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# Report On

Emergency Beacons Limited Testing of the
McMurdo Limited
uBlox NEO - 6M (G5 Smartfind Plus)

Document 75911555 Report 04 Issue 1 March 2011

Product Service

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**REPORT ON**

Emergency Beacons Limited Testing of the
McMurdo Limited
uBlox NEO - 6M (G5 Smartfind Plus)

Document 75911555 Report 04 Issue 1

March 2011

**PREPARED FOR**

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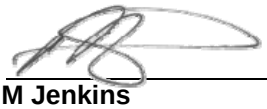

**M Jenkins**
Authorised Signatory

**DATED** 22 March 2011

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**CONTENTS**

**SECTION 1**

**REPORT SUMMARY**

Emergency Beacons Limited Testing of the
McMurdo Limited
uBlox NEO - 6M (G5 Smartfind Plus)

## 1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Emergency Beacons Testing of the uBlox NEO - 6M (McMurdo Limited G5 Smartfind Plus) to the requirements of IEC 61108-1.

| | |
|---|---|
| Objective | To perform GPS Testing to determine the Equipment Under Test's (EUT's) compliance with the Test Specification, for the series of tests carried out. |
| Manufacturer | McMurdo Limited |
| Model Number(s) | uBlox NEO - 6M (G5 Smartfind Plus) |
| Serial Number(s) | Not serialised<br>TÜV Reference Number: 75911555-TSR0004 |
| Number of Samples Tested | One |
| Test Specification/Issue/Date | IEC 61108-1: 2003 |
| Order Number<br>Date | PC0004329<br>29 October 2010 |
| Start of Test | 29 November 2010 |
| Finish of Test | 09 March 2011 |
| Name of Engineer(s) | R Hampton |
| Related Documents | EN 61162-1: 2008 |

## 1.2 DECLARATION OF BUILD STATUS

| MAIN EUT | |
|---|---|
| **MANUFACTURING DESCRIPTION** | Emergency Positioning Indicating Radio Beacon (EPIRB) |
| **MANUFACTURER** | McMurdo Ltd |
| **TYPE** | EPIRB |
| **PART NUMBER** | G5/E5 Smartfind |
| **SERIAL NUMBER** | 1 |
| **HARDWARE VERSION** | Issue 1 |
| **SOFTWARE VERSION** | 1.3.220 |
| **TRANSMITTER OPERATING RANGE** | 406.040MHz & 121.5MHz |
| **RECEIVER OPERATING RANGE** | N/A |
| **INTERMEDIATE FREQUENCIES** | N/A |
| **EMISSION DESIGNATOR(S): (i.e. G1D, GXW)** | 3K20A3X & 16K0G1D |
| **MODULATION TYPES: (i.e. GMSK, QPSK)** | 121.5MHz = AM (Swept tone) & 406.040MHz = Phase Modulation |
| **HIGHEST INTERNALLY GENERATED FREQUENCY** | 406.040MHz |
| **HIGHEST INTERNALLY GENERATED FREQUENCY IN RECEIVE IDLE MODE** | N/A |
| **OUTPUT POWER (W or dBm)** | 121.5MHz = 16dBm 406.040MHz = 37dBm |
| **TECHNICAL DESCRIPTION (a brief description of the intended use and operation)** | Emergency Positioning Indicating Radio Beacon (EPIRB) for last resort safeguard against life threatening incidents that may occur anywhere in the world at sea. |
| **If unit is SRD being tested to ETS 301 489-3 please state Class of Equipment as defined in Section 6.1** | |
| **BATTERY/POWER SUPPLY** | |
| **MANUFACTURING DESCRIPTION** | Lithium Battery Pack |
| **MANUFACTURER** | Varta/Panasonic |
| **TYPE** | Lithium Manganese Dioxide |
| **PART NUMBER** | CR 2/3 AH |
| **VOLTAGE** | 9V |
| **SERIAL NUMBER** | N/A |

**Signature** 

**Date** 15 March 2011

**D of B S Serial No** 75911555/01

Note: This document has been prepared to enable manufacturers with no mechanism for producing their own Declaration of Build Status, to declare the build state of the equipment submitted for test.

No responsibility will be accepted by TÜV SÜD Product Service as to the accuracy of the information declared in this document by the manufacturer.

## 1.3 PRODUCT INFORMATION

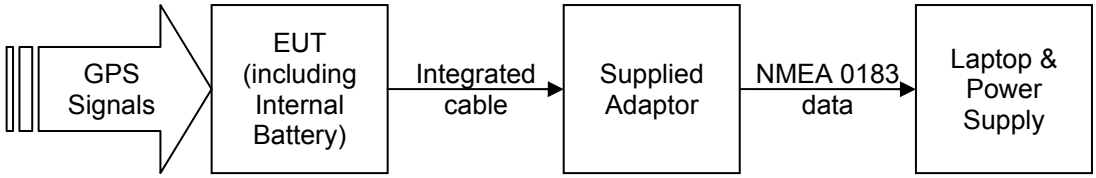
### 1.3.1 Technical Description

The Equipment Under Test (EUT) was a McMurdo Limited uBlox NEO - 6M (G5 Smartfind Plus) as shown in the photograph below. A full technical description can be found in the manufacturer's documentation.


Equipment Under Test

### 1.3.2 Physical Test Configuration

The EUT was configured so that the RF transmitters were disabled and module data output (normally to EUT internal systems) was output to a remote (integral) adaptor. The Equipment Under Test (EUT) was operated using an internal battery and the NMEA 0183 serial output connected to an external laptop (test equipment) running logging/monitoring software "VisualGPS".



### 1.3.3 Modes of Operation

Modes of operation of the EUT during testing were as follows:

Operating:

- Physical configuration as above, EUT entered operational mode upon activation of its main switch
- Low intensity Green LEDs flashing at ~2 Hz initially to indicate activation
- High Intensity white LEDs (strobe lights) flashing at ~0.4 Hz
- NMEA 0183 serial data outputting to Test Equipment

Off/Idle:

- Main switch moved to “OFF” position

Isolated:

- Battery disconnected.

## 1.4 MODIFICATIONS

The table below details modifications made to the EUT during the test programme. The modifications incorporated during each test are recorded on the appropriate test pages.

| Modification State | Description of Modification still fitted to EUT | Modification Fitted By | Date Modification Fitted |
|---|---|---|---|
| 0 | As supplied by the customer | Not Applicable | Not Applicable |
| 1 | To allow enable constant power to the GPS module (to facilitate testing to IEC 61108) the PCB pads 1 & 4 for device Q10 (FET FDC638p) were shorted together to provide a constant 3v3 voltage drive to the uBlox NEO-6M GNSS module. | Neil Jordan, McMurdo Limited | 07 February 2011 |

## 1.5 REPORT MODIFICATION RECORD

Issue 1 – First Issue

Product Service

## SECTION 2

## TEST DETAILS

Emergency Beacons Limited Testing of the
McMurdo Limited
uBlox NEO - 6M (G5 Smartfind Plus)

## 2.1 PERFORMANCE MONITORING

### 2.1.1 Performance Checks

IEC 61108-1, Clause 5.3 Standard test signals:

"A "performance check" is defined as a shortened version of the static accuracy test described in 5.6.4.1, i.e. a minimum of 100 position measurements shall be taken over a period of not <5 min and not >10 min, discarding any measurements with HDOP ≥4. The position of the antenna of the EUT shall not be in error compared with the known position by >100 m 95 % using WGS 84 as the reference datum."

Clause 4.3.3.1 Static Accuracy:

"(M.112/A3.4*) The GPS receiver equipment* shall have *static accuracy such that the horizontal position of the antenna is determined to within 100 m (95 %) with horizontal dilution of precision (HDOP) ≤4 (or PDOP ≤ 6)*. Since Selective Availability has been set to zero, the static accuracy has been determined to be within 13 m (95 %) as specified by the GPS SPS Performance Standards of October 2001."

Performance Check Procedure:

For every Performance Check, the following actions were completed:

| Action | Reported |
|---|---|
| EUT provided with GPS signals | Signal Type (Live or Simulated) |
| EUT powered 'ON' | EUT started simultaneously (Y or N)<br>Note: for Live GPS Signals this is N/A |
| EUT allowed to acquire valid position | Time to acquire valid position |
| >100 position measurements recorded (NMEA output) | Measurement duration |
| Measurement duration noted | Total number of measurements |
| Measurements with HDOP≥4 discarded | Number of measurements with HDOP ≥ 4 (and PDOP ≥ 6) |
| Haversine position error calculated for each measurement | N/A |
| Proportion within tolerance calculated | Measurements with position error ≤ (13) m |

[1] The term 'valid position' (also referenced as 'position lock' or 'lock' within this report) is defined as when the NMEA data GGA sentence reports "Position Quality" as any value between 1 and 8. EN 61162:2008 states that "*All GPS quality indicators in headings 1 through 8 are considered "valid". The heading "0" is the only "invalid" indicator.*"

[2] Earth's radius taken as 6367 km

## 2.2 STATIC ACCURACY (GPS)

### 2.2.1 Specification Reference

IEC 61108-1, Clause 5.6.4.1.1

### 2.2.2 Equipment Under Test

uBlox NEO - 6M (G5 Smartfind Plus), S/N: 75911555-TSR0004

### 2.2.3 Date of Test and Modification State

10 to 11 February 2011 – Modification State 1

### 2.2.4 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

### 2.2.5 Test Setup

Test Set-up

### 2.2.6 Environmental Conditions

| | 10 February 2011 | 11 February 2011 |
|---|---|---|
| Ambient Temperature: | 8.1°C | 7.9°C |
| Relative Humidity: | 84% | 92% |

### 2.2.7 Test Results

Static Test Site, Clause 5.5.2

"The antenna shall be mounted according to the manufacturer's instructions at a height of between 1 m and 1,5 m above the electrical ground in an area providing clear line of sight to the satellites from zenith through to an angle of +5° above horizontal. The position of the antenna shall be known, with reference to WGS 84 to an accuracy of better than 0,1 m in (x, y, z). Maximum cable lengths as specified by the manufacturer shall be used during testing.

All static tests shall utilize actual GPS signals."

Test Method, Clause 5.6.4.1.1

"Position fix measurements shall be taken over a period of not <24 h. The absolute horizontal position accuracy shall be within 13 m (95 %), having discarded measurements taken in conditions of HDOP ≥ 4 and PDOP ≥6."

Procedure/Results:

EUT was placed on the static test site on a non-conductive platform. It was operated and monitored continuously for the period of measurement as below. Results were as follows:

| Test Parameter | Units | Result | Limit |
|---|---|---|---|
| Signal Type | Live/Simulated | Live | - |
| EUT started simultaneously | Y/N | N/A | - |
| Time to acquire valid position | s | 29 | - |
| Total number of measurements | - | 89477 | - |
| Number of measurements with HDOP ≥ 4 and PDOP ≥6 | - | 89477 | > 100 |
| Measurement duration | h | 24.85 | > 24 |
| Measurements with position error ≤ 13 m | % | 100 | ≥ 95 |

Limits Clause 4.3.3.1

"(M.112/A3.4) *The GPS receiver equipment* shall *have static accuracy such that the horizontal position of the antenna is determined to within 100 m (95 %) with horizontal dilution of precision (HDOP) ≤4 (or PDOP ≤ 6).* Since Selective Availability has been set to zero, the static accuracy has been determined to be within 13 m (95 %) as specified by the GPS SPS Performance Standards of October 2001."

## 2.3 ANGULAR MOVEMENT OF THE ANTENNA

### 2.3.1 Specification Reference

IEC 61108-1, Clause 5.6.4.2

### 2.3.2 Equipment Under Test

uBlox NEO - 6M (G5 Smartfind Plus), S/N: 75911555-TSR0004

### 2.3.3 Date of Test and Modification State

09 and 10 February 2011 - Modification State 1

### 2.3.4 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

### 2.3.5 Test Setup

Test Set-up (Two images showing EUT in positive and negative stages of oscillation)

### 2.3.6 Environmental Conditions

| | 09 February 2011 | 10 February 2011 |
|---|---|---|
| Ambient Temperature: | 7.1°C | 8.1°C |
| Relative Humidity: | 73% | 84% |

### 2.3.7 Test Results

Test Method Clause 5.6.4.2:

"The static tests specified in 5.6.4.1.1 and 5.6.4.1.2 shall be repeated with the antenna performing an angular displacement of ±22,5° (simulating roll) in a period of about 8 s (see IEC 60721-3-6) during the duration of the tests.

