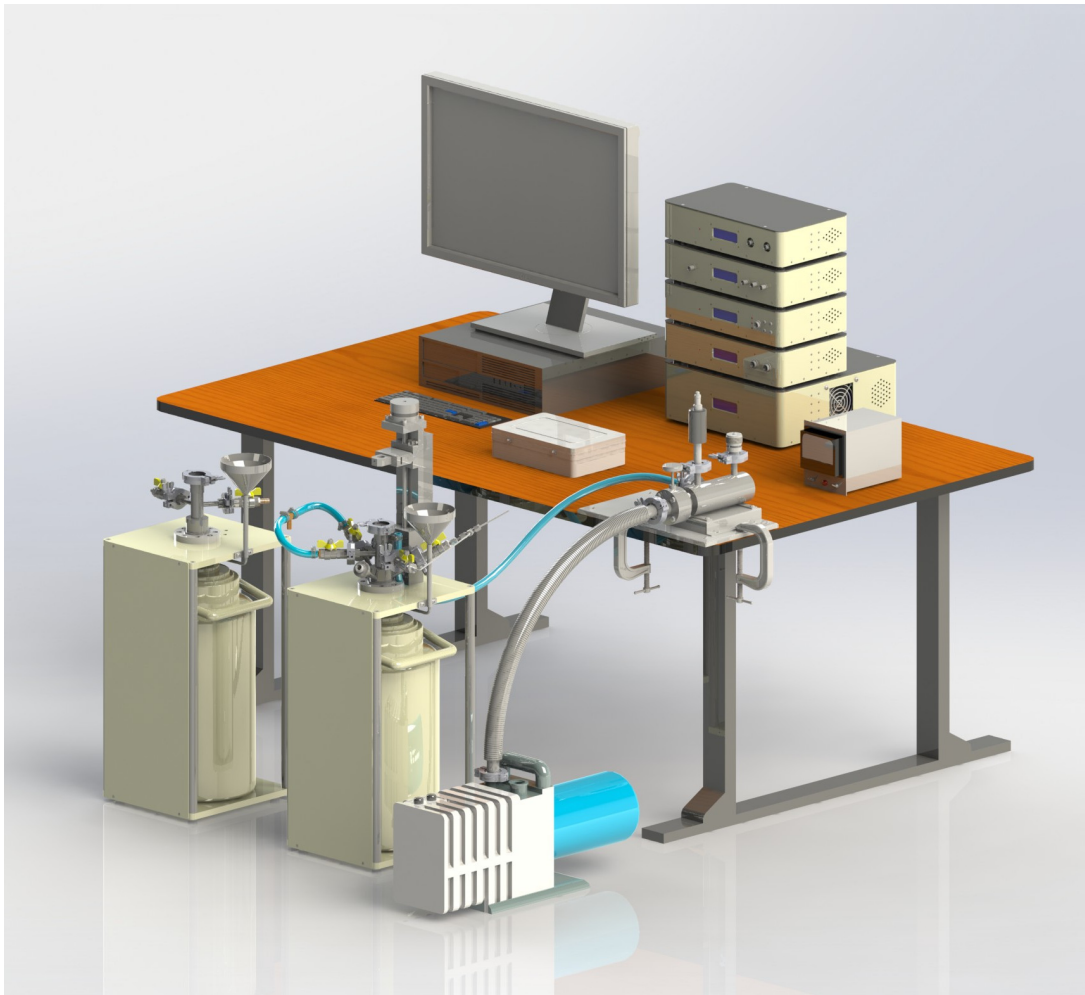


# XPLORE 1.2

## Physical Quantities Measurement System (PQMS)

### Technical specifications

Precision-Quazar Tech Pvt. Ltd.



# Contents

<b>1</b>	<b>Cryostat and temperature controller</b>	<b>3</b>
<b>2</b>	<b>Electrical transport property measurement</b>	<b>4</b>
2.1	4-probe insert . . . . .	4
2.2	I-V source and measurement unit . . . . .	4
2.3	2-probe high resistance insert . . . . .	5
2.4	High resistance measurement unit . . . . .	5
<b>3</b>	<b>Magnetic AC-susceptibility measurement</b>	<b>7</b>
3.1	Sample insert . . . . .	7
3.2	Lock-in amplifier . . . . .	7
3.3	Automatic sample positioner . . . . .	8
<b>4</b>	<b>Magneto-resistance and Hall coefficient measurement</b>	<b>9</b>
4.1	Electromagnet insert . . . . .	9
4.2	Magneto-resistance insert . . . . .	9
4.3	Magnet Power Supply (MGPS) . . . . .	10
<b>5</b>	<b>Data acquisition and control software: Qrius 2.0</b>	<b>11</b>
<b>6</b>	<b>Other accessories supplied with the system</b>	<b>11</b>

