



TRIMBLE MX9

MOBILE LASER MAPPING SYSTEM

USER GUIDE

Revision C
January 2019

Legal information

Contact

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Release Note

This is the January 2019 release revision C of the Trimble MX9 Manual, P/N T001454. It applies to:

- Trimble MX9 Dual Head, AP60, Spherical+3x5MP, T001445
- Trimble MX9 Dual Head, AP40, Spherical+3x5MP, T001446
- Trimble MX9 Single Head, AP40, Spherical+, T001552

The manual contains extracts and parts from the VUX®-1HA Technical Documentation and Operating Instructions from Riegl as the Riegl VUX® -1HA is the laser unit used in the Trimble MX9 System.

The sections and extracts introduced in this manual refer to the following documents and are not flagged separately:

- OP-V-Line-02e_acclimatisation_2014-06-13
- RIEGL_VUX-1SERIES_General-Manual_BA02xx_912_2017-11-16
- RIEGL_VUX-1SERIES_Technical-Manual_BA02xx_800_2017-11-07
- Safety-Warnings-Instructions_for_RIEGL-V-Line_2014-06-13

The T001545 original document is written in English. All documents in other languages are translations from the original English document.

Document History

Date	Revision	Comment
Mar 18, 2018	A	First Release
July 30, 2018	B	T001446 (AP40) added; Manual content improved
Jan 30, 2019	C	T001552 (AP40 Single Head) added; Manual content improved

Registration

In order to register your product or check the status of your system maintenance, please register your system and software at <https://mytrimbleprotected.com/>.

My Trimble Protected enables Trimble users, channel partners, and end customers to streamline business processes for customer engagement and service. As a centralized instrument panel, *My Trimble Protected* manages registrations, serial number lookups, product catalogs, reports, settings, and locator processes. It allows users to configure, monitor, and optimize each aspect of the process.

Compliance Information

Europe

EC Compliance



Trimble declares that the Trimble MX9 system and associated accessories comply with the applicable directives, standards and regulations.

WARNING: Trimble MX9 Equipment is Class A.

This is a class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

WEEE



Notice to our European Customers

For product recycling instructions and more information, please go to:

http://www.trimble.com/Corporate/Environmental_Compliance.aspx

Recycling in Europe: To recycle Trimble® batteries and WEEE (Waste Electrical and Electronic Equipment, products that run on electrical power),

Call +31 497 53 24 21 or mail a request for recycling instructions to:

Trimble Europe BV
c/o Menlo Worldwide Logistics
Meerheide 45
5521 DZ Eersel, NL

USA

FCC Statement



This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference.
- (2) This device must accept any interference received, including interference that may cause undesired operation.

NOTE: Trimble MX9 Equipment is Class A

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

In order to maintain compliance with FCC regulations shielded cables must be used with this equipment. Operation with non-approved equipment or unshielded cables is likely to result in interference to radio & television reception.

CANADA

ICES Statement

NOTE: Trimble MX9 Equipment is Class A

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.

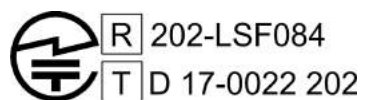
Japan

TCB-Certification for the MX9 Control-Unit

Japanese Radio Law and Japanese Telecommunications Business Law Compliance.

This device is granted pursuant to the Japanese Radio Law (電波法) and the Japanese Telecommunications Business Law (電気通信事業法)

This device should not be modified (otherwise the granted designation number will become invalid).



Australia / New Zealand

ACMA Statement



WARNING: This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

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Safety Instructions





Acclimatisation

The Trimble MX9 system incorporates sensitive electronics and optical components.

Due to variation in temperature and air pressure during airfreight transportation, rapid increase of temperature after unpacking may cause condensation of water inside the main components of the Trimble MX9 system (Sensor Unit, Control Unit, Power Unit). Water inside the components respective their housings can cause short circuits and can damage the instrument when switched on.

Therefore, after airfreight transportation, allow a period of 24 hours for acclimatisation in a place with constant temperature and air pressure before switching on the Trimble MX9 system.

General

	<p>The Trimble MX9 system was developed for acquisition of 360° images and laser point cloud data in mobile mapping applications.</p> <p>This system is designed for industrial usage only. Any other usage can be dangerous and is strictly forbidden. The system must be used only by well-trained persons.</p>
	<p>Any unauthorized changes to the product, including software changes made through whatever means, can cause personal injury or damage to the system and renders all guarantees null and void.</p>
	<p>Any final installation of the Trimble MX9 system or its components is under control and responsibility of the owner, or the person authorized by the owner.</p>
	<p>It is the customer's responsibility to ensure that there are adequate mounting facilities and the component layout has been planned carefully. If necessary, the customer must obtain the approval of the local authorities before installing the Trimble MX9 system or any of its components.</p>

	<p>We strongly recommend that you check the quality of the acquired data on a regular basis. Especially before starting an extensive data acquisition campaign.</p> <p>This check can for example be carried out by registering a scan position by means of scanning a number (e.g. 8) of flat retro-reflecting targets at different distances and at angles covering a range of more than 180° horizontally, which have also been surveyed by a highly accurate total station. The check is passed if the residual error is less than the instrument's specified accuracy.</p>
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Electronics

	<p>The system must never be connected to 110, 230, or 400 VAC! Opening the instrument is unacceptable and must therefore be avoided at all costs.</p>
	<p>Electrostatics can destroy the system.</p>
	<p>Before and after every mission, check all system cables, connectors and pins for damage or notches. Do not use damaged system cables!</p>
	<p>To prevent electric shock and damage, do not plug in, connect or handle with wet hands.</p>
	<p>In vehicles using electric propulsion, make sure you install the product in such a way that it is fully separate from the car battery charging system.</p>







Laser

The installed laser instruments are classified as Class 1 laser products in compliance with the International Standard IEC60825-1:2014 and the European Standard EN60825-1:2014 "Safety of Laser Products- Part 1: Equipment Classification and Requirements".










	<p>Never open the instruments housing!</p>
	<p>Do not operate evidently damaged instruments!</p>

	Do not look unnecessarily into the transmitter aperture!
	Do not point the transmitter aperture unnecessarily at people's eyes
	Do not align the laser scanners of the Sensor Unit with infrared cameras or night vision devices as this may damage these devices!
	Do not use the Trimble MX9 system for measuring targets with a surface temperature higher than 600°C as this may result in damage of the highly sensitive laser scanner units.
	Do not expose the instrument or its components (including electrical cables and accessories) to radioactive radiation. This can completely degrade or even destroy the highly sensitive electronics and electro-optical components. Furthermore, it is practically impossible to decontaminate the equipment after exposure to radioactive radiation.








Mechanics

	All mechanical parts must be checked before and after each mission (e.g. screws, damage on mechanical parts, etc.).
	During non-operating or storage time intervals, the Sensor Unit should be protected from the environmental conditions (it should be stored in its transportation case).
	Do not open the devices!
	Never modify any of the devices!
	Never push objects of any kind into sockets or connectors
	If there is a need for changing standard parts in the Trimble MX9 system (screws, washers, etc.), always use the same type of material.

Usage, Installation and Transportation

	When not collecting data or preparing the system for future campaigns, store the Sensor Unit safely in its transportation case, taking care to cover the laser scanner units.
	When the Trimble MX9 system is not in use for a longer period of time, turn it on at regular intervals of time (every two months) and keep it running for 30 to 60 minutes to avoid that internal CMOS batteries get too low.
	Make sure the people who are involved in installing or uninstalling the MX9 system and its components are familiar with the “installation” chapter of this manual and have received prior training before handling the system.
	All connections/screws must be tightened by complying with the torque values recommended in the manual!
	Owing to its weight and particular handling required, the MX9 Roof Rack and Trimble MX9 Sensor Unit should be installed by two operators.
	Lift or carry the Sensor Unit with the dedicated handles!
	During operation, all components of the MX9 system must be safely and firmly secured to avoid any unwanted move. Cables should be fixed and secured with straps or binders. All other components should be mounted or strapped using the dedicated facilities!
	The MX9 is designed to be used only on board vehicles fitted with rubber wheels and driven on paved surfaces.
	The maximum speed of a vehicle fitted with the MX9 system should not exceed 110 km/h (68 mph).
	The driver should remember that the MX9 system brings additional height to the vehicle and so should be aware of the total height of the vehicle!
	The driver is not allowed to operate the system while driving. It is recommended that a second person be dedicated to operating the system.

1 Safety Instructions

	Never operate the system in any other way than explained in the manual!
	Avoid to work overhead. Use tools to get a better position for installation.
	Switch off the vehicle engine during MX9 system installation
	Clean all optics of the sensors before starting a mission. Depending on weather and road surface conditions, a cleaning of the optics during the mission might be necessary to collect good quality data.
	In order to avoid the danger of suffocation, keep plastic foils, bags and bubble wraps away from babies and children. Do not use them in or near children's bed, pushchairs or playpens. Packaging materials are not a toy, so please tie them up before disposing of them.
	Keep product surfaces clean and dry, always unplug the instrument before cleaning.
	Do not place any liquids on or next to the instrument or its components.

System Overview and Installation

Introduction

The Trimble MX9 mobile laser mapping system is a premium, fully integrated system with two high-performance laser scanners, a 360° spherical camera and three additional oblique cameras. The MX9 mobile laser mapping system is also equipped with a position and orientation system, utilizing integrated inertial technology for a stable, reliable and repeatable positioning solution and system trajectory.

Different variants of the Trimble MX9 Sensor Unit exist. Each variant includes a specific Sensor Unit.

Highly accurate and geo-referenced high-density point cloud data can be collected even at regular vehicle speeds on roads.

High-precision and high-density point cloud data can be used not only for GIS asset extraction, but also to perform 3D measurements of highway characteristics such as 3D model generation, road surface measurements, road clearance measurements.

The Trimble MX9 system consists of three main devices:

- Trimble MX9 Sensor Unit (SU)
- Trimble MX9 Control Unit (CU)
- Trimble MX9 Power-Unit (PU).

An additional and specially designed MX9 Roof Rack (RR) is used to mount the Trimble MX9 Sensor Unit on top of a vehicle. It can easily be detached for safe indoor storage at the end of the day.

The Trimble MX9 Sensor Unit includes the laser scanners, the cameras and the GNSS/IMU system.

The Trimble MX9 Control Unit is used both as a computer for controlling the Trimble MX9 Sensor Unit and a recording device for sensor data (Navigation, LiDAR, Camera). The recording device consists of a large-capacity SSD.

The Trimble MX9 Power Unit, which is the electrical interface to the power source, provides the equipment with power.

A tablet or PC (BYOD) can be used to operate the system. Connection to the Control Unit is achieved through wired Ethernet or WiFi. The system operation and data collection is controlled through a web browser (no additional software needed).



Sensor Unit

Description

The Trimble MX9 Sensor Unit is fully equipped with two laser scanners, three oblique cameras, a 360-degree panoramic camera and a position-and-orientation system, utilizing an integrated inertial technology device for precise vehicle trajectory determination. Different variants of the Trimble MX9 Sensor Unit exist, which means a different MX9 P/N exists for each of these variants.

The horizontal and vertical orientations of both the laser scanners and two of the three oblique cameras (forward/sideways looking, horizontally oriented cameras on the front side) are adjustable within some limits.

- Horizontal orientation= Heading angle, opening angle, yaw
- Vertical orientation= Pitch angle, tilt

NOTE – In this document, the terms "horizontal orientation" and "vertical orientation" are used.

NOTE – After any adjustment of the laser scanners or oblique cameras, the system has to be re-calibrated (boresight calibration).

The laser scanners can be protected with safety caps when not operated or for storage.

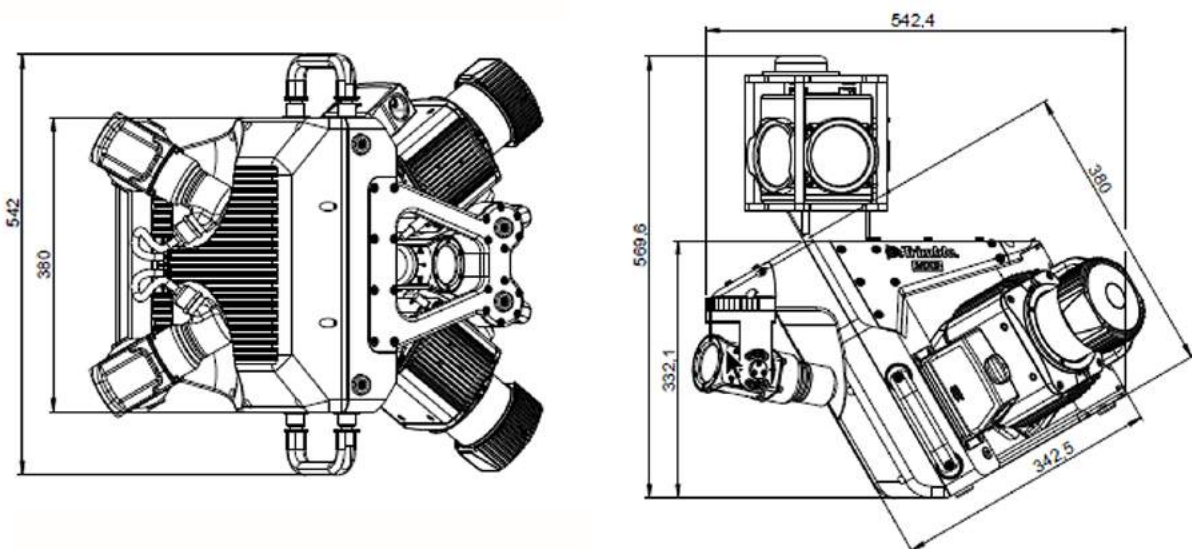
The Sensor Unit is additionally equipped with one main connector (on the left side of the Sensor Unit) and three additional connectors (on the right side of the Sensor Unit):

- **Main Connector:** Used to connect the Control Unit to the Sensor Unit
- **Ant.:** Used to connect the Trimble GAMS antenna kit (optional)
- **DMI:** Used to connect the Trimble MX9 DMI kit (optional)
- **Ext.:** Used to connect other external devices. Pinout and signals are provided in the Appendix.



Dimensions

All dimensions in mm.



Adjusting Laser Scanner and Oblique Cameras

The horizontal and vertical orientations of the laser scanners and oblique cameras (oblique cameras are on the front side) can be adjusted to fit with the installation environment and the vehicle used. The default adjustment of each laser scanner is:

- Horizontal (II)
- Vertical (I)

It is recommended to adjust the laser scanners symmetrically. The horizontal orientation III is for special applications (please consult Trimble Support). The default adjustment of the oblique cameras on the front side is:

- Horizontal (30°)
- Vertical (0°)

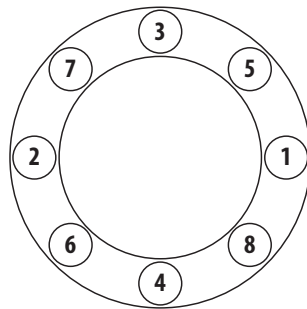
Any adjustment requires a new calibration of the system and is not suitable for a daily adjustment!

In this chapter, the mechanical adjustment is explained. The resulting horizontal angles in relation to the different vertical angles are explained in the MX9 Sensor Angle Chart (see chart in the Appendix).

The laser scanners and oblique cameras should be adjusted in a suitable environment (e.g. in a clean workshop) by well trained staff. No adjustment can be done with the system installed on a vehicle or if the system is powered.

In case you need assistance regarding vehicle dimensions and the preferred sensor adjustments, please contact Support.

Tighten all the screws evenly and crosswise (in the order mentioned below) in at least three runs to get the required torque value.



Horizontal Adjustment of Laser Scanners

The horizontal orientation of each laser scanner can be adjusted through a three-step procedure:

1. Loosen and remove the ten screws of the mounting tube on the laser scanner
2. Turn it until you get the position you want. The tube itself is guided so the laser scanner cannot fall off
3. After reaching the new desired position, re-tighten the screws using the recommended torque values (**8.0 Nm**).

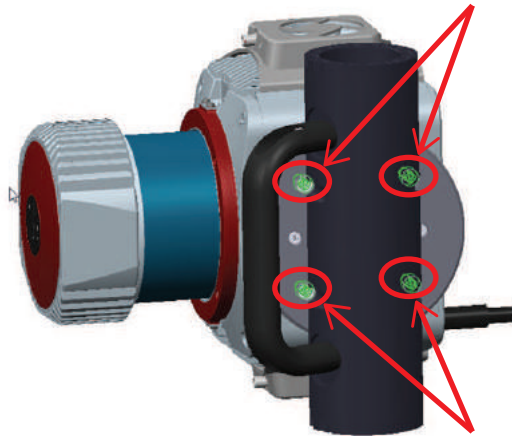
For any adjustment operation, please refer to the marks on the mounting tube and the Sensor Unit housing.



Vertical Adjustment of Laser Scanners

The vertical orientation of each laser scanner can also be adjusted through a three-step procedure:

1. Loosen and remove the four screws of the laser scanner adjustment plate. The adjustment is mechanically guided as well so the laser scanner cannot fall off.
2. Turn the laser scanner into the desired position.
3. Re-tighten the four screws using the recommended torque value (**8 Nm**). Please also refer to the marks.

