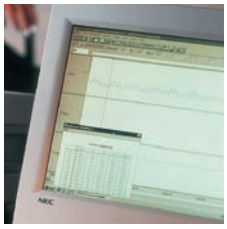
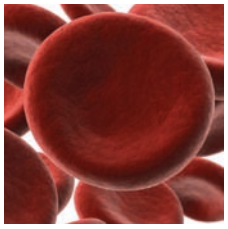
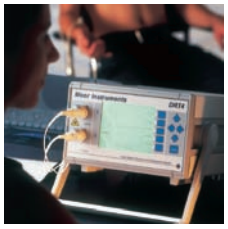
Tissue blood flow and temperature monitoring

with DRT4™









moor instruments
laser Doppler blood flow assessment

DRT4 – independent

The most advanced laser Doppler monitor combining the assessment of tissue blood flow with skin temperature measurement.

- **Portable design** can operate with or without a PC. On-board data storage and analysis.
- **Large graphical display** for easy viewing of traces and menus.
- **Internal memory** for up to 20 days of continuous monitoring.
- **User-friendly menus** make learning easy and operation intuitive. Set-up of chart speed, trace height and smoothing during measurement optimises the display for your application.
- **Labelled markers** added to data manually or automatically to record significant events.
- **Review** of stored data from memory.
- **Compression** feature enables long trends to be displayed from memory.
- **Analysis** of data segments include:
  - maximum, minimum, mean
  - standard deviation
  - area under curve
  - percentage change
- **Data transfer** either in real-time or post measurement to PC for permanent storage.
- **Also available; Easy to use** Windows™ based software with extensive analytical features and automatic report generation.



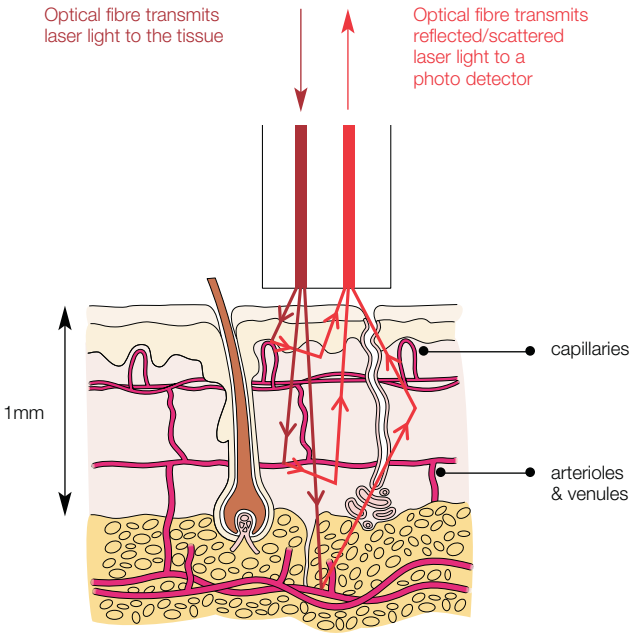
Print out report *Test results are presented with a single click*

The laser Doppler technique

The laser Doppler technique is a unique method for continuous monitoring of tissue blood perfusion. It can be used for registering dynamic or evolving responses of blood flow in the capillaries, venules and arterioles responsible for nutrition of the skin and thermoregulation. The sampling depth depends on probe design and tissue characteristics but is typically around 1mm.

Low power laser light is transmitted via an optic fibre to the tissue. The light is scattered by tissue and moving blood cells and its frequency is Doppler broadened. Some of the scattered light is collected by one or more optic fibres and transmitted to a photo detector. The resulting photo current is electronically processed to produce the laser Doppler flux signal. The average Doppler frequency shift is directly proportional to the average speed of the blood cells.

Changes in skin blood flow can be stimulated by a number of provocations including partial occlusion with a pressure cuff, heating both local and whole body, the iontophoresis of drugs, changes in the position of limbs etc.



Linearity of response is rigorously tested for each system manufactured for the bandwidth settings provided: 20Hz to 3.1, 14.9 or 22.5KHz, user selectable. This enables optimum response sensitivity whatever tissue is sampled, e.g. teeth, bone, skin, organ or cerebral.