# 1 Cryostat and temperature controller

Parameter	Value
<b>Sample chamber</b>	
Dimension	21 mm (dia) × 100 mm (length), top loading
Construction	Non-magnetic SS 316, double walled
<b>Temperature range</b>	
Temperature range	80 K – 450 K
Cryogen	Liquid N <sub>2</sub>
Exchange gas	Helium
<b>Temperature measurement and control</b>	
Sensors	Pt100
Temperature resolution	0.01 K
Temperature stability	Better than ±0.1 K in isothermal mode
Temperature ramp-rate	0.1 K/min – 10 K/min in steps of 0.1 K/min
Control algorithm	PID
PID parameters	User configurable
<b>Heater</b>	
Heater power	40 Watt
Winding type	Non-magnetic nichrome
<b>Flushing system</b>	
Connection	Four independent on/off valves for heater and sample chambers
Vacuum system	Zone Heater and/or sample chamber
	Pressure 10 <sup>-3</sup> Torr
	Mechanism Double stage rotary pump
	Sense Pirani gauge with readout unit
Exchange gas system	Zone Heater and/or sample chamber
	Gas Helium
	Cylinder volume 10 liters
	Purity 99.99%
	Accessories Pressure regulator and piping
<b>Others</b>	
Computer connectivity	USB
Software development kit (SDK)	Python library for user programming
Liquid N <sub>2</sub> container	4 liters (BA-3 from IndianOil Corp. Ltd.)
Input Power	200V-240V AC

## 2 Electrical transport property measurement

### 2.1 4-probe insert

Parameter	Value
Mounting area	25 mm × 15 mm
Mounting glue	GE varnish (supplied)
Contact glue	Silver ink (supplied)
Connection topology	2-probe or 4-probe
Base insulator	Kapton tape (supplied)
Temperature range	70K to 450K

### 2.2 I-V source and measurement unit

Parameter	Value
Source mode	Current or voltage
<b>Current source specification</b>	
Current source range(s)	$\pm 100 \mu\text{A}$ , $\pm 1 \text{ mA}$ , $\pm 10 \text{ mA}$
Current set-point resolution	Better than 0.05 % of full-scale
Voltage compliance	$\pm 10\text{V}$
<b>Voltage source specification</b>	
Voltage source range(s)	$\pm 10 \text{ V}$
Voltage set-point resolution	Better than 0.05 % of full-scale
Current compliance	$\pm 10 \text{ mA}$
<b>Ammeter specification</b>	
Current measurement range(s)	$\pm 100 \mu\text{A}$ , $\pm 1 \text{ mA}$ , $\pm 10 \text{ mA}$
Current measurement resolution	6½ digit
<b>Voltmeter specification</b>	
Voltage measurement range(s)	$\pm 100 \text{ mV}$ , $\pm 1 \text{ V}$ , $\pm 10 \text{ V}$
Voltage measurement resolution	6½ digit
Input impedance	$> 10^{12} \Omega$
<b>Ohmmeter specification</b>	
Resistance measurement range	$0.01\Omega$ to $10^8\Omega$ with $< 1\%$ error
Resistance measurement error	See Fig. 1

I-V Source and Measurement unit specification continued on next page ...

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... I-V Source and Measurement unit specification continued from previous page

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<b>Parameter</b>	<b>Value</b>
<b>Others</b>	
Computer connectivity	USB
Software development kit (SDK)	Python library for user programming
Input Power	From Power supply box (supplied)

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### 2.3 2-probe high resistance insert

<b>Parameter</b>	<b>Value</b>
Mounting area	10 mm × 18 mm
Mounting glue	GE varnish (supplied)
Contact glue	Silver ink (supplied)
Connection topology	2-probe
Mounting surface	Teflon
Temperature range	70K to 450K

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### 2.4 High resistance measurement unit

<b>Parameter</b>	<b>Value</b>
Source mode	Voltage
<b>Voltage source specification</b>	
Voltage source range(s)	± 10 V, ± 100 V
Voltage set-point resolution	Better than 0.005 % of full-scale
<b>Ammeter specification</b>	
Current measurement range(s)	± 10 nA, ± 1 μA
Current measurement resolution	6½ digit
<b>Voltmeter specification</b>	
Voltage measurement range(s)	100 V
Voltage measurement resolution	6½ digit

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High resistance measurement unit specification continued on next page ...

