

# DFX Series

## Liquid Ultrasonic Flow Meters



The DFX series of ultrasonic flow meters has been designed for high accuracy volume measurement of crude oils and other liquid hydrocarbons.

The M&T ultrasonic flow meter is based on the principle of transit-time difference measurement. A pair of ultrasonic transducers, one located upstream and the other downstream, send pulsed waves in the liquid and an electronic converter measures the difference in transit time between the wave travelling upstream to downstream and the one travelling downstream to upstream. This difference provides an accurate measurement of the average velocity of the liquid along the ultrasonic path.

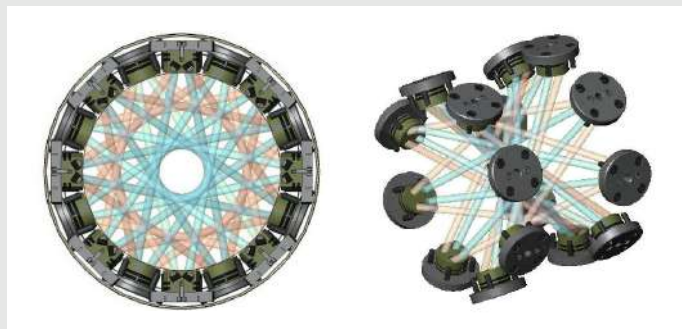
All DFX meters are calibrated at world-class accredited laboratories such as Trapil (France), using hydrocarbons of similar viscosity to site conditions. Flow profiles can be compared between laboratory and field conditions for a unique condition based monitoring.

DFX meters are directly proved against ball or compact provers on a wide range of Reynolds numbers (laminar, transition and turbulent flows). They are approved for fiscal metering and custody transfer in many countries. In addition, they comply with the relevant internationally recognised standards such as API, OIML and GOST.



## Design

The DFX-MM meter consists of two rings of 8 transducers, one located upstream and the other downstream. Each transducer of one ring produces 4 ultrasonic beams and communicates with 4 transducers of the other ring, so creating a three dimensional structure made of 32 ultrasonic paths.



The DFX-LV meter, is equipped with 15 paths and is dedicated to metering low viscosity products.

Thanks to the large number of ultrasonic beams, the DFX new generation of ultrasonic flow meters gives rich and reliable access to quantitative, traceable and accurate information on the velocity profile inside the metering section.

- 15 or 32 beam patented design transit time operating principle
- Unique axial symmetry which is much less sensitive to flow profile disturbances than chordal beam designs
- Small volume transducer cavities minimise scaling effects and avoid gas pockets

## Installation

- Reduced straight runs installation possible
- Compact integrated electronics for easy site commissioning and start-up



## Performance

- A master meter class ultrasonic flow meter exceeding current standards from naphthas/ condensates/liquid gases to heavy crudes/ fuel oils
- Superior linearity and repeatability thanks to unequalled spatial coverage and ultrafast scanning rate
- Compliant with OIML R117-1 class 0.3, M.I.D. 2004/22/EC and API MPMS Ch5.8
- Truly provable with standard turbine prover loops



## Applications

- FSO & FPSO custody transfer (crude oil, condensates)
- On & offshore allocation metering (crude oil, condensates)
- Pipeline metering stations (crude oil, refined products)
- Tanker loading/unloading terminals (crude oil, refined products, petrochemicals)
- Storage management (crude oil, refined products, petrochemicals)
- 15 beams for refined products/light oils
- 32 beams for multi-viscosity/medium to high viscosity oils



## Communication

- Ethernet communication
- Compatible with all types of flow computer using Modbus TCP
- Condition based monitoring (CBM) software
- Configuration utility with full security and audit trail
- Powerful flow imaging capability

## Service

- Transducers are exchangeable without the need to recalibrate the meter
- No zeroing adjustment needed in case of transducer replacement
- Thanks to their many redundant ultrasonic paths, DFX meters maintain fiscal accuracy in the unlikely event of a transducer failure. Replacement operation can be delayed and planned. This is a quick operation which reduces shutdown time





### Benefits

- Extremely high accuracy (better than 0.1%)
- 32 beam design provides the best redundancy
- Smallest prover volume requirement to achieve fiscal type repeatability
- Compatible with compact and ball provers
- Works with water cut from 0 to 100%
- Successfully tested with GVF up to 20%
- Much lower pressure drop on heavy oil
- Calibration on products by 3rd party at the best laboratories (example: Trapil lab uncertainty 0.043%)
- Can be used without a flow conditioner
- Calibration performance monitoring unique feature
- Condition based monitoring (CBM) available (smart diagnostics)



### International Approvals

M&T's ultrasonic flow meters have received approvals for fiscal metering and custody transfer in many countries. In addition, they comply with the relevant International standards, such as API, OIML and GOST.



