

DUNHAM-BUSH

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OPERATOR'S GUIDE

VISION 2020i CONTROLLER FOR ROTARY SCREW COMPRESSOR PACKAGES

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1.0 INTRODUCTION

1.1 GENERAL DESCRIPTION

Dunham-Bush compressorized product lines and Integrated Chiller Plantroom and Ice-Thermal storage system are now being controlled by an advance and flexible **Vision2020i** controller system. The **Vision2020i** system is composed of a main controller, semi-graphical display terminal and various sensors. Three sizes of main controller boards are provided to handle different number of input and output requirements: DB3-S small board, DB3-M medium board and DB3-L large board. Up to five additional DB1 expansion boards can be added for larger packages contain more Input and Output requirements. The display terminal is connected with controller through telephone cable.

All the versions of these controls feature a 16-bit microprocessor and up to 4 MByte of Flash memory, guaranteeing high performance in terms of speed and available memory. The unit algorithm program for the **Vision2020i** and the unit operating parameters are stored in FLASH-MEMORY that does not require a back-up battery. The program can be loaded through PC or programming key.

There are two types of inputs that the controller uses to determine control functions. The first is the digital input. A digital input indicates that a contact is open or closed. Such contacts may be is Flow Switch or Unit Control. The other type of input is called an analog input. This type of input is used to measure temperature, pressure, current, voltage, or anything that has a value analog in nature. The **Vision2020i** takes this analog value and converts it to a digital value through its built-in analog to digital converter so that the computer can process this information.

The **Vision2020i** uses mechanical relays to make or break a circuit that controls devices such as compressor contactors/starters, fan contactors, solenoids and etc.

Vision2020i also allows connection to the DBLAN (DB Local Area Network). Up to six individual **Vision2020i** controllers can be configured and connected through twisted pair wires to form as a DBLAN that allows multiple units sequencing control without additional hardware.

With various optional add-on cards, **Vision2020i** controller can be interfaced directly and easily to the BMS, or the Dunham-Bush remote monitoring software. BMS protocols supported by **Vision2020i** are ModBus RTU, LonWorks FTT10, BACnet MSTP Over IP. With an optional RS485 communication card, the **Vision2020i** can be interfaced to Dunham-Bush ModBus Poll software for simple remote monitoring and controlled from a local PC terminal through RS485 to USB converter. With optional RS232 or RS485 communication cards, the **Vision2020i** can be interfaced to Dunham-Bush NetVisor software for full graphical remote monitoring and controlled from a PC terminal and optional phone modem or internet connection through local PC server.

2.0 VISION 2020i

2.1 PRECAUTIONS

The following precautions must be taken while working with the **Vision2020i** system.

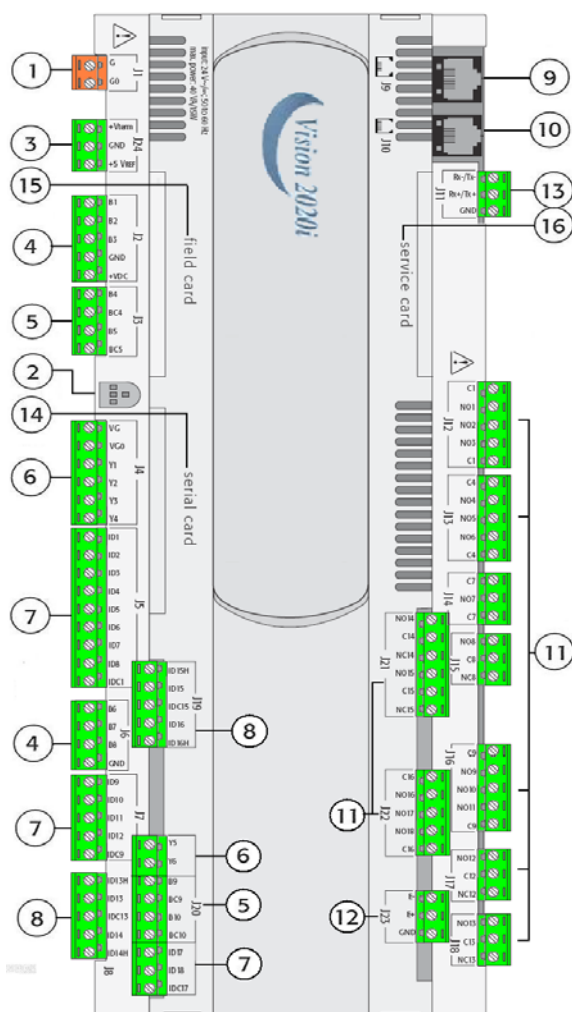
- 1) Cover the controller components completely when drilling sheet metal near the **Vision2020i** and Expansion boards.
- 2) Strip wires away from **Vision2020i** boards to prevent strands from falling on components.
- 3) Do not allow **Vision2020i** boards to get wet.
- 4) Disconnect power to the **Vision2020i** before changing the wiring connection or inserting the I/O terminal connector to the controller.
- 5) Route communication cables and sensor wires away from control and power wires.
- 6) Handle boards with care.

2.2 VISION2020i CONTROLLER BOARD

The **Vision2020i** boards are available in three different versions, differentiated according to the number of inputs and outputs:

- DB3-S **Vision2020i** Small board part number 4030003381
- DB3-M **Vision2020i** Medium board part number 4030003382
- DB3-L **Vision2020i** Large board part number 4030003383
- DB-EXP **Vision2020i** Expansion board part number 4030003396
- DB1-S **Vision 2020i** Small board part number 4030003378
- DB1-M **Vision 2020i** Medium board part number 4030003377

Figure 2.2.1 outlines the **Vision2020i** large board with set of terminals required for various I/O connections. The plastic case of this controller is to be mounted on DIN rail in the control panel.



2.2.1 Instrument Elements

1.	Power supply connector [G(+), G0 (-)]
2.	Yellow power LED and 3 LEDs for the DBLAN networks
3.	Additional power supply (max. 200mA) for the terminal and 0-5V ratiometric probes
4.	Universal analog inputs, NTC, 0-1V, 0-5V ratiometric, 0-10V, 0/4-20mA
5.	Passive analog inputs, NTC, PT1000, ON/OFF
6.	Analog outputs, 0-10Vdc
7.	Digital inputs, 24Vac/Vdc
8.	Digital inputs, 230Vac, or 24Vac/Vdc
9.	Connector for terminal display (external panel with direct signal)
10.	Connector for all standard DB series terminals and for uploading the application software
11.	Digital outputs
12.	Connector for expansion board
13.	DBLAN connector
14.	Cover for inserting the optional supervisor serial board
15.	Cover for inserting the optional field board
16.	Cover for inserting the optional service board

Figure 2.2.1 : Outline of DB3-L Board

2.2.2 Meaning of the terminals

The following table summaries the meaning of **Vision2020i** board input and output terminals and provides a brief description of each connection.

Connector No	Signal	Description
J1-1	G	Power Supply 24Vac
J1-2	Go	Power Supply Reference
J2-1	B1	Analog Input 1 –Universal Type
J2-2	B2	Analog Input 2 –Universal Type
J2-3	B3	Analog Input 3 –Universal Type
J2-4	GND	Common for analog inputs
J2-5	+VDC	21Vdc power for active probes (maximum current 150mA)
J3-1	B4	Analog Input 4 –Passive Type
J3-2	BC4	Analog Input 4 –common
J3-3	B5	Analog Input 5 –Passive Type
J3-4	BC5	Analog Input 5 –common
J4-1	VG	Power supply 24Vac for Analog Outputs
J4-2	VGo	Power supply Reference for Analog Outputs
J4-3	Y1	Analog Output 1, 0 to 10Vdc
J4-4	Y2	Analog Output 2, 0 to 10Vdc
J4-5	Y3	Analog Output 3, 0 to 10Vdc
J4-6	Y4	Analog Output 4, 0 to 10Vdc
J5-1	ID1	Digital Input 1, 24Vac / Vdc
J5-2	ID2	Digital Input 2, 24Vac / Vdc
J5-3	ID3	Digital Input 3, 24Vac / Vdc
J5-4	ID4	Digital Input 4, 24Vac / Vdc
J5-5	ID5	Digital Input 5, 24Vac / Vdc
J5-6	ID6	Digital Input 6, 24Vac / Vdc
J5-7	ID7	Digital Input 7, 24Vac / Vdc
J5-8	ID8	Digital Input 8, 24Vac / Vdc
J5-9	IDC1	Common for digital Inputs 1 to 8
J6-1	B6	Analog Input 6 –Universal Type
J6-2	B7	Analog Input 7 –Universal Type
J6-3	B8	Analog Input 8 –Universal Type
J6-4	GND	Common for analog inputs
J7-1	ID9	Digital Input 9, 24Vac / Vdc
J7-2	ID10	Digital Input 10, 24Vac / Vdc
J7-3	ID11	Digital Input 11, 24Vac / Vdc
J7-4	ID12	Digital Input 12, 24Vac / Vdc
J7-5	IDC9	Common for digital Inputs 9 to 12
J8-1	ID13H	Digital Input 13, 230Vac

Connector No	Signal	Description
J8-2	ID13	Digital Input 13, 24 Vac / Vdc
J8-3	IDC13	Common for Digital Inputs 13 and 14
J8-4	ID14	Digital Input 14, 24 Vac / Vdc
J8-5	ID14H	Digital Input 14, 230Vac
J9		8-way Telephone Connector for connection to a synoptic terminal
J10		6-way Telephone Connector for connection to standard user terminal
J11-1	TX-	RX- / TX- Connector for RS485 Connection to pLAN
J11-2	TX+	RX+ / TX+ Connector for RS485 Connection to pLAN
J11-3	GND	GND Connector for RS485 Connection to pLAN network
J12-1	C1	Common Relay: 1, 2, 3
J12-2	NO1	Normally-Open Contact Relay 1
J12-3	NO2	Normally-Open Contact Relay 2
J12-4	NO3	Normally-Open Contact Relay 3
J12-5	C1	Common Relay: 1, 2, 3
J13-1	C4	Common Relay: 4, 5, 6
J13-2	NO4	Normally-Open Contact Relay 4
J13-3	NO5	Normally-Open Contact Relay 5
J13-4	NO6	Normally-Open Contact Relay 6
J13-5	C4	Common Relay: 4, 5, 6
J14-1	C7	Common Relay 7
J14-2	NO7	Normally-Open Contact Relay 7
J14-3	C7	Common Relay 7
J15-1	NO8	Normally-Open Contact Relay 8
J15-2	C8	Common Relay 8
J15-3	NC8	Normally-Closed Contact Relay 8
J16-1	C9	Common Relay: 9, 10, 11
J16-2	NO9	Normally-Open Contact Relay 9
J16-3	NO10	Normally-Open Contact Relay 10
J16-4	NO11	Normally-Open Contact Relay 11
J16-5	C9	Common Relay: 9, 10, 11

Connector No	Signal	Description
J17-1	NO12	Normally-Open Contact Relay 12
J17-2	C12	Common Relay 12
J17-3	NC12	Normally-Closed Contact Relay 12
J18-1	NO13	Normally-Open Contact Relay 13
J18-2	C13	Common Relay 13
J18-3	NC13	Normally-Closed Contact Relay 13
J19-1	ID15H	Digital Input 15, 230 Vac
J19-2	ID15	Digital Input 15, 24 Vac / Vdc
J19-3	IDC15	Common Digital Inputs 15 and 16
J19-4	ID16	Digital Input 16, 24 Vac / Vdc
J19-5	ID16H	Digital Input 16, 230 Vac
J20-1	Y5	Analog Output 5, 0 to 10 V
J20-2	Y6	Analog Output 6, 0 to 10 V
J20-3	B9	Passive Analog Input 9
J20-4	BC9	Common Analog Input 9
J20-5	B10	Passive Analog Input 10
J20-6	BC10	Common Analog Input 10
J20-7	ID17	Digital Input 17, 24 Vac / Vdc
J20-8	ID18	Digital Input 18, 24 Vac / Vdc
J20-9	IDC17	Common Digital Inputs 17 and 18
J21-1	NO14	Normally-Open Contact Relay 14
J21-2	C14	Common Relay 14
J21-3	NC14	Normally-Closed Contact Relay 14
J21-4	NO15	Normally-Open Contact Relay 15
J21-5	C15	Common Relay 15
J21-6	NC15	Normally-Closed Contact Relay 15
J22-1	C16	Common Relay 16
J22-2	NO16	Normally-Open Contact Relay 16
J22-3	NO17	Normally-Open Contact Relay 17
J22-4	NO18	Normally-Open Contact Relay 18
J22-5	C16	Common Relay 16
J23-1	E-	E- Terminal for RS485 Connection to I / O Expansion
J23-2	E+	E+ Terminal for RS485 Connection to I / O Expansion
J23-3	GND	GND Terminal for RS485 Connection to I / O Expansion

Connector No	Signal	Description
J24-1	+V _{term}	Additional Power Supply (max. 200mA) for the terminal
J24-2	GND	GND terminal for the supply
J24-3	+5V _{ref}	5Vdc power supply for ratiometric probe

2.3 **GENERAL CHARACTERISTICS**

Vision2020i is a microprocessor-based electronic control system provides by Dunham Bush in compliance with the European RoHS directives, as dedicated control system for Dunham-Bush compressorized product lines, Integrated Chiller Plantroom and Ice-Thermal storage system. The **Vision2020i** system is composed of a main controller DB3, several types of expansion boards DB1, and various sensors. The DB3 main controller runs the control program, and is fitted with the set of terminals required for connection to the devices (compressors, fans...)

The program and the parameters are saved to FLASH-MEMORY and E2prom, ensuring they are stored even in the event of power failures (without requiring a backup battery).

The program can be loaded using a PC (28.8 kbps and 115.2 kbps) or the special programming key. DB3 also allows connection to the DBLAN (DB Local Area Network) and can be connected, as well as to other DB3 main controllers, to all the other controllers in the DB system and all the DBG family display terminals. All the controllers in the DBLAN can exchange information (variables, digital or analogue, depending on the application software used) at high transmission speed. Up to 6 units can be connected, including DB controllers and terminals, so as to share the information effectively.

The connection to the supervisor/ tele-maintenance serial line, via the Modbus™ communication protocol over the RS485 standard, is performed by inserting an optional serial board in the DB3.

Other optional cards can be used to connect to a supervisor via standards other than RS485. Finally, the serial field bus interface, using the optional board, ensures connection to the field devices controlled (for example: valves, DB-EXP I/O expansions, electronic valve drivers, DB Link, NetVisor...).

DB3 controller is available with three different version; SMALL, MEDIUM, LARGE

Note: the application software can be uploaded to the flash memory using the smart key (P/N: 4030004388), see section 2.6; or a PC using the USB-485 adapter (P/N: 4030001028) and the "WINLOAD32" program, see section 6.1, to be ordered from Dunham Bush.

2.3.1 **Power supply**

A Class II safety transformer with a minimum rating of 50 VA must be used in the installation to supply just one DB3 controller. The power supply to the DB3 controller and terminal (or DB3 controllers and terminals) should be separated from the power supply to the other electrical devices (contactors and other electromechanical components) inside the electrical panel. If the secondary of the transformer is earthed, make sure that the earth wire is connected to terminal G0. This is true for all the devices connected to the DB3.

If powering more than one DB3 board connected in the DBLAN network, make sure that the references G and G0 are observed (the reference G0 must be maintained for all the boards).

If using the DBLAN network and for further explanations and information, please refer to the Dunham-Bush.

2.3.2 **Add-On Card Options – Field Bus Devices & BMS Communication**

2.3.2.1 **Field Bus Options**

Optically Isolated RS485	4030003439
tLAN	4030003447
Modem	4030003440

2.3.2.2 **BMS Communication Options**

RS485/Modbus	4030003436
Modem	4030003219
BACnet MSTP	4030003404
Ethernet board	4030003319
LonWorks FTT10	4030003438

2.3.2.3 Connectors

Controller / Expansion Board	Connectors	Part Number
DB3-Large Board	V2020i-DB3-L-CON	4030004386
DB3-Medium Board	V2020i-DB3-M-CON	4030004385
DB3-Small Board	V2020i-DB3-S-CON	4030004384
DB-EXP Expansion Board	V2020i-DB3-EXP-CON	4030004397
DB1-Small Board	V2020i-DB1-S-CON	4030004229
DB1-Medium Board	V2020i-DB1-M-CON	4030004230

2.4 **TECHNICAL SPECIFICATIONS**

2.4.1 **Mechanical Characteristics**

Dimensions	DB3 MEDIUM and DB3 LARGE boards fitted on 18 DIN modules, 110x315x60mm DB1 and DB3 SMALL boards fitted on 13 DIN modules, 110x227.5x60mm DB-EXP board fitted on 4 DIN modules, 110x70x60mm
Installation	DIN rail

2.4.2 **Plastic Case**

- fitted on DIN rail according to DIN 43880 and CEI EN 50022 standards;
- material: technopolymer;
- flame retardancy: V0 (UL94) and 960°C (IEC 695);
- ball pressure test: 125°C;
- resistance to creeping current: ≥ 250 V;
- colour: grey RAL7035;

2.4.3 **Electrical Specifications**

Power Supply (controller with terminal connected)	28 to 36 Vdc +10/-20% and 24 Vac +10/-15% 50 to 60 HZ maximum power input P= 15 W (24 Vdc power supply), P= 40 VA (24 Vac)
Terminal block	with plug-in male/female connectors, max voltage 250 Vac; cable cross-section: min. 0.5 mm ² - max 2.5 mm ²
CPU	H8S2320, 16bit, 24 MHz
Memory (FLASH MEMORY)	2+2 MB; in the extended versions further memory of 32 MB or higher
Data memory (static RAM)	512 kB at 16 bit (296 kB BIOS; 216 application software)
Parameter data memory	13 kB at 16 bit (max. limit: 400,000 writes per memory location) and a further 32 kB E2prom (not available to the DBLAN)
Working cycle duration	(applications of average complexity) 0.2 s (typical)

2.4.4 **Digital Inputs**

Type	optically-isolated		
Maximum number	8, 14, 18, respectively on the SMALL, MEDIUM and LARGE boards, according to the combinations shown below:		
	Optoinsulated input no. to 24 Vac 50/60 Hz or 24 Vdc	Optoinsulated input no. to 24 Vac/Vdc or 230 Vac (50/60 Hz)	Inputs
SMALL	8	none	8
MEDIUM	12	2	14
LARGE	14	4	18
Classification of the measuring circuits (CEI EN 61010-1)	Category I (J5, J7, J20) 24 Vac/Vdc Category III (J8, J19) 230 Vac		

WARNINGS:

- 230 Vac 50/60 Hz (10/-15%);
- The two 230/24 Vac inputs present on J8 and J12 have the same common pole and consequently will be both 24 Vac/Vdc or both 230 Vac. Basic insulation between the two inputs.
- For DC inputs, connect the negative pole to the common terminal.

Note: separate as much as possible the probe and digital input signal cables from the cables carrying the inductive loads and the power cables, to avoid possible electromagnetic disturbance.

2.4.5 Analogue Inputs

Analogue Conversion	10 bit A/D converter in the CPU
Type	Universal: (inputs B1, B2, B3, B6, B7, B8) Dunham-Bush NTC-WP temperature sensor (-50 To 90°C; R/T 10 k Ω at 25°C), NTC-HT 0 To 150°C, voltage: 0 to 1 Vdc, 0 to 5 V ratiometric or 0 to 10 Vdc, current: 0 to 20 mA or 4 to 20 mA, selectable via software. Input resistance in 0 to 20 mA= 100 Ω Passive: (inputs B4, B5, B9, B10) Dunham-Bush NTC temperature sensor (see universal type), PT1000 (-100 To 200°C; R/T 1000 Ω at 0°C) or voltage-free digital input (5 mA), selectable via software
Maximum number	5, 8, 10, on the SMALL, MEDIUM and LARGE boards respectively
Time onstant for each input	0.5 s
Input precision	± 0.3 % of full scale
Classification of the measuring circuits (CEI EN 61010-1)	Category I

WARNING: The 21 Vdc available at the +Vdc terminal (J2) can be used to power any active probes, the maximum current is 150 mA, thermally protected against short-circuits. To supply the ratiometric 0 to 5 V probes, use the +5VREF (I_{max} : 60 mA) present at terminal J24.

2.4.6 Analogue outputs

Type	0 to 10 Vdc optically-isolated
Maximum number	4, 4, 6, on the SMALL, MEDIUM and LARGE boards respectively
Power supply	external 24 Vac/Vdc
Resolution	8 bit
Maximum load	1 k Ω (10 mA)
Precision	± 3 % of full scale

2.4.7 Digital outputs

Type	relay
Maximum number	8, 13, 18, 27, 29, on the SMALL, MEDIUM, LARGE boards respectively

Note the presence of outputs with changeover contacts kept separately (that is, without the poles shared between different outputs). Groups from 2 to 5 outputs have 2 “common” poles for easy assembly.

Make sure that the current running through the common terminals does not exceed the rated current of each individual terminal that is 8A.

Insulation distance	The outputs can be divided by groups with basic insulation and double insulation. Note: the relays in the same group with basic insulation must have the same power supply (24 or 230 Vac).																								
Makeup of the groups	<table><tr><td>version</td><td colspan="4">relays with same insulation</td></tr><tr><td>SMALL</td><td>1...7</td><td>8</td><td>-</td><td>-</td></tr><tr><td>MEDIUM</td><td>1...7</td><td>8</td><td>9...13</td><td>-</td></tr><tr><td>LARGE</td><td>1...7</td><td>8</td><td>9...13</td><td>14...18</td></tr></table>					version	relays with same insulation				SMALL	1...7	8	-	-	MEDIUM	1...7	8	9...13	-	LARGE	1...7	8	9...13	14...18
	version	relays with same insulation																							
	SMALL	1...7	8	-	-																				
	MEDIUM	1...7	8	9...13	-																				
	LARGE	1...7	8	9...13	14...18																				
Note: the relays in the individual cells of the table have basic insulation between them, while between groups (cell-cell) there is double insulation.																									
Changeover contacts	1, 3, 5, on the SMALL, MEDIUM and LARGE boards respectively																								
Switchable power	Warning: the relay outputs have different characteristics according to the model of DB3																								
	relay outputs from 1 to 13 and from 14 to 18 LARGE version		type of relay: 2000 VA, 250 Vac, 8 A resistive certification: UL: 8 A resistive, 2 A FLA, 12 A LRA, 250 Vac, C300 (30000 cycles) EN 60730-1: 2 A resistive, 2 A inductive, cosφ= 0,4, 2(2) A (100000 cycles)																						
SSR outputs	1: SMALL (output 7); 2: MEDIUM (outputs 7, 12); 3: LARGE (OUTPUTS 7, 12, 14)																								
operating voltage	24 Vac/Vdc; maximum power: 10																								

2.4.8 Relation between AWG and wire cross-section

AWG	Cross-section (mm ²)	Current (mA)
20	0.5	2
15	1.5	6
14	2.5	8

2.4.9 DBLAN network/user terminal connection

Type	RS485 half-duplex asynchronous
Transmission speed	62.5 Kbps or 115.2 Kbps, selectable via software
Terminal connector	6 pin telephone (J10)
DBLAN network/graphic terminal/aria terminal connector	3 pin plug-in connector (J11)

The maximum distance between the DB and user terminal is shown in the following table.

Cable Type	Power Supply Distance	Power supply
telephone	50 m	taken from the pCO (150 mA)
AWG24 shielded cable	200 m	taken from the pCO (150 mA)
AWG20/22 shielded cable	500 m	separate power supply via T-Connector (part number : 4030004446)

The maximum distance between two DB3 controllers with AWG20/22 shielded cable is 500 m.

Note:

- A maximum of one terminal (DBG1) can be connected, or two terminals but without using the backlighting on display. One version of the DB3 features optically-isolated connection to the DBLAN network.
- The terminal should be always powered with a separate power supply.
- The 21 Vdc present at +V_{term} (J24) can be used to power an external terminal with a maximum input of 2 W. Only one terminal can be connected in addition to the one connected to terminal J10

2.4.10 Other Specifications

storage conditions	-20 To 70 °C, 90% RH non-condensing
operating conditions	-10 To 60 °C, 90% RH non-condensing
index of protection	IP20, IP40 front panel only
environmental pollution	normal
class according to protection against electric shock	to be incorporated into Class I and/or II appliances
PTI of the insulating materials	250 V
period of stress across the insulating parts	long
type of action	1C
type of disconnection or microswitching	microswitching
category of resistance to heat and fire	category D (UL94 - V0)
immunity against voltage surges	category 1
ageing characteristics (operating hours)	80,000
no. of automatic operating cycles	100,000 (EN 60730-1); 30,000 (UL 873)
software class and structure	Class A
category of immunity to voltage surges (CEI EN 61000-4-5)	Category III
The device is not designed to be hand-held	

WARNING

- For applications subject to strong vibrations (1.5 mm pk-pk 10/55 Hz), secure the cables connected to the DB3 using clamps placed around 3 cm from the connectors
- If the product is installed in industrial environments (application of the EN 61000-6-2 standard) the length of the output connections must be less than 30 m.
- Installation must be performed according to the standards and legislation in force in the country where the appliance is used;
- For safety reasons the appliance must be housed inside an electrical panel, so that the only accessible part is the display and the control keypad;
- All the very low voltage connections (analogue and digital inputs at 24 Vac/Vdc, analogue outputs, serial bus connections, power) must have reinforced or double insulation from the mains;
- In the event of malfunctions do not attempt to repair the appliance, but rather contact the Dunham-Bush service centre.

2.4.11 PRELIMINARY NOTES FOR THE INSTALLER: COMPARISON BETWEEN DB3 AND DB2

- The DB3 family controllers do not have the connector using the programming key code (P/N: 4030022234). To program the controller, use the new Smart Key (P/N: 4030004388) available from September 2005. Otherwise use WinLoad version 3.35 and higher:



Figure 2.4.1 : Smart Key

Please take note that an application cannot be run from the Smart Key.

- Unlike the DB2, there is no fuse between J1 and J2. All DB3 family controllers have an internal thermal protector on the power supply. No external fuse is required;

- A further terminal J24 (in place of the fuse) is provided for the power supply to the ratiometric probes (+5 VREF), as well as 20 Vdc to supply a secondary terminal, such as the aria terminal, in alternative to the standard one;
- The terminal J11 (connection to the DBLAN network) in the first prototypes of the DB3 only has a pitch of 3.81, rather than the 5.08 on the DB2;
- The LEDs near the dipswitches for setting the DBLAN address have been moved between connectors J3 and J4;
- The red probe power supply overload LED has been removed.

DB3 simulator:

If testing the DB3 with a simulator, note that the DB2 simulator cannot be used in place of the DB3 simulator. Contact Dunham-Bush for the availability of the latter.

2.5 Vision2020i Display and User Terminal

The **Vision 2020i** controller comes with a user friendly back-lit 128 by 64 pixels DBG1 Semi-Graphic Display panel connected with controller through a telephone cable. This terminal allows carrying out all program operations, displaying the unit working conditions, component run times, alarm history and modifying the parameters. The display also has an automatically self-test of the microprocessor during the system start-up. Multiple messages will be displayed by automatically scrolling from each message to the next. All of these messages are spelled out in English language on the display terminal.

There are 15 dedicated buttons; consists of 15 polycarbonate buttons. These buttons enable user to access information, base on the security level of the password. For detail operation of the DBG1 Display Terminal, please refer to the Unit Operation Manual.

Optional Graphical Display (DBG2 & DBG3)

DBG2 and DBG3 are the latest Dunham-Bush state of art user interfaces, featuring a 5.7inch touch screen display with ¼ VGA resolution, and a 32-bit microprocessor that allows the management of complex graphic images up to 320x240 pixels in size and with up to 256 colors (DBG3 only), various animated icons, non-proportional fonts in Unicode format, trend graphs of alarms, temperature, and pressure values. A keypad is always fitted to the side of the display for use in all those applications where the touch screen is not the preferred solution.

Following are the part number for the user terminals.

User Terminal	Part Number
DBG1 Semi-Graphic Display	4030003312
DBG2 Graphical Display (Blue & White)	4030003338
DBG3 Graphical Display (256 colors)	4030003340

DBG3 graphical display will replace DBG1 semi-graphical display as standard terminal display for all water-cooled screw chillers beginning April 2008.

2.5.1 DBG1 Semi-Graphic Display

These terminals have been designed for panel installation (Figure 2.5.1); the drilling template must measure 173x154 mm. For installation, follow the instructions provided below:

- Remove the click-on decorative frame;
- Insert the plastic part containing the display and electronic boards on the drilled front face of the panel, making sure that the gasket on the lower edge of the front panel rests correctly against the front of the panel;
- Make 4 holes, diameter 2.5 mm, in the panel, in exact correspondence with the holes present on the instrument. Insert the fastening screws supplied, choosing the self-tapping or thread-cutting screws, according to the material the panel is made from (plastic or metallic).

Make the envisaged electrical connections.

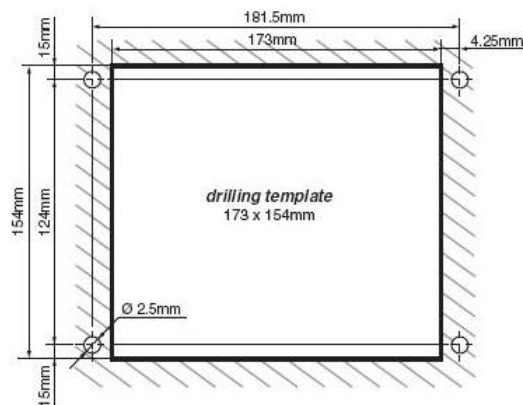


Figure 2.5.1 : Dimensions (DBG1)

Technical Specifications

<u>Display</u>	
Type:	FSTN graphic
Backlighting:	Green LEDs (controlled by “application software”)
Graphic resolution:	132x64 pixels
Text mode:	8 rows x 22 columns (font sizes 5x7 and 11x15 pixels) 4 rows x 11 columns (font size 11x15 pixels)
Character height:	3.5 mm (font size 5x7 pixels) 7.5 mm (font size 11x15 pixels)
Size of active area:	66x32 mm
Size of display area:	72x36 mm
<u>Power Supply</u>	
Voltage:	Power supply from DB3 controller through telephone cable or external source 18/30 Vdc protected with a 250 mA fuse
Maximum power input:	1.8 W
<u>Maximum distances</u>	
Maximum DBLAN length:	500 m with AWG22 twisted pair cable
DB3 terminal distance:	50 m with telephone cable 500 m with AWG22 twisted pair cable and T-Connector <i>Note:</i> to reach the maximum length, use a bus layout, with branches not exceeding 5 m
<u>Materials</u>	
Case:	Combination of ABS and polycarbonate
Keypad:	silicon rubber + ABS
Self-extinguishing rating:	V0
<u>Other</u>	
Index of protection:	IP55 UL type 1
Operating conditions:	-20 to 60 °C, 90% r.H. non-condensing
Storage conditions:	-20 to 70 °C, 90% r.H. non-condensing
Software class and structure:	A
Classification according to protection against electric shock:	To be integrated into class 1 or 2 devices
PTI of insulating materials:	250 V
Period of electric stress across insulating parts:	long
Category of resistance to fire and heat:	D
Category (immunity against voltage surges):	I
Environmental pollution:	normal

2.5.2 **DBG2/3 Graphical Display**

DBG2 and DBG3 are electronic devices designed as the user interface for the DB3 controllers.

