

IP PROTECTION CLASSES

PRE 1213(2)



Practical tips relating to IP protection classes

Mitutoyo

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Introduction

During use and over the course of their service life, technical equipment – such as a hand-held measuring device – is exposed to numerous environmental influences. These invariably have a sustained impact on the function, useful life, quality and reliability of the product, oil and emulsion can get into the equipment and render it unfit for usage or cause materials such as rubber to become brittle. This is why it is so enormously important, not only from a technical and economic perspective but also in view of work safety, to ensure that technical products are designed and manufactured to withstand the anticipated loads and to perform reliably.

Providing a comparable definition for users in respect of the stress and resistance levels of a product with regard to specific influences is equally important. The allocation to so-called IP protection classes can provide valuable orientation assistance.

This brochure is dedicated to providing a more detailed explanation of the term IP and its specific references and significance in production, quality testing, and the use of hand-held measuring devices.

The specialists at Mitutoyo are willing to provide personal assistance if you have any other questions or required detailed explanations in respect of a specific application. There are numerous means you can choose to contact Mitutoyo Messgeräte GmbH directly. We look forward to helping you. You will find our phone and fax numbers, e-mail and internet details on the back page of this brochure.

Yours

Mitutoyo Messgeräte GmbH



Standard outside micrometer and caliper, "old" design without IP protection.

IP protection class: What does it actually mean?



Two digits that provide a host of information

The term “protection class” generally indicates the type of protection of a device or the internal workings of a device against direct contact and against the infiltration of foreign bodies, such as objects, dust or water.

The resistance to stress arising from prevailing working conditions is defined using international protection (IP) classes. These protection classes are, in turn, indicated in IP standards (DIN EN 60529), whereby a combination of two digits specifies the level of protection.

The first digit indicates the level of resistance to foreign bodies and dust, the second digit the level of resistance to water infiltration. A higher value of the relevant digit (first digit 0 – 6, second digit 0 - 8) indicates a higher level of protection.

The table on the following pages offers clarity and an overview of the IP rules:

First digit: Protection grades for contact and foreign matter protection

Digit	Designation	Explanation
0	No protection	No special protection to prevent infiltration by solid objects.
1	Protection against large foreign matter	Protection against solid objects greater than 50 millimeters in diameter.
2	Protection against medium-sized foreign matter	Protection against solid objects greater than 12.5 millimeters in diameter.
3	Protection against small foreign matter	Protection against solid objects greater than 2.5 millimeters in diameter.
4	Protection against circular foreign matter	Protection against solid objects greater than 1 millimeter in diameter.
5	Dust protected	Complete protection against dust is not necessary, but infiltration must be prevented to a sufficiently high degree to ensure that the functioning and safety of the device are not impaired.
6	Dustproof	Complete protection against dust infiltration.

Second digit: Protection grades for water protection

Digit	Designation	Explanation
0	No protection	No special protection to prevent water infiltration.
1	Protection against vertically dripping water	Water dripping vertically on to the device may not have any harmful effect.
2	Protection against water dripping at an angle	Water dripping vertically onto a device tilted to an angle of up to 15° from the vertical may not have any harmful effect.
3	Protection against spray water	Protection against water sprayed at any angle up to 60° from the vertical on to the device.
4	Protection against splash water	Water splashing against the device from any direction may not have any harmful effect.
5	Protection against water jets	A jet of water aimed at the housing from any direction may not have any harmful effect.
6	Protection against strong water jets	A strong water jet aimed at the device from any direction may not have any harmful effect.
7	Protection against temporary immersion	When the device is immersed in water up to 1 meter from the lower edge of the device, water may not enter the device in any sufficient quantity to cause damage.
8	Protection against continuous immersion	The device is suitable for continuous immersion in water. The conditions must be individually agreed between the manufacturer and the user but must, at least, exceed the specification of digit 7.

How is testing performed?

Contact and foreign matter protection

Two devices are used to test contact and foreign matter protection, depending on the level of requirements: a probe is used for protection grades 1 through 3 and a dust chamber for digits 5 and 6.

Probe testing

Probe testing involves pressing a probe – a rigid ball with a diameter of between 12.5 and 50 millimeters, or a rigid rod with de-burred edges and a diameter of 2.5 or 1 millimeter (depending on the protection grade) – against each opening in the device housing. The full diameter may not be able to penetrate the inside of the device through any of these openings.

