

COMPRESSOR SEQUENCE OF OPERATION

TABLE OF CONTENTS

1.0	TYPE OF SYSTEM.....	2
2.0	SPECIAL PROVISIONS.....	2
3.0	UNIT MODE.....	2
4.0	GENERAL MOTOR CONTROLS.....	2
5.0	PLC I/O FORCING.....	3
6.0	POWER UP AND READY TO START.....	3
7.0	START SEQUENCE.....	4
8.0	UNIT RUNNING LOADED.....	4
9.0	CLEARING CYCLE (DRAIN INTERVAL).....	4
10.0	STORAGE FILLING SEQUENCE (OPTIONAL PRIORITY PANEL).....	4
11.0	STOP SEQUENCE (NORMAL, FAULTED, and ESD).....	6
12.0	DISPENSER VALVE ACTUATION.....	8
13.0	TEMPERATURE COMPENSATION.....	9
14.0	ALARM AND SHUTDOWN FUNCTIONS.....	10
15.0	HMI MENUS & CONFIGURABLE PROCESS VARIABLES.....	13
15.1	Main Status.....	13
15.2	Alarm Screen.....	15
15.3	Compressor Menu Selection Screen.....	16
15.4	Compressor Pressure Alarm and Shutdown Settings.....	17
15.5	Compressor Temperature Alarm and Shutdown Settings.....	18
15.6	Compressor Digital and Logical Shutdown Settings.....	19
15.7	Compressor Transducer Settings.....	21
15.8	Compressor Thermocouple Settings.....	22
15.9	Compressor Oil Heater Settings.....	23
15.10	Compressor Sequence Timers.....	24
15.11	Storage Menu Selection Screen.....	26
15.12	Storage Pressure Alarm and Shutdown Settings.....	27
15.13	Storage Transducer Settings.....	28
15.14	Storage Settings.....	29
15.15	PLC/HMI Main Selection Menu.....	31
15.16	PLC/HMI Network Settings.....	32
15.17	PLC/HMI Email Settings.....	33
15.18	PLC/HMI General Settings.....	34
15.19	PLC/HMI Input IO Flips.....	35
15.20	PLC/HMI Output IO Forces.....	36
16.0	WEB VIEWER ACCESS.....	37
17.0	PLC IO List.....	39
17.1	OUTPUT IO.....	39
17.2	INPUT IO.....	40
17.3	ANALOG IO.....	41
18.0	TECHNICIANS NOTES.....	42

COMPRESSOR SEQUENCE OF OPERATION

1.0 TYPE OF SYSTEM

- 1.1 The PLC is an IDEC FC6A-C40P1CE system performing configuring, monitoring, reporting of shutdown, pressures, and temperatures to a local 8.4" IDEC HG3G Series HMI touch display. All user configurable variables can be entered into the PLC via the local HMI touch display. The panel is powered by a customer supplied 120vac. throughout this sequence the controller is referred to as PLC.
- 1.2 The PLC is serving the function of both a unit controller (controlling the compressor package) and a site controller (controlling priority valves and SCADA)

2.0 SPECIAL PROVISIONS

- 2.1 The PLC outputs can be forced (latching type function) via the **PLC/HMI > OUTPUT I/O FORCES** screen. Once the **MAINTENANCE MODE** is made active any running processes will be sequenced to a NORMAL shutdown state and the unit operating mode will be placed into a **MANUAL** state. The **MAINTENANCE MODE** will automatically be disabled when the timer runs out or by pressing the **MAINTENANCE MODE "OFF"** button on the HMI. While in this mode **NO automatic sequencing of the PLC will be available** and a **MAINTENANCE MODE** indicator will be visible in the top section of all HMI screens.
- 2.2 Password protection exists on all set points
- 2.3 The power for all relays is tied into the site ESD loop.

3.0 UNIT MODE

- 3.1 **MANUAL** (HMI based) - The unit is started manually via the local start pushbutton or the HMI start pushbutton while the panel selection switch is in the "RUN" position.
- 3.2 **AUTO** (HMI based) - The unit is started automatically via a call to start from the storage bank while the panel selection switch is in the "RUN" position.
- 3.3 OPERATION SELECTION SWITCH
 - 3.3.1 **RESET** Position (momentary) – Used to reset alarms and fault conditions if they have been resolved.
 - 3.3.2 **OFF** Position (maintained) – No action allowed.
 - 3.3.3 **RUN** Position (maintained) – Required position for manual and automatic operation of the unit.

4.0 GENERAL MOTOR CONTROLS

- 4.1 The Motor have running input feedbacks (**AUX** contacts). If the motor is commanded on (when in **AUTO** sequencing), the relevant motor run fail timer will be started. If the relevant motor running input is not closed before the timer expires, the unit will be shut down on the relevant motor run failure.

COMPRESSOR SEQUENCE OF OPERATION

5.0 PLC I/O FORCING (MAINTENANCE MODE)

- 5.1 While the unit is in a non-ESD shutdown state, waiting for start permissive from the station, or if it is ready to start, the operator has the ability to manually force on all relevant digital outputs via the **PLC/HMI SETTINGS > OUTPUT I/O FORCES** page on the HMI.
- 5.2 When the **MAINTENANCE MODE 'ON'** touch display button is pressed any active running processes will be sequenced to a **NORMAL** shutdown state and the unit's operating mode will be placed into a **MANUAL** state. Once the proper state is in effect and the units panel selection switch is in the **RUN** position the latch (**ON**) and unlatch (**OFF**) touch display buttons for the so labeled I/O become functional
- 5.3 When **MAINTENANCE MODE** is enabled the operator has 10 minutes to manually force the outputs. Additional time can be added by pressing the **ADD TIME** button located next to the remaining time countdown.
- 5.4 **MAINTENANCE MODE** may be disabled at any time when the **MAINTENANCE MODE 'OFF'** touch display button is pressed or the timer runs out.
- 5.5 While **MAINTENANCE MODE** is enabled ALL unit shut down conditions are in effect with the exception of low pressure alarms and faults for **ALL** storage banks. Any shutdown will cause **MAINTENANCE MODE** to become inactive and any active forces will be reset.

6.0 POWER UP AND READY TO START

When the Power ON/OFF switch is turned to the 'ON' position the PLC will power up. The PLC will scan all inputs and the local HMI will display any alarms or shut downs that may exist. After the operator has corrected all shutdown conditions the PLC will initiate the currently selected fill mode selection. If the selected mode does not immediately require a unit run command the outputs will be driven to the following states.

- ESD Remote loop = Energized (De-energized on ESD activation)
- Unit Fault Indicator = De-Energized (Energized when in fault condition)
- Unit/Station Healthy Status Indicator = Energized (De-energized when not healthy)
- Main Motor Starter = De-Energized
- Inlet valve actuator = De-Energized (Closed)
- ESD / Flow valve = De-Energized (Closed)
- Drain / Load valve = De-Energized (Open)
- High Bank solenoid valve = De-Energized (Closed)
- Mid Bank solenoid valve = De-Energized (Closed)
- Low Bank solenoid valve = De-Energized (Closed)
- Time-Fill solenoid valve = De-Energized (Closed)

COMPRESSOR SEQUENCE OF OPERATION

7.0 START SEQUENCE

- 7.1 When the PLC is powered up and **AUTO** mode is selected, the PLC will examine the pressures of the **HIGH BANK, MID BANK, LOW BANK,** and **TIME-FILL**. When any of these pressures fall below the user configurable start pressure set point of that bank, the controller will issue a run command to the units.
- 7.2 When the PLC is powered up and **MANUAL** mode is selected, the local HMI start pushbutton or the start pushbutton located on the main panel is pressed then the controller will issue a run command to that unit.

8.0 UNIT RUNNING LOADED

- 8.1 The HMI will display an indicator of the **LOAD VALVE** state and the outputs will be driven to the following states:
- Drain/Load valve actuator = Energized (**Closed**)

9.0 CLEARING CYCLE (DRAIN INTERVAL)

- 9.1 When the unit is running loaded the '**INTERVAL**' timer will start. Once the interval timer expires, the Drain / Load valve output will be De-Energized to open the valve and the '**DURATION**' timer will start. Once the Duration timer expires, the Drain / Load valve output will be Energized and the Interval timer will re-start.
- During the clearing duration the low process pressure shutdowns and alarms will be locked out. When the '**DURATION**' timer expires the low process pressure shutdowns and alarms will be enabled. This sequence will occur repeatedly when the unit is running.

10.0 STORAGE FILLING SEQUENCE (OPTIONAL PRIORITY PANEL)

- 10.1 Once the PLC has issued a run command, the PLC will energize the corresponding solenoid valve to the bank whose pressure is below its start pressure to begin filling the bank.
- 10.2 The **DEMAND OFFSET** set points for high, mid, and low banks should be of value ranging from smallest offset to largest because storage filling is always **HIGH BANK** first, then the **MID BANK**, and lastly the **LOW BANK**. **DIRECT-FILL**, when enabled, can supersede **HIGH BANK** when a **HOSE IN USE** signal is active. **TIME-FILL**, when enabled, will fill after **LOW BANK**. This will allow the user to better utilize the storage capacity of each bank.
- 10.2.1 **DIRECT-FILL (IF ENABLED)**: Once the **DIRECT-FILL** demand has been satisfied, the **HIGH BANK** valve (solenoid/actuator) is energized (**OPEN**)

COMPRESSOR SEQUENCE OF OPERATION

10.2.2 HIGH BANK: Once the **HIGH BANK** demand has been satisfied, the **HIGH BANK** valve (solenoid/actuator) will remain energized (**OPEN**) and the **MID BANK** valve (solenoid/actuator) is energized (**OPEN**).

10.2.3 MID BANK: Once the **MID BANK** demand has been satisfied, the **MID BANK** valve (solenoid or actuator) will remain energized (**OPEN**) and the **LOW BANK** valve (solenoid or actuator) is energized (**OPEN**).

10.2.4 TIME-FILL (IF ENABLED): Once the **LOW BANK** demand has been satisfied, the **LOW BANK** valve (solenoid or actuator) will remain energized (**OPEN**) and the **TIME-FILL** valve (solenoid or actuator) is energized (**OPEN**).

10.3 Check valves should be installed downstream of the solenoid/actuator valves to prevent the banks from equalizing during the fill process. However, the storage banks will equalize pressures once the low bank is near the temperature compensated stopping pressure.

10.4 PRIORITIZING

10.4.1 When **DIRECT-FILL** is enabled, **HIGH BANK** is being filled, a **HOSE IN USE** signal is active, and the **DIRECT-FILL** pressure drops below its **FINAL TARGET PRESSURE** minus its **PRIORITY DEADBAND** setting, then the **HIGH BANK** valve (solenoid/actuator) will be de-energized (**CLOSED**) to allow the compressors to fill the **DIRECT-FILL** line.

10.4.2 When the **MID BANK** is being filled, if the **HIGH BANK** pressure drops below its **FINAL TARGET PRESSURE** minus its **PRIORITY DEADBAND** setting, then the **MID BANK** valve (solenoid/actuator) will be de-energized (**CLOSED**) to allow the compressors to fill **HIGH BANK** storage.

10.4.3 When the **LOW BANK** is being filled, if **HIGH BANK** or **MID BANK** pressures drops below their **FINAL TARGET PRESSURE** minus their **PRIORITY DEADBAND** settings, then the **LOW BANK** valve (solenoid/actuator) will be de-energized (**CLOSED**) to allow the compressors to fill the **HIGH BANK** or **MID BANK** as necessary.

10.4.4 **TIME-FILL (IF ENABLED):** When **HIGH BANK**, **MID BANK**, or **LOW BANK** pressures drops below their **FINAL TARGET PRESSURE** minus their **PRIORITY DEADBAND** settings, the **TIME-FILL** valve (solenoid/actuator) will be de-energized (**CLOSED**) to allow the compressors to fill the **HIGH BANK**, **MID BANK**, **LOW BANK** as necessary.

10.5 DIRECT FILLING

10.5.1 While dispensing gas (a **HOSE IN USE** signal is received). If the **DIRECT-FILL** pressure drops below the direct-fill **DEMAND** pressure while the compressor is running loaded, then the site controller de-energizes the **HIGH BANK**, **MID**

COMPRESSOR SEQUENCE OF OPERATION

BANK, LOW BANK, and SLOW-FILL (if enabled) valves to directly fill the vehicle at the dispenser. Once the dispenser **HOSE IN USE** signal is removed or if the **DIRECT-FILL** pressure exceeds its **FINAL TARGET** pressure, then the site controller will resume filling the storage banks.

10.6 DIRECT-FILL line pressure falling below its **DEMAND** pressure will not start the compressor.

11.0 STOP SEQUENCE

11.1 NORMAL SHUTDOWN SEQUENCE

11.1.1 In control mode **MANUAL**, the unit stop will be initiated via the **STOP** touch display pushbutton available on the **STATUS** page dropdown menu for each compressor or their respective **STOP** pushbuttons on the control panel.

