

USER'S MANUAL

5972 MAGNET CONTROL



PROPRIETARY

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Section 1

WARNINGS

REFER TO WARNINGS BELOW BEFORE OPERATING THE 5972 MAGNET CONTROL

2.1 - Personal Safety

Never service alone. Do not perform service to the 5972 Magnet Control and associated DC Power Supply unless another person is present who is capable of rendering first aid.

The output from the DC Power Supply is potentially lethal. It is capable of delivering high voltages at high current. Do not remove protective covers or leave cable terminations exposed. Do not operate if terminals or cables are damaged.

2.2 - Current Connections

Special care should be taken to insure that the current terminations are secure and do not work loose in operation. Local heating at the terminations can cause rapid oxidation leading to a high contact resistance and high power dissipation at the terminals. If left unchecked this can cause enough local heating to damage or destroy the current connection terminals.

2.3 - Interlocks

The 5972 Magnet Control has interlock connections between the DC Power Supply and the Electromagnet load. The interlocks must be connected for proper system functioning and protection of the equipment, facility and to protect against personal injury. Attempting to operate the system with the interlocks defeated is not recommended and will void the warranty.

Section 2

SPECIFICATIONS

Table 1. Model 5972 Magnet Control Specifications

Electrical

Power Input 85-240VAC, 50/60Hz, 2A
Note: While the power input module has a 'selectable' voltage range, it is not necessary to select the range for any voltage between 85 - 240VAC.

Control Modes

Computer Control

National Instruments Multifunction DAQ, Model USB-6351
Current Control Resolution: 16 bits
Current & Voltage Monitor Resolution: 16 bits
Digital read back of amplifier and magnet interlock status
Magnetic field read back resolution: 16 bits

Manual Control

Manual control of the DC current via the DC Power Supply's front panel controls

Computer Control with external Analog Current Programming Input

National Instruments Multifunction DAQ, Model USB-6351
Current & Voltage Monitor Resolution: 16 bits
Digital read back of amplifier and magnet interlock status
Magnetic field read back resolution: 16 bits
User provided 0 - 10 volt analog control
Run-Time software included. To view or modify the source VI,
National Instruments LabView 8.6.1 or later is required.

Current Control Programming Voltage⁽¹⁾ 0 - 10 volt analog

Note (1): The Current output control may be via either the USB interface or the external analog input, but not both.

Mechanical

5972 Current Magnet Control

Form Factor 2U rack mount fully enclosed chassis
Overall Dimensions 482mm (19") wide x 88.1mm (3.5") high x 507mm (20") deep
Weight 15.75 kg (35lbs)

5972 Magnet Control & SGA Power Supply in Optima Rack

Overall Dimensions 560.5 (22") wide x 1,058 (41.6") high x 823 (32.4") deep
Weight (with Sorensen SGA 60/83) 105.75kg (235lbs)
Weight (with Sorensen SGA 100/150) 115kg (250lbs)

Section 3

INSTALLATION

Caution: In many cases, the Magnet Control and DC Power Supply will be pre-installed by GMW into a 19" EIA equipment rack. If it is not, care should be taken during rack mounting to avoid personal injury or damage to the equipment.

3.1 - Unpacking Instructions and Damage Inspection

3.1.1 - Systems Shipped with a GMW Supplied Rack:

1. Remove all eight of the lag bolts located at the lower edge of all the side panels of the crate top cover.
2. Gently rock the crate top cover to work it loose from the shipping crate base.
3. Use one person on each side of the shipping crate grip the side panels of the crate top cover. Lift the crate top cover high enough to clear top of the rack, walk the cover sideways to a clear area and place it upon the floor.
4. Inspect the rack and its contents to ensure that no damage has occurred during shipment. If any damage is evident report the damage in detail to the shipper for claim and simultaneously notify GMW in case an assessment of the damage must be made. If no damage is found, proceed with the unpacking and installation.
5. Cut the straps that secure the rack to the pallet base.
6. Remove the wood block at the bottom front edge of the rack.
7. Carefully slide the rack forward and off of the pallet base.
8. Unpack any other system components as per their instruction manuals.

