LiquiPhysics™ Excellence

Perfect Specs
For a Myriad of Applications

METTLER TOLEDO

Flexible Solutions
Many Industries – One Concept

■ Food and Beverage [DM45] [RM50] [Color] [pH] [LabX]

The sugar content in Brix of soft drinks, alcohol concentrations of spirits in volume %, pH values of fruit juices, Gardner color of sunflower oil etc. ...
LiquiPhysics™ Excellence does not only cover a great many common quality control checks, it also paves the way for improved efficiency. Measurements can be automated and several parameters determined in a single run.

... Density, Specific Gravity, Brix%, Alcohol (% w/w, % v/v, Proof, HMCE), °Baume, °Plato, Refractive Index ...

... AOAC, OIV, ASBC, TTB, ICUMSA, ASTM, SSDT, ISI, AOAC, OIML, JIS, DIN, CID, A.O.C.S. Cc7-25 ...

■ Food Ingredients and Additives [DM40] [RM40] [Color] [pH] [LabX]

Specific gravity and refractive index are the two key parameters in the quality control of food additives. Manufacturers of flavors increasingly also systematically determine pH and color. LiquiPhysics™ Excellence offers all the tools required to set up fully automatic measuring systems which can cope with many parameters per sample and many samples per day with inclusive automatic barcode reading and data export.

... Density, Specific Gravity, CIE L*a*b, pH ...

... EN/ISO 15212, ISO 280 ...

■ Cosmetics [DM45] [RM40] [Color] [pH]

Density meters, refractometers, pH meters and colorimeters are essential elements of the standard equipment of most cosmetics labs. These instruments are used for a wide range of applications. Density determinations to comply with the fill-volume ordinance and combined specific gravity refractive index measurements to ensure that fragrances are perfectly composed are only two examples of many tasks LiquiPhysics™ Excellence can assume in the cosmetics lab.

... Density, Specific Gravity, %Water in Glycerol, Alcohol (% w/w, % v/v, Proof), Zeiss, CIE L*a*b, pH ...

... EN/ISO 15212, Ph. Eur., USP, JP, ISO 280 ...

■ Chemical [DM45] [RM40] [Color] [pH/Cond.] [LabX]

Urea concentration in water, quality control of organic solvents, characterization of liquid inter-stage product and acid concentration determinations: The chemical industry has a wide range of problems which are easily solved with LiquiPhysics™ Excellence.

... Density, Specific Gravity, Refractive Index, pH, µS/cm, ASTM Color ...

... EN/ISO 15212, ASTM D1747-89, ASTM D1218-92 ...

■ Pharma   [DM45] [RM40] [Color] [pH] [LabX]

Specific gravity and refractive index determinations are among the simplest and fastest methods to characterize liquid samples. Moreover, these two parameters are becoming more and more popular for concentration determinations in binary mixtures. The pH value and the USP or EP Color are similarly decisive in the quality con-

trol of pharmaceutical solutions. LiquiPhysics™ Excellence covers all these applications. With the LabX™ Laboratory Software it provides the tools required to ensure all results are traceable and comply with the strict regulations governing the pharmaceutical industry.

... Density, Specific Gravity, %Water in Glycerol, EP Color, USP Color, pH ...

... EN/ISO 15212, Ph. Eur., USP, JP, 21 CFR part 11, cGLP/GMP ...

■ Education & Government   [DM45] [RM40]

High precision density meters are the appropriate tools to detect two popular tricks to evade taxes: Fuel adulteration and fake alcohol concentration declarations. With the DeltaRange™ density measuring cells, LiquiPhysics™ Excellence offers the accuracy required for these

applications at best value prices. Almost every educational lab is equipped with at least one refractometer although many of them are still optical Abbé type refractometers. LiquiPhysics™ Excellence provides state-of-the-art replacements for such instruments.

... Density, Specific Gravity, Alcohol (% w/w, % v/v, Proof, HMCE at 15 °C, 20 °C, 60 °F), Refractive Index ...

... ASTM D4052, IP 365/84, EC 2870/2000, EC 355/2005, EC 128/2004, EEC 2676/90 ...

■ Biofuel   [DM45] [RM40] [Color] [LabX]

LiquiPhysics™ Excellence covers several of the core parameters determined in the quality control of biofuel: Density of bioethanol and biodiesel, ASTM color of biodiesel and the density and refractive index

of Glycerol. At the same time, it offers the possibility of performing quick and reliable quality control checks of the liquid raw materials used in the production of biodiesel.

