LORADD UTC timing trials & developments

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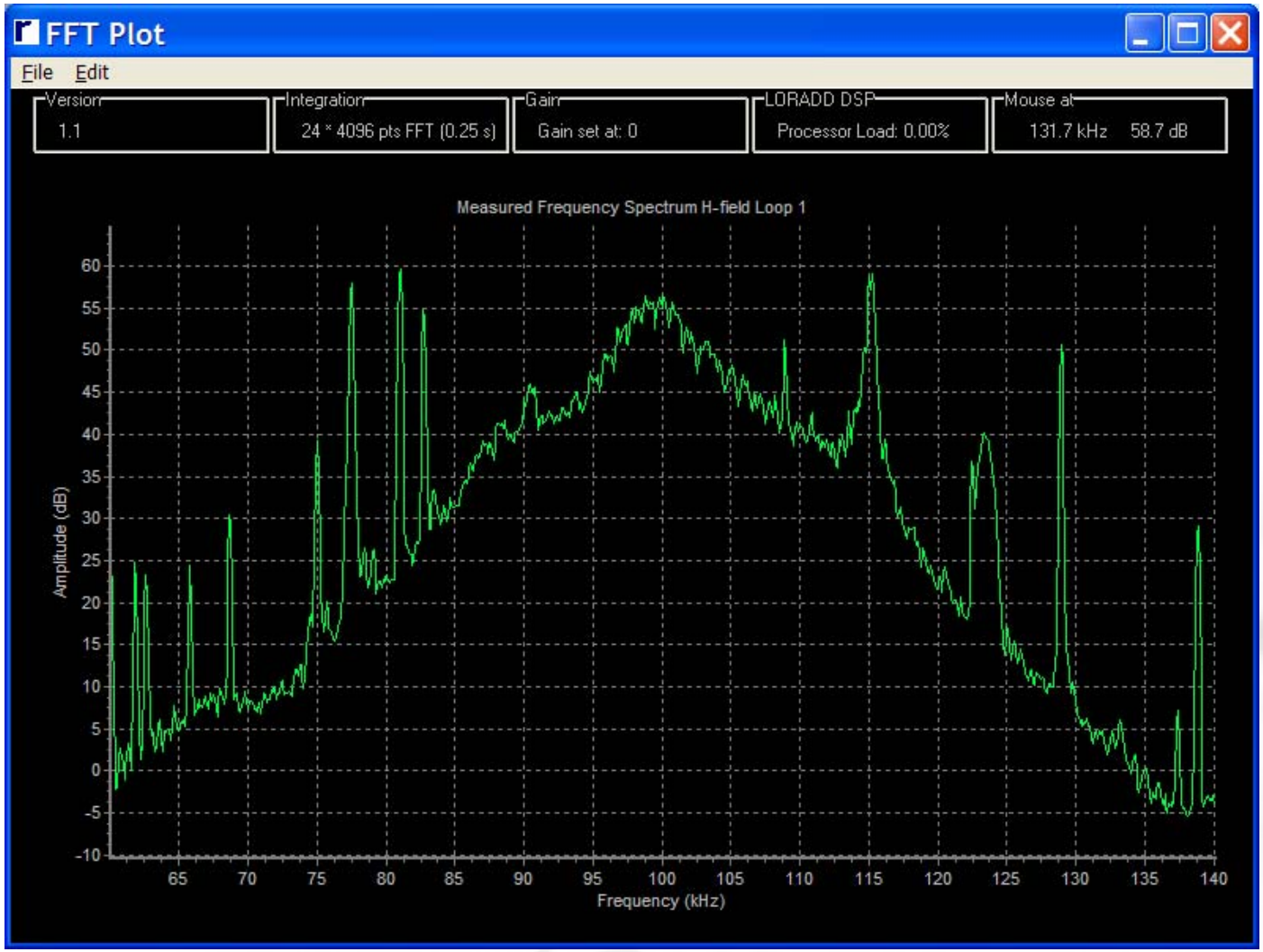
Loradd Firmware development

Firmware development

- Time-domain interference rejection
- AGC-correction
- Increased number of stations that can be tracked
- 30 Notch filters (per channel)
- Time-tagging capability enhancements
- Hi-speed data output interface

