



# **NovAtel SPAN System Integrated with PAV80/PAV100**

## Firmware

Latest OEM6 firmware release [OEM060601SN0007+].

This manual is written for use with NovAtel's OEM638 Card/ProPak6.

## Description

The NovAtel SPAN System is integrated with the PAV80/PAV100 Mount to provide stabilization information to enable the mount to stay level amid vibration/aircraft crabbing. Gimbal angles are received from the mount via serial connection at 20 Hz and the INS solution attitude is sent back to the mount at 20 Hz. This allows the mount to level itself, and the SPAN system to output the attitude of the IMU and also the attitude of the mount base (or aircraft body) while correcting for any changes to lever arm due to mount rotations. It is important to note the IMU must be rigidly mounted on the PAV80/PAV100 Mount which in turn must be rigidly mounted to the Aircraft.

## Hardware Setup

See Appendix A for block diagram of Hardware setup.

1. Install PAV80/PAV100 Mount into the Aircraft.<sup>i</sup>
  - *Recommended: Install PAV80/PAV100 according to the flight direction (Arrow on the PAV80/PAV100 Mount aligned with flight direction).*
2. Install IMU onto PAV80/PAV100 Mount.<sup>i</sup>
  - *Recommended: Install IMU with Z-axis upwards, and Y-Axis aligned with flight direction.*
3. Connect 'Control' Port on the PAV80/PAV100 Mount to the SPAN-Receiver / Computer using 'Leica cable 771716 Cable PAV80/PAV100 to IMU System' and 'Leica cable 837571 Cable ProPak6 Interface'. See Appendix B for details.
  - Leica Cable 771716 is designed to plug directly into the 'Control' Port on the Mount and break out the pins to a DB15 pin connector. The 771716 DB15 end will directly connect to the 837571 DB15 end.<sup>i</sup>
  - Leica Cable 837571 is designed to plug directly into ProPak6 COM2 and I/O Port using SPAN's Event-Out 2. If you require use of the other I/O Pins we recommend a '9 Pin Serial Splitter Cable DB9 1M / 2F RS232' to break out the other I/O Pins.<sup>ii</sup>
4. Connect the Power cable of the PAV80/PAV100 to power supply +28 V DC.

