ROBOTEAM

MTGR

Maintenance Manual

ROBOTEAM

Table of Contents

Warranty and Liability

Please carefully read the following before operating any part of the MTGR System

- Use of any part of the system (MTGR, ROCU-7, MANP) is exclusively the responsibility of the operator
- All operators must attend the MTGR training course provided by Roboteam and or its affiliates and be qualified before operating the system
- Be careful of moving parts to avoid injury – to fingers or other body parts
- Roboteam and its affiliates are not responsible in any way for injuries resulting from misuse of the system
- Do not perform any maintenance procedures before verifying that the battery has been removed from the MTGR and/or the Manipulator Arm
- Do not try and operate the system with batteries other than those specified. This can result in irreversible damage to the system, hurt the operator, and damage the surroundings
- Do not look into the lasers and/or into the LED illumination module (both IR and visible) Lasers are eye-safe in accordance with Class IIIa classification

List of Figures

Instructions

How to Use This Maintenance Manual

All pages in this manual are color coded according to this color guide:

Color	Description	Qualification needed
Blue	Basic maintenance and troubleshooting procedures (before mission, storage, etc.).	MTGR Operators Training Course
Green	After mission maintenance	MTGR Operators Training Course
Orange	Field maintenance: periodical maintenance procedures (usually after 100 operating hours)	Qualified MTGR Technician / FSR
Red	Lab maintenance: part replacement, opening the robot, 300 working hours maintenance procedure	Qualified MTGR lab technician (should be performed in designated labs only)

Warning

- *Do not perform any tests or procedures that you have not been qualified for*
- *Procedures performed by unqualified personnel can result in irreversible damage to the system*

Introduction

MTGR

The MTGR System consists of a Micro Tactical Ground Robot (MTGR); Manipulator arm (MANP); Ruggedized Operator Control Unit (ROCU) and Accessories set.

The MTGR is a unique and robust lightweight, tactical unmanned vehicle with high maneuverability in a variety of terrains both indoors and outdoors while maintaining a simple and intuitive control interface.

The MTGR was specially designed to aid ground forces in various combat situations. The system includes the ROCU-7, a generic, hand-held, 7" screen, high resolution, and resistive touch-screen operator console with gamepad controllers.

Moreover, the MTGR's unique communication system allows a single

Figure 1 - MTGR

MTGR Main Features

- Maneuverability in any terrain
- Ability to climb stairs and overcome other vertical obstacles both indoors and outdoors
- 360° video coverage day & night vision for uninterrupted mission control
- Intuitive control unit
- Includes inertial sensors
- Enables mounting of various add-ons (manipulator arm, thermal camera, and more) through standardized connections

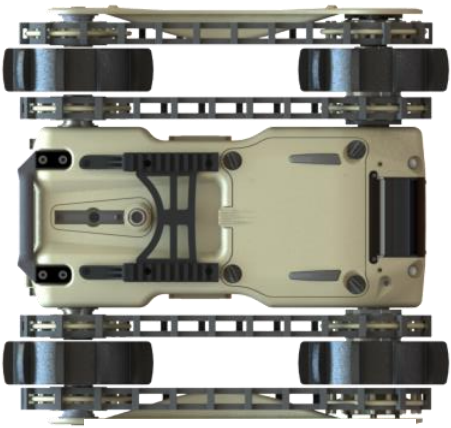


Figure 2 - MTGR Top View

MTGR™ - System Components

MTGR

ROCU-7+ x2 Protective Film

X2

Battery Pack

X2

Lite Adapter

Manipulator

MPU3

X2

Spring Antenna

X6

Battery US BB-2557/U

Documentation

Battery Charger for BB-2557/U

Tracks Gauge

ROCU7-MPU3 Data Cable
(ROCU-M-2030-00)

ROCU7-MPU3-Battery Cable
(ROCU-M-4000-28)

ROCU-7 Technician Cable
(ROCU-M-2020-00)

Field Tool Kit

Rachet wrench handle- drive 1/4"
Socket wrench adapter 1/4"-3/8"
Socket wrench extention 3"-drive 1/4"
Hex.socket 19mm d3/8 (12 ribs)short
Hex.socket -3mm T-Handle
Hex.Socket wrench 7mm-drive 1/4"
Microfiber cleanning cloth
Wheel cleaning brush
Hex.L.N Key-2.5mm T-Handle
Hex.socket 5.5mm D1/4
Hex.Socket wrench 13mm-drive 1/4"

Drive & Idler Wheels Set

Arm flange insert x2
Arm flange (shoshana) x2
Drive wheels middle insert x2
Screw DIN M4X20 st-st x6
Screw DIN 912 M4X55 st-st x16
Nylon Nut DIN 985 M4 st-st x8
Spring lock washer DIN 7980 M4 st-st x6

Recovery Rope

Stylus Pen

Supplied cables

Energy Cable

(ROCU-M-4000-28)

1. Connects the battery to the ROCU and the MPU Comm. Unit
2. Battery
3. Power connector to MPU
4. Energy connector to ROCU

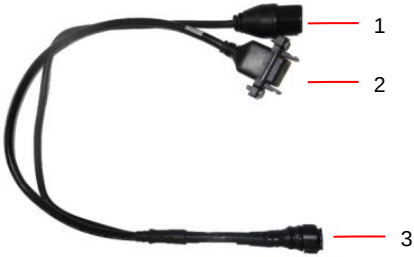
Communication Cable

(ROCU-M-2030-00)

- Connects the MPU to the ROCU

1. Communication to MPU
2. Communication to microphone

Figure 3 - Supplied Cables

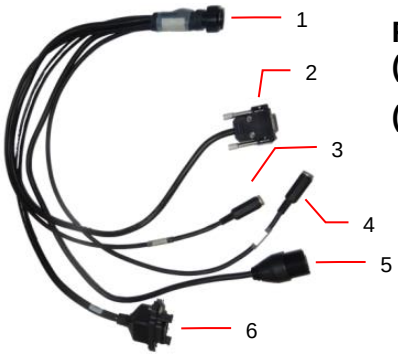


ROCU Technician Cable

(ROCU-M-2020-00)

- Enables DATA updates to the ROCU

1. USB
2. RJ45 (Ethernet)
3. Connects to ROCU



ROCU-7 Debug Cable-
(*for FSR's only*)

(ROCU-M-1030-00)

- Maintenance and updates to the ROCU

1. Glenair
2. VGA
3. Line IN (Audio)
4. Line OUT (Audio)

Figure 4.1 - Supplied Cables

MTGR Technical Specifications:

Parameter	Description
Width	14.5 inches , with wheel kit 18.5 inches
Length Arms Closed	17.9 inches, with wheel kit 18.6 inches
Height	5.7 inches, with wheel kit 6.5 inches
Weight	15.0 Lbs. with wheel kit 18.5 Lbs.
Max Payload Weight	20.0 Lbs.
Speed	3.5 Kmh.
Environmental	Ingress Protection 65, Operating Temperature -4°F + 140°F
Vertical Obstacle	13.8 inches
Stair Climbing Ability	8 inches 45˚
Operating Range	1600 feet . LOS
Operating Time	2 hours (operation mode dependent)
Payload Ports	Power (12-28V) Ethernet RJ45 (IP65) RS232 Video/Audio port
Mechanical Interfaces	Standard Picatinny Rails
GPS	Google Earth and Falcon View compatible
Video & Cameras	Real time day & night audio and 360° video + zoom
Sensor Tilt Module	-20^0 - $+90^0$
Illumination Module	360˚ IR illumination + front white LED

ROCU-7 Technical Specifications

Parameter	Description
Width	11.8 inches
Length	6.7 inches
Screen Size	7 inches
Weight	
○ **Without battery**	3.9 lbs.
○ **Including battery**	5.0 lbs.
Ingress Protection	IP65
Operating Temperature	-4°F – +140°F
Operational Time	4 hours
Power Supply	BB-2557 US Military Standard Battery or Roboteam 24V battery

Wave Relay MPU3 Communication Unit Technical Specifications:

Parameter	Description
Width	4.7 inches
Length	5.0 inches
Weight	0.88 lbs.
Peak Transmission Power	2W
Ingress Protection	IP67
Operating Temperature	-4°F – +140°F
Encryption	256-bit AES Encryption with SHA-512 MAC on Backbone
Power Supply	BB-2557 US Military Standard Battery

Manipulator Technical specifications:

Name	Description
Actuator DOF (Degree Of Freedom)	
Shoulder	180º Pitch
Elbow	+/- 110º Pitch
Wrist	360º continues Pitch
Gripper	0-100º
Operating Time	4 hours
Installation Time	under 30 Sec.
Environmental	IP65 MIL-STD-810F
Max Gripper Opening	110 mm
System Weight	7.2 lbs.
Max Lift Capacity	5 lbs. (fully extended)
Reach Length	390 mm MAX; 50 mm MIN

Figure 5 - MTGR with Manipulator

The MTGR is compatible with various standard add-ons, such as:

- Thermal camera
- Tactical manipulator
- Beacons

Note: Maximum payload weight is 20 lbs.