DBG2 is a monochromatic (blue/white) LCD graphic terminal with 320x240 pixel resolution and LED backlighting. DBG3 is a 256-colour LCD graphic terminal with 320x240 pixel resolution and CCFL backlighting.

These terminals have been designed for panel installation; the drilling template must measure 194.5x128 mm + 6 circular holes, diameter 4 mm, as shown in Figure 2.5.2.

For installation, proceed as follows:

- Connect the power and RS485 serial interface cables;
- Insert the terminal, without the front frame, into the opening in the panel, and using the 6 countersunk screws supplied in the packaging, secure the device to the panel as shown in Figure 5, then check the correct positioning of the front rubber gasket;
- Finally, install the click-on frame.

Important: Installation must be performed so that the operator may access the rear cover of the instrument only using a tool.

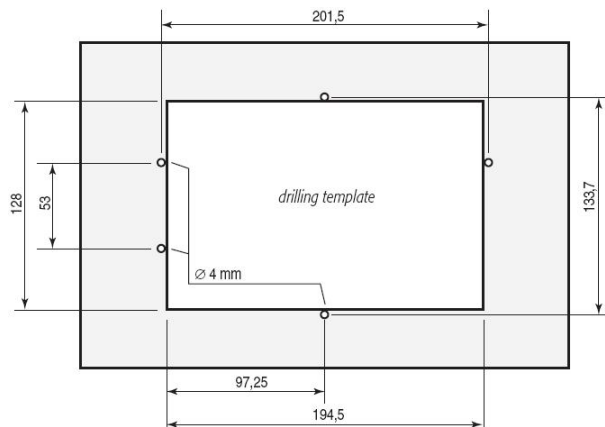


Figure 2.5.2 : Dimensions (DBG2 & DBG3)

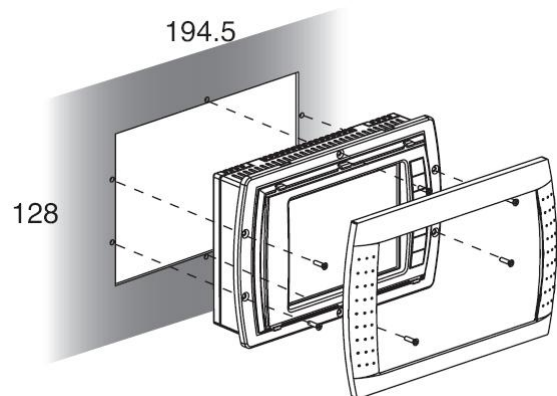


Figure 2.5.3 : Installation of DBG2 & DBG3 display

Installation Warnings

- Avoid assembling the devices in environments with the following characteristics:
- Relative humidity greater than the value specified in the technical specifications;
- Strong vibrations or knocks;
- Exposure to continuous water sprays;
- Exposure to corrosive or pollutant gases (e.g. sulphur or ammonia fumes, saline mist, smoke) so as to avoid corrosion and oxidation;
- Strong magnetic and/or radio interference (therefore avoid installing the unit near transmitting antennae);
- Exposure to direct sunlight or the elements in general;
- Large and rapid fluctuations in ambient temperature;
- Environments where explosives or mixes of flammable gases are present;
- Exposure to dust (formation of corrosive patina with possible oxidation and reduction of insulation).
- Avoid touching or nearly touching the electronic components fitted on the boards, so as to avoid electrostatic discharges (extremely dangerous) from the operator to the components.

Further Warnings

1. Using a different power supply from the one specified may seriously damage the system.
2. Use cable ends suitable for the terminals. Loosen each screw and insert the cable ends, and then tighten the screws. When completed, lightly tug the cables to check that they are tight.
3. The touch screen is a sensitive device. Exerting excessive pressure or using sharp objects may cause irreparable damage.
4. Use a dry soft cloth to clean the screen and never use water.
5. Operation at particularly low temperatures may cause a visible decrease in the response speed of the display. This is normal and does not signify a malfunction.
6. To improve the visual performance of the application, use full colors and images that do not feature dithering (wirings). Otherwise, especially at high temperatures, flickering (display flashing) may be visible.

Technical Specifications

Power supply	24 Vac $\pm 15\%$, 50/60 Hz or 30 Vdc $\pm 25\%$; Use a class 2 safety transformer with a rating of least 15VA
Rated power	10 W
<u>Power supply connections to the DBG2/3:</u>	
Observe the following rules:	
• The power supply terminals on the DBG2/3 are called G and G0. The connection is made using 2-pin removable terminals. Possible cross-section of the wires: 0.5 to 1.5 mm²; • A dedicated 800 mA fuse must be installed externally between the power supply and terminal G; • If the transformer that supplies the DBG2/3 is the same that also supplies Vision 2020i controllers, then terminal G0 on the DBG2/3 must be connected to terminal G0 on the Vision 2020i controller; • Important: if the secondary of the power supply transformers needs to be earthed, then terminal G0 must be earthed (and NOT the terminal G), both on the Vision 2020i controller and the DBG.	
<u>Interfaces:</u>	
RS485 serial for communication with Vision 2020i controllers, via 3-pin removable terminals. Use a shielded twisted pair cable, AWG20-22, maximum length 200 m. The total length of the network must not exceed 500 m. The capacitance between the wires must not exceed 90 pF/m.	
Note: to reach the maximum length use a bus layout with branches that do not exceed 5 m.	
<u>Functional characteristics</u>	
Protocols supported	DBLAN protocol, "Point-Point" protocol (text mode only).
Backlighting	With two levels of brightness, "high" and "normal".
<u>General characteristics</u>	
Operating conditions	DBG2: 0T50°C, 0 to 85% rH non-condensing DBG3: 0T45°C, 0 to 85% rH non-condensing
Storage conditions	-10T70°C, 0 to 85% rH non-condensing
Index of protection (IP)	IP20
Dimensions (mm)	See Figure 2.5.2
Environmental pollution	normal
Category of resistance to heat and fire	D
Class and structure of the software	A
Duration of the backlighting lamp	30,000 hours at 20 °C and "normal" brightness

2.6 SMART Key For Vision 2020i Controllers

The SMART key (P/N: 4030004388) is an electronic device used to program and service the **Vision 2020i** controllers. The SMART key simplifies the transfer of data between the controllers installed and a personal computer by exploiting the high capacity flash memory for storing software applications, Bios and variable logs.

The **Vision 2020i** controller is connected directly via the telephone connector using cable supplied, while to transfer the data to a personal computer, the USB adapter (P/N: 4030004389) is required. The power supply comes either via the USB port on the PC or from the controller, therefore no external power supply is needed.

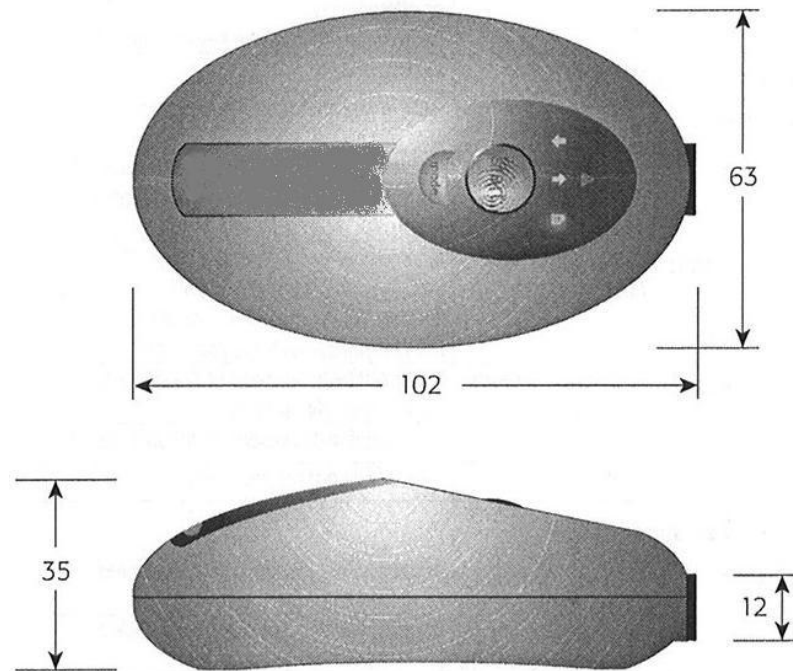


Figure 2.6.1 : Dimensions For Smart Key

2.6.1. Technical Specifications

Power Supply	4.5 to 35V (via telephone connector from the Vision2020i or via the USB converter). No batteries or external power supplies are required
Power input (max)	0.25W USB; 0.60W Vision2020i
Max. transmission speed	460kb/s
Buttons	2 backlit silicone rubber
LED	4 green, 1 yellow, 1 red
Maximum cable length between key and Vision2020i	<3m; <1.8m for use in domestic environments (EN55014-1)
Operating conditions	0 To 55 °C; <80% RH non-cond
Storage conditions	0 To 70 °C; <80% RH non-cond
Dimensions (mm)	63x102x35
Connections	Serial via RJ11 telephone connector
Index of protection	IP20
Environment pollution	Normal
Immunity against voltage surges	Category I
Software class and structure	Class A
Category of resistance to heat and fire	Category D (UL94 Vo)
PTI of insulating materials	>250V
Period of electric stress across insulating parts	Long

3.0 USER INTERFACE

3.1 DBG1 PANEL – OPERATOR KEYPAD

The DBG1 panel operator keypad consists of 15 polycarbonate buttons:

Figure 3.1.1 : Vision 2020i keypad



The top right 'Authorization' button is for password log in to gain authorization, to the access setting menu.

The top left six operator buttons functions are to view status only, except the 'Setpoint' button also allows setting changes after gained authorization.

The three buttons at the bottom left are to access different level of setting changes.

These are 'User', 'Technician' and 'Factory' levels, from left.

It can only be access depend on the password level. The higher password can access the lower password level's setting and not vice versa.

3.1.1 The fifteen polycarbonate buttons:

a) Seven polycarbonate buttons at top row

Button	Description
	Input Status Displays the analog inputs and digital inputs status measured by the probes/sensors.
	Output Status Displays the relay outputs and analog outputs status.
	Compressor Status Displays the status of Compressor 1, 2 and so on.
	Setpoint Displays the status of set points.
	Clock/ Schedule Displays the date, time and day.
	Alarm History Display the alarm history.
	Authorization To log in the level of passwords.

b) Eight polycarbonate buttons at bottom row

Button	Description
	User User Control Changeable Settings.
	Technician Technician Control Changeable Settings.
	Factory Factory Control Changeable Settings.
	Menu Unit information / Compressor Information.
	Alarm Reset Display the active alarms and to perform alarm manual resets.
	Up Scroll the various screens when the cursor is in the top left of the display. If the cursor is inside a numeric field, the button increases or decreases the corresponding value. If the field is a selection, pressing the button displays the available options.
	Down See the UP arrow
	Enter To move the cursor around the screens and to save the values of the set parameters

3.1.2 STATUS READING

3.1.2.1 Input status key

To read inputs status press input status key:



The display is showing the data as follows:

ANALOG INPUTS	
Supply Temp	044.8 °F
Return Temp	055.6 °F
Suction Pres	073 PSI
Disch Press	179 PSI

Press down arrow key or input key to go to next screen:



The display is showing the data as follows:

ANALOG INPUTS	
C1 Amps	112A
C2 Amps	118 A
C1 Disch T	128.5 °F
C2 Disch T	131.2 °F

Repeat the same steps to go to other sensor inputs screen.

3.1.2.2 Output status key

To read relay outputs status press output status key:



The display is showing the data as follows:

RELAY OUTPUTS	
Comp 1	ON-LOAD
Comp 2	ON-LOAD
Alarm Status	OFF
Control Power	ON
SDD Control	OFF
Setback	OFF

Press down arrow key or output key to go to next screen:



The display is showing the data as follows:

RELAY OUTPUTS	
C1 Liq Inj Sol	ON
C2 Liq Inj Sol	OFF
CW Pump	ON
Hotgas Relay	OFF

Repeat the same steps to go to other relay outputs screen.

3.1.2.3 Compressor status key

To read compressor status press compressor status key:



The display is showing the data as follows:

COMPRESSOR 1 STATUS	
Comp 1	OK
Amps	= 100A
FLA1	= 230A
Target	= 087.5%
Capacity	= 065.5%
Status	= ON-LOAD

Press down arrow key or press compressor key to go to next screen:



The display is showing the data as follows:

COMPRESOR 1 HISTORY		
Run Hour	Today	Total
Cycle	05	000076
	02	00006
Last On	04/24	19:06
Last Off	04/24	19:03

3.1.2.4 Setpoint key:

To read the setpoint value press setpoint key

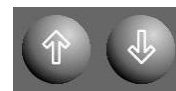


The display is showing the data as follows:

SETPOINT 1	
Supply Water Temp	
Set point=	44.0 °F
Dead band=	0.8 °F

To alter setpoint data, you must be authorized. See the authorization procedure and you must be authorized at least as user level.

Press enter key to select the setpoint to alter and use the up-down arrow key to change the value and press enter key to confirm.



Press down arrow key or press setpoint key to go to next screen:



Repeat the same steps to go to other setpoints screen and perform setpoint modification.

3.1.2.5 Clock key:

To read the current day, time and date, unit scheduling and ice-cel mode scheduling (optional), press the clock key



The display is showing the data as follows:

REAL TIME CLOCK		
Day	>	MONDAY
Time	>	16:10
Date	>	05/12/05

To set the date and time, you must be authorized. See the authorization procedure and log in at least as user level.

Press enter key to select the date or time to alter and use the up-down arrow key to change the value and press enter key to confirm.



3.1.2.6 Alarm history key:

To view the unit alarm history press alarm history key:



The display is showing the data as follows:

ALARM HISTORY	
001 - C1 Starter	
19:03	05/12/05
TR: 030.2	LWT: 64.3
DP: 191	SP: 076
C1 AMP: 000	
C2 AMP: 154	

Press down arrow key or press alarm key to go to next screen for other alarm history:



To clear alarm history, press input key and authorization key together and then press the alarm key again. Now the display should be showing "No alarm"



3.1.3.1 Authorization key

To get authorization level, press authorization key:



The display is showing the current access level as view only:

AUTHORIZATION	
Please Enter your Password	
PASSWORD = 0000	
Status = View	

Press enter key and use the up-down arrow key to change the password settings and press enter key to confirm.



Now the authorization status changes to different access level.

3.1.4 ADVANCED USER KEY AND MENU

3.1.4.1 User Key

User key is use to view and change the pressure, ampere safety limits and liquid injection temperature setpoints, unit of measurements. In order to gain access to this button, you must be authorized and log in at least as user level.



Press the user key and display is showing the data as follows:

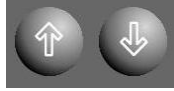
USER SETPOINT 1	
High Pressure Safety Limits	
Hold =	360PSI
Unload =	370PSI
Cutout =	400PSI

Press down arrow key or user key to go to next screen for other setpoint:



To alter setpoint data, press enter key to select the setpoint to alter and use the up-down arrow key to change the value and press enter key to confirm.

3.1.3 AUTHORIZATION



Repeat the above steps for others setpoints.

3.1.5 **TECHNICIAN KEY AND MENU**

3.1.5.1 **Technician status key**

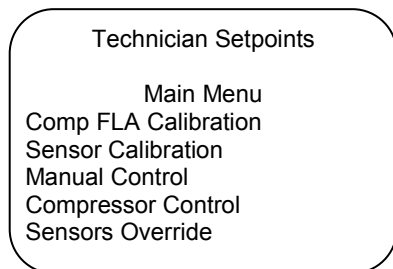
This key is use to view and change the compressor FLA setpoint, sensors calibration, manually control digital inputs and outputs, manually control compressor. In order to gain access to this button, you must be authorized and log in at least as user level. See the authorization section about this procedure.

3.1.5.2 **Technician status key – main menu**

Press technician key to go to technician setpoints main menu:

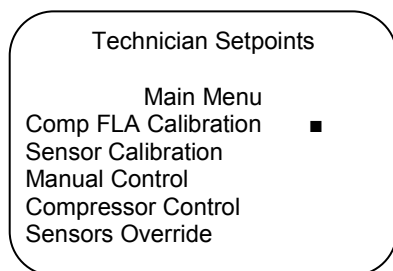


The display is showing the data as follows:



Press enter key to move the cursor to the sub-menu.

The display is showing the data as follows:

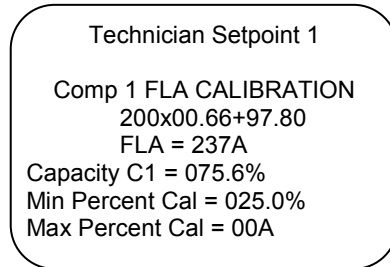


3.1.5.3 **Compressor FLA Calibration:**

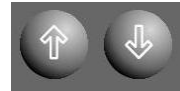
To calibrate compressor FLA, press down arrow key to go the sub-menu 'Comp FLA Calibration',



The display is showing the data as follows:

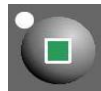


Press enter key to move the cursor to calibrate the comp FLA and use the up-down arrow key to change the value and press enter key to confirm.

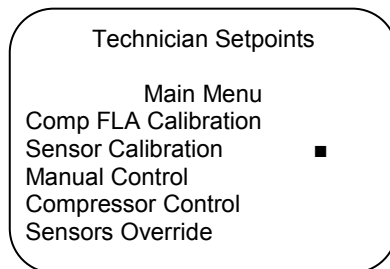


3.1.5.4 **To perform Sensor Calibration:**

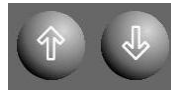
Press technician key to go to technician setpoints main menu and press enter key twice to move the cursor to the sensor calibration sub-menu:



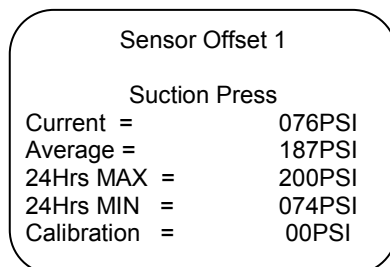
The display is showing the data as follows:



Use up or down arrow key to move the cursor to the desired 'Sensor Calibration',



The display is showing the data as follows:



Press enter key to move the cursor to calibrate the desired sensor and use the up-down arrow key to change the value and press enter key to confirm.



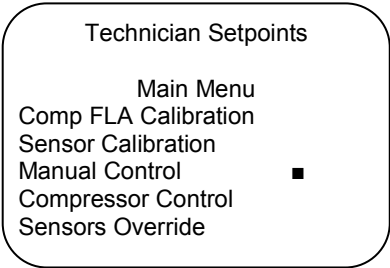
Repeat the above steps for others sensors calibrations.

3.1.5.5 Manual Control:

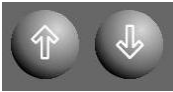
A digital input sensor or relay output can be controlled manually with the keypad. Digital input sensor or relay output can be turned on, off manually and placed back to auto mode. To place a digital input or relay output in manual control, the operator must be authorized at technician level or higher. Press technician key to go to technician setpoints main menu and press enter key three times to move the cursor to the manual control sub-menu:



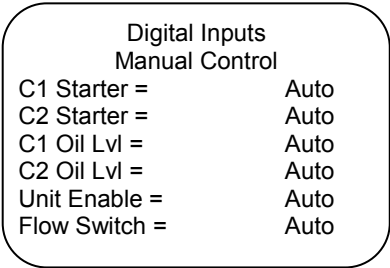
The display is showing the data as follows:



Use up or down arrow key to move the cursor to the desired digital input or relay output,



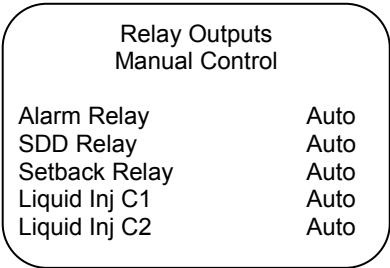
The display is showing the data as follows:



Press enter key to move the cursor to the desired point for manual control and use the up or down arrow key to change the status of the digital input or relay output to AUTO/CLOSE/OPEN or AUTO/ON/OFF.



The display is showing the data as follows:



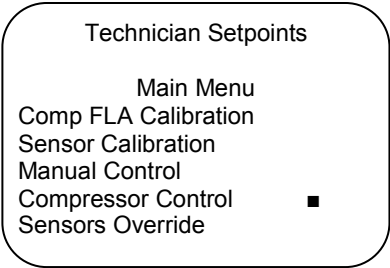
Press enter key to confirm the change.

3.1.5.6 Compressor Control:

Screw compressors can be controlled manually with the keypad. A compressor can be turned on, off, or placed in computer control. When a compressor is controlled manually, it can be commanded to load, hold, or unload. If safety limiting condition is active, it will not accept a load command. To place a compressor in manual control, the operator must be authorized and log in as technician level and higher. Press technician key to go to technician setpoints main menu and press enter key four times to move the cursor to the manual control sub-menu:



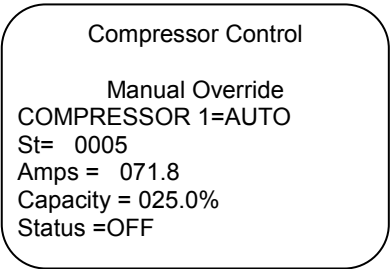
The display is showing the data as follows:



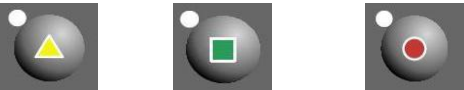
Use down arrow key to move the cursor to the desired compressor control screen, then press enter key to move the cursor to compressor status position, AUTO /MAN/OFF



The display is showing the data as follows:



Use up or down arrow key to select MAN and press enter key to confirm the change. The compressor will start or continue to run in hold state. Press the user key to continue hold, press the technician key to load and factory key to unload.



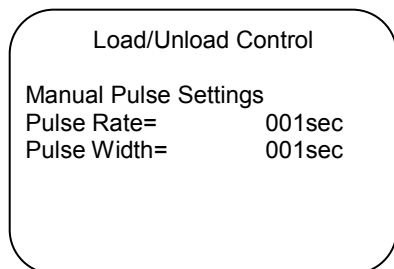
Manual Hold Manual Load Manual Unload

If a safety condition is exceeded while operating manually, the compressor will shutdown.

CAUTION: Anti-recycle timer is bypassed by manual control. **DO NOT** start a compressor more than once every 15 minutes.

NOTE: All compressors will revert back to automatic control if the computer is the computer is not given a load, unload, or hold command at least once every 15 minutes. A command can be repeated to meet the 15 minute requirement for manual control.

To the change the settings of compressor load/Unload, follow the above steps and go to compressor control. Use down arrow key to move the following and press to change the settings.



3.1.5.7 Sensors Override:

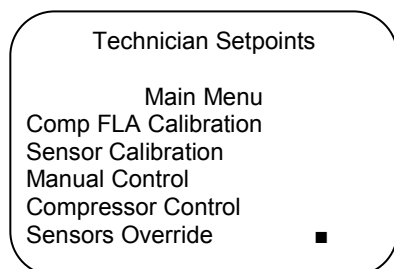
Value of analog readings can be temporary override during sensor failure.

To override the analog readings, the operator must be authorized at technician level or higher.

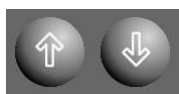
Press technician key to go to technician setpoints main menu and press enter key five times to move the cursor to the 'Sensors Override' sub-menu:



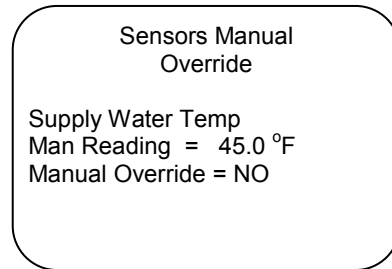
The display is showing the data as follows:



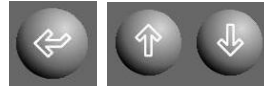
Use up or down arrow key to move the cursor to the desired analog reading,



The display is showing the data as follows:



Press enter key to move the cursor to the "Man Reading" and use the up or down arrow key to change the value of the analog reading, press enter key move the cursor to the "Manual Override" to enable, or disable the manual override control.



Repeat the above steps for other sensors override.

Caution: Sensors override require continuous monitoring and observation by the field service personnel at all time during the unit operation. Faulty sensor shall be replaced as soon as possible in order to allow the unit to be running in automatic mode.

3.2 **DBG3 PANEL – OPERATOR KEYPAD**

Vision 2020i controller is equipped with user friendly 5.7" touch screen display with 256 colors and 320 × 240 pixel on graphic resolution. It is connected with controller through twisted pair shielded cable. The graphic display terminal allows carrying out all program operations. The user terminal allows displaying the unit working conditions, component run times, alarm history at any time and modifying the parameters. The terminal also has an automatically self-test of the controller on system start-up. Multiple messages will be displayed by automatically scrolling from each message to the next. All of these messages are spelled out in English language on the screen.

3.2.1 **Touch Screen Terminal Display**

The touch screen keypad consists of 14 touch keys, and 7 physical keys:



Figure 3.2.1.1 Vision 2020i keypad

The top right 'Authorization' button is for password log in to gain authorization, to the access setting menu.

The three buttons at the top row which is to access different level of setting changes. These are 'User', 'Technician' and 'Factory' levels.

It can only be access depend on the password level. The higher password can access the lower password level's setting and not vice versa.

3.2.2 **The Fourteen Touch keys:**

Key	Description
	MAIN Display the main screen
	USER User Control Changeable Settings.
	TECHNICIAN Technician Control Changeable Settings.
	FACTORY Factory Control Changeable Settings.
	SETPOINT Displays the status of set points.
	AUTHORIZATION To log in the level of passwords
	MENU Unit information / Compressor Information.
	CLOCK/SCHEDULE Displays the date, time and day.
	ALARM RESET Display the active alarms and to perform alarm manual resets.
	LEFT Scroll the various screens when the cursor is in the top left of the display. If the cursor is inside a numeric field, the button increases or decreases the corresponding value. If the field is a selection, pressing the button displays the available options.
	RIGHT See the LEFT arrow
	INPUT STATUS Displays the analog inputs and digital inputs status measured by the probes/sensors.
	OUTPUT STATUS Displays the relay outputs and analog outputs status.
	COMPRESSOR STATUS Displays the status of Compressor 1, 2 and so on.

3.2.3 **The Seven Physical Keys:**

Key	Description
	UP Scroll the various screens when the cursor is in the top left of the display. If the cursor is inside a numeric field, the button increases or decreases the corresponding value. If the field is a selection, pressing the button displays the available options.
	ENTER To move the cursor around the screens and to save the values of the set parameters
	DOWN See the UP arrow
	MENU Unit information / Compressor Information.
	ALARM RESET Display the active alarms and to perform alarm manual resets.
	AUTHORIZATION To log in the level of passwords
	INPUT STATUS Displays the analog inputs and digital inputs status measured by the probes/sensors.

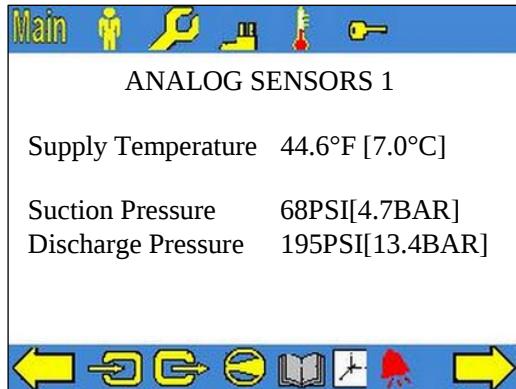
3.2.4 STATUS READING

3.2.4.1 Input status key

To read inputs status, touch on input status key:



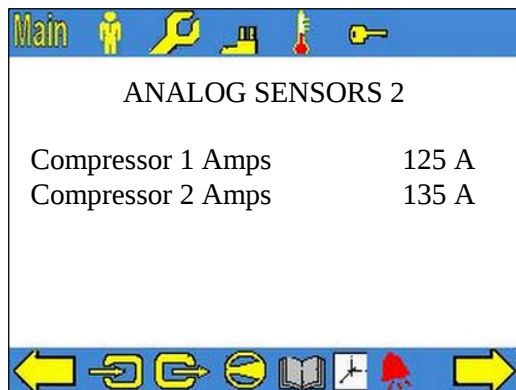
The display is showing the data as follows:



Touch on right arrow key or input key to go to next screen:



The display is showing the data as follows:



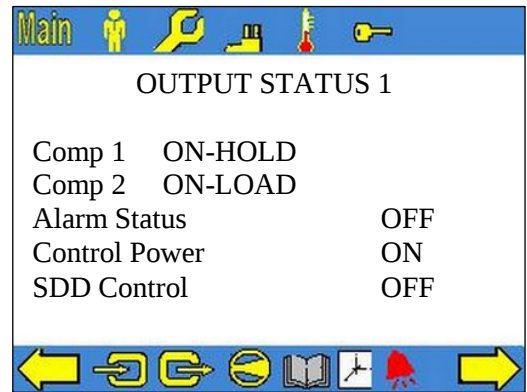
Repeat the same steps to go to other sensor inputs screen:

3.2.4.2 Output status key

To read relay outputs status, touch output status key:



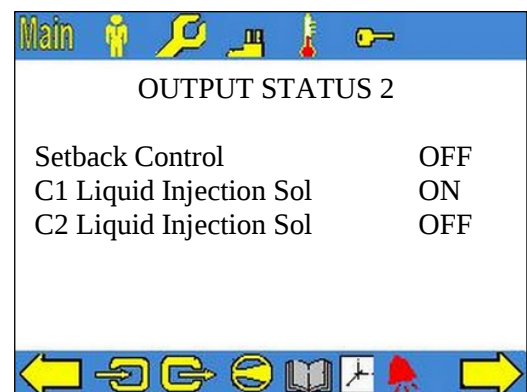
The display is showing the data as follows:



Touch on right arrow key or output key to go to next screen:



The display is showing the data as follows:



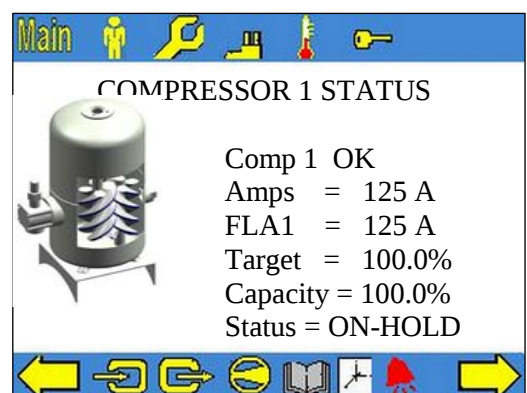
Repeat the same steps to go to other relay outputs screen:

3.2.4.3 Compressor status key

To read compressor status, touch on compressor status key:



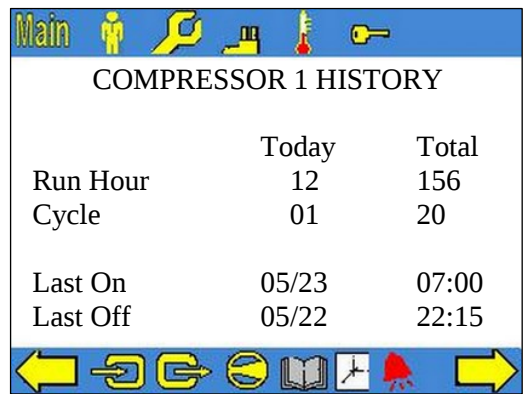
The display is showing the data as follows:



Touch on right arrow key or compressor key to go to next screen:



The display is showing the data as follows:



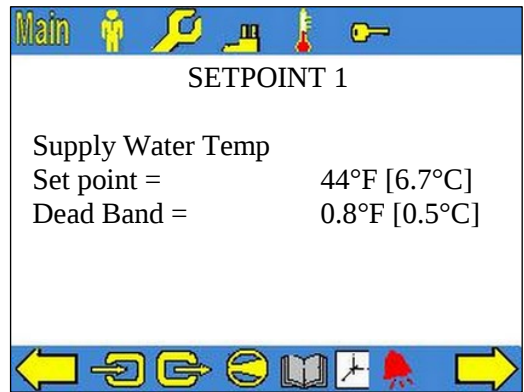
	Today	Total
Run Hour	12	156
Cycle	01	20
Last On	05/23	07:00
Last Off	05/22	22:15

3.2.4.4 Setpoint key:

To read the setpoint value, touch on setpoint key



The display is showing the data as follows:



SETPOINT 1	
Supply Water Temp	
Set point =	44°F [6.7°C]
Dead Band =	0.8°F [0.5°C]

To alter set point data, you must be authorized. See the authorization procedure and you must be authorized at least as user level.

