**Quark RMR**

Indirect Calorimetry

# The gold standard for metabolic measurements in applied human physiology research



COSMED

The Metabolic Company

*"Quark RMR was demonstrated to be unbiased, precise, reproducible, and accurate device for measuring oxygen consumption[1]"*

- **Measurement of Oxygen Consumption over the entire human physiological range**
- **Top of the range $O_2$/$CO_2$ gas analyzers (Paramagnetic, NDIR)**
- **Three flowmeters available for Resting and Exercise applications**
- **Gas Exchange measurements via Breath by Breath or optional Mixing Chamber**
- **Powered by OMNIA, the most intuitive software in the industry**
- **Independently validated at rest and exercise conditions**

The Quark RMR is a state-of-the-art metabolic cart for gas exchange analysis ($VO_2$, $VCO_2$) either during resting or exercise.

The number of available configurations make the Quark RMR the most versatile metabolic cart for applied research in human physiology.

Quark RMR's accuracy and reliability have been validated against Gold Standard methods either with spontaneously breathing subjects (at rest and during exercise) and mechanically assisted patients.

## Design

- **Unsurpassed reliability.** Fast-response stable and durable paramagnetic technology for $O_2$ sensor, and rapid infrared for the $CO_2$. Both analyzers can ensure reliable data for a long time without requiring their replacement.
- **Breath by Breath & Mixing Chamber.** Quark RMR is provided with Breath by Breath analyzers however the system is also available with an optional Mixing Chamber.
- **Modular architecture** allows to configure Quark RMR according to the different metabolic testing requirements. This cost-effective solution gives the opportunity to scale at any time to a more complex configuration.
- **Low running costs and easy maintenance.** Quark RMR design has been conceived to reduce ordinary maintenance and to easily and rapidly solve any possible technical problem through parts replacement.
- **Powered by OMNIA software** innovative user interface, touch screen ready, easy-to-use and self-explanatory.
- **Calibrations and Verifications procedures** are available to ensure that main measurement components perform according to their specifications.
- **Independently validated technology.** Quark RMR is the only metabolic cart in the market that has been validated both on different gas exchange methods (Breath by Breath and Mixing Chamber), and on the whole human physiological range (from resting to a wide range of exercise intensities).

| Main Features and Tests | |
|---|---|
| Resting Energy Expenditure (REE) with Canopy Hood | Standard |
| Resting Energy Expenditure (REE) with Mask | Standard |
| Resting Energy Expenditure (REE) with Ventilator (for mechanically assisted patients) | Option |
| "Breath by Breath" Cardio Pulmonary Exercise Testing (CPET) with Face mask | Option |
| "Mixing Chamber" Cardio Pulmonary Exercise Testing (CPET) with Face mask/Mouthpiece | Option |
| Spirometry (FVC, SVC, MVV etc.) | Option |

[1] *Ashcraft C.M. et al. "A Test of Validity of a New Open-Circuit Indirect Calorimeter. " J Parenter Enteral Nutr. 2014 Mar 10*

## Resting Energy Expenditure (REE)

The Quark RMR in its standard configuration provides the following features:

- Breath by Breath Gas exchange Measurement of oxygen consumption ($VO_2$), carbon dioxide production ($VCO_2$) and related ventilatory and metabolic parameters.
- Assessment of either spontaneously breathing or mechanically ventilated subjects.
- Intended for testing patients above 15kg of weight or 6 years of age.
- Available with "Low Flow" Turbine Flowmeter for canopy and mask tests and a single-use pneumotach for tests with mechanical ventilated patients.

### REE by Canopy Dilution

- Provided with an Adult Canopy hood, a paediatric version of canopy hood is available as an option.
- Canopy blower is integrated in the device and it is easily controlled through software.
- The software prompts an intuitive widget to help the operator in maintaining a stable $CO_2$ expired fraction ($FeCO_2$) during dilution.
- The Canopy veil is easy to mount and made in medical grade LDPE. It's a single-use item in order to avoid any possible cross contamination between subjects.
- Cleaning the hood is easy and can be done with easily accessible solutions.

