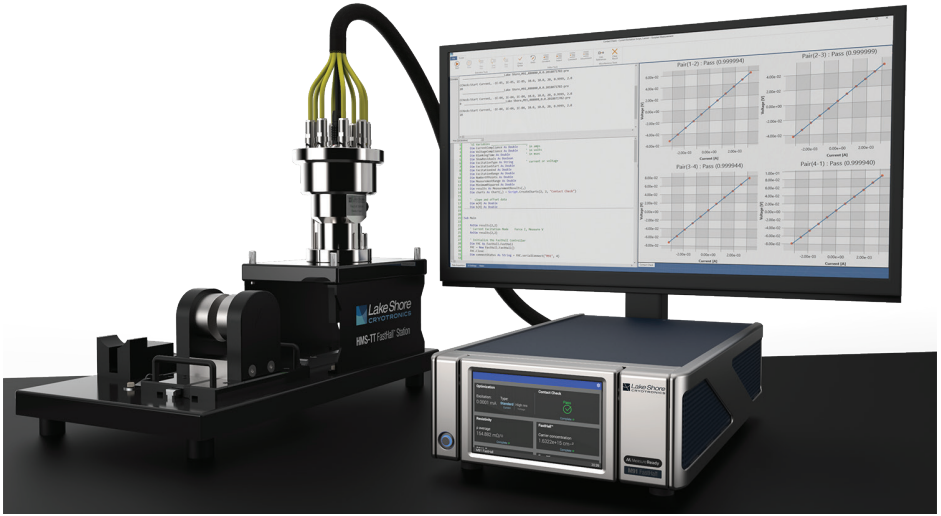
Quick Start Guide

MeasureReady

FastHall™ Station



Lake Shore
CRYOTRONICS

Safety Precautions

Observe these general safety precautions during all phases of instrument operation, service, and repair. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended instrument use. Lake Shore Cryotronics, Inc. assumes no liability for Customer failure to comply with these requirements.

The MeasureReady™ M91 FastHall™ measurement controller protects the operator and surrounding area from electric shock or burn, mechanical hazards, excessive temperature, and spread of fire from the instrument. Environmental conditions outside of the conditions below may pose a hazard to the operator and surrounding area.

- Indoor use
- Altitude to 2000 m
- 23 °C ±5 °C at rated accuracy
- 10 °C to 35 °C at reduced accuracy, <65% relative humidity non-condensing
- Overvoltage category II
- Pollution degree 2
- Mains fluctuations up to ±10%

Ground the Instrument
To minimize shock hazard, the instrument is equipped with a 3-conductor AC power cable. Plug the power cable into an approved 3-contact electrical outlet or use a 3-contact adapter with the grounding wire firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet Underwriters Laboratories (UL) and International Electrotechnical Commission (IEC) safety standards.

Ventilation
The instrument has ventilation holes in its side covers. Do not block these holes when the instrument is operating. Ensure that there is 1 in (25 mm) clearance on both sides after rack mounting.

Do Not Operate in an Explosive Atmosphere
Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

Keep Away from Live Circuits
Operating personnel must not remove instrument covers. Refer component replacement and internal adjustments to qualified maintenance personnel. Do not replace components with power cable connected. To avoid injuries, always disconnect power and discharge circuits before touching them.

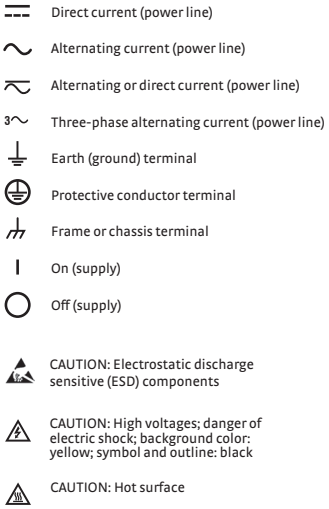
Do Not Substitute Parts or Modify Instrument
Do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to an authorized Lake Shore Cryotronics, Inc. representative for service and repair to ensure that safety features are maintained.

Cleaning
Do not submerge instrument. Clean only with a damp cloth and mild detergent. Exterior only.

Desktop Installation
When installing the instrument in a desktop environment, ensure it is mounted on a flat, level surface.

