
CT-BOX Command Reference Manual

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Welcome to the **CT-BOX Command Reference Manual**. This document describes, in a compact reference format, the full ASCII command set exposed by the CT-BOX Digital Current Measurement & Calibration System over its Ethernet TCP/IP, USB 2.0 and RS-232 communication interfaces.

WELCOME TO THE CT-BOX COMMAND REFERENCE MANUAL

1.1 The CT-BOX Measuring System

The **CT-BOX** by ELS Instruments is a stand-alone digital measuring system designed to measure DC and AC currents with high accuracy, wide bandwidth, high precision and extremely high stability.

The system is developed to be used with the ELS Instruments **CT-series** current-output DC current transformers (referred to as **DCCT** in this manual), allowing high-performance measurements of currents up to 1000 A. The device integrates temperature-stabilized components (a burden resistor, signal conditioning networks and a precision 24-bit ADC) in order to keep the temperature dependence lower than 1 ppm/K. The digital section interfaced to the ADC performs a calibrated measurement, drastically reducing the non-ideal behaviour and providing very high accuracy.

The ADC sampling frequency is **fixed at 100 kHz** (100 ksp/s), which allows the acquisition of high-frequency components and fast current transients. The *output* data frequency can be reduced through software commands (*TS* in OSC mode, *FREQ* in DLOG mode, *DMM:FREQ* and *DMM:NOP* in DMM mode); in that case an averaging of the sampled data is performed, which both reduces the required transmission data rate and reduces high-frequency noise, increasing the signal-to-noise ratio.

1.2 CT-BOX Versions

The CT-BOX unit is available in the following versions, depending on the maximum current measuring range:

Product Code	Ordering Code	Description
CT-BOX-100	WCTBOX100XAA	100 A Current Transducer Digital Box with Local Display and Ethernet, USB, RS-232 interfaces
CT-BOX-150	WCTBOX150XAA	150 A Current Transducer Digital Box with Local Display and Ethernet, USB, RS-232 interfaces
CT-BOX-200	WCTBOX200XAA	200 A Current Transducer Digital Box with Local Display and Ethernet, USB, RS-232 interfaces
CT-BOX-300	WCTBOX300XAA	300 A Current Transducer Digital Box with Local Display and Ethernet, USB, RS-232 interfaces
CT-BOX-400	WCTBOX400XAA	400 A Current Transducer Digital Box with Local Display and Ethernet, USB, RS-232 interfaces
CT-BOX-600	WCTBOX600XAA	600 A Current Transducer Digital Box with Local Display and Ethernet, USB, RS-232 interfaces
CT-BOX-1000	WCTBOX1000XA	1000 A Current Transducer Digital Box with Local Display and Ethernet, USB, RS-232 interfaces

Note: The command set documented here is common to the whole CT-BOX family. The full-scale current depends on the connected DCCT, which can be identified with the *DCCT* command. When the primary conductor is wound

more than once through the DCCT, the full-scale current is divided by the number of turns set with the *PTURNS* command.

1.3 Scope of this Manual

This Command Reference Manual is aligned with CT-BOX firmware $\geq$ **3.1.0** and covers:

- the *communication interfaces* (Ethernet TCP/IP, UDP, USB 2.0 and RS-232), the ASCII command syntax, the three *modes of operation* (OSC, DLOG and DMM) and the corresponding *data representations*;
- the full *command set*, grouped by the mode(s) of operation in which each command can be used;
- the structure of the internal *Status and Error registers*;
- the *error codes list*.

Note: For mechanical, electrical and installation information (front/rear panel layout, LED indicators, connectors, DIP-switches, power supply, mounting brackets, firmware upgrade procedure, technical specifications and mechanical dimensions) please refer to the **CT-BOX User's Manual**.

The plug-and-play GUI acquisition package **CT-BOX Viewer**, which allows controlling, configuring and acquiring data from multiple units over different interfaces, is described in its own software guide.

COMMUNICATION INTERFACE

The CT-BOX is provided with the following communication interfaces:

- **Ethernet TCP/IP 10/100 Mbit**;
- **UDP** (only for the output data stream in OSC mode);
- **USB 2.0** (only in DLOG mode);
- **RS-232** with a fixed 115 200 baud rate (only in DLOG mode).

The command structure is **the same for all communication interfaces**, and the device automatically recognizes the interface in use.

Tip: It is strongly suggested to use the standard Ethernet interface, since it does not limit the throughput performance of the device. The RS-232 serial interface (fixed baud rate at 115 200 bps) and USB 2.0 are simpler but less performing, and are therefore subject to restrictions.

Warning: The CT-BOX can only be used in **DLOG mode** when communicating via the RS-232 and the USB 2.0 interfaces. **OSC and DMM modes are only allowed with Ethernet communication.**

This chapter describes the network configuration, the ASCII command syntax, the three modes of operation, the resulting data representations and a few practical communication examples.

