American Magnetics Inc.
P.O. Box 2509, 112 Flint Road, Oak Ridge, TN 37831-2509
Tel: (865) 482-1056, Fax: (865) 482-5472
Internet: http://www.americanmagnetics.com
E-mail: sales@americanmagnetics.com

Conductively Cooled Magnet Manual

Contents

Introduction

This is not a standalone instructional document. The following are generic instructions, procedures or general practices that should apply to most of the commonly available *conduction cooled (CC) / dry / cryogen free* magnets manufactured by American magnetics (AMI). When applicable, AMI will provide additional information based on specific operational procedures for a given magnet system. Supplemental instructions from other relevant third-party manufacturers are also provided.

Identification

An AMI magnet can be identified by its five-digit serial number (example 12345, 15913) that is either stamped or engraved on the assembly.

Specifications

A *Magnet Specification Sheet* is provided with each magnet. Exceeding magnet specifications will void the warranty and may compromise safety. A rotating vector magnet (Maxis™ / Optimaxes™) will have a ramp rate specified for each axis. See Specifications section on page 5 for detailed information.

Magnet Protection

All AMI magnets are designed and constructed such that in the unlikely event of a quench at fields up to and including the rated field, the quench will not damage the magnet. This is accomplished by the installation of protection diodes that absorb the energy stored in the magnetic field. Protection diodes are installed in parallel to the magnet coils. During a quench, the voltage across the coils will dissipate as current through the diodes instead of arcing, shorting, or degrading the superconductor. Each magnet is warranted against such damage by the standard AMI warranty on page 33. AMI magnets are not warranted if operated above the rated fields or above rated ramp rates.

Maintenance

AMI magnets are designed and constructed so as to provide years of service and require no maintenance if installed and operated in accordance with these instructions.

Specifications

Below is an example of a typical AMI Magnet Specification Sheet which is included in the magnet shipment. The following is an explanation of typical magnet specification parameters as they appear on the Magnet Specification Sheet. Some specifications are unique to particular magnet types, and will only appear on the data sheet when appropriate.

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MAGNET SPECIFICATIONS

AMI Magnet Number: 15xxx
Type: CC-MX-911-096-111-LD
For: xxxxx
Test Date: 13 August 2020

Simultaneous Magnet Operation

Rated Rotatable Vector[1] .... **10 kG**

Note

This magnet system produces a rotatable field vector of 10 KG by appropriate combinations of fields from the 3-axis system.

Independent Solenoid (Z-Axis)

Rated Central Field @ 4.2K	**90.0 kG**
Maximum Test Field @ 4.2K[2]	**90.5 kG**
Rated Operating Current	**86.21 Amperes**
Rated Ramp Rate	**0.0382 Amps/Second**
Field to Current Ratio	**1.044 kG/Amp**
Homogeneity over 1 cm DSV	**+/-0.1%**
Inductance	**26.2 Henry**
Clear Bore	**96 mm [3.78"]**
Recommended Persistent Switch Heater Current	**18**
Persistent Switch Heater Nominal Resistance[3]	**78**
Magnet w/ Switch Resistance[3]	**37 Ohms**

1. Magnets not warranted for simultaneous operation of resultant field magnitudes above 10 kG.
2. Magnet not warranted for independent operation of Z-Axis magnet above 90.0 kG., Y-Axis magnet above 10.0 kG, and X-Axis magnet above 10.0 kG.
3. All resistance measurements made at room temperature

EXCELLENCE IN MAGNETICS AND CRYOGENICS

Independent Split Coil (Y-Axis)

Rated Central Field @ 4.2K ....**10.0 kG**
Maximum Test Field @ 4.2K[2]..............................**10.5 KG**
Rated Operating Current ....**65.10 Amps**
Rated Ramp Rate ....**0.0964 Amps/Second**
Field to Current Ratio ....**0.1536 kG/Amp**
Homogeneity over 1 cm DSV ....**+/-1.0%**
Inductance ....**10.4 Henry**
Recommended Persistent Switch Heater Current **19**
Persistent Switch Heater Nominal Resistance[1]..................**78**
Magnet w/ Switch Resistance[3]............................**36 Ohms**

Independent Split Coil (X-Axis)

Rated Central Field @ 4.2K ....**10.0 KG**
Maximum Test Field @ 4.2K[2]..............................**10.5 KG**
Rated Operating Current ....**62.38 Amps**
Rated Ramp Rate ....**0.0892 Amps/Second**
Field to Current Ratio ....**0.1603 kG/Amp**
Homogeneity over 1 cm DSV ....**+/-1.0%**
Inductance ....**11.2 Henry**
Recommended Persistent Switch Heater Current **20**
Persistent Switch Heater Nominal Resistance[1]..................**78**
Magnet w/ Switch Resistance[3]............................**36 Ohms**

Overall Magnet Dimensions

Mounting Flange Outer Diameter ....**352 mm [13.86"]**
Magnet Height (flange to flange) ....**325 mm [12.8"]**
Weight ....**58.5 kg [129 lbs]**

EXCELLENCE IN MAGNETICS AND CRYOGENICS

Rated Central Field @4.2 K - The maximum field the magnet is guaranteed to achieve without quenching.

⚠ CAUTION: AMI magnets are **not** warranted for operation above rated field.

Rated Current - The magnet current required to achieve the rated field.

Maximum Test Field @4.2 K - The maximum field achieved during AMI testing. Please note that the magnet is not warranted for operation at this field. AMI tests the magnet at this field only briefly, to ensure a safety factor for the rated field.

Field-to-Current Ratio – The magnitude of magnetic field produced per amp of magnet current. This ratio is verified by nuclear magnetic resonance (NMR) tests at 4.2 K or by computer calculation if NMR measurement is not possible.

Homogeneity – The maximum field deviation from the rated central field specified over a specific length or volume.

Calculated Inductance - The inductance of the magnet is determined during magnet testing using the relationship $L = E(\delta t/\delta I)$. Where E = Magnet charging voltage, δt = elapsed time, and δI = change in current.

Charging Voltage (used in test) - The maximum voltage developed across the magnet during testing at AMI. A magnet with multiple voltages shows a segmented ramp rate. Do not exceed this value when charging the magnet.

Ramp Rate- The rate at which the magnet was charged, expressed in amperes per second. Do not exceed this value when charging the magnet. A magnet may have a segmented ramp rate where it charges slower at higher fields.

Clear Bore - The minimum magnet bore diameter at operating temperature.

Radial Access - The minimum magnet radial access bore diameter at operating temperature. (Split coil systems only)

Overall Length (flange to flange) - The measured overall length of the coil including the end flanges. This dimension excludes the persistent switch and current lugs if applicable.

Maximum Outside Diameter - Maximum outside diameter of the magnet.

Magnet Weight - Magnet weight in pounds.

Recommended Persistent Switch Heater Current - The amount of current used to drive persistent switch normal during the magnet's factory test.

Persistent Switch Heater Nominal Resistance - The room temperature resistance of the switch heater.

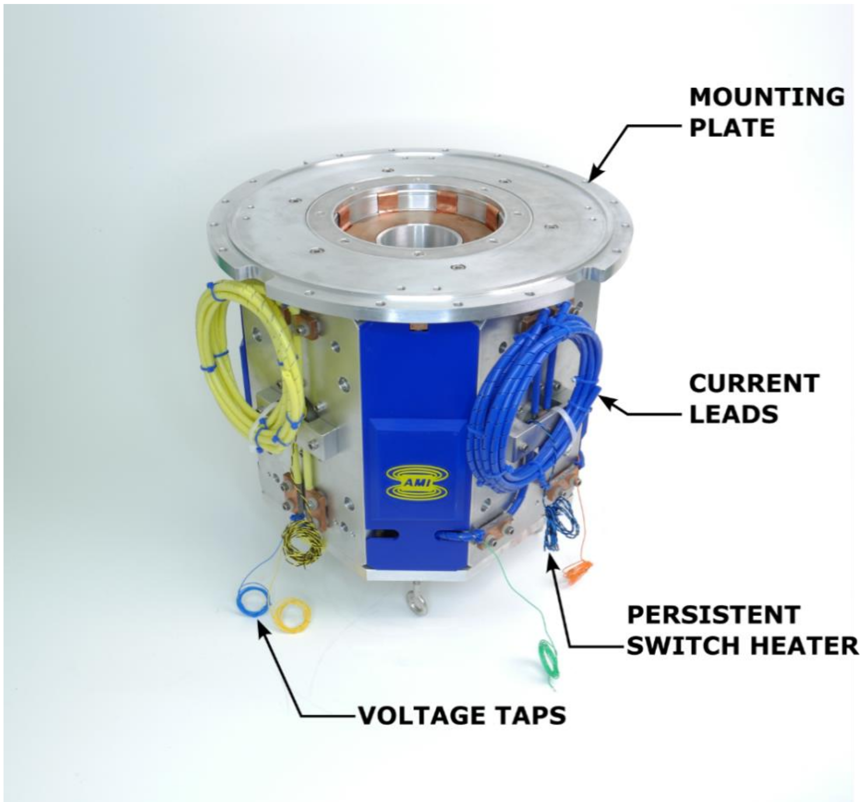
Magnet Resistance in Parallel with Switch - The room temperature resistance of the magnet windings and the switch superconducting wire in parallel.

Mounting Holes - The magnet mounting method and geometry.

Installation

Unpack the magnet

If your crate came equipped with tip and shock indicators, inspect these first. Carefully remove the magnet from the shipping carton and remove all packaging material. Inspect all contents for any damage that may have occurred during shipment.