3.1.2 - Systems Shipped without a GMW Supplied Rack:

1. Open the outer shipping carton by cutting the packing tape along the joints.
2. Remove the inner shipping carton by carefully lifting it out.
3. Open the inner shipping carton by cutting the packing tape along the joints.
4. Carefully lift the Magnet Control clear of the shipping carton.
5. Inspect the Magnet Control for any damage.
6. Retain all packing materials for future shipping needs.

3.2 - Rack Mounting

When rack mounting the 5972 Magnet Control it is important to note that the vertical mounting flanges alone are not strong enough to support the weight of the Magnet Control. Support angles on each side, beneath the 5972 must also be used. Failure to use adequate support angles will result in equipment damage.

Take care when selecting a rack that it has enough depth to completely house the Magnet Control and DC Supply. The RC-351930 Bench Height Rack offered by GMW has an internal depth of 762mm (30"). Typical installations would put the DC Supply at the bottom of the rack, with the Magnet Control just above, thus keeping the center of gravity as low as possible in the rack. Other instrumentation may then be installed in to the upper sections of the rack.

Note: Telco style racks are NOT appropriate for the Magnet Control and DC Supply.

3.3 - Electrical Connections

Even if the 5972 Magnet Control was ordered as a complete system and assembled into a rack by GMW, it is still recommended to follow and verify the following section as connections may have loosened during shipment.

Refer to drawing 13907-0020-0, for a detailed connection diagram.

3.3.1 - DC Supply, Magnet Control, and Electromagnet Connections

1. Connect the DC Supply to Magnet Cable to the input +, input – and ground. This cable provides the DC power and ground between the DC Power Supply and the Magnet. Ensure that ALL connections are tight, the polarity is correct and the interlock cable is properly connected.
2. Connect the Magnet Cable interlock plug to the Magnet Control.
3. Connect the Magnet Control to DC Supply interface cable between the Magnet Control and the DC Supply.

3.3.2 – Magnet Control Power

Connect the 115Vac or 220Vac power cord to the Magnet Control.

3.3.1 - DC Supply Main Power

This procedure should be carried out by a qualified electrician.

1. Connect the DC Supply to the AC Mains service via an appropriate three-phase AC power disconnect / breaker panel. For a GMW supported power supply, the maximum input currents per phase are given below.

DC Power Supply	Voltage	Phases	Current per Phase
DLM60-10			
DLM40-75E, 3kW	180-264V	3	16A
SGA 60/83, 5kW	187-242V	3	21A
SGA 100/150, 15kW	187-242V	3	62A
SGA 160/156, 25kW	187-242V	3	103A
BOP20-20L		1	
BOP38-28MG			

2. Ensure that the Electromagnet and DC Power Supply grounds are connected. The DC Power Supply must be connected to the local service ground.

Section 4

SYSTEM DESCRIPTION

4.1 - System Description

A complete system would typically consist of an appropriate SGA series DC power supply, the GMW 5972 Magnet Control, a Senis magnetic field transducer, an electromagnet and an appropriate computer and software or an external analog programming signal.

The DC Supply provides current directly to the electromagnet. The Supply's output is enabled on a closed contact, providing protection should the interlock cable be disconnected. A failure in either the magnet temperature or water flow will cause the interlock relay to open, shutting down the DC Supply's output:

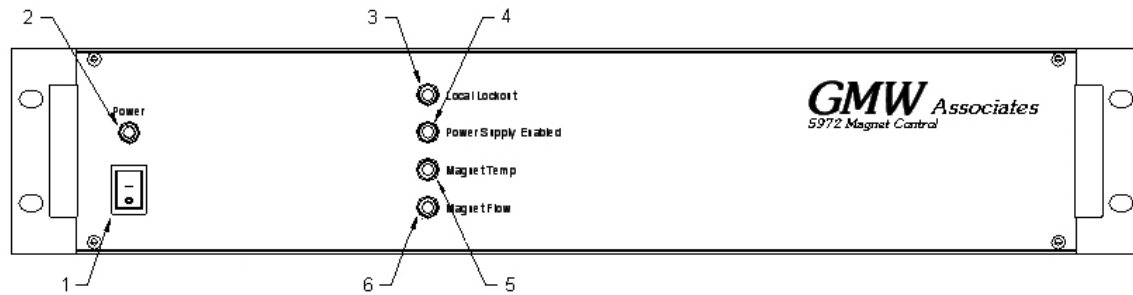
The 5972 Magnet Control is comprised of several sections: The display and interlock control electronics, a National Instruments USB-6351 Control with USB interface and an auxiliary power supply all integrated into a single 19" rack mounting chassis. Refer to drawing no. 13907-0019-0, Rev. A for an internal block diagram.

The internal power supply provides power for the display and interlock control circuitry and the NI USB-6351 DAQ. It also provides -12V and +12V (400mA each) on the rear panel for an optional external Senis Magnetic Field Transducer for magnetic field measurement and closed-loop field control.

The interlock circuit for the magnet requires a 'closed contact' connection. Provision for both the magnet over temperature and water flow is provided, and a failure of either one is indicated on the front panel of the Magnet Control. When using the NI USB-6351 DAQ, this information is available via the computer control software. In the event of a magnet interlock fault, the output of the DC Supply is inhibited.

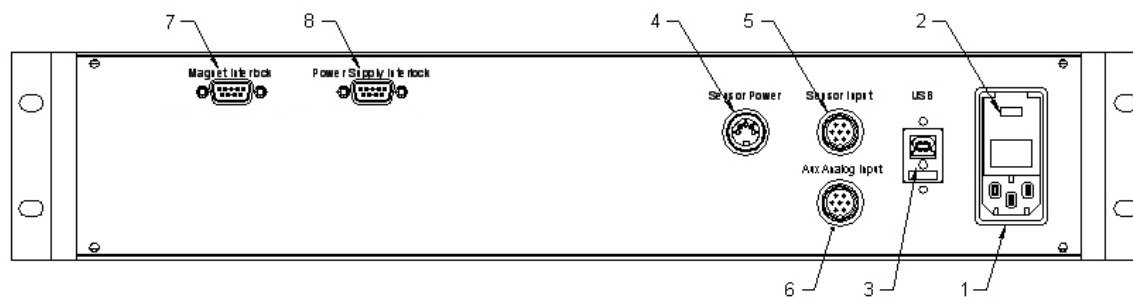
The NI USB-6351 DAQ interface provides computer control and monitoring of the system. It provides a 16-bit analog output ($\pm 10V$) as a programming signal to the DC Supply. The output voltage and current are monitored by two 16-bit input channels. The magnet interlock status is also monitored via its digital input channels. When using an optional Senis Magnetic Field Transducer, the field is read back on a third 16-bit analog channel. An Auxiliary Analog Input connector allows for up to five additional analog inputs with user settable full scale inputs from $\pm 2V$ to $\pm 10V$. For more information, please refer to the NI USB-6351 Manual and section 4.5 in this manual.