Touch on the selected set point which written in blue color and underlined. Use the keypad to key in the desired setpoint and press **OK** key to confirm the change. If the value you key in is out of acceptable range, the setpoint will not change and the keypad will remain to receive another value.



Touch on right arrow key or setpoint key to go to next screen:



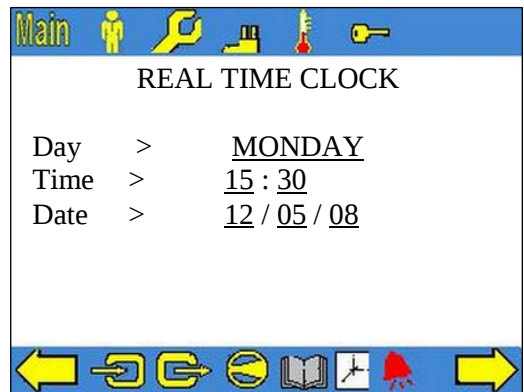
Repeat the same steps to go to other setpoints screen and perform setpoint modification.

3.2.4.5 Clock key:

To read the current day, time and date, unit scheduling and Ice-cel mode scheduling (optional), touch on the clock key



The display is showing the data as follows:



REAL TIME CLOCK	
Day >	<u>MONDAY</u>
Time >	<u>15 : 30</u>
Date >	<u>12 / 05 / 08</u>

To set the date and time, you must be authorized. See the authorization procedure and log in at least as user level.

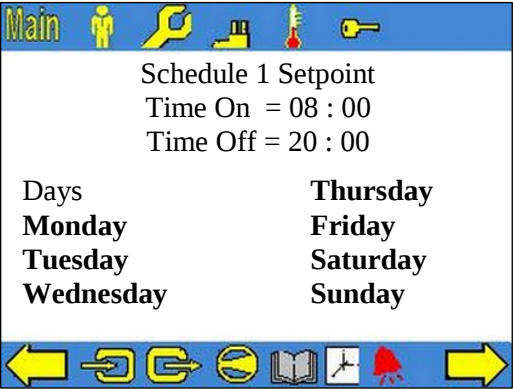
Touch on the date or time which is written in blue color and underlined to change the setpoint. Use the up or down keys of the keypad below to change the value and touch on **OK** key to confirm.



Touch on right arrow key or clock key to go to next screen:



The display is showing the data as follows:

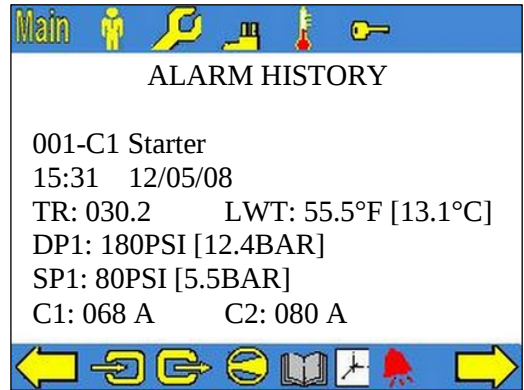


3.2.4.6 **Alarm history key:**

To view the unit alarm history, touch on Main key to go to main menu, and then touch on alarm history key:



The display is showing the data as follows:



Touch on left arrow key or alarm history key to go to next screen for other alarm history:



To clear alarm history, press “Prg” key and “Esc” key together at the right hand side of the terminal and then press the alarm key again. Now the display should be showing “No alarm”

3.2.5 **AUTHORIZATION**

3.2.5.1 **Authorization key**

To get authorization level, touch on authorization key:



The display is showing the current access level as view only



Key in the password by using the touch keys and touch on Enter key to confirm.



Now the authorization status changes to different access level.

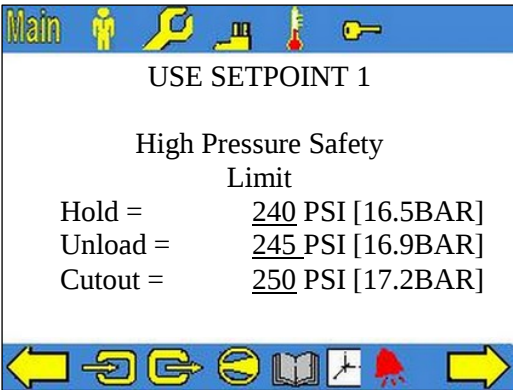
3.2.6 **ADVANCED USER KEY AND MENU**

3.2.6.1 **User Key**

User key is use to view and change the pressure, ampere safety limits and liquid injection temperature set points, unit of measurements. In order to gain access to this button, you must be authorized and log in at least as user level.



Touch on the user key and display is showing the data as follows:



Touch on right arrow key or user key to go to the next screen or setpoints.



To alter setpoint data, press on the setpoint which in written in blue color and underlined. Use the keypad below to change the value and press **OK** key to confirm. If the value you key in is out of acceptable range, the setpoint will not change and the keypad will remain to receive another value.



Repeat the above steps for other setpoints.

3.2.7 **TECHNICIAN KEY and MENU**

3.2.7.1 **Technician status key**

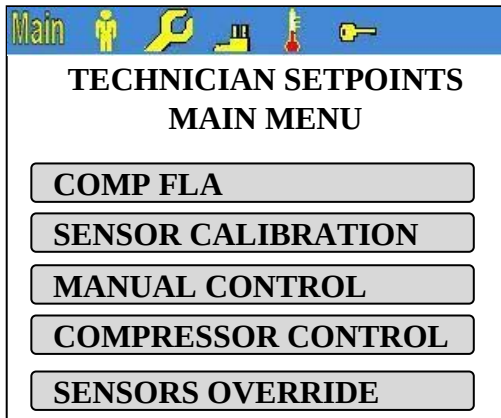
This key is use to view and change the compressor FLA setpoint, sensors calibration, manually control digital inputs and outputs, manually control compressor and override sensor reading. In order to gain access to this button, you must be authorized and log in at least as technician level. See the authorization section about this procedure.

3.2.7.2 **Technician status key - main menu**

Touch on technician key to go to technician set points main menu:



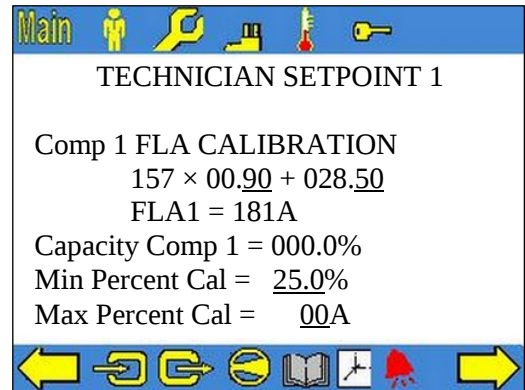
The display is showing the data as follows:



Touch on on the selected sub-menu to move the next page to the sub menu.

3.2.7.3 **Compressor FLA Calibration:**

To calibrate compressor FLA, touch on the sub-menu 'Comp FLA Calibration',
The display is showing the data as follows:



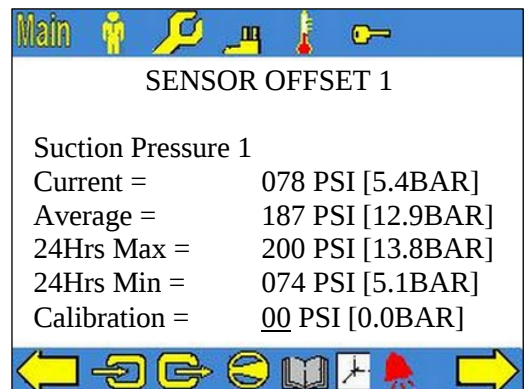
Touch on the desired setpoint with blue color and underlined to calibrate the comp FLA and use the keypad shown as below to change the value and press OK key to confirm.



3.2.7.4 **To Perform Sensor Calibration:**

To perform sensor calibration, touch on the 'Sensor Calibration' sub-menu:

The display is showing the data as follows:



Touch on the selected sensor calibration and key in the calibration value by using the keypad.

Press OK to confirm. Repeat the above steps for others sensors calibrations.

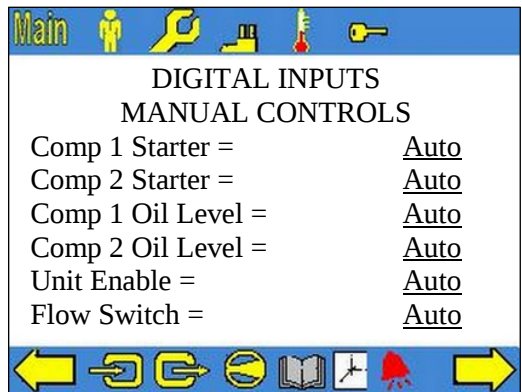
3.2.7.5 **Manual Control:**

A digital input sensor or relay output can be controlled manually with the keypad. Digital input sensor or relay output can be turned on, off manually and placed back to auto mode. To place a digital input or relay output in

manual control, the operator must be authorized at technician level or higher.

Touch on technician key to go to technician set points main menu and touch on the 'Manual Control' sub-menu:

The display is showing the data as follows:

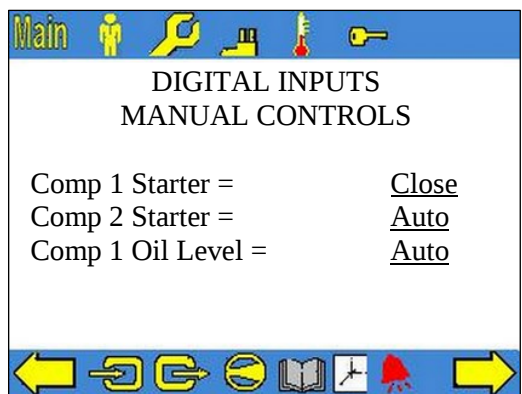


Touch on desired point with blue color and underlined for manual control.

Use the keypad shown as below to change to the desired digital input to AUTO/CLOSE/OPEN. Touch on OK to confirm.



The display is showing the data as follows:



For manual control of digital outputs, use the following keypad to change the desired digital output to AUTO/ON/OFF. Touch on OK to confirm.



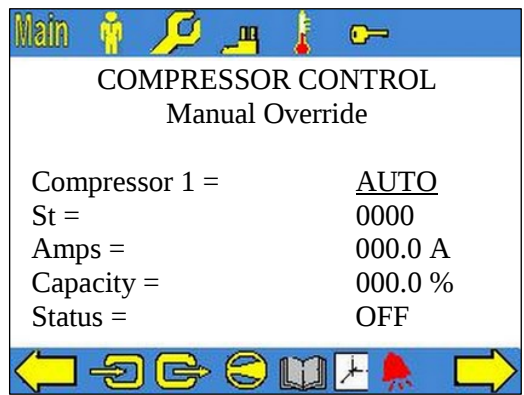
3.2.7.6 Compressor Control:

Screw compressors can be controlled manually with the keypad. A compressor can be turned on, off, or placed in computer control. When a compressor is controlled manually, it can be commanded to load, hold, or unload. If safety limiting condition is active, it will not accept a load command.

To place a compressor in manual control, the operator must be authorized and log in as technician level and higher.

Touch on technician key to go to technician setpoints main menu and touch on the 'Compressor Control' sub-menu:

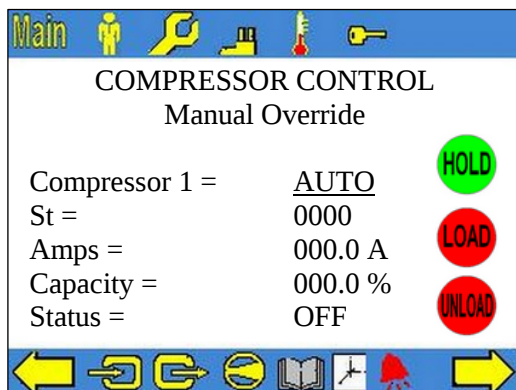
The display is showing the data as follows:



Use the keypad shown as below to change to the compressor control to AUTO/MANUAL/OFF. Touch on OK to confirm.



If the compressor control is placed on MANUAL control, the display is showing data as follow:



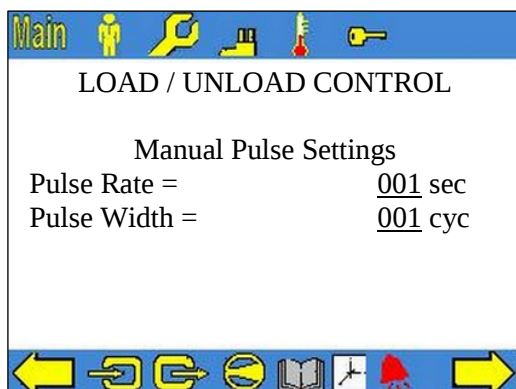
Touch on HOLD, LOAD or UNLOAD key to manually control the compressor running status.

If a safety condition is exceeded while operating manually, the compressor will shutdown.

CAUTION: Anti-recycle timer is bypassed by manual control. **DO NOT** start a compressor more than once every 15 minutes.

NOTE: All compressors will revert back to automatic control if the computer is the computer is not given a load, unload, or hold command at least once every 15 minutes. A command can be repeated to meet the 15 minute requirement for manual control.

To the change the settings of compressor load/Unload, follow the above steps and go to compressor control. Use right arrow key to move to the following page as shown:



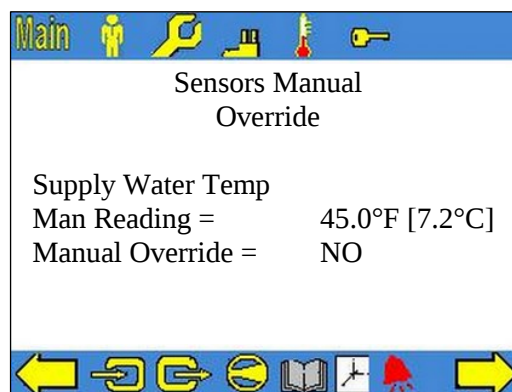
3.2.7.7 Sensors Override

Value of analog readings can be temporary override during sensor failure.

To override the analog readings, the operator must be authorized at technician level or higher.

Touch on technician key to go to technician setpoints main menu and touch on 'Sensors Override' sub-menu:

The display is showing the data as follows:



Touch on the value to key in the override reading. Then, touch on NO/YES key with blue color and underlined to enable, or disable the manual override control.

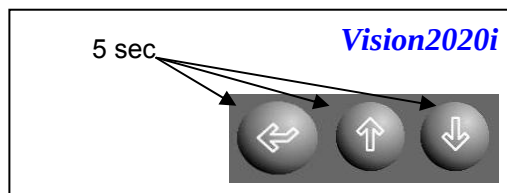
Repeat the above steps for other sensors override.

CAUTION: Sensors override requires continuous monitoring and observation by the field service personnel at all time during the unit operation. Faulty sensor shall be replaced as soon as possible in order to allow the unit to be running in automatic mode.

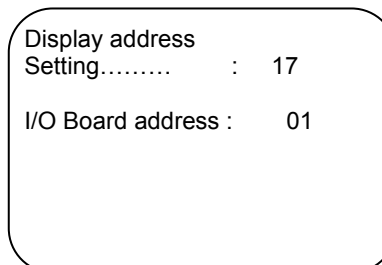
3.3 ADDRESSING THE VISION 2020i CONTROLLER AND TERMINAL

3.3.1 Vision 2020i Controller with DBG1 Display

At the *Vision 2020i* terminal, push simultaneously the last three keys on the lower right corner of the Vision 2020i terminal keyboard. Push them for at least 5 seconds.



This display will appear:



Change the display address setting to 0 as follow.

Display address
Setting..... : 0

Turn off DB3 controller.

At the Vision 2020i DBG1 terminal, hold simultaneously the “Alarm” key and “Up arrow” key, turn on DB3 controller and hold these keys until “Self Test” mask is appeared. Hold for 10 seconds



SELF TEST
PLEASE WAIT

The following mask will appear. Set pLAN address to 1 (or accordingly) using “Up” and “Down” arrow key. Press “Enter” key to save and exit.

pLAN Address : 1
Up : Increase
Down : Decrease
Enter : Save & Exit

Again, at the **Vision 2020i** terminal, push simultaneously the last three keys on the lower right corner of the Vision 2020i terminal keyboard. Push them for at least 5 seconds. This display will appear:

Display address
Setting..... : 17
I/O Board address : 01

Change Display address setting to “17”. The terminal display will now become blank.

Again, at the Vision 2020i terminal, push simultaneously the last three keys on the lower right corner of the Vision 2020i terminal keyboard. Push them for at least 5 seconds. This display will appear:

Display address
Setting..... : 17
I/O Board address: --

Change I/O board address to “01”. Press Enter key to continue. The following display will appear:

Termianl Config
Press ENTER
To continue

Press Enter to continue and the following display will appear:

P:01	Adr	Priv/Shaed	
Trm1	17	Pr	
Trm2	32	Sh	
Trm 3	None	---	OK? NO

Change “NO” to “YES” and press Enter key. Configuration of terminal display and controller are done now.

Terminal display address shall be set to “18” if it is connected to a Vision 2020i controller with I/O address “02”.

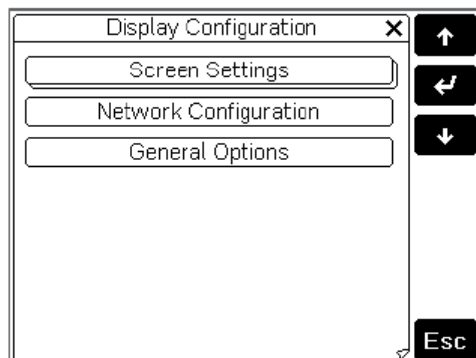
3.3.2 **Vision 2020i Controller with DBG2/DBG3 Display**

The menus can be accessed by pressing any point on the touchscreen together with the ↑ (up) and **Prg** buttons for at least one second. Alternatively, press the ↑ (up) / ↓ (down), ↵ (enter) buttons together for at least one second.

The following operations exit the menu:

1. Pressing the Esc button;
2. Automatically 1 minute after a button was pressed or the touchscreen touched;
3. Pressing the “X” symbol when displayed at the top right.

As shown in the following figure, the buttons that can be used during the configuration phase are also visible on the right side of the display:



To access an item, simply press the touchscreen on the corresponding indication, or press the ↑ (up) / ↓ (down) buttons until selecting it and then confirm by pressing ↵ (enter).

To modify the value of a field, after having activated it (a field is active when the cursor is flashing inside), press the ↑ (up) / ↓ (down) buttons to change the value and press ↵ (enter) to save it. Pressing Esc before ↵ (enter) cancel the modifications made to the field.

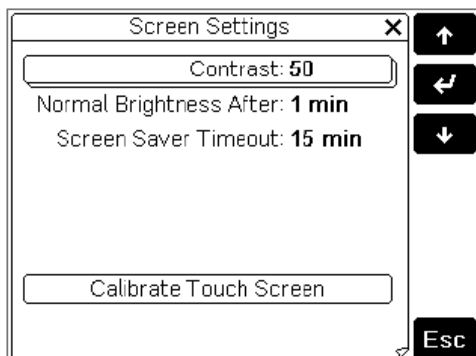
3.3.2.1 Description of the menu

Main menu

The main menu, visible in the previous image "Display Configuration", is used to select the main three configuration categories, that is:

- Screen Settings: Settings relating to the screen
- Network Configuration: Settings relating to the RS485 network
- General Options: Various settings

"Screen Settings" menu



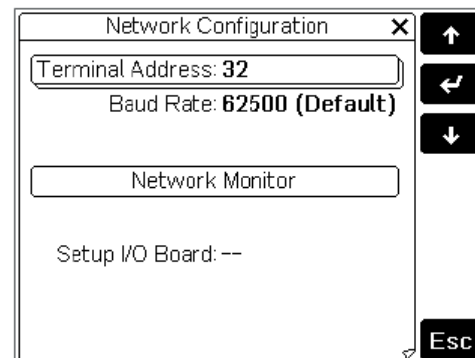
The following options are available:

- Contrast: Used to set the contrast of the display (from 0 to 100, default: 50).
- Normal Brightness After: Used to set the time after the touchscreen or the buttons

are last pressed that the display switches from "high brightness" to "normal brightness". The possible values range from 30 s to 15 min, default: 1 min.

- Screen Saver Timeout: Used to set the time after the touchscreen or the buttons are last pressed that the display switches off, after having switched to "normal brightness". The possible values range from 30 s to 4 hours (4 hrs), default: 15 min.
- Calibrate Touch Screen: The touchscreen can be calibrated if it is evidently misaligned. To align the touchscreen, press the exact centre of the crosses displayed in sequence. The message "Done: touch the screen to ESC" indicates that the operation has been completed correctly. If, on the other hand, the message "Bad: touch to ESC and repeat" is displayed, the operation will need to be repeated.

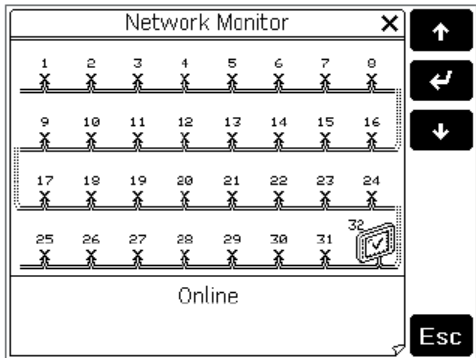
"Network Configuration" menu



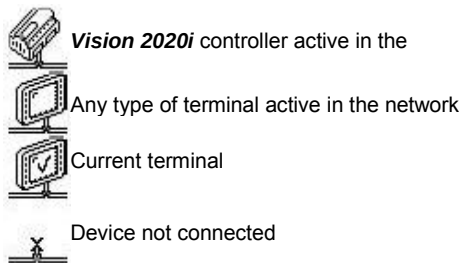
The following options are possible:

- Terminal Address: Used to set the address of the terminal (from 1 to 32, default: 32). If the value "--" is set (two dashes are displayed) the terminal will communicate with the Vision 2020i board using the "Point-Point" protocol : the "Baud Rate", "Network Monitor" and "Setup I/O Board" fields will then disappear, as they have no meaning.
- Baud Rate: Used to set the DBLAN communication baud rate. The possible values are 62500 (default) or 115200 (used only if all the devices in the network are configured for this speed). Note that not all the DBLAN devices support the 115200 setting.
- Network Monitor: This is used to display the status of the network (see next paragraph)
- Setup I/O Board Setup: These fields are used to modify the list of terminals associated with each individual **Vision 2020i** board.

Network Monitor



This screen is used to display the status of the network when master-slave sequencing control is furnished, indicating graphically which devices are connected for each address. The meaning of the symbols is the following:

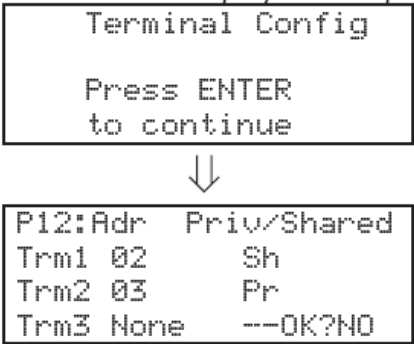


If activity is detected on the network, the message "Online" is displayed.
To exit the screen, press the **Esc** button.

Assigning the list of private and shared terminals

The list of terminals associated with each individual **Vision 2020i** board can be modified from the "Network Configuration" menu, as follows:

1. Select the address of the required board using the **↑**(up) / **↓** (down) buttons in the "Setup I/O Board" field (only the boards that are effectively on-line can be selected) and confirm by pressing **↵**(enter). If the DBLAN network is not working correctly, or no **Vision 2020i** board is present, the field is not modifiable, and "--"(two dashes) will be displayed.
2. Press the "Setup" button: the following screens will be displayed in sequence:

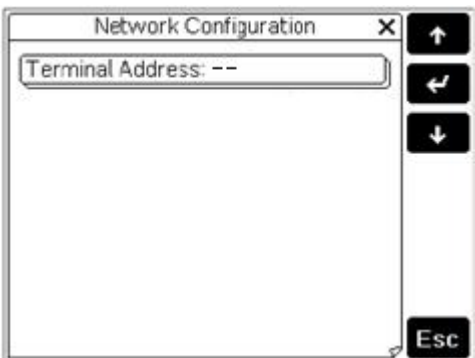


3. Now the **↵** (enter) button is used to move the cursor from one field to the next, and **↑** (up) / **↓** (down) change the value of the current field. The "P:xx" field shows the address of the selected board (in the example, board number 12 has been selected);
4. To exit the configuration procedure and save the data, select the "OK ?" field, set "Yes" and confirm by pressing **↵** (enter). Alternatively, if the terminal remains inactive (no button is pressed) for more than 30 s, the configuration procedure is automatically ended without saving the changes.

Important: the DBG2/3 terminals cannot be configured as "Sp" (shared printer) as the printer output is not featured. Selecting this mode has no effect on the management of printed messages sent via DBLAN.

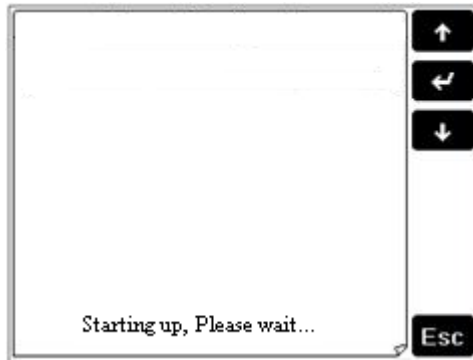
Assigning the I/O Board Address of the Controller

In order to configure the I/O board address of the **Vision 2020i** controller, the terminal address must set to "--". Please refer to "Network Configuration Menu" for procedures to configure the terminal address. The following display will appear:

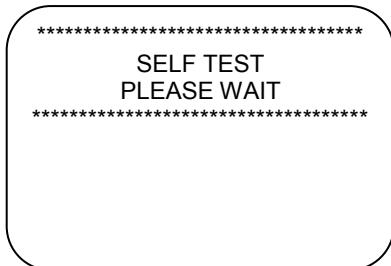


Switch off power supply of the controller now.
Disconnect connector at J23 on the controller.

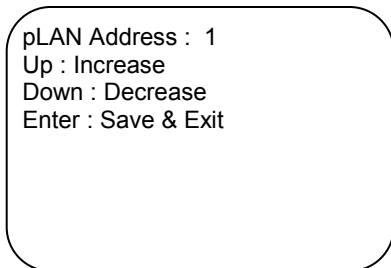
Resume power supply of the controller, press and hold "alarm reset" and "up" key, when the below screen is appeared.



After a few seconds, the controller commences the start-up sequence, and then the following display is shown.



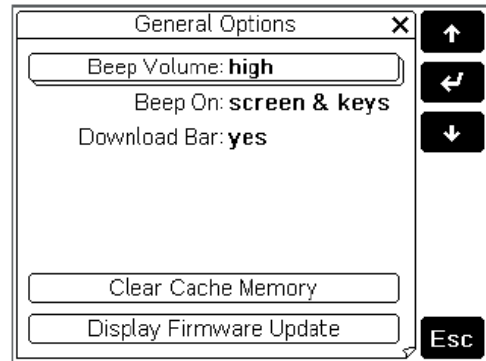
When this screen appears, wait 10 seconds and then release the buttons. The controller stops the start-up sequence and the following display is shown.



Then, set the "pLAN Address" using the "Up" and "Down" buttons on the terminal. Confirm the setting by pressing "Enter" button. The controller completes the start-up sequence and uses the specified address.

Now, configure the "Terminal Address" to its desired setting. Terminal display address shall be set to "17" if it is connected to a **Vision 2020i** controller with I/O address "01". If the terminal is connected to a **Vision 2020i** controller with I/O address "02", terminal display address shall be set to "18".

"General Options" menu



The following options are possible:

1. Beep Volume: Used to set the volume associated of the "Beep" with the buttons and the touchscreen pressing.

The possible values are "off", "low", "high". Default: high.

This parameter has no effect on the alarm signal, which is activated or deactivated by the **Vision 2020i**.