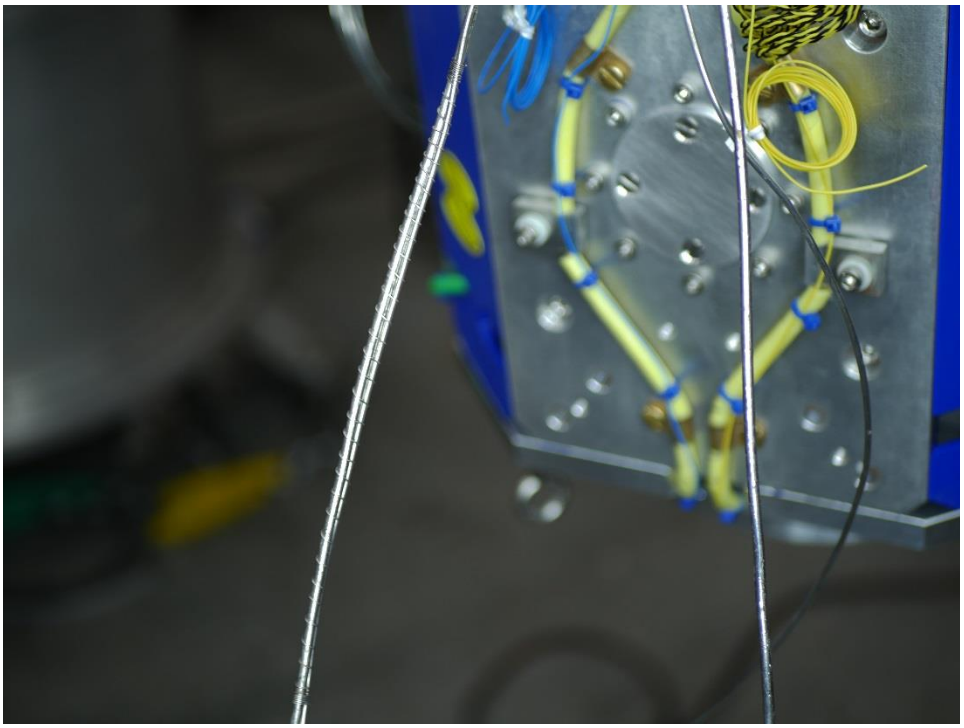
NOTE: *If there is any shipping damage, save all packing material and contact the shipping representative to file a damage claim. Do not return the magnet to AMI unless prior authorization has been received and an RMA issued.*

Mounting

Align the magnet so that current leads may be routed to cryostat leads without sharp bending. (see Current Leads section below) Mount the magnet on the conduction plate, ensuring an even and appropriate torque across all bolts. You may optionally use cryogenic vacuum grease, such as Apiezon N grease, to aid in heat transfer between the magnet and cryostat. If you are not confident that metal surfaces are mating flush, you may install an indium wire between the magnet and mounting plate. The indium will relax after installation, causing the bolts to loosen. Tighten the bolts every hour until the torque values remain consistent between tightening procedures.

Current Leads

Current leads should be anchored both physically and thermally to the cryostat. Eliminate long unsecured lengths that will flex in the presence of a magnetic field. Leads should have gentle bends and allow for thermal contraction. Avoid sharp bends and limit to one half inch minimum bending radius. Thermally anchor the magnet current lead to a 4 K surface to prevent heat from reaching the coil structure. Current leads may be secured with nylon zip ties. Do not make the ties too tight, as they will thermally contract once cooled, and may break.



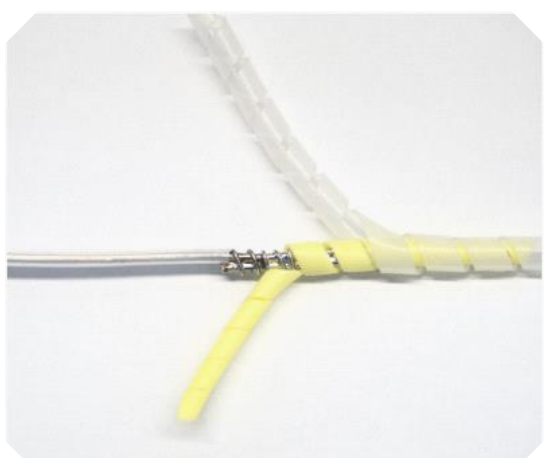
Soldering of current leads:

1. After routing magnet current leads to the appropriate cryostat current leads or bus bars, overlap them approximately 4 to 6 inches and remove any insulation from the area to be soldered.
2. If a remote diode was provided, mount the diode according to remote diode section of this manual then overlap the diode leads with the current leads.
3. Clamp the overlapped leads together with hemostats.
4. Wrap all leads tightly with a tinned copper wire (~22-AWG).

5. Trim excess lead material.
6. Once the joint is tightly wrapped, heat sink the leads during the soldering process. This can be done by placing a wet sponge on either side of the solder connection to keep the heat from reaching sensitive parts of the magnet and cryostat. Solder the two wires with rosin flux eutectic SnPb (tin-lead) solder.

⚠ **CAUTION:** Overheating of the bus bars or magnet leads can degrade magnet performance. Exercise care during the soldering process and limit the amount of heat applied to the joint.

7. Clean the flux from the soldered connectors with flux remover.
8. Double-insulate the wire connection with fiberglass tubing and nylon spiral wrap, or some other method that provides adequate electrical insulation



Voltage Taps

Nearly all AMI magnets are equipped with voltage monitoring taps, which play an important role in magnet operation and maintenance. These taps facilitate monitoring of the charging voltage and aid in diagnosing issues such as cryostat current lead problems, current control instability, or potential magnet malfunctions. Voltage taps are constructed from copper wire with Teflon insulation. The voltage taps are designed to connect to fine wires, typically around 28AWG, and made of materials with low thermal conductivity, such as phosphor bronze. These wires are then routed to a room-temperature vacuum feedthrough connector. Since voltage taps are solely used for monitoring, they carry only a very small current. The Model 430 power supply programmer is configured to accept voltage taps on pins 11-12.

Magnet Axis	Wire Color (+ / -)
Z Axis	Blue / Yellow
Y Axis	Orange / Blue
X Axis	White / Violet

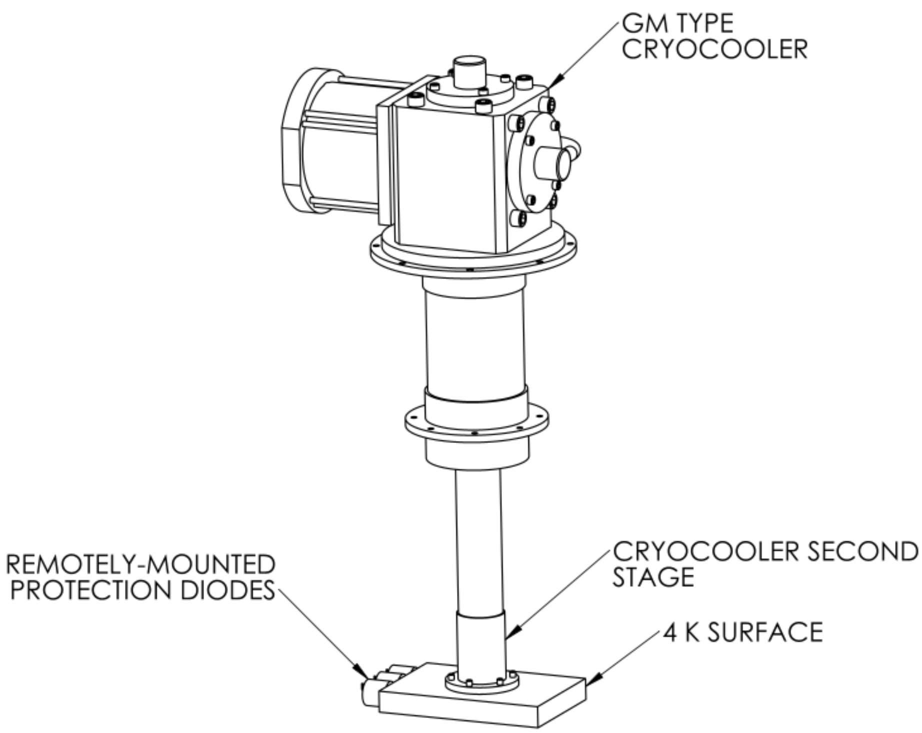
Persistent Switch Heater wires

When you purchase a magnet with a persistent switch (PSw) on one or more axes, two additional leads are required to allow PSw heater current to heat each switch while the magnet is in *driven* mode. (See **Persistent Mode** on page 19) Heater wires are constructed from copper wire with Teflon insulation. The heater wires are designed to connect to fine wires, typically around 28AWG, and made of materials with low thermal conductivity, such as phosphor bronze. These wires are then routed to a room-temperature vacuum feedthrough connector. PSw heater wires are used for driving the PSw resistive and use a small current between 15mA and 40mA. This value is listed on the magnet's specification sheet. The Model 430 power supply programmer is configured to accept PSw heater wires on pins 9-10.