The results shall be as in 5.6.4.1.1 and 5.6.4.1.2."

Procedure/Results:

EUT was placed on the static test site on a non-conductive platform oscillating ±22.5° from the vertical with a period of approximately 8 seconds. It was operated and monitored continuously for the period of measurement as below. Results were as follows:

| Test Parameter | Units | Result | Limit |
|---|---|---|---|
| Signal Type | Live/Simulated | Live | - |
| EUT started simultaneously | Y/N | N/A | - |
| Time to acquire valid position | s | 43 | - |
| Total number of measurements | - | 90975 | - |
| Number of measurements with HDOP ≥ 4 and PDOP ≥6 | - | 90975 | > 100 |
| Measurement duration | h | 26.25 | > 24 |
| Measurements with position error ≤ 13 m | % | 100 | ≥ 95 |

Limits Clause 4.3.3.1

"(M.112/A3.4) *The GPS receiver equipment* shall *have static accuracy such that the horizontal position of the antenna is determined to within 100 m (95 %) with horizontal dilution of precision (HDOP) ≤4 (or PDOP ≤ 6).* Since Selective Availability has been set to zero, the static accuracy has been determined to be within 13 m (95 %) as specified by the GPS SPS Performance Standards of October 2001."

## 2.4 DYNAMIC ACCURACY (GPS)

### 2.4.1 Specification Reference

IEC 61108-1, Clause 5.6.4.3.1

### 2.4.2 Equipment Under Test

uBlox NEO - 6M (G5 Smartfind Plus), S/N: 75911555-TSR0004

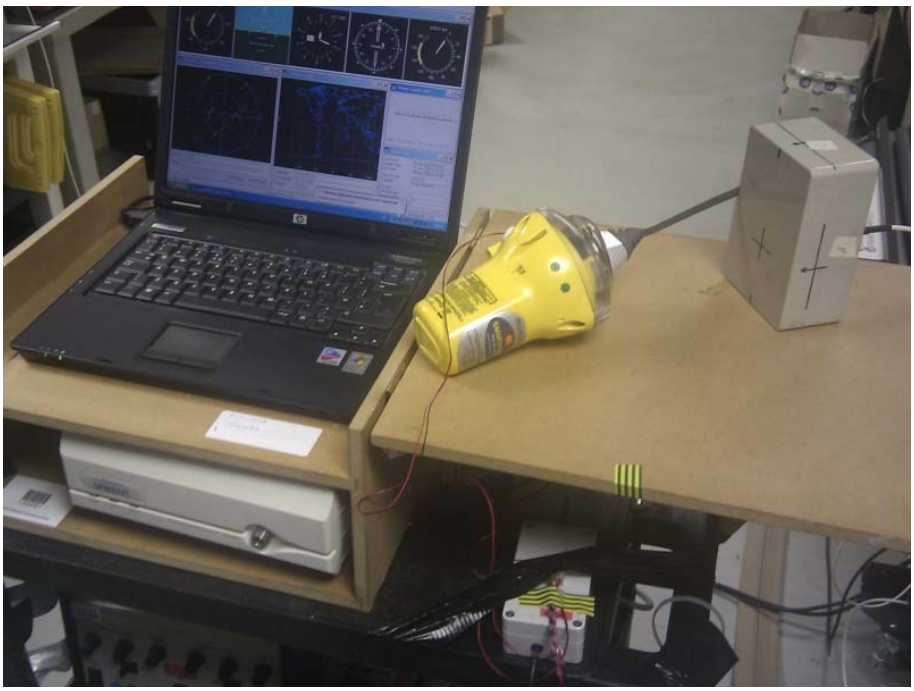
### 2.4.3 Date of Test and Modification State

28 February 2011 – Modification State 1

### 2.4.4 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

### 2.4.5 Test Setup



Test Set-up

### 2.4.6 Environmental Conditions

| | |
|---|---|
| Ambient Temperature: | 22.2°C |
| Relative Humidity: | 30% |

### 2.4.7 Test Results

Test Method Clause 5.6.4.3.1:

"The tests for dynamic accuracy are a practical interpretation of the conditions set out in IEC 60721-3-6, Table V, item e), X – direction (surge) and Y – direction (sway). These are stated as surge 5 $m/s^2$ and sway 6 $m/s^2$ for all classes of environment. When using a simulator, the simulator characteristics shall accurately represent the signals required.

The results of the test performed by simulation facilities shall be identical with those in a) and b) below. *[…]*

a) a fully locked and settled EUT travelling in a straight line at 48 knots ± 2 knots for a minimum of 1,2 min which is reduced to 0 knots in the same straight line in 5 s […]

b) a fully locked and settled EUT travelling at least 100 m at 24 knots ± 1 knot in a straight line then subjected, for at least 2 min, to smooth deviations either side of the straight line of approximately 2 m at a period of 11 s to 12 s[…]"

Procedure/Results - Dynamic Accuracy A:

EUT and GPS simulator were started simultaneously and the EUT acquired a position lock after the acquisition time stated in the table below; the simulator ran a dynamic position travelling at 48 knots in a straight line for 10 minutes before decelerating to 0 knots in 5 seconds (in the same straight line). The position output 10 seconds after coming to rest was determined from the NMEA 0183 output. A Performance Check was then performed for information.

| Test Parameter | Units | Result | Limit |
|---|---|---|---|
| Initial Acquisition Time | s | 18 | - |
| Position Error 10 s after coming to rest | m | 3.96 | < 13 |
| Performance Check | | | |
| Signal Type | Live/Simulated | Simulated | - |
| EUT started simultaneously | Y/N | Y | - |
| Time to acquire valid position | s | N/A | - |
| Total number of measurements | - | 302 | - |
| Number of measurements with HDOP ≥ 4 and PDOP ≥6 | - | 302 | > 100 |
| Measurement duration | min | 5.02 | > 5 and < 10 |
| Measurements with position error ≤ 13 m | % | 100 | ≥ 95 |

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Procedure/Results - Dynamic Accuracy B:

EUT and GPS simulator were started simultaneously and the EUT acquired a position lock after the acquisition time stated in the table below; the simulator ran a dynamic position travelling at 24 knots in a straight line for 10 minutes before starting to oscillate smoothly ±2 m either side of the original path for a further 20 minutes.

EUT position output error compared to the simulated dynamic position was determined from the EUT NMEA output.

A Performance Check was conducted during the 20-minute oscillation period in order to determine that the position error was not outside of the ±30 m 'lane' of tolerance.

| Test Parameter | Units | Result | Limit |
|---|---|---|---|
| Initial Acquisition Time | s | 19 | - |
| Performance Check | | | |
| Signal Type | Live/Simulated | Simulated | - |
| EUT started simultaneously | Y/N | Y | - |
| Time to acquire valid position | s | N/A | - |
| Total number of measurements | - | 317 | - |
| Number of measurements with HDOP ≥ 4 and PDOP ≥6 | - | 317 | > 100 |
| Measurement duration | min | 5.27 | > 5 and < 10 |
| Measurements with position error ≤ **30 m** | % | 100 | ≥ 95 |

Limits Clause 5.6.4.3.1 (Test Method Clause)

"a) […] shall not indicate a positional offset >±13 m from the final position 10 s after coming to rest;

b) […] shall remain in lock and follow the actual position to within a lane of 30 m wide centred on the mean direction of motion."

## 2.5 ACQUISITION - CONDITION A - INITIALIZATION

### 2.5.1 Specification Reference

IEC 61108-1, Clause 5.6.5.1

### 2.5.2 Equipment Under Test

uBlox NEO - 6M (G5 Smartfind Plus), S/N: 75911555-TSR0004

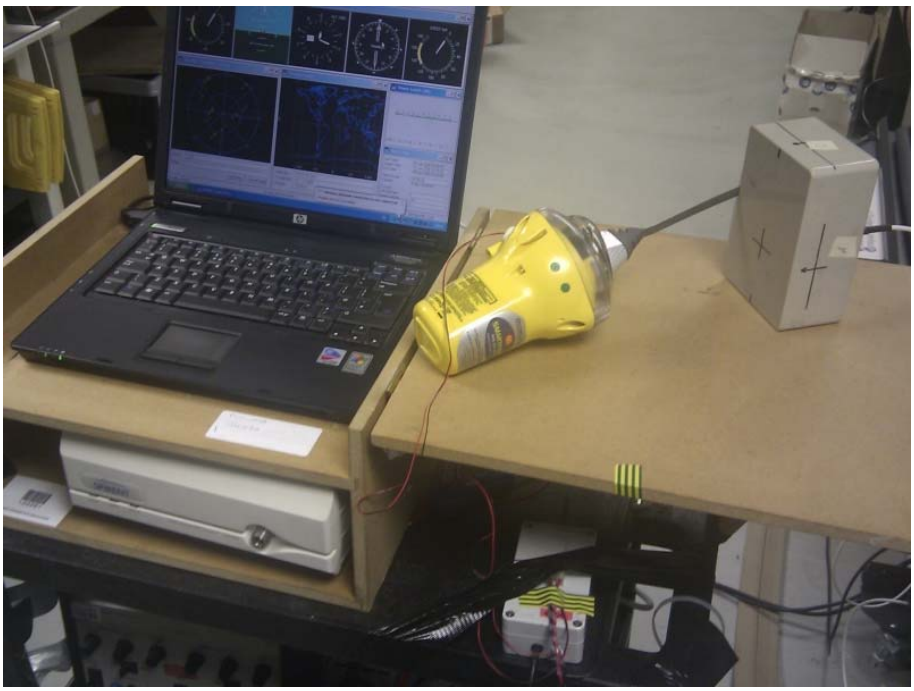
### 2.5.3 Date of Test and Modification State

28 February 2011 - Modification State 1

### 2.5.4 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

### 2.5.5 Test Setup



Test Set-up

### 2.5.6 Environmental Conditions

| | |
|---|---|
| Ambient Temperature: | 22.2°C |
| Relative Humidity: | 30% |

### 2.5.7 Test Results

Test Method Clause 5.6.5.1

"The EUT shall be either:

a) initialized to a false position at least 1 000 km and not greater than 10 000 km from the test position, or alternatively, by deletion of the current almanac; or

b) isolated from a power source for >7 days.

A performance check shall be carried out after the time limit contained in Table 1."

Procedure/Results:

EUT was previously isolated from its power supply for >7 days (approx 14 days).

The GPS simulator scenario was started followed by the EUT, the time to position lock was measured. A Performance Check was started once position lock was obtained.

| Test Parameter | Units | Result | Limit |
|---|---|---|---|
| Power isolation period | days | 14 | > 7 |
| Performance Check | | | |
| Signal Type | Live/Simulated | Simulated | - |
| EUT started simultaneously | Y/N | N | - |
| Time to acquire valid position | min | 0.417 | 30 |
| Total number of measurements | - | 508 | - |
| Number of measurements with HDOP ≥ 4 and PDOP ≥6 | - | 508 | > 100 |
| Measurement duration | min | 8.87 | > 5 and < 10 |
| Measurements with position error ≤ 13 m | % | 100 | ≥ 95 |

Limits Clause 4.3.4

"(M.112/A3.8) *The GPS receiver equipment* shall *be capable of acquiring position to the required accuracy, within 30 min, when there is no valid almanac data.*"

## 2.6 ACQUISITION - CONDITION B - POWER OUTAGE

### 2.6.1 Specification Reference

IEC 61108-1, Clause 5.6.5.2

### 2.6.2 Equipment Under Test

uBlox NEO - 6M (G5 Smartfind Plus), S/N: 75911555-TSR0004

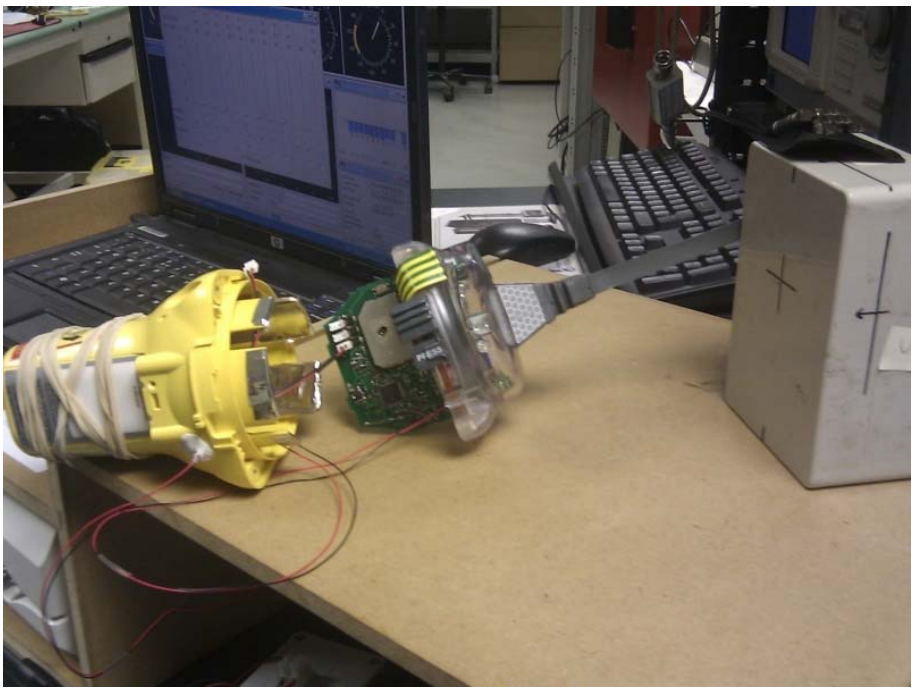
### 2.6.3 Date of Test and Modification State

28 February to 01 March 2011 - Modification State 1

### 2.6.4 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

### 2.6.5 Test Setup



Test Set-up

Note: EUT is configured to operate with 3 battery packs in parallel, throughout the test only one battery pack was connected, this was sufficient to operate the EUT and also ensured that Power On/Off times were accurate as only one battery need be connected/disconnected.

### 2.6.6 Environmental Conditions

| | 28 February 2011 | 01 March 2011 |
|---|---|---|
| Ambient Temperature: | 22.2°C | 22.9°C |
| Relative Humidity: | 30% | 20%RH |

### 2.6.7 Test Results

Test Method Clause 5.6.5.2

"The EUT shall be isolated from the power source for a period within 24 h to 25 h. At the end of the period, a performance check shall be carried out after the time limit contained in Table 1."

Procedure/Results:

EUT was locked and stable and the power was removed for the "power isolation period", as below, then re-applied. A Performance Check was then completed:

| Test Parameter | Units | Result | Limit |
|---|---|---|---|
| Power isolation period | h | 24.25 | > 24 and < 25 |
| Performance Check | | | |
| Signal Type | Live/Simulated | Simulated | - |
| EUT started simultaneously | Y/N | N | - |
| Time to acquire valid position | min | 0.317 | 5 |
| Total number of measurements | - | 508 | - |
| Number of measurements with HDOP ≥ 4 and PDOP ≥6 | - | 508 | > 100 |
| Measurement duration | Min | 5.02 | > 5 and < 10 |
| Measurements with position error ≤ 13 m | % | 100 | ≥ 95 |

Limits Clause 4.3.4

"(M.112/A3.9) *The GPS receiver equipment* shall *be capable of acquiring position to the required accuracy, within 5 min, when there is valid almanac data.*"

## 2.7 ACQUISITION - CONDITION C - INTERRUPTION OF GPS SIGNALS

### 2.7.1 Specification Reference

IEC 61108-1, Clause 5.6.5.3

### 2.7.2 Equipment Under Test

uBlox NEO - 6M (G5 Smartfind Plus), S/N: 75911555-TSR0004

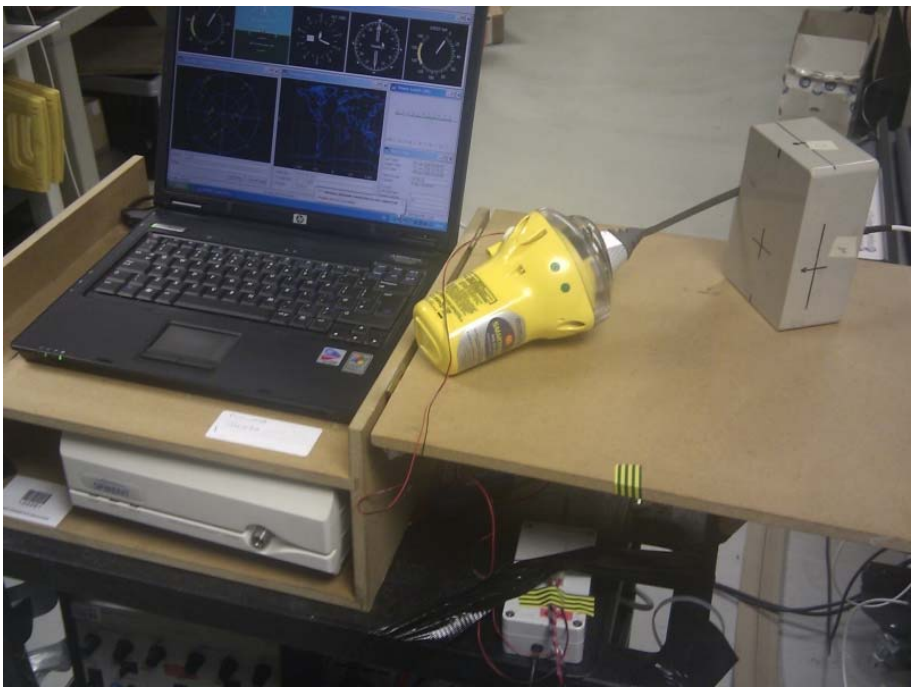
### 2.7.3 Date of Test and Modification State

01 to 02 March 2011 - Modification State 1

### 2.7.4 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

### 2.7.5 Test Setup



Test Set-up

### 2.7.6 Environmental Conditions

| | 01 March 2011 | 02 March 2011 |
|---|---|---|
| Ambient Temperature: | 22.9°C | 20.8°C |
| Relative Humidity: | 20% | 26% |

### 2.7.7 Test Results

Test Method Clause 5.6.5.3

"During normal operation of the EUT, the antenna shall be completely masked for a period between 24 h and 25 h.

At the end of the period, a performance check shall be carried out after the time limit contained in Table 1."

Procedure/Results:

The EUT was locked and settled in 'normal operation', the GPS Signals were then removed (but the scenario kept running) for the "GPS signal isolation period" as below. The GPS signals were re-applied and a Performance Check was then completed.

| Test Parameter | Units | Result | Limit |
|---|---|---|---|
| GPS signal isolation period | h | 24.25 | > 24 and < 25 |
| Performance Check | | | |
| Signal Type | Live/Simulated | Simulated | - |
| EUT started simultaneously | Y/N | N | - |
| Time to acquire valid position | min | 0.583 | 5 |
| Total number of measurements | - | 339 | - |
| Number of measurements with HDOP ≥ 4 and PDOP ≥6 | - | 339 | > 100 |
| Measurement duration | min | 5.63 | > 5 and < 10 |
| Measurements with position error ≤ 13 m | % | 100 | ≥ 95 |

Limits Clause 4.3.4

"(M.112/A3.10) *The GPS receiver equipment* shall *be capable of re-acquiring position to the required accuracy, within 5 min, when the GPS signals are interrupted for a period of at least 24 h, but there is no loss of power.*"

## 2.8 ACQUISITION - CONDITION D - BRIEF INTERRUPTION OF POWER

### 2.8.1 Specification Reference

IEC 61108-1, Clause 5.6.5.4

### 2.8.2 Equipment Under Test

**Error! Reference source not found.**, S/N: 75911555-TSR0004

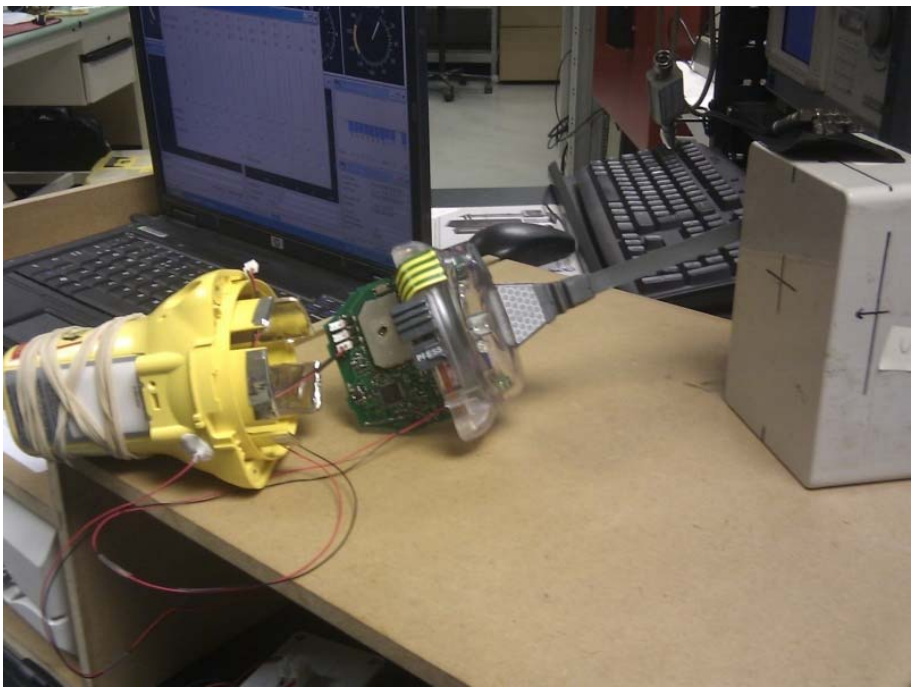
### 2.8.3 Date of Test and Modification State

28 February 2011 - Modification State 1

### 2.8.4 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

### 2.8.5 Test Setup



Test Set-up

Note: EUT is configured to operate with 3 battery packs in parallel, throughout the test only one battery pack was connected, this was sufficient to operate the EUT and also ensured that Power On/Off times were accurate as only one battery need be connected/disconnected.

### 2.8.6 Environmental Conditions

| | |
|---|---|
| Ambient Temperature: | 21.3 °C |
| Relative Humidity: | 32% |

### 2.8.7 Test Results

Test Method Clause 5.6.5.4

"During normal operation of the EUT, the power shall be removed for a period of 60 s. At the end of this period, the power shall be restored.

A performance check shall be carried out after the time limit contained in Table 1."

Procedure/Results:

The EUT was locked and settled in 'normal operation'; power was then removed for the "power isolation period", as below, then re-applied. A Performance Check was then completed.

| Test Parameter | Units | Result | Limit |
|---|---|---|---|
| Power isolation period | s | 60 | 60 |
| Performance Check | | | |
| Signal Type | Live/Simulated | Simulated | - |
| EUT started simultaneously | Y/N | N/A | - |
| Time to acquire valid position | min | 0.367 | 2 |
| Total number of measurements | - | 388 | - |
| Number of measurements with HDOP ≥ 4 and PDOP ≥6 | - | 388 | > 100 |
| Measurement duration | min | 6.45 | > 5 and < 10 |
| Measurements with position error ≤ 13 m | % | 100 | ≥ 95 |

Limits Clause 4.3.4

"(M.112/A3.11) *The GPS receiver equipment* shall *be capable of re-acquiring position to the required accuracy, within 2 min, when subjected to a power interruption of 60 s."*

