



CRX/VIPER 4+ ROS - RS1

RAVEN EUROPE KIT INSTALLATION

MTZ - BELARUS

016-5035-065EN REV. A

Installation manual

(English) (Original)

RAVEN

PREFACE

This installation manual is intended for persons responsible for installing a CRx\Viper 4+ ROS kit. The manual contains important instructions that should be complied with when commissioning, operating and servicing the CRx\Viper 4+ ROS kit.

This manual has been compiled with the utmost care. Raven Europe assumes no responsibility for any errors or omissions in this document.

Any comments or questions can be sent to service-eu@ravenind.com.

Raven Europe or any of its suppliers will accept no liability for physical or material damage caused whilst using the CRx\Viper 4+ ROS.

The installed Raven system produces less than 70dB (A) noise.

This installation guide uses a number of concepts for extra attention to a few things:

**Hint!:**

Provides recommendations on how certain activities can be performed much easier.

**Please note!:**

Indicates certain problems that the user should take note of.

**Caution!:**

Indicates that the machine can be damaged.

**Warning!:**

Indicates a risk of injury.

DISCLAIMER

WARNING!

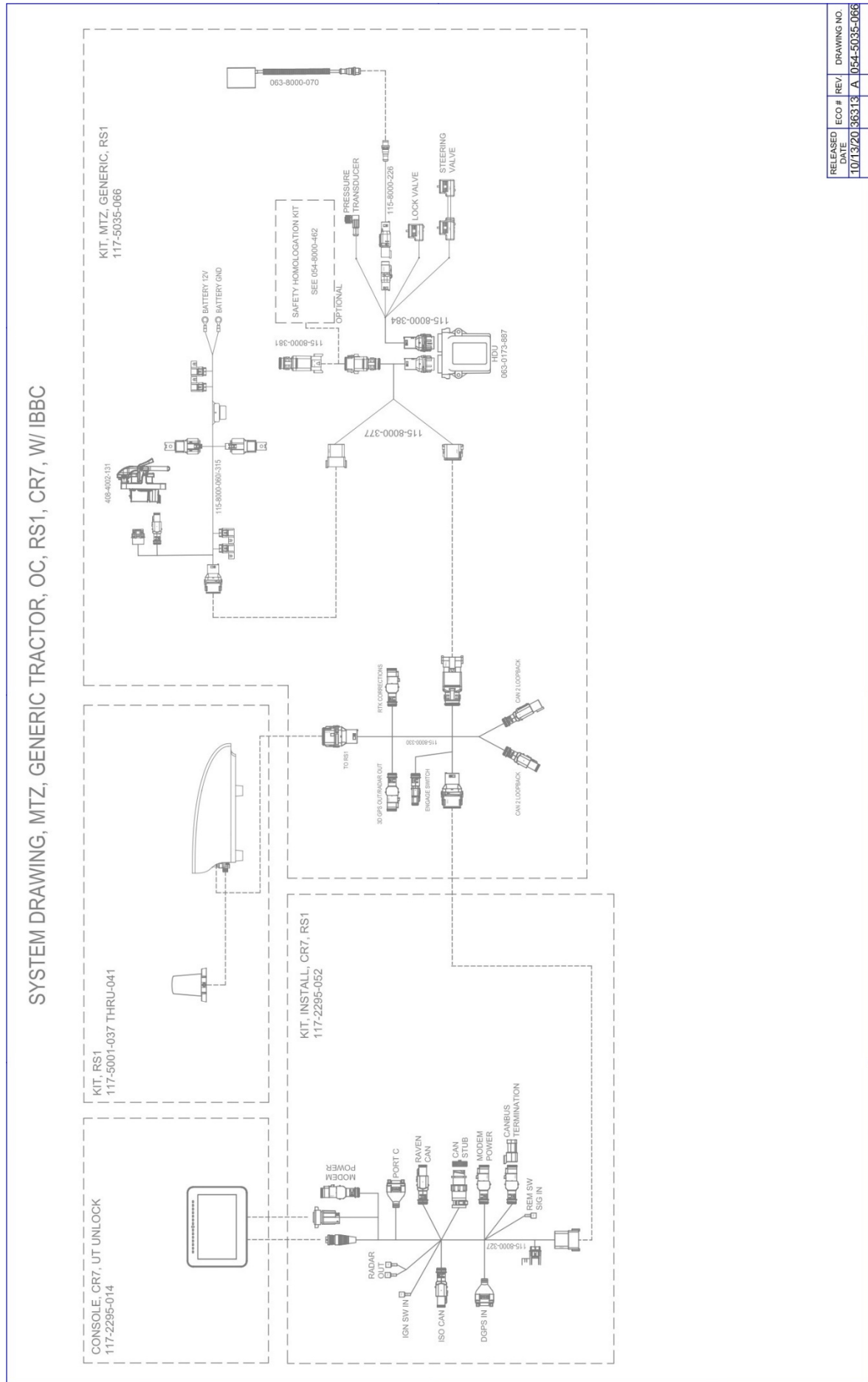
- The safety instructions contained in the manuals of the tractor or implements must be complied with at all times.
- Always switch off the tractor before installing or repairing hydraulic and electrical components of Raven system.
- It is strictly prohibited to use the CRX\Viper 4+ ROS systems on public roads.
- It is strictly prohibited to leave a driving vehicle unattended when the CRX\Viper 4+ ROS system is switched on. The driver is always responsible for the direction and course of the vehicle.
- To prevent injury or fire, replace defective fuses only with fuses of the same type and amperage.
- Raven the operating system is not able to detect and avoid obstacles. If there is an obstacle in your path, you will always need to take action for it to be avoided.
- Only allow authorized/qualified persons to operate the system. Authorized/qualified persons are defined as: persons who have read and understood the manual, have been given instructions by a product specialist, and who are both physically and mentally fit and able to operate the system.
- The system contains moving parts! Make sure the immediate environment is clear of people before operating the system.
- In case of system failure or breakdown switch of the tractor and disconnect the electrical power source to avoid further damage. Contact your dealer for further instructions on how to repair your system.
- Always wear personal protective equipment when operating/adjusting/repairing the system outside of the tractor cab.
- In order to prevent power surges from occurring, always start the machine first, before initiating Raven control system.

PAY ATTENTION!

- Only touch the touch-screen with your finger or by using a special touch-screen stylus/pen. Operating the touch-screen with sharp objects may cause permanent damage to the screen.
- Always consult your supplier as to which products are best suited first before cleaning the touch-screen with chemicals or alcohol.
- If the terminal is not used for a long period, better remove the terminal from the tractor and store in a heated environment. This will extend the life span of the electronic components.
- To prevent theft, it is better to not let the terminal and GPS-antenna unattended in the tractor on the field.