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Parameter	Value
<b>Ohmmeter specification</b>	
Resistance measurement range	$10^5\Omega$ to $10^{13}\Omega$ with $< 1\%$ error
Resistance measurement error	See Fig. 1
<b>Others</b>	
Computer connectivity	USB
Software development kit (SDK)	Python library for user programming
Input Power	200V-240V AC

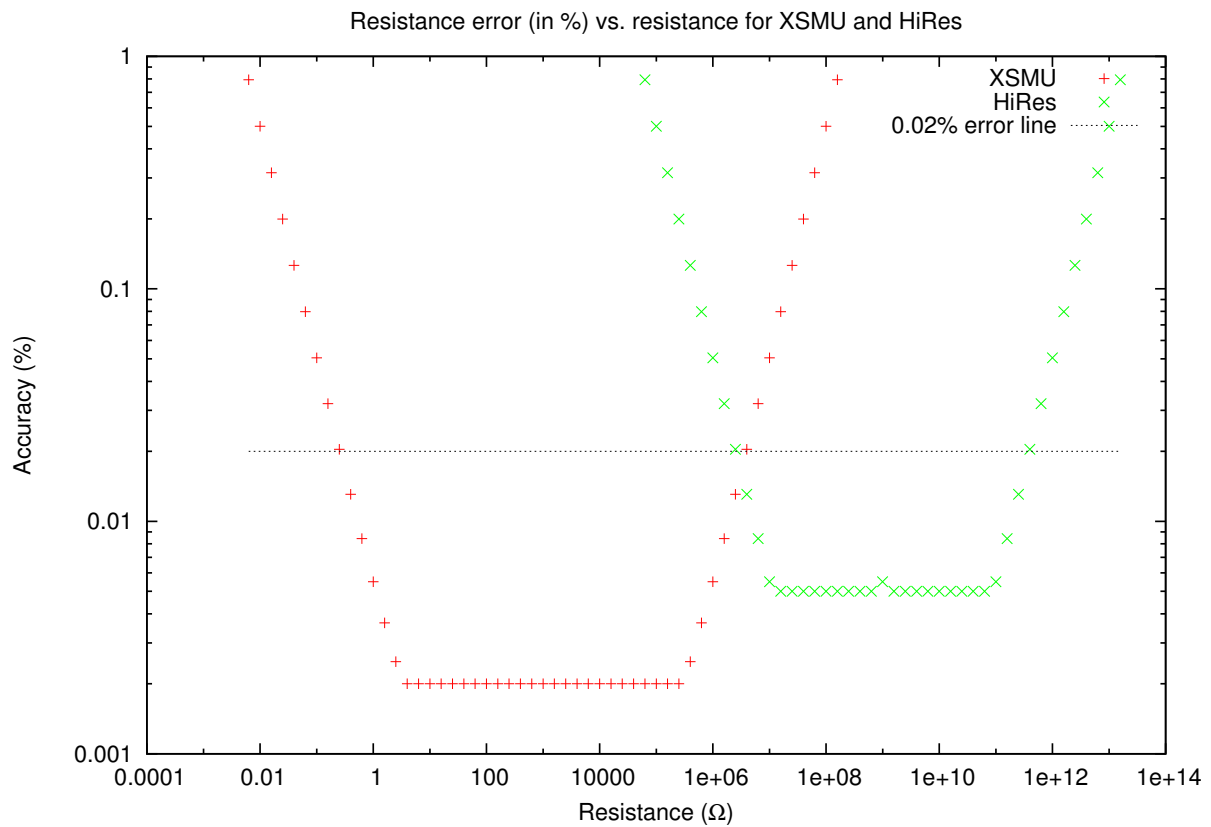


Figure 1: Error in resistance when measured using XSMU and XHiRes boxes.

### 3 Magnetic AC-susceptibility measurement

#### 3.1 Sample insert

Parameter	Value
Maximum sample dimensions	5 mm (dia) × 10 mm (length)
Sample form	Powder or solid in paper capsule
Sample holder	Non-magnetic glass fibre sleeve
Temperature range	70K to 450K
<b>Primary Coil Specification</b>	
Length	57 mm
Number of turns	1000
Average diameter	8.3 mm
H-field	≈10 Oe pk-pk at 50 mA pk-pk current
<b>Secondary Coils (2 Nos.) Specification</b>	
Length	10 mm each
Number of turns	3000 each
Average diameter	14 mm each

#### 3.2 Lock-in amplifier

Parameter	Value
<b>Primary driver</b>	
Frequency range(s)	10 Hz – 10 KHz
Reference output	Constant voltage: 2V peak-to-peak Constant current: 50 mA peak-to-peak
Reference generation	Direct digital synthesis
<b>Lock-in detection</b>	
Integration time	1 sec
Pre-amp gain(s)	1, 10, 100
Post-amp gain(s)	1, 10, 100
<b>Measurement</b>	
Measurement resolution	16-bit
Measured quantities	Both amplitude and phase

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Lock-in Amplifier specification continued on next page ...