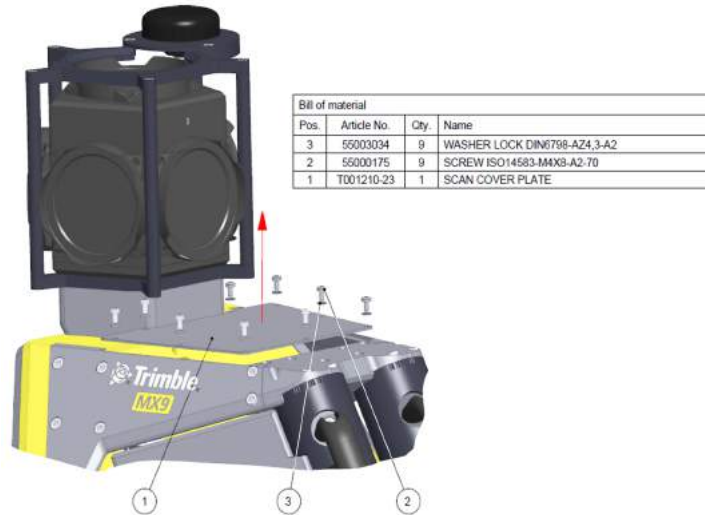


Conversion from "Scanner Right" to "Scanner Left"

(For single scanner only. This conversion is achieved through a 15-step procedure.)

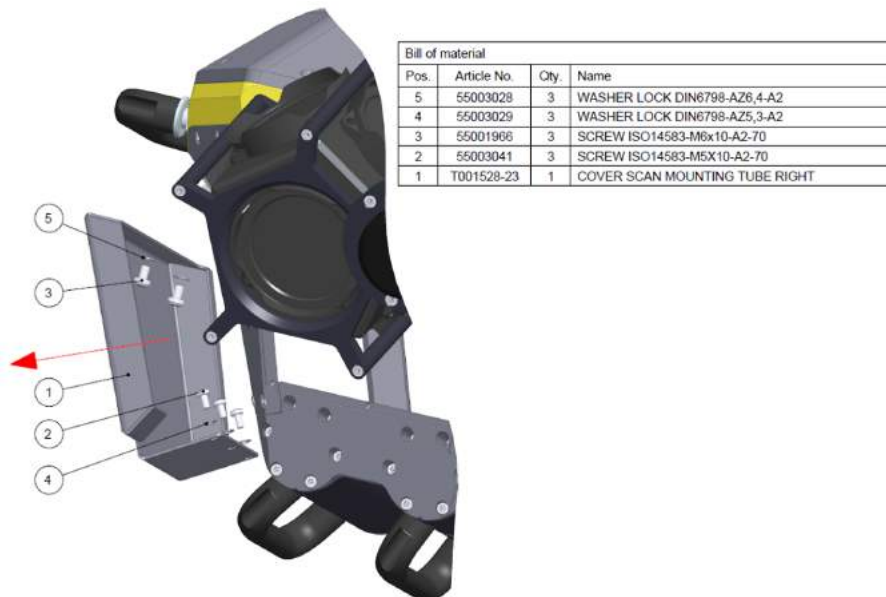
Step 1:

- a. Loosen then remove the nine screws ② and washers ③.
- b. Detach scan cover plate ① from the rear top.



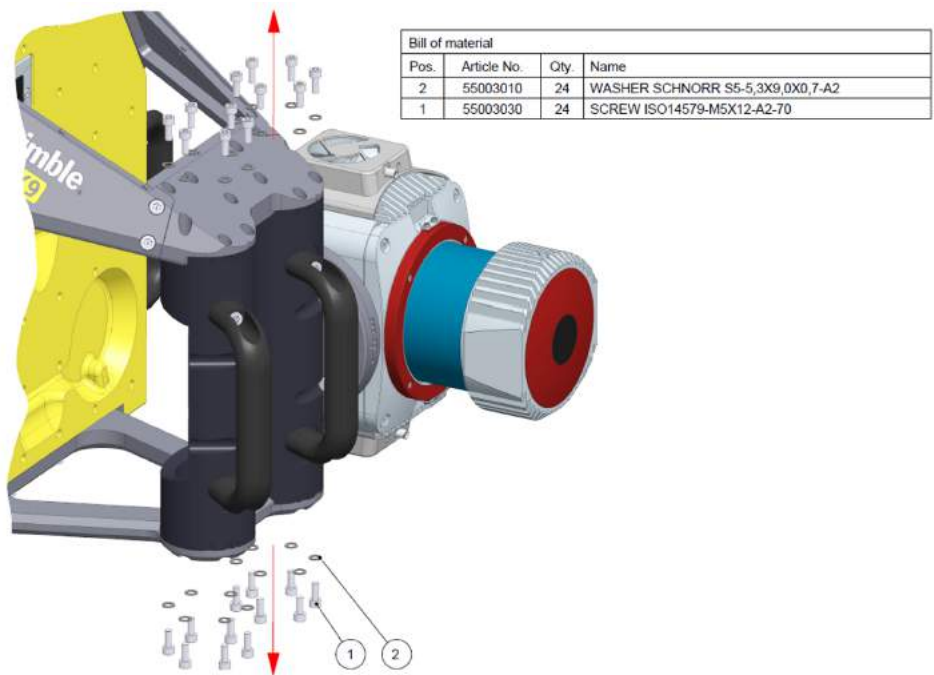
Step 2:

- a. Loosen then remove the six screws ② + ③ and washers ④ + ⑤.
- b. Detach right-hand cover ① from the scan mounting tube.



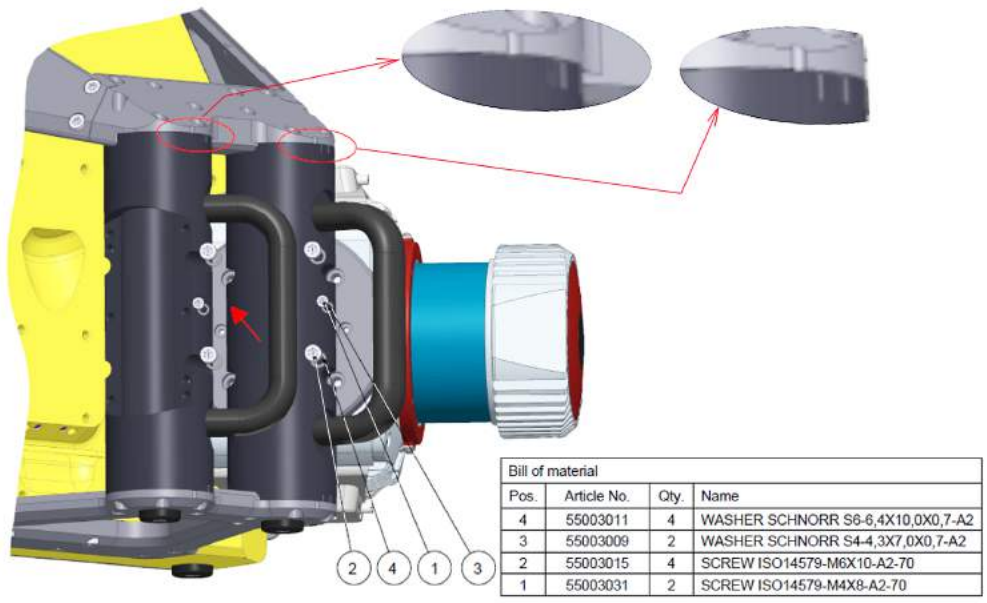
Step 3:

- a. Loosen then remove the 24 screws ① and washers ②.



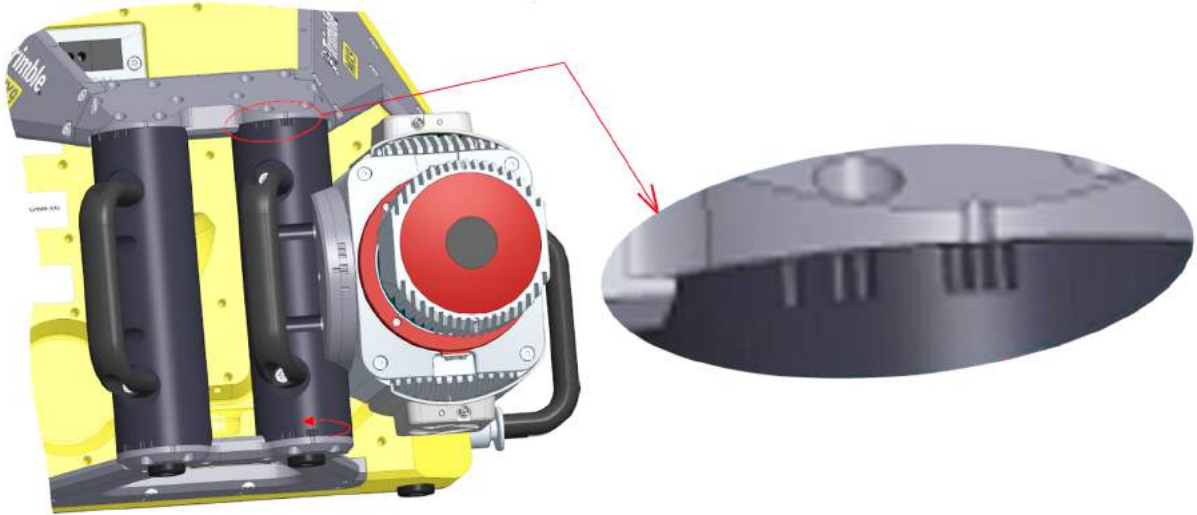
Step 4:

- a. Rotate the scanner columns as shown below.
- b. Loosen then remove the six screws ① + ② and washers ③ + ④.



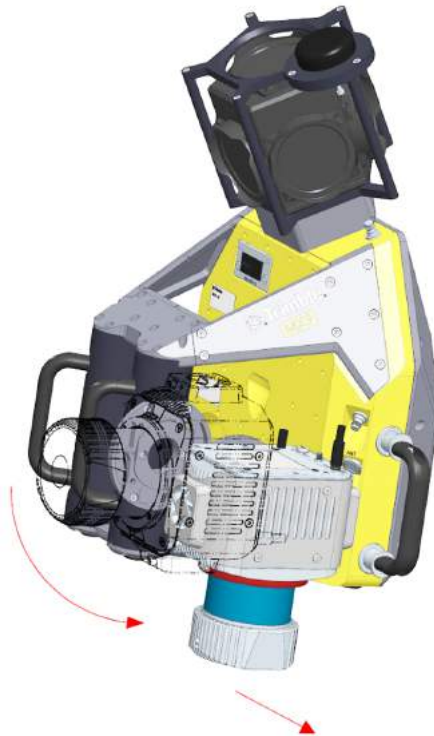
Step 5:

- a. Rotate the scanner assembly until it is positioned at least on the "III" mark. The red arrow on the illustration below shows the direction of rotation.



Step 6:

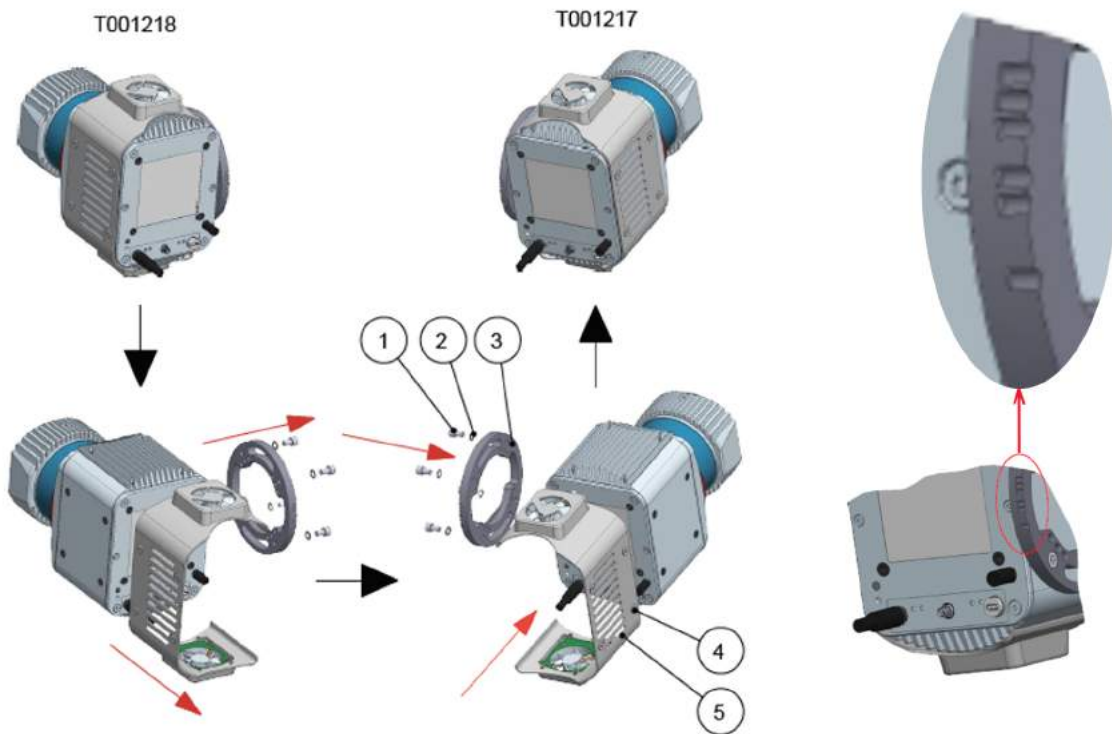
- a. Turn the scanner downwards until the scan axis is parallel to the axis of the scan column.
- b. Detach the scanner from the scan column.



Step 7:

- a. Loosen then remove the four screws ① and washers ②.
- b. Remove scan mounting plate ③.
- c. Loosen then remove the four screws ④.
- d. Remove the fan assembly ⑤ by sliding it over the back of the scanner.
- e. Turn the fan assembly ⑤ around the scan axis by 180° and slide it back over the scanner.
- f. Put back and then tighten the four screws ④ evenly and crosswise in at least three runs to the required torque of **8 Nm**.
- g. Attach scan mounting plate ③ onto the opposite side compared to its original position, then put back and tighten the four screws ① and washers ② evenly and crosswise in at least three runs to the required torque of **8 Nm**.

(Conversion from scanner right to scanner left)



CAUTION - When attaching scan mounting plate ③ onto the other side, remember mark "I" has to be in bottom position and mark "III" in top position (see above illustration on the right).

NOTE - The inverse conversion, i.e. scanner left (T001217) to scanner right (T001218) is also possible using the same procedure.

Step 8:

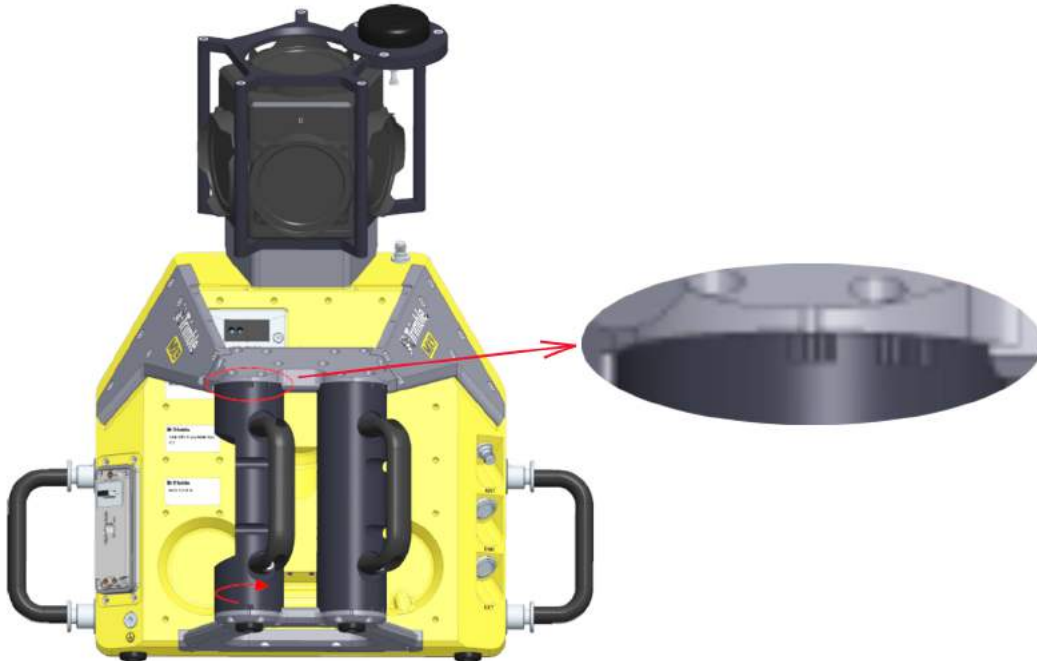
- a. Loosen then remove the 6 screws ③ and washers ④.
- b. Remove scan mounting plate 2②
- c. Remove pin ①



Bill of material			
Pos.	Article No.	Qty.	Name
4	55003010	6	WASHER SCHNORR S5-5,3X9,0X0,7-A2
3	55003030	6	SCREW ISO14579-M5X12-A2-70
2	T001212-24	1	SCAN MOUNTING PLATE 2
1	55003095	2	PIN DIN6325-H6-5X10-ST

Step 9:

- a. Rotate the left scanner column until it is positioned at least on the "III" mark. The red arrow on the illustration below shows the direction of rotation.



Step 10:

- a. Insert the two pins ① into the pin holes located in the left scanner column.
- b. Attach scan mounting plate 2 ② to the left scanner column.
- c. Insert and tighten the six screws ③ and washers ④.



