SERIES 3900
LOW HUMIDITY GENERATOR

OPERATION AND
MAINTENANCE MANUAL

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Section 1

GENERAL INFORMATION

1.1 INTRODUCTION

The Model 3900 low humidity generating system is a facility capable of producing known humidity values using the combined fundamental principles of the "two temperature" and "two pressure" generators developed by NIST. This system is capable of continuously supplying accurately known humidity values for instrument calibration and evaluation. When used within the specified frost point range of -95.00 °C to 10.00 °C, the system will generate manually entered setpoints for days or even weeks unattended.

The 3900 operates using an embedded computer and control system to perform calculation and control functions. The Computer Control System utilizes a multifunction CPU in conjunction with other peripheral cards for control and is incorporated into the 3900 low humidity generator. Peripheral equipment, such as a printer or computer, may be connected using the bi-directional RS-232C interfaces.

Humidity and temperature setpoint values are input by the operator from the front panel keypad. The system is then automatically controlled at a setpoint, with visual indications of system status displayed in real time on the Liquid Crystal Display. The automatic features of this system allow the 3900 to generate humidity and temperature setpoints completely unattended, freeing the operating technician from the task of system monitoring and adjustment.

1.2 PRINCIPLE OF OPERATION

1.2.1 General Description

The Model 3900 humidity generation system is based on the "two temperature - two pressure" principle. This process involves saturating air or some other gas, such as nitrogen, with water vapor at a given temperature and pressure. The saturated high pressure gas is then reduced to test pressure and warmed to test temperature. The indication of saturation temperature, saturation pressure, test temperature, and test pressure may be used in the determination of all hygrometric parameters. Humidity generation by this system does not depend upon measuring the amount of water vapor, but rather is dependent on the measurements of temperature and pressure alone. The precision of the system is determined by the accuracy of the temperature and pressure measurements, and on the constancy of them throughout.

1.2.2 Humidity Formulas

The humidity (or water vapor content) of a gas may be expressed in a variety of ways. The humidity parameters available with the 3900, and the formulas used to derive them, will be expressed in terms of the two-temperature two-pressure generator. While some basic understanding of humidity is helpful, thorough knowledge of the following formulas and their relationships to the 3900 is not a requirement for successful operation of the generator.

1.2.2.1 Saturation Vapor Pressure, e

Saturation Vapor Pressure (SVP) is the pressure exerted by water vapor alone when in equilibrium with pure ice or water, and is expressed as a function of temperature only. Since SVP can be established with respect to either ice or water, two separate formulas are used. Wexler's[1] formula for SVP over water is expressed as

$$e_w(T) = \exp\left\{ \left[\sum_{i=0}^{6} C_i (T+273.15)^{i-2} \right] + D \bullet \ln(T+273.15) \right\} \quad (1)$$

where $C_0 = -2.9912729 \times 10^{3}$
$C_1 = -6.0170128 \times 10^{3}$
$C_2 = 1.887643854 \times 10^{1}$
$C_3 = -2.8354721 \times 10^{-2}$
$C_4 = 1.7838301 \times 10^{-5}$
$C_5 = -8.4150417 \times 10^{-10}$
$C_6 = 4.4412543 \times 10^{-13}$
$D = 2.858487$
T = temperature of the gas in °C.

For SVP over ice, the equation of Hyland & Wexler[2] is expressed as

$$e_i(T) = \exp\left\{ \left[\sum_{i=0}^{5} C_i (T+273.15)^{i-1} \right] + D \bullet \ln(T+273.15) \right\} \quad (2)$$

where $C_0 = -5.6745359 \times 10^{3}$
$C_1 = 6.3925247$
$C_2 = -9.6778430 \times 10^{-3}$
$C_3 = 6.2215701 \times 10^{-7}$
$C_4 = 2.0747825 \times 10^{-9}$
$C_5 = -9.4840240 \times 10^{-13}$
$D = 4.1635019$
T = temperature of the gas in °C.

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[1] Wexler, Arnold, Vapor Pressure Formulation for Water in Range 0 to 100 °C. A Revision., Journal of Research of the National Bureau of Standards - A. Physics and Chemistry, Vol. 80A, Nos. 5 and 6, September-December 1976, pp. 775-785, Equation 15.

[2] Hyland, Richard, and Wexler, Arnold, Formulations of the Thermodynamic Properties of the Saturated Phases of H_2O from 173.15 K to 473.15 K, Ashrae Transactions 1983, Part 2A, pp. 500-513, Equation 18

1.2.2.2 Enhancement Factor, *f*

The enhancement factor, *f*, corrects for the non-ideal behavior of air when it is used as the carrier gas. The enhancement factor is a function of two independent variables; pressure, P, and temperature, T. A formula for calculation of the enhancement factor at any given pressure and temperature above freezing is given by Greenspan[1] as

$$f_w(T,P) = \exp\left[\alpha\left(1 - \frac{e_w(T)}{P}\right) + \beta\left(\frac{P}{e_w(T)} - 1\right)\right] \qquad (3)$$

where P = the absolute pressure in Pascals, and

$e_w(T)$ = the saturation vapor pressure (in Pascals) at temperature, T.

The two remaining variables, α and β, are given as

$$\alpha = \sum_{i=0}^{3} A_i T^i$$

$$\beta = \exp \sum_{i=0}^{3} B_i T^i$$

where $A_0 = 3.53624 \times 10^{-4}$

$A_1 = 2.93228 \times 10^{-5}$

$A_2 = 2.61474 \times 10^{-7}$

$A_3 = 8.57538 \times 10^{-9}$

$B_0 = -1.07588 \times 10^{1}$

$B_1 = 6.32529 \times 10^{-2}$

$B_2 = -2.53591 \times 10^{-4}$

$B_3 = 6.33784 \times 10^{-7}$, and

T = temperature of the gas in °C.

This formula for the enhancement factor is valid over the pressure range of the 3900 and over the temperature range of 0 to 100 °C.

When calculating enhancement factors with respect to ice for temperatures from -100 to 0 °C, the formula becomes

$$f_i(T,P) = \exp\left[\alpha\left(1 - \frac{e_i(T)}{P}\right) + \beta\left(\frac{P}{e_i(T)} - 1\right)\right] \qquad (4)$$

where P = the absolute pressure in Pascals, and

$e_i(T)$ = the saturation vapor pressure (in Pascals) at temperature, T.

[1] Greenspan, Lewis, Functional Equations for the Enhancement Factors of CO_2-Free Moist Air, Journal of Research of the National Bureau of Standards - A. Physics and Chemistry, Vol. 80A, No.1, January-February 1976, pp. 41-44

Again the variables, α and β, are given as

$$\alpha = \sum_{i=0}^{3} A_i T^i$$

$$\text{and } \beta = \exp \sum_{i=0}^{3} B_i T^i$$

where $A_0 = 3.6449 \times 10^{-4}$
$A_1 = 2.93631 \times 10^{-5}$
$A_2 = 4.88635 \times 10^{-7}$
$A_3 = 4.36543 \times 10^{-9}$
$B_0 = -1.07271 \times 10^{1}$
$B_1 = 7.61989 \times 10^{-2}$
$B_2 = -1.74771 \times 10^{-4}$
$B_3 = 2.46721 \times 10^{-6}$, and
T = temperature of the gas in °C.

1.2.2.3 Frost Point

Frost point temperature, T_f, is the temperature to which a gas must be cooled in order to just begin condensing water vapor in the form of ice or frost. For this reason, frost point is not applicable above freezing. In relation to the two-temperature two-pressure generator, frost point vapor pressure is derived from the formula

$$e_i(T_f) = \frac{f(T_s,P_s) \cdot e(T_s) \cdot P_c}{f(T_f,P_c) \cdot P_s} \qquad (5)$$

where $f(T_s,P_s)$ = the enhancement factor at saturation temperature, T_s, and saturation pressure, P_s
$f(T_f,P_t)$ = the enhancement factor at the frost point temperature, T_f, and test pressure, P_t. (Since frost point is not known, this equation is solved by iteration.)
$e(T_s)$ = the SVP (e_i or e_w) at saturation temperature, T_s
P_t = the absolute test pressure, P_t
P_s = the absolute saturation pressure, P_s.

Then frost point temperature relative to that vapor pressure is solved for as the inverse of the SVP formula (see equation 2 section 1.2.2.1)

$$T_f = t \,\big|\, e_i(T_f) \qquad (6)$$

where $e_i(T_f)$ = SVP over ice at the frost point temperature, T_f, obtained from equation 5.

The 3900 generates a particular frost point by first selecting a suitable saturation temperature, T_s, then determining the saturation pressure, P_s, required to establish the correct frost point vapor pressure (and ultimately the correct frost point temperature) at any given test pressure, P_t. Frost point is independent of test temperature.

1.2.2.4 Dew Point

Dew point temperature, T_d, is the temperature to which a gas must be cooled in order to just begin condensing water vapor in the form of dew. Unlike frost point, dew point can exist both above and below freezing. In relation to the two-temperature two-pressure generator, dew point vapor pressure is derived from the formula

$$e_w(T_d) = \frac{f(T_s,P_s) \cdot e(T_s) \cdot P_t}{f(T_d,P_t) \cdot P_s} \qquad (7)$$

where $f(T_s,P_s)$ = the enhancement factor at saturation temperature, T_s, and saturation pressure, P_s

$f(T_d,P_t)$ = the enhancement factor at the dew point temperature, T_d, and test pressure, P_t. (Since dew point is not known, this equation is solved by iteration.)

$e(T_s)$ = the SVP (e_i or e_w) at saturation temperature, T_s

P_t = the absolute test pressure, P_t

P_s = the absolute saturation pressure, P_s.

Then dew point temperature relative to that vapor pressure is solved for as the inverse of the SVP formula (see equation 1 section 1.2.2.1)

$$T_d = t \,\big|\, e_w(T_d) \qquad (8)$$

where $e_w(T_d)$ = SVP over water at the dew point temperature, T_d, obtained from equation 7.

The 3900 generates a particular dew point by first selecting a suitable saturation temperature, T_s, then determining the saturation pressure, P_s, required to establish the correct dew point vapor pressure (and ultimately the correct dew point temperature) at any given test pressure, P_t. Dew point is independent of test temperature.

1.2.2.5 Parts Per Million by Volume, PPM_v

PPM_v is a relationship between the number of molecules of water vapor to the number of molecules of the dry carrier gas. In the two-temperature two-pressure generator, it is expressed by the relationship

$$PPM_v = \frac{f(T_s,P_s) \cdot e(T_s)}{P_s - f(T_s,P_s) \cdot e(T_s)} \cdot 10^6 \qquad (9)$$

where $f(T_s,P_s)$ = the enhancement factor at saturation temperature, T_s, and saturation pressure, P_s

$e(T_s)$ = the SVP (e_i or e_w) at saturation temperature, T_s

P_s = the absolute saturation pressure, P_s.

The 3900 generates a particular PPM_v by first selecting an appropriate saturation temperature, T_s, then determining the required saturation pressure, P_s. PPM_v is independent of test pressure and test temperature.

1.2.2.6 Parts Per Million by Weight, PPM_w

PPM_w is a relationship between the weight of the molecules of water vapor to those of the dry gas carrier. PPM_w is related to PPM_v by the relationship

$$PPM_w = \frac{MW_w}{MW_a} \cdot PPM_v \qquad (10)$$

where MW_w = molecular weight of water (≈ 18.02 g/mol)
MW_a = molecular weight of air (≈ 28.97 g/mol)
PPM_v = Parts Per Million by Volume from equation 9.

Therefore $PPM_w \approx 0.622\ PPM_v$. With the exception of the 0.622 scaling factor, PPM_w is generated in a manner identical to that of PPM_v. PPM_w is also independent of test temperature and test pressure. As shipped from the factory the default molecular weight of the carrier gas is set at 28.9645 g/mol, appropriate for a carrier gas of air. To change the molecular weight, consult the factory.

1.2.2.7 Relative Humidity, %RH

Relative Humidity, %RH, is a percentage ratio of the amount of water vapor in a given gas mixture to the maximum amount physically allowable in the gas at the same temperature and same pressure. As it relates to the two-temperature two-pressure generator, %RH is expressed as

$$\%RH = \frac{f(T_s,P_s) \cdot e(T_s) \cdot P_t}{f(T_t,P_t) \cdot e(T_t) \cdot P_s} \cdot 100 \qquad (11)$$

where $f(T_s,P_s)$ = the enhancement factor at saturation temperature, T_s, and saturation pressure, P_s
$f(T_t,P_t)$ = the enhancement factor at test temperature, T_t, and test pressure, P_t
$e(T_s)$ = the SVP (e_i or e_w) at saturation temperature, T_s
$e(T_t)$ = the SVP (e_i or e_w) at test temperature, T_t
P_t = the absolute test pressure, P_t
P_s = the absolute saturation pressure, P_s

The 3900 generates a particular Relative Humidity by first selecting a suitable saturation temperature, T_s, then determining the saturation pressure, P_s, required to establish the correct %RH at test temperature, T_t, and test pressure, P_t. Relative Humidity is dependent on both test temperature and test pressure.

The 3900 can display and generate %RH in either of two different methods. In the *Normal* mode of RH calculation, saturation vapor pressure at the test temperature, $e(T_t)$, is computed with respect to water (equation 1) for test temperatures above 0 °C, and with respect to ice (equation 2) for test temperatures below 0 °C. However, when configured for the *WMO* mode of RH calculation (in accordance with the guidelines of the World Meteorological Organization), the saturation vapor pressure at the test temperature, $e(T_t)$, is always computed with respect to water (equation 1) for all test temperatures, even those below 0 °C. Note that the two methods are identical when the test temperature is above 0 °C, and only differ from each other when the test temperature is below 0 °C. The method of RH calculation used by the 3900 is user selectable. See section 3.3.

1.3 SPECIFICATIONS

Frost Point / Dew Point Range-- -95 to +10 °C
Frost Point Accuracy--- ± 0.1 °C
Frost Point Resolution -- 0.01 °C
PPMv Range --- 0.05 to 12000 PPMv
Relative Humidity Range ---0.0002 to 50%
Saturation Pressure Range------------------------ 2 psi above ambient to 300 psiA
Saturation Pressure Accuracy (10 - 50 psiA)-------------------------- ±0.075 psiA
Saturation Pressure Accuracy (50 - 300 psiA) ------------------------ ±0.45 psiA
Saturation Pressure Resolution (10 - 50 psiA)--------------------------- 0.01 psiA
Saturation Pressure Resolution (50 - 300 psiA)---------------------------- 0.1 psiA
Saturation Temp Range --- -80 to +12 °C
Saturation Temp Accuracy-- ±0.1 °C
Saturation Temp Resolution-- 0.01 °C
Saturation Heating Rate-- 2 minutes per °C Avg
Saturation Cooling Rate-- 2 minutes per °C Avg
Gas Flow Rate Range---0.1 to 2 l/m
Gas Flow Rate Resolution---0.01 l/m
Gas Flow Rate Accuracy-- ±0.2 l/m
Gas Type-- Air or Nitrogen
Gas Pressure Rating (MAWP)---350 psiG
Refrigeration----------------------------- 1/3 HP R134A & 1/3 HP R23 in cascade
Heating-- Stainless Steel Immersion Heaters
Test Port ---1/4 Inch Swagelok® Tube Fitting

1.3.1 Facility Requirements

Electrical Power------------------------------------- 208-230VAC @ 50/60 Hz, 8A
Gas Supply (External)------------------Zero Air or Nitrogen @ 325 psiG @ 5 l/m
Floor Space------------------- 9 Square Feet, Allows 6 Inches on Sides and Rear

1.3.2 Environmental

Operating Temperature--- 15 °C to 30 °C
Storage Temperature--- 0 °C to 50 °C
Humidity-- 5% to 95% non-condensing

1.4 COMPUTER / CONTROL SYSTEM

1.4.1 General Description

The Computer Control System is embedded in the humidity generator. The computer controls all aspects of the humidity generation process (i.e. controlling temperatures, pressures, etc.) as well as performing all human interface functions of keypad input and information display. The computer also controls printer operation and interfaces with an external computer (optional) for bi-directional RS-232C communications.

The Computer Control System is considered a "single-point automation" unit, controlling the functions of the humidity generator to bring it to any operator input setpoint. The computer will always control the system at the most current setpoint that has been input, whether from keypad input, or from external computer input through the RS-232C port. The Computer Control System knows nothing of past or future setpoints, requiring the use of an external computer if automated humidity profiling or sequencing is desired.

1.4.2 Computer / Control System Configuration

Reference Drawings 95M39102, 95S39103 & 104

The Computer Control System consists of the following key components:

1) Embedded Computer system, consisting of:
    - a) CPU card
    - b) 8 channel, 16 bit A/D converter card with signal conditioning
    - c) Memory Card
    - d) Liquid Crystal Display driver card
    - e) Solid State Relay Board
2) 256 x 128, backlit, dot matrix Liquid Crystal Display (LCD) module
3) 16 key front panel keypad

1.4.2.1 Central Processing Unit (CPU)

Reference Drawing 95M39102

The Central Processing Unit (CPU) consists of a microprocessor, along with all supporting hardware required to interface with the other devices. During the humidity generation process, the CPU executes programming designed to control the parameters needed to generate humidity, such as pulsing heaters and operating valves. Virtually all functions of the system are controlled by this CPU which is responsible for system timing, user interfacing, information display, and parameter control.

The CPU also retrieves measured temperature and pressure data from the A/D, which it uses to calculate frost point, dew point, parts per million by volume, parts per million by weight and relative humidity. Once calculated, this and all other pertinent information is sent to the Liquid Crystal Display for real time numeric display. At given (user definable) intervals, the CPU also sends this data to the printer, if enabled, for hard copy output.

1.4.2.2 Liquid Crystal Display (LCD)

Reference Drawing 95S39112

The display incorporated into the 3900 low humidity generator is a backlit, 256 x 128, dot matrix Liquid Crystal Display (LCD). It is used for the purpose of displaying system information such as setpoints, measurements and any other information pertinent to the operation of the 3900 humidity generator.

1.4.2.3 Liquid Crystal Display Driver

Reference Drawings 95S39103, 95S39112

The Liquid Crystal Display Driver card receives display commands and data from the Central Processing Unit then converts these into the signals required to drive the Liquid Crystal Display module. It also incorporates a voltage inversion circuit, which converts +5 VDC input to a -21 VDC output required by the LCD module.

1.4.2.4 Keypad

Reference Drawings 95M39102, 95S39103

The 4 x 4 keypad is the human interface to the 3900 generator. From this keypad, the operator will select modes of operation from the menus, enter humidity and temperature setpoints for humidity generation, and perform any other interface functions where user input is required. During operation, most of the screens will show four rectangular shaped blocks at the right side of the display. These blocks correspond with the four blank keys on the left side of the keypad, which will be used to perform certain functions within the program.

1.4.2.5 Memory Card

Reference Drawings 95M39102, 95S39103

The Memory Card contains EPROM and battery backed RAM. This memory contains all program code and data required for operation of the generator. All programs are stored in EPROM, while all factory and user editable parameters (such as Calibration Coefficients) are stored in battery backed RAM.

1.4.2.6 Analog to Digital Converter (A/D)

Reference Drawings 95M39102, 95S39103

The Analog to Digital Converter card is a 16 bit analog to digital converter, with integral signal conditioning. It is used to continuously measure thermistor resistances and pressure transducer / flow meter voltages. Data obtained from the A/D board is sent to the CPU where it is used in the control process. The A/D converter has a usable voltage range of 0 to +5 VDC.

1.5 ELECTRICAL SYSTEM

1.5.1 AC Power Distribution

Reference Drawings 95M39104, 95S39105 through 95S39108

The 3900 requires a single phase AC power source. From the primary power switch S1, primary power is distributed to the refrigeration compressors, C1 and C2, through SSR8 and SSR9, the saturator fluid heater H1 through SSR10; the fluid pump P1 through SSR6; the console fan F1 through SSR7; and the DC power supplies PS1 and PS2.

1.5.2 Power Supply ±15, +5 VDC

Reference Drawings 95M39104, 95S39106 through 95S39112

The ±15 VDC portion of power supply PS1 provides power to the flow meter, the pressure transducers, the A/D card, and the LCD backlight inverter board. The mass flow transducer and the A/D card use ±15 VDC for their particular voltage requirements, while the pressure transducers require +15 VDC and the LCD backlight inverter board requires - 15 VDC.

The +5 VDC portion of power supply PS1 provides power to the computer system, the solid state relay board and the terminal interface board.

1.5.3 Power Supply +24 VDC

Reference Drawings 95M39104, 95S39106 & 107, 95S39109 & 110

The +24 VDC power supply PS2 provides power for all solenoid valves as well as the stepper motor drives SMD-1 and SMD-2.

1.5.4 Analog Inputs

The temperature, flow and pressure transducers are measured by the Analog to Digital Converter. Each of these is discussed further in the following sections.

1.5.4.1 Temperature Measurement

Reference Drawing 95S39111, 95S39114 & 115

Two thermistors are used by the system for continuous real time temperature monitoring.

A 1KΩ thermistor probe, RTD1, is connected to channel 1 of the Analog Terminal Board, ATB. It is used to measure and control the actual saturation temperature.

A 10KΩ thermistor probe, RTD2, is connected to channel 2 of the ATB. It is used to measure the test temperature, which is utilized for calculation and control of various humidity parameters, such as %RH. The computer senses that the probe is connected by monitoring terminal A2 of TIB.

When the Test Temperature probe is connected, a logic low is transferred from pin 1 to pin 2 of the probe connector, CN2, then to terminal A2 of TIB. When disconnected, terminal A2 is internally pulled high.

The thermistor temperatures are measured by the Analog to Digital Converter card (A/D) with a resolution of approximately 0.01 °C/bit. Since the temperatures measured by the A/D card are based on ideal R-T curves, further calibration to actual temperature values is performed by the CPU prior to use or display (refer to 4.2.2 for calibration).

A reference resistor of approximately 10KΩ is connected to channel 3 of the ATB, and is used to compensate for short and long term drift of the temperature measurement electronics in the A/D circuitry. Deviations from the reference resistor's nominal value are used to mathematically offset the measured values of the two thermistor probes.

1.5.4.2 Test Pressure Transducer

Reference Drawings 95S39111, 95S39114 & 115

The Test Pressure Transducer TR5 is powered by +15 VDC from the ±15 VDC power supply PS1. The output, 0-5 VDC for 0 to full scale (typically 50 psiA), is connected to channel 7 of the ATB for measurement by the A/D card. When connected this transducer continually monitors the test or barometric pressure. The computer senses that the probe is connected by monitoring terminal A3 of TIB. When the probe is connected, a logic low is transferred from pin 1 to pin 2 of the probe connector, CN3, then to terminal A3 of TIB. When disconnected, terminal A3 is internally pulled high.

1.5.4.3 Low Range Saturation Pressure Transducer

Reference Drawings 95S39111, 95S39114 & 115

The Low Range Saturation Pressure Transducer TR3 is powered by the ±15 VDC power supply PS1, and has a measurement range of 0 to 50 psiA. This pressure transducer is pneumatically connected to the saturator via a computer controlled solenoid valve SOL4 that is only activated below 50 psiA to monitor saturation pressure. The output voltage, 0-5 VDC for 0 to 50 psiA, is connected to channel 5 of the ATB for measurement by the A/D card.

1.5.4.4 High Range Saturation Pressure Transducer

Reference Drawings 95S39111, 95S39114 & 115

The High Range Saturation Pressure Transducer TR4 is powered by the ±15 VDC power supply PS1, and has a measurement range of 0 to 300 psiA. This transducer is generally used to measure saturation pressures above 50 psiA. Operation is identical to that of the test pressure transducer described in section 1.5.4.3. The output voltage, 0-5 VDC for 0 to full scale, is connected to channel 6 of the ATB for measurement by the A/D card.

1.5.4.5 Gas Supply Pressure Transducer

Reference Drawings 95S39111, 95S39114 & 115

The Gas Supply Transducer TR1 is powered by +15 VDC from the ±15 VDC power supply PS1. The output is connected to channel 4 of the ATB for measurement by the A/D card. This transducer monitors the regulated gas supply pressure.

1.5.4.6 Mass Flow Meter

Reference Drawings 95S39111, 95S39114 & 115

The mass flow meter TR2 is a thermal type transducer and is powered by the ±15 VDC power supply PS1. The output of the transducer is 0-1 VDC for a mass flow rate of 0-2 l/m. The output voltage is connected to channel 0 of the ATB for measurement by the A/D card.

1.5.5 Control Logic

All control is performed digitally at a logic level of 5 VDC. Activation of most devices is accomplished by applying a logic low to the control input of the associated solid state relay or other coupling device.

1.5.5.1 Gas Supply Solenoid Valve

Reference Drawings 95S39107, 95S39114 & 115

The Gas Supply Solenoid Valve SOL1 is activated (gas on) by applying a low from the CPU (monitored at TIB terminal C5) to the optical input (-) side of SSR5 on the Solid State Relay Board. Valve actuation voltage is 24 VDC.

1.5.5.2 Fluid Pump Purge Solenoid Valve

Reference Drawings 95S39107, 95S39114 & 115

The Fluid Pump Purge Solenoid Valve SOL2, when activated, allows a dry gas supply to be vented into the pump motor housing area in an effort to keep this area free of ice build up when operating at very cold temperatures. The valve is activated by applying a low from the CPU (monitored at TIB terminal C4) to the optical input (-) side of SSR4 on the Solid State Relay Board. Valve actuation voltage is 24 VDC.

1.5.5.3 Saturator Vent / Purge Solenoid Valve

Reference Drawings 95S39107, 95S39114 & 115

The Saturator Vent / Purge Solenoid Valve SOL3, when activated, allows the saturator pressure to vent to ambient. This valve is activated when performing shutdown, clear and purge procedures. The valve is activated by applying a low from the CPU (monitored at TIB terminal C3) to the optical input (-) side of SSR3 on the Solid State Relay Board. Valve actuation voltage is 24 VDC.

1.5.5.4 Pressure Select Solenoid Valve

Reference Drawings 95S39107, 95S39114 & 115

The Pressure Select Solenoid Valve SOL4, when activated, allows the generator to monitor the saturator using the 50 psiA pressure transducer when the saturator is operating in the ambient to 50 psiA range. The valve is activated by applying a low from the CPU (monitored at TIB terminal C2) to the optical input (-) side of SSR2 on the Solid State Relay Board. Valve actuation voltage is 24 VDC.

1.5.5.5 Saturator Refrigerant Solenoid Valve

Reference Drawings 95S39107, 95S39116

The Saturator Refrigerant Solenoid Valve SOL5, when activated, allows refrigerant to be injected into the refrigeration evaporator EX1 to cool and control the temperature of the saturator. Activation of this solenoid valve is accomplished by applying a low from the CPU (monitored at TIB terminal C0) to the optical input (-) side of SSR0 on the Solid State Relay Board. Saturation temperature is controlled through fixed frequency pulse width modulation of SOL5. Valve actuation voltage is 24 VDC.

1.5.5.6 Saturator Inlet/Outlet Heater

Reference Drawing 95S39107

The Saturator Inlet/Outlet Heater H2 is a resistive heating element which keeps the inlet and outlet tubing of the saturator slightly warmer than the saturator itself in order to limit condensation in this area. Activation of this heater is accomplished by applying a low from the CPU (monitored at TIB terminal C5) to the optical input (-) side of SSR5 on the Solid State Relay Board. Heater drive voltage is 24 VDC.

1.5.5.7 Saturator Fluid Heater

Reference Drawings 95S39108, 95S39116

The Saturator Fluid Heater H1 is a resistive heating element, activated by a two-stage control process. Heat limit switch HLS1 must be in the normally closed position, indicating that saturator fluid temperature is within allowable limits (i.e. below 30°C). Activation is then accomplished by applying a low from TIB channel B5 to the optical input (-) side of SSR10. Saturator heater temperature is controlled through fixed frequency pulse width modulation of the heater power at the AC line voltage.

1.5.5.8 Saturator Fluid Circulation Pump

Reference Drawings 95S39107, 95S39116

The Saturator Fluid Circulation Pump P1 is a centrifugal pump energized by applying a low from the CPU (monitored at TIB terminal C6) to the optical input (-) side of SSR6 on the Solid State Relay Board. The pump is powered at AC line voltage.

1.5.5.9 Saturator Refrigeration Compressors

Reference Drawings 95S39108, 95S39116

The R-134A Compressor, C1, is energized by applying a low from the CPU (monitored at TIB terminal C6) to the optical input (-) side of SSR8. The R-23 Compressor, C2, is energized by applying a low from the CPU (monitored at TIB terminal B6) to the optical input (-) side of SSR9. Compressor C2 is not activated by the computer until compressor C1 has been on for several minutes. Both compressors are powered at AC line voltage.

1.5.5.10 Flow Control Valve

Reference Drawing 95S39109, 95S39114 & 115

The Flow Control Valve V1 is a bi-directional ball valve actuated by a gear reduced stepper motor. The valve is driven indirectly via pulses from the CPU to TIB terminals B0 & B2, which trigger stepper motor driver SMD-1. Pulses on channel B0 turn the valve clockwise, while pulses on channel B2 turn the valve counter clockwise. The stepper motor driver is powered from the 24 VDC power supply. Controlled by the CPU using feedback from the mass flow sensor, the computer operated flow control valve allows the mass flow rate to be controlled by varying the orifice of the flow control valve from nearly closed to fully open depending upon the required mass flow rate. This valve also determines direction of flow for purge and generate modes. When in generate mode, flow control is accomplished in the proper direction using one of the orifices. When in purge mode the other orifice is used causing the gas to flow in a different direction. The central point between the two orifices is the HOME or CENTER CLOSED position of the valve. The HOME position is sensed by a low at TIB channel A0 resulting from the contact closure of limit switch SL1.

1.5.5.11 Expansion Valve

Reference Drawings 95S39110, 95S39114 & 115

The Expansion Valve V2, or saturation pressure control valve, is a bi-directional ball valve actuated by a gear reduced stepper motor. The valve is driven indirectly via pulses from the CPU to TIB terminals B1 & B3, which trigger stepper motor driver SMD-2. Pulses on channel B1 turn the valve clockwise, while pulses on channel B3 turn the valve counter clockwise. The stepper motor driver is powered from the 24 VDC power supply. Controlled by the CPU using feedback from the saturator pressure transducers, the computer controlled expansion valve allows the saturated high pressure air stream to be reduced to test pressure by varying the orifice of the expansion valve from nearly closed to fully open depending upon the required saturation pressure. This valve also determines direction of flow for purge and generate modes. When in generate mode, flow control is accomplished in the proper direction using one of the orifices. When in purge mode the other orifice is used causing the gas to flow in a different direction. The central point between the two orifices is the HOME or CENTER CLOSED position of the valve. The HOME position is sensed by a low at TIB channel A1 resulting from the contact closure of limit switch SL2.

1.6 PNEUMATIC SYSTEM

The pneumatic system of the Model 3900 is an open loop "two pressure" system. Dry, high pressure, high purity gas is saturated with water vapor as it passes through the saturator assembly, then reduced to test pressure. Once reduced to the test pressure the gas is sent to the device under test and ultimately vented to the atmosphere.

Dry high purity gas, regulated at up to 350 psiG, is connected to the gas supply inlet. The gas is filtered by a 7 micron filter LF1, then admitted through the supply pressure regulator REG to the ON/OFF solenoid valve SOL1. This regulator is factory preset to 300 psiG. Regulated pressure is measured by the supply pressure transducer TR1.

After pressure regulation, the gas flows from the mass flow transducer TR2 to the flow control valve V1. The gas is admitted through valve V1 in one of two modes:

A) Generate Mode: (reference drawing 95S39114)

The gas flows from flow control valve V1 through the saturator and is saturated with water vapor as the gas establishes thermal equilibrium with the saturator fluid. The saturation pressure, P_s (TR3 or TR4), and saturation temperature, T_s (RTD1), of the gas are then measured. Upon exiting the saturator, the saturated gas encounters the expansion valve V2 and the saturation pressure is reduced to test pressure. The gas stream enters the device under test from the fitting located on counter top, at the desired humidity, given test pressure, P_t, and test temperature, T_t, conditions. The gas exits the device under test and is then vented to the atmosphere.

B) Purge Mode: (reference drawing 95S39115)

By reversing the normal path the gas follows in the generate mode, it is possible to purge the system of any unwanted moisture. The gas flows from flow control valve V1 through valve V2 to the saturator. The gas passes from the saturator to the vent / purge solenoid valve SOL3 and out the saturator vent outlet.

1.7 FLUID SYSTEMS

1.7.1 Saturator Fluid System

Reference Drawing 95S39116

Temperature conditioning of the saturator employs a methanol fluid circulation system in conjunction with a cascade refrigeration system. Methanol is circulated by a magnetically coupled centrifugal pump P1 at approximately two gallons per minute. The methanol is piped from the circulation pump to the immersion heater H1, through the R-23 refrigerant evaporator EX1 to the saturator fluid jacket. From the saturator fluid jacket the methanol is piped back to the circulation pump completing the saturator fluid circuit. RT1 is a methanol expansion tank.

1.8 REFRIGERATION

The Model 3900 utilizes a cascade refrigeration system to cool the fluid circulating the saturator assembly.

1.8.1 Saturator Refrigeration

Reference Drawing 95S39116

The saturator fluid system is cooled by two hermetic refrigeration systems in cascade. The high stage refrigeration utilizes Refrigerant 134A. This refrigerant is compressed from a low-pressure vapor into a high-pressure vapor by compressor C1. The high-pressure vapor flows to the air-cooled condenser CON1 where it is cooled to a high-pressure liquid as heat is removed. The condensed refrigerant passes through the filter-drier FD1 to the thermostatic expansion valve V3. Refrigerant is metered into the interstage cooler CON2, heat is removed, and the heat laden vapor is piped back to the compressor and the cycle is repeated.

The low stage refrigeration system utilizes Refrigerant 23, which has a boiling point of -81.4°C. The refrigerant is compressed from a low-pressure vapor to a high-pressure vapor by compressor C2. The high-pressure vapor flows through the oil separator OS1 to the interstage cooler CON2 where heat is removed as it is cooled to a high-pressure liquid. Upon demand, refrigerant is admitted through solenoid valve SOL5 to the capillary tube where it is metered into the saturator fluid heat exchanger/R-23 evaporator EX1. The refrigerant expands and changes to a low-pressure vapor as it absorbs heat from the saturator fluid circuit. The vapor is then piped back to the suction side of the compressor and the cycle is repeated.

