

UAV VISION

Affordable UAV Platforms and Accessories



UAVV-VD/GD170

User Manual

AVIONICS & ENGINEERING TEAM

UAVV-VD170 User Manual

Version 1.3

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UAVV-VD170 User Manual,
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You are required to read this manual thoroughly and pay attention to voltages and mounting instructions.

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Features

This section will present the features for the UAV Vision VD/GD170 gimbals.

Pan and Tilt operation is super smooth with our internal controller, you can pan the system continuously and tilt from +90 through 0 to -90 degrees.

The gyro sensors are being read and filtered at 3khz giving us great vibration smooth data enabling us to provide you with the best stabilization possible.

The VD170 can be fitted with multiple sensors, as default we fit the SONY FCB-EX980SP.

We have fitted a 5 Megapixel video camera for a particular project and have fantastic tracking results.

Control Modes

The VD170 Gimbal has three operational modes:

Position Mode

As the name suggests, this allows a user to demand pan/tilt position. This position is relative to the VD170. The VD170 will move to the demanded position in the direction that is quickest for the system to arrive at the demanded position.

The velocity of movement toward the demanded position will be dependant on the distance away from the demanded position.

The position demands are capable of demanding the system to one of 16384 positions in pan, corresponding to the full 360° rotations. The 16384 positions result in a position resolution for the system of 0.022° ($360/16384$) in both the pan and tilt axis. The tilt axis is limited by the end stops programmed into the system, with an effective travel of $\pm 90^{\circ}$ from the centre position.

Velocity Mode

The pan and tilt can be controlled via a velocity, this being an absolute system pan or tilt velocity to the VD170.

This velocity is the actual velocity (in degrees per second) that the system will move at. The velocity limit demands are $\pm 100^{\circ}/\text{sec}$ and $0.01^{\circ}/\text{sec}$ for both pan and tilt.

Gyro Mode

The VD/GD170 can be delivered with or without gyros, user specified. When fitted with gyros the GD170 gimbal performs excellently on moving platforms, this feature gives us the ability to hold an image still even through adverse movements.

When the GD170 is in Stabilization Mode, the user can demand velocities on both Pan and Tilt which are relative to the 'World', lets say the platform which is carrying the GD170 is rotating at $+10^{\circ}/\text{sec}$ and the user would like to continue to pan the image slowly at $-2^{\circ}/\text{sec}$ then the internal calculations will pan the system at $-12^{\circ}/\text{sec}$, relative to the GD170 but a smooth $-2^{\circ}/\text{sec}$ relative to the image/world.

The VD170 is capable of streaming its current angle at 40Hz, therefore giving the user the ability to close the loop on a hybrid position control manually. This can be activated in all three modes.

Daylight Camera Controls

Zoom Velocity Set

The VD170 is fitted with the Sony FCB-EX980SP as standard and as such comes with an incredible 26x optical continuous zoom; the Sony protocol allows us to demand 6 levels that the user can demand the zoom velocity. The numbers are from 2 to 7, with 2 being the slowest zoom speed and 7 the highest. The user can choose to zoom in or out at any of these speeds.

Focus Manual/Auto

Occasionally you will need to set the focus to manual, this sometimes needs to occur according to the surroundings, if you are looking backwards and an undercarriage leg is in view the camera will focus on that, you will probably wish to have the focus set to the surroundings, the easiest way to achieve this is to move the image away from the foreground and focus on the background press manual focus it will lock the focus to the background and then you can move back to the previous position and the foreground will now be blurry but you can now concentrate on the background without the camera pumping in and out of focus. Another trick to focus is if you are at a continuous height, zoom in to an object let the camera focus and the press manual and zoom out, now everything at that distance will be in focus and you will even be able to zoom and keep the focus.

Focus Set

Alternatively you can manually set the focus with a simple numeric command.

Auto Exposure On/Off

As above there will be times in which the light between what you are trying to recognize and the surrounding light becomes an issue with the auto setting, you will need to turn the auto exposure control of the camera off. If the control is off, then this allows the user to control the iris, shutter and gain manually with the manual commands listed below.

Iris Manual Mode

If the iris manual mode is turned on, then the iris can be controlled manually, but the camera shutter and gain controls will still be automatic.

