SERVICE MANUAL
Navigator™ Series Scales

TABLE OF CONTENTS

1 GETTING STARTED

1.1 INTRODUCTION

This service manual contains the information needed to perform routine maintenance and service on the Ohaus Navigator Series scales. Familiarity with the scale's Instruction Manual is assumed. The contents of this manual are contained in five chapters:

Chapter 1 Getting Started – Contains information on service facilities, tools, specifications, and the mechanical and electronic functions of the scale.

Chapter 2 Troubleshooting – Contains a diagnostic guide and error code table.

Chapter 3 Maintenance Procedures – Contains preventive maintenance procedures and disassembly, repair and replacement procedures.

Chapter 4 Testing – Contains a list of required test masses, an operational test, segment display test, performance tests and adjustments.

Chapter 5 Drawings and Parts Lists – Contains exploded views of Navigator scales identifying all serviceable components.

Appendix A Standard Calibration – Explains procedures for Standard Calibration, performed prior to using a scale, and after service.

Appendix B Service Calibration – Describes the Service Menu and sub-menus, which allow authorized service personnel to perform factory Linearity and Span calibrations (no pre-set limits), take Ramp readings, adjust the GEO Factor, and use E.PAnd to temporarily increase readability to at least 1/10th of the standard readability.

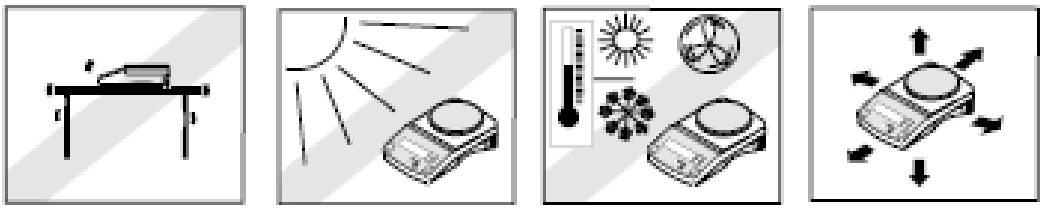
Appendix C Service Tool – Used to re-configure the scale after replacing a Printed Circuit Board, and download the software

Appendix D Geographical Adjustment Values – The chart of scale settings for every geographical latitude away from the equator (in degrees and minutes) and every elevation above sea level (in meters or feet).

1.2 SERVICE FACILITIES

To service a scale, the service area should meet the following requirements:

- Should be temperature controlled and meet scale specifications for temperature environmental requirements.
- Must be free of vibrations such as fork lift trucks close by, large motors, air currents or drafts from air conditioning/heating ducts, open windows, people walking by, fans, etc.
- Area must be clean and free of excessive dust.
- Work surface must be stable and level.
- Scale must not be exposed to direct sunlight or radiating heat sources.
- Handle all electronic assemblies with appropriate Electro-Static protection.



1.3 TOOLS AND TEST EQUIPMENT REQUIRED

1. Common hand tools are sufficient to disassemble the Navigator scales.
2. RS233 Interface Kit – PN 83032107
3. USB Interface Kit – PN 83032108

1.4 SPECIFICATIONS

Specifications for the Ohaus Navigator Scales are listed in Table 1-1. When a scale has been serviced, it must meet the specifications listed in the table. Before servicing the scale, determine what specifications are not met.

Special Note regarding Approved scales
The specifications for the approved scales below are only for initial testing. These scales must be tested according to the requirements of the local Weights and Measures authority. Before returning the scale to service an approved representative of the local Weights and Measures authority must certify the scale. Ohaus does not generally recommend the repair of an approved scale that involves replacement of the load cell or PCB.

TABLE 1-1 SPECIFICATIONS

Non-Approved Models:

Model*	Capacity	Readability (d)	Repeatability (Std. Dev.)	Linearity	Span Cal. Wt.	Lin. Cal. Wt.
NV222	220g	0.01g	1d	±2d	200g	100g, 200g
NV422	420g	0.01g	2d	±2d	200g	200g, 400g
NV622	620g	0.01g	2d	±2d	300g	300g, 600g
NV221	220g	0.1g	1d	±2d	200g	100g, 200g
NV621	620g	0.1g	1d	±2d	300g	300g, 600g
NV1201	1200g	0.1g	1d	±2d	500g	500g, 1kg
NV2201	2200g	0.1g	1d	±2d	1kg	1kg, 2kg
NVT2201	2200g	0.1g	1d	±2d	1kg	1kg, 2kg
NVT4201	4200g	0.1g	2d	±2d	2kg	2kg, 4kg
NVT6201	6200g	0.1g	2d	±2d	5kg	3kg, 6kg
NVT2200	2200g	1g	1d	±2d	1kg	1kg, 2kg
NVT6200	6200g	1g	1d	±2d	5kg	3kg, 6kg
NVT12000	12000g	1g	1d	±2d	5kg	5kg, 10kg
NVT22000	22000g	1g	1d	±2d	10kg	10kg, 20kg

Model* (NVHD)	Capacity	Readability (d)	Repeatability (Std. Dev.)	Linearity	Span Cal. Wt.	Lin. Cal. Wt.
NV123	120	0.001	2d	±9d	100g	50g,100g
NV223	220	0.001	2d	±9d	200g	100g,200g
NV323	320	0.001	2d	±9d	300g	150g,300g
NV1202	1200	0.01	2d	±6d	1kg	500g,1kg
NV2202	2200	0.01	2d	±6d	2kg	1kg,2kg
NV3202	3200	0.01	2d	±6d	3kg	1.5kg,3kg
NVT10201	10200	0.1	2d	±4d	5kg	5kg,10kg

Approved Models:

Model*	Max	e	Approval Class	Span Cal. Wt.	Lin. Cal. Wt.
NVT1601M	1600g	0.5g	III	1kg	1kg,1.5kg
NVT3200M	3200g	1g	III	2kg	2kg, 3kg
NVT6400M	6400g	2g	III	5kg	3kg, 6kg
NVT16000M	16000g	5g	III	10kg	10kg, 15kg

1.5 Controls

This section contains information on the basic operation of the scale.

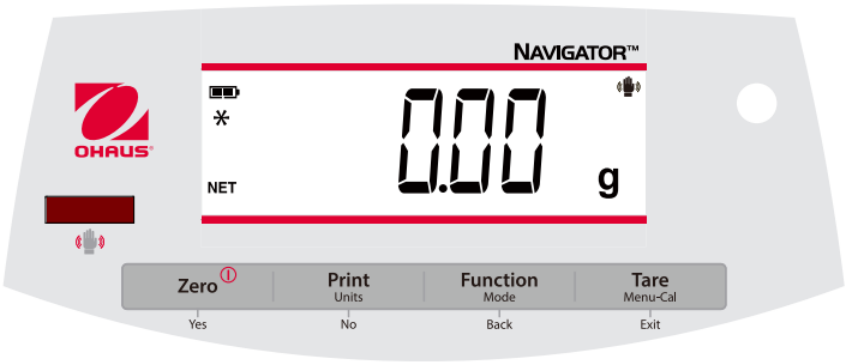


TABLE 1-3 FUNCTIONS OF DISPLAY CONTROLS

Button	Functions
Zero ⏻ **Yes**	Short Press (when on): Sets display to zero (when off): Turns balance on Long Press (when on): Turns the balance off Short Press (in Menu): Selects/accepts displayed setting
Print **Units** **No**	Short Press: See Interface Manual for operation description. Long Press: Toggles through active units Short Press (in Menu): Toggles through available settings
Function **Mode** **Back**	Short Press: Selects function setting Long Press: Selects active Mode Short Press (in Menu): returns to previous settings
Tare **Menu-Cal** **Exit**	Short Press: Enter / clear a Tare value Long Press: Enters User Menu Short Press (in Menu): Quickly exit User Menu
IR Sensor *	IR Sensors can be programmed to act as a “touchless” button. See the User Menu section 4.3 for the available settings.

The IR Sensors can be activated by a hand or other object that is placed about 12mm (½ inch) above the sensor location. The sensor activation distance will vary based on the reflective nature of the object. If unwanted activations occur due to unique situations the sensor can be turned off.

*Availability of IR Sensor is dependent on model and region.

1.6 MENU STRUCTURE

Programmable features of the Navigator are contained in the User Menu and Service Menu which are accessed through the Display Panel's control switches. The menu structures are illustrated below.

1.6.1 User Menu

The User Menu is easily accessed and documented for the scale operator. For more detail on using the menu, see the Navigator Instruction Manual.

TABLE 1-5 NAVIGATOR USER MENU STRUCTURE

Sub-Menus:	.C.a.l.	.S.e.t.u.p.*	.M.o.d.e.	.U.n.i.t.*	.E.n.d.
Menu Items:	Span Lin End	b.light A-OFF IR Filter AZT Stab Stab.C End	Count Percnt Check End	g kg … End	

* Note: Available settings vary by models and regions
**Availability of IR Sensor is dependent on model and region.

Press and hold Menu until [MENU] (Menu) is displayed. When released the first sub-menu [.CAL.] (Cal) will be shown.

Press Yes to enter the displayed sub-menu or press **No** to advance to the next.

Selecting a sub-menu will display the first menu item. Press **Yes** to view the menu item setting or press **No** to move to the next menu item. When viewing the setting, press **Yes** to accept the setting, or press **No** to change the setting. When [End] is displayed, press **Yes** to return to the sub-menu selections or **No** to return to the first item in the current menu.

1.6.2 Cal Sub-Menu

- Span [SPAN] (yes, no) - Initiates a span calibration procedure (zero and span). A span calibration is important when initially setting up the balance.
- Lin [L in] (yes, no) - Initiates a linearity calibration procedure (zero, mid-point and span).

1.6.3 Setup Sub-Menu

- Back Light [b.L ight] (on,off,**Auto**)-When Back light is set to "on" the balance will always "on". When Back light is set to "Auto" the balance will turn on when a button is pressed or the display weight changes.
- Auto Off [A-OFF] (on, **off**) - When Auto Off is set to "on" the balance will turn off automatically after 5 minutes of inactivity. Auto off is used to save battery power.
- IR Sensor [ir.Func] (Off, Tare, Function, Print, Zero, **Display**) - These settings determine the role of the IR Sensor. "Zero", "Print", "Function" or "Tare" allows the IR sensor to act the same as the related button. "Display" activates the display if Display-Auto is set. "Off" disables the sensor.*

- Filter [FiLtEr] (L1,**L2**,L3,L4) – set the amount of signal filtering
  L1————————————————>L4
  Stability less————————————— > greater
  Stabilization time faster———— >slower
- Auto Zero Tracking[AZT] (OFF,0.5d,1d,3d,5d,8d,10d) – Set the automatic zero tracking functionality. The display will maintain zero until a change of "0.5d,1d,3d,5d,8d,10d" divisions per second has been exceeded.
- Stable [StAb] (0.5d,**1d**,2d,5d) – Set the amount of the reading can vary while the stability symbol remains on.
- Stable Compensation [StAb.C] (on, off) - Set the automatic stable tracking functionality. Set it "off" for dosing or filling application.

Note: Bold always represents factory default Value

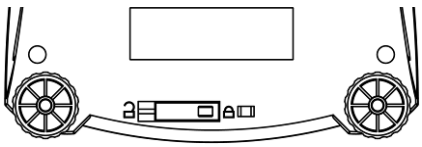
*Availability of IR Sensor is dependent on model and region.

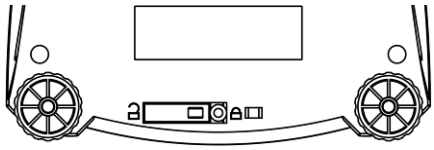
1.6.4 Units Menu

This sub-menu activates units so they will be accessible with the **Units** button. The units in the menu must be turned “on” to be active.
Note: Available units and modes vary by model and local regulations.