Magnet Axis	Wire Color (+ / -)
Z Axis	Yellow-Black
Y Axis	Blue-Black
X Axis	Green-Black

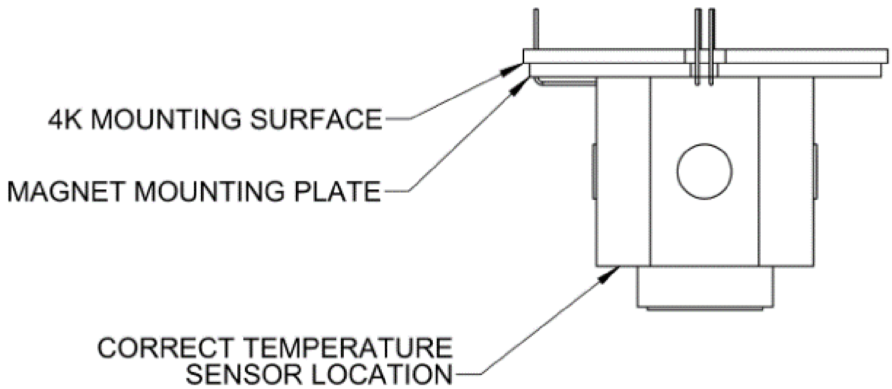
Remote-mounted Protection Diodes

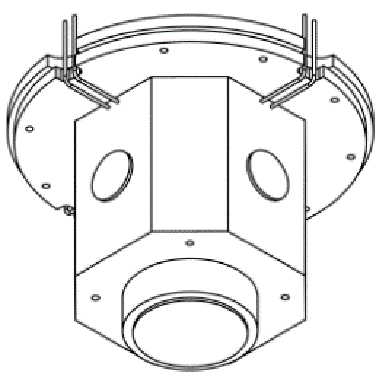
Certain AMI magnets require the use of a remotely mounted quench protection diode. This will be specified on the customer approval drawing. This diode must be thermally anchored to the cryostat's second stage cold head as well as soldered in parallel to the magnet's current leads. Failure to install the protection diode will void the magnet's warranty. The lead wires of the diode should be formed and secured the same as the current leads.



Temperature Sensor

AMI recommends the use of a cryogenic temperature sensor with the magnet. These sensors are valuable for routine magnet operation and also provide important information when troubleshooting the magnet system. Mount the temperature sensor at the farthest possible point from the magnet's mounting flange to ensure it is measuring the warmest part of the magnet structure.





Cryostat Pre-Assembly Checklist

1. Ensure all magnet mounting bolts are properly and evenly torqued.
2. Verify that the current lead routing allows for thermal contraction and does not have long unsupported lengths.
3. Verify that all current leads, voltage taps, remote-mounted protection diodes, switch heater leads, etc. are electrically insulated.
4. Measure magnet resistances at the cryostat's instrumentation connector and compare to the magnet specification sheet to ensure proper connection. Verify the following:
   - -Magnet coil resistances at voltage tap pins match specification sheet (all axes).
   - -No short exists from coil to cryostat (all axes).
   - -Switch heater resistance matches specification sheet (all axes).
   - -No short exists from switch heaters to cryostat (all axes).
5. Verify temperature sensor is reading as expected.

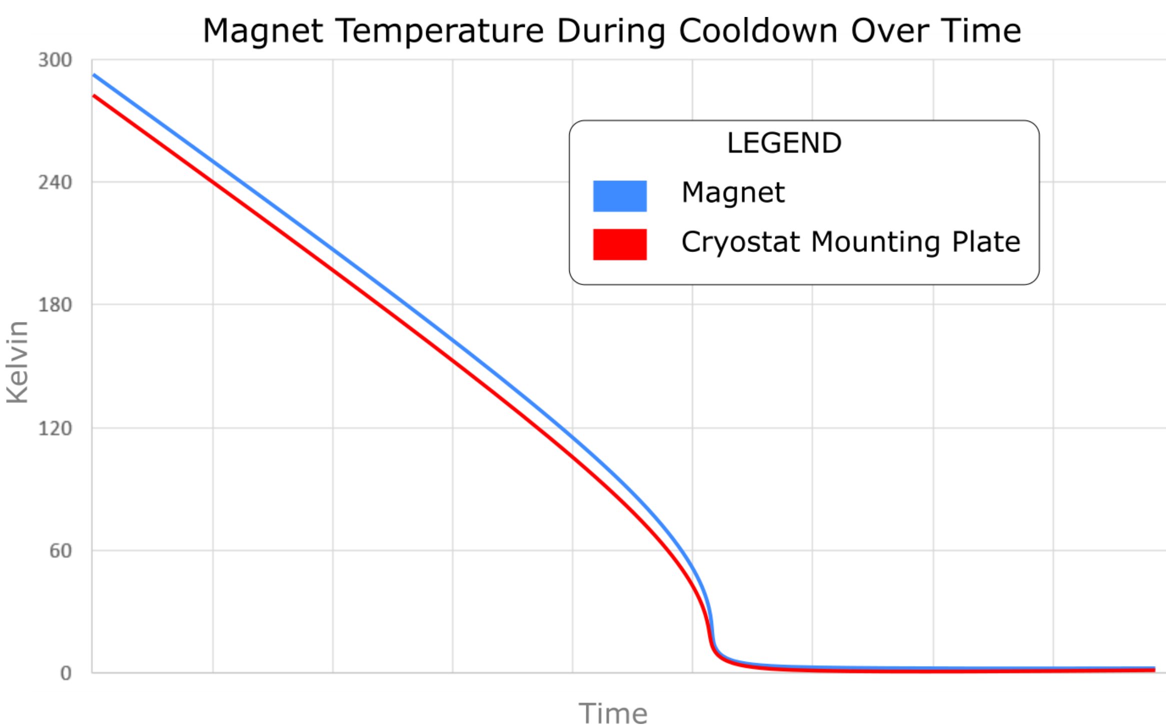
NOTE: *Cryostat wiring such as Phosphor Bronze or Manganin will add a significant resistance (20 Ohms) to all measurements listed on specification sheet.*

Operation

Cooling from higher temperatures

Once the magnet has reached operating temperature (less than 4.2 K) as read on the magnet's temperature sensor, allow the magnet to cool at least another hour. Keep in mind that the temperature sensor is most likely mounted to the thermally conductive aluminum structure of the assembly. Materials in less thermally conductive parts of the magnet may take longer to cool completely.

Note: If an additional temperature sensor is also equipped on the cryostat's mounting plate, a temperature difference of approximately 0.5 K is expected between them.

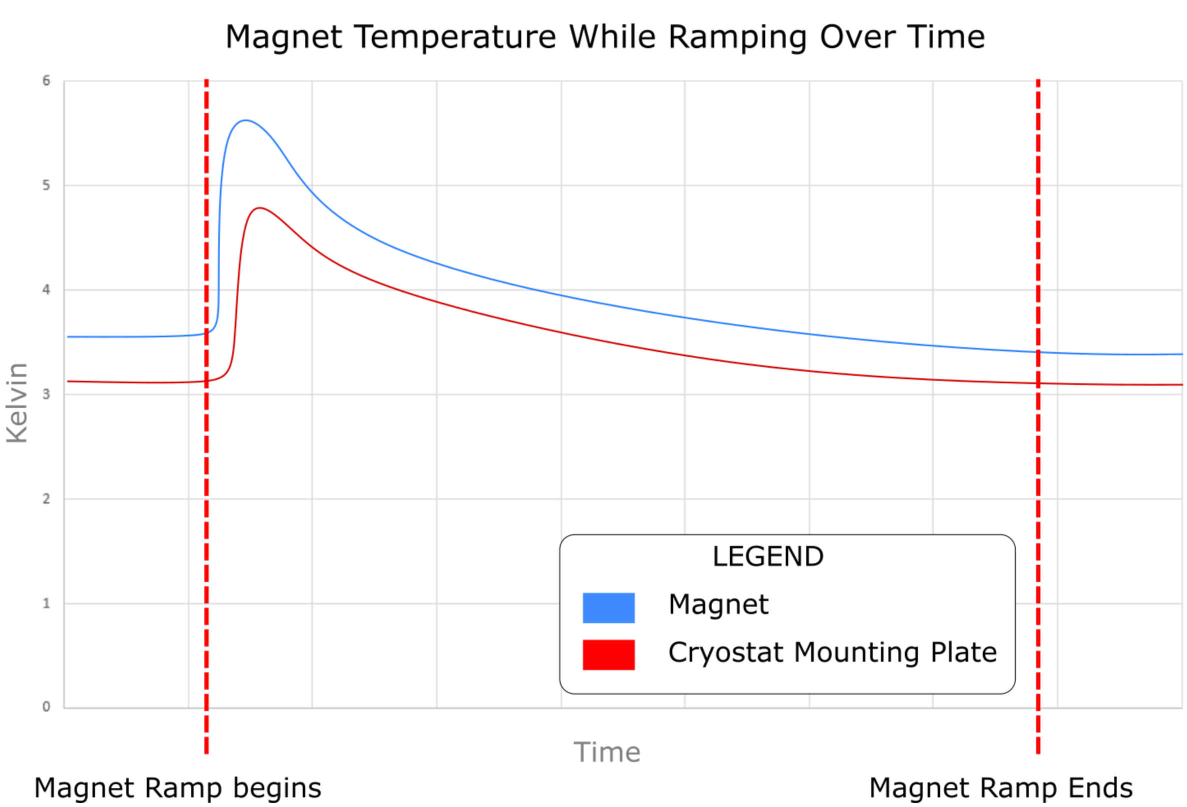


Ramp Rate and Temperature

Your magnet specification sheet lists a magnet ramp rate for each applicable axis. This is the rate AMI uses to maintain safe operating temperatures. The magnet is expected to have a sharp rise in temperature when the magnet is initially charged from zero field, and may briefly exceed 5.0 Kelvin, but the temperature should level off and begin cooling quickly. A superconducting magnet can safely operate at low field while at these temperatures, but the magnet needs to be at or below 4.2 K to reach its rated field. AMI specifies a ramp rate that will keep the magnet below its critical temperature and prevent quenches. If you notice that you cannot maintain safe temperatures, this may be due to several reasons:

- Poor thermal contact between the magnet and cryostat (high temperature differential between magnet and cold head second stage)
- Physical contact between magnet and thermal radiation shield, creating a heat load
- The cryostat's cryocooler may be experiencing a higher heat load than those seen by AMI. This is usually due to cryostat design differences, heat loads from helium condensation systems and magnet inserts, etc.

