



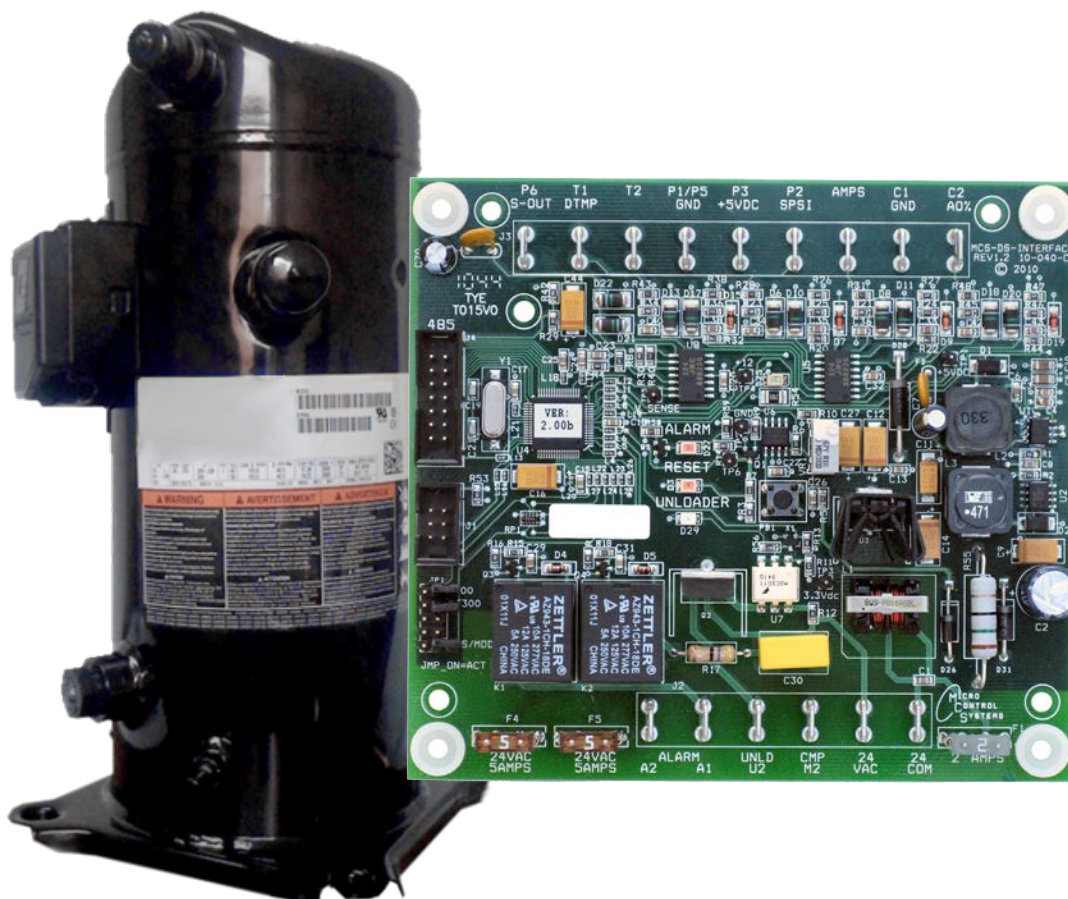
MCS Digital Scroll Controller

Rev. 1.2

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Installation and Operations Manual

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Date	Author	Description of Changes
01-25-11	JGW	<ul style="list-style-type: none">• Rev 1.0• Developed this manual from preliminary version.
02-07-11	WLK	<ul style="list-style-type: none">• Rev 1.1• Edited this manual to match MCS standard. (Changed fonts, headers and footers, text styles, etc.)• Updated MCS-DS-INTERFACE picture and caption.
08-14-18	DEW	<ul style="list-style-type: none">• Rev 1.2• Add blink codes as per Danny B.

MCS DIGITAL SCROLL CONTROLLER (MDS)

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GENERAL DESCRIPTION

MDS

The MDS is a four layer printed circuit board designed to control your Digital Scroll Compressor and interface to your System Controller. It accepts a 0 to 5 vdc signal from your System Controller telling the MDS its loading percentage. The Digital Scroll can modulate between 10% to 100% based on a 15 second time period.

The user must select the minimum speed that will be allowed based on operating conditions. The System should then operate the Digital Scroll within this range.

The MDS uses a 5 amp fused relay to turn on and off the compressor contactor. A second 5 amp relay is provided to provide the user with an external alarm. A heavy duty Solid State Relay (Triac) is provided to control the loading/unloading of the compressor solenoid.