1.6.5 Sealing access to balance settings

The Menu Lock switch limits changes to the Cal, Setup, Mode and Unit menus. The switch in type approved models may set some balance settings as required by the approval agency. The switch may be secured using paper seals, wire seals or plastic ties.


Locked


Unlocked

1.6.6 Service Menu

The Service Menu is intended for use by service personnel. The menu items are generally used when servicing the scale but there are setting that may be changed to satisfy a customer's special requirements. For more detail on using the service menu see Appendix B.

TABLE 1-6 NAVIGATOR SERVICE MENU STRUCTURE

	Service Menu
Menu Items:	Ramp Lin Span Geo LFT Expand Reset End

2 DIAGNOSTIC GUIDE

This section of the manual contains troubleshooting information. Information is contained to isolate specific problems using Table 2-1, Diagnostic Guide. Follow all directions step by step. Make certain that the work area is clean. Handle scale components with care. Use appropriate electro-static protection devices to prevent damage to the sensitive electronic components.

2.1 TROUBLESHOOTING

2.1.1 General procedures for Troubleshooting

1. Do the most obvious, user-level remedies.
2. Visual Check:
   - Check that the internal parts are clean and free from debris.
   - Examine the scale for damage or signs of abuse, replace any damaged items.
   - Examine the load cell for signs of bending, twisting or corrosion.
   - Check the overload stops, adjust if necessary. (see Section 3.6)
3. Use the error code table for solutions for specific codes.
4. Use the Diagnostic Guide; locate the symptom then follow the suggested remedies in order.

2.2 DIAGNOSTIC GUIDE

Table 2-1 is a Diagnostic Guide designed to help locate the problem area quickly and easily. The probable causes are listed with the most common cause first. If the first remedy does not fix the problem, proceed to the next remedy. Before attempting to repair the scale, read all chapters of this manual to be familiar with the scale components and operation.

Diagnosis:

1. Isolate and identify the symptom.
2. Refer to Table 2-1, Diagnostic Guide and locate the symptom.
3. Follow the suggested remedies in the order they appear.
4. Perform the indicated checks, or see the appropriate section of the manual.
5. Repair or replace the defective section of the scale.

NOTE:
If more than one symptom is observed, approach one area at a time, and remember that the symptoms may be interrelated. If a problem arises that is not covered in this manual, contact Ohaus Corporation for further information.

TABLE 2-1. DIAGNOSTIC GUIDE

Symptom	Possible Cause	Remedy
Cannot turn on	No power to balance	Verify connections and voltage
Poor accuracy	Improper calibration Unstable environment	Perform calibration Move balance to suitable location
Cannot calibrate	Unstable environment Incorrect calibration weight	Move the balance to suitable location Use correct calibration weight
Cannot access mode	Mode not enabled	Enter menu and enable mode
Cannot access unit	Unit not enabled	Enter menu and enable unit
Lo rEF	Reference weight is too low	Increase reference weight.
rEF Err	Parts counting– sample weight <1d.	Shows error - exits mode or goes to [CLr.APU]
Err 3.0	Incorrect calibration weight	See section 2.5 for correct weights
Err 4.4	RS232 buffer is full	Set Handshake on, see Interface User Manual.
Err 8.1	Power on zero range exceeded	Clear pan, check Shipping Lock setting
Err 8.2	Power on zero under range	Install pan, check Shipping Lock setting
Err 8.3	Overload (>cap+9e)	Load exceeds balance maximum capacity
Err 8.4	Under load	Reading below min. range - Re-install pan.
Err 8.6	Displayed value >999999	Result exceeds display capability
Err 9	Internal data error	Contact an authorized service agent
Err 9.1	Calibration data lose	Implement service calibration
Err 9.2	Load cell connection with PCBA is not good	Re-connect the cable between load cell and main PCBA, and then do the service calibration
Err 9.3	EEPROM data error	Implement service calibration
Err 13	Fail to write EEPROM.	Contact an authorized service agent
Err 53	Invalid checksum data	Contact an authorized service agent

3 MAINTENANCE PROCEDURES

3.1 PREVENTIVE MAINTENANCE

Ohaus scales are precision instruments and should be carefully handled, stored in a clean, dry, dust-free area, and cleaned periodically. Follow these precautionary steps:

- When a scale has had chemicals or liquids spilled on it, all exterior surfaces should be cleaned as soon as possible with warm water on a damp cloth.
- Do not leave a mass on the scale when the scale is not in use.
- Allow time for the scale to stabilize after moving it from an area which is at a different temperature than the area where it is to be operated. Allow one hour for each 5°F (2.7°C) temperature change before using the scale. After temperature stabilization, allow an additional 20 minutes after turning the scale on, for the scale electronics to stabilize.

Preventive Maintenance Checklist

The scale should be inspected and checked regularly, as follows:

1. Remove the Pan and Sub Pan to inspect and clean the area beneath the Pan.
2. Clean the outside of the scale using a damp cloth with warm water.

CAUTION
DO NOT USE CHEMICAL CLEANERS OR SOLVENTS OF ANY TYPE.
SOME CLEANERS ARE ABRASIVE AND MAY AFFECT THE SCALE'S FINISH.

3. Check the Power Cord for broken or damaged insulation.
4. If using batteries and the scale malfunctions, first replace the batteries to see if this resolves the problem. To isolate a problem with the rechargeable battery option kit, the scale can be converted back to standard alkaline batteries (see Rechargeable Battery Option User Manual).
5. Make a visual inspection for faulty connectors, wiring, and loose hardware.

3.2 OPENING THE SCALE

Opening the Navigator scale varies slightly according to the specific model, as detailed below. Use these procedures in order to replace the Load Cell, the Printed Circuit Board or other components.

Opening Navigator Models
Common hand tools are sufficient to disassemble the Navigator scales. Turn the scale off and unplug the power cord before you begin. Remove any installed batteries. On models with the Rechargeable Battery Option installed, the battery and the Recharge PCB must be removed. See the Rechargeable Battery Option Kit instructions for additional information.

1. Remove the stainless steel Weigh Pan.
2. Remove the conductive rubber cap over the Pan Support Screws.

NV Models NVT Models

Figure 3-1 Pan Support Conductive Rubber Caps.

3. Remove the Pan Support by removing the two screws shown in Figure 3-1.
4. Remove the 5 screws holding the Top and Bottom Housings in place. (See Figure 3-2.)

(Note: NV model shown)

Figure 3-2 Separating the Top and Bottom Housings

5 Turn the scale over and remove the upper housing.

3.3 REPLACING THE LOAD CELL

The Load Cell may need to be replaced because of scale instability, or because the scale does not calibrate or repeat, or because it is physically broken or displays an error code.

Disassembly:

1. Open the scale – see Section 3.2. Verify that there is no mechanical interference, pinched wire or bad solder connection that may be causing the load cell to appear defective.

2. Remove the Load Cell – turn the scale over, holding the Load Cell by hand, and remove the 2 load cell screws from the bottom housing. The NV model uses cross-recess screw heads (Phillips type) while the NVT use hex socket head screws.

3. Turn the scale back on its feet and gently lift off the Load Cell, the attached PCB and the AC Adapter cable. Place the Load cell and the PCB on a static protected work area.

4. The load cell connection is a five-wire cable that is soldered directly to the PCB. Before disconnecting the cable record the wire colors and their location on the PCB. (Hint: A digital picture is an easy and reliable record.) Disconnect the cable connecting the PCB to the Load Cell by un-soldering the 5 wires from the PCB. Take care not to over heat the PCB which will damage the thin PCB conductors.

Re-Assembly:

1. Re-solder the new load cell to the PCB, connection J3.

NOTE: The spare part Load Cell may not have the same wire color identifications as the original load cell. It is necessary to identify the wires from the table below.

J3 has 5 solder pads with the following connections; GND, -EXE, -SIG, +SIG, +EXE.

TABLE 3-1. Load Cell Wire Color Identification

Spare Part Load Cell	Wire Color Identification
NV Models	GND Green thick wire -EXE Black wire -SIG White wire +SIG Green wire +EXE Red wire
NVT Models	GND Yellow wire -EXE Black wire -SIG White wire +SIG Green wire +EXE Red wire
NVT Approve Models	GND Yellow wire -EXE Black wire -SIG Red wire +SIG White wire +EXE Green wire

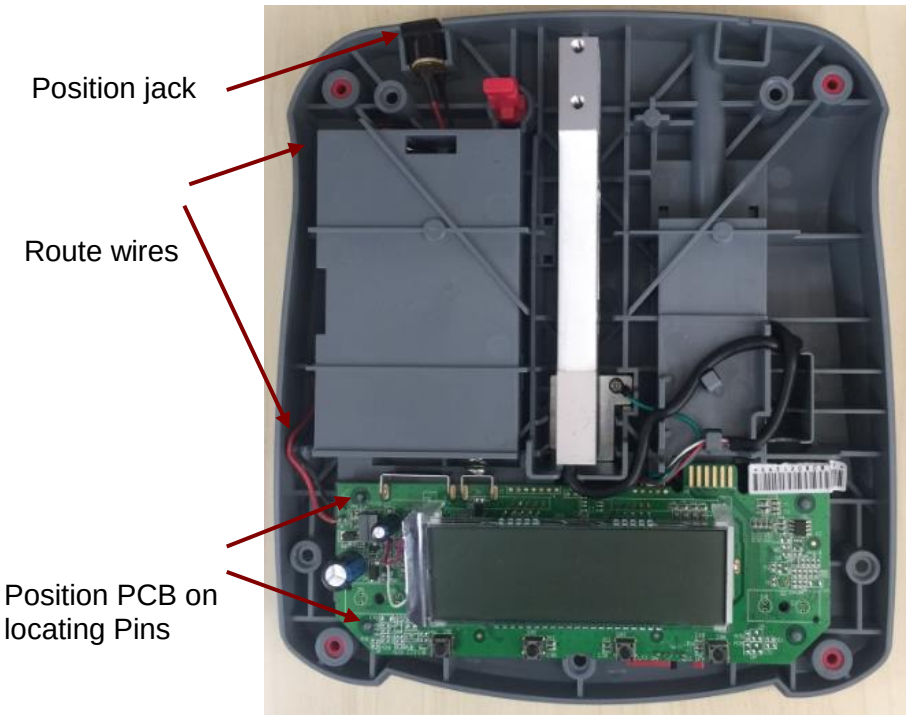
NV models NVT models NVT Approve models

Figure 3-3 Load cell connections, J3

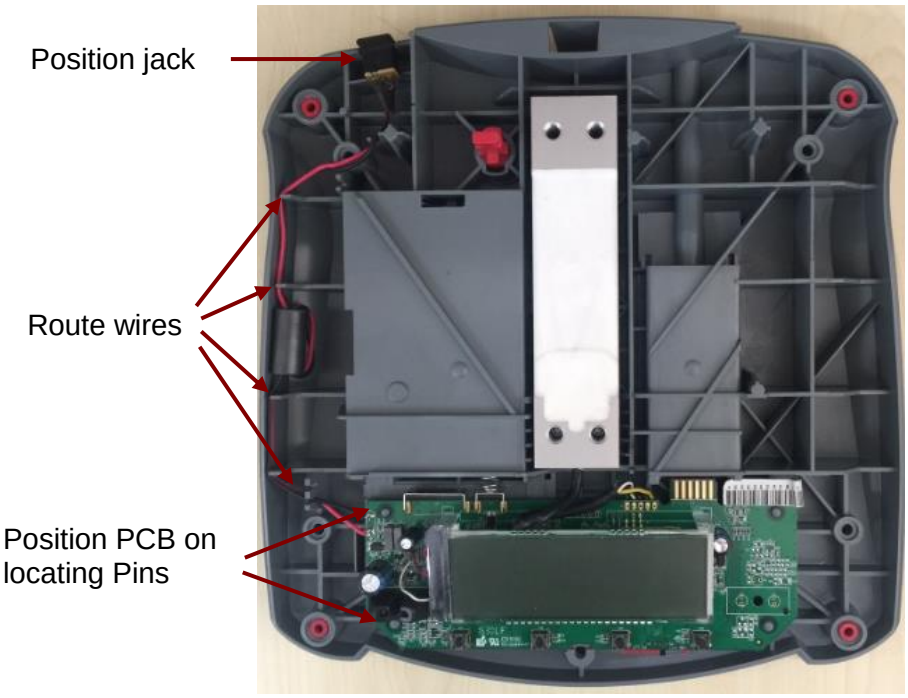
2. NV models require a load cell spacer to be positioned between the load cell and the Base. Position the load cell back into the lower housing. Turn the scale over to install the (2) load cell screws. Loosely tighten the screws so that the load cell can be aligned in the housing. While holding the load cell, fully tighten the screws. The screws should be tight enough so that the load cell does not move when pushed from the side. Verify that the load cell is centrally located between the ribs.

