Operation Manual

Mensor Model 9477 Calibration System with Model 9479 System Controller

Mensor Model 9477 Pressure Calibration System
UTC – Collins Aerospace Configuration 10/04/2021
Mensor LP, 201 Barnes Drive, San Marcos, TX, USA

Mensor Model 9477
Pressure Calibration System
With Model 9479 System Controller

General Description:

The Mensor Model 9477 Pressure Calibration System for UTC / Collins Aerospace is a high accuracy, wide pressure range pneumatic control system. This particular configuration of the system can control pneumatic pressures up to 1000 psi absolute.

The pneumatic rack system consists of multiple CPC6050 controllers, a computer control module (designated the Model 9479) who's function is to select the active pressure range, control the transition between ranges and control the on/off activation of the vacuum pump. Also included in the system is a rear mounted pressure panel with pressure regulators to adjust incoming pressures for the individual CPC6050 controllers, direct the controller outputs to the proper pressure output port and a power bus bar. An emergency power shutoff switch with key-lock reactivation is mounted in the front of the rack along with a power shutoff switch activated when the rear door is open. This switch has a pull to enable function as well. The rack is a 31" deep instrumentation rack with an approximate width of 23" and height of 50". Each of the two CPC6050 controllers have dual control channels with multiple sensors in each instrument. The ranges and accuracy breakdown is as follows:

Designation & Channel	Pressure Range	Accuracy
A - High Range A Channel	0 to 1000 psi A	0.01% IS-50
A - High Range A Channel	0 to 500 psi A	0.01% IS-50
B – High Range B Channel	0 to 250 psi A	0.01% IS-50
C – Low Range A Channel	0 to 100 psi A	0.01% IS-50
C – Low Range A Channel	0 to 37.5 psi A	0.01% IS-50
D – Low Range B	0 to 12.5 psi A	0.01% FS

Channel		

Notes:
1. Accuracy of 0.01% IS-50 is equivalent to 0.01% of reading in the upper 50% of range and a fixed 0.005% of FS in the lower half of the pressure range.

Precautions:

1. The system requires a maximum working pressure of 1050 to 1500 psi dry air or nitrogen for full operation.

2. The system that contain large pressure storage tanks can hold large amounts of kinetic energy. User should bleed all pressure stored in tanks before servicing, removing pressure hoses, or removing instruments. Normal shutdown and emergency shutdown should start the process, but depending on the size of the tanks and desire to maintain a safe discharge rate, this operation may take an extended period of time to achieve.

3. The system uses normal power line AC voltages. User should remove the AC power cord from mains when servicing inside enclosures.

4. Due to the internal pressures and voltages used within the 9477 pressure calibration system, only qualified and properly trained personnel should service this system.

5. The emergency shutdown electrical system is limited in capacity to approximately 10 amps of power. It is intended to shut down the pressure portion of the system and slowly release pressure from internal instruments

6. Rack handles if provided are not intended for lifting. Their purpose is only to assist in rolling the rack when necessary. Use other means for lifting.

Setup:

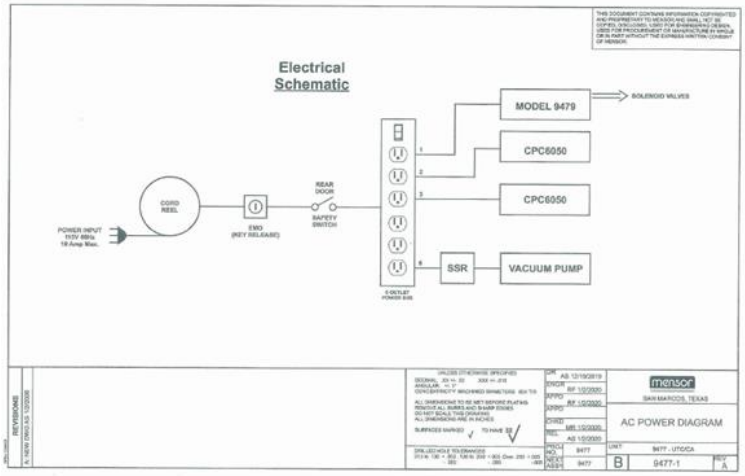
The initial installation should include removing any packing material used in shipment and inspect that fittings and screws are snug, and that hoses and electrical cords are not chaffed or cut. The rack is mounted on casters and should be installed on a level surface with adequate airflow to keep the system within its 15 to 45 C optimum operating temperature range. Any handles