Improper Use
If the instrument is used in a manner that is not specified by Lake Shore, the safety protections provided by the instrument are no longer guaranteed, and may be impaired.

Child Safety
This equipment is not suitable for use in locations where children are likely to be present.



Key Specifications

NOTE: For full specifications, see: https://www.lakeshore.com/FHS

Ambient temperature
23 °C to ±5 °C at rated accuracy, 10 °C to 35 °C at reduced accuracy

Power requirement
100 V to 240 V (universal input), 50 Hz or 60 Hz, 30 VA

MeasureReady™ M91 FastHall™ measurement controller size
216 mm wide × 87 mm high × 369 mm deep
(8.5 in × 3.4 in × 14.5 in), half rack

Measurement platform with magnet and insert size
254 mm wide × 330.2 mm high × 457.2 mm deep
(10 in × 13 in × 18 in)

LN_2 option with 0.75 T magnet and stand size
140 mm wide × 235 mm high × 209.6 mm deep
(5.5 in × 9.25 in × 8.25 in)

Model 155 precision I/V source (gate bias option) instrument size
216 mm wide × 87 mm high × 369 mm deep
(8.5 in × 3.4 in × 14.5 in), half rack

Weight

M91 FastHall™ measurement controller:	3.2 kg (7 lb)
Measurement platform with magnet and insert:	9.1 kg (20 lb)
LN_2 option with 0.75 T magnet and insert:	5.4 kg (12 lb)
Model 155 precision I/V source:	3.2 kg (7 lb)

Introduction

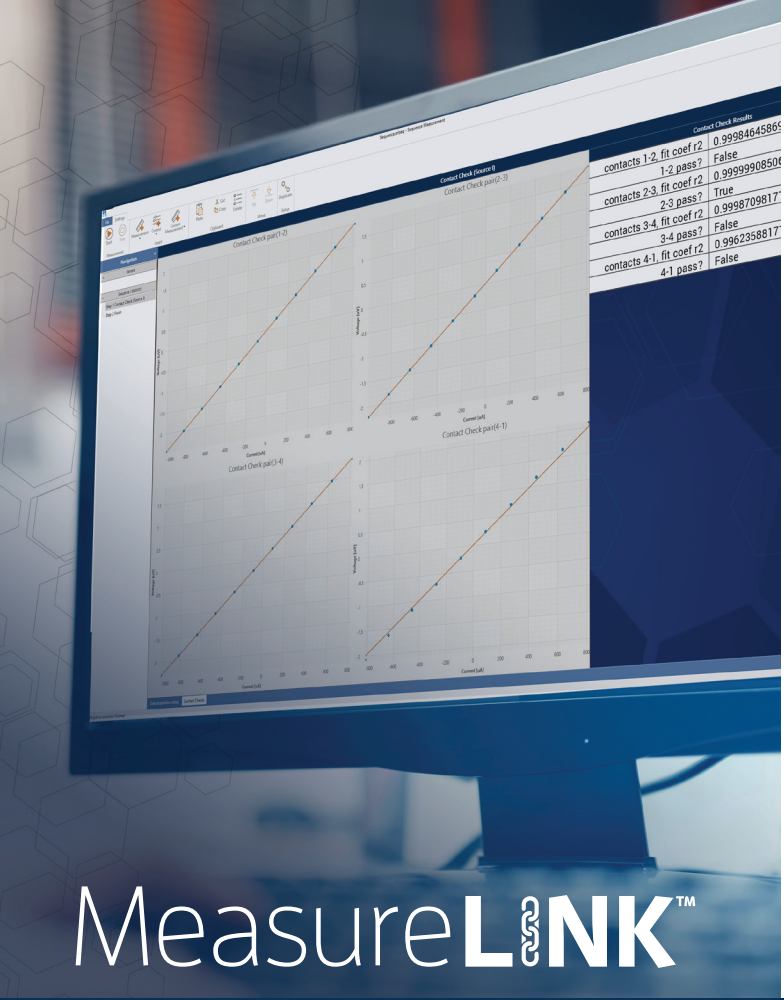
This guide provides basic information for getting started with your MeasureReady™ FastHall™ Station. For further information, see our website.