Section 2

INSTALLATION

2.1 GENERAL

Preparations should be made to have adequate floor space, proper power source, and a dry gas supply available at the location of installation.

2.2 FACILITIES REQUIRED

Reference Drawing 94M39100

2.2.1 Floor Space

A minimum 9 ft^2 (0.84 m^2) of floor space is recommended for the 3900. This allows 6 inches (0.15 m) of access to side and rear console panels.

2.2.2 Power

The 3900 humidity generator requires a single phase AC power source as indicated on the identification label on the rear of the unit.

2.2.3 Gas Supply

The 3900 requires a gas supply that is clean, dry and oil free. Zero nitrogen or air regulated to a pressure between 325 and 350 psiG (≈ 22 to 24 bar gauge), with a flow rate capability of 5 standard liters/minute, and an ambient pressure frost point of -80 °C or lower is recommended.

2.3 PREPARATION

Reference Drawing 95M39101

Temperature conditioning of the 3900's saturator employs a fluid circulation system in conjunction with a cascade refrigeration system. Methyl alcohol (methanol) is used as the heat transfer medium in this fluid circulation system because of its low freezing point (-93 °C). The methanol has been drained prior to shipment and must be replaced prior to power-up and operation. Extreme caution is required in the filling due to the flammability of methanol.

2.3.1 Methanol Filling Procedure

Equipment Required:

1. 1.5 gallons (5.675 Liters) of anhydrous methanol
2. 7/8" (23 mm) socket with 6" (0.15 m) extension
3. 3/16" (4.5 mm) ball/hex driver (to remove counter top bolts)
4. 3/8" (9.5 mm) ball/hex driver (to remove Methanol Expansion Tank Fill Port Plug)
5. Funnel
6. Gloves and goggles

CAUTION!

METHANOL IS FLAMMABLE AND POISONOUS

Keep away from sparks, flames, or other ignition sources. Avoid prolonged or repeated breathing of vapors or contact with skin. Do not allow material to contaminate water sources.

To fill saturator fluid system, proceed as follows:

1) Ensure power source is **not** connected.

2) Remove left and right side console panels.

3) Using 3/16" ball/hex driver, remove 4 securing bolts near corners, and remove counter top.

4) Locate and remove RTD access insulation. Using the 7/8" socket with 6" extension, remove the Saturator Methanol Fill Port Cap from the top of the saturator.

5) Remove circular insulation and the Methanol Expansion Tank Fill Port Plug.

6) Insert the funnel into the Methanol Expansion Tank Fill Port. **Slowly and carefully** fill the saturator assembly until methanol is observed just below the Saturator Methanol Port Fitting located on top of the saturator (in the square insulation area).

   Note - *The methanol must be added slowly as it is being gravity fed through 3/8" tubing between the methanol expansion tank and the saturator. Do not allow funnel to fill.*

   Methanol degrades the urethane foam insulation; sponge dry any methanol spilled during the filling operation!

7) Replace the saturator methanol port cap (tighten 1/4 turn past finger tight).

8) Replace methanol expansion tank fill port plug.

9) Replace all insulation.

10) Replace counter top and console panels.

2.3.2 Vent Muffler

Install vent muffler into gas vent port at rear of system.

2.4 POSITIONING & LEVELING

1) Position the system so as to have access to all sides of the console.

2) Lower leveling legs and raise the wheels off the floor to hold system stationary. Level the console using counter top as a reference. Tighten leveling leg locking nuts against frame.

2.5 FACILITY CONNECTIONS

Reference Drawing 94M39100

2.5.1 Gas Supply

1) Connect a source of clean, oil free, gas to "GAS INLET" with a line size equal to or larger than the 1/4" OD tubing on console. The gas supply should be regulated to a pressure between 325 and 350 psiG (Maximum Allowable Working Pressure is 350 psiG).

2.5.2 Pressure Vent

No connection is required. Normally a sintered filter is installed. A small tray should be placed under the vent to catch drips of water.

CAUTION!

Do not restrict or back-pressure the gas vent in any way.

2.5.3 AC Power

1) Connect to a source of single phase AC power per specifications on the identification label on the rear of the unit.

OPERATION

3.1 GENERAL

At this point, all preparation and positioning of the Model 3900 humidity generator should have been performed. Refer to section 2.

3.2 STANDARD OPERATING PROCEDURES

3.2.1 Power-Up

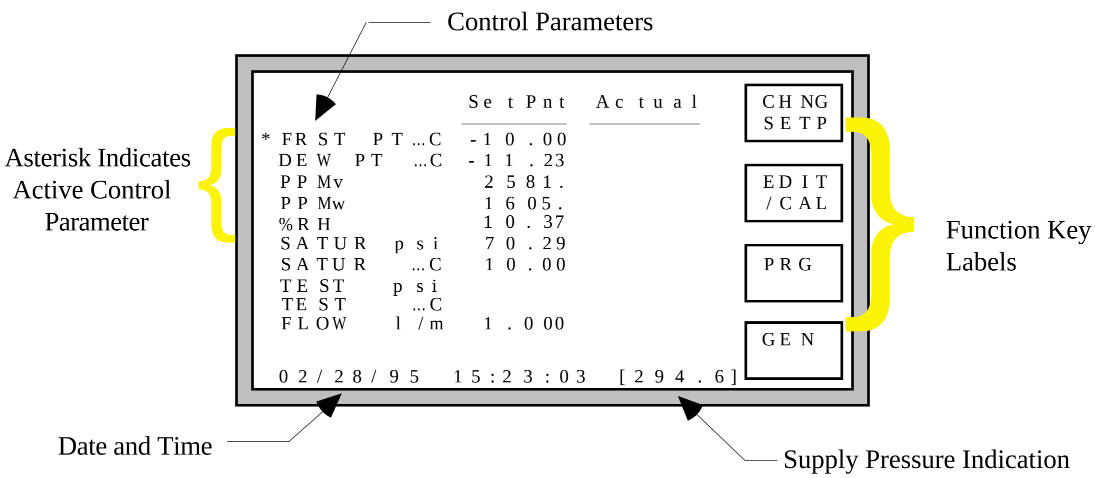
1) Verify that the gas supply connection has been made and the gas supply is pressurized. Open any On/Off valve in the supply line if applicable.

2) Verify that primary AC power is connected to the console and is switched ON.

3) Toggle the Power switch located at rear console panel to ON. Within a few seconds, the liquid crystal display will light, a banner will appear, and the generator will perform a very short diagnostics test.

3.2.2 Control/Display Screen

At the end of the power-up sequence, the following Control/Display Screen appears.



All control and measurement parameters critical to the operation of the humidity generator are displayed on this screen. Notice that in the leftmost column, each parameter is identified with a brief title and corresponding units. The asterisk in the leftmost column indicates the active humidity control parameter (section 3.2.4).

The Date and Time are displayed at the bottom of the screen, updating continuously every few seconds. To the right of the Date and Time is a number enclosed in square brackets [ ]. This is a measurement of the regulated input supply pressure.

The SetPnt column lists the user entered (and system calculated) control setpoints. The 3900 uses the setpoints as target values when controlling these parameters. The setpoints may be changed by the user at will (section 3.2.3).

The Actual column lists all of the measured data and calculated parameters of the generator.

A description of each of the Control/Display parameters follows:

Parameter	**Description**
FRST PT »C -	The Frost Point temperature calculated at test pressure, P_t, from saturation temperature, T_s, and saturation pressure, P_s. This calculation is independent of test temperature, and is only valid when below 0.01 °C Frost Point. Although inter-related, Frost Point is not the same as Dew Point.
DEW PT »C -	The Dew Point temperature calculated at test pressure, Pt, from saturation temperature, T_s, and saturation pressure, P_s. This calculation is valid both above and below 0 °C, and is independent of test temperature. While inter-related, Dew Point is not the same as Frost Point.
PPMv -	Parts Per Million by Volume, PPMv, calculated from saturation temperature, T_s, and saturation pressure, P_s. This calculation is independent of test temperature and test pressure.
PPMw -	Parts per Million by Weight, PPMw, calculated from saturation temperature, T_s, saturation pressure, P_s, and the molecular weight of the carrier gas. To change the molecular weight of the carrier gas, refer to section 3.3. This calculation is independent of test temperature and test pressure.
%RH -	The %RH calculated from saturation pressure, P_s, saturation temperature, T_s, at test pressure, P_t, and test temperature, T_t. This calculation is only accurate if the device under test is at the conditions indicated by the test temperature and test pressure probes. Placing these external probes at the humidity sensing point of devices under test gives the actual value of the relative humidity being imposed on the devices, as %RH is dependent on both test pressure and test temperature.
SATUR psi -	The saturation pressure measurement, P_s, in pounds per square inch absolute, as measured by the low or high range saturation pressure transducer. (Pressure units may be set to psi, bar, or hPa. See section 3.3) Various humidity values are generated by controlling the saturation pressure, relative to a constant saturation temperature, T_s. Saturation pressure is used in the calculation of all humidity parameters.
SATUR »C -	The temperature of saturation, T_s, as measured by the saturation fluid temperature probe. This is used to control the temperature of the fluid surrounding the saturator, thereby ultimately controlling the saturation temperature. Saturation temperature is used in the calculation of all humidity parameters.

TEST psi - The test pressure, P_t, in pounds per square inch absolute, measured whenever the test pressure transducer is plugged in. (Pressure units may be set to psi, bar, or hPa. See section 3.3) Since test pressure is used in the determination of Frost Point, Dew Point, and %RH, the test pressure transducer should be placed as close as possible to, but down stream of, the device under test in order to measure device pressure. When the test pressure transducer is not plugged in, calculations of Frost Point, Dew Point, and %RH are referenced to the user entered test pressure setpoint rather than any measured value. For accurate humidity generation under these conditions, the absolute pressure at the device under test should be entered as the test pressure setpoint.

TEST »C - The test temperature, T_t, as measured by the test temperature probe whenever the test temperature probe is plugged in. Since test temperature is used in the calculation of %RH, the test temperature probe should be placed as close as possible to either the temperature sensing element (for chilled mirror hygrometers, etc.) or the humidity sensing element (for solid state humidity sensors) of any device under test. When the test temperature probe is not plugged in, calculations of %RH are referenced to the user entered test temperature setpoint rather than any measured value. For accurate humidity generation under these conditions, the temperature at the device under test should be entered as the test temperature setpoint.

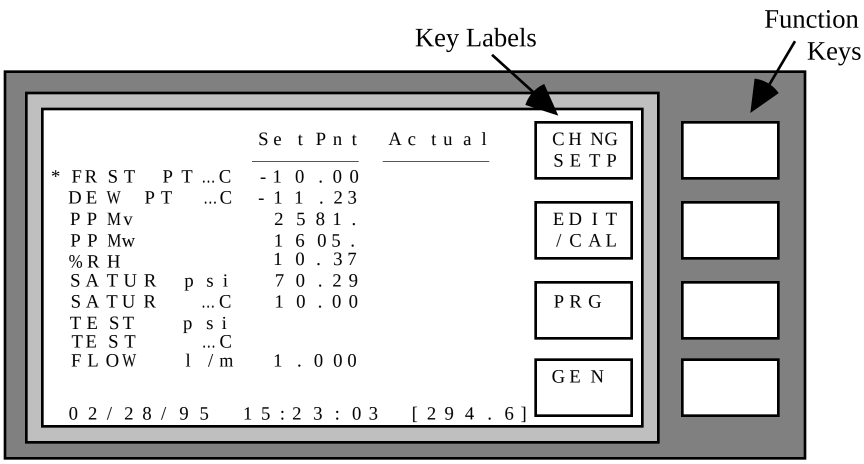
FLOW l/m - The mass flow rate, in standard liters per minute. Flow rate is not used in the calculation of humidity and is only an indication of the amount of gas flowing into the system. Since all gas flowing into the system also flows through and out of the system, it is useful for setting the desired flow rate through a device under test.

3.2.2.1 Changing the Display Contrast

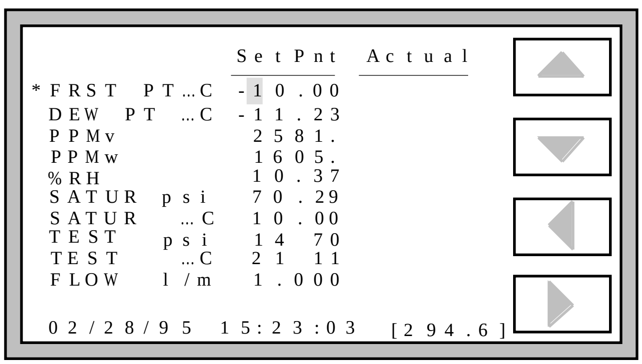
To increase the display contrast press the <1> key on the numeric keypad. To decrease the contrast, press the <0>. The new contrast setting is automatically remembered by the system.

3.2.3 Changing Setpoints

After the initial power-up sequence of section 3.2.1, the Control/Display screen appears. On the display are four rectangular function key labels. These labels correspond to the four blank keys on their right.



To change any of the Frost Point, Dew Point, PPMv, PPMw, %RH, pressure, temperature, or flow setpoints, press the [CHNG SETP] key. The menu labels then change to arrows.



A cursor block will begin flashing in the SetPnt column on the first digit of the **current humidity control parameter** (the one with the asterisk to the left). Move the cursor up, down, left, or right using the appropriate arrow key.

To change any (or all) of the setpoints, position the cursor over the desired setpoint, then edit the value using the numeric keypad. Continue using the arrow keys and the numeric keypad until all desired values have been changed.

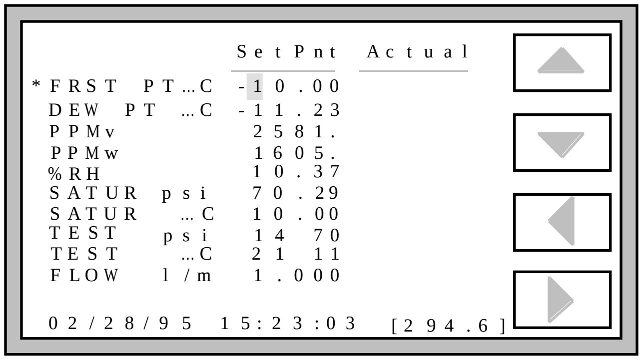
To enter a negative setpoint value for Frost Point, Dew Point, or Saturation Temperature, place the cursor on the leftmost digit of the desired setpoint and press the left arrow key to toggle the minus sign on and off.

End the setpoint editing session by pressing the <ENTER> key on the numeric keypad. The arrow keys revert back to their previously displayed functions, and the setpoints are validated and updated.

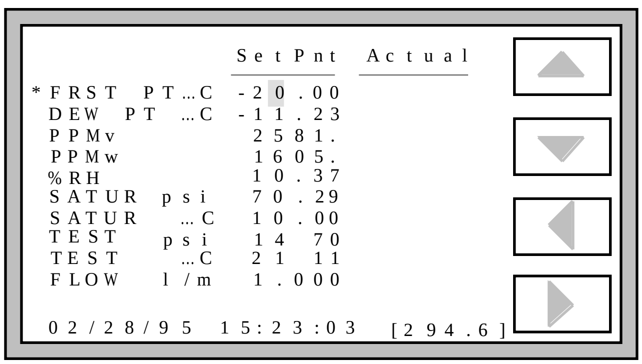
3.2.3.1 Example Setpoint Change

Change the setpoints to -20°C Frost Point at a flow rate of 0.50 l/m.

1) Press [CHNG SETP]. The key labels change to arrows, and the cursor begins flashing.

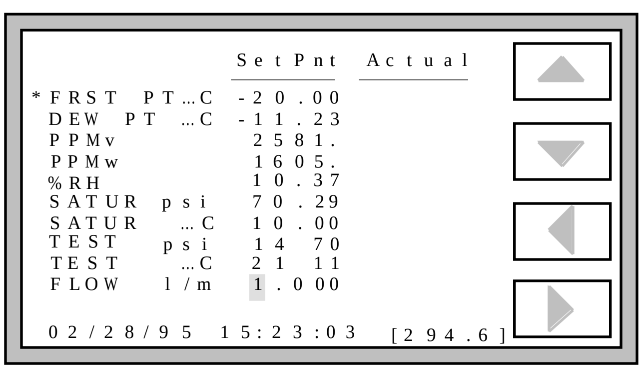


2) Using the arrow keys and numeric keys as necessary, make the FRST PT »C setpoint value on the screen appear as -20.00.

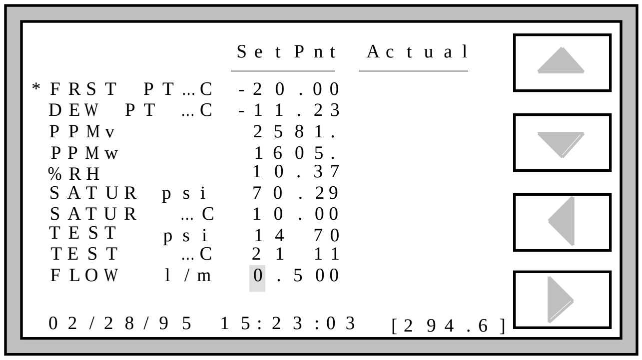


3) If the negative sign is not present, use the arrow keys to place the cursor on the leftmost digit of the FRST PT »C setpoint and press the left arrow key once. The negative sign will appear.

4) Move the cursor down to the FLOW l/m setpoint value.



5) Using the arrows and numeric keys as necessary, make the FLOW l/m setpoint value appear as 0.500.



6) Find the asterisk in the left most column of the display. If it <u>is not</u> next to the FRST PT »C label, use the arrow keys and position the cursor back at the FRST PT »C setpoint value. This tells the system to switch to Frost Point Control mode (see section 3.2.4).

7) Press the <ENTER> key. The cursor disappears, and the displayed function key labels revert back to their previous descriptions. There should also be an asterisk left of FRST PT »C to indicate that it is the humidity controlling parameter.

Setpoints within legal limits are accepted. Those setpoints that are slightly above or below these limits are simply replaced by the appropriate limit value. Those setpoints that are far beyond the limits revert back to the previous setpoint value and are accompanied by a short audible warning beep. This most often occurs when the user inadvertently enters a wrong value or fails to include a decimal point.

The system automatically chooses a suitable saturation temperature setpoint if the one displayed would require a saturation pressure outside the range of the systems capability. In other words, if the value of the current control parameter requires a saturation pressure that is either too high or too low to achieve, the saturation temperature is automatically adjusted to a new value that allows saturation pressure to work within normal limits. The resulting humidity output will be valid regardless of the saturation temperature and saturation pressure combination that the system chooses.

3.2.4 Control Modes

The generator has the ability to control the humidity in one of six possible modes.

Mode 0 *Power-up Default*

*FRST PT »C is controlled at a constant value by varying the saturation pressure, P_s, to compensate for changes in either saturation temperature, T_s, or test pressure, P_t. While Frost Point is held constant, PPMv, PPMw, and %RH may vary. When in Frost Point control mode, the saturation temperature setpoint is automatically determined.

Frost Point control mode is the one most often used, and is the power-up default mode of the generator. Frost Point control mode will automatically change to Dew Point control mode for setpoints above 0.01 °C.

Frost Point is independent of test temperature.

Mode 1

*DEW PT »C is controlled at a constant value by varying saturation pressure, P_s, to compensate for any changes in either saturation temperature, T_s, or test pressure, P_t. While Dew Point is held constant, PPMv, PPMw, and %RH may vary. While in Dew Point control mode, the saturation temperature setpoint is automatically determined.

Dew Point control mode is valid both above and below 0 °C.

Dew Point is independent of test temperature.

Mode 2

*PPMv is controlled at a constant value by varying saturation pressure, P_s, to compensate for any changes in saturation temperature, T_s. While PPMv is held constant, Frost Point, Dew Point, and %RH may vary. While in PPMv control mode, the saturation temperature setpoint is automatically determined.

PPMv is independent of test pressure and test temperature.

Mode 3

*PPMw is controlled at a constant value by varying saturation pressure, P_s, to compensate for any changes in saturation temperature, T_s. While PPMw is held constant, Frost Point, Dew Point, and %RH may vary. While in PPMw control mode, the saturation temperature setpoint is automatically determined.

PPMw is independent of test pressure and test temperature.

Mode 4

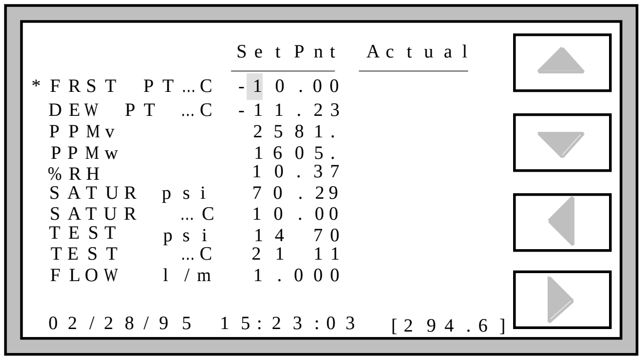
*%RH is controlled at a constant value by varying saturation pressure, P_s, to compensate for any changes in saturation temperature, T_s, test temperature, T_t, or test pressure, P_t. While %RH is held constant, all other humidity parameters may vary. While in %RH control mode, the saturation temperature setpoint is automatically determined.

Mode 5

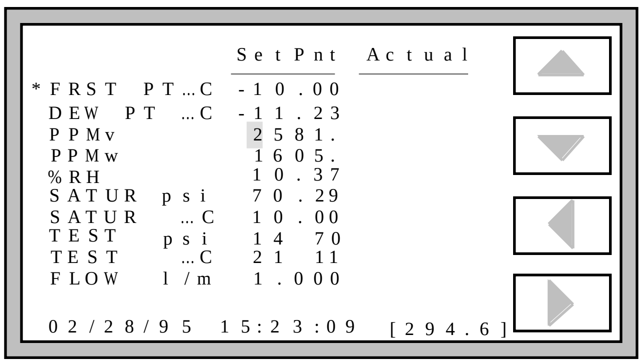
*SATUR psi , P_s, is controlled at a constant value independent of any other pressure, temperature, or humidity value. While saturator pressure is held constant, all humidity parameters may vary. While in saturation pressure control mode, the saturation temperature remains fixed at the user entered setpoint.

3.2.4.1 Changing Control Mode

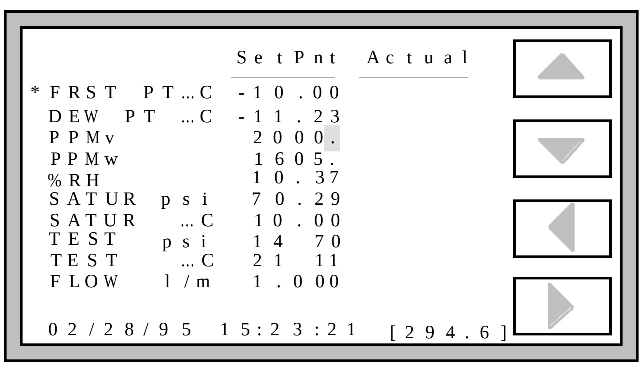
1) Get into the setpoint editing mode by pressing [CHNG SETP]. The key labels change to arrows.



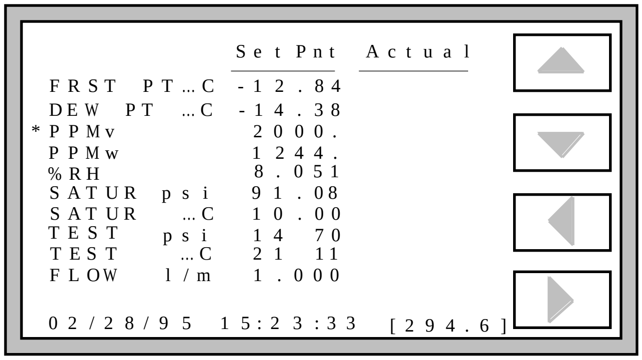
2) Position the cursor on the desired control parameter.



3) Change its value if needed.



4) With the cursor *still on that parameter*, press <ENTER>. The asterisk will then appear next to this selected control mode parameter.



When <ENTER> is pressed, the system first determines if there is a requested control mode change based on the position of the cursor. If the cursor is on one of the first six parameters, the control mode is changed to that parameter; otherwise the previous control mode remains in effect.

Next the setpoint of the active control mode is read and validated. Finally, the remaining parameters (Test Temperature, Test Pressure, and Flow) are read and validated. The current control mode parameter is indicated with an asterisk to it's left.

3.2.5 Purging

The Purge mode is generally used to prevent icing within the saturator and dry the saturator outlet after movement (transportation), storage (power off, no gas flow, etc.), after performing the saturator fill procedure (section 3.2.8), or while transitioning the saturator from higher to lower temperatures.

When the system is not being used (power off, no gas flow, etc.), the saturator is closed off and the gas within is static. As thermal equilibrium is reached, water vapor will condense on all inner surfaces between the saturator outlet and the expansion valve inlet. The Purge mode counteracts this condition by allowing the carrier gas to flow in the opposite direction (expansion valve to saturator), drying the affected sections of tubing. This is a necessary preparatory step in any low humidity system.

As a general rule, when starting from an ambient condition the system should be purged for 24 hours or more before attempting to operate in the Generate mode. If sufficient purge time is not allowed, condensed or trapped water will remain and system accuracy will suffer. Insufficient purge time is usually indicated by higher than normal (wetter than normal) indications of the device under test. These indications can be as little as a few tenths of a degree to as much as several degrees frost point.

Purging should also be performed while transitioning from warmer to colder saturation temperatures, and for approximately 5 hours after each 500 hours of continuous Generate mode operation.

During Purge mode, both flow control and saturation temperature control are active, but saturation pressure control is disabled. The generator will attempt to achieve the indicated flow and saturation temperature setpoint values.

Notes *-1) When the saturation temperature is lowered, the fluid jacket surrounding the saturator cools in order to reduce the saturation temperature to its new setpoint value. As the saturator cools during this transition period, temperature gradients will exist between the inside of the saturator and the fluid jacket that surrounds it. The saturator outlet passes through this fluid jacket and will also exhibit temperature gradients along its length. If gas is allowed to flow normally through the saturator during this cooling period, the 100% humidified gas of the saturator may condense at the colder saturator outlet. Therefore, Purge mode should be used while cooling the saturator to lower temperatures. For this reason, the lowest humidity of a generation sequence or profile should be performed first. This low to high order requires that a Purge be performed only once prior to the generation sequence when cooling to the lowest saturation temperature. Then as humidity values are increased, warming the saturator to higher values, further purging is not required.*

2) During Purge, no gas flows to the 3900 Conditioned Gas Outlet, and consequently no gas flows through the device under test if connected.

3.2.5.1 Purge Procedure

1) From the idle Control/Display screen press [PRG]. The pump and compressors start and purge gas begins flowing within several seconds. Or, if the system is currently running in the Generate mode, press [PRG GEN*] to switch to Purge mode. Within a few seconds, the following screen appears.

```
                     SetPnt    Actual       [CHNG]
                                            [SETP]
* FRST PT ...C     -10.00
  DEW  PT  ...C    -11.23
  PPMv              2581.                   [CLR ]
  PPMw              1605.
  %RH               10.39
  SATUR  psi        70.29      14.48
  SATUR   ...C      10.00      10.00        [PRG*]
  TEST   psi                   14.70        [GEN ]
  TEST    ...C                 21.10
  FLOW   l/m        1.000      1.001
                                            [STOP]
  02/28/95   15:23:03   [296.4]
```

2) Using the [CHNG SETP] key, adjust setpoints to desired settings.

   A) Typical purge flow rate is 1 liter/minute. Lower flows (minimum 0.1 l/m) will conserve gas while higher flow rates (maximum 5 l/m) will decrease purge time.

   B) Saturation temperature should be set to the lowest temperature desired in the humidity generation sequence. However, when starting from a power-on condition, allow the generator to purge at the default setpoint (10 °C) for several hours before adjusting the setpoint to a lower value. The higher the saturation temperature during purge, the quicker the system will dry down. This makes it easier to evaporate any condensate that may exist in the saturator outlet tubing.

   To change the saturation temperature setpoint, edit one of the humidity control setpoints to a desired minimum target value. The saturation temperature setpoint will automatically adjust. (See note 1.)

3) Remain in the Purge mode for 24 to 48 hours if possible, depending on (1) flow rate, (2) how low the saturation temperature setpoint is, and (3) the length of time that the system purged while at a higher saturation temperature (discussed in step 2B above). Lower flow rates and lower saturation temperatures require longest purge times.

Notes *-1. Entering a humidity control setpoint value causes the generator to automatically determine a suitable saturation temperature for that humidity. Saturation temperature setpoint must always be at least 2 °C above the frost point setpoint, and in general will not be more than 20 to 30 °C above frost point setpoint. If an attempt is made to directly adjust the saturation temperature setpoint outside these bounds, it will automatically readjust to a suitable value for the setpoint of the current humidity control parameter.*

2. When in the Purge mode, if the flow rate will not achieve setpoint or drops to zero, icing may have occurred within the saturator passages, the saturator vent, or at the saturator inlet causing the generator to shutdown due to Error 4 - Low Supply Pressure. If this condition occurs, restart the generator, adjust the mass flow setpoint to zero, adjust the saturation temperature setpoint to 5 °C or warmer and allow to stabilize. Perform the Saturator Clear procedure (Section 3.2.6), then readjust setpoints and continue in the Purge mode.

3.2.6 Saturator Clear

This procedure is used to clear the saturator of any excess water that may have occurred as a result of filling (see section 3.2.8), as a result of movement (such as transportation), or as a result of freezing and thawing a full saturator. Any time that water is observed at the gas vent whether after filling, movement, or thawing, the saturator should be cleared several times until no further indication of excess water exists.

If the saturator has not been recently filled, and the generator not moved, saturator clearing is normally not needed (although it can never hurt).

3.2.6.1 Saturator Clear Procedure

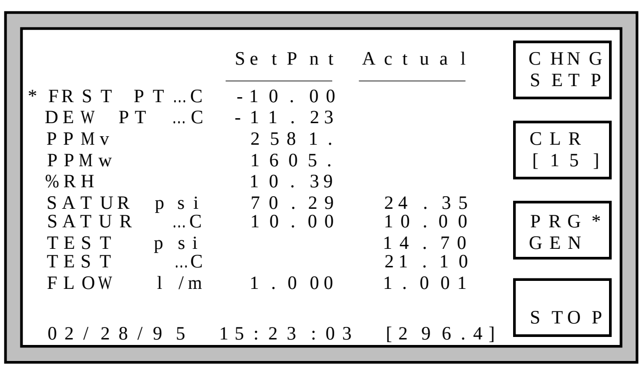
1) From the Control / Display screen press [PRG] to enable the purge mode. The pump and compressors start and purge gas begins flowing within several seconds.

   Or, if the system is currently running in the Generate mode, press [PRG GEN*] to switch to Purge mode.

2) View the saturator temperature. If the generator is or has been operating below 0 °C, adjust the Dew Point setpoint to 2 °C or warmer. Then adjust the saturation temperature setpoint to 5 °C or warmer and allow the system to stabilize.

   Note - *The saturation temperature must be above 0 °C for a minimum of four hours before proceeding with the saturator clear procedure. This allows any ice in the saturator to completely melt.*

3) Press [CLR] key **3 times**. The key will increment to [CLR 15]. This clears the saturator of excess water for 15 cycles by pressurizing the system at 1 liter/minute and then quickly depressurizing the system through the gas vent at the rear of the generator. This will occur 15 times, decrementing the number on the [CLR] key after each cycle.



4) If water is still observed at the pressure vent port by the fifteenth cycle, press the [CLR] key again for more cycles. Each time the [CLR] key is pressed, 5 cycles are added. Repeat this step until all excess water has been cleared. (Pressing the <0> key on the numeric keypad aborts the clearing process, removing the number from the [CLR] key label.)

Upon completion of the Saturator Clear process, the system remains in the Purge mode at the flow rate indicated in the SetPnt column.

3.2.7 Generating

The Generate mode is used to generate a gas stream of desired humidity. In the Generate mode, the gas flows through the saturator where it is saturated with water vapor at the indicated saturation temperature and saturation pressure conditions, then flows to the device under test at test pressure and test temperature conditions. Before attempting to Generate, the Purge procedure (Section 3.2.5) should have been performed.

> ***Notes*** - *1. Upon initial receipt of the generator prior to use for the very first time, a Saturator Fill procedure (section 3.2.8 should be performed.)*
>
> *2. Before attempting to Generate after periods of inactivity, the Purge procedure (section 3.2.5) must be performed and allowed to purge for 24 to 48 hours.*
>
> *3. When in the Generate mode, if the flow rate indicates zero or remains well below setpoint, icing has occurred at the saturator outlet. This condition can occur after a saturator fill if an insufficient saturator clear and/or purge was performed. If this condition occurs, the saturator must be warmed above freezing (in the Purge mode) until the problem corrects itself. The Purge procedure (section 3.2.5) and the Saturator Clear procedure (section 3.2.6) must be performed.*

When the [GEN] key is pressed (or the [PRG* GEN] key from within the Purge mode), the temperature, pressure, and flow control processes begin. The fluid circulation pump will start and the refrigeration system will begin its start up sequence. If switching to Generate from the Purge mode, all control processes were already active with the exception of pressure control.

When in Generate mode, the 3900 will control at the values of humidity, temperature, and flow indicated in the SetPnt column. Setpoints may be freely changed regardless of whether the system is Generating, Purging, or Stopped. The values in the Actual column are the actual measured values, and when Generating will update approximately every 2 seconds.

```
                    SetPnt    Actual     [CHNG]
                                         [SETP]
*FRST PT …C        -10.00    -10.02
 DEW  PT …C        -11.23    -11.25
 PPMv               2581.     2576.      [PRNT]
 PPMw               1605.     1603.
 %RH                10.39     10.36
 SATUR  psi         70.29     70.42
 SATUR   …C         10.00     10.00      [PRG ]
 TEST   psi                   14.70      [GEN*]
 TEST    …C                   21.10
 FLOW   l/m         0.200     0.205

 02/28/95   15:23:03   [296.4]           [STOP]
```

The [PRNT] key is used to activate/deactivate the printer (see section 3.2.12).

The [PRG GEN] key is used to switch back and fourth between Generate and Purge modes.

Pressing [STOP] causes the computer to perform a system shutdown (see section 3.2.9).