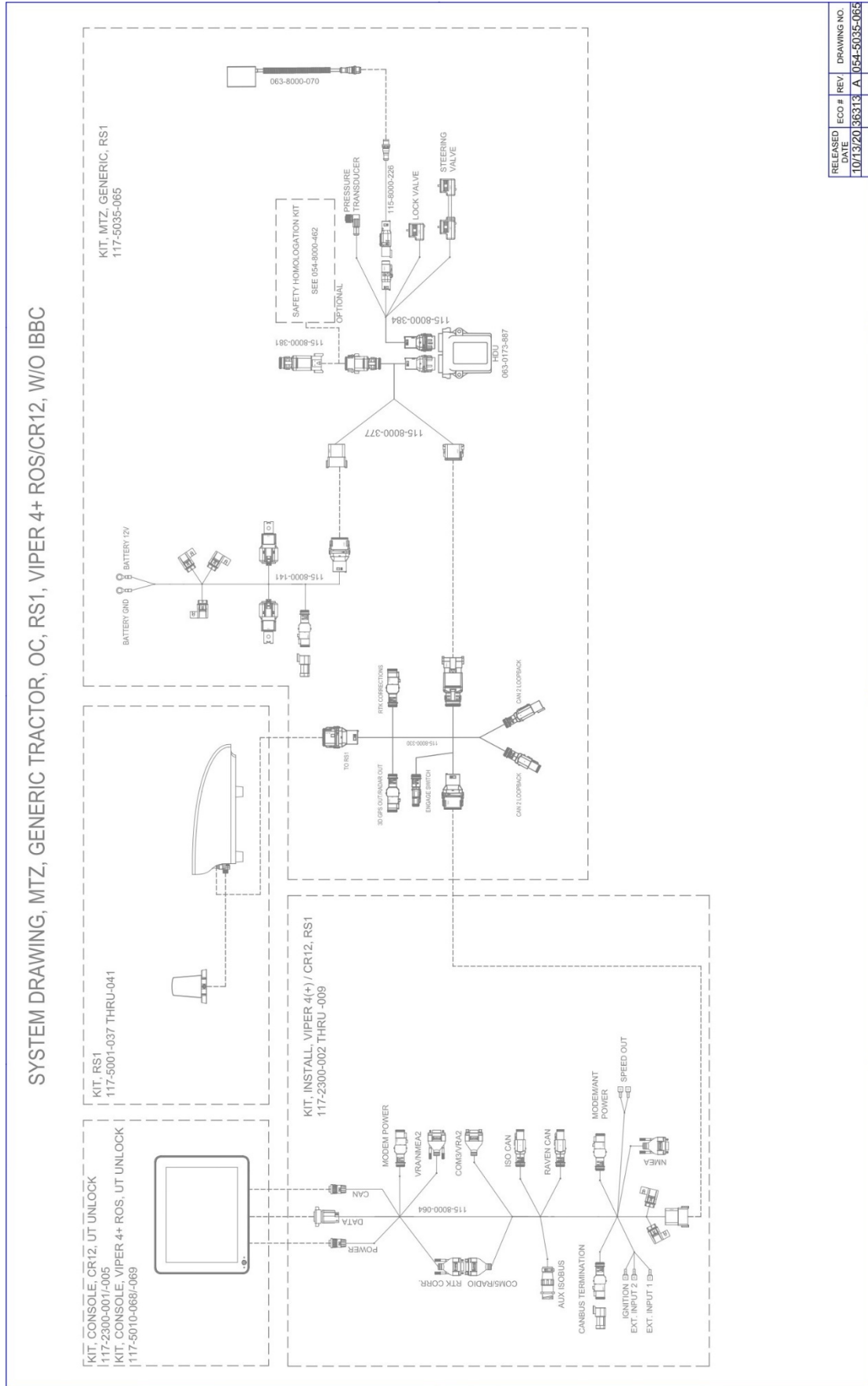
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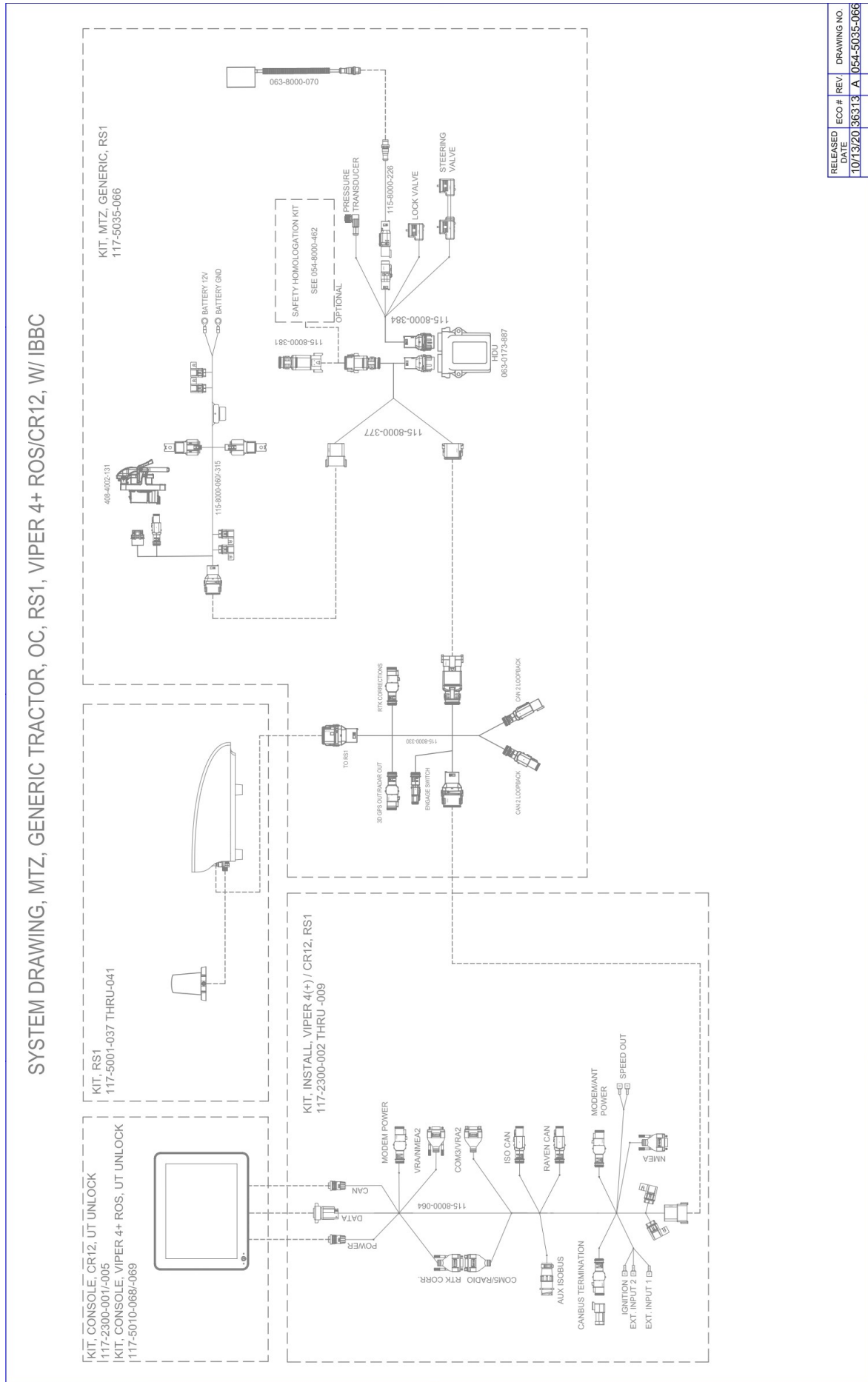
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SYSTEM DRAWINGS, MTZ TRACTOR, RS1, CR12 / VIPER 4+ ROS





1 STEERING SYSTEM INSTALLATION

This chapter describes the installation of all the different steering systems, hydraulic and SmarTrax MD. Look carefully at the system overviews to know which parts of the installation are applicable.

