510(k) SUBSTANTIAL EQUIVALENCE DETERMINATION
DECISION SUMMARY

I Background Information:

A. 510(k) Number

K253606

B. Applicant

Hamamatsu Photonics K.K.

C. Proprietary and Established Names

- NanoZoomer S20MD Slide scanner system
- NanoZoomer S360MD Slide scanner system

D. Regulatory Information

Product Code(s)	Classification	Regulation Section	Panel
PSY	Class II	21 CFR 864.3700 - Whole Slide Imaging System	PA - Pathology

II. Submission/Device Overview:

A Purpose for Submission:

i. New device-NanoZoomer S20MD Slide scanner system

ii. Modification of NanoZoomer S360MD Slide scanner system originally cleared in K213883 and K233027
- Allow remote maintenance of the NanoZoomer S360MD System using TeamViewer, Microsoft Teams, or WebEx software installed on the NanoZoomer S360MD Control PC (Dell Precision T5820 or higher).
- Change of LED for the micro camera in the S360MD Scanner.

iii. Establish a Pre-Determined Change Control Plan (PCCP; version 4.1) for qualifying and adding additional FDA-cleared displays as interoperable components to the NanoZoomer S20MD and NanoZoomer S360MD Slide scanner system.

B Type of Test:

Digital pathology whole slide imaging

III Intended Use/Indications for Use:

A Intended Use(s):

See Indications for Use below.

B Indication(s) for Use:

NanoZoomer S20MD Slide scanner system

The NanoZoomer S20MD Slide scanner system (NanoZoomer S20MD System) is an automated digital slide creation, viewing, and management system. The NanoZoomer S20MD System is for creation and viewing of digital images of scanned glass slides that would otherwise be appropriate for manual visualization by conventional light microscopy. The NanoZoomer S20MD System is intended for in vitro diagnostic use as an aid to the pathologist to review and interpret digital images of surgical pathology slides prepared from formalin-fixed paraffin embedded ("FFPE") tissue. The NanoZoomer System is not intended for use with frozen section, cytology, or non-FFPE hematopathology specimens.

It is the responsibility of a qualified pathologist to employ appropriate procedures and safeguards to assure the validity of the interpretation of images obtained using NanoZoomer S20MD System.

NanoZoomer S360MD Slide scanner system

The NanoZoomer S360MD Slide scanner system (NanoZoomer S360MD System) is an automated digital slide creation, viewing, and management system. The NanoZoomer S360MD System is for creation and viewing of digital images of scanned glass slides that would otherwise be appropriate for manual visualization by conventional light microscopy. The NanoZoomer System is intended for in vitro diagnostic use as an aid to the pathologist to review and interpret digital images of surgical pathology slides prepared from formalin-fixed paraffin embedded ("FFPE") tissue. The NanoZoomer System is not intended for use with frozen section, cytology, or non-FFPE hematopathology specimens.

It is the responsibility of a qualified pathologist to employ appropriate procedures and safeguards to assure the validity of the interpretation of images obtained using NanoZoomer System.

C Special Conditions for Use Statement(s):

Rx - For Prescription Use Only

IV Device/System Characteristics:

A. Device Description:

NanoZoomer S20MD and S360MD Slide scanner systems are automated systems for creating diagnostic-quality digital images of glass slides containing FFPE tissue. Slide images may be viewed, stored, retrieved, duplicated, annotated, and/or shared, permitting the pathologist to make a primary diagnosis based on the review of the whole-slide images (WSIs). The NanoZoomer S20MD and S360MD Slide scanner systems do not include any automated Image Analysis software or algorithms that would constitute computer aided detection or diagnosis.
The NanoZoomer S20MD System has the same basic technological characteristics as the S360MD NanoZoomer System (K233027). The NanoZoomer S20MD System uses a removable cassette (model A16696-03), which contains up to 20 standard-sized slides (length 75.0–76.5 mm, width 24.7–26.5 mm, thickness 0.9–1.2 mm). The Sakura slide basket also can be loaded with 20 slides. Slides are inserted into the slide cassette with the sample facing up and the label sticker positioned on the front side of the cassette. Slides can be scanned in batches or manually.