Dust chamber testing

Dustproof testing in the chamber is much more sophisticated than probe testing. A dust circulating pump keeps talcum powder suspended in a hermetically sealed chamber. The powder must be fine enough to easily pass through a sieve with a pre-defined mesh size that is installed in the chamber. The quantity of powder in the chamber is also specified.

A vacuum pump ensures that the inside of the test specimen housing remains beneath the ambient atmospheric pressure. The specifications of the relevant IP protection class 5 or 6 are fulfilled when no functional impairment and/or no dust infiltration is witnessed.



Water protection

As is also the case with contact and foreign matter, the methods for testing for water protection become more sophisticated as the protection grade increases. The tests for grades 0 through 4 of the second IP digit are still fairly moderate, involving water drips, sprays or splashes, whereas testing for grades 5 and 6 is much more severe. A fundamental distinction is made between jet water and immersion testing.



Water protection IP X5 test



Water protection IP X6 test

Jet testing

This test procedure for the second IP grades 5 and 6 involves directing a jet of water from a high pressure nozzle from all possible directions at the test device. The diameter of the nozzle is specified, as are the duration and quantity of water to be used. The minimum test duration, for example, is three minutes, while the flow rate is 12.5 or 100 liters per minute.

How is testing performed?

Immersion testing

Immersion testing for the second IP grade 7 requires that the test specimen be completely immersed in a bowl of water for a period of 30 minutes. The device must be positioned as it would normally be during frequent, real use conditions. The immersion depth is also specified, of course. For example, the lowest point of the Mitutoyo caliper IP67 must be a full meter below water level.



TÜV Certification for Safety



External testing for heightened credibility

As a pioneer in the field of developing and manufacturing hand-held measuring devices with extremely high IP protection, Mitutoyo has many measuring devices with high-grade IP protection externally tested by TÜV Rheinland.

The high stress levels and IP protection classes of Mitutoyo hand-held measuring devices are confirmed by corresponding test certificates issued by TÜV Rheinland Group following a series of in-depth tests. This is extremely helpful for users when deciding which device to purchase: They are not just dependent on the information provided by the manufacturer but can also rely on the independent judgment of a neutral expert opinion.

What and how does TÜV certify?

A certified product has successfully passed certain tests performed by TÜV Rheinland Group, for example safety and quality tests. The TÜV issues a certificate confirming the results of the tests. It confirms the tested product characteristics and indicates the relevant standards to which they were tested.

TÜV Rheinland Group first tests a representative sample from serial production in line with the corresponding criteria. These tests are normally performed in TÜV's testing laboratories.

To ensure that the certificate does not just reflect a spot test, TÜV employees subsequently monitor the relevant products at regular intervals. In the case of Mitutoyo devices, this involves random testing by TÜV once a year. This ensures that the certified products continue to meet the high standards.

TÜV Certification for Safety

Direct information for users: TUVdotCOM-ID

TUVdotCOM-ID is the key to the certificates awarded by TÜV Rheinland Group. This ten-digit sequence of numbers can be used to call up the tested characteristics of a product – for example a tested hand-held measuring device made by Mitutoyo – on the internet at any time. The ID is entered in an input field on the TÜV homepage www.tuv.com and navigates straight to an overview of the test results.

The TUVdotCOM-ID is an integral part of the round TÜV Rheinland seal that can be found, for example, on the pages describing the tested hand-held measuring devices in the Mitutoyo catalog or on Mitutoyo's homepage www.mitutoyo.de.

The relevant TUVdotCOM-ID as listed gives users quick access to all relevant information via the TÜV internet URL, which is equally indicated on the seal. A product can be correctly classified within just seconds using the TUVdotCOM-ID. You are also protected against forged test marks: If a product displays an incorrect ID, a quick look at the description on the internet is all it takes to uncover the mistake.

Neutral testing of quality and safety characteristics by the TÜV removes uncertainty, simplifies communication and creates a basis of mutual trust.



Mitutoyo hand-held measuring devices with extremely high IP protection classes

As a globally leading manufacturer of hand-held measuring devices, Mitutoyo also demonstrates their outstanding commitment to development in terms of IP protection. In recent years, for example they have created the widest range of length measuring devices that set new standards in terms of contact, foreign matter and water protection.

Digital outside micrometer IP65

The digital outside micrometer IP65 developed by Mitutoyo marks a huge step forward in increasing protection classes. It was the first of its kind in the world to offer this level of protection. Previously, all other outside micrometers had only complied with protection class IP54 at the most.