The programmable DRT4

Dedicated embedded and PC software is available to set up the control and measurement protocols for the DRT4 when used in conjunction with a Moor 'protocol' instrument – the SH02 skin heater or the MIC2 iontophoresis controller. These protocols can be started and stopped by a single key press. Application software then automatically controls, times, marks and analyses results. This ensures reliability and reproducibility of the user defined measurement protocols.

Skin heating with the SH02

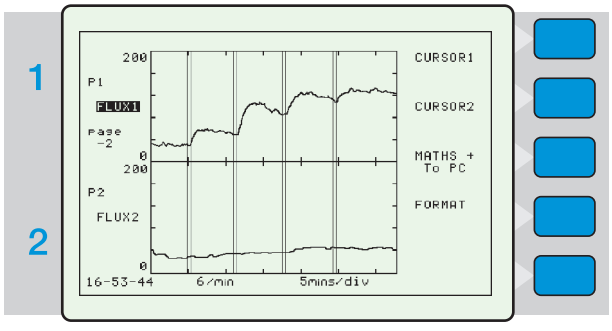
The SH02 skin heater is designed for routine tests and research into skin blood flow change with temperature, and where blood flow measurements need to be done at static and reproducible skin temperatures.

Typical applications include the assessment of tissue viability and the measurement of skin blood flow in diabetic studies with heating conditions that produce maximal blood vessel dilation.

Iontophoresis transdermal drug delivery with the MIC2

Real-time graphical traces showing changes in skin blood flow, due to delivery of vasoactive drugs are recorded and analysed using the DRT4 dedicated software and hardware package. The DRT4 is the only laser Doppler monitoring system that can be programmed to control flexible multi-period iontophoresis and heating protocols. Automation of control is continued with the analysis functions easing the research workload.

Upper trace *– response of skin blood flow to pulses of acetylcholine delivered transdermally using the iontophoresis protocol system*

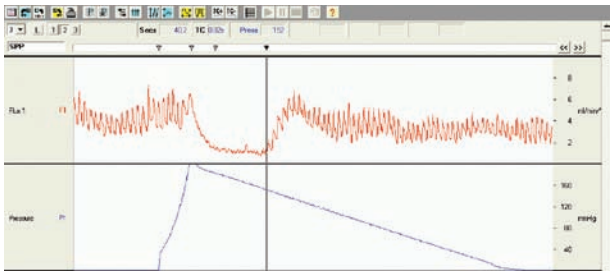


Lower trace *– adjacent site used as a control*

Pressure monitoring DRT4/PRM2

The PRM2 is a standard DRT4 with an integral pressure measurement module and an electronically controlled pump. The PRM2 combines four standard pressure related assessments (Limb/Toe Pressure, Skin Perfusion Pressure, Pulse Volume and Post Occlusion Reactive Hyperaemia) in one system with flexible protocol set up for each, coupled with automatic inflation and deflation of a pressure cuff.

A manual rapid release valve is also included to maximise the hyperaemic response. Automatic analysis provides a range of parameters, e.g. time to recovery and peak, area under the curve and set point flux levels.



Linear cuff deflation *shown during toe pressure assessment*

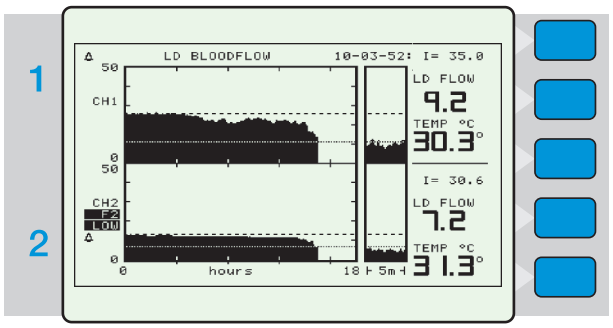
Please refer to separate PRM2 brochure.

Plastic surgery

(flap monitoring DRT4/Trend)

Specifically designed to automate and simplify the routine monitoring of flaps post operatively, TREND is a dedicated operating system for the DRT4. A unique 'noise' filter is used to minimise the effect of patient movement artifacts in recording thus easing interpretation.