Firmware improvements

Firmware version 1



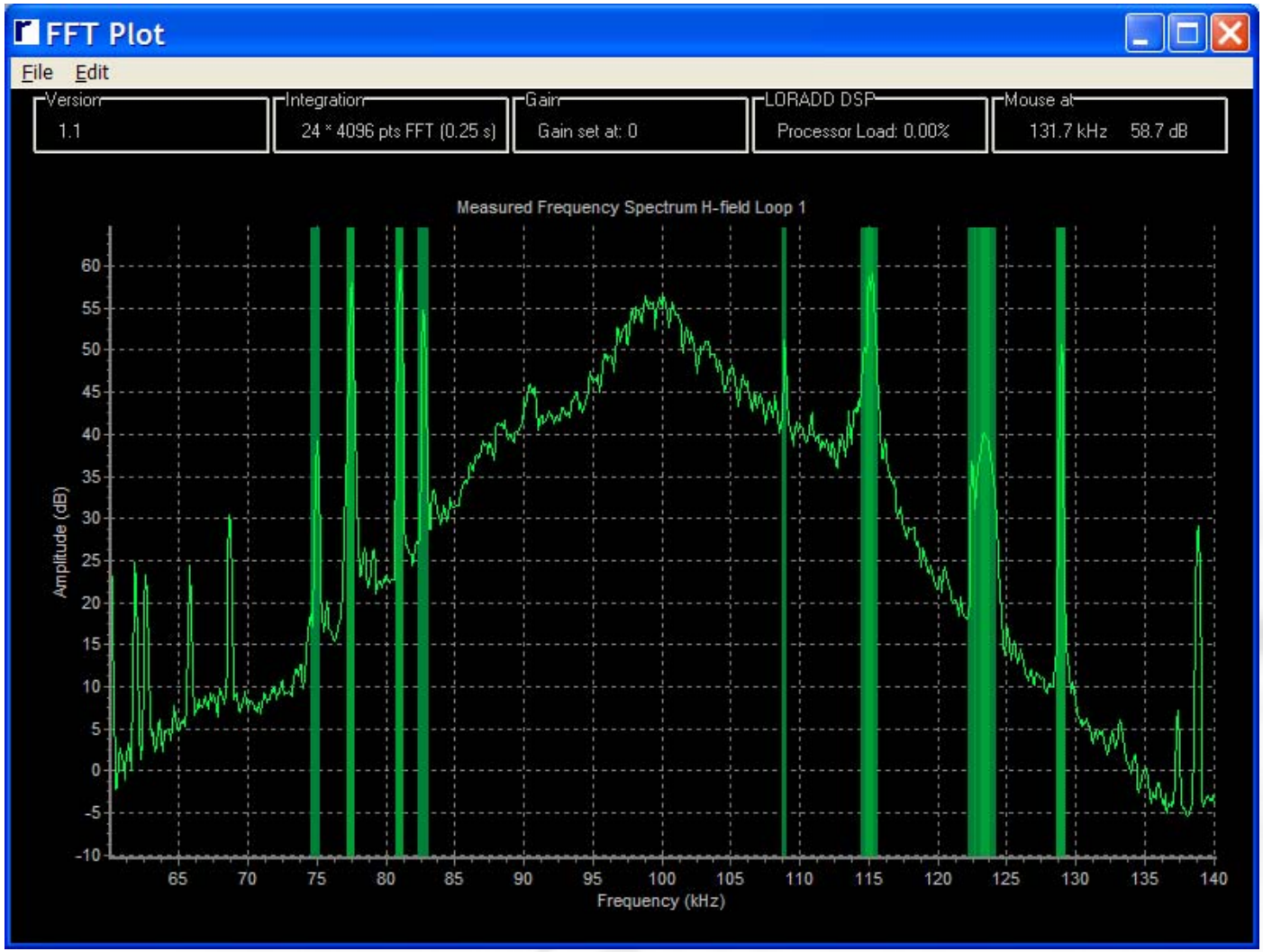
Firmware improvements

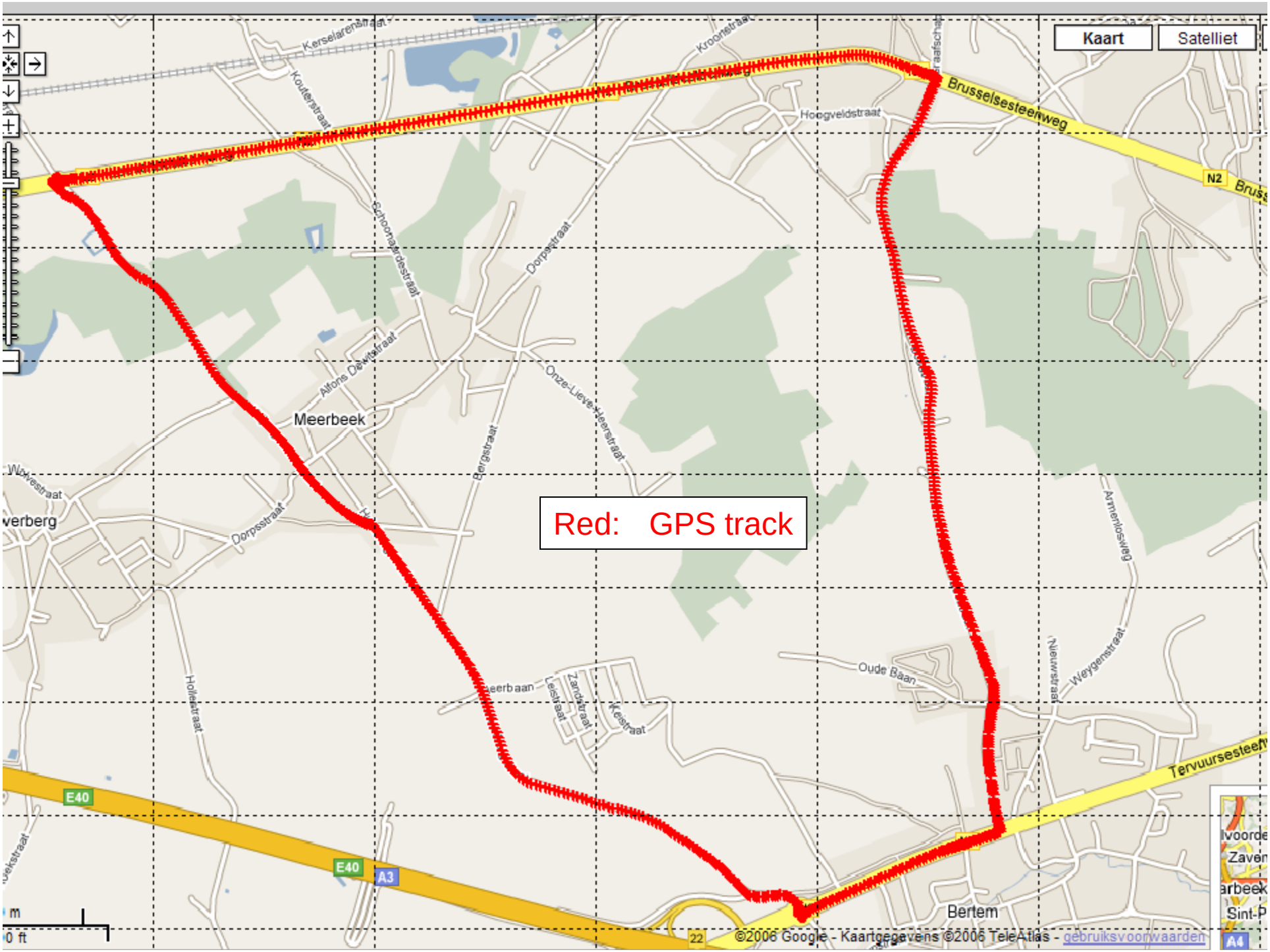
Firmware version 2

NOTCH...