The following chapter describes the details regarding the different mounting options for the MTGR.

Mechanical Formation

The MTGR is equipped with two (2) standard Picatinny rails, located at the rear end of the robot.

Figure 6 - Picatinny Rails

MTGR Upper View with Picatinny

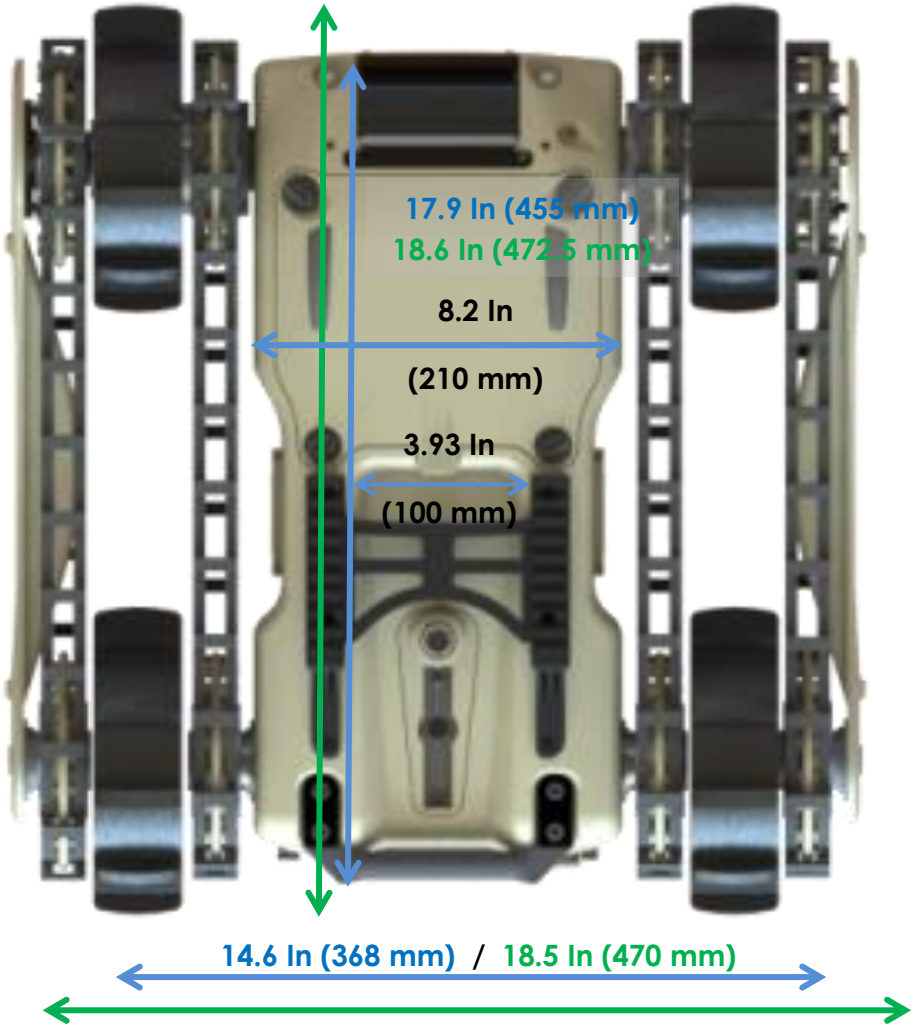


Figure 7 - MTGR dimensions

MTGR Rear View with Picatinny

Note: Height difference between the Picatinny rail and the inner tracks is approximately 0.32 in (8 mm).

Note: Maximum payload height is approximately 12.2 in (310 mm). Beyond this height, the MTGR will not be able to flip itself over.

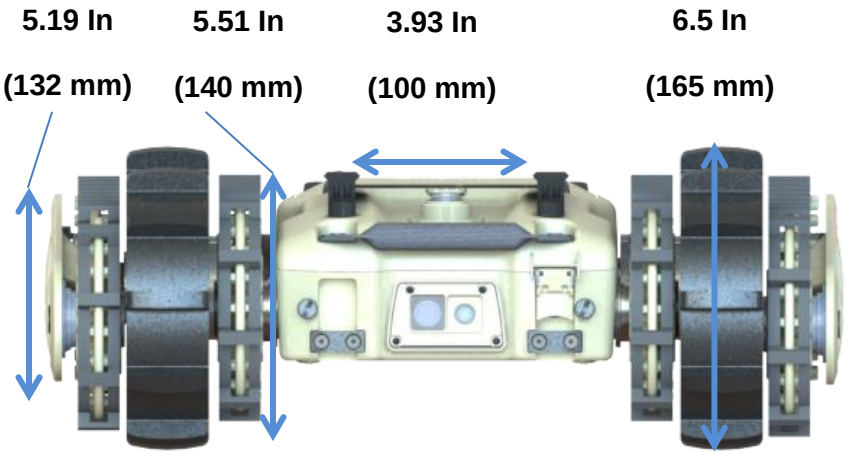


Figure 8 - Rear view

Electronic Formation – Glenair Mighty-Mouse

The MTGR is equipped with a Glenair Mighty-Mouse connector. The connector is located in the rear part of the MTGR, between the Picatinny rails, as shown in the following image:

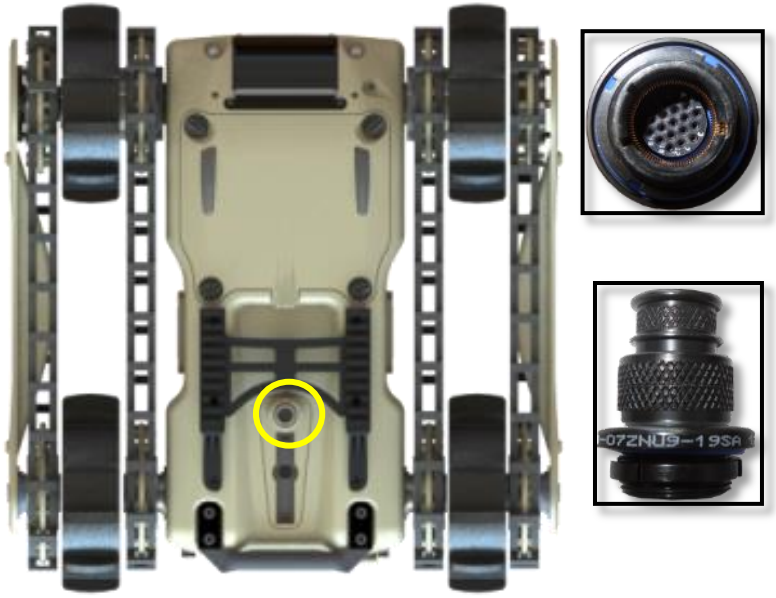


Figure 9 - Glenair Connector

Connector Line Out

- 19 pins
- Pin configuration:

Table 1

Audio WR	LAN
Audio Com	Video
USB	General

PIN	Description	Comments
1	In Battery - GND	
2	In Battery - GND	
3	In Battery + 14.4V	
4	In Battery + 14.4V	
5	14.4V out (0.5A)	
6	5V out (2A)	
7	GND out	
8	Video 1 IN	
9	Video 2 IN	
10	Video Audio GND	
11	Video 1 5V (0.15A)	
12	Video 2 5V (0.15A)	
13	CANL	
14	CANH	
15	TX+	* To enable these pins please contact Roboteam at support@robo-team.com
16	TX-	
17	RX+	
18	RX-	
19	Audio Out	