1.1 MOUNTING HARNESES

When installing an autosteer system, the power cables should always be connected to the battery. Two options are possible, a Basic Harness (1-115-8000-141) or an Implement Ready Harness (1-115-8000-060 frontmount or 1-115-8000-315 midmount). The difference between these harnesses is the IBBC connector, this one is included at an Implement Ready (IR) Harness (Figure 1).



FIGURE 1. IBBC CONNECTOR

Power harness: an Implement Ready power harness is mounted from the battery to the rear of the tractor. A Basic power harness is mounted from the battery to the chassis harness. Make sure that the relays and fuses are mounted in a dry, clean and accessible spot (Figure 2).

The harness that is connected to the Power Harness depends on the steering type that will be installed. For system overviews, see pages 6 - 13. All the harnesses with a hard casing should be mounted outside the cabin, all the harnesses with a braided sleeve should be mounted inside the cabin. At all time, find a good location where the cabling can enter the cabin.

In addition, several guidelines have been established for the assembly of all types of cable harnesses:

- Mount the relays fixed and in a dry, clean and accessible spot (Figure 2).
- The red wire is + (12V). The black wire is minus (ground). Make sure that the first part of the red wire (part in between battery and fuses) cannot damage during operation.

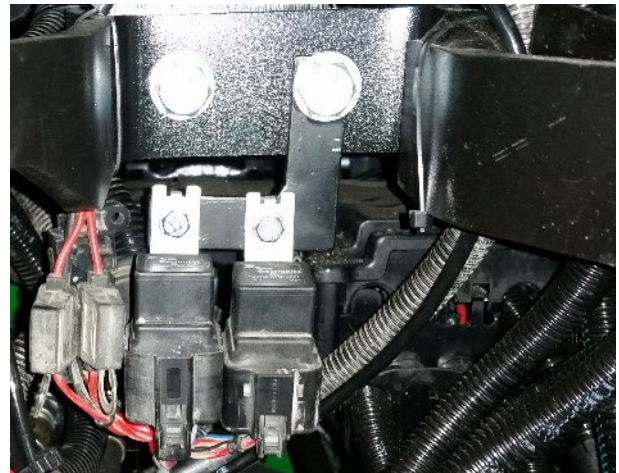


FIGURE 2. CORRECT MOUNTED RELAYS AND FUSES

- If necessary the positive and negative wires, in between the battery and the fuses, can be shortened. Be sure to use cable sockets with the correct size for proper connection.
- If a ground switch is used in the tractor, connect the wiring harness behind the ground switch (not at the battery side of the ground switch!).
- If a main (12V) switch is used in the tractor, the red wire connect the wiring harness behind the main switch (not at the battery side of the main switch!).
- If no main switch is used, always connect the wiring harness directly to the battery.
- If the system is connected to a 24 Volt machine, always use a 24V to 12V converter. Never connect between the two batteries of a 24V machine!
- Lead the terminal harness along with the GPS and radio/GSM antenna cables through one pillar of the cab.
- Tie-wrap the harnesses so they are attached free from vibration and friction.

**Caution!**

It is important to ensure that the wiring harness is always connected to the battery AFTER installing all wires and controllers!

1.2 HYDRAULICS

In this chapter a short overview of the hydraulic system that needs to be installed on a tractor will be given.

1.2.1 PRESSURE RELIEF VALVE

A pressure relief valve is mounted to the add-on part of the open center manifold (Figure 3). This pressure relief valve must be set to the maximum allowable control pressure of the steering system. The default setting of the pressure relief valve is about 180 bar. Determine the maximum pressure of the steering system before mounting the manifold. Follow the next steps:

- Mount a pressure gauge, by making use of a t-piece in the pressure line between the hydraulic pump and the steering orbitrol.
- Steer the front wheels to one side and keep steering until the maximum pressure is reached.
- Read out the value on the pressure gauge.

After mounting the manifold. Set the maximum pressure of the pressure relief valve, equal to the maximum pressure of the steering system. Follow the next steps:

- Mount a pressure gauge, by making use of a t-piece in the pressure line between the hydraulic pump and the manifold.
- Loosen the locking nut of the pressure relief valve.
- Loosen the pressure relief valve two turns counter clockwise.
- Steer the front wheels to one side, using the Left/Right buttons of the CRx/Viper4+ ROS. Keep steering until the maximum pressure is reached.
- Read out the value on the pressure gauge.
- Adjust the pressure relief valve until the pressure is equal to the pressure it was before mounting the manifold.
- Secure the pressure relief valve with the locking nut.

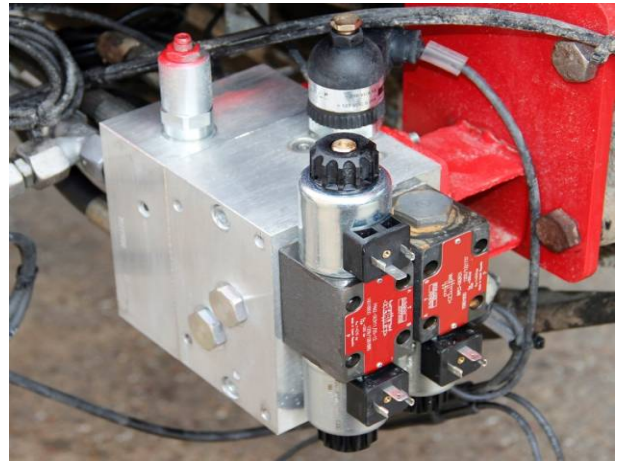


FIGURE 3 OPEN CENTER MANIFOLD

1.2.2 HYDRAULIC VALVE INSTALLATION

Figure 4 shows the manifold mounted onto a manifold bracket with four M8 bolts. The manifold bracket is preferably mounted at the left-hand side of the MTZ tractor (Figure 7) because this is usually the side of the tractor with the most space.

Method of mounting:

- Unscrew toolbox (Figure 5).
- Mount the Manifold Bracket (107-8000-062) to the tractor frame on a holes showed on a Figure 6.
- Install the Manifold valve to the bracket (107-8000-062).
- Mount toolbox back (Figure 7).

Please note!:

Make sure the connectors of the valves and the pressure sensor can still be connected after mounting the manifold.