11.1.2 In control mode **AUTO**, when the **FINAL TARGET** pressure has been met for all storage banks, the unit **STOP** command will be initiated.

11.1.3 When given the **STOP** command and once the **INLET VALVE, MOTOR, and LOAD** timers expire the following conditions will be provided:

- ESD Remote loop = Energized (De-energized on ESD activation)
- Unit Fault Indicator = De-Energized (Energized when in fault condition)
- Unit/Station Healthy Status Indicator = Energized (Energized when healthy)
- Main Motor Starter = De-Energized
- Inlet valve actuator = De-Energized (Closed)
- ESD / Flow valve = De-Energized (Closed)
- Drain / Load valve = De-Energized (Open)
- High Bank solenoid valve = De-Energized (Closed)
- Mid Bank solenoid valve = De-Energized (Closed)
- Low Bank solenoid valve = De-Energized (Closed)
- Time-Fill solenoid valve = De-Energized (Closed)

11.1.4 In **AUTO** mode, once the start/stop cycle is complete a restart delay timer starts (**HMI: COMP SETTINGS > SEQUENCE TIMINGS**). When the restart delay timer expires a **START SEQUENCE** can be initiated.

COMPRESSOR SEQUENCE OF OPERATION

11.2 **FAULT SHUTDOWN SEQUENCE**

11.2.1 If a shutdown condition occurs, the following conditions will be provided:

- ESD Remote loop = Energized (De-energized on ESD activation)
- Unit Fault Indicator = Energized (Energized when in fault condition)
- Unit/Station Healthy Status = De-Energized (Energized when healthy)
- Main Motor Starter = De-Energized
- Inlet valve actuator = De-Energized (Closed)
- ESD / Flow valve = De-Energized (Closed)
- Drain / Load valve = De-Energized (Open)
- High Bank solenoid valve = De-Energized (Closed)
- Mid Bank solenoid valve = De-Energized (Closed)
- Low Bank solenoid valve = De-Energized (Closed)
- Time-Fill solenoid valve = De-Energized (Closed)

11.2.2 The HMI will indicate the shutdown condition on the main **STATUS** page and **ALARM DISPLAY** page.

11.2.3 Once the fault shutdown condition has been corrected and the operator has pressed the **RESET** HMI pushbutton from the dropdown menu or selected **RESET** on the faulted compressors panel selection switch, the PLC will advance that compressor to a **STATUS OK** state and will await a new start sequence.

11.3 **ESD SHUTDOWN SEQUENCE**

11.3.1 If an ESD condition occurs, the following conditions will be provided:

- ESD Remote loop = De-Energized (De-energized on ESD activation)
- Unit Fault Indicator = Energized (Energized when in fault condition)
- Unit/Station Healthy Status = De-Energized (Energized when healthy)
- Main Motor Starter = De-Energized
- Inlet valve actuator = De-Energized (Closed)
- ESD / Flow valve = De-Energized (Closed)
- Drain / Load valve = De-Energized (Open)
- High Bank solenoid valve = De-Energized (Closed)
- Mid Bank solenoid valve = De-Energized (Closed)
- Low Bank solenoid valve = De-Energized (Closed)
- Time-Fill solenoid valve = De-Energized (Closed)

11.3.2 The HMI will indicate the ESD condition on the main **STATUS** page and **ALARMS DISPLAY** page.

11.3.3 Once the ESD condition has been corrected and the operator has pressed the **RESET** HMI pushbutton from the dropdown menu or selected **RESET** on either compressors panel selection switch, the PLC will advance that compressor to a

COMPRESSOR SEQUENCE OF OPERATION

STATUS OK state and will await a new start sequence.

12.0 DISPENSER VALVE ACTUATION

12.1 When a dispenser handle signal (**HOSE IN USE**) is received, the **FLOW VALVE** will be Energized (**OPEN**) to open the valves. Any time the signal is removed the output will be De-Energized (**CLOSED**).

13.0 TEMPERATURE COMPENSATION

13.1 Formula used to derive the temperature compensated **FINAL TARGET** pressures for **DIRECT-FILL** and **TIME-FILL**

$$P_T = (((T - 70) * 16.6) + P_S)$$

$$P_O = P_T * (1 + (F / 100))$$

If ($P_O > C$) then { $P_{Final} = C$ } else { $P_{Final} = P_O$ }

- P_t = **TARGET** pressure
- P_s = **FILL TO** pressure
- $P_{O=}$ Target with **OVERFILL** percentage applied
- P_{Final} = **FINAL TARGET** pressure with clipping applied
- T = Ambient Temperature in degrees Fahrenheit
- F = Overfill percentage
- C = Clipping pressure

If FINAL TARGET pressure exceeds CLIPPING pressure then FINAL TARGET shall equal CLIPPING pressure.

13.2 Formula used to derive the temperature compensated **FINAL TARGET** pressures for **HIGH BANK, MIDBANK, and LOW BANK.**

$$P_T = P_S * (T + R) / (T_{HI} + R)$$

$$P_O = P_T * (1 + (F / 100))$$

If ($P_O > C$) then { $P_{Final} = C$ } else { $P_{Final} = P_O$ }

- P_t = **TARGET** pressure
- P_s = **FILL TO** pressure
- $P_{O=}$ **TARGET** with **OVERFILL** percentage applied
- P_{Final} = **FINAL TARGET** pressure with clipping applied
- T = Ambient Temperature in degrees Fahrenheit
- T_{HI} = Ambient High Temperature in degrees Fahrenheit
- R = is the value of 460 to convert Degrees Fahrenheit to Rankine
- F = Overfill percentage
- C = Clipping pressure

COMPRESSOR SEQUENCE OF OPERATION

14.0 ALARM AND SHUTDOWN FUNCTIONS

AL: Alarm

SD: Shutdown

IND: Indication (value display only)

CTL: Control

N/A: Not applicable

Shutdown/Alarm class descriptions:

Class "ESD" - Active at all times.

Class "A" - Active at all times.

Class "A/S" – Active at all times once a certain condition is met.

Class "S" – Active when a certain process condition is met.

Class "P" Enable once the unit is RUNNING – Load Control Enabled

#	ANNUNCIATION	DEVICE	TYPE	RANGE	SD/ AL/ IND	CLASS	SETPOINT
1	Remote Shutdown Pressed		Discrete	N/A	SD	ESD	N/A
2	Local Shutdown Pressed		Discrete	N/A	SD	ESD	N/A
3	HMI Shutdown Pressed		Discrete	N/A	SD	ESD	N/A
4	COMP1: Low Oil Level		Discrete	N/A	SD	A	N/A
5	COMP1: Discharge Overpressure Switch		Discrete	N/A	SD	S	N/A
6	COMP1: Motor Overload		Discrete	N/A	SD	S	N/A
7	COMP1: Motor Run Fault		Discrete	N/A	SD	S	N/A
8	COMP1: Excessive Motor Starts		Logic	N/A	SD	S	N/A
9	COMP1: Stopped While in AUTO mode		Logic	N/A	SD	P	N/A
10	COMP1: Excessive Run Time		Logic	N/A	SD	P	N/A
11	COMP2: Low Oil Level		Discrete	N/A	SD	A	N/A
12	COMP2: Discharge Overpressure Switch		Discrete	N/A	SD	S	N/A
13	COMP2: Motor Overload		Discrete	N/A	SD	S	N/A
14	COMP2: Motor Run Fault		Discrete	N/A	SD	S	N/A
15	COMP2: Excessive Motor Starts		Logic	N/A	SD	S	N/A
16	COMP2: Stopped While in AUTO mode		Logic	N/A	SD	P	N/A
17	COMP2: Excessive Run Time		Logic	N/A	SD	P	N/A
18	INLET: Transducer Fault	K-30V100	4-20ma	-30in to 100 PSIG	SD	A	N/A
19	INLET: High Pressure				SD	S	35
20	INLET: Low Pressure				SD	S	10

COMPRESSOR SEQUENCE OF OPERATION

21	INLET: High Pressure				AL	S	30
22	INLET: Low Pressure				AL	S	5
23	BLOWDOWN: Transducer Fault	K-300	4-20ma	0-300 PSIG	SD	A	N/A
24	BLOWDOWN: High Pressure				SD	S	275
25	BLOWDOWN: High Pressure				AL	S	250
26	COMP1: Suction - Transducer Fault	K-30V100	4-20ma	-30in to 100 PSIG	SD	A	N/A
27	COMP1: Suction - High Pressure				SD	A/S	25
28	COMP1: Suction - Low Pressure				SD	A/S	-5
29	COMP1: Suction - High Pressure				AL	A/S	20
30	COMP1: Suction - Low Pressure				AL	A/S	0
31	COMP2: Suction - Transducer Fault	K-30V100	4-20ma	-30in to 100 PSIG	SD	A	N/A
32	COMP2: Suction - High Pressure				SD	A/S	25
33	COMP2: Suction - Low Pressure				SD	A/S	-5
34	COMP2: Suction - High Pressure				AL	A/S	20
35	COMP2: Suction - Low Pressure				AL	A/S	0
36	COMP1: Discharge - Transducer Fault	K-10000	4-20ma	0-10000 PSIG	SD	A	N/A
37	COMP1: Discharge - High Pressure				SD	A/S	4400
38	COMP1: Discharge - Low Pressure				SD	A/S	0
39	COMP1: Discharge - High Pressure				AL	A/S	4350
40	COMP1: Discharge - Low Pressure				AL	A/S	0
41	COMP2: Discharge - Transducer Fault	K-10000	4-20ma	0-10000 PSIG	SD	A	N/A
42	COMP2: Discharge - High Pressure				SD	A/S	4400
43	COMP2: Discharge - Low Pressure				SD	A/S	0
44	COMP2: Discharge - High Pressure				AL	A/S	4350
45	COMP2: Discharge - Low Pressure				AL	A/S	0
46	COMP1: Discharge - Thermocouple Fault	K-TYPE	Thermo-couple	-328 to 2372°F	SD	A	N/A
47	COMP1: Discharge - High Temperature				SD	A/S	275
48	COMP1: Discharge - High Temperature				AL	A/S	250
49	COMP2: Discharge - Thermocouple Fault	K-TYPE	Thermo-couple	-328 to 2372°F	SD	A	N/A
50	COMP2: Discharge - High Temperature				SD	A/S	275
51	COMP2: Discharge - High Temperature				AL	A/S	250
52	AMBIENT TEMPERATURE: Probe Fault	TGT-TP	0-10v	0-1000 °F	AL	A	N/A
53	AMBIENT TEMPERATURE: High				AL	A/S	150

COMPRESSOR SEQUENCE OF OPERATION







	Temperature						
54	STORAGE: Direct Fill - Transducer Fault	K-10000	4-20ma	0-10000 PSIG	SD	A	N/A
55	STORAGE: Direct Fill - High Pressure				SD	A	4450
56	STORAGE: Direct Fill - Low Pressure				SD	A	0
57	STORAGE: Direct Fill - High Pressure				AL	A	4375
58	STORAGE: Direct Fill - Low Pressure				AL	A	0
59	STORAGE: High Bank - Transducer Fault	K-10000	4-20ma	0-10000 PSIG	SD	A	N/A
60	STORAGE: High Bank - High Pressure				SD	A	4450
61	STORAGE: High Bank - Low Pressure				SD	A	0
62	STORAGE: High Bank - High Pressure				AL	A	4375
63	STORAGE: High Bank - Low Pressure				AL	A	0
64	STORAGE: Mid Bank - Transducer Fault	K-10000	4-20ma	0-10000 PSIG	SD	A	N/A
65	STORAGE: Mid Bank - High Pressure				SD	A	4450
66	STORAGE: Mid Bank - Low Pressure				SD	A	0
67	STORAGE: Mid Bank - High Pressure				AL	A	4375
68	STORAGE: Mid Bank - Low Pressure				AL	A	0
69	STORAGE: Low Bank - Transducer Fault	K-10000	4-20ma	0-10000 PSIG	SD	A	N/A
70	STORAGE: Low Bank - High Pressure				SD	A	4450
71	STORAGE: Low Bank - Low Pressure				SD	A	0
72	STORAGE: Low Bank - High Pressure				AL	A	4375
73	STORAGE: Low Bank - Low Pressure				AL	A	0
74	STORAGE: Time Fill - Transducer Fault	K-10000	4-20ma	0-10000 PSIG	SD	A	N/A
75	STORAGE: Time Fill - High Pressure				SD	A	4200