The S20MD System includes the following subsystems:

1. The NanoZoomer S20MD Slide scanner creates digital WSIs of conventional histological glass slides containing surgical tissue samples.
2. Identical to the software used with the NanoZoomer S360MD Slide scanner system cleared in K213883 and K233027, it directs the scanner to create and store WSI images and allows the user to view, manipulate, and annotate them on the display monitor.
    - NZAcquireMD allows the user to operate the scanner and to store and archive digital images. NZAcquireMD is software that scans pathology slides by controlling the hardware and firmware components required to acquire pathology images according to the specifications and procedures set by the user through the user interface.
    - NZViewMD allows the user to view, manipulate, and annotate the image on the monitor.
3. The display monitors, a JVC Kenwood JD-C240 (K213883) or Barco MDPC-8127 (K203364), or a 510(k)-cleared display that has been assessed in accordance with the PCCP (version 4.1) for qualifying additional interoperable displays. The display monitor allows the slide images to be viewed. The JVC display monitor is the same as that used with the S360MD System cleared in K213883 and the display were cleared for use with the S360MD in K233027.

NanoZoomer S360MD Slide scanner system is similar to NanoZoomer S360MD Slide scanner system cleared in K213883 and K233027 with the following modifications: (i) change of LED for the micro camera in the S360MD Scanner and (ii) remote maintenance of the NanoZoomer S360MD System using Teamviewer, Microsoft Teams, or WebEx software installed on the NanoZoomer S360MD Control PC.

Principles of Operation

Glass slides are first transferred to a macro stage, where a WSI is captured containing both the specimen and the de information present on each slide. This macro image is used to determine which areas of the slide need to be scanned in greater detail. Slides are then moved to a micro stage, where the NanoZoomer S20MD System uses its motorized stage, 20x objective lens, CMOS camera, and LED to detect appropriate focusing points and scan the identified areas of interest in fine detail to create a 40x equivalent high-resolution digital slide image. Low magnification is achieved by using a binning strategy, so only one objective lens is needed to create both low- and high-magnification images. Images are automatically saved to the hard disk during scanning and may be viewed later by using the included viewing software. The NZAcquireMD software organizes all WSI tiles into a single NDPI file. Each digital image covers an entire slide and typically contains billions of image pixels. The NZAcquire software allows the user to operate the scanner and to store and archive digital images.

The S20MD System can be connected to a server and a display monitor over a customer provided local area network ("LAN"). The data flow over the LAN connection is only meant for transferring, storing, or displaying images. The S20MD System does not use wireless communication in any form or any cloud communication.

B. Instrument Description Information:

a. Instrument Names:

NanoZoomer S20MD Slide scanner system and NanoZoomer S360MD Slide scanner system.

b. Specimen Identification:

Glass slides and scanned images are identified based on the previously assigned specimen identifiers such as patient identifiers, barcodes, etc. Digital images of surgical pathology slides prepared from formalin-fixed paraffin embedded (FFPE) tissue.

c. Specimen Sampling and Handling:

Specimen sampling and handling are performed upstream and independent of the use of the subject device. Specimen sampling includes surgical pathology specimens such as biopsy or resection specimens which are processed using standard histology techniques. The FFPE tissue sections are Hematoxylin and Eosin (H&E) stained. Then digital images are obtained from these glass slides using the NanoZoomer S20MD Slide scanner.

d. Calibration:

When the system is launched (powered up), automatic system diagnosis is performed by the software using the provided calibration slides. This process evaluates the proper functioning of the light source, imaging sensor, and macro sensor and light source. When necessary, based on the automatic system diagnosis, adjustment of the shading correction and color

balance correction features are performed automatically by the system. Monthly cleaning such as dusting of the scan mechanism and optical components is also performed by the user.

