xProGPS_max

OPERATING MANUAL - VERSION 2.2

Modification Log

Document-Nr.	Versions and changes	Type of Change[1)]	Release date
30-12-2014-01	First edition (English Version)		30.12.2014
13-01-2015-01	Block Diagram added	A	13.01.2015
20-04-2015-01	Connector Pin-Out modified, SD-CARD-LED added	A	20.04.2015
12-10-2015-01	Connector Pin-Out PLU modified	A	12.10.2015
08-05-2020-01	Connector definition Speed In / PLU corrected	A	08.05.2020

1) A: Changes as a result of enhancements / improvements to the specification

B: Changes to provide complete or, as the case may be, external compatibility

C: Changes which reduce or exclude compatibility

Content

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KEY-FEATURES

xProGPS_max is an extremely flexible and powerful GPS Speed Sensor and Data Acquisition System providing GPS information with a native data rate of 100 Hz. The high data rate specially is of importance for the speed data as speed in almost any test appication is the most essential input. The extreme data rate combined with an absolute precision much better than conventional GPS makes **xProGPS_max** the perfect choice for all automotive test scenarios.

The 100 Hz receiver unit has been specially selected for a perfect performance of speed changes with high dynamic as seen in applications such as brake tests or standing start tests. With the help of our Windows softare package dynamical behaviour can be fine tuned and adjusted to individual needs.

The main GPS receiver of **xProGPS_max** is assisted by an additional 10 Hz GPS unit with an extremely high sensivity. By combining the information of these two receivers GPS data will be available even in situations where the main receiver cannot detect satellite signals.

Precision of the current vehicle position in standard mode is already better than 2.5 m CEP and can be improved by additional equipment if necessary. Deviation for GPS altitude data however usually is limited to around 10 m. To achieve a better precision for the altitude, **xProGPS_max** is equipped with a barometric pressure sensor, which pushes static precision to around 2 meters.

xProGPS_max communicates via 4 CAN busses, 1 USB and 1 standard COM port. When attaching our separate driver display to the COM port **xProGPS_max** will be a complete stand-alone data acquisition system logging data rapidly to the internal SDHC card.

The provided number of 3 user accessible CAN busses will read data at speeds of up to 1 MBits/sec. Typical applications are interfacing to the vehicle CAN plus some of our CAN extension units such as our inertial sensor **xProINS** or our 32 channel thermocouple units **xProTherm32 etc.** CAN bus #4 is reserved for internal communication of **xProGPS_max**

There are 2 additional counter inputs so that convential incremental decoders can be attached to measure vehicle speed or fuel consumption. In this way the system provides means to measure wheel slip or to provide a speed information even in situations where a GPS signal is not available or of not of good quality.

Besides communicaton through the digital output channels **xProGPS_max** sends out data also on 2 analogue outputs. There is also a programmable frequency synthesizer installed which converts any of the input channels into a frequency. 3.3V-TTL level or Open Collector output can be selected by DIP switches.

Tests can be triggered by a special trigger input. Users do have the choice to apply either a passive contact, such as a brake pedal switch or an active sensor such as a light barrier.

Last but not least, there is a 1 pulse per second output to precisely synchronize several DAQ units in a more complex test environment.

Of course **xProGPS_max** is built in automotive quality and has been designed using the latest chip and software technologies. Thus it will be a valuable instrument to support our customers for many years in their daily test work.

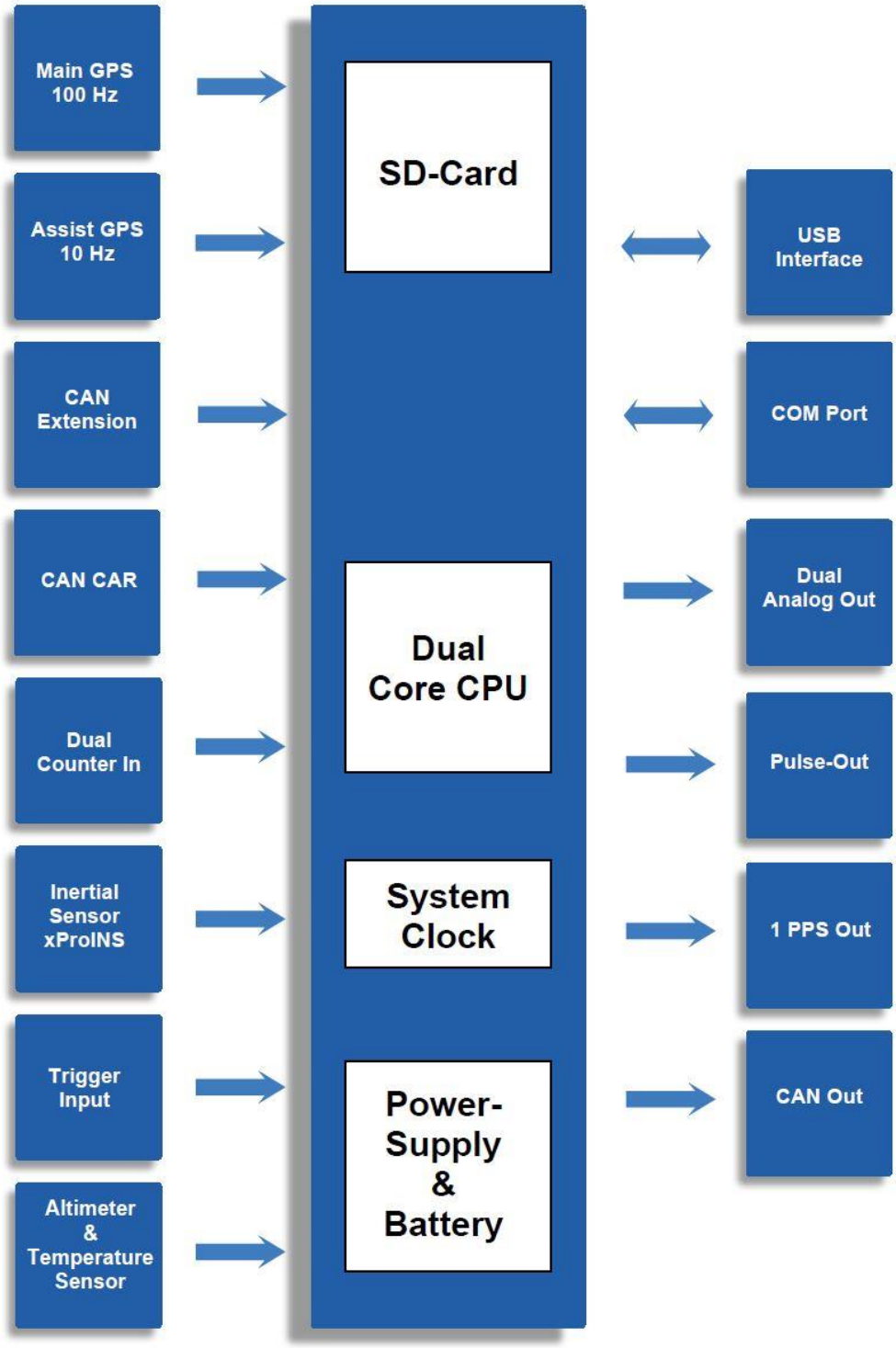
Depending on the purchased software options **xProGPS_max** can be used in several constellations:

1. Precision GPS Speed Sensor with a native data rate of up to 100 Hz and optional integration of xProINS inertial sensor
2. Powerful Performance Test System (Standing Start, Flexibility, Coast Down, Fuel Eco and Brake Test)
3. Speedy CAN-Logger sampling up to 3 independent CAN busses plus GPS to internal SD-Card
4. CAN Gateway to route 3 CAN busses into one single output CAN (Inertial Sensor, Thermo Units)
5. Logging of vehicle CAN supporting several protocols

xProGPS_max can be used in several operating modes making it extremely flexible:

1. Sensor mode sending collected GPS / CAN data to another DAQ system via CAN, USB or COM-Port
2. Complete Data Acquisition system in combination with a Laptop and xProGPS Windows software package
3. Robust Stand-Alone Data Acquisition system storing GPS plus CAN data to SD-Card while monitoring on a separate driver display for applications where size of system or temperature range or mechanical stress matters

Block Structure xProGPS_max



QUICK START

FOR QUITE QUICK PROFESSIONALS ...

- Fix the magnetic antenna in the middle of the vehicle roof
- Lead the antenna cable, without kinks, inside the vehicle
- Connect the antenna to the **xProGPS_max** unit (choice of antenna input main receiver or assist)
- Connect one of the outputs of **xProGPS_max** to your measurement equipment (use CAN-Out for a CAN communication, use DAC 0/1 for an analogue interface, use Pulse Out for a digital counter input or simply connect to a USB input)
- Setup your CAN data acquisition to communicate with **xProGPS_max** (read-in dbc-file from CD-ROM which comes with the system) or refer to CAN definitions at the end of this document
- Do a final careful check of the cabling before powering up
- Observe all safety regulations for cabling, positioning of components etc.
- Connect **xProGPS_max** to a suitable power supply with 11 … 30 V DC and power-up the system. Sufficient Power must be applied throughout the time you are using the instrument. Even a short power-fail will lead to a shut-down in order to protect open files on the SD-Card.

By default **xProGPS_max** outputs are already pre-configured.

Default standard settings for the individual outputs are defined as

1. CAN: Bit rate 500kBit, default Base Address 500H, Identifier definition please see .dbc file on CD-ROM or description at the bottom of this document

2. Pulse Output (Frequency): Source: Speed of 100 Hz Receiver, Level: 3.3 V TTL, Scaling: 5000 p/m

3. DAC-Output (Analogue): DAC 0 Speed 0-250 km/h Scaling 0-10 V, DAC1 Altitude 0-10000 m Scaling 0 – 10 V

As soon as power is applied **xProGPS_max** will perform a self-test while front LEDs will be flashing. After around 3 seconds self test is terminated and 2 beeps will signal that the instrument is in normal operation mode.

According to the status of the 2 internal GPS receivers, the LEDs next to the antenna plugs will start blinking around 50 seconds after power-on. The number of flashes on the LEDs will inform you how many satellites are seen by the individual receiver.

Usually the receivers will be ready with their initialization within around 1 minute. However when moving the instrument for a large distance in off-state, the almanac will have to be recalculated, which can take a couple of minutes. As soon as the system is recalibrated it is a good idea, to reboot the system again.

Active input and output channels (CAN, DACs etc.) are signalled by a status LED.

Data storage to the SD-Card is initiated either by activating the trigger input or by an attached driver display. Alternatively the system can be initialized to start data storage to SD card as soon as power is on. This feature can be activated in the xProGPS Windows software package.

Writing to the SD-Card is stopped by sending another trigger pulse or by a programmed software trigger. Data storage is automatically stopped when there is a power-fail or when switching it off. An active write process to the SD-Card is indicated by a flashing LED next to the 1 PPS BNC socket.

To protect your data **xProGPS_max** comes with an internal battery, which provides enough power to safely close all open files and switch down the system into power-down mode. This battery is not intended to operate the system for a longer period of time.

STARTING UP – STEP BY STEP

xProGPS_max can be installed within a couple of seconds. However before the first start-up we recommend to carefully study the detailed explanations and operating instructions below.

CONNECTING THE GPS RECEIVERS (DUAL RECEIVER DESIGN)

As there are 2 independent GPS receivers in **xProGPS_max** of course there are also 2 antenna inputs on the front panels. The SMA input “Antenna” is for the 100 Hz main receiver, the SMA “Assist” is for the high sensivity 10 Hz assist receiver.

The dual receiver design allows greatest flexibility. For high end applications the 100 Hz GPS will be the best choice as the extremely high data rate is perfect for brake tests, standing start tests etc. This will give a perfect resolution on the time axis of your plots.

The assist receiver is by a factor of 10 more sensitive to satellite signals and works on a different decoding technology. This receiver is best when running tests on public roads in areas with lots of trees or high buildings or in mountain areas with high rocks close to the track.

You can even order a **xProGPS_max** without the costy 100 Hz unit when your application is more on the side of logging lots of CAN data from several busses. This will reduce costs of the system dramatically, though providing almost identical functionality.

In case you would like to just work with one of the GPS receivers of course only antenna has to be attached to the corresponding SMA input.

CONNECTING THE GPS ANTENNA

Choose a suitable position for the GPS receiver within the vehicle, ideally close to the main data acquisition system. Consider mechanical fixing in order to prevent injury in the event of an accident.

Be sure to switch off the external data acquisition equipment before connecting the receiver.

First select a suitable position for the magnetic antenna. The antenna should be placed in the middle of the roof in order to achieve the best possible reception. Where the vehicle has a roof rack the antenna must be mounted above the rack. Be certain that the antenna is secure as vibration can lead to measurement errors.

Carefully lead the antenna through a door column to the inside of the vehicle. Be careful that the cable is not squashed or heavily kinked as a short circuit in the cable could damage the receiver.

Screw the SMA antenna plug into the xProGPS SMA plug. Be sure that this occurs when no power supply is connected as otherwise the equipment may be damaged. Screw down the nut that locates the plug very carefully. The (mother) plug must on no account be subject to excessive force.

To ensure that the antenna will not come loose at very high speeds please also use industrial tape to secure the antenna cable.

Do not install the antenna inside the test vehicle as the metallic parts within the vehicle can cloak reception. In vehicles with soft tops (Cabriolets) an attempt could be made to fix the antenna within the vehicle.

Note: **Do not place the magnetic antenna on floppies or hard disk drives!**

Danger of data loss!!!

SD CARD AS DATA STORAGE MEDIUM

During an active data acquisition data is stored onto the integrated SD card of **xProGPS_max**.

Data is written in a Microsoft compatible format. In this way data transfer to a PC is an easy matter as files generated by **xProGPS_max** can immediately be read by a without any conversion.

As an outstanding feature, we support FAT32 format, thus eliminating the 2 GB file size limitation of the conventional FAT16 format, which still is widely seen in competitive products. Due to FAT32 SD-cards with a capacity of up to 32 GByte can be used.

We also support long file names, not restricting file and folder names to the "8.3" format. So data files can be perfectly organized.

Please note:

- Formatting a SD Card should only be done using the FAT32 format
- SD Cards should only be inserted / removed while power of **xProGPS_max** is down
- Before removing the SD card take care the system actually has shut down and is not in battery back-up state

We recommend using a special flash card in industrial quality and with high speed specification. Compared to cheaper commercial products these devices show an increased number of write cycles, higher data transfer rates and a wider temperature range.

It is essential that the SD card provides a continuous data throughput of 45 Mbit/sec as otherwise data losses can occur. We do not recommend using low-cost SD cards !

A good card at a reasonable price will be i.e. SANDISK Ultra 32 GB

From time to time you should format the SD card again to refresh eventual data corruptions of the directory area. You should also always have spare SD card with you so that in case a card gets faulty you still can continue your work.

There is a LED close to the USB connector which signals data access to the SD-card.

PROPER UTILISATION

xProGPS can be used to measure vehicle speeds and record GPS information and / or CAN bus data from 3 separate busses and either store data to the built in SD card or send the collected information out to another data acquisition system such as our powerful **xPro_2HE-PCI** or to a laptop.

xProGPS should only be used with measurement systems approved by us and using accessories that we have supplied. Any other usage will be considered as not being in accordance with this agreement. The consequences of this will be the operator's responsibility.

Please be aware:

- Correct utilisation also includes adherence to mounting, start-up, operation and maintenance conditions, the EMI notes as well as suitable disposal measures.
- Only qualified, assigned and trained personnel should work on or with the equipment. In addition the operator should school the personnel about possible dangers that may occur.
- The operator must ensure that these operating instructions are understood by all persons who will work with the equipment.
- An example of the operating instructions should always be available where the equipment is being used.

INTRODUCTION TO GPS TECHNOLOGY

xProGPS_max takes its information from the NAVSTAR Global Positioning System of the US defence ministry. At the present time this system can be used at no charge by civilians.

Within the American satellite system 28 satellites are stationed above the earth at a height of around 20.000 km. These satellites follow 6 different orbits with a period of about 12 hours.

Each satellite is equipped with four atomic clocks to provide the highest possible accuracy. Each satellite transmits the precise time and the exact satellite position to earth on the frequency of 1.57542 GHz.

As the radio waves travel at the speed of light, the time the signal takes to reach the surface of the earth is 67.3 msec. Each additional kilometer takes an additional 3.33 µsec.

To define that location over GPS, signal run-times of at least 4 satellite are determined. Using triangulation it is possible to calculate the precise position of the receiver on the surface of the earth.

xProGPS processes this data using a set of filters and other mathematical means and provides the results over a variety of standardised interfaces using a largely spreaded protocol.

The NMEA data provided has standardised naming conventions and standardised data content.

NMEA name	Data Content
GGA	UTC-Time, longitude, latitude, Status, accuracy, altitude, number of satellites used, Geoid Separation, age of the diff. correction data, ID of the DGPS reference station
VTG	Heading in Degrees True, Heading in Degrees Magnetic, speed over ground in knots and km/h
ZDA	UTC-Time, Date, Local Time Zone offset from UTC

The processing unit inside xProGPS_max reads in these data sets, processes them and sends them via the available interfaces to external computer systems.

System specific proprietary NMEA records are generated by xProGPS_max to support special measurement tasks. These are processed by our xProGPS Windows software:

ZDL	Header record (only once per file) Information on several sensor settings e.g. Start of measurement, source of speed informaton (GPS or Speed Pulse input), speed pulse factors, etc.
ZHT	Information calculated from Barometric Pressure Sensor: Altitude [m], Air pressure absolute [mbar], Air pressure NN [mbar], Sensor temperature [°C]
SPU	Information calculated from Speed Pulse Input (detailed information on request)
INS	Information calculated from Inertial MEMS Sensor xProINS: Accelerations in X,Y and Z, Gyroscope data in X, Y and Z, etc.
TTT	Precise time stamp of trigger input (used for brake test or distance calculations)

Alongside pure speed information xProGPS also supplies a vast of additional information:

- Precise positional data in the form of Longitude and Latitude
- Output of the geodetic altitude above mean Sea-Level
- Precise time details
- Information of driving direction
- Output of the reception quality
- Output of satellite information
- and much more……

HOW IT WORKS

xProGPS_max is a highly accurate sensor that allows vehicle speeds to be recorded with contactless technology.

xProGPS_max calculates the speed of a vehicle using special analysis of GPS signals. In a method similar to Radar the speed of the vehilce is derived from the run-times of the satellite signals using Doppler-Effect calculations.

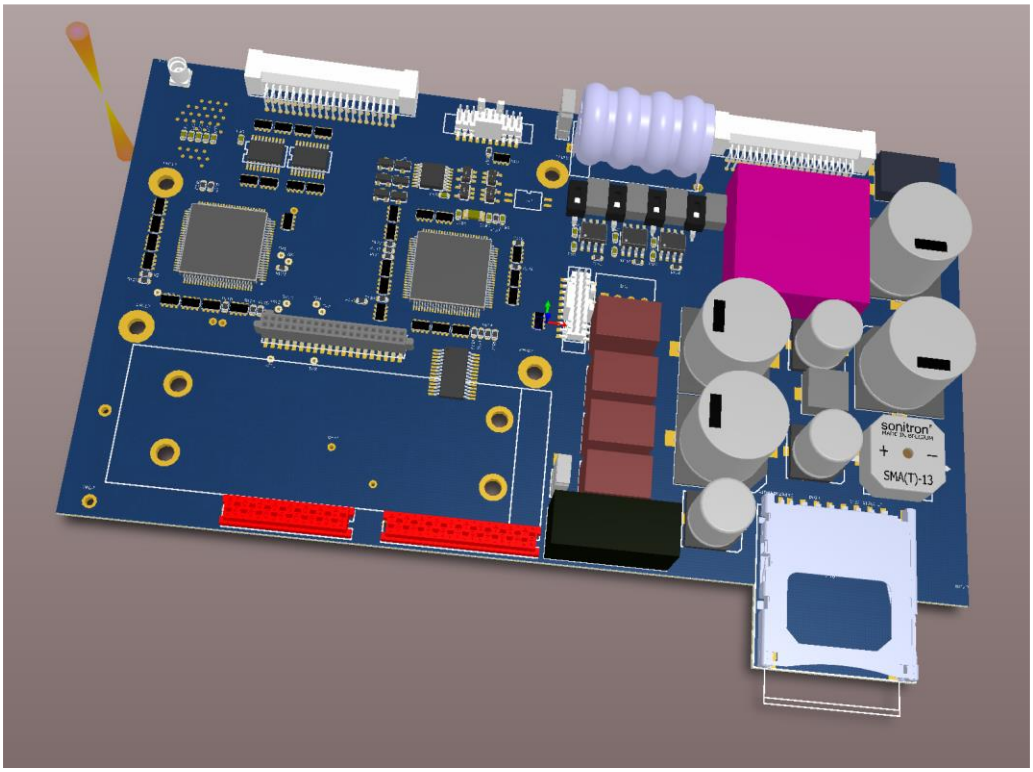
This information is distributed from a high performance processing unit and supplied across various Interfaces:

xProGPS_max allows almost any measurement system to access GPS technology – without the need for special Software to support GPS Protocols.

Location accuracy for standard receivers is approximately 2.50 meters CEP. Using additional instruments and the help *of Differential GPS* the accuracy of the position information can be improved to better than one meter.

xProGPS_max can also store data on the integrated SD card. This allows **xProGPS_max** to be used as a very high performance stand-alone data logger. Data is stored in Microsoft FAT Format, which allows a more simple data transfer to a standard PC.

FAT32-Format with longer file names is been supported as well as SD cards with up to 32 GByte of capacity.



xProGPS_max is built around a cluster of ARM controllers which communicate via high-speed channels to reduce latency to a minimum.

xProGPS_max comes in a robust metal housing and with industrial standard Lemosa sockets. Power supply is in the automotive range of 10 … 30 VDC and is internally buffered by a backup NiMh pack.

SETUP OF AIR PRESSURE AND BAROMETRIC ALTITUDE

As an extra feature xProGPS_nano is equipped with a precision barometric sensor to measure altitude. This technology usually is seen in smaller aircrafts.

To convert the physically measured “pressure” into altitude is a complex mathematical process**. xProGPS_max** does all the conversions in the firmware, so you don’t have to worry for it.

To receive a correct altitude reading the reference altitude must be calibrated before starting a measurement. Starting from this reference altitude the barometric sensor will dynamically calculate altitude with a changing air pressure.

Please note that the local air pressure at a certain position is not a fixed value and changes continuously with the weather conditions. Therefore the base altitude has to be re-calibrated by setting the correct altitude after a reasonable time.

To set up the reference altitude you can choose one of the following options:

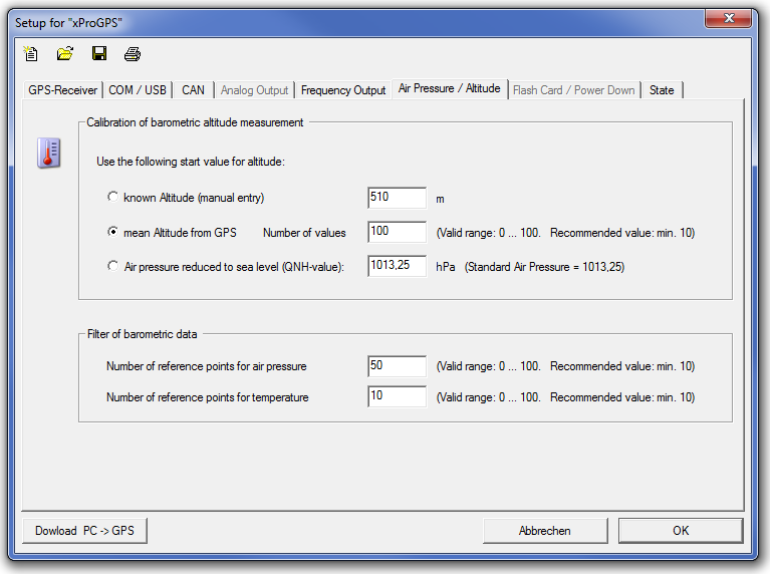
- Automatically set the reference altitude by using the geological altitude which the GPS receiver of xProGPS_nano provides. An automatic calibration cycle is initiated at power-up of xProGPS_nano. This is the default option.

- Set the reference altitude to the known altitude of the reference, i.e. entry of test circuit

- Set the known air pressure (QNH) of the reference position before starting a measurement. You can get the current QNH value from internet.

To set the preferred method please use the provided **xProGPS** Windows software package. Here you can choose from several options and download the selected settings into the **xProGPS_max** sensor unit. After a new setting has been downloaded please boot the **xProGPS_max**.

Open xProGPS Windows software tool and select the “Setup” menu. Here you will find a folder named “Air pressure / altitude” which provides the setting options for the barometric pressure sensor.