## 2.9 PROTECTION – ANTENNA AND INPUT/OUTPUT CONNECTIONS

### 2.9.1 Specification Reference

IEC 61108-1, Clause 5.6.6.1

### 2.9.2 Equipment Under Test

uBlox NEO - 6M (G5 Smartfind Plus), S/N: 75911555-TSR0004

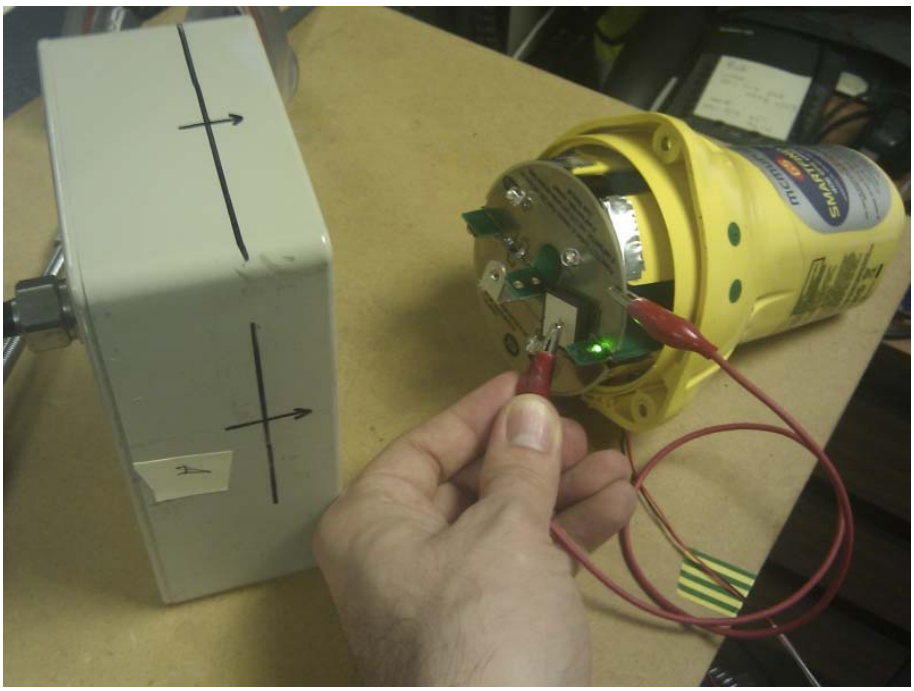
### 2.9.3 Date of Test and Modification State

09 March 2011 - Modification State 1

### 2.9.4 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

### 2.9.5 Test Setup



Test Set-up

### 2.9.6 Environmental Conditions

| | |
|---|---|
| Ambient Temperature: | 22.8 °C |
| Relative Humidity: | 27 %RH |

### 2.9.7 Test Results

Test Method Clause 5.6.6.1

"The antenna input of the receiver, if provided, shall be connected to ground for 5 min. After completion of the test and reset of the EUT, if required, the antenna or input/output connections shall be connected normally, and a performance check shall be carried out to ensure that no permanent damage has resulted."

Procedure/Results:

As per customer instructions, EUT case was opened and main transmitting antenna disconnected in order to gain access to the GPS patch antenna (see setup photo).

The EUT was allowed to lock and settle on a GPS position. An electrical connection was made between the centre pin and the PCB ground plane for 5 min. After removal of the electrical connection, the EUT was allowed to re-acquire a position. A Performance Check was then carried out.

Note: Although the EUT lost its position lock at the beginning of the grounded period, it re-acquired a position before the 5-minute period was complete. Removal of the electrical connection at the end of the grounded period did not result in another loss of position only an increase in reported signal to noise ratio. Hence, the performance check was started as soon as the electrical connection was removed.

| Test Parameter | Units | Result | Limit |
|---|---|---|---|
| Time antenna was grounded | min | 5 | 5 |
| Performance Check | | | |
| Signal Type | Live/Simulated | Simulated | - |
| EUT started simultaneously | Y/N | N/A | - |
| Time to acquire valid position | Min | N/A | - |
| Total number of measurements | - | 311 | - |
| Number of measurements with HDOP ≥ 4 and PDOP ≥6 | - | 311 | > 100 |
| Measurement duration | min | 5.17 | > 5 and < 10 |
| Measurements with position error ≤ 13 m | % | 100 | ≥ 95 |

Limits Clause 4.3.5.1

"(M.112/A4) *Precautions* shall *be taken to ensure that no permanent damage can result from an accidental short circuit or grounding of the antenna or any of its input or output connections or any of the GPS receiver equipment inputs or outputs for a duration of 5 min.*"

## 2.10 SENSITIVITY AND DYNAMIC RANGE – ACQUISITION

### 2.10.1 Specification Reference

IEC 61108-1, Clause 5.6.8.1

### 2.10.2 Equipment Under Test

uBlox NEO - 6M (G5 Smartfind Plus), S/N: 75911555-TSR0004

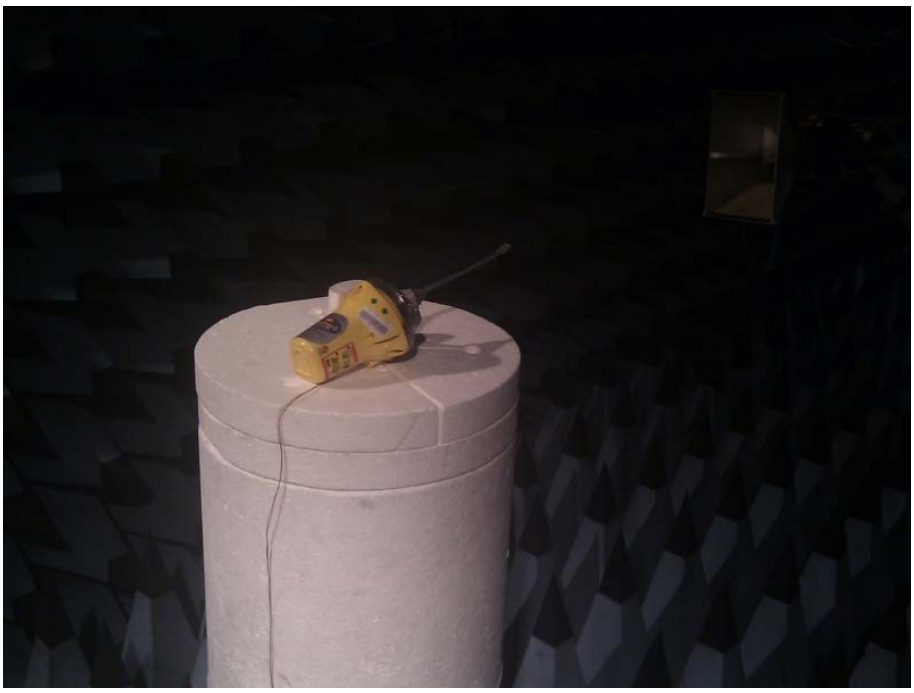
### 2.10.3 Date of Test and Modification State

29 November 2010 – Modification State 0

### 2.10.4 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

### 2.10.5 Test Setup



EUT with internal GPS patch antenna facing GPS transmitting antenna (right)

Note: GPS Signal Transmitting Antenna is a linearly polarised Double Ridged wave-Guide (DRG). EUT antenna is a patch antenna (neither helical-form nor circularly polarised). Hence, the linear transmitting antenna was deemed 'suitable' as per the test clause. No 3 dB correction factor was applied.

Product Service

Field Calibration

Field strength was ascertained by the following process.

1) “System Loss” taken from calibrated chamber ‘Transducer Factor’. This is the loss from the (normally) transmitting EUT, over the 1 m air gap to the receiving antenna (including antenna gain) and trough the connecting cables bulkhead and interlock system. This is normally used to adjust the received power outside the chamber into an EIRP. In this case, however, the transmission path is in reverse but this makes no difference to the loss. The system is calibrated at 1.5 GHz and 1.6 GHz and the value for 1.57542 GHz was interpolated as follows:

| Frequency (x) | System Loss (y) | Comments |
|---|---|---|
| 1.5 GHz | 30.190 | Calibrated (a) |
| 1.57542 GHz | 30.73 | Interpolated as below |
| 1.6 GHz | 30.912 | Calibrated (b) |

The Interpolant, y (System Loss at 1.575GHz) is given by the equation:

$$y = y_a + (x - x_a)\frac{(y_b - y_a)}{(x_b - x_a)}$$

$$y = 30.190 + \left((1.57542 - 1.5) \times \frac{30.912 - 30.190}{1.6 - 1.5}\right)$$

$$y = 30.73$$

Where x, y, a and b are indicated in parenthesis in the above table.

2) Additional Attenuation was calibrated using a Power Meter zeroed (i.e. Relative Measurement) on the output of a Signal Generator at 1.57542 GHz. This Additional Attenuation was required to drop the GPS Simulator output from the measurable range into the required range. This was measured as 34.60 dB.

3) GPS Simulator output (1 satellite) measured on a spectrum analyser using the following settings:

| Parameter | Setting | Comments |
|---|---|---|
| Centre Frequency | 1.57542 GHz | GPS L1 Band |
| Span | 10 MHz | |
| Reference Level | -50 dBm | |
| Reference Attenuation | 10dB | Automatic |
| Resolution Bandwidth | 1 MHz | |
| Video Bandwidth | 1 MHz | Automatic |
| Sweep Time | 5 ms | Automatic |
| Trace Type | Peak (200) | Peak of 200 samples |
| Sweep Count | 200 | |
| Marker Frequency | 1.57542 GHz | GPS L1 Band |

Note: Investigation prior to this test programme indicated that using a Peak Trace Type gives a power level approximately 13dB higher than average and so the field strength would be effectively this much lower.

GPS Simulator software was adjusted to achieve a power output of -59.67 dBm.

4) Final Calculation:

| Component | Value & Units |
|---|---|
| GPS Simulator output, $P_{GPS}$ | -59.67 dBm |
| Additional Attenuation, $L_A$ | 34.60 dB |
| System Loss, $L_S$ | 30.73 dB |
| Signal Power, $P_S = P_{GPS} – L_A – L_S$ | -125.00 dBm |

### 2.10.6 Environmental Conditions

Ambient Temperature: 21.3 °C
Relative Humidity: 21 %

### 2.10.7 Test Results

Test Method Clause 5.6.8.1:

"a) Transmit the simulator signal over a suitable antenna.
b) Adjust the signal power by use of a calibrated test receiver to -125 dBm ± 5 dBm.
c) Replace the antenna of the calibrated test receiver by the receiving unit of the EUT.
d) A performance check shall be carried out."

Procedure/Results:

EUT was placed in the test chamber on a non-conductive platform. GPS simulator was started and the field strength calibrated as per the above procedure.

The EUT was powered up and the acquisition time noted in the following table; a Performance Check was then performed.

| Test Parameter | Units | Result | Limit |
|---|---|---|---|
| Field Strength | dBm | -125.00 | -125 dBm ± 5 dBm |
| Initial Acquisition Time | s | 35 | - |
| Performance Check | | | |
| Signal Type | Live/Simulated | Simulated | - |
| EUT started simultaneously | Y/N | N/A | - |
| Time to acquire valid position | s | N/A | - |
| Total number of measurements | - | 358 | - |
| Number of measurements with HDOP ≥ 4 and PDOP ≥6 | - | 358 | > 100 |
| Measurement duration | min | 5.95 | > 5 and < 10 |
| Measurements with position error ≤ 13 m | % | 100 | ≥ 95 |

Limits Clause 4.3.7

"(M.112/A3.7) *The GPS receiver equipment* shall *be capable of acquiring satellite signals with input signals having carrier levels in the range of -130 dBm to -120 dBm* as measured at the output of a 3 dBi linear polarized receiving antenna. *Once the satellite signals have been acquired the equipment shall continue to operate satisfactorily with satellite signals having carrier levels down to -133 dBm* as measured at the output of a 3 dBi linear polarized receiving antenna."

Limits Clause 5.6.8.1

"The EUT shall meet the requirements of this check, within this signal range."

## 2.11 SENSITIVITY AND DYNAMIC RANGE – TRACKING

### 2.11.1 Specification Reference

IEC 61108-1, Clause 5.6.8.2

### 2.11.2 Equipment Under Test

uBlox NEO - 6M (G5 Smartfind Plus), S/N: 75911555-TSR0004

### 2.11.3 Date of Test and Modification State

29 November 2010 – Modification State 1

### 2.11.4 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

### 2.11.5 Test Setup

As per Section 2.10.5, Sensitivity and Dynamic Range – Acquisition

### 2.11.6 Environmental Conditions

Ambient Temperature: 21.3°C
Relative Humidity: 21 %

### 2.11.7 Test Results

Test Method Clause 5.6.8.2

"[As per Clause 5.6.8.1 except:]

d) After the start of transmission and tracking with the nominal transmission level condition, gradually reduce transmission level down to −133 dBm."

Procedure/Results:

EUT remained operational after the Sensitivity and Dynamic Range – Acquisition test in "Normal Operation"; locked and settled having just passed a Performance Check. GPS Signal power was then reduced gradually in 0.5dB steps over 1.5 minutes to -133 dBm.