Bill of material			
Pos.	Article No.	Qty.	Name
4	55003010	6	WASHER SCHNORR S5-5,3X9,0X0,7-A2
3	55003030	6	SCREW ISO14579-M5X12-A2-70
2	T001212-24	1	SCAN MOUNTING PLATE 2
1	55003066	2	PIN DIN6325-H6-5X10-ST

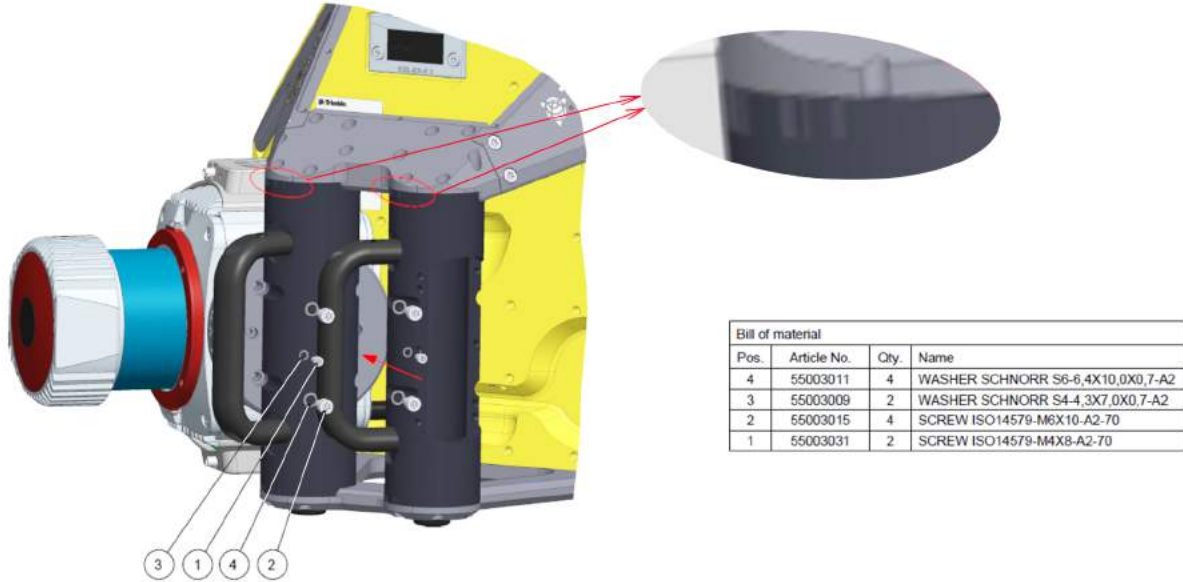
Step 11:

- a. Attach the VUX LEFT scanner assembly (T001217) onto the scan mounting plate 2 (scan axis has to be parallel to the column axis).
- b. Turn the VUX LEFT scanner assembly upward to the desired pitch position (I, II or III).



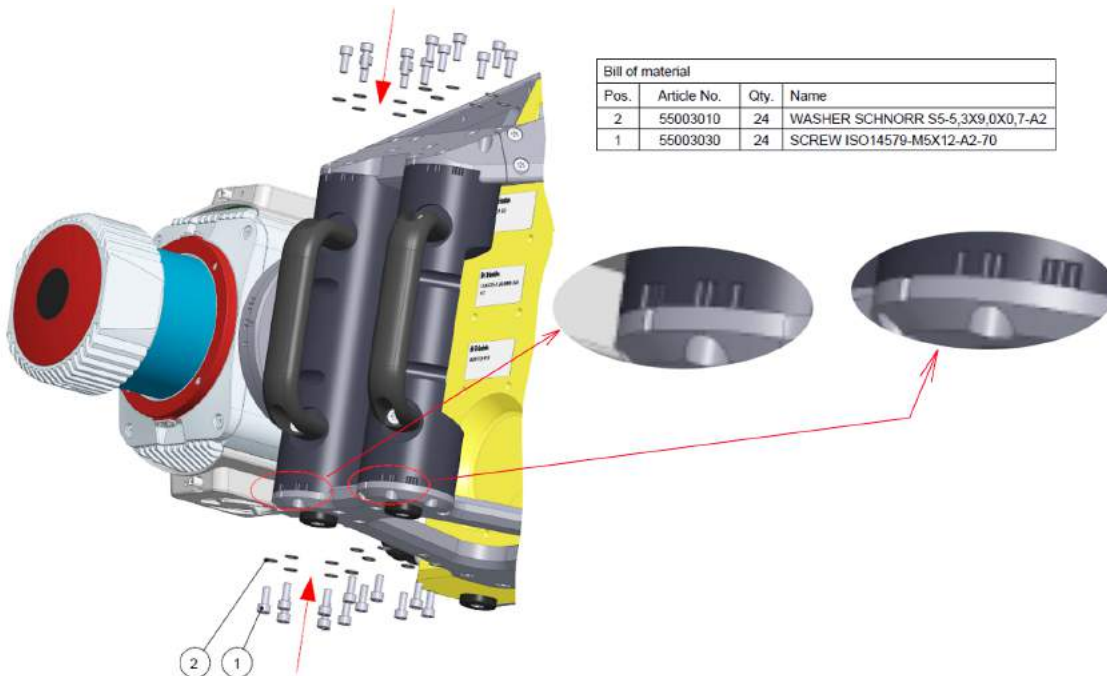
Step 12:

- a. Turn the scanner columns as shown below.
- b. Insert and tighten the six screws ① + ② and washers ③ + ④.



Step 13:

- a. Turn the left scanner column to position "III" and the right scanner column one step before position "I".
- b. Insert and tighten the twenty-four screws ① and washers ②.



Step 14:

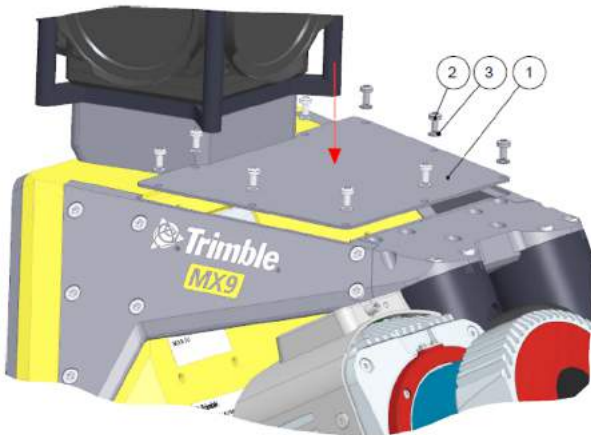
- a. Attach right-hand cover ① of the scan mounting tube to the back of the base plate and to the right scanner column.
- b. Insert and tighten the six screws ② + ③ and washers ④ + ⑤.



Bill of material			
Pos.	Article No.	Qty.	Name
5	55003028	3	WASHER LOCK DIN6798-AZ6,4-A2
4	55003029	3	WASHER LOCK DIN6798-AZ5,3-A2
3	55001966	3	SCREW ISO14583-M6x10-A2-70
2	55003041	3	SCREW ISO14583-M5x10-A2-70
1	T001528-23	1	COVER SCAN MOUNTING TUBE RIGHT

Step 15:

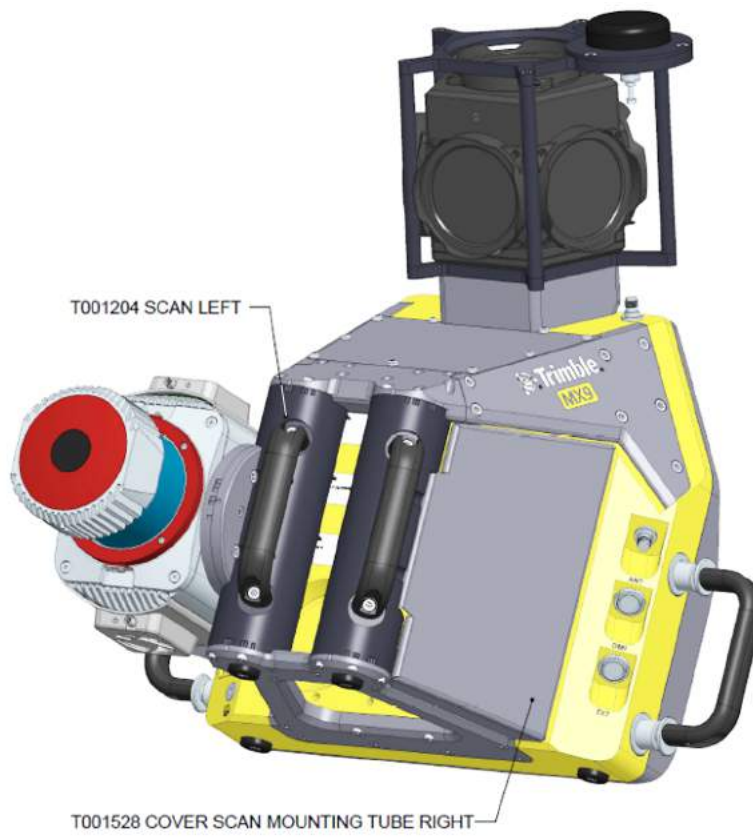
- a. Attach scan cover plate ① to the rear top.
- b. Tighten the nine screws ② and washers ③.



Bill of material			
Pos.	Article No.	Qty.	Name
3	55003034	9	WASHER LOCK DIN6798-AZ4,3-A2
2	55000175	9	SCREW ISO14583-M4x8-A2-70
1	T001210-23	1	SCAN COVER PLATE

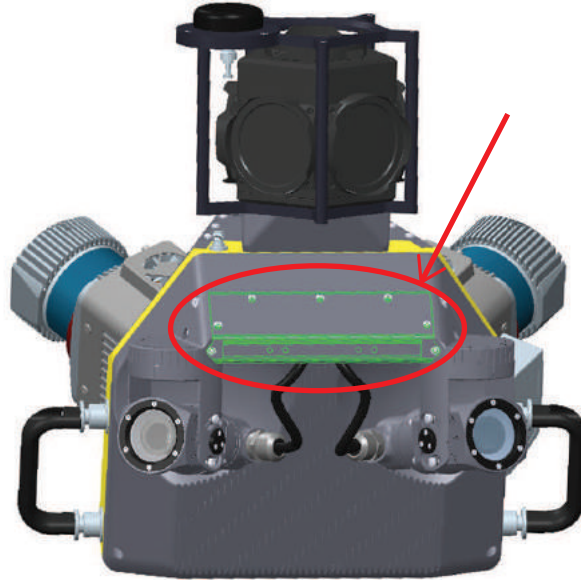
2 System Overview and Installation

This is what the Sensor Unit looks like after conversion:



Horizontal Adjustment of Oblique Cameras

To adjust the horizontal orientation of the oblique cameras on the front side, first remove the front shade between the cameras. Loosen and remove the seven screws then remove the front shade.



The horizontal orientation of each oblique camera can be adjusted in 10° increments from -20° to +120°.

To adjust the horizontal orientation, loosen the three screws shown (see picture below) and remove them. The camera holder being guided, the camera cannot fall off.

After reaching the desired angle, re-tighten the three screws using the recommended torque value (4.5 Nm) and reinstall the front shade (the torque value for the front shade screws is 2.3 Nm).



Vertical Adjustment of Oblique Cameras

The vertical orientation of the oblique cameras can be adjusted to any angle (no increment) between -30° and $+30^{\circ}$.

To adjust the vertical orientation, loosen the four marked screws on the camera holder, adjust the angle to the desired value and re-tighten the screws, again using the recommended torque value (4.5 Nm).

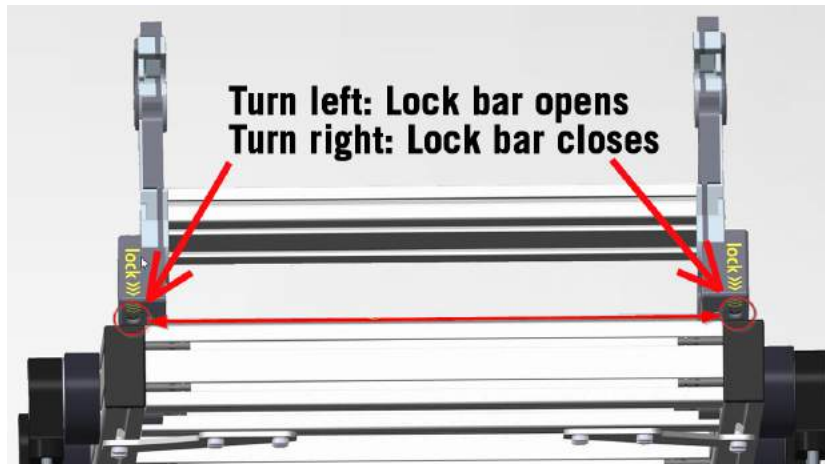


Installing the Sensor Unit

Before installing the Trimble MX9 Sensor Unit, make sure the MX9 Roof Rack has been installed safely on the vehicle (see [Roof Rack](#), page 39).

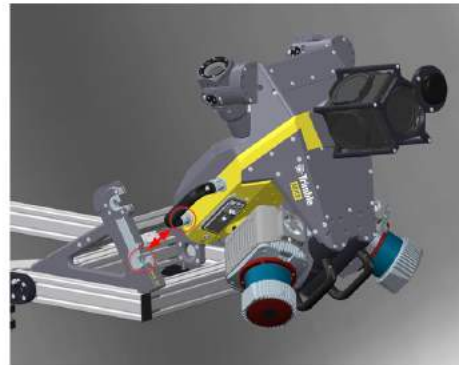
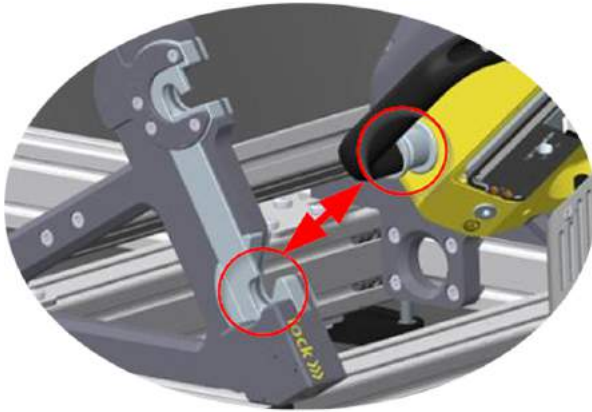
The MX9 Sensor Unit should be installed by two people.

1. Before lifting up the MX9 Sensor Unit, make sure the safety locks of the Trimble MX9 Roof Rack are open. Use the tool stored in the Trimble MX9 Control Unit case for opening and closing the safety locks.

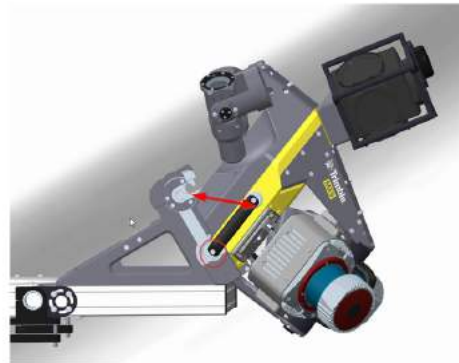
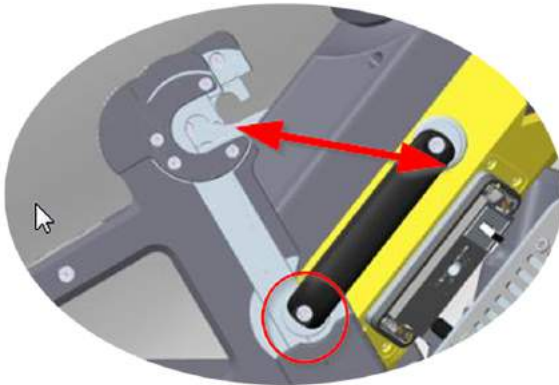


2. Then carefully lift the MX9 Sensor Unit (two people, four hands, one on each handle) and let the lower mounting bolts of the MX9 Sensor Unit slide into the lower mounting facilities of the MX9 Roof Rack.

2 System Overview and Installation



3. As the lower mounting bolts get in their final position, tilt the Sensor Unit ahead until the upper mounting bolts click in position and the fast lock of the Roof Rack mounting facilities is engaged.



4. After the upper mounting bolts have “clicked” in their final position (fast lock), the Sensor Unit is stable and cannot turn over or fall from the Roof Rack. To finally secure the Sensor Unit, tighten the safety

locks to close the lock bars (reverse action compared to what you did in step 1 above).



5. The MX9 Sensor Unit is now safely installed on the Roof Rack and cable installation can take place.

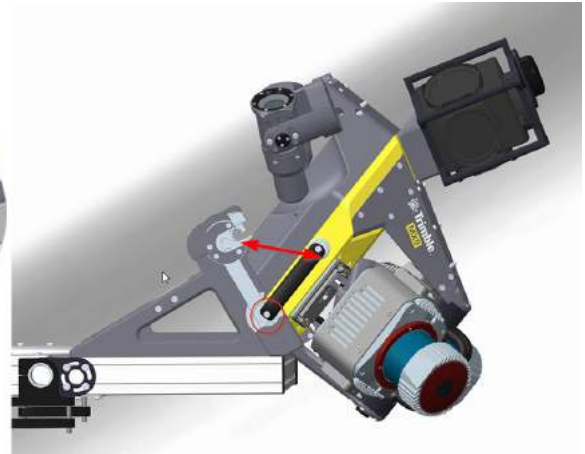
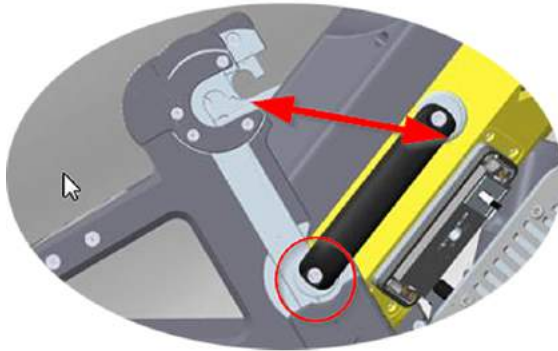
Uninstalling the Sensor Unit

1. Remove cables
2. Open the safety locks
3. Release the fast locks by pressing the fast-lock button downwards.

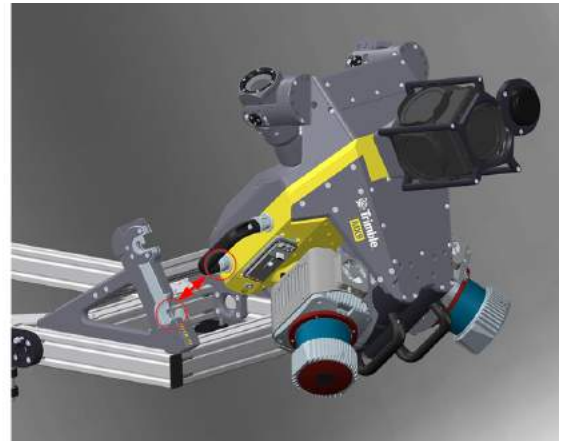
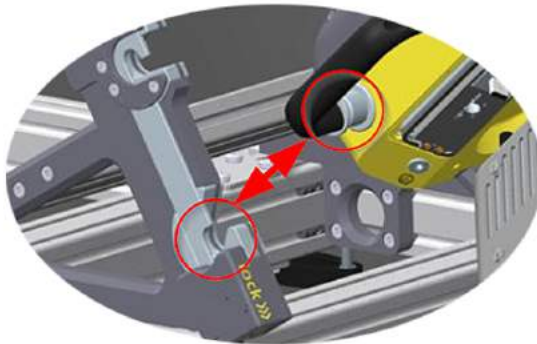


4. Turn the MX9 Sensor Unit (while pressing the fast-lock button) and remove the upper mounting bolts from their position.