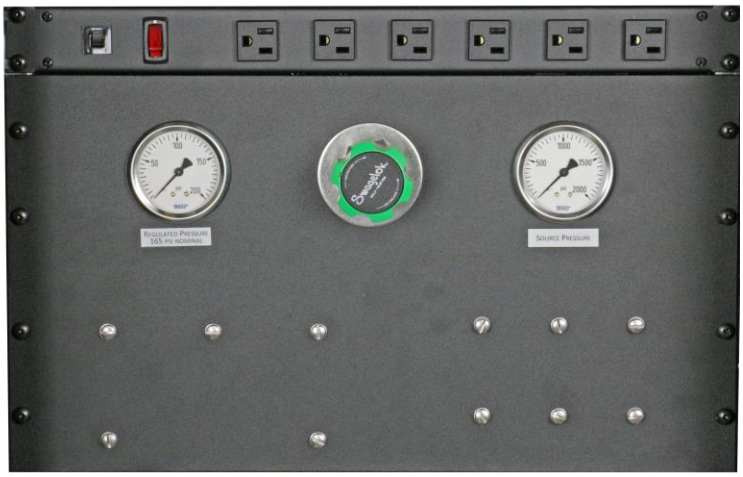
provided on the side of the rack (if equipped) are intended to assist in the rolling of the rack, but are not intended for lifting. Wheel chucks/brakes or support feet should be used where appropriate to keep the unit in place.

Setup and operation of the system requires:

1. A level surface to locate the rack.
2. AC power
3. Unregulated dry compressed air or Nitrogen of 1050 psi to 1500 psi
4. Command instructions in the form of SCPI commands over the GPIB bus.

The system operates on a line voltage of 115 Volts AC +/- 10%, 50/60 Hz. A standard 15 or 20 amp wall circuit is sufficient for normal operation. The system is designed to accept and operate with a current draw of 10 Amps maximum. Power is brought into the system at the bottom of the rack and serves the pneumatic controllers, the vacuum pump and the 9479 control module. The power cord plug on the input to the rack can be replaced to accept other plugs or tied directly into a main feed. Internal is a retractable power cable rated for 10-amp service. Incoming power goes directly to an emergency shutoff switch near the top of the pneumatic control rack and a rear door power shutoff. From there it feeds a 10 output power strip which can switch power to the different instruments and modules within the rack. The pneumatic system typically draws slightly more than 1 amp at 125 volts without the vacuum pump operating. The pump has a short surge current but draws about 4 amps nominal. The spare outlets and switches are available internally can be used for other user devices up to approximately an additional 4 Amps maximum before approaching the systems maximum rating. The system has multiple electrical power safety features built in. Power automatically shuts off if (1) the rear door is opened while the system is active, (2) if the EMO switch

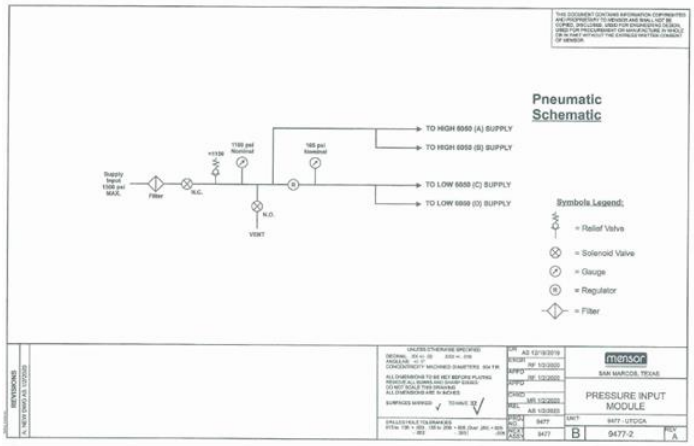




on the front of the rack on the upper bar is activated or if the power distribution bus bar is shutoff in the back of the rack. All three cutoffs should be checked along with the power switches on each instrument if the instruments fail to start.