Iris Set

The iris may be set manually if you have turned off the auto exposure control or if you have enabled the iris manual mode.

Shutter Manual Mode

As above if you are finding difficulties getting enough light on the subject you may have to set all/one of these settings to manual and control the light yourself, we have given you every setting which is available from the Sony's capability. This sometimes has to be set to get either a video sync if there are any other TV's or Monitors your are pointing at or in extreme light conditions and you don't want the gain to creep up to an unbearable grainy picture, bear in mind the slower the shutter speed the better the illuminations but you suffer from a jumpy image.

If the shutter manual mode is turned on, then the shutter can be controlled manually, but the camera iris and gain controls will still be automatic.

Shutter Speed Set

The shutter may be set manually if you have turned off the auto exposure control or if you have enabled the shutter manual mode.

Camera Gain Set

The camera gain can be set manually only if you have turned off the auto exposure control. Bear in mind the higher the gain the worse the picture quality.

Stabilize Lens On/Off

Along with the internal gyros of the VD170 the Sony FCB-EX980SP is fitted with an optical image stabilizer, the image stabilizer works extremely well under harsh vibrations and smoothes the whole picture making it a viewable image for recognition however there are a couple of downfalls, 1, image resolution and 2, if you are trying to locate an object via Geo-pointing then this can push your object off by a few degrees. This may or may not be useful depending on the application, but is worth experimenting with to determine if it is useful.

Picture Invert On/Off

As the name suggests, this is used to invert the image streamed from the system.

Specifications

| Gimbal Specs | Units |
|------------------------|-----------------|
| Position Resolution | 0.022° |
| Position Accuracy | 0.01° |
| Stabilization Accuracy | 0.05° (GD Only) |
| Elevation | +/- 90° |
| Azimuth | 360° Continuous |
| Slew Rate | 100°/sec |
| Slew Acceleration | 100°/s/s |
| Power | 6w/20w |
| Voltage | 12-36V |
| Physical | |
| Weight | 950g |
| Dimensions | Ø170mm x 180mm |

Compatible Sensors

Daylight Cams:

- Sony FCB-EX Series block cameras
- Gigabit Cameras
- Firewire Cameras

Unpacking the Box

As you will notice the VD170 is well packed in an aluminum protective case, this case has been supplied with transportation in mind. The soft foam will protect your new VD170 from most of the harsh handling during shipping etc.

The VD170 can easily be removed by placing your hands either side of the cradle and gently pulling in an upwards fashion, please take care not to apply pressure upon the actual ball section.

Alongside the gimbal is a cutout where you will find a CD with a test GUI for Windows XP and the cables require for operation, please read below for voltage and power requirements.

Handling instructions

Please note that the VD170 is fitted with an anti-backlash device, which also doubles up as a torque limiter, this device enables us to give you perfect gear alignment for years to come, you should never suffer from backlash.

The VD170 can be handled via the outer shell, try to avoid handling the system via the ball, this will be fine but it will obviously cause a dirty lens and the possibility of excessive wear.

Mounting

Please NOTE: The single 8mm mounting hole is a depth of 6mm, the system can be seriously damaged if this is exceeded.

Powering the system

Note: before powering the system ensure that you are powering within the limits of the GD170 as specified in the above section Specifications, taking note to the minimum current draw/limit, this should be at least 2A and capable of peaking at 4A, as during boot up the Gimbal can draw upto 4A for split seconds.

Boot-up Sequence

Due to the high-resolution digital optical encoders the VD170 has to go through a boot-up sequence, this being as follows:

Pan and Tilt

After power is applied the VD170, the system will remain stationary until the boot delay (10 Seconds) has expire then the internal mechanism will pan and tilt to find it's index positions, the Pan will drive to find the index and then return to it's initial offset position known as it's '0' and alike the Tilt will tilt upside down and then point directly down or up depending on the mounting configuration.

(GD Only) Please note that this happens at quite a high speed and the unit must be fixed to a solid platform and **Remain Stationary** for the initial 10 seconds, this is to give us a perfect gyro bias, although every effort is made to predict the inherent bias of the gyro due to temperature and random walk, this is the best way to achieve the bias, otherwise you can experience a gyro drift when in stabilize mode.