### REE by Mask and Mouthpieces

- REE tests can also be done by wearing multi-use silicone oro-nasal face masks (available in 5 sizes: 3 adult, 2 pediatric).
- In addition to Canopy and Mask, users can also use mouthpiece with Antibacterial filters, together with a nose clip.

### REE on mechanically ventilated patients

- The ICU Kit is an optional module available for measuring REE in patients undergoing mechanically assisted ventilation in intensive care units.
- Flow and Volume is measured with a single-use pneumotach flowmeter (Flow-REE), to be positioned in line between the endotracheal tube and the "Y" connector of the ventilator circuit.
- All parts required during testing (Flowmeter, sampling line and HME filter) are single patient, with no need for cleaning and disinfecting after a test.
- Quark RMR allows to assess ventilated patients up to $FiO_2 \leq 70\%$.
- The patient setup makes Quark RMR completely independent from any type of ventilator in use.


*REE by dilution with canopy hood*

*REE breath by breath by face mask and with mouthpiece and AB filter*

*REE on mechanically ventilated patients*

## Cardio Pulmonary Exercise Testing

On top of the standard features, the optional module for Cardio Pulmonary Exercise Testing (CPET) extends the possibility to perform full exercise protocols during exercise efforts.

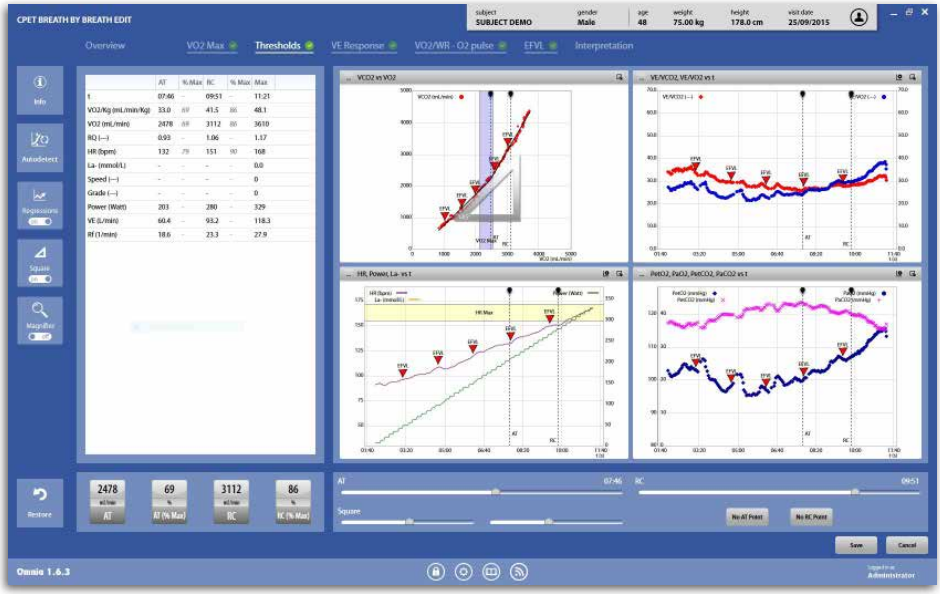
- Fast response analyzers provide accurate, reliable, breath-by-breath gas exchange data at any exercise intensity.
- CPET made easy thanks to OMNIA, the new generation of COSMED software. The intuitive, beautiful, and innovative user interface brings complex CPET procedures to a new simpler stage.

### CPET by breath by breath

- BxB is the standard configuration of the CPET Module. It includes a "High-Flow Range" flow reader with 2 extra turbines.
- Tests are conducted using ergonomic multi-use silicone oro-nasal face masks (available in 5 sizes: 3 adult, 2 pediatric) for comfortable testing in any condition.
- Masks are also available with 2 inspiratory valves, to reduce inspiratory resistance and to prevent moisture accumulation especially at high intensity exercise.