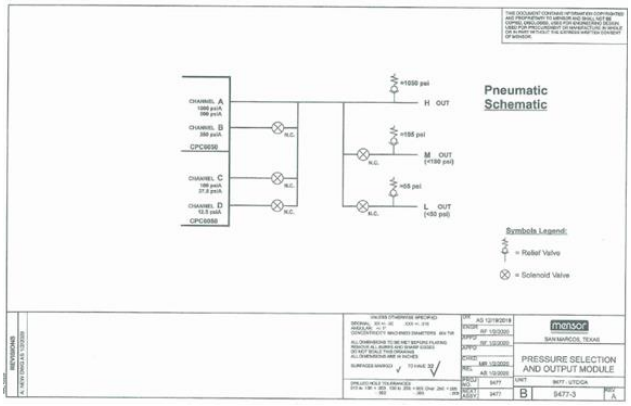
A dry compressed air supply or dry Nitrogen gas is recommended for pneumatic operation. This supply should be within a range of 1050 to 1500 psi. If compressed air is used in place of the dry nitrogen, the air supply should be a quality class of 5 or better (per ISO 8573.1 & ISO 12500 standards). This limits dirt particles to less than 40 microns, a water pressure dew point of 45 F or lower at 100 psig, and oil vapor of less than 25 ppm. The supply pressure port is located next to the GPIB connector on the top of the rack near the back.

The system is designed to accept control signals and commands from a remote computer using the GPIB (IEEE-488) communication port on the top of the rack. The Mensor 9479 control module accepts the commands using the SCPI command set, interprets the instructions and determines the appropriate action to take. It then communicates with the appropriate Mensor Pressure Controller, appropriate solenoid valves and enabling the vacuum pump when needed. The SCPI command set can be found in the appendix.



The vacuum pump is controlled by the Model 9479 control module. It is enabled when a commanded pressure is required at or below 15 psi A. The actual solid state AC control module is located in the bottom of the rack just behind the front panel. The vacuum pump is a scroll pump that is both quiet and has low power

consumption. The pump manual is included in the system documentation.



User pressure port connections are located on the top rear of the rack and a matching set on a panel on the front of the rack. The ports all have ¼ FNPT fittings. For pressures 180 psi use the Output High port, pressures between 50 and 180 psi are available on both the high pressure fitting and the mid-pressure fitting. Pressures below 50 are available on all three fittings.

Operation:

Once configured the system generally requires power and clean dry shop air or dry nitrogen. Start up operation commences when power is applied using the EMO at the top of the rack. The pressure controllers will take a minute or more to boot up. Once everything is operational, the normally closed isolation valves are placed in safe state (typically measure or vent mode) until commanded to control at a valid pressure point. Once a control pressure is set, the system will select the proper range controller and determine if operation of the pump is required. During normal operation, the system will always try to minimize any rapid pressure changes.

Changes in a pressure setting that require a change in the instrument or control channel will always sequence in a fixed order. If pressure is increasing, the higher range instrument will decrease its pressure to match the lower pressure setting before switching to the new instrument and driving to the higher pressure. This is done to minimize pressure transients. If pressure is decreasing, the high pressure channel will drive down to the new lower pressure setting while the lower pressure channel drives up to the new setting before it switches. Once

equal, the lower channel will take over and provide a higher accuracy reading and better control at the new pressure.

Operation of Model 9477

The 9477 was designed exclusively for remote operation through the 9479 control module. The system has two sets of 3 pressure output ports. One set is on the top rear of the rack and the other set is on a front panel. Which port or ports that have air available is controlled by the 9479 controller. If pressure is above 180 psi, only the high pressure port is active. If pressure is above 50 psi, both the high pressure and mid-pressure port are active. All ports are active if the pressure is less than 50 psi. The user can select if the front ports or the top ports are used (or both), making sure the ones not used remain capped.

On power up, the 9479 control unit will initialize (with the blue LED illuminated) and will command all pressure channels into the measure mode or vent mode. The system takes about one minute to initialize with most of this time allocated to initialize the CPC6050 controllers. The system verifies communications, determines the control channels and insures the system is vented.

The system will remain in the vent mode until a control setting is received. The system will determine which controller and which controller channel will be the control channel in charge. The highest range control channel (Channel A) will always be in the measure mode monitoring operations unless it is required to be the pressure control channel for the highest range pressures.

