

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

A. 510(k) Number:

k070524

B. Purpose for Submission:

New Device

C. Measurand:

Glucose

D. Type of Test:

Quantitative (Glucose Dehydrogenase)

E. Applicant:

Cambridge Sensors Limited

F. Proprietary and Established Names:

Microdot Blood Glucose Monitoring System

G. Regulatory Information:

1. Regulation section:

21 CFR 862.1345 Glucose Test System

21 CFR 862.1660 Quality Control Material (assayed and unassayed)

2. Classification:

Class II, Class I (reserved)

3. Product code:

NBW – Blood glucose test system, over the counter

LFR – Glucose dehydrogenase, glucose

JJX – Single (specified) analyte controls (assayed and unassayed)

4. Panel:

75, Clinical Chemistry

H. Intended Use:

1. Intended use(s):

See indications for use below

2. Indication(s) for use:

microdot Blood Glucose Monitoring System

The microdot Blood Glucose Monitoring System is intended for self testing of glucose in capillary whole blood by persons with diabetes or by health care professionals in home settings or healthcare facilities. It is intended for monitoring of blood glucose levels only.

microdot Blood Glucose Meter

The microdot Blood Glucose Meter is intended for the quantitative measurement of glucose in fresh capillary whole blood from a fingerstick. It is intended for use by persons with diabetes or by health care professionals in home settings or healthcare facilities. It is intended for monitoring of blood glucose levels only.

microdot Test Strips

The microdot® Test Strips are intended for the quantitative measurement of glucose in fresh capillary whole blood from a fingerstick. It is intended for use by persons with diabetes or by health care professionals in home settings or healthcare facilities. It is intended for monitoring of blood glucose levels only.

microdot Control solutions

The microdot® Control solutions are intended for use with microdot® Blood Glucose Meter and microdot® Test Strips as a quality control check to verify the accuracy of the blood glucose test results.

microdot® Blood Glucose Monitoring System is intended for over the counter use.

3. Special conditions for use statement(s):

For over-the-counter use. Not for use with newborn patients.

4. Special instrument requirements:

Microdot blood glucose monitor

I. Device Description:

The microdot Blood Glucose Monitoring System consists of the microdot Blood Glucose Meter, microdot Test Strips, microdot Control Solutions and a commercially available lancing device and lancets.

Each lot of test strips is calibrated to give plasma equivalent glucose readings. The calibration code is printed on the vial of strips and is entered into the meter manually by using the meter buttons. The meter is turned on by strip insertion, the user applies a drop of blood or control solution to the test strip and the meter starts the measurement. After 10 seconds, the meter displays the glucose concentration and time and date on the LCD display.

J. Substantial Equivalence Information:

1. Predicate device name(s):

One Touch Ultra blood glucose monitoring system

Senova Blood Glucose monitoring system

Senova control solutions

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

k002134

k032076

k032819

3. Comparison with predicate:

Similarities			
Item	Device (Microdot)	Predicate (One Touch Ultra)	Predicate (SeNova)
Sample	Fresh Capillary whole blood	Fresh Capillary whole blood	Fresh Capillary whole blood
Calibration	Plasma	Plasma	Plasma

Similarities			
Item	Device (Microdot)	Predicate (One Touch Ultra)	Predicate (SeNova)
	equivalent	equivalent	equivalent
Sample volume	600 nanoliters	At least 1 microliter	600 nanoliters
Control Solutions	3 levels	1 level	3 levels

Differences			
Item	Device (Microdot)	Predicate (One Touch Ultra)	Predicate (SeNova)
Test range	20-525 mg/dL	20-600 mg/dL	20-600 mg/dL
Test time	10 seconds	5 seconds	10 seconds
Hematocrit Range	30-50%	30-55%	20-60%

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

CLSI Guideline EP 5-A - Evaluation of Precision Performance of Clinical Chemistry devices

CLSI Guideline EP6-A – Evaluation of the linearity of Quantitative Analytical Methods

CLSI Guideline EP7-A – Interference testing in Clinical Chemistry

CLSI Guideline EP9-A – Method comparison and Bias Estimation Using Patient Samples

ISO15197 in vitro diagnostic test systems- requirements for blood-glucose monitoring systems for self testing in managing diabetes mellitus

L. Test Principle:

The test is base on the enzymatic conversion of glucose. Glucose dehydrogenase converts glucose in the sample to gluconolactone, with concomitant reduction of the enzyme cofactor NAD⁺ to NADH. The NADH is re-oxidised to NAD⁺ by the mediator compound which in turn becomes reduced; re-oxidation of the mediator by the meter induces a micro current to flow, and the size of this micro current is directly proportional to the amount of glucose in the sample.

M. Performance Characteristics (if/when applicable):

1. Analytical performance:

a. *Precision/Reproducibility:*

Within-run precision was tested with two test strip lots within one day. Whole blood

was spiked with glucose to achieve 5 levels of glucose concentration. The low glucose concentration was obtained by allowing the whole blood to glycolyse until the required concentration was reached. Twenty replicate glucose measurements were carried out for each concentration in one day. Results are summarized in the table below.