### CPET by Mixing Chamber

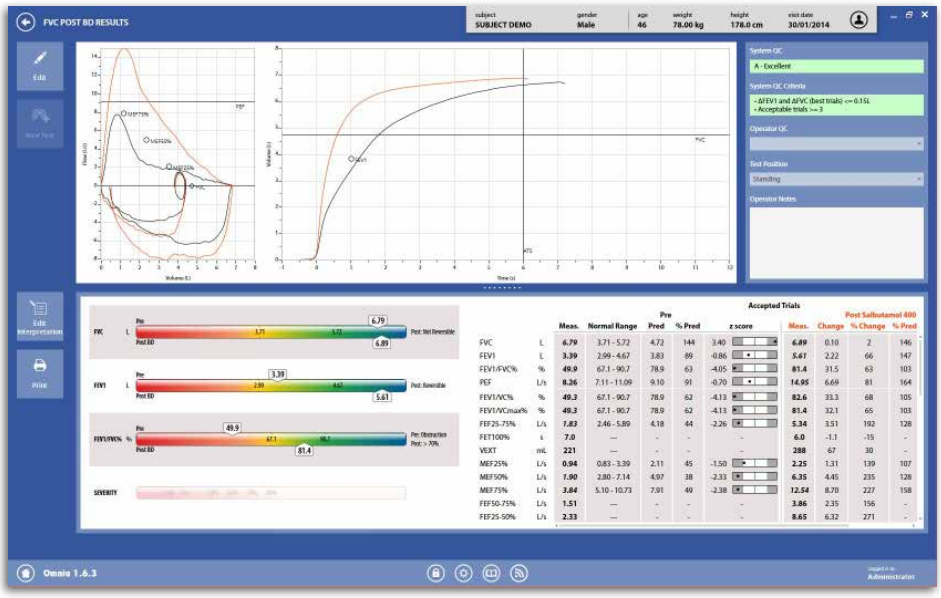
- This optional module includes a physical mixing chamber (7 liters) with 2/way valve and adapters.
- Ideal for gas exchange analysis when testing athletes ventilating at a frequency over 60 breaths per minute.
- Simplified patient set-up, with turbine flowmeter placed at the exhalation port of the mixing chamber, avoids the use of the cumbersome conventional helmet.
- The software provides flowmeter calibration specific for Mixing Chamber test to linearize response at its best.




*Mixing chamber*

## Spirometry

- Software module for performing FVC, SVC, MMV and Pre/Post Bronchial Provocation.
- Real time acquisition and capture of Exercise Flow/Volume loops (EFVL) with comparison of resting FVC for evaluating ventilatory limitation.
- Trial Selection and Quality Control in compliance with ERS/ATS guidelines.
- Paediatric incentivations with user defined effort grade on both volume and flow.
- Full compliance with "2005 ATS/ERS consensus" (Interpretation, QC, etc.).
- GOLD COPD Interpretation on FVC PostBD.
- Latest Global Lung Initiative (GLI) predicteds (including Z-score).




*FVC Test*

## Options and Accessories

- **Carts.** Full range of carts either medical-graded with isolation transformer (available either with 230 or 120 VAC) or not electrified cart. Both 1 and 3-cylinder holder carts can be equipped with 1 or 2 monitors.
- **High $FiO_2$ kit.** Gas exchange measurements using hypoxic and hyperoxic gas mixtures.
- **Ethanol burning Kit.** The kit consists of a lamp, parts and connectors to be wired to the Quark RMR. Burning ethanol generates a predictable ratio of $VO_2$ and $VCO_2$ and it can be used to verify the Quark RMR accuracy of Respiratory Quotient measurement.
- **Wide selection of ergometers**, available from COSMED, including treadmills, cycle-ergometers, arm-ergometers and recumbent bikes, suitable for any kind of tested subject.

