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

I Background Information:

A 510(k) Number

K222447

B Applicant

Abbott Diabetes Care Inc.

C Proprietary and Established Names

FreeStyle Libre 2 Flash Glucose Monitoring System, FreeStyle Libre 3 Continuous Glucose Monitoring System

D Regulatory Information

Product Code(s)	Classification	Regulation Section	Panel
QBJ	Class II	21 CFR 862.1355 - Integrated Continuous Glucose Monitoring System	CH - Clinical Chemistry
NBW	Class II	21 CFR 862.1345 - Glucose test system	CH - Clinical Chemistry

II Submission/Device Overview:

A Purpose for Submission:

Modification to the sensor tail to reduce interference from ascorbic acid and to remove the contraindication against the use with automated insulin dosing (AID) systems.

B Measurand:

Blood glucose from interstitial fluid.

C Type of Test:

Quantitative, amperometric assay (Glucose Oxidase).

III Intended Use/Indications for Use:

A Intended Use(s):

See Indications for Use below.

B Indication(s) for Use:

FreeStyle Libre 2 Flash Glucose Monitoring System

The FreeStyle Libre 2 Flash Glucose Monitoring System is a continuous glucose monitoring (CGM) device with real time alarms capability indicated for the management of diabetes in persons age 2 and older. It is intended to replace blood glucose testing for diabetes treatment decisions, unless otherwise indicated.

The System also detects trends and tracks patterns and aids in the detection of episodes of hyperglycemia and hypoglycemia, facilitating both acute and long-term therapy adjustments. Interpretation of the System readings should be based on the glucose trends and several sequential readings over time.

The System is also intended to autonomously communicate with digitally connected devices, including automated insulin dosing (AID) systems. The System can be used alone or in conjunction with these digitally connected devices for the purpose of managing diabetes.

FreeStyle Libre 3 Continuous Glucose Monitoring System

The FreeStyle Libre 3 Continuous Glucose Monitoring System is a real time continuous glucose monitoring (CGM) device with alarms capability indicated for the management of diabetes in persons age 2 and older. It is intended to replace blood glucose testing for diabetes treatment decisions, unless otherwise indicated.

The System also detects trends and tracks patterns and aids in the detection of episodes of hyperglycemia and hypoglycemia, facilitating both acute and long-term therapy adjustments. Interpretation of the System readings should be based on the glucose trends and several sequential readings over time.

The System is also intended to autonomously communicate with digitally connected devices, including automated insulin dosing (AID) systems. The System can be used alone or in conjunction with these digitally connected devices for the purpose of managing diabetes.

C Contraindications

MRI/CT/Diathermy: The System must be removed prior to Magnetic Resonance Imaging (MRI), Computed Tomography (CT) scan, or high-frequency electrical heat (diathermy) treatment. The effect of MRI, CT scans, or diathermy on the performance of the System has not been evaluated. The exposure may damage the Sensor and may impact proper function of the device which could cause incorrect readings.

D Special Conditions for Use Statement(s):

Rx - For Prescription Use Only

The following special conditions for use statements apply to both the FreeStyle Libre 2 Flash Glucose Monitoring System and the FreeStyle Libre 3 Continuous Glucose Monitoring System:

- Do not use the System if you are on dialysis or critically ill. The System is not cleared for use in these groups and it is not known how different conditions or medications common to these populations may affect performance of the System.
- Do not ignore symptoms that may be due to low or high blood glucose: If you are experiencing symptoms that are not consistent with your glucose readings, consult your health care professional.
- Do not use the System in people less than 2 years of age. The System is not cleared for use in people under 2 years of age.
- The system is intended for use by a single person. It must not be used by more than one person due to the risk of misinterpreting glucose information.
- Use your blood glucose meter to make diabetes treatment decisions when you see the "check blood glucose" symbol during the first 12 hours of wearing a Sensor. In addition, use your blood glucose meter to make diabetes treatment decisions, if your Sensor glucose reading does not match how you feel, or if the reading does not include a number.
- Store the Sensor Kit between 36 °F and 82 °F. Storage outside of this range may cause inaccurate Sensor glucose readings. If you suspect that the temperature may exceed 82 °F (for example, in an un-airconditioned home in summer), you should refrigerate your Sensor Kit. Do not freeze your Sensor Kit.
- Use of the Sensor with devices, apps, and software that are not listed (as compatible) may cause inaccurate glucose readings.
- Do not force close the App. The App must be running in the background to receive alarms. If you force close the App you will not receive alarms. Re-open the App to ensure you will receive alarms.

The following special conditions for use statements apply to the FreeStyle Libre 2 Flash Glucose Monitoring System only:

- You must scan the Sensor to get your real-time current glucose level as both the Reader and App will not provide this information without a scan.
- For you to receive alarms, they must be on and your Reader should be within 20 feet of you at all times. The transmission range is 20 feet unobstructed. If you are out of range, you may not receive glucose alarms.
- To prevent missed alarms, make sure the Reader has sufficient charge and that sound and/or vibration are turned on.
- The Reader is for use by a single person. It must not be used on more than one person including other family members due to the risk of spreading infection. All parts of the Reader are considered biohazardous and can potentially transmit infectious diseases, even after performing the cleaning and disinfection procedure.
- The Reader is not intended for use with multiple patients in health care or assisted-use settings such as hospitals, physician offices, or long-term care facilities because it has not been cleared by FDA for use in these settings, including for routine assisted testing or as part of glycemic control procedures. Use of this device on multiple patients may lead to transmission of Human Immunodeficiency Virus (HIV), Hepatitis C Virus (HCV), Hepatitis B Virus (HBV), or other bloodborne pathogens.

The following special conditions for use statements apply to the FreeStyle Libre 3 Continuous Glucose Monitoring System only:

- For you to receive alarms, your phone should be within 33 feet of you at all times. The transmission range is 33 feet unobstructed. If you are out of range, you may not receive alarms. If you want to receive the App's optional alarms, make sure these are turned on.