3. Turn the scale over onto its feet. Position the PCB on to its locating pins. Coil the excess load cell cable in front of the load cell.

4. Slide the AC jack into its position in the lower housing. Route the AC adapter cable as shown in Figure 3-4.



NV models



NVT models

Figure 3-4 Position load cell, PCB and AC wires

5. To assemble the Housing, follow the steps in Section 3.2.1 in reverse order.

3.4 REPLACING THE PRINTED CIRCUIT BOARD AND DISPLAY

1. Open the scale – see Section 3.2.
2. Pick the PCB off its mounting pins and position the PCB upside-down so that the load cell wire connection is easy to access.
3. Disconnect the Load Cell cable from the PCB. The load cell connection is a five-wire cable that is soldered directly to the PCB. Before disconnecting the cable record the wire colors and their location on the PCB. (Hint: A digital picture is an easy and reliable record.) Disconnect the cable connecting the PCB to the Load Cell by un-soldering the 5 wires from the PCB. Take care not to over heat the PCB which will damage the thin PCB conductors.
4. Unsolder the AC Cable wires from the PCB.
5. Follow these steps in reverse order to install the new PCB.
6. Configure the Scale. (See Appendix C.)

Note: The PCB and the LCD Display are supplied as a single unit. However, if only the LCD Display needs replacement, it can be separated from the PCB by unsoldering the fine lead-wires connecting it to the PCB. When installing the new LCD Display, carefully feed the lead-wires through their holes, check that the new assembly is seated properly on the PCB and then solder the lead-wires.

3.5 REPLACING THE FUNCTION LABEL

The Function Label may need to be replaced. (See Chapter 5 for parts information.) Use a broad blade, such as a wide X-Acto™ knife, to remove the label. Clean the glue residue from the Housing surface. Then carefully place the new label where the old one was. (See Figure 3-5.)

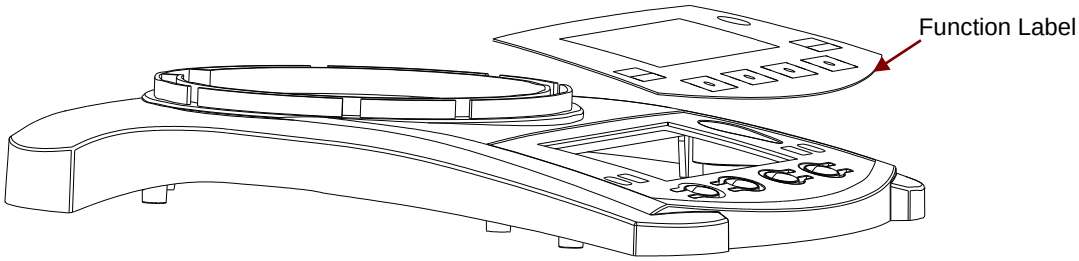
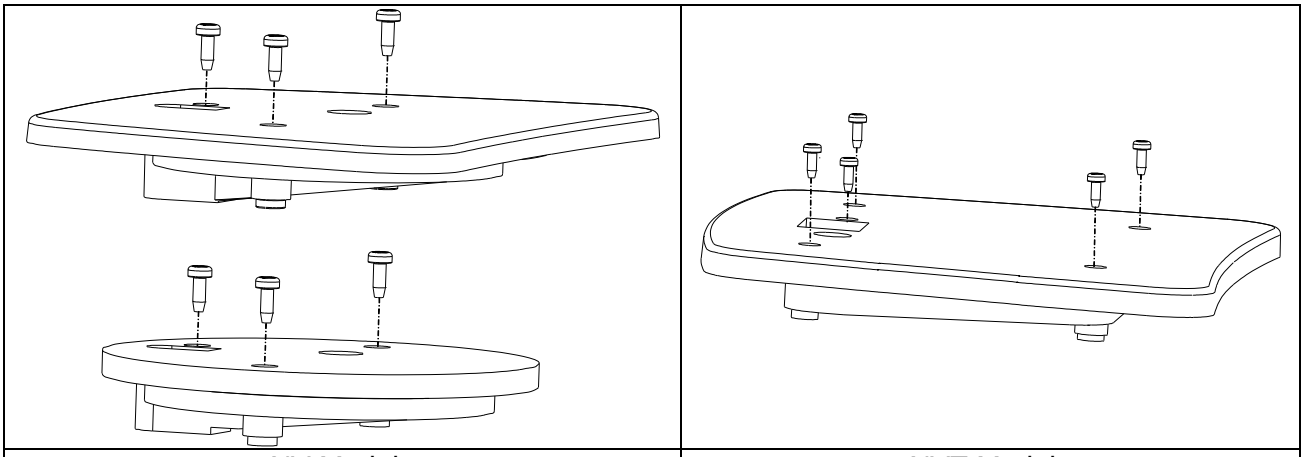


Figure 3-5. Function Label Removal

3.6 DOWN-STOP ADJUSTMENT

The purpose of the down-stops is to protect the load cell from physical damage. The down-stops are created by contacting bosses in the Base and adjustment screws or bosses in the Sub-Pan. The NV models have 3 down-stops, left, right and center near the load cell attachment to the Sub-Pan. The NVT models have 5 down-stops, left-front, left-rear, right-front, right-rear and center near the load cell attachment to the Sub-Pan.

NV models with capacity greater than 2kg and NVT models with a capacity greater than 10kg do not have adjustable down-stops. The down-stop bosses on the Sub-pan are designed to be at the correct distance to protect these load cells. The smaller capacity load cells require the down-stop clearance to be decreased for proper load cell protection. Adjustment screws are placed in the Sub-pan down-stop bosses to reduce the clearance, see figure 3-6.



NV Models	NVT Models

Figure3-6. Down Stop Adjustment Screws

To adjust the down-stops on the applicable models follow the procedures below. Models without adjustable down-stops need no action.

To ensure full weight reading:

The proper down-stop adjustment will allow full weight reading provided the center of the mass is less than ½ the distance from the pan center to the pan edge. To allow for tolerance this adjustment is being done at 120% of scale capacity or at scale capacity but ¾ of the distance to the pan edge.

To protect the load cell:
To protect the load cell from physical damage the down-stops should touch at about 200% of scale capacity. Again to allow for adjusting tolerance the adjustment is made using a 150% weight.

The adjustment screws in the Sub-Pan can be adjusted with a #2 cross-recess (Phillips) screw driver. Each adjustment screw should contact the Base when 120% to 150% of the scale capacity is placed in the center of the 4 quadrants of the scale. The Top Housing must be removed to visually check if the down-stops are touching. Turn the adjustment screw counterclockwise to increase the clearance and clockwise to decrease the clearance.

An easy method to check the down-stop adjustment is to use the scales weight reading to detect if the down-stop is touching. This method can only check if the down-stop is set too close preventing accurate weighing.

1. Place 100% scale's capacity in the center of the Pan.
2. Note the reading.
3. Move the mass ¾ of the way (between the center and the edge) to the front of the Pan. Note any significant difference in the displayed weight reading.
4. Repeat the test for the back, left, and right position of the Pan.
5. If there was a weight reading change turn the adjustment screw nearest the quadrant counterclockwise ¼ turn. Repeat the test to see if it is corrected.
6. If the weight is placed at the edges of the pan there may be a weight change which indicates the down-stop is working and this is okay.

4 TESTING

Before and after servicing a Navigator scale, an operational test and various performance tests should be made to confirm that the scale meets specifications. Turn the scale on and allow it to warm up for at least one hour before performing these tests.

NOTE:
Make sure the test area is free from drafts and that the scale rests on a level and vibration-free surface.

4.1 TEST MASSES REQUIRED

The masses required to test the Ohaus Navigator scales must meet the requirements of ASTM Class 4 or OIML F2 Tolerance. The mass values are listed in Table 4-1.

TABLE 4-1 CALIBRATION MASS VALUES

Model	Span Calibration mass	Linearity Calibration masses
NV222	200g	100g, 200g
NV422	200g	200g, 400g
NV622	300g	300g, 600g
NV221	200g	100g, 200g
NV621	600g	300g, 600g
NV1201	500g	500g, 1kg
NV2201	1kg	1kg, 2kg
NVT1601M	1kg	1kg,1.5kg
NVT2201	1kg	1kg, 2kg
NVT4201	2kg	2kg, 4kg
NVT6201	5kg	3kg, 6kg
NVT2200	1kg	1kg, 2kg
NVT3200M	2kg	2kg, 3kg
NVT6200	5kg	3kg, 6kg
NVT6400M	5kg	3kg, 6kg
NVT12000	5kg	5kg, 10kg
NVT16000M	10kg	10kg, 15kg
NVT22000	10kg	10kg, 20kg
NV123	100g	50g,100g
NV223	200g	100g,200g
NV323	300g	150g,300g
NV1202	1kg	500g,1kg
NV2202	2kg	1kg,2kg
NV3202	3kg	1.5kg,3kg
NVT10201	5kg	5kg,10kg

4.2 OPERATIONAL TEST

1 Connect a functioning Power Adapter to the scale power receptacle located on the bottom of the scale, or install the required batteries.

2 Plug the Power Cord into a suitable power source.

4.3 SEGMENT DISPLAY TEST

Turn the scale on, and ensure that all segments are enabled and displayed briefly. This is a Segment Display Test. (See Figure 4-1)

Figure 4-1 LCD Segment Display

4.4 LOAD CELL TEST USING RAMP

To test the Load Cell using RAMP, see Appendix B.

4.5 PERFORMANCE TESTS

Accurate performance of the Navigator scales is determined by a series of four performance tests. The displayed readings are compared with the tolerances listed in Tables 4-2 and 4-3. Tolerance values are expressed in counts. A one-count difference is shown in the last digit on the scale display.