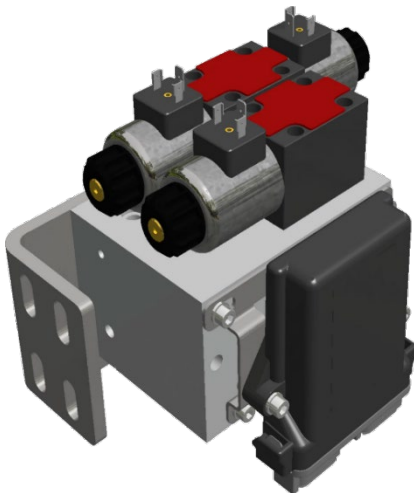


FIGURE 4 MANIFOLD BRACKET WITH A MANIFOLD AND HURAILIC DRIVE UNIT MOUNTED

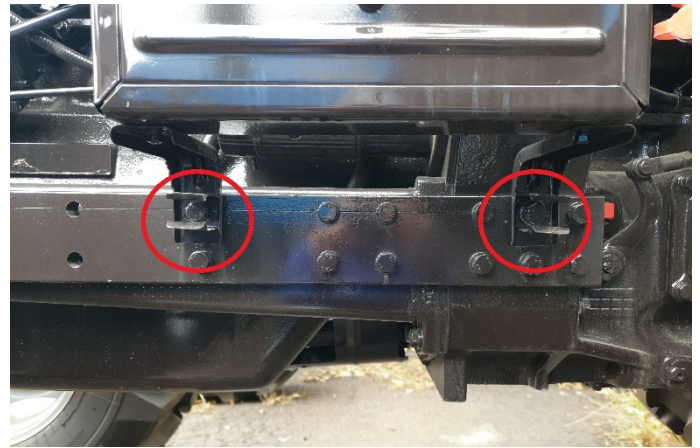


FIGURE 5 TOOLBOX

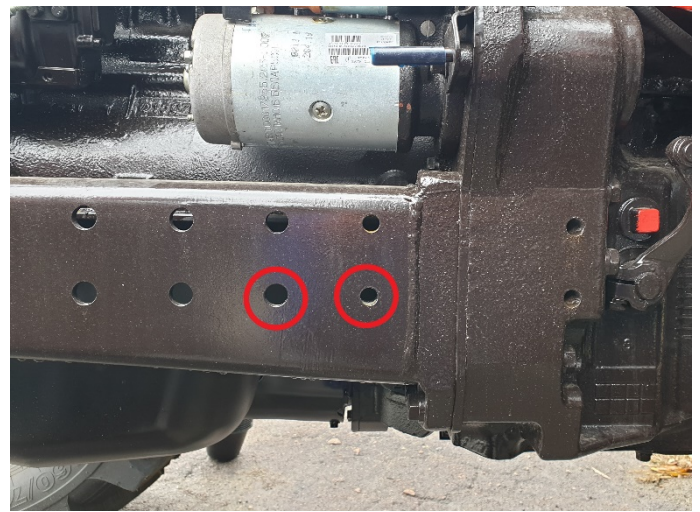


FIGURE 6 TRACTOR FRAME HOLSES FOR THE MANIFOLD BRACKET MOUNT



FIGURE 7 MANIFOLD BRACKET WITH A MANIFOLD AND HURAILIC DRIVE UNIT MOUNTED ON MTZ

1.2.3 HYDRAULIC INSTALLATION OPEN CENTER

The manifold v3 open center consists of the standard load sense manifold v3 (p/n 334-8000-008) with an add-on open center part (p/n 334-8000-012) (Figure 8).

MANIFOLD VALVE PARTS CONNECTION

Put 7 o-rings in grooves on manifold with p/n 334-8000-008, install the second part of the valve body with p/n 334-8000-012 on top of the first part and screw them on 4 bolts like showed on a Figure 8.

Before mounting the manifold v3 valve on the machine, install the proper fittings in the valve. This prepares the valve for installation and simplifies the hose connection process later in the procedure (Figure 9).

HOSES LIST

In tablet 1 is a list of the hose for connecting to the manifold v3 valve and MTZ 892 tractor hydraulic steering system.

TABLET 1: HYDRAILIC HOSE

Hole	Item Description
A	Hydraulic Hose-DKOL, M18*1.5 (F) (90°) to -DK, M20*1,5 (F) (90°)-120 cm
B	Hydraulic Hose-DKOL, M18*1.5 (F) (45°) to-DK, M20*1,5 (F) (90°)-120 cm
A1	Hydraulic Hose-DKOL, M18*1.5 (F) (90°) to-DK, M20*1,5 (M)-120 cm
B1	Hydraulic Hose-DKOL, M18*1.5 (F) (45°) to-DK, M20*1,5 (M)-120 cm
P	Hydraulic Hose-DKOL, M18*1.5 (F) (45°) to-DK, M20*1,5 (F) (90°)-120 cm
P1	Hydraulic Hose-DKOL, M18*1.5 (F) (90°) to-DK, M20*1,5 (M)-120 cm
T	Hydraulic Hose-DKOL, M18*1.5 (F) (90°) to-DK, M24*1,5 (M)-120 cm

On the Figure 10 shows the connection diagram for the MTZ 892 hydraulic steering system.

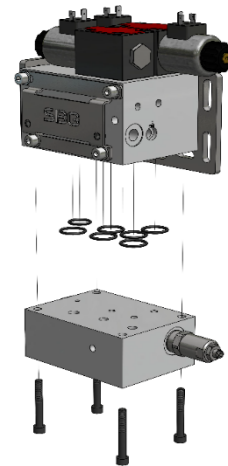


FIGURE 8 ADD-ON PART OF THE OPEN CENTER MANIFOLD

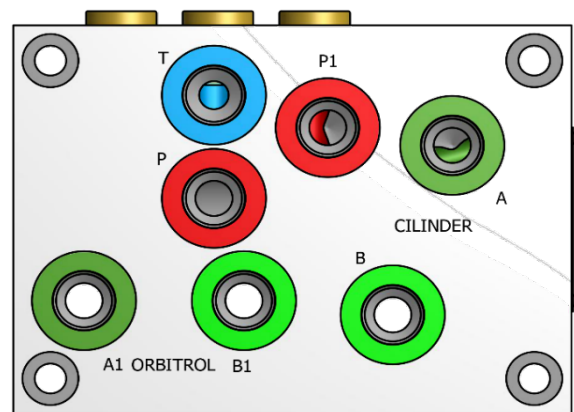


FIGURE 9 MANIFOLD VALVE PORTS

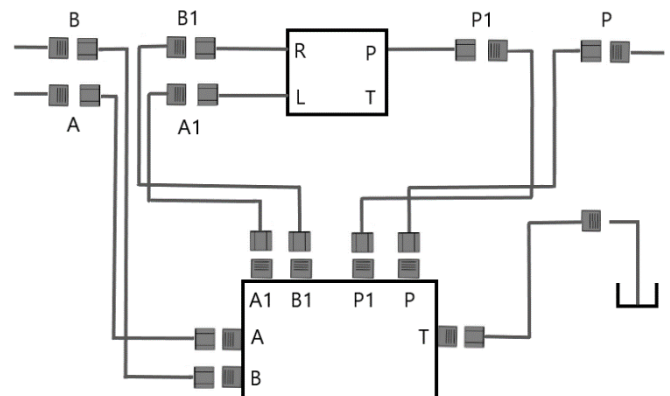


FIGURE 10 CONNECTION DIAGRAM TO THE MTZ 892 HYDRAULIC STEERING SYSTEM

INSTALL THE LEFT, RIGHT AND PRESSURE STEERING HOSES

On Figure 11 showed location the machine's left and right steering hoses on the top of the engine.

- Disconnect the **left** steering hose from the steel line.
- Install steering hose **DKOL, M18*1.5 (F) (90°) to -DK, M20*1,5 (F) (90°)-120 cm** between **A** port on the Manifold valve and left steel line.
- Install steering hose **DKOL, M18*1.5 (F) (90°) to-DK, M20*1,5 (M)-120 cm** between **A1** port on the Manifold valve and left rubber line.
- Disconnect the **right** steering hose from the steel line.
- Install steering hose **DKOL, M18*1.5 (F) (45°) to-DK, M20*1,5 (F) (90°)-120 cm** between **B** port on the Manifold valve and right steel line.
- Install steering hose **DKOL, M18*1.5 (F) (45°) to-DK, M20*1,5 (M)-120 cm** between **B1** port on the Manifold valve and right rubber line.
- Disconnect the pressure steering hose from the steel line.
- Install steering hose **DKOL, M18*1.5 (F) (45°) to-DK, M20*1,5 (F) (90°)-120 cm** between **P** port on the Manifold valve and pressure steel line.
- Install steering hose **DKOL, M18*1.5 (F) (90°) to-DK, M20*1,5 (M)-120 cm** between **P1** port on the Manifold valve and pressure rubber line.



