

CFDL1 V0.6.3

General

The data logger *CFDL1* has the ability to acquire signals from its voltage inputs, digital inputs (i.e. frequency signals), serial input (i.e. GPS-receiver) and logical signal input, and to save these signals onto a CF card (max. 4 GB). Additionally the *CFDL1* can also acquire signals from up to two *CANs* (Controller Area Network).

Before using the data logger, it must first be set up by defining a parameter set with the PC program *TEMES* (requires a PC with a CF card reader and Windows 2000/XP/Vista), and then by copying this parameter to a CF card. After the CF card has been inserted into the *CFDL1*, and after making the measurement, the CF card can be put again into a CF card reader, and the stored data can be written to a PC file for further processing.



Figure 1: Data Logger CFDL1.

Sample Rate

The input signals can be recorded at two different sample rates. The first sample rate is the basic sample rate and the second sample rate is an integer multiple of the basic sample rate. The slower second sample rate is 1 to 256 times larger and may also not be larger than 15 s (to prevent an overflow of the internal average value registers). Note, that the sample rate is practically limited to 1 kHz (but can be higher in simple configurations).

The data logger has a further cycle which runs at a default rate of 10 ms. This cycle is used for *CAN* signals, calculated signals, voltage output signals and logical input and output signals. If the operations are not too complex, the cycle rate can be reduced

down to 1 ms.

Voltage Signal Input (AI1...AI16)

The data logger can acquire up to 16 voltage signals with a resolution of 12 bits. These signals can be measured within the voltage range from 0 V to 5.12 V where 0 V correspond to bit value 0, and where 5 V correspond to bit value 64000 (= 16×4000). However, the signals can lie within the range from -30 V to 30 V without a negative impact on other signals. The internal impedance of each voltage input is greater than 10 M Ω . The max. drift of the reference voltage signal is about 10 ppm/ $^{\circ}$ C.

Each voltage signal input connector has a pin to supply a preamplifier with the operating voltage (decreased by about 1 V) of the data logger.

Voltage input signals can optionally be linearized via a table look-up during the calculation cycle. For this purpose user defined characteristic curves are used. Look-up values for input values, which lie between two sampling points, are obtained by linear interpolation.

Digital Signal Input (DI1...DI3)

The data logger has three main channels for digital signals (DI1...DI3, with prescaler):

Frequency Signal: The input voltage level (TTL, CMOS) may lie within the range from 0 V to 20 V. The frequencies to be measured may lie in the range from 0.1 Hz to 50 kHz. This range can accordingly be extended with an integrated integer prescaler from 1 to 65535. Note that the sum over all five (prescaled) input frequencies must not be greater than 50 kHz.

The digital signal can be triggered either with the raising or with the falling edge of the input signal, and is represented by the average value over a period of the sample rate.

Digital Signal Input (DI4...DI5)

The data logger has two auxiliary inputs for digital signals (DI4...DI5, without prescaler):

Frequency Signal: The input voltage level (TTL, CMOS) may lie within the range from 0 V to 20 V. The frequencies to be measured may lie in the range from 0.1 Hz to 50 kHz. Note that the sum over all five (prescaled) input frequencies must not be greater than 50 kHz.

The digital signal can be triggered either with the raising or with the falling edge of the input signal, and is represented by the average value over a period of the sample rate.

Each digital input connector has a pin to supply a preamplifier with the operating voltage (decreased by about 1 V) of the data logger.

Serial Ports

The data logger has three serial ports. The first serial port is used for the communication between data logger and host PC (*RS232 1*). The second serial port is used as input for NMEA sentences of a GPS receiver. Alternatively, the fourth connector *RS232 4* can be used instead of *RS232 2*. *RS232 4* is only listening and provides power to the GPS receiver (by reusing the unused TX wire). The third serial port (*RS232 3*) is used for firmware upgrade.

The NMEA receiver can be set to either 4800 baud or 38400 baud. It supports the messages GGA, VTG and RMC.

Following unsigned 16-bit signals can be extracted: Message counter, time (resolution: 0.01 s), speed (resolution: 0.01 kph), height (resolution: 0.1 m; lowest height: 500 m below sea level), number of visible satellites.

Following signed 32-bit signals can be extracted: longitude, latitude (with a resolution of 1/600000 degree).

Logical Signal Input

The data logger has three 16-bit input signals, which can be (in groups of 8 bits) fed into the logger over an I²C-bus during the calculation cycle. For each of the three 16-bit signals a bus address for the lower significant byte, and a bus address for the higher significant byte can be specified. External devices (which are connected to the logger) have bus addresses from 1 to 7.

Logical Signal Output

The data logger cannot only acquire signals via the I²C-bus, it can also put out up to three 16-bit signals (in groups of 8 bits). For each of the 16-bit signals a bus address for the lower significant byte, and a bus address for the higher significant byte can be specified. Bus addresses of external devices lie within the range from 1 to 7.

Voltage Signal Output

The data logger has eight 12-bit-D/A-converters. They are used to put out eight voltage signals during the calculation cycle. The output voltage lies within the range from 0 V to 5.12 V. Each output has an

internal impedance of 470 Ω.

CAN

The data logger *CFDL1* can be connected to two *CANs* (Controller Area Network). It has the ability to receive or transmit up to 16 *CAN messages* (with either 11-bit or 29-bit message identifiers). The messages (to be received or to be transmitted) are refreshed during the calculation cycle.

Input signals are embedded within a received message. To extract them, following properties are supported: *start bit* within a message, *bit length* (max. 16 bits), *data type* (*unsigned* or *signed*) and *byte order* (*Intel* or *Motorola*).

Multiplex signals are only supported for message reception (and not for transmission).

The data logger hardware (physical layer) is compatible to a *high speed CAN* (usually run at 125 kBit/s, 500 kBit/s or 1 MBit/s). An optional adapter is required to integrate the data logger in a *low speed CAN* (usually run at 83.3 kBit/s, 100 kBit/s or 125 kBit/s).

Note, that each of the two ends of a *high speed CAN* must be terminated (typically with a 120 Ω resistor between *CAN_H-wire* and *CAN_L-wire*).

If the CAN signals can be assigned freely, then following rules should be followed in order to reduce the computational complexity:

- Choose Intel as byte-alignment
- Choose 16-bit unsigned as data type
- Word-align the start bit: 0, 16, 32, 48. (If you cannot choose word-alignment, try byte-alignment: 0, 8, 16, 24, 32, 40, 48, 56.)
- Avoid further linear transformations

Calculated Signals

The data logger supports operations with signal values. For this purpose the signal values are treated as unsigned 16-bit integer values with little-endian (= Intel) byte order. Following operations are already built in the firmware: definition of constants; basic arithmetic (sum, difference, product, ratio); bit manipulations (AND, OR, XOR, mirror bits, byte order change from Intel to Motorola and vice versa); comparisons (=, <, ≤); condition (use signal s_1 if condition is true, otherwise use signal s_2); delay (e.g. for derivation or signal filtering); counter operations (e.g. for 32-bit-counters or for integration).

More complex operations can be obtained by using the result of a single operation as an operand for following operations.

Power Control

The data logger should never be powered off by suddenly breaking the supplying voltage while it is recording (indicated by the *REC* LED). Instead, it should be powered off either manually with the power slider, or automatically by removing the power control signal from connector *ON/CAN2*.

By turning off the power slider, while the data logger is recording, first a stop event is created, and then (after this stop event has been processed) the data logger is powered off (because the data logger is no longer recording).

When using the *ON/CAN2* connector to control the power state of the data logger, the power slider should be left turned off.

An ongoing recording after the stop event can be stopped forcibly by turning the *REC* slider off.

Recording Control

Note that a measurement can only be erased with holding the buttons *B1* and *B2* down after the *REC* slider has been turned off. If there exists a measurement, then the *L4* LED is lit for about two seconds, and when it automatically extinguishes (with unchanged button states), also the measurement is erased.

Trigger Conditions

The data logger supports up to four trigger conditions. If one condition changes from not satisfied to satisfied, it generates either a start or a stop event. The condition is always a comparison of an input signal with a constant threshold value. Calculated signals can be used to obtain a more complex trigger.

Display

The LCD (liquid-crystal display) has four lines with 20 alphanumeric characters per line. The LCD is considered as a 4×2 matrix with 8 cells and 10 characters per cell. Each cell shows one of the following display items: static text; signal value (either as fixed point value, hexadecimal value or binary value), status information (like CPU load or sample rate), or date and time.

The user can switch the display to a second set of items, and re-initialize the display, with the *1-2 slider*.

A user-defined text can be displayed for a few seconds during the start-up of the data logger (or when the displayed items are changed via the *1-2 slider*). This can for example be used to display the name of the parameter set or the device number.

Real Time Clock

The data logger has a built-in real time clock. A 32-bit time stamp is derived from current date and time with a resolution of 1 s. This time stamp represents the seconds from the beginning of the year 2000 to the actual point in time.

If, however, the real time clock is not available, the time stamp is set to zero. Note, that the real time clock is not automatically adjusted for daylight saving changes.

