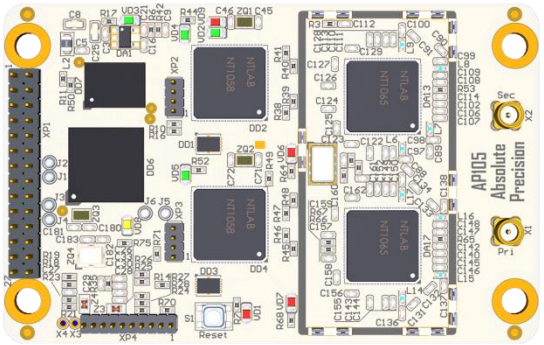
NTL105

GNSS OEM RECEIVER MODULE

Datasheet



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CONTENTS

1 NTL105 TECHNICAL DOCUMENTS

The complete information about NTL105 GNSS OEM receiver includes:

- **Actual datasheet**. It contains information about the GNSS OEM receiver structure, its basic features, technical specifications, interfaces, pin definitions, etc. It gives some utilization aspects specific for particular receiver structure.
- **GNSS-PPU-SETUP-GUIDE-AA-BB-CC.pdf**. It describes the concept of PPU (Primary Processing Unit), the basic object of the NTLab GNSS receivers. Then NTL105 structure will be described in terms of PPU. It contains detailed information about operational aspects of GNSS receivers which have AA-BB version of embedded firmware (CC – revision of the document). Refer to this document to get information about available operational modes, control parameters, some internal logic aspects and interface commands which are used to control the receiver performance.
- **GNSS-DCP-BUILD-AA-BB-CC.pdf**. It contains information about Data Communication Protocols from the firmware version AA-BB. It describes how to parse data coming from NTL105, how to construct control commands and how to use the receiver in the most optimal way.
- **NTL-BROWSER-GIUDE-CC.pdf**. It contains a quick guide for NTL_Browser application. It is a Windows 7/10 utility. It is used to visualize data coming from the receiver, to control receiver configuration, to update firmware. It is useful to a "fast start" with GNSS receiver.
- **NTL10X-ADP BOARD-MANUAL-CC.pdf**. It contains information about interface adapter which can be used with OEM GNSS receivers to implement of "fast start" and to connect them to PC.

2 NTL105 FUNCTIONAL DIAGRAM AND OPERATIONAL ASPECTS

NTL105 consists of three functional blocks:

- Master PPU;
- Slave PPU;
- RTK-Engine.