### Calibration Uncertainty

All DFX meters are calibrated at accredited laboratories such as Trapil (France), using hydrocarbons of similar viscosity to site conditions.

No master meters: direct proving against ball provers for best calibration laboratory uncertainty: 0.043%.

Typically, the meters are calibrated on 6 flowrates over 5 runs each to achieve a K-Factor uncertainty of +/-0.027% at 95% confidence level as per API MPMS 4.8 table A-1.





## Proving Volume

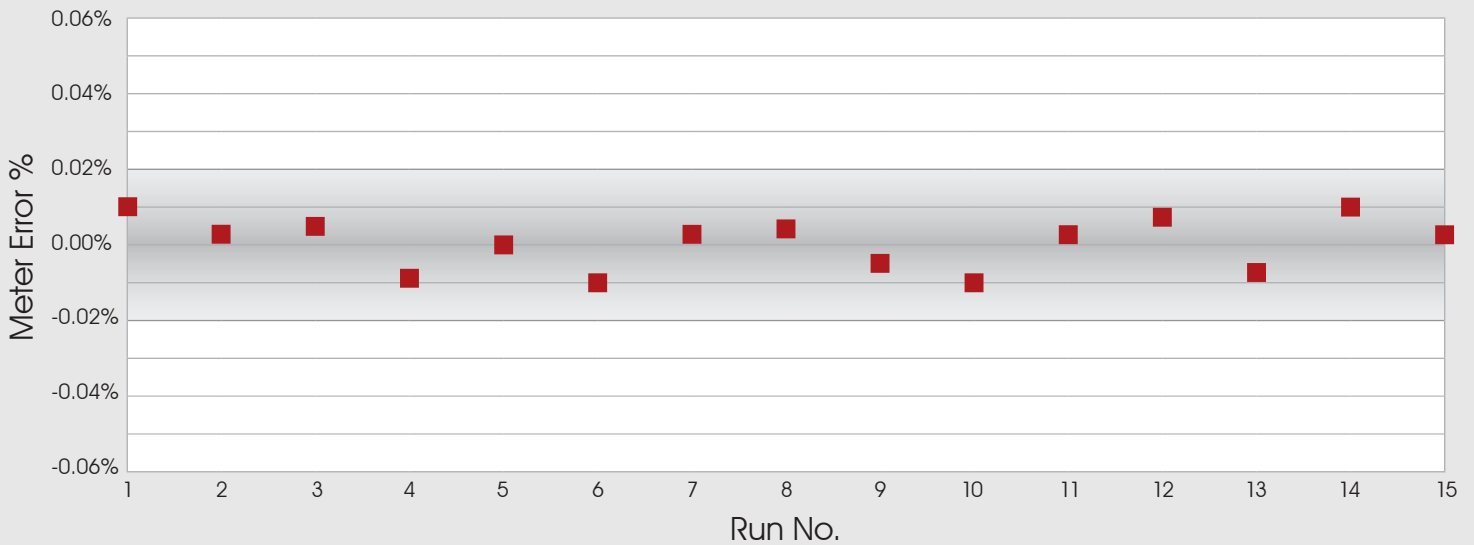
M&T DFX ultrasonic flow meters require much smaller prover volumes than other USMs and are therefore truly provable with standard turbine prover loops where other USMs have to be proved by master meter method. Based on the following results, we are able to provide smaller prover volumes.

## Repeatability

M&T DFX ultrasonic flow meters are provable with standard ball provers thanks to repeatability improved by their unequalled spatial coverage and ultrafast scanning rate.

