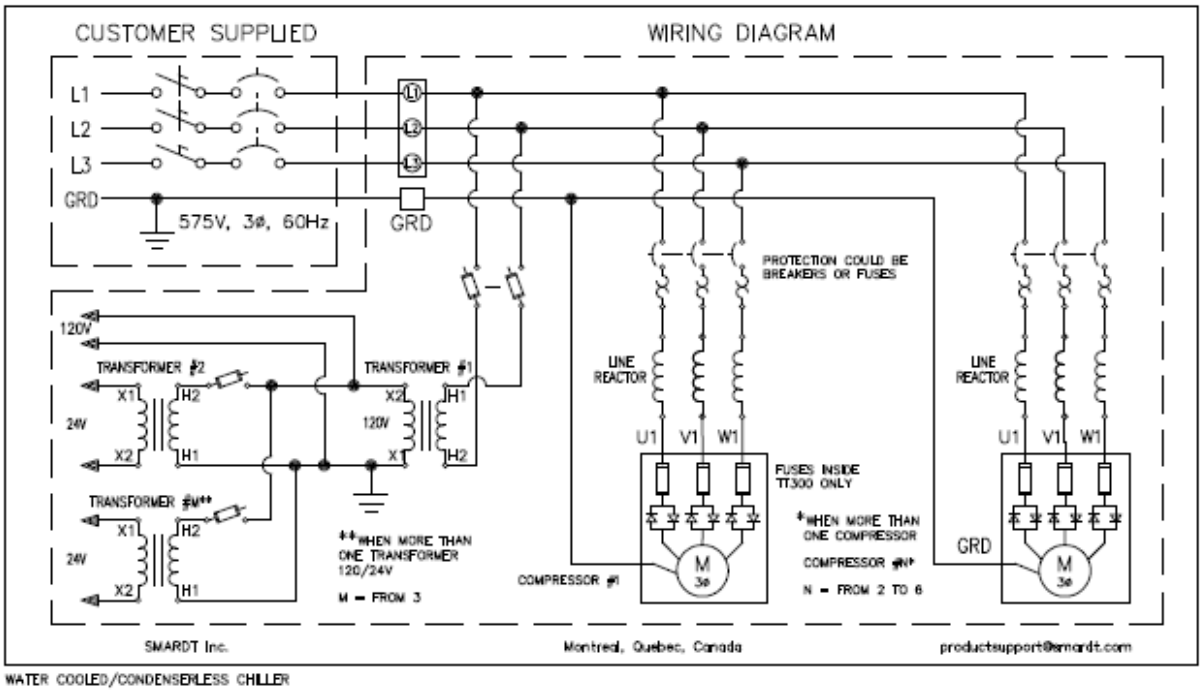


Figure 13: Field Wiring for 575V Water Cooled Chiller

ELECTRICAL RATINGS

ELECTRICAL RATING - WATERCOOLED - **TT300 460V 60Hz**							
CHILLER	**COMP. - TT300**		**CHILLER**				
	QTY	MODEL	MCA (A)	MOP (A)	MDS (A)	MFW/ **90°C**	MFW/ **75°C**
WA021.1BXX.XXX,	1	G2	90	150	83	4	3
WA026.1BXX.XXX,		G3	100	175	92	3	3
WA027.1BXX.XXX,		G4	125	225	115	2	1
WA030.1BXX.XXX,		G6	150	250	138	1	1/0
WA031.1BXX.XXX		G7	169	300	155	1/0	2/0
WA044.2BXX.XXX,	2	G2	162	225	166	1/0	2/0
WA050.2BXX.XXX,		G3	180	250	184	2/0	3/0
WA056.2BXX.XXX,		G4	225	300	230	3/0	4/0
WA059.2BXX.XXX,		G6	270	350	276	250	250
WA062.2BXX.XXX		G7	304	400	311	300	350
WA074.3BXX.XXX, WA084.3BXX.XXX, WA092.3BXX.XXX	3	G2	234	300	248	4/0	250
		G3	260	300	276	4/0	300
		G4	325	400	345	350	400
		G6	390	500	414	2 x 2/0	2 x 3/0
		G7	439	500	466	2 x 3/0	2 x 4/0
WA105.4BXX.XXX, WA120.4BXX.XXX	4	G2	306	350	331	300	350
		G3	340	400	368	350	500
		G4	425	500	460	2 x 3/0	2 x 4/0
		G6	510	600	552	2 x 4/0	2 x 250
		G7	574	700	621	2 x 250	2 x 350
WA150.5BXX.XXX	5	G2	378	450	414	400	500
		G3	420	500	460	2 x 3/0	2 x 4/0
		G4	525	600	575	2 x 250	2 x 300
		G6	630	700	690	2 x 300	2 x 400
		G7	709	800	776	2 x 400	2 x 500
WA180.6BXX.XXX	6	G2	450	500	497	2 x 3/0	2 x 4/0
		G3	500	500	552	2 x 4/0	2 x 250
		G4	625	700	690	2 x 300	2 x 400
		G6	750	800	828	2 x 400	2 x 500
		G7	844	900	932	2 x 600	2 x 700
MDS: MINIMUM DISCONNECT SIZE RATING							
MFW: MINIMUM FIELD WIRING SIZE: BASED ON COPPER (AWG / kcmil)							

Table 7: Electrical Ratings

ELECTRICAL RATING - WATERCOOLED - **TT400 460V 60Hz**							
CHILLER	**COMP. - TT400**		**CHILLER**				
	QTY	MODEL	MCA (A)	MOP (A)	MDS (A)	MFW/**90°C**	MFW/**75°C**
WA046.1HXX.XXX, WA047.1HXX.XXX, WA048.1HXX.XXX	1	G4	125	225	115	2	1
		G5	138	225	127	1	1/0
		G6	150	250	138	1	1/0
		G8	175	300	161	2/0	2/0
		G9	188	300	173	2/0	3/0
WA088.2HXX.XXX, WA095.2HXX.XXX, WA096.2HXX.XXX	2	G4	225	300	230	3/0	4/0
		G5	248	350	253	4/0	250
		G6	270	350	276	250	300
		G8	315	450	322	300	400
		G9	338	450	345	350	500
WA125.3HXX.XXX, WA140.3HXX.XXX	3	G4	325	400	345	350	400
		G5	358	450	380	400	500
		G6	390	500	414	2 x 2/0	2 x 3/0
		G8	455	500	483	2 x 4/0	2 x 4/0
		G9	488	600	518	2 x 4/0	2 x 250
WA190.4HXX.XXX	4	G4	425	500	460	2 x 3/0	2 x 4/0
		G5	468	500	506	2 x 4/0	2 x 250
		G6	510	600	552	2 x 4/0	2 x 250
		G8	595	700	644	2 x 300	2 x 350
		G9	638	700	690	2 x 300	2 x 400
WA240.5HXX.XXX	5	G4	525	600	575	2 x 250	2 x 300
		G5	578	600	633	2 x 250	2 x 350
		G6	630	700	690	2 x 300	2 x 400
		G8	735	800	805	2 x 400	2 x 500
		G9	788	800	863	2 x 500	2 x 600
WA280.6HXX.XXX	6	G4	625	700	690	2 x 300	2 x 400
		G5	688	700	759	2 x 350	2 x 500
		G6	750	800	828	2 x 400	2 x 500
		G8	875	1000	966	2 x 600	2 x 700
		G9	938	1000	1035	2 x 700	2 x 750
MDS: MINIMUM DISCONNECT SIZE RATING							
MFW: MINIMUM FIELD WIRING SIZE: BASED ON COPPER (AWG / kcmil)							

Table 8: Electrical Ratings

ELECTRICAL RATING - WATERCOOLED - **TT300 575V 60Hz**							
CHILLER	**COMP. - TT300**		**CHILLER**				
	QTY	MODEL	MCA (A)	MOP (A)	MDS (A)	MFW/**90°C**	MFW/**75°C**
WA021.1BXX.XXX, WA026.1BXX.XXX, WA027.1BXX.XXX, WA030.1BXX.XXX, WA031.1BXX.XXX	1	F2	80	125	74	4	4
		F3	90	150	83	3	3
		F4	100	175	92	3	3
		F5	113	200	104	2	2
		F6	125	225	115	1	1
		F7	138	225	127	1	1/0
WA044.2BXX.XXX, WA050.2BXX.XXX, WA056.2BXX.XXX, WA059.2BXX.XXX, WA062.2BXX.XXX	2	F2	144	200	147	1/0	1/0
		F3	162	225	166	2/0	2/0
		F4	180	250	184	2/0	3/0
		F5	203	250	207	3/0	4/0
		F6	225	300	230	4/0	4/0
		F7	248	350	253	250	250
WA074.3BXX.XXX, WA084.3BXX.XXX, WA092.3BXX.XXX	3	F2	208	250	221	3/0	4/0
		F3	234	300	248	4/0	250
		F4	260	300	276	250	300
		F5	293	350	311	300	350
		F6	325	400	345	350	400
		F7	358	450	380	500	500
WA105.4BXX.XXX, WA120.4BXX.XXX	4	F2	272	300	294	300	300
		F3	306	350	331	350	350
		F4	340	400	368	400	500
		F5	383	450	414	2 x 3/0	2 x 3/0
		F6	425	500	460	2 x 4/0	2 x 4/0
		F7	468	500	506	2 x 4/0	2 x 250
WA150.5BXX.XXX	5	F2	336	400	368	400	500
		F3	378	450	414	500	500
		F4	420	500	460	2 x 3/0	2 x 4/0
		F5	473	500	518	2 x 250	2 x 250
		F6	525	600	575	2 x 250	2 x 300
		F7	578	600	633	2 x 300	2 x 350
WA180.6BXX.XXX	6	F2	400	450	442	2 x 3/0	2 x 3/0
		F3	450	500	497	2 x 4/0	2 x 4/0
		F4	500	500	552	2 x 250	2 x 250
		F5	563	600	621	2 x 300	2 x 300
		F6	625	700	690	2 x 350	2 x 400
		F7	688	700	759	2 x 400	2 x 500
MDS: MINIMUM DISCONNECT SIZE RATING							
MFW: MINIMUM FIELD WIRING SIZE: BASED ON COPPER (AWG / kcmil)							

Table 9: Electrical Ratings

GENERAL

All applicable codes should be adhered to. The Limited Product Warranty does not cover damaged equipment caused by wiring non-compliance, an open fuse resulting from an overload, a short, or a ground. Correct the cause of the open fuse before replacing the fuse and restarting the compressor.

Compressor motors are designed to operate satisfactorily over a range of ± 10 percent of the standard design voltage.

ELECTRICAL WIRING

All electrical wiring connecting to the unit should be made of copper.

All wiring must be installed in accordance with appropriate local and national electrical codes, and will require a circuit breaker or fuses to protect the main wiring run from the final distribution sub-board to the unit.

According to specific model and/or option selected, field wiring connections will require either one or two supply conductors in parallel.

Each SMARDT Chiller is provided with a 3 pole power distribution block or busbar system, splitting field supply main power into multiple secondary circuits.

Ground lugs are located next to field wiring terminals for equipment grounding.

Minimum required bending space at terminals and means for strain relief of supply conductors, shall be provided by the installation contractor in order to prevent leads separating from their terminations or subjecting them to damage from sharp edges.

All electrical wiring connecting to the unit shall only be made of copper and shall be shielded and grounded. It is normal that supply conductors rated at 75°C (167°F) will be used in determining the size of terminals.

The main power input connection for the SMARDT range of chillers is a single point termination via a main termination box (supplied as standard) on each chiller unit. All power wiring from this point on, is the responsibility of the installation contractor.

From the main termination box, each compressor control box (power and controls) is pre-wired to the individual compressors.

COMMISSIONING, START-UP, & WARRANTY INITIATION

PRE-COMMISSIONING - REQUEST FOR START-UP, COMMISSIONING & WARRANTY INITIATION PROCESS

SMARDT factory service start-up is offered on all units sold for installation in Canada and the U.S., and in order to have SMARDT provide commissioning and warranty initiation, a SMARDT authorized service contractor should firstly fill out and complete the "Pre-Commissioning - Request for Start-Up" form. Duly completed and signed forms should be submitted by e-mail to SMARDT at: PRODUCTSUPPORT@SMARDT.COM Once received and approved, SMARDT factory service personnel or a SMARDT authorized service contractor can then instigate the start-up, commissioning, & warranty initiation process, by completing the SMARDT "Commissioning and Warranty Initiation" form and process, and also faxing or mailing in the completed form to SMARDT. Please allow up to 14 days from approval of the submitted "Pre-Commissioning - Request for Start-Up" form, to commencement of the start-up, commissioning and warranty initiation process. Copies of the above mentioned forms may be obtained through SMARDT Product Support at: PRODUCTSUPPORT@SMARDT.COM.

STORAGE

If the SMARDT chiller is to be stored before installation and operation, the following should be observed:

Store the chiller in a clean dry warm location free from air borne debris.

Do not remove protective water connection covers.

Do not remove any protective enclosure/electrical panel.

Every three months, attach a set of refrigeration gauges to the evaporator and condenser and check the dry nitrogen holding charge pressure. If there is a pressure drop greater than 0.35 bar (5 psi) over this period, call a qualified service technician to investigate for a potential leakage.

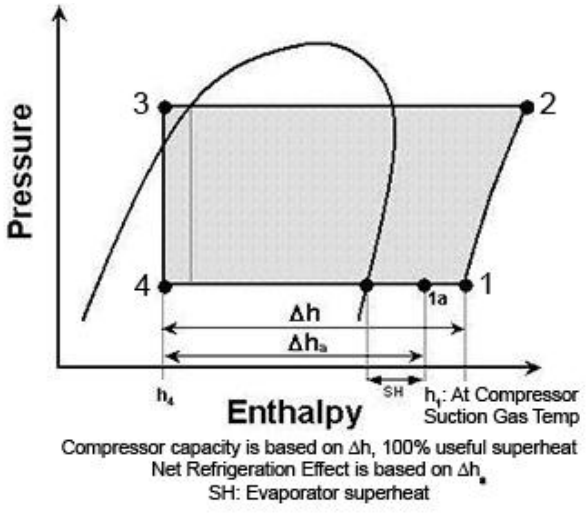
If the chiller is in storage and holding a refrigerant charge, the only way to check the charge, is by reclaiming it and weighing each bottle minus the bottle weight.

OPERATION

WATER COOLED CHILLER CYCLE

Controls – Cooling cycle operation:

When the SMARDT chiller control system is set to "HVAC_COOL" mode, indicating the chiller is to be used to control the leaving chilled water temperature (LCWT) to a desired value, the following description of operation is true:



The Pressure-Enthalpy (PH) Diagram

Figure 14: Pressure v Enthalpy

The refrigeration cycle is depicted in Figure 14 in a pressure v enthalpy diagram. Each point represents the pressure and enthalpy (i.e. energy in the refrigerant) associated with the refrigerant at each particular point. Point 1 to point 2 represents the rise in pressure and enthalpy added by the compressor, point 2 to point 3 represents the decrease in enthalpy at a constant pressure, by the transfer of energy from the refrigerant in the condenser to the cooler fluid flowing across it, and point 3 to point 4 represents the decrease in pressure at a constant enthalpy, while the refrigerant is flowing across the expansion valve. Point 4 to point 1 represents the increase in enthalpy at constant pressure, while the refrigerant is absorbing energy from the evaporator.

EVAPORATOR DESCRIPTION

When the chiller is operated in cooling mode, the condensed liquid refrigerant exits the electronic expansion valve (4) Figure 15, and enters the bottom of the flooded evaporator, where it is evenly dispersed along the length of the evaporator by the use of a distributor plate (3). Liquid refrigerant inside the evaporator at low pressure then makes contact with the copper tubes that the building's water runs through, exchanges heat to the refrigerant, and vaporizes it (2) at the suction pressure of the compressor (1). As a result of the lower density of the vapor and the suction of the compressor, the vaporized refrigerant gas is then drawn to the top of the evaporator through the mist eliminators (5). (Mist eliminators inhibit minute liquid particles entrained in the vaporized refrigerant, from entering the compressor). Passing through the (pre-rotation) inlet guide vanes (6), the vaporized refrigerant then enters the compressor inlet (7), where the angle of incidence of the refrigerant hitting the first stage impeller, is altered, thereby allowing a higher compression efficiency for a given compressor rotor speed.

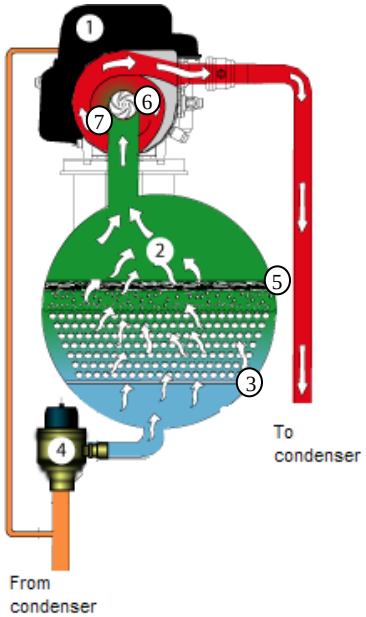


Figure 15: Evaporator Refrigerant Flow

COMPRESSOR DESCRIPTION

SMARDT oil free chillers exclusively use Turbocor™ variable speed magnetic bearing compressors (Figure 16) on all chillers. All of the Turbocor™ compressors are a two stage design, meaning the compression of the vapor refrigerant takes place through two impellers.

Figure 16: Turbocor™ Compressor - External View

The refrigerant enters the suction side of the compressor as a low-pressure, low-temperature, super-heated gas - ref Figure 17, (1). The refrigerant gas passes through a set of adjustable inlet guide vanes (IGV) (2) that are used to control the compressor capacity at low load conditions.

The first compression element that the gas encounters is the first-stage impeller (3), and the centrifugal force produced by the rotating impeller results in an increase in both gas velocity and pressure. The high-velocity gas discharging from the impeller is directed to the second stage impeller (4) through de-swirl vanes (5). The gas is further compressed by the second stage impeller and then discharged through a volute (6) via a vane-less diffuser (7). (A volute is a curved funnel increasing in area to the discharge port. As the area of the cross-section increases, the volute reduces the speed of the gas and increases its pressure.) From there, the high-pressure/high temperature gas exits the compressor at the discharge port (8).

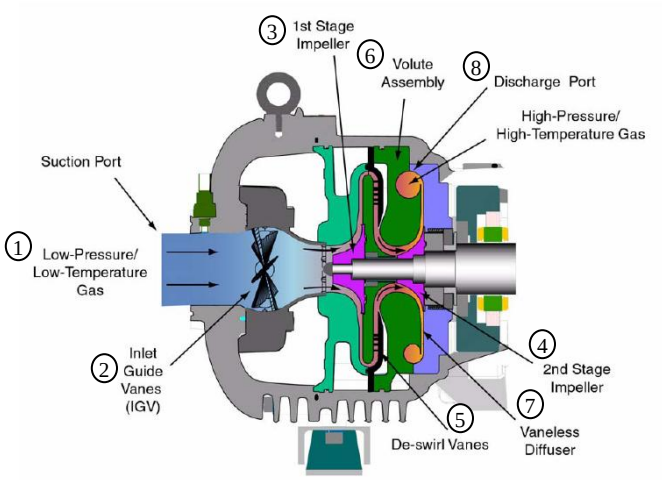


Figure 17: Turbocor™ Compressor Cross Section

Capacity control on SMARDT chillers is achieved by varying the speed, inlet guide vane position, and number of operating compressors. Figure 18 provides a graphical representation of the centrifugal compressor's response to demand and operating conditions.

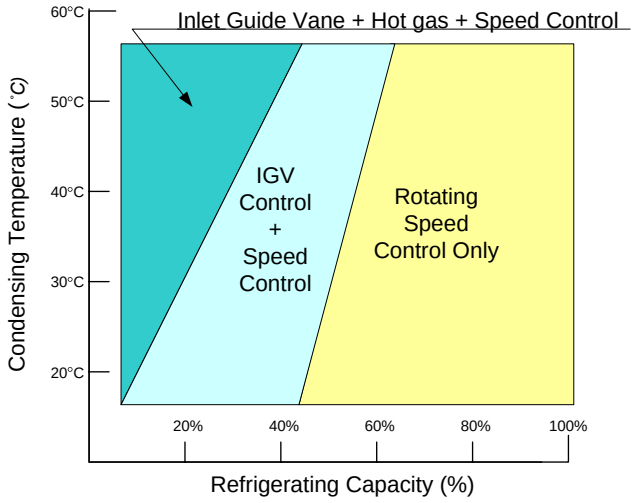


Figure 18: Graphic Representation of Capacity Control

CONDENSER DESCRIPTION

Superheated refrigerant from the compressor enters at the top of the condenser barrel where it is dispersed by a deflection plate. As the refrigerant is moving around the tubes in the condenser, heat is being constantly removed from the refrigerant and dissipated to the cooling water that is moving through the condenser tubes.

HOT GAS VALVE CONTROL

The hot gas valve provides the following functionality:

- Capacity control at low load.
- Assisted pressure ratio relief for starting new compressors.
- Head pressure relief for heat pump and air cooled chillers operating above design conditions.

Low Load Capacity Control Functionality

Hot gas control of leaving water temperature (LWT) is a last resort method of control when speed control and inlet guide vane control is no longer an option. The hot gas valve control uses the compressor's *IGV%* surge, choke and actual rpm to determine when to use the hot gas valve for capacity control.

The set point for the hot gas control is a differential temperature below the leaving temperature set point. By using a differential temperature, the hot gas control set point automatically adjusts with a change in supply temperature set point for the chiller, such that it is easy to implement alongside set point reset strategies.

As the diagram in Figure 18 shows, the hot gas valve is only used once the compressors have used up all speed and *IGV* control envelopes. If the chiller's capacity must be increased, and the hot gas valve is in the open position, the valve will close before adjustment is made for increased compressor demand.

It should be noted that the hot gas capacity control of SMARDT air cooled chillers, only takes place when the last compressor is operating.

The chiller control system makes best use of compressor staging before resorting to hot gas control. Under normal air conditioning loads where the outside air temperature and the heat load applied to the chiller are closely related, it is not uncommon for the hot gas capacity control valve never to be used.

Assisted Pressure Ratio Relief

Major reasons for requiring pressure ratio relief when turning on one or more additional compressors within a refrigerant circuit where compressors are already operating, are:

- To avoid rapid rotor displacement - which is an inherent weakness of all centrifugal compressors which do not incorporate pressure ratio unloading.

  To reduce the potential of rotating component damage.

  High dynamic forces can impact traditional bearing technology significantly. With the incorporation of the revolutionary magnetic bearing design used in the Turbocor™ compressor on SMARDT chillers, the potential for rotating component damage is greatly reduced, in that shutdown can occur before any surface impact takes place.

- Instability, as the compressor overcomes the system pressure and begins to open the discharge check valve.

  The danger of holding ramp up conditions without flow, for an extended period of time:.

  – All energy transferred to the compressor, has no outlet, and results in high internal temperatures.

  – Large sudden amperage spikes on the inverter can be dangerous, due to low thermal inertia on Inert Gate By-polar Transistors (IGBT). The higher the head that must be overcome, the higher the amperage spikes.

Control Strategy

SMARDT chillers have multiple options available to assist compressor staging. The first option is to reduce the speed of the operating compressor(s) to lower the pressure ratio within the system and allow more compressors to come on-line. The second option is to use the "Load Balancing Valve" to assist in reducing the pressure ratio. The third option of assisted compressor staging is by having individual bypass valves for each compressor, in order to allow the system pressure ratio to stay constant while staging-up the next compressor. This latter method is applicable to temperature sensitive and higher pressure ratio applications.

Although standard ARI conditions may not require any of these methods in order to stage compressors, during staging however, leaving chilled water temperature may fluctuate.

Return Water Control

Occasionally, instead of supplying chilled water control, SMARDT chillers are selected to provide return water temperature control in a plant. Return water temperature control allows the leaving chilled water set point to automatically float with the actual building load. Running higher leaving chilled water temperatures permits a higher chiller performance – an efficiency increase of approximately 3% per 0.5°C (1°F) increase in set point is possible (ref. Figure 19 - Power Consumption v Load graph shown below).

Selecting "HVAC_RET" mode on the chiller's graphical touch pad interface will enable control from the return water temperature. All alarm and fault trip points are active in this mode, and extra care must be taken when selecting a return water temperature to run, to avoid driving the chiller into low suction pressure or low leaving chilled water faults. SMARDT suggests a set point of 10°C (50°F) to 15.5°C (60°F).

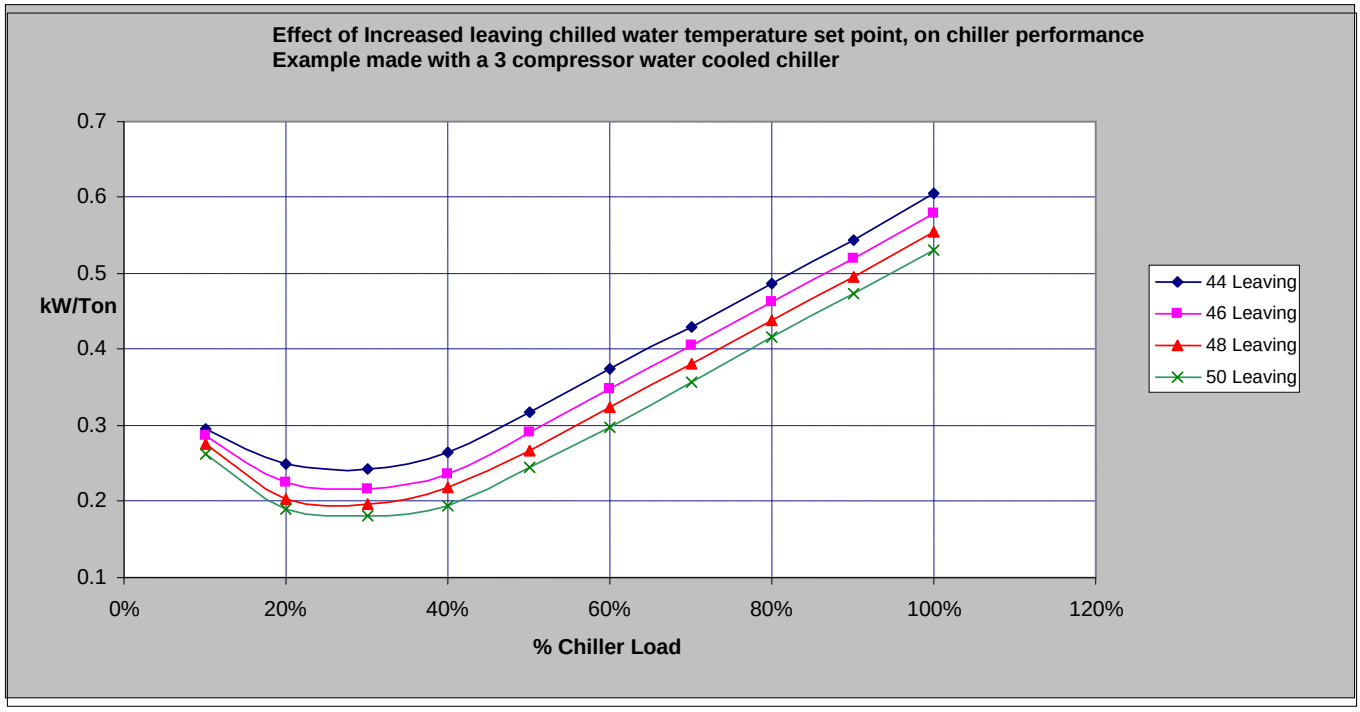


Figure 19: Power Consumption v Load

CHILLED WATER SYSTEM

EVAPORATOR WATER CIRCUITS

Chiller performance and efficiency can be adversely affected by contaminants in the water circuits, and such contaminants could impede or block the flow of water through the circuit or reduce the performance of the heat exchanger.

Strainers should be located on the inlet side of the evaporator, return water to the chiller must be connected to the lower connection of the evaporator, and all external water piping must be cleaned or flushed before being connected to the chiller set.

Water circuits should be arranged so that pumps discharge through the evaporator and are controlled as necessary, to maintain essentially constant chiller water flows through the unit at all load conditions.

To ensure the chiller's performance and longevity, air must be purged from both water boxes on the evaporator, and from the entire water circuit.

CHILLED WATER PUMPS

Make all connections prior to filling with water. Run a preliminary leak check before insulating the pipes and putting into service. SMARDT recommends consulting authorities in order to be compliant with local building codes and safety regulations.

Additional considerations, as follows, should be made when designing the piping system:

- All piping systems should include temperature and pressure measures at the evaporator. Make these connections prior to filling with water.
- Water pressure should be maintained throughout the system. Install regulating valves or comparable pressure maintenance devices.
- The piping system should be designed with a minimum number of elevation and directional changes in order to minimize system pressure drop.
- To prohibit debris from entering the pump, a strainer should be installed at the water supply line, and ahead of (before) the pump.
- Piping made to and from the chiller water connections must be made in such a way that weight and strain is removed from the chiller connections. All chilled water piping attached to chiller connections, should be adequately insulated.
- Strainers with filters should be installed up stream of the evaporator. Filter mesh sizing should be in-line with water quality and system design, and selected by the engineer of record.
- Adequate valving should be supplied to permit draining of water from the evaporator and cleaning of the strainers.
- Install vibration eliminators to reduce vibration transmission to the building. (Ref. Installation section Unit Placement).
- Install air valves at the system high points and drain valves at the system low points. Additionally, shutoff valves should be installed for unit servicing.

- Protect water from freezing by insulating water piping. Ensure there is a vapor barrier on the outside of the insulation, in order to protect from pipe condensation within the insulation.

Note: If glycol or propylene is added for freeze protection, this will cause a pressure drop, which may then result in the loss of performance. Only use glycol with factory approval.

WATER VOLUME

When designing the chilled water system, consider:

- The minimum cooling load.
- The minimum plant capacity during a low load period.
- The desired cycle time for the compressor.
- If the chiller plant has a reasonable turndown, the water volume should be two to three times the chilled water gpm flow rate. If the system components do not provide the required water volume, add a storage tank.

VARIABLE WATER FLOW

A large range of SMARDT chillers are well suited to installations where the chilled water and condenser water flow rates are changed in the chiller, relative to the instantaneous building load and outdoor conditions. When applying SMARDT chillers to variable volume (variable speed) pumping applications, the designer must make sure SMARDT's design parameters are met as follows:

1. That water flow shall not be altered at a rate greater than 10% per minute.
2. That the water flow rates shall not exceed the maximum and minimum flows detailed in the chiller selection sheet.

Variable speed pumping is a design feature of the SMARDT water-cooled chiller, which reduces the water flow through the evaporator as the load decreases. This feature will function successfully if the design and minimum flow rates are not exceeded. Check individual rating sheets for maximum and minimum flow rates.

OPERATING LIMITS

- Maximum standby ambient temperature = 49°C (120°F)
- Maximum operating ambient temperature = 41°C (105°F)
- Minimum operating ambient temperature (standard) = 3°C (38°F) Unless specified for low ambient use
- Leaving chilled water temperature (LCWT) = 3°C to 16°C (38°F to 60°F)
  Operating ΔT = 3K to 9K (6°F to 16°F)
- Maximum operating inlet fluid temperature = 24°C (76°F)
- Maximum startup inlet fluid temperature = 32°C (90°F)
- Maximum non-operating inlet fluid temperature = 38°C (100°F)

FLOW SWITCH

Flow switches are SMARDT factory installed.

A flow switch for the chilled water system is necessary to ensure adequate water flow to the evaporator before starting the unit. A flow switch will also guard against possible evaporator freezing should water flow be interrupted. SMARDT recommends use of one of the following instruments:

Figure 20: Flow Switch

IFM - Thermal Dispersion Flow Switch - P01408, & IFM - Thermal Dispersion Flow Switch Cable - E00825:

The flow switch is SMARDT installed on the water box and wired to the control panel by the installation contractor. The IFM flow switch (Fig. 20) is standard, the Danfoss (Fig. 21) or Dwyer (Fig. 22) flow switches are options.

Figure 21: Flow Switch

Danfoss RT262A - Differential Pressure Flow Switch - P01026

Figure 22: Flow Switch

Dwyer - Differential Pressure Transmitter - P00239

HIGH PRESSURE & LOW PRESSURE SWITCHES

The High Pressure (HP) & Low Pressure (LP) switches provide an additional safety feature, which prevents overpressure or water freezing. The cut-off pressures for the HP and LP switches are as follows:

HP: 1200 kPa (174 psig) (≈ 60°C / 140°F), reset at 896 kPa (130 psig) (≈ 52°C / 125°F) (installed on discharge header)

LP: 179 kPa (26 psig) (≈ -1.7°C / 29°F), reset at 345 kPa (50 psig) (≈ 12.2°C / 54°F), (installed on the evaporator, except for low ambient/glycol applications, where the LP switch is not installed).

RELIEF VALVES

Ensure relief valves vent outside a building in accordance with national safety regulations and jurisdictional requirements. Concentrations of refrigerant in enclosed spaces can displace oxygen and lead to asphyxiation. Do not displace any safety devices.

RELIEF VALVE CHARACTERISTICS

The following table gives SMARDT Pressure Relief Valve parameters for the noted chiller model. Refer to SMARDT specification for other model specific values.

R134A SMARDT Chiller with Safety Master relief valves				
	EVAPORATOR		CONDENSER	
	Dual relief valves (2)		Dual relief valves (2)	
	Set pressure 1317 kPa (191 psig)		Set pressure 1317 kPa (191 psig)	
TAG	(C_r) min kg/min (lbs/min)	Outlet size (NPT)	(C_r) min kg/min (lbs/min)	Outlet size (NPT)
WA031.1BXX.44N	**14.0 (30.8)**	**25.4mm (1")**	**6.3 (13.9)**	**19mm (3/4")**

Table 10: Pressure Relief Valve Parameters

SMARDT Water Cooled chillers are supplied with dual pressure relief valves mounted on the evaporator. The valves are connected to a changeover manifold. Using a common body chamber that serves as the base for two independent relief valves, a system can remain fully operational when valves need to be serviced and replaced. When the chiller is in operation, ensure that only one relief valve is in operation at a time and that the service on the manifold is front or back seated.

All pressure relief valves on SMARDT chillers have been sized, selected and supplied in accordance with ASHRAE 15 and the ASME unfired pressure vessel code. All discharge rates are certified by the National Board of Boiler and Pressure Vessel Inpectors.

RELIEF VALVE APPLICATION

The ASHRAE 15 Safety Standard for Refrigeration Systems provides guidelines for sizing refrigerant relief valves and vent piping. Without attempting to provide a complete and thorough interpretation, this document provides the necessary data to properly determine piping requirements.

VENT LINE SIZING

Piping. ASHRAE 15-2004, Section 9.7.8 outlines acceptable relief piping locations and sizing. Summarized, the relief piping should vent R-134a refrigerant at least 15 feet above ground level and at least 20[1] feet from any window, ventilation opening, or building exit. The discharge piping should prevent a discharged refrigerant from being sprayed directly on personnel and prevent foreign material or debris from entering the piping. Additionally, discharge piping for a fusible plug or rupture disc shall have provisions to prevent plugging the pipe in the event of a discharge by the plug or disc.

As indicated in SMARDT Installation Instructions (Form 160.73-N1), each vent line must contain a dirt trap in the vertical section to allow collection and removal for any stack condensation or debris. The piping MUST be arranged to avoid strain on the relief valves - *SMARDT recommends the use of a flexible connector*. The vent line should be sized in accordance with ANSI/ASHRAE 15, and local codes, but should never be smaller than the relief valve outlet sizes provided in specific chiller documentation.

