

GDL 110

GPS-time synchronized data acquisition system

User Manual

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Dear Customer,

We would like to welcome you in the community of DM Technology device users!

We appreciate your choice and hope you will be satisfied with our product.

Our goal is to provide you with a reliable and easy to use device so that you can focus on your work. Therefore, if you have questions regarding operation of our device, please contact us immediately. We will provide you with quick and competent help through our service staff and product managers.

You can contact us in the following ways:

Internet: At our website www.dmtechnologies.eu please do find Support section where you can find answers to frequently asked questions and a service contact form.

Email: info@dmtechnologies.eu

Phone: +48 609 413 923

In order to facilitate your contact please have your product ID and serial number ready.

As our aim is to improve our products, we greatly appreciate all customer feedback. We would like to encourage you to contact us with any positive remarks, regarding our product, but also with any suggestions regarding potential its improvements. We truly believe that with your help we manage to further develop our products to meet your ever-increasing demands.

We would like you to thank you for your choice.

Sincerely yours,

Dr. Szymon Pustelny



CEO of DM-Technologies

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1. SAFETY INSTRUCTIONS AND WARNINGS

!!! WARNING !!!

Dangerous voltages, capable of causing injury or death, are present in this instrument. Use extreme caution whenever the instrument cover is removed. Do not remove the cover while the device is plugged into an electric outlet.

Before operating GDL110 please read carefully the manual. Operation of the device according to the instructions and safety guidelines will prevent personal injury and damage of the device.

The following safety instructions must be followed at any times.

The GDL110 system must be supplied using a **three-wire power cord** with independent power wires and a separate protective-ground wire. **Always use the power cord and electric outlet with the ground wire.** The exposed metal parts of the instrument are connected to the outlet ground to protect against electrical shock.

Never operate the device without the cover.

Any service and adjustment may only be performed by trained personnel.

Do not perform any unauthorized modifications to the device. Any unauthorized modifications of the device will cause termination of the warranty.

The instrument must not be operated in hazardous environment. In particular:

- (1) **Do not use the device in wet or humid environment.**
- (2) **Do not use the device in atmosphere containing explosive or corrosive gasses.**

Provide proper cooling of the device.

2. SPECIFICATION

GDL110 is a multi-channel stand-alone global-time-synchronized data acquisition system.

Analog channel

Number of channels:	4
Input range:	$\pm 1.25\text{ V}$, $\pm 2.5\text{ V}$, $\pm 5\text{ V}$, $\pm 10\text{ V}$
Resolution:	16 bit
Noise:	1 LSB_{rms}
Sampling rate:	1 S/s to 1024 S/s (power-2 sequence)
Input impedance:	1 MΩ

Digital sensors

Magnetic sensor

Type:	GMR
Field range:	$\pm 88\text{ }\mu\text{T}$, $\pm 130\text{ }\mu\text{T}$, $\pm 250\text{ }\mu\text{T}$, $\pm 400\text{ }\mu\text{T}$, $\pm 470\text{ }\mu\text{T}$, $\pm 560\text{ }\mu\text{T}$, $\pm 810\text{ }\mu\text{T}$
Sampling rate:	1 S/s to 50 S/s (1-2-5 sequence)

Temperature sensor

Type:	DS18B20
Temperature range:	-55°C - 125°C
Sampling rate:	1 S/s

Time synchronization

Time frame:	GPS or UTC
Absolute time precision:	$\pm 200\text{ ns}$

Communication

Computer communication:	USB
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Memory

Type:	SD card
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Capacity: **Switchable (4 GB preinstall)**