... Density, Specific Gravity, Refractive Index, ASTM Color ...

... EN/ISO 12185, ASTM D4052-96, Eur. Ph. 1979, ASTM D1500 ...

■ Petrochemistry   [DM40] [RM40] [Color]

Most petrochemical products are liquid at ambient temperature. Density and its industry specific unit API gravity have always been important parameters for the classification and characterization of petrochemical products even for those which are highly viscous or solid at room temperature. LiquiPhysics™ Excellence offers ideal solutions for a large variety of petrochemical products thanks to wide measuring temperature ranges, very quick

heating up- and cooling down rates, automatic viscosity correction, whole temperature range adjustments and powerful automation units which are also available as heated versions. Furthermore, LiquiPhysics™ Excellence allows the determination of several parameters in one run. For instance, measuring density at 15 °C, refractive index at 20 °C and ASTM color of lubricants is a matter of one single click.

... Density, Specific Gravity, API Gravity, Refractive Index, ASTM Color, Saybolt, Gardner ...

... DIN 51757, ISO 12185, ASTM D 1250, ASTM D 4052, ASTM D 5002, ASTM D 5931, ASTM D1500 ...

█ Units

█ Norms

Density and Refractive Index
Compact Size with Great Specs

Density Meters and External Density Cells

DM   DX

Density Meter Density Cell	DM40 DX40	DM45 DeltaRange DX45 DeltaRange	DM50 DX50
Measuring range	0.0000 ... 3.0000	0.00000 ... 3.00000	0.00000 ... 3.00000
Repeatability (S.D. n=10)	0.00005	0.000005	0.000005
Limit of error [g/cm^3]	0.0001	0.00002 (0.7 ... 1 g/cm^3, 15 ... 20 °C) 0.00005 (0 ... 3 g/cm^3, 0 ... 91 °C)	0.00002 (0 ... 1 g/cm^3) 0.00004 (0 ... 3 g/cm^3)
Limit of error Brix [% w/w]	0.03	0.02	0.02
Limit of error ethanol [% v/v]	0.1	0.02	0.02
Temperature range [°C]	0 ... 91	0 ... 91	0 ... 91
Limit of error [°C]	0.05 (10 ... 30 °C) 0.10 (0 ... 91 °C)	0.02 (15 ... 20 °C) 0.05 (0 ... 91 °C)	0.02 (10 ... 30 °C) 0.05 (0 ... 91 °C)

Sample contacted materials: PTFE, borosilicate glass
Minimal sample volume: Approx. 1 mL
Typical measuring time: 30 s (5 s after reaching temperature equilibrium)
Dimensions (L x W x H in mm): DM density meters: 272 x 385 x 215, DX density cells: 272 x 238.5 x 215
Weight: DM density meters: 13.52 kg, DX density cells: 12.80 kg
Power supply: AC 100 to 240 V; 50 to 60 Hz; 40 to 100 W

The models differ only in their measuring accuracy. All the density meters offer the same features of:
- **Temperature control**
  Extremely fast heating up- and cooling down rates:
  10 → 60 °C: 12 min.
  60 → 10 °C: 12 min.
- **Measurements**
  Reliable results even prior to thermal equilibrium being reached: A patented algorithm shortens the time required per measurement by up to 75%.
- **Error detection**
  A built-in algorithm detects non homogeneous measuring cell filling.
- **Adjustments**
  With air and water, air and a liquid density standard or two liquid density standards. Built-in reference temperature probe, no errors due to fluctuations of the ambient temperature. Only one adjustment required for the whole temperature range.
- **Viscosity correction**
  Full range correction of errors caused by the sample's viscosity.

Refractometers and External Refractive Index Cells

RM

RX

Refractometer Refractive Index Cell		RM40 RX40	RM50 RX50
Measuring range		1.3200 ... 1.7000	1.32000 ... 1.58000
Repeatability (S.D. n=10)	nD	0.00005	0.00001
	Brix [% w/w]	0.05	0.01
Limit of error	nD	0.0001	0.00002
	Brix [% w/w]	0.1	0.014
Temperature range [°C]		5 ... 100	5 ... 75
Limit of error [°C]		0.10	0.03