E Special Instrument Requirements:

Not applicable

IV Device/System Characteristics:

A Device Description:

The subject devices are the FreeStyle Libre 2 (FSL2) Flash Glucose Monitoring System and the FreeStyle Libre 3 (FSL3) Continuous Glucose Monitoring System with a modified sensor tail design, henceforth also referred to as 'modified FSL2 System' and 'modified FSL3 System'. The subject devices include a modified subcutaneously inserted sensor tail of the previously cleared systems to reduce ascorbic acid (vitamin C) interference. The subject devices are also compatible with the Libre Data Sharing API cleared in K223537.

FreeStyle Libre 2 Flash Glucose Monitoring System

The FreeStyle Libre 2 (FSL2) Flash Glucose Monitoring System with a modified sensor tail design, henceforth also referred to as 'modified FSL2 System', is an integrated continuous glucose monitoring (iCGM) systems that perform continuous glucose measurements every minute to provide glucose levels, trends, and real-time alarms capability to aid in the management of diabetes. The modified FSL2 System requires a prescription, is intended for home use, and consists of the following components:

FreeStyle Libre 2 Sensor

- The Sensor is single use, disposable, and powered by a silver oxide battery. The Sensor continuously measures glucose concentration in interstitial fluid and has an 8-hour memory capacity. The Sensor is factory calibrated, does not require fingerstick calibration, and can be worn for up to 15 days.

FreeStyle Libre 2 Reader

- The Reader is a small handheld device that uses near field communication (NFC) to start new Sensors and to scan Sensors to display and record data. The Reader uses Bluetooth low energy (BLE) communication to issue alarms that notify the user to scan his/her sensor when glucose values pass a high or low glucose threshold. The Reader also has a built-in strip port with blood glucose functionality (that is intended to work with the FreeStyle Precision Neo Blood Glucose test strips, cleared under K171941), and a user interface that includes event logging features.

FreeStyle Libre 2 App (iOS and Android)

- When downloaded to a compatible smartphone, the App uses NFC communication to start new Sensors and to scan Sensors to display and record data and uses BLE communication to issue alarms. The FreeStyle Libre 2 App allows connectivity with

cloud-based applications. The FreeStyle Libre 2 App is an alternative primary display for the System and does not interact with the Reader. The FreeStyle Libre 2 App is distributed using the Apple App Store and Google Play Store, and a list of compatible devices is accessible in the App via the Help feature or product website.

FreeStyle Libre 3 Continuous Glucose Monitoring System

The FreeStyle Libre 3 (FSL3) Glucose Monitoring System with a modified sensor tail design, henceforth also referred to as 'modified FSL3 System', is an integrated continuous glucose monitoring (iCGM) systems that perform continuous glucose measurements every minute to provide glucose levels, trends, and real-time alarms capability to aid in the management of diabetes. The modified FSL3 System requires a prescription, is intended for home use, and consists of the following components:

FreeStyle Libre 3 Sensor

- The Sensor is single use, disposable, and powered by a silver oxide battery. The Sensor continuously measures glucose concentration in interstitial fluid and has a 15-day memory capacity. The Sensor is factory calibrated, does not require fingerstick calibration, and can be worn for up to 15 days.

FreeStyle Libre 3 App (iOS or Android)

- When downloaded to a compatible smartphone, the FreeStyle Libre 3 App uses NFC communication to start new Sensors and BLE communication to display glucose data and issue alarms based on the measurements calculated by the Sensor. As a mobile application, the FreeStyle Libre 3 App allows connectivity with cloud-based applications. The FreeStyle Libre 3 App is distributed using the Apple App Store and Google Play Store and a list of compatible devices is accessible in the App via the Help feature or product website.

B Principle of Operation:

The modified FreeStyle Libre 2 Flash Glucose Monitoring System and the modified FreeStyle Libre 3 Continuous Glucose Monitoring System use an electrochemical sensor to monitor glucose levels in the interstitial fluid (ISF). The sensor is held in place with an adhesive pad and incorporates both the subcutaneously implanted sensor and associated electronics. The sensor uses a glucose oxidase enzyme to oxidize glucose and transfer electrons to an electrode, producing a current. The strength of the current is proportional to the amount of glucose present in the ISF. The system converts the electrical current signal to a glucose value (in mg/dL) accompanied by trend arrow for display to the user on a display device.

C Instrument Description Information:

1. Instrument Name:

   FreeStyle Libre 2 Flash Glucose Monitoring System
   FreeStyle Libre 3 Continuous Glucose Monitoring System

2. Specimen Identification:

   Not applicable

3. Specimen Sampling and Handling:

   Not applicable

4. Calibration:

   The sensor is factory calibrated and does not require calibration from the user/operator.

5. Quality Control:

   Not applicable

This medical device product has functions subject to FDA premarket review as well as functions that are not subject to FDA premarket review. For this application, if the product has functions that are not subject to FDA premarket review, FDA assessed those functions only to the extent that they either could adversely impact the safety and effectiveness of the functions subject to FDA premarket review or they are included as a labeled positive impact that was considered in the assessment of the functions subject to FDA premarket review.

V Substantial Equivalence Information:

A Predicate Device Name(s):

FreeStyle Libre 2 Flash Glucose Monitoring System (with FreeStyle Libre 2 App)

FreeStyle Libre 3 Continuous Glucose Monitoring System

B Predicate 510(k) Number(s):

K210943

C Comparison with Predicate(s):

Device & Predicate Device(s):	K222447	K210943
Device Trade Name	FreeStyle Libre 2 Flash Glucose Monitoring System FreeStyle Libre 3 Continuous Glucose Monitoring System	FreeStyle Libre 2 Flash Glucose Monitoring System
General Device Characteristic Similarities		
Intended Use	The System is intended to monitor interstitial fluid glucose	Same

	concentrations and communicate with digitally connected devices for the purpose of managing a disease or condition related to glycemic control.	
General Device Characteristic Differences		
Intended Use Population	Persons with diabetes age 2 and older	Persons with diabetes age 4 and older
Contraindicated for AID system	No	Yes
Interoperability	Allows the same wireless and secure communications as the predicate device and additionally enables users to communicate iCGM data wirelessly and securely to and from digitally connected devices (client software) through a cloud-based communication method, the Libre Data Sharing API.	Designed to enable communication of glucose data and other information wirelessly and securely to and from digitally connected devices as described below: Wireless communication from the FreeStyle Libre 2 Sensor directly to interoperable receiver devices, which connect with the Sensor using the NFC and BLE wireless interfaces provided by the Sensor The FreeStyle Libre 2 App communicates through the cloud to another software device.
Compatible Sensors	FreeStyle Libre 2 Sensor (15 day) FreeStyle Libre 3 Sensor (15 day)	FreeStyle Libre 2 Sensor (14 day) FreeStyle Libre 2 MediRx Sensor (10 day)