### DFX-MM 08 Repeatability Test

Diesel oil 4.9 cSt - 600m<sup>3</sup>/h - 10m<sup>3</sup> ball prover - 15 runs

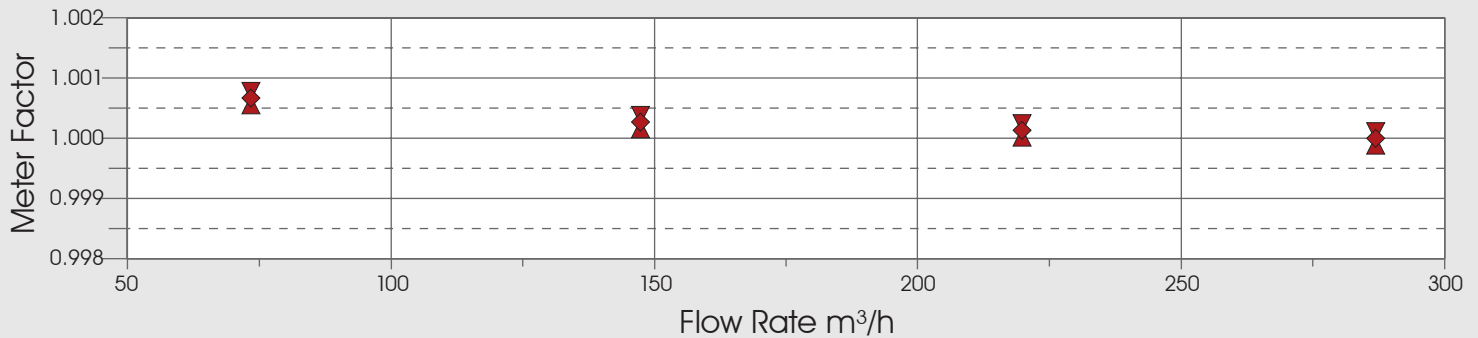


## Heavy Oil

DFX-MM meters accurately measure viscous flows and therefore are ideal when pressure drop is a concern.

