MP NovAtel Integration Guide

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About

General Information

The MP-NovAtel Remote GPS receiver is a high precision GPS receiver based on the NovAtel OEM GPS modules and is designed to interface easily with all MicroPilot Autopilots.

Warning: The NovAtel GPS, while more accurate, is also more susceptible to loss of GPS lock than the GPS receiver integrated in the autopilot. Ensure that the carrier phase GPS is well tested.

NovAtel Models

Before mid-2013, the NovAtel OEMV-1 GPS receiver was used. *http://www.novatel.com/products/gnss-receivers/oem-receiver-boards/oemv-receivers/oemv-1/*

After mid-2013, the NovAtel OEM615 GPS receiver was used. *http://www.novatel.com/products/gnss-receivers/oem-receiver-boards/oem6-receivers/oem615/*

Supported Signal Tracking and Constellations

The OEMV-1 supports the L1, L-Band, and SBAS signal tracking. It supports the GPS constellation. It does not support OmniSTAR.

The OEM615 supports L1, L2, L2C, B1, and E1 signal tracking. It supports the GPS, GLONASS, Galileo, and BeiDou constellations. It does not support OmniSTAR. For the OEM6 series, only the OEM628 and OEM638 built before October 25, 2013 are able to use OmniSTAR.

With the correct license installed, and an antenna that supports the L2 band (see the antenna section below), the OEM615 is capable of up to 1 cm + 1 PPM accuracy. PPM refers to the error in millimetres per 1000 meters.

Antenna

Before December 2014, the standard antenna supplied with the MP NovAtel was p/n ANT-35C50P1GLA-TW-N. It can receive the following signals: GPS L1 and GLONASS L1. It cannot receive GPS L2 or GLONASS L2 signals. To take full advantage of a GPS L2 and/or GLONASS L2 license then another antenna must be chosen such as p/n 42GOXX16A4-XT-1-1-CERT (*http://www.NovAtel.com/assets/Documents/Papers/Antennas-Brochure.pdf*).
There is also a wide variety of suitable antennas from ANTCOM (*http://www.antcom.com/products/gps-gns-sbas-crpa.php*)
Contact *MicroPilot Support* for assistance selecting an antenna.

Figure 1 - NovAtel Antenna p/n: ANT-35C50P1GLA-TW-N

After December 2014, the standard antenna supplied with the MP NovAtel is NovAtel p/n 42GOXX16A4-XT-1-1-Cert. It can receive the following signals: GPS L1/L2, GLONASS L1/L2, BeiDou B1/B2. This antenna has a built-in ground plane so it is not necessary to create one.

Figure 2 - NovAtel Antenna p/n: 42GOXX16A4-XT-1-1-Cert

Both of these antennas have female TNC connectors. The NovAtel OEM615 and OEMV-1 have female MCX connectors. The MP-NovAtel comes with a dual shielded TNC to MCX GPS antenna cable.

Interface Board

The MP-NovAtel base and remote units consist of two parts. The NovAtel board and the interface board. The interface board plugs into the NovAtel board. The interface board contains a voltage regulator allowing use of a wider range of input voltages. The interface board also contains an RS232 to TTL converter. This converts the TTL logic levels that the NovAtel board uses to RS232 logic levels for easier communication. The interface board has RS232 and TTL communications connectors. The RS232 connector is used to communicate with the NovAtel board using a terminal program such as HyperTerminal or TeraTerm. The TTL connector is used to connect the NovAtel board to the MicroPilot autopilot's TPU lines. The NovAtel board has two communications ports. COM1 is routed through to the TTL connector on the interface board. COM2 is routed through to the

RS232 connector on the interface board. If the user is not using ALIGN heading, either COM port can be used.

NovAtel Connect Software

NovAtel's Connect software can be used to connect to the NovAtel units using the RS232 connector. With this software, it is possible to see if there is a GPS lock, see what satellites it is locked on to, see each satellite's SNR (Signal to Noise Ratio), see model information, change settings, and access many other useful features. It can be downloaded from NovAtel's website for free.
http://www.NovAtel.com/support/info/documents/809

Requirements

Software

HORIZON^{mp} and firmware version 3.5.1866 or newer. This can be found on the support website site under HORIZON^{mp} beta upgrades.

Input Voltage Range and Average Current Draw

Remote

Input Voltage Range:

Rev B interface board (2010 and newer):
7 to 20 VDC

V1 interface board (2010 and older):
6 to 14 VDC

To see which version is being used, look at the top of the interface board under the MicroPilot writing.

Note: The higher the input voltage, the hotter the interface board will run. If the NovAtel board gets too hot, it will shutdown and its LED will start flashing orange. If this happens, turn it off and let it cool down before using again. To prevent overheating, use the lowest input voltage possible and provide adequate airflow around the NovAtel board.

Average Current Draw: 361 mA (OEMV-1)
354 mA (OEM615)

Base

Input Voltage:

Rev B interface board (2010 and newer):
7 to 20 VDC

V1 interface board (2010 and older):
6 to 14 VDC

We recommend the supplied 9 VDC AC adapter.

Average Current Draw: 380 mA

Dimensions and Weights

Remote

Size:

Width: 46.8 mm

Length: 71.15 mm

Height: 24.5 mm approx.
(interface board 13 mm, receiver 9.4 mm, plus standoffs); this allows a minimum clearance for the wires on the connector; the user may choose to allow a bit extra for the wiring.

Weight: 44 g (receiver, interface, standoffs etc.)
cables may add approximately 15 g.

How to Get the Best Base Position:

The DPGS plug-in requires the GPS coordinates and altitude of the NovAtel base's antenna location to be entered. The more accurate these coordinates are, the more accurate the autopilot's coordinates will be. In order to get the most accurate coordinates, two commands must be issued to the NovAtel base. It will then run for an hour and calculate the most accurate GPS coordinates.

1. Connect the USB-to-RS232 converter to the NovAtel base unit.
2. Connect the GPS antenna and place it near where the GCS will be when the flight is planned. The GPS antenna must have a clear view of the sky.
3. Open a terminal program and power on the NovAtel base unit.
4. Enter the following two commands. (Local character echo can be enabled in the terminal program so the user can see what they're typing.) Hit the enter key after each command:
   i. posave on 1
   ii. log bestpos on time
5. Press [Enter]. '<OK' should be visible after pressing the enter key. Then the output should look like shown below:

[COM2]<BESTPOS COM2 0 94.0 UNKNOWN 0 49.000 804c0000 6145 6988
< INSUFFICIENT_OBS NONE 0.00000000000 0.00000000000 -6378054.2000 17.2000 WGS84 0.0000 0.0000 0.0000 "" 0.000 0.000 0 0 0 0 0 00 0 00

6. “Insufficient_OBS” means that it does not have GPS lock yet. After the GPS locks, the output will change to the following:

   [COM2]<BESTPOS COM2 0 85.0 FINESTEERING 1792 318201.000 80000000 6145 6988
   < SOL_COMPUTED SINGLE 50.06989041322 -97.27409557569 244.2690 -28.2000 WGS84 2.1171 1.5331 3.2899 "" 0.000 0.000 8 8 0 0 0 02 0 01

7. After one hour, “SINGLE” will change to “FIXEDPOS” as shown below:

   [COM2]<BESTPOS COM2 0 79.5 FINESTEERING 1792 322643.000 00100000 6145 6988
   < SOL_COMPUTED FIXEDPOS 50.06986994614 -97.27414097148 256.8313 -28.2000 WGS84 0.0000 0.0000 0.0000 "" 0.000 0.000 8 7 0 0 0 02 0 01

8. The important data is the latitude and longitude (50.06986994614 -97.27414097148) and the height above sea level (256.8313).

   Enter these values in the DGPS plug-in via the following steps:

   a. Open the DGPS plug-in from the tool menu.
   b. Go to “Settings > Set Base Station Position”.
   c. Enter the above values into the “Set Base Station Position” window. In this example the Latitude would be 50.06986994614N, the Longitude would be 97.27414097148E and the base station altitude (metres) would be 256.8313.

Configuration & Connection - Board Autopilots

VRS Configuration - Board Autopilots

VRS Setup for MP NovAtel Remote GPS when Using Provided J2 Connector Cable and Modified P2 Connector:

This section is for configuring the autopilot for using the MP-NovAtel GPS receiver with the provided cable and interface.

(For using an MP2128[LRC2] *autopilot, see* ***Configuration & Connection – LRC Autopilots*** *on page 12.)*

1. Open the .vrs file with the VRS Editor and select the Comms tab. See Figure 3 - Comms Tab Uart Configuration.
2. Set Protocol to External GPS.
3. Set the UART Rx Channel to 22 for the standard P2 connector included with the NovAtel GPS.
   The autopilot will receive TTL data from the MP-NovAtel on the blue wire on pin 6 of J2 of the MP-NovAtel GPS. When using an alternate cable, set the Rx channel to the appropriate TPU channel which connects to the blue wire of the TTL connector.

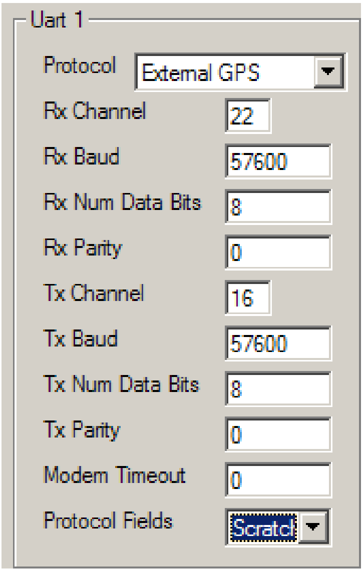

Figure 3 - Comms Tab Uart Configuration

4. For the standard P2 connector included with the MP-NovAtel GPS, set the UART Tx Channel to 16.
   The autopilot will then transmit TTL data to the MP-NovAtel on the green wire on pin 4 of J2 of the MP-NovAtel GPS.
   Note: if using another cable, set the Tx channel to the appropriate TPU channel which connects to the green wire of the TTL connector.
5. For both Rx and Tx, set Baud to 57600,
   set Num Data Bits to 8 and
   set parity to 0.
6. Protocol fields can be set to 'scratch' or 'protocol' because the external GPS protocol does not use any protocol fields.
7. Now select the GPS tab. See Figure 4 - GPS Tab.

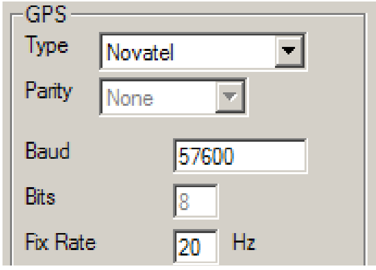

Figure 4 - GPS Tab

8. Set Type to NovAtel.
9. Set Baud to 57600 and Fix Rate to 20 Hz. Acceptable fix rate values are 1, 2, 5, 10, and 20 Hz. 20 Hz will give the best performance. 1 and 2 Hz are not recommended because they are too slow.
10. Click ‘Save’ and close the VRS Editor.
11. Transmit this *.vrs* file to the autopilot.

Now use HyperTerminal and Autopilot Setup mode to edit field 995 [*externalGpsTpuPps*] and field 898 [*gpsFixDelay*].

Note: these fields are new and only in beta 3.5 code; they are not in the VRS editor yet

1. Set field 995 [*externalGpsTpuPps*] = 30, or to the TPU pin number that the PPS (Pulse Per Second) signal from the NovAtel GPS is connected to.
2. Set field 898 (the GPS Fix delay) to 0.
3. Write these changes to flash memory (press w).

Physical Connections - Board Autopilots

For wiring/connector diagrams see *Figure 9 – MP-NovAtel Remote/Modified P2 Connector Diagram* and *Figure 10 – MP-NovAtel Remote/J2 Connector*

1. Plug the MP NovAtel Remote wiring harness into the J2 connector on the board, as shown in *Figure 5 - J2 Connector On MP-NovAtel Interface Board*.

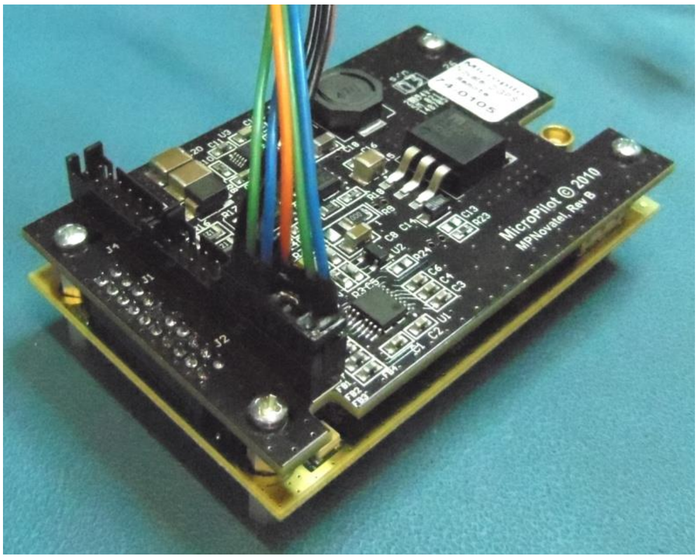

Figure 5 - J2 Connector On MP-NovAtel Interface Board

2. Plug the TTL connection from the P2 connector to the TTL connection on the MP-NovAtel J2.

3. Plug the PPS connections from the P2 and J2 connectors together.

4. If the user is powering the autopilot and MP-NovAtel Remote from the same supply, there is no further connection to make. MicroPilot's P2 connector leaves out the TTL ground purposely to avoid a ground loop when powering the autopilot and MP-NovAtel Remote from the same supply.

5. If the user decides to power the MP-NovAtel Remote from a separate power supply to the autopilot, make sure that a ground line is connected externally between the MP-NovAtel Remote and the autopilot, to ensure the signals have a reference—no ground is provided with the connectors. The battery negatives can be tied together to make a common ground between devices.

Note: Some NovAtel GPS receivers have more than two COM ports. OEMV-1, OEM615 and OEM617/OEM617D models have two COM ports. OEM628 and OEM638 models have four COM ports. To connect COM3 or COM4 to the MicroPilot autopilot, a firmware version of 3.6.458/3.7.458 or higher must be used.

Configuration & Connection – LRC2 Autopilots

VRS Configuration - LRC Autopilots

VRS Setup for MP NovAtel Remote GPS When Using MP2128^{LRC2} Autopilot:

This section is for configuring the MP2128^{LRC2} autopilot for using the MP-NovAtel GPS receiver; the required cables must be made *(MicroPilot may be able to supply suitable cables).*

The suggested method of connection is to use the LRC2 remote COM2 connector for Tx, Rx, and ground; this will connect to the NovAtel GPS COM1 RS232 connector.

The LRC GPIO connector will connect to the NovAtel PPS because this is a CMOS level input. Connector cables must be made for this. MicroPilot may be able to supply such cables.

1. Open the *.vrs* file with the VRS Editor and select the Comms tab. See *Figure 6 - Comms Tab UART Configuration for LRC* or *Figure 7* for the LRC2. (The LRC2 has slightly different pin-outs on the COM2 connector.)