Communication Protocol:

Communications between the user's external computer and the 9479 System Control Module is GPIB (IEEE-488) communications using the SCPI (Standard Commands for Programmable Instruments) command set. A complete command set can be found below and also in the appendix. Both upper and lower case ASCII characters are accepted, but the user must either use the short command set (listed as capital letters) or the complete long command set. Anything other than those two commands will not be accepted or converted properly. Optional commands are indicated by the square brackets "[ ]'. Queries (commands that have responses end with a '?'.

Communications between the 9479 System Control Module and the Pressure controllers (CPC6050s) utilize the Mensor command set over the USB communications port. The instruments should utilize the USB Device ports on the back of the controller. This is the small 'house' or square shaped connector as opposed to the longer rectangular USB Host connector.

Command Set:

SCPI Command Set

MEASure	
[:PRESsure]?	Returns current pressure reading
:PRESsure2?	Returns pump pressure
:POSITION?	Returns pump position (%)
CALCulate	
:LIMit	
:LOWer <value>	Get or Set low pressure limit
:SLEW <value>	Get or Set slew rate limit
:UPPer <value>	Get or Set high pressure limit
:VENT <value>	Get or Set Auto-Vent limit
:TARE	
:VALue <value>	Get or Set tare value
:STATe ON/OFF	Set tare using current pressure
CALibration	
[:PRESsure]	
DISP	
:ENABle ON|OFF|1|0	(Ignored)
:TEXT <string>	(Ignored)
OUTPut	
:STATe ON|OFF|1|0	off = measure, on = control
:STATe?	Returns 0 for measure, 1 for control
:MODE MEASure|CONTrol|VENT	sets mode
:MODE?	Returns mode string
SENSE	
[:PRESSure][:RESolution] <value>	Set Pressure Display resolution
:MODE?	Returns ABSOLUTE or TARE
:RANGE	
[:UPPer] <value>	Sets Sensor FS range in current units
:LOWer?	Returns lower pressure range.
REFerence	
[HEIGht] <value>	Sets head height
:SGRavity <value>	Sets specific gravity (0.851)
[SOURCE]	
[:PRESsure]	
[:LEVel]	
[:IMMediate]	

```
                    [:AMPLitude] <value> Sets Pressure Setpoint
                    [:AMPLitude]?       Gets current setpoint
            :MODE FIXed|LIST            Sets source parameter set
            :TOLerance <value>          Sets output tolerance
            :SLEW <value>               Sets Slew Rate
            :CONTrol <value>            Sets control  band
    :LIST
            :PRESsure  <value>[,<value>]  Set list of pressure values
                    :POINts?            Returns number of points defined
            :DWELl <value>[,<value>]    Sets list of dwell times
                    :POINts?            Returns number of dwell times
            :TOLerance <value>[,<value>]  Sets list of tolerances
                    :POINts?            Returns number of tolerances
            :DIRection UP|DOWN          Direction to go thru list
            :COUNt  <value>             Number of times to go through
list
    STATus
            :OPERation
                    [:EVENT]?           Read/clear operation event
register
                    :CONDition?         Read operation condition register
                    :ENABle <value>     Set operation enable mask
            :QUEStionable
                    [:EVENT]?           Read/clear questionable event
registr
                    :CONDition?         Read questionable condition
register
                    :ENABle <value>     Set Questionable condition flags

            :PRESet                     Reset condition flags
    SYSTem
            :DATE <year>,<month>,<day>  Sets or returns date
            :ERRor?                     Returns error#,"descry:info"
                                                Or 0,"No Error"
            :KLOCk ON|OFF|1|0                   Sets keyboard lock to on
or off
            :TIME <hour>,<minute>,<second>Sets or returns time
            :VERSion?                   Returns software version
            :LANGuage  "SCPI"           Returns command language
"SCPI"
            :PRESet                     reset condition flags
    TEST
            :ELECtronic?                Performs electronic self test
    UNIT
            :DEFine <n>,<name>,<number>  Defines a unit
            :LENGth MM|IN               Sets units of head height length
```

[:PRESsure] <unit name> Sets or gets Pressure Units

All commands should terminate with a linefeed. Carriage Returns are ignored on incoming commands and should be avoided to reduce communication traffic. Responses are terminated with a carriage return followed by a linefeed. Commands are accepted in either uppercase or lowercase characters, but must either comply with the 'short' command format or the complete 'long' command format.