File system: **FAT32**

Time referencing

External pulse precision **± 80 ns + GPS antenna-cable delay (4 ns/m)**

3. GETTING STARTED

3.1. IN THE BOX

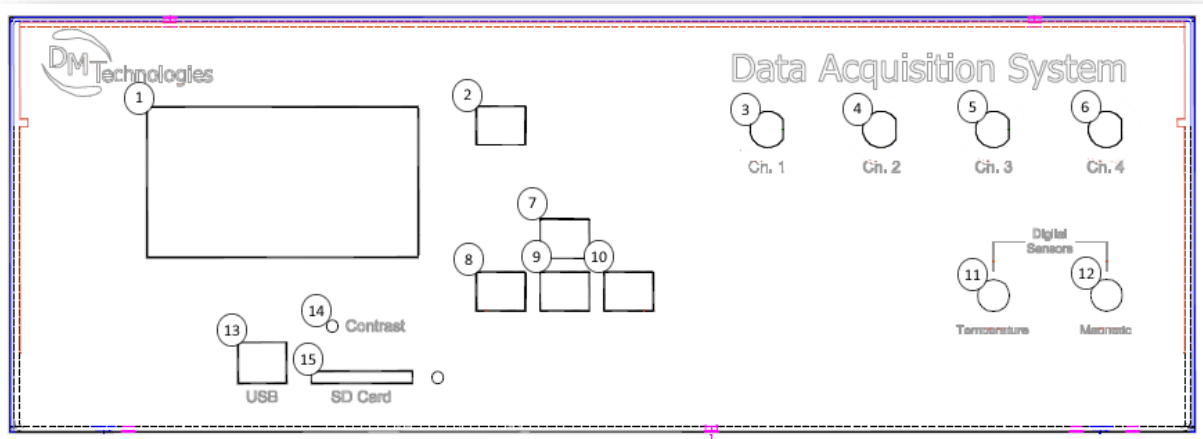
The box contains following elements:

- GDL110 box
- Power cord (EU standard)
- Magnetic-field sensor with a cable (2 m)
- Temperature sensor with a cable (2 m)
- GPS antenna
- 1.8 m USB2 connection cable, type A – B
- 5 m GPS antenna cable
- Device manual

3.2. OVERVIEW

In this section, we briefly discuss all elements of GDL110 front and rear panel.

GDL110 front panel



1 – LCD Screen

The screen displays a menu when operated in the non-acquisition mode and analog- and digital-channel readouts when operated in the acquisition mode.

2 – Acquisition Start/Stop Button

Button that starts or stops data acquisition. Pressing the button initiates/interrupts the acquisition at any time, i.e., independently from a position in a menu.

3 - BNC Connector – CH1 Signal In

Channel 1 input connector accepts signals within -10 V to 10 V (Channel ground connected to the device ground via a 100-k Ω resistance)

4 - BNC Connector – CH2 Signal In

Channel 2 input connector accepts signals within -10 V to 10 V (Channel ground connected to the device ground via a 100-k Ω resistance)

5 - BNC Connector – CH3 Signal In

Channel 3 input connector accepts signals within -10 V to 10 V (Channel ground connected to the device ground via a 100-k Ω resistance)

6 - BNC Connector – CH4 Signal In

Channel 4 input connector accepts signals within -10 V to 10 V (Channel ground connected to the device ground via a 100-k Ω resistance)

7 – Control Button – Up

Control button – Up enables vertical navigation in the menu

8 – Control Button – Left

Control button – Left enables horizontal navigation in the menu

9 – Control Button – Down

Control button – Down enables vertical navigation in the menu

10 – Control Button – Right

Control button – Right enables horizontal navigation in the menu

11 – Digital Sensor Connector – Temperature

Digital Sensor Connector – Temperature links the GDL110 with the temperature sensor

12 – Digital Sensor Connector – Magnetic Field

Digital Sensor Connector – Magnetic Field links the GDL110 with the magnetic-field sensor

13 – USB Connector

USB Connector enables communication with a computer. The port is used to transfer data from the device to a computer, as well as, to set up GPS time receiver (Trimble resolution T) parameters, using a dedicated Trimble software. The delivered system is factory preset, i.e., it does not require any time adjustments

14 – Contrast Control Screw

Control screw used to adjust contrast of the LCD screen

15 – SDD Card Slot

Slot for the memory card

GDL110 rear panel



16 – BNC Connector – PPS Out

The BNC provides a time reference signal (pulse per second).

