NEO-M9N

u-blox M9 standard precision module

Data sheet

Abstract

Technical data sheet describing the u-blox NEO-M9N module. NEO-M9N offers ultra-robust meter-level GNSS positioning performance with concurrent reception of up to four GNSS (GPS, GLONASS, BeiDou, Galileo) in a 12.2 x 16.0 mm package.

Document information

Title	**NEO-M9N**	
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Product status	Corresponding content status	
In development / prototype	Objective specification	Target values. Revised and supplementary data will be published later.
Engineering sample	Advance information	Data based on early testing. Revised and supplementary data will be published later.
Initial production	Early production information	Data from product verification. Revised and supplementary data may be published later.
Mass production / End of life	Production information	Document contains the final product specification.

This document applies to the following products:

Product name	Type number	Firmware version	PCN reference
NEO-M9N	NEO-M9N-00B-00	SPG 4.04	N/A

Contents

1 Functional description

1.1 Overview

The NEO-M9N GNSS receiver features the u-blox M9 standard precision GNSS platform, and provides exceptional sensitivity and acquisition times for all L1 GNSS systems. u-blox M9 receivers are available in different variants to serve automotive and industrial tracking applications, such as navigation, telematics and UAVs.

The u-blox M9 standard precision GNSS platform, which delivers meter-level accuracy, succeeds the well-known u-blox M8 product range.

u-blox M9 receivers support concurrent reception of four GNSS. The high number of visible satellites allows the receiver to select the best signals. This maximizes the position accuracy, in particular under challenging conditions such as deep urban canyons.

u-blox M9 receivers detect jamming and spoofing events and report them to the host, which allows the system to react to such events. Advanced filtering algorithms mitigate the impact of RF interference and jamming, thus enabling the product to operate as intended.

The receiver also provides higher navigation rate and improved security features compared to previous u-blox GNSS generations.

The NEO-M9N module is available in the 12.2 x 16.0 mm NEO form factor LCC package.

1.2 Performance

Parameter	Specification	
Receiver type	Multi-constellation GNSS standard precision receiver	
Accuracy of time pulse signal	RMS 99%	30 ns 60 ns
Frequency of time pulse signal		0.25 Hz to 10 MHz (configurable)
Operational limits[1]	Dynamics Altitude Velocity	≤ 4 g 80,000 m 500 m/s
Velocity accuracy[2]		0.05 m/s
Dynamic heading accuracy[2]		0.3 deg

GNSS		GPS+GLO+GAL+BDS	GPS+GLO+GAL	GPS+GLO	GPS+BDS	GPS+GAL
Acquisition[3]	Cold start	24 s	25 s	26 s	28 s	29 s
	Hot start	2 s	2 s	2 s	2 s	2 s
	Aided start[4]	2 s	2 s	2 s	2 s	2 s
Nav. update rate	PVT	25 Hz	25 Hz	25 Hz	25 Hz	25 Hz

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[1] Assuming Airborne 4 g platform

[2] 50% at 30 m/s for dynamic operation

[3] Commanded starts. All satellites at -130 dBm. GPS always in combination with QZSS and SBAS. Measured at room temperature.

[4] Dependent on the speed and latency of the aiding data connection, commanded starts.

GNSS		GPS+GLO+GAL+BDS	GPS+GLO+GAL	GPS+GLO	GPS+BDS	GPS+GAL
Sensitivity[5]	Tracking and nav.	-167 dBm	-167 dBm	-167 dBm	-166 dBm	-166 dBm
	Reacquisition	-160 dBm	-160 dBm	-160 dBm	-160 dBm	-160 dBm
	Cold start	-148 dBm	-148 dBm	-148 dBm	-148 dBm	-148 dBm
	Hot start	-159 dBm	-159 dBm	-159 dBm	-159 dBm	-159 dBm
Position accuracy	PVT	2.0 m CEP	2.0 m CEP	2.0 m CEP	2.0 m CEP	2.0 m CEP