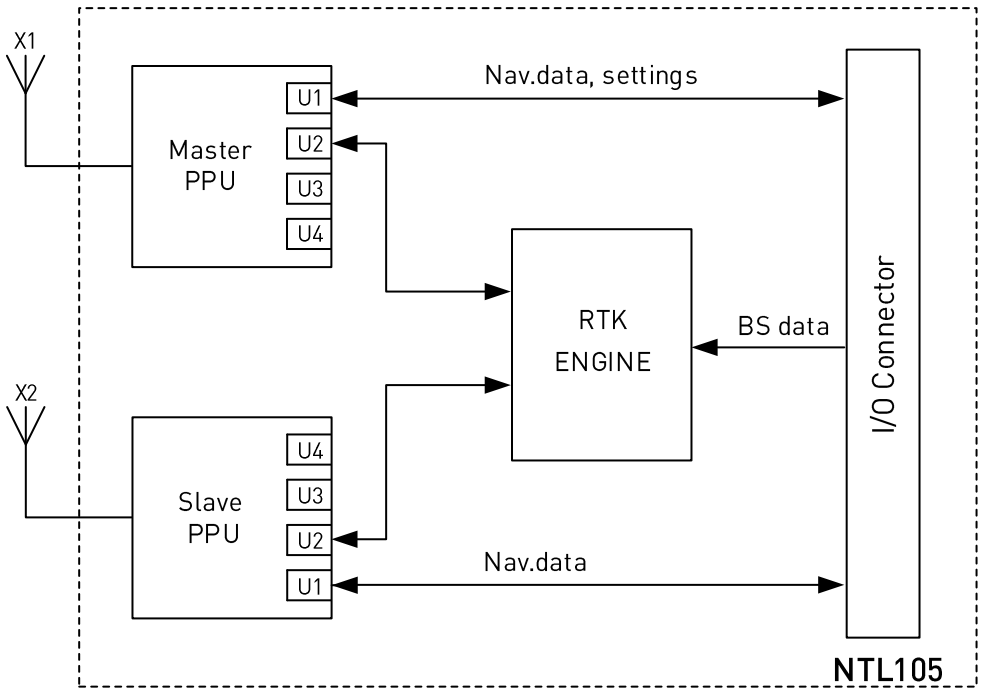

Figure 2.1 – NTL105 functional diagram

PPU – Primary Processing Unit – is a basic functional block of GNSS receiver. The definition of PPU is given in «GNSS-PPU-SETUP-GUIDE-AA-BB-CC.pdf» document. It is a set of hardware and firmware means required to process GNSS signals achieved from one antenna. It is a simple GNSS receiver with a standalone positioning mode. There are more sophisticated positioning modes available in combination with an additional PPU (Slave PPU) and an RTK Engine.

Purpose of functional blocks:

- *Master PPU* provides basic functionality of GNSS receiver:

- computation of coordinates and velocity in standalone and DGPS (+SBAS) modes;
- computation of precise time and generation of Pulse Per Second strobes;
- generation of raw ranging data, based on code and carrier phase measurements.

Due to Slave PPU and RTK-Engine Master PPU gains its functionality:

- computation of coordinates in differential modes (RTK-FIX, RTK-FLOAT, RTK-CDDIFF), in static and moving-base modes;
- heading + pitch determination.

- *RTK-Engine* is a kind of coprocessor. It provides additional computations for differential positioning. It allows computation of two differential vectors with the rate up to 10 Hz. Differential vector is a vector which connects the phase centers of two antennas.

In NTL105 basic architecture the first vector connects Master and Slave antennas. If the vector components are computed it is possible to determine heading and pitch of antenna system.

The second vector connects Master and Base station (BS) antennas. Base station is a reference receiver whose precise coordinates are known. The base station data should be provided to implement this mode an access. High accuracy position of Master antenna is available when this vector is determined.

- *Slave PPU* provides RTK-Engine with raw ranging measurements made on Slave antenna signals. Even though, it is a full-function PPU having the same basic features as Master PPU. Coordinates of Slave antenna, that were achieved in standalone mode, are mostly out of interest for final user, but raw ranging measurements may be a point of interest. One of Slave PPU UART is available on I/O connector to give access to this data. RTK and Heading modes are not available for Slave PPU.

The final user should deal with Master PPU to gain RTK and Heading data. Refer to « GNSS-DCP-BUILD-AA-BB-CC.pdf » to get detailed information about its modes, control parameters, etc.

NOTES:

- *Commutation*

Each PPU has four physical UART modules. Only two of them are active – UART1 and UART2. Both Master UART2 and Slave UART2 is used for internal purpose – interaction with RTK-Engine. While RTK and/or Heading function is on, it is not available for NTL Binary or for raw data flow transmission. For Master PPU and Slave PPU UART1 is brought out onto I/O connector and it is the only physical channel to communicate with PPU.

One more UART available channel on I/O connector is used to receive base station data and connected directly to RTK-Engine module. Use BMT_CONFIG.UART4_CTRL command to setup bitrate of the port.

- *Control*

Master and Slave PPU are full-functional modules. They have independent sets of control parameters. Their settings should be kept in compliance while they work in pair. This is special necessary when NTL105 works in Heading, RTK+ Heading modes. Control parameters from Master PPU are transferred to Slave PPU

via special data channel in RTK-Engine. As a result, there is no need in any additional actions to set up Slave PPU. Refer to Master PPU controls to make settings and Slave PPU will stay in compliance automatically. Interface settings are the only block of control parameters which are not shared. As far as Slave is still available for access via separate UART, nothing should interfere with such communication.

Two more options are available for NTL105: *DUAL-RTK* and *OPEN-PLATFORM*, besides basic configuration.

