SUNPOWER

AMETEK®

Installation & Operation Manual

for the

Active Vibration Cancellation (AVC) System

Rev. A

Revision History

Rev.	Description of Change	Date
–	Initial release.	December 15, 2014
A	Added this Revision History section. Inserted an important note in section 3 above the **LOGIN=<PASSWORD>** command described in subsection 14). The important note describes an issue with the **LOGIN=<PASSWORD>** command. (It does not unlock the **COOLER=<VAL>** command as it should.) The workaround is to use the **SU=FRIO** command. This known issue is only present in controller software versions AB_V1.0.5a through AB_V1.1.1a. Rearranged the installation section to install the AVC balancer after installing the accelerometer and the cryocooler power connector. Added torque values for tightening the fasteners that secure the accelerometer and the AVC balancer to the cryocooler. Added an extra line of description to applicable commands in section 3 to denote whether or not the value set by the command is stored in non-volatile memory.	December 19, 2014

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Section 1
Equipment Description

System Components

The Sunpower Active Vibration Cancellation (AVC) system includes an AVC balancer, AVC controller, over-temp thermistor cable, accelerometer cable, power wiring harness, and instrumentation wiring harness as shown in figure 1.

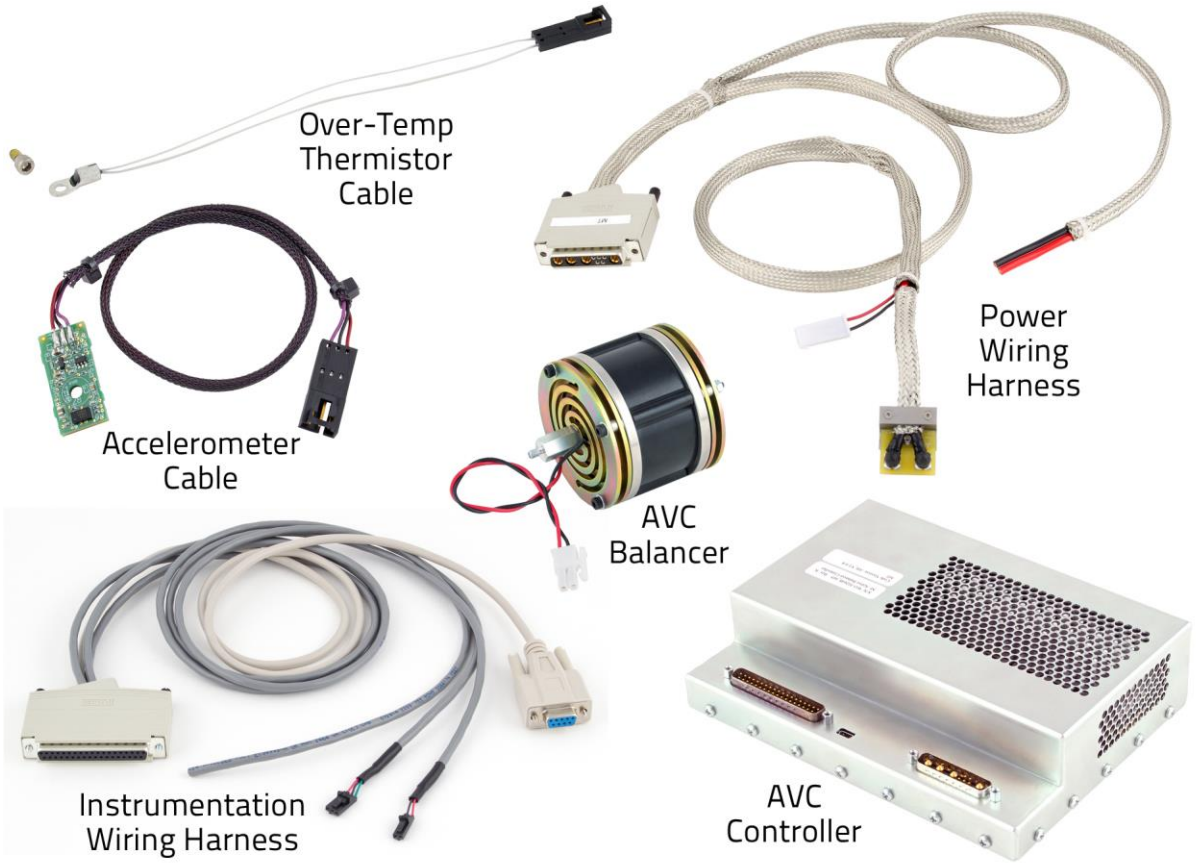

Figure 1. Active Vibration Cancellation (AVC) System Components

Specifications

Mass *(cryocooler with AVC balancer attached)*

MT: 2.6 kg
CT: 3.5 kg
GT: 3.5 kg

Length *(cryocooler with AVC balancer attached)*

MT: 275 mm
CT: 305 mm
GT: 325 mm

Section 2
Installation

Remove the Passive Balancer

If a passive balancer is attached to the cryocooler, remove the bolt from the middle of the passive balancer and remove the passive balancer from the cryocooler.