*Ethanol burning kit*

- **Non- Invasive Blood Pressure** (Suntech Tango). Cardiac stress blood pressure monitor specifically designed to overcome noise, motion and physical difficulties associated with cardiac stress and exercise testing
- **Cardiac Output** (Physioflow Enduro) Portable, battery powered, non-invasive hemodynamic monitor for reliable and repeated cardiac output measurements during exercise.
- **Philips Intellibridge compatibility.** It allows to transfer REE parameters during testing ($VO_2$, $VCO_2$, RQ, REE, VE, Rf) through Philips monitoring solution directly to the Hospital Information System or to Philips IntelliSpace Critical Care (ICCA) systems.

## Interfaced Devices

- **Diagnostic quality 12-lead Stress ECG** (available either in wireless or patient cable configuration) with full disclosure and scroll back during test. High resolution ECG processing produces an exceptionally clear on-screen display and allows detailed, reliable analysis of ST segments and minimal arrhythmia changes. Available with Resting and Exercise ECG interpretation software.
- **Pulse Oximeter.** High quality monitors (Nonin© technology) with a broad range of sensors (finger, earlobe or forehead/reflectance).

*COSMED stress test ECGs (wireless or patient cable)*

*Cardiac Output monitor (Physioflow)*

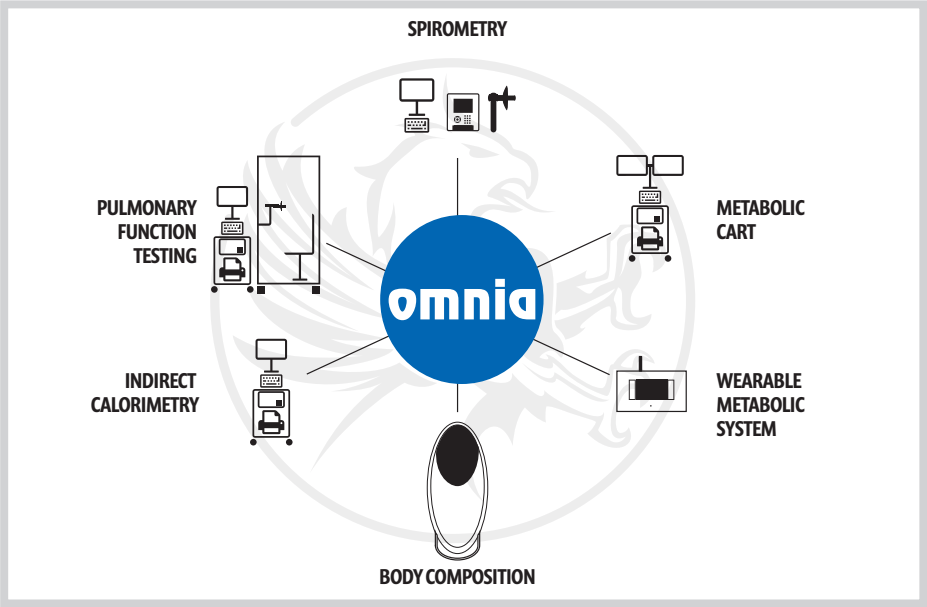
*Pulse oximeter*

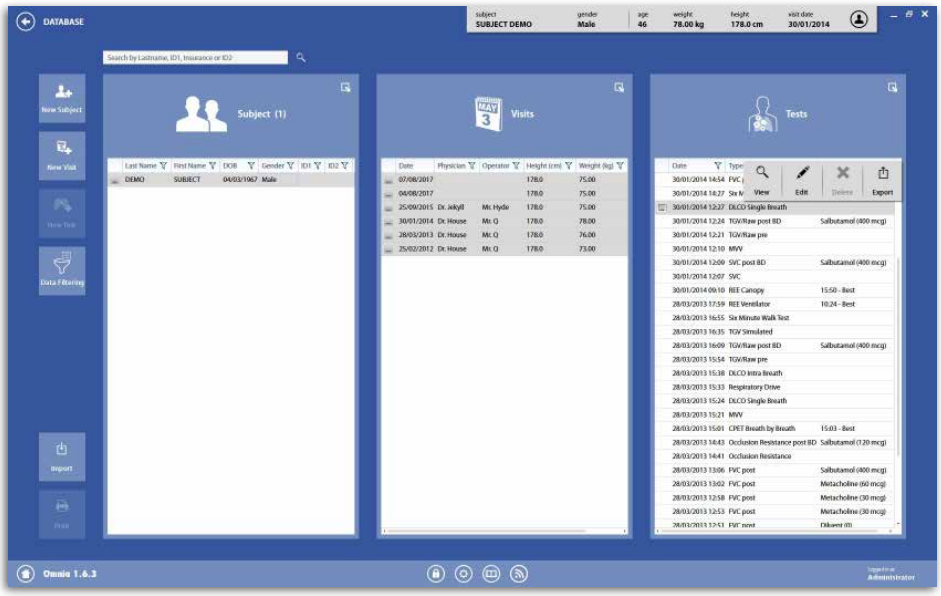

*Blood Pressure Monitor (Tango)*

## Data Management & Software

Quark RMR comes with **OMNIA Metabolic Module**, the new software designed by COSMED, compatible with the entire COSMED product range, OMNIA allows the user to operate different equipment in a single software environment.

- Easy-to-use touch-screen graphic user interface with intuitive workflow and hierarchy.
- Manage and display data and charts through standard (9 panel plot, etc.) or user defined Dashboards.
- Select and define charts, data and widgets to define your preferred working environment.
- Powerful chart creation (up to 4 Y axis and one X axe) with full control on settings.