NOTE: It is possible that the magnet ramp rate (charging voltage) may need to be reduced below specified values if temperatures are too high to reach full field normally.



⚠ CAUTION: Follow ALL safety precautions included with the equipment when operating the superconducting magnet. Be mindful of the dangers from magnetic field forces, cryogenic temperatures, and potentially high voltages. Refer to the AMI model 430 manual's forward section for a list of general precautions.

Initial Operation of magnet

The first time the magnet is operated after system setup and cooldown, charge it to a low field setpoint and verify that the magnet is being properly controlled by the power supply system. Verify proper heating of switch (if applicable), ramp rate, and stability once field is reached. If the magnet does not behave as expected, STOP operation and consult the TROUBLESHOOTING section of this manual and/or the power supply system manual.

AMI Model 430 equipment First Time Startup

1. Verify magnet temperature has been less than 4.2 Kelvin for at least an hour
2. Ensure all load and control cables are connected to the magnet cryostat connections.
3. Turn ON the AMI model 430 power supply programmer. DO NOT TURN ON POWER SUPPLY.
4. Set up the Model 430 by entering magnet specifications from specification sheet. Please refer to the Model 430 manual's "Example Setup" section

NOTE: Please refer to the Model 430 instruction manual for more detailed information on each setting

5. Press [SHIFT] + [RAMP TO ZERO] to return the model 430 to the "Turn on power supply Press [ENTER] to continue" prompt. (On legacy models, recycle 430 power and await the prompt.)
6. Turn on power supply, allow it to self-test and extinguish fault lights.
7. Press [ENTER] if required
8. Begin Switch heating sequence (if applicable) by pressing [PERSISTENT SWITCH CONTROL] then wait for timer to complete.
9. Set Target field to half the specified value or less for initial testing by pressing [TARGET FIELD SETPOINT] and entering value.
10. Enter desired ramp rate to a value equal or less than specified ramp rate by pressing [SHIFT] + [1] then inputting value.

NOTE: [SHIFT] + [5] changes setpoint units between field and current

[SHIFT] + [7] changes field units between kG and Tesla

11. Press [RAMP | PAUSE] button to begin charging magnet. Magnet voltage should slowly rise to expected value based on ramp rate.
    Expected coil voltage can be calculated by V= $L(\delta I/\delta t)$, where *V* = voltage, L = magnet inductance, δI = change in current, and δt = change in time.
    i.e. 15.3 H (0.05 A/sec) = 0.765 V
12. Allow magnet to ramp to set field and monitor magnet temperatures. (see **Ramp Rate and Temperature** on page 17).
13. Verify the following during charging:
    a. The magnet charges at expected ramp rate with expected voltage
    b. Magnet current reaches target and stabilizes without oscillations
    c. Magnet temperature stays within safe limits and falls below 4.2 K before reaching rated field
14. If all above have been verified, the system has been verified to be set up correctly and working properly. You may run the magnet to its rated field.

⚠ **CAUTION:** It is important to ensure the magnet current never exceeds the Rated Operating Current as listed on the Magnet Specification Sheet. Exceeding the rated current specification may void the magnet warranty and may cause damage to the magnet in the event of a magnet quench.

Persistent Mode

Magnets equipped with a Persistent Switch (PSw) have a switch wired in parallel to the magnet current leads. In *driven* mode the PSw heater is energized and the PSw becomes a resistive load in parallel to the magnet. In this mode, the magnet may be charged and discharged as needed.

Once a desired field is reached, the magnet can be "locked" into *persistent* mode by removing PSw heater current and allowing the switch to cool and transition to a superconductive state. The switch then provides a superconducting path in parallel to the magnet current leads. This allows the power supply to be de-energized. The persisting magnetic field is very stable over a long period of time and the magnet may remain in this state for months or indefinitely, provided the magnet stays cold.

To "unlock" a magnet from persistent mode, the current lead cables are energized to match the current the magnet was last at in driven mode. The PSw heater is then heated and the switch transitions to a resistive state. The magnet is once again in driven mode and may be charged and discharged.

Transitioning between driven mode and persistent mode safely and reliably requires a specific sequence of events to occur. The AMI Model 430 Programmer ensures safe, quick and easy transitions between these two operational modes.

De-energizing the magnet

Ramp the magnet current to zero using the power supply/programmer system. The target field setpoint may be set to 0 and then the programmer may be commanded to Ramp. Alternatively, the RAMP TO ZERO command button may be used. This does not change the target field setpoint. When the current in the magnet and the voltage across the magnet both reach zero, the magnet is de-energized.

System shutdown

Once the system is completely de-energized, the power supply may be powered OFF, then the AMI Model 430 must be powered OFF second. This ensures that an incorrect signal is not sent to the supply while the Model 430 is off.

⚠ **CAUTION:** Superconducting magnets can store large amounts of energy, and are dangerous if mishandled. Make sure the magnet is completely discharged and all electronics are de-energized before performing any disassembly.

Exercise caution when handling materials at cryogenic temperatures. Contact with unprotected skin can cause severe burns.

Multi-Axes (Maxes) Magnets and Vector Fields

Use and Ratings

Multi-axis (Maxes) magnets contain two or three orthogonal magnet axes. Each magnet axis is an independent coil with a dedicated power supply system. Powering multiple axes in different combinations allows for precise orientation and magnitude of the magnetic field. The field vectors allow the sample to remain stationary during experiments. While each coil may be independently charged to its Rated Central Field specification, simultaneous operation of the magnet is limited by a “Maximum Rotatable Field” specification. This specification limits the allowable field whenever powering multiple axes.

When calculating field vectors, the Ramp Rate of each axis must also be considered. When matching the ramp rate of axes, always slow the faster axis or axes to match the speed of the slowest axis. The AMI Model 430 can be set to display Ramp Rate by pressing [SHIFT] + [1]. If the default display is in amperes per second, the ramp rate units may be changed to field per second using with the [SHIFT] + [5] command. If any of the magnet axes have multiple ramp rates, ramping more slowly at higher field values, this too must be accounted for. Ramping a magnet more slowly is always safer for temperature and avoiding magnet quenches.

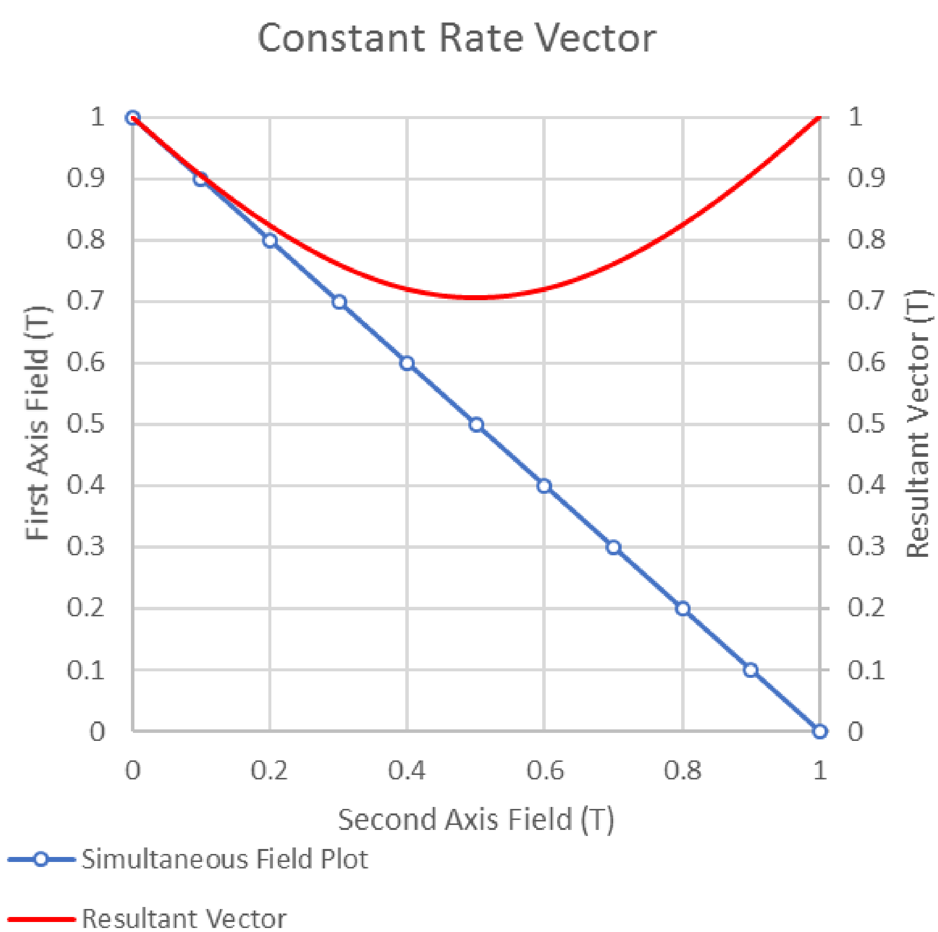
Magnet temperature should be carefully observed with magnet operation. The magnet will generate more heat while running multiple axes, and ramp rates may need to be slower than if charging just one axis. Refer to the Ramp Rate and Temperature section on page 17 for more information.

Achieving vectors

During the transition from one field orientation to another, the method of transition determines the intermediate field exposure the sample experiences between the target fields. In some applications, the final target field vector may be the sole factor of interest. In others, it is crucial for the sample to experience a relatively constant field vector as the field rotates. The following examples illustrate a 90-degree transition between two orthogonal magnetic axes.

