

HiSeq X System

Lab Setup and Site Prep Guide

For Research Use Only. Not for use in diagnostic procedures.

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Introduction

This guide provides specifications and guidelines for preparing your site for installation and operation of the Illumina® HiSeq X® instrument. The HiSeq X Ten system comprises a suite of 10 HiSeq X instruments. The HiSeq X Five comprises a suite of 5 HiSeq X instruments. Either configuration can be used in a lab equipped for Illumina SeqLab.



NOTE

To calculate dimensions and specifications for a HiSeq X Ten or a HiSeq X Five system lab, multiply the requirements listed for a single instrument by the total number of instruments to be installed.

- ▶ Laboratory space requirements
- ▶ Electrical requirements
- ▶ Environmental constraints
- ▶ Computing requirements
- ▶ User-supplied consumables and equipment

Safety Considerations

See the *HiSeq X System Safety and Compliance Guide (document # 15050094)* for important information about safety considerations.

Additional Resources

The following documentation is available for download from the Illumina website.

Resource	Description
<i>Custom Protocol Selector</i>	A wizard for generating customized end-to-end documentation that is tailored to the library prep method, run parameters, and analysis method used for the sequencing run.
<i>TruSeq Nano DNA Sample Prep Guide (document # 15041110)</i>	Provides instructions for preparing TruSeq Nano DNA libraries.
<i>TruSeq DNA PCR-Free Sample Prep Guide (document # 15036187)</i>	Provides instructions for preparing TruSeq DNA PCR-Free libraries.
<i>HiSeq X System Safety and Compliance Guide (document # 15050094)</i>	Provides information about instrument labeling, compliance certifications, and safety considerations.
<i>HiSeq X System Guide (document #15050091)</i>	Provides an overview of instrument components and software, instructions for preparing sequencing reagents and performing sequencing runs, and procedures for instrument maintenance and troubleshooting.

Visit the HiSeq X support page on the Illumina website for access to documentation, software downloads, online training, and frequently asked questions. For information specific to Illumina SeqLab, visit the Illumina SeqLab support page.

Delivery and Installation

An authorized service provider delivers the system, uncrates components, and places the instrument on the lab bench. Make sure that the lab space and bench are ready before delivery.



CAUTION

Only authorized personnel can uncrate, install, or move the instrument. Mishandling of the instrument can affect the alignment or damage instrument components.

An Illumina representative installs and prepares the instrument. When connecting the instrument to a data management system or remote network location, make sure that the path for data storage is selected before the date of installation. The Illumina representative can test the data transfer process during installation.



CAUTION

After your Illumina representative has installed and prepared the instrument, *do not* relocate the instrument. Moving the instrument improperly can affect the optical alignment and compromise data integrity. If you have to relocate the instrument, contact your Illumina representative.

Crate Dimensions and Contents

The HiSeq X instrument and components are shipped in 3 crates. Use the following dimensions to determine the minimum door width required to accommodate the shipping crates.

- ▶ Crate #1 contains the instrument.
- ▶ Crate #2 contains an uninterruptible power supply (Japan, North America, or an international version).
- ▶ Crate #3 contains the following items:
 - ▶ Instrument control computer, monitor, and monitor arm
 - ▶ Waste bottle and reagent racks
 - ▶ Instrument panels
 - ▶ Power cords—1 domestic power cord or 3 international power cords (UK, EU, and China)

Measurement	Crate #1: Instrument	Crate #2: UPS	Crate #3: Computer, Covers, and Power Cords
Width	165 cm (65 in)	78 cm (31 in)	115 cm (45 in)
Height	122 cm (48 in)	51 cm (20 in)	102 cm (40 in)
Depth	107 cm (42 in)	61 cm (24 in)	82 cm (32 in)
Weight	317 kg (698 lb)	81 kg (177 lb)	125 kg (265 lb)

System Configuration

The HiSeq X system comprises the instrument, monitor, instrument control computer, barcode scanner, keyboard, mouse, and universal power supply. The instrument control computer is a dedicated subsystem of the instrument and is not intended for use as a general-purpose computer.

Principles of Production Lab Layout and Design

The following guidelines assume that starting material is extracted DNA and do not include provisions for DNA extraction from starting material. If extraction is part of the production facility, additional space is required.

Pre-PCR and Post-PCR Lab Areas

- ▶ To avoid cross-contamination, establish a pre-PCR area with lab coats in separate gowning areas and positive air pressure.
- ▶ Establish dedicated entrances to the pre-PCR area. Make sure that lab personnel do not have to pass through the post-PCR lab area to access the pre-PCR area.
- ▶ A pass-through is recommended for material transfer from the pre-PCR area to the post-PCR area.
 - ▶ A pass-through can be ordered from several industrial scientific catalogs.
 - ▶ Example ordering information: Pass-Through, Acrylic, 24"W x 24"D x 24"H, wall mount with brackets, Terra Universal.com, part # 1992-51D.
- ▶ Do not pass material or equipment from the post-PCR area to the pre-PCR area. Purchase separate equipment for each area.
- ▶ Make sure that the post-PCR is negatively pressurized.

Cold Storage

- ▶ Make sure that freezers and refrigerators have temperature monitors and alarm systems that activate in the event of a system failure, and send a notification to users that an event has occurred.
- ▶ A combination walk-in freezer/refrigerator for the storage of reagents is a cost-effective solution for production-level operations.
- ▶ Allow sufficient cold storage in the lab area for a minimum of 3 days of operation for reagents and work-in-progress samples. Additional cold storage can be outside of the lab area. For more information, see *Space Requirements* on page 8.

Waste

- ▶ Establish provisions for liquid and solid hazardous waste collection and disposal. For more information, see *Hazardous Waste Production* on page 31.
- ▶ Consult your local regulations for universal precautions regarding the handling of biohazardous material.

Facilities

- ▶ Make sure that there is at least 1 sink in each lab area and ice machines in both labs.
- ▶ Make sure that each lab has access to Milli-Q water or an equivalent water source.
- ▶ Follow local ordinances for fire suppression systems and chemical safety showers.

Service Area

For optimal production efficiency, establish a service area for use if an instrument requires extended service interactions.



CAUTION

Only authorized personnel can move the instrument. Mishandling the instrument can affect alignment or damage components.

