SAFETY / WARRANTY

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This manual describes the functions and use of a programmable liquid nitrogen level sensor. The manual is designed to familiarize users that are already experienced with liquid nitrogen storage equipment, with the operation of the sensor. For more generalized information on safe handling and storage of liquid nitrogen refer to CGA P-12 "Safe Handling of Cryogenic Liquids" available from the Compressed Gas Association, www.cganet.com , 703-412-0900.

No attempt should be made to install or operate this equipment until this manual has been read and fully understood.

Hazards Associated with this Equipment

Automatic Operation

The sensor can be configured to automatically control valves and alarms in response to its state. It is unaware of your presence and only responds to the state of the sensor. If automatic control operation creates a hazard to persons working with or maintaining the cryogenic equipment to which the sensor is attached it should be disabled while those activities take place.

24 Volt Power

The sensor operates on 24 vdc power and is fused at 3 amps (max). While this poses no life safety risk from electrocution, it is sufficient to create arcs and high temperatures if short-circuited. Normal wire routing precautions should be taken to keep the wiring away from sharp or abrasive objects and away from flammable materials.

User Supplied Power

The sensor can be configured to switch user-supplied power up to 110 vac. This can pose a life safety risk if so configured and precautions appropriate to the power being switched must be observed.

Warranty

This unit has been inspected, calibrated and tested at the factory and is fully functional at time of delivery. We will further warrant the unit against defects in materials and workmanship for a period of 30 days from delivery. This warranty is limited to repair or replacement of the defective unit, upon return to our factory, or refund of the purchase price. This warranty does not cover damages to the unit caused by improper installation, accident, fire, flood, acts of God, or failure of the product if it is used for other than its intended purpose.

THE WARRANTOR IS NOT RESPONSIBLE FOR CONSEQUENTIAL DAMAGES.

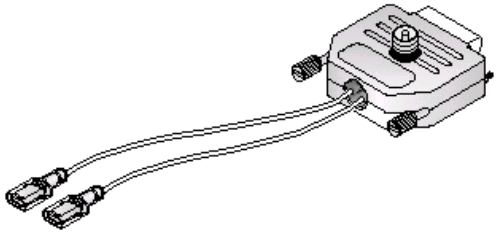
INTRODUCTION

Congratulations !!

You have just purchased the world's most versatile liquid nitrogen level sensor. In spite of its small size and simple appearance, it can be easily configured for a wide variety of cryogenic monitoring and control functions.

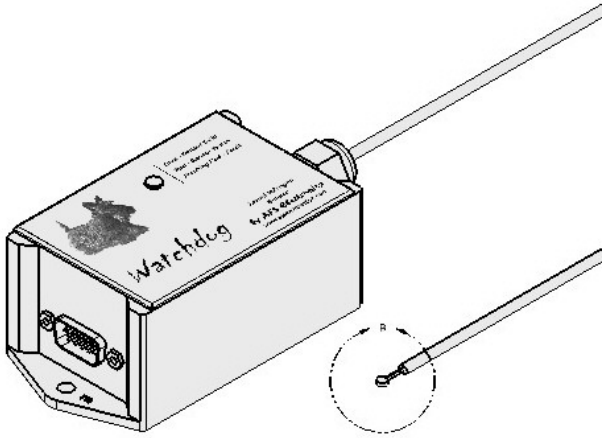
Functional Description

The Watchdog combines reliable analog electronics with a thermistor liquid level sensor and an external DB-9 Program Plug into a rugged, compact package. The Watchdog Box, the heart of the unit, continuously monitors and displays the state of the sensor on a bi-color LED. A Red LED means the sensor is warm (out of the LN_2). A Blue LED means the sensor is cold (in the LN_2). If there is a sensor failure the LED will Flash Red. The Watchdog is equipped with relay outputs for both control and alarm functions. The Watchdog Plug, the brains of the unit, is used to configure the functions of the Watchdog Box. The plug also serves as an internally fused junction box for input and output connections. The Watchdog Plug is color coded, to match the normal LED color and to denote unit function. For low level sensing, where the sensor would normally be cold, a Blue plug is used. For high level sensing, where the sensor would normally be warm, a Red plug is used. While the Watchdog operates on 24 vdc power it is capable of and can be configured to switch 5 – 120 volt, ac or dc externally supplied power up to 3 A.



