

## Testing of Nav5plus receiver performance (EN 300065)

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McMurdo Limited  
Silver Point  
Airport Service Road  
Portsmouth  
Hampshire  
PO3 5PB

### ISSUE RECORD

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### **Introduction**

The Nav5plus Navtex receiver is an updated version of the existing Nav5. The objective of these tests is to ensure the Nav5plus complies with EN 300 065.

The Nav5plus also includes a second (490kHz) receiver which needs to be tested.

Some requirements are checked by inspection, and some require measurement.

### **Conclusions**

The Nav5plus meets the requirements of EN300 065-1 as tested below.

### **Further actions required**

None.

### **Reference documents**

The original Nav5 was tested by Assessment Services, and reference should be made to their report 102151 (February 1993).  
ETSI EN 300 065-1 V1.1.3 (2001-05)  
IEC 1097-6 (EN61097-6) (1995)  
IEC60945 (2002)  
EMC test report 04J025CR from Hursley EMC Services

### **Location etc of tests**

Testing was carried out in the McMurdo Ltd electronics laboratory.  
Personnel carrying out the tests was John Knapp.  
Testing was carried out between 03/02/04 and 08/03/04

### **Equipment tested**

Nav5plus assembly 28-224A, serial number 677B with the following modifications made for EMC compliance:  
C110, C111, C112, C116 added with a value of 10n (previously no fit)  
R210, R213, R310, R313 changed from 100k to 22k  
1n capacitor added between pins 1 and 2 of U201  
1n capacitor added between pins 1 and 2 of U302  
Ferrite clamp added around ribbon between CPU board and receiver board

### **Equipment used**

PC running HyperTerminal, sending text files.  
Codec to generate FEC data stream from text files from PC. ICS electronics DSC2-006, serial number 00600775.  
Attenuator to reduce output level from Codec to that suitable for signal generator modulation input.  
RF signal generator Marconi 2030, serial number 119562/056 (SG1)  
RF signal generator Marconi 2022D, serial number 119133/053 (SG2)  
RF signal generator Hewlett Packard 8657B, serial number 3630U8273 (SG3)  
RF signal generator Adret 742A, serial number 156 (SG4)  
Combiners, with attenuation in each leg of 3dB  
Power supply PDA3502A 000396  
Spectrum analyser Agilent E4403B MY41440411

Note SG3 was substituted for SG1 as the calibration date expired.

### **General notes on testing**

Testing of the unit is carried out at 12V, as it is meant to function at nominal voltages of 12 and 24V.

For testing of character reception (e.g. call sensitivity and intermodulation) the PC repeatedly sends the Standard Test Signal in IEC1097-6, which includes all the characters required by EN 300 065 and punctuation characters. This has forward error correction applied by the Codec and is output as a digital data stream at approximately 0 and 5V. The attenuator reduces this to approximately 0 to 1V which is then applied to the modulation input of the signal generator. The signal generator is set to the appropriate settings to give a 518kHz +/-85Hz FSK signal out. This is checked by forcing the Codec output high and low (using test mode) and ensuring the two test frequencies (517.915 and 518.085kHz) are correct to less than 1Hz (2ppm).

Input test levels vary between the two required standards EN 300 065 and IEC1097-6. EN 300 065 calls up 20dBuV (-87dBm) whereas IEC6097-6 requires 2uV+6dB (-95dBm), a difference of 8dB. Most of the testing in EN 300 065 is carried out with antenna (b), 10 ohms in series with 150pF. IEC1097-6 is not explicit about which antenna should be used. However, both specifications say call sensitivity should be checked at 2uV with antenna (a), 50 ohms, and 5uV with antenna (b). The difference between these levels is 8dB, implying that testing with antenna (a) should be carried out at a level 8dB lower than if antenna (b) is used.

The Nav5 and Nav5plus are intended to work with a 50 ohm antenna, i.e. antenna (a), not (b). To allow for this, testing is carried out 8dB below the levels in EN 300 065 using a 50 ohm source. This applies to both the wanted and unwanted signals.

As this is an upgrade to the Nav5, testing is only carried out at the 'Normal Test Conditions' described in section 4.3. There are no 'Extreme Tests' as defined in sections 4.4, 4.5 and 4.6.

## **Tests and results**

### **3. General requirements**

#### **3.1 Construction**

- 3.1.1 The Nav5plus meets this requirement.
- 3.1.2 The Nav5plus meets this requirement. All controls are labelled, and further information is provided behind the printer door. All terminals are identified with a label on the rear panel. Supply voltage is also shown on this label. The type designation label will be affixed to the rear of the case.
- 3.1.3 The Nav5plus meets this requirement by allowing the LCD backlight to be turned off.
- 3.1.4 The Nav5plus meets this requirement and also receives on 490kHz. Both frequencies are received simultaneously, so 518kHz is always on by default.
- 3.1.5 The Nav5plus meets this requirement by carrying out a self test when turned on and printing the selected B12 characters. The operator can also carry out a self test manually. No audio output is provided.
- 3.1.6 The Nav5plus meets this requirement. The operator can disable any selection of B1 characters.
- 3.1.7 The Nav5plus meets this requirement. This information is printed when turned on, and can be accessed through the menu.
- 3.1.8 The Nav5plus meets this requirement. The operator can disable any selection of B2 characters except A, B, D and L.
- 3.1.9 The Nav5plus meets this requirement. This information is printed when turned on, and can be accessed through the menu.
- 3.1.10 The Nav5plus meets this requirement. It was confirmed on the Nav5 and has not been altered.
- 3.1.11 The Nav5plus meets this requirement. It was confirmed on the Nav5 and has not been altered.
- 3.1.12 The Nav5plus meets this requirement. It was confirmed on the Nav5 and has not been altered.
- 3.1.13 The Nav5plus meets this requirement. It was confirmed on the Nav5 and has not been altered.
- 3.1.14 The Nav5plus meets this requirement. It was confirmed on the Nav5 and has not been altered.
- 3.1.15 The Nav5plus meets this requirement. An alarm sounds when the paper is about to run out.
- 3.1.16 The Nav5plus meets this requirement. It was confirmed on the Nav5 and has not been altered.
- 3.1.17 The Nav5plus meets this requirement. It was confirmed on the Nav5 and has not been altered.

#### **3.2 Safety precautions**

- 3.2.1 The Nav5plus meets this requirement. Insufficient power is dissipated to cause a large temperature rise. The supply is fused.
- 3.2.2 The Nav5plus meets this requirement. There is a reverse protection diode and transient protection device.
- 3.2.3 The Nav5plus meets this requirement. There is an earthing stud on the rear of the unit.

- 3.2.4 The Nav5plus meets this requirement. There are no voltages or combinations of voltages greater than 50V.
- 3.2.5 This does not apply because of 3.2.4 above.
- 3.2.6 The Nav5plus meets this requirement. Data is retained by battery backed up memory.

#### 4. Test conditions

See general notes above.

#### 5. Receiver and signal processor

##### 5.1 Call sensitivity

The Nav5plus meets this requirement with an error rate of 0%.  
For comparison, the Nav5 gave an error rate of 0%.

518kHz

Tested with artificial antenna (a) and a 2uV (-101dBm) signal, with the repeated STS defined above. SG1 generating test signals.  
0 errors were detected in 1343 characters giving an error rate of 0% against the test limit of <4%.  
The signal level was reduced until an error appeared, and this occurred at -116dBm (15dB better than the test level).