4.1.1 - Front Panel - Standard Version



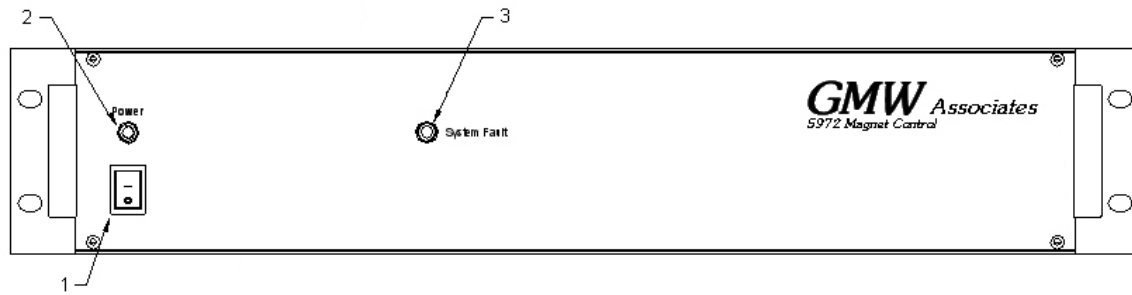
1. Power Switch
2. Power Indicator
3. Local Lockout Indicator
4. Power Supply Enabled Indicator
5. Magnet Over-Temperature Indicator
6. Magnet Water Flow Failure Indicator

4.1.2 - Rear Panel - Standard Version



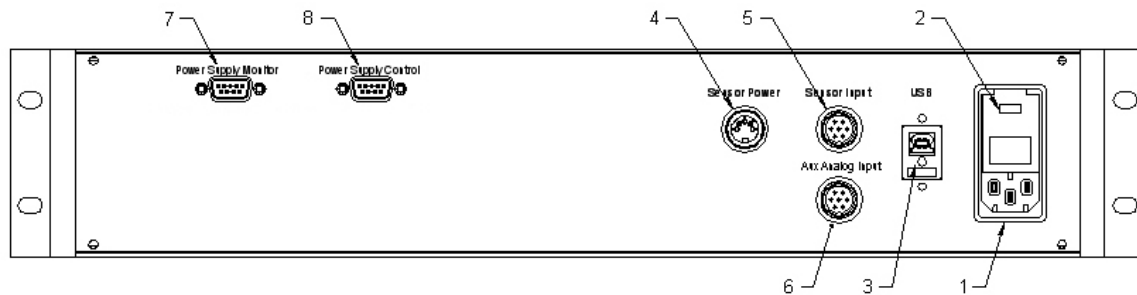
1. AC Mains Input (Auxiliary Power Supply) - 115 - 220VAC, 2A
2. Fuse Holder / Voltage Selector
3. USB Port - Type B USB connection for computer control
4. Sensor Power - $\pm 12V$ power for Senis Magnetic Field Transducer
5. Sensor Input - Senis analog Magnetic Field Transducer input
6. Auxiliary Analog Inputs (up to five channels)
7. Magnet Interlock Connection
8. Power Supply Interlock Connection

4.1.1 - Front Panel - HTS-110 Version



1. Power Switch
2. Power Indicator
3. System Fault Indicator

4.1.2 - Rear Panel - HTS-110 Version



1. AC Mains Input (Auxiliary Power Supply) - 115 - 220VAC, 2A
2. Fuse Holder / Voltage Selector
3. USB Port - Type B USB connection for computer control
4. Sensor Power - $\pm 12V$ power for Senis Magnetic Field Transducer
5. Sensor Input - Senis analog Magnetic Field Transducer input
6. Auxiliary Analog Inputs (up to five channels)
7. Power Supply Monitor Connection
8. Power Supply Control Connection

4.2 - Initial Operational Testing - Standard Version - Local Mode

Once the Power Supply, Magnet Control and Electromagnet system are connected it is time to perform initial system operational checks.

Start by switching on the Magnet Control. The power and power supply enable indicators should illuminate. All interlock indicators should show green provided that proper interlock conditions are met.

4.2.1 - Interlock Check - Standard Version

Temporarily disconnect the Magnet Interlock Cable from the Magnet Control. The 'Magnet Temp' and 'Magnet Flow' interlock indicators should illuminate red signifying a problem with the magnet interlocks. Re-connect the Magnet Interlock Cable. The interlock indicators on the front panel should change to green.

