Procedure, Field Replacement, Level Cage, Side Exit

Approval:

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Revision History

Rev.	ECO	Description of Change	Date
A	8791	Initial release	08-05-2011
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1. Brief Summary:

Troubleshooting document for diagnosing a fault with and replacing the level cage assembly.

2. Checklist:

- Verify Remote Tilt
- Verify Initialization
- Verify Sensor Outputs using DacRemP
- Azimuth and Relative Targeting
- Drift and Sensor Monitoring

3. Theory of Operation:

The level cage contains 4 sensors, a fluid filled tilt sensor which is used as the systems horizon reference (level position) as well as long term stabilization reference, and 3 solid state rate sensors; one for each axis which act as the antennas short term stabilization reference. A faulty sensor inside the level cage will cause the antenna to lose stability and mispoint from the satellite under dynamic conditions. However, the system may appear to be operational in the port when there is no motion to counteract. This document will run through testing the sensors inside the level cage, replacing the level cage assembly and calibrating the systems remote tilt setting.

4. Verify Remote Tilt:

If the pedestal is having stability problems, firstly, check the remote tilt setting by looking at the level bubble on top of the level cage (note: older systems didn't have a bubble installed on top of the level cage). It is only possible to do so when the vessel is stationary. If the bubble isn't as close to central as possible, the remote tilt setting isn't correctly calibrated meaning the rate sensors won't be correctly aligned with their axis. This will cause the rate sensors to output incorrect feedback into the PCU's control loop, potentially causing a stabilization issue. Calibrate the remote tilt setting as per the instructions at the end of this document and continue to test the level cage using the follow procedures.

5. Verify Initialization:

- Power cycle the pedestal
    1. Brakes release (if applicable)
    2. Level cage drives to its end stop and then backs off exactly 45 degrees. El is tracked based on steps issued by transistors in the PCU.
    3. Elevation axis drives to 45 degrees based on feedback from the level cages tilt sensor.
    4. Cross level axis drives to level, again based on feedback from the tilt sensor.
    5. Unlimited azimuth systems drive clockwise until the hall affect sensor/switch sees the home flag (magnet or notch) on the AZ drive pulley.
    6. Limited azimuth systems drive clockwise into the end-stop then drives CCW away from the stop. If a 6003A/6004 system, the REL would at this point be 580.0 degrees.

If any of these steps fail, or the ACU reports model "xx03/xx97", the antennas No parameter needs calibrating. Once entered, verify that the parameter has saved correctly to the PCU's NVRAM. A motor drive issue or pedestal error requires further troubleshooting.

6. Verify Stabilization:

Using the below procedure we will physically move the systems axis under static conditions, thus introducing an error into the PCU's control loop. This will allow us to verify that the system is able to return to its level position (stabilize itself) efficiently. We are able to monitor the sensor outputs on DacRemP to observe what is happening, or we can just watch the pedestal and observe how it responds.

1. Turn dishscan and tracking off. Select the DISP_V chart of DacRemP; you will see the current output from the tilt sensor in graph form. Once a remote tilt has been set and when in stable conditions, the trace should be stable and no more than +/- 4 divisions from the red reference line. If outside this limit then re-check the remote tilt and then if necessary, replace and re-calibrate the level cage.
2. Verify Cross Level response:

   Push the cross level beam down to the left (CCW) and hold it in position. Verify that the CL trace on DacRemP moves down an equal amount to the movement exerted on the axis. Release the CL beam and verify that the DacRemP trace returns back to its original position, without deviating or taking time to settle. Now push the cross level beam down to the right and hold it in position. This time verify that the CL trace on DacRemP moves up an equal amount to the movement exerted on the axis. Release the Axis and verify the DacRemP trace and cross level beam return back to their original positions, without deviating or taking time to settle.
3. Verify Level (Elevation) response:

   Push the reflector up in Elevation and hold it in position. Verify that the LV trace on DacRemP moves down an equal amount to the movement exerted on the axis. Release the axis and verify the DacRemP trace returns (or the systems axis returns) back to its original position, without deviating or taking time to settle. Push the reflector down in elevation and hold it in position. Verify that the LV trace on DacRemP moves up an equal amount to the movement exerted on the axis. Release the axis and verify the DacRemP trace returns (or the systems axis returns) back to its original position, without deviating or taking time to settle.

If using DacRemP the trace should look similar to the image to the left. Note how after each movement the system returns to its level position efficiently without taking time to settle.

7. Rate Sensor Monitoring:

Rate sensor outputs can also be monitored using the DISP_W screen of DacRemP to verify any deviations under static conditions. The traces should remain consistent. Any drifting or spikes are an indication the sensors voltage output is changing and the sensor is defective (provided no forces are being exerted on the system). Normal trace is +/- 1 division from red line.

