July 15, 2025

Tempus AI, Inc.
Matthew Trachtenberg
Senior Director, Regulatory Affairs
600 W Chicago Ave
Suite #510
Chicago, Illinois 60654

Re: K250119
　　Trade/Device Name: Tempus ECG-Low EF
　　Regulation Number: 21 CFR 870.2380
　　Regulation Name: Cardiovascular machine learning-based notification software
　　Regulatory Class: Class II
　　Product Code: QYE
　　Dated: June 12, 2025
　　Received: June 12, 2025

Dear Matthew Trachtenberg:

We have reviewed your section 510(k) premarket notification of intent to market the device referenced above and have determined the device is substantially equivalent (for the indications for use stated in the enclosure) to legally marketed predicate devices marketed in interstate commerce prior to May 28, 1976, the enactment date of the Medical Device Amendments, or to devices that have been reclassified in accordance with the provisions of the Federal Food, Drug, and Cosmetic Act (the Act) that do not require approval of a premarket approval application (PMA). You may, therefore, market the device, subject to the general controls provisions of the Act. Although this letter refers to your product as a device, please be aware that some cleared products may instead be combination products. The 510(k) Premarket Notification Database available at https://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpmn/pmn.cfm identifies combination product submissions. The general controls provisions of the Act include requirements for annual registration, listing of devices, good manufacturing practice, labeling, and prohibitions against misbranding and adulteration. Please note: CDRH does not evaluate information related to contract liability warranties. We remind you, however, that device labeling must be truthful and not misleading.

If your device is classified (see above) into either class II (Special Controls) or class III (PMA), it may be subject to additional controls. Existing major regulations affecting your device can be found in the Code of Federal Regulations, Title 21, Parts 800 to 898. In addition, FDA may publish further announcements concerning your device in the Federal Register.

Additional information about changes that may require a new premarket notification are provided in the FDA guidance documents entitled "Deciding When to Submit a 510(k) for a Change to an Existing Device" (https://www.fda.gov/media/99812/download) and "Deciding When to Submit a 510(k) for a Software Change to an Existing Device" (https://www.fda.gov/media/99785/download).

Your device is also subject to, among other requirements, the Quality System (QS) regulation (21 CFR Part 820), which includes, but is not limited to, 21 CFR 820.30, Design controls; 21 CFR 820.90, Nonconforming product; and 21 CFR 820.100, Corrective and preventive action. Please note that regardless of whether a change requires premarket review, the QS regulation requires device manufacturers to review and approve changes to device design and production (21 CFR 820.30 and 21 CFR 820.70) and document changes and approvals in the device master record (21 CFR 820.181).

Please be advised that FDA's issuance of a substantial equivalence determination does not mean that FDA has made a determination that your device complies with other requirements of the Act or any Federal statutes and regulations administered by other Federal agencies. You must comply with all the Act's requirements, including, but not limited to: registration and listing (21 CFR Part 807); labeling (21 CFR Part 801); medical device reporting (reporting of medical device-related adverse events) (21 CFR Part 803) for devices or postmarketing safety reporting (21 CFR Part 4, Subpart B) for combination products (see https://www.fda.gov/combination-products/guidance-regulatory-information/postmarketing-safety-reporting-combination-products); good manufacturing practice requirements as set forth in the quality systems (QS) regulation (21 CFR Part 820) for devices or current good manufacturing practices (21 CFR Part 4, Subpart A) for combination products; and, if applicable, the electronic product radiation control provisions (Sections 531-542 of the Act); 21 CFR Parts 1000-1050.

All medical devices, including Class I and unclassified devices and combination product device constituent parts are required to be in compliance with the final Unique Device Identification System rule ("UDI Rule"). The UDI Rule requires, among other things, that a device bear a unique device identifier (UDI) on its label and package (21 CFR 801.20(a)) unless an exception or alternative applies (21 CFR 801.20(b)) and that the dates on the device label be formatted in accordance with 21 CFR 801.18. The UDI Rule (21 CFR 830.300(a) and 830.320(b)) also requires that certain information be submitted to the Global Unique Device Identification Database (GUDID) (21 CFR Part 830 Subpart E). For additional information on these requirements, please see the UDI System webpage at https://www.fda.gov/medical-devices/device-advice-comprehensive-regulatory-assistance/unique-device-identification-system-udi-system.

Also, please note the regulation entitled, "Misbranding by reference to premarket notification" (21 CFR 807.97). For questions regarding the reporting of adverse events under the MDR regulation (21 CFR Part 803), please go to https://www.fda.gov/medical-devices/medical-device-safety/medical-device-reporting-mdr-how-report-medical-device-problems.