APPLICATION AND USAGE OF THE XPROGPS SPEED SENSOR

The GPS based speed calculation is the result of highly developed DSP technology and meets the highest requirements:

xProGPS_max can provide speed information starting at speeds of less than 0.1 km/h and is significantly more effective than any other contactless sensor technologies. This is particularly effective in measurement of acceleration from a standing start, braking or coast down tests.

The speed information provided by **xProGPS_max** is linear across the complete range of measurement and is just as precise even at top speeds of Formula 1 cars. For dynamic acceleration the **xProGPS_max** provides readings with almost no delays.

xProGPS_max is the perfect sensor for all drive tests where a high level of accuracy and reliabilty is required.

- Fuel consumption measurements
- Vehicle Performance tests
- Coast-Down
- Endurance Tests
- Test rides on public roads and highways
- Distance measurements
- Dynamic measurement of track altitude
- and much more…..

The Sensor System can be installed within seconds. Apart from positioning the magnetic antenna and providing power supply to no other attachments are required on the vehicle.

You will have just to

- attach the miniature magnetic antenna on the roof top of the vehicle
- connect the antenna to the xProGPS
- provide power supply to the device

… and measurement can start straight away !

ADVANTAGES OF THE GPS SPEED SENSOR

GPS technology opens a lot of new opportunites for high precision data acquisition:

- practically no change to vehicle wind resistance
- no slippage
- no dependency to the vehicle speed as seen with wheel mounted sensors / 5th wheels
- not depending on road conditions such as wet roads, sand, ice, snow etc.
- high resolution, perfect linearity and excellent dynamic behaviour
- almost no delay / perfect real time behaviour
- can be used in difficult terrains i.e. for tractors or tanks
- quickly mounted
- operates across a large band of temperatures and mechanical stresses

The safety aspects of **xProGPS_max** also provide advantages. As except for the antenna no additional parts have to be attached outside of the vehicle, there is no risk from retainers / sensor units should they become loose from the vehicle.

xProGPS_max offers a speed sensor system which fulfils all needs of todays most demanding data acquisition tasks with respect to accuracy, ease of use as well as super fast installation.

XPROGPS_MAX GENERAL INFORMATION

The System contains a high precision GPS receiver which provides speed data of up to 100 Hz. Compared to commercial GPS receivers with only 1Hz capability, a significantly improved positioning accuracy and a high resolution speed signal can be provided.

After being switched on the receiver needs a certain amount of time before valid data is available at the various outputs. The boot-up time is dependent on various conditions:

Cold Boot

Equipment has been switched off for more than 2 hours or has been transported over a long distance in the meantime. A cold boot takes around 3 minutes; an initial boot, where no Almanac is available, under difficult conditions can take up to 20 minutes.

Warm Boot

Equipment has been switched off for up to 2 hours. The current position is the same as the last Power-On position. A Warm Boot takes around 50 seconds.

Hot Boot

Equipment is already switched on, but there has been a break in reception for example due to loss of the satellite due to line of sight obstruction. The current position is the same as the last Power-On position and a valid almanac is available. Usually xProGPS will start to deliver new values within a couple of seconds.

In normal operation a boot time of between 30 and 60 seconds can be expected.

QUALITY OF THE RESULTS

The accuracy of the GPS information is extremely high and in most cases significantly better than any conventional measurement technologies. A prerequisite for the high accuracy is however a perfect reception of the satellites signals.

Therefore, when using our GPS-Receiver it is necessary to consider that a free view skywards is always available. The more satellites that are available for the calculation, the more accurate the results will be and therefore the weakness of one reception channel will lead to less noise in the measurement data.

Even though the system can deliver results using just 3 satellites, for reliable operation a minimum of 6 space vehicles should be available continuously.

LIMITATION OF ALTITUDE AND SPEED

Because of the US Governments COCOM regulations the maximum height for measurement by the GPS receiver is limited to 18.000 m. The limit for speed measurements is 515 m/s.

The minimum speed that can be permissibly measured with our receiver is about 0.1 km/h depending on the signal quality and the number of satellites seen by the receiver.

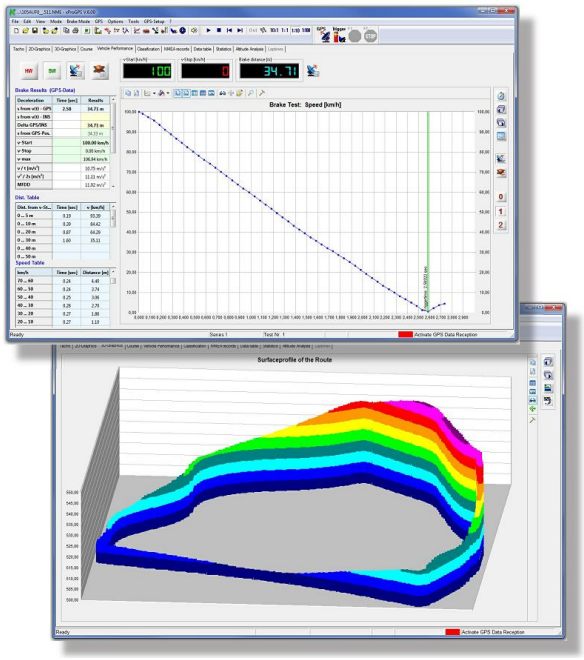
OPERATING MODES OF XPRO GPS

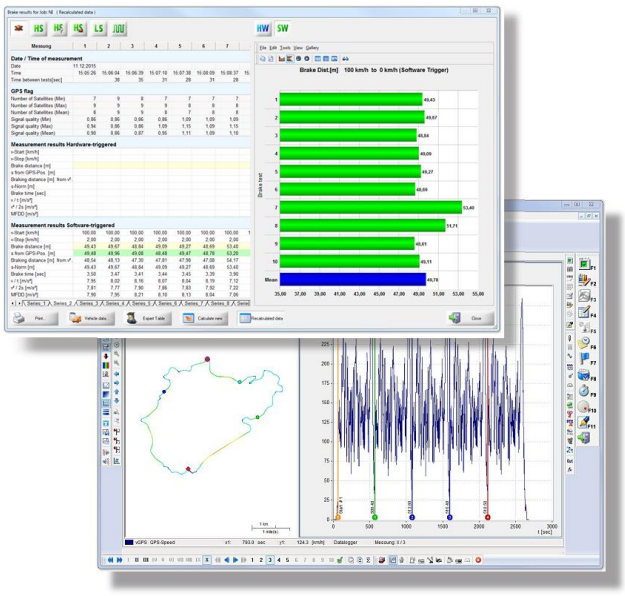
xProGPS_max can be operated in 3 different modes:

- Sensor mode – as a speed sensor attached to another data acquisition system
- PC mode – team work of xProGPS_max and a Laptop for data storage and visualization
- Stand-Alone mode – super compact high performance data acquisition system
- Brake-Test mode – Setup with xProGPS Windows Software, Data acquisition in Stand-Alone Mode, Analysis of Braking results on a Laptop with xProGPS Windows Software

xProGPS_max is supported by xProGPS Windows setup software and by the **xProGPS_Win** data analyzing tool.

Dozens of different diagrams and spreadsheets can be created. Just see some samples below.





XPRO GPS IN SENSOR MODE

In this operating mode **xProGPS_max** works as a precision sensor providing GPS information for speed, position, heading etc. to another data acquisition system.

In addition to the GPS data provided from the 100 Hz main receiver further data can be sent out:

- Altitude information from the built in barometric pressure sensor
- CAN data from external extension and signal conditioning units
- GPS information of the high sensitive assist receiver
- Data from the **xProINS** inertial sensor

xProGPS_max provides several communication channels to export above data to another system:

- CAN-OUT sends out collected data on a separate CAN bus
- DAC 0 / 1 provides 2 channels of analogue output with 0 … 10 V range and 16 bit resolution
- PLL provides 1 channel of frequency output i.e. for fifth wheel simulation
- USB sends out GPS data onto the USB
- COM sends out data on a V24 port (alternatively used by the driver display)

All communication parameters plus the selection of the channels to transfer can comfortably be set in the xProGPS Windows software package.

There is a default setting which will already be a perfect solution for most cases. In case these standard settings already fit to your application, you are ready to run.

Just apply power and **xProGPS_max** will perform a self-test while front LEDs will be flashing. After around 3 seconds self test is terminated and 2 beeps will signal that the instrument is in normal operation mode.

Under normal conditions after around 60 seconds from a cold boot GPS data will be available (-> see LEDs next to SMA antenna socket).

When done, data is automatically sent to the specified interfaces.

1. CAN: Bit rate 500kBit, default Base Address 500H, Identifier definition please see .dbc file on CD-ROM or description at the bottom of this document

2. Pulse Output (Frequency): Source: Speed of 100 Hz Receiver, Level: 3.3 V TTL, Scaling: 5000 p/m

3. DAC-Output (Analogue): DAC 0 Speed 0-250 km/h Scaling 0-10 V, DAC1 Altitude 0-10000 m Scaling 0 – 10 V

In case these settings do not comply with your data acquisition system, you can easily change the parameters with the help of the **xProGPS** Windows software.

XPRO GPS IN TEAM WITH A LAPTOP

Specially for quick tests you can hook **xProGPS_max** to a Laptop and run the **xProGPS** Windows software tool.

There are 3 versions of this software:

- A free version to initialize all parameters of **xProGPS_max** also running a speed graph
- A datalogger version, which will log GPS data to disk and plot various diagrams/spreadsheets to the screen
- A Performance Test version with additional special operating modes such as standing start, coast down, brake test, speedometer calibration etc.

Connect **xProGPS_max** to the laptop with a standard USB cable. Make sure you have installed the proper real-time driver of **xProGPS_max.** Also the correct USB driver (Virtual Com Port VCP) has to be installed.

XPRO GPS AS STAND-ALONE DATA ACQUISITION SYSTEM

In combination with the driver display CANFAZ4 and a corresponding optional firmware version of **xProGPS_max** the GPS sensor can also be operated as an extremely compact stand-alone-measuring system for a whole range of applications:

- General data logger tests > record of NMEA data sets and CAN data
- Vehicle Performance Tests > acceleration, flexibility and coast-down (option)
- Brake tests with convenient organization of up to 100 structured individual tests (option)

Especially for brake tests we provide a powerful software package which elegantly manages complex measurement requirements.

Please note that the brake test module and vehicle performance test modules are an option

Test setups can be defined on a PC and as well on the actual instrument. Data transfer is either by USB or by the SD card.

Even complex jobs can be generated or modified straight within the embedded **xProGPS_max** system, without any assistance of a PC or laptop. This is an important advantage since during brake tests ordinary PC technology cannot be used due to great mechanical stress.

Evaluation of test data can be elegantly achieved with the help of the Windows software package **xProGPS_Win**.

All functions of **xProGPS_max** in stand-alone mode are accessed via the function keys on the driver display unit CANFZ4.

The self-explaining menu structure guarantees minimum learning efforts.

OPERATING XPROGPS WITH HELP OF THE DRIVER DISPLAY CANFAZ4

So let's start with installing all cables to the **xProGPS_max** receiver :

- Place the GPS antenna on the vehicle roof and attach the SMA plug at the receiver
- Mount the driver display unit in the windshield of the vehicle and connect it to the receiver via the cable with the orange color coding
- Insert a good quality SD card
- Provide an appropriate DC power supply in the range of 12 ... 30 V

As soon as the **xProGPS_max** receiver recognizes an attached driver display during boot time, Data Acquisition Stand-Alone mode is activated automatically.

A corresponding text will appear on the display. After a couple of seconds the main menu of the stand-alone acquisition software will be shown.