Table 1: NEO-M9N typical performance in multi-constellation GNSS modes

GNSS		GPS	GLONASS	BEIDOU	GALILEO
Acquisition[3]	Cold start	29 s	27 s	32 s	42 s
	Hot start	2 s	2 s	2 s	2 s
	Aided start[4]	2 s	2 s	2 s	5 s
Nav. update rate	PVT	25 Hz	25 Hz	25 Hz	25 Hz
Sensitivity[5]	Tracking and nav.	-166 dBm	-164 dBm	-160 dBm	-159 dBm
	Reacquisition	-160 dBm	-155 dBm	-157 dBm	-154 dBm
	Cold start	-148 dBm	-145 dBm	-145 dBm	-140 dBm
	Hot start	-159 dBm	-156 dBm	-159 dBm	-154 dBm
Position accuracy	PVT	2.0 m CEP	4.0 m CEP	3.0 m CEP	3.0 m CEP

Table 2: NEO-M9N typical performance in single-GNSS modes

1.3 Supported GNSS constellations

The NEO-M9N is a concurrent GNSS receiver which can receive and track multiple GNSS systems. Owing to the multi-band RF front-end architecture all four major GNSS constellations, GPS, Galileo, GLONASS and BeiDou can be received concurrently. The NEO-M9N receiver can be configured for concurrent GPS, GLONASS, Galileo and BeiDou plus SBAS and QZSS reception. If power consumption is a key factor, then the receiver can be configured for a subset of GNSS constellations.

The NEO-M9N supports the GNSS and their signals as shown in Table 3.

GPS	GLONASS	Galileo	BeiDou
L1C/A (1575.42 MHz)	L1OF (1602 MHz + k*562.5 kHz, k = –7,..., 5, 6)	E1-B/C (1575.42 MHz)	B1I (1561.098 MHz)

Table 3: Supported GNSS and signals on NEO-M9N

The following GNSS assistance services can be activated on NEO-M9N:

AssistNow™ Online	AssistNow™ Offline	AssistNow™ Autonomous
Supported	Supported	Supported

Table 4: Supported Assisted GNSS (A-GNSS) Services

NEO-M9N supports the following augmentation systems:

SBAS	QZSS	IMES	Differential GNSS
EGNOS, GAGAN, MSAS and WAAS supported	L1s (SAIF) supported	Not supported	RTCM 3.3

Table 5: Supported Augmentation Systems of NEO-M9N

☞ The augmentation systems SBAS and QZSS can be enabled only if GPS operation is also enabled.

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5 Demonstrated with a good external LNA. Measured at room temperature.

1.4 Supported protocols

The NEO-M9N supports the following protocols:

Protocol	Type
UBX	Input/output, binary, u-blox proprietary
NMEA 4.10	Input/output, ASCII
RTCM 3.3	Input, binary

Table 6: Supported protocols

For specification of the protocols, see the u-blox NEO-M9N Interface description [2].

1.5 Firmware features

Feature	Description
Assisted GNSS	AssistNow Online, AssistNow Offline and AssistNow Autonomous supported
Backup modes	Hardware backup mode, software backup mode
Data batching	Autonomous tracking up to 5 min.
Data-logger	Position, velocity, time, and odometer data
Geofencing	Up to 4 circular areas
Power save modes	On/off, cyclic
Odometer	Measure traveled distance with support for different user profiles
Upgradeable firmware	Firmware can be upgraded via host upload or updated in the internal flash memory

Table 7: Firmware features

Feature	Description
Anti-jamming	RF interference and jamming detection and reporting; Active GNSS in-band filtering
Anti-spoofing	Spoofing detection and reporting
Configuration lockdown	Receiver configuration can be locked by command
Message integrity	All messages signed with SHA-256
Secure boot	Only signed FW images executed