3.2.7.1 Generating Procedure

> ***Note -*** *Before attempting to Generate after periods of inactivity, the Purge procedure (section 3.2.5) must be performed and allowed to purge for 24 to 48 hours.*

To operate the system in the Generate mode:

1) Enter the desired setpoints (section 3.2.3) and set the control mode (section 3.2.4).

> ***Note -*** *Flow rate must not be set higher than 2.0 liters/minute while in Generate mode.*

2) From an idle mode press [GEN]. Or, from the Purge mode, press [PRG* GEN]. Within a few seconds, the following screen appears.

```
                      SetPnt     Actual         CHNG
                                                SETP
*FRST PT …C          -10.00     -10.02
 DEW PT  …C          -11.23     -11.25
 PPMv                 2581.      2576.          PRNT
 PPMw                 1605.      1603.
 %RH                  10.39      10.36
 SATUR  psi           70.29      70.42
 SATUR   …C           10.00      10.00          PRG
 TEST   psi                      14.70          GEN*
 TEST    …C                      21.10
 FLOW   l/m           0.500      0.505

 02/28/95   15:23:03   [296.4]                  STOP
```

3) Allow the system to run overnight if possible.

> ***Note -*** *Even though the greatest portion of excess moisture is removed with the purge procedures, an accurate humidity point may still take several hours to achieve, especially when attempting to generate very low humidities. For instance, a -80°C frost point temperature can typically take 24 hours or more to completely dry down the outlet tubing and the device under test.*

4) After operating in the Generate mode for several hours, the system should be at the desired humidity point. Check all instrumentation for stability and record a data point.

5) Adjust humidity to the next desired setpoint. Several hours should be allowed for the system and instrumentation being calibrated to stabilize and equilibrate to the new humidity value.

6) After the required amount of time, check all instrumentation for stability and record the data point.

7) Repeat steps 5 and 6 as required.

3.2.7.2 Example Instrument Set-Up

A chilled mirror hygrometer is to receive dew/frost point calibration at ambient temperature and pressure conditions.

1) Connect the gas inlet side of the chilled mirror to the generator outlet fitting with polished ID stainless steel tubing. The generator outlet is the Swagelok fitting located on the counter top farthest from the front of the generator. For best chilled mirror stability, insulate this tube.

2) Allow the chilled mirror outlet to exhaust to atmosphere through a short section of tubing. This helps to prevent upstream humidity permeation.

3) Connect the pressure transducer to mirror exhaust if other than atmospheric pressure. Ensure that the transducer is plugged into the 3900. Otherwise, enter the mirror pressure as the Test Pressure Setpoint.

4) If making relative humidity measurements, plug the Test Temperature probe into the 3900 and attach the probe to the mirror thermometer.

3.2.8 Saturator Fill

The saturator filling procedure should be performed upon initial use after installation, and approximately every 500 hours or more of operation thereafter, depending upon the humidities and flow rates generated. Generating high flow rates and high humidity values requires more frequent filling.

The generator may require up to ten ounces (300 cc) of pure water (triple distilled or better) per fill. The amount of run time available from each fill is dependent upon the Frost/Dew Point being generated (during a Purge, it is based upon the saturation temperature). Colder temperatures (lower humidities) require less water than do higher temperatures (higher humidities).

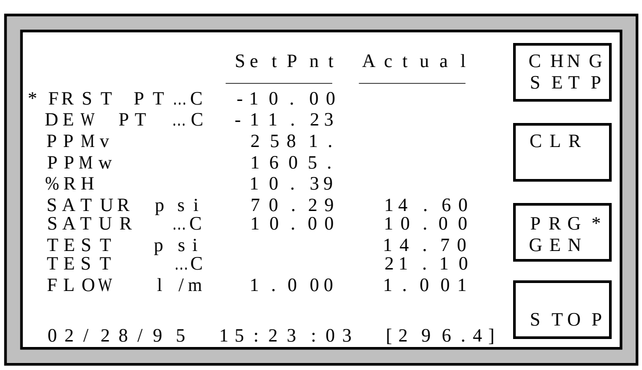
The following table illustrates the approximate run time available at various generated humidity values. The amount of water used is also dependent upon flow rate. For instance, using only 0.5 liters/min gives twice as much run time as listed below, while using 2.0 liters/min gives only one half as much run time as listed.

Dew/Frost Point Generated	**Approximate Continuous Run Time @ 1 liter/min flow**
+15 °C	400 hours (2 weeks)
+10 °C	500 hours (3 weeks)
0 °C	1000 hours (1.5 months)
-10 °C	2500 hours (3.5 months)
-30 °C	17,000 hours (2 years)
-50 °C	150,000 hours (17 years)
-70 °C	2,500,000 hours (285 years)

Even though the lower temperatures make it appear that the system would never require filling; remember that a Purge always starts first at the higher temperatures to remove excess condensed water within the saturator passages and outlet tubing. Under these circumstances, the saturator water will eventually be depleted even if the lower temperatures are all that is ever generated.

3.2.8.1 Saturator Fill Procedure

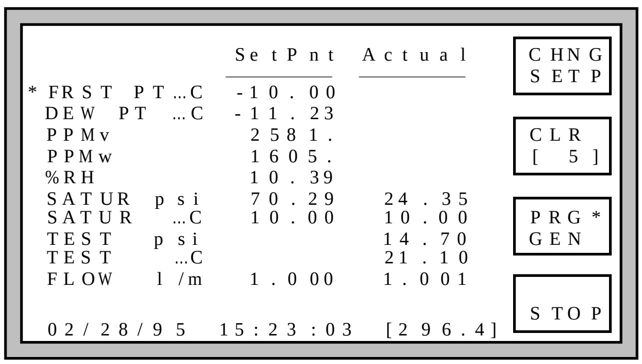
1) Put the system in a Purge mode, using the [PRG] key if the system is idle, or the [PRG* GEN] if currently in the Generate mode. Within a few seconds, the Purge screen appears.



2) View the Saturation Temperature (SATUR »C). If the Saturation Temperature Setpoint is below 0 °C, then (1) adjust the dew point to 2 °C or warmer, and (2) adjust the saturation temperature to 5 °C or warmer. Allow the Saturation Temperature to warm above 0 °C and stabilize before proceeding to allow all ice in the saturator to completely melt.

> ***Note*** - *Due to the large thermal mass of the saturator, the saturation temperature must be above 0 °C for a minimum of four hours before proceeding with the saturator fill procedure. This allows for sufficient thermal lag time when undergoing an ice/water phase change within the saturator.*

3) Press the [CLR] key. The key will increment to [CLR 5]. This step will perform 5 cycles of a pressurization/depressurization process which clears excess water from the pressure vent tubing and lower portions of the saturator prior to performing a saturator fill. Excess water is cleared by pressurizing the saturator at 1 liter/minute and then quickly depressurizing the saturator through the gas vent at the lower rear of the generator.



4) After the completion of the Clear cycles, adjust flow setpoint to 0.5 liters/minute.

5) Locate the saturator fill port at front right of counter top and remove the port cap.

6) Slowly add two ounces of pure water (triple distilled or reagent grade) into the fill port.

7) Press saturator [CLR] key **3 times** to increment the saturator clear counter to [CLR 15]. This clears the saturator of excess water for 15 cycles.

8) If water is not observed in the gas vent during the 15 cycles repeat steps 6-7. Continue repeating steps 6-7 until water is observed in the gas vent. Saturator capacity is approximately 10 ounces (300 cc).

9) If water is observed in the gas vent after the fifteenth cycle, press the [CLR] key for more cycles. Each time the [CLR] key is pressed, 5 cycles are added. Repeat this step until all excess water has been cleared.

10) Replace the port cap and tighten port cap 1/4 turn past finger tight.

11) Adjust flow setpoint to 1.0 liter/min.

12) Allow the generator to continue purging for 24 to 48 hours before proceeding.

13) While remaining in the Purge mode, adjust setpoints to desired settings and allow the saturation temperature to achieve its setpoint.

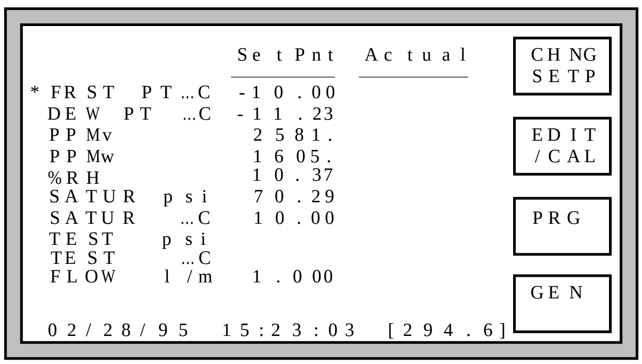
3.2.9 Stopping

The system may be stopped while either Generating or Purging. When stopped, all system functions shutdown, pressure is vented, the printer is disabled (if attached), and the idle Control/Display screen is shown. The system must be stopped in order to access the Edit and Cal modes.

During this idle time when the system is either Stopped, in the Edit mode, or in the Cal mode, no gas is flowing in the saturator. After extended periods of this idle time, the system must be Purged again prior to further use.

To Stop the system and enter and idle mode:

1) From either the Generate or Purge modes, press [STOP]. Within a few seconds, all system functions will shutdown and the idle Control/Display screen will appear.



The Stopped mode is easily distinguished from all others since all data in the Actual column is blank on this idle Control/Display screen.

3.2.10 Shutdown

A shutdown should be performed when servicing the 3900, or when use is not frequent enough (such as day to day) to justify leaving the instrument in the Generate or Purge mode. When these conditions apply, follow the complete shutdown procedure:

1) Press the [STOP] key. This disables the temperature control circuits, vents the system of excess pressure, and closes all valves.

2) Allow all pressure to vent, then toggle main power switch to OFF.

3) Cap conditioned gas outlet.

4) Turn gas source OFF.

5) If maintenance is to be performed, disconnect power source from the system.

3.2.11 Changing Gas Supply

It is quite common to operate the system from a non-permanent gas source such as compressed bottled gas or a LN_2 Dewar. These gas sources eventually become depleted and require changing. To change the gas supply without completely stopping or shutting down the system:

1) Set the Flow setpoint to 0 liters/minute. Allow a few seconds for the flow and saturation pressure indications to drop off. Temperature control will remain active.

2) Disconnect and remove the depleted gas source.

3) Connect to the new gas source.

4) Set the Flow setpoint back to the original setting. Within a few minutes, the system will return to its previous state.

3.2.12 Printer (optional)

Reference Drawings 94M39100, 95M39113

An optional printer is used for hard copy output of system data and other parameters. While the 3900 humidity generator is operating in a Generate mode, data is output on a timed interval basis when activated by the user. User alterable printer parameters are explained in section 3.3.2.6. The printer is connected to the printer port using either a factory supplied or user made cable. The required cable is simply a 9 to 25 pin AT Port Adapter (see drawings).

The [PRNT] key, when pressed, toggles to [PRNT ON] and causes measured system data to be sent to the printer at regular time intervals (see section 3.3 to change default time and other print parameters).

The [PRNT ON] key, when pressed, toggles to [PRNT], disables printer output, and sends a form feed to the printer. This also occurs when switching to Purge mode or Stopping.

The <ENTER> or <•> key, when pressed, immediately sends one line of system data to the printer regardless of the PRNT ON/OFF status, and independent of print time interval. Notice that this *print now* feature is not active while in the Change Setpoint mode.

3.3 EDITING SYSTEM COEFFICIENTS AND PARAMETERS

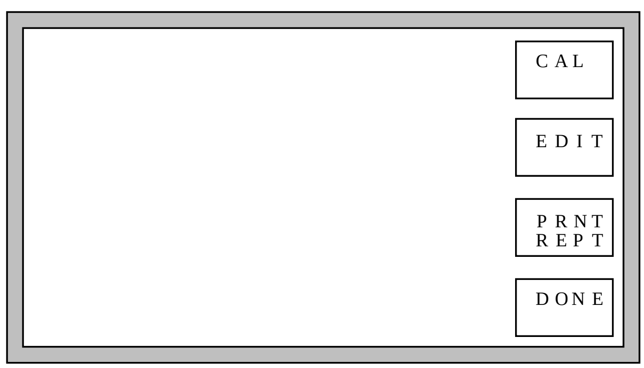
All of the calibration coefficients and system parameters may be viewed and/or edited by the operator. The following is a summary of these items.

Category	Editable Parameters
Temperature Coefficients	Coefficients and Averaging
Pressure Coefficients	Coefficients and Averaging
Flow Coefficients	Coefficients and Averaging
Console Port Parameters	Baud Rate, Parity, etc.
Printer Port Parameters	Baud Rate, Parity, Print Interval, Lines per Page, etc.
Time & Date	Time and Date of Real Time Clock
Misc User Parameters	RH Calculation Method (WMO), Pressure Units, Date Format, Molecular Weight of Carrier Gas

3.3.1 Edit Mode

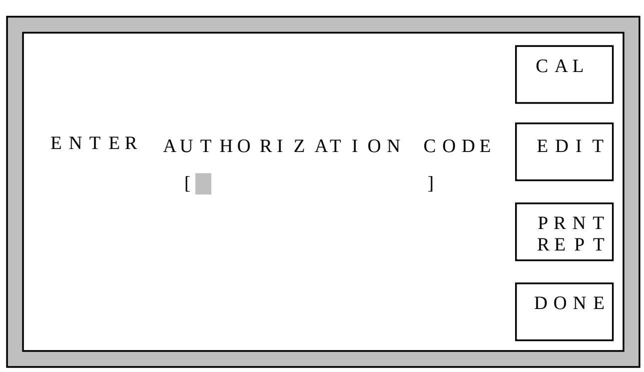
The EDIT mode is used for the viewing and editing process.

1) From the idle Control/Display screen, press [EDIT/CAL]. Note, for this menu option to appear the generator must not be in Generate or Purge mode. In a few seconds, the following menu appears.

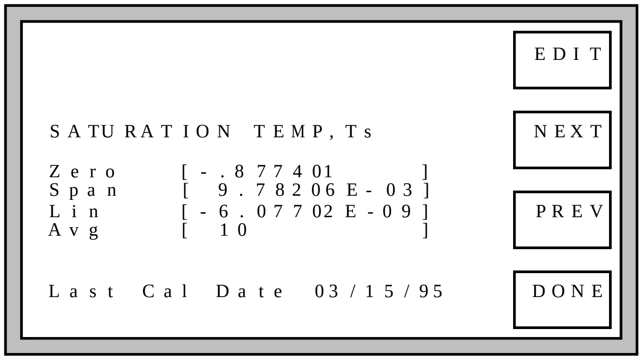


2) From this menu, press [EDIT].

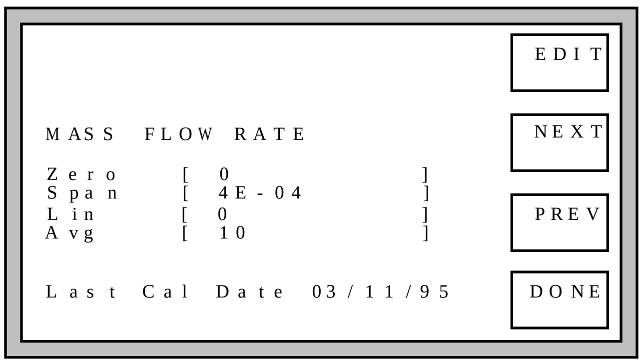
3) At the prompt, enter in your authorization code (found at the back of the manual).



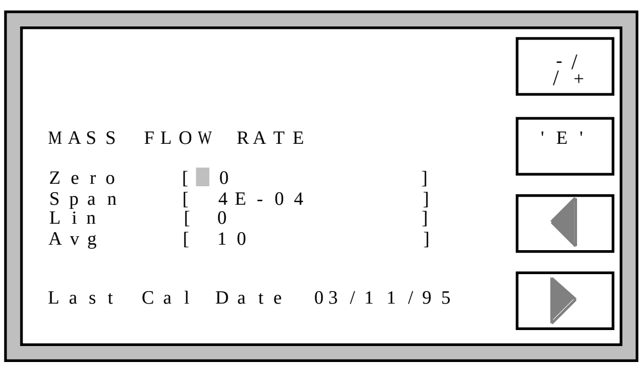
An incorrect code prevents access and returns to step 3. A correct code results in the display of calibration coefficients.



4) Using the [NEXT] and [PREV] keys, view any or all of the remaining coefficient and parameter screens.



5) To edit a particular displayed value, press [EDIT]. The cursor begins flashing at the left of the first parameter displayed.



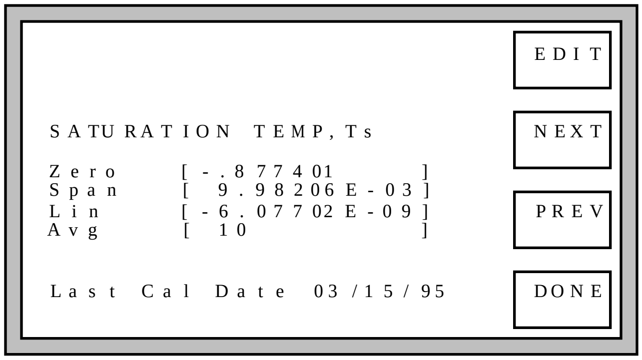
Using [-/+], ['E'], arrow keys, and the numeric keys as necessary, change any or all displayed values as desired. Then press <ENTER>.

6) After Editing or Viewing, press [DONE]. Then from the next menu, press [DONE] again. The system reinitializes back to the Control/Display screen.

3.3.2 Coefficients and Parameters

Each of the values on the various coefficient and parameter screens will be discussed in detail in the following sections.

3.3.2.1 Temperature Coefficients



The ZERO, SPAN, and LIN values are coefficients to the formula

$$\text{Temp} = A + Bx + Cx^2$$

where A = zero coefficient
B = span coefficient
C = linearity coefficient
x = output of the A/D converter card.

These coefficients are automatically computed during temperature calibration (section 4.2.2).

AVG is the amount of averaging applied to the displayed value. Averaging is applied with the formula

$$\text{New Value} = \{(\text{Previous Value} * \text{AVG}) + \text{New Reading}\}/(\text{AVG} + 1)$$

An AVG of zero (0) effectively eliminates averaging. An AVG that is very large has a correspondingly large averaging affect. Non-integer averaging amounts are allowable; however, negative amounts should <u>never</u> be used. An AVG of approximately 10 is typical, while an AVG of 1000 would be excessively high.

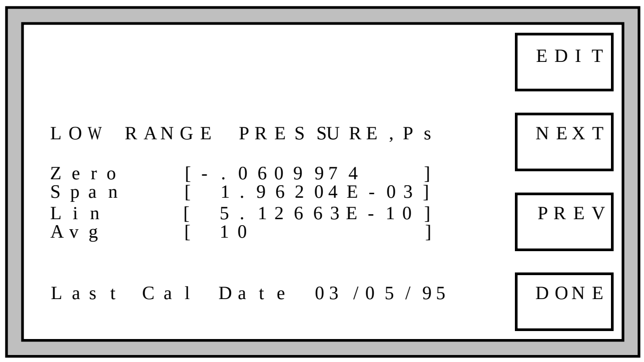
The date indicated at the bottom of the screen is the last date of calibration or the date of the most recent editing of any of the listed values. The date shown may not be edited and is updated automatically during calibration or when changing coefficients on this screen.

3.3.2.2 Reference Resistor Coefficients

These coefficients are factory set and similar to the temperature coefficients of section 3.3.2.1. The reference resistor is approximately 10KΩ with coefficients chosen to provide a reference value of approximately 0°C. An AVG amount of approximately 50 is typical.

Any change made to either the reference resistor or the coefficients (with the exception of AVG) requires that the temperature calibration of section 4.2.2 be performed on both temperature probes.

3.3.2.3 Pressure Coefficients



The ZERO, SPAN, and LIN values are coefficients to the formula

$$\text{Pressure} = A + Bx + Cx^2$$

where A = zero coefficient
B = span coefficient
C = linearity coefficient
x = output of the A/D converter card.

These coefficients are automatically computed during pressure calibration (section 4.2.3)

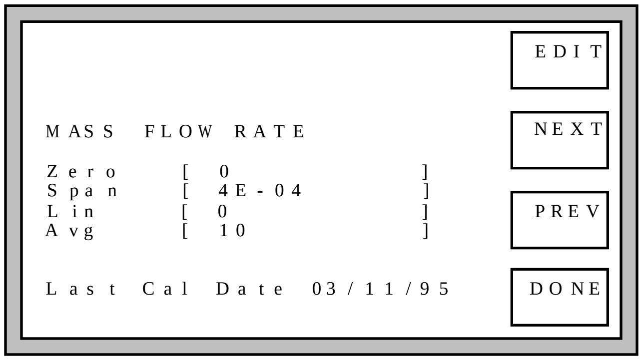
AVG is the amount of averaging applied to the displayed value. Averaging is applied with the formula

$$\text{New Value} = \{(\text{Previous Value} * \text{AVG}) + \text{New Reading}\}/(\text{AVG} + 1)$$

An AVG of zero (0) effectively eliminates averaging. An AVG that is very large has a correspondingly large averaging affect. Non-integer averaging amounts are allowable; however, negative amounts should never be used. An AVG of approximately 10 is typical, while an AVG of 1000 would be excessively high.

The date indicated at the bottom of the screen is the last date of calibration or the date of the most recent editing of any of the listed values. The date shown may not be edited and is updated automatically during calibration or when changing coefficients on this screen.

3.3.2.4 Flow Coefficients



The ZERO, SPAN, and LIN values are coefficients to the formula

$$\text{Flow} = A + Bx + Cx^2$$

where A = zero coefficient
B = span coefficient
C = linearity coefficient
x = output of the A/D converter card.

These coefficients are automatically computed during flow calibration (section 4.2.4)

AVG is the amount of averaging applied to the displayed value. Averaging is applied with the formula

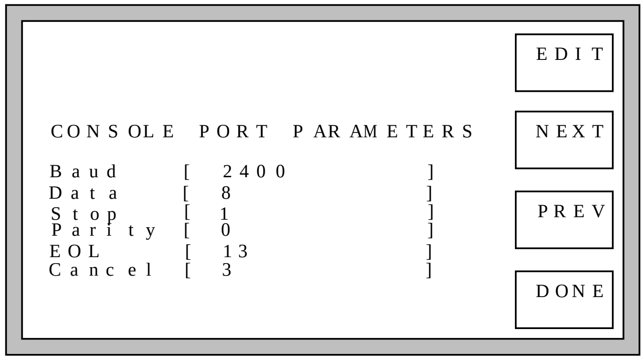
$$\text{New Value} = \{(\text{Previous Value} * \text{AVG}) + \text{New Reading}\}/(\text{AVG} + 1)$$

An AVG of zero (0) effectively eliminates averaging. An AVG that is very large has a correspondingly large averaging affect. Non-integer averaging amounts are allowable; however, negative amounts should never be used. An AVG of approximately 10 is typical, while an AVG of 1000 would be excessively high.

The date indicated at the bottom of the screen is the last date of calibration or the date of the most recent editing of any of the listed values. The date shown may not be edited and is updated automatically during calibration or when changing coefficients on this screen.

3.3.2.5 Console Port Parameters

These parameters affect the manner in which the bi-directional RS-232C Console Port behaves.



Baud: 300, 600, 1200, 2400, 4800, 9600, 19200 or 38400 bits per second

Data: 7 or 8 bit word size.

Stop: 1 or 2 stop bits

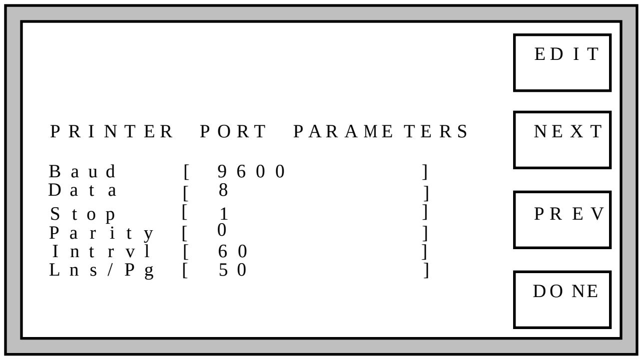
Parity: 0 for NO parity, 1 for ODD parity, or 2 for EVEN parity

EOL: The ASCII value of the desired End-Of-Line or terminator character for the 3900's input buffer. Here, '13' is the ASCII value for a Carriage Return. Regardless of the value of EOL, output from the console port of the 3900 is terminated with a carriage return (ASCII 13) and linefeed (ASCII 10).

Cancel: The ASCII value of the desired cancel-the-line character. Sending this character clears anything in the input buffer of the Console Port. Here, '3' is the ASCII value sent when executing a Control-C on most computers.

3.3.2.6 Printer Port Parameters

These parameters affect the manner in which the unidirectional RS-232 Printer Port behaves. It not only affects communication parameters, but time interval between printouts of system data, and the number of lines to print per page.



Baud: 300, 600, 1200, 2400, 4800, 9600, 19200 or 38400 bits per second

Data: 7 or 8 bit word size.

Stop: 1 or 2 stop bits

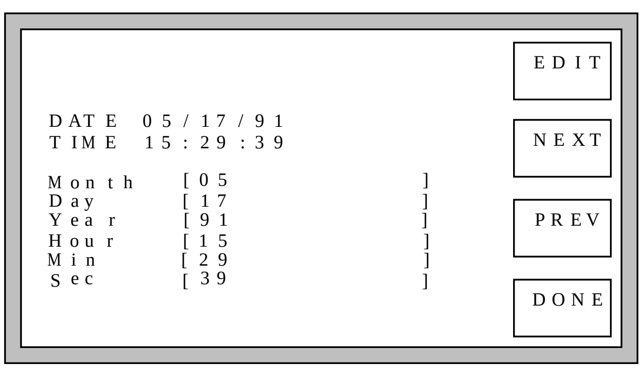
Parity: 0 for NO parity, 1 for ODD parity, or 2 for EVEN parity

Intrvl: The print interval, or number of seconds between printouts of system data.

Lns/Pg: Lines per Page of printed data.

3.3.2.7 Time and Date

This screen is used to change the Time and/or Date of the Real Time Clock. Note that time is input and displayed in 24-hour format. Also notice that the date is displayed in the date format selected in Miscellaneous User Parameters (section 3.2.2.8).



3.3.2.8 Miscellaneous User Parameters

This screen is used to change the Miscellaneous User Parameters.

```
MISC USER PARAMETERS                          EDIT

WMO      [ 1                  ]               NEXT
P Units[ 0                    ]
T Units[ 0                    ]
F Units[ 0                    ]
DateFmt[ 0                    ]               PREV
MW Gas [ 28.9645              ]
Tt Type[ 0                    ]
Pt Type[ 50                   ]
Pg Warn[ 50                   ]               DONE
Pg Stop[ 35                   ]
Ps Ctrl[ 1                    ]
```

WMO: When the Test Temperature is below 0 °C, %RH may be computed with respect to either water in accordance with the World Meteorological Organization (WMO=1) or with respect to ice (WMO=0).

P Units: 0 = psi
1 = bar
2 = hPa

Note that all pressure measurements are *absolute* *with the exception of the input supply transducer which is gauge.*

T Units: 0 = °C (currently the only option)

F Units: 0 = liters/min (currently the only option)

Date Fmt: 0 = mm/dd/yy (U.S. format)
1 = dd/mm/yy (European format)

MW Gas: Molecular Weight of the carrier gas. Setting this value to zero (0) forces the system to revert back to the factory setting of 28.9645 (Molecular Weight of Air). When using N_2 as the carrier gas, set the value to 28.000. PPMw is the only parameter directly affected by the value entered.

> ***Note*** - *The Molecular Weight does not alter the Enhancement Factors in any way nor compensate for variations in solubility or compressibility of various gasses. Therefore, when using a carrier gas other than air or nitrogen, the validity of the Enhancement Factors used in the calculation of humidity parameters can not be assured.*

Tt Type: Set this to zero (0) when using the standard 10K thermistor for Test Temperature measurement. A setting of one (1) indicates that the optional low temperature 1K thermistor is to be used. Any time that the test temperature probe is changed, it must either be recalibrated, or its previously computed calibration coefficients must be re-entered.

Pt Type: This must be set to the full scale range (in psiA) of the Test Pressure transducer.

Pg Warn: If the supply pressure drops below this pressure, the system emits a warning signal to indicate that the supply pressure is low.

Pg Stop: If the supply pressure drops below this pressure while generating or purging, the system will shutdown.

> ***Note*** - *If the Flow Rate setpoint is set to zero (0), the system does not shutdown on low supply pressure. This allows gas supply bottles to be changed while generating and purging without requiring that the system be shutdown.*

Ps Ctrl: The system has the capability of operating simply as a two-temperature generator (Ps Ctrl = 0), or in a combined two-temperature two-pressure mode (Ps Ctrl = 1). When operating as a two-temperature generator only, the expansion valve remains fully open in order to minimize any pressure drop between the saturator and devices under test. In this mode, all humidity changes require changes in the saturator temperature. The lowest frost point obtainable in the two-temperature mode is governed by the saturation temperature range as defined in section *1.3 Specifications.*

Section 4

CALIBRATION AND MAINTENANCE

4.1 GENERAL

The Model 3900 low humidity generation system requires little periodic maintenance. Following the proper operating procedures as given in this manual will help assure trouble-free operation of this system.

4.2 CALIBRATION

Proper calibration of the temperature and pressure transducers is critical to the accuracy of the generated humidity. Each time a transducer is calibrated its current calibration coefficients and calibration date are stored to non-volatile memory.

Calibration of the system requires the following support equipment:

1) Temperature:

   A. Temperature bath with a liquid medium (recommend Fluorinert FC-77, a 3M product), a range of 0-50 °C, and stability of ±0.01 °C or better. Less stable baths may require the use of a thermal block.

   B. Standard or reference thermometer (PRT or Thermistor) for the range of -80 to 10 °C for the saturator temperature, and 0 to 50 °C for the test temperature both having a resolution of 0.01 °C or better. Thermometer accuracy should be ±0.03 °C or better.

2) Low Pressure Range:

   A. Static gas pressure source for the pressure range of ambient to 50 psi, 3.5 bar, or 3500 hPa absolute with a stability of ±0.0025 psi, 0.00017 bar, 0.17 hPa or better.

   B. Standard or reference pressure gauge for the range of ambient to 50 psi, 3.5 bar, or 3500 hPa absolute with a resolution of ±0.0025 psi, 0.00017 bar, 0.17 hPa or better. Reference pressure accuracy should be ±0.025 psi, 0.0017 bar, 1.7 hPa or better.

3) High Pressure Range:

   A. Static gas pressure source for the pressure range of ambient to 300 psi, 21 bar, or 21000 hPa absolute with a stability of ±0.01 psi, 0.00069 bar, 0.69 hPa or better.

   B. Standard or reference pressure gauge for the range of ambient to 300 psi, 21 bar, or 21000 hPa absolute with a resolution of ±0.01 psi, 0.00069 bar, 0.69 hPa or better. Reference pressure accuracy should be ±0.10 psi, 0.0069 bar, 6.9 hPa or better.

4) Flow:

   A. Standard or reference flow meter for the range of 0 to 2 standard liters per minute with a resolution of 0.01 l/m or better. Flow meter accuracy should be ±0.005 l/m or better.

Calibration of all transducers is to be performed "in the system, as a system". There are no provisions for, nor is it recommended that calibration of any of the transducers (temperature, pressure, or flow) be performed while electrically disconnected from the generator. Since all calibration is performed mathematically by the computer, there are no manual adjustments to make.

Calibration is performed on all of the transducers by solving for the coefficients A, B, and C of the quadratic formula:

$$Y=A+Bx+Cx^2$$

where x is the raw count (or uncalibrated output of the A/D converter) while measuring a transducer, and

Y is the desired value (the standard or reference transducer's reading) for the transducer being calibrated.

The three coefficients A, B, and C are found by applying three separate, distinct, and stable references to each transducer, measuring the resulting raw count, then solving the mathematical system of three equations with three unknowns. Since all of these calculations are performed automatically by the 3900's embedded computer, the operator need only be concerned with providing three known stable references required for the calibration of each transducer.

4.2.1 A/D Card

Equipment Required: (None)

All calibration errors appearing in the A/D card will be accounted for automatically during calibration of the temperature, pressure, and flow transducers. The card is also equipped with built in auto-zero and auto-span circuitry which automatically and continually accounts for short and long term drift in measurement accuracy. No user calibration is required. A card suspected of extreme inaccuracies or malfunctions should be sent to the factory for repair.

4.2.2 Temperature Calibration

The systems EDIT/CAL mode may be used in conjunction with a precision temperature bath for temperature probe calibrations. Only one temperature probe may be calibrated at a time.

By using the temperature bath to generate three known temperatures, all coefficients (ZERO, SPAN, LINEARITY) can be calculated automatically by the embedded computer and used to update the system calibration. A new expanded calibration report may also be printed at the conclusion of the calibration sequence.

4.2.2.1 Test Temperature Calibration Procedure

Reference Drawing 95M39101

Equipment Required:

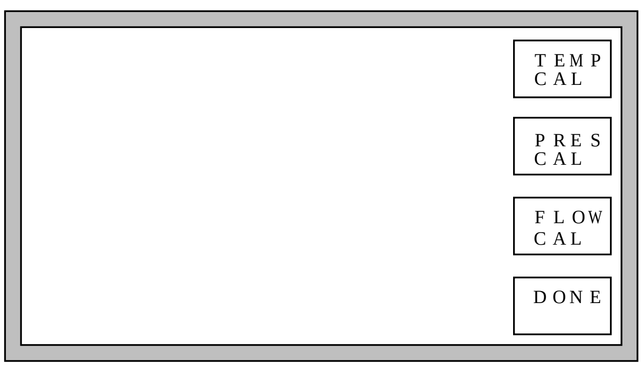
1. Temperature Bath (per section 4.2).
2. Standard or Reference thermometer (per section 4.2)

Calibration Procedure:

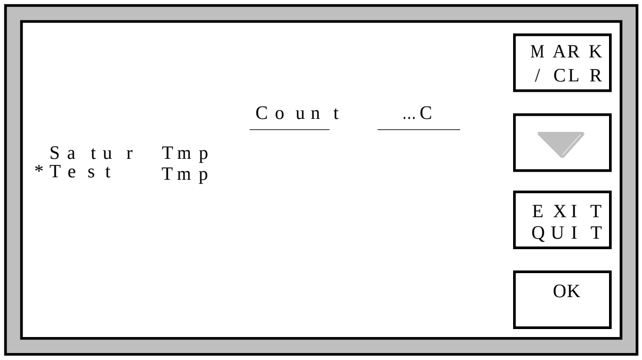
1) Bring a precision temperature bath with reference thermometer to the system, and install the Test Temperature thermistor into temperature bath. If using water as the fluid medium, do not submerse the probe completely or water may get into the probe and damage the thermistor element.

