HEXAGON METROLOGY

Portable Arm CMM Buyer's Guide

By Eric Hollenbeck

The portable measuring arm, or portable arm CMM (PCMM) has become an important quality control tool at many manufacturing companies. With the flexibility to be used nearly anywhere on a manufacturing floor, from in-process checks to large scale assembly to inside machine tools, measuring arms have the capability to deliver real-time feedback right at the point of production.

The first-time buyer, and even repeat buyers, may be overwhelmed by the variety of features, accessories and capabilities available. Even those knowledgeable about CMM technology, may find the conventions of measuring arms to be unfamiliar and confusing. It is the purpose of this guide to explain the various conventions

of the portable measuring arm and provide a guide for qualitative and quantitative evaluation of their many aspects.

It's false to assume that all portable CMMs are the same and price is the only differentiation. Though a consideration in any equipment purchase, the reality is that cost savings up front will not necessarily translate to savings over the product's lifecycle. A buyer's checklist is included in this document to evaluate the ROMER Absolute Arm feature by feature .

Arm Accuracy

While the accuracy of traditional CMM products is quite straightforward, with portable arms, it is worth some explanation.

With the advent of the B89.4.22 specification and the VDI/VDE 2617-9 specification, it has become much clearer and easier to compare specifications between products. Always compare the closest similar arm length from one product to another, and the volumetric accuracy specification is the most important. The volumetric accuracy test calls for measuring a certified length standard in various positions around the arm volume with the arm in many different positions, and is the closest simulation of real-world use conditions.

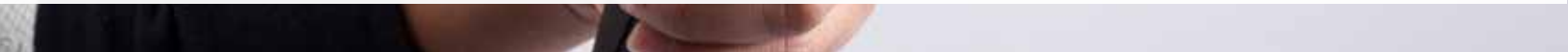
A point of significant difference when reading an arm specification to those familiar with ISO or B89 specifications for bridge CMMs is the use of +/- when calling out an arm's specification value. The single point repeatability spec and the volumetric accuracy specs on an arm are specified according to the B89 specification as a +/- value, so even if the data sheet does not say plus or minus in front of the number, it is most likely a +/- value. This is important to understand when making a comparison between arm specifications, and understanding if the arm is accurate enough for the application.

Unfortunately, although the range of accuracy figures is given, a factor which may distort those numbers is operator fatigue. A fatigued operator will not take good measurements so ergonomic factors in, particularly when you consider that most systems are not designed around the contours of a human hand. Most cost conscious companies do not necessarily consider operator comfort, and it is difficult to quantify in concrete terms, but it is an important quality to consider. This point is expanded upon on page 4.

Laser Scanning System Performance

With respect to the laser scanners, it is important to understand how the specification is called out. If it is a specification just for the laser scanner or if it is derived from the sum of the laser scanner accuracy plus the arm repeatability or accuracy. If this is the case, it is not an actual system specification, but instead a laser scanner performance assumed value. ROMER arms with integrated scanners are tested and calibrated as a single system, so the spec of the system is the spec of the system as actually configured for use. ROMER Absolute scanning systems also include the artifacts used at the factory so you can do your own test at your facility to verify your system maintains its accuracy.

...Cost savings up front will not necessarily translate to savings over the product's lifecycle.