### DFX-MM 06 Heavy Oil

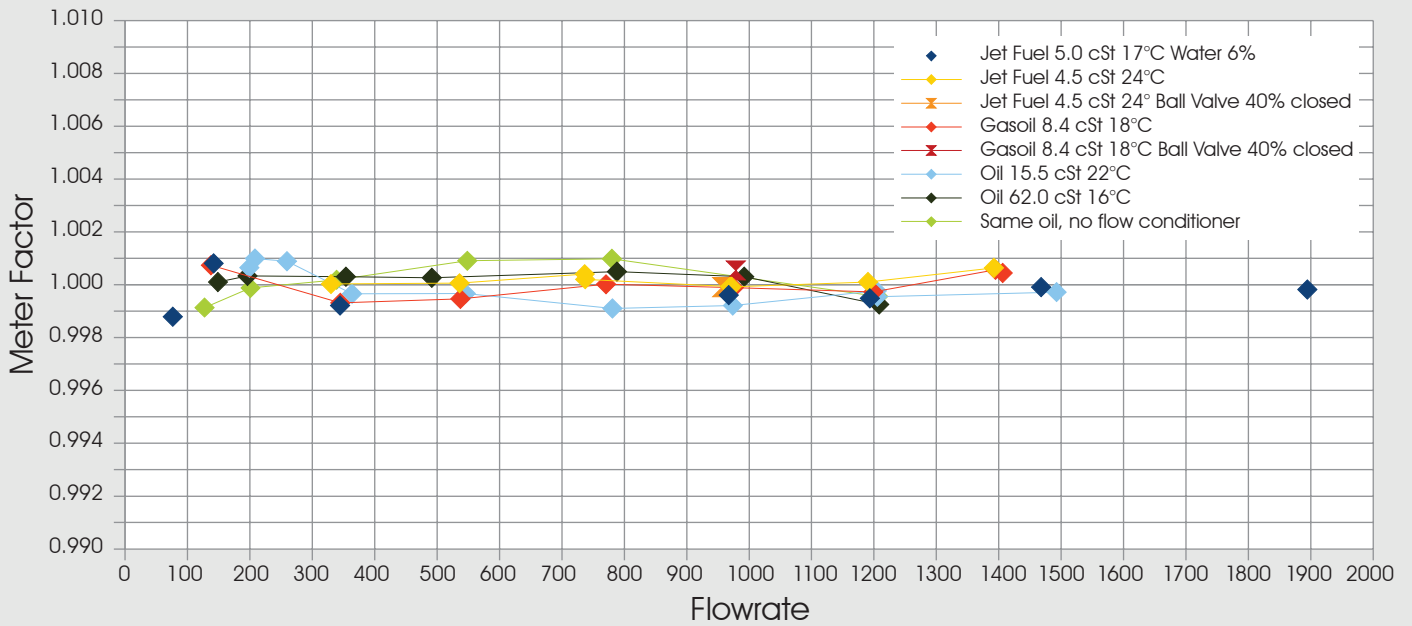
300 cSt mineral oil, 6" PD master meter



# Calibration Curves

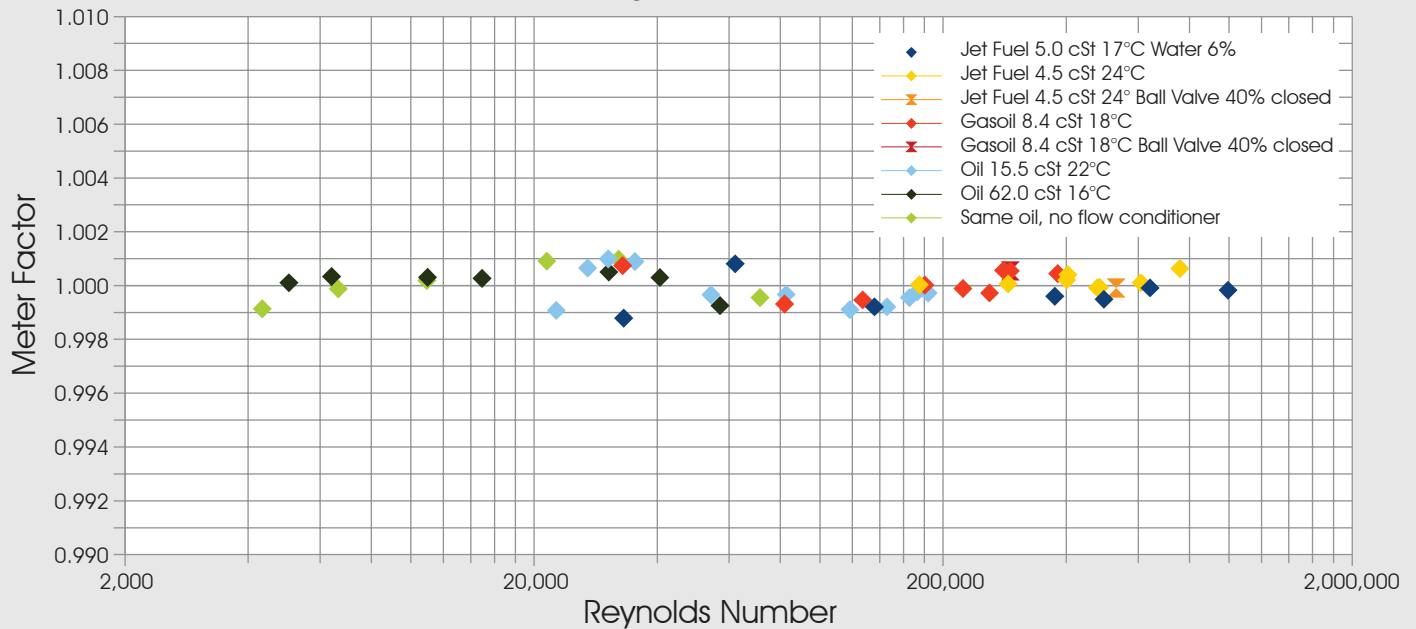
## DFX-MM 08" baselines

7D upstream flow straightener and a 10m<sup>3</sup> ball prover



## DFX-MM 08" baselines vs Reynolds Number

7D upstream flow straightener and a 10m<sup>3</sup> ball prover



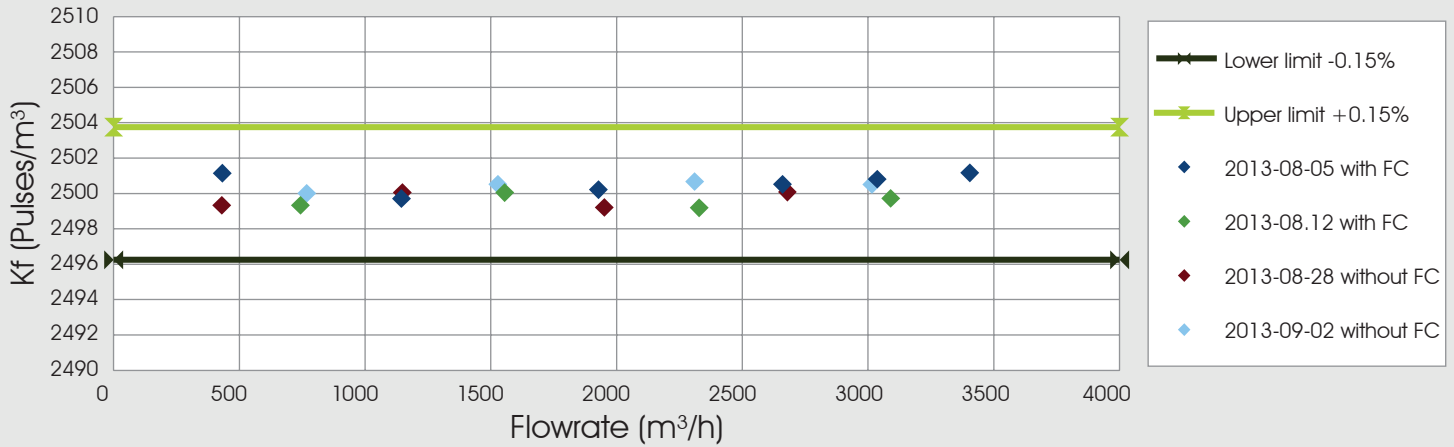
DFX sustains a premium +/- 0.10% accuracy with a constant K-factor over a wide range of viscosities and operating conditions



# Proving Superior Performance

Customer comparison of DFX installed with and without flow conditioner

DFX-MM 16" prove results on medium oil (15 cSt) with end user ball prover, K-factor deviation



# DFX-MM (32 Beam) Performance & Technical Data

## Nominal Flow Ranges

for standard accuracy +/-0.15%

Meter Size		Flow Rate (m³/h)		Flow Rate (BPH)	
Inch	mm	Min.	Max.	Min.	Max.
4"	100	15	350	100	2200
6"	150	30	800	200	5000
8"	200	60	1400	400	8800
10"	250	90	2200	600	13800
12"	300	130	3200	800	20100
14"	350	160	3800	1000	23900