2) From the main Control/Display screen, press the [EDIT/CAL] key. The Edit/Cal menu appears.

3) Press the [CAL] key. The calibration menu appears.

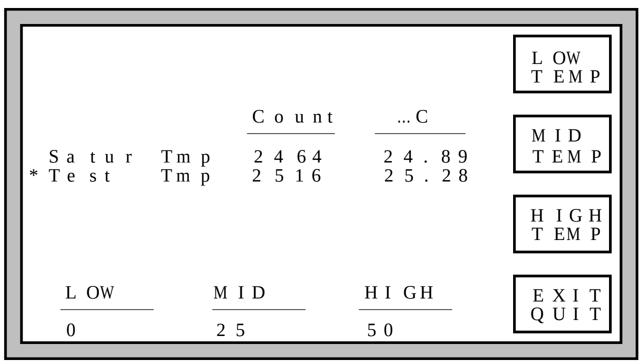


4) Press the [TEMP CAL] key. The probe selection screen appears.



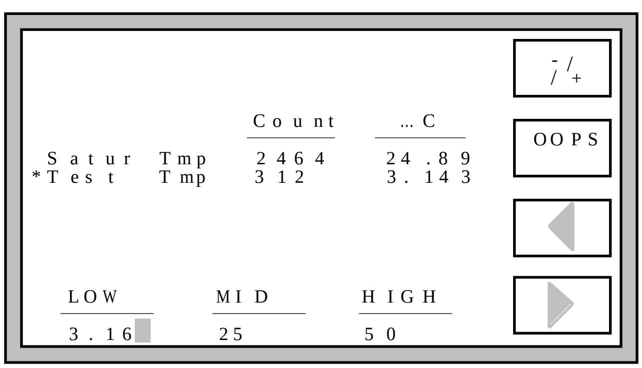
5) Using [MARK/CLR] and the down arrow key as necessary, mark the Test Tmp probe. A marked probe is indicated with an asterisk on the left. Since the two temperature probes require different calibration ranges, the computer will only allow you to mark one probe at a time.

6) After marking the Test Tmp probe, press [OK] or <ENTER>. The LOW, MID, and HIGH temperature reference values appear at the bottom of the screen, and within a few seconds, actual data begins updating in the Count and …C columns.



7) Adjust the temperature bath to a LOW temperature point at or near 0 °C and allow sufficient time for stability.

8) Once stable, press [LOW TEMP], and input the value of the Standard Thermometer as the LOW temperature. Use [-/+] and arrow keys as necessary.



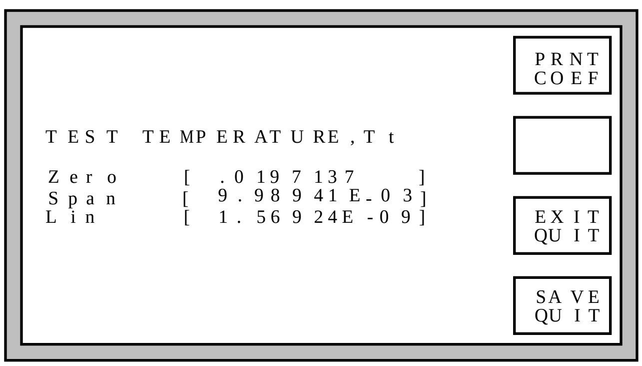
Then press <ENTER>. The LOW temperature value just entered, and the values of the marked probe are automatically saved to memory for later computation of calibration coefficients.

> ***Note -*** *If a mistake was made during the temperature entry mode, use [OOPS] rather than <ENTER>. This will cancel the temperature entry mode and restore the previous "standard" and "marked" probe values to memory. For instance, [OOPS] could be used if the operator wanted to take the LOW temperature point, but had mistakenly pressed the [MID TEMP] key.*

9) Repeat step 8 for both a MID temperature (near 25 °C) and HIGH temperature (near 50 °C). Be sure to use the appropriate [MID TEMP] and [HIGH TEMP] keys.

> ***Note -*** *Using the [LOW TEMP], [MID TEMP], or [HIGH TEMP] key more than once allows the previous point of the thermistor to be over-written with the most current measured value. The reference thermometer value will also be over-written with the new value entered. The data stored is that which exists on the screen in the "Count" column when the [LOW TEMP], [MID TEMP], or [HIGH TEMP] key is pressed.*

10) After all three temperature points have been taken, press [CALC COEF] to calculate the new temperature coefficients for the probe which is marked. Unmarked probes retain their previous coefficients. The current coefficients for the marked probe will appear on the screen.



11) If a printer is attached, a calibration record of the temperature points and calculated coefficients is printed. Press the [PRNT COEF] key if additional printouts are desired. This is the only opportunity to print this report. Upon leaving this screen, the data used for report generation is lost (with the exception of the calculated coefficients being displayed.)

12) To update the calibration with new coefficients, press the [SAVE QUIT] key. To abort without storing these new coefficients, press the [EXIT QUIT] key.

> ***Note -*** *If the new coefficients were printed but not SAVED, the new coefficient values may be entered later using the EDIT mode described in section 3.3.*

13) Check the accuracy of the calibration if desired, by repeating steps 4 through 6, however, don't "mark" any of the probes for calibration. Adjust the temperature bath to any values between 0 and 50 °C and visually compare readings. When done, press [EXIT QUIT].

14) At the calibration menu, press [DONE]. Then press [DONE] at the next menu. The system reinitializes and the Control/Display screen appears.

15) To print a condensed coefficient report, listing temperature, pressure, and flow coefficients together on one page, refer to section 4.2.5.

4.2.2.2 Saturation Temperature Calibration

Reference Drawings 95M39101

Equipment Required:

1. Standard or Reference Thermometer (per section 4.2)
2. 3/16" (4.5 mm) ball/hex driver
3. 9/16" (15 mm) wrench
4. 9/16" (15 mm) socket with 6" (15 cm) extension

Calibration Procedure:

The saturation temperature probe may be calibrated using the 3900's temperature controlled saturator as the fluid bath.

1) For safety purposes, switch console power OFF and remove line cord.

2) Remove both side panels, and then remove the four socket head screws that secure the counter top. Lift off the counter top and remove the 4" square foam insert that insulates the saturator.

3) Using a 9/16" socket with 6" extension, loosen and remove the 1/4" Swagelok cap on the Auxiliary Temperature Port.

4) Slide a 1/4" Swagelok nut and nylon ferrule set onto the shaft of the Standard Thermometer and then insert it into the saturator's Auxiliary Temperature Port approximately 3 to 4 inches. Seal the saturator by tightening the nut.

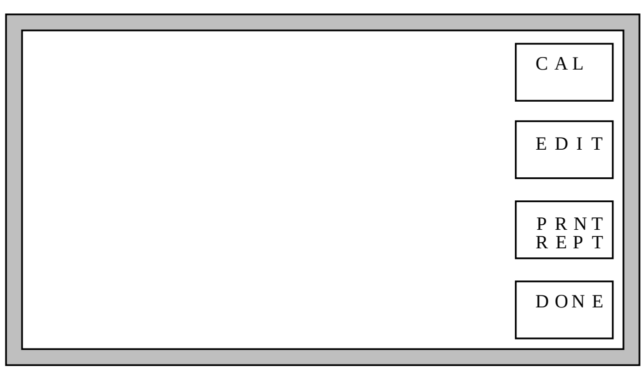
5) Install foam insulation around the saturator and the Standard Thermometer.

6) Replace side panels.

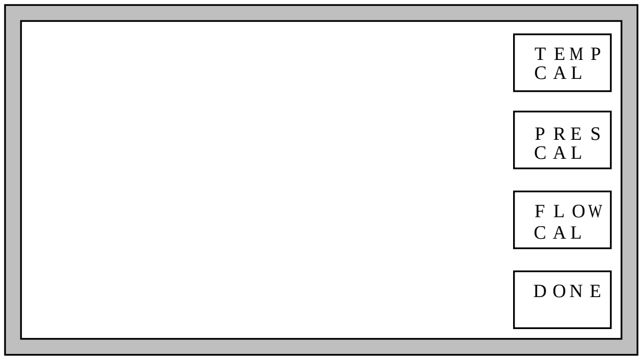
> ***Note -*** *The system must not be operated unless all panels are in place or the refrigeration system will overheat.*

7) Reinsert the line cord and switch console power ON.

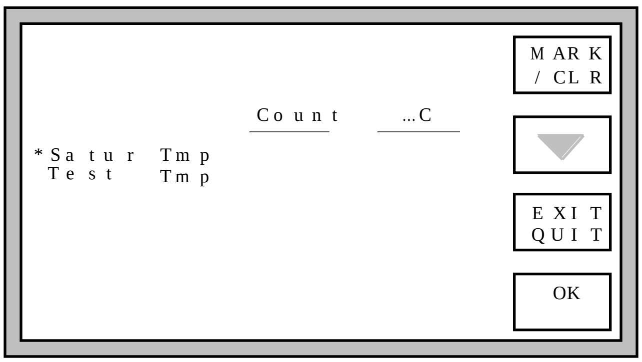
8) From the main Control/Display screen, press the [EDIT/CAL] key. The Edit/Cal menu appears.



9) Press the [CAL] key. The calibration menu appears.

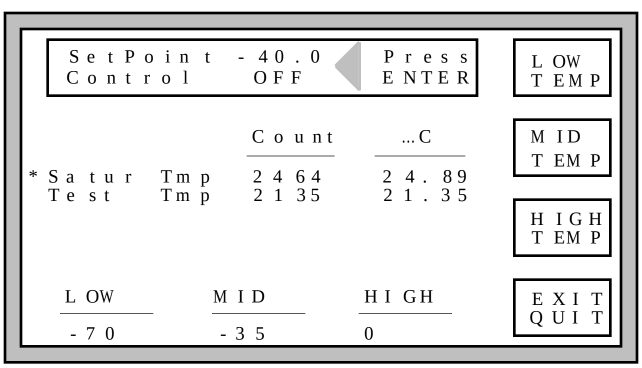


10) Press the [TEMP CAL] key. The probe selection screen appears.

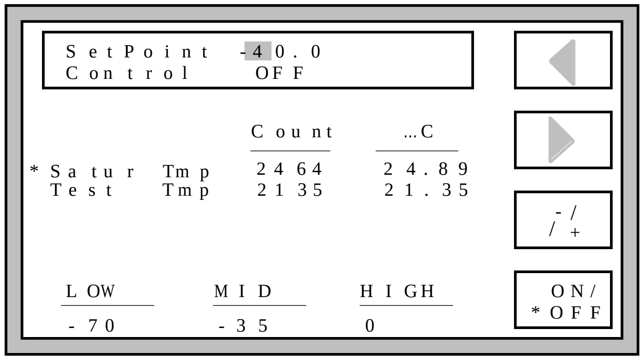


11) Using [MARK/CLR] and the down arrow key as necessary, mark the Satur Tmp probe. A marked probe is indicated with an asterisk on the left. To complete selection, press [OK] or <ENTER>.

12) The saturation temperature calibration screen consists of two sections, the saturator temperature control and the calibration data.



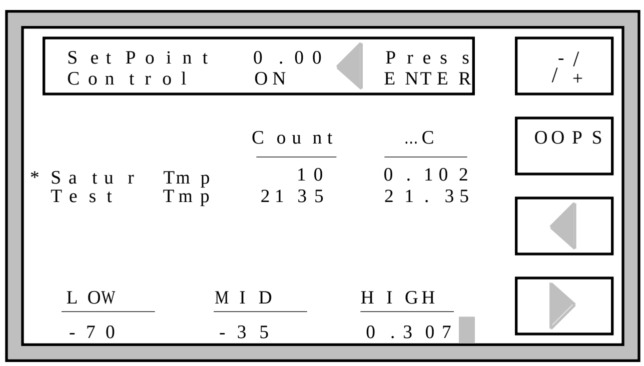
To obtain access to the setpoint control, press the <ENTER> key on the numeric keypad.



At this time, the cursor will begin flashing on the control setpoint in the saturator temperature control section. The temperature setpoint may be changed to any value within the operational limits of the saturator by using the numeric keypad, the arrow keys and the [-/+] key as necessary. To enable the saturator temperature control at the setpoint entered, press the [ON/OFF] toggle key. To return to the calibration section, press <ENTER> on the numeric keypad.

Using the method described above, enter the high temperature setpoint and enable the control. Allow sufficient time for movement to and stability at the setpoint.

13) Once stable, press [HIGH TEMP], and input the value of the Standard Thermometer as the HIGH temperature. Use [-/+] and arrow keys as necessary.



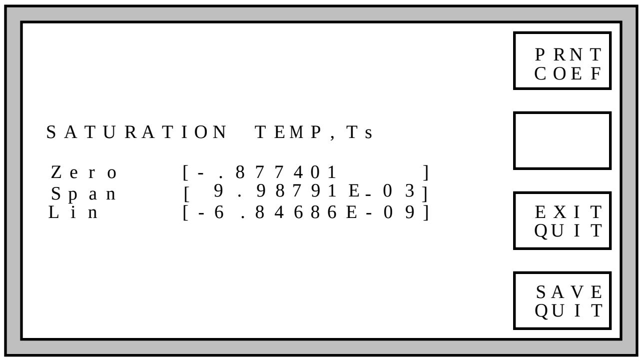
Then press <ENTER>. The HIGH temperature value just entered, and the values of the marked probe are automatically saved to memory for later computation of calibration coefficients.

> ***Note -*** *If a mistake was made during the temperature entry mode, use [OOPS] rather than <ENTER>. This will cancel the temperature entry mode and restore the previous "standard" and "marked" probe values to memory. For instance, [OOPS] could be used if the operator wanted to take the HIGH temperature point, but had mistakenly pressed the [MID TEMP] key.*

14) Repeat steps 12 and 13 for both a MID temperature and LOW temperature. Be sure to use the appropriate [MID TEMP] and [LOW TEMP] keys.

Note - *Using the [LOW TEMP], [MID TEMP], or [HIGH TEMP] key more than once allows the previous point of the thermistor to be over-written with the most current measured value. The reference thermometer value will also be over-written with the new value entered. The data stored is that which exists on the screen in the* `Count` *column when the [LOW TEMP], [MID TEMP], or [HIGH TEMP] key is pressed.*

15) After all three temperature points have been taken, press [CALC COEF] to calculate the new coefficients for the probe which is marked. Unmarked probes retain their previous coefficients. The current coefficients for the probe will appear on the screen.



16) If a printer is attached, a calibration record of the temperature points and calculated coefficients is printed. Press the [PRNT COEF] key if additional printouts are desired. This is the only opportunity to print this report. Upon leaving this screen, the data used for report generation is lost (with the exception of the calculated coefficients being displayed.)

17) To update the calibration with the new coefficients, press the [SAVE QUIT] key. To abort without storing these new coefficients, press the [EXIT QUIT] key.

Note - *If the new coefficients were printed but not SAVED, the new coefficient values may be entered later using the EDIT mode described in section 3.3.*

18) Check the accuracy of the calibration if desired, by repeating steps 10 through 12, however, don't "mark" any of the probes for calibration. Adjust the Saturator control setpoint to any values between -80 and +12 °C and visually compare readings. When done, press [EXIT QUIT]

19) At the calibration menu, press [DONE], then press [DONE] at the next menu. The system reinitializes and the Control/Display screen appears.

20) To print a condensed coefficient report, listing temperature, pressure, and flow coefficients together on one page, refer to section 4.2.5.

21) For safety purposes, switch the console power off and remove line cord.

22) Remove Standard Temperature probe and reinstall Swagelok cap. Reinstall the foam insulation, counter top and replace side panels. *The system must not be operated unless all panels are in place.*

4.2.3 Pressure Transducer Calibration

Pressure Transducer Calibration is typically performed in a calibration laboratory and requires that the transducers be removed from the pneumatic system of the 3900, but must remain electrically connected. The pressure readings must be precise in order to retain accurate relative humidity calculations. Since the 3900 may be operated and calibrated in various pressure units (psi, bar, hPa), ensure that the system is set to the desired units (section 3.3) prior to performing the pressure calibration.

Reference Drawing 95M39101

Equipment Required:

1. Static pressure source, and standard or reference measurement, with absolute pressure range of ambient to 50 psi, 3.5 bar, or 3500 hPa (per section 4.2).
2. Static pressure source, and standard or reference measurement, with absolute pressure range of ambient to 300 psi, 21 bar, or 21000 hPa (per section 4.2).
3. 9/16" (15 mm) and 11/16" (18 mm) open end wrenches.
4. Flat blade screwdriver.

Pressure Conversion Factors:

psi = bar * 14.503774
psi = hPa * 0.014503774

bar = psi * 0.068947573
bar = hPa * .001

hPa = psi * 68.947573
hPa = bar * 1000

4.2.3.1 Saturator and Test Pressure Calibration Procedure

Reference Drawing 95M39101

1) For safety purposes, switch console power OFF and remove the line cord.

2) For safety purposes, turn OFF or disconnect air supply.

CAUTION!
ALL SYSTEM PRESSURE MUST BE
VENTED BEFORE PROCEEDING.

3) Bring the pressure source to the generator or take the generator to the pressure calibration lab.

4) To access the saturator pressure transducers, remove left console panel.

5) Slowly disconnect pressure transducers (11/16" & 9/16" wrench required). Some static pressure may still exist in the saturator and pressure transducers. This pressure should be allowed to vent slowly through the fitting during removal. Using a screwdriver, pry open the round snap-lock transducer mounts, and remove the transducers. Ensure the electrical connectors are in place.

6) Reinsert line cord and switch console power ON. Wait a few moments for the softkey menu to appear. Allow approximately 30 minutes or more for warm-up of the pressure transducer electronics.

7) Connect the pressure source to the transducer to be calibrated (only one transducer at a time may be calibrated).

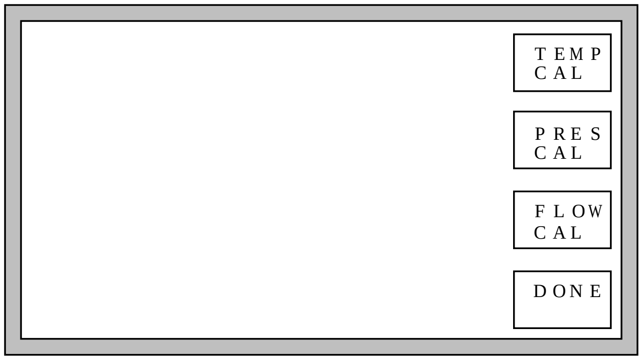
   Note - *Each transducer is operated over a limited range and requires calibration within this range only.*

   A) Low Range Saturation Pressure Transducer - Calibrate from ambient to approximately 50 psi, 3.5 bar, or 3500 hPa absolute.

   B) High Range Saturation Pressure Transducer - Calibrate from ambient to approximately 300 psi, 21 bar, or 21000 hPa absolute.

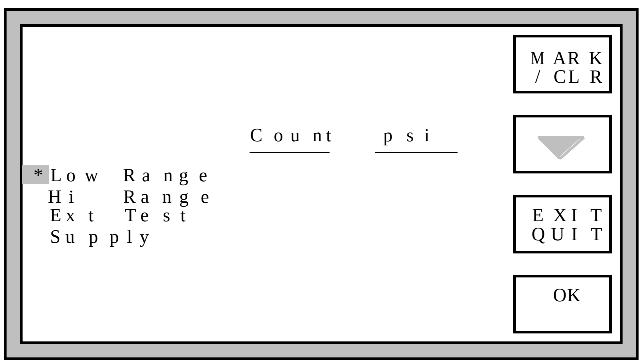
   C) External Test Pressure Transducer - Calibrate from its lowest to highest range of actual use (typically ambient to full scale).

8) Press the [EDIT/CAL] key, then the [CAL] key. The calibration menu appears.



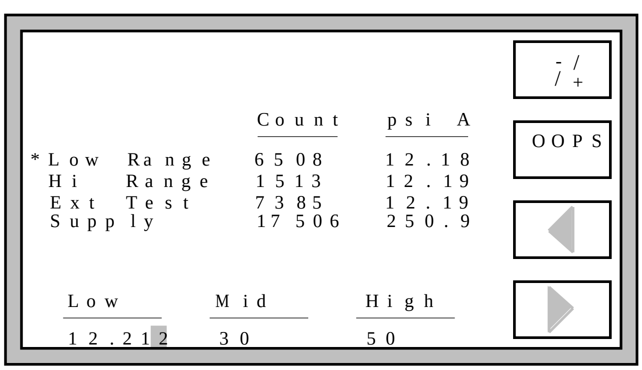
9) Press the [PRES CAL] key.

10) Using [MARK /CLR] and the down arrow key as necessary, mark the transducer to be calibrated. A marked transducer is indicated with an asterisk in the left most display column. Since each of the transducers require a different calibration range, the computer will only allow you to mark one transducer at a time.



11) Confirm selection by pressing [OK] or <ENTER>.

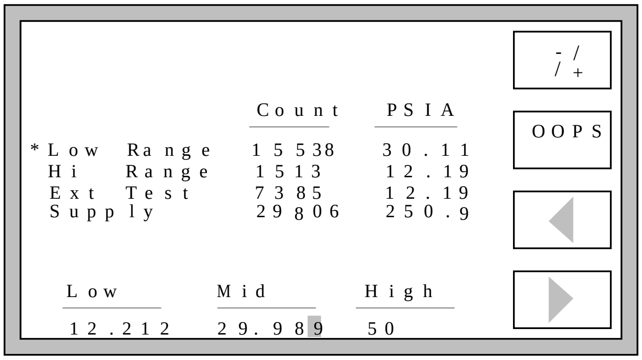
12) Apply the lower recommended calibration pressure and watch the displayed value of the marked transducer. Once stable, press the [LOW PRES] key and enter the reference pressure.



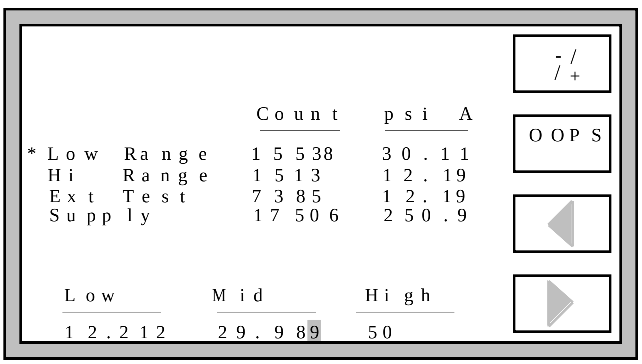
Note - *For all transducers, ambient pressure may be used for the low pressure calibration point.*

Note - *If a mistake is made during reference pressure entry, pressing the [OOPS] key cancels the data entry mode, leaving all values for that point unchanged.*

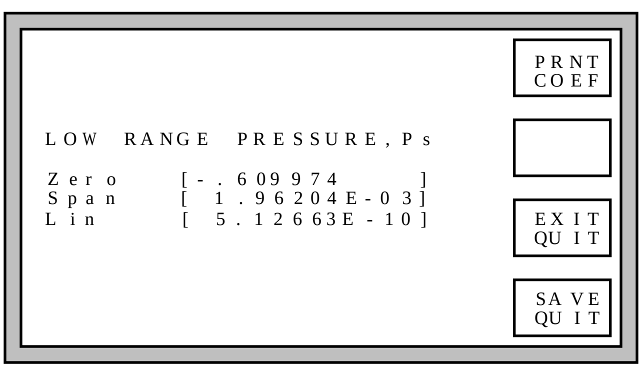
13) Apply the mid range pressure and watch the displayed value. Once stable, press the [MID PRES] key and enter the reference pressure.



14) Apply the upper recommended pressure and watch the displayed value. Once stable, press the [HIGH PRES] key and enter the reference pressure.



15) Press the [CALC COEF] key. All coefficients for the marked transducer will be calculated, and appear on the LCD display.



16) If a printer is attached, a calibration record of the pressure points and calculated coefficients is printed. Press the [PRNT COEF] key if additional printouts are desired. This is the only opportunity to print this report. Upon leaving this screen, the data used for report generation is lost (with the exception of the calculated coefficients being displayed.)

17) To save the coefficients, press [SAVE QUIT]. The coefficients will be stored to non-volatile memory. To abort the calibration without saving the coefficients just calculated, press [EXIT QUIT]. The previous coefficients will be reinstated.

18) Check the accuracy of the calibration if desired by repeating steps 9 through 11 however don't "mark" any of the probes. Apply various pressures within the range of the transducer and visually compare the readings.

19) Repeat steps 7 through 18 for the high-pressure saturator and the external test pressure transducers, using the suggested LOW, MID, and HIGH pressures indicated on the screen.

20) For safety purposes, switch main console power to OFF and disconnect line cord.

21) Re-install the pressure transducers (0-50 psiA Saturator transducer, TR3, goes on the right next to the solenoid valve.) Tighten all connections 1/4 turn past finger tight.

22) Replace left console panel. *The system must not be operated unless all panels are in place.*

23) To print a condensed coefficient report, listing temperature, pressure, and flow coefficients together on one page, refer to section 4.2.5.

4.2.3.2 Supply Pressure Transducer Calibration

The supply pressure measurement, while indicated on the screen, is not critical to the accuracy of the 3900 and is not used in the humidity calculations.

Reference Drawing 95M39101

Equipment Required:

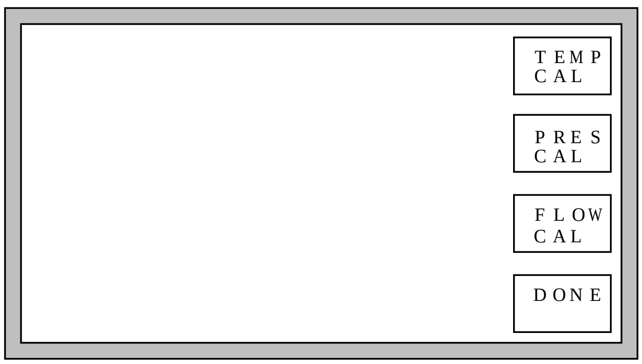
1. Gas Supply of at least 300 psi, 21 bar, or 21000 hPa gauge.

Calibration Procedure:

1) For safety purposes, switch the console power OFF and then remove front console panel.

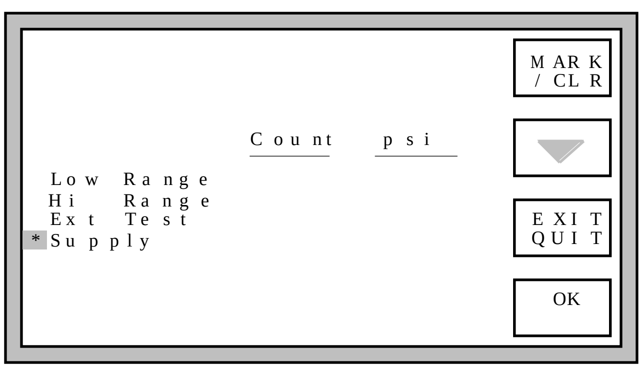
2) Switch console power ON. Wait a few minutes for the softkey menu to appear. Allow approximately 30 minutes or more for warm-up of the pressure transducer electronics.

3) Press the [EDIT/CAL] key, then the [CAL] key. The calibration menu appears.



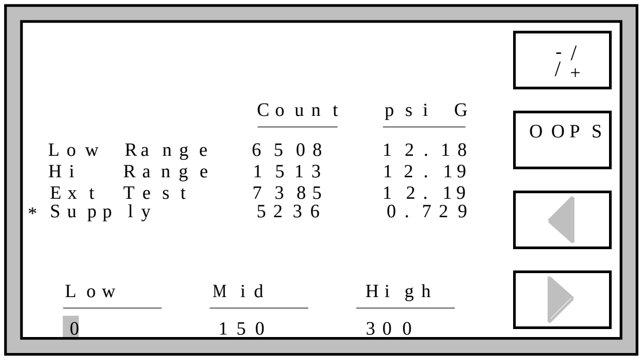
4) Press the [PRES CAL] key.

5) Using [MARK /CLR] and the down arrow key as necessary, mark the Supply pressure transducer.



6) Confirm the selection by pressing [OK] or <ENTER>.

7) Apply the lower recommended calibration pressure by adjusting the internal pressure regulator REG fully counter clockwise and watch the displayed value. Once stable, press the [LOW PRES] key and enter the reference pressure as read from the regulator's pressure gauge (zero in this case). Since the regulator is a non-relieving type, pressure is vented through the pump purge solenoid. This is a very low flow and may take several minutes to vent the pressure to zero.



Note - *If a mistake is made during reference pressure entry, pressing the [OOPS] key cancels the data entry mode, leaving all values unchanged.*

8) Apply the mid range and high range pressure by adjusting the internal pressure regulator and watch the displayed value. Once stable, press the [MID PRES] or [HIGH PRES] key as applicable and enter the reference pressure as read from the regulator's pressure gauge.

9) Press the [CALC COEF] key. All coefficients for the marked transducer will be calculated, and appear on the LCD display.

10) If a printer is attached, a calibration record of the pressure points and calculated coefficients is printed. Press the [PRNT COEF] key if additional printouts are desired. This is the only opportunity to print this report. Upon leaving this screen, the data used for report generation is lost (with the exception of the calculated coefficients being displayed.)

11) To save the coefficients, press [SAVE QUIT]. The coefficients will be stored to non-volatile memory. To abort the calibration without saving the coefficients just calculated, press [EXIT QUIT]. The previous coefficients will be reinstated.

12) At the calibration menu, press [DONE]. Then press [DONE] at the next menu. The system reinitializes and the Control/Display screen appears.

13) Replace front console panel. *The system must not be operated unless all panels are in place.*

14) To print a condensed coefficient report, listing temperature, pressure, and flow coefficients together on one page, refer to section 4.2.5.

4.2.4 Flow Meter Calibration

The flow measurement, while indicated on the screen, is not critical to the accuracy of the generated humidity and is not used in the humidity calculations. Flow calibration accuracy depends upon the requirements of the user.

Equipment Required:

1. Standard or Reference flow meter (per section 4.2).

4.2.4.1 Flow Calibration Procedure

Reference Drawing 95M39101

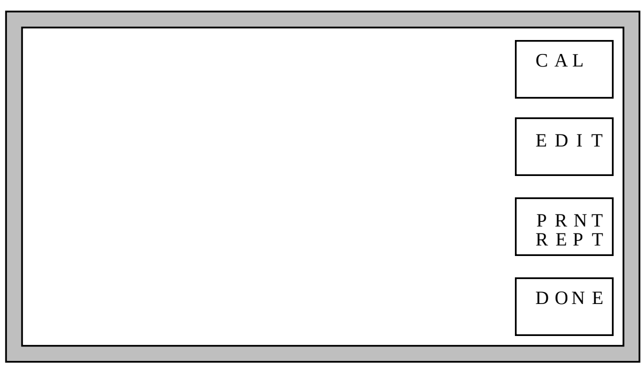
The calibration for the flow meter is slightly different than for the temperatures and pressures, and does not require the removal of the flow meter from the system.

1) Using appropriate fittings, connect a flow meter reference instrument to the gas outlet port of the system.

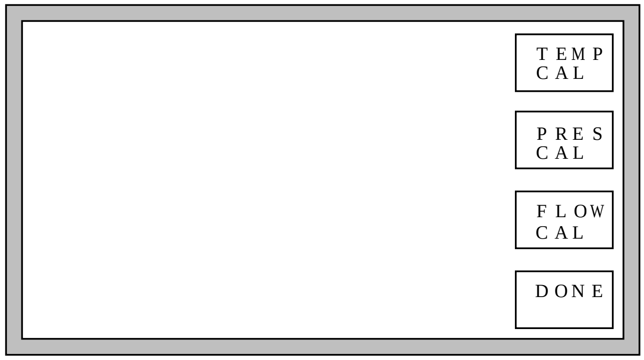
2) Generate a flow rate of approximately 1.0 l/m. Once stable, note the readings of the reference flow meter and of the indicated flow of the 3900.

3) Change the flow to 2.0 l/m. Once stable note both readings again.

4) Press [STOP]. Once the shutdown is complete, press [EDIT/CAL]. The following menu appears.

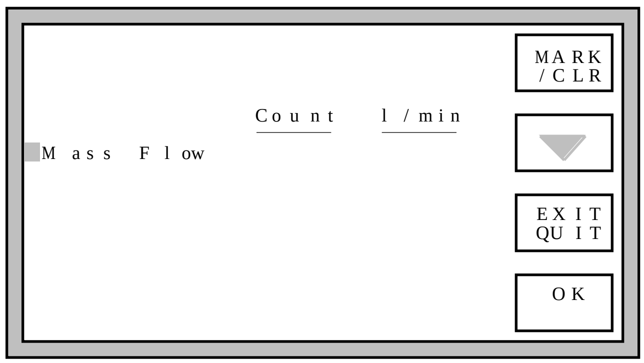


5) Press [CAL]. The calibration menu appears.

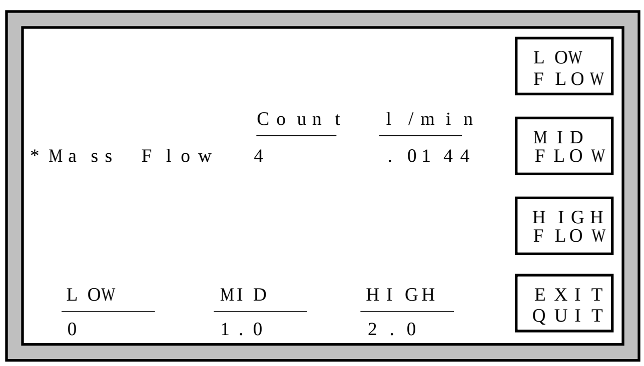


6) Press [FLOW CAL].

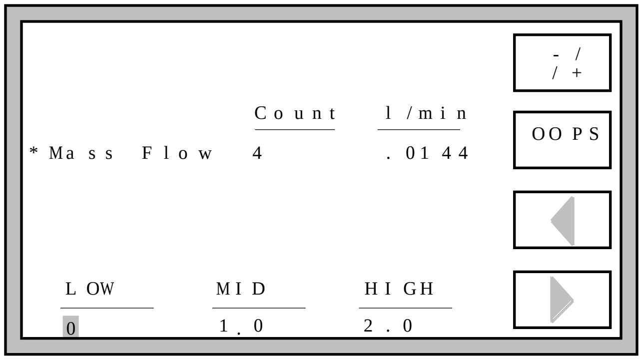
7) Press [MARK/CLR] to mark the flow meter (indicated by an asterisk to its left).