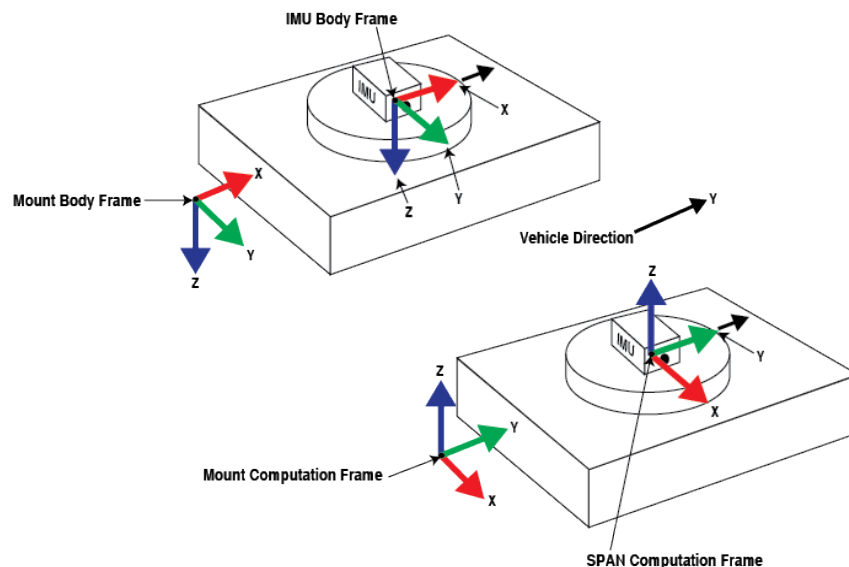
## Operation

1. Power on the mount, the IMU and the NovAtel Receiver.<sup>iii</sup>
2. Specify the rotation between the SPAN Computation Frame and Gimbal Computation Frame (the Gimbal to SPAN Rotation), using the GIMBALSPANROTATION command. The Gimbal to SPAN Rotation is the right-handed rotation from the Gimbal Computation Frame, to the SPAN Computation Frame. The computation order of rotations is Z, X, Y.<sup>iv</sup>
  - See Appendix C for examples on determining GIMBALSPANROTATION values.
  - GIMBALSPANROTATION <XAngle> <YAngle> <ZAngle> [XUncert] [YUncert] [ZUncert]
    - i. X,Y,Z Angle Options: +/-180 degrees
    - ii. X,Y,Z Uncertainty Options: 0-180 degrees
  - ASCII Example: GIMBALSPANROTATION 0 15 -90 5 5 5
3. Specify the approximate orientation of the Mount Body Frame using the SETGIMBALORIENTATION command. Although the mount frame axes of the PAV80/PAV100 are actually defined as Z-down, X-forward (Mapping 6), incoming data from the PAV80/PAV100 is internally rotated into a Z-up, Y-forward frame (Mapping 5). Therefore when using PAV80/PAV100 this must be set to 5.<sup>iv</sup>
  - SETGIMBALORIENTATION <Orientation>
  - ASCII Example: SETGIMBALORIENTATION 5
4. Specify the COM port and Event-Out line connected to the PAV80/PAV100 using the PAVCONFIG command:
  - PAVCONFIG <State> [COM Port] [Event-Out Line]
    - i. <State> Options: [DISABLE | ENABLE | RESET]
    - ii. [COM Port] Options: [COM1 | COM2 | COM3 | COM4] - Default = COM3
    - iii. [Event-Out] Options: [MARK1 | MARK2 | MARK3 | MARK4] - Default = MARK2
  - ASCII Example: PAVCONFIG ENABLE COM2 MARK2
    - i. **COM2 and MARK2 if following instructions on Leica's '837571 Cable ProPak6 Interface'**
5. When the PAVCONFIG state command is set to ENABLE, the receiver will decode messages from the PAV80/PAV100, and will publish an INPUTGIMBALANGLE message containing gimbal angles at 20Hz. To log this information for post-processing, issue the following log request to the receiver:
  - LOG INPUTGIMBALANGLEB ONNEW
  - LOG GIMBALLEDPVAB ONNEW
  - LOG VARIABLELEVERARMB ONCHANGED
6. The log PAVSTATUS can be a helpful indicator for the status of the PAV80/PAV100 Mount as well as the INS Attitude's performance.
  - PAVSTATUS <Task Status> <Roll Status> <Pitch Status> <Azimuth Status>
    - i. Task Status: [DISABLED, RESET, INITIALIZE, WAITING\_ON\_INS, OPERATIONAL]
    - ii. Roll/Pitch/Azimuth Status: [UNKNOWN, HIGH\_VARIANCE, GOOD]
    - iii. Suggested log request: LOG PAVSTATUSB ONCHANGED

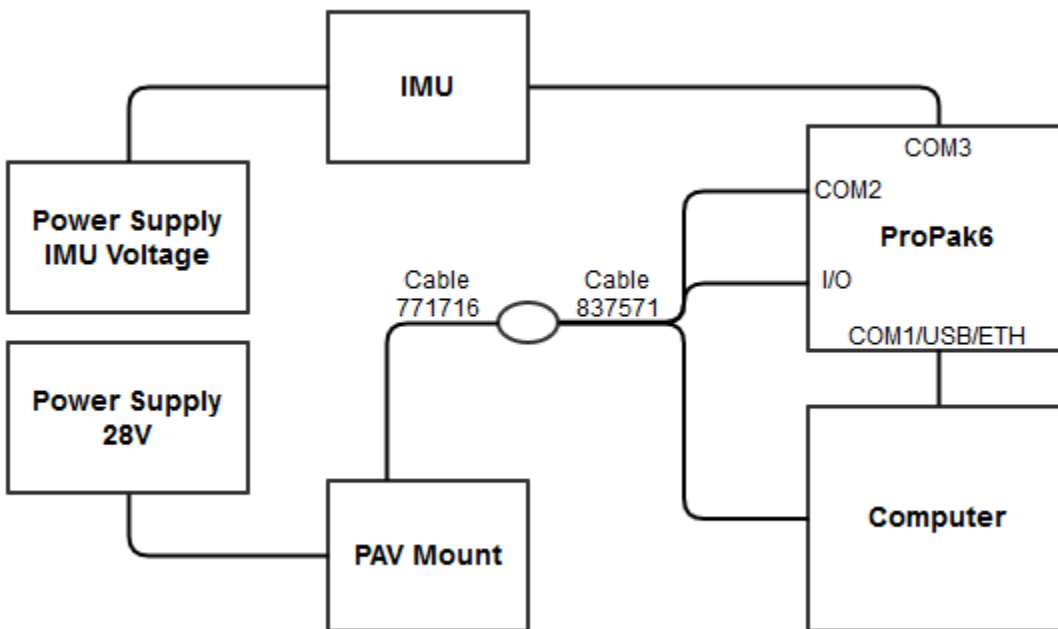
## Reference Frames

There are several frames of reference involved when dealing with a gimballed mount. The frames are all very similar, but can be quite confusing due to small differences. Below are all frames applicable to the implementation of the variable lever arm:<sup>iv</sup>