TABLE 4-2 TOLERANCES

Model	Precision (d)	Repeatability (d)	Linearity (d) (Std. Dev.)	OCL (d)
NV222	±1	1	±2	±3
NV422	±1	2	±2	±3
NV622	±1	2	±2	±3
NV221	±1	1	±2	±3
NV621	±1	1	±2	±3
NV1201	±1	1	±2	±3
NV2201	±1	1	±2	±3
NVT1601M	±1	1	±2	±3
NVT2201	±1	2	±2	±3
NVT4201	±1	2	±2	±3
NVT6201	±1	1	±2	±3
NVT2200	±1	1	±2	±3
NVT3200M	±1	1	±2	±3
NVT6200	±1	1	±2	±3
NVT6400M	±1	1	±2	±3
NVT12000	±1	1	±2	±3
NVT16000M	±1	1	±2	±3
NVT22000	±1	1	±2	±3
NV123	±1	5	±9	±8
NV223	±1	5	±9	±8
NV323	±1	5	±9	±8
NV1202	±1	7	±6	±8
NV2202	±1	7	±6	±8
NV3202	±1	7	±6	±8
NVT10201	±1	5	±4	±4

The following performance tests are used to evaluate scale operation before and after repairs. The scale must meet the requirements specified in each test as well as the specifications listed in Table 4-2. Before proceeding with the following tests, the scale should be calibrated. (See Appendix A)

4.5.1 Precision Test

The Precision Test is a quick test that measures the deviation of a limited number of weight readings, which should match the specification for each model, listed in Tolerance Table 4-2.

1. Power on the balance. The reading on the display should be 0g.

2. Select a mass weighing near the maximum capacity of the balance, and place it on the center of the Pan. Observe and record the reading.
3. Remove the mass. The reading should return to 0g ± the precision tolerance in Table 4-2.
4. Repeat this test three times. The readings should be within tolerances. If so, the balance passes the Precision Test.
5. If the deviation for any set of readings (using the same mass placed on the center of the Pan) is greater than the tolerance listed in Table 4-2, the balance does not meet the precision specification. Inspect and correct the following areas:
   - Check for mechanical obstructions. Any foreign object touching any part of the moving assemblies will cause a balance to fail the Precision Test. Inspect and correct as necessary.
   - If the scale does not meet specifications, move it to a suitable location, ensure that it is level, and try again. If it still does not meet specifications, perform a service calibration, and try again. (See Appendix B for Service Calibration.)
   - If the scale does not pass this test, the Load Cell may need to be replaced.

4.5.2 Repeatability Test

The repeatability specification is defined as the Standard Deviation value derived from a set of weight readings. This test uses more weight data than the Precision Test and will allow for occasional weight deviations due to testing variations.

Requirements:

– To perform this test a single mass must be used for all readings.

– The test mass should be approximately ½ of the capacity of the instrument.

– Wear gloves when handling the mass.

Set Up:

Before starting a repeatability test, set up the instrument as follows.

Enter the service menu (see appendix B.1) and adjust and record the following settings:

A. Set the Stability setting to 0.5d (its lowest setting).

B. Set the Filter level to L2 (close to mid range).

C. Set the AZT (Auto Zero Tracking) to .5d (its lowest setting). Do not turn it off.

Enter the User Menu (see 1.8.1) and adjust the following settings:

A. Set the instrument to display the same units as the performance specifications. (Usually kg, g, or mg)

Record Settings:

Stability Setting = _____

Filter Level Setting = _____

Auto Zero Tracking Setting = _____

Displayed Units = _____

Mass Used = _____

Test Procedure:

1. Zero the instrument.
2. Using a test mass approximately half the capacity of the instrument, place the mass on the center of platform. Record the reading on the worksheet provided.
3. Remove the mass from the platform.
4. Repeat this test starting at Step 1 until you record a total of ten readings

Fill in the worksheet (Table 4-3) with the ten (10) readings.

TABLE 4-3. REPEATABILITY WORKSHEET

n	Reading	Delta = Reading – Mean	Delta x Delta
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
n = number of Reading Mean = Sum of readings / 10 Delta = Reading – Mean Standard Deviation = Square Root of (sum of (Delta x Delta) / 9)			

5. Add the ten readings and divide the total by 10 to find the Mean (average).
6. Mean = (Reading 1 + Reading 2 + Reading 3 + Reading 4 + Reading 5
7. + Reading 6 + Reading 7+ Reading 8 + Reading 9 + Reading 10) / 10

   Mean =_____

6. Calculate the Delta for each reading and record in the work sheet.

   Delta = Reading – Mean

7. Calculate the Delta x Delta for each reading and record in worksheet.
8. Add the ten Delta x Delta values and divide by 9
9. Calculate the Standard Deviation by applying the square root of the result from step 8.

   Standard Deviation =_____

Note: If the balance does not meet specifications, move it to a suitable location, ensure that it is level, and try again. If it still does not meet specifications, perform a service calibration, and try again. (See Appendix B for Service Calibration)

4.5.3 Linearity Test

This test is used to determine the linearity of the unit throughout its operating range. The masses used to perform this test can be utility masses.

NOTE:

The scale must pass the Precision and Repeatability Tests, and be calibrated before the Linearity Test may be performed.

TABLE 4-4 LINEARITY TEST MASSES

Model	Reference Wt.	Load 1	Load 2	Load 3
NV222	50g	50g	100g	150g
NV422	100g	100g	200g	300g
NV622	150g	150g	300g	450g
NV221	50g	50g	100g	150g
NV621	150g	150g	300g	450g
NV1201	250g	250g	500g	750g
NV2201	500g	500g	1000g	1500g
NVT1601M	400g	400g	800g	1200g
NVT2201	500g	500g	1000g	1500g
NVT4201	1000g	1000g	2000g	3000g
NVT6201	1500g	1500g	3000g	4500g
NVT2200	500g	500g	1000g	1500g
NVT3200M	750g	750g	1500g	2250g
NVT6200	1500g	1500g	3000g	4500g
NVT6400M	1500g	1500g	3000g	4500g
NVT12000	2500g	2500g	5000g	7500g
NVT16000M	4000g	4000g	8000g	12000g
NVT22000	5000g	5000g	10000g	15000g
NV123	50g	50g	100g	120g
NV223	50g	50g	100g	150g
NV323	50g	50g	100g	200g
NV1202	100g	100g	300g	500g
NV2202	500g	500g	1000g	1500g
NV3202	500g	500g	1000g	2000g
NVT10201	1000g	1000g	3000g	5000g

NOTE: All masses are nominal values. Be certain to use the same reference mass throughout the procedure.

2. Place the test mass on the Scale, record the weight and remove.
3. Place Load 1 on the Scale and press TARE.
4. Place the test mass on the Scale, record the weight and remove.
5. Place Load 2 on the Scale and press TARE.
6. Place the test mass on the Scale, record the weight and remove.
7. Place Load 3 on the Scale and press TARE.

8. Place the test mass on the Scale and record the weight.
9. The difference in the weights of the test mass should be within the tolerance in Table 4-2. If the differences are out of tolerance, calibrate (see Appendix A.1) and repeat the test.
10. If the Scale remains out of tolerance, the Load Cell may need to be replaced.

4.5.4 Off-Center Load Test

The Off-Center Load Test is used to determine whether displayed weight values are affected by moving the sample to different areas of the Pan.

11. Place half of the scale's capacity in the center of the Pan.
7. Note the reading.
8. Move the mass halfway (between the center and the edge) to the front of the Pan. Note any differences in the displayed weight reading.
9. Repeat the test for the back, left, and right position of the Pan.
10. Maximum allowable change in displayed weight readings for each of the four positions can be found in Specifications Tables 4-2. If this maximum is exceeded, follow procedures in Section 4.5.5, Adjusting Off Center Load.

4.5.5 Adjusting Off Center Load

If the Off Center Load (OCL) is excessive, perform adjustment as follows:

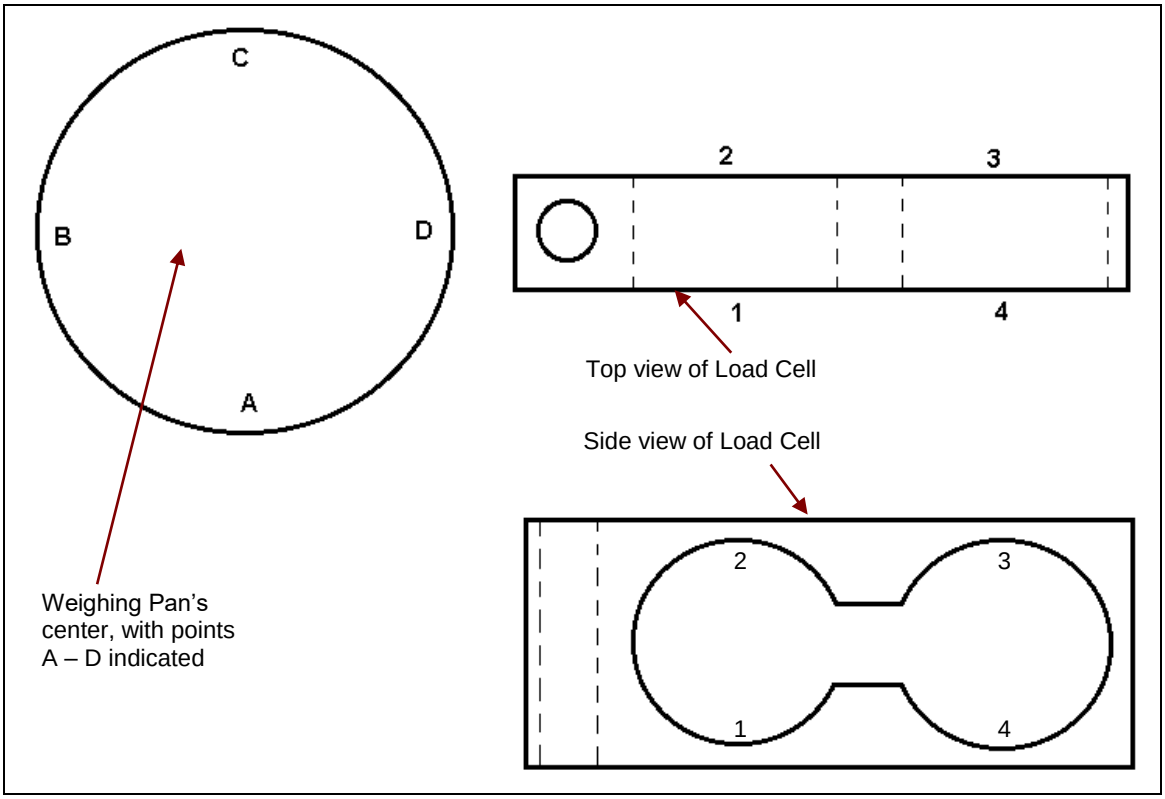


Figure 4-4. Navigator Load Cell and Weighing Pan

1. Place the test weight in the center of the Weighing Pan.
2. Tare the balance.

3. Move the weight to point A and record the reading.
4. Move the weight to point B and record the reading.
5. Move the weight to point C and record the reading.
6. Move the weight to point D and record the reading.
7. If the reading at point A is negative, file at points 1 and 4 AT AN ANGLE.
8. If the reading at point B is negative, file at points 1 and 2 STRAIGHT ACROSS.
9. If the reading at point C is negative, file at points 2 and 3 AT AN ANGLE.
10. If the reading at point D is negative, file at points 3 and 4 STRAIGHT ACROSS.
11. Repeat 1 to 10 until within specifications.

Note: It is not recommended that you try to adjust more than –5 counts if the beam has been filed already. If the beam has not been filed previously, you can adjust –10 counts. Remember, when filing you are weakening the beam. File a little at a time.

5 PARTS LISTS & DIAGRAMS

This section of the manual contains exploded views for the Navigator series scales. The exploded view drawings are designed to identify the parts which can be serviced on the scale in the field.

> ATTENTION: In all cases where a part is replaced, the indicator must be thoroughly checked after the replacement is made. The indicator **MUST** meet the parameters of all applicable specifications in this manual.

If further technical information is needed, please contact your local Ohaus distributor, or:

www.ohaus.com

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Fax: +1 973-944-7177

In the United States call toll free, 800-672-7722 ext. 7852 between 8:00 a.m. and 5:00 p.m. EST.

