6625A-QHR System

Complete Quantum Hall Resistance System

Introducing the World's Most Advanced Turn-Key QHR System!

Guildline Instruments 6625A-QHR System has been developed to meet the needs of Standards Laboratories around the world for an improved level of accuracy in the calibration and maintenance of primary resistance standards.

The 6625A-QHR System is based on 60 years of Guildline expertise in precise resistance measurements and on over 50 years of design and manufacturing expertise with Direct Current Comparator (DCC) Resistance Bridges.

Guildline has being worked closely with Oxford Instruments, a company that also has over 50 years of experience, to supply the cryogenic and superconducting magnet systems; and with a leading National Metrology Institute (NMI) that has over 20 years of experience developing semiconductor Quantum Hall Effect (QHE) sensors. Guildline has fully integrated all required system components to provide customers with an advanced, easy-to-use, fully automatic QHR System!

6625A-QHR Features

- Complete Turn Key System – Fully integrated and ready to use!
- Built in Nano-voltmeter for Hall resistances and longitudinal resistances!
- Pre-Cool with Nitrogen for cost savings!
- 4 to 6 Day Uninterrupted QHR Operation!
- Option for Magnetic Field Strength up to 14 Tesla!
- Best DCC Accuracy: ± 0.02 ppm of Reading!
- Premium QHR sample included, built by NMI with 20 years' experience!
- BridgeWorks™ Data Acquisition Software!

The 6625A-QHR Provides the Best in Innovations, Cutting Edge Technology, and Most Importantly, the Best Measurement Performance of Any QHR System with a DCC Bridge Manufactured Today!

The 6625A-QHR System provides an absolute value of resistance related to the von Klitzing constant of 25812.807 Ω. To provide this reference, a Quantum Hall semiconducting device is maintained at 1.5 Kelvin with a He-4 refrigerator within a high magnetic field. A superconducting magnet is used to generate a background field of up to 12 Tesla. Under these conditions the Quantum Hall plateaus of resistance are easily obtained. This system has the ability to make Turn-Key measurements of resistance devices at any point within the measurement range of 10 mΩ to 100 kΩ.

6625A-QHR Quantum Hall Resistance System

6622A-QHR Room Temperature DCC Bridge

The 6622A-QHR Bridge, **designed for QHR measurements**, is a room temperature DCC can measure **Hall resistances (Rxy), longitudinal (Rxx) resistances,** and contact resistance of the Quantum Hall device using the **Built-In Nano-voltmeter**. The 6622A-QHR Bridge, operating at **room temperature**, will scale from the quantum Hall resistance value of 12,906.4035 Ω to nominal resistance values of 1 kΩ, 10 kΩ, and 100 kΩ. The 6622A-QHR full operating range is **from 0.01 Ω to 100 kΩ** with best **uncertainty of 0.02 ppm**.

This bridge will be used with enhanced Bridgeworks software to **fully control and operate the QHR system**, and is capable of automated resistance measurements enabling the transfer of the QHR resistance to other resistance devices throughout the System measurement range.

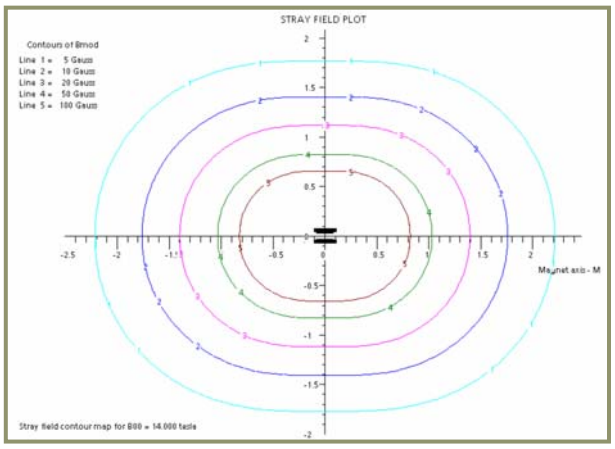
Every effort has been taken in the 6622A-QHR design to reduce noise and error. **Thermal EMF effects are eliminated** by automatic current reversal. The **unique architecture** of the bridge and its **control algorithm** further removes gain and offset errors in the **Nano-voltmeter balance detector** and the **precision toroid**. The end results are shown by **long term accuracy and linearity** without the need for routine, frequent verification tests or calibrations. The 6622A-QHR incorporates unique 'self-calibration' functionality for the embedded null detector which is performed as part of each measurement. In addition, via the standard interchange technique, the bridge automatically performs a 'self-calibration' of the measurement ratios to $< 0.02 \times 10^{-6}$.