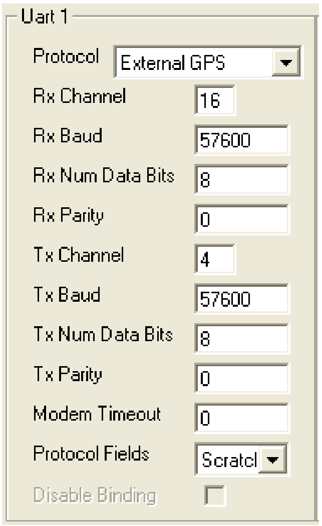

Figure 6 - Comms Tab UART Configuration for LRC

2. Set Protocol to External GPS.
3. For the earlier version LRC, set the UART Rx Channel to 16 for the suggested connections to the NovAtel GPS, as in *Figure 6 - Comms Tab UART Configuration for LRC*.

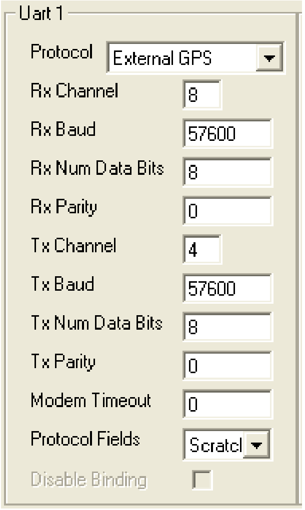

Figure 7 - Comms Tab UART Configuration for LRC2

4. For the LRC2, set the UART Rx Channel to 8 for the suggested connections to the NovAtel GPS as in *Figure 7 - Comms Tab UART Configuration for LRC2.*

   The autopilot will receive RS232 data from the MP NovAtel on the blue wire on pin 11 of J2 of the MP-NovAtel GPS. If using another cable, set the Rx channel to the appropriate TPU channel which connects to the blue wire of the RS232 connector.

5. For either LRC or LRC2, set the UART Tx Channel to 4 for the suggested connections to the MP-NovAtel GPS.

   The autopilot will transmit RS232 data to the MP-NovAtel on the green wire on pin 9 of J2 of the MP-NovAtel GPS. If using another cable, set the Tx channel to the appropriate TPU channel which connects to the green wire of the RS232 connector.

6. For both Rx and Tx, set Baud to 57600, set Num Data Bits to 8, and set parity to 0.

7. Protocol fields can be set to 'scratch' or 'protocol' because the external GPS protocol doesn't use any protocol fields.

8. Now select the VRS Editor GPS tab. See *Figure 8 - GPS Tab*.

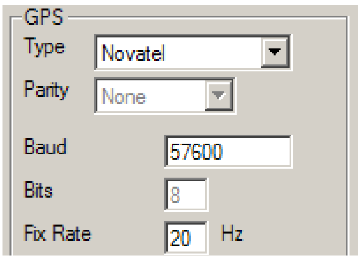

Figure 8 - GPS Tab

9. Set Type to NovAtel.
10. Set Baud to 57600 and Fix Rate to 20 Hz. Fix rates of 1, 2, 5, 10, and 20 Hz are acceptable but 20 Hz will achieve the best performance. 1 and 2 Hz are not recommended because they are too slow.
11. Click Save and close the VRS Editor.
12. Transmit this *.vrs* file to the LRC autopilot.

Now use HyperTerminal and Autopilot Setup mode to edit field 995 [*externalGpsTpuPps*] and field 898.

Note: These fields are new and only in beta 3.5 code; they are not in the VRS editor yet.

1. For the LRC or LRC2, set field 995 [*externalGpsTpuPps*] = 31 for our suggested connections, or to the TPU pin chosen to accept the PPS signal from the NovAtel GPS.
2. Set field 898 [*gpsFixDelay*] to 0.
3. Write these changes to flash memory (press [w]).

Physical Connections - LRC Autopilots

See *Figure 11 – MP-NovAtel Remote/LRC Suggested Connector Diagram*.

1. The MP-NovAtel Remote wiring harness (shown in *Figure 10 – MP-NovAtel Remote/J2 Connector*) plugs into the J2 connector on the NovAtel board, just the same as for board autopilots – see *Figure 5 - J2 Connector On MP-NovAtel Interface Board*.
2. Plug the RS232 connection cable from the MP-NovAtel RS232 connector to the COM2 connector on the LRC or LRC2.
3. Plug the PPS connection from the MP-NovAtel connector to the GPIO connector of the LRC or LRC2.
4. When powering the autopilot and MP-NovAtel Remote from the same supply make sure to **Disconnect** the black ground-wire connection shown in *Figure 11 – MP-NovAtel Remote/LRC Suggested Connector Diagram* to avoid a ground loop.
5. If the user decides to power the MP-NovAtel Remote from a separate power supply as the LRC autopilot, then make sure that the black ground line shown in *Figure 11 – MP-NovAtel Remote/LRC Suggested Connector Diagram* is connected, to ensure the signals have a common reference. It is possible to tie the battery negatives together to make a common ground between devices.

Installation Considerations

- If the autopilot is too close to the NovAtel GPS receiver or its antenna interference may degrade the GPS quality or prevents a GPS lock.

- Check the SNR (Signal to Noise Ratio) of the satellites using NovAtel's Connect software which can be downloaded from NovAtel's website (*http://www.NovAtel.com/products/firmware-options/*).
- Follow the antenna's ground plane recommendations found in the manual.
- Ensure the antenna cable is not kinked since a kink can degrade the signal.
- If using NovAtel ALIGN heading, the distance between the two airborne GPS antennas must be at least 0.5 meters.

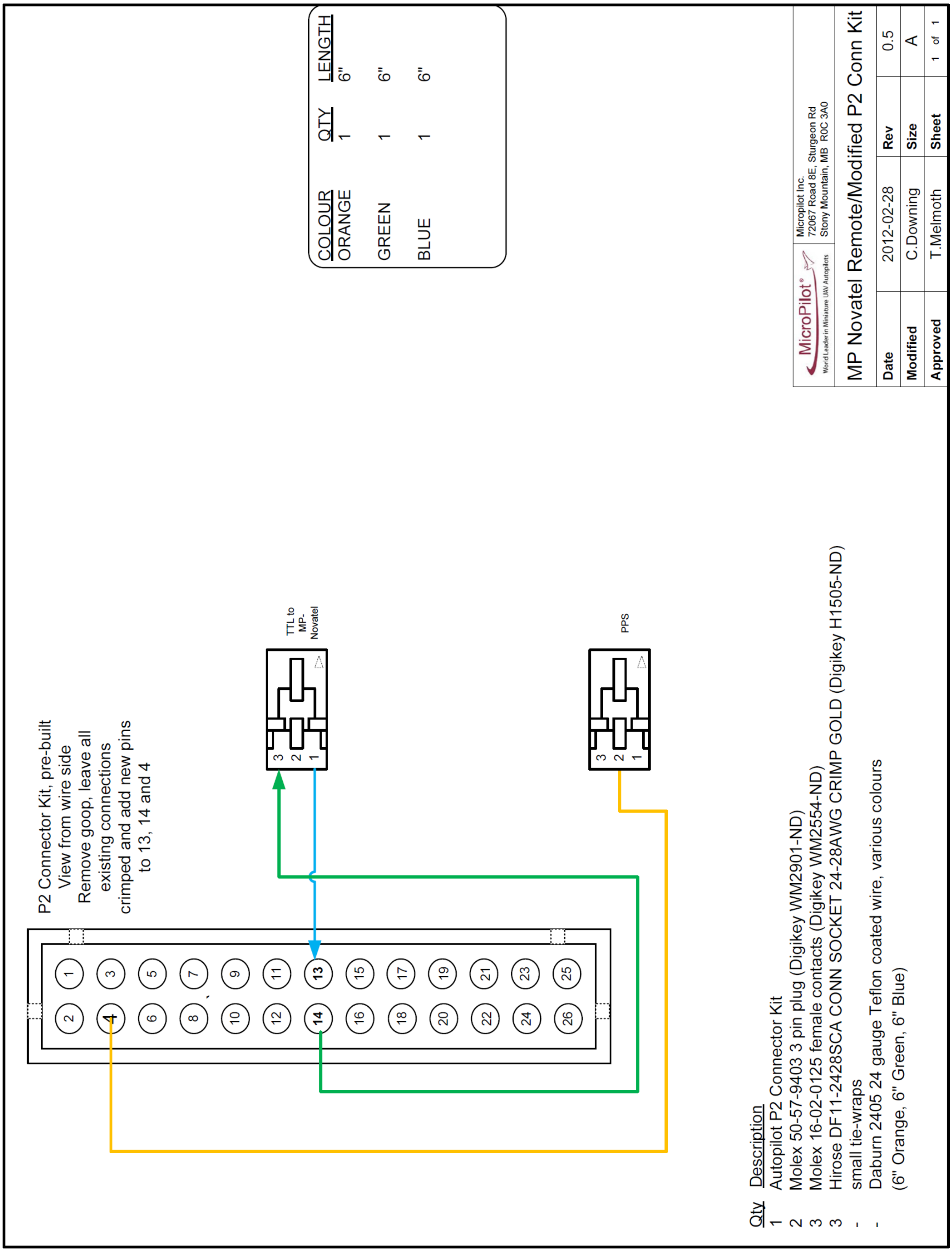

Figure 9 – MP-NovAtel Remote/Modified P2 Connector Diagram

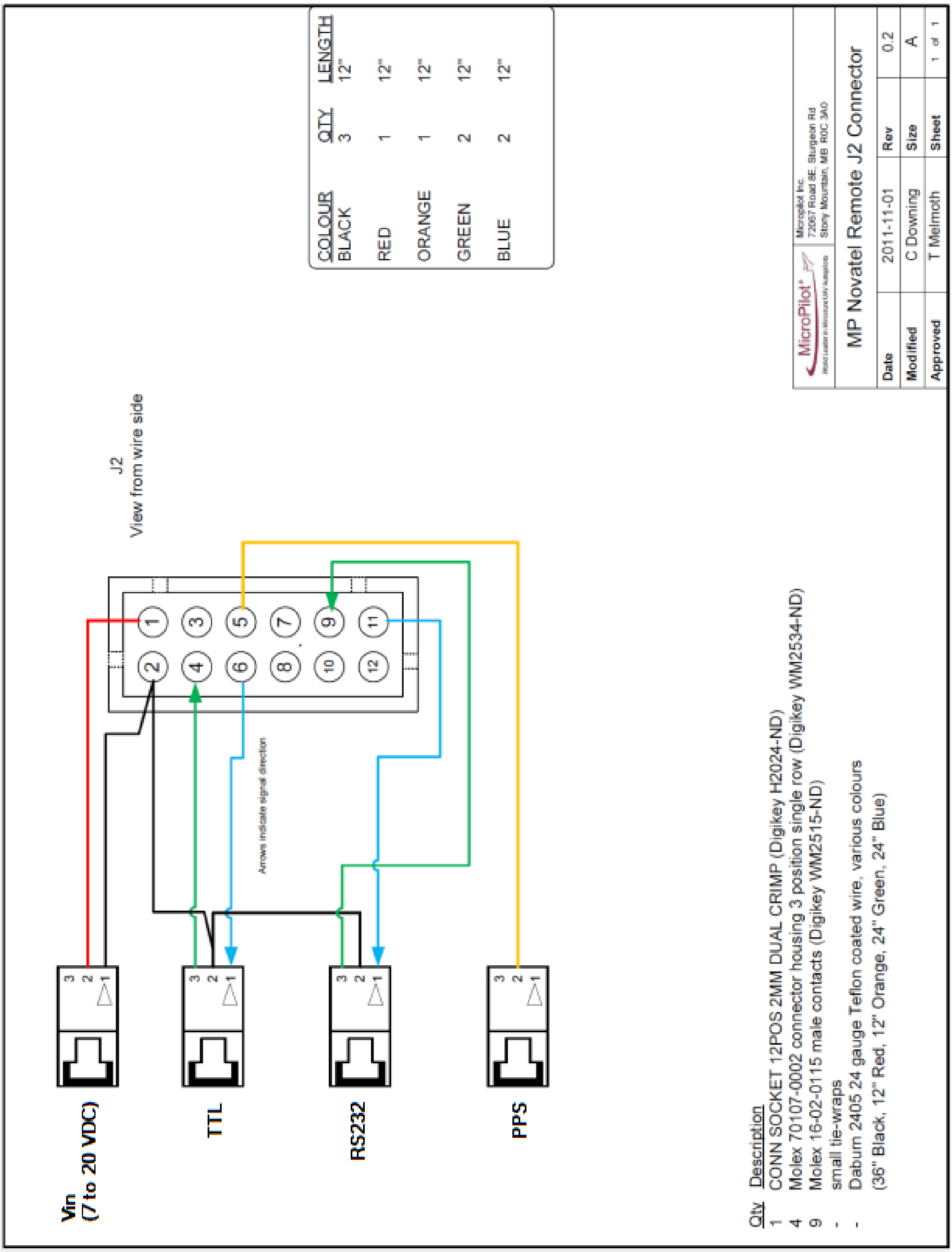

Figure 10 – MP-NovAtel Remote/J2 Connector

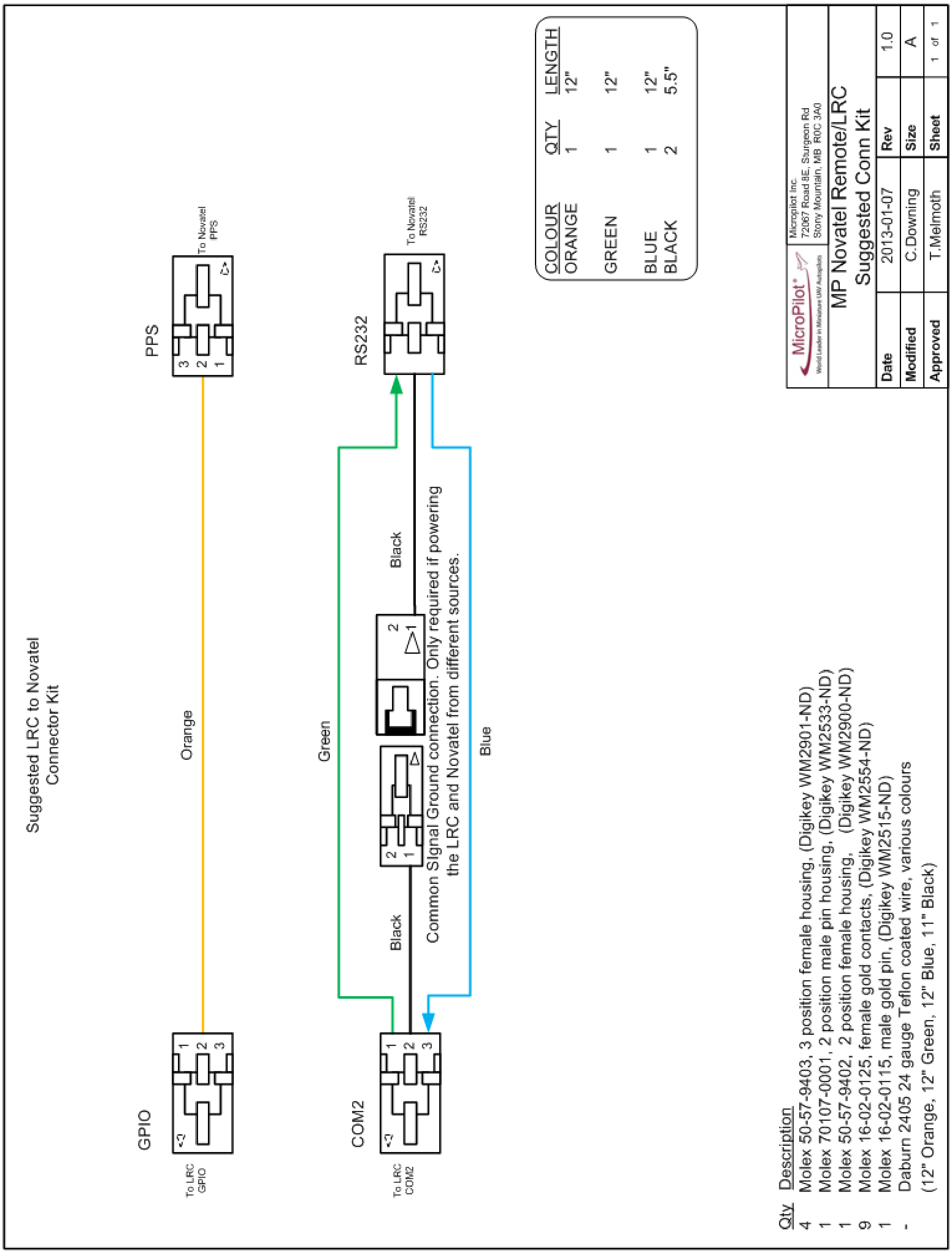

Figure 11 – MP-NovAtel Remote/LRC Suggested Connector Diagram

NovAtel OEMV-1 Model Options

The MP-NovAtel Base requires only a regular L1 license for using any DGPS modes.
It is not necessary to have a base to operate the MP-NovAtel Remote GPS receiver in normal mode without RT-20.