DUAL-RTK is a configuration where RTK mode is available for both PPU, which are absolutely equal and independent. Heading function is not available. Such configuration may be used as a part of 3D orientation system. Instead of static base station, an additional reference receiver (e.g. AP101) may be used for raw data generation. Supplied with such measurements, NTL105 may compute two RTK vectors in moving-base mode. Information about precise relative positions of three antennas may be used further to determine 3D orientation of the object they are installed on.

OPEN-PLATFORM is a configuration for customers who are interested in implementation of own post processing algorithms. Such configuration is provided without embedded firmware RTK functionality. MCU is available for programming and debugging. Both PPUs can be used as sources of raw ranging measurements and other information which is required for implementation of positioning algorithms. Measurements are based at all available civil GNSS signals at the moment. If you are interested in it, please, refer to NTLab company.

3 MODULE STRUCTURE, TOP VIEW AND INDICATION

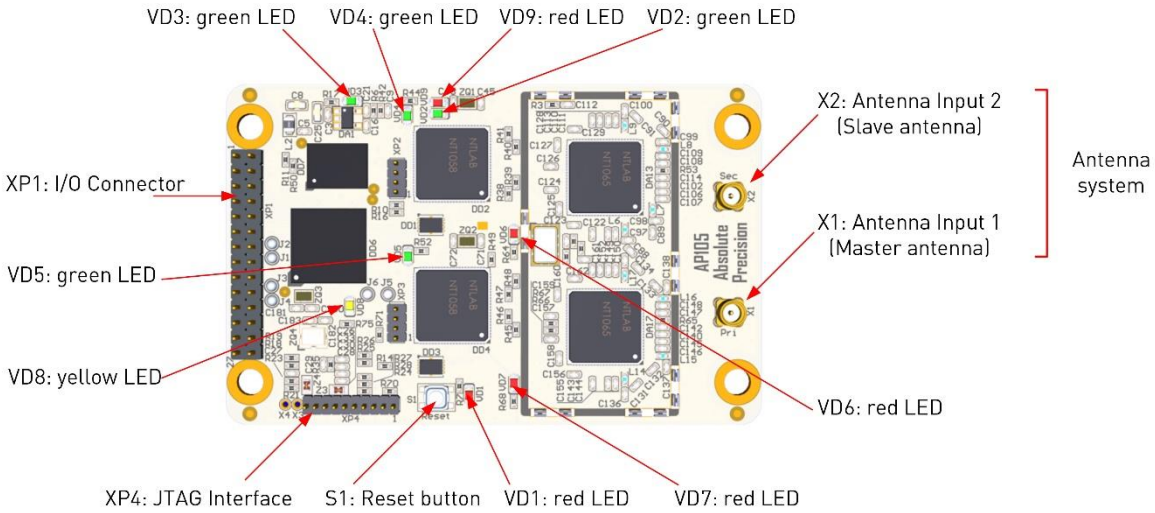

Figure 3.1 – NTL105 top view

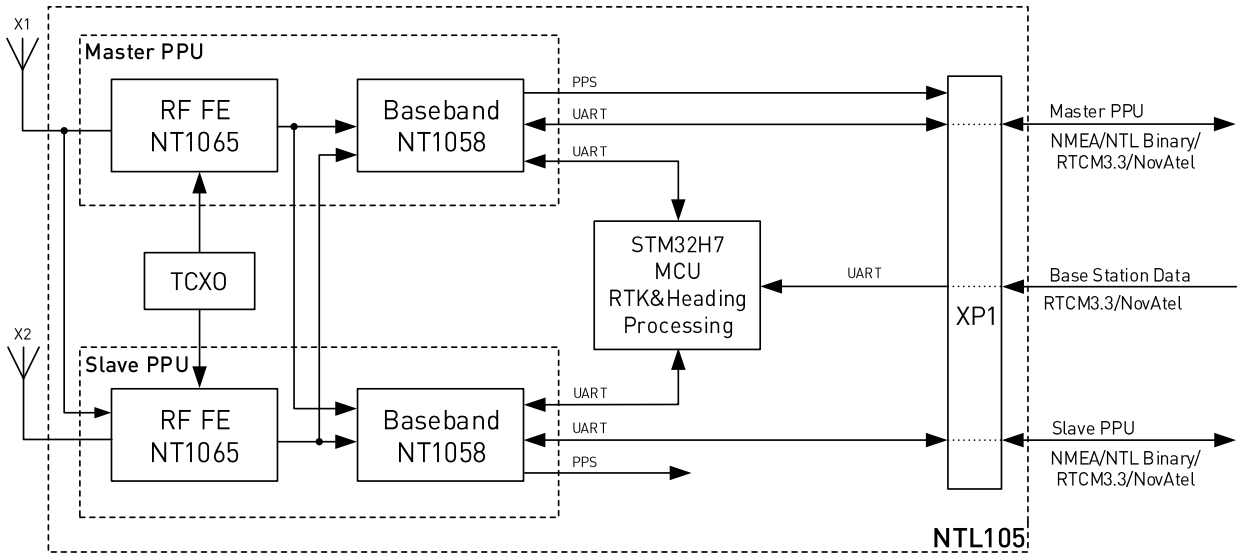

Figure 3.2 – NTL105 structural diagram

Both PPUs have equal hardware platform. They are implemented on chips set which are designed by NTLab company:

- NT1065 is a 4-channel L1/L2/L5 band radio-frequency integrated circuit for GNSS signals reception;
- NT1058 is a digital baseband processor having 64 dual channels for GNSS signals acquisition and tracking.

RTK-Engine is based on STM32H7 MCU having 400 MHz system clock and double word FPU coprocessor.

Connectors:

- X1, X2 – MMCX type connectors for external active antennas[1] commutation. Central pin provides DC voltage for antenna power supply. DC voltage is wired from Pin 5 of I/O Connector XP1. It means that a NTL105 host-device must provide DC voltage in accordance with active antenna requirements.