Install the Accelerometer

Attach the AVC accelerometer (figure 2) to the end plate of the CryoTel cryocooler with the provided #5-40 bolt into the end plate of the cryocooler (figure 3) and torque it to 12 in-lb. If the cryocooler is an older model not equipped with a #5-40 threaded hole, then use a small amount of super glue to attach the accelerometer onto the end plate in the location shown in figure 3.

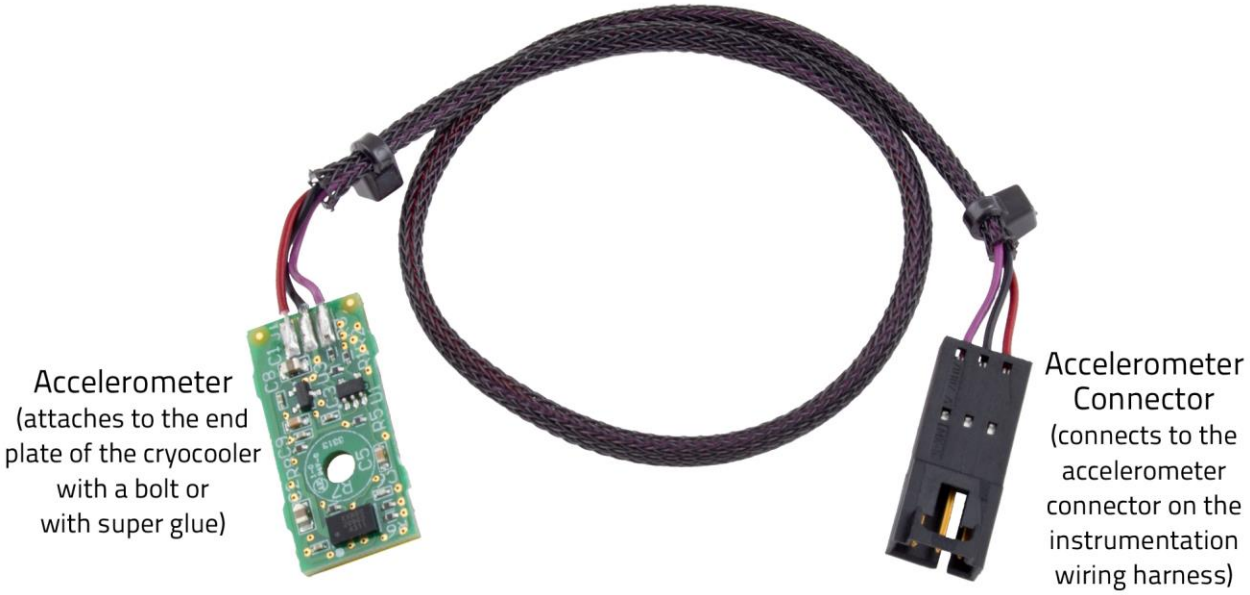

Figure 2. AVC Accelerometer Cable

Install the Cryocooler Power Connector

Install the cryocooler power connector (part of the power wiring harness, figure 6) onto the power feedthrough pins on the end plate of the cryocooler as shown in figure 3.