For comprehensive regulatory information about medical devices and radiation-emitting products, including information about labeling regulations, please see Device Advice (https://www.fda.gov/medical-devices/device-advice-comprehensive-regulatory-assistance) and CDRH Learn (https://www.fda.gov/training-and-continuing-education/cdrh-learn). Additionally, you may contact the Division of Industry and Consumer Education (DICE) to ask a question about a specific regulatory topic. See the DICE website (https://www.fda.gov/medical-devices/device-advice-comprehensive-regulatory-

assistance/contact-us-division-industry-and-consumer-education-dice) for more information or contact DICE by email (DICE@fda.hhs.gov) or phone (1-800-638-2041 or 301-796-7100).

Sincerely,

Stephen C. Browning -S

LCDR Stephen Browning
Assistant Director
Division of Cardiac Electrophysiology,
   Diagnostics, and Monitoring Devices
Office of Cardiovascular Devices
Office of Product Evaluation and Quality
Center for Devices and Radiological Health

Enclosure

Indications for Use

510(k) Number *(if known)*
K250119

Device Name
Tempus ECG-Low EF

Indications for Use *(Describe)*

Tempus ECG-Low EF is software intended to analyze resting, non-ambulatory 12-lead ECG recordings and detect signs associated with having a low left ventricular ejection fraction (LVEF less than or equal to 40%). It is for use on clinical diagnostic ECG recordings collected at a healthcare facility from patients 40 years of age or older at risk of heart failure. This population includes but is not limited to patients with atrial fibrillation, aortic stenosis, cardiomyopathy, myocardial infarction, diabetes, hypertension, mitral regurgitation, and ischemic heart disease.

Tempus ECG-Low EF only analyzes ECG data and provides a binary output for interpretation. Tempus ECG-Low EF is not intended to be a stand-alone diagnostic tool for cardiac conditions, should not be used for patient monitoring, and should not be used on ECGs with paced rhythms. Results should be interpreted in conjunction with other diagnostic information, including the patient's original ECG recordings and other tests, as well as the patient's symptoms and clinical history.

A positive result may suggest the need for further clinical evaluation in order to establish a diagnosis of low LVEF. Patients receiving a negative result should continue to be evaluated in accordance with current medical practice standards using all available clinical information.

Type of Use *(Select one or both, as applicable)*

☒ Prescription Use (Part 21 CFR 801 Subpart D)   ☐ Over-The-Counter Use (21 CFR 801 Subpart C)

CONTINUE ON A SEPARATE PAGE IF NEEDED.

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510(k) Summary
Tempus ECG-Low EF
K250119

Sponsor Name:	Tempus AI, Inc. 600 W Chicago Ave Ste #510, Chicago, IL 60654 Phone: (833) 514-4187
Contact Person:	Matthew Trachtenberg Senior Director, Regulatory Affairs Tempus AI, Inc. Phone: (800) 739-4137 matthew.trachtenberg@tempus.com
Date Summary Prepared:	July 14, 2025
Device Trade Name:	Tempus ECG-Low EF
Common Name:	AI-based ECG analysis software
Classification Name:	Cardiovascular machine learning-based notification software
Regulation Number:	21 CFR § 870.2380
Product Code:	QYE
Predicate Device:	Anumana, Inc. Low Ejection Fraction AI-ECG Algorithm
Submission Number:	K232699
Product Code:	QYE

Indications For Use

Tempus ECG-Low EF is software intended to analyze resting, non-ambulatory 12-lead ECG recordings and detect signs associated with having a low left ventricular ejection fraction (LVEF less than or equal to 40%). It is for use on clinical diagnostic ECG recordings collected at a healthcare facility from patients 40 years of age or older at risk of heart failure. This population includes but is not limited to patients with atrial fibrillation, aortic stenosis, cardiomyopathy, myocardial infarction, diabetes, hypertension, mitral regurgitation, and ischemic heart disease.

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A positive result may suggest the need for further clinical evaluation in order to establish a diagnosis of low LVEF. Patients receiving a negative result should continue to be evaluated in accordance with current medical practice standards using all available clinical information.