16"	400	200	5000	1300	31400
18"	450	250	6200	1600	39000
20"	500	350	7800	2200	49100
24"	600	500	11000	3100	69200
26"	650	600	13000	3800	81800
28"	700	700	16000	4400	100600
30"	750	900	18000	5700	113200
32"	800	1000	20000	6300	125800
34"	850	1100	23000	6900	144700
36"	900	1200	26000	7500	163500
38"	950	1300	29000	8200	182400
40"	1000	1400	32000	8800	201300
42"	1050	1500	36000	9400	226400

## Nominal Flow Ranges

for premium accuracy +/-0.1%

Meter Size		Flow Rate (m³/h)		Flow Rate (BPH)	
Inch	mm	Min.	Max.	Min.	Max.
4"	100	30	300	200	1900
6"	150	65	650	400	4100
8"	200	120	1200	800	7500
10"	250	200	2000	1300	12600
12"	300	300	3000	1900	18900
14"	350	320	3200	2000	20100
16"	400	400	4000	2500	25200
18"	450	520	5200	3300	32700
20"	500	650	6500	4100	40900
24"	600	1000	10000	6300	62900
26"	650	1150	11500	7200	72300
28"	700	1350	13500	8500	84900
30"	750	1550	15500	9700	97500
32"	800	1750	17500	11000	110100
34"	850	2000	20000	12600	125800
36"	900	2200	22000	13800	138400
38"	950	2500	25000	15700	157200
40"	1000	2750	27500	17300	173000
42"	1050	3000	30000	18900	188700