Sample contacted materials: Sapphire, stainless steel SUS316, perfluoroelastomer
Minimal sample volume: 0.4 mL
Typical measuring time: 20 s (5 s after reaching temperature equilibrium)
Dimensions (L x W x H in mm): RM refractometers: 208 x 372 x 192.5, RX refractive index cells: 208 x 226 x 192.5
Weight: RM refractometers: 5.40 kg, refractive index cells: 4.35 kg
Power supply: AC 100 to 240 V, 50 to 60 Hz, 60 W

The models differ only in their measuring accuracy. All the refractometers offer the same features of:

- **Temperature control**
  Very fast heating up and cooling down rates:
  $10 \rightarrow 60$ °C: 7 min.
  $60 \rightarrow 10$ °C: 28 min.
- **Measurements**
  Possibility of performing accurate measurements at the nominal temperature without having to wait for thermal equilibrium.
- **Adjustments**
  With air and water or two refractive index standards.
- **Measuring stage**
  Easy to clean. Top section can be easily removed and rinsed with tap water without the need for any tools.

Common features for all instruments:

- **Temperature control**
  Built-in solid state thermostat. Certified NTC temperature probe. Virtually no drift in contrast to traditional Pt100 and Pt1000 probes.
- **Error detection**
  Automatic multiple measurement to detect the most frequent sources of measuring errors.
- **Adjustments**
  Automatic plausibility checks to prevent erroneous adjustments. Four different adjustment sets can be stored and adjustments monitored.
- **Instrument performance tests**
  The tests can be scheduled. The data on the certificates of the combined liquid standard reference material from METTLER TOLEDO can be scanned with a barcode reader.

- **Communication interfaces**
  Density meters and refractometers: FillPal™, DryPal™, SC1/SC30, WasteSens™, ErgoSens™, aux. device. 1 Ethernet (PC), 2 USB for printer, external measuring cell (density or refractive index), PC, LogStraight™, barcode reader, ScanStraight™, AtmoSens™ (on DM and DX only), SevenEasy™ pH meter or conductivity meter, Lovibond® PFX colorimeter and memory stick. Density and refractive index cells: Four USB connectors (for the same aforementioned devices).

Automation
The Best Guarantee for a Fast Payback

DryPal™ Drying Pump and FillPal™ Sampling Pumps

DryPal™ Drying Pump
Required for DM density meters which are used without SC1 or SC30 automation units in order to dry the measuring cell prior to adjustments.

FillPal™ Sampling Pumps – The robust approach to reliable results
FillPal™ sampling pumps simplify the measurement of low viscous samples (max. sample viscosity: 1000 mPa·s) which are available

in larger quantities. These pumps can be used for all DM density meters and RM refractometers and are suitable for all applications where the samples to be measured are of a similar nature.

The FillPal™ sampling pump is available in two versions:
• **FillPal™ Food:** For water based samples such as beer, milk and soft drinks. The pump is resistant to solvents normally used for cleaning prior to adjustments

such as ethanol and acetone. Sample contacted materials: Borosilicate glass (density) or stainless steel SUS318 + artificial sapphire (refractive index), FEP and TYGON® 2075 (TYGON is a registered trade mark of SAINT-GOBAIN Performance Plastics).
• **FillPal™ Chem:** Suitable for aggressive samples including most acids, bases and organic solvents. The pump can handle virtually all types of chemicals, including most organic solvents. Sample contacted materials: Borosilicate glass (density) or stainless steel SUS318 + artificial sapphire (refractive index), FEP and CHEM-SURE™ (CHEM-SURE is a registered trade mark of W.L. Gore & Associates, Inc.).

SC1H and SC30H Heated Versions

Density determinations of samples which are solid at ambient temperature.
The SC automation units are available as heated versions suitable for performing density measurements on samples which are solid at ambient temperature, such as

paraffins, vaseline, edible fats, etc. A PPU power purge unit is included in the standard delivery of the SC1H and SC30H. The SC1H and SC30H can handle samples with a melting point of up to 60 °C.

SC1 and SC30 Automation Units

SC30

SC1

The key to a string of advantages including less work, greater certainty and increased occupational safety.
The SC1 sample delivery and cleaning unit can automate the determination of the density and/or the refractive index and additional parameters (color, pH and/or conductivity) of individual samples. The SC30 sample delivery and

cleaning unit is a sample changer with 30 positions. The SC automation units are the best guarantee for a fast measuring system payback and for highly reliable results. Thanks to their powerful sampling mechanism, the SC1 and SC30 automate the complete measuring cycle of basically every type of liquid (max. sample viscosity: 30'000 mPa·s). The pump used

for sampling is contacted by dry air only. To ensure correct results, automatic n-fold measurements out of one vial can be performed. The samples can be pushed back into the vials after measurements and used for other purposes.
The systems are automatically cleaned with one or two rinsing liquids and dried after measurements. Cross contamination between samples can safely be ruled out. A WasteSens™ (see p. 8) prevents the waste container from being overfilled. The sample vials can be closed and are opened by the SC immediately before the measurement starts. This prevents measuring errors due to evaporation.