The EUT continued to track enough satellites to maintain a position fix. The NMEA 0183 'GSV' sentence, the 'GGA' sentence gave the number of satellites used from the position solution as 10 or 11 out of a possible 11 throughout a 3-minute period of observation.

Limits Clause 4.3.7

"(M.112/A3.7) *The GPS receiver equipment* shall *be capable of acquiring satellite signals with input signals having carrier levels in the range of -130 dBm to -120 dBm* as measured at the output of a 3 dBi linear polarized receiving antenna. *Once the satellite signals have been acquired the equipment shall continue to operate satisfactorily with satellite signals having carrier levels down to -133 dBm* as measured at the output of a 3 dBi linear polarized receiving antenna."

Limits Clause 5.6.8.1

"The EUT shall continue tracking at least one satellite."

## 2.12 SLOW SPEED UPDATE RATE

### 2.12.1 Specification Reference

IEC 61108-1, Clause 5.6.10.1

### 2.12.2 Equipment Under Test

uBlox NEO - 6M (G5 Smartfind Plus), S/N: 75911555-TSR0004

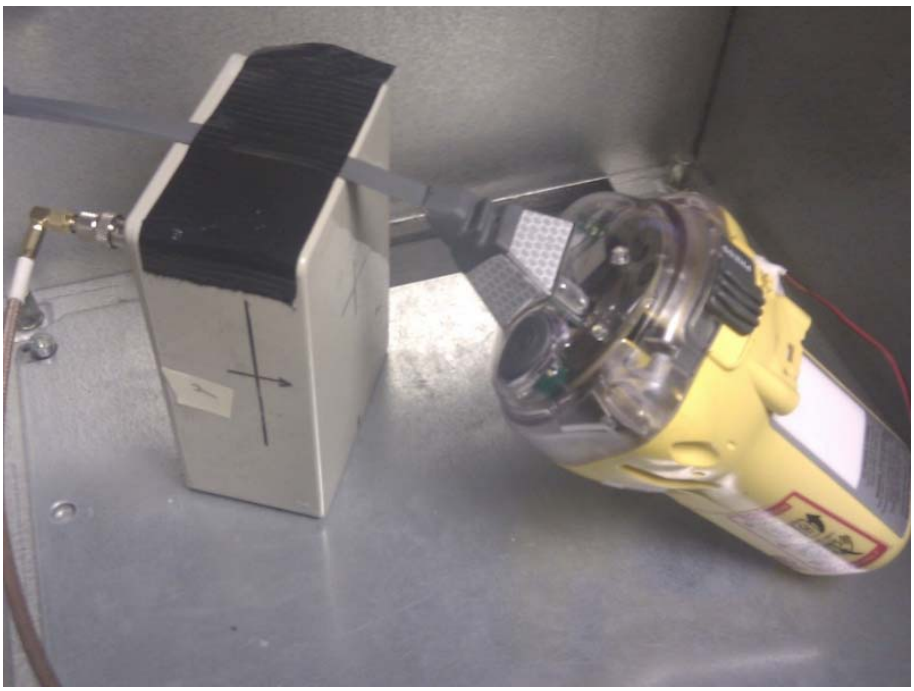
### 2.12.3 Date of Test and Modification State

08 March 2011 – Modification State 1

### 2.12.4 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

### 2.12.5 Test Setup



Test Set-up

### 2.12.6 Environmental Conditions

| | |
|---|---|
| Ambient Temperature: | 22.0 °C |
| Relative Humidity: | 27 %RH |

### 2.12.7 Test Results

EUT was locked and settled on a static simulated position; the simulated scenario then began a period of motion at 5 knots ±1 knot. During a 10-minute period of observation, the time between position output messages and time between position updates was checked. Maximum values are recorded in the table below.

To confirm the minimum resolution of position, the GGA sentence of the NMEA 0183 output was inspected for the Latitude and Longitude field values (see table below), in the format *DDMM.X* and *DDDMM.X* respectively. Where *D* is degrees, *M* is minutes and *X* is decimal places of minutes.

A Performance Check was carried out during the 10-minute observation period to confirm that the received positions complied with the simulated position.

| Test Parameter | Units | Result | Limit |
|---|---|---|---|
| Maximum position output interval | s | 1 | ≤ 1 |
| Maximum position update interval | s | 1 | ≤ 10 |
| Sample latitude field value | Min | 5051.01672 | Resolution must be to 0.001 |
| Sample longitude field value | Min | 00107.40478 | Resolution must be to 0.001 |
| Performance Check | | | |
| Signal type | Live/Simulated | Simulated | - |
| EUT started simultaneously | Y/N | Y | - |
| Time to acquire valid position | s | N/A | - |
| Total number of measurements | - | 599 | - |
| Number of measurements with HDOP ≥ 4 and PDOP ≥ 6 | - | 599 | > 100 |
| Measurement duration | min | 10.00 | > 5 and < 10 |
| Measurements with position error ≤ 13 m * | % | 100 | ≥ 95 |

* Position error relative to the instantaneous position

## 2.13 HIGH SPEED UPDATE RATE

### 2.13.1 Specification Reference

IEC 61108-1, Clause 5.6.10.2

### 2.13.2 Equipment Under Test

uBlox NEO - 6M (G5 Smartfind Plus), S/N: 75911555-TSR0004

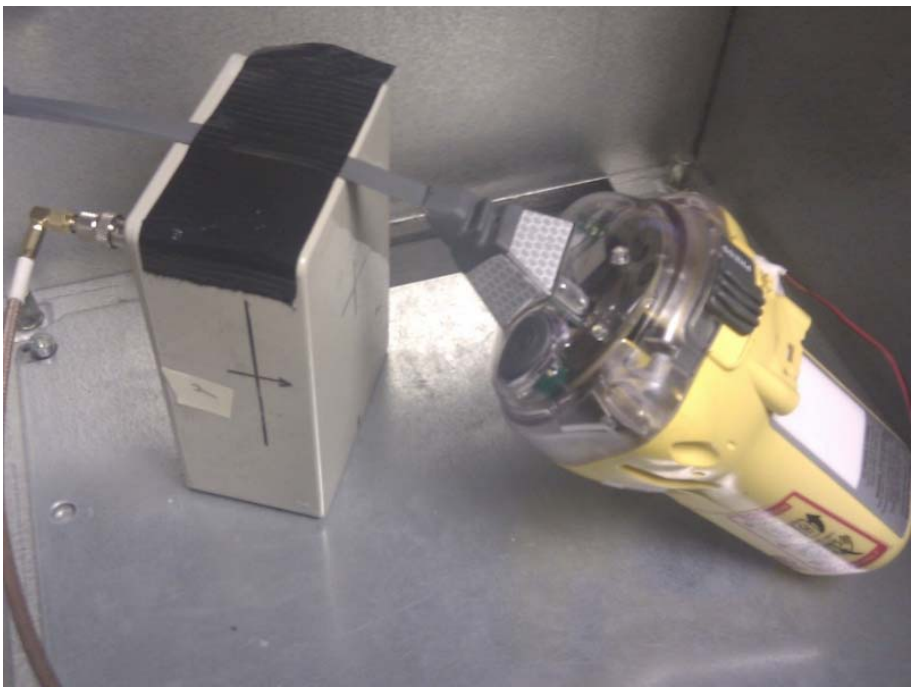
### 2.13.3 Date of Test and Modification State

08 March 2011 – Modification State 1

### 2.13.4 Test Equipment Used

The major items of test equipment used for the above tests are identified in Section 3.1.

### 2.13.5 Test Setup



Test Set-up

### 2.13.6 Environmental Conditions

| | |
|---|---|
| Ambient Temperature: | 22.6 °C |
| Relative Humidity: | 28 %RH |

### 2.13.7 Test Results

Deviation from the Test Method Clause

A simulator was used to perform this test; however, EUT output was at 1-second intervals, not 0.5 s as required (or "recommended" as per Clause 4.3.9).

Results

EUT was locked and settled on a scenario simulating motion at 70 knots. During a 10-minute period of observation, the time between position output messages and time between position updates was checked. Maximum values are recorded in the table below.

To confirm the minimum resolution of position, the GGA sentence of the NMEA 0183 output was inspected for the Latitude and Longitude field values (see table below), in the format *DDMM.X* and *DDDMM.X* respectively. Where *D* is degrees, *M* is minutes and *X* is decimal places of minutes.

A Performance Check was carried out during the 10-minute observation period to confirm that the received positions complied with the simulated position.

| Test Parameter | Units | Result | Limit |
|---|---|---|---|
| Maximum position output interval | s | 1 | ≤ 1 |
| Maximum position update interval | s | 1 | ≤ 1 |
| Sample latitude field value | min | 5052.99614 | Resolution must be to 0.001 |
| Sample longitude field value | min | 00102.79923 | Resolution must be to 0.001 |
| Performance Check | | | |
| Signal type | Live/Simulated | Simulated | - |
| EUT started simultaneously | Y/N | Y | - |
| Time to acquire valid position | s | N/A | - |
| Total number of measurements | - | 601 | - |
| Number of measurements with HDOP ≥ 4 and PDOP ≥ 6 | - | 601 | > 100 |
| Measurement duration | min | 10.00 | > 5 and < 10 |
| Measurements with position error ≤ 13 m * | % | 100 | ≥ 95 |

**SECTION 3**

**TEST EQUIPMENT USED**

## 3.1 TEST EQUIPMENT

List of absolute measuring and other principal items of test equipment.

| Instrument | Manufacturer | Type No. | TE No. | Calibration Period (months) | Calibration Due |
|---|---|---|---|---|---|
| **Section 2.2 Beacons - GPS Static Accuracy** | | | | | |
| Power Supply Unit | Farnell | LT-30-2 | 41 | - | O/P Mon |
| Multimeter | Iso-tech | IDM101 | 2421 | 12 | 26-Oct-2011 |
| Stop Clock | R.S Components | RS328 061 | 2674 | - | TU |
| Inclinometer | FISCO | EN 17 | 3223 | 12 | 24-Dec-2011 |
| Humidity and Temperature Meter | R.S Components | 1361C | 3844 | 12 | 7-Feb-2012 |
| **Section 2.3 Beacons - GPS Angular Movement of the Antenna** | | | | | |
| Power Supply Unit | Farnell | LT-30-2 | 41 | - | O/P Mon |
| Multimeter | Iso-tech | IDM101 | 2421 | 12 | 26-Oct-2011 |
| Stop Clock | R.S Components | RS328 061 | 2674 | - | TU |
| Inclinometer | FISCO | EN 17 | 3223 | 12 | 24-Dec-2011 |
| Humidity and Temperature Meter | R.S Components | 1361C | 3844 | 12 | 7-Feb-2012 |
| **Section 2.4 Beacons - GPS Dynamic Accuracy** | | | | | |
| Power Supply Unit | Farnell | LT-30-2 | 41 | - | O/P Mon |
| Multimeter | Iso-tech | IDM101 | 2421 | 12 | 26-Oct-2011 |
| Stop Clock | R.S Components | RS328 061 | 2674 | - | TU |
| GPS/SBAS Simulator | Spirent | STR4500 | 3056 | - | TU |
| **Sections 2.5, 2.6, 2.7 and 2.8 Beacons - GPS Acquisition (Power Conditions)** | | | | | |
| Power Supply Unit | Farnell | LT-30-2 | 41 | - | O/P Mon |
| Multimeter | Iso-tech | IDM101 | 2421 | 12 | 26-Oct-2011 |
| Stop Clock | R.S Components | RS328 061 | 2674 | - | TU |
| GPS/SBAS Simulator | Spirent | STR4500 | 3056 | - | TU |
| Hygrometer | Rotronic | I-1000 | 3068 | 12 | 10-Jul-2011 |
| Timer | Radio Spares | 427-590 | 3282 | - | TU |
| **Sections 2.10 and 2.11 Beacons - GPS Position Update and 2.9 Beacons - GPS Protection** | | | | | |
| Power Supply Unit | Farnell | LT-30-2 | 41 | - | O/P Mon |
| RF Shielded Enclosure | Rittal | AE1380 | 162 | - | TU |
| Multimeter | Iso-tech | IDM101 | 2421 | 12 | 26-Oct-2011 |
| Stop Clock | R.S Components | RS328 061 | 2674 | - | TU |
| GPS/SBAS Simulator | Spirent | STR4500 | 3056 | - | TU |
| Hygrometer | Rotronic | I-1000 | 3068 | 12 | 10-Jul-2011 |
| Timer | Radio Spares | 427-590 | 3282 | - | TU |
| **Section 2.12 and 2.13 Beacons – Slow and High Speed Update Rate** | | | | | |
| Power Supply Unit | Farnell | LT-30-2 | 41 | - | O/P Mon |
| RF Shielded Enclosure | Rittal | AE1380 | 162 | - | TU |
| Multimeter | Iso-tech | IDM101 | 2421 | 12 | 26-Oct-2011 |
| Stop Clock | R.S Components | RS328 061 | 2674 | - | TU |
| GPS/SBAS Simulator | Spirent | STR4500 | 3056 | - | TU |
| Hygrometer | Rotronic | I-1000 | 3068 | 12 | 10-Jul-2011 |
| Timer | Radio Spares | 427-590 | 3282 | - | TU |

TU – Traceability Unscheduled
O/P MON – Output Monitored with Calibrated Equipment

## SECTION 4

## DISCLAIMERS AND COPYRIGHT

## 4.1 DISCLAIMERS AND COPYRIGHT

This report relates only to the actual item/items tested.