We recommend you have the system powered up for at least 10 minutes prior to it's operation, then just before it's flight you should perform a reboot on the system, giving the best bias for the flight. Altitude should not affect the gyro bias due to our initial bias calculation and temperature compensation.

Once the boot-up sequence has finished you will have full control over the system.

Test GUI

We understand the first thing you would like to do is pan and tilt the gimbal to confirm it works! For this reason we have supplied a CD with a basic GUI file, place the test-gui.exe in a suitable place to run from your pc and double click to open.

Once the GUI has opened select the Com port, which you are using and the Baud will already be inserted as 38400 as standard, click connect and the ports will initialize. Unless otherwise stated on delivery the system is RS232 and not TTL Level.

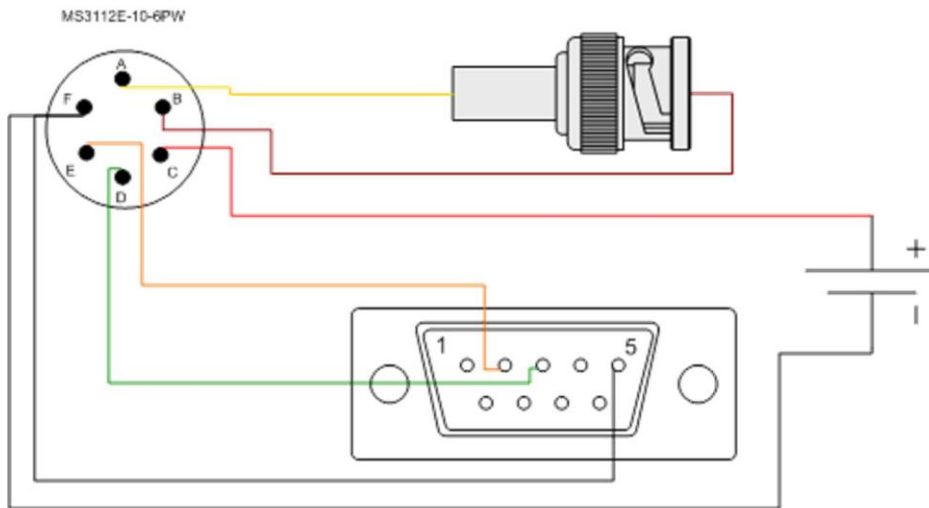
You will now be able to perform simple commands, such as Pan and Tilt.

Cleaning the VD170

The VD170 is finished with a fairly robust coating, as used on the DC3's in Australia. The coating is scratch resistant and solvent resistant, the lenses are also resistant to most solvents, please clean the VD170 with a window cleaning solution and avoid cleaning with solvents although they shouldn't damage it.

Cable Configuration

Please see below for hookup instructions:



| | |
|---|--------------|
| A | Video Signal |
| B | Video Screen |
| C | VCC |
| D | RS232 RX |
| E | RS232 TX |
| F | Ground |

