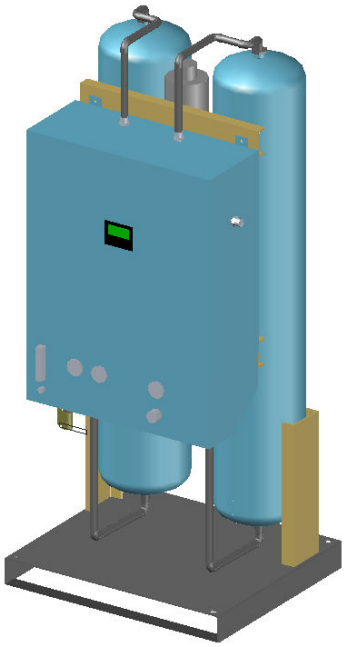
Holtec Gas Systems

Delivering the **Science** of Nitrogen Generation™

# Holtec *NitroBreeze™* Series
# "HNBS"- PSA NITROGEN GENERATOR

## Operating and Maintenance Manual



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By

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# 1 Safety Precautions and Operating Limits

**Caution:** Nitrogen is an inert gas that can and will cause asphyxiation or oxygen deprivation if leaking into an enclosed area. It is therefore important to check nitrogen tanks and piping for leaks and always vent nitrogen outside the building or to a well-ventilated area.

The waste air stream from the nitrogen generator is enriched in oxygen content (average is typically 25 - 35%). Local fire-code may require that this gas be piped outside the building. Check with local authorities to find out if this is required, particularly if the ventilation is insufficient. It is not harmful to breathe oxygen-enriched air.

***IMPORTANT: Do not install any valves or restrictions in the vent / waste-gas line since the waste-gas line must remain at atmospheric pressure at all times for the system to function properly.***

The nitrogen generator will start and stop automatically when turned to “Auto”, and run continuously when turned to “Manual”.

The nitrogen generator has to be connected to a grounded outlet rated for min 2 amps and max 10 amps. Before opening the control panel or doing any electrical/wiring work, always disconnect the power supply with facility breaker or disconnect switch. The power on/off switch located on the right side of the nitrogen generator control panel removes power to everything inside except the incoming terminal blocks and power switch terminals.

The nitrogen generator adsorber vessels are each equipped with a Safety Relief Valve set to 165 psig / 11.3 barg (setpoint may vary on custom orders). This valve is sized to protect the system from over pressurization due to external fire. Note that the MAWP of the absorbers may be higher than this. Considerations for sizing the relief valve were derived from the American Petroleum Institute (API) standards. The Owner/user is responsible to ensure that the upstream air source (compressor) has a relief device and/or other means to ensure pressure of air feeding the nitrogen generator can never exceed 165 psig.

Always depressurize lines and components before performing maintenance or repair work that require opening to the atmosphere.

***WARNING: If maintenance will be performed on switching valves, or any items connected to the adsorber vessels, open the manual ball valves (V-113 & V-114) in the bottom pipe sections (gases will desorb from the Carbon Molecular Sieve for many hours, so even if the adsorber pressure has been brought to zero once, the pressure will build up again by itself if the ball valves and vent valves are closed, which could lead to dangerous situations). Isolate air and nitrogen lines and depressurize as needed.***

The nitrogen generator is designed to produce Nitrogen using dry, particle and oil free compressed air. See section 3.4 for specification.

Limitations:

- Operating a Holtec nitrogen generator without using an operating and effective upstream dryer, to achieve a dew point of max 38 °F / 3 °C, will invalidate any warranty given for this equipment.
- Failure to use proper filtration and replace filter cartridges in the compressed air filters, on an annual basis as a minimum, will invalidate any guarantees given for this equipment.
- Failure to ensure that the compressed air being fed to the nitrogen generator remains oil free (<0.003 ppm oil) before the activated carbon filter will invalidate any guarantees given for this equipment.
- Restriction orifices RO-101, 105, & 106 have been installed at the factory to limit maximum flow for the protection of the adsorber beds. Removal or tampering with these orifices without factory authorization may result in rapid equalization or pressurization and excessive velocities across the adsorber beds, causing the Carbon Molecular Sieve pellets to turn into dust. This mode of operation can result in catastrophic failure and invalidates any warranties given for this equipment.
- Failure to comply with the recommended procedures set out in this manual and attached Manufacturers' Catalogues invalidates any warranty or performance guarantee given for this equipment.

This manual is designed to be read in conjunction with the P&ID and manufacturers' catalogues included in Section 10.

## 2 Introduction

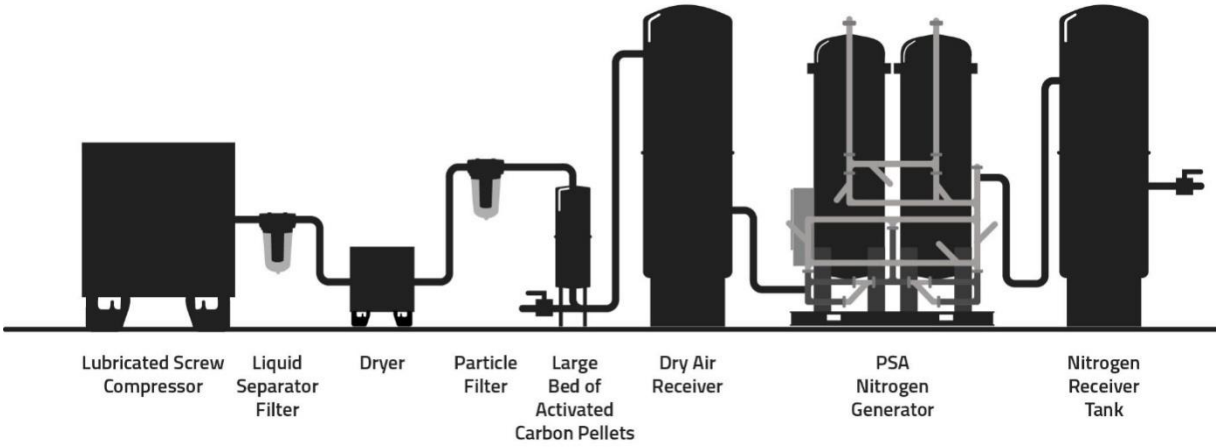
The Holtec HNBS is a skid-mounted Pressure Swing Adsorption (PSA) type Nitrogen Generation System. The Generator includes adsorber vessels filled with Carbon Molecular Sieve (CMS), switching valves, manual valves, instrumentation, oxygen analyzer with sampling system, and automated PLC and HMI control system with digital display and alarms.

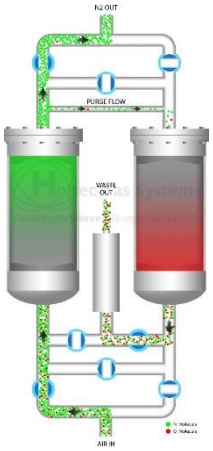
The supplied equipment and controls are suitable for indoors operation in a non-hazardous environment. A heated control panel can be offered as an option for operation in below freezing conditions under a roof.

Scheduled maintenance requirements are minimal, limited to replacing the air supply and nitrogen product filters (optional/by others) once every 6 – 12 months. Your nitrogen generator will provide you with many years of reliable service as long as the compressed feed air quality remains as specified in this manual.

# 3 Technical Specification

## 3.1 Process Description / Operation Sequence




*Typical PSA Diagram*

The Nitrogen Generator is comprised of two adsorber vessels filled with CMS, together with a valve & piping assembly. Dry, clean, pre-filtered, oil-free, compressed air (78% nitrogen, 21% oxygen, <1% argon) is supplied to one of the adsorber beds where oxygen and water vapor is adsorbed faster than nitrogen into the pore structure of the CMS, thus increasing the nitrogen concentration of the product gas stream exiting the bed. This product flows out of the top of the adsorber bed, through a flow control valve before entering a nitrogen receiver.