The MP-NovAtel Remote GPS receiver requires a license type as follows:

Table 1 - NovAtel OEMV-1 Models

Remote GPS mode	License Type	Includes
Regular GPS	L1	-
RT-20	L1R	*RT-20 only*
	L1BR	*With OmniSTAR support*

NovAtel OEM615 Model Options

Option 1:

The user would like to have the UAV's GPS position more accurate (2 cm versus the usual 1.5 m).

Base model: X-NOVAR615 -G2SB0GTT0

Rover model: X-NOVAR615 -G2SR0GTT0 OR X-NOVAR615 -D2SR0GTT0

Option 2:

The user would like to use the NovAtel ALIGN relative positioning feature. This will allow the hovering UAV to match the position and heading of the base.

Base model: X-NOVAR615 -G2SB0GTT0

Rover model: X-NOVAR615 -G2SY0G0T0 OR X-NOVAR615 -D2SY0G0T0

Note: NovAtel ALIGN relative position is only available with heli firmware and helicopter or multirotor vehicles.

Option 3:

The user would like to use the NovAtel ALIGN heading feature to use two antennae on the UAV as a GPS-compass to determine the orientation of the UAV.

Base model: X-NOVAR615 -G2SB0GTT0

Normal Rover model (provides normal GPS position reports): X-NOVAR615 -G2SR0GTT0 OR X-NOVAR615 -D2SR0GTT0
Heading only Rover model (provides only the UAV heading information): X-NOVAR615 -G2SZ00000 OR X-NOVAR615 -D2SZ00000

Notes:

1. For option 3, the base model is optional and only needs to be purchased if the user wants UAV heading information PLUS 2 cm accuracy. Without the base there is a 1.5 m accuracy with an L1 fix and 0.6 m with an L2 fix.

2. For all rovers there is an option between two models where the only difference is GLONASS support. If the user wishes to have GLONASS support, it should be on both the base and remote. The models with GLONASS will start with OEM615-D and the models without GLONASS will start with OEM615-G.

3. The OEM615 does not support OmniSTAR. For the OEM6 series, only the OEM628 and OEM638 built before October 25, 2013 are able to use OmniSTAR.

Table 2 - NovAtel Model Legend

Channel Configuration						Positioning Options						Logging/COMS					
D		2		S		R		0		G		T		T		0	
Constellation		Frequency		Systems		Positioning		**Other Positioning**		Pseudorange		Raw Measurement Output		Position Output		Correction Service	
G	GPS Only	1	L1/B1	S	SBAS	R	RTK Tx/Rx DGPS Tx/Rx	0	Default	P	Default Positioning	1	1 Hz	1	1 Hz	0	Disabled
D	GPS+GLO	2	L1/L2/B1	Q	QZSS/SBAS	Z	ALIGN Heading Only			G	GLIDE	5	5 Hz	5	5 Hz		
P	GPS+BDS	D	L1/L2/B1/B2			Y	ALIGN Heading or Relative Positioning			R	GLIDE & RAIM	X	10 Hz	X	10 Hz		
C	GPS+GLO+BDS					B	RTK Tx DGPS Tx/Rx			0	None	T	20 Hz	T	20 Hz		
						X	RTK Rx + Heading					F	50 Hz	F	50 Hz		
						W	RTK Tx/Rx + Heading					0	1 Hz, no range content*	0	1 Hz, no range content*		

** 0 models will support 1 Hz TIME and RANGE logs, with the actual observation content removed. This is intended to allow users to confirm signal strength and sync time.*

Table 3 - NovAtel OEM615 Models

NovAtel OEM615 Models		
NovAtel Model Code	**Model Type**	**Accuracy**
CONFIG #1 - Stock		
OEM615-G1S-000-000	Stock Model. Will not get a GPS lock.	N/A
CONFIG #2 – GPS L1 Stand Alone		
OEM615-G1S-00G-0T0	Standalone position, velocity, time.	1.5m (0.6m WAAS)
CONFIG #3 – GPS + GLONASS L1 Stand Alone		
OEM615-D1S-00G-0T0	Standalone position, velocity, time.	1.5m (0.6m WAAS)
CONFIG #4 - GPS L1/L2 Stand Alone		
OEM615-G2S-00G-0T0	Standalone position, velocity, time.	1.2m (0.6m WAAS)
CONFIG #5 - GPS + GLONASS L1/L2 Stand Alone		
OEM615-D2S-00G-0T0	Standalone position, velocity, time.	1.2m (0.6m WAAS)
CONFIG #6 – GPS+BEIDOU L1 Only		
OEM615-P1S-B0G-TT0	Standalone/DGPS	1.5 m (40 cm DGPS)
CONFIG #7 – GPS+BEIDOU+GLONASS L1 Only		
OEM615-P1S-B0G-TT0	Standalone/DGPS	1.5 m (40 cm DGPS)
CONFIG #8 - GPS L1/L2 RT2		
OEM615-G2S-B0G-TT0	RTK Base	40cm
OEM615-G2S-R0G-TT0	RTK Rover	2cm

OEM615-G2S-Z00-000	ALIGN Heading (rover add on)	N/A
CONFIG #9 - GPS + GLONASS L1/L2 RT2-G		
OEM615-D2S-B0G-TT0	RTK Base	40cm
OEM615-D2S-R0G-TT0	RTK Rover	2cm
OEM615-D2S-Z00-000	ALIGN Heading (rover add on)	N/A
CONFIG #10 - GPS L1/L2 ALIGN Relative Positioning (Moving Baseline RTK)		
OEM615-G2S-B0G-TT0	RTK Base	40cm
OEM615-G2S-Y0G-0T0	ALIGN Relative Positioning Rover	2cm (rel)
OEM615-G2S-Z00-000	ALIGN Heading (rover add on)	N/A
CONFIG #11 - GPS + GLONASS L1/L2 ALIGN Relative Positioning (Moving Baseline RTK)		
OEM615-D2S-B0G-TT0	RTK Base	40cm
OEM615-D2S-Y0G-0T0	ALIGN Relative Positioning Rover	2cm (rel)
OEM615-D2S-Z00-000	ALIGN Heading (rover add on)	N/A

Table 4 - NovAtel OEM615 Feature Matrix

NovAtel OEM615 Feature Matrix												
Receiver Model	**GPS**	**GLO**	**L1**	**L2**	**WAAS**	**PVT**	**BEIDOU**	**RT2 Tx**	**RT2 Rx**	**ALIGN-Heading**	**ALIGN-Relative Positioning**	**20Hz**
CONFIG #1 - STOCK												
OEM615-G1S-000-000												
CONFIG #2 – GPS L1 Stand Alone												
OEM615-G1S-00G-0T0 (Remote)	X		X		X	X						X
CONFIG #3 – GPS + GLONASS L1 Stand Alone												
OEM615-D1S-00G-0T0 (Remote)	X	X	X		X	X						X
CONFIG #4 - GPS L1/L2 Stand Alone												
OEM615-G2S-00G-0T0 (Remote)	X		X	X	X	X						X
CONFIG #5 - GPS + GLONASS L1/L2 Stand Alone												
OEM615-D2S-00G-0T0 (Remote)	X	X	X	X	X	X						X
CONFIG #6 - GPS + BEIDOU L1 Only												
OEM615-P1S-B0G-TT0 (Base)	X		X		X	X	X					X
OEM615-P1S-F0G-TT0 (Remote)	X		X		X	X	X					X
CONFIG #7 - GPS + GLONASS L1 Only												
OEM615-P1S-B0G-TT0 (Base)	X	X	X		X	X	X					
OEM615-P1S-F0G-TT0 (Remote)	X	X	X		X	X	X					
CONFIG #8 - GPS L1/L2 RT2												
OEM615-G2S-B0G-TT0 (Base)	X		X	X	X	X		X				X
OEM615-G2S-R0G-TT0 (Remote)	X		X	X	X	X		X	X			X
OEM615-G2S-Z00-000 (Heading only)	X		X	X	X					X		X

CONFIG #9 - GPS + GLONASS L1/L2 RT2-G												
OEM615-D2S-B0G-TT0 (Base)	X	X	X	X	X	X		X				X
OEM615-D2S-R0G-TT0 (Remote)	X	X	X	X	X	X		X	X			X
OEM615-D2S-Z00-000 (Heading only)	X	X	X	X	X					X		X
CONFIG #10 - GPS L1/L2 ALIGN Relative Positioning (Moving Baseline RTK)												
OEM615-G2S-B0G-TT0 (Base)	X		X	X	X	X		X				X
OEM615-G2S-Y0G-0T0 (Remote)	X		X	X	X	X				X	X	X
OEM615-G2S-Z00-000 (Heading only)	X		X	X	X					X		X
CONFIG #11 - GPS + GLONASS L1/L2 ALIGN Relative Positioning (Moving Baseline RTK)												
OEM615-D2S-B0G-TT0 (Base)	X	X	X	X	X	X		X				X
OEM615-D2S-Y0G-0T0 (Remote)	X	X	X	X	X	X				X	X	X
OEM615-D2S-Z00-000 (Heading only)	X	X	X	X	X					X		X

Adding/Changing a Model

Checking the Currently Installed Model on the NovAtel Remote

Method 1: Autopilot and NovAtel GPS Receiver Required:

1. Connect the autopilot to the NovAtel remote unit following the instructions in Configuration and Connection section.
2. Connect to the autopilot using HyperTerminal.
3. Once the startup report has completed, type '**NNNN**' or '**nnnn**' (it is not case sensitive) to enter NovAtel GPS terminal mode. 'Direct communication to NovAtel GPS' will be visible.

   Note: Once in NovAtel GPS terminal mode, the only way to exit is to restart the autopilot.
4. If random-looking characters are received, type '**unlogall <enter>**'.
5. Type '**log version <enter>**' A few lines will print out that look like this:

   [COM1]<VERSION COM1 0 88.0 UNKNOWN 0 50.158 004c0000 3681 11526

   < 1

< GPSCARD "D1S00G0T0" "BJYA13175265K" "OEM615-1.01" "OEM060220RN0000" "OEM060200RB0000" "2013/Mar/05" "16:54:45"

In this example, the model is D1S00G0T0 .

Method 2: Only NovAtel GPS Receiver Required:

1. Connect the serial cable to the RS232 connector of the NovAtel.
2. Power up the NovAtel remote unit.
3. Open hyper terminal and type '**log version <enter>'.**

Checking the Currently Installed Model on the NovAtel Base

1. Connect the RS232-USB cable to the back of the MP-NovAtel base unit. Connect the power supply. Turn on the switch on the front.
2. Open hyper terminal and type '**log version <enter>'.**

Obtaining an Authorization Code to Change the Model

1. Obtain the 'log version' output as described in the steps above.
2. Contact *sales@NovAtel.com* requesting the desired license.
3. The user will need to email them the log version output obtained in the above steps.
4. They will respond with an authorization code.

Installing a New Model by Entering an Authorization Code

1. When the authorization code is received, go back into the NovAtel GPS terminal mode, then type 'auth' followed by the authorization code with commas in the code replaced by spaces then press enter. If the code was entered correctly, the response will be ' <OK'.

For example if the auth code is:
G4F98R,PZDIFD,HJ3TGB,84BP8R,2ZHQKG,D1S00G0T0,141003

Type 'auth g4f98r pzdifd hj3tgb 84bp8r 2zhqkg d1s00g0t0 141003' then hit the enter key.

Note: The code is not case sensitive.

2. Then type 'log version' to verify the new model.

Switching Between Installed Models

Multiple models can be installed onto the NovAtel GPS receiver. Each time a valid auth code is entered, a new model will be added. To switch models, type 'model <model name> <enter>'. For example, typing 'model D1S00G0T0 <enter>' will switch to the D1S00G0T0 model. Type 'log version' to see the currently selected model. To view the list of installed models, use NovAtel's Connect software and go to 'view', 'receiver version window'.

Operational Checks

Upon starting the MP-NovAtel Remote GPS receiver, the status LED should flash orange then green then turn off for a second. It should then begin blinking once per second.

With the NovAtel Remote GPS receiver connected to the autopilot and the autopilot configured correctly for the NovAtel GPS, monitor the autopilot COM in HyperTerminal.

The very first lines should indicate that the TPU lines selected in the VRS have been setup for Tx and Rx lines and the UART is configured for the GPS. See below.

TXUART1: Initializing TPU 16 to be an 57600 baud, 8 data bits, 0 parity OUTPUT.....success

RXUART1: Initializing TPU 22 to be an 57600 baud, 8 data bits, 0 parity INPUT.....success
Initialized UART 1 for GPS.

After the autopilot start-up report is complete, press MMMM to see the NovAtel messages coming out to the autopilot.

The following is a typical result:

msg id 37 - Component 0, type = 1:
  Model = "GENERIC"
  PSN = "DCH10010093"
  hw_version = "OEMV1G-1.01-TT"
  sw_version = "3.700"
  boot_version = "3.000"
  comp_date = "2009/Sep/18"
  comp_time = "15:09:31"

msg id 101 - TIME - 3/1 - 0:0:0 (0.000)
msg id 42 - BESTPOS (0.000000, 0.000000, -6378054.-483648)
msg id 99 - BESTVEL (0.00, 0.00)
(msg 101, 42 and 99 repeat 5 times between each msg 83)

msg id 83 - TRACKSTAT

NovAtel ALIGN Heading Feature

About

NovAtel ALIGN Heading calculates the heading between the two airborne GPS antennas. This heading replaces the heading otherwise obtained by an MP-Compass unit. It can be useful in cases where a high precision heading is needed or cases where a compass (magnetometer) does not work.