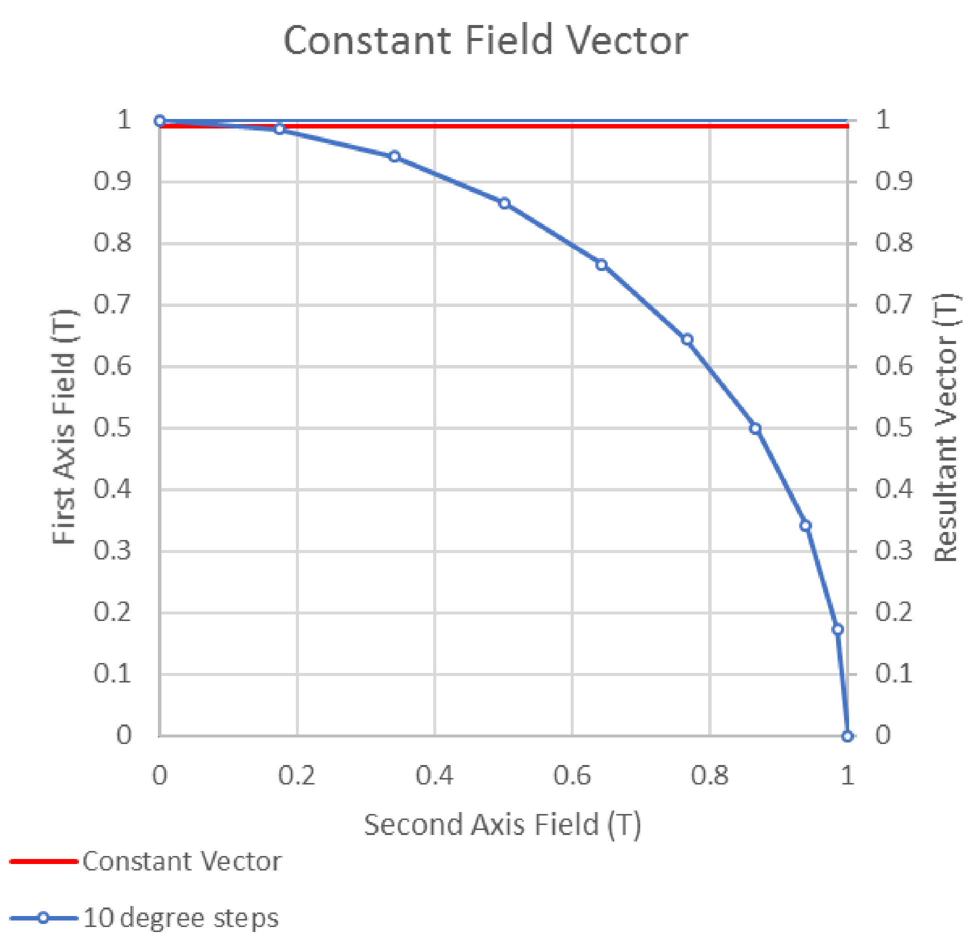
Constant Field Rate on Both Axes

When rotating a field along a flat plane, it is typical to ramp the two axes at a rate (kG/sec) that ensures both axes reach the target vector simultaneously. This approach streamlines automation, dwell time at each vector, and script execution once the target vector is achieved. Ramping in this manner creates a "straight" path for the field as it transitions between target vectors. In the XY plot below, the field rotates 90 degrees between the two axes. The sample is exposed to a 1T vector at both the start and end of the magnet ramp, but the resultant vector is not constant during the transition. In the following XY plot, the first axis is ramped up at the same rate the second axis is ramped down. This creates a straight path, but results in a significant change in the resultant vector, which drops significantly at the midpoint.



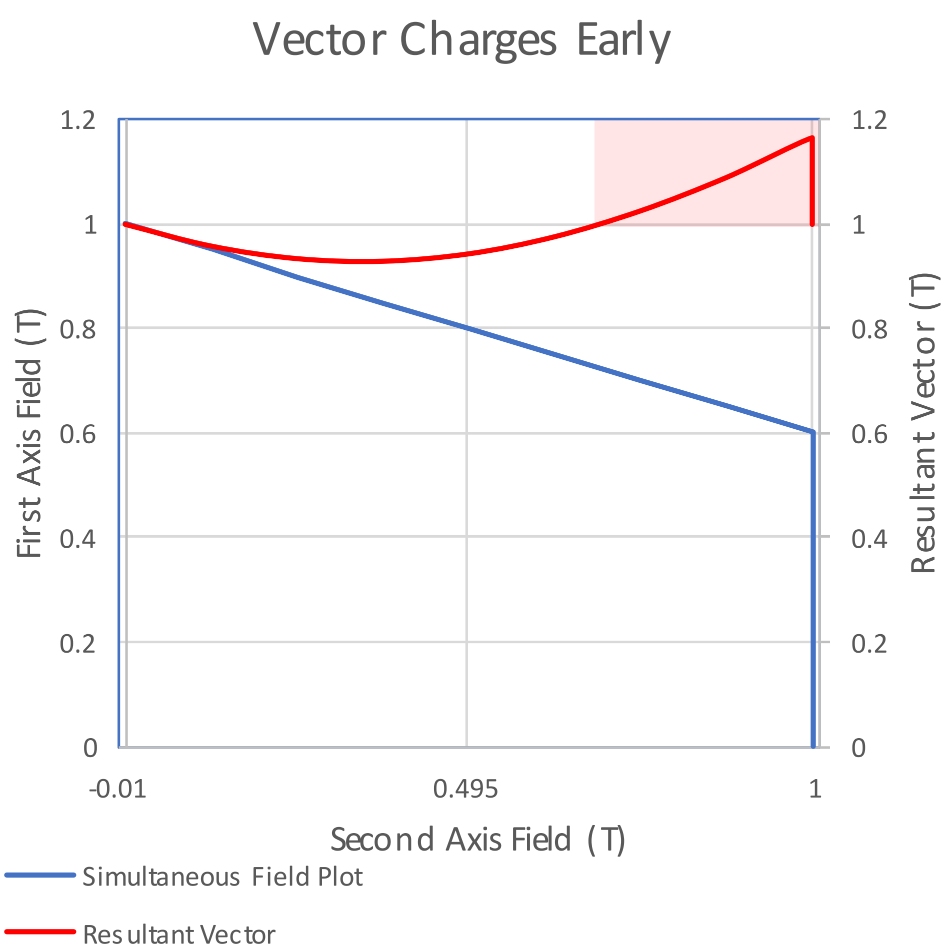
Separating the Transition into smaller steps

When a sample needs to be exposed to a more consistent field intensity during the vector transition, the path to the target vector can be divided into multiple smaller target vectors as necessary to achieve the desired outcome. In the example below, the field is rotated 90 degrees between two axes, but the transition is broken down into ten discrete angles. The ramp rate of each axis is adjusted between each target angle to ensure both axes reach the target field simultaneously. As shown in the following XY plot, the resultant vector remains much more consistent as both axes reach each angle at synchronized rates. Achieving constant vectors requires more time and synchronization as the ramp rate for each axis is changing between every target angle. Software control, as described later in this section, is an option to minimize human error.



Dangers of Unsynchronized Axes

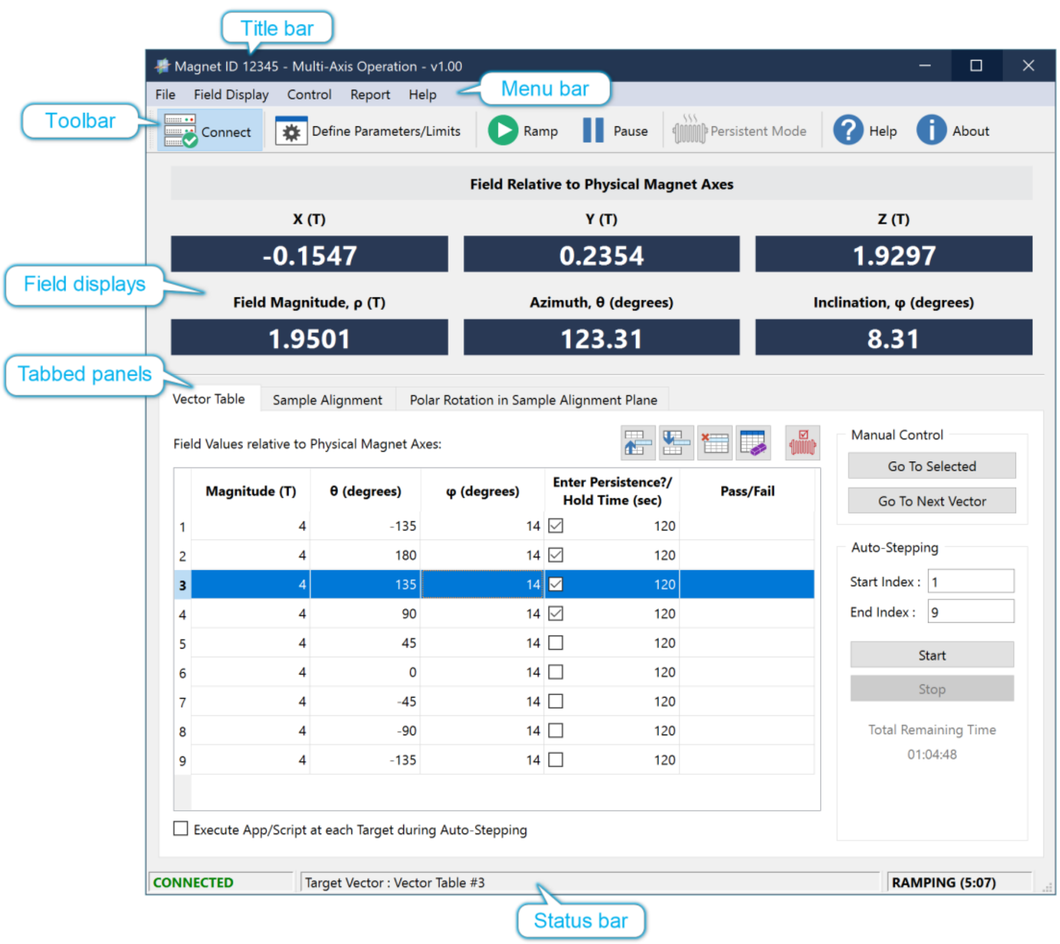
If one axis reaches its target before the others, the transition may exceed the Maximum Rotatable Field specification. This typically occurs when one axis charges faster than the other axes can discharge. In the following XY plot, the first axis is discharging to 0 T while the second axis is charging to 1 T. The second axis reaches its target early, causing the resultant vector to exceed the 1 T Maximum Rotatable Field specification