- XP1 is a PLD2-28 connector. Form factor of the board and XP1 pin-out is compatible with popular GNSS receiver families (Novatel 6xx, Trimble and others). Refer to Section 5 for XP1 pinout, refer to Section 6 for PCB dimensions.
- XP4 is a PLS-10 connector for STM MCU debugging and programming with JTAG.

LEDs:

- Red LED VD1 is indicator of the Reset control.
- Green LED VD2 is indicator of the antenna power supply (Green Solid).
- Green LED VD3 is indicator of the DC voltage 3.3V (Green Solid).
- Green LEDs VD4 and VD5 are the indicators of normal performance of the PPU1 and the PPU2. It must blink once per second during normal operation (Green Blinking).
- Red LEDs VD6 and VD7 are the indicators of the RF FE normal operation. Should be OFF during normal operation (No Light).

  If those LEDs are ON, please, check active antenna circuitry. That may indicate not appropriate level of amplification in active antenna: too low or too high.
- Yellow LED VD8 is indicator of the RTK-Engine normal operation (Yellow Solid).
- Red LED VD9 is indicator of the erroneous situation (backward current) in antenna power circuit. Should be OFF during normal operation (No Light).

So, nine user LED indicators (VD1…VD9) allow you to monitor the status of some nodes of the board: the board power status, the current operation status, malfunction. Green LEDs indicate correct operation. Red LEDs indicate a fault.

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[1] GNSS External Active Antenna Requirements:
- Antenna voltage supply 5V;
- Maximum current 100mA;
- LNA Gain Range (minus signal loss) 20…35dB.

4 TECHNICAL PARAMETERS

Table 4.1 – Technical parameters

Supported GNSS signals												
PPU	GPS			GLO		GAL			BDO		IRN	
	L1	L2	L5	L1	L2	E1	E5b	E5a	B1	B2	L5	S
Master	+	+/- or -/+		+	+	+	+/- or -/+		+	+	+	-
Slave	+	+	-	+	+	+	-	-	+	-	-	-

Measurement Precision			
	Precision, RMS	Units	Notes
C/A pseudoranges	20	cm	Smoothed pseudoranges
L1, L2 carrier phase	0.8	mm	

