# The Mirics MSi001 with Linrad.
(Jan 27 2014)

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**Hardware.**

The Mirics MSi001 chip is used in the FUNcube Dongle Pro+ and in the Logitec LDT-1S310U/J USB dongles. There is other hardware with the MSi001 chip, but I have no information about that.

On this page and sub-pages there are tests and comparisons between the FUNcube PRO+ and the Logitec dongles. The FUNcube PRO+ has a temperature stabilized crystal oscillator while the Logitec oscillator is not temperature stabilized. The FUNcube has a preamplifier and RF filters while the Logitec dongle routes the antenna signal directly to the tuner chip. The Logitec dongle does not use LW/MW/SW inputs on the chip so frequency coverage is starting at nominally 64 MHz.

These dongles can provide very good performance, but they are low cost so one has to be a little careful to get the full performance out of them.

**Frequency stability vs supply voltage.**

The 5V supply voltage on the USB connector should be stable to within 0.3 mV for the Logitec dongle and to within 3 mV for the FUNcube PRO+ dongle. It may be a good idea to supply 5 V from a separate and highly stable supply. For details, look here: stability vs supply

**Frequency stability vs temperature.**

To avoid the influences of room temperature changes, the dongles were buried in a 10 litre bucket filled with sand. In that way a very long time constant is provided for the dongles without degradation of the cooling.

For details look here: thermal stability *This page shows (among other things) how to make a dongle frequency stable and should apply to rtlsdr and any other small radio.*

**Gain and noise figure.**

The MSi001 can provide very high baseband gain. It is possible to saturate the unit even without any antenna signal.

Tables 1 and 2 give the NF and the noise floor level for the Logitec and the FUNcube PRO+ respectively. Two dongles of each kind were tested on 144 MHz.

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| | | Logitec 12834 | | Logitec 01968 | |
|---|---|---|---|---|---|
| Gain (dB) | IF | NF (dB) | Floor (dB) | NF (dB) | Floor (dB) |
| 102 | on | 6.6 | 90.9 | 6.0 | 92.6 |
| 99 | on | 6.4 | 90.5 | 6.0 | 90.6 |
| 96 | on | 6.4 | 88.0 | 6.0 | 87.6 |
| 93 | on | 6.3 | 85.2 | | |

| | | | | | |
|---|---|---|---|---|---|
| 90 | on | 6.3 | 82.0 | | |
| 87 | on | 6.3 | 79.2 | | |
| 84 | on | 6.3 | 76.1 | | |
| 81 | on | 6.3 | 73.2 | | |
| 78 | on | 6.3 | 70.0 | | |
| 75 | on | 6.3 | 67.2 | | |
| 72 | on | 6.3 | 64.0 | | |
| 69 | on | 6.3 | 61.2 | | |
| 66 | on | 6.3 | 58.1 | | |
| 63 | on | 6.3 | 55.2 | | |
| 60 | on | 6.4 | 52.1 | | |
| 57 | on | 6.4 | 49.3 | | |
| 54 | on | 6.5 | 46.4 | 6.3 | 46.0 |
| 51 | on | 6.8 | 43.8 | | |
| 48 | on | 7.9 | 41.5 | | |
| 45 | on | 9.9 | 40.5 | | |
| 43 | on | 10.7 | 39.3 | 8.9 | 37.8 |
| 42 | off | 26.8 | 53.1 | | |
| 39 | off | 26.8 | 50.3 | | |
| 29 | off | 26.9 | 41.0 | | |

***Table 1.*** *Two different Logitec dongles are very similar. From this table one can conclude that the gain should be set in the range 43 to 60 or below 29 on 144 MHz.*

| | | FCDPP 16328 | | FCDPP 16329 | |
|---|---|---|---|---|---|
| Gain (dB) | IF | NF (dB) | Floor (dB) | NF (dB) | Floor (dB) |
| 50 | on | 4.0 | 94.4 | saturated | |
| 40 | on | 4.0 | 89.5 | saturated | |
| 30 | on | 4.0 | 77.5 | saturated | |
| 20 | on | 4.0 | 67.3 | 3.8 | 66.9 |
| 10 | on | 4.2 | 57.3 | 3.8 | 56.9 |
| 5 | on | 4.7 | 52.9 | 4.5 | 52.5 |
| 0 | on | 4.8 | 48.2 | 4.7 | 47.9 |
| 40 | off | 10.8 | 74.8 | 10.9 | 74.8 |
| 30 | off | 10.8 | 64.9 | 10.9 | 65.0 |
| 20 | off | 10.8 | 55.0 | 11.0 | 55.0 |
| 10 | off | 12.6 | 46.8 | 12.8 | 46.7 |
| 5 | off | 16.8 | 46.0 | 16.8 | 45.8 |
| 0 | off | 18.0 | 42.0 | 18.0 | 41.7 |

***Table 2.*** *Two different FUNcube PRO+ dongles are very similar. From this table one can conclude that the gain should be set in the range 0 to 15 dB on 144 MHz while the mixer gain can be used to reduce gain further in case of saturation.*

The measurements were made with Linrad, the repo version of Jan 24 2014 which is close to Linrad-03.52. The Logitec dongle was set to a sampling rate of 5 MHz with the format 252_S16, zero IF and a bandwidth of 600 kHz.