# ANNEX A

## CUSTOMER SUPPLIED INFORMATION: GPS MODULE DATASHEET

GPS

# NEO-6

## u-blox 6 GPS Modules

### Data Sheet

locate, communicate, accelerate



**Abstract**

Technical data sheet describing the cost effective, high-performance u-blox 6 based NEO-6 series of GPS modules, that brings the high performance of the u-blox 6 positioning engine to the miniature NEO form factor.

These receivers combine a high level of integration capability with flexible connectivity options in a small package. This makes them perfectly suited for mass-market end products with strict size and cost requirements.

16.0 x 12.2mm

www.u-blox.com

| Document Information | |
|---|---|
| **Title** | NEO-6 |
| **Subtitle** | u-blox 6 GPS Modules |
| **Document type** | Data Sheet |
| **Document number** | GPS.G6-HW-09005 |
| **Document status** | Objective Specification<br>This document contains target or goal specification for product development. |

**This document applies to the following products:**

| Name | Type number | ROM/FLASH version | PCN reference |
|---|---|---|---|
| NEO-6Q | | 6.01 | |
| NEO-6M | | 6.01 | |

# Contents

# 1 Functional description

## 1.1 Overview

The NEO-6 module series is a family of stand-alone GPS receivers featuring the high performance u-blox 6 positioning engine. These flexible and cost effective receivers offer numerous connectivity options in a miniature 16 x 12.2 x 2.4mm package. Their compact architecture and power and memory options make NEO-6 modules ideal for battery operated mobile devices with very strict cost and space constraints.

The 50-channel u-blox 6 positioning engine boasts a Time-To-First-Fix (TTFF) of under 1 second. The dedicated acquisition engine, with 2 million correlators, is capable of massive parallel time/frequency space searches, enabling it to find satellites instantly. Innovative design and technology suppresses jamming sources and mitigates multipath effects, giving NEO-6 GPS receivers excellent navigation performance even in the most challenging environments.

## 1.2 Product features

| Series | Power | Memory | Function | | | | | Antenna | | Input / Output | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Voltage range [V] | Programmable (Flash) FW update | Power Save mode | Capture & Process | TCXO | Dead Reckoning | Raw data | Precision Timing | Antenna supply | Antenna supervisor | UART | USB | SPI | DDC (I²C compliant) | Reset input | Configuration pin |
| **NEO-6M** | 2.7 - 3.6 | | • | | | | | | | | 1 | 1 | | 1 | | 1 |
| **NEO-6Q** | 2.7 - 3.6 | | • | | • | | | | | | 1 | 1 | | 1 | | 3 |

**Table 1: Features of the NEO-6 Series**

## 1.3 GPS performance

| Parameter | Specification | | |
|---|---|---|---|
| Receiver type | 50 Channels<br>GPS L1 frequency, C/A Code<br>GALILEO Open Service L1 frequency | | |
| Time-To-First-Fix[1] | | NEO-6Q | NEO-6M |
| | Cold Start (Autonomous) | 29 s | 32s |
| | Warm Start (Autonomous) | 29 s | 32s |
| | Hot Start (Autonomous) | <1 s | <1s |
| | Aided Starts[2] | <1 s | <3s |
| Sensitivity[3] | | NEO-6Q | NEO-6M |
| | Tracking & Navigation | -160 dBm | -160 dBm |
| | Reacquisition | -160 dBm | -160 dBm |
| | Cold Start (Autonomous) | -147 dBm | -146 dBm |
| Horizontal position accuracy[4] | Autonomous | < 2.5 m | |
| | SBAS | < 2.0 m | |
| Accuracy of Timepulse signal | RMS<br>99%<br>Time Pulse | 30 ns<br><60 ns<br>Configurable f = 0.25 Hz ... 1 kHz | |
| Max navigation update rate | | up to 5 Hz | |
| Velocity accuracy[5] | | 0.1m/s | |
| Heading accuracy[6] | | 0.5 degrees | |
| Dynamics | | ≤ 4 g | |
| Operational limits[7] | Altitude<br>Velocity | 50000 m<br>500 m/s | |

**Table 2: NEO-6 GPS performance**



[1] All satellites at -130 dBm
[2] Dependent on aiding data connection speed and latency
[3] Demonstrated with a good active antenna
[4] CEP, 50%, 24 hours static, -130dBm, SEP: <3.5m
[5] 50% @ 30 m/s
[6] 50% @ 30 m/s
[7] Assuming Airborne <4g platform

## 1.4 Block diagram

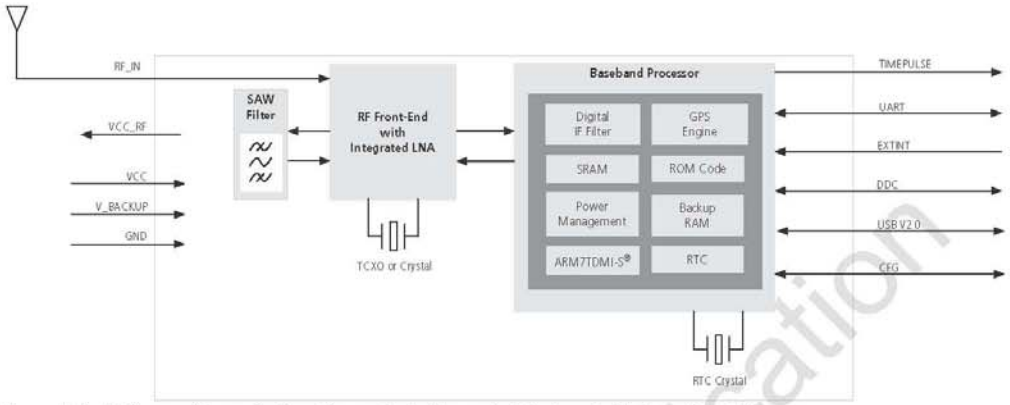



**Figure 1: Block diagram (For available options refer to the product features table in section 1.2).**

## 1.5 Assisted GPS (A-GPS)

Supply of aiding information like ephemeris, almanac, rough last position and time and satellite status and an optional time synchronization signal will reduce time to first fix significantly and improve the acquisition sensitivity. All NEO-6 modules support the u-blox AssistNow Online and AssistNow Offline A-GPS services[8] and are OMA SUPL compliant.

## 1.6 SuperSense Indoor GPS

All NEO-6 modules come with SuperSense, providing ultra-fast acquisition/reacquisition and exceptional tracking sensitivity. SuperSense enables best-in-class tracking and navigation in difficult signal environments such as urban canyons or indoor locations.

## 1.7 KickStart / Oscillators

An available feature is KickStart. This functionality uses a TCXO to accelerate weak signal acquisition, enabling faster start and reacquisition times. KickStart is available with the NEO-6Q.

## 1.8 Protocols and interfaces

| Protocol | Type |
|---|---|
| NMEA | Input/output, ASCII, 0183, 2.3 (compatible to 3.0) |
| UBX | Input/output, binary, u-blox proprietary |

**Table 3: Available protocols**

Both protocols are available on UART, USB, and DDC. For specification of the various protocols see the *u-blox 5 & u-blox 6 Receiver Description Including Protocol Specification* [2].

NEO-6 modules support a number of peripheral interfaces for serial communication. The embedded firmware uses these interfaces according to their respective protocol specifications. For specific applications, the firmware also supports the connection of peripheral devices, such as external memories, to some of the interfaces.

[8] Requires external memory.

### 1.8.1 UART

NEO-6 modules include one configurable UART interface for serial communication (for information about configuration see section 1.11).

### 1.8.2 USB

NEO-6 modules provide a USB version 2.0 FS (Full Speed, 12Mbit/s) interface as an alternative to the UART. The pull-up resistor on USB_DP is integrated to signal a full-speed device to the host. The VDD_USB pin supplies the USB interface, independently from the VDD_IO pin.

### 1.8.3 Display Data Channel (DDC)

The $I^2C$ compatible DDC interface can be used either to access external devices with a serial interface (e.g. EEPROM or A/D converters) or to interface with a host CPU. It is capable of master and slave operation.

☞ The maximum bandwidth is 100kBit/s.

## 1.9 Antenna

NEO-6 modules are designed for use with passive and active[9] antennas.

| Parameter | Specification | |
|---|---|---|
| Antenna Type | | Passive and active antenna |
| Active Antenna Recommendations | Minimum gain | 15 - 20 dB (to compensate signal loss in RF cable) |
| | Maximum noise figure | 1.5 dB |
| | Maximum gain | 50 dB |

**Table 4: Antenna Specifications for all NEO-6 modules**

## 1.10 Power management

For more information about power management strategies, see the *u-blox 5 & u-blox 6 Receiver Description Including Protocol Specification* [2].

### 1.10.1 Operating modes

NEO-6 modules have 2 continuous operating modes (Maximum Performance and Eco) and 1 intermittent operating mode (Power Save). Maximum Performance mode freely uses the acquisition engine, resulting in the best possible TTFF, while Eco mode optimizes the use of the acquisition engine to deliver lower current consumption. At medium to strong signals, there is almost no difference for acquisition and tracking performance in these modes.

### 1.10.2 Maximum Performance mode

In Maximum Performance mode, u-blox 6 receivers use the acquisition engine at full performance to search for all possible satellites until the Almanac is completely downloaded.

As a consequence, tracking current consumption level will be achieved when:

- A valid GPS position is fixed
- Almanac is entirely downloaded
- Ephemeris for all satellites in view are valid

### 1.10.3 Eco mode

In Eco mode, u-blox 6 receivers use the acquisition engine to search for new satellites *only when needed* for navigation:

- In cold starts, u-blox 6 searches for enough satellites to navigate and optimizes use of the acquisition engine to download their ephemeris.
- In non-cold starts, u-blox 6 focuses on searching for visible satellites whose orbits are known from the Almanac.

In Eco mode, the u-blox 6 acquisition engine limits use of its searching resources to minimize power consumption. As a consequence the time to find some satellites at weakest signal level might be slightly increased in comparison to the Max. Performance mode.

[9] For information on using active antennas with NEO-6 modules, see the *LEA-6/NEO-6 Hardware Integration Manual* [1].

u-blox 6 deactivates the acquisition engine as soon as a position is fixed and a sufficient number (at least 4) of satellites are being tracked. The tracking engine continues to search and track new satellites without orbit information.

### 1.10.4 Power Save mode

NEO-6 modules include intelligent power management that allows reducing the average tracking current consumption by periodically switching off parts of or the complete GPS receiver and waking it up at configurable intervals from one second to one week. This can be done by using a hardware interrupt or by sending a serial command.

## 1.11 Configuration

### 1.11.1 Boot-time configuration

NEO-6 modules provide configuration pins for boot-time configuration. These become effective immediately after start-up. Once the module has started, the configuration settings may be modified with UBX configuration messages. The modified settings remain effective until power-down or reset. If these settings have been stored in battery-backup RAM, then the modified configuration will be retained, as long as the backup battery supply is not interrupted.