Its protection rating of IP65 proves that the digital outside micrometer is absolutely dustproof – and therefore offers the highest definition of IP safety in terms of contact and foreign matter protection. The second grade of 5 certifies that the hand-held measuring device is also protected against jet water and can withstand a jet spray of water aimed at the device from any direction without suffering any damage. Remarkably, the device complies with IP65 specifications without restriction even when a signal line is connected.



QuantuMike Outside Micrometers

Quality tests during production



100 % seal integrity test on the production line

Various tests are performed on all outside micrometers on the production line to ensure their reliability. For example, the IP protection class test is simulated using a pressure chamber to identify faulty devices.

QuantuMike® outside micrometers

Quick measurements combined with IP65 protection – that is QuantuMike. This outside micrometer is fitted with a precision thread spindle with 2 mm pitch. This extreme pitch enables measurements to be performed 50% faster than with a conventional outside micrometer with 0.5 mm spindle pitch.



Moreover, the error limits of 2 μm are well below the requirements of DIN 863, which only permits deviations of 4 μm .



Mitutoyo

Special Designs

Special design outside micrometers and sliding calipers

Users want to be able to benefit from high-grade IP protected measuring devices even when using special designs.

These measuring devices with special measuring surfaces or shapes are crucial for measuring inaccessible points, for example.

When machines are located in dirty environments and a lot of coolant is used, outside micrometers with IP65 protection or calipers with IP67 protection are definitely worth having.



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Absolute System Patented by MITUTOYO



Internal measuring devices and micrometers

Three-point internal measuring devices

Thanks to their 3 measuring jaws, which are offset by 120° and ensure self centering bores, three-point internal measuring devices are ideally suited for workshop use.

If the work piece is fixed in the machine, cooling lubricant is probably also present. IP65 offers protection for the electronics of the internal measuring device so that these tasks can be performed.



Digital micrometer heads

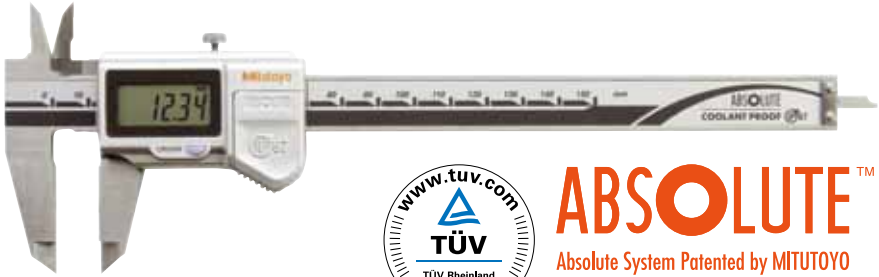
Micrometer heads are installed in the widest range of applications for use as contact, positioning or measuring units.

This equipment needs to work faultlessly and also be resistant to ambient influences. IP65 micrometer heads are dustproof and protected against water jets and thus offer the properties needed for these tasks.



Mitutoyo

Calipers



ABSOLUTE™
Absolute System Patented by MITUTOYO



The digital caliper IP67. It can even survive temporary complete immersion in water without suffering any damage.

Immersion testing for the second IP grade 7 specifies that the test specimen maybe completely immersed in a bowl of water for a period of 30 minutes. The device must be positioned as it would normally be during frequent, real use conditions. The lowest point of the housing must be a full meter below water level.



Mitutoyo's IP67 caliper is also able to demonstrate enormous stress resistance thanks to the use of innovative housing seals developed specifically for this task and of polyamide enclosures and vulcanized nitrile rubber.

Super Calipers

Tests for 100 percent assurance

As is also the case with the IP65 outside micrometer, the IP calipers are subjected to reliability tests on the production line. A test vessel and reference vessel are used to ensure that devices with faulty seals are identified immediately when the pressure drops in the test vessel. This simulation ensures provision of the IP protection. Unlike normal random tests, every single caliper, without exception, is subjected to quality testing.



IP safety check

Absolute Super Solar caliper

Mitutoyo's Super Solar caliper combines all of the innovative technologies within one device. In addition to its IP67 protection class, the caliper is, of course, also fitted with the Absolute system, solar cells for battery-free use, a capacitor offering a power reserve of up to 1 hour when using less than 60 Lux and a shock-resistant display housing.



