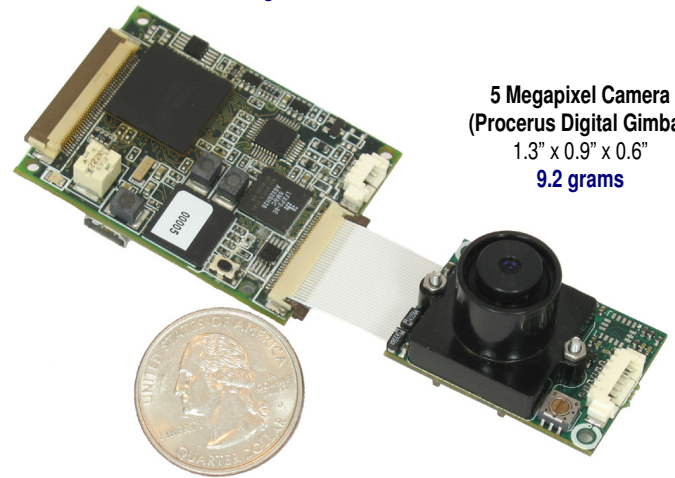


Procerus VPU 1.0

VPU:
2" x 1.34" x 0.44"
11.6 grams

5 Megapixel Camera
(Procerus Digital Gimbal)
1.3" x 0.9" x 0.6"
9.2 grams



FEATURES

- Grabs standard definition video frames from analog or digital camera(s)
- High-resolution image capture
 - Capture at 1 Hz (theoretical 15 Hz maximum @ 5 megapixel)
 - JPEG compressed
 - Store to onboard SD card
- Very Small Size, Weight, and Power
- Analog video output with optional text overlay
- Automatic Electronic Pan/Tilt/Zoom of 5 megapixel imager for keeping eye on target reliably
- Capable of receiving and processing high-rate telemetry (25 Hz) from Kestrel autopilot
- Based on the OMAP3530 dual processor System-on-Chip
- 600 MHz ARM processor, 430 MHz DSP
- Up to 512 MB NAND Flash for nonvolatile storage
- Up to 256 MB POP RAM memory
- Flash File System support (solid state hard drive)
- Up to 600 Hz gyro sample rate (gyros available on imager or as separate stand-alone hardware)
- Fast Micro SD Read/Write
- USB OTG 2.0 (Host or Slave)
- Two serial ports
- General Purpose/SPI connection
- Multi-camera support available as an add-on
- Software SDK Available (Purchased Separately)
- External Control Interface for controlling Kestrel autopilot available for recent Kestrel 2.x firmware
- Ethernet and RS232 DB-9 expansion interface available (Purchased Separately)
- Onboard Vision Capabilities: (Optional add-on)
 - Gyro- and Vision-based stabilization of video
 - High-quality target tracking (interactive with Virtual Cockpit 3D's video window)
 - Track-centered rendering to aid in target designation
 - Track nudge capability to easily refine target position
 - Geo-location of target coordinates
 - Augmented Reality indicators of inertial points in video window
- Terminal Guidance: (Optional add-on)
 - Proven ground-target prosecution capabilities
 - Solutions for tracking and engaging moving targets can be developed for individual customer needs

DESCRIPTION

The Procerus OnPoint Vision Processing Unit (VPU) is a very compact, highly capable onboard vision platform capable of capturing video and still imagery from analog video cameras and custom-built digital cameras. The VPU is a self-contained micro computer with both an ARM core and a DSP core, providing a very capable platform for performing onboard vision algorithms with very low latency. The VPU provides convenient connections for analog and digital cameras as well as common peripherals such as USB OTG and microSD for non-volatile data storage. The VPU complements the Kestrel autopilot and works in conjunction with the Virtual Cockpit 3D software.

APPLICATIONS

- Onboard Vision Processing on micro UAS
- Video Stabilization and Target Tracking
- Synchronized video and metadata
- Capture and store high-resolution imagery
- Interface with and control electronic pan/tilt/zoom camera(s)
- Easily use inline with existing analog video transmission equipment
- Gyro-stabilized camera
- Target geo-location
- Target prosecution (terminal guidance)

OnPoint Onboard VPU v1.0

Video Capture (SD analog and 5 megapixel digital)

The VPU is a robust vision processing computer with integrated hardware and drivers for capturing standard-definition analog video or capturing sub-regions of a 5 megapixel imager. When in video mode and connected to the Procerus Digital Gimbal, the VPU captures high-quality video at standard definition resolution. Its ability to electronically pan, tilt, and zoom without sacrificing output resolution makes the OnPoint Onboard system a sophisticated payload. The digital gimbal provides 4 discrete zoom levels, and when zoomed in by at least one level, the VPU will automatically pan and tilt to keep a target centered in the video window despite ego-motion of the camera. The camera interface was designed to be modular so that other cameras can be connected to the VPU in a seamless manner to suit individual project needs. A serialized hardware interface is available to extend the distance between the VPU and imager. A mux board is also available to allow dynamic switching between two imagers connected to a single VPU.

Vision-based Stabilization and Targeting

With the full OnPoint Onboard software suite, video is stabilized using both sub-region shifting in the CCD and software vision stabilization. Gyros on board the camera aid the vision stabilization and tracking solution. Low-latency, synchronized telemetry from a connected autopilot allows for high geo-location accuracy and highly effective autopilot control for improved terminal guidance. By operating on uncorrupted, un-transmitted video, the vision tracker is greatly enhanced and able to stay locked on with little to no user interaction. Vision-based target localization allows the user to obtain GPS coordinates of desired ground targets to within 5m or less. The targeting system can be optimized for stationary, pedestrian, or vehicle targets.

Integration with Procerus Kestrel Autopilot and VC3D

The OnPoint Onboard VPU has been integrated with the Kestrel autopilot and Virtual Cockpit 3D in a tight-knit system. A user simply configures the Kestrel autopilot to communicate with the VPU and connects the VC3D video window to the VPU's video feed. Tracks can then be started, stopped, and adjusted by clicking in the video window or through keyboard or joystick interfaces. Terminal guidance capabilities (available as a purchased add-on) are greatly enhanced and user interaction is made simple. The VC3D ground station has been optimized for utilization on a single window, but the video and configuration windows can be moved to separate monitors when desired.

High-resolution Image Capture

When used in conjunction with a Procerus Digital Gimbal, the VPU can capture full-frame 5-megapixel images and store these to non-volatile media with corresponding metadata. Images can be captured at approximately 1 Hz, though greater speeds are theoretically possible. Images are normally JPEG compressed before storage, but RAW images can also be captured. The Micro-SD slot allows for nonvolatile removable media up to 32 GB in size, so thousands of images can be captured and stored.

Data Logging

Since the VPU regularly receives high-rate video synchronized telemetry from the Kestrel autopilot, it is an ideal system for logging data from the Kestrel. Under normal operation of the VPU, if an SD card is plugged in, it will store data logs containing essential information collected from the autopilot at 25-30 Hz. Video can also be collected in raw (uncompressed) format and stored to SD card with the data time stamped to match up the video and telemetry in post-processing.

Gimbal Support:

The VPU can drive mechanical gimbals (like the BTC 88-R) using the targeting information collected onboard the vehicle. If the VPU camera is packaged in a mechanical turret, the user can lock on to a target and use both mechanical and digital means of panning and tilting the image. This hybrid gimbal approach provides steady footage of the target since it is able to very quickly respond to ego-motion of the vehicle and motion of the target.

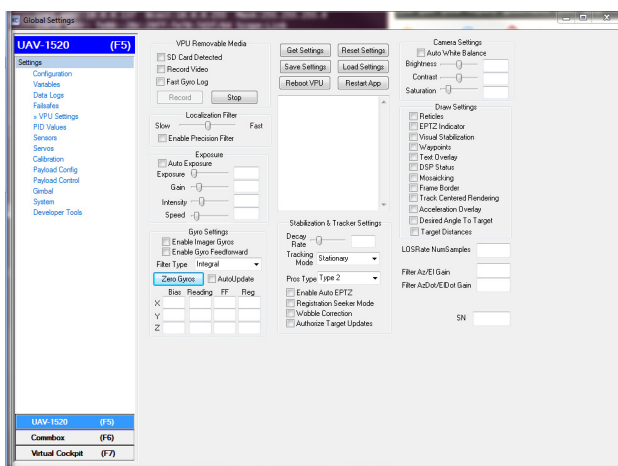


Figure 1: The VPU Settings window in VC3D allows users to easily configure settings on the VPU while in flight.

OnPoint Onboard VPU

ABSOLUTE MAXIMUM RATINGS

Input Supply Voltage 4.8V to 5.2V
 Maximum Current (VPU only)..... 600mA @ 5.0V
 Operating Temperature Range 0°C to 80°C