2 System Overview and Installation



5. Lift the Sensor Unit out of the lower mounting facilities and place it safely in its transportation case.



Control Unit

Description

The Trimble MX9 Control Unit is the central computer unit as well as the man-machine interface for the MX9.



The control panel of the Trimble MX9 Control Unit includes the following elements:

1. **Power In Connector**

This connector is used to connect the “MX9 Power Unit to Control Unit” cable through which power is provided to the Control Unit from the Power Unit.

2. **Connector for “MX9 Control Unit to Sensor Unit” Cable**

Power and signal interface with the Trimble MX9 Sensor Unit is achieved by making this connection. Before plugging in the cable, please make sure you use the right end of the cable and all the pins are in good state.

3. **On/Off Button**

The On/Off button is used to start up the system. To avoid unintended startup of the Trimble MX9 system, the On/Off button has to be held depressed for a minimum of 5 seconds before the system can initiate a startup sequence.

4. **Status LEDs** for Control Unit, Sensor Unit and WiFi Status

The different LED statuses have the same meanings for the three components:

- Blinking green: Component is being started, updated or shut down
- Solid green: Component is ready
- Blinking red: Component failed.

5. **Exchangeable Data Discs**

The Exchangeable Data Discs are the storage media for the collected data:

- Data Disc 1: Data from the 360° spherical camera, navigation and laser devices
- Data Disc 2: Data from the three oblique cameras

6. **WiFi Antenna 1**

WiFi Antenna 1 is used for a WiFi connection through which the control device (tablet computer/ laptop) can be connected to the Trimble MX9 system wireless and the Trimble MX9 system can be operated.

7. **WiFi Antenna 2**

With WiFi Antenna 2, the Trimble MX9 system can be connected to a hotspot/WiFi network, thus allowing the Trimble MX9 system to access the Internet. This connection can be used for remote support as well.

8. **LAN Connector**

The LAN connector is used to connect the operating device (tablet computer/ laptop) to the Trimble MX9 Control Unit thus providing full control over the Trimble MX9 system.

9. **WAN Connector**

The WAN Connector can be used to connect the Trimble MX9 system to the Internet. This connection can also be used for remote support.

10. **USB 2 Connector**

The USB 2 connector is reserved for use by the Trimble Support Team only.

11. **USB 1 Connector**

The USB 1 connector can be used to:

- Provide the system with the required software
- Update the system license

12. **Grounding Point**

To make sure the Trimble MX9 Control Unit is grounded in the same way as the other components of the Trimble MX9 system, a grounding cable (not included) can be used. The cable can simply be attached using the M5 knurled head screw (provided).

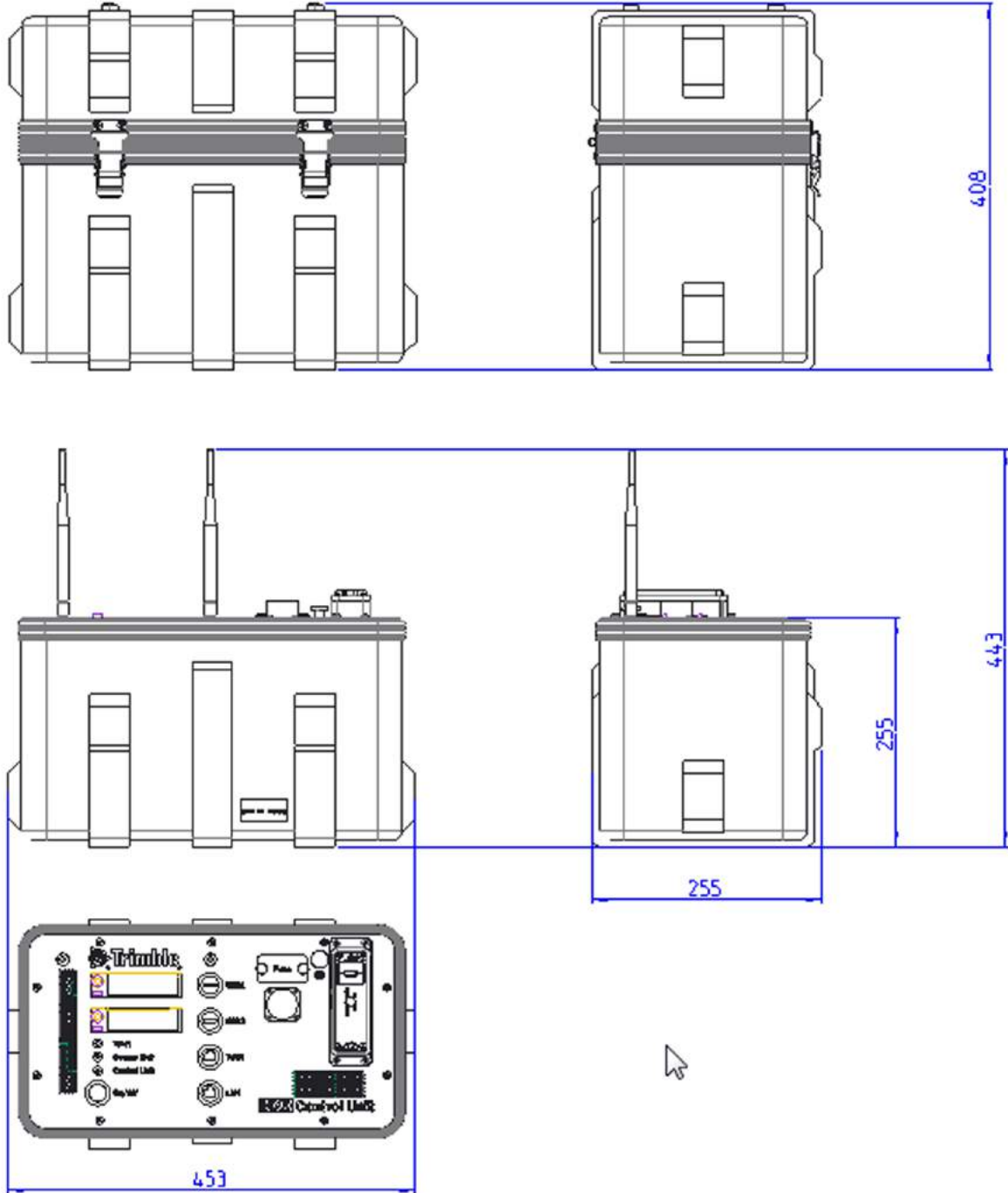
13. **Fuses** (Circuit Breaker 1 for Control Unit, Circuit Breaker 2 for Sensor Unit)

The Trimble MX9 Control Unit and Sensor Unit are each protected by a circuit breaker inserted in the power input circuit. In the Control Unit, the two circuit breakers are located underneath the fuse cover. To reach the circuit breakers, you just have to remove the cover.

After reactivating one of the circuit breakers and before turning the system back on, check all the cables to make sure the problem was not due to a damaged cable.

Dimensions

All dimensions in the drawing are in mm.



Installation

The MX9 Control Unit should be installed where the operator can have reasonable access to the Data Discs and where the Status LEDs on the unit can readily be seen.

Accessibility is strongly dependent upon the installation choices you make, the model of the vehicle used and the operator preferences. The only restriction in installing the unit on board the car is the length of the cable connecting the MX9 Control Unit to the MX9 Sensor Unit. The length of that cable (“MX9 - Cable - 5m, Control Unit to Sensor Unit, STD”) is 5 meters.

To install the MX9 Control Unit, first remove the cap from the unit, then place the unit where planned and secure it.

Flexible installation is also possible using the two belt guides (one on the front side, the other on the back side) through which a belt or a band may be inserted to secure the MX9 Control Unit to the desired location.



For Safety Regulation, see [Safety Instructions, page 7](#).

Power Unit

Description

The Trimble MX9 Power Unit operates as the interface and power converter between the vehicle's battery and the Trimble MX9 Control Unit. The Power Unit also acts as a filter to protect the equipment from any possible electrical disturbance (spikes, etc.) coming from the car's alternator.

The "Source to Power Unit" cable (T001273), 5 meters long, is used for connecting the MX9 Power Unit to the vehicle's battery.

See details and specifications in the "Technical Parameters" section and in "Typical Installation of a Power Supply for MX9 in a vehicle" in the Appendix.



The front panel of the Trimble MX9 Power Unit includes:

- Power In (IN) connector, where the vehicle's power supply is plugged in
- Power Out (OUT) connector, provides power to the Trimble MX9 Control Unit
- Status LED, indicates that power is available on the Power Out (OUT) connector when the MX9 system is started using the Power button on the Control Unit. Note that the LED may stay ON for some time after the system has been powered off.
- Grounding Point, where a grounding cable can be fixed with an M5 screw
- 1 A Fuse, T001497, protects the power control line between the Trimble MX9 Power Unit and the Trimble MX9 Control Unit



WARNING – The Trimble MX9 Power Unit is also equipped with two air vents (one at the bottom, the other at the back) as well as three mounting points to safely secure the Trimble MX9 Power Unit in the vehicle. NEVER COVER THE VENTS!

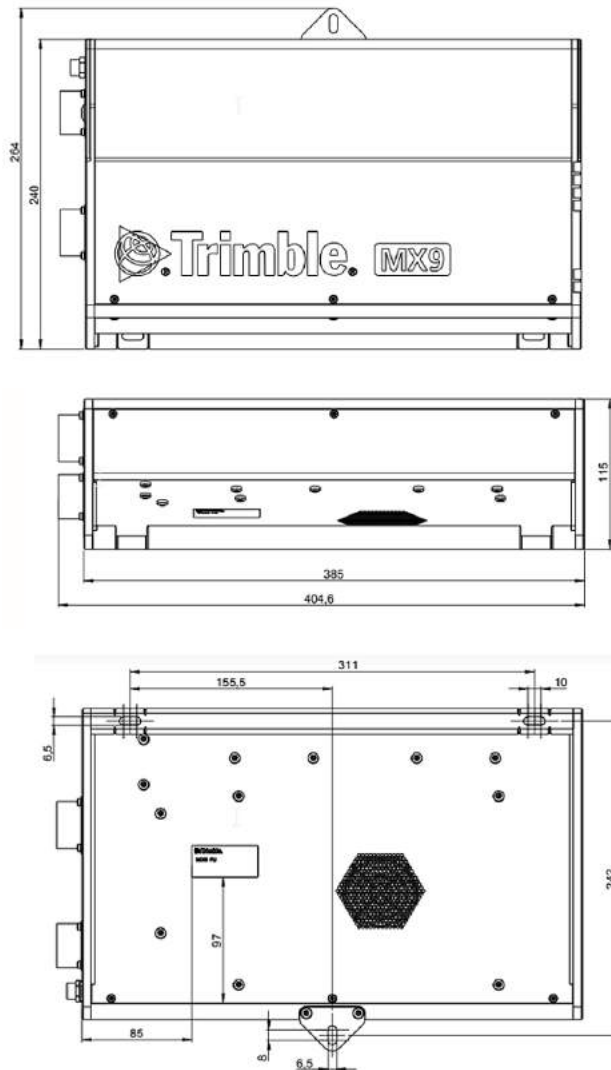
The Trimble MX9 Power Unit needs a minimum amount of power to operate in standby mode:

Power Consumption in Standby Mode	2.7 mA @13.8 V DC
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If the Trimble MX9 system is used on a daily basis, the Trimble MX9 Power Unit can be kept connected to the vehicle's power supply.

If the Trimble MX9 system is not used for a longer period of time, the Trimble MX9 Power Unit should be disconnected from the vehicle to save the vehicle's battery.

Dimensions



Properties and Functionality

- Provides power required for the Trimble MX9 system
- Protects the MX9 system from possibly defective vehicle's battery
- Protects vehicle's battery from going low (The Trimble MX9 Power Unit is equipped with a relay that cuts off power if the vehicle's battery drops below 8.5 V)
- Indicates when power is available on the Power Out (OUT) connector (LED status is then solid green)
- Is controlled by the On/Off button on the Control Unit. To protect the system from unintentional power-on sequence, the On/Off Button on the Trimble MX9 Control Unit has to be pressed for a minimum of 5 seconds.

Installation

Like for all components of the Trimble MX9 system, the installation of the MX9 Power Unit is strongly dependent upon the installation environment and the vehicle used or preferred.

Due to this, the final installation is under the responsibility of the customer in relation to the vehicle used.

The Trimble MX9 Power Unit can and should be tightly installed using the three mounting points (use screws with a diameter of 6 mm) inside the vehicle (e.g. in the trunk).

When installing the MX9 Power Unit, consider the following parameters:

- Install in a dry place within the vehicle
- Secure the installation (use the mounting holes in the housing for a safe installation using screws)
- ALWAYS keep clear space around the air vents on the back and bottom sides of the unit!
- Consider cable routing for Power In and Power Out connections (e.g. a cable 3 meters in length is used to connect to the Trimble MX9 Control Unit)
- NEVER COVER the Trimble MX9 Power Unit as this could lead to exceedingly high operating temperature.



Roof Rack

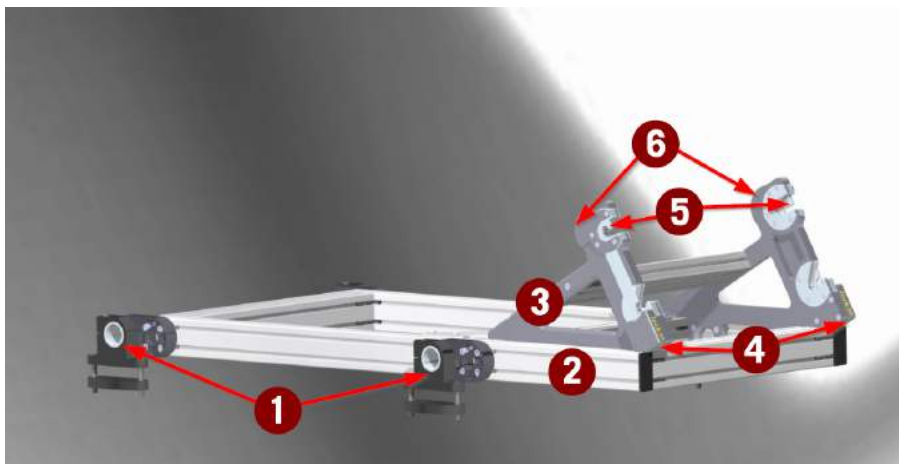
Description

The MX9 Roof Rack is the mounting facility for the MX9 Sensor Unit and is designed to fit on square cut universal roof load bars installed on the vehicle.

The position in length and height of the mounting brackets is adjustable (with some restrictions). It is also possible to level the MX9 Roof Rack if leveling is required because of installation restrictions or for some other reasons.

The MX9 Roof Rack consists of the following components:

1. **Mounting Brackets:** Used to fix the MX9 Roof Rack on the universal roof bars. These are adjustable on the mounting points so that the roof rack can be leveled and adjusted distance-wise
2. **Roof Rack Mainframe:** Is the main structure of the MX9 Roof Rack
3. **Mounting Facilities** for the MX9 Sensor Unit
4. **Safety Locks:** Used to firmly secure the MX9 Sensor Unit
5. **Lock Bars:** Used in conjunction with the safety locks
6. **Fast Locks:** Latches that get automatically locked in once the MX9 Sensor Unit has been properly inserted.



Basic Requirement for a Car Roof

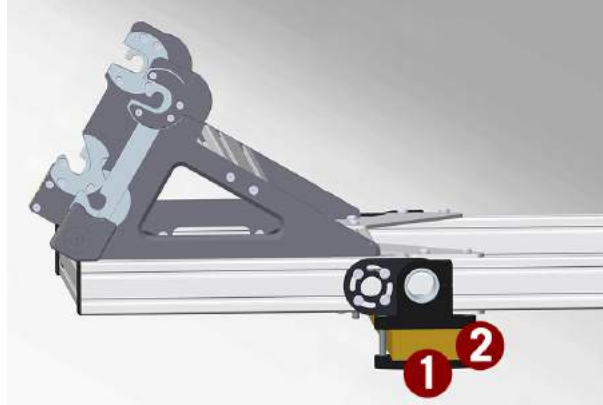
About the roof rails of the car you have chosen to carry the MX9, these should be designed and specified to withstand the MX9 Roof Rack (18 kg), the MX9 Sensor Unit (37 kg) and the universal roof bars (whose weight depends on the model you choose).

Basic Requirements for Universal Roof Bars

The MX9 Roof Rack is designed to fit on square cut universal roof bars having a width of up to 85 mm (see 1 in figure below) and a height of up to 30 mm (see 2 in figure below).