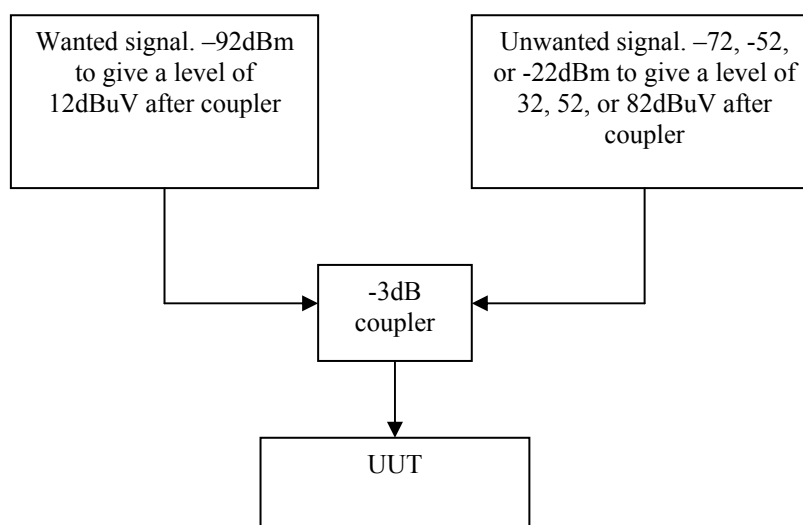
490kHz

Tested with artificial antenna (a) and a 2uV (-101dBm) signal, with the repeated STS defined above. SG1 generating test signals.  
0 errors were detected in 1343 characters giving an error rate of 0% against the test limit of <4%.  
The signal level was reduced until errors appeared, and this occurred at -114dBm (13dB better than the test level).

##### 5.2 Interference rejection and blocking immunity

The Nav5plus meets this requirement with an error rate of 0%.  
For comparison, the Nav5 gave a worst case error rate of 0.4%.

This test was carried out with antenna (a) and with levels reduced by 8dB as discussed above. The test set up is:



With a 518kHz wanted signal, for each frequency range the unwanted signal was swept to look for frequencies that cause errors. If errors were seen then a measurement of the error rate was taken, to compare against the test limit of 4%. This was then repeated for a 490kHz wanted signal.

518kHz. SG1 generating wanted signal, SG2 generating unwanted signal

| Frequency range | Unwanted signal level | Error rate                                              | Pass/fail |
|-----------------|-----------------------|---------------------------------------------------------|-----------|
| 100kHz-515kHz   | 82dBuV                | 0%, occasional errors seen at 86dBuV at 515kHz.         | Pass      |
| 515kHz-517kHz   | 52dBuV                | 0%, occasional errors seen at 75dBuV at 517kHz.         | Pass      |
| 517kHz-517.5kHz | 32dBuV                | 0%, occasional errors seen at 45dBuV at 517.5kHz.       | Pass      |
| 518.5kHz-519kHz | 32dBuV                | 0%, occasional errors seen at 46dBuV at 518.5kHz.       | Pass      |
| 519kHz-521kHz   | 52dBuV                | 0%, occasional errors seen at 73dBuV at 519kHz.         | Pass      |
| 521kHz-30MHz    | 82dBuV                | 0%, occasional errors seen at 87dBuV at 521kHz.         | Pass      |
| 156MHz-174MHz   | 82dBuV                | 0%, no errors seen up to greater than 107dBuV at 165MHz | Pass      |
| 450MHz-470MHz   | 82dBuV                | 0%, no errors seen up to greater than 107dBuV at 460MHz | Pass      |

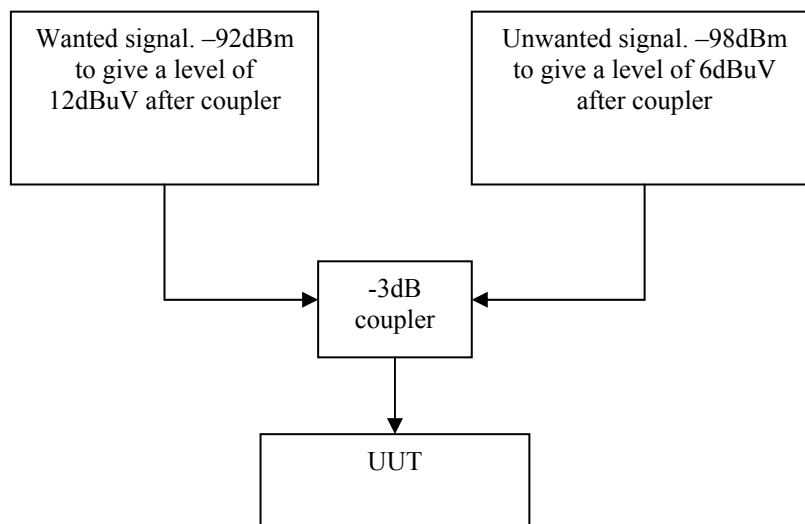
490kHz. SG3 generating wanted signal, SG2 generating unwanted signal