Mitutoyo

Lightweight Calipers

Absolute carbon fiber caliper

A carbon fiber caliper with a measuring range, e.g., of 1000 mm weighs just 1.8 kg. The disadvantage of large steel calipers is their weight. A device with a measuring range of 1000 mm, for example, weighs 3.3 kg, which is a crucial advantage over the carbon fiber design to ensure measurement stability. Mitutoyo offers all of these devices with a measuring range up to 2000 mm with protection class IP66.



Gauges and Styli

Absolute gauges ID-N/ID-B LG-S styli

Gauges are frequently mounted on measuring tables or integrated into measuring devices, e.g., 2-point micrometers.

Or they might be incorporated in machinery or equipment as classic gauges with integrated display or as styli with external display.

This latter application, in particular, necessitates small designs and high-grade IP protection. The ID-N (front display) and ID-B (top display) gauges and the LG-S stylus all comply with both of these requirements.



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IP66

Mitutoyo

Internal Calipers

The IP66 version as a digital internal caliper is also equipped with all of the safety qualities guaranteed by the highest levels of resistance to dust and jet water infiltration. Mitutoyo offers three types with measuring ranges up to 100, 150 and 200 millimeters.



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Linear Scale

ABSOLUTE™ Linear scale AT715

Coolants/lubricants are constantly in use in processing equipment, such as cutting, grinding or jigging machines.

Even without the seal air usually used to achieve high levels of protection, an integrated linear scale with IP67 protection simplifies installation and use enormously and ensures uninterrupted operation. (Provided it is properly installed in line with the operating instructions.)

And if the scale is Absolute, i.e., the reference points do not need to be reset when the equipment is switched on, this linear scale is tailor made for use in the manual tool industry.



PAT. JP3436510, US6329813, US6400138 P. CN1272620A, EP1014041A1



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Interpreting IP protection classes correctly

When the going gets tough:

Digital hand-held measuring devices, such as calipers, outside micrometers or three-point internal measuring devices, are frequently found in rough surroundings. When performing their functions in rough workshop surroundings or the direct production environment, users must be very sure of the level of stress they can really expose the devices to.

Anyone working in extremely tough ambient conditions who needs a really stress-resistant, top quality hand-held measuring device should definitely make sure it has the right IP protection class - preferably confirmed by the TUVdotCOM seal - and take additional structural measures to prevent chemical and oil impacts.

Mitutoyo uses materials that are extremely resistant to emulsion, oil, grease and coolant when manufacturing its "Coolant Proof" measuring equipment.* "Coolant Proof" equipment may not reveal any impairment in function and properties, even after extreme exposure to such substances – an additional material competitive advantage in extremely severe working conditions.

The following should, however, generally be observed:

Both high IP grades and additional measures and certifications should not be misunderstood as a license to careless or even negligent treatment of the equipment. No matter how high the quality of the hand-held measuring device is, it will eventually suffer damage if not treated with the proper care throughout its service life.

According to DIN EN 60529, IP protection on its own only describes the behavior of an object in the conditions defined by the standard.

How long, and how reliably a digital hand-held measuring device performs faultlessly in severe working conditions is largely ultimately, and literally, in the hands of the users.

* List of tested coolants / lubricants, see page 24

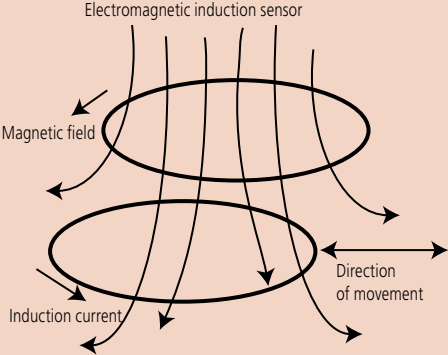
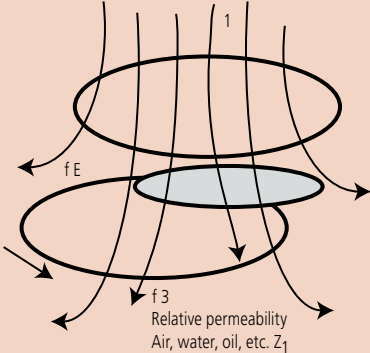
List of tested coolants / lubricants

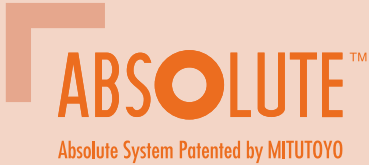
The length measuring devices were exposed to various coolants / lubricants in the course of extensive tests to determine their impact on the equipment. None of the tests revealed any impairment, neither in function nor of the material.