VI Standards/Guidance Documents Referenced:

- ISO 14971: 2019 - Medical Devices - Application of risk management to medical devices
- ANSI AAMI IEC 62304:2006/A1:2016 - Medical device software - Software life cycle processes
- ANSI AAMI IEC 62366-1:2015 - Medical devices - Application of usability engineering to medical devices
- AAMI / ANSI HE75: 2009/(R)2018 - Human Factors Engineering - Design of Medical Devices
- Guidance for the Content of Premarket Submissions for Software Contained in Medical Devices - May 11, 2005
- Applying Human Factors and Usability Engineering to Medical Devices - February 3, 2016

VII Performance Characteristics (if/when applicable):

A Analytical Performance:

The FreeStyle Libre 3 Continuous Glucose Monitoring System is physically identical to the predicate FreeStyle Libre 2 Flash Glucose Monitoring System except for the differences in sensor transmission dimensions as previously established in K212132. Therefore, the pivotal clinical studies for the modified FreeStyle Libre 2 Flash Glucose Monitoring System were leveraged for the modified FreeStyle Libre 3 Continuous Glucose Monitoring System.

1. Precision/Reproducibility:

   iCGM performance was evaluated in clinical studies described below in section C(3). Subjects wore two modified FreeStyle Libre 2 Flash sensors concurrently, one on the back of each upper arm, to evaluate device precision.

   In the study for 18 years and older, the mean paired absolute relative difference (between the 2 concurrently worn devices) was 8.0 %; and the mean coefficient of variation (mean %CV) was 5.6 %.

   For pediatric age 6 to 17 years, the mean paired absolute relative difference was 8.6 %; and the mean %CV was 6.1 %.

   For pediatric age 2 to 5 years old, the mean paired absolute relative difference was 6.5%; and the mean %CV was 4.6 %.

Precision by subject age group:

Subject Age Group	Coefficient of Variation (%)	Paired Absolute Difference (mg/dL)	Paired Absolute Relative Difference (%)	Number of Paired Readings	Number of Subjects
18+ years	5.6	12.3	8.0	25029	148
Pediatric 6 to 17 years	6.1	13.8	8.6	10945	127
Pediatric 2 to 5 years	4.6	10.5	6.5	428	9

2. Linearity:

The reportable range for the modified FreeStyle Libre 2 Flash System and FreeStyle Libre 3 Continuous Glucose Monitoring System is 40 to 400 mg/dL. Data supporting this claimed measuring range was generated in the clinical study described in Section C(3) below.

3. Analytical Specificity/Interference:

Ascorbic acid (vitamin C) was shown to significantly interfere with system performance of the predicate device.

A clinical study was conducted to evaluate ascorbic acid interference for the modified FreeStyle Libre 2 Flash System. This was a prospective, multi-center, single-arm study that enrolled 60 subjects at 2 sites. The study was designed to evaluate performance of the system in people with diabetes (age 18 and older) taking ascorbic acid. Each subject wore two sensors, one on the back of each upper arm, for a period of up to 10 days. The sensors were from a single production lot.

The interference effect of ascorbic acid on the modified Freestyle Libre 2 Flash System was assessed by the difference (mg/dL) between CGM and comparator method (CM), in this case the Yellow Springs Instrument Life Sciences 2300 STAT Plus™ Glucose and Lactate Analyzer, readings at baseline and after each ascorbic acid doses. In this study, maximum bias was observed approximately 2 to 3 hours after each ascorbic acid dose.

The maximum average interference bias was 5.1 mg/dL after one 1000 mg dose. The maximum average total interference biases were 9.2 mg/dL and 9.0 mg/dL (vs. baseline) after the second and third 1000 mg doses (given every 4 hours), respectively.

Based on data from the clinical interference study, the sponsor included the following statement in the User Guide:

> "Interfering Substances: Taking more than 1000 mg of Vitamin C per day may falsely raise your Sensor readings, which could cause you to miss a severe low glucose event.

Vitamin C can be found in supplements including multivitamins and cold remedies such as Airborne® and Emergen-C®. See your health care professional to understand how long Vitamin C is active in your body.

Additional Notes for Health Care Professionals: In the original version of the FreeStyle Libre 2 system, ascorbic acid (Vitamin C) doses of larger than 500 mg per day could affect the Sensor readings, making them look higher than they really were. With the current version of the FreeStyle Libre 2 System, users can take up to 1000 mg of ascorbic acid per day and can still use the Sensor readings to make treatment decisions."

4. Assay Reportable Range:

   The reportable range for modified FreeStyle Libre 2 Flash Glucose Monitoring System and the modified FreeStyle Libre 3 Continuous Glucose Monitoring System is 40 to 400 mg/dL.

5. Traceability, Stability, Expected Values (Controls, Calibrators, or Methods):

   The storage shelf-life of 9 months at 36 to 82 °F within the humidity range of 10 % - 90 % previously established for the predicate FreeStyle Libre 2 Flash sensor in K193371 is applicable to the modified FreeStyle Libre 2 Flash sensor.

   The storage shelf-life of 3 months at 36 to 82 °F within the humidity range of 10 % - 90 % previously established for the reference FreeStyle Libre 3 sensor in K212132 is applicable to the modified FreeStyle Libre 3 sensor.

6. Detection Limit:

   If a glucose measurement is less than 40 mg/dL, the result will be displayed by the system as 'LO'. If the glucose measurement exceeds 400 mg/dL, the result will be displayed as 'HI'. Data supporting this claimed measurement range was generated in the clinical study described in Section C(3) below.