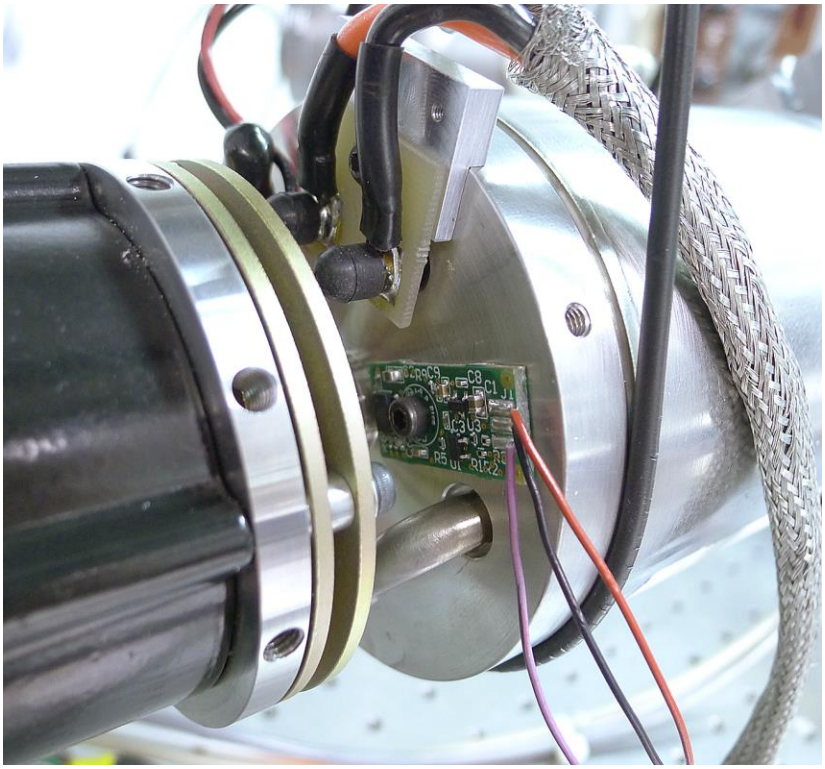

Figure 3. AVC Accelerometer & Cryocooler Power Connector Installed onto a Cryocooler

Install the AVC Balancer

1. Unscrew and remove the hex standoff from the balancer (figure 4).
2. Screw the hex standoff onto the cryocooler end plate and torque it to 50 in-lb.
3. Place the balancer onto the hex standoff, insert the long bolt through the middle of the balancer and into the hex standoff, and torque it to 50 in-lb. (Figure 5 shows the AVC balancer attached to a cryocooler.)

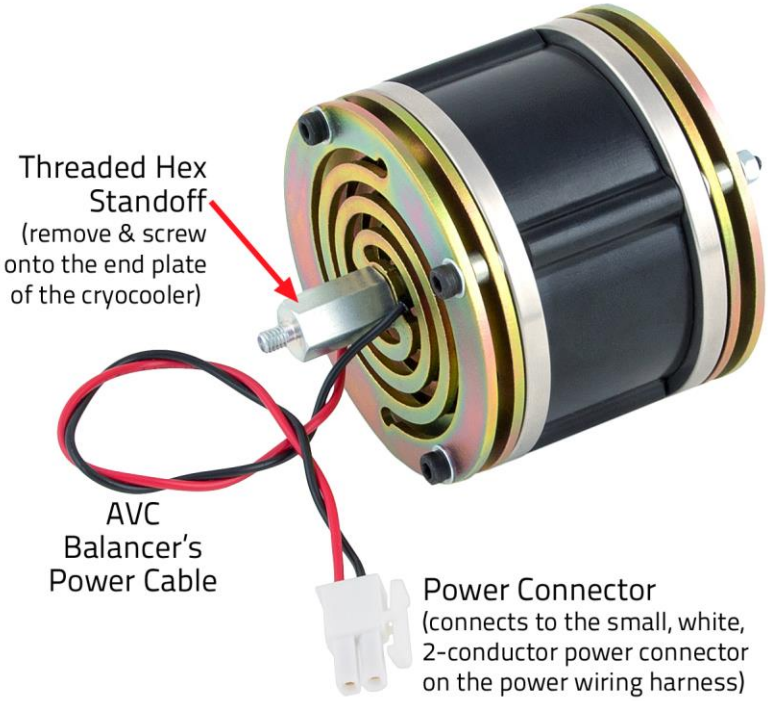

Figure 4. AVC Balancer

Figure 5. AVC Balancer Installed on a CryoTel CT Cryocooler

Attach the Wiring Harnesses

The components of the AVC system are interconnected with the cryocooler and with other interfacing equipment using the two supplied wiring harnesses: the power wiring harness, and the instrumentation wiring harness.

Power Wiring Harness

The power wiring harness (figure 6) has four connections:

- **DC Power Supply Leads** – A black lead and a red lead that connect to the DC power supply [not included] for the cooler.
- **AVC Controller Power Wiring Harness Connector** – A D-sub connector with various pin sizes that connects to the power wiring harness connector on the AVC controller.
- **Cryocooler Power Connector** – A two-pin connector that mounts to the end plate of the cryocooler and connects to the two feedthrough pins used to power the cryocooler.
- **AVC Balancer Power Connector** – A small, two-conductor white plastic connector that connects to the power connector on the AVC balancer's power cable (figure 4).