FIGURE 11 LEFT, RIGHT AND PREASURE STEERING HOSES LOCATION



FIGURE 12 LEFT, RIGHT AND PREASURE STEERING HOSES INSTALLED

INSTALL THE TANK HOSE

- Remove the **tank** port plug.
- Install tank hose **DKOL, M18*1.5 (F) (90°) to-DK, M24*1,5 (M)-120 cm** between **T** port on the Manifold valve and the open tank port Figure 13.



FIGURE 13 TANK PORT LOCATIONS

1.2.4 MOUNTING AND CONNECTING THE HYDRAULIC DRIVE UNIT, DIN CONNECTOR AND PRESSURE SENSOR

The Hydraulic Drive Unit bracket can be mounted to the manifold (Figure 14). The Hydraulic Drive Unit can then be fitted to the manifold bracket (Figure 15).

Important notes when mounting the Unit:

- Mount the Hydraulic Drive Unit with connectors directed downwards to prevent the ingress of water.
- Do not mount the Hydraulic Drive Unit too close to parts which have a high temperature (for example, the exhaust system of the tractor).

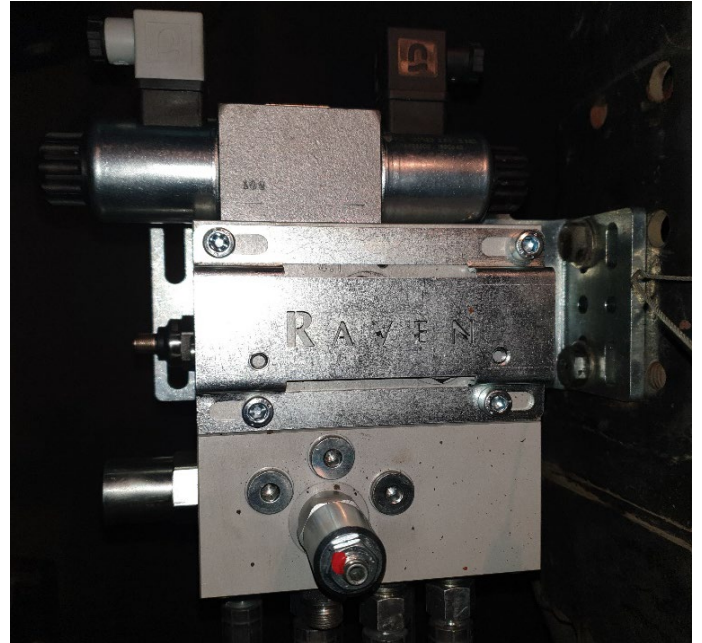


FIGURE 14 THE HYDRAULIC DRIVE UNIT BRACKET MOUNTED TO THE MANIFOLD

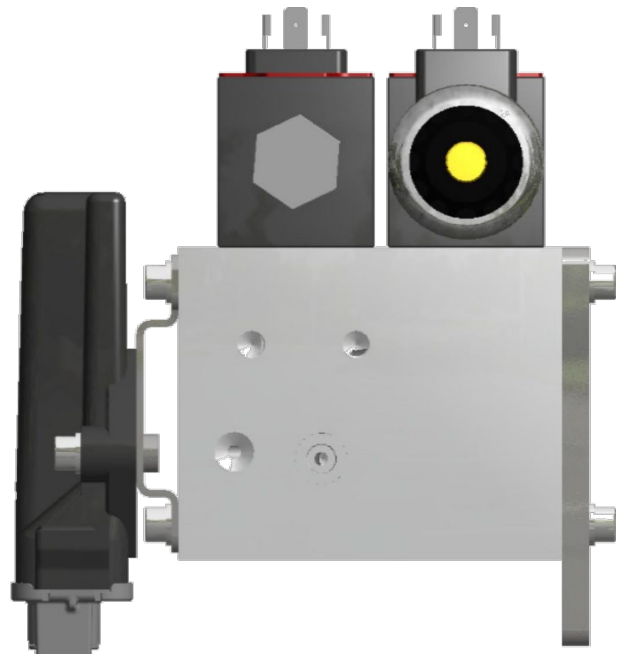


FIGURE 15 SIDE VIEW OF THE HYDRAULIC DRIVE UNIT TO THE MANIFOLD

Connect the DIN connectors marked "Left" and "Right" to the proportional valve. Connect the DIN connector marked "Lock" to the shut-off valve (Figure 16). Connect the 4-pin Phoenix M12 connector to the pressure sensor of the manifold (Figure 17).

i Please note!

The torque of the pressure sensor in the manifold V3 is 30 Nm. It is not necessary to check this at delivery of an assembled manifold. However, make sure, when replacing the pressure sensor, that it is tightened with the correct torque.



FIGURE 16 DIN CONNECTOR CONNECTION

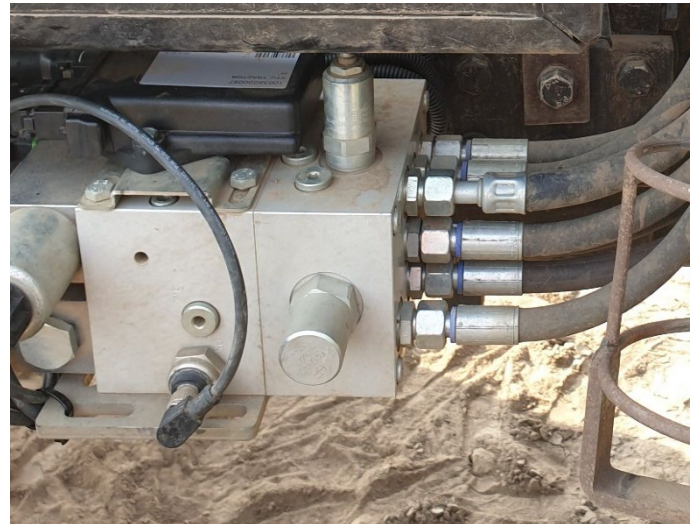


FIGURE 17 CONNECTION TO THE PRESSURE SENSOR

1.2.5 WHEEL ANGLE SENSOR INSTALATION

Axle Type:

On MTZ tractors, 2 types of the axles are most common, with back cylinder and front cylinder (Figure 18, Figure 19).

The most convenient place to install WAS located on Front Left Axle. Turn the machines front wheels to the right to access the left front axle.



FIGURE 18 AXCEL WITH FRONT CYLINDER

TABLET 2: PARTS FOR WAS INSTALLATION

P/N	Description
063-8000-168	WAS ASY, BRCKT, 12V 180°, 35CM, LONG (Figure 20)
117-8000-546	KIT, WAS LINK, M8 300, RAD-RAD
331-9000-022	EXHAUST CLAMP, M8, 38MM
107-0172-715	BRACKET, PLATE, U-BOLT, M8
107-8000-066	Hoeksensor bracket recht



FIGURE 19 AXCEL WITH BACK CYLINDER



Please note!:

At all times the triangles on the sensor housing and sensor disc must be pointing in the same direction!

