

*Operation Manual for*  
*Mag-03DAM*  
*Data Acquisition Module*



**Bartington**<sup>®</sup>  
Instruments

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## 1. About this Manual

This document describes the installation, operation and maintenance of the Mag-03DAM Data Acquisition Module from Bartington Instruments. It should be read in conjunction with product brochure [DS2519](#), which can be found on the Mag-03DAM product page of the Bartington Instruments website at [www.bartington.com](http://www.bartington.com).

### 1.1. Symbols Glossary

The following symbols used within this manual call your attention to specific types of information:



**WARNING:** Indicates a situation in which serious bodily injury or death could result if the warning is ignored.



**Caution:** Indicates a situation in which bodily injury or damage to your instrument, or both, could result if the caution is ignored.



Identifies items that must be disposed of safely to prevent unnecessary damage to the environment.

**Note:** A note provides useful supporting information and sometimes suggests how to make better use of your purchase.

## 2. Safe Use



**WARNING:** These products are not qualified for use in explosive atmospheres or life support systems. Consult Bartington Instruments for advice.



**WARNING:** This unit is not sealed against the ingress of water and should be operated only under dry conditions.

## 3. Compatible Magnetometers

The Mag-03DAM is designed to be compatible with the sensors shown on the Product Compatibility page of the Bartington Instruments website at: [www.bartington.com/product-compatibility](http://www.bartington.com/product-compatibility).



**Caution:** Use of incompatible sensors may cause damage to the Mag-03DAM and/or the sensor.

## 4. Introduction to the Mag-03DAM

The Mag-03DAM allows data to be collected from two three-axis sensors and stored on a computer. If the user requires only one sensor to be connected to the module for monitoring the geomagnetic field then the three unused channels are available for recording other parameters such as temperature. (The power supply from the Mag-03DAM to the sensor is also available for external use.) An output connector allows direct access to the analogue signals from the sensors.

The unit is supplied complete with:

- Mains power adaptor
- 25-way to 9-way D type serial adaptor
- 9-way serial cable
- USB to RS232 adaptor (with driver CD)
- Mating connectors as appropriate
- Software CD
- This operation manual.

### 4.1. Data Acquisition

The module contains a data acquisition card with up to 24-bit resolution and a battery-backed power supply. The parameters of the data acquisition card are under software control. The software provided allows time-stamped geomagnetic field data from each of the three axes of one or two connected sensors to be recorded.

Power is provided from a mains adaptor and the data is transmitted to the user's computer via an optically isolated RS232 serial link. This prevents the internal computer noise from affecting the data acquisition circuits and allows more precise measurements than can be obtained with computer plug-in cards.

### 4.2. Software

The Mag-03DAM is supplied with 'MagDAMWin' software for operation under Windows 2000, XP, 7, 8 or 10.

Demonstration software for the data acquisition system is also provided for operation only under DOS. The source code for demonstration programs in Microsoft QuickBASIC (V4.5) is included,

allowing users to adapt the programs as required. The module allows the user to program the data acquisition system for the optimum speed or resolution for a particular application.

The software allows user selection of the full-scale range of the sensor. This scaling is applied to both inputs so both sensors must have the same scaling if they are to be used simultaneously.