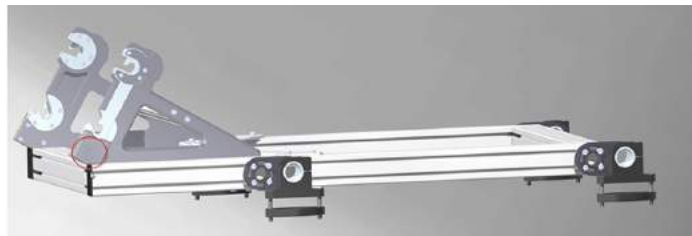
If your universal roof bars do not meet the height requirements, choose longer screws (ISO 4762 M8- A2).

Any installation other than the one using universal roof bars is possible provided it complies with the above requirements, which means you should make sure these requirements are met.



External Reference Point

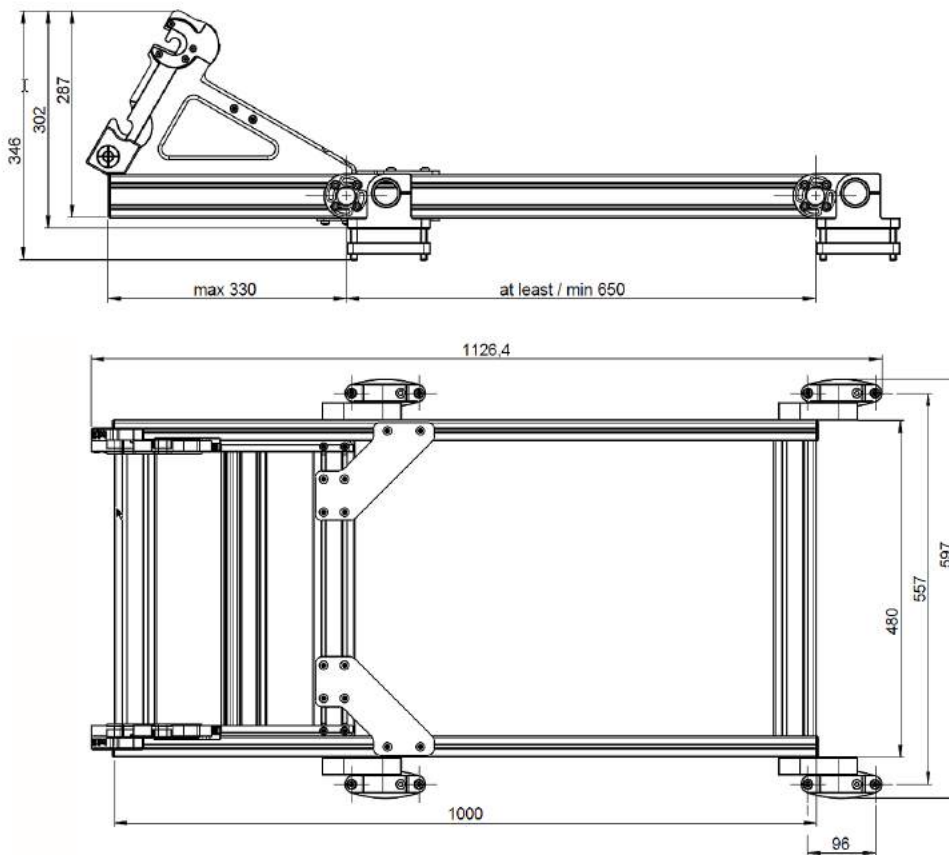
The MX9 Roof Rack also carries the External Reference Point of the system for lever-arm measurements. For more information, refer to [External Reference Point, page 55](#).



Dimensions

All dimensions are in mm.

Parameters	Max Value
Maximum overhang	330 mm
Minimum space between mounting brackets	650 mm



Installation Restrictions

The MX9 Roof Rack is delivered pre-installed. The position and height of the brackets are adjustable, but with the two restrictions listed below:

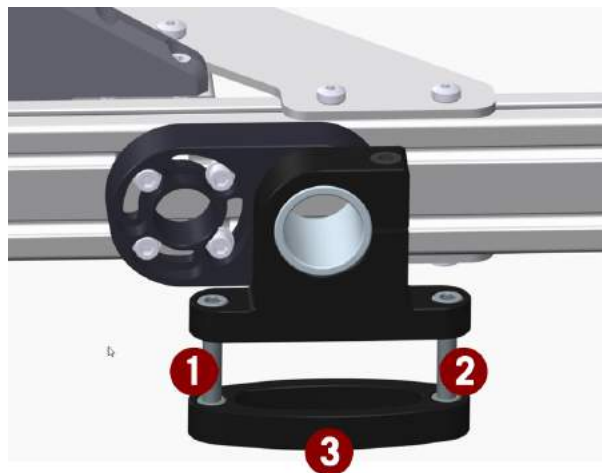
- The overhang of the end of the MX9 Roof Rack to the back eye of the mounting bracket should not be greater than 330 mm.
- The distance between the eyes of the front and back mounting brackets should not be less than 650mm. This minimum distance is indicated as a red marking (a stripe) on the mainframe.

Adjusting the Position of the MX9 Roof Rack on the Roof Bars

Install the universal roof bars on the car. Please consider the restrictions described in section “Installation Restrictions”.

To install the MX9 Roof Rack on the universal roof bars (see figure below):

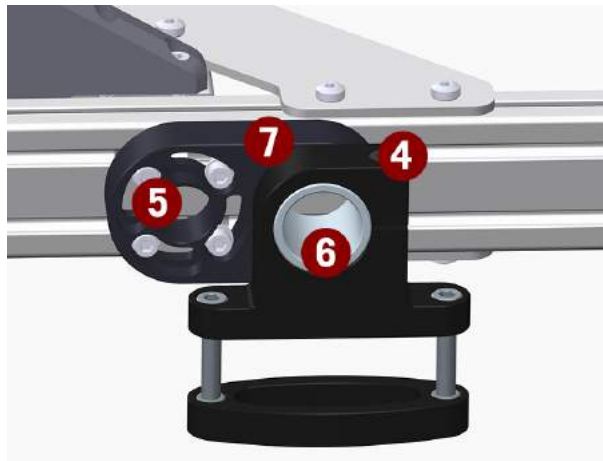
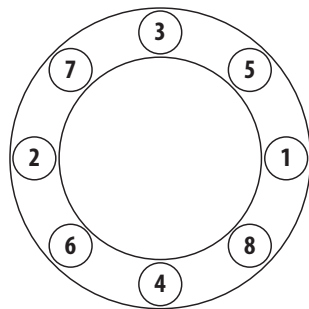
- Loosen and remove the two main screws (1 and 2) on each mounting bracket.
- Remove the screw bridge (3).
- Put the MX9 Roof Rack on the universal roof bars (now installed on the vehicle).
- Put back the two main screws and the screw bridge together again, then tighten the screws to secure the MX9 Roof Rack. As this is a universal mount, there is no explicit torque recommendation for this mounting.



After the MX9 Roof Rack has been secured on the universal roof bars, the height, the overhang and the angle can be adjusted:

- **Overhang:** Loosen screws No. 5 on all mounting brackets and push the MX9 Roof Rack in the desired position (Please consider the restrictions). Then re-tighten screws No. 5 using a torque value of 8 Nm.
- **Height and Angle:** Loosen screws No. 4 and No. 5, turn shaft block No. 7 around bracket shaft No. 6 to reach the desired angle, or at least the desired height. Then re-tighten the screws, complying with the recommended torque values:
 - Screws No. 5: 8 Nm
 - Screws No. 4: There cannot be any torque value recommended as the grip of the rivet is infinite.

Tighten all the screws evenly and crosswise (in the order mentioned below) in at least three runs to get the required torque value.



Cables - Identification & Installation

NOTE - Before making any cable connection, please read the [Safety Instructions, page 7](#).

The MX9 system is delivered with three different cables. These should be used and connected as indicated below:

1. **Source-to-Power-Unit Cable, 5 meters.** See picture below:



Connect this cable between the MX9 Power Unit and the power source available on board the vehicle. For more details on a typical installation, please refer to [Installing a Power Supply in a Vehicle for Safely Operating the MX9 System, page 77](#).

2. **Power-Unit-to-Control Unit Cable, 3 meters.** See picture below.



Connect this cable between the MX9 Power Unit and the MX9 Control Unit. Both power and signals are routed via this cable.

Additionally, connect the ground terminal of the three MX9 units to the vehicle chassis. All ground connections for the Trimble MX9 components are under the control and responsibility of the system owner and are dependent on the installation environment specific to the vehicle.

3. **Control-Unit-to-Sensor-Unit Cable, 5 meters, STD.** See picture below.



Each end of this cable uses a specific connector type. Make sure you hold the right end of the cable before inserting it into a unit. You should also make sure the pins on each of these two connectors are in good state (the pins should not be bent or broken).

- Connect the "Sensor Unit" end of the cable to the Trimble MX9 Sensor Unit.
- Slide in and secure the Sensor Unit Side of the cable by turning the lock screw to the right. The lock screw is colored black and located on top of the connector.
- Install and secure the cable safely (in relation to the vehicle and the installation environment).
- Plug the other end (the "Control Unit" end) of the cable to the Trimble MX9 Control Unit. Also slide in and secure this end of the cable by turning the lock screw.
- The plugs used at the ends of this cable are design to withstand up to 1,500 mating cycles.



User Interface Device

The Trimble MX9 system is operated from a mobile device. This can be a tablet computer or a laptop, ideally with a touch display.

The device should have at least the following specifications:

- Fitted with a 10" (or larger) display
- Ideally fitted with a touch display (laptop and mouse may work as well, but might be unhandy considering that the system is used in a vehicle moving at normal road speeds)
- Google Chrome for running the Trimble Mobile Imaging User Interface

The installation can take place where it is comfortable for the operator. Note that the driver is not allowed to operate the system and should not be distracted by the whole equipment. It is recommended that the system be operated by a second person (the operator).

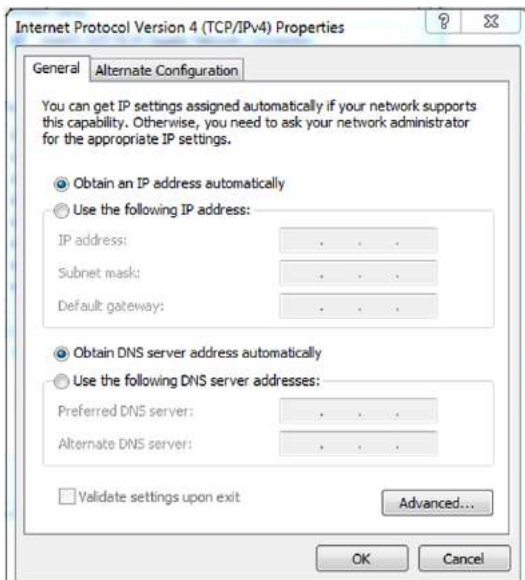
Ensure that the tablet computer or laptop is mounted and stored as advised in its manual.

Connecting the Device Via Ethernet

For connecting the user interface device to the MX9 via Ethernet, an active network port should be made available on this device and should be set as follows:

- **Obtain an IP address automatically** check box enabled
- **Obtain DNS server address automatically** check box enabled

(See below the typical Windows dialog to make these settings.)



A standard Ethernet cable, fitted with an RJ45 connector, should be connected to the LAN port on the Control Unit (see 8 on the above picture).

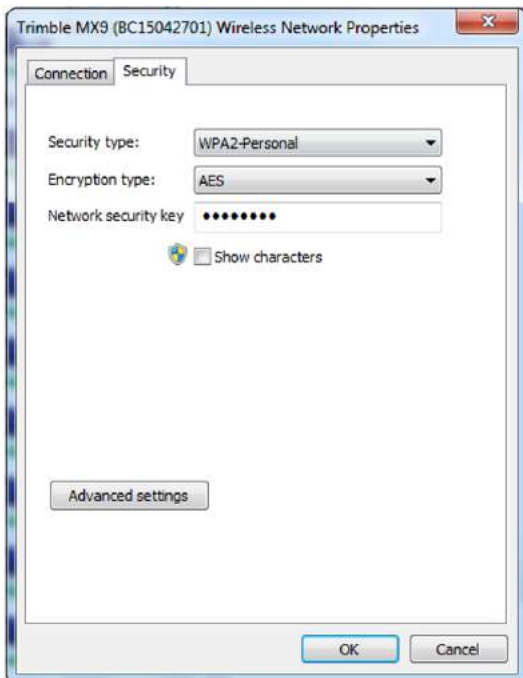
Connecting the Device via WiFi

When scanning for available WiFi networks, the MX9 should show up in the list of detected devices.

The SSID of the MX9 is in the form: "Trimble MX9 (117070101)", where the number within the brackets is the serial number of the MX9.

The password to connect to the MX9 WiFi is provided on separate stickers shipped inside the transportation case of the MX9 Sensor Unit. This password is unique for each system and cannot be changed.

See below the typical WiFi settings dialog (in MS Windows).



Storage and Transportation

Delivered Items

The Trimble MX9 System is delivered in two different boxes:

1. **Box 1.** This shipping box includes:

- The Trimble MX9 Sensor Unit in its transportation case. The dimensions of the transportation case are (L x W x H): 806 x 716 x 634 mm.
- The *Control-Unit-to-Sensor-Unit* cable, 5 meters, also included in the transportation case.
See picture below (transportation case open, shipping box not shown; the transportation case also includes a hex wrench, a Quick Start Guide and three copies of a sticker providing the WiFi password).
- Quick Start Guide
- Hex wrench 6 tool
- Three stickers with printed WiFi password.



Box 1 weighs 58 kg and has the following inner dimensions (L x W x H): 800 x 800 x 800 mm.

2. **Box 2:** This shipping box includes the following items:

2 System Overview and Installation

- Trimble MX9 Roof Rack



- Trimble MX9 Power Unit



- Trimble MX9 Control Unit

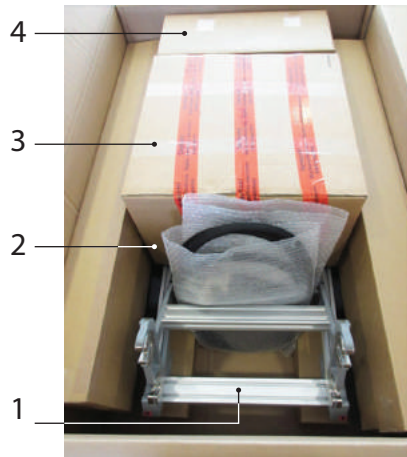


2 System Overview and Installation

This unit has no transportation case as such, but once you have fastened the lid onto it, it can safely be transported without the need for a specific transportation case. You will also find the following items inside the Control Unit transportation case (see also previous picture):

- Tool Hex Wrench 6 (in the transportation case of the Sensor Unit)
- USB 3.0 Cable (for Data Storage Discs)
- Keys for Data Storage Discs
- 2 WiFi Antennas
- Quick Start Guide (in the transportation case of the Sensor Unit)
- *Source-to-Power-Unit* cable
- *Power-Unit-to-Control-Unit* cable.

In box 2, these items are organized as shown on the picture below.



Where:

- 1: Roof Rack
- 2: Cables
- 3: Control Unit
- 4: Power Unit

Box 2 weighs 75 kg and has the following dimensions (L x W x H): 1170 x 770 x 500 mm.

Use Assumptions

Trimble assumes the different components of the MX9 system are used as follows:

- The Roof Rack is permanently installed on the vehicle roof.
- The Power Unit is permanently installed inside the vehicle.
- The *Source-to-Power-Unit* cable is permanently installed inside the vehicle.
- The Control Unit is temporarily installed in the vehicle just for operation.
- The Sensor Unit is temporarily installed on the Roof Rack and removed for transfer¹.
- External instruments (e.g. DMI) as well as the cabling for these instruments are removed for transfer and storage.
- Cables between Power Unit and Control Unit and between Control Unit and Sensor Unit temporarily installed in and on the vehicle for operation and removed for storage and transfer.

Whenever the Trimble MX9 system is not used (storage, transportation or transfer), the Sensor Unit must be stored in its transportation case and the Control Unit must be closed by placing its lid back on.

Storage

Storage conditions are provided in the Technical Parameters section of this manual. See [Environmental](#), page 63.

¹"Transfer" refers to that period of time during which the vehicle is driven without operating the MX9 system, although it's still installed in the vehicle (except for the Sensor Unit which should have been removed from the roof).

Optional Accessories

DMI

The “Trimble MX9-DMI Kit” T001507 is an additional mechanical assembly group allowing you to use the DMI (Distance Measuring Indicator) functionality with the Trimble MX9 system.

To improve the measurement accuracy of the Trimble MX9 system, this additional sensor can be used (Zero Velocity Update (ZUPT) information for navigation post-processing).

For more information about the Distance Measuring Indicator, refer to the *Trimble® MX7-DMI Installation & Operation Manual* or contact your Trimble dealer.



GAMS

The "Trimble MX7 GAMS Antenna Kit" is an additional mechanical assembly group allowing you to use the GAMS (GNSS Azimuth Measurement System) functionality with the Trimble MX9 system.

GAMS is an additional GNSS antenna used in the field to speed up the initialization of the navigation system, hence of the MX9 system. Thanks to the second GNSS antenna, the orientation of the car can be estimated far more quickly compared to what can be achieved with a single-antenna solution. For more details, please contact your Trimble dealer.

For more information about the GNSS Azimuth Measurement System, refer to the manual "Trimble® GAMS Antenna Kit Installation & Operation Manual".



To connect the GAMS kit to the MX9 system, use the "Ant." connector on the MX9 Sensor Unit.

Operation

Safety Check

- Complete a safety check before and after each mission
- All broken or damaged components should be exchanged immediately.
- All loose screws should be tightened.
- Any screw must be tightened with the correct torque value as mentioned in the System Overview and Installation chapter. Be aware of the appropriate procedure to tighten screws
- Any dirty or wet part should be cleaned or dried.
- Do not start a mission before solving any issue you may have had previously with the system. Not doing this may damage the system permanently.
- The operator must take care to fulfill all requirements and certifications.