5.1 SPARE PARTS NV

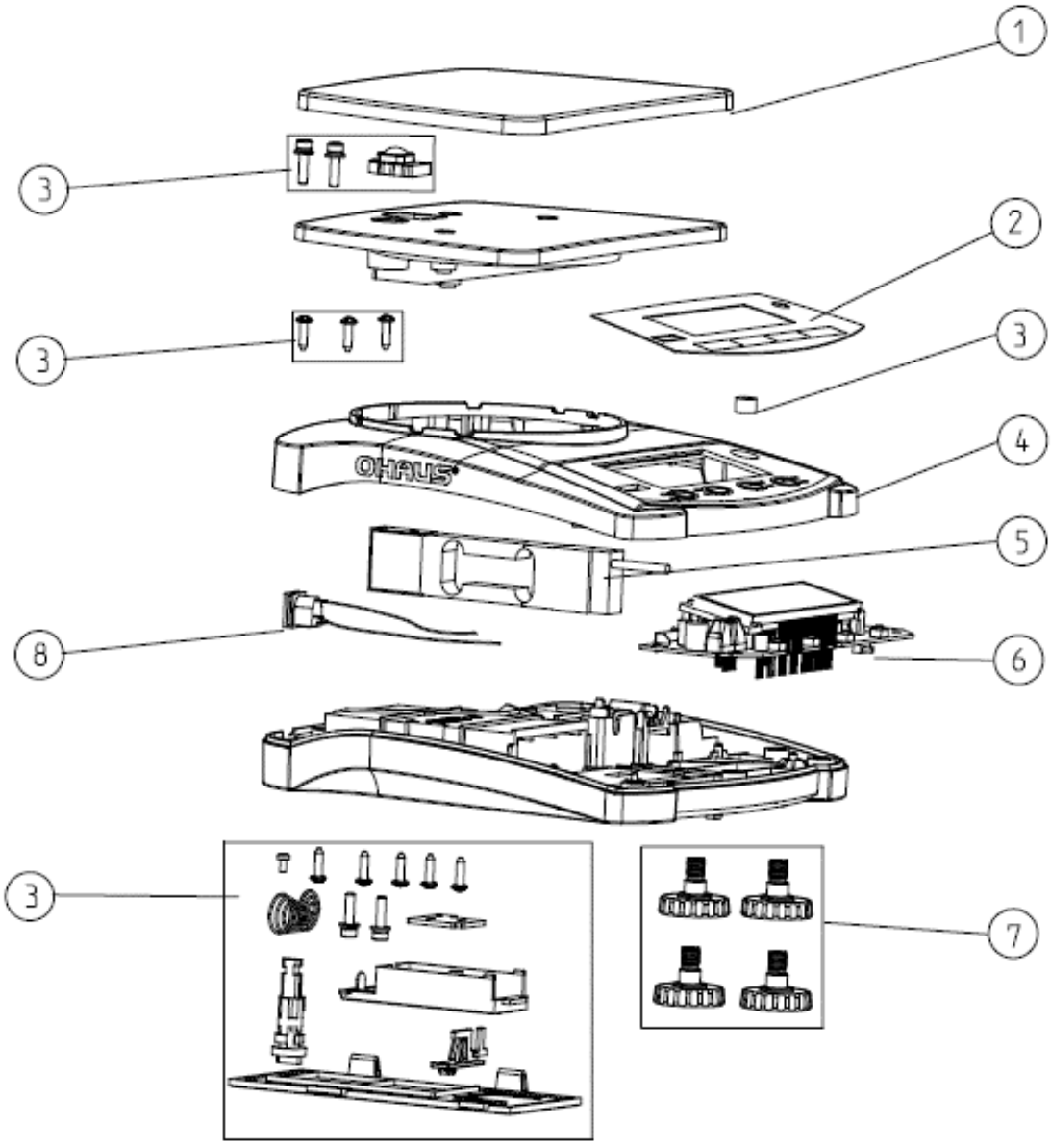


Figure 5-1. Navigator NV Spare Parts

TABLE 5-1 Navigator NV Spare Parts

Drawing Item	Description
1a	Pan Spare SUS Square NV NVT
1b	Pan Spare SUS Round NV NVT
2	Overlay Spare RU NV NVT
	Overlay Spare EN No IR NV NVT
	Overlay Spare EN One IR NV NVT
	Overlay Spare CN NV NVT
3	Hardware Kit Spare NV NVT
4	Top Housing Assembly Spare NV
5	Loadcell Spare Rated 0.5kgx0.01g NV
	Loadcell Spare Rated 1kgx0.01g NV
	Loadcell Spare Rated 3kgx0.1g NV
6	PCBA Spare 2Laye No IR NV NVT
	PCBA Spare 2Layer 1IR NV NVT
7	Feet
8	CableKit
NS	PowerAdapter(noplugs)
NS	PowerAdapterPlugSet
NS	PWR,Something 12V 0.5A UK PLUG
NS	Box, DS, STX SPX SKX SJX/E SJX
NS	Carton Spare 300x250x182mm Ohaus style

5.2 SPARE PARTS NVT

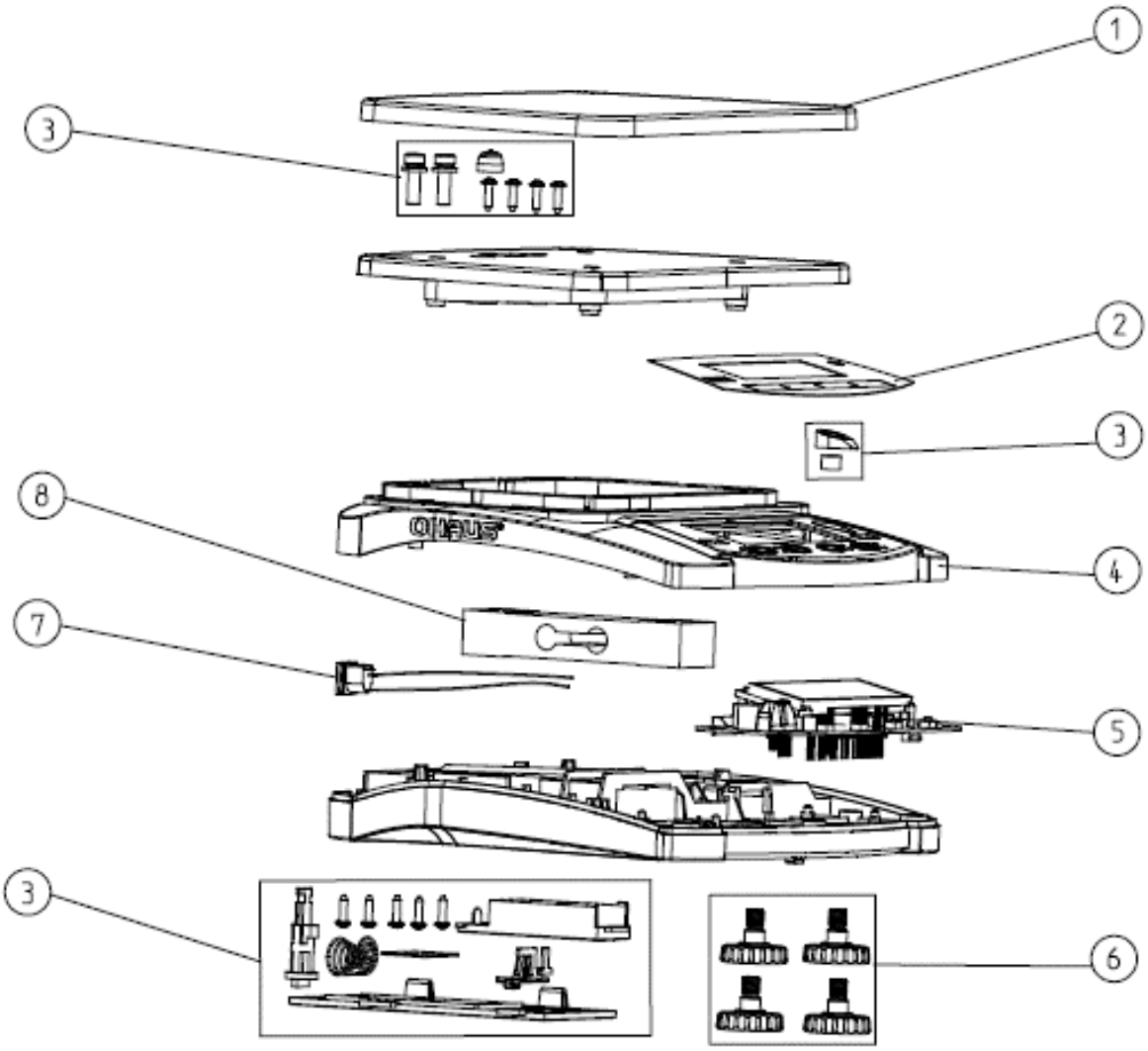
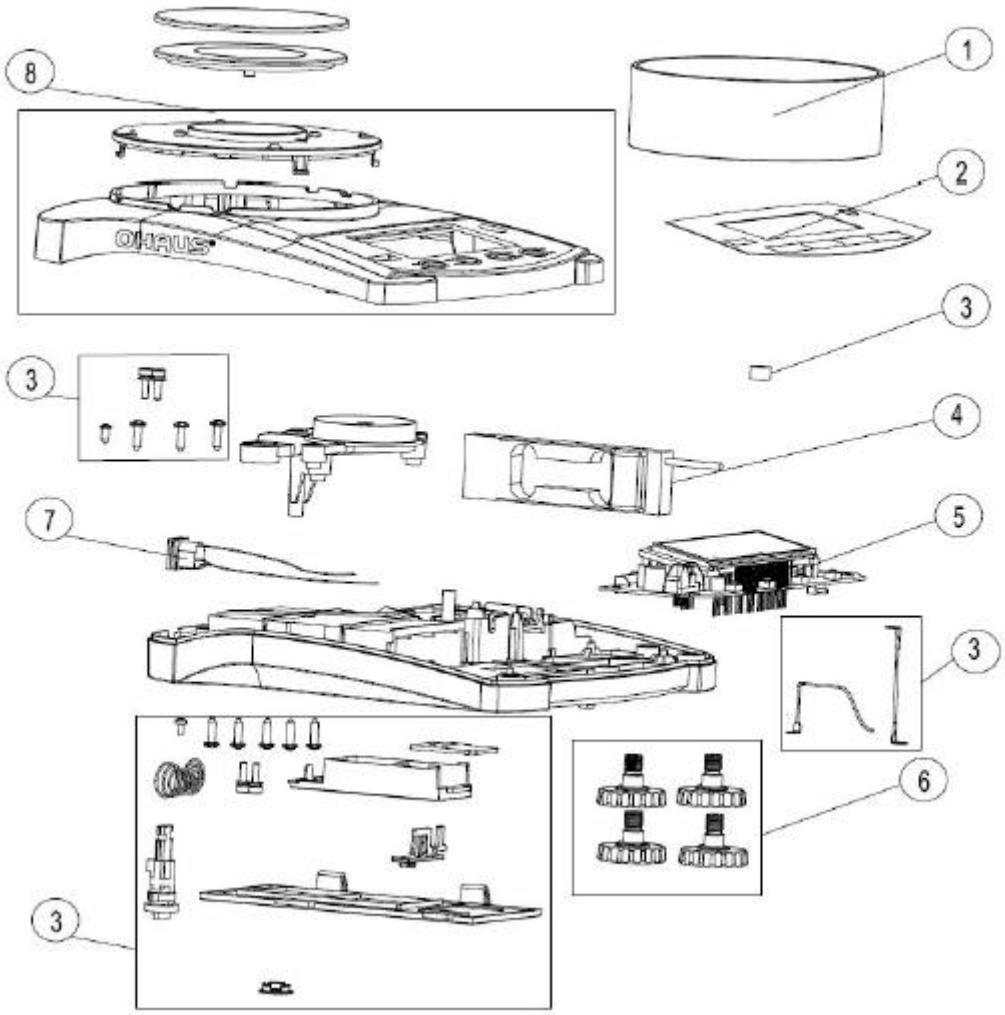