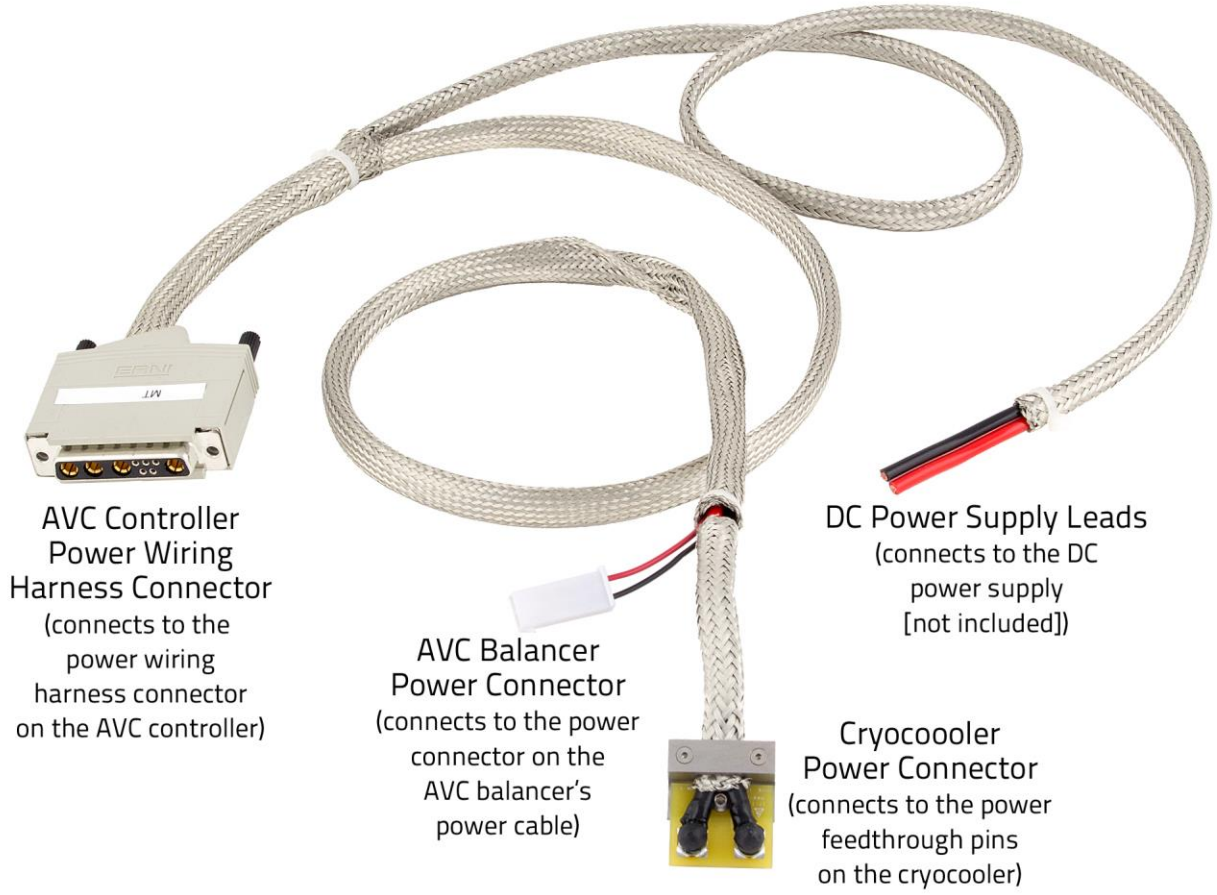

Figure 6. Power Wiring Harness

Instrumentation Wiring Harness

The instrumentation wiring harness (figure 7) has five connections:

- **Computer Connector** – A molded plastic, 9-pin, female RS-232 serial communications connector that connects to an RS-232 serial port on a computer for relaying control commands and replies.
- **AVC Controller Instrumentation Wiring Harness Connector** – A molded plastic 37-pin D-sub connector that connects to the instrumentation wiring harness connector on the AVC controller.
- **Over-Temp Thermistor Connector** – A small, black, two-pin plastic connector that connects to the plastic connector on the over-temp thermistor cable.
- **Accelerometer Connector** – A small, black, three-pin plastic connector that connects to the plastic connector on the accelerometer cable.
- **RTD Leads** – Four leads that connect to the Resistance Temperature Detector (RTD) wire supplied with the cryocooler. The RTD wire is attached to an RTD which is attached to the thermal load or to the cryocooler's cold tip as described in the cryocooler installation and operation manual.

