Hardware Manual

ParticleTrack G400

Real-Time Particle Characterization

METTLER TOLEDO

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For technical support, email: AutoChemCustomerCare@mt.com

For updates, webinars, and the latest documents: http://community.autochem.mt.com

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Contents

1 Introduction

This manual covers specific safety and quality information relating to the ParticleTrack™ G400 with FBRM® (Focused Beam Reflectance Measurement) technology. Throughout this manual, the system is referred to by the name: ParticleTrack G400 or FBRM G400. The ParticleTrack G400 system includes the base unit and probe connected by a flexible armored conduit.

ParticleTrack G400 is a probe-based instrument that is inserted directly into laboratory reactors to track changing particle size and count in real time at full process concentrations. Particles, particle structures, and droplets are monitored continuously, as process parameters vary, providing scientists with the evidence required to deliver consistent particles with the required attributes. A ParticleTrack G400 system has fixed or interchangeable probe options and includes options for a single or dual-system configuration. ParticleTrack G400 dual-system configurations can simultaneously measure two small-scale vessels or points in a process stream. Click the link to see the FBRM Method of Measurement video (requires internet connection).

www.mt.com/ParticleTrack G400

2 Intended Use

The system includes a power supply, laser and detector modules, and PCBs. The base unit is fitted with a permanently attached flexible armored conduit, which is connected to the process probe. The ParticleTrack G400 system is designed for indoor use.

The system may only be used in safe locations and is not certified for use in hazardous locations.

3 Technical Data

System certifications	**CE/NRTL-C** Approved, Class 1 Laser Device, Compliant with 21CFR1040.10 and 1040.11 and IEC 60825-1; IPX0
Functional specifications	
Method of Measurement	Focused Beam Reflectance Measurement (FBRM®)
Measurement range	0.5 to 2,000 µm
Scan speed	2 m/s (14 mm probe: 125 Hz) 1.2 m/s (19 mm probe: 75 Hz)

Table 1. System certifications and functional specifications

Base Unit Specifications

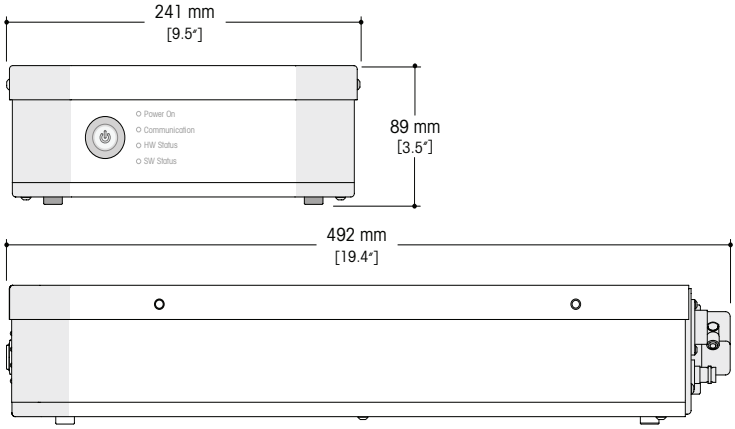

Figure 1. System Dimensions—Base unit

Environmental	
Operating humidity range	0 to 85%
Operating temperature range	5 to 35 °C
General	
Material of construction	14 ga Aluminum with Class 3 RoHS-compliant chemical film
Ingress protection	IPX0
Power	100-240 VAC, 50/60 Hz, 1.2A
Weight	3.25 kg [7.17 lb]
Communication interface	USB, 3 m [10 ft] cable
Pollution degree	2
Installation (overvoltage) category	II
PCBs	Fr–4