Table 8: Security features

2 System description
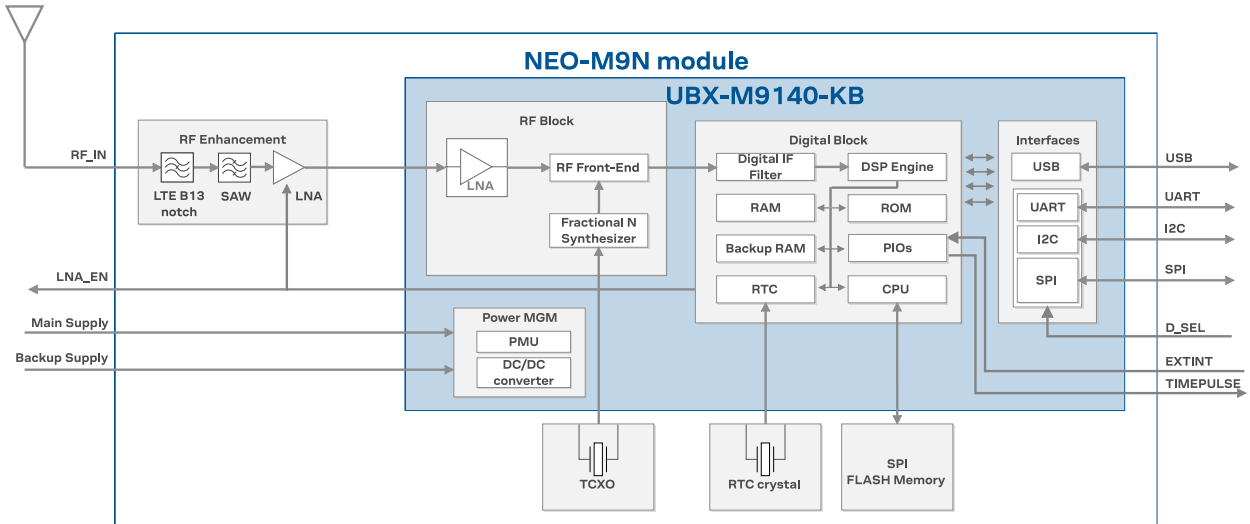
2.1 Block diagram

Figure 1: NEO-M9N block diagram

3 Pin definition

3.1 Pin assigment

The pin assignment of the NEO-M9N module is shown in Figure 2. The defined configuration of the PIOs is listed in Table 9.

For detailed information on pin functions and characteristics, see the u-blox NEO-M9N Integration manual [1].

13	GND	GND	12
14	LNA_EN	RF_IN	11
15	Reserved	GND	10
16	Reserved	VCC_RF	9
17	Reserved	RESET_N	8
	NEO-M9N		
	Top View		
18	SDA / SPI CS_N	V_USB	7
19	SCL / SPI SLK	USB_DP	6
20	TXD / SPI MISO	USB_DM	5
21	RXD / SPI MOSI	EXTINT	4
22	V_BCKP	TIMEPULSE	3
23	VCC	D_SEL	2
24	GND	SAFEBOOT_N	1

Figure 2: NEO-M9N pin assignment

Pin no.	Name	I/O	Description
1	SAFEBOOT_N	I	SAFEBOOT_N (used for FW updates and reconfiguration, leave open)
2	D_SEL	I	Interface select (open or VCC = UART + I2C; GND = SPI)
3	TIMEPULSE	O	TIMEPULSE (1 PPS)
4	EXTINT	I	EXTINT (PIO 7)
5	USB_DM	I/O	USB data (DM)
6	USB_DP	I/O	USB data (DP)
7	V_USB	I	USB supply
8	RESET_N	I	RESET (active low)
9	VCC_RF	O	Voltage for external LNA
10	GND	I	Ground
11	RF_IN	I	GNSS signal input
12	GND	I	Ground
13	GND	I	Ground
14	LNA_EN	O	Antenna/LNA control
15	Reserved	-	Reserved

Pin no.	Name	I/O	Description
16	Reserved	-	Reserved
17	Reserved	-	Reserved
18	SDA / SPI CS_N	I/O	I2C data if D_SEL = VCC (or open); SPI chip select if D_SEL = GND
19	SCL / SPI SLK	I/O	I2C clock if D_SEL = VCC (or open); SPI clock if D_SEL = GND
20	TXD / SPI MISO	O	UART output if D_SEL = VCC (or open); SPI MISO if D_SEL = GND
21	RXD / SPI MOSI	I	UART input if D_SEL = VCC (or open); SPI MOSI if D_SEL = GND
22	V_BCKP	I	Backup voltage supply
23	VCC	I	Supply voltage
24	GND	I	Ground

Table 9: NEO-M9N pin assigment

☞ For detailed information on the pin functions and characteristics see the u-blox NEO-M9N Integration manual [1].

4 Electrical specification

☞ The limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only. Operation of the device at these or at any other conditions above those given below is not implied. Exposure to limiting values for extended periods may affect device reliability.

☞ Where application information is given, it is advisory only and does not form part of the specification.

☞ For detailed information on the device integration, see the u-blox NEO-M9N Integration manual [1].