Hardware Requirements

NovAtel ALIGN Heading requires:

- Two single antenna airborne NovAtel remote units (such as the NovAtel OEM615) or one dual antenna airborne NovAtel remote unit (such as the NovAtel OEM617D).
- Two NovAtel GPS antennas.
- An MP2128^{HELI2} autopilot.

Software Requirements

The NovAtel ALIGN heading feature will only function on MP2128^{HELI2} autopilot code (mp2128G2Heli-*.bin) starting from version 3.5.1782.0. Support for dual antenna GPS receivers such as the NovAtel OEM617D exists in versions 3.6.273 or 3.7.273 and higher.

The NovAtel remote units need to have models with NovAtel ALIGN heading enabled. See *Table 3 - NovAtel OEM615 Models* and *Table 4 - NovAtel OEM615 Feature Matrix*.

NovAtel ALIGN Heading with a Board Autopilot Connections

- See *Figure 12 - NovAtel ALIGN Heading with Board Autopilot Wiring Diagram* when using two single antenna GPS receivers.
- When using one dual-antenna GPS receiver, the wiring is the same as with one single antenna GPS.
- Connect NovAtel remote #1 to the autopilot using the TTL connector.
- Connect NovAtel remote #1's RS232 connector to NovAtel remote #2's RS232 connector as follows:
  Connect NovAtel remote #1 pin 1 to NovAtel remote #2 pin 3.
  Connect NovAtel remote #1 pin 3 to NovAtel remote #2 pin 1.
- If NovAtel remote #1 is powered from a different power supply or battery than NovAtel remote #2 then connect NovAtel remote #1 RS232 connector pin 2 to NovAtel remote #2 RS232 connector pin 2. This supplies a communication ground.

Figure 12 and *Figure 13* only apply to the OEM615 with one antenna. With the current OEM617D, the connection is the same for the NovAtel ALIGN heading as for normal operation, except two antennas are connected to the GPS instead of one.

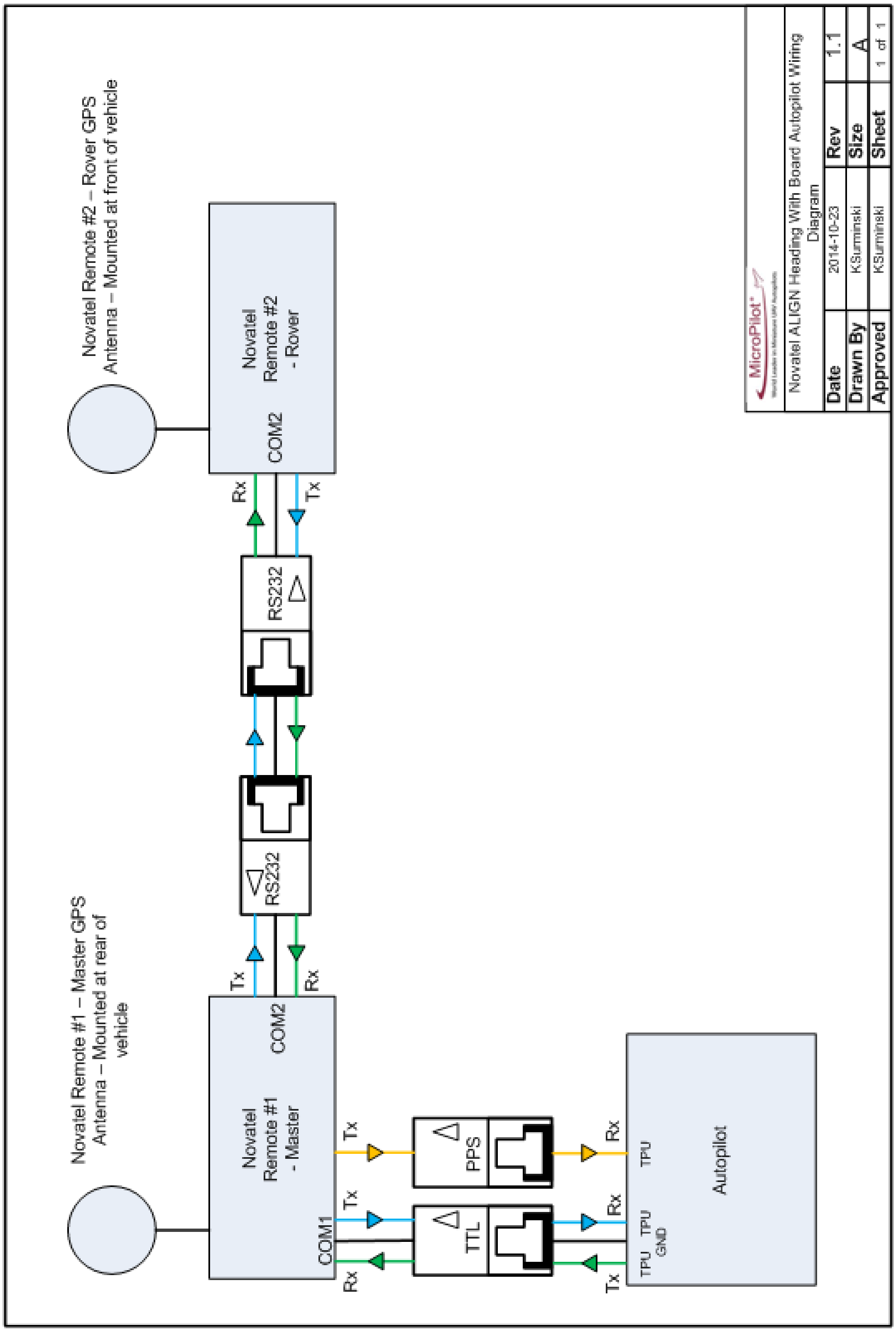

Figure 12 - NovAtel ALIGN Heading with Board Autopilot Wiring Diagram

NovAtel ALIGN Heading with an LRC2 Autopilot Connections

See *Figure 13 - NovAtel ALIGN Heading with LRC2 Autopilot Wiring Diagram*

NovAtel ALIGN heading requires NovAtel remote #1's COM1 (TTL connector) be connected to the autopilot. The GPIO connector on the LRC can be used for this. The GPIO connector pin 2 goes to TPU31 and pin 3 goes to TPU 15. The PPS signal can then be connected to J1 pin 2 which is TPU 31. The user will have to add their own pin and wire for this.

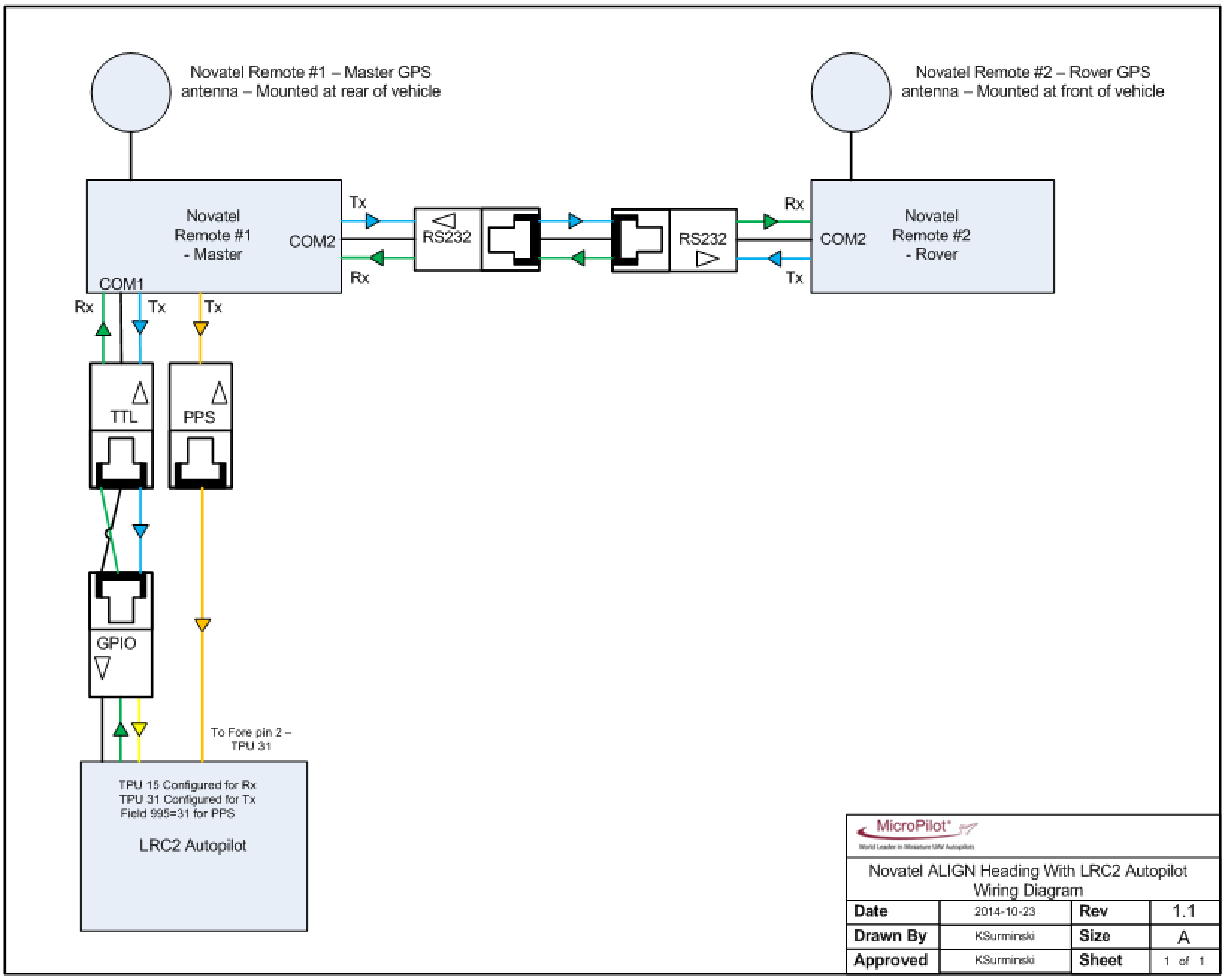

Figure 13 - NovAtel ALIGN Heading with LRC2 Autopilot Wiring Diagram

NovAtel ALIGN Heading with an MP21283X Autopilot Connections

See *Figure 14 - NovAtel ALIGN Heading with MP21283X Autopilot Wiring Diagram*

In order to use NovAtel ALIGN Heading with an MP2128^{3X} autopilot, there is an internal CMOS to RS232 converter that will need to be enabled first. A 0 ohm resistor, R65 needs to be removed from the MP2128^{3X} interface board. The user must send their MP2128^{3X} in on an RMA and

MicroPilot will perform this modification. Contact MicroPilot support (support@micropilot.com) to request an RMA.

Note: once the internal CMOS to RS232 converter is enabled, there will be signals on J4 pins 3 and 4. It is important that these pins are not grounded or connected to anything else or else the NovAtel to board A communications will cease to function properly.

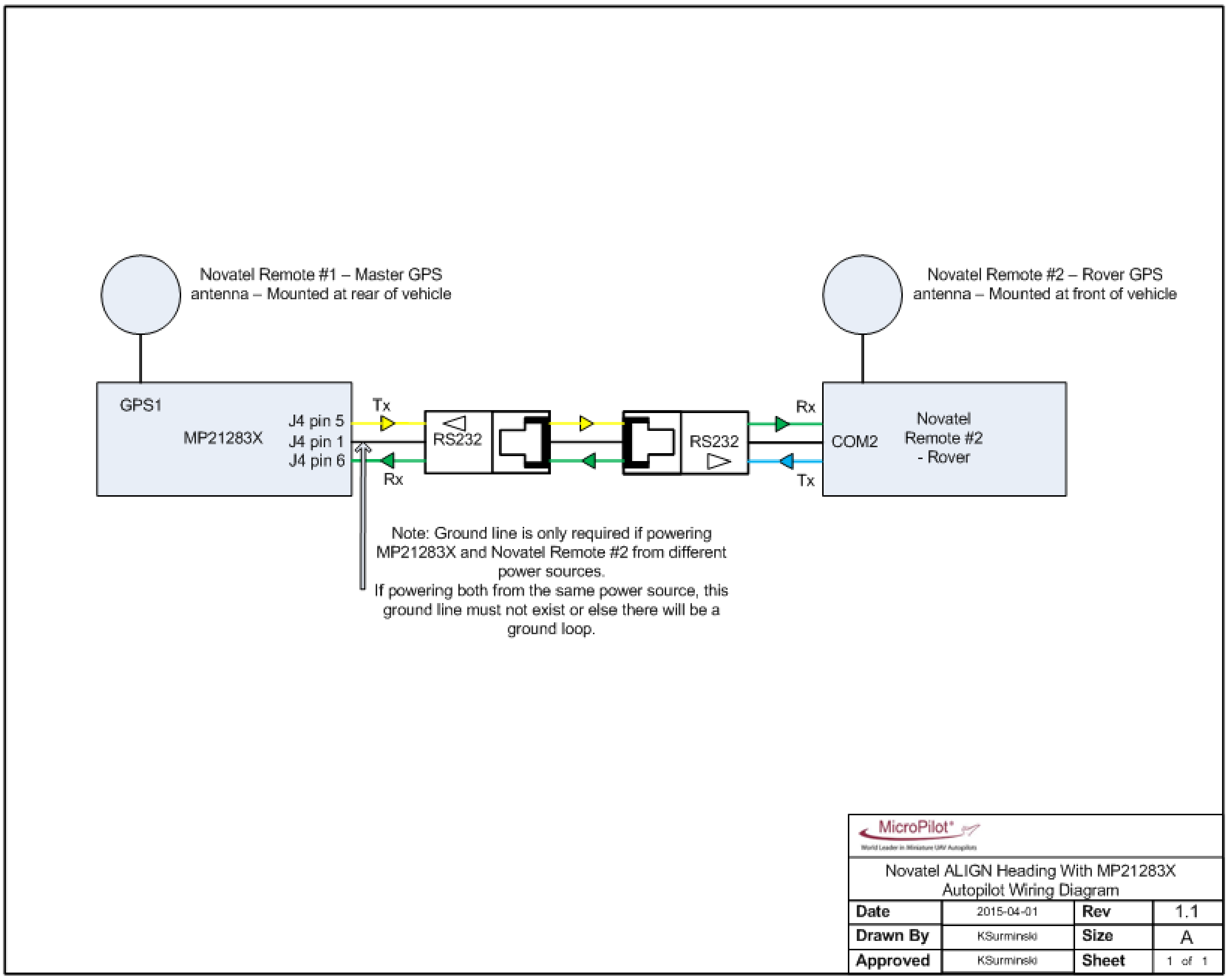

Figure 14 - NovAtel ALIGN Heading with MP2128^{3X} Autopilot Wiring Diagram

GPS Antenna Mounting

- Mount NovAtel remote #1's GPS antenna at the rear of the vehicle.
- Mount NovAtel remote #2's GPS antenna at the front of the vehicle.
- The distance between the two GPS antennae must be at least 0.5 meters. The accuracy of the heading solution is dependent on the baseline length between the master's antenna and the rover's antenna. The longer this baseline is, the more accurate the heading. See *Figure 15 - NovAtel ALIGN Heading Accuracy vs. Baseline Length*

- If the line drawn from one GPS antenna to the other is not parallel to the forward x direction of the airframe, then the declination field must be set to the angle between the two antennas and the forward x direction. If the line drawn from one GPS antenna to the other is to the East of the forward x direction of the airframe, the declination angle is positive. If the line drawn from one GPS antenna to the other is to the West of the forward x direction of the airframe, the declination angle is negative.
- For dual antenna GPS receivers, mount the primary GPS antenna at the rear of the vehicle. Mount the secondary GPS antenna at the front of the vehicle.