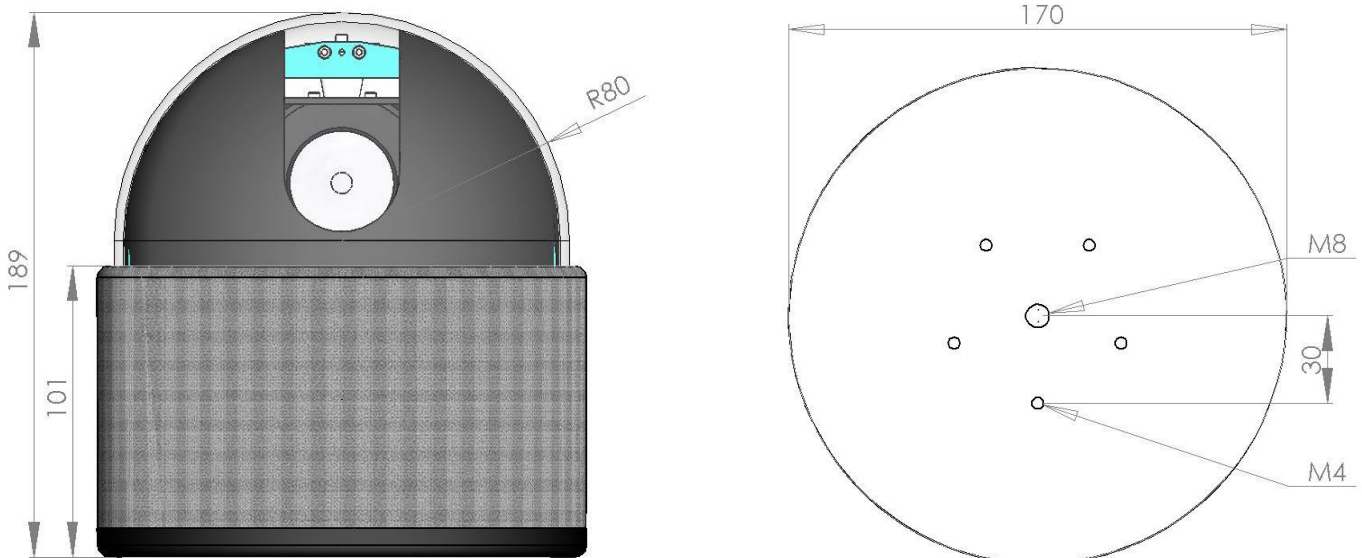
Absolute Maximum Ratings

| Symbol | Characteristic | Min | Max | Unit |
|----------------|--|------|-------|------------------|
| VCC Supply | Main Power Supply | 12.1 | 36.00 | V |
| RS232 RX 1 | System Receive Line | -15 | +15 | V |
| RS232 TX 1 | System Transmit Line | -15 | +15 | V |
| VID Screen | Video Screen (Both Outputs) | 0 | 0 | V |
| VIDEO Signal 1 | Day-light Camera Video Signal 1 (switchable) | 0 | 1 | V _{p-p} |
| Power | Current Draw | 300 | 2000 | mA |
| Temperature | Ambient Temperature | -20 | 40 | °C |

Recommended operating Conditions

| Symbol | Characteristic | Typ | Unit |
|-------------|---------------------------|------|------|
| VCC Supply | Main Supply Voltage | 13.8 | V |
| VCC Supply | Main Supply Current Limit | 4 | A |
| Temperature | Ambient Temperature | 30 | °C |
| Humidity | Average Humidity | 70 | % |

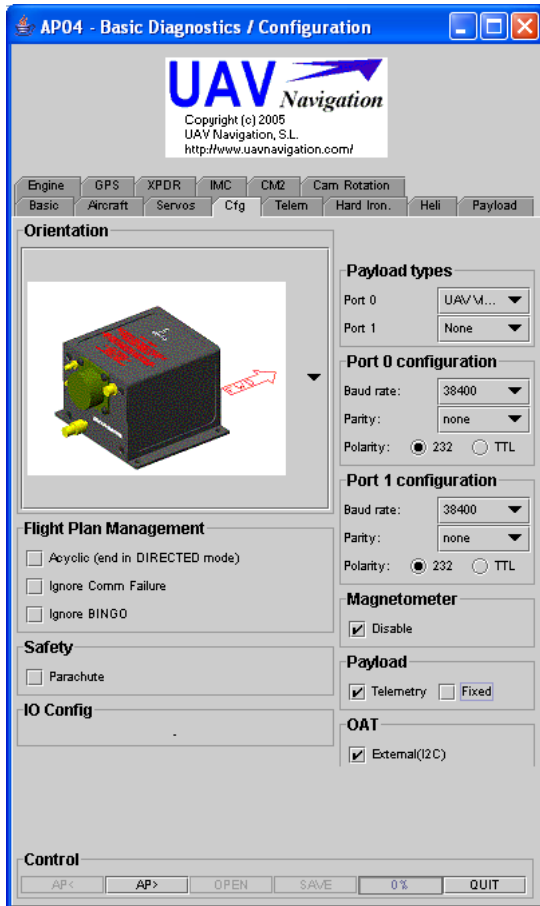
System Dimensions



UAV NAVIGATION With VD170 – GD170 and CM160 Setup

To setup the UAV Vision Camera Gimbals with the AP04, open the AP04 User Tools and follow these steps:

CFG Tab:

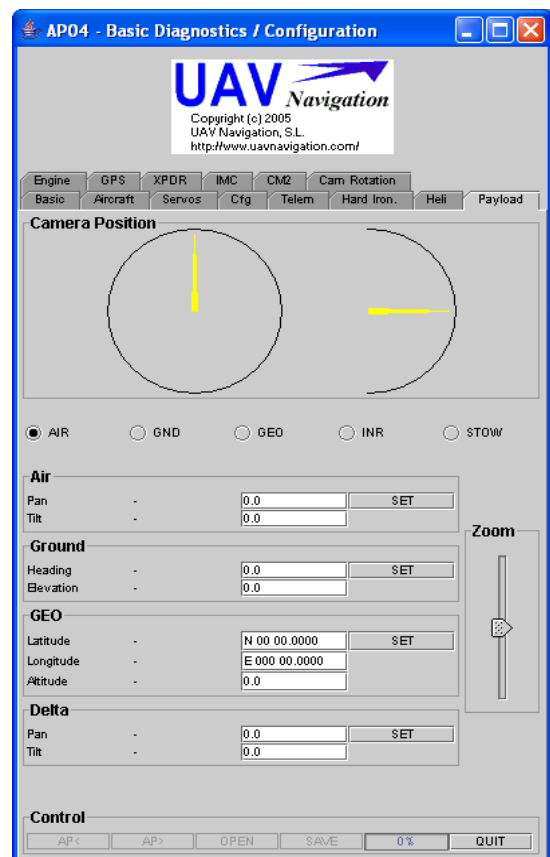


Ensure the Port are connected to is enabled with:

UAV Vision VD170
Baud rate of 38400
Parity none
232

Next upload that data and check the Payload square where you will find telemetry and fixed, ensure fixed is not ticked!.

Payload Tab

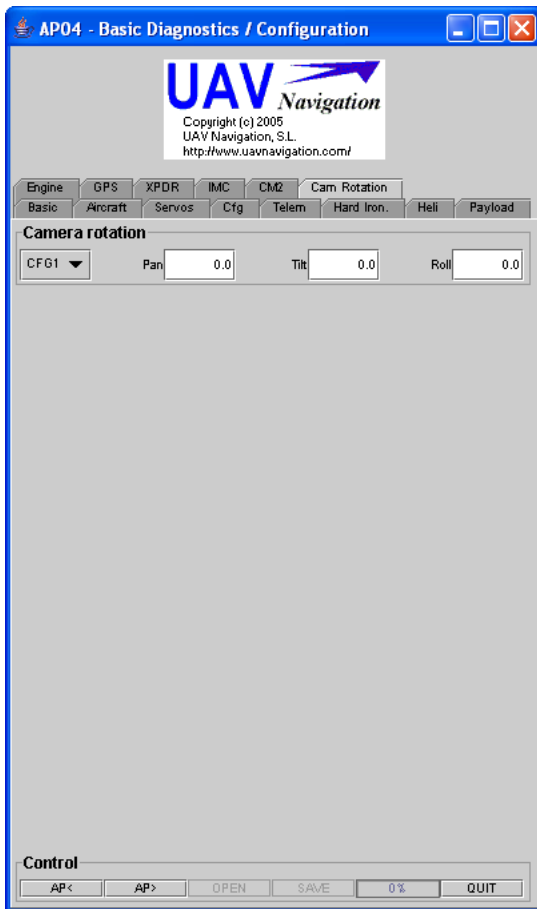


Next go to the payload tab:

You can now select an angle on the AIR square and the pan/tilt should move to that angle. If not reboot both AP04 and the camera, once the systems have been rebooted select STOW by ticking the box.

The camera should pan and tilt to the STOW position.

Go to Cam Rotation tab:



The camera should be pointing in the forward slightly down direction, if it isn't then you have to program an offset, i.e. if it is pointing left by 90deg then put -90 in the pan box and it should pan right and point forwards.

MicroPilot With VD170 – GD170 and CM160 Setup

The UAV Vision Camera is set up in a similar manner to the PTZ Camera. It utilises the same type of protocol fields / setup.