4.1 Absolute maximum ratings

Parameter	Symbol	Condition	Min	Max	Units
Power supply voltage	VCC		-0.5	3.6	V
Backup battery voltage	V_BCKP		-0.5	3.6	V
Input pin voltage	Vin	VCC ≤ 3.1 V	-0.5	VCC + 0.5	V
		VCC > 3.1 V	-0.5	3.6	V
VCC_RF output current	ICC_RF			100	mA
Supply voltage USB	V_USB		–0.5	3.6	V
USB signals	USB_DM, USB_DP		-0.5	V_USB + 0.5	V
Input power at RF_IN	Prfin	source impedance = 50 Ω, continuous wave		13^6	dBm
Storage temperature	Tstg		-40	+85	°C

Table 10: Absolute maximum ratings

⚠ The product is not protected against overvoltage or reversed voltages. Voltage spikes exceeding the power supply voltage specification, given in the table above, must be limited to values within the specified boundaries by using appropriate protection diodes.

4.2 Operating conditions

☞ All specifications are at an ambient temperature of 25 °C. Extreme operating temperatures can significantly impact the specification values. Applications operating near the temperature limits should be tested to ensure the specification.

Parameter	Symbol	Min	Typical	Max	Units	Condition
Power supply voltage	VCC	2.7	3.0	3.6	V	
Supply voltage for USB interface	V_USB	3.0		3.6	V	
Backup battery voltage	V_BCKP	1.65		3.6	V	
Backup battery current	I_BCKP		36		µA	V_BCKP = 3 V, VCC = 0 V
SW backup current	I_SWBCKP		0.36		mA	
Input pin voltage range	Vin	0		VCC	V	
Digital IO pin low level input voltage	Vil			0.4	V	
Digital IO pin high level input voltage	Vih	0.8 * VCC			V	

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6   +13 dBm for outband; 0 dBm for inband

Parameter	Symbol	Min	Typical	Max	Units	Condition
Digital IO pin low level output voltage	Vol			0.4	V	Iol = 2 mA
Digital IO pin high level output voltage	Voh	VCC – 0.4			V	Ioh = 2 mA
DC current through any digital I/O pin (except supplies)	Ipin			5	mA	
Pull-up resistance for D_SEL, SCL, SDA	R_{pu}	7	15	30	kΩ	
Pull-up resistance for RXD, TXD, SAFEBOOT_N, EXTINT	R_{pu}	30	75	130	kΩ	
Pull-up resistance for RESET_N	R_{pu}	7	10	13	kΩ	
Voltage at USB pins	V_USBIO	0		V_USB	V	
VCC_RF voltage	VCC_RF		VCC - 0.1		V	
VCC_RF output current	ICC_RF			50	mA	
Receiver chain noise figure[7]	NFtot		3.5		dB	
External gain (at RF_IN)	Ext_gain			30	dB	
Operating temperature	Topr	-40	+25	85	°C	

Table 11: Operating conditions

☞ Operation beyond the specified operating conditions can affect device reliability.

4.3 Indicative power requirements

Table 12 lists examples of the total system supply current including RF and baseband section for a possible application.

☞ Values in Table 12 are provided for customer information only, as an example of typical current requirements. The values are characterized on samples by using a cold start command. Actual power requirements can vary depending on FW version used, external circuitry, number of satellites tracked, signal strength, type and time of start, duration, and conditions of test.

Symbol	Parameter	Conditions	GPS+GLO+GAL+BDS	GPS+GLO	GPS	Unit
I_{PEAK}	Peak current	Acquisition	100	100	100	mA
I_{VCC}[8]	VCC current	Acquisition	50	43	36	mA
		Tracking (Continuous mode)	36	32	28	mA
		Tracking (Power save mode)	21	20	19	mA

Table 12: Currents to calculate the indicative power requirements

All values in Table 12 are measured at 25 °C ambient temperature. SBAS and QZSS are activated in all measurements.

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[7] Only valid for the GPS

[8] Simulated signal, current measured at 3.0 V

5 Communications interfaces

There are several communications interfaces including UART, SPI, I2C[9] and USB.

All the inputs have internal pull-up resistors in normal operation and can be left open if not used. All the PIOs are supplied by VCC, therefore all the voltage levels of the PIO pins are related to VCC supply voltage.

5.1 UART interface

The NEO-M9N has one UART interface, it supports configurable baud rates. See the NEO-M9N Integration manual [1].

Hardware flow control is not supported.

The UART1 is enabled if D_SEL pin of the module is left open or "high".