ALIGN Accuracy

	0.5 m Baseline	1 m Baseline	2 m Baseline
Dual Frequency - Fixed Heading Accuracy	0.40 degrees	0.20 degrees	0.10 degrees

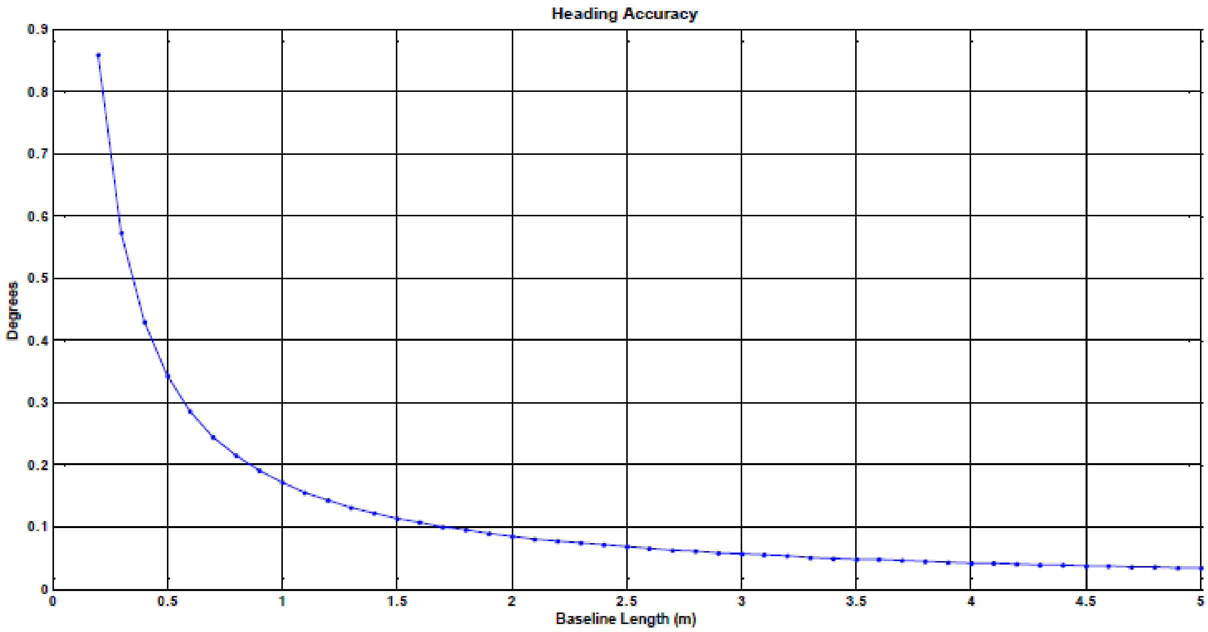

Figure 15 - NovAtel ALIGN Heading Accuracy vs. Baseline Length

VRS Configuration

1. On the GPS tab of the VRS editor, set **Type** to **NovAtel**. Set **Baud** to **57600**. Set **Fix Rate**, with firmware 3.6.209/3.7.209 and newer, to **1, 2, 5, 10 or 20** Hz. With firmware 3.5.1782.0 to 3.6. the fix rate must be set to **10** Hz. 1 and 2 Hz are not recommended because they are too slow.

2. In the Carrier Phase/RTK Settings section, select **Enable Heading (UAVOrientation)** as shown in *Figure 16 - NovAtel ALIGN Heading VRS Settings*.

3. **Dual Antenna Receiver:** Enable this option only if using a dual antenna GPS receiver such as the NovAtel OEM617D. When using a NovAtel OEM615 leave this option unchecked.

4. **Request time messages at 1 Hz (for licenses without raw measurements):** Enable this option only if the model loaded on the NovAtel remote unit does not support raw measurements. Model names ending with TT0 support raw measurements. Model names ending with 0T0 do not support raw measurements.

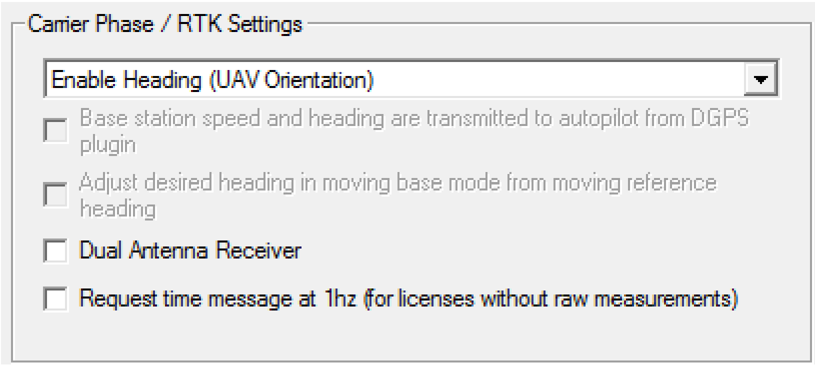

Figure 16 - NovAtel ALIGN Heading VRS Settings

5. On the Sensors tab of the VRS editor, set **Compass** to **NovAtel ALIGN**, as shown in *Figure 17 - NovAtel ALIGN Heading Compass Setting*. This sets field 94 [*useCompass*] to **4**.

6. Set the **Declination (deg)** setting to the angle between the line drawn from GPS antenna 1 to GPS antenna 2 and the forward x direction of the airframe. For example, if the NovAtel ALIGN heading is 10 degrees to the right or East of the forward x direction of the airframe, set declination to 10 degrees. If the NovAtel ALIGN heading is 10 degrees to the left or West of the forward x direction of the airframe, set declination to -10 degrees. This setting will be rounded to the nearest whole number.

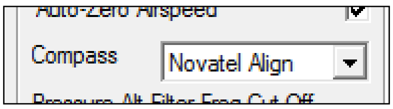

Figure 17 - NovAtel ALIGN Heading Compass Setting

Note: with Compass set to Novatel ALIGN (field 94 [*useCompass*] set to 4) the autopilot will not finish initialising until it reads a valid heading from the Heading log received from the NovAtel. Be ready to expect a bit longer delay in this mode and remember that if the NovAtel is not turned on and providing data output, the autopilot will not become ready.

Fields to Monitor

Field #	Name	Description
94	*useCompass*	When field 94 [*useCompass*] is set to 4, this field contains the NovAtel ALIGN heading in degrees * 100.
1208	*compassHdg*	When field 94 [*useCompass*] is set to 4, this field contains the NovAtel ALIGN heading in degrees * 100.
2134	*gpsMovingReferenceAccuracy*	If the user does not have ALIGN Relative Positioning enabled, this field contains the NovAtel ALIGN Heading standard deviation (accuracy) in degrees * 100.
2139	*gpsRTKMovingReferencePosType*	If the user does not have ALGIN Relative Positioning enabled, then this field contains the NovAtel ALIGN Heading fix type. Possible values are: 0 - No heading fix 32 - L1 Float (low accuracy heading fix - not used by autopilot) 50 - Narrow Int (high accuracy heading fix - used by autopilot)
2379	*gpsRTKHeadingFixType*	If the user has both ALIGN Heading and ALIGN Relative Positioning enabled, then the standard deviation is found in this field instead of field 2134.
2380	*gpsRTKHeadingAccuracy*	If the user has both ALIGN Heading and ALIGN Relative Positioning enabled, then the standard deviation

		is found in this field instead of field 2139.
2381	*gpsRTKHeadingBaselineLength*	Contains the distance between the two antennae on the UAV in ft * 8. This can be used to verify that the RTK solution is correct by comparing the baseline to the known distance between the antennae. When using a model that supports only ALGIN Heading and not ALGIN Relative Positioning, then this field will contain only the decimal portion of the baseline length in meters. For example, a 1.5 m baseline length will provide a value of 0.5 m in this field.
2382	*gpsRTKTiltOrientation*	Contains the tilt between the two antennae on the UAV in rad * 4096.

GPS Failure Modes with ALIGN Enabled

The GPS failure modes regarding the position/velocity/navigation/IMU when position fix is lost are the same.

If GPS lock is lost, then the compass heading will no longer be used. A warning saying that **GPS compass is lost** will appear in HORIZON^{mp}. If the GPS doesn't re-lock within a short amount of time, the user should land immediately.

What happens depends on the type of vehicle:

Fixed Wing: The GPS heading will always be used for navigation because our PID loops use GPS heading and not compass heading. The Kalman filter will stop correcting the current yaw towards the compass heading and will not correct yaw gyro bias anymore, so the Kalman filter estimate of current yaw will be incorrect. The wind estimate will become incorrect while the GPS compass is broken.

Heli/Multirotor: The Kalman filter will stop correcting the current yaw towards the compass heading and will not correct yaw gyro bias anymore, so the Kalman filter estimate of current yaw will become incorrect over time. This has a direct effect on navigation and position hold because GPS heading is not used on these platforms therefore the user should land if the error persists.

NovAtel ALIGN Relative Positioning Feature

About

NovAtel ALIGN Relative Positioning generates high accuracy heading, pitch, relative separation, and positioning between two or more receivers.

One possible application is if the user wanted to land on a moving platform, such as a ship at sea.

Hardware Requirements

NovAtel ALIGN Relative Positioning requires:

- A NovAtel remote unit.
- A NovAtel base unit.
- Two NovAtel GPS antennas.
- A dedicated wireless data link between the NovAtel remote and NovAtel base units.
- An MP2128^{HELI2} autopilot.

The NovAtel remote unit must send large amounts of data to and from the NovAtel base unit. The Microhard radio modems sold by MicroPilot cannot handle this increased amount of data. Therefore, a separate set of radio modems is required. The radio modems must be RS232 and support a baud rate of at least 230400 bps (bits per second). The amount of latency on the modems directly affects the latency of the relative positioning solution, so lower latency modems will allow for better control.

Currently, NovAtel ALIGN Relative Positioning is only supported on MP2128^{HELI2} autopilots flying helicopters or multirotor aircraft.

Software Requirements

The NovAtel ALIGN Relative Positioning feature will only function on MP2128^{HELI2} autopilot code (mp2128G2Heli-*.bin) starting from version 3.5.1782.0.

The NovAtel remote (rover) unit needs to have a model with NovAtel ALIGN Relative Positioning enabled. See *Table 3 - NovAtel OEM615 Models* and *Table 4 - NovAtel OEM615 Feature Matrix*.

NovAtel ALIGN Relative Positioning with a Board Autopilot Connections

- See *Figure 18 - NovAtel ALIGN Relative Positioning with Board Autopilot Wiring Diagram*
- Connect the NovAtel remote (rover) to the autopilot using the TTL connector.
- Connect the NovAtel remote (rover) to the secondary remote modem using the RS232 connector.
- Connect the NovAtel base (master) to the secondary base modem using the RS232 connector.
- Connect the NovAtel base (master) to the TTL-RS232 converter using the TTL connector.

- Connect the RS232 side of the TTL-RS232 converter to RS232-USB converter.
- Connect the USB side of the RS232-USB converter to the GCS computer's USB port.

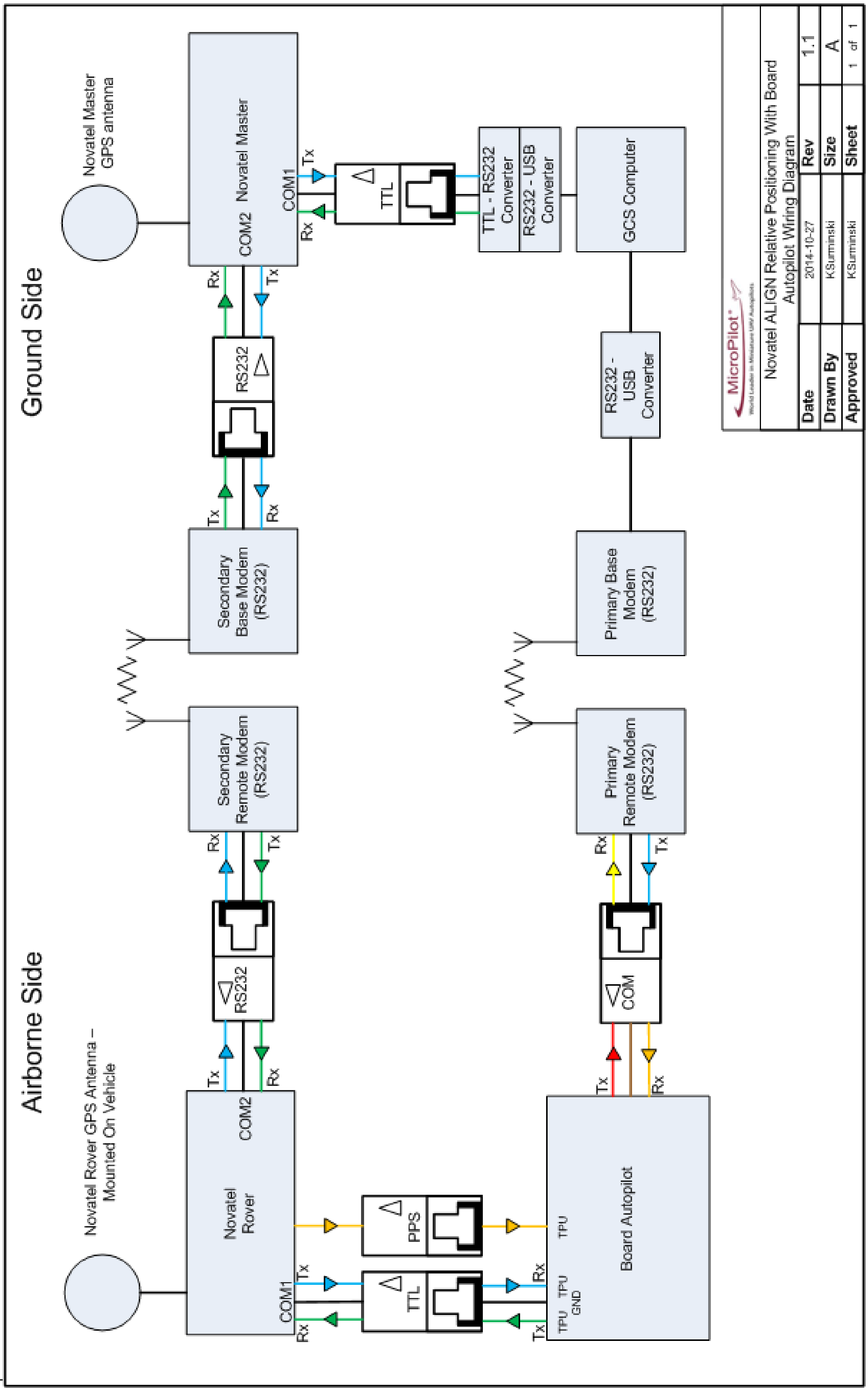
Ground Side
Airborne Side
Novatel Master GPS antenna
Novatel Master
COM2
COM1
Rx
Tx
TTL
TTL - RS232 Converter
RS232 - USB Converter
GCS Computer
RS232
Secondary Base Modem (RS232)
Secondary Remote Modem (RS232)
Primary Base Modem (RS232)
RS232 - USB Converter
Primary Remote Modem (RS232)
COM
Novatel Rover GPS Antenna – Mounted On Vehicle
Novatel Rover
PPS
Board Autopilot
TPU
TPU GND
Novatel ALIGN Relative Positioning With Board Autopilot Wiring Diagram
Date 2014-10-27
Rev 1.1
Drawn By KSurminski
Size A
Approved KSurminski
Sheet 1 of 1

Figure 18 - NovAtel ALIGN Relative Positioning with Board Autopilot Wiring Diagram

NovAtel ALIGN Relative Positioning with an LRC2 Autopilot Connections

- See *Figure 19 - NovAtel ALIGN Relative Positioning with LRC2 Autopilot Wiring Diagram*
- Connect the NovAtel remote (rover)'s TTL connector to the LRC2's GPIO connector as shown in the wiring diagram.
- Connect the NovAtel remote (rover)'s RS232 connector to the tertiary remote modem.
- Connect the NovAtel base (master)'s RS232 connector to the tertiary base modem.
- Connect the NovAtel base (master)'s TTL connector to the TTL side of the TTL-RS232 converter.
- Connect the RS232 side of the TTL-RS232 converter to RS232-USB converter.
- Connect the USB side of the RS232-USB converter to the GCS computer's USB port.