Troubleshooting

Single Camera Malfunction

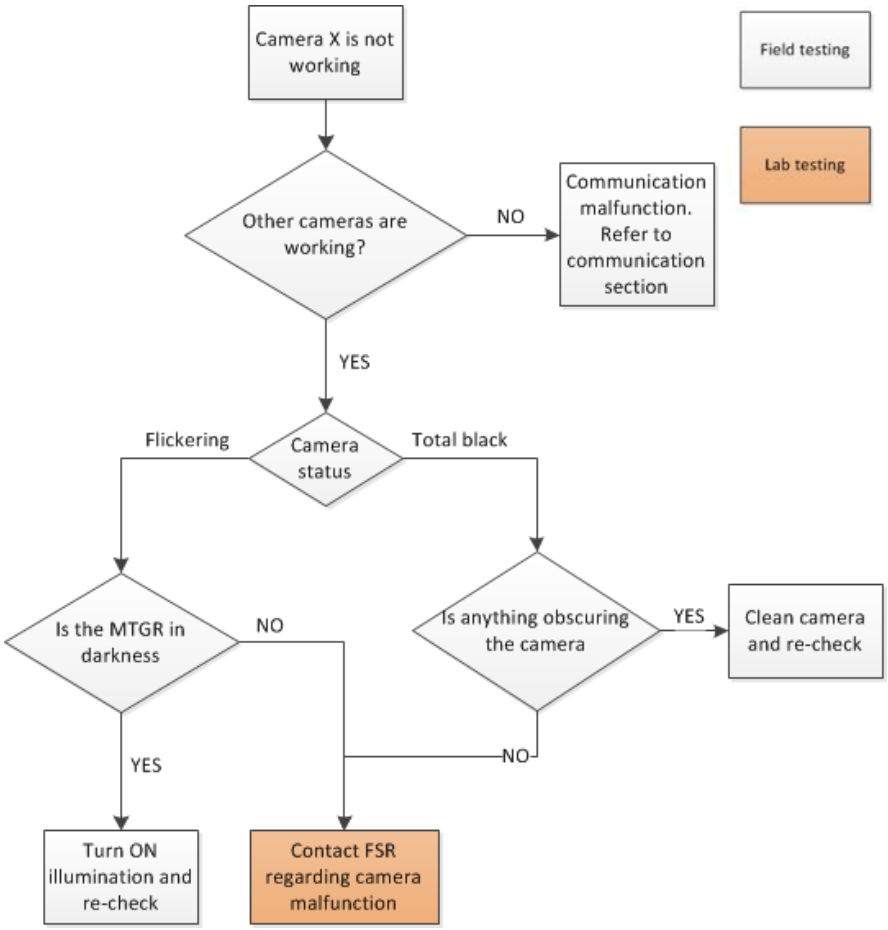


Figure 10 - Camera Malfunction

Communication Malfunction

Figure 11 - Communication Malfunction

MTGR is Drifting in One Direction

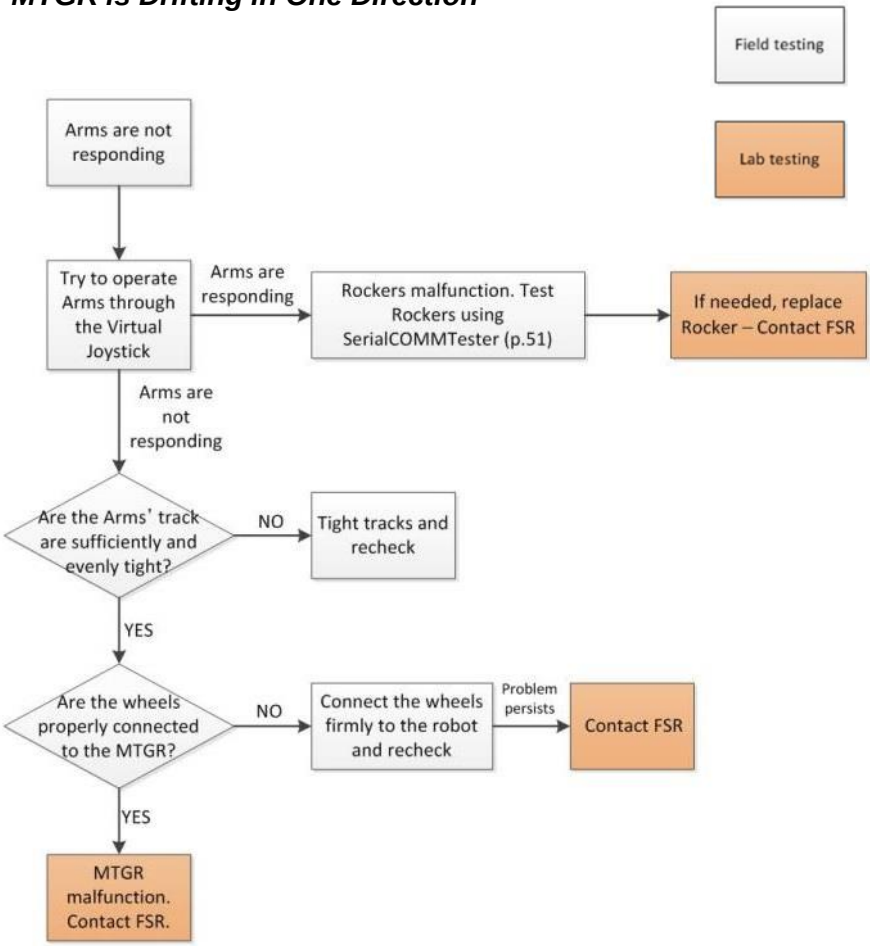


Figure 12 - MTGR Drifting

IMU Malfunction / Arms Are Not Calibrated

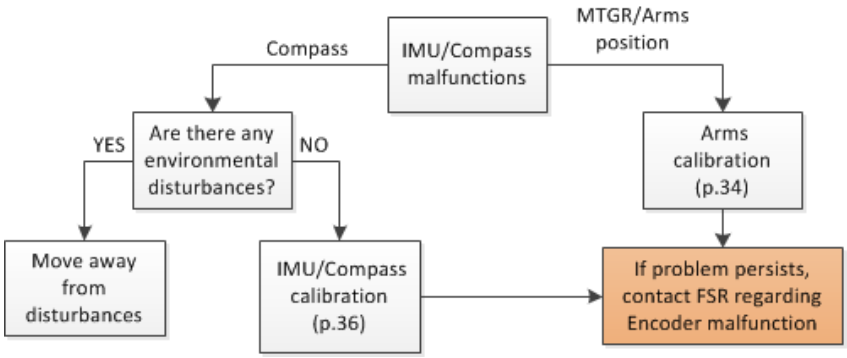


Figure 13 - Arms Error

GPS is Not Responding / Accurate

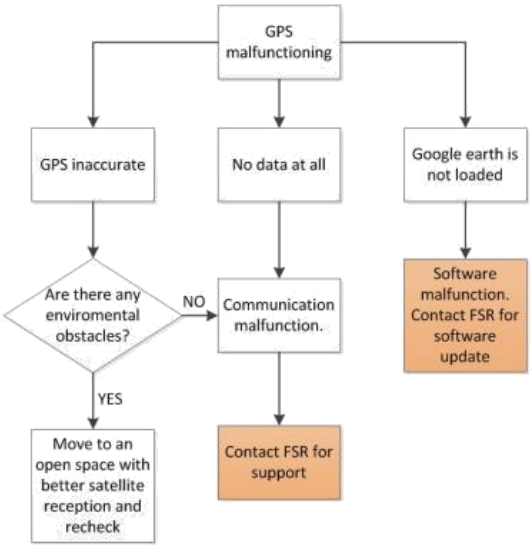


Figure 14 - GPS Malfunction

Arms Are Not Responding

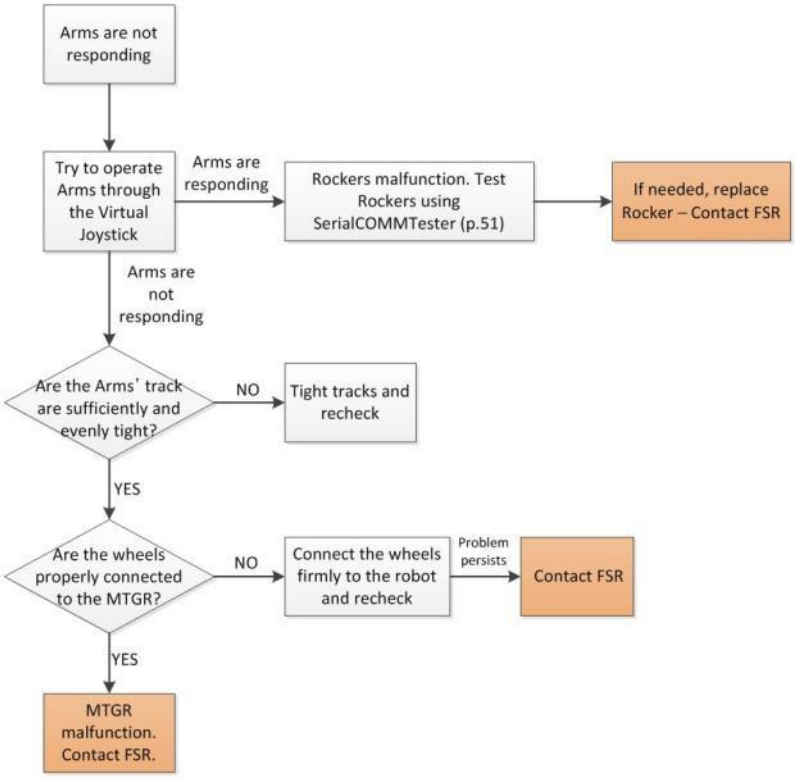


Figure 15 - Arms Malfunction

Log Folder is Empty

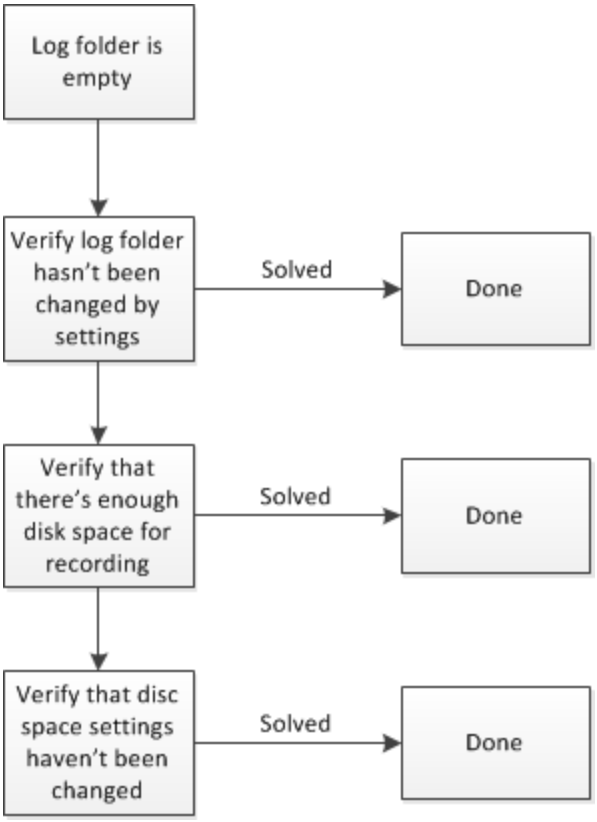


Figure 16 - Log Error

Storage Maintenance

While not operational the MTGR should be stored according to the following maintenance rules:

- Always store the MTGR together with its ROCU-7 and MPU3 inside the supplied case.
- When not in use, batteries should be charged at 20% (single bar)
- MTGR should be stored in a dry and cool place.

Remember basic preparations before every mission!

- Verify batteries are fully charged
- Tracks are sufficiently tight and secure
- Cameras' covers are clean
- Wheels are secured
- ROCU-7 screen is intact and clean
- Verify 2 cables are connected and secured
  - MPU3 battery cable
  - Communication cable
- Remember to update the attached operation log, tracking the amount of operational hours.

Operational Maintenance

The operational maintenance should only be performed by qualified MTGR operators. These procedures should be done after every mission to ensure the highest performance of the robot. Remember to update the attached operation log.

Table 3

Operation	Description	Tools Used
Whole Body Cleanup	Remove dust, sand gravel, etc.	Air pump
Cameras	Wipe off dust, mud, etc.	Moist cloth (use specialized lens cleaner cloth)
Main Tracks	Tighten tracks to proper tension	Ratchet wrench handle (drive 1/4" – short handle), 19 mm socket Allen 3mm
Arms Tracks	Tighten tracks to proper tension	13mm socket + Ratchet wrench
Battery Compartment	Clean battery compartment and battery connector	Air pump Moist cloth
