TechTip: TMC Telescopic Hex Install

1. Introduction

This post is intended to explain how to install, measure and configure a 3D guidance system on an excavator whose stick is extendable (figure 1). These types of excavators are widely used in Marine environments, and they usually equip a grab connected to the last segment of the telescopic stick.

Figure 1 - Telescopic hex; Top: Stick fully retracted; Bottom: Stick fully extended

2. Hardware

This installation is based in a standard TMC marine hex, whereby a full standard marine kit is required (figure 2).

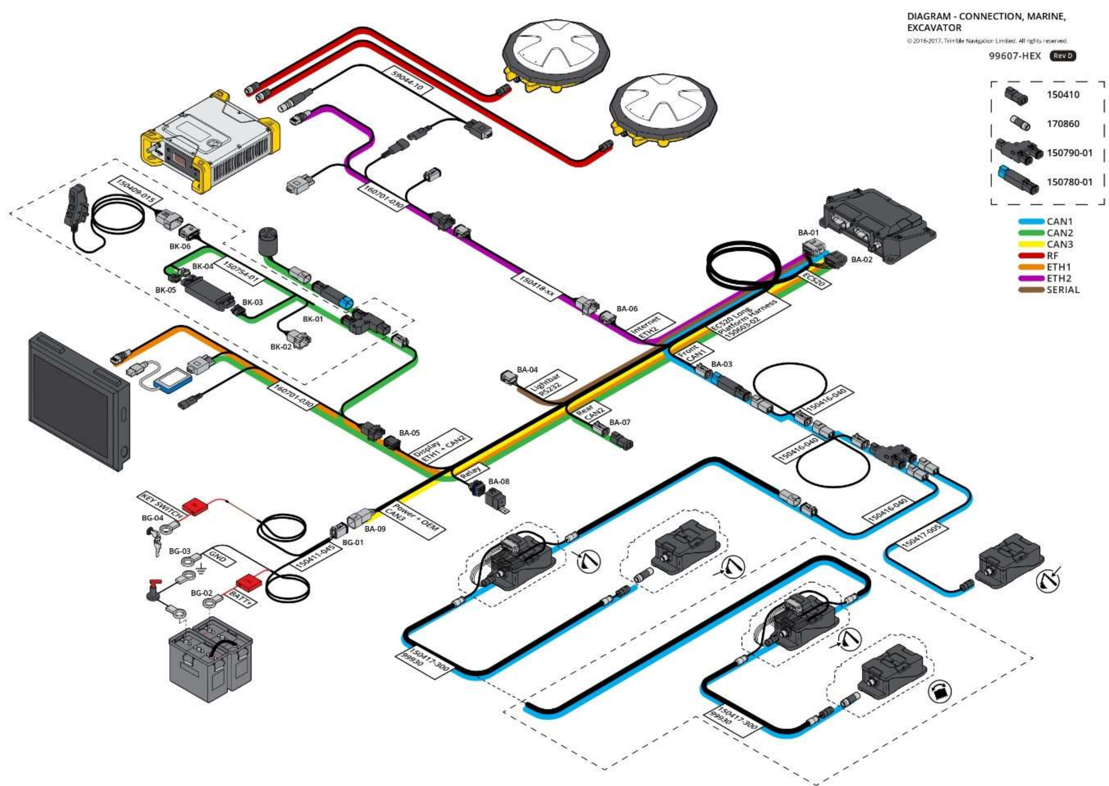


Figure 2 - Standard TMC Marine Excavator Connection Diagram

It also requires an extra sensor to monitor the variable length of the telescopic part. For that purpose, we use a draw-wire multiturn as the one showed on the figure 3.

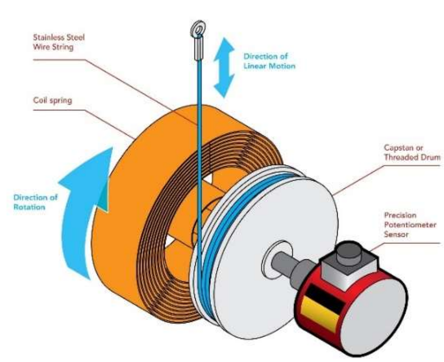


Figure 3 - Draw-Wire Multiturn Sensor Principles

There is limited number of brands supported, so even if they are all CAN open, we advise to stick to the supported ones, which are Posital and Sick. The figure 4 shows the model used for this installation, the [Sick Wire Draw Absolute Encoder] (BTF13-C1QM3049; ID 1068896), which have 30m wire inside and a step of 0.333m per turn (= sensor ratio).

Figure 4 – Sick Wire Draw Absolute Encoder

Note that Sick brand also sells the wire draw mechanism standalone for Posital sensors, which would allow us to reduce the amount of different sensors installed.

3. HW connection

This sensor is attached to the main harness, at the CAN2 (CAN Rear – green line), just nearby the audible alarm, at the free deutsch port we find on this splitter (figure 5, right). Since this CAN line is already terminated, it doesn´t require any extra terminator, however, we will need to adapt a 4pins deutsch male connector at the sensor, following the indicated pinout (figure 5, left), in order to get the Sick sensor connected to the harness.

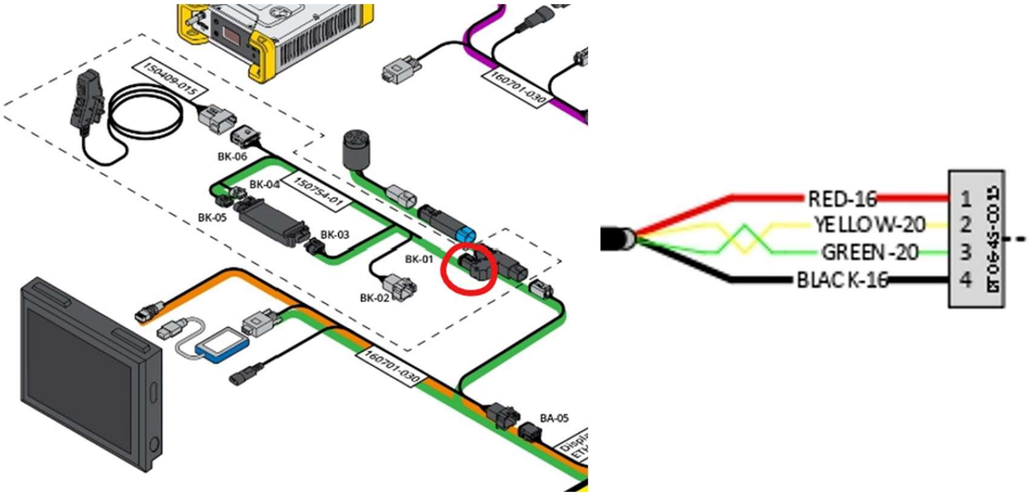


Figure 5 – Right: Sensor connection to the main harness; Left: pinout required for Sick multiturn

4. Sensor initialization – HW preparation

The initialization of the parameters set for the Sick sensor must be applied with no other sensor present on the CAN line. Since we still need to have power on our sensor, we will temporarily remove the CAN Hi (pin 7) and CAN Low (pin 8) pins at the BA-05 connector (figure 6), so this will disconnect any other traffic on the CAN line.