System administrators and field service personnel may also complete a system check following the NZAcquireMD Instructions for Use and the NZTuneMD service software and the calibration slides. This checks correction status and acquires correction data for whole slide and scanned images. Additional calibration and quality control procedures are performed during field service visits following procedures provided in the NanoZoomer S20MD and S360MD maintenance manual. These include annual testing of several critical components in the system and annual calibration of the components and the display.

e. Quality Control:

Quality control (QC) activities are performed by the user. Prior to scanning slides using the NanoZoomer S20MD and S360MD Slide scanner system, the user conducts QC of the slides per the laboratory's standards and professional guidelines (e.g., staining, cover-slipping, and barcode placement, etc.). After completing a scan, the user checks the image data and image quality using Quality Check (QC) mode in NZAcquireMD which includes the following steps:

- Display the Scan Result screen by selecting a slide for which scanning has been completed.
- Confirm scan area, focus quality, and barcode information. Confirm that the barcode information displayed above the slide image is consistent with the barcode label.
- Check the slide image to ensure all tissue on the slide are present within the scan area.

Manually verifying tissue block with the scanned images is also performed as needed. Slides are rescanned if necessary.

Before reading the scanned WSIs, the pathologist should ensure that all scanned slide images have been imported for every case, and that the images are of acceptable quality for diagnostic purposes. The pathologist reviews scanned images from all the slides associated with a case before rendering a diagnosis.

V Substantial Equivalence Information:

A. Predicate Device Name(s):

NanoZoomer S360MD Slide scanner system

B. Predicate 510(k) Number(s):

K213883, K233027

C. Comparison with Predicate(s):

The subject devices are similar to the predicate, having similar indications for use, intended use, technological characteristics as its predicate device. Each subject device has a Predetermined Change Control Plan (PCCP) that specifies the protocols and acceptance criteria for validating and adding additional FDA-cleared displays as interoperable

components to the NanoZoomer S20MD and NanoZoomer S360MD Slide scanner systems in a controlled manner, such that the device is as safe and as effective as the predicate.

The PCCPs for validating the use of additional FDA-cleared display are part of the Hamamatsu quality management system and comprise the following phases:

1. When a new FDA-cleared display is identified as the candidate, the candidate display, and its supplier will be evaluated based on various considerations. A design change request will be generated if the candidate display and its supplier pass the evaluation.
2. The candidate display will be tested with a set of FDA-approved test methods and acceptance criteria, including system-level tests for the complete WSI system specified in the PCCP. The tests will be conducted by a qualified tester according to the quality management system. If there is a failure detected during the test, the failure(s) will be recorded, and the design change will not be implemented.
3. If the candidate display meets the acceptance criteria, the design change will be implemented according to the quality management system, and the new display may be added as an interoperable component to the NanoZoomer S20MD and/or NanoZoomer S360MD Slide scanner systems without additional premarket review.
4. Any display-specific software will be verified by Hamamatsu to confirm it does not impact performance of the NanoZoomer S20MD and NanoZoomer S360MD Slide scanner systems.
5. The system labeling and company website will be revised to identify the new display according to the quality management system.

The similarities and differences between the subject and predicate devices are summarized in the Table below.

Comparison with Predicate

Device & Predicate Device(s):	**S20MD System Subject Device**	**S360MD System Subject Device**	**S360MD System Predicate Device (K233027)**
Device Trade Name	NanoZoomer S20MD Slide scanner system	NanoZoomer S360MD Slide scanner system	NanoZoomer S360MD Slide scanner system
General Device Characteristic: Similarities			
Intended Use/ Indications for Use	The NanoZoomer S20MD Slide scanner system (NanoZoomer S20MD System) is an automated digital slide creation, viewing, and management system. The NanoZoomer S20MD System is for creation and viewing of digital images of	The NanoZoomer S360MD Slide scanner system (NanoZoomer S360MD System) is an automated digital slide creation, viewing, and management system. The NanoZoomer S360MD System is for creation and viewing of	The NanoZoomer S360MD Slide scanner system ("NanoZoomer System") is an automated digital slide creation, viewing, and management system. The NanoZoomer System is intended for in vitro diagnostic use as an aid to the pathologist to review and