MDS General Specifications

Power and Control

- The MDS is powered by a 24 vac transformer fused at 2 amps. (Transformer supplied by others)
- The MDS controller for the digital scroll compressor operates on a 15 second cycle.
- The MDS cycles the unloader solenoid to achieve 10% to 100% capacity based on the input signal from the System Controller.

Sensor Inputs

- The MDS has 4 input options as follows:
 1. The MDS has an Analog input sensor for Discharge temperature. (It can be a MCS-T100 temperature sensor or a Copeland discharge temperature sensor.)
 2. The MDS has an optional Analog amperage input sensor (MCS-CT300)
 3. The MDS has an optional Modbus (RS-485) printed circuit board with addressing capability from 0 to 99.
 4. The MDS has an optional Suction psi transducer. (MCS-200F Transducer.)

Relay Outputs

- The MDS has 3 controlled Relay Outputs as follows:
 1. The Compressor Relay Output fused at 5 Amps.
 2. The Alarm Relay Output fused at 5 Amps.
 3. The Unloader Solid State Output. (Triac)

Analog Output

- The MDS has an analog output. (Provides average suction PSI if installed)
 - The MDS provides the average suction pressure averaged over the 15 second cycle.

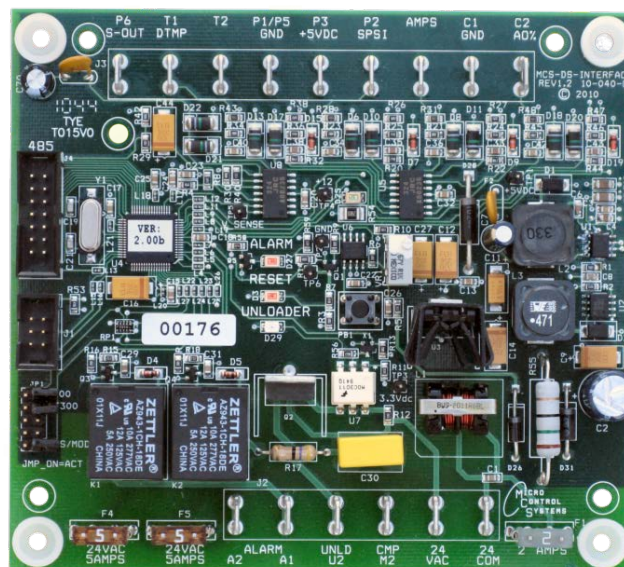
Notification LED's

- The MDS has 4 notification LED's as follows:
 - A Green LED signaling input power is OK.
 - A Yellow LED signaling the unloader is on.
 - A Red LED signaling the MDS is in reset.
 - A Red LED for Alarm Notification (Blinking)

Jumper Selection

- The MDS has 6 jumper options as follows:
 - Default all jumpers off. Nothing selected.
 - Jumper 1 (Discharge Temperature Sensor Input)
 - Jumper ON = MCS-T100 Jumper OFF = Copeland
 - Jumper 2 (Ampere Sensor Input)
 - Jumper ON = MCS-CT300 Jumper OFF = No Amp sensor
 - Jumper 3 (Future Use)
 - Jumper ON = Jumper OFF =
 - Jumper 4 (Future Use)
 - Jumper ON = Jumper OFF =
 - Jumper 5 (Optional Modbus Adaptor Installed)
 - Jumper ON = Modbus Jumper OFF = MCS-Connect

MCS-DS-INTERFACE



MDS Hardware Specifications

Operating Temperature

- -40° F to 185° F

Supply voltage

- 24 vac \pm 10% at 50 / 60 Hz

Physical Size

- 5"w x 4.5"h x 2.5"d

Mounting

- Requires 4 # 6 Stainless Steel sheet metal screws (provided)