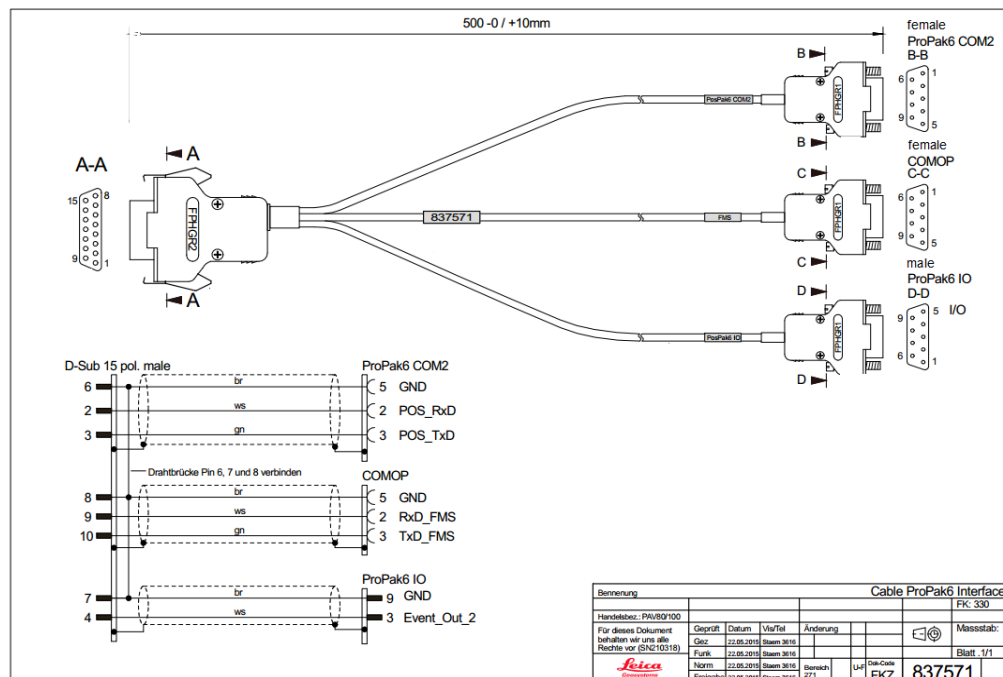
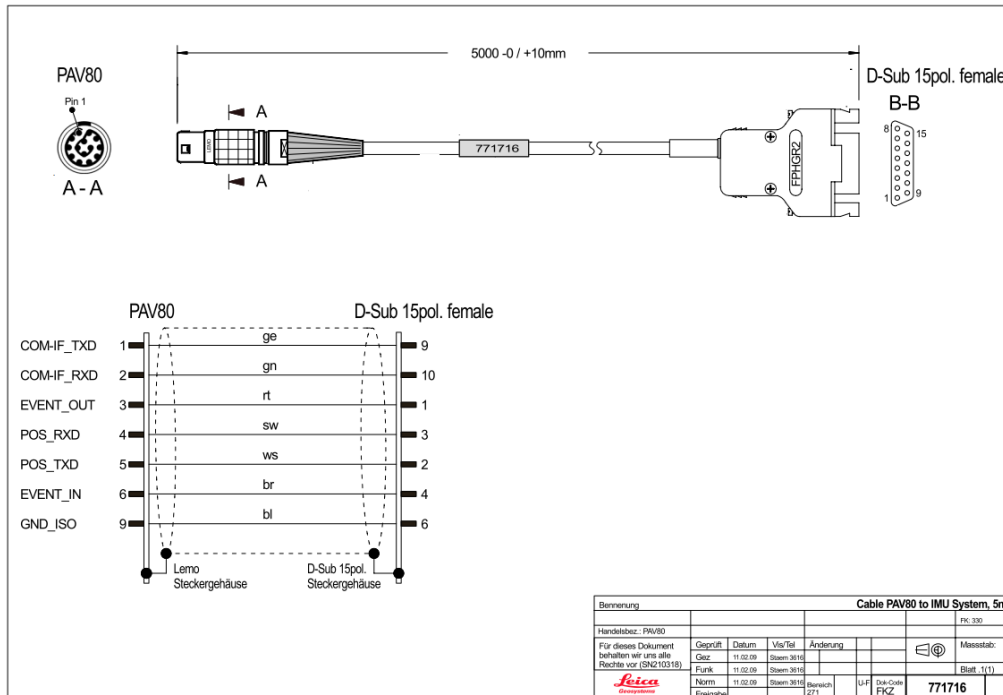
- SPAN Body Frame is defined by the physical axes of the IMU.
- SPAN Computation Frame is derived by rotating the SPAN Body Frame to point the Z-axis upwards. The direction of the X and Y axes are determined by the physical axes of the IMU. To reach this Frame from the IMU Body Frame, apply the Mapping rotation entered with the SETIMUORIENTATION command.
- Mount Body Frame is defined as the axis frame of the gimbal mount. For the PAV80/PAV100 Mount the Z-axis faces down, the X-axis follows the arrow marked on the top of the Mount, and the Y-axis completes the right-handed system.
- Mount Computation Frame is derived by rotating the Mount Body Frame to make the Z-axis point upwards, to more closely match the SPAN Computation Frame.
- Vehicle Frame is defined by the frame of the Vehicle/Aircraft. The Z-axis points upwards, the Y-axis points along the vehicle 'forward' direction, and the X-axis completes the right handed system.
  - The VEHICLEBODYROTATION command should be used to define the rotation between the SPAN Computation Frame and the Vehicle Frame. The rotation between the SPAN Computation Frame and Vehicle Frame is independent of the rotation between the SPAN Computation Frame and the Mount Computation Frame.