Positioning modes and accuracy					
		Accuracy, RMS		Units	Notes
		Plane	Vertical		
Autonomous	Standalone	1.5	2.1	m	Depends on atmospheric conditions, satellite visibility and geometry, multipath conditions, GNSS antenna
	DGPS	0.8	1.1	m	GPS+SBAS
Differential	CDDIFF	0.6	0.85	m	Accuracy depends on the baseline length.
	FLOAT	0.5	0.75	m	
	FIX	5+0.5ppm	8+1.0ppm	mm	
2D orientation accuracy					
Heading	0.1			deg	Measured on 2 meters antenna baseline
Pitch	0.2			deg	
Data update rates					
Position, velocity, time	Standalone mode		1	Hz	no options
	Differential mode		10	Hz	1,2,5 Hz available
Heading, pitch			10	Hz	
Raw data			20	Hz	1,2,5,10 Hz available

Electro-mechanical characteristics				
Operating temperature, °C	-55 to +85		Storage temperature, °C	-40 to +80
Supply voltage, V	3.3 to 5.3		Power consumption, W	< 2
Dimensions (L x W x H), mm	71 x 46 x 10		All specifications are at an ambient temperature of 25 °C. Extreme operating temperatures can significantly impact specification values.	
Weight, g	< 45			

5 COMMUNICATION PORTS AND PIN DEFINITION

Table 5.1 – I/O connector XP1 pin definitions

Pin No	Name	I/O	Type	Description
1	USB_ID	Input	CMOS_3.3	MCU STM32H7 USB FS[2]
2	USB_VBUS	Input		MCU STM32H7 USB FS[2]
3	BOOT	Input		MCU STM32H7 boot mode selection[2]
4	TPO-MID	Output		MCU STM32 ETHERNET[2]
5	LNA_PWR	Power	Analogue	Antenna power supply voltage
6	Power	Power	Analogue	NTL105 power supply voltage
7	USB_D-	I/O	CMOS_3.3	MCU STM32H7 USB FS[2]
8	USB_D+	I/O		MCU STM32H7 USB FS[2]
9	GRESET	Input	CMOS_3.3	Reset control (active-low)
10	MF01[1]	I/O	CMOS_3.3	MCU STM32H7 GPIO
11	MF02[1]	I/O		MCU STM32H7 GPIO
12	RxD3/CANRx[3]	Input		UART3 Rx line (optionally Can Rx line)
13	EVENT[1]	Input		MCU STM32H7
14,17,20,22	GND	Power	Analogue	Signal and Power Ground
15	TXD1	Output	CMOS_2.5	Slave PPU UART Tx line (UART1 Tx line)
16	RXD1	Input		Slave PPU UART Rx line (UART1 Rx line)
18	TXD2	Output		Master PPU UART Tx line (UART2 Tx line)
19	RXD2	Input		Master PPU UART Rx line (UART2 Rx line)
21	PV	Output	CMOS_3.3	«Position Valid» indicator
23	PPS	Output	CMOS_2.5	PPS time mark (wired from Master PPU)
24	TxD3/CANTx[3]	Output	CMOS_3.3	UART3 Tx line (optionally Can Tx line)
25	TPO+	Output		MCU STM32H7 Ethernet[2]
26	TPI+	Input		MCU STM32H7 Ethernet[2]
27	TPO-	Output		MCU STM32H7 Ethernet[2]
28	TPI-	Input		MCU STM32H7 Ethernet[2]
Notes	1- Signals are implemented in hardware for compatibility with Trimble and Novatel receivers, which have the same form factor; not supported in actual firmware. 2– NTL105 hardware is ready to support marked interfaces; basic firmware doesn't provide such options; may be developed on demand. 3- UART3 TX/RX by default; CAN may be implemented on demand.			