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... Lock-in Amplifier specification continued from previous page

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<b>Parameter</b>	<b>Value</b>
<b>Others</b>	
Computer connectivity	USB
Software development kit (SDK)	Python library for user programming
Input Power	200V-240V AC with ground isolation

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### **3.3 Automatic sample positioner**

<b>Parameter</b>	<b>Value</b>
Stoke length	60 mm
Positioning accuracy	Better than 100 micron
Speed	0.5 mm/sec
Limit switch	In-built optical sensor
Stall detection	In-built optical sensor
Computer connectivity	USB

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## 4 Magneto-resistance and Hall coefficient measurement

### 4.1 Electromagnet insert

Parameter	Value
<b>Electromagnet Specification</b>	
Electromagnet wire	Enameled copper wire
Electromagnet wire gauge	SWG-22 (0.711 mm dia)
Electromagnet bobbin material	Brass
Magnetic field to current ratio	~195 Gauss per Ampere
Magnetic field direction	Axial to cryostat
Temperature range	70K to 450K
Maximum magnetic field	1000 Gauss @ 5.2 A

**Note:** Liquid Nitrogen is needed as coolant to achieve above specifications.

#### **Cryostat Specification**

Core material	Quartz
Top assembly material	Stainless steel

### 4.2 Magneto-resistance insert

Parameter	Value
Mounting area	Circular, 19 mm dia
Magnetic field direction	Perpendicular to mounting area
Mounting glue	GE varnish (supplied)
Contact glue	Silver ink (supplied)
Connection topology	2-probe or 4-probe
Base insulator	Teflon
Temperature range	70K to 450K

### 4.3 Magnet Power Supply (MGPS)

Parameter	Value
Source mode	Magnetic field or current
<b>Magnetic field source specification</b>	
Magnetic field source range(s)	$\pm 100$ mT (1000 Gauss)
Magnetic field set-point resolution	Better than 0.05 % of full-scale
Voltage compliance	$\pm 15$ V
<b>Current source specification</b>	
Current source range(s)	$\pm 6$ A
Current set-point resolution	Better than 0.05 % of full-scale
Voltage compliance	$\pm 15$ V
<b>Gauss meter specification</b>	
Magnetic field measurement range(s)	$\pm 100$ mT ( $\pm 1000$ Gauss)
Current measurement resolution	6½ digit
<b>Ammeter specification</b>	
Current measurement range(s)	$\pm 6$ A
Current measurement resolution	6½ digit
<b>Voltmeter specification</b>	
Voltage measurement range(s)	$\pm 20$ V
Voltage measurement resolution	6½ digit
Input impedance	$> 10^{12}$ $\Omega$
<b>Others</b>	
Computer connectivity	USB
Software development kit (SDK)	Python library for user programming
Input Power (supplied)	200V-240V AC with ground isolation

## 5 Data acquisition and control software: Qrius 2.0

Computer automation of  $R$ - $T$  and  $\chi$ - $T$  measurements using above mentioned modules have been provided by Qrius 2.0 software. It allows easy control of all experimental parameters and real time recording and plot of physical quantities. The software runs on Ubuntu 14.04, and Fedora 20 or later.

New Qrius 2.0 features:

- Improved user interface.
- SmartSwitch™ technology for automatic switching between constant current and constant voltage sources for easy I-V characterization of non-linear devices, like P-N junction diodes.
- Maximize susceptometer signal through software controlled automatic sample positioning utility.
- Offset nullified susceptometer signal acquisition through alternate sample positioning between two susceptometer secondary coils.

## 6 Other accessories supplied with the system

The following is a list of items that are supplied for proper operation of XPLORE 1.2 system.

- 4l liquid nitrogen dewar (BA-3 from IndianOil Corp. Ltd.). *Liquid nitrogen has to be provided by the user.*
- Cryostat stand made of aluminium.
- Rotary pump (with bellow) for flushing/vacuum.
- A computer with DVD drive, 4 nos. USB 2.0 ports, minimum 2GB RAM, 100GB of hard-disk space and Pentium dual core or above processor. *If not included in the purchase order, this needs to be provided by the user.*
- 10 point power extension board.