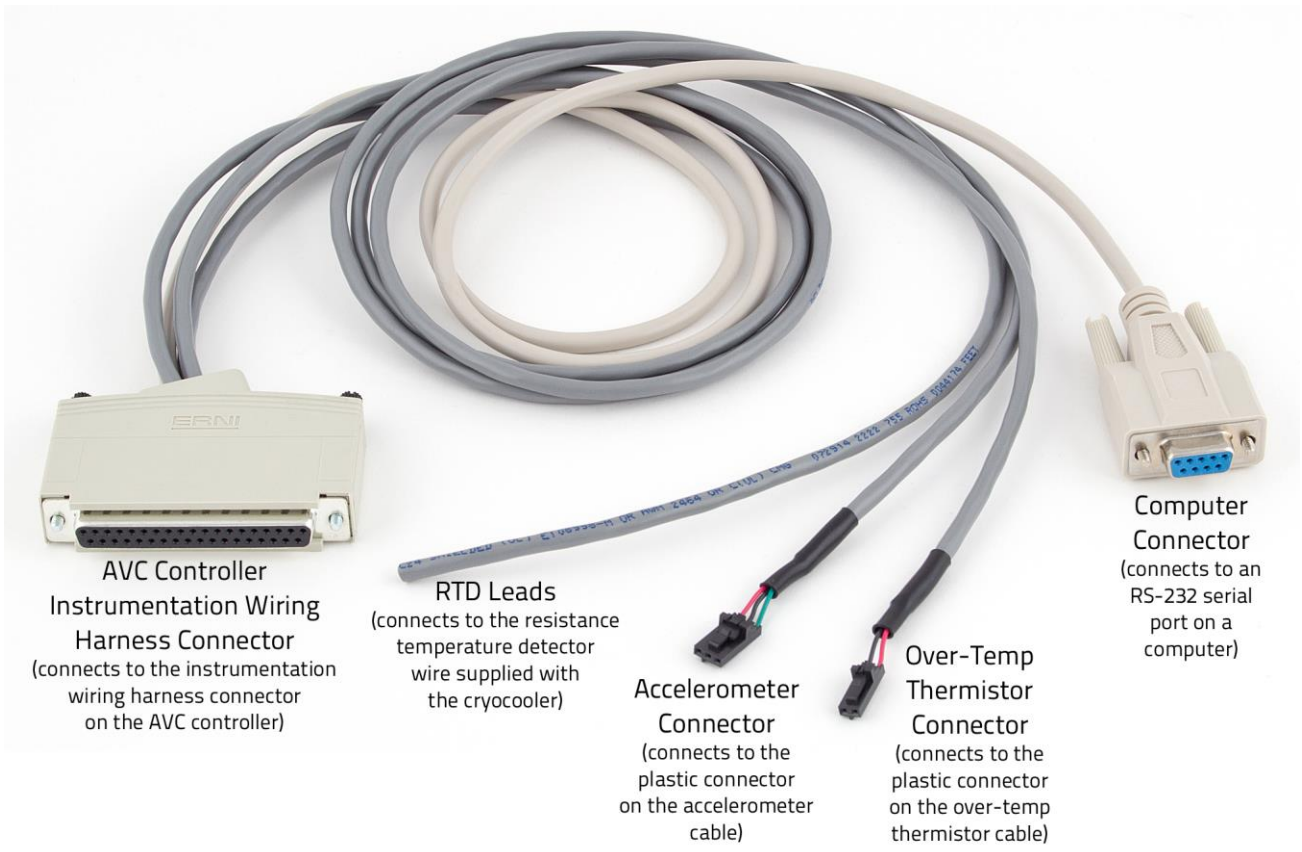

Figure 7. Instrumentation Wiring Harness

AVC Controller & Over-Temp Thermistor

The AVC controller (figure 8) drives the AVC balancer as well as the cryocooler. A feature of the AVC controller that is not among the features of the standard CryoTel controllers is the reject over-temperature alarm. A provided thermistor (figure 9) is attached to the cooling fins via the available threaded hole (or near the water jacket via thermal epoxy in the case of water cooled systems [figure 10]). If the thermistor reaches 70 °C during operation, the controller will cut off power to the cryocooler until the temperature drops below 70 °C.