Common Header. ASHRAE 15 section 9.7.8.4 allows for multiple relief devices (on the same or multiple units) to be connected into a common line or header. The sizing of the common discharge header and vent piping for relief devices - expected to operate simultaneously - shall be based on the sum of their outlet areas, with due allowance for the pressure drop in all downstream sections and back-pressure

resulting from the discharge of multiple relief devices.

Maximum Length. ASHRAE 15 section 9.7.8.5 and Appendix H define the maximum length of discharge piping downstream of the pressure-relief device as:

$$L = \frac{0.2146 d^5 (P_0^2 - P_2^2)}{f C_r^2} - \frac{d \times \ln(P_0 / P_2)}{6 f}$$

[feet]Eq. (2)a

$$L = \frac{7.4381 \times 10^{-15} d^5 (P_0^2 - P_2^2)}{f C_r^2} - \frac{d \times \ln(P_0 / P_2)}{500 f}$$

[meters] Eq.(2)b

Where:

L = equivalent length of discharge piping, m (ft)
C_r = rated capacity as stamped on the device in kg/sec (lb/min)
f = moody friction factor in fully turbulent flow
d = inside diameter of pipe or tube, mm (inches)
ln = natural logarithm
P_2 = absolute pressure at the outlet of discharge piping, kPa (psia)
P_0 = allowed back pressure (absolute) at the outlet of pressure release device, kPa (psi) = (0.15 x relief valve set pressure + atmospheric pressure)

The ASHRAE 15 users manual states that when the length of the vent pipe exceeds approximately 220 diameters (L/d > 220), the first term in equation (2)a or (2)b may be used to solve for the diameter, d.

$$d = 1.36 \times \left(\frac{f L C_r^2}{P_0^2 - P_2^2} \right)^{0.2}$$ [inches] Eq. (3)a

$$d = 2521 \times \left(\frac{f L C_r^2}{P_0^2 - P_2^2} \right)^{0.2}$$ [millimeters] Eq. (3)b

An average friction factor f = 0.02, may be used when the pipe size is not known.

This section on the discharge vent line is to be used as a guide only. For a complete description of the relief valve vent line sizing, please refer to ASHRAE Standard 15 or local overriding codes.

[1]CSAB-52 requires 25' from any opening.

CONTROLS

SPECIFICATIONS - GEN 3

The SMARDT Chiller Controller Software is available for both KILTECH & CAREL Control Hardware.

SMARDT Chiller Control solutions are ready to use control interfaces and I/O devices, developed specifically for Turbocor™ chiller applications.

DESCRIPTION	Manufacturer	MODEL#
Full color touch panel graphical chiller control system	Kiltech Inc	KCT 1000

Features/ Benefits

- Enhanced energy efficiency capabilities, utilizing the latest compressor optimization technologies
- Remote monitoring - via web to obtain real time energy / performance data and system interrogation
- Panel mount 10.4" TFT Color Touch Screen Displays available
- Modular Input / Output devices – allowing for simple expansion
- User friendly navigation and trending capabilities
- Engineered solution – allows for quick and simple installation and commissioning.
- Live updates / system configuration functionality.
- Variable speed condenser controls.
- In built stepper motor controls for EXV's.
- Continuous data logging – 1 year of data stored on device in easy to use .csv format.
- Logging of 32,000 chiller and compressor faults and events.

Operating System

- Custom, real time O/S
- Memory - 100 MB (application specific)

Graphic Terminal

- Colour, SVGA TFT LCD, with resistive type touch screen
- Resolution – 800 x 600
- Luminance – 400 nits (suitable for exterior use)
- Power Supply 110 VAC
- 25vA max

Inputs and Outputs

- Thermistor Inputs (10K NTC) – Qty. 8
- Digital Inputs (Voltage Free) - Qty. 8
- Analogue Inputs (4-20mA or 0-10V) – Qty. 8
- Digital Outputs (Relay) – Qty. 8
- Analogue Outputs (0-10VDC) – Qty. 6
- EXV Output-Bipolar Stepper Motor Drive

BAS Protocols

- ModbusTM, TCP/IP module
- ModbusTM, RTU RS485 module
- LonTalk®, FT-10 module
- BacNetTM, MSTP module
- BacNetTM, IP module

Physical Dimensions

- Enclosure – 16" x 24"
- Color – White, enamel (gloss)
- Weight – 45 Lbs

Environment

- Operating range: 0° - 50°C (32° - 122°F)
- Storage range: -10° - 70°C (14° - 158°F)
- Relative humidity: 5 - 95% RH - non condensing

SPECIFICATIONS - GEN 4

The SMARDT Chiller Controller Software is available for KILTECH Control Hardware.

SMARDT Chiller Control solutions are ready to use control interfaces and I/O devices developed specifically for Turbocor™ chiller applications.

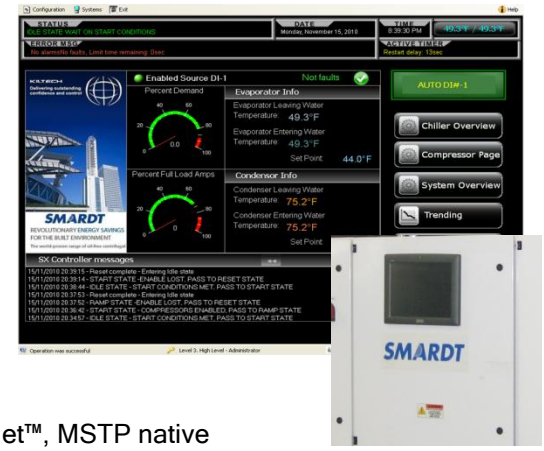
DESCRIPTION	Manufacturer	MODEL#
Full color touch panel graphical chiller control system	Kiltech Inc	190250

Features/ Benefits

- Enhanced energy efficiency capabilities, utilizing the latest compressor optimization technologies
- Remote monitoring - via web to obtain real time energy / performance data and system interrogation
- Panel mount 12.0" TFT Color Touch Screen Displays available
- Modular Input / Output devices – allowing for simple expansion
- User friendly navigation and trending capabilities
- Engineered solution – allows for quick and simple installation and commissioning
- Live updates / system configuration functionality
- Variable speed condenser fan controls
- Built in stepper motor controls for EXV's
- Continuous data logging – 1 year of data stored on device in easy to use .csv format
- Logging of 32,000 chiller and compressor faults and events

Operating System

- Custom, real time O/S
- System Memory -128/256 MB DDR2 (application specific)
- Flash Drive – 128 MB MSTI Embeded Disk Module



Graphic Terminal

- AFL – 12A – N270
- Intel Atom™ Processor
- 1GB 533 DDR2 SD RAM
- Touch Screen
- Max Resolution – 1024 x 768
- Brightness – (cd/m2) 500 (suitable for exterior use)
- Power Supply 110 VAC

Inputs and Outputs

- Thermistor Inputs (10K NTC) – Qty. 8
- Digital Inputs (Voltage Free) - Qty. 24
- Analogue Inputs (4-20mA or 0-10V) – Qty.
- Digital Outputs (Relay) – Qty. 12
- Analogue Outputs (0-10VDC) – Qty. 6
- EXV Output: Bipolar Stepper Motor Drive

BAS Protocols

- Modbus™, TCP/IP native
- Modbus™, RTU RS485
- LonTalk®, FT-10 module
- BacNet™, MSTP native
- BacNet™, IP native

Physical Details

- Enclosure – 26" x 30" x 6"
- Color – White, enamel (gloss)
- Weight – 60 Lbs

Environment

- Operating range: 0° - 50°C (32° - 122°F)
- Storage range: -20° - 60°C (-4° - 140°F)
- Relative humidity: 5 - 95% RH - non-condensing.

CONTROLS WIRING - GEN 3

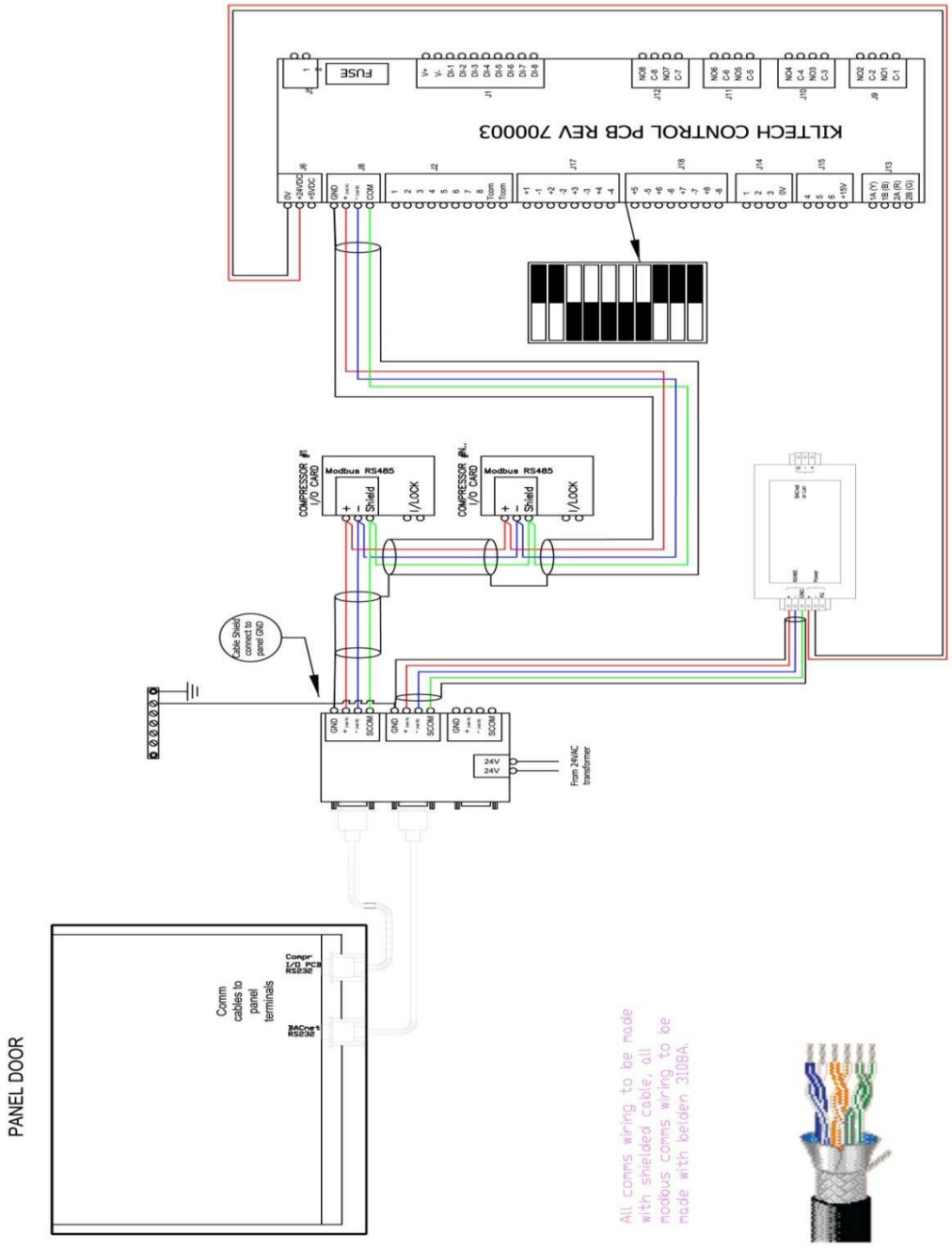


Figure 23: G3 Controls Wiring Diagram – Optical Isolated Converter – G3 Touch Panel

CONTROLS WIRING - GEN 4

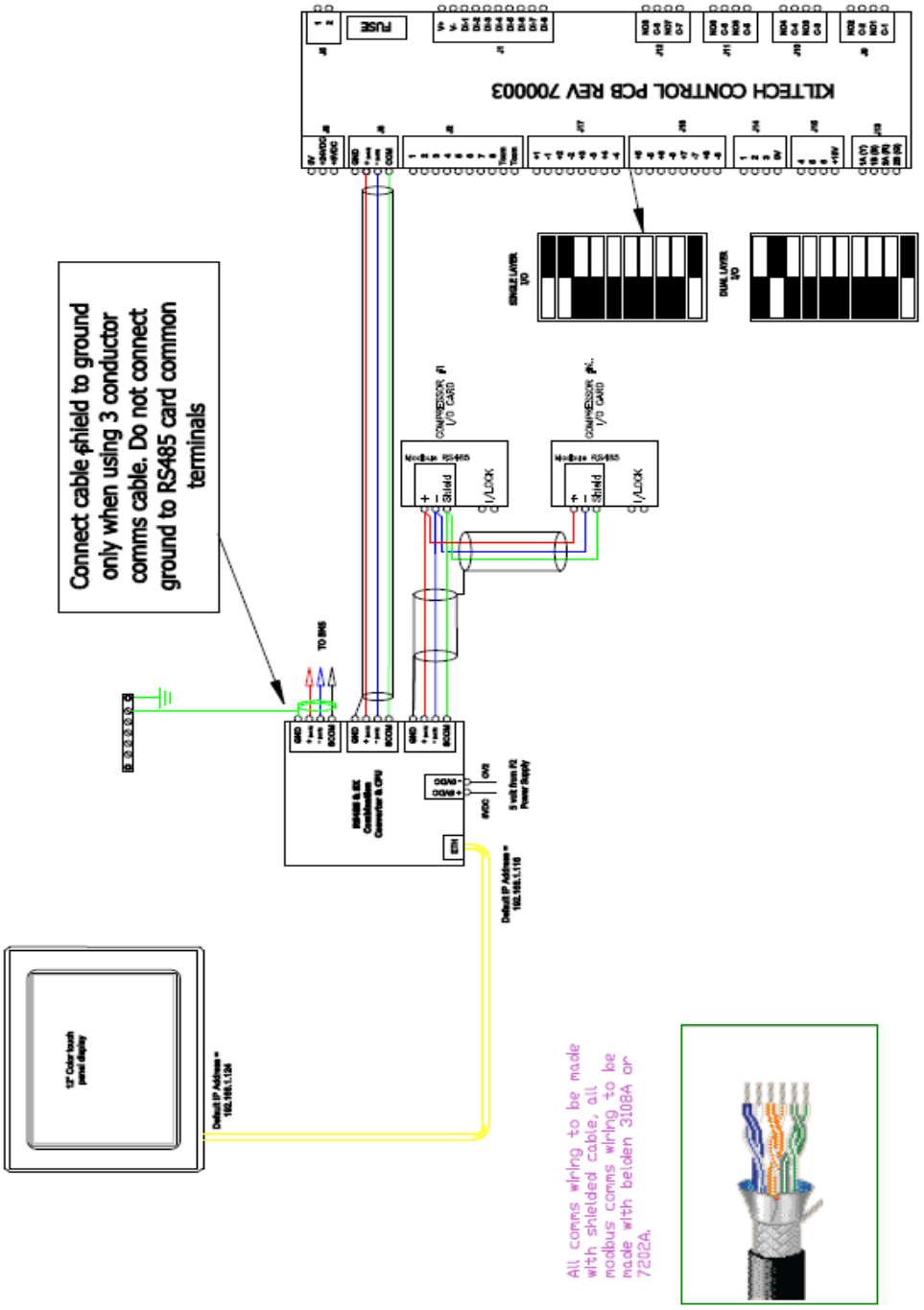


Figure 24: G4 Controls Wiring Diagram - Optical Isolated Converter - G4 Touch Panel

CONTROL PANEL WIRING

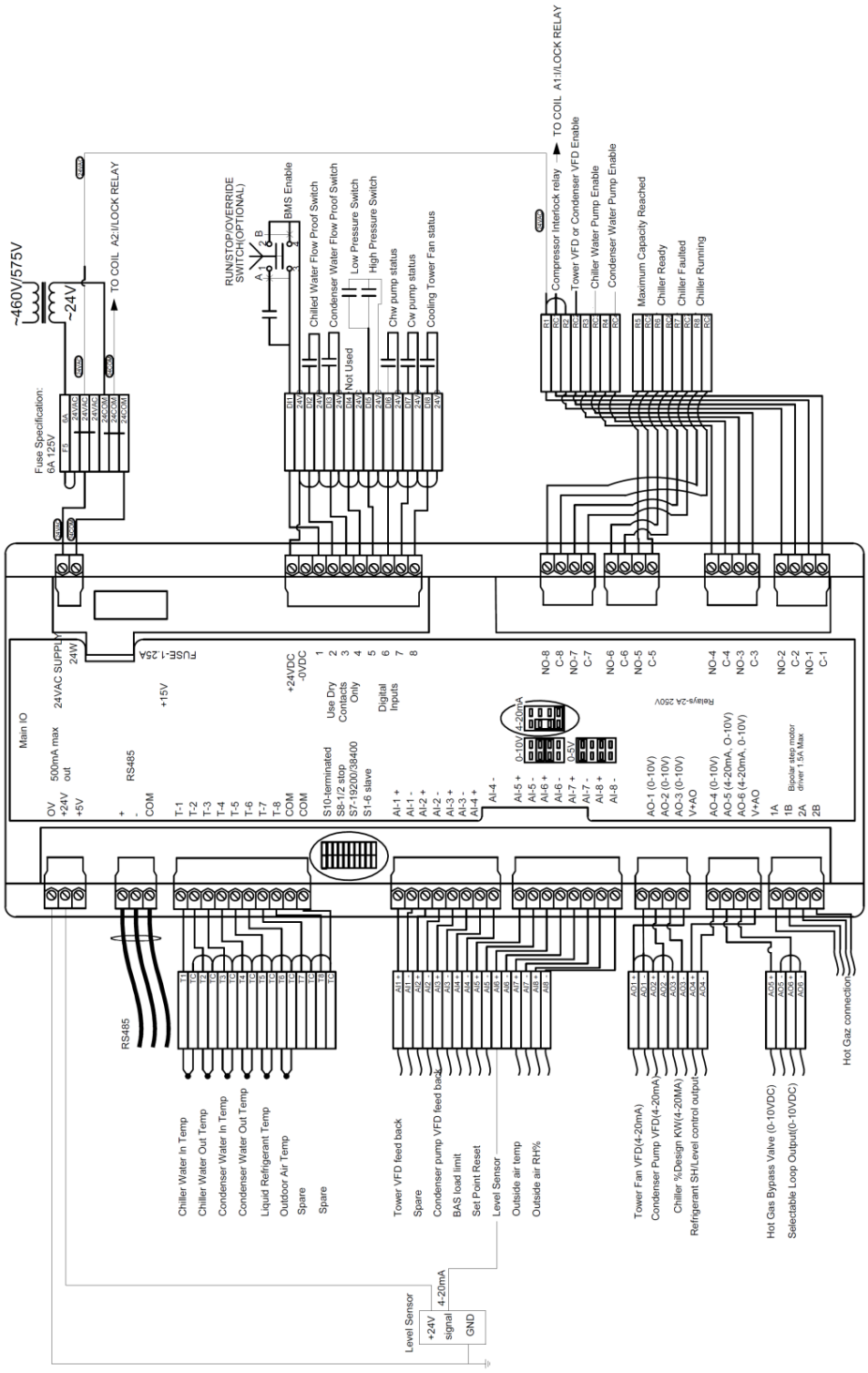


Figure 25: Control Panel Wiring Schematic – 460V/575V

Control Panel Wiring (cont'd)

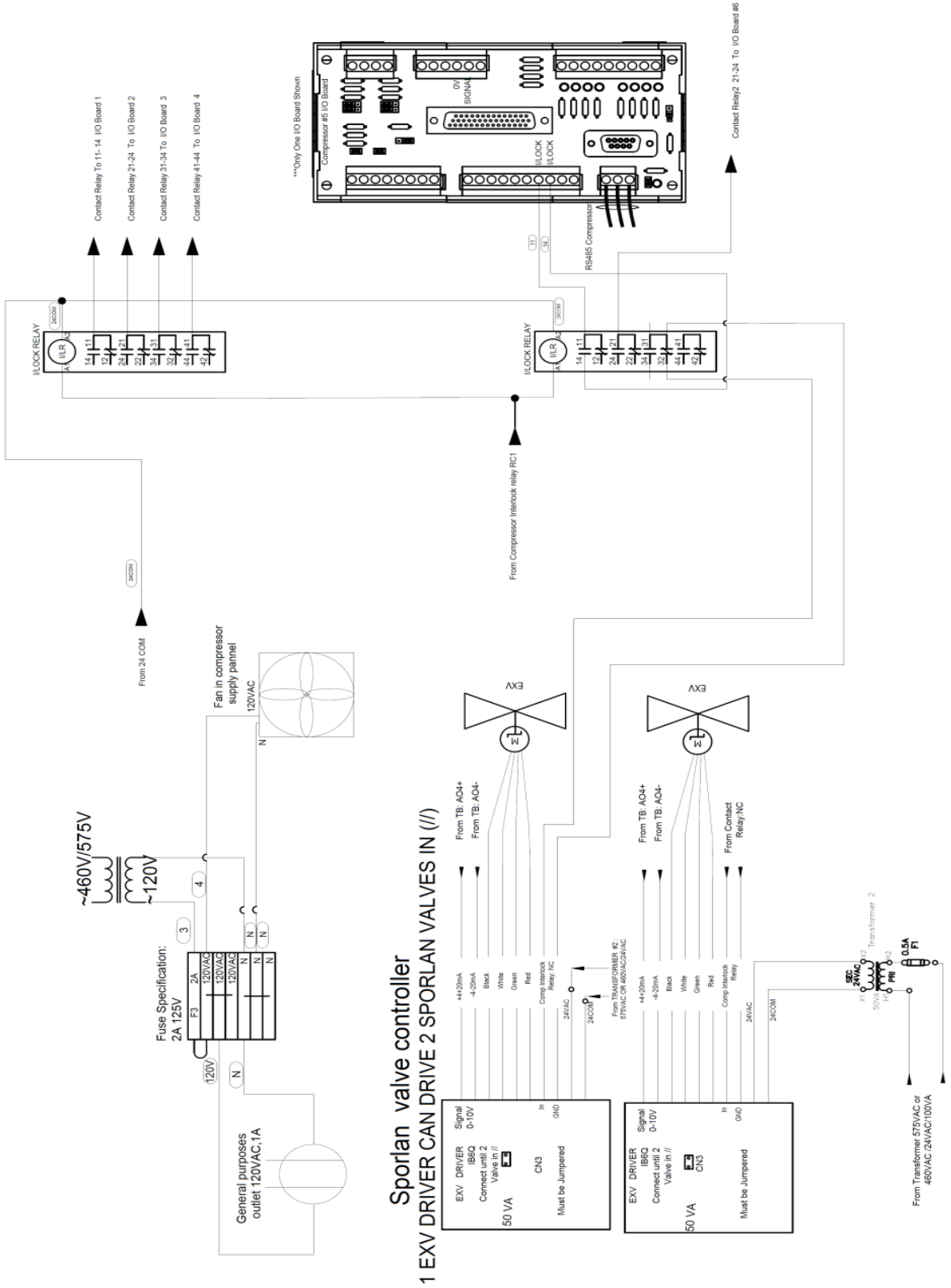


Figure 25: Control Panel Wiring Schematic (cont'd) - 460V/575V

FIELD WIRING

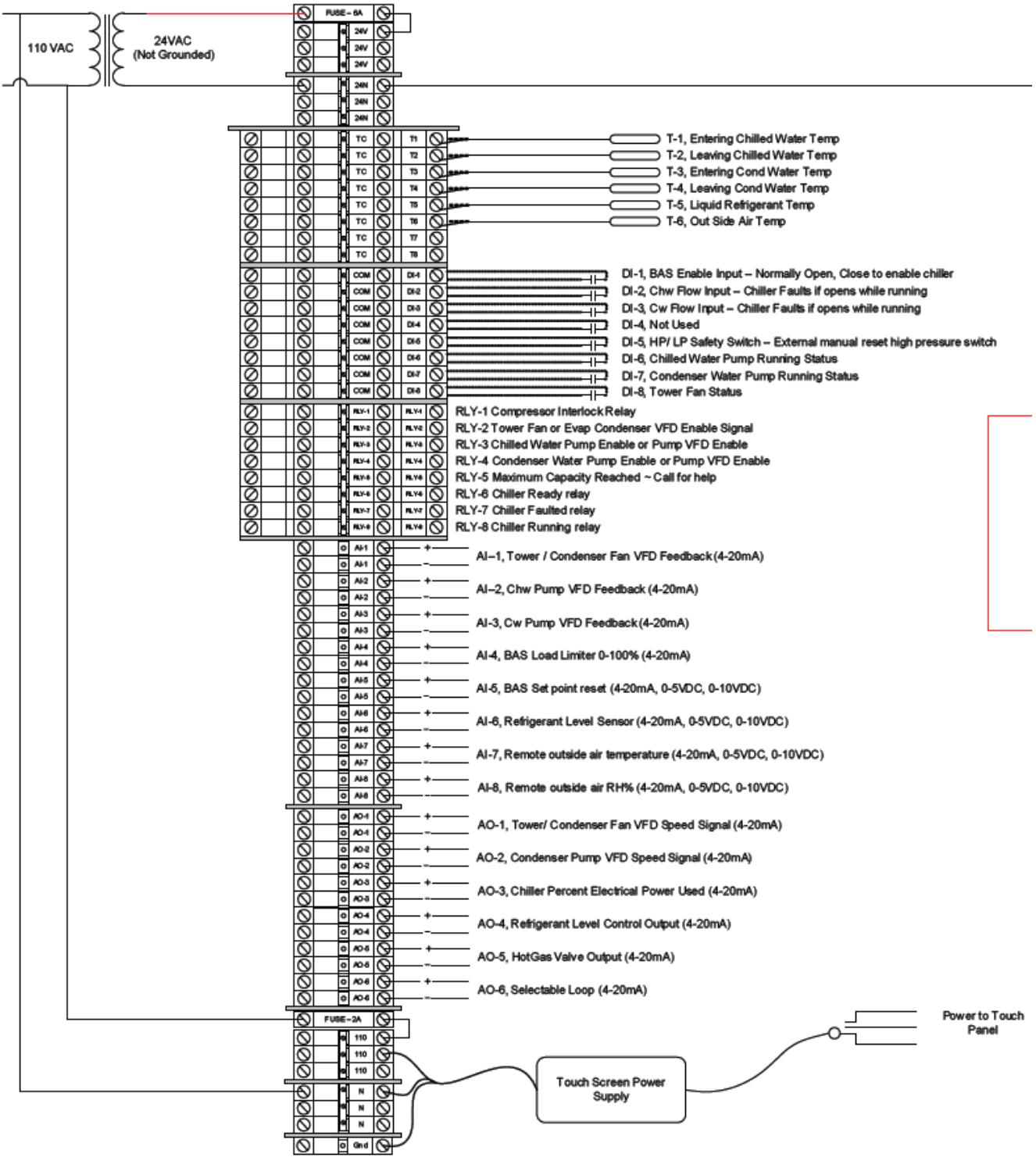


Figure 26: Field Wiring Terminations

CONTROLS I/O POINT FUNCTIONALITY

The water cooled chiller control program in the KILTECH control system is applicable to flooded water cooled chillers with one or two refrigerant circuits and a chilled water circuit. The software is configurable for up to six Turbocor™ compressors on a SMARDT chiller.

Gen #3, Configuration #:10400 - Water Chiller – Full Function

Temperature Inputs (TI)	Function
TI1 Chilled Water In Temp	Used for leaving chilled water control and monitoring of the chiller. Low leaving chilled water fault and high evaporator ΔT faults may be generated from this sensor‘s reading.
TI2 Chilled Water Out Temp	Used to monitor inlet chilled water. High evaporator ΔT faults may be generated from this sensor’s reading.
TI3 Condenser Water In Temp	Used for condenser water control and monitoring. Condenser control algorithm for variable speed cooling tower fan and variable speed condenser water pump, use this temperature as feedback.
TI4 Condenser Water Out Temp	Used for monitoring only.
TI5 Liquid Refrigerant Temp (Condenser liquid)	Used for monitoring only.
TI6 Outdoor Air Temp	Used for monitoring and control. Variable speed water cooled condenser loop uses this value, along with outside air relative humidity to calculate wet bulb temperature.
TI7 Spare	No function.
TI8 Spare	No function.
Digital Inputs (DI)	**Function**
DI1 Chiller Enable	Enables and disables the chiller via a set of volt free contacts, provided via a BAS or remote signal.
DI2 Chilled Water Flow Proof	Monitors chilled water flow status through chiller barrel. If status turns false while chiller is running, a “no chilled water flow fault” is generated and chiller is stopped.
DI3 Condenser Water Flow Proof	Monitors condenser water flow status through chiller barrel. If status turns false while chiller is still running, a “no condenser water flow fault” is generated and chiller is stopped.
DI4 LP Switch	Monitors digital input for a closure of a chiller LP switch. A chiller fault is stopped on a “pressure safety cutout fault” if input circuit is closed.
DI5 HP Switch	Monitors digital input for closure of chiller HP switch. A chiller fault is stopped on a “pressure safety cutout fault” if input circuit is closed.

DI6 Spare	
DI7 Spare	
DI8 Chilled Water Pump #1 Status	Monitors chilled water pump status. May be connected to auxiliary contact of chilled water pump contactor or VFD status.
DI9 Chilled Water Pump #2 Status	Monitors chilled water pump status. May be connected to auxiliary contact of chilled water pump contactor or VFD status. For chillers with two pumps.
DI10 Condenser Water Pump #1 Status	
DI11 Condenser Water Pump #2 Status	
DI12 Cooling Tower Fan #1 Status	
DI13 Cooling Tower Fan #2 Status	
DI14 Refrigerant Monitor	Safety device for leak detection. Customer supplied.
DI15 Spare	
DI16 Condenser Rupture Disc -1	
DI17 Condenser Rupture Disc -2	
DI18 Evaporator Rupture Disc -1	Optional input to monitor refrigerant rupture disk.
DI19 Evaporator Rupture Disc -2	Optional input to monitor refrigerant rupture disk.
DI20 Chilled Water Isolation Valve EPS	Optional input used when multiple chillers are connected to a common header. Used to monitor when one chiller is removed from chilled water loop.
DI21 Condenser Water Isolation Valve EPS	
DI22 Generator Power On	Optional input used to monitor when chiller is sequenced to stand by power source.
DI23 Generator Switch Request	Optional input used to indicate when request for stand power is initiated.
DI24 E Stop	Optional mechanical push button that can be mounted onto control panel. Used to stop chiller in emergency situation.
Digital Outputs (DO)	**Function**
DO1 Compressor Interlock	Relay enables and disables a variable speed fan, output is enabled when chiller starts to run and condensing temperature is above the minimum temperature limit setting in controller.
DO2 Tower Fan #1 Enable	
DO3 Tower Fan #2 Enable	
DO4 Chilled Water Pump #1 Enable	Used to enable external pump #1.
DO5 Chilled Water Pump #2 Enable	Used to enable external pump #2.
DO6 Condenser Water Pump #1 Enable	

DO7 Condenser Water Pump #2 Enable	
DO8 Call Next Chiller	
DO9 Chiller Ready	
DO10 Chiller Run	
DO11 Spare	
DO12 Chiller Fault SPDT	Signals BAS when chiller is faulted.
Analogue Outputs (AO)	**Function**
AO1 Tower VFD (0-10V)	Variable speed control signal for cooling tower fan. Signal is generated from condenser control loop.
AO2 Tower Bypass Valve (0-10V)	
AO3 Chiller % Design kW (0-10V)	Output indicates current percentage of chiller capacity. The design kW are defined as the electrical power consumption and the full load design point of the chiller.
AO4 EXV Position (0-10V)	Output to control an electronic expansion valve from a refrigerant level sensor or suction super heat (SSH) measurement. Control output is generated from chiller controller EXV control loop.
AO5 Hot-gas Valve (0-10V)	Output to control an electronic hot-gas bypass valve. The hot-gas valve is used for three purposes: Low load capacity control Pressure ratio assistance for starting compressors High discharge pressure avoidance.
AO6 Spare	
AO7 Compressor Bypass - 1	Staging valve control signal
AO8 Compressor Bypass - 2	Staging valve control signal
AO9 Compressor Bypass - 3	Staging valve control signal
AO10 Compressor Bypass - 4	Staging valve control signal
AO11 Compressor Bypass - 5	Staging valve control signal
AO12 Compressor Bypass - 6	Staging valve control signal
Analogue Inputs (AI)	**Function**
AI1 Chilled Water dP (0-10 psi)	Monitors pressure signal from dP switch.
AI2 Condenser Water dP (0-10 psi)	
AI3 BAS Demand Limit	Input to limit the demand output control to the compressors. 4mA input = no demand limiting, 20mA = full demand limiting to 25%.
AI4 Set Point Reset	Input receives signal from BAS to reset the chilled water temperature set point. Scaling for the set point reset is configured on controller touch panel.
AI5 Spare	
AI6 Liquid Level -1	Input to receive a signal from a refrigerant level sensor connected to either the chiller evaporator

	or condenser. This sensor is used to control the electronic expansion output.
AI7 Condenser Pressure	Input signal to monitor condenser pressure.
AI8 Spare	

Table 11: Controls I/O Point Functionality

Gen #4, Configuration #: 20400 – Water Chiller - One Refrigerant Circuit, Bypass Valves – Full Function

Temperature Inputs (TI)	Function
TI1 Chilled Water In Temp	Used for leaving chilled water control and monitoring of the chiller. Low leaving chilled water fault and high evaporator ΔT faults may be generated from this sensor's reading.
TI2 Chilled Water Out Temp	Used to monitor inlet chilled water. High evaporator ΔT faults may be generated from this sensor's reading.
TI3 Condenser Water In Temp	Used for condenser water control and monitoring. Condenser control algorithm for variable speed cooling tower fan and variable speed condenser water pump, use this temperature as feedback.
TI4 Condenser Water Out Temp	Used for monitoring only.
TI5 Liquid Refrigerant Temp (Condenser liquid)	Used for monitoring only.
TI6 Outdoor Air Temp	Used for monitoring and control. Variable speed water cooled condenser loop uses this value, along with outside air relative humidity to calculate wet bulb temperature.
TI7 Spare	No function.
TI8 Spare	No function.
Digital Inputs (DI)	**Function**
DI1 Chiller Enable	Enables and disables the chiller via a set of volt free contacts, provided via a BAS or remote signal.
DI2 Chilled Water Flow Proof	Monitors chilled water flow status through chiller barrel. If status turns false while chiller is running, a "no chilled water flow fault" is generated and chiller is stopped.
DI3 Condenser Water Flow Proof	Monitors condenser water flow status through chiller barrel. If status turns false while chiller is still running, a "no condenser water flow fault" is generated and chiller is stopped.
DI4 LP Switch	Monitors digital input for a closure of a chiller LP switch. A chiller fault is stopped on a "pressure safety cutout fault" if input circuit is closed.
DI5 HP Switch	Monitors digital input for closure of chiller HP switch. A chiller fault is stopped on a "pressure safety cutout fault" if input circuit is closed.
DI6 Spare	
DI7 Spare	
DI8 Chilled Water Pump #1 Status	Monitors chilled water pump status. May be connected to auxiliary contact of chilled water pump contactor or VFD status.
DI9 Chilled Water Pump #2 Status	Monitors chilled water pump status. May be

	connected to auxiliary contact of chilled water pump contactor or VFD status. For chillers with two pumps.
DI10 Condenser Water Pump #1 Status	
DI11 Condenser Water Pump #2 Status	
DI12 Cooling Tower Fan #1 Status	
DI13 Cooling Tower Fan #2 Status	
DI14 Refrigerant Monitor	Safety device for leak detection. Customer supplied.
DI15 Spare	
DI16 Condenser Rupture Disc -1	
DI17 Condenser Rupture Disc -2	
DI18 Evaporator Rupture Disc -1	Optional input to monitor refrigerant rupture disk.
DI19 Evaporator Rupture Disc -2	Optional input to monitor refrigerant rupture disk.
DI20 Chilled Water Isolation Valve EPS	Optional input used when multiple chillers are connected to a common header. Used to monitor when one chiller is removed from chilled water loop.
DI21 Condenser Water Isolation Valve EPS	
DI22 Generator Power On	Optional input used to monitor when chiller is sequenced to stand by power source.
DI23 Generator Switch Request	Optional input used to indicate when request for stand power is initiated.
DI24 E Stop	Optional mechanical push button that can be mounted onto control panel. Used to stop chiller in emergency situation.
Digital Outputs (DO)	**Function**
DO1 Compressor Interlock	Relay enables and disables a variable speed fan, output is enabled when chiller starts to run and condensing temperature is above the minimum temperature limit setting in controller.
DO2 Tower Fan #1 Enable	
DO3 Tower Fan #2 Enable	
DO4 Chilled Water Pump #1 Enable	Used to enable external pump #1.
DO5 Chilled Water Pump #2 Enable	Used to enable external pump #2.
DO6 Condenser Water Pump #1 Enable	
DO7 Condenser Water Pump #2 Enable	
DO8 Call Next Chiller	
DO9 Chiller Ready	
DO10 Chiller Running	

DO11 Spare	
DO12 Chiller Fault SPDT	Signals BAS when chiller is faulted.
Analogue Outputs (AO)	**Function**
AO1 Tower VFD (0-10V)	Variable speed control signal for cooling tower fan. Signal is generated from condenser control loop.
AO2 Tower Bypass Valve (0-10V)	
AO3 Chiller % Design kW (0-10V)	Output indicates current percentage of chiller capacity. The design kW are defined as the electrical power consumption and the full load design point of the chiller.
AO4 EXV Position (0-10V)	Output to control an electronic expansion valve from a refrigerant level sensor or suction super heat (SSH) measurement. Control output is generated from chiller controller EXV control loop.
AO5 Hot-gas Valve (0-10V)	Output to control an electronic hot-gas bypass valve. The hot-gas valve is used for three purposes: Low load capacity control Pressure ratio assistance for starting compressors High discharge pressure avoidance.
AO6 Spare	
AO7 Compressor Bypass - 1	Staging valve control signal
AO8 Compressor Bypass - 2	Staging valve control signal
AO9 Compressor Bypass - 3	Staging valve control signal
AO10 Compressor Bypass - 4	Staging valve control signal
AO11 Compressor Bypass - 5	Staging valve control signal
AO12 Compressor Bypass - 6	Staging valve control signal
Analogue Inputs (AI)	**Function**
AI1 Chilled Water dP (0-10 psi)	Monitors pressure signal from dP switch.
AI2 Condenser Water dP (0-10 psi)	
AI3 BAS Demand Limit	Input to limit the demand output control to the compressors. 4mA input = no demand limiting, 20mA = full demand limiting to 25%.
AI4 Set Point Reset	Input receives signal from BAS to reset the chilled water temperature set point. Scaling for the set point reset is configured on controller touch panel.
AI5 Spare	
AI6 Liquid Level -1	Input to receive a signal from a refrigerant level sensor connected to either the chiller evaporator or condenser. This sensor is used to control the electronic expansion output.
AI7 Condenser Pressure	Input signal to monitor condenser pressure.
AI8 Spare	

Table 12: Controls I/O Point Functionality

SEQUENCE OF OPERATION

General
The graphical chiller control system is responsible for providing demand to compressors, staging on and off compressors, control of electronic expansion valves, control of load balance valves, alarm condition avoidance and fault detection/shutdown.