	scanned glass slides that would otherwise be appropriate for manual visualization by conventional light microscopy. The NanoZoomer S20MD System is intended for in vitro diagnostic use as an aid to the pathologist to review and interpret digital images of surgical pathology slides prepared from formalin-fixed paraffin embedded ("FFPE") tissue. The NanoZoomer System is not intended for use with frozen section, cytology, or non-FFPE hematopathology specimens. It is the responsibility of a qualified pathologist to employ appropriate procedures and safeguards to assure the validity of the interpretation of images obtained using NanoZoomer S20MD System.	digital images of scanned glass slides that would otherwise be appropriate for manual visualization by conventional light microscopy. The NanoZoomer S360MD System is intended for in vitro diagnostic use as an aid to the pathologist to review and interpret digital images of surgical pathology slides prepared from formalin-fixed paraffin embedded ("FFPE") tissue. The NanoZoomer System is not intended for use with frozen section, cytology, or non-FFPE hematopathology specimens. It is the responsibility of a qualified pathologist to employ appropriate procedures and safeguards to assure the validity of the interpretation of images obtained using NanoZoomer S360MD System.	interpret digital images of surgical pathology slides prepared from formalin-fixed paraffin embedded ("FFPE") tissue. The NanoZoomer System is not intended for use with frozen section, cytology, or non-FFPE hematopathology specimens. The NanoZoomer System comprises the NanoZoomer S360MD Slide scanner, the NZViewMD Software and a compatible display that has been 510(k) cleared for use with the NanoZoomer system or a 510(k)-cleared display that has been assessed in accordance with the Predetermined Change Control Plan (PCCP) for qualifying additional compatible displays. The NanoZoomer System is for creation and viewing of digital images of scanned glass slides that would otherwise be appropriate for manual visualization by conventional light microscopy. It is the responsibility of a qualified pathologist to employ appropriate procedures and safeguards to assure the validity of the interpretation of images obtained using NanoZoomer System.
Intended Use	Intended for use in primary surgical pathology diagnosis in lieu of optical microscopy	Intended for use in primary surgical pathology diagnosis in lieu of optical microscopy	Same
Viewer	NZViewMD	NZViewMD	Same
Display	JVC Kenwood JD-C24BN01A Barco MDPC-8127 Display, or FDA-cleared display validated per the PCCP to ensure performance requirements are met prior to modifications being implemented.	JVC Kenwood JD-C24BN01A Barco MDPC-8127 Display, or FDA-cleared display validated per the PCCP to ensure performance requirements are met prior to modifications being implemented.	Same
Image File Formats	NDPi file format	NDPi file format	Same
General Device Characteristic: Differences			
Slide Feeder	20 slides	360 slides	360 slides

Macro Camera	DAHENG IMAGING VEN-505-36U3C-M05 Lens: LWXD SH2806-5M	Hamamatsu C13770-50U Lens: KENKO TC1214-3MP	Hamamatsu C13770-50U Lens: KENKO TC1214-3MP
Light Source	LED CCT:6500K (CITIZEN CLU038-1210C4-653M2M2-F1)	LED CCT:6500K (CITIZEN CLU038-1210C4-653M2M2-F1)	LED CCT:6500K (CITIZEN CLU038-1210C4-653M2K1)
Remote Service of Scanner	Remote maintenance may be performed using the customer's virtual private network ("VPN") and Window's Remote Desktop Protocol ("RDP") or using Teamviewer, Microsoft Teams, or WebEx software installed on the NanoZoomer S20MD Control PC.	Remote maintenance may be performed using the customer's virtual private network ("VPN") and Window's Remote Desktop Protocol ("RDP") or using Teamviewer, Microsoft Teams, or WebEx software installed on the NanoZoomer S360MD Control PC.	Remote maintenance may only be performed using the customer's virtual private network ("VPN") and Window's Remote Desktop Protocol ("RDP"). No additional software should be installed on the computer targeted for remote maintenance.