Typical Features of Portable CMMs

FEATURE	BENEFIT
Carbon Fiber Construction	Eliminates the need for temperature compensation. The arm does not lockup with minor temperature changes.
Integrated Scanners	Arm and scanner can be calibrated and certified as a single system. No need to waste time recalibrating the scanner after changing.
Externally Attached Scanner	Scanner can be upgraded in the field with newer technology later. One scanner can be shared among multiple arms.
Laser Line Technology	Fast and compact technology with automatic exposure adjustment line by line for changing surface types.
Sensory Feedback	Haptic feedback vibrates the wrist to alert users in noisy environments.
Flying Dot Technology	Automatic exposure adjustment point by point—best for the most difficult to measure surfaces.
Exposure Adjustment	Adjustment of scanner parameters to accommodate differing colors and reflectivity of materials scanned. On the ROMER Line and flying dot lasers it is automatic.
Warm Up Time	Time for scanner to reach optimal accuracy. ROMER scanners require no warm up time.
Wireless Scanning	Ability to transmit scan data from arm to computer without a USB or network cable. Ideal for environments where contaminants could corrode or cut cables.
Battery Scanning	Ability to scan data without power cords. Ideal for environments where contaminants could corrode or cut cables.
Line Width	Single full-time high-accuracy mode that does not change the field of view or line length to enable faster scanning at all times.
Scan Density	Two lines of differing widths with the same number of points per line will yield the same data, but cover a different size area. The denser the point cloud, the higher the resolution.
Scan Line Orientation	How the laser line is projected on the surface in front of the user. It is either perpendicular to the handle or parallel to the handle. Orientation of the scan line affects how the user holds and moves the scanner and is generally an ergonomic preference.
Range/Distance Finder	ROMER places the range finder directly on the part so that there is no need to look away to a computer screen or LED Lights.
Stand-Off Distance	The distance away from the part the scanner must be held to acquire data. Some systems require different standoff distances for different scanning settings.

It's in the Way That You Use It

Encoder Systems

Encoder systems are rotary position referencing systems embedded in each joint of the arm that reads the angular measurements to determine the position of the probe. The encoders allow the arm to know the position it is oriented in, and are essential to arm accuracy and measuring performance. ROMER Absolute Arms use absolute encoder technology which allows the arm to always "know" it's position, and therefore never requires a homing procedure prior to the start of operation, and have no warm up time. Reliability of encoders is also important to consider since they are essentially the backbone of a PCMM.

Though a seasoned operator will easily keep homing procedures to a minimum, if they are needed throughout the course of the day, downtime will start to accumulate. Try to gage how often you will need to perform homing procedures. Changing of the arm location or operator may require a shutdown and re-homing procedure once the arm is re-started.

Convenience Features, Ergonomics and Ease of Use

Since an arm is a manual device, it is always in the hands of an operator. Being able to conveniently operate the device for a long period of time is essential for effective operation, which is why the latest ROMER Absolute Arm is designed around the complex contours of the human hand. Ergonomics are an often overlooked part of the purchase decision. It is truly impossible to judge the "feel" of an arm without holding and using one, so it is always important to get a demonstration and try the operation yourself.

CONVENIENCE FEATURES	BENEFIT
Ergonomic Wrist	Designed around the contours of the human hand.
Digital Camera	Capture pictures of workpieces for future documentation.
Integrated Worklight	In harsh shop conditions or dim lighting, the worklight illuminates hard-to-see features.
Counterweight/Counterbalance	Offsets arm weight during operation, reducing operator fatigue and increasing accuracy.
Resting Position Lock	Safety feature that protects your investment and does not allow the arm to fall when not in use or being moved.
Battery Power	Allows arm to be used anywhere without power.
Hot Swappable Battery	Allows battery to be exchanged without disrupting operation.
Wireless Operation	Faster setup, allows use of arm anywhere, allows computer to be placed anywhere.
Interchangeable Feature Packs	ROMER exclusive. A modular field-replaceable accessory package that allows feature capability upgrades as a customer-installable option. This ensures future upgrade paths exist for newer features and capabilities.
Mouse Mode	Allows arm wrist to be used as a mouse for software operation.
Arm "Sized Right" to the Application	An arm of proper length to inspect the largest part without having to move (leapfrog) the arm.

Important characteristics of ergonomics include how light the arm feels under operation, which is a function of the balance mechanism offsetting the weight of the arm. Its especially important to try this in many possible positions in the high, low and middle of the arm's range of motion. The arm should "float" and not feel as if it is pulling or pushing against the operator. The counterbalance method of supporting the arm weight is also critical to how rigid the setup of the arm must be to measure within specification. If a counterbalance design exerts more force (moment), then the mounting option must be very rigid to overcome the force, which means that fewer mounting options will be suitable. This detracts from the inherent flexibility of a PCMM's design. The counterbalance on the ROMER Absolute arm by design exerts minimal force so many mounting options are available. Other convenience features that may be available include the ones shown in the table below.