Multi-Axis Operation Software

As previously mentioned, each axis is controlled by an independent power supply system. Charging and discharging of each axis can be initiated either simultaneously by the user or via external software with a remote connection. The Model 430 supports SCPI protocol, enabling full remote control. Additionally, AMI offers a free and open-source program that can automate the control of all axes in a multi-axis magnet based on user input. The user can define vectors using Cartesian, Polar, or Spherical coordinates. This software streamlines operation by:

- Limiting the rotatable field to a specified value
- Automatically changing the ramp rate of all axes to accommodate the slowest axis
- Allowing target vector programs that auto step between target values
- Automates transition between Driven and Persistent mode of all axes
- Optionally executing scripts at each target vector



The Multi-Axis Operation Software may be downloaded from www.americanmagnetics.com on our support page.

Mutual Inductance

While the orthogonal axes of Maxes™ magnets theoretically have no mutual inductance between them, it is possible for one axis to induce small fields into another while ramping. These small fields induce a current that is normally dissipated across the magnet current supply cables. Magnets equipped with persistent switches may optionally choose to heat the persistent switches of unused axes to prevent a field from developing.

Troubleshooting

The following troubleshooting aids can be used to identify and correct magnet system problems. In the event that further help is needed, please contact an AMI representative for assistance.

Voltage developed across magnet but magnet field less than predicted

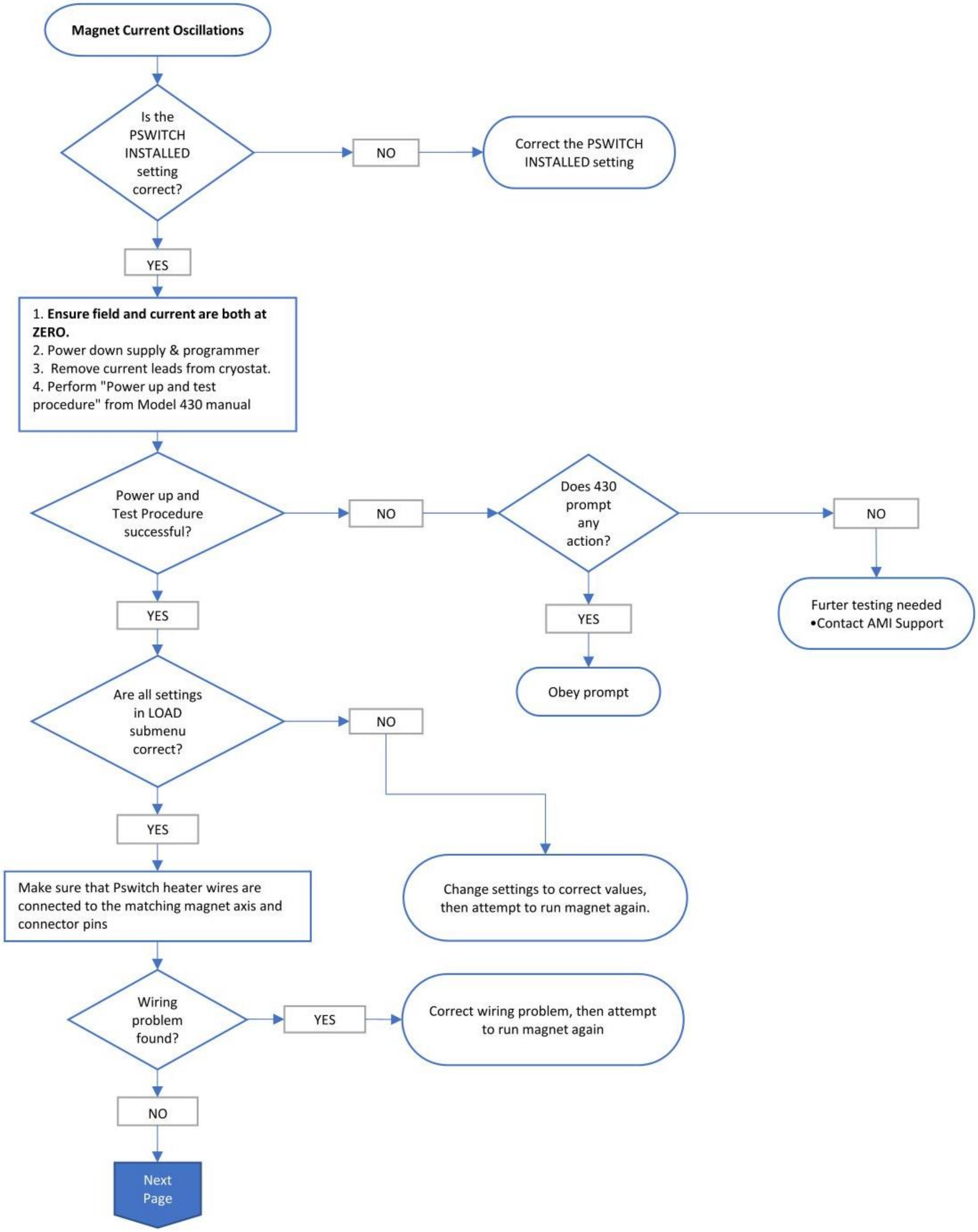
1. If the magnet current increases while the magnetic field increases slowly and magnet temperature increases significantly, the protection diodes may have turned on and current is flowing through them. This occurs when the diode is subjected to a voltage which is larger than its turn-on voltage (typically 4-6 volts). The magnet current should be reduced to zero as rapidly as possible. Wait for the current in the magnet to reach zero and the temperatures to return to normal. Make sure the ramp rate previously attempted is low enough to keep the charging voltage of the magnet at or below the voltage listed on the Magnet Specification Sheet.

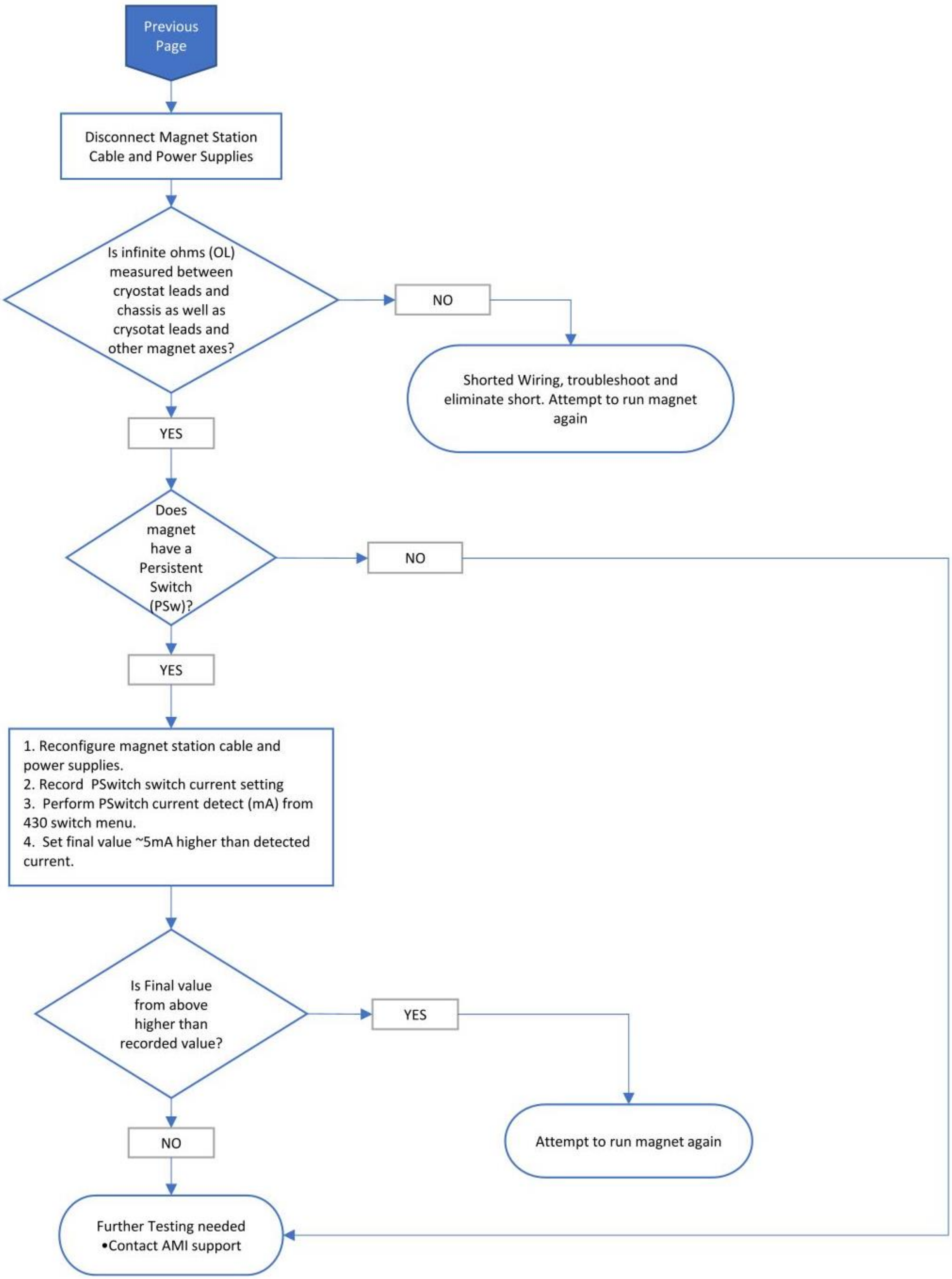
2. If after a quench the magnet current ramps but the magnetic field increases slowly and the temperature increases, one of the protection diodes may be damaged as a result of the quench and consequently shunting the magnet current. It is common that the “Voltage Limit Timeout” feature of the Model 430 will be triggered as well. If these conditions occur, call AMI and speak with a support representative.

