NB1041

Rev. 1.0 - Sept 2004

Dual Antenna GPS Engine Board

Preliminary Specification

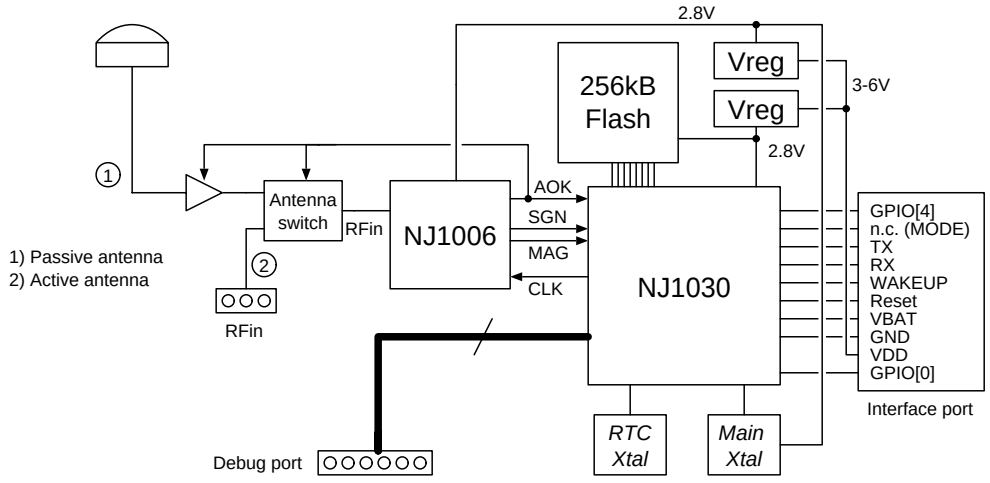
1 General Description

The NB1041 is a self-contained GPS receiver module intended to be used as an add-on board on systems requiring GPS real time data. It supports both an on-board passive antenna and external active antennas. It includes the NemeriX NJ1006 and NJ1030 GPS chip-set, and flash memory required to support navigation. The navigation SW and the navigation database are stored on the NB1041. The application SW and the mapping information will stay on the host device. The NB1041 interfaces to the host device via the NJ1030 UART.

1.1 Features

- Plug and Play GPS receiver module
- Small compact design – 26x26x8mm
- On-board 25mm x 25mm patch antenna
- Port for external active antenna with auto-detect
- Simple UART interface
- Low power consumption

Figure 1 : Block Diagram



1.2 Specifications

Parameter	Min	Typical	Max
Operating Temperature	-40°C		+85°C
Power Consumption (fully active)		36mA	
GPS Channels		16	
Cold Start		38 sec	
Warm Start		35 sec	
Hot Start		7 sec	
Re-acquisition time		100 msec	
Update rate (default)		1 Hz	
Active antenna current range	2mA		20mA

Frequency	1575.42MHz - L1 C/A Code
I/O Port	UART interface
Protocol	NMEA (Extended) - NemeriX binary
Weight (with patch antenna)	<15g
Dimensions (with shielding and patch antenna w/o connector)	26x26x8mm