Installation

- The MDS must be installed in a dry location away from high voltage as much as possible.
- The Lexan cover can be used as a template to mark the four (4) mounting holes.
- When drilling the pilot holes make sure you do not get metal filings anywhere.
- Screw on the nylon standoffs before mounting.
- Mount the MDS with the Stainless Steel screws provided.
- Wire the Line and Common from the 24 vac transformer to terminals marked 24 VAC and 24 COM. **Make sure the phasing for the MDS 24 vac is the same as the System Controller.**
- Wire from terminal M2 (compressor output) to the compressor contactor.
- Wire from terminal U2 (unloader output) to the unloader solenoid.
- Wire Alarm input power to terminal A1. (Not greater than 24 vac/vdc)
- Wire Alarm output power from terminal A2 to Alarm.
- Wire Discharge temperature sensor to terminals T1, T2 and P1/P5. Black to terminal T2 (+5 vdc), White to terminal T1 (sensor input) and shield to terminal P1/P5. (Ground) This sensor can either be a MCS-T100 or the Copeland discharge temperature sensor. If no discharge temperature sensor is installed the digital scroll will only run to a max of 50% capacity.
- Wire the Suction pressure transducer Red wire is connected to terminal + 5 VDC, (P3). The shield and Black wire are connected to ground terminal (P1 / P5) and the White lead to terminal SPSI IN (P2). If this option is installed the Suction PSI Output will provide the 15 second average of the suction pressure.

- Wire the optional Amps sensor (MCS-CT300) Black and Shield to ground. The White wire is connected to terminal AMPS.
- Wire the Analog input from the system controller (0 to 5 vdc signal) to terminal C2. No ground wires should be connected, only the signal wire.

Digital Scroll Requirements

- Minimum capacity 10%
- Maximum capacity 100%
- Unload 100 ms prior to start
- Keep unloaded for 100 ms after starting
- Unload 500 ms before turning off compressor
- Keep unloaded for 100 ms after off
- Anti cycle time is 2 minutes
- Disc temp $\geq 268^{\circ}\text{F}$ off for 30 minutes
- High discharge temp restart after 30 min
- If Hi Disc temp occurs 5 times in 4 hours the compressor is locked out
- Provide 15 sec average suction psi

LED Description

- Green Led 24 vac Power
- Yellow Led Unloader Solenoid on
- Red Led (1) Reset Brown Out (< 20 vac)
- Red Led (2) Alarm Flash Code

	(# Blinks)
▪ NO ALARM	0
▪ Low Suction Pressure	1
▪ High Discharge Temp	2 - Red Alarm LED
▪ Comp Protector Trip	3
▪ Locked Rotor	4
▪ Demand Signal Low	5
▪ Discharge Temp Fault	6 - Red Alarm LED
▪ Unloader Solenoid Fault	7
▪ Comp Contactor Fault	8
▪ Low 24 VAC Supply	Red Reset LED will be on solid indicating under voltage

Blinking Alarms are on a 10 second cycle. For a High Discharge Temperature Alarm the Red Alarm LED will get a blink at second 1, a blink at second 2 and no blinks for 8 seconds.