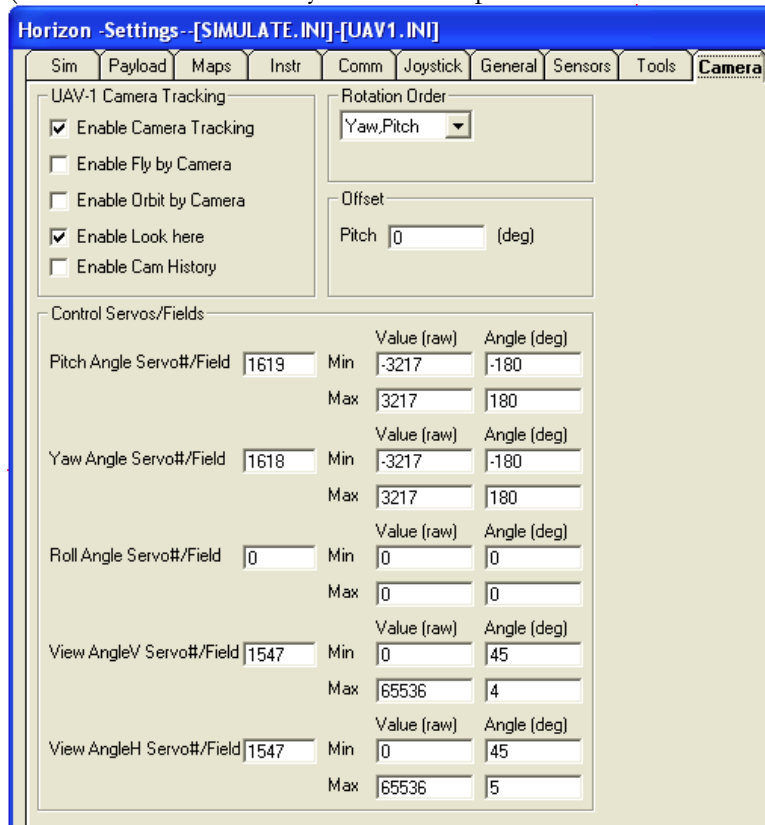
Protocol Setup:

| Field ID | Value | Parameter |
|----------|--------------------|---------------------|
| 932 | 5 | Protocol |
| 656 | * depends on setup | Rx Channel |
| 967 | 0 or 10 | UART Field Location |
| 657 | 38400 | Rx Baud |
| 658 | 8 | Rx Bits |
| 659 | 0 | Rx Parity |
| 660 | * depends on setup | Tx Channel |
| 661 | 38400 | Tx Baud |
| 662 | 8 | Tx Bits |
| 663 | 0 | Tx Parity |

Note: field 656 and 660 should be chosen from available unused TPU channels. Please see Appendix A of the current MicroPilot Autopilot Installation and Operation Manual for TPU channels and their physical pin-outs on the autopilots.

Horizon GCS Configuration:

(This can be used for any camera setup that uses the camera targeting software)



Note that the angles for the Horizontal / Vertical Field of View need to be entered accurately.

Setup for Camera in the autopilot:
There are three ways to setup the camera.

1). Control Camera by Position.

Pros:

- Can use autopilot stabilisation.

Cons:

- Joystick Plug-in will not allow continuous motion in the yaw Axis. (Stops at 180 degrees.)
- User Control may not be as smooth as with velocity.

2). Control Camera by Velocity

Pros:

- Can use autopilot stabilisation.
- Joystick Control will allow complete revolution if Camera Direct Mode is enabled.

Cons:

- Not using the internal control of the camera. Likely slower response.
- Have to configure PID loops.
- Uses more processing power of the autopilot.
- This mode will not utilize camera stabilisation when using Camera Direct Mode.

3). Hybrid. Autopilot Controls Position, Joystick Control Velocity.

Pros:

- Allows autopilot to control angles allowing the use of the internal gains of the camera.
- Allows user to control movement by velocity and the joystick.

Cons:

- This mode will not utilise camera stabilisation. (User is in control)

We recommend using the Hybrid mode (#3). Stabilisation can be done internally by the camera if the GD170 or CM160 model is used.

For setting up the camera for any of the three modes I would recommend reading the camera setup guide from MicroPilot.

We have included some additional setup information to help setup the camera.

For setting up modes #1 or #2 field 967 should be set to '0'.
For mode #3 (Hybrid mode) field 967 should be set to '10'.