8. Azimuth Targeting:

Should the antenna have issues targeting in azimuth, such as not accurately finding the satellite or repeatedly finding the satellite in different azimuth positions, then it's important to diagnose if the system is mispointing in azimuth or relative. Relative feedback from the AZ encoder can be verified by initializing the system, verifying it calibrates itself correctly and then driving the pedestal clockwise in 90 degree increments over a 360 degree rotation. Make note that the system points correctly (bow, starboard, aft, port, bow and starboard) and that no AZ reference error is flagged by the PCU. A mechanical problem such as the belt slipping on the pulley could also cause this kind of error, as could some other mechanical issue. Skewing the antenna in azimuth by holding the right or left arrow key to drive the antenna slowly may also present an issue.

If the system keeps finding the satellite at different azimuth positions but at the same relative, the encoder is functioning correctly and one of the reference inputs (Level cage, gyro) to the PCU is causing the antenna to mispoint.

9. Drift:

Another failure which can occur is if a rate sensor starts drifting; this means the sensors voltage output deviates from what the PCU is expecting under stable condition (2.50VDC). This fault will introduce an error into the control loop. It is more common to see this in the Azimuth axis as the CL and EL axis have the tilt sensor as their long term reference (although should the rate sensors drift be large enough to overpower the tilt sensor you would see the system driving into one of the CL or EL end stops). This is more noticeable with tracking turned off.

To verify if the system is drifting in Azimuth, first turn off tracking and then monitor the relative position. Under static conditions (the vessels heading isn't changing) the relative should remain still. If the relative value begins to increase/decrease from its nominal position then the azimuth rate sensor is drifting, creating an error into the PCU's control loop. This will cause the PCU to believe the vessels heading is changing and in turn drive the azimuth axis in the opposite direction to compensate.

10. Diagnostics:

Any incorrect readings from the above tests would relate to an error in the antennas control loop causing the system to not stabilize correctly. The most likely cause of this is a defective sensor in the level cage. The next step would be to replace and re-calibrate the level cage. Now repeat the failed test to verify that the system is now functioning correctly.

Should the problem remain, another possible cause may be a fault with the reference harness between the level cage and PCU. The PCU itself should not be ruled out as faulty either. Even so, the level cage is the most likely component to be causing this issue, therefore replacing it is the first step when troubleshooting.

Once the problem has been rectified, it is good practice to refit the original level cage and see if the fault returns. It is possible that corrosion on the pins of the reference harness and/or connectors of the PCU/level cage caused the initial fault. By connecting the replacement level cage, it is likely that any pin corrosion may have rubbed off, creating a cleaner electrical contact. You may have been under the impression that replacing the level cage rectified the fault when in actual fact; the issue was a poor electrical contact causing varying resistance.

11. Further Information:

Should the system fail to target the correct elevation (physically pointing at a different position to the reading on the DAC), or have issues driving past a certain elevation position then the most likely cause is a defective level cage motor.

If the system is displaying a pedestal error (error 8), there is a drive issue with the antenna and attention will need to be paid to the motor and motor driver (servo amp) for the relevant axis. There is no error code that directly tells you if the level cage or level cage stepper motor has failed, however, a pointing or stabilization issue is a good indication.

Another potential issue which could cause the antenna to lose the satellite is if the vessels gyro compass is drifting. This accumulating error is then fed into the control loop. This can be verified by running a DacRemP log file at sea to monitor the pedestals readings when the AGC drops, or by putting the system into satellite reference mode to uncouple the gyro feed from the azimuth stabilization loop.

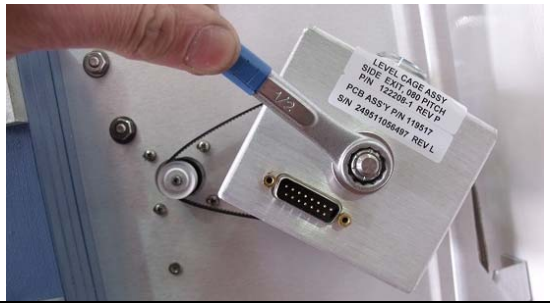
12. Replacing the Level Cage Assembly:

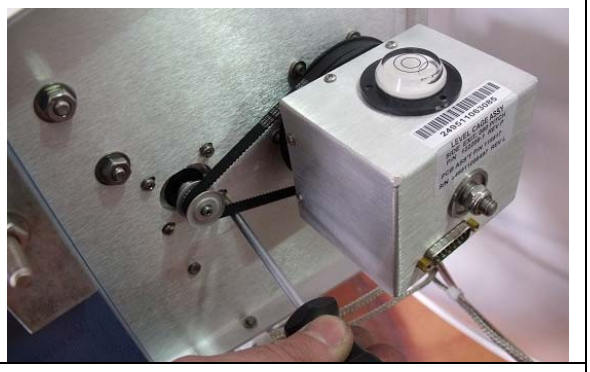
12.1. Tools.