Multiplexer Support

In order to control multiplexed input signal sources, the data logger can broadcast the next control byte to connected multiplexers over its logic I/O port just after storing its signal values during the fast or slow recording cycle. This synchronization minimizes signal crosstalk between two neighboring channel time slices since the command to switch to the next channel is sent as soon as possible. The list of control bytes contains 16 items, where the 4 least significant bits of a control byte represent the channel number, and where the 4 most significant bits of a control byte can be used for the corresponding operation range.

Optionally, the channel number (0...15) can be copied to the four least significant bits of the input signal. This allows to record only the multiplexed signal and to assign its signal values to the corresponding channels afterwards.

Communication

The CFDL1 can communicate with the host PC over three means:

Serial Connector (*RS232 1+2*, *RS232 3+4*): The serial connections are used to upgrade the firmware of both controllers.

USB 2.0 (full-speed, 12 Mbit/s): The USB connection is (at the moment only) used to set the real time clock.

CF I/II ATA card: The CF card is used to set up the CFDL1 and to keep the measurement data.

Technical Data

| | |
|---|--|
| Power supply: | 8 V to 16 V DC |
| Current consumption (@ 12 V DC): | with lighted display: about 220 mA with unlighted disp.: about 100 mA |
| Sample rate: | 1 ms (with limited abilities: 500 μ s) or slower |
| Memory size: | up to 4 GB (CF I/II ATA card) |
| RS232 port: | from 4800 baud to 230400 baud |
| CAN-Bit rate: | up to 1 Mbit/s; (1 Mbit/s) / k , where k is an integer from 1 to 64 |
| Box size without plugs, sockets, buttons and sliders: | 106 × 90 × 42 mm |
| Weight: | 0.38 kg |

PC Software

The data logger can be set up with the PC software TEMES. TEMES requires a PC with a CF card reader and Windows 2000/XP/Vista. The current version can be downloaded from the Internet (<http://tellert.de/?product=TEMES>).

Further functions of TEMES are:

- **Saving Measurements:** The measurements, which are captured by the logger, can be stored to a PC file. After storing the data, the measurement can directly be displayed in a curve chart.
- **Exporting Measurements:** A measurement (or each of its sample blocks) can be exported to ASCII, DIADEM, TurboLab or x-y Recorder format. TEMES provides a documented DLL interface for accessing TEMES measurement files. This allows programmers to read TEMES measurement files without knowing the internal file structure (<http://tellert.de/?product=til>).

Following TEMES functions require an optional available single-PC license:

- **Import of ASCII files:** Measurements can be imported from ASCII files.

Scope of Supply

The delivery of a data logger CFDL1 includes:

- CFDL1 box
- CF card
- 4-pin-cable for power supply (12 V DC) and CAN with open wire ends
- PC-connection cable with 9-pin SUB-D-socket

- PC-software (TEMES) (requires a computer with a CF card reader and Windows 2000/XP/Vista)

Optional Accessories

General accessories:

- Power transformer (Euro plug; 100-230 V AC; 50-60 Hz)
- Low speed CAN adapter *LCC719* (to connect the CFDL1 to a low speed CAN)

Accessories for digital input:

- Hall effect sensor *HS-M10X1* (to detect passing magnets)
- Hall effect sensor *FPS* (to measure the frequency of steal teeth wheels, even at lowest frequencies)
- Pre-amplifier *PP1* for AC-coupled signals (for magnetic sensors)

Accessories for voltage input:

- Passive voltage transformer *BNC-PI2* or *PI2LU30V*
- Galvanically isolated pre-amplifier *INA1* or *INA2U100mV*
- NTC temperature sensor *NTC10K* (operating point 25 °C) and *NTC2K* (operating point 66 °C) for temperatures from -40 °C to 150 °C
- Thermal sensor amplifier *TH2*
- DC-bridge amplifier *DCBA2/DCBA8*
- Galvanically isolated thermal sensor amplifier *TH16MI* or *TH16MI/CAN* (16 channels, multiplexed)
- Thermal sensor amplifier *TH16M* (16 channels, multiplexed)

Accessories for logical signals:

- Switch/button *SW1* for connector *DIN1 + 2*
- Input for eight logical signals *L/8*
- Output for eight logical signals *LO8*

Firmware Update

The firmware can be flashed with the serial programming cable (RS232). Note that both controllers (RS232 1 + 2, RS232 3 + 4) need to be flashed with the same firmware version number.

