GSM 5000

User Manual

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Revision History

Version	Updated	Changes
/01	April 14, 2025	Initial version

Content

1 Safety

1.1 Symbol Description

Warning! / Important Message

Handling instruction / use marked place to handle the device

Handling instruction / DO NOT use marked place to handle the device

1.2 Proper Usage

The GSM 5000 (Gyro Stabilization Mount) is designed to automatically stabilize airborne cameras, scanners, LIDARs and similar equipment in all three rotational axes. The device is used to compensate random aircraft movements caused by turbulences or pilot error.

The GSM 5000 can only be used with airborne data acquisition equipment which fulfills the requirements of the RTCA DO-160G and EUROCAE-14G.

Only use the device in accordance with its specifications (e.g. maximum current load). A differing usage is not recommended. The manufacturer is not responsible for any damages resulting from improper use of the device.

1.3 Environmental- and Application Conditions

It is necessary to follow the mechanical and electrical mounting advice described in chapter 4.1 and 4.2. The components need to be installed by staff that are trained and qualified to install the equipment. The mounting conditions in the aircraft need to fulfill the requirements of the RTCA DO-160G and EUROCAE-14G.

In addition, only staff members that are trained to handle airborne photogrammetric equipment and accessory should be allowed to use the GSM 5000. Improper handling of the device will void the warranty and shorten the lifetime.

1.4 Safety Area

To ensure safety during stabilization motions, a safety area must be clearly delimited around the Stabilization Mount to prevent collisions. Safety markings, compliant with current standards, must prohibit access to this area while the system is in motion.

One method of estimating the safety area is to select critical points and calculate their displacement during rotations. The selection of these points is up to the user. The Z-axis refers to the change in height, the Y-axis to the change in width and the X-axis to the change in length. The following formulas can be used to calculate the rotation of a critical point A shown in Figure 1 and Figure 2. Add appropriate safety margins to these values to ensure comprehensive protection.

1.4.1 Roll rotation

The roll axis angle φ_R can vary between -8.1° … +8.1° for this calculation.

Rotation in positive Roll direction:

$$A_{+Y} = Y_P \cdot \cos\varphi_R - (Z_M + Z_P) \cdot \sin\varphi_R$$
$$A_{+Z} = Y_P \cdot \sin\varphi_R + (Z_M + Z_P) \cdot \cos\varphi_R$$

Rotation in negative Roll direction:

$$A_{-Y} = Y_P \cdot \cos\varphi_R + (Z_M + Z_P) \cdot \sin\varphi_R$$
$$A_{-Z} = -Y_P \cdot \sin\varphi_R + (Z_M + Z_P) \cdot \cos\varphi_R$$

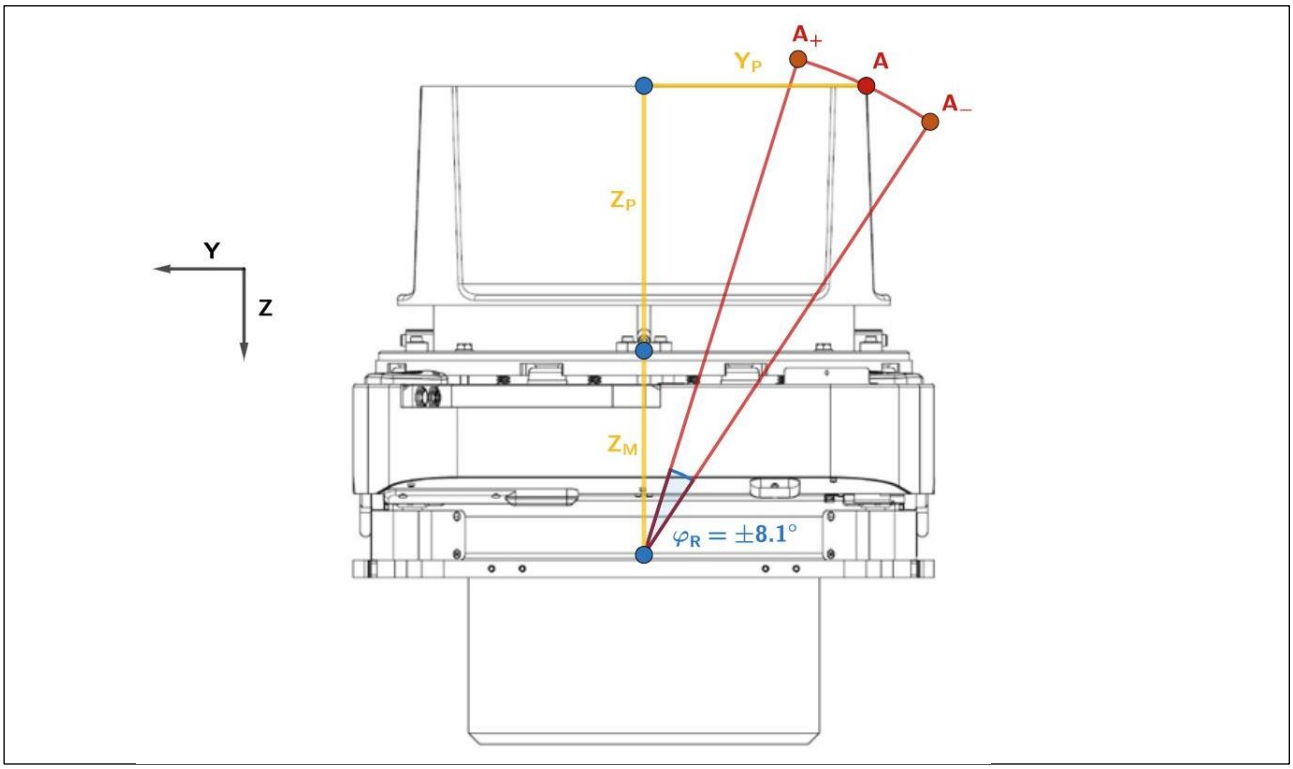


Figure 1: Safety Area estimation using the rotational displacement A_+ and A_- of a critical Point A in Roll axis. In this drawing, Z_M = 178.5 mm, and the payload height Z_P is measured relative to the screw level of the payload.

1.4.2 Pitch rotation

The pitch axis angle φ_P can vary between -10.1° … +10.1° for this calculation.

Rotation in positive Pitch direction:

$$A_{+X} = X_R \cdot \cos\varphi_P + (Z_M + Z_R) \cdot \sin\varphi_P$$
$$A_{+Z} = -X_R \cdot \sin\varphi_P + (Z_M + Z_R) \cdot \cos\varphi_P$$

Rotation in negative Pitch direction:

$$A_{-X} = X_R \cdot \cos\varphi_P - (Z_M + Z_R) \cdot \sin\varphi_P$$
$$A_{-Z} = X_R \cdot \sin\varphi_P + (Z_M + Z_R) \cdot \cos\varphi_P$$