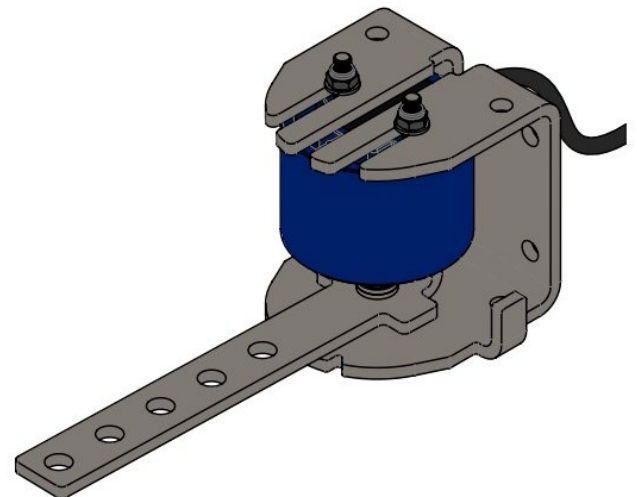


FIGURE 20 WAS ASSEMBLY, BRACKET, 12V 180°, 35CM, M12 CONNECTOR

Plate for WAS mounting:

Pre-prepare the generic flat bracket plate 107-8000-066 with holes for installing the WAS with part number 063-8000-168 on the tractor axle. The plate will be different on 2 types of the axle (Figure 21, Figure 22).

Plate for mounting the wheel angle sensor is installing:

- on front cylinder axle - from the back side of the axle on a holes, showed on Figure 23.
- on back cylinder axle - on the top of the axle on the holes of the cover for adjusting the track gauge showed on Figure 24.



FIGURE 22 WAS MOUNTED ON BACK CYLINDER AXLE



FIGURE 23 PLACE FOR PLATE INSTALLATION-FRONT CYLINDER AXLE



FIGURE 21 WAS MOUNTED ON FRONT CYLINDER AXLE



FIGURE 24 PLACE FOR PLATE INSTALLATION- BACK CYLINDER AXLE

Method of mounting:

- Install the wheel angle sensor to the plate.
- Mount the plate with WAS to the front axle (Figure 21, Figure 22).
- Ball Linear Sensor Mounts Installation, (p/n 117-8000-546):
 - Cut the threaded rod to measure.
 - Install one hex nut, nylock, din985 (p/n 312-6001-001) and one angle joint, m8, radial (p/n 321-8000-001) on each end of the was threaded rod, m8x210 (p/n 311-8000-004) (Figure 25).
- Insert the bolt of the angle joint (p/n 321-8000-001) through the center hole in the WAS rod mounting bracket. Install one hex nut, nylock, din985 (p/n 312-6001-001) on bolt of the angle joint.
- Insert the second bolt of the angle joint (p/n 321-8000-001) through the center hole in the bracket, plate, U-bolt (p/n 107-0172-715) (Figure 26).
- Remove the nuts and clamp from the U-bolt muffler clamp (P/N 311-9000-022) and install the U-bolt around the tie rod with the legs of the U-bolt pointing up.
- Reinstall the clamp on the legs of the U-bolt (Figure 27).
- Insert the legs of the installed U-bolt through the holes in the bracket, plate, U-bolt (P/N 107-0172-715).
- Secure the bracket, plate, U-bolt (P/N 107-0172-715) to the exhaust clamp using two nylon insert lock nuts.
- After mounting check the mechanism by steering fully left and right.

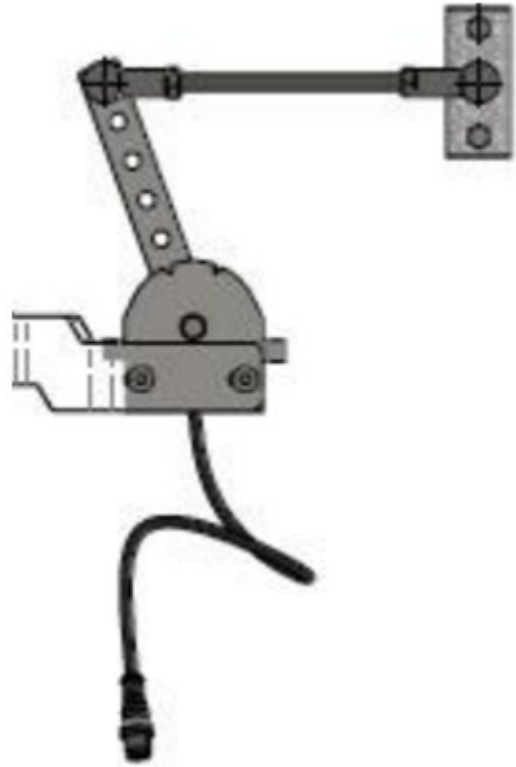


FIGURE 25 SENSOR WITH BRACKETS

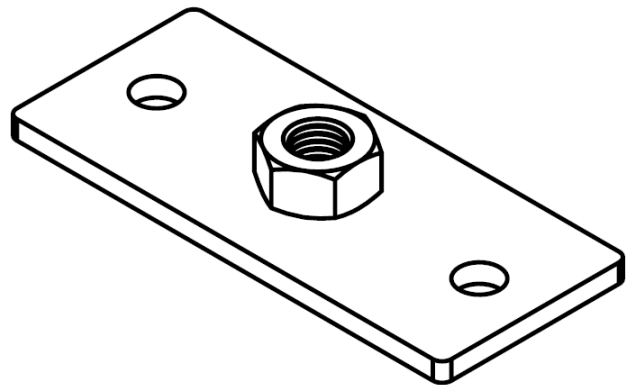


FIGURE 26 BRACKET, PLATE, U-BOLT



FIGURE 27 EXHAUST CLAMP INSTALLED

2 SAFETY HOMOLOGATION KIT INSTALLATION

To comply with the rules of homologation on the European continent installation kits and software have been developed.

The Raven RS1/SC1 system is an approved steering system per the requirements of 2009/66/EC, § 38 StVZO (EU) 2015/208 IV and V incl. all amendments up to (EU) 2015/208. By GTÜ No. GTÜ 2015/208/ V-19002.00.

For using homologation terms, the appropriate kit must be used.

TABLE 3. KIT, SAFETY HOMOLOGATION, CRX, GENERIC.

Part	Description
115-8000-157	HRNS HDU TO MASTER ENGAGE SEAT
115-8000-428	CBL, OPS, W/ HDU, GENERIC
115-8000-411	CABLE 6P TO DT MASTER SWITCH
063-8000-149	MASTER SWITCH AUTO PILOT
013-9000-003	TECH REPORT RS1/SC1 2009/66EC

Connect the 8-pin connector of HARNESS, HDU TO MASTER ENGAGE SWITCH (115-8000-157) to CABLE, CHASSIS, HYDRAULICS, HDU (115-8000-377) (Figure 28).

On the 115-8000-157 cable three connectors are available:

- Engage - push button or foot switch.
- Master switch – Switch on/off high current power to the valve.
- Seat switch – Detects if the driver is on the seat or not.