Timestamp:	16610.63
Version:	1.0
Num Notches:	30
Active Notches:	16

Num	Frequency	Bandwidth
0	114.7	0.601
1	115.0	0.601
2	115.4	0.601
3	77.5	0.617
4	77.5	0.617
5	81.0	0.577
6	81.0	0.577
7	128.9	0.695
8	128.9	0.695
9	123.0	0.757
10	123.4	0.757
11	123.8	0.757
12	82.7	0.718
13	74.9	0.732
14	122.5	0.508
15	108.9	0.394




Kaart
Satelliet
Red: GPS track
Meerbeek
Bertem
Brusselsesteenweg
N2
Tervuursesteenweg
Hoogveldstraat
Dorpsstraat
Onze-Lieve-Heerstraat
Bergstraat
Oude Baan
Weygenstraat
Armenhofweg
Zandstraat
Leistraat
Kerkstraat
Hollestraat
Schoonaardestraat
Alfons Dewitstraat
Kouterstraat
Kroonstraat
Kerselarenstraat
E40
A3
A4
22
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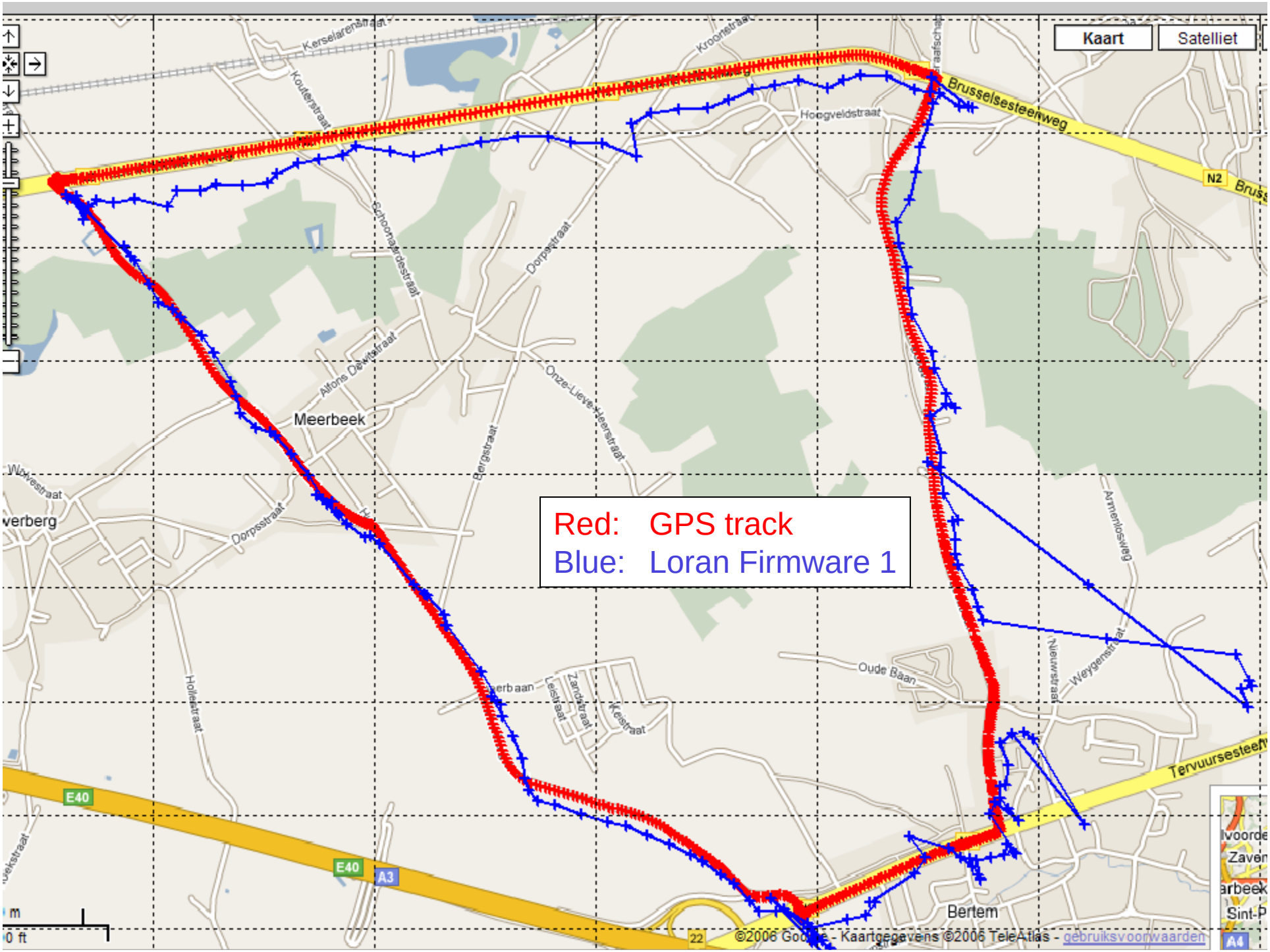
Red: GPS track
Blue: Loran Firmware 1
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Alfons Dewitstraat
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Zandstraat
Keistraat
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Armenhoswig
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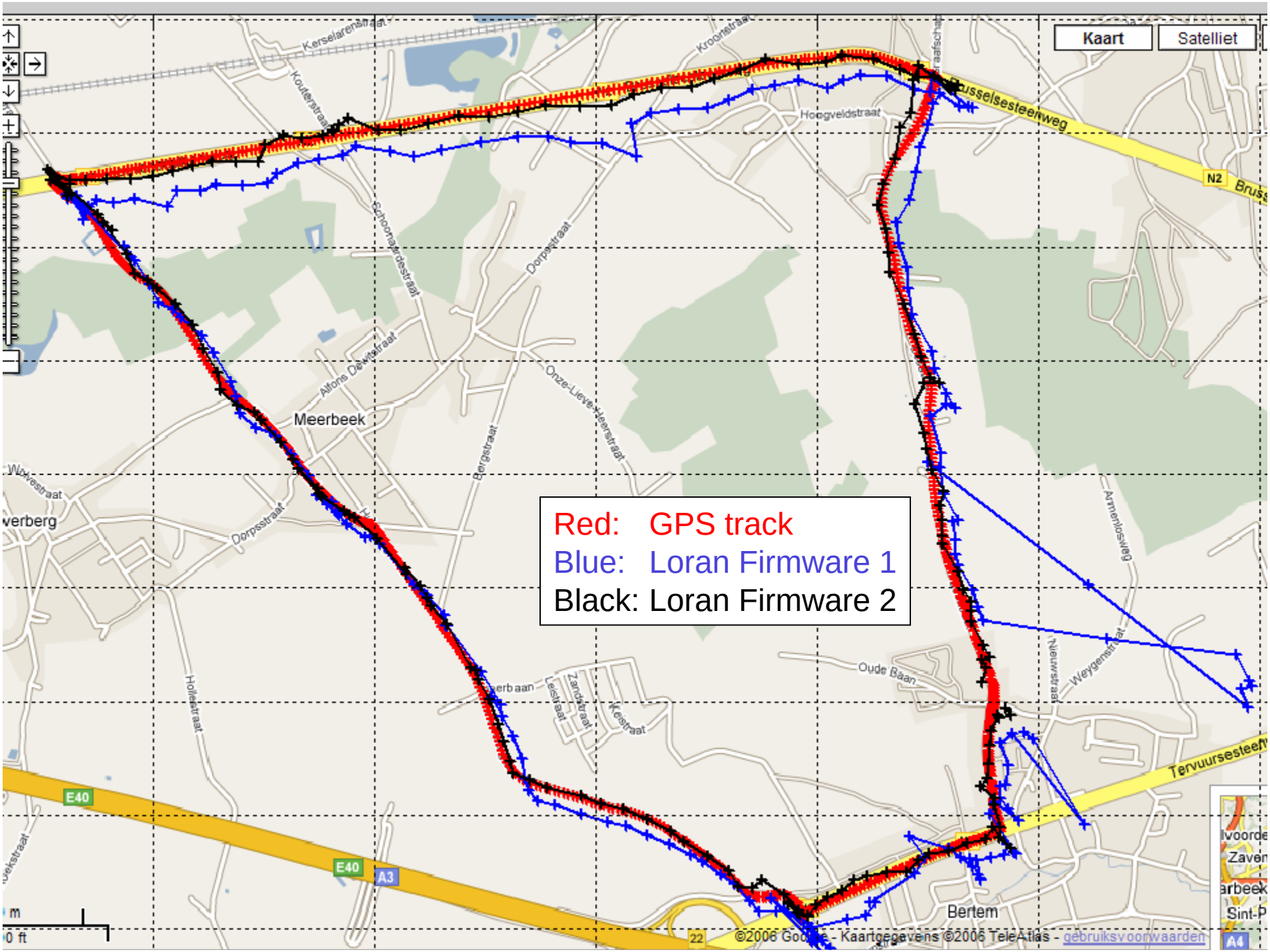
Red: GPS track
Blue: Loran Firmware 1
Black: Loran Firmware 2
Kaart
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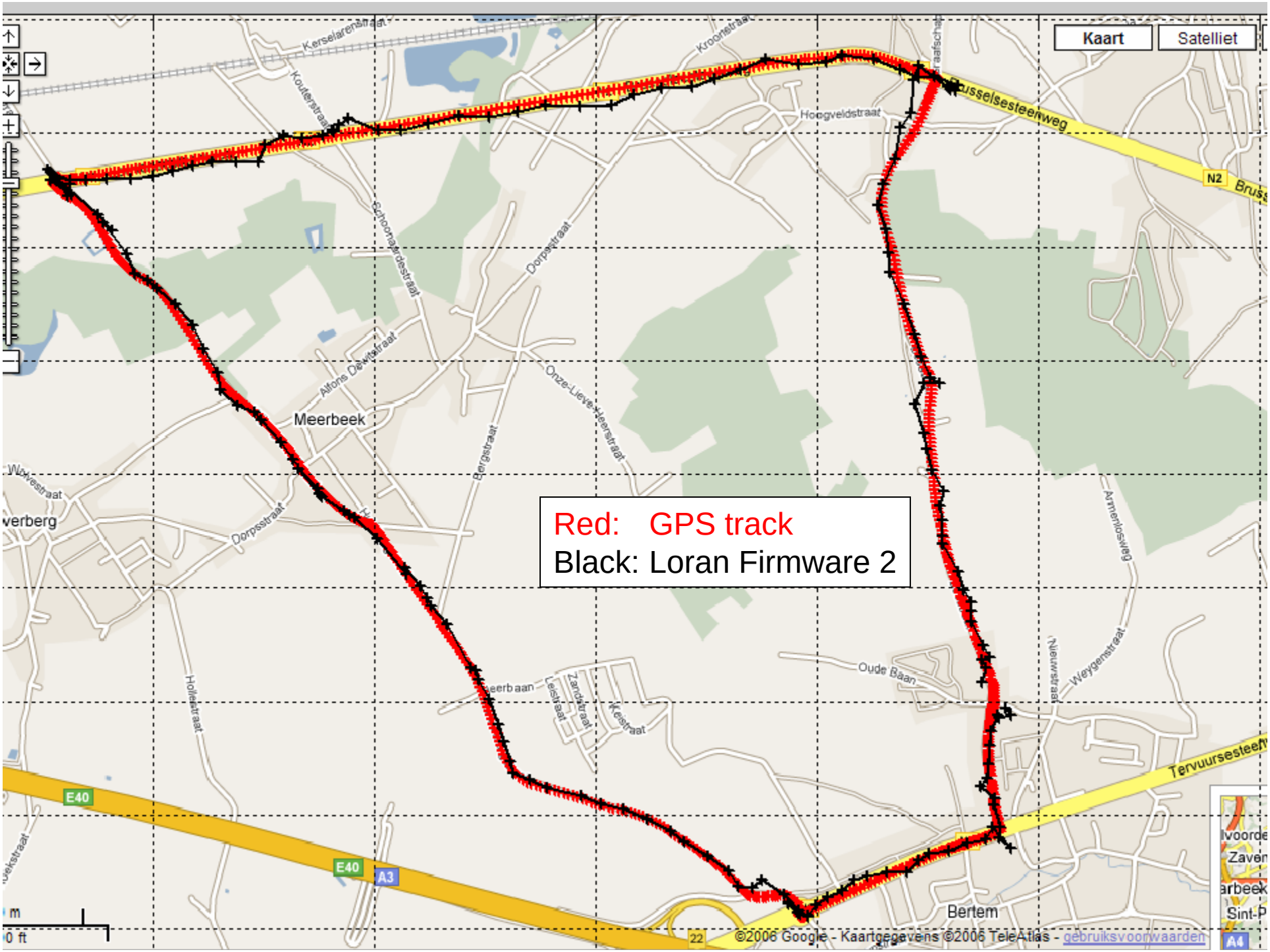
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Loradd UTC receiver development

Loradd UTC series

- All functionalities of a normal LORADD receiver
- Ovenized crystal for improved stability and hold-over (SRS SC10)
- 10 MHz, 2.048 MHz and 1.544 MHz outputs
- 1 PPS (Loran-C derived) output
- 1 PPS (GPS derived) output
- Loran-C Timing Source Station selectable

Loradd UTC
Timing Tests
in cooperation with

The World of Synchronisation

- Telecom networks need timing traceable to an atomic standard
  - Synchronisation - Sync
- Timing needs to be transported around the network
  - Traffic needs timing – whether it be bits or certain types of packet
  - Some applications need timing
- Timing used to be within the traffic
  - Plesiochronous Digital Hierarchy - PDH
- Modern faster methods compromised the transport layer and pushed timing transport to the overhead
  - Synchronous Digital Hierarchy - SDH
- Packet methods compromise sync transport further to the near impossible
  - Asynchronous Transport Mode – ATM
  - Next Generation Networks – NGN
  - Ethernet
- **GNSS (GPS) offers a simple way to bring sync into the network to anyplace anytime**

Buzz Words & Standards

- PRC – Primary Reference Clock
  - Delivers 1 x 10^{-11} sync (Cs)
  - ITU – G.811
  - ETSI – EN 300 462- 6 - 1
- PRS – Primary Reference Source
  - Provides 1 x 10^{-11} sync from GPS/Cs
- SSU – Sync Supply Unit
  - Recovers, filters & distributes sync
  - Flywheels sync on failure of input feed

MTIE / TDEV

Relevant measurements:

- MTIE
  - **Maximum Time Interval Error (MTIE):** The maximum peak-to-peak delay variation of a given timing signal with respect to an ideal timing signal within an observation time $(\tau = n\tau_0)$ for all observation times of that length within the measurement period (T).
- TDEV
  - **Time Deviation (TDEV or $\sigma_x(\tau)$):** A measure of the expected time variation of a signal as a function of integration time. TDEV can also provide information about the spectral content of the phase (or time) noise of a signal. TDEV is in units of time.

ETSI – EN 300 462- 3 - 1

ETSI EN 300 462-3-1
V1.1.1 (1998-05)

Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 3-1: The control of jitter and wander within synchronization networks

7.2.1 Network limits for wander at PRC outputs

The maximum wander that may be generated at the output of a PRC, expressed in MTIE shall not exceed the limits given in table 2.

Table 2: Network limit for wander at PRC outputs expressed in MTIE

MTIE	Observation Interval
25 ns	$0{,}1 < \tau \leq 83$ s
0,3 τ ns	$83 < \tau \leq 1\,000$ s
300 ns	$1\,000 < \tau \leq 30\,000$ s
0,01 τ ns	$\tau > 30\,000$ s

The resultant overall specification is illustrated in figure 3.

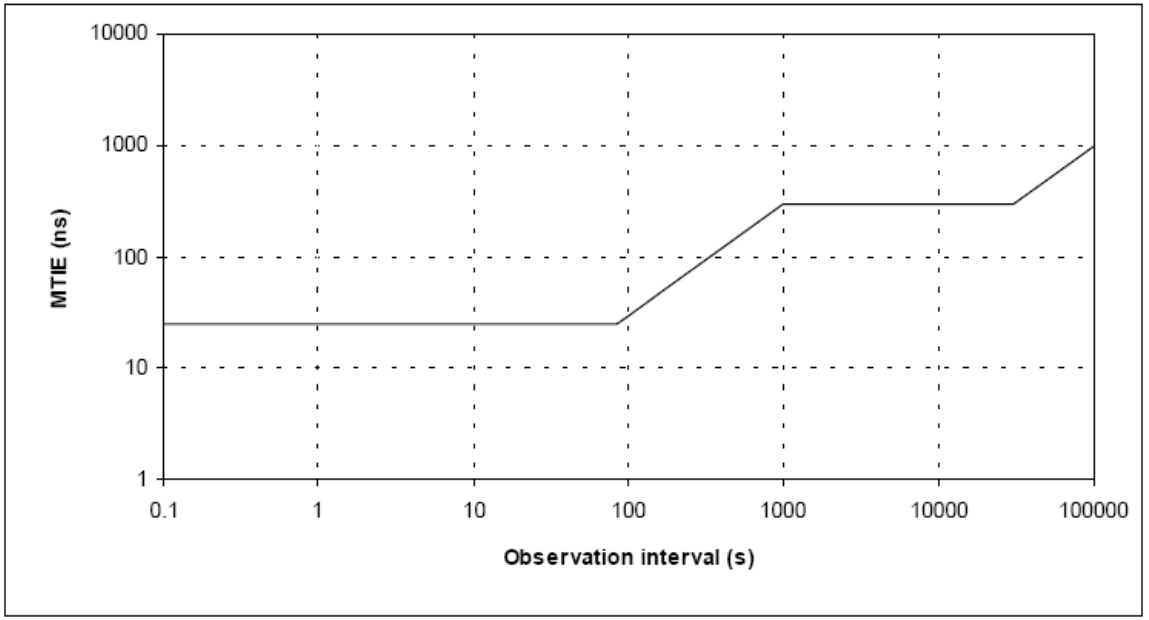
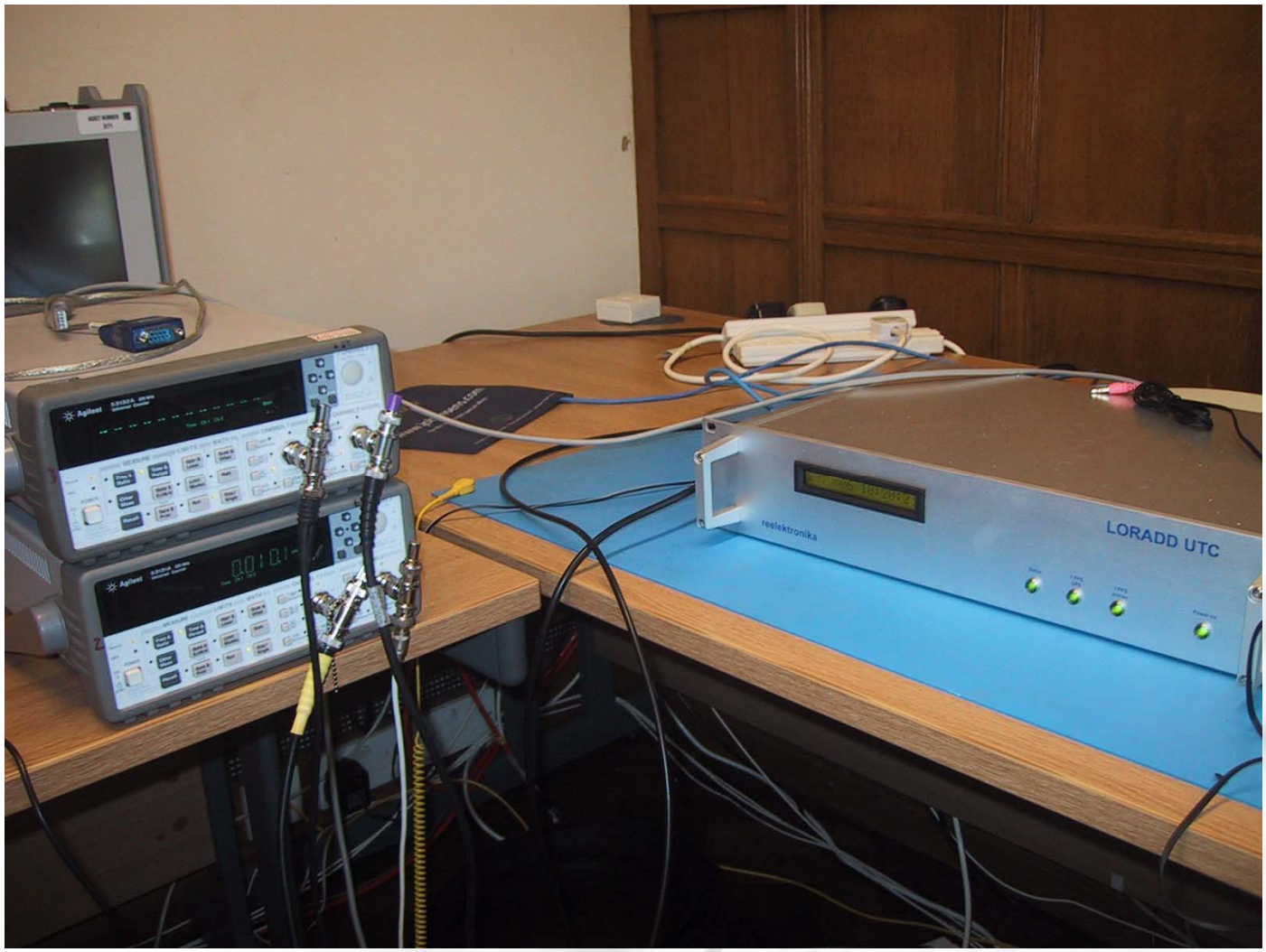