7. Assay Cut-Off:

   Not applicable

8. Accuracy (Instrument):

   Not applicable

9. Carry-Over:

   Not applicable

B Comparison Studies:

1. Method Comparison with Predicate Device:

   Not applicable. Accuracy is determined by comparing device values to an FDA cleared

laboratory grade glucose measurement method.

2. Matrix Comparison:

Not applicable. Interstitial fluid is the only indicated matrix.

C Clinical Studies:

1. Clinical Sensitivity:

Not applicable.

2. Clinical Specificity:

See Section A(3), Analytical Specificity/Interference, above.

3. Other Clinical Supportive Data (When 1. and 2. Are Not Applicable):

The accuracy performance of the modified FreeStyle Libre 2 Flash Glucose Monitoring System was assessed in a single pivotal clinical study conducted in the United States at seven centers.

The study enrolled 150 subjects (18 years and older) with diabetes (85.3% with Type 1 diabetes and 14.7% with insulin-requiring Type 2 diabetes). Subjects wore two sensors for up to 16 consecutive days following Sensor application and accuracy analysis is based on the first applied sensor to each subject only. Subjects took part in up to three ten-hour clinical sessions that took place during four distinct periods: Days 1 to 3; Days 5 to 7; Days 9 to 11, and Days 13 to 15. During each clinic session, each subject's glucose was manipulated to observe data spanning the measuring range.

The study also enrolled 142 pediatric subjects with Type 1 diabetes. Subjects wore two sensors for up to 16 consecutive days following Sensor application and accuracy analysis is based on the first applied sensor to each subject only. Subjects age 2 to 5 years took part in one four-hour clinical session. Subjects age 6 to 12 years took part in one twelve-hour clinical session. Subjects age 13 to 17 years took part in two twelve-hour clinical sessions. Clinic sessions for each subject took place during four distinct periods: Days 1 to 3; Days 5 to 7; Days 9 to 11, and Days 13 to 15. During each clinic session, glucose levels were manipulated in subjects 11 years and older to observe data spanning the measuring range. Subjects 10 years and younger underwent observation only without glucose manipulation.

The modified FreeStyle Libre 2 Flash Glucose Monitoring System was evaluated by comparing iCGM glucose values to glucose values from venous blood draws measured with an FDA-cleared laboratory grade comparator method (YSI 2300) subjects 6 years and older, and glucose values from capillary blood measured with a self-monitoring blood glucose meter (SMBG) for subjects 2 to 5 years of age.

Glucose values were obtained from the system and from the comparator at the same or similar time. In both studies, absolute differences in mg/dL of values compared to the comparator method were calculated for all values below 70 mg/dL. For values of 70 mg/dL

and above, percentage differences compared to the comparator method were calculated.

Percent and Point Accuracy by iCGM Glucose Range (Adult)

iCGM Glucose Range (mg/dL)	No. Pairs	No. Subjects	Percent within 15 mg/dL (95% LCL*)	Percent within 40 mg/dL (95% LCL)	Percent within 15% (95% LCL)	Percent within 40% (95% LCL)	Mean Bias, mg/dL (95% UCL*)
< 70	3712	129	90.4 (88.2)	99.6 (99.3)			-4.7 (-3.2)
70 - 180	8258	148			82.3 (80.0)	99.6 (99.4)	-6.9 (-5.5)
>180	8527	145			94.2 (92.5)	100.0 (99.9)	-5.3 (3.0)

*95% LCL is the lower bound of the 95% confidence limit and 95% UCL is the upper bound of the 95% confidence limit.

Percent and Point Accuracy by iCGM Glucose Range (Pediatric*)

iCGM Glucose Range (mg/dL)	No. Pairs	No. Subjects	Percent within 15 mg/dL (95% LCL)	Percent within 40 mg/dL (95% LCL)	Percent within 15% (95% LCL)	Percent within 40% (95% LCL)	Mean Bias, mg/dL (95% UCL)
< 70	930	80	82.8 (78.0)	99.2 (98.2)			-8.6 (-6.9)
70 - 180	3074	122			82.6 (79.6)	99.8 (99.6)	-8.5 (-6.9)
>180	3021	113			95.8 (94.3)	100.0 (100.0)	-3.7 (-1.3)

*Includes subjects age 6 to 17 years. Subjects 2 to 5 years of age were compared to an SMBG meter.

Percent and Point Accuracy by Comparator Glucose Range (Adult)

CM Glucose Range (mg/dL)	No. Pairs	No. Subjects	Percent within 15 mg/dL (95% LCL)	Percent within 40 mg/dL (95% LCL)	Percent within 15% (95% LCL)	Percent within 40% (95% LCL)	Mean Bias, mg/dL (95% UCL)
< 70	3259	127	97.1 (95.9)	99.9 (99.7)			0.2 (1.0)
70 - 180	8386	149			80.6 (78.2)	99.6 (99.4)	-5.8 (-4.6)
>180	8852	144			92.9 (91.0)	99.9 (99.8)	-7.1 (-4.8)

Percent and Point Accuracy by Comparator Glucose Range (Pediatric*)

CM Glucose Range (mg/dL)	No. Pairs	No. Subjects	Percent within 15 mg/dL (95% LCL)	Percent within 40 mg/dL (95% LCL)	Percent within 15% (95% LCL)	Percent within 40% (95% LCL)	Mean Bias, mg/dL (95% UCL)
< 70	693	56	98.0 (96.6)	100.0 (100.0)			-2.0 (-0.9)
70 - 180	3178	122			79.4 (76.1)	99.6 (99.3)	-7.0 (-5.6)
>180	3154	114			94.2 (92.3)	99.9 (99.7)	-6.3 (-4.0)

*Includes subjects age 6 to 17 years. Subjects 2 to 5 years of age were compared to an SMBG meter.