| Frequency range | Unwanted signal level | Error rate                                              | Pass/fail |
|-----------------|-----------------------|---------------------------------------------------------|-----------|
| 100kHz-487kHz   | 82dBuV                | 0%, occasional errors seen at 89dBuV at 487kHz.         | Pass      |
| 487kHz-489kHz   | 52dBuV                | 0%, occasional errors seen at 74dBuV at 489kHz.         | Pass      |
| 489kHz-489.5kHz | 32dBuV                | 0%, occasional errors seen at 51dBuV at 489.5kHz.       | Pass      |
| 490.5kHz-491kHz | 32dBuV                | 0%, occasional errors seen at 51dBuV at 490.5kHz.       | Pass      |
| 491kHz-493kHz   | 52dBuV                | 0%, occasional errors seen at 74dBuV at 491kHz.         | Pass      |
| 493kHz-30MHz    | 82dBuV                | 0%, occasional errors seen at 87dBuV at 493kHz.         | Pass      |
| 156MHz-174MHz   | 82dBuV                | 0%, no errors seen up to greater than 107dBuV at 165MHz | Pass      |
| 450MHz-470MHz   | 82dBuV                | 0%, no errors seen up to greater than 107dBuV at 460MHz | Pass      |

### 5.3 Co-channel rejection

The Nav5plus meets this requirement with an error rate of 0%.  
For comparison, the Nav5 gave an error rate of 0%.

This test was carried out with antenna (a) and with levels reduced by 8dB as discussed above. The test set up is:



With a 518kHz wanted signal, the error rate was noted for the unwanted signal level above, to compare against the test limit of 4%. If there were no errors, then the unwanted signal was increased until some occasional errors were seen, and the level noted. This was then repeated for a 490kHz wanted signal. SG3 used to generate wanted signal, SG2 to generate unwanted signal.

#### 518kHz

Error rate at levels above: 0% (0 errors in 1000 characters)

Unwanted signal level to give errors: 37dBuV

Margin over test level: 31dB

#### 490kHz

Error rate at levels above: 0% (0 errors in 1000 characters)

Unwanted signal level to give errors: 44dBuV

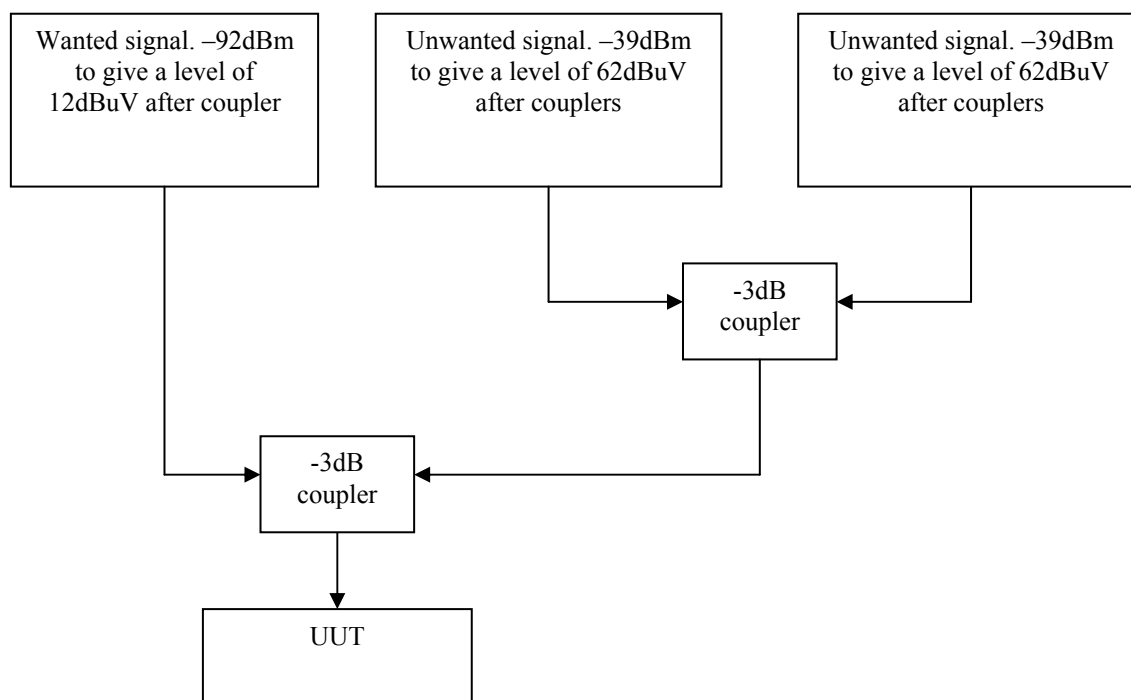
Margin over test level: 38dB

#### 5.4 Intermodulation

The Nav5plus meets this requirement with an error rate of 0%.