The tables show that the the FUNcube provides a better noise figure by about 2.3 dB.

**Reciprocal mixing.**

At close range, below 100 kHz or so, the dynamic range of both dongle types is limited by the

sideband noise of the local oscillator in the MSi001. Table 3 gives the dynamic range for the two dongle types at 20 and 100 kHz frequency separation.

| Offset | Level in 500 Hz bandwidth | | | |
|---|---|---|---|---|
| | FCDPP 16328 | FCDPP 16329 | Logitec 12834 | Logitec 01968 |
| (kHz) | (dB) | (dB) | (dB) | (dB) |
| 0 | 0 | 0 | 0 | 0 |
| 20 | -73.9 | -72.3 | -71.6 | -73.2 |
| 100 | -88.3 | -88.4 | -91.6 | -91.4 |
| off | -94.2 | -94.5 | -102.1 | -101.9 |

***Table 3.*** *The dynamic range at close range is similar in all the dongles. It is determined by the MSi001 chip. The data is obtained with mixer and LNA gain on and minimum IF gain.*

Table 3 is produced with a good crystal oscillator giving a signal on 144.040 MHz. The center frequency is set to 144.010 and the signal on 144.040 is clicked to get in the center of a 500 Hz baseband filter. The level is set near saturation and the S-meter reading is taken as the zero point, different values for different dongles. The center frequency is then changed to 143.990 and 143.910 and the average S-meter readings of the noise floor are subtracted from the signal level for each dongle. The fact that the noise is dominated by reciprocal mixing is obvious from the lower noise floor when the signal at 144.040 is switched off.

The measurements were made with Linrad, the repo version of Jan 24 2014 which is close to Linrad-03.52. The Logitec dongle was set to a sampling rate of 5 MHz with the format 252_S16, zero IF and a bandwidth of 600 kHz.

**Dynamic range at medium and wide frequency separations.**

Table 4 shows the signal level required to degrade S/N by 3 dB and the corresponding dynamic range referenced to a bandwidth of 500 Hz.

| Dongle | Level | NF | DR |
|---|---|---|---|
| | (dBm) | (dB) | (dB) |
| FCDPP 16328 | -42 | 4.8 | 100 |
| FCDPP 16329 | -42 | 4.7 | 100 |
| Logitec 12834 | -35 | 10.7 | 101 |
| Logitec 01968 | -36 | 8.9 | 102 |

***Table 4.*** *The dynamic range at a frequency separation of 500 kHz is about 100 dB for all the dongles.*

The dynamic range stays at about 100 dB in 500 Hz bandwidth for separations up to about 5 MHz. The limiting mechanism is reciprocal mixing. At wider separations the filter in the FUNcube dongle makes a difference. For a signal on 120 MHz, a frequency separation of 24 MHz, the Logitec can tolerate a level of -21 dBm for 3 dB S/N loss to equal amounts caused by compression and sideband noise. The corresponding dynamic range is about 116 dB. The

FUNcube PRO+ can tolerate -4 dBm on 120 MHz for a S/N loss of 3 dB. The mechanism is compression only. Since the Miri chip is protected by the filter one can increase the gain for minimum noise figure without adverse effects. The dynamic range is then about 139 dB.

**Conclusions.**

There are two major differences between the FUNcube PRO plus and the Logitec dongles. The FUNcube PRO plus has temperature control on the local oscillator and RF filters that protect the MSi001 from out-of-band signals.

The FUNcube does not really need much attention on frequency stability issues. The Logitec dongle does. It is possible and cheap to make temperature drift very slow by putting the Logitec dongle in a bucket of sand. One can even keep the temperature near the sweet point to get really excellent frequency stability provided that the 5V supply to the dongle is stable to within a fraction of a mV.

Both dongles are limited by the sideband noise of the MSi001 chip. The dynamic range is the same when the dongles are used in a properly designed EME receive system. With a LNA at the antenna feedpoint that lifts the noise floor by about 17 dB both dongles would provide a system NF very close to the LNA NF. Whenever needed a suitable band pass filter should be inserted. Typically 500 kHz wide which is trivial with simple LC circuits. With such a filter the filter inside the FUNcube dongle does not give any advantage at all. The extra LNA in the FUNcube dongle causes a very small loss of dynamic range, about 2 dB when minimum IF gain is selected and that is insignificant.

The FUNcube PRO plus may be a little easier to use because it has the filter to suppress 88-108 MHz and it has frequency stability without a bucket of sand.

The FUNcube PRO plus is GBP 125 while the Mirics dongle is GBP 50. The Mirics dongle allows much more bandwidth and can be run in non-zero IF modes which would avoid problems with the center spur which could affect reception of 88 to 108 MHz FM radio.

The MSi001 is significantly less good than average amateur transceivers in dynamic range. A radio like the IC706MKIIG is 15 to 20 dB better when it comes to problems caused by inband strong stations.