## Technical Data

Type	Length				Weight							
	Meter Size		Meter Length		Weight (kg)				Weight (lb)			
	Inch	mm	Inch	mm	#150	#300	#600	#900	#150	#300	#600	#900
DFX-MM04	4"	100	16	406	51	60	72	79	113	132	159	174
DFX-MM06	6"	150	18	457	70	88	113	151	154	194	249	333
DFX-MM08	8"	200	20	508	99	125	159	215	218	275	350	473
DFX-MM10	10"	250	22	559	139	176	240	300	306	388	528	660
DFX-MM12	12"	300	24	610	186	232	328	394	410	511	722	867
DFX-MM14	14"	350	28	711	230	300	352		506	660	775	
DFX-MM16	16"	400	32	813	258	364	448		568	801	986	
DFX-MM18	18"	450	36	914	295	442			650	973		
DFX-MM20	20"	500	40	1016	350	504			770	1101		
DFX-MM24	24"	600	48	1220	495	721			1089	1587		
DFX-MM26	26"	650	52	1321	568	866			1250	1906		
DFX-MM28	28"	700	56	1422	646	1035			1422	2277		
DFX-MM30	30"	750	60	1524	748	1192			1646	2623		
DFX-MM32	32"	800	64	1626	862	1322			1897	2909		
DFX-MM34	34"	850	68	1727	951	1553			2093	3417		
DFX-MM36	36"	900	72	1829	1072	1742			2359	3833		
DFX-MM38	38"	950	76	1930	1194				2627			
DFX-MM40	40"	1000	80	2032	1355				2981			
DFX-MM42	42"	1050	84	2130	1423				3130			





# DFX-LV (15 Beam) Performance & Technical Data

## Nominal Flow Ranges

for standard accuracy +/-0.25% (1:20)

Meter Size		Flow Rate (m³/h)		Flow Rate (BPH)	
Inch	mm	Min.	Max.	Min.	Max.
4"	100	17	350	107	2200
6"	150	40	800	252	5000
8"	200	70	1400	440	8800
10"	250	110	2200	692	13800
12"	300	160	3200	1006	20100
14"	350	190	3800	1195	23900
16"	400	250	5000	1572	31400
18"	450	310	6200	1950	39000
20"	500	390	7800	2453	49100
24"	600	550	11000	3459	69200
26"	650	650	13000	4088	81800
28"	700	800	16000	5031	100600
30"	750	900	18000	5660	113200
32"	800	1000	20000	6289	125800
34"	850	1150	23000	7233	144700
36"	900	1300	26000	8176	163500
38"	950	1450	29000	9119	182400
40"	1000	1600	32000	10063	201300
42"	1050	1800	36000	11321	226400

## Nominal Flow Ranges

for premium accuracy +/-0.15% (1:10)

Meter Size		Flow Rate (m³/h)		Flow Rate (BPH)	
Inch	mm	Min.	Max.	Min.	Max.
4"	100	30	300	200	1900
6"	150	65	650	400	4100
8"	200	120	1200	800	7500
10"	250	200	2000	1300	12600
12"	300	300	3000	1900	18900
14"	350	320	3200	2000	20100
16"	400	400	4000	2500	25200
18"	450	520	5200	3300	32700
20"	500	650	6500	4100	40900
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26"	650	1150	11500	7200	72300
28"	700	1350	13500	8500	84900
30"	750	1550	15500	9700	97500
32"	800	1750	17500	11000	110100
34"	850	2000	20000	12600	125800
36"	900	2200	22000	13800	138400
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DFX-LV24	24"	600	48	1220	495	721			1089	1587		
DFX-LV26	26"	650	52	1321	568	866			1250	1906		
DFX-LV28	28"	700	56	1422	646	1035			1422	2277		
DFX-LV30	30"	750	60	1524	748	1192			1646	2623		
DFX-LV32	32"	800	64	1626	862	1322			1897	2909		
DFX-LV34	34"	850	68	1727	951	1553			2093	3417		
DFX-LV36	36"	900	72	1829	1072	1742			2359	3833		
DFX-LV38	38"	950	76	1930	1194				2627			
DFX-LV40	40"	1000	80	2032	1355				2981			
DFX-LV42	42"	1050	84	2130	1423				3130			