The Bridge provides a full 10 digits of resolution (i.e. 1 part in 10^{10} for all resistance values) and the ability to **graphically see** the data (trending). You can have the data presented in a **summary or detailed format** right on the Bridge Screen or available via PC Base BridgeWorks Software. Measurement and **Uncertainty Analysis** you need as a Metrologist or to meet the requirements of ISO 17025 Accreditation!

Examples of Actual 6622A Display Pictures Taken at Trade Shows - Note Std Dev is in ppm showing **ppb performance**!

OXFORD Cryogenics

The **cryogenics** cooling **Dewar**, **Superconducting Magnet**, **associated power supply**, and the **QHR device insert** are provided in cooperation with **Oxford Instruments**. The superconducting magnet system is equipped with a low loss Dewar that can contain up to **70 litres of liquid helium**. It is capable of producing DC magnetic fields up to **12 Tesla** in normal operation and **14 Tesla** with using an optional lambda point refrigerator. The Dewar can maintain the liquid helium level for routine **QHR operation for 4 to 6 days** with the setting of the magnet and the QHR device inserted into the Dewar. The power supply offers bi-polar DC current to support the magnet persistent mode switch feature. For the consideration of safety, the **magnet quench detection** and protection is designed and built into the System. The magnet will be de-energised automatically **without quenching** when the helium level falls below the pre-set limit. A **safety valve** is also built-in to ensure the pressure inside the Dewar is under the pre-set limit. The magnet and Dewar both have liquid helium level and temperature sensors and there is a temperature sensor set up close to the QHR sample.



The **QHR device insert** has a **TO-8 socket for mounting the QHR device**. The interface for the user to link the measurement system to the QHR sample is located on top of the insert. The insert can be easily inserted into the Dewar and **pulled out through the O-ring seal**. Optionally a **Split Hinged Insert** can be provided to allow sample insertions in room with ceiling heights **below 3.2 m**.

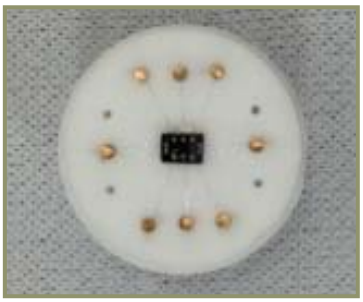
The cooling system includes the variable temperature insert (VTI), the needle, and the pump. The needle and the pump can control the temperature of the environment where the sample is located to reduce the nominal operating temperature of the sample to **1.5 Kelvin**. A temperature sensor is designed to be close to the needle on the bottom of the VTI.

Supporting all **standard cryogenic sensors** (ruthenium oxide, cernox, silicon diodes, platinum, thermocouple and RhFe), the system measures and controls temperatures to **1.5 K with a precision of 0.1 mK**. (24 bit A to D resolution).

The use of the room temperature **6622A-QHR DCC Resistance Bridge** and low loss Dewar greatly reduces the operation complexity and the consumption of liquid helium, thus **reducing the operating cost** of the 6625A-QHR System.

6625A-QHR Quantum Hall Resistance System

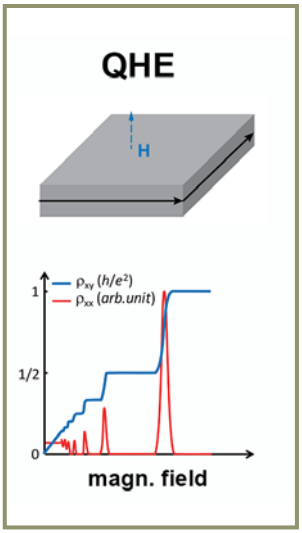
NMI QHR Sample



The QHR Sample is designed and manufactured by a **NMI** with over **20 years of experience developing QHR devices**. It can be operated on the **plateau of i =2 or i =4** under the operating current **lower than 100 μA.** Sample can be supplied with the magnet field strength of either higher than 9 Tesla or lower than 9 Tesla at the centre of plateau i =2. The longitudinal potential difference of the sample is **less than 20 nV** at nominal operating current. The contact resistance of the sample is less than **1 Ω at nominal operating current**. The sample can be mounted on a **TO-8 socket** which is part of the QHR device insert. As an option, the 6625A-QHR System can be **calibrated by a NMI** prior to delivery to a customer.