For comparison, the Nav5 gave an error rate of 0%, but was only tested with the first frequency pair.

This test was carried out with antenna (a) and with levels reduced by 8dB as discussed above. The test set up is:



With a 518kHz wanted signal, the error rate was noted for the unwanted signal level above, to compare against the test limit of 4%. This was carried out at the pairs of frequencies shown in the table. If there were no errors, then the unwanted signals were increased until some errors were seen.

This was then repeated for a 490kHz wanted signal.

SG3 used to generate wanted signal, SG2 and SG4 to generate unwanted signals.

##### 518kHz

| Freq. 1 | Freq. 2   | Error rate | Pass/Fail | Comments                                |
|---------|-----------|------------|-----------|-----------------------------------------|
| 1036kHz | 1554kHz   | 0/1000=0%  | Pass      | Occasional errors at 89dBuV (27dB over) |
| 516kHz  | 514kHz    | 0/1000=0%  | Pass      | Occasional errors at 78dBuV (16dB over) |
| 515kHz  | 512kHz    | 0/1000=0%  | Pass      | Occasional errors at 78dBuV (16dB over) |
| 514kHz  | 510kHz    | 0/1000=0%  | Pass      | Occasional errors at 78dBuV (16dB over) |
| 516kHz  | 515kHz    | 0/1000=0%  | Pass      | Occasional errors at 82dBuV (20dB over) |
| 515kHz  | 513.5kHz  | 0/1000=0%  | Pass      | Occasional errors at 83dBuV (21dB over) |
| 514kHz  | 512kHz    | 0/1000=0%  | Pass      | Occasional errors at 87dBuV (25dB over) |
| 516kHz  | 515.33kHz | 0/1000=0%  | Pass      | Occasional errors at 80dBuV (18dB over) |
| 515kHz  | 514kHz    | 0/1000=0%  | Pass      | Occasional errors at 84dBuV (22dB over) |
| 514kHz  | 512.67kHz | 0/1000=0%  | Pass      | Occasional errors at 80dBuV (18dB over) |
| 516kHz  | 515.5kHz  | 0/1000=0%  | Pass      | Occasional errors at 81dBuV (19dB over) |
| 515kHz  | 514.25kHz | 0/1000=0%  | Pass      | Occasional errors at 84dBuV (22dB over) |
| 514kHz  | 513kHz    | 0/1000=0%  | Pass      | Occasional errors at 87dBuV (25dB over) |
| 520kHz  | 522kHz    | 0/1000=0%  | Pass      | Occasional errors at 78dBuV (16dB over) |
| 521kHz  | 524kHz    | 0/1000=0%  | Pass      | Occasional errors at 79dBuV (17dB over) |
| 522kHz  | 526kHz    | 0/1000=0%  | Pass      | Occasional errors at 80dBuV (18dB over) |
| 520kHz  | 521kHz    | 0/1000=0%  | Pass      | Occasional errors at 81dBuV (19dB over) |
| 521kHz  | 522.5kHz  | 0/1000=0%  | Pass      | Occasional errors at 83dBuV (21dB over) |
| 522kHz  | 524kHz    | 0/1000=0%  | Pass      | Occasional errors at 84dBuV (22dB over) |