In order to run the chiller, the following field installed inputs must be made:

DI-1 BAS enable – Start command

DI-2 Chilled water flow proof

DI-3 Condenser water flow proof

Bridge emergency stop with corresponding digital input

Bridge leak detector status with corresponding digital input

For physical wiring locations of inputs see “Control Wiring Diagram – Field Connections” section of submittal.

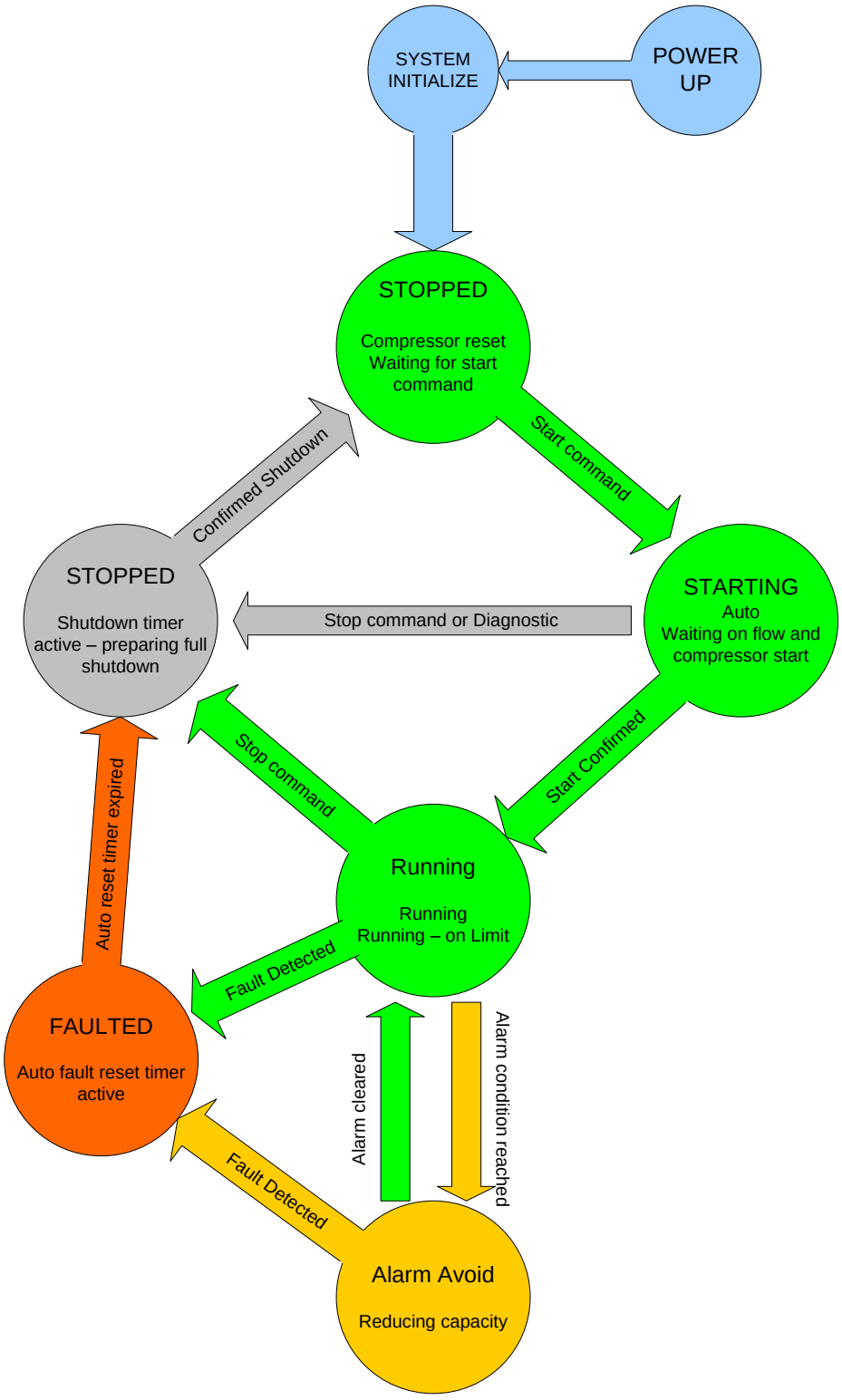


Figure 27: Sequence of Operation

POWER UP TO RUNNING

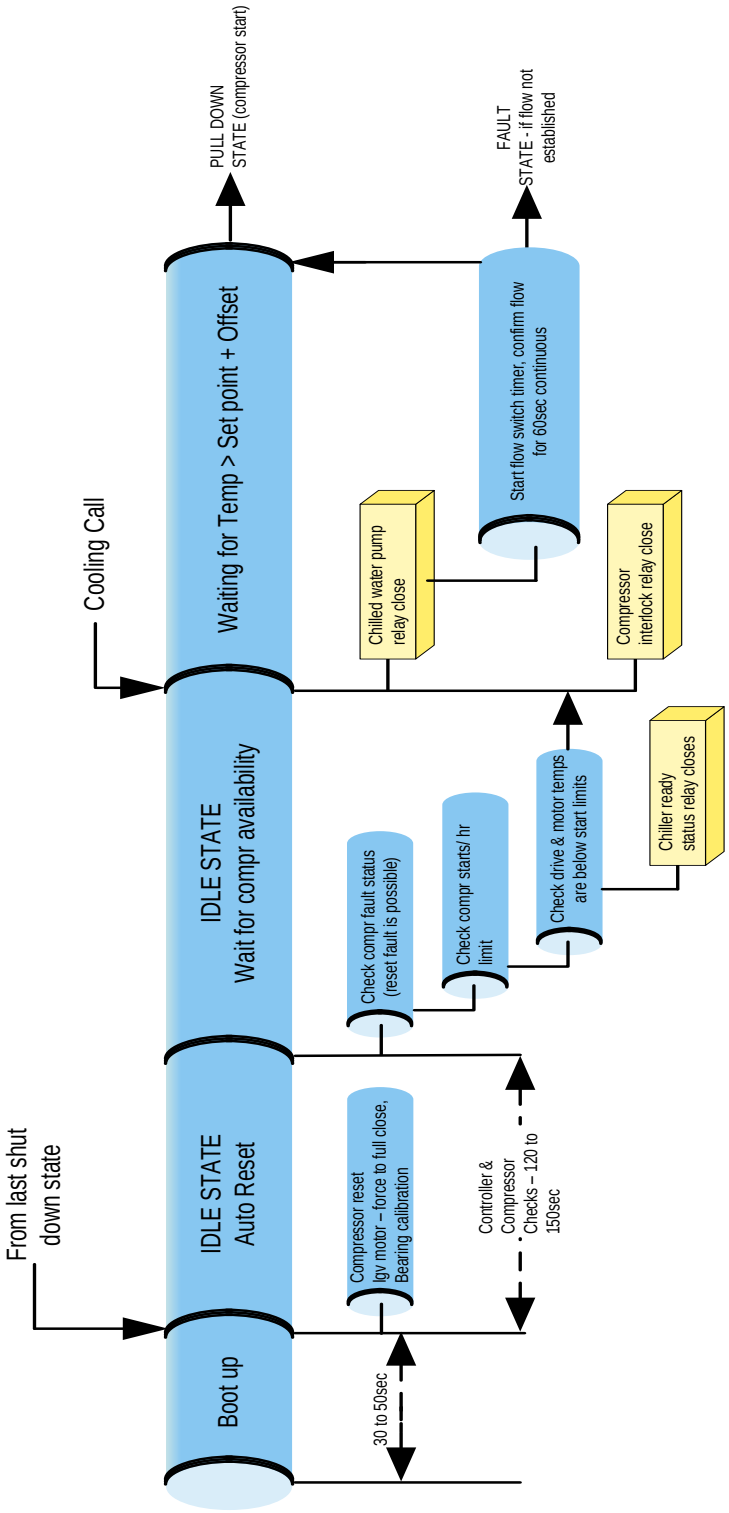


Figure 28: Power Up to Running

TEMPERATURE PULL DOWN AND NORMAL RUNNING

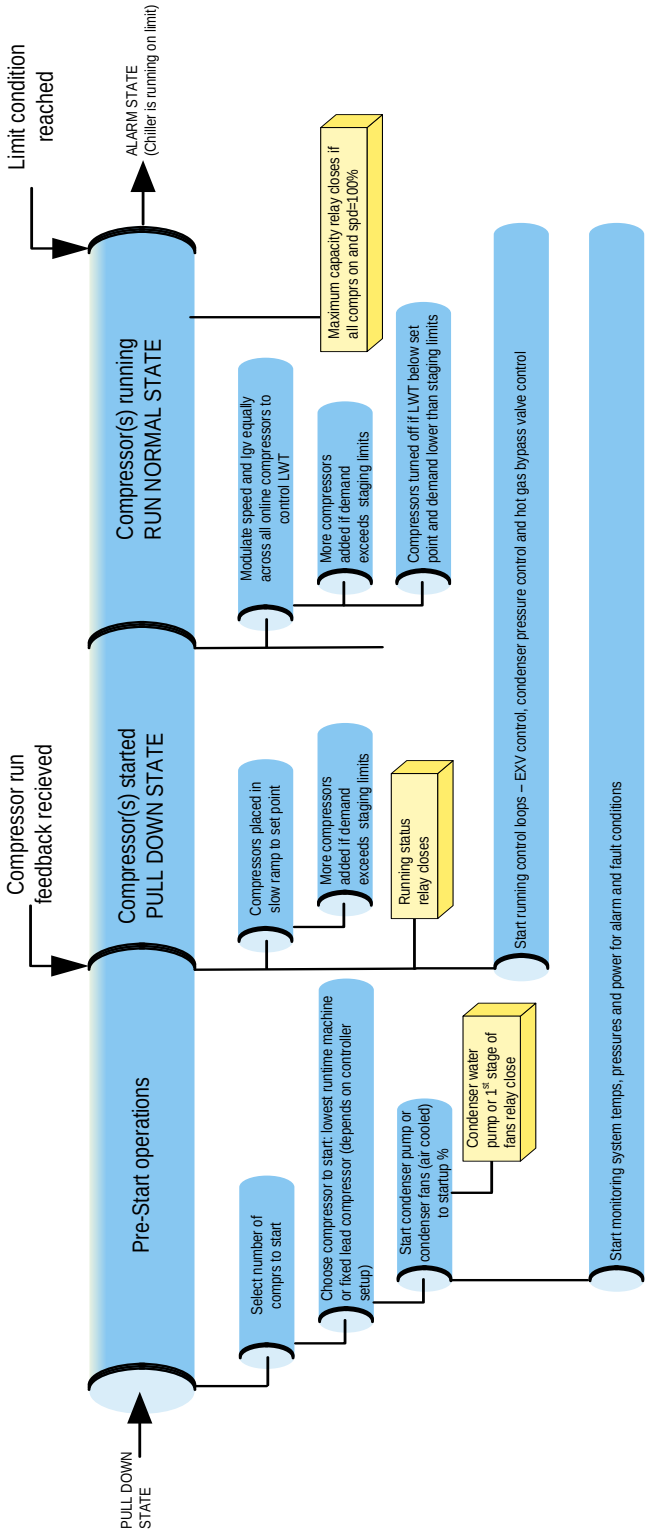


Figure 29: Temperature Pull Down and Normal Running

RUNNING WITH AN ALARM LIMIT (FAULT AVOIDANCE)

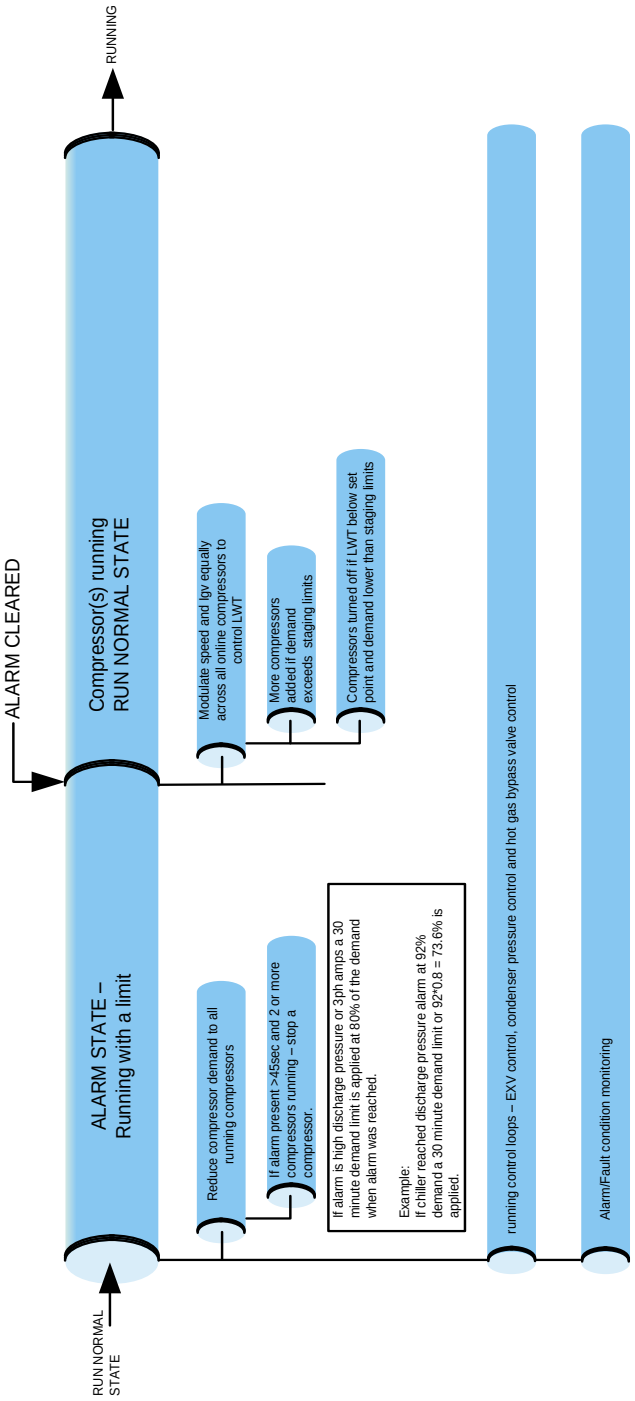


Figure 30: Running with an Alarm Limit (Fault Avoidance)

NORMAL SHUT DOWN

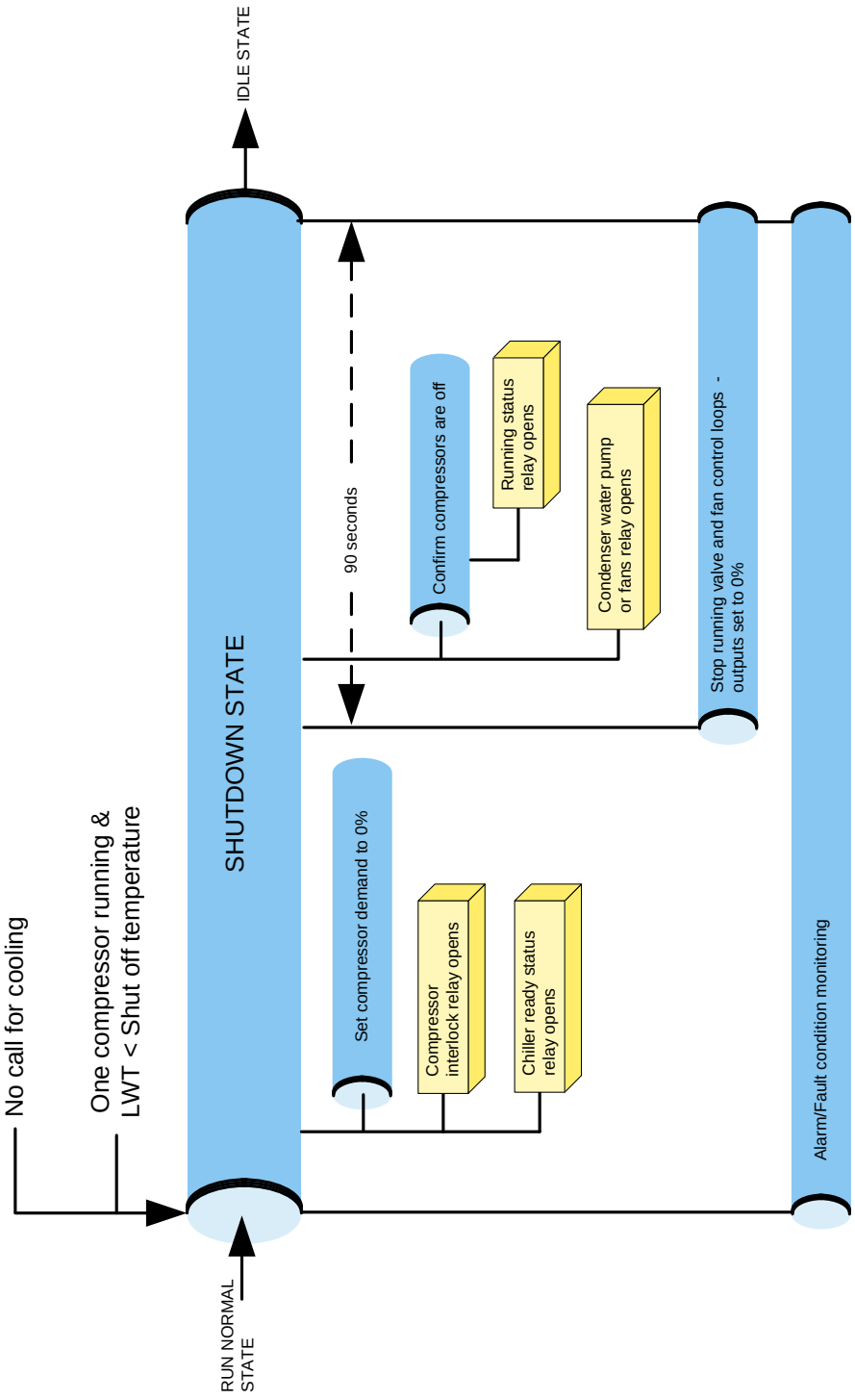


Figure 31: Normal Shut Down

ABNORMAL SHUT DOWN (FAULT PRESENT)

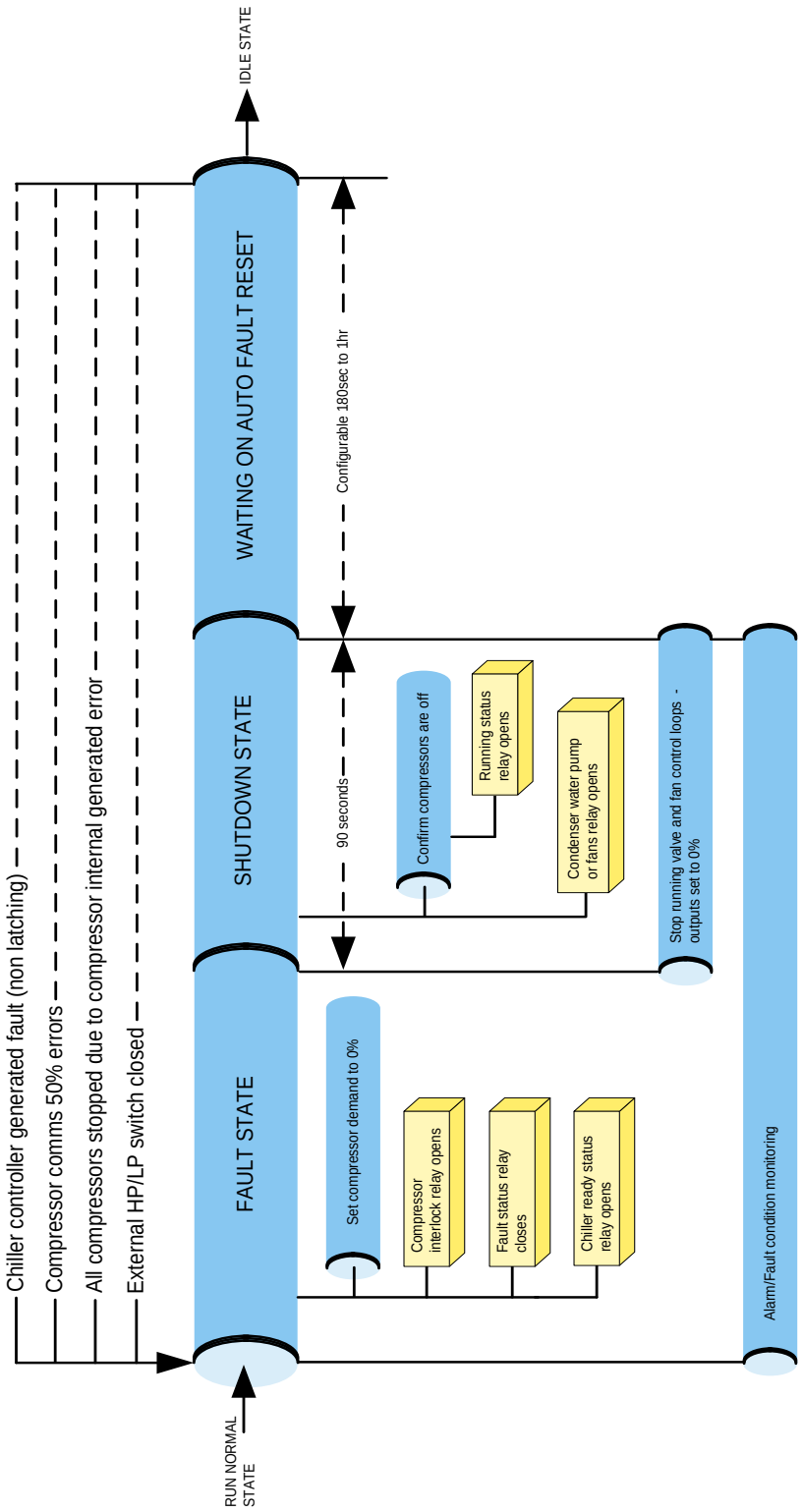


Figure 32: Abnormal Shut Down (Fault Present)

MAINTENANCE

MAINTENANCE PROCEDURES

Maintenance of the SMARDT line of oil free chillers may be divided into six categories:

- **Compressor Maintenance**
- **Condenser Barrel Maintenance**
- **Cleaning Instructions**
- **Evaporator Barrel Maintenance**
- **Component Maintenance**
- **Maintenance Inspections**

COMPRESSOR MAINTENANCE

The oil-free magnetic bearing technology in the compressor, provides quiet and reliable operation, and reduces maintenance and reliability issues.

The following should be observed:

- A full leak test of the compressor should be periodically performed; this includes powering down the compressor and checking the o-rings around the inverter cooling plate and motor terminals.
- Once every ten years, the DC bus capacitors must be replaced.
- During routine maintenance, manually check that the inlet guide vanes are moving freely from 0% to 110%.
- Check against a calibrated gauge or temperature sensor, that the suction and discharge temperature/pressure sensors on the compressor are correct.
- Download all compressor fault and event logs, and identify any repeat errors.
- For Danfoss Turbocor™ Compressor information, please ref. www.turbocor.com

CONDENSER TUBE MAINTENANCE

In order to maintain the optimum condition of the condenser heat transfer surfaces, proper water treatment is of the utmost importance, and maintaining monthly chiller operational logs and monitoring any possible condenser approach temperature changes, will give a good indication of when the condenser may require cleaning.

If the condenser or evaporator tubes require cleaning in order to remove sludge and other loose material, SMARDT suggests the use of a light detergent, and a round nylon or bristle brush attached to a rod, which should be moved in a reciprocal motion in and out of the tubes, followed by flushing with clean water.

Condenser Barrel Freeze Protection - While Off-line During Winter Months:

To protect the heat exchanger during freezing conditions, when ambient temperatures fall below zero (0°C / 32°F) and the unit is “not on duty”, it is the chiller owner’s responsibility to ensure that the following storage freeze protection procedure is followed:

1. All water is drained from the barrel,
   or
2. The barrel is filled with an appropriate glycol solution which will prevent freezing in local conditions.

CLEANING INSTRUCTIONS

CAUTION

Never use an acid-based cleaner.

Clean the inside tube surfaces at least every six months. More frequent cleaning may be required if extreme conditions cause clogging or fouling of tubes. Use a non-acidic, non-toxic, fully biodegradable alkaline detergent or equivalent.

Use non-metallic brushes to clean tubes.

It is important to keep monthly chiller operation logs, recording the load of the chiller, water temperature, discharge pressure and the power input of the chiller. Any major changes in condenser approach or discharge pressure should be noted and a tube cleaning should be undertaken.

EVAPORATOR BARREL MAINTENANCE

In most cases the evaporator is part of a closed water circuit and therefore should not accumulate as much scale or sludge as a condenser barrel. In order to maintain the optimum condition of the evaporator heat transfer surfaces, proper water treatment is of the utmost importance, and maintaining monthly chiller operational logs and monitoring any possible evaporator approach temperature changes, will give a good indication of when the evaporator may require cleaning.

If the evaporator tubes require cleaning in order to remove sludge and other loose material, SMARDT suggests the use of a light detergent, and a round nylon or bristle brush attached to a rod, which should be moved in a reciprocal motion in and out of the tubes, followed by flushing with clean water.

Evaporator Barrel Freeze Protection - While Off-line During Winter Months:

To protect the heat exchanger during freezing conditions, when ambient temperatures fall below zero (0°C / 32°F) and the unit is “not on duty”, it is the chiller owner’s responsibility to ensure that the following storage freeze protection procedure is followed:

3. All water is drained from the barrel,
   or
4. The barrel is filled with an appropriate glycol solution which will prevent freezing in local conditions.

COMPONENT MAINTENANCE

Electrical

Check for any visible hot spots, discoloration of bus bars, connections or wiring insulation, and whenever possible, use an infra-red camera or temperature gun for best detection.

With chiller power off, verify that all electrical connections are secure and not loose.

Valves

Refrigerant Valves

Check for potential refrigerant valve leaks and ensure that valves close effectively.

Water Valves

Check for potential water valve leaks and ensure that valves close effectively. If excessive corrosion is observed, replace valves.

Temperature Sensors

Prior to use, all temperature sensors should be calibrated in a bucket of chilled water at 0 deg. C.

Temperature / Pressure Sensors

See Danfoss Turbocor™ Manual

Temperature Side: Make a comparison between the temperature reading of the compressor as indicated by the Danfoss Turbocor™ monitoring software, and the actual temperature reading as detected by a technician's hand held multi-meter. A difference of approx 5 deg. F is permissible. If a discrepancy is observed, contact SMARDT's Product Support for information on further tests to be carried out.

Pressure Side: Make a comparison between the compressor pressure reading as indicated by the Danfoss Turbocor™ monitoring software, and the actual pressure reading as detected by technician's hand held set of gauges. Care should be taken to make a difference between absolute value and gauge value. Differences can be as much as approx 14.7 psi. If a discrepancy is observed, contact SMARDT's Product Support for information on further tests to be carried out.

MAINTENANCE INSPECTIONS

SMARDT recommends that owner operators:

- Report any damage to the chiller set.
- Report any faults that occur with the chiller set.
- Turn off the chiller if fault condition persists.
- Maintain a safe working environment in the plant room, free from obstructions and debris.
- Provide adequate lighting.
- Ensure plant room ventilation is adequate and as per government regulations.

SMARDT recommends on-site scheduled maintenance be carried out. Scheduled maintenance evaluates the system performance, fault history and trends, and helps with preventative maintenance. The following list of owner responsible scheduled maintenance must be carried out by authorized and qualified personnel, and be within the recommended timeframe frequency indicated. See tables 9 & 10 for details:

FREQUENCY OF SCHEDULED MAINTENANCE FOR SMARDT CHILLERS

ITEM	TASK	Frequency		
		3mths	6mths	12mths
Electrical checks	Check main power supply voltages	✓		
	Check electrical terminals are tight		✓	
	Check hot spots / discoloration on power cables	✓		
	Check Amperages are as per design	✓		
Electronic inspections	Check communication cables are secure	✓		
	Check pressure and temperature sensor connections are secure.		✓	
	Check there are no signs of physical damage / discoloration on printed circuit boards.		✓	
	Check the printed circuit boards (PCBs) are free of dust		✓	
	Check EXV winding resistance (do NOT disturb connections unless repair is required)			✓
Compressor refrigeration circuit inspections	Check all mounting bolts are secure	✓		
	Check for refrigerant leaks	✓		
	Check for mechanical damage	✓		
	Check operating temperatures and pressures	✓		

Table 17: Frequency of Scheduled Maintenance for SMARDT Chillers

FREQUENCY OF SCHEDULED MAINTENANCE FOR TURBOCOR™ COMPRESSORS

ITEM	TASK	Frequency		
		3mths	6mths	10yrs
General inspections	Check for visible mechanical damage to compressor	✓		
	Check for excessive vibration from other rotating equipment	✓		
Electrical inspections	Check main power supply voltages (refer to Turbocor™ service manual)	✓		
	Check electrical terminals are tight		✓	
	Check for signs of hotspots / discoloration on power cables	✓		
	Check amperages as per design	✓		
	Check DC bus voltage	✓		
	Check capacitor mid bus voltage	✓		
	Replace capacitor set			✓
	Check operation of all system safety devices and interlocks		✓	
	Check all communications cables are secure and tight	✓		
	Check all electronic modules are secure	✓		
	Check physical condition of all exposed Printed Circuit Boards (PCB's)	✓		
	Check all exposed PCB's for dust build-up and clean if necessary		✓	
	Check calibration pressure / temperature sensors		✓	
Refrigeration	Check operation of IGV assembly		✓	
	Check system refrigeration charge	✓		
	Check superheat level / control, if applicable		✓	
	Check system and motor cooling liquid line to ensure sufficient sub-cooling	✓		
	Check operating conditions external to the compressor	✓		
	Clean / inspect motor-cooling strainers (if service has taken place)	As Required		

Table 18: Frequency of Scheduled Maintenance for Turbocor™ Compressors

SUB-COOLING MEASUREMENT PROCEDURE CHECK

Set up the service manifold; however, connect the discharge hose (red) to the liquid line upstream of the electronic expansion valve (EXV).

Note the corresponding saturation temperature of the refrigerant at the pressure indicated. (In order to have sub-cooling, the measured value must be less than the saturation temperature.)

With a temperature probe, measure the temperature on the liquid line upstream of the EXV. (In order to have sub-cooling, the measured value must be less than the saturation temperature.)

Calculate the difference between the saturated temperature and the measured temperature. This difference is the amount of sub-cooling.

Design spec: 5-8° C (9-15° F)
ΔT = 2K to 5K (4°F to 10°F)

SUCTION SUPERHEAT MEASUREMENT PROCEDURE

Connect the service manifold discharge hose (red), to the discharge header, downstream of the compressors.

Note the corresponding saturation temperature of the R134a at the pressure indicated.

With a temperature probe, measure the temperature on the suction line. (In order to have superheat, the measured value must be greater than the saturation temperature.)

Calculate the difference between the saturated temperature and the measured temperature. This difference is the amount of superheat.

Design spec: 0-3° C (0-5° F)

CHECKING IGV OPERATION

During compressor ramp-up, the inlet guide vanes open, depending on load conditions, as indicated by the ball bearing on the outside of the IGV housing. If the ball does not move, further testing will be required; refer to the Compressor Service Manual. When the Turbocor™ compressor is not in operation the Inlet Guide Vanes will move to the closed position.