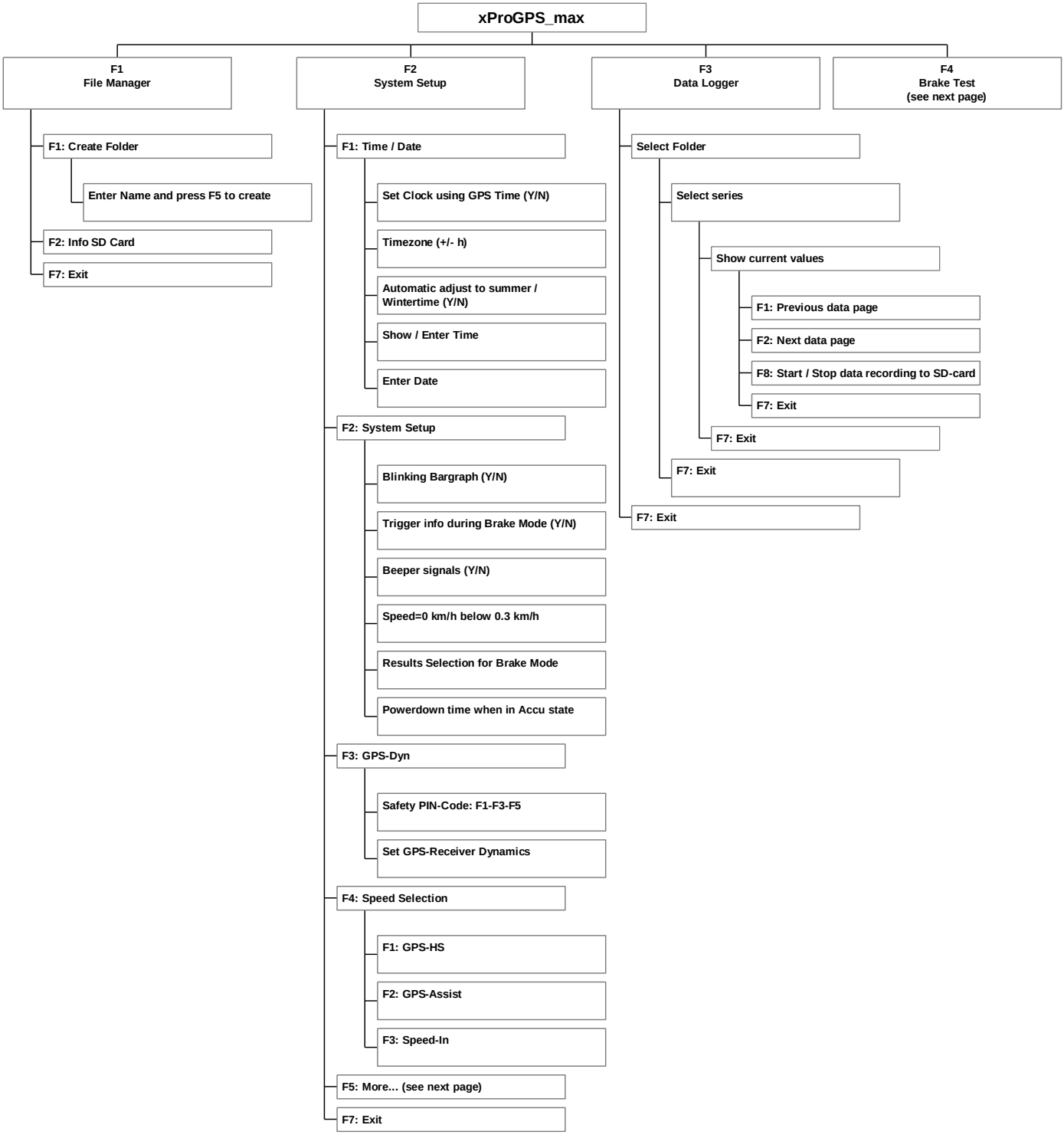
The user interface is straight forward and easy to understand:

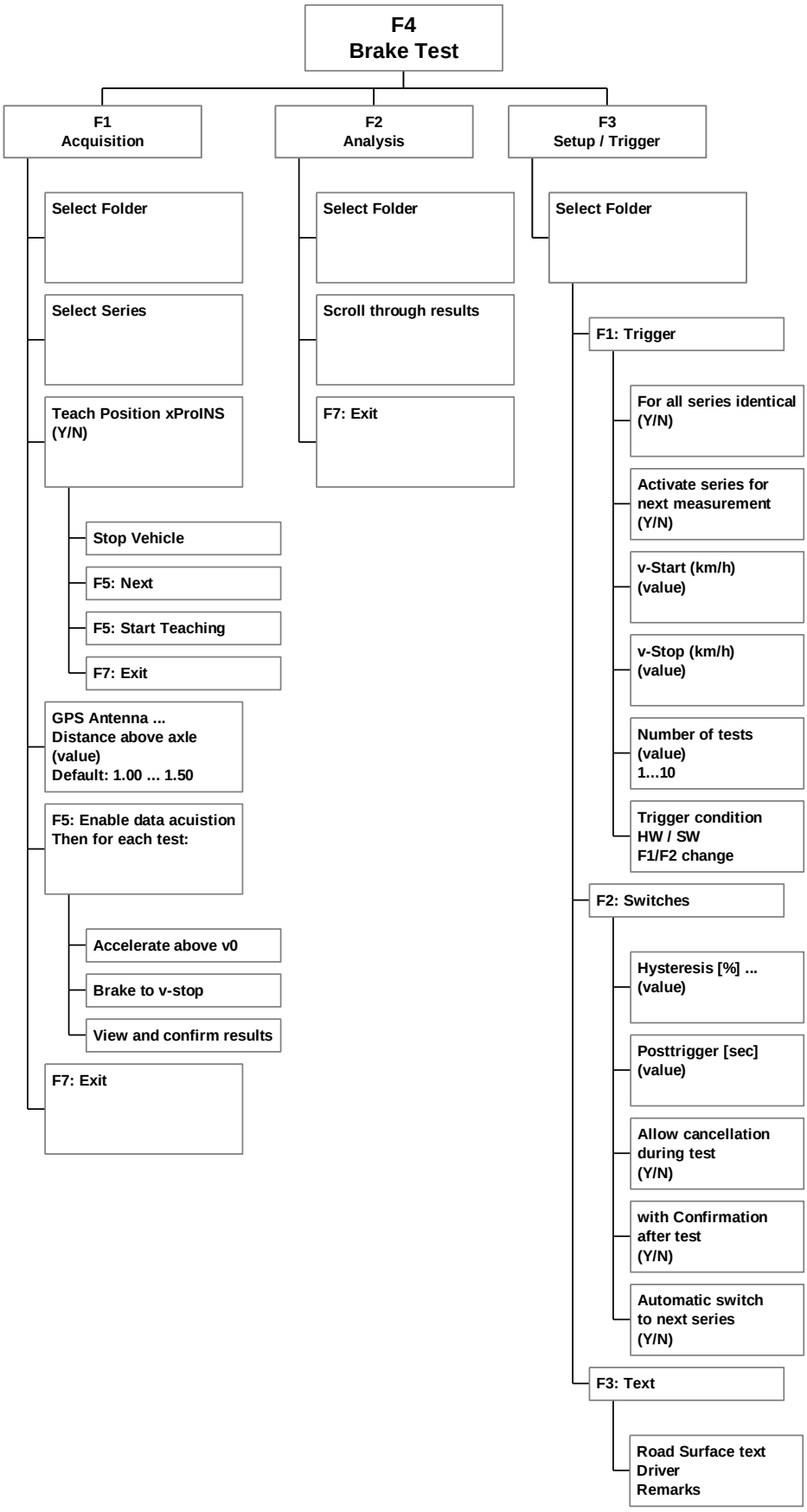
- All software operations are activated by the function keys F1 … F8 of the driver display
- Active function keys are signaled by a red LED
- With keys F1 … F4 cursor control is accessible (left, right, up, down)
- By F5 a data entry is confirmed or transition to the next state is initiated
- F7 performs an ESC function which leads back one level up
- F8 manually starts or stops a test run

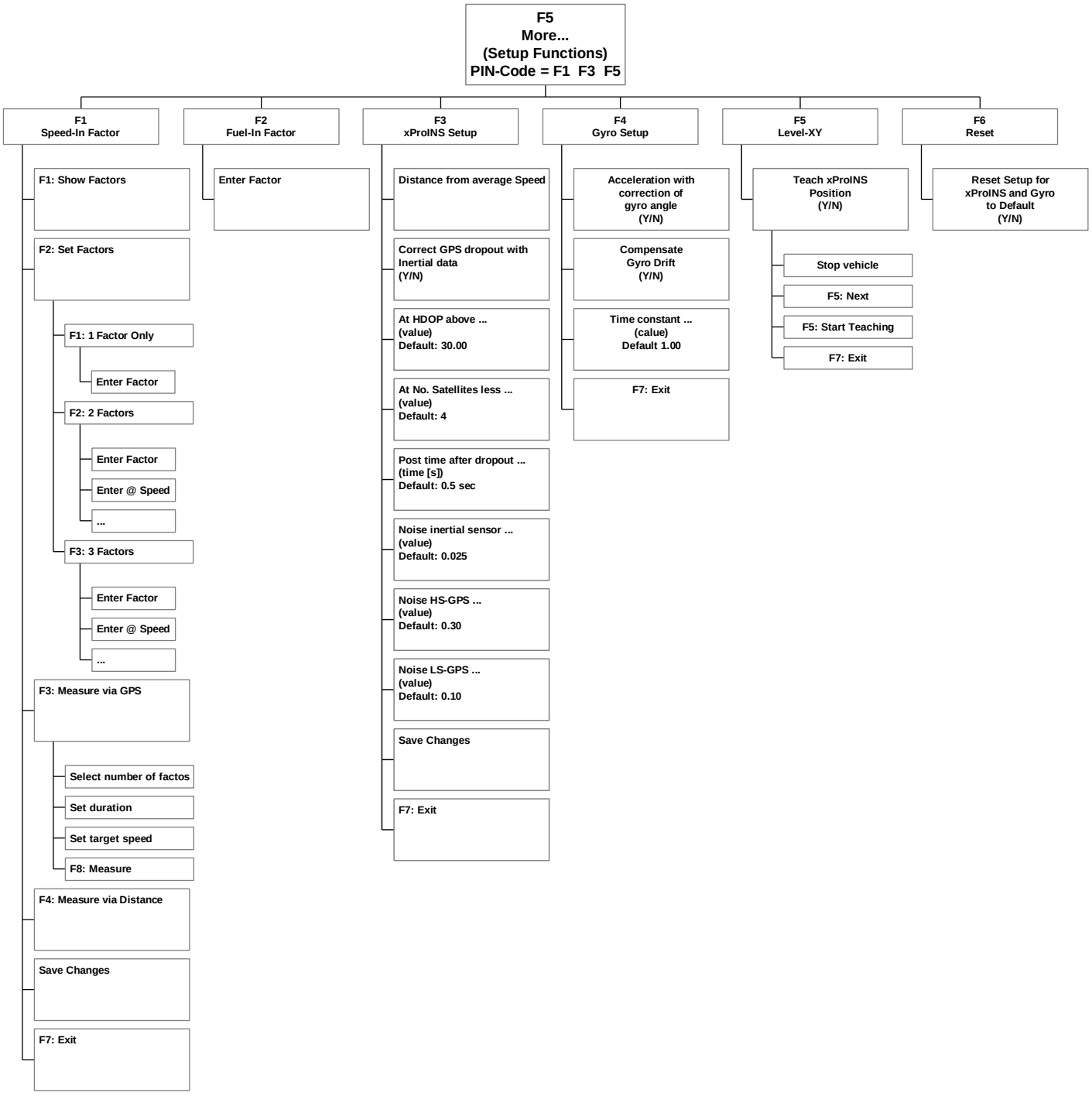
Please see the menu structure below which lists all the commands accessible via the function keys of the display unit.

For a very first test it is a good idea to power-up the system having the manual with this command tree diagram next to you and step through the individual levels until you feel confident with the command structure.

It is easy to learn and straight forward – just try it out !







MAIN MENU

The main menu consists out of several commands and provides fast access to the individual operating modes.

F1 File Manager

F2 System Setup

F3 Data Acquisition

F4 Brake Test (option)

F1 MAIN MENU - FILE MANAGER

When pressing F1 on the top level of the menu, the File Manager opens and provides access to the commands below.

F1 Create a new Folder

F2 Status and Statistics of CFC

F7 Return to Main Menu

F1 SUB MENU OF FILE MANAGER - CREATING A NEW FOLDER

This command creates a new job folder on the SD card.

The folder name can be entered with the help of the function keys F1 ... F4.

F1 – F2	Shift cursor position
F3 – F4	Increment / decrement ASCII letter
F5	Create Folder
F7	Return to main level of File Management Menu

In this way it is possible to enter a regular file name even without the help of a “real” keyboard.

Please note:

Creating a new folder on the CANFAZ4 limits the name of a folder to 12 characters, due to the maximum length of one display line.

When preparing job folders on a PC folder names can be of larger size. Longer names will be shown on the display in 2 lines.

HOW XPROGPS_MAX TREATS FOLDERS AND FILES

xProGPS_max is a very powerful embedded instrument which can handle hundreds of individual test files collected within different operating modes.

A huge amount of data has to be structured and organized as without a clever data management you probably will not find your valuable test data again.

Therefore **xProGPS**_max organizes data within so called jobs. One job means one folder on the SD card and one folder / job is strictly correlated to one vehicle.

In this way all test data and all settings of a single individual vehicle will be stored in an individual folder on the SD card. It is a good idea to name the folder identical to the vehicle (version) itself so you can easily find the test again even after a long period of time. In real world applications usually a vehicle to test will have an individual IT compliant number. So you should use this number as job name.