Symbol	Parameter	Min	Max	Unit
R_u	Baudrate	4800	921600	bit/s
Δ_{Tx}	Tx baudrate accuracy	-1%	+1%	-
Δ_{Rx}	Rx baudrate tolerance	-2.5%	+2.5%	-

Table 13: NEO-M9N UART specifications

5.2 SPI interface

The NEO-M9N has an SPI slave interface that can be selected by setting D_SEL = 0. The SPI pins available are:
- SPI_MISO (TXD)
- SPI_MOSI (RXD)
- SPI_CS_N
- SPI_CLK

The SPI interface is designed to allow communication to a host CPU. The interface can be operated in slave mode only. Note that SPI is not available in the default configuration because its pins are shared with the UART and I2C interfaces. The maximum transfer rate using SPI is 125 kB/s and the maximum SPI clock frequency is 5.5 MHz.

This section provides SPI timing values for the NEO-M9N slave operation. The following tables present timing values under different capacitive loading conditions. Default SPI configuration is CPOL = 0 and CPHA = 0.

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[9] I2C is a registered trademark of Philips/NXP
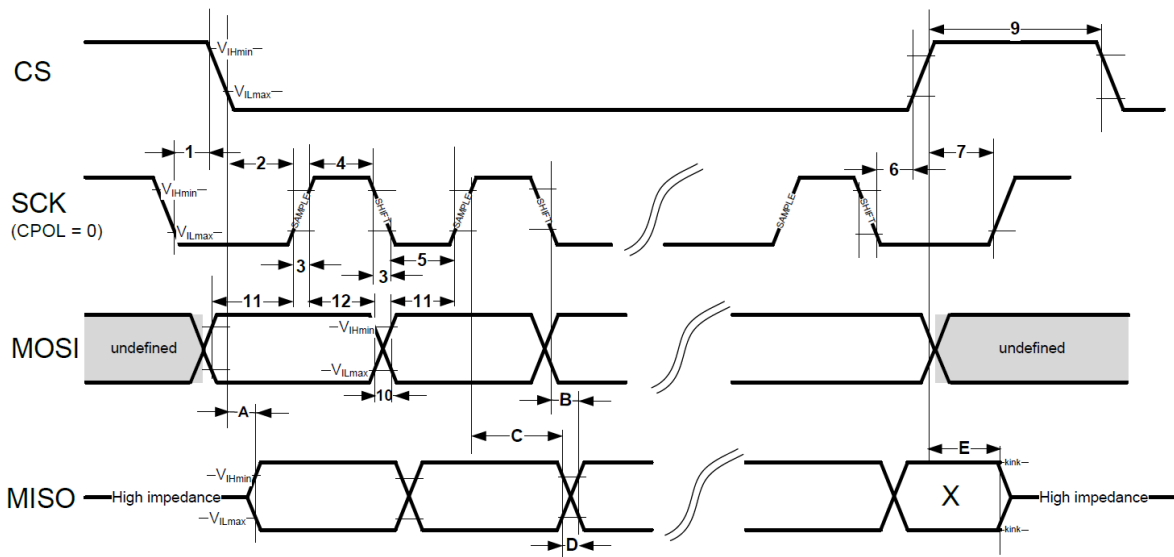
Figure 3: NEO-M9N module SPI specification mode 1: CPHA=0 SCK = 5.33 MHz

☞ Timings 1 - 12 are not specified here as they are dependent on the SPI master. Timings A - E are specified for SPI slave.

Timing value at 2 pF load	Min (ns)	Max (ns)
"A" - MISO data valid time (CS)	14	38
"B" - MISO data valid time (SCK) weak driver mode	21	38
"C" - MISO data hold time	114	130
"D" - MISO rise/fall time, weak driver mode	1	4
"E" - MISO data disable lag time	20	32

Table 14: NEO-M9N SPI timings at 2 pF load

Timing value at 20 pF load	Min (ns)	Max (ns)
"A" - MISO data valid time (CS)	19	52
"B" - MISO data valid time (SCK) weak driver mode	25	51
"C" - MISO data hold time	117	137
"D" - MISO rise/fall time, weak driver mode	6	16
"E" - MISO data disable lag time	20	32

Table 15: NEO-M9N SPI timings at 20 pF load

Timing value at 60 pF load	Min (ns)	Max (ns)
"A" - MISO data valid time (CS)	29	79
"B" - MISO data valid time (SCK) weak driver mode	35	78
"C" - MISO data hold time	122	152
"D" - MISO rise/fall time, weak driver mode	15	41
"E" - MISO data disable lag time	20	32

Table 16: NEO-M9N SPI timings at 60 pF load

5.3 Slave I2C interface

An I2C-compliant interface is available for communication with an external host CPU. The interface can be operated in slave mode only. It is fully compatible with fast-mode of the I2C industry standard.