only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

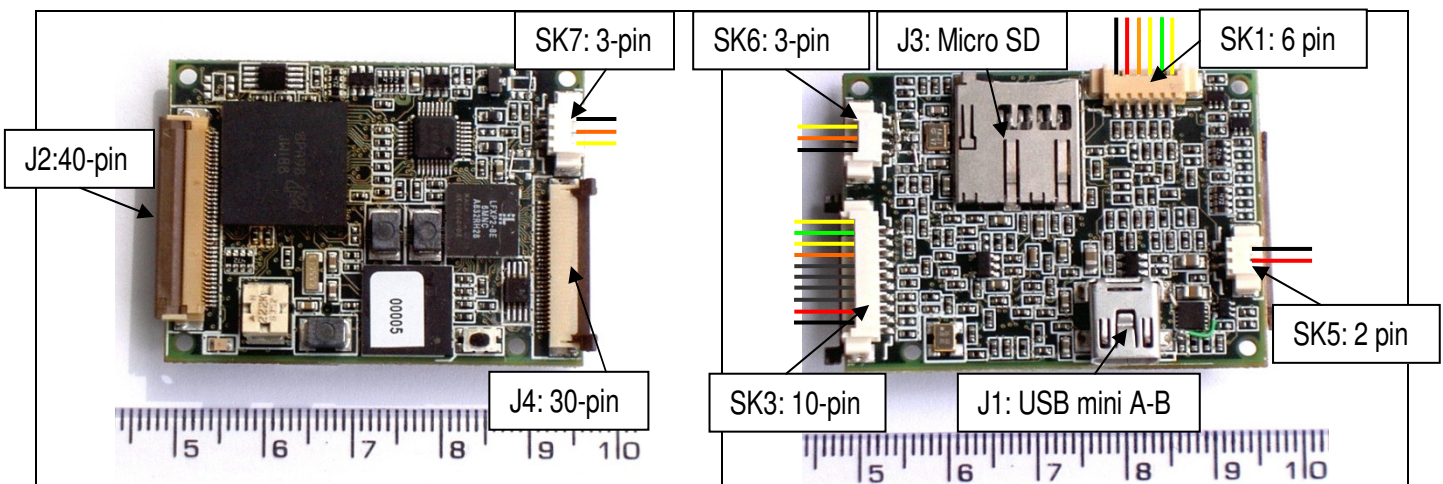
Stresses above those listed under the Absolute Maximum Ratings may cause permanent damage to the VPU. This is a stress rating

OPERATING CHARACTERISTICS

Parameter	Conditions	Min	Typ	Max	Units
Power (PWR)					
Input Voltage Range (Vin)		4.8	5.0	5.2	V
Quiescent Supply Current	Vin @ 5V		350		mA
Operating Current (no digital camera)	Vin @ 5V		350		mA
Operating Power (no digital camera)			1.75	2.0	W
Operating Current (with 1 digital camera)	Camera Pixel Clock @ 73.2 MHz		530		mA
Operating Power (with 1 digital camera)	Camera Pixel Clock @ 73.2 MHz		2.65	2.9	W
Payload POWER (Over 30-pin ribbon for camera)					
3.3V Source			3.3		V
Supply Current	@ 3.3V		225	250	mA
Serial Ports					
Logic High		2.3			V
Logic Low				0.4	V
Current (Sink & Source)				6.8	mA
SPI/GPIO Logic Levels					
Voltage			1.8		V
Dimensions					
Accuracy			2 x 1.34 x 0.44		inches
			±0.5		%
Weight					
Accuracy			11.6		grams
			±4		%

PERIPHERAL OVERVIEW

The following figures show top and bottom views of the OnPoint Onboard VPU hardware:



PORT FUNCTIONS

The following table describe the use of each peripheral port (see picture on previous page for hardware locations).

Port	Description
J1	USB mini A-B port. Not currently supported (Future)
J2	40-pin ribbon connector for Ethernet expansion. The expansion board also overrides the TTL level serial ports and replaces them with RS232 level serial ports with DB-9 connectors. If the expansion board is plugged in, the TTL serial level ports will not operate properly and the RS232 level equivalents should be used exclusively. Contact Procerus for pin-out.
J3	Micro SD Connector for removable storage (supports SDHC cards up to 32 GB)
J4	Camera 30-pin ribbon connector. Pin-out included below. 5 Megapixel camera is supported. Other cameras could be interfaced over this connector. (Future work dependent on client needs)
SK1	6-pin TTL-level serial ports. See pin-out below. Both serial ports are configurable, but generally Port 1 is connected to the Kestrel autopilot for telemetry and control and port 2 is used as a control terminal.
SK3	10-pin Molex connector containing SPI signals (for connecting to camera gyros) and several GPIO lines
SK5	Input Power connector: Requires 5-Volt input (Do not exceed maximum input voltage!)
SK6	Analog video output port. Generally configured for NTSC Composite Video output (CVBS). Can be configured for S-video and PAL (Requires software customization)
SK7	Analog Video Input. Generally this is mutually exclusive with the digital camera input port. See pin-out below

SK1: Serial Ports
(two ports in one)