|        |           |           |      |                                          |
|--------|-----------|-----------|------|------------------------------------------|
| 520kHz | 520.67kHz | 0/1000=0% | Pass | Occasional errors at 78dBuV (16dB over)  |
| 521kHz | 522kHz    | 0/1000=0% | Pass | Occasional errors at 85dBuV (23dB over)  |
| 522kHz | 523.33kHz | 0/1000=0% | Pass | Occasional errors at 80dBuV (18dB over)  |
| 520kHz | 520.5kHz  | 0/1000=0% | Pass | Occasional errors at 83dBuV (21dB over)  |
| 521kHz | 521.75kHz | 0/1000=0% | Pass | Occasional errors at 85dBuV (23dB over)  |
| 522kHz | 523kHz    | 0/1000=0% | Pass | Occasional errors at 87dBuV (25dB over)  |
| 531kHz | 544kHz    | 0/1000=0% | Pass | Occasional errors at 87dBuV (25dB over)  |
| 531kHz | 537.5kHz  | 0/1000=0% | Pass | Occasional errors at 91dBuV (29dB over)  |
| 531kHz | 535.33kHz | 0/1000=0% | Pass | Occasional errors at 87dBuV (25dB over)  |
| 531kHz | 534.25kHz | 0/1000=0% | Pass | Occasional errors at 95dBuV (33dB over)  |
| 530kHz | 542kHz    | 0/1000=0% | Pass | Occasional errors at 87dBuV (25dB over)  |
| 530kHz | 536kHz    | 0/1000=0% | Pass | Occasional errors at 90dBuV (28dB over)  |
| 530kHz | 534kHz    | 0/1000=0% | Pass | Occasional errors at 93dBuV (31dB over)  |
| 530kHz | 533kHz    | 0/1000=0% | Pass | Occasional errors at 95dBuV (33dB over)  |
| 540kHz | 562kHz    | 0/1000=0% | Pass | Occasional errors at 90dBuV (28dB over)  |
| 540kHz | 551kHz    | 0/1000=0% | Pass | Occasional errors at 96dBuV (34dB over)  |
| 540kHz | 547.33kHz | 0/1000=0% | Pass | Occasional errors at 90dBuV (28dB over)  |
| 540kHz | 545.5kHz  | 0/1000=0% | Pass | Occasional errors at 100dBuV (38dB over) |