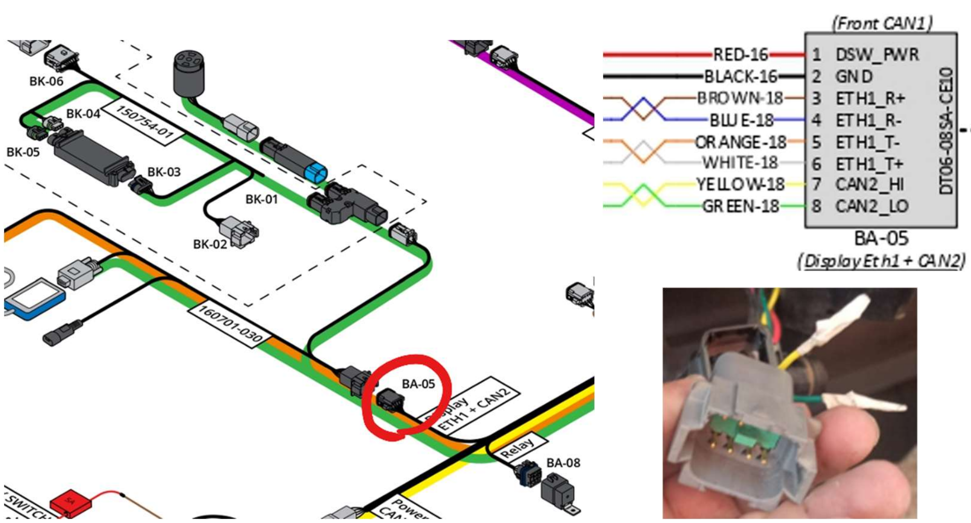


Figure 6 – Initialization of Sick sensor requires pins 7&8 to be removed from the BA-05 connector

5. TMC configuration

The TMC configuration is similar to a standard marine hex, but instead of choosing *backhoe application*, we will select *multipurpose application* (figure 7), what will allow us to get access to any developed driver on TMC.

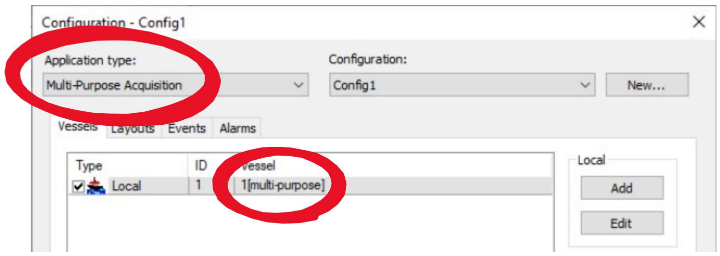


Figure 7 – Multipurpose application configuration

Then, we will set it up as any other standard excavator in terms of offsets, shapes and equipment, just selecting the *Trimble EC520 Telescopic* driver instead of the standard one, and the extra sensor driver for the Sick encoder, which will be available under *Auxiliary dredge sensors, SICK Linear Sensor* (figure 8). The port configured will be the same as for the EC520 sensors. **Note that the telescopic driver is only available if a grab tool is selected.**

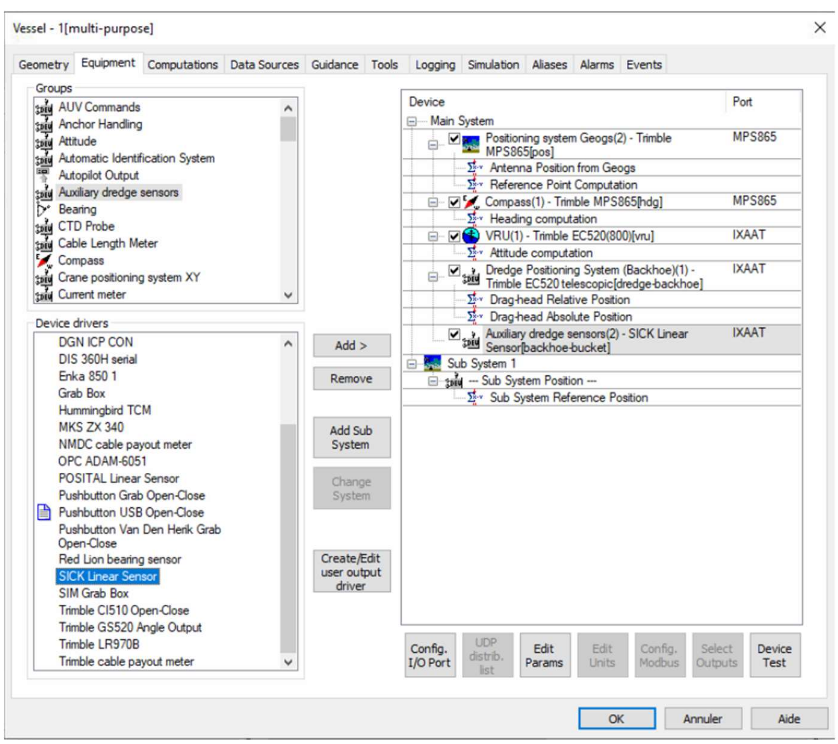


Figure 8 – Equipment list; Auxiliary dredge sensors, SICK Linear Sensor

6. Sensor initialization – SW

Selecting the added driver and pressing on *Device Test*, we will be able to access the window to soft code the settings we must apply to the sensor. Remember that, for making this step, any other sensor must be removed from the harness (section 4).

Then, we select *Window, Tiles* for a better visualization of the needed components.

We must select the sensor we want to initialize (the only one present in the chain) and we will set the node 71 as the current ID, then we will press on *Select Node Id* and we will be required to do a power cycle to the sensor, which means cutting the power for it and reestablish it few seconds later. Then, we will set 250 bauds as bit rate and will hit the button for it, doing a power cycle once again. Last step, we will hit *Init Parameters* button, what will enable the sensor to be properly recognized by TMC. We will be able to see how the data flows on the *Messages – I/O Port* window and a value for the *Wire Length* (figure 9).

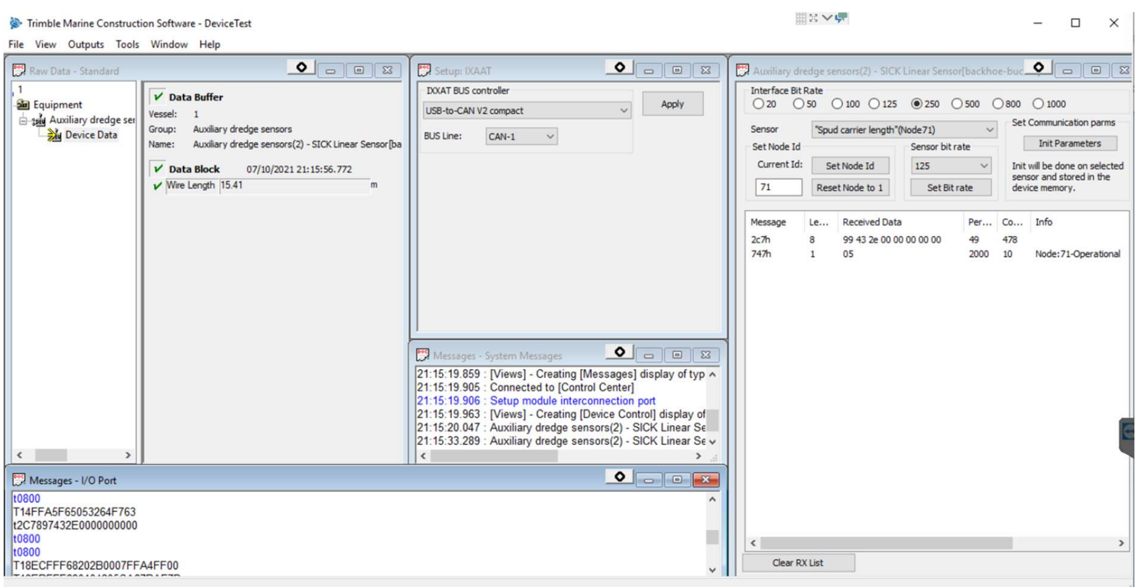


Figure 9 – Device Test menu, sensor initialization

We must then reconnect the previously disconnected pins at section 4. It is recommended to do all this on a bench test before going to the actual installation.

7. EW measure up and calibration

The EW part differs from a normal hex in the fact that there is not a bucket, but we still must connect the complete standard kit to be able to use it, therefore we can fix the bucket GS520 in any safe place along the stick. The measurements and calibrations related to the boom and the stick remain the same as for a standard hex, while the *Dogbone* section can be cheated with dummy values for both, measures and cals (figure 10).

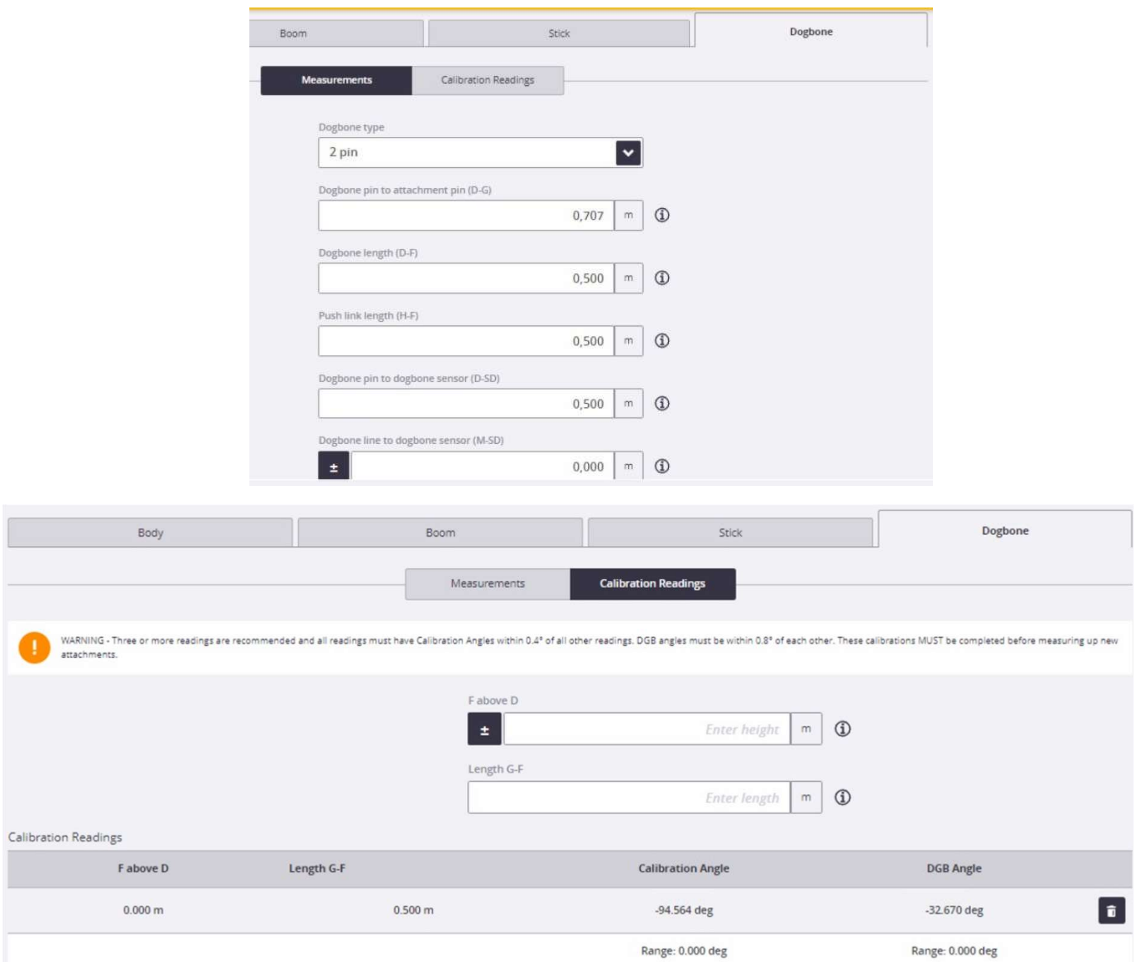
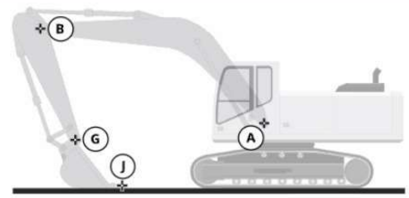


Figure 10 – Dogbone calibration section at the EC520 Tech WebUI

If the measure/calibration process has been successfully completed, we will be able to see the machine readings (figure 11), where we can validate our EW 2D install before going deeper on the telescopic part.

Pin Positions



	Reach [m]	Height [m]	Distance [m]
Boom (A)	0.000	0.000	0.000
Stick (B)	5.002	3.830	6.300
Attachment (G)	5.634	-2.136	6.025
Attachment Tip (J)	5.515	-2.297	5.974

Figure 11 – Machine readings for EW 2D part validation.

8. Draw wire mechanical install

The draw-wire sensor must be installed in a protected place of the fixed part, at the telescopic stick. We can protect this with an extra steel frame around. Then, the wire must be connected to the last segment of the telescopic stick. Ideally, this wire must be protected by a telescopic stick as well, in order to prevent its damage.

Figure 12 – Sensor on the fixed part, wire attached to the last telescopic segment

9. Sketchup drawings

Since the telescopic segments aren't included as standard shapes, these must be drawn in Sketchup, following the axis criteria shown on the figure 13 (main axis of the segment aligned with the green Y axis; starting point at the origin; pulled to the negative side of the Y axis) and already at the right dimensions, since these cannot be scaled afterwards (as any other custom shape on TMC) and then, imported into the *Project Common Files* from the TMC project folder (or the path we have designated for this project). We will need as many as segments on the telescopic stick, usually 3.

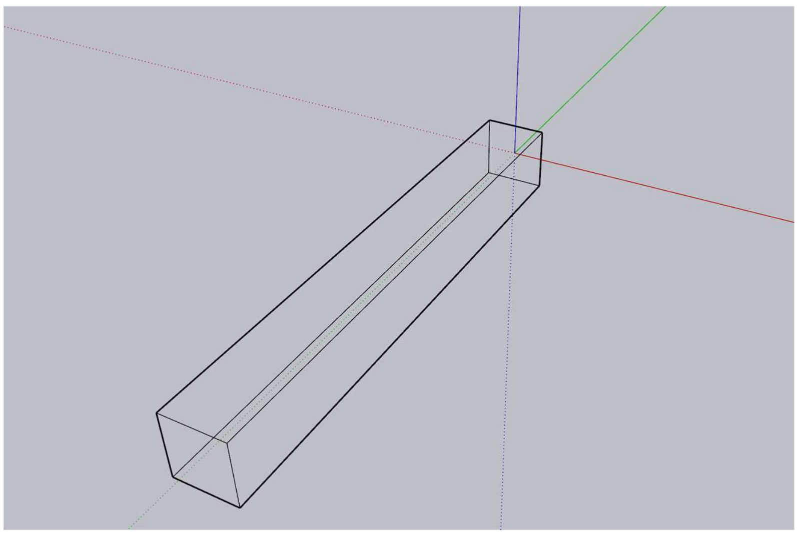


Figure 13 – Sketchup segment axis criteria

10. Measure up and calibration of the telescopic stick

For this step, we position the stick fully vertical, with the aid of a spirit level and we fully retract the telescopic part. This position will be maintained during the whole calibration process. Then, on TMC, we start calibrating the angle of the stick. For doing that, on the acquisition mode, we need to open the *RAW Data View* and check what is the inclination value read by TMC for each segment. This value is indicated in the SW as *Segment Pitch* (figure 14). Each of these inline values represents the inclination of each of the segments of the excavator, being the 2 first given by the EC520 API (EW boom and stick) and the other 3, all with the same value, the inclination computed by TMC for each telescopic segment. Note, that the user may visualize only the desired segments by editing the blank entry box behind, which will indicate how many segments will be hidden, starting by the left side.

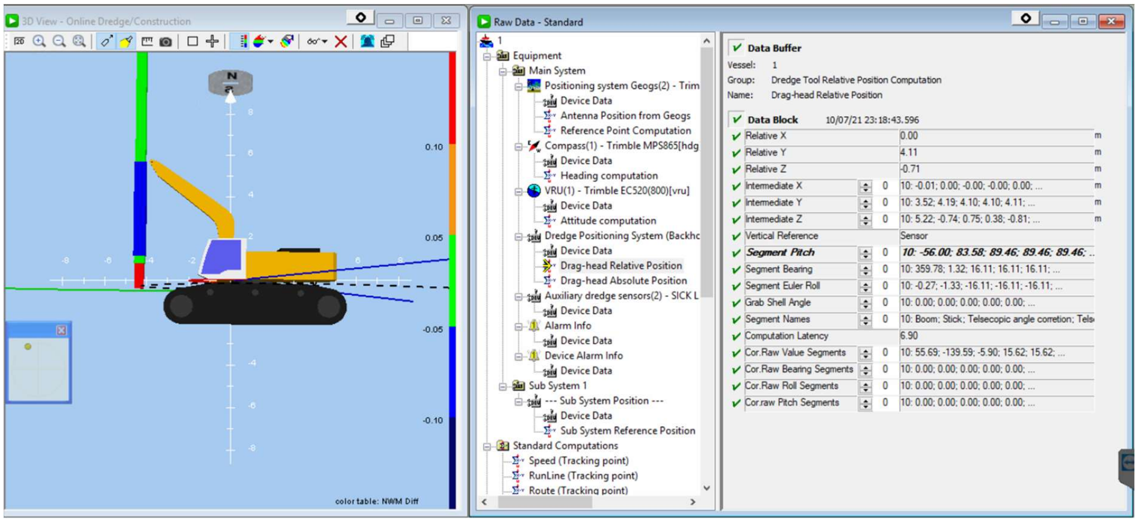


Figure 14 – Segment angles read by TMC

Editing the properties of the *Dredge Positioning System*, we will find a section called *Telescopic Angle Correction* (figure 15), where we may apply offset values to correct this angle to match the reality.

