Seismic Data Recorder

DATA-CUBE³

User Manual

DATA-CUBE³ User Manual

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DATA-CUBE³ User Manual

1. Introduction

The DATA-CUBE³ is a 3-channel, 24-bit seismic data recorder. It was initially developed at GFZ Potsdam until 2011, later enhanced and introduced to the international market by Omnirecs, now produced and distributed by DiGOS. The DATA-CUBE³ is a great candidate for different seismologic applications by its unique combination of features.

This document provides an overview of the different DATA-CUBE³ types & applications, software, available cables and sensor signal converters as well as detailed usage information.

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2. DATA-CUBE³

The DATA-CUBE³ is available as Type 1 (int) and Type 2 (ext). Choosing the right DATA-CUBE³ type depends on the intended application and usage scenarios. Both types are electronically identical except for the internal vs. external GPS antenna and internal/external power supply.

2.1. DATA-CUBE³ Type 1 (int)
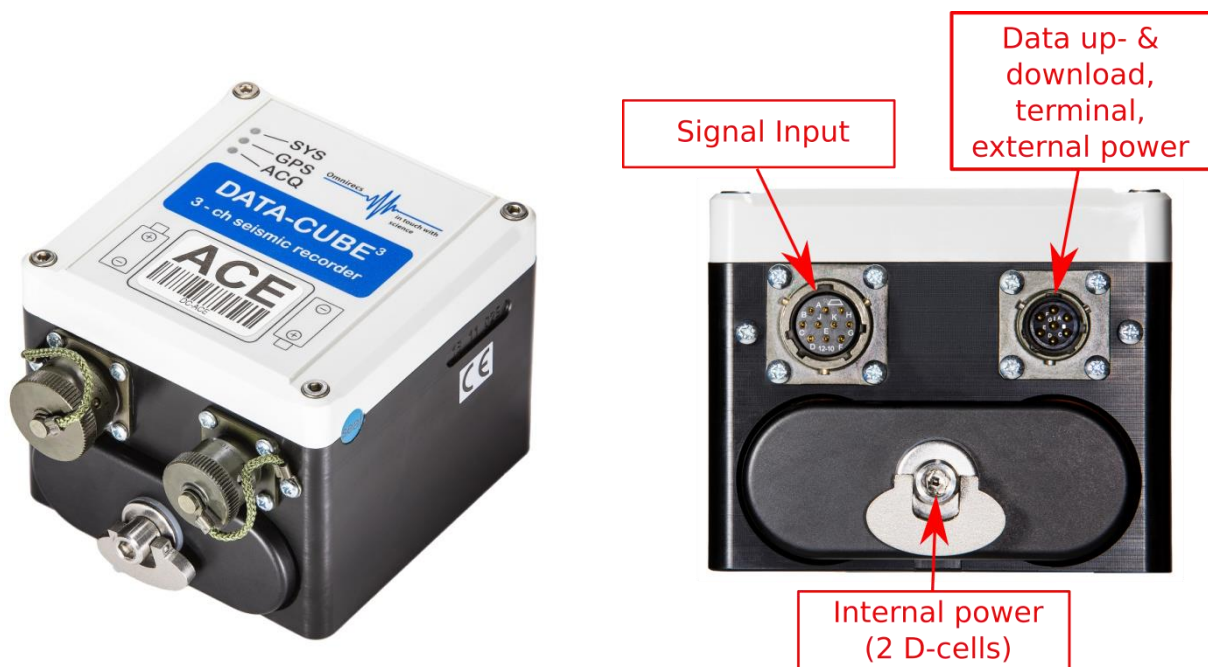
Features:
- Internal GPS antenna located under top cover
- Internal power supply (2x D-cells for up to 2 weeks operation) or external power supply

Typical applications:
- Active seismic measurements and short campaigns with a recording time of up to ~2 weeks (continuous recording of 3 channels @ 100sps using 2 D-cell alkaline batteries)
- Outdoor installation with direct *visibility* of GPS satellites
- Optionally: Long-term, outdoor deployments with external power supply (internal batteries are to be removed)
- Vault or tunnel installations without continuous GPS (see 9.3 Field Installation9.3)