Since the maximum SCL clock frequency is 400 kHz, the maximum bit rate is 400 kbit/s. The interface stretches the clock when slowed down while serving interrupts, therefore the real bit rates may be slightly lower.

☞ The I2C interface is only available with the UART default mode. If the SPI interface is selected by using D_SEL = 0, the I2C interface is not available.
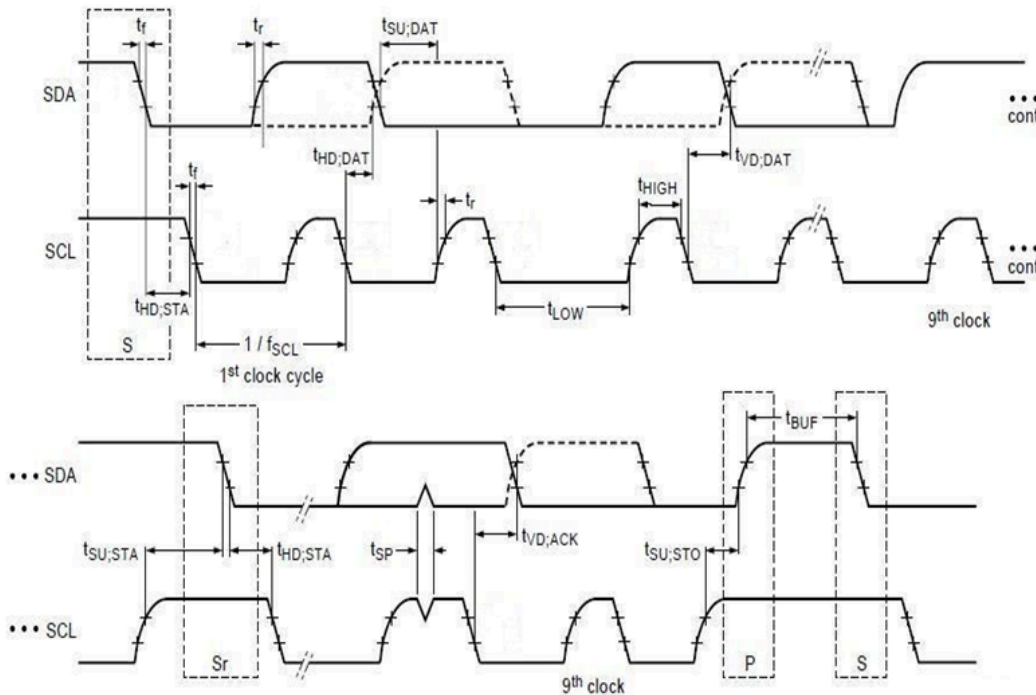

Figure 4: NEO-M9N module I2C slave specification

Symbol	Parameter	Min (Standard / Fast-mode)	Max	Unit
f_{SCL}	SCL clock frequency	0	400	kHz
$t_{HD;STA}$	Hold time (repeated) START condition	4.0/1	-	µs
t_{LOW}	Low period of the SCL clock	5/2	-	µs
t_{HIGH}	High period of the SCL clock	4.0/1	-	µs
$t_{SU;STA}$	Set-up time for a repeated START condition	5/1	-	µs
$t_{HD;DAT}$	Data hold time	0/0	-	µs
$t_{SU;DAT}$	Data set-up time	250/100		ns
t_r	Rise time of both SDA and SCL signals	-	1000/300 (for C = 400pF)	ns
t_f	Fall time of both SDA and SCL signals	-	300/300 (for C = 400pF)	ns
$t_{SU;STO}$	Set-up time for STOP condition	4.0/1	-	µs
t_{BUF}	Bus-free time between a STOP and START condition	5/2	-	µs
$t_{VD;DAT}$	Data valid time	-	4/1	µs
$t_{VD;ACK}$	Data valid acknowledge time	-	4/1	µs
V_{nL}	Noise margin at the low level	0.1 VCC	-	V
V_{nH}	Noise margin at the high level	0.2 VCC	-	V

Table 17: NEO-M9N I2C slave timings and specifications

5 Communications interfaces
Early production information

5.4 USB interface

The USB 2.0 FS (Full speed, 12 Mbit/s) interface can be used for host communication. Due to the hardware implementation, it may not be possible to certify the USB interface. The V_USB pin supplies the USB interface.