Emergency Shutdown Sequence:

- The emergency shutdown mode is entered when the red emergency shutdown switch is depressed. This effectively removes power from the electronics and de-energizes solenoid valves. The effect is that source air and vacuum are shut off, internal source pressures are vented through the controllers.

- Rotating the emergency shutdown button clockwise (with the key provided) allows power to be re-applied to the system. The normal power up sequence should be followed to re-establish operating conditions.

Calibration:

Calibration of the pressure equipment should be performed periodically. The main pressure standards for the system are Mensor CPR6050 Digital Pressure Transducers mounted inside the front doors of the CPC6050 controllers. These are easily removed and replaced with a small Philips screwdriver. Consult the CPC6050 manual for additional instructions. Instructions for calibrating the transducers can be found in the Manual.

Storage and Transportation:

The system can be stored for a reasonable amount of time without any adverse effects. Storage temperature should not exceed 70C or drop below -20 C. The humidity should not be so high as to cause condensation in the system. Once the system brought back on line, it should be allowed to stabilize within its normal

operating temperature range before power is applied. The pressure ports should be covered, but not necessarily sealed to prevent contamination in the system.

Maintenance:

Standard maintenance may include checking for loose fitting and screws and general housekeeping. The calibration of the Mensor CPR 6050 Pressure Transducers located in the controllers should be periodically checked (annual calibration checks are recommended.) Spare transducers can be purchased for continuous operation during calibration checks. The low range CPC6050 has a pressure regulator before its supply port. This can be adjusted if necessary.

Appendix:

Mensor Model 9479 SCPI Command Set
Electrical Diagram – AC Power Routing
Pneumatic Diagram – Pressure Input Module
Pneumatic Diagram – Pressure Selection and Output Module
Agilent IDP-15 Scroll Pump Manual
Mensor CPC6050 Manual

Communication Protocol (SCPI Command Set)

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:UPPer <value>	Get or Set high pressure limit
:VENT <value>	Get or Set Auto-Vent limit
:TARE	
:VALue <value>	Get or Set tare value
:STATe ON/OFF	Set tare using current pressure
CALibration	
[:PRESsure]	
DISP	
:ENABle ON|OFF|1|0	(Ignored)
:TEXT <string>	(Ignored)
OUTPut	
:STATe ON|OFF|1|0	off = measure, on = control

```
        :STATe?                                 Returns 0 for measure, 1 for
control
        :MODE MEASure|CONTrol|VENT              sets mode
        :MODE?                                  Returns mode string

SENSE
        [:PRESSure][:RESolution] <value>        Set Pressure Display resolution
        :MODE?                                  Returns ABSOLUTE or TARE
        :RANGE
                [:UPPer] <value>                Sets Sensor FS range in current
units
                :LOWer?                         Returns lower pressure range.
        REFerence
                [HEIGht] <value>                Sets head height
                :SGRavity <value>               Sets specific gravity (0.851)
[SOURCE]
        [:PRESsure]
                [:LEVel]
                        [:IMMediate]
                                [:AMPLitude] <value> Sets Pressure Setpoint
                                [:AMPLitude]?   Gets current setpoint
                :MODE FIXed|LIST                Sets source parameter set
                :TOLerance <value>              Sets output tolerance
                :SLEW <value>                   Sets Slew Rate
                :CONTrol <value>                Sets control  band
        :LIST
                :PRESsure  <value>[,<value>]    Set list of pressure values
                        :POINts?                Returns number of points defined
                :DWELl <value>[,<value>]        Sets list of dwell times
                        :POINts?                Returns number of dwell times
                :TOLerance <value>[,<value>]    Sets list of tolerances
                        :POINts?                Returns number of tolerances
                :DIRection UP|DOWN              Direction to go thru list
                :COUNt  <value>                 Number of times to go through
list
        STATus
                :OPERation
                        [:EVENT]?               Read/clear operation event
register
                        :CONDition?             Read operation condition register
                        :ENABle <value>         Set operation enable mask
                :QUEStionable
                        [:EVENT]?               Read/clear questionable event
registr
                        :CONDition?             Read questionable condition
register
```