### 4.3. Mag-03DAM Features

#### 4.3.1. Front Panel

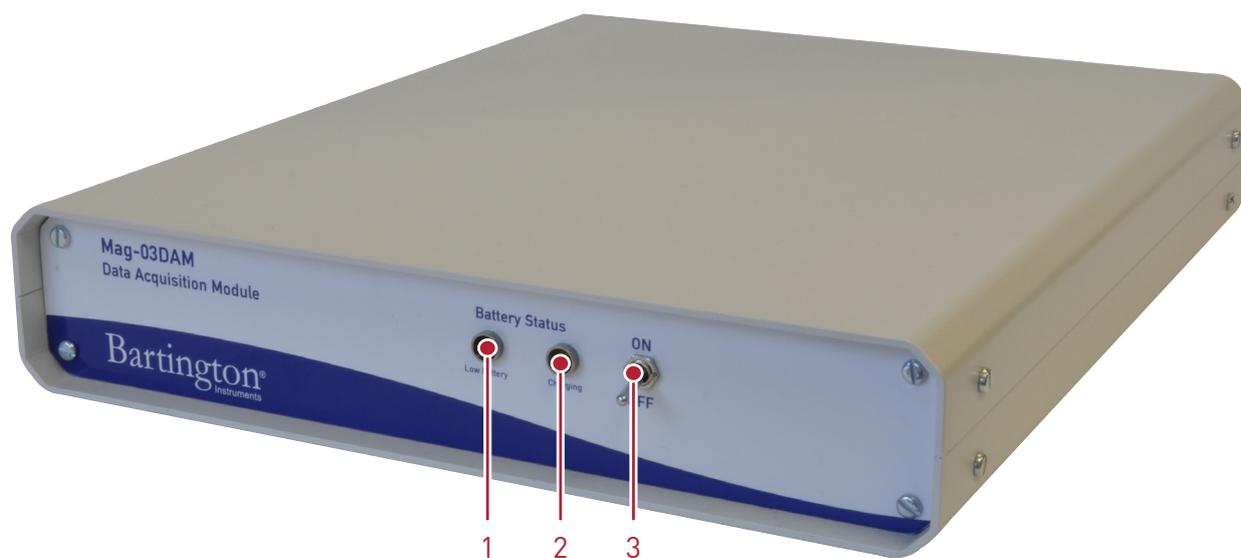


Figure 1. Mag-03DAM front panel

#### Key to Figure 1

1. Battery status indicator: LOW BATTERY
2. Battery status indicator: CHARGING
3. On/Off switch

### 4.3.2. Rear Panel

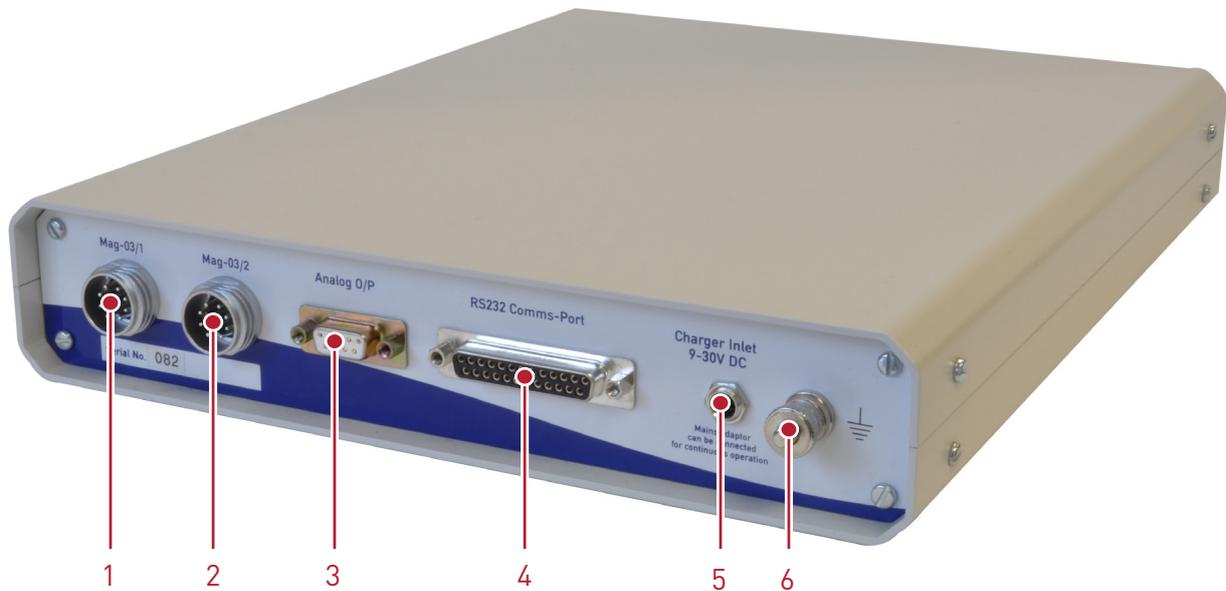


Figure 2. Mag-03DAM rear panel

#### Key to Figure 2

1. Mag-03/1 input connector (other Bartington Instruments sensors may also be connected)
2. Mag-03/2 input connector (other Bartington Instruments sensors may also be connected)
3. D-type analogue O/P connector
4. RS232 comms port connector
5. Charger inlet connector
6. Earthing point

## 5. Power

Electrical specifications for the Mag-03DAM are given in datasheet DS2519.