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2.2. DATA-CUBE³ Type 2 (ext)
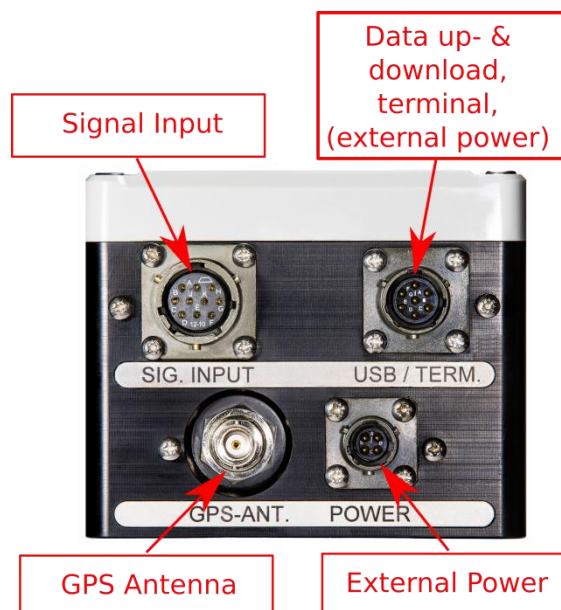
Features:
- External GPS antenna
- External power supply only

Typical applications:
- Long-term, passive seismic measurement campaigns and experiments for unattended operation of up to ~280 days (continuous recording 3 channels @ 100sps)
- Outdoor, vault or indoor installation

2.3. Custom-built Types

In the past, some users required special versions of the DATA-CUBE³ with different configurations. As an example, the following modified types have been manufactured in medium & large quantities:

DATA-CUBE³ Type 2: Plus electronics to adapt for a dedicated sensor signal level
DATA-CUBE³ Type 2: Antarctica & desert version for -40 - +70°C temperature rating (specified)
DATA-CUBE³ Type 2: Big data version with 64GB memory (experimental / under field tests)
CUBE+: Autonomous version with telemetry, signal level adaptation, solar power supply including charge electronics

Please contact us if you require special adaptations.

3. Accessories

3.1. Software and Configuration

The following software tools are available and are delivered with the DATA-CUBE³ at no additional fees:

- **CubeMonitor:** Used to check the proper function of the DATA-CUBE³ and noise at the installation/deployment site (monitor cable required). Available for Windows only.

- **CubeTools:** Software package to convert recorded raw data into SEG-Y or miniSEED format. Available for Windows and Linux.

- **State-of-Health routine:** Used to retrieve live state-of-health data during the measurement (GPS information, state of battery, etc.).

- **Example configuration file:** Used as a template to create a custom configuration of the DATA-CUBE³ recorder according to the requirements of the experiment (see section 4 below).

3.2. Transport Box

Rugged and perfectly fitting transport boxes are available for comfortable and safe transport of up to 12 DATA-CUBE³ (or 12 geophones) in the field.
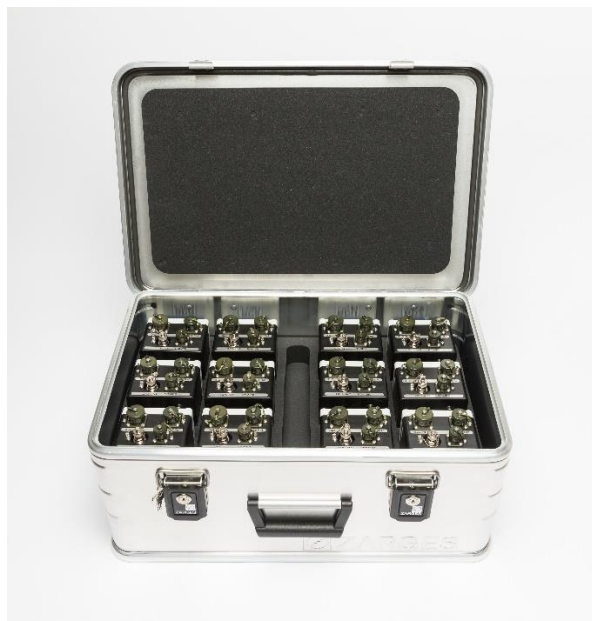
Transport box for up to 12 DATA-CUBE³

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3.3. Breakout Box (BOB)

A breakout box (BOB) is necessary if the DATA-CUBE³ is used together with an active sensor. The BOB powers the sensor and adjusts the voltage level of the sensor output to match the voltage input range of the DATA-CUBE³. This grants maximum flexibility and allows connecting a wide range of sensors to the DATA-CUBE³ like broadband seismometers or infrasound sensors.
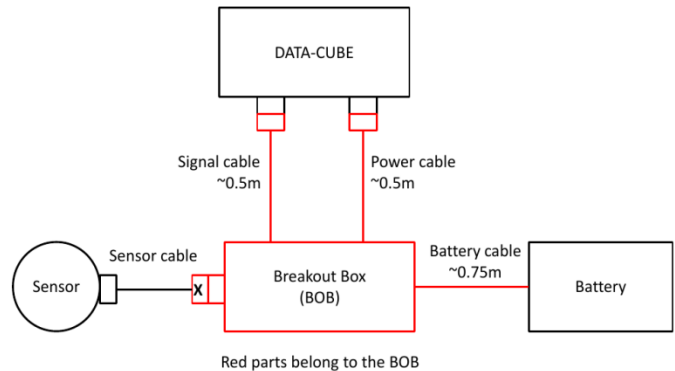
Photo of an example BOB and a schematic diagram to clarify individual customer requirements

The breakout boxes are custom-made by DiGOS according to the sensor output signal specification. Additionally, the breakout box can be manufactured with the correct connector for the sensor or a corresponding socket for an already existing sensor cable.