4.2.2 - Interlock Check - HTS-110 Version

Temporarily disconnect the Power Supply Monitor Cable from the Magnet Control. The 'System Fault' indicator should illuminate red signifying that the power supply has gone into fault mode. Re-connect the Power Supply Monitor Cable. The System Fault indicator on the front panel should turn off.

Note that If during operation the System Fault is tripped, it will be necessary to shut down all connected Kepco power supplies to clear the fault condition. Furthermore, no information as to the cause of the fault is available via the 5972 Magnet Control. Fault information may be available via the HTS-110 Magnet Supervisor. Refer to the Magnet Supervisor Manual for more information.

4.2.3 - Power Supply Check - Standard Version only.

Once the interlocks have been verified as operational, it is time to check that power supply functions as expected. Insure that the 'Voltage' and 'Current' controls on the DC Supply are turned down to their minimum values and switch on the DC Power Supply. Slowly turn up the voltage and current controls until about 5 amps is indicated on the DC Supply display. Refer to the power supply operators manual for more details.

It is important to note that for normal operation, the DC Power Supply voltage be set at Maximum. If this is not done, the DC Power Supply will be voltage limited and full output current may not be achieved.

With Kepco Bi-polar Power Supplies, typically only the current control need be operated.

4.3 - Computer Control

The 5972 is provided with a LabVIEW driver that allows basic control and monitoring of the Magnet Control and DC Power Supply.

Start up the computer software and ensure that everything configured correctly. Please refer to section 5 of this manual for more information.

4.3.1 - USB-6351 DAQ

The National Instruments USB-6351 DAQ together with GMW's Magnet Control software provides control and monitoring of the 5972 Magnet Control. If GMW's Magnet Control software is not used, it is still possible to computer control the 5972 Magnet Control by writing custom software to communicate with the USB-6351. The table below describes the channels used and their functions.

USB-6351 Connections			
Signal	Type	Direction	6251 Terminal
Current Control Output 10V output proportional to 100% current output	Analog Single Ended	Output	AO-0
Current Control Common	Ground	Ground	AO-GND
Voltage Monitor 10V / 100% of the power supply's rated output voltage	Analog Single Ended	Input	AI-0
Voltage Monitor Common	Analog	Input	AI-GND
Current Monitor 10V / 100% of the power supply's rated output current	Analog Single Ended	Input	AI-1
Current Monitor Common	Analog	Input	AI-GND
Field Monitor +	Analog	Input	AI-2
Field Monitor -	Differential	Input	AI-10
Field Monitor Common	Ground	Ground	AI-GND
- Reserved -	Digital	Input	P0.0
- Reserved -	Digital	Input	P0.1
Magnet Flow – Low = Okay	Digital	Input	P0.2
Magnet Temperature – Low = Okay	Digital	Input	P0.3
P/S Enabled – High = Enabled	Digital	Input	P0.4
- Reserved -	Digital	Input	P0.5
Local Lockout – High = Remote	Digital	Output	P0.6
- Reserved -	Digital	Output	P0.7
General Interlock	Digital	Input	P1.0
EPO Status	Digital	Input	P1.1
EPO Shutdown	Digital	Output	P1.2
Interlock Status Common	Ground	-	DGND
+5V Power	Power	-	+5V
User defined aux analog inputs - configured as ±10V input, single ended.			
Auxiliary Analog Input 1	Analog, S/E	Input	AI-2
Auxiliary Analog Input 1 Common	Ground	Ground	AI-GND
Auxiliary Analog Input 2	Analog, S/E	Input	AI-3
Auxiliary Analog Input 2 Common	Ground	Ground	AI-GND
Auxiliary Analog Input 3	Analog, S/E	Input	AI-4
Auxiliary Analog Input 3 Common	Ground	Ground	AI-GND
Auxiliary Analog Input 4	Analog, S/E	Input	AI-5
Auxiliary Analog Input 4 Common	Ground	Ground	AI-GND
Auxiliary Analog Input 5	Analog, S/E	Input	AI-6
Auxiliary Analog Input 5 Common	Ground	Ground	AI-GND