17 – Cable Connector – GPS Antenna

Input socket for the cable connected to the GPS antenna

18 – AC Line Power Socket

The power socket of the device

19 – AC Line Voltage Selector

A switch enabling changing the AC line voltage range. The switch enables to choose between 230 V (50 Hz) and 115 V (60 Hz).

3.3. QUICK START

This section describes procedures of setting up GDL110, performing the first acquisition, and transferring data from the device to a computer.

Setting up the device

- 1) Install the GPS antenna. The antenna ought to have a clear view of sky. Preferentially, the central part of the sky ought to be visible, to provide the best time precision.
- 2) Connect the antenna to the device via the connector (17) install at the back of the device.
- 3) Connect the power cord to supply the device.
- 4) Make sure an appropriate AC voltage range (19) is chosen. **The instrument may be damaged if operated with the AC Line Voltage Selector set for the wrong AC line voltage or if the wrong fuse is installed.**
- 5) Turn on the power switch at the AC Line Power Socket (18).
- 6) Insert (if not in the socket) a SD card into the slot (15). In case the card has not been used previously, the device performs a procedure, consisting in creation of a number of storage files, to prepare for the card for measurements. **The SD card needs to be formatted using FAT32 file system architecture.** If used card is not completely empty, the device fills the

remaining free space, so that 25% of the total space remains free (performance optimization). This aim of the procedure is to allocate the files on the card, which, over time, will be filled with recorded data.

Connection with a computer

- 1) Connect GDL110 with a computer via a USB cable. The device should be automatically install on the computer (the GDL110 drivers for Windows XP, Windows 7 and Windows 8, Windows 8.1 both 32-bit and 64-bit are provided). The connection of GDL110 with the computer enables communication. Communication is realized both ways (to and from the device):
 - a. Connection to the device – Using the computer, the GPS Time Receiver (Trimble Resolution T) may be run in a service mode. In this way, one can learn about current status of the timing module, including number of visible satellites, time precision, locations, etc. The software is stored on the SD card send with the device or can be download the time-module manufacturer website (<http://www.trimble.com/timing/resolution-t.aspx>)
 - b. Data transfer from the device – Using the computer, the recorded data can be transferred from the device to the computer. The communication is performed though a serial port (RS-232). The data storage is possible through a simple serial-port terminal or through dedicated software (not provided).
- 2) Turn on the Trimble Resolution T firmware to diagnose the number of visible satellites and the precision of your time reference.
- 3) Using the navigation buttons (7)-(10), select *Tools*.
- 4) From the *Tools* submenu, choose *GPS Service*.
- 5) From the *GPS Service* submenu, select *Enter service mode*.
- 6) In *Trimble Visual Timing Studio* (Trimble firmware), choose *Connect to Device*.
- 7) In the pop-up dialog box, choose COM Port (choose GPS DATA LOGGER), set up Baud Rate (factory setting: 115200), Parity (factory setting: None), Data Bits (factory setting: 8), and Stop Bits (factory setting: 1).
- 8) From the *Monitor* mode, select *Timing receiver mode*.
- 9) Perform the survey until it is completed. **Prior to the very first measurement GDL110 needs to be run for roughly 2 hours, to obtain a precise position and timing.**
- 10) Before closing the mode (2), save the location. **Any change in the location of the device requires repeating the procedure to obtain appropriate timing.**

Setting up measurement parameters

- 1) With the navigation buttons (7)-(10), select *Analog channels* from *Main menu*.
- 2) With the navigation buttons (7)-(10), set up a number of channels used in the measurements by choosing the input voltage ranges. For the initial run, it is advised to use all channels at different input-voltage ranges (e.g., CH1 ± 10 V, CH2 ± 5 V, CH3 ± 2.5 V, CH4 ± 1.25 V).
- 3) Within the same submenu, choose Sampling rate using the navigation buttons (7)-(10). For the initial run, it is advised to use, the maximum sampling rate (1 kS/s).
- 4) With the navigation buttons (7)-(10), return to *Main menu*.
- 5) With the navigation buttons (7)-(10), select *Magnetic sensor* from *Main menu*.
- 6) With the navigation buttons (7)-(10), set up range and sampling rate for the Magnetic-field sensor. For the initial run, it is advised to use maximum sampling rate of a Magnetic-field sensor (50 S/s).