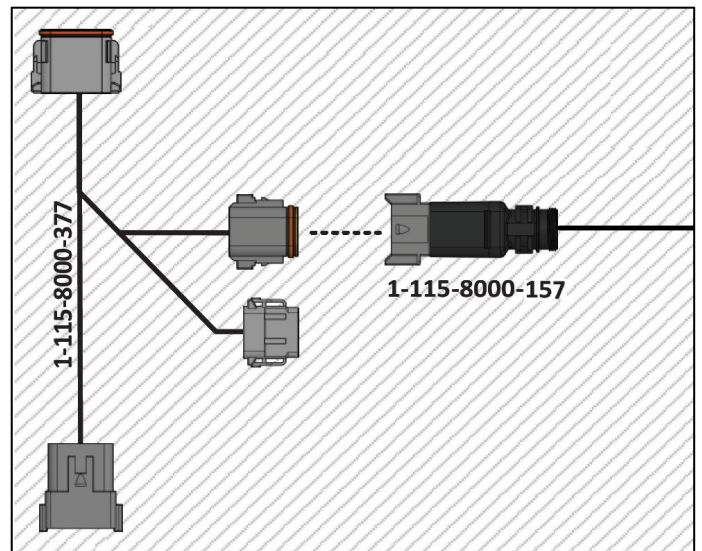
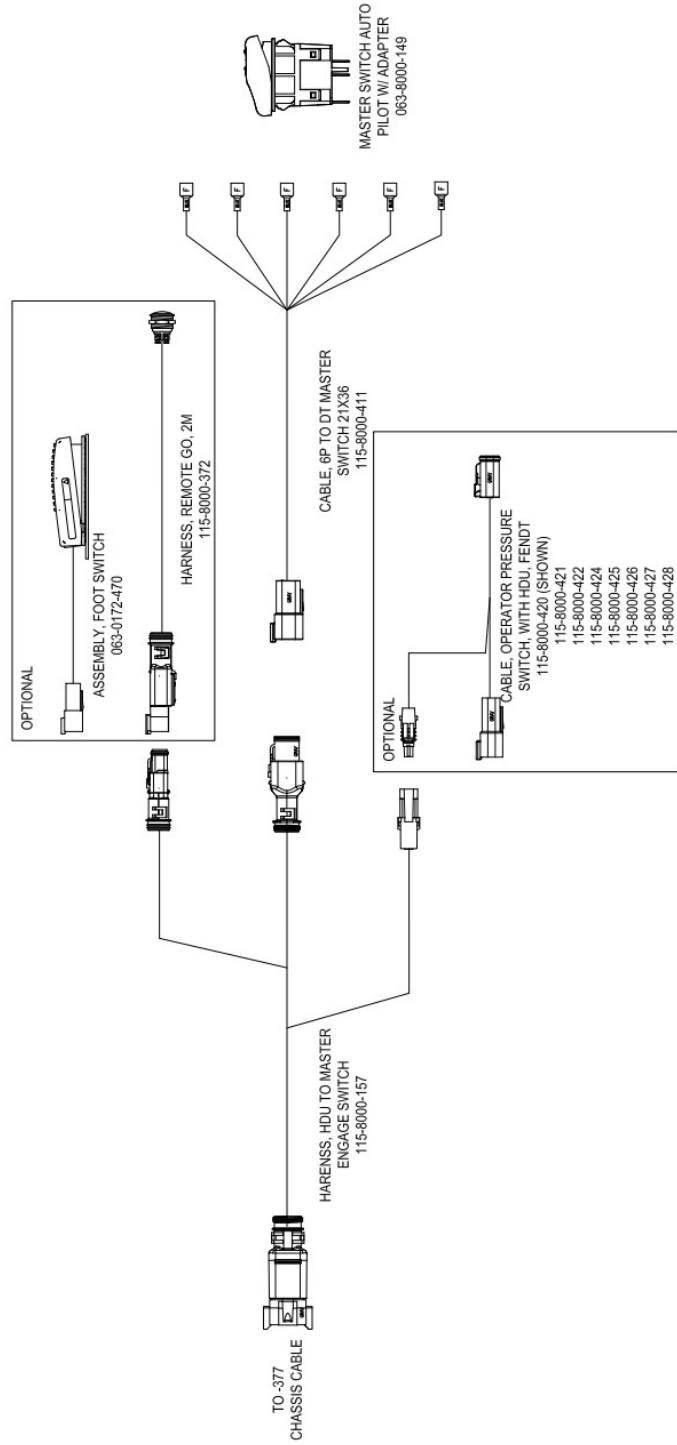


FIGURE 28 CONNECTED 115-8000-157 TO THE 115-8000-377

2.1 SAFETY HOMOLOGATION KIT DRAWINGS

SYSTEM DRAWING, SAFETY HOMOLOGATION, CRX



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	35056	X1	1054-8000-462

2.2 MASTER SWITCH

The master switch can be used to switch high current power off during road transport.

Connect the 6-pin connector of the CABLE, 6P TO DT MASTER SWITCH 21X36 (115-8000-411) to the 115-8000-157 cable.

Install the MASTER SWITCH AUTO PILOT switch (063-8000-149) in the armrest or dashboard in a convenient position for the tractor driver (Figure 29).

Connect the 115-8000-411 cable to the 063-8000-149 master switch.

2.3 ENGAGE

Select a suitable location to install the push button or foot switch.

Note: the push button or foot switch should be installed in a location where the operator has easy access to it and is able to fully press the button or switch.

Using the holes in the foot switch as a template, drill holes in the floor of the cab. Secure the foot switch to the floor by installing the screws in each of the mounting holes.

In the case of a push button, drill a hole in the panel or armrest and mount the push button (Figure 30).

Route the push button or foot switch connector to the engage connector of the 115-8000-157 cable (Figure 31).



FIGURE 29 MASTER SWITCH AUTO PILOT BUTTON



FIGURE 30 PUSH BUTTON MOUNTING



FIGURE 31 RESUME FOOT SWITCH CONNECTION

2.4 SEAT SWITCH

Note: an operator presence switch cable connects the seat switch of the tractor to the HDU. A few seconds after the driver has left the seat, the automatic steering will be deactivated.

Disconnect the connectors from the existing seat switch cable of the tractor (Figure 32). Connect the Raven operator presence cable (for Claas use the 115-8000-428 for example) between the connectors of the existing seat switch (Figure 33). Cables for various types of tractors are available on request.

Connect the 1-pin operator presence switch connector of the 115-8000-428 cable to the 1-pin seat switch connector of the 115-8000-157 cable.



FIGURE 32 EXISTING TRACTOR OPERATOR PRESENC SWITCH CONNECTOR



FIGURE 33 OPERATOR PRESENCE SWITCH T-CABLE (115-8000-428) CONNECTION

3 RS1 INSTALLATION

The RS1 mounting package comes with 2 metal strips with an adhesive: 107-0172-618. Insert the included screws into the metal strips and screw the fixed mount: 107-0182-531 onto the metal strips (Figure 34). Tape the metal brackets as close to center of the roof as possible. Make sure the roof is clean and dry before mounting the strips. This mount stays permanent on the tractor.

On the bottom of the RS1 there are 4 screws located, unscrew them and insert the SIM into the SIM slot. The SIM must be inserted into the J11 slot or the RS1 will not receive any signal (Figure 35).

Mount the Latch Plate: 116-0159-802 onto the RS1 using the provided screws (Figure 36). This latch plate stays connected to RS1.

Connect the RS1 with latch plate to the fixed plate and secure it with the latch. Connect the connector.

The LAIRD antenna is the main receiver of the RS1. The RS1 / LAIRD-antennas should be mounted atleast 50 cm apart (Figure 43).

Furthermore, the following guidelines must be observed when installing the GPS antenna:

- Mount the GPS-antenna with the connectors pointing to the backside.
- Mount the GPS-antenna in front of the rear axle.

