Field Service Spares Replacement Procedure – AZ Motor Kit, USAT

Approval:

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Revision History

Rev.	ECO	Description of Change	Date
A	9117	Initial release	11-15-2011

1. Brief Summary:

Troubleshooting document for diagnosing a fault with and replacing the azimuth motor on the USAT series antennas.

2. Checklist:

- Verify Initialization
- Pedestal Error
- Verify Encoder Feedback

3. Theory of Operation:

The azimuth motor is used for azimuth stabilization, satellite targeting and signal tracking decisions requiring drive in azimuth. During stabilization, the azimuth motor drives only in response to motion of the stabilized mass of the antenna in 3-dimensional free space (as sensed by the azimuth rate sensor on the motion platform PCB). The PCU receives azimuth drive commands and ships heading input from the DAC.

The BLDC motor does not have brushes, therefore, it must be commutated by a servo amp/motor controller. Hall sensors in the motor provide feedback to the controller so it can commutate and control the torque output of the motor. When no drive is applied to the motor it offers very little rotational friction, allowing inertia to provide 98 percent of stabilization.

A high output digital encoder is integrated into the top of the azimuth motor to provide the relative position into the PCUs azimuth control loop. During initialization the relative position will be calibrated when the system comes into contact with its end stop. The PCU receives relative drive commands from changes in heading which are fed into the DAC from the vessels gyro compass.

4. Verify Initialization:

- Power cycle the pedestal
    1. The elevation axis activates, the antenna reflector is driven down to the lower elevation stop.
    2. The azimuth axis activates, the USAT 24 antenna is driven clockwise to its upper physical stop then azimuth is driven counter-clockwise to a relative position of 630°. The USAT 30 antenna is driven counter-clockwise to its lower physical stop then azimuth is driven clockwise to a relative position of 180°.
    3. The polarity axis activates, the polarity assembly is driven to center of range (at which point the LNB will be horizontal).
    4. The antenna is then driven to a 45° elevation pointing angle

If any of these steps fail, or the DAC reports model "USATxx", the PCUs N0 parameter needs calibrating. Verify that it saves correctly. A drive issue, pedestal error or error LED requires further troubleshooting.

5. Pedestal Error (Error 8):

5.1. Decoding a Pedestal Error.

When the DAC displays a pedestal error enter into the remote command window and input "S0000" then press enter twice. The error code will now be displayed in the Remote Monitor screen. Decode the 4th character of the error code from the below table…

@	None	**K**	Ref + LV + CL	**V**	Stab Limit + AZ + LV
A	CL	**L**	Ref + AZ	**W**	Stab Limit + AZ + LV + CL
B	LV	**M**	Ref + AZ + CL	**X**	Stab Limit + Ref
C	CL + LV	**N**	Ref + AZ + LV	**Y**	Stab Limit + Ref + CL
D	AZ	**O**	Ref + AZ + LV + CL	**Z**	Stab Limit + Ref + LV
E	AZ + CL	**P**	Stab Limit	**[**	Stab Limit + Ref + LV + CL
F	AZ + LV	**Q**	Stab Limit + CL	****	Stab Limit + Ref + AZ
G	AZ + LV + CL	**R**	Stab Limit + LV	**]**	Stab Limit + Ref + AZ + CL
H	Ref	**S**	Stab Limit + CL + LV	**^**	Stab Limit + Ref + AZ + LV
I	Ref + CL	**T**	Stab Limit + AZ	_	Stab Limit + Ref + AZ + LV + CL
J	Ref + LV	**U**	Stab Limit + AZ + CL		

5.2. Error Types.

The 3 types of pedestal error are....

1. **Servo Limit (CL, LV & AZ) –** A servo limit error means the PCU motherboard is issuing the command to the motor driver PCB/servo amp to drive the relevant axis harder than it should under normal operation (the servo limit has been reached). This could be while the antenna is trying to maintain its pointing angle, or while the antenna is driving the axis to a target position.
2. **Stability Limit –** A stability limit error means the antenna has mispointed from its desired target position by more than half a degree. When a stability limit error is flagged on a VSAT antenna the DAC will send the TX Mute command to inhibit the transmit function of the satellite modem (It's common to see the servo limit and stability limit errors together).
3. **AZ Reference Error –** An azimuth reference error means the there is a corrupt reading in the relative scale. This could be caused by the encoder failing, a limited azimuth antenna hitting its end stop under normal operation, an unlimited antenna completing a 360 degree rotation without the sensor coming into contact with the home flag, the sensor coming into contact with the home flag too early, a physical problem such the belt slipping on the motor pulley, or the pulley slipping on the motor shaft.

5.3. Troubleshooting Pedestal Errors – Servo Limit and Stability Limit.

1. Reinitialize the pedestal; does it drive correctly or at all? If none of the axis drive verify the N0 and motor gain parameters (N1 = CL, N2 = EL & N3 = AZ) are correctly configured in the PCU through the Remote Command window of the DAC.
2. Verify the balance of the antenna and check for physical restrictions on the pedestal. If the axis isn't correctly balanced the PCU will be outputting additional drive commands to maintain the antennas level position.
3. If the motor isn't driving correctly or no motor drive is present, test the motor for faults using the below procedure, if the motor is defective replace it and then retest the function of the antenna. If the axis still fails to drive correctly the defective motor may have damaged the motor driver PCB. Replace the PCU assembly.
4. Another potential problem could be a damaged or intermittent harness connection. Remove the harness back shells and verify all the pins are seated correctly, check continuity from pin to pin and also across the pins to verify there is no short in the connections.