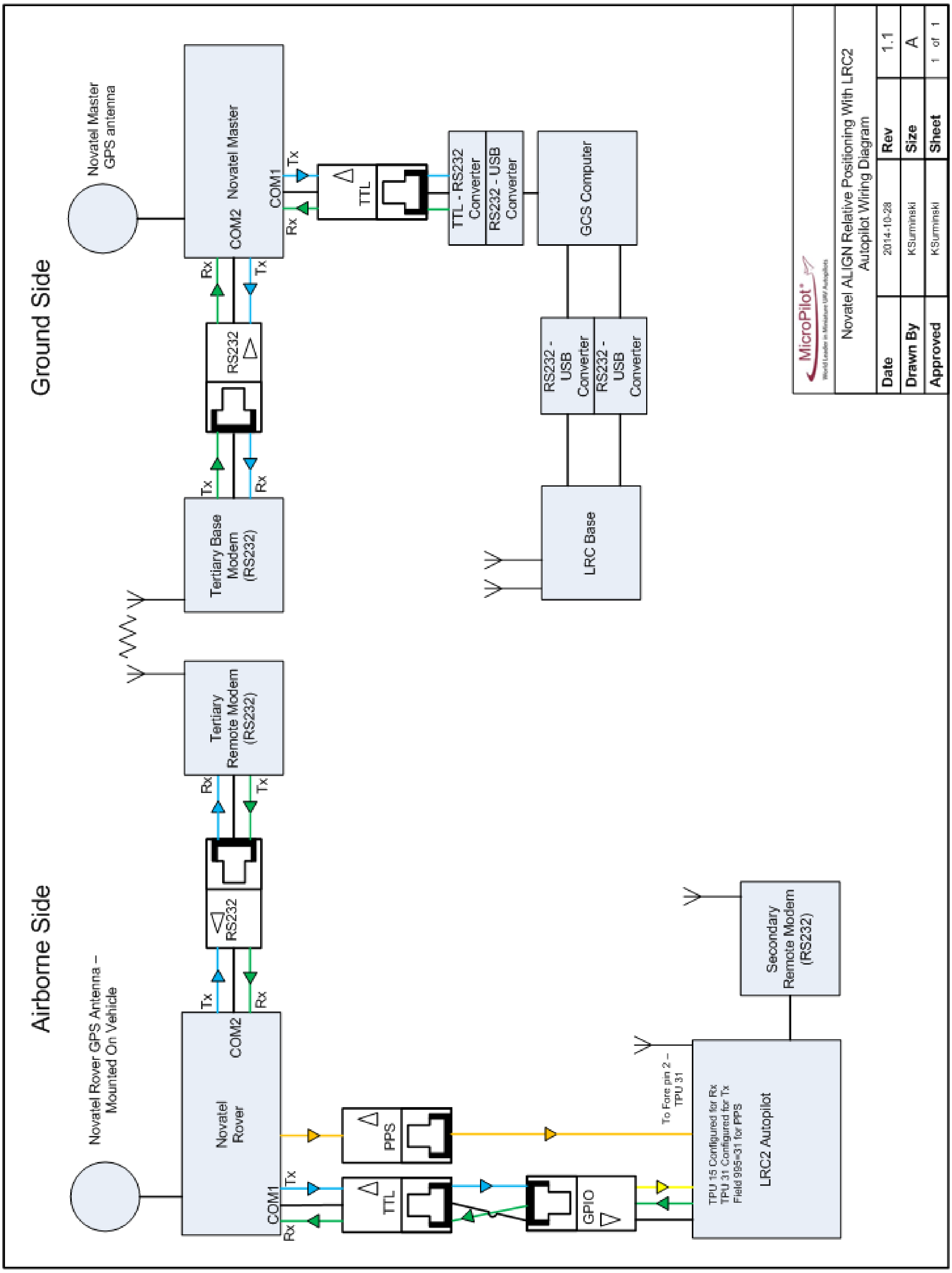

Figure 19 - NovAtel ALIGN Relative Positioning with LRC2 Autopilot Wiring Diagram

NovAtel ALIGN Relative Positioning with an MP2128^3X Connections

See *Figure 20 - NovAtel ALGIN Relative Positioning with MP21283X Autopilot Wiring Diagram*

In order to use NovAtel ALIGN Relative Positioning with an MP2128^3X autopilot, there is an internal CMOS to RS232 converter that will need to be enabled first. A 0 ohm resistor, R65 needs to be removed from the MP21283X interface board. The MP2128^3X must be sent in on an RMA and MicroPilot will perform this modification. Contact MicroPilot support (support@micropilot.com) to request an RMA.

Note: Once the internal CMOS to RS232 converter is enabled, there will be signals on J4 pins 3 and 4. It is important that these pins are not grounded or connected to anything else or else the NovAtel to board A communications will cease to function properly.

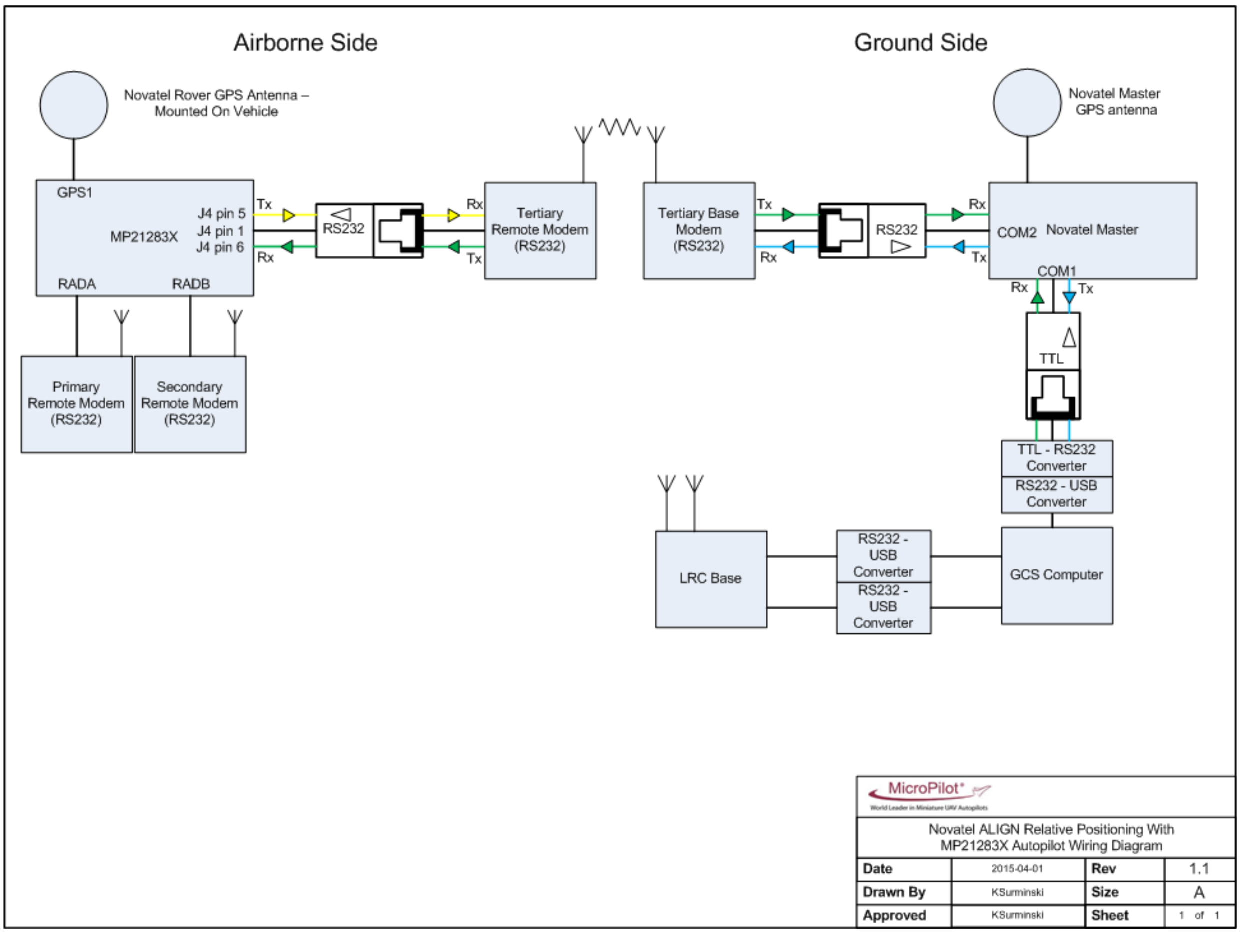

Figure 20 - NovAtel ALGIN Relative Positioning with MP2128^{3X} Autopilot Wiring Diagram

VRS Configuration

1. On the GPS tab of the VRS Editor, for **Type**, select **NovAtel**. For **Baud** enter **57600**. For **Fix Rate**, with firmware 3.6.209/3.7.209 and newer, **1, 2, 5,** or **10** Hz may be set. **20 Hz will not work.** From 3.5.1782.0 to 3.6.208 the fix rate must be set to **10** Hz. 1 and 2 Hz are not recommended because they are too slow.

2. In the Carrier Phase/RTK Settings section, select **Enable Relative Positioning (Moving Base)** as shown in *Figure 21 - NovAtel ALIGN Relative Positioning VRS Settings*.

3. **Base station speed and heading are transmitted to autopilot from DGPS plugin:** If this option is enabled, the NovAtel base unit needs to be connected to the GCS computer via a COM cable. This means that access to both of the NovAtel base's COM ports is required. It is necessary to either purchase an MP-NovAtel remote unit to use as a base or add in pins to the connector. Connect the base's RS232 connector to the 2nd base modem. Connect the base's TTL connector to a TTL-RS232 converter. Connect the RS232 side of the converter to the GCS computer. When this option is OFF: GPS on the ground does not have to be connected to DGPS plugin, the speed and heading of the base GPS are estimated using the GPS base position received by the autopilot from the rover GPS. We found using this method that the speed and heading estimates were very inaccurate so that is why we added the other option. When this option is ON: GPS on the ground is connected to the DGPS plugin and directly sends its speed and heading to the autopilot through the DGPS plug-in. This mode is recommended since the speed and heading is much more accurate this way. The only time we would not recommend this mode is if the base following option is not used, only hovering, and therefore the user is not concerned with the accuracy of the base speed and heading.

4. **Adjust desired heading in moving base mode from moving reference heading:** If this option is disabled, then the desired heading of the heli will follow the GPS heading of the base, field 2137 [*gpsBaseLocationHeading*]. For example, if the heli is pointing North and the GCS is moving East then turns 90 degrees right to point South and begins to travel South, the heli's heading will also turn 90 degrees right to point East. Field 2152 [*movingReferenceHeading*] is set to be equal to field 2137 [*gpsBaseLocationHeading*].

   If this option is enabled then the desired heading of the heli will follow the moving reference heading, field 2152 [*movingReferenceHeading*]. The user can set field 2152 to any heading they wish. For example, a custom plug-in could be used to set it based on some external information such as a compass located on the base or another source of heading information. Or field 2152 can be left constant if the user does not want the desired heading of the heli to change as it follows the base.

Note: The moving reference heading (field 2152) determines the coordinate system for the offset between the UAV desired position and base position in fields 2141 [*gpsReferenceDesiredOffsetE*] and 2142 [*gpsReferenceDesiredOffsetN*]. For example: the [*gpsReferenceDesiredOffsetE*] field will say that the user wants the UAV to hover x feet to the right of the GCS. The direction of 'right' will be determined by the moving reference heading field.

5. **Request time messages at 1 Hz (for licenses without raw measurements):** Enable this option only if the model loaded on the NovAtel remote unit does not support raw measurements. Model names ending with TT0 support raw measurements. Model names ending with 0T0 do not support raw measurements.

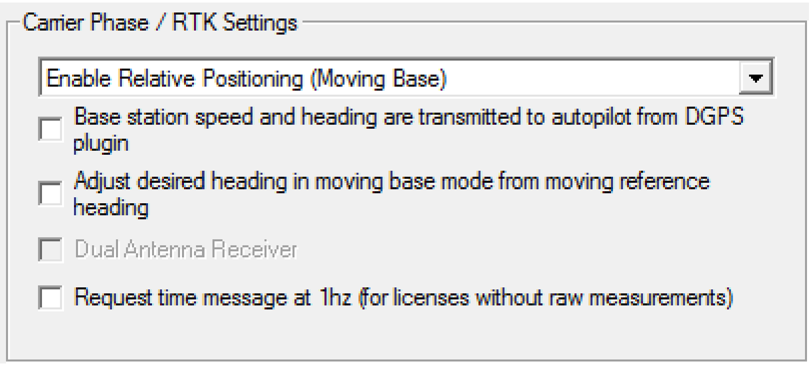

Figure 21 - NovAtel ALIGN Relative Positioning VRS Settings

DGPS Plug-in

When the NovAtel ALIGN relative positioning feature is enabled the DGPS plug-in will display information about the ALIGN status and allow the selection of the operation mode and specification of the hover offset. The DGPS plug-in does not need to connect to the base station GPS via a COM cable, as the remote and base are already directly connected. Instead, the DGPS plug-in will only connect to the autopilot through HORIZON^mp^.