Low power protection can be included into the BOB if required. This avoids deep discharging of an external, rechargeable battery.

DiGOS also built BOBs with manual sensor centering support. Please ask us for a tailored quote.

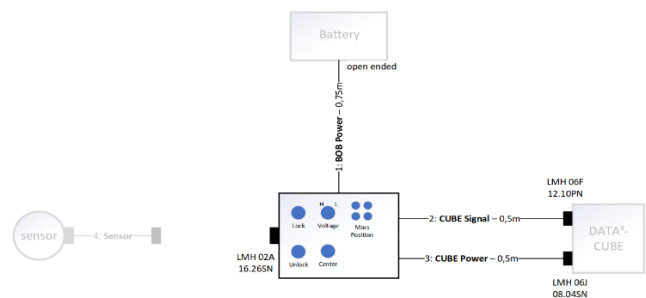Photo of an example BOB with special functions (Un-Lock, Center...) and a schematic diagram to clarify individual customer requirements

The low power protection disconnects the load (power) at approx. 11.5V and switches off at 10V.

Please note that Geophones that are distributed by DiGOS do not require a breakout box!

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3.4. Cables

The following cables are available:

Power cable

This cable is used to feed the DATA-CUBE³ with external power (5-24V DC). The input is protected against reverse poling. Connector and pin-out are different between DATA-CUBE³ Type 1 and 2. The D-cell batteries must be removed when powering DATA-CUBE³ Type 1 by external power!

USB up-/download cable (light grey)

This cable is used to upload a new configuration file to the DATA-CUBE³ or to download recorded data from the internal storage. When connecting the DATA-CUBE³ via this cable to a computer it will appear as an external drive. It is not necessary (yet possible) to additionally power the DATA-CUBE³ when connecting this cable. The DATA-CUBE³ will receive power from the computer via USB to enable access to the internal storage.

Please note: Recording of the DATA-CUBE³ stops automatically when connecting this cable! For data post-processing it is important to have a GPS fix at the end of the recording. The user must make sure that a GPS fix is acquired before downloading the data. The recording will continue automatically when the cable is disconnected again. It is recommended to disconnect the DATA-CUBE³ from the power supply before downloading the measurement data and reconnect afterwards.

Monitor cable (black)

This cable is used to check the proper operation of the DATA-CUBE³ and to observe the noise level of an installation / deployment site. The necessary software CubeMonitor is delivered with the DATA-CUBE³ and runs on Windows only.

Sensor cable

A sensor cable is either delivered by the sensor manufacturer or can be ordered in various lengths from DiGOS for most common sensors. We can also offer posthole cables on customer request.

Please contact us if you require special cable modifications.

3.5. Geophones

Different types of geophones can be ordered from DiGOS:

- Available natural frequencies: 4.5Hz, 8Hz, 10Hz or 14Hz
- 1 component (vertical) or 3 components (1 vertical & 2 horizontal)
- 3m cable (or custom length)

3 component geophone

The geophones are connected to the DATA-CUBE without an additional breakout box.

3.6. Mass Data Download by Parallel CUBE Downloader

A Parallel CUBE Downloader (PCD) is available for parallel data download from up to 12 DATA-CUBE³ units. The PCD comes with a powered USB 3.0 hub and Windows/Linux software. The software detects when a DATA-CUBE³ is connected to the PCD and automatically starts downloading the recorded data to a preconfigured directory. It informs the user via LEDs when the download of a DATA-CUBE³ is completed to connect the next unit.

Parallel CUBE Downloader (PCD)

3.7. Batteries & Power Supply

Standard batteries or power supplies are depending on the deployment settings/ requirements. Therefore, the batteries are user obligations and are not provided by DiGOS. However, DiGOS supports and offers design, engineering and installation for more complex multi-parameter, multi-sensor stations also as turnkey solutions.

Please contact us if you want to benefit from our expertise in your campaign, experiment or project.

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4. Pin-out

Please note: The following pin-out tables are describing the data sockets of the DATA-CUBE³!