All NEO-6 modules include a **CFG_COM0** pin, which can be configured as seen in Table 5. Default settings in bold.

| CFG_COM0 | Protocol | Messages | UART Baud rate | USB Power |
|---|---|---|---|---|
| **1** | **NMEA** | **GSV, RMC, GSA, GGA, GLL, VTG, TXT** | **9600** | **BUS Powered** |
| 0 | NMEA | GSV, RMC, GSA, GGA, GLL, VTG, TXT | 38400 | Self Powered |

**Table 5: Supported CFG_COM0 settings**

NEO-6Q includes both **CFG_COM0** and **CFG_COM1** pins and can be configured as seen in Table 6. Default settings in bold.

| CFG_COM1 | CFG_COM0 | Protocol | Messages | UART Baud rate | USB power |
|---|---|---|---|---|---|
| **1** | **1** | **NMEA** | **GSV, RMC, GSA, GGA, GLL, VTG, TXT** | **9600** | **BUS Powered** |
| 1 | 0 | NMEA | GSV, RMC, GSA, GGA, GLL, VTG, TXT | 38400 | Self Powered |
| 0 | 1 | NMEA | GSV, RMC, GSA, GGA, VTG, TXT | 4800 | BUS Powered |
| 0 | 0 | UBX | NAV-SOL, NAV-STATUS, NAV-SVINFO, NAV-CLOCK, INF, MON-EXCEPT | 57600 | BUS Powered |

**Table 6: Supported COM settings (NEO-6Q)**

NEO-6Q includes a **CFG_GPS0** pin, which enables the boot-time configuration of the power mode. These settings are described in Table 7. Default settings in bold.

| CFG_GPS0 | Power Mode |
|---|---|
| 0 | Eco Mode |
| **1** | **Maximum Performance Mode** |

**Table 7: Supported CFG_GPS0 settings (NEO-6Q)**

## 1.12 External serial EEPROM

NEO-6 modules allow an optional external serial EEPROM to be connected to the DDC interface.

☞ For more information see the *LEA-6/NEO-6 Hardware Integration Manual* [1].

# 2 Mechanical specifications

| Parameter | Specification | |
|---|---|---|
| A | 16.0 +0.6/-0.1mm | [628.8 +24/-4mil] |
| B | 12.2 ±0.1mm | [479.5 ±4mil] |
| C | 2.4 ±0.2mm | [94.3 ±8mil] |
| D | 1.0 +0.3/-0.1mm | [39.3 +18/-4mil] |
| E | 1.1 ±0.1mm | [43.2 ±4mil] |
| F | 3.0 ±0.1mm | [117.9 ±4mil] |
| G | 1.1 ±0.1mm | [43.2 ±4mil] |
| Weight | 1.6 g | |

**Table 8: Dimensions**

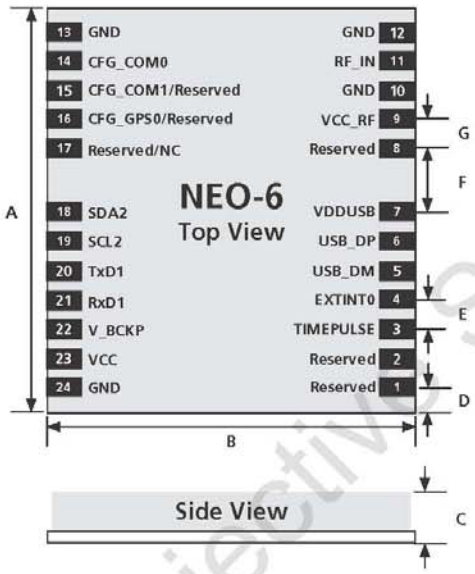



**Figure 2: Dimensions (see Table 9 for specification)**

For information regarding the Paste Mask and Footprint see the *LEA-6/NEO-6 Hardware Integration Manual* [1].

## 2.1 Pin assignment

| No | Module | Name | I/O | Description |
|---|---|---|---|---|
| 1 | All | Reserved | I | Reserved |
| 2 | All | Reserved | I | Reserved |
| 3 | All | TIMEPULSE | O | Time pulse (1PPS) |
| 4 | All | EXTINT0 | I | External Interrupt Pin |
| 5 | All | USB_DM | I/O | USB Data |
| 6 | All | USB_DP | I/O | USB Data |
| 7 | All | VDDUSB | I | USB Supply |
| 8 | All | Reserved | | See Hardware Integration Manual<br>Pin 8 and 9 must be connected together. |
| 9 | All | VCC_RF | O | Output Voltage RF section<br>Pin 8 and 9 must be connected together. |
| 10 | All | GND | I | Ground |
| 11 | All | RF_IN | I | GPS signal input |
| 12 | All | GND | I | Ground |
| 13 | All | GND | I | Ground |
| 14 | All | CFG_COM0 | I | Configuration Pin |
| 15 | NEO-6Q | CFG_COM1 | I | Configuration Pin.<br>Leave open if not used. |
| | NEO-6M | Reserved | I | Reserved |
| 16 | NEO-6Q | CFG_GPS0 | I | Power Mode Configuration Pin |
| | NEO-6M | Reserved | I | Reserved |
| 17 | NEO-6Q | Reserved | I | Reserved |
| | NEO-6M | NC | I | Not Connected |
| 18 | All | SDA2 | I/O | DDC Data |
| 19 | All | SCL2 | I/O | DDC Clock |
| 20 | All | TxD1 | O | Serial Port 1 |
| 21 | All | RxD1 | I | Serial Port 1 |
| 22 | All | V_BCKP | I | Backup voltage supply |
| 23 | All | VCC | I | Supply voltage |
| 24 | All | GND | I | Ground |

**Table 9: Pinout**

Pins designated Reserved should only be used with caution. For more information about Pinouts see the *LEA-6/NEO-6 Hardware Integration Manual* [1].

# 3 Electrical specifications

## 3.1 Absolute maximum ratings

| Parameter | Symbol | | Condition | Min | Max | Units |
|---|---|---|---|---|---|---|
| Power supply voltage (VCC) | Vcc | All | | -0.5 | 3.6 | V |
| Backup battery voltage (V_BCKP) | Vbckp | All | | -0.5 | 3.6 | V |
| USB supply voltage (VDDUSB) | Vddusb | All | | | 3.6 | V |
| Input pin voltage | Vin | All | | -0.5 | 3.6 | V |
| | Vin_usb | All | | -0.5 | Vddusb | V |
| VCC_RF output current | Iccrf | All | | | 100 | mA |
| Input power at RF_IN | Prfin | All | source impedance = 50 Ω, continuous wave | | -5 | dBm |
| Storage temperature | Tstg | All | | -40 | 85 | °C |

**Table 10: Absolute maximum ratings**

**GPS receivers are Electrostatic Sensitive Devices (ESD) and require special precautions when handling. For more information see the *LEA-6/NEO-6 Hardware Integration Manual* [1].**

**Stressing the device beyond the "Absolute Maximum Ratings" may cause permanent damage. These are stress ratings only. The product is not protected against overvoltage or reversed voltages. If necessary, voltage spikes exceeding the power supply voltage specification, given in table above, must be limited to values within the specified boundaries by using appropriate protection diodes.**

## 3.2 Operating conditions

☞ All specifications are at an ambient temperature of 25°C.

| Parameter | Symbol | Module | Min | Typ | Max | Units | Condition |
|---|---|---|---|---|---|---|---|
| Power supply voltage (VCC) | Vcc | All | 2.7 | 3.0 | 3.6 | V | |
| Peak supply current [10] | Iccp | All | | | 150 | mA | Vcc = 3.6V |
| Sustained supply current [11] | Icc Acquisition | All | | 49 [12] | | mA | Vcc = 3.0V |
| | Icc Tracking (Max Performance mode) | NEO-6Q | | 42 [13] | | mA | Vcc = 3.0V |
| | | NEO-6M | | 40 [13] | | mA | Vcc = 3.0V |
| | Icc Tracking (Eco mode) | NEO-6Q | | 40 [13] | | mA | Vcc = 3.0V |
| | | NEO-6M | | 38 [13] | | mA | Vcc = 3.0V |
| | Icc Tracking (Power Save mode / 1 Hz) | NEO-6Q | | 17 [13] | | mA | Vcc = 3.0V |
| | | NEO-6M | | 16 [13] | | mA | Vcc = 3.0V |
| Backup battery voltage | Vbckp | | 1.4 | | 3.6 | V | |
| Backup battery current | Ibckp | | | 25 | | µA | Vbckp = 1.8V |
| Input pin voltage range | Vin | | | | 3.6 | V | |
| Input pin low voltage | Vin_low_1 | | | | 0.2x Vcc | V | |
| Input pin high voltage | Vin_high_1 | | 0.7x Vcc | | | V | |
| Input pin low voltage for EXTINT0 and RxD1 | Vin_low_2 | | | | 0.22 | V | |
| Input pin high voltage for EXTINT0 and RxD1 | Vin_high_2 | | 0.91 | | | V | |
| Output pin low voltage | Vout_low | | | | 0.4 | V | Iout = 4 mA |
| Output pin high voltage | Vout_high | All | Vcc – 0.4 | | | V | Iout = -4 mA |
| VDDUSB (Pin 24) for USB operation | Vddusb1 | All | 3.0 [14] | | 3.6 | V | |
| USB_DM, USB_DP | VinU | All | Compatible with USB with 27 Ohms series resistance | | | | |
| Antenna gain | Gant | All | | | 50 | dB | |
| Receiver Chain Noise Figure | NFtot | | | 2.5 | | dB | |
| VCC_RF voltage | Vccrf | All | | Vcc-0.1 | | V | |
| VCC_RF output current | Iccrf | All | | | 50 | mA | |
| Operating temperature | Topr | All | -40 | | 85 | °C | |

**Table 11: Operating conditions**

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

# 4 Design-in

In order to obtain the necessary information to conduct a proper design-in, u-blox strongly recommends consulting the *LEA-6/NEO-6 Hardware Integration Manual* [1].

[10] Use this figure to dimension maximum current capability of power supply
[11] Use this figure to determine required battery capacity.
[12] ROM 6.00, >8 SVs in view, CNo >40 dBHz, current average of 30 sec after cold start
[13] ROM 6.00, with strong signals, all orbits available. For Cold Starts typical 12 min after First Fix. For Hot Starts typical 15 sec after First Fix.
[14] If USB not used connect to GND

# 5 Reliability tests and approvals

## 5.1 Reliability tests

The u-blox 6 product family is qualified according to the ISO 16750 standard: "Road vehicles - Environmental conditions and testing for electrical and electronic equipment".

## 5.2 Approvals

Products marked with this lead-free symbol on the product label comply with the "Directive 2002/95/EC of the European Parliament and the Council on the Restriction of Use of certain Hazardous Substances in Electrical and Electronic Equipment" (RoHS).

All u-blox 6 GPS modules are RoHS compliant.

# 6 Product handling

## 6.1 Packaging

NEO-6 modules are delivered as hermetically sealed, reeled tapes in order to enable efficient production, production lot set-up and tear-down.

**Figure 3: Reeled u-blox 6 modules**

### 6.1.1 Reels

NEO-6 GPS modules are deliverable in quantities of 250pcs on a reel. The dimensions of the reel are shown in Figure 4.

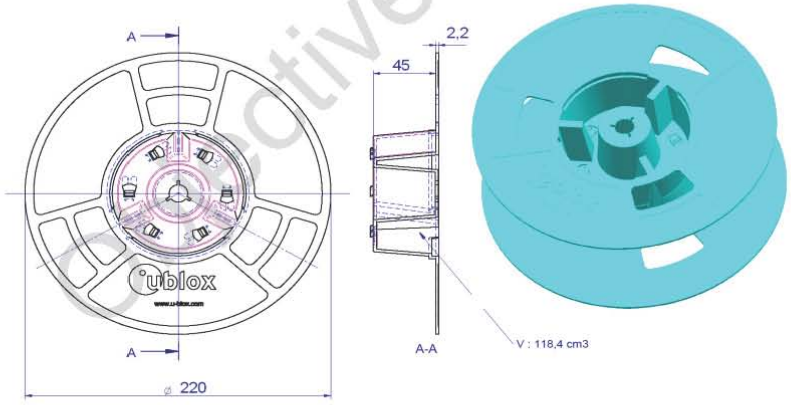



**Figure 4: Dimension of reel for 250 pieces (dimensions unless otherwise specified in mm)**

### 6.1.2 Tapes

The dimensions and orientations of the tapes for NEO-6 modules are specified in Figure 5.