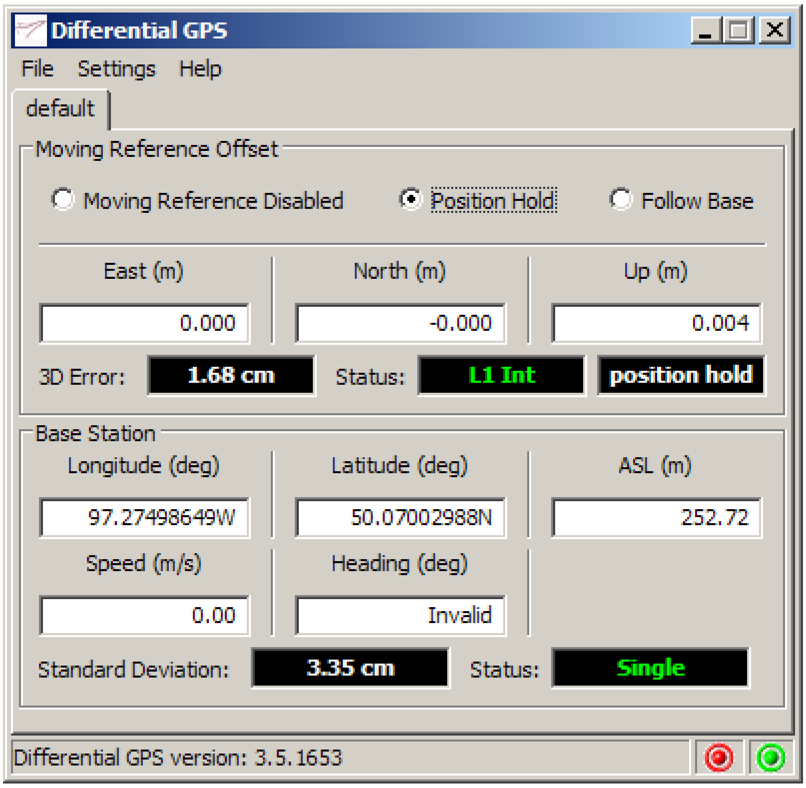

Figure 22 - DGPS Plug-in with NovAtel ALIGN Relative Positioning Enabled

The radio box at the top allows the user to select whether to ignore NovAtel ALIGN data, hold position with the NovAtel ALIGN, or follow the base station.

The Moving Reference Offset box will show the relative position of the remote and base, as well as the standard deviation, fix type, and what mode is active.

The Base Station box shows the location of the base station as well as its calculated speed and heading. If the speed is below 9 ft/s the heading is not calculated because the velocity is too noisy to calculate heading at low speed.

In the settings menu, choose "Set Desired Position Relative to Base" to bring up the dialog box shown below in *Figure 23 - Set Desired Position Dialog Box*.

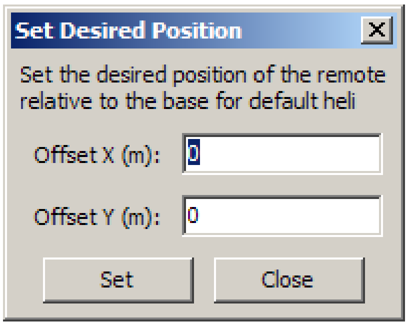

Figure 23 - Set Desired Position Dialog Box

Operating the NovAtel ALIGN Relative Positioning Feature Manually

Instead of using the DGPS plug-in to control the ALIGN feature, these fields can also be set directly.

Enabling Hovering Over the Base Station

To enable hovering with the NovAtel ALIGN system, set bit 0x1 of the field 2133 [*gpsMovingReferenceStatus*] to 1. The UAV will hover directly over the base's (master's) antenna location, or with an offset specified by the [*gpsReferenceDesiredOffsetE*] / [*gpsReferenceDesiredOffsetN*] fields.

Enabling Following the Base Station

To enable following the base station with the NovAtel ALIGN system, set bit 0x4 of field 2133 [*gpsMovingReferenceStatus*] to 1. If this bit is set and the speed of the base station is above 3 ft/s, the UAV will turn to the heading of the base station and will try to maintain a forward speed matching the base (master) station's speed as well as trying to maintain the offset [*gpsReferenceDesiredOffsetE*] / [*gpsReferenceDesiredOffsetN*] above the base location.

Setting the Desired Location Relative to the Base Station

Set the fields [*gpsReferenceDesiredOffsetE*] and [*gpsReferenceDesiredOffsetN*] to the desired location of the UAV relative to the base station. [*gpsReferenceDesiredOffsetE*] is the offset to the right of the base station and [*gpsReferenceDesiredOffsetN*] is the offset in front of the base station. The field [*movingReferenceHeading*] is used to convert the desired offset from relative position to East/North offsets. If the moving reference heading is not available (field is -1) then the desired offset will be considered to be zero. The moving reference heading can be set three ways:

- If the base moves above 9 ft/s the moving reference heading will be set to the base heading.
- If the vision system is providing a camera heading, then the moving reference heading will be set to that value.
- The [*movingReferenceHeading*] field can be set manually by a *.fly* file command, pattern, or the sensor monitor plug-in.

Modes of Operation

- If the autopilot has received external position guide data that has not timed out and the option to hover via the external position guide is enabled, then the UAV will hover using that relative offset information.
- If the NovAtel ALIGN system is providing relative positions with L1 INT accuracy and the option to hover using NovAtel ALIGN data is enabled, the UAV will hover at the location determined by the NovAtel ALIGN relative offset and the desired offset North

and East. The hover offsets will be directly replaced by the offset received from the ALIGN system plus the desired offset from the base antenna location.

- If at any time the UAV is being aided in hovering by either the external position guide or the NovAtel ALIGN system, the desired waypoint in normal hovering mode will constantly be updated to be the location specified by those systems. Therefore if the external aid is lost, the UAV will try to hold its last desired position. The accuracy of the position being held will slowly degrade over time, but if an aiding source returns then the UAV will return to hovering accurately.
- If data from both the external position guide and NovAtel ALIGN are available at once, the external position guide data will be used and the NovAtel ALIGN data will be ignored.
- If the base (master) station position is moving at a speed over the minimum and follow base (master) station mode is enabled, the UAV will hover using the external position guide data if available, and if not, will use the NovAtel ALIGN data. When following via the NovAtel ALIGN, the desired x and y velocity will be calculated by adding the hover offset times the gain to the master velocity. If the master position is available but the ALIGN solution is not L1 INT, the hover waypoint will be updated based on the master position.
- If the vision system is being used to follow a base (master), the velocity must be replaced using the vision system, and the velocity must be relative to the ground.
- If the base station is moving faster than 9 ft/s and follow base mode is enabled, the desired heading will be updated with the difference between the new base station heading and the previous base station heading. This update will not occur the first time a base station heading is available after going off ground.
- When setting desired heading and camera heading from the vision system, a value of zero is considered NO DATA – send a value close to zero instead.
- When following the base using the external position guide plug-in, then the desired heading must be set from the external position guide – the desired heading will not be updated when the base turns.

Verifying Operation

Run the DGPS plugin and connect HORIZON^{mp} to the autopilot. It should display the Moving Reference Offset as the distance between the master and rover antennae, and the Base Station location as the position of the master antenna. The Moving Reference Offset status should go to L1 INT when there is an accurate relative position between the antennae. It may take a couple minutes for it to switch to L1 INT mode. Move the two antennae relative to one another and verify the relative position updates correctly.

NovAtel ALIGN Relative Positioning Fields

Field #	Name	Description
2127	gpsMovingReferencePositionOffsetE	Offset between remote (rover) and base (master) antenna, positive for rover East of master, ft * 4096
2128	gpsMovingReferencePositionOffsetN	Offset between remote (rover) and base (master) antenna, positive for rover North of master, ft * 4096
2129	gpsMovingReferencePositionOffsetU	Offset between remote (rover) and base (master) antenna, positive for rover above master, ft * 4096
2130	gpsBaseLocationE	GPS base (master) longitude, rad * 500,000,000
2131	gpsBaseLocationN	GPS base (master) latitude, rad * 500,000,000
2132	gpsBaseLocationU	GPS base (master) altitude, ft * 8
2133	gpsMovingReferenceStatus	Status of moving reference system: -Set bit 0x1 to hover using the NovAtel ALIGN system, the autopilot will try to maintain a horizontal position relative to the base set by the moving reference offset fields. -Set bit 0x4 to follow a moving base station, if the speed of the base station is above the minimum speed set by field 8895 [*NovAtelAlignOptions*] the autopilot will reconfigure its control loops to follow the base station. -If bit 0x2 is set, then the UAV is hovering using the NovAtel ALIGN system.

		-If bit 0x8 is set, then the UAV is following the base station.
2134	gpsMovingReferenceAccuracy	3D accuracy of moving reference offset, ft * 4096
2135	gpsBaseLocationAccuracy	3D accuracy of base (master) position, ft * 4096
2136	gpsBaseLocationSpeed	Speed of base station, ft * 8
2137	gpsBaseLocationHeading	Heading of base station, deg * 100
2139	gpsMovingReferencePosType	Type of position fix for moving reference, see NovAtel OEM6 Firmware manual table 56. The UAV will hover using NovAtel Align data only when this position type is L1 INT, indicating accuracy on the order of 2 cm.
2140	gpsBaseLocationPosType	Type of position fix for base (master), see NovAtel OEM6 Firmware manual table 84 (*http://www.NovAtel.com/assets/Documents/Manuals/om-20000129.pdf*). The UAV will only follow the base station if this position type indicates that there is a GPS lock on the master and if the option to follow the base is enabled.
2141	gpsReferenceDesiredOffsetE	Desired hover offset from the GPS base (master) position, +ve indicates the desired position is to the right of the base, ft * 4096
2142	gpsReferenceDesiredOffsetN	Desired hover offset from the GPS base (master) position, +ve indicates the desired position is in front of the base, ft * 4096
2152	movingReferenceHeading	The heading of the moving reference in deg * 100. This heading is used to convert the

		desired offset in fields 2141/2142 to east and north.
8895	NovAtelAlignOptions	Bit field that contains the settings set in the 'NovAtel ALIGN settings' box in the VRS editor GPS tab.

Figure 24 - NovAtel ALIGN Relative Positioning Fields

NovAtel ALIGN Heading and Relative Positioning Feature

About

It is possible to use NovAtel ALIGN Heading and Relative Positioning at the same time. It requires a NovAtel OEM617D dual antenna receiver to be used as the remote unit. It is possible with board autopilot and LRC2 autopilots. Currently it is not possible with MP2128^{3X} autopilots because NovAtel OEM617D receivers are not compatible with the MP2128^{3X}.

MicroPilot does not sell NovAtel OEM617D receivers. They must be purchased directly from Novatel. It is compatible with MicroPilot's NovAtel interface board which is required. It is also compatible with the NovAtel GPS antenna that MicroPilot sells.

The primary difference between the NovAtel OEM615 and the OEM617D is the OEM615 has one MCX GPS antenna connector, while the OEM617D has two MMCX GPS antenna connectors. MicroPilot does not sell MMCX GPS antenna cables. MMCX GPS antenna cables can be purchased from http://www.customcableinc.com/. 793 is their part number for MMCX right angle connectors. 740 is their part number for the TNC connector. LMR-100a is a flexible, dual shielded cable. The part number for a 36 inch length of this cable would be 36-740-L100-793.

Hardware Requirements

NovAtel ALIGN Heading and Relative Positioning requires:

- One NovAtel OEM617D GPS receiver
- One MicroPilot NovAtel interface board
- Two MMCX to TNC GPS cables
- Two NovAtel GPS antennas
- One NovAtel OEM615 base unit which includes GPS antenna and cable
- An MP2128$^{HELI2/LRC2}$ autopilot or LRC2 heli autopilot
- A dedicated wireless data link between the NovAtel remote and NovAtel base units

The NovAtel remote unit must send large amounts of data to and from the NovAtel base unit. The Microhard radio modems sold by MicroPilot cannot handle this increased amount of data. Therefore, a separate set of radio modems is required. The radio modems must be RS232 and support a baud rate of at least 230400 bps (bits per second). The amount of latency on the modems directly affects the latency of the relative positioning solution, so lower latency modems will allow for better control. Currently NovAtel ALIGN Relative Positioning is only supported on MP2128^{HELI2} autopilots flying helicopters or multirotor aircraft.

Software Requirements

The NovAtel ALIGN Heading and Relative Positioning feature will only function on MP2128^{HELI2} autopilot code (mp2128G2Heli-*.bin) starting from version 3.7.322.0. It is not available with 3.6 firmware.

Horizon 3.7.322.0 or newer is also required.

The NovAtel remote (rover) unit needs to have a model with NovAtel ALIGN Heading and ALIGN Relative Positioning enabled.

The NovAtel base unit needs to have a RTK base model.

NovAtel ALIGN Heading and Relative Positioning with a Board Autopilot Connections

- See *Figure 25 - NovAtel ALIGN Heading and Relative Positioning with Board Autopilot Wiring Diagram*.
- Connect the NovAtel remote (rover) to the autopilot using the TTL connector.
- Connect the NovAtel remote (rover) to the secondary remote modem using the RS232 connector.
- Connect the NovAtel base (master) to the secondary base modem using the RS232 connector.
- Connect the NovAtel base (master) to the TTL-RS232 converter using the TTL connector.
- Connect the RS232 side of the TTL-RS232 converter to RS232-USB converter.
- Connect the USB side of the RS232-USB converter to the GCS computer's USB port.