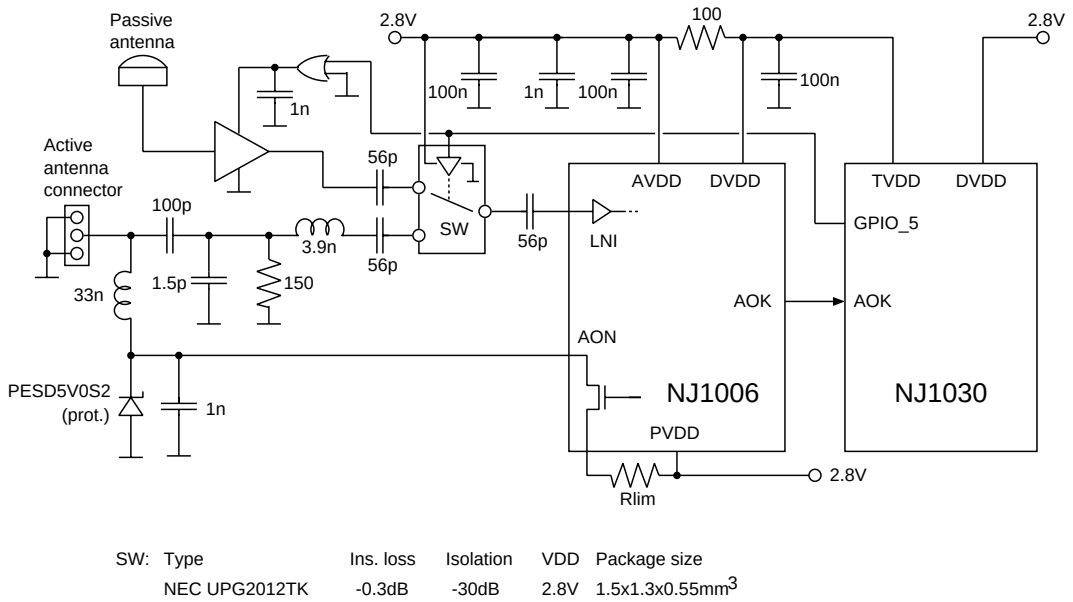


Figure 2 : Antenna Switch Schematic Diagram

2 NB1041 Receiver Parts

2.1 Antenna/RF connector

The NB1041 can be operated either from its on-board patch antenna or from an external active antenna. The on-board patch antenna, likely OnShine DAS1575R25, is fitted on top of the NB1041 case, while the external active antenna is connected to the NB1041 via a 3 pin connector. Phantom power is provided on the center pin of the antenna connector. Its nominal value is 2.5V. Short-circuit, as well as ESD protections are provided.

The NB1041 will auto-detect an active antenna and use it immediately as soon as a user connects it to the external antenna port. It will automatically revert to its internal patch antenna if the external antenna is either disconnected by the user, damaged or out of specification. When an external antenna is connected, the internal antenna will be disabled, in order to prevent any spurious radiation (see Figure 2).

2.2 NJ1006

The NJ1006 is the down-converter. It contains all RF active parts and PLL frequency generation, and connects directly to the NJ1030 base-band processor via a 2-bit interface. It is packaged in a 28 lead QFN package (JEDEC MO-220 var. VHHD-1). Power supply for the NJ1006 is set to 2.8V (AVDD) with a low dropout regulator. To reduce overall size, the TST TA0295A L1 SAW filter is used. Filter size is 2x2.5x0.75mm.

2.3 NJ1030

The GPS base-band processor is the NJ1030U8, which is packaged in a 0.8mm pitch BGA package (JEDEC MO-216 var. BAE-1). It is used in its minimum configuration, i.e. only as GPS processor. The only required external part is the flash memory containing the code. Apart from basic navigation, some minimum extra performance should be made available, at least the low power modes. Power supply is set to 2.8V (DVDD) with a linear regulator. Supply voltage for the core is set to 1.2V using the on-chip regulator. Communication to the NJ1030 is provided via the UART.

2.4 Flash Memory

A 4Mbit x 16 flash memory is needed by the NJ1030 IC. The NB1041 can support the following flash memories:

- SST – SST39VF400A
- ST – M29W400B
- AMD – Am29LV400B
- MXIC – MX29LV400B

The memories operate from DVDD and come in a 6x8mm BGA package (JEDEC MO-210 var. AB-1).

2.5 Clock

The clock frequency is set to 16.367MHz and is generated by a TCXO, Rakon IT5320BE. It has a 2.0ppm accuracy, a size of 5x3.2x1.5mm and requires a minimum voltage supply of 2.7V. It is therefore connected to AVDD.