Performing the first run

- 1) Initiate the measurements by pressing Acquisition Start/Stop Button (2). If the system is set up properly, being ready to use, the screen (1) displays readouts of analog and digital sensors (updated every second) and the data is stored at the SD card.
- 2) Every minute, the complete file is saved on the SD card and, if the computer-device communication is established, it is sent to the serial port. **If appropriate software is run on the computer, the files are received and saved at the specific location on the computer hard drive (determined by the software).** If no communication between computer and device is established, the files are stored on the SD card. With the SD card delivered by the manufacturer (4 GB), roughly 20 hours of computer independent operation of the device is possible. After that time and with not computer-device communication reestablished, new data will be stored by overwriting the old data. When the communication between the device and a computer is established during the acquisition, the transfer starts with the oldest files recorded in the session, which prevents overwriting the old data files with newly recorded data.
- 3) Conclude the acquisition, by pressing the Acquisition Start/Stop Button (2).

Transferred of the stored data in non-acquisition mode (data stored without computer-device communication)

- 1) Using the navigation buttons (7)-(10), choose *Tools* from *Main Menu*.
- 2) Using the navigation buttons (7)-(10), choose *Send buffered data*. If there is a data that has not been sent previously and the computer-device communication is established, the transfer starts immediately. The transfer continues until all data is transferred to the computer or it is interrupted externally (navigation buttons, power switch off). In the case of no new data, the message: *No data to send* is displayed on the screen (1).

Resetting data buffer (neglecting data stored previously without computer-device communication)

- 1) Using the navigation buttons (7)-(10), choose *Tools* from *Main Menu*.
- 2) Using the navigation buttons (7)-(10), choose *Delete buffered data*. This command resets the buffer and no data previously stored is transferred to the computer either in acquisition and non-acquisition mode. **Despite this operation the data is stored at the SD card, until it is overwritten during the next run.**

!!! WARNING !!!

Take extreme care when operating with an open lid. Dangerous voltages, capable of causing injury or death, are present in this instrument.

4. FIRMWARE UPGRADE

The following procedure can be used for GPS box firmware upgrade.

- 1) Connect the J-tag programmer to the computer via USB.
- 2) Open the lid of the GPS box.
- 3) Connect the GPS box and the programmer through the J-tag connector (the connector on the board looks like this



- 4) Install the Segger J-Link. The installation file (Setup_JLinkARM_V454a.exe) is in the Dropbox folder. I suggest installing it in default directory (c:\Program Files (x86)\SEGGER\JLinkARM_V454a)
- 5) Copy three remaining files:
 - upgrade.bat
 - main2_05.bin (most recent version of the firmware as for July 2019)
 - Jlink_program_script.txtto a folder in your computer. The source folder does not matter.
- 6) Turn on the GPS device. **Please be careful as the box lid is open and there is a danger of voltage shock.**
- 7) If you install J-Link into a default folder (c:\Program Files (x86)\SEGGER\JLinkARM_V454a\JLink.exe), you simple need to click on upgrade.bat. It will start the upgrade procedure: the pop-up menu will appear at the screen and the upgrading procedure will be initiated. It should take roughly 30 seconds after which the menu will automatically close. If Segger folder was change you need to edit upgrade.bat (e.g., with notepad) and adjust the SEGGER folder location. After saving the file, click on the file and the upgrading procedure will be initiated.
- 8) After the upgrade is completed, turn off and on the device. If the upgrading procedure was completed successfully, you should see a version of "2.05" during booting the device.
- 9) If the procedure was completed successfully (indicated by upgraded version of the software), turn on the device, disconnect the programmer, and close the lid.