A small portion of the intermediate product is directed through an interconnecting line containing a restriction orifice and flows back through the other adsorber sieve bed and out through the exhaust line at atmospheric pressure. This action purges the CMS of oxygen, and prepares the bed for the next cycle. One adsorber bed is operated for a set time period (in the range of one to two minutes) before the next cycle starts. The beds switch roles; the first bed is de-pressurized and purged while the second bed produces nitrogen product. The active bed will remain on-line until just prior to becoming saturated with oxygen. When the cycle is completed, the PLC controller will switch the valves in the system to depressurize and exhaust the saturated bed, and pressurize the fresh adsorber bed. This allows a continuous flow of nitrogen gas from the unit for as long as the unit is in operation.

Oxygen enriched waste gas is piped to atmosphere through a silencer.

The dry nitrogen product stream, with the specified max $O_2$ content (see section 3.4), monitored continuously by an oxygen analyzer, enters a downstream product receiver tank before it is filtered (optional) and supplied

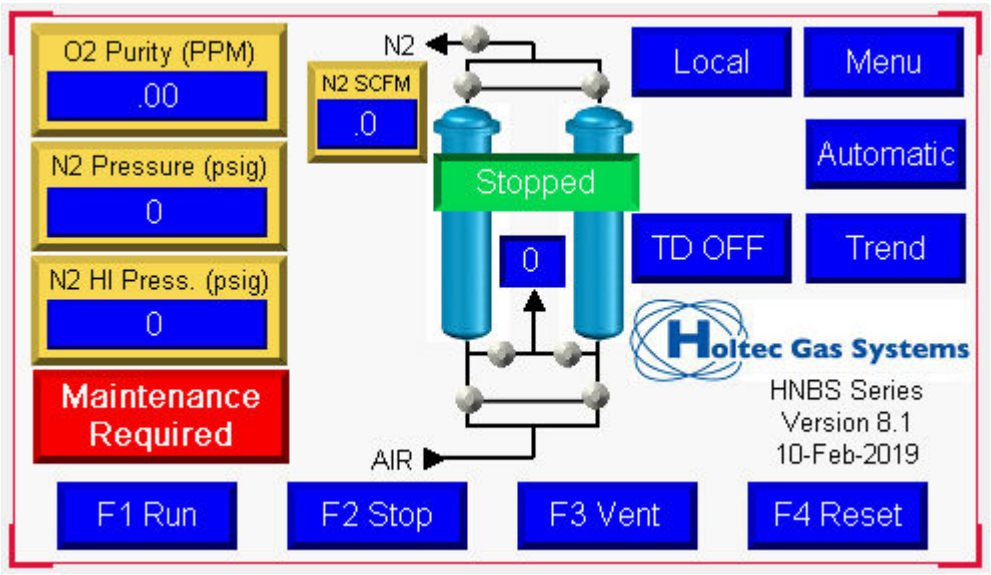
to the consumer. Note that the nitrogen generator can be operated at lower flow rates to produce nitrogen with higher purity.

The nitrogen generator includes a pressure transducer that will turn the nitrogen generator to standby mode if nitrogen usage falls. The pressure settings for standby/restart are programmable from the HMI display. The system will automatically start again when the pressure drops to the restart set point.

## 3.2 PSA HMI Operation

The HMI provides the means of control and informational feedback to and from the internal PLC that operates the PSA. On power up, the screen defaults to the Home Screen. There are screens which are Operator accessible and additional screens which are Engineering accessible which can be accessed only after a correct password is entered.

**Home Screen (Operator accessible):**




**O2 Purity (% or PPM)** – shows the amount of Oxygen in the product Nitrogen.

**N2 Pressure (psig)** – shows the product Nitrogen pressure.

**N2 HI Press. (psig)** – Only displayed when booster skid connected. Displays Nitrogen pressure in the high-pressure tank on the skid.

The circular valve indicators appear when the system is in Run status and turn **red** independently when the corresponding valve is Open.

The boxed number between vessels indicates current time in seconds for production cycles.

**System Status indicator ("Stopped" above) –** shows the current system status, either: "Stopped", "Running", "Stopping", "Standby" or "Venting".

**F1 Run** – Press to Start the process of Nitrogen generation and sequence to a run cycle.

**F2 Stop** – Press to Stop the system. System waits until the process reaches end of sequence and then stops the run cycle.

**F3 Vent** – Press to open the vessel exhaust valves. Note that the system has to be in a "stopped" sate for vent operation. (Will not activate in "stopping" state.). Be sure to deactivate as soon as finished!

**F4 Reset** – Press to Reset the nitrogen generation process and stop all sequences.

**Menu** – Press to change to the Menu screen.

**Automatic** – Press to toggle between Manual and Automatic operation. Box text will indicate which operation mode it is currently in.

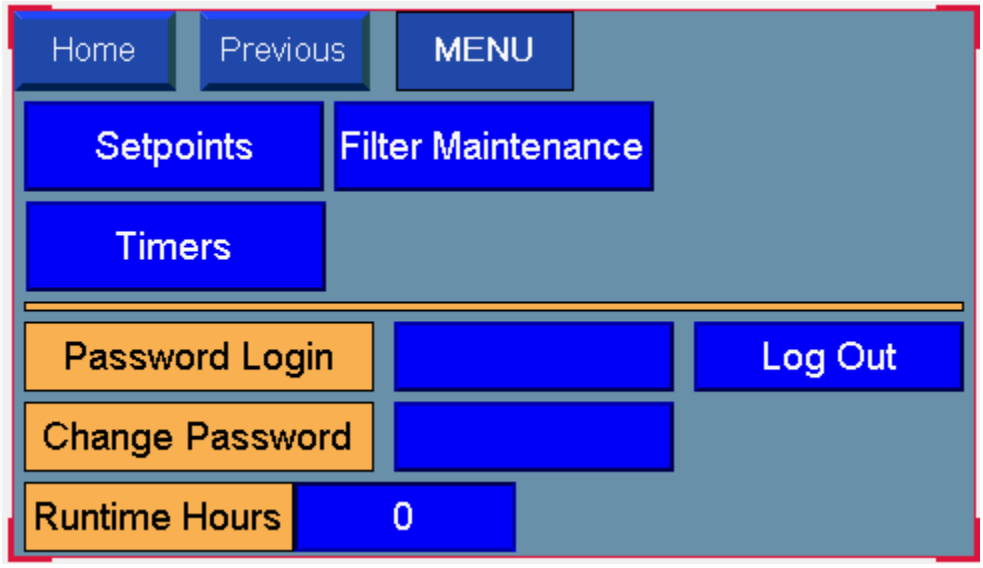
**Trend** – Press to change to the Trend graphing screen.

**Local** – Only displayed when remote connections are set up. Prevents system from starting remotely if in local mode.

**TD OFF** – Only displayed on systems with EnergyAssistant set up. Turns the feature on and off.

**Filter Maintenance Required** – Appears when filters need to be inspected or changed. Press to go to the Filter Maintenance screen.

**Menu Screen (Operator accessible):**




**Setpoints** – Press to go to the Setpoints screen.

**Filter Maintenance** – Press to change to the Filter Maintenance screen.

**GotoConfig** – Visible only with correct password entered. Press to exit the application and go to the terminal configuration mode screen. To return to the application, Run the appropriate file, typically PV800_PSA_HMI.