- Easy, quick and fully assisted calibration for high accuracy measurements, either for flowmeters (calibration and linearity check) or for gas sensors (zero, gain and delay).
- Powerful post-test editing phase for data filtering, calculation of thresholds (AT, RCP), $VO_2$max, EFVL, VE/$VCO_2$ slope, intercept and other parameters requested for interpretation.
- Comprehensive interpretation tool automatically elaborates CPET tests and provides interpretation including text strings and numerical results based on latest scientific guidelines[1].
- Built-in Rest and Exercise Protocol editor to design and save any type of protocol.
- Wide list of Ergometers can be automatically controlled: (COSMED Bike/Treadmill, Ergoline, HPCosmos, Monark, Trackmaster) and with the optional Ergometer module (LODE, CSafe Treadmill, Cyclus 2, Technogym, Imbramed, Woodway and many others).
- Export data in .pdf, .xml, and xls formats. Import data in .xml format.
- SQL Database allowing virtually unlimited records and data safety.
- Multi-users access rights management (Principal Investigator, Physician, Technician, Administrator…) with event logging.
- Compatible with Win 7, 8, 8.1, 10 (32/64). Mac OS compatibility when installed in Virtual PC OS (Parallel, VMware).




*Subjects/Visits/Tests database in OMNIA*

| Measured Parameters with OMNIA | | |
|---|---|---|
| **Resting Energy Expenditure (REE)** | | |
| Resting Energy Expenditure | REE, RMR (Kcal/day) | ● |
| Respiratory Quotient | RQ | ● |
| Substrates | %FAT, %PRO, %CHO | ● |
| **Cardio Pulmonary Exercise Test (CPET)** | | |
| $VO_2$max | $VO_2$/Kg, RQ, Dyspnea@Max, HR@Max | ○ |
| Thresholds | AT, RCP | ○ |
| VE Response | VE/$VCO_2$ slope, VE/$VCO_2$ intercep., OUES | ○ |
| $VO_2$/WR | $VO_2$/WR slope, $O_2$ Pulse R2 | ○ |
| EFVL | Flow/volume loop events | ○ |
| **Spirometry** | | |
| Forced Vital Capacity | FVC, FEV1, FEV1/FVC%, PEF | ○ |
| Slow Vital Capacity | VC, IVC, EVC | ○ |
| Maximum Voluntary Ventilation | MVV, MRf, MVT | ○ |
| Broncho-challenge | | ○ |