Options and Consumables for SC1 and SC30 Automation Units

PPU power purge unit – Enhanced power for higher sample throughput
The PPU power purge unit substantially shortens the time required to complete the cleaning and drying cycles between measurements and lowers the amount of solvent required for cleaning.

Sampling needle made of Hastelloy C22
Equipped with this highly corrosion resistant sampling needle (option), the SC automation units are able to handle very corrosive samples such as concentrated sulfuric acid.

Sample vials
The SC automation units can be used with different types of vials of 6, 9 or 20 mL made of borosilicate glass. The 6 and 9 mL vials are fitted with an adapter. The 20 mL vials are also available in polypropylene and can be used with or without a cap.

Description	Part No.
DryPal™ drying pump	51337029
FillPal™ Food sampling pump for aqueous products	51337027
FillPal™ Chem sampling pump for corrosive products and organic solvents	51337028
PPU power purge unit for SC1 and SC30 automation units	51327365
Sampling needle made of Hastelloy C22	51327323
Sample vials 20 mL made of borosilicate glass. 148 pcs.	51322310
Sample vials 20 mL made of borosilicate glass. 31080 pcs.	51327397
Sample vials 20 mL made of polypropylene. 148 pcs.	51322360
Sample vials 20 ml made of polypropylene. 1400 pcs.	51322361
Screw caps for 20 mL sample vial (opened by the SC prior to measurement). 148 pcs.	51322319
Screw caps for 20 mL sample vials (opened by the SC prior to measurement). 31080 pcs.	51322351
Sample vials 6 mL made of borosilicate glass. 1860 pcs.	51322313
Sample vials 9 mL (amber) made of borosilicate glass 1860 pcs.	51322312
Septa for 6 and 9 mL sample vials (required). 2000 pcs.	51322305
Adapter for small sample vials (required). 30 pcs.	51322304
Screw caps for small sample vials with seal (to store samples). 3500 pcs.	51322306
deconex 12 NS surfactant (concentrate) for rinsing liquid	51322309

Valuable Options
Custom Tailored Performance

▩ ErgoSens™

No need to touch the instrument
ErgoSens™ is an infrared sensor for hands-free operation. It allows measurements to be started on

the DM density meters and the RM refractometers without the need to touch anything.

▩ LogStraight™

Biometric user management
No more user names to enter, no more cumbersome password management. With LogStraight™, the

operators simply put their finger onto the reader and the instrument knows immediately who they are.

▩ AtmoSens™

**Reliable 5 place
density adjustments**
The instrument needs to know the local air pressure for accurate

5 place adjustments of the density cell using air. AtmoSens™ is the tool which makes sure adjustments are performed accurately.

▩ Smartcodes™ and ScanStraight™

**The most convenient way
to enter sample data**
LiquiPhysics™ Excellence is not only able to read barcodes but can also interpret them correctly. Smartcodes™ allow the most effortless approach to quality control: If barcodes are used that contain both the sample identification plus

information about the type of product or the method to be used for the measurement, the operator simply scans in the barcodes to start the measurements. No button to click! The SC30 sample changers can be equipped with ScanStraight™, a built-in barcode reader. With this option, the sample information is

scanned directly from the barcode labels on the sample vials. All the operator needs to do is put the vials on the tray and click 'Start'. New samples can be added to or inserted into a running series at any time as the system keeps on working until all the samples have been analyzed.

▩ WasteSens™

Comprehensive safety
Wherever toxic samples must be measured or harmful solvents must be used to clean the cell, automa-

tion provides the basis for health protection. In such cases, Waste-Sens™ makes sure the waste cannot spill under any circumstances.

WasteSens™ can be easily attached to basically any type of waste container with tool-free mounting.

Density, Refractive Index, Color, Conductivity and pH

Enhanced productivity

Consistent color quality is essential for most liquid products whether a cosmetic product, an edible oil or a flavored alcoholic beverage. The pH value is another important parameter in quality control for products such as shampoos, fruit juices and certain specific flavors.