2.6 RTC and Battery Backup

The NB1041 includes a real time clock and 8kB NVRAM. This allows time and navigation database to be kept when the power to the NB1041 is removed. The RTC crystal is a tuning fork type, 32.768kHz crystal. Microcrystal MS3V-T1R is the selected crystal. It comes in a 6.7x1.4x1.48mm package.

RTC and NVRAM require a supply voltage of 1.2V to 2V. Power must be provided via a dedicated pin on the interface connector. Any 1.2-1.5V battery or a super-capacitor can be used. If a rechargeable battery or a super-capacitor are used, a charging circuit must be provided. This may consist of a simple resistor-diode circuit. A means to limit battery charging voltage to below 2V should be included if the battery can be removed while the main power is on.

One suitable battery is the Varta V15H NiMH 1.2V rechargeable battery. This battery has a capacity of 15mAh and a size of ∅11.5mm x 3mm. It can be recharged at 1.5mA via a simple diode-resistor network. If the back-up voltage is not present RTC and NVRAM do not work. This has no influence on NB1041 operation, but a cold start is forced at start-up.

2.7 Voltage Regulators

Two voltage regulators (Torex XC6206) generate two voltage supplies (AVDD and DVDD) from the main voltage supply (VDD). VDD is an unregulated voltage supply between 3V and 6V. AVDD is 2.8V (3V) and provides voltage to the NJ1006, and the TCXO. DVDD is 2.7V and provides voltage to the NJ1030 and the flash memory. Power for the NJ1030 core is obtained with the internal voltage regulator.

3 Serial Interface

Communication to the NB1041 is provided via a serial interface. A 10 pin 1.25mm hole connector is used. The pinout is shown in Table 1. Pin 6 (Reset) is the active-low reset input. The NB1041 always requires a reset at power-up, or it will not start properly. An optional on-board reset circuit can be provided. A reset forces the NB1041 processor to reboot, but will not influence other parameters such as hot or cold start. Pin 1 (GPIO[4]) and pin 10 (GPIO[0]) are spare pins that can be used e.g. to control power modes, to indicate NB1041 status, or to force a cold start. They can be left unconnected if desired. I/O voltage level is set to 2.7V.

Pin #	Description
1	GPIO[4]
2	NC (MODE)
3	NMEA TX
4	NMEA RX
5	WAKEUP
6	Reset
7	VBAT
8	GND
9	VDD (3-6V)
10	GPIO[0]

Table 1 : Interface Port Pinout

4 Communication Protocol

The communication protocol used can be either standard NMEA or NemeriX binary. The choice will be dictated by the host application SW.

5 Debug Port

A dedicated pinout (in form of test points) is provided on the board to give the possibility to connect the NJ1030 debug unit. The debug port is intended to be used only during the development stage and to download the firmware at factory setup. It is not meant to be used by the customers unless they want to develop or modify the SW of the NB1041 module. The debug port includes the signals required by the debug system unit (DSU). A companion DSU interface board has been already developed.

Pin #	Description
1	DSU_MUX
2	DSUEN
3	DSUBRE
4	DSUTX
5	DSURX
6	DSUACT

Table 2 : Debug Port Pinout

6 SW Upgrade

New SW releases can be downloaded to the NB1041 via the serial interface. First firmware download requires access to the debug port, any further upgrade may be performed through the serial interface (UART) only. The SW is structured into a boot section (cannot be upgraded by user) and a navigation section (can be user upgraded). This SW structure prevents unrecoverable damages in case of problems during the upgrade operation. The flash sectors, containing the boot code needs to be write protected.