**Timers** – Visible only with correct password entered. Press to change to the Timers screen.

**Password Login** – Touch the adjacent blue box to enter password to gain access to the Timer Setpoints screen and GotoConfig. Initial value for Password is: 1234

**Log Out** – Press to log out and block access to Timers screen.

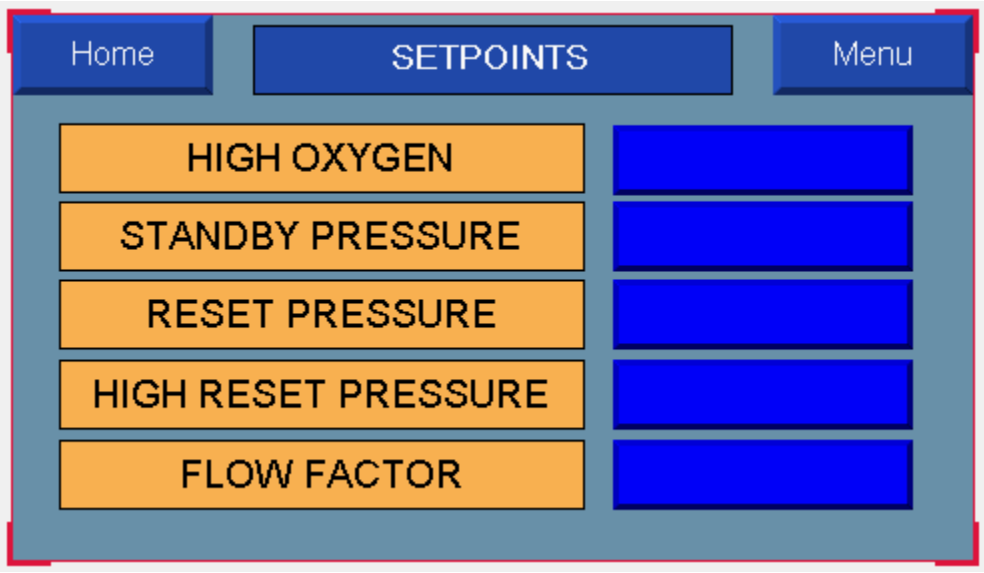
**Change Password** – Visible only with correct password entered. Touch the adjacent blue box to enter a new user password.

**Runtime Hours** – Indicates the number of hours the system has operated.

**Home** – Press to return to the Home screen.

**Previous** – Press to return to the previous screen.

**Setpoints Screen (Operator accessible):**




Each individual setpoint can be accessed and changed by touching the adjacent blue box showing the current value.

**High Oxygen** – Indicates the setpoint for alarm condition.

**Standby Pressure** – Indicates the setpoint for initiating Standby.

**Reset Pressure** – Indicates the setpoint for the pressure to drop below to exit Standby.

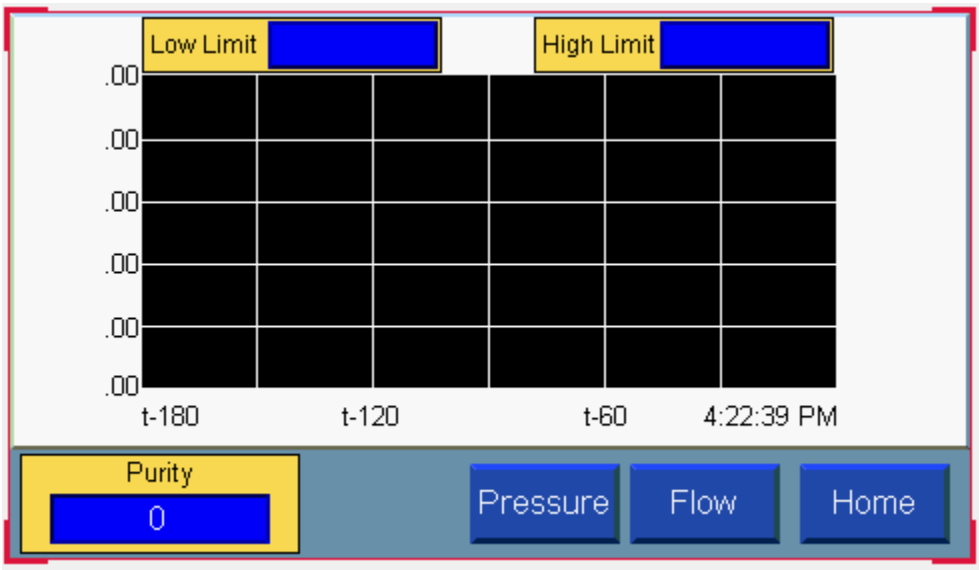
**High Reset Pressure** – Only displayed when booster is connected. Indicates the setpoint for the pressure to drop below in the high-pressure tank to exit Standby.

**Flow Factor** – Only present on generators with Energy Assistant. Indicates the amount of turndown for the system when turndown is enabled (Further Explaination in turndown operation section)

**Home** – Press to return to the Home screen.

**Menu** – Press to return to the Menu screen.

**Trend Screen (Operator accessible):**




Depending on which 'button' is pressed, the Trend Graph can display the Purity, Nitrogen Pressure, or Flow on the vertical axis with time along the horizontal axis.

**Purity*** - shows the amount of oxygen in the nitrogen gas.

**Pressure** – Press to change to the Pressure trend screen.

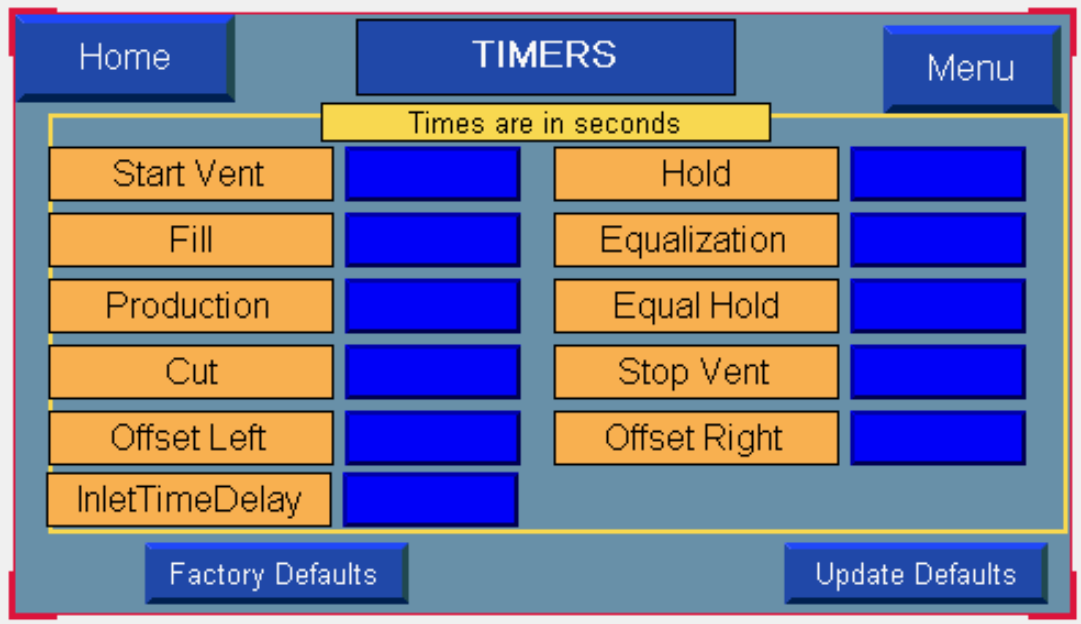
**Flow** – Press to change to the Flow trend screen.