Example HiSeq X Ten Lab Layout

The following figure provides an example layout for 10 HiSeq X instruments, 5 cBot instruments, 4 liquid handling automation robots, and ancillary lab equipment. This example layout requires approximately 84 square meters (900 sq ft):

- ▶ 28 square meters (300 sq ft) pre-amplification
- ▶ 56 square meters (600 sq ft) post-amplification

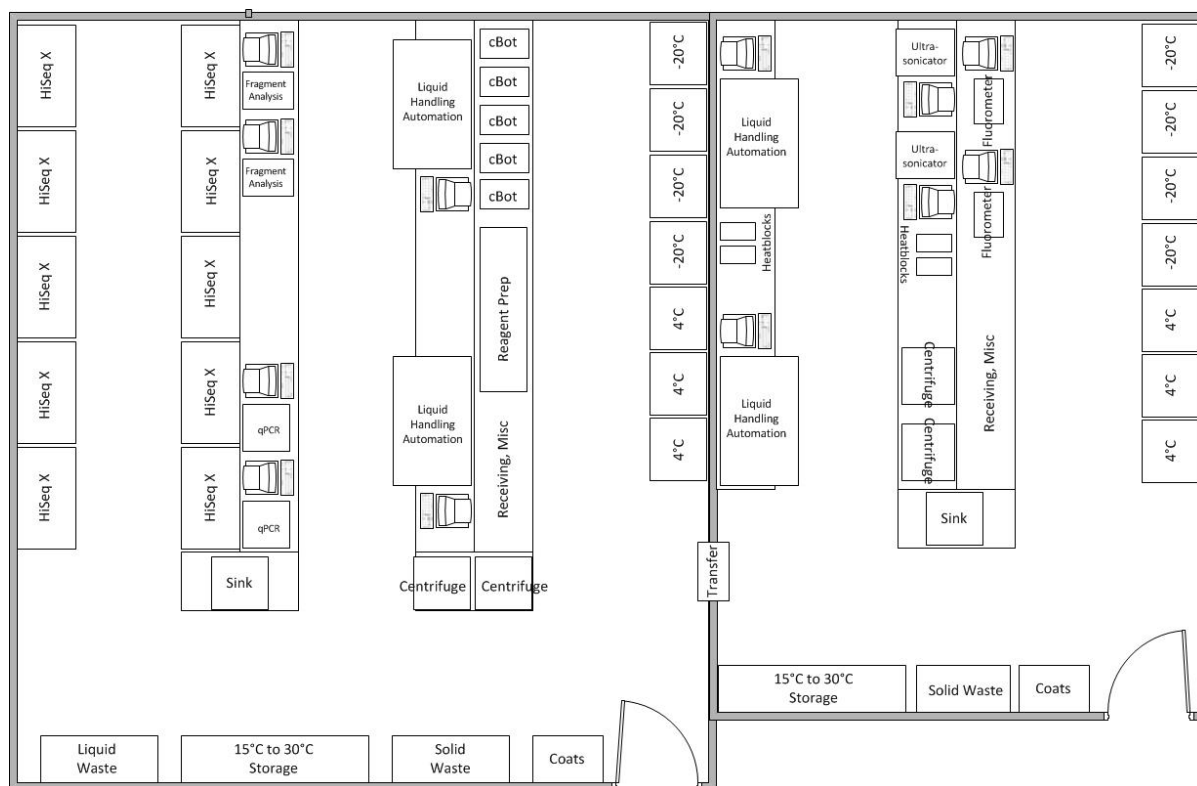
Allow an additional 19 square meters (200 sq ft) for miscellaneous storage.



NOTE

Follow placing requirements and minimum allowances. For more information, see *Placement Requirements* on page 13 and *Principles of Production Lab Layout and Design* on page 5.

Figure 1 HiSeq X Ten Example Lab Layout (not to scale)



HiSeq X Five Lab Layout

To configure your lab for the HiSeq X Five system, use the same general lab layout as HiSeq X Ten. For details about instrument placement and ancillary equipment, see *Space Requirements* on page 8 and *User-Supplied Consumables and Equipment* on page 24.

Equipment for Illumina SeqLab

Although labs configured for Illumina SeqLab use specific equipment, the same general dimensions and placement shown in the example lab layout apply. For Illumina SeqLab equipment requirements, see *Estimated Minimum Space Requirements for HiSeq X Ten* on page 8 or *Estimated Minimum Space Requirements for HiSeq X Five* on page 9.

Space Requirements

Instrument placement and lab layout depend on how your lab space is configured. However, you can use the following estimated space requirements to determine the best lab layout for your facility.



NOTE

Follow placing requirements and minimum allowances. For more information, see *Placement Requirements* on page 13.

The HiSeq X Ten and HiSeq X Five systems are high-throughput systems and can require significant storage space for sequencing consumables depending on your inventory requirements. For efficient production-level operation and risk reduction, maintain a minimum inventory of library preparation and sequencing consumables using the following guidelines:

- ▶ With an arranged reagent ship schedule, maintain a 2-week inventory.
- ▶ Without a reagent ship schedule, maintain a 3-week inventory.

Estimated Minimum Space Requirements for HiSeq X Ten

Lab Area	Equipment		Minimum Space	Recommended Space
	General Purpose	Illumina SeqLab		
Pre-PCR	Covaris LE220	Covaris LE220	24.43 m ² (263 ft ²)	35.58 m ² (383 ft ²)
	Liquid handling automation	Hamilton Microlab STAR		
	Fluorometer	Molecular Devices SpectraMax (M Series or Gemini XPS) Microplate Reader		
	Centrifuge Bench space	Centrifuge Bench space		
Post-PCR	HiSeq X instruments	HiSeq X instruments	60.67 m ² (653 ft ²)	71.81 m ² (773 ft ²)
	Liquid handling automation	Hamilton Microlab STAR		
	qPCR instruments	Roche LightCycler 480 Real-Time PCR system		
	cBot instruments	cBot 2 instruments		
	Centrifuge	Centrifuge		
	Fragment analysis instruments	PerkinElmer Caliper GX		
	Bench space	Bench space		

Maintaining a 3-week inventory of library preparation and sequencing consumables requires the following storage space.

Lab Area	-25°C to -15°C	2°C to 8°C	15°C to 30°C
Pre-PCR	36 L (1.28 ft ³)	9.6 L (0.34 ft ³)	--
Post-PCR (single-pack)	1639 L (57.89 ft ³)	41.3 L (1.46 ft ³)	1.72 m ³ (60.56 ft ³)
Post-PCR (10-pack)	1042 L (36.81 ft ³)	44.2 L (1.56 ft ³)	1.75 m ³ (62.04 ft ³)

Estimated Minimum Space Requirements for HiSeq X Five

Lab Area	Equipment		Minimum Space	Recommended Space
	General Purpose	Illumina SeqLab		
Pre-PCR	Covaris LE220 Liquid handling automation Fluorometer Centrifuge Bench space	Covaris LE220 Hamilton Microlab STAR Molecular Devices SpectraMax (M Series or Gemini XPS) Microplate Reader Centrifuge Bench space	24.43 m ² (263 ft ²)	35.58 m ² (383 ft ²)
Post-PCR	HiSeq X instruments Liquid handling automation qPCR instruments cBot instruments Centrifuge Fragment analysis instruments Bench space	HiSeq X instruments Hamilton Microlab STAR Roche LightCycler 480 Real-Time PCR system Centrifuge PerkinElmer Caliper GX Bench space	43.20 m ² (465 ft ²)	54.35 m ² (585 ft ²)

Maintaining a 3-week inventory of library preparation and sequencing consumables requires the following storage space.