Operator Considerations

Certain functions of the ROMER Absolute Arm are automatic and require no user intervention. The more the user needs to interact with the arm, the greater the potential for error. Homing procedures, probe re-qualifications, and laser scanning adjustments such as enabling different accuracy modes or exposure adjustments all introduce the potential for mistakes. All these functions are automatic with the ROMER Absolute Arm.

Arm Weight and Length

Also important to consider is the weight of the arm and how easy it is for a single person to carry and mount, including in the case and out of the case.

Available arm length is an important consideration if you have a large variety of parts or especially large parts. Ideally you want to be able to inspect the entire part without moving the arm. If your parts are especially large, a longer arm will deliver the extra measuring volume without having to "leapfrog" around the part. Leapfrogging progressively reduces accuracy with each successive "leap".

Probe Exchange and Field Certification

The ROMER Absolute Arm includes 3 standard probes (3 mm, 6 mm and 15 mm) which can be interchanged during a measurement task without tools or the need to re-qualify the tip to the arm. The probes have a special lever knob which is attached and cannot be lost or dropped. The interface between the arm and probe is a kinematic joint and is repeatable within 1 micron. The probe self-identifies when attached to the arm allowing recall of the stored tip qualification data, saving you time with every probe change.

Included as standard with ROMER Absolute Arms are NIST traceable artifacts such as a length bar and/or qualification sphere, so the operator can do a self-check of the arm accuracy. This ability to self-check is vital as the majority of arms are used in less than perfect environments, and might not always be used with care. The self-check procedure allows the operator to verify that the arm is within specifications at any time, or if it needs to be sent into the factory for re-certification.

Included Accessories

The included accessories in an arm package can differ, depending on the manufacturer. The cost of non-included accessories can often run into thousands of dollars if purchased separately, so be sure to check what accessories are included in a package. ROMER includes premium accessories such as probes with replaceable ruby styli, magnetic bases for fast setups, and certified qualification artifacts as standard equipment on the most popular configurations.

Optional Accessories

Sometimes your measurement application doesn't fall within the standard offering of included accessories. ROMER arms have always allowed a wide variety of custom probe configurations to be used. A vast variety of optional accessories are available for ROMER arms to suit most applications. Hexagon Metrology offers hundreds of optional ROMER accessories and probes via our parts department or our online store www.ShopMetrology.com (USA shipments only).

Price is Only the Starting Point

Portable Measuring Arm Buyer's Checklist

1. ARM ACCURACY	ROMER ABSOLUTE	OTHER
Is the arm certified to B89.4.22?	Yes	
Is the arm certified to VDI/VDE 2617-9?	Available	
Includes certified and NIST traceable artifacts?	Yes	
Does the arm have sensory feedback such as wrist vibrations to improve accuracy in harsh environments?	Yes	

2. LASER SCANNER PERFORMANCE - INTEGRATED WITH ARM	ROMER ABSOLUTE SI SCANNER	OTHER
Is the arm and laser scanner certified as a complete system?	Yes	
Does the scanning system include traceable certification artifact to verify system performance?	Yes	
Does the scanner scan on battery power?	Yes	
Can the scanner transmit data wirelessly?	Yes	
Does the scanner have an external control box?	No	
Does the scanner require different settings to achieve the stated accuracy?	No	
Does the system include a visual range finder on the part?	Yes	
Scan Line Orientation to handle	Perpendicular	
Point Acquisition Rate per second	50,000	
Points Per Line	1,000	
Line Rate	50Hz	
Line width (mid-field of view)	65mm	
Stand-off (distance from the part)	150mm ± 50mm	
Minimum point spacing	.046mm	
Accuracy (2 sigma)	.030mm	
Scanner Weight	340g	
Working temperature	5°C - 40°C	
Warm Up Time	Instant	
System Operating Principle	Laser Triangulation	
Exposure Adjustment	Automatic	

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Portable Measuring Arm Buyer's Checklist

3. LASER SCANNER PERFORMANCE - EXTERNAL ATTACHED	ROMER ABSOLUTE CMS 108 SCANNER	OTHER
Does the scanner have to be re-calibrated if it's removed and replaced?	No	
Can the scanner be removed and replaced with an integrated scanner?	Yes	
Can the system be bought without a scanner and upgraded at a later date?	Yes	
Does the hard probe have to be recalibrated if the scanner is removed and replaced?	No	
Does the scanning system include traceable certification artifact to verify system performance?	Yes	
Does the scanner require different settings to achieve the stated accuracy?	No	
Does the scanner scan on battery power?	No	
Can the scanner transmit data wirelessly?	No	
Does the system include a visual range finder on the part?	Yes	
Scan line orientation to handle	Perpendicular	
Point Acquisition Rate per second	30,000	
Points Per Line	Max 2,000	
Line Rate	53Hz	
Line width (mid-field of view)	124/60/24mm	
Stand-off (distance from the part)	180mm ± 40mm	
Minimum point spacing	.046mm	
Accuracy (2 sigma)	.020mm	
Weight	398g	
Working temperature	10°C - 42°C	
Warm Up Time	Instant	
System Operating Principle	Flying Dot	
Exposure Adjustment	Automatic, point-by-point	

4. ENCODERS	ROMER ABSOLUTE	OTHER
Does the arm require homing (referencing)?	No	
Does the arm allow immediate measuring once turned on?	Yes	
Does the arm require warm-up time?	No	

Portable Measuring Arm Buyer's Checklist

4. CONVENIENCE AND ERGONOMICS	ROMER ABSOLUTE	OTHER
Does the balance mechanism support the weight of the arm, allowing single-handed operation?	Yes	
Is the wrist designed around the complex contours of the human hand?	Yes	
Does the arm feel lightweight and natural when held?	Demo to evaluate	
Does the arm push or pull against the operator when used?	Demo to evaluate	
Does the counterbalance design allow versatile mounting options?	Yes	
Does the arm include a safety locking mechanism?	Yes	
Does the safety lock allow use of the arm in intermediate positions?	Yes	
Does the safety lock have a security mechanism to prevent arm damage if the arm is moved while locked?	Yes	
Does the laser scan line orientation and required offset (distance from the part) allow for comfortable scanning positioning and movement?	Demo to evaluate	
Can the arm transmit measurement data wirelessly and while operating on battery power?	6axis: Yes 7axis SI scanner: Yes 7axis SE scanner: No	
Can the arm measure on battery power alone?	6axis: Yes 7axis SI scanner: Yes 7axis SE scanner: Yes (Touch mode only)	
How many batteries can the arm hold?	1 (feature pack 2) 2 (feature pack 3)	
Are the batteries hot swappable?	Yes (feature pack 3)	
Battery life under typical conditions	Probe: approx 8 hrs Scan: approx 4 hrs	
Can arm capabilities be field upgraded?	Yes, feature packs	
Does the arm have a "mouse mode" to operate the software without removing your hands from the arm?	Yes	

Price is Only the Starting Point

Portable Measuring Arm Buyer's Checklist

5. ARM WEIGHT AND AVAILABLE LENGTH	ROMER ABSOLUTE	OTHER
Is the appropriate length for my application available?		
1.5 meter (4.9 feet) / 6 axis (73 series)	7.1 kg / 15.6 lbs	
2.0 meter (6.6 feet) / 6 axis (73 series)	7.4 kg / 16.3 lbs	
2.5 meter (8.2 feet) / 6 axis (73 series)	7.7 kg / 17 lbs	
3.0 meter (9.8 feet) / 6 axis (73 series)	8.0 kg / 17.6 lbs	
3.5 meter (11.5 feet) / 6 axis (73 series)	8.3 kg / 18.3 lbs	
4.0 meter (13.1 feet) / 6 axis (73 series)	8.6 kg / 19 lbs	
4.5 meter (14.8 feet) / 6 axis (73 series)	8.9 kg / 19.6 lbs	
2.0 meter (6.6 feet) / 7 axis (73 series SI model)	8.3 kg / 18.3 lbs	
2.5 meter (8.2 feet) / 7 axis (73 series SI model)	8.6 kg / 19.0 lbs	
3.0 meter (9.8 feet) / 7 axis (73 series SI model)	8.9 kg / 19.6 lbs	
3.5 meter (11.5 feet) / 7 axis (73 series SI model)	9.2 kg / 20.3 lbs	
4.0 meter (13.1 feet) / 7 axis (73 series SI model)	9.5 kg / 20.9 lbs	
4.5 meter (14.8 feet) / 7 axis (73 series SI model)	9.8 kg / 21.6 lbs	
2.0 meter (6.6 feet) / 7 axis (73 series SE model)	7.9kg/ 17.4 lbs	
2.5 meter (8.2 feet) / 7 axis (73 series SE model)	8.2kg/18.1 lbs	
3.0 meter (9.8 feet) / 7 axis (73 series SE model)	8.5kg/18.7 lbs	
3.5 meter (11.5 feet) / 7 axis (73 series SE model)	8.8kg/19.4 lbs	
4.0 meter (13.1 feet) / 7 axis (73 series SE model)	9.1kg/20.1 lbs	
4.5 meter (14.5 feet) / 7 axis (73 series SE model)	9.4kg/20.7 lbs	