The module contains an internal sealed lead acid battery that can power two magnetometers and the data acquisition circuit for up to 6 hours, or 11 hours when only one magnetometer is used. The battery is recharged from a DC main charger input located on the rear panel.

**Note:** If an appropriate earth/ground connection is not provided through your mains supply lead, the earth terminal should be connected to ground.

The mains power adaptor provides a stabilised DC supply and trickle charges the battery continuously. The mains adaptor should be connected continuously during data collection if power is available, so that the battery is being used only as a back-up in case of mains failure. The battery may be charged with or without the sensor and data acquisition operating.



**Caution:** The unit should be switched off at the front panel when not in use to prevent the battery being discharged. If the battery becomes completely discharged and left for some time then it will be irreversibly damaged. If the unit is to be stored for longer than a few months then the battery should be recharged at three-monthly intervals for 24 hours or removed for storage. (See [Battery replacement](#).)

When the unit is switched on, the “LOW BATTERY” warning indicator on the front panel illuminates and an internal buzzer bleeps to indicate that the unit is active. If the battery voltage is above the minimum level, the battery warning indicator and associated buzzer will then turn off. The indicator and buzzer will be switched on continuously when the internal battery is below 10.5V and requires re-charging. The unit will continue to operate only for a further five minutes after this.



**Caution:** The unit should not be left running when the warning devices indicate that the battery charge level is low, or the battery will be deeply discharged and may not recover.

## 5.1 Battery Charging

**Note:** The battery will be charging whenever the mains adaptor is connected and powered. The On/Off switch ([see Figure 1](#)) controls only the power out to the sensor and data acquisition circuits. The “CHARGING” indicator on the front panel shows when the battery is being charged. It may be left on charge for up to a week but should not be left permanently on charge when data is not being collected.

The battery is maintenance free and will give many years of service if maintained in a charged condition. Using the mains adaptor provided, the battery will be fully charged from a discharged condition in about 4 days (100 hours). The front panel switch should be left in the OFF position to remove the supply to the internal circuits during battery charging when recording is not required.

**Note:** Always check that the front panel “CHARGING” indicator is illuminated, indicating that the battery is being charged, when the mains adaptor is connected.

**Note:** The battery must be recharged as soon as possible after use. In no circumstances should it be left in a discharged state for any length of time as this will cause irreversible damage.

## 6. Connection

Before turning on the power to the sensors or computer, connect all the cables to the connectors on the rear panel ([see Figure 2](#)) as follows:

- a. If mains power is available, connect the mains adaptor to the charger inlet connector.

- b. Connect the sensors to the Mag-03/1 and Mag-03/2 connectors with the appropriate cables.

**Note:** If only one sensor is used then it should be connected to the Mag-03/1 connector.

- c. The RS232 25-way to 9-way adaptor and 9-way to 9-way null-modem cable supplied should be connected from the RS232 Comms Port connector to the appropriate computer serial port. See drawing DR0681 for pin connections.

Mag-03DAM 25-way pin-out	Signal	Computer 9-way pin-out
2	TX	3
3	RX	2
20	DTR	4
7	GND	5
4	RTS	7

**Note:** If the computer has no serial port but has a USB port, then the USB to RS232 converter supplied can be used. Use the Windows Control Panel/Device Manager to determine which COM port the converter has been assigned to.

- d. The data acquisition module is isolated from mains ground and should be connected to a local ground, where possible, using the earth tag on the rear panel. This will reduce noise due to interference from power lines etc.
- e. If only one sensor is connected then the MAG-03/2 connector may be used for recording other parameters. See the product brochure for input range. (See [Electromagnetic Compatibility](#).)
- f. The 9-way D-type socket on the rear panel provides access to the analogue outputs from the sensors. See drawing DR0681 for pin connections.

**Note:** For the best results, measurements should be made between the output signal and the common line from the appropriate sensor. Care should be taken to avoid injecting noise if the signals are to be recorded through the Mag-03DAM to a computer.