2. Beep On: Used to set when the "Beep" sounds. The possible values are: "active items" (associates a sound with the active area of the display), "screen" (associates a sound with any point on the touchscreen) and "screen & keys" (associates a sound with both the touchscreen and the keypad). Default: "screen & keys".
3. Download Bar: activates ("yes") or deactivates ("no") the display of the status bar that indicates the progress of the page. Default: "yes".
4. Clear Cache Memory: deletes the cache memory used to accelerate the display of the screens. This function may be useful if there are errors in the graphics. Pressing the button displays a window that prompts for confirmation. Press "yes" to confirm the operation or "no" to abort it.
5. Display Firmware Update: starts the DBG2/3 firmware update procedure.

4.0 CONTROL & OPERATIONS

4.1 CONTROL FUNCTIONS

The Vision 2020i controller performs the following functions on screw compressor chillers.

- 4.1.1. Chilled Water Pump Interlock And Flow Switch
- 4.1.2. Customer Control Interlock /Unit Enable
- 4.1.3. Compressor Start Delay Timer
- 4.1.4. Compressor Stage Delay Timer
- 4.1.5. Compressor Off-Cycle Delay Timer
- 4.1.6. Compressor Anti-Recycle Timer
- 4.1.7. Load Control
- 4.1.8. Ramp Control
- 4.1.9. Capacity Control Of Screw Compressors
- 4.1.10. Staging Of Compressors
- 4.1.11. Compressor Current Limiting
- 4.1.12. Modmotor Setback Control
- 4.1.13. Suction/Discharge Pressure Differential Control (SDD Control)
- 4.1.14. Automatic Or Manual Lead/Lag
- 4.1.15. Liquid Injection Solenoid Control
- 4.1.16. Second Liquid Injection Solenoid Control (Optional)
- 4.1.17. Condenser Fan Control (Air-Cooled Only)
- 4.1.18. Pumpdown Control (DX Only)
- 4.1.19. Liquid Line Solenoid Control (DX Only)
- 4.1.20. Chilled Water Reset (Optional)
- 4.1.21. Demand Limit Input (Optional)
- 4.1.22. Hot Gas Bypass Control (Optional)
- 4.1.23. Hot Gas Injection Control (R134a Units)
- 4.1.24. Electronic Expansion Valve (EEV) Control (Optional)
- 4.1.25. Vapor Injection Solenoid Control (Optional)
- 4.1.26. Anti-Freeze Control (Circulating Pump and Heater Control) (Optional)

A description of each of these functions follows:

4.1.1. Chilled Water Pump Interlock And Flow Switch

These are field installed switches, both of them are used to ensure chilled water flow before the unit is allowed to start. Failure of either one during operation will cause the compressor to shut down. A No Water Flow alarm will be generated and 'Reset Alarm' must be pressed to clear the alarm.

4.1.2. Customer Control Interlock /Unit Enable

Control contacts from an external source can be used to enable or disable operation of the unit. The wiring diagram specifies the terminals to which this contact must be wired. To enable the unit, the contacts must be closed. To disable the unit, the contacts must be opened.

4.1.3. Compressor Start Delay Timer

A compressor start delay of one minute is incorporated into controller before the first compressor is started to ensure the system load requires the compressor. A start delay timer is shown at compressor status screen during this timing.

4.1.4. Compressor Stage Delay Timer

A compressor stage delay of one minute is incorporated into the controller to ensure that the system load requires another compressor. A stage delay timer is shown at compressor status screen during stage delay timing.

4.1.5. Compressor Off-Cycle Delay Timer

An off-cycle delay of five minutes is initiated when the compressor is stopped. The compressor will not start before the off-cycle timer is elapsed. If cooling is called for during this time, an off-cycle delay timer is displayed at compressor status. This feature applied to horizontal screw compressor units only.

CAUTION: This timer is bypassed by manual control of compressors. DO NOT manually start a compressor in five minutes after a stop.

4.1.6. Compressor Anti-Recycle Timer

The compressor motor requires an anti-recycle time delay which prevents restart for 15 minutes after a start. The purpose of this feature is to avoid frequent starts which tend to elevate the motor winding temperature and impose undue wear on contactors. The controller will not restart the compressor motor until the 15 minutes have elapsed. An OFF-SC timer is displayed at the compressor status during anti-cycle timing.

CAUTION: This timer is bypassed by manual control of compressors. DO NOT manually start a compressor more than once every 15 minutes.

4.1.7. Load Control

The controller controls the leaving water temperature within a narrow deadband by pulsing load and/or unloads solenoids on the compressor. The load and unload solenoids position the slide valve within the compressor to control its capacity. The controller determines a desired level of loading and varies pulse duration depending on difference between load target and actual load. The load target is varied based on rate of approach to desired temperature preventing significant temperature oscillations. The status of the compressor can be observed at terminal display.

4.1.8. Ramp Control

Another feature of the controller is ramp control, which is the ability to vary ramping time of the machine from start. Often when the machine is started, the water in the chilled water circuit is warm, and the unit will go to full load quickly. With ramp control, the user can program the controller so that it loads at a predetermined rate. This is a valuable tool, since it can help reduce power consumption and demand charges. Two variables are used to define the ramp profile: Ramp rate and ramp start setpoint. Ramp Rate defines the maximum amount that can be added to the target each second. Ramp Start point defines the percent capacity target at which the ramp begins on the first compressor. The Ramp Rate setpoint can be set anywhere from 0.1 to 1.0, smaller values producing slower loading rates. The Ramp Start setpoint can be set anywhere between 0 and 50%. The compressor will load quickly to this value and then follow the ramp slope from there. See Table 4.1.8 for ramp rates at various settings with 1-minute compressor start/stage delay timer. These values are calculated with assumption that the chilled water temperature is not descending more than slope temperature setpoint, typically -2.0 °F (-1.1 °C) per minute.

TABLE 4.1.8 Ramp Rates for Several Setpoints (In Minutes)

Ramp Rate Setpoint	1 Comp.			2 Comp.			3 Comp.			4 Comp.		
	Start Point Setpoint			Start Point Setpoint			Start Point Setpoint			Start Point Setpoint		
	30%	50%	75%	30%	50%	75%	30%	50%	75%	30%	50%	75%
0.1	12	9	4.5	22	18.5	14	29	25.5	21	33	29	25
0.2	6	5	2	11.5	10	8	16	14	12	18	16	14
0.3	4	3	1.5	8	7	5.5	11	10	9	13	12	11
0.4	3	2.5	1	6.5	5.5	4.5	9	8	7	11	10	9

4.1.9. Capacity Control Of Screw Compressors

The capacity of a screw compressor can be controlled manually or automatically.

The status of a compressor can be observed at terminal display, "Compressor Status" key.

4.1.9.1 Automatic Control

The controller calculates the operating percent capacity of a compressor by measuring discharge pressure and amps. This operating percent capacity is then compared to a target percent capacity. If the operating capacity is outside of a $\pm 3\%$ dead band, the load or unload solenoids are pulsed to match the operating and target percent capacities. Since all compressors have the same target, their percent of capacities are balanced.

The target percent capacity is given a fixed value when a compressor starts or stops. This value is then increased or decreased based on how far the leaving water temperature (LWT) is from setpoint and also how fast the LWT is approaching setpoint. The target percent capacity will not change if the temperature is within a temperature dead band around the setpoint. Besides, compressor loading will be stop if the leaving water temperature is falling (negative derivative) more than the derivative setpoint typically at -2.0 °F /-1.1 °C.

The desired leaving water temperature is stored in the "Supply Water Temperature" setpoint and the temperature dead band is stored in the "Supply Water Temperature Dead band". The factory default dead band is 0.8 °F /0.5 °C.

4.1.9.2 Calibration of Screw Compressor Capacity Amps at Full Load & Minimum Load Percentage

The amps calculation is calibrated at the factory and does not normally need to be altered. If a compressor is replaced or improper operation is observed, the amps values can be calibrated as follows: -

1. Check calibration of all sensors (pressure sensors, current transducers, NTC temp sensors and etc.). All calibration on sensors shall be done in this step.
2. Load the compressor to full load. If the amps reading do not match with calculated FLA value within 2-3A, do this calculation: Amps – FLA
For example, FLA = 150A, however the max amps at full load is 130A, so, do the calculation
 $130 - 150 = -20$
3. Key in this value into “**Max Percent Cal**” of the compressor in “**COMPRESSOR FLA CALIBRATION**” mask under technician key.
4. Therefore, the value of FLA will change. Verify that amps and FLA now match closely.
5. Manually unload the compressor all the way.
6. Locate the minimum percentage of capacity for the compressor. If this value is $25\% \pm 3\%$, no change required. Else, enter this value into “**Min Percent Cal**” in the same mask. The default value of “**Min Percent Cal**” is 25%.
For example, the minimum percentage of capacity for the compressor is 32.2%, therefore, enter 32.2 at “**Min Percent Cal**”.
7. Repeat this procedure for each compressor.

4.1.9.3 Manual Control

Screw compressors can be controlled manually with the terminal display. A compressor can be turned on, off, or placed in manual control. When a compressor is controlled manually, it can be commanded to load, hold, or unload. If the limiting condition is active, it will not accept a load command. To place a compressor in manual control, the operator must be authorized and log on. Refer to section 3.1.5.6 for procedure for manual control on compressor.

If a safety condition is exceeded while operating manually, the compressor will shutdown. Reset alarm to put all compressors back into automatic control from a locked off state.

CAUTION: Anti-recycle timer is bypassed by manual control. DO NOT start a compressor more than once every 15 minutes.

NOTE: All compressors will revert back to automatic control if the terminal display is not given a command once every 15 minutes.

4.1.10. Staging Of Compressors

The staging of compressors is based on leaving water temperature and the capacity calculations mentioned in section 4.1.9. When the percent capacity target gets up to full load and temperature is above dead band, time delay of one or two minutes is initiated before starting the next compressor. When the capacity target falls below a stored setpoint and the temperature is below the dead band, a compressor is turned off.

The percent capacity values that the controller is calculating can be observed at “Compressor Status” key of the terminal display.

Standard unit screw patterns are as follows.

	Max. Target	Min. Target	Target Start	Target Stop
1 Comp	100.0	15.0	30.0	90.0
2 Comp	98.0	15.0	30.0	90.0
	100.0	40.0	47.5	90.0
3 Comp	97.0	15.0	30.0	90.0
	98.0	40.0	47.5	90.0
	100.0	55.0	64.0	90.0
4 Comp	96.0	15.0	30.0	90.0
	97.0	40.0	55.0	90.0
	98.0	55.0	65.0	90.0
	100.0	65.0	75.0	90.0

Max Target: Maximum setpoint of the pattern

Min Target: Minimum setpoint of the pattern

Target Start: Setpoint where the next stage is starts

Target Stop: Setpoint after the pattern staged down

4.1.11. Compressor Current Limiting

The Amp Hold setpoint is the amp value at which the compressor will be prevented from loading. The Amp Unload setpoint is the amp value at which the compressor will be given an unload command until the current drops below the Amp Unload setpoint.

Typical current limit settings may be calculated with the following equations:

$$\text{Hold amps} = \text{RLA} \times 1.1$$

$$\text{Unload amps} = \text{Hold amps} \times 1.1$$

The setpoints should not be increased above 1.4 times of RLA since the overload trip might occur. If the values are decreased, the difference between the hold and unload setpoint should not be decreased so that oscillations will not occur.

4.1.12. Modmotor Setback Control

A controller contact and a resistor are wired in parallel in the modmotor control circuit. The contact is Vision 2020i controlled to open under light load conditions. This lowers liquid level slightly, preventing excessive liquid level in the evaporator. When the unit loads up, the contacts close and the resistor is bypassed.

4.1.13. Suction/Discharge Pressure Differential Control (SDD Control)

This control function seeks to prevent a low differential pressure alarm. It monitors the difference between condenser and evaporator pressure. If this difference is less than 30 psid (R22) for more than 10 seconds, and evaporator pressure is above 75 psig (R22), the controller will open a set of contacts in the modmotor circuit, causing valves to travel in the closed direction. This starves the evaporator, which increases pressure differential. When this difference exceeds 30 psid, modmotor control returns to normal.

If a resistor (approximately 200 ohms) is wired to the control point, the valve may not close fully when the relay contacts open. This helps prevent suction pressure undershoot. Decrease this resistance to keep the valve fully open. Increase the resistance to close the valve further if the 30 psid is not generated with the control relay open.

4.1.14. Automatic Or Manual Lead/Lag

This feature allows the customer to manually select the lead compressor or let the controller automatically rotate the lead compressor. There are two setpoints in this control. The lead compressor setpoint specifies which compressor is the lead compressor in manual lead/lag mode. The rotation setpoint specifies automatic or manual lead/lag mode is in effect. Select "None" to disable automatic compressor lead/lag rotation. Select either "By Running Hours", "By Day" or "By Stage" for automatic compressor lead/lag rotation.

4.1.15. Liquid Injection Solenoid Control

The liquid injection solenoid is energized when the compressor is operating and compressor discharge temperature rises above the liquid injection ON setpoint (typically 160 °F). The liquid injection solenoid is turned off when the compressor stops or when discharge temperature falls below liquid injection OFF setpoint (typically 150 °F).

If discharge superheat (DSH) control is enabled, the liquid injection solenoid may energize when discharge superheat is above DSH ON setpoint (typically 65 °F), besides discharge temperature control. Liquid injection solenoid is de-energized when both discharge superheat and discharge temperature is below the OFF setpoints. Typical setting for DSH OFF setpoint is 55 °F.

4.1.16. Second Liquid Injection Solenoid Control (Optional)

A low temperature unit or high ambient air-cooled unit may furnish with two liquid injection solenoids. Three stages of liquid injection control is available with these two solenoids. The valves opening are adjusted so that valve opening of liquid injection #2 is larger than liquid injection #1.

	Liquid Inj. Sol #1	Liquid Inj. Sol #2	Typical Turn ON Conditions	Typical Turn OFF Condition
Stage 1	ON	OFF	Discharge Temperature > Stage 1 ON setpoint (160 °F)	Discharge Temperature < Stage 1 OFF setpoint (150 °F)
Stage 2	OFF	ON	Discharge Temperature > Stage 2 ON setpoint (170 °F)	Discharge Temperature < Stage 2 OFF setpoint (160 °F)
Stage 3	ON	ON	Discharge Temperature > Stage 3 ON setpoint (180 °F), OR Discharge superheat > ON setpoint (65 °F)	Discharge Temperature < Stage 3 OFF setpoint (170 °F), AND Discharge superheat < OFF setpoint (55 °F)

The above setpoints are typical for water-cooled units.

4.1.17. Condenser Fan Control (Air-Cooled Only)

The **Vision 2020i** controller provides two types of control logic for air-cooled condensers. The type of control will be governed by the physical condenser layout of the unit. Each method of control is enhanced with adaptive, self-learning, fan control logic. The end result is condenser control that offers significantly reduced fan cycling and improved efficiency. The two types of air-cooled condenser control logic are explained as follows:

A. Adaptive Individual Air-cooled Condenser Control

This type of control is based upon a single compressor per circuit. The individual discharge pressure on that circuit will be the controlling pressure.

B. Adaptive Air Combined Air-cooled Condenser Control

This type of control is based upon a condenser that is controlled by the highest discharge pressure from any one of the compressors sharing that circuit (compressor 1&3 - share; compressor 2&4 - share). The highest discharge pressure between the sharing compressors will be the controlling pressure.

Air Cooled Condenser Control Setpoints

The air-cooled condenser setpoints are as follows:

Stage 1 ON	-	Condenser fan stage 1 on.
Stage 2 OFF	-	Condenser fan stage 2 off.
Stage On Diff	-	Differential pressure for additional condenser fan stages.
Stage Off Diff	-	Differential pressure for subtracting condenser fan stages.
Stage 1 Off	-	Condenser fan stage 1 off
Last Stg Max	-	Maximum setpoint for last stage on

A compressor must be operating for the condenser fans to operate. The condenser points (i.e. fans) will turn on based upon the value in setpoint STAGE 1 ON. When the discharge pressure exceeds this value, the first condenser point is turned on. If additional condenser points exist, they will be turned on when the pressure exceeds the previous cut in value (Stage 1 ON for the first stage) plus the value contained in STAGE DIFF ON setpoint.

Condenser points (i.e. fans) will be turned off based upon the value in the setpoint STAGE 2 OFF (Stage 2 turn OFF point). As the discharge pressure is reduced, the condenser points will be turned off based upon the STAGE 2 OFF setpoint, plus the value in STAGE OFF DIFF setpoint for each stage number above stage 2. Stage 1 of condenser staging will be turned off based upon the value in the setpoint (Stage 1 OFF). See below for an example of condenser staging.

INCREASING CONDENSER PRESSURE

(Example of 4 stage fan cycling, R22 unit)

COND FAN1 ON when discharge pressure is > 230psig (Stage 1 ON setpoint)

COND FAN2 ON when discharge pressure is > 250psig (Stage 1 ON plus 1xStage ON Diff setpoint values)

COND FAN3 ON when discharge pressure is > 270psig (Stage 1 ON plus 2x Stage ON Diff setpoint values)

COND FAN4 ON when discharge pressure is > 290psig (Stage 1 ON plus 3x Stage ON Diff setpoint values)

And so on for the number of condenser fans supplying the circuit.

DECREASING CONDENSER PRESSURE

(4 fan example "continued")

COND FAN4 OFF when discharge pressure is < 200psig (Stage 2 OFF plus 2xStage OFF Diff setpoint values)

COND FAN3 OFF when discharge pressure is < 190psig (Stage 2 OFF plus 1xStage OFF Diff setpoint values)

COND FAN2 OFF when discharge pressure is < 180psig (Stage 2 OFF setpoint value)

COND FAN1 OFF when discharge pressure is < 170psig (Stage 1 OFF setpoint value)

▪ **Adaptive Control Logic**

The controller enhances the condenser control logic above with a unique, adaptive, self-learning fan control logic. These enhancement results in a control scheme that offers reduced fan cycling and improved efficiency. Adaptive Control Logic automatically adjusts the fan cut-in offset based upon the following criteria:

- 1> If the last stage fan turned on (including stage 1) is cycled off in 10 minutes or less, then a COND ON OFFSET value will be incremented by 5 psig. This increases the stage 1 turn on value (Stage 1 ON plus COND ON OFFSET) which in turn increases all of the fan turn on settings. This process will continue until fan cycling ceases or the adjusted turn on point for the last fan stage is 320 psig (R22). This will also be a setpoint (Last Stg Max).
- 2> The cut-in offset (COND ON OFFSET) will be decreased by 5 psig if the last fan to be turned on has not cycled off within 1 hour. The offset will continue to decrease by 5 psig every 10 minutes unless fan cycling begins again.

The Adaptive Control Logic will only affect the condenser fan turn on logic, it will not affect the fan turn off logic.

4.1.18. Pumpdown Control (DX Only)

This feature is to stored refrigerant in condenser when compressor is stopped. Pumpdown control will take place when temperature set point is achieved before compressor is being cycled off or unit enable input is off. The compressor will stop when suction pressure is lower than pumpdown setpoint, 65PSI/4.5BAR (for R22) or 15 seconds (setpoint) delay timer is elapsed.

4.1.19. Liquid Line Solenoid Control (DX Only)

When compressors starts, the liquid line solenoid will energize when suction pressure falls below the pumpout setpoint or a time delay of 5 seconds is elapsed. For unit with two liquid lines per refrigerant circuit, the second liquid line solenoid will energize when suction pressure falls below low pressure cutout setpoint or a time delay of 25 seconds is elapsed and unit target is above 40%. The second liquid line solenoid will be de-energized when the unit target is less than 35%.

4.1.20. Chilled Water Reset (Optional)

If an analog input is available, the desired chilled water temperature can be raised automatically by an external signal provided by an external controller. The external signal can be 0–5Vdc, or 4–20mA. CW Reset Enable setpoint must be enable for this option. Input Type setpoint defines the external signal, 0–5Vdc, or 4–20mA. The maximum temperature reset (increase) desired must be stored in Max Reset setpoint. For example, to raise the chilled water setpoint from 44 °F to 50 °F with a 4–20mA input, “4–20mA” is selected for Input Type setpoint and 6.0 °F is stored in Max Reset setpoint.

4.1.21. Demand Limit Input (Optional)

If demand limiting is desired, a 4–20mA, or 0–5Vdc signal must be supplied to the Demand Limit analog input as shown on the wiring diagram.

Supplying 4mA, or 0Vdc will have no limiting effect, and 20mA, or 5Vdc will have maximum limiting. The Demand Limit setpoint is used to determine the maximum amount mA/Vdc supplied to Demand limit analog input will have. If the Demand Limit setpoint is set to 0, there will be no limiting, and if set to 100, there will be maximum limiting. The Demand Limit setpoint can be set anywhere between 0 and 100 depending on the amount of Demand Limit desired.

4.1.22. Hot Gas Bypass Control (Optional)

When hot gas bypass has been supplied with the unit, an output from the controller controls the solenoid. The solenoid is turned on if only one compressor is operating in the entire unit and the target percent capacity of the compressor drops below the Hot Gas Bypass ON setpoint. If the target percent capacity then climbs above the Hot Gas Bypass OFF setpoint, the solenoid id turned off. Typical setpoints are 45% for Hot Gas Bypass ON setpoint and 80% for Hot Gas Bypass OFF setpoint.

4.1.23. Hot Gas Injection Control (R134a Units)

Hot gas injection control is supplied to the R134a unit as a standard feature. An output from the controller controls the solenoid. The solenoid is turned on if only one compressor is operating in the refrigerant circuit and the target percent capacity of the compressor drops below the Hot Gas Injection ON setpoint. If the target percent capacity then climbs above the Hot Gas Injection OFF setpoint, the solenoid id turned off. Typical setpoints are same as hot gas bypass control setpoints.

4.1.24. Electronic Expansion Valve (EEV) Control (Optional)

When compressor starts, the electronic expansion valve will stay closed until suction pressure falls to Pumpdown setpoint. Then the controller energizes a contact to enable EEV controller. By measuring the suction pressure and temperature, the EEV controller modulates EEV to maintain suction superheat at setpoint.

4.1.25. Vapor Injection Solenoid Control (Optional)

The vapor injection solenoid is energized when the compressor is operating and its percent capacity is higher than the Vapor Injection ON setpoint (typically 80%). The vapor injection solenoid is turned off when compressor is stops or when its percent capacity falls below Vapor Injection OFF setpoint (typically 75%). This option applied to horizontal screw compressor only.

4.1.26. Anti-Freeze Control (Circulating Pump and Heater Control) (Optional)

Anti-Freeze control is furnished to prevent water in cooler to be frozen by low surrounding temperature. Heater is on when ambient temperature is lower than ON setpoint (typically 35 °F) and unit if off. Circulating pump will be started when heater is on and chilled water flow switch is opened. Heater will be turned off when ambient temperature is higher than OFF setpoint (typically 38 °F) or the unit is on. Circulating pump will stop three minutes after heater is off, or stop immediately when flow switch is closed.

4.2 SAFETY AND ALARMS

The Vision 2020i controller performs the following safety protection on screw compressor chillers.

- 4.2.1. Low Pressure Limiting
- 4.2.2. High Pressure Limiting
- 4.2.3. Amp Limiting
- 4.2.4. Low Pressure Safety
- 4.2.5. High Pressure Safety
- 4.2.6. Low Differential Pressure Alarm
- 4.2.7. Evaporator Freeze Safety
- 4.2.8. Low Oil Safety
- 4.2.9. Sensor Failure Alarm
- 4.2.10. No-Stop Alarm
- 4.2.11. External Shutdown Indication (No Run Alarm)
- 4.2.12. Compressor Starter Alarm
- 4.2.13. Low Chilled Water Flow Alarm
- 4.2.14. Power Loss Reset

A description of each of these safety and alarms follows:

4.2.1. Low Pressure Limiting

This function prevents the unit from tripping at low evaporator refrigerant pressure. If evaporator pressure drops below Low Pressure Hold setpoint, the compressor will hold and load command will be bypassed. If evaporator pressure drops further below Low Pressure Unload setpoint, the compressor will unload continuously, hold and load command will be bypassed. After the evaporator pressure rises above the Low Pressure Hold setpoint, the compressor will operate based on the unit target. Typical setting for Low Pressure Hold setpoint is 62PSI and Low Pressure Unload setpoint is 60PSI, for R22 units.

4.2.2. High Pressure Limiting

This function prevents the unit from tripping at high condenser refrigerant pressure. If condenser pressure rises above High Pressure Hold setpoint, the compressor will hold and load command will be bypassed. If the condenser pressure rises further above High Pressure Unload setpoint, the compressor will unload continuously, hold and load command will be bypassed. After the condenser pressure drops below the High Pressure Hold setpoint, the compressor will operates based on the unit target. Typical setting for High Pressure Hold setpoint is 240PSI and High Pressure Unload setpoint is 245PSI, for R22 water-cooled units.

4.2.3. Amps Limiting

This function prevents the compressor from tripping at overload. If the compressor amperage rises above Amps Hold setpoint, the compressor will hold and load command will be bypassed. If the compressor amperage rises further above Amps Unload setpoint, the compressor will unload continuously, hold and load command will be bypassed. After the compressor amperage drops below the Amps Hold setpoint, the compressor will operates based on the unit target. Typical settings for Amps Hold setpoint 1.1XRLA, and Amps Unload setpoint is 1.21XRLA. (RLA = Rated Load Amps)

4.2.4. Low Pressure Safety

This function protects the unit from operating at abnormally low evaporator refrigerant pressure. When the evaporator pressure of a refrigeration circuit drops below the Low Pressure Cutout setpoint, a time delay is initiated. If the pressure stays below the setpoint during the time period, or pressure drops below cutout setpoint minus deadband, all compressors on the circuit will be locked off immediately and the low pressure alarm will be recorded by the controller. The time delay is 45 seconds for flooded units, 60 seconds for DX units. The deadband is 5 psig for flooded units, 10 psig for DX units.

Reset by pressing the 'Reset Alarm' button on terminal display of the controller.

4.2.5. High Pressure Safety

This function protects the compressor from operating at abnormally high discharge refrigerant pressures. The controller will shut down the compressor when condenser pressure reaches the high pressure set point, and turn on the alarm indicator lamp on the control box. The high discharge pressure alarm will be recorded by the controller. Reset by pressing the 'Reset Alarm' button on terminal display of the controller.

4.2.6. Low Differential Pressure Alarm

For proper lubrication, a screw compressor requires a 30 psid (for R22) differential pressure between condenser and evaporator pressures. If the differential pressure is less than 30 psid (for R22) for more than 3 minutes while a compressor is operating, all compressors in the same refrigerant circuit will be shut down. The controller will store the low differential pressure alarm code and turn on the alarm light. The 'Reset Alarm' key must be pressed to clear the alarm.

4.2.7. Evaporator Freeze Safety

If the leaving chilled water temperature drops below the freeze setpoint, the controller will shut down the unit and store the freeze alarm. After solving the problem, press 'Reset Alarm' on terminal display of the controller to clear the alarm.

4.2.8. Low Oil Safety

A standard oil level sensor is located in each compressor. If low oil indication (digital input is OFF) persists for 60 seconds during compressor operation, the controller will then shut down the compressor. The status of the oil level sensor can be seen on the terminal display.

Failure is indicated on the alarm pilot light. The low oil alarm code will be recorded by the controller.

4.2.9. Sensor Failure Alarm

If the controller measures an analog sensor (temperature, pressure, or Amp sensor.) the reading is beyond its measuring range, the associated compressors are shutdown. The controller then stores the alarm code corresponding to the sensor alarm. A sensor alarm indicates a problem in the analog measurement system.

4.2.10. No-Stop Alarm

If the controller turns off a compressor, but the compressor digital input does not turn off, a No-Stop alarm is generated. The controller will turn off the control power relay which disables all compressor control circuits and will turn on the alarm light. This alarm indicates a wiring or hardware error.

4.2.11. External Shutdown Indication (No Run Alarm)

A No-Run alarm is generated if the controller has starts a compressor but the compressor is not running and no amps reading. The controller determines that the compressor is not operating if the associated digital input from the compressor contactor is ON, but the amps of the compressor is less than 20 amps. If No-Run alarm is occurred, monitor the amps sensor input and external safety devices to see which is producing the fault.

4.2.12. Compressor Starter Alarm

Compressor starter alarm is generated if the controller tries to start (run) a compressor but the associated digital input from the compressor contactor does not indicate that the contactor is pulled in (digital input stays OFF), If compressor starter alarm is occurred, monitor the digital input (from starter) to troubleshoot the problem.

4.2.13. Low Chilled Water Flow Alarm

A No Flow alarm will be generated if a compressor control point is ON and the flow switch digital input is OFF all compressors will be locked off and the alarm light turned on. After resolving the problem, press "RESET ALARM".

4.2.14. Power Loss Reset

A "Power Loss" setpoint is included in Vision 2020i controller to give the customer the option of automatic or manual reset on a power failure to the unit. If the "Power Loss" setpoint is set to "Auto", the unit will reset automatically. If the "Power Loss" setpoint is set to manual, the controller will lock the unit off on a power failure and store the Power Loss alarm code. "Reset Alarms" must be pressed to reset the alarm.

4.3 EXTERNAL CONTROL FUNCTION AND SAFETY PROTECTIONS

The following control function and safety protections are standard in Dunham-Bush screw compressor chillers.

- 4.3.1. High Oil Temperature Thermostat
- 4.3.2. Overload Protector
- 4.3.3. Phase Control Relay (PCR)

A description of each of these safety and alarms follows:

4.3.1. High Oil Temperature Thermostat

A thermostat is located in each compressor which will open the compressor run circuit if oil temperature exceeds 203°F. The high oil temperature pilot light will indicate an excessive oil temperature and a No-Run alarm will be recorded by the controller. Reset is activated by pressing the 'Reset Alarm' button on terminal display.

4.3.2. Overload Protector

A solid state overload protects each compressor by three phase current monitoring to prevent high current draw. The trip setting is factory set and is reset by pressing button on overload after correcting problem. The 'Reset Alarm' button on controller must also be pressed to clear the alarm. A No-Run alarm is stored in the controller.

4.3.3. Phase Control Relay (PCR)

The PCR protects the unit from the following electric supply malfunctions: undervoltage, phase reversal and single phasing. If the PCR trips, a control relay (1CR) will de-energize and open the control circuit. A green LED indicates presence of power supply. The yellow LED indicates a good voltage supply. The power loss setpoint is factory set to "Auto" to allow automatic start after PCR failure. Compressor will not start for 15 minutes after failure. To select manual reset, set power loss setpoint to "Manual". In this case, a power loss alarm will be stored by the controller and 'Reset Alarm' must be pressed to start.

5.0 DBLAN & MASTER-SLAVE CONTROL

5.1 DBLAN NETWORK

5.1.1 General Descriptions

As mentioned earlier, the **Vision 2020i** controllers can be connected to DBLAN local network, allowing the communication of data and information from one location (node) to another.