Items included with the MeasureReady™ FastHall™ station:

- MeasureReady™ M91 FastHall™ measurement controller with high resistance option (M91-HR)
- Measurement platform with high performance sample insert and 1 T permanent magnet
- Windows® 10 computer
- MeasureLINK-MCS™ software with scripting development license and FastHall™ application pack:
  - Fully automated Hall measurement data collection and analysis
  - Data table, charts, and reports
  - Creates .csv data file output for further analysis
- Sample card starter kit (includes both solder and prober cards)
- One set of triaxial cables

Features

- Van der Pauw and Hall bar geometries supported
- Excitation parameter optimization for one-button operation
- High performance for measuring mobilities down to 0.01 $cm^2/V\ s$ and sample resistances of 10 mΩ to 1 GΩ
- Triax connections with driven guard all the way to sample
- Fully enclosed electrically shielded measurement
- Light-tight measurement space
- Sample space purge fitting for controlled measurement space
- Automatically creates data files; software development kit allows for full measurement customization
- Uses the same sample cards as Lake Shore's premium electromagnet-based 8400 Series Hall measurement system
- 2-year standard warranty



MeasureLINK™-MCS software

The FastHall™ station uses MeasureLINK™-MCS software, which is pre-loaded on the system computer. The software can also be downloaded at no charge from https://www.lakeshore.com/software. The FastHall station includes the latest version of the scripting development license (ML-SDL), which allows users to edit the standard experiments and create new ones.

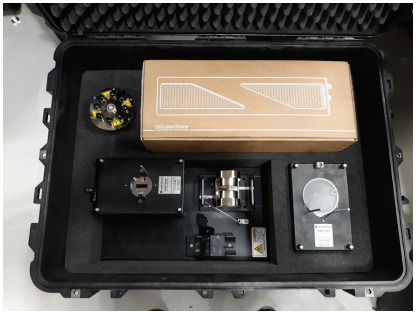
MeasureLINK software requires activation. An activation code (located on the computer desktop in a file named "MeasureLINK activation code") is required to register the product and to receive an annual license. MeasureLINK software and the scripting development license need to be reactivated annually (no annual fee, except when upgrading to the new version).

The software allows the user to combine environmental and electrical instrumentation into a coordinated measurement system. The software provides a simple software driver connection for Lake Shore instruments, and a generic driver for third-party instruments. MeasureLINK™ has a built in Visual Basic interpreter that permits simple user Interfaces and measurements, including the ability to construct, save and run data tables, charts and output files.

See the integrated Help files within the MeasureLINK™-MCS software for more details.

Unpacking

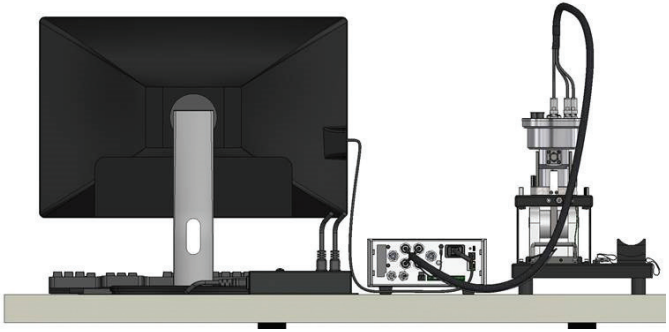
1. Inspect all items for both visible and hidden damage that occurred during shipment. If there is visible damage to the contents, contact the shipping company and Lake Shore immediately.
   NOTE: Procedures vary with shipping companies. Keep all damaged shipping materials and contents until instructed to either return or discard them.
2. Check off each item on the packing list as it is unpacked.

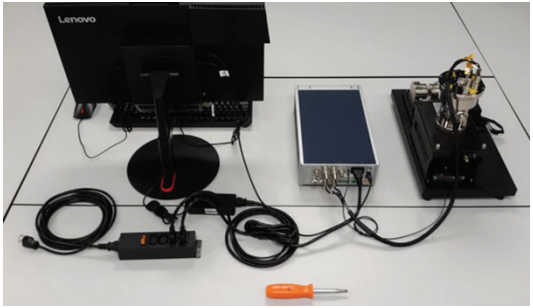


3. Unpack the measurement platform and the M91 FastHall™ measurement controller.
4. Unpack the computer and monitor: The system computer and monitor are packed in the original manufacturer's packaging. Remove the packaging and set these components aside in preparation for completing the system setup and assembly.