Batteries	Verify batteries are fully charged	Certified BB-2557 charger

Field Tool Kit

Table 4

No.	Tool Name	Picture
1.	Ratchet Wrench Handle (drive 1/4" – Short Handle)	
2.	Wrench Extension Adaptor (3" –long)	
3.	Wrench Drive Adaptor (1/4" → 3/8")	
4.	7 mm Hexagonal Socket Wrench (drive 1/4")	
5.	13 mm Hexagonal Socket Wrench (drive 1/4")	
6.	19 mm Hexagonal Socket Wrench (drive 3/8")	
7.	3 mm Allen Key (T-Handle).	
8.	2.5 mm Allen Key (T-Handle).	
9.	2 mm Allen bit	

Thread Lock Glue (Loctite) – not supplied with system 

Systems' Tracks

Manipulating the tracks properly is the key to obtaining the maximum maneuverability from your system. As a basic rule, when driving the MTGR in an urban/indoor environment the tracks should be relatively loose, while driving in open field, the tracks should be tight.

Main Tracks

1. Open the rear wheel screw using the ratchet wrench with the 3" extension and 19mm Hexagonal Socket Wrench

Figure 17 – MTGR Side View

2. Remove the cap (using a regular flat screwdriver or a coin) and use 3mm Allen Key in order to turn the tension screw to set the tense level

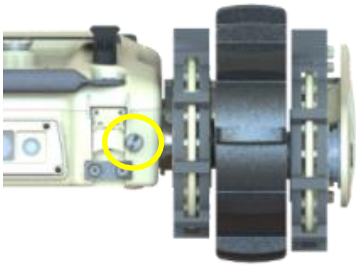


Figure 18 - Tightening Screw

3. Fasten the main screw M12X25 (using the 19mm socket)

4. Pinch the tracks and make sure they are approximately 3.24 inch (82.5mm) apart - for extra tightening rotate the tension screw clockwise, to release rotate counter clockwise.

Figure 19 - Drive Tracks

Arms' Tracks

1. Use the 19mm Hexagonal Socket Wrench and set the arms track tension with the screw located on the long edge.

2. Measure the tension. It should be taken at the middle of the track; behind the central arch. Make sure the tracks are approximately 3.24 inch (82.5mm) apart (use the gauge supplied – with the DRIVE side).

View from the inside:

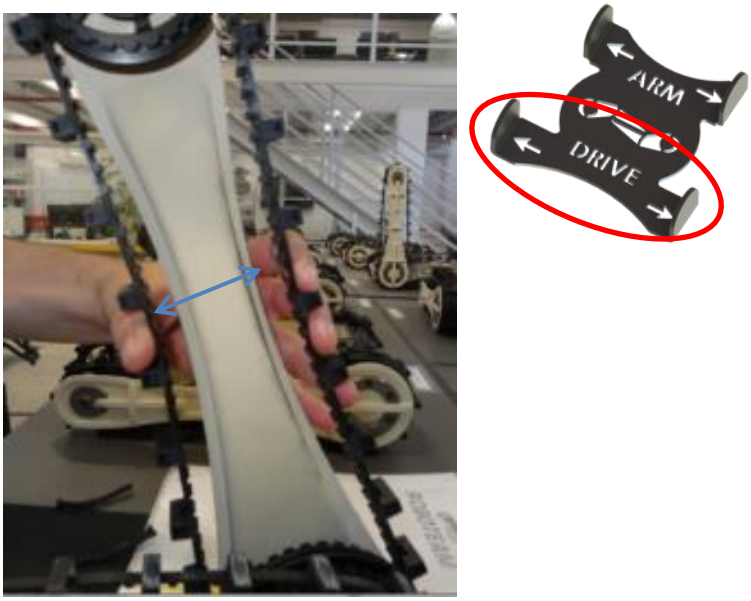


Figure 20 - Arms Tracks

Field Maintenance

The following maintenance should be performed after 100 operational hours.

Warning! Do not exceed the procedures specified in this booklet. Any action that involves the opening the MTGR/ROCU-7 casing could result in irreversible damage to the MTGR/ROCU-7.