Figure 5-2. Navigator NVT Spare Parts

TABLE 5-2 Navigator NVT Spare Parts

Drawing Item	Description
1	Pan Spare SUS Square NV NVT
2	Overlay Spare RU NV NVT
	Overlay Spare EN No IR NV NVT
	Overlay Spare EN One IR NV NVT
	Overlay Spare CN NV NVT
3	Hardware Kit Spare NV NVT
4	Top Housing Assembly Spare NVT
5	PCBA Spare 2Laye No IR NV NVT
	PCBA Spare 2Layer 1IR NV NVT
6	Feet
7	CableKit
8	Loadcell Spare Rated 6kgx0.1g NVT
	Loadcell Spare Rated 10kgx0.1g NVT
	Loadcell Spare Rated 35kgx1g NVT
NS	PowerAdapter(noplugs)
NS	PowerAdapterPlugSet
NS	PWR,Something 12V 0.5A UK PLUG
NS	Box,Shipping

5.3 SPARE PARTS NVHD with Draftshield



Drawing Item	Description
1	Wind Ring NVHD
2	Overlay EN No IR NV NVT
	Overlay EN One IR NV NVT
3	Hardware Kit NV NVT
4	Load Cell LAK-B-300g-M NVHD
5	PCB Main One IR sensor NVHD
	PCB Main No IR sensor NVHD
6	Feet
7	CableKit
8	Housing Top w/ EMC plate NVHD
NS	PowerAdapter(noplugs)
NS	PowerAdapterPlugSet
NS	PWR 12V 0.5A UK PLUG
NS	Box, DS, STX SPX SKX SJX/E SJX
NS	Carton 300x250x182mm Ohaus style

NOTE: PELASE FIND THE SPARE PART VIA MODEL IN THE SPARE PART LIST DOCUMENT.

APPENDIX A. STANDARD CALIBRATION

A.1 SPAN CALIBRATION

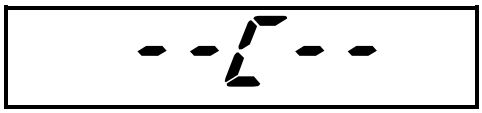
Standard calibration should be performed prior to using a scale, and after service.
See Section 4.1 for Calibration Masses required for each model.

Note: This menu is locked out in Legal for Trade applications. To regain access, see Section 1.6.5.

Note:
Be careful not to touch the scale or the table while calibration is in progress, as it will cause the process to fail.

1. With scale powered on, press and hold the **MENU** button until *MENU* appears. When the button is released *.CAL.* will then be displayed.

2. Press **Yes** to enter the sub-menu. *SPAN* will be the first menu item. Press **Yes** again to accept, the display will show a flashing *--C--* while the zero point weight data is stored.



3. The specified calibration weight value will appear. Place the weight on the pan. Note: Early production scales scales require a **Yes** press to start the calibration.
   The display shows *--C--* while the span point weight data is stored.

4. When calibration is complete, the display shows done, and then returns to the previous application mode and scale is ready for use.

NOTE: If calibration fails, ensure that the test area is free from drafts and the surface the scale rests on is level and free of vibrations. Then try to calibrate again. If it continues to fail, there may be an internal problem. To resolve internal problems, follow procedures in Chapters 2 and 3.

A.2 LINEARITY CALIBRATION

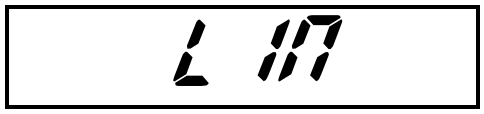
Note: This menu is locked out in Legal for Trade applications. To regain access, see Section 1.6.5.

See Section 4.1 for Calibration Masses required for each model.

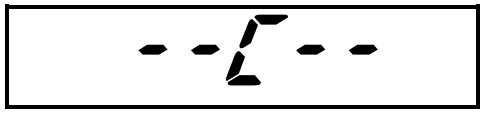
Note:
Be careful not to touch the scale or the table while calibration is in progress, as it will cause the process to fail.

1. With scale powered on, press and hold the **MENU** button until *MENU* appears. When the button is released *.CAL.* will then be displayed.

2. Press **Yes** to enter the sub-menu. *SPAN* will be the first menu item. Press **No** to advance to the *LIN* menu item.



3. Press **Yes** to accept, the display will show a flashing *--C--* while a zero point weight data is stored.



4. The first linearity calibration point weight value will appear. Place the weight on the pan. Note: Early production scales required a **Yes** press to continue.
   The display shows *--C--* while the weight data is stored.

5. The second linearity point weight value will appear. Place the weight on the pan. Note: Early production scales require a **Yes** press to start the calibration.
   The display shows *--C--* while the weight data is stored.

6. When calibration is complete, the display shows done, and then returns to the previous application mode and scale is ready for use.

NOTE: If calibration fails, ensure that the test area is free from drafts and the surface the scale rests on is level and free of vibrations. Then try to calibrate again. If it continues to fail, there may be an internal problem. To resolve internal problems, follow procedures in Chapters 2 and 3.

APPENDIX B. SERVICE MENU

This section describes the Service Menu and sub-menus, which allow authorized service personnel to perform factory Linearity and Span calibrations (no pre-set limits).

B.1 ENTERING THE SERVICE MENU

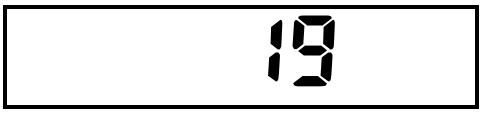
Turn the scale off.

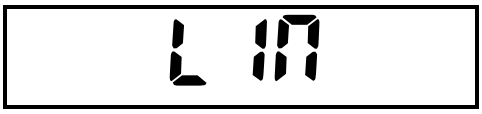
Enter the Service Menu by pressing and holding **Zero/On** and **Tare** together until rAMP appears. This will take approximately 8 seconds.
Press **Yes** to select **Ramp**.

B.2 RAMP

The ramp display shows the percentage of use of the A to D circuit, that is, of the temperature-compensated duty cycle. The actual value is not as important as how it changes. It should increase as the weight on the scale is increased. The ramp display should remain constant without fluctuations.

If you press **Yes** to select **Ramp**, a number appears. It should be constant. Add masses from minimum to maximum capacity. The reading will increase, but should not fluctuate. The example at right is with no weight on the Pan. It will vary with other scales.
To exit the ramp function, press **Yes**.
The scale advances to the **Linear** calibration menu.
Press **Yes** to perform Linear Calibration.



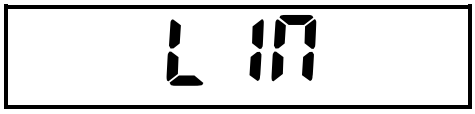


B.3 LINEAR CALIBRATION

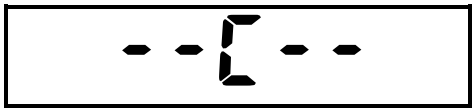
Linear calibration automatically follows Ramp. To start from the Service Menu, press and hold **Zero/On** and **Tare** together. As the scale powers up, **RAMP** appears. Press **No** to bypass Ramp. Service Linearity does not have limit ranges on the weights used as does the standard user linearity procedure.

Note:
Be careful not to touch the scale or the table while calibration is in progress, as it will cause the process to fail.

When LIN appears, press **Yes**.

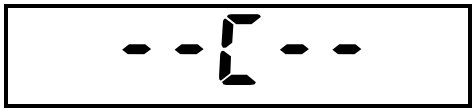


The display shows --C-- while the scale acquires the zero point weight data.



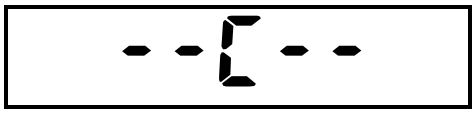
The display then shows the first calibration point value. Place the indicated weight on the Pan, and press **Yes**.

The display shows --C-- while the scale acquires the weight data.



After the first calibration point value is acquired, the display shows the second calibration point value.

Pressing **Yes** after placing the prompted weight accepts the second linearity calibration point weight. The display shows --C-- while the scale acquires the weight data.



After the second linearity calibration point weight value is acquired, the display shows **done** for 2 seconds and advances to SPAN.

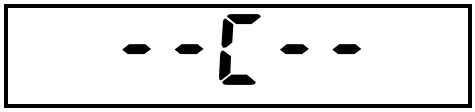
Press **Yes** to confirm a span calibration.

B.4 SPAN CALIBRATION

Span calibration from the service menu allows you to set a new zero and maximum setting. This is distinct from user level span calibration, which allows a user to adjust the zero and maximum setting within the range established by the service menu span setting.
Span calibration automatically follows linear calibration. To start from the Service Menu, press and hold **Zero/On** and **Tare** together. As the scale powers up, rAMP appears. Press **No** to bypass Ramp, when L in appears press **No**.

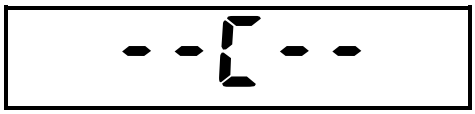
SPAN appears. Press **Yes**.

The display shows --C-- while the scale acquires the zero point weight value.



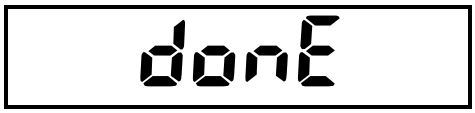
The specified span weight flashes.
Place the indicated weight in the center of the Pan.

Pressing **Yes** after placing the prompted weight accepts the span weight shown on the display. The display then shows --C-- while the scale acquires the span point



weight data.

After the span value is acquired, the display shows **done** for 2 seconds and advances to **GEO**. (To exit the Service Menu, press **No** until **End** appears. Then press **Yes**.)



NOTE: If calibration fails, ensure that the test area is free from drafts and the surface the scale rests on is level and free of vibrations. Then try to calibrate again. If it continues to fail, there may be an internal problem. To resolve internal problems, follow procedures in Chapters 2 and 3.

B.5 GEOGRAPHICAL ADJUSTMENT FACTOR (GEO)

The Geo Factor adjustment allows entry of values from 0 to 31 and is used to compensate for slight variations in gravity at different geographical locations around the world.
This feature allows authorized personnel to accurately calibrate the scale at a location other than the location where the scale is to be used. Prior to calibration, the Geo Factor is set to correspond to the geographical location where the calibration is being performed. Following calibration, the Geo Factor is changed to match the location where the scale is to be used. If required, the scale may also be sealed according to the required approval regulations.

NOTE:
Only an authorized manufacturer's representative or certified verification personnel should make these changes. Changing the Geo Factor alters the calibration values.

In the Service Menu, press **No** until **GEO** appears.

