

Introducing the World's Most Advanced QHR DCC Bridge!



### FEATURES

- New Patented Toroid Design
- New Dual Processor Design
- New Dedicated High Speed Real-Time Processor For Fast Measurements
- New Built-in Windows 10 Computer and Touch Screen Display Providing Complete Measurement Results and Graphs
- Best Accuracy:  $\pm 0.015$  ppm of Reading at QHR currents of  $30 \mu\text{A}$  -  $100 \mu\text{A}$  with Interchange
- Fasted Measurement Speed of 2 Seconds
- Change All Key parameters "On-the-Fly" While the Measurement is Running
- Linearity:  $\pm 0.005$  ppm of Full Scale
- Resolution:  $\pm 0.0001$  ppm of Full Scale
- Fully Programmable USB, IEEE 488.2
- Industry Standard SCPI Programming Command Language
- BridgeWorks™ Data Acquisition Software
- Unique Calibration Support Strategy
- Complete Automated Measurements
- Quantum Hall Turn-Key Systems Available

**GUILDLINE INSTRUMENTS 6640Q QUANTUM HALL RESISTANCE (QHR) BRIDGE** has been completely redesigned to provide better uncertainties and more operational capability.

The 6640Q Quantum Bridge incorporates many patented new design and measurement technologies to provide a Precision Resistance Bridge operating at room temperature that will scale from the Quantum Hall resistance value of  $12906.4035 \Omega$  to nominal resistance values of  $0.1 \Omega$  to  $100 \text{ k}\Omega$ .

**THE 6640Q PROVIDES THE BEST IN INNOVATIONS, PATENTED CUTTING EDGE TECHNOLOGY, AND MOST IMPORTANTLY, THE BEST MEASUREMENT PERFORMANCE OF ANY DCC BRIDGE MANUFACTURED TODAY!**

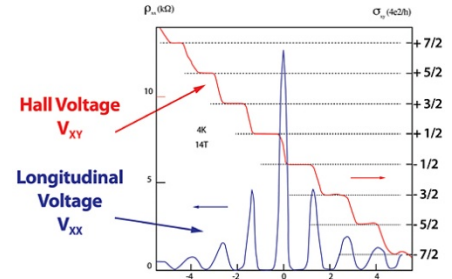
The 6640Q Bridge, utilizing an internal calibrated Nano-voltmeter as the null detector, is used to measure Hall resistances ( $R_{xy}$ ), longitudinal resistances ( $R_{xx}$ ) and contact resistance of a Quantum Hall device. The 6640Q is capable of making the measurements necessary to ensure the accuracy of the QHR Resistance Standard. It is a room temperature Direct Current Comparator (DCC) Resistance Bridge that has been designed to provide better uncertainties and more operational capability when used with Quantum Hall Resistance Systems (i.e. QHRs).

The 6640Q incorporates a new patented toroid design, Nano-voltmeter (i.e. null detector), two new faster processors, new internal communications structure, and new firmware. The new touch screen interface and associated embedded Windows 10 Computer makes the 6640Q easy to use while providing complete functionality for resistance measurements.

# 6640Q Quantum Hall Bridge

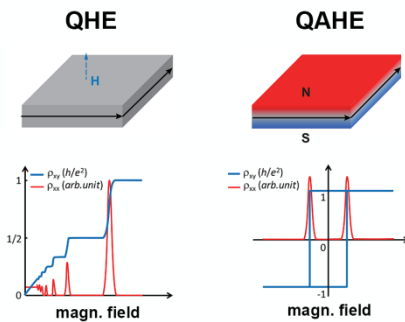
The 6640Q QHR Bridge is not merely a touch screen interface centered on the same technology used for the last 25 years, but incorporates the most advanced design and best operational features. The 6640Q is based on over 50 Years of Guildline's experience designing and manufacturing DCC Bridges; and incorporates customer feedback from over two hundred Guildline 6622A Resistance Bridges in use at NIMs, militaries, and calibration laboratories throughout the world.

In fact, many of the **design concepts incorporated** into this new 6640Q Bridge **are patent protected**. While the design enhancements are not visible, the end measurement results are clearly visible. These enhancements allow for considerably **less noise, faster measurement cycles, improved stability and repeatability**; and most of all, the world's most advanced operator interface found on any Resistance Bridge.



The 6640Q Bridge can be used to build up or down from the Quantum Hall value of 12906.4035  $\Omega$  to nominal resistance values from 0.1  $\Omega$  to 100 k $\Omega$ ; transferring directly to 1 k $\Omega$  and 10 k $\Omega$  with a relative accuracy of  $2 \times 10^{-8}$  (2 sigma level) or better at the 30  $\mu\text{A}$  to 100  $\mu\text{A}$  level required for QHR Systems. The 6640Q Quantum Bridge can be used stand-alone, with Guildline's Bridgeworks software, or with its advanced IEEE-488.2 Structure and Industry Standard SCPI Command Set. Guildline's **6664C Low Thermal Quad Matrix Scanner** is also available to automate this process and a customer can easily use their own software to make automated measurements.