Table 2

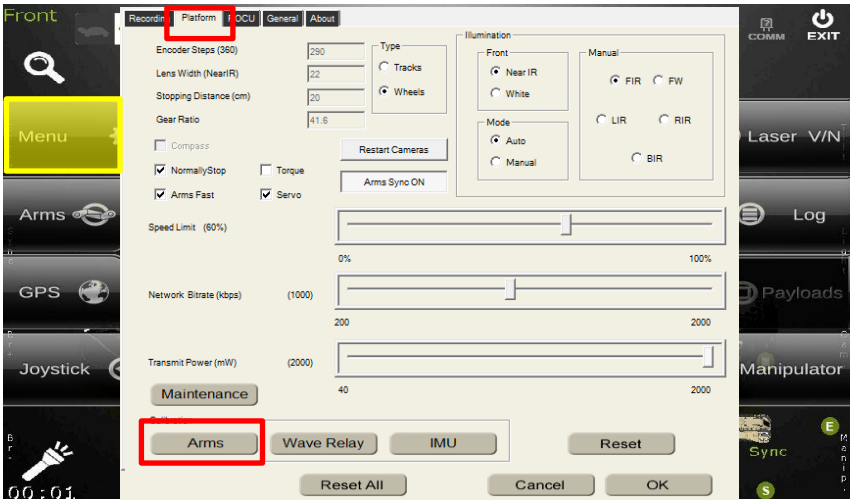
Operation	Description	Tools Used
Replace Front Window	Remove the 4 M2X6 DIN912 screws and replace the front window	2 mm Allen bit + Ratchet wrench
Replace the Tracks	Replace all 4 tracks	Refer to tracks maintenance in this manual
Exterior Screws	Tighten all of the **exterior** screws	

Calibration

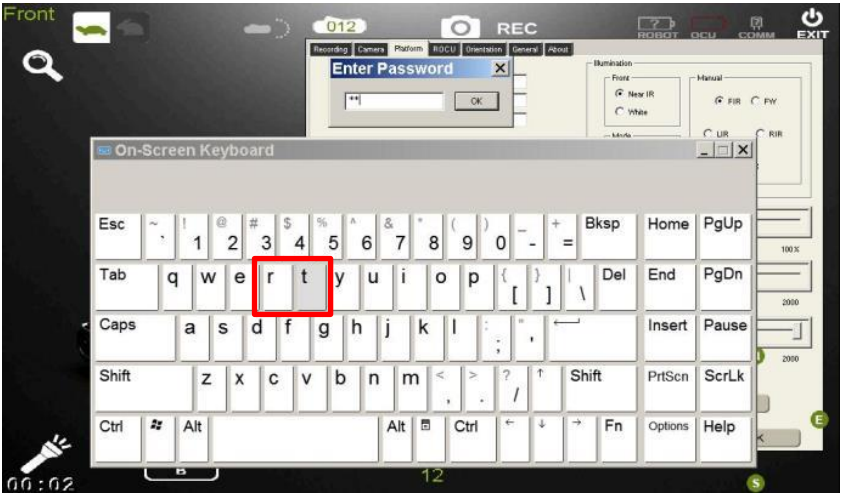
- Calibration procedures should not be done while in operation.
- Verify calibration before operating the MTGR.
- Operating the MTGR and the Manipulator without proper calibration can damage the system.

Arms calibration

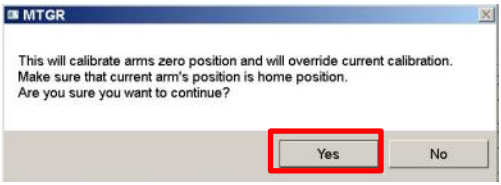
1. Press the Menu button in the MTGR application, and select the "Platform" section. Press the "Arms" button:



2. Enter the password: "rt"



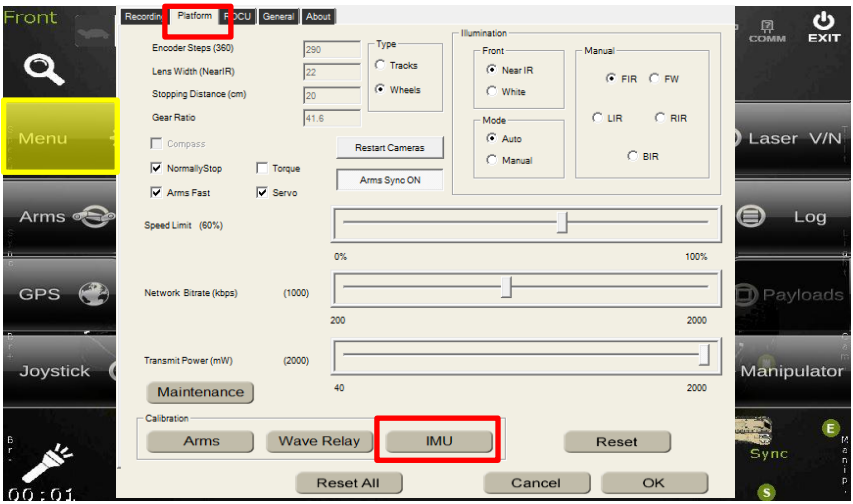
3. Verify the arms are in "home position" (fully folded) and press YES:
4.



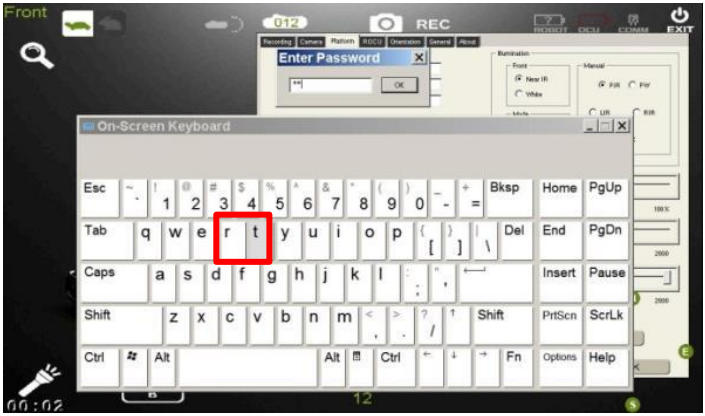
5. Press OK to exit the Menu screen.

IMU and Compass Calibration

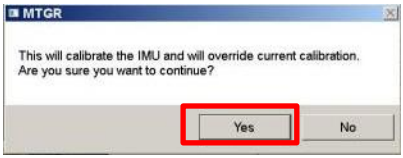
1. Press the Menu button in the MTGR application, and select the "Platform" section. Press the "IMU" button:



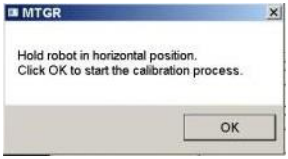
Enter the password:"rt":



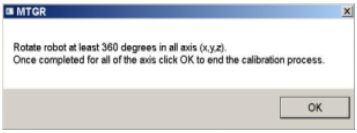
Press YES to continue:

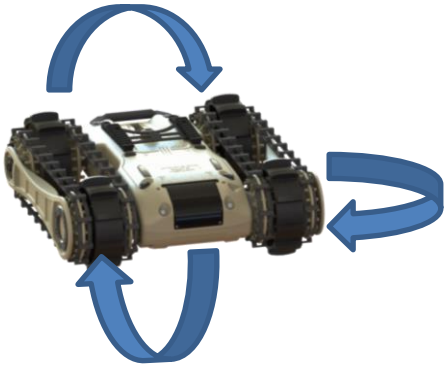


2. Place the MTGR on a flat horizontal surface, and press OK:



3. Hold the MTGR and rotate it in every axis (x,y,z). Verify full rotation once in every axis. Press OK when done.

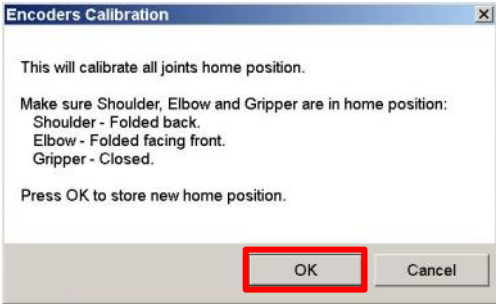




Manipulator Calibration

1. Activate the Manipulator and enter the settings menu. Select the "Calibration" Button:

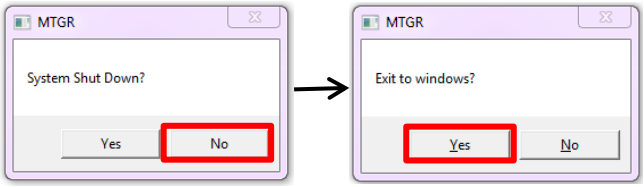
2. Verify the Manipulator is in full home position and press OK:



3. Press OK to exit the Menu.

Touchscreen Calibration

1. Exit the MTGR application by pressing the ON/OFF button, and choosing the option to exit to Windows:

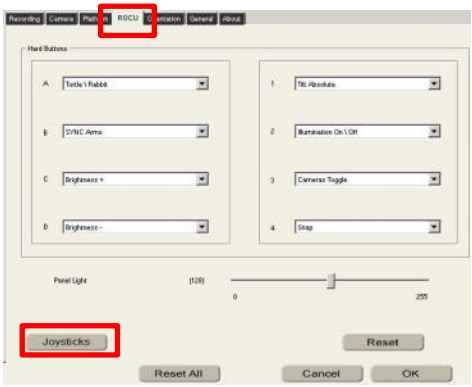


2. Press the Start menu button 

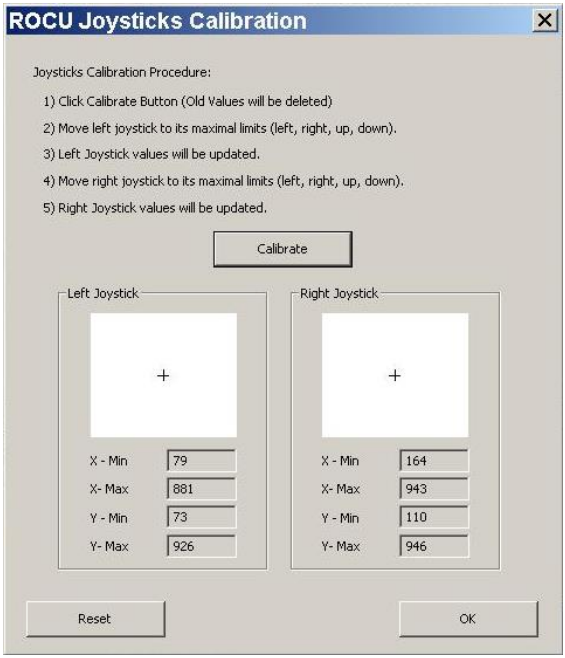
3. In the search bar type: "calibration" and activate the software.
4. Follow the instructions on the screen.

Joystick Calibration

1. Press the Menu button in the MTGR application, and select the "ROCU" section. Press the "Joysticks" button:



2. Follow the instructions and press OK to exit the Menu (verify you move both joysticks in every direction):



Lab Maintenance

300 Hours Maintenance Lab Treatment

Warning

- The following procedures should be performed only by specially qualified lab personnel.
- Remember: Opening the robot can result in irreversible damage. Whenever in doubt, consult the following pages in this manual and contact Roboteam Ltd. for support.
- These procedures should be done after 300 hours of operational use.

Table 3

Operation	Description	Tools Used
Inside Cleanup	Open the robot upper cover and clean the inside of the robot by using an Air pump	Air pump 3 mm Allen Key
Screw Tightening	Tighten all of the screws in the robot.	Various screwdrivers and Allen keys
Connectors Verification	Verify all the connectors are tightly connected	
Battery Change	Consider battery change in case of faulty batteries	
Wheels Replacement	Replace all wheels	Use instruction manual MTGR-3X00 assembly

Communication Malfunction

Note:

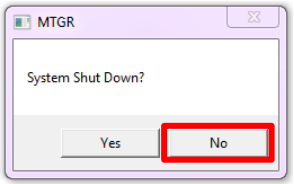
- This procedure should be performed only in a designated robotic lab, and by qualified personnel.
- Verify that all field solutions have been exhausted before proceeding with the following steps.

Required Tools:

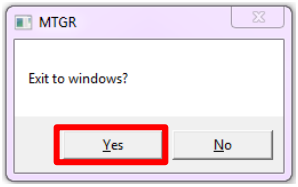
- ROCU-7
- MPU3 COMM. Unit
- MTGR

1. Using the ROCU-7 (while connected to an operating MPU3) Exit to windows by pressing the ON/OFF button. When asked to shut down system press No.

–

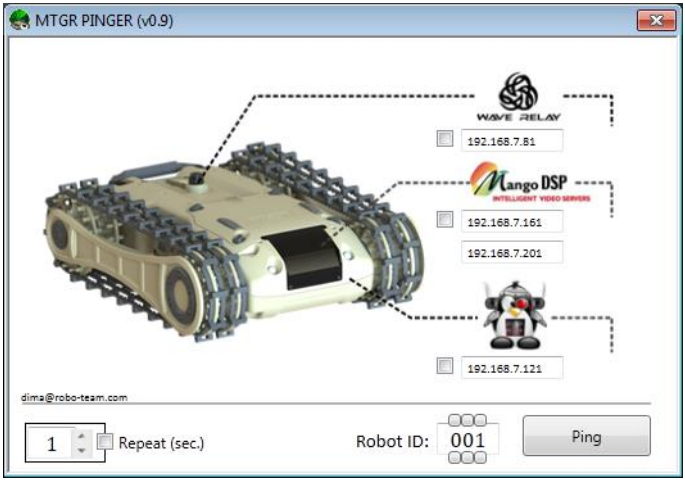


2. In the next window press Yes.

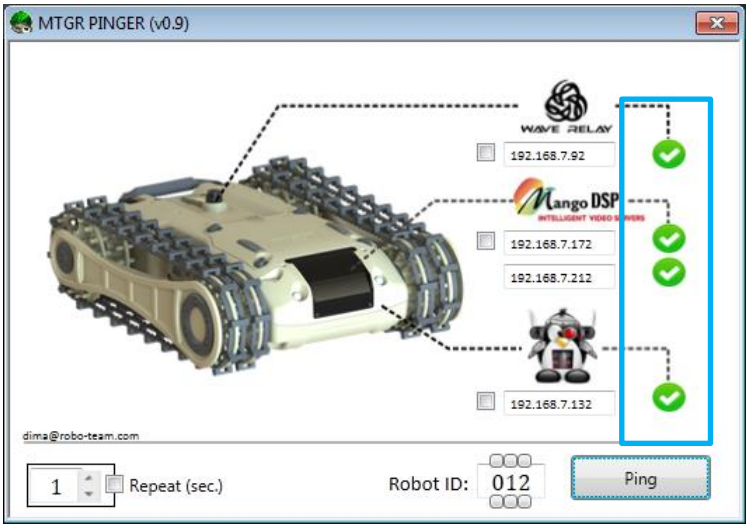


3. On the desktop locate the shortcut “MTGRPinger” and activate it.

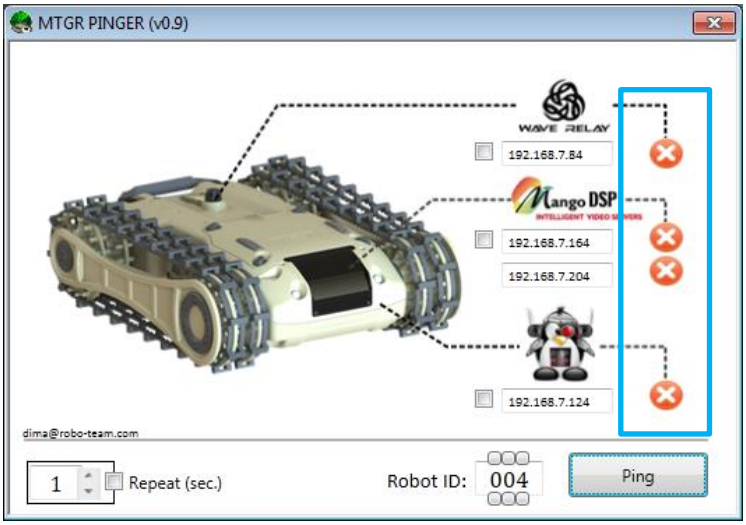
4. In the window that opens up, select the MTGR you would like to test (verify MTGR is ON) and press “Ping”.



5. The software will try to connect to the robot and will report which parts are malfunctioning.



All components are functioning



Components malfunction

6. Proceed according to the following instructions:
   a. Wave Relay dead: wave relay encryption key might have been erased. Refer to “WR encryption key” section in this manual.
   b. Mango DSP 1 / 2 dead: Contact customer support.
   c. SOM Card dead: Contact customer support.

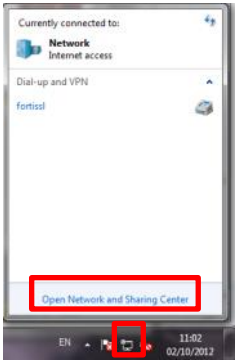
Wave Relay Encryption Key Setup

Note:

- This procedure should be performed only in a designated robotic lab, and by qualified personnel.
- Verify that Wave Relay was identified as a probable cause for communication malfunction **before** beginning this process.
- Do not make any changes except for the ones detailed in the following instructions.
- The process should be done for **both** MTGR and the corresponding MPU-3 COMM. Unit.