Lab Area	-25°C to -15°C	2°C to 8°C	15°C to 30°C
Pre-PCR	18 L (0.64 ft ³)	4.8 L (0.17 ft ³)	--
Post-PCR (single-pack)	819 L (28.94 ft ³)	20.6 L (0.73 ft ³)	0.86 m ³ (30.28 ft ³)
Post-PCR (10-pack)	579 L (20.45 ft ³)	24.6 L (0.87 ft ³)	0.97 m ³ (34.47 ft ³)

Reagent Kit Storage Dimensions of Single-Pack Kits

The following quantities and dimensions represent components in a single-pack HiSeq X Ten v2.5 reagent kit.

Kit Component	Quantity	Storage	Length	Width	Height
PE Cluster Kit (Box 1 of 2)	2	-25°C to -15°C	19.7 cm (7.75 in)	14 cm (5.50 in)	8.9 cm (3.50 in)
PE Cluster Kit (Box 2 of 2)	2	-25°C to -15°C	22.2 cm (8.75 in)	6.3 cm (2.50 in)	15.2 cm (6.00 in)
Patterned Flow Cell	2	2°C to 8°C	19 cm (7.50 in)	10 cm (4.00 in)	1.3 cm (0.50 in)
Hybridization Manifold	2	15°C to 30°C	24 cm (9.50 in)	14 cm (5.50 in)	8.5 cm (3.38 in)
SBS Kit (Box 1 of 2)	2	15°C to 30°C	20.3 (8.00 in)	13.3 cm (5.25 in)	19 cm (7.50 in)
SBS Kit (Box 2 of 2)	2	-25°C to -15°C	20.3 (8.00 in)	13.3 cm (5.25 in)	19 cm (7.50 in)
Accessories Kit	2	15°C to 30°C	22.2 cm (8.75 in)	6.3 cm (2.50 in)	15.2 cm (6.00 in)

Reagent Kit Storage Dimensions of 10-Pack Kits

The following quantities and dimensions represent components in a 10-pack HiSeq X v2.5 reagent kit.

Kit Component	Quantity	Storage	Length	Width	Height
PE Cluster Kit (Box A)	1	-25°C to -15°C	48 cm (18.90 in)	30.8 cm (12.12 in)	11.3 cm (4.44 in)
PE Cluster Kit (Box B)	1	-25°C to -15°C	10 cm (4.00 in)	8.1 cm (3.20 in)	5.8 cm (2.30 in)
PE Cluster Kit (Box C)	1	-25°C to -15°C	45.1 cm (17.75 in)	25.4 cm (10.00 in)	14.2 cm (5.60 in)
Patterned Flow Cell	20	2°C to 8°C	19 cm (7.50 in)	10 cm (4.00 in)	1.3 cm (0.50 in)
Hybridization Manifold	20	15°C to 30°C	24 cm (9.50 in)	14 cm (5.50 in)	8.5 cm (3.38 in)
Accessories Kit (Box A)	1	15°C to 30°C	24.9 cm (9.80 in)	19.7 cm (7.75 in)	13.3 cm (5.25 in)
Accessories Kit (Box B)	1	15°C to 30°C	26.2 cm (10.30 in)	22.8 cm (9.00 in)	12 cm (4.75 in)
SBS Kit (Box A)	1	15°C to 30°C	40 cm (15.75 in)	17.8 cm (7.00 in)	19.3 cm (7.60 in)
SBS Kit (Box B)	2	15°C to 30°C	40 cm (15.75 in)	17.8 cm (7.00 in)	19.3 cm (7.60 in)
SBS Kit (Box C)	6	15°C to 30°C	40 cm (15.75 in)	17.8 cm (7.00 in)	19.3 cm (7.60 in)
SBS Kit (Box D)	2	-25°C to -15°C	40 cm (15.75 in)	17.8 cm (7.00 in)	19.3 cm (7.60 in)
SBS Kit (Box E)	2	-25°C to -15°C	40 cm (15.75 in)	17.8 cm (7.00 in)	19.3 cm (7.60 in)
SBS Kit (Box F)	2	-25°C to -15°C	40 cm (15.75 in)	17.8 cm (7.00 in)	19.3 cm (7.60 in)

Library Prep Kit Storage Dimensions

The following quantities and dimensions represent components in the TruSeq Nano DNA kit and TruSeq PCR-Free kit.

Table 1 TruSeq Nano DNA Kit

Kit Component	Quantity	Storage	Length	Width	Height
TruSeq Nano DNA Sample Prep	1	-25°C to -15°C	21.5 cm (8.5 in)	14.5 cm (5.7 in)	6 cm (2.4 in)
Sample Purification Beads Box	1	2°C to 8°C	14.5 cm (5.7 in)	8.5 cm (3.3 in)	5.5 cm (2.2 in)
Adapter Plate Box	1	-25°C to -15°C	14.5 cm (5.7 in)	8.5 cm (3.3 in)	5.5 cm (2.2 in)

Table 2 TruSeq PCR-Free Kit

Kit Component	Quantity	Storage	Length	Width	Height
TruSeq DNA PCR-Free Sample Prep	1	-25°C to -15°C	21.5 cm (8.5 in)	14.5 cm (5.7 in)	6 cm (2.4 in)
Sample Purification Beads Box	1	2°C to 8°C	14.5 cm (5.7 in)	8.5 cm (3.3 in)	5.5 cm (2.2 in)
Adapter Plate Box	1	-25°C to -15°C	14.5 cm (5.7 in)	8.5 cm (3.3 in)	5.5 cm (2.2 in)

Lot Number Tracking

Upon receipt of your inventory, Illumina recommends that you enter lot numbers into an inventory tracking system. Tracking lot numbers helps confirm inventory and monitor expiration dates. Implement a first in, first out policy for using reagents to ensure the most efficient use of inventory.

Laboratory Requirements

Use the following specifications and guidelines to determine required lab space.

HiSeq X Dimensions

The instrument and instrument control computer have the following dimensions after installation.