Of course data of another vehicle should be stored under a different job / folder name.

A job can contain data from several test modes, such as datalogger, acceleration, brake tests, etc. Furthermore test runs within a specific test mode can be structured into groups with varying parameters, such as trigger settings. Within one group up to 10 individual test runs can be sampled and stored.

Data files within a folder will be named automatically and show the name of the folder plus an extension representing the operating mode plus a sequential number of the test.

All files being part of the same job will have the identical name. The distinction takes place by a three-step file extension.

The first file extension defines the test mode, the test group and the individual test.

The second file extension defines the receiver which is related to the file. HS is data from High Speed receiver (100 Hz), LS is data from Low Speed receiver (10 Hz).

The third extension is fixed to .NME and signals, this is a file in the NMEA format containing GPS data. Corresponding files from High Speed and Low Speed receiver are automatically created if data is available.

Examples:

Name_Test-File.912.HS.NME

Name_Test-File	is part of the measurement folder "Name_Test-File"
HS	Data from High Speed Receiver
.912	9 = signal for Datalogger mode, 1 = first test series, 2 = test #2

Name_Test-File.532.HS.NME

Name_Test-File	is part of the measurement folder "Name_Test-File"
LS	Data from Low Speed Receiver
.532	5 = signal for brake mode, 3 = third test series, 2 = test #2

In brake mode two additional files are generated:

Name_Test-File.XGP	Setup file containing settings for trigger etc.
Name_Test-File.BRK	File containing resulting and summarizing data
Name_Test-File.BRX	File containing results calculated by xProGPS Windows software
Name_Test-File.XRX	File containing experts table results calculated by xProGPS
Name_Test-File.XFL	Setup file for job specific flags used by xProGPS Windows software

This file structure of **xProGPS_max** provides an adequate organization for even the most complex test scenarios.

To analyze the collected data you will have to transfer the jobs to a PC running xProGPS Windows software. You can either just insert the SD card into the PC or transfer the data via USB.

The job and file structure of the **xProGPS_max** instrument will be kept also within the PC software.

F2 SUB MENU OF FILE MANAGER - SD CARD INFORMATION

This function lists the SD card status.

The total capacity of the card, the available memory space and the number of existing folders will be shown on the display.

F2 MAIN MENU - SYSTEM SETUP

System Setup is activated by pressing F2 within the Main Menu.

Within System Setup all basic settings of xProGPS in stand-alone mode can be programmed.

F1	Set Date and Time
F2	Setup of several system parameters
F3	Selection of Speed Source
F4	Info of installed firmware version
F7	Exit

F1 SUB MENU OF SYSTEM SETUP - SET DATE AND TIME

By using F1 ... F4 date and time of the internal real time clock of the system can be set.

These data entries are essential to generate standard date and time information for all data files.

Please note, that due to temperature, humidity and aging processes the internal real time clock show a certain drift.

Depending on the version of the firmware and the individual settings, **xProGPS_max** performs an automatic correction related to the high precision GPS time received via satellite.

F2 SUB MENU OF SYSTEM SETUP - GENERAL SYSTEM SETUP

This menu provides access to the following parameters:

- Flashing mode of bar graph during data acquisition
- Define display mode of trigger information during data acquisition
- Set Beeper signals during data acquisition
- Set threshold for speed zero to eliminate speed-noise of the GPS receiver
- Select calculation method for displaying test results (Hardware or software triggered)
- Setup of power-down timer (countdown of timer starts when external power is disconnected)

SET FLASHING MODE OF BARGRAPH

In order to signal to the driver that the system is ready for a brake test, the bar graph of the system can be programmed in a way, that it starts flashing as soon as the vehicle exceeds the programmed trigger speed plus a certain programmable hysteresis.

With the command “Flashing Mode of Bar Graph” this behavior can be activated or switched off.

DISPLAYING TRIGGER-SETTINGS DURING DATA ACQUISITION

By setting this parameter it is possible to show the programmed trigger mode during data acquisition on the driver display.

- Hardware / Software triggered
- Harddware and / or software triggered by logical combination

The definition of the trigger settings will be explained in chapter “Setup for Brake Test Mode” and applies only for this operating mode.

BEEPER-SIGNALS DURING DATA ACQUISITION

System states such as trigger detection or end of test can be signaled by a beep tone.

With this set-up function the beep tone can be alternatively switched on or off.

DETECTION OF SPEED ZERO

The GPS receiver used by **xProGPS_max** provides an extraordinary smooth signal quality and therefore shows only an extremely low noise level of the speed signal.

Of course this is depending on the respective reception situation and as a rule speed noise is at a receipt of approx. 8 satellites and a HDOP of approx. 1 just around 0.1 km/h, which is an extraordinary excellent result.

For brake tests down to speed zero the threshold of speed zero can be adjusted.

For an uncritical behavior we recommend a threshold of 0.5 km/h. In case the satellite signals are absolutely perfect, the threshold can be reduced down to 0.1 km/h.

SELECTION OF CALCULATION METHOD FOR TEST RESULTS

xProGPS_max offers a flexible usage of different trigger scenarios to initiate a brake test.

The different possibilities for triggering a test are:

- Hardware Trigger — Measuring starts with pressing the brake pedal
- Software Trigger — Measuring starts when speed drops below v_start
- Hardware and software Trigger — Measuring starts if both triggers activate
- Hardware or software Trigger — Measuring starts if one of the triggers is activate

The software function “Selection of calculation method for test results" determines which result to be shown first.

The result value calculated along by this selection is shown on the display immediately after finishing the test run. Further values, derived from different settings, can be accessed by scrolling with the function keys.

Please note:

The described method of Soft- and Hardware trigger applies only to Brake Test mode (option)

SETUP OF POWER-DOWN TIMER

xProGPS_max will start a power-down timer as soon as external power is disconnected. This time can be individually set according to the needs. Please note that this time is depending on the internal power consumption which can vary depending on the connected systems, e.g. driver display.

The system allows to set the power-down time between 3 and 1800 seconds. However we recommend a value of 5…10 seconds.

F3 MAIN MENU - DATA LOGGER MODE

By pressing F3 within the main menu the data acquisition mode is selected.

With the help of the next screen, the job folder can be selected. By pressing function keys F1 and F2 it is possible to scroll through the list of all available folders on the SD card. Pressing F5 actually selects the folder.

Now select the test group in the same way. Pressing F5 activates the selected group.

After selection of job folder and test group, the system will show the first of several predefined screens with GPS data. You can scroll through the pages by pressing F1 or F2.

To start a measurement and record the data to the SD card press the F8 key of the driver display. The LED above the 1PPS output is blinking while data is stored to the SD card.

As soon as valid GPS data is detected, some essential data are displayed on CANFAZ4:

- Speed
- Distance travelled
- GPS Position
- Heading
- Altitude
- Number of received satellites
- Signal quality HDOP

With the help of this information a quick decision can be taken, if the signal quality is sufficient to start a test run. This helps to avoid bad test results under weak signal conditions.

F4 MAIN MENU - BRAKE TEST

By pressing F4 of main menu the special brake test is accessible. Please refer to the next pages for detailed description for the brake test mode.

Brake Test System:

For further information of the brake test mode please refer to the separate manual

"xProGPS_max – Brake Test System – Manual.pdf", which describes the procedures for brake tests in detail.

INTERFACING CONNECTORS AND PINOUT

All interfaces of **xProGPS_max** are equipped with high quality Lemosa jacks.

- Power supply
- USB slave
- Display / COM Interface
- Trigger input
- CAN-Bus of Vehicle
- Inertial sensor xProINS (optional)
- CAN-Bus Out (Gateway)
- CAN-Bus Extension (connecting thermocouple modules xProTherm32, xProtThermAnalog32 etc.)
- Input for incremental speed sensor
- Input for incremental fuel sensor
- 2 Analogue Outputs (DAC 0 / 1)
- Pulse Output (frequency synthesizer)
- 1 PPS Output (1 Pulse per Second)

The detailed pin out of all connectors is described below.

POWER SUPPLY

Connect the power supply for the equipment to the 3 pole plug. The accepted voltage can be between 11 … 30 Volts DC. **xProGPS_max** itself draws around 400mA @ 13.8 Volts. Depending on additional equipment attached to the system the necessary current will increase.

The power supply of **xProGPS_max** is protected against wrong polarity. Nevertheless always make sure the applied voltage is of proper polarity and in the defined voltage range.

A blue Status LED next to the power supply socket indicates that the supply has been connected correctly.

xProGPS_max is galvanically isolated between the vehicles circuits and those of the measurement equipment. This provides additional protection to the GPS Receivers and the user's external data acquisition equipment.

As a result of the **xProGPS_max**'s sophisticated power supply very little heat is developed.

xProGPS_max comes with an internal back-up battery which buffers open files on the SD-Card during the shut-down process. In a later hardware revision this back-up battery will also power the system for several minutes.

New in Hardware Release V1.2

In addition **xProGPS_max** is equipped with an internal back-up accumulator which can maintain the functioning of the equipment in the event of a loss of external power supply. The operational period when operating on the accumulator can be defined using the set-up software. The default setting is 15 Seconds. After this period the system will switch itself off.

A fully loaded accumulator can provide a maximum operating period of around 30 minutes.

Before the first start-up and before any longer test drive the accumulator should be charged. To do so, connect the device to a suitable power source for around 12 hours.

ELECTRONIC FUSE

xProGPS_max is equipped with an internal electronic fuse. In the event that the fuse is triggered the equipment should be disconnected from the power supply. The cause of the over current, for example a crushed signal cable, should be rectified. The equipment can then be restarted.

It is not necessary to open the equipment to change the fuse.

Pin-Out Power Supply	Lemosa FGG.1B.303 black
Pin 1	+U-Board 11.0 ... 30 VDC
Pin 2	-U-Board
Pin 3	-U-Board

USB CONNECTION

The built in USB interface of **xProGPS_max** provides an easy to use access to the PC world to setup the instrument and to transfer GPS data sets from the receiver unit into a Laptop etc.

xProGPS_max is USB2.0 compatible and supports the High Speed Modus with 12 MBit / sec.

Please note:

As the USB Bus allows very high rates the PC must provide a corresponding level of performance.

There is a vast of different USB controllers and drivers available. It is a known fact that not all chips / drivers work smoothly and interfacing problems can occur.

The USB-technology we provide supports as many host controllers as possible. However a complete coverage is not possible as for this the host controller in the PC / Laptop is responsible.

Never:

Remove and replug the USB whilst data is being recorded by the PC!

Close the PC software before removing the USB connector. To re-initialise both the PC and the **xProGPS_max** has to be restarted.

DISPLAY / COM INTERFACE / INTERNAL CAN OF GPS RECEIVER

This socket can be used to connect a communication cable to allow data transfer between the device and a PC unit.

xProGPS_max transmits GPS data in NMEA format to any other data acquisition system across this connection. The set-up software provided allows comfortable modification of all systems parameters and defines which NMEA data sets will be transferred.

The COM interface can also be selected to operate one of our driver display units.

Interface setting is 115kBd, 1 stop Bit, no Parity.

Pinout Display Interface	Lemosa FGG.1B.307 orange
Pin 1	+U-Board to external equipment, max. 300mA
Pin 2	CAN-H Raw data of 100 Hz GPS (do not use)
Pin 3	CAN-L Raw data of 100 Hz GPS (do not use)
Pin 4	COM-RxD-FROM-PC
Pin 5	COM-TxD-TO-PC
Pin 6	GND-CAR
Pin 7	SYNC-PULSE

TRIGGER INPUT

With the help of the trigger input a new test run can be started or stopped and recording data to the SD-Card can be initiated / terminated or. The trigger input provides a very accurate determination when i.e. a brake pedal has been pressed or a light barrier has been passed. The trigger can be determined with a resolution of around 1 µsec depending on the actual application.

In order to be able to use the trigger function it first has to be activated with the help of the set-up software. The corresponding command can be found under

Setup –> xProGPS-Setup –> GPS-Receiver –> initialisation options

Once the trigger is activated the **xProGPS_max** delivers a high resolution time stamp message. All Start / Stop calculations for a measurement can be referenced to this point.

A single beep signals when the Start trigger has been recognised by the equipment. The Stop trigger is signalled with a double beep. Triggering is also indicated by the LED alongside the equipment's plug.

Please note:

The corresponding Lemosa plug is of Code Type "A". So you will have to order a FGA.1B.306 connector. A standard FGG type will not fit.