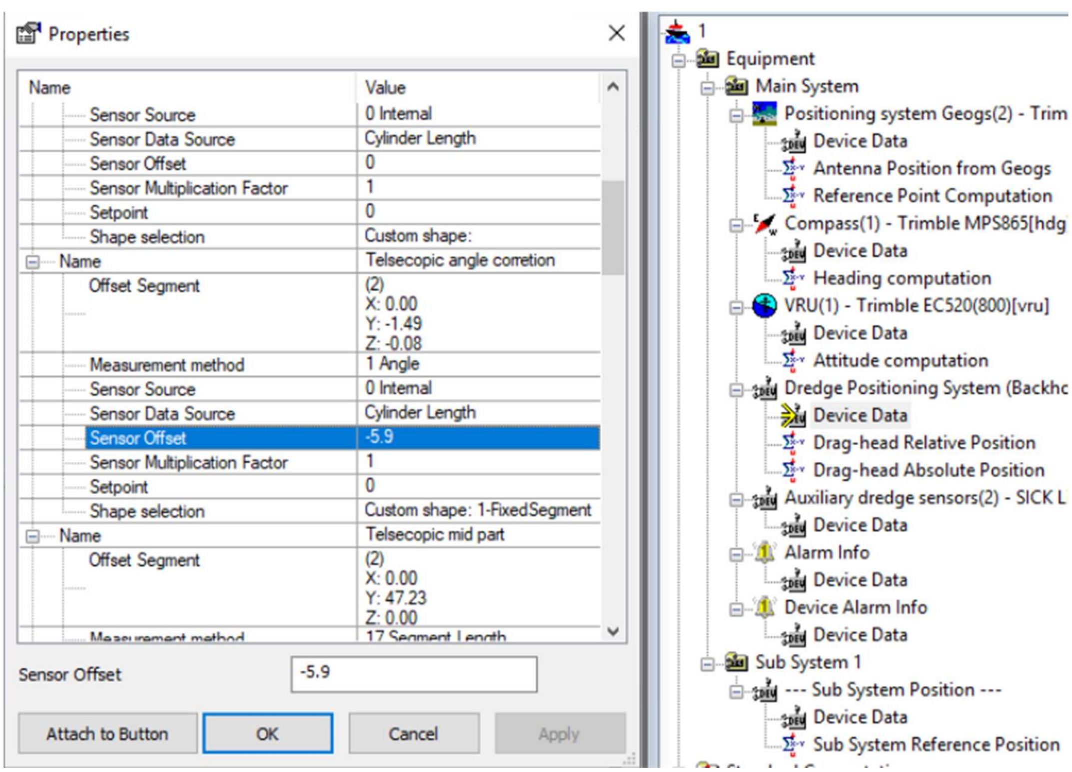


Figure 15 – Telescopic segment angle correction on TMC

Setting a *Sensor Offset,* TMC determines the departure point of the linear sensor. Looking into the *Raw Data* (figure 16; top) we can find how much is this offset and then type it straight onto the *Equipment Config Page* (figure 16; bottom). This will move the segments to a random place on the space, fact that must be corrected applying offsets on a later step.

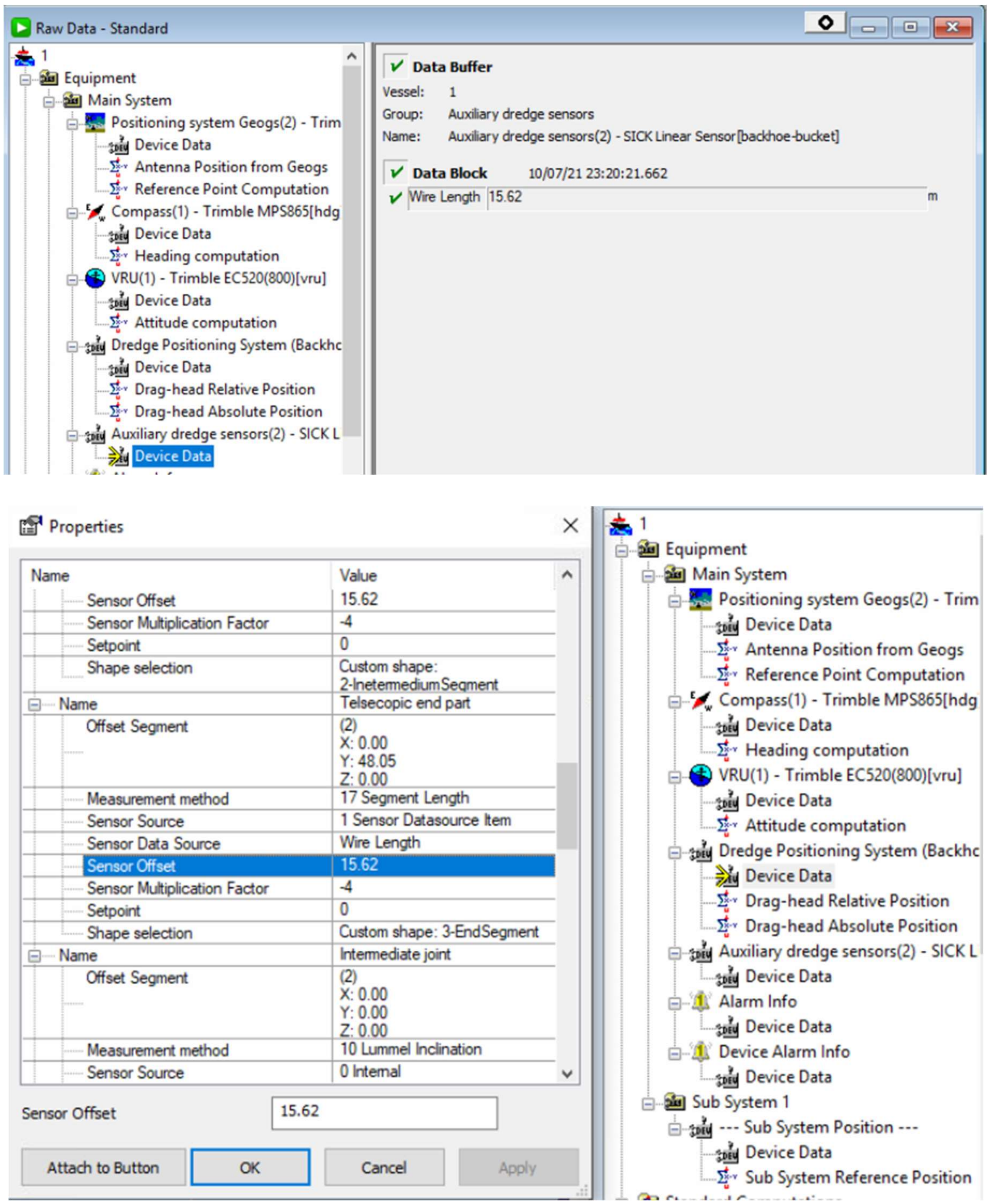


Figure 16 – Sensor departure point set; Top: Raw value; Bottom: Sensor offset adjustment

The *Sensor Multiplication Factor* (figure 17) is equal to the *Sensor* Ratio. This value is specified for this manufacturer as 0.333, although this must be validated per installation. For validating it, the easiest way is to pull 1m cable and check (from the *Helpdesk View*) how many turns were needed for this amount of linear distance. *Distance divided by turns* is the ratio to input.