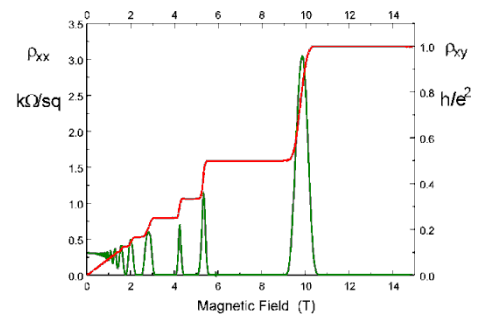
## 6640Q – The Absolute Best in Engineering Design and Innovation



For quality in measurements, you must have quality design and quality manufacturing in your standard. If you examine the internal layout of the new 6640Q Bridge you will find this **quality throughout**. Special attention has been paid to: isolation and use of shielding to reduce noise, better grounding, the latest in modern components to reduce affects due to temperature and power dissipation, increased resolution, better stability in excitation current, increased reliability, and faster measurement cycles. Add to this the **new patented designs** and a carefully thought internal and external layout; and you will find a **completely redesigned Bridge** that meets customer requirements today, as well as years into the future.

The 6640Q uses a **Tertiary wound current comparator** which is a **superior design** versus a binary wound comparator. The 6640Q comparator requires fewer taps and relays therefore is less noisy, and is faster (i.e. division by 3 results in fewer taps and a faster balance than division by 2). The 6640Q provides 27 bits of guaranteed resolution and **35 bits maximum resolution** which **ensures 0.0075 ppm or better resolution**. This allows a 6640Q to truly measure at the 0.015 ppm level **without allowance for rounding and filtering**. In comparison the competition only provides 25 bits of resolution. Given the limitation of 25 bits, the competition requires interpolation through heavy filtering in order to report measurements at the 0.015 ppm level.

Every effort has been taken in the 6640Q 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 **new precision toroid**. The end results are shown by **long term accuracy and linearity** without the need for routine, frequent verification tests or calibrations.



## Advanced Design Incorporates New Operators Interface

**The 6640Q uses a NEW 10 inch VGA capacitive touch screen with a full color graphical user interface.** The most visible feature on the new 6640Q Bridge is the 10 Inch display running Windows 10 software. This display not only has low noise characteristics, but is designed to provide maximum protection from Electromagnetic Interface (EMI) with respect to the internal measurement circuitry.

The embedded Intel processor running the Windows 10 operating system provides a modern user interface that is completely independent from the high-speed processor used to make the measurements, thus providing faster response times and lowering the measurement noise.

**USB** is standard with the universally recognized **Standard Code Programmable Interface (SCPI)** based commands incorporated as the programming language of choice. **IEEE 488.2** is provided in addition to USB. You can have a rack or bench mount model and even have your choice of **front or rear terminals**.

**IT IS IMPORTANT TO NOTE THAT THE 6640Q BRIDGE IS NOT THE SAME APPROACH TAKEN BY OUR COMPETITORS. RATHER THAN SIMPLY INCORPORATING A NEW SCREEN AROUND THE SAME OLD HARDWARE, FIRMWARE AND TECHNOLOGY, WE DESIGNED THE 6640Q FROM THE GROUND UP AS THE NEWEST AND TRULY NEXT GENERATION QUANTUM HALL BRIDGE.**

## Unique New Design Incorporates Two Processors

Older Guildline DCC Bridges had, and **competitive models** still have, only **a single old processor** for all functions. This older processor controlled the measurement circuitry, data collection, display, user interface, IEEE and communications, and much more. This work load puts a **heavy burden on the capability** of this single older-generation processor. The competition appears to make their instruments more modern by simply adding a larger screen, however all the functionality and control is still based on an older design with a very old processor. The use of a single processor, especially an older generation processor, makes it **very difficult to improve performance** and speed of a DCC Bridge, and makes it impossible to provide a modern user interface. **Guildline solved these issues** by using a complete new design for the 6640Q, including using two modern, very fast processors.