Dimension	Instrument	Instrument Control Computer
Width	118.6 cm (46.7 in) The waste bottle extends an additional 10 cm (4.0 in) on the right side of the instrument.	18 cm (7.0 in)
Height	94 cm (37.0 in) minimum The instrument height is adjustable to an additional 1.27 cm (0.5 in).	45 cm (17.7 in)
Depth	76 cm (30.0 in) The keyboard tray extends an additional 19 cm (7.5 in) from the front panel.	28 cm (11.0 in)
Weight	226 kg (498 lb)	34 kg (75 lb)

Placement Requirements

The following requirements ensure access to the instrument power switch and power outlet, allow proper ventilation, and provide sufficient access for servicing the instrument.

- ▶ Position the instrument so that personnel can reach around the right-side of the instrument to turn on or turn off the power switch on the back panel adjacent to the power cord.
- ▶ Position the instrument so that personnel can quickly disconnect the power cord from the outlet.
- ▶ Make sure that the instrument is accessible from all sides using the following minimum clearance dimensions.

Access	Minimum Clearance
Sides	Allow at least 61 cm (24 in) on each side of the instrument.
Rear	Allow at least 10.2 cm (4 in) behind the instrument. If instruments are positioned back to back, allow 21–38 cm (8–15 in) of clearance between instruments.
Top	Allow at least 61 cm (24 in) above the instrument. If the instrument is positioned under a shelf, make sure that the minimum clearance requirement is met.

Vibration Guidelines for the HiSeq X

Use the following guidelines to minimize vibrations during sequencing runs and ensure optimal performance:

- ▶ Place the instrument on a sturdy immobilized lab bench.
- ▶ Do not install the instrument near frequently used doors. Opening and closing of doors might induce vibrations.
- ▶ Do not install a keyboard tray that hangs below the bench.
- ▶ Do not place other equipment on the bench that can produce vibrations, such as a shaker, vortexer, centrifuge, or instruments with heavy fans.
- ▶ Do not place objects on top of the instrument.

Lab Bench Guidelines for the HiSeq X

Place the HiSeq X on a mobile lab bench with locking casters and a bottom shelf capable of supporting the instrument control computer. The bench must support the weight of the instrument and instrument control computer.

Width	Height	Depth	Locking Casters
152.4 cm (60 in)	76.2–91.4 cm (30–36 in)	76.2 cm (30 in)	Yes

For North American customers, Illumina recommends the following mobile lab benches: Bench-Craft (www.bench-craft.com), part # HS-30-60-30 P2 with casters or part # HS-30-60-36 P2 with casters.

- ▶ **HS** indicates standard bench
- ▶ **30-60-30** indicates 30 inch wide x 60 inch long x 30 inch high
- ▶ **30-60-36** indicates 30 inch wide x 60 inch long x 36 inch high
- ▶ **P2** indicates outlets on rear of bench

You can order any of the following casters for use with either of the recommended lab benches.

Caster	Supplier
Zinc casters	Bench-Craft, part # C-ML4**TPS
Medical-grade composite casters	Bench-Craft, part # PZT40120GR-TPR33(GG)
Stainless steel casters	Bench-Craft, part # 94-20-DADI-M-PO-SS-TL

Lab Bench Guidelines for the Hamilton Microlab STAR

For labs using the Hamilton Microlab STAR (ML STAR) for automated library preparation, place the instrument on an immobile lab bench with A-frame support. A bottom shelf is optional for additional storage. The bench must support the weight of the instrument and be sturdy enough to withstand pipetting arm movements.

Width	Height	Depth	Castors
243.8 cm (96 in)	91.4 cm (36 in)	91.4 cm (36 in)	None

For more information about the ML STAR, see the *Hamilton Microlab STAR Reference Guide* (document # 15070074).

cBot Dimensions

For clustering flow cells, Illumina recommends at least 5 cBot instruments for use with the HiSeq X Ten system.

Using the HiSeq X Five system requires at least 2 cBot instruments for clustering flow cells. For labs running at full capacity, at least 4–6 cBot instruments are recommended to manage capacity efficiently.

If you plan to use the 10-pack reagent kit, at least 4 cBot instruments are required. The 10-pack kit is packaged so that 4 flow cells are prepared at the same time, which requires that 4 cBot instruments are available for clustering.

Measurement	cBot 2 Dimensions	cBot Dimensions
Height (lid open)	71 cm (28 in)	70 cm (27.5 in)
Height (lid closed)	45 cm (17.75 in)	39 cm (15.5 in)
Depth	62 cm (24.5 in)	62 cm (24.5 in)
Width	38 cm (15 in)	38 cm (15 in)
Weight	30 kg (66 lbs)	31 kg (68 lbs)

For more information about cBot, see the *cBot 2 System Guide* (document # 15065681) or the *cBot System Guide* (document # 15006165).

Electrical Requirements

The following specifications describe electrical requirements for operating the instrument.

Power Specifications

Type	Specification
Line Voltage	100–240 VAC at 50–60 Hz
Power Consumption	Maximum 1500 Watts combined for the instrument, monitor, and work station

Receptacles

Your facility must be wired with the following equipment.

- ▶ **For 100–120 Volts AC**—A 20-amp grounded dedicated line with proper voltage and electrical ground is required.
North America and Japan—Receptacle: NEMA 5-20
Interpower Corp. Receptacle, part # 88030080 (or equivalent)
- ▶ **For 200–240 Volts AC**—At minimum, 10-amp grounded line with proper voltage and electrical ground is required. Use a higher rating as needed according to requirements for your region.
- ▶ If the voltage fluctuates more than 10%, a power line regulator is required.

Protective Earth



The instrument has a connection to protective earth through the enclosure. The safety ground on the power cord returns protective earth to a safe reference. The protective earth connection on the power cord must be in good working condition when using this device.

Power Cords

The instrument is equipped with an international standard IEC 60320 C13 receptacle and is shipped with a region-specific power cord.

Hazardous voltages are removed from the instrument only when the power cord is disconnected from the AC power source.

To obtain equivalent receptacles or power cords that comply with local standards, consult a third-party supplier such as Interpower Corporation (www.interpower.com).



CAUTION

Never use an extension cord to connect the instrument to a power supply.

Fuses

Only Illumina field personnel are qualified to replace internal fuses. The power entry module includes 2 input fuses on the high-voltage input lines. The fuses are size 5x20 and rated for 10 Amps, 250 VAC, Slo-Blo.

Uninterruptible Power Supply

The instrument is shipped with a region-specific uninterruptible power supply (UPS).