Magnet quenches lower than rated field

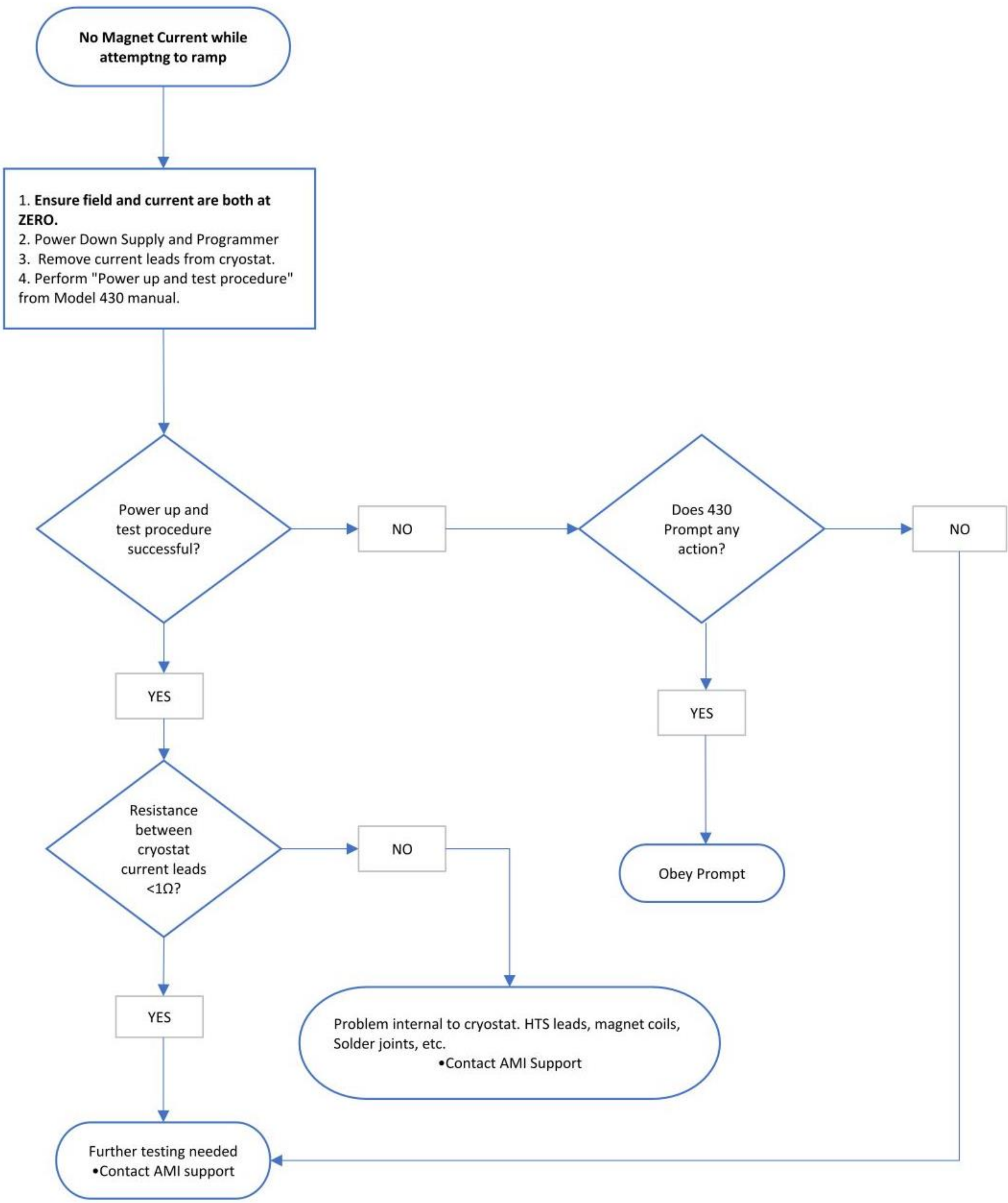
1. Ensure rated operating current and ramp rate on the Magnet Specification Sheet are not being exceeded.
2. Ensure magnet temperature is below 4.2 K when operating. If the magnet temperature exceeded 4.2 K at the time of the quench, slow the ramp rate of the magnet to decrease temperature.