7 Schematics Diagram

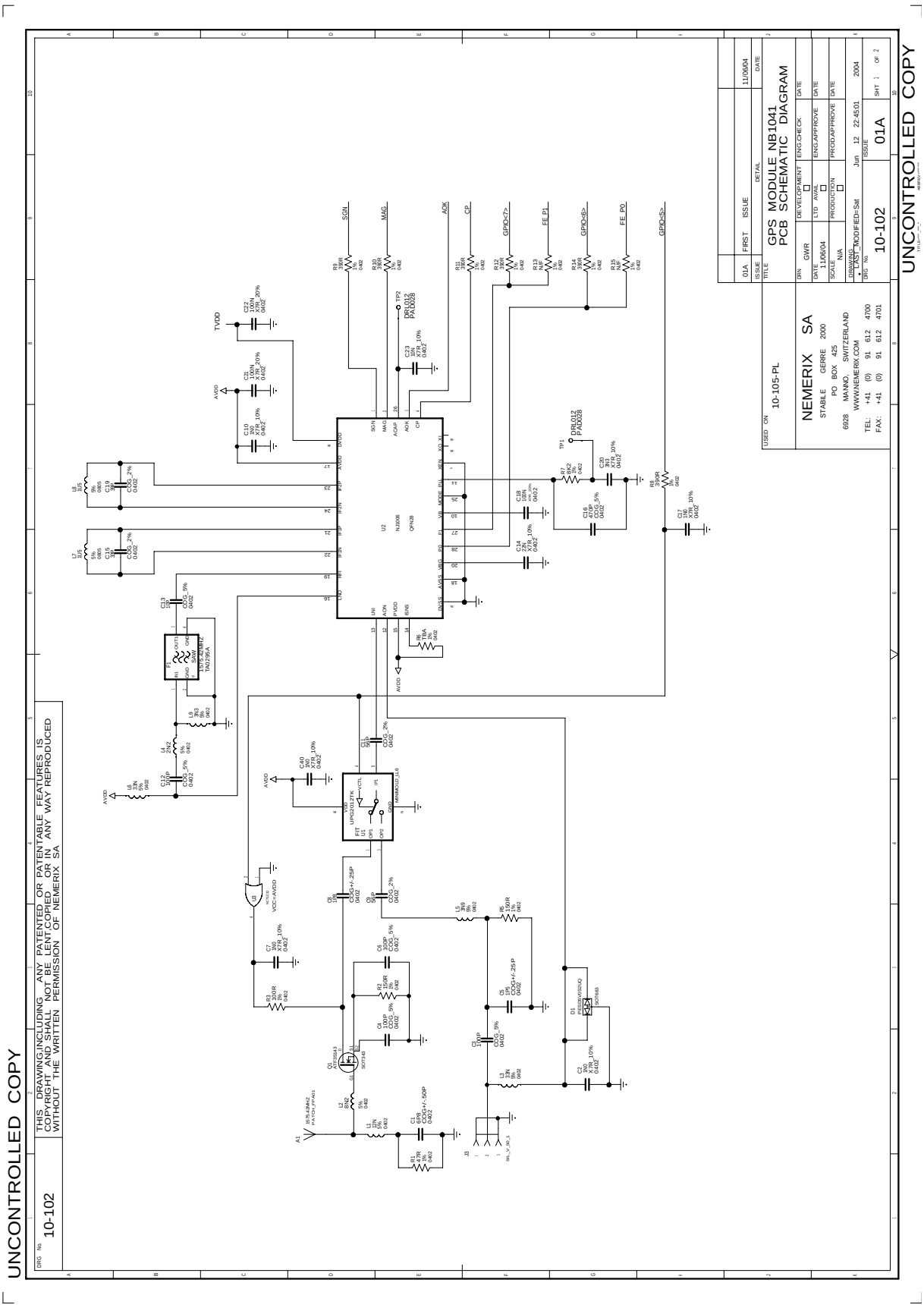


Figure 3 : NJ1030 Schematic Diagram

Schematic Diagram (Continued)