**Home** – Press to return to the Home screen.

* The purity for the gas in the receiver as it is being produced depending on setting of the sample source valve.

The vertical axis high and low limit values can be changed on each of the screens by pressing the appropriate blue 'buttons' and inputting the desired values.

## Timers Screen (Engineering accessible):




Each individual timer can be accessed and changed by touching the adjacent blue box showing the current value. Consult factory before adjusting values.

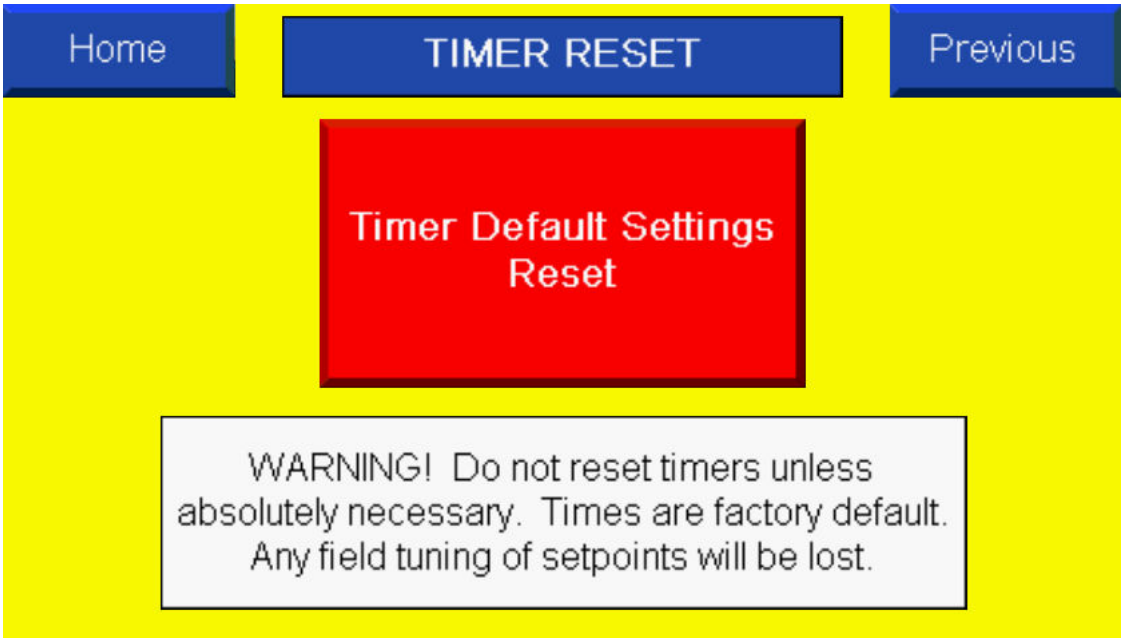
**Home** – Press to return to the Home screen.

**Menu** – Press to return to the Menu screen.

**Factory Defaults** – Press to change to the Timer Default reset screen.

**Update Defaults** – Press to insert current settings in the Factory Defaults

**Timer Reset Screen (Engineering accessible):**

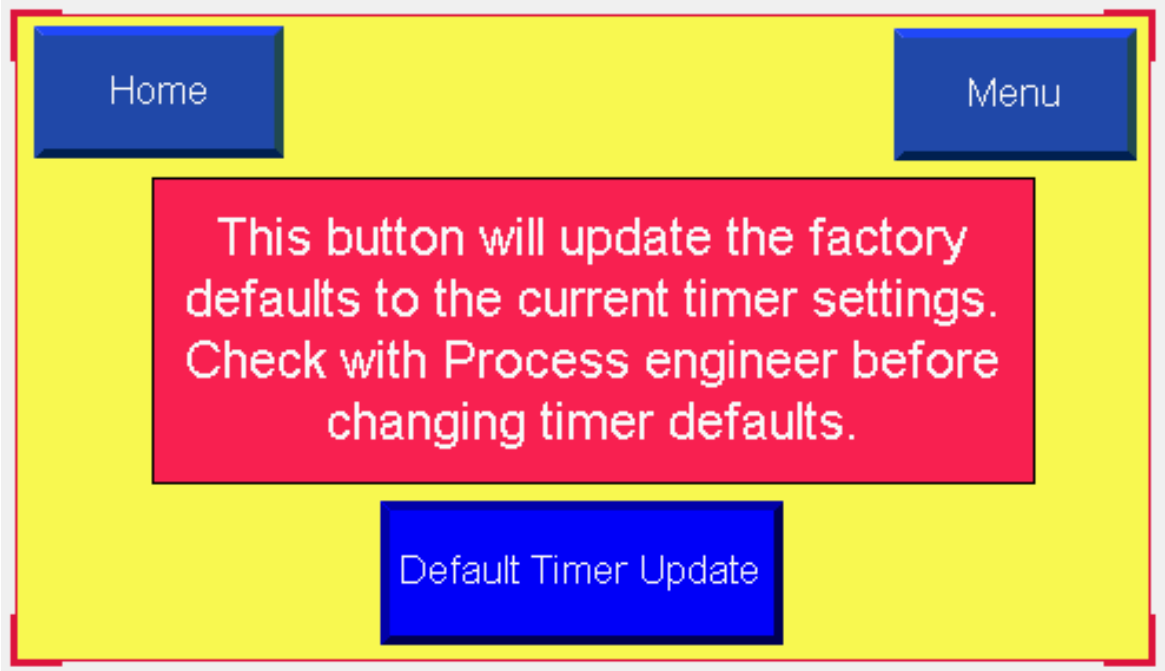



**Timer Default Settings Reset** red box – Press to reset all timer values to factory default values. Note that the offset left and right values will not be reset.

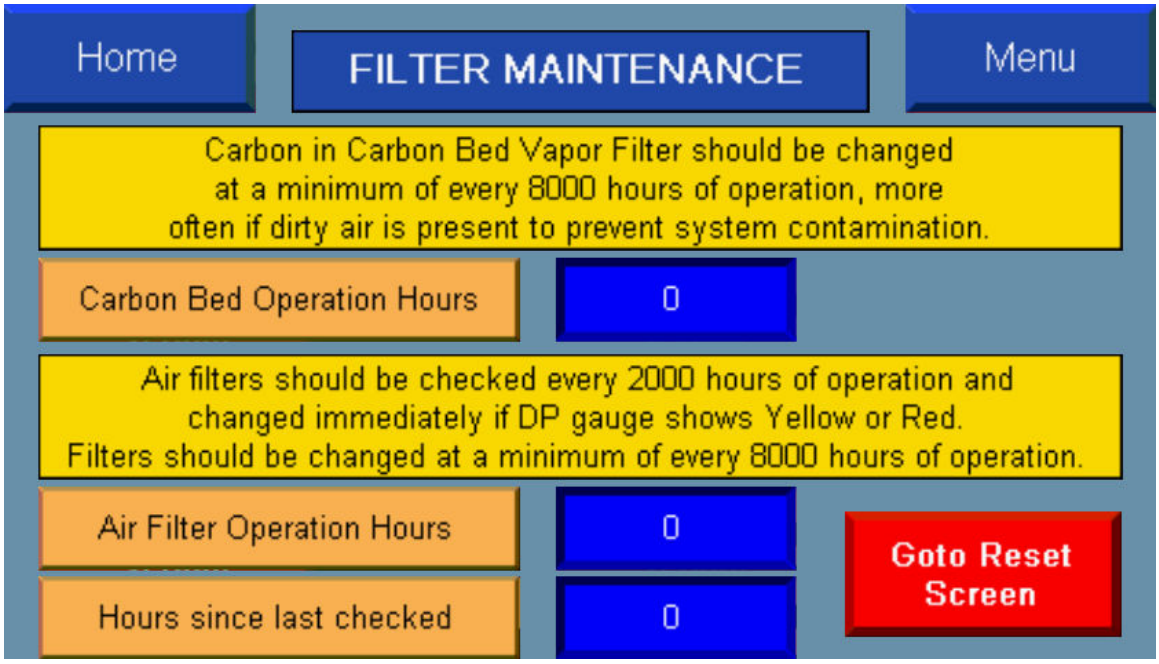
**Home** – Press to return to the Home screen.