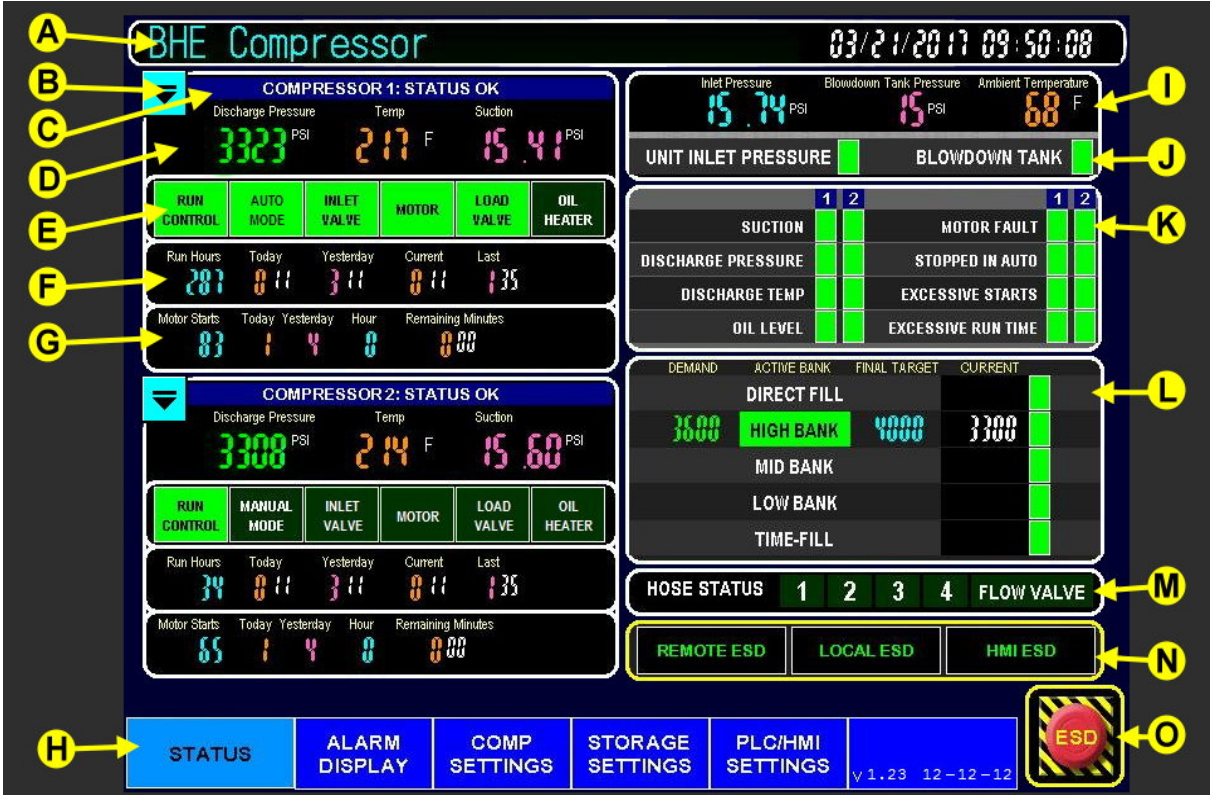
COMPRESSOR SEQUENCE OF OPERATION

76	STORAGE: Time Fill - Low Pressure				SD	A	0
77	STORAGE: Time Fill - High Pressure				AL	A	4100
78	STORAGE: Time Fill - Low Pressure				AL	A	0

15. HMI MENUS & CONFIGURABLE PROCESS VARIABLES

15.1. Main Status Screen: Legend and overview

-  Alternating **GREEN** and **RED** indicates a TRANSDUCER FAULT.
-  **RED** = SD (High) condition, example OVER PRESSURE.
-  **YELLOW** = AL (High) condition.
-  **GREEN** = OK, normal operating condition.
-  **CYAN** = AL (Low) condition.
-  **MAGENTA** = SD (Low) condition, example UNDER PRESSURE.



The screenshot shows the HMI interface for the BHE Compressor. It features two main compressor status panels (Compressor 1 and Compressor 2) and a central control panel. Callouts A through O point to various elements:

- A:** Title 'BHE Compressor' and date/time '03/21/2017 09:50:08'.
- B:** 'COMPRESSOR 1: STATUS OK' header.
- C:** Discharge Pressure (3323 PSI), Temp (217 F), Suction (15.41 PSI).
- D:** Control buttons: RUN CONTROL, AUTO MODE, INLET VALVE, MOTOR, LOAD VALVE, OIL HEATER.
- E:** Run Hours table for Compressor 1.
- F:** Motor Starts table for Compressor 1.
- G:** 'COMPRESSOR 2: STATUS OK' header.
- H:** Discharge Pressure (3300 PSI), Temp (214 F), Suction (15.60 PSI).
- I:** Inlet Pressure (15.74 PSI), Blowdown Tank Pressure (15 PSI), Ambient Temperature (68 F).
- J:** UNIT INLET PRESSURE and BLOWDOWN TANK status indicators.
- K:** SUCTION and MOTOR FAULT status indicators.
- L:** DEMAND, ACTIVE BANK, FINAL TARGET, CURRENT table.
- M:** HOSE STATUS table (1-4) and FLOW VALVE.
- N:** REMOTE ESD, LOCAL ESD, HMI ESD buttons.
- O:** ESD (Emergency Stop) button.

At the bottom, there are menu buttons: STATUS, ALARM DISPLAY, COMP SETTINGS, STORAGE SETTINGS, PLC/HMI SETTINGS, and version information 'v 1.23 12-12-12'.

COMPRESSOR SEQUENCE OF OPERATION

- (A) Site Name, Defined in the EMAIL section under PLC/HMI SETTINGS.
- (B) Individual compressors dropdown pushbutton menu allowing for HMI Starting, Stopping, and Manual/Auto Mode unit changes.
- (C) Individual compressor general health, either STATUS OK or STATUS FAULTED.
- (D) Individual compressor Discharge pressure, Discharge Temperature, and Suction pressure.
- (E) Individual compressor operational states of the RUN position switch, Logical Manual/Auto mode, Inlet valve, Motor starter, Load valve, and Crankcase oil heater.
- (F) Individual compressor total RUN HOURS, for today, for yesterday, for current run, and for the last run.
- (G) Individual compressor total MOTOR STARTS, today starts, yesterday starts, and dynamic start window for the excessive motor starts within an Hour fault and its remaining timer (This is a logical fault condition to prevent excessive short cycling of the compressor).
- (H) Menu Categories.
- (I) Inlet pressure, Blowdown tank pressure, and Ambient temperature.
- (J) UNIT INLET PRESSURE OK/AL/SD indicator
BLOWDOWN TANK pressure OK/AL/SD indicator
- (K) (Analog) SUCTION 1 & 2 OK/AL/SD indicator
(Analog) DISCHARGE PRESSURE 1 & 2 OK/AL/SD indicator
(Analog) DISCHARGE TEMPERATURE 1 & 2 OK/AL/SD indicator
(Digital) OIL LEVEL 1 & 2 OK/SD indicator
(Digital) MOTOR FAULT 1 & 2 OK/SD indicator
(Logical) STOPPED IN AUTO 1 & 2 OK/SD indicator
(Logical) EXCESSIVE STARTS 1 & 2 indicator
(Logical) EXCESSIVE RUN TIME 1 & 2 OK/SD indicator.
- (L) DEMAND pressure values, ACTIVE BANK(s) indicator , FINAL TARGET pressure(s), and CURRENT BANK pressure(s).
- (M) HOSE IN USE (1-4) and FLOW VALVE indicators.
- (N) ESD Condition indicators.
- (O) HMI ESD pushbutton (Logical).

COMPRESSOR SEQUENCE OF OPERATION

15.2. Alarm Screen

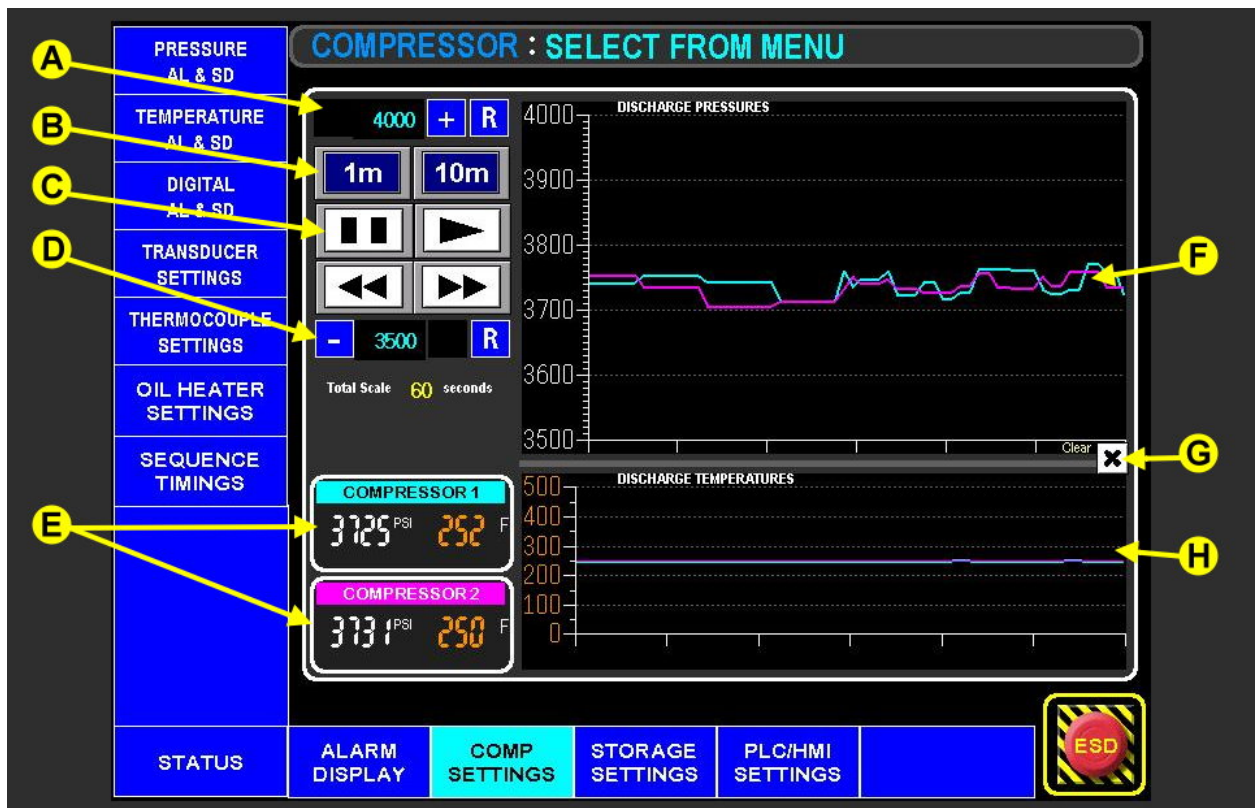
The screenshot displays the 'SYSTEM ALARMS' screen. At the top, it shows 'COMPRESSOR 1: STATUS OK' and 'COMPRESSOR 2: STATUS OK'. The main area is a table with three columns: 'EVENT OCCURRENCE', 'ALERT MESSAGE', and 'EVENT RECOVERED'. Below the table are several control buttons: 'CLEAR LIST', 'COMP1 RESET', a set of four directional arrow buttons (up, down, left, right), and 'COMP2 RESET'. At the bottom, there is a navigation bar with buttons for 'STATUS', 'ALARM DISPLAY', 'COMP SETTINGS', 'STORAGE SETTINGS', 'PLC/HMI SETTINGS', and an 'ESD' button.

EVENT OCCURRENCE	ALERT MESSAGE	EVENT RECOVERED
03/20/17 11:41:23	[AL] COMP2: Suction - High Pressure	03/20 15:18:31
03/20/17 11:41:23	[AL] COMP1: Suction - High Pressure	03/20 15:18:25
03/20/17 11:41:23	[AL] INLET: High Pressure	03/20 15:18:25
03/20/17 11:18:25	[AL] COMP2: Suction - High Pressure	03/20 11:41:16
03/20/17 11:18:25	[AL] COMP1: Suction - High Pressure	03/20 11:41:16
03/20/17 11:18:25	[AL] INLET: High Pressure	03/20 11:41:16
03/20/17 11:10:07	[AL] COMP2: Suction - High Pressure	03/20 11:18:17
03/20/17 11:10:07	[AL] COMP1: Suction - High Pressure	03/20 11:18:17
03/20/17 11:10:07	[AL] INLET: High Pressure	03/20 11:18:17
03/20/17 11:00:07	[AL] COMP2: Suction - High Pressure	03/20 11:10:01
03/20/17 11:00:07	[AL] COMP1: Suction - High Pressure	03/20 11:10:01
03/20/17 11:00:07	[AL] INLET: High Pressure	03/20 11:10:01
03/20/17 10:52:23	[AL] COMP2: Suction - High Pressure	03/20 11:00:00
03/20/17 10:52:23	[AL] COMP1: Suction - High Pressure	03/20 11:00:00
03/20/17 10:52:23	[AL] INLET: High Pressure	03/20 11:00:00

- (A) Individual compressor general health, either STATUS OK or STATUS FAULTED.
- (B) Event Occurrence: Date and timestamp when the event triggered.
Alert Message: [Type] source: affected
Event Recovered: Date and timestamp when the event was recovered or reset.
- (C) Clears the SYSTEM ALARMS list.
- (D) COMPRESSOR # reset pushbutton.
- (E) Page up, scroll up, scroll down, and page down pushbuttons.