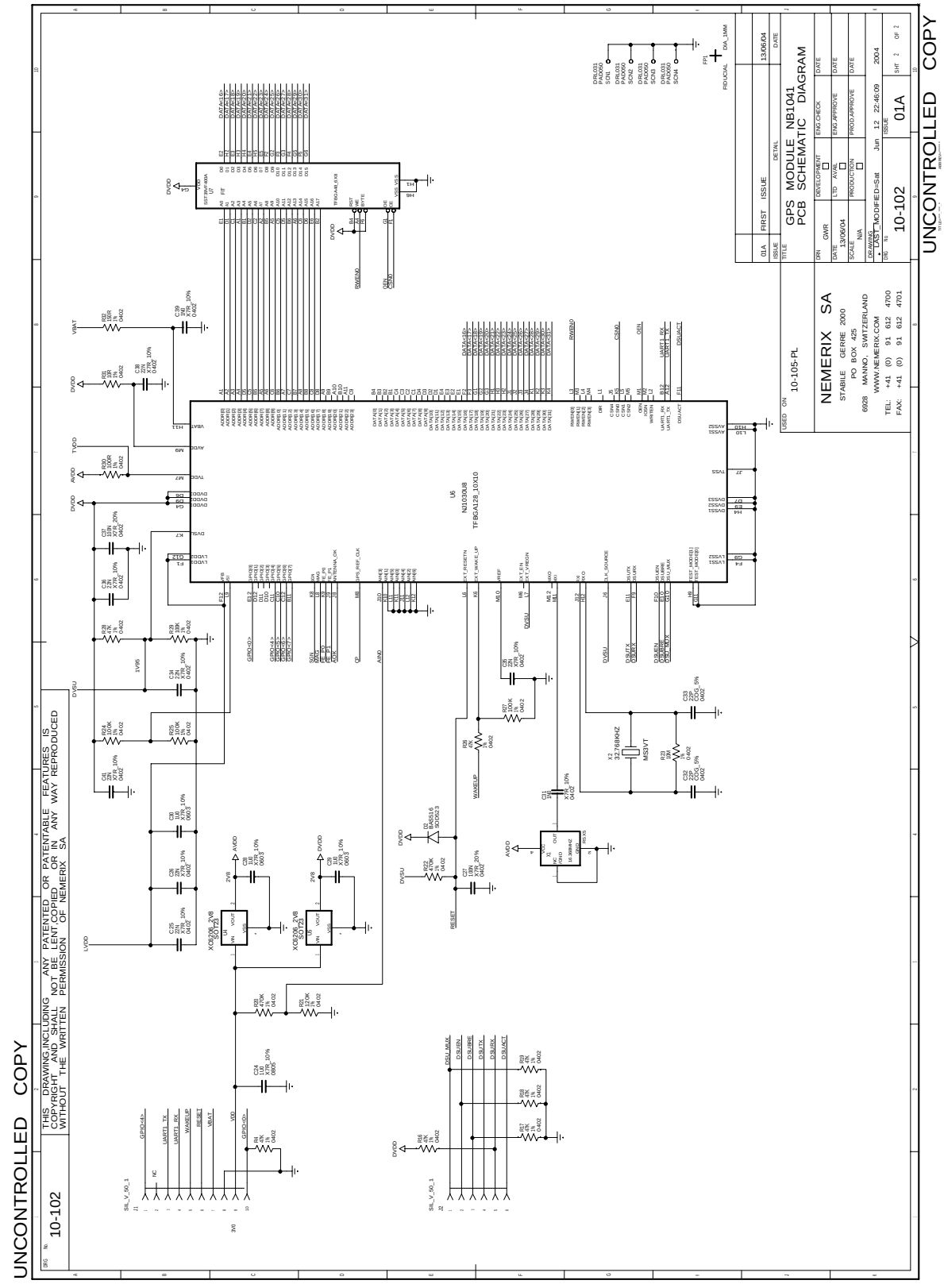


Figure 4 : Flash Memory Schematic Diagram

8 Layout

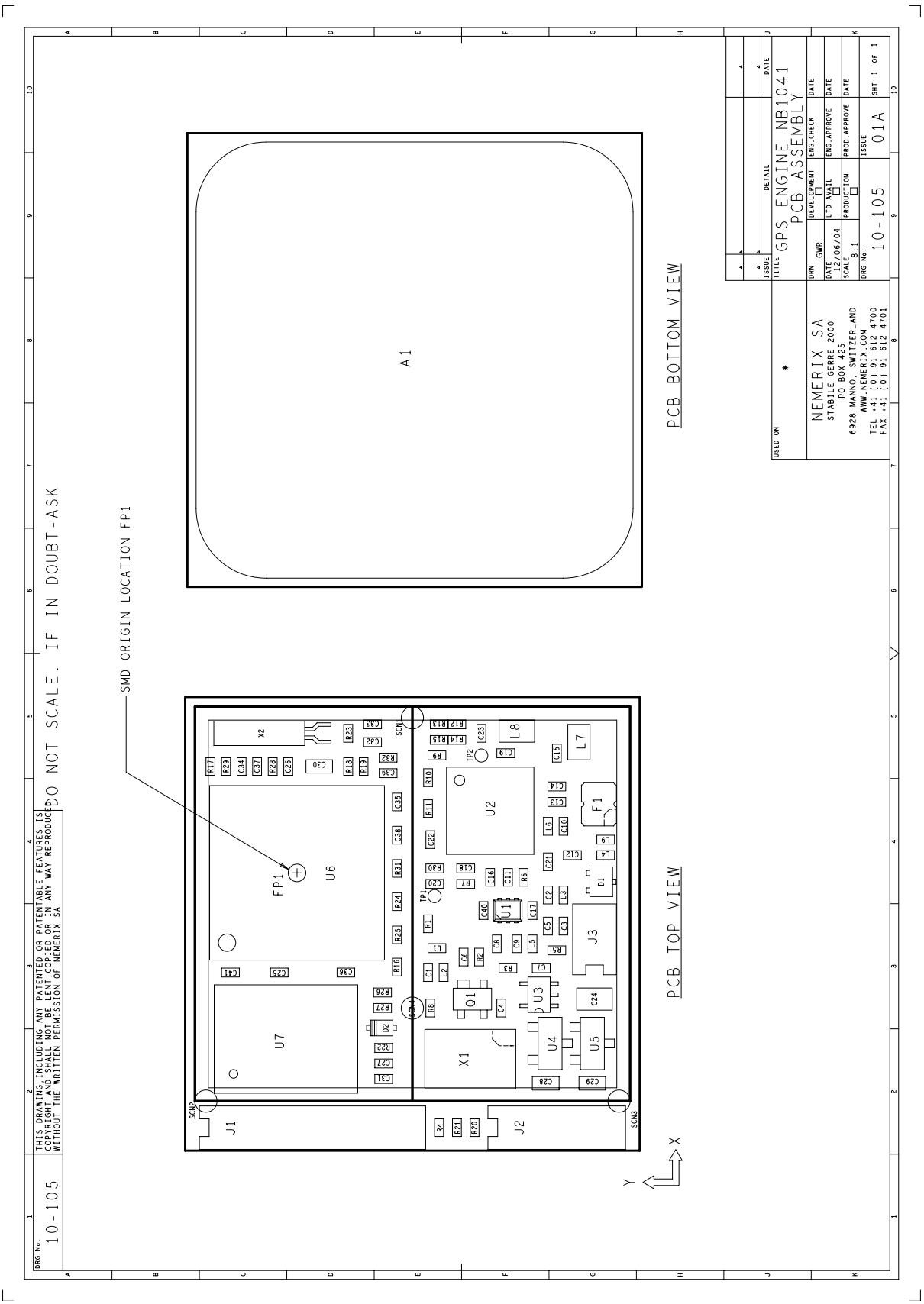


Figure 5 : NB1041 top layout

9 Bill of Material

Symbol	Type	Value	Size	Description
C1	COG	6.8pF	0402	RF input matching capacitor
C2	X7R	1nF	0402	AON decoupling capacitor.
C3	COG	100pF	0402	RF input coupling capacitor
C4	COG	100pF	0402	LNA decoupling capacitor
C5	COG	1.5pF	0402	RF input matching capacitor
C6	COG	100pF	0402	LNA decoupling capacitor
C7	X7R	1nF	0402	LNA power supply decoupling capacitor.
C8	COG	1.8pF	0402	RF switch input matching capacitor.
C9	COG	56pF	0402	RF switch input coupling capacitor.
C10	X7R	1nF	0402	AVDD decoupling capacitor.
C11	COG	56pF	0402	RF switch output coupling capacitor.
C12	COG	100pF	0402	LNA output coupling capacitor
C13	COG	10pF	0402	RFI input matching capacitor