Percent of iCGM values within 20% of Comparator Glucose Values

Subject group	No. Pairs	No. Subjects	Percent within 20% Overall (95% LCL)	Percent Within ±20% / ±20 mg/dL on Day 1	Percent Within ±20% / ±20 mg/dL in first 12 hours
18 years and up	20497	149	92.5 (91.0)	82.9	79.2
Pediatric (6 to 17 years)	7025	124	92.9 (91.1)	89.8	90.5
Pediatric (2 to 5 years)*	135	10	86.7 (79.1)	78.9	88.9

*Subjects 2 to 5 years of age were compared to an SMBG meter.

Percent values within 15%/15 mg/dL, 20%/20 mg/dL and 40%/40 mg/dL stratified by glucose ranges of <54, 54-69, 70-180. 181-250 and >250 mg/dL for iCGM and laboratory comparator were also provided. For pediatric subjects ages 2 to 5, values were compared to SMBG.

Accuracy to Comparator within iCGM Glucose Ranges (Adult)

iCGM Glucose Level (mg/dL)	No. Pairs	Percent Within ±15 mg/dL	Percent Within ±20 mg/dL	Percent Within ±40 mg/dL	Percent Within ±15%	Percent Within ±20%	Percent Within ±40%	Mean bias (mg/dL)	MARD* (%)
<54	555	84.3	91.0	98.4				-5.9	14.1
54-69	3157	91.5	95.2	99.1				-3.8	10.0
70-180	8258				82.3	90.2	99.1	-6.0	9.5
181-250	2976				89.9	94.5	99.9	- 9.1	7.4
>250	5551				96.5	98.7	100.0	-3.1	5.1

Accuracy to Comparator within iCGM Glucose Ranges (Pediatric*)

iCGM Glucose Level (mg/dL)	No. Pairs	Percent Within ±15 mg/dL	Percent Within ±20 mg/dL	Percent Within ±40 mg/dL	Percent Within ±15%	Percent Within ±20%	Percent Within ±40%	Mean bias (mg/dL)	MARD (%)
<54	175	75.4	86.3	97.7				-8.9	15.7
54-69	755	84.5	88.6	97.5				-6.9	11.2
70-180	3074				82.6	90.9	99.6	-8.1	9.2
181-250	1176				92.0	97.4	100.0	-11.2	7.5
>250	1845				98.3	99.8	100.0	-3.5	4.8

*Includes subjects age 6 to 17 years. Subjects 2 to 5 years of age were compared to an SMBG meter.

Accuracy to Comparator within Comparator Glucose Ranges (Adult)

CM Glucose Level (mg/dL)	No. Pairs	Percent Within ±15 mg/dL	Percent Within ±20 mg/dL	Percent Within ±40 mg/dL	Percent Within ±15%	Percent Within ±20%	Percent Within ±40%	Mean bias (mg/dL)	MARD (%)
< 54	460	93.9	98.3	100.0				6.7	14.4
54-69	2799	97.6	99.0	99.6				-0.1	8.4
70-180	8386				80.6	89.2	98.9	-5.8	9.8
181-250	2792				89.9	94.6	99.7	-6.3	7.3
>250	6060				94.2	96.8	99.9	-7.5	5.8

Accuracy to Comparator within Comparator Glucose Ranges (Pediatric*)

CM Glucose Level (mg/dL)	No. Pairs	Percent Within ±15 mg/dL	Percent Within ±20 mg/dL	Percent Within ±40 mg/dL	Percent Within ±15%	Percent Within ±20%	Percent Within ±40%	Mean bias (mg/dL)	MARD (%)
<54	94	100.0	100.0	100.0				4.1	9.7
54-69	599	97.7	99.8	100.0				-2.1	7.6
70-180	3178				79.4	87.9	99.0	-7.8	10.1
181-250	1080				89.8	96.2	99.8	-8.7	7.6
>250	2074				96.5	98.7	99.9	-8.0	5.6

*Includes subjects age 6 to 17 years. Subjects 2 to 5 years of age were compared to an SMBG meter.

Concurrence of iCGM values compared to the comparator method across the entire measuring range was also evaluated. iCGM glucose ranges of <40, 40-60, 61-80, 81-120, 121-160, 161-200, 201-250, 251-300, 351-400 and >400 mg/dL were evaluated against the comparator glucose ranges and percent of iCGM values within those ranges were reported.

Concurrence Analysis by iCGM Glucose Level (Adult)

iCGM (mg/dL)	Comparator (mg/dL)											N
	<40	40-60	61-80	81-120	121-160	161-200	201-250	251-300	301-350	351-400	>400	
<40	.	100.0	.	.	.	.	.	.	.	.	.	1
40-60	0.7	53.1	42.1	4.0	0.1	0.1	.	.	.	.	.	1929
61-80	0.0	12.2	68.0	19.0	0.7	.	.	.	.	.	.	3112
81-120	.	0.2	6.6	71.5	20.4	1.2	0.1	.	.	.	.	3338
121-160	.	.	0.1	6.8	72.5	19.2	1.2	0.2	.	.	.	2568
161-200	.	.	.	0.1	9.7	68.2	18.9	3.0	0.1	.	.	1897
201-250	.	.	.	.	0.2	8.6	61.7	27.2	2.4	.	.	2102
251-300	.	.	.	.	.	0.0	6.1	71.5	21.5	0.8	0.1	2818
301-350	.	.	.	.	.	.	0.1	16.4	74.6	8.7	0.3	2100
351-400	.	.	.	.	.	.	0.2	1.3	22.7	70.6	5.2	633
>400	.	.	.	.	.	.		.	1.7	60.3	38.0	121

Concurrence Analysis by iCGM Glucose Level (Pediatric*)

iCGM (mg/dL)	Comparator (mg/dL)											N
	<40	40-60	61-80	81-120	121-160	161-200	201-250	251-300	301-350	351-400	>400	
<40	.	75.0	25.0	.	.	.	.	.	.	.	.	4
40-60	.	46.5	44.5	8.0	1.0	.	.	.	.	.	.	499
61-80	.	6.2	62.4	30.5	1.0	.	.	.	.	.	.	840
81-120	.	0.1	4.1	71.0	24.1	0.7	.	.	.	.	.	1321
121-160	.	.	.	7.2	71.6	21.0	0.2	.	.	.	.	975
161-200	.	.	.	.	9.0	65.1	25.0	0.7	0.1	.	.	680
201-250	.	.	.	.	.	6.1	61.0	31.3	0.6	0.9	.	865
251-300	.	.	.	.	.	.	6.1	75.7	18.1	0.1	.	995
301-350	.	.	.	.	.	.	.	11.2	79.4	9.4	.	607
351-400	.	.	.	.	.	.	.	0.4	24.3	67.1	8.2	243
>400	.	.	.	.	.	.	.	.	.	34.7	65.3	49

*Includes subjects age 6 to 17 years. Subjects 2 to 5 years of age were compared to an SMBG meter.