COMPRESSOR SEQUENCE OF OPERATION

15.3. Compressor Menu Selection Screen



- (A) Upper graph display boundary (5000 maximum). 'R' button resets to maximum.
- (B) Visible data sample duration for both DISCHARGE PRESSURES and DISCHARGE TEMPERATURES each in their respective line colors. When 1 minute is selected each segment is 10 seconds. When 10 minute is selected each segment is approximately 100 seconds.
- (C) PAUSE, PLAY real-time, scroll BACKWARDS and scroll FORWARD (only while paused).
- (D) Lower graph display boundary (0 minimum). 'R' button resets to minimum.
- (E) Real-time compressor DISCHARGE PRESSURE(s) and DISCHARGE TEMPERATURE(s).
- (F) DISCHARGE PRESSURES trending graph with user selectable ranges and scale.
- (G) Clear all trending data pushbutton.
- (H) DISCHARGE TEMPERATURES trending graph follows user selected durations.

COMPRESSOR SEQUENCE OF OPERATION

15.4. Compressor Pressure Alarm and Shutdown Settings

PRESSURE AL & SD	COMPRESSOR : PRESSURE AL & SD							
	(A)	(B)	(C) LOW TRIGGER TIMER (ms)	(D) SD LOW	(E) AL LOW	(F) AL HIGH	(G) SD HIGH	(H) HIGH TRIGGER TIMER (ms)
TEMPERATURE AL & SD	INLET	15.95	1000	1.25	1.50	20.00	35.00	1000
DIGITAL AL & SD	BLOWDOWN	15	1000			90	100	1000
TRANSDUCER SETTINGS	COMPRESSOR : #1							
THERMOCOUPLE SETTINGS	SUCTION	14.94	2000	-5.00	1.00	20.00	25.00	1000
OIL HEATER SETTINGS	DISCHARGE	34.10	5000	0	60	4300	4400	1000
SEQUENCE TIMINGS	COMPRESSOR : #2							
	SUCTION	14.59	2000	-5.00	1.00	20.00	25.00	1000
	DISCHARGE	33.77	5000	0	60	4300	4400	1000
STATUS	ALARM DISPLAY	COMP SETTINGS	STORAGE SETTINGS	PLC/HMI SETTINGS				ESD

- (A) Device name.
- (B) A reference display of the current pressure as reported by the plc.
- (C) LOW TRIGGER TIMER setting. This timer starts once a LOW condition is in effect. If in effect for the duration of the timer and the timer expires, then the corresponding LOW condition alarm (AL) or shutdown (SD) is triggered and the UNIT will respond according to the related defined sequence.
- (D) Pressure condition 'SD LOW' threshold that if passed below, will start the LOW TRIGGER TIMER for said shutdown (SD) condition.
- (E) Pressure condition 'AL LOW' threshold that if passed below, will start the LOW TRIGGER TIMER for said alarm (AL) condition.
- (F) Pressure condition 'AL HIGH' threshold that if exceeded, will start the HIGH TRIGGER TIMER for said alarm (AL) condition.
- (G) Pressure condition 'SD HIGH' threshold that if exceeded, will start the HIGH TRIGGER TIMER for said shutdown (SD) condition.
- (H) HIGH TRIGGER TIMER setting. This timer starts once a HIGH condition is in effect. If in effect for the duration of the timer and the timer expires, then the corresponding HIGH condition alarm (AL) or shutdown (SD) is triggered and the UNIT will respond according to the defined sequence.

COMPRESSOR SEQUENCE OF OPERATION

15.5. Compressor Temperature Alarm and Shutdown Settings

COMPRESSOR : TEMPERATURE AL & SD	(A)	(B)	(C)	(D)	(E)
	TEMP	ALARM HIGH	S/D HIGH	TRIGGER TIMER (ms)	
AMBIENT	69.8	120	200	500	

COMPRESSOR : #1	TEMP	ALARM HIGH	S/D HIGH	TRIGGER TIMER (ms)
DISCHARGE	230	275	325	1000

COMPRESSOR : #2	TEMP	ALARM HIGH	S/D HIGH	TRIGGER TIMER (ms)
DISCHARGE	227	275	325	1000

STATUS	ALARM DISPLAY	COMP SETTINGS	STORAGE SETTINGS	PLC/HMI SETTINGS	ESD
--------	---------------	---------------	------------------	------------------	-----

- (A) Device name.
- (B) A reference display of the current temperature as reported by the thermocouple.
- (C) Pressure condition 'AL HIGH' threshold that if exceeded, will start the TRIGGER TIMER for said alarm (AL) condition.
- (D) Pressure condition 'SD HIGH' threshold that if exceeded, will start the TRIGGER TIMER for said shutdown (SD) condition.
- (E) TRIGGER TIMER setting. This timer duration starts once a condition is in effect. If in effect for the duration of the timer and the timer expires, then the corresponding HIGH condition alarm (AL) or shutdown (SD) is triggered and the UNIT will respond according to the defined sequence.

COMPRESSOR SEQUENCE OF OPERATION

15.6. Compressor Digital and Logical Shutdown Settings

Menu Item	Setting	Value	Unit / Description
PRESSURE AL & SD TEMPERATURE AL & SD DIGITAL AL & SD TRANSDUCER SETTINGS THERMOCOUPLE SETTINGS OIL HEATER SETTINGS SEQUENCE TIMINGS	COMPRESSOR : DIGITAL SETTINGS		
	A	100	LOCAL ESD TRIGGER TIMER (0-1000ms)
	B	100	REMOTE ESD TRIGGER TIMER (0-1000ms)
	C	100	DISPENSER IN USE TRIGGER TIMER (0-1000ms)
	COMPRESSOR : #1		
	D	1000	LOW OIL LEVEL TRIGGER TIMER (0-5000ms)
	E	8000	MOTOR RUN SIGNAL TRIGGER TIMER (0-10000ms)
	F	3000	MOTOR OVERLOAD TRIGGER TIMER (0-5000ms)
	G	7	MOTOR MAX STARTS / HR TRIGGER @ # (0-30)
	H	720	MOTOR MAX RUNTIME TRIGGER @ # (0-3000mins)
	COMPRESSOR : #2		
	I	1000	LOW OIL LEVEL TRIGGER TIMER (0-5000ms)
J	8000	MOTOR RUN SIGNAL TRIGGER TIMER (0-10000ms)	
K	3000	MOTOR OVERLOAD TRIGGER TIMER (0-5000ms)	
L	7	MOTOR MAX STARTS / HR TRIGGER @ # (0-30)	
M	720	MOTOR MAX RUNTIME TRIGGER @ # (0-3000mins)	
STATUS	ALARM DISPLAY	COMP SETTINGS	STORAGE SETTINGS
	PLC/HMI SETTINGS	ESD	

- (A) LOCAL ESD: TRIGGER TIMER setting. This timer duration starts once the condition is in effect. If in effect for the duration of the timer and the timer expires, then the corresponding shutdown (ESD) is triggered and the UNIT will respond according to the defined ESD shutdown sequence.
- (B) REMOTE ESD: TRIGGER TIMER setting. This timer duration starts once the condition is in effect. If in effect for the duration of the timer and the timer expires, then the corresponding shutdown (ESD) is triggered and the UNIT will respond according to the defined ESD shutdown sequence.
- (C) DISPENSER IN USE: TRIGGER TIMER setting. This timer duration starts once a 'HOSE IN USE' signal is received. If in effect past the duration of the timer, the FLOW VALVE will be Energized (OPEN) to allow flow from storage to the signaling dispenser until ALL 'HOSE IN USE' signals have been terminated.
- (D,I) Compressor #, LOW OIL LEVEL: TRIGGER TIMER setting. This timer duration starts once the condition is in effect. If in effect for the duration of the timer and the timer expires, then the corresponding shutdown (SD) is triggered and the UNIT will respond according to the defined shutdown sequence.
- (E,J) Compressor #, MOTOR RUN SIGNAL: TRIGGER TIMER setting. This timer duration starts once the motor has been commanded to start. If no MOTOR RUN SIGNAL is returned and the timer expires, then the corresponding shutdown (SD) is triggered and the UNIT

COMPRESSOR SEQUENCE OF OPERATION

will respond according to the defined shutdown sequence.

- (F,K) Compressor #, MOTOR OVERLOAD: TRIGGER TIMER setting. This timer duration starts once the MOTOR OVERLOAD signal has been lost. If no MOTOR OVERLOAD signal is returned and the duration of the timer expires, then the corresponding shutdown (SD) is triggered and the UNIT will respond according to the defined shutdown sequence.
- (G,L) Compressor #, MAX STARTS / HR: TRIGGER EVENT setting. Once the motor starts and no MAX STARTS timer is in effect, a 60 minute countdown timer starts. Each start while the timer is active counts toward MAX STARTS. If the MAX STARTS count is exceeded a shutdown condition for the specific compressor is triggered. Once the countdown timer expires the starts counter is reset to zero. This information is displayed on the main status page in the STARTS section.
- (H,M) Compressor #, MOTOR MAX RUNTIME: TRIGGER EVENT setting. During a single sequence cycle, if the motor is energized longer than the specified time (defined in minutes) a shutdown event will be triggered for the specific compressor.

COMPRESSOR SEQUENCE OF OPERATION

15.7. Compressor Transducer Settings

COMPRESSOR : TRANSDUCER SETTINGS	LOW SCALE 4mA	HIGH SCALE 20mA	CURRENT mA	SCALED PRESSURE	WATCHDOG TIMER (ms)
A INLET	B -15	C 100	D 8.260	E 16.00	F 1500
BLOWDOWN TANK	0	300	4.841	15.74	1500

COMPRESSOR : #1	LOW SCALE 4mA	HIGH SCALE 20mA	CURRENT mA	SCALED PRESSURE	WATCHDOG TIMER (ms)
DISCHARGE PRESSURE	0	10000	9.491	3457.74	750
SUCTION PRESSURE	-15	100	8.225	15.66	250

COMPRESSOR : #2	LOW SCALE 4mA	HIGH SCALE 20mA	CURRENT mA	SCALED PRESSURE	WATCHDOG TIMER (ms)
DISCHARGE PRESSURE	0	10000	9.501	3460.18	750
SUCTION PRESSURE	-15	100	8.236	14.26	250

STATUS	ALARM DISPLAY	COMP SETTINGS	STORAGE SETTINGS	PLC/HMI SETTINGS	ESD
--------	---------------	---------------	------------------	------------------	-----

- (A) Device name.
- (B) Transducer scale LOW value (4ma)
- (C) Transducer scale HIGH value (20ma)
- (D) A reference display of the transducer current as reported by the plc.
- (E) A reference display of the current scaled pressure.
- (F) WATCHDOG TIMER setting. This monitors the state of the transducer. This timer starts once the transducer current is < 3.82ma or > 20.36ma (out of bounds low or high). If the timer expires, then the corresponding shutdown (SD) condition is triggered and the UNIT will respond according to the defined sequence.

COMPRESSOR SEQUENCE OF OPERATION

15.8. Compressor Thermocouple Settings

The screenshot displays the 'COMPRESSOR : THERMOCOUPLE SETTINGS' screen. On the left is a vertical menu with options: PRESSURE AL & SD, TEMPERATURE AL & SD, DIGITAL AL & SD, TRANSDUCER SETTINGS, THERMOCOUPLE SETTINGS (highlighted), OIL HEATER SETTINGS, SEQUENCE TIMINGS, and STATUS. The main display area is divided into three sections for different compressors:

- COMPRESSOR : THERMOCOUPLE SETTINGS** (Overall title)
- COMPRESSOR : #1** (Thermocouple Type K are typically ranged -328°F to 2372°F)

	LOW SCALE	HIGH SCALE	SCALED TEMPERATURE	WATCHDOG TIMER (ms)
AMBIENT TEMPERATURE	0	1000	70.92	1000
- COMPRESSOR : #2** (Thermocouple Type K are typically ranged -328°F to 2372°F)

	LOW SCALE	HIGH SCALE	SCALED TEMPERATURE	WATCHDOG TIMER (ms)
DISCHARGE TEMPERATURE	-328	2372	234.21	1500

At the bottom, the status bar includes: ALARM DISPLAY, COMP SETTINGS (highlighted), STORAGE SETTINGS, PLC/HMI SETTINGS, and an ESD (Emergency Stop) button.