C14	X7R	22nF	0402	VBG decoupling capacitor.
C15	COG	33pF ±5%(2%)	0402	IF filter ceramic capacitor.
C16	X7R	470pF ±10%	0402	PLL loop filter capacitor.
C17	X7R	1nF	0402	Switch control decoupling capacitor.
C18	X7R	100nF	0603	VB decoupling capacitor.
C19	COG	39pF ±5%(2%)	0402	IF filter ceramic capacitor.
C20	X7R	3.3nF ±10%	0402	PLL loop filter capacitor.
C21	X7R	100nF	0402	AVDD decoupling capacitor.
C22	X7R	100nF	0402	TVDD decoupling capacitor.
C23	X7R	10nF	0402	AGC filter capacitor.
C24	X7R	1uF	0805	VDD decoupling capacitor.
C25	X7R	22nF	0402	LVDD decoupling capacitor.
C26	X7R	22nF	0402	LVDD decoupling capacitor.
C27	X7R	100nF	0402	Power-up reset capacitor.
C28	X7R	1uF	0805	AVDD decoupling capacitor.
C29	X7R	1uF	0805	DVDD decoupling capacitor.
C30	X7R	1uF	0805	LVDD decoupling capacitor.
C31	X7R	1nF	0402	TCXO coupling capacitor.
C32	COG	22pF ±5%	0402	RTC crystal oscillator load capacitor.
C33	COG	22pF ±5%	0402	RTC crystal oscillator load capacitor.
C34	X7R	22nF	0402	DVSU decoupling capacitor.
C35	X7R	22nF	0402	Decoupling capacitor for VREF power supply.
C36	X7R	22nF	0402	DVDD decoupling capacitor.
C37	X7R	100nF	0402	DVDD decoupling capacitor.
C38	X7R	22nF	0402	AVDD decoupling capacitor.
C39	X7R	1nF	0402	VBAT decoupling capacitor.
C40	X7R	1nF	0402	RF switch power supply decoupling capacitor.
C41	X7R	22nF	0402	DVDD decoupling capacitor.
L1	Multi-layer	12nH ±5%	0402	LNA input matching inductor.
L2	Multi-layer	8.2nH ±5%	0402	LNA input matching inductor.
L3	Multi-layer	33nH	0402	Phantom power inductor.
L4	Multi-layer	2.2nH ±5%	0402	LNA output matching inductor.
L5	Multi-layer	3.9nH ±5%	0402	Active antennas RF input for matching inductor.