10-way socket (female): signal input from sensor (type 1 and 2)

Pin	A	B	C	D	E	F	G	H	K	J
Signal	Ch1 Input+	Ch1 Input–	Ch2 Input+	Ch2 Input–	Ch3 Input+	Ch3 Input–	NC	Analogue GND	NC	NC
Color	white	brown	green	yellow	grey	pink	blue	red	purple	black
Axis	vertical		north – south		east – west					

7-way socket (male): USB/Terminal/External Power (type 1 and 2)

Pin	A	B	C	D	E	F	G
Signal	USB + 5V	USB + D	USB – D	GND	Terminal Tx 3.3V	Termial Rx 3.3V	Power 5-24V DC

4-way socket (male): External Power (type 2 only)

Pin	A	B	C	D
Signal	Power 5-24V DC	NC	NC	GND
Color	brown			blue

Please note that the corresponding connectors (plugs) must have the opposite gender.

5. Power Budget (examples)

The power budget has been estimated based on power consumption measurements of DATA-CUBE³ type 1 at laboratory conditions and on using two "Duracell Procell MN1300" batteries with a capacity of 39.6Wh.

DATA-CUBE³ type 1, measuring all 3 channels @ 100sps

GPS Cycle F_TIME	GPS on GPS_TI	GPS on duration	GPS off duration	Sum power	Runtime duration
Min	min	min/h	min/h	mW	days
15	5	20	40	147	11.2
15	4	16	44	140	11.8
15	3	12	48	133	12.4
30	5	10	50	129	12.8
30	4	8	52	125	13.2
30	3	6	54	122	13.5
30	2	4	56	118	14.0
59	59	59	0	219	7.5

Current while GPS on: 73mA / 219mW
Current while GPS off: 37mA / 111mW
Battery capacity: 39.6Wh

DATA-CUBE³ type 1, measuring only 1 channel @ 100sps

GPS Cycle F_TIME	GPS on GPS_TI	GPS on duration	GPS off duration	Sum power	Runtime duration
Min	min	min/h	min/h	mW	days
15	5	20	40	114	14.5
15	4	16	44	107	15.4
15	3	12	48	100	16.6
30	5	10	50	96	17.2
30	4	8	52	92	17.9
30	3	6	54	89	18.6
30	2	4	56	85	19.4
59	59	59	0	186	8.9

Current while GPS on: 62mA / 186mW
Current while GPS off: 26mA / 78mW
Battery capacity: 39.6Wh

Please note that the real runtime in the field can vary and is strongly depend on different parameters like environmental temperature, real capacity and age of batteries. Please see the battery capacity vs. temperature diagram below to estimate the runtime of the DATA-CUBE³ Type 1
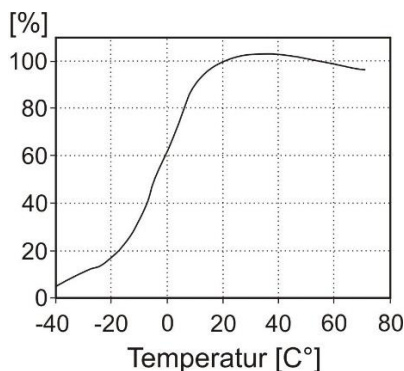
Battery capacity depending on temperature for "Duracell Procell MN1300" alkaline batteries

Additionally, the values of F_TIME and GPS_TI should not be a multiple of 60. This can lead to undefined behaviour for internal reasons.

6. Recording Times & Data Storage

The internal data storage capacity of the DATA-CUBE³ is up to 32GB. A 16GB version is available mostly for historic reasons. The following table provides an estimation of recorded raw data. It assumes a typical noise level of the measured data:

3 channels @ 100 sps	1 channel @ 800 sps
~ 1.3 kB/s	~ 3.5 kB/s
~ 78 kB/min	~ 208 kB/min
~ 4.68 MB/h	~ 12.48 MB/h
~ 112.32 MB/d	~ 300 MB/d

The maximum continuous recording time is estimated from the data above:

	3 channels			1 channel
	100 sps	200 sps	400 sps	800 sps
16 GB (historic)	142 days	71 days	35.5 days	53.3 days
32 GB	284 days	142 days	71 days	106.7 days

Please note: The real maximum continuous recording time may be less than the values above by 2-3%. The user must make sure to download the recorded data and clean the internal storage before the memory is filled up. Otherwise, the DATA-CUBE³ stops recording when the internal storage is full.

7. Counts and Voltage

The signal input range of the DATA-CUBE³ is ± 2.048V = 4.096Vpp.
For 24 Bit ADC this equals 0.000 000 244 140 625V per count at gain 1 (4.096V / 2e24).

The following table shows the volts per count for different gains:

Gain	Volts per count
1	244.140625 nV
2	122.070313 nV
4	61.035156 nV
8	30.517578 nV
16 (default)	15.258789 nV
32	7.629395 nV
64	3.814697 nV

This represents the value at the input side of the DATA-CUBE³.