More information (Internet)

The CFDL1 homepage is available at:

<http://tellert.de/?product=cfdl1>

Pin Assignment

The sockets and plugs of the CFDL1 are manufactured by *Binder* and parts of *Binder Series 719*. The socket pins (in front view) are numbered clockwise starting with the first pin after 12 o'clock position. The plug pins are numbered correspondingly anti-clockwise. The first pin is respectively labeled at the solder side (back view).

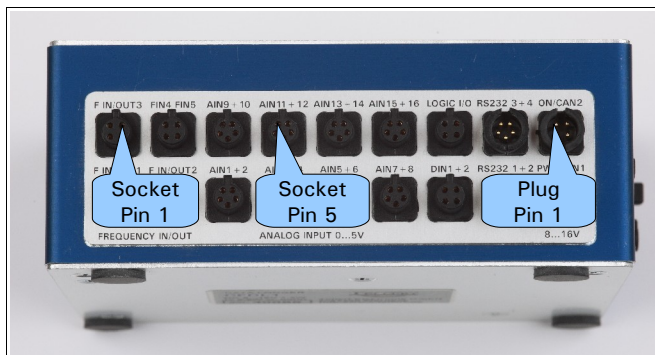


Figure 2: CFDL1 pin assignment.

PWRCAN1: This plug supplies the data logger with voltage and connects the data logger to CAN1.

| Pin | Assignment [Wire Color Alt. Wire Color] |
|-----|---|
| 1 | Supplying voltage (8 V to 16 V DC inverse-polarity protected) [red brown] |
| 2 | Ground [brown white] |
| 3 | CAN_L (CAN1) [black blue] |
| 4 | CAN_H (CAN1) [orange black] |

ON/CAN2: This plug provides a power control input and connects the data logger to CAN2.

| Pin | Assignment [Wire Color Alt. Wire Color] |
|-----|--|
| 1 | Power control input (8 V to 16 V DC) [red brown] |
| 2 | Ground [brown white] |
| 3 | CAN_L (CAN2) [black blue] |
| 4 | CAN_H (CAN2) [orange black] |

RS232 1 + 2: This plug provides two serial ports.

| Pin | Assignment | 9-pin SUB-D plug of host PC |
|-----|------------|-----------------------------|
| 1 | TX1 | Pin 2 |
| 2 | Ground | Pin 5 |
| 3 | RX1 | Pin 3 |
| 4 | TX2 | |
| 5 | RX2 | |

RS232 3 + 4: This plug provides one full serial port, and one listening serial port with power supply.

| Pin | Assignment | 9-pin SUB-D plug of host PC |
|-----|--------------------|-----------------------------|
| 1 | TX3 | Pin 2 |
| 2 | Ground | Pin 5 |
| 3 | RX3 | Pin 3 |
| 4 | $U_B - 1\text{ V}$ | |
| 5 | RX2 | |

DIN1 + 2: This socket provides inputs to create start and stop events (recording control).

| Pin | Assignment |
|-----|--|
| 1 | $U_B - 1\text{ V}$ (Supplying voltage) |
| 2 | Ground |
| 3 | <i>External recording control or Start trigger</i> (connected over a 100 k Ω resistor to 5 V): start event at low level (< 2 V) |
| 4 | <i>Stop trigger</i> (connected over a 100 k Ω resistor to 5 V): stop event at low level (< 2 V) |

LOGIC I/O: This socket provides access to the I²C-bus for logical input and output signals.

| Pin | Assignment |
|-----|--|
| 1 | $U_B - 1\text{ V}$ (Supplying voltage) |
| 2 | Ground |
| 3 | SDA (serial data line) |
| 4 | SCL (serial clock line) |

AIN1 + 2, ..., AIN15 + 16: These sockets provide inputs for the voltage input signals.

| Pin | Assignment |
|-----|--|
| 1 | $U_B - 1\text{ V}$ (Supplying voltage) |
| 2 | Ground |
| 3 | Analog input 1 (...15) |
| 4 | Analog input 2 (...16) |
| 5 | 5.12 V reference voltage (max. 20 mA for AIN1 + 2...AIN7 + 8, and max. 20 mA for AIN9 + 10...AIN15 + 16) |

F IN/OUT1, ..., F IN/OUT3: These sockets provide a connection to the main digital (frequency) signals.

| Pin | Assignment |
|-----|---|
| 1 | $U_B - 1\text{ V}$ (Supplying voltage) |
| 2 | Ground |
| 3 | Digital input 1 (...3) connected over 100 k Ω to 5 V |
| 4 | Frequency output |

FIN4 FIN5: This socket provide a connection to the auxiliary digital (frequency) signals.