:ENABle <value>	Set Questionable condition flags
:PRESet	Reset condition flags
SYSTem	
:DATE <year>,<month>,<day>	Sets or returns date
:ERRor?	Returns error#,"descry:info" Or 0,"No Error"
:KLOCk ON|OFF|1|0	Sets keyboard lock to on or off
:TIME <hour>,<minute>,<second>	Sets or returns time
:VERSion?	Returns software version
:LANGuage "SCPI"	Returns command language "SCPI"
:PRESet	reset condition flags
TEST	
:ELECtronic?	Performs electronic self test
UNIT	
:DEFine <n>,<name>,<number>	Defines a unit
:LENGth MM|IN	Sets units of head height length
[:PRESsure] <unit name>	Sets or gets Pressure Units

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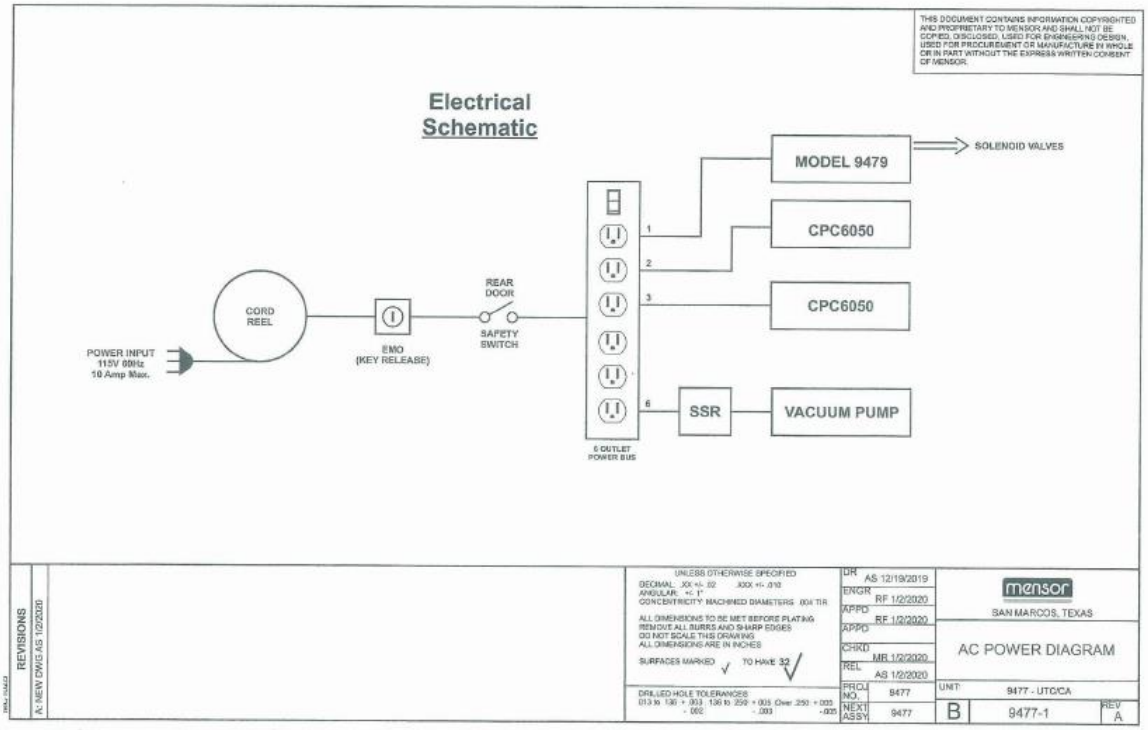
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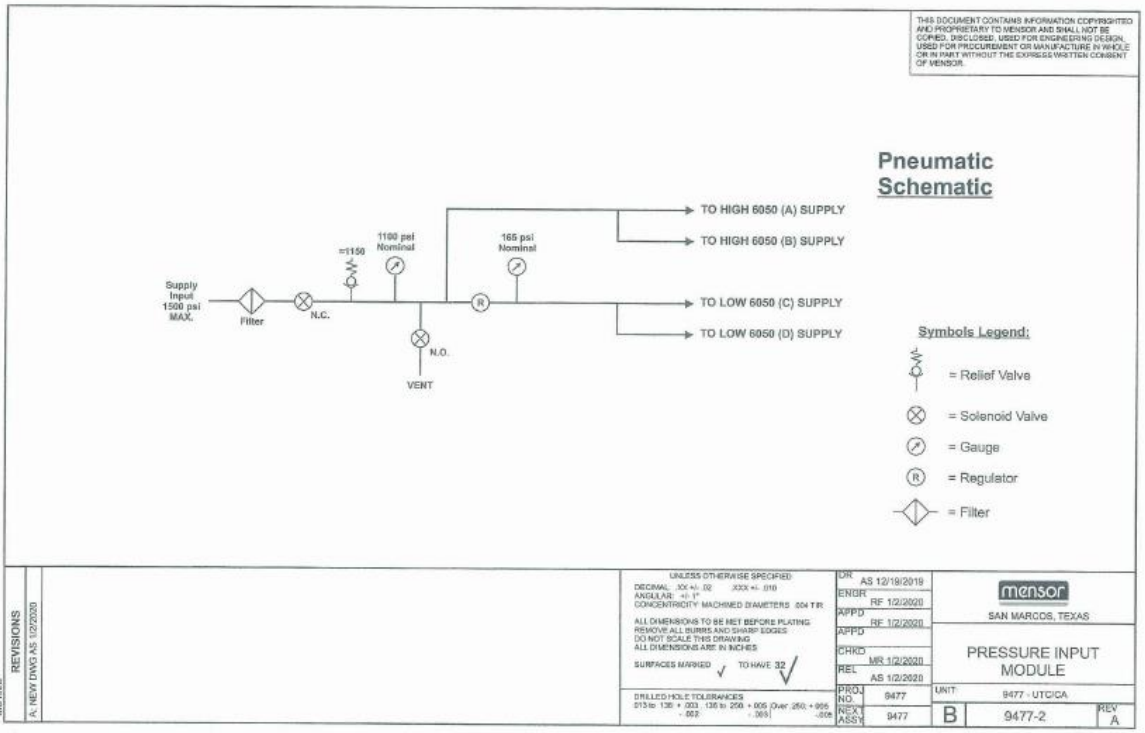
Electrical Schematic
MODEL 9479
SOLENOID VALVES
CPC6050
CPC6050
SSR
VACUUM PUMP
CORD REEL
EMO (KEY RELEASE)
REAR DOOR
SAFETY SWITCH
POWER INPUT 115V 60Hz 10 Amp Max.
6 OUTLET POWER BUS
REVISIONS
A: NEW DWG AS 1/2/2020
UNLESS OTHERWISE SPECIFIED
DECIMAL: .XX +/- .02 .XXX +/- .010