- (A) Device name.
- (B) Thermocouple scale LOW value.
- (C) Thermocouple scale HIGH value
- (D) A reference display of the current scaled temperature in degrees Fahrenheit.
- (E) WATCHDOG TIMER setting. This monitors the state of the thermocouple. This timer starts once the thermocouple sensor is out of bounds low or high. If the timer expires, then the corresponding shutdown (SD) condition is triggered and the UNIT will respond according to the defined sequence.

COMPRESSOR SEQUENCE OF OPERATION

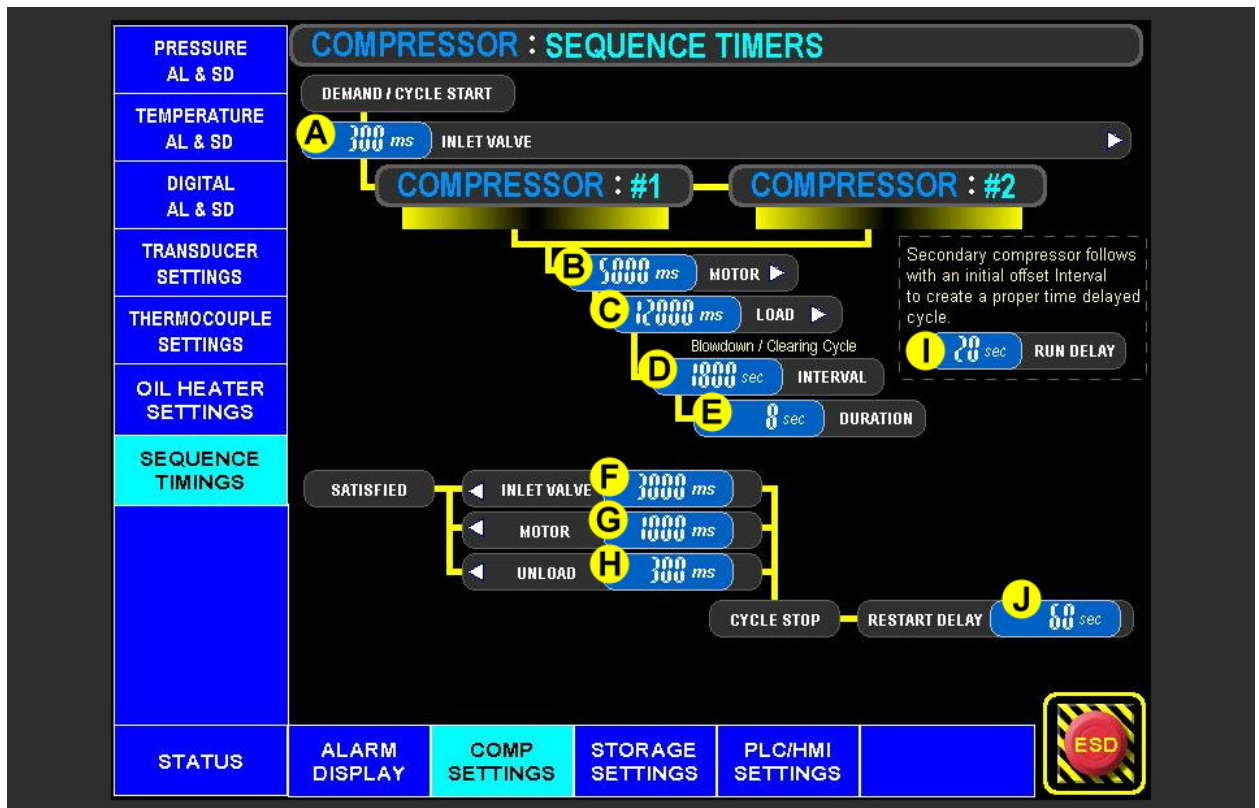
15.9. Compressor Oil Heater Settings

The screenshot displays a control panel interface for 'COMPRESSOR : OIL HEATER SETTINGS'. On the left is a vertical menu with options: PRESSURE AL & SD, TEMPERATURE AL & SD, DIGITAL AL & SD, TRANSDUCER SETTINGS, THERMOCOUPLE SETTINGS, OIL HEATER SETTINGS (highlighted in cyan), SEQUENCE TIMINGS, and STATUS. The main display area is divided into two sections for 'COMPRESSOR : #1' and 'COMPRESSOR : #2'. Each section shows 'ON @ (0-99)', 'OFF @ (0-99)', and 'PERMIT START @ (0-99)' settings. For Compressor #1, the values are 40 (labeled B), 60 (labeled C), and 0 (labeled D). For Compressor #2, the values are 40, 60, and 0. A yellow 'A' label is positioned above the 'OIL HEATER' text in the Compressor #1 section. At the bottom, there are buttons for 'ALARM DISPLAY', 'COMP SETTINGS' (highlighted in cyan), 'STORAGE SETTINGS', 'PLC/HMI SETTINGS', and an 'ESD' emergency stop button with a red and yellow hazard symbol.

- (A) Device name.
- (B) Low temperature at which to energize the compressors crankcase oil heater.
- (C) High temperature at which to de-energize the compressors crankcase oil heater.
- (D) Permit AUTO mode starting when temperature is \geq set point (0=Disabled).

COMPRESSOR SEQUENCE OF OPERATION

15.10. Compressor Sequence Timers



- (A) Once a cycle starts, be it from 'DEMAND' or manual 'START' pushbutton, the 'INLET' delay timer is started. When the timer expires the INLET valve is energized (OPEN).
- (B) Once the 'INLET' valve is energized a 'MOTOR' delay timer starts. When the timer expires the 'MOTOR' run is energized (ON).
- (C) Once the 'MOTOR' run is energized a 'LOAD' delay timer starts. When the timer expires the 'Blowdown/Clearing cycle' logic is activated.
- (D) Once the 'Blowdown/Clearing cycle' logic is active an 'INTERVAL' timer is started.
- (E) Each time the 'INTERVAL' timer is triggered the compressor De-energizes (OPEN) the 'LOAD' valve, starts a duration timer, then Re-Energizes (CLOSE) the 'LOAD' valve once the timer expires.

When all storage is brought to a satisfied state, meaning pressures => Final target pressures, the compressor starts three separate 'NORMAL' shutdown timers.

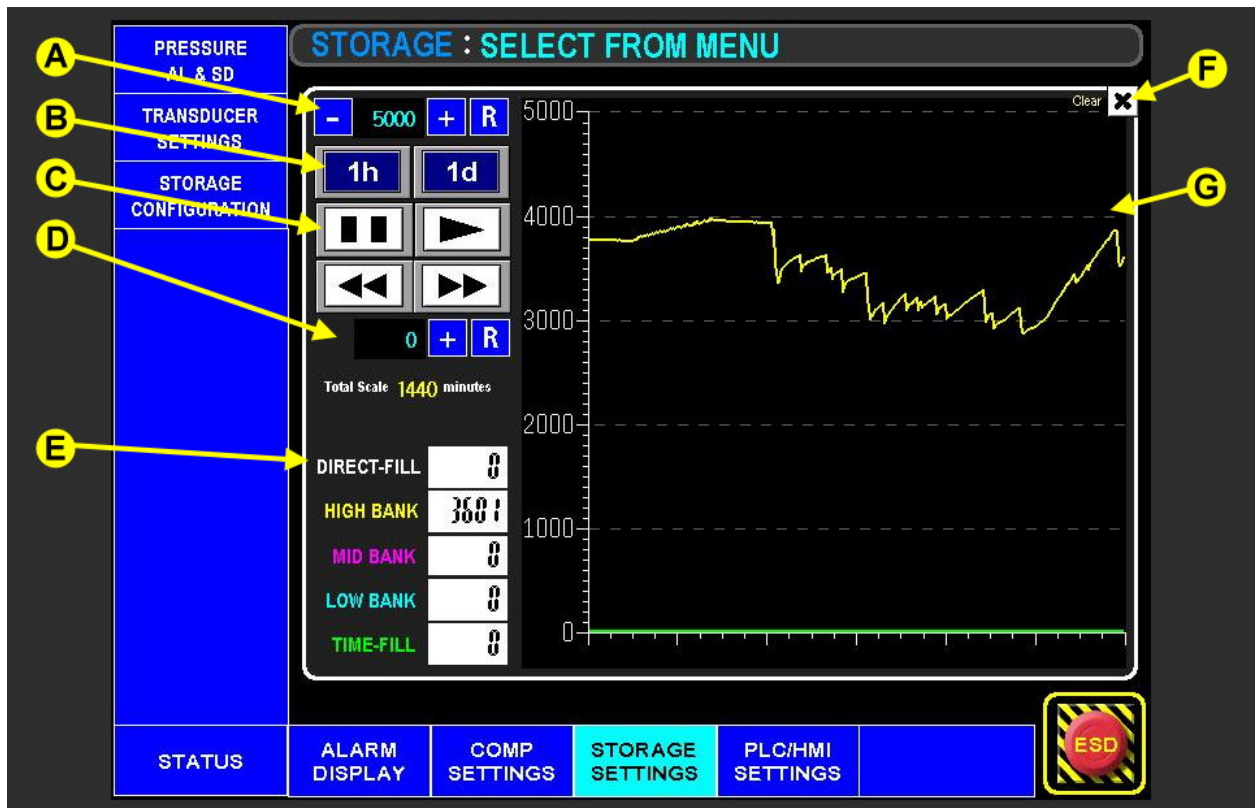
- (F) When the INLET VALVE timer expires the inlet valve will be De-Energized (CLOSED).
- (G) When the MOTOR run timer expires the motor will be De-Energized (OFF).
- (H) When the UNLOAD timer expires the 'Blowdown/Clearing cycle' logic is deactivated and the 'LOAD' valve is De-Energized (OPEN).

COMPRESSOR SEQUENCE OF OPERATION

- (I) Once a 'MOTOR' is energized for a compressor a delay timer starts. When the timer expires the second compressor is permitted to start.
- (J) When a 'NORMAL' shutdown of a compressor (in AUTO mode) takes place a RESTART timer is established. Once the RESTART timer expires, the compressor is permitted to START.

COMPRESSOR SEQUENCE OF OPERATION

15.11. Storage Main Selection Menu



- (A) Upper graph display boundary (5000 maximum). 'R' button resets to maximum.
- (B) Visible data sample duration for STORAGE PRESSURE(s) each in their respective line colors. When 1h is selected each minor segment is 2.5 minutes. When 1d is selected each minor segment is approximately 1 hour.
- (C) PAUSE, PLAY real-time, scroll BACKWARDS and scroll FORWARD (only while paused).
- (D) Lower graph display boundary (0 minimum). 'R' button resets to minimum.
- (E) Real-time STORAGE PRESSURE(s).
- (F) Clear all trending data pushbutton.
- (G) STORAGE PRESSURE(s) trending graph with user selectable ranges and scale.

COMPRESSOR SEQUENCE OF OPERATION

15.12. Storage Pressure Alarm and Shutdown Settings

PRESSURE AL & SD		STORAGE : PRESSURE AL & SD						
TRANSUCER SETTINGS	A	B	C	D	E	F	G	H
STORAGE SETTINGS	DIRECT-FILL	CURRENT	LOW TRIGGER TIMER (ms)	SD LOW	AL LOW	AL HIGH	SD HIGH	HIGH TRIGGER TIMER (ms)
	0	3622	5000	0	0	4400	4450	1000
	0	0	5000	0	0	4400	4450	1000
	0	0	5000	0	0	4400	4450	1000
	0	0	5000	0	0	4400	4450	1000
	0	0	5000	0	0	4400	4450	1000

STATUS ALARM DISPLAY COMP SETTINGS STORAGE SETTINGS PLC/HMI SETTINGS ESD

- (A) Device name.
- (B) A reference display of the current pressure as reported by the plc.
- (C) LOW TRIGGER TIMER setting. This timer starts once a LOW condition is in effect. If in effect for the duration of the timer and the timer expires, then the corresponding LOW condition alarm (AL) or shutdown (SD) is triggered and the UNIT will respond according to the related defined sequence.
- (D) Pressure condition 'SD LOW' threshold that if passed below, will start the LOW TRIGGER TIMER for said shutdown (SD) condition.
- (E) Pressure condition 'AL LOW' threshold that if passed below, will start the LOW TRIGGER TIMER for said alarm (AL) condition.
- (F) Pressure condition 'AL HIGH' threshold that if exceeded, will start the HIGH TRIGGER TIMER for said alarm (AL) condition.
- (G) Pressure condition 'SD HIGH' threshold that if exceeded, will start the HIGH TRIGGER TIMER for said shutdown (SD) condition.
- (H) HIGH TRIGGER TIMER setting. This timer starts once a HIGH condition is in effect. If in effect for the duration of the timer and the timer expires, then the corresponding HIGH condition alarm (AL) or shutdown (SD) is triggered and the UNIT will respond according to the defined sequence.