5.4. Troubleshooting Pedestal Errors – Azimuth Reference Error.

1. Reinitialize the system and verify that the USAT 24 antenna drives clockwise to its end stop or the USAT 30 drives counter clockwise to its end stop.
2. Drive the azimuth axis in 90 degree increments and verify that the antenna points correctly, and that the DAC displays the correct relative position. Also verify that there is no physical restriction on the azimuth axis such as the belt slipping on the motor pulley or the pulley slipping on the motor shaft.

6. Test the Motor:

Check continuity between ground (the motor connector back shell) and the 3 driver outputs on pins 1, 2 and 3 of the harness.

Now check continuity between pins 4, 5, 6, 7 and 8 and the ground (the motor connector back shell).

Also check between the individual pins 1, 2 and 3 and the rest of the pins (i.e. test pin 1 to pin 4, 5, 6, 7 and 8 and so on, not between pins 1 and 2, 1 and 3 or 2 and 3).

If there is any continuity measured on the steps mentioned above, the motor is defective. If the motor has drawn excessive current then there is a possibility the motor driver PCB (inside the PCU) has been damaged and its operation should be verified with a replacement motor. If after replacing the motor the system is still not operational the antennas PCU may be defective and should be replaced.

7. Verify Encoder Feedback:

During initialization the sensor and home flag will come into contact (typically when the antenna is facing the bow of the ship) at which point the relative position will be calibrated. Changes in relative should be equal to the amount of drive from the pedestal. Drive the azimuth axis of the antenna in 90 degree increments and verify that the pedestal and relative position on the DAC move the correct amount.

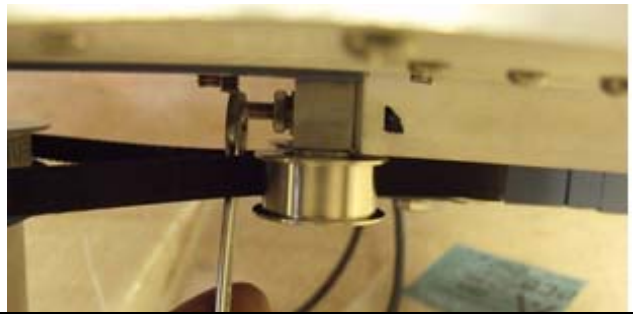
8. Replacing the Azimuth Motor:

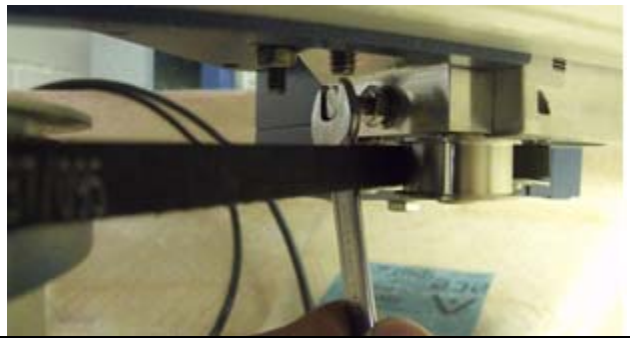
8.1. Tools.

- 2mm Flat Blade (Terminal) Screwdriver
- Snips/ Cutters
- 8mm Wrench
- 9/64” Allen Wrench/Key
- 1/16” Allen Wrench/Key
- Cable Ties/Tie Wraps

8.2. Procedure.

Procedure for replacing the azimuth motor, Sea Tel kit part number: 130776 (azimuth motor part number: 121951-2).

***Caution:** Power down the pedestal before following this procedure. 1. Using a 2mm flat blade screw driver disconnect the azimuth motor D-sub connector from the PCU.	
2. Cut the cable ties securing the azimuth motor harness using a pair of cutters.	
3. Now using an 8mm wrench back of the tensioning screw on the underside of the motor bracket to allow the motor to be removed.	

4. Now using a 9/64” Allen wrench remove the four screws securing the azimuth motor to its bracket and remove the motor assembly. Save the hardware for future use.	
5. Apply Loctite 638 to the shaft of the replacement motor and fit the pulley in the same position as the one on the defective motor. Fit the set screw into the pulley with Loctite 222 using a 1/16” Allen wrench. ***Note:** For further information refer to the Loctite Procedure 121730 provided with this kit.	
6. Apply Loctite 242 to the hardware removed in step 4 and loosely install the replacement azimuth motor assembly, slotting the motor pulley into the azimuth belt. ***Note:** Install the motor with the harness facing away from the pedestal (as shown on the right).	
7. Ensure the belt is correctly installed over the motor pulley and in between the tensioning wheels and tighten the belt tensioning screw using an 8mm wrench.	

8. While adjusting the tensioning screw periodically verify the belt tension by rotating it at the central point between the tensioning wheel and main sprocket. The belt should easily rotate to 90 degrees and then become stiff, if the belt can easily be rotated past 90 degrees it's too lose, if the belt becomes stiff before 90 degrees it's too tight. 9. Once satisfied with the belt tension tighten the four motor screws using a 9/64" Allen wrench. Verify the belt tension is still correct and adjust if necessary.	
10. Connect the azimuth motor D-sub connector to the PCU tighten the retaining screws using a 2mm flat blade screw driver.	
11. Secure the azimuth motor harness using cable ties.