## Condition Based Monitoring (CBM)

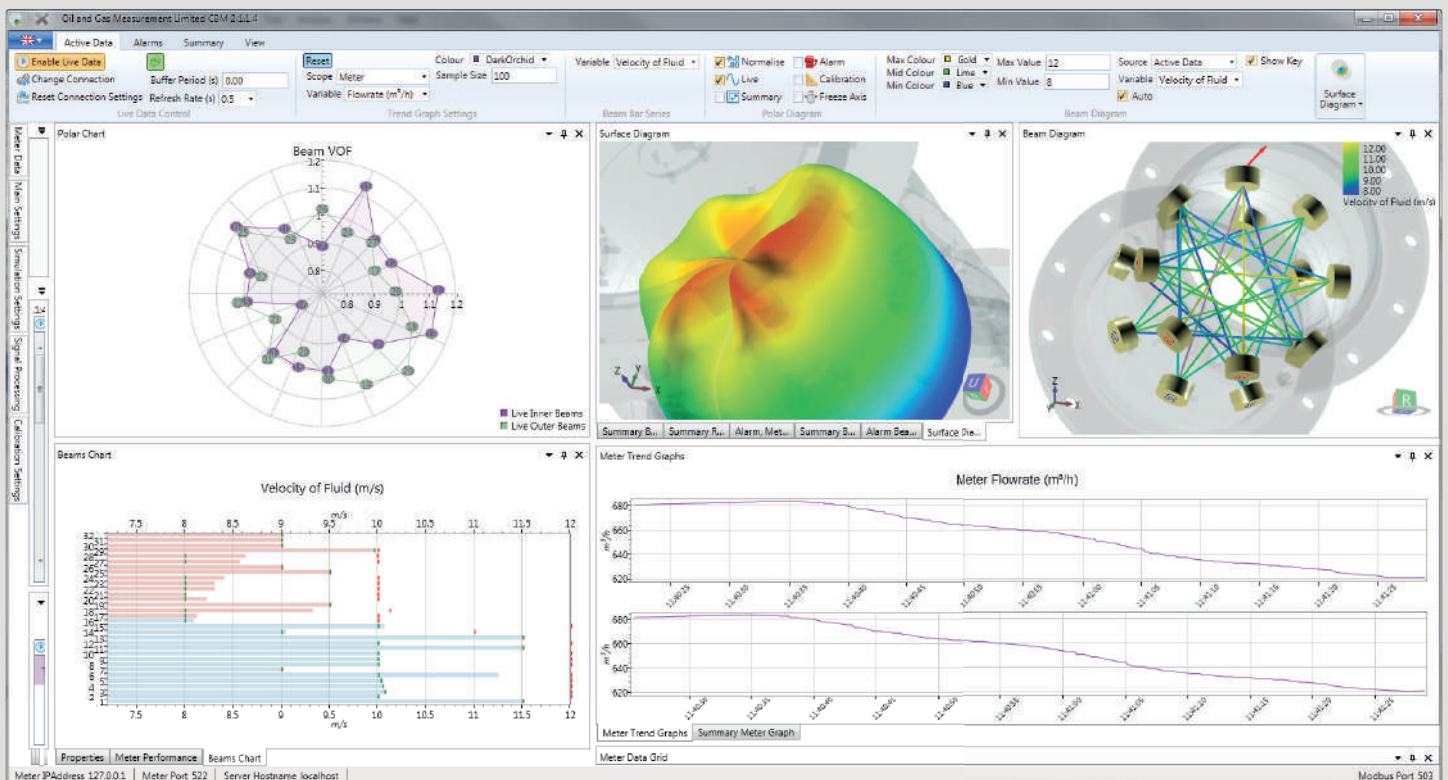
Condition based monitoring (CBM) is the process of monitoring parameters in a system in order to identify a change which is indicative of a developing fault condition.

This then allows condition based maintenance to be used rather than conventional time based maintenance.

The M&T CBM system records all major parameters for all 32 beams several times a second into a fully searchable SQL database. This database can be located on any computer connected to the meter via a standard ethernet connection and runs as either an application or a service. For the greatest security it is recommended that it is run as a service on a secure server forming part of the flow computer system.



The CBM application accesses this database continually and is therefore running very nearly in "real time". By using a database very fast access can be obtained to the complete operating history of the meter and trending can either be applied continuously or "as required". The database is accessed normally from the CBM application, but can also be accessed at any time using standard SQL searches from within Microsoft® Excel.



Condition based monitoring (CBM) live data screens showing the status of each of the 32 beams in "real time".