TREND features automatic alarm level setting (with manual override), alarm delay (to avoid false alarms) and automatic compression to ensure the entire trace is displayed whether 1 hour or 3 days long. Alarms are audible and visual. Rapid data transfer to a PC enables permanent record keeping.



Trend *LD blood flow traces showing flap failure at the 15 hour time point*

Please refer to separate TREND brochure.

DRT4 – connectability



Data output

The functionality of the DRT4 is enhanced by the provision of convenient and flexible built-in interfaces: a standard RS232 and USB type connection for direct communication with any IBM compatible PC (laptop or desktop).

The computer link enables data transfer either in real-time or from the DRT4 memory.

Fully featured PC software moorSOFT for Windows™ is available for display, acquisition, analysis, storage and transfer to spreadsheet.

An analogue interface is also included for output of blood flow and temperature data to a chart recorder or PC and for control of Iontophoresis and Skin Heating modules.

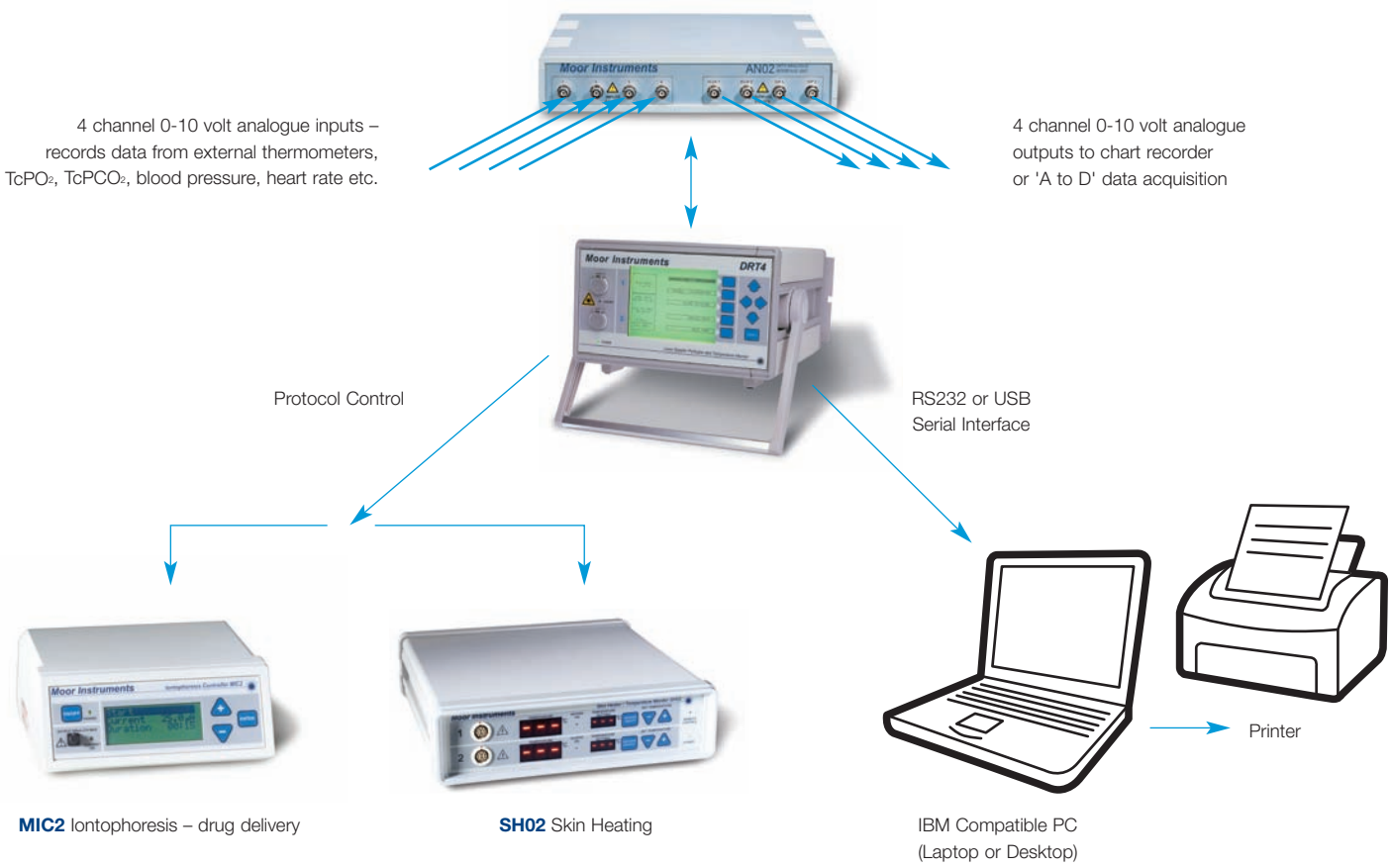
The same interface (12 bit 'A to D') can accept incoming analogue data from up to four other systems.