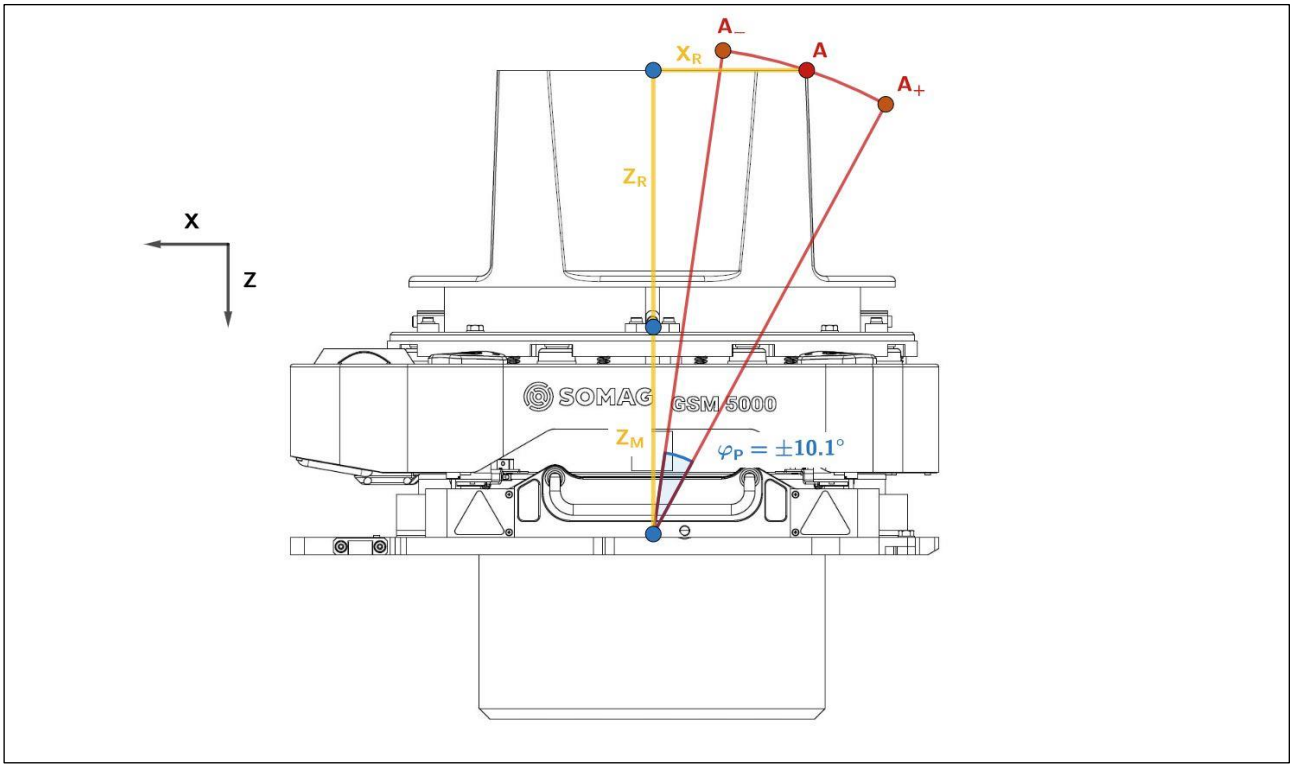


Figure 2: Safety Area estimation using the rotational displacement A_+ and A_- of a critical Point A in Pitch axis. In this drawing, Z_M = 178.5 mm, and the payload height Z_R is measured relative to the screw level of the payload.

- **The safety area is the minimum area which needs to be secured around the Stabilization Mount. It is the user's responsibility to do a risk analysis to define the right area size according to the circumstances as shown in Figure 1 and Figure 2 and in accordance with the used payload.**

1.5 General Safety Tips

- Always use two people to lift and carry the GSM 5000. Grip the device at the handles located on both sides of the Mount (see Figure 2). Any other handling could cause irreparable damage to the device and risks serious injury.

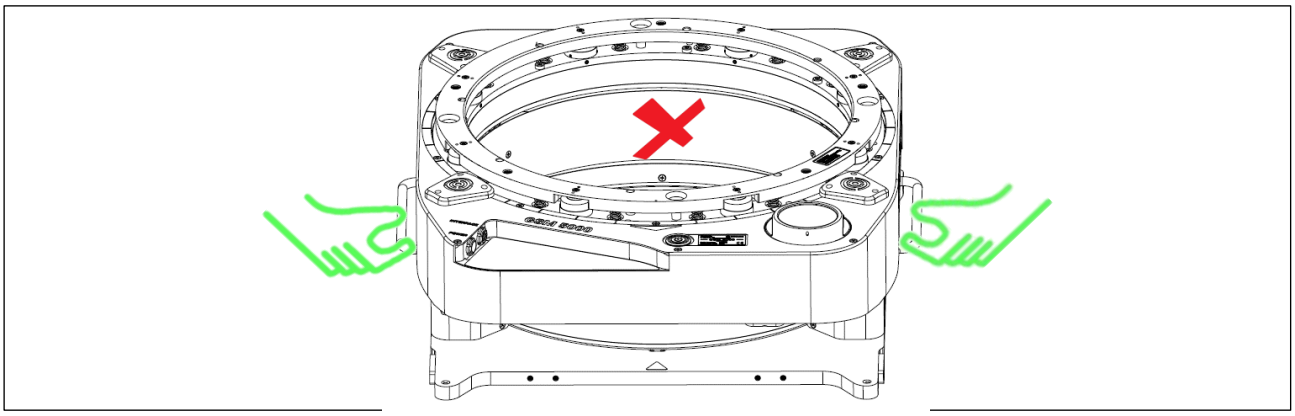


Figure 2: lifting the GSM 5000

- DO NOT grab the GSM 5000 by the areas marked by the red crosses. You will likely squeeze your hands if you use these positions to lift and carry the device. Furthermore, it is possible to damage the shell of the device.
- The moving parts of the Mount are not rigid, but can be moved even with the power turned off. Be aware of any movements of the Mount caused by external forces.
- The Power-Switch disables the function of the entire device. Beware of weight displacement of the payload that can cause an unwanted movement of the GSM 5000.

- **DO NOT put anything near the areas marked by the red crosses in Figure 3 and Figure 5! Damage to the device and any nearby objects may result. Always keep the area around the Mount clear to ensure safe operation.**

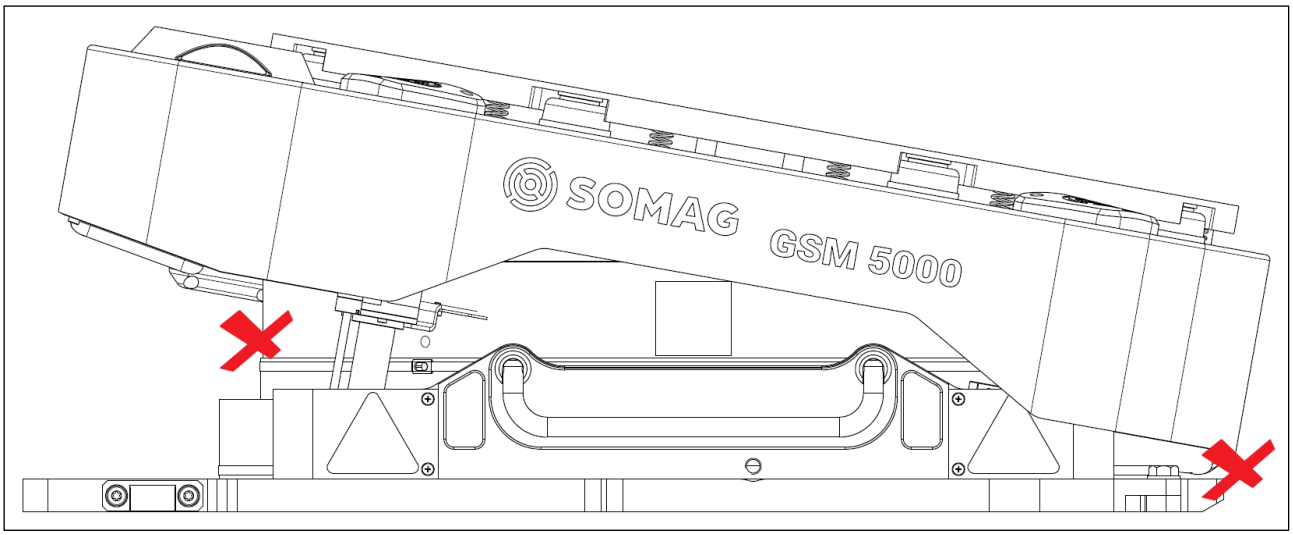


Figure 3: GSM 5000 cover (pitch)

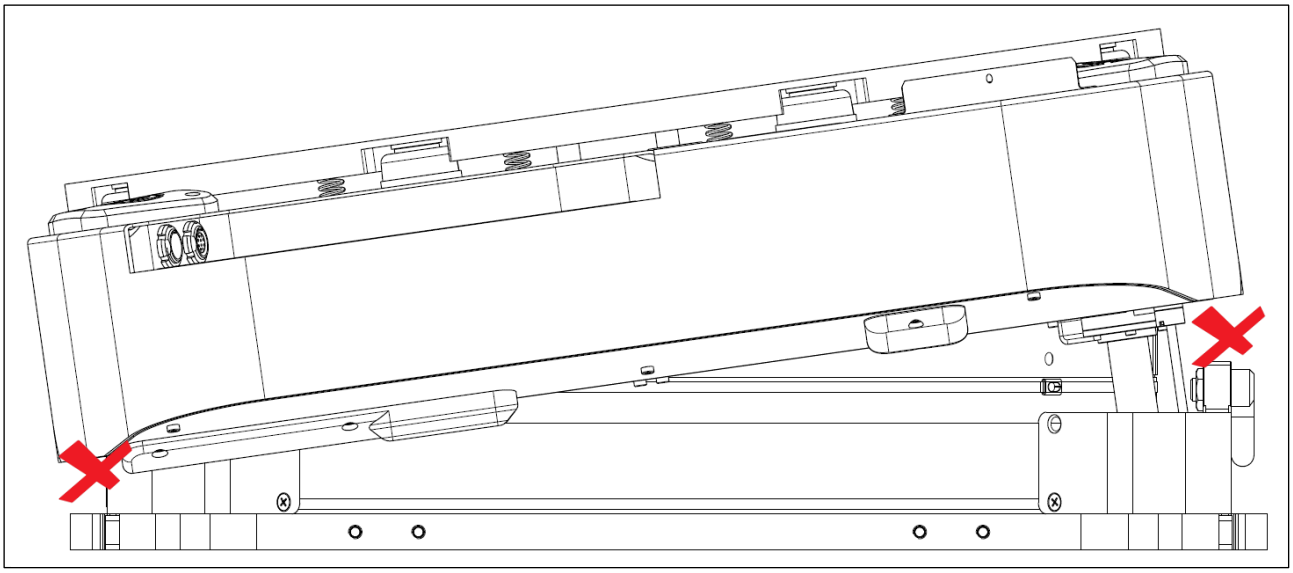


Figure 5 GSM 5000 cover (roll)