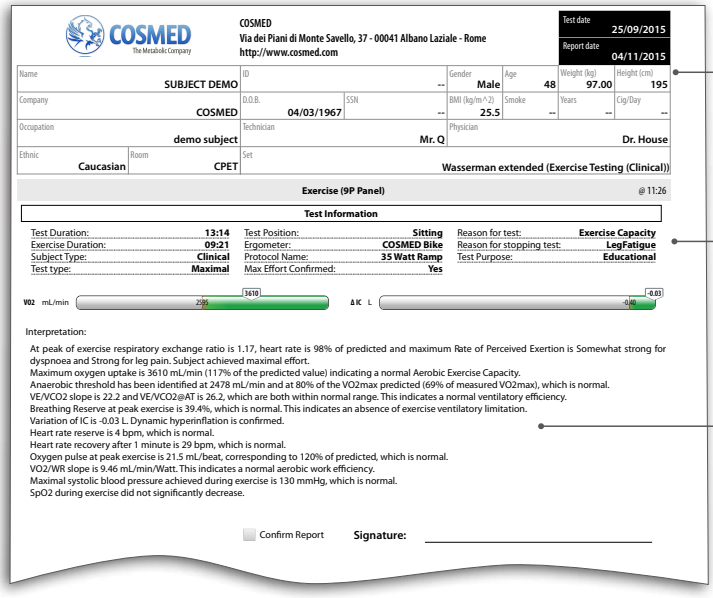
1 *ATS/ACCP 2001, ESC 2009, EACPR/AHA 2012, AHA 2010*

# Networking

OMNIA Network allows to share a single database in either a small network (LAN) or a large network (WAN) environment.

OMNIA Network is based on a Client/Server architecture and allows to run different COSMED devices through simultaneous access of data and run tests via a virtually unlimited number of COSMED products.

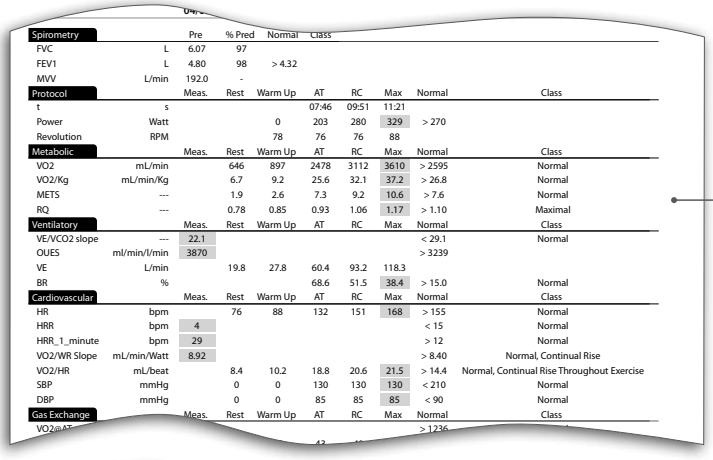
- The network license includes five clients (simultaneous access) and can be extended with the purchase of additional single licenses.
- A user management system allows to define users (Physician, Technician, Administrator, etc.) and roles (which specific feature can a user access).
- OMNIA can exchange data with Hospital Information Systems (HIS) via HL7, GDT and with a proprietary Protocol (OCP).
- With the optional HL7 module (either standalone or network) OMNIA allows to get data from an HL7 worklist and send results back to Electronic Medical Records (EMR) and Hospital Information Systems (HIS).
- Access and security compliant according to US HipAA, ISO 27799:2008, EU 95/46/CE and 2002/58/CE.
- OMNIA Network runs on Windows Server 2008 (SP2, R2 SP1) and 2012.
- Based on standard SQL database (Express or Standard) to store data securely.