Figure 3: Network limit for wander at PRC outputs expressed in MTIE

Test setup

Test setup



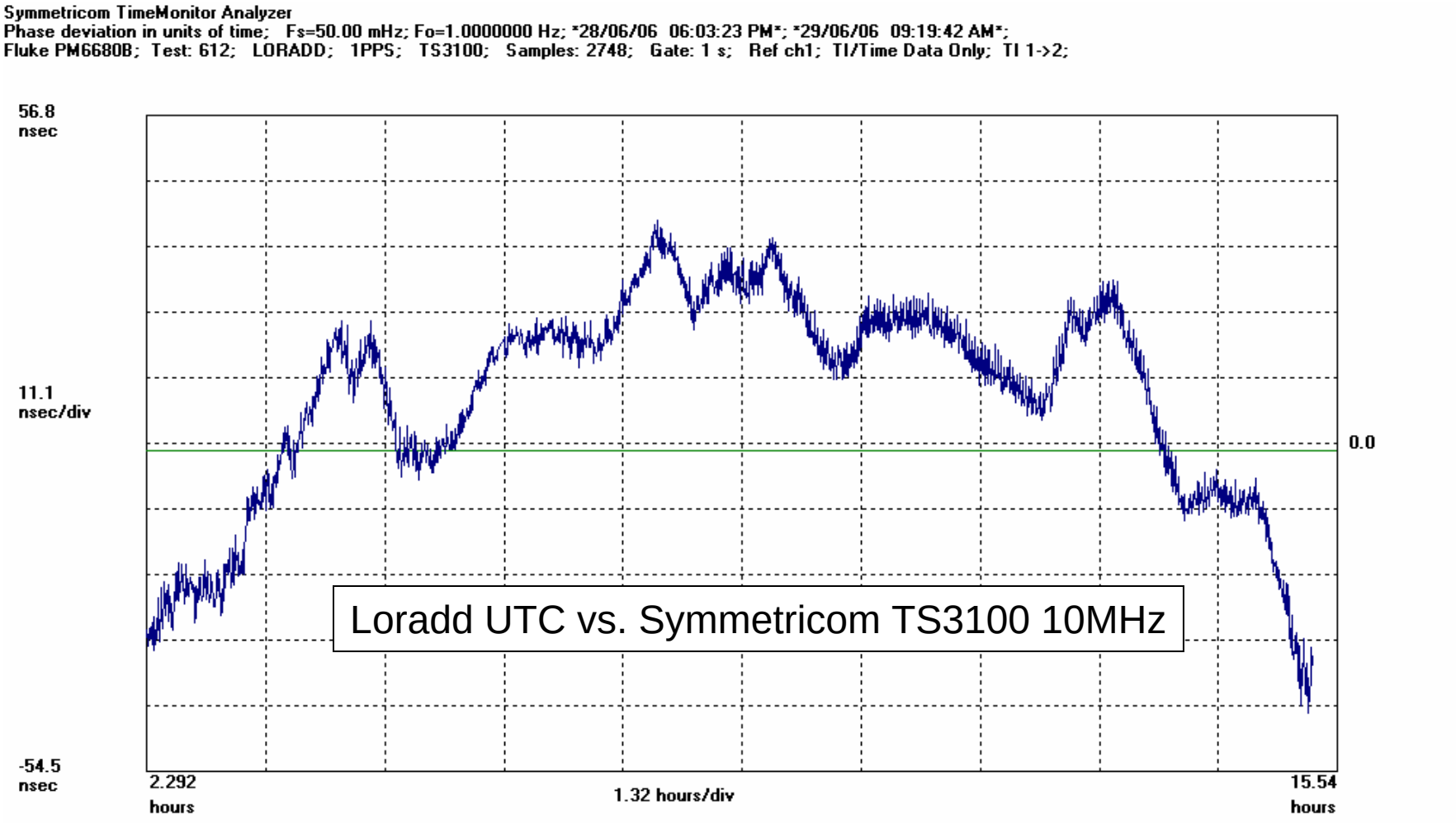
Test setup

- Loradd UTC has been measured against Symmetricom TimeSource™ 3100

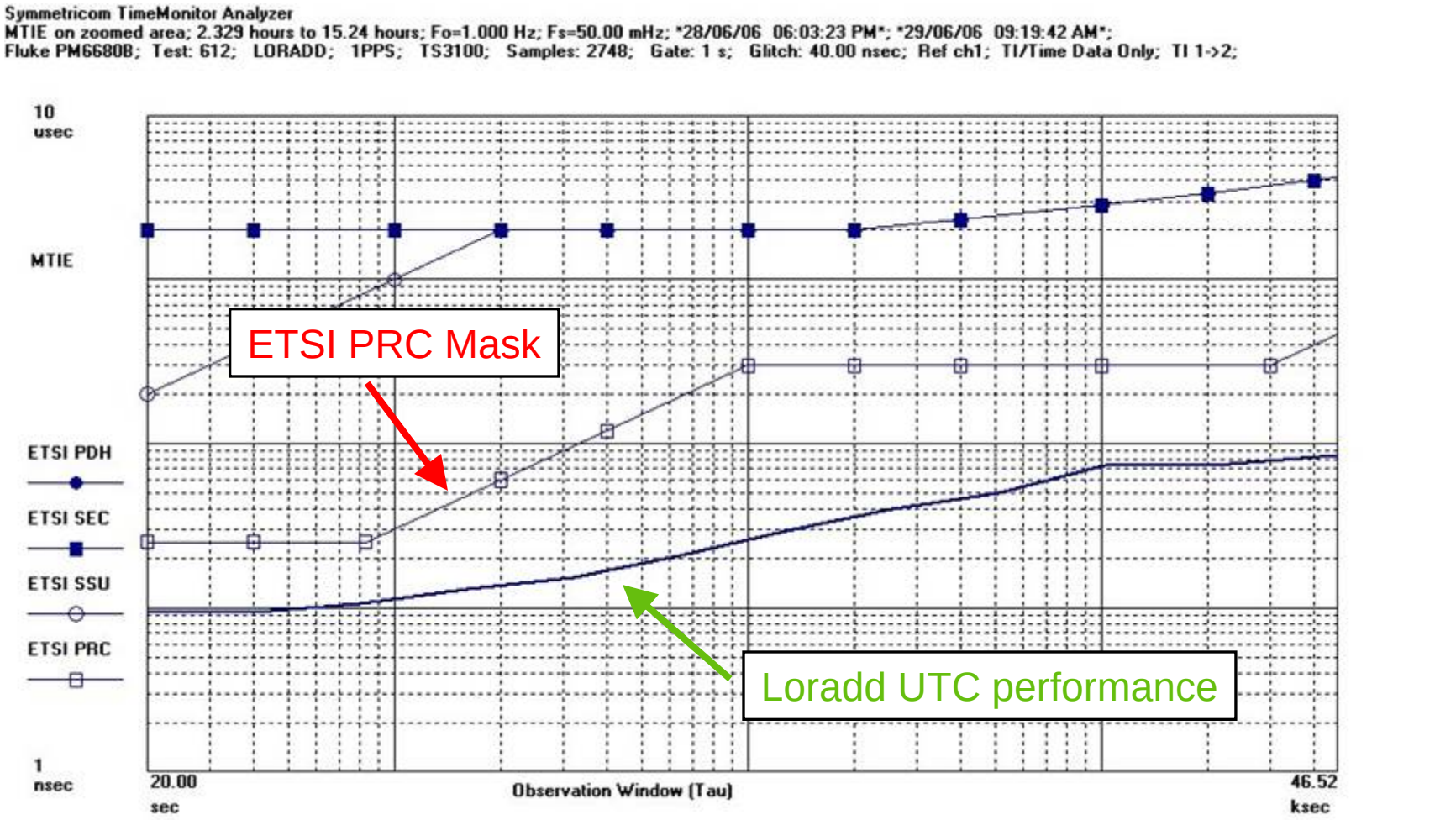
- *“TimeSource™ 3100 is a stand alone office Primary Reference Source (PRS) with integrated GPS receiver which meets ITU-T G.811 network performance requirements. The TimeSource 3100 provides undisturbed frequency and time Stratum 1 synchronization when locked to GPS. Upon loss of GPS, continued Stratum 1 performance can be maintained for up to 72 hours with optional inputs.”*