ANGULAR: +/- 1°
CONCENTRICITY: MACHINED DIAMETERS .004 TIR
ALL DIMENSIONS TO BE MET BEFORE PLATING
REMOVE ALL BURRS AND SHARP EDGES
DO NOT SCALE THIS DRAWING
ALL DIMENSIONS ARE IN INCHES
SURFACES MARKED √ TO HAVE 32
DRILLED HOLE TOLERANCES
DR AS 12/19/2019
ENGR RF 1/2/2020
APPD RF 1/2/2020
APPD
CHKD MR 1/2/2020
REL AS 1/2/2020
PROJ. NO. 9477
NEXT ASSY 9477
mensor
SAN MARCOS, TEXAS
AC POWER DIAGRAM
UNIT: 9477 - UTC/CA
B 9477-1 REV A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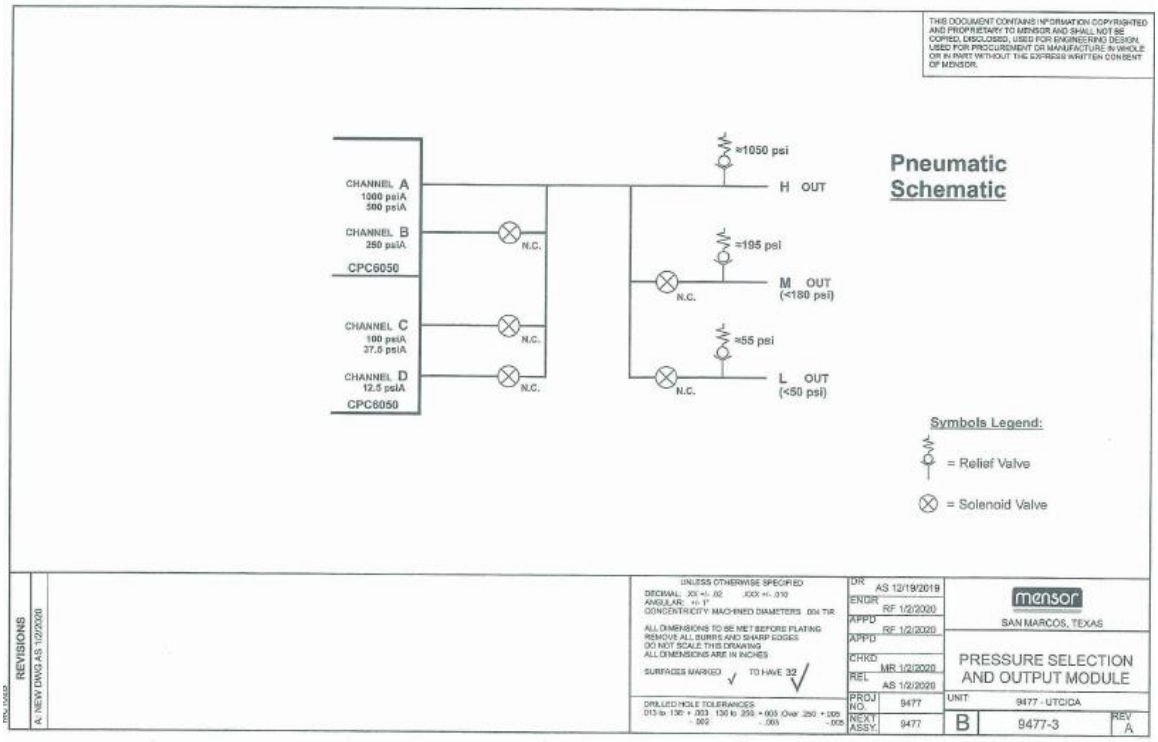
Pneumatic Schematic
TO HIGH 6050 (A) SUPPLY
TO HIGH 6050 (B) SUPPLY
TO LOW 6050 (C) SUPPLY
TO LOW 6050 (D) SUPPLY
=1150
1100 psi Nominal
165 psi Nominal
Supply Input 1500 psi MAX.
Filter
N.C.
N.O.
VENT
Symbols Legend:
= Relief Valve
= Solenoid Valve
= Gauge
= Regulator
= Filter
REVISIONS
A: NEW DWG AS 1/2/2020
UNLESS OTHERWISE SPECIFIED
DECIMAL: .XX +/- .02 .XXX +/- .010
ANGULAR: +/- 1°
CONCENTRICITY: MACHINED DIAMETERS .004 TIR
ALL DIMENSIONS TO BE MET BEFORE PLATING
REMOVE ALL BURRS AND SHARP EDGES