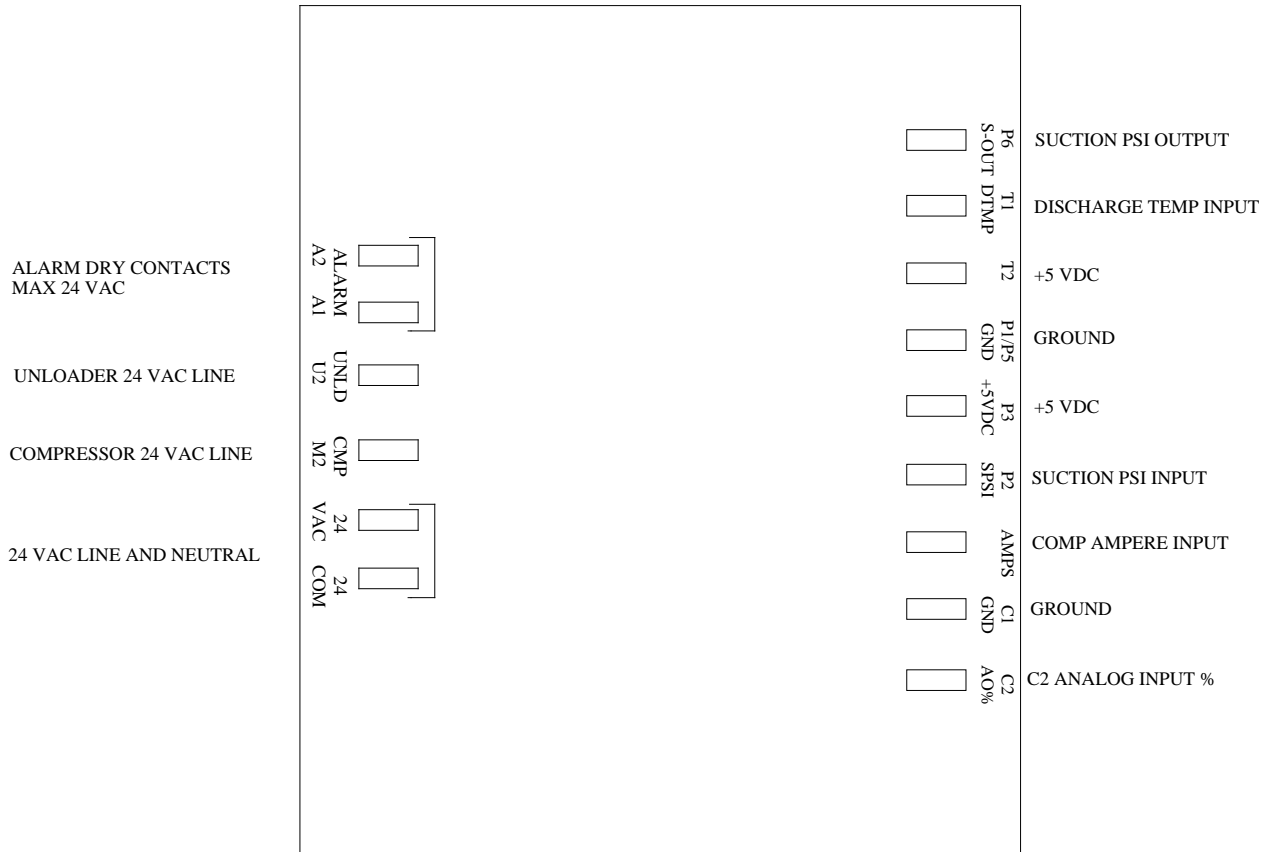
Machine States

The MDS is a State Machine. If you are communicating via the Modbus Option you will see one of the following machine states.

- **Power Up State**
When 24 vac power is applied the MDS will go through a power up state lasting 30 seconds. This allows the micro to see stable power before starting its control.
- **Compressor Off State**
When in this state the Analog Input is less than 1.0 vdc.
- **Compressor Prestart State**
The Analog Input is at 1.45 vdc or higher. The compressor unloader is turned on for 100 ms prior to starting the compressor.
- **Compressor On State**
The Compressor is turned on.
- **Compressor Unld State**
The compressor is held in the unloaded state for 100 ms after starting.
- **Comp Stop State**
The compressor stop state is entered when the analog input signal is 1.44 vdc or lower.
- **Hi Temp Safety**
If the compressor discharge temperature goes above the high temperature allowed it is put in this state.
- **Hi Temp Lockout**
If the HI Temp Safety has occurred 5 times in 4 hours the Compressor is put in Lockout. The Lockout LED will blink on second 1 thru second 6 then be off for 4 seconds.
- **Comp Stop Safety**
In this state the control analog input is < 1.44 vdc.
- **Comp On 50%**
This state is reached because the discharge temperature sensor has not been installed or has failed.

Terminal Blocks

IMPORTANT! ALL TERMINALS ARE 24 vac OR 5 vdc. DO NOT BUNDLE 24 vac IN WITH 5 vdc. ALL SENSOR WIRING MUST BE SHIELDED CABLE.



Terminal Connections

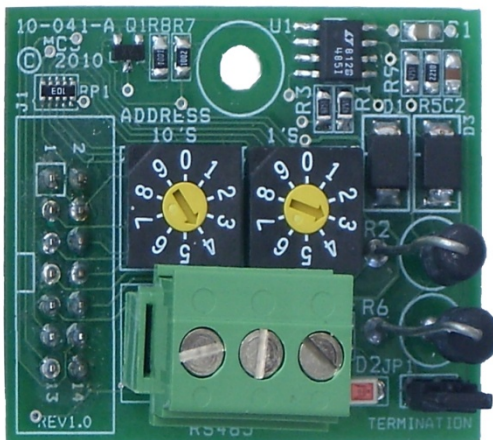
- Control Power (24 VAC, 24 COM)**
 The power supply for the MDS is 24 vac ± 10%. The unit is fused for 2 amps @ 24 vac. The 24 vac phasing for the MDS must match the system controller to avoid a transformer short circuit condition because they have their commons connected. The 24 vac power must be on anytime the unit is on. Center tap transformers are not to be used.
- System Controller Demand (C2)**
 Controller demand is an analog input signal from the System Controller to the Compressor Controller. It is proportional to the capacity required. (1.45 vdc to 5.00 vdc provides a range of 10% to 100% capacity)
- Suction Pressure Input (SUCTION PSI INPUT) (P2)**
 The Suction pressure Red wire is connected to terminal + 5 VDC, (P3) The shield and Black are connected to ground terminal (P1 / P5) and the white lead to terminal SPSI IN. (P2)