Table 2. Base unit specifications

Probe Specifications

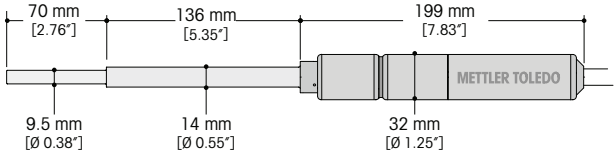

Figure 2. Probe dimensions—G400 14 mm probe

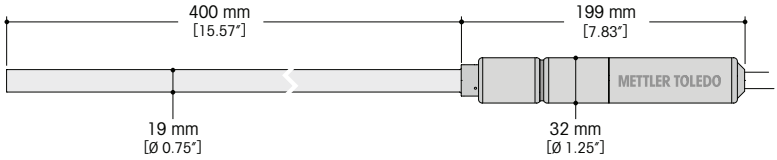

Figure 3. Probe dimensions—G400 19 mm probe

	14/9.5 mm	**19 mm**
Wetted materials of construction		
Probe tip	Alloy C22	Alloy C22
Probe window	Sapphire	Sapphire
Probe window seals	TM [Thermo-Mechanical press-fit] (standard)	Kalrez® 6375 (standard) TM [Thermo-Mechanical press-fit] (optional)
Environmental		
Operating pressure range *	3 barg (standard) 0 to 100 barg (optional, requires custom engineering design)	
Operating temperature range	+10 to 90 °C (standard) –80 to 90 °C (TM seal and purge) –10 to 90 °C (Kalrez® seal and purge)	
Installation		
Conduit length	3 m [9.8 ft]	3 m [9.8 ft]
Conduit diameter	11.6 mm [0.46 in]	11.6 mm [0.46 in]
Conduit bend radius (min.)	12.7 cm [5 in]	12.7 cm [5 in]
Probe and conduit weight	1.36 kg [3 lb]	1.81 kg [4 lb]

*** Note:** Probe operating temperatures below the dew point temperature of the environment require purge air, described on page 11.

Table 3. Probe specifications

Site preparation for the METTLER TOLEDO ParticleTrack G400 system is the end user's responsibility. The following should be considered to ensure successful system installation:

Power Requirements

Verify that a power outlet is accessible in the area of intended use for the ParticleTrack G400. Provide one outlet for a single system or two outlets for a dual-system configuration.

Area of Intended Use

The area of intended use must provide adequate space for the base unit, conduit and probe. The probe conduit should not bend beyond 12.7 centimeters (5 inches) and it should not be put into an "S" shape. The base unit must be convenient for access at eye level to view the LED status indicators; readily accessible for service; securely placed horizontally on a flat surface; and installed in an area that has access to instrument quality air (when operating below the dew point, purge gas is to be connected to the rear of the instrument). The ParticleTrack G400 system enclosure contains sensitive electronic components that should be protected from severe environmental conditions. Direct, intense sunlight can raise the internal temperatures above operating specifications. Refer to section "3 Technical Data" starting on page 4, for the temperature and humidity specifications of the base unit, and the system size and weight specifications.

Air/Gas Requirements (if applicable)

To prevent condensation when operating below the dew point of the environment, ParticleTrack G400 probes require a source of clean, dry, and pressure-regulated instrument air or inert gas. The quality of the air or gas supply must meet the specifications of the American National Standards Institute/Instrument Society of America (ANSI/ISA) S7.0.01-1996 Quality Standard for Instrument Air. Air/gas must:

- Have a dew point at least 10 °C [50 °F] lower than the minimum temperature to which any part of the system will be exposed.
- Contain less than 1 ppm total oil or hydrocarbons
- Contain less than 1 ppm particulates at a maximum size of 3 microns
- Be free of any corrosive contaminants and flammable or toxic gases.

Air supply pressure, maximum	8.6 barg [125 psig]
Operating pressure, normal	1.0 barg [15 psig]
Pre-purge for one (1) hour	1.2 SLPM [0.042 SCFM]
Operating flow rate	0.15 SLPM [0.005 SCFM]

Table 4. Probe air/gas specification

4 Safety Information

CE	The CE Mark applies only to unmodified instruments as supplied by Mettler-Toledo AutoChem, Inc. Modifications may require on-site testing for compliance verification. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.
	**Caution**—Read all safety warnings before installing or operating this equipment. Failure to follow the instructions and caution/warning statements could result in personal injury and/or product damage that could void the warranty.
	**WARNING**—This equipment shall be connected to mains socket outlet with a protective earthing connection.
	**WARNING**—This equipment is approved for indoor use only.

Table 5. Safety cautions and warnings

Laser Classification

All standard-model FBRM G400 instruments are in compliance with the U. S. Department of Health and Human Services (DHHS) Radiation Performance and in accordance with International Standards.