**Previous** – Press to return to the Timer Setup screen.

**Timer Default Update (Engineering accessible):**



**Filter Maintenance Screen (Operator accessible):**




**Carbon Bed Operation Hours** – Indicates the number of hours of runtime since reset of the last change of carbon.

**Air Filter Operation Hours** – Indicates the number of hours of runtime since reset of the last change of air filter elements.

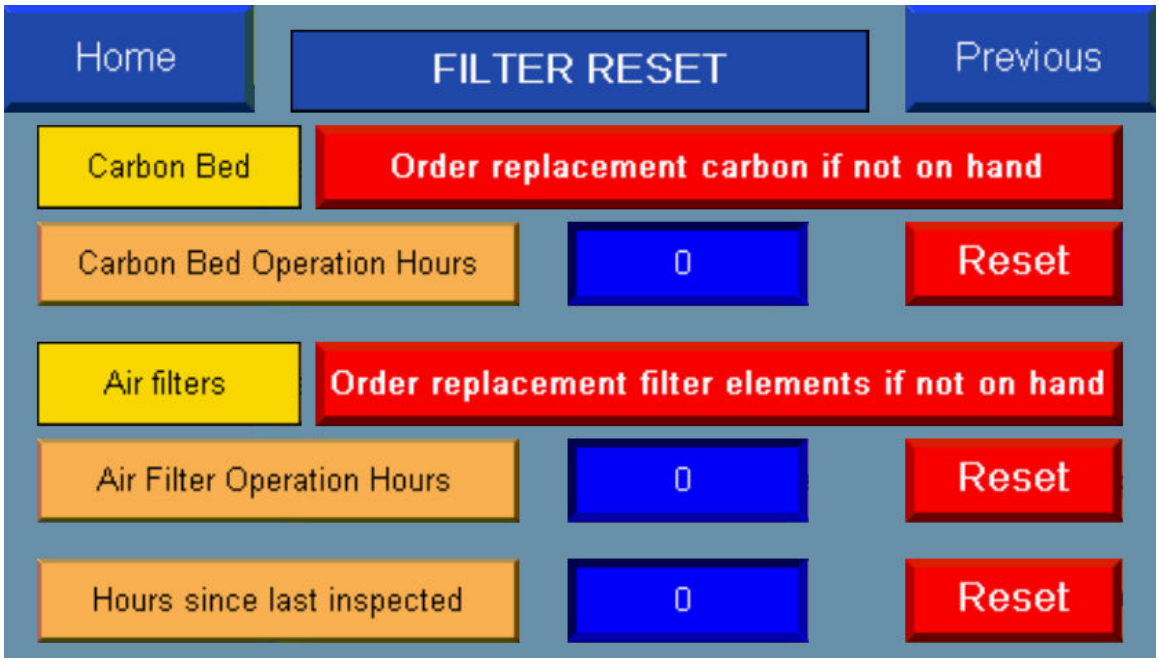
**Hours since last checked** – Indicates the number of hours of runtime since reset of checking the air filters for element replacement needs.

**Goto Reset Screen** – Press to change to the Filter Reset screen.

**Home** – Press to return to the Home screen.

**Menu** – Press to return to the Menu screen.

**Filter Reset Screen (Operator accessible):**




**Carbon Bed Operation Hours** – Indicates the number of hours of runtime since reset of the last change of carbon. Press adjacent **Reset** button when carbon is changed to reset time to zero.

**Air Filter Operation Hours** – Indicates the number of hours of runtime since reset of the last change of air filter elements. Press adjacent **Reset** button when filter elements are changed to reset time to zero.

**Hours since last checked** – Indicates the number of hours of runtime since reset of checking the air filters for replacement needs. Press adjacent **Reset** button when air filters are inspected to reset time to zero.

**Order replacement carbon if not on hand** – Appears when carbon bed operation hours gets to 7000 hrs. Touch notification after verifying carbon is on hand or ordered and hours exceeds 7000 hrs to acknowledge and clear warning.

**Order replacement filter elements if not on hand** – Appears when air filter operation hours gets to 7000 hrs. Touch notification after verifying filter elements are on hand or ordered and hours exceeds 7000 hrs to acknowledge and clear warning.

**Home** – Press to return to the Home screen.

**Previous** – Press to return to the Filter Maintenance screen.

## 3.3 *System Performance& Physical Characteristics*

| Model Number | 95% | 96% | 97% | 98% | 99% | 99.5% | 99.9% | 99.99% | 99.999% |
|---|---|---|---|---|---|---|---|---|---|
| HNBS-25 | 14.6 | 12.1 | 10.4 | 9.1 | 7.3 | 6.1 | 4.8 | 2.9 | 1.9 |
| HNBS-35 | 19.1 | 15.8 | 13.6 | 11.9 | 9.5 | 7.9 | 6.3 | 3.9 | 2.4 |
| HNBS-45 | 25.3 | 20.9 | 18.1 | 15.7 | 12.6 | 10.5 | 8.3 | 5.1 | 3.2 |
| HNBS-55 | 31.5 | 26.0 | 22.5 | 19.5 | 15.7 | 13.0 | 10.3 | 6.4 | 4.0 |
| HNBS-70 | 38.3 | 31.5 | 27.3 | 23.7 | 19.1 | 15.8 | 12.5 | 7.7 | 4.9 |
| HNBS-80 | 46.1 | 38.0 | 32.9 | 28.6 | 23.0 | 19.1 | 15.1 | 9.3 | 5.9 |
| HNBS-100 | 54.6 | 45.0 | 38.9 | 33.9 | 27.2 | 22.6 | 17.9 | 11.0 | 6.9 |
| HNBS-115 | 63.6 | 52.4 | 45.4 | 39.4 | 31.7 | 26.3 | 20.8 | 12.8 | 8.1 |
| HNBS-130 | -- | 59.9 | 51.8 | 45.0 | 36.2 | 30.0 | 23.8 | 14.6 | 9.2 |
| Air Factor | 1.83 | 1.91 | 2.00 | 2.13 | 2.36 | 2.59 | 3.11 | 4.12 | 5.49 |

Performance and air factor listed above is for ambient temperature 70°F and inlet pressure 110 psig. Please contact Holtec for performance at other conditions. Air factor listed may vary by ±5%. **(Flow listed in SCFM)**

| Model Number | 95% | 96% | 97% | 98% | 99% | 99.5% | 99.9% | 99.99% | 99.999% |
|---|---|---|---|---|---|---|---|---|---|
| HNBS-25 | 11.9 | 10.3 | 9.3 | 8.2 | 6.6 | 5.4 | 4.3 | 2.6 | 1.5 |
| HNBS-35 | 15.6 | 13.5 | 12.1 | 10.7 | 8.6 | 7.1 | 5.6 | 3.4 | 2.0 |
| HNBS-45 | 20.6 | 17.9 | 16.0 | 14.2 | 11.4 | 9.4 | 7.4 | 4.4 | 2.7 |
| HNBS-55 | 25.7 | 22.2 | 20.0 | 17.7 | 14.2 | 11.7 | 9.2 | 5.5 | 3.3 |
| HNBS-70 | 31.1 | 27.0 | 24.2 | 21.5 | 17.3 | 14.2 | 11.1 | 6.7 | 4.0 |
| HNBS-80 | 37.6 | 32.5 | 29.2 | 25.9 | 20.8 | 17.1 | 13.4 | 8.1 | 4.8 |
| HNBS-100 | 44.4 | 38.5 | 34.6 | 30.6 | 24.6 | 20.2 | 15.9 | 9.6 | 5.7 |
| HNBS-115 | 51.8 | 44.9 | 40.3 | 35.7 | 28.7 | 23.6 | 18.5 | 11.2 | 6.7 |
| HNBS-130 | -- | 51.2 | 46.0 | 40.8 | 32.8 | 26.9 | 21.1 | 12.7 | 7.6 |
| Air Factor | 2.00 | 2.09 | 2.19 | 2.34 | 2.59 | 2.85 | 3.44 | 4.71 | 6.46 |