Data input/acquisition

The analogue input facility enables users to route signals from other equipment through the DRT4 for simultaneous computer storage and display, for example $TcPO_2$, $TcPCO_2$, pressure and pH.

Four external signals can be monitored simultaneously by moorSOFT for Windows™, along with the blood flow and temperature signals from the DRT4 itself. Data analysis of the external signals and transfer to spreadsheet format is offered as standard.

Please refer to separate AN01/2 brochure.



Probes

The use of a robust electro-optic connector provides a single connection for combined laser Doppler and temperature measurement.



Probes are available for a wide range of applications. Bio-compatible materials that can be sterilised are used to ensure safety for surgically invasive applications. *Please refer to separate probe listings at* ***www.moor.co.uk***

Skin probes are available with two fibre configurations, twin or multi fibre designs. Multi fibre designs usually employ a ring of collecting fibres around a central delivery fibre to provide an averaged signal from a larger volume than the conventional twin fibre design. Both include temperature measurement as standard.

Endoscopic probes enable investigations of internal tissues such as colon, stomach, bronchus and urethra.

Needle probes can be used for surface measurements where access is impaired (e.g. nasal, oral), inserted into tissue bulk (e.g. muscle, cerebral, adipose) or used for direct single vessel measurements.

Disposable probes are available for many experimental and clinical applications including post-operative flap monitoring (buried and oral flaps) and measurement of cerebral perfusion. Disposable single fibre implantable probes are also available.

Low profile designs are either used when access is difficult (oral flaps) or to reduce application pressure when the probe is covered by bandages.



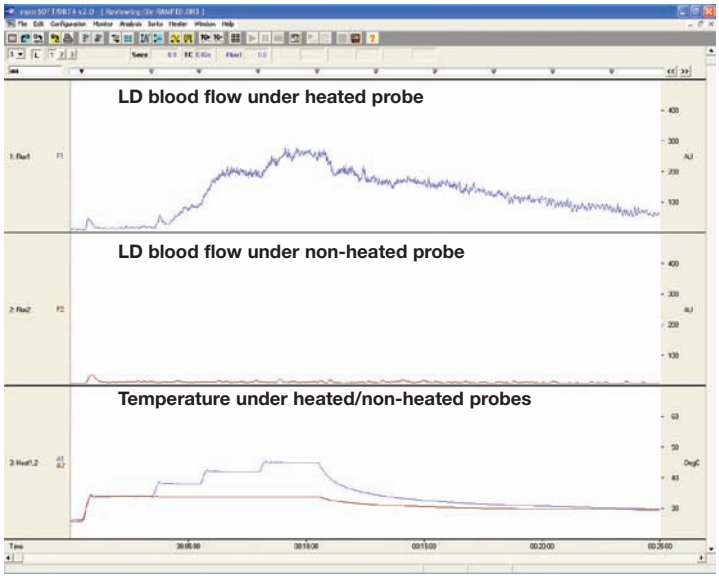
Probes *– available for a wide range of tissues*

Applications

These are often non-invasive and may involve tests of microvascular function. Examples include post operative flap monitoring, responses to heating for wound healing assessment, post occlusive reactive hyperaemia (e.g. in studies of peripheral arterial disease) and responses to drug tests or treatment.

Since its origin in 1975 laser Doppler has become standard equipment in many physiology laboratories and clinical research facilities. Routine clinical uses are increasing and take advantage of the wide dynamic range to capture the cardiac cycle, vasomotion effects or trends over hours, days or weeks.

The levels of safety, durability, and service found in the DRT4 meet the demands for ease of use and reliability on the ward, in clinics and for laboratories.