## Specifications

### Metrology

Compliances	OIML R117-1 class 0.3 API MPMS ch5.8 MID 2004/22/EC
Accuracy	see pages 6 and 7
Flow Range	see pages 6 and 7
Repeatability	0.05% 5 runs with conventional prover loops
Uncertainty	+/-0.027% at 95% confidence level as per API MPMS 4.8 table A-1
Installation	10D upstream with recommended flow conditioner + 3D downstream for an option without a flow conditioner, please contact us for details

### Certifications

Safety	ATEX 94/9/EC II 2 G Exd IIB+H2 T6..T5
Pressure	PED 97/23/EC ASME B31.3
Metrology	OIML R117-1 (PTB-1.5-4037579) GOST SIRIM (ATS 04/10) MIGAS (14599/18.06/DMT/2009) SPRING (WMO 423/08) INMETRO (P-0003-11-36896-10)
Environment	EMC 89/336/EC
Ingress Protection	IP 66/67 IEC529

### Process

Temperature	Process: -20°C to +120°C Ambient: -20°C to +55°C
Pressure	Up to 100 bar
Viscosity	0.1 to 600 cSt (please contact M&T for higher viscosities)
Density	400 to 1500 kg/m <sup>3</sup>

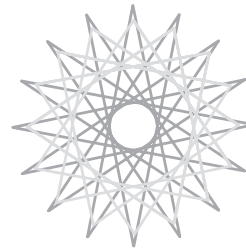
### Body

Materials	Carbon steel, low temp carbon steel, stainless steel, duplex, super duplex stainless steel
Flanges	ANSI 150, 300, 600, 900 (Other flange types available upon request)
Internal	full bore

### Converter

Power Supply	110/220 VAC 50/60 Hz or 18/32 VDC, 10W, isolation 1500V
Pulse Volume Output	two fully floating solid state relays 350V 0.12A isolation 5000V
Communication Port	10/100 Base-T IEEE 802.3 Ethernet RJ45
Protocols	Modbus TCP





## DFX Series - Ordering Codes

<b>MM</b>	DFX-MM (32 Beam)							<b>Product Line</b>
<b>LV</b>	DFX-LV (15 Beam)							
	<b>04</b>	4"/DN100						<b>Meter Size</b>
	<b>06</b>	6"/DN150						
	<b>08</b>	8"/DN200						
	<b>10</b>	10"/DN250						
	<b>12</b>	12"/DN300						
	<b>14</b>	14"/DN350						
	<b>16</b>	16"/DN400						
	<b>18</b>	18"/DN450						
	<b>20</b>	20"/DN500						
	<b>24</b>	24"/DN600						
	<b>26</b>	26"/DN650						
	<b>28</b>	28"/DN700						
	<b>30</b>	30"/DN750						
	<b>32</b>	32"/DN800						
	<b>34</b>	34"/DN850						
	<b>36</b>	36"/DN900						
	<b>38</b>	38"/DN950						
	<b>40</b>	40"/DN1000						
	<b>42</b>	42"/DN1050						
	<b>A</b>	150# ANSI RF Flanges						<b>Pressure Class</b>
	<b>B</b>	300# ANSI RF Flanges						
	<b>C</b>	600# ANSI RF Flanges						
	<b>D</b>	Other (please contact us)						
			<b>BODY</b>		<b>FLANGES</b>		<b>TRANSDUCERS</b>	<b>Materials of Construction</b>
		<b>1</b>	CS A106 or equ		CS A106 or equ		Peek / SS 316L	
		<b>2</b>	LTCS A333 Gr6 or equ		LTCS A350 LF2 or equ		Peek / SS 316L	
		<b>3</b>	SS 316L or equ		SS 316L or equ		Peek / SS 316L	
		<b>4</b>	Other		Other		Peek / SS 316L	
			<b>1</b>	Standard with recommended flow straightener				<b>Installation Conditions</b>
			<b>2</b>	Standard without flow straightener				
			<b>3</b>	Customised				
			<b>1</b>	Standard +/- 0.15%				<b>Accuracy Class DFX-MM</b>
			<b>2</b>	Premium +/- 0.1%				
			<b>1</b>	Standard +/- 0.25%				<b>Accuracy Class DFX-LV</b>
			<b>2</b>	Premium +/- 0.15%				
			<b>0</b>	None				<b>Documentation</b>
			<b>1</b>	Standard				
			<b>2</b>	Customised				
			<b>0</b>	None				<b>Special Request*</b>
			<b>1</b>	Special Request				
<b>MM</b>	<b>12</b>	<b>A</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>Example Product Code</b>

\*Upstream and downstream lengths can be provided upon request