5.5 Default interface settings

Interface	Settings
UART	38400 baud, 8 bits, no parity bit, 1 stop bit.
	Output messages: NMEA **GGA, GLL, GSA, GSV, RMC, VTG, TXT** (no UBX).
	Input protocols: UBX, NMEA and RTCM 3.3.
USB	Output messages activated as in UART. Input protocols available as in UART.
I2C	Output messages activated as in UART. Input protocols available as in UART.
SPI	Output messages activated as in UART. Input protocols available as in UART.

Table 18: Default interface settings

☞ Refer to the u-blox NEO-M9N Interface description [2] for information about further settings.

By default the NEO-M9N outputs NMEA 4.10 messages that include satellite data for all GNSS bands being received. This results in a higher-than-before NMEA load output for each navigation period. Make sure the UART baud rate being used is sufficient for the selected navigation rate and the number of GNSS signals being received.

6 Mechanical specification

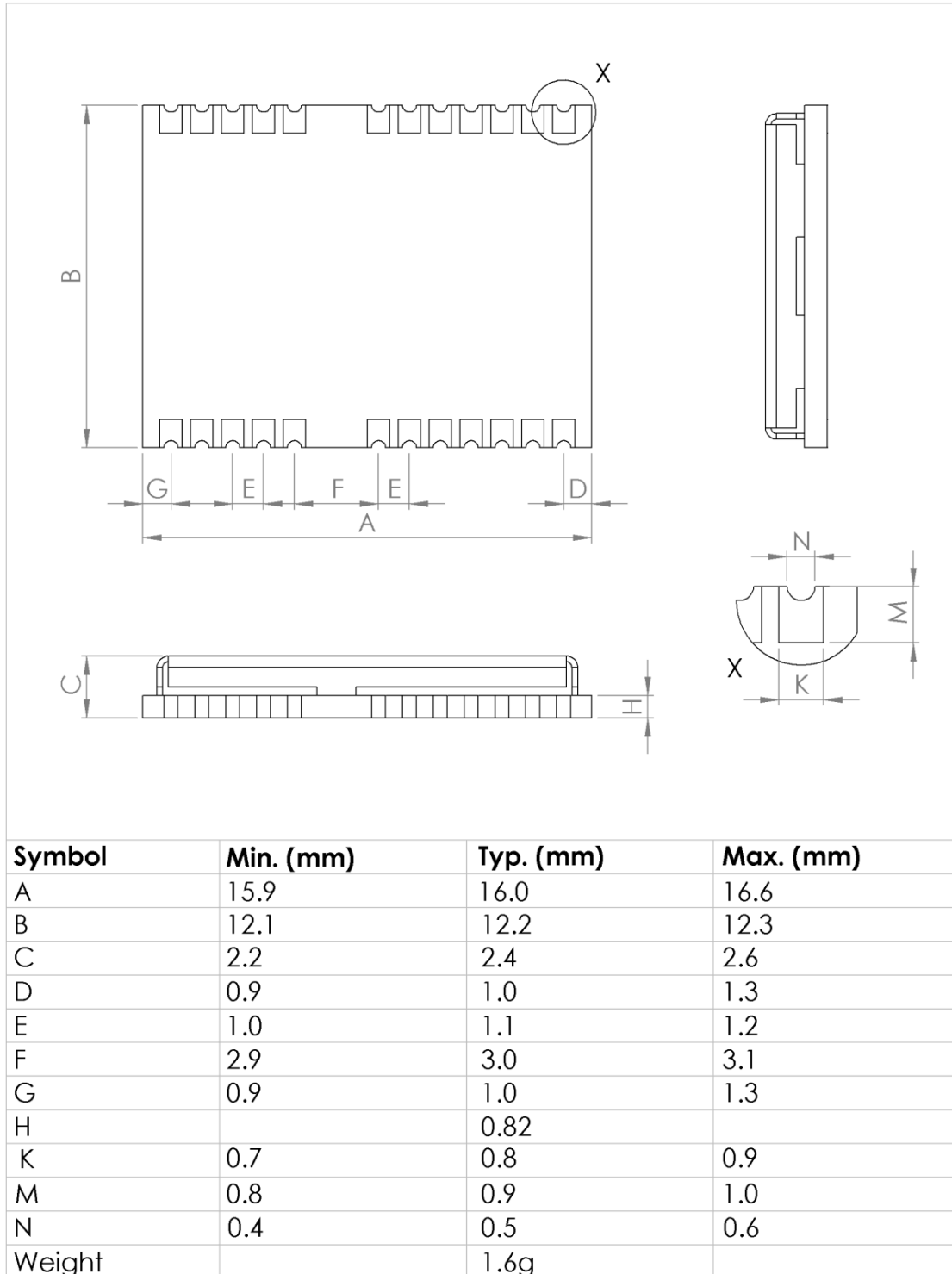| Symbol	Min. (mm)	Typ. (mm)	Max. (mm)
A	15.9	16.0	16.6
B	12.1	12.2	12.3
C	2.2	2.4	2.6
D	0.9	1.0	1.3
E	1.0	1.1	1.2
F	2.9	3.0	3.1
G	0.9	1.0	1.3
H		0.82	
K	0.7	0.8	0.9
M	0.8	0.9	1.0
N	0.4	0.5	0.6
Weight		1.6g	