Please note that if a BOB is used, the output of the sensor is calculated by multiplication with the denominator of the dividing ratio given at the BOB. The value of the electromagnetic constant of the seismometer must be taken into account, too, if the ground velocity is the value of interest.

8. ADC Performance

The ADC performance is given for 100sps operation mode.

	Gain 1	Gain 16	Gain 64
High Resolution SNR	125.6 dB	122.2 dB	113.5 dB
Effective Bits	22.4 Bit	21.8 Bit	20.3 Bit
Low Resolution SNR	122.6 dB	120.7 dB	113.0 dB
Effective Bits	21.9 Bit	21.5 Bit	20.2 Bit

Noise:

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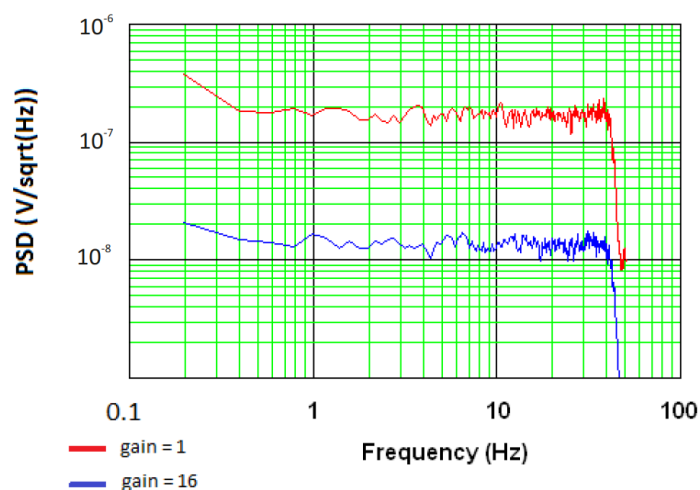
9. Operation

9.1. Configuration

This is an example of a default configuration file. It is to be adapted for the experiment and uploaded to the DATA-CUBE³ via USB before deployment in the field. Please refer to the configuration file manual for a detailed description of the configuration file.

```
************************************************************************
*                                                                      *
*         Configuration File for the 1 & 3 Channel DATA-CUBE           *
*                                                                      *
*                         Software V0.1                                *
************************************************************************
* Syntax:                                                              *
* - Lines beginning with a star '*' are comments (and are ignored)     *
* - Empty lines are not allowed                                        *
* - Parameter keywords are of six capitalized characters,              *
*   directly followed by an equal sign                                 *
* - The parameter value starts at column #8                            *
* - Line length is limited to 70 characters *
************************************************************************
****** !!! Parameters for 3 channel Cubes only !!!           ******
************************************************************************
*
** Active Channels 1 = ch1 // 2 = ch1 & ch2 // 3 = ch1 to ch3
CH_NUM=3
*
** Amplifier Gain 1, 2, 4, 8, 16, 32 or 64
P_AMPL=16
*
** AD Converter Mode 0 = Low power // 1 = High resolution
C_MODE=0
*
** Amplifier Chopping 0 = off // 1 = on
A_CHOP=1
*
************************************************************************
***** General parameters for 1 and 3 channel Cubes          *******
************************************************************************
*
** Project Name Project name of max. 20 characters. ONLY ASCII!!
E_NAME=N/A
*
** Sample Rate 50, 100, 200, 400, (800@1ch) sps
S_RATE=100
*
** Digital High Pass 0 = off // 1 = on
A_FILT=0
*
** FIR Filter 0 = Linear phase // 1 = Minimum phase
A_PHAS=0
*
** Time Base Correction 0 = off // 1 = PLL // 2 = DIFF
PLL_XO=0
*
** Geographic position lat, lon, alt; to speed up satellite search
*GPS_PO=>SIP+52+013+0000
*
** GPS Mode 0 = cycled // 1 = continuously
GPS_ON=0
*
** GPS & Flush Interval 3 to 60 minutes
```

```
* (GPS interval only in cycled mode)
F_TIME=30
*
************************************************************************
***** Parameters relevant for GPS cycled mode only        *******
************************************************************************
** GPS OFF after 0 = 'GPS_TI' // 1 = 60 GPS fixes max.'GPS_TI'
GPS_OF=0
*
** GPS ON Time: 3 to 60 minutes
GPS_TI=5
*
```

Notes

High resolution / C_MODE=1

The high resolution mode increases the resolution/dynamics by approx. 0.5Bit/3dB, but also increases the power consumption of around 40-50mW. It is recommended to use this mode only if the capacity of the batteries is still suffcient. The response is unchanged compared to the low power mode.