8) Press [OK]. Within a few seconds, the measured flow readings begin updating.



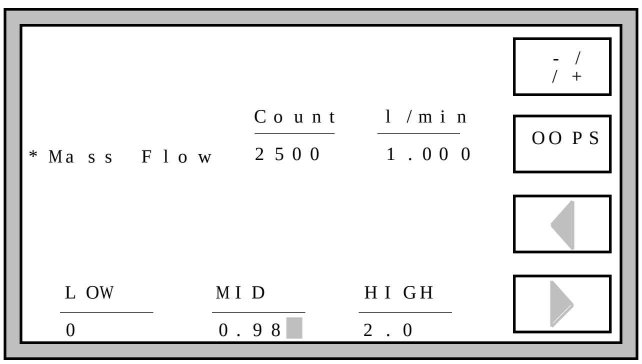
9) Allow a few moments for stability of the flow indication. This "no flow" condition will be used for a LOW flow reference. Press [LOW FLOW] to store this point. Then press <ENTER>.



10) Using the 1.0 liter data obtained in step 2, calculate the following:

1.0 + (Reference Indication) - (3900 Indication)

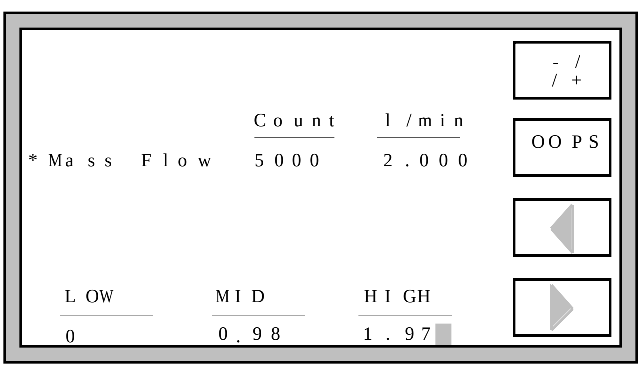
Press [MID FLOW] and enter this calculated value.



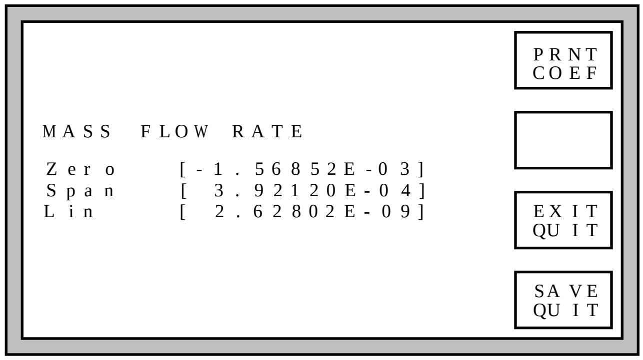
11) Using the 2.0 liter data obtained in step 3, calculate the following:

2.0 + (Reference Indication) - (3900 Indication)

Press [HIGH FLOW] and enter this calculated value.



12) Press [CALC COEF] to calculate the new flow meter coefficients. These new coefficients appear on the display.



13) If a printer is attached, a calibration record of the flow points and calculated coefficients is printed. Press the [PRNT COEF] key if additional printouts are desired. This is the only opportunity to print this report. Upon leaving this screen, the data used for report generation is lost (with the exception of the calculated coefficients being displayed.)

14) To save the coefficients to non-volatile memory, press [SAVE QUIT]. To discard these new coefficients and revert to the previous ones, press [EXIT QUIT].

15) At the calibration menu, press [DONE]. At the next menu, press [DONE] again. The system reinitializes to the Control / Display screen.

16) To print a calibration report, refer to section 4.2.5.

4.2.5 Printing Condensed Coefficient Report

If a printer is connected to the Printer Port, a Coefficient Report for the temperature, pressure and flow transducers may be printed. This condensed report lists the current system calibration coefficients and calibration date for all of the system transducers. This report is printed from the Edit/Cal menu.

To print the report:

1) From the idle Control/Display screen press [EDIT/CAL], or from the Cal menu press [DONE]. Both actions should bring up the Edit/Cal menu.

2) Ensure the printer is on, then press [PRNT REPT]. The Coefficient Report will be sent to the printer. See sample below.

3) Press [DONE] to return to the Control/Display screen.

```
                         Coefficient Report
                                for
                 TSC Model 3900 Low Humidity Generator



  S/N:  9506003
  Date: 09/12/95



  Temperature                Zero          Span          Linearity      Cal Date

  Saturation Temperature   -8.77401E-01  9.98791E-03  -6.84686E-09    08/29/95
  Test Temperature         -1.46305E-02  9.94955E-03   2.56446E-08    09/01/95
  Temp Reference Resistor  -2.50000E+01  1.00000E-02   0.00000E+00    06/22/95

         _____               _____         _____         _____          _____

  Pressure                   Zero          Span          Linearity      Cal Date

  Low Range Sat             4.74038E-01  2.00075E-03  -8.90800E-11    09/05/95
  Hi Range Sat             -2.73215E-01  1.18864E-02   4.11819E-09    09/05/95
  External Test            -6.12872E-02  2.00973E-03  -3.18225E-10    09/05/95
  Supply                   -1.00167E+02  2.01220E-02  -1.67007E-09    09/05/95

         _____               _____         _____         _____          _____

  Flow                       Zero          Span          Linearity      Cal Date

  Mass Flow Rate            0.00000E+00  4.00000E-04   0.00000E+00    03/11/95




Certified by  ________________________

        Date  ________________________
```

4.3 ROUTINE MAINTENANCE

4.3.1 Console Intake: Monthly

Reference Drawing 94M39100

Equipment Required: (None)

Cleaning Procedure:

1) Locate console intake on left side of console.
2) Remove any obstruction and dust from console panel.
3) Remove left console panel and dust finned aluminum condenser.
4) Replace left console panel

4.3.2 7 Micron Gas Input Filter: Yearly

Reference Drawing (pneumatic)

Equipment Required:

1. 9/16" open end wrench
2. Two 3/4" open-end wrenches.

Filter Change Out Procedure:

1) For safety purposes, switch console power OFF and remove line cord.
2) Disconnect facility gas supply.
3) Remove right side console panel.
4) Using both a 9/16" and a 3/4" wrench, remove inline filter from gas supply line tubing.
5) Using both 3/4" wrenches, disassemble filter body and remove filter from tapered bore.
6) Insert new filter element into tapered bore.
7) Reassemble filter body and tighten securely.
8) Replace inline filter into gas supply line tubing.
9) Replace console access panel and reconnect console power.

4.4 SERVICING REFRIGERATION AND FLUID SYSTEMS

Reference Drawings 95S39116

Before starting repairs on either refrigeration system, the serviceman should be familiar with the location of all components of the stages. Especially important is the identification of the high and low stages of the refrigeration system. The high stage compressor always connects directly to the air-cooled condenser. The low stage compressor connects directly to the oil separator. By following the tubing and referring to the flow diagram, most parts can easily be traced. By necessity, some parts are foam insulated and rarely require servicing.

4.4.1 Fault Isolation and Diagnosis

In the event of system failure, before attaching gauges or opening either refrigeration circuit, every effort should be made to ensure that the problem is not electrical in nature. If compressors are suspected, check the compressor relays, overloads, and capacitors. Check the temperature control contacts and associated wiring. Use the above procedure on the high stage first, as it is impossible to run the low stage system unless the high stage is functional and has had time (10 minutes) to cool the interstage heat exchanger.

Although great care is taken in the design and manufacture, these systems can be subject to normal failures. Refrigerant leaks, moisture, and component failure can be diagnosed in much the same way as in other refrigeration equipment. There are some differences, especially with respect to the low stage.

4.4.1.1 Moisture In Low Stage

This can be diagnosed and repaired as in any medium temperature refrigeration system.

Excess moisture in the low stage results in ice blocking the capillary tube; however, the replacement of the drier is not possible as it is located within the foam insulation. The cabinet must be allowed to warm up to room temperature so that sufficient heat will enter the interstage heat exchanger. Then proceed in this order:

1) Bleed off all refrigerant from the low stage.
2) Evacuate for 8 to 12 hours.
3) Replace vacuum with ultra dry nitrogen to a pressure of 150 psiG.
4) Bleed off pressure.
5) Repeat steps 2-4 three times.
6) Evacuate again as in step 2.
7) Replace refrigerant with specified amount (Section 4.4.2).

4.4.1.2 Oil In Low Stage Evaporator

The migration of compressor oil to the low stage capillary tube will create symptoms similar to those of moisture. Solidification does occur as the oil reaches the capillary tube. This can reduce flow resulting in lower suction pressure. If the cabinet is warmed to a temperature of -18 °C or higher and then restarted, the oil will be flushed out of the capillary tube and will not build up again for a week or more. Moisture will show up much sooner, usually in a matter of hours.

4.4.2 Refrigerant Charge

Saturator Refrigeration: High stage requires fourteen (14) ounces of R-134A. Low stage requires six (6) ounces of R-23.

4.4.3 Saturator Fluid System

The saturator fluid system uses methyl alcohol (methanol) as a heat transfer medium because of its low freezing point. This fluid is circulated by a magnetically coupled centrifugal pump (P1) at approximately two gallons per minute. This pump has an approximate life of 10,000 hours and may ultimately need service. Should this system require repair, extreme caution is required in the draining and filling due to the flammability of methanol.

CAUTION!

THIS SYSTEM CONTAINS METHYL ALCOHOL (METHANOL)

FLAMMABLE AND POISONOUS

Keep away from sparks, flames, or other ignition sources. Avoid prolonged or repeated breathing of vapors or contact with skin. Do not allow material to contaminate water sources.

4.4.4 Methanol System Drain / Fill Procedure

Reference Drawing 95M39101

Equipment Required:

1. 3/16" & 3/8" ball/hex driver
2. 7/8" socket with 6" extension
3. 4 feet of 1/4" OD tube with 1/4" Swagelok nut and ferrules attached on one end
4. 5.675 liters (1.5 gallons) of anhydrous methanol
5. Marked 7.5 liter (2 gallon) container for used methanol
6. Funnel
7. Gloves and goggles

To drain saturator fluid system, proceed as follows:

1) Disconnect power source from console.
2) Remove all console panels.
3) Locate and remove the four counter top bolts using 3/16" ball/hex driver, then remove the counter top.
4) Remove circular insulation and using the 3/8" ball/hex driver remove the Methanol Expansion Tank Fill Port Plug.
5) Locate saturator drain valve (located below pump on right side of console). Remove Drain Valve Cap and connect 1/4" hose to drain valve. Place other end of drain hose into two gallon container.
6) Open drain valve and drain methanol.
7) After draining methanol, close drain valve, remove drain hose and replace Drain Valve Cap.
8) Repairs may be made at this time.

To refill saturator fluid system, proceed as follows:

9) Locate RTD1 Access Insulation and remove. Using the 7/8" socket with 6" extension, remove the Saturator Methanol Port Cap from the top of the saturator.
10) Insert the funnel into the Methanol Expansion Tank Fill Port. **Slowly and carefully** fill the saturator assembly until methanol is observed just below the Saturator Methanol Port Fitting located on top of the saturator (in the square insulation area).

> ***Note -*** *The methanol must be added slowly as it is being gravity fed through 3/8" tubing between the methanol expansion tank and the saturator. Do not allow funnel to fill.*
>
> *Methanol degrades the urethane foam insulation; sponge dry any methanol spilled during the filling operation!*

11) Replace the Saturator Methanol Fill Port Cap (tighten 1/4 turn past finger tight).
12) Replace Methanol Expansion Tank Fill Port Plug.
13) Replace all insulation.
14) Replace counter top and console panels.

4.5 ERROR CODES and TROUBLESHOOTING

Prior to system start-up, and during humidity generation, the system monitors itself for errors and sources of possible malfunction. When a catastrophic error occurs, the system automatically shuts down, then alerts the operator with a visual flashing message and an audible tone. The visual message displays the error number and a brief description of the problem.

It is possible (in many cases probable) to have multiple errors occurring at one time. Under these circumstances, the error codes simply add together algebraically, and all of the associated messages are displayed in turn. Any error code greater than 16383 will be displayed as a negative number. In this case, simply add 65536 to the displayed number to calculate the appropriate code. While it is not necessary to understand the error code system, it is important to write down the error code number exactly as it appears on the screen when consulting the factory for technical support. Little can be done to ascertain the nature of the problem without the exact error code.

The following is a list of error codes and a brief description of each.

ERROR CODE	DESCRIPTION
1	Expansion Valve Not Closing
2	Flow Valve Not Closing
4	Low Supply Pressure
8	Cabinet Temperature Overrange
32	Reference Temperature Underrange
48	Reference Temperature Overrange
64	Test Temperature Underrange
80	Test Temperature Overrange
128	Saturator Temperature Underrange
144	Saturator Temperature Overrange
512	Test Pressure Underrange
768	Test Pressure Overrange
1024	Low Range Saturator Pressure Underrange
1280	Low Range Saturator Pressure Overrange
2048	High Range Saturator Pressure Underrange
2304	High Range Saturator Pressure Overrange

Error 1 - Expansion Valve Not Closing

This indicates that while attempting to close the expansion valve, the HOME position limit switch closure was not detected. This could mean that either the valve is not moving properly or the switch is mechanically or electrically malfunctioning.

Error 2 - Flow Valve Not Closing

This indicates that while attempting to close the flow valve, the HOME position limit switch closure was not detected. This could mean that either the valve is not moving properly or the switch is mechanically or electrically malfunctioning.

Error 4 - Low Supply Pressure

This indicates that there is insufficient gas supply pressure to continue or that icing has occurred (section 3.2.5.1 Note 2). Check the gas supply. A malfunction of solenoid valve SOL1 or solid state relay SSR5 may also cause this problem.

Error 8 - Cabinet Temperature Overrange

The measured cabinet temperature is too high. Most likely causes include a blocked or clogged intake vent on the left side of the unit, a blocked outlet at the back of the unit, or a faulty fan. Anytime the rear panel is removed and reinstalled, ensure that the fan gets plugged in.

Error 32 - Reference Temperature Underrange

The temperature reference resistor is well below its nominal value of 0 °C. This typically indicates a faulty reference resistor or a malfunctioning A/D converter card.

Error 48 - Reference Temperature Overrange

The temperature reference resistor is well above its nominal value of 0 °C. This typically indicates a faulty reference resistor or a malfunctioning A/D converter card.

Error 64 - Test Temperature Underrange

The indicated test temperature is below -80 °C. One possible cause could be the testing environment temperature is less than -80 °C. The most likely cause is a malfunction of the temperature probe.

Error 80 - Test Temperature Overrange

The indicated test temperature is above 100 °C. One possible cause could be the testing environment temperature is greater than 100 °C. The most likely cause is a malfunction of the temperature probe.

Error 128 - Saturation Temperature Underrange

The indicated saturation temperature is below -85 °C. The most likely cause is a malfunction of the temperature probe. This could also be caused by a faulty heat control circuit or a short in SSR0.

Error 144 - Saturation Temperature Overrange

The indicated saturation temperature is above 30 °C. The most likely cause is a malfunction of the temperature probe.

Error 512 - Test Pressure Underrange

The test pressure transducer indicates a pressure that is less than 10 psiA. The most likely cause is a pressure transducer malfunction or calibration error.

Error 768 - Test Pressure Overrange

The test pressure transducer indicates a pressure more than 10% above its full scale reading. The most likely cause is a pressure transducer malfunction or calibration error.

Error 1024 - Low Range Saturation Pressure Underrange

The low range saturation pressure transducer indicates a pressure less than 10 psiA. The most likely cause is a pressure transducer malfunction or calibration error.

Error 1280 - Low Range Saturation Pressure Overrange

The low range saturation pressure transducer indicates a pressure more than 10% above its full scale reading. One possible cause would be a malfunction or leak in the pressure select solenoid, SOL4. This error could also be caused by a pressure transducer malfunction or calibration error.

Error 2048 - High Range Saturation Pressure Underrange

The high range saturation pressure transducer indicates a pressure less than 10 psiA. The most likely cause is a pressure transducer malfunction or calibration error.

Error 2304 - High Range Saturation Pressure Overrange

The high range saturation pressure transducer indicates a pressure more than 10% above its full scale range. The most likely cause is a pressure transducer malfunction or calibration error.

Section 5

3900 PARTS LISTS

Find #	Qty.	Description	Mfg.	Part Number
A/D	1	Analog A/D Card	Sensoray	MCM-7418
ATB	1	Analog Terminal Board	Sensoray	ADP-7409TB
C1	1	Compressor, R-134A	Aspera	E6187B
C2	1	Compressor, R-23	Aspera	E6187B
CON1	1	Condenser, R-134A	Modine	066-C221-04
CON2	1	Condenser, R-13	Thunder Sci	CON2-3900
CP1,2	2	Capacitor, 10uF 35V Elec	Generic	*********
CPU	1	CPU Card	Octagon Sys	1166
CV1	1	Valve, Check	Nupro	SS-4C-1/3
EX1	1	Exchanger, Heat	Thunder	REF-3900
F1	1	Fan, Console	Rotron	MR77B3
F2	1	Fan, Console	Papst	614
FB1	1	Core, Ferrite	Fair-Rite	2643540002
FD1,2	2	Filter/Drier	Sporlan	C-032-S
G1	1	Gauge, Pressure	Noshok	25.400.300
H1	1	Heater, Cartridge	Watlow	N9N-1560
H2	3	Heater, Foil	Minco	HK5161-22Ω
HLS1	1	Heat Limit Switch	Penn	A19AAF-12
KB	1	Keypad	Memtron	MTI-10-747
LCD-CON	1	Display Controller	Thunder Sci	TS-CDS6255
LCD-DISP	1	Liquid Crystal Display	Apollo Display	DMF6104NB-FW
LCD-INV	1	Inverter Board (Back-Lite)	Apollo Display	CXAM10L
LF1	1	Filter, Inline	Nupro	SS-4F-7
MB	1	Mother Board	Thunder Sci	PWB97B00237
MEM	1	Memory Card	RH Systems	RH829A
MOV1	3	Varistor, Metal Oxide	NTE	NTE2V250
OS1	1	Separator, Oil	Danfoss	D40B0010
P1	1	Pump, Centrifugal	Micro-Pump	P101-605
PLF1	1	Filter, Power Line	Curtis	F1700BB03
PS1	1	Supply, ±15/5VDC Power	Power-One	HTAA-16W-A
PS2	1	Supply, +24VDC Power	Power-One	MAP55-1024
RECR	1	Receiver, Refrigeration	Copeland	077-C221-02
REG	1	Regulator, Pressure	Concoa	0425-5001-00
RT1	1	Tube, Reservoir	Thunder Sci	RT1-3900
RTD1	1	Sensor, Temperature	Therm-X	D080796B
RTD2	1	Sensor, Temperature	Therm-X	YSP44006-18-2-TT-ST
RV1	1	Valve, Relief	Nupro	SS-4CPA2-150
S1	1	Power Switch	Carling Switch	AF2-X0-03-947-531-C
SAT	1	Saturator	Thunder	SAT-3900
SL1,2	2	Switch, Limit	Micro Switch	MCRSW2
SM-1,2	2	Motor, Stepper	Oriental Motor	PK243B1A-SG18
SMD-1,2	2	Driver, Stepper Motor	Semix	RD-023MS
SOL1-4	4	Valve, Solenoid	Burkert	456175S
SOL5	1	Valve, Solenoid	Sporlan	E3S120
SPKR	1	Minilert Audible Signal	Newark	44F3221

3900 PARTS LIST (continued)

Find #	Qty.	Description	Mfg.	Part Number
SSR0,2-5	5	DC SSR Module	Opto 22	G4-ODC5A
SSR6,7	2	AC SSR Module	Opto 22	G4-OAC5A
SSR8-10	3	10 Amp SSR	Opto 22	240D10
SSRB	1	SSR Module Board	Octagon Sys	2512
TB1	20	Terminal Block	Allan-Bradley	1492-WM3
TIB	1	Terminal Interface Board	Octagon Sys	1183
TR1	1	Transducer, Pressure	SenSym	ST2300G1
TR2	1	Transducer, Flow	Brooks Instr	BK5860E
TR3	1	Transducer, Pressure	Sensotec	77-01155-01
TR4	1	Transducer, Pressure	Sensotec	HT-E-300-A-B
TR5	1	Transducer, Pressure	Sensotec	77-01155-01
			Sensotec	* HT-E-150-A-B
V1	1	Valve, Flow	Thunder	V1-3900
V2	1	Valve, Expansion	Thunder	V2-3900
V3	1	Valve, Refrig Expansion	Sporlan	NIF-1/2-C
V5	1	Valve, Metering	Nupro	SS-2MA

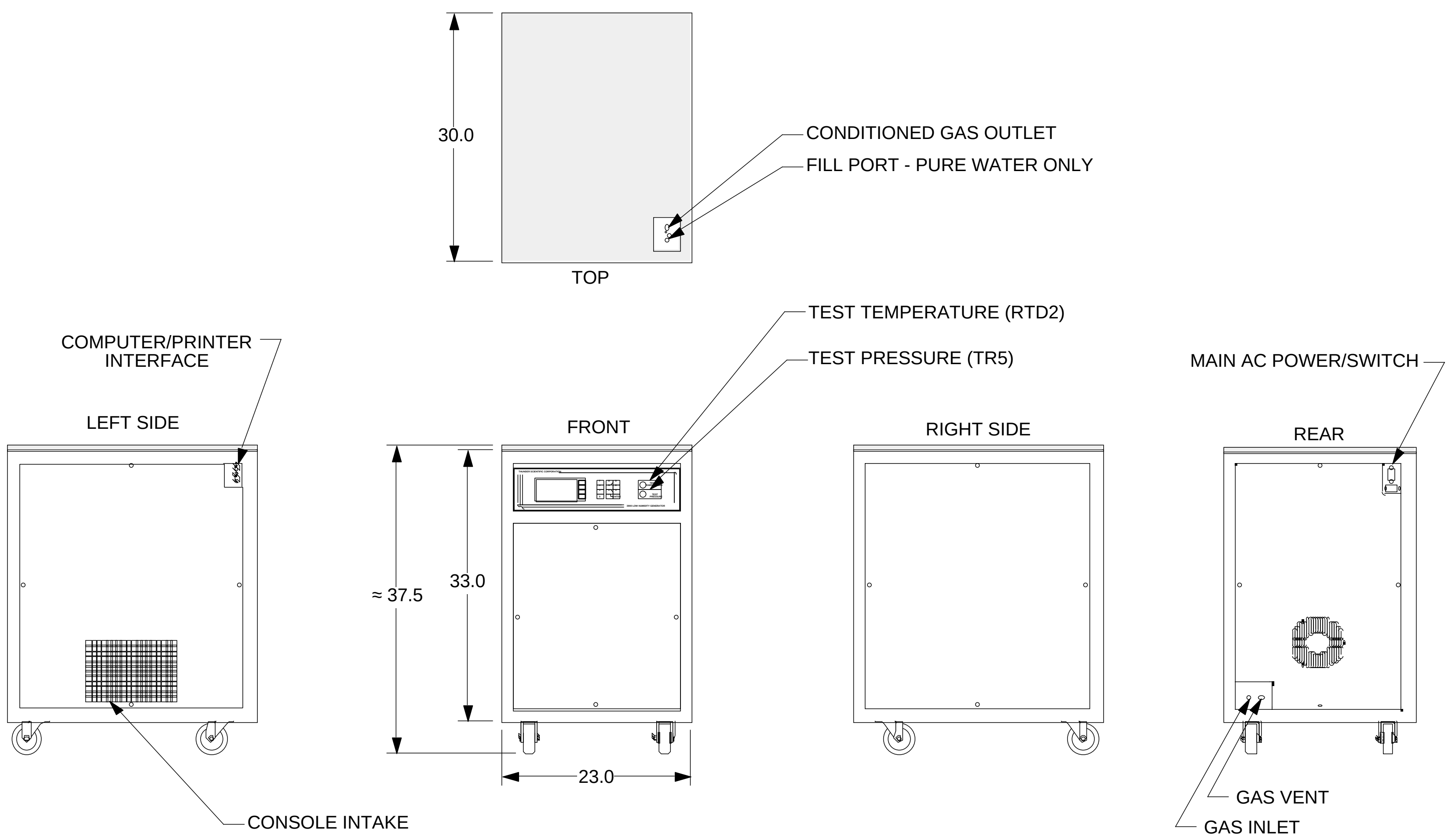
* High Pressure (HP) Option Parts

NOTES:

1. INTERPRET DRAWING PER DOD-STD-100
2. INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5M
3. ALL UNITS ARE IN INCHES UNLESS OTHERWISE SPECIFIED

REVISIONS

DWN	REV	DESCRIPTION	DATE	APPROVED
GMF	A	REMOVED DIMS ON REAR PANEL AND ADDED CALLOUTS	8/2/94	BB
BKS	B	CLARIS TO MINICAD	3/29/99	MB

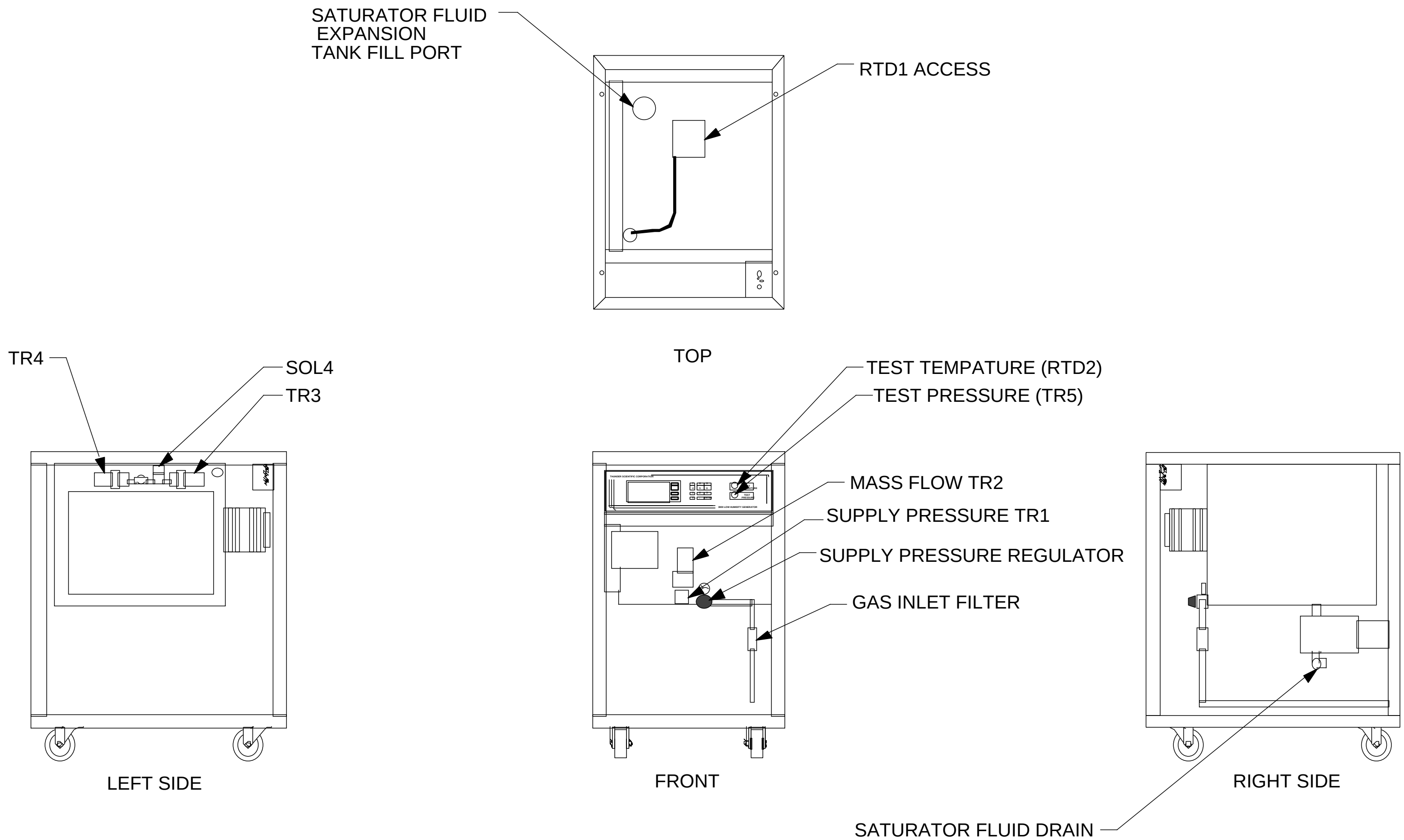


	TOLERANCES .X ±.015 .XX ±.010 .XXX ±.005 ∠ ±2° UNLESS OTHERWISE SPECIFIED	CONTRACT NO.	THIRD ANGLE PROJECTION	**Thunder Scientific Corporation** 623 Wyoming S.E. Albuquerque, NM 87123-3198
3900		DRAWN FISCHER	DATE 07/28/94	MECHANICAL/UTILITY
NEXT ASSY / USED ON	TREATMENT	CHECKED BB	07/28/94	A DWG SIZE / DWG NO. 94M39100 / REV B
APPLICATION	FINISH	ISSUED		SCALE 1 : 20 / WEIGHT / SHEET 1 OF 1

NOTES:

1. INTERPRET DRAWING PER DOD-STD-100

REVISIONS				
DWN	REV	DESCRIPTION	DATE	APPROVED
GMF	A	RENAMED METH. TO SAT. FLUID & RTD5 TO TR5.	9/28/95	
BKS	B	CLARIS TO MINICAD	3/29/99	MB

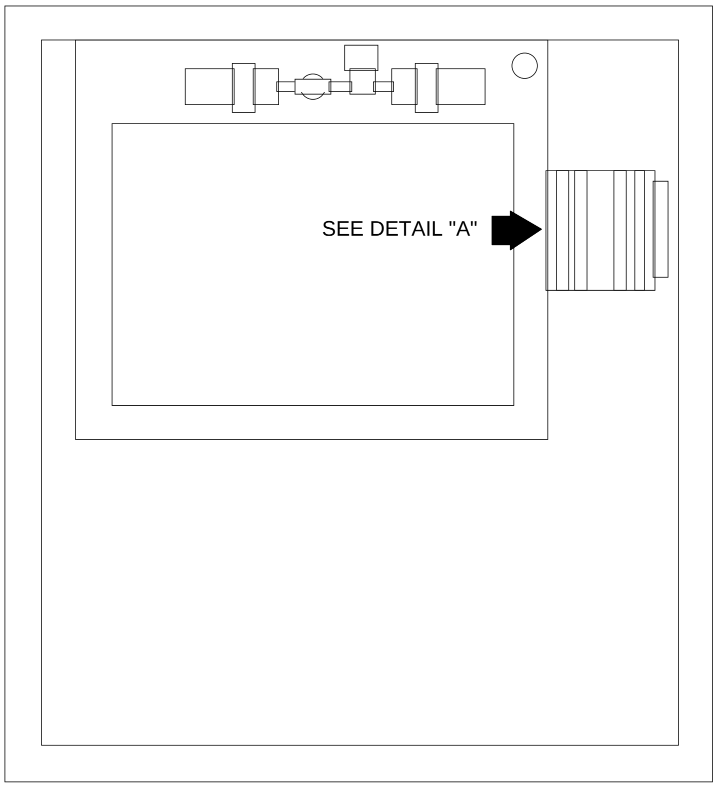


		TOLERANCES .X ±.015 .XX ±.010 .XXX ±.005 ±2° UNLESS OTHERWISE SPECIFIED	CONTRACT NO.	THIRD ANGLE PROJECTION	**Thunder Scientific Corporation** 623 Wyoming S.E. Albuquerque, NM 87123-3198
	3900		DRAWN FISCHER	DATE 04/04/95	LOCATIONS, COMPONENTS
NEXT ASSY	USED ON	TREATMENT	CHECKED MB	04/04/95	A DWG SIZE | DWG NO. 95M39101 | REV B
APPLICATION		FINISH	ISSUED		SCALE NTS | WEIGHT | SHEET 1 OF 1

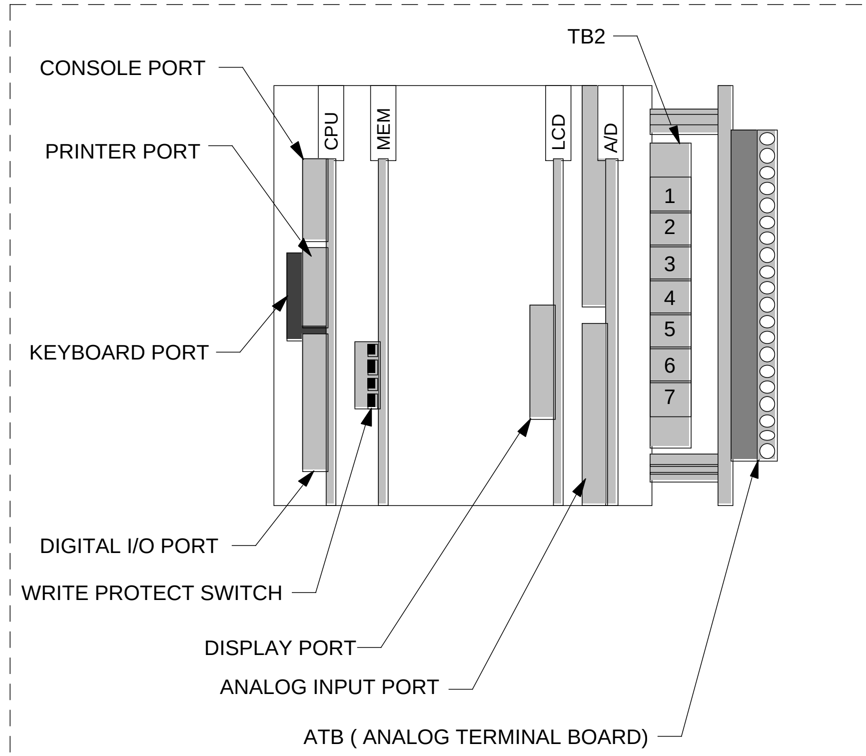
NOTES:

1. INTERPRET DRAWING PER DOD-STD-100

REVISIONS				
DWN	REV	DESCRIPTION	DATE	APPROVED
GMF	A	MOVED ALL WRITE PROTECT SWITCHES TO ON POSITION, AND REVERSED PRINTER AND CONSOLE PORTS, DROPPED LCD CONTRAST KNOB	1/28/97	MB
BKS	B	CLARIS TO MINICAD	3/29/99	MB



LEFT SIDE VIEW

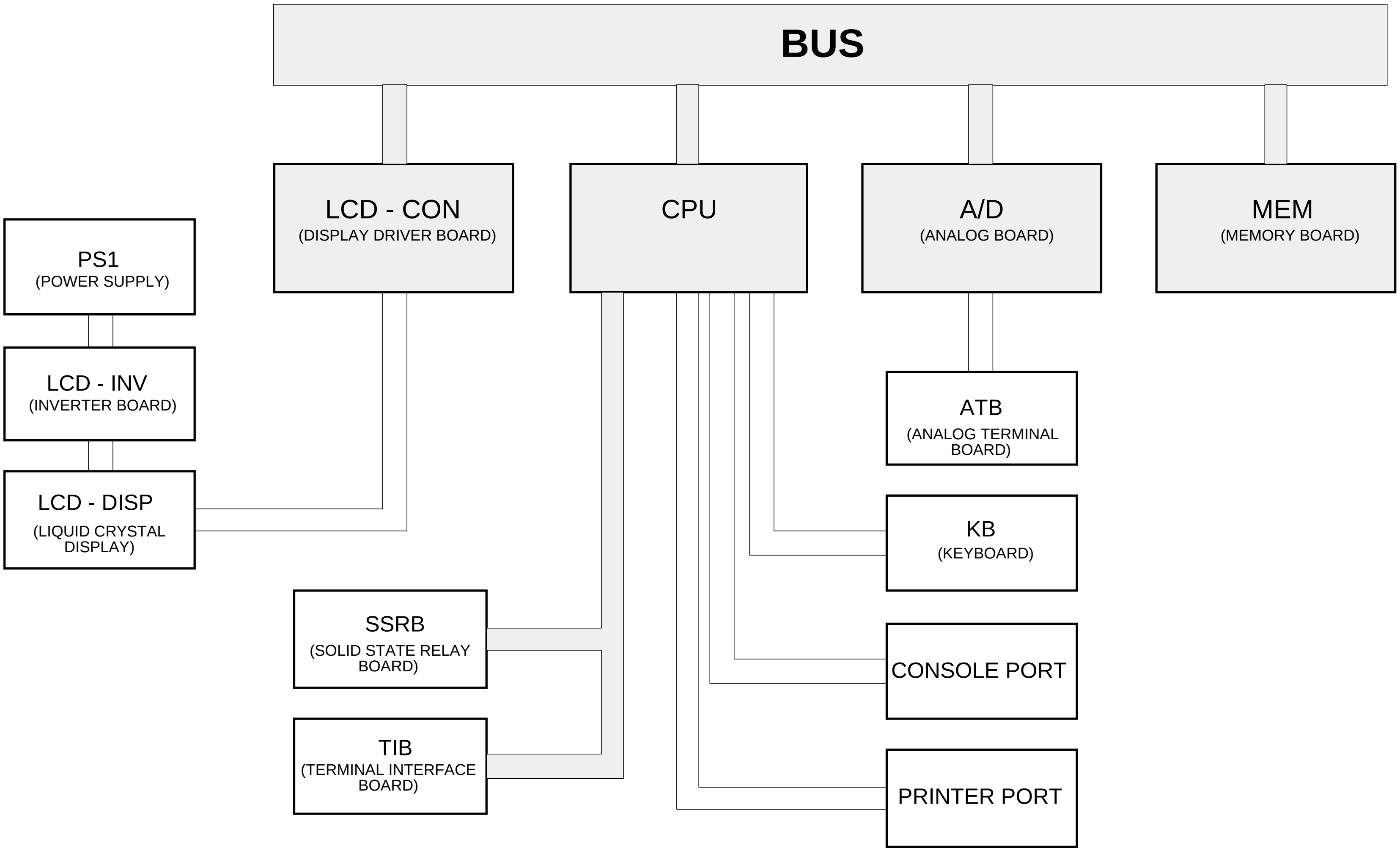


DETAIL "A"

	3900	TOLERANCES .X ±.015 .XX ±.010 .XXX ±.005 ∠ ±2° UNLESS OTHERWISE SPECIFIED	CONTRACT NO.	THIRD ANGLE PROJECTION	**Thunder Scientific Corporation** 623 Wyoming S.E. Albuquerque, NM 87123-3198
NEXT ASSY	USED ON	TREATMENT	DRAWN FISCHER	DATE 03/31/95	CAGE, CARDS & CARD
APPLICATION		FINISH	CHECKED MB	04/04/95	A DWG SIZE · DWG NO. 95M39102 · REV B
			ISSUED		SCALE NTS · WEIGHT · SHEET 1 OF 1

NOTES:
1. INTERPRET DRAWING PER DOD-STD-100
2. INTERPRET DIMENSIONS AND TOLERANCES PER ANSI Y14.5M

REVISIONS				
DWN	REV	DESCRIPTION	DATE	APPROVED
BKS	A	CLARIS TO MINICAD	3/29/99	MB



	3900	TOLERANCES .X ±.015 .XX ±.010 .XXX ±.005 ∠ ±2° UNLESS OTHERWISE SPECIFIED	CONTRACT NO.	THIRD ANGLE PROJECTION
NEXT ASSY	USED ON	TREATMENT	DRAWN FISCHER	DATE 03/29/95
APPLICATION		FINISH	CHECKED MB	04/04/95
			ISSUED	

Thunder Scientific Corporation
623 Wyoming S.E. Albuquerque, NM 87123-3198

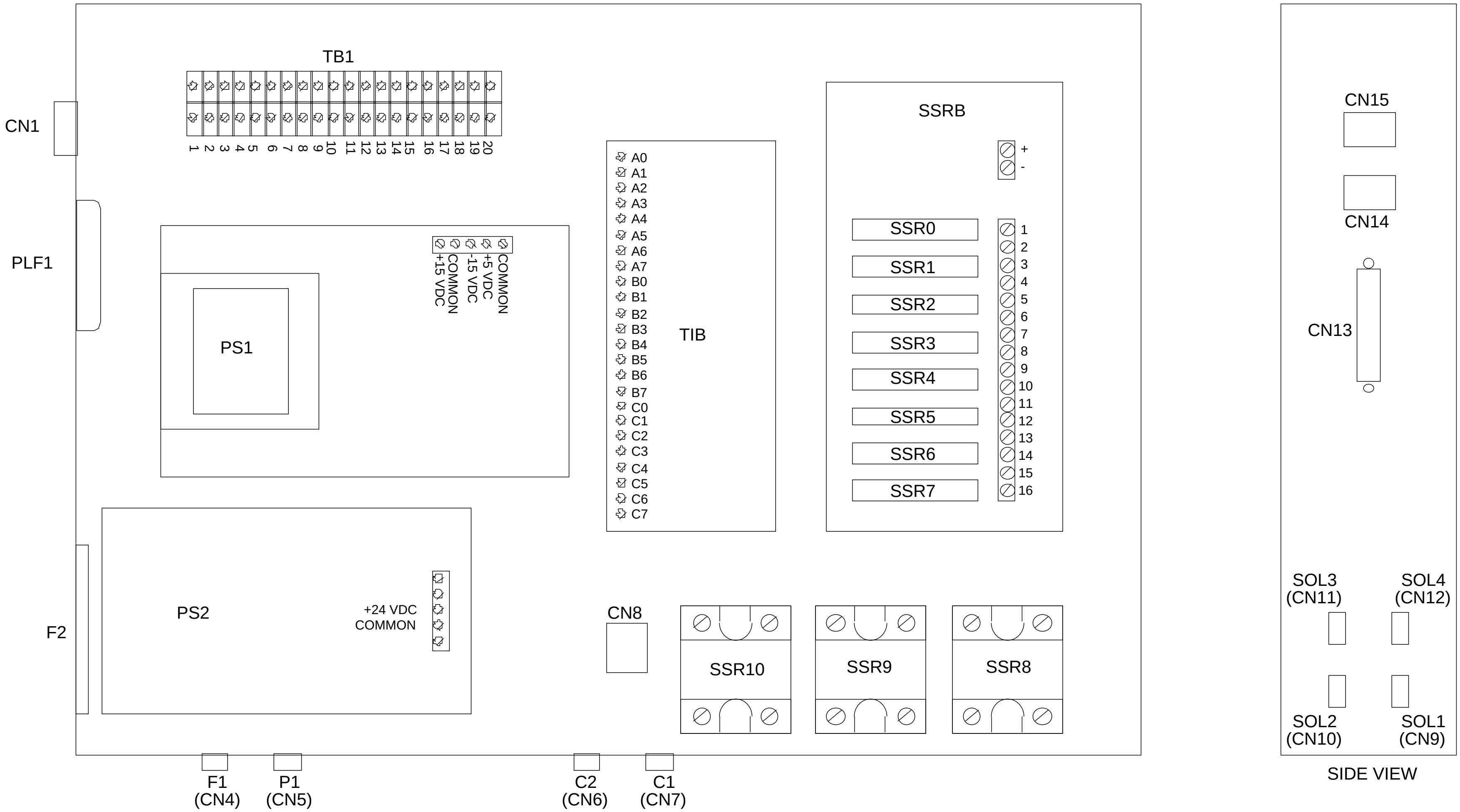
DIAGRAM, 3900 BUS

DWG SIZE	DWG NO.	REV
A	95S39103	A
SCALE NTS	WEIGHT	SHEET 1 OF 1

NOTES:

1. INTERPRET DRAWING PER DOD-STD-100

REVISIONS				
DWN	REV	DESCRIPTION	DATE	APPROVED
GMF	B	ADDED PLF1.	1/28/97	MB
BKS	C	CLARIS TO MINICAD	4/9/99	MB



		TOLERANCES .X ±.015 .XX ±.010 .XXX ±.005 ∠ ±2° UNLESS OTHERWISE SPECIFIED	CONTRACT NO.	THIRD ANGLE PROJECTION	**Thunder Scientific Corporation** 623 Wyoming S.E. Albuquerque, NM 87123-3198
	3900		DRAWN FISCHER	DATE 03/29/95	LAYOUT, ELECTRICAL SUB-PANEL
NEXT ASSY	USED ON	TREATMENT	CHECKED MB	04/13/95	A DWG SIZE — DWG NO. 95M39104 — REV C
APPLICATION		FINISH	ISSUED		SCALE NTS — WEIGHT — SHEET 1 OF 1

NOTES:

1. INTERPRET DRAWING PER DOD-STD-100
2. INTERPRET ELECTRICAL AND ELECTRONIC DIAGRAMS PER ANSI Y14.15

REVISIONS

DWN	REV	DESCRIPTION	DATE	APPROVED
GMF	B	ADDED 240 VAC HIGH VOLTAGE OPTION	1/28/97	MB
GMF	C	CHANGED 1-10 ON TB1, 1-CHASSIS GND,	6/27/97	MB
		2-4 L_1, AND 5-10 L_2 /NEUTRAL		
BKS	D	CLARIS TO MINICAD	4/2/99	MB

TB1

1	CHASSIS GND
2	L_1
3	L_1
4	L_1
5	L_2 /NEUTRAL
6	L_2 /NEUTRAL
7	L_2 /NEUTRAL
8	L_2 /NEUTRAL
9	L_2 /NEUTRAL
10	L_2 /NEUTRAL
11	+5 VDC
12	+5 VDC
13	+5 VDC
14	+5 VDC
15	+5 VDC
16	COMMON
17	COMMON
18	COMMON
19	COMMON
20	COMMON

TB2

1	-15 VDC
2	COMMON
3	+15 VDC
4	COMMON
5	+15 VDC
6	COMMON
7	+15 VDC

CP1 + CP2 +

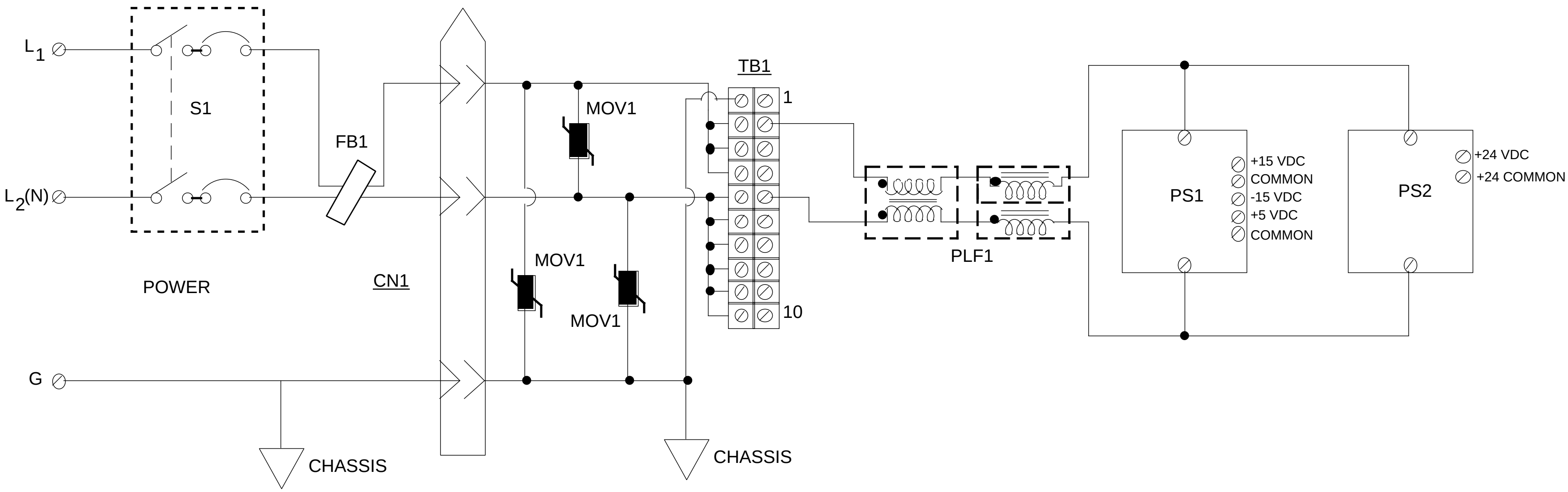
		TOLERANCES	CONTRACT NO.	THIRD ANGLE PROJECTION	**Thunder Scientific Corporation** 623 Wyoming S.E. Albuquerque, NM 87123-3198
		.X ±.015 .XX ±.010 .XXX ±.005 ±2°			
	3900	UNLESS OTHERWISE SPECIFIED	DRAWN FISCHER	DATE 03/29/95	LAYOUT, TERMINAL
NEXT ASSY	USED ON	TREATMENT	CHECKED MB	04/04/95	A DWG SIZE / DWG NO. 95S39105 / REV D
APPLICATION		FINISH	ISSUED		SCALE NTS / WEIGHT / SHEET 1 OF 1

NOTES:

1. INTERPRET DRAWING PER DOD-STD-100
2. INTERPRET ELECTRICAL AND ELECTRONIC DIAGRAMS PER ANSI Y14.15

REVISIONS

DWN	REV	DESCRIPTION	DATE	APPROVED
GMF	B	ADDED HIGH VOLTAGE OPTION AND FILTERING	1/28/97	MG
GMF	C	DELETED HIGH VOLTAGE OPTION	6/27/97	MG
BKS	D	CLARIS TO MINICAD	4/2/99	MG



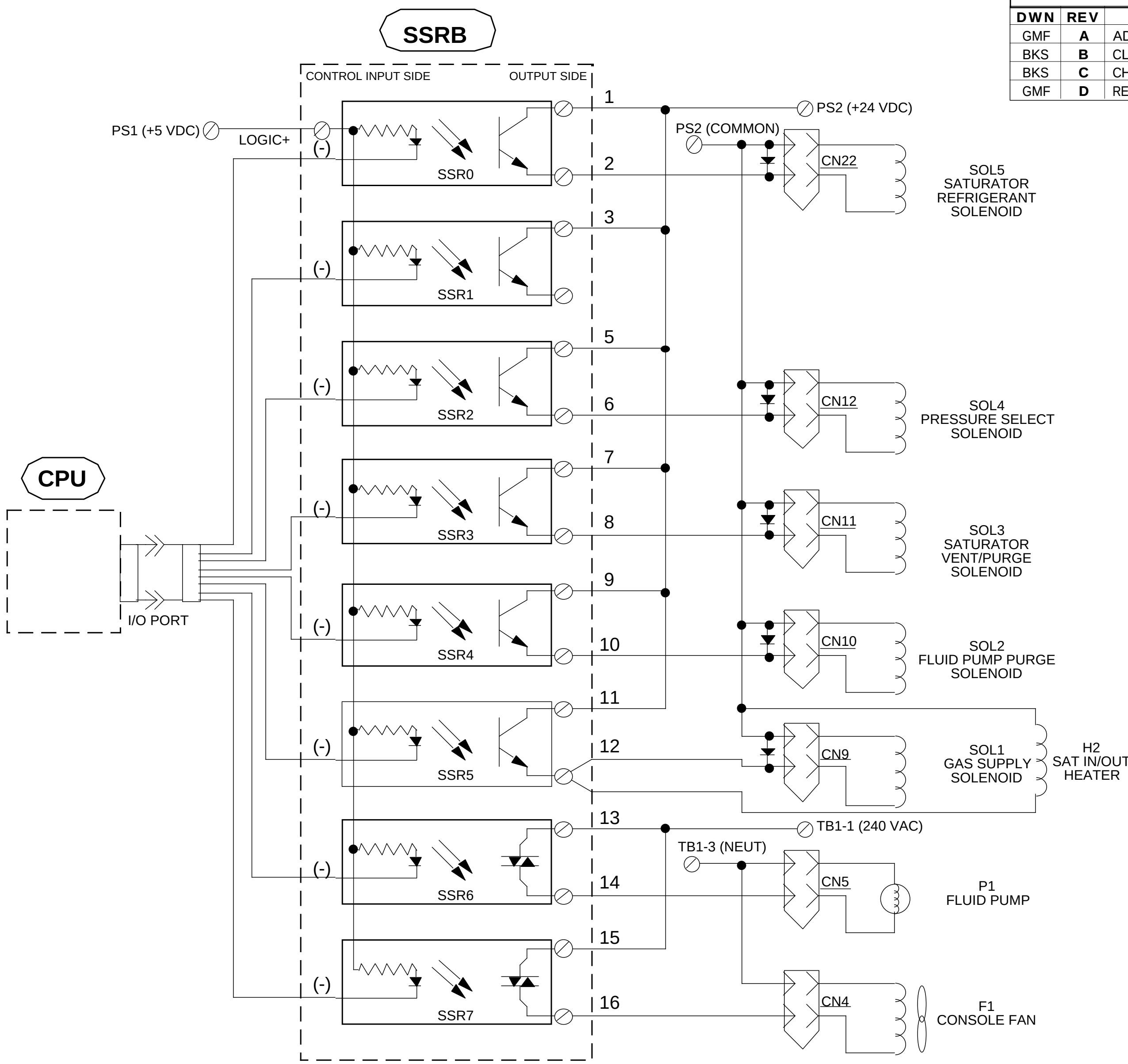
3900		TOLERANCES .X ±.015 .XX ±.010 .XXX ±.005 ∠ ±2° UNLESS OTHERWISE SPECIFIED	CONTRACT NO.	THIRD ANGLE PROJECTION
NEXT ASSY	USED ON	TREATMENT	DRAWN FISCHER	DATE 03/28/95
APPLICATION		FINISH	CHECKED MG	04/04/95
			ISSUED	

Thunder Scientific Corporation
623 Wyoming S.E. Albuquerque, NM 87123-3198

SCHEMATIC, AC / DC POWER

DWG SIZE	DWG NO.	REV
A	95S39106	D
SCALE NTS	WEIGHT	SHEET 1 OF 1

REVISIONS				
DWN	REV	DESCRIPTION	DATE	APPROVED
GMF	A	ADDED H2 SAT HEATER	9/24/96	MB
BKS	B	CLARIS TO MINICAD	4/1/99	MB
BKS	C	CHANGED TB1-1 FROM 120 TO 240 VAC	4/5/99	MB
GMF	D	REMOVED SOLENOID 6, CN23 & #4 FROM SSR1	9/29/99	MB



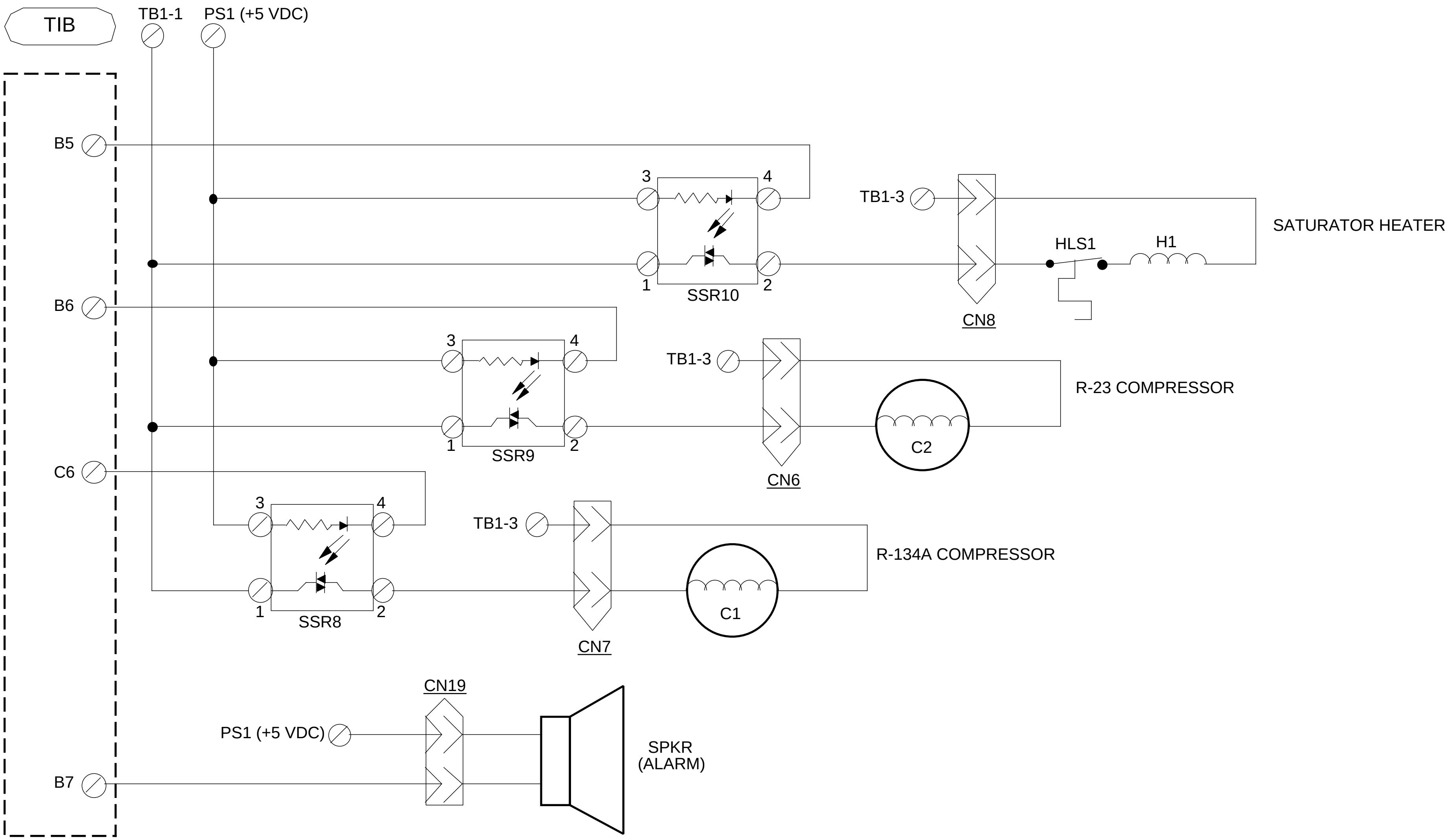
		TOLERANCES	CONTRACT NO.	THIRD ANGLE PROJECTION	Thunder Scientific Corporation 623 Wyoming S.E. Albuquerque, NM 87123-3198
	3900	.X ±.015 .XX ±.010 .XXX ±.005 ±2° UNLESS OTHERWISE SPECIFIED	DRAWN FISCHER	DATE 03/31/95	BOARD, SOLID STATE RELAY MODULE
NEXT ASSY	USED ON	TREATMENT	CHECKED MB	03/31/95	A DWG SIZE | DWG NO. 95S39107 | REV D
APPLICATION		FINISH	ISSUED		SCALE NTS | WEIGHT | SHEET 1 OF 1

NOTES:

1. INTERPRET DRAWING PER DOD-STD-100
2. INTERPRET ELECTRICAL AND ELECTRONIC DIAGRAMS PER ANSI Y14.15

REVISIONS

DWN	REV	DESCRIPTION	DATE	APPROVED
GMF	A	CHANGED R-13 TO R-23 COMPRESSOR	6/27/97	MB
BKS	B	CLARIS TO MINICAD	4/2/99	MB



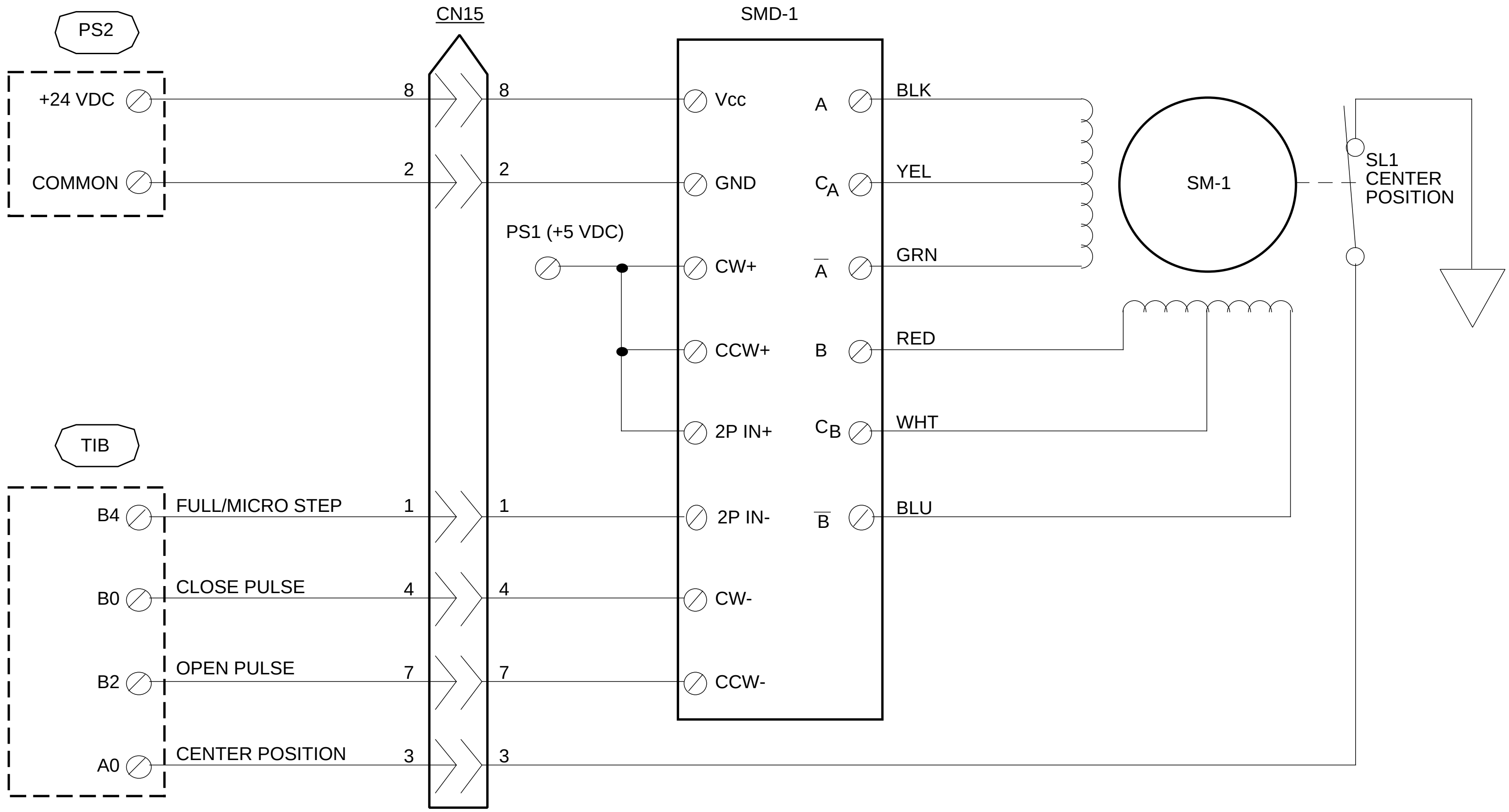
		TOLERANCES .X ±.015 .XX ±.010 .XXX ±.005 ∠ ±2° UNLESS OTHERWISE SPECIFIED	CONTRACT NO.	THIRD ANGLE PROJECTION	**Thunder Scientific Corporation** 623 Wyoming S.E. Albuquerque, NM 87123-3198
	3900		DRAWN FISCHER	DATE 03/30/95	SCHEMATIC, COMPRESSOR/ HEATER / ALARM
NEXT ASSY	USED ON	TREATMENT	CHECKED MB	04/04/95	A DWG SIZE · DWG NO. 95S39108 · REV B
APPLICATION		FINISH	ISSUED		SCALE NTS · WEIGHT · SHEET 1 OF 1

NOTES:

1. INTERPRET DRAWING PER DOD-STD-100
2. INTERPRET ELECTRICAL AND ELECTRONIC DIAGRAMS PER ANSI Y14.15

REVISIONS

DWN	REV	DESCRIPTION	DATE	APPROVED
BKS	A	CLARIS TO MINICAD	4/2/99	MB
BKS	B	CHANGED S2 TO SL1	4/7/99	MB



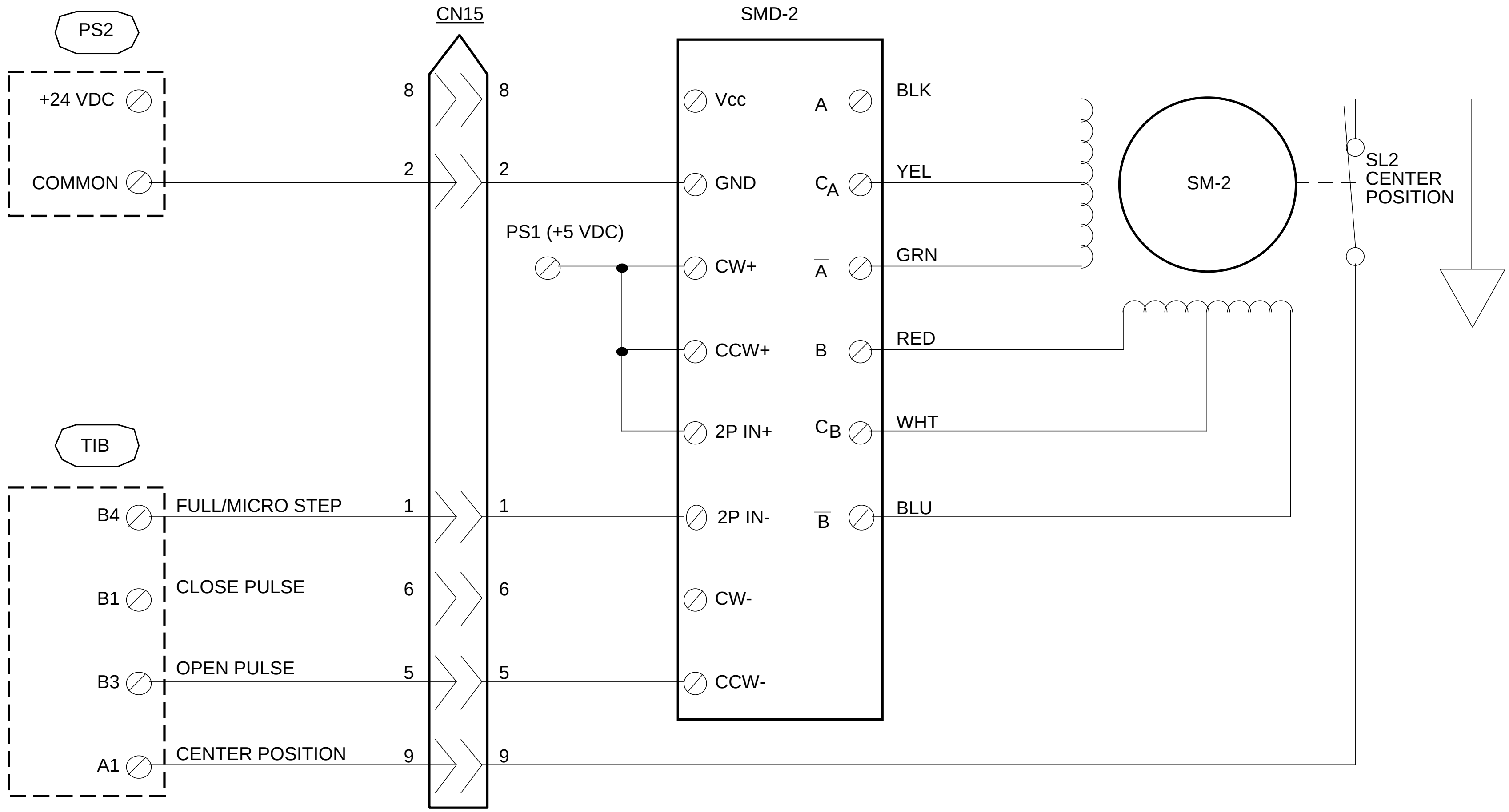
		TOLERANCES .X ±.015 .XX ±.010 .XXX ±.005 ∠ ±2° UNLESS OTHERWISE SPECIFIED	CONTRACT NO.	THIRD ANGLE PROJECTION	**Thunder Scientific Corporation** 623 Wyoming S.E. Albuquerque, NM 87123-3198
	3900		DRAWN FISCHER	DATE 03/30/95	SCHEMATIC, FLOW VALVE DRIVE
NEXT ASSY	USED ON	TREATMENT	CHECKED MB	04/04/95	A DWG SIZE · DWG NO. 95S39109 · REV B
APPLICATION		FINISH	ISSUED		SCALE NTS · WEIGHT · SHEET 1 OF 1