The **Vision 2020i** terminals can monitor the control variables (temperature, pressure, alarms) from one or more boards. If one or more terminals are disconnected or malfunctioning, the control program continues to function correctly on each **Vision 2020i** controller.

Generally, the application program can monitor the status of the network and intervene as a consequence to ensure the continuity of the control functions.

All the versions of the **Vision 2020i** controller can be connected in a local DBLAN network. However, the software program may need modifications based on applications of the project.

All the devices connected to the DBLAN network are identified using their own individual address. As the terminals and the Vision 2020i I/O boards use the same type of address, terminals and Vision 2020i boards can not have the same identifier. The values which can be selected for the address range from 1 to 32 for the terminals and from 1 to 31 for the I/O boards. For addresses configurations, please refer to section 3.2.

5.1.2 DBLAN Electrical Connections

Connection between boards in a DBLAN network is carried out using an AWG20/22 shielded cable, made up of a twisted pair plus shield. The boards are connected in parallel, with terminal J11 as the reference.

Figure. 5.1.1 shows a diagram of a number of boards connected in a DBLAN network and powered by different transformers (with G0 not earthed). Typical application: a number of boards inside different electrical panels.

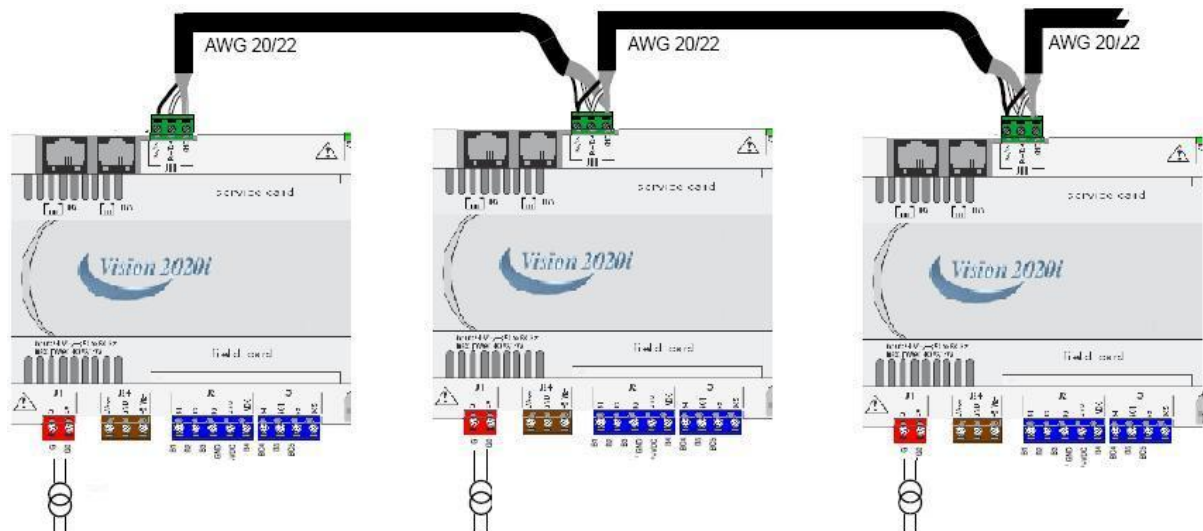


Figure 5.1.1

Figure 5.1.2 shows a diagram of a number of boards connected in a DBLAN network and powered by different transformers with the same earth reference. Typical application: a number of boards inside different electrical panels.

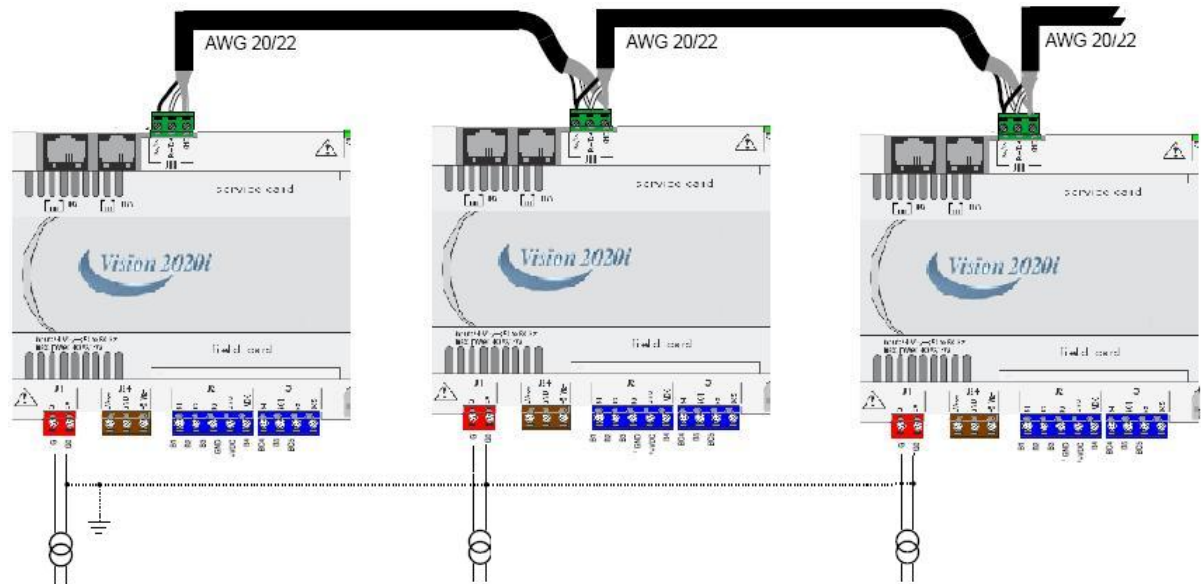


Figure 5.1.2

Important Warnings

- The ground connection must be made to the same ground (same ground pole, for all the **Vision 2020i** boards);
- With these configurations, Class II safety transformers must be installed.

5.2 Master-Slave Control

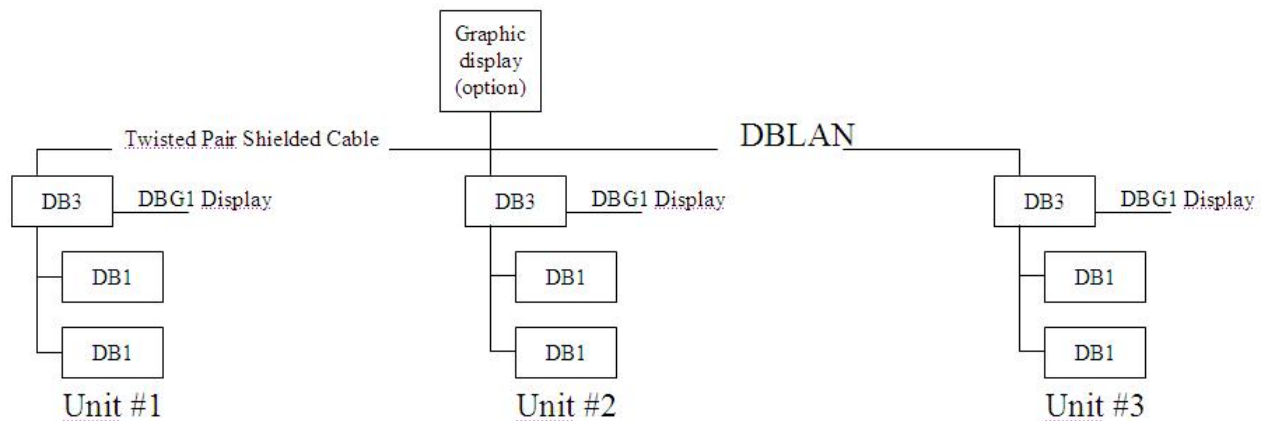
5.2.1 General Descriptions

The optional master/slave control sequence is used to sequence multiple chillers in one installation according to the building load demand. It also controls the dedicated chilled water pump or motorized valve.

Vision2020i Controller offers this feature with minimized field wiring cost compare to conventional method that involves lots of hardware cost. It is carried out this control function via the advanced DBLAN communication bus to implement the network management for multiple chillers lead/lag communication, sequencing and monitoring.

5.2.2 Principle Of Operation Via DBLAN Communication Bus

Example: 3 chillers network with 2 units on duty and 1 unit standby



Notes

- Each chiller has a stand-alone master DB3 board and dedicated display (DBG1)
- Each chiller DB3 will be connected to DBLAN network through J11 connector using twisted pair shielded cable
- The chiller lead/lag selection can be determined by
 - Manual lead/lag setpoint
 - Schedule and holiday setup
 - Alarm conditions

- d) The lead/lag selection determine the chiller operation sequence as follows, The following is an example of three chillers network with two units on-duty and one unit standby.

Lead chiller selection	Normal chillers operation sequence	When DBLAN fails
1	1 & 2 on duty 3 standby	1, 2 & 3 on duty (if unit enable are ON)
2	2 & 3 on duty, 1 standby	1, 2 & 3 on duty (if unit enable are ON)
3	1 & 3 on duty, 2 standby	1, 2 & 3 on duty (if unit enable are ON)

- e) If the lead/lag selection is changed over to a different chiller, the sequence of operation will be rotated
 f) Each chiller will use a network address setpoint to determine individual chiller network address
 g) Each chiller will require a dedicated chilled water pump or motorized valve digital output, unit enable and chilled water flow status digital inputs as well as enable next output command.
 h) Master-slave control can be extended up to maximum six chillers in the DBLAN network.

5.2.3 Sequence of Operation

- When the customer enable input is 'on' to start the lead unit, the chilled water pump starter or motorized valve control point will close and water will start to flow through the evaporator, this will activate the flow switch. The flow switch and water pump status are interlocked and feedback as digital input to the chiller and upon receipt of a valid 'on' signal, the lead chiller will begin to execute its running program.
- The controller will start and load the compressor(s), upon both compressors achieving full load; it will send an output signal via the DBLAN to enable second unit (lag 1)
- The second unit will now command its chilled water pump to start if the customer unit enable is activated. The second chiller will start and load the compressor(s) until it reaches full load
- When the second chiller or lag 1 unit reaches full load, the third chiller will not starts unless all three chillers are set to be on-duty. However, the third chiller will starts if any of the on-duty chiller is tripped by alarm.
- If the leaving water temperature falls below setpoint, all of the chillers will begin to unload evenly.
- If the load drops below 40% total capacity, enable next signal to second chiller will be disabled, and second chiller will stop. The master chiller will load up to compensate if necessary. The pump for second chiller will be shut off.
- As the load demand falls, the master chiller will unload continuously to cycle off the second compressor, and finally the entire unit.
- Each unit in the network can monitor the operation of other units via DBLAN. If the master unit is having critical alarm, the lag 1 will take over as the master unit automatically.
- In order to enable next unit, the following conditions must met
 - Leaving water temperature (LWT) $\geq$ (LWT Setpoint + Next ON deadband), typical setting for LWT setpoint is 44 °F and Next ON DeadBand is 5 °F (both are adjustable).
 - When the lead unit's packaged capacity is higher than "Next on setpoint", typical setting is 75%. For example, when capacities of both compressors are higher than 75% or either one compressor is locked out by alarm.
 - When conditions (a) & (b) fulfilled, an enable next time delay of 3 minutes (adjustable) will be initiated. Upon completion of this timer, the next unit will be enabled.
- In order to off next unit, the following conditions must met
 - Leaving water temperature (LWT) $\leq$ (LWT Setpoint + Next OFF deadband), typical setting for Next OFF DeadBand is 1 °F (both are adjustable).
 - Unit Capacity $\leq$ OFF Capacity setpoint + Net Offset. Typical settings for OFF Capacity setpoint is 40%, and Net Offset is 5%.

Please refer to the Appendix for the master-slave control sequence flow chart.

6.0 WINLOAD32 & DATALOGGING

6.1 WINLOAD 32

6.1.1 Introduction

WinLoad32 is the software for PCs that manages communication between the PC and the DB3 controllers (DB1, DB2 and DB3).

The following operations can be performed using this connection between the PC and the controller:

- Update the firmware and the software of the controller;
- Acquire data from the board, such as the configuration parameters and the data logged;
- Define the logic for logging the events saved on the board.

The following conventions have been adopted to indicate the direction of transfer of the files:

PC	→	UPLOAD	→	DB3 Controller
	←	DOWNLOAD	←	

6.1.2 Connection of Converters To Vision 2020i Controller

Power supply for controller must be turned off before connects it to any of the converter. For different type of converter, different method of connection is used.

a. RS232 – RS485 Converter

Connection/communication between controller and this converter can be done in two ways:

- Using 6 cores telephone cable and connect it to J10 on controller
- Using AWG 20/22. A MODBUS serial card shall be inserted into SERIAL CARD slot on controller. Connect output of converter to the MODBUS serial card using AWG 20/22. Besides, a DC power supply shall be supplied to the converter.

b. USB – RS485 Converter

- i. Using AWG 20/22 cable

Connect the output of converter to MODBUS serial card using AWG 20/22. The MODBUS card shall be inserted into SERIAL CARD slot on controller.

- ii. Using RJ10 (6 cores phone cable)

Connect the output of converter to J10 on controller using a RJ10 cable (6 cores phone cable)

6.1.3 Uploading Program/DataLog File to Controller

- i. After connects converter to controller, turn on the controller and run WinLoad program.
- ii. pCO address shall be set by refer to dip switch setting on the controller/unit number. Serial port in WinLoad is determined by type of converter used in this application. **Serial port** shall be set to 1 if RS232 – RS485 converter is used. Else if USB – RS485 is used, **Serial port** shall be set to the same port number where the converter is plugged. (Figure 6.1.1)

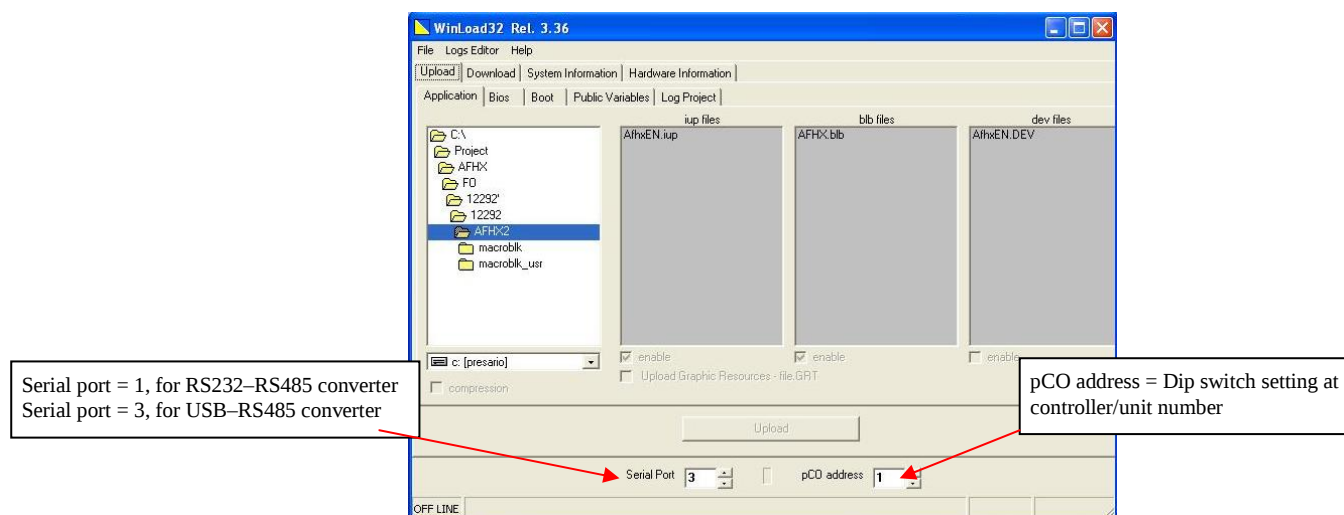


Figure 6.1.1

- iii. When WinLoad starts to communicate with controller, a password is required to access into the controller. The password is 5907 or 0032 (Figure 6.1.2). When WinLoad is On-Line, click on the “Upload” column. To upload application program onto the controller, column “Application” shall be selected. In this section, two files shall be selected; one is .iup file and another .bin file. (Figure 6.1.3)

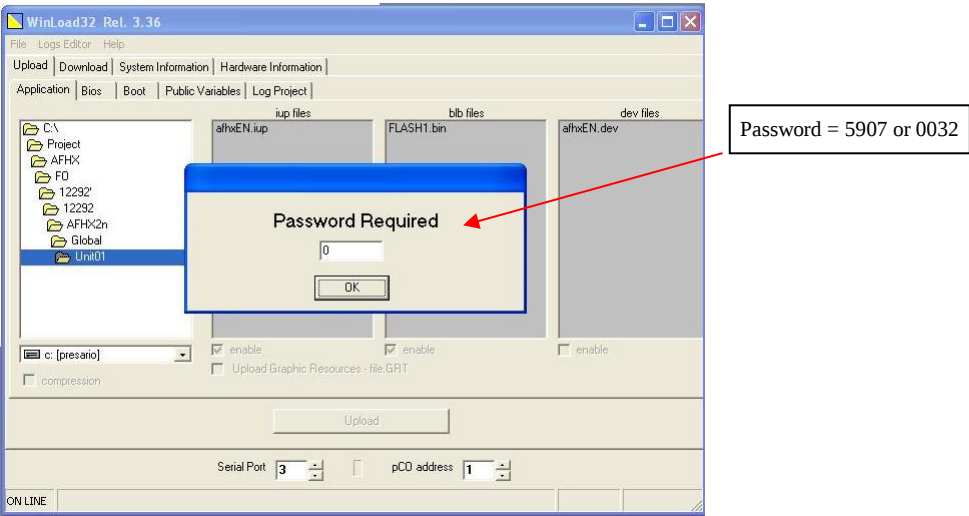


Figure 6.1.2

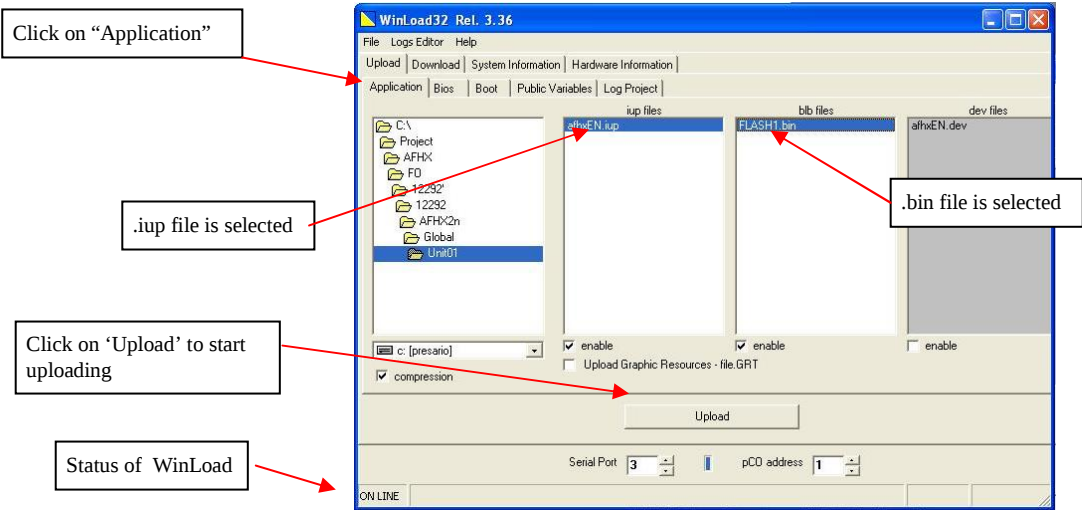


Figure 6.1.3

- iv. Click on “Upload” to start uploading. (Figure 6.1.3)
- v. Uploading application program is progress (Figure 6.1.4) and uploading is done (Figure 6.1.5).

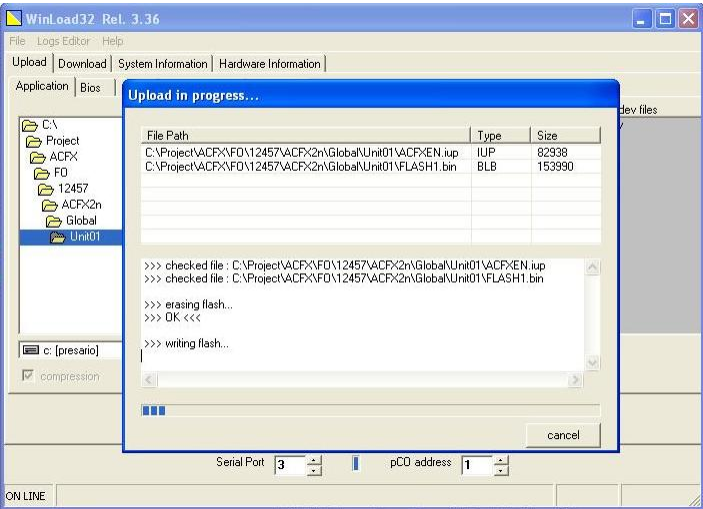


Figure 6.1.4

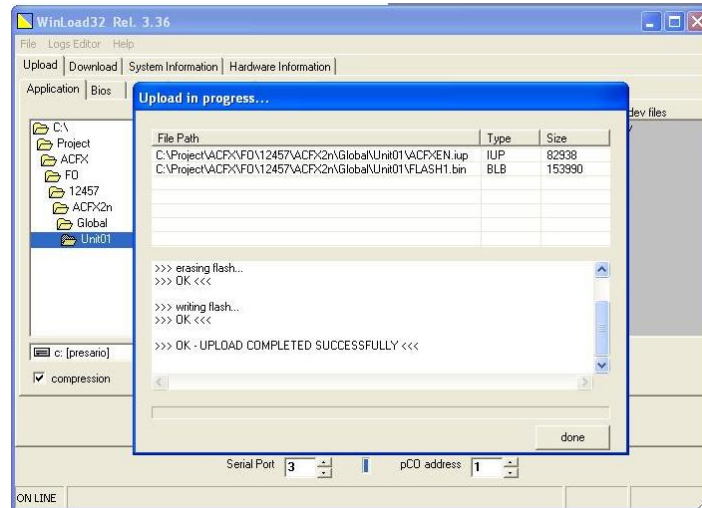


Figure 6.1.5

- vi. To upload data log file to controller, column “Public Variables” shall be selected. A .pvt file shall be selected and upload it into controller. (Figure 6.1.6).

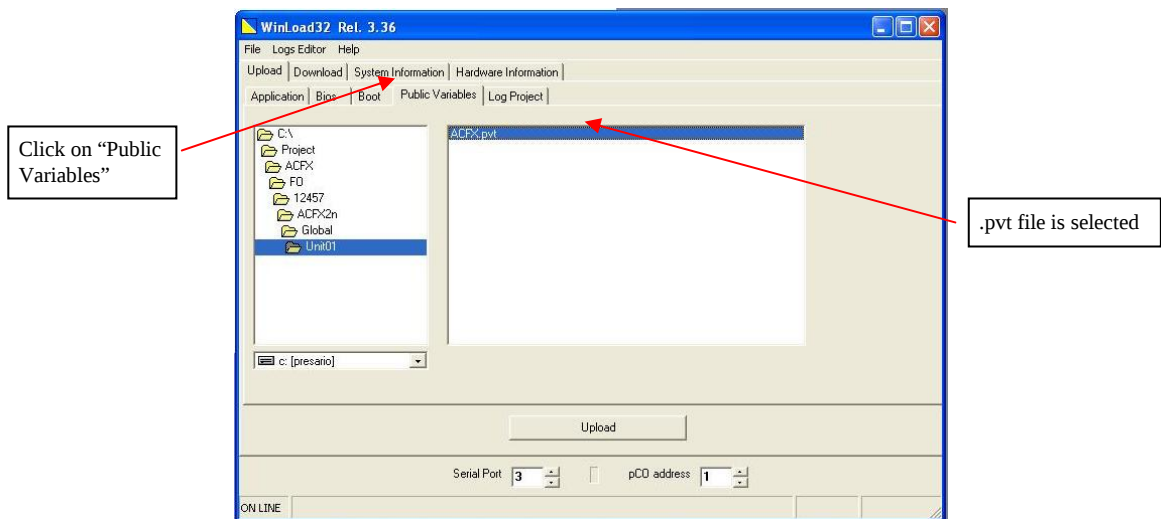


Figure 6.1.6

- vii. The next step is to select column “Log Project” and upload a .LCT file from this column. (Figure 6.1.7)

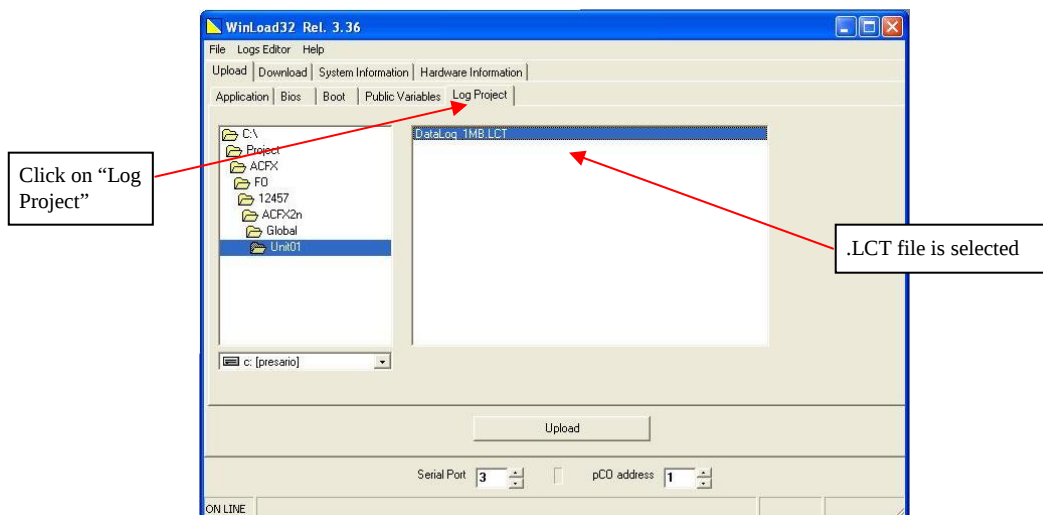


Figure 6.1.7

- viii. After this .LCT is completely uploaded, data log file is uploaded to the controller successfully.

6.2 **DATALOGGING**

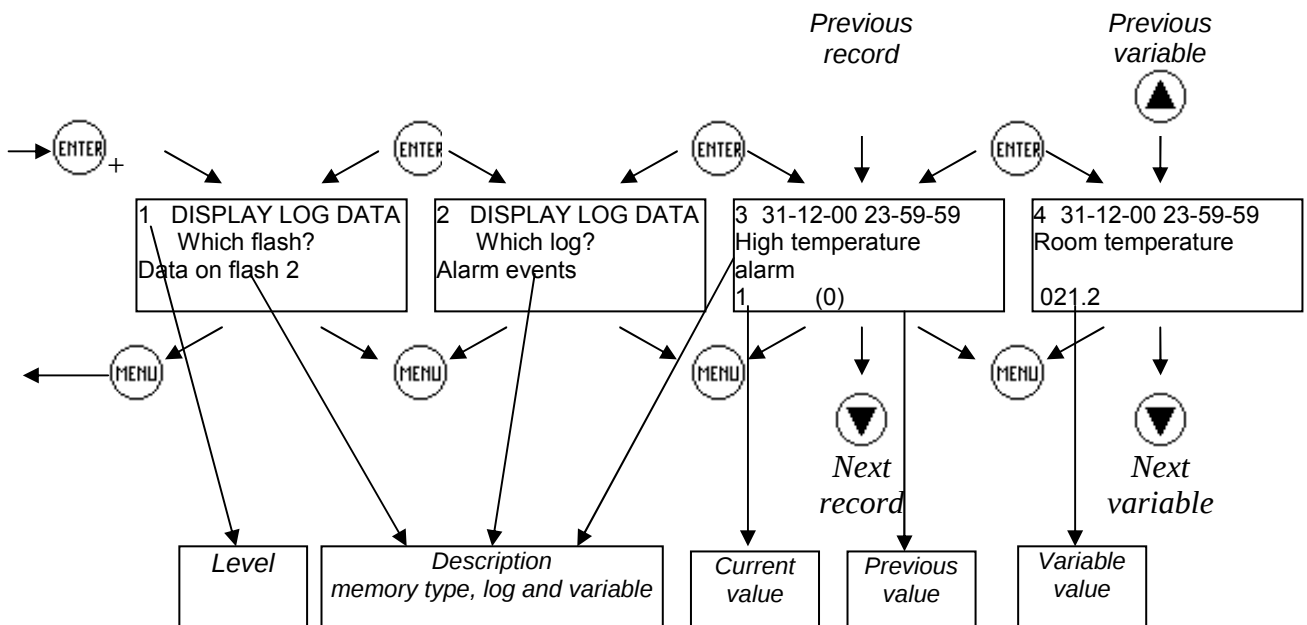
There are two ways to read the data log from the Vision 2020i controller.

- A) Reading Data Log from Terminal Display Using Keypad
- B) Reading Data Log from WINLOAD using a local connection
- C) Reading Data Log from WINLOAD using a remote connection

6.2.1 **Reading from terminal display using keypad**

This is done using the following buttons:

- i. To start reading the logs: ENTER + ALARM
- ii. To navigate around the screens: MENU, ▼, ▲, ENTER.
- iii. There are 4 types of screens:
 - Type 1 (Level 1): Select the memory where the log is saved.
"Flash 2": memory expansion.
"Flash 3": internal memory.
Press ▼/ ▲ to select the memory.
Press ENTER to move to level 2.
Press MENU or ESC to exit the display of the logs.
 - Type 2 (Level 2): Select the log.
Press ▼/ ▲ to select the log.
Press ENTER to move to level 3.
Press MENU or ESC to move to level 1.
 - Type 3 (Level 3): Display the data of the last event saved.
The first event displayed when entering this level is the most recent one generated.
Press ▼/ ▲ to display the following or previous event.
Press ENTER to move to level 4.
Press MENU or ESC to move to level 2.
 - Type 4 (Level 4): Display the variables saved together with the event.
Press ▼/ ▲ to display the following or previous variable.
Press MENU or ESC to move to level 3.
- iv. The number of the level is displayed in the top left.
- v. The structure of the screens that shows the data saved cannot be customized.
- vi. If there is only one memory installed to save the data, the screen corresponding to level 1 is not displayed
- vii. If only one log has been configured, the screen corresponding to level 2 is not displayed



6.2.2 Reading From WINLOAD Using A Local Connection

The connection between the PC and the controller is the same used to download the application to the controller. Therefore, a RS 485 serial card shall be inserted to the Vision 2020i controller to allow this feature.

This function allows all the data relating to a log to be downloaded and saved in a text format file that can be opened using Excel (CSV format).

The data cannot be download for a specific period of time or one log only.