Amplifier Chopper

The chopper amplifier hacks the signal to rectify it synchronously after amplification. Thus, 1/f noise is largely avoided. The switching frequency is 1.6kHz. Signal components above 1kHz can lead to aliasing.

PLL_XO=2 & PLL_XO=1

The settings should eliminate gaps by slowly matching the frequencies of the GPS-PPS and the internal oscillator. The PLL_XO=2 option is valid and also used by different groups, while the PLL_XO=1 option, which would be a full PLL implementation (phase-locked loop), is not available.

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9.2. Getting Started in the Lab

- Connect the DATA-CUBE³ via the light grey USB cable with a computer. The DATA-CUBE³ will appear as a USB storage device and the configuration file can be accessed. If desired edit the configuration file and change the values like sampling rate, gain, number of channels, interval of active GPS according to your requirements. A brief description can be found in the configuration file itself. Please refer to the configuration file manual for a detailed description.

- Safely remove the USB storage from your Windows computer or unmount the drive in Linux before disconnecting the USB cable.

- Insert the batteries with correct polarity (DATA-CUBE³ Type 1) or connect an external power supply (DATA-CUBE³ Type 1 or 2).

- Wait typically 3-5 minutes for reception of the GPS signal at an open sky location. When only the red and blue LEDs are blinking at 1 sec interval the DATA-CUBE³ is operating ok. After the DATA-CUBE³ has received a GPS lock once, it can acquire data without GPS signal as well (e.g. for installations inside tunnels or buildings). Only red LED is blinking when the GPS signal is lost.
  Important notice: **It is mandatory that the DATA-CUBE³ receives a GPS signal after the deployment at least once before being switched off. This allows a proper resampling in the post-processing.**

9.3. Field Installation

DATA-CUBE³ Type 1

- Insert the batteries into the battery compartment and check for correct polarity!

- Connect the sensor with the upper left socket (10-way) for data recording.

- Wait typically 3-5 minutes for reception of the GPS signal at an open sky location if the coordinates in the configuration file match your location by a radius of about 300km. It might take much longer if for example the coordinates do not match the values in the configuration file. Adopting the correct GPS coordinates in the configuration file will speed up the GPS synchronization drastically.

- The DATA-CUBE³ is OK & recording when the red and the blue LEDs are blinking at 1 sec interval.

- Optionally: To check the function of the DATA-CUBE³ and to see the current noise you can connect the black 7-way cable to the upper right socket and connect it to a laptop. The DATA-CUBE³ type 1 must be powered by internal batteries during this check. The software CubeMonitor will show the live recorded data.

- If the correct operation of the DATA-CUBE³ has been verified, it should be wrapped into a plastic bag and dug into a shallow hole. Make sure that the top side is uncovered! Otherwise the built-in GPS antenna will not receive a signal.

DATA-CUBE³ Type 2

- Connect the external power supply with the DATA-CUBE³ using the 4-way socket.

- Connect the external GPS antenna using the BNC socket and place it outside if the DATA-CUBE³ will be installed in a shelter, vault or building.

- Connect the sensor with the upper left socket (10-way) for data recording.

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- Wait typically 3-5 minutes for reception of the GPS signal if the coordinated in the configuration file match your location by a radius of about 300km. It might take much longer if for example the coordinates do not match the values in the configuration file. Adopting the correct GPS coordinates in the configuration file will speed up the GPS synchronization drastically.

- The DATA-CUBE³ is OK & recording when the red and the blue LEDs are blinking at 1 sec interval.

- Optionally: To check the function of the DATA-CUBE³ and to see the current noise you can connect the black monitor cable and connect it to a laptop. The software CubeMonitor will show the live data which is recorded.

- In case the DATA-CUBE³ will be placed outside, it should be wrapped in a plastic bag. The external power supply (e.g. battery) must be protected as well.

- Note: It is possible to supply the DATA-CUBE³ Type 1 with external power via the 7-pin connector for a short time during the change of the internal batteries (D-cells), and keep it in function. The parallel power supply (internal and external at the same time) should be in place only for up to ~30s.

Installation example:

All components for DATA-CUBE³ (Type 1) and Geophone installation

All components for DATA-CUBE³ (Type 2) and Geophone installation

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Connect the devices and wait until red & blue LEDs are blinking synchronously! Do not place the magnetic GPS antenna (Type 2 only) on the DATA-CUBE!

The components are:
channel 0 – vertical (Z)
channel 1 – north (N)
channel 2 – east (E)

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Example for tunnel installation:

The DATA-CUBE³ can be used for measurements without permanent GPS reception and still get precise timing.
The general procedure is as follows:

1. The DATA-CUBE³ has to be powered outside the tunnel until it received a GPS fix (only then the DATA-CUBE³ starts to record data from the sensor)

2. While powered (no interruption of the power supply), the DATA-CUBE³ has to be installed inside the tunnel.

3. The measurement must not be interrupted during installation (i.e. neither disconnect the power supply nor use the USB port for data download).