If we notice that the telescopic part moves in the opposite direction to reality, we must apply a draw wire multiplication factor of -1 to change its direction, as we also do with any other multiturn in marine.

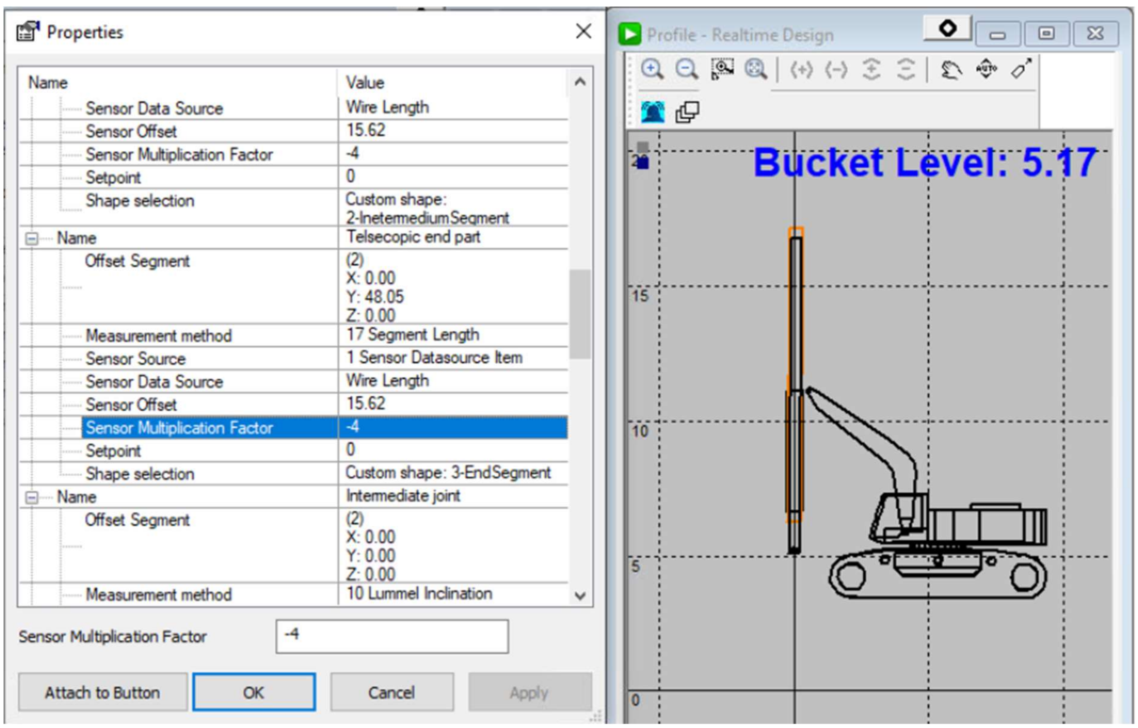


Figure 17 – Multiturn sensor ratio adjustment

Then, we need to measure on the real machine, how much is the offset Y offset from the boom-stick pin to the main axis of the telescopic part (how far behind it is). Then, we need to measure the Z offset of the segment respect to boom-stick pin (how far below it is). See the figure 18 for a graphic reference.