Concurrence Analysis by Comparator Glucose Level (Adult)

CM (mg/dL)	iCGM (mg/dL)											N
	<40	40-60	61-80	81-120	121-160	161-200	201-250	251-300	301-350	350-400	>400	
<40	.	92.9	7.1	.	.	.	.	.	.	.	.	14
40-60	0.1	72.5	26.9	0.5	.	.	.	.	.	.	.	1412
61-80	.	25.8	67.2	7.0	0.1	.	.	.	.	.	.	3151
81-120	.	2.4	18.3	73.8	5.4	0.1	.	.	.	.	.	3233
121-160	.	0.0	0.8	24.7	67.6	6.7	0.1	.	.	.	.	2754
161-200	.	0.0	.	2.0	24.6	64.3	9.0	0.0	.	.	.	2011
201-250	.	.	.	0.1	1.7	19.3	69.6	9.2	0.1	0.1	.	1863
251-300	.	.	.	.	0.2	1.9	19.0	67.1	11.5	0.3	.	3001
301-350	.	.	.	.	.	0.0	2.1	25.5	66.1	6.1	0.1	2368
351-400	.	.	.	.	.	.	.	3.2	25.1	61.7	10.1	725
>400	.	.	.	.	.	.	.	2.3	6.9	37.9	52.9	87

Concurrence Analysis by Comparator Glucose Level (Pediatric*)

CM (mg/dL)	iCGM (mg/dL)											N
	<40	40-60	61-80	81-120	121-160	161-200	201-250	251-300	301-350	351-400	>400	
<40	.	.	.	.	.	.	.	.	.	.	.	0
40-60	1.0	80.6	18.1	0.3	.	.	.	.	.	.	.	288
61-80	0.1	27.7	65.4	6.7	.	.	.	.	.	.	.	801
81-120	.	3.1	19.6	71.9	5.4	.	.	.	.	.	.	1304
121-160	.	0.5	0.7	29.2	64.0	5.6	.	.	.	.	.	1091
161-200	.	.	.	1.3	28.9	62.4	7.5	.	.	.	.	710
201-250	.	.	.	.	0.3	22.3	69.4	8.0	.	.	.	761
251-300	.	.	.	.	.	0.5	24.7	68.6	6.2	0.1	.	1098
301-350	.	.	.	.	.	0.1	0.7	24.8	66.3	8.1	.	727
351-400	.	.	.	.	.	.	3.3	0.4	23.2	66.3	6.9	246
>400	.	.	.	.	.	.	.	.	.	38.5	61.5	52

*Includes subjects age 6 to 17 years. Subjects 2 to 5 years of age were compared to an SMBG meter.

Trend Accuracy

Trend accuracy describes the accuracy of the sensor during times of rapidly changing glucose and is characterized by slopes, such as from > 2mg/dL/min to < -2 mg/dL/min. Trend accuracy was assessed by the concurrence rate of the glucose rate of change from the iCGM and the corresponding comparator values for each iCGM-comparator measurement pair.

Concurrence Analysis by Glucose Rate of Change (Adult)

iCGM Rate (mg/dL/min)	Comparator Rate (mg/dL/min)						N
	<-2	[-2, -1)	[-1, 0)	[0, 1]	(1, 2]	>2	
<-2	31.5	43.1	20.0	3.4	1.0	0	295
-2 to -1	11.1	44.5	37.8	5.5	0.8	0.4	841
-1 to 0	1.5	7.8	65.8	21.1	2.6	1.2	9254
0 to 1	1.1	4.2	25.5	47.2	15.2	6.7	6905
1 to 2	0.1	2.9	9.9	29.9	36.7	20.6	1577
>2	0	1.2	4.8	17.5	32.2	44.3	1038

Concurrence Analysis by Glucose Rate of Change (Pediatric*)

iCGM Rate (mg/dL/min)	Comparator Rate (mg/dL/min)						N
	<-2	[-2, -1)	[-1, 0)	[0, 1]	(1, 2]	>2	
<-2	27.7	53.5	16.8	1.0	1.0	0	101
-2 to -1	8.2	46.8	39.9	3.5	1.1	0.5	376
-1 to 0	1.1	8.8	66.5	20.5	2.0	1.1	2969
0 to 1	1.2	3.3	24.6	51.7	13.1	6.2	2344
1 to 2	0	3.2	8.8	30.8	39.9	17.3	571
>2	0	2.0	5.4	15.2	32.4	45.1	408

*Includes subjects age 6 to 17 years. Subjects 2 to 5 years of age were compared to an SMBG meter.

Agreement When iCGM Reads 'LO' or 'HI'

The FreeStyle Libre 2 Flash Glucose Monitoring System reports glucose readings between 40 and 400 mg/dL. When the system determines that the glucose reading is below 40 mg/dL, it will display 'LO' whenever the sensor is scanned. When the system determines that the glucose reading is above 400 mg/dL, it will display 'HI' whenever the sensor is scanned. Because the system does not display glucose values below 40 mg/dL or above 400 mg/dL, the comparisons to the actual blood glucose levels (as determined by the comparator) when the iCGM value is classified as 'LO' or 'HI' are evaluated separately. The cumulative percentages of when the comparator values were less than certain glucose values (for 'LO') and when comparator values were more that certain glucose values (for 'HI') are presented in the tables below.