- Datasheet at www.symmetricom.com

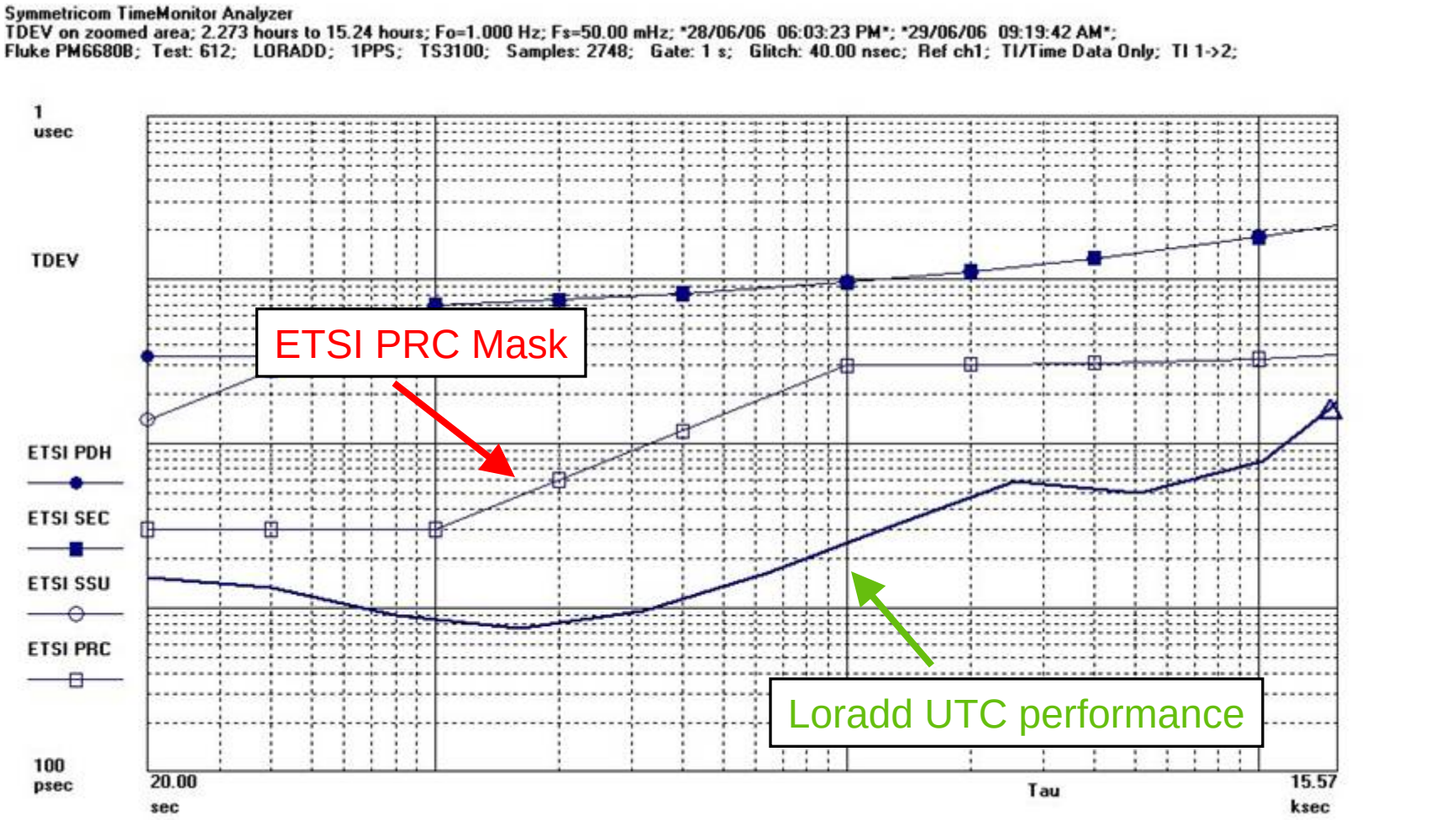
Test results - Phase deviation



Test results - MTIE



Test results - TDEV



Conclusions

- Loran/Loradd meets most stringent requirements as set by ETSI/ITU
  - Can be used as input to SSU
  - Can be included in a PRC due to its dissimilarity to GPS
  - Can be used as low-cost timing source where ever GPS is currently employed in network
  - Antenna may be mounted indoors – even ‘buried’ indoors!
- Cost issues
  - With GPS units available for well below $ 100, Loran units will need to come down significantly for mass application
    - Complexity and components can be reduced
    - Mass production reduces cost
    - Antenna design can be simplified