VI Standards/Guidance Documents Referenced:

- FDA Guidance: Technical Performance Assessment of Digital Pathology Whole Slide Imaging Devices. Guidance for Industry and Food and Drug Administration Staff. April 20, 2016
- FDA Guidance: Cybersecurity in Medical Devices: Quality System Considerations and Content of Premarket Submissions Guidance for Industry and Food and Drug Administration Staff. February 2026
- FDA Guidance: Content of Premarket Submissions for Device Software Functions. Guidance for Industry and Food and Drug Administration Staff Document. June 14, 2023
- IEC 61010-1:2010 + AMD1:2016 Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General requirements
- IEC 61010-2-101:2018 Safety requirements for electrical equipment for measurement, control and laboratory use – Part 2-101: Particular requirements for in vitro diagnostic (IVD) medical equipment
- IEC 61326-2-6:2020 – Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 2-6: Particular requirements – In vitro diagnostic (IVD) medical equipment
- IEC 61326-1:2020 – Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements

VII Performance Characteristics:

A. Analytical Performance:

1. Precision/Reproducibility: The precision study was previously conducted for the predicate device (K213883) per the Special Control in 21 CFR 864.3700(b)(1)(iv)(A) and 864.3700(b)(1)(iv) (B). A new precision study was not conducted for the current device because a pixel-wise comparison study demonstrated equivalent image quality between the S20MD and S360MD Slide scanner systems.

2. Linearity:
   Not applicable

3. Analytical Specificity/Interference:
   Not applicable

4. Assay Reportable Range:
   Not applicable

5. Traceability, Stability, Expected Values (Controls, Calibrators, or Methods):
   Not applicable

6. Detection Limit:
   Not applicable

7. Assay Cut Off:
   Not applicable

8. Accuracy (Instrument):
   Not applicable

9. Carry-Over:
   Not applicable

B. Technical Performance Assessment

The following component-level technical performance assessment tests were performed with the S20MD System:

1. **Light Source:** Specifications and performance characterization of the LED light source were provided, including bulb type, spectral power distribution, output adjustment control, intensity and spectral variation over a single slide, a single workday, and the expected device lifetime.

   For the S360MD, specifications and performance characterization of the S360MD's new LED light source were provided, including intensity and spectral variation over a single slide, a single workday, and the expected device lifetime. Results of the color reproducibility test following the LED change were also provided.

2. **Imaging Optics:** Specifications and performance characterization of the imaging optics were provided, including the optical schematic, magnification, relative irradiance uniformity, optical distortion, and chromatic aberration (lateral and longitudinal).

3. **Mechanical Scanner Movement:** Specifications and performance characterization of the X-Y stage and Z stage were provided, including stage configuration, materials, method of movement, resolution, speed, travel distance, control method, and positional accuracy and repeatability.

4. **Digital Image Sensor:** Specifications and performance characterization of the digital image sensor were provided, including sensor type, pixel information, linearity, spatial uniformity, noise, dark current, electron conversion factor, and digital readout rate and output format.

5. **Image Processing Software:** Design of the embedded image processing software was provided, including pixel offset correction, white balance and shading correction, color correction, distortion correction, tile cutout and image blending, and exposure control.

6. **Image File Format:** Specifications of the NDPi proprietary file format were provided, including header, tags, file organization, compression method, compression type, and compression ratio.

7. **Image Composition:** Specifications of the image composition process were provided, including the scanning pattern, tile merging algorithm, automatic background correction, scanning speed, Z-stack depth, and focus quality metric.

8. **Image Review Manipulation Software:** Specifications of the NZViewMD viewer software were provided, including continuous panning and zooming, discrete Z-axis navigation (Z-stack), simultaneous display and synchronization of multiple images, annotation tools and digital bookmarks, image enhancement and color manipulation, and tracking of visited areas and annotations.

9. **Computer Environment:** Specifications of the Control PC and Viewer PC were provided, including the operating system, CPU, memory, storage, graphics card, display interface, and network connectivity.

The following system-level technical performance assessment tests were performed with the S20MD System:

10. **Color Reproducibility:** Test data to quantify the accuracy and precision of the end-to-end color transformation from the slide to display monitors, Barco MDPC-8127 and JVC JD-C240BN01A, were provided. The mean CIEDE2000 values for each of the three enrolled S20MDs were below the pre-defined maximum acceptable value and all three passed the test.