Features

In addition to its ability to serve as either a high level (overfill) monitor or low level monitor, the Watchdog's outputs can be individually configured for multiple alarm and control functions. Its sensor driven outputs may be directly used to control an overfill shutoff valve, low-level fill valve, or local audible alarm by switching the units internal 24 vdc power. They also can be configured to switch externally supplied ac or dc power (3 A max). Alternatively, the sensor output may be configured as normally open or closed dry contacts for remote alarm circuitry. In addition to the sensor outputs, there is an auxiliary SPDT relay. This relay may be driven from internal or external power to provide additional alarm or control functions. All of the options are factory configured using the Watchdog Plug; simply specify what you want the unit to do, and it will be so configured via the plug. In addition to the numerous built in functions and capabilities, external circuitry can be added via the DB-9 port for timed control, alarm latching, and similar functions. If all of this isn't enough versatility, two Watchdogs may be ganged together to function as a low cost liquid level controller.

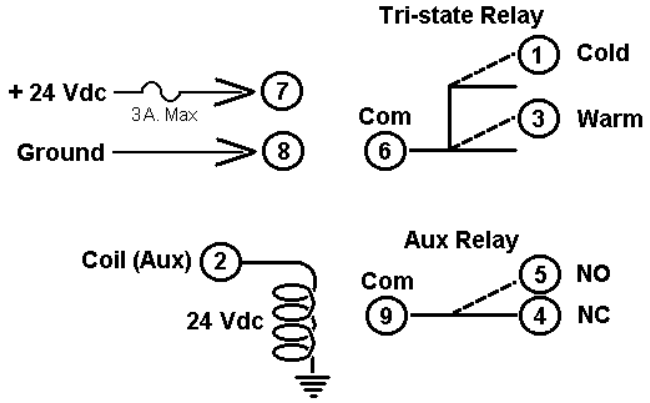


COMPONENTS

Watchdog Box

The Watchdog Box houses the potted electronics, LED indicator, output relays, thermistor sensor, and DB-9 socket in a sealed ABS enclosure. Each box is factory calibrated to a letter graded thermistor sensor. The sensor can be replaced without recalibration of the unit with one of the same letter grade. The letter is stamped on the box flange below the sensor wire. The unit is powered, through the Program Plug, by a 24 vdc supply. The electronics determine the state of the thermistor sensor and control the output of a tri-state relay and LED display. The three possible outputs for the tri-state relay are sensor in liquid (cold), sensor out of liquid (warm) or neither (sensor fault). This relay can be configured to switch supply power, external power, or act as dry contacts through the Program Plug. In addition to the tri-state relay, there is a separate auxiliary SPDT relay that may be used for control functions, accessible through the Program Plug.

Watchdog Pinout



Thermistor Sensor

The thermistor sensor is a cryogenic thermistor located at the end of a teflon insulated cable. A thermistor is a special form of resistor that changes resistance in response to temperature changes. A small electrical current flows through the sensor causing it to self heat. A thermistor that is immersed in LN_2 will remain cold since the heat is carried away by the liquid. A thermistor that is located in the nitrogen vapor space, above the LN_2, is warmed slightly by the current flow causing its resistance to change. The electronics detect this change in resistance and use it to determine the state of the sensor.

Program Plug

The Program Plug is used to configure the Watchdog functions. It does this by interconnecting the 9 input and output pins on the DB-9 plug. The Program Plug also serves as an internally fused junction box for the output wires and audible alarm. Factory supplied Program Plugs are color coded to the normal state of the LED. For example in a low level alarm application the thermistor sensor would normally be cold and the LED would be blue, hence a blue Program Plug would be used. This convention provides an easy visual check of the operation. If the LED is the same color as the Program Plug everything is normal, if they are different something is amiss. To integrate the Watchdog into another machine the customer may supply his own connector and fuse. Configure the Watchdog by following the pin out convention for the unit.

OPERATION

Installation

The Watchdog is designed for indoor operation. The box should be mounted to a secure surface away from cryogenic vents, sources of extreme heat or water spray.