COMPRESSOR SEQUENCE OF OPERATION

15.13. Storage Transducer Settings

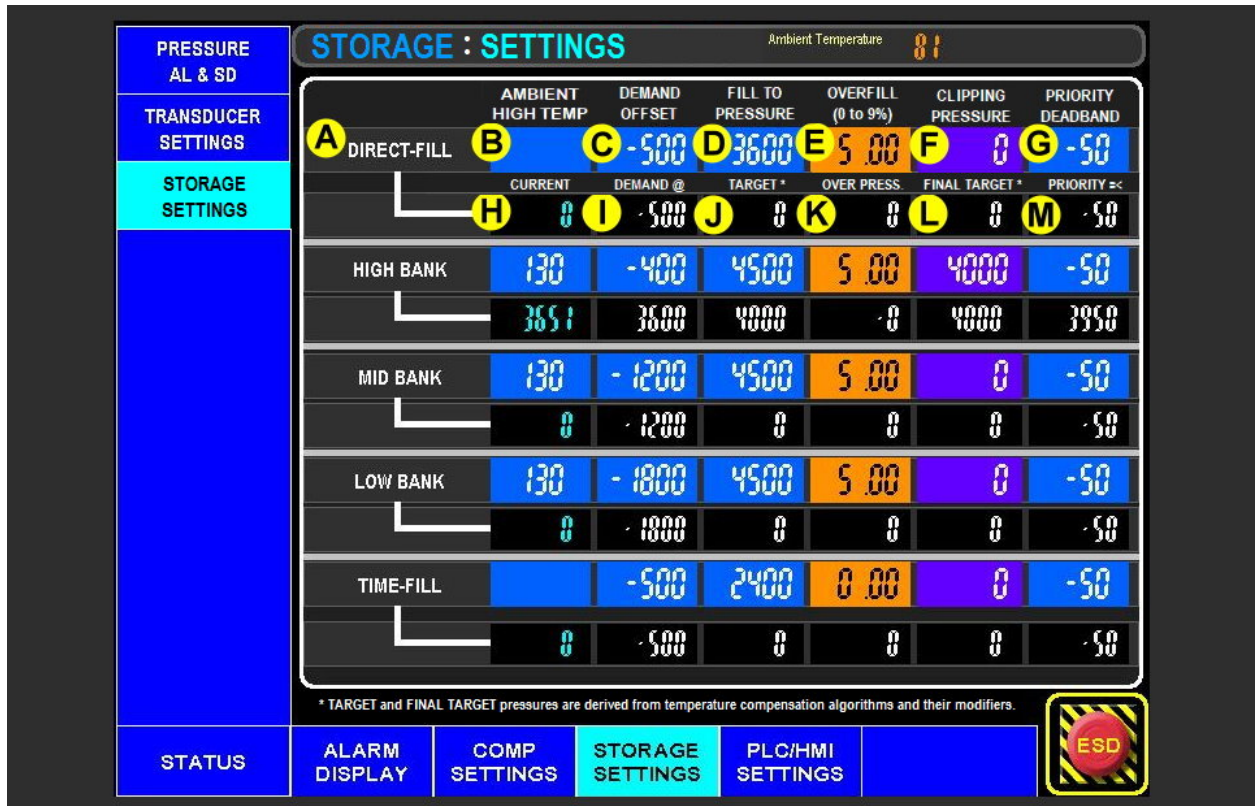
(A)	(B) 4mA	(C) 20mA	(D) mA	(E)	(F)
DIRECT-FILL	0	10000			3000
HIGH BANK	0	10000	9.805	3635.97	3000
MID BANK	0	10000			3000
LOW BANK	0	10000			3000
TIME-FILL	0	10000			3000

Set "LOW SCALE" and "HIGH SCALE" to zero to disable the bank.
 If "CURRENT mA" and "SCALED PRESSURE" are not visible for a bank, check the transducer wiring.
 It could also be out of range for exceeding minimum or maximum thresholds.

- (A) Device name.
- (B) Transducer scale LOW value (4ma)
- (C) Transducer scale HIGH value (20ma)
- (D) A reference display of the transducer current as reported by the plc.
- (E) A reference display of the current scaled pressure.
- (F) WATCHDOG TIMER setting. This monitors the state of the transducer. This timer starts once the transducer current is < 3.82ma or > 20.36ma (out of bounds low or high). If the timer expires, then the corresponding shutdown (SD) condition is triggered and the UNIT will respond according to the defined sequence.

COMPRESSOR SEQUENCE OF OPERATION

15.14. Storage Settings



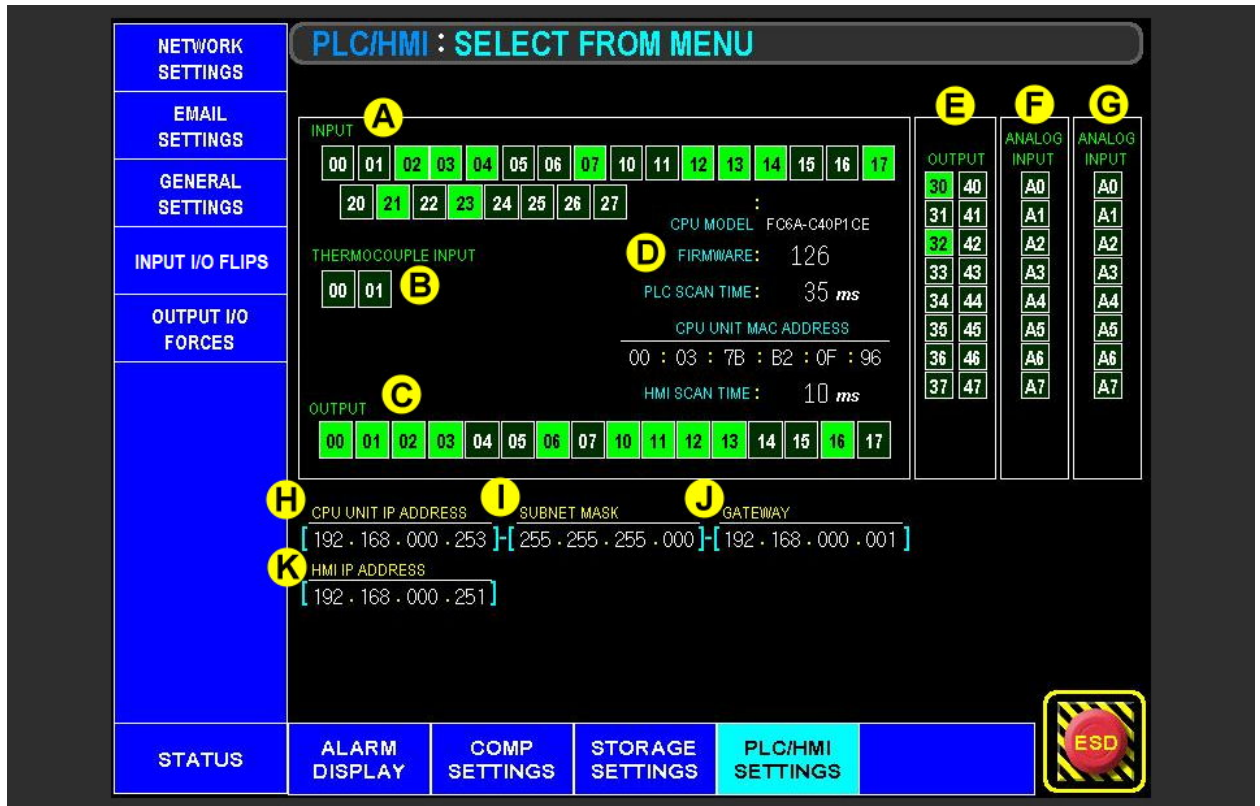
- (A) Storage bank name.
- (B) **Ambient High Temperature:** Applies to High, Mid, and Low banks. The ambient temperature in which the 'Fill to pressure' setting is achieved.
- (C) **Demand Offset:** Offset from 'TARGET' pressure to determine a demand state.
- (D) **Fill to Pressure:** For High, Mid, and Low banks see temperature compensation in section 13.2. For Direct-fill and Time-fill see temperature compensation in section 13.1
- (E) **Overfill %:** Percentage of 'TARGET' pressure to 'OVER-FILL'.
- (F) **Clipping Pressure:** No pressure target pressure shall rise above this setting regardless of temperature compensation.
- (G) **Priority Deadband:** Offset to decide at what pressure a bank is given priority/re-prioritization.
- (H) A reference display of the current scaled pressure.
- (I) **Demand @:** The pressure in which 'DEMAND' calls for a UNIT start.
- (J) **Target:** See section 13 Temperature Compensation.
- (K) **Over Pressure:** The amount of pressure added to 'TARGET' pressure to formulate 'FINAL TARGET' pressure. 'CLIPPING' pressure will reduce this amount if it causes 'FINAL TARGET' pressure to exceed 'CLIPPING' pressure.

COMPRESSOR SEQUENCE OF OPERATION

- (L) **Final Target:** Pressure in which the banks 'DEMAND' is considered 'SATISFIED'.
- (M) **Priority \leq :** When the bank is equal to or less than this pressure, it is in consideration for prioritization following the guidelines set forth in section 10.4.

COMPRESSOR SEQUENCE OF OPERATION

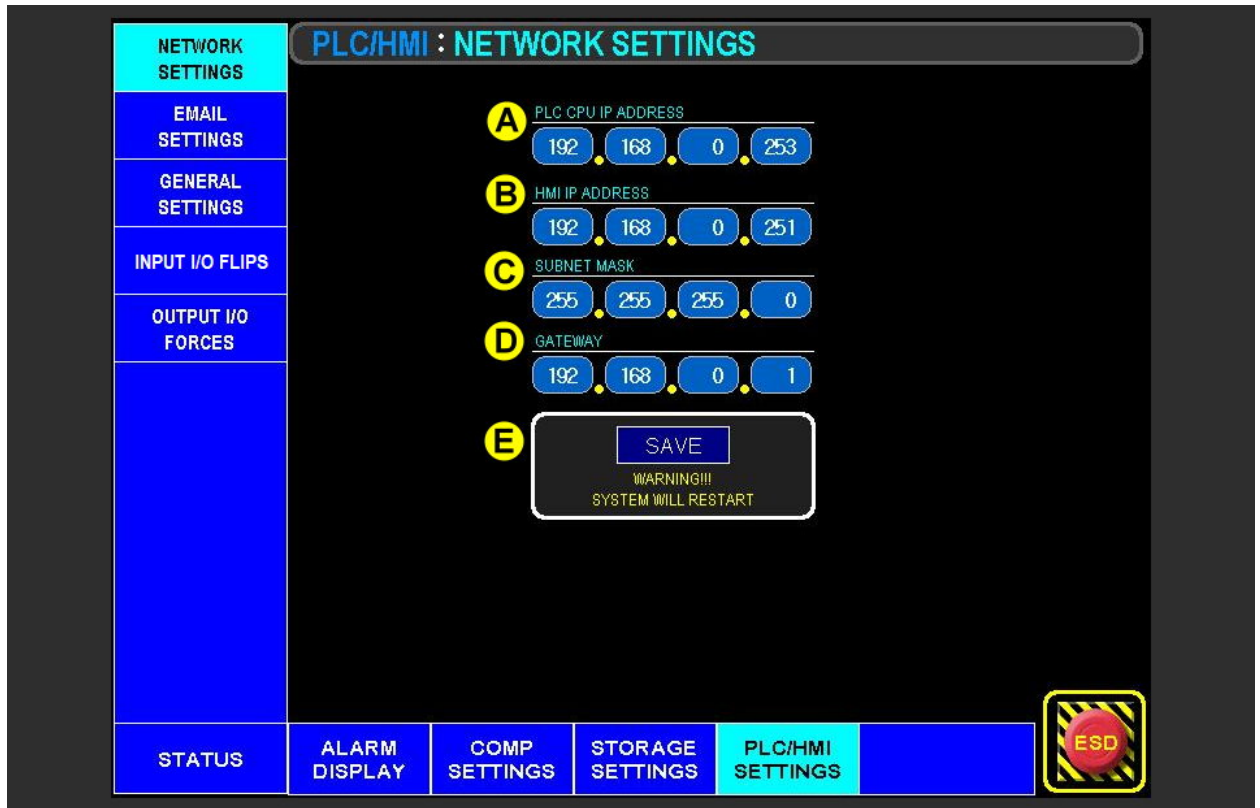
15.15. PLC / HMI Main Selection Menu



- (A) Input Status.
- (B) Thermocouple fault status.
- (C) Output Status.
- (D) PLC / HMI CPU Information.
- (E) Module Output Status.
- (F,G) Analog fault status.
- (H) PLC IP address, (I) PLC Subnet mask, (J) PLC gateway IP.
- (K) HMI IP address.