- ▶ **Japan**—APC SmartUPS 2200VA Model SUA2200JB
- ▶ **North America**—APC SmartUPS 2200VA Model SUA2200XL
- ▶ **International**—APC SmartUPS 2200VA Model SUA2200XLI

Specification	Japan	North America	International
Maximum Watts	1980 W	1980 W	1980 W
Maximum Current	2200 VA	2200 VA	2200 VA
Input Voltage (nominal)	100 VAC	120 VAC	230 VAC
Input Connection	NEMA L5-30P	NEMA 5-20P	IEC-320 C20 Schuko CEE 7/EU1-16P British BS1363A
Typical Run Time (50% load)	28.5 minutes	28.5 minutes	28.5 minutes
Typical Run Time (100% load)	10.4 minutes	10.4 minutes	10.4 minutes

To obtain an equivalent UPS that complies with local standards for facilities outside the referenced regions, consult a third-party supplier such as Interpower Corporation (www.interpower.com).



NOTE

The UPS *cannot* maintain the instrument during an extended power outage. Illumina recommends that the UPS receptacle is connected to a backup electrical source, such as a generator, to ensure minimal loss of data during an extended power outage.

Environmental Considerations

Element	Specification
Temperature	Maintain a lab temperature of 19°C to 25°C (22°C \pm 3°C). This temperature is the operating temperature of the instrument. During a run, do not allow the ambient temperature to vary more than \pm 2°C.
Humidity	Maintain a noncondensing relative humidity between 20–80%.
Elevation	Locate the instrument at an altitude below 2000 meters (6500 feet).
Air Quality	Operate the instrument in a Pollution Degree II environment or better. A Pollution Degree II environment is defined as an environment that normally includes only nonconductive pollutants.
Ventilation	Consult your facilities department for ventilation requirements based on the instrument heat output specifications.

Noise Output

Noise output is 65 dB when standing 1 meter (3.3 feet) from the front of the instrument.

Heat Output

Measured power is 1000 Watts for each combined instrument, computer, and monitor under normal operating conditions. Thermal output is 3400 BTU/hour.



CAUTION

Do not operate the HiSeq X Ten with any of the panels removed. Do not touch the temperature station in the imaging compartment. The Peltier effect heater used in the stage area is normally controlled between ambient room temperature (22°C) and 85°C. Exposure to temperatures at the upper end of this range could result in burns.

Instrument Control Computer

The instrument is shipped with an instrument control computer that is customized to the latest system requirements. Contact Illumina Technical Support for more information about the computer specifications.

The instrument control computer is a dedicated subsystem of the instrument and is not intended for use or supported as a general-purpose computer. Loading and using third-party software can result in slow processing, loss of data, or invalid data.

Data Connections

The HiSeq X has 5 connections to the controlling computer:

- ▶ One USB connection for communication between the instrument and the computer. A standard USB type A to type B style connector is used.
- ▶ Four low voltage differential signaling (LVDS) CameraLink connections for the 2 main cameras. Standard CameraLink cables are used. The cameras transfer raw data from the instrument to the computer.

Antivirus Software

An antivirus software of your choice is highly recommended to protect the instrument control computer against viruses.

To avoid data loss or interruptions, configure the antivirus software as follows:

- ▶ Set for manual scans. Do not enable automatic scans.
- ▶ Perform manual scans only when the instrument is not in use.
- ▶ Set updates to download without user authorization, but not install.
- ▶ Do not update during instrument operation. Update only when the instrument is not running and when it is safe to reboot the instrument computer.
- ▶ Do not reboot the computer automatically upon update.
- ▶ Exclude the application directory and data drives from any real-time file system protection. Apply this setting to the C:\Illumina directory, O:\ drive, and S:\ drive.

Network Considerations

Illumina does not provide installation or technical support for networking instrument control computers. However, you can configure and maintain a network connection on the instrument control computer after installation of the instrument.

- ▶ Use a 1 gigabit connection between the instrument control computer and your data management system. This connection can be made directly or through a network switch.



NOTE

Illumina does not recommend or support using a greater than 1 gigabit connection per instrument control computer, such as a Fiber Channel PCI card.

- ▶ If you are using BaseSpace, Illumina recommends the following minimum network connections.

BaseSpace Use During Run	HiSeq X (per Instrument)	HiSeq X Five (per 5 Instruments)	HiSeq X Ten (per 10 Instruments)
Data transfer of base call (BCL) files	100 Mbps	0.5 Gbps	1 Gbps
Send instrument health and run monitoring only	1 Mbps	5 Mbps	10 Mbps

- ▶ Upon connection to a network, configure Windows Update so that system does not update automatically. Illumina recommends waiting 1 month after a Windows release before allowing an update.

Network Support

Illumina does not install or provide technical support for network connections.

Review network maintenance activities for potential compatibility risks with the Illumina system, including the following risks:

- ▶ **Removal of the Group Policy Objects (GPOs)**—GPOs can affect the operating system (OS) of connected Illumina resources. OS changes can disrupt the proprietary software in Illumina systems.
- ▶ Illumina instruments have been tested and verified to operate correctly. After connecting to domain GPOs, some settings might affect the instrument software. If the instrument software operates incorrectly, consult your facility IT administrator about possible GPO interference.
- ▶ **Activation of Windows Firewall and Windows Defender**—These Windows products can affect the OS resources used by Illumina software. Install antivirus software to protect the instrument control computer.
- ▶ **Changes to the privileges of preconfigured users**—Maintain existing privileges for preconfigured users. Make preconfigured users unavailable as needed.

Multiple Instruments

- ▶ Make sure that the server drive is sufficient for the high volume of data being transferred from multiple instruments. Consider setting up the instruments to copy to different servers.

- ▶ Make sure that the connection to analysis servers is sufficient for the high volume of data being transferred from multiple instruments. Consider setting up the instruments to use different connections or use a higher bandwidth link for the shared connection, such as 10 gigabit.

Data Analysis and Storage Requirements

For each flow cell, a sequencing run and subsequent secondary analysis generates files of approximately the following file sizes:

- ▶ BCL files: 620 GB
- ▶ Thumbnail Images folder: 60 GB
- ▶ InterOp folder: 75–80 MB
- ▶ FASTQ files: 700 GB
- ▶ BAM files: 600 GB
- ▶ VCF files: 28 GB

The following information is provided as guidelines for building an infrastructure to support data generated with the HiSeq X system. Analysis times are examples and do not represent Illumina specifications.



NOTE

Because actual data retention can be subject to local policies, confirm conditions before calculating storage needs.

This information assumes that a dual flow cell run generates 1.8 terabases (Tb) of data at a 100% rate of use on each instrument. Adjust the numbers in the table for a lower rate of use. If you expect to perform repeat analysis of data sets, increase the number of compute nodes and storage proportionately.



NOTE

The following recommendations do not include storage for data backup and archival.