# 6640Q Quantum Hall Bridge

## System Controller and Interface Processor (Processor #1)

The 6640Q QHR Bridge contains an Intel based Computer which is dedicated to running the user interface and has a Windows 10 Operating System installed. This embedded Intel Computer also does all of the data analysis, display graphics, and controls the embedded 10-inch capacitive, multi-touch screen. This architecture allows the 6640Q to become the center of a larger measurement system via many different interfaces commonly available to a modern Windows 10 Professional computer such as GPIB, TCP/IP, RS-232, and USB. This computer processor, through Guildline's unique architecture, can also be placed into a slave mode allowing the 6640Q to be remotely controlled with the same flexibility as any remotely controlled Windows Computer. This allows the 6640Q to run in an already established larger system with an external PC and custom or off-the-shelf software; or to be operated remotely via a smart phone! Finally third party analysis software, such as Excel, can be installed right on the 6640Q Bridge thus providing enhanced capabilities.

## Measurement Processor (Processor #2)

The real heart of the 6640Q is its modern embedded high speed measurement processor. This is one of the latest real-time processors dedicated to the control of only the measurement circuitry hardware. The real-time processor ensures fast measurements and reliable control of the hardware such that the reported data is consistent and fail-safe. The embedded processor is dedicated to this function and is complete isolated and EMI shielded from the sensitive measurement circuitry.

With the **two processors working together** in the 6640Q, Guildline provides the best of both worlds. A real-time processor ensuring consistent reliable fast measurements; and the flexibility of an Intel computer running the Windows 10 operating system! This **allows advanced control and analysis** through Guildline's flexible software architecture as well as a limitless set of options provided by the Windows 10 Professional platform.

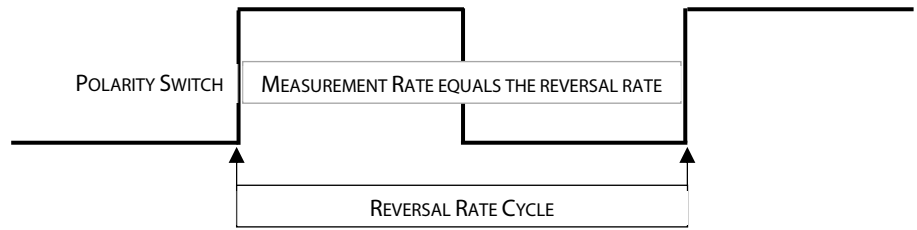
## Even More Design Advantages

The 6640Q Quantum Bridge provides a full  $10^{1/2}$  digits of resolution 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/IEC 17025 Accreditation!

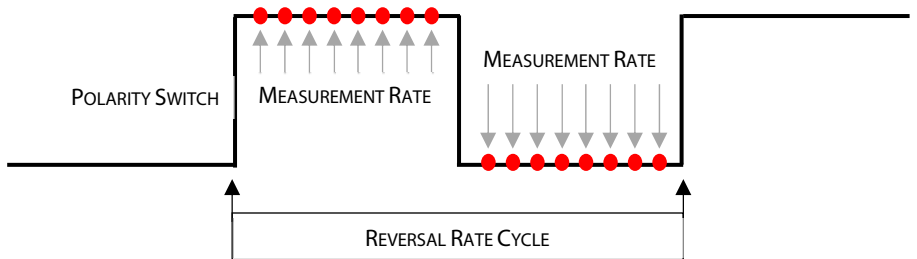
The 6640Q can be used in either a **fixed or automatic** mode of operation. In fixed mode, **measurement rate** is programmable, updating measurements from every 2 seconds to 14 minutes. In automated mode, a unique computerized algorithm provides automatic reversal rates, optimizing the measurement rate to the required uncertainty. The 6640Q, when used with the **Guildline Instruments Model 6634A Temperature Stabilized Resistance Standards**, effectively **eliminates errors** due to the effects of temperature environment.

## New Design Decouples the Measurement Rate From Reversal Rate

Old DCC technology, **used by competitors** and older Guildline Bridges, requires that a measurement be based on the polarity reversal. This can be represented by the figure shown to the right. While having statements such as reversal rates as low as 2 seconds, in truth – to meet published specifications, the reversal rates are typically 20 seconds or more. This equates to a **reading every 20 to 40 seconds**.



Like all of our new 6640 Series Bridges, Guildline's 6640Q QHR Bridge **decouples the polarity reversal rate** from the measurement rate allowing **measurements to be made much faster** than competitive DCC bridges. As shown in the right figure, you can independently specify a measurement rate and a reversal rate.

