

# MRU recalibration



KONGSBERG

## How and when to recalibrate the MRU

A recalibration of the MRU (Motion Reference Unit) is recommended due to changes in the characteristics of the internal sensors over time and is therefore necessary in order to achieve the specified performance.

The need for recalibration depends on the MRU generation, the MRU model and the application in which it is used.

### General recommendations

The accuracy which is required by the equipment using the MRU sensor, decides the recalibration interval of the MRU. This might vary depending on the application and must be considered for each of the devices using the MRU.

For equipment requiring factory specifications we recommend the following intervals from the calibration date:

MRU all gens.	MRU 3 <sup>rd</sup> & 4 <sup>th</sup> gen.	MRU 5 <sup>th</sup> gen.
MRU 1 & 4	4 years	
MRU D sn <5320	1 year	
MRU D sn >5320	3 years	2 years
MRU Z	1 year	
MRU 2 & H	4 years	2 years
MRU E		2 years
MRU S		2 years
MRU 3, 5	2 years	2 years
MRU 5+		2 years
MRU 6	2 years	

The above mentioned recommendations are valid for applications where it is required that the roll and pitch measurements are within their specifications, except for the MRU Z, where recalibration is required also for the heave performance.

Recalibration of the 5<sup>th</sup> generation MRU models are recommended for applications that depend on high static accuracy in roll and pitch. The table can be used to evaluate when recalibration is necessary due to the static roll and pitch accuracy required for your application.

### MRU 5<sup>th</sup> generation - Typical static roll and pitch changes over years

MRU 5 <sup>th</sup> gen.	2 years	3 years	4 years	6 years
MRU 5+	0.008°	0.016°	0.022°	0.034°
MRU 5	0.02°	0.04°	0.055°	0.085°
MRU E	0.03°	0.05°	0.065°	0.095°
MRU H	0.03°	0.05°	0.065°	0.095°
MRU 3	0.08°	0.16°	0.24°	0.40°
MRU S	0.2°	0.28°	0.34°	0.46°
MRU 2	0.03°	0.05°	0.065°	0.095°
MRU D	0.2°	0.28°	0.34°	0.46°

The dynamic roll, pitch and heave accuracy is not significantly changed over years. For applications that only require dynamic accuracy, no recalibration is needed. Applications such as:

- Fishery sonar compensation
- Heave compensation of offshore cranes
- GNSS antenna motion compensation in Dynamic Positioning systems
- Seabed mapping with multi-beam echosounder where patch tests are carried out regularly
- MRU units part of Seapath with Automatic Online Calibration

## Validity of MRU calibration certificate

An individual Calibration Certificate is generated for each manufactured MRU. The certificate confirms performance for the MRU compared with test requirements valid for the specific type of MRU. The calibration date is printed on the Calibration Certificate. The certificate does not include an expiry date as the MRU will still be working even if there has been a long time since the last calibration. However, the uncertainty whether the MRU is within its specification, will increase over the years without a recalibration.

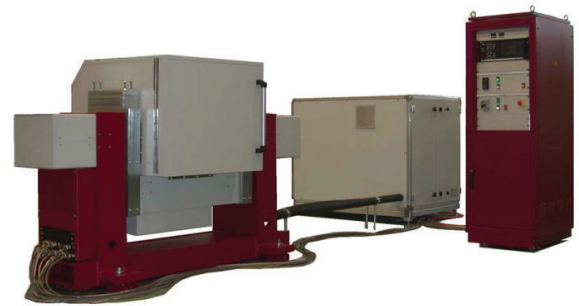
Recalibration of the MRU is recommended due to changes in the characteristics of the internal sensors over time, and is therefore necessary in order to achieve the specified performance. Exactly when a recalibration is required, will depend on the user application (use of the unit, i.e. thermal cycling, vibration and shock).

Seatex MRU Calibration Certificate				KONGSBERG	
Seatex MRU model number:	E	1 position			
Serial number:	27855				
Calibration certificate number:	2024002/27855				
<b>1. Roll and Pitch Accuracy Tests</b>					
Roll and pitch accuracy	Test requirement	Roll	Pitch		
RMS static roll and pitch (deg)	0.02	Passed	Passed		
RMS dynamic roll and pitch (deg)	0.02	Passed	Passed		
The static accuracy was measured by sampling at 1 Hz for 30 minutes, when the Seatex MRU is stationary.					
The dynamic accuracy was measured in a rate table test with sinusoidal motions at calibration in two axes for 10 minutes.					
Plots of results from dynamic test of Seatex MRU with serial number 27855					
Measured roll angle		Measured pitch angle			
Roll error		Pitch error			
<b>2. Bias Core Accuracy Tests</b>					
Length rate accuracy	Test requirement	R-roll	P-pitch	Y-yaw	
RMS rate sensor static factor (%)	0.1	Passed	Passed	Passed	
RMS rate sensor scale factor error (%)	0.2	Passed	Passed	Passed	
The static rate sensor static level was measured by sampling at 1 Hz for 30 minutes, when the Seatex MRU is stationary.					
The rate gyro scale factor error was tested by single-axis rotation on a rate table at 450°/s and at 450°/s.					
<b>3. Accelerometer Accuracy Tests</b>					
Linear acceleration accuracy	Test requirement	R-roll	P-pitch	Y-yaw	
RTD acceleration sensor static level (%)	0.002	Passed	Passed	Passed	
RMS acceleration sensor scale factor error (%)	0.02	Passed	Passed	Passed	
The acceleration sensor static level was measured by sampling at 1 Hz for 30 minutes, when the Seatex MRU is stationary.					
The acceleration scale factor was measured by using the Seatex MRU in steps of 90° around a circle.					
The Calibration Certificate test requirements are the technical specification limits in the MRU User Manual.					
A two-axis rate table with temperature chamber (CIE 2205-11-01 from Acutronic AG, 2007) was used to test the unit.					
All tests were performed at room temperature according to test procedures in the MRU Production Manual.					
KONGSBERG DISCOVERY AS				Date of calibration: 2024-02-02	

## Calibration facilities and method

To achieve optimum performance and reliability of each MRU, six state-of-the-art two-axes calibration machines with an integral temperature chamber of Acutronic type are being used. The temperature chamber can test temperatures from -45° to +90° Celsius. The position accuracy is better than 3.00 arc-seconds. It also measures acceleration and force of gravity.

After 18 hours of data collection at different speeds, positions and temperatures, the machine performs a static and dynamic test of each MRU for final performance verification. The results from these tests are presented in the MRU Calibration Certificate, specially designed for Seatex MRU. The certificate is delivered with the unit and verifies that the accuracy numbers stated are correct.



## MRU dispatch procedure

If a recalibration of an MRU is required, please follow these steps to ensure an efficient and smooth recalibration process:

1. Contact your local Kongsberg Discovery or Kongsberg Maritime office or directly to Kongsberg Discovery AS, Seatex. Email: support.seatex@kd.kongsberg.com. Phone: +47 33 03 41 00. Please inform about the MRU model and serial number of the unit you want to recalibrate. If you need a spare MRU during recalibration, please ask for a quote.
2. You will receive an RMA (Return Material Authorization) number. This number should follow your shipment.
3. Place the MRU in its original transportation box, or similar hard-shell quality box, to secure safe transportation. Contact local authorities to check if you will need an export license.

## MRU recalibration turnaround time

- In general, the turnaround time for MRU calibration service is two weeks after reception.
- The calibration may uncover the need for service that does not appear during static testing on arrival and thus delays should be expected. The unit must then undergo service followed by a new calibration cycle. The delivery time will be extended accordingly.

Specifications subject to change without any further notice.