11. **Spatial Resolution:** Test data based on ISO 12233:2014 to evaluate the spatial resolution, including the composite optical performance of all components during the image acquisition phase, was provided using a phantom calibration slide. All three enrolled S20MDs passed the pre-defined acceptance criterion.

12. **Focusing Test:** Test data demonstrate that the focus quality is clinically acceptable for a variety of histologic preparations, including 13 different tissue types, 5 specimen thicknesses, and 9 stain types, was provided. All three enrolled S20MDs passed the pre-defined acceptance criterion.

13. **Whole Slide Tissue Coverage:** Test data based on 12 instances per tissue type, 13 different tissue types, 5 specimen thicknesses, and 9 stain types to demonstrate the ability of the S20MD to detect and acquire all tissue on a clinical slide, was provided. All three enrolled S20MDs passed the pre-defined acceptance criterion.

14. **Stitching Error Test:** Test data based on a variety of histologic preparations, including 9 different tissue types, 5 specimen thicknesses, and 9 stain types, to assess the quality of WSI stitching boundaries was provided. All three enrolled S20MDs passed the pre-defined acceptance criterion.

The following system-level technical performance assessments for the S20MD System utilize data submitted for the S360MD System in K213883:

- Display (K213883 and K233027)
- Turnaround Time

NanoZoomer S20MD and S360MD Slide Scanner System Pixel-Wise Comparison Study:

A pixel-wise comparison (PWC) study was conducted to evaluate the difference in image quality between NanoZoomer S20MD and S360MD Slide scanner systems. Most of the components in the imaging pipelines of the predicate and subject devices are identical. Therefore, a PWC study was conducted in lieu of a clinical study to assess the image quality equivalency between the devices. The test data was to demonstrate that the difference between subject and predicate device instances, i.e., systems with the same model numbers but different serial numbers, is equal to or less than that among FDA-cleared predicate device instances. For each comparison, two scanned images of the same glass slide—generated by two different device instances—were compared at the pixel level using the standard CIEDE2000 color difference metric (ΔE). Each comparison yielded a distribution of ΔE values, and the Wasserstein-1 metric was used to quantify the distance between two ΔE distributions, where a smaller distance indicates greater agreement between the distributions. The acceptance criterion, i.e., image quality equivalence between the subject scanner units and predicate scanner units, was met if the minimum W1 distance to a predicate unit was lower than the maximum W1 distance observed among predicate-unit (S360MD) comparisons.

The study was conducted with three S20MD units and three S360MD units using 13 clinical glass slides. Study results showed that all S20MD units met the predefined acceptance criterion.

C. Clinical Studies

No clinical studies were required to demonstrate substantial equivalence of the NanoZoomer S20MD Slide scanner system or modified NanoZoomer S360MD Slide scanner system since PWC studies demonstrated image quality equivalency between the devices.

VIII Pre-determined Change Control Plan (PCCP)

Hamamatsu provided PCCP (version 4.1) is similar to PCCP cleared in K233027 and will be followed to validate compatibility of additional FDA-cleared displays with the NanoZoomer S20MD Slide scanner system and NanoZoomer S360MD Slide scanner system, including

specific performance requirements that must be met prior to updating the device labeling to reference the newly added displays. The PCCP also includes verification that any display-specific software will not impact performance of the NanoZoomer S20MD and 360MD software. With inclusion of the PCCP, future changes to add additional FDA-cleared displays to the labeling can be made in accordance with the PCCP without a premarket submission. The Hamamatsu website will provide information on additional displays that are compatible with the NanoZoomer S20MD and S360MD Slide scanner systems and allow users to request updated versions of the system labeling.

IX Proposed Labeling:

The labeling supports the finding of substantial equivalence for NanoZoomer S20MD Slide scanner system and NanoZoomer S360MD Slide scanner system.

X Conclusion:

The submitted information on the NanoZoomer S20MD Slide scanner system and S360MD Slide scanner system in this premarket notification is complete and supports a substantial equivalence decision to the predicate device cleared in K233027.