  - Investment needed
    - Market analysis

One more thing…

Firmware 2 now available to all Loradd owners

Cost: $ 0.00

Download via www.reelektronika.nl

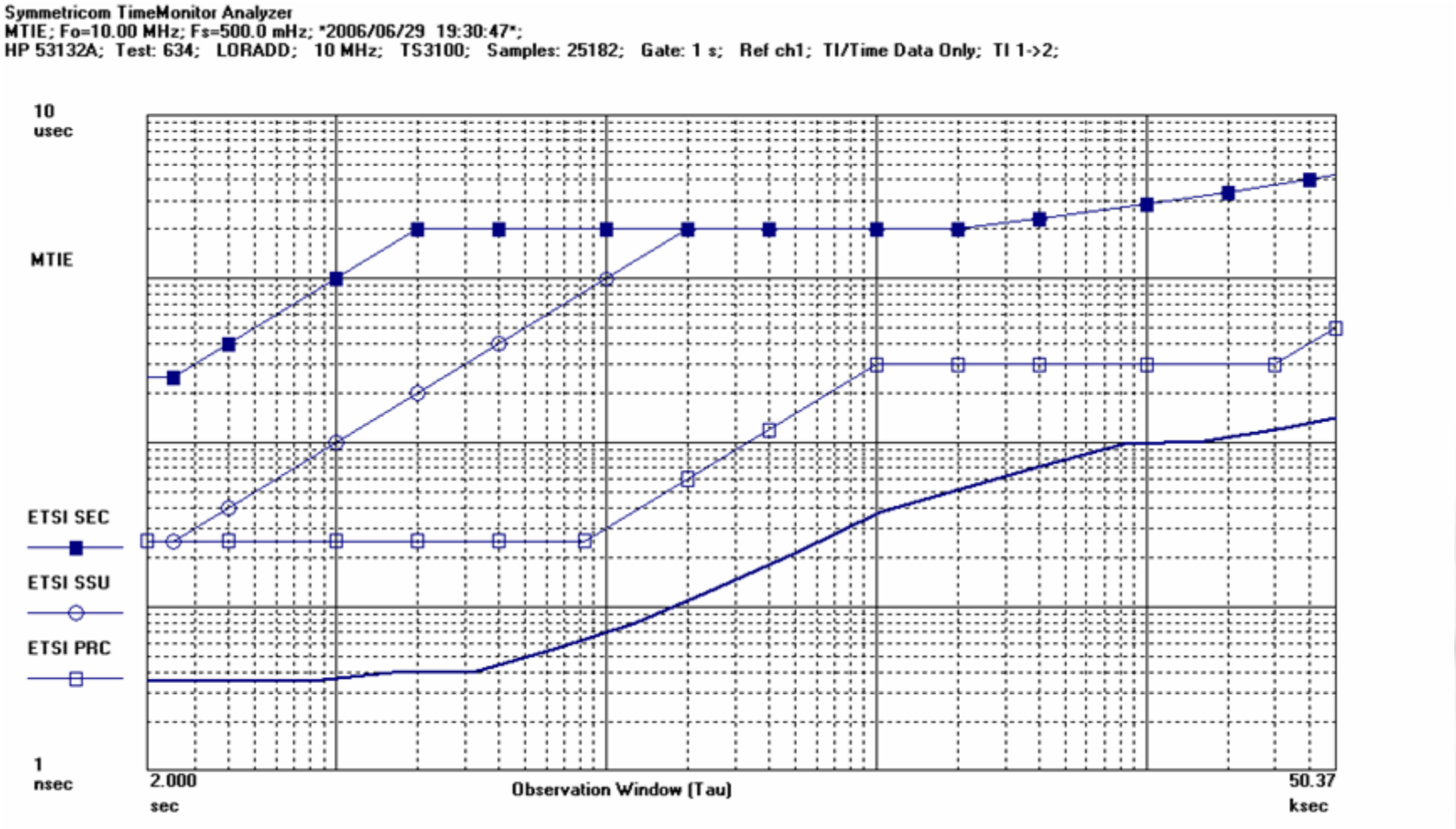
Receive authentication code via e-mail

Backup slides

- INGGA
- INRMC
- New Applications: TomTom, Navigon

Results in lift - MTIE

LORADD UTC 10MHz output (Antenna in lift, ground floor, door closed)



Results in lift - TDEV

LORADD UTC 10MHz output (Antenna in lift, ground floor, door closed)

Symmetricom TimeMonitor Analyzer
TDEV; No. Avg=1; Fo=10.00 MHz; Fs=500.0 mHz; *2006/06/29 19:30:47*;
HP 53132A; Test: 634; LORADD; 10 MHz; TS3100; Samples: 25182; Gate: 1 s; Ref ch1; TI/Time Data Only; TI 1->2;