Required Tools:

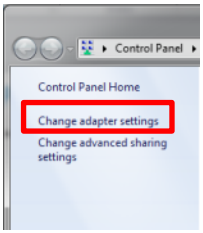
- ROCU-7
- MPU3 COMM. Unit
- MTGR
- MTGR Technician cable
- ROCU-7 Technician cable
- Windows 7 based Computer with Ethernet cable



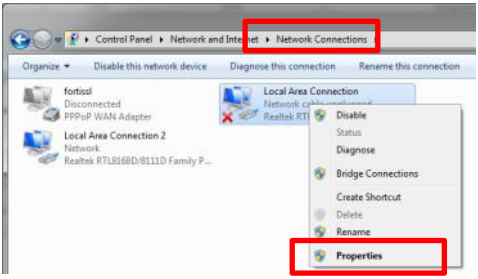
Configuring the Computer

1. Enter the “Network and Sharing Center”

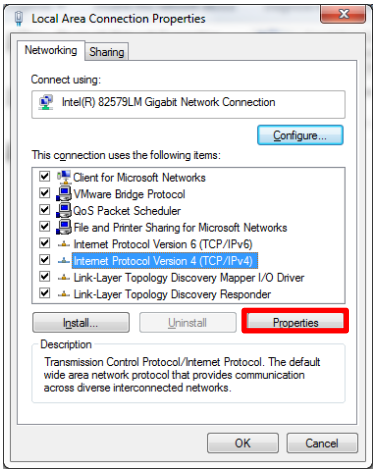
2. Select “Change adapter settings”



3. Right click on “Local Area Connection” - Enter “Properties”

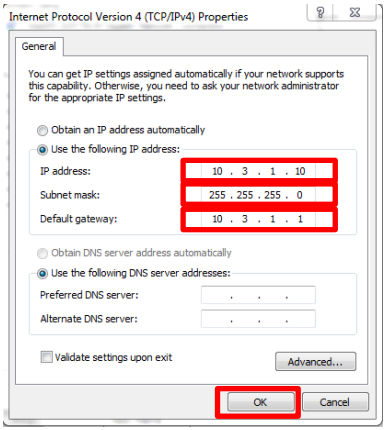


4. Select: Internet Protocol Version 4 (TCO/IPv4)and choose "Properties"



5. Select “Use the following IP address” and enter the following data:
   - IP address: 10.3.1.10
   - Subnet mask: 255.255.255.0
   - Default gateway: 10.3.1.1

   Press OK



Configuring the WR Encryption Key (MTGR)

1. Connect the Glenair connector on the Technician cable into the Glenair port on top of the MTGR. Connect the Ethernet cable from the computer to the RJ45 connector on the Technician cable.

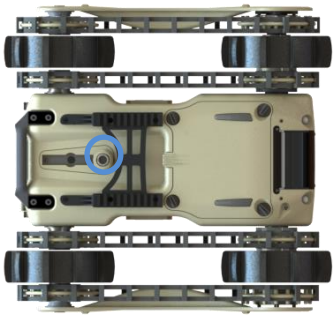
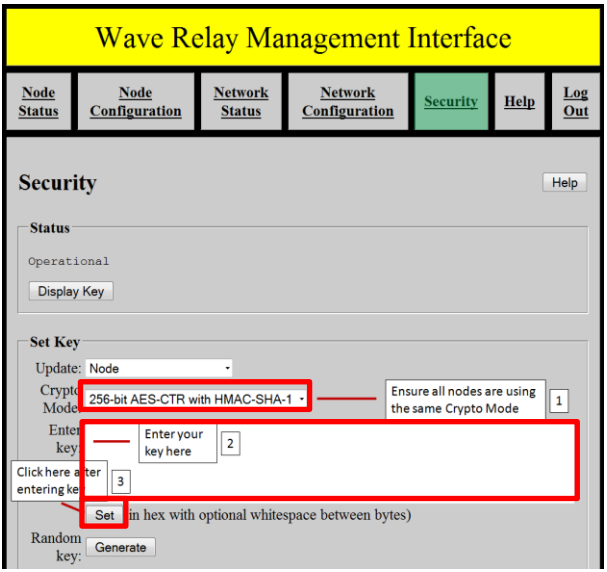


Figure 21 - Technician Cable

2. On the computer, activate "Internet Explorer" and enter the MTGR's IP address. If you do not know the address enter: 10.3.1.254
   (if asked, press "continue to unsecured website").
   The password is "password".
3. In the first page, select "Security" and copy the security key from the attached file "Security key.txt".
   Note: do not copy the security key to other file formats! This will damage the key and make it obsolete.
4. Paste the security key in the box. Verify that Crypto mode is set to : **256-bit AES-CTR with HMAC-SHA-512 (Suite B)**



5. Press set. Note: the process might take a few moments.

Configuring the WR Encryption Key (MPU3)

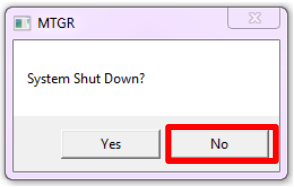
This process is essentially identical to the one done with the MTGR. The only difference is that the computer needs to be connected to the MPU3 by using the ROCU Technician Cable (and follow the same instructions):

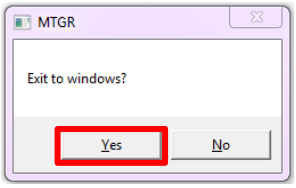
Figure 22 - MPU3 Technician cable

Testing the ROCU-7 Buttons

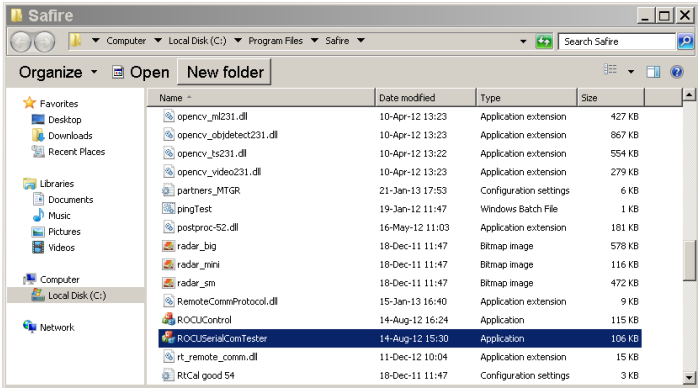
- This test should be performed when experiencing problems and difficulties operating the MTGR. A good indication for buttons malfunction will be the ability to operate the MTGR normally through the Virtual Joystick and not via the ROCU-7 hard buttons.

1. Exit the MTGR application by pressing the ON/OFF button, and choosing the option to exit to Windows:

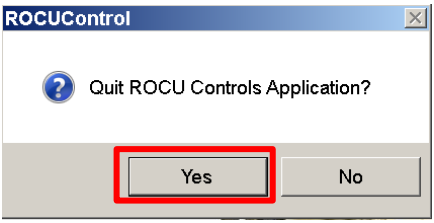




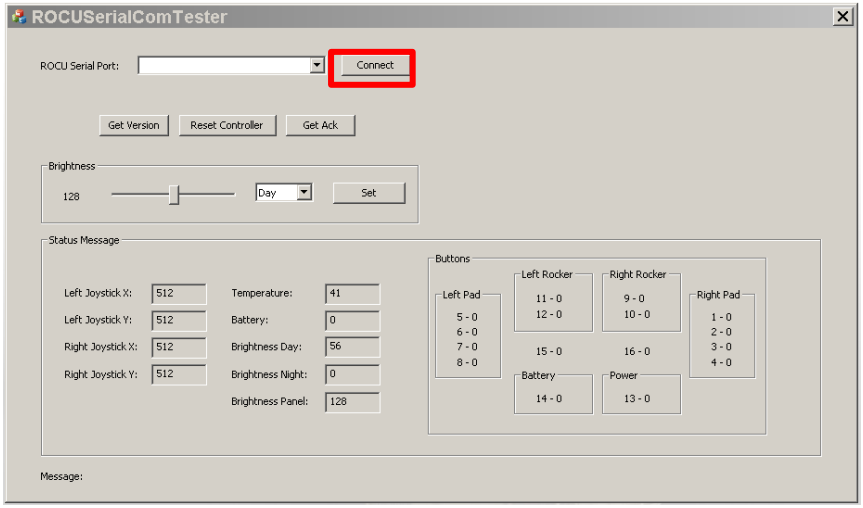
2. ROCUSerialComTester shortcut is on the desktop. If not, right click (hard button no.1) on the MTGR application icon and select "open file location".
3. In the folder opened, activate "ROCUSerialComTester"



4. Press ROCU-7 button no.4. A pop-up window will appear behind the Windows Explorer window. Make sure to press "Yes" when asked to quit ROCU Control Application:



5. Return to ROCUSerialComTester screen. Press "connect". Activate each button in turn and verify activation (1) and di-activation (0), according to the following scheme:



6. Controls are now disabled. In order to re-activate buttons, press the ROCUControl shortcut on the desktop (or reset the ROCU-7).