Pin-Out Trigger-Input	Lemosa FGA.1B.306 yellow
Pin 1	+U-Board max. 100mA
Pin 2	+5-TRIGGER max. 100mA
Pin 3	TRIGGER-GND
Pin 4	TRIGGER-IN non-inverting
Pin 5	#TRIGGER-IN inverting
Pin 6	GND-CAR

The trigger socket has two inputs – one for an active rising edge signal and one for an active falling edge signal. Usually the falling edge input will be used as in this case a simple passive switch between TRIGGER-GND and #TRIGGER-IN will already activate the trigger.

On the rising edge input an active signal, such as provided from a light barrier, has to be provided.

The system will automatically detect which of the 2 trigger inputs is being used. So there is no software setting necessary for a proper selection.

Please ensure that the external trigger signal is free of glitches. Provisions have been made to automatically suppress glitches of up to 0,4 sec.

The input of the trigger is equipped with full galvanic isolation. The acceptable input voltage range is 0 ... 18 Volt

In order to provide power supply to an external trigger device the plug provides voltage +U-Board and -U-Board as well as +5-Volt referenced to TRIGGER-GND. The maximum power load on the +5-V supply is 100mA.

CAN BUS CONNECTION CAN-CAR

This socket usually will be used to read in data from the vehicle's CAN bus. The data then is either stored onto the SD-Card in parallel with GPS information and other data or is sent out through the socket CAN-Out to another instrument.

The required identifiers can be activated using the set-up software. Bit-rate and timing of the CAN bus interface can also be set.

Please note:

CAN bus systems need a terminating resistors at both ends of the bus as otherwise the signals cannot be transmitted properly. If **xProGPS_max** is connected into an existing and already fully working bus system then no terminating resistor is required otherwise a terminating resistor must be installed.

This can easily be done either externally or by activating the built in resistor of **xProGPS_max.** There is a DIP-Switch for each of the 4 CAN busses of the instrument.

To set the DIP-Switch open the system from the front-side, smoothly slide out the front and the printed circuit board. There are 4 single Dip-Switches next to the CAN inductors. A printing next to the DIP-Switch will tell you which switch to set.

Once the CAN bus is working the status LED next to the corresponding socket will indicate an active data transmission.

In order to synchronize several systems an additional SYNC-PULSE is provided by the system. It correlates to the internal time base and is also available on other sockets.

Activation of CAN-CAR depends on purchased software option.

Optionally we can provide support for several CAN protocols and services such as DPID etc. Please contact us for details.

CAN-Bus Interface CAN-CAR	Lemosa FGG.1B.307 white
Pin 1	+U-Board, max. 100mA
Pin 2	CAN-H Bus: CAN-CAR
Pin 3	CAN-L Bus: CAN-CAR
Pin 4	
Pin 5	
Pin 6	-U-Board
Pin 7	SYNC-PULSE

CONNECTING OF SPI DEVICES

As an option xProGPS_max can communicate with external SPI devices. As the protocol is non-standard and a software modification is necessary depending on the device attached.

Pin-Out INS Inertial Sensor Input	Lemosa FGA.1B.308 green
Pin 1	+U-BOARD max. 300 mA
Pin 2	MOSI-IN-TO-INS
Pin 3	MISO-OUT-TO-INS
Pin 4	SDIO-CLOCK
Pin 5	CE-INS-0
Pin 6	GND
Pin 7	GND-CAR
Pin 8	SYNC-PULSE (Option)

Please note:

The corresponding Lemosa plug is of Code Type “A”. So you will have to order a FGA.1B.308 connector. A standard FGG type will not fit.

CAN-BUS CAN-OUT CAN-GATEWAY OUTPUT TO ANOTHER SYSTEM

This CAN-Bus socket usually will be used to transfer all collected data from **xProGPS_max** to another system, such as our 2HE-PCI.

In such way, **xProGPS_max** operates as a CAN bus gateway.

The required identifiers can be activated using the set-up software. Bit-rate and timing of the CAN bus interface can also be set.

Please note:

CAN bus systems need a terminating resistors at both ends of the bus as otherwise the signals cannot be transmitted properly. If **xProGPS_max** is connected into an existing and already fully working bus system then no terminating resistor is required otherwise a terminating resistor must be installed.

This can easily be done either externally or by activating the built in resistor of **xProGPS_max.** There is a DIP-Switch for each of the 4 CAN busses of the instrument.

To set the DIP-Switch open the system from the front-side, smoothly slide out the front and the printed circuit board. There are 4 single Dip-Switches next to the CAN inductors. A printing next to the DIP-Switch will tell you which switch to set.

Once the CAN bus is working the status LED next to the corresponding socket will indicate an active data transmission.

In order to synchronize several systems an additional SYNC-PULSE is provided by the system. It correlates to the internal time base and is also available on other sockets.

CAN-Bus Interface CAN-OUT	Lemosa FGG.1B.307 white
Pin 1	+U-Board, max. 100mA
Pin 2	CAN-H BUS: CAN-OUT
Pin 3	CAN-L BUS: CAN-OUT
Pin 4	
Pin 5	
Pin 6	GND-CAR
Pin 7	SYNC-PULSE

CAN-BUS CAN-EXT EXTENSION CAN-BUS TO INTERFACE TO ADDITIONAL CAN-SOURCES

This CAN-Bus socket usually will be used read in data from our extension units such as our 32-channel thermocouple amplifier etc. Other CAN sources can also be adapted.

With the help of this additional CAN bus, **xProGPS_max** will become an extremely powerful data acquisition system:

- read data from 2 GPS sources
- read data from inertial sensor xProINS
- read data from vehicle CAN
- read data from additional CAN sources (thermocouple modules etc.)
- export data on CAN gateway
- write data to SD-Card

The required identifiers can be activated using the set-up software. Bit-rate and timing of the CAN bus interface can also be set.

Please note:

CAN bus systems need a terminating resistors at both ends of the bus as otherwise the signals cannot be transmitted properly. If **xProGPS_max** is connected into an existing and already fully working bus system then no terminating resistor is required otherwise a terminating resistor must be installed.

This can easily be done either externally or by activating the built in resistor of **xProGPS_max.** There is a DIP-Switch for each of the 4 CAN busses of the instrument.

To set the DIP-Switch open the system from the front-side, smoothly slide out the front and the printed circuit board. There are 4 single Dip-Switches next to the CAN inductors. A printing next to the DIP-Switch will tell you which switch to set.

Once the CAN bus is working the status LED next to the corresponding socket will indicate an active data transmission.

In order to synchronize several systems an additional SYNC-PULSE is provided by the system. It correlates to the internal time base and is also available on other sockets.

CAN-Bus Interface CAN-EXT	Lemosa FGG.1B.307 white
Pin 1	+U-Board, max. 100mA
Pin 2	CAN-H BUS: CAN-EXT
Pin 3	CAN-L BUS: CAN-EXT
Pin 4	
Pin 5	
Pin 6	GND-CAR
Pin 7	SYNC-PULSE

CONNECTING AN INCREMENTAL SPEED SENSOR

xProGPS_max can also read in distance and speed information from an incremental decoder such as an optical sensor or a fifth wheel.

The scaling factor pulses / meter can be set in the set-up software.

This input is very helpful in situations where GPS is not functional due to trees or dense buildings etc.

With the help of this input the identical instrument plus the identical software for data acquisition and data analysing can be used. You will only have to switch from GPS input as the major speed source to the incremental decoder input.

The input speed supports sensors with 2 separate channels. A DIP-Switch sets if pulses are processed as provided by the sensor or if they should be doubled by an additional internal circuit to improve sensor resolution.

By default pulse doubling is set.

The socket in addition provides an I2C-bus to automatically read-in sensor settings, such as scaling factors.

Pin-Out Pulse Input Speed	Lemosa FGA.1B.305 blue
Pin 1	Galvanically isolated +12 VDC (max. 100 mA)
Pin 2	Galvanically isolated +5VDC (max. 50 mA)
Pin 3	SPEED-A (optional pulse doubling by DIP-Switch)
Pin 4	SPEED-B (optional pulse doubling by DIP-Switch)
Pin 5	GND (not GND-CAR !!!)

INPUT FOR AN INCREMENTAL FUEL SENSOR

The consumption sensor can be connected through this input. With the help of this sensor xProGPS can also record dynamic fuel consumption. Particular firmware is required.

Input voltage range is 0 … 10 VDC.

There is an 1k Pull-Up resistor installed on PLU-A to support PLU 116 H etc.

Pin-Out Pulse Input Fuel Sensor	Lemosa FGA.1B.305 red
Pin 1	Galvanically isolated +12 VDC (max. 100 mA)
Pin 2	Galvanically isolated +5VDC (max. 50 mA)
Pin 3	PLU-A
Pin 5	GND (not GND-CAR !!!)

ANALOGUE OUTPUTS DAC0 AND DAC1

To these outputs any of the system's channels can be routed in order to provide the information in form of an analogue voltage.

The output voltage can be set between 0 ... 10 Volt. As an option the equipment can also be delivered with an output range of –10V ... +10V.

xProGPS uses high resolution 16 Bit converters. This allows a 16x improvement in quantifying when compared to the normally used 12 Bit converter.

The set-up software allows selection of the channels to be output and the setting of scaling factors (output voltage range). As a default setting, speed and geodetic height of the 100 Hz receiver are provided.

Scaling factors for the default outputs are: 0 … 250 km/h => 0 … 10 Volts, 0 … 10000 meters => 0 … 10 Volts

The status LED indicates that the respective output has been activated.

Analog-Out OUT0 ... OUT1	BNC white
Pin 1	ANALOG-OUT
Pin 2	GND (not GND-CAR !!!)

ANTENNA INPUTS

xProGPS has 2 antenna inputs. The socket named “Antenna“is the antenna input of the 100 Hz main GPS receiver. The second antenna input “Assist” is for the additional high sensitive 10 Hz receiver.

Connect the magnetic antenna that is supplied to these input. The status LED will start blinking as soon as satellite data is available. The number of flashes represents the number of satellites seen by the corresponding receiver.

Please note:

Take care that the antenna is only connected before power is supplied to avoid the risk of damaging the equipment.

Also take care not to damage the antenna cable by door locks etc. as this might destroy electronic devices inside **xProGPS_max**.

GPS Antenne	SMA
Pin 1	GPS
Pin 2	GND (not GND-CAR !!!)

PULSE OUT

Any of the system's channels can be output on this socket in form of a proportional frequency.

The scaling of the frequency can be set in the set-up software.

Output level is either 5V TTL level or Open Collector. There is a DIP-Switch on the main board to select either option.

The status LED indicates an active output.

Please note:

There is a programmable threshold. The output signal is available, as soon as the vehicle moves faster than this threshold.

PLL / Frequency-Synthesizer	BNC blue
Pin 1	F-OUT
Pin 2	GND (not GND-CAR !!!)

1 PPS OUT

Both internal GPS receivers send out a precise 1 PPS signal (1 pulse per second). This signal can be routed to the 1PPS BNC on the front side of **xProGPS_max**.

Selection is made by a DIP-Switch on the main board.

Output level is either 5V TTL level or Open Collector. There is a DIP-Switch on the main board to select either option.

The status LED indicates an active output.