THE FBRM G400 IS A CLASS 1 LASER PRODUCT COMPLIANT WITH
DHHS 21 CFR 1040.10 AND 1040.11
EXCEPT FOR DEVIATIONS PURSUANT TO LASER NOTICE 50, DATED JUNE 24, 2007.
THE FBRM G400 IS A CLASS 1 LASER PRODUCT COMPLIANT WITH IEC 60825-1

Laser de Classe 1
Conforme à la norme 21 CFR 1040.10 et 1040.11
À l'exception des écarts conformement à l'avis Laser 50 en date du 24 Juin 2004
et conforme à la norme IEC 60825-1

	**LASER SAFETY WARNING** Opening the enclosure and making adjustments, or performing procedures other than those specified in the instrument manual may result in hazardous radiation exposure.
	**Caution**—Use of controls or adjustments or performance of procedures other than those specified in the instrument manual may result in hazardous radiation exposure.
	There are no user-serviceable components in the laser module. Only skilled, trained technicians can service this equipment.
	Looking directly into the aperture of any laser-emitting device is never advised.

Table 6. Laser safety warnings and cautions

5 Supplementary Documentation

An electronic ParticleTrack G400 Hardware Documentation Portfolio, shipped with the instrument, includes the following documents in addition to this manual:

- Quick Ref: "Positioning the ParticleTrack or ParticleView Probe" (MK-PB-0050-AC)
- "Calibration Validation in iC FBRM" (MK-PB-0071-AC)
- "System Calibration in iC FBRM" (MK-PB-0082-AC)
- QuickRef: "Changing ParticleTrack G400 Interchangeable Tips" (MK-PB-0080-AC)
- QuickRef: "Using the PSC Purge Controller" (MK-PB-0120-AC)

Please refer to the iC FBRM software user assistance and Documentation Portfolio for software publications.

Check the http://community.autochem.mt.com site for the latest portfolios.

6 Product Installation

ParticleTrack G400 system installation involves two connections to the power and USB communication inlets at the back of the base unit. If the optional purge controller is purchased, a third connection to instrument-quality air is also on the back of the unit. For dual-system configurations, note that the procedure is to connect and configure the first system entirely. Then, connect and configure the second system. System connections are completed by a METTLER TOLEDO qualified Field Service Engineer. Connection details are provided below should the system be relocated following the initial installation.

Due to the complex nature of multi-phase flow, proper installation is very important for successful application of inline particle and droplet measurement techniques. Installation and mounting of probe-based instruments for particle characterization should consider multiple factors including:

- Existing or planned laboratory or process equipment
- Expected ranges of process variables such as temperature, pressure, flow rates, and/or flow patterns
- Expected range of particle/droplet size and concentration
- Probe location and orientation as shown in Figure 4.

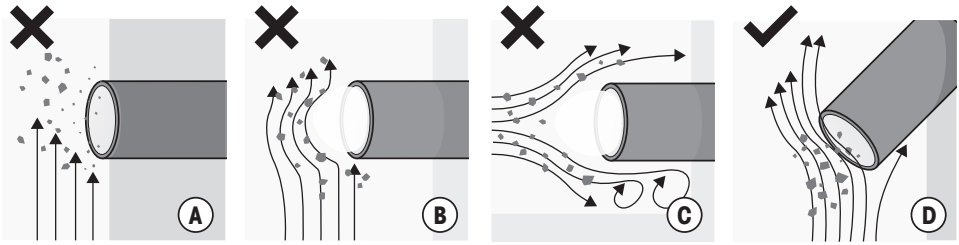

Figure 4. Implementation of a ParticleTrack instrument: (**A**) flush with wall of vessel or pipeline; (**B**) inserted tangentially to process flow; (**C**) inserted perpendicular to process flow at an elbow; and (**D**) inserted at optimal angle (45°) relative to process flow

Connect Power (**A, B**)

1. Connect the pin-terminated end of the country-specific, auto-switching AC Power Adapter (**B**) to the Power connection (**A**) at the back of the ParticleTrack G400 base unit (Figure 5).
2. Connect the opposite end to an AC outlet.
3. Press the power button on the front of the ParticleTrack G400 base unit and observe that the Power LED indicator illuminates.
4. Ensure the ParticleTrack G400 system has been powered ON for 30 minutes before performing calibration validation or recording particle system measurements.

