
- UTC time accurate to less than 2 seconds
- Latitude and Longitude accurate to 2.5m
- Altitude, speed, and direction of travel
- Modbus RTU slave on RS-485
- Open collector outputs to indicate position fix, and to synchronise clock
- Status LED to indicate position fix
- DIN rail mountable

The KTA-291 provides a Modbus interface for the high performance Venus638 GPS receiver. Acting as a Modbus RTU slave, any Modbus Master (PC, PLC, SCADA system, etc) can poll the unit over RS-485 and retrieve extremely accurate time, position, and velocity data.

## Connections:

The lower label on the front sticker depicts the closer terminal. For example, V+ is the closer terminal to the front sticker, GND is further away.

| Name | Description |
|---|---|
| **V+** | 8 to 28 V DC power |
| **GND** | Ground |
| **D+** | RS-485 Data+ |
| **D-** | RS-485 Data+ |
| **RST** | Communications reset. Short to ground to reset Modbus comms to default |
| **OC 1** | Open Collector 1. Active when GPS has satellite lock. |
| **OC 2** | Open Collector 2. Pulses once a second. See appendix 1. |
| **SMA connector** | GPS antenna connector |
| **Status LED** | Indicates GPS lock status:<br>Flashing = no position found<br>Solid on = position lock |

# Holding Registers:

| Register Number | Register Name | Description | Units/Notes |
|---|---|---|---|
| **40001** | GPS Quality Indicator | 0: Position fix unavailable<br>1: Valid position fix, SPS mode<br>2: Valid position fix, differential GPS mode<br>3: GPS PPS mode, fix valid<br>4: Real Time Kinematic<br>5: Float Real Time Kinematic<br>6: Estimated (dead reckoning) Mode<br>7: Manual Input Mode<br>8: Simulator Mode | See appendix 2 |
| **40002** | Satellites In Use | The number of simultaneous satellite connections currently being used by the receiver | 0 to 12 |
| **40003** | Year | Current year; UTC | |
| **40004** | Month | Current month of the year; UTC | |
| **40005** | Day | Current day of the month; UTC | |
| **40006** | Hour | Current hour of the day; UTC | |
| **40007** | Minute | Current minute of the hour; UTC | |
| **40008** | Second | Current second of the minute; UTC | |
| **40009** | Decimal Second | Current thousandth fraction of the second; UTC. | Three decimal places of accuracy. |
| **40010** | Latitude Degrees | Degrees of latitude | |
| **40011** | Latitude Minutes | Minutes of latitude | |
| **40012** | Latitude Decimal Minutes | Ten thousandths of a minute of latitude | Four decimal places of accuracy |
| **40013** | Latitude N/S | Latitude hemisphere indicator<br>1: Northern hemisphere<br>0: Southern hemisphere | |
| **40014** | Longitude Degrees | Degrees of longitude | |
| **40015** | Longitude Minutes | Minutes of Longitude | |
| **40016** | Longitude Decimal Minutes | Ten thousandths of a minute of longitude | Four decimal places of accuracy |
| **40017** | Longitude E/W | Longitude hemisphere indicator<br>1: Eastern hemisphere<br>0: Western hemisphere | |

| | | | |
|---|---|---|---|
| **40018** | Altitude | Altitude above sea level in tenths of metres (I.e 35 = 3.5 m ASL) | 0.1 metres |
| **40019** | Velocity | Velocity over ground in tenths of knots (I.e 24 = 2.4 knots) | 0.1 knots |
| **40020** | Course | Direction of travel in tenths of degrees from North (I.e 900 = 90.0 = due East) | 0.1 degrees |
| **40021** | Precision | Horizontal Dilution of Precision. Gives a measure of the accuracy/confidence of the GPS lock | 0.1 HDOP<br><br>See appendix 3 |
| **40022** | Modbus Address | Modbus RTU slave address. 1 to 247 (default 1) | |
| **40023** | Modbus Baud | Modbus RTU baud rate<br>1: 2400 baud<br>2: 4800 baud<br>3: 9600 baud (default)<br>4: 19200 baud<br>5: 38400 baud<br>6: 57600 baud | |
| **40024** | Modbus Parity | 1: None (default)<br>2: Even<br>3: Odd | |
| **40025** | Modbus Set Parameters | Write to 1 to commit Modbus comms settings to the slave. Upon successful write, register will return 2. | |

## Setting Modbus Communications Parameters:

By default, the KTA-291 will communicate at:

*Address: 1*
*Baud rate: 9600*
*Parity: None*

These settings can be altered by writing to Modbus holding registers 22, 23, 24, and 25. Write your preferred address, baud rate, and parity respectively to these holding registers. Writing register 25 to a one will commit the values to the slave.

Should any problems occur, the slave can be returned to its default comms settings by shorting the reset pin to ground momentarily.

## Open Collector Outputs:

The two open collector outputs are capable of sinking up to 300mA at up to 50V. Open Collector 1 is active when the GPS has a position lock. Open Collector 2 gives a pulse output once a second as a means to accurate the received time (see appendix 1).