Summary of results for within run Precision / mg/dL						
Strip Lot no	YSI 2300:	296 mg/dL	197 mg/dL	124 mg/dL	81 mg/dL	43 mg/dL
CSL-5B2301	Mean/mg/dL	297	189	121	78	46
	Std Dev	11.03	7.93	3.89	3.21	2.66
	%CV	3.71	4.20	3.23	4.13	5.74
CSL-5E1801	Mean/mg/dL	285	189	120	81	49
	Std Dev	8.26	5.51	3.98	3.23	2.67
	%CV	2.90	2.91	3.31	4.01	5.48

Between-run precision studies were carried out on control solutions at 3 glucose concentration levels. Ten meters were used and one strip was tested for each level on each meter daily for 10 days. The results are summarized in the table below.

Summary of results for between run Precision / mg/dL			
Strip Lot No CSL - 5L1901			
Control solution	Mean	St Dev	%CV
Low	45	2.45	5.42
Normal	117	5.78	4.96
High	371	18.12	4.89

b. Linearity/assay reportable range:

The reportable range of the assay is from 20 mg/dL to 525 mg/dL. The linearity study measured spiked whole blood samples with the microdot device using two test strip batches and the YSI analyzer. A linear regression was performed resulting in a slope of 0.946 ($r^2 = 0.997$) for batch 5L1091 and a slope of 0.940 ($r^2 = 0.994$) for batch 5L2001. Additional samples were performed in a second study to verify performance at concentrations down to 20 mg/dL and showed no bias between the microdot device and the YSI analyzer results.

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

The control solutions are prepared at three target concentrations by gravimetric addition of glucose to an aqueous matrix. The glucose concentration of the control solutions are verified with the YSI reference method.

Expected values for the control solutions are verified for each manufactured lot of strips.

Shelf life studies show that the unopened test strips have a 24 month life-span and 3 months shelf-life once a vial of strips is opened. Unopened controls have a 24-month shelf life and are stable for 3 months after first use.

d. Detection limit:

The detection limit is 20 mg/dL. Measurement of samples down to 20 mg/dL showed no bias between the microdot device and the YSI analyzer results. See linearity/assay reportable range section above.

e. Analytical specificity:

Effect of hematocrit over the range of 30 to 50% was tested at nominal glucose concentrations of 30, 60, 150, and 400 mg/dL. Testing was performed with two strip batches and each sample was measured n=6 with each test strip batch and compared to the YSI value for the samples (YSI showed no bias due to hematocrit). The results are summarized below:

Hematocrit Interference results

Nominal Sample Hematocrit % Mean YSI/mg/dL	30 mg/dL			40			51		
	microdot	Bias / mg/dL	ABS	microdot	Bias / mg/dL	ABS	microdot	Bias / mg/dL	ABS
36				36			35		
Reading 1	39	3	3	33	-3	3	29	-6	6
2	36	0	0	35	-1	1	27	-8	8
3	36	0	0	32	-4	4	31	-4	4
4	40	4	4	31	-5	5	32	-3	3
5	35	-1	1	32	-4	4	34	-1	1
6	37	1	1	30	-6	6	28	-7	7
Mean	37.17	1.17	1.50	32.17	-3.83	3.83	30.17	-4.83	4.83
Std Dev	1.94			1.72			2.64		
%CV	5.22			5.35			8.75		

Nominal Sample Hematocrit % Mean YSI/mg/dL	60 mg/dL			41			51		
	microdot	Bias mg/dL	ABS	microdot	Bias mg/dL	ABS	microdot	Bias mg/dL	ABS
Reading 1	67	7	7	61	1	1	56	-3	3
2	65	5	5	61	1	1	57	-2	2
3	64	4	4	60	0	0	55	-4	4
4	66	6	6	61	1	1	57	-2	2
5	63	3	3	60	0	0	53	-6	6
6	64	4	4	60	0	0	54	-5	5
Mean	64.83	4.83	4.83	60.5	0.5	0.5	55.33	-3.67	3.67
Std Dev	1.47			0.55			1.63		
%CV	2.27			0.91			2.95		

Nominal Sample Hematocrit % Mean YSI/mg/dL	150 mg/dL			40			50		
	microdot	Bias %	ABS	microdot	Bias %	ABS	microdot	Bias %	ABS
Reading 1	174	7.41	7.41	159	-1.85	1.85	142	-11.80	11.80
2	165	1.85	1.85	159	-1.85	1.85	140	-13.04	13.04
3	191	17.90	17.90	166	2.47	2.47	141	-12.42	12.42
4	181	11.73	11.73	151	-6.79	6.79	136	-15.53	15.53
5	178	9.88	9.88	149	-8.02	8.02	142	-11.80	11.80
6	173	6.79	6.79	162	0	0	134	-16.77	16.77
Mean	177	9.26	9.26	157.67	-2.67	3.5	139.17	-13.56	13.56
Std Dev	8.74			6.5			3.37		
%CV	4.94			4.12			2.42		