- **Discharge Temperature Input (DISC TEMP INPUT) (T1)**
The Discharge Temperature Black wire is connected to terminal + 5 VDC (T2), The shield is tied to ground terminal and the White wire is connected to terminal DTMP IN.
- **AMPERES (AMPS)**
The AMPS Black and Shield are wired to ground terminal. The White wire is connected to terminal AMPS.
- **Suction PSI Out (SPSI OUT) (P6)**
The Suction pressure output is the 15 second average of the input suction pressure.
- **Compressor Output Relay (M2 COMP)**
The compressor output relay is the normally open portion of the relay. It will provide 24 vac to the compressor contactor. The 24 vac Common is connected off the MDS.
- **Unloaded Output Traic (U2 UNLD)**
The Unloader output Triac provides 24 vac line to the Unloader solenoid. The 24 vac common is wired off the board.
- **Alarm Relay Output (A1 and A2 ALARM)**
The Alarm relay output provides the common and normally open contact for the user to wire to varies types of alarm signals. This must be 24 vac or vdc.

Optional Modbus Interface

There is an optional MCS-DS-COMM Modbus communications interface printed circuit board. It mounts on the MDS via a 14 pin keyed connector along with a nylon bolt to secure the PCB to the MDS.

MCS-DS-COMM



Modbus 485 Connection settings

- Baud Rate: 9600
- Parity: None
- Stop Bit: 1
- Control RTS: No

There are 2 rotary dials for addressing from 0 to 99 individual units. This allows 100 units to be specifically addressed via Modbus.

MCS also has available a 15" color touch screen that will communicate via Modbus allowing the user to do Graphics addressing each of the (up to) 100 units individually.

Any Building Management System (BMS) communicating Modbus can address the units directly.