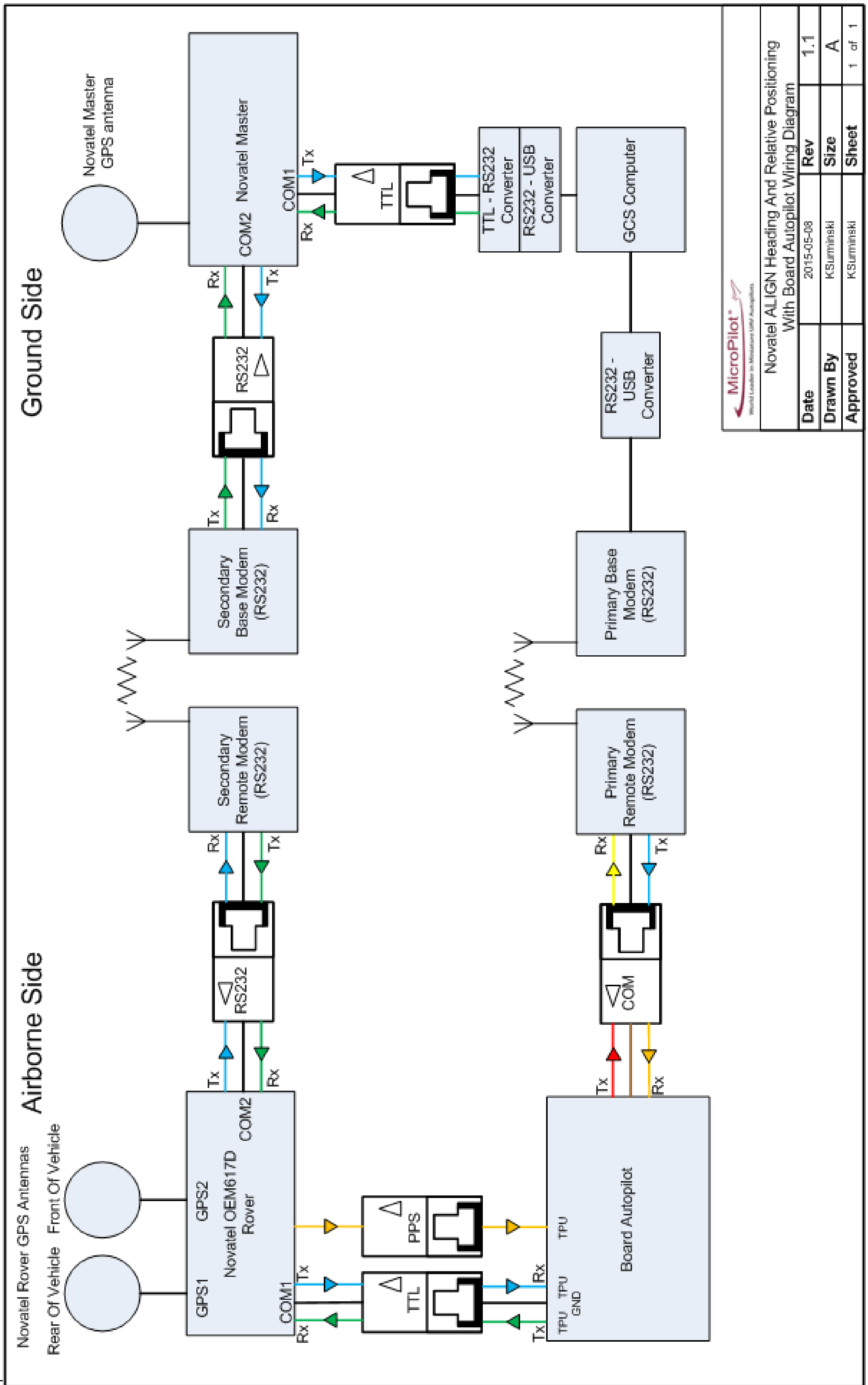
Ground Side
Airborne Side
Novatel Master GPS antenna
Novatel Master
COM2
COM1
Tx
Rx
TTL
TTL - RS232 Converter
RS232 - USB Converter
GCS Computer
RS232
Secondary Base Modem (RS232)
Primary Base Modem (RS232)
RS232 - USB Converter
Secondary Remote Modem (RS232)
Primary Remote Modem (RS232)
COM
Novatel Rover GPS Antennas
Rear Of Vehicle
Front Of Vehicle
GPS1
GPS2
Novatel OEM617D Rover
PPS
Board Autopilot
TPU
TPU GND
MicroPilot
Novatel ALIGN Heading And Relative Positioning With Board Autopilot Wiring Diagram
Date 2015-05-08
Drawn By KSuminski
Approved KSuminski
Rev 1.1
Size A
Sheet 1 of 1

Figure 25 - NovAtel ALIGN Heading and Relative Positioning with Board Autopilot Wiring Diagram

NovAtel ALIGN Heading and Relative Positioning with LRC2 Autopilot Connections

- See *Figure 26 - NovAtel ALIGN Heading and Relative Positioning with LRC2 Autopilot Wiring Diagram*.
- Connect the NovAtel remote (rover)'s TTL connector to the LRC2's GPIO connector as shown in the wiring diagram.
- Connect the NovAtel remote (rover)'s RS232 connector to the tertiary remote modem.
- Connect the NovAtel base (master)'s RS232 connector to the tertiary base modem.
- Connect the NovAtel base (master)'s TTL connector to the TTL side of the TTL-RS232 converter.
- Connect the RS232 side of the TTL-RS232 converter to RS232-USB converter.
- Connect the USB side of the RS232-USB converter to the GCS computer's USB port.

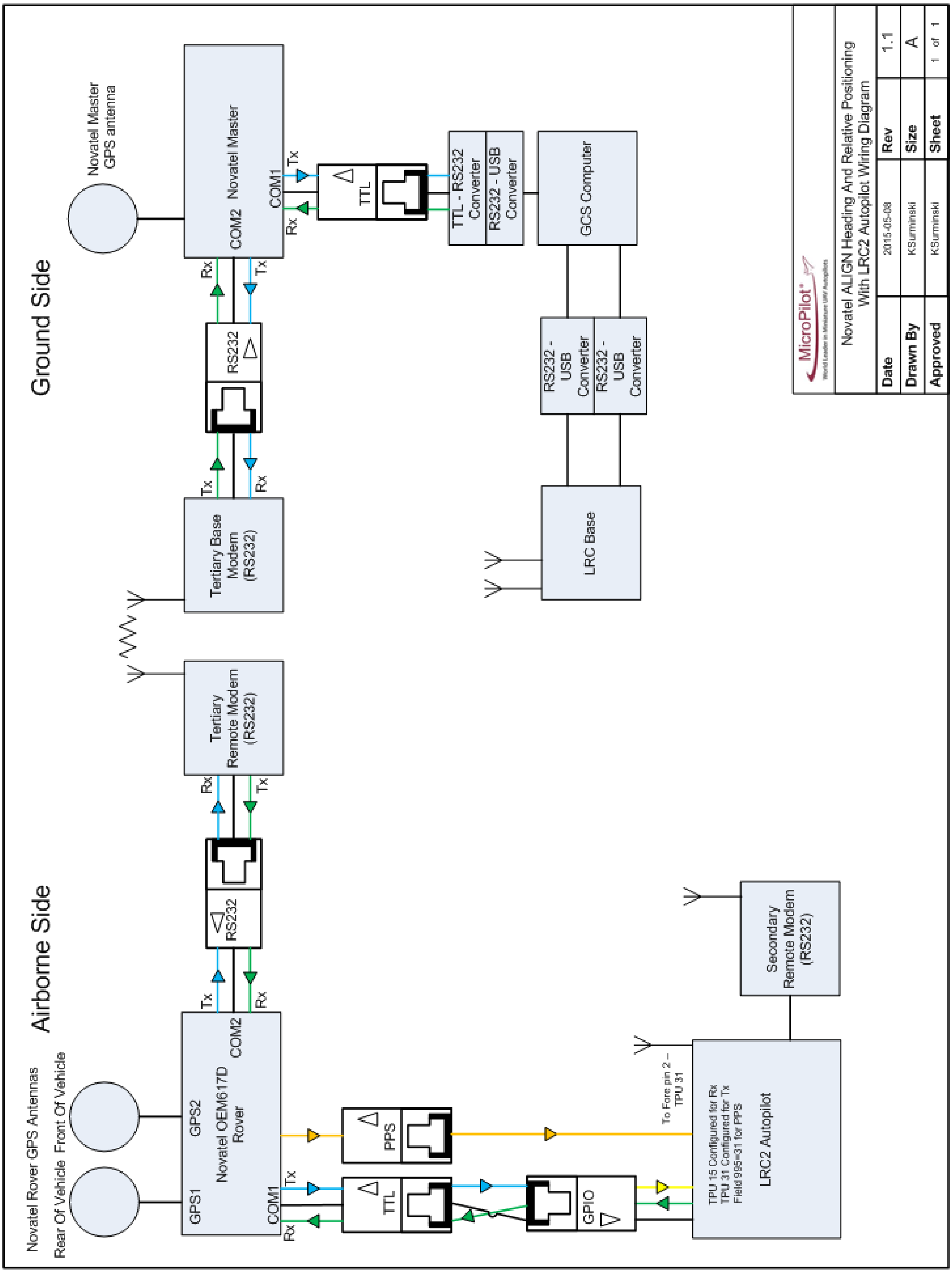

Figure 26 - NovAtel ALIGN Heading and Relative Positioning with LRC2 Autopilot Wiring Diagram

VRS Configuration

1. On the GPS tab of the VRS Editor, For **Type**, select **NovAtel**. For **Baud** enter **57600**. For **Fix Rate**, with firmware 3.6.209/3.7.209 and newer set **1, 2, 5,** or **10** Hz. **20 Hz will not work.** From 3.5.1782.0 to 3.6.208 set the fix rate to **10** Hz. 1 and 2 Hz are not recommended since it is too slow.
2. In the Carrier Phase/RTK Settings section, select **Enable Relative Positioning and Heading** as shown in *Figure 27 - NovAtel ALIGN Heading and Relative Positioning VRS Settings*.
3. The other options are described in the previous sections.

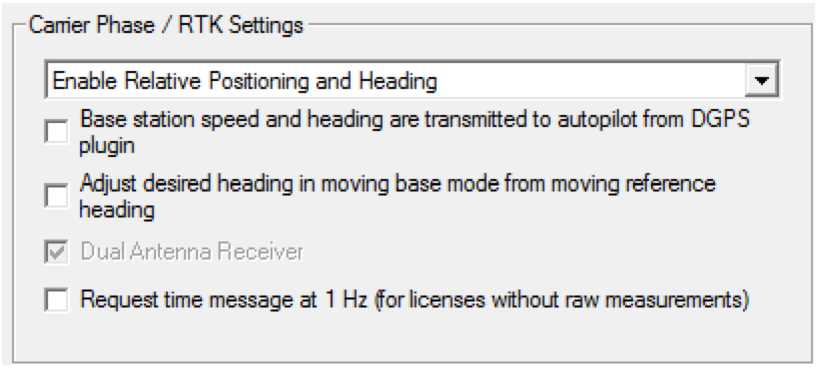

Figure 27 - NovAtel ALIGN Heading and Relative Positioning VRS Settings

Troubleshooting

General Tips

- The RS232 connection on the J2 connector can be used with a standard MicroPilot serial cable to talk to the NovAtel GPS with HyperTerminal or a similar serial terminal program.
- NovAtel's Connect software can be downloaded from the NovAtel website (*http://www.NovAtel.com/support/info/documents/809*). Connect via the RS232 connector when using this software. The user can see if it locks, which satellites it is locked onto, their SNR, and many other things.
- To see whether or not messages are being received by the autopilot from the NovAtel, type **mmmm** and if the data is visible then the communication is okay.
- In 3.6 code onwards, the autopilot allows direct access to the NovAtel GPS receiver port; type **nnnn** to enter this mode. The user can then issue commands to the NovAtel, like log version, freset, or enter the authcode for a license.
- **Note:** In the NovAtel Connect software, *Solution Type = single* means there is a lock. The autopilot will also say it is 'Locked'.

Loss of Communication/Baud Rate Check

If there is sudden communication issues with the NovAtel GPS receiver, it should be checked if the receiver baud rate has changed. It is possible in rare occasions, such as after upgrading NovAtel firmware, that the settings may change. If the baud-rate setting has changed, the user will be unable to communicate at 57600 bps. The most likely baud-rate change will be to the default 9600 bps.

To check the baud rate and ensure the NovAtel Remote receiver is set to 57600 bps:

1. Connect an MP serial cable to the RS232COM connector of the MP NovAtel Remote.
2. Start HyperTerminal.
3. Set HyperTerminal to 9600 bps and turn on echo characters so what is being typed in HyperTerminal is visible.
4. Type **log version <enter>.**
   If this produces a string of text similar to that shown below:

   [COM1]<VERSION COM1 0 88.0 UNKNOWN 0 50.158 004c0000 3681 11526

   < 1

   < GPSCARD "D1S00G0T0" "BJYA13175265K" "OEM615-1.01" "OEM060220RN0000" "OEM060200RB0000" "2013/Mar/05" "16:54:45"

   That means the NovAtel receiver is configured to 9600 bps. If no output is received, then that means the NovAtel is configured for a baud rate other than 57600. Change the baud rate in HyperTerminal and try again until the above output is received, and what baud rate the NovAtel is configured for is known.
5. To set the baud rate to 57600, type **com com1 57600 <enter>**, then type **com com2 57600 <enter>.**
6. Change the HyperTerminal baud rate to 57600.
   Do not turn off the NovAtel.
   Type **saveconfig<enter>**. It will respond with '<OK' This saves the current settings. Typing this without first changing HyperTerminal's baud rate will not save the changes.
   Type **log version <enter>.**
   Make sure it responds with a string of text like before.
   If it does, the NovAtel has been correctly configured for 57600bps.
7. Power cycle the NovAtel and type '**log version<enter>'** again. Make sure it responds with a string of text like before. If it does not, repeat the above steps.

Poor GPS Lock/Signal Quality

If the autopilot is too close to the NovAtel GPS receiver or its antenna, the user may experience interference that degrades the GPS quality or prevents a GPS lock.

ALIGN Heading

Check the NovAtel DGPS base license: On OEM615 Receivers, B0G type will work for the base. ROG will also work for the base, although it is a more expensive license than is necessary for a base (ROG type is really for a rover, or airborne receiver).

For example, with a G2SB0G110 license on the base station it will generate base station corrections at 1Hz for DGPS, RTK, or ALIGN operations. In the air a G2SR0G110 will work as the master receiver to provide a DGPS (or RTK) master position, and it will work with an ALIGN Heading receiver (G2SZ00000) on the aircraft which will provide the heading.

If both antennae do not have a good signal or see the same satellites it will be difficult to get a differential lock.

If the base station coordinates entered in the DGPS plug-in settings are different than the actual base station position, then the DGPS status reported in the DGPS plug-in will always be 'off'.

To check this, connect to the base unit using hyper terminal and type:

'log bestpos ontime 1 <enter>'.

If the output says integrity error, then that means the base station coordinates entered in the DGPS plug-in settings are off from where the base actually is.

ALIGN Relative Positioning

1. If there are no updates to either the Base Station or the Moving Reference Offset in the DGPS plug-in:
    a. Verify that the base (master) antenna has a clear view of the sky.
    b. Verify that the base (master) receiver was powered either before or at the same time the autopilot was turned on.
    c. Check the ‘mmmm’ command to see if there are any packets that contain the words ‘MASTERPOS’ – if there are then that means that data is being received from the master. If the master does not have a lock it will give the string “msg id 1051 - MASTERPOS (0.000000, 0.000000, -6378054.-483648)”.
    d. Check that the communication between the master and rover is okay by verifying that there is bidirectional data being transferred between the receivers using an oscilloscope.

2. If there are base (master) station updates but no moving reference offset updates, or the moving reference offset status is not L1 INT, verify the following:
    a. Both antennae have a clear view of the sky.
    b. The antenna cables are not bent at the end with the connector going into the antenna. If the cable is bent it may have been damaged.
    c. If the antennae are closer together than 0.5 m, it may not be possible for the NovAtel ALIGN system to achieve high accuracy.
    d. Issue the 'freset' command to both the NovAtel units.
    e. Connect the master and rover receivers to the NovAtel Connect software, and use it to view the carrier to noise ratio of each receiver and ensure that each receiver can separately get a lock.

DGPS plugin Bytes received and Bytes transmitted are not changing

- A GNSS antenna must be connected to the base unit otherwise RTCM messages will not be transmitted.
- Verify the baud rate and com port of the NovAtel base using a terminal program. You should see a response when you type “log version”.
- Verify that the loaded model/license is correct.
- Verify the communication settings in the DGPS plugin.
- Double check the DGPS plugin DGPS correction settings. “Base Station Type” must be set to “Novatel” and “DGPS Correction Type” must be set to “RTCM for Airborne Novatel GPS.”
- Check the DGPS plugin log screen.
- Send DGPS plugin log screen to MicroPilot support.