1 PPS	BNC red
Pin 1	1 PPS Out
Pin 2	GND (not GND-CAR !!!)

CAN BUS DATA DEFINITION

To provide an optimal transmission to the CAN Bus. the GPS channels are distributed as follows:

- Bit rate 100 / 125 kB / 250 kB / 500 kB / - can be set over parameter
- Identifier set according to definition

Data Definition:

- The CAN-Bus channel is defined in xProGPS
- Corresponding identifiers are activated and processed within the box
- The required NMEA data is requested by the Receiver.
- A global switch allows the CAN-Bus output to be activated / deactivated
- Default Identifier base address is 0x500 (0x500 ... 0x50F)
- The Start Bit defines the position of the MSB in the highest value Byte
- Byte Order = Motorola (e.g. 16 Bit -> High-Byte in Byte 0, Low-Byte in Byte 1)

IDENTIFIER OVERVIEW:

ID = Identifier-Base + Offset

Identifier-Offset (Hex)	Content
	High Speed receiver:
+0H	GPS longitude, GPS latitude
+1H	Lateral acceleration, speed, filtered speed, direction
+2H	Height, UTC time, HDOP, N/S, O/W, DGPS(J/N), Trigger active(J/N), GPS-Status
+3H	Distance since Trigger, time since Trigger, speed at point of triggering
+4H	Total distance since reset, Trigger time point
+5H	Height diff., DGPS age , DGPS ID, number of satellites in use,
+6H	UTC:Day, Month, Year, PDOP, VDOP (only if RTC record is activated in High speed receiver)
+10H	Speed vectors x,y,z and TDOP
+11H	GPS Longitude (64Bit resolution)
+12H	GPS Latitude (64Bit resolution)
	Barometric pressure sensor:
+13H	Barometric pressure, Barometric pressure QNH
+14H	Barometric gradient, GPS gradient
	External Sensor Inputs:
+15H	Speed from Speed pulse input, pulse value from fuel input
+16H	Acceleration X,Y from inertial sensor (if present)
	Assist Speed receiver data: (CAN-Identifier Definition identical to ID-Offsets 0..6)
+20H	GPS longitude, GPS latitude
+21H	Lateral acceleration, speed, filtered speed, direction
+22H	Height, UTC time, HDOP, N/S, O/W, DGPS(J/N), Trigger active(J/N), GPS-Status
+23H	Distance since Trigger, time since Trigger, speed at point of triggering
+24H	Total distance since reset, Trigger time point
+25H	Height diff., DGPS age , DGPS ID, number of satellites in use,
+26H	UTC:Day, Month, Year, PDOP, VDOP

EXPLANATION OF IDENTIFIER DEFINITION

All CAN definitions follow the structure below:

Column	Meaning	Value range	Example
Data Byte	Byte number(s) within the CAN operation	#0 ... #7	#0 #1
Content	○ Identifier ○ Valid value range ○ Where necessary example for calc. ○ Details: "Where no value is available ", means for as long as no GPS value has been made available and no new value has been delivered because no GPS data is being supplied the previous value will be maintained **or** "When invalid", means - in the case that no value is available in the data because no GPS data is being supplied then the inputted value will be supplied		○ GPS longitude ○ +/-1.800.000.000 = -180…+180° ○ e.g.: 81234567 = 8,1234567 Grad ○ As long as no value is available: 200°
Data Format	Number of data bits values are without sign, except otherwise noted	1 … 32 Bit Poss.: (signed short) (signed int)	16 Bit
Start-Bit	Information only relevant for data of less than 8 Bit: Bit position of the highest bits in the Byte: Shows from which Bit within the Bytes the value has been entered.	0…7	4-Bit data format, Start Bit = 3, i.e. 7 6 5 4 3 2 1 0 - - - - x x x x (xxxx = value)
Factor / Offset	Recalculation factor for calculation of the physical size: (CAN raw value * Factor) + Offset = Phys. size		

IDENTIFIER-DETAILS:

ID = Identifier-Base + 0

Data Byte	Content	Data Format	Start-Bit	Factor	Offset
#0 #1 #2 #3	GPS longitude +/-1.800.000.000 = -180…+180° e.g.: 81234567 = 8,1234567 ° As long as no value is available: 200°	32 Bit (signed int)	7	0.0000001	0.0
#4 #5 #6 #7	GPS latitude +/- 900.000.000 = -90…+90° e.g.: 491234567 = 49,1234567 ° As long as no value is available: 200°	32 Bit (signed int)	7	0.0000001	0.0

ID = Identifier-Base + 1

Data Byte	Content	Data Format	Start-Bit	Factor	Offset
#0 #1	Lateral acceleration [m/s] +/- 100.0 As long as no value is available: 100.0	16 Bit (signed short)	7	0.01	0.0
#2 #3	Filtered Speed [km/h] 0..650.00 As long as no value is available: 655.0	16 Bit (unsigned short)	7	0.01	0
#4 #5	Speed [km/h] 0..650.00 As long as no value is available: 655.0	16 Bit (unsigned short)	7	0.01	0
#6 #7	Direction [degree] 0..359.99 As long as no value is available: 400°	16 Bit (unsigned short)	7	0.01	0

ID = Identifier-Base + 2

Data Byte	Content	Data Format	Start-Bit	Factor	Offset
#0 #1	Height [m] 0...6500.0 m As long as no value is available: 6550	16 Bit (unsigned short)	7	0.1	0
#2 #3 #4	UTC Time [sec] 0..8639995 e.g.: 5239535 = 52395,35 sec = 14:33:15,35	24 Bit	7	0.01	0
#5 #6	HDOP 0..99.99 If invalid: 100.0	16 Bit (unsigned short)	7	0.01	0
#7 Bit 7	North / South Hemisphere 0 = North 1 = South	1	7	1	0
#7 Bit 6	East / West Hemisphere 0 = West 1 = East	1	6	1	0
#7 Bit 5	DGPS-Status 0 = DGPS not active 1 = DGPS active	1	5	1	0
#7 Bit 4	Trigger-Status 0 = Not active 1 = Active	1	4	1	0
#7 Bit 0-3	GPS-Status 0 = no GPS 1 = GPS 2 = DGPS	4	3	1	0

ID = Identifier-Base + 3

Data Byte	Content	Data Format	Start-Bit	Factor	Offset
#0 #1 #2 #3	Distance since Trigger [m] 0.. 429483.6225 m	32 Bit (unsigned int)	7	0.0001	0
#4 #5	Time since Triggering [sec] 0..3276.75	16 Bit (unsigned short)	7	0.05	0
#6 #7	Speed at time of Triggering [km/h] 0..650.00 As long as no value is available: 6550	16 Bit (unsigned short)	7	0.01	0

ID = Identifier-Base + 4

Data Byte	Content	Data Format	Start-Bit	Factor	Offset
#0 #1 #2 #3	Total distance since reset [m] 0.. 429483.6225 m	32 Bit (unsigned int)	7	0.0001	0
#4 #5 #6 #7	Trigger time point [sec]	32 Bit (unsigned int)	7	0.05	0

ID = Identifier-Base + 5

Data Byte	Content	Data Format	Start-Bit	Factor	Offset
#0 #1	Height difference between Mean Sea Level and WGS-84-Ellipsoid [m] 0...6500.0 m As long as no value is available: 6550	16 Bit (unsigned short)	7	0.1	0
#2 #3	Age of the DGPS correction data [sec] 0..6553.5 sec	16 Bit (unsigned short)	7	0.1	0
#4 #5	ID of the DGPS reference station 0..1023 As long as no value is available: 2000	16 Bit (unsigned short)	7	1	0
#6	Number of Satellites 0..255	8 Bit (unsigned byte)	7	1	0
#7	unused				

ID = Identifier-Base + 6

Data Byte	Content	Data Format	Start-Bit	Factor	Offset
#0	UTC Day (1..31) As long as no value is available: 99	8 (unsigned byte)	7	1	0
#1	UTC Month (1..12) As long as no value is available: 99	8 (unsigned byte)	7	1	0
#2 #3	UTC Year (0..9999) As long as no value is available: 10000	16 Bit (unsigned short)	7	1	0
#4 #5	PDOP 0..99.99 If invalid: 100	16 Bit (unsigned short)	7	0.01	0
#6 #7	VDOP 0..99.99 If invalid: 100	16 Bit (unsigned short)	7	0.01	0

ID = Identifier-Base + 10H

Data Byte	Content	Data Format	Start-Bit	Factor	Offset
#0 … #7	GPS longitude [DDMM.MMMMM) NMEA scaling Degrees/Minutes +/-18000.00 = -180…+180° 00.00' e.g.: 812.34567 = 8°12.34567' As long as no value is available: 200°	64 Bit (signed double)	7	1.0	0.0

ID = Identifier-Base + 11H

Data Byte	Content	Data Format	Start-Bit	Factor	Offset
#0 … #7	GPS latitude [DDMM.MMMMM) NMEA scaling Degrees/Minutes +/-9000.00 = -90…+90° 00.00' e.g.: 812.34567 = 8°12.34567' As long as no value is available: 200°	64 Bit (signed double)	7	1.0	0.0

ID = Identifier-Base + 12H

Data Byte	Content	Data Format	Start-Bit	Factor	Offset
#0 #1 #2 #3	Barometric Altitude [m] +/- 10000 m	32 Bit (signed int)	7	0.01	0
#4 #5	Sensor temperature [°C] +/- 100.00°	16 Bit (signed short)	7	0.1	0
#6 #7	Unused				

ID = Identifier-Base + 13H

Data Byte	Content	Data Format	Start-Bit	Factor	Offset
#0 #1 #2 #3	Barometric Pressure [mbar] +/- 10000 mbar	32 Bit (signed int)	7	0.001	0
#4 #5 #6 #7	Barometric Pressure QNH [mbar] +/- 10000 m	32 Bit (signed int)	7	0.001	0

ID = Identifier-Base + 14H

Data Byte	Content	Data Format	Start-Bit	Factor	Offset
#0 #1	Barometric Gradient [%] +/- 100 %	16 Bit (signed int)	7	0.01	0
#2 #3	GPS Gradient [%] +/- 100 %	16 Bit (signed int)	7	0.01	0

ID = Identifier-Base + 15H

Data Byte	Content	Data Format	Start-Bit	Factor	Offset
#0 #1	Speed from Speed Pulse Input [km/h] 0.. 655.0 km/h As long as no value is available: 0.0	16 Bit (unsigned short)	7	0.01	0.0
#2 #3 #4 #5	Fuel Input Pulse Count 0..429467295 As long as no value is available: 0.0	32 Bit (unsigned short)	7	1.0	0
#6 #7	unused				

ID = Identifier-Base + 20H

Data Byte	Content	Data Format	Start-Bit	Factor	Offset
#0 #1 #2 #3	GPS longitude +/-1.800.000.000 = -180…+180° e.g.: 81234567 = 8,1234567 ° As long as no value is available: 200°	32 Bit (signed int)	7	0.0000001	0.0
#4 #5 #6 #7	GPS latitude +/- 900.000.000 = -90…+90° e.g.: 491234567 = 49,1234567 ° As long as no value is available: 200°	32 Bit (signed int)	7	0.0000001	0.0

ID = Identifier-Base + 21H

Data Byte	Content	Data Format	Start-Bit	Factor	Offset
#0 #1	Lateral acceleration [m/s] +/- 100.0 As long as no value is available: 100.0	16 Bit (signed short)	7	0.01	0.0
#2 #3	Filtered Speed [km/h] 0..650.00 As long as no value is available: 655.0	16 Bit (unsigned short)	7	0.01	0
#4 #5	Speed [km/h] 0..650.00 As long as no value is available: 655.0	16 Bit (unsigned short)	7	0.01	0
#6 #7	Direction [degree] 0..359.99 As long as no value is available: 400°	16 Bit (unsigned short)	7	0.01	0

ID = Identifier-Base + 22H

Data Byte	Content	Data Format	Start-Bit	Factor	Offset
#0 #1	Height [m] 0...6500.0 m As long as no value is available: 6550	16 Bit (unsigned short)	7	0.1	0
#2 #3 #4	UTC Time [sec] 0..8639995 e.g.: 5239535 = 52395,35 sec = 14:33:15,35	24 Bit	7	0.01	0
#5 #6	HDOP 0..99.99 If invalid: 100.0	16 Bit (unsigned short)	7	0.01	0
#7 Bit 7	North / South Hemisphere 0 = North 1 = South	1	7	1	0
#7 Bit 6	East / West Hemisphere 0 = West 1 = East	1	6	1	0
#7 Bit 5	DGPS-Status 0 = DGPS not active 1 = DGPS active	1	5	1	0
#7 Bit 4	Trigger-Status 0 = Not active 1 = Active	1	4	1	0
#7 Bit 0-3	GPS-Status 0 = no GPS 1 = GPS 2 = DGPS	4	3	1	0

ID = Identifier-Base + 23H

Data Byte	Content	Data Format	Start-Bit	Factor	Offset
#0 #1 #2 #3	Distance since Trigger [m] 0.. 429483.6225 m	32 Bit (unsigned int)	7	0.0001	0
#4 #5	Time since Triggering [sec] 0..3276.75	16 Bit (unsigned short)	7	0.05	0
#6 #7	Speed at time of Triggering [km/h] 0..650.00 As long as no value is available: 6550	16 Bit (unsigned short)	7	0.01	0

ID = Identifier-Base + 24H

Data Byte	Content	Data Format	Start-Bit	Factor	Offset
#0 #1 #2 #3	Total distance since reset [m] 0.. 429483.6225 m	32 Bit (unsigned int)	7	0.0001	0
#4 #5 #6 #7	Trigger time point [sec]	32 Bit (unsigned int)	7	0.05	0

ID = Identifier-Base + 25H

Data Byte	Content	Data Format	Start-Bit	Factor	Offset
#0 #1	Height difference between Mean Sea Level and WGS-84-Ellipsoid [m] 0...6500.0 m As long as no value is available: 6550	16 Bit (unsigned short)	7	0.1	0
#2 #3	Age of the DGPS correction data [sec] 0..6553.5 sec	16 Bit (unsigned short)	7	0.1	0
#4 #5	ID of the DGPS reference station 0..1023 As long as no value is available: 2000	16 Bit (unsigned short)	7	1	0
#6	Number of Satellites 0..255	8 Bit (unsigned byte)	7	1	0
#7	unused				

ID = Identifier-Base + 26H

Data Byte	Content	Data Format	Start-Bit	Factor	Offset
#0	UTC Day (1..31) As long as no value is available: 99	8 (unsigned byte)	7	1	0
#1	UTC Month (1..12) As long as no value is available: 99	8 (unsigned byte)	7	1	0
#2 #3	UTC Year (0..9999) As long as no value is available: 10000	16 Bit (unsigned short)	7	1	0
#4 #5	PDOP 0..99.99 If invalid: 100	16 Bit (unsigned short)	7	0.01	0
#6 #7	VDOP 0..99.99 If invalid: 100	16 Bit (unsigned short)	7	0.01	0

SETTING OF DIP-SWITCHES

There is a total of 7 DIP-Switches plus 2 Jumpers ST6 and J1 with which you can configure the system.