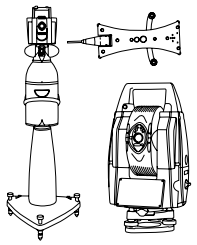
PROBE CHANGING AND QUALIFICATION	ROMER ABSOLUTE	OTHER
Does the probe have an embedded chip to self-identify itself when attached to the arm?	Yes	
Does the arm hold a tip qualification in memory so it can be removed and replaced without requalifying or reverifying?	Yes	
Does the system require a separate tool to do probe changes?	No	
Can one probe be used with more than one arm without entering probe data?	Yes (initial qualification required for each arm used)	
How repeatable is the probe mounting?	1 micron	

Price is Only the Starting Point

Portable Measuring Arm Buyer's Checklist

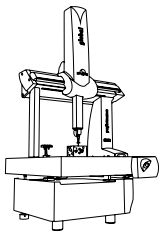
STANDARD ACCESSORIES (TYPICALLY EQUIPPED, 75 SERIES)	ROMER ABSOLUTE	OTHER
Are there low-cost probe tips commercially available?	Yes	
What probes are included?	3 probes (3mm, 6mm, 15mm)	
Can probe styli be replaced?	Yes	
Is a magnetic base included?	Yes (75 Series), optional (73 Series)	
Does the system include a certified artifact for checking probe accuracy such as a certified sphere?	Yes	
Does the system include a certified artifact for checking volumetric arm accuracy such as a certified length bar?	Yes (75 Series)	
Is a wheeled hard case included?	Yes	
Is a dust cover included?	Yes	

OPTIONAL ACCESSORIES AVAILABLE	ROMER ABSOLUTE	OTHER
"Build Your Own" probe kits	Available	
Extended Length Probes	Available	
Angled probes	Available	
Touch trigger probes (standard TP20 and "robust" types)	Available	
Replaceable probe styli ("tips")	Available	
Tube Inspection Probes	Available	
Heavy Duty Rolling Stands and carts	Available	
Tripod Stands	Available	
Magnetic base	Available	
Vacuum mount base	Available	
Screw or bolt mountable base/nut	Available	
Online Accessory Store (Shopmetrology.com)	Available	

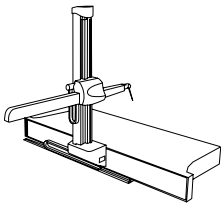


Laser Trackers & Stations

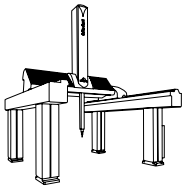
Portable Measuring Arms



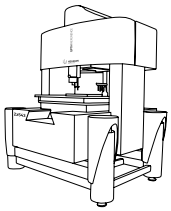
Bridge CMMs



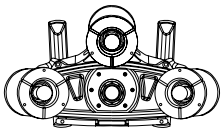
Horizontal Arm CMMs



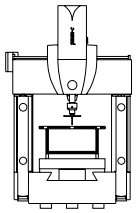
Gantry CMMs



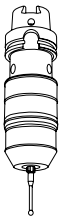
Multisensor & Optical Systems



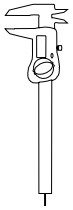
White Light Scanners



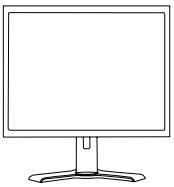
Ultra High Accuracy CMMs



Sensors



Precision Measuring Instruments



Software Solutions

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www.hexagonmetrology.us
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