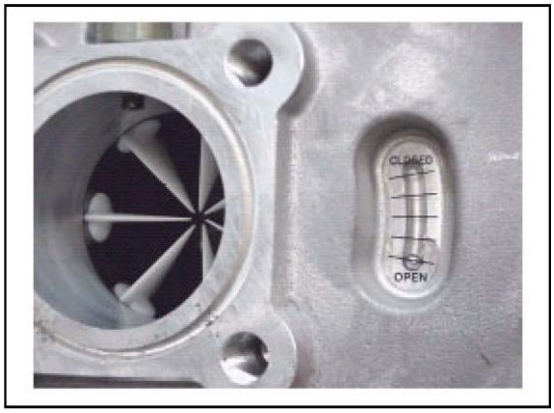


Figure 33: Inlet Guide Vane

CHECKING ELECTRONIC EXPANSION VALVE (EXV) OPERATION

During normal operation the EXV modulates to maintain a pre-set level in the condenser. The EXV responds via the chiller controller. If the super heat sensor control is operating correctly, use the chiller controller interface to manually drive the EXV. Verify that the level fluctuates according to the drive signal, as observed through the chiller controller. If the EXV fails to respond to the manual input, the EXV is defective and requires replacement.

ELECTRONIC EXPANSION VALVE (EXV)

KILTECH I/O BOARD -1A -1B -2A -2B	SPORLAN (6386 STEPS) 1A WHITE 1B BLACK 2A RED 2B GREEN	PowerPax (6000 STEPS) 1A YELLOW 1B BLACK 2A RED 2B GREEN

Note: SMARDT chillers are supplied with a separate expansion valve driver board by Sporlan. The Sporlan EXV is connected to the Sporlan driver board.

Table 19: EXV Wiring

WARRANTY

WARRANTY CLAIM / RETURN PROCEDURE

SMARDT has the following warranty claim / return procedure in place:

North American customers	30 days
European customers	60 days
Asian and Australian customers	90 days

If a buyer believes an article to be defective under the SMARDT Inc. Standard Warranty Policy, the buyer is required to complete an Incident Report Form, which must be submitted with a P.O. # to SMARDT Inc. at productsupport@smardt.com within ten (10) business days of the alleged failure. Claims will only be considered for products within the warranty period. If the article qualifies for return, an RMA number will be issued.

The buyer must return the article unless otherwise advised by SMARDT Inc. The buyer shall be responsible for handling, storage, freight, labor, or other related charges for the return of the defective part to SMARDT Inc. or Danfoss Turbocor™ Compressors Inc., using standard shipping methods, unless otherwise specified by SMARDT Inc.

SMARDT Inc. will invoice the buyer to ensure that the failed article is returned within the allowable time frame. If the article is returned and deemed defective under the SMARDT Inc. Warranty Policy, SMARDT Inc. will issue credit.

Conditions

All returns must respect the 30, 60, 90 day terms (as stated above), to be considered for credit.

All compressor and part returns must be properly sealed and packaged to avoid any potential damage during transportation.

All packages must be clearly labeled with the appropriate RMA #'s attached (use shipping label provided by SMARDT Inc.)

STANDARD WARRANTY POLICY

For details, refer to SMARDT Standard & Extended Warranties (SEW) document TD-0076.

EXTENDED WARRANTY

For details, refer to SMARDT Standard & Extended Warranties (SEW) document TD-0076.

TERMS AND CONDITIONS OF SALE

The Terms and Conditions stated below are incorporated into and shall constitute part of the Sales Order Acknowledgment ("Sales Order Acknowledgment") between you ("The Buyer") and Smardt Inc., its subsidiaries and its authorized distributors ("The Seller"). These Terms and Conditions shall be binding upon The Buyer unless otherwise stated in writing on the Sales Order Acknowledgment.

ACCEPTANCE AND BINDING

All purchase orders are subject to acceptance at The Seller's factory, and The Seller shall have no liability until and unless they are so accepted. Sales representatives are not authorized to bind The Seller. Clerical errors are subject to correction. The Seller shall not be bound by any representations or warranties which are not expressly set forth in writing and signed by an authorized employee of The Seller.

PRICES AND TAXES

Unless otherwise acknowledged by The Seller in writing: (i) all prices are subject to change without notice; (ii) goods will be billed at the prices in effect at the time of shipment; (iii) prices are quoted F.O.B. at The Seller's factory; (iv) prices on the items set forth in the Sales Order Acknowledgment are exclusive of all city, state, provincial and federal excise taxes, including, without limitation, taxes on manufacture, sales, receipts, occupation, use and similar taxes. Whenever applicable, any taxes will be added to the Sales Order Acknowledgment as a separate charge to be paid by The Buyer.

The acknowledged purchase price is firm if the product is shipped within 180 days of the purchase order date. Thereafter, the purchase price is subject to a 1% increase for each month or part thereof that shipment is delayed beyond the initial 180 day period. Any purchase order not released for immediate manufacture and shipment by the customer within 180 days of purchase order receipt, may be cancelled by The Seller and/or subject to re-quotation.

TERMS OF PAYMENT

Terms of payment shall be as stated in the Sales Order Acknowledgment, or, unless otherwise stated, payment is due in full 30 days after the shipping date from The Seller, with no retention. All "Pay when Paid" or "Pay if Paid" provisions contained in The Buyer's Terms are expressly rejected. No Payment due to The Seller shall be withheld or subject to retainage for any reason without The Sellers consent, including back-charges. Any back-charges made by The Buyer prior to The Seller's written approval will be the sole responsibility of The Buyer. In the event that payment is not made promptly when due, The Buyer agrees to pay a penalty at the rate of 1½% per month, or as limited by state, federal or other applicable laws, from the due date. Partial shipments on quantity orders shall be deemed a separate and independent contract for billing.

CREDIT APPROVAL

Shipment of the items set forth in the Sales Order Acknowledgment shall at all times be subject to the approval of The Seller's credit department. The Seller may at any time decline to make any shipment except upon receipt of payment or security or upon Terms and Conditions satisfactory to The Seller.

SUBMITTALS

The Seller manufactures its products based on a customer approved submittal. When discrepancies exist

between a customer approved submittal and the corresponding project plans & specifications, customer approved submittals shall take precedence. For purposes of this contract, customer approved submittals are those technical drawings and related documentation, prepared by The Seller and sent to the customer, whose primary purpose is to define the equipment that The Seller proposes to manufacture on behalf of the customer.

SHIPMENT

Shipping dates are approximate and may be contingent upon the prompt receipt from The Buyer, of drawings, access, or approvals to release, for procurement of materials and manufacturing. The Seller shall have no liability for delays in delivery. All shipments are made at The Buyer's risk. Method and route of shipment are at the seller's discretion, unless The Buyer supplies written instructions that are accepted by The Seller. Regardless of the method of delivery, however, risk of loss shall pass to The Buyer upon the seller's delivery to a carrier. If The Seller is prepared to make shipment, but The Buyer delays delivery, terms of payment shall apply as though delivery had been effected as of the date that The Seller was prepared to make shipment. All costs associated with handling, care and custody of the material shall be to the account of The Buyer. The acceptance of the material by The Buyer shall constitute a waiver of all claims for losses due to delay.

CANCELLATION AND CHANGES

Orders shall not be subject to cancellation unless cancellation charges (including recovery of lost profit) are paid by The Buyer for all work done by The Seller and for any obligations incurred by The Seller in connection with the order. Requests to change an order by The Buyer after acceptance by The Seller may result in changes to design, delivery lead time, cost and/or terms of payment. The Buyer agrees that such changes may require renegotiation of the order.

INDEMNITY

The Buyer agrees to hold The Seller harmless from any and all liability, and to pay all costs and attorney's fees for injury or damage to persons or property caused in any manner, by material covered by the Sales Order Acknowledgment while in possession or under the control of The Buyer or The Buyer's successor in interest.

INDEMNITY FOR INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS

The Seller shall have no liability for infringement of any patents, trademarks, copyrights, trade dress, trade secrets or similar rights except as provided in paragraph 9 of the SMARDT Terms & Conditions of Sale. The Seller will defend and indemnify The Buyer against allegations of infringement of U.S. patents, U.S. trademarks, copyrights, trade dress and trade secrets (hereinafter collectively referred to as the "Intellectual Property Rights"). The Seller will defend at its expense and will pay the cost of any settlement or damages awarded in any action brought against The Buyer based on an allegation that an item sold to The Buyer that is listed in the Sales Order Acknowledgment ("Item") infringes upon the Intellectual Property Rights of a third party. The Seller's obligation to defend and indemnify The Buyer is contingent upon The Buyer notifying The Seller within ten (10) days after The Buyer becomes aware of such allegations of infringement, and The Seller having sole control over the defense of any allegations or actions including all negotiations for settlement or compromise. If an item is subject to a claim that it infringes the intellectual

property rights of a third party, The Seller may, at its sole discretion, procure for The Buyer, the right to continue using the item, replace or modify the item so as to make it non-infringing, or to offer to accept return of the item and return the purchase price less a reasonable allowance for depreciation. Notwithstanding the foregoing, The Seller shall have no liability for claims of infringement based on information provided by The Buyer, or directed to items for which the designs are specified in whole or in part by The Buyer, or infringements resulting from the modification, combination, or use in a system of the items. The foregoing provisions of this paragraph 9 of the SMARDT Terms & Conditions of Sale, shall constitute The Seller's sole and exclusive liability and The Buyer's sole and exclusive remedy for infringement of intellectual property rights.

If a claim is based on information provided by The Buyer or if the design for an item is specified in whole or in part by The Buyer, The Buyer shall defend and indemnify The Seller for all costs, expenses, or judgments resulting from any claim that such an item infringes any patent, trademark, copyright, trade dress, trade secret or similar right.

INSTALLATION, INITIAL OPERATION AND SERVICE

All material provided by The Seller shall be installed by and at the expense of The Buyer, unless otherwise arranged in writing. Should The Buyer request the services of The Seller, such service shall be rendered and charged at the established rate at the time of performing the said service, plus other expenses including travel, hotel bills and living expenses.

TOOLING

Any tooling designed or produced by The Seller in the manufacture of any product or material sold to The Buyer, shall remain the sole and exclusive property of The Seller, unless the cost of designing and producing the tooling is paid by The Buyer, in which case such tooling shall be the sole and exclusive property of The Buyer and shall be provided to The Buyer upon completion of the work.

LIMITED WARRANTY

The seller warrants that upon shipment, the products sold to The Buyer shall be as described in the SMARDT submittal document, and shall be free from defects in materials and workmanship for a period of 12 months from start-up or 18 months from the date of shipment, whichever is shorter. Standard warranty includes the labor necessary to replace or repair the defective component but does not include crane rigging, speciality tools, refrigerant, equipment rental, special unit access, or overtime or holiday premiums. Warranty applies only to equipment that has been started by SMARDT direct employees or SMARDT Authorized Service Contractors (SASC).

Optional extended labor, refrigerant and parts warranties may be quoted under a separate agreement. Please consult SMARDT. It is the customer's responsibility to advise The Seller of any and all changes required to affect warranty repairs. Prior to affecting repairs, approval must be obtained from The Seller before proceeding with any work. If warranty is in effect and The Seller ascertains that the damage was due to an accident, abuse, or misapplication, and the seller has incurred costs in this regard, these charges will be billed to the customer at cost.

This warranty applies only to equipment that is properly installed, maintained and operated under normal conditions and in the presence of competent supervision. In addition, equipment must be installed, maintained and operated in accordance with the equipment Installation, Operation & Maintenance Manual. Company recommendations, if any, made in the submittal document of the said equipment, does not cover physical damage resulting from corrosion, excessive heat or degradation in performance as a result of dirt, dust or other foreign materials. At its option, The Seller's obligation under this warranty is limited to repair or replacement of any returned part prepaid, and which upon examination, shall prove to be defective. Freight charges incurred for shipment of warranty repair or replacement parts will be the responsibility of the purchaser.

This warranty shall be void in the case of any equipment which has been disassembled, repaired or tampered with in any way, except when such work has been done with Company written approval.

THIS WARRANTY COMPRISES THE SOLE AND ENTIRE WARRANTY PERTAINING TO ITEMS SOLD TO THE BUYER BY THE SELLER. THE SELLER MAKES NO OTHER WARRANTY, GUARANTEE, OR REPRESENTATION OF ANY KIND WHATSOEVER. ALL OTHER WARRANTIES, INCLUDING BUT NOT LIMITED TO MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WHETHER EXPRESS, IMPLIED, OR ARISING BY OPERATION OF LAW, TRADE USAGE, OR COURSE OF DEALING, ARE HEREBY DISCLAIMED.

NOTWITHSTANDING THE FOREGOING, THERE ARE NO WARRANTIES WHATSOEVER ON ITEMS BUILT OR ACQUIRED, WHOLLY OR PARTIALLY, TO THE BUYER'S DESIGNS OR SPECIFICATIONS.

LIMITATION OF REMEDY

THE SELLER'S LIABILITY ARISING FROM OR IN ANY WAY CONNECTED WITH THE ITEMS SOLD TO THE BUYER BY THE SELLER, AT THE SELLER'S SOLE OPTION, SHALL BE LIMITED EXCLUSIVELY TO REPAIR OR REPLACEMENT OF THE ITEMS SOLD, OR REFUND OF THE PURCHASE PRICE PAID BY THE BUYER. IN NO EVENT SHALL THE SELLER BE LIABLE FOR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES OF ANY KIND OR NATURE WHATSOEVER, INCLUDING BUT NOT LIMITED TO LOST PROFITS ARISING FROM OR IN ANY WAY CONNECTED WITH ITEMS SOLD TO THE BUYER BY THE SELLER, WHETHER ALLEGED TO ARISE FROM BREACH OF CONTRACT, EXPRESS OR IMPLIED WARRANTY, OR IN TORT, INCLUDING WITHOUT LIMITATION, NEGLIGENCE, FAILURE TO WARN, OR STRICT LIABILITY.

SOFTWARE PROGRAMS

Computer Software Programs that may be included in material or products sold to The Buyer, have been designed to perform a standard sequence of operations as defined in the documentation provided, and are offered AS IS. It is The Buyer's responsibility to determine if the features of the software programs are suitable for The Buyer's requirements. In the event The Buyer desires site specific modifications, The Buyer is responsible for commissioning, final validation, and cost of upgrades that may be required to conform to future software generations provided by SMARDT.

To obtain assistance under this limited warranty, please contact the selling agency. To obtain information or to gain factory assistance, contact Smardt Inc., 1800 Trans Canada Highway, Dorval, Quebec, H9P 1H7 Canada; Telephone (514) 683-5585.

SELLER'S RIGHT OF POSSESSION

The Seller shall have the right, in addition to all others it may possess, at any time, for credit reasons or because of The Buyer's default, to withhold shipments in whole or in part, and to recall goods in transit, retake the same, and repossess all goods which may be stored with The Seller for The Buyer's account, without the necessity of taking any other proceedings, and The Buyer consents that all goods so withheld, recalled, retaken or repossessed, shall become The Seller's absolute property, provided that The Buyer is given full credit thereof. The foregoing shall not be construed as limiting in any manner, any of the rights or remedies available to The Seller because of any default by The Buyer.

CONTROLLING PROVISIONS

If the Sales Order Acknowledgment is accepted and The Buyer's purchase order is used for any purpose, it is expressly understood and agreed that the Terms and Conditions set forth in the Sales Order Acknowledgment and these Terms and Conditions of Sale, shall prevail in so far as the same may in any way conflict with the terms and conditions set forth in The Buyer's order form, and the issuance of such an order by The Buyer, shall be deemed to note The Buyer's assent to the foregoing. Provisions in The Buyer's purchase orders contrary to these terms and conditions, are not binding upon The Seller, unless accepted in writing by an authorized agent or representative of The Seller. Acceptance of the material or products covered by the Sales Order Acknowledgment shall in all events, constitute such acceptance and assent, and the Terms and Conditions of the Sales Order Acknowledgment shall herein supersede any provisions, terms and conditions contained in any confirmation, order, or other writing that The Buyer may give or receive, and the parties shall be governed exclusively by the provisions, Terms and Conditions hereof. The Seller makes no representations or warranties concerning the Sales Order Acknowledgment, except those that are expressly contained in the Sales Order Acknowledgment and these Terms and Conditions of Sale, and which may not be changed or modified orally.

FORCE MAJEURE

The seller shall not be liable for any delay in the performance of the Sales Order Acknowledgment or in the delivery or shipment of goods, or for any damages suffered by The Buyer or its customers by reason of such delay, if such delay is directly or indirectly caused by or in any manner arises from, fires, floods, accidents, civil unrest, acts of God, war, governmental interference or embargoes, strikes, labor difficulties, shortage of labor, fuel, power, materials or supplies, computer issues, transportation delays, or for any other cause (whether or not similar in nature to any of the–aforementioned) that are beyond its control.

CONDITIONS

The Sales Order Acknowledgment is accepted with the understanding that it is subject to The Seller's ability to obtain the necessary raw materials, and the Sales Order Acknowledgment and all shipments applicable thereto are subject to The Seller's current manufacturing schedules, governmental regulations, orders, directives, and restrictions, that may be in effect from time to time.

ASSIGNMENT

The Buyer shall not assign, subcontract, delegate or transfer in any way whatsoever, the Sales Order Acknowledgment, in whole or in part, without the prior written consent of The Seller. Any such assignment, subcontract, delegation or transfer, without The Seller's prior written consent, shall become void. The Buyer shall not be relieved of any of its obligations under the Sales Order Acknowledgment, notwithstanding any such written consent by The Seller.

NON-WAIVER BY SELLER

Waiver by The Seller of a breach of any of the Terms and Conditions of the Sales Order Acknowledgment or the Terms and Conditions of Sale, shall not be construed as a waiver of any other breach.

GOVERNING LAW

The Sales Order Acknowledgment and these Terms and Conditions of Sale, shall be governed by and construed in accordance with the internal laws of the Province of Quebec, Canada. The Convention on Contracts for the International Sale of Goods shall be applicable to the Sales Order Acknowledgment or these Terms and Conditions of Sale. No actions arising out of the sale of material or products covered by the Sales Order Acknowledgment, other than an action by the seller to recover the purchase price of such material or products, may be brought by either party more than two (2) years after the cause of the accrued action.

The following specific pages have been extracted from the

SMARDT – KILTECH GEN 3 COMPRESSOR MANAGEMENT CONTROL SYSTEM MANUAL

The full CMCS Manual is available upon request

PRODUCT OVERVIEW

INTRODUCTION

The purpose of this section of the manual is to describe the installation, functionality and operation of the Kiltech Compressor Management Control System, which is specifically designed for applications where the Turbocor™ centrifugal compressor is being integrated on OEM chillers and / or for retrofit applications.

The controller consists of specific software suitable for the control and optimization of six (6) Turbocor™ compressors, and for auxiliary components for a given refrigeration application.

Note: As a prerequisite, all readers should be fully conversant with the Turbocor™ technology and have sufficient training and application experience. The reader must also have access to the relevant Danfoss Turbocor™ documentation, and use this document as an “application supplement” when integrating the compressor into a given system.

SAFETY GUIDELINES

Every control system has its own unique set of requirements, which are based on each particular application. Please ensure that all National, State and Local government requirements are met when applying this product.

Throughout this manual there will be reference to specific safety symbols, which are intended to highlight their importance to the reader.

⚠ CAUTION

The caution symbol and associated text will warn the reader about the possibility of damage to the equipment, data, and other mechanical devices.

⚠ WARNING

The warning symbol and associated text will warn the reader about the possibility of minor personal injury.

⚠ DANGER

The danger symbol and associated text will warn the reader about the possibility of serious or fatal personal injury.

The Kiltech Compressor Management Control System performs the following primary functions:

•Provides optimum control of the entire chiller/system, compressors, and auxiliary devices, in order to achieve higher energy efficiency.

•Performs real time system monitoring, analysis and fault display

The controller features an integrated color 10.4" TFT, panel mount touch screen display, and embedded real time microprocessor, giving the operator the ability to:

•View compressor operational data points

•View the necessary input & output data points

•View and adjust set points

•View and adjust timers where applicable

•View operational trends and system performance

•Acknowledge and reset warnings and alarms

•View the alarm history

TERMS AND DEFINITIONS

SST - Saturated Suction Temperature

SDT - Saturated Discharge Temperature

kW / TonR - Kilowatts (energy) per Tons of Refrigeration

COP - Coefficient of Performance

I/O - Input / Output

AO - Analogue Output

AI - Analogue Input

DI - Digital Input

DO - Digital Output

BMS - Building Management System

LED - Light Emitting Diode

Evap. - Evaporator

Cond. - Condenser

CH. W - Chilled Water

CO.W - Condenser Water

VDC - Volts, Direct Current

VAC - Volts Alternating Current

RH % - Relative Humidity

NTC - Negative Temperature Coefficient

VFD - Variable Frequency Drive

kW - Electrical Power (energy)

kWR - Kilowatts (refrigeration)

INSTALLATION

The Kiltech compressor management controller is supplied either as an OEM kit, or a pre-packaged electrical enclosure complete with auxiliary switch gear. The control system comes equipped with the operating system and application software installed ready for installation at the OEM's manufacturing facility. The installation of the device and connections to the I/O may vary, depending on the specific model of the chiller or application type.

PC PANEL SPECIFICATIONS

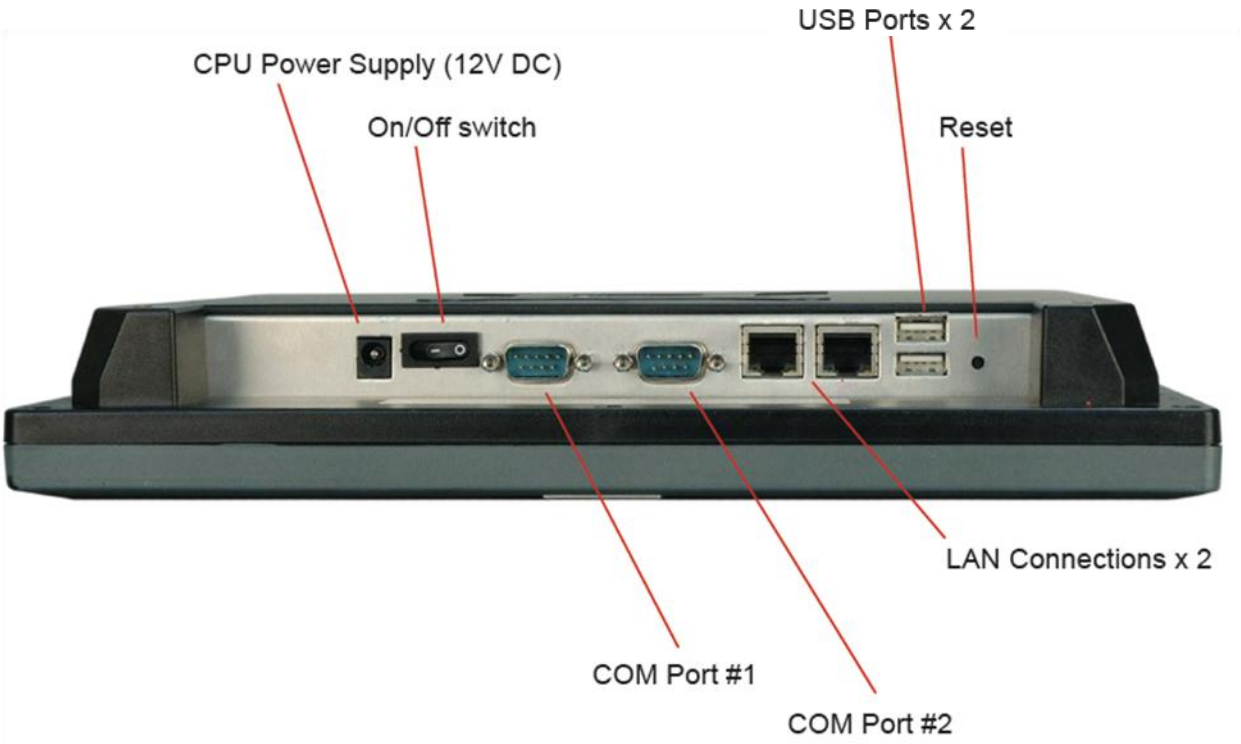
LCD Size: 10.4"
Max Resolution: 800 x 600
Brightness: (cd/ÜF) 400
Contrast Ratio: 500:1
LCD Color: 262K
Backlight MTBF: 50000
CPU: AMD Geode LX 800 (500MHz)
RAM: Supports one 1GB (maximum) 333MHz or 400MHz SO-DIMM
I/O Ports and Switches: 1 x RS-232 COM port
1 x RS-232/422/485 COM port
2 x RJ-45 for 10/100Mbps LAN
x USB 2.0
1 x Power switch
1 x Reset button
Watchdog Timer: Software programmable supports 1~255 sec. System reset
Audio: AMP 1.5W + AMP 1.5W
Expansion: 1 x Mini PCI, (Wireless LAN Module)
1 x Bluetooth module, (USB Interface, Bluetooth V2.0)
Construction Material: ABS + PC Plastic front frame
LED Function: 1 x Power ON/OFF LED on front panel
Mounting: Panel, Wall, Rack, Stand or Arm VESA 75mm x 75mm / 100mm x 100mm
Dimension (WxHxD) (mm): 276 x 227 x 50.7
Operation Temperature: 0°C~50°C

Storage Temperature:-20°C~60°C
Net Weight: 1.4kg
IP Level (front panel): IP 64
Safety & EMI: EMC, CE, FCC, UL and CCC
Touch Screen: Resistive Type 5-Wire, (touch controller IC is on board)
Power Adapter: P/N: 63000-FSP0361AD101C-RS
Power: 36W:
Input: 90VAC~264VAC @ 50/60Hz
Output: 12VDC
Power Requirement: 12VDC or 18~30VDC
Power Consumption: 25W

CPU - PC PANEL LAYOUT

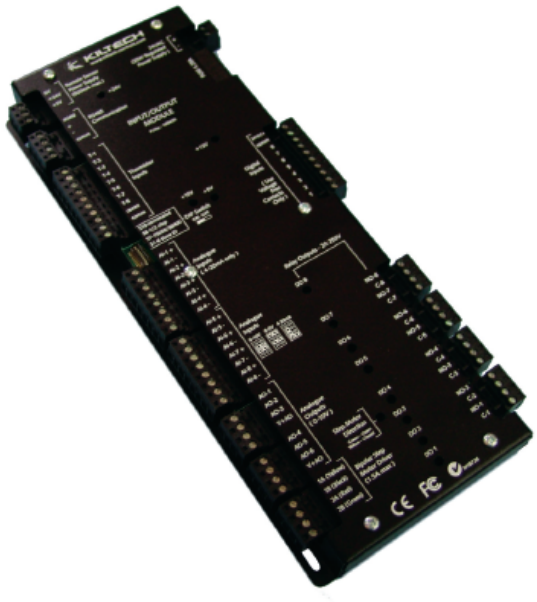
All connections to the PC Panel are located at the bottom of the rear cover, to allow for the following:

- CPU Power Supply
- On/Off Switch
- COM Port #1
- COM Port # 2
- USB Ports x 2
- LAN Connections x 2
- Reset



I/O MODULES

I/O MODULE (39 POINT OPTION) - SPECIFICATIONS



Supply Voltage
24V AC/DC, 50/60 Hz, 30VA required.
Supply voltage fused on board at 1.25A.

Temperature Input - 8
8 Thermister inputs – Software scaled for 10K NTC (Type F) sensor, 10 bit accuracy.

Digital Inputs - 8
8 Digital inputs (Opto isolated) – pull up voltage is 24VDC supplied internally, input impedance = 20kOhm, debouncing hardware integrated.

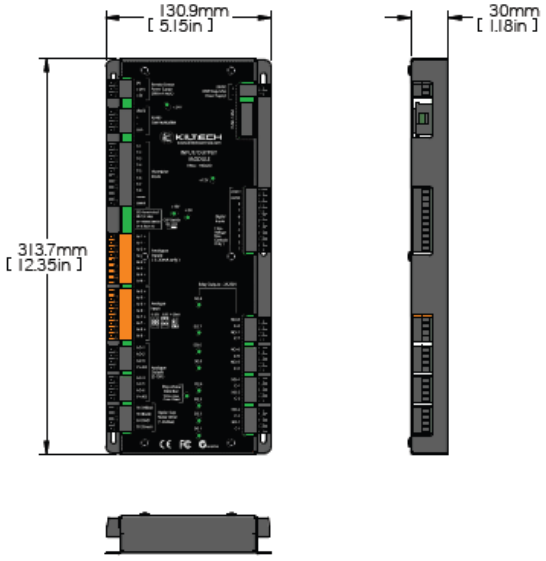
Digital Outputs - 8
8 Digital/Relay outputs – 5 Amps@250VAC Rated (Normally Open). 4 kV potential separation.

Analogue Inputs - 8
4 Analogue Inputs (1 to 4) – Non selectable 4-20mA, 10 bit accuracy.
4 Analogue inputs (5 to 8) – Three (3) selectable ranges (4-20mA, 0-5VDC or 0-10VDC)

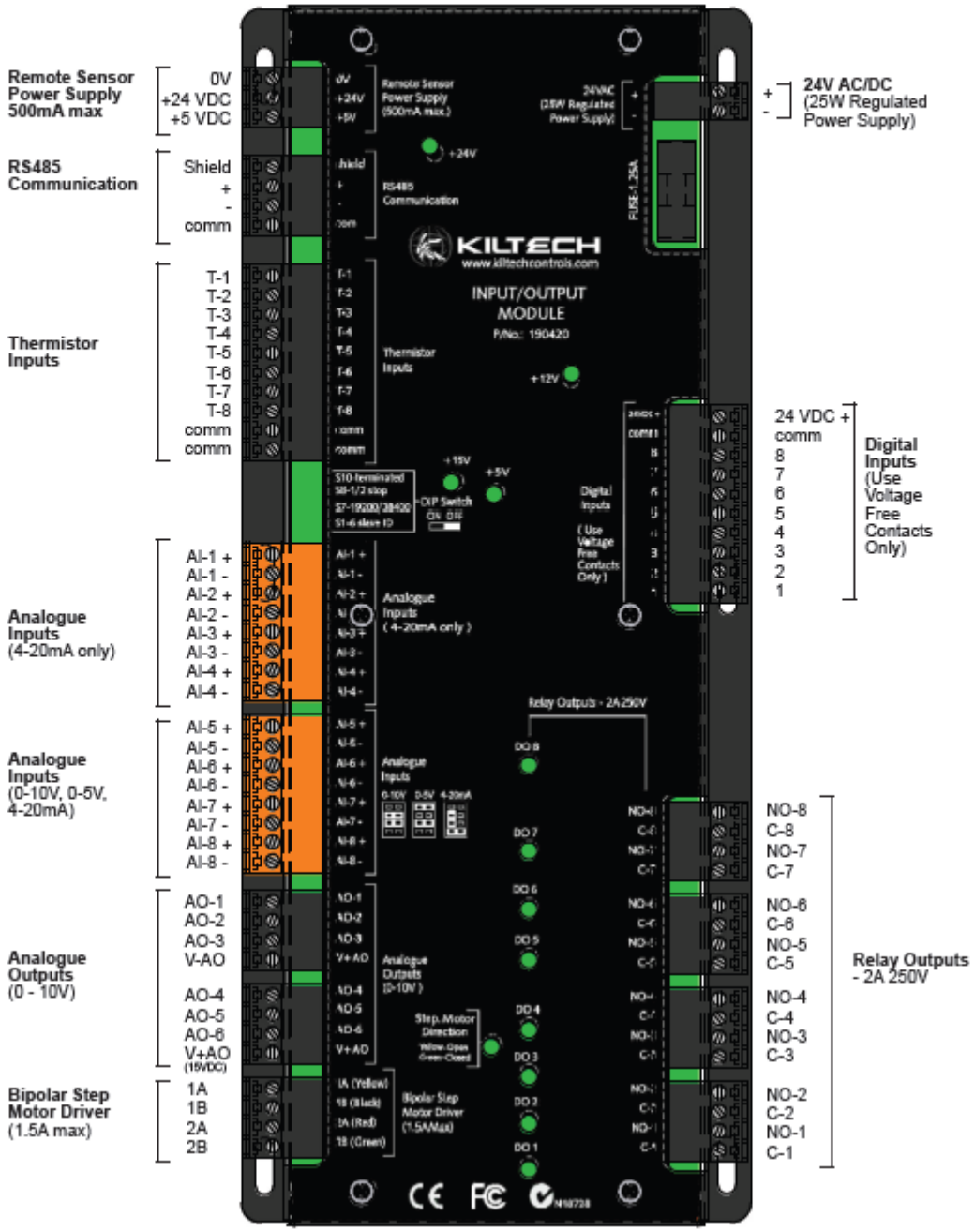
Analogue Outputs – 6
Analogue Outputs – Non selectable, 0-10VDC only.

Stepper Motor Driver - 1
1 Bipolar stepper motor driver – Micro-stepping, rated to 1.5A, software configurable number of steps and step rate.
Drive – Alco, Danfoss, Sporlan and PowerPax electronic expansion valves.

Onboard Power Supplies
5VDC and 24VDC 500mA max. for use with sensors.



I/O MODULE (39 POINT OPTION) - TERMINAL LAYOUT



I/O MODULE (65 POINT OPTION) - SPECIFICATIONS

Supply Voltage
24V AC/DC, 50/60 Hz, 30VA required.
Supply voltage fused on board at 1.25A.

Temperature Input - 8
8 Thermister inputs – Software scaled for 10K NTC (Type F) sensor, 10 bit accuracy.

Digital Inputs - 24
24 Digital inputs (Opto isolated) – pull up voltage is 24VDC supplied internally, input impedance = 20kOhm, debouncing hardware integrated.

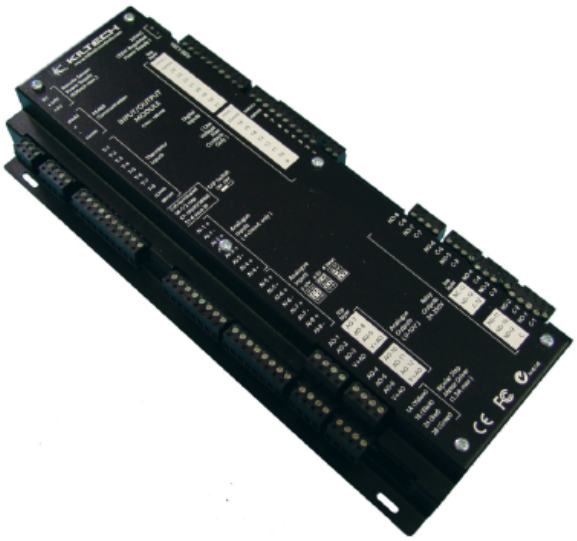
Digital Outputs - 12
12 Digital/Relay outputs – 5 Amps@250VAC Rated (Normally Open). 4 kV potential separation.

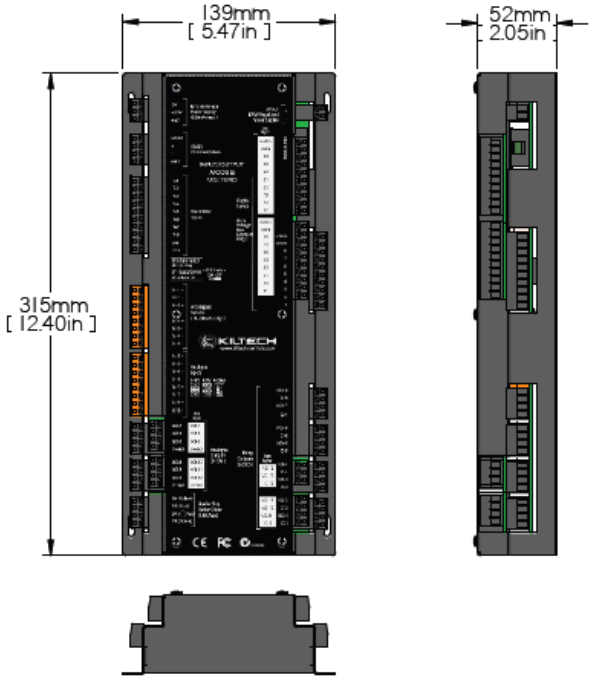
Analogue Inputs - 8
4 Analogue Inputs – Three (3) selectable ranges (4-20mA, 0-5VDC or 10VDC)
4 Analogue inputs – non-selectable 4-20mA, 10 bit accuracy.