- 4 Switches to set the terminating resistor of the individual CAN busses
- Select speed pulses to be 1:1 or quad
- Select PLL output to be TTL level or Open Collector
- Select 1 PPS output to be TTL level or Open Collector and also select source 100 Hz GPS or Assist Receiver

Usually you will not have to change these settings.

When doing so, be extremely careful when opening the system. Only trained personal should do so. We do not take any responsibility on damages caused by opening the system.

To open xProGPS_max you will need a TORX tool. Unlock the 4 TORX screws on the front side and on the rear side of the system. Carefully slide out front together with the CPU mainboard.

Take special care that the main board never will touch the metal housing as there is continuous power from the backup battery on the printed circuit board.

Locate the Dip-Switches and change them accordingly to your needs.

When re-inserting the board take extreme care that the board slides into the holder on the rear-side properly as otherwise the board can get damaged seriously. Check that the CPU board is inserted properly into the front panel and close first the front screws and finally the rear side screws.

Check that the SD card holder fits properly into the slot of the rear cover.

DESCRIPTION OF DIP-SWITCHES

SW1 **selects if output of PLL frequency synthesizer is either TTL level or O.C.**

1-4 on and 2-3 off	default	sets output to TTL
1-4 off and 2-3 on		sets output to Open Collector

SW2 – SW5 **activate terminating resistors of CAN busses**

SW2	1-2 on	default = on	sets terminating resistor of internal CAN
SW3	1-2 on	default = off	sets terminating resistor of CAN-CAR
SW4	1-2 on	default = off	sets terminating resistor of GPS-OUT
SW5	1-2 on	default = off	sets terminating resistor of CAN-EXT

SW6 **selects source of 1 PPS pulse (100Hz GPS or Assist GPS) and output level TTL or Open Collector**

1-8	default = on	selects 100Hz GPS as source
2-7	default = off	selects Assist Receiver as source
3-6	default = on	selects TTL output level
4-5	default = off	selects Open Collector ouput

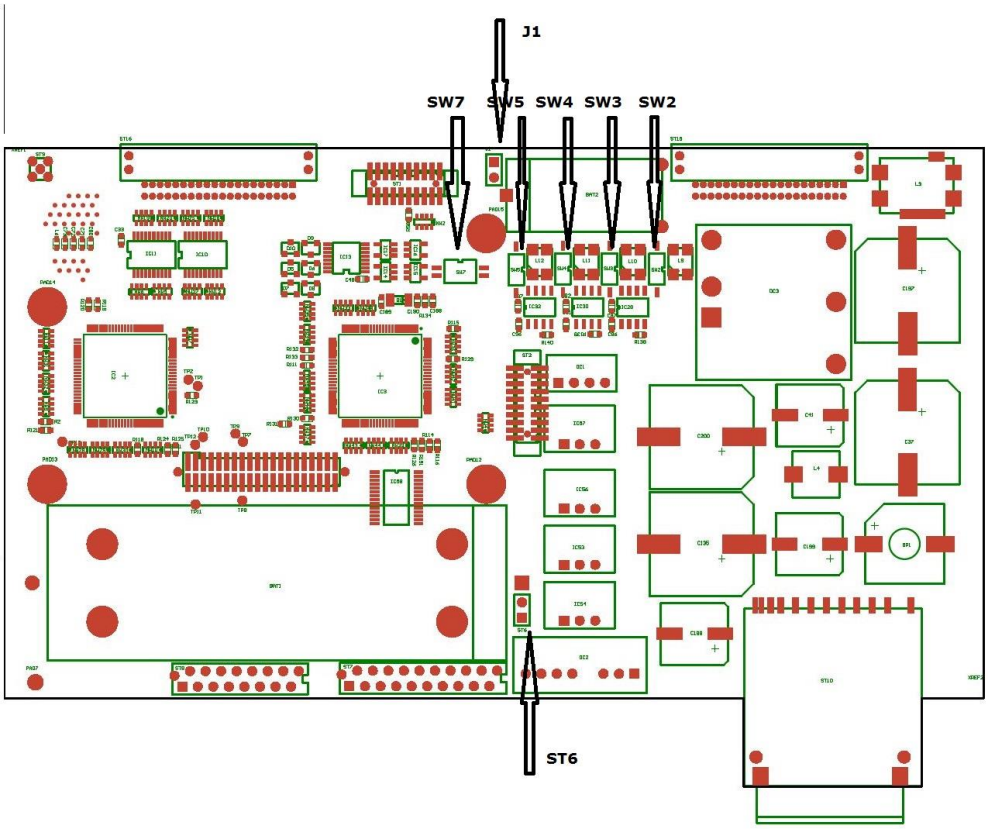
SW7 **selects single or quadruple output of incoming speed pulses on counter input**

1-4	default = on	selects four output pulses per one input pulse

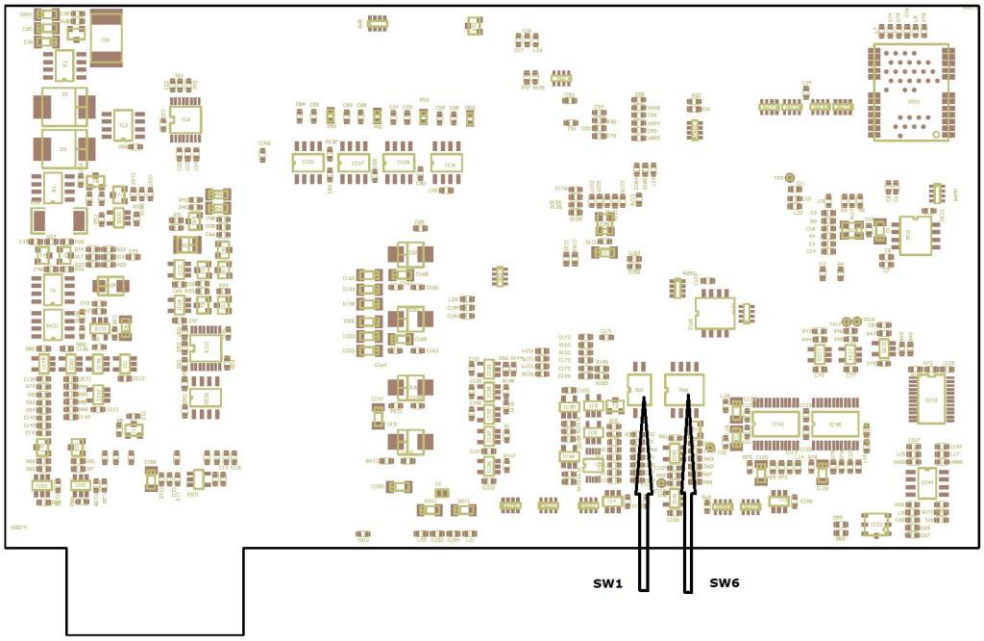
	2-3	default = off	selects one output pulse per one input pulse

ST6 **activates NiMh battery pack**

J1 **activates backup battery for real-time clock**



Locate SW 2, 3, 4, 5, 7 and ST6 and J1



Locate SW1 und SW6

SAFETY NOTES AND GENERAL COMMENTS

INSTALLATION OF EQUIPMENT

The Measurement system should not be installed in a location where, as a result of an accident, it could hit the driver or passenger as this could cause serious injury. The measurement system or other accessories should on no account be mounted in an area so as to reduce the effectiveness of an *Airbag*.

Discuss the location of mounting in the vehicle with a suitable safety advisor and follow the safety instructions.

POWER SUPPLY

The power supply of the data acquisition system may be carried out exclusively via a protected electrical circuit of the vehicle. The released maximum supply voltage may not be exceeded, also not short-time.

The system has a built in electronic fuse. But by squeezing the supply cable connected to an unsecured power outlet, a dangerous cable fire can be the result! Injury to persons is a possible consequence.

The supply must be suitable for the withdrawal of the permanent operating current of the device.

It has to be taken care that the supply voltage is provided with correct polarity. Although the 2HE-PCI system is protected against wrong polarity, external connections of peripheral components can eventually by-pass the protection circuit. A destruction of the equipment might then be the consequence.

INSTALLATION OF INTERFACE CABLES

The connection cables may be laid only in such a way that they cannot unintentionally jam or reduce in their effect operating devices of the vehicle or safety installations. The driver may under no circumstances be hindered by the laid cables (steering, pedals, gear shifting, operating devices etc.)

ENVIRONMENTAL CONDITIONS FOR OPERATION AND STORAGE

The device may be operated exclusively in the temperature range released by us. Exceeding the maximum or minimum storage or operating temperature can lead to irreversible damages to the data acquisition system or peripheral devices attached.

The measuring system may be operated only under suitable air conditions. Dust, humidity or wetness has to be kept away from the device since it can cause severe damage to the equipment.

SUMMARY OF SAFETY HINTS

At start-up please consider the following summary of safety instructions:

- Secure magnetic antenna (danger of injury to pedestrians etc.)
- Position the equipment outside areas where any airbags may be active (danger of injury)
- The cable should not hinder the driver in any way (pedals, steering etc.)
- Only connect the system to fused electrical circuits
- Take into consideration the general employer's and government safety regulations
- Do not place the magnetic antenna on floppies or close to the hard drive of a laptop (potential data loss)

GENERAL COMMENTS

CLEANING

Use only soft cotton to clean, if necessary with a glass cleaner. Never use either cleaning solution or anything hard or sharp.

EMI NOTES

Please ensure that only connection cables that have been sanctioned by us are used when connecting the xProGPS. The xProGPS must only be used with suitable and acceptable CE certified measurement equipment. Never operate the equipment when the housing is open.

ADVICE FOR DISPOSAL

The equipment contains a Lithium as well as an NiMh accumulator. The contents are poisonous! Never allow any fluids/paste that escapes from the battery to come into contact with skin or eyes. Contaminated parts of the body should be thoroughly rinsed with water immediately!

Batteries cannot be disposed of as normal household rubbish. Please contact your local authorities where these parts can be handed in.

OPENING THE EQUIPMENT

There are no parts within the housing that require maintenance from the user. Please always keep the housing closed as it is possible that sensitive parts could be damaged during opening of the housing.

Such actions will render all guarantees worthless.

LIABILITY EXCLUSIONS

This document has been checked for its accuracy. However Suchy Data Systems GmbH retains the right to make technical changes and modifications without pre-warning. All pieces of equipment are thoroughly checked by Suchy Data Systems GmbH before delivery. Suchy Data Systems GmbH accepts no liability for any damages that may result, directly or indirectly as a result of the use of the measurement system or through misunderstanding of this document.

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DECLARATION OF EC CONFORMITY

Name and address of manufacturer

Suchy Data Systems GmbH.

Am Steinacker 29

D-85253 Erdweg

Suchy Data Systems GmbH. herewith declares conformity of the product

Product name CAN-Bus-Converter / CAN bus converter

Type **xProGPS**_max

with -

options -

The following regulations apply;-

EMC directive 89/336/EEC amended by 91/263/EWG, 92/31/EEC

Low-Voltage Equipment Directive 73/23/EEC amended by 93/68/EEC

Applicable standards

Safety requirements

IEC 1010-1 *Safety requirements for electrical equipment for measurement control and laboratory use*

VDE 0411 Section 1

Electromagnetic compatibility

VDE0839 Section 82-2 *Generic immunity standard part 2: Industrial environment*

VDE 843 Section 2 ..5

IEC 801-1 ... IEC 801-5

DIN EN 55011 *Limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical radio-frequency equipment*

VDE0875 Section 11

Date	*Signature*
10.12.2014	Manfred Suchy, Managing Director