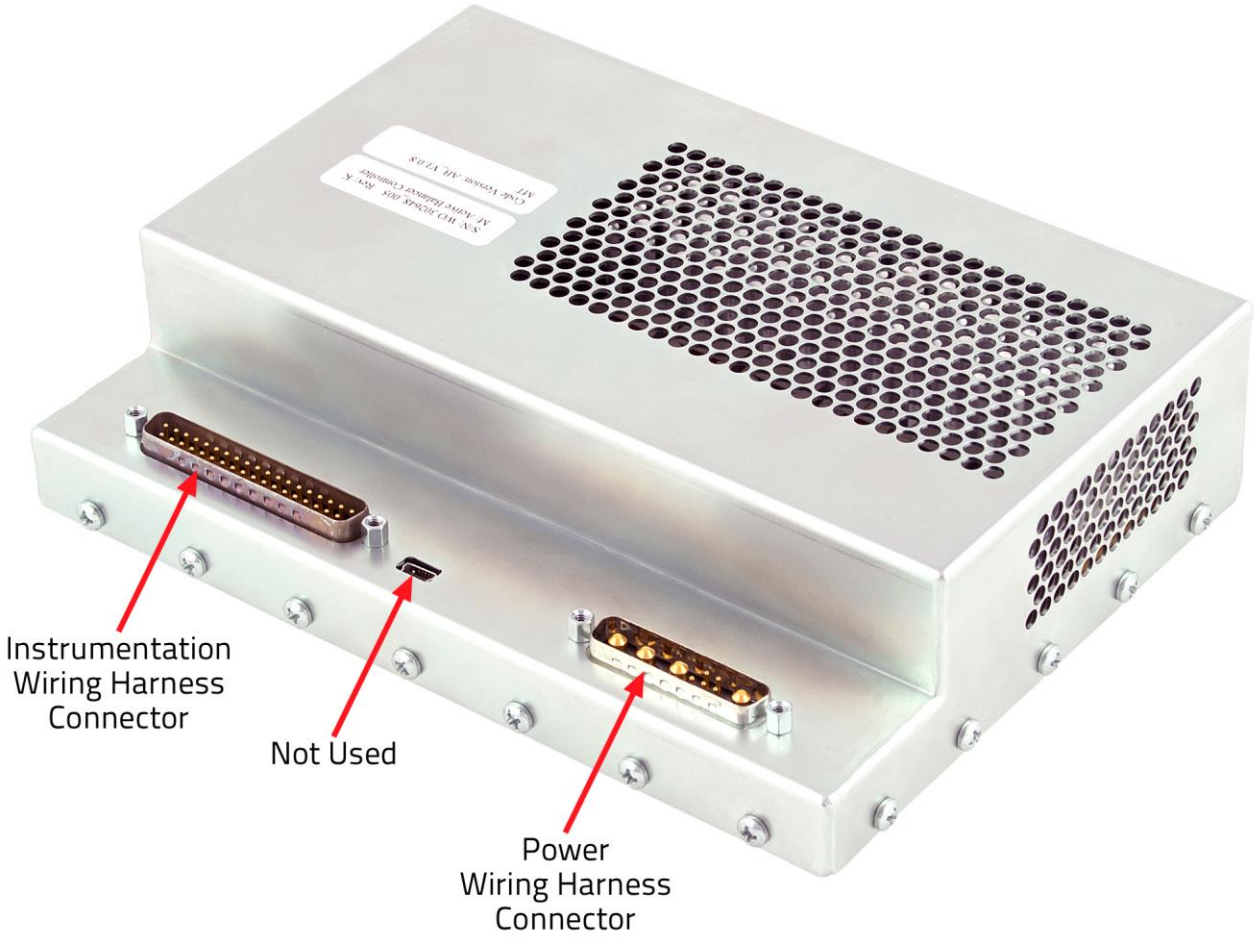

Figure 8. AVC Controller

Figure 9. Over-Temp Thermistor Cable

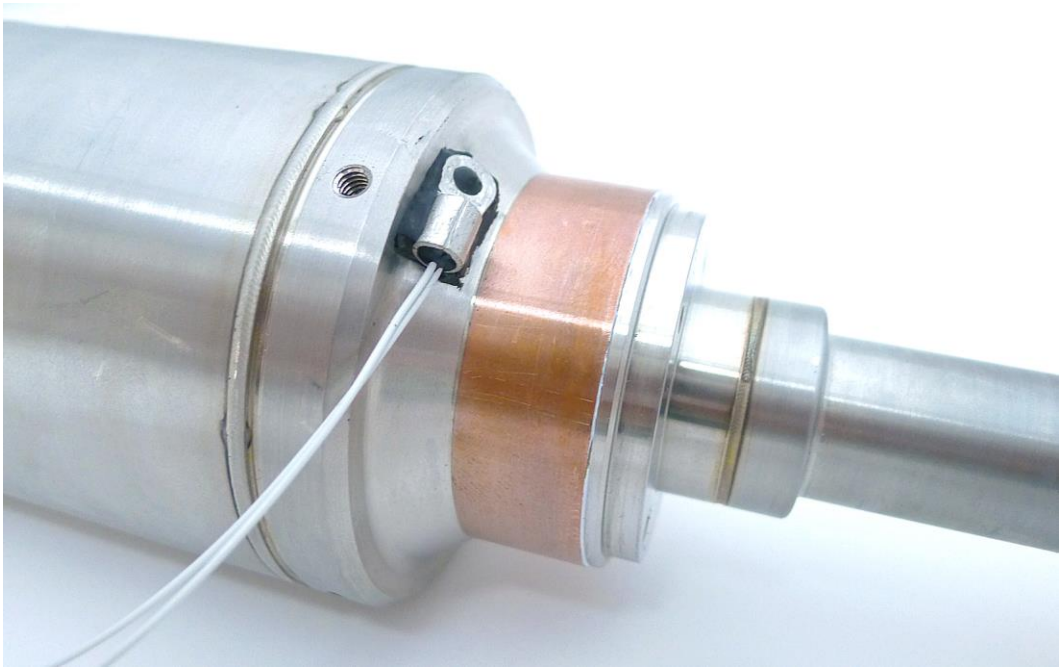

Figure 10. Thermistor Attached to the Cryocooler with Epoxy

Section 3
Operation

Introduction

This section lists all the commands available for use with an AVC controller over the RS-232 interface and replaces the command reference section of the cryocooler user manual.

