PHILIPS

Expression **MR400**

MRI Patient Monitoring System

Technical Data Sheet

(Model MR400)

15.5.

13. The Expression MR400 MRI Patient Monitoring System is designed to assist clinicians in monitoring patient vital signs in the dynamic magnetic resonance environment. The Expression MR400 combines wireless communication, radio frequency shielding and digital signal processing to address the challenges associated with patient monitoring in the MR environment.

The Expression MR400 consists of these primary components:

- Traditional Roll-Around Cart
- Wireless ECG (wECG) module
- Wireless SpO2 (wSpO2) module

11.

Optional Components

- Expression Information Portal (IP5)

Features and Benefits

- Integral color, 15” LED widescreen display for high resolution patient information
- Intuitive touchscreen graphical user interface
- Colored waves and large numerics
- Bedside-quality “SINC” parameters
- Exclusive, advanced ECG solution for MRI
- 8-hour battery life and user-replaceable batteries for extended run time
- Simultaneous display of up to thirteen parameters, and six waveforms and associated values
- Multi-priority visual and audible alarm signals, unique “alarm flag” messages, and pulse tones
- Gating, both digital pulse and analog waveform
- Expression Information Portal (IP5), (optional)
- Wireless remote printing to IP5 (optional)

System Parameters

The MR400 can include the following vital sign parameters:

- Electrocardiogram (ECG), dual channel
- Blood oxygen saturation/pulse oximetry (SpO2)
- Invasive blood pressure (IBP)
- Non-invasive blood pressure (NIBP)
- End-tidal and inspired CO2
- Respiration from CO2 or bellows
- Anesthetic Agents, including end-tidal and inspired N2O, inspired O2, and Total MAC
- Temperature

The system can include the ability to display these parameters:

- Alarms: High and low selectable limits for each patient parameter
- ECG: Waveform scale, dual channels displayed
- Heart rate: Factory-default derived from ECG; also from pulse oximetry or IBP
- Pulse oximeter: Pulse rate, pulse waveform, and percent saturation
- CO2: End-tidal and inspired
- IBP (two channels, P1 and P2): Systolic, mean, and diastolic pressures
- NIBP: Systolic, mean, and diastolic pressures
- Anesthetic Agents, including end-tidal and inspired N2O, and inspired O2
- Bellows respiration: Rate derived from pneumatic chest bellows
- Temperature
- Trends: Heart rate, respiration rate, IBP (systolic, diastolic, mean), NIBP (systolic, diastolic, mean), CO2, O2, N2O, SpO2, agents, and temperature
- Respiration: Rate derived from CO2
- Time: Battery-backed quartz clock

Main Component

Display Panel

- Type: Liquid Crystal Display (LCD), touch screen, color
- Screen size: 39.5 cm (15.6 inches) diagonal
- Drive type: a-Si TFT active matrix
- Pixels: 1366 (H) by 768 (V) pixels, color
- Area: 344.2 (H) by 193.5 (V) mm
- Dot pitch: 0.084 (H) by 0.252 (V) mm
- Pixel pitch: 0.252 (H) by 0.252 (V) mm
- Contrast ratio: 500:1 (typical)
- Backlight: LED
- Polarizer surface: Anti-glare
- Tilt: Adjustable, 5° to 35°
- Sweep speeds for ECG, SpO2, and IBP: 25 mm/second gives 9.2 seconds of display time, while 50 mm/second gives 4.6 seconds. Sweep speeds for respiration: 0.33, 1.56, 3.13, 6.25, 12.5 or 25 mm/second are provided.
- Waveform display mode: Fixed trace, moving erase bar
- Waveform display width: Approximately 228 mm
- Waveform display height:
  - ECG (single trace): Approximately 40 mm
  - ECG (dual trace): Approximately 20 mm
  - All other waveforms: Approximately 25 mm
- Audio speaker

Control of monitored parameters is provided by these components:

- Power switch
- Touchscreen

User Interface

Four groups of data are displayed:

- Informational
- Vital signs traces
- Vital signs numerics
- System status

Application Features

Trends

- Automatically can store the parameter trend information for heart rate, IBP, NIBP, SpO2, CO2, N2O, O2, agents, respiration, and temperature
- Trend arrows graphically indicate an increasing, decreasing or stable parameter
- Graphical trends (with the IP5 option)

Alarms

- High, medium, and low alarm severity
  - Visual alarm indicators: Alarm light, flashing numeric values, alarm flags, icons
  - Audible alarms, user-configurable for volume, tone, and silence
- Configurable alarm limits
- 1-Touch Alarms allow alarm limits to be quickly adjusted

Device Connections

Input/output ports permit the connection of external equipment:

- USB port (system update use only)
- ECG and peripheral gating output port

Specifications

Safety Standards

- Conforms to ANSI/AAMI ES 60601-1: 2012. Certified to CAN/CSA C22.2 No. 60601-1-08; IEC 60601-1-2
- Conforms to 93/42/EEC as amended by 2007/47/EEC, *Medical Device Directive*
- Defibrillator protection up to 5 KV

Physical Specifications

Height

- Cart: 127.3 cm (50.1 inches)
- Wireless ECG module: 18.2 cm (7.17 inches)
- Wireless SpO2 module: 13.0 cm (5.13 inches)

Width

- Cart: 47.5 cm (18.7 inches)
- Wireless ECG module: 6.7 cm (2.65 inches)
- Wireless SpO2 module: 6.5 cm (2.55 inches)

Depth

- Cart: 55.9 cm (22 inches)
- Wireless ECG module: 3.1 cm (1.24 inches)
- Wireless SpO2 module: 3.1 cm (1.24 inches)

Weight

- Cart: 46.9 kg (103.3 pounds)
- Wireless ECG module: 340 g (12 ounces)
- Wireless SpO2 module: 204 g (7.2 ounces)

Electrical Specifications

Power Requirements

- Operating voltage range: 100 – 240 VAC
- Frequency range: 50 – 60 Hz
- Current: 1.4 A @ 100 VAC / 0.7 A @ 240 VAC
- Power consumption, maximum: ≤ 65 Watts

Battery Type

- Cart: Lithium-Ion
- Module: Lithium polymer

Battery Operation Time

Cart: Dependent upon enabled parameters and settings:

- All displays, alarms, and monitoring functions continuously for 8 hours
- ECG & SPO2 continuously for 8 hours
- CO2 continuously for 6 hours (with or without AGENT)
- P1 and P2 continuously for 6 hours
- AGENT analysis continuously for 6 hours
- Temperature continuously for 6 hours
- NIBP readings every 5 minutes for 6 hours

Module: Approximately 8 hours

Battery Capacity

- Cart: 75 Wh
- Module: 3.1 Wh

Environmental Specifications

- Operating temperature range:
  - Cart, modules and all accessories (except as listed below): 10 – 35°C (50 – 95°F)
- Relative humidity range:
  - Cart, modules and all accessories (except as listed below): 5 – 80 percent, non-condensing
  - Philips IBP Transducer and cable (optional): 15 – 80 percent, noncondensing
- Storage and transport temperature range:
  - Batteries: 0 – 40°C (32 – 104°F)
  - Cart: -20 – 60°C (-4 – 140°F)
  - Wireless modules, and all other accessories not specified below: -20 – 60°C (-4 – 140°F)

- ECG skin prep gel: Follow instructions on tube
- Quadtrodes: 10 – 32°C (50 – 90°F)
- Transducer and cable (optional) (REF 989803179721): -15 – 60°C (-50 – 140°F)
- O2 sensor (AGENT option), storage temperature: +5 – 25 °C (+41 – 77 °F); transport temperature -40 – 50 °C (-40 – 122 °F)

(When storing or transporting in temperatures beyond the ranges specified above, remove the designated component and store or move it appropriately.)

- Operating pressure range: Up to 3,000 m (9,842 feet) above sea level (708 mbar or 531 mmHg)
- Storage and transport pressure range: 708 – 1020 mbar

MRI Rating

MR Conditional

- 4W/kg SAR
- 7.2µT $B1_{rms}$
- 5,000 gauss
- 3.0T

Measurement Specifications

Electrocardiogram Channel (ECG)

ECG Amplifier

- Protected against defibrillator and electro-surgery potentials
- Standard lead configurations: I, II, III, AVR, AVL, AVF
- Lead Fail: Passive, sensing signal imbalance
- ECG input impedance: > 2.5MΩ (according to IEC 60601-2-27, 50.102.3)
- Electrode contact impedance: ≤ 20K ohms @ 10 Hz

Heart Rate

- Range: 30 – 250 BPM (adult); 30 – 300 BPM (pediatric and neonate)
- Resolution: 1 beat per minute (BPM)
- Accuracy: ± 1 percent or ± 1 BPM, whichever is greater

Cardiotach

- Sensitivity (Monitor filter):
  - Adult ECG mode: > 200 µV
  - Neonate/Pediatric ECG mode: > 100 µV
- Bandwidth: Monitor: 0.5 – 40 Hz
- QRS Duration:
  - Adult: 70 to 120 ms
  - Neonate/Pediatric: 40 to 120 ms
- Baseline Offset: Automatically removed
- Tall T-wave rejection capability for heart rate indication: 2 mV with a 1 mV QRS amplitude
- Leads-off sensing: Detection by DC current waveform of < 100 nA, not applied

Alarm Limits

- Lower: Off, or 30 – 250 BPM
- Upper: 60 – 250 BPM, or off

Test / Calibrations

- Square wave test signal: 60 BPM ± 1 BPM, 1 mV ± 10 percent

Pulse Oximeter

- Pitch of pulse tone is modulated by saturation value
- Saturation range: 1 – 100 percent
- Saturation value resolution: 1 percent
- Saturation accuracy: ± 3 percent at 70 – 100 percent (the specified accuracy is the RMS difference between the measured and reference values)
- Pulse accuracy: ± 2 percent or ± 1 BPM, whichever is greater
- Pulse rate range: 30 – 250 BPM
- Pulse rate resolution: 1 BPM
- Data update period: 5, 10, or 15 seconds (according to the SPO2 Averaging Time setting)
- Data Update Period during Alarm: 9, 14, or 19 seconds, maximum (4 seconds plus the SPO2 Averaging Time setting of 5, 10, or 15 seconds)
- Wavelength range: 500 – 1000 nm (Information about wavelength range can be especially useful to clinicians)
- Emitted light energy: < 15 mW
- Pulse oximeter calibration range: 70 – 100 percent

Alarm Limits

- SpO2 alarm limits:
  - Lower: Off, or 50 – 100 percent
  - Upper: 70 – 100 percent, or off
- When "HR" is derived from SpO2:
  - Lower: Off, or 30 – 250 BPM
  - Upper: 60 – 250 BPM, or off

CO2 (Optional LoFlo)

Side stream non-dispersive infrared absorption technique, including multiple water trap filtration system and microprocessor control of sample handling and calibration. Method for determining end tidal CO2 measurement: Measures peak of the expired CO2 waveform every 20 seconds.

- Output: CO2 waveform, EtCO2 and FiCO2 numeric values, and respiration rate
- Initialization time: Waveform displayed in less than 20 seconds, at an ambient temperature of

25°C (77°F); full specifications attained within 2 minutes

- Zero calibration interval: Automatic or user requested
- CO2 unit of measure: Millimeters of mercury (mmHg) or kilopascals* (kPa)
- CO2 resolution: 1 mmHg (0.1 kPa)
- Flow rate: 50 mL per minute ± 10 mL per minute
- Data sample rate: 100 Hz
- End-tidal CO2 (EtCO2) measurement range (in which the accuracy specification is met): 0 – 76 mmHg (0 – 10.1 kPa) for respiration rates ranging from 4 – 60 breaths per minute, inclusive 8.5.1.
- Inspired CO2 (FiCO2) measurement range: 3 – 50 mmHg (0.4 – 6.7 kPa) (method: lowest reading of the CO2 waveform in the previous 20 seconds)
- CO2 accuracy: ± 4 mmHg (± 0.5 kPa) or ± 12 percent, whichever is greater
- CO2 stability:
  - Short term drift: Not to exceed 0.8 mmHg (0.1 kPa) over a 4-hour period
  - Long term drift: Accuracy specification maintained over a 120-hour period
- Respiration accuracy: ± 1 breath or ± 3 percent, whichever is greater
- Respiration resolution: 1 breath per minute
- Respiration rate range (in which the respiration accuracy specification is met): 4 – 100 breaths per minute, inclusive 8.5.2.
- Accessory usage: Functional without changing accessories for a minimum of 6 hours
- Response and rise times (as measured from the patient gas input of the complete pneumatic circuit, including tubing, from 10 – 90 percent of the measured CO2 levels):
  - Airway adaptor:
    - Response time: 10.89 seconds
    - Rise time: 0.94 seconds
  - Cannula:
    - Response time: 12.44 seconds
    - Rise time: 1.12 seconds
  - Divided cannula:
    - Response time: 16.17 seconds
    - Rise time: 2.01 seconds
- Compensations (automatic CO2 ambient pressure compensation 400 to 800 mmHg [53.3 – 106.6 kPa])
  - For expired O2 balance gas (N2, N2O, O, He) and anesthetic agents
  - Uses gas compensation information to correct the raw carbon dioxide value
- Anesthetic agent effects (MAC levels):
  - Sensitivity (uncompensated): Accuracy maintained for halogenated anesthetic agents present at accepted Minimum Alveolar Concentration clinical levels
  - Sensitivity (compensated): Testing at regulatory standards 60601-2-55)
- Cross-sensitivity compensation error (additional worst case error when compensation for O2, N2O, anesthetic agents, or helium is correctly selected for the actual fractional gas constituents present):
  - 0 – 40 mmHg: ± 1 mmHg additional error (0 – 5.3 kPa: ± 0.1 kPa additional error)
  - 41 – 70 mmHg: ± 2.5 mmHg additional error (5.5 – 9.3 kPa: ± 0.3 kPa additional error)
  - 71 – 100 mmHg: ± 4 mmHg additional error (9.5 – 13.3 kPa: ± 0.5 kPa additional error)
  - 101 – 150 mmHg: ± 5 mmHg additional error (13.5 – 20 kPa: ± 0.6 kPa additional error)
- Quantitative effects of gas sample humidity or condensate**):
  - 0 – 40 mmHg: ± 2 mmHg (0 – 5.3 kPa: ± 0.2 kPa)
  - 41 – 70 mmHg: ± 5 percent (5.5 – 9.3 kPa: ± 5 percent)
  - 71 – 100 mmHg: ± 8 percent (9.5 – 13.3 kPa: ± ± 8 percent)
  - 101 – 150 mmHg: ± 10 percent (13.5 – 20 kPa: ± 10 percent)

Alarm Limits

- Et CO2:
  - Lower: Off, or 5 – 60 mmHg (Off, or 0.6 – 8.0 kPa)
  - Upper: 5 – 90 mmHg, or off (0.7 – 12.0 kPa, or off)
- Fi CO2:
  - Lower: No low alarm limit
  - Upper: 0 – 20 mmHg, or off (0 – 2.7 kPa, or off)
- Respiration:
  - Lower: Off, or 4 – 40 breaths per minute
  - Upper: 20 – 100 breaths per minute, or off

**For kilopascals (kPa), allow ± 1 least significant digit to accommodate round-off error for calculated values.*

***With appropriate compensations applied*

Invasive Pressure (Optional)

Pressure Amplifier

- Isolation voltage: 5 KVDC
- Signal range: -30 – 250 mmHg
- Sensitivity: 5 µV/V/mmHg
- Gain accuracy: ±0.5 percent
- Bandwidth: 0 – 10 Hz (-3 dB)
- Offset range: ±300 mmHg

Transducer (REF 989803179721)

- Operating pressure: -50 – 300 mmHg 8.3.
- Overpressure limits: -400 – 5000 mmHg

- Sensitivity: 5 µV/V/mmHg ±1 @ 6 VDC and 22°C (71.6°F)
- Zero offset: < 25 mmHg
- Zero drift: < 2 mmHg in 8 hours
- Input impedance: 300 – 350 ohms

Auto Zero

- Range: +300 mmHg
- Zero accuracy: ±1.0 mmHg
- Response time: 1 second, notification upon completion

Pressure Wave Display

- Number of channels: 0, 1 or 2
- ABP, PAP and LAP: Numeric display of systolic, diastolic and mean pressures
- CVP and ICP: Numeric display of mean pressure only

Pressure Scale Ranges (User Selectable)

- 0 – 250 mmHg
- 0 – 200 mmHg
- 0 – 150 mmHg
- 0 – 100 mmHg
- 0 – 75 mmHg
- 0 – 45 mmHg

Pulse Rate (When derived from P1 or P2)

- Range: 30 – 250 BPM
- Accuracy: ±2 percent of full scale
- Resolution: 1 BPM

Alarm Delay

- Transducer disconnect: 6 seconds
- Pressure disconnect: 6 seconds
- High and low pressure: 10 seconds

Alarm Limits

- When "HR" is derived from P1 or P2):
  - Lower: Off, or 30 – 250 BPM
  - Upper: 60 – 250 BPM, or off
- Systolic, Mean, Diastolic
  - Lower: Off, or -30 mmHg to 250 mmHg (Off, or -4.0 to 33.3 kPa)
  - Upper: -30 mmHg to 250 mmHg, or off (-4.0 to 33.3 kPa, or off)

Transducer Connector Pin Compatibility

- Pin A: - Signal
- Pin B: + Excitation
- Pin C: + Signal
- Pin D: - Excitation
- Pin E: Shield

Anesthetic Agents (Optional)

Side stream, non-dispersive infrared (NDIR) absorption technique, including water trap filtration system and microprocessor control of sample handling and calibration

- Simultaneously measured gases (any two of the following, inspired or expired, while also measuring CO2, N2O, and O2):
  - Halothane
  - Isoflurane
  - Desflurane
  - Enflurane
  - Sevoflurane
- Measurement Range (after maximum warm-up period):
  - Halothane: 0 – 5.0 volume percent
  - Isoflurane: 0 – 5.0 volume percent
  - Desflurane: 0 – 18.0 volume percent
  - Enflurane: 0 – 5.0 volume percent
  - Sevoflurane: 0 – 8.0 volume percent
  - Carbon dioxide: 0 – 10.0 volume percent
  - Nitrous oxide: 0 – 100 volume percent
- Accuracy (includes stability and drift):
  - Halothane:
    - ±0.15 volume percent at 0 to 1.00 volume percent
    - ±0.20 volume percent at 1.00 to 5.00 volume percent
    - Unspecified > 5.00
  - Isoflurane:
    - ±0.15 volume percent at 0 to 1.00 volume percent
    - ±0.20 volume percent at 1.00 to 5.00 volume percent
    - Unspecified > 5.00
  - Desflurane:
    - ±0.15 volume percent at 0 to 1.00 volume percent
    - ±0.20 volume percent at 1.00 to 5.00 volume percent
    - ±0.40 volume percent at 5.00 to 10.00 volume percent
    - ±0.60 volume percent at 10.00 to 15.00 volume percent
    - ±1.00 volume percent at 15.00 to 18.00 volume percent
    - Unspecified > 18.00
  - Enflurane:
    - ±0.15 volume percent at 0 to 1.00 volume percent
    - ±0.20 volume percent at 1.00 to 5.00 volume percent
    - Unspecified > 5.00
  - Sevoflurane:
    - ±0.15 volume percent at 0 to 1.00 volume percent
    - ±0.20 volume percent at 1.00 to 5.00 volume percent
    - ±0.40 volume percent at 5.00 to 8.00 volume percent
    - Unspecified > 8.00
  - Carbon dioxide:
    - ±0.10 volume percent at 0 to 1.00 volume percent

        - ±0.20 volume percent at 1.00 to 5.00 volume percent
        - ±0.30 volume percent at 5.00 to 7.00 volume percent
        - ±0.50 volume percent at 7.00 to 10.00 volume percent
        - Unspecified > 10.00
    - Nitrous oxide:
        - ±2.00 volume percent at 0 to 20 volume percent
        - ±3.00 volume percent at 20.0 to 100 volume percent
- Interference Gas:
    - CO2: N2O, O2, any agent = 0.1%$_{ABS}$ inaccuracy allowance for each
    - N2O: CO2, O2, any agent = 0.1%$_{ABS}$ inaccuracy allowance for each
    - Agents: CO2 = 0%$_{ABS}$ inaccuracy allowance
    - N2O, O2, second agent = 0.1%$_{ABS}$ inaccuracy allowance for each
- Flow Rate:
    - Adult and pediatric: 200 ±20 ml per min
    - Neonate: 150 ±15 ml per min
- Maximum specified interval for intervention of water (hours at specified minimum sample flow rate):
    - AGENT mode: Adult and pediatric is 17 hours @ 200 ml/min, 37°C, 100% RH; neonate is 17 hours @ 120 ml/min, 37°C, 100% RH
    - CO2 mode: 8 hours @ 50 mL/min +/- 10 ml/min
- System Response and Rise Times (as measured from patient gas input of the complete pneumatic circuit, including tubing, from 10 – 90 percent of measured levels)
    - Cannula, adult:
        - Halothane —
          System response: 11.56 seconds
          Rise time: 5.77 seconds
        - Isoflurane —
          System response: 6.71 seconds
          Rise time: 0.88 seconds
        - Desflurane —
          System response: 6.63 seconds
          Rise time: 0.57 seconds
        - Enflurane —
          System response: 7.55 seconds
          Rise time: 1.75 seconds
        - Sevoflurane —
          System response: 6.45 seconds
          Rise time: 0.62 seconds
        - CO2 —
          System response: 6.62 seconds
          Rise time: 0.61 seconds
        - Oxygen —
          System response: 6.99 seconds
          Rise time: 1.02 seconds
        - Nitrous oxide —
          System response: 6.28 seconds
          Rise time: 0.25 seconds
    - Cannula, infant:
        - Halothane —
          System response: 15.95 seconds
          Rise time: 8.63 seconds
        - Isoflurane —
          System response: 9.26 seconds
          Rise time: 1.70 seconds
        - Desflurane —
          System response: 6.47 seconds
          Rise time: 0.61 seconds
        - Enflurane —
          System response: 11.98 seconds
          Rise time: 4.75 seconds
        - Sevoflurane —
          System response: 6.48 seconds
          Rise time: 0.62 seconds
        - CO2 —
          System response: 6.51 seconds
          Rise time: 0.48 seconds
        - Oxygen —
          System response: 8.61 seconds
          Rise time: 1.13 seconds
        - Nitrous oxide —
          System response: 7.95 seconds
          Rise time: 0.72 seconds
    - Divided cannula, adult:
        - Halothane —
          System response: 20.81 seconds
          Rise time: 14.18 seconds
        - Isoflurane —
          System response: 10.99 seconds
          Rise time: 3.91 seconds
        - Desflurane —
          System response: 7.38 seconds
          Rise time: 0.64 seconds
        - Enflurane —
          System response: 13.83 seconds
          Rise time: 7.11 seconds
        - Sevoflurane —
          System response: 7.48 seconds
          Rise time: 0.78 seconds
        - CO2 —
          System response: 7.57 seconds
          Rise time: 0.64 seconds
        - Oxygen —
          System response: 8.02 seconds
          Rise time: 1.07 seconds

        - Nitrous oxide —
          System response: 7.16 seconds
          Rise time: 0.51 seconds
    - Divided cannula, infant:
        - Halothane —
          System response: 9.98 seconds
          Rise time: 3.95 seconds
        - Isoflurane —
          System response: 6.75 seconds
          Rise time: 0.89 seconds
        - Desflurane —
          System response: 6.25 seconds
          Rise time: 0.60 seconds
        - Enflurane —
          System response: 7.32 seconds
          Rise time: 1.37 seconds
        - Sevoflurane —
          System response: 5.45 seconds
          Rise time: 0.67 seconds
        - CO2 —
          System response: 5.49 seconds
          Rise time: 0.49 seconds
        - Oxygen —
          System response: 7.25 seconds
          Rise time: 0.84 seconds
        - Nitrous oxide —
          System response: 6.51 seconds
          Rise time: 0.39 seconds
- Data sample rate: 25 Hz
- Full accuracy respiration rate (range permitting specified gas accuracy): 2–60 respirations per minute (RPM)
- Total respiration range: 2–100 rpm; accuracy is unspecified from 60–100 rpm
- Relevant interference: 0.5 mmHg equivalent with 37.5°C saturated with H_2O (0.1 percent relative max)
- Display resolution: 0.1 percent volume
- Maximum warm-up time: 10 minutes; ISO accuracy achieved in less than 45 seconds of activation
- Auto ID threshold (full accuracy mode):
    - Primary agent ID: 0.15 percent
    - Secondary agent ID: 0.3 percent
- Multiple agents alarm threshold: 0.3 percent (0.5 percent during ISO accuracy mode) or 5% $_{REL}$ (10 percent for isoflurane) of primary agent if primary agent > 10 percent (For halothane add 0.1%$_{ABS}$ to threshold values)
- CO2 ambient pressure compensation range: 500–900 mmHg
- Pressure compensation: Unaffected by cyclical pressures of up to 10 kPa as, apart from the described automatic pressure compensation, the pump automatically regulates flow so that not only gas readings but also gas sample flow is unaffected
- Calibration interval: Calibration verification (as described in service instructions) must be performed at one year intervals

Alarm Limits

- Et CO2:
    - Lower: Off, or 5 – 60 mmHg (Off, or 0.6 – 8.0 kPa)
    - Upper: 5 – 90 mmHg, or off (0.7 – 12.0 kPa, or off)
- Fi CO2:
    - Lower: No low alarm limit
    - Upper: 0 – 20 mmHg, or off (0 – 2.7 kPa, or off)
- Fi N2O:
    - Lower: No low alarm limit
    - 0 – 80 percent
- Et Halothane:
    - Lower: Off, or 0.1 – 5.0 Vol. %
    - Upper: 0.1 – 5.0 Vol. %, or off
- Fi Halothane:
    - Lower: Off, or 0.1 – 5.0 Vol. %
    - Upper: 0.1 – 5.0 Vol. %, or off
- Et Isoflurane:
    - Lower: Off, or 0.1 – 5.0 Vol. %
    - Upper: 0.1 – 5.0 Vol. %, or off
- Fi Isoflurane:
    - Lower: Off, or 0.1 – 5.0 Vol. %
    - Upper: 0.1 – 5.0 Vol. %, or off
- Et Desflurane:
    - Lower: Off, or 0.1 – 18.0 Vol. %
    - Upper: 0.1 – 18.0 Vol. %, or off
- Fi Desflurane:
    - Lower: Off, or 0.1 – 18.0 Vol. %
    - Upper: 0.1 – 18.0 Vol. %, or off
- Et Enflurane:
    - Lower: Off, or 0.1 – 5.0 Vol. %
    - Upper: 0.1 – 5.0 Vol. %, or off
- Fi Enflurane:
    - Lower: Off, or 0.1 – 5.0 Vol. %
    - Upper: 0.1 – 5.0 Vol. %, or off
- Et Sevoflurane:
    - Lower: Off, or 0.1 – 8.0 Vol. %
    - Upper: 0.1 – 8.0 Vol. %, or off
- Fi Sevoflurane:
    - Lower: Off, or 0.1 – 8.0 Vol. %
    - Upper: 0.1 – 8.0 Vol. %, or off
- Fi O2:
    - Lower and upper: 18 – 100 percent

CO2

- Range: 0 – 100 percent
- Resolution: 1 percent

O2

- Range: 0 – 100 percent
- Resolution: 1 percent

- Signal Output (at constant temperature and pressure): 10 mV ±1.5 mV @ 20° C / 20.95 percent O_2
- Maximum response time (21 – 100 percent step change through patient sampling line as seen in WPU gas monitor window):
    - Adult and Pediatric: < 7.3 seconds
    - Neonate: < 8.2 seconds
- Accuracy (includes stability and drift), full scale (gas measurement performance met after the maximum warm-up period):
    - ±1 percent at 0 – 40 percent
    - ±2 percent at 40 – 60 percent
    - ±3 percent at 60 – 80 percent
    - ±4 percent at 80 – 100 percent
- Offset: ±1 percent
- O2 interfering gas effects:
    - N2O: < 0.3 volume percent @ 80 volume percent N2O
    - CO2: < 0.3 volume percent @ 5 volume percent CO2
    - Halothane: < 0.3 volume percent @ 5 volume percent halothane
    - Enflurane: < 0.3 volume percent @ 5 volume percent enflurane
    - Isoflurane: < 0.3 volume percent @ 5 volume percent isoflurane
    - Desflurane: < 0.3 volume percent @ 18 volume percent desflurane
    - Sevoflurane: < 0.3 volume percent @ 8 volume percent sevoflurane
    - Acetone: < 0.3 volume percent @ 1 volume percent acetone
    - Ethanol: < 0.3 volume percent @ 0.1 volume percent ethanol
    - Helium: < 0.3 volume percent @ 80 volume percent helium
    - Methane: < 0.3 volume percent @ 0.1 volume percent methane
    - Nitric oxide: < 0.3 volume percent @ 50 ppm nitric oxide
- Oxygen Sensor:
    - Operating temperature: 15 – 35 °C (59 – 95°F)
    - Expected operating life: Product labeled with a use-by date 15 months from manufacturing date (2500 hours at 100 percent O2); exchange recommended every 12 months
    - Expected shelf life: 3 months in sealed container

Respiration (Pneumatic)

- Displayed numerically by detecting the patient's abdominal or chest wall motion through a pneumatic bellows placed at the patient's chest.
- No user adjustable options, including alarms, as this parameter is not intended for vital sign monitoring
- Respiration rate measurement range: 0 to 60 breaths per minute
- Respiration rate resolution: 1 breath per minute
- Respiration rate accuracy: ± 1 breath per minute

Temperature (Optional)

For use with the FlexTEMP II Sensor

- Channel: One
- Units: Celsius and Fahrenheit
- Range: 20.0 – 44.0°C (68.0 – 111.2°F)
- Resolution: 0.1°C (0.1°F)
- Accuracy: ±0.5°C (±0.9°F)
- Response time: The measuring time to obtain a steady-state reading within the manufacturer's accuracy specifications is within 15 seconds, compliant to ISO 80601-2-56.
- Numeric display update time: 2 seconds
- Sensor type: Fiber-optic, multiple-use (when used with single-use sterilized jackets)
- Application site: Axillary, esophageal, rectal
- Measurement mode: Direct

Alarm Limits

- Lower: Off, or 20.0 to 44.0°C (Off, or 68.0 to 111.2°F)
- Upper: 20.0 to 44.0°C, or off (68.0 to 111.2°F, or off)

8.4.1. Non-invasive Blood Pressure

Oscillometric method (with inflatable cuff) determines systolic, diastolic and mean arterial pressures, and pulse rate.

Patient Types

- Adult, pediatric, and neonate

Pneumatic Systems

- Unit of measure: Millimeters of mercury (mmHg) or kilopascals* (kPa)
- Cuff inflation pressure:
    - Initially 165 mmHg (22 kPa) for Adult, 130 mmHg (17.3 kPa) for Pediatric, and 100 mmHg (13.3 kPa) for Neonate; all pressures are ± 15 mmHg (2 kPa)
    - Subsequent inflation pressures determined by last NIBP measurement
- Overpressure protection: release of cuff pressure if inflation pressure exceeds 300 mmHg (40 kPa) for Adult and Pediatric modes, and 150 mmHg (20 kPa) for Neonate mode

Measurement Range

- Systolic:
    - Adult: 30 – 270 mmHg (4.0 – 36 kPa)
    - Pediatric: 30 – 180 mmHg (4.0 – 24 kPa)

8.4.2.

- Neonate: 30 – 130 mmHg (4.0 – 17.3 kPa)
- Mean arterial:
  - Adult: 20 – 255 mmHg (2.7 – 34 kPa)
  - Pediatric: 20 – 160 mmHg (2.7 – 21.3 kPa)
  - Neonate: 20 – 120 mmHg (2.7 – 16 kPa)
- Diastolic:
  - Adult: 10 – 245 mmHg (1.3 – 32.7 kPa)
  - Pediatric: 10 – 150 mmHg (1.3 – 20 kPa)
  - Neonate: 10 – 100 mmHg (1.3 – 13.3 kPa)

Accuracy

- Pressure measurement accuracy: Maximum mean error ± 5 mmHg (± 0.6 kPa) with a standard deviation of less than 8 mmHg (1 kPa)
- Pressure measurement resolution: 1 mmHg (0.1 kPa)
- Pressure transducer range: 0 – 300 mmHg (0 – 40 kPa)

Modes

- Manual: Immediate upon operator command
- Automatic: Determinations automatically made with selectable intervals of 1, 2, 3, 5, 10, 15, 20, and 30 minutes

8.4.3.

Alarm Limits

- Systolic:
  - Adult:
    - Lower: Off, or 30 to 270 mmHg (Off, or 4.0 to 36.0 kPa)
    - Upper: 30 to 270 mmHg, or off (or 4.0 to 36.0 kPa, or off)
  - Pediatric:
    - Lower: Off, or 30 to 180 mmHg (Off, or 4.0 to 24.0 kPa)
    - Upper: Upper: 30 to 180 mmHg, or off (or 4.0 to 24.0 kPa, or off)
  - Neonate:
    - Lower: Off, or 30 to 130 mmHg (Off, or 4.0 to 17.3 kPa)
    - Upper: 30 to 130 mmHg, or off (4.0 to 17.3 kPa, or off)
- Mean:
  - Adult:
    - Lower: Off, or 20 to 255 mmHg (Off, or 2.7 to 34.0 kPa)
    - Upper: 20 to 255 mmHg, or off (2.7 to 34.0 kPa, or off)
  - Pediatric:
    - Lower: Off, or 20 to 160 mmHg (Off, or 2.7 to 21.3 kPa)
    - Upper: 20 to 160 mmHg, or off (2.7 to 21.3 kPa, or off)
  - Neonate:
    - Lower Off, or 20 to 120 mmHg (Off, or 2.7 to 16.0 kPa)
    - Upper: 20 to 120 mmHg, or off (2.7 to 16.0 kPa, or off)
- Diastolic:
  - Adult:

8.4.2.

    - Lower: Off, or 10 to 245 mmHg (Off, or 1.3 to 32.7 kPa)
    - Upper: 10 to 245 mmHg, or off (1.3 to 32.7 kPa, or off)
  - Pediatric:
    - Lower: Off, or 10 to 150 mmHg (Off, or 1.3 to 20.0 kPa)
    - Upper: 10 to 150 mmHg, or off (1.3 to 20.0 kPa, or off
  - Neonate:
    - Lower: Off, or 10 to 100 mmHg (Off, or 1.3 to 13.3 kPa)
    - Upper: 10 to 100 mmHg, or off (1.3 to 13.3 kPa, or off)

**For kilopascals (kPa), allow ± 1 least significant digit to accommodate round-off error for calculated values.*

Gating

Parameter result outputs to the MRI system as data and discrete signals:

- Digital pulses (parameter event-associated signals):
  - ECG (3.3 to 5.0 V p-p signal, pulse duration 10 ms ± 3 ms)
  - SpO2 (3.3 to 5.0 V p-p signal, pulse duration 10 ms ± 3 ms)
  - Negative pulses (-3.3 to -5.0 V p-p signals), other characteristics same as above
- Analog waveforms (monitored parameter representative signals):
  - ECG (1 mV/mV scaling, 5 mA maximum current, 20 mV maximum output voltage)
  - ECG (1 V/mV scaling, ± 5 V maximum output voltage, 5 mA maximum current)
  - IBP (200 mV maximum output voltage)
  - Respiration (± 5 V maximum output voltage, 5 mA maximum current, 1 V p-p signal voltage)
  - SpO2 IR/red (1 V/mV scaling, 40 mV maximum output voltage)
  - SpO2 IR/red (2 V maximum output voltage)

Ordering Information

Standard Features, 866185

- A01: Standard Accessories

Options

- F01: Basic (NBP, ECG, SpO2, CO2, RR)
- F02: Basic + IBP (x2)
- F03: Basic + Temp
- F04: Basic + AA, O2
- F05: Basic + AA, O2, IBP (x2)
- F06: Basic + AA, O2 ,Temp
- F07: Basic + AA, O2, IBP (x2), Temp

Accessories

AGENT

- 989803152561: CANNULA, DISP, ADULT
  - *(Original part number: 9012)*
- 989803152601: CANNULA, DISP, ADULT
  - *(Original part number: 9016)*
- 989803152621: CANNULA,DISP,INT INF, (DIVIDED)
  - *(Original part number: 9016B)*
- 989803152631: CANNULA, DISP, PED, (DIVIDED)
  - *(Original part number: 9016C)*
- 989803152611: CANNULA, DISP, INFANT, (DIVIDED)
  - *(Original part number: 9016A)*
- 989803152591: CANNULA, DISP, INT INFANT
  - *(Original part number: 9015)*
- 989803152571: CANNULA, DISP, PED
  - *(Original part number: 9013)*
- 989803152581: CANNULA, DISP, INFANT
  - *(Original part number: 9014)*
- 989803162051: ANESTHETIC OXYGEN (O2) SENSOR
- 989803152671: KIT,DISPOSABLE WATER TRAP,3160
  - *(Original part number: 94012)*
- 989803152661: KIT,SAMPLE,AGENTS,3160
  - *(Original part number: 94018)*

CO2

- 989803183241: LOFLO SAMPLE LINE, ADULT CANNULA, BOX 20
- 989803183251: LOFLO SAMPLE LINE, PED. CANNULA, BOX 20
- 989803183261: LOFLO SAMPLE LINE, NEO. CANNULA, BOX 20
- 989803183271: LOFLO LINE, ADU DVD CANNULA,BOX 20
- 989803183281: LOFLO LINE, PED DVD CANNULA, BOX 20
- 989803183291: LOFLO LINE, ADU AIRWAY ADPT, BOX 20
- 989803185331: LOFLO SAMPLE LINE, ADULT CANNULA,BOX 100
- 989803185341: LOFLO SAMPLE LINE, PED CANNULA, BOX 100
- 989803185351: LOFLO SAMPLE LINE, NEO CANNULA, BOX 100
- 989803185361: LOFLO LINE, ADU DVD CANNULA, BOX 100
- 989803185371: LOFLO LINE, PED DVD CANNULA, BOX 100
- 989803185381: LOFLO LINE ADU AIRWAY ADPT, BOX 100

ECG

- 989803152291: GEL, ECG/EEG, SKIN PREP, TUBE, 3-PACK
  - *(Original part number: 9009)*
- 989803193721: EXPRESSION MR ECG LEADS, AAMI, CV
- 989803193731: EXPRESSION MR ECG LEADS, AAMI, STANDARD
- 989803193741: EXPRESSION MR ECG LEADS, AAMI, NEONATAL
- 989803193751: EXPRESSION MR ECG LEADS, IEC, CV
- 989803193761: EXPRESSION MR ECG LEADS, IEC, STANDARD
- 989803193771: EXPRESSION MR ECG LEADS, IEC, NEONATAL
- 989803179031: QUADTRODE MRI ECG PAD, 25/BOX
- 989803179041: ELCTRD, MRI ECG, QUTRD.CV, 25/BOX
- 989803179051: ELCTRD, MRI, NEO.QUDTRD, 25/BOX
- 989803192761: WIRELESS ECG PATIENT MODULE (GEN 3) 1-5
- 989803194341: WIRELESS ECG PATIENT MODULE (GEN 3) 6-10

Gating

- 989803152821: CAB, DIGITAL GATING, GE, 3160
  - *(Original part number: 9292)*
- 989803152831: CAB, GATING, SIEMENS, 3160
  - *(Original part number: 9291)*
- 989803152851: CAB, DIG.GATING, HIT/TOSH, 3160
  - *(Original part number: 9293)*
- 989803195521: UNIVERSAL GATING INTERFACE

Invasive Blood Pressure

- 989803194601: EXPRESSION MR IBP TRANSDUCER CABLE, 5FT
- 989803194631: EXPRESSION MR IBP DPT KIT, A/P, BOX 20
- 989803194641: EXPRESSION MR IBP DPT KIT, I/N, BOX 20

Note that Hospira [Transpac models], and Edwards Lifesciences [Transducer, Model PX260 and adapter cables], have also been qualified for use. Please contact Hospira or Edwards Lifesciences for information about Invivo-compatible devices, and contact your sales representative with any questions.