## 7. Operation

### 7.1. Positioning

The Mag-03DAM is a freestanding unit that is positioned between the sensors and the computer. The unit has a low magnetic signature but should not be placed closer than about 2 metres from either sensor to avoid affecting the measured field. The sensor output characteristics allow the module to be situated up to 600 metres from the sensor.

## 7.2. Initial Operation

Create a new directory MagDamWin in the root directory of the C:\ drive on the hard disc and copy the contents of the CD into this directory. The disc contains a program, MagDAMWin.exe, and two other files. Create a shortcut to C:\MagDAM Win\MagDAMWin.exe on the desktop. The procedure for installing a shortcut may vary from one operating system to another.

The programs DRIVR201, DEM0201, SCAN201 and SCRIPT from Lawson Labs Inc. may also be provided. These are MS-DOS programs only. Details are provided in the manual supplied with them.

If power is available, switch on the power to the mains adaptor and check that the “CHARGING” indicator on the front panel is illuminated. Turn on the Mag-03DAM unit and the computer.

**Note:** If the “LOW BATTERY” indicator and sounder remain on then there are only a few minutes of operational life left in the battery. The unit should be switched off and left on charge until the indicator and sounder turn off automatically after the unit is switched on.

## 7.3. Starting the MagDAMWin program

Double click the shortcut created above or on the MagDAMWin.exe file to start the program. The Main Menu screen should appear showing:

```
1> Baud rate           9600
2> Serial port         Com1
3> Scaling:            +/-100uT
4> Polled mode
5> Scanning mode
Esc> Exit program
```

The complete program acts as a DOS type application, using input keys and not a mouse. The items in the Main Menu are selected by pressing the number keys.

Pressing 1 will scroll through the available baud rates in turn. Leave the selection at 9600.

Pressing 2 will scroll through the available RS232 serial COM ports. Select the port to which the Mag-03DAM is connected.

Pressing 3 will toggle the scaling of the sensors to allow selection of the sensor range.

When the program is run for the first time, the user should set all parameters as required. This will entail setting the configuration in both the Polled mode menu and the Scanning mode menu (see below). The configuration may be saved for future use when closing the program.

## 7.4. Polled Mode Menu

The unit is normally operated in Scanning mode, where all inputs are scanned in turn. However, some configuration items are set using the polled mode which reads from one channel only. Select 4 from the main menu: the display should show that the program is signing on to the Mag-03DAM hardware. If the wrong communication port has been selected then the message will show that the program was unable to sign on. When the program has established communication with the Mag-03DAM, it will perform a system calibration and then display the Polled mode menu.

The Polled mode menu allows parameters to be selected using the alphabetic keys. The menu operation and a recommended initial set up is as follows:

Key	Function
A	Allows the remote averaging to be set using the + and – keys. Leave this set to <u>1</u> .
B	Allows the unit to be put into and out of standby mode. The current mode is shown in the menu. Set to <u>out of standby mode</u> .
C	Allows the current A/D input channel to be selected.
D	Shows the state of the digital inputs (not used in this application).
E	Allows the external sub-channel to be set (not used in this application).
G	Allows the gain to be set between 1 and 128. Leave this set at <u>1</u> .
K	Causes the checksum generated by the communication to be checked.
O	Starts an offset calibration.
P	Selects unipolar or bipolar polarity. Set this to <u>bipolar</u> .
R	Sets the sample rate between 10 and 1027Hz. This can be set to suit the application. The lower the rate, the higher will be the effective resolution of the results. This will also directly affect the possible scan times. Select a value of <u>10</u> for the highest resolution.
S	Causes a system calibration to be started.
T	Sets up the filter cut-off frequency at 4, 40 or 400Hz. This filter has a long settling time and the lower frequencies will increase the scan time required. A value of 400Hz is typical.
U	Sets the digital output (not used in this application).
W	Sets the word length to 16 or 24 bits. A faster operation is possible when set to 16 bits, but this should be set to 24 bits in this application for the highest resolution.
Z	Sets the unit to sleep mode (not used in this application).

The display also shows the most recent readings for the selected channel in terms of the count and input voltage, the maximum and minimum values, standard deviation, and effective

resolution. This will assist the user in selecting suitable parameters for the scan. Pressing Escape returns the user to the main menu.