Serial Port Configuration

Baud Rate 9600
Data Bit..... 8
Parity ..... none
Stop Bits 1
Flow Control..... none

Commands

The following subsections describe the terminal emulator commands and provide examples of what is displayed on the computer screen as you enter the command and receive a reply. All of the parameters set using these commands will be retained in memory when the controller is power cycled unless otherwise noted.

1) Display the current control status of the controller
   a) Command: **COOLER<CR>**
   b) This command displays the current control status of the controller.

   Control Modes:
   OFF – The cryocooler is OFF or being powered down and turned OFF.
   ON – The cryocooler is running in temperature control mode and will attempt to maintain the temperature set using the TTARGET command.
   POWER – The cryocooler is running in power control mode and will maintain the commanded power set using the PWOUT command.

```
COOLER
ON
```

2) Set the control mode of the controller
   a) Command: **COOLER=<VAL><CR>**
   b) This command is User locked.
   c) This command sets the control mode of the controller.
   d) The value set by this command is stored in non-volatile memory.

   Control Modes:
   OFF – The cryocooler ramp down and powered OFF.
   ON – The cryocooler is running in temperature control mode and will attempt to maintain the temperature set using the TTARGET command.
   POWER – The cryocooler is running in power control mode and will maintain the commanded power set using the PWOUT command.

```
COOLER=OFF
OFF
```

3) Display the current commanded power and power limits
   a) Command: **E<CR>**
   b) The top value is the maximum allowable power for the current temperature. The middle value is the minimum allowable power. The bottom value is the current commanded power. All values displayed with this command are in watts.

```
E
085.00
060.00
075.00
```

4) Display the current controller error flags
   a) Command: **ERROR<CR>**
   b) All active errors are displayed simultaneously. Each error flag will cause the cooler to stop running or keep it from running.

Visual indication (when LCD is ON) - when any error flag is active:
The LCD will flicker ON and OFF at approximately 0.4s interval.
The LCD's content will toggle between the regular data and an error screen.
The error screen will have the ERROR command's output.
The regular screen will have an ERROR flag on the upper right corner.

Error codes:
00000001 - High Reject Temperature
00000010 - Low Reject Temperature
10000000 - Over Current Error
11111111 - Invalid Configuration

```
ERROR
00001010
```

5) Display the derivative constant of the temperature control loop
   a) Command: **KD<CR>**
   b) Returns the proportional constant of the temperature control loop.

```
KD
001.00000
```

6) Set the derivative constant of the temperature control loop
   a) Command: **KD=<VAL><CR>**
   b) This command is User locked.
   c) <VAL> is the user defined derivative constant of the temperature control loop.
   d) The value set by this command is stored in non-volatile memory.

```
KD=0.2
000.20000
```

7) Display the integral constant of the temperature control loop
   a) Command: **KI<CR>**
   b) Returns the integral constant of the temperature control loop.

```
KI
001.00000
```

8) Set the integral constant of the temperature control loop
   a) Command: **KI=<VAL><CR>**
   b) This command is User locked.
   c) <VAL> is the user defined integral constant of the temperature control loop.
   d) The value set by this command is stored in non-volatile memory.

```
KI=0.5
000.50000
```

9) Display the proportional constant of the temperature control loop
   a) Command: **KP<CR>**
   b) Returns the proportional constant of the temperature control loop.

```
KP
001.00000
```

10) Set the proportional constant of the temperature control loop
   a) Command: **KP=<VAL><CR>**
   b) This command is User locked.
   c) <VAL> is the user defined proportional constant of the temperature control loop.
   d) The value set by this command is stored in non-volatile memory.

```
KP=5
005.00000
```

11) Display the current status of the LCD
   a) Command: **LCD<CR>**
   b) Returns the current status of the LCD.

```
LCD
OFF
```

12) Set the state of the LCD
   a) Command: **LCD=<VAL><CR>**
   b) This command is User locked.
   c) The value set by this command is stored in non-volatile memory.

   LCD states:
   ON – LCD is regularly updated.
   OFF – LCD is not updated.

```
LCD=ON
ON
```

13) Display User lock state
    a) Command: **LOGIN<CR>**
    b) Returns the User lock state.

    User lock states:
    0 – Controller parameters and features mark "User locked" are fully accessible.
    1 – Controller parameters and features mark "User locked" are restricted and write protected.

```
LOGIN
001.00
```

Important Note – Known Issue

This issue effects code versions AB_V1.0.5a through AB_V1.1.1a.