2.1 Physical Interfaces

2.1.1 Ethernet Interface

The device is shipped with the following factory network configuration:

Parameter	Factory value
IP address	192.168.0.10
Subnet mask	255.255.255.0
Gateway	192.168.0.1
TCP/IP port	10001
Remote port (UDP)	10002

The network settings can be changed remotely with the *IP*, *MASK*, *GATE* and *PORT* commands. The new IP address, subnet mask and gateway take effect **after a CT-BOX reset** (see *HWRESET*).

Tip: Even though the CT-BOX can be connected to a LAN network, a **point-to-point** Ethernet connection is strongly recommended in order to obtain minimum delay, maximum data-rate performance and to avoid possible

communication problems, i.e. to increase communication reliability. This implies that the host PC and the CT-BOX should reside on the same Ethernet subnet.

Tip: The free software **ELS Device Manager** searches the local network for connected CT-BOX units and configures their network settings (IP address, subnet mask and gateway).

Network settings changed with the ELS Device Manager take effect immediately: no CT-BOX reset is needed. For example, after a new IP address is set, the unit can be reached at that address right away.

The ELS Device Manager uses **UDP port 30719** to find the CT-BOX units, so make sure that no firewall on the host PC or on the network blocks UDP traffic on this port, in both directions.

The ELS Device Manager can be downloaded from the CT-BOX product page on the ELS Instruments website (<https://www.els-instruments.com/product/ct-box/>). For a description of all its features, refer to the **Device_manager_Quick_Start_Guide**.

In OSC mode the acquired data stream is sent out over **UDP** to the IP address of the connected TCP client, on remote host port **10002** (configurable with *PORT*); the receiving application must bind a datagram socket to that port. Commands and replies always travel over the TCP/IP connection on port **10001**.

Note: The CT-BOX accepts only **one TCP/IP connection at a time**. While a client is connected, a connection attempt from a second client is refused; the second client must wait until the first client closes its connection.

Tip: Make sure that no firewall on the host PC or on the network blocks incoming UDP traffic on port **10002** (or on the port set with *PORT*), otherwise the OSC data stream is not received.

2.1.2 USB Interface

The USB 2.0 interface can be used **only in DLOG mode**.

- **Windows:** the latest **ST VCP** (Virtual COM Port) driver must be installed. Once the USB cable is connected, a COM port is recognized and becomes visible in the Device Manager.
- **Linux:** no driver is required.

Communication is possible using standard serial terminal programs such as PuTTY or Minicom.

Note: If a command that is not supported over USB is issued, the unit replies with error code **26** (*USB communication is only supported in DLOG mode*); see *List of the Error Codes*.

2.1.3 RS-232 Interface

The RS-232 serial interface uses a **fixed 115 200 baud rate** and, like USB, can be used **only in DLOG mode**. Issuing an unsupported command over RS-232 returns error code **07** (*RS-232 communication is only supported in DLOG mode*).

Note: The firmware of the CT-BOX device can only be updated over **USB**, using the third-party STM32CubeProgrammer software. The procedure is described in the **CT-BOX User's Manual**.

2.2 Command Syntax

Commands must be sent to the CT-BOX in ASCII format. Each command is composed of a **command field** and zero, one or two **parameter field(s)**, separated by a colon (: – 0x3A in hexadecimal notation). The number of parameter fields depends on the specific command.

Note: Commands are **NOT case sensitive**: they can be sent using uppercase or lowercase characters (conversion to uppercase is performed internally by the CT-BOX unit).

Each command must be terminated with a **carriage return** character \r (0x0D in hexadecimal notation, commonly known as CR).

Command example:

```
ACQ:ON\r
```

- ACQ is the command field;
- : is the parameter separation character;
- ON is the first parameter field;
- \r is the command termination character.

Commands are processed **one at a time**: the user must wait for a reply from the unit before sending the next command.

2.2.1 Replies

Replies **from** the CT-BOX are all formatted in **upper case** and are terminated with the **carriage return / line feed** sequence \r\n. The reply depends on the specific command; refer to the individual command sections for details.

Two specific replies are commonly used to indicate whether the command has been correctly processed:

- **ACKnowledge (ACK)**: the command is valid and has been correctly processed by the device.

```
ACK\r\n
```

- **Not AcKnowledge (NAK)**: the command is either not valid, or it was not accepted by the device. The NAK reply is followed by an **error code** field that identifies the cause of the error (see the [List of the Error Codes](#)).

```
NAK:2\r\n
```

- NAK is the Not AcKnowledge response to an invalid command;
- : is the parameter separation character;
- 2 is a sample error code;
- \r\n is the reply termination sