

**510(k) SUBSTANTIAL EQUIVALENCE DETERMINATION
DECISION SUMMARY
ASSAY AND INSTRUMENT COMBINATION TEMPLATE**

A. 510(k) Number:

k061597

B. Purpose for Submission:

New device

C. Measurand:

pH, pCO₂, pO₂, Na, K, iCa, Hct

D. Type of Test:

Electrode technology

E. Applicant:

Epocal, Inc.

F. Proprietary and Established Names:

Epoc Blood Analysis System

G. Regulatory Information:

1. Regulation section:

21 CFR§-862.1120-Blood gases (PCO₂, PO₂) and blood pH test system

21CFR §-862.1665-Sodium test system

21 CFR§-862.1600-Potassium test system

21 CFR§-862.1145-Calcium test system

21 CFR§-864.6400-Hematocrit measuring device

2. Classification:

Class II

3. Product code:

CHL - Electrode Measurement, Blood-Gases (Pco₂, Po₂) And Blood pH

JGS - Electrode, Ion Specific, Sodium

CEM -Electrode, Ion Specific, Potassium

JFP - Electrode, Ion Specific, Calcium

JPI - Device, Hematocrit Measuring

4. Panel:

Chemistry (75) Hematology (81)

H. Intended Use:

1. Intended use(s):

See indications for use below

2. Indication(s) for use:

The EPOC Blood Analysis System is intended for use by trained medical professionals as an in vitro diagnostic device for the quantitative testing of samples of whole blood in the laboratory or at the point of care in hospitals, nursing homes or other clinical care institutions.

The Blood Gas Electrolyte (BGE) test card panel configuration includes sensors for Sodium - Na, Potassium - K, ionized Calcium - iCa, pH, pCO₂, pO₂ and Hematocrit - Hct.

Measurement of Sodium and Potassium are used in diagnosis and treatment diseases involving electrolyte imbalance. Measurement of Ionized Calcium is used in diagnosis and treatment of parathyroid disease, a variety of bone diseases, chronic renal disease and tetany. Measurement of pH, pCO₂, pO₂ (blood gases) is used in the diagnosis and treatment of life-threatening acid-base disturbances. Measurement Hct distinguish normal from abnormal states of blood volume, such as anemia and erythrocytosis.

3. Special conditions for use statement(s):

For prescription use

4. Special instrument requirements:

EPOC Card Reader, EPOC Host

I. Device Description:

The EPOC Blood Analysis System consists of three (3) components:

1. EPOC Test Card

The single use blood test card comprises a port for introduction of a blood sample to an array of sensors on a sensor module. The sensor module is mounted proximal to a fluidic channel contained in a credit-card sized housing. The card has an on-board calibrator contained in a sealed reservoir fluidically connected to the sensor array through a valve.

2. EPOC Card Reader

The reader is a minimally featured raw-signal acquisition peripheral. The reader comprises a card orifice for accepting a test card, and a mechanical actuation assembly for engaging the test card after it is inserted into the card orifice. Within the reader's card orifice there is a bar code scanner, an electrical contact array for contacting the card's sensor module, and a thermal subsystem for heating the card's measurement region to 37°C during the test. The reader also comprises circuits for amplifying, digitizing and converting the raw sensor signals to a wireless transmittable Bluetooth format,

3. EPOC Host

The host is a dedicated use Personal Digital Assistant (PDA) computing device

with custom software that displays the test results. The reader and host computer together constitute all of the subsystems generally found in a traditional analyzer that operates on unit-use sensors and reagents.

J. Substantial Equivalence Information:

1. Predicate device name(s):

i-STAT Model 300

2. Predicate 510(k) number(s):

k001387

3. Comparison with predicate:

	EPOC Blood Analysis System			i-STAT Model 300			Same / Different
510(k) #	To be determined			K001387			
Item	Device			Predicate			
Intended use	The EPOC Blood Analysis System is intended for use by trained medical professionals as an in vitro diagnostic device for the quantitative testing of samples of whole blood using the BGE (Blood Gas Electrolyte) and ABG (Arterial Blood Gas) test card panels.			The i-STAT Model 300 Portable Clinical Analyzer is intended to be used by trained medical professionals for use with i-STAT test cartridges and MediSense blood glucose test strips. i-STAT cartridges comprise a variety of clinical chemistry tests and test panels.			same
Where used	hospital			Hospital			same
Measured parameters	pH, pCO ₂ , pO ₂ , Na, K, iCa, Hct			pH, pCO ₂ , pO ₂ , Na, K, iCa, Hct			same
Calculated parameters	TCO ₂ , HCO ₃ ,BE,sO ₂ ,Hgb			TCO ₂ , HCO ₃ ,BE,sO ₂ ,Hgb			same
Sample type	Venous, arterial whole blood			Venous, arterial and skin puncture whole blood			same
Reportable ranges	pH	6.5 – 8.0	pH units	pH	6.5 – 8.2	pH units	different
	pCO ₂	5 – 250	mm Hg	pCO ₂	5 – 130	mm Hg	different
	pO ₂	5 – 750	mm Hg	pO ₂	5 – 800	mm Hg	same
	Na	85 – 180	mmol/L	Na	100 – 180	mmol/L	different
	K	1.5 – 12	mmol/L	K	2.0 – 9.0	mmol/L	different
	iCa	0.25 – 4	mmol/L	iCa	0.25 – 2.5	mmol/L	different
	Hct	10 – 75	%PCV	Hct	10 – 75	%PCV	same
	TCO ₂	1 – 85	mmol/L	TCO ₂	5 - 50	mmol/L	different
	HCO ₃	1 – 85	mmol/L	HCO ₃	1 – 85	mmol/L	same
	BE _{ecf}	-30 - +30	mmol/L	BE _{ecf}	-30 - +30	mmol/L	same
	BE _b	-30 - +30	mmol/L	BE _b	-30 - +30	mmol/L	same
	sO ₂	0 – 100	%	sO ₂	0 – 100	%	same
	Hb	3.3 – 25	g/dL	Hb	3 – 26	g/dL	same
	Sample volume	95-125 µL			100µL		
Test card	Unit-use card with - on-board calibrator in sealed reservoir - an electrochemical multi-sensor array - port for sample introduction - fluid waste chamber			Unit-use cartridge with - on-board calibrator in sealed reservoir - an electrochemical multi-sensor array - port for sample introduction - fluid waste chamber			same
Test card storage	Room temperature until expiry date			Fridge storage until expiry date including max 2 weeks at room temperature			different
Sensor array	A laminated foil sensor module			A micro-fabricated chip-set			different
Tests/sensor components	pH - PVC ion selective electrode pCO ₂ - QH modified Severinghaus type			pH - PVC ion selective electrode pCO ₂ - QH modified Severinghaus type			same same

	pO2 – membrane coated gold cathode Na - PVC ion selective electrode K - PVC ion selective electrode iCa - PVC ion selective electrode Hct – conductivity, gold electrodes	pO2 – membrane coated gold cathode Na - PVC ion selective electrode K - PVC ion selective electrode iCa - PVC ion selective electrode Hct – conductivity, gold electrodes	same same same same same
Analyzer components	Two housings; 1 - The reader comprising <ul style="list-style-type: none"> - Orifice for test card introduction - electrical connector to card - heater for 37°C operation - mechanical card engagement device for <ul style="list-style-type: none"> o making electrical contact to card's sensors o for rupture of calibrator reservoir o moving calibrator to sensors o engaging heaters with card - op-amp sensor signal detectors - iQC monitoring devices - Thermal controllers - MUX - A/D - Bluetooth stack for wireless transmission of digitized raw sensor signals to computing device - bar code scanner for acquiring card info - internal electronic reader self-test circuit 2 - The computing device comprising a PDA <ul style="list-style-type: none"> - microprocessor - memory - color LCD display - keyboard - i/o for communicating test results to other devices - software to control the test and calculate analytical values from raw sensor signals - battery operated with rechargeable batteries via plug in plug-in power supply 	A single housing comprising <ul style="list-style-type: none"> - Orifice for test card introduction - electrical connector to card - heater for 37°C operation - mechanical card engagement device for <ul style="list-style-type: none"> o making electrical contact to card's sensors o for rupture of calibrator reservoir o moving calibrator to sensors o engaging heaters with card - op-amp sensor signal detectors - iQC monitoring devices - Thermal controllers - MUX - A/D - wire transmission of digitized raw sensor signals to computing subsystem in same housing - n/a - internal and external electronic reader self-test circuit <ul style="list-style-type: none"> - microprocessor - memory - monochrome LCD display - keyboard - i/o for communicating test results to other devices - software to control the test and calculate analytical values from raw sensor signals - battery operated with rechargeable batteries via external power supply in downloader cradle 	different same same same same same same same same different different same same different same same same same
Measurement temperature	37°C	37°C	same
Measurement sequence	Calibrate test card-introduce sample-measure	Introduce sample-calibrate test cartridge-measure	different
Measurement time	30sec from sample introduction	200 sec from sample introduction	different
Error detection	iQC system to detect user errors iQC system for reader self-check iQC system to detect card non-conformance	iQC system to detect user errors iQC system for reader self-check iQC system to detect card non-conformance	same same same

K. Standard/Guidance Document Referenced (if applicable):

Reference Number (Revision)	Title
CISPR 11:1997 + A1:1999 + A2:2002, modified	Limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment
CISPR 22:1997 + A1:2000 + A2:2002, modified	Information technology equipment. Radio disturbance characteristics. Limits and methods of measurement
IEC 60601-1: 1988 + A1:1991 + A2:1995	Medical Electrical Equipment - Part 1-1: General Requirements for Safety - Collateral Standard: Safety Requirements for Medical Electrical Systems
IEC 60601-1-2:2001	Medical Electrical Equipment - Part 1-2: General Requirements for Safety - Collateral Standard: Electromagnetic Compatibility - Requirements and Tests
IEC 61000-3-2:2000, modified	Part 3-2: Limits for harmonic current emissions
IEC 61000-3-3:1994 (includes amendment A1:2001)	Part 3-3: Limits. Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current ≤ 16 A
IEC 61000-4-2:1995 + A1:1998 + A2:2000	Part 4-2: Electrostatic discharge immunity test
IEC 61000-4-3:1995 + A1:1998 + A2:2000	Part 4-3: Radiated, radio-frequency, electromagnetic field immunity test (Field strength 3 V/m. 80% AM modulated with 1kHz)
IEC 61000-4-4:1995 + A1:2000 + A2:2001	Part 4-4: Electrical fast transient/burst immunity test
IEC 61000-4-5:1995 + A1:2000	Part 4-5: Surge immunity test
IEC 61000-4-6:1996 + A1:2000	Part 4-6: Immunity to conducted disturbances, induced by radio-frequency fields
IEC 61000-4-8:1993 + A1:2000	Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test
IEC 61000-4-11:1994 +A1:2000	Part 4-11: Voltage dips, short interruptions and voltage variations immunity tests
IEC 61010-1:2001	Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General Requirements
IEC 61010-2-81:2001	Part 2-081: Particular requirements for automatic and semi-automatic laboratory equipment for analysis and

Reference Number (Revision)	Title
	other purposes
IEC 61010-2-101:2002	Part 2:-101: Particular requirements for in vitro diagnostic (IVD) medical equipment
IEC 61326:2002 (includes amendments A1:1998, A2:2001 and A3:2003)	Electrical equipment for measurement, control and laboratory use – EMC Requirements
ISO 14971* (2000)	Medical devices - Application of risk management to medical devices
CLSI AST02-A (1999)	Point Of Care <i>In Vitro</i> Diagnostic IVD Testing; Approved Guideline
CLSI C46-A (2001)	Blood Gas and pH Analysis and Related Measurements; Approved Guideline
CLSI EP05-A (1999)	Evaluation of Precision Performance of Clinical Chemistry Devices; Approved Guideline
CLSI EP07-A (2002)	Interference Testing in Clinical Chemistry; Approved Guideline
CLSI EP09-A2 (2002)	Method Comparison and Bias Estimation Using Patient Samples; Approved Guideline – Second Edition
CLSI H07-A3 (2000)	Procedure for Determining Packed Cell Volume by the Microhematocrit Method – Second Edition; Approved Standard – Third Edition
CLSI H11-A4 (2004)	Procedures for the Collection of Arterial Blood Specimens; Approved Standard – Fourth Edition
SW68 (2001)	Medical device software - Software life cycle processes

L. Test Principle:

There are three types of sensor measurements used in the EPOC BGE test card – potentiometric, amperometric and conductimetric.

In potentiometry, (for sodium, potassium, ionized calcium, pH and pCO₂) the open circuit potential of a membrane coated sensor electrode (which is responsive to the concentration of the analyte) is measured versus a reference electrode (which is non-responsive). The measurement is performed by a high input impedance operational amplifier in the card reader connected to each of the electrode pairs comprising sensor electrode and reference electrode.

In amperometry (for pO₂) the current, *i*, flowing through a membrane-coated amperometric indicator electrode to the ground electrode is measured, when the indicator electrode is poised at a fixed potential versus the reference electrode.

Hematocrit is measured by ac conductimetry. A pair of spaced apart electrodes in the flow channel is used to minimize contact impedance and blood cell settling errors. The down-stream conductivity-high electrode also serves as the detector for adequate sample volume delivery. The measurement employs a 20 kHz voltage source with

100mV p-p. The normalized sensor signal is the ratio of the resistance of blood to the resistance of calibrator fluid.

M. Performance Characteristics (if/when applicable):

1. Analytical performance:

a. *Precision/Reproducibility:*

Commercial Quality Control Material

This study used the CLSI guideline for a twenty day precision study with one run per day. (CLSI EP5-A “Evaluation of Precision Performance of Clinical Chemistry Devices”). Cards from four lots from the pilot production process were randomized. Two cards per day at each control level over a twenty day span. Mission Control Aqueous Blood gas Controls levels 1 and 3 were used for all analytes and Mission Control Hematocrit Controls levels A and B for hematocrit only.

	L1						
	pH	pCO2	pO2	Na+	K+	Ca++	Hct
Mean	6.986	80.6	78.4	114.5	2.15	2.2	-16.9
S _{WR}	0.006	1.94	1.94	0.57	0.021	0.023	0.35
%CV _{WR}	0.09%	2.40%	2.47%	0.50%	0.97%	1.02%	
S _{DD}	0.004	1.31	1.96	0.67	0.011	0.017	0.42
%CV _{DD}	0.05%	1.63%	2.50%	0.59%	0.51%	0.76%	
S _T	0.008	2.36	2.57	0.80	0.025	0.028	0.49
%CV _T	0.11%	2.92%	3.28%	0.70%	1.15%	1.26%	
	L3						
	pH	pCO2	pO2	Na+	K+	Ca++	Hct
Mean	7.676	22.5	141.2	153.2	6.58	0.67	-14.5
S _{WR}	0.005	0.36	1.78	0.71	0.053	0.009	0.36
%CV _{WR}	0.06%	1.61%	1.26%	0.47%	0.80%	1.29%	
S _{DD}	0.004	0.55	1.44	0.77	0.037	0.010	0.33
%CV _{DD}	0.05%	2.44%	1.02%	0.50%	0.56%	1.43%	
S _T	0.006	0.56	2.24	0.97	0.064	0.012	0.46
%CV _T	0.08%	2.50%	1.58%	0.63%	0.98%	1.77%	

	Level A	Level B
	Hct	Hct
Mean	25.3	46.1
S _{WR}	0.370	0.68
%CV _T	1.46%	1.48%
S _{DD}	0.160	0.00
%CV _T	0.63%	0.00%

	Level A	Level B
S_T	0.400	0.68
%CV _T	1.58%	1.48%

Whole blood

Whole blood test materials were prepared from fresh blood drawn into a green top heparinized vacuum collection tube from a Company volunteer in the morning on each test day. The normal blood sample (nb), as collected, comprised the first test material. A spiked blood sample (sb) was tonometered and electrolyte spiked to an elevated analyte level for the second test material.

Lot	nb							sb						
	pH	pCO2	pO2	Na+	K+	Ca++	Hct	pH	pCO2	pO2	Na+	K+	Ca++	Hct
06024-1	0.006	1.54	1.75	0.61	0.02	0.021	0.70	0.009	3.30	2.47	1.93	0.07	0.022	0.99
06025-1	0.008	1.49	2.71	0.72	0.04	0.014	0.69	0.014	1.79	2.29	1.08	0.04	0.027	0.43
06026-1	0.005	1.05	1.85	0.90	0.02	0.016	0.97	0.006	3.77	1.72	1.01	0.03	0.025	0.54
06027-1	0.006	1.27	2.07	0.83	0.03	0.014	0.91	0.011	3.91	1.64	1.22	0.05	0.029	0.46
06031-1	0.009	2.02	0.92	0.87	0.06	0.017	0.61	0.012	4.12	2.15	1.88	0.06	0.038	0.71
06032-1	0.010	1.13	1.60	1.46	0.06	0.019	0.96	0.009	2.24	2.00	1.49	0.07	0.027	1.24
06033-1	0.004	0.79	3.85	1.90	0.07	0.034	0.89	0.009	3.48	3.68	2.36	0.10	0.047	0.96
06034-1	0.009	1.32	3.73	1.41	0.10	0.023	0.98	0.009	2.75	5.76	1.89	0.08	0.040	0.85
06038-1	0.008	1.25	4.65	1.56	0.07	0.021	0.64	0.009	3.36	5.57	1.64	0.08	0.035	0.83
06040-1	0.007	1.75	1.59	0.44	0.03	0.016	0.42	0.009	2.23	1.47	0.61	0.03	0.018	0.33
06041-1c	0.006	0.87	3.02	1.02	0.02	0.020	0.83	0.009	3.24	1.66	1.47	0.04	0.035	0.77
06041-1s	0.008	0.82	3.13	0.90	0.02	0.023	0.66	0.009	2.50	1.72	1.55	0.05	0.025	0.67
06045-1	0.005	1.57	1.13	0.68	0.04	0.019	0.73	0.010	2.71	2.17	1.83	0.04	0.028	0.87
06046-1	0.005	1.93	2.08	0.48	0.03	0.012	0.55	0.008	1.99	1.56	0.81	0.02	0.009	0.76
06047-1	0.005	1.18	1.69	0.41	0.03	0.016	0.62	0.004	2.66	1.05	1.36	0.03	0.017	0.50
06048-1	0.007	2.14	1.82	0.84	0.02	0.017	0.50	0.008	2.57	2.99	0.88	0.03	0.025	0.32
06052-1	0.009	1.74	2.54	1.07	0.04	0.017	0.42	0.008	3.12	1.99	1.57	0.06	0.012	0.52
06053-1	0.007	1.27	1.66	0.45	0.04	0.014	0.51	0.007	2.19	1.98	1.25	0.03	0.019	0.55
06054-1	0.007	2.04	1.53	0.97	0.02	0.010	1.07	0.005	2.63	2.65	1.39	0.03	0.021	0.49
06055-1	0.006	2.17	1.38	1.41	0.05	0.023	0.60	0.013	3.31	2.04	0.82	0.04	0.015	0.48
Mean	7.200	65.0	38.0	147	4.30	1.35	44.0	7.700	90.0	70.0	168.0	6.20	2.20	22.0
S_{WR}	0.0068	1.47	2.24	0.95	0.041	0.018	0.71	0.0089	2.89	2.43	1.40	0.050	0.026	0.66
CV %	0.09%	2.26%	5.88%	0.64%	0.96%	1.35%	1.62%	0.12%	3.21%	3.47%	0.83%	0.80%	1.17%	3.02%

The data indicates that the whole blood imprecision data are consistent with the aqueous imprecision data.

Supplemental field trial data acquired at one hospital at three different POC sites: the cardiac ICU, the medical ICU and the Neonatal ICU. From these sites various operators who perform POC testing on the predicate device were chosen for inclusion in the study. The study included 2 nurses, 2 RT's and 3 nurses' assistants.

The following protocol was used. After a training period each POC operator was asked to run 10 replicates of a whole blood patient sample. A different sample was used for each precision study. There were 5 readers in operation for each precision study, 2 test replicates being run per each of 5 readers for a total of 10 replicates.

			pH	PCO2	PO2	Na	K	Ca	Hct
Site 1	Operator 1								
		mean:	7.365	52.3	28.6	142.3	4.04	1.20	40.1
		sd:	0.006	1.98	1.71	0.48	0.05	0.018	0.57
		cv%:	0.08	3.8	6.0	0.3	1.3	1.5	1.4
		n:	10	10	10	10	10	10	10
Site 1	Operator 2								
		mean:	7.368	49.2	31.3	140.0	4.0	1.19	40
		sd:	0.005	0.94	1.83	1.49	0.00	0.023	0.52
		cv%:	0.06	1.9	5.5	1.0	0.0	1.9	1.3
		n:	10	10	10	10	10	10	10
Site 2	Operator 3								
		mean:	7.322	56.9	33.9	141.9	3.70	1.191	39.2
		sd:	0.005	0.87	1.20	1.20	0.00	0.020	0.63
		cv%:	0.04	1.5	3.5	0.8	0.0	1.7	1.6
		n:	10	10	10	10	10	10	10
Site 2	Operator 4								
		mean:	7.335	55.4	30.0	143.0	3.81	1.211	40.7
		sd:	0.006	1.36	1.49	0.82	0.03	0.026	0.48
		cv%:	0.08	2.5	5.0	0.6	0.8	2.1	1.2
		n:	10	10	10	10	10	10	10
Site 2	Operator 5								
		mean:	7.303	58.9	40.1	142.9	3.69	1.20	39.9
		sd:	0.009	1.11	1.23	0.74	0.03	0.019	0.57
		cv%:	0.12	1.9	3.1	0.5	0.9	1.6	1.4
		N:	10	10	10	10	10	10	10
Site 3	Operator 6								
		mean:	7.266	61.7	61.8	140.6	359	1.226	39.8
		sd:	0.006	1.80	3.47	0.84	0.03	0.022	0.79
		cv%:	0.08	2.9	5.6	0.6	0.9	1.8	2.0
		n:	10	10	10	10	10	10	10
Site 3	Operator 7								
		mean:	7.381	41.5	74.6	139.5	4.14	1.236	37.5
		sd:	0.004	0.87	2.91	0.97	0.05	0.024	0.71
		cv%:	0.05	2.1	3.9	0.7	1.2	1.9	1.9
		n:	10	10	10	10	10	10	10

b. Linearity/assay reportable range:

The summary statistics for the whole blood linearity data set are tabulated as follows:

	Test range	Units	Slope	Intercept	R ²
pH	6.4-7.9	pH units	1.021	-0.15	0.998
pCO ₂	10-230	mm Hg	1.058	-3.6	0.998
pO ₂	10-750	mm Hg	1.022	-3.9	0.999
K	1.5-12	mmol/L	1.006	0.03	0.999
Na	80-190	Mmol/L	0.973	3.8	0.999
iCa	0.6-3.7	Mmol/L	1.017	-0.01	0.998
Hct	0-75	% PCV	1.005	-0.58	0.999

c. *Traceability, Stability, Expected values (controls, calibrators, or methods):*

Calibration of the EPOC system is performed using both primary and secondary NIST traceable standards.

For calibration of blood gases multiple blood samples are obtained. These are prepared by tonometry to various analytical levels spanning the reportable range. To establish proper calibration for gases, the analytical values from the EPOC system are compared with both the tonometry value (using gas compositions traceable to NIST standards) and the value obtained from two commercially available blood gas and electrolyte instruments in routine use in the clinical laboratory. Each instrument itself is calibrated with NIST traceable gas mixtures.

d. *Detection limit:*

The detection limit is defined as the lower limit of the linearity.

e. *Analytical specificity:*

Interference testing was performed to demonstrate the specificity of the EPOC measurements.

The following protocol was used. A normal whole blood sample (collected into a heparinized green top vacuum collection tube) was divided into two equal volume aliquots, each aliquot then spun down. A spiking solution of the test interference was prepared in aqueous solution and added into the plasma of the first aliquot, at 25µL of spiking solution per mL of plasma. The second plasma aliquot was spiked with the aqueous spiking solution containing no test interference (blank control), also at 25µL per mL of plasma. The concentration of the test interference in the spiking solution was calculated to achieve the desired test level when diluted into the plasma. After spiking, the plasma and blood cells were reconstituted. In some cases where the test interference was only sparingly soluble in aqueous solution or where it was slow to fully dissolve, ethanol spike solutions instead of aqueous were used. Interference test levels were those recommended by the CLSI guideline (CLSI EP7-A).

The applicant measured the spiked blood and the blank on the EPOC system, each plasma sample measured six times, as well as on an in-house reference

instrument. In most cases six replicates was sufficient to resolve the bias. Where resolution was insufficient replicates were added. Two EPOC readers were used. In the first round the applicant measured A (the test blood) on reader 1 and B (the blank) on reader 2 at the same time, and A then B on the reference instrument also at the same time. In the second round the applicant measured B on reader 1 and A on reader 2 and B then A on the reference instrument, all at the same time. Six rounds in total were performed, reversing the AB order in each round. The applicant computed the bias between test and blank as the mean of each AB difference from the six rounds. If the AB difference was systematically changing from round to round (because the analyte value was changing over time differently in the test blood and the control, the applicant computed the difference between the EPOC AB pairs and the AB pairs from the reference instrument for each round.

In most cases the interference could be established directly from the test minus control result. In some cases where the addition caused changes in both test and control that were in addition to interference effects, or where the samples were unstable over time, the applicant computed the test minus control versus the test minus control for a reference instrument known not to have an interference, then compared the result against the reference instrument result as the control and used that value.

The table below shows the random error, RE, of each method, expressed either as a standard deviation or a coefficient of variation (CV%). $SD_{diff} = 1.4RE$ is the standard deviation of the difference between a pair of measurements. The 95% confidence limit of the mean difference of 6 replicates is given by $2SD_{diff} / \sqrt{6}$. This is the value of measured bias due to interference, b, which can be resolved as being different from zero with 95% confidence. b/TE is the resolvable bias expressed as a fraction of the total allowable error. $SEc = TE - 1.65RE$ is the critical systematic error which results in a medically significant error more than 5% of the time. SEc/TE is the critical systematic error expressed as a fraction of the total allowable error.

	pH	pCO ₂	pO ₂	K	Na	iCa	Hct
TE	0.04	8%	10%	0.5	4	5%	2.0% PCV
RE	0.007	2.2%	3.5%	0.04	0.95	1.35%	0.7% PCV
SD _{diff}	0.01	3.9%	4.9%	0.06	1.3	2.1%	1.0% PCV
95% confidence	0.008	3.1%	3.9%	0.05	1.1	1.7%	0.8% PCV
b/TE	0.2	0.4	0.39	0.1	0.27	0.34	0.4
Sec	0.023	3.3%	5.0%	0.43	2.43	2.5%	0.85% PCV
SEc/TE	0.6	0.41	0.48	0.87	0.61	0.5	0.42

The interference test data are shown in tabulated form below. For each tested interference there is an entry showing the concentration of test interference and the result of the mean difference between the blood with interference and

the blank blood, expressed in multiples of the total allowable error (except where the interference is entered at %, in which case the value is percent bias).

Exogenous Interference	Level	Mean(Test result - blank control)/TE						
		pH	pCO ₂	pO ₂	K	Na	iCa	Hct
Ethanol	447 mg/dL	-0.4	-0.2	0.0	+0.1	+0.1	0.0	+0.3
Sodium pentothal	1 mmol/L	0.0	+0.1	-0.2	+0.1	+0.2	-0.4	+0.1
Acetyl salicylate	4.3 mmol/L	0.0	-0.1	-0.1	0.0	0.0	-0.4	+0.2
Ascorbate	0.4 mmol/L	+0.1	-0.3	+0.2	0.0	0.0	0.0	+0.1
Salicylate	4.3 mmol/L	+0.3	0.0	-0.2	+0.1	0.0	-0.4	-0.1
Bromide	18 mmol/L	-0.6	+7%	+0.3	+0.1	+0.3	+0.3	-0.3
Bromide	37.5 mmol/L	-1.2	+13%	+0.0	+0.2	+0.6	+0.9	X
Iodide	1 mmol/L	-0.5	5%	-0.1	+0.0	+0.1	+0.3	-0.1
Iodide	3 mmol/L	-1.2	11%	-0.2	+0.2	+0.0	+0.3	X
Ibuprofen	2.2 mmol/L	-0.3	+0.1	-0.1	0.0	-0.1	-0.3	+0.1
Tylenol	1.66 mmol/L	0.0	-0.1	0.0	0.0	0.0	0.0	X
Ammonium	2 mmol/L	+0.1	-0.2	-0.1	0.0	0.0	-0.1	X
Lithium	4 mmol/L	-0.1	-0.1	0.0	+0.1	0.0	+0.1	-0.1
Halothane	2.7%	X	X	0.0	X	X	X	X

Endogenous interference	Level	Mean(Test result - blank control)/TE						
		pH	pCO ₂	pO ₂	K	Na	iCa	Hct
NaCl	20 mmol/L	-0.3	+0.1	-0.1	+0.1	X	+0.1	X
KCl	8 mmol/L	+0.2	0.0	0.0	X	+0.1	-0.4	X
CaCl ₂	3 mmol/L	+0.1	+0.3	-0.3	+0.1	+0.4	X	X
pH	+/-0.4 pH	X	X	0.0	0.0	+0.1	-/+0.3	X
pCO ₂	-/+60 mm Hg							
Bicarbonate	20 mmol/L	+0.5	+0.3	-0.3	0.1	+0.1	+0.1	X
Lactate	10 mmol/L	+0.2	+0.1	+0.0	-0.1	-0.3	-0.3	X
Hct	+20% PCV		-0.1	+0.1	0.0	-0.5	-0.5	X
Total Protein	+3 g/dL	-0.1	-0.1	+0.1	-0.1	-0.5	-0.5	+0.8
Lipids	0.8%	+0.0	+0.2	+0.1	+0.1	+0.0	+0.2	+0.1
Cholesterol	9.1 mmol/L	0.0	+0.1	0.0	0.0	0.0	0.0	+0.3
Hydroxy butyrate	20 mmol/L	+0.4	-0.2	+0.1	-0.1	-0.7	-0.6	-0.7
Cysteine	1 mmol/L	-0.2	+0.2	0.0	0.0	0.0	0.0	-0.1
Bilirubin	0.26 mmol/L	+0.1	+0.2	-0.1	0.0	+0.1	-0.2	+0.1
NH ₄	2 mmol/L	-0.3	-0.3	+0.5	-0.1	0.0	-0.1	-0.1
Phosphate	2 mmol/L	X	X	X	-0.1	0.0	-0.5	-0.3

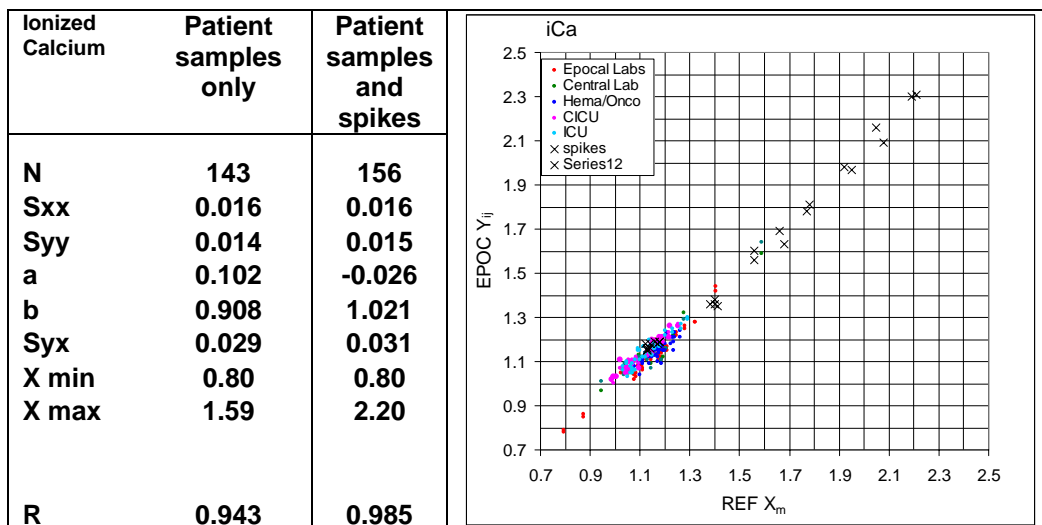
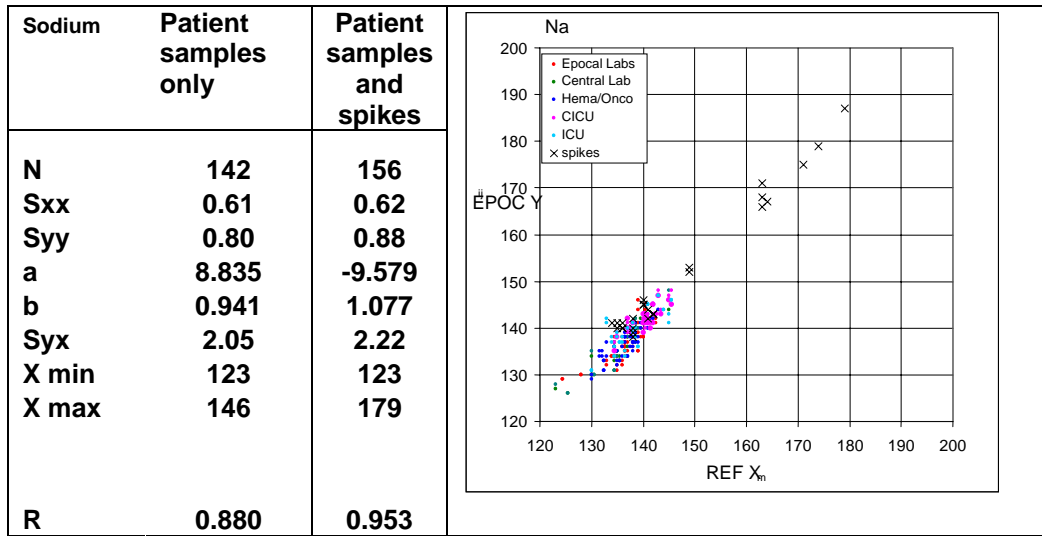
f. Assay cut-off:
Not Applicable