Performance and air factor listed above is for ambient temperature 95°F and inlet pressure 110 psig. Please consult Holtec for performance at other conditions. Air factor listed may vary by ±5%.**(Flow listed in SCFM)**

| Model Number | L (in.) | W (in.) | H (in.) | Weight (lb) |
|---|---|---|---|---|
| HNBS-25 | 35 | 26 | 80 | 702 |
| HNBS-35 | 35 | 26 | 101 | 738 |
| HNBS-45 | 35 | 26 | 80 | 866 |
| HNBS-55 | 35 | 26 | 97 | 998 |
| HNBS-70 | 35 | 30 | 80 | 1060 |
| HNBS-80 | 35 | 30 | 101 | 1194 |
| HNBS-100 | 35 | 30 | 80 | 1292 |
| HNBS-115 | 35 | 30 | 91 | 1443 |
| HNBS-130 | 35 | 30 | 101 | 1597 |

## 3.4 Connections and recommended air and nitrogen receiver sizes

| Model Number | Air Tie-in* (inches) | Nitrogen Tie-in* (inches) |
|---|---|---|
| HNBS-25 | ½″ | ½″ |
| HNBS-35 | ¾″ | ½″ |
| HNBS-45 | ¾″ | ½″ |
| HNBS-55 | ¾″ | ½″ |
| HNBS-70 | 1″ | ¾″ |
| HNBS-80 | 1″ | ¾″ |
| HNBS-100 | 1″ | ¾″ |
| HNBS-115 | 1″ | ¾″ |
| HNBS-130 | 1″ | ¾″ |

**** Notes:*** ***Filters and dryer are always installed upstream of the air receiver. Filter sizes, air and nitrogen lines may have to be larger than the tie-in connections depending on flow, pipe lengths and configurations.***

### Recommended Air Receiver Sizes, in gallons*

| Nominal Model # | 95% | 96% | 97% | 98% | 99% | 99.5% | 99.9% | 99.99% | 99.999% |
|---|---|---|---|---|---|---|---|---|---|
| HNBS-25 | 60 | 60 | 60 | 60 | 60 | 60 | 60 | 30 | 30 |
| HNBS-35 | 80 | 80 | 60 | 60 | 60 | 60 | 60 | 60 | 60 |
| HNBS-45 | 120 | 120 | 80 | 80 | 80 | 80 | 60 | 60 | 60 |
| HNBS-55 | 120 | 120 | 120 | 120 | 80 | 80 | 80 | 80 | 80 |
| HNBS-70 | 200 | 200 | 120 | 120 | 120 | 120 | 120 | 80 | 80 |
| HNBS-80 | 200 | 200 | 200 | 200 | 120 | 120 | 120 | 120 | 120 |
| HNBS-100 | 200 | 200 | 200 | 200 | 200 | 200 | 200 | 120 | 120 |
| HNBS-115 | 240 | 240 | 200 | 200 | 200 | 200 | 200 | 200 | 200 |
| HNBS-130 | -- | 240 | 240 | 200 | 200 | 200 | 200 | 200 | 200 |

### Recommended Nitrogen Receiver Sizes, in gallons*

| Nominal Model # | 95% | 96% | 97% | 98% | 99% | 99.5% | 99.9% | 99.99% | 99.999% |
|---|---|---|---|---|---|---|---|---|---|
| HNBS-25 | 120 | 120 | 120 | 80 | 80 | 60 | 60 | 60 | 30 |
| HNBS-35 | 200 | 200 | 120 | 120 | 120 | 80 | 80 | 60 | 30 |
| HNBS-45 | 240 | 200 | 200 | 200 | 120 | 120 | 120 | 60 | 60 |
| HNBS-55 | 400 | 240 | 200 | 200 | 200 | 120 | 120 | 120 | 60 |
| HNBS-70 | 400 | 400 | 240 | 240 | 200 | 200 | 200 | 120 | 60 |
| HNBS-80 | 400 | 400 | 400 | 400 | 240 | 200 | 200 | 120 | 80 |
| HNBS-100 | 500 | 400 | 400 | 400 | 400 | 240 | 200 | 120 | 120 |
| HNBS-115 | 660 | 500 | 400 | 400 | 400 | 240 | 240 | 200 | 120 |
| HNBS-130 | -- | 500 | 500 | 400 | 400 | 400 | 240 | 200 | 120 |

***NOTE:** **Recommended receiver sizes are provisional and based on worst case scenario. In many cases, depending on application conditions, smaller receivers may be suitable. Contact Holtec for further advice.**

### 3.5 Other Utility Consumption

Electric power:

$N_2$ Generator ..... <0.12 kW, 120 - 240 V / 1ph / 50/60 Hz

## 4 Installation, Piping and Tie-in Points

### 4.1 Lifting and Installation

1. Put the skid gently down in the desired location on a concrete pad. It may be moved with a pallet jack or forklift using the forklift pockets. The system is top-heavy, use extreme caution when using this method. Always ensure the forks are fully through the back end of skid. Do not transport over uneven or slippery surfaces.

2. Anchor holes are provided in the skid base at the corners. Anchor skid base as required (anchors supplied by others).

3. Connect the feed air supply line with dry, oil free air (max 38 °F / 3 °C dew point and <0.003 ppm oil before activated carbon bed) to tie-in T-101 for the nitrogen generation system. Make sure the line has been blown out prior to making the connection to make sure no dirt or foreign material is introduced to the nitrogen generator.

4. Connect the nitrogen distribution line to skid outlet tie-in T-102.

5. Install the power supply conduit and wiring (power supply will accept 110-240 VAC, 1–ph, 50/60 Hz). Connect the L1 and N wires to the matching terminal blocks and connect ground wire to a ground terminal block. See Nitrogen Generator Wiring Diagrams for details.

6. All equipment and piping have been hydro-tested / pneumatically leak tested if required by code and do not require further hydro-testing. Additional testing for the piping system is not recommended, due to the difficulty to remove all the water. **Caution**: ***Do not*** *hydro-test adsorber vessels (B-101/102) or filter housings as this will damage the Carbon Molecular Sieve and filter media inside the filter housings.*

7. Install nitrogen sample line, (shipped loose). Line should be run from V-116 located on the side of the control panel to downstream of the nitrogen receiver tank.

**Note:** Confirm proper pipe class and material of construction for all lines and that the nitrogen distribution line is protected against pressurization above 165 psig. All facility piping must be properly supported to avoid application of excessive forces or moments to the nitrogen generator piping.

8. Check all instrument and piping connections for leaks with a soap solution after the system has been started up. Repair detected leaks, if any.