ESSO	Mobil	Castrol	Blaser
DRT45	Met 734,735,737	Honilo 130	Blasocut Kombi*
DRT44,48,52	Met 303,411,414,417	Ilogrind 484	
		Honilo 171*	
		Ilocut 670,JP-1	
		Ilocut 430,482,486	
		Ilogrind 483 Honio 480,481	
		Ilobroach 219	
PNX 37	MetJ, 762*,763*,766*	Ilobroach 30	
		Ilocut 103,334*,603	
		Ilogrind 600SP	
PNX 36, DRT52	Met 421,422,423*,426*	Varoocut C165	
		Ilocut 654,734	
FNX32		Ilogrind 407*,500FG*	
		Honilo 981*,988*	
Kutwell 40*,EP61,M61		Hysol X*	
Super Cut50		Alsol B*	
		SuperedgeJ, SW	
Kutwell M62		Hysol AM,B	
		Syntilo R,DC	
		ClearedgeEP,500	
	Met 265	Syntilo 9974,9954,9913,1023	
		Syntilo* GX,81*,CR70	
Lector		SE Fluid180*	
Anti Rust		Safecoat*	
		Rustilo*	
		DOT 4	

* = available in Germany

Inductive measuring and ABS system: Functional principles

<p>Principle</p>	 <p>Electromagnetic induction sensor</p> <p>Magnetic field</p> <p>Induction current</p> <p>Direction of movement</p>	<p>Permittivity between coils. Incident induction flow.</p>
<p>Resistance to ambient influences</p>	 <p>1</p> <p>$f E$</p> <p>$f 3$</p> <p>Relative permeability Air, water, oil, etc. Z_1</p>	<p>Since the permeability scarcely varies, the induction voltage is not influenced by moisture or oil infiltrating the gaps in the coils.</p>



Globally patented: Mitutoyo's Absolute System

The Absolute System, for which Mitutoyo has applied for global patent protection, has revolutionized working with hand-held measuring devices.

Calipers equipped with the system can be used without always having to start back at zero point. Since they reset the zero reference point themselves, they can display the absolute value of the measured length at any point. This means: You only need to start at zero point once, and then the measuring device keeps track of it itself – even if it is turned off in between. Once it is restarted, you can continue measuring from any point you choose – without restarting from zero and without any errors whatsoever. In simplified terms: Absolute devices do not count; they always “know” where they are at any precise moment. They do not “move along” a length to be measured like conventional equipment; they “see” it. This means you are guaranteed to work precisely and comfortably under all conditions, and to save time.

Mitutoyo has not just developed and patented its Absolute System; it has also perfected it: Mitutoyo is the only supplier in the world to implement the original Absolute technology in a very wide range of different length measuring devices.

Extreme IP protection: What do users say?

By increasing the IP protection classes, Mitutoyo has clearly and consciously exceeded current market requirements. Without any problems this gives users the assurance of being able to cope with conditions for operating their digital hand-held measuring devices, even under future conditions that are not required or not conceivable at present.

Well-known practitioners and users of Mitutoyo's hand-held measuring devices agree, and warmly welcome the dramatic leap forward – especially since some of the designs with better protection are offered at the same price as previous designs.

OKUMA Europe GmbH: Recommendation with a clear conscience

OKUMA

OKUMA corporation, one of the technology leaders in the field of CNC machining technology and one of the world's largest manufacturers of CNC tool machines, has a very clear opinion on IP development,

According to Hartmut Ehrentraut,

Projekt Manager Application Department at OKUMA Europe GmbH:

“I must confess that I do not see ad hoc any of the working environments in which more than 25,000 OKUMA CNC jiggling machines and processing centers are operated in Europe, of which 5,000 are located in Germany alone, which would require such a high level of protection as currently offered by Mitutoyo. By the same token, it is, however, comforting to be able to recommend measuring equipment to our clients that even meets the possible safety requirements of the future. There can be no doubt that the new IP protection classes raise the quality and reliability of the measuring devices in all areas – which is the beginning and end of a daily, multifaceted production process”.

Extreme IP protection: What do users say?