## 7.5. Scanning Mode

From the main menu, select 5 > Scanning Mode. The Scanning Configuration menu will be displayed. This menu allows the scanning configuration to be completed and the scanning operation to be started.

The individual sensor axes can be selected for recording. If only one sensor is used then the sensor should be connected to the Mag-03/1 input and only the axes for sensor 1 should be selected as active. To deactivate the second sensor channels, select keys 3 to 5 and then select n to deactivate that channel.

To set the scan interval, select key 6. This will show the range of scanning times available and the user should then enter a suitable time. A scan interval of between 1 and 5 seconds may be suitable for high resolution measurements.

To select the scan type, select key 7. This will toggle the type between Normal and Self-Calibration. For most operations, select Normal. Selecting Self-Calibration will cause a calibration operation to be carried out at the start of each scan. This will take a little longer and will require a longer scanning interval than for a normal scan. A self-calibration scan will also cause the offset and full scale results to be saved at the front of each scan, and make the data more difficult to interpret.

When the active channels, scan interval and scan type have been selected, press Enter to perform the scan. The unit will then sign on, perform a calibration scan and request a name for the data file; or, simply press Enter for no data file to be recorded. Data will be saved in the same folder as the program if no path is specified.

**Note:** Any path specified must be valid and the folders must already exist. No default extension is generated so the full filename and extension should be specified, e.g. C:\magdata\mydata.dat.

**Note:** Take care not to use an existing file name for the data. If a file exists it will be overwritten and the previous data lost.

When the data file name has been entered and the Return key is pressed, the scanning operation will start. The channels will be shown at the top of the screen with the sensor range. The magnetic field recorded in each axis will be shown and updated after each scan. The total scanning time will be shown. The scan number will be shown at the bottom of the screen with the scan interval.

**Note:** When a scan is started, if averaging has been selected in the Polled mode menu then there might be a considerable delay before the first results are seen.

Scanning will be halted when any key is pressed. A short delay will occur while the current scan is completed and the program will then return to the Scanning Configuration menu. Further scans may then be started or the user may return to the Main menu using the escape key. Using the escape key from the Main Menu will terminate the program.

## 8. Recorded Data Format

The data is recorded as tab separated ASCII data formatted in columns as follows:

Date	Time	X1	Y1	Z1	X2	Y2	Z2
------	------	----	----	----	----	----	----

The data is shown as month/day/year; the time as hour:minute:second; and the magnetic field for each axis in  $\mu\text{T}$  with four decimal places. The least significant digit therefore represents 0.1nT.

## 9. Electromagnetic Compatibility

The Mag-03DAM has a low magnetic signature and contains no high frequency electronics likely to cause emissions that could affect other apparatus. The metal case, constant voltage charger and lead-acid battery all combine to minimise any emissions.

**Note:** While the unit is unlikely to be affected by interference from other equipment in the normal operating environment, avoid operation close to a source of high electromagnetic fields to prevent pick-up that will be evident as noise in the recorded magnetic field values. Due to the sampling operation of the Mag-03DAM this noise may cause aliasing, where the noise signal appears to have a frequency lower than the true value.

## 10. Connecting External Signals

If only one sensor is connected to the data acquisition module then up to three single ended inputs can be recorded by the user in place of the three axes of the second sensor. It is then necessary for the user to scale the input voltage to suit the full scale input of the data acquisition module and modify the program as required.

The sensor should be connected to the Mag-03/1 connector and the user's inputs connected to the Mag-03/2 connector. The pin connections are shown in drawing DR0681, available from Bartington Instruments.

The full-scale channel inputs are  $\pm 10\text{V}$  with respect to the common input. The supply 0V is connected to the earth terminal on the rear panel. The input circuit has a voltage divider which reduces the voltage applied to the internal data acquisition board to  $\pm 5\text{V}$  full scale and presents an input impedance of 20k $\Omega$ . The common input is connected to the supply 0V via a 1M $\Omega$  resistor. The supply 0V, +15V and -15V normally provide a power supply to the sensor but can be used for

external sensors. The absolute maximum current available is  $\pm 20$  mA. Alternatively, an external, fully isolated supply can be used. The input signals should be referred to the supply 0V. The common line should be maintained within 6V of the supply 0V and no input should exceed  $\pm 12$ V.