## 4.2 Piping and Tie-in Points

All internal interconnecting piping and wiring are included inside of Nitrogen System battery limits. The termination points will be as follows: (See data sheet or General Arrangement Drawing for connection sizes)

a) Compressed air supply to PSA Inlet: T-101

b) Nitrogen Generator Product Outlet: T-102

c) Vent Gas: T-103

- For HNBS-25 through -55, the Vent Gas exhausts to atmosphere through a silencer. The silencer elements should be replaced annually or as needed, to avoid excessive backpressure.
- For HNBS-70 through -130, there is a 2.5" MNPT Vent Gas connection. The O2-rich vent gas can be left un-piped in many facilities, especially large ones, depending on specific facility requirements. Otherwise, it can be piped out of building, but pressure drop must be minimized. **Note**: ***Pipe size must not be reduced, blocked, or be of excessive length or nitrogen generator function will be impaired.*** Standard HNBS models are not intended for outdoor operation.

# 5 Start-up Procedure

## 5.1 Initial Start-up

The nitrogen generator has been functionally tested and leak tested prior to delivery. Flow control valves have been adjusted close to their final positions, and PLC timers have been pre-set. Fine-tuning to reach specified nitrogen flow and purity at other conditions will be done in the field.

The nitrogen generator should be operated for minimum 1 hour after the system has first been started and the resulting product nitrogen vented continuously at or near the exit of any new pipes that have been installed close to point of use. ***Caution: Ensure adequate ventilation and O2 level in room, or pipe N2 out with temporary hose.*** The purpose is to remove oxygen from the nitrogen receiver tank and downstream lines before nitrogen is supplied to the end use points. We do not recommend making any adjustments until the system has been operated for at least one hour since this may result in improper flow and pressure settings. Higher purity (lower O2) applications need to be operated longer than lower purity applications.

It is important to check the nitrogen purity with the oxygen analyzer (AIT-301) when adjusting nitrogen production flow control valve FCV-102.

After the nitrogen generator has been tuned in as described below, it is sufficient to follow the instructions given in section 5.2 for consecutive start-ups. Should the nitrogen generator have to be tuned in again for any reason, the initial start-up procedure for the system is as follows:

1. Leak test, and make the nitrogen distribution system ready to receive nitrogen and open isolation valves between the nitrogen generator and the nitrogen receiver. All nitrogen outlet valves downstream of the nitrogen receiver tank should be closed.

2. Turn the nitrogen generator main Power switch to “On”.

3. Verify that clean, oil-free, dry (dew point <38 °F) is available upstream of tie-in T101.

4. Open the main inlet air isolation valve V-100. Verify that process air pressure is per process specifications.

5. Open nitrogen receiver tank inlet and outlet isolation valve V-110.

6. Set nitrogen generator instrument air regulator PCV-104 to about 90 psig.

7. Turn the lever for sample gas selector valve V-109 towards RUN (nitrogen product sample). Verify that V-116 and any other sample isolation valves are open. Note: The purity of the nitrogen from the individual adsorber

vessels will fluctuate during the production cycle. The purity will be close to constant downstream of the nitrogen receiver.

8. Start the nitrogen generator by pushing the "Start" button on the HMI. To stop the system, push the "Stop" button on the HMI. The nitrogen generator will complete the cycle before stopping.

9. The nitrogen generator will run continuously if in "Manual" mode. In "Auto" mode the generator will cycle between operating and standby should the nitrogen demand be less than the nitrogen generator capacity. Manual/Auto mode is selected on the HMI.

10. It will take several minutes from when the nitrogen generator is started until the nitrogen receiver tank has been pressurized (see data sheet for recommended nitrogen pressure). The oxygen content will be higher than design when the system is first started. Open a valve close to the main nitrogen point of use to purge the nitrogen distribution system of oxygen during this initial run period of 1 hour or more, or until the oxygen level is within the specifications. (A nitrogen receiver drain valve can be cracked open if the purpose is only to purge the nitrogen receiver)**. Warning:** ***Make sure there is very good ventilation in the area where the nitrogen is vented to avoid asphyxiation, or direct the vent to the open atmosphere using a temporary hose line*****.**

11. Signal from pressure transducer PT-301 controls the automatic nitrogen generator operation. Adjust standby pressure set point in the PLC/HMI, if required. Typical setpoint is 5 – 10 psig below the air pressure. A slightly lower set pressure may be considered if the nitrogen generator never switches to "Standby" mode.

12. Slightly open a drain valve or product isolation valve to purge out oxygen in the downstream piping and/or nitrogen receiver.

13. If the concentration of oxygen indicated on AIT-301 is higher than design after the nitrogen receiver tank and piping have been purged for oxygen, gradually reduce the setting (clockwise adjustment) of valve FCV-102, using the Allen wrench provided, (a small adjustment every 5 minutes) until the design oxygen concentration is achieved. Actual nitrogen concentration is indicated on AIT-301. If the concentration of oxygen is lower than design, gradually increase the setting (counter-clockwise adjustment) of valve FCV-102 valve until the design oxygen concentration is achieved. **(In summary, decreasing the opening (CW) of the valve will reduce the nitrogen production rate and reduce the oxygen content. Opening (CCW) the valve will increase nitrogen production and the oxygen content).**

**Note:** *It is important to keep the nitrogen receiver pressurized at normal operating pressure to achieve optimum performance. The nitrogen*

*receiver is a process tank not designed to cover large surges in the nitrogen consumption. Additional tanks may be required to cover peak consumptions. Consult Holtec for recommendations*.

14. Adjust sample pressure control valve PCV-103 if the flow shown on FI-301 has changed from the target value of 1.2 scfh.

15. Restriction orifices RO-105, 106, have been installed at the factory to limit maximum flow. Some units may use flow control valves in lieu of orifices in these equalization lines, in which case they must not be adjusted without factory authorization, to avoid invalidation of any warranty and performance guarantee. **NOTE: In the case of systems with flow control valves for equalization, equalization time must be a minimum of 3.5 seconds.**

## 5.2 Normal Start-up

Assuming that main power switch is turned "ON" and the tasks described in section 6.1 have been performed, normal start-up procedure is as follows:

1. Verify that clean, dry, oil-free feed air is available and the pressure dew point is below 38 °F/ 3 °C.

2. Slowly open all air supply isolation valves upstream of the nitrogen generator tie-in T101.

3. Open the system main inlet air isolation valves (V-100).

4. Start the nitrogen generator by pushing the "Start" icon on the LCD HMI.

5. It takes 3 to 4 minutes for the PSA to start producing nitrogen and feeding it into the nitrogen receiver.

6. Verify that nitrogen isolation valve V-110; downstream of the nitrogen generator tie-in T102 is open.

## 5.3 Continuous automatic operation

Once the nitrogen generator has been started as described above, the nitrogen generator will successively run and then switch to standby mode as the pressure in the nitrogen receiver tank falls below and rises above set point pressure in response to variations in nitrogen consumption.

### 5.4 Turndown operation (EnergyAssistant)

The nitrogen generator produces nitrogen on demand based on automatic on/off control. It is possible to reduce the opening of nitrogen flow control valve FCV-102 to produce less nitrogen of better purity. Using an Allen wrench, turn clockwise to reduce flow. ***See Section 5.1 paragraph 13 for additional instructions.***

**Holtec EnergyAssistant**, when purchased and enabled on the HMI home screen, automatically adjusts the cycle time to match demand. If Turndown is enabled and oxygen level remains high, the Flow Factor on the Setpoints screen should be decreased. If the oxygen level is always well under required levels, then it can be increased (example 10% step) to maximize performance.