Press **Yes** to edit the GEO setting. The current setting is the first to be shown. NOTE: Factory setting for GEO is 13 in general and 19 for Europe

See Appendix D to determine the correct Geo value. Values from 1 to 31 are available. **No** will increase the GEO value while **Back** will decrease it. Press **Yes** to accept the value shown on the display. The menu returns to the next item, **Filter**

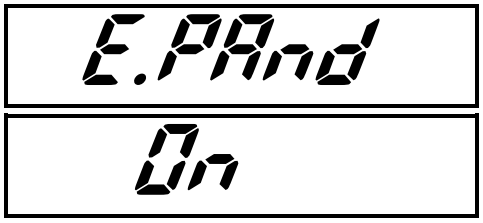
B.6 LFT

Press **Yes** to enter the LFt setting menu, OFF appears. Press **No** to toggle the setting, On appears.
Pressing **Yes** again accepts the On setting.
When the Service Menu is exited the scale will be with LFT setting until it is turned off in the Service Menu.

B.7 EXPANDED RESOLUTION (E.PAnd)

Expand reading is the internal calculation result, which should be up and down following with the Ramp changes.

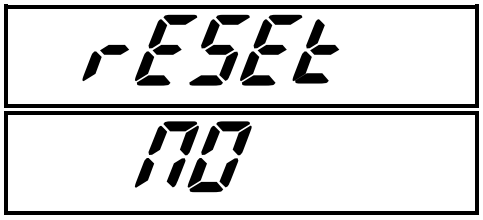
Press **Yes** to enter the E.PAnd setting menu, OFF appears. Press **No** to toggle the setting, On appears.
Pressing **Yes** again accepts the On setting.
When the Service Menu is exited the scale will read with expanded resolution until it is turned off in the Service Menu.



B.8 RESET

rESEt returns the scale to its factory default conditions. All the user and service settings will return to the factory defaults. All reference weights, average piece weights and set points will be reset.
In the Service Menu, press **No** until rESEt appears.

Press **Yes** to enter the rESEt setting menu, no appears. Press **No** to toggle the setting, YES appears.
To accept a chosen setting (either **No** or **Yes**) press **Yes**. The display will advance to the next menu item, **End**.



APPENDIX C. SERVICE TOOL

The Software Service Tool (Part Number 83032124) is required when a main PC Board is replaced in a Navigator scale. It is used to re-configure the scale to its original parameters in the case of a PCB replacement.

Note: NVHD models are separated from NV general models in service tool, since the configuration and software are both different.

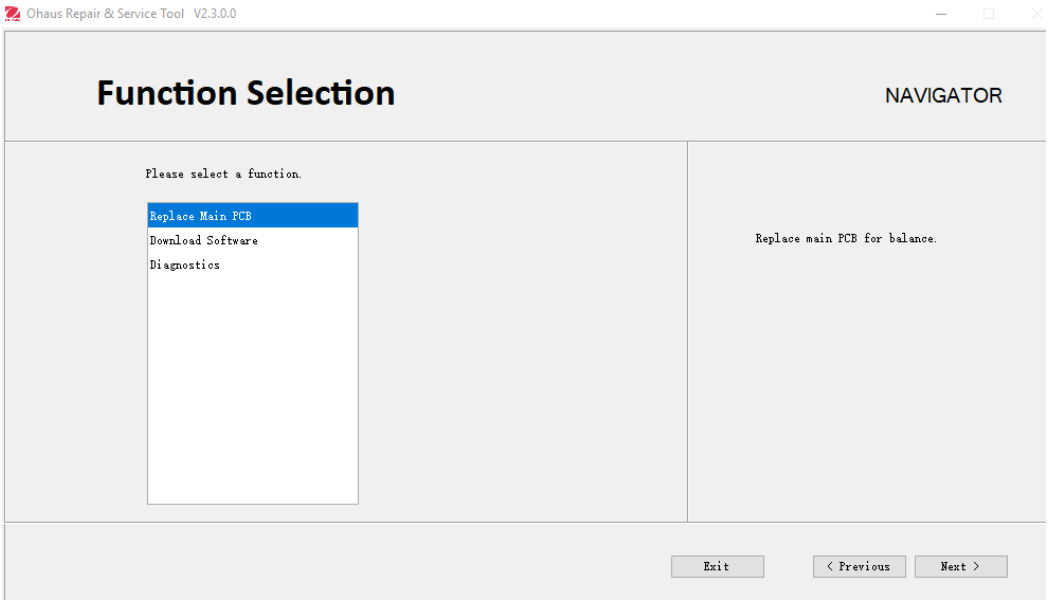
The latest software service tool and support files are available on the Ohaus DMX site.

Tools to connect the scale with computer

1. RS233 Interface Kit – PN 83032107 (USB Interface Kit – PN 83032108 is not fit for software upgrade)

C.1 HARDWARE AND SOFTWARE SETUP

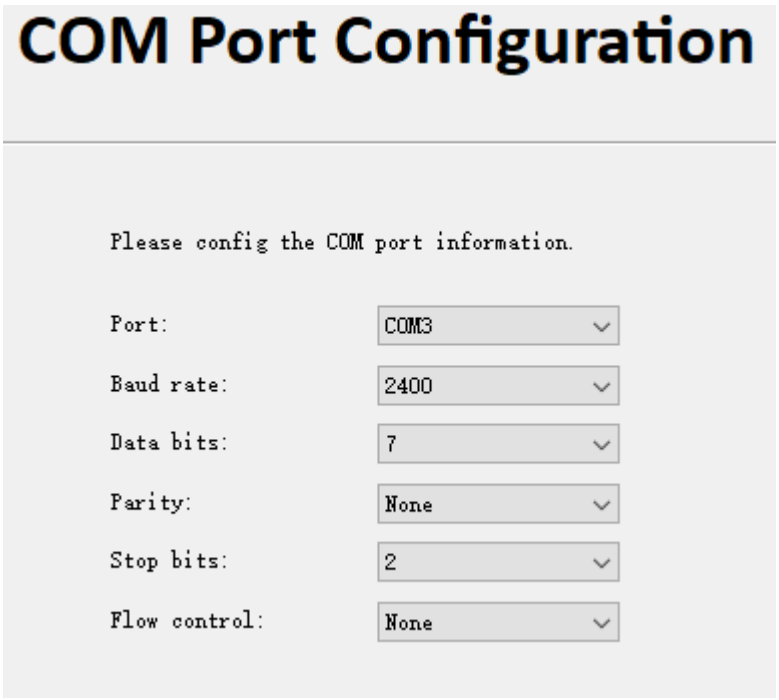
1. First, check that the scale's **A-Off** feature, under the **SETUP** menu, is set to **OFF**.
   If this setting is left **ON,** the scale will shut off during configuration.
2. Install the RS232 Interface Kit into the scale. Follow the instructions in the RS232 Interface Kit User Manual.
3. Plug the cable into the PC's RS232 or the USB port, which need another cable PN 30304101 (RS232 - USB).
4. Install the software on the PC.
5. Download the Service Software ZIP file from the Ohaus DMX Navigator (New) directory.
6. Place the Zip file in its own directory on the PC, un-Zip the file.
7. Run the program Service Tool with the version V2.3.0.0 or later.
8. Go to Repair Tool ➡ NAVIGATOR, you will see the Function Interface.



C.2 REPLACE PCB/ CONFIGURING THE SCALE

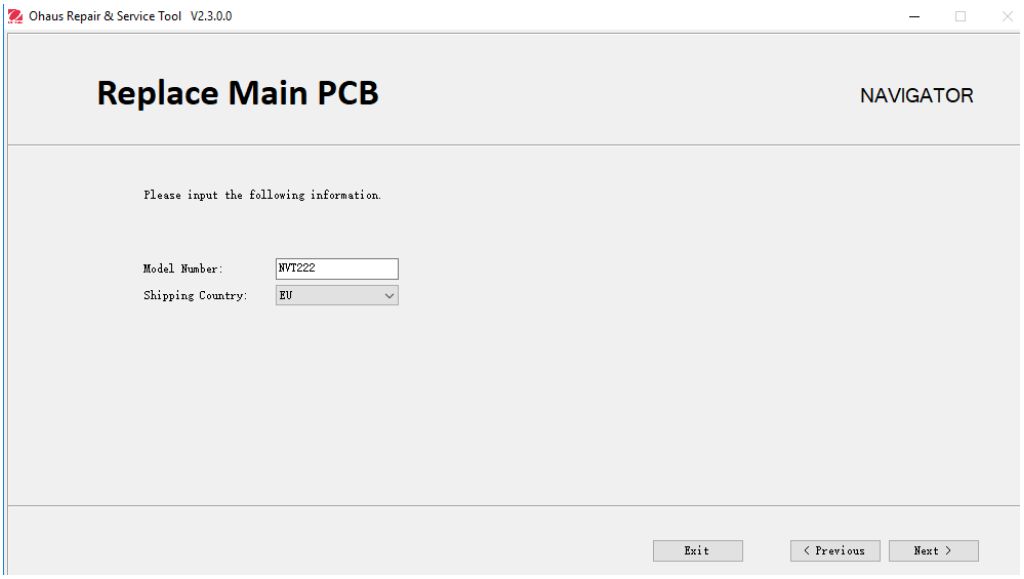
If the PC Board has been replaced, the scale needs to be configured. The software tool will send the PCB the required data for the Model Name entered.

1. Continue from the Procedure 8 in C.1 section, select **Replace Main PCB** and input the COM Port Configuration



Note: NV models are with the setting 2400 7 none 2; NVHD models with 9600 8 none 1.

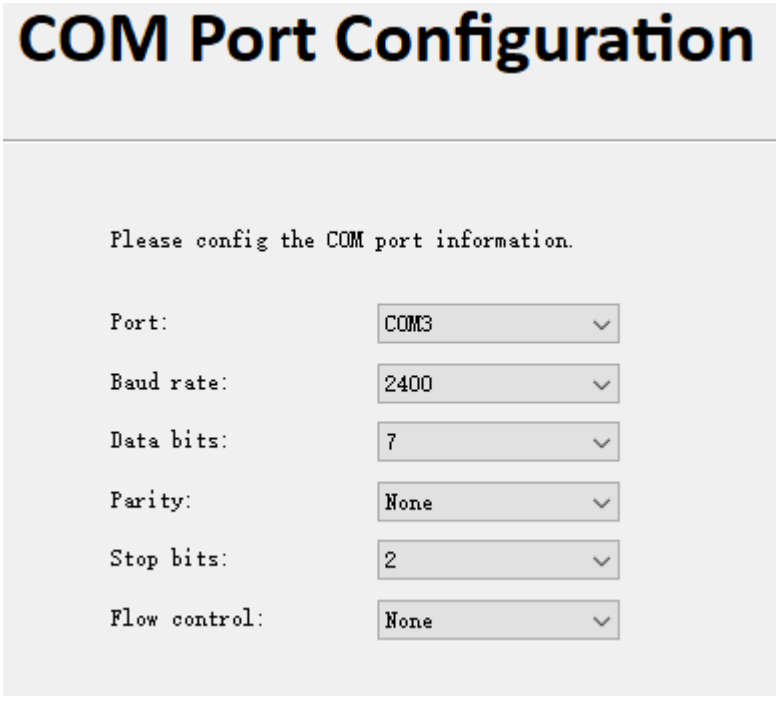
2. Input the Model Name and shipping Country (depend on the model), then click Next