Analogue Outputs – 12
12 Analogue Outputs – Non-selectable, 0-10VDC only.

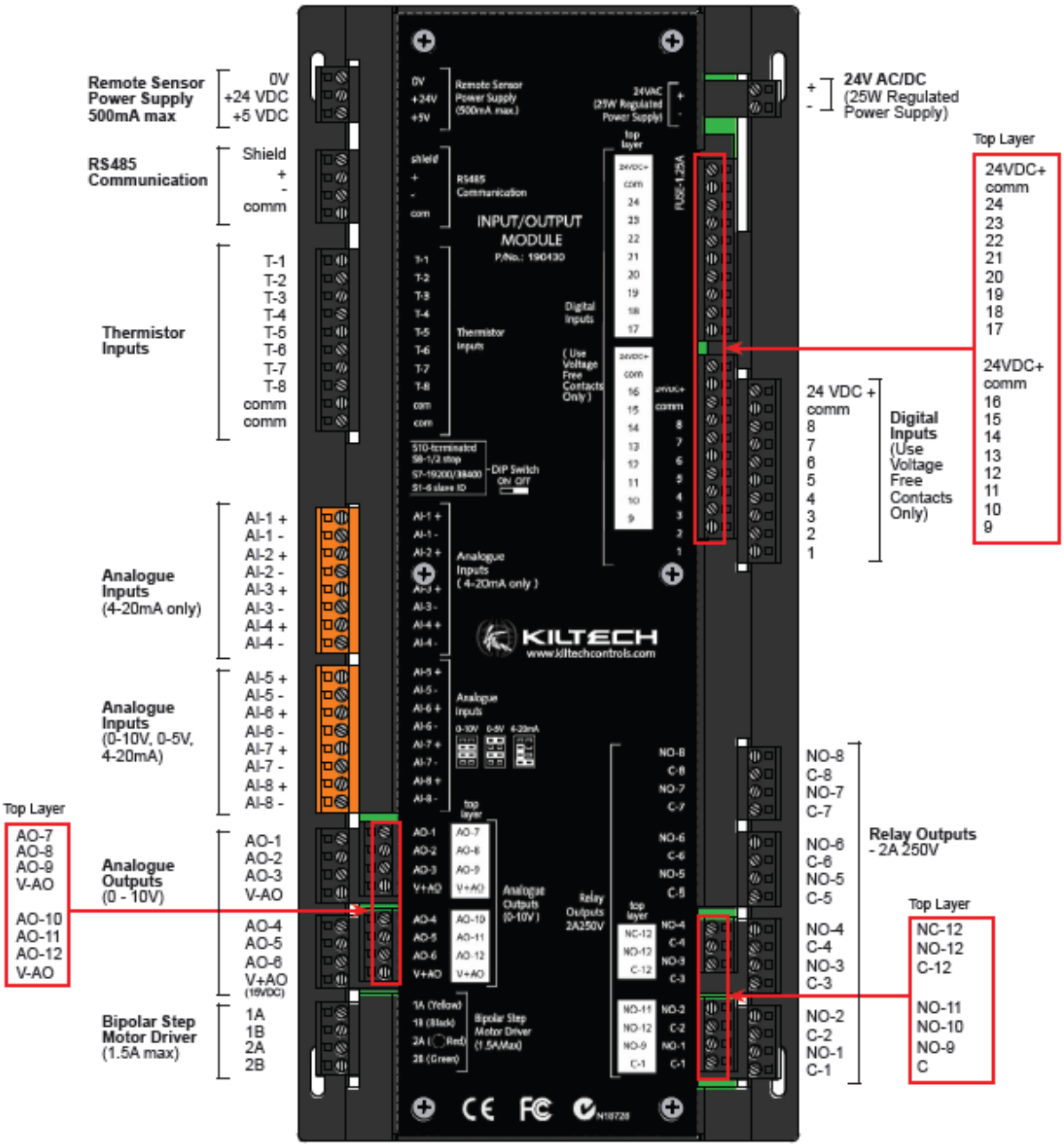
Stepper Motor Driver - 1
1 Bipolar stepper motor driver – Micro-stepping, rated to 1.5A, software configurable number of steps and step rate.
Drive – Alco, Danfoss, Sporlan and PowerPax electronic expansion valves.

Onboard Power Supplies
5VDC and 24VDC 500mA max. for use with sensors.



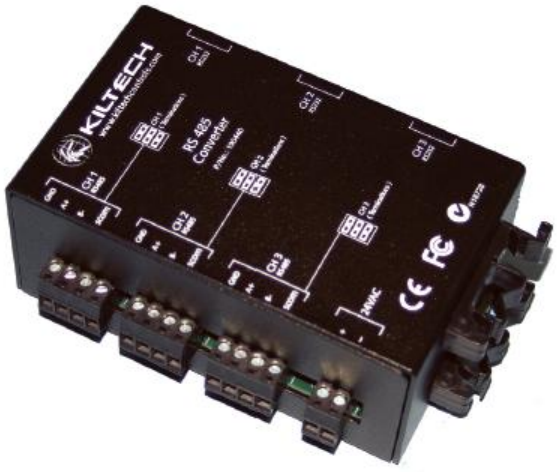


I/O MODULE (65 POINT OPTION) - TERMINAL LAYOUT



RS 485 CONVERTER

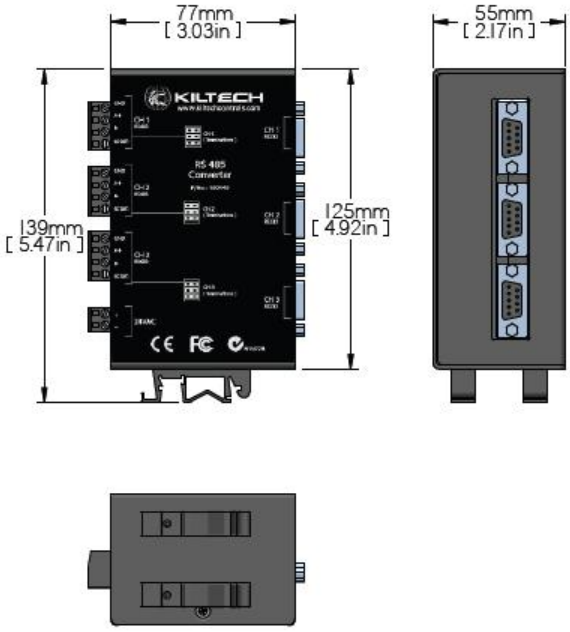
SPECIFICATIONS



Supply Voltage
24V AC/DC, 50/60 Hz

RS232 to RS485 Channels
3 of RS232 to RS485 converter channels
(Opto isolated)

Mounting
DIN RAIL mount



PROTOCOL CONVERTER

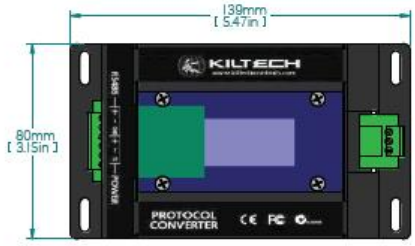
SPECIFICATIONS

Supply Voltage
24V AC/DC, or 5VDC (jumper selectable)

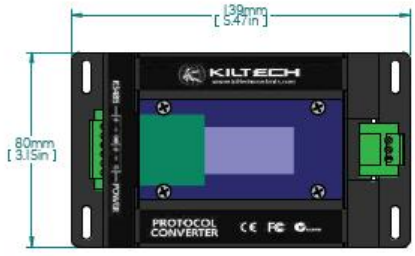
Standard Options Available:
Modbus RTU - LON
Modbus RTU - BACnet
Modbus RTU - Metays N2

- *Specific application data available on request.*
- *Other options available on request if required.*

Lon



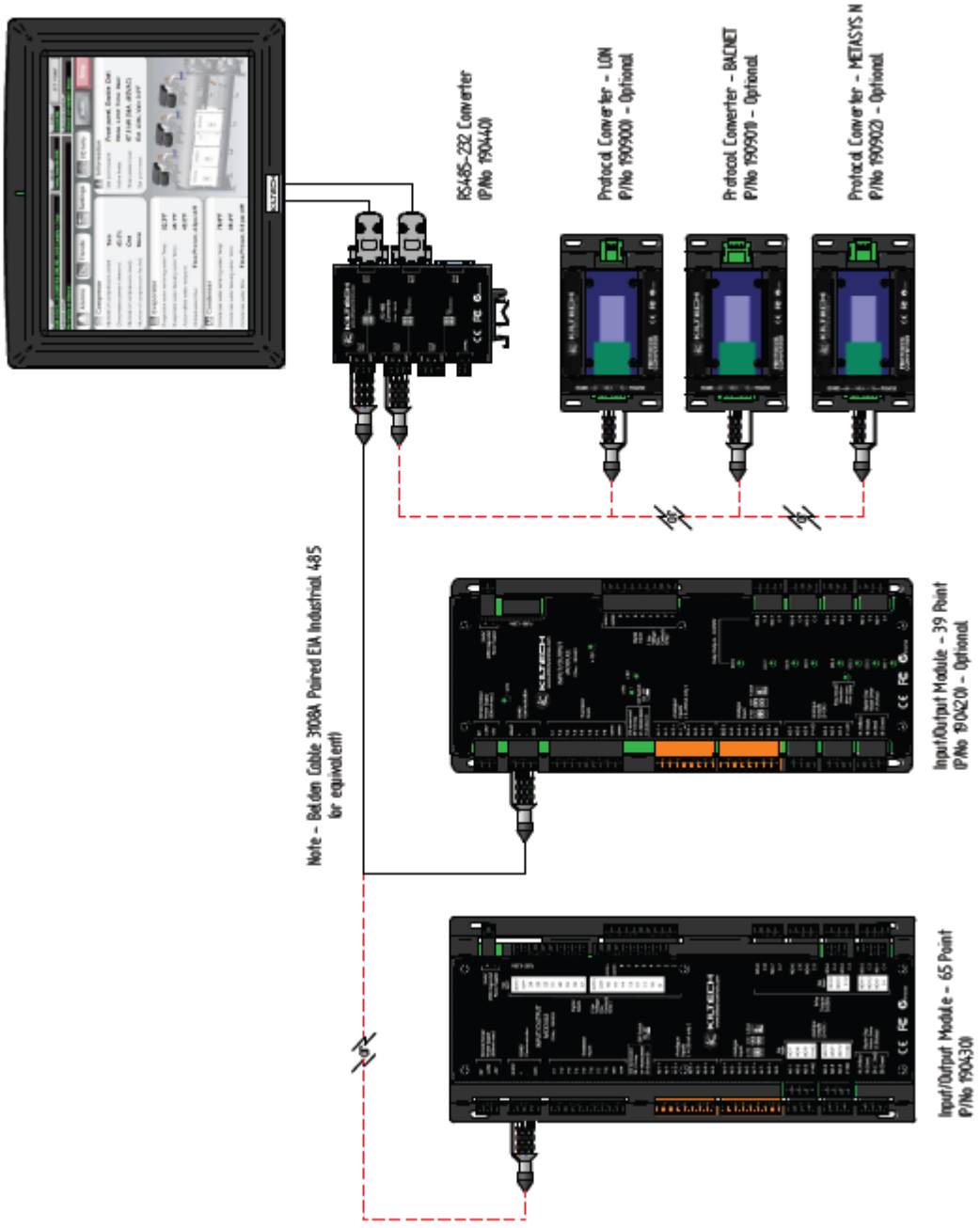
BACnet



Metasys N2

NETWORK DIAGRAM

Typical Layout



OPERATION

MAIN SCREEN

The chiller control system is equipped with a colour 6.4 inch touch screen, providing a simple and effective way to navigate through the system to obtain operational data and carry out simple procedures on the chiller system.

The controller consists of 6 navigational soft keys located at the top of the display.

By pressing the page tab, the operator will be redirected to the corresponding page to access the appropriate data

SEQUENCE OF OPERATION

Master Compressor Control

On the main page on the operator interface, it is possible to view the state of the chiller. These states can be categorized into two sections:

Chiller States

- Idle
- Start System / Pull Down
- Run
- Stage Up
- Stage Down
- Alarm
- Fault
- Locked Out
- Manual

Compressor States

- Offline
- Resetting
- Ready To Run
- Ramping
- Running
- Alarmed
- Resetting With Fault
- Finished Reset With Fault
- Clearing Fault
- Locked Out
- Locked Out By Chiller

Offline

Communication statistics less than 50%, 50 communication attempts in the last 100 to a specific compressor have failed. If this happens, the compressor is deemed unreliable to control or has a power failure, disconnect wire etc.

Resetting

Compressor has just been powered up and is going through bearing and drive checks or compressor has just stopped and is going through IGV reset.

Ready to Run

Compressor is at idle with no faults or alarms and may be started at any time.

Ramping

Compressor is below its minimum operating speed and ramping up.

Running

Compressor is above its minimum operating speed with no alarms present.

Alarmed

Compressor is above its minimum operating speed with one or more alarms present. In this state, the compressor would be unloading itself.

Resetting With Fault

Compressor is shut down going through IGV reset with a fault present.

Finished Reset With Fault

Compressor is shut down with a fault present.

Clearing Fault

Chiller controller is attempting to clear a fault on one of the compressors.

Chiller controller is attempting to reset the compressor.

Locked Out By Chiller

Compressor has had more than 10 faults in a 12 hr period.

Compressor must be powered down and fully discharged, then powered back up in order to reset the fault.

Locked Out

Compressor has faulted on either high current, high discharge pressure, or three motor cooling faults in 30 mins. Each of these faults requires that the compressor is powered down and fully discharged, then powered back up in order to reset the fault.

Turning the Chiller On / Off

On the enclosure, there is no actual on / off switch provided. However, it is possible for the OEM to install an on / off switch in series with the BMS cooling call input.

By turning the switch to the “Off” position, the system will be disabled, turning the chiller / compressor(s) off (approx 0.5 second delay).

By turning the switch to the “On” position, the chiller will be put into operation (locally).

For the chiller to be enabled and provide cooling, the system is fitted with external interlocks, which are required to be closed.

Interlocks include:

- Chilled Water Flow
- Condenser Water Flow
- BMS Bypass – leave open circuited, unless service is required and the BMS needs to be bypassed in emergency operation

Within the digital inputs, there are other interlocks which are required to be open circuit during normal operation. If the contacts close, it means that a fault has occurred.

These interlocks include:

- External LP switch
- External HP switch
- Refrigerant Monitor
- Spare
- Emergency Stop

Auto Select

Once all the interlocks are made or closed, as per the above descriptions, the chiller will start the cycle of providing cooling.

Depending on the configuration, the chiller controller will automatically select the compressor (if a multiple configuration) with the least number of run hours.

The “auto roll over” compressor select feature, allows even run hours for the compressors installed on the chiller platform.

Anti Recycle Timer

Providing the Anti Recycle Timer on the compressor(s) has timed out, the compressor will be called on to run, and will ramp up to the required level, based on the commissioning setting specific to the application.

Note: Some chillers may require either a quick response to increase the load, or vice versa, and it will typically depend on the chilled water loop, the amount of time it takes to cycle the full amount of water through the system, and the way in which the AHU and associated valves are controlled in the field.

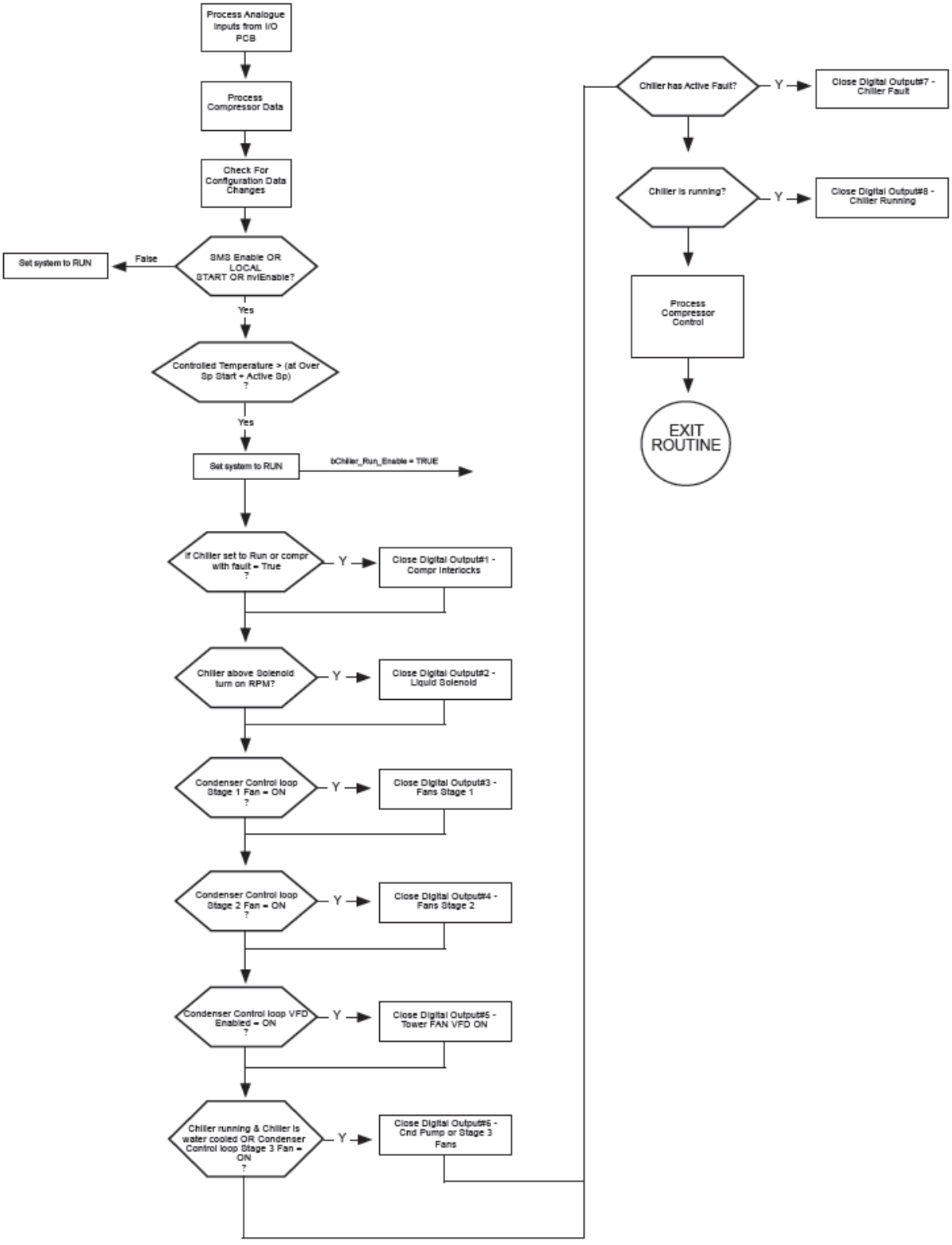
Part of the control strategy is to look at the load requirements and determine the compressor demand, which is done by a FUZZY PID control loop and the Kiltech compressor optimization loop. During the operation of the compressor and the control of the chilled water, the chiller controller is processing the necessary data points to target the optimum compressor speed/motor power to deliver the cooling required.

For multiple compressor applications, the chiller control will also target the optimum control point for any given condition.

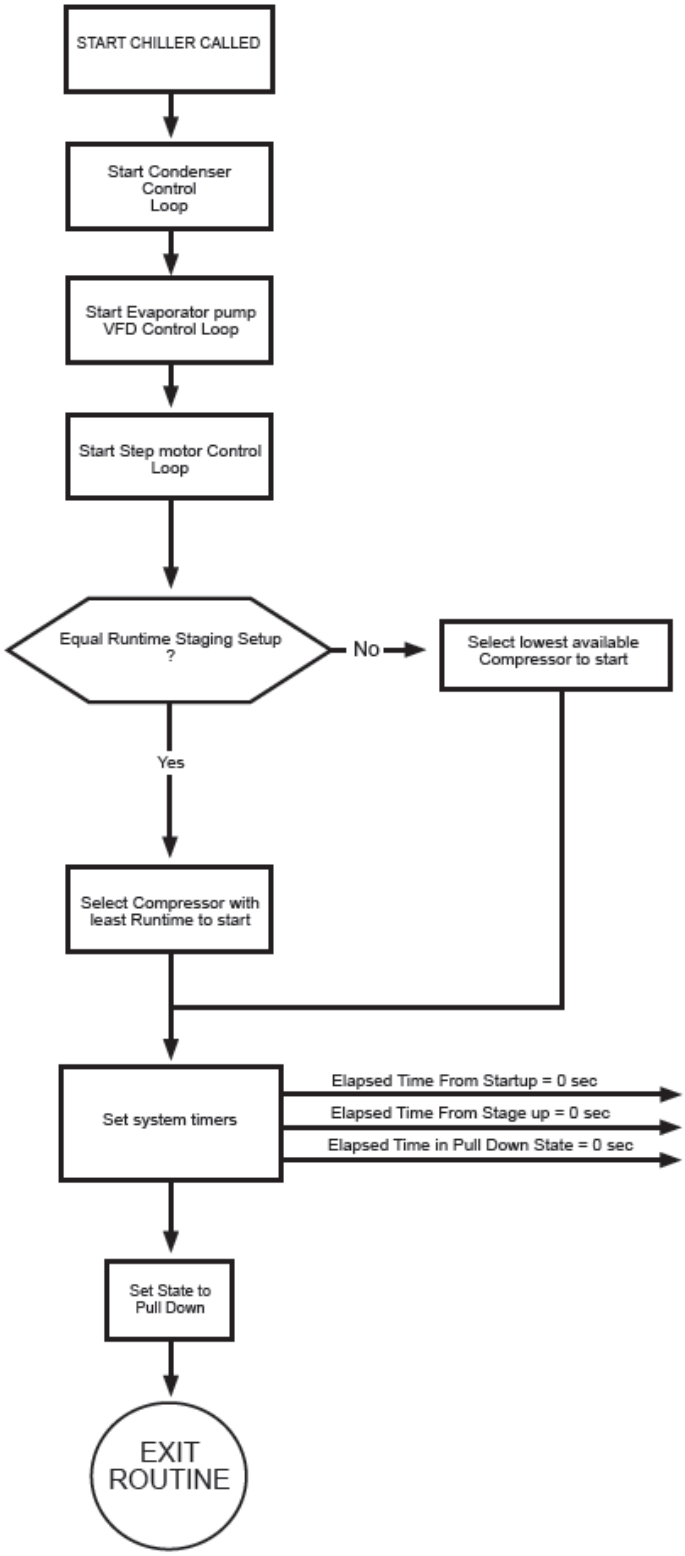
The information is dynamically changing and therefore the chiller controller needs to adjust to reset the optimum “sweet spot” for the chiller.

Within the commissioning settings, the commissioning engineer can input parameters to open the hysteresis or range of the control sweet spot, to avoid frequent and excessive cycling / ramping up of the compressors.

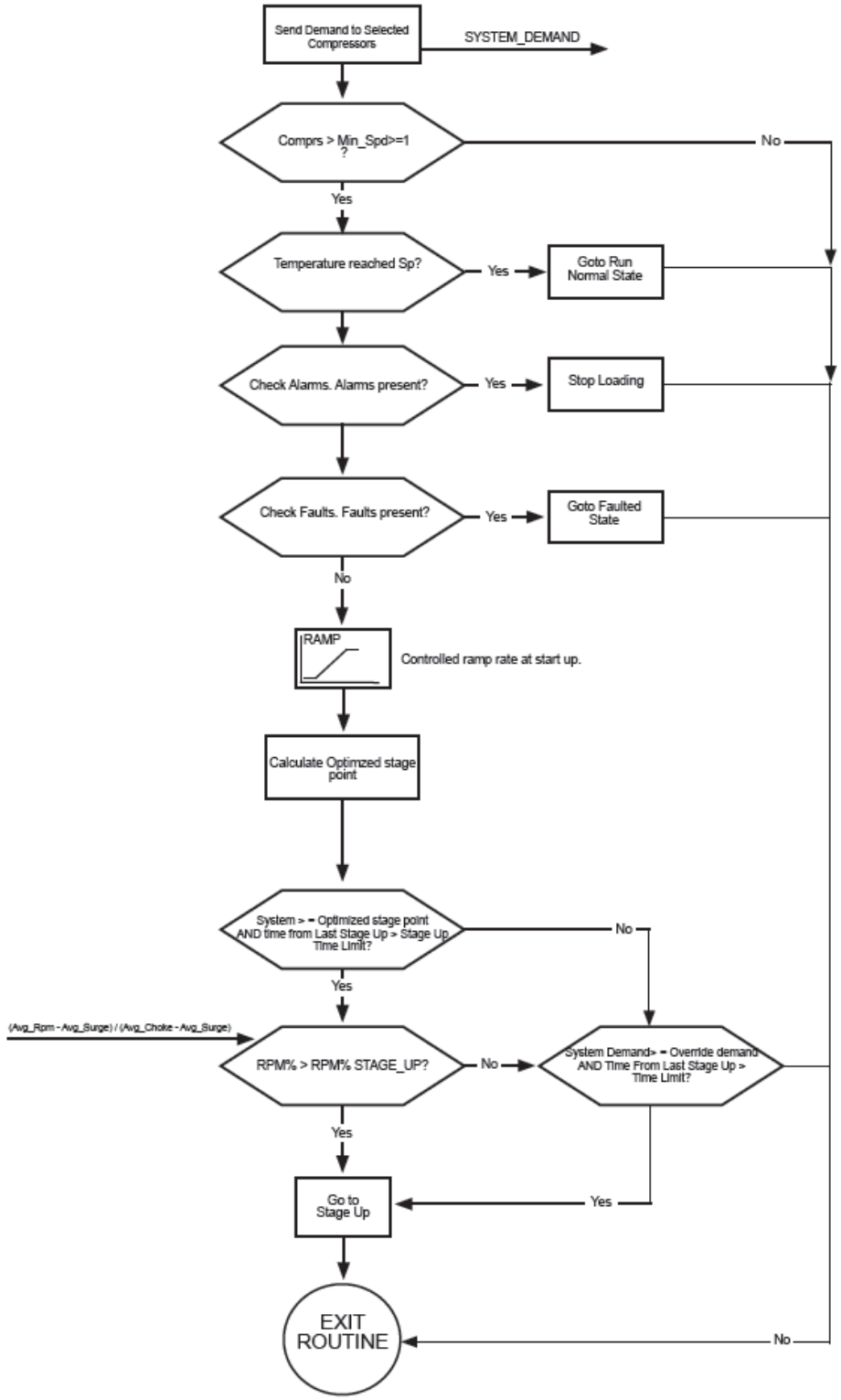
HIGH LEVEL CHILLER CONTROL FLOW CHART



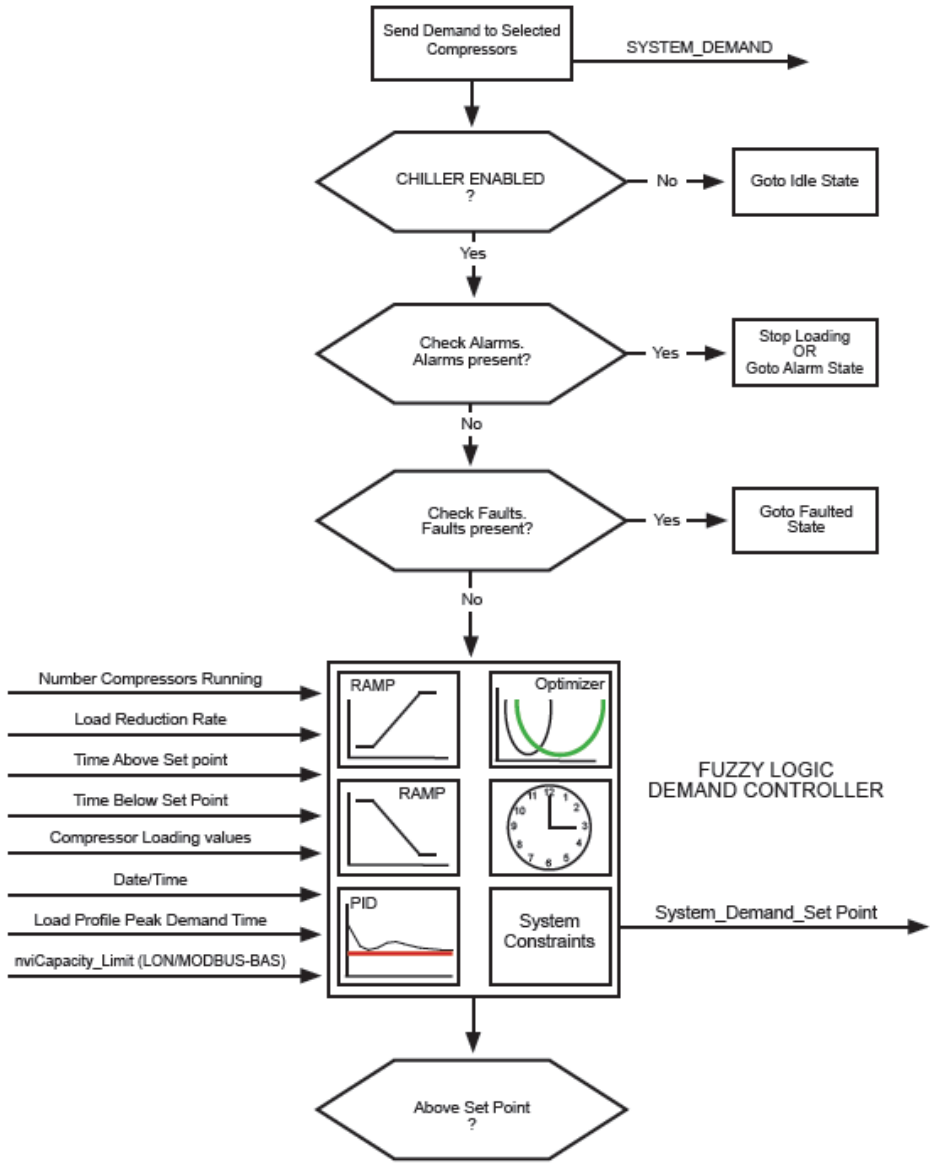
CHILLER STARTUP FLOW CHART



CHILLER PULL DOWN FLOW CHART

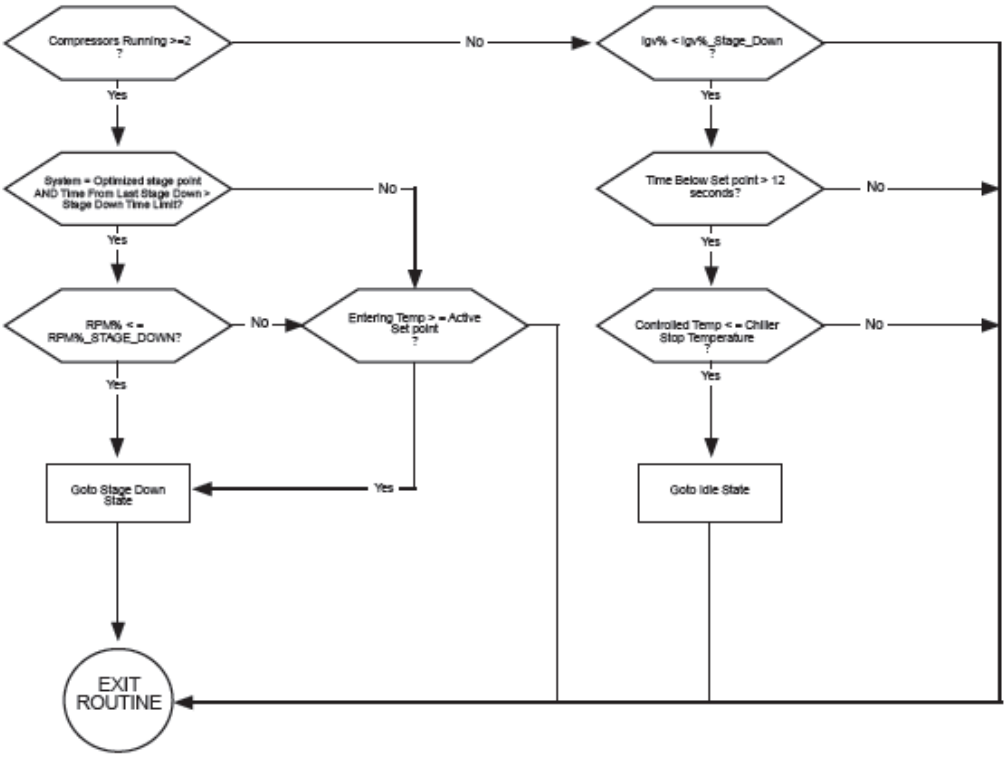


CHILLER RUN NORMAL FLOW CHART

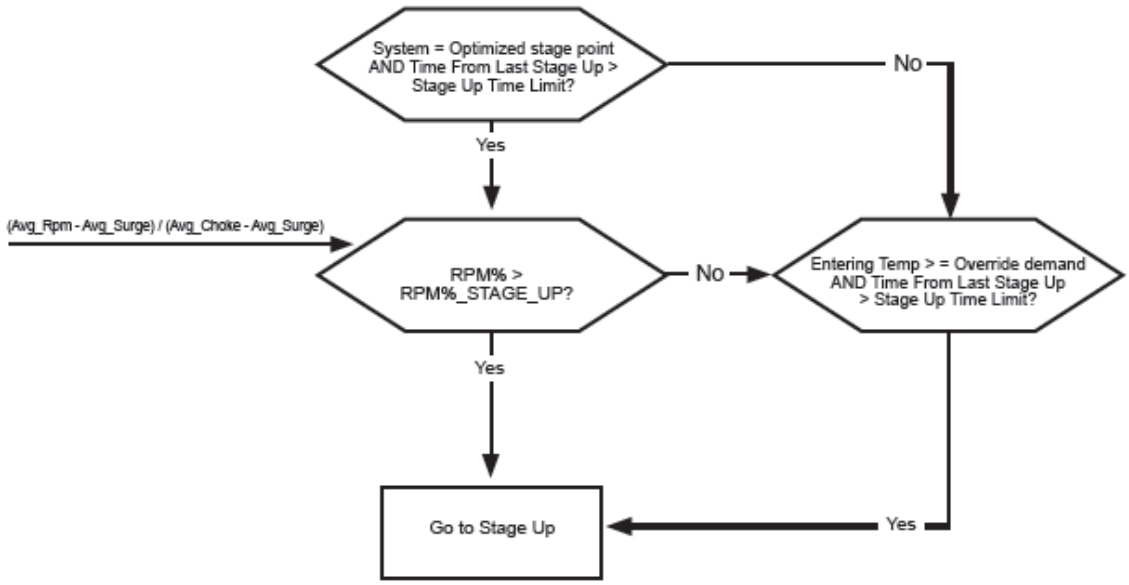


See Next Page for Control Above/ Below Set point

BELOW SET POINT



ABOVE SET POINT

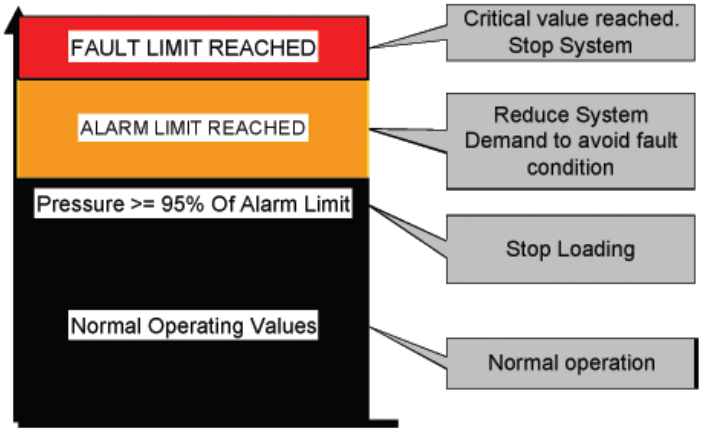


CHILLER ALARM & FAULT HANDLING CHART

The Kiltech Inc. Chiller Management System continuously monitors for abnormal system conditions such as low suction pressure, high discharge pressure, low leaving temperature, high amp draw and more.