Concurrence Analysis with 'LO' iCGM Reading (Adult)

iCGM-Reference Pairs	Comparator (mg/dL)					N
	<50	<60	<70	<80	≥80	
n	1	1	1	1	0	1
Cumulative %	100.0	100.0	100.0	100.0	0.0	

Concurrence Analysis with 'LO' iCGM Reading (Pediatric*)

iCGM-Reference Pairs	Comparator (mg/dL)					N
	<50	<60	<70	<80	≥80	
n	0	3	4	4	0	4
Cumulative %	0	75.0	100.0	100.0	0.0	

*Includes subjects age 6 to 17 years. Subjects 2 to 5 years of age were compared to an SMBG meter.

Concurrence Analysis with 'HI' iCGM Reading (Adult)

iCGM-Reference Pairs	Comparator (mg/dL)				N
	>350	>300	>250	≤250	
n	119	121	121	0	121
Cumulative %	98.3	100.0	100.0	0.0	

Concurrence Analysis with 'HI' iCGM Reading (Pediatric*)

iCGM-Reference Pairs	Comparator (mg/dL)				N
	>350	>300	>250	≤250	
n	49	49	49	0	49
Cumulative %	100.0	100.0	100.0	0.0	

*Includes subjects age 6 to 17 years. Subjects 2 to 5 years of age were compared to an SMBG meter.

Alarm Performance

The tables in this section show the accuracy of the System's Low and High Glucose Alarms. The Alarm Rate tells the user how often the alarm is right or wrong. The Detection Rate tells the user how often the System is able to recognize and notify the user about a low or high glucose event (within 15 minutes before or after the event).

Low Glucose Alarm Performance

True Alarm Rate: Percentage of time the alarm issued, and blood glucose was below the alarm level within 15 minutes before or after the alarm.

False Alarm Rate: Percentage of time the alarm issued, and blood glucose was not below the alarm level within 15 minutes before or after the alarm.

Detection Rate: Percentage of time blood glucose was below the alarm level and the alarm issued within 15 minutes before or after the glucose event.

Missed Detection Rate: Percentage of time blood glucose was below the alarm level and the alarm didn't issue within 15 minutes before or after the glucose event.

Low Glucose Alarm Performance (Adult)

Low Glucose Alarm Level (mg/dL)	Alarm Rate			Detection Rate		
	Hypo Alerts (n)	True Alarm Rate (%)	False Alarm Rate (%)	Hypo Events (n)	Correct Detection Rate (%)	Missed Detection Rate (%)
60	9756	71.1	28.9	1376	84.5	15.5
70	23078	84.6	15.4	3451	95.5	4.5
80	33676	90.8	9.2	4655	98.0	2.0
90	42322	92.2	7.8	5525	98.8	1.2

Low Glucose Alarm Performance (Pediatric*)

Low Glucose Alarm Level (mg/dL)	Alarm Rate			Detection Rate		
	Hypo Alerts (n)	True Alarm Rate (%)	False Alarm Rate (%)	Hypo Events (n)	Correct Detection Rate (%)	Missed Detection Rate (%)
60	2760	58.9	41.1	275	87.6	12.4
70	6138	74.2	25.8	735	98.6	1.4
80	9664	82.8	17.2	1104	98.6	1.4
90	13113	88.3	11.7	1434	99.7	0.3

*Includes subjects age 6 to 17 years. Subjects 2 to 5 years of age were compared to an SMBG meter.

High Glucose Alarm Performance

True Alarm Rate: Percentage of time the alarm issued, and blood glucose was above the alarm level within 15 minutes before or after the alarm.

False Alarm Rate: Percentage of time the alarm issued, and blood glucose was not above the alarm level within 15 minutes before or after the alarm.

Detection Rate: Percentage of time blood glucose was above the alarm level and the alarm issued within 15 minutes before or after the glucose event.

Missed Detection Rate: Percentage of time blood glucose was above the alarm level and the alarm didn't issue within 15 minutes before or after the glucose event.

High Glucose Alarm Performance (Adult)

High Glucose Alarm Level (mg/dL)	Alarm Rate			Detection Rate		
	Hyper Alerts (n)	True Alarm Rate (%)	False Alarm Rate (%)	Hyper Events (n)	Correct Detection Rate (%)	Missed Detection Rate (%)
120	96119	99.3	0.7	13212	97.8	2.2
140	83016	99.2	0.8	11728	98.0	2.0
180	61513	98.8	1.2	9337	98.0	2.0
200	53287	98.5	1.5	8388	98.0	2.0
220	45745	98.4	1.6	7615	97.8	2.2
240	38393	98.9	1.1	6902	97.2	2.8
300	16594	94.8	5.2	3369	91.2	8.8

High Glucose Alarm Performance (Pediatric*)

High Glucose Alarm Level (mg/dL)	Alarm Rate			Detection Rate		
	Hyper Alerts (n)	True Alarm Rate (%)	False Alarm Rate (%)	Hyper Events (n)	Correct Detection Rate (%)	Missed Detection Rate (%)
120	34730	99.4	0.6	4845	97.2	2.8
140	29844	99.2	0.8	4268	97.2	2.8
180	21855	99.0	1.0	3352	97.9	2.1
200	18820	99.2	0.8	3030	97.9	2.1
220	15886	98.8	1.2	2753	96.9	3.1
240	12743	98.4	1.6	2449	96.0	4.0
300	5140	97.5	2.5	1098	92.2	7.8

*Includes subjects age 6 to 17 years. Subjects 2 to 5 years of age were compared to an SMBG meter.

Sensor Stability

Sensor stability describes the performance of the sensor over the sensor lifetime. Sensors can be worn for up to 14 days. Performance was estimated by calculating the mean of the absolute relative differences between iCGM and comparator measurement and percentage of device readings within 15 mg/dL or 15 % (15/15%), 20 mg/dL or 20 % (20/20%) and 40 mg/dL or 40 % (40/40%) of the comparator values during the beginning, early middle, late middle, and end of the wear period. These times were defined as follows:

- Beginning (Days 1, 2 or 3)

- Early Middle (Days 5, 6 or 7),
- Late Middle (Days 9, 10 or 11), and
- End (Days 13, 14 or 15).