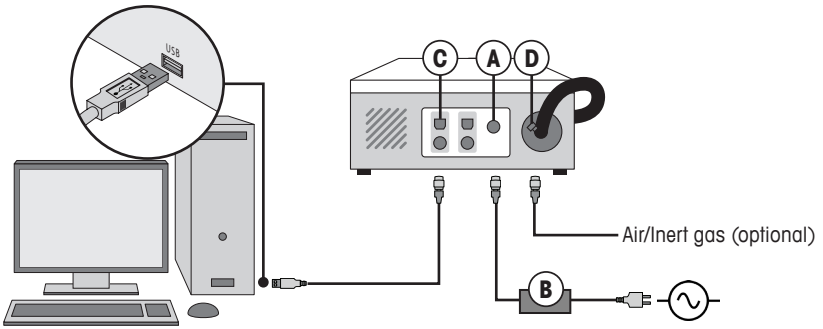

Figure 5. Instrument connections: (**A**) Power input (**B**) Switching AC Adapter; (**C**) USB communications; (**D**) Air/inert gas (if applicable)

Connect USB Communications (**C**)

1. Connect the USB cable to the first input (**C**) at the back of the ParticleTrack G400 base unit.
2. Connect the other end of the cable to a USB port on the control computer.

   Note: The Communications LED on the front of the base unit will not illuminate permanently until the software connection is complete.

Optional: Connect Air Supply (**D**)

When operating below the dew point temperature of the environment, purge air is required. The Purge Controller should be used to regulate the purge air flow.

1. Clean/purge all air lines and tubes before connecting to the ParticleTrack G400 instrument.
2. Connect the air supply to the air inlet on the Purge Controller. The required tubing from the air supply, to the Purge Controller is user-supplied (6.35 mm [1/4-inch], rated for 120 psig, may be made of polypropylene, PVC, or nylon).
3. Connect the purge tubing (6 mm [0.23 inch], supplied with Purge Controller) to the purge fitting on the rear of the ParticleTrack G400 base unit, near the probe conduit connection (**D** in Figure 5).
4. Adjust the Purge Controller pressure and set it to the pre-purge flow rate for one hour (Table 4). After the one hour pre-purge, set the purge flow rate to the operating flow rate to run an experiment.
5. Refer to the quick reference guide for further details—"QuickRef-Using the PSC Purge Controller" (MK-PB-0120-AC).

   Note: The probe exhaust holes for purge air are located at the top of the probe, just below the retaining nut (Figure 7).Take care during installation and cleaning of the probe to ensure the exhaust holes are not blocked or submerged in liquid.

Figure 6. Purge Controller

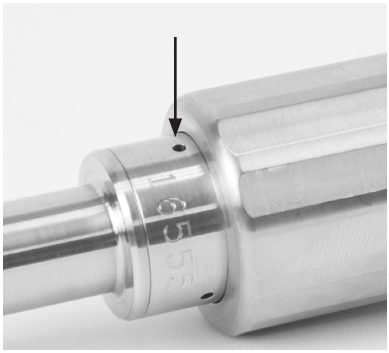

Figure 7. Probe exhaust (one of three)

7 Probe Mounting Options

ParticleTrack G400 probes are specifically designed for mounting in small reactors such as the METTLER TOLEDO EasyMax™ or OptiMax™.

Lab-joint adapters are manufactured from PTFE (polytetrafluoroethylene) with O-ring seals, and designed for the installation of ParticleTrack G400 probes in a range of standard laboratory glass joints on round-bottomed flasks or jacketed lab reactors.

All installation requirements should be discussed with your METTLER TOLEDO Technology and Applications Consultant.

8 Operating Instructions

During system installation, a trained METTLER TOLEDO engineer makes all system connections and verifies the system is ready for use.

1. If applicable, attach the correct interchangeable probe tip. If interchangeable tips have been configured for the given probe and a larger (or smaller) probe diameter would be better suited to the current particle system vessel, change the probe tip. Refer to the quick reference guide for further details--- "QuickRef-Changing ParticleTrack G400 Interchangeable Tips" (MK-PB-080-AC).
2. If required, start the pre-purge.
3. Press the Power button on the front of the ParticleTrack G400 base unit and verify the Power On indicator illuminates.
4. Allow 30 minutes for the instrument electronics to warm up before taking critical measurements.
5.  Turn on the computer and start the iC FBRM software. To connect/configure the instrument in iC FBRM, please refer to the applicable software user guide.
6. For dual system configuration, repeat steps 1 through 5 for second ParticleTrack G400 system.
7. Observe the indicator LEDs on the front of the ParticleTrack G400 for an indication of the system status.