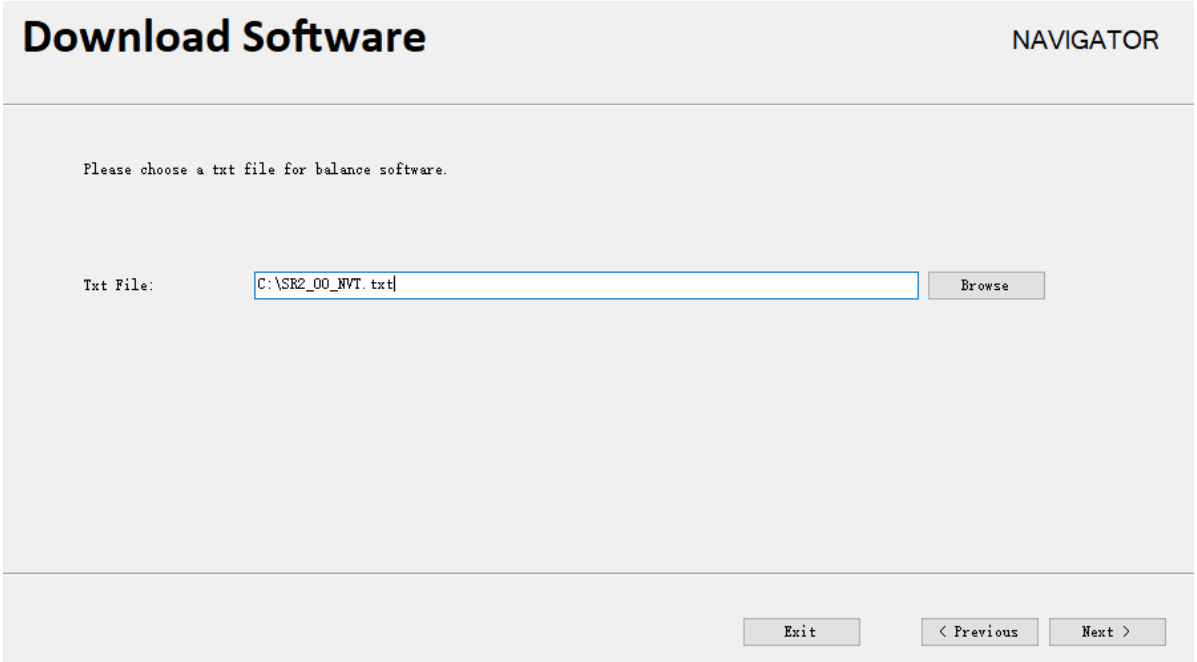
3. Click Finish, when the configuration process is completed.

C.3 DOWNLOAD SOFTWARE

1. Continue from the Procedure 8 in C.1 section, select **Download Software** and input the COM Port Configuration



2. Select the software and click "Next"



3. Cycle the power and press button "Zero" for the software download.
4. When the downloading is complete, turn the scale off.
5. Turn the scale on and perform a Service Calibration (see Appendix B), followed by Operational and Performance tests (Chapter 4).

TABLE C3-1. MODELS AND SOFTWARE MATCHING

Model	**30481498_SR2.xx.txt**
NV222	Y
NV422	Y
NV622	Y
NV221	Y
NV621	Y
NV1201	Y
NV2201	Y
NVT2201	Y
NVT4201	Y
NVT6201	Y
NVT2200	Y
NVT6200	Y
NVT12000	Y
NVT22000	Y
NVT1601M	Y
NVT3200M	Y
NVT6400M	Y
NVT16000M	Y

Model	30645900_SR1.xx_ NVHD.mot	30645899_SR1.xx_ NVHD.mot
NV123	Y	
NV223	Y	
NV323	Y	
NV1202		Y
NV2202		Y
NV3202		Y
NVT10201		Y

C.4 DIAGNOSTICS

1. Continue from the Procedure 8 in C.1 section, select **Diagnostics**
2. Enter the Command and click **Send** to get the response in the right box

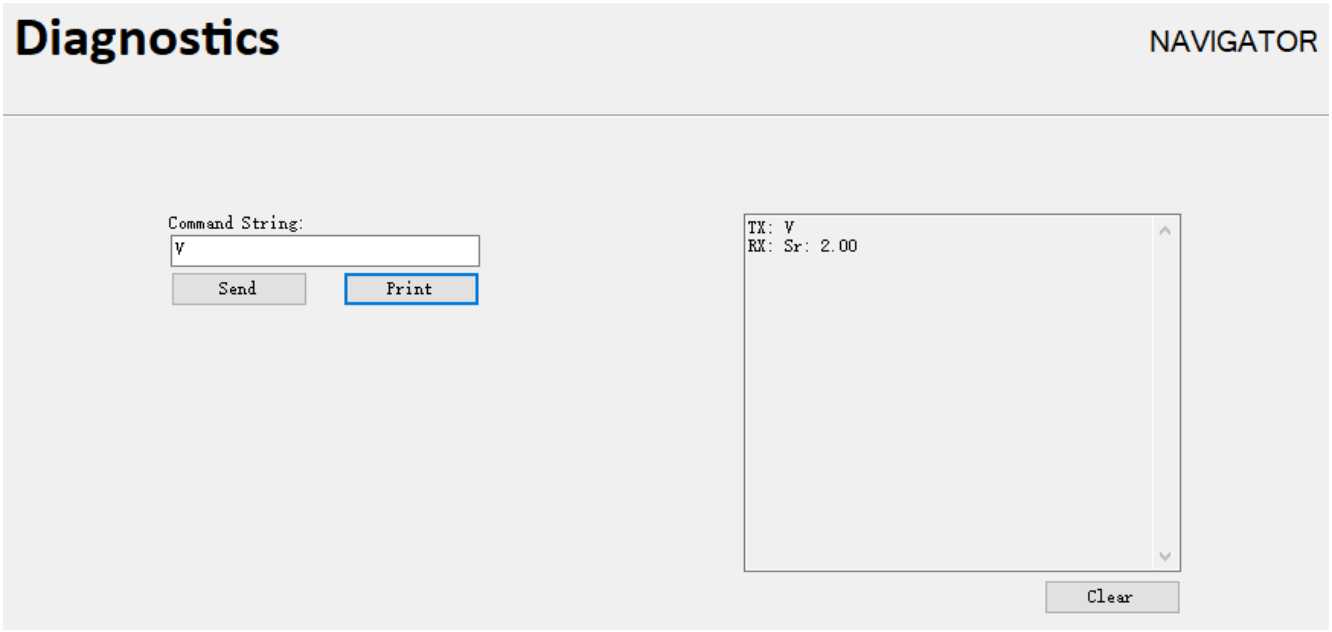


Figure C-3. Diagnostic screen

Enter a “V” command. The response should be the software version (*e.g.,* Sr: 2.00).

APPENDIX D. GEOGRAPHICAL ADJUSTMENT VALUES

TABLE D-1. GEOGRAPHICAL ADJUSTMENT VALUES.

	Elevation above sea level in meters										
Geographical latitude away from the equator (North or South), in degrees and minutes.	0 325	325 650	650 975	975 1300	1300 1625	1625 1950	1950 2275	2275 2600	2600 2925	2925 3250	3250 3575
	Elevation above sea level in feet										
	0 1060	1060 2130	2130 3200	3200 4260	4260 5330	5330 6400	6400 7460	7460 8530	8530 9600	9600 10660	10660 11730
0°00′ - 5°46′	5	4	4	3	3	2	2	1	1	0	0
5°46′ - 9°52′	5	5	4	4	3	3	2	2	1	1	0
9°52′ - 12°44′	6	5	5	4	4	3	3	2	2	1	1
12°44′ - 15°06	6	6	5	5	4	4	3	3	2	2	1
15°06′ - 17°10′	7	6	6	5	5	4	4	3	3	2	2
17°10′ - 19°02′	7	7	6	6	5	5	4	4	3	3	2
19°02′ - 20°45′	8	7	7	6	6	5	5	4	4	3	3
20°45′ - 22°22′	8	8	7	7	6	6	5	5	4	4	3
22°22′ - 23°54′	9	8	8	7	7	6	6	5	5	4	4
23°54′ - 25°21′	9	9	8	8	7	7	6	6	5	5	4
25°21′ - 26°45′	10	9	9	8	8	7	7	6	6	5	5
26°45′ - 28°06′	10	10	9	9	8	8	7	7	6	6	5
28°06′ - 29°25′	11	10	10	9	9	8	8	7	7	6	6
29°25′ - 30°41′	11	11	10	10	9	9	8	8	7	7	6
30°41′ - 31°56′	12	11	11	10	10	9	9	8	8	7	7
31°56′ - 33°09′	12	12	11	11	10	10	9	9	8	8	7
33°09′ - 34°21′	13	12	12	11	11	10	10	9	9	8	8
34°21′ - 35°31′	13	13	12	12	11	11	10	10	9	9	8
35°31′ - 36°41′	14	13	13	12	12	11	11	10	10	9	9
36°41′ - 37°50′	14	14	13	13	12	12	11	11	10	10	9
37°50′ - 38°58′	15	14	14	13	13	12	12	11	11	10	10
38°58′ - 40°05′	15	15	14	14	13	13	12	12	11	11	10
40°05′ - 41°12′	16	15	15	14	14	13	13	12	12	11	11
41°12′ - 42°19′	16	16	15	15	14	14	13	13	12	12	11
42°19′ - 43°26′	17	16	16	15	15	14	14	13	13	12	12
43°26′ - 44°32′	17	17	16	16	15	15	14	14	13	13	12
44°32′ - 45°38′	18	17	17	16	16	15	15	14	14	13	13
45°38′ - 46°45′	18	18	17	17	16	16	15	15	14	14	13
46°45′ - 47°51′	19	18	18	17	17	16	16	15	15	14	14
47°51′ - 48°58′	19	19	18	18	17	17	16	16	15	15	14
48°58′ - 50°06′	20	19	19	18	18	17	17	16	16	15	15
50°06′ - 51°13′	20	20	19	19	18	18	17	17	16	16	15
51°13′ - 52°22′	21	20	20	19	19	18	18	17	17	16	16
52°22′ - 53°31′	21	21	20	20	19	19	18	18	17	17	16
53°31′ - 54°41′	22	21	21	20	20	19	19	18	18	17	17

TABLE D-1. GEOGRAPHICAL ADJUSTMENT VALUES.

	Elevation above sea level in meters										
Geographical latitude away from the equator (North or South), in degrees and minutes.	0 325	325 650	650 975	975 1300	1300 1625	1625 1950	1950 2275	2275 2600	2600 2925	2925 3250	3250 3575
	Elevation above sea level in feet										
	0 1060	1060 2130	2130 3200	3200 4260	4260 5330	5330 6400	6400 7460	7460 8530	8530 9600	9600 10660	10660 11730
54°41′ - 55°52′	22	22	21	21	20	20	19	19	18	18	17
55°52′ - 57°04′	23	22	22	21	21	20	20	19	19	18	18
57°04′ - 58°17′	23	23	22	22	21	21	20	20	19	19	18
58°17′ - 59°32′	24	23	23	22	22	21	21	20	20	19	19
59°32′ - 60°49′	24	24	23	23	22	22	21	21	20	20	19
60°49′ - 62°09′	25	24	24	23	23	22	22	21	21	20	20
62°09′ - 63°30′	25	25	24	24	23	23	22	22	21	21	20
63°30′ - 64°55′	26	25	25	24	24	23	23	22	22	21	21
64°55′ - 66°24′	26	26	25	25	24	24	23	23	22	22	21
66°24′ - 67°57′	27	26	26	25	25	24	24	23	23	22	22
67°57′ - 69°35′	27	27	26	26	25	25	24	24	23	23	22
69°35′ - 71°21′	28	27	27	26	26	25	25	24	24	23	23
71°21′ - 73°16′	28	28	27	27	26	26	25	25	24	24	23
73°16′ - 75°24′	29	28	28	27	27	26	26	25	25	24	24
75°24′ - 77°52′	29	29	28	28	27	27	26	26	25	25	24
77°52′ - 80°56′	30	29	29	28	28	27	27	26	26	25	25
80°56′ - 85°45′	30	30	29	29	28	28	27	27	26	26	25
85°45′ - 90°00′	31	30	30	29	29	28	28	27	27	26	26

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