COMPRESSOR SEQUENCE OF OPERATION

15.16. PLC / HMI Network Settings



- (A) PLC CPU IP address.
- (B) HMI Touch Display IP address.
- (C) Subnet mask for both, (D) Gateway address for both.
- (E) Commit changes and restart the PLC and HMI.

COMPRESSOR SEQUENCE OF OPERATION

15.17. PLC/HMI Email Settings

PLC/HMI : EMAIL SETTINGS

A SMTP SERVER: 62.13.128.187 **B** PORT: 2525

C Senders Email Address (40 max) **D** Site Name (40 max)

E REQUIRE AUTH: YES

F Account Name (40 max) **G** Password (40 max)

H Email Recipients (60 max)

#1 #4
#2 #5
#3 #6

I SEND TEST EMAIL

J 000 SMTP Idle...
002 Successfully Completed

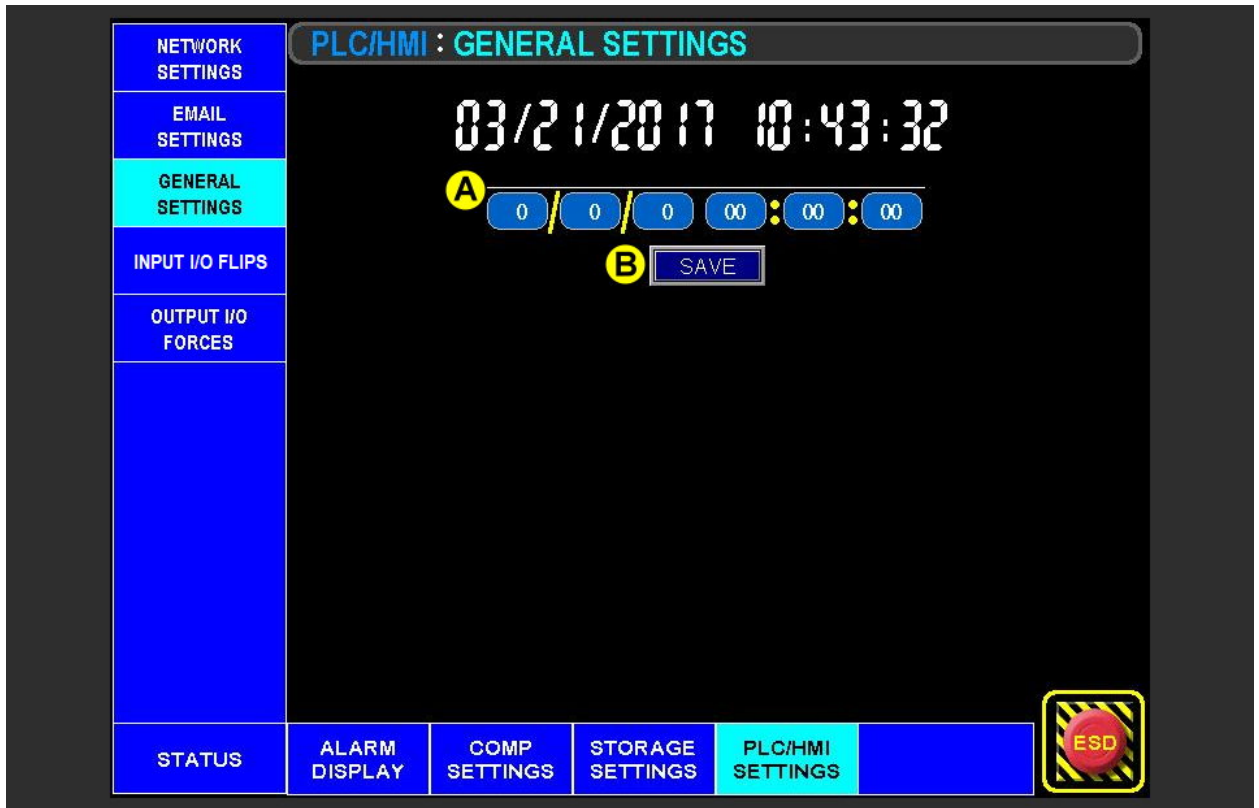
K LOAD AUTHSMTP DEFAULT SETTINGS

STATUS ALARM DISPLAY COMP SETTINGS STORAGE SETTINGS **PLC/HMI SETTINGS** ESD

- (A) SMTP Servers IP address.
- (B) SMTP Servers port number.
- (C) Senders Email Address. Must be a fully qualified email address.
- (D) Site Name, this is displayed in the 'From' field in the email as well as displayed on the main status page.
- (E) Setting for if the SMTP server requires TLS/SSL.
- (F) Email account login name.
- (G) Email account password.
- (H) Email recipients list, only 1 per.
- (I) Once configured this will allow you to send out a test email to the recipients list.
- (J) Test email sending status and error code if failure.
- (K) Preloaded Authsmtp service defaults.

COMPRESSOR SEQUENCE OF OPERATION

15.18. PLC/HMI General Settings

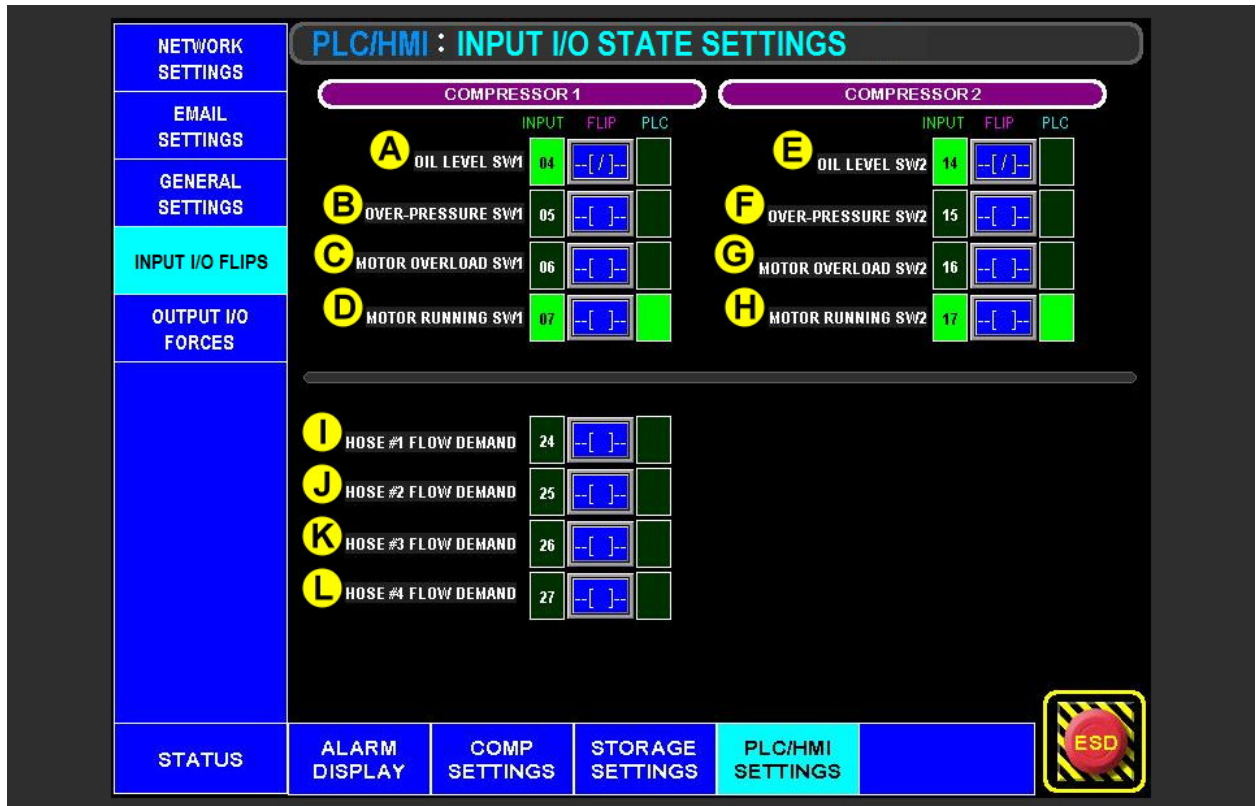


(A) HMI Date and Time setting: MM/DD/YYYY HH:MM:SS

(B) Commit changes

COMPRESSOR SEQUENCE OF OPERATION

15.19. PLC/HMI Input IO State Settings



- (A) OIL LEVEL SW1.
- (B) OVER-PRESSURE SW1 (Optional Pressure Switch).
- (C) MOTOR OVERLOAD SW1 (Contactor Overload AUX contacts).
- (D) MOTOR RUNNING SW1 (Contactor AUX contacts or Soft Starter dry contacts).
- (E) OIL LEVEL SW2.
- (F) OVER-PRESSURE SW2 (Optional Pressure Switch).
- (G) MOTOR OVERLOAD SW2 (Contactor Overload AUX contacts).
- (H) MOTOR RUNNING SW2 (Contactor AUX contacts or Soft Starter dry contacts).
- (I,J,K,L) 'HOSE IN USE' Signals (Flow demand).

COMPRESSOR SEQUENCE OF OPERATION

15.20. PLC/HMI Output IO Forces

- (A) Compressor 1 Status, Discharge Pressure, Discharge Temperature, and Suction Pressure.
- (B) Compressor 2 Status, Discharge Pressure, Discharge Temperature, and Suction Pressure.

Sections (C, D, and E) are only active if (G) MAINTENANCE MODE is 'ON' and (H) REMAINING TIME is greater than zero.

- (C) Compressor 1 LATCH/UNLATCH pushbuttons for MOTOR RUN SIGNAL, INLET VALVE, LOAD VALVE, and OIL HEATER.
- (D) Compressor 2 LATCH/UNLATCH pushbuttons for MOTOR RUN SIGNAL, INLET VALVE, LOAD VALVE, and OIL HEATER.
- (E) Storage LATCH/UNLATCH pushbuttons for FLOW VALVE, HIGH BANK VALVE, MID BANK VALVE, LOW BANK VALVE, and SLOW FILL VALVE.
- (F) UNIT Inlet pressure, BLOWDOWN tank pressure, and AMBIENT TEMPERATURE.
- (G) Enable (ON) MAINTENANCE MODE or Disable (OFF) MAINTENANCE MODE.
- (H) Remaining Time until MAINTENANCE MODE is automatically disabled (OFF).
- (I) Add 10 minutes to the remaining time (max 60 minutes).

COMPRESSOR SEQUENCE OF OPERATION

- (J) Compressor state to permit MAINTENANCE MODE
- (1) Panel selector switch must be in the 'RUN' position.
 - (2) Operational mode must be in 'MANUAL' mode.

Note: *ALL SHUTDOWNS except LOW STORAGE PRESSURES are in effect. There is NO sequencing while in MAINTENANCE MODE proceeding with extreme caution is advised.*

Unsafe use can cause damage to equipment and/or operator.