	Illumina Algorithms ¹			BWA + GATK ²		
	Five Instruments	Ten Instruments	Each Additional Instrument	Five Instruments	Ten Instruments	Each Additional Instrument
Number of computer nodes ³	7	14	2	43	85	9
Analysis time 30X whole-genome sequencing	6 hours	6 hours	6 hours	38 hours	38 hours	38 hours
BAM online storage 10 runs/1 month per system ¹	60 TB	120 TB	12 TB	60 TB	120 TB	12 TB
VCF online storage 10 runs/1 month per system	1.5 TB	3 TB	0.3 TB	1.5 TB	3 TB	0.3 TB
BAM archive storage 120 runs/1 year per system ⁴	720 TB	1440 TB	144 TB	720 TB	1440 TB	144 TB
VCF archive storage 120 runs/1 year per system	18 TB	36 TB	3.6 TB	18 TB	36 TB	3.6 TB

¹ Whole-genome sequencing analysis with HiSeq Analysis Software v2.0.

² BWA v0.7.9a; GATK v1.6.

³ Per node, 20 CPU cores @ 2.8 GHz, 128 GB of memory, 6 x 1 terabyte (TB) hard drives. Increase speed by increasing CPU cores or clock speed; maximum coverage supported is > 240X.

⁴ Storing raw sequencing data in the form of BCL and FASTQ files long term is not necessary. These files can be deleted after the creation of BAM/VCF files. If necessary, FASTQ files can be regenerated from BAM files.

User-Supplied Consumables and Equipment

The following user-supplied consumables and equipment are used for library preparation, clustering on the cBot, and sequencing on the HiSeq X. For more information, see the *HiSeq X System Guide (document #15050091)*.

Library Prep Consumables

Consumable	Supplier	Monthly Usage	Purpose
96-well FLUOTRAC plates, black	General lab supplier Greiner Bio-One, part # 655076	Varies	Library preparation: Quant DNA on SpectraMax
96-well PCR plates (HSP), Hard-Shell	General lab supplier Bio-Rad, part # HSP-9601		Library preparation: PCR steps
96-well PCR plates, 0.3 ml skirtless, or 96-well PCR plates, Twin.tec	General lab supplier E&K Scientific, part # 480096 Eppendorf, part # 951020303	2 cases (25/case) ¹ 1 case (25/case) ²	Library preparation: PCR steps
96-well PCR plates (TCY), 0.2 ml full-skirted	Thermo Scientific, part # AB-0800150		Automated library preparation: PCR steps
96-well storage plates (midi), 0.8 ml round well	Thermo Scientific, part # AB-0859	5 cases (50/case) ¹ 3 cases (50/case) ²	Library preparation
96-well storage plates (super midi), 1.2 ml round well	Thermo Scientific, part # AB-0564	5 cases (50/case) ¹ 3 cases (50/case) ²	Automated library preparation: PDP steps, Library quantification
Axygen PCR 384-C plate	General lab supplier VWR, part # 10011-194	Varies	Automated electrophoresis on the Caliper GX
Bottle, 125 ml	General lab supplier		Automated library preparation: DNA quantification
DNA High Sensitivity Reagent Kit	PerkinElmer, part # CLS760672		Library preparation: Quality control
Cap mats	General lab supplier		Automated library preparation: DNA plate storage
Cloth, lint-free	General lab supplier		Automated library preparation: ML STAR maintenance
Ethanol 200 proof (absolute) for molecular biology (500 ml)	Sigma-Aldrich, part # E7023		Automated library preparation

Consumable	Supplier	Monthly Usage	Purpose
Ethanol, 70%	General lab supplier		Automated library preparation: ML STAR maintenance
Fluorometric quantification with dsDNA binding dye reagents	General lab supplier		Library quantification
Foil seals	Covaris, part # 520073		Automated library preparation: shearing DNA with Covaris
HT DNA Extended Range LabChip	PerkinElmer, part # 760517		Library preparation: Quality control
KAPA Library Quantification Complete Kit (Universal)	KAPA Biosystems, part # KK4824		Library quantification
Lambda (λ) DNA	Life Technologies, part # 25250-010		Automated library preparation: DNA quantification
LightCycler 480 multiwell 384 plates, white	Roche, part # 04729749001	Varies	Library preparation: PCR on the LightCycler 480 Automated library preparation: Library quantification
LightCycler 480 sealing foil	Roche, part # 04729757001		Automated library preparation: Library quantification
Microside SQ Broad Spectrum Disinfectant	Hamilton, part # 3896-01		Automated library preparation: ML STAR maintenance
microTUBE, 8-tube strip (12/package)	Covaris, part # 520053		Library preparation: shearing DNA with Covaris
Microseal 'B' adhesive seals	Bio-Rad, part # MSB-1001	Varies	Library preparation
Microseal 'F' adhesive seals	Bio-Rad, part # MSF-1001	Varies	Library preparation: sealing Quant plates and protecting Quant dye, sealing PCR plates
Pipettes, single channel, 20 μ l	General lab supplier		Library preparation
Pipettes, single channel, 200 μ l	General lab supplier		Library preparation
Pipettes, single channel, 1000 μ l	General lab supplier		Library preparation
Pipette tips, barrier, 10 μ l	General lab supplier		Library preparation
Pipette tips, barrier, 20 μ l	General lab supplier		Library preparation
Pipette tips, barrier, 200 μ l	General lab supplier		Library preparation

Consumable	Supplier	Monthly Usage	Purpose
Pipette tips, barrier, 1000 µl	General lab supplier		Library preparation
Pipette tips, Hamilton, filtered, sterile, 50 µl	Hamilton, part # 235979	400 boxes ¹ 200 boxes ²	Automated library preparation
Pipette tips, Hamilton, sterile, 300 µl	Hamilton, part # 235938	400 boxes ¹ 200 boxes ²	Automated library preparation: Splitting reagent volumes
Quant-iT PicoGreen dsDNA reagent	Life Technologies, part # P11495		Automated library preparation: DNA quantification
Reagent reservoirs, multichannel, disposable, RNase/DNase-free	General lab supplier VWR, part # 89094-658	Varies	Library preparation
Reservoir frame	Beckman Coulter, part # 372795		Automated library preparation: DNA quantification
Reservoirs, half, 75 ml	Beckman Coulter, part # 372786		Automated library preparation: DNA quantification
Reservoirs, 60 ml	Hamilton, part # 194051		Automated library preparation
Reservoirs, 96-well	Seahorse Bioscience, part # 201246-100		Automated library preparation
RNaseZap	General lab supplier	Varies	Decontaminating surfaces
TE Buffer, 1X, Molecular Biology Grade	General lab supplier		Automated library preparation: DNA quantification
Tubes, conical, 15 ml	General lab supplier Corning, catalog # 430052		General use
Tubes, microcentrifuge, 1.7 ml	General lab supplier	Varies	General use
Tween 20	Sigma-Aldrich, part # P7949	Varies	General use
Water, deionized	General lab supplier		Automated library preparation: ML STAR maintenance
Water, PCR grade	General lab supplier		Automated library preparation: Library quantification