The mean absolute relative difference (MARD) and agreement rates with the comparator method were evaluated over 14 day life of the sensor.

Sensor Accuracy Relative to Comparator Over the Wear Duration (Adult)

Wear Period	No. Pairs	MARD (%)	Within ±15% / ±15mg/dL	Within ±20% / ±20mg/dL	Within ±40% / ±40mg/dL
Beginning days (1-3)	5410	10.0	83.0	89.7	99.1
Early Middle days (5-7)	5043	7.2	91.6	96.1	99.8
Late Middle days (9-11)	5142	7.7	89.9	94.8	99.3
End days (13-15)	4902	7.8	90.0	94.5	99.6

Sensor Accuracy Relative to Comparator Over the Wear Duration (Pediatric*)

Wear Period	No. Pairs	MARD (%)	Within ±15% / ±15mg/dL	Within ±20% / ±20mg/dL	Within ±40% / ±40mg/dL
Beginning days (1-3)	2634	9.0	84.0	91.0	99.5
Early Middle days (5-7)	2277	6.9	92.3	97.3	99.9
Late Middle days (9-11)	1209	6.9	92.3	96.9	99.8
End days (13-15)	905	10.4	82.1	87.0	97.9

*Includes subjects age 6 to 17 years. Subjects 2 to 5 years of age were compared to an SMBG meter.

Sensor Life

The Sensor can be worn for up to 15 days. 151 Sensors were evaluated on the adult subjects and 142 Sensors were evaluated in the pediatric subjects to determine how many days of readings each Sensor provided.

Of the 151 Sensors with adult subjects, 83.1 % lasted until the final day of use. Four (4) Sensors (2.6 %) had "early sensor shut-off" where the Sensor algorithm detected that the Sensors did not function as intended and presented the user with a "Replace Sensor" message.

Of the 142 Sensors with pediatric subjects, 76.8 % of the Sensors lasted until the final day of use. Three (3) Sensors (2.1 %) had "early sensor shut-off" and presented the user with a "Replace Sensor" message.

Sensor Survival Rate Over Wear Duration (Adult)

Day of Wear	No. of Sensors	Survival Rate (%)
1	150	100.0
2	150	100.0
3	149	99.3
4	147	98.7
5	142	96.0
6	139	95.3
7	138	95.3
8	131	92.5
9	129	91.1
10	127	90.4
11	125	88.9
12	122	87.5
13	118	85.3
14	111	83.1
15	105	83.1

Sensor Survival Rate Over Wear Duration (Pediatric)

Day of Wear	No. of Sensors	Survival Rate (%)
1	141	100.0
2	140	99.3
3	140	99.3
4	136	96.5
5	134	95.0
6	131	93.6
7	129	92.9
8	126	90.7
9	123	90.0
10	119	89.3
11	115	87.7
12	111	85.4
13	102	79.3
14	97	77.7
15	85	76.8

Glucose Reading Availability

The System is designed to show a Sensor glucose reading after each scan that is performed throughout the wear period after the start-up time. As such, the capture rate characterizes the reliability of the communication between components of the system.

Glucose Reading Capture Rate Over Wear Duration (Adult)

Day of Wear	No. of Sensors	Capture Rate (%)
1	146	96.4
2	146	97.4
3	146	97.7
4	142	97.8
5	143	97.9
6	141	97.9
7	136	98.1
8	135	98.1
9	130	98.2
10	127	98.3
11	125	98.2
12	123	98.2
13	118	98.2
14	116	98.2
15	111	98.3

Glucose Reading Capture Rate Over Wear Duration (Pediatric)

Day of Wear	No. of Sensors	Capture Rate (%)
1	141	96.9
2	138	96.5
3	135	97.1
4	137	96.6
5	137	96.9
6	129	96.9
7	127	97.0
8	122	96.8
9	118	96.6
10	118	96.6
11	112	96.5
12	111	96.4
13	109	96.3
14	101	96.3
15	101	96.1

D Clinical Cut-Off:

Not applicable

E Expected Values/Reference Range:

Not applicable

F Other Supportive Instrument Performance Characteristics Data:

The following supportive performance characteristics were established in the predicate device (K210943) and the reference devices (K213996 and K212132) and are not affected by the introduction of the modified Sensor tail in this 510(k):

- Human Factors
- Sterilization
- Biocompatibility
- Mechanical Engineering

- Electromagnetic Compatibility
- Electrical Safety
- Cybersecurity
- Environmental Testing
- Shelf-Life Stability
- Packaging Integrity/Shipping Integrity

Software
Software regression testing was conducted in accordance with established specifications and IEC 62304 and documentation was provided as recommended by FDA Guidance "Guidance for the Content of Premarket Submissions for Software Contained in Medical Devices", published May 11, 2005. The test results met acceptance criteria and support that the subject devices are acceptable for their intended use.

Interoperability
The FreeStyle Libre 2 Flash Glucose Monitoring System and FreeStyle Libre 3 Continuous Glucose Monitoring System include the Libre Data Sharing API (cleared in K223537) to communicate iCGM data with authorized client software. The sponsor developed an approach for interoperability in alignment with FDA guidance, “Design Considerations and Pre-market Submission Recommendations for Interoperable Medical Devices,” published September 6, 2017. The approach to interoperability with authorized partners provides information to support device expectations, requirements, development methodology, testing protocols for their software integration, and interface specifications for data exchange with compatible interoperable devices, including automated insulin dosing (AID) systems.

As standalone iCGMs, the first 12 hours of sensor wear for the FreeStyle Libre 2 Flash Glucose Monitoring System and FreeStyle Libre 3 Continuous Glucose Monitoring System is intended to be adjunctive. The sponsor includes a “Check Blood Glucose” icon in the user interface to remind users to use a blood glucose meter to make diabetes treatment decisions. Authorized partners should consider the sensor performance throughout the duration of device wear with particular consideration during the first 12 hours of adjunctive use.

VIII Proposed Labeling:

The labeling supports the finding of substantial equivalence for this device.

IX Conclusion:

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