Pin	Description
1	GND
2	PWR (3.3V output)
3	VPU TX1
4	VPU RX1
5	VPU TX2
6	VPU RX2

SK3:
10-pin SPI/GPIO header

Pin	Description
1	GND (Black)
2	Volt, 3.3 V (Red)
3	GPIO, 1.8V (Future Use)
4	GPIO, 1.8V (Future Use)
5	GPIO, 1.8V (Future Use)
6	GPIO, 1.8V (Future Use)
7	SPI1 CS0, 1.8V (Orange)
8	SPI1 MISO, 1.8V (Yellow)
9	SPI1 MOSI, 1.8V (Green)
10	SPI1 CLK, 1.8V (Yellow2)

SK5:
Input Power Connector

Pin	Description
1	GND (Black)
2	PWR (5V)

Analog Video Ports
(SK6 and SK7)

Pin	Description
1	GND
2	Not used (S-video=PbPr)
3	CVBS Video Signal (S-video=Y)

J4: 30-PIN CAMERA CABLE PINOUT

Pin #	Name	Function
1	nSTANDBY	Standby. Active Low. When asserted, chip enters low-power standby mode
2	TRIGGER	Snapshot trigger.
3	nRESET	When LOW, sensor resets all settings. When HIGH, resumes normal operation.
4	OEB	OEA, OEB, OEC used for determining which sensor is currently active. Interface TBD.
5	OEA	OEA, OEB, OEC used for determining which sensor is currently active. Interface TBD.
6	GND	Common Ground.
7	D0	Parallel Pixel Output D[0:9]. Lowest significant data bit.
8	D1	Parallel Pixel Output D[0:9].
9	D2	Parallel Pixel Output D[0:9].
10	VCC	Input power: must be between 2.85 Volts and 3.35 Volts.
11	D3	Parallel Pixel Output D[0:9].
12	D4	Parallel Pixel Output D[0:9].
13	GND	Common Ground.
14	EXTCLK	External Clock Input: Normally 36 MHz. Consult Procerus for details.
15	PIXCLK	Pixel Clock Output: data bits are clocked out relative to the pixel clock.
16	GND	Common Ground.
17	D5	Parallel Pixel Output D[0:9].
18	D6	Parallel Pixel Output D[0:9].
19	VCC	Input Power, same as Pin 10.
20	D7	Parallel Pixel Output D[0:9].
21	D8	Parallel Pixel Output D[0:9].
22	D9	Parallel Pixel Output D[0:9]. Most significant data bit.
23	GND	Common Ground.
24	OEC	OEA, OEB, OEC used for determining which sensor is currently active. Interface TBD.
25	LINE_VALID (HCLK)	Driven HIGH with active pixels of each line. LOW during blanking intervals.
26	FRAME_VALID (VCLK)	Driven HIGH during active pixels and horizontal blanking. LOW during vertical blanking.
27	VCC	Input Power, same as Pin 10.
28	SDATA	Serial data for two-wire interface.
29	SCLK	Serial clock for two-wire interface.
30	GND	Common Ground

Notes:

See Procerus Digital Imager Technical Reference Sheet for additional information.

RELATED PARTS

Part Number	Manufacturer	Description	Comments
PRT-OP-ONB-I30	Procerus	OnPoint OnBoard - Vision Suite w/imager	
PRT-OP-ONB-X30	Procerus	OnPoint OnBoard - Vision Suite w/o imager	
PRT-OP-ONB-010	Procerus	OnPoint OnBoard - VPU only	
PRT-OP-TSG-P01	Procerus	Tracking, Stabilization, Geo-location, Click n fly	Software upgrade, locked to hardware
PRT-OP-TRG-P01	Procerus	Terminal Guidance Plug-in for OnPoint Onboard	Software upgrade, subject to ITAR restrictions
PRT-OP-SDK-001	Procerus	OnPoint VPU SDK: API's, 5 MP Camera, VPU	NDA and licensing agreement required
PRT-OP-SDK-KT1	Procerus	Case-mounted kit with all necessary cables for desktop use	
PRT-OP-SDK_SW1	Procerus	OnPoint VPU SDK, Software only	NDA and licensing agreement required
PRT-OP-MUX-01	Procerus	MUX Board for added camera and serialization support	
52437-3072	Molex Connector Corporation	30-pin Bottom Contact FPC Ribbon Cable Receptacle, 0.020" Pitch, Surface Mount, Right Angle	These are used on the PDG itself for the two 30-pin cable receptacles. The VPU has a corresponding 30-pin receptacle which is a top-contact part.

Part numbers that begin with PRT are products offered by Procerus Technologies. For all other parts, a list of distributors that carry these parts may be found on the manufacturers' web site.