Table 5.2 – Basic configuration of NTL105 UART channels

<table>
<tr><th>Pin No</th><th>Name</th><th>Description</th></tr>
<tr><td>18</td><td>UART2 Tx</td><td rowspan="2">It provides access to Master PPU UART1 (UART1 in terms of PPU-SETUP-GUIDE).
Available data transmission formats:
• NMEA-0183 or NTL Binary for nav. data transmission and control;
• RTCM3.3 (MSM+Legacy messages) or Novatel OEMv7 for raw ranging measurements transmission.
Available baud rate diapason: 9600 to 460800.
Default settings: 115200 Baud, 8 bits, no parity bit, 1 stop bit, NTL Binary.</td></tr>
<tr><td>19</td><td>UART2 Rx</td></tr>
<tr><td>15</td><td>UART1 Tx</td><td rowspan="2">It provides access to Slave PPU UART1 (UART1 in terms of PPU-SETUP-GUIDE).
Available data transmission formats:
• NMEA-0183 or NTL Binary for nav. data transmission and control;
• RTCM3.3 (MSM+Legacy messages) or Novatel OEMv7 for raw ranging measurements transmission.
Available baud rate diapason: 9600 to 460800.
Default settings: 115200 Baud, 8 bits, no parity bit, 1 stop bit, NTL Binary.</td></tr>
<tr><td>16</td><td>UART1 Rx</td></tr>
<tr><td>12</td><td>UART3 Rx</td><td>Base station data input. Available data formats:
• RTCM3.3 (MSM+Legacy messages);
• Novatel OEMv7 messages.
Available baud rate diapason: 9600 to 460800.
Default settings: 115200 Baud, 8 bits, no parity bit, 1 stop bit, RTCM3.3.</td></tr>
<tr><td>24</td><td>UART3 Tx</td><td>Not used</td></tr>
<tr><td colspan="3">Refer to «GNSS-DCP-BUILD-AA-BB-CC.pdf» document to get more information about interface performance details.</td></tr>
</table>

In OPEN-PLATFORM version definition of UART1, UART2 and UART3 data channels can be different. Up to three STM32H7 UART modules can be commutated to XP1 connector as well as some GPIO signals and other peripherals. If you are interested in OPEN-PLATFORM version, please, refer to NTLab company for extended version of NTL105 datasheet.

6 BOARD LAYOUT AND DIMENSIONS

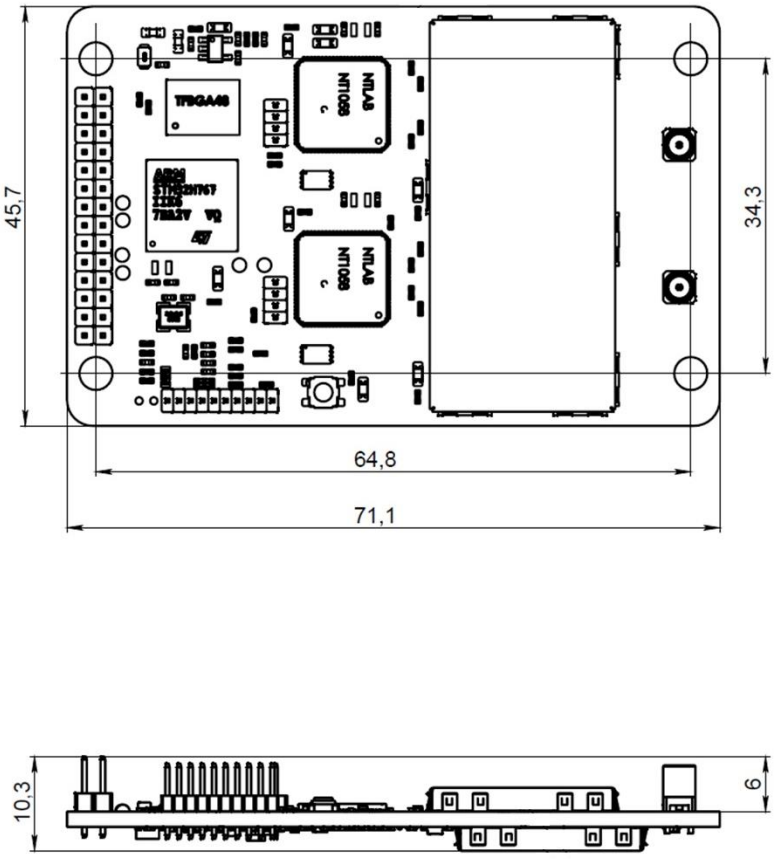

Figure 6.1 – NTL105 Board Layout and Dimensions

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