Figure 5: NEO-M9N mechanical drawing

7 Reliability tests and approvals

NEO-M9N modules are based on AEC-Q100 qualified GNSS chips.

Tests for product family qualifications are according to ISO 16750 "Road vehicles – environmental conditions and testing for electrical and electronic equipment", and appropriate standards.

7.1 Approvals

The NEO-M9N is designed to in compliance with the essential requirements and other relevant provisions of Radio Equipment Directive (RED) 2014/53/EU.

The NEO-M9N complies with the Directive 2011/65/EU (EU RoHS 2) and its amendment Directive (EU) 2015/863 (EU RoHS 3).

Declaration of Conformity (DoC) is available on the u-blox website.

8 Labeling and ordering information

This section provides information about product labeling and ordering. For information about product handling and soldering see the NEO-M9N Integration manual [1].

8.1 Product labeling

The labeling of the NEO-M9N modules provides product information and revision information. For more information contact u-blox sales.

8.2 Explanation of product codes

Three different product code formats are used. The **Product name** is used in documentation such as this data sheet and identifies all u-blox products, independent of packaging and quality grade. The **Ordering code** includes options and quality, while the **Type number** includes the hardware and firmware versions. Table 19 below details these three different formats.

Format	Structure	Code for this product
Product name	PPP-TGV	NEO-M9N
Ordering code	PPP-TGV-NNQ	NEO-M9N-00B
Type number	PPP-TGV-NNQ-XX	NEO-M9N-00B-00

Table 19: Product code formats

The parts of the product code are explained in Table 20.

Code	Meaning	Example
PPP	Product family	NEO
TG	Platform	M9 = u-blox M9
V	Variant	N = Standard precision with SAW and LNA
NNQ	Option / Quality grade	NN: Option [00…99]
		Q: Grade, A = Automotive, B = Professional
XX	Product detail	Describes hardware and firmware versions

Table 20: Part identification code

8.3 Ordering codes

Ordering code	Product	Remark
NEO-M9N-00B	u-blox NEO-M9N module, professional grade	

Table 21: Product ordering codes

☞ Product changes affecting form, fit or function are documented by u-blox. For a list of Product Change Notifications (PCNs) see our website at: https://www.u-blox.com/en/product-resources.

UBX-19014285 - R04
C1-Public
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Related documents

[1] NEO-M9N Integration manual, UBX-19014286
[2] NEO-M9N Interface description, UBX-19035940

☞ For regular updates to u-blox documentation and to receive product change notifications please register on our homepage https://www.u-blox.com.

Revision history

Revision	Date	Name	Status / comments
R01	15-Aug-2019	jesk	Objective specification
R02	14-Nov-2019	jesk	Advance information
R03	24-Jan-2020	jesk	Advance information.
			Added outband value for Prfin, renamed VDD_USB to V_USB.
R04	11-Sep-2020	jesk	Early production information.
			- Updated firmware to SPG 4.04.
			- Updated I_BCKP and indicative power consumption values.
			- Added supported voltage range for V_USB.
			- Added value for Ext_gain, External gain at RF_IN.
			- Added digital I/O pin DC current and pull up resistance values.
			- Clarified UART timing specifications.
			- Clarified use of USB interface.

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