6622A BridgeWorks Software

Not only does Guildline provide unique DCC Bridge hardware, but we offer complete solutions for software as well. Guildline's proven **BridgeWorks** software provides for setup, control, measurements, and reporting. BridgeWorks is provided free with any of the Bridges in the 6622A Series. **Optional BridgeWorks plug-ins** are available to expand BridgeWorks functionality, including control of a QHR System. BridgeWorks software is extremely powerful, yet **straight forward and user friendly**. The software comes with all of the useful and convenient features commonly found in **Windows based** commercial software programs. **On-line context help** is available to provide added assistance in understanding the functions of the software. BridgeWorks was **developed in LabVIEW©** offering direct compatibility to all National Instruments GPIB interfaces. These interfaces come in a wide variety of connection options to your PC such as **USB, FireWire, Ethernet, PCI, PCMCIA, IEEE 488.2 RS232/485** and more. Guildline can even provide a complete Resistance Measurement System with the 6622A Series by adding Resistance Standards, Scanners, and software. **Complete turnkey solutions**!



The BridgeWorks QHR plug-in software controls the 6622A-QHR Resistance Bridge, superconducting magnet and the rest of the QHR system. The QHR plug-in has routines to: check the remote connection of the instruments connected to the entire QHR System; display and change all system variables; and to modify control parameters and variables in order to optimize the QHR System to improve measurement uncertainty and speed. Note that the Guildline 6622A-QHR Bridge is the **only commercially available resistance bridge that allows dynamic changes to the measurement parameters** without having to stop the bridge and associated measurement. All other manufacturers require the measurement to be stopped in order to change key system variables.

For a **complete, automated resistance** measuring system, a 6622A-QHR Bridge can be used with Guildline's 6664C Low Thermal Scanners and Guildline's 6634A Temperature Stabilized Resistance Standards. When the Bridge is used with a Guildline low **thermal matrix scanner,** the software can turn the bridge into a **multiple-channel** calibration and measurement system. Timed, sequenced single or multiple tests can be initiated while the bridge is unattended.

All user **definable test variables**, such as excitation current, measurement speed, reversal rate, etc. can be **programmed on a per test basis**, giving the **users full control and flexibility** in conducting well designed experiments. Additionally, internal utilities reside within the software to enhance and **simplify the calibration of the 6622A** Series DCC Bridge by using the Guildline 6634A Series of Temperature Stabilized Resistance Standards.

OXFORD MF120LLD Integra System

Cryostat type: LLD1-FRP LN2 Liquid nitrogen-shielded low loss dewar & FRP neck

- Central neck diameter (nominal): 140 mm
- Top plate surface to magnet field centre position: 1352 mm
- Usable liquid helium volume (nominal) excluding tail and without insert fitted: 70 litres
- Liquid helium consumption: Dewar fitted with VTI or HELVL insert: <= 325 cc/h
- Liquid nitrogen volume (nominal): 66 litres
- Liquid nitrogen consumption: <= 250 cc/h
- Dewar height from ground level to top flange: approximately 1652 mm
- Dewar top plate diameter: approximately 622 mm

NOTE: Liquid helium consumption is specified for stated configuration(s) only. The figures specified are in static mode (magnet at zero or persistent 4.2 K field zero flow through insert)

Magnet type: S12/14/52/13 Vertical field solenoid superconducting magnet

- Central field at 4.2 K: 12 Tesla at 4.2 K, 14 Tesla at 2.2 K
- Ramp rate (nominal): 1.0 T/min at 4.2 K, 0.5 T/min at 2.2 K
- Operating current (nominal): = 120 A
- Magnetic field homogeneity: = 0.1 % total variation over a 10 mm diameter sphere (dsv)
- Magnetic field stability in persistent mode: <= 1.0 x 10E-4 relative/h measured at 12 T
- Clear bore diameter (nominal): 52 mm

NOTE: Ferrous materials in the environment: The offer assumes that NO static/structural steel is within 1.2 m, or moving steel is within 1.8 m the distance from magnetic field centre.