The controller implements a three stage alarm management strategy in order to stay online as long as possible. The alarm management routine operates as follows:

ALARM STATE	ACTION REQUIRED
All monitored values Normal	No Action Required
One or more monitored values is within 5% of the alarm setting	If system is loading the system stops loading.
One or more monitored values is equal to or greater than the alarm setting	System demand is reduced by 0.5% per second until demand reaches 10% or compressors ride to the surge speed. If the alarm is still present and the compressors are at the surge speed the controller will enter stage down state turning compressors off every 120seconds until the last compressor is left online.
One or more monitored values is equal to or greater than the trip setting	Chiller is turned off, all compressors shutdown. The Fault will be automatically reset after the time value setup in the advanced setting screen (default =180sec). Once the fault has been reset the system is set back to idle state where it must wait for 180sec anti-recycle timer before starting the chiller again.



CONDENSER CONTROLLER – WATER COOLED SYSTEM

The Kiltech Inc. Chiller Management System contains the ability to control a water cooled condenser system that consists of a cooling tower fan, cooling tower fan fitted with VFD, and a condenser pump fitted with VFD.

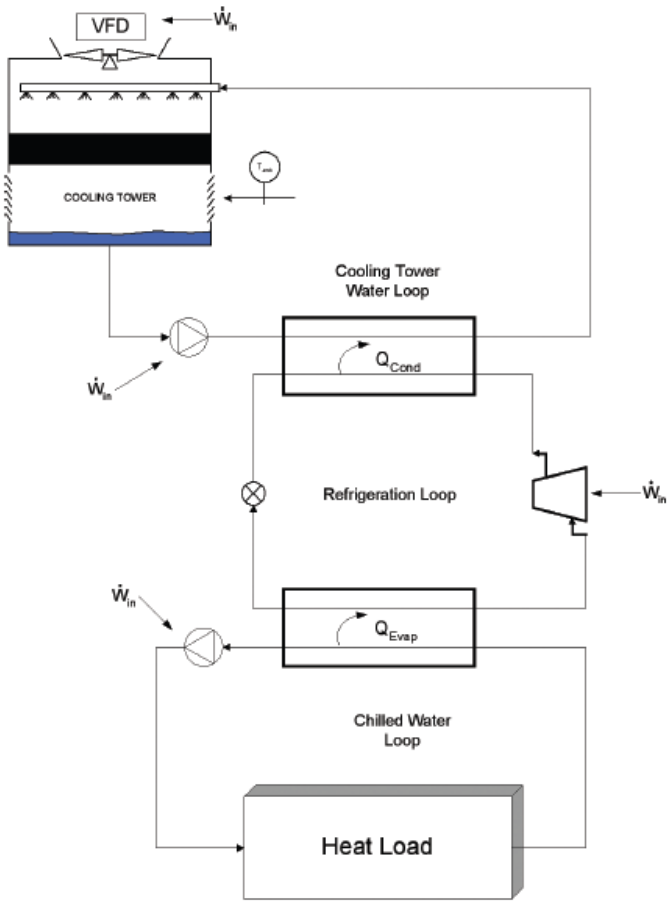
The condenser control system seeks to optimize the condenser loop's energy consumption, as well as optimizing chiller capacity during pull down conditions.

The control loop utilizes the following inputs and outputs to operate:

- Condenser inlet temperature
- Outdoor air relative humidity
- Outdoor air temperature
- 4-20mA VFD signal for tower fan
- 4-20mA signal for condenser pump VFD

Based on these inputs, the controller is able to calculate an ideal cooling tower return water temperature set point slightly above the wet bulb temperature.

The condenser pump is also controlled at its optimum value via a fixed mass relationship loop with the tower fan.



SCREEN NAVIGATION

Main Screen – System Information

The main page as displayed in Fig 1 below, is the summary page which allows the operator to view the chiller's operational conditions. It is from this main page that the operator will navigate through to other screens to obtain specific data relating to the operation and performance of the chiller package.

On this page the operator shall obtain:

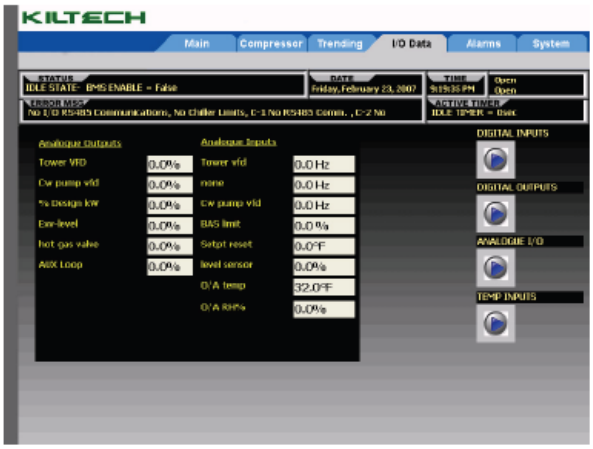
- System type
- External interlock status
- Alarms – if present
- Demand status
- Time
- Percentage maximum amperes
- Entering chiller water temperature
- Leaving chiller water temperature
- Compressor status
- Control set point

Fig. 1

I/O DATA – INPUT & OUTPUT MODULE

Depending on the number of (application specific) inputs/outputs utilized, the operator can view the feedback of either the current status or value of the sensors connected to the system.

Some values are a duplication of the values seen on the main system page. However, it provides a total snapshot of all items connected to the I/O module.



COMPS – COMPRESSOR LIVE DATA

When the “Comps” button is pressed, the operator will be routed to the Compressor Live Data screen, where it is possible to view the key operating conditions and points of each individual compressor, to gather data directly from the compressor via the Modbus Communication Network.

From this page the operator can view the following data from either one (1) or multiple compressors.

- Alarm codes
- Active fault code
- Demand applied to the compressor(s)
- Interlock status on the compressor(s)
- Compressor speed
- Inlet guide vane position
- Suction pressure
- Suction temp
- Suction superheat
- Discharge pressure
- Discharge temp
- Discharge superheat
- Power input to compressor
- Desired power from chiller cont.
- 3 phase amps
- Surge RPM
- Choke RPM
- Active CC faults and alarms
- Active BMCC fault

Note: If additional high level data is required from the compressor, the operator will require an authorized service provider to access this information via a laptop or dedicated PC containing appropriate monitoring software.

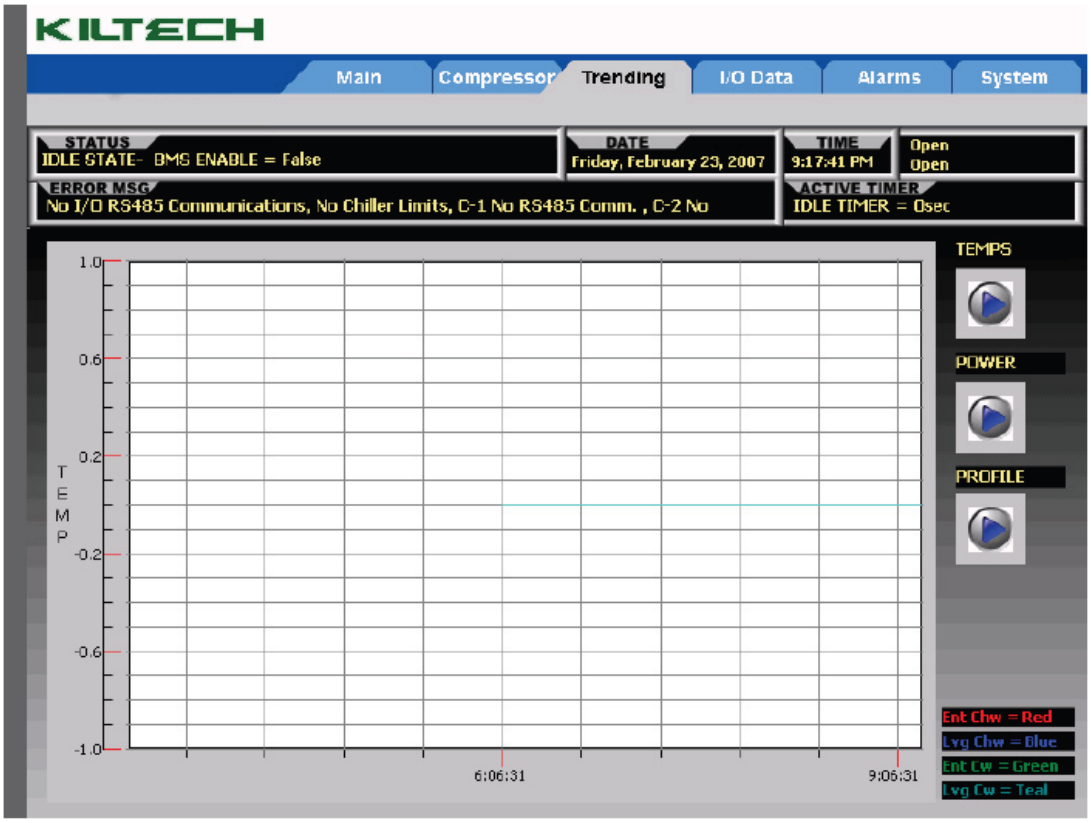
TRENDS – SYSTEM TRENDING

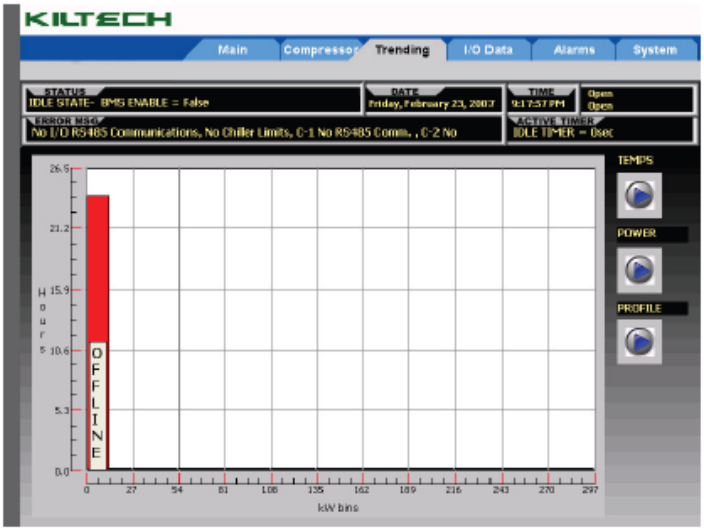
When the Trending button is pressed, the operator will be directed to the Trends page. This page provides a trend graph of the chiller's operational conditions. For convenience, additional menus have been created to scale the amount (time) of data samples on the screen.

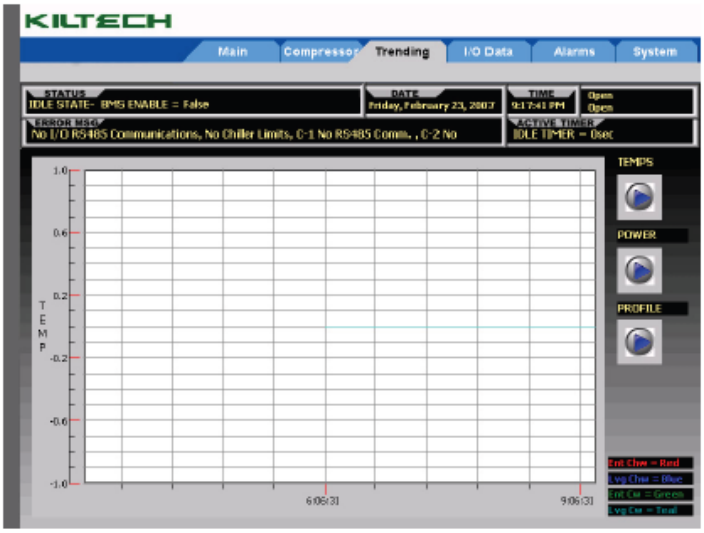
Key Trends available:

- Power Measurement
- Entering/Leaving Chilled Air/Water Temperatures
- Entering/Leaving Condenser Water Temperatures (Water Cooled Chiller) …. OR
- Saturated Suction / Discharge Temperatures (Air/Evaporative Cooled Chiller)
- Load Profiles (Page #2 - Weekly Profile)
- Energy Hours (Page #2 - Energy Hours)

Note: Once the operator has been directed to the Trending page, it is also possible to view weekly energy data and load profiles by pressing the Trending tab an additional time.







Upon review of the additional trends, the operator returns to the main trend page by pressing the Trend tab again, or decides to exit and presses a different navigation tab.

Note: This information is stored within the buffer memory of the chiller controller, therefore it can be retrieved at any time using the USB download feature. Refer to settings page.

This is useful information that can be integrated into monthly service documentation and/or energy reporting to facility managers and the like.

APPENDIX A – I/O REGISTER

Gen #3, Configuration #:10400 - Water Chiller – Full Function

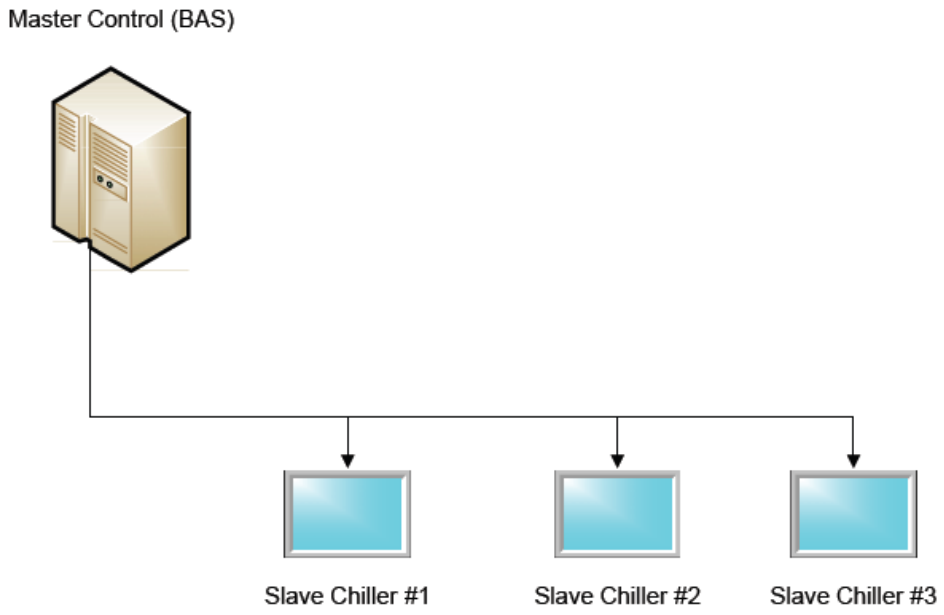
Digital Inputs	Digital Outputs	Analog Outputs	Analog Inputs	Temp Inputs
DI1 = Chiller Enable	DO1 = Compressor Interlock	AO1 = Tower VFD pos	AI1 = Chw dP (0-10psi)	TI1 = Chw In T
DI2 = Chw Flow Proof	DO2 = Tower Fan#1 Enable	AO2 = Tower Bypass Valve	AI2 = Cw dP (0-10psi)	TI2 = Chw Out T
DI3 = Cw Flow	DO3 = Tower Fan#2 Enable	AO3 = % Design kW	AI3 = BAS Demand Limit	TI3 = Cw In T
DI4 = LP Switch	DO4 = Chwp#1 Enable	AO4 = EXV Position	AI4 = Set Point Reset	TI4 = Cw Out T
DI5 = HP Switch	DO5 = Chwp#2 Enable	AO5 = Hotgas Valve	AI5 = Spare	TI5 = Liquid T
DI6 = Spare	DO6 = Cwp#1 Enable	AO6 = Spare	AI6 = Liquid Level-1	TI6 = OAT
DI7 = Spare	DO7 = Cwp #2 Enable	AO7 = Compressor Bypass-1	AI7 = Cond. Pressure	TI7 = Spare
DI8 = Chwp#1 Status	DO8 = Call Next Chiller	AO8 = Compressor Bypass-2	AI8 = Spare	TI8 = Spare
DI9 = Chwp#2 Status	DO9 = Chiller Ready	AO9 = Compressor Bypass-3		
DI10 = Cwp#1 Status	DO10 = Chiller Run	AO10 = Compressor Bypass-4		
DI11 = Cwp#2 Status	DO11 = Spare	AO11 = Compressor Bypass-5		
DI12 = CTF#1 Status	DO12 = Chiller Fault SPDT	A O12 = Compressor Bypass-6		
DI13 = CTF#2 Status				
DI14 = Refrigerant Monitor				
DI15 = Spare				
DI16 = Cond. Rupture Disc-1				
DI17 = Cond. Rupture Disc-2				
DI18 = Evap. Rupture Disc-1				
DI19 = Evap. Rupture Disc-2				
DI20 = Chw Isolation Valve EPS				
DI21 = Cw Isolation Valve EPS				
DI22 = Generator Power On				
DI23 = Generator Switch Request				
DI24 = E Stop				

APPENDIX F – HIGH LEVEL COMMUNICATION DEFINITION

Introduction

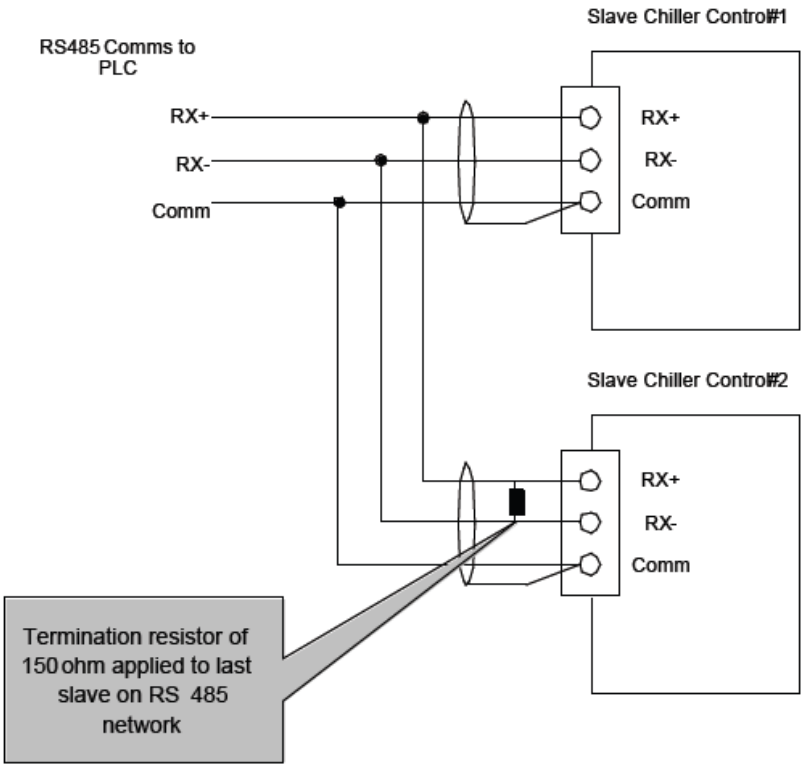
The Kiltech Controller Series uses the Modbus RTU protocol; a protocol widely used in the HVAC and industrial automation industries. This manual explains how the Modbus communication functionality works. For information on how the chiller controller operates, please refer to the complete Kiltech chiller control operating manual.

With Modbus communications, data transfer is possible between a single master (PLC) and up to 64 Kiltech Chiller Controllers (the slave). As the master (the BAS) transfers data simultaneously between single slave chiller controllers, the address for each slave must first be set. The slave chiller controller receiving data from the master will execute the instructed function, and then respond to the master (BAS).



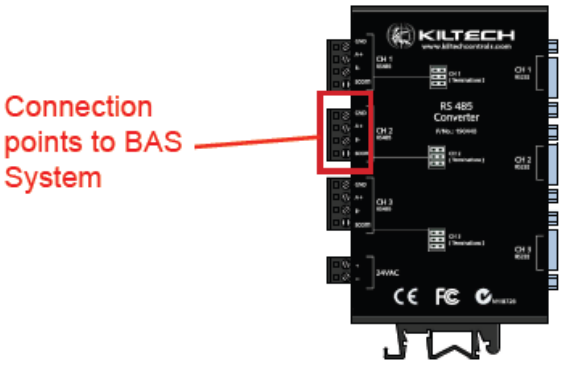
CONNECTION DIAGRAM

Interconnection Diagram during RS-485 Transfer



Above: Sample connection diagram between multiple controllers and master plc.

Below: Connection points found on left hand side of RS485 Converter



COMMUNICATION RELATED PARAMETERS

Before the Kiltech Chiller Controller can communicate with a master controller, the serial communication parameters must be set up via the touch panel. Communication parameters are found in the "Chiller Commissioning Screen", a service password is required to gain access to this page – see Kiltech Chiller Control Manual.

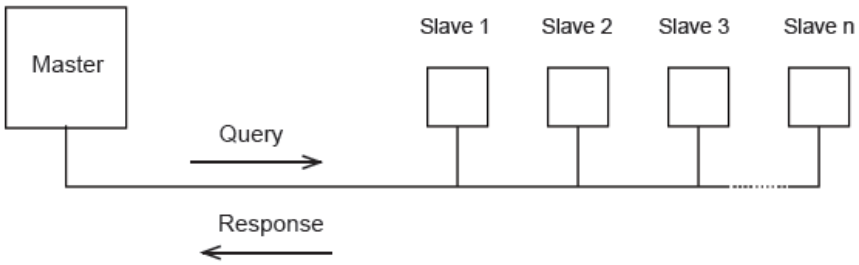
Baud Rate – possible settings = 9600, 19200, & 38400
Stop Bits – possible settings = 1 or 2
Modbus Slave Address = 1 to 64

The Modbus RS485 parity is fixed at none.

The inverter uses an RTS signal when operating with an RS-485 transfer, switching the transfer direction for sending and receiving.

MODBUS MESSAGES & MODBUS PROTOCOL

Communication on a MODBUS Network is initiated (started) by a "Master" (BAS) with a "query" to a "Slave" (Chiller Controller). The "Slave", which is constantly monitoring the network for "Queries", will only recognize "Queries" addressed to it, and will respond either by performing an action (setting a value for example), or by returning a "response" Only the Master can initiate a query.



In the MODBUS protocol, the master can address individual slaves, or, using a special "Broadcast" address, can initiate a broadcast message to all slaves. The SPR and Integra products do not support the broadcast address.

For further information, ref. HTTP://WWW.MODBUS.ORG

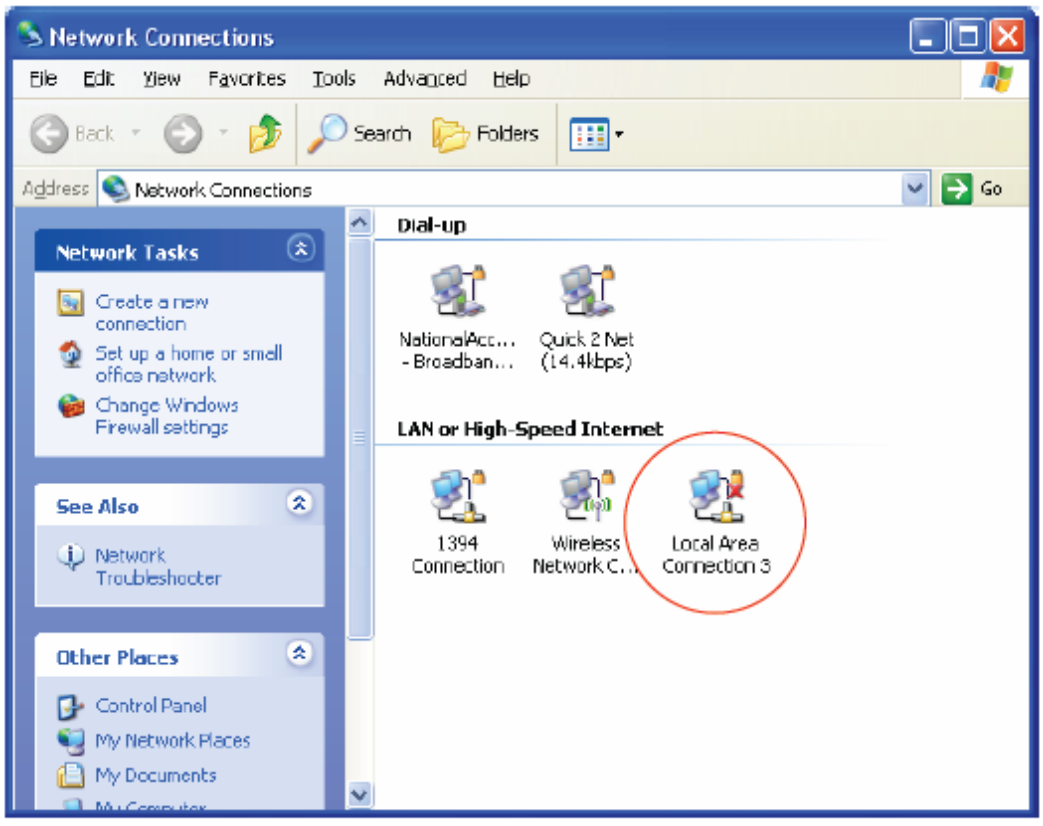
APPENDIX G – DIRECT CONNECTION OVER IP

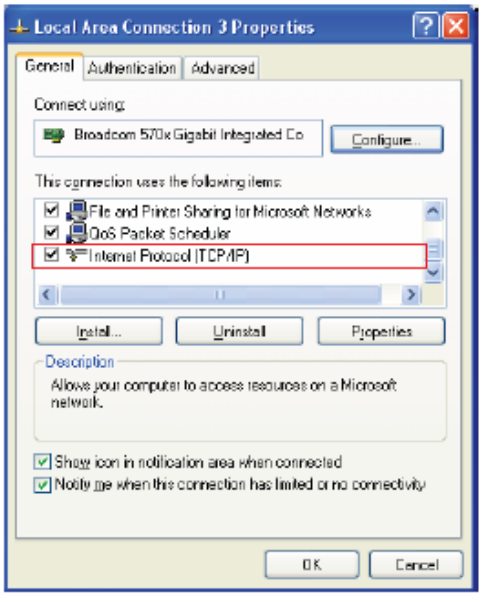
To connect to the controller touch panel via the Ethernet crossover cable, the following procedure should be used:

1. Connect the crossover cable to both the PCs Ethernet port and the touch panels Ethernet port.

2. From the windows start menu, firstly navigate to “Connect To” and then to “Show All Connections.”

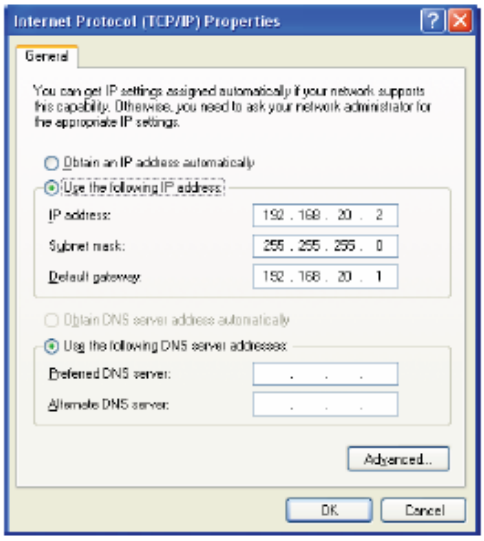
3. Find the PCs wired Ethernet controller icon, and right mouse click it and select “Properties.”





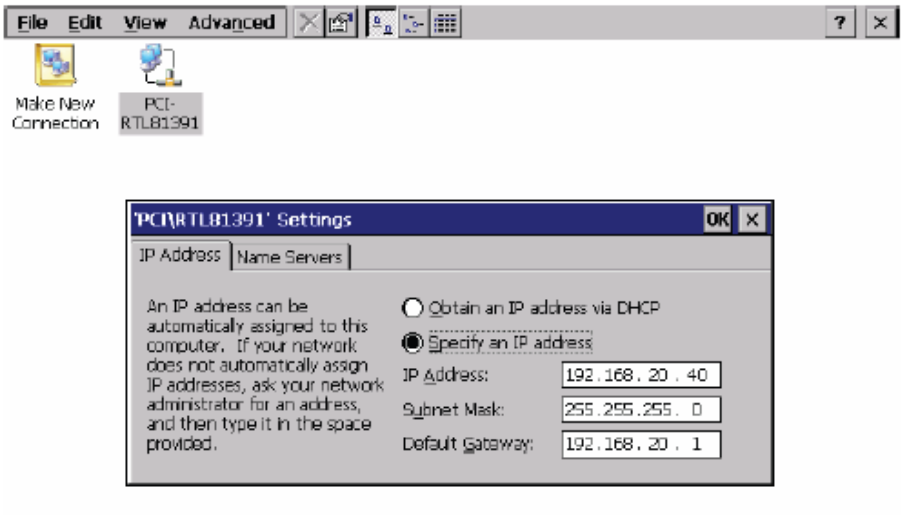
4. From the menu, select Internet Protocol" (TCP/IP) and press the properties button.

5. Next, set-up the PC for fixed IP address settings See example below:

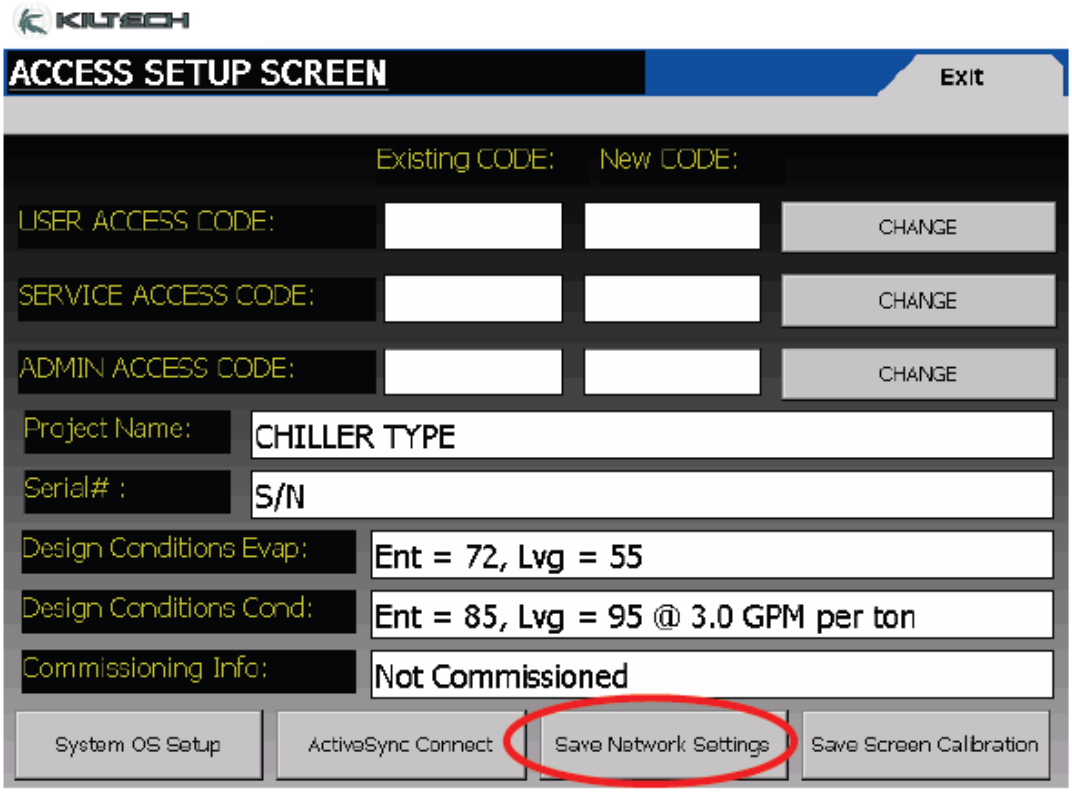


6. Click OK to accept the settings and then close the Local Area Network (LAN) connection properties window.

7. Now go to the touch panel and enter the set-up screen and navigate to: "Operating System & User Access" → "System OS Set-up" then double click the "Network and Dial-up Connections" button.

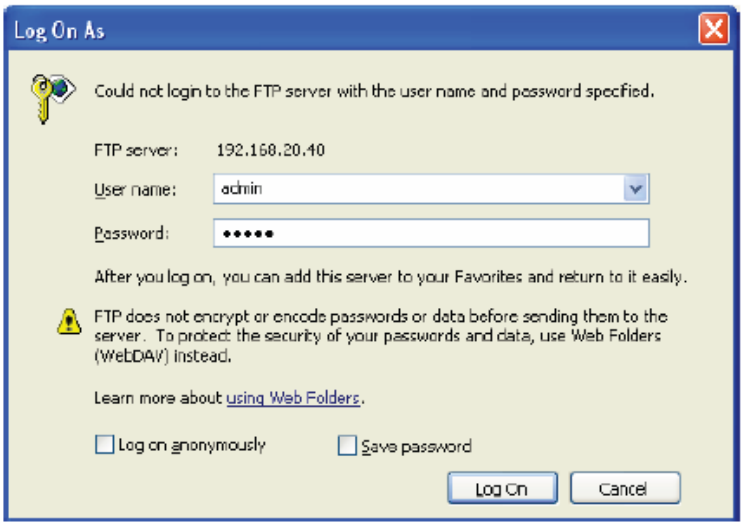


8. With a keyboard plugged into the controller, enter an IP Address that matches the same network setting as the PC, but with a different end number for the IP Address. Then click OK, close the network setup page and close the control panel page.