Components Checklist

- Check that the MX9 Roof Rack is installed correctly
 - Check that all the screws of the MX9 Roof Rack have been tightened.
 - Check that the MX9 Roof Rack components show no cracks or deformation.
- Check that the MX9 Sensor Unit is damage-free (no scratches or deformation of material):
 - Check that all camera lenses and laser windows are clean and not damaged in any way (scratches or marks).
- Check that the MX9 Sensor Unit is in operation position and properly locked.
- Check the Control Unit for damages or any broken parts.
- Check that the Control Unit is installed correctly and secured.
- Check that the Power Unit is damage-free, and there is no broken part.
- Check that the Power Unit is installed correctly, air inlet and air outlet are free and the Power Unit is secured.

3 Operation

- Check all cable connections:
 - Check that the connectors are plugged in and fixed.
 - Check that the cables are fixed to the vehicle roof rack before being led inside the vehicle cabin.
 - Check that no cable is damaged or might get damaged during operation.
- Check that the user interface device (laptop, tablet, etc.) is operational.

External Reference Point

The MX9 System needs to know how it has been mounted on the vehicle and how the external components have been mounted relative to the MX9. These mounting measurements are listed below:

- **Installation Height:** Height of the MX9 system above the road surface
- **DMI Lever Arm:** Three-axis distance between the MX9 system and the DMI (wheel sensor)
- **GAMS Lever Arm:** Three-axis distance between the MX9 system and the secondary GNSS antenna.

Measuring Installation Parameters and Lever Arms

All these measurements are performed from the MX9's External Reference Point to the corresponding counterpart. The **External Reference Point** is located on the right side, at the back of the MX9 Roof Rack.

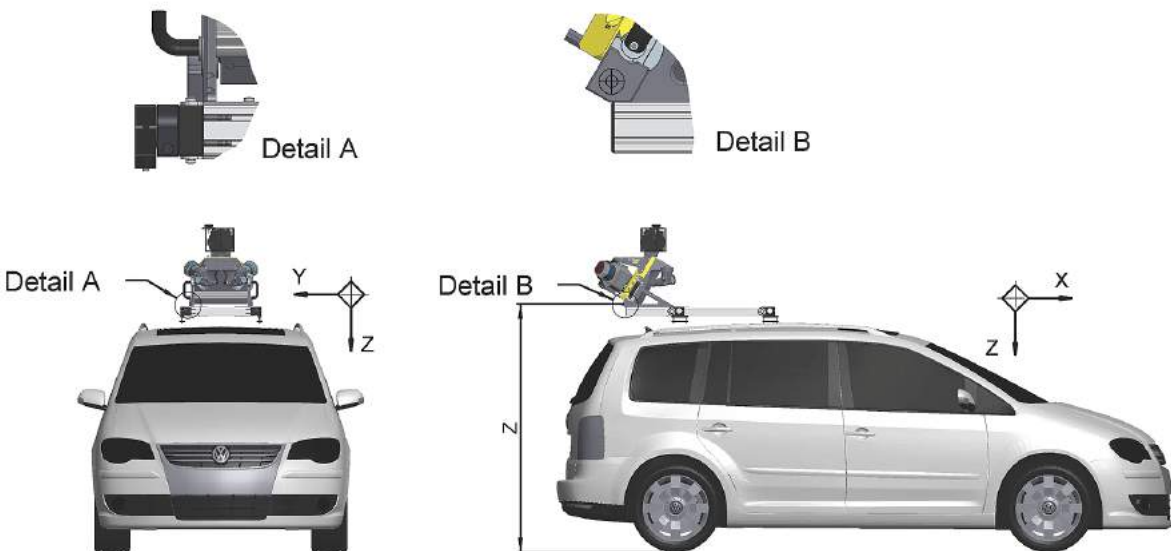


The **Installation Height** is measured from the External Reference Point down to the road surface. The value is always given in meters as an absolute value.

Lever Arm measurements for DMI and GAMS are performed in the so-called Vehicle Frame from the External Reference Point to the center of the corresponding sensor (DMI or GAMS) as measurements of distance (also in meters) along three different axes. The orientation of the axis in the vehicle frame is defined as follows:

Positive X-axis	In forward driving direction
Positive Y-axis	Right-hand side of vehicle
Positive Z-axis	Downward

⚠ CAUTION – Make sure you are using the correct sign when measuring Lever Arm values. For example, a DMI mounted on the left wheel has a negative Y Lever Arm value.



Additional Note for DMI


The DMI Lever Arm is a three-dimensional vector defining the offset from the External Reference Point to the sensing center of the DMI. This offset vector is measured in the Vehicle Frame. Lever distances are measured from the External Reference Point to the center of the tread (where the DMI-equipped wheel makes contact with the road). The DMI-equipped wheel must be a non-steering wheel.

Additional Note for GAMS

The GAMS Lever Arm is a three-dimensional vector defining the offset from the External Reference Point to the GAMS Antenna. This offset vector is measured in the Vehicle Frame. Lever distances are measured from the External Reference Point to the Antenna Phase Center of the GAMS Antenna (secondary GNSS Antenna).

Configuring MX9 for Operation


All parameters mentioned above need to be measured after having installed the MX9 system and all the additional sensors (DMI, GAMS) on the vehicle. In the next step, the measured numerical values need to be stored as the Vehicle Preset in the TMI Software, which is used to configure the system before a mission is started.

 **CAUTION** – Using incorrect or poor measurement values in the Vehicle Preset may result in faulty navigation solutions. Make sure that all values are entered correctly (on the order of 1 cm). Later on, make sure you select the correct Vehicle Preset before starting a mission.

Additional Note on POSPac Processing

The origin of the MX9 System Reference Frame is different from the External Reference Point. For this reason, the TMI Software adds additional internal vectors to the Lever Arm values provided in a Vehicle Preset. In POSPac processing, you will be able to read the corrected Lever Arm values and you will see that they are different from the mechanical measurements.

Prerequisites to System Setup and Operation

 **CAUTION** – Before starting, please make sure all connections are secure and the recording SSD's are inserted and locked.

Before starting data capture, make sure the measurement parameters (e.g. sensor setup on the vehicle and capture parameters like laser pulse rate) have been set properly. The parameters you have defined may be saved as presets under user-defined names and can be selected when starting a mission later.

A standard operation workflow and an “In-the-field operation checklist” are described more in detail in the *Trimble MX9 Quick Start Guide*.

 **WARNING** – The first time you use the Trimble MX9, and then every time you start a data collection campaign in a different country, you must specify the name of this country when setting the WiFi access point. This is a mandatory prerequisite. That way, you are sure to comply with the regulations of this country in terms of WiFi use. To set the country of use, run the TMI Software, then in the menu, select **System Administration > WiFi > MX9 WiFi Access Point** and then choose a country.

For more information, refer to [Wifi Setup, page 1](#).

System Software

The software running the MX9 system –called TMI– is described in a separate manual. See *Trimble TMI Software for Trimble Mobile Mapping Systems User Guide* for detailed information.

Maintenance and Support

Maintenance

Dismantling or attempting to have a Trimble MX9 system repaired by unauthorized personnel can be hazardous and costly. Maintenance should be limited to the cleaning and inspection of external surfaces, lens glass, operating controls, etc.

Preventive Maintenance

The preventative maintenance to be carried out by the operator should include:

- During use:
 - Avoid operating the system in rainy or misty weather.
 - Avoid mechanical shock.
 - Clean and dry the equipment before, during and after use if necessary.
- Before storage:
 - Dry the system thoroughly before storing.
 - Correctly pack the equipment in the transportation / storage case provided.
 - Ensure the transportation / storage case is kept dry and clean inside.
 - Ensure that your equipment is dry before storage.
 - Store within the equipment environmental temperature and humidity limits.
- During transportation:
 - Correctly pack the equipment in the supplied transportation cases.
 - Do not allow the equipment to slide around inside transport vehicles or containers.
 - Ensure that your equipment is dry before putting it into the transportation box.
- General:
 - Carry out regular functional testing of the system.
 - Detect and report damage, malfunctions and poor performance.

Lubrication of Movable Parts

The lock bars as well as the fast lock mechanism of the Roof Rack should be cleaned and re-lubricated frequently. After cleaning, simply use a spray oil for re-lubrication.

Cleaning the Camera Lens Glass and Laser Glass

- Perform all cleaning operations in a clean environment.
- To remove dust and dirt, first try to gently blow the debris off with an air compressor.
- If the debris will not come off using an air compressor, apply a small amount of optics cleaner (e.g. Photographic Solutions Eclipse Optics Cleaner) or ethyl alcohol to a clean lens cloth (e.g. Pentax lens cloth). The cloth should be moist but not dripping.
- Wipe the cloth or swab along the length of the glass surface in smooth movements. Do not press hard on the surface or rub repeatedly on one spot.
- If pooling or streaks occur, there may be too much solution – wait for it to dry, then repeat.
- When finished cleaning, examine the glass surface in light.
- If dust spots remain, repeat this procedure using a clean lens cloth.

Support

General

In case you need support for the Trimble MX9 or Trimble Mobile Mapping software please contact our Customer Support team via email:

Trimble Support Email Address imaging_support@trimble.com

Or call:

APAC: +86 1 088 5775 75824

Americas: +1-289-695-4416

Europe & Middle East: +49 7351 47402 47

Please describe the issue you are facing as precisely as possible:

- Short description of the problem
- Workflow and how to reproduce the problem
- If occurring during a mission:
 - Location of the mission.
 - Environmental conditions.

Also send the following information about your Trimble MX9 system:

- System Log file
- Serial Number
- Total operating hours of your Trimble MX9 system since purchase.
- Photos or videos may also be useful to report a problem

Trimble Land Mobile Download Center

System Software Updates, FAQ and documentation are available in the Trimble Land Mobile Download Center.

Appendix

Technical Specifications

MX9 System

These specifications apply to all three MX9 systems listed below:

- MX9 Dual Head, AP60, Spherical+3x5MP, T001445 (one spherical camera, three oblique cameras)
- MX9 Dual Head, AP40, Spherical+3x5MP, T001446 (one spherical camera, three oblique cameras)
- MX9 Single Head, AP40, Spherical+, T001552 (one spherical camera, no oblique camera)

Power Requirements

Parameter	Value
Input Voltage Range	12 V to 16 V DC (280 W typical)
DC Current at start-up	25 A @ 13.8 V (345 W)
DC Current in steady state operation ¹	20 A @ 13.8 V (276 W)

¹Depends on temperature.

Weight

Parameter	Value
Sensor Unit, Dual Head	37 kg
Sensor Unit, Single Head (without 3x5MP)	31 kg
Control Unit	12 kg
Power Unit	9 kg
Roof Rack	18 kg
Source-to-Power-Unit Cable, 5 meters	2 kg approx.
Power-Unit-to-Control Unit Cable, 3 meters	1.5 kg approx.
Control-Unit-to-Sensor-Unit Cable, 5 meters, STD	3.5 kg approx.

Environmental

Parameter	Value
Operating Temperature Range ¹	0°C to +40°C (32°F to 104° F)
Storage Temperature Range	-20°C to +50° C (-4°F to 122°F)
Operating Relative Humidity Range ²	10% to 80%
Storage Relative Humidity Range	20% to 95%
IP Rating	IP64 (Sensor Unit) IP30 (Power Unit and Control Unit)
Maximum Vehicle Speed (With operating or non-operating system on board)	110 km/h (68 mph)
Recommended Maximum Vehicle Speed (with operating system on board)	80 km/h (50 mph)

¹Not exposed to direct sun and with vehicle speed less than 10 km/h (6 mph).

²Non-condensing.

Spherical Camera Performance

The spherical camera system included in the Trimble MX9 Sensor Unit consists of six single cameras that deliver a spherical image. The performance data of the cameras, as applied in the MX9, are given below.

Parameter	Value
Image resolution (total)	30 megapixels
Image format	PGR (compressed JPEG)
Shutter system	Global shutter
Focal length	4.4 mm
Focus distance	About 2.0 m (Sharpness from 0.7 m to infinity)
Field of view	90% of full sphere
Number of single cameras	6
Image resolution of single cameras	5 Megapixels
Sensor type	CMOS
Sensor size (single camera)	2/3 "
A/D converter	8 bits

Oblique Camera Performance

The oblique cameras included in the Trimble MX9 Sensor Unit are split into two front cameras and one down camera. All cameras have the same sensors and lenses.

The performance data of the cameras, as applied in the MX9, are given in the table below.

Parameter	Value
Image resolution	5 megapixels
Image format	MXIPS (compressed RAW format)
Shutter system	Global shutter
Lens focal length	8.5 mm
Focus distance (front camera)	About 4.5 m (Sharpness from 3.5 m to infinity)
Focus distance (down camera)	About 3.0 m (Sharpness from 2.0 m to 9.0 m)
Field of view	H: 53.1° , V: 45.3°
Sensor type	CMOS
Sensor size	2/3 "
A/D converter	8 bits

Laser Performance


The Trimble MX9 Sensor Unit includes two scanner units. The scanner consists of a pulsed laser (time-of-flight measurement) and a rotating mirror.

The laser scanners include the following functions: echo digitization, online waveform processing, multi-target capability, calibrated amplitude, calibrated reflectance, pulse shape information of echo signal on all measurements, variable measurement speed and multiple-time-around capability.

Each of the scanners provides full 360° beam deflection without any gaps.

The laser scanners are synchronized (SCANSYNC) and use the Multi-Time-Around (MTA) processing (in office software).

Scanner and Laser Specifications

Parameter	Value			
Measurement Principle	Time-of-flight measurement: <ul style="list-style-type: none"> • Echo signal digitization • Online waveform processing • Multiple-time-around processing 			
Laser Pulse Repetition Rate PRR ^{1 7}	300 kHz	500 kHz	750 kHz	1000 kHz
Max. Measurement Range ^{2 3} : - For natural targets, $\rho \geq 10\%$ - For natural targets, $\rho \geq 80\%$	150 m 420 m	120 m 330 m	100 m 270 m	50 m 135 m
Max. Unambiguous Range ¹	490 m	295 m	200 m	145 m
Max. Number of Targets per Pulse	up to 15	up to 10	up to 7	up to 5
Minimum Range	1.2 m			
Accuracy ^{4 5}	5 mm			
Precision ^{5 6}	3 mm			
Angle Measurement Resolution	0.001°			
Max. Effective Measurement Rate ¹	Up to 1 000 000 measurements/sec (@ 1000 kHz PRR & 360° FOV)			
Echo Signal Density	For each echo signal, high-resolution 16-bit intensity information is provided			
Scan Speed (No. of profiles per second)	20 Hz up to 250 Hz (in 10-Hz steps)			
Laser Beam Footprint (Gaussian Beam Definition)	4.5 mm @ exit 5.0 mm @ 5 m 6.6 mm @ 10 m 13.0 mm @ 25 m 25.0 mm @ 50 m 50.0 mm @ 100 m			
Laser Wavelength	Near Infrared			
Laser Product Classification ⁸ according to IEC60825-1:2014				

¹ Rounded values.

² Typical values for average conditions. Maximum range is specified for flat targets with size in excess of the laser beam diameter, perpendicular angle of incidence, and for atmospheric visibility of 23 km. In bright sunlight, the maximum range is shorter than under overcast sky.

³ Ambiguity to be resolved by post-processing with Trimble MMS software.

⁴ Accuracy is the degree of conformity of a measured quantity to its actual (true) value.

⁵ One sigma @ 30 m range under test conditions.

⁶ Precision, also called reproducibility or repeatability, is the degree to which further measurements show the same result.

⁷ User selectable.

⁸ The classification is based upon the assumption that the laser beam is continuously scanned.

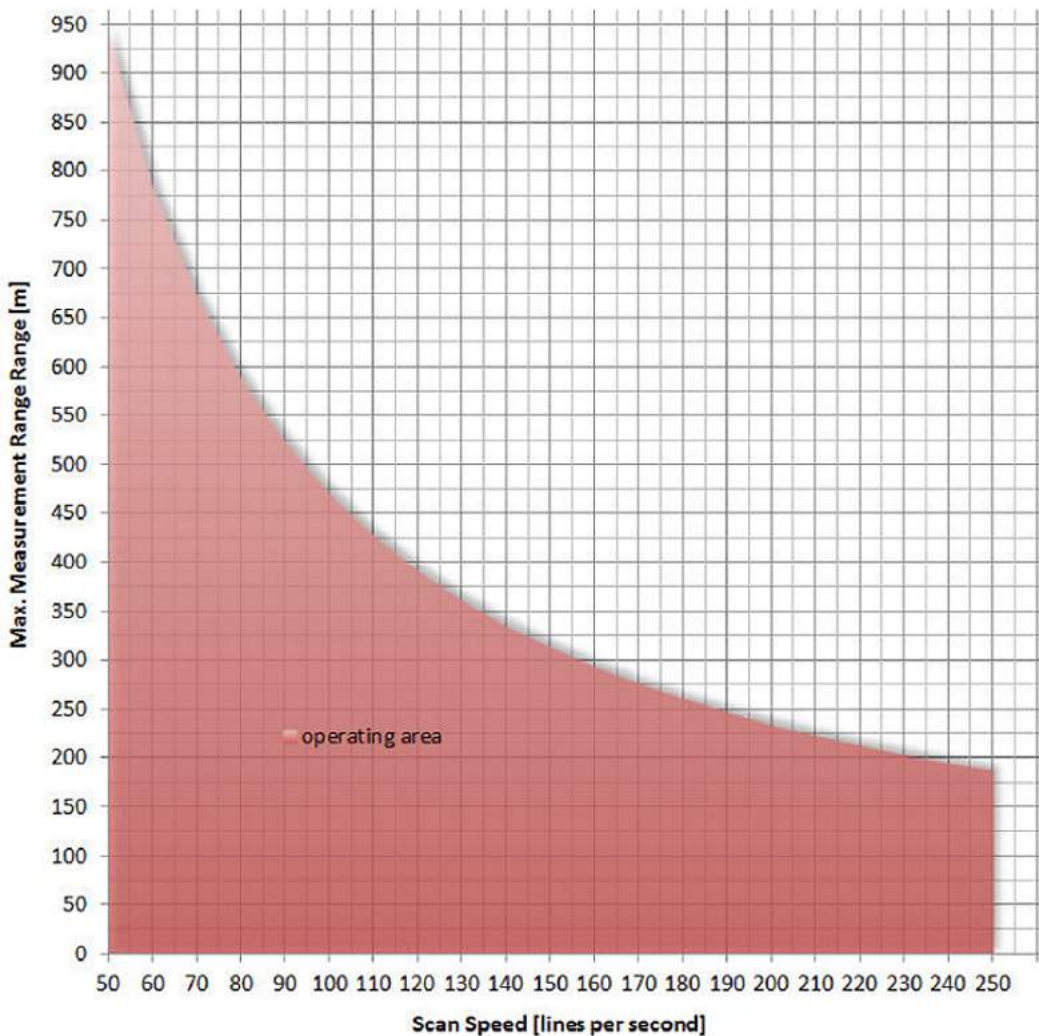
⁹ Scan speed limits the maximum measurement range.