## 6 Shutdown

### 6.1 Manual shutdown

The normal shutdown procedure is as follows:

1. Push the “Stop” icon on the LCD HMI. The unit will cycle to stop.

### 6.2 Long term shutdown

If the system will be shut down for an extended period of time, stop the system as described in section 6.1 and:

1. Turn the nitrogen generator main power switch to “Off”.

2. Close feed air isolation valve (V-100).

3. Close nitrogen product isolation valve (V-110).

# 7 Inspection and Maintenance

This section covers the general maintenance procedure for the PSA Nitrogen Generator and the upstream air purification system (optional or by others). Please refer to Manufacturer Catalogues in section 10 for further details.

## 7.1 Operation, Inspection and Maintenance Check List

| | Daily | Weekly | Monthly | 3 Months | 6 - 12 Months |
|---|---|---|---|---|---|
| Visually check the overall system operation. Make adjustments if required. | X | | | | |
| Check nitrogen purity | X | | | | |
| Check nitrogen sample flow | X | | | | |
| Check operating pressure | X | | | | |
| Check dryer dew point temp. below 38°F / 3 ºC | X | | | | |
| Check oxygen analyzer span(AIT-01) | | | | | X |
| Check pressure transducer setting/standby operation (PT-301) | | | | X | |
| Check for air and nitrogen leaks | | | | X | |
| Replace filters and activated carbon | | | | | X[a] |
| Replace switching valve muffler element | | | | | X |

a. Activated carbon should be replaced once every 12 months as a minimum. Filter cartridges should be replaced once every 12 months as a minimum or when the pressure differential indicator gets into the red zone.

Pressure safety (relief) valves (PSVs) are sized for fire-case protection of vessels. If the plant has a maintenance schedule for PSVs, these can be included in that schedule.

## 7.2 Instrument Air Filter Replacement

The instrument air filter (F-106) element needs to be replaced at least every 12 months. The filter is located under the control panel skirt directly behind the instrument air pressure gauge (PI-104).

## 7.3 Oxygen Analyzer

The zirconium oxygen analyzer does not require calibration. Calibration can only be done by Holtec. The sensor must be returned to Holtec for calibration. A replacement transmitter can be sent out and partially credited upon the return of the old sensor.

The oxygen analyzer's span can be verified by using calibrated gas for PPM analyzer, and air for percent analyzers. Allow the oxygen analyzer to warm up for minimum 1 hour before checking span.

1. Obtain a bottle of nitrogen mixed with appropriate PPM $O_2$. Connect the regulated calibration gas pressure (max 125 psig) to sample gas.

2. Turn the lever for sample gas selector valve V-109towards CAL = Calibration gas source. Wait until reading is stable (~ 1 hour for PPM ranges).

3. Adjust sample flow control valve PCV-103 if necessary until the sample flow as indicated on flow indicator FI-101 is about 1.2 scfh.

4. Turn the lever for sample gas selector valve V-109 towards RUN = nitrogen product sample.

If a galvanic type sensor is provided, It must be periodically calibrated. It is spanned using compressed air. For calibration instructions see analyzer manual in section 10.3.

The oxygen analyzer "Hi" Alarm can be set to desired value. The value is set by programming the set points using the HMI touch-screen.

1. Touch MENU on the HMI.

2. Touch SETPOINTS and the return symbol.

3. Touch HIGH O2 SETPOINT and enter the desired set point.

4. After both the HIGH and LOW values are set, touch the home icon to return to the main screen.

## 7.4 Switching Valve or Solenoid Replacement

If any of the switching valves or solenoid valves have to be replaced, it is important to connect the various fittings and tubes to the appropriate valve ports, and the wires to the appropriate terminals. See the wiring diagram and Piping & Instrument Diagram in section 10 for details.

### 7.5 Lubrication Recommendations

The Nitrogen Generators do not require lubrication.

### 7.6 Special Tools

The Nitrogen Generator does not require any special tools for operation and maintenance. Except for the following: Allen wrench for adjusting FCV-102 and Wago terminal block insertion tool, located in envelope inside control panel.

### 7.7 Clearances

A minimum of 3 ft./ 0.9 meters clearance should be kept around the nitrogen generator for proper access to maintenance and operation.

## 8 Troubleshooting

This section covers general trouble shooting for the PSA Nitrogen Generator. Please refer to Manufacturers' Catalogues in section 10 for further details.

**Nitrogen Generator runs continuously**

| Probable Cause | Suggested remedy |
|---|---|
| Leaks in air or nitrogen lines | Check and repair leaks |
| The nitrogen consumption is too high | Reduce nitrogen consumption. |
| Feed air supply pressure too low | Increase supply pressure or replace air filter elements. |
| The nitrogen production is set too low | Adjust control valve FCV-102 to increase the product flow. This adjustment must only be done by an experienced operator and close attention must be paid to the oxygen content in the product nitrogen. |
| Nitrogen transducerPT-301 set too high or defective | Reduce pressure set point or replace pressure transducer. |
| One or more of the switching valves (XV-100 – 108) or solenoid valves (SOV-100 – 108) are malfunctioning. | Check operation or consult Holtec. |

**Nitrogen Generator is not running**

| Probable Cause | Suggested remedy |
|---|---|
| Main power switch is turned "Off" | Turn switch to "On" |
| System is not in Run mode | Push "Start" icon on HMI |
| Feed air supply closed | Open all feed air isolation valves including V-103 |
| System is in "Standby" mode | Start using nitrogen. Open all manual valves downstream of the nitrogen generator |
| The switching valves (XV-100 – 08) are not opening. | Check valve operation. |
| Fuse blown | Check and replace fuse. See wiring diagram for proper fuse rating. |
| PLC controller is not working | See PLC manual section 10 for suggestions. |
| External circuit breaker tripped | Reset circuit breaker |

### Nitrogen product flow below design

| Probable Cause | Suggested remedy |
|---|---|
| Leaks in air or nitrogen lines | Check and repair leaks. |
| Feed air supply pressure too low | Increase supply pressure psig or replace air filter elements |
| The oxygen content in the product nitrogen is below specification | Adjust control valve FCV-102 to increase the product flow until the nitrogen purity increases to specification |
| One or more of the switching valves (XV-100 – 08) or solenoid valves) are malfunctioning. | Check operation or Consult Holtec. |
| Carbon Molecular Sieve contaminated with oil or water. | Contact Holtec. |

### Too high oxygen content in the Nitrogen product

| Probable Cause | Suggested remedy |
|---|---|
| Leaks in air or nitrogen lines | Check and repair leaks |
| Feed air supply pressure too low | Increase supply pressure or replace air filter elements. |
| The nitrogen consumption is set too high | Reduce nitrogen consumption. |
| The nitrogen production is set too high | Adjust valve FCV-102 to decrease the product flow until the nitrogen purity is at specification. |
| One or more of the switching valves (XV-100 – 108) or solenoid valves are malfunctioning. | Check and replace. |
| Carbon Molecular Sieve contaminated with oil or water. | Contact Holtec |

### Filter drains not working properly

| Probable Cause | Suggested remedy |
|---|---|
| Auto drains (by others) stuck in open or closed position | Check and clean drain mechanism |

## 9 Warranty

See section 10.

# 10 Drawings and Manufacturers' Catalogues

1. Drawings & pictures:
   - General Arrangement
   - Piping & Instrument Diagram
   - Wiring Diagrams, Nitrogen Generator

2. Material Safety Data Sheets:
   - Nitrogen MSDS
   - CMS MSDS

3. Analyzer:
   - Galvanic Oxygen analyzer, AIT-301 (If applicable)

4. Warranty:
   - Holtec's standard warranty

5. Additional Equipment (If applicable)
   - Compressor
   - Dryer
   - Filters