## Appendix A: Hardware Setup



## Appendix B: Cable drawings



## Appendix C: GIMBALSPANROTATION Computation

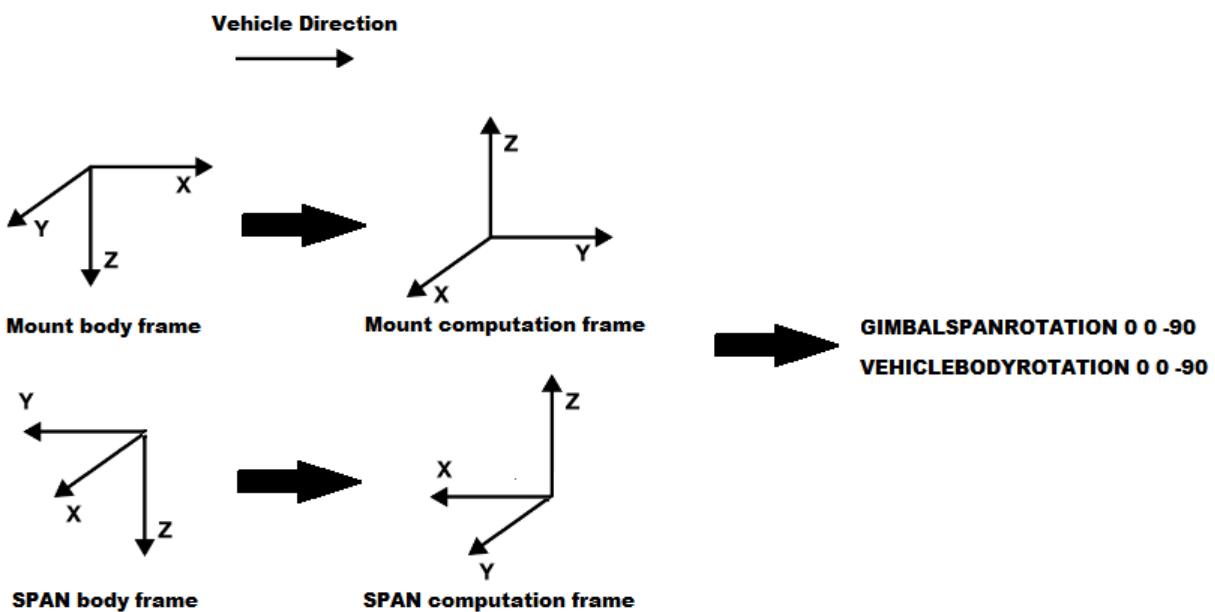
### EXAMPLE 1: Mount Computation Frame matches Vehicle Frame.

In this example, the PAV80/PAV100 is installed with the Mount Body Z axis pointed downwards, and the X axis aligned with the vehicle direction of travel. With the automatic translation applied by the receiver, the Mount Computation Z is pointed upwards, and the Y axis aligned with the vehicle direction of travel.