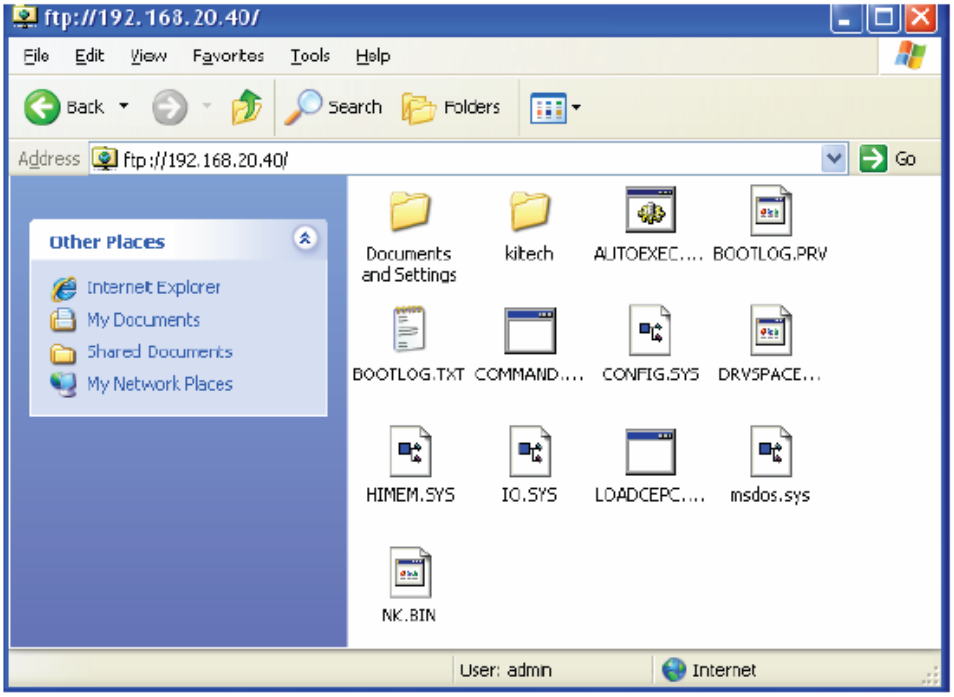


9. Save the network settings that have been configured by pressing the “Save Network Settings” button.

To connect to the controller's ftp server, open an internet explorer window and type the following in the address bar: ftp:// ADMIN@192.168.20.40

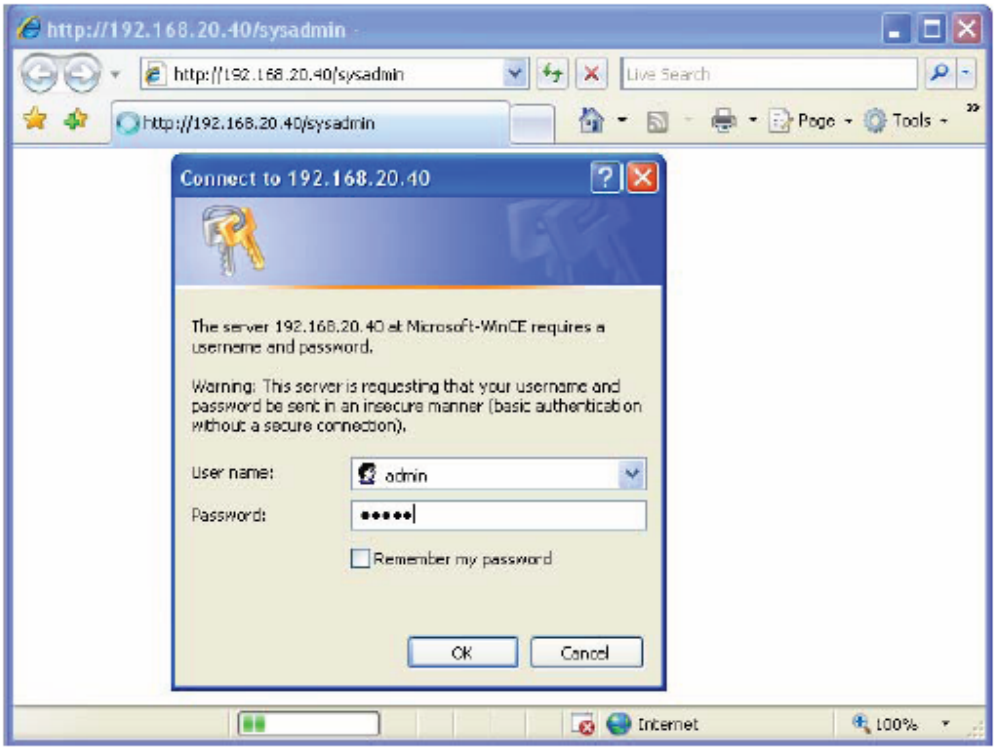


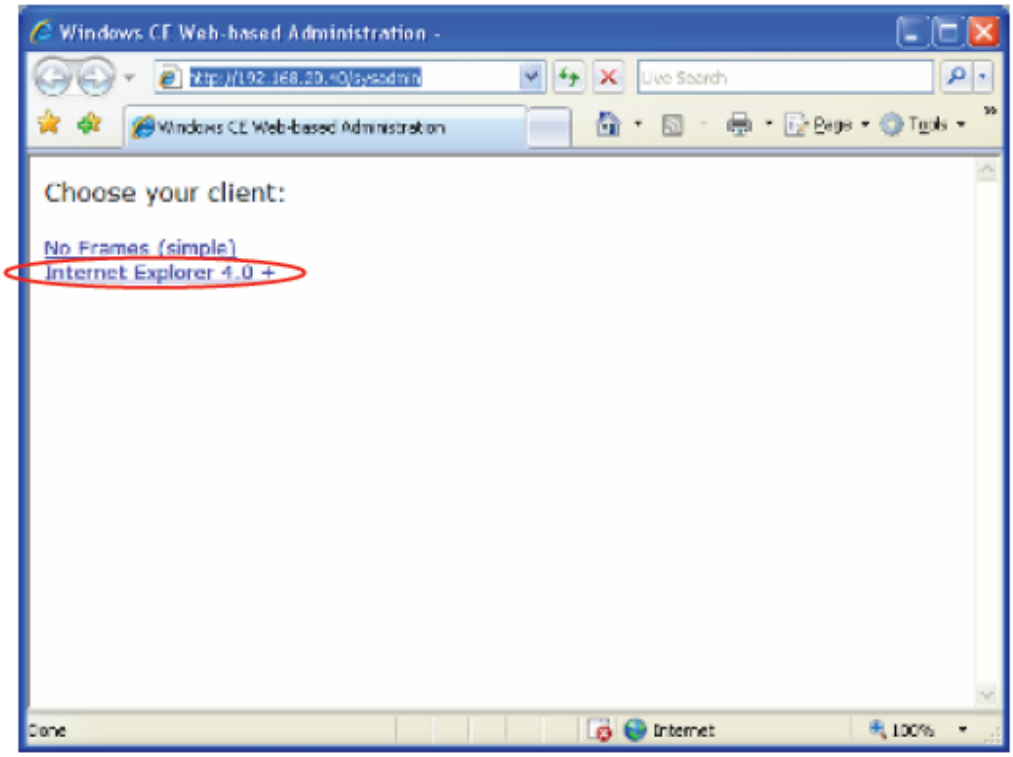
The above log on box should appear.
Enter "admin" in the password box and press "Log On"

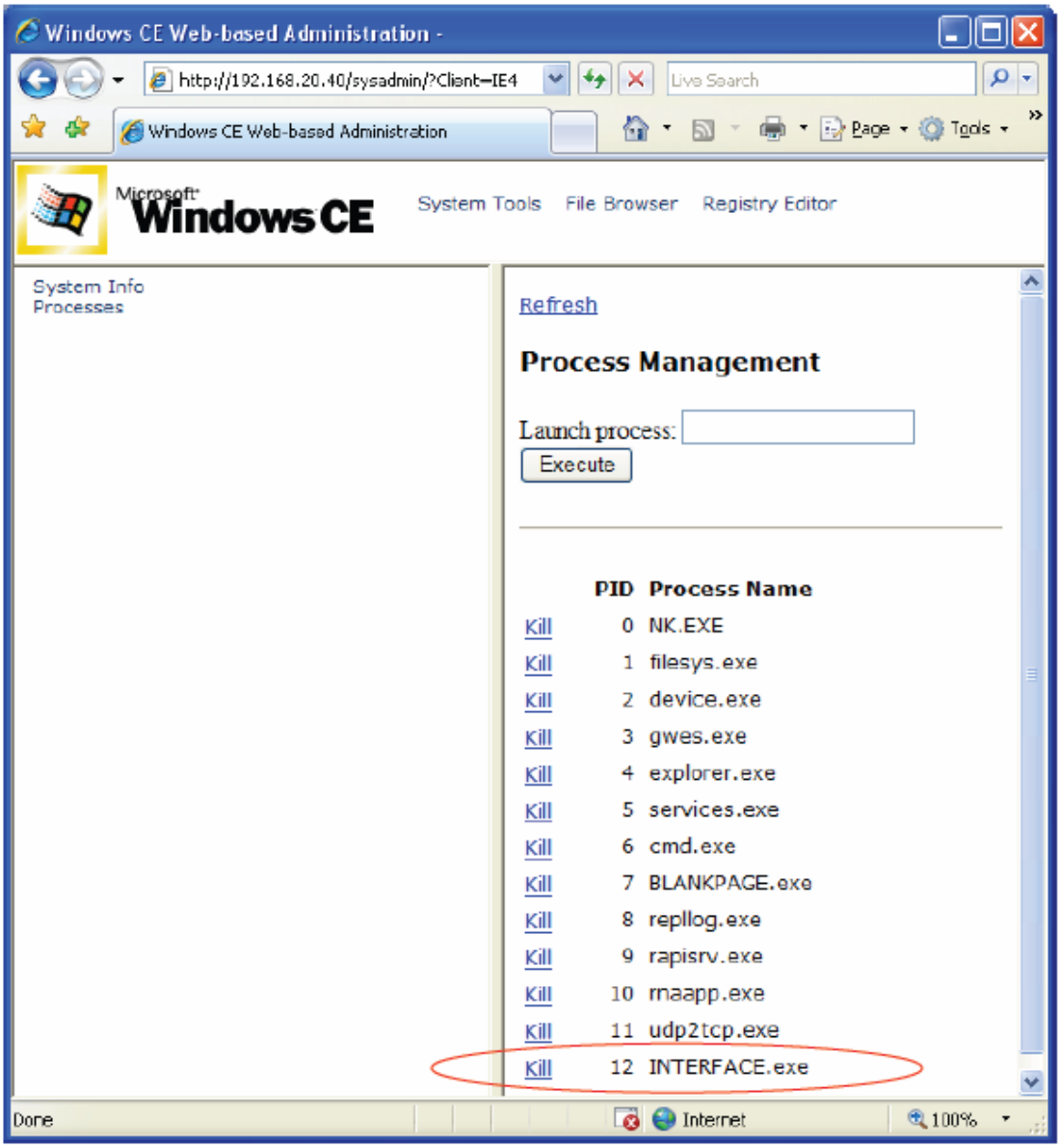


The user now has ftp access to the controller and may update files as required.

To access the controller via internet explorer, load files, and start/stop the control application running, proceed thus:







If the software is to be remotely updated via the internet, the “interface.exe” process should first be stopped.

Once the interface is stopped, then the new software may be loaded via the ftp server.

To start the chiller control software again, type “startup_app” in the launch process box.

APPENDIX H – COMMISSIONING FORM

Contact SMARDT Product Support to obtain Commissioning Form.

The following specific pages have been extracted from the

SMARDT – KILTECH GEN 4 COMPRESSOR MANAGEMENT CONTROLLER MANUAL

The full Gen 4 Compressor Management Controller Manual is available upon request

PRODUCT OVERVIEW

INTRODUCTION

The purpose of this manual is to describe the installation, functionality and operation of the Kiltech Compressor Management Control System, which is specifically designed for applications where the Turbocor™ centrifugal compressor is being integrated on OEM Chillers and / or for retrofit applications.

The controller consists of specific software suitable for the control and optimization of six (6) Turbocor™ compressors, and for auxiliary components for a given refrigeration application.

Note: As a prerequisite, all readers should be fully conversant with the Turbocor™ technology and have sufficient training and application experience. The reader must also have access to the relevant Danfoss Turbocor™ documentation, and use this document as an “application supplement” when integrating the compressor into a given system.

SAFETY GUIDELINES

Every control system has its own unique set of requirements, which are based on each particular application. Please ensure that all National, State and Local government requirements are met when applying this product.

Throughout this manual, there will be reference to specific safety symbols, which are intended to highlight their importance to the reader.

⚠ CAUTION

The caution symbol and associated text will warn the reader about the possibility of damage to the equipment, data, and other mechanical devices.

⚠ WARNING

The warning symbol and associated text will warn the reader about the possibility of minor personal injury.

⚠ DANGER

The danger symbol and associated text will warn the reader about the possibility of serious or fatal personal injury.

The Kiltech Compressor Management Control System performs the following primary functions:

•Provides optimum control of the entire chiller / system, compressors, and auxiliary devices, in order to achieve higher energy efficiency.

•Performs real time system monitoring, analysis, and fault display.

The controller features an integrated color 12.0" TFT panel mounted touch screen display and embedded real time microprocessor, giving the operator the ability to:

•View compressor operational data points

•View the necessary input & output data points

•View and adjust set points

•View and adjust timers where applicable

•View operational trends and system performance

•Acknowledge and reset warnings and alarms

•View the alarm history

TERMS AND DEFINITIONS

SST - Saturated Suction Temperature

SDT - Saturated Discharge Temperature

kW/Ton - Kilowatts (energy) per Tons of Refrigeration

COP - Coefficient of Performance

I/O - Input/Output

AO - Analogue Output

AI - Analogue Input

DI - Digital Input

DO - Digital Output

BMS - Building Management System

LED - Light Emitting Diode

Evap. - Evaporator

Cond. - Condenser

CH. W - Chilled Water

CO.W - Condenser Water

VDC - Volts, Direct Current

VAC - Volts, Alternating Current

RH % - Relative Humidity

NTC - Negative Temperature Coefficient

VFD - Variable Frequency Drive

kW - Electrical Power (energy)

kWR - Kilowatts (refrigeration)

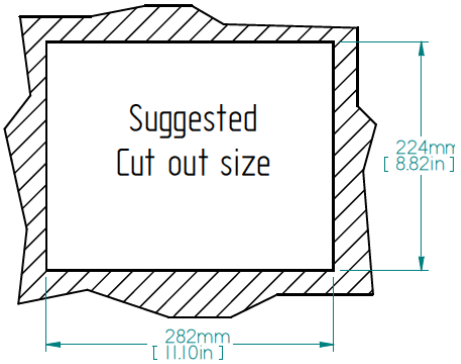
OEM - Original Equipment Manufacturer

EXV - Electronic Expansion Valve

INSTALLATION

The Kiltech compressor management controller is supplied either as an OEM kit or as a pre-packaged electrical enclosure complete with terminal strip and auxiliary switch gear. The control system comes equipped with the operating system and application software installed, ready for installation at the OEM's manufacturing facility. The installation of the device and connections to the I/O may vary, depending on the specific model of the chiller or application type.

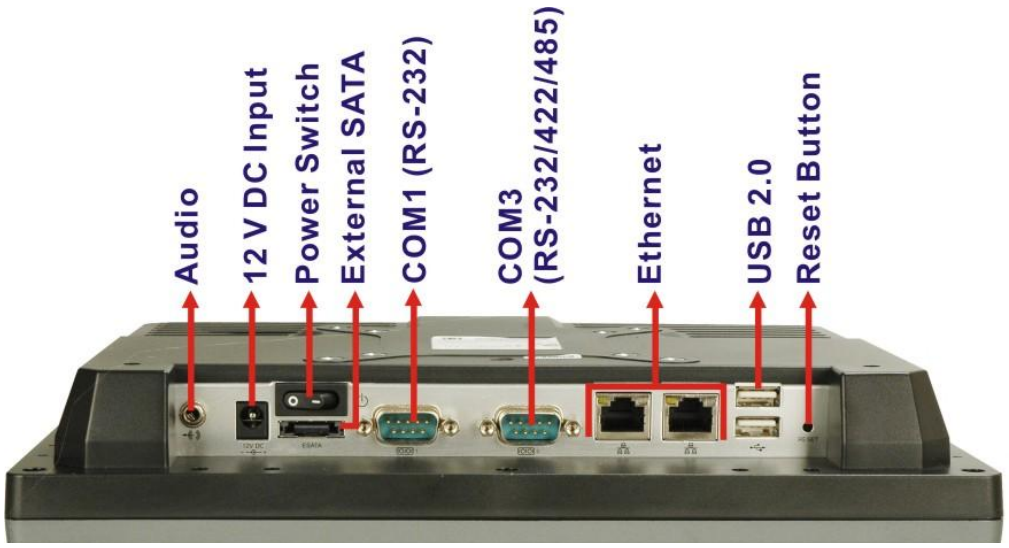
LCD Size: 12.0"
Max Resolution: 1024 x 768
Brightness: (cd/ÜF) 400
Contrast Ratio: 500:1
LCD Color: 262K
Backlight MTBF: 50000
CPU: Intel® Atom™ process N270 1.6GHz CPU
RAM: Supports one 2GB (maximum) 400MHz or 533MHz DDR2 SO-DIMM
I/O Ports: 1 x RS-232 COM port
1 x RS-232/422/485 COM port
2 x RJ-45 for 10/100Mbps
LAN: 2 x USB 2.0
1 x Power Switch
1 x Reset Button
Construction Material: ABS + PC Plastic front frame
LED Function: 1 x Power ON/OFF LED on front panel
Mounting: Panel,
Operation Temp.: 0°C~50°C
Storage Temp.:-20°C~60°C
IP Level (front panel): IP 64
Safety & EMI: EMC, CE, FCC, UL and CCC
Touch Screen: Resistive Type 5-Wire, (touch controller IC is on board)
Power Requirement: 12VDC or 18~30VDC
Power Consumption: 32W



CPU - PC PANEL LAYOUT

All connections to the PC Panel are located at the bottom of the rear cover, to allow for the following:

CPU Power Supply (12V DC)
- On/Off Switch
- COM Port #1
- COM Port #2
- USB Ports x 2
- LAN Connections x 2
- Reset



I/O MODULE

I/O MODULE (39 POINT OPTION) - SPECIFICATIONS

Supply Voltage
24V AC/DC, 50/60 Hz, 30VA required. Supply voltage fused on board at 1.25A.

Temperature Input - 8
8 Thermister inputs – Software scaled for 10K NTC (Type F) sensor, 10 bit accuracy.

Digital Inputs - 8
8 Digital inputs (Opto isolated) – pull up voltage is 24VDC supplied internally, input impedance = 20kOhm, debouncing hardware integrated.

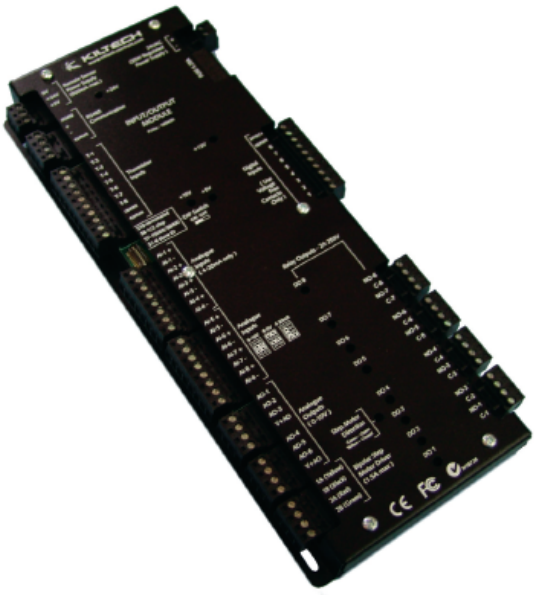
Digital Outputs - 8
8 Digital/Relay outputs – 5 Amps@250VAC Rated (Normally Open). 4 kV potential separation.

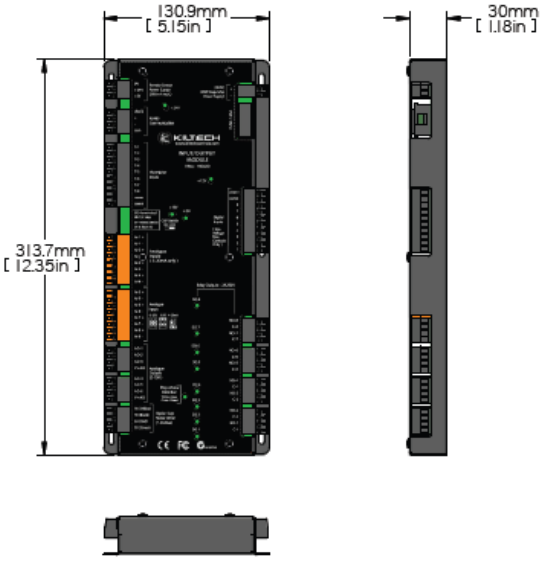
Analogue Inputs - 8
4 Analogue Inputs (1 to 4) – Non selectable 4-20mA, 10 bit accuracy.
4 Analogue inputs (5 to 8) – Three (3) selectable ranges (4-20mA, 0-5VDC or 0-10VDC)

Analogue Outputs - 6
6 Analogue Outputs – Non selectable, 0-10VDC only.

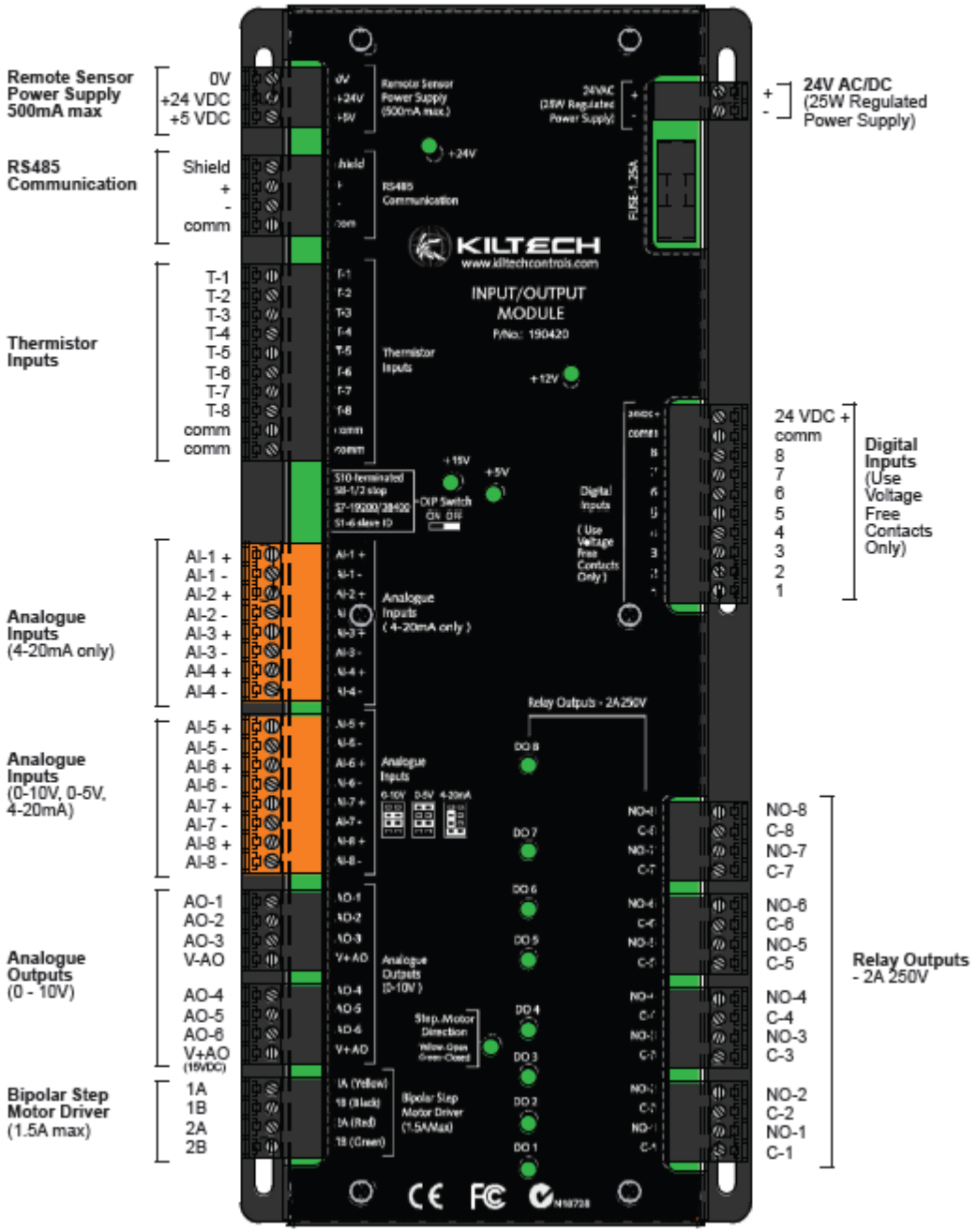
Stepper Motor Driver - 1
1 Bipolar stepper motor driver – Micro-stepping, rated to 1.5A, software configurable number of steps and step rate.
Drive – Alco, Danfoss, Sporlan and PowerPax electronic expansion valves.

Onboard Power Supplies
5VDC and 24VDC 500mA max. for use with sensors.





I/O MODULE (39 POINT OPTION) - TERMINAL LAYOUT



I/O MODULE (65 POINT OPTION) - SPECIFICATIONS

Supply Voltage
24V AC/DC, 50/60 Hz, 30VA required. Supply voltage fused on board at 1.25A.

Temperature Input - 8
8 Thermister inputs – Software scaled for 10K NTC (Type F) sensor, 10 bit accuracy.

Digital Inputs - 24
24 Digital inputs (Opto isolated) – pull up voltage is 24VDC supplied internally, input impedance = 20kOhm, debouncing hardware integrated.

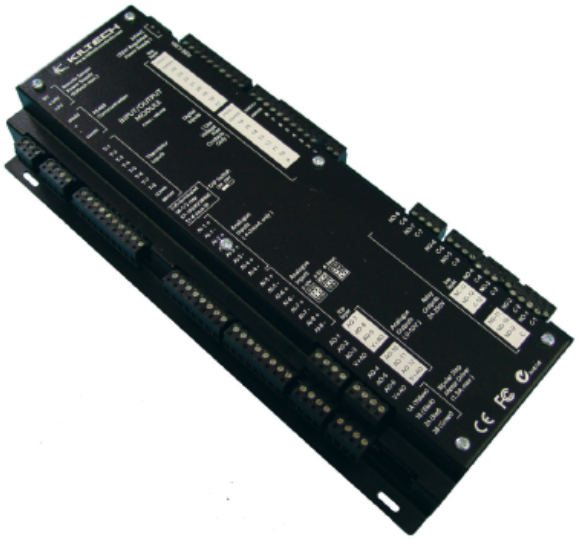
Digital Outputs - 12
12 Digital/Relay outputs – 5 Amps@250VAC Rated (Normally Open). 4 kV potential separation.

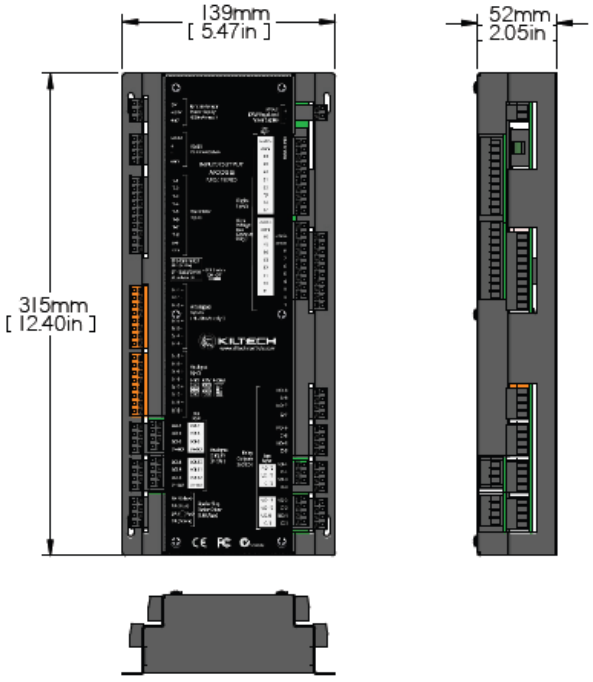
Analogue Inputs - 8
4 Analogue Inputs – Three (3) selectable ranges (4-20mA, 0-5VDC or 10VDC)
4 Analogue inputs – non-selectable 4-20mA, 10 bit accuracy.

Analogue Outputs - 12
12 Analogue Outputs – Non-selectable, 0-10VDC only.

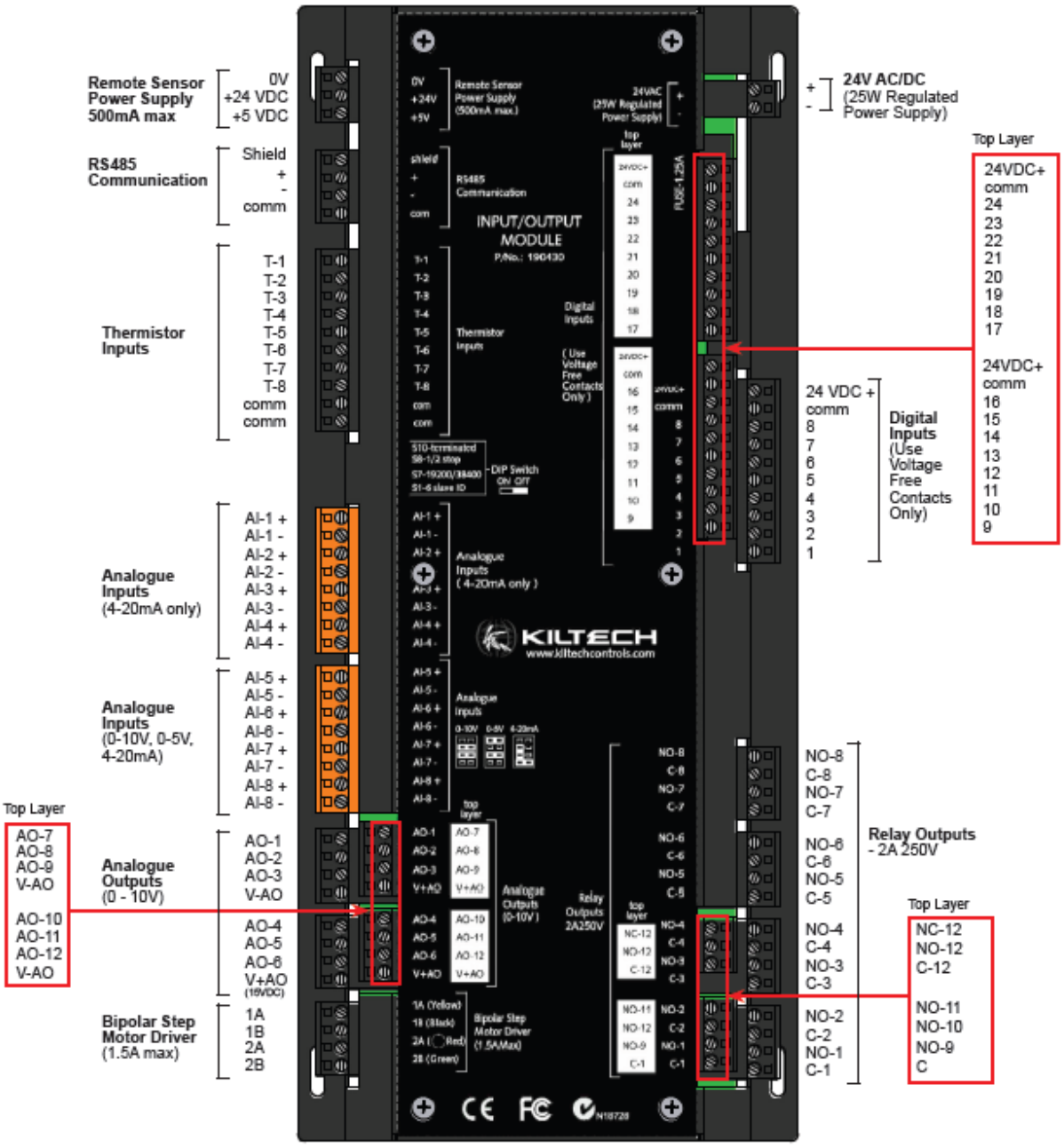
Stepper Motor Driver - 1
1 Bipolar stepper motor driver – Micro-stepping, rated to 1.5A, software configurable number of steps and step rate.
Drive – Alco, Danfoss, Sporlan and PowerPax electronic expansion valves.

Onboard Power Supplies
5VDC and 24VDC 500mA max. for use with sensors.