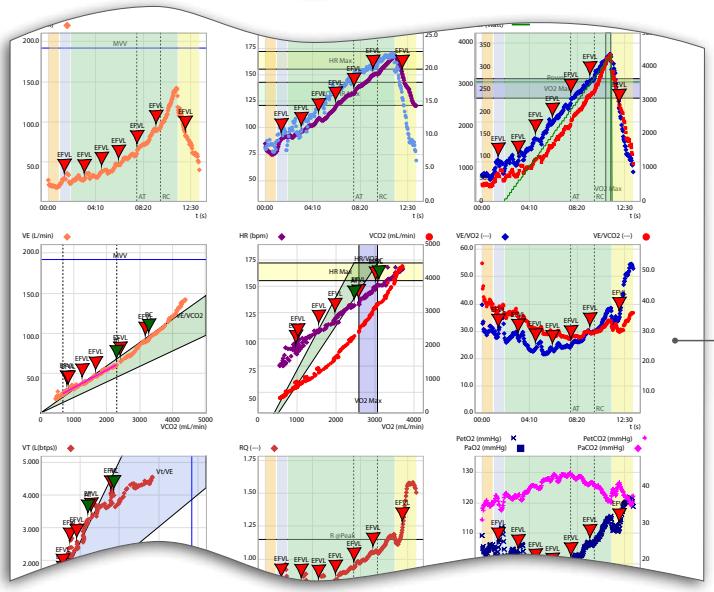

Customisable header and patient information

Test information

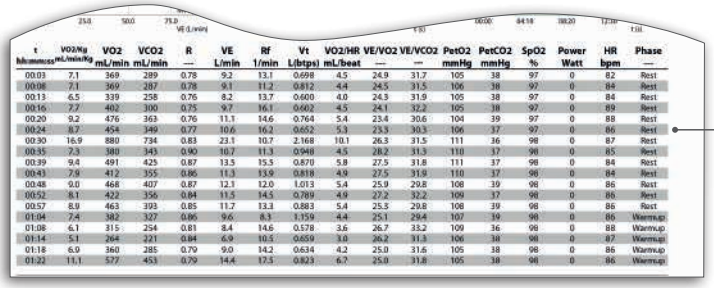
Editable interpretation string




For each test, users can define parameters and columns to display



Select and edit graphs




Customisable tabular data

Custom "CPET" printout report

## Validation articles

*REE*

- *Ashcraft C.M. et al. "A Test of Validity of a New Open-Circuit Indirect Calorimeter. " J Parenter Enteral Nutr. 2014 Mar 10*
- *Sundström M et al. "Indirect calorimetry in mechanically ventilated patients. A systematic comparison of three instruments. " J. Clin Nutr. 2013 Feb;32(1):118-21*
- *Blond E. et al. "A new indirect calorimeter is accurate and reliable for measuring basal energy expenditure, thermic effect of food and substrate oxidation in obese and health " e-SPEN e-Journal of Clinical Nutrition and Metabolism 6 (2011) e7ee15*

*CPET*

- *Gullstrand L., et al. Validation of the Quark CPET Respiratory gas analyser in the BBB mode. 2013; Elite Sport Centre, Bosön*
- *Gullstrand L., et al. Validation of the Quark CPET Respiratory gas analyser (Mixing Chamber). 2013; Elite Sport Centre, Bosön*
- *Nieman DC, et al. Validity of COSMED's Quark CPET mixing chamber system in evaluating energy metabolism during aerobic exercise in healthy male adults. Res Sports Med. 2013;21(2):136-45*