A+K Präzision CNC-Fertigung GmbH

Solingen-based A+K Präzision CNC-Fertigung GmbH is one of the companies that uses OKUMA machinery and has also been placing its trust in Mitutoyo's measuring equipment for years. The innovative company manufactures top quality products for the international automotive construction industry, farming equipment, drive technology, pumps and compressors, together with general mechanical engineering products. For years, the company has been following the recommendation and uses Mitutoyo measuring devices virtually exclusively as they ideally complement the state of the art machinery.

Specific inquiry: Interview with A+K quality testing department

Jürgen Meyer, head of quality assurance at A+K-Präzision agreed to answer specific questions relating to the issues of IP protection classes and the use of hand-held measuring devices at his company.



?: Mr Meyer, what are the conditions in which you use production measuring equipment?

Jürgen Meyer: "We regularly have between 15 and 20 OKUMA processing machines in operation. Mitutoyo's hand-held measuring devices are usually used directly on these machines by the workers as testing equipment. Although the measuring areas are kept as clean as possible, the equipment is inevitably exposed to dirt and liquids."

?: Which production measuring devices do you use?

Jürgen Meyer: "Primarily digital calipers and digital outside micrometers with and without data output. By the way, we have been using Mitutoyo's hand-held measuring devices for nearly 40 years now – quite simply because they are most frequently requested by our employees."

?: What is your experience with digital calipers offering the former protection classes of IP65?

Jürgen Meyer: "All good. Even with IP65 we did not have any problems whatsoever in terms of dust and moisture protection. The same applies, by the way, to the now old IP54 version of the outside micrometer – here again, I cannot recall any difficulties whatsoever. But as I said: Even more safety is definitely not a bad thing. Who knows what operating conditions we will encounter tomorrow ..."

?: Are your production measuring devices exposed to aggressive substances?



Jürgen Meyer: "In our business, dust is a relatively minor problem. Cooling lubricants are quite a different matter. We primarily use oil manufactured by Blaser. And, of course, we have any number of different shavings – short and long, aluminum, steel and, above all, cast iron, which is predominantly wet processed. Nothing that is necessarily dramatic but equally not totally harmless for a hand-held measuring device. So it is good to know that we are on the safe side."

Extreme IP protection: What do users say?

?: What is your experience with the shock and impact resistance of outside micrometers?

Jürgen Meyer: "A+K specifies unequivocally that any hand-held measuring device that drops on to our concrete or stone tiled floors must be submitted for testing immediately. Thanks to the particular shock resistance of your new outside micrometer with IP65 protection, any functional impairments or damages will be even more rare than already currently witnessed with Mitutoyo equipment."

?: Does the extension of the battery life and simultaneous reduction of the number of batteries for the IP66 and IP67 caliper to just one produce any benefits?

Jürgen Meyer: Well, Mitutoyo's hand-held measuring devices have already proven to date that their power consumption is extremely economical compared with others. So basically, a peak position is being topped once again, without this probably being directly noticeable on each individual hand-held measuring device – since a battery life of up to 15,000 hours might possibly even exceed the time over which the equipment is used. I see this economy, however, as an incredibly important contribution toward protecting the environment – given that several million such devices are probably going to be in use at any time around the world.



?: Finally, Mr Meyer, how would you evaluate the issue of extremely high IP protection classes and the point of hand-held measuring devices designed to comply with them?

Jürgen Meyer: “Although the resistance levels offered by the previous Mitutoyo hand-held measuring devices have so far been fully sufficient for performing the tasks our company needs, I have to say that I do indeed welcome the added safety offered by the new devices. In our business, especially, you never know which specific job may require which unusual conditions, maybe even tomorrow. So instead of then frantically searching around for a solution that may be more or less feasible, the new IP classes and material standards mean that we are already prepared.

Apart from which, the devices don't score points merely on the basis of direct IP optimization. This is joined by other factors, such as the improved shock protection or outstanding temperature resistance. For someone who is responsible for quality, like myself, all of these strengths combined together are very comforting and convincing.”



Registered Mitutoyo patents*

Patent no.	US4879508	US4878013	US5053715	US6329813	US6400138
	JP1783035	JP1783036	JP1745485	JP3436510	JP1745486
	EP0248165	EP0404980	EP0240020	EP1014041	
	CN87102580	CN87102624	CN89106051	CN1272620	

* Valid as at the time of going to press: January 2008

Coordinate Measuring Machines

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Form Measurement

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Test Equipment and
Seismometers

Digital Scale and DRO Systems

Small Tool Instruments and
Data Management

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