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General Warnings and Precautions

- Tempus ECG-Low EF has not been evaluated in and should not be used for patients younger than 40 years of age.
- Tempus ECG-Low EF is not intended to replace other diagnostic tests.
- Results do not represent a diagnosis of low LVEF.
- Results do not rule-out low LVEF.
- Tempus ECG-Low EF should not be used on ECG recordings with paced rhythms.
- Tempus ECG-Low EF should not be used for patient monitoring.
- Tempus ECG-Low EF should not be used to initiate any therapy or treatment for low LVEF.
- Tempus ECG-Low EF should not be used for repeated testing of the same patient within a 12-month period.

Device Description

Tempus ECG-Low EF is a cardiovascular machine learning software intended for analysis of 12-lead resting ECG recordings using machine-learning techniques to detect signs of cardiovascular conditions for further referral or diagnostic follow-up. The software employs machine learning techniques to analyze ECG recordings and detect signs associated with a patient experiencing low left ventricular ejection fraction (LVEF), less than or equal to 40%. The device is designed to extract otherwise unavailable information from ECGs conducted under the standard of care, to help health care providers better identify patients who may be at risk for undiagnosed LVEF in order to evaluate them for further referral or diagnostic follow up.

As input, the software takes data from a patient's 12-lead resting ECG (including age and sex). It is only compatible with ECG recordings collected using 'wet' Ag/AgCl electrodes with conductive gel/paste, and using FDA authorized 12-lead resting ECG machines manufactured by GE Medical Systems or Philips Medical Systems with a 500 Hz sampling rate. It checks the format and quality of the input data, analyzes the data via a trained and 'locked' machine-learning model to generate an uncalibrated risk score, converts the model results to a binary output (or reports that the input data are unclassifiable), and evaluates the uncalibrated risk score against pre-set operating points (thresholds) to produce a final result. Uncalibrated risk scores at or above the threshold are returned as 'Low LVEF Detected,' and uncalibrated risk scores below the threshold are returned as 'Low LVEF Not Detected.' This information is used to support clinical decision making regarding the need for further referral or diagnostic follow-up. Typical diagnostic follow-up could include transthoracic echocardiogram (TTE) to detect previously undiagnosed LVEF, as described in device labeling. Results should not be used to direct any therapy against LVEF itself. Tempus ECG-Low EF is not intended to replace other diagnostic tests.

Tempus ECG-Low EF does not have a dedicated user interface (UI). Input data comprising ECG tracings, tracing metadata (e.g., sample count, sample rate, patient age/sex), is provided to Tempus ECG-Low EF through standard communication protocols (e.g., file exchange) with other medical systems (e.g., electronic health record systems, hospital information systems, or other data display, transfer, storage, or format-conversion software). Results from Tempus ECG-Low EF are returned to users in an equivalent manner.

Intended Use and Technological Characteristics Comparison

The intended use of the subject and predicate devices is the same. Both are intended for analysis of 12-lead resting ECG recordings using machine-learning techniques to detect signs of cardiovascular conditions for further referral or diagnostic follow-up. The indications for use of the subject and predicate devices are similar; differences in the indications for use statement do not result in a new intended use.

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The subject device has similar technological characteristics as the predicate device. Both are machine-learning based software used to analyze recordings of resting 12-lead ECGs. Differences (e.g., in the proprietary AI algorithm) do not raise different questions of safety or effectiveness.

Summary of Non-Clinical Studies

The performance of Tempus ECG-Low EF was evaluated based on non-clinical testing, as follows:

- Software Verification and Validation (V&V): SW V&V activities were completed and all Unit Tests, Integration Tests, System Tests, and Design Inspection cases met acceptance criteria. There were no anomalies during testing.
- Cybersecurity Testing: Cybersecurity activities were completed and associated risks have been appropriately mitigated.
- Human Factors Assessment: No potential use errors were identified during analysis of FDA databases, and the completed usability assessment supports the conclusion that use-related risks have been appropriately mitigated.

Summary of Clinical Studies

Clinical performance of Tempus ECG-Low EF for analysis of ECG tracings to identify signs associated with a clinical diagnosis of low LVEF was validated in a retrospective observational cohort study, in which the device was used as intended in a representative intended use population. The model was trained on data from more than 930,000 ECGs. The average age of patients in the training dataset was 68 years. 50% of subjects were female and 50% were male. The racial distribution of the patients in the training dataset was 97% White, and 2% Black, and 1% Asian/Other/Unknown.

The model was locked prior to clinical performance validation on an independent real-world dataset derived from 4 geographically distinct US clinical sites. Patients were included in the analysis based on subjects with at least one ECG-TTE pair where the ECG occurred within 30 days prior to the TTE to determine the presence or absence of a clinical diagnosis of Low EF. Each clinical site contributed >3,500 patient records. The total study size was greater than 15,000 ECGs. The median age of study participants was 70 years. 49% of subjects were female and 51% were male. The racial distribution of the study population was 79% White, and 14% Black, 2% Asian, and 5% Other/Unknown. Various models of 12-lead ECG machines (from manufacturers GE and Philips) were represented in the study as providing ECG inputs to the device.