Nominal Sample	400 mg/dL								
Hematocrit %	30			40			50		
Mean YSI/mg/dL	303			405			399		
	microdot	Bias %	ABS	microdot	Bias %	ABS	microdot	Bias %	ABS
Reading 1	355	17.16	17.16	424	4.69	4.69	395	-1.00	1.00
2	345	13.86	13.86	417	2.96	2.96	348	12.78	12.78
3	323	6.60	6.60	445	9.88	9.88	369	-7.52	7.52
4	317	4.62	4.62	439	8.40	8.40	367	-8.02	8.02
5	340	12.21	12.21	426	5.19	5.19	373	-6.52	6.52
6	354	16.83	16.83	410	1.23	1.23	378	-5.26	5.26
Mean	339	11.88	11.88	426.83	5.39	5.39	371.67	-6.85	6.85
Std Dev	15.86			13.17			15.33		
%CV	4.68			3.08			4.13		

Common interferences were evaluated by spiking venous blood with glucose to two concentrations. Each of these glucose concentrations was then spiked with the interfering compound at two concentrations to make the interference samples. Control samples were each spiked with the solvents used to make the interfering samples. No Interference effects were observed from the common interfering compounds shown below. No interference was defined as a bias of $\geq 15\%$ between the interfering sample and the control sample.

Acetaminophen- up to 20 mg/dL

Ascorbic acid – up to 3 mg/dL

Dopamine – up to 13 mg/dL

Triglycerides- up to 3000 mg/dL

Cholesterol – up to 500 mg/dL

Bilirubin – up to 20 mg/dL

Uric acid – up to 20 mg/dL

Tolbutamide – up to 100 mg/dL

L-Dopa – up to 5 mg/dL

The microdot Blood Glucose Monitoring System was not tested at altitudes above sea level. Temperature and humidity studies were performed and showed that the device can be used from 10°C to 40°C and from 10% to 90% relative humidity.

f. Assay cut-off:

Not applicable

2. Comparison studies:

a. *Method comparison with predicate device:*

The method comparison study was performed with 121 capillary fingerstick patient samples. In order to fully cover the measuring range, 19 of the samples were spiked with glucose or allowed to glycolyze. The samples ranged in concentration from 36 to 473 mg/dL on the microdot device and met the ISO 15197 sample distribution requirements. Samples were measured in singlicate on the microdot meter and in duplicate on the YSI analyzer. An analysis of the results calculated a slope of 1.006, an intercept of 0.778, and an R^2 value of 0.9644. In addition, 98% of the results were within the ISO 15197:2003 accuracy criteria of 95% of samples with ± 15 mg/dL bias for glucose samples ≤ 75 mg/dL and $\pm 20\%$ bias for glucose samples > 75 mg/dL.

System accuracy results for glucose concentrations < 75 mg/dL

Within ± 5 mg/dL	Within ± 10 mg/dL	Within ± 15 mg/dL
17/20 (85%)	20/20 (100%)	20/20 (100%)

System accuracy results for glucose concentrations ≥ 75 mg/dL

Within $\pm 5\%$	Within $\pm 10\%$	Within $\pm 15\%$	Within $\pm 20\%$
40/101 (46%)	75/101 (74%)	92/101 (91%)	98/101 (97%)

b. *Matrix comparison:*

Not applicable

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:

The expected blood glucose values for people without diabetes¹:

<u>Time</u>	<u>Range, mg/dL</u>
Before meals	70-105
1 hour after meals	less than 160
2 hours after meals	less than 120
Between 2 and 4 AM	greater than 70

¹Krall, L.P., and Beaser, R.S.: Joslin Diabetes Manual, Philadelphia: Lea and Febiger (1989), 138

N. Instrument Name:

Microdot Blood Glucose Meter

O. System Descriptions:

1. Modes of Operation:

Each test strip is single use and must be replaced with a new strip for each additional reading.

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:

There is no sample identification function with this device. Samples are applied directly to the test strip as they are collected.

4. Specimen Sampling and Handling:

This device is intended to be used with capillary whole blood from the finger only. Since the whole blood sample is applied directly to the test strip, there are no special handling or storage issues.

5. Calibration:

The meter automatically detects the code number when a test strip is inserted. The user must check to see if the code number the meter displays matches the number on the test strip vial. If the number matches, the user is instructed to begin testing. If the number does not match, or if no number appears, the user is instructed how to manually enter the correct code number. No other calibration is required from the user.

6. Quality Control:

One control level is provided with the device. Two additional control levels are available from authorized distributors. The user is instructed to run controls when the meter is first used in order to verify that they can use the meter correctly. In addition they are instructed to run a control when a new vial of test strips is opened, at least once a week, when they suspect the meter or strips are not working correctly, when test results are not consistent with the patient's symptoms or the patient does not think the results are accurate, or if the meter is dropped. The acceptable results ranges are shown on the test strip vial label. If the results are outside the expected range, the user is instructed to repeat the test. If the results continue to fall outside the expected range, the user is instructed to call customer service.

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

Not applicable

Q. Proposed Labeling:

The labeling is sufficient and it 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.