5. TROUBLESHOOTING

Problems with installing drivers

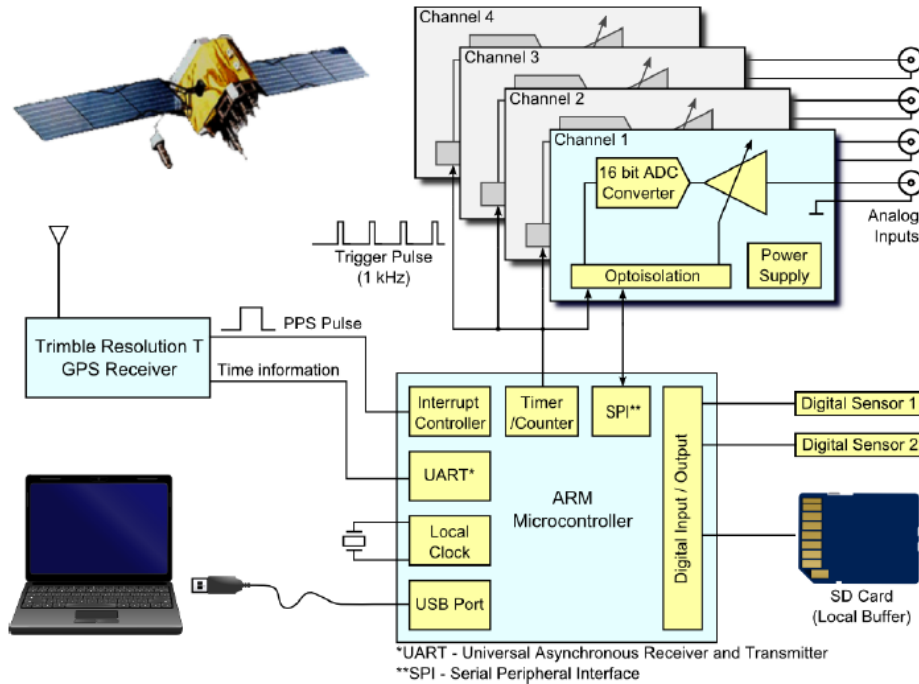
In the case of unsuccessful installation of the GDL110 drivers on a computer, the dedicated GDL110 driver needs to be installed manually. The driver is provided by the manufacturer, and saved at the SD card provided by the manufacturer. In order to install the driver, one needs to perform following train of actions:

- 1) Insert the manufacture-deliver SD card in the card slot of a computer.
- 2) In *Start menu*, go to *Control Panel*.
- 3) In *Control Panel*, choose *Device and Printers*.
- 4) In *Device and Printers*, right click the *Unknown device icon* and choose *Properties* (the device need to be connected with the computer with a USB cable).
- 5) From the pop-up dialog box, choose *Hardware* tab and click *Properties*.
- 6) In the *General settings* tab of the new dialog box, choose *Change settings*.
- 7) In the following dialog box, go to the *Driver* tab and choose *Update driver*.
- 8) In the pop-up dialog box choose *Browse my computer for driver software*.
- 9) In *Search for driver update in this location* choose the SD card and click *Next*.
- 10) In case the computer does not recognize the device automatically, turn off and on GDL110 to reset the device and communication.

APPENDIX. THE SYSTEM BLOCK DIAGRAM

The schematic block diagram of GDL110 is presented below.

GDL 110 schematic diagram



The detailed description of the system, along with the careful characterization of all time uncertainties and delays are presented in Ref. [1]. The exemplary, synchronization budget, is shown in Table 1.

Table 1: Synchronization-error budget.

Source of Error	Min. Delay	Max. Delay	Max. Uncertainty
Antenna cable delay*	0	+ 200 ns (50 m of cable)	±10 ns
GPS synchronization error (3σ)	-45 ns	45 ns	±45 ns
Program delays (t_s) **	1450 ns	1630 ns	±90 ns
Estimated onboard propagation delays	40 ns	110 ns	±35 ns
ADC Aperture delay	40 ns	40 ns	±20 ps
Total	1485 ns	2025 ns	±180 ns

* The system provides compensation if the cable delay is known.

** Possible to eliminate in the next version, hardware changes required.

[1] P. Włodarczyk, S. Pustelny, D. Budker, and, M. Lipiński, *Multi-Channel Data Acquisition System with Absolute Time Synchronization*, Nuclear Instruments & Methods in Physics Research A **763**, 150-154 (2014).