Connections and Installation

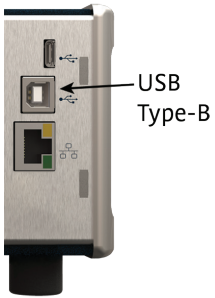
Basic connections are shown here. For further details, see the MeasureReady™ M91 FastHall™ measurement controller user's manual.



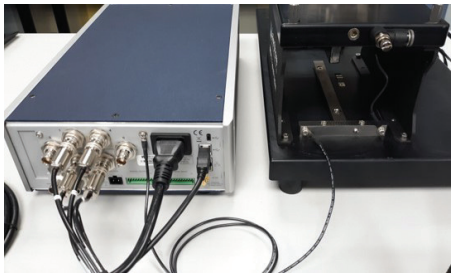


Connections

1. Connect the computer, monitor and peripherals: The FastHall™ station comes with an integrated computer and monitor. A USB Type-B cable is provided to connect the computer to the USB connector on the M91.
2. Connect the M91 FastHall™ measurement controller.



3. Connect the ground wire from the measurement platform to the M91 using a Phillips screwdriver.



4. Mount the sample insert onto the standard light-tight option body.

5. Connect the triaxial cables. The ends marked with warning labels attach to the insert.
6. Connect the instrument AC power cord to the back of the M91 FastHall™ measurement controller.
7. Connect the computer and instrument power cords to the supplied IEC outlet strip.
8. Using the supplied *country-specific* AC power cord, connect the IEC outlet strip to the wall.

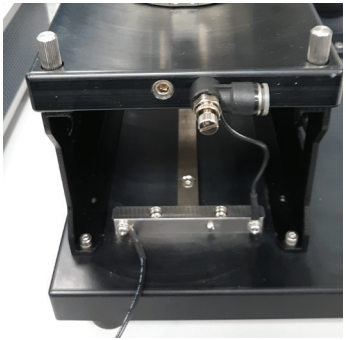
Optional components

Connect the gate bias: For applications requiring a gate bias signal, the voltage source is connected as follows:

- V_{low} = source holder pin 7
- V_{hi} = source holder pin 8
- SIG-RTN connection: generally required to connect the signal common connectors of the M91 and gate bias source together..

Gas connections

A flow control valve is provided on the back of the light tight option body to allow users to connect to the sample space for inert gas purge. The fitting is sized for 8 mm or 5/16 in tubing. The sample space includes a 0.5 PSI pressure relief valve. The user is responsible for providing regulated inert gas.



Operation

Magnet assembly

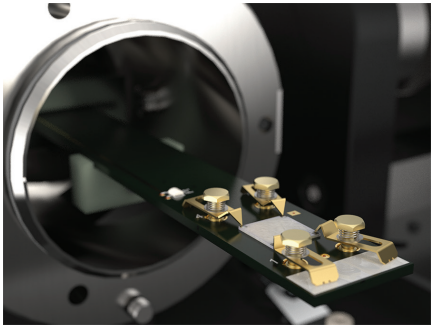
The standard FastHall™ station is provided with a nominal 1 T permanent magnet. The N-S orientation is marked directly on the base of the magnet. The magnet is mounted to a base palette with guide assembly, which aligns to a guide track mounted to the measurement platform. The magnet assembly can be moved back and forth along the track. There is a mechanical detent on each end of the track to positively identify the magnet placement with respect to the sample. This ensures the placement of the magnet, and therefore the magnetic field, is repeatable. To reverse the field, the magnet can be slid past the detent, rotated 180° and replaced on the track. Labels on the option bodies and magnet assemblies explain how to orient the magnets to create the desired fields. For further details, see the user's manual.

The FastHall™ station is a complete Hall measurement system utilizing a permanent magnet. It automates the process of making the measurement, and provides an easy way to determine important transport properties such as material resistivity, carrier concentration, mobility and the Hall coefficient.

Sample Insert

Samples for Hall measurement have either four (van der Pauw geometry) or six (Hall bar geometry) connections. Four triaxial cables are included and connect the M91 to the top of the sample card. Additional cables may be purchased from Lake Shore.