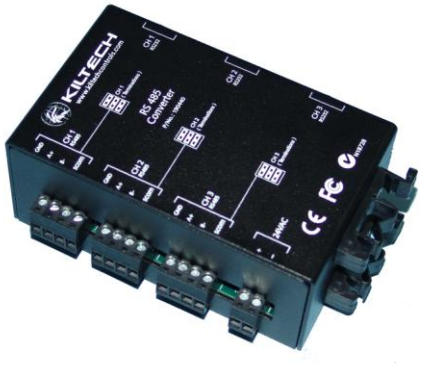




I/O MODULE (65 POINT OPTION) - TERMINAL LAYOUT



RS 485 CONVERTER

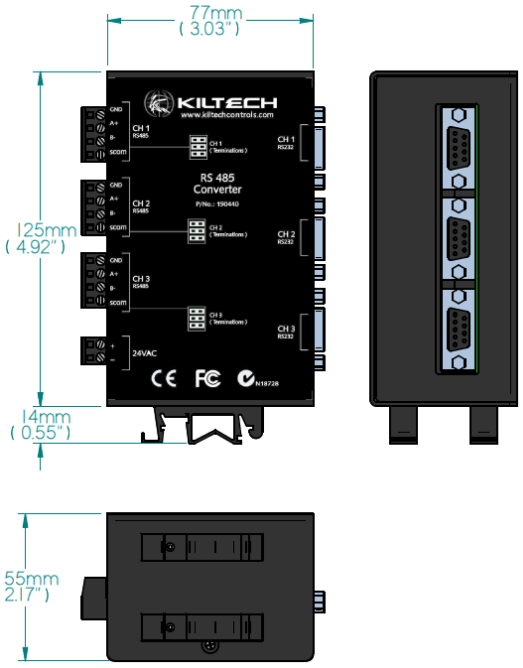


SPECIFICATIONS

Supply Voltage
24V AC/DC, 50/60 Hz

RS232 to RS485 Channels
3 of RS232 to RS485 converter channels
(Opto isolated)

Mounting
DIN RAIL mount



PROTOCOL CONVERTER

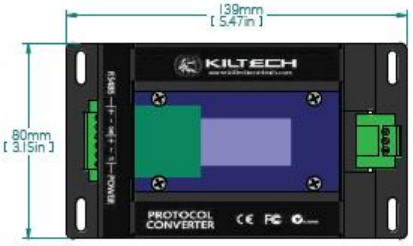
SPECIFICATIONS

Supply Voltage
24V AC/DC, or 5VDC (jumper selectable)

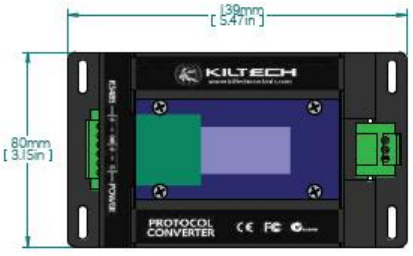
Standard Options Available:
Modbus RTU - LON
Modbus RTU - BACnet
Modbus RTU - Metays N2

- *Specific application data available on request.*
- *Other options available on request if required.*

Lon



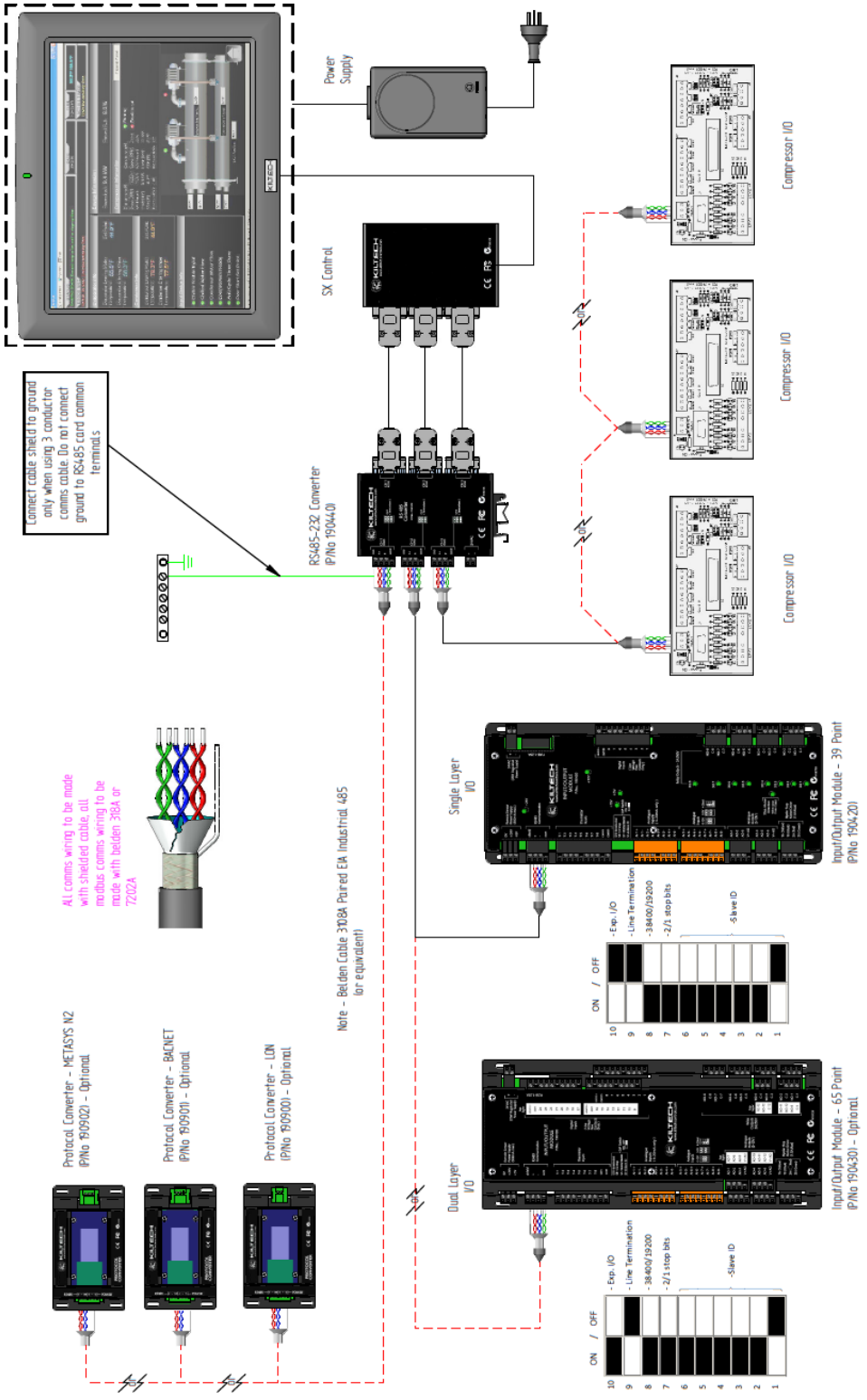
BACnet



Metasys N2

NETWORK DIAGRAM

Typical Layout



OPERATION

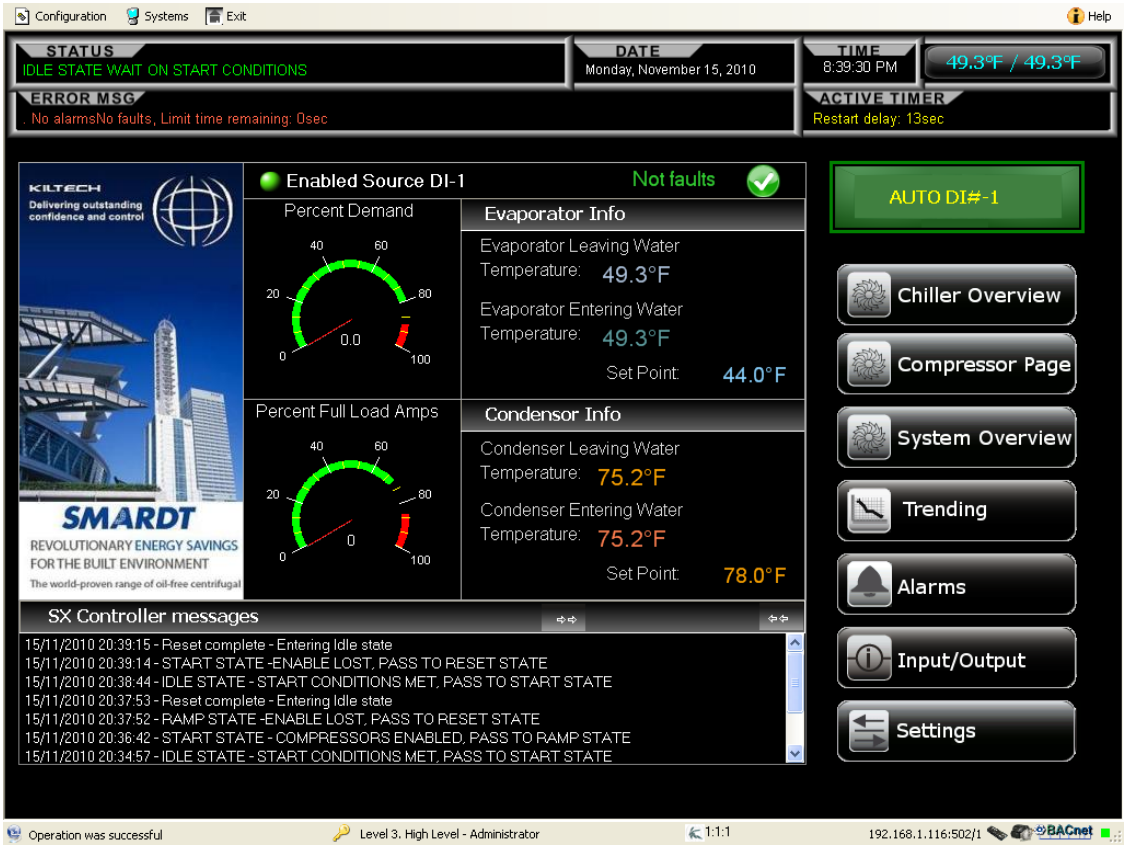
The chiller control system is equipped with a 12.0 inch colour touch screen, providing a simple and effective way to navigate through the system to obtain / view operational data and to carry out simple procedures on the chiller system.

The controller consists of 7 navigational soft keys and the start / stop software button located on the right hand side of the display.

From this page, the operator can:

- View current chiller status
- View active error messages
- View time/date
- View active timers
- View entering and leaving chilled water temperature
- View chilled water set point
- View entering and leaving condenser water temperatures (water cooled chillers)
- View condenser water set point
- View percentage of running amps
- View percentage of running demand
- View active cooling call
- View active fault status
- Access detailed operational data via soft keys

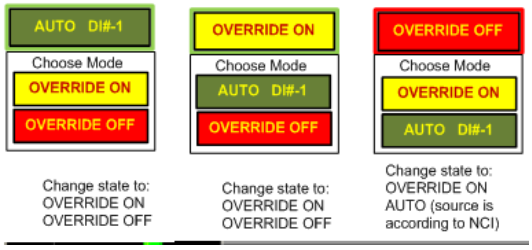
Located at the bottom of the main screen page, is the SX controller message window which displays sequential active chiller control events.



TURNING THE CHILLER ON / OFF

In the Kiltech control system, there is no actual mechanical “on / off” switch provided. However, there is an integrated soft key on the main system page, which can be used to either enable / disable the chiller control locally.

On the top right hand side of the main screen there are three soft keys:
AUTO DI#-1
OVERRIDE ON
OVERRIDE OFF



For the chiller to be enabled and provide system cooling, it is fitted with external interlocks which are required to be closed.

Interlocks include:

- Chilled water flow
- Condenser water flow
- BMS bypass – left open circuited unless service is required and the BMS needs to be bypassed for service purposes.

Within the digital inputs, there are other interlocks which are required to be open circuit during normal operation. If the contacts close, it indicates that a fault has occurred

These interlocks include:

- External HP switch
- External LP switch
- Refrigerant monitor
- Emergency stop button

AUTO SELECT

Once all the interlocks are made or closed as per the above description, the chiller will start the cycle of providing cooling.

Depending on the configuration, the chiller controller will automatically select the compressor (if a multiple configuration) with the least amount of run hours.

This “auto roll over” compressor select feature allows even run hours for the compressors installed on the chiller platform.

ANTI-RECYCLE TIMER

Providing that the anti-recycle timer on the compressor(s) has timed out, the compressor will be called on to run. The compressor will ramp to the required level, based on the commissioning settings specific to the application.

Note: Some chillers may require either a quick response to increase of load or

vice versa. This will typically depend on the chilled water loop, the amount of time it takes to cycle the full amount of water through the system, and the way the AHU and associated valves are controlled in the field.

Part of the control strategy is to look at the load requirements and determine the compressor demand, which is done by a FUZZY PID control loop and the Kiltech compressor optimization loop.

During the operation of the compressor and the control of the chilled water, the chiller controller is processing the necessary data points to target the optimum compressor speed / motor power, to deliver the cooling required.

For multiple compressor applications, the chiller controller will also target the optimum control point for any given condition.

This information is dynamically changing and therefore the chiller controller needs to adjust to reset the optimum “sweet spot” for the chiller.

Within the commissioning settings the commissioning engineer can input parameters to open the hysteresis or range of the control sweet spot, to avoid excessive cycling / frequent ramping of compressors.

CONTROL STATES

On the main page on the operator interface, you will be able to view the state of the chiller. These states can be categorized into two sections:

CHILLER STATES

- RESET
- FAULT
- IDLE
- START UP
- RAMP/ PULLDOWN
- ALARM AVOIDANCE
- RUN
- SEQUENCE UP
- SEQUENCE DOWN

RESET STATE

All pid loops are set back to the initial values, outputs are cleared. Start requests to compressors are removed and power demand is set to zero for each compressor. All analog and digital outputs are set to non active.
System timers are reset and the state exits to the “IDLE” state.

IDLE STATE

Controller waits for an enable from the selected source (digital input, Modbus, BacNet or Touch panel). When enable is received and the restart delay timer has timed out the controller checks for compressor availability and the leaving chilled water temperature is greater than the set point plus the start offset. If the conditions are met the system is set to the start state.

START STATE

Chilled water pump and condenser water pump outputs are set, there is 45sec allowed where the lead/ lag pumps may be switched if the lead is turned on and after 30sec there is no flow feedback (duty standby pump control).

Evaporator and condenser flow switches are monitored for 60 seconds for continuous proof. Once flow has been established, compressors are selected to run based on user configurable variables such as sequencing mode and number of compressors to start at enable time.

Once feedback is received from the compressors indicating they are ramping, the system is set to the RAMP (PULL DOWN) STATE.

RAMP STATE

In the ramp state the demand is increased at a slow rate and compressors added until the chilled water temperature is within 1°C of the set point. Once the chilled water set point temperature is reached, the system is set to the RUN STATE.

RUN STATE

In the RUN STATE the chilled water temperature control is made via the motor power demand PID loop, compressors are added and removed as required in order to maintain the chilled water temperature with as many compressors as possible, and running above surge is with fully opened inlet guide vanes. If the cooling demand is reduced to a point where only a single compressor is left online, the leaving temperature is reduced to less than the set point minus the stop temperature

offset, then the system is set to the SHUT DOWN STATE.

SEQUENCE UP STATE (Sub State of Run and Ramp)

In the SEQUENCE UP STATE, the next lead compressor is selected to run based on the compressor sequencing settings saved in the system. If the pressure ratio on the active refrigerant circuit is less than the maximum limit the demand to all compressors is reduced slightly and the new lead compressor is enabled via Modbus. If the pressure ratio on the active refrigerant circuit is greater than the maximum limit the following shall take place in this state prior to enabling the next lead compressor:

- Hot gas valve(s) are driven open
- Compressor speed is reduced
- Load reduction timer is started (time limit to avoid holding in a reduced capacity state too long)

Once the pressure ratio is reduced to less than the maximum limit and remains below that value for 15 seconds the new lead compressor is enabled via Modbus. If the pressure ratio does not reduce within the sequencing time limit (default 300sec) the state exits back to RUN or RAMP. However, the sequencing delay timer is tripled in order to provide more operation with less compressors at higher speed.

If the new lead compressor starts correctly the state exits the RUN or RAMP state once the newly added compressor has reached the surge speed of the other compressors operating on the same refrigerant circuit.

SEQUENCE DOWN STATE (Sub State of Run, Ramp and Alarm Avoidance)

In the SEQUENCE DOWN state the operating lag compressor is selected based on the compressor sequencing settings saved in the system. Once the compressor to turn off is selected, the enabled is removed via Modbus and then monitored. When feedback is received indicating the compressor has stopped, the state exits back to the initiating state (IRUN, RAMP or ALARM).

ALARM / AVOIDANCE STATE (Sub State of Run and Ramp)

In ALARM / AVOIDANCE DOWN state the chillers capacity is reduced in an attempt to avoid faulting the entire chiller offline. Demand to all compressors is reduced at a rate of 1% per second until the alarm condition clears or 45 seconds goes, by in which case if there is more than one compressor online the next compressor is removed from operation. If the alarm condition is high discharge pressure, high lift or high 3ph amps, the controller's maximum output to the compressors is limited to 80% of the demand value that caused the discharge pressure alarm, for a period of 15 mins.

This state may exit to RAMP, RUN or FAULT.

FAULT STATE

In the FAULT state all devices are set inactive. Reset delay timer counts down.

When reset delay timer is done the fault status is checked, if the fault has cleared the state is set to IDLE. If the fault condition still exists the control will remain in fault state.

COMPRESSOR STATES

- Offline
- Resetting
- Ready to Run
- Ramping
- Running
- Alarmed
- Resetting With Fault
- Finished Reset With Fault
- Clearing Fault
- Locked Out
- Locked Out By Chiller

OFFLINE

Communication statistics less than 50%, 50 communication attempts in the last 100 to a specific compressor have failed. If this happens the compressor is deemed unreliable to control or has a power failure, disconnect wire etc...

RESETTING

Compressor has just been powered up and is going through bearing and drive checks or compressor has just stopped and is going through IGV reset.

READY TO RUN

Compressor is idle with no faults or alarms and may be started at any time.

RAMPING

Compressor is below its minimum operating speed and ramping up.

RUNNING

Compressor is above its minimum operating speed with no alarms present.

ALARMED

Compressor is above its minimum operating speed with one or more alarms present. In this state the compressor would be unloading itself.

RESETTING WITH FAULT

Compressor is shut down going through IGV reset with a fault present.

FINISHED RESET WITH FAULT

Compressor is shut down with a fault present.

CLEARING FAULT

Chiller controller is attempting to clear a fault on one of the compressors. Chiller controller is attempting to reset the compressor fault.

LOCKED OUT BY CHILLER

Compressor has had more than 10 faults in a 12 hour period. Compressor must be powered down and fully discharged then powered back up in order to reset the fault.

LOCKED OUT

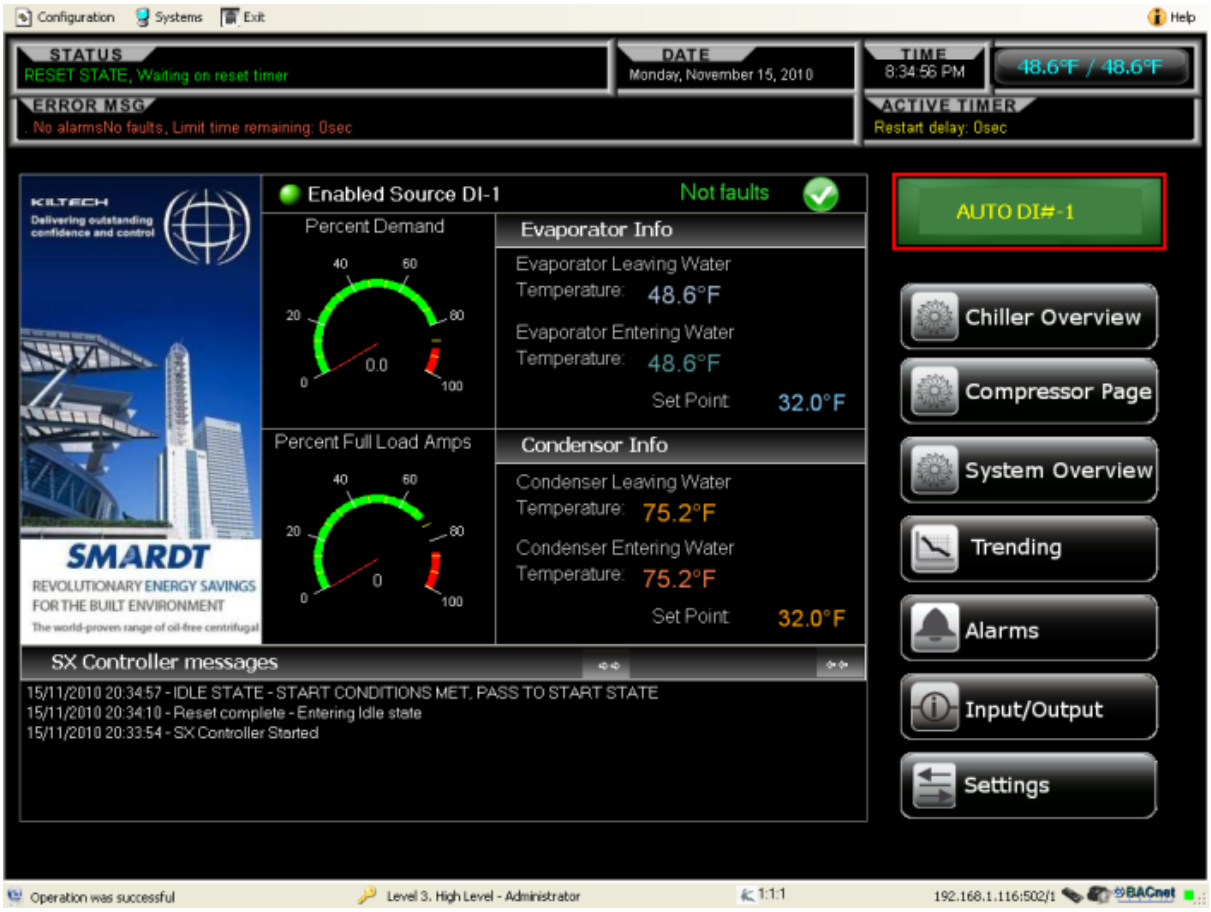
Compressor has faulted on either high current, high discharge pressure or three motor cooling faults in 30min. Each of these faults requires that the compressor is powered down and fully discharged, then powered back up in order to reset the fault.

MAIN SCREEN

The main page is the summary page which allows the operator to view the chiller's operational conditions. It is from the main page that the operator will navigate through to other screens to obtain specific data relating to the operation and/or performance of the chiller package.

In this page the operator shall obtain:

- System type
- External interlock status
- Alarms – if present
- Demand status
- Time
- Percentage maximum amperes
- Entering chilled water temperature
- Compressor status
- Control set point



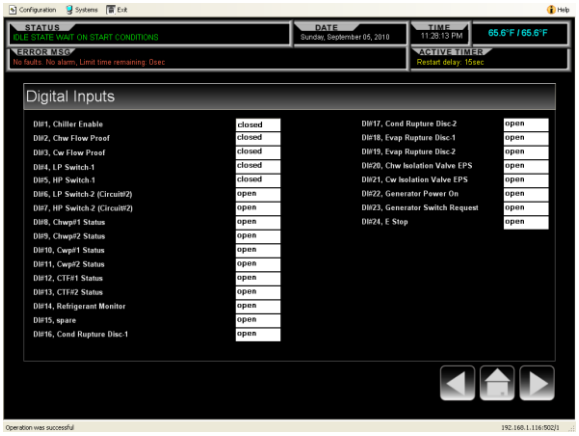
I/O DATA – INPUT & OUTPUT MODULE

Select the “I/O DATA” button.

Depending on the number of inputs/outputs utilized (application specific) the operator can view the feedback of either the current status or value of the sensors connected to the system.

Some values are a duplication of the values seen in the main system page. However, it does provide a total snapshot of all items connected to the I/O module.

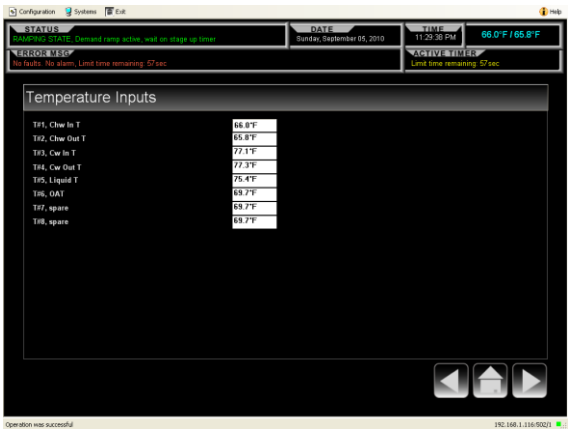
Digital Inputs



Digital Outputs

Analogue Outputs/Intputs

Temperature Inputs



COMPRESSOR DATA

Select the “I/O DATA” button.

When the “Compressor Page” button is pressed, the operator will be routed to the Compressor Live Data screen, where it is possible to view the key operating conditions and points of each individual compressor – gathering data directly from the compressor via the Modbus communication network. From this page the operator can view the following data for either one compressor or for multiple compressors:

Alarm codes
Active fault codes
Demand applied to compressor
Interlock status on compressor
Compressor speed
Inlet guide vane position
Suction pressure
Suction temp
Suction superheat
Discharge pressure
Discharge temp
Discharge super heat
Power input to compressor
Desired power from chiller controller
3 phase amps
Surge RPM
Choke RPM
Active CC faults and alarms
Active BMCC fault

Depending on the number of compressors the system is controlling, the compressor page will automatically populate them on this page. The operator can press either the right arrow key to scroll to the specific compressor row (if more than 4 compressors are used), or the operator may also choose to view a graphical representation of a specific compressor by pressing the compressor number button, whereby a compressor graphic shall appear with the relevant compressor information.

Note: If additional high level data is required from the compressor, the operator will require an authorized service provider to access this information via the Turbocor™ monitoring tool that is accessible via the chiller controller touch panel (password protected).

SYSTEM TRENDING

Select the "COMPRESOR PAGE" button.

When the "Trending" button is pressed, the operator will be directed to the Trends page. This page provides a trend graph of the chiller's operational conditions. For convenience, additional menus have been created to scale the amount (time) of data samples on the screen.

Key trends available:

- Power Measurement
- Entering / Leaving Chilled Air / Water Temperatures
- Entering / Leaving Condenser Water Temperatures (Water Cooled Chiller)
- Saturated Suction / Discharge Temperatures (Air / Evaporative Cooled Chiller)
- Load Profiles
- Energy Hours

Note: Once the operator has been directed to the Trending page, it is also possible to view weekly energy data and load profiles by pressing the Trending tab an additional time.

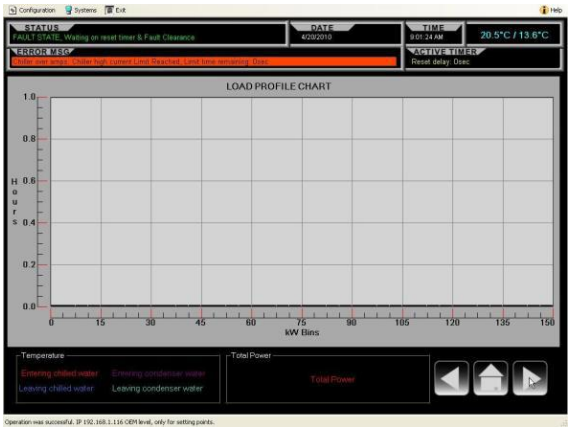
Upon review of the additional trends, the operator either returns to the main trend page by pressing the Trending tab again or decides to exit and presses a different navigation tab.

Note: This information is stored within the buffer memory of the chiller controller, therefore it can be retrieved at any time using the USB download feature. Please refer to the "Settings" page. This is useful information that can be integrated into monthly service documentation and / or energy reporting given to facility managers and the like.

Temperature and Power

PID Outputs

Load Profiles



APPENDIX A – I/O REGISTER

Gen #4, Configuration #: 20400 – Water Cooled Chiller - One Refrigerant Circuit, Bypass Valves – Full Function

Digital Inputs	Digital Outputs	Analog Outputs	Analog Inputs	Temp Inputs
DI1= Chiller Enable	DO1 = Compressor Interlock	AO1 = Tower VFD	AI1 = Chw dP (0-10psi)	TI1 = Chw In T
DI2= Chw Flow Proof	DO2 = Tower Fan#1 Enable	AO2 = Tower Bypass Valve	AI2 = Cw dP (0-10psi)	TI2 = Chw Out T
DI3= Cw Flow	DO3 = Tower Fan#2 Enable	AO3 = % Design kW	AI3 = BAS Demand Limit	TI3 = Cw In T
DI4= LP Switch	DO4 = Chwp#1 Enable	AO4 = EXV Position	AI4 = Set Point Reset	TI4 = Cw Out T
DI5= HP Switch	DO5 = Chwp#2 Enable	AO5 = Hotgas Valve	AI5 = Spare	TI5 = Liquid T
DI6= Spare	DO6 = Cwp#1 Enable	AO6 = Spare	AI6 = Liquid Level-1	TI6 = OAT
DI7= Spare	DO7 = Cwp #2 Enable	AO7 = Compressor Bypass-1	AI7 = Cond. Pressure	TI7 = Spare
DI8= Chwp#1 Status	DO8 = Call Next Chiller	AO8 = Compressor Bypass-2	AI8 = Spare	TI8 = Spare
DI9= Chwp#2 Status	DO9 = Chiller Ready	AO9 = Compressor Bypass-3		
DI10 = Cwp#1 Status	DO10 = Chiller Run	AO10 = Compressor Bypass-4		
DI11 = Cwp#2 Status	DO11 = Spare	AO11 = Compressor Bypass-5		
DI12 = CTF#1 Status	DO12 = Chiller Fault SPDT	AO12 = Compressor Bypass-6		
DI13 = CTF#2 Status				
DI14 = Refrigerant Monitor				
DI15 = Spare				
DI16 = Cond. Rupture Disc-1				
DI17 = Cond. Rupture Disc-2				
DI18 = Evap. Rupture Disc-1				
DI19 = Evap. Rupture Disc-2				
DI20 = Chw Isolation Valve EPS				
DI21 = Cw Isolation Valve EPS				
DI22 = Generator Power On				
DI23 = Generator Switch Request				
DI#24 = E Stop				

APPENDIX G – HIGH LEVEL COMMUNICATIONS

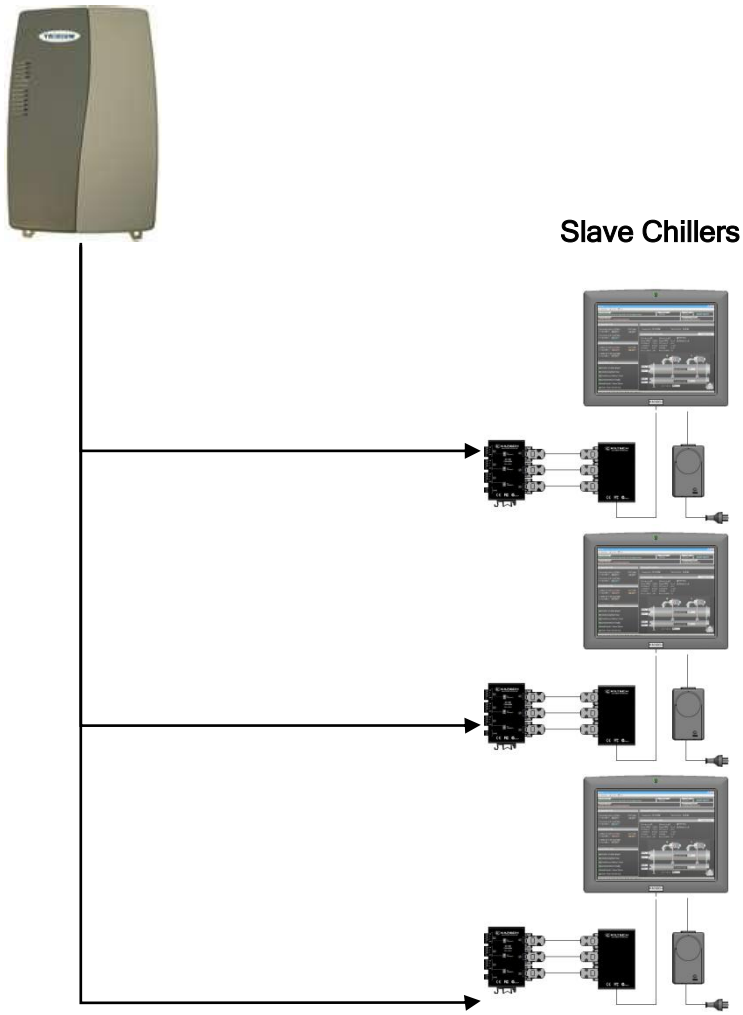
MAIN SCREEN

Introduction

The Kiltech Controller Series uses the Modbus RTU & TCP/IP, BACnet MSTP and BACnet IP protocols, all of which are widely used in the HVAC and industrial automation industries. This manual explains how the Modbus communication functionality works. For information on how the chiller controller operates, please refer to the complete Kiltech chiller control operating manual.

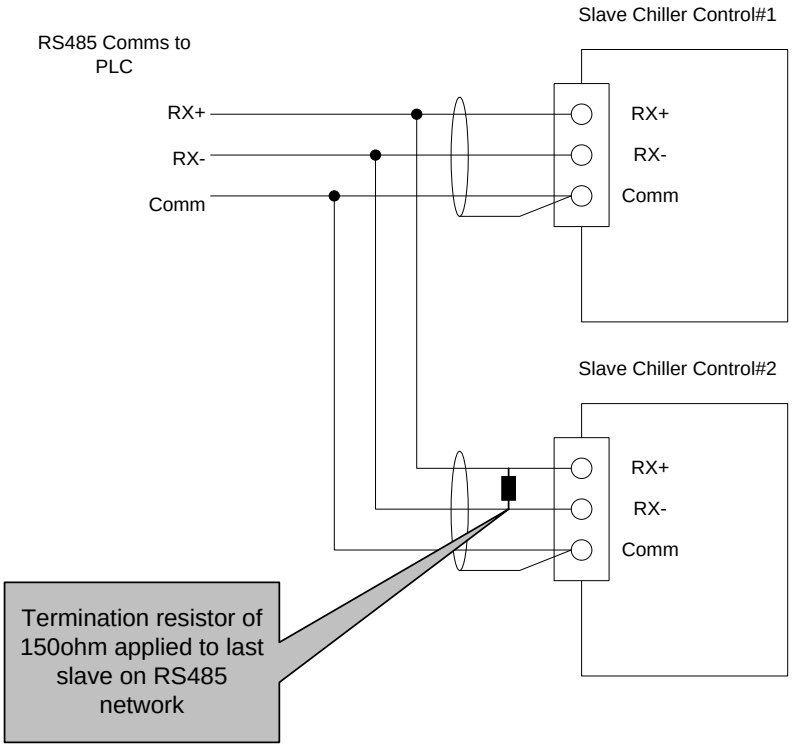
With Modbus communications, data transfer is possible between a single master (PLC) and up to 64 Kiltech Chiller Controllers (the slave). As the master (the BAS) transfers data simultaneously between single slave chiller controllers, the address for each slave must first be set. The slave chiller controller receiving data from the master will execute the instructed function, and then respond to the master (BAS).

Master Control (BAS) or BACnet Controller



CONNECTION DIAGRAM

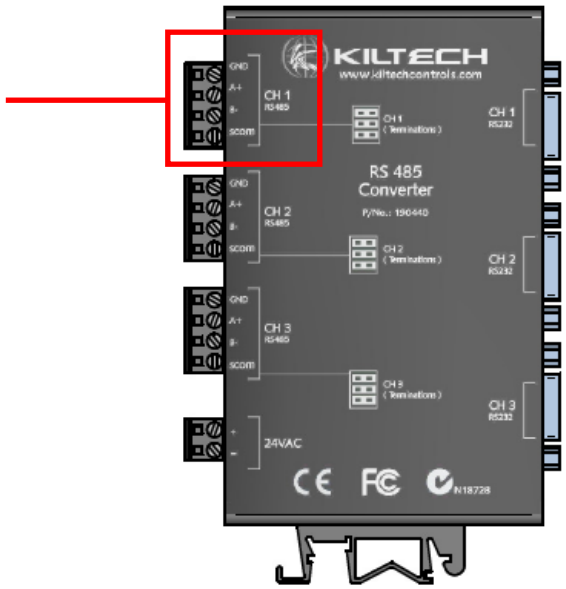
Interconnection Diagram during RS-485 Transfer



Above: Sample connection diagram between multiple controllers and master plc.

Below: Connection points found on rear of touch panel.

RS 485 Connection Point to BAS System



COMMUNICATION RELATED PARAMETERS

Before Kiltech Chiller controller can communicate with a master controller the serial communication parameters must be set up via the touch panel. Communication parameters are found in the Chiller Commissioning window.

Baud Rate - possible settings=9600, 19200 & 38400

Stop Bits - possible settings =1 or 2

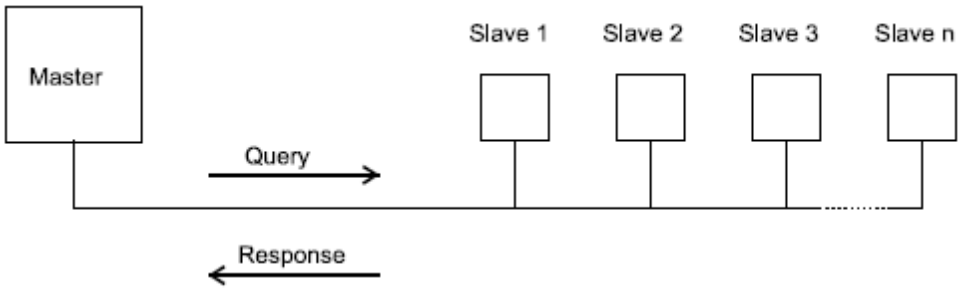
Modbus Slave Address = 1 to 64

The modbus RS485 parity is fixed at none.

The inverter uses RTS signal when operating with RS-485 transfer, switching the transfer direction for sending and receiving.

MODBUS MESSAGES & MODBUS PROTOCOL

Communication on a MODBUS Network is initiated (started) by a “Master” (BAS) with a “query” to a “Slave” (Chiller Controller). The “Slave “ which is constantly monitoring the network for “Queries” will recognize only the “Queries” addressed to it and will respond either by performing an action (setting a value for example) or by returning a “response”. Only the Master can initiate a query.



In the MODBUS protocol the master can address individual slaves, or, using a special “Broadcast” address, can initiate a broadcast message to all slaves. The SPR and Integra products do not support the broadcast address.

For extra information please see HTTP://WWW.MODBUS.ORG/ on the web.

APPENDIX H - COMMISSIONING FORM

Contact SMARDT Product Support to obtain Commissioning Form.

APPENDIX I - GEN 4 DIRECT CONNECTION OVER IP

Pending Data Release