4. After the tunnel measurements are done, the DATA-CUBE³ has to be brought to the outside again and wait for it receiving a final GPS fix.

5. Only after it has received a GPS fix, the DATA-CUBE³ can be switched off or a USB cable can be connected for downloading data.

In post-processing with the CubeTools, cube2mseed performs a resampling of the data with the first and last GPS fix. This is based on a linear clock drift.

Depending on the installation (e.g. larger batteries or mains power available in the tunnel), the DATA-CUBE³ Type 1, which has an internal GPS antenna and also the internal power supply by 2x d-cells, is recommended for this application. It can *additionally* be powered externally for a short time.
This makes it possible to:

1. Use DATA-CUBE³ Type 1 with d-cells during GPS fix acquisition outdoors

2. Go in and prepare the installation

3. Connect the large external battery or the power supply to the DATA-CUBE³ while it is powered by d-cells, and then remove the d-cells quickly (the DATA-CUBE³ can be supplied with power for a short time by internal and external means [e.g. 30s], but not too long)

4. After measurement is done insert the d-cells again and disconnect the DATA-CUBE³ from the big batteries or mains power supply. Then the DATA-CUBE³ must be brought back outside to receive the GPS fix again.

9.4. LEDs

The LEDs indicate the status of the DATA-CUBE³.

SYS	GPS	ACQ	Status	Interpretation What to do?
ON	Blinking fast	Blinking fast	Error: Batteries are empty	→Use new batteries
OFF	OFF	Blinking fast	Error: SD card full or damaged	→Data download or don't use this DATA-CUBE³
OFF	Blinking slow	ON	Error: No GPS reception	→Check conditions of GPS reception
OFF	Blinking fast	Blinking fast	Error: GPS problem (protocol)	→Don't use this DATA-CUBE³
OFF	Blinking fast	OFF	Error: GPS problem (module)	→Don't use this DATA-CUBE³
OFF	OFF	ON	Wait for GPS signal	→Wait max. 5 min & check GPS reception again
OFF	Blinking 1Hz	Blinking 1Hz	Acquisition ok, GPS ok	→OK
OFF	OFF	Blinking 1Hz	Acquisition ok, GPS lost	→OK, but uses internal clock only (no GPS)
Blinking 1Hz	Blinking 1Hz	Blinking 1Hz	Error: Buffer overrun	→format the SD card

9.5. Monitoring

The CubeMonitor software allows a live view of the sensor data for noise monitoring and verification of a DATA-CUBE³ installation. This software runs on Windows platforms only.

In order to use the CubeMonitor software the following steps are required:

1. Download the CubeMonitor software from http://digos.eu/downloads-docs/
2. Extract the contents of the ZIP file
3. Install the FTDI drivers. This step is required only once per computer. It might be necessary to assign a dedicated COM port to the FTDI interface on some computers. Please check the system settings.
4. Connect the DATA-CUBE³ via the Monitor cable (black) with the computer.
5. Start the CubeMonitor.exe

9.6. Restart while running (REED contact)

The DATA-CUBE³ has a built-in REED contact which can be activated by a magnet. It is located at the top of the housing:

If a magnet is hold close to the REED contact, the DATA-CUBE³ will perform a reboot.

Please note: The bottom of the GPS antenna is magnetic. Therefore, the GPS antenna must not be placed on top of the DATA-CUBE³!

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9.7. Data Download & Conversion

The data download from a DATA-CUBE³ to a computer very easy. Connect the DATA-CUBE³ using the (grey) USB cable with the USB interface of the computer. It will appear as a new external USB drive. Subsequently, the data from DATA-CUBE³ can be copied the computer. Please note that the recording stops as soon as the USB cable is connected!

The recorded data is stored in a simple way on the internal DATA-CUBE³ file system:

- Daily folders with the naming "YYMMDD"
- Daily file in the daily folder with the naming "MMDDHHMM.'no-of-recorder'"
  (time value is given in UTC)

The DATA-CUBE³ records the data samples as well as time information in a raw binary format. DiGOS provides the following info & conversion software to convert this raw data into standard data formats like miniSEED, SEG-Y or ASCII:

- **cubeinfo**: Summarizes the content of a DATA-CUBE³ file recording

- **cube2mseed**: Converts DATA-CUBE³ files to miniSEED format

- **cube2segy**: Converts DATA-CUBE³ files to SEG-Y format

- **cube2ascii**: Coverts the DATA-CUBE³ files to ASCII format

The CubeTools software package can also be used to cut out individual events like earthquakes, explosions, specific time windows from raw data. This allows the operator to save processing/conversion time and only analyse the relevant data. The resampling of measurements in case of lost GPS signal is supported by the CubeTools. A detailed usage description of the conversion tools is included in the CubeTools software package (please see download information below).