The thermistor sensor should be positioned at its desired level in the dewar and secured. For low level monitoring and control the sensor may hang free, however for sensor protection and to minimize splashing effects in high level sensing applications it's best to mount the sensor inside of a stillwell tube. The sensor is designed to fit into tubes as small as 3/8" (10mm) outside diameter. The stillwell tubes may be either of metallic or non-metallic construction. For best operation the stillwell should be open at the bottom, sealed at the top and have one or more 1/16" (1.5mm) holes drilled in it above the maximum anticipated liquid level. To minimize icing inside of the tube the holes in the stillwell tube should be located in the nitrogen vapor space of the dewar.

Once the box is mounted and the sensor installed the unit is ready to be powered up. Insert the P-5 power plug from the 24 vdc supply into the socket in the Program Plug. If a factory power supply isn't used, the plug polarity must be observed. The center pin of the connector is positive, the shell is ground. Once power is applied the unit is functional and the LED will light displaying the state of the sensor.

Operation

In operation the unit will respond to the state of the sensor in accordance with the functions configured into the Program Plug. The state of the DB-9 connector outputs are controlled by two relays.

The tri-state relay and the LED display are controlled solely by the state of the sensor. If the sensor is cold, the LED will be Blue and the Common Terminal (Pin 6) of the tri-state relay will be connected to the Cold Terminal (Pin 1). If the sensor is warm, the LED will be Red and the Common Terminal (Pin 6) of the tri-state relay will be connected to the Warm Terminal (Pin 3). If the sensor is open or shorted, the LED will Flash Red and none of the tri-state relay terminals will be connected. The tri-state relay will switch immediately with the change in sensor state.

The auxiliary relay is controlled by the Program Plug. The relay is activated by supplying 24 vdc positive power to the Coil (Pin 2). This control power must be the same 24 vdc power that is supplying the unit. The relay outputs are Common (Pin 9), Normally Open (Pin 5), and Normally Closed (Pin 4). The action of the auxiliary relay is time delayed by 1 millisecond to allow for logical control sequences to be used. Once power is supplied to the Coil (Pin 2) it will take 1 ms for the contacts to switch, similarly when power is removed from the Coil (Pin 2) the contacts will hold for 1 ms before switching back.

FUNCTIONS

The Watchdog outputs can easily be configured for multiple, independent functions. For ease of specification they are divided into Control and Alarm functions.

Control

Control functions output 24 vdc control power or externally supplied power (3 A max). There are three options for the output. First is Power on Cold Sensor, typically used for overfill protection circuits. Second is Power on Warm Sensor, used for LN_2 supply switching circuits to guard against low liquid levels. Finally there is a Power on Sensor Failure option used to drive external audible or visual alarm indicators.

Alarm

There are two alarm functions available. The first is the audible alarm option. The audible alarm is a local piezoelectric buzzer that activates when the unit is in alarm. The audible alarm can be made to sound on either or both of the following conditions: A sensor failure or an abnormal operating condition (LED opposite plug color).

The second alarm function is the Remote Contacts option. The remote alarm contacts can be configured as normally open or normally closed dry contacts to connect to an alarm panel. The remote contacts can be made to activate on any or all of the following conditions: Loss of electrical power to the unit, sensor failure, or abnormal operating condition (LED color opposite plug color).

Function Independence

All alarm and control functions are independent from one another. This means that you may specify as many or as few functions as necessary for your application and the Program Plug will be configured to accommodate the application. This information is specified in the part number for the Watchdog and Program Plug. There is a guide for specifying the part numbers in the appendix. AFS will aide you in the specification of the unit to meet your needs.

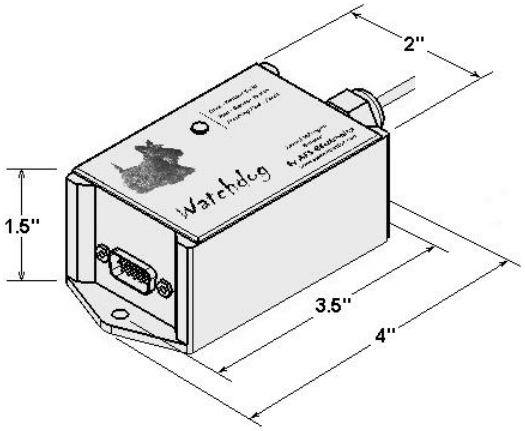
Special Functions

Even if a Watchdog function isn't listed, its modular construction makes special functions possible. If you need alarm latching, time delays on outputs, or special connections they are easily accommodated. Just contact AFS with your requirements, and we will work out the details.