- *More scientific studies on [www.cosmed.com/bibliography](www.cosmed.com/bibliography)*

## Technical Specifications

| Product | Description |
|---|---|
| Quark RMR | Indirect Calorimetry Laboratory (Ref. C09074-01-99) |
| Standard packaging | Quark RMR unit, canopy hood (with pipes and backpack), turbine flowmeter w/ sampling line, calibration syringe (3 liters), HR monitor (receiver and transmitter), OMNIA PC software, adapters, pipes, cables, probes and user manual |
| **Standard tests** | |
| Indirect Calorimetry | Resting Energy Expenditure (REE, RMR), w/ face masks or mouthpieces. Respiratory Quotient (RQ) & Substrates Analysis |
| **Optional tests** | |
| ICU kit for vent Patients | Allowing Quark RMR measurement of REE in patients undergoing mechanically assisted ventilation. |
| Cardio Pulmonary Exercise Test (CPET) | Pulmonary Gas Exchange ($VO_2$, $VCO_2$), $VO_2$max, Sub-max $VO_2$, Thresholds (AT, RCP), EFVL, Heart Rate |
| Spirometry | Forced Vital Capacity (FVC) Pre/Post, Slow Vital Capacity (SVC) Pre/Post, Maximum Voluntary Ventilation (MVV), Broncho-challenge - Bronchial Dilator/Constrictor test |
| **Flowmeters** | |
| Turbine 0-18 (Standard) | Multiuse digital turbine for REE Mask/Canopy Test: Flow range 0-8 l/s; Accuracy ± 2% or 20 ml/s (flow) ± 2% or 100 ml/min (vent.); Resistance <0.7 cmH2O l/s @ 3l/s; Ventilation range 0.04-50 l/min |
| Flow-REE (ICU Option) | Disposable PNT (Lilly) for REE ICU Test: Flow range 0-1,7 l/s; Accuracy ± 2 %; Resistance <2,35 cmH2O/l/s @ 1 l/s |
| Turbine 0-28 (CPET Option) | Multiuse digital turbine for CPET Mask/Mix test: Flow range 0.08-20 l/s; Accuracy ± 2% or 20 ml/s (flow) ± 2% or 200 ml/min (vent.); Resistance <0.6 cmH2O /l/s @ 14l/s; Ventilation range 0.08-300 l/min |
| **Gas Analyzers** | |
| $O_2$ | Paramagnetic sensor. Range: 0-100% (Standard 0-30% - ICU 0-70% - or user defined); Accuracy: ± 0.1 %; Response time: 120 ms |
| $CO_2$ | Nondispersive infrared sensor (NDIR). Range: 0-10%; Accuracy: ± 0.02 %; Response time: 100 ms |
| **Hardware** | |
| Dimensions & weight | Unit: 17 x 30 x 45 cm/8 Kg Canopy: 32 x 50 x 30 cm/0.6 Kg |
| Interface ports | USB A-B, RS-232, HR-TTL, SpO2 |
| Electrical requirements | 100-240V ± 10% 50/60 Hz |
| Internal emergency battery | 12V; 1,2 Ah |
| Environmental conditions | Temperature 0-50 °C (32 - 122 °F); Barometer 400-800 mmHg; Humidity 0-100% |
| **Software** | **OMNIA** |
| Available languages | Italian, English, Spanish, French, German, Portuguese, Greek, Dutch, Turkish, Russian, Chinese (Traditional & Simplified), Korean, Romanian, Polish, Czech, Norwegian, Hebrew |
| PC Configuration | I3 or higher processor speed. Compatible with Windows 7, 8, 8.1, 10 (32 or 64 bit). RAM 4GB (8GB recommended). HD with 4GB of free space (plus tools) |
| **Safety & Quality Standards** | |
| MDD (93/42 EEC); FDA 510(k); EN 60601-1 (safety) / EN 60601-1-2 (EMC) | |

CE 0476

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