| Pin | Assignment |
|-----|--|
| 1 | $U_B - 1\text{ V}$ (Supplying voltage) |
| 2 | Ground |
| 3 | Digital input 4 connected over 100 k Ω to 5 V |
| 4 | Digital input 5 connected over 100 k Ω to 5 V |

AOUT1...4, AOUT5...8: These sockets provide outputs for the voltage output signals.

| Pin | Assignment |
|-----|--|
| 1 | Analog output 1 / 5: 0...5.12 V, $R_i = 470\ \Omega$ |
| 2 | Analog output 2 / 6: 0...5.12 V, $R_i = 470\ \Omega$ |
| 3 | Analog output 3 / 7: 0...5.12 V, $R_i = 470\ \Omega$ |
| 4 | Analog output 4 / 8: 0...5.12 V, $R_i = 470\ \Omega$ |
| 5 | Ground |

EXT. DISPLAY: This socket provides access to the I²C-bus for the display.

| Pin | Assignment |
|-----|--|
| 1 | $U_B - 1\text{ V}$ (Supplying voltage) |
| 2 | Ground |
| 3 | SDA (serial data line) |
| 4 | SCL (serial clock line) |

Optional 4-pin DUALCAN connector: This plug connects the optional integrated DUALCAN controller optionally to a CAN.

| Pin | Assignment [Wire Color Alt. Wire Color] |
|-----|---|
| 1 | (unconnected) |
| 2 | Ground [brown white] |
| 3 | CAN_L (CAN3) [black blue] |
| 4 | CAN_H (CAN3) [orange black] |

Optional 5-pin DUALCAN connector: This plug provides two serial ports of the optional integrated DUALCAN controller.

| Pin | Assignment | 9-pin SUB-D plug of host PC |
|-----|------------|-----------------------------|
| 1 | TX4 | Pin 2 |
| 2 | Ground | Pin 5 |
| 3 | RX4 | Pin 3 |
| 4 | TX5 | |
| 5 | RX5 | |

Annex 1: System Information

The following information is displayed while the button B4 is held down:

```
G0000          R01267
12.0V          W00000
 45°C S:      8K B00000
E0000 F: 3898M 00008K
```

- G0000:** Number of correctly received NMEA sentences (only available when the GPS receiver is enabled).
- 12.0V:** Supplying voltage.
- 45°C:** Internal temperature in degree Celsius.
- E0000:** Number of discarded (erroneous) messages from the internal bus between working controller and storage controller.
- S: 8K:** Measurement size (incl. Parameters).
- F: 3898 M:** Unused but available (free) space for remaining measurement.
- R01267:** Number of available (remaining) CF sector buffers.
- W00000:** Number of current write sector buffer.
- B00000:** Current position within recording block.
- 00008K:** Write position (CF file).

Annex 2: CF Card

The CF card has to be formatted with FAT16 and the following file needs to be present for a device independent setup:

```
\TELLERT\CFDL\00000001.TMF
```

If the same CF card is used to setup multiple CFDL1 with a different set of parameters, the directory layout can vary to distinguish the different device serial numbers. E.g. for S/N 40123:

```
\TELLERT\CFDL\00040123\00000001.TMF
```

Note that only those parts of the CF card are used by the CFDL1 which are allocated for the file 00000001.TMF.

The batch file *INIT_CF.BAT* can be used to initialize a new CF card (to initialize = to format with FAT16 and to create the 00000001.TMF file). After the initialization, the CF card needs to be programmed with TEMES to replace the placeholder TMF file with an empty but valid TMF file.

In order to keep the FAT16 file system healthy, a CF card needs to be *ejected* before it is unplugged from the PC. TEMES has a checkbox for ejecting a CF card automatically (see the corresponding CF dialog boxes), otherwise the CF card needs to be ejected manually (e.g. with the context menu of Windows Explorer).

Note that the *REC* LED should be unlit if you remove the power from connector *PWRCAN1*. See section *Power Control* for further information.

Annex 3: Opening the CFDL1

First, the two M2.5x16 screws from the lid must be unscrewed:



Figure 3: CFDL1 lid.

Second, the two M2.5x10 screws from the bottom must be unscrewed:

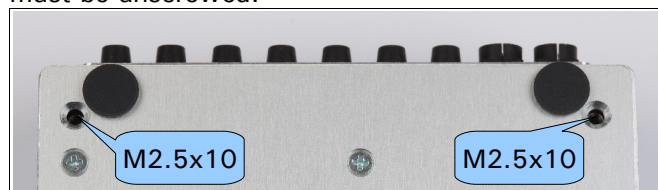


Figure 4: CFDL1 bottom.