¹ HiSeq X Ten

² HiSeq X Five

Library Prep Equipment

Item	Source	Quantity
96-well thermal cycler (with heated lid)		4 ¹
<ul style="list-style-type: none"> Bio-Rad S1000 Bio-Rad C1000 Eppendorf Mastercycler pro S 	Bio-Rad, part # S1000 Bio-Rad, part # C1000 Eppendorf, part # 6325	2 ²
Barcode scanner, handheld	Motorola, part # DS4208	2
Covaris LE220	Covaris LE220 (Contact Covaris)	1 (minimum) 2 (recommended)
Covaris rack, for 8 microTUBE Strip (12)	Covaris, part # 500191	2
Desktop microcentrifuge tube centrifuge	General lab supplier	2
LabChip GX Touch 24 for Genomics	PerkinElmer	1
Hamilton Microlab STAR, Pre-PCR lab and Post-PCR lab	Hamilton, part # 95300-01	2 (minimum) 4 (recommended)
Hybex microsample incubator	SciGene, part # 1057-30-0	4
Ice Bucket	General lab supplier	1
LightCycler 480 Instrument II, 384-well system	Roche, part # 05015243001	1 (minimum) 2 (recommended)
Magnetic stand-96	Life Technologies, part # AM10027	1 (minimum) 2 (recommended)
Microplate shaker, high speed (capable of shaking at 1800 rpm)	VWR, part # 13500-890	2
Microseal roller	General lab supplier	2
Mini vortexer	VWR, part # 58816-121	2
MiniFuge	VWR, part # 93000-196	2
Plate centrifuge	General lab supplier	2
Pre-PCR heat blocks	Illumina, part # BD-60-601	4
SciGene Heating System		2
<ul style="list-style-type: none"> 115 V 220 V 	Illumina, part # SC-60-503 Illumina, part # SC-60-503	
SpectraMax Gemini XPS or M series models	Molecular Devices, part # XPS Molecular Devices, M series	1 (minimum) 2 (recommended)

¹ HiSeq X Ten

² HiSeq X Five

Clustering and Sequencing Consumables

Consumable	Supplier	Monthly Usage	Purpose
1 N NaOH	General lab supplier	Varies	Denature libraries before cluster generation
cBot 2 Barcoded Strip Tubes (8 wells)	Illumina, catalog # 20002011	Varies	Clustering on the cBot 2 with sample tracking
8-tube strips, 0.2 ml	Thermo Scientific, catalog # AB-0264	Varies	Clustering on the cBot 2 without sample tracking, or Clustering on the cBot
8-cap strips, flat	Thermo Scientific, catalog # AB-0784	Varies	Capping the 8-tube strips when not in use
60 ml reservoirs	Hamilton, catalog # 194051	Varies	Preparing an 8-tube strip of library template on the ML STAR
96-well reservoirs	Seahorse Bioscience, catalog # 201246-100-01	Varies	Preparing an 8-tube strip of pooled libraries on the ML STAR
Carboy, at least 6 liters	General lab supplier, Corning, part # 430776	Varies	Preparing maintenance wash solution
Ethanol, 70%, or Alcohol wipes, 70% Isopropyl	General lab supplier VWR, part # 95041-714	Varies	Cleaning the flow cell and flow cell stage
Ethanol, 200 proof (Absolute) for molecular biology	General lab supplier Sigma-Aldrich, part # 7023	Varies	General use
Gloves, disposable, powder-free	General lab supplier	Varies	General use
Lab tissue, low-lint	General lab supplier VWR, part # 21905-026	Varies	Cleaning the flow cell and flow cell stage
Lens paper, 4 x 6 inch	General lab supplier VWR, part # 52846-001	Varies	Cleaning the flow cell
Pipette tips, barrier, 10 µl	General lab supplier	Varies	General use
Pipette tips, barrier, 20 µl	General lab supplier	Varies	General use
Pipette tips, barrier, 200 µl	General lab supplier	Varies	General use
Pipette tips, barrier, 1000 µl	General lab supplier	Varies	General use
Pipettes, multichannel, 10 µl	General lab supplier	Varies	General use
Pipettes, multichannel, 20 µl	General lab supplier	Varies	General use

Consumable	Supplier	Monthly Usage	Purpose
Pipettes, multichannel, 200 µl	General lab supplier	Varies	General use
Pipettes, multichannel, 1000 µl	General lab supplier	Varies	General use
Pipettes, single channel, 10 µl	General lab supplier	Varies	General use
Pipettes, single channel, 20 µl	General lab supplier	Varies	General use
Pipettes, single channel, 200 µl	General lab supplier	Varies	General use
Pipettes, single channel, 1000 µl	General lab supplier	Varies	General use
ProClin 300, 50 ml	Sigma-Aldrich, part # 48912-U	Varies	Instrument maintenance wash
Tris-HCl 10 mM, pH 8.0	General lab supplier	Varies	General use
Tubes, centrifuge, 250 ml	General lab supplier Corning, part # 430776	Varies	Instrument and monthly maintenance washes
Tubes, conical, 15 ml	General lab supplier Corning, part # 430052	Varies	Collecting and measuring waste volumes
Tubes, conical, 50 ml, self-standing	General lab supplier Corning, part # 430921	Varies	Storing flow cells (Additional to the storage tubes provided in the reagent kit.)
Tubes, microcentrifuge, 1.5 ml	VWR, catalog # 20170-650*	Varies	General use
Tween 20, viscous liquid, 100 ml	Sigma-Aldrich, part # P7949	Varies	Instrument maintenance wash
Water, distilled	General lab supplier	Varies	General use
Water, laboratory-grade	Millipore	1000 L	Instrument washes and empty reagent positions
Water, PCR-grade	General lab supplier	Varies	General use

* Or equivalent.