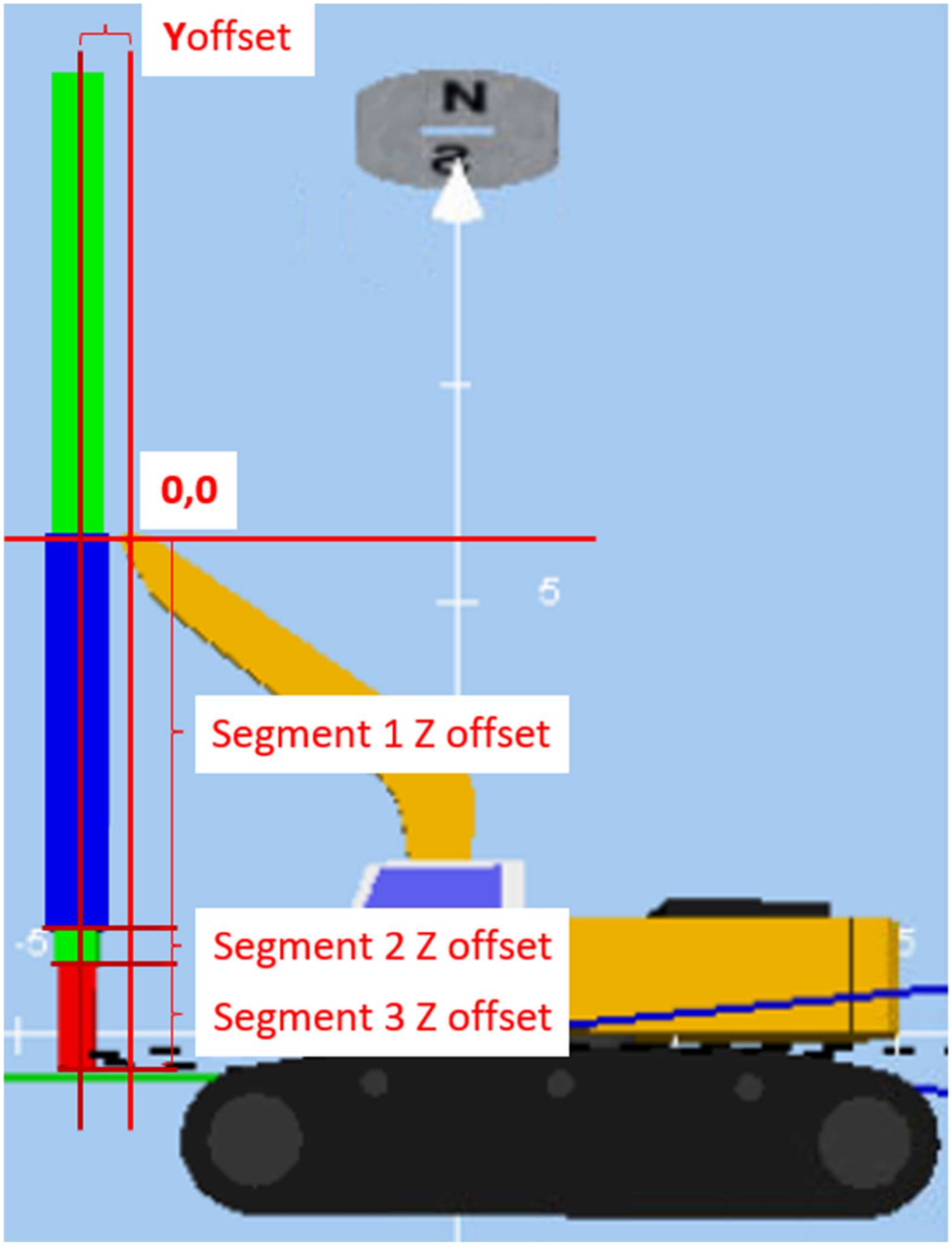


Figure 18 – Graphic reference of the telescopic segments to the boom-stick pin

We won´t use them yet, since first, we need to place the telescopic segments at the boom-stick pin. For that, we will use the *Raw Data View* or *Helpdesk View* once again (figure 19). We will look at the *Intermediate XYZ* values, which are the offsets, on each axis, for each segment taking the boom pin (A) as reference. For instance, looking at the *Intermediate Z* in the figure 19, the boom-stick pin is 5.22m above the A pin; the second value, given by the EC520 API is not used; then, the third value says that the end of the first telescopic segment (rigid segment attached to the boom) is only 0.75m above the pin A; and so on.

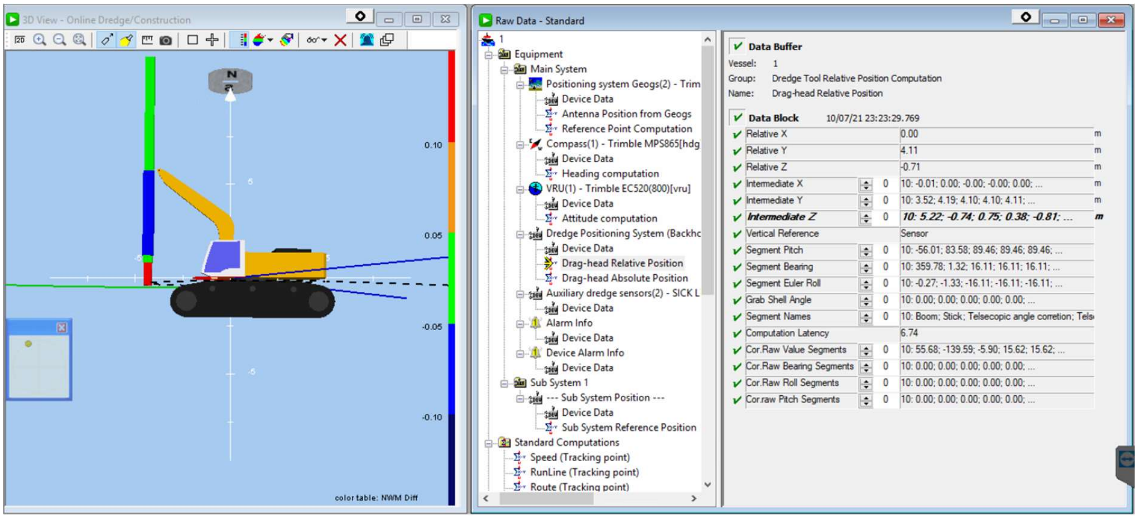


Figure 19 – XYZ relative offsets to boom pin (A)

We will use these values to compute the offsets required (figure 20) to move all the segments reference points to the boom-stick pin and then, from there, we will add the offset values measured at figure 18. Usually, each segment does not retract 100%, but there is a portion of them that they stay outside of the previous one, when fully retracted. Any offset applied at figure 20 will be related to the previous segment reference point. **Note that the offsets applied at figure 20 have the axis twisted in relation to the raw data, so Z offsets must be inserted on Y and Y on Z.**