# Specifications

| Power Supply | Min | Typ | Max | Unit |
|---|---|---|---|---|
| **Voltage** | 8 | 24 | 28 | V |
| **Current Draw** | | 30 | 100 | mA |
| **Operating Temperature** | -20 | 25 | 80 | C |

| RS-485 Transceiver | Min | Typ | Max | Unit |
|---|---|---|---|---|
| **Driver Current** | | | 28 | mA |
| **Symbol Rate** | 2400 | 9600 | 57600 | Baud |
| **Data Bits** | | 8 | | |
| **Parity** | | None | Odd, Even | |
| **Stop Bit** | | 1 | | |

| Open Collector Outputs | Parameter | Unit |
|---|---|---|
| **Max Current Sink** | 300 | mA |
| **Max Voltage** | 50 | V |

| GPS Receiver | Nominal | Unit |
|---|---|---|
| **Position Accuracy** | 2.5 | m CEP |
| **Velocity Accuracy** | 0.1 | m/s |
| **Timing Accuracy** | 60 | ns |
| **Start up Time to Fix** | 29 | s |
| **Sensitivity** | -165 (tracking)<br>-148 (cold start) | dBm |
| **Update Rate** | 4 | Hz |
| **Altitude Operational Limit** | < 18 000 | m |
| **Velocity Operational Limit** | < 515 | m/s |

# Appendix 1

### *Improving Timing Accuracy*

The GPS receiver has a nominal timing accuracy of 60 nanoseconds, however much larger timing errors will be introduced by the delays associated with communications. The GPS receiver updates the Modbus holding registers 4 times a second; therefore the data in the registers can be as much as 250 ms old. If the KTA-291 is then polled at a slow baud rate, the delay in the slave receiving the request, and then sending a response, could be approaching half a second (a typical timeout period for a Modbus Master is 400ms).

The KTA-291 specifies a timing accuracy better than 2 seconds. This is a conservative figure that considers the worst case from each of the timing interfaces. But, timing accuracy can be dramatically improved by using the PPS output from open collector 2.

**The PPS output is derived directly from the GPS module, and provides a pulse once a second, on the second (4ms duration).**

If better timing accuracy is required, this output can be used to match up the Modbus received data with a known time stamp from the open collector. Ideally, this allows all communications delays to be cancelled out downstream (in the controller).

Example using a PLC:

1. The PLC polls the KTA-291. At some later period, the Modbus command is received.
2. The PPS output from the open collector is sensed on a digital input of the PLC. This pulse gives the exact time that the previous second expires, and the next second begins.
3. The time stamp received over Modbus is incremented to the next whole second. At that instant, the time is accurate to 60 nanoseconds.

# Appendix 2

*Description of GPS fix data*

**0: Position fix unavailable**
Not enough satellites can be found; no position fix.

**1: Valid position fix, SPS mode**
A valid position fix is provided using the Standard Positioning Service (SPS). SPS could be described as the “regular” GPS service using satellites, and is what the KTA-291 will typically use most of the time.

**2: Valid position fix, differential GPS mode**
A valid position fix is provided using Differential GPS. This system improves upon the nominal accuracy of SPS using land based reference stations to broadcast the difference between the SPS data and the known fixed positions of the ground stations.

**3: GPS PPS mode, fix valid**
Valid position fix is provided using the Precise Positioning Service (PPS). SPS is deliberately degraded by the U.S Department of Defence for civil use. Authorised users with the correct cryptographic equipment (and keys) can be granted access to the more accurate PPS service.

**4: Real Time Kinematic**
Valid position fix with enhanced accuracy by using Real Time Kinematic techniques. RTK uses the phase of the carrier signal - received from the satellites - to find a position lock; ignoring the actual information contained within.

**5: Float Real Time Kinematic**
Same as above except uses floating point integers as opposed to fixed integers. Fixed integers, generally speaking, give a more accurate position lock, but require more satellites and a longer processing time.

**6: Estimated (dead reckoning) Mode**
Uses knowledge of a previous position fix, and known or estimated speeds, to estimate the current position.

**7: Manual Input Mode**
Testing and debugging

**8: Simulator Mode**
Testing and debugging.

# Appendix 3

### *Horisontal Dilution of Precision*

The Horisontal Dilution of Precision gives an indication of the strength or quality of the GPS fix. The KTA-291 has a nominal accuracy of 2.5m CEP (Circular Error Probable), meaning that 50% of the time, the location fix will fall within a 2.5m radius circle of the actual absolute position.

The Horisontal Dilution of Precision gives a factor representing the current accuracy of the location fix. Thsi factor is **roughly** in relation to this absolute accuracy:

$$Current\ Accuracy \approx Horisontal\ Dilution\ of\ Precision \times Absolute\ Accuracy$$

Example:
Horisontal Dilution of Precision is currently 3.4. The current location data can be  roughly trusted as:

$$Current\ Accuracy = 3.4 \times 2.5 = 8.5\mathrm{m}\ CEP$$

This table can be used as a general guideline for measurement confidence:

| HDOP | Rating | Description |
|---|---|---|
| **<1** | Ideal | Best possible accuracy |
| **1-2** | Excellent | Good enough accuracy for almost all applications |
| **2-5** | Good | The minimum required accuracy for most sensitive applications |
| **5-10** | Moderate | Positional data is degraded and may not be accurate enough to make decisions |
| **10-20** | Fair | Low accuracy. Measurements should be discarded unless a very rough estimate of positional data is required |
| **>20** | Poor | Measurements should be discarded |