**Note:** Avoid connecting any sensor that could introduce noise into the power supply lines as this will affect the operation of the sensor.

**Note:** The data acquisition module analogue inputs have a 2/1 voltage divider and the voltage reported by the programs will reflect this. For further information on the operation of the data acquisition card see the Lawson Labs Model 201 manual.

## 11. Servicing



**Caution:** Servicing should only be undertaken by a qualified person with the appropriate knowledge and measuring equipment. If in doubt, the equipment should be returned to the manufacturer for repairs.

### 11.1. Access

Access to the internal circuits can be obtained by carefully pulling off the plastic bezels around the front and rear panels. These bezels are held by lugs at the sides of the panels and can be removed by squeezing the corners to expand the sides away from the front panel. When the bezels have been removed, the screws holding the front and rear panels to the case will be exposed. Each panel is held by four self-tapping screws. When the screws securing the front panel are removed, the top of the case will slide forward to allow access to the internal circuitry.

The battery is held in position by means of a clamp across the top and by the rubber feet of the circuit board fixing screws. The data acquisition card is situated towards the front of the module whilst the board containing the power supplies, fuse, etc. is towards the back.

### 11.2. Battery Replacement



**Caution:** The battery is of the fully sealed lead acid type and can deliver current in excess of 40A. Do not under any circumstances short circuit the battery.

See the product brochure for battery type.

To replace the battery, remove the nuts holding the top battery clamp, disconnect the two spade connectors and lift the battery out.

**Note:** When fitting the new unit, ensure that the battery has the rubber spacers fitted to the side and fit this side down.

Connect the spade terminals after fixing the battery in position.



**Caution:** Avoid shorting the terminals of the battery as it has a very high short circuit discharge current which could cause serious injury. Cover the battery terminals with insulating tape until ready to connect to the rest of the circuit.



**Caution:** When changing batteries in this equipment, ensure that the replacement battery is of the same type as shown in the product brochure.

#### 11.2.1. Shipping the Battery in this Equipment



**WARNING:** Batteries and equipment containing batteries should only be shipped in accordance with local regulations. Refer to the IATA website ([www.iata.org](http://www.iata.org)) for regulations regarding air transport.



**Caution:** If there is any doubt at all as to the integrity of a battery (for example, cracked or dented casing) then it must not be shipped. Remove it from the equipment and dispose of it according to local regulations.

### 11.3. Fuse Replacement

The battery is protected by a fuse fitted on the circuit board PC45. Access to the circuit board is as described above. Only replace the fuse if the fault causing it to blow has been found and corrected. See the product brochure for fuse type.

### 11.4. Fault Finding

Examples of possible fault conditions are given in the fault finding table below with a guide to their cause and remedy. Measurements on the module should be made with a high impedance digital voltmeter or oscilloscope.

FAULT	CHECK	RESULT	REMEDY
Failure of program to sign on (cannot wake data acquisition module)	Power is switched on at module	Correct	Next check
	Battery is charged	Low voltage	Connect mains adaptor
		Correct	Next check
	Connections to serial port	Apparently correct	Next check
	Computer comms port allocation	Incorrect/unknown	Change using DRVR201 program.
		Correct	Next check
15V supply to data acquisition board	No supply	Replace MAD 4030 $\pm 15V$ power supply	
	Correct	Change data acquisition board	
Failure to operate on battery power	Operation on mains adaptor	Correct	Next check
		No operation	Go to first fault symptom
	Internal 1A fuse on PC45	Blown	Identify short circuit and replace fuse
		Correct	Next check
	Battery voltage on charge	Correct	Replace battery
		Low voltage	Replace MLS 4040-8 +15V supply or D2/D3
Failure to record the input variation on any one channel	Connections to sensor by connection to other input connector	Channel now correct	Test and repair input resistor network or connections
		No improvement	Test sensor and cables

## 12. Further Information

In addition to the offered control software, users may wish to provide their own acquisition software. The A/D card used is as specified in the Product Datasheet DS2519.

Additional information for communication with the A/D, current dlls, and example of interface code can all be found on Lawson Lab [website](#).