Reduction of the Maximum Range Due to Mirror Rotation

The previous specifications table indicates the maximum range as a function of the selected laser pulse rate (PRR) and the reflectivity coefficient of the target.

Additionally, a reduction of the maximum range occurs at high rotational mirror speeds. While the laser pulse propagates to the target and back to the instrument’s receiver optics, the mirror continues rotation. By the time the laser pulse echo is received, the receiver is oriented in an angular direction different from that of the laser transmitter at the time the pulse was emitted. An echo signal can only be detected when the laser footprint is still within the field of view of the receiver.

The maximum range values shown in the figure below are calculated in the case where the reflected signal still fully hits the receiver sensor. This figure has to be taken into account additionally to the “range performance” values. The maximum range values shown are not hard limits, as highly reflecting targets with strong echo signals may be sufficient for a measurement with only a partial detection.



Scanner Motion Synchronization (SCANSYNC)

The two laser scanners are synchronized to reduce potential interference between the two scanners. This will ensure that a laser pulse sent out by one scanner is not received and detected by the other one, which would create wrong measurements.

Multi-Time-Around (MTA) Processing

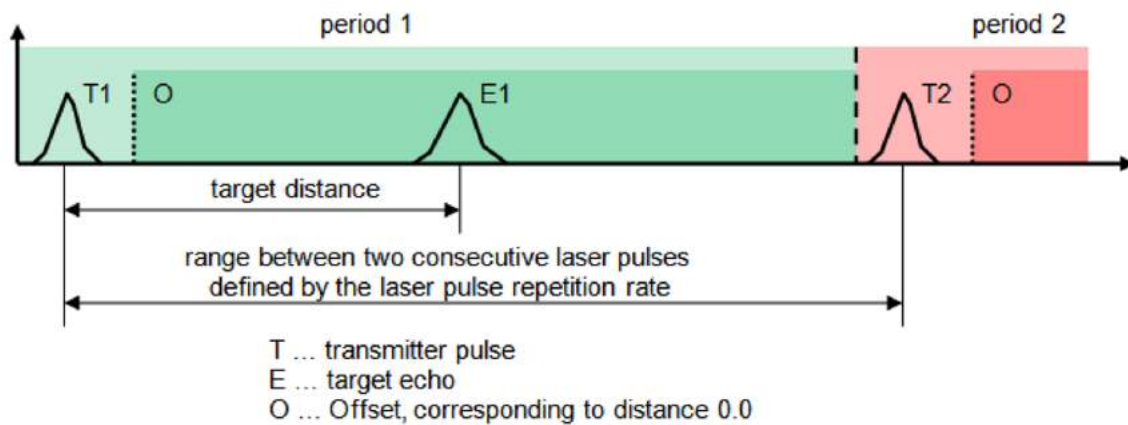
When a laser pulse is emitted, the echo of the target signal usually has to be detected before the next laser pulse for the next measurement is fired.

As a consequence, the maximum detectable range is limited by the laser pulse repetition rate. That means the time of flight of the laser pulse to the target and back to the instrument must not exceed the time between two consecutive laser shots.

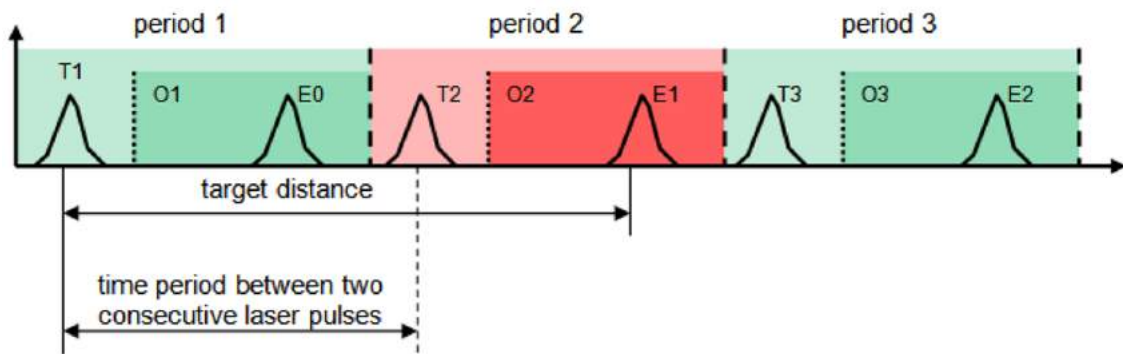
The **MTA** processing allows the utilization of target echo signals which occur after the next – or next but one – laser pulse fired.

The time period between a laser shot at time T_n and the following laser shot at time T_{n+1} is called “*period n*” in the next two diagrams.

In this diagram below, target distances are determined by measuring the distance between the transmitter pulse and the target echoes within the same period:



As shown in the diagram below, the MTA processing offers the possibility to determine the target distance of echo pulses located in one of the following periods:



This diagram shows that, with MTA processing, target distances are determined between the transmitter pulse of period n and the target echoes detected in period $n+1$.

For a given transmitter pulse, if the target echoes are returned within the same period, the echoes are then in **MTA zone 1**.

For a given transmitter pulse, if the target echoes are returned within the next period, the echoes are then in **MTA zone 2**.

For a given transmitter pulse, if the target echoes are returned within the next but one period, the echoes are then in **MTA zone 3**.

All data regarding the MTA zone will be collected with the the laser data. The handling of the MTA Zone is part of the office software.

Use of Retro-Reflective Targets

The laser scanner makes use of a high power laser source and an extremely high sensitive electro-optical receiver. Thus the laser scanner works with natural reflecting targets like trees, stones, asphalt etc. only.

Retro-reflective targets like reflecting paint, reflecting foil or plastic cat's eye reflectors can only be used at very long distances.



WARNING – Never use glass retro-reflectors (so-called corner cube reflectors or prisms) as a target with this instrument! Measuring to optical-grade retro-reflectors at ranges below 300 m can permanently damage the instrument and should therefore be avoided under all circumstances.

APxx POS System Performance

The Trimble AP60 and AP40 feature a high-performance, precision GNSS receiver and the industry-leading, Applanix IN-Fusion™ GNSS-Inertial integration technology running on a dedicated and powerful Inertial Engine (IE) board.

Assuming the best operation conditions regarding satellite configuration, atmospheric conditions and other environmental effects, the following performance with the DMI option can be achieved.

Ideal POS System Performance for AP60

Terrestrial Applications	No GNSS Outage		60-second GNSS Outage	
	SPS	Post-Processed ¹	SPS	Post-Processed ¹
Position (m)	1.5-3.0	0.02-0.05	1.5-3.0	0.07-0.10
Velocity (m/s)	0.030	0.005	-	-
Roll (degrees)	0.005	0.005	0.008	0.005
Pitch (degrees)	0.005	0.005	0.008	0.005
True Heading (degrees) ^{2, 3}	0.020	0.015	0.050	0.015

Ideal POS System Performance for AP40

Terrestrial Applications	No GNSS Outage		60-second GNSS Outage	
	SPS	Post-Processed ¹	SPS	Post-Processed ¹
Position (m)	1.5-3.0	0.02-0.05	3.75	0.10-0.12
Velocity (m/s)	0.050	0.005	-	-
Roll (degrees)	0.020	0.015	0.025	0.020
Pitch (degrees)	0.020	0.015	0.025	0.020
True Heading (degrees) ³	0.020	0.020	0.040	0.020

¹ Calculated with POSpac MMS

² Typical mission profile, max RMS

³ With GAMS option, 2 m baseline

Technical Specifications

- Advanced Applanix IN-Fusion™ GNSS-Inertial integration technology
- Advanced Trimble Maxwell® 6 Custom GNSS survey technology (two chipsets)
- Primary Chipset:
 - GPS: Simultaneous L1 C/A, L2C, L2E, L5
 - GLONASS: Simultaneous L1 C/A, L2 C/A, L2 P
 - BeiDou: B1, B2
 - Galileo: Simultaneous L1 BOC, E5A, E5B
 - QZSS: L1 C/A, L1 SAIF, L2C, L5
 - SBAS: Simultaneous L1 C/A, L5
 - L-Band: OmniSTAR VBS, HP, XP and G2, Trimble CenterPoint RTX
- Secondary Chipset:
 - GPS: Simultaneous L1 C/A, L2C, L2E
 - GLONASS: Simultaneous L1 C/A, L1 P, L2 C/A, L2 P
 - BeiDou: B1
- High precision multiple correlator for GNSS pseudorange measurements
- Unfiltered, unsmoothed pseudorange measurements data for low noise, low multipath error, low time domain correlation and high dynamic response
- Very low noise GNSS carrier phase measurements with <1 mm precision in a 1 Hz bandwidth
- Data logging:
 - Time tag, status, position, attitude, velocity, track and speed, dynamics, performance metrics, raw IMU data (200 Hz)
 - Raw GNSS data (5 Hz)
- Proven Trimble low elevation tracking technology
- Support for optional Distance Measurement Indicator (DMI) input
- Support for optional POSpac Mobile Mapping Suite post-processing software

Abbreviations

The following table explains some of the acronyms and expressions used in this manual.

Abbreviation	Description
#SAT	The number of GNSS satellites being received by the GNSS receiver
Ah	Battery rating (Ampere hours)
Applanix®	Registered trademark of Applanix Corporation
DMI	Distance Measuring Indicator
fps	Frames per Second
Google Chrome	Registered trademark of Google Inc.
GAMS	GNSS Azimuth Measurement System
Galileo	European GNSS system
GLONASS	Russian GNSS system
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
IMU	Inertial Measurement Unit
IP	Internet Protocol
LED	Light Emitting Diode
PDOP	Positional Dilution of Precision
PWR	Power
PRR	Pulse Repetition Rate
RMS	Root Mean Square
SSD	Solid State Disk
SRR	Scan Repetition Rate
UTC	Universal Time Coordinated
VDC	Volts Direct Current
ZUPT	Zero Velocity Update

Vehicle Requirements

General

- Vehicle should be fitted with rubber wheels for use on paved roads
- No bright color to avoid exposure artefacts
- Room for system storage during transfer:
 - Dimensions of Sensor Unit transportation case: 806 x 716 x 634 mm (L x W x H)
 - Dimensions of Control Unit transportation case: 453 x 255 x 408 mm (L x W x H)
- Hatchback vehicle with upright rear door
- Minimum height of 1.60 m for the vehicle roof to comply with the minimum-distance requirement of the down-looking camera.

Mechanical

- Roof rails should withstand the required roof load
- Required dimensions of roof wings to properly install the MX9 Roof Rack (width x height): 85 x 30 mm
- Roof rails should cover the entire roof so the scanner position can be adjusted in case of slightly unfavorable roof rail design
- Remember the maximum lengths for system cables:
 - Power-Unit-to-Control-Unit cable: 3 meters
 - Control-Unit to-Sensor-Unit cable: 5 meters
- Allow for mounting options for Power Unit and Control Unit inside the vehicle (these two units are NOT waterproof).

Electrical

See [Appendix, page 62](#) and [Installing a Power Supply in a Vehicle for Safely Operating the MX9 System, page 77](#).

- Capable of delivering the required power
- Start/stop mechanism must be switched off
- Sufficient alternator power (or additional battery pack)


Typical Installation Example



Installing a Power Supply in a Vehicle for Safely Operating the MX9 System

To safely operate the MX9 in a vehicle, a reliable 12 V DC power supply should be made available in the vehicle. See also [Power Requirements, page 62](#).

Typically this can be accomplished using the vehicle's own battery and charging system. With the help of a buffer battery, the MX9 system operation will be independent of the short-term behavior of the vehicle's electrical power management system.

 **CAUTION** – Please observe the following recommendations:

- Any installation and integration of a power supply in a vehicle must be done by a professional car electrician service and are under customer's responsibility and control.
 - All selected components (cable type, cable gauge, fuses, relay, etc.) have to be selected to be compliant with the MX9 input power requirements and with the local law and vehicle regulations.
 - Please consider car-related restrictions like for example, car battery & energy management (Auto On/Off, Energy Management Emission Level Euro 6 and higher, etc.) as well as any restrictions given by local law.
-

The power input of the MX9 system should meet the following electrical requirements:

Input Voltage Range:		12 to 16 V DC
DC Current:	At startup:	25 A @ 13.8 V (350 W)
	Steady-state operation:	20 A @ 13.8 V (280 W)
Battery Capacity:		60 Ah min.

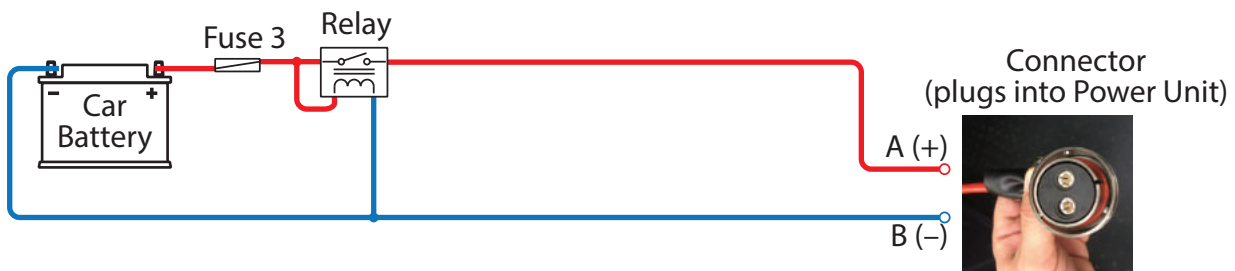
Typical Power Supply Setups

The two setups described below are designed with a relay, which only provides power to the connector when the alternator – and in this case the car engine – is running. This prevents the primary battery (i.e. the car battery) from going too low.

Direct connection

(Only the car battery is used.)

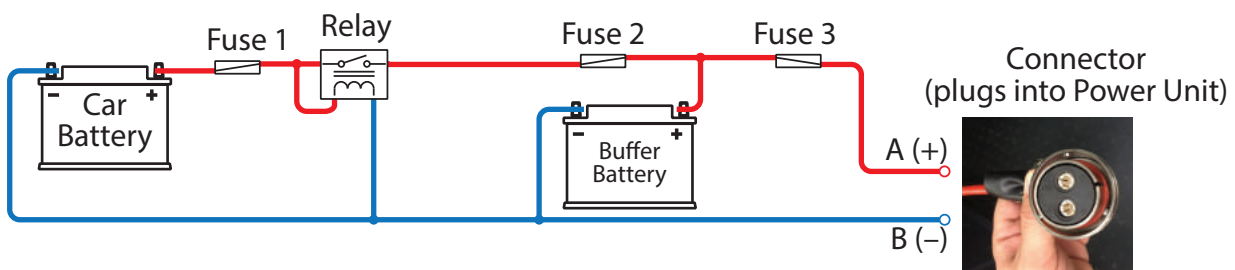
In this scenario, the provided Source-to-Power-Unit cable (P/N T001273; 5 meters long), with its open end, can be connected directly to the fuse and to the relay. Both the fuse and the relay should be placed close to the battery, as shown in the electrical diagram below. The current rating of fuse 3 should be 35 A.



