Forced Oscillations Technique (FOT), the easiest way to measure respiratory resistance

- Pseudo Random Noise Signal
- Total Respiratory Impedance: Resistance and Reactance
- No patient collaboration required, ideal for pediatric use
- Fast and easy assessment (8 sec processing time)
- High level of reproducibility
- Software fully integrated with COSMED Quark PFT
The Quark i2m allows the measurement of total respiratory input impedance (Zrs) under tidal breathing conditions by means of the Forced Oscillations Technique (FOT).

This technique consists in superimposing a random signal to the patient’s breath and measure the respiratory apparatus response. This signal is generated by an acoustic source connected to a mouthpiece with a pressure transducer, where the patient breathes at rest. The acoustic pulses are sent to the mouth at high frequency in casual sequence (Pseudo Random Noise - PRN). The frequency analysis consists to take the pressure at the mouth and the flow for each applied pulse frequency.

Quark i2m randomizes the pressure output frequency as recommended by the main respiratory governing organizations. Quark i2m system consists of two main components:

- **Main Unit**: includes a loudspeaker which generates the pressure signal
- **Head**: contains the electronics for pressure and flow data processing

Quark i2m can be used either as a standalone system or as a module fully integrated with COSMED pulmonary function laboratory Quark PFT.

### Main Measurements

Quark i2m measures pressure and flow at the subject’s mouth while an imperceptible, low intense and high frequency (4-48 Hz) pressure signal is applied. Elaborating flow and pressure signals, Quark i2m provides respiratory impedance measurement (Zrs) and its two components: resistance (R) and reactance (X).

The simple technology design provides extremely accurate, reliable and reproducible data.

The measurement of tidal flow and end pressure is critical also for quality control, identifying potential data corruption (mouthpiece obstruction, glottis closure and swallowing), which is detected as a reduction or interruption of flow oscillation.

The system doesn’t require any particular maintenance except the common disinfection recommendations. COSMED recommends the use of anti-bacterial filters to prevent cross-contamination.

An adjustable arm support clips on to any surface, holds the flowmeter and makes the test accessible for both adults and children.

An optional SpO₂ module is available for the measurement of oxygen saturation during the test.

### Application Fields

The Forced Oscillation Technique (FOT) is particularly useful for the assessment of the mechanical properties of the respiratory system in uncooperative patients or patients unable to perform forced expiratory manoeuvres, such as children or the elderly. As the FOT is noninvasive, it may be used for routine testing, epidemiological studies, research and monitoring the efficacy of treatment in COPD, asthma and mucoviscidiosis.

[... The main advantages of the forced oscillation technique are that minimal cooperation of the patient and no respiratory manoeuvres are needed; therefore, the measurement of respiratory impedance should be considered whenever spirometry cannot be performed or appears to be unreliable [...]] (Bibliography Ref.1).

A number of studies have demonstrated that FOT is able to identify airway obstruction and responses to bronchodilators and bronchoconstrictors.

A simple and fast (8-second) manoeuvre performed while the patient is breathing normally throughout a measuring device.

Quark i2m is the ideal instrument for testing children.

Quark i2m can be fully integrated in a COSMED Quark PFT system. A special rack can be added to the Quark PFT medical graded cart, allowing thus the operator to manage, with one single PC program, tests of respiratory mechanics, diffusing lung capacity, static and dynamic lung volumes.
Step by step data within the range 4-48 Hz

Mean values and resonance frequency against predicted values for accurate diagnosis

Flow and pressure waveforms for quality control

Resistance (R) and Reactance (X)

PC Software

The Quark i2m comes with software designed according to the latest guidelines concerning user interface and ease of use.

- Full patient database management
- Automatic calibration procedure
- Pre-Post display of bronchodilator/bronchoconstrictor test
- User-defined protocols for easy management of bronchochallenge test
- Built-in set of predicted values for easy diagnosis (included Pre-school children predicted)
- Comprehensive printout report
- Easy test quality control by the analysis of the breathing pattern and of the quality index displayed for all the frequencies (4-48 Hz)
- Possibility to export tests to txt (ASCII), xls (Excel), xpo (COSMED) formats for further data analysis

Antibacterial filters are strongly recommended for the prevention of cross contamination

Device calibration (recommended daily) is performed with a tube with a reference impedance (2 hPa/l/s) and connected to the Quark i2m Head (without antibacterial filter)

Resistance (R) values describe dissipative properties of respiratory system

Reactance (X) values measure elastic properties of the lung and inertial properties of the column air in the airways

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Last Name: BONO
First Name: James
ID: 000001
Date: 26/01/2007
Predicted: ERG 93

Date of Birth: 10/12/999
Sex: Male
Ethnic Corr.: 100
Description: Company:

Age: 7
Weight (Kg): 40.0
Height (cm): 130.9
BMI (Kg/m²): 33.7
Smoke: No

R, X/Freq

Resistance (R) values describe dissipative properties of respiratory system

Reactance (X) values measure elastic properties of the lung and inertial properties of the column air in the airways
### Technical Specifications

#### Forced Oscillations

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Type</td>
<td>Optimized pseudorandom noise (PRN) between 4Hz and 48Hz</td>
</tr>
<tr>
<td>Measurement range</td>
<td>0.5 - 40 hPa/l/s</td>
</tr>
<tr>
<td>Accuracy</td>
<td>± 2%</td>
</tr>
<tr>
<td>Resistance (Rrs)</td>
<td>in hPa/l/s</td>
</tr>
<tr>
<td>Reactance (Xrs)</td>
<td>in hPa/l/s</td>
</tr>
<tr>
<td>Coherence</td>
<td>0-1, (Index = 0.95)</td>
</tr>
<tr>
<td>Measurements</td>
<td>Resonance frequency, frequency dependency, average Rrs and Xrs, discriminant function</td>
</tr>
<tr>
<td>Monitoring</td>
<td>Online of both breathing signal and PRN</td>
</tr>
<tr>
<td>Processing time</td>
<td>8 sec</td>
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<tr>
<td>Data</td>
<td>between 4 and 48Hz (frequency step 2 Hz)</td>
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</tbody>
</table>

#### Pressure sensors

<table>
<thead>
<tr>
<th>Type</th>
<th>Piezo-resistive</th>
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<tbody>
<tr>
<td>Range</td>
<td>0-1 psi</td>
</tr>
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</table>

#### Hardware

<table>
<thead>
<tr>
<th>Dimension</th>
<th>33 x 20 x 16 cm (12.9 x 7.8 x 6.2 in)</th>
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</thead>
<tbody>
<tr>
<td>Weight</td>
<td>6.5 Kg (13.2 lb)</td>
</tr>
</tbody>
</table>

#### Standard Packaging Includes

- Quark i2m unit
- Calibration unit
- Antibacterial filters
- PC software
- Serial communication cable
- User manual

#### Electrical requirements

- Power supply unit: 90-264Vac
- Power consumption: 100W Max @ 230 VAC

#### PC configuration required

- Pentium or faster, Windows XP, 128 MB RAM or more
- Serial port RS-232 available, CD-Rom reader, 80 Mb on HD space available.

#### Safety

Quark i2m complies with MDD (93/42 EEC), EN 60601-1, EN 60601-1-2

COSMED is an organisation whose quality management system is certified by CERMET according to UNI EN ISO 9001:2008 and UNI EN ISO 13484:2004

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**Bibliography**