The **LOGIN=<PASSWORD>** command in item 14) below does not unlock the **COOLER=<VAL>** command as it should (but it still unlocks all the other "User locked" commands as it should). To work around this known issue, the user may use the SU=FRIO command to unlock the **COOLER=<VAL>** command. The result of this unlocking is not stored in non-volatile memory as the **LOGIN=<PASSWORD>** command is, so if power is cycled, the SU=FRIO command must be issued again to access the **COOLER=<VAL>** command.

```
SU=FRIO
000.00
```

The SU=FRIO command will not work in version 1.1.2 and above, but in those versions this known issue has been fixed and the **LOGIN=<PASSWORD>** command *will* work normally (enable access) for *all* the commands designated as "User locked."

14) Clear User lock state
    a) Command: **LOGIN=<PASSWORD><CR>**
    b) Enable access to the commands designated as "User locked."
    c) A return of 0 confirms that controller parameters are unlocked.
    d) <PASSWORD> is the current user defined password. The default password is STIRLING.

```
LOGIN=STIRLING
000.00
```

15) Set User lock state
    a) Command: **LOGOUT=<PASSWORD><CR>**
    b) Disable access to the commands designated as "User locked."
    c) A return of 1 confirms that controller parameters are locked.
    d) <PASSWORD> is the current user defined password. The default password is STIRLING.
    e) The lock state is stored in non-volatile memory.

```
LOGOUT=STIRLING
001.00
```

16) Display the current operating cryocooler type
    a) Command: **MODE<CR>**
    b) Returns the current operating cryocooler type.

    Cryocooler Types:
    CT – The controller is configured to control CryoTel CT cryocoolers.
    GT – The controller is configured to control CryoTel GT cryocoolers.
    MT – The controller is configured to control CryoTel MT cryocoolers.

```
MODE
GT
```

17) Display the cryocooler power as measured by the controller
    a) Command: **P<CR>**
    b) Returns the cooler power in watts as measured by the controller.

```
P
070.00
```

18) Set user password
    a) Command: **PASSWD=<VAL><CR>**
    b) This command is User locked.
    c) A return of 1 confirms the password has been changed.
    d) <VAL> is the user defined password. The default password is STIRLING.
    e) The password must be between 1 and 10 characters in length.
    f) The value set by this command is stored in non-volatile memory.

```
PASSWD=ABC123
001.00
```

19) Display the user commanded power
    a) Command: **PWOUT<CR>**
    b) Returns the commanded power when in power control mode as set by the COOLER=POWER command.

```
PWOUT
070.00
```

20) Set the user commanded power
    a) Command: **PWOUT=<VAL><CR>**
    b) This command is User locked.
    c) Set commanded power when in power control mode as set by the COOLER=POWER command.
    d) <VAL> is the target power in watts. While any number from 0.0 to 999.99 can be input, the controller will only command a power that will not damage the cryocooler.
    e) The value set by this command is stored in non-volatile memory.

```
PWOUT=77
077.00
```

21) Display the configured temperature sensor type
   a) Command: **SENSOR<CR>**
   b) Returns the currently configured temperature sensor.

   Supported temperature sensors:
   DT-670 – Lake Shore Silicon Diode DT-670
   PT-100 – Lake Shore Platinum RTD PT-100

```
SENSOR
PT-100
```

22) Display relevant system information
   a) Command: **STATUS<CR>**
   b) Returns relevant system information.

```
STATUS
Stopped.
Mode              = MT
Power Measured    = 000.00
Power Commanded   = 000.00
Target Temp       = 077.00
Reject Temp       = 025.30
Coldhead Temp     = 115.23
```

23) Display the temperature sensor reading in kelvin
   a) Command: **TC<CR>**
   b) Returns the cold head temperature in kelvin.

```
TC
295.21
```

24) Display the reject temperature in Celsius
   a) Command: **TEMP<SP>RJ<CR>**
   b) Returns the current reject temperature measured at the base of the fins on the cooler. Reject temperature is displayed in Celsius.

```
TEMP RJ
025.30
```

25) Display target temperature in kelvin
   a) Command: **TTARGET<CR>**
   b) Returns the target temperature of the controller in kelvin when in temperature control mode (default mode).

```
TTARGET
077.00
```

26) Set target temperature
   a) Command: **TTARGET=<VAL><CR>**
   b) This command is User locked.
   c) Set the temperature the cryocooler will try to attain (to ±0.1 K) when in temperature control mode.
   d) <VAL> is the value of the desired target temperature in kelvin.
   e) The value set by this command is stored in non-volatile memory.

```
TTARGET=77
077.00
```

27) Display current controller code version
   a) Command: **VERSION<CR>**
   b) Returns the current controller coder version.

```
VERSION
1.0.4
```

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