Magnet Power Supply: MERC-IPS-120-L magnet power supply with cryogen level meter

- Output current: ± 120 A nominal, ± 125 A maximum.
- Output voltage: ± 10 V
- Current output stability (typical): < ± 2.8 mA
- Current output drift (typical): < 0.14 mA/h/°C
- Current setting resolution: 0.1 mA
- Operating voltage: Single Phase 100-240 VAC 47-63 Hz (800W) per unit (2 required for 120 A)
- 426 x 480 x 131 mm (W x D x H) per unit (2 required for 120 A)

Controller: MERC-ITC-3-AUX temperature controller and needle valve gas flow control

- Temperature Sensor Inputs/PID Control Loops: 3
- Heater output: 80 W per channel
- Operating voltage: Single Phase 100-240 VAC 50-60 Hz (650 W)
- 426 x 272 x 131 mm (W x D x H)

NMI QHR Sample

- Operational Plateau: i =2 or i =4
- Operational Current Range: < 100 µA
- i=2 plateau magnet field strength: sample can be supplied with either lower than 9 Tesla or higher than 9 Tesla specification
- Longitudinal Potential Difference: < 20 nV (at nominal operating current)
- Contact resistance: < 1 Ω (at nominal operating current)
- Socket Mounting: TO-8 socket

6622A-QHR Specifications

Resistance Standard	Ratio Specifications			
Actual Ratio	0.008 > Rx < 0.08	0.08 > Rx < 0.8	0.8 > Rx < 6.3	6.3 > Rx < 13.4
Nominal Ratio	**0.01 : 1**	**0.1 : 1**	**1 : 1**	**10 : 1**
1 Ω	± 0.6 ppm	± 0.3 ppm	± 0.02ppm	± 0.02 ppm
10 Ω	± 0.6 ppm	± 0.3 ppm	± 0.02 ppm	± 0.02 ppm
100 Ω	± 0.6 ppm	± 0.3 ppm	± 0.02 ppm	± 0.02 ppm
1 kΩ	± 0.6 ppm	± 0.3 ppm	± 0.02 ppm	± 0.02 ppm
10 kΩ	± 0.6 ppm	± 0.3 ppm	± 0.02 ppm	± 0.1 ppm

Specifications are relative, 2 Sigma (95 % Confidence Level) and include a ±1 °C Temperature Environment. Specifications are valid for 1 year

6622A-QHR General Specifications			
Linearity		± 0.005 ppm (1:1 to 13.4:1 Ratios)	
Display resolution (ppm)		Selectable (Programmable) from 0.0001 ppm to 10 ppm	
Temperature Coefficient		0.01 ppm/°C of reading (Outside Operating Temperature)	
Automatic current reversal rate (in seconds)		4 to 1637 programmable, increment of 1 second	
Fastest Measurement Sample Rate		2 seconds	
Communication		USB, IEEE 488.2, SCPI Based Language Instructions	
Test current (for measurements to 100 kΩ)	Range (±30 Vdc compliance)	10 μA to 150 mA	
	Resolution (μA)	1 μA	
	Accuracy [error(ppm) + offset(A)]	±100 ppm ± 10 μA	
Bridge Operating Temperature to Full Specifications		21 °C to 25 °C	69.8 °F to 77 °F
Bridge Maximum Operating Range (<50 % RH)		+18 °C to +28 °C	+65 °F to +82 °F
Bridge Temperature Storage Range		-20 °C to +60 °C	-4 °F to +140 °F
Power Requirements	Vac: 100V, 120V, 220V, 230V and 240V; All ± 10% 50 or 60Hz ±5 %, Or 45 Hz – 65 Hz		

Dimensions (Width x Height x Depth)		Weight	
440 mm x 200 mm x 465 mm	17.3" x 7.8" x 18.3"	27 kg	59.5 lbs

Ordering Information	
6625A-QHR	QHR System
	Includes Calibration Certificate, Operator and Software manual, and one set of Rs/Rx Low Thermal Leads
/RC	Report of Calibration Available at Nominal Charge
/RT	Specifies Rear Terminals versus Front Terminals (Default)