Using a Buffer battery

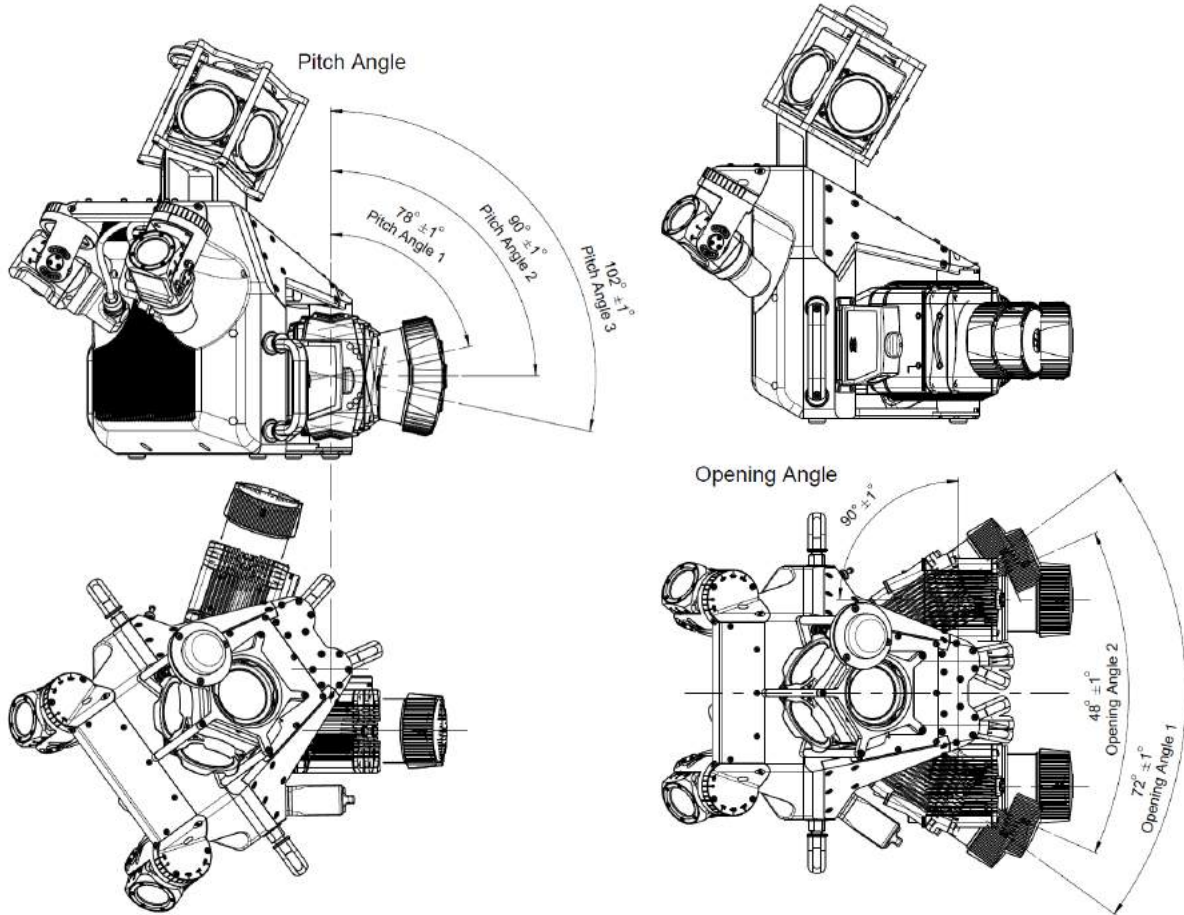
(A buffer battery is used, in addition to the car battery.)

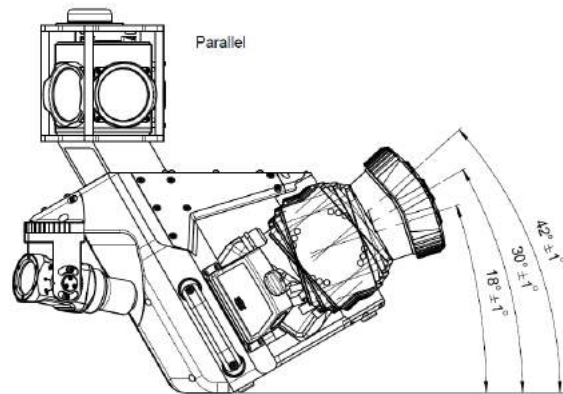
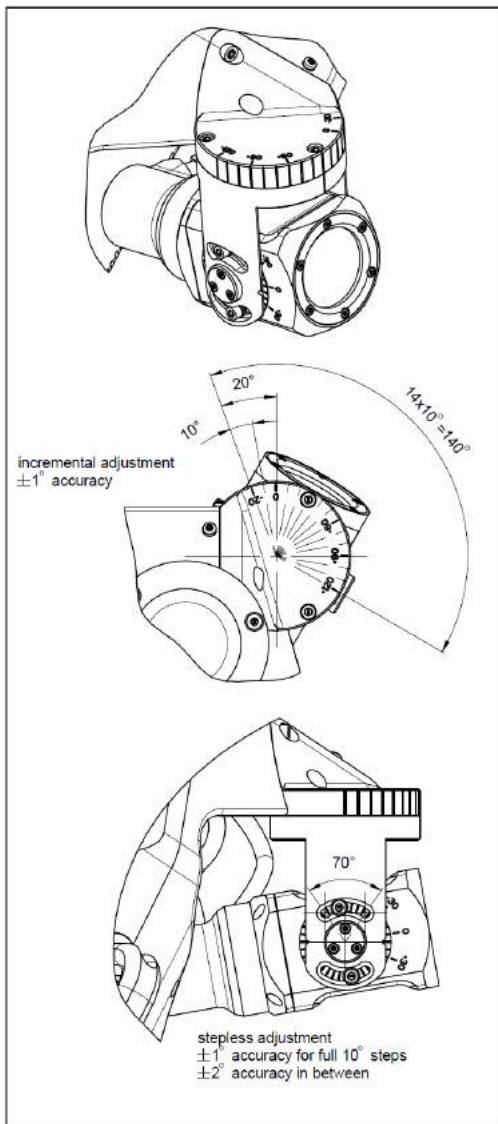
In this scenario, additional fuses (Fuse 1 and Fuse 2) are required as the buffer battery is also a power source. Fuse 1 should be placed as close as possible to the car battery and fuse 2 as close as possible to the buffer battery. As shown in the electrical diagram below, the provided Source-to-Power-Unit cable (P/N T001273) is then connected to Fuse 3 and to the buffer battery.



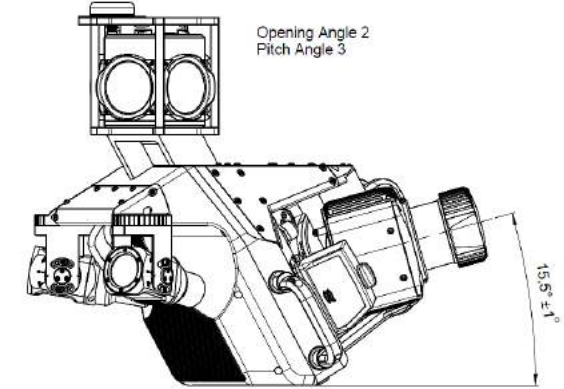
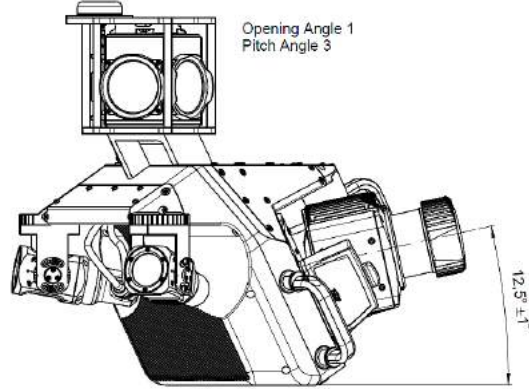
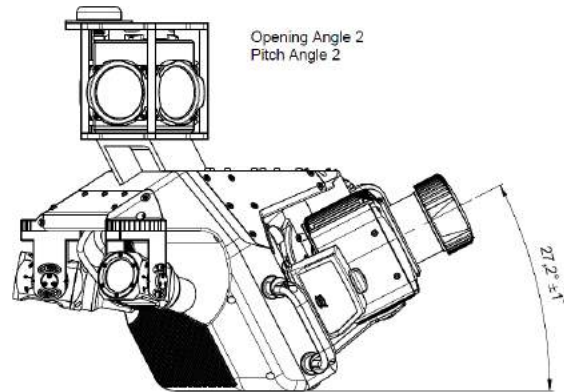
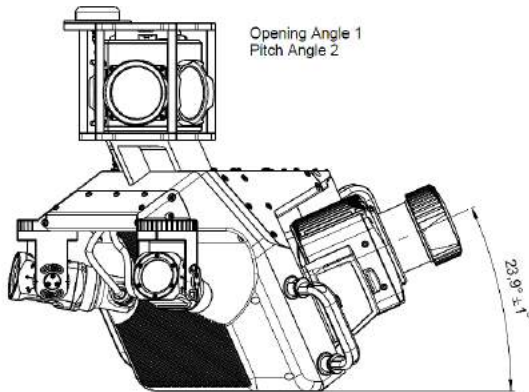
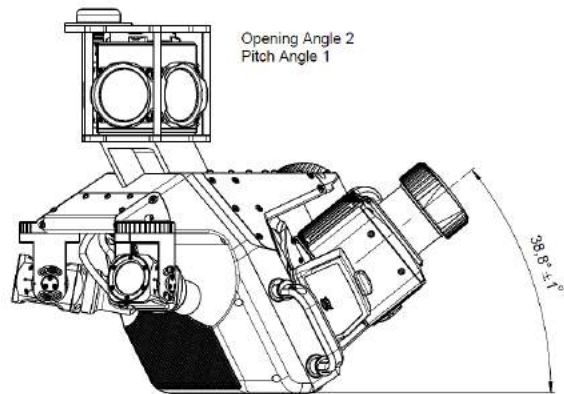
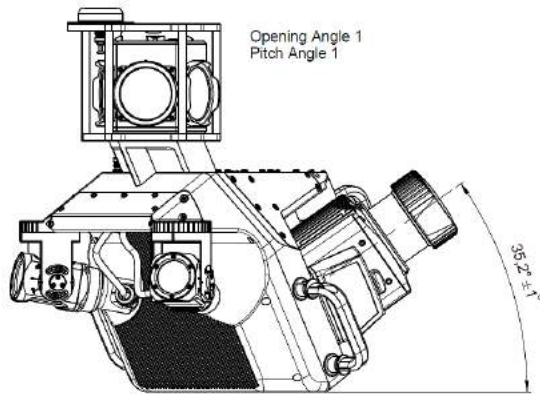
For more details, please contact Trimble Support.

MX9 Sensor Angle Charts

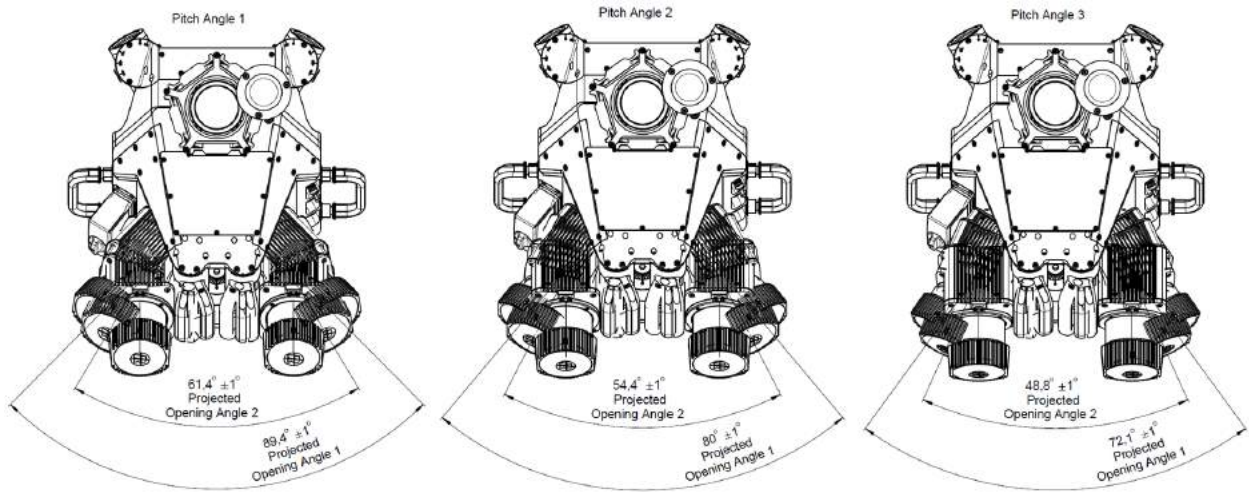




5 Appendix



5 Appendix



External-Signal Connector

This connector provides the possibility to time-synchronize other systems with the GNSS clock of the MX9 (PPS and serial interface). Furthermore it can provide two trigger signals and can receive two different event signals.

The use of this connector requires some very specific and technically advanced settings in the MX9 internal system. Please contact Support for more details.

System Socket: LEMO EEG.2K.314.CLL

Pin No.	Name	Type	Comment
1	Trigger 1	5 V TTL	Output
2	GND		Ground for Trigger 1
3	Event 1	5 V TTL	Opto-isolated Input
4	GNDI		Ground for Opto-isolated Event 1
5	Trigger 2	5 V TTL	Output
6	GND		Ground for Trigger 2
7	Event 2	5 V TTL	Opto-isolated Input
8	GNDI		Ground for Opto-isolated Event 2
9	Com 4 RX	RS232	RS232 Receiving Channel
10	Com 4 TX	RS232	RS232 Transmitting Channel
11	GND		Ground for Com 4
12	PPS 1	5 V TTL	
13	PPS 2	5 V TTL inverted	
14	GND		Ground for PPS 1/2

Setting the Location of the GAMS Antenna

Why Use a GAMS? The GAMS helps to speed up the initialization of the navigation system inside the MX9. The initialization procedure is a mission-specific task, which has to be done before every mission.

Using a GAMS, not only is the initialization time reduced but also no special driving maneuvers are necessary to complete initialization.

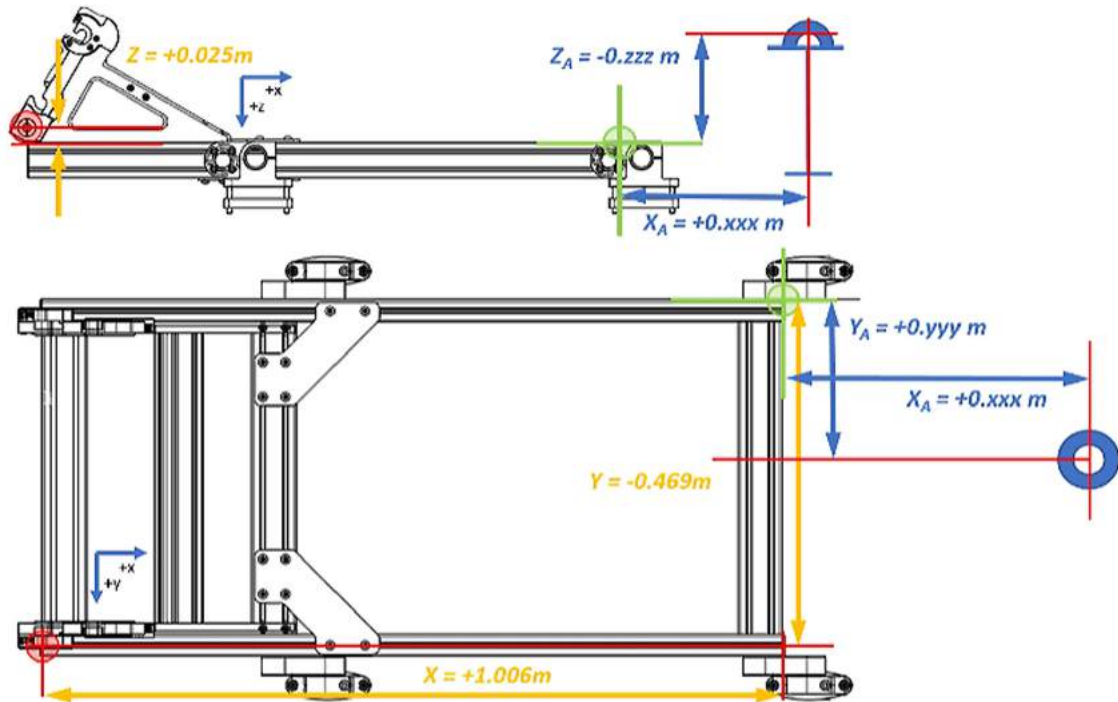
GAMS Setting Requirements. Before using a GAMS, you need to specify the three XYZ components (XYZ offsets) of the vector connecting the GAMS antenna to the External Reference Point on the Roof Rack. And remember these measurements need to be done every time you re-install the GAMS on the car roof for a new mission. Depending on how you wish to use the GAMS, specific requirements need to be met when setting up the GAMS:

- **If you intend to use a GAMS just for collecting data:**
 - XYZ offsets should be measured with an accuracy of only 10 cm (or better).
 - Base length between primary and secondary antennas should not be less than 1.6 m.
 - Use of different antenna types for primary and secondary antennas is allowed.
 - If the antenna phase center (APC) is unknown, you need to estimate the Z offset with respect to the center of the antenna.
- **If you intend to use a GAMS for later being able to post-process the collected navigation data,** tighter requirements need to be met:
 - XYZ offsets should be measured with an accuracy in the order of a few millimeters.
 - Base length between primary and secondary antennas should not be less than 2.0 m.
 - The primary and secondary antennas used **MUST** be of the same type. **DO NOT** mix different antenna types in the setup.
 - **IMPORTANT-** Offsets should always be measured with respect to the L1 antenna phase center (APC) of the corresponding antenna!

What to Measure exactly? The GAMS antenna being usually installed close to the front of the Roof Rack (on the roof of the car), it's easier to measure the offsets from the GAMS antenna to the top-left front corner of the Roof Rack (these are relatively short distances) rather than measuring those to the external reference point (these distances, which are larger, would be more difficult to measure). Because the components of the distance from the top-left front corner of the Roof Rack to the External Reference point are accurately known, it will be easy to deduce all the offset values separating the GAMS antenna from the External Reference Point.

GAMS Setup Instructions (see also illustration below):

- Measure the XYZ offsets between the GAMS antenna and the top-left front corner of the Roof Rack (this corner is shown in green below).
- Add your measured offset values (in blue) to the known offsets (in yellow). The resulting values describe the position of the GAMS antenna with respect to the External Reference Point on the Roof Rack.
- Enter these values as *Lever Arm X*, *Lever Arm Y*, *Lever Arm Z* in the TMI software when setting the GAMS before you make it active.



Location of External Reference Point on Trimble standard Roof Rack.



Location of top-left front corner of the Trimble standard Roof Rack. Its offset values along the lever arms compared to the location of the External Reference Point are fixed and known. These are given in the right-hand column:

X= +1.006 m
Y= -0.469 m
Z= +0.025 m



Location of GAMS antenna. Its offset values along the lever arms compared to the location of the Ext. Ref. Point are calculated as follows:

Lever Arm X= +1.006 m + 0.xxx m
Lever Arm Y= -0.469 m + 0.yyy m
Lever Arm Z= +0.025 m - 0.zzz m

Where 0.xxx, 0.yyy and 0.zzz are your measured values (in meters).