2 Standard Scope of Delivery

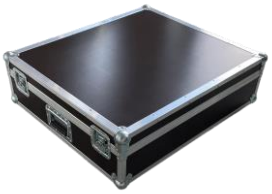
500101-006-02/XX
GSM 5000

500101-XXX-02/XX
Passive Vibration Isolation Ring
(designed for XX kg)

110002-001-06/XX
Cable Power Lemo, 3 m, straight plug (black), open end

110002-058-06/XX
Cable ETH Interface Lemo, 3 m, straight plug (green)

112300-385-02/XX
Bag with Portage Sensors



500101-400-02/XX
Transportation and Storage Box

Additional kit (optional)

- **You will receive an individual scope of delivery with your order. The content which is shown above refers to the standard scope of delivery which can vary for each specific order.**

3 Specifications

Angular Stabilization Ranges: Pitch at 0° Roll Roll at 0° Pitch Yaw (Drift):	 -10.1°…+10.1° -8.1°…+8.1° -30.0°…+30.0° | -177.5°…+177.5° (optional[1])
Residual Angular Rate[2]:	≤ 0.2°/s rms
Residual Deviation: Without IMU Support[2] With IMU Support[2,3]	 ≤ 0.3° rms ≤ 0.02° rms
Payload[4]	10…120 kg | 22…264.6 lbs
Mass	28.5 kg | 62.8 lbs
Dimensions (regular leveling positions): Length Width Height[5]	 600 mm | 23.6 in 530 mm | 20.9 in 198 mm | 7.8 in
Usable Diameter	Ø 425 mm | Ø 16.7 in
Operating Temperature	-15 °C…+55 °C | 5 °F…+131 °F
Storage Temperature	-55 °C…+85 °C | -67 °F…+185 °F
Communication Interfaces	Ethernet | RS 232
SD-Card Logging	32 GB
Operational Voltage	28 VDC (24…30 VDC)
Average Power Consumption at Operational Voltage	50 W
Peak Power Consumption at Operational Voltage	200 W
Applied Standards	RTCA DO-160-G, EUROCAE-14G, ISO 7137, 2006/42/EC Machinery

[1] Activation of the extended drift movement range is possible through an optional software feature
[2] Vehicle angular motion < 10°/s and with typical data acquisition profile frequency spectrum
[3] Deviation from perpendicular depends on accuracy of used IMU
[4] Minimum payload is based on usage of Passive Vibration Isolation Ring
[5] Minimum 167.5 mm (6.6 in) / Maximum 228.5 mm (9.0 in)

4 Installation

4.1 Mechanical Installation

4.1.1 General Advice

- The device must be installed on a rigid and flat surface (flatness ≤ 0.5 mm). DO NOT install the GSM 5000 on an unstable or uneven base. This could result in damage.
- The area around the device must be large enough to suit the installed payload and to ensure an unobstructed movement of it. The opening of the hatch needs to be large enough to prevent the lens from crashing into the sidewalls and / or vignetting images.
- The device could be excessively damaged if exposed to exhaust fumes / gases from engines or heaters. Some single-engine aircraft may require special modifications to divert exhaust away from the GSM 5000 and the payload.
- The usage of an adapter plate between the aircraft floor and the GSM 5000 must be authorized by SOMAG AG Jena or qualified aeronautical personnel. The installation of an unsuitable adapter could lead to heavy vibrations, which would cause serious damage to the device.
- An installation of a rigid and stiff adapter plate is generally preferred because it ensures a secured mounting of the device in the aircraft. This advice applies to the installation of a wedge adapter as well.
- All measurements in the following technical drawings and images are in METRIC units!

- **Modifications to the payload or the mechanical attachment must be carried out by authorized aeronautical personnel. SOMAG AG Jena does not take responsibility for any damages to the payload and to the GSM 5000 caused by an inappropriate installation by unauthorized personnel!**

4.1.2 Dimensions of Fastening Holes / Footprint

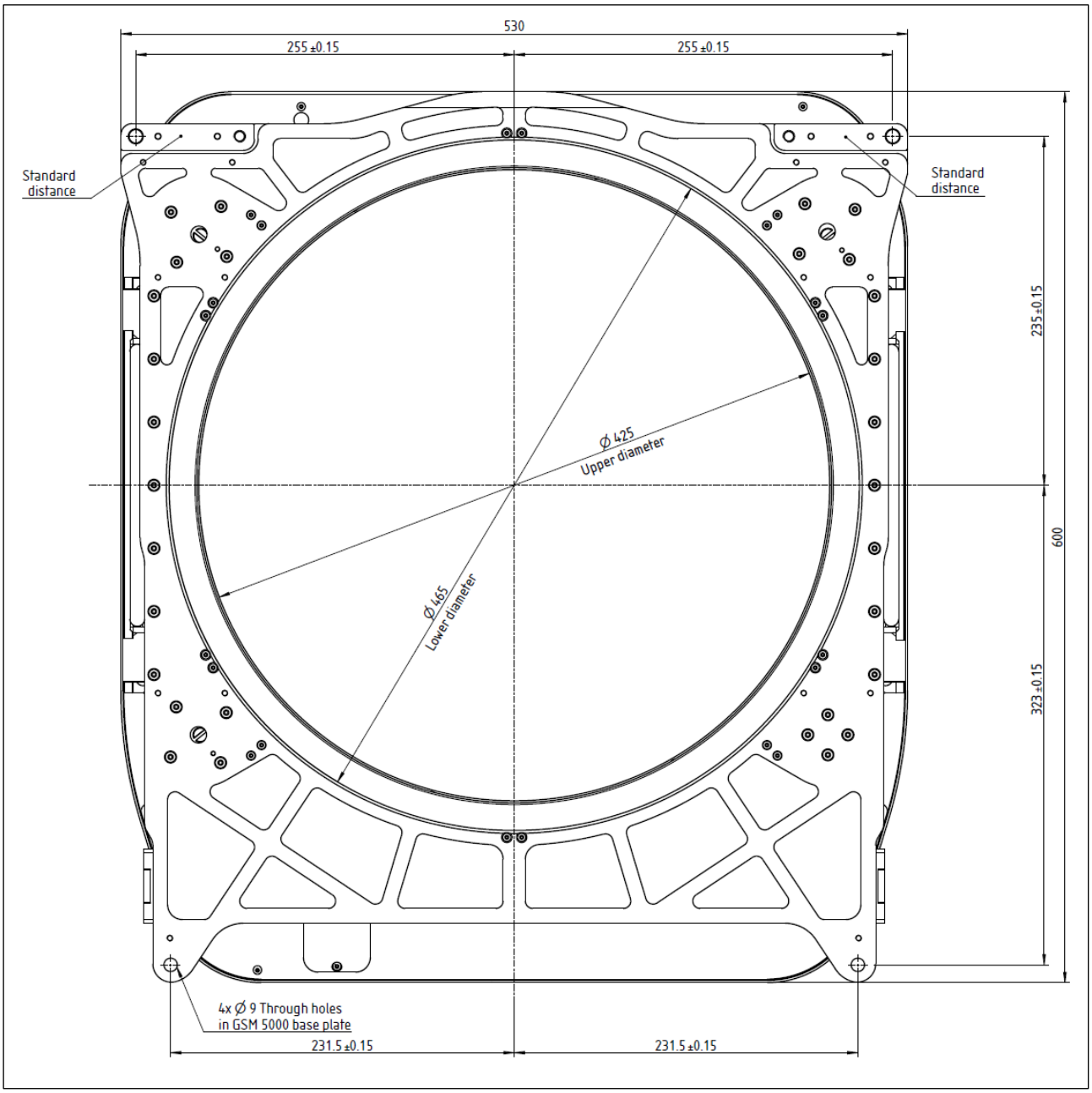


Figure 6: Dimensions of fastening holes and footprint of the standard installation

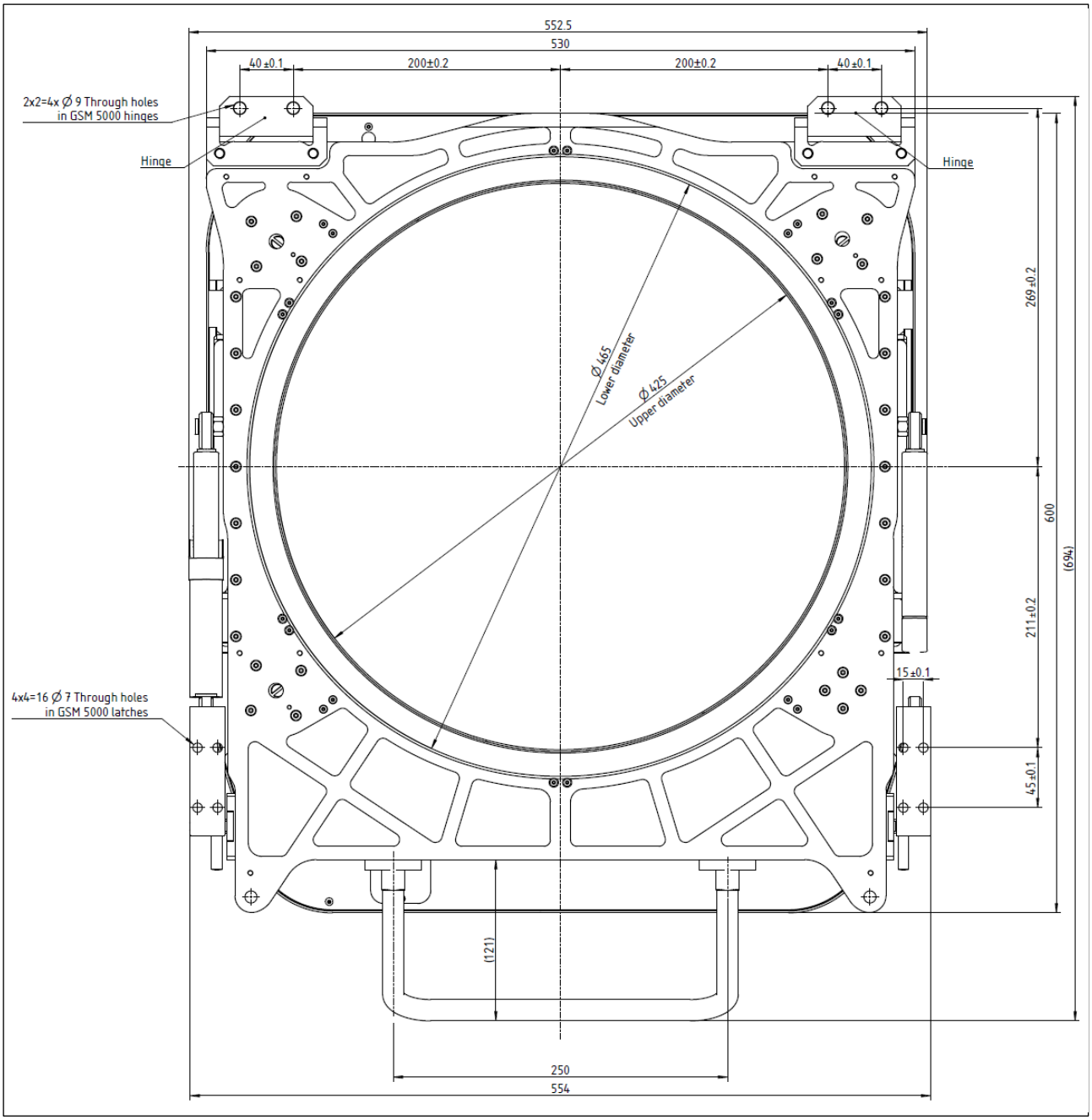


Figure 7 Dimensions of fastening holes and footprint with optional installation parts

Notes:

Standard Installation see Figure 6:

4x Ø 9.0 mm through holes in base plate

Optional Installation (with gas springs, hinges and latches) see Figure 7:

4x Ø 9.0 mm through holes in base plate, 4x Ø 9.0 mm through holes for the hinges and 16x Ø 7 mm through holes for the latches

- **The footprint of the GSM 5000 is exactly the same as that of the GSM 4000. Additionally, the installation holes are identical, ensuring compatibility with existing mounting setups.**

4.1.3 Installing the GSM 5000 in the Aircraft

- Make sure that the movement space area (see Figure 8) is clear of objects.
- Position the device straight over the installation holes.
- Install the GSM 5000 with the necessary number of screws according to the installation configuration. A torque of 8 Nm is required to secure the device safely.

- **DO NOT install the mounting screws of the latches without the provided washers!**

4.1.4 Main Dimensions / Mounting the Payload

The following image shows the GSM 5000 movement space without payload. The Standard Installation requires at least 655 mm x 580 mm x 245 mm (length x width x height) of space. The Optional Installation needs slightly more space in length (720 mm) because of the additional handle. Access to the control panel is to be ensured at all times.

- **Less space can cause the device to collide with obstacles. This needs to be considered when installing the GSM 5000.**

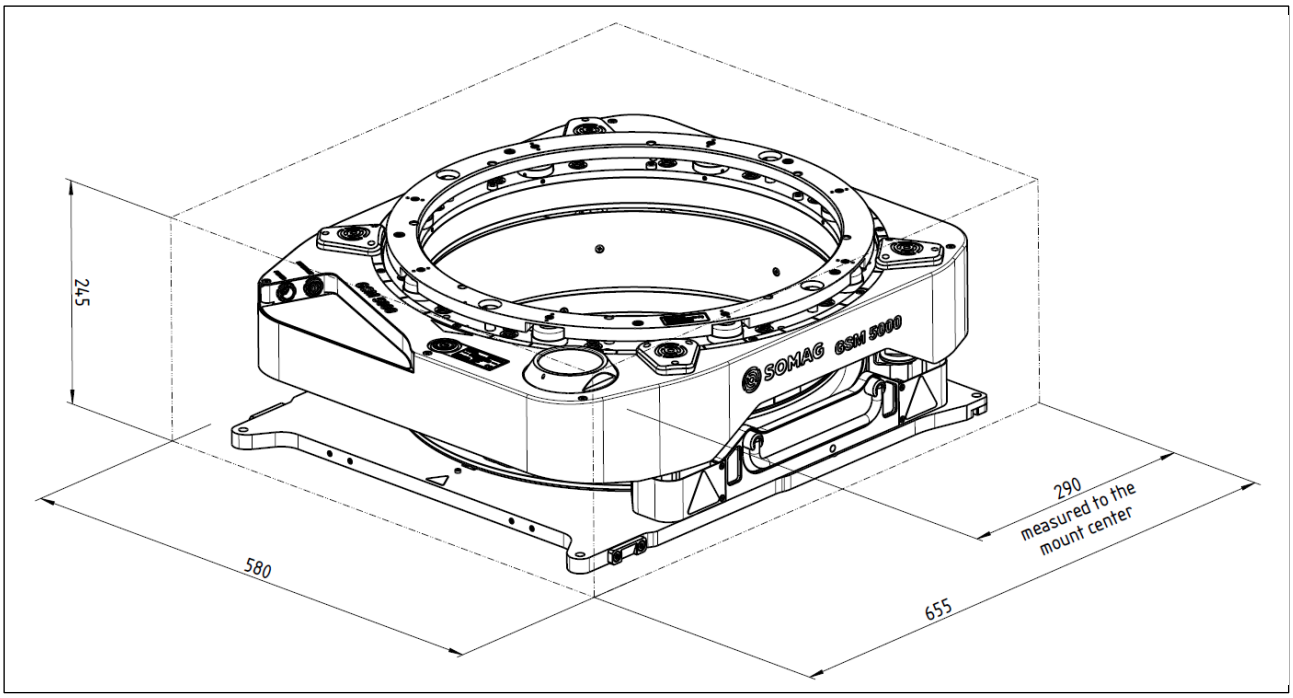


Figure 8: Movement space around the GSM 5000

Figure 9 shows the two important centers of rotation for the GSM 5000. It is desirable to move the center of gravity of the payload to the pivot of the PaVIR (Passive Vibration Isolation Ring). That ensures that the PaVIR works properly and that the vibrations from the aircraft are sufficiently damped. In case of not being able to do so, it is preferred to position it below the PaVIR pivot than above. In such a case it is advisable to move the Center of Gravity (CoG) between the PaVIR pivot and the GSM 5000 pivot. Figure 13 also shows the CoG of the device while at its operational level. Both pivots are located in the center of the usable diameter of the GSM 5000 (see Figure 13). The CoG changes vertically according to the working height of the device within borders of ±30.5 mm.

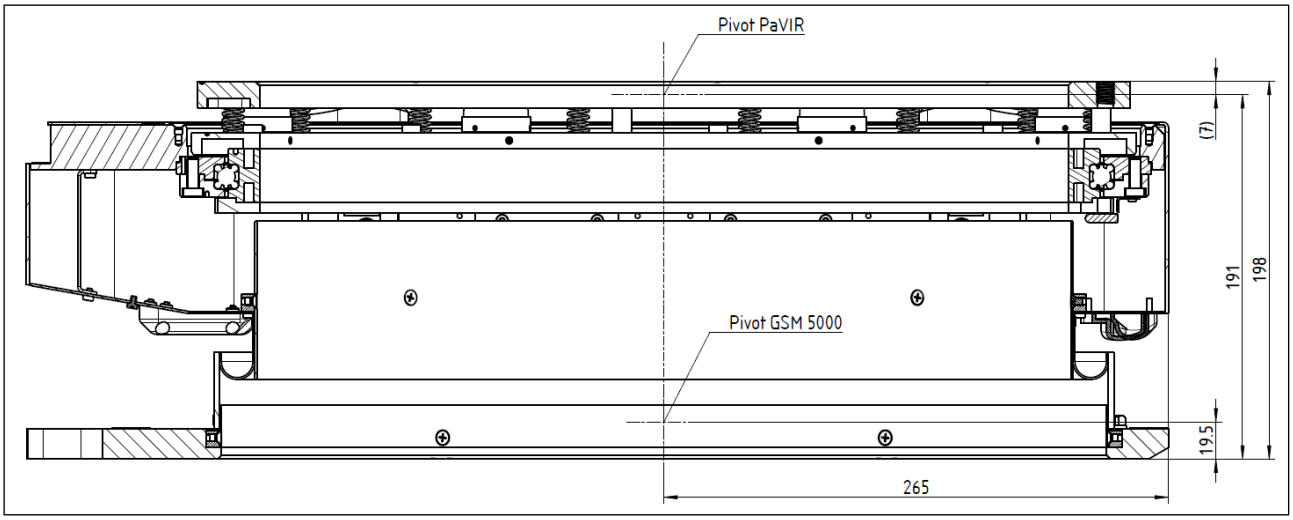


Figure 9: GSM 5000 center of rotation in operational level

The following images illustrate the lowest and highest possible positions of the GSM 5000. The device can be lowered to the bottom position using the Touch Encoder or the SOMAG Mount Control App. This position is intended for shipping and storing the device. The Mount cannot move at all whilst in this position.

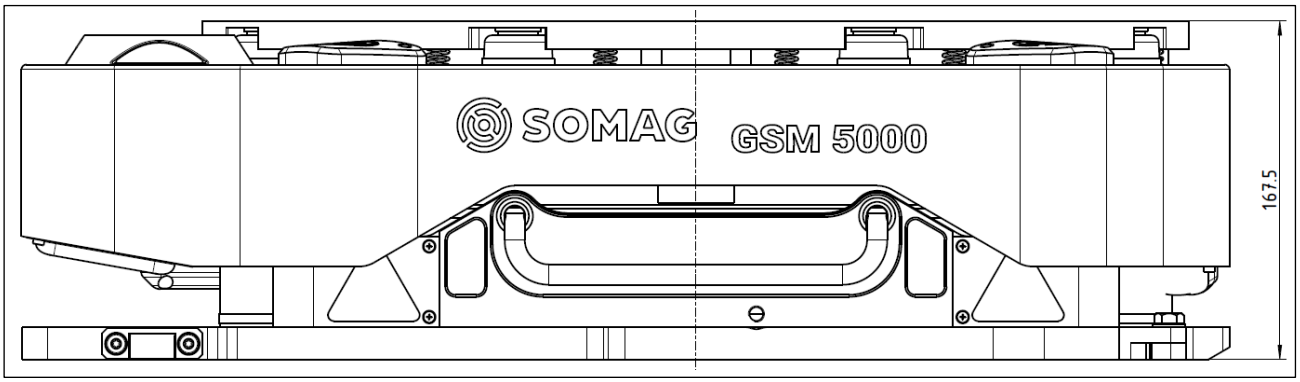


Figure 10: GSM 5000 / lowest position / hydraulic circuit completely drained

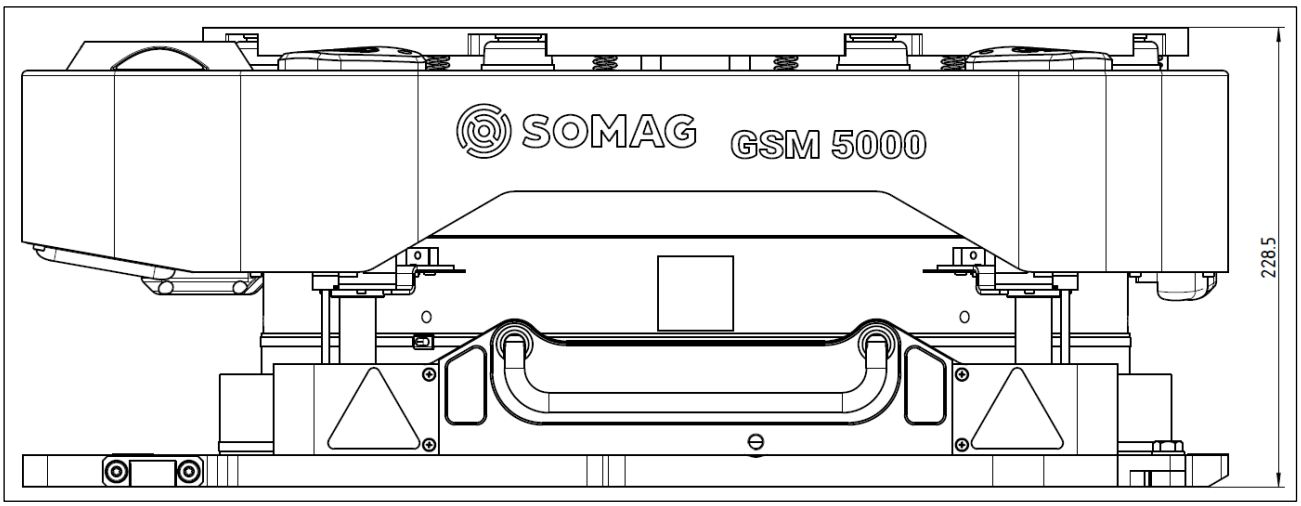


Figure 11: GSM 5000 / highest position / hydraulic circuit completely filled

The GSM 5000 cannot move either whilst in the highest position. In operating mode, the electrical valve is automatically opened so that the Mount can lower itself down to working height. This takes time depending on the weight of the payload.

With the Optional Installation, the GSM 5000 can be lifted from one side in order to access the payload from below as shown in Figure 12.

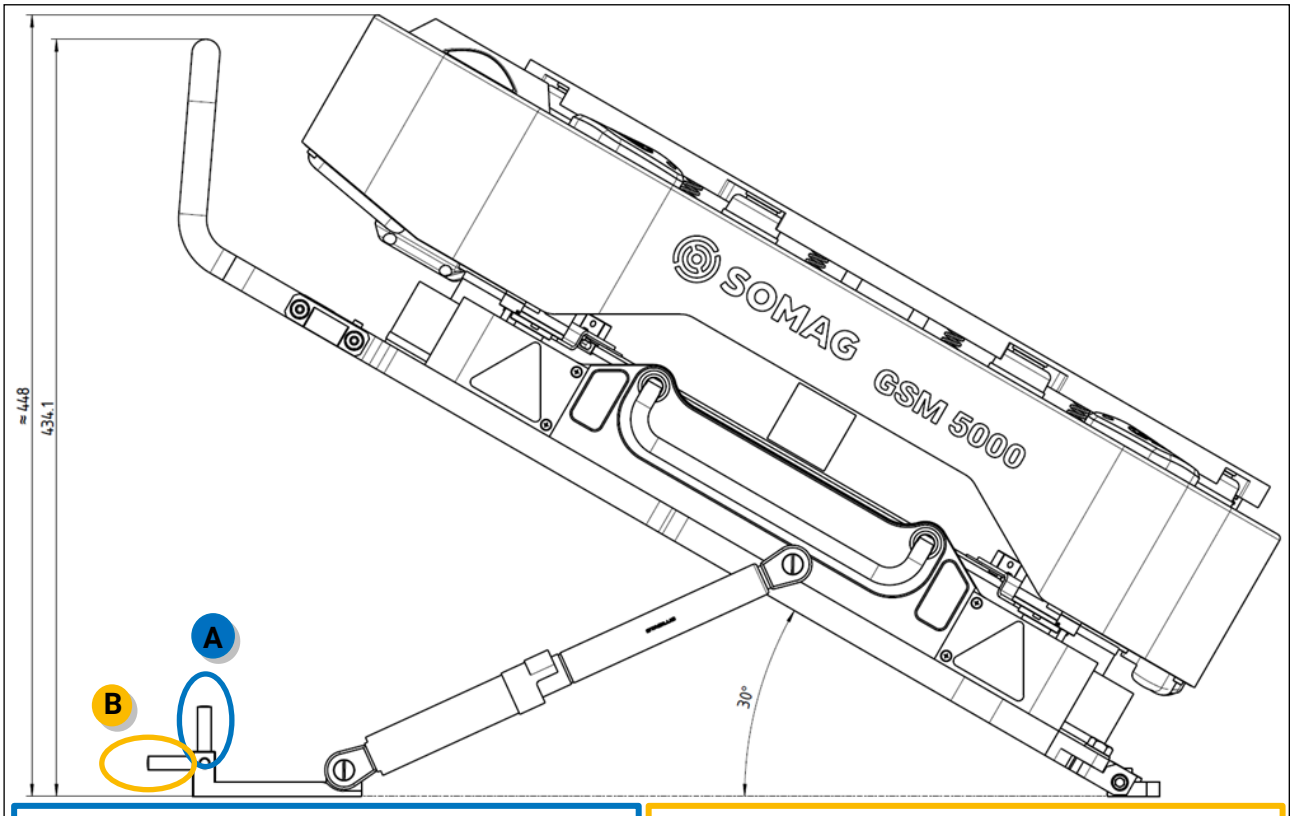
- **Using this function requires an additional 65 mm of space on the back of the GSM 5000 (see Figure 12)! It should also be ensured to have enough space for the payload, so that it doesn't get damaged. Before lowering the Mount, make sure that the levers are down / horizontal. You will likely squeeze your hands otherwise.**

Lifting the Mount

First, lift the levers to open the latches (A). Lift the Mount until the gas pressure springs lock into place. Now lower the levers so that the latches engage when you lower the Mount.

Lowering the Mount

Make sure that the levers are down (B). Now release the lock on the gas pressure springs by pressing the red markings on the joint. Push the Mount down and it will slowly lower back to its original position. If the levers are in position B, the latches will engage automatically.



Position A

The levers are up and the Mount can be lifted away from the aircraft floor. This position should only be used very briefly while using the lift-up function of the device.

Position B

The levers are down and the latches are ready to engage. This is the regular and safe position, and should be used at all times, except when using the lift-up function of the Mount.

Figure 12: GSM 5000 lift-up-function (optional)

Figure 13 illustrates the main dimensions of the device and the payload mounting holes. Five M8 / 12 mm deep threaded holes are provided for payload installation purposes.

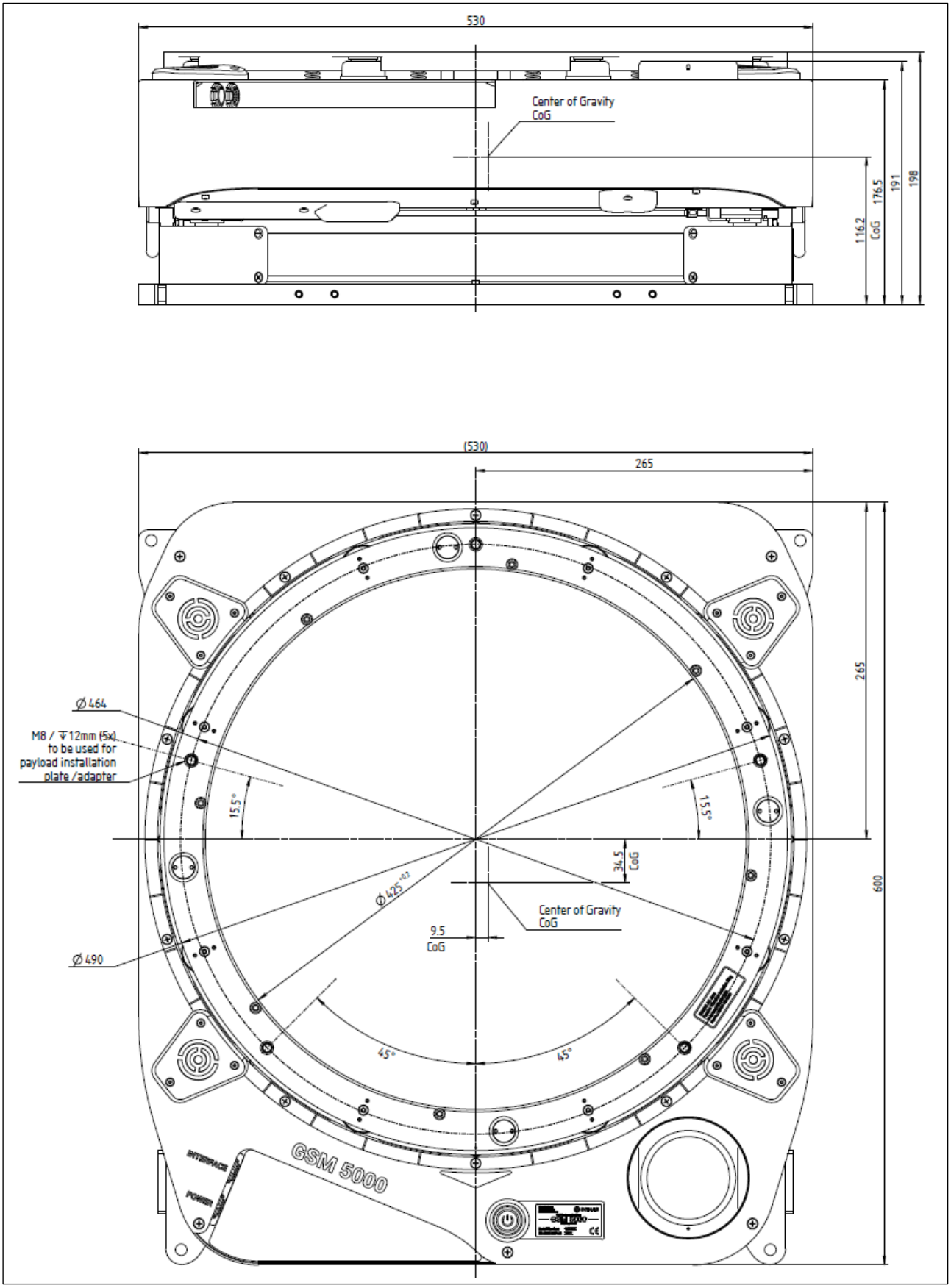


Figure 13: GSM 5000 payload mounting holes and main dimensions at operational level

4.2 Electrical Installation

4.2.1 General Advice

- DO NOT excessively bend the cables of the GSM 5000! Allow a minimum bending radius of 40 mm for all cables.
- Provide strain relief for all connectors to prevent the cables, plugs or sockets from breaking when moved or bent.
- The used cables fulfill the requirements of RTCA DO-160G and EUROCAE-14G. Use only components, which fulfill these requirements as well, if the cables are connected to third party components.

4.2.2 Cabling of the GSM 5000

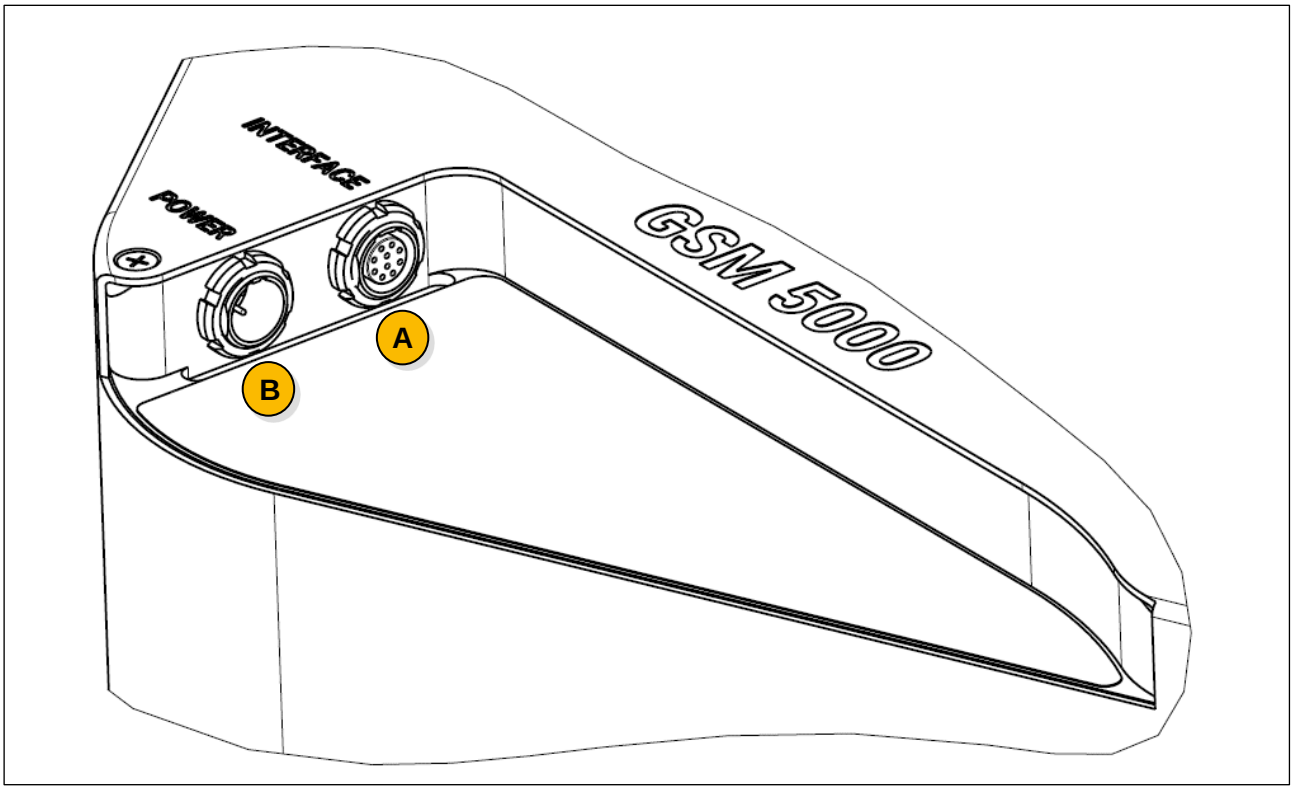


Figure 14: Cabling of the GSM 5000

A – Interface

Use the interface cable to link the Mount with a remote computer (FMS).

B – Power-Socket

Connect the power supply cable here. For connector-PIN-assignment, see chapter 4.2.3.

4.2.3 Power Cable

Wire	Pin	Function
Red / brown / 1	1	+28 VDC
Blue / black / 2	2	0 V
shield	housing	ground

It is recommended to use:

- A safeguard against accidentally reversing the polarity.
- An external fuse with a max. current of 16 A.

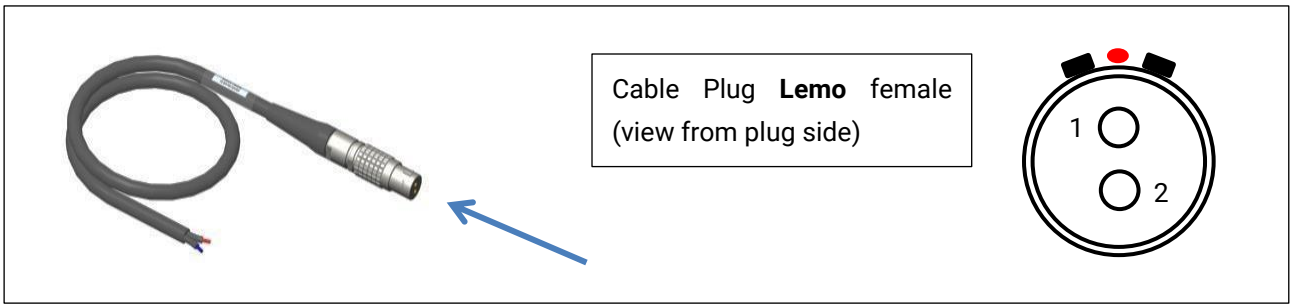


Figure 13: Power cable pin assignment

4.2.4 Interface Cable

ETH (Ethernet)

- to be used for communication with Mount Control App or / and
- for communication via Mount Communication Protocol 2.0 or / and
- for receiving NMEA or similar navigation data.
- connector type: RJ-45 male / 10BASE-T and 100BASE-TX / Auto MDI-X / without PoE.

4.2.5 Grounding

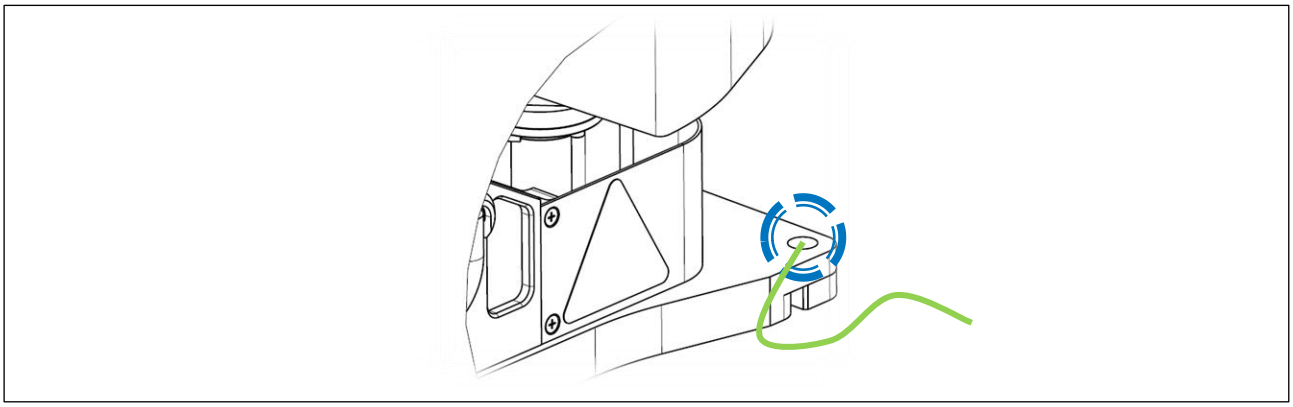


Figure 14: GSM 5000 Grounding

- Loosen the ISO 4017-M8x20 (blue circled) screw to install a grounding wire (green labeled / not part of the deliverables) to the aircraft frame.
- Make sure that the circled position is used because it contains a counter sunk bare part of aluminum.

4.3 SOMAG Mount Control App Installation

Information regarding the installation of the SOMAG Mount Control App can be found in the following document: '323101-901-08/XX SOMAG Mount Control App Manual'.

5 Getting Started

5.1 Set Up via GSM 5000 Control Panel

The GSM 5000 control panel enables the end user to control the device manually and to change the mode of operation. The following page provides an overview of the various elements and their function.

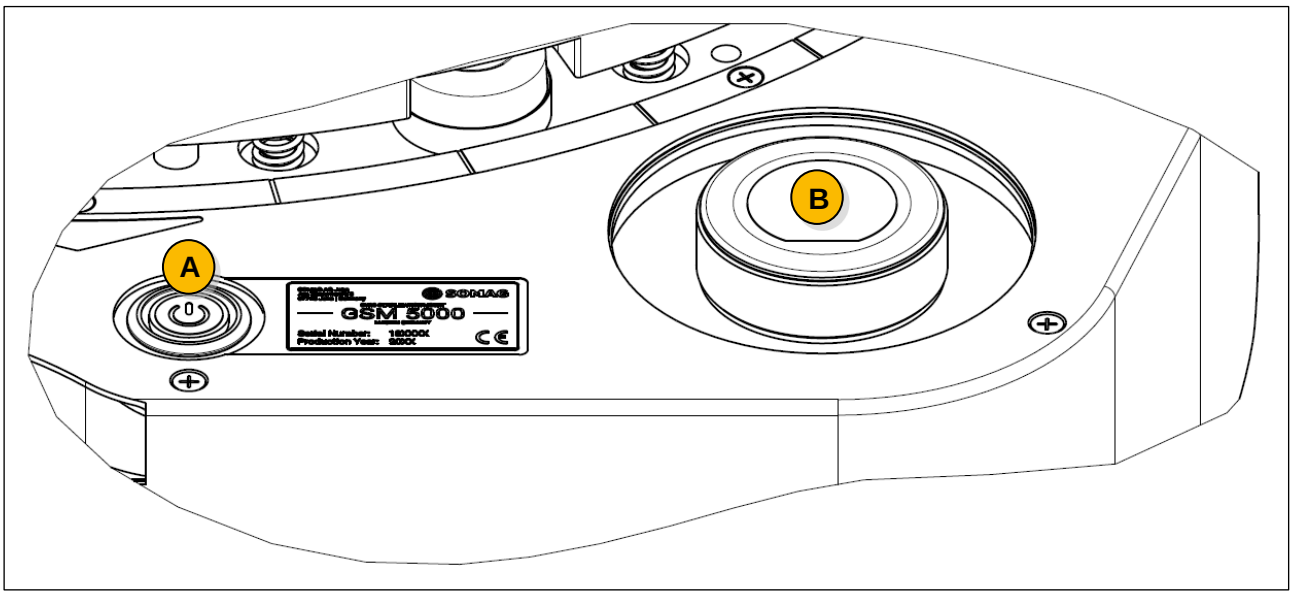
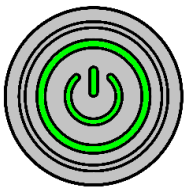
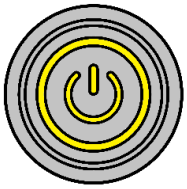


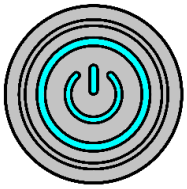
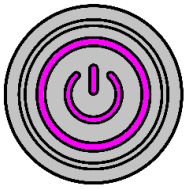
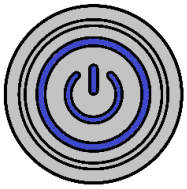
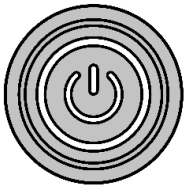
Figure 17: GSM 5000 control panel (top), oil level control window and main valve (bottom)

A – Power-Switch

Switching the power on / off

It also provides the current status of the Mount which is displayed depending on the LED color as follows:

LED Color		Description
 Green	**Non flashing**	**STAB** mode activated
	Flashing (slow)	FMS / Remote PC has taken over control
	Flashing (fast)	“Fast Leveling” active
 Yellow	**Non flashing**	**MAN** mode activated
	Flashing (slow)	FMS / Remote PC has taken over control

LED Color	Description
 Red	a **major** failure occurred e.g. a motor of the Mount is defective
 Cyan	a **minor** failure occurred e.g. the worklevel of the Mount is incorrect
 Magenta	Mount has reached its end stop
 Blue	Active pump process
 White	Firmware update in progress

- **A sequential flashing sequence of the LED – regardless of its displayed color – indicates that service of the device is recommended.**

B – Touch Encoder

The Mount can also be controlled without the SOMAG Mount Control App using the Touch Encoder. All control functions of the Mount are accessible through the Touch Encoder. A detailed overview of all functions is described in the '323104-901-08/XX SOMAG Mount Touch Encoder – Manual'.

- **When the Touch Encoder is not in use, please make sure that the protective cap is properly in place to prevent damage or contamination.**

5.2 Set Up via SOMAG Mount Control App

Information regarding the usage of SOMAG Mount Control App can be found in the following document: '323101-901-08/XX SOMAG Mount Control App Manual'.

5.3 Power Up / Initialization

It is necessary to check the cabling of the different components before switching on the device. All cables need to be arranged and connected according to chapter 4.2.2. Power-Switch LED is off.

- **The GSM 5000 safety area (see chapter 1.4) must not be obstructed by any other components. If this is the case, the device or the payload might receive irreparable damage.**
- **Make sure that the device is properly secured / bolted to a stable and even surface before power is applied.**

When the power is applied the internal controller of the Mount starts up the following phases:

- Electronic Test Phase (ETP)
  - The device runs the electronic test phase (ETP) to check proper functionality of all sensors and electronic components.
- Mechanical Test Phase (MTP)
  - The Mount refills its hydraulic cylinders with oil until it reaches the positive end stops. Meanwhile the Yaw axis of the Mount moves to its 0° position.
- Range Test Phase (RTP)
  - The Mount fulfills a short movement in all axes to ensure functionality of them.

After completing these phases, the GSM 5000 automatically switches to its preset default mode within approximately 15 seconds.

Further notes:

- In 'STAB' mode, the Mount actively stabilizes the payload to ensure a level position.
- In 'MAN' mode, the automatic gyro stabilization is turned off.

The current mode is displayed in the SOMAG Mount Control App / Touch Encoder (see chapter 5.1 / chapter 5.2). Both tools can be used to switch between modes and set the default.

5.3.1 Manual Operation (MAN Mode)

Under certain flight conditions (strong turbulence, harsh environmental conditions) or for troubleshooting purposes it can be necessary to control the Mount manually with the SOMAG Mount Control App / Touch Encoder to set the attitude. In this case it is recommended to use the SOMAG Mount Control App.

5.3.2 Automatic Operation (STAB Mode)

Before switching to 'STAB' mode, the Yaw axis angle needs to be set for each line by using the SOMAG Mount Control App / Touch Encoder. When the aircraft changes its desired heading, it must be readjusted because the device needs a pre-set desired heading value to actively stabilize around it. Only Roll and Pitch can be detected by GSM 5000 itself with its in-built tilt sensors.

Fly at least 30 seconds before capturing data when the GSM 5000 is stabilizing. The device requires a short time to adjust to the exact level after each turn.

It is important to switch the Mount into ‘MAN’ mode during turns, otherwise the device will move to its end stops. This will decrease the performance of the GSM 5000 if the device runs like that for several hours.

Switch back to ‘STAB’ mode after each turn and fly a straight line for 30 seconds before resuming data acquisition. At each change from ‘MAN’ to ‘STAB’ mode the Mount checks if it is still at the correct working height. If this is not the case, a re-pump process will be carried out to refill the hydraulic circuits with oil, similar to the initialization process (MTP).

If the horizon of the Mount is far away from the desired value and the standard gyro stabilization is not fast enough to reach the desired horizon, ‘Fast Leveling’ will start automatically. The operator can start ‘Fast Leveling’ as well by pushing the ‘Fast Leveling’ button in the SOMAG Mount Control App / Touch Encoder.

- **If the GSM 5000 ‘STAB’ mode fails, respectively the device starts to oscillate, you can switch back to ‘MAN’ mode.**

5.3.3 Operation with a Remote Computer

The GSM 5000 can also be controlled by a remote computer using the ‘INTERFACE’ port. No specific setup on the Mount control panel is necessary to take over control of the GSM 5000. A detailed description of the interface protocol can be handed out on demand.

5.3.4 Operation with Flight Management System (FMS)

Please follow the instructions of the FMS manufacturer to integrate the GSM 5000 properly into the whole system. If problems occur, contact SOMAG AG Jena or the FMS manufacturer.

The GSM 5000 is capable to operate with the following FMS:

- Applanix: POS AV™ and POS Track™
- IGI: CCNS 4/5 / AeroControl
- Lead’Air: TrackAir FMS
- TopoFlight: TopoFlight FMS
- AeroScientific: Aviatrix

Any other FMS can be integrated on demand.

5.4 Mount Communication Protocol

Information regarding the Mount Communication Protocol can be found in the following document:

‘323403_901_08/XX_ICD_Interface_Control_Document’.

6 Maintenance, Transport and Storage

6.1 Maintenance

The GSM 5000 should be returned to the manufacturer for maintenance every two years. The requirement for service is also signaled in the SOMAG Mount Control App / Touch Encoder (see chapter 5.1). Should a malfunction of the Mount occur, please contact SOMAG AG Jena to solve the problem as quickly as possible.

6.2 Cleaning the Mount

Try to keep the GSM 5000 clean and free from dust, dirt and other environmental influences. The device is not designed for usage outside the airplane or any other vehicle. If necessary, clean the surfaces of the Mount with a damp cloth. DO NOT attempt to clean any inaccessible parts of the GSM 5000.

6.3 Transport and Storage

The GSM 5000 scope of delivery contains a rugged transportation case (see chapter 2) which is necessary to ship and store the device. If the Mount is removed from the aircraft, it should be placed in the storage box to keep it clean and protected.

For long-term storage (more than one month), the device needs to be stored in a moderate temperature environment with less than 70 % humidity.

The device needs to reach local temperature before it is taken out of the transportation case to avoid condensation, especially when the GSM 5000 was stored or transported in cold environments.

- **Use only the original transportation case for shipping or transporting the device. Using any other transportation housings or boxes will void the warranty.**
- **Before the device can be placed inside the transportation and storage box, first it must be lowered to the bottom position. This can be initialized via the SOMAG Mount Control App / Touch Encoder and ensures that the GSM 5000 is in its lowest position and can fit inside the box.**
- **Mark the package with the supplied package of transport sensors for the reshipment (please make sure to position the tilt watch sensors on two different axes as shown in the picture).**

Packing dimensions (L x W x H): 800 x 700 x 265 mm

Figure 18: Shipping labels and transportation case

7 Troubleshooting

If you encounter any issues with the Mount and wish to contact our Support Team, please always include the serial number of the device along with a current self-test file.

Additionally, we highly appreciate any flight data or a short video showing the device during the fault condition, as this can significantly speed up the diagnosis process.

If the Touch Encoder becomes unresponsive or freezes, a simple restart of the mount is usually sufficient to restore normal operation.

- **It is strongly recommended to contact the manufacturer (SOMAG AG Jena) immediately if a problem occurs. Any repairs which are not authorized by the manufacturer will void the warranty.**
- **Please include the Serial number as well as the Selftest file generated via the SOMAG Mount Control App (see chapter 5.2).**

7.1 Firmware Update

If you need to change or update the firmware version, please contact your local support or the manufacturer, SOMAG AG Jena.

7.2 Reshipment

Reshipment information can be found on our website: www.somag-ag.de/contact/support. Please contact your local support or the manufacturer, SOMAG AG Jena for further information.