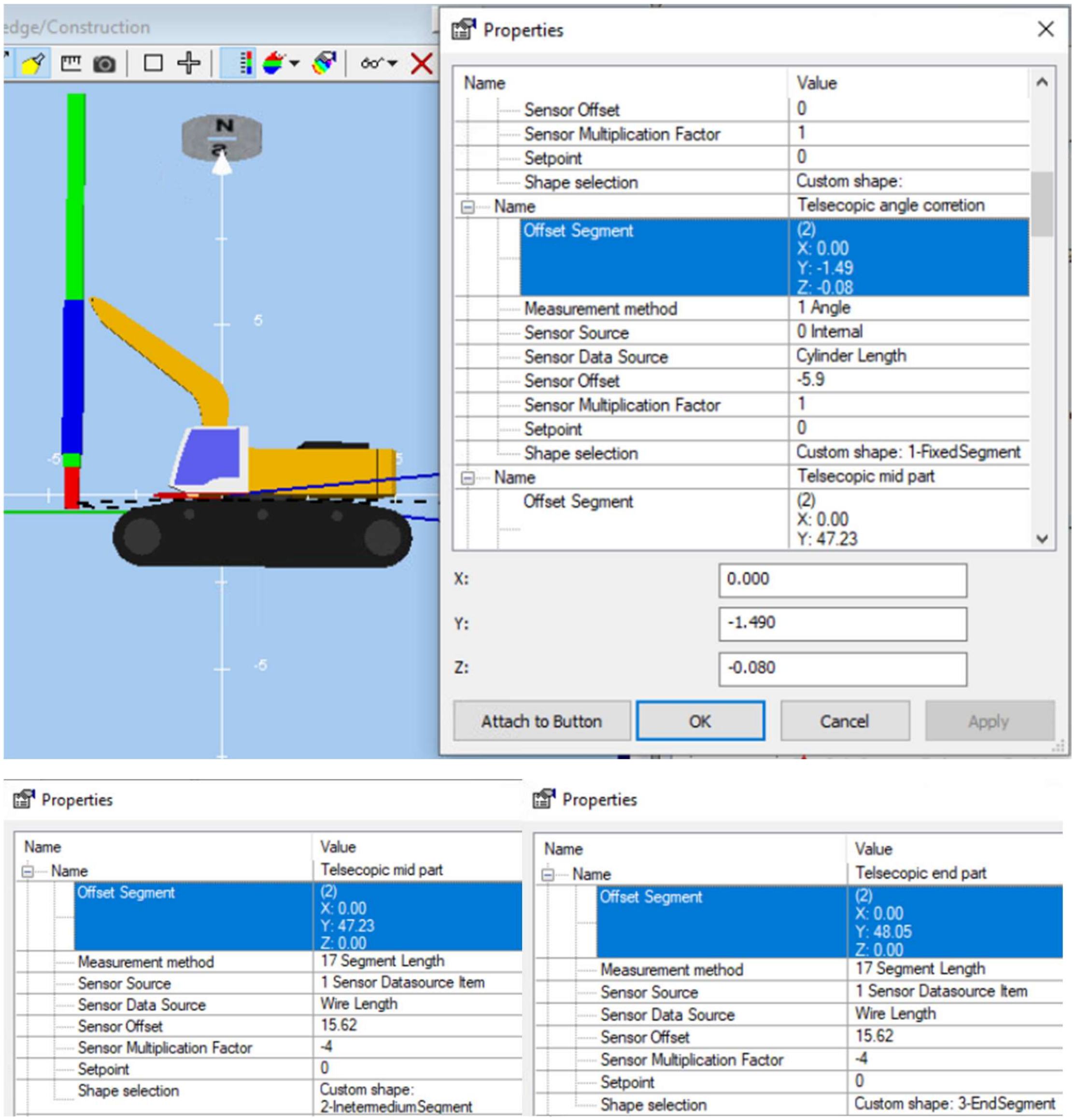


Figure 20 – XYZ relative offsets adjustment menus for each telescopic segment

11. Tool Creation

As earlier mentioned, the use of the telescopic hex requires the creation of a grab tool according to the real one installed on the machine. This can be done on the *Crane configuration Menu,* under the *Tool* tab (figure 21).

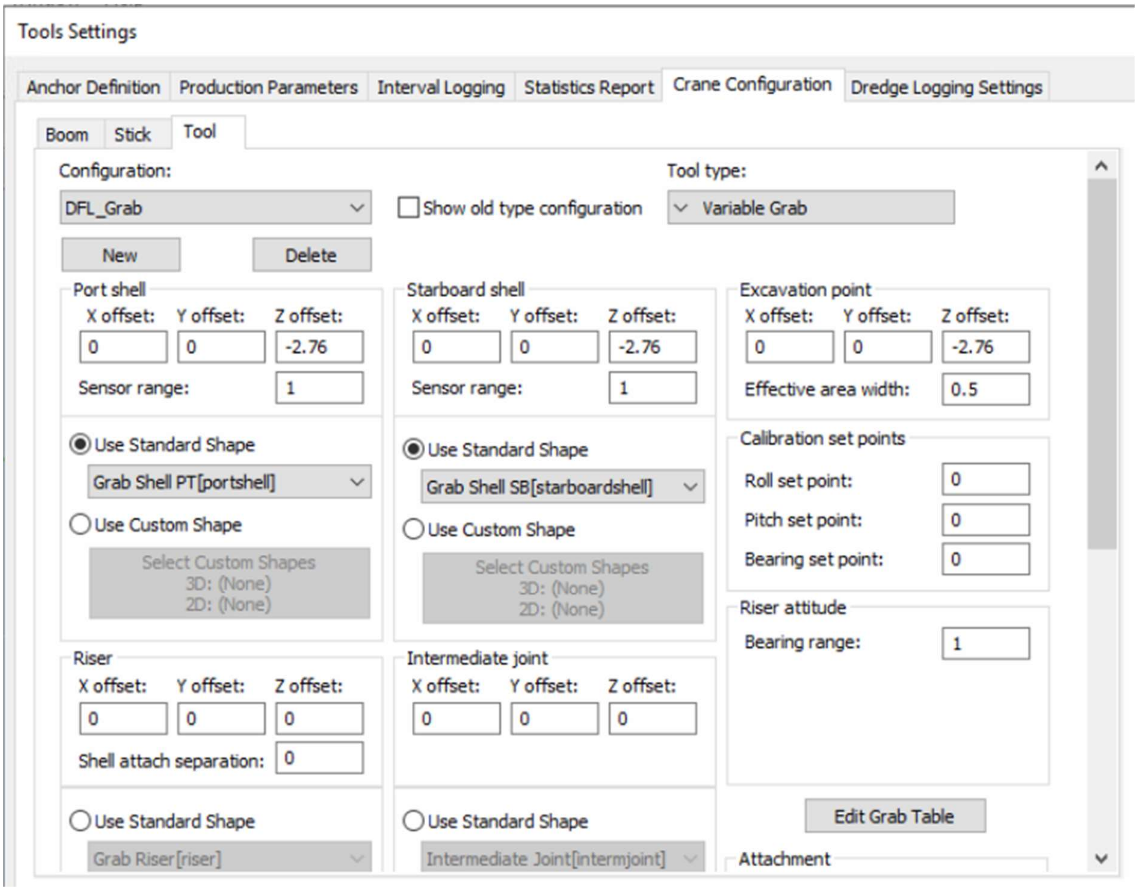


Figure 21 – Required grab tool creation page

Figure 22 shows the results of the job done.

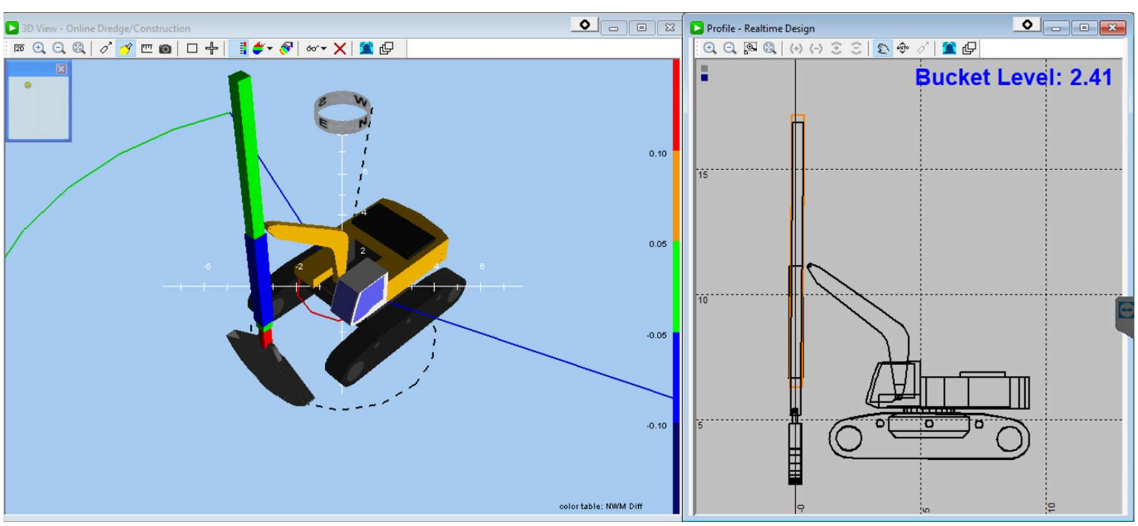


Figure 22 – TMC telescopic excavator ready to work