MTGR FW Upgrade Procedure

1. This document describes FW upgrade procedure for the following devices:

1.1. SOM Carrier – J7

1.2. SOM Carrier IMU – J8

1.3. Motherboard CPU

1.4. Tilt

1.5. BLDC Drivers

1.6. Manipulator

2. Requirements:

2.1. Wave Relay Transmitter.

2.2. PC/ROCU-7.

2.3. MTGR PINGER Application (v1.3 or higher).

2.4. Upgrade Files.

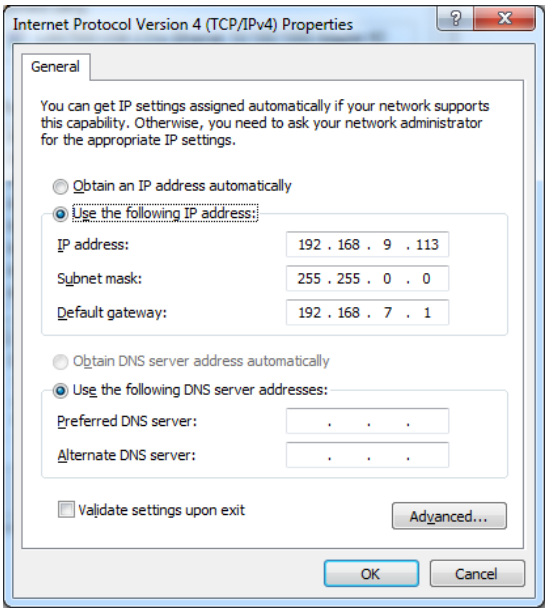
2.4.1. 'update.zip' – Contains FW versions for any combination of the devices listed in 1.

2.4.2. 'update.zip.sig' – Unique signature for security purposes. This file should be stored in the same directory of 'update.zip' file.

3. FW upgrade is possible only if bootloader on a specific device is pre-burned.

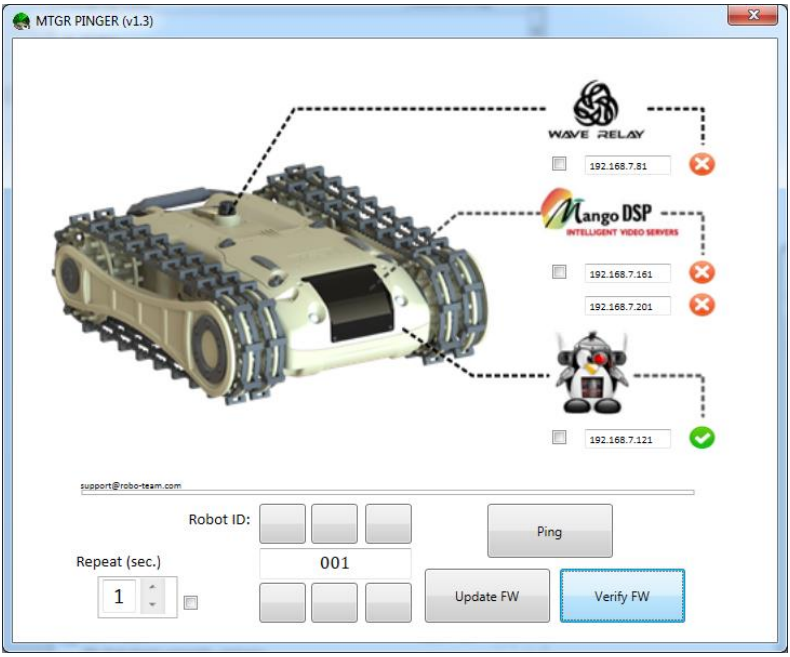
4. Connect Wave Relay transmitter to a PC or ROCU-7.

5. Make sure that the PC/ROCU-7 network setting set in the MTGRs domain, for example:

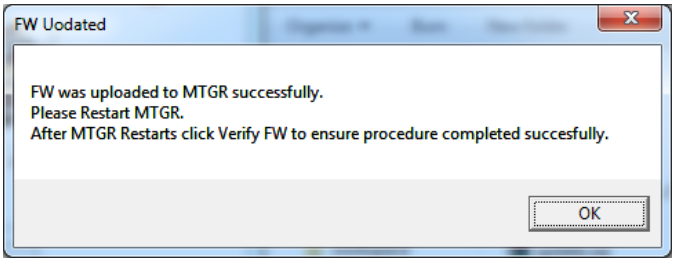


6. Power up the MTGR and the Wave Relay. The connection between them could take up to 2 minutes.

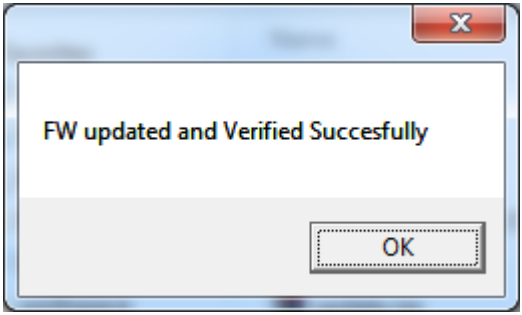
7. Open the latest MTGR PINGER.



8. Select the MTGR ID in the text box.
9. Press Ping button and make sure that at least SOM is online (the penguin icon).
10. Press "Update FW" button and select 'update.zip' file of the requested FW version. Make sure that both: 'update.zip' and 'update.zip.sig' files are stored in a same folder.
11. Wait for the following pop-up window:

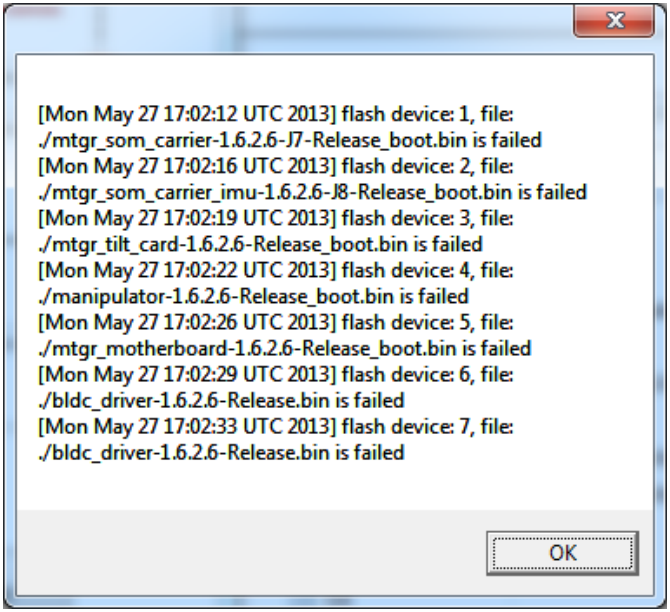


12. Restart the MTGR and wait about 3 minutes.
13. Press on "verify FW" button to receive upgrade log. If the upgrade is finished successfully, the following message will appear:



Otherwise the following message will appear (depends on how many operations failed):

- Note: some devices don't exist in a system, for example: if manipulator isn't connected to the MTGR, upgrading manipulator FW will fail, the user should ignore this error.



14. If the FW upgrade failed, it is recommended to start from step 8 again.

15. The MTGR is ready for operation.

Appendix List

- **Note**: Appendixes are available at specific and authorized labs only.

Appendix	Sub-Assembly	Name
A	MTGR-0000-00	FINAL ASSEMBLY
B	MTGR-3100-00	DRIVE WHEEL ASSEMBLY
C	MTGR-3300-00	ARM WHEEL ASSEMBLY
D	MTGR-4000-00	SIDE AND BACK CAMERA REPLACEMENT
E	MTGR-5000-00	ARM ASSEMBLY
F	MTGR-6000-00	FRONT TILT BRACKET REPLACEMENT
G	MTGR-7100-00	MOTHER BOARD REPLACEMENT

Contact

The Roboteam Support Team is always available to assist with any matter or question.

7979 Old Georgetown Rd, Suite 900

Bethesda, MD 20814

Email: support@robo-team.com

Website: www.robo-team.com

ROBOTEAM

Operation Log

Robot ID: _____

ROCU-7 ID: _____

Operator	Operation type	Operation time	Comments	Total operation time

DOMINATE THE UNKNOWN