The point estimate for sensitivity for the prediction of LVEF ≤ 40% was 86% and the lower bound of the 95% CI was 84% which was above the predetermined acceptance criteria of 80%. The point estimate for specificity for the prediction of LVEF > 40% was 83% and the lower bound of the 95% CI was 82% which was above the predetermined acceptance criteria of 80%. The overall positive predictive value (PPV) observed in the study was 38% and the negative predictive value (NPV) was 98%. No clinically significant differences in performance were observed based on analysis of subgroups.

Demographic and clinical characteristics of the training data and performance study data are described in Table 1.

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Table 1. Demographic and Clinical Characteristics of the Training Datasets and Performance Study Dataset*

Parameter	Performance Study	Training Dataset
N	14,924	930,689
Age (in years) Mean (SD) Median Q1/Q3 Min/Max	 70 (13) 70 61-80 40-90	 66 (15) 68 57-77 18-90
Age (%) <65 ≥65 Unknown	 5,277 (35) 9,647 (65)	 387,889 (42) 540,456 (58) 2,344 (<1)
Sex (%) Female Male Unknown	 7,284 (49) 7,640 (51)	 466,701 (50) 461,287 (50) 2,701 (<1)
Race (%) White Black Asian Other Unknown	 11,842 (79) 2,028 (14) 291 (2) 584 (4) 179 (1)	 904,274 (97) 14,381 (2) 3,998 (<1) 2,908 (<1) 5,128 (1)
Ethnicity (%) Hispanic Not Hispanic Unknown	 1,344 (9) 13,514 (91) 66 (<1)	 13,506 (1) 845,441 (91) 71,742 (8)
BMI (%) <18.5 [18.5, 25) [25, 30) ≥30 Unknown	 367 (3) 3,315 (22) 4,244 (28) 6,456 (43) 542 (4)	 16,449 (2) 164,447 (18) 236,550 (25) 380,846 (41) 132,397 (14)
Clinical condition** Atrial fibrillation Aortic stenosis Cardiomyopathy Diabetes Hypertension Ischemic heart disease Myocardial infarction Mitral regurgitation	 6,223 (42) 1,877 (13) 2,344 (16) 7,422 (50) 13,226 (89) 8,348 (56) 3,369 (23) 1,832 (12)	 401,967 (43) 181,235 (19) 106,350 (11) 461,920 (50) 805,104 (87) 580,404 (62) 308,962 (33) 195,385 (21)

* Counts are based on ECG-level metrics. Note that for the performance study, there is only one ECG per patient.

** Columns sum to >100% because patients can have more than one of the included conditions.

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Substantial Equivalence Conclusion

Based on non-clinical and clinical performance testing conducted, the subject device, Tempus ECG-Low EF, is substantially equivalent to the predicate device from Anumana, Inc. (K232699). The devices have the same intended use, any differences in technological characteristics do not raise different questions of safety and effectiveness, and the results of non-clinical testing and clinical performance validation demonstrate that the subject device is substantially equivalent to the predicate device.

Table 2. Substantial Equivalence Comparison

	Predicate Device (Anumana, Inc., Low Ejection Fraction AI-ECG Algorithm, K232699)	**Subject Device (Tempus AI, Inc., Tempus ECG-Low EF, K250119)**
Intended Use	Analysis of 12-lead resting ECG recordings using machine-learning techniques to detect signs of cardiovascular conditions for further referral or diagnostic follow-up.	Same
Rx / OTC	Rx only	Same
Cardiovascular Condition Evaluated	Left Ventricular Ejection Fraction ≤40%	Same
Age of Intended Patient (Years)	Adults	40+ years
Machine-Learning based Model	Locked	Same
Input	12-lead ECG waveform in digital format	Same
Output	Detection of signs associated with LVEF ≤ 40% provided for each ECG as Low LVEF Detected, Low LVEF Not Detected, or Error.	Detection of signs associated with LVEF ≤40% provided for each ECG as Low LVEF Detected, Low LVEF Not Detected, or Unclassifiable.
Data Display	Output is provided to third party software for display of results.	Same
Hardware	Compatible 12-Lead diagnostic ECG machines with 500Hz digital output.	Same
Software	Proprietary algorithm and software	Same