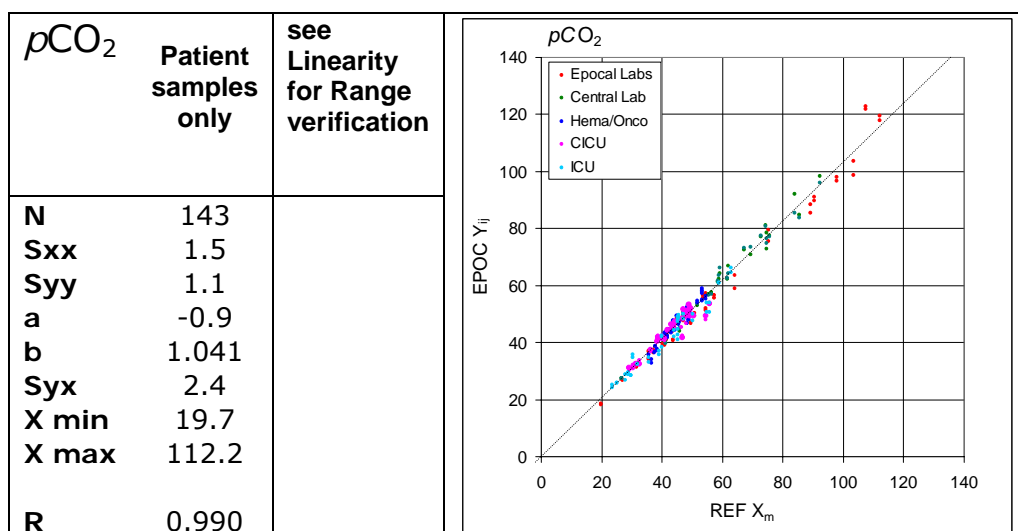
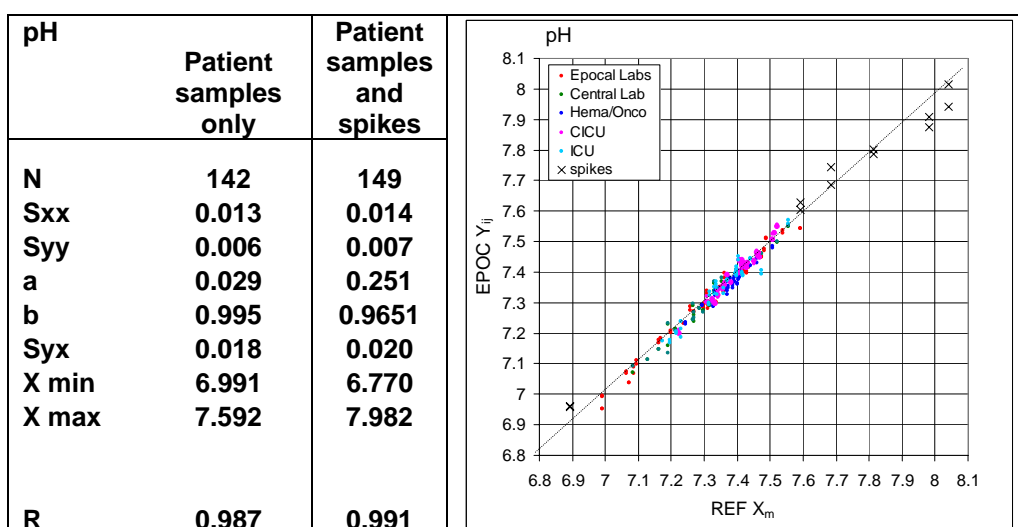
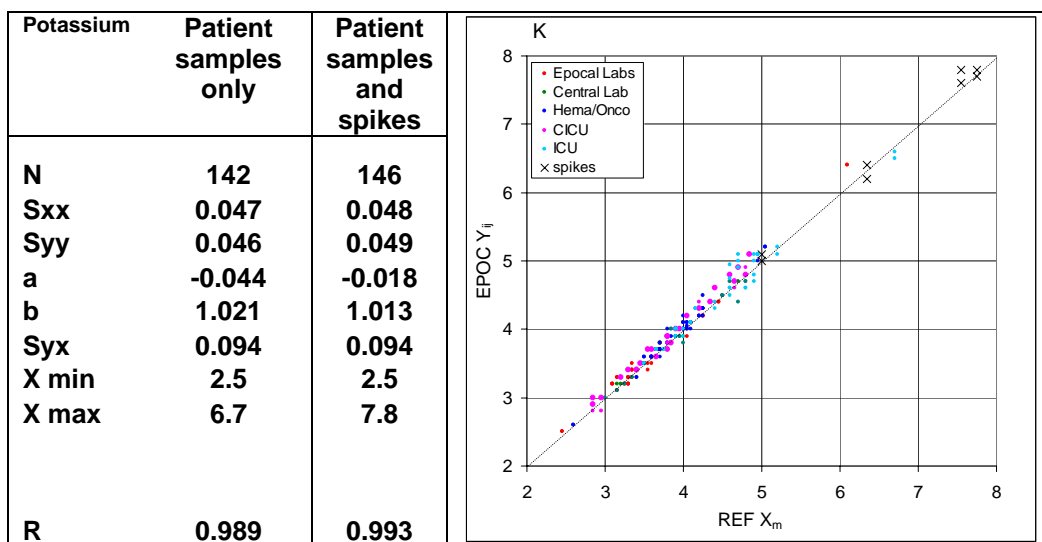
2. Comparison studies:

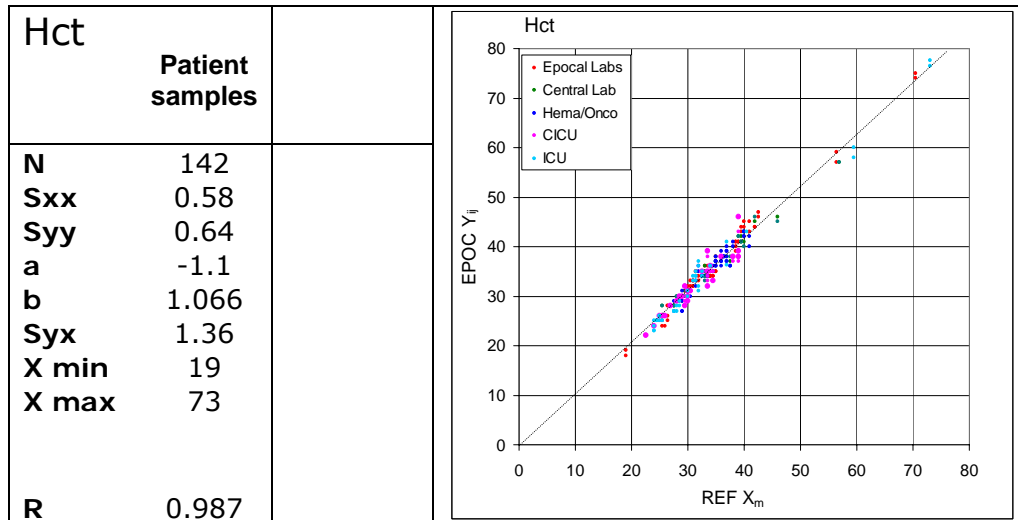
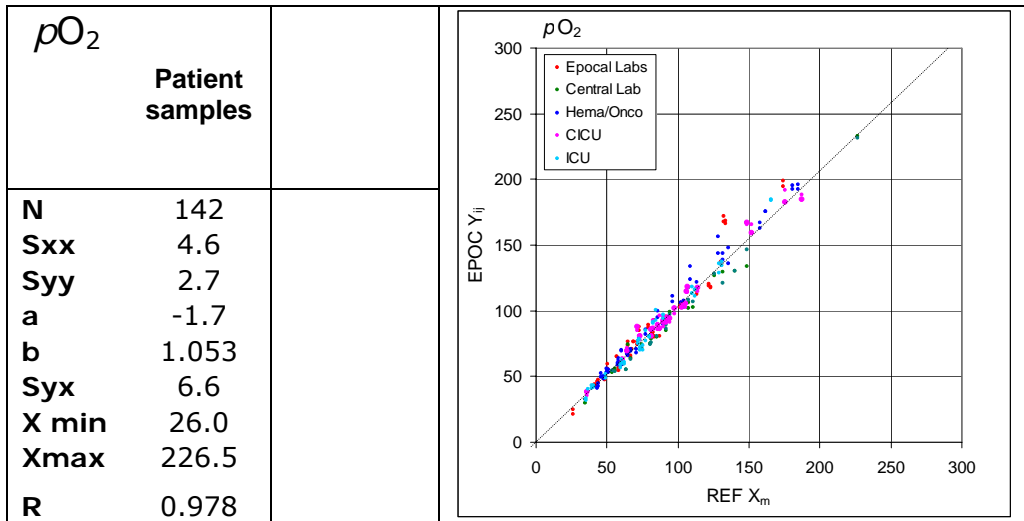
a. Method comparison with predicate device:

Method comparison to the predicate device was conducted with patient samples where possible. In the laboratory phase of the clinical trial at the hospital site, additional data were collected on patient samples spiked with sodium and calcium. Spiked samples were used for range testing of the EPOC device to validate that the EPOC sensors were operating to specification across a larger data range than is usually encountered in clinical trials for

sodium and calcium These analytes, in particular sodium, exhibit a narrow range in patient samples, even in large studies with over 100 patient samples. To obtain $R > 0.9$ in method comparison studies the patient data were supplemented with spiked samples. Additionally some method comparison data on samples with potassium and pH spikes were added. Samples for range-testing were whole blood specimens collected in green top vacuum collection tubes with normal range values for these analytes, which were then adjusted to elevated calcium, sodium and potassium values by spiking with the chloride salts of those ions, and elevated pH by spiking with NaOH.







b. Matrix comparison:

Matrix comparison testing was performed. The results are organized by analyte and by sample type (heparinized whole blood samples versus non-heparinized whole blood).

	Heparinized	Non-heparinized	All
pH			
N	93	49	142
Sxx	0.013	0.013	0.013
Syy	0.006	0.007	0.006
a	0.171	-0.320	0.029
b	0.975	1.043	0.995
Syx	0.017	0.019	0.018
X min	6.991	7.174	6.991
X max	7.592	7.557	7.592

	Heparinized	Non-heparinized	All
R	0.989	0.977	0.987
pCO2			
N	93	50	143
Sxx	1.4	1.6	1.5
Syy	1.1	1.1	1.1
a	-1.3	2.3	-0.9
b	1.051	0.962	1.041
Syx	2.4	2.4	2.4
X min	19.7	23.6	19.7
X max	112.2	63.0	112.2
R	0.992	0.967	0.990
pO2			
N	92	50	142
Sxx	3.3	6.3	4.6
Syy	2.7	2.7	2.7
a	-1.7	-1.7	-1.7
b	1.050	1.063	1.053
Syx	7.5	4.6	6.6
X min	26.0	35.5	26.0
X max	226.5	187.5	226.5
R	0.978	0.992	0.978
K			
N	93	49	142
Sxx	0.046	0.049	0.047
Syy	0.046	0.045	0.046
a	-0.144	0.100	-0.044
b	1.046	0.987	1.021
Syx	0.085	0.105	0.094
X min	2.5	2.9	2.5
X max	6.1	6.7	6.7
R	0.989	0.989	0.989
Na			
N	93	49	142
Sxx	0.64	0.55	0.61
Syy	0.81	0.80	0.80
a	13.7	26.5	8.8
b	0.902	0.821	0.941
Syx	1.96	1.90	2.05
X min	123	130	123
X max	145	146	146
R	0.876	0.837	0.880
iCa			
N	93	50	143
Sxx	0.016	0.015	0.016
Syy	0.014	0.015	0.014
a	0.034	0.111	0.102

	Heparinized	Non-heparinized	All
b	0.958	0.918	0.908
Syx	0.026	0.020	0.029
X min	0.8	1.0	0.8
X max	1.6	1.3	1.6
R	0.960	0.962	0.943
Hct			
N	92	50	142
Sxx	0.53	0.68	0.58
Syy	0.61	0.68	0.64
a	-0.989	-0.512	-1.1
b	1.067	1.041	1.066
Syx	1.18	1.64	1.36
X min	19	23	19
X max	73	60	73
R	0.991	0.968	0.987

3. Clinical studies:

a. *Clinical Sensitivity:*

Not Applicable

b. *Clinical specificity:*

Not Applicable

c. Other clinical supportive data (when a. and b. are not applicable):

Not Applicable

4. Clinical cut-off:

Not Applicable

5. Expected values/Reference range:

Literature references are provided in the labeling.

N. Instrument Name:

EPOC Blood Analysis System

O. System Descriptions:

1. Modes of Operation:

Single sample mode of operation for sample reader, Host Personal Digital Assistant (PDA) can link to up to seven readers and actively control up to 4 readers in the analysis mode.

2. Software:

FDA has reviewed applicant's Hazard Analysis and software development processes for this line of product types:

Yes X or No

3. Specimen Identification:

Hand entry or Bar-Code

4. Specimen Sampling and Handling:

Single sample using syringe

5. Calibration:

Unitized calibrator fluid

6. Quality Control:

Internal Quality control and recommendation of commercially available external quality control material

P. Other Supportive Instrument Performance Characteristics Data Not Covered In The "Performance Characteristics" Section above:

Q. Proposed Labeling:

The labeling is sufficient and satisfies the requirements of 21 CFR Part 809.10.

R. Conclusion:

The submitted information in this premarket notification is complete and supports a substantial equivalence decision.