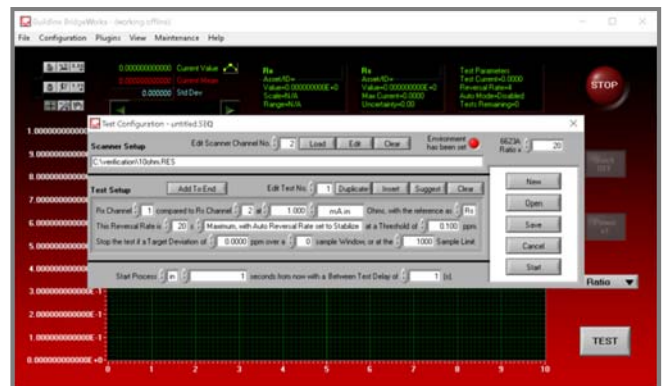


With the **6640Q's dedicated measurement processor**, many measurements can be made while on a single polarity. This allows a vastly **increased number of measurements** to be made on a **single reversal rate cycle**. Add to this our many other patented design features and you will find that Guildline's 6640Q QHR Bridge is truly the latest in innovations and technology. Guildline's **new 6640Q QHR Bridge provides best performance** across the entire resistance operating range. Imagine what you could now analyse and see with **complete data available from the entire measurement cycle**.

## 6640Q Software

Not only does Guildline provide unique DCC Bridge hardware, but we offer complete new solutions for software as well. Note that all bridge measurements, including automated measurements, can be controlled and results displayed by using the embedded Windows 10 computer that exists inside the 6640Q Bridge.

Alternatively, a customer can use Guildline's proven **BridgeWorks** software running on either the internal computer or an external computer. BridgeWorks Software is provided at no charge with the 6640Q QHR Bridge. **Optional BridgeWorks plug-ins** are available to expand BridgeWorks functionality including control of the superconducting magnet and the rest of the QHR system.





# 6640Q Quantum Hall Bridge

The QHR plug-in has routines to: check the remote connection of the instruments used in the 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. The software comes with all of the useful and convenient features commonly found in **Windows based** commercial software programs, and is designed to work with a touch screen. **On-line context help** is available to provide added assistance in understanding the functions of the software. The 6640Q Bridge software 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.

For a **complete, Automated Resistance Measuring System**, a 6640Q Bridge can be provided with Guildline's 6664C Low Thermal Scanners and Guildline's 6634A Temperature Stabilized Resistance Standards. This System is integrated, verified and tested in a rack a little more than 36" high (i.e. less than 1 meter). 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. **Complete turnkey solutions!**

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 measurements. No other manufacturer allows bridge measurement parameters to be changed while taking a measurement. Competitors require that the measurement be stopped, parameters reset, and the measurement restarted. As a result measurement data is lost. Additionally, internal utilities reside within the BridgeWorks software to enhance and **simplify the calibration of the 6640Q QHR Bridge** by using the Guildline 6634A Series of Temperature Stabilized Resistance Standards.



## 6640Q QHR Specifications

| <b>6640Q QHR</b>                                |  | Range 0.1 Ω to 100 kΩ. Specifications are relative and 1 year (except Interchange @ 24 hours), 2 Sigma Level (95 %) and within ±2 °C Temperature. Includes all secondary specifications including noise and linearity. |       |        |          |
|---|--|--|-------|--------|----------|
| Rs / Rx<br>(EITHER CAN BE SELECTED AS STANDARD) | <b>Ratio / Ratio Uncertainties (± ppm)</b> |  |       |        |          |
|   | Interchange <sup>1</sup> (1:1)             | 0.1 : 1 <sup>2</sup>   | 1 : 1 | 10 : 1 | 13.4 : 1 |
| 1 Ω   | 0.015                                      | 0.05   | 0.02  | 0.02   | 0.02     |
| 10 Ω  | 0.015                                      | 0.02   | 0.02  | 0.02   | 0.02     |
| 100 Ω   | 0.015                                      | 0.02   | 0.02  | 0.02   | 0.02     |
| 1 kΩ  | 0.015                                      | 0.02   | 0.02  | 0.02   | 0.02     |
| 10 kΩ   | 0.020                                      | 0.02   | 0.03  | 0.05   | 0.05     |

- 1 - Interchange specification is a 24 hour specification (i.e. sometimes referred to as a self-calibration).
- 2 - Ratio Uncertainties of 0.02 ppm are based on reversing Rs and Rx (i.e. Rx / Rs) connections.
- 3 - Specifications are based on standard practice use of 30 μA - 100 μA of current in the QHR.
- 4 - Specifications are based on 1mW to 10mW dissipated in resistance standards for tests not using 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 |                                   | 20 °C to 26 °C  | 68 °F to 78.8 °F |
| Bridge Maximum Operating Range (20 % to 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: 100 V, 120 V, 220 V, 230 V and 240 V; All ± 10 %<br>50 or 60 Hz ±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 |  |
|----------------------|--|
| <b>6640Q</b>         | QHR Bridge   |
|                      | *Includes:<br>An <b>ISO/IEC 17025 Accredited Calibration Certificate</b><br>A set of Rs/Rx Low Thermal Leads<br>Operator and Software Manuals available from Guildline's WebSite |
| /RT                  | Specifies Rear Terminals versus Front Terminals (Default)  |

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