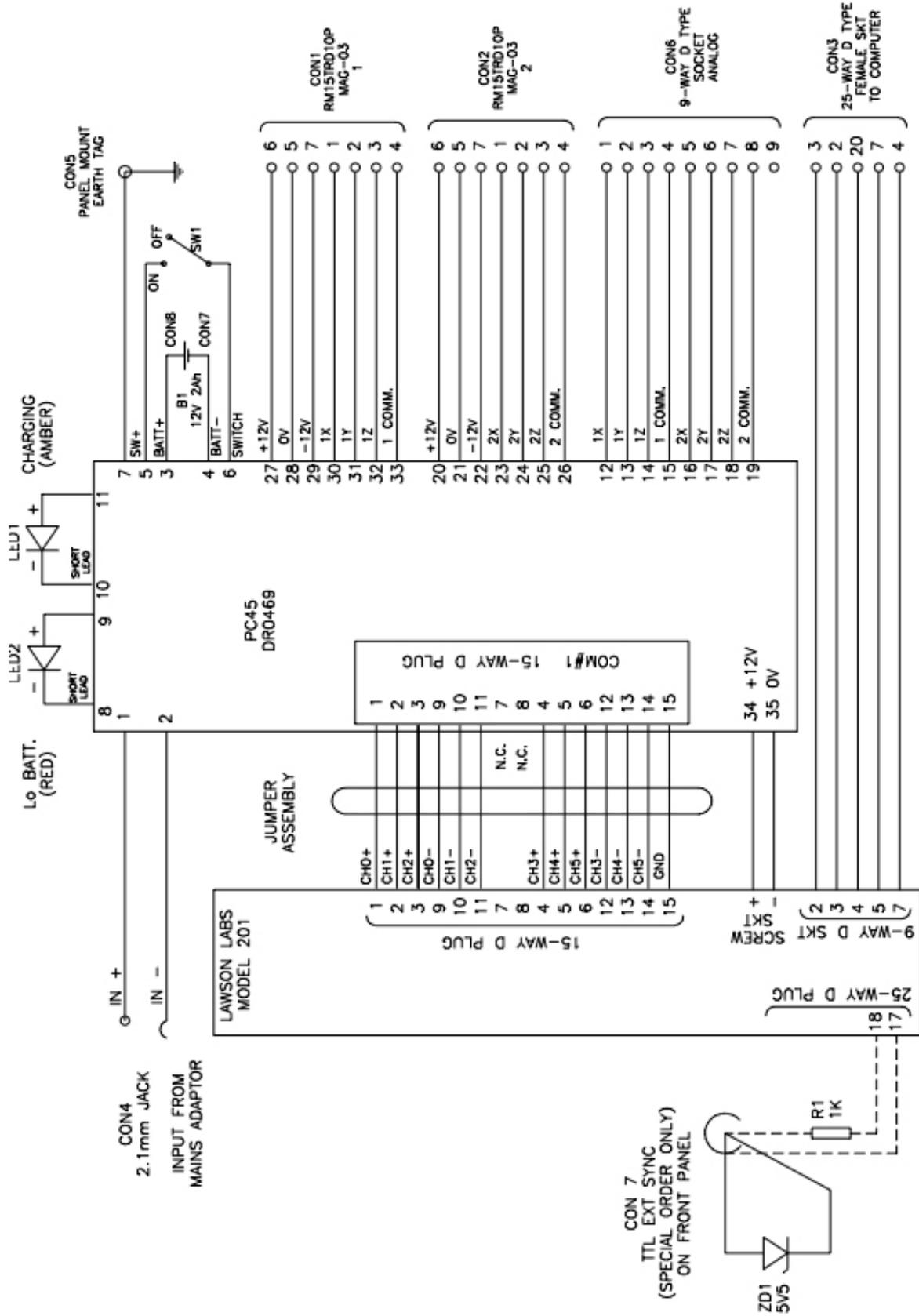
## 13. End of Life Disposal

### 13.1. Waste Electrical and Electronic Equipment (WEEE) Regulations



The Mag-03DAM complies fully with RoHS (Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment) Regulations current at the time of printing. However, electronic equipment should never be disposed of in normal waste. For information about disposing of your sensor safely, check local regulations for disposal of electronic products.

Appendix 1



DR0681



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