DRT4 controlled ramped heating protocol *showing a normal response to elevation of tissue temperature*

About Moor Instruments

Moor Instruments, established in 1987, is a world leader in the design, manufacture and distribution of laser Doppler systems, used for the measurement and imaging of blood flow in the microvasculature.

First hand experience of laser Doppler research and development within Moor dates back to 1978 and with this we have the breadth of knowledge to help with your application and the enthusiasm to try to find answers to any of your questions.

By giving priority to performance, quality and service we strive to be our customers number one choice.

Our dedicated design team are involved with a number of development projects for other partners and manufacturers. Whatever your needs, as a researcher, clinician or manufacturer, Moor will work harder for you.



Optional MS3 Mobile Stand with touchscreen panel PC

Specifications:

Quality Control
Moor Instruments is certified to ISO 13485: 2003.
The DRT4 is CE and BSI certified.

Reliability
Assured by our two year warranty on all electronic products manufactured by Moor Instruments.

Optics
Temperature stabilised output laser diode; 785nm.
Maximum output power 2.5mW.

Laser Safety Classification
Class 1M per IEC 60825-1:2001.
Class 1 per 21 CFR 1040.10 and 1040.11.

Laser Doppler Signal Processing
Bandwidth: high pass 20Hz,
Low pass selectable (3.1KHz, 14.9KHz, 22.5Khz).
Smoothing time constants: 0.1s, 0.5s, 1.0s, 3.0s and unfiltered.
Automatic gain control and zeroing.
Data rate 1, 2, 6, 15, 30/min and 1, 2, 5, 10, 20, 40/sec.

Temperature Measurement
Range: 5ºC to 50ºC.
Resolution: 0.1ºC, accuracy +/- 0.5ºC.
Sampling rate: 40Hz.
Patient isolation to IEC 601-1 Class 1 type BF.

Outputs/Inputs
Graphical and digital LCD screen display of flux, blood cell concentration, speed and temperature.
DRT4 and computer display rates are independent.
0-1000 arbitrary perfusion units, percentage change.
1 serial interface RS232/USB (optically isolated).
Analogue outputs 0-10V D/A, 12 bit 4 channel.
Analogue Inputs 0-10V A/D, 12 bit, 4 channel.

Internal Software Features
Flash memory programmable from PC
Alarm levels and labelled event markers.
Trends – data review and time scale compression (x2 to x128).
Memory: 150 screens. Range: 5 seconds to 3.5 hours per screen.
Percentage change.
Analyses: maximum, minimum, mean with standard deviation, area under curve.
Calibration: including confidence test and storage of multiple probe scaling constants.

General
Universal switch mode power supply.
Range: 100-230 V AC, 55VA, 50 to 60Hz.
Dimensions: W H D mm. 280 x 160 x 360.
Weight: 8kgs. Storage temperature 0-45ºC.
Operating temperature: 15-30ºC.
Electrical Safety Standards: patient isolation to IEC 601-1.
Class 1 type BF.
EMC tested to EN60601-1-2.

References

General – A.P. Shepherd, P. Å. Öberg, Laser-Doppler Blood Flowmetry, 1990, ISBN 0-7923-0508-6, Kluwer Academic Publishers.

Heating – Rayman G, Williams SA, Spencer PD, Smaje LH, Wise PH and Tooke JE Impaired microvascular hyperaemic response to minor skin trauma in Type I diabetes. British Medical Journal, May 1986, 292:1295-1298.

MIC2 – Ferrell W R, Ramsay J E, Brooks N, Lockhart J C, Dickson S, McNeece G M, Greer I A, Sattar N, Elimination of Electrically Induced Iontophoretic Artefacts: Implications for Non-Invasive Assessment of Peripheral Microvascular Function. Journal of Vascular Research 2002; 39:447-455.

Pressure – Wahlberg E, Olofsson P, Swendenborg J, Fagrell B. Eur, Changes in post occlusive reactive hyperaemic values as measured with laser Doppler fluxmetry after infrainguinal arterial reconstructions, J Vasc Endovasc Surg. 1995 Feb;9(2):197-203.

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Moor Instruments reserves the right to change specifications without notice.

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