L6	Multi-layer	33nH ±5%	0402	LNA output matching inductor.
L7	Multi-layer	1.5uH ±5%	0805 (0603)	IF filter inductor.
L8	Multi-layer	1.5uH ±5%	0805 (0603)	IF filter inductor.
L9	Multi-layer	3.3nH ±5%	0402	LNA output matching inductor.
R1	Chip	47	0402	Passive antennas input matching resistor.
R2	Chip	150	0402	LNA biasing resistor.
R3	Chip	100	0402	LNA biasing resistor.
R4	Chip	47k	0402	GPIO[0] pull-down resistor.
R5	Chip	150	0402	TVDD power supply filter resistor.
R6	Chip	TBA	0402	WAKEUP partitioning resistor.
R7	Chip	8.2k ±5%	0402	PLL loop filter resistor.
R8	Chip	390	0402	RF switch power supply filter resistor (GPIO 5).
R9	Chip	390	0402	Damping resistor (SGN).
R10	Chip	390	0402	Damping resistor (MAG).
R11	Chip	390	0402	Damping resistor (CP).
R12	Chip	390	0402	Noise filtering resistor (GPIO 7).
R13	Chip	N/F	0402	Damping resistor (FE P1).
R14	Chip	390	0402	Noise filtering resistor (GPIO 6).
R15	Chip	N/F	0402	Damping resistor (FE P0).
R16	Chip	47k	0402	DSURX pull-up resistor.
R17	Chip	47k	0402	DSUBRE pull-down resistor.
R18	Chip	47k	0402	DSUEN pull-down resistor.
R19	Chip	47k	0402	DSU_MUX pull-down resistor.
R20	Chip	470k ±5%	0402	Supply voltage monitoring resistor.
R21	Chip	120k ±5%	0402	Supply voltage monitoring resistor.
R22	Chip	470k ±5%	0402	Power-up reset resistor.
R23	Chip	10M	0402	RTC oscillator bias resistor.
R24	Chip	100k ±5%	0402	Set threshold on voltage supervisor.
R25	Chip	100k ±5%	0402	Set threshold on voltage supervisor.
R26	Chip	47k ±5%	0402	WAKEUP partitioning resistor.
R27	Chip	100k ±5%	0402	WAKEUP partitioning resistor.
R28	Chip	47k ±5%	0402	DVSU partitioning resistor.
R29	Chip	100k ±5%	0402	DVSU partitioning resistor.
R30	Chip	100	0402	TVDD power supply filter resistor.
R31	Chip	10	0402	AVDD power supply filter resistor.
R32	Chip	150	0402	VBAT power supply filter resistor.
D1	Philips PESD5V0S2UQ		SOT-663	Protection diode.
D2	Philips BAS516		SOD-516	Power-up reset diode.
J1	E&T 1600	CON10SIL V 50	10x1-1.27mm	I/O and supply connector.
J2	E&T 1600	CON10SIL V 50	6x1-1.27mm	Debug unit connector.
J3	E&T 1600	CON10SIL V 50	3x1-1.27mm	Active antenna RF connector.
SAW1	TST TA0295A			L1 SAW filter.
U1	NEC UPG2012TK		6-lead micro pak	Antenna switch.
U2	NemeriX NJ1030U8		10x10 128LTFBGA	GPS Base-band processor.
U3	NC7SZ32		SC-70	LNA power supply switch.
U4	Torex XC6206_2V8		SOT-23	2.8V voltage regulator for AVDD.
U5	Torex XC6206_2V8		SOT-23	2.8V voltage regulator for DVDD.

U6	NemeriX NJ1006M5		5x5 LPCC28	NemeriX GPS front-end.
U7	SST SST39VF400A		TFBGA_48_6x8	4Mbit flash memory.
X1	Rakon IT5300B		4PADS5032	16.368MHz TCXO.
X2	MC MS3V-T1R		SMD4115XTAL	32kHz 30ppm Crystal for RTC.

Notes:

Ordering information

Part	Description
NB1041	Dual antenna GPS engine board

Related products

Part	Description
NJ1030U5	GPS Baseband Processor BGA 7x7, 0.5mm pitch
NJ1030U8	GPS Baseband Processor BGA 10x10, 0.8mm pitch
NJ1006	GPS RF Front-End
DK1030	Software Development Kit

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