To download the data saved:

- i. Open WinLOAD, key-in password and get WinLoad on-line with controller. (Figure 6.1.2)
- ii. Select the "Download" tab and select "LOG DATA". Then click the "Download" button. (Figure 6.2.1)

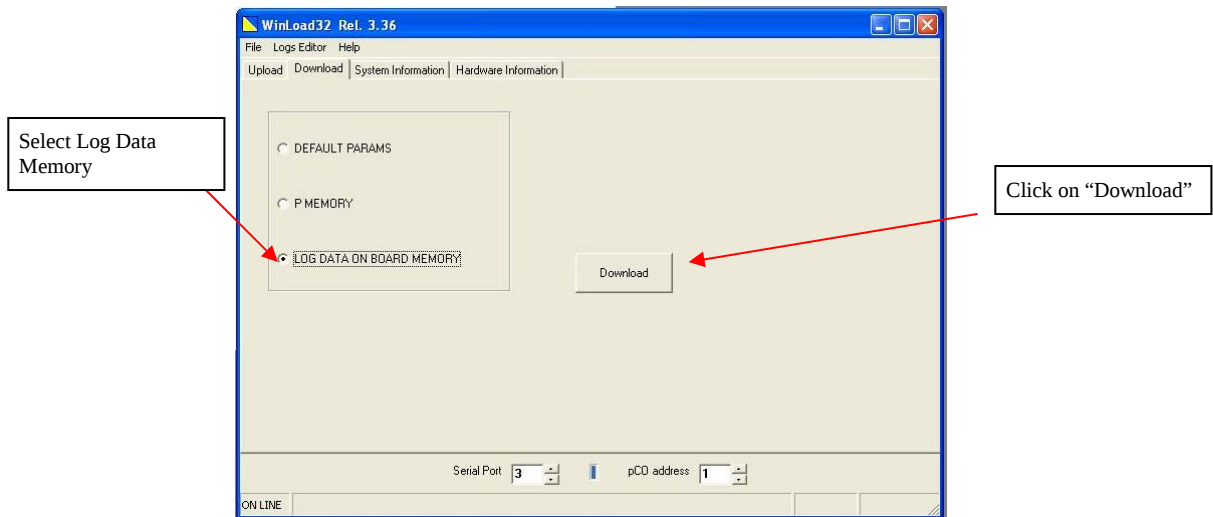


Figure 6.2.1

- iii. Enter the name of the file used to save the data downloaded from the controller. Each directory can only store 1 data log file. (Figure 6.2.2 & 6.2.3)

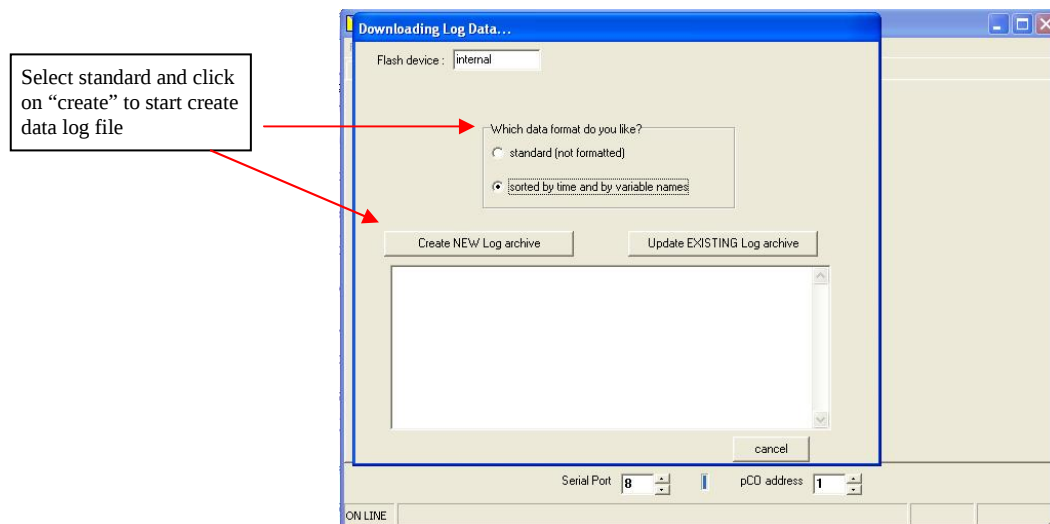


Figure 6.2.2

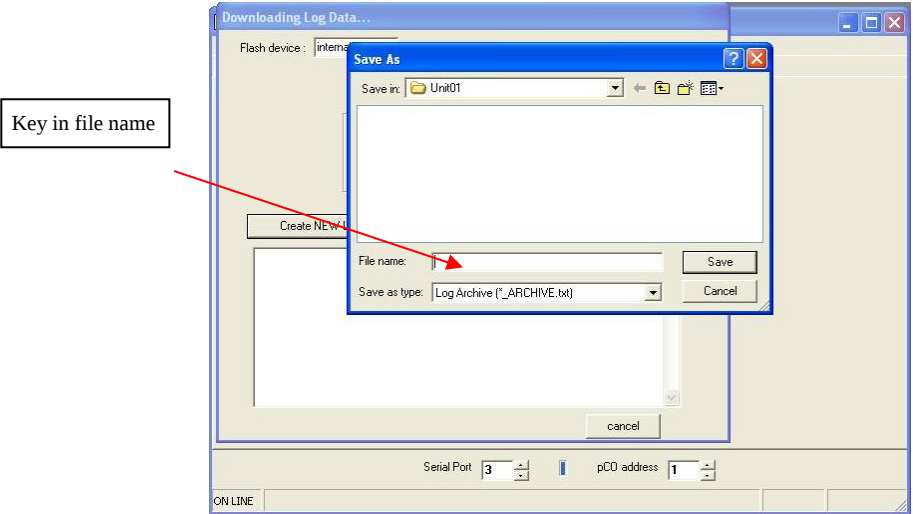


Figure 6.2.3

iv. Download in progress (Figure 6.2.4) and downloading is done. (Figure 6.2.5)

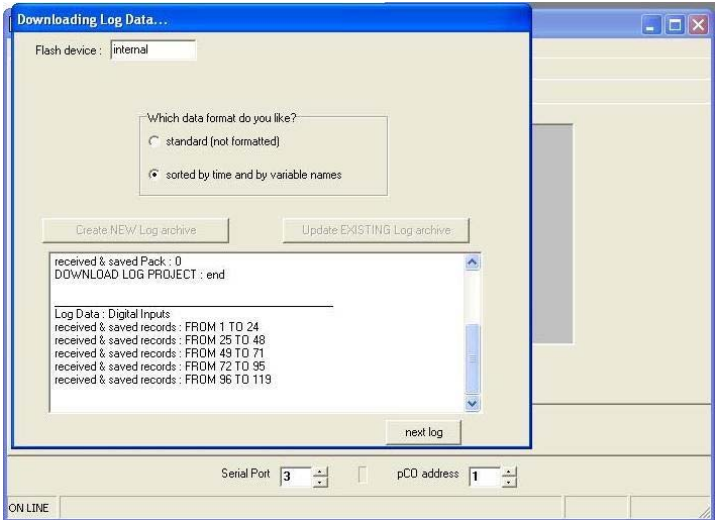


Figure 6.2.4

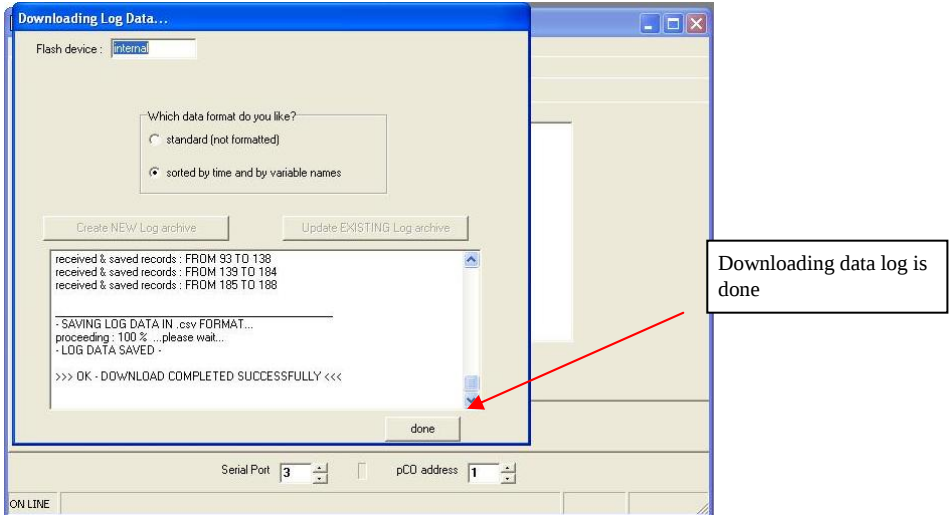


Figure 6.2.5

6.2.3 Reading From WINLOAD Using A Remote Connection

As above, except for the fact that the connection between the PC and WINLOAD is made via modem. Therefore, a RS232 modem card shall be inserted to the Vision 2020i controller and a serial modem and telephone line shall supply to the unit to allow this feature. Besides. The BMS protocol must set to "Modem" option. When reading the logs, the application and the logs themselves will continue to operate.

To download the data saved through a remote connection:

- i. Open WinLOAD program. A warning message may be pop-up, but this all right if a remote connection is used. (Figure 6.2.1)

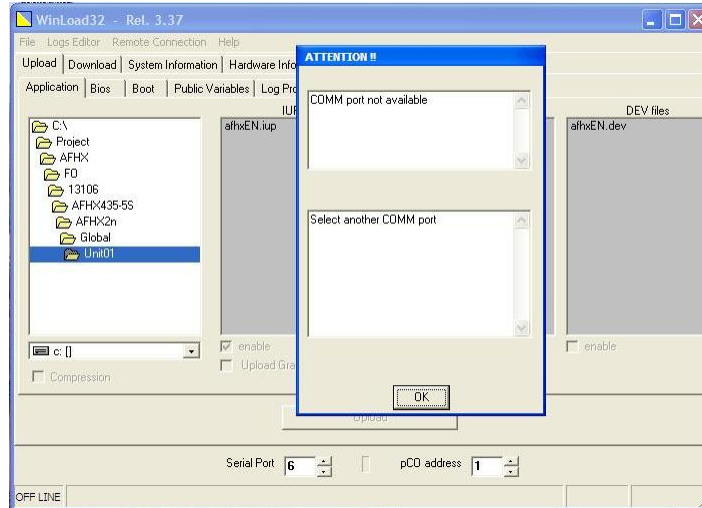


Figure 6.2.1

- ii. Connects the PC to a telephone line via a serial modem.
- iii. Click on "Remote Connection" and "Connect" to start the remote connection. (Figure 6.2.2)

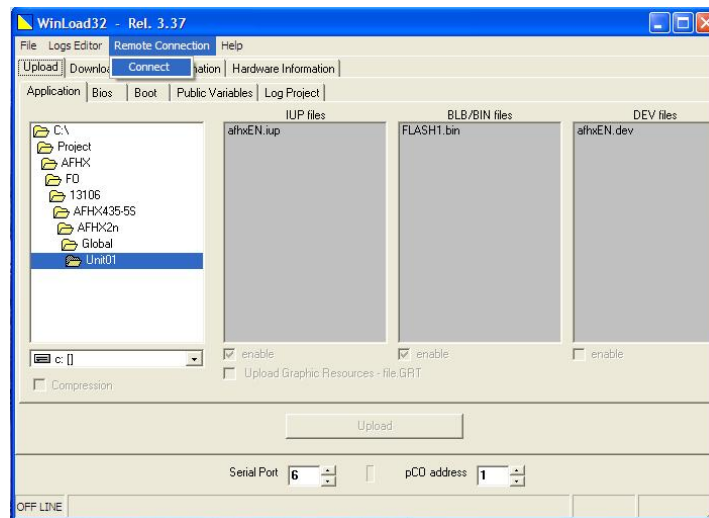


Figure 6.2.2

- iv. A "Connect" window will pop up. Select modem at key number to call. "Password" is refer to modem password which has been set in the controller. "IDENT" refer to "IDENT" setting in the controller. Click on "CONNECT" to start dialing to the unit. (Figure 6.2.3)

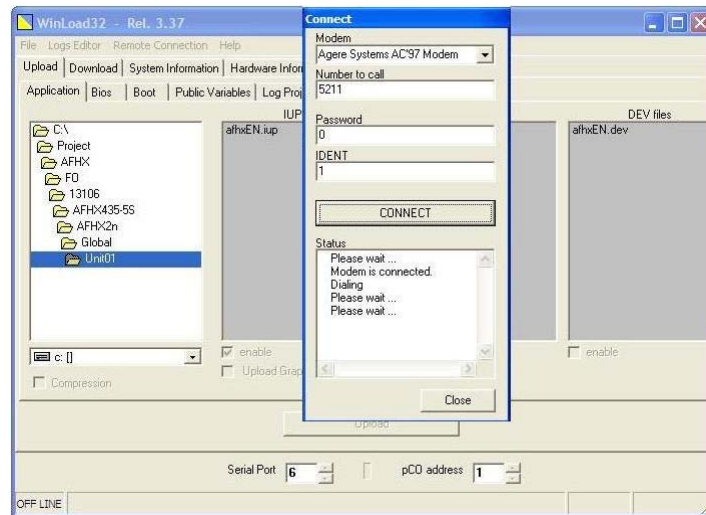


Figure 6.2.3

- v. After the line is connected, everything is the same as with local connection.
- vi. After the downloading process is done. Click on “Remote Connection” and “Hang Up” to disconnect the line. (Figure 6.2.4)

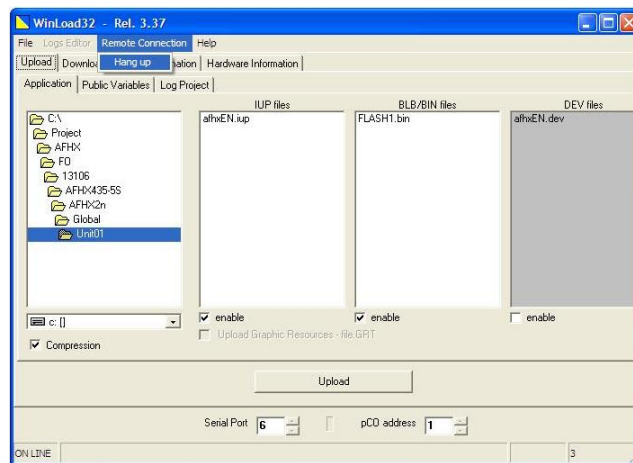


Figure 6.2.4

7.0 SMART KEY

7.1 SMART Key For Vision 2020i Controllers

The SMART key is an electronic device used to program and service the Vision 2020i controllers. The SMART key simplifies the transfer of data between the controllers installed and a personal computer by exploiting the high capacity flash memory for storing software applications, Bios and variable logs.

The Vision 2020i controller is connected directly via the telephone connector using cable supplied, while to transfer the data to a personal computer, the USB adapter (P/N: 4030004389) is required. The power supply comes either via the USB port on the PC or from the controller, therefore no external power supply is needed.

7.2 SMART Key Programming by Personal Computer

The different operating modes described in the table below can be configured using a program on the PC. The same program can also load the software to the key or transfer the logged data from the Vision 2020i to disk.

Type	Function	Mode Button
B	Update software from key to Vision 2020i	Disabled
C	Copy software from Vision 2020i to Vision 2020i	Switches the key from write mode to read mode
D	Read logged data	Disabled
E	Read logged data and software from Vision 2020i	Disabled
G	Copy software from Vision 2020i to Vision 2020i and read logged data	Switches the key from write mode to read and read logged data mode

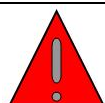
When the key is connected to the personal computer, the symbols have the following meanings:

	Flashing Alternating	Awaiting the connection to the PC During the connection to the PC, indicates that data transfer is in progress
---	-------------------------	---

“pCO Manager” software is needed for communication between PC and smart key. A USB converter (P/N: 4030004389) is also needed for this application. Please refer to section 7.5 for “pCO Manager” software.

7.3 Use When Connected To The Vision 2020i

Switch off the Vision 2020i, remove any peripherals present in the DBLan network and plug the key into the telephone connector of the controller. When switching on again, all the symbols light up momentarily and the buzzer emits a beep. Then wait a few seconds before the key is operational. This waiting phase is indicated by the flashing of the  symbols. At the end, the controller enters programming mode and the start button, now on steady, can be pressed to start the data transfer.

	Important: If the key is type “B”, “C” or “G” (in write mode), pressing the start button immediately deletes the software already loaded on the Vision 2020i.
	Important: The key must not be removed while a write operation is in progress to the key, as the file being transferred will be lost and the corresponding space is not restored. To restore the original capacity, all files will need to be deleted. If the key is type “C” or “G”, simply perform a new application read operation.

7.4 Meanings of the buttons/symbols

	Flashing: the key is connecting to the Vision 2020i, during this phase, which may last a few seconds, the start Button is disabled.
start	Flashing: the key has detected the Vision 2020i and is checking the access right.
start + 	On steady: pressing the start button starts writing the software to the Vision 2020i
start + 	On steady: pressing the start button start reading the software from Vision 2020i
start + 	On steady: pressing the start button starts reading the logs from the Vision 2020i
mode	On steady: for key type “C” or “G”, pressed for 1 second switches from read to write

If the key is type “C” or “G”, pressing *mode* button for 1 second switches from read to read logged data (only “G”) or write, the symbols  (write to Vision 2020i),  (read from Vision 2020i),  (read logged data) reflect the selected status. If the key is not type “C” or “G”, the button is disabled and off.

The *start* button starts the read or write operation, indicated by the flashing of the corresponding symbol ( or ) at a frequency proportional to the progress of the operation. When the operation is completed, the buzzer sounds intermittently for 2 seconds. Pressing the *start* button again, the buzzer sounds without repeating the operation; to repeat the operation, the key must first be unplugged.

In the event of error, the corresponding symbol  comes on in combination with the other LEDs. The table below shows the causes of the problem.

7.4.1 Errors before pressing *start*

 +  + 	Flashing	Communication error: no response from the Vision 2020i or alternatively Firmware version of the key incompatible
 + <i>mode</i>	Continuous	Password error
 + <i>mode</i>	Flashing	Type of key incompatible
 + 	Continuous	The key is missing one or more required files (empty memory; no kit for the connected Vision 2020i type)
 +  + <i>start</i>	Continuous + <i>start</i> flashing	Incompatibility between the key software and Vision 2020i hardware
 +  + <i>mode</i>	Continuous + <i>mode</i> flashing	Incompatibility between Vision 2020i application and hardware
 +  + 	Continuous	No logged data present on the Vision 2020i
	Continuous	Type of key not programmed

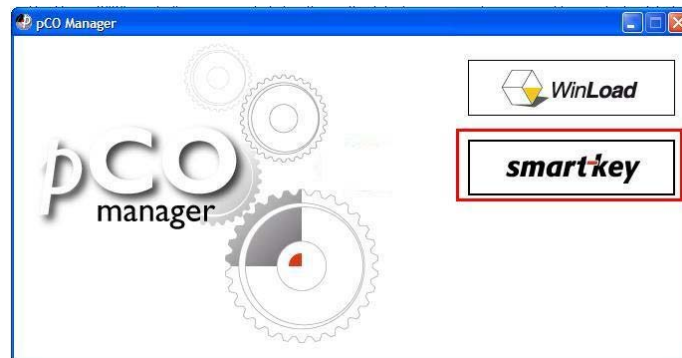
7.4.2 Error after pressing *start*

 + <i>start</i> +  + buzzer	Flashing and buzzer intermittent	The write operation has failed
 + <i>start</i> +  + buzzer	Flashing and buzzer intermittent	The read operation has failed
 + <i>start</i> +  + buzzer	Flashing and buzzer intermittent	The read logs operation has failed
 +  + 	Continuous flashing + 	Incompatibility between log configuration and Vision 2020i hardware (no dedicated flash). This error does not damage the writing of the remaining files
 + 	Continuous	Insufficient space to read logged data
	Flashing	General error

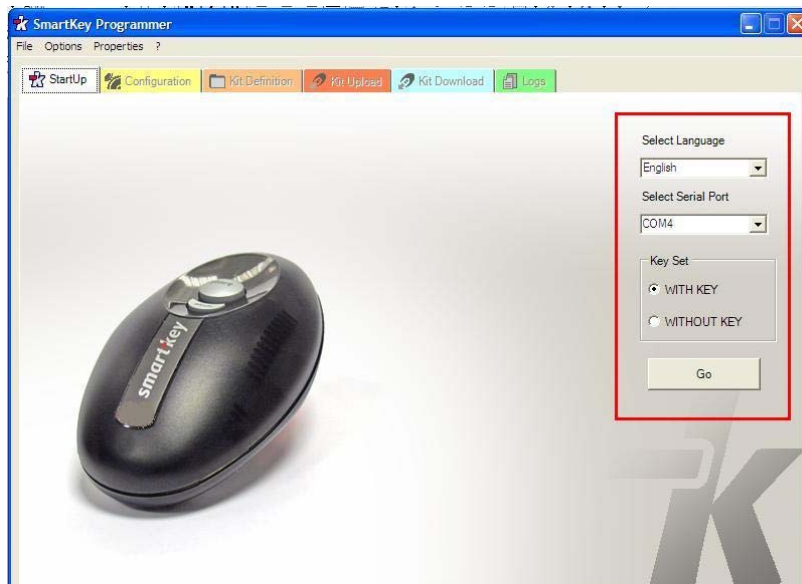
7.5 **pCO Manager**

pCO Manager software is used to configure the Smart Key, upload program files, or download data log files from Smart Key. Following are procedure to configure and upload program files to Smart Key.

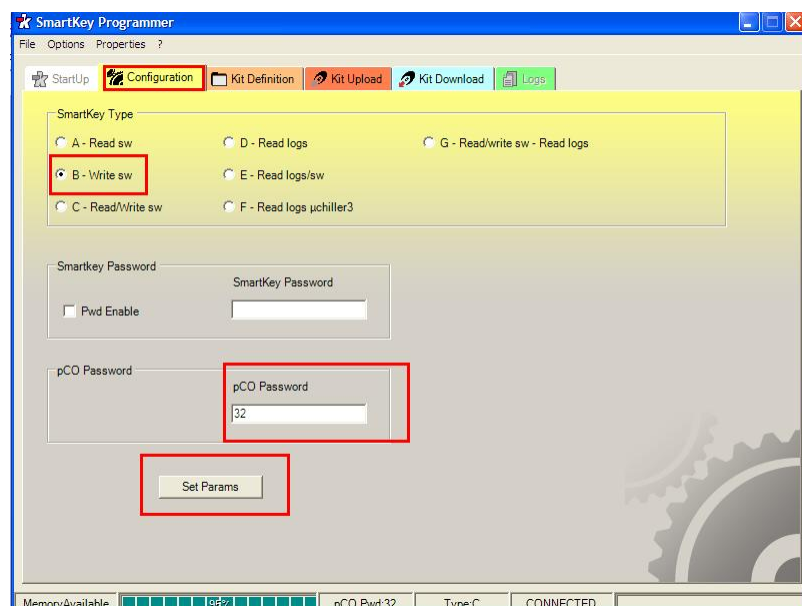
- a. Connects the USB converter to PC and connect the smart key. Start program “pCO manager”. Click on “Smart key” to proceed with configurations for smart key.



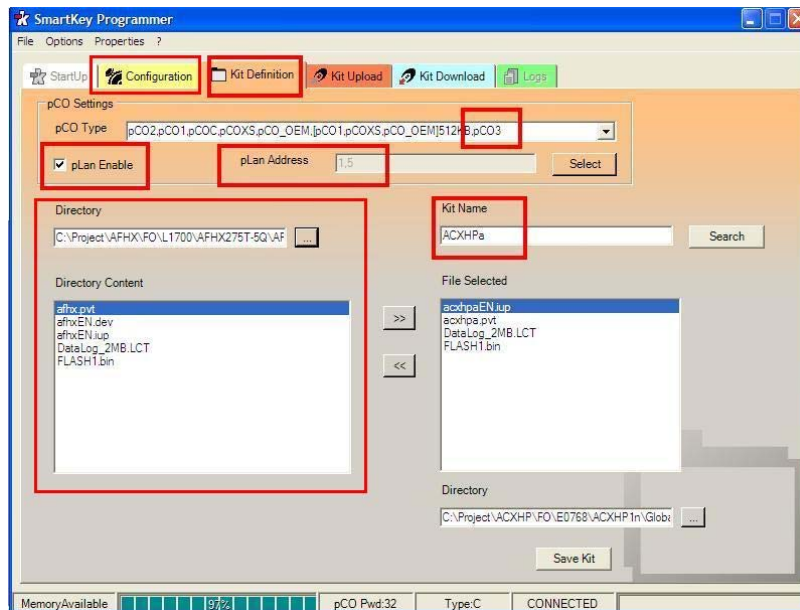
- b. Select language and serial port. Check “With key” if the smart key is connected to the converter. If the smart key is not connected, check on “Without Key”.



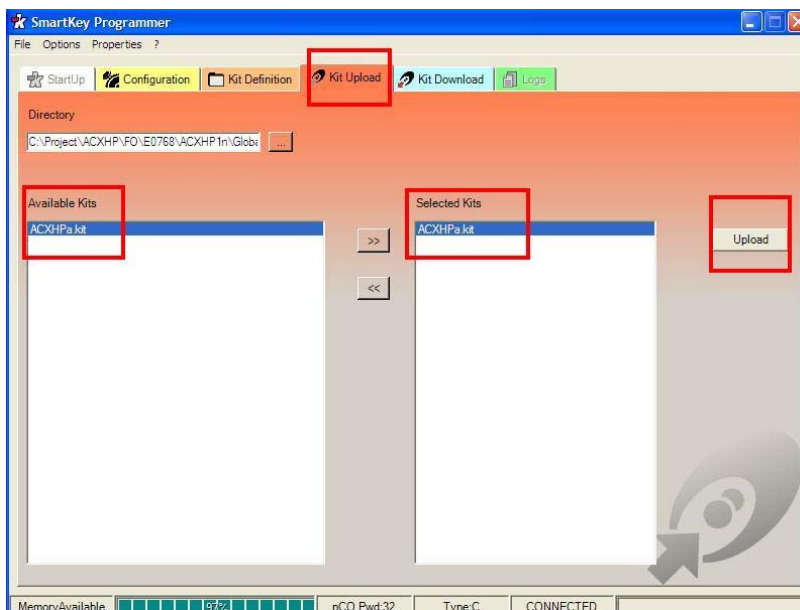
- c. At “Configuration” section, select smart key type to type “B”. Set pCO password to “32”. Click on “Set Params” to program the key.



- d. In “Kit Definition” section, select pCO type to pCO3, check “pLAN enable” and select the pLAN address. Click on “SELECT ALL” to check all pLAN addresses.



- e. Browse for the program files and “Save Kit”.
- f. Click on “Kit Upload”, select the kit that saved just now and upload it into the smart key.



- g. After the kit is uploaded, the program has been uploaded to the smart key successfully. Click on “Option” followed by “Disconnect Key” to disconnect smart key from the PC. After a “beep” sound, then removed the key from the converter.

8.0 TROUBLE SHOOTING GUIDE

8.1 General Servicing Procedures

Use the operating guide and trouble-shooting guide below to do the following:

- a. Check compressor status to see if it is locked off.
- b. If locked off, check alarms to see cause.
- c. Check all analog inputs for accuracy.
- d. If digital input is associated with failure, check digital inputs.
- e. Repair mechanical system problem or electrical system problem.
- f. Reset alarm by pressing "RESET ALARM".
- g. Check that all requirements for start-up are met.
- h. Operate machine over full operating conditions and observe results.
- i. Verify that all analog values are correct.

8.2 Trouble-shooting Guide

This trouble-shooting guide lists problems, possible causes, and corrective action.