All CubeTools software utilities are command line programs. They were programmed in Java and require an installed and working Java Runtime Environment (JRE 1.5 or newer). The software has been tested Windows and Linux.

Please make sure to download and operate the latest release of the CubeTools software package which can be downloaded from the DiGOS website at:

    http://digos.eu/downloads-docs/

The software is updated periodically to include the most recent leap seconds handling. Users are highly encouraged to check for updates regularly.

10. General Usage Information

10.1. Safety Instructions

Improper use voids the warranty and can damage or even burn the electronics of the DATA-CUBE³! Besides general recommendations of electronics usage, the user must pay attention to the following, additional usage information:

All pins are <u>not protected</u> against overvoltage!

Do not connect RS-232 of the DATA-CUBE³ directly to a computer!
The DATA-CUBE³ uses low voltage RS-232.

Do not open the DATA-CUBE³! It voids the warranty and can damage internal parts!

The DATA-CUBE³ Type 1 is designed to be operated with 2x Alkaline D-cells only! The DATA-CUBE³ electronics is designed for less than 3V internal battery supply only! Higher voltages will damage the DATA-CUBE³. Do not use e.g. Li batteries!

Do not connect external power supply when using DATA-CUBE³ Type 1 with internal batteries! Make sure to remove the batteries from the compartment first!

Do not specify F_TIME and GPS_TI as a multiple of 60 in the DATA-CUBE³ configuration file! Use the value 59 instead.

Do not place the GPS antenna on top of the DATA-CUBE³ Type 2 housing! The bottom of GPS antenna is magnetic and can lead to a restart of the DATA-CUBE³ via REED contact (see chapter 9.6).

Disconnect the DATA-CUBE³ from the power supply before using the USB cable to download the measurement data. USB connection will provide enough power to access the DATA-CUBE³ memory.

10.2. Additional Information

All DATA-CUBE³ recorders are thoroughly tested by DiGOS prior to shipment. The recorders have proven reliable and trouble-free operation in many deployments worldwide. However, DiGOS excludes any liability for data loss due to hardware malfunction or operation errors.

11. Technical Specifications

A/D converter
- Type: Delta-Sigma 24 Bit
- ADC resolution: 24 Bit per channel
- ADC channels: 3
- ADC dynamic range: 125db @ 100sps (128db @ 50sps)
- Effective resolution: 22.4 bit @ 100sps @ gain 1 (typical)
- ADC sample rates: 50, 100, 200 or 400sps in 3 channel mode, 800sps in 1 channel mode
- ADC gain selection: 1, 2, 4, 8, 16, 32, 64
- ADC noise level: 10nV/sqrt(Hz)
- Full scale input: 4.096Vpp @ gain 1
- Input impedance: 100kOhm
- Signal input voltage: Adjusted by customized breakout box according to sensor specification

Time base
- Type: GPS synchronized free running internal quartz
- GPS: GPS receiver built-in
- GPS accuracy: 1μs
- GPS antenna: Internal (type 1), external included with 5m antenna cable (type 2)
- Free running accuracy: <0.01ms with processing (resampling with CubeTools, see section 9.6)
  <10ms for 20 days without processing

Data storage
- Storage type: SDHC memory card (internal)
- Capacity: 32GB (ca. 270 days @ 100sps)
- Recording type: Continuous recording
- Recording format: Raw (miniSEED & SEG-Y offline converter software included)

Local user interfaces
- Serial port: Monitoring, additional sensor modules on request
- USB 2.0: Configuration, setup, data download (16MB/s)
- LEDs: Indicating status of system, acquisition, GPS timing and data storage

Connectors
- Sensor: MIL-C-2684 A12-10S
- Power/Communication: MIL-C-2684 A10-07P (type 1)
- Communication: MIL-C-2684 A10-07P (type 2)
- Power: MIL-C2684 A08-04P (type 2)
- GPS antenna: BNC female (type 2)

Power supply
- Input voltage: 5-24V DC
- Battery: Internal (2x D-cell) or external via separate cable (type 1)
  External via separate cable only (type 2)
- Power consumption: 128mW (rated for 100sps & GPS active 3min per 59min)

Physical
- Size: 100 x 100 x 83mm (830ml)
- Weight: 890g (type 1), 850 (type 2)
- Operating outdoor temperature: -20 – 70°C (lower temperature version available)
- Housing: Reinforced plastic
- Shock resilience: 5g (sinus)
- Waterproof: in accordance with IP67 (1m water depth for 48 hours)