Indicators	Color	LED State	Status
Power	Green	ON	System is powered.
Communication	Green	ON	System is communicating with the FBRM service.
		OFF	Computer is off, FBRM service is off, or system needs to be connected in iC FBRM.
HW Status	Red	ON	HARDWARE STATUS—Hardware error exists that results in loss of particle/droplet measurements. Check iC FBRM Events Viewer for detailed description.
		OFF	Normal status
SW Status	Red	ON	SOFTWARE STATUS—Software issue error occurs for calculating Chord Length Distribution (CLD) that may cause loss of measurement. Check iC FBRM Events Viewer.
		OFF	Normal status

Table 7. ParticleTrack G400 LEDs

9 Best Practices for Routine Operation

Ensure Reliable Instrument Performance

- Follow recommended calibration validation procedures monthly or quarterly as determined by your SOP.
- Follow preventative maintenance guidelines for your ParticleTrack instrument.
- Check probe window cleanliness as part of routine SOP.

Ensure Measurement Sensitivity by Optimizing Probe Location and Positioning

- Probe should be positioned in the process where it can obtain maximum sensitivity to changes in particle or droplet system.
- Probe must be oriented to ensure particle system flows optimally across the probe window surface.
- Probe tip must remain fully immersed to provide measurements of the particle/droplet system.
- Probe location is more critical under the following conditions:
  - Extreme difference between particle density compared to the carrying solution density (ranges from very low or very high).
  - Lower Rheology
  - Larger median particle dimension
  - Greater deviation between average particle shape and a sphere (more irregular particles or particle structures).
- Probe location is less critical under the following conditions:
  - Smaller difference between particle density compared to carrying solution density.
  - Higher solids concentration (or higher dispersed phase in liquids)
  - Smaller median particle dimension.
  - Narrower particle distribution.
  - Smaller deviation between average particle shape and a sphere (fewer irregular particles or particle structures)

Track Particle Systems Reliably

- Use iC FBRM as the reliable SOP for routine monitoring of particle and droplet systems in the laboratory.
- Use iC FBRM for advanced data analysis of collected data.
- Use iC FBRM for further improvement and optimization of templates to be used in application-specific SOPs.

Develop a Standard Operating Procedure (SOP)

- Select or create an appropriate iC FBRM template for each given application. A well-designed template will simplify the startup procedure and ensure consistent operation in each experiment.
- Include appropriate statistical trends that can directly track particle and product quality parameters of interest.
- Include reference and target distributions as process milestones or final product quality set-points.
- Optimize the measurement configuration (measurement interval and averaging settings) to ensure robust repeatable measurement and to maximize sensitivity to dynamic changes in the particle system.

Save Experiment Settings as a Template—Make sure to select the right template for a specific particle or droplet system. Use a template that includes trends and reference distributions that are important to track in order to characterize the particle or droplet system.

Manage Reference Distributions—Distributions can be saved as references and designated as targets for subsequent experiments. Reference distributions or target distributions can be saved in particle-specific templates.

Check Probe Window Cleanliness—The probe window must be clean before mounting in particle or droplet system and before performing Calibration Validation.

10 Troubleshooting

Errors are generally hardware-related issues that affect data acquisition. The following table documents how hardware errors are displayed in the control software, describes what the error means, and provides possible root causes to assist with troubleshooting and resolving the issue. If the issue cannot be resolved, please contact the AutoChem Market Support Group for assistance.

Errors

Error Message	Description	Possible Cause
Box temperature high / low	Internal temperature of base unit has fallen outside of the operating temperature range (5 °C to 35 °C).	The base unit is installed in a location that is not within recommended specification.
Scan speed or Scan frequency high / low	Desired scan speed or frequency is outside acceptable range.	Bearings nearing end of life or incorrect probe configuration. Check configuration. If error continues, contact METTLER TOLEDO.
Tach Pulse missing **Note**: **SW Status** LED illuminates red for this error if it persists.	Data acquisition error.	Verify USB connections are secure. If error continues, contact METTLER TOLEDO.