Problems encountered	Possible Causes	Corrective Action
1. No text display on terminal display	i. No power on Vision 2020i controller	- Check for 24VAC on G and G ₀ at J1 on the controller
	ii. Phone cable problem	- Check that the phone cable is connected to proper connector on the controller (J10) - Remove the phone cable and re-try. If available, test with another phone cable
	iii. Board damaged	- Inspect board for shorted traces or foreign objects
	i. Improper settings of terminal display or IO address	- Set address of terminal display and IO board accordingly
	ii. Phone cable problem	- Remove the phone cable and re-try. If available, test with another phone cable
	iii. Faulty connector at terminal display	- If possible, connect the phone cable to another terminal display
	iv. Faulty connector at controller (J10)	- If possible, connect the terminal display to another controller
2. Analog input sensor reading incorrectly	i. Sensor out of calibration	- Verify that sensor reading is close to what is expected - Verify that gauge or meter is correct and the same location as the sensor - Use keypad to calibrate sensor.
	ii. Wiring problem	- Check that excitation voltage on transducer is correct - Check signal wiring - Check that shielded cable is grounded at only one end
	iii. Sensor problem	- Verify that the excitation voltage on transducer is correct - Check the analog signal (Vdc or mA) at sensor and at controller. Refer to sensor description for expected output - Make sure that sensor and meter are the same location
	iv. Damaged analog input	- Verify is the analog reading shows is out of measuring range - Inject a same type of signal to the analog input and observe changes on analog reading
3. Several digital inputs not correct	i. Wiring problem	- Check ground of digital inputs, IDC1, IDC9, IDC13, IDC15 and IDC17 are grounded properly
	ii. Damaged board	- Inspect board for shorted traces or foreign objects

9.0 APPENDIXES

- 9.1 *ALARM LIST*
- 9.2 *SIGNALS FOR PRESSURE TRANSDUCER (0-200PSI, 0.5-4.5Vdc)*
- 9.3 *SIGNALS FOR PRESSURE TRANSDUCER (0-500PSI, 0.5-4.5Vdc)*
- 9.4 *SIGNALS FOR PRESSURE TRANSDUCER (0-200PSI, 4-20mA)*
- 9.5 *SIGNALS FOR PRESSURE TRANSDUCER (0-500PSI, 4-20mA)*
- 9.6 *SIGNALS FOR CURRENT TRANSDUCER (0-250A, 0-20mA)*
- 9.7 *SIGNALS FOR CURRENT TRANSDUCER (0-500A, 0-20mA)*
- 9.8 *SIGNALS FOR VOLTAGE TRANSDUCER (0-500V, 0-20mA)*
- 9.9 *SIGNALS FOR NTC TEMPERATURE SENSOR (WP TYPE)*
- 9.10 *SIGNALS FOR NTC TEMPERATURE SENSOR (HP TYPE)*
- 9.11 *FLOW CHART – MASTER-SLAVE CONTROL SEQUENCE*

9.1 ALARM LIST

Vision 2020i - Chillers Lockout Safety Functions

Won MF - June 2008

Item	Alarm Description	Model	Conditions	Delay (sec)	Lockout Pattern
1	Low Suction Pressure	Flooded	When Suction Pressure < (Low Pressure Cutout Setpoint - 5PSI), and Any Compressor in the system is on	0.0	Turn Off - Relay Outputs for all compressors in the same system
			When Suction Pressure is within Low Pressure Cutout SP and Low Pressure Cutout SP - 5 PSI, and Any Compressor in the system is on	45.0	
		DX	When Suction Pressure < (Low Pressure Cutout Setpoint - 10PSI), and Any Compressor in the system is on	0.0	Turn On - Alarm Relay Output
			When Suction Pressure is within Low Pressure Cutout SP and Low Pressure Cutout SP - 10 PSI, and Any Compressor in the system is on	60.0	
2	High Discharge Pressure	Std	When Discharge Pressure > High Pressure Setpoint and Any Compressor in the system is on	0.0	Turn Off - Relay Outputs for all compressors in the same system
			When the difference between Discharge Pressure and Suction Pressure in the system is less than 30 PSI		Turn On - Alarm Relay Output
3	Low Differential Pressure	R22	Any Compressor in the system is on	180.0	Turn Off - Relay Outputs for all Compressors
		R134a	When the difference between Discharge Pressure and Suction Pressure in the system is less than 25 PSI	180.0	Turn On - Alarm Relay Output
			Any Compressor in the system is on		
4	Freeze	Std	When Leaving Water Temp < Freeze Setpoint (Typically 38.0°F) and Any one Comp is on	3.0	Turn Off - Relay Outputs for all Compressors
5	No Water Flow	Std	When Digital Input for Flow Switch is off and Any one comp is on	2.0	Turn On - Alarm Relay Output
6	Compressor Starter Error	P/W - Part Winding S/D - Star-Delta, or Softstarter	When Digital Input for Comp Starter is off, and Relay output for the respective Comp is on	5.0	Turn Off - Relay Outputs for the Compressor
		P/W - Part Winding S/D - Star-Delta, or Softstarter	When Digital output for Compressor is on, and amps reading < 20A	10.0	Turn On - Alarm Relay Output
7	Compressor No Run Alarm	Std	Compressor discharge temperature > 210 °F	5.0	Turn Off - Relay Outputs for the Compressor
8	High Comp Discharge Temp Alarm	Std	When Digital Input for Oil Level Status is off and the respective Comp is on	10.0	Turn On - Alarm Relay Output
9	Compressor Low Oil Alarm	Std	When Digital Input for Comp Starter is on and Replay output for the respective Comp is off	2.0	Turn Off - Relay Outputs for the Compressor
10	Compressor No Stop Alarm	Std	When Digital Input for the respective Comp is off	60.0	Turn On - Alarm Relay Output
11	Power Loss	Std	When Power Loss Setpoint = manual and power off	15.0	Turn Off - Relay Outputs for the Compressor
12	Expansion Board Not Present	Std	When the expansion board is not detected and main board is on	-	Turn On - Alarm Relay Output
				60.0	Turn Off - Relay Outputs for all Compressors
					Turn On - Alarm Relay Output

9.1 ALARM LIST (Continue)

Item	Alarm Description	Model	Conditions	Delay (sec)	Lockout Pattern
13	Chiller off Network	Std	When number of unit present in network $\neq$ total units	60.0	Turn On - Alarm Relay Output
14	High Leaving Water Temperature	Std	When (LWT Temp) $\geq$ LWT High SP	2.0	Turn On - Alarm Relay Output
15	Low Leaving Water Temperature	Std	When (LWT Temp) $<$ LWT Low SP	2.0	Turn On - Alarm Relay Output
16	Chilled Water Pump Alarm	Unit with CWP Control	When Chilled Water Pump is on and Chilled Water Pump Output is on, and No compressor is running, and Digital Input for Flow Switch is off	60.0	Turn Off - Chilled Water Pump Output Relay Turn On - Alarm Relay Output
17	High Voltage	Unit with voltage readout	When Supply Voltage $>$ High Voltage SP	2.0	Turn Off - Relay Outputs for all Compressors Turn On - Alarm Relay Output
18	Low Voltage	Unit with voltage readout	When Supply Voltage $>$ Low Voltage SP	2.0	Turn Off - Relay Outputs for all Compressors Turn On - Alarm Relay Output
19	Leaving Water Temp Sensor Error	Std	When (Leaving Water Temp $>$ 212°F, or $<$ -45°F)	5.0	Turn Off - Relay Outputs for all Compressors Turn On - Alarm Relay Output
20	Suction Pressure Sensor Error	Std	When signal from Suction Press sensor is $<$ 0V or $>$ 5V for 0-5V scale or When signal from Suction Press sensor is $<$ 4mA or $>$ 20mA for 4-20mA scale and Any Comp in the system is on	5.0	Turn Off - Relay Outputs for all compressors in the same system Turn On - Alarm Relay Output
21	Discharge Pressure Sensor Error	Std	When signal from Discharge Press sensor is $<$ 0V or $>$ 5V for 0-5V scale or When signal from Discharge Press sensor is $<$ 4mA or $>$ 20mA and Any Comp in the system is on	5.0	Turn Off - Relay Outputs for all compressors in the same system Turn On - Alarm Relay Output
22	Amps Sensor Fail	Std	When compressor is on and the signal from sensor is $<$ 0A or $>$ 20mA	5.0	Turn Off - Relay Outputs for the Compressor Turn On - Alarm Relay Output
23	Other Temperature Sensor Fail	Std	When temperature is $<$ -45°F or $>$ 212 °F	5.0	Turn On - Alarm Relay Output
24	Compressor Discharge Temperature Sensor Failure	Std	When (Discharge Temp $>$ 300°F, or $<$ 32°F)	5.0	Turn Off - Relay Outputs for the Compressor Turn On - Alarm Relay Output
25	Volt Sensor Fail	Unit with voltage readout	When signal from sensor is $<$ 0A or $>$ 20mA	5.0	Turn Off - Relay Outputs for all Compressors Turn On - Alarm Relay Output

9.2 SIGNALS FOR PRESSURE TRANSDUCER (0-200PSI, 0.5 to 4.5Vdc)

Pressure Transducer (P/N: 4030005443)

Range = 0 - 200PSI

Feedback = 0.5 - 4.5 Vdc

Pressure		Signal (V)	Pressure		Signal (V)	Pressure		Signal (V)	Pressure		Signal (V)
PSI	BAR		PSI	BAR		PSI	BAR		PSI	BAR	
0	0.00	0.50	50	3.45	1.50	100	6.90	2.50	150	10.34	3.50
1	0.07	0.52	51	3.52	1.52	101	6.97	2.52	151	10.41	3.52
2	0.14	0.54	52	3.59	1.54	102	7.03	2.54	152	10.48	3.54
3	0.21	0.56	53	3.66	1.56	103	7.10	2.56	153	10.55	3.56
4	0.28	0.58	54	3.72	1.58	104	7.17	2.58	154	10.62	3.58
5	0.34	0.60	55	3.79	1.60	105	7.24	2.60	155	10.69	3.60
6	0.41	0.62	56	3.86	1.62	106	7.31	2.62	156	10.76	3.62
7	0.48	0.64	57	3.93	1.64	107	7.38	2.64	157	10.83	3.64
8	0.55	0.66	58	4.00	1.66	108	7.45	2.66	158	10.90	3.66
9	0.62	0.68	59	4.07	1.68	109	7.52	2.68	159	10.97	3.68
10	0.69	0.70	60	4.14	1.70	110	7.59	2.70	160	11.03	3.70
11	0.76	0.72	61	4.21	1.72	111	7.66	2.72	161	11.10	3.72
12	0.83	0.74	62	4.28	1.74	112	7.72	2.74	162	11.17	3.74
13	0.90	0.76	63	4.34	1.76	113	7.79	2.76	163	11.24	3.76
14	0.97	0.78	64	4.41	1.78	114	7.86	2.78	164	11.31	3.78
15	1.03	0.80	65	4.48	1.80	115	7.93	2.80	165	11.38	3.80
16	1.10	0.82	66	4.55	1.82	116	8.00	2.82	166	11.45	3.82
17	1.17	0.84	67	4.62	1.84	117	8.07	2.84	167	11.52	3.84
18	1.24	0.86	68	4.69	1.86	118	8.14	2.86	168	11.59	3.86
19	1.31	0.88	69	4.76	1.88	119	8.21	2.88	169	11.66	3.88
20	1.38	0.90	70	4.83	1.90	120	8.28	2.90	170	11.72	3.90
21	1.45	0.92	71	4.90	1.92	121	8.34	2.92	171	11.79	3.92
22	1.52	0.94	72	4.97	1.94	122	8.41	2.94	172	11.86	3.94
23	1.59	0.96	73	5.03	1.96	123	8.48	2.96	173	11.93	3.96
24	1.66	0.98	74	5.10	1.98	124	8.55	2.98	174	12.00	3.98
25	1.72	1.00	75	5.17	2.00	125	8.62	3.00	175	12.07	4.00
26	1.79	1.02	76	5.24	2.02	126	8.69	3.02	176	12.14	4.02
27	1.86	1.04	77	5.31	2.04	127	8.76	3.04	177	12.21	4.04
28	1.93	1.06	78	5.38	2.06	128	8.83	3.06	178	12.28	4.06
29	2.00	1.08	79	5.45	2.08	129	8.90	3.08	179	12.34	4.08
30	2.07	1.10	80	5.52	2.10	130	8.97	3.10	180	12.41	4.10
31	2.14	1.12	81	5.59	2.12	131	9.03	3.12	181	12.48	4.12
32	2.21	1.14	82	5.66	2.14	132	9.10	3.14	182	12.55	4.14
33	2.28	1.16	83	5.72	2.16	133	9.17	3.16	183	12.62	4.16
34	2.34	1.18	84	5.79	2.18	134	9.24	3.18	184	12.69	4.18
35	2.41	1.20	85	5.86	2.20	135	9.31	3.20	185	12.76	4.20
36	2.48	1.22	86	5.93	2.22	136	9.38	3.22	186	12.83	4.22
37	2.55	1.24	87	6.00	2.24	137	9.45	3.24	187	12.90	4.24
38	2.62	1.26	88	6.07	2.26	138	9.52	3.26	188	12.97	4.26
39	2.69	1.28	89	6.14	2.28	139	9.59	3.28	189	13.03	4.28
40	2.76	1.30	90	6.21	2.30	140	9.66	3.30	190	13.10	4.30
41	2.83	1.32	91	6.28	2.32	141	9.72	3.32	191	13.17	4.32
42	2.90	1.34	92	6.34	2.34	142	9.79	3.34	192	13.24	4.34
43	2.97	1.36	93	6.41	2.36	143	9.86	3.36	193	13.31	4.36
44	3.03	1.38	94	6.48	2.38	144	9.93	3.38	194	13.38	4.38
45	3.10	1.40	95	6.55	2.40	145	10.00	3.40	195	13.45	4.40
46	3.17	1.42	96	6.62	2.42	146	10.07	3.42	196	13.52	4.42
47	3.24	1.44	97	6.69	2.44	147	10.14	3.44	197	13.59	4.44
48	3.31	1.46	98	6.76	2.46	148	10.21	3.46	198	13.66	4.46
49	3.38	1.48	99	6.83	2.48	149	10.28	3.48	199	13.72	4.48

9.3 SIGNALS FOR PRESSURE TRANSDUCER (0-500PSI, 0.5 to 4.5Vdc)

Pressure Transducer (P/N: 4030005444)

Range = 0 - 500PSI

Feedback = 0.5 - 4.5 Vdc

Pressure		Signal (V)	Pressure		Signal (V)	Pressure		Signal (V)	Pressure		Signal (V)	Pressure		Signal (V)
PSI	BAR		PSI	BAR		PSI	BAR		PSI	BAR		PSI	BAR	
0	0.00	0.50	100	6.90	1.30	200	13.79	2.10	300	20.69	2.90	400	27.59	3.70
2	0.14	0.52	102	7.03	1.32	202	13.93	2.12	302	20.83	2.92	402	27.72	3.72
4	0.28	0.53	104	7.17	1.33	204	14.07	2.13	304	20.97	2.93	404	27.86	3.73
6	0.41	0.55	106	7.31	1.35	206	14.21	2.15	306	21.10	2.95	406	28.00	3.75
8	0.55	0.56	108	7.45	1.36	208	14.34	2.16	308	21.24	2.96	408	28.14	3.76
10	0.69	0.58	110	7.59	1.38	210	14.48	2.18	310	21.38	2.98	410	28.28	3.78
12	0.83	0.60	112	7.72	1.40	212	14.62	2.20	312	21.52	3.00	412	28.41	3.80
14	0.97	0.61	114	7.86	1.41	214	14.76	2.21	314	21.66	3.01	414	28.55	3.81
16	1.10	0.63	116	8.00	1.43	216	14.90	2.23	316	21.79	3.03	416	28.69	3.83
18	1.24	0.64	118	8.14	1.44	218	15.03	2.24	318	21.93	3.04	418	28.83	3.84
20	1.38	0.66	120	8.28	1.46	220	15.17	2.26	320	22.07	3.06	420	28.97	3.86
22	1.52	0.68	122	8.41	1.48	222	15.31	2.28	322	22.21	3.08	422	29.10	3.88
24	1.66	0.69	124	8.55	1.49	224	15.45	2.29	324	22.34	3.09	424	29.24	3.89
26	1.79	0.71	126	8.69	1.51	226	15.59	2.31	326	22.48	3.11	426	29.38	3.91
28	1.93	0.72	128	8.83	1.52	228	15.72	2.32	328	22.62	3.12	428	29.52	3.92
30	2.07	0.74	130	8.97	1.54	230	15.86	2.34	330	22.76	3.14	430	29.66	3.94
32	2.21	0.76	132	9.10	1.56	232	16.00	2.36	332	22.90	3.16	432	29.79	3.96
34	2.34	0.77	134	9.24	1.57	234	16.14	2.37	334	23.03	3.17	434	29.93	3.97
36	2.48	0.79	136	9.38	1.59	236	16.28	2.39	336	23.17	3.19	436	30.07	3.99
38	2.62	0.80	138	9.52	1.60	238	16.41	2.40	338	23.31	3.20	438	30.21	4.00
40	2.76	0.82	140	9.66	1.62	240	16.55	2.42	340	23.45	3.22	440	30.34	4.02
42	2.90	0.84	142	9.79	1.64	242	16.69	2.44	342	23.59	3.24	442	30.48	4.04
44	3.03	0.85	144	9.93	1.65	244	16.83	2.45	344	23.72	3.25	444	30.62	4.05
46	3.17	0.87	146	10.07	1.67	246	16.97	2.47	346	23.86	3.27	446	30.76	4.07
48	3.31	0.88	148	10.21	1.68	248	17.10	2.48	348	24.00	3.28	448	30.90	4.08
50	3.45	0.90	150	10.34	1.70	250	17.24	2.50	350	24.14	3.30	450	31.03	4.10
52	3.59	0.92	152	10.48	1.72	252	17.38	2.52	352	24.28	3.32	452	31.17	4.12
54	3.72	0.93	154	10.62	1.73	254	17.52	2.53	354	24.41	3.33	454	31.31	4.13
56	3.86	0.95	156	10.76	1.75	256	17.66	2.55	356	24.55	3.35	456	31.45	4.15
58	4.00	0.96	158	10.90	1.76	258	17.79	2.56	358	24.69	3.36	458	31.59	4.16
60	4.14	0.98	160	11.03	1.78	260	17.93	2.58	360	24.83	3.38	460	31.72	4.18
62	4.28	1.00	162	11.17	1.80	262	18.07	2.60	362	24.97	3.40	462	31.86	4.20
64	4.41	1.01	164	11.31	1.81	264	18.21	2.61	364	25.10	3.41	464	32.00	4.21
66	4.55	1.03	166	11.45	1.83	266	18.34	2.63	366	25.24	3.43	466	32.14	4.23
68	4.69	1.04	168	11.59	1.84	268	18.48	2.64	368	25.38	3.44	468	32.28	4.24
70	4.83	1.06	170	11.72	1.86	270	18.62	2.66	370	25.52	3.46	470	32.41	4.26
72	4.97	1.08	172	11.86	1.88	272	18.76	2.68	372	25.66	3.48	472	32.55	4.28
74	5.10	1.09	174	12.00	1.89	274	18.90	2.69	374	25.79	3.49	474	32.69	4.29
76	5.24	1.11	176	12.14	1.91	276	19.03	2.71	376	25.93	3.51	476	32.83	4.31
78	5.38	1.12	178	12.28	1.92	278	19.17	2.72	378	26.07	3.52	478	32.97	4.32
80	5.52	1.14	180	12.41	1.94	280	19.31	2.74	380	26.21	3.54	480	33.10	4.34
82	5.66	1.16	182	12.55	1.96	282	19.45	2.76	382	26.34	3.56	482	33.24	4.36
84	5.79	1.17	184	12.69	1.97	284	19.59	2.77	384	26.48	3.57	484	33.38	4.37
86	5.93	1.19	186	12.83	1.99	286	19.72	2.79	386	26.62	3.59	486	33.52	4.39
88	6.07	1.20	188	12.97	2.00	288	19.86	2.80	388	26.76	3.60	488	33.66	4.40
90	6.21	1.22	190	13.10	2.02	290	20.00	2.82	390	26.90	3.62	490	33.79	4.42
92	6.34	1.24	192	13.24	2.04	292	20.14	2.84	392	27.03	3.64	492	33.93	4.44
94	6.48	1.25	194	13.38	2.05	294	20.28	2.85	394	27.17	3.65	494	34.07	4.45
96	6.62	1.27	196	13.52	2.07	296	20.41	2.87	396	27.31	3.67	496	34.21	4.47
98	6.76	1.28	198	13.66	2.08	298	20.55	2.88	398	27.45	3.68	498	34.34	4.48

9.4 SIGNALS FOR PRESSURE TRANSDUCER (0-200PSI, 4-20mA)**Pressure Transducer (P/N: 4030005289)****Range = 0 - 200PSI****Feedback = 4 - 20mA**

Pressure		Signal (mA)	Pressure		Signal (mA)	Pressure		Signal (mA)	Pressure		Signal (mA)
PSI	BAR		PIS	BAR		PSI	BAR		PSI	BAR	
0	0.00	4.00	50	3.45	8.00	100	6.90	12.00	150	10.34	16.00
1	0.07	4.08	51	3.52	8.08	101	6.97	12.08	151	10.41	16.08
2	0.14	4.16	52	3.59	8.16	102	7.03	12.16	152	10.48	16.16
3	0.21	4.24	53	3.66	8.24	103	7.10	12.24	153	10.55	16.24
4	0.28	4.32	54	3.72	8.32	104	7.17	12.32	154	10.62	16.32
5	0.34	4.40	55	3.79	8.40	105	7.24	12.40	155	10.69	16.40
6	0.41	4.48	56	3.86	8.48	106	7.31	12.48	156	10.76	16.48
7	0.48	4.56	57	3.93	8.56	107	7.38	12.56	157	10.83	16.56
8	0.55	4.64	58	4.00	8.64	108	7.45	12.64	158	10.90	16.64
9	0.62	4.72	59	4.07	8.72	109	7.52	12.72	159	10.97	16.72
10	0.69	4.80	60	4.14	8.80	110	7.59	12.80	160	11.03	16.80
11	0.76	4.88	61	4.21	8.88	111	7.66	12.88	161	11.10	16.88
12	0.83	4.96	62	4.28	8.96	112	7.72	12.96	162	11.17	16.96
13	0.90	5.04	63	4.34	9.04	113	7.79	13.04	163	11.24	17.04
14	0.97	5.12	64	4.41	9.12	114	7.86	13.12	164	11.31	17.12
15	1.03	5.20	65	4.48	9.20	115	7.93	13.20	165	11.38	17.20
16	1.10	5.28	66	4.55	9.28	116	8.00	13.28	166	11.45	17.28
17	1.17	5.36	67	4.62	9.36	117	8.07	13.36	167	11.52	17.36
18	1.24	5.44	68	4.69	9.44	118	8.14	13.44	168	11.59	17.44
19	1.31	5.52	69	4.76	9.52	119	8.21	13.52	169	11.66	17.52
20	1.38	5.60	70	4.83	9.60	120	8.28	13.60	170	11.72	17.60
21	1.45	5.68	71	4.90	9.68	121	8.34	13.68	171	11.79	17.68
22	1.52	5.76	72	4.97	9.76	122	8.41	13.76	172	11.86	17.76
23	1.59	5.84	73	5.03	9.84	123	8.48	13.84	173	11.93	17.84
24	1.66	5.92	74	5.10	9.92	124	8.55	13.92	174	12.00	17.92
25	1.72	6.00	75	5.17	10.00	125	8.62	14.00	175	12.07	18.00
26	1.79	6.08	76	5.24	10.08	126	8.69	14.08	176	12.14	18.08
27	1.86	6.16	77	5.31	10.16	127	8.76	14.16	177	12.21	18.16
28	1.93	6.24	78	5.38	10.24	128	8.83	14.24	178	12.28	18.24
29	2.00	6.32	79	5.45	10.32	129	8.90	14.32	179	12.34	18.32
30	2.07	6.40	80	5.52	10.40	130	8.97	14.40	180	12.41	18.40
31	2.14	6.48	81	5.59	10.48	131	9.03	14.48	181	12.48	18.48
32	2.21	6.56	82	5.66	10.56	132	9.10	14.56	182	12.55	18.56
33	2.28	6.64	83	5.72	10.64	133	9.17	14.64	183	12.62	18.64
34	2.34	6.72	84	5.79	10.72	134	9.24	14.72	184	12.69	18.72
35	2.41	6.80	85	5.86	10.80	135	9.31	14.80	185	12.76	18.80
36	2.48	6.88	86	5.93	10.88	136	9.38	14.88	186	12.83	18.88
37	2.55	6.96	87	6.00	10.96	137	9.45	14.96	187	12.90	18.96
38	2.62	7.04	88	6.07	11.04	138	9.52	15.04	188	12.97	19.04
39	2.69	7.12	89	6.14	11.12	139	9.59	15.12	189	13.03	19.12
40	2.76	7.20	90	6.21	11.20	140	9.66	15.20	190	13.10	19.20
41	2.83	7.28	91	6.28	11.28	141	9.72	15.28	191	13.17	19.28
42	2.90	7.36	92	6.34	11.36	142	9.79	15.36	192	13.24	19.36
43	2.97	7.44	93	6.41	11.44	143	9.86	15.44	193	13.31	19.44
44	3.03	7.52	94	6.48	11.52	144	9.93	15.52	194	13.38	19.52
45	3.10	7.60	95	6.55	11.60	145	10.00	15.60	195	13.45	19.60
46	3.17	7.68	96	6.62	11.68	146	10.07	15.68	196	13.52	19.68
47	3.24	7.76	97	6.69	11.76	147	10.14	15.76	197	13.59	19.76
48	3.31	7.84	98	6.76	11.84	148	10.21	15.84	198	13.66	19.84
49	3.38	7.92	99	6.83	11.92	149	10.28	15.92	199	13.72	19.92

9.5 SIGNALS FOR PRESSURE TRANSDUCER (0-500PSI, 4-20mA)**Pressure Transducer (P/N: 4030005290)****Range = 0 - 500PSI****Feedback = 4 - 20mA**

Pressure		Signal (mA)	Pressure		Signal (mA)	Pressure		Signal (mA)	Pressure		Signal (mA)	Pressure		Signal (mA)
PSI	BAR		PSI	BAR		PSI	BAR		PSI	BAR		PSI	BAR	
0	0.00	4.00	100	6.90	7.20	200	13.79	10.40	300	20.69	13.60	400	27.59	16.80
2	0.14	4.06	102	7.03	7.26	202	13.93	10.46	302	20.83	13.66	402	27.72	16.86
4	0.28	4.13	104	7.17	7.33	204	14.07	10.53	304	20.97	13.73	404	27.86	16.93
6	0.41	4.19	106	7.31	7.39	206	14.21	10.59	306	21.10	13.79	406	28.00	16.99
8	0.55	4.26	108	7.45	7.46	208	14.34	10.66	308	21.24	13.86	408	28.14	17.06
10	0.69	4.32	110	7.59	7.52	210	14.48	10.72	310	21.38	13.92	410	28.28	17.12
12	0.83	4.38	112	7.72	7.58	212	14.62	10.78	312	21.52	13.98	412	28.41	17.18
14	0.97	4.45	114	7.86	7.65	214	14.76	10.85	314	21.66	14.05	414	28.55	17.25
16	1.10	4.51	116	8.00	7.71	216	14.90	10.91	316	21.79	14.11	416	28.69	17.31
18	1.24	4.58	118	8.14	7.78	218	15.03	10.98	318	21.93	14.18	418	28.83	17.38
20	1.38	4.64	120	8.28	7.84	220	15.17	11.04	320	22.07	14.24	420	28.97	17.44
22	1.52	4.70	122	8.41	7.90	222	15.31	11.10	322	22.21	14.30	422	29.10	17.50
24	1.66	4.77	124	8.55	7.97	224	15.45	11.17	324	22.34	14.37	424	29.24	17.57
26	1.79	4.83	126	8.69	8.03	226	15.59	11.23	326	22.48	14.43	426	29.38	17.63
28	1.93	4.90	128	8.83	8.10	228	15.72	11.30	328	22.62	14.50	428	29.52	17.70
30	2.07	4.96	130	8.97	8.16	230	15.86	11.36	330	22.76	14.56	430	29.66	17.76
32	2.21	5.02	132	9.10	8.22	232	16.00	11.42	332	22.90	14.62	432	29.79	17.82
34	2.34	5.09	134	9.24	8.29	234	16.14	11.49	334	23.03	14.69	434	29.93	17.89
36	2.48	5.15	136	9.38	8.35	236	16.28	11.55	336	23.17	14.75	436	30.07	17.95
38	2.62	5.22	138	9.52	8.42	238	16.41	11.62	338	23.31	14.82	438	30.21	18.02
40	2.76	5.28	140	9.66	8.48	240	16.55	11.68	340	23.45	14.88	440	30.34	18.08
42	2.90	5.34	142	9.79	8.54	242	16.69	11.74	342	23.59	14.94	442	30.48	18.14
44	3.03	5.41	144	9.93	8.61	244	16.83	11.81	344	23.72	15.01	444	30.62	18.21
46	3.17	5.47	146	10.07	8.67	246	16.97	11.87	346	23.86	15.07	446	30.76	18.27
48	3.31	5.54	148	10.21	8.74	248	17.10	11.94	348	24.00	15.14	448	30.90	18.34
50	3.45	5.60	150	10.34	8.80	250	17.24	12.00	350	24.14	15.20	450	31.03	18.40
52	3.59	5.66	152	10.48	8.86	252	17.38	12.06	352	24.28	15.26	452	31.17	18.46
54	3.72	5.73	154	10.62	8.93	254	17.52	12.13	354	24.41	15.33	454	31.31	18.53
56	3.86	5.79	156	10.76	8.99	256	17.66	12.19	356	24.55	15.39	456	31.45	18.59
58	4.00	5.86	158	10.90	9.06	258	17.79	12.26	358	24.69	15.46	458	31.59	18.66
60	4.14	5.92	160	11.03	9.12	260	17.93	12.32	360	24.83	15.52	460	31.72	18.72
62	4.28	5.98	162	11.17	9.18	262	18.07	12.38	362	24.97	15.58	462	31.86	18.78
64	4.41	6.05	164	11.31	9.25	264	18.21	12.45	364	25.10	15.65	464	32.00	18.85
66	4.55	6.11	166	11.45	9.31	266	18.34	12.51	366	25.24	15.71	466	32.14	18.91
68	4.69	6.18	168	11.59	9.38	268	18.48	12.58	368	25.38	15.78	468	32.28	18.98
70	4.83	6.24	170	11.72	9.44	270	18.62	12.64	370	25.52	15.84	470	32.41	19.04
72	4.97	6.30	172	11.86	9.50	272	18.76	12.70	372	25.66	15.90	472	32.55	19.10
74	5.10	6.37	174	12.00	9.57	274	18.90	12.77	374	25.79	15.97	474	32.69	19.17
76	5.24	6.43	176	12.14	9.63	276	19.03	12.83	376	25.93	16.03	476	32.83	19.23
78	5.38	6.50	178	12.28	9.70	278	19.17	12.90	378	26.07	16.10	478	32.97	19.30
80	5.52	6.56	180	12.41	9.76	280	19.31	12.96	380	26.21	16.16	480	33.10	19.36
82	5.66	6.62	182	12.55	9.82	282	19.45	13.02	382	26.34	16.22	482	33.24	19.42
84	5.79	6.69	184	12.69	9.89	284	19.59	13.09	384	26.48	16.29	484	33.38	19.49
86	5.93	6.75	186	12.83	9.95	286	19.72	13.15	386	26.62	16.35	486	33.52	19.55
88	6.07	6.82	188	12.97	10.02	288	19.86	13.22	388	26.76	16.42	488	33.66	19.62
90	6.21	6.88	190	13.10	10.08	290	20.00	13.28	390	26.90	16.48	490	33.79	19.68
92	6.34	6.94	192	13.24	10.14	292	20.14	13.34	392	27.03	16.54	492	33.93	19.74
94	6.48	7.01	194	13.38	10.21	294	20.28	13.41	394	27.17	16.61	494	34.07	19.81
96	6.62	7.07	196	13.52	10.27	296	20.41	13.47	396	27.31	16.67	496	34.21	19.87
98	6.76	7.14	198	13.66	10.34	298	20.55	13.54	398	27.45	16.74	498	34.34	19.94

9.6 SIGNALS FOR CURRENT TRANSDUCER (0-250A, 0-20mA)**Current Transducer (P/N: 40307331)****Current Transformer (P/N: 4008014080) Range = 0 - 250A****Feedback = 0 - 20mA**