Connect the sample insert: The sample insert is intended to be easily removable to gain access to the sample. Two thumb screws are located on each side of the sample insert. When the screws are loosened, the holder can be lifted off of the magnet assembly. Two guide posts are provided to ensure that the sample aligns properly and does not touch the sides of the electrical shield when being inserted or removed. Additionally, the guide posts ensure that the sample card cannot be reversed.



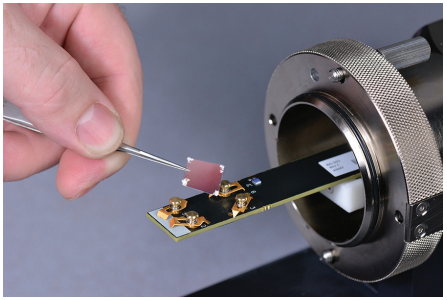
Install a sample card into the sample insert: Hold the card firmly and push into the card guide until it engages. Push into the sample holder.

Exchanging a sample

The FastHall™ station uses a high precision sample card with plug-in sample cards. The sample cards are available in two basic varieties, prober cards and solder pad cards.

The prober card has four, spring-loaded contacts to implement a van der Pauw geometry sample with maximum dimensions of 10 × 10 mm.

The solder connection sample card has 8 connection pads in the sample area. Connections labeled 1 to 6 are intended for the connection of either a van der Pauw geometry (pins 1 to 4), or a Hall bar geometry (pins 1 to 6) sample with maximum dimensions of 10 × 10 mm. Two additional connection pads are located between connections 2 and 3. These pads are connected to the top of sample card. Connections 7 and 8 are intended to provide a gate bias capability as needed.



Making a measurement

The basic Hall measurement consists of three steps:

1. Checking the sample contacts to ensure they are ohmic (i.e., linear).
2. Measuring the resistivity. These first two steps are performed at 0 T field.
3. Placing the sample into a known magnetic field and measuring the Hall voltage.

After the completion of these measurements, the derived parameters can be calculated. The FastHall™ station automates the process of entering the required input parameters, collecting the measurement data, and reporting the output results.

The steps for completing a standard measurement are shown below. For more details, see the MeasureReady™ M91 FastHall™ measurement controller user's manual.

Making a static Hall measurement with MeasureLINK™-MCS software

Scripts for fixed point Hall measurements are included in the MeasureLINK-MCS™ software. This script completes a Hall measurement at a single field for a van der Pauw sample. To use this script, open the software and follow the steps below.

1. Click **Sequence**.
2. In the Sequence window, click **Measurement**.
3. Click **M91 FastHall™.**
4. Click **Hall measurement.**
5. Fill out the fields in each section of the screen:
   - **Preferences:** defines where and how data will be stored, and the units for displaying data.
   - **Measurement Setup:** defines the sample parameters of the measurement.
   - **Optimization:** determines excitation type and values, and blanking time.
   - **Contact Check:** when selected, the measurement will complete a contact check.
   - **Resistivity:** when selected, the measurement will complete a resistivity measurement.
   - **Hall:** when selected, the measurement will include a Hall measurement.

Included in the sample card kit is one card with InAs mounted on the card. This is a n-type material. To run this sample, insert the card into the sample card and mount the sample card onto the light tight box. Set the MeasureLINK software to these parameters:

- **Preferences:** choose your desired settings, or use the defaults settings.
- **Measurement Setup:** set the sample thickness to 250 µm. Use the default values for the rest of the settings in this section.
- **Optimization:** click **Full optimization**, then use the default values.
- **Resistivity:** click **Include resistivity**, then use the default values.
- **Hall:** click **Include Hall**, Enter the Magnetic field value on the magnet label. Use the default values for the rest of the selections.

After setting the parameters, click **Start**. The software will tell you when to move the magnet. When complete, the carrier type should be n type and the mobility about 24000 $cm^2/(V\ s)$.

Contacting Lake Shore

The Lake Shore Service Department is staffed Monday through Friday between the hours of 8:00 a.m. and 5:00 p.m. EST, excluding holidays and company shut down days.

Contact Lake Shore Service through any of the means listed below. However, the most direct and efficient way is to complete the online service request form at https://www.lakeshore.com/Service/.

The Lake Shore Forum is also a great place to look for solutions, to post issues, and to share successes: http://forums.lakeshore.com/.

For further documentation and information, please see https://www.lakeshore.com/FHS

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