Density and/or refractive index play a decisive role in the quality assurance of most of these products. As a consequence, several different properties are often determined in the same sample. In practice, this usually means performing several measurements one after the other. LiquiPhysics™ Excellence offers the key to greatly increased efficiency in such cases. Thanks to its flexible concept, automatic measurement systems for the simultaneous determination of several parameters can be easily realized.

The refractive index flow cell and the color, pH and conductivity connecting kits contain all the items required (cables, connecting tubes, sensor, flow cell, etc.) to connect the corresponding instrument to any automated LiquiPhysics™ measuring system.

Press, Lid and Flow Cell

From tasty and very pasty to toxic and highly volatile: Refractive index solutions for a wide range of different products.

Thanks to valuable options, RM refractometers and RX refractive index cells are suitable for a wide range of different products.

To measure highly volatile products, the cover of the cell is equipped with a special lid which prevents evaporation. A press, which can simply be clipped onto the cover lid, makes it possible to measure pasty products.

Any RM or RX can easily be converted into an automatic measuring system with a flow cell. If many thin samples of a similar nature must be measured in a row, a Fill-Pal™ sampling pump saves a lot of valuable time. This set-up not only offers the same convenience as funnel type flow cells, but is also capable of detecting measuring errors automatically and ensuring improved repeatability of results when measuring non homogeneous products.

An SC30 automation unit can automate the measurement of a sample series even where the samples are of a different nature or available in very small quantities.

Employers need to take responsibility for the security and health protection of their employees in all work-related aspects at their own expense. Due to this legal regulation, toxic samples or products which require harmful solvents for cleaning must normally not be measured manually.

In such cases, the RM refractometers and RX refractive index cells should be automated with an SC1 or SC30 automation unit in order to safe guard the operators.

Description	Part No.
ErgoSens™ for hands-free operation	11132601
LogStraight™ finger print reader	51192107
AtmoSens™ (atmospheric pressure sensor)	51337020
Barcode scanner (hand scanner), requires cable 21901309	21901297
ScanStraight™ (barcode scanner for SC30 sample changer)	51337185
WasteSens™ (to prevent overflow of waste container)	51337026
Refractive index flow cell (required to automate refractometers with FillPall™ or SC automation unit)	51337024
Color connecting kit (suitable for Lovibond PFX PFX 8XX and PFX 9XX from Tintometer)	51337021
pH connecting kit (required to connect a SevenEasy™ pH meter)	51337023
Conductivity connecting kit (required to connect a SevenEasy™ conductivity meter)	51337022
Holding plate for pH / Conductivity cell (required for RM and RX)	51337197
Press for refractometers to measure pasty products	51337155
USB-P25 compact printer for DM density meters and RM refractometers	11124301
Disposable in use cover for DM density meters and RM refractometers	51337079

LabX™ Laboratory Software
Make the Most of LiquiPhysics™

■ Enhanced Flexibility – Optimized Workflow

Custom made LiquiPhysics™
Nowadays, measuring systems must be capable of producing more than just correct results. They are also required to offer the functionality necessary to optimize operations. A seamless integration of the measuring system into superordinate workflows is generally a must. The desirable degree of integration can hardly be achieved with stand alone measuring systems as every environment has its specific requirements:

- Sample lists must be imported having a specific format
- Result reports with a definite format must be created
- Measuring data must automatically be exported to an ERP system such as SAP

- Operators should be guided through special measuring procedures
- 21 CFR part 11 regulations must be fulfilled

To cope which such requirements, METTLER TOLEDO created LabX™, a new concept for laboratory software. LabX™ combines flexibility, ease of use and advanced networking facilities:

- Features tailored to your needs. LabX™ consists of a software platform, which offers the basic functionality required by all applications. This platform can be upgraded with modules containing additional features in order to adapt it exactly to specific requirements. The advantage of this is

that you pay only for the features you need and operators are not confronted with unnecessary functions.
- Easy operation. The personal computer is remotely controlled by the instrument. LabX™ offers full user guidance at the instrument. It is therefore not essential that the personal computer is located next to the instrument.
- Centralized management. LabX™ can be set up as a client server system and therefore be managed centrally.