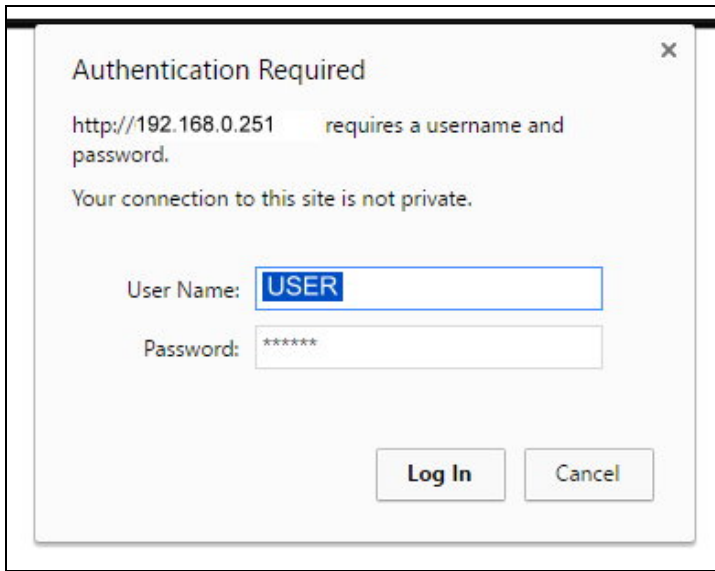
COMPRESSOR SEQUENCE OF OPERATION

16. WEB VIEWER ACCESS

Using a web browser connect to <http://192.168.0.251> (this is the factory default)

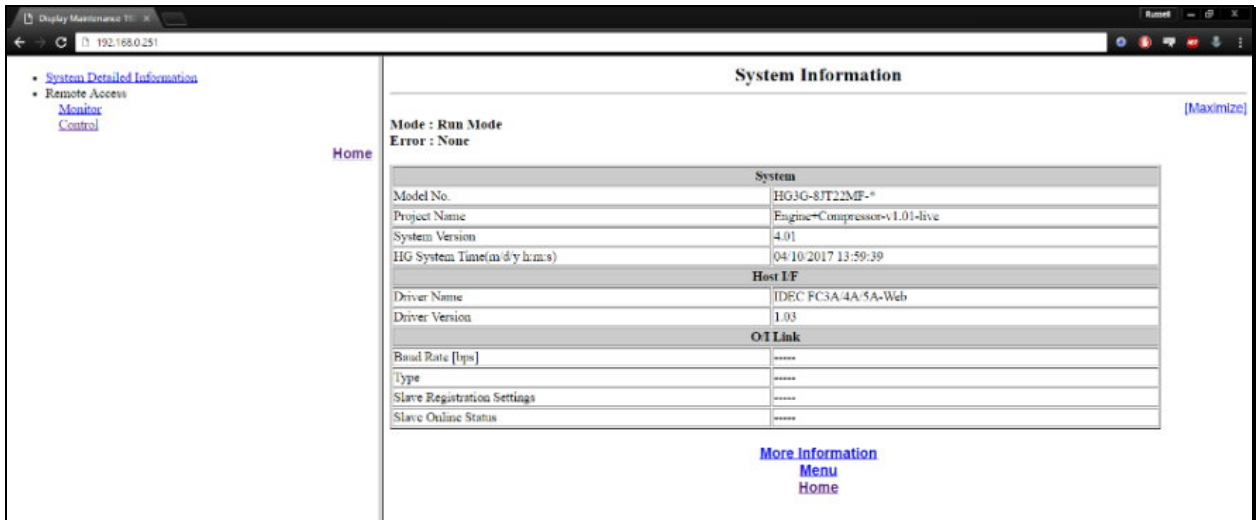


You will be prompted for login information.



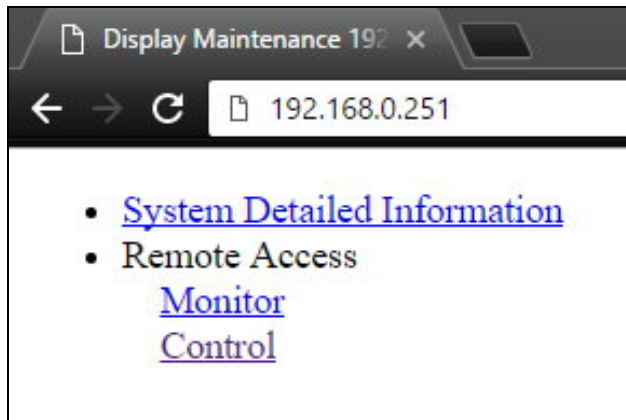
Enter USER for user name and 4321 for the password. Then click 'Log In'

Once fully loaded you should see the default System Information Screen.

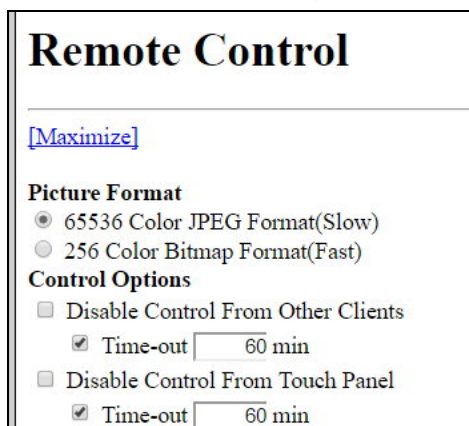


COMPRESSOR SEQUENCE OF OPERATION

To just monitor the UNIT Select 'Monitor' to fully control the UNIT Select 'Control'



Once the 'REMOTE CONTROL' panel is loaded you can select 'Maximize' to open the HMI in a standalone tab or screen (It is recommended that you bookmark this page for easy access).



You can select a 'Picture Format' to optimize your latency with the HMI. '65536 Color' will look much better but load slowly on a poor or slow connection.

Control options allow you disable control from other connections and Disable the 'LOCAL' touch panel input for the designated time-out.

COMPRESSOR SEQUENCE OF OPERATION

17. IO PLC Reference

17.1. OUTPUT IO List

PLC OUTPUT CHANNEL	DESCRIPTION
Q00	COMPRESSOR 1: SHUTDOWN STATE STATUS (OK=ON, FAULTED=OFF)
Q01	COMPRESSOR 1: MOTOR RUN SIGNAL
Q02	COMPRESSOR 1: INLET VALVE
Q03	COMPRESSOR 1: BLOWDOWN/LOAD VALVE
Q04	COMPRESSOR 1: OIL HEATER
Q05	COMPRESSOR 1: RED LED INDICATOR
Q06	COMPRESSOR 1: GREEN LED INDICATOR
Q07	Unused
Q10	COMPRESSOR 2: SHUTDOWN STATE STATUS (OK=ON, FAULTED=OFF)
Q11	COMPRESSOR 2: MOTOR STARTER
Q12	COMPRESSOR 2: INLET VALVE
Q13	COMPRESSOR 2: BLOWDOWN/LOAD VALVE
Q14	COMPRESSOR 2: OIL HEATER
Q15	COMPRESSOR 2: RED LED INDICATOR
Q16	COMPRESSOR 2: GREEN LED INDICATOR
Q17	Unused
OUTPUT MODULE CHANNEL	DESCRIPTION
Q0	GLOBAL: ESD LOOP PERMISSIVE (ZERO VOLTAGE COMPLIANCY)
Q1	GLOBAL: FLOW PERMISSIVE VALVE
Q2	GLOBAL: HIGH BANK STORAGE VALVE
Q3	GLOBAL: MID BANK STORAGE VALVE
Q4	GLOBAL: LOW BANK STORAGE VALVE
Q5	GLOBAL: SLOW FILL STORAGE VALVE

COMPRESSOR SEQUENCE OF OPERATION

17.2. INPUT IO List

PLC INPUT CHANNEL	DESCRIPTION
I00	COMPRESSOR 1: SELECTOR SWITCH 'RESET'
I01	COMPRESSOR 1: START PUSHBUTTON
I02	COMPRESSOR 1: STOP PUSHBUTTON
I03	COMPRESSOR 1: SELECTOR SWITCH 'RUN'
I04	COMPRESSOR 1: OIL LEVEL FLOAT SWITCH
I05	COMPRESSOR 1: OVERPRESSURE SWITCH
I06	COMPRESSOR 1: MOTOR OVERLOAD SWITCH
I07	COMPRESSOR 1: MOTOR RUN STATUS SWITCH
I10	COMPRESSOR 2: SELECTOR SWITCH 'RESET'
I11	COMPRESSOR 2: START PUSHBUTTON
I12	COMPRESSOR 2: STOP PUSHBUTTON
I13	COMPRESSOR 2: SELECTOR SWITCH 'RUN'
I14	COMPRESSOR 2: OIL LEVEL FLOAT SWITCH
I15	COMPRESSOR 2: OVERPRESSURE SWITCH
I16	COMPRESSOR 2: MOTOR OVERLOAD SWITCH
I17	COMPRESSOR 2: MOTOR RUN STATUS SWITCH
I20	Unused
I21	GLOBAL: REMOTE EMERGENCY SHUTDOWN (FROM RELAY)
I22	GLOBAL: EXTERNAL EMERGENCY SHUTDOWN (FROM RELAY)
I23	GLOBAL: LOCAL EMERGENCY SHUTDOWN PUSHBUTTON
I24	GLOBAL: HANDLE IN USE (1)
I25	GLOBAL: HANDLE IN USE (2)
I26	GLOBAL: HANDLE IN USE (3)
I27	GLOBAL: HANDLE IN USE (4)

COMPRESSOR SEQUENCE OF OPERATION

17.3. ANALOG IO List

ANALOG MODULE 1 CHANNEL	DESCRIPTION
A00	TRANSDUCER – GLOBAL: INLET PRESSURE
A01	TRANSDUCER – GLOBAL: BLOWDOWN TANK PRESSURE
A02	TRANSDUCER – COMPRESSOR 1: SUCTION PRESSURE
A03	TRANSDUCER – COMPRESSOR 2: SUCTION PRESSURE
A04	TRANSDUCER – COMPRESSOR 1: DISCHARGE PRESSURE
A05	TRANSDUCER – COMPRESSOR 2: DISCHARGE PRESSURE
A06	Unused
A07	GLOBAL: AMBIENT TEMPERATURE PROBE
ANALOG MODULE 2 CHANNEL	DESCRIPTION
A00 (A10)	TRANSDUCER – GLOBAL: DIRECT-FILL
A01 (A11)	TRANSDUCER - GLOBAL: HIGH-BANK
A02 (A12)	TRANSDUCER - GLOBAL: MID-BANK
A03 (A13)	TRANSDUCER - GLOBAL: LOW-BANK
A04 (A14)	TRANSDUCER - GLOBAL: TIME-FILL
A05 (A15)	Unused
A06 (A16)	Unused
A07 (A17)	Unused
THEROCOUPLE ANALOG MODULE 1	DESCRIPTION
TC00	THERMOCOUPLE – COMPRESSOR 1: DISCHARGE TEMPERATURE
TC01	THERMOCOUPLE – COMPRESSOR 2: DISCHARGE TEMPERATURE

COMPRESSOR SEQUENCE OF OPERATION

TECHNICIANS NOTES:

#	ANNUNCIATION	DEVICE	TYPE	RANGE	FACTORY	SETPOINT
SD	INLET: High Pressure		4-20ma		35	
SD	INLET: Low Pressure				10	
AL	INLET: High Pressure				30	
AL	INLET: Low Pressure				5	
SD	BLOWDOWN: High Pressure		4-20ma		275	
AL	BLOWDOWN: High Pressure				250	
SD	COMP1: Suction - High Pressure		4-20ma		25	
SD	COMP1: Suction - Low Pressure				-5	
AL	COMP1: Suction - High Pressure				20	
AL	COMP1: Suction - Low Pressure				0	
SD	COMP2: Suction - High Pressure		4-20ma		25	
SD	COMP2: Suction - Low Pressure				-5	
AL	COMP2: Suction - High Pressure				20	
AL	COMP2: Suction - Low Pressure				0	
SD	COMP1: Discharge - High Pressure		4-20ma		4400	
SD	COMP1: Discharge - Low Pressure				0	
AL	COMP1: Discharge - High Pressure				4350	
AL	COMP1: Discharge - Low Pressure				0	
SD	COMP2: Discharge - High Pressure		4-20ma		4400	
SD	COMP2: Discharge - Low Pressure				0	
AL	COMP2: Discharge - High Pressure				4350	
AL	COMP2: Discharge - Low Pressure				0	
SD	COMP1: Discharge - High Temperature	K-TYPE	Thermo-couple	-328 to 2372°F	275	
AL	COMP1: Discharge - High Temperature				250	
SD	COMP2: Discharge - High Temperature	K-TYPE	Thermo-couple	-328 to 2372°F	275	
AL	COMP2: Discharge - High Temperature				250	
AL	AMBIENT TEMPERATURE: High Temperature	TGT-TP	0-10v	0-1000 °F	150	

COMPRESSOR SEQUENCE OF OPERATION

SD	STORAGE: Direct Fill - High Pressure				4450	
SD	STORAGE: Direct Fill - Low Pressure		4-20ma		0	
AL	STORAGE: Direct Fill - High Pressure				4375	
AL	STORAGE: Direct Fill - Low Pressure				0	
SD	STORAGE: High Bank - High Pressure				4450	
SD	STORAGE: High Bank - Low Pressure		4-20ma		0	
AL	STORAGE: High Bank - High Pressure				4375	
AL	STORAGE: High Bank - Low Pressure				0	
SD	STORAGE: Mid Bank - High Pressure				4450	
SD	STORAGE: Mid Bank - Low Pressure		4-20ma		0	
AL	STORAGE: Mid Bank - High Pressure				4375	
AL	STORAGE: Mid Bank - Low Pressure				0	
SD	STORAGE: Low Bank - High Pressure				4450	
SD	STORAGE: Low Bank - Low Pressure		4-20ma		0	
AL	STORAGE: Low Bank - High Pressure				4375	
AL	STORAGE: Low Bank - Low Pressure				0	
SD	STORAGE: Time Fill - High Pressure				4200	
SD	STORAGE: Time Fill - Low Pressure		4-20ma		0	
AL	STORAGE: Time Fill - High Pressure				4100	
AL	STORAGE: Time Fill - Low Pressure				0	

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