Magnet Oscillations

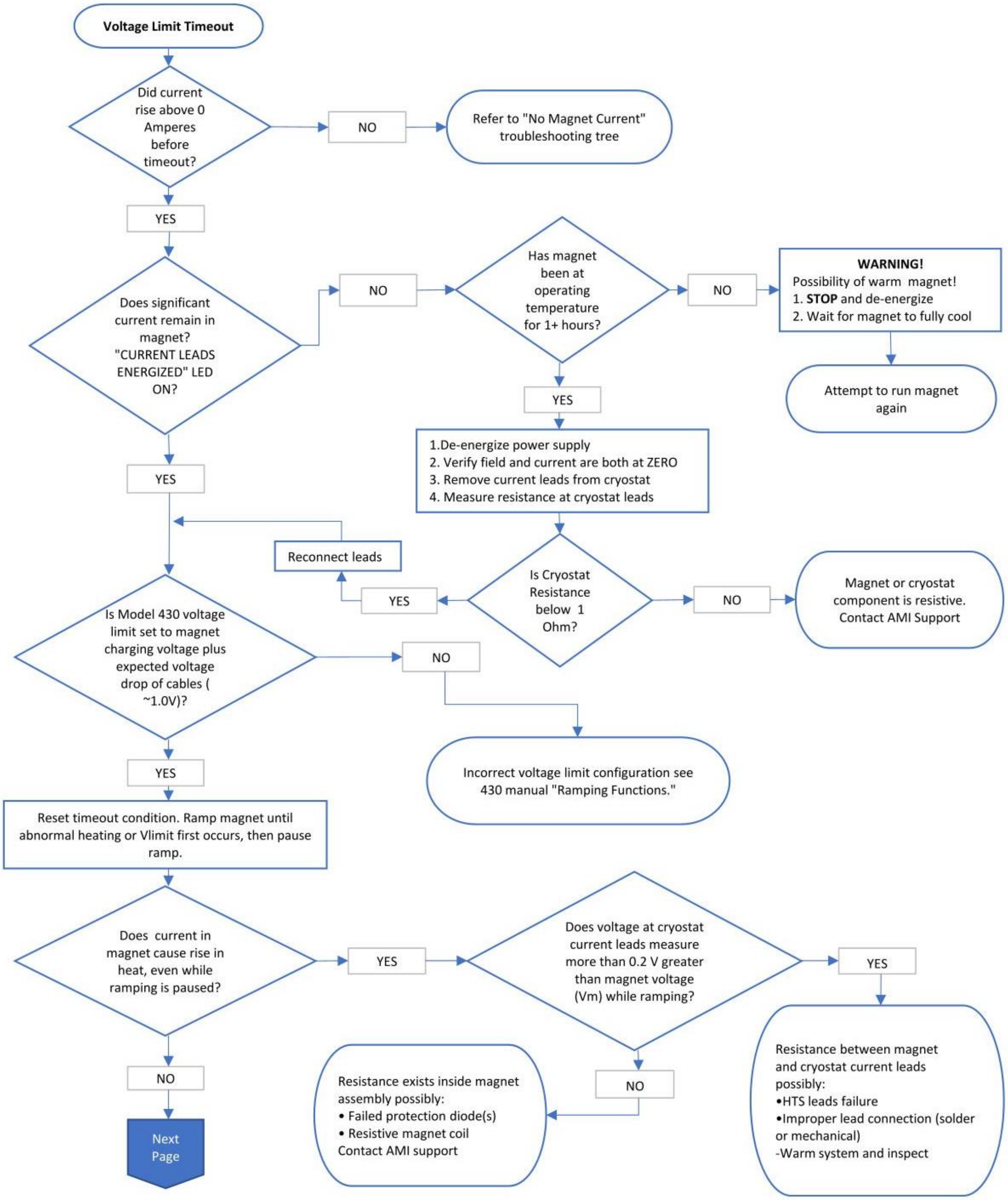


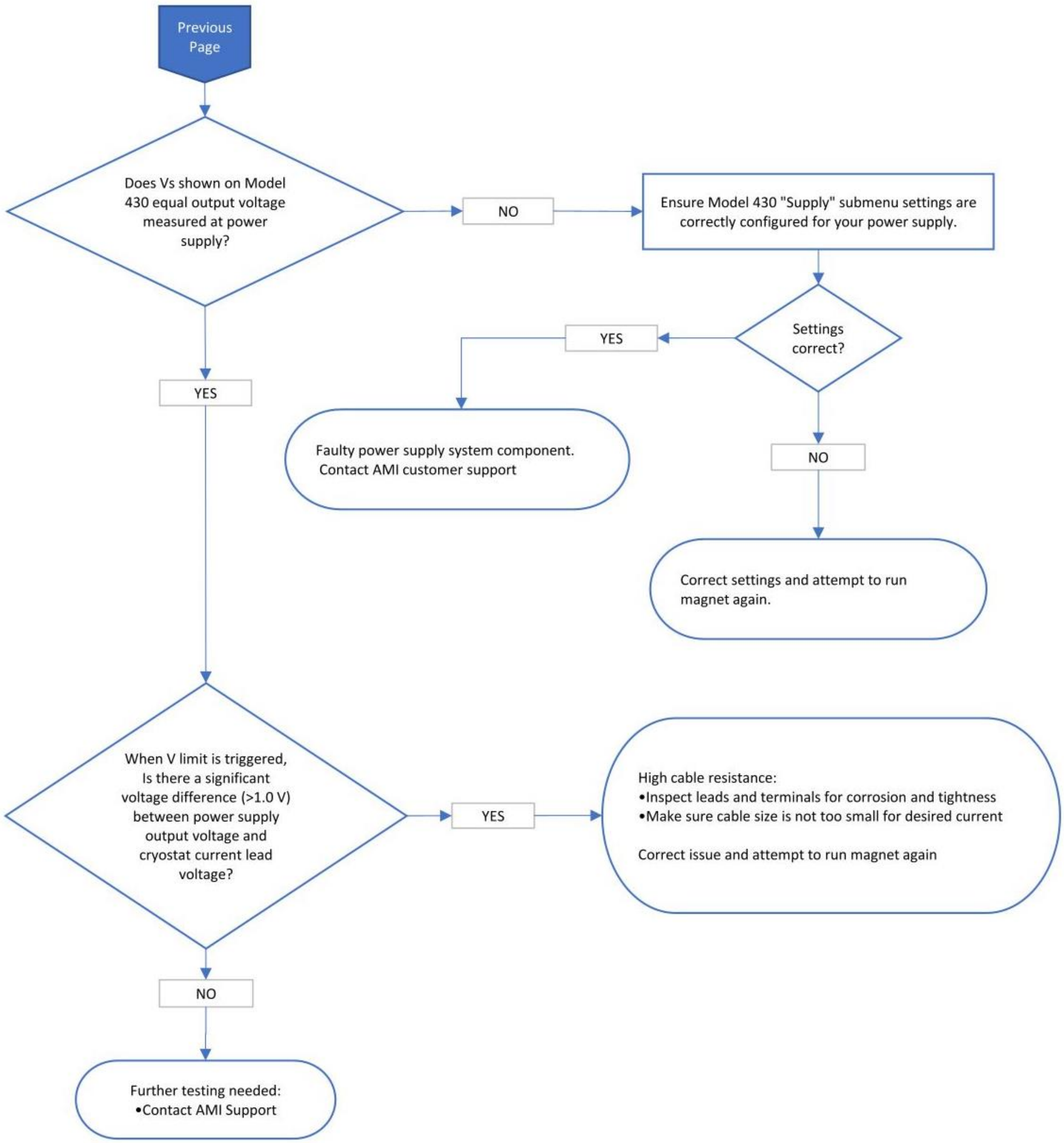

Previous Page
Disconnect Magnet Station Cable and Power Supplies
Is infinite ohms (OL) measured between cryostat leads and chassis as well as crysotat leads and other magnet axes?
NO
Shorted Wiring, troubleshoot and eliminate short. Attempt to run magnet again
YES
Does magnet have a Persistent Switch (PSw)?
NO
YES
1. Reconfigure magnet station cable and power supplies.
2. Record PSwitch switch current setting
3. Perform PSwitch current detect (mA) from 430 switch menu.
4. Set final value ~5mA higher than detected current.
Is Final value from above higher than recorded value?
YES
Attempt to run magnet again
NO
Further Testing needed
•Contact AMI support

Magnet Current does not Rise when attempting to Ramp



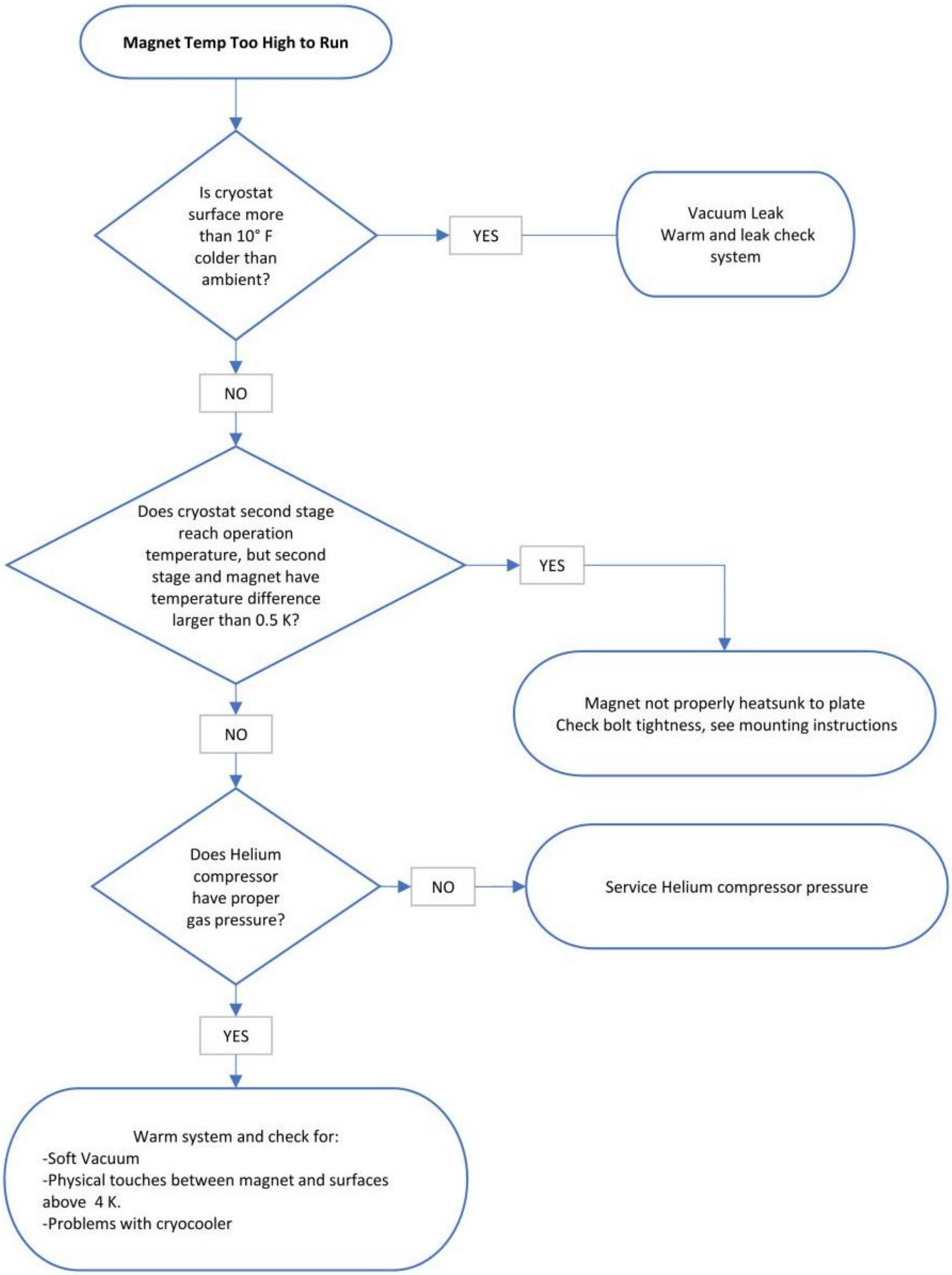
Voltage limit Reached while ramping (Voltage Limit timeout error)





Previous Page
Does Vs shown on Model 430 equal output voltage measured at power supply?
NO
Ensure Model 430 "Supply" submenu settings are correctly configured for your power supply.
Settings correct?
YES
Faulty power supply system component. Contact AMI customer support
NO
Correct settings and attempt to run magnet again.
YES
When V limit is triggered, Is there a significant voltage difference (>1.0 V) between power supply output voltage and cryostat current lead voltage?
YES
High cable resistance:
•Inspect leads and terminals for corrosion and tightness
•Make sure cable size is not too small for desired current
Correct issue and attempt to run magnet again
NO
Further testing needed:
•Contact AMI Support

Magnet Temperature Too High to Run After Cooling (above 4.2 Kelvin)



Additional Assistance

If the cause of the problem cannot be located, contact an AMI customer service representative for assistance. DO NOT SEND A UNIT BACK TO AMI WITHOUT PRIOR RETURN AUTHORIZATION.

Warranty/Return Authorization

All products manufactured by AMI are warranted to be free of defects in materials and workmanship and to perform as specified for a period of fifteen months from date of shipment. In the event of failure occurring during normal use, AMI, at its option, will repair or replace all products or components that fail under warranty, and such repair or replacement shall constitute a fulfillment of all AMI liabilities with respect to its products. Since, however, AMI does not have control over the installation conditions or the use to which its products are put, no warranty can be made of fitness for a particular purpose, and AMI cannot be liable for special or consequential damages.

All warranty repairs are F.O.B. Oak Ridge, Tennessee, USA.

Return Authorization

Items to be returned to AMI for repair (warranty or otherwise) require a return authorization number to make sure your order will receive proper attention. Please call an AMI representative at +1 (865) 482-1056 for a return authorization number before shipping any item back to the factory.