IMU is installed with the SPAN Body Z axis pointed downwards and the Y axis misaligned from the vehicle direction of travel by 180 degrees, after applying IMU Mapping the SPAN computation Z axis points upwards with the X axis misaligned with the vehicle direction of travel by 180 degrees.

To find the Gimbal-SPAN rotation, start at the Mount Computation Frame. Observe that a negative 90 degree right-hand rotation about Z is required to align the Mount Computation Frame with the SPAN Computation Frame.

Therefore our Gimbal-SPAN rotation is (0, 0, -90): GIMBALSPANROTATION 0 0 -90



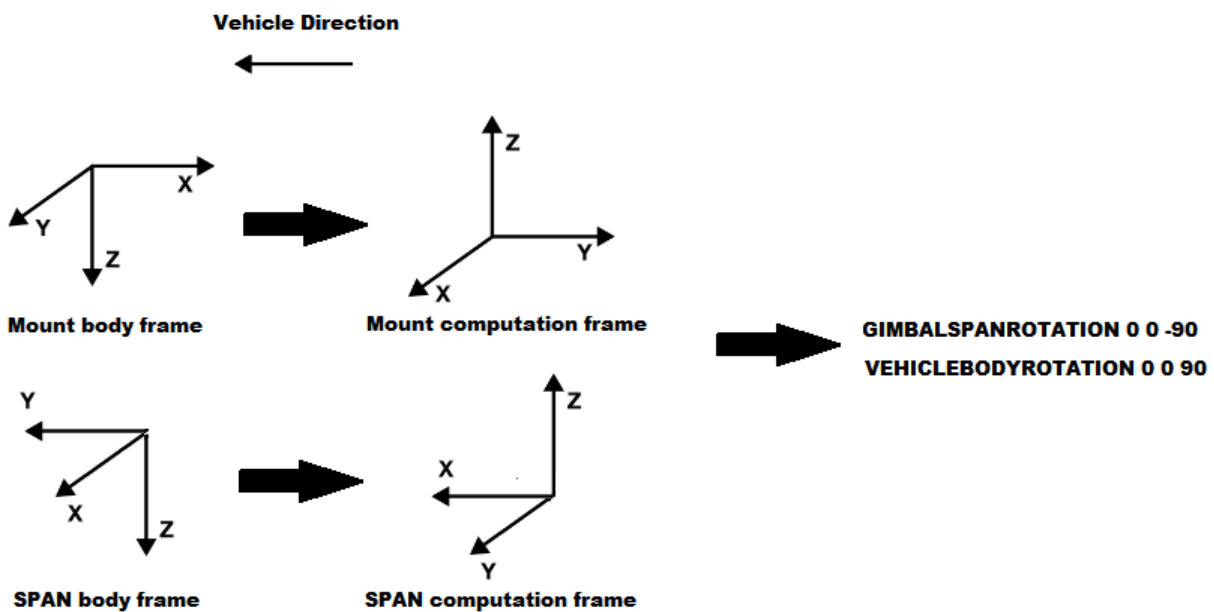
**EXAMPLE 2: Mount Computation Frame differs from Vehicle Frame by 180 degrees.**

In this example, the PAV80/PAV100 is installed with the Mount Body Z axis pointed downwards and the X axis misaligned with the vehicle direction of travel by 180 degrees. With the automatic translation applied by the receiver, the Mount Computation Z is pointed upwards, and the Y axis misaligned from the vehicle direction of travel by 180 degrees.

IMU is installed with the SPAN Body Z axis pointed downwards and the Y axis aligned with the vehicle direction of travel, after applying IMU Mapping the SPAN computation Z axis points upwards with the X axis aligned with the vehicle direction of travel.

To find the Gimbal-SPAN rotation, start at the Mount Computation Frame. Observe that a negative 90 degree right-hand rotation about Z is required to align the Mount Computation Frame with the SPAN Computation Frame.

Therefore our Gimbal-SPAN rotation is (0, 0, -90): GIMBALSPANROTATION 0 0 -90



<sup>i</sup> Refer to *Leica PAV80/PAV100 Documentation* for advanced instructions.  
<sup>ii</sup> Refer to *837571 Cable ProPak6 Interface* document for full electrical interface.  
<sup>iii</sup> Refer to [OM-200000128 - OEM6 Installation and Operation User Manual](#) for advanced instructions.  
<sup>iv</sup> Refer to [OM-200000144 - SPAN on OEM6 Firmware Reference Manual](#) for advanced instructions.