Autopilot Fields for VD170 / GD170 and CM160 Cameras.

| Name of Field | Number | Units / Description |
|-------------------------|--------------|-------------------------------------|
| Current Pan | 1545 | Rads x 1024 |
| Current Tilt | 1546 | Rads x 1024 |
| Current Zoom | 1547 | 0 to 65534 |
| Desired Pan | 1548 | Rads x 1024 |
| Desired Tilt | 1549 | Rads x 1024 |
| Desired Zoom Velocity | 1550 | -7 to 7 |
| Desired Pan Velocity | 1551 | Rads / s x 1024 |
| Desired Tilt Velocity | 1552 | Rads / s x 1024 |
| Camera State | 1553 | Bit Field. *See Below* |
| Shutter Value | 1554 | 0 to 27 |
| Iris Value | 1555 | 0 to 17 |
| Gain Value | 1556 | 0 to 7 |
| Focus Value | 1557 | 0 to 65534 |
| Enable Position Control | 1558 or 1610 | (Hybrid) 0 – Velocity, * - Position |

The camera state field allows the user to enable / disable certain features on the camera.

- 1– Resets Camera when set to this value
- 0x01 – Enable Stabilisation when set. (GD170 only)
Default is OFF
- 0x02 –Manual Focus is enabled when set.
Default is AUTO
- 0x04 – Manual Exposure is enabled when set. (Control of shutter, iris, and gain)
Default AUTO
- 0x08 – Iris Manual is enabled when set.
Default is AUTO
- 0x10 – Shutter Manual is enabled when set.
Default AUTO
- 0x20 – Len Stabilisation is enabled when set.
Default OFF
- 0x40 – Picture Invert is enabled when set.
Default is OFF / normal

Hybrid Mode Setup:

Camera Targeting Settings

Rotation order: 1 - Yaw,Pitch

Pitch offset from body (deg): 0

| | First rotation | Second rotation |
|-------------------------|----------------|-----------------|
| Position field | 1545 | 1546 |
| Output position field | 1548 | 1549 |
| User Input Field | 0 | 0 |
| Raw Value for Min Angle | -3217 | -1608 |
| Raw Value for Max Angle | 3217 | 1608 |
| Minimum angle (deg) | -180 | -180 |
| Maximum angle (deg) | 180 | 0 |
| Stabilization D-Term | 0 | 0 |

Advanced Camera Settings

Calculate Body To Camera Eulers

Calculate Body to Camera Euler Rates

Apply Stabilization to Desired Output

Camera Direct Input Mode

Notes: Joystick input is configured directly in the joystick plug-in. Have the joystick output to the following fields.
1551 for Pan control, and 1552 for Tilt control.

***** Setting up the Raw Values / Angles *****

When setting up the angles please note that the angles the camera uses and the angles the Autopilot uses do not have to match. In fact it is likely they will not match. It is important that the camera software angles are reported correctly. The camera software angles are based off the UAV. In the above example the camera was mounted on the belly of the plane. The VD170 / GD170 reports a Tilt of 0 degrees when the lens is directly in the middle of the hemisphere. If the camera is mounted on the belly of the plane, this would mean it was pointing straight into the ground, and from the planes reference that would be -90 degrees.

In order to figure out the angles, you must decide how the camera will be mounted first. Then calculate the angles in the plane's reference, (from the nose of the plane) and then fill in the corresponding raw values to match the angles that would be reported from the actual camera.

Example: Mounting on the belly.

On the belly of the plane, the camera's tilt or pitch would go from 0 degrees (Facing out the nose) and -180 degrees facing out of tail. At 0 degrees the camera would report that it is at 90. Convert 90 to radians $90/180 * \pi * 1024 = 1608$. Then calculate for the -180 degree angle. At -180 degrees the camera would report that it is at -90 which is -1608.

Revision Record

The following table lists all revisions made to this document after v1.0.

Table 1

| Document Version | Page Number | Change Description |
|------------------|-------------|--|
| v1.0 | NA | First release. |
| v1.1 | 11-16 | Added UAV Navigation and Micro Pilot Support |
| v1.2 | 10 | Added to boot sequence, 10 sec instead of 4. |
| V1.3 | 10 12 | Added paragraph regarding minimum power supply Added Row Current Draw |
| | | |
| | | |
| | | |

Contact

Support

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All software support issues can be directed to software@uavvision.com

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All sales enquiries can be directed to sales@uavvision.com

General Enquiries

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