■ Bring Your Laboratory Together

A common platform for METTLER TOLEDO Excellence balances and LiquiPhysics™ Excellence
LabX™ does not only support your daily routine with LiquiPhysics™ Excellence but can also manage any METTLER TOLEDO Excellence balance!
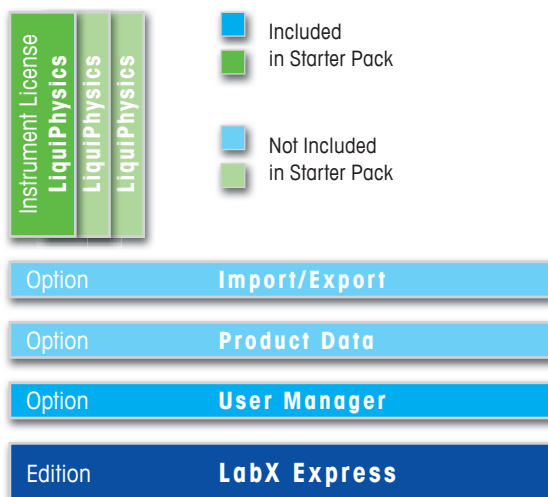
LabX™
Solutions powered by LabX™

METTLER TOLEDO

■ Design the World you Need

Starter Packs
Instrument Licenses
Options

| Included in Starter Pack |
| Not Included in Starter Pack |

LabX Express diagram:

- Option — Import/Export
- Option — Product Data
- Option — User Manager
- Edition — LabX Express

LabX Server diagram:

- Option — Report Design
- Option — Integration
- Option — Regulation
- Option — Product Data
- Option — Import/Export
- Option — User Manager
- Edition — LabX Server

Name	Description	Part No.
Starter Packs		
LabX™ LiquiPhysics™ Express	Functionality for a small system installed on a single personal computer, based on the LabX™ Express edition. Up to three instruments can be connected. Includes one instrument license and the user manager option.	11153130
LabX™ LiquiPhysics™ Server	Functionality for a client-server system consisting of up to 15 personal computers based on the LabX™ Server Edition. Up to 30 LiquiPhysics™ systems can be connected. Capable of exporting data to a superordinate system. System validation possible. Includes one instrument license, the user manager and the import/export option.	11153131
Instrument Licenses		
IL LiquiPhysics	One instrument license is required for each additional LiquiPhysics™ measuring system. The LiquiPhysics™ measuring system can consist of several instruments, however only one of them can be a DM density meter or an RM refractometer.	11153250
Options		
Product Data	To store the characteristics (nominal values, measuring method to be used, etc.) of all products to be checked in a database.	11153103
User Manager [1]	Possibility to create and manage system users.	11153102
Regulation [3]	All the tools required to work according to 21 CFR part 11.	11153104
Import/Export [2]	Only for express edition (included in LabX™ Server). Flexible setup of data export to a superordinate system.	11153105
Integration [3]	Enables other system to flexibly exchange data with LabX™ (e.g. import sample lists, special format of data export, etc.).	11153107
Report Design [3]	Free customization of reports with all details and possibilities like charts, plots and tables.	11153106

[1] Included in LabX™ LiquiPhysics™ Express and LabX™ LiquiPhysics™ Server.
[2] Included in LabX™ LiquiPhysics™ Server.
[3] Only available for LabX™ LiquiPhysics™ Server.

Combined Liquid Standard Reference Materials
Improved Data Security for Density and Refractive Index

The combined liquid standard reference materials from METTLER TOLEDO reduce uncertainty, eliminate time-consuming and error-prone sample transfer and facilitate fully automatic performance verification.

The four liquid standard reference substances are all certified for both density (uncertainty +/-0.00003 g/cm^3) and refractive index (uncertainty +/-0.00002) at three different temperatures (15, 20 and 25 °C).
The standards come in standard 9 mL vials suitable for use directly on the SC1 and SC30 automation units – no syringe required.
All the information contained in the certificates is coded in a single bar-code – no need to input data manually when performing system performance tests.

To make sure you can count on reliable results right from the beginning, every DM density meter and DX density cell come with a free combined water standard.

Standard Reference Material	Density [g/cm^3] at 20 °C	Refractive Index nD at 20 °C	Part No.
Water	0.998..	1.333..	51338010
Dodecane	0.749..	1.422..	51338012
2,4-dichlorotoluene	1.250..	1.546..	51338013
1- bromonapthalene	1.481..	1.658..	51338014

The uncertainty and the nominal values mentioned above are typical values and may change from lot to lot without prior notice.

www.mt.com/LiquiPhysics

For more information

Quality certificate. Development, production and testing according to ISO9001.

Environmental management system according to ISO14001.

European Conformity. The CE conformity mark provides you with the assurance that our products comply with the most recent EU directives.