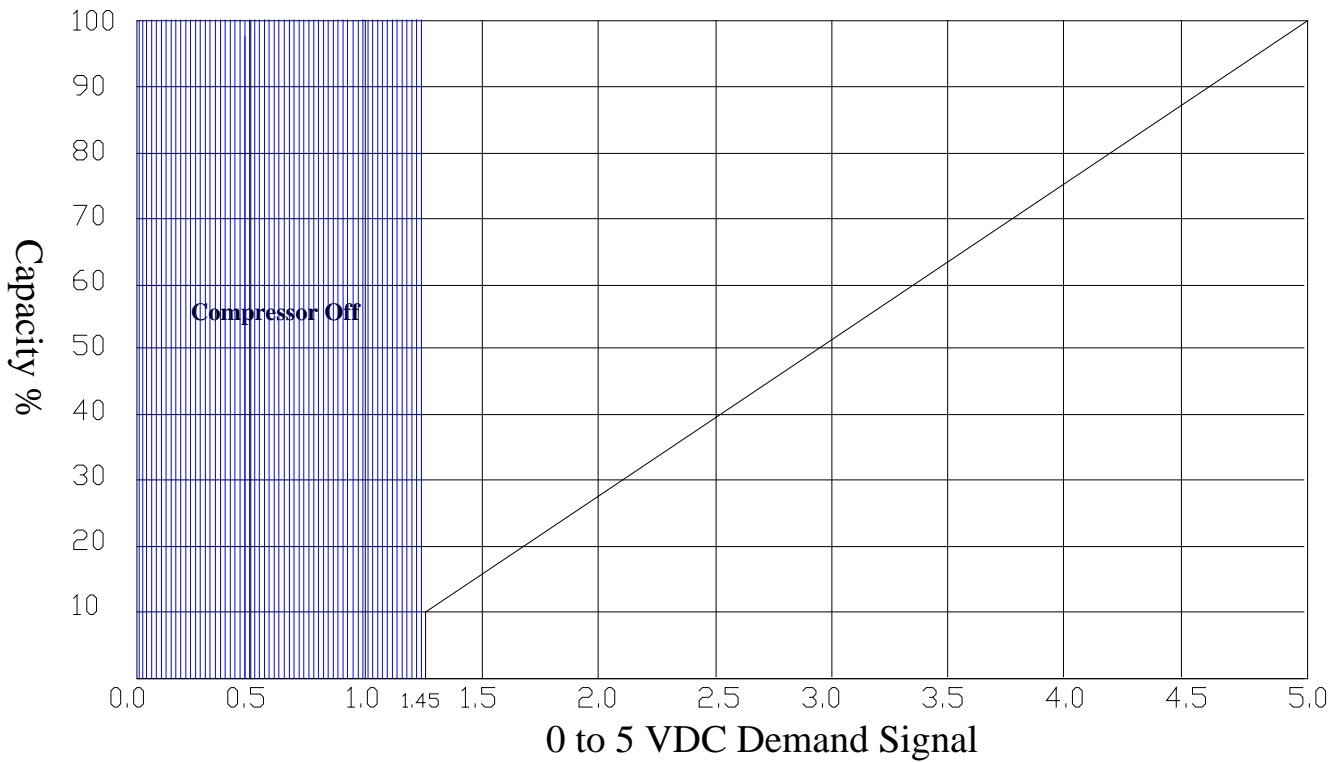
System Controller

The MDS accepts a 0 to 5 VDC signal from your System Controller telling the MDS its loading percentage. The Digital Scroll can modulate from 10 % to 100 % based on a 15 second time period.

The user must select the minimum speed that will be allowed based on operating conditions. The System should then operate the Digital Scroll within this range.

The figure below shows the MDS control of the Digital Scroll based on a 0 to 5 VDC Demand input signal from the System Controller.

At 1.45 VDC the compressor will be at 10% of capacity. At 5 VDC the compressor will be at 100% of capacity. At 1.44 VDC or lower the Digital Scroll will be off.



Tables and Charts

Input Jumper Table (Factory Default all Off)

JUMPER 1	ON = MCS-T100 OFF = Copeland Sensor	Discharge Temperature
JUMPER 2	ON = MCS-CT300 OFF = No Ampere Input	Ampere Input
JUMPER 3	ON = OFF =	Future Use
JUMPER 4	ON = OFF =	Future Use
JUMPER 5	ON = Modbus Output OFF = MCS-Connect Output	Optional Communications

Percent Load / Unload Table

ANALOG INPUT (VDC)	%LOAD	SECONDS LOADED	SECONDS UNLOADED
<= 1.440	0.00%	0.0	0.0
1.450	10.00%	1.5	13.5
1.844	20.00%	3.0	12.0
2.238	30.00%	4.5	10.5
2.632	40.00%	6.0	9.0
3.026	50.00%	7.5	7.5
3.420	60.00%	9.0	6.0
3.814	70.00%	10.5	4.5
4.208	80.00%	12.0	3.0
4.602	90.00%	13.5	1.5
4.996	100.00%	15.0	0.0

MCS-T100 Temperature Sensor

A/D COUNTS	TEMP	VDC
12 BIT	DEG F	
< 80	-99	≤ 0.098
84	-40	0.103
176	-22	0.215
340	-4	0.415
576	14	0.703
908	32	1.108
1328	50	1.621
1804	68	2.202
2280	86	2.783
2708	104	3.306
3064	122	3.740
3340	140	4.077
3548	158	4.331
3696	176	4.512
3804	194	4.644
3880	212	4.736
3936	230	4.805
3976	248	4.854
4004	266	4.888
> 4004	999	≥ 4.893

Copeland Temperature Sensor

TEMP	RESISTANCE	TEMP	RESISTANCE
DEGREES F	K OHMS	DEGREES F	K OHMS
-40	2889.60	167	12.73
-31	2087.22	176	10.79
-22	1522.20	185	9.20
-13	1121.44	194	7.87
-4	834.72	203	6.77
5	627.28	212	5.85
13	475.74	221	5.09
23	363.99	230	4.45
32	280.82	239	3.87
41	218.41	248	3.35
50	171.17	257	2.92
59	135.14	266	2.58
68	107.44	275	2.28
77	86.00	284	2.02
86	69.28	293	1.80
95	56.16	302	1.59
104	45.81	311	1.39
113	37.58	320	1.25
122	30.99	329	1.12
131	25.68	338	1.01
140	21.40	347	0.92
149	17.91	356	0.83
158	15.07		

Sensors and Action

SENSOR	INSTALLED ON SYS	CONDITION	ACTION	PRO ACTIVE CTL
DISCHARGE TEMP	YES	≥ 268 ° F, SHUTDOWN 30 MIN	5 TIMES IN 4 HRS LOCKOUT	Future
	NO	LIMIT COMP TO 50%		
SUCTION PSI	YES	AVERAGE PSI AND OUTPUT	Future	Future
	NO	0 PSI OUTPUT		
AMP SENSOR	YES	AVERAGE AMPS OUTPUT	Future	Future
	NO	0 AMPS OUTPUT		