Liquid Level Controller

One special function that is listed in the appendix is the use of two Watchdogs ganged together as a simple liquid level controller. By interconnecting a low level Watchdog with a high level Watchdog through a two plug harness a liquid level controller that will maintain the LN2 level between the two sensors is created. It will output 24 vdc to a cryogenic solenoid valve allowing for automatic dewar filling from a LN2 supply.

SPECIFICATIONS



Electrical

Power 24 vdc regulated or unregulated via a P-5 circular power connector (5.5mm od, 2.1mm pin), Center Pin Positive. Customer supplied DB-9 plugs (not using Watchdog Program Plug) must have Pin 7 power lead fused (3 A max.)

Current requirement is dependant on load driven. 100 ma minimum (local alarm only), 3 amp maximum.

Output contacts rated 3 A @ 30 vdc, 3 A @ 120 vac. 100 million cycles mechanical, 10 million cycles electrical (full load).

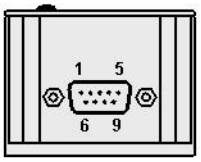
Sensor Heat Dissipation: (<20mw)
Response Time: (<1 sec LN_2 rising)
(<1 min LN_2 falling)

Audible Alarm 85 dB @ 2300 hz

Operating Environment

Indoor Use Only.
Liquid Nitrogen Only.
Temperature (32° F to 120° F)
Humidity (5% to 95% RH)
Altitude (No Restrictions)

Connections



DB-9 Pin out

Pin 1 Tri-State Relay Cold
Pin 2 Aux. Relay Coil
Pin 3 Tri-State Relay Warm
Pin 4 Aux. Relay Normally Closed
Pin 5 Aux. Relay Normally Open
Pin 6 Tri-State Relay Common
Pin 7 24 vdc Positive Input
Pin 8 24 vdc Negative Input
Pin 9 Aux. Relay Common

Control Function Wires

24 vdc Positive Output (Red)
24 vdc Negative (Black)

All control function wires are protected to switch inductive loads and terminate in a 1/4" x .032 fully insulated male spade terminal

User Supplied Power Input (Red Fused) 3 A max.

User Supplied Power Output (Yellow)

Alarm Contact Wires

Common (White)
NC (Open in Alarm) (Green)
NO (Closed in Alarm) (Blue)

All remote alarm contact wires terminate in a 3/16" x .020 fully insulated male spade terminal. If used to switch dc inductive loads a TVS should be placed across the load to increase contact life.

APPENDIX - Part Numbering

WD8-BA1C23-S1

The Watchdog Part Number individually specifies the Watchdog Box, Program Plug, and Power Supply via a hyphenated part number. Contact AFS for assistance in specifying PN's.

Watchdog Box (WD)

Sensor Options

Length	(feet)
Plug Mount	(P)

Example : WD8

Watchdog Box with 8 foot Sensor (Standard)

Program Plug

Low Level Sensing (Blue)	(B)
High Level Sensing (Red)	(R)
Liquid Level Control	(LL)

Audible Alarm (A)

Abnormal Conditions	(1)
Sensor Failure	(2)
Both	(12)

Remote Contacts

NC, Open on Alarm	(C)
NO, Close on Alarm	(O)
Abnormal Conditions	(1)
Power Failure	(2)
Sensor Failure	(3)
Any Combination of	(123)

Control Power

24 vdc	(P)
User Supplied Powe	(U)
On Warm Sensor	(1)
On Cold Sensor	(2)
On Sensor Failure	(3)

Program Plug (cont.)

Example: BA1C23

Low Level Sensing Plug with a local audible alarm that sounds abnormal conditions (warm sensor), and normally closed remote alarm contacts that open on power failure or sensor failure.

Power Supply 24 vdc (S)

.25 Amp Strip Mt.	(.25)
1 Amp Wall Mount	(1)
3 Amp Desktop	(3)

Example: S1

1 amp wall mount 24 vdc power supply.