Measured Current (A)	Signal (mA)	Measured Current (A)	Signal (mA)	Measured Current (A)	Signal (mA)	Measured Current (A)	Signal (mA)	Measured Current (A)	Signal (mA)
0	0.00	50	4.00	100	8.00	150	12.00	200	16.00
1	0.08	51	4.08	101	8.08	151	12.08	201	16.08
2	0.16	52	4.16	102	8.16	152	12.16	202	16.16
3	0.24	53	4.24	103	8.24	153	12.24	203	16.24
4	0.32	54	4.32	104	8.32	154	12.32	204	16.32
5	0.40	55	4.40	105	8.40	155	12.40	205	16.40
6	0.48	56	4.48	106	8.48	156	12.48	206	16.48
7	0.56	57	4.56	107	8.56	157	12.56	207	16.56
8	0.64	58	4.64	108	8.64	158	12.64	208	16.64
9	0.72	59	4.72	109	8.72	159	12.72	209	16.72
10	0.80	60	4.80	110	8.80	160	12.80	210	16.80
11	0.88	61	4.88	111	8.88	161	12.88	211	16.88
12	0.96	62	4.96	112	8.96	162	12.96	212	16.96
13	1.04	63	5.04	113	9.04	163	13.04	213	17.04
14	1.12	64	5.12	114	9.12	164	13.12	214	17.12
15	1.20	65	5.20	115	9.20	165	13.20	215	17.20
16	1.28	66	5.28	116	9.28	166	13.28	216	17.28
17	1.36	67	5.36	117	9.36	167	13.36	217	17.36
18	1.44	68	5.44	118	9.44	168	13.44	218	17.44
19	1.52	69	5.52	119	9.52	169	13.52	219	17.52
20	1.60	70	5.60	120	9.60	170	13.60	220	17.60
21	1.68	71	5.68	121	9.68	171	13.68	221	17.68
22	1.76	72	5.76	122	9.76	172	13.76	222	17.76
23	1.84	73	5.84	123	9.84	173	13.84	223	17.84
24	1.92	74	5.92	124	9.92	174	13.92	224	17.92
25	2.00	75	6.00	125	10.00	175	14.00	225	18.00
26	2.08	76	6.08	126	10.08	176	14.08	226	18.08
27	2.16	77	6.16	127	10.16	177	14.16	227	18.16
28	2.24	78	6.24	128	10.24	178	14.24	228	18.24
29	2.32	79	6.32	129	10.32	179	14.32	229	18.32
30	2.40	80	6.40	130	10.40	180	14.40	230	18.40
31	2.48	81	6.48	131	10.48	181	14.48	231	18.48
32	2.56	82	6.56	132	10.56	182	14.56	232	18.56
33	2.64	83	6.64	133	10.64	183	14.64	233	18.64
34	2.72	84	6.72	134	10.72	184	14.72	234	18.72
35	2.80	85	6.80	135	10.80	185	14.80	235	18.80
36	2.88	86	6.88	136	10.88	186	14.88	236	18.88
37	2.96	87	6.96	137	10.96	187	14.96	237	18.96
38	3.04	88	7.04	138	11.04	188	15.04	238	19.04
39	3.12	89	7.12	139	11.12	189	15.12	239	19.12
40	3.20	90	7.20	140	11.20	190	15.20	240	19.20
41	3.28	91	7.28	141	11.28	191	15.28	241	19.28
42	3.36	92	7.36	142	11.36	192	15.36	242	19.36
43	3.44	93	7.44	143	11.44	193	15.44	243	19.44
44	3.52	94	7.52	144	11.52	194	15.52	244	19.52
45	3.60	95	7.60	145	11.60	195	15.60	245	19.60
46	3.68	96	7.68	146	11.68	196	15.68	246	19.68
47	3.76	97	7.76	147	11.76	197	15.76	247	19.76
48	3.84	98	7.84	148	11.84	198	15.84	248	19.84
49	3.92	99	7.92	149	11.92	199	15.92	249	19.92

9.7 SIGNALS FOR CURRENT TRANSDUCER (0-500A, 0-20mA)**Current Transducer (P/N: 40307331)****Current Transformer (P/N: 4008014135) Range = 0 - 500A Feedback = 0 - 20mA**

Measured Current (A)	Signal (mA)	Measured Current (A)	Signal (mA)	Measured Current (A)	Signal (mA)	Measured Current (A)	Signal (mA)	Measured Current (A)	Signal (mA)
0	0.00	100	4.00	200	8.00	300	12.00	400	16.00
2	0.08	102	4.08	202	8.08	302	12.08	402	16.08
4	0.16	104	4.16	204	8.16	304	12.16	404	16.16
6	0.24	106	4.24	206	8.24	306	12.24	406	16.24
8	0.32	108	4.32	208	8.32	308	12.32	408	16.32
10	0.40	110	4.40	210	8.40	310	12.40	410	16.40
12	0.48	112	4.48	212	8.48	312	12.48	412	16.48
14	0.56	114	4.56	214	8.56	314	12.56	414	16.56
16	0.64	116	4.64	216	8.64	316	12.64	416	16.64
18	0.72	118	4.72	218	8.72	318	12.72	418	16.72
20	0.80	120	4.80	220	8.80	320	12.80	420	16.80
22	0.88	122	4.88	222	8.88	322	12.88	422	16.88
24	0.96	124	4.96	224	8.96	324	12.96	424	16.96
26	1.04	126	5.04	226	9.04	326	13.04	426	17.04
28	1.12	128	5.12	228	9.12	328	13.12	428	17.12
30	1.20	130	5.20	230	9.20	330	13.20	430	17.20
32	1.28	132	5.28	232	9.28	332	13.28	432	17.28
34	1.36	134	5.36	234	9.36	334	13.36	434	17.36
36	1.44	136	5.44	236	9.44	336	13.44	436	17.44
38	1.52	138	5.52	238	9.52	338	13.52	438	17.52
40	1.60	140	5.60	240	9.60	340	13.60	440	17.60
42	1.68	142	5.68	242	9.68	342	13.68	442	17.68
44	1.76	144	5.76	244	9.76	344	13.76	444	17.76
46	1.84	146	5.84	246	9.84	346	13.84	446	17.84
48	1.92	148	5.92	248	9.92	348	13.92	448	17.92
50	2.00	150	6.00	250	10.00	350	14.00	450	18.00
52	2.08	152	6.08	252	10.08	352	14.08	452	18.08
54	2.16	154	6.16	254	10.16	354	14.16	454	18.16
56	2.24	156	6.24	256	10.24	356	14.24	456	18.24
58	2.32	158	6.32	258	10.32	358	14.32	458	18.32
60	2.40	160	6.40	260	10.40	360	14.40	460	18.40
62	2.48	162	6.48	262	10.48	362	14.48	462	18.48
64	2.56	164	6.56	264	10.56	364	14.56	464	18.56
66	2.64	166	6.64	266	10.64	366	14.64	466	18.64
68	2.72	168	6.72	268	10.72	368	14.72	468	18.72
70	2.80	170	6.80	270	10.80	370	14.80	470	18.80
72	2.88	172	6.88	272	10.88	372	14.88	472	18.88
74	2.96	174	6.96	274	10.96	374	14.96	474	18.96
76	3.04	176	7.04	276	11.04	376	15.04	476	19.04
78	3.12	178	7.12	278	11.12	378	15.12	478	19.12
80	3.20	180	7.20	280	11.20	380	15.20	480	19.20
82	3.28	182	7.28	282	11.28	382	15.28	482	19.28
84	3.36	184	7.36	284	11.36	384	15.36	484	19.36
86	3.44	186	7.44	286	11.44	386	15.44	486	19.44
88	3.52	188	7.52	288	11.52	388	15.52	488	19.52
90	3.60	190	7.60	290	11.60	390	15.60	490	19.60
92	3.68	192	7.68	292	11.68	392	15.68	492	19.68
94	3.76	194	7.76	294	11.76	394	15.76	494	19.76
96	3.84	196	7.84	296	11.84	396	15.84	496	19.84
98	3.92	198	7.92	298	11.92	398	15.92	498	19.92

9.8 SIGNALS FOR VOLTAGE TRANSDUCER (0-500V, 0-20mA)**Voltage Transducer (P/N: 4030007367)****Range = 0 - 500V Feedback = 0 - 20mA**

Measured Voltage (V)	Signal (mA)	Measured Voltage (V)	Signal (mA)	Measured Voltage (V)	Signal (mA)	Measured Voltage (V)	Signal (mA)	Measured Voltage (V)	Signal (mA)
0	0.00	100	4.00	200	8.00	300	12.00	400	16.00
2	0.08	102	4.08	202	8.08	302	12.08	402	16.08
4	0.16	104	4.16	204	8.16	304	12.16	404	16.16
6	0.24	106	4.24	206	8.24	306	12.24	406	16.24
8	0.32	108	4.32	208	8.32	308	12.32	408	16.32
10	0.40	110	4.40	210	8.40	310	12.40	410	16.40
12	0.48	112	4.48	212	8.48	312	12.48	412	16.48
14	0.56	114	4.56	214	8.56	314	12.56	414	16.56
16	0.64	116	4.64	216	8.64	316	12.64	416	16.64
18	0.72	118	4.72	218	8.72	318	12.72	418	16.72
20	0.80	120	4.80	220	8.80	320	12.80	420	16.80
22	0.88	122	4.88	222	8.88	322	12.88	422	16.88
24	0.96	124	4.96	224	8.96	324	12.96	424	16.96
26	1.04	126	5.04	226	9.04	326	13.04	426	17.04
28	1.12	128	5.12	228	9.12	328	13.12	428	17.12
30	1.20	130	5.20	230	9.20	330	13.20	430	17.20
32	1.28	132	5.28	232	9.28	332	13.28	432	17.28
34	1.36	134	5.36	234	9.36	334	13.36	434	17.36
36	1.44	136	5.44	236	9.44	336	13.44	436	17.44
38	1.52	138	5.52	238	9.52	338	13.52	438	17.52
40	1.60	140	5.60	240	9.60	340	13.60	440	17.60
42	1.68	142	5.68	242	9.68	342	13.68	442	17.68
44	1.76	144	5.76	244	9.76	344	13.76	444	17.76
46	1.84	146	5.84	246	9.84	346	13.84	446	17.84
48	1.92	148	5.92	248	9.92	348	13.92	448	17.92
50	2.00	150	6.00	250	10.00	350	14.00	450	18.00
52	2.08	152	6.08	252	10.08	352	14.08	452	18.08
54	2.16	154	6.16	254	10.16	354	14.16	454	18.16
56	2.24	156	6.24	256	10.24	356	14.24	456	18.24
58	2.32	158	6.32	258	10.32	358	14.32	458	18.32
60	2.40	160	6.40	260	10.40	360	14.40	460	18.40
62	2.48	162	6.48	262	10.48	362	14.48	462	18.48
64	2.56	164	6.56	264	10.56	364	14.56	464	18.56
66	2.64	166	6.64	266	10.64	366	14.64	466	18.64
68	2.72	168	6.72	268	10.72	368	14.72	468	18.72
70	2.80	170	6.80	270	10.80	370	14.80	470	18.80
72	2.88	172	6.88	272	10.88	372	14.88	472	18.88
74	2.96	174	6.96	274	10.96	374	14.96	474	18.96
76	3.04	176	7.04	276	11.04	376	15.04	476	19.04
78	3.12	178	7.12	278	11.12	378	15.12	478	19.12
80	3.20	180	7.20	280	11.20	380	15.20	480	19.20
82	3.28	182	7.28	282	11.28	382	15.28	482	19.28
84	3.36	184	7.36	284	11.36	384	15.36	484	19.36
86	3.44	186	7.44	286	11.44	386	15.44	486	19.44
88	3.52	188	7.52	288	11.52	388	15.52	488	19.52
90	3.60	190	7.60	290	11.60	390	15.60	490	19.60
92	3.68	192	7.68	292	11.68	392	15.68	492	19.68
94	3.76	194	7.76	294	11.76	394	15.76	494	19.76
96	3.84	196	7.84	296	11.84	396	15.84	496	19.84
98	3.92	198	7.92	298	11.92	398	15.92	498	19.92

9.9 SIGNALS FOR NTC TEMPERATURE SENSOR (WP TYPE)

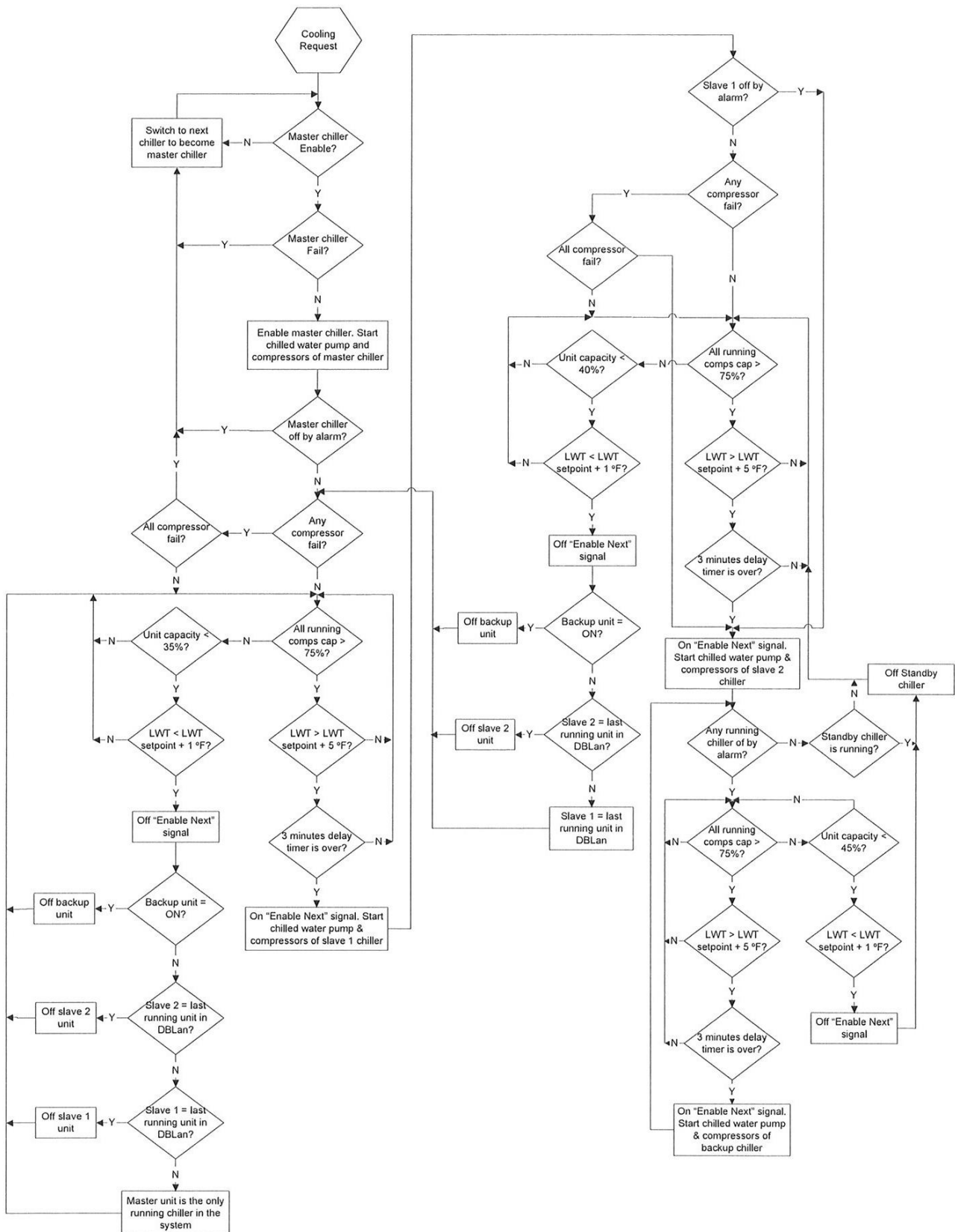
Table For NTC Sensor Versus Temperature (WP Type)														
Temp		NTC Resistance			Temp		NTC Resistance			Temp		NTC Resistance		
		Max.	Std	Min.			Max.	Std	Min.			Max.	Std	Min.
°F	°C	kΩ	kΩ	kΩ	°F	°C	kΩ	kΩ	kΩ	°F	°C	kΩ	kΩ	kΩ
-58.0	-50	344.40	329.20	314.70	33.8	1	26.64	26.13	25.52	132.8	56	3.49	3.42	3.35
-56.2	-49	324.70	310.70	297.20	35.6	2	25.51	25.03	24.55	134.6	57	3.39	3.31	3.24
-54.4	-48	306.40	293.30	280.70	37.4	3	24.24	23.99	23.54	136.4	58	3.28	3.21	3.14
-52.6	-47	289.20	277.00	265.30	39.2	4	23.42	22.99	22.57	138.2	59	3.18	3.11	3.04
-50.8	-46	273.20	261.80	250.60	41.0	5	22.45	22.05	21.66	140.0	60	3.09	3.02	2.95
-49.0	-45	258.10	247.50	237.20	42.8	6	21.52	21.15	20.78	141.8	61	2.99	2.92	2.86
-47.2	-44	244.00	234.10	224.60	44.6	7	20.64	20.29	19.95	143.6	62	2.90	2.83	2.77
-45.4	-43	230.80	221.60	212.70	46.4	8	19.80	19.40	19.15	145.4	63	2.81	2.75	2.69
-43.6	-42	218.50	209.80	201.50	48.2	9	19.00	18.70	18.40	147.2	64	2.73	2.66	2.60
-41.8	-41	206.80	198.70	191.00	50.0	10	18.24	17.96	17.67	149.0	65	2.65	2.58	2.52
-40.0	-40	195.90	188.40	181.10	51.8	11	17.51	17.24	16.97	150.8	66	2.57	2.51	2.45
-38.2	-39	185.40	178.30	171.59	53.6	12	16.80	16.55	16.31	152.6	67	2.49	2.43	2.37
-36.4	-38	175.50	168.90	162.00	55.4	13	16.13	15.90	15.87	154.4	68	2.42	2.36	2.30
-34.6	-37	166.20	160.10	154.10	57.2	14	15.50	15.28	15.06	156.2	69	2.35	2.29	2.24
-32.8	-36	157.50	151.80	140.20	59.0	15	14.89	14.68	14.48	158.0	70	2.28	2.22	2.17
-31.0	-35	149.30	144.00	138.80	60.8	16	14.31	14.12	13.93	159.8	71	2.21	2.16	2.10
-29.2	-34	141.60	136.60	131.80	62.6	17	13.75	13.57	13.40	161.6	72	2.15	2.10	2.04
-27.4	-33	134.40	129.70	125.20	64.4	18	13.22	13.06	12.89	163.4	73	2.09	2.04	1.98
-25.6	-32	127.60	123.20	118.90	66.2	19	12.72	12.56	12.41	165.2	74	2.03	1.98	1.93
-23.8	-31	121.20	117.10	113.10	68.0	20	12.23	12.09	11.95	167.0	75	1.97	1.92	1.87
-22.0	-30	115.10	111.30	107.50	69.8	21	11.77	11.63	11.57	168.8	76	1.92	1.87	1.82
-20.2	-29	109.30	105.70	102.20	71.6	22	11.32	11.20	11.07	170.6	77	1.86	1.81	1.78
-18.4	-28	103.80	100.40	97.16	73.4	23	10.90	10.78	10.60	172.4	78	1.81	1.76	1.71
-16.6	-27	98.63	95.47	92.41	75.2	24	10.49	10.38	10.27	174.2	79	1.76	1.71	1.68
-14.8	-26	93.75	90.80	87.93	77.0	25	10.10	10.00	9.90	176.0	80	1.71	1.66	1.62
-13.0	-25	89.15	86.39	83.70	78.8	26	9.73	9.63	9.52	177.8	81	1.66	1.62	1.57
-11.2	-24	84.82	82.22	79.71	80.6	27	9.38	9.28	9.18	179.6	82	1.62	1.57	1.53
-9.4	-23	80.72	78.29	75.93	82.4	28	9.04	8.94	8.84	181.4	83	1.57	1.53	1.49
-7.6	-22	76.85	74.58	72.36	84.2	29	8.72	8.62	8.52	183.2	84	1.53	1.49	1.44
-5.8	-21	73.20	71.07	68.99	86.0	30	8.41	8.31	8.21	185.0	85	1.49	1.45	1.40
-4.0	-20	69.74	67.74	65.80	87.8	31	8.11	8.01	7.91	186.8	86	1.45	1.41	1.37
-2.2	-19	66.42	64.54	62.72	89.6	32	7.82	7.72	7.62	188.6	87	1.41	1.37	1.33
-0.4	-18	63.27	61.52	59.81	91.4	33	7.55	7.45	7.35	190.4	88	1.37	1.33	1.29
1.4	-17	60.30	58.66	57.05	93.2	34	7.28	7.19	7.09	192.2	89	1.34	1.30	1.26
3.2	-16	57.49	53.39	51.97	95.0	35	7.03	6.94	6.84	194.0	90	1.30	1.26	1.22
5.0	-15	54.83	53.39	51.97	96.8	36	6.79	6.69	6.60	195.8	91	1.27	1.23	1.19
6.8	-14	52.31	50.96	49.83	98.6	37	6.56	6.46	6.37	197.6	92	1.23	1.20	1.16
8.6	-13	49.93	48.65	47.12	100.4	38	6.33	6.24	6.15	199.4	93	1.20	1.16	1.13
10.4	-12	47.67	46.48	45.31	102.2	39	6.12	6.03	5.94	201.2	94	1.17	1.13	1.10
12.2	-11	45.53	44.41	43.32	104.0	40	5.92	5.82	5.73	203.0	95	1.14	1.10	1.07
14.0	-10	43.50	42.25	41.43	105.8	41	5.72	5.63	5.54	204.8	96	1.11	1.08	1.04
15.8	-9	41.54	40.56	39.59	107.6	42	5.53	5.45	5.35	206.6	97	1.08	1.05	1.01
17.6	-8	39.68	38.76	37.85	109.4	43	5.34	5.25	5.17	208.4	98	1.05	1.02	0.99
19.4	-7	37.91	37.05	36.20	111.2	44	5.16	5.08	4.99	210.2	99	1.03	0.99	0.96
21.2	-6	36.24	35.43	34.02	113.0	45	4.99	4.91	4.82	212.0	100	1.00	0.97	0.94
23.0	-5	34.65	33.89	33.14	114.8	46	4.83	4.74	4.66	213.8	101	0.98	0.94	0.91
24.8	-4	33.14	32.43	31.73	116.6	47	4.67	4.59	4.51	215.6	102	0.95	0.92	0.89
26.6	-3	31.71	31.04	30.39	118.4	48	4.52	4.44	4.36	217.4	103	0.93	0.90	0.87
28.4	-2	30.35	29.72	29.11	120.2	49	4.38	4.30	4.22	219.2	104	0.91	0.87	0.84
30.2	-1	30.00	28.47	27.89	122.0	50	4.24	4.16	4.08	221.0	105	0.88	0.85	0.82
32.0	0	27.83	27.28	26.74	123.8	51	4.10	4.02	3.95	222.8	106	0.86	0.83	0.80
					125.6	52	3.97	3.90	3.82	224.6	107	0.84	0.81	0.78
					127.4	53	3.84	3.77	3.69	226.4	108	0.82	0.79	0.76
					129.2	54	3.72	3.65	3.57	228.2	109	0.80	0.77	0.74
					131.0	55	3.61	3.53	3.46	230.0	110	0.78	0.75	0.73

9.10 SIGNALS FOR NTC TEMPERATURE SENSOR (HP TYPE)

Table For NTC Sensor Versus Temperature (HP Type)														
Temp.		NTC Resistance			Temp.		NTC Resistance			Temp.		NTC Resistance		
		Max.	Std	Min.			Max.	Std	Min.			Max.	Std	Min.
°F	°C	KΩ	KΩ	KΩ	°F	°C	KΩ	KΩ	KΩ	°F	°C	KΩ	KΩ	KΩ
-58.0	-50	344,40	329,20	314,70	33.8	1	26,64	26,13	25,52	132.8	56	3,49	3,42	3,35
-56.2	-49	324,70	310,70	297,20	35.6	2	25,51	25,03	24,55	134.6	57	3,39	3,31	3,24
-54.4	-48	306,40	293,30	280,70	37.4	3	24,24	23,99	23,54	136.4	58	3,28	3,21	3,14
-52.6	-47	289,20	277,00	265,30	39.2	4	23,42	22,99	22,57	138.2	59	3,18	3,11	3,04
-50.8	-46	273,20	261,80	250,60	41.0	5	22,45	22,05	21,66	140.0	60	3,09	3,02	2,95
-49.0	-45	258,10	247,50	237,20	42.8	6	21,52	21,15	20,78	141.8	61	2,99	2,92	2,86
-47.2	-44	244,00	234,10	244,60	44.6	7	20,64	20,29	19,95	143.6	62	2,90	2,83	2,77
-45.4	-43	230,80	221,60	212,70	46.4	8	19,80	19,40	19,15	145.4	63	2,81	2,75	2,69
-43.6	-42	218,50	209,80	201,50	48.2	9	19,00	18,70	18,40	147.2	64	2,73	2,66	2,60
-41.8	-41	206,80	198,70	191,00	50.0	10	18,24	17,96	17,67	149.0	65	2,65	2,58	2,52
-40.0	-40	195,90	188,40	181,10	51.8	11	17,51	17,24	16,97	150.8	66	2,57	2,51	2,45
-38.2	-39	185,40	178,30	171,59	53.6	12	16,80	16,55	16,31	152.6	67	2,49	2,43	2,37
-36.4	-38	175,50	168,90	162,00	55.4	13	16,13	15,90	15,87	154.4	68	2,42	2,36	2,30
-34.6	-37	166,20	160,10	154,10	57.2	14	15,50	15,28	15,06	156.2	69	2,35	2,29	2,24
-32.8	-36	157,50	151,80	140,20	59.0	15	14,89	14,68	14,48	158.0	70	2,28	2,22	2,17
-31.0	-35	149,30	144,00	138,80	60.8	16	14,31	14,12	13,93	159.8	71	2,21	2,16	2,10
-29.2	-34	141,60	136,60	131,80	62.6	17	13,75	13,57	13,40	161.6	72	2,15	2,10	2,04
-27.4	-33	134,40	129,70	125,20	64.4	18	13,22	13,06	12,89	163.4	73	2,09	2,04	1,98
-25.6	-32	127,60	123,20	118,90	66.2	19	12,72	12,56	12,41	165.2	74	2,03	1,98	1,93
-23.8	-31	121,20	117,10	113,10	68.0	20	12,23	12,09	11,95	167.0	75	1,97	1,92	1,87
-22.0	-30	115,10	111,30	107,50	69.8	21	11,77	11,63	11,57	168.8	76	1,92	1,87	1,82
-20.2	-29	109,30	105,70	102,20	71.6	22	11,32	11,20	11,07	170.6	77	1,86	1,81	1,78
-18.4	-28	103,80	100,40	97,16	73.4	23	10,90	10,78	10,60	172.4	78	1,81	1,76	1,71
-16.6	-27	98,63	95,47	92,41	75.2	24	10,49	10,38	10,27	174.2	79	1,76	1,71	1,68
-14.8	-26	93,75	90,80	87,93	77.0	25	10,10	10,00	9,90	176.0	80	1,71	1,66	1,62
-13.0	-25	89,15	86,39	83,70	78.8	26	9,73	9,63	9,52	177.8	81	1,66	1,62	1,57
-11.2	-24	84,82	82,22	79,71	80.6	27	9,38	9,28	9,18	179.6	82	1,62	1,57	1,53
-9.4	-23	80,72	78,29	75,93	82.4	28	9,04	8,94	8,84	181.4	83	1,57	1,53	1,49
-7.6	-22	76,85	74,58	72,36	84.2	29	8,72	8,62	8,52	183.2	84	1,53	1,49	1,44
-5.8	-21	73,20	71,07	68,99	86.0	30	8,41	8,31	8,21	185.0	85	1,49	1,45	1,40
-4.0	-20	69,74	67,74	65,80	87.8	31	8,11	8,01	7,91	186.8	86	1,45	1,41	1,37
-2.2	-19	66,42	64,54	62,72	89.6	32	7,82	7,72	7,62	188.6	87	1,41	1,37	1,33
-0.4	-18	63,27	61,52	59,81	91.4	33	7,55	7,45	7,35	190.4	88	1,37	1,33	1,29
1.4	-17	60,30	58,66	57,05	93.2	34	7,28	7,19	7,09	192.2	89	1,34	1,30	1,26
3.2	-16	57,49	53,39	51,97	95.0	35	7,03	6,94	6,84	194.0	90	1,30	1,26	1,22
5.0	-15	54,83	53,39	51,97	96.8	36	6,79	6,69	6,60	195.8	91	1,27	1,23	1,19
6.8	-14	52,31	50,96	49,83	98.6	37	6,56	6,46	6,37	197.6	92	1,23	1,20	1,16
8.6	-13	49,93	48,65	47,12	100.4	38	6,33	6,24	6,15	199.4	93	1,20	1,16	1,13
10.4	-12	47,67	46,48	45,31	102.2	39	6,12	6,03	5,94	201.2	94	1,17	1,13	1,10
12.2	-11	45,53	44,41	43,32	104.0	40	5,92	5,82	5,73	203.0	95	1,14	1,10	1,07
14.0	-10	43,50	42,25	41,43	105.8	41	5,72	5,63	5,54	204.8	96	1,11	1,08	1,04
15.8	-9	41,54	40,56	39,59	107.6	42	5,53	5,43	5,35	206.6	97	1,08	1,05	1,01
17.6	-8	39,68	38,76	37,85	109.4	43	5,34	5,25	5,17	208.4	98	1,05	1,02	0,99
19.4	-7	37,91	37,05	36,20	111.2	44	5,16	5,08	4,99	210.2	99	1,03	0,99	0,96
21.2	-6	36,24	35,43	34,02	113.0	45	4,99	4,91	4,82	212.0	100	1,00	0,97	0,94
23.0	-5	34,65	33,89	33,14	114.8	46	4,83	4,74	4,66	213.8	101	0,98	0,94	0,91
24.8	-4	33,14	32,43	31,73	116.6	47	4,67	4,59	4,51	215.6	102	0,95	0,92	0,89
26.6	-3	31,71	31,04	30,39	118.4	48	4,52	4,44	4,36	217.4	103	0,93	0,90	0,87
28.4	-2	30,35	29,72	29,11	120.2	49	4,38	4,30	4,22	219.2	104	0,91	0,87	0,84
30.2	-1	30,00	28,47	27,89	122.0	50	4,24	4,16	4,08	221.0	105	0,88	0,85	0,82
32.0	0	27,83	27,28	26,74	123.8	51	4,10	4,02	3,95	222.8	106	0,86	0,83	0,80
					125.6	52	3,97	3,90	3,82	224.6	107	0,84	0,81	0,78
					127.4	53	3,84	3,77	3,69	226.4	108	0,82	0,79	0,76
					129.2	54	3,72	3,65	3,57	228.2	109	0,80	0,77	0,74
					131.0	55	3,61	3,53	3,46	230.0	110	0,78	0,75	0,73

9.11 FLOW CHART – MASTER-SLAVE CONTROL SEQUENCE

Dunham-Bush Master-Slave Control Sequence (3 Duty + 1 Standby Chillers)



NOTE: THE ABOVE SEQUENCE AND SETTINGS ARE TYPICAL SETTINGS FOR 3 DUTY AND 1 STANDBY CHILLERS SYSTEM. THE SETTINGS MAY VARY DEPENDS ON SITE CONDITIONS.



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Manufacturer reserves the right to change specifications without prior notice.