Guidelines for Laboratory-Grade Water

Always use laboratory-grade water or deionized water to perform instrument procedures. Never use tap water. Use only the following grades of water or equivalents:

- ▶ Deionized water
- ▶ Illumina PW1
- ▶ 18 Megohms (MΩ) water
- ▶ Milli-Q water
- ▶ Super-Q water

- ▶ Molecular biology grade water

Clustering and Sequencing Equipment

Item	Source	Quantity
Balance, top-loading, digital, 420 g capacity	Sartorius, Model CPA423S (or similar)	1
Bottle rack, 15 ml centrifuge tube, epoxy-coated	General Lab Supplier LabScientific, catalog # TR-15	10 ¹ 5 ²
Bottle rack, 6-position 250 ml centrifuge tube, epoxy-coated	General Lab Supplier LabScientific, catalog # CBR-200	10 ¹ 5 ²
Desktop microcentrifuge	General lab supplier	2 (minimum) 5 (recommended) ¹ 3 (recommended) ²
Freezer, -25°C to -15°C	General lab supplier	Several
Freezer storage boxes, shelves (If not included)	General lab supplier	
Ice bucket	General lab supplier	
Microcentrifuge tube racks	General lab supplier	
Microplate centrifuge	General lab supplier	
Midi heat block insert	Illumina, part # BD-60-601	2
Parafilm	General lab supplier	
PCR tube racks	General lab supplier	
Refrigerator, 2° to 8°C	General lab supplier	
Tweezers, square-tip plastic	McMaster-Carr, catalog # 7003A22 (or similar)	
Vortexer	General lab supplier	

¹ HiSeq X Ten

² HiSeq X Five

Hazardous Waste Production

Waste Type	Waste Category	Hazard Identification	Volume/month per HiSeq X Ten	Volume/month per HiSeq X Five
Liquid	Chemical hazard	Formamide, 10 ml/1.3 L, total aqueous volume	1.3 L per run 110–120 L per month	0.62 L per run 55–60 L per month
Solid	Chemical hazard	Formamide, empty reagent plastics		
Solid	Sharps	Glass sharps		



CAUTION

Dispose of containers and any unused contents in accordance with the governmental safety standards for your region. For more information, see the Safety Data Sheet (SDS) for this kit at support.illumina.com/sds.html.

Revision History

Document	Date	Description of Change
Document # 15050093 v05	January 2017	Removed Sigma-Aldrich catalog # SRE0076 for SeqClin Wash Solution. If you cannot obtain ProClin due to its restricted use for IVD, use the alternative maintenance wash that does not require ProClin 300.
Document # 15050093 v04	September 2016	Added Custom Protocol Selector to Additional Resources. Added Sigma-Aldrich catalog # SRE0076 for SeqClin Wash Solution. Updated microcentrifuge tubes to VWR catalog # 20170-650 for 1.5 ml microcentrifuge tubes. Removed VWR part # 13500-890 and VWR part # 14216-214 for a high-speed microplate shaker from Clustering and Sequencing Equipment.
Document # 15050093 v03	January 2016	Added cBot 2 dimensions. Added Illumina catalog # for 8-tube strips with barcode labels. Updated guidelines for laboratory-grade water to include deionized water as an acceptable form of water for performing instrument procedures.
Document # 15050093 v02	December 2015	Updated lab bench guidelines for the HiSeq X Ten to include an additional lab bench option and casters for either bench option.
Document # 15050093 v01	September 2015	Added minimum and recommended quantities for the desktop microcentrifuge. Corrected the weight and crated weight of the instrument. Corrected the specifications for heat output.
Part # 15050093 Rev. H	July 2015	Renamed the guide to specify the HiSeq X system. This guide applies to the HiSeq X Ten and HiSeq X Five, including configurations for Illumina SeqLab. Replaced Isaac Genome Alignment Software + Isaac Variant Caller with HiSeq Analysis Software v2.0 as the product used for whole-genome sequencing analysis. Added the following information: <ul style="list-style-type: none"> • Recommendations to use separate gowning areas and keep equipment confined to the appropriate pre-PCR or post-PCR lab area. • Example lab layout for the HiSeq X Ten and ancillary instruments and equipment. • Lab bench guidelines for the Hamilton Microlab STAR. Updated the following information: <ul style="list-style-type: none"> • Minimum space requirements to include specific equipment for Illumina SeqLab. • Reagent kit storage dimensions to include HiSeq X v2.5 reagent kits. • Data analysis and storage requirements: BWA and GATK versions, number of computing nodes, and analysis times. Updated user-supplied consumables and equipment: <ul style="list-style-type: none"> • Separated items by application: library prep or clustering and sequencing. • Added items needed for Illumina SeqLab.

Document	Date	Description of Change
Part # 15050093 Rev. G	January 2015	Added information about estimated minimum space requirements for pre-PCR lab space, post-PCR lab space, and consumables storage at specific temperatures. Updated data analysis and storage requirements: number of computing nodes, analysis time using Illumina algorithms, and VCF online and archive storage. Corrected storage requirements for VCF files.
Part # 15050093 Rev. F	November 2014	Updated the storage temperature for SBS reagents PW1, PB1, and PB2 to room temperature (15°C to 30°C).
Part # 15050093 Rev. E	October 2014	Added denature libraries as a purpose for user-supplied NaOH. Denaturing libraries is a preparation step when using HiSeq X HD Reagent Kit v2. Added storage dimensions for library prep kits.
Part # 15050093 Rev. D	August 2014	Updated antivirus software recommendation to include drive names. Added compatibility recommendations for network maintenance activities. Updated VWR catalog # for alcohol wipes to 95041-714. Updated SDS link to support.illumina.com/sds.html .
Part # 15050093 Rev. C	July 2014	Added section titled, Principles of Production Lab Layout and Design, which lists best practices for lab setup. Added consumables and equipment used for production-level library preparation, clustering, and sequencing.
Part # 15050093 Rev. B	May 2014	Updated storage temperature for SBS reagents (box 1 of 2) to 2°C to 8°C as labeled. Updated URL for Safety Data Sheets (SDS) to support.illumina.com/sds.ilmn .
Part # 15050093 Rev. A	March 2014	Initial release.

Notes

Technical Assistance

For technical assistance, contact Illumina Technical Support.

Table 3 Illumina General Contact Information

Website	www.illumina.com
Email	techsupport@illumina.com

Table 4 Illumina Customer Support Telephone Numbers

Region	Contact Number	Region	Contact Number
North America	1.800.809.4566	Japan	0800.111.5011
Australia	1.800.775.688	Netherlands	0800.0223859
Austria	0800.296575	New Zealand	0800.451.650
Belgium	0800.81102	Norway	800.16836
China	400.635.9898	Singapore	1.800.579.2745
Denmark	80882346	Spain	900.812168
Finland	0800.918363	Sweden	020790181
France	0800.911850	Switzerland	0800.563118
Germany	0800.180.8994	Taiwan	00806651752
Hong Kong	800960230	United Kingdom	0800.917.0041
Ireland	1.800.812949	Other countries	+44.1799.534000
Italy	800.874909		

Safety data sheets (SDSs)—Available on the Illumina website at support.illumina.com/sds.html.

Product documentation—Available for download in PDF from the Illumina website. Go to support.illumina.com, select a product, then select **Documentation & Literature**.



Document # 15050093 v05



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