Non-invasive Blood Pressure (NIBP)

- 989803182611: NIBP CUFF, SINGLE LUMEN, INFANT
- 989803182621: NIBP CUFF, SINGLE LUMEN, PEDIATRIC
- 989803182631: NIBP CUFF, SINGLE LUMEN, SMALL ADULT
- 989803182641: NIBP CUFF, SINGLE LUMEN, ADULT
- 989803182651: NIBP CUFF, SINGLE LUMEN, ADULT-L
- 989803182661: NIBP CUFF, SINGLE LUMEN, LRG ADULT
- 989803182671: NIBP CUFF, SINGLE LUMEN, LRG ADULT-L
- 989803182681: NIBP CUFF, SINGLE LUMEN, THIGH
- 989803182511: NIBP CUFF, SINGLE LUMEN, INFANT, DISP
- 989803182521: NIBP CUFF, SINGLE LUMEN, PEDIATRIC, DISP
- 989803182531: NIBP CUFF, SINGLE LUMEN, SMALL ADULT,DISP
- 989803182541: NIBP CUFF, SINGLE LUMEN, ADULT, DISP
- 989803182551: NIBP CUFF, SINGLE LUMEN, ADULT-L, DISP
- 989803182561: NIBP CUFF, SINGLE LUMEN, LRG ADULT, DISP
- 989803182571: NIBP CUFF, SINGLE LUMEN,LRG ADULT-L,DISP
- 989803182581: NIBP CUFF, SINGLE LUMEN, THIGH, DISP
- 989803183171: NIBP CUFF, SINGLE LUMEN, NEO #1, DISP
- 989803183181: NIBP CUFF, SINGLE LUMEN, NEO #2, DISP
- 989803183191: NIBP CUFF, SINGLE LUMEN, NEO #3, DISP
- 989803183201: NIBP CUFF, SINGLE LUMEN, NEO #4, DISP
- 989803183211: NIBP CUFF, SINGLE LUMEN, INFANT #5, DISP
- 989803183221: ADULT PRESSURE INTERCONNECT HOSE
- 989803183231: NEONATAL PRESSURE INTERCONNECT HOSE

Respiration (Pneumatic)

- 989803152791: PNEUMOGRAPH, CHEST, NM, 3160
    - *(Original part number: 94023)*

SPO2

- 989803161991: QUICK CONNECT SPO2 PROBE, MRI
- 989803166531: QUICK CONNECT SPO2 CLIP, ADULT
- 989803166541: QUICK CONNECT SPO2 CLIP, PEDIATRIC
- 989803166551: QUICK CONNECT SPO2 GRIP, ADULT, 20/BOX
- 989803166561: QUICK CONNECT SPO2 GRIP, PED, 20/BOX
- 989803166571: QUICK CONNECT SPO2 GRIP, INFANT, 20/BOX
- 989803166581: QUICK CONNECT SPO2 GRIP, NEO, 20/BOX
- 989803192771: WIRELESS SPO2 PATIENT MODULE (GEN 3) 1-5
- 989803194331: WIRELESS SPO2 PATIENT MODULE (GEN 3) 6-10

System

- 989803191341: BATTERY, MODULE (GEN 3)
- 989803169491: BATTERY, MRI, 14.8V, 5.08 AH, UL
- 865471: EXPRESSION INFORMATION PORTAL (IP5)
- 989803176521: ADVANCED COMMUNICATIONS OPTION
- 453564177501: EUROPEAN LINE CORD
- 989803168211: NORTH AMERICAN LINE CORD
- 989803168221: CORD, JUMPER, 25 FEET
- 989803173901: BRAZILIAN POWER CORD, 3 METER
- 989803174171: UK LINE CORD, 3 METER
- 989803181291: POWER CORD, AUS/NZL, 3 METER
- 989803181321: POWER CORD, S AFRICA, 3 METER
- 989803181331: POWER CORD, DANISH, 3 METER
- 989803181341: POWER CORD, ISRAELI, 3 METER
- 989803181351: POWER CORD, ARGENTINA, 3 METER
- 989803181361: POWER CORD, SWISS, 3 METER

Temperature

- 989803194511: FLEXTEMP II SENSOR (ESOPHAGEAL/RECTAL/AXILLARY, DIRECT MODE)
- 989803168891: SURGICAL LUBRICANT, 12 PACK
- 989803178181: FLEXTEMP SYSTEM, JACKET (BOX 10)

Miscellaneous

- 453564557591: MR400 QUICK REFERENCE GUIDE
- 989803195211: MANUAL, SERVICE, MR400
- 989803193191: MANUAL, OPERATOR, MR400, DANISH

- 989803193201: MANUAL, OPERATOR, MR400, DUTCH
- 989803193211: MANUAL, OPERATOR, MR400, ENGLISH
- 989803193221: MANUAL, OPERATOR, MR400, FINNISH
- 989803193231: MANUAL, OPERATOR, MR400, FRENCH
- 989803193241: MANUAL, OPERATOR, MR400, GERMAN
- 989803193251: MANUAL, OPERATOR, MR400, INDONESIAN
- 989803193261: MANUAL, OPERATOR, MR400, ITALIAN
- 989803193271: MANUAL, OPERATOR, MR400, JAPANESE
- 989803193281: MANUAL, OPERATOR, MR400, KOREAN
- 989803193291: MANUAL, OPERATOR, MR400, NORWEGIAN
- 989803193301: MANUAL, OPERATOR, MR400, POLISH
- 989803193311: MANUAL, OPERATOR, MR400, PORTUGUESE
- 989803193321: MANUAL, OPERATOR, MR400, RUSSIAN
- 989803193331: MANUAL, OPERATOR, MR400, SPANISH
- 989803193341: MANUAL, OPERATOR, MR400, SWEDISH
- 989803193351: MANUAL, OPERATOR, MR400, TRAD. CHINESE
- 989803193361: MANUAL, OPERATOR, MR400, TURKISH

PHILIPS

For more information about the Philips Expression MR400 or any of our complete solution products, please contact us. We are glad to hear from you.

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REF A-866185-90058, Rev. A