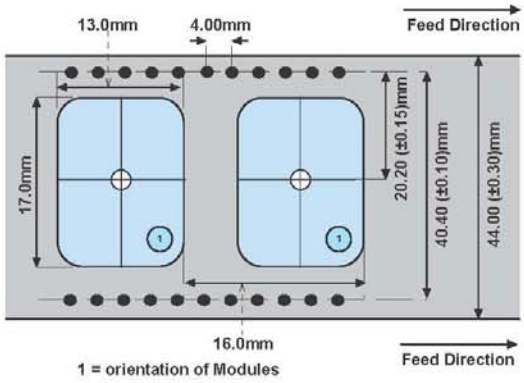



Figure 5: Dimensions and orientation for NEO-6 modules on tape

## 6.2 Shipment, storage and handling

NEO modules are designed and packaged to be processed in an automatic assembly line, and are shipped in Tape-and-Reel.

**NEO-6 modules are Moisture Sensitive Devices (MSD) in accordance to the IPC/JEDEC specification. Appropriate MSD handling instructions and precautions are summarized in Sections 6.2.1 to 6.2.3. Read them carefully to prevent permanent damage due to moisture intake.**

**GPS receivers contain highly sensitive electronic circuitry and are Electrostatic Sensitive Devices (ESD). Handling NEO-6 modules without proper ESD protection may destroy or damage them permanently. See Section 6.2.6 for ESD handling instructions.**

### 6.2.1 Moisture Sensitivity Levels

The Moisture Sensitivity Level (MSL) relates to the packaging and handling precautions required. NEO-6 modules are rated at MSL level 4.

For MSL standard see IPC/JEDEC J-STD-020, which can be downloaded from www.jedec.org.

### 6.2.2 Shipment

Table 12 summarizes the dry pack requirements for different MSL levels in the IPC/JDEC specification.

| MSL Level | Dry Pack Requirement |
|---|---|
| 1 | Optional |
| 2 | Required |
| 2a | Required |
| 3 | Required |
| 4 | Required |

**Table 12: JEDEC specification of dry pack requirements**

According to IPC/JEDEC specification J-STD-020, if a device passes MSL level 1, it is classified as not moisture sensitive and does not require dry pack. If a device fails level 1 but passes a higher numerical level, it is classified as moisture sensitive and must be dry packed in accordance with J-STD-033.

NEO-6 modules are delivered on Tape-and-Reels in a hermetically sealed package ("dry bag") to prevent moisture intake and protect against electrostatic discharge. For protection from physical damage, the reels are individually packed in cartons.

Carrier materials such as trays, tubes, reels, etc., that are placed in the Moisture Barrier Bag (MBB) can affect the moisture level within the MBB. Therefore, the effect of these materials is compensated by adding additional desiccant in the MBB to ensure the shelf life of the SMD packages.

The dry bag provides an IPC/JEDEC compliant MSD label describing the handling requirements to prevent humidity intake. IPC/JEDEC specifications require that MSD sensitive devices be packaged together with a Humidity Indicator Card (HIC) and desiccant to absorb humidity. If no moisture has been absorbed, the three fields in the HIC indicate blue color. Figure 6 shows examples of an MSD label and HIC.

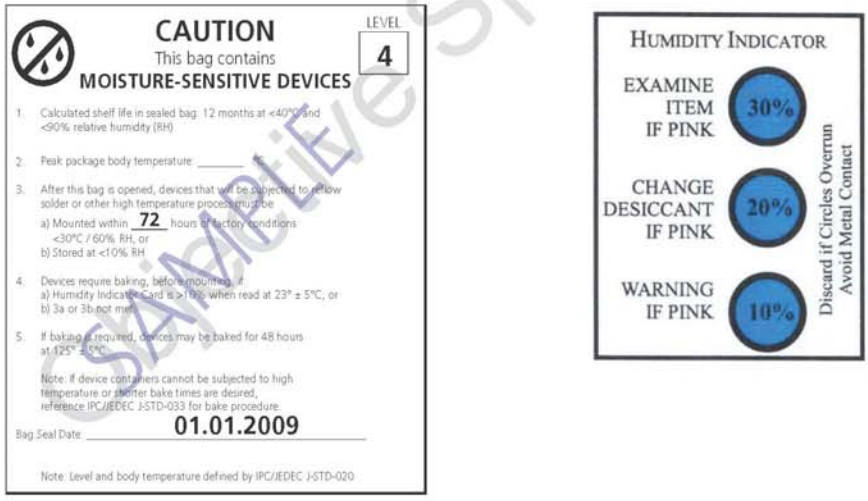



**Figure 6: Examples of MSD label and Humidity Indicator Card**

### 6.2.3 Storage and floor life

The calculated shelf life for dry packed SMD packages is a minimum of 12 months from the bag seal date, when stored in a noncondensing atmospheric environment of <40°C/90% RH.

Table 13 lists floor life for different MSL levels in the IPC/JEDEC specification.

| MSL level | Floor life (out of bag) at factory ambient ≤30°C/60% RH or as stated |
|---|---|
| 1 | Unlimited at ≤30°C/85% RH |
| 2 | 1 year |
| 2a | 4 weeks |
| 3 | 168 hours |
| 4 | 72 hours |

**Table 13: JEDEC specification of floor life**

The parts must be processed and soldered within the time specified for the MSL level. If this time is exceeded, or the humidity indicator card in the sealed package indicates that they have been exposed to moisture, the devices need to be pre-baked before the reflow solder process.

### 6.2.4 Drying

Both encapsulant and substrate materials absorb moisture. IPC/JEDEC specification J-STD-020 must be observed to prevent cracking and delamination associated with the "popcorn" effect during reflow soldering. The popcorn effect can be described as miniature explosions of evaporating moisture. Baking before processing is required in the following cases:

- Humidity indicator card: At least one circular indicator is no longer blue
- Floor life or environmental requirements after opening the seal have been exceeded, e.g. exposure to excessive seasonal humidity.

Refer to Section 4 of IPC/JEDEC J-STD-033 for recommended baking procedures. Table 4-1 of the specification lists the required bake times and conditions for drying. For example, a module that has exceeded its floor life by >72 hours shall be baked at 125°C for 9 hours. (Floor life begins counting at time = 0 after bake).

⚠ **Do not attempt to bake NEO-6 modules while contained in tape and rolled up in reels. For baking, place parts individually onto oven tray.**

⚠ **Oxidation Risk: Baking SMD packages may cause oxidation and/or intermetallic growth of the terminations, which if excessive can result in solderability problems during board assembly. The temperature and time for baking SMD packages are therefore limited by solderability considerations. The cumulative bake time at a temperature greater than 90°C and up to 125°C shall not exceed 96 hours. If the bake temperature is not greater than 90°C, there is no limit on bake time. Bake temperatures higher than 125°C are not allowed.**

### 6.2.5 Reflow soldering

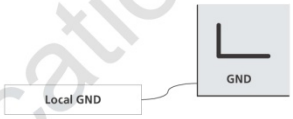
Reflow profiles are to be selected according to IPC/JEDEC J-STD-020.

### 6.2.6 ESD handling precautions

**NEO-6 modules are Electrostatic Sensitive Devices (ESD). Observe precautions for handling! Failure to observe these precautions can result in severe damage to the GPS receiver!**

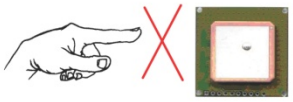
GPS receivers are Electrostatic Sensitive Devices (ESD) and require special precautions when handling. Particular care must be exercised when handling patch antennas, due to the risk of electrostatic charges. In addition to standard ESD safety practices, the following measures should be taken into account whenever handling the receiver:

- Unless there is a galvanic coupling between the local GND (i.e. the work table) and the PCB GND, then the first point of contact when handling the PCB shall always be between the local GND and PCB GND.

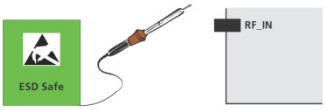



- Before mounting an antenna patch, connect ground of the device
- When handling the RF pin, do not come into contact with any charged capacitors and be careful when contacting materials that can develop charges (e.g. patch antenna ~10pF, coax cable ~50-80pF/m, soldering iron, …)


- To prevent electrostatic discharge through the RF input do not touch the mounted patch antenna.



- When soldering RF connectors and patch antennas to the receiver's RF pin, make sure to use an ESD safe soldering iron (tip).



# 7 Default settings

| Interface | Settings |
|---|---|
| Serial Port 1 Output | 9600 Baud, 8 bits, no parity bit, 1 stop bit<br>Configured to transmit both NMEA and UBX protocols, but only following NMEA and no UBX messages have been activated at start-up:<br>**GGA, GLL, GSA, GSV, RMC, VTG, TXT** |
| USB Output | Configured to transmit both NMEA and UBX protocols, but only following NMEA and no UBX messages have been activated at start-up:<br>**GGA, GLL, GSA, GSV, RMC, VTG, TXT**<br>USB Power Mode: Bus-Powered |
| Serial Port 1 Input | 9600 Baud, 8 bits, no parity bit, 1 stop bit<br>Automatically accepts following protocols without need of explicit configuration:<br>**UBX, NMEA**<br>The GPS receiver supports interleaved UBX and NMEA messages. |
| USB Input | Automatically accepts following protocols without need of explicit configuration:<br>**UBX, NMEA**<br>The GPS receiver supports interleaved UBX and NMEA messages.<br>USB Power Mode: Bus-Powered |
| TIMEPULSE (1Hz Nav) | 1 pulse per second, synchronized at rising edge, pulse length 100ms |
| Power Mode | Maximum Performance mode |

**Table 14: Available protocols**

Refer to the *LEA-6/NEO-6 Hardware Integration Manual* [1] for information about further settings.

# 8 Labeling and ordering information

## 8.1 Product labeling

The labeling of u-blox 6 GPS modules includes important product information. The location of the product type number is shown in Figure 7.

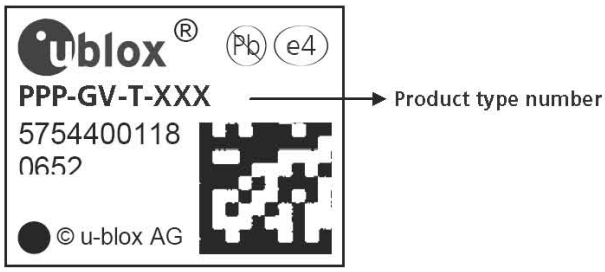



**Figure 7: Location of product type number on u-blox 6 module label**

## 8.2 Explanation of codes

3 different product code formats are used. The **Product Name** is used in documentation such as this data sheet and identifies all u-blox 6 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 15 below details these 3 different formats:

| Format | Structure |
|---|---|
| **Product Name** | PPP-GV |
| **Ordering Code** | PPP-GV-T |
| **Type Number** | PPP-GV-T-XXX |

**Table 15: Product Code Formats**

The parts of the product code are explained in Table 16.

| Code | Meaning | Example |
|---|---|---|
| PPP | Product Family | NEO |
| G | Product Generation | 6 = u-blox6 |
| V | Variant | T = Timing, R = DR, etc. |
| T | Option / Quality Grade | Describes standardized functional element or quality grade such as Flash size, automotive grade etc. |
| XXX | Product Detail | Describes product details or options such as hard- and software revision, cable length, etc. |

**Table 16: part identification code**

## 8.3 Ordering information

| Ordering No. | Product |
|---|---|
| NEO-6M-0 | ROM-based u-blox 6 GPS Module, 12x16mm, 250 pcs/reel |
| NEO-6Q-0 | ROM-based u-blox 6 GPS Module with TCXO, 12x16mm, 250 pcs/reel |

**Table 17: 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: http://www.u-blox.com/customersupport/pcn/ublox5.html.

# Related documents

[1] LEA-6/NEO-6 Hardware Integration Manual , Docu. No GPS.G6-HW-09007

[2] u-blox 5 & u-blox 6 Receiver Description Including Protocol Specification, Docu. No GPS-X-07036

All these documents are available on our homepage (http://www.u-blox.com).

For regular updates to u-blox documentation and to receive product change notifications please register on our homepage.

# Revision history

| Revision | Date | Name | Status / Comments |
|---|---|---|---|
| | 31/08/2009 | tgri | Initial Version |

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