DO NOT SCALE THIS DRAWING
ALL DIMENSIONS ARE IN INCHES
SURFACES MARKED √ TO HAVE 32
DRILLED HOLE TOLERANCES
DR AS 12/19/2019
ENGR RF 1/2/2020
APPD RF 1/2/2020
APPD
CHKD MR 1/2/2020
REL AS 1/2/2020
PROJ. NO. 9477
NEXT ASSY 9477
mensor
SAN MARCOS, TEXAS
PRESSURE INPUT MODULE
UNIT: 9477 - UTC/CA
B 9477-2 REV A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CHANNEL A
1000 psiA
500 psiA
CHANNEL B
250 psiA
CPC6050
CHANNEL C
100 psiA
37.5 psiA
CHANNEL D
12.5 psiA
CPC6050
N.C.
≈1050 psi
H OUT
≈195 psi
M OUT
(<180 psi)
≈55 psi
L OUT
(<50 psi)
Pneumatic
Schematic
Symbols Legend:
= Relief Valve
= Solenoid Valve
REVISIONS
A. NEW DWG AS 1/2/2020
UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS TO BE MET BEFORE PLATING
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DRILLED HOLE TOLERANCES
DR AS 1/19/2019
ENGR RF 1/2/2020
APPD RF 1/2/2020
APPD
CHKD MR 1/2/2020
REL AS 1/2/2020
PROJ NO. 9477
NEXT ASSY. 9477
mensor
SAN MARCOS, TEXAS
PRESSURE SELECTION AND OUTPUT MODULE
UNIT 9477 - UTC/CA
B
9477-3
REV A

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