USB-6351 Connections			
Signal	Type	Direction	6251 Terminal
User defined aux digital channels - may be user defined as input or output			
Auxiliary Digital Channel 1	Digital	In or Out	P1.3
Auxiliary Digital Channel 2	Digital	In or Out	P1.4
Auxiliary Digital Channel 3	Digital	In or Out	P1.5
Auxiliary Digital Channel 4	Digital	In or Out	P1.6
Auxiliary Digital Channel 5	Digital	In or Out	P1.7
Auxiliary Digital Channel 6	Digital	In or Out	P2.0
Auxiliary Digital Channel 7	Digital	In or Out	P2.1
Auxiliary Digital Channel 8	Digital	In or Out	P2.2
Auxiliary Digital Channel 9	Digital	In or Out	P2.3
Auxiliary Digital Channel 10	Digital	In or Out	P2.4
Auxiliary Digital Channel 11	Digital	In or Out	P2.5
Auxiliary Digital Channel 12	Digital	In or Out	P2.6
Auxiliary Digital Channel 13	Digital	In or Out	P2.7
Digital Ground	Ground	-	DGND
+5V Power	Power	-	+5V

Section 5

MAINTENANCE

The 5972 Current Magnet Control should operate for many years without any trouble provided that the following basic maintenance points are observed. Always remember that the AC power should be disconnected before performing any maintenance procedure. The 5972 may generate lethal voltages and must not be operated with damaged components, protective covers or cable insulation. For more information, please refer to Section 2, Warnings

1. Electrical Connections: Ensure that all electrical connections are clean and tight. Ensure that the insulation of all electrical cables is undamaged and repair or replace if necessary. Pay particular attention to high voltage and/or high current cables and connections. All electrical termination covers must be in place and firmly secured.

2. Warning Labels: Ensure that all protective covers on the system and the magnet are in place. There are warning labels on all removable covers.

3. Cleaning: To clean wipe the case with a soft cloth with a mild detergent or plain water. Do not use any solvents as they may damage the finish.

Section 6

DRAWINGS

Section 7
PHOTOGRAPHS



5972 Front View



5972 Rear View

Section 8

WARRANTY

GMW Associates warrants that all Electromagnets, Laboratory Electromagnet Systems and Electromagnet System Components supplied by GMW Associates will be free of defects in materials or workmanship for a period of 12 months from the date of installation or 15 months from the date of shipment whichever is the shorter.

Within this period GMW Associates will repair or replace defective parts free of charge either at the end user's site or at GMW Associates location at GMW choice.

GMW Associates will reimburse or pay the lowest two way freight charges on items returned to GMW Associates or our authorized agent provided prior authorization for shipment has been given by GMW Associates.

This warranty shall not apply to any equipment which our inspection shows to have become defective due to mishandling, misuse, improper maintenance or any other damage not generally acceptable for equipment of a similar type.

GMW Associates reserves the right to make changes in product or system design without incurring any obligation to modify previously delivered equipment.

The foregoing is the full extent of the GMW Associates warranty. No other warranty is expressed or implied. In no event shall GMW Associates be liable for damage arising from late delivery or misuse of the equipment. GMW Associates makes no warranty of the fitness of the equipment for the intended end-use other than the equipment meets the written specifications presented to the purchaser by GMW Associates.

If any defect or fault in the equipment is discovered the end-user should notify GMW Associates of the problem including details of Model numbers and serial numbers. GMW Associates will either make arrangements for service by the end-user or GMW Associates, or give authorization for return shipment to GMW Associates.

All return shipments must be made according to GMW Associates instructions with adequate packaging and documentation identifying the shipment including the GMW Associates Return Material Authorization (RMA) number. GMW Associates will not accept responsibility for equipment damaged in return shipment and thus all shipments should be properly packed and adequately insured by the customer.