- 2mm Flat Blade (Terminal) Screwdriver
- #1 Phillips Screwdriver
- ½" Wrench/Spanner

12.2. Procedure.

Procedure for replacing the level cage assembly, Sea Tel kit part number: 135344 (level cage assembly part number: 122208-1) and tensioning the level cage belt.

***CAUTION:** Power down the pedestal before following this procedure. 1. Using a 2mm flat blade screwdriver, loosen the screws securing the reference harness D-Sub connector to level cage.	
2. Using a #1 Phillips screwdriver, loosen the four screws attaching level cage motor to the EL pan **(do not fully remove)**.	
3. Using a ½" socket or spanner, remove the Nylock nut securing the level cage to the spindle.	

4. Slide the motor towards the level cage to allow enough slack on the belt to remove it without stressing it. 5. Remove the defective level cage, taking care not to remove the standoff spacer from the spindle.	
6. Install the replacement level cage onto the spindle, slipping the belt over the level cage pulley and making sure its end stops are aligned correctly. 7. Secure it with the 1/2" Nylock nut. When tight (so that there is no horizontal play along the spindle) add an additional ½ a turn for a good ground. Rotate the level cage by hand and verify it has 90 degrees of motion and that the cage rotates freely, ensuring the stops do not rub against the EL pan.	
8. Tension the belt by sliding the motor assembly by hand away from level cage and then tighten the four screws.	
9. A correctly tensioned belt will allow ¼ turn with your fingers. If the belt tension is too tight/loose adjust until correct. 10. If the belt tension is incorrect loosen the screws and re-tension. No Loctite is required as lock washers are used on the securing screws. 11. Re-connect the reference harness to the level cage and tighten the retaining screws, again no need to use Loctite as lock washers are installed on the connector shell.	

13. Calibrating the Remote Tilt Setting:

This procedure is required to calibrate the level cage so that all the sensors will be accurately aligned to their axis. The fluid filled tilt sensor provides a two dimensional horizon reference. The system is not able to automatically calculate the exact center value, therefore it is necessary to perform this procedure to manually enter any offset required to make sure the PCU receives a true horizon reference.

1. Turn dishscan off:

   Enter into the Setup Menu by pressing and holding the  arrows together until the EL Trim or Auto Trim parameter is displayed.

   Use the  arrow key to scroll through the menu until the dishscan window is displayed.

   Press the  arrow to activate the window and then press the  arrow, followed by the  button to turn dishscan from on to off.

   Note: When you press the  arrow to turn dishscan off you won't see the display change until you press the  button.

(*Steps 2-7 requires assistance to observe and operate antenna simultaneously*)

2. Enter into the Setup Menu by pressing and holding the  arrows together until the EL Trim or Auto Trim parameter is displayed.

3. Push the  arrow key until the Remote Tilt window is displayed.

4. Push the  arrow key to activate the Remote Tilt setting.

5. Use the arrow keys to position the bubble as close to the center as possible. Each press of an arrow key on the directional pad will move the Remote Tilt ½ a degree. It is advised that you only press the button once and wait for the axis to move before pressing it again.

   When standing behind the antenna looking at the bubble, if the bubble is over to the right, you need to press the  (right) arrow to bring the bubble into the center. If the bubble is down towards you, you need to press the  (down) arrow to bring it towards the center. If the bubble is to the left, you need to press the  (left) arrow and if the bubble is up towards the top, you need press the  (up) arrow to move it towards the center.

When correct the bubble should be as close to the center of the fluid as possible

6. When the bubble is as central as possible press the ENTER button to deactivate the Remote Tilt setting.
7. Turn dishscan on:

   Enter into the Setup Menu by pressing and holding the arrows until either the EL Trim or Auto Trim parameter is displayed.

   Use the arrow key to scroll through the menu until the dishscan window is displayed.

   Press the arrow key to activate the window and then press the arrow key, followed by the ENTER button to turn dishscan from off to on.

   ***Note:** When you press the arrow to turn dishscan on you won't see the display change until you press the ENTER button.

8. Save the Remote Tilt setting in the PCU:

   Press the arrow key until the Remote Parameters window is displayed.

   Press the arrow key to activate the window followed by the ENTER button (you'll see a confirmation on the display saying "Saved").

9. As good practice make a note of your N4 and N5 parameters once you have correctly set the remote tilt. The N4 and N5 parameters are a numeric read of the remote tilt. To do this go to the remote command window and key in N4999 to read the CL setting, followed by N5999 to read the EL setting.