Table 8. Troubleshooting errors

Warnings

Warning Message	Description	Possible Cause
ProbeA Effective Duration Low **Note**: **SW Status** LED illuminates red for this warning if it persists.	Effective Duration reports the percentage of the scan signal from the previous measurement interval used to calculate the currently displayed Chord Length Distribution (CLD). Normal operation results in an Effective Duration of approximately 50%.	Effective Duration Low may indicate that the PC specifications are inadequate for complete transfer and processing of the available signal. A low Effective Duration may reduce the precision of the measurement. If the Effective Duration is significantly less than 40%, contact METTLER TOLEDO. The measurement interval can also impact Effective Duration. Only select an interval <10 s where you expect rapid process changes.
Average Signal Intensity High	Average Signal Intensity is an indicator of the amount of light backscattered by the particles or droplets being measured.	Average Signal Intensity High may indicate that the particles being measured are highly reflective. Very high backscatter may saturate the sensor, resulting in erroneous measurements.

Table 9. Troubleshooting warnings

11 Product Maintenance

METTLER TOLEDO warrants its products against defects in materials and workmanship for twelve months from the date of installation or fifteen months from the date of shipment, whichever comes first. For details, please refer to the warranty provided with the instrument. For assistance, please email AutoChemCustomerCare@mt.com.

It is recommended that you retain the original packing materials if you need to return the ParticleTrack system. If factory service is required, your METTLER TOLEDO service engineer will issue you a Return Material Authorization (RMA) form.

There are no user-serviceable parts inside a ParticleTrack G400. Contact your METTLER TOLEDO Field Service Engineer for all service needs.

Schedule the following maintenance tasks:

- Run the Calibration Validation procedure for the probe every three to six months, if the probe is dropped or the system is transported, and after new software is installed, if desired.

  The "Calibration Validation in iC FBRM" procedure uses the PVC Reference Sample and reference file, provided with the system. The procedure also requires a Fixed Beaker Stand (FBS). Locate the procedure document in the ParticleTrack G400 Hardware Portfolio.

- Clean the probe window periodically. To clean the outside window, use a medium such as water, alcohol, or acetone to clear the surface. A fine, abrasive polishing compound may be used to remove stubborn stains (0.3 micron alumina, used to polish optical surfaces is recommended). After cleaning, use a dry, clean Kimwipe® to remove the cleaning solution. The probe window cleanliness can be verified in the software.

- Ensure the air/gas supply meets the required standards, when using the optional purge.

- Change bearings, if necessary, as recommended by METTLER TOLEDO. The average life of the bearings on the ParticleTrack G400 is one to two years. Under normal operating conditions, the probes should be serviced every other year during Preventive Maintenance to ensure optimal uptime with no unexpected failures. Probes operated at elevated temperatures and/or continuously must be serviced more frequently, and in this case a Full Coverage Service Contract is recommended. To extend bearing life, turn off the probe when not in use.

- The ParticleTrack G400 system is designed for indoor use, so the base unit and probe back end can only be wiped clean. The wetted portion of the probe tip can be cleaned with solvent such as ethanol, IPA, or soap and water.

METTLER TOLEDO has offices around the world. Contact the Mettler-Toledo AutoChem, Inc., headquarters in the USA for technical support or service. To arrange for specific application assistance from a METTLER TOLEDO Technology and Applications Consultant, or for assistance, contact Customer Care through the toll-free number on page 2.

Recommended Maintenance

A qualified METTLER TOLEDO Field Service Engineer should perform regular Preventive Maintenance (PM) on the system. Table 10 shows the normal life expectancy of several component parts and identifies any customer-replaceable parts. Use this information for planning potential cost of ownership.

Replacement Interval	Part
Annually	PVC Reference Sample, G400 • customer-replaceable • PVC life: 10 uses or one year, whichever comes first • included in annual PM.
Every two (2) years	Scanning assembly
Every three (3) years	Laser Board

Table 10. Parts life expectancy

Relocation, Shipment, or Storage

To prevent and minimize damage to the ParticleTrack G400, follow the instructions below to prepare the system for relocation, shipment, or storage.

1. Close the iC FBRM software application and shutdown the computer according to normal operating procedures.
2. Disconnect the power, air, and communications from the back panel of the base unit.
3. Disconnect the USB cable from the control computer.
4. Store the system and all components in the factory-supplied box.

12 Disposal

Please dispose of this product in accordance with local regulations at the collecting point specified for electrical and electronic equipment.

If you have any questions please contact the responsible authority or the distributor from which you purchased this device.

Thank you for your contribution to environmental protection.

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