#### 490kHz

| Freq. 1 | Freq. 2   | Error rate | Pass/Fail | Comments                                |
|---------|-----------|------------|-----------|-----------------------------------------|
| 1036kHz | 1526kHz   | 0/1000=0%  | Pass      | Occasional errors at 89dBuV (27dB over) |
| 488kHz  | 486kHz    | 0/1000=0%  | Pass      | Occasional errors at 82dBuV (20dB over) |
| 487kHz  | 484kHz    | 0/1000=0%  | Pass      | Occasional errors at 86dBuV (24dB over) |
| 486kHz  | 482kHz    | 0/1000=0%  | Pass      | Occasional errors at 89dBuV (27dB over) |
| 488kHz  | 487kHz    | 0/1000=0%  | Pass      | Occasional errors at 82dBuV (20dB over) |
| 487kHz  | 485.5kHz  | 0/1000=0%  | Pass      | Occasional errors at 86dBuV (24dB over) |
| 486kHz  | 484kHz    | 0/1000=0%  | Pass      | Occasional errors at 90dBuV (28dB over) |
| 488kHz  | 487.33kHz | 0/1000=0%  | Pass      | Occasional errors at 82dBuV (20dB over) |
| 487kHz  | 486kHz    | 0/1000=0%  | Pass      | Occasional errors at 85dBuV (23dB over) |
| 486kHz  | 484.67kHz | 0/1000=0%  | Pass      | Occasional errors at 88dBuV (26dB over) |
| 488kHz  | 487.5kHz  | 0/1000=0%  | Pass      | Occasional errors at 81dBuV (19dB over) |
| 487kHz  | 486.25kHz | 0/1000=0%  | Pass      | Occasional errors at 86dBuV (24dB over) |
| 486kHz  | 485kHz    | 0/1000=0%  | Pass      | Occasional errors at 90dBuV (28dB over) |
| 492kHz  | 494kHz    | 0/1000=0%  | Pass      | Occasional errors at 83dBuV (21dB over) |
| 493kHz  | 496kHz    | 0/1000=0%  | Pass      | Occasional errors at 87dBuV (25dB over) |
| 494kHz  | 498kHz    | 0/1000=0%  | Pass      | Occasional errors at 87dBuV (25dB over) |
| 492kHz  | 493kHz    | 0/1000=0%  | Pass      | Occasional errors at 82dBuV (20dB over) |
| 493kHz  | 494.5kHz  | 0/1000=0%  | Pass      | Occasional errors at 87dBuV (25dB over) |
| 494kHz  | 496kHz    | 0/1000=0%  | Pass      | Occasional errors at 89dBuV (27dB over) |
| 492kHz  | 492.67kHz | 0/1000=0%  | Pass      | Occasional errors at 81dBuV (19dB over) |
| 493kHz  | 494kHz    | 0/1000=0%  | Pass      | Occasional errors at 87dBuV (25dB over) |
| 494kHz  | 495.33kHz | 0/1000=0%  | Pass      | Occasional errors at 87dBuV (25dB over) |
| 492kHz  | 492.5kHz  | 0/1000=0%  | Pass      | Occasional errors at 83dBuV (21dB over) |
| 493kHz  | 493.75kHz | 0/1000=0%  | Pass      | Occasional errors at 85dBuV (23dB over) |
| 494kHz  | 495kHz    | 0/1000=0%  | Pass      | Occasional errors at 88dBuV (26dB over) |
| 503kHz  | 516kHz    | 0/1000=0%  | Pass      | Occasional errors at 89dBuV (27dB over) |
| 503kHz  | 509.5kHz  | 0/1000=0%  | Pass      | Occasional errors at 94dBuV (32dB over) |
| 503kHz  | 507.33kHz | 0/1000=0%  | Pass      | Occasional errors at 85dBuV (23dB over) |
| 503kHz  | 506.25kHz | 0/1000=0%  | Pass      | Occasional errors at 96dBuV (34dB over) |
| 502kHz  | 514kHz    | 0/1000=0%  | Pass      | Occasional errors at 89dBuV (27dB over) |
| 502kHz  | 508kHz    | 0/1000=0%  | Pass      | Occasional errors at 93dBuV (31dB over) |
| 502kHz  | 506kHz    | 0/1000=0%  | Pass      | Occasional errors at 95dBuV (33dB over) |
| 502kHz  | 505kHz    | 0/1000=0%  | Pass      | Occasional errors at 96dBuV (34dB over) |
| 512kHz  | 534kHz    | 0/1000=0%  | Pass      | Occasional errors at 92dBuV (30dB over) |
| 512kHz  | 523kHz    | 0/1000=0%  | Pass      | Occasional errors at 98dBuV (36dB over) |
| 512kHz  | 519.33kHz | 0/1000=0%  | Pass      | Occasional errors at 91dBuV (29dB over) |
| 512kHz  | 517.5kHz  | 0/1000=0%  | Pass      | Occasional errors at 99dBuV (37dB over) |

## 5.5 Spurious emissions

The Nav5plus meets this requirement.

See EMC report 04J025CR referenced above.

In addition, a test was made of conducted emissions from the aerial port. A spectrum analyser with an input impedance of 50 ohms (antenna (a)) was attached to the aerial connector, and a search made for any significant emissions in the range 9kHz to 2GHz. The largest emissions are listed, a specific check was made at 490kHz and 518kHz, but no emissions were seen above the noise floor of the spectrum analyser (about -95dBm)

Any emissions seen are required to have a power less than 1nW (-60dBm).

| Frequency | Power  | Pass/Fail |
|-----------|--------|-----------|
| 68.8MHz   | -64dBm | Pass      |
| 70.8MHz   | -65dBm | Pass      |
| 97.8MHz   | -66dBm | Pass      |
| 186MHz    | -66dBm | Pass      |
| 272MHz    | -65dBm | Pass      |

The same antenna is used by both receivers simultaneously, so a separate check at 490kHz is not required.

## 5.6 Protection of input circuits

The overload test has not been carried out due to lack of equipment capable of generating 30V RMS of RF. However, the design of the input stage is based on that of the Nav5, including clipping diodes to limit any overload, and so no problems are expected.

The DC impedance from antenna to case is <1 ohm with the case link in place, against the specification of <100k. Hence the Nav5plus meets this requirement.

## 6. Printing device

The Nav5plus uses the same printer as Nav5, and hence meets these requirements. It has a low noise level, prints 40 characters per line, and has a total capacity of 210000 characters.

## 7. Interference

The Nav5plus meets this requirement. See EMC report 04J025CR as referenced above