NOTES:

1. INTERPRET DRAWING PER DOD-STD-100
2. INTERPRET ELECTRICAL AND ELECTRONIC DIAGRAMS PER ANSI Y14.15

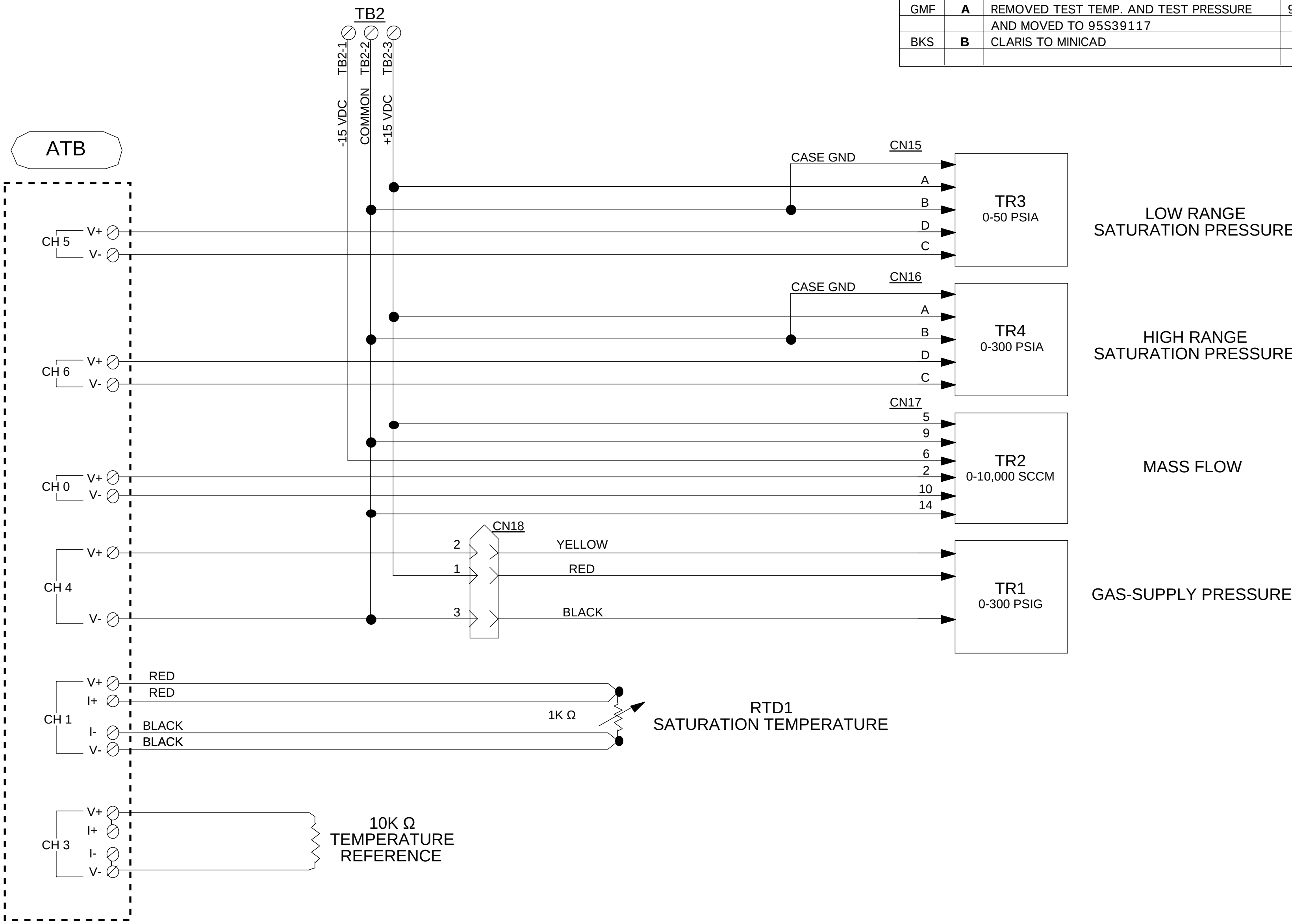
REVISIONS

DWN	REV	DESCRIPTION	DATE	APPROVED
BKS	A	CLARIS TO MINICAD	4/2/99	MB
BKS	B	CHANGED S3 TO SL2	4/7/99	MB



		TOLERANCES	CONTRACT NO.	THIRD ANGLE PROJECTION	Thunder Scientific Corporation 623 Wyoming S.E. Albuquerque, NM 87123-3198
	3900	.X ±.015 .XX ±.010 .XXX ±.005 ∠ ±2° UNLESS OTHERWISE SPECIFIED	DRAWN FISCHER	DATE 03/30/95	SCHEMATIC, EXPANSION VALVE DRIVE
NEXT ASSY	USED ON	TREATMENT	CHECKED MB	04/04/95	A DWG SIZE · DWG NO. 95S39110 · REV B
APPLICATION		FINISH	ISSUED		SCALE NTS · WEIGHT · SHEET 1 OF 1

REVISIONS				
DWN	REV	DESCRIPTION	DATE	APPROVED
GMF	A	REMOVED TEST TEMP. AND TEST PRESSURE AND MOVED TO 95S39117	9/15/95	[signature]
BKS	B	CLARIS TO MINICAD	4/5/99	[signature]



	3900
NEXT ASSY	USED ON
APPLICATION	

TOLERANCES
.X ±.015
.XX ±.010
.XXX ±.005
∠ ±2°
UNLESS OTHERWISE SPECIFIED

TREATMENT

FINISH

CONTRACT NO.

THIRD ANGLE PROJECTION

DRAWN FISCHER — DATE 03/30/95

CHECKED [signature] — 04/04/95

ISSUED

Thunder Scientific Corporation

623 Wyoming S.E. Albuquerque, NM 87123-3198

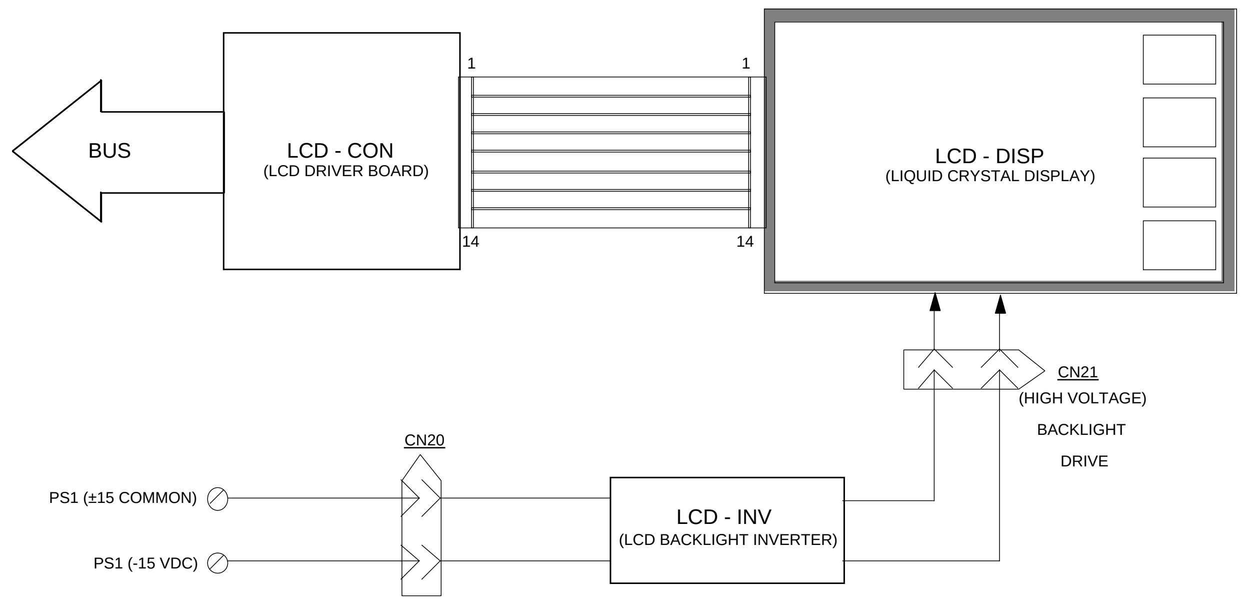
SCHEMATIC, TEMPERATURE PROBE / TRANSDUCER

DWG SIZE	DWG NO.	REV
A	95S39111	B

SCALE NTS — WEIGHT — SHEET 1 OF 1

NOTES:
1. INTERPRET DRAWING PER DOD-STD-100

REVISIONS				
DWN	REV	DESCRIPTION	DATE	APPROVED
BKS	A	CLARIS TO MINICAD	4/5/99	MB



	3900
NEXT ASSY	USED ON
APPLICATION	

TOLERANCES
.X ±.015
.XX ±.010
.XXX ±.005
∠ ±2°
UNLESS OTHERWISE SPECIFIED
TREATMENT
FINISH

CONTRACT NO.
THIRD ANGLE PROJECTION
DRAWN FISCHER — DATE 03/31/95
CHECKED MB — 04/04/95
ISSUED

Thunder Scientific Corporation
623 Wyoming S.E. Albuquerque, NM 87123-3198

DIAGRAM, DISPLAY BLOCK

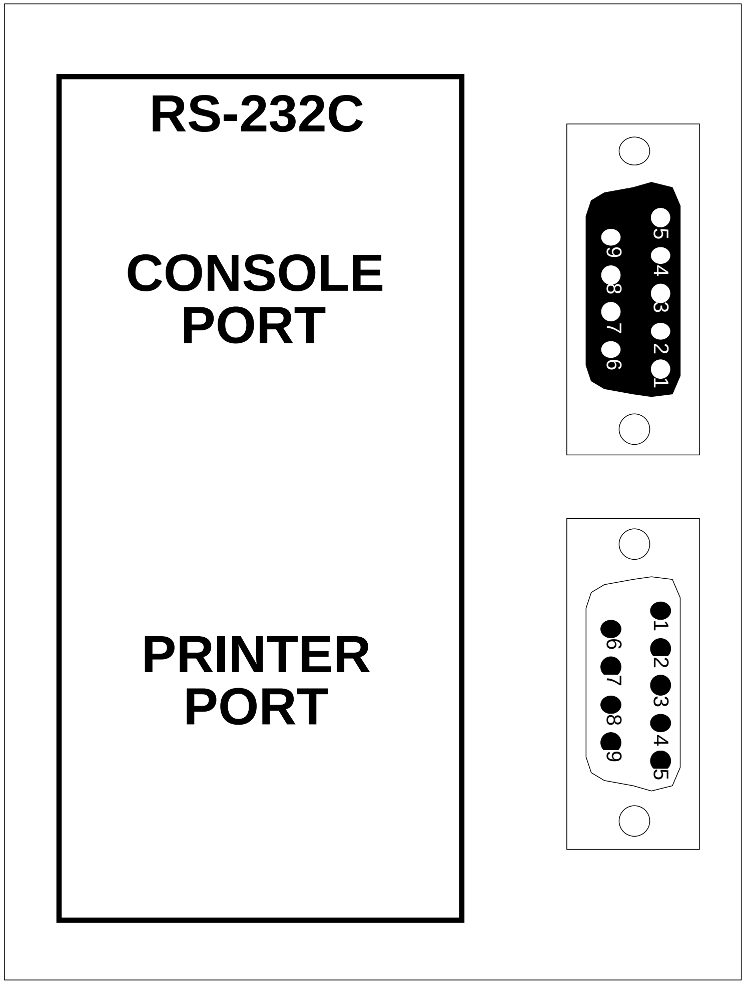
DWG SIZE	DWG NO.	REV
A	95S39112	A

SCALE NTS | WEIGHT | SHEET 1 OF 1

NOTES:
1. INTERPRET DRAWING PER DOD-STD-100
2. THESE CONNECTORS CAN BE FOUND ON THE UPPER RIGHT HAND CORNER OF THE LEFT SIDE PANEL
   AT AND XT ARE REGISTERED TRADEMARKS OF IBM CORPORATION
3. AT AND XT ARE REGISTERED TRADEMARKS OF IBM CORPORATION

REVISIONS

DWN	REV	DESCRIPTION	DATE	APPROVED
BKS	A	CLARIS TO MINICAD	3/29/99	MB



PIN #	CONSOLE PORT	PRINTER PORT	DATA/LOGIC DIRECTION
1	NC	NC	
2	TxD	TxD	OUT
3	RxD	RxD	IN
4	DSR**	DSR**	
5	SIG GND	SIG GND	
6	DTR**	DTR**	
7	RTS*	RTS	IN
8	CTS*	CTS	OUT
9	NC	NC	

* = CONSOLE PORT DOES NOT SUPPORT RTS/CTS.
PINS 7 & 8 ARE STRAPPED TOGETHER WITHIN UNIT.

** = 3900 DOES NOT SUPPORT DSR AND DTR SIGNALS.
PINS 4 & 6 ARE STRAPPED TOGETHER WITHIN
THE UNIT FOR THE USE OF PERIPHERAL EQUIPMENT.

PRINTER CONNECTION

TO CONNECT A SERIAL PRINTER TO THE PRINTER PORT, USE PRINTER CABLE (PART NUMBER: PCABLE) OR A STANDARD AT® MODEM CABLE.

COMPUTER CONNECTION

TO CONNECT AN AT® COMPUTER TO THE CONSOLE PORT USE CONSOLE CABLE (PART NUMBER: CCABLE) OR 9 PIN EXTENDER CABLE. CONNECTION TO PC OR XT® COMPUTER MAY REQUIRE AN AT® OR XT® PORT ADAPTER.

NEXT ASSY	USED ON
	3900
APPLICATION	

TOLERANCES
.X ±.015
.XX ±.010
.XXX ±.005
±2°
UNLESS OTHERWISE SPECIFIED
TREATMENT
FINISH

CONTRACT NO.
THIRD ANGLE PROJECTION

DRAWN	FISCHER	DATE	03/29/95
CHECKED	MB		04/04/95
ISSUED			

Thunder Scientific Corporation
623 Wyoming S.E. Albuquerque, NM 87123-3198

CONSOLE, RS-232C / PRINTER

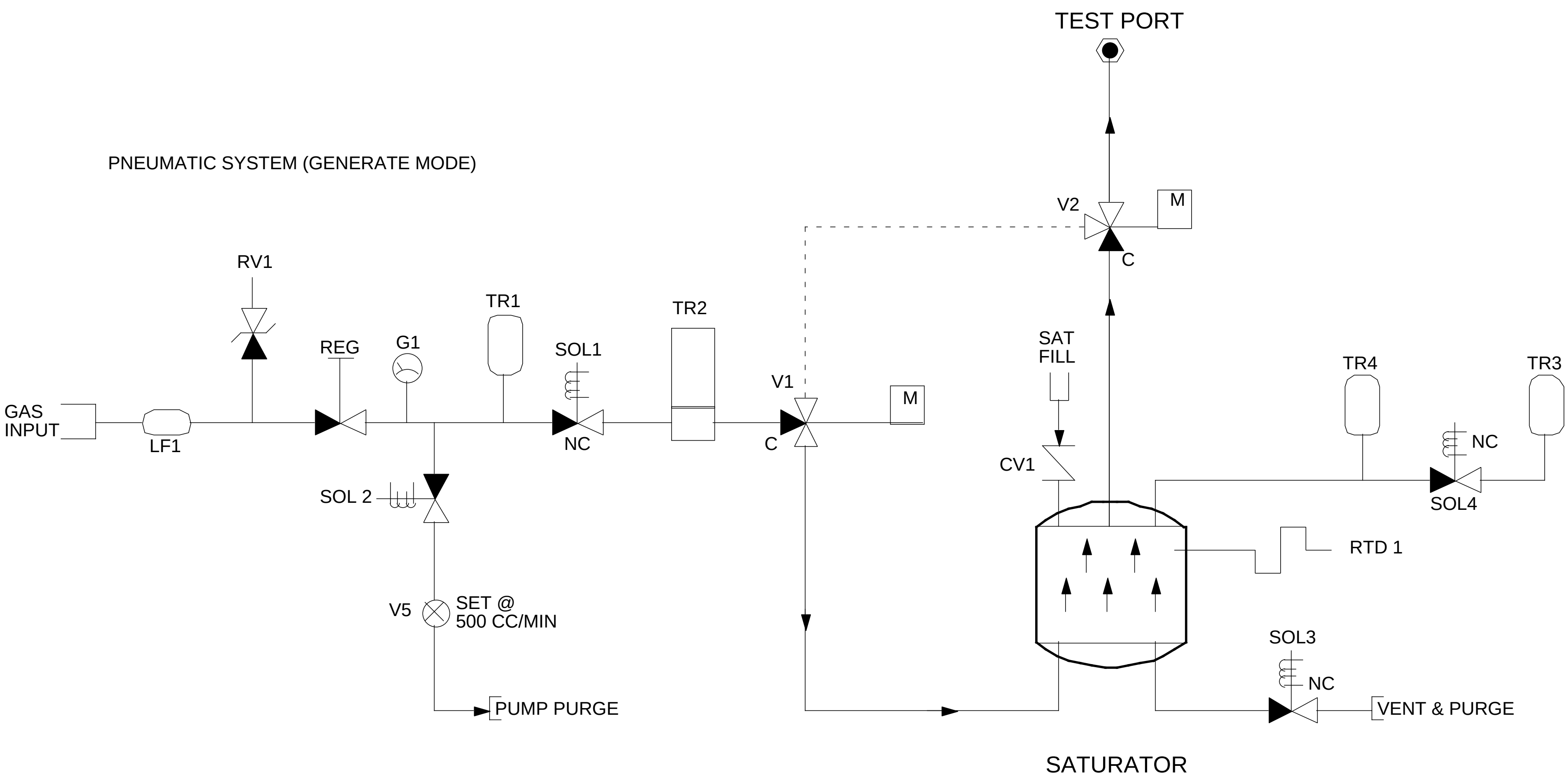
A DWG SIZE	DWG NO. 95M39113	REV A	
SCALE NTS	WEIGHT	SHEET 1 OF 1	

NOTES:

1. INTERPRET DRAWING PER DOD-STD-100
2. INTERPRET ELECTRICAL AND ELECTRONIC DIAGRAMS PER ANSI Y14.15

REVISIONS				
DWN	REV	DESCRIPTION	DATE	APPROVED
GMF	A	DROPPED RV2.	9/24/96	MB
BKS	B	CLARIS TO MINICAD	4/2/99	MB

PNEUMATIC SYSTEM (GENERATE MODE)

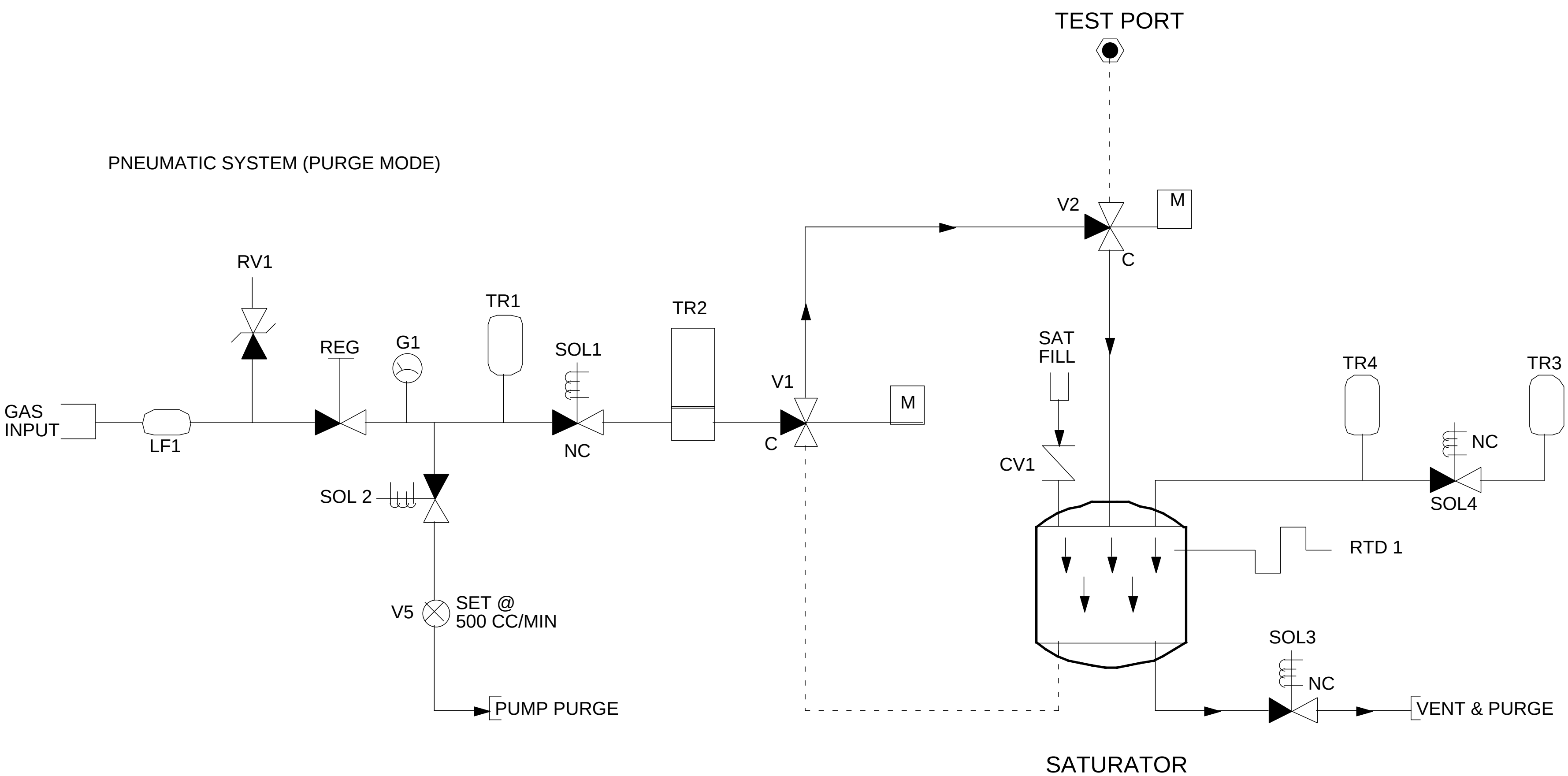


		TOLERANCES .X ±.015 .XX ±.010 .XXX ±.005 ∠ ±2° UNLESS OTHERWISE SPECIFIED	CONTRACT NO.	THIRD ANGLE PROJECTION	**Thunder Scientific Corporation** 623 Wyoming S.E. Albuquerque, NM 87123-3198
	3900		DRAWN FISCHER	DATE 03/07/95	SYSTEM, PNEUMATIC (GENERATE MODE)
NEXT ASSY	USED ON	TREATMENT	CHECKED MB	04/04/95	A DWG SIZE · DWG NO. 95S39114 · REV B
APPLICATION		FINISH	ISSUED		SCALE NTS · WEIGHT · SHEET 1 OF 1

NOTES:
1. INTERPRET DRAWING PER DOD-STD-100
2. INTERPRET ELECTRICAL AND ELECTRONIC DIAGRAMS PER ANSI Y14.15

REVISIONS				
DWN	REV	DESCRIPTION	DATE	APPROVED
GMF	A	DROPPED RV2.	9/24/96	MB
BKS	B	CLARIS TO MINICAD	4/5/99	MB

PNEUMATIC SYSTEM (PURGE MODE)

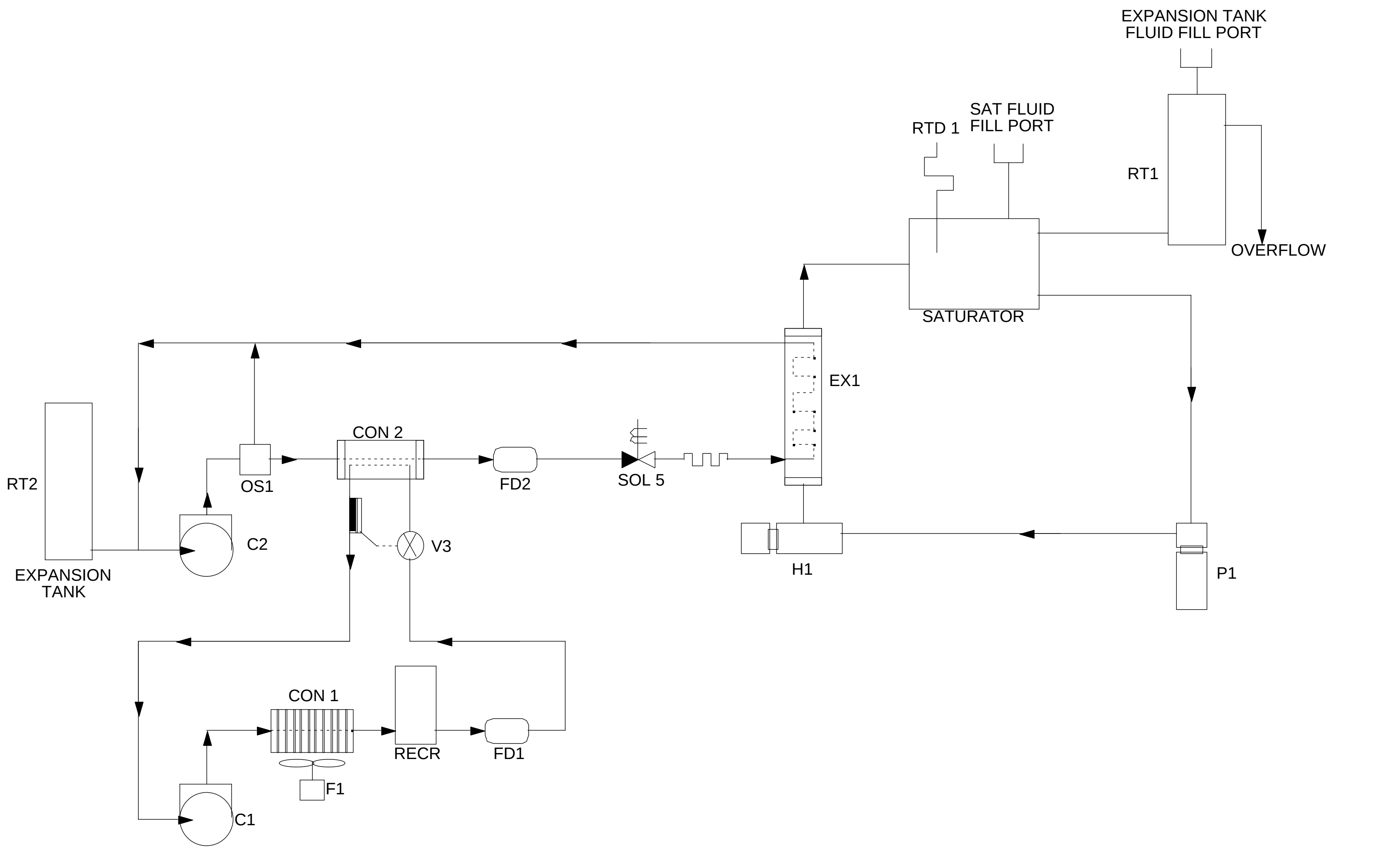


		TOLERANCES .X ±.015 .XX ±.010 .XXX ±.005 ∠ ±2° UNLESS OTHERWISE SPECIFIED	CONTRACT NO.	THIRD ANGLE PROJECTION	**Thunder Scientific Corporation** 623 Wyoming S.E. Albuquerque, NM 87123-3198
	3900		DRAWN FISCHER	DATE 03/07/95	SYSTEM, PNEUMATIC (PURGE MODE)
NEXT ASSY	USED ON	TREATMENT	CHECKED MB	04/04/95	A DWG SIZE · DWG NO. 95S39115 · REV B
APPLICATION		FINISH	ISSUED		SCALE NTS · WEIGHT · SHEET 1 OF 1

NOTES:

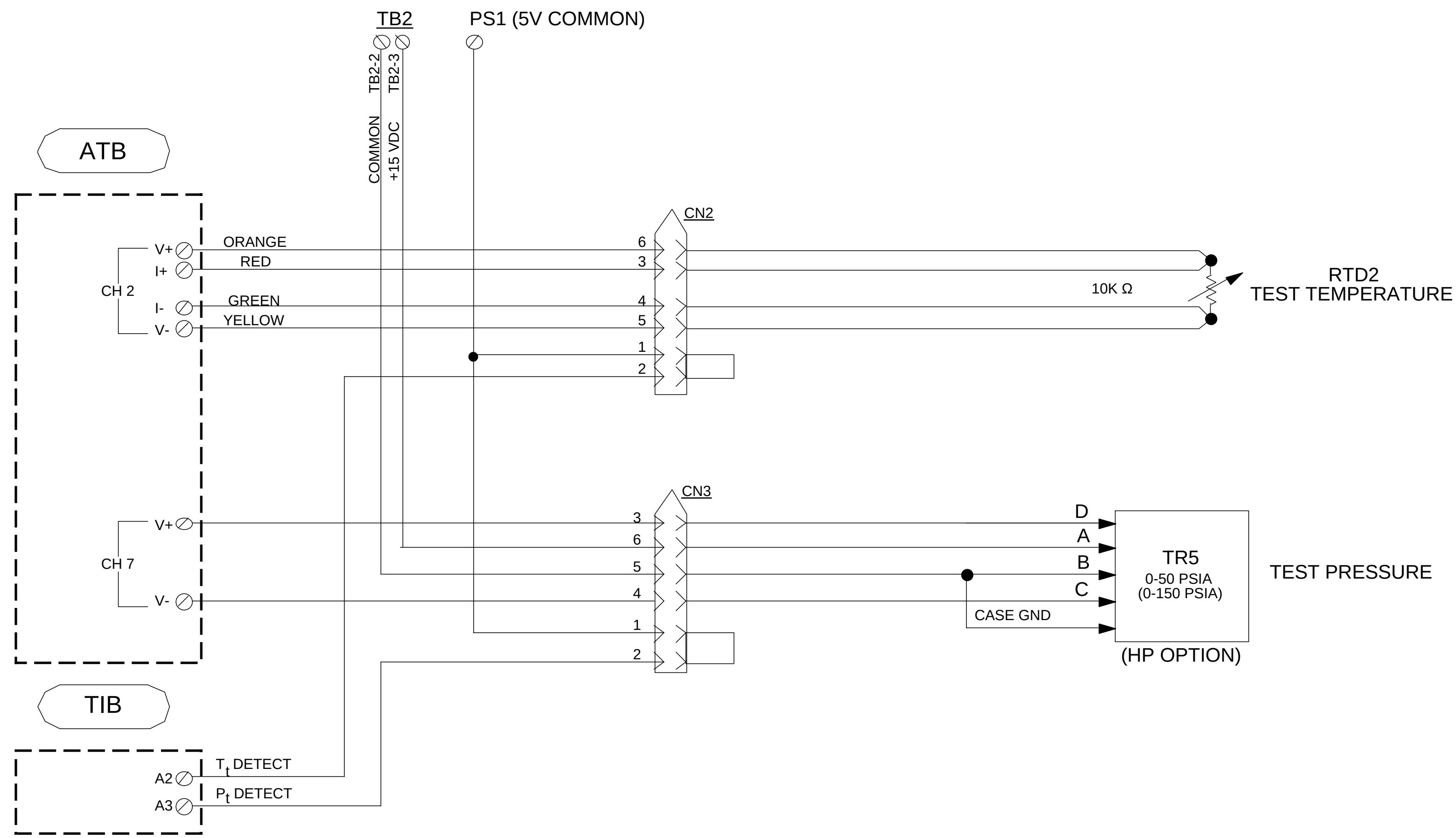
1. INTERPRET DRAWING PER DOD-STD-100

REVISIONS				
DWN	REV	DESCRIPTION	DATE	APPROVED
GMF	A	REMOVED DW1 ADDED RECR	9/29/95	MB
BKS	B	CLARIS TO MINICAD	2/24/99	MB
GMF	C	REMOVED SOLENOID 6	9/29/99	MB



		TOLERANCES .X ±.015 .XX ±.010 .XXX ±.005 ∠ ±2° UNLESS OTHERWISE SPECIFIED	CONTRACT NO.	THIRD ANGLE PROJECTION	**Thunder Scientific Corporation** 623 Wyoming S.E. Albuquerque, NM 87123-3198
	3900		DRAWN FISCHER	DATE 03/07/95	SATURATOR, REFRIG & FLUID FLOW
NEXT ASSY	USED ON	TREATMENT	CHECKED MB	04/04/95	A DWG SIZE · DWG NO. 95S39116 · REV C
APPLICATION		FINISH	ISSUED		SCALE NTS · WEIGHT · SHEET 1 OF 1

REVISIONS				
DWN	REV	DESCRIPTION	DATE	APPROVED
GMF	A	ADDED (HP OPTION)	6/27/97	MB
BKS	B	CLARIS TO MINICAD	4/5/99	MB



		TOLERANCES .X ±.015 .XX ±.010 .XXX ±.005 ∠ ±2° UNLESS OTHERWISE SPECIFIED	CONTRACT NO.	THIRD ANGLE PROJECTION	**Thunder Scientific Corporation** 623 Wyoming S.E. Albuquerque, NM 87123-3198
	3900		DRAWN FISCHER	DATE 09/15/95	SCHEMATIC, TEST TEMPERATURE PROBE / TEST PRESSURE TRANSDUCER
NEXT ASSY	USED ON	TREATMENT	CHECKED	09/19/95	A DWG SIZE · DWG NO. 95S39117 · REV B
APPLICATION		FINISH	ISSUED		SCALE NTS · WEIGHT · SHEET 1 OF 1

Command Summary

The following is a comprehensive list of commands, grouped by type, which are available over the RS-232 interface. Each of the commands is organized in alphabetical order on the following pages. Each command contains examples of its usage and proper syntax.

Setpoint / Data Retrieval Commands

?	Returns current system actual/generated values
?DP	Returns current value of generated Dew Point
?FL	Returns current value of actual Flow Rate
?FP	Returns current value of generated Frost Point
?PG	Returns current value of actual Supply Pressure
?PS	Returns current value of actual Saturation Pressure
?PT	Returns current value of actual Test Pressure
?PV	Returns current value of generated PPMv
?PW	Returns current value of generated PPMw
?RH	Returns current value of generated %RH
?SP	Returns current system setpoint values
?TS	Returns current value of actual Saturation Temperature
?TT	Returns current value of actual Test Temperature

Action Commands

GEN	Changes system to generate mode
PRI	Prints system data
PUR	Changes system to purge mode
SAV	Saves system parameters
STO	Stops system

Setpoint Commands

DP=	Changes Dew Point setpoint
FL=	Changes Flow Rate setpoint
FP=	Changes Frost Point setpoint
PS=	Changes Saturation Pressure setpoint
PT=	Changes Test Pressure setpoint
PV=	Changes PPMv setpoint
PW=	Changes PPMw setpoint
RH=	Changes %RH setpoint
TS=	Changes Saturation Temperature setpoint
TT=	Changes Test Temperature setpoint

Utility/Status Commands

?CL Returns number of Saturator Clear cycles remaining
CL= Sets number of Saturator Clear cycles
?DA Returns the system date
?DF Returns Date Format type
DF= Sets Date Format type
?ER Returns Error code
?MW Returns Molecular Weight
MW= Sets Molecular Weight
?PI Returns Print Interval
PI= Sets Print Interval
?PR Returns Print On/Off status
PR= Sets Print On/Off status
?PU Returns Pressure Units type
PU= Sets Pressure Units type
?RU Returns Run status
?TF Returns Cabinet Fan Temperature
?TI Returns the system time
?WM Returns WMO calculation status
WM= Sets WMO calculation status

Read Actual Values ?

Description

Returns the current generated system values.

Prerequisites

None

Syntax

?

Parameters

None

Remarks

Data Returned

? returns a list of 11 comma separated values indicating the current data and status of the system. These values are returned in the same order as they appear on the 3900 screen. The values in the sequence shown represent the following:

ITEM	DESCRIPTION
1	Frost Point °C
2	Dew Point °C
3	PPMv
4	PPMw
5	%RH
6	Saturation Pressure, in current system units
7	Saturation Temperature, °C
8	Test Pressure, in current system units
9	Test Temperature, °C
10	Flow Rate, l/m
11	System Status

The System Status parameter (item 11 above) indicates the system's generation status. The three possible returned values are as follows:

VALUE	DESCRIPTION
0	System is idle
1	System is running
-1	System is purging

Examples

The **?** command is used to request the current generated system values and status. This example assumes current system pressure units are set to psi.

computer sends **?**<CR>

3900 responds *-10,-11.23, 2581, 1606, 10.39, 34.73,-.01, 14.7, 21.1, .5, 1<CR><LF>*

The data returned indicates that the system is currently running (last item in the list=1), and the generated values are:

Frost Point = -10 °C
Dew Point = -11.23 °C
PPMv = 2581
PPMw = 1606
%RH = 10.39
Sat Pressure = 34.73 psiA
Sat Temperature = -0.01 °C
Test Pressure = 14.7 psiA
Test Temperature = 21.1 °C
Flow Rate = 0.5 l/m

See Also

GEN, ?PU, PU=, PUR, ?RU, ?SP, STO

Read Saturator Clear Cycles ?CL

Description

Returns an integer value that corresponds to the number of Saturator Clear cycles left to complete.

Prerequisites

Firmware Ver 2.0 or newer

Syntax

?CL
?CLEAR

Parameters

None

Remarks

Data Returned

?CL returns the number of saturator clear cycles left to complete.

Examples

The **?CL** command is used to request the number of saturator clears left to complete:

computer sends	**?CL**<CR>
3900 responds	*0<CR><LF>*

The "0" returned indicates that there are no more clear cycles left to complete.

See Also

CL=, PUR

CL= Set Saturator Clear Cycles

Description

Changes the number of Saturator Clear Cycles to a given value.

Prerequisites

Firmware Ver 2.0 or newer

Syntax

CL=*value*

Parameters

value

The *value* is the number of clear cycles the generator should complete before returning to a purge mode.

Remarks

Data Returned

None. The only response is a carriage return/linefeed terminator. If the generator is not in a purge mode then the carriage return/linefeed terminator will be returned but the command will not be processed.

Examples

The **CL=***value* command is used to set the number of clear cycles to five, assuming the generator is currently in the purge mode:

computer sends **CL=** 5<CR>
3900 responds *<CR><LF>*

The *<CR><LF>* response signifies completion of the command.

See Also

?CL, PUR

Read System Date ?DA

Description

Returns the current system date.

Prerequisites

Firmware Ver 2.0 or newer

Syntax

?DA
?DATE

Parameters

None

Remarks

Data Returned

?DA returns the system date in the current date format.

Examples

The **?DA** command is used to request the current date, assuming the system is using the default US date format:

computer sends **?DA**<CR>
3900 responds *10/11/95<CR><LF>*

The date returned indicates that the system date is 11 October 1995.

See Also

?DF, DF=, ?TI

?DF Read Date Format

Description

Returns an integer value that corresponds to a date format type.

Prerequisites

Firmware Ver 2.0 or newer

Syntax

?DF

Parameters

None

Remarks

Data Returned

?DF returns one of two values to indicate the current date format. The two possible returned values are as follows:

VALUE	DESCRIPTION
0	US date format, mm/dd/yy
1	European date format, dd/mm/yy

Examples

The **?DF** command is used to request the current date format:

computer sends **?DF**<CR>
3900 responds *0<CR><LF>*

The "0" returned indicates that the system is using the US date format, mm/dd/yy.

See Also

DF=

Change Date Format **DF=**

Description

Changes the system date format to one of two possible date format types.

Prerequisites

Firmware Ver 2.0 or newer

Syntax

DF=*value*

Parameters

value

The *value* corresponds to a date format type. The date format types are as follows:

VALUE	DESCRIPTION
0	US date format, mm/dd/yy
1	European date format, dd/mm/yy

A value other than 0 or 1 will cause the system to default to the US date format.

Remarks

Data Returned

None. The only response is a carriage return/linefeed terminator.

Saving Changes to Non-Volatile Memory

The **DF=***value* command only temporarily changes the date format. Changes will be lost on power down of the system or when switching to the Edit or Cal mode using the front panel keypad. To save the changes permanently, use the **SAV** command.

Examples

The **DF=***value* command is used to change the current date format to a European style:

computer sends: **DF=** 1<CR>
3900 responds: *<CR><LF>*

The *<CR><LF>* response signifies completion of the command.

See Also

?DF, SAV

?DP Read Generated Dew Point

Description

Returns the current value of the Dew Point being generated.

Prerequisites

Firmware Ver 2.0 or newer

Syntax

?DP

Parameters

None

Remarks

Data Returned

The value returned is the Dew Point value, in °C, calculated from the current generator values for Ts, Ps, Tt, and Pt.

Examples

The **?DP** command is used to request the current Dew Point value:

computer sends **?DP**<CR>
3900 responds *10.5 <CR><LF>*

The generator is currently generating a Dew Point of 10.5 °C.

See Also

?

Change Dew Point Setpoint **DP=**

Description

Changes the Dew Point setpoint to a given value.

Prerequisites

None

Syntax

DP=*setpoint*

Parameters

setpoint

The *setpoint* value is the Dew Point, in °C, that the system should generate.

Remarks

Control Mode Changed

Sending **DP=***setpoint* also changes the control mode to Dew Point (mode 1). In this mode PPMv, PPMw, %RH and Saturation Pressure setpoints vary as system temperatures and pressures change.

Data Returned

None. The only response is a carriage return/linefeed terminator.

Examples

The **DP=***setpoint* command is used to set the Dew Point setpoint to 10 °C.

computer sends **DP=10**<CR>
3900 responds *<CR><LF>*

The *<CR><LF>* response signifies completion of the command.

See Also

?SP

?ER Read Error Number

Description

Returns the current error number relating to system shutdown.

Prerequisites

None

Syntax

?ER

Parameters

None

Remarks

Data Returned

?ER returns one of several values indicating the reason(s) that the system shut down. The value returned can be any one, or an algebraic combination, of several, of the following:

VALUE	DESCRIPTION
0	No Error
1	Expansion Valve Not Closing
2	Flow Valve Not Closing
4	Low Supply Pressure
8	Cabinet Temperature Overrange
32	Reference Temperature Underrange
48	Reference Temperature Overrange
64	Test Temperature Underrange
80	Test Temperature Overrange
128	Saturation Temperature Underrange
144	Saturation Temperature Overrange
512	Test Pressure Underrange
768	Test Pressure Overrange
1024	Low Range Saturation Pressure Underrange
1280	Low Range Saturation Pressure Overrange
2048	High Range Saturation Pressure Underrange
2304	High Range Saturation Pressure Overrange

Examples

After an unexpected system shutdown (indicated by the value returned from the **?RU** command or the last parameter in the **?** command), the **?ER** command is used to determine the nature of the failure:

computer sends **?ER**<CR>
3900 responds *4<CR><LF>*

The "4" returned indicates that the system shutdown due to a low supply pressure.

See Also

?, ?RU

Description Returns the current value of the Flow Rate.

Prerequisites Firmware Ver 2.0 or newer

Syntax **?FL**

Parameters None

Remarks Data Returned

The value returned is the current value of the Flow Rate in liters/minute.

Examples The **?FL** command is used to request the current Flow Rate:

computer sends **?FL**<CR>
3900 responds *3.027CR><LF>*

The current flow rate is 3.027 l/min.

See Also **?**

FL= Change Flow Rate Setpoint

Description

Changes the Flow Rate setpoint to a given value.

Prerequisites

Firmware Ver 2.0 or newer

Syntax

FL=*setpoint*

Parameters

setpoint

The *setpoint* value is the Flow rate, in l/m, that the system should control at.

Remarks

Data Returned

None. The only response is a carriage return/linefeed terminator.

Examples

The **FL=***setpoint* command is used to set the Flow Rate setpoint to 0.5 l/m.

computer sends **FL=.5**<CR>
3900 responds *<CR><LF>*

The *<CR><LF>* response signifies completion of the command.

See Also

?SP

Read Generated Frost Point ?FP

Description

Returns the current value of the Frost Point being generated.

Prerequisites

Firmware Ver 2.0 or newer

Syntax

?FP

Parameters

None

Remarks

Data Returned

The value returned is the Frost Point value, in °C, calculated from the current generator values for Ts, Ps, Tt, and Pt. Frost Point values that are above 0 °C are most likely invalid, use Dew Point.

Examples

The **?FP** command is used to request the current Frost Point value:

computer sends	**?FP**<CR>
3900 responds	*-27.5<CR><LF>*

The generator is currently generating a Frost Point of -27.5 °C.

See Also

?

FP= Change Frost Point Setpoint

Description

Changes the Frost Point setpoint to a given value.

Prerequisites

None

Syntax

FP=*setpoint*

Parameters

setpoint — The *setpoint* value is the Frost Point, in °C, that the system should generate.

Remarks

Control Mode Changed

Sending **FP=***setpoint* also changes the control mode to Frost Point (mode 0). In this mode PPMv, PPMw, %RH and Saturation Pressure setpoints vary as system temperatures and pressures change.

Data Returned

None. The only response is a carriage return/linefeed terminator.

Examples

The **FP=***setpoint* command is used to set the Frost Point setpoint to -10 °C.

computer sends **FP=-10**<CR>
3900 responds *<CR><LF>*

The *<CR><LF>* response signifies completion of the command.

See Also

?SP

Start the System GEN

Description Starts the system just as if the front panel "GEN" key had been pressed.

Prerequisites Firmware Ver 2.0 or newer

Syntax
GEN
GENERATE

Parameters None

Remarks

Data Returned

None. The only response is a carriage return/linefeed terminator.

Examples The **GEN** command is used to start the system.

computer sends	**GEN**<CR>
3900 responds	*<CR><LF>*

The *<CR><LF>* response will be delayed several seconds until the system start-up is complete.

See Also **PUR, STO**

?MW Read Molecular Weight

Description Returns the molecular weight of the carrier gas in g/mol.

Prerequisites None

Syntax **?MW**

Parameters None

Remarks Data Returned

?MW returns the value currently being used as the molecular weight of the carrier gas in g/mol. The molecular weight of the carrier gas is used by the system when calculating PPMw from the fundamental measurements of Ts, Ps, Tt and Pt.

Examples The **?MW** command is used to request the current Molecular Weight value:

computer sends	**?MW**<CR>
3900 responds	28*<CR><LF>*

The 28.00 g/mol returned indicates that the system is most likely using Nitrogen (N_2) as the supply gas type.

See Also **MW=**

Description

Changes the value used as the Molecular Weight of the carrier gas to a given value.

Prerequisites

None

Syntax

MW=*value*

Parameters

value

The *value* is the molecular weight of the carrier/supply gas in grams/mole. If zero is input for the molecular weight the system will revert to a default value of 28.9645, the molecular weight of Air. PPMw is the only parameter directly affected by the value entered.

Remarks

Data Returned

None. The only response is a carriage return/linefeed terminator.

Saving Changes to Non-Volatile Memory

The **MW=***value* command only temporarily changes the value used as the molecular weight of the carrier/supply gas. Changes will be lost on power down of the system or when switching to the Edit or Cal mode using the front panel keypad. To save the changes permanently, use the **SAV** command.

Validity of Enhancement Factors

The Molecular Weight does not alter the Enhancements Factors in any way or compensate for variations in solubility or compressibility of various gasses. Therefore, when using a carrier gas other than air or nitrogen, the validity of the Enhancement Factors used in the calculation of humidity parameters can not be assured.

Examples

The **MW=***value* command is used to set the Molecular Weight value to 28.9645 g/mol.

computer sends **DP=28.9645**<CR>
3900 responds *<CR><LF>*

The *<CR><LF>* response signifies completion of the command.

See Also

?MW, SAV

?PG Read Gas Supply Pressure

Description

Returns the current value of the Gas Supply Pressure.

Prerequisites

Firmware Ver 2.0 or newer

Syntax

?PG

Parameters

None

Remarks

Data Returned

The value returned is the current value of the Gas Supply Pressure in current system units.

Examples

The **?PG** command is used to request the current Gas Supply Pressure value, assuming the system units are in psi:

computer sends **?PG**<CR>
3900 responds *259.3* *<CR><LF>*

The current gas supply pressure is 259.3 psiG.

Read Print Interval **?PI**

Description Returns the print interval in seconds.

Prerequisites Firmware Ver 2.0 or newer

Syntax **?PI**

Parameters None

Remarks Data Returned

?PI returns the value currently being used as the print interval in seconds.

Examples The **?PI** command is used to request the current print interval:

computer sends **?PI**<CR>
3900 responds 300*<CR><LF>*

The 300 seconds returned indicates that the system will send a line of data to the printer that is connected to the systems printer port once every five minutes.

See Also **PI=**

PI= Change Print Interval

Description

Changes the printer interval to a given value and executes a Print Now command (PRI).

Prerequisites

Firmware Ver 2.0 or newer

Syntax

PI=*value*

Parameters

value — The *value* is the time interval (in whole seconds) that the system will use as the lapse time between printed data points.

Remarks

Data Returned

None. The only response is a carriage return/linefeed terminator.

Saving Changes to Non-Volatile Memory

The **PI=***value* command only temporarily changes the value used as the Print interval. Changes will be lost on power down of the system or when switching to the Edit or Cal mode using the front panel keypad. To save the changes permanently, use the **SAV** command.

Examples

The **PI=***value* command is used to set the print interval to 60 seconds.

computer sends — **PI=60**<CR>
3900 responds — *<CR><LF>*

The *<CR><LF>* response signifies completion of the command.

See Also

?PI, PRI, SAV

Read Print ON/OFF Status ?PR

Description
Returns an integer value that is associated with the Print On/Off status.

Prerequisites
Firmware Ver 2.0 or newer

Syntax
?PR

Parameters
None

Remarks
Data Returned

?PU returns an integer value indicating the print function is on or off. The printer status values are as follows:

VALUE	DESCRIPTION
0	Print is off
1	Print is on

Examples
The **?PR** command is used to request the current print function status:

computer sends **?PU**<CR>
3900 responds 1*<CR><LF>*

The 1 returned indicates that the print function is on.

See Also
PR=

PR= Change Print ON/OFF Status

Description

Changes the current print on/off status.

Prerequisites

Firmware Ver 2.0 or newer

Syntax

PU=*value*

Parameters

value

The *value* corresponds to the following:

VALUE	DESCRIPTION
0	Print off
1	Print on

Remarks

Data Returned

None. The only response is a carriage return/linefeed terminator.

Examples

The **PR=***value* command is used to turn on the generators print function.

computer sends **PR=1**<CR>

3900 responds *<CR><LF>*

The *<CR><LF>* response signifies completion of the command.

See Also

?PR

Print System Data

Description

Sends one line of data to a printer if connected to the 3900's printer port just as if the front panel Enter or Decimal Point key had been pressed in a non-setpoint entering mode.

Prerequisites

The system must be running, and the serial port parameters must match between the 3900 and the printer used. See section 3.3.2.6 Printer Port Parameters of the 3900 Operations Manual to review and edit parameters.

Syntax

PRI
PRINT

Parameters

None

Remarks

Data Returned

None. The only response is a carriage return/linefeed terminator. If the system is not running or no printer is connected, printing will not take place; but the carriage return/linefeed terminator will still be sent back.

Examples

The **PRINT** command is used to send a line of data to the printer which is connected to the 3900.

computer sends	**PRI**<CR>
3900 responds	*<CR><LF>*

The *<CR><LF>* response indicates completion of the command even if the system is currently stopped or no printer is connected.

?PS   Read Saturation Pressure

Description

Returns the current value of the Saturation Pressure.

Prerequisites

Firmware Ver 2.0 or newer

Syntax

?PS

Parameters

None

Remarks

Data Returned

The value returned is the current value of the Saturation Pressure in current system units.

Examples

The **?PS** command is used to request the current Saturation Pressure value, assuming the system units are in psi:

computer sends	**?PS**<CR>
3900 responds	*150<CR><LF>*

The saturation pressure is currently 150 psiA.

See Also

?

Change Saturation Pressure Setpoint **PS=**

Description

Changes the Saturation Pressure setpoint to a given value.

Prerequisites

None

Syntax

PS=*setpoint*

Parameters

setpoint

The *setpoint* value is the Saturation Pressure, in current system units, that the system should control at.

Remarks

Control Mode Changed

Sending **PS=***setpoint* also changes the control mode to Saturation Pressure (mode 5). In this mode Frost Point, Dew Point, PPMv, PPMw and RH setpoints vary as system temperatures and test pressure change.

Data Returned

None. The only response is a carriage return/linefeed terminator.

Examples

The **PS=***setpoint* command is used to set the Saturation Pressure setpoint to 121.4 psiA, assuming current system pressure units are set to psi.

computer sends **PS=121.4**<CR>
3900 responds *<CR><LF>*

The *<CR><LF>* response signifies completion of the command.

See Also

?PU, PU=.

?PT Read Test Pressure

Description Returns the current Test Pressure value.

Prerequisites Firmware Ver 2.0 or newer

Syntax **?PT**

Parameters None

Remarks Data Returned

The value returned is the current value of the Test Pressure in current system units. If the external pressure transducer is not connected then this value is the test pressure setpoint value.

Examples The **?PT** command is used to request the current Test Pressure, assuming current system pressure units are set to psi:

computer sends **?PT**<CR>
3900 responds *14.7 <CR><LF>*

The test pressure is currently 14.7 psiA.

See Also **?**

Change Test Pressure Setpoint PT=

Description

Changes the Test Pressure setpoint to a given value.

Prerequisites

None

Syntax

PT=*setpoint*

Parameters

setpoint

The *setpoint* value is the Test Pressure, in current system units, that the system should use for calculations when the external pressure transducer is not connected.

Remarks

Data Returned

None. The only response is a carriage return/linefeed terminator.

Examples

PT=*setpoint* command is used to set the Test Pressure default to 14 psiA, assuming current system pressure units are set to psi.

computer sends	**PT=14**<CR>
3900 responds	*<CR><LF>*

The *<CR><LF>* response signifies completion of the command.

See Also

?PU, PU=.

?PU Read Pressure Units

Description

Returns an integer value that is associated with the Pressure unit's type.

Prerequisites

Firmware Ver 2.0 or newer

Syntax

?PU

Parameters

None

Remarks

Data Returned

?PU returns an integer value indicating which of the 3 possible pressure unit types the system is using. The Pressure unit types are as follows:

VALUE	DESCRIPTION
0	psi, pounds per square inch
1	bar
2	hPa, hectoPascals

Examples

The **?PU** command is used to request the current pressure units type:

computer sends **?PU**<CR>
3900 responds 2*<CR><LF>*

The 2 returned indicates that the system is operating in hPa, hectoPascals.

See Also

PU=

Change Pressure Units **PU=**

Description

Changes the current pressure units type.

Prerequisites

Firmware Ver 2.0 or newer

Syntax

PU=*value*

Parameters

value

The *value* corresponds to one of the three following pressure unit types:

VALUE	DESCRIPTION
0	psi, pounds per square inch
1	bar
2	hPa, hectoPascals

Remarks

Data Returned

None. The only response is a carriage return/linefeed terminator.

Saving Changes to Non-Volatile Memory

The **PU=***value* command only temporarily changes the pressure units type. Changes will be lost on power down of the system or when switching to the Edit or Cal mode using the front panel keypad. To save the changes permanently, use the **SAV** command.

Examples

The **PU=***value* command is used to set the pressure units type to bars.

computer sends **PU=1**<CR>
3900 responds *<CR><LF>*

The *<CR><LF>* response signifies completion of the command.

See Also

?PU, SAV

PUR Purge the System

Description

Starts the system in the purge mode, just as though the Purge mode had been activated from the front panel.

Prerequisites

Firmware Ver 2.0 or newer

Syntax

PUR
PRG
PURGE

Parameters

None

Remarks

Data Returned

None. The only response is a carriage return/linefeed terminator.

Examples

The **PUR** command is used to start the system in the purge mode.

computer sends **PUR**<CR>
3900 responds *<CR><LF>*

The *<CR><LF>* response will be delayed several seconds until system purge mode configuration is complete.

See Also

GEN, STO

Description

Returns the current value of the PPMv, Parts Per Million by Volume, being generated.

Prerequisites

Firmware Ver 2.0 or newer

Syntax

?PV

Parameters

None

Remarks

Data Returned

The value returned is the PPMv value calculated from the current generator values for Ts, Ps, Tt, and Pt.

Examples

The **?PV** command is used to request the current PPMv value:

computer sends **?PV**<CR>
3900 responds *2485.368* *<CR><LF>*

The generator is currently generating 2485.368 parts per million by volume.

See Also

?

PV= Change PPMv Setpoint

Description Changes the PPMv setpoint to a given value.

Prerequisites None

Syntax **PV=***setpoint*

Parameters

setpoint The *setpoint* value is the PPMv that the system should generate.

Remarks

Control Mode Changed

Sending **PV=***setpoint* also changes the control mode to PPMv (mode 2). In this mode Frost Point, Dew Point, %RH and Saturation Pressure setpoints vary as system temperatures and pressures change.

Data Returned

None. The only response is a carriage return/linefeed terminator.

Examples The **PV=***setpoint* command is used to set the PPMv setpoint to 2500.

computer sends **PV=2500**<CR>
3900 responds *<CR><LF>*

The *<CR><LF>* response signifies completion of the command.

See Also **?SP**

Read Generated PPMw ?PW

Description

Returns the current value of the PPMw, Parts Per Million by Weight, being generated.

Prerequisites

Firmware Ver 2.0 or newer

Syntax

?PW

Parameters

None

Remarks

Data Returned

The value returned is the PPMw value calculated from the current generator values for Ts, Ps, Tt, Pt and the molecular weight of the gas type being used.

Examples

The **?PW** command is used to request the current PPMw value:

computer sends	**?PW**<CR>
3900 responds	*1546.249 <CR><LF>*

The generator is currently generating 1546.249 parts per million by weight.

See Also

?

PW= Change PPMw Setpoint

Description

Changes the PPMw setpoint to a given value.

Prerequisites

None

Syntax

PW=*setpoint*

Parameters

setpoint — The *setpoint* value is the PPMw that the system should generate.

Remarks

Control Mode Changed

Sending **PW=***setpoint* also changes the control mode to PPMw (mode 3). In this mode Frost Point, Dew Point, %RH and Saturation Pressure setpoints vary as system temperatures and pressures change.

Data Returned

None. The only response is a carriage return/linefeed terminator.

Examples

The **PW=***setpoint* command is used to set the PPMw setpoint to 1000.

computer sends **PW=1000**<CR>
3900 responds *<CR><LF>*

The *<CR><LF>* response signifies completion of the command.

See Also

?SP

Read Generated %RH ?RH

Description Returns the current value of the %RH being generated.

Prerequisites Firmware Ver 2.0 or newer

Syntax **?RH**

Parameters None

Remarks Data Returned

The value returned is the %RH value calculated from the current generator values for Ts, Ps, Tt, and Pt as defined by the RH calculation method.

Examples The **?RH** command is used to request the current %RH value:

computer sends **?RH**<CR>
3900 responds *10<CR><LF>*

The generator is currently generating 10% RH.

See Also **?, ?WM, WM=**

RH= Change RH Setpoint

Description

Changes the RH setpoint to a given value.

Prerequisites

None

Syntax

RH=*setpoint*

Parameters

setpoint

The *setpoint* value is the %RH that the system should generate.

Remarks

Control Mode Changed

Sending **RH=***setpoint* also changes the control mode to %RH (mode 4). In this mode Frost Point, Dew Point, PPMv, PPMw and Saturation Pressure setpoints vary as system temperatures and pressures change.

Data Returned

None. The only response is a carriage return/linefeed terminator.

Examples

The **RH=***setpoint* command is used to set the %RH setpoint to 10.

computer sends **RH=10**<CR>
3900 responds *<CR><LF>*

The *<CR><LF>* response signifies completion of the command.

See Also

?SP

Read Run Status ?RU

Description Returns the current system operating status.

Prerequisites None

Syntax **?RU**
?RUN

Parameters None

Remarks Data Returned

?RU returns one of three values to indicate whether or not the system is currently generating, purging or idle. The three possible returned values are as follows:

VALUE	DESCRIPTION
0	System is idle
1	System is generating
-1	System is purging

Examples The **?RU** command is used to request the current system status:

computer sends	**?RU**<CR>
3900 responds	*0<CR><LF>*

The "0" returned indicates that the system is currently idle.

See Also **?, GEN, PUR, STO**

SAV Save System Parameters

Description

Saves the current system parameters (i.e. Date Format, Molecular Weight, Pressure Units, Print Interval, and RH calculation method) to non-volatile memory for use as system defaults.

Prerequisites

None

Syntax

SAV
SAVE

Parameters

None

Remarks

Data Returned

None. The only response is a carriage return/linefeed terminator.

Examples

The **SAVE** command is used to save all changes previously made to the system parameters:

computer sends	**SAVE**<CR>
3900 responds	*<CR><LF>*

The *<CR><LF>* response signifies completion of the command.

See Also

?DF, DF=, ?MW, MW=, ?PI, PI=, ?PU, PU=, ?WM, WM=

Read Setpoints ?SP

Description Returns the current system Setpoints and operating mode.

Prerequisites None

Syntax **?SP**

Parameters None

Remarks

Data Returned

?SP returns a list of 11 comma separated values indicating the current setpoints and control mode of the system. These values are returned in the same order as they appear on the 3900 screen. The values in the sequence shown represent the following:

ITEM	DESCRIPTION
1	Frost Point setpoint, °C
2	Dew Point setpoint, °C
3	PPMv setpoint
4	PPMw setpoint
5	%RH setpoint
6	Saturation Pressure setpoint, in current system units
7	Saturation Temperature setpoint, °C
8	Test Pressure setpoint, in current system units
9	Test Temperature setpoint, °C
10	Flow Rate setpoint, l/m
11	Current Control Mode (0 to 5)

The control mode parameter (item 11 above) indicates which of the six possible parameters the system is set to control on. The control modes are as follows:

MODE	DESCRIPTION
0	System controls on Frost Point
1	System controls on Dew Point
2	System controls on PPMv
3	System controls on PPMw
4	System controls on %RH
5	System controls on Saturation Pressure

Examples The **?SP** command is used to request the system setpoints and control mode. This example assumes current system pressure units are set to psi.

computer sends **?SP**<CR>
3900 responds *-8.894, -10, 2846, 1771, 11.44, 131.5, 10, 14.7, 21.1, .2, 1<CR><LF>*

?SP

The data returned indicates that the setpoints are:

Frost Point = 8.894 °C
Dew Point = -10 °C (also the control mode)
PPMv = 2846
PPMw = 1771
%RH = 11.44
Sat Pressure = 131.5 psiA
Sat Temperature = 10 °C
Test Pressure = 14.7 psiA
Test Temperature = 21.1 °C
Flow Rate = 0.2 l/m

and the Control Mode = 1 (Dew Point)

See Also **DP=, FL=, FP=, PS=, PT=, PV=, PW=, RH=, TS=, TT=**

Stop the System STO

Description

Stops the system just as if the front panel "STOP" key had been pressed.

Prerequisites

None

Syntax

STO
STOP

Parameters

None

Remarks

Data Returned

None. The only response is a carriage return/linefeed terminator.

Examples

The **STOP** command is used to stop a running or purging system.

computer sends **STOP**<CR>
3900 responds *<CR><LF>*

The *<CR><LF>* response will be delayed several seconds until the system is vented of pressure and the shutdown complete.

See Also

GEN, PUR

?TF Cabinet Fan Temperature

Description

Returns the cabinet fan temperature in °C.

Prerequisites

None

Syntax

?TF

Parameters

None

Remarks

Data Returned

?TF returns the value (in whole degrees only) of the cabinet fan temperature.

Examples

The **?TF** command is used to read the current cabinet temperature.

computer sends **?TF**<CR>
3900 responds *30<CR><LF>*

The system indicates that the current measured cabinet temperature is 30°C. At this temperature, the cabinet fan should be running.

Read System Date ?TI

Description Returns the current system time.

Prerequisites Firmware Ver 2.0 or newer

Syntax **?TI**
?TIME

Parameters None

Remarks Data Returned

?TI returns the system time in hh:mm:ss.

Examples The **?TI** command is used to request the current time:

computer sends **?TI**<CR>
3900 responds *13:59:32<CR><LF>*

The time returned indicates that the system time is 1:59:32 PM.

See Also **?DA**

?TS Read Saturation Temperature

Description

Returns the current value of the Saturation Temperature.

Prerequisites

Firmware Ver 2.0 or newer

Syntax

?TS

Parameters

None

Remarks

Data Returned

The value returned is the current value of the Saturation Temperature in degrees Celsius.

Examples

The **?TS** command is used to request the current Saturation Temperature:

computer sends **?TS**<CR>
3900 responds *-15<CR><LF>*

The saturation temperature is currently -15 °C.

See Also

?

Change Saturation Temp Setpoint TS=

Description

Changes the Saturation Temperature setpoint to a given value.

Prerequisites

None

Syntax

TS=*setpoint*

Parameters

setpoint

The *setpoint* value is the Saturation Temperature, in °C, that the system should control at.

Remarks

Data Returned

None. The only response is a carriage return/linefeed terminator.

Control Modes and Saturation Temperature

An inherent characteristic of the 3900 is its ability to adjust the Saturation Temperature setpoint to allow the generator to achieve a wider range of humidity values. The only mode that the user has complete control over the Saturation Temperature is the Saturation Pressure Control mode, Mode 5. If the control mode is other than mode 5 (Saturation Pressure) the Saturation Temperature may automatically readjust to a value required for the current humidity setpoint independent of any setpoint sent to the generator via the **TS=***setpoint* command.

Examples

The **TS=***setpoint* command is used to set the Saturation Temperature setpoint to 10°C.

computer sends	**TS=10**<CR>
3900 responds	*<CR><LF>*

The *<CR><LF>* response signifies completion of the command.

See Also

?SP

?TT   Read Test Temperature

Description

Returns the current Test Temperature value.

Prerequisites

Firmware Ver 2.0 or newer

Syntax

?TT

Parameters

None

Remarks

Data Returned

The value returned is the current value of the Test Temperature in degrees Celsius. If the external temperature probe is not connected then this value is the test temperature setpoint value.

Examples

The **?TT** command is used to request the current Test Temperature:

computer sends   **?TT**<CR>
3900 responds   *21.1 <CR><LF>*

The test temperature is currently 21.1 °C.

See Also

?

Change Test Temperature Setpoint **TT=**

Description

Changes the Test Temperature setpoint to a given value.

Prerequisites

None

Syntax

TT=*setpoint*

Parameters

setpoint

The *setpoint* value is the Test Temperature, in °C that the system should use in calculations when the external temperature probe is not connected.

Remarks

Data Returned

None. The only response is a carriage return/linefeed terminator.

Examples

The **TT=***setpoint* command is used to set the Test Temperature default to 25 °C.

computer sends **TT=25**<CR>

3900 responds *<CR><LF>*

The *<CR><LF>* response signifies completion of the command.

See Also

?SP

?WM Read WMO Status

Description Returns an integer value that corresponds to the RH calculation method.

Prerequisites None

Syntax **?WM**

Parameters None

Remarks Data Returned

?WM returns one of two values to indicate the current RH calculation method. The two possible returned values are as follows:

VALUE	DESCRIPTION
0	Normal
1	WMO, World Meteorological Organization

Examples The **?WM** command is used to request the WMO status:

computer sends **?WM**<CR>
3900 responds *0<CR><LF>*

The "0" returned indicates that the system is not using the WMO Relative Humidity calculation method.

See Also **WM=**

Change WMO Status **WM=**

Description

Changes the system RH calculation method.

Prerequisites

None

Syntax

WM=*status*

Parameters

status

The *status* corresponds to an RH calculation type. The RH calculation types are as follows:

VALUE	DESCRIPTION
0	Normal
1	WMO, World Meteorological Organization

A value other than 0 or 1 will cause the system to default to the Normal method.

Remarks

Data Returned

None. The only response is a carriage return/linefeed terminator.

Saving Changes to Non-Volatile Memory

The **WM=***status* command only temporarily changes the RH calculation method. Changes will be lost on power down of the system or when switching to the Edit or Cal mode using the front panel keypad. To save the changes permanently, use the **SAV** command.

Examples

The **WM=***status* command is used to change the current RH calculation method to WMO:

computer sends **WM=** 1<CR>
3900 responds *<CR><LF>*

The *<CR><LF>* response signifies completion of the command.

See Also

?WM, SAV