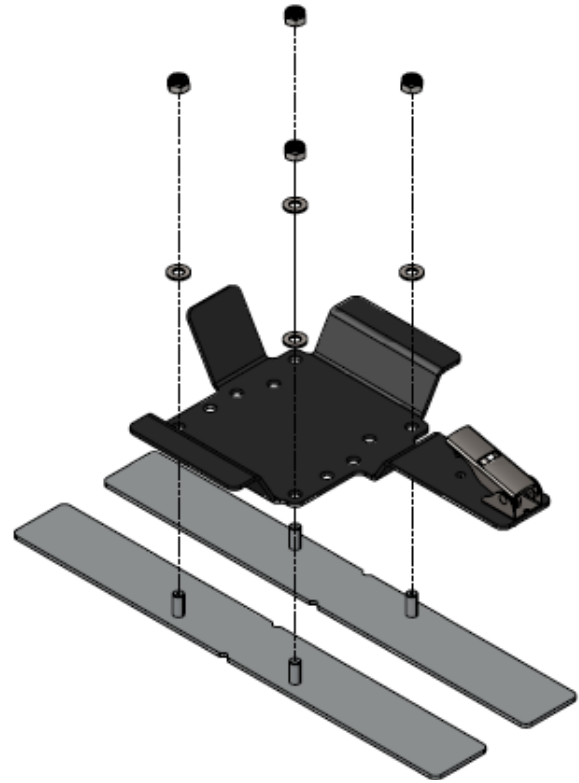


FIGURE 34 BOTTOM ASSEMBLY OF RS1 MOUNT

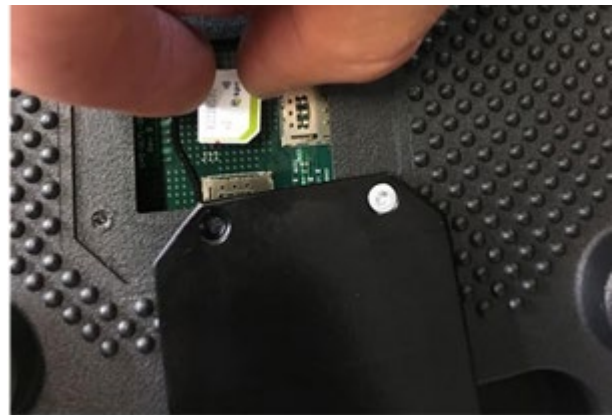


FIGURE 35 INSERT SIM CARD INTO THE J11 SLOT



FIGURE 36 MOUNTING THE RS1 ON THE GENERIC BRACKET

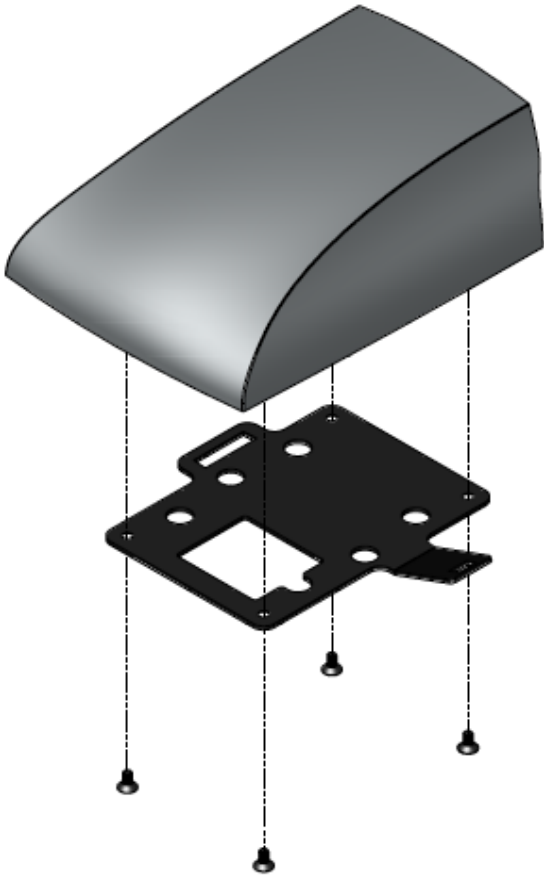


FIGURE 37 TOP ASSEMBLY OF THE RS1



FIGURE 38 RS1 MOUNTED ON TRACTOR

4 CRX/VIPER4+ ROS INSTALLATION

4.1 MOUNTING THE CR7

The following guidelines have been established for mounting the Field Computer (Figure 39):

- Always contact the customer about the terminal position in the cabin.
- Always use a RAM-C ball attachment. (Figure 40, Figure 41)
- Mount the terminal free of vibrations with a solid bracket. A variety of mounting brackets are available for this purpose.
- Secure all cables in the cabin.
- Mount in such a way that the display is directed straight towards the driver.
- Mount in such a way that driver has a clear view all around.

i Hint! *Mount the terminal in such a way that it does not obstruct the view of the driver over the top of the right-hand fender, but also so that the inside of the front wheel on the ground is still clearly visible.*



FIGURE 39 CR7 ON A-PILLAR



FIGURE 40 RAM-C BALL ATTACHEMENT



FIGURE 41 CR7 MOUNTED

4.2 SLINGSHOT INSTALLATION

If a SlingShot modem is used, in addition to the GPS-antenna, two LAIRD antennas and a GPS patch should be mounted.

The LAIRD antennas should be mounted at least 100 cm of each other. If a standard GPS-antenna bracket is mounted, one of the LAIRD-antennas should be mounted on this bracket. The second GPRS / UMTS-antenna should be mounted on a metal bracket on the cabin (Figure 43).

It is important that the following conditions are met at all times:

- The LAIRD antenna is equipped with a magnetic base and must be placed on top of the cabin.
- The antenna should have a clear reception all around.
- Label the antenna cables inside the cabin with labels 'Cellular' and 'Diversity' (Figure 42).
- Mount a grey SMA grip on both connectors.

Connect the power cable to the connector with label "Slingshot PWR" and connect the RTK IN/GPS OUT connectors with each other. Connect the Serial RTK IN with the Slingshot and connect the Ethernet cable between the SlingShot and the CR7.

- Mount in such a way that driver has a clear view all around.



FIGURE 42 ANTENNA CABLES WITH LABELS AND SMA-GRIP SET



FIGURE 43 GPRS/UMTS-ANTENNA AND GPS PATCH ANTENNA ON A METAL BRACKET

4.3 MOUNTING THE CR12/VIPER4+ ROS

The following guidelines have been established for mounting the Field Computer:

- Always contact the customer about the terminal position in the cabin.
- Always use a RAM-C or RAM-B ball attachment. (Figure 44 & Figure 45)
- Mount the terminal free of vibrations with a solid bracket. A variety of mounting brackets are available for this purpose.
- Secure all cables in the cabin.
- Mount in such a way that the display is directed straight towards the driver.



- **Hint!:**

Mount the terminal in such a way that it does not obstruct the view of the driver over the top of the right-hand fender, but also so that the inside of the front wheel on the ground is still clearly visible.



FIGURE 44 CR12 ON A PILLAR



FIGURE 45 RAM B BALL ATTACHMENT ON PILLAR

Nieuwe Steen 5
1625 HV Hoorn
The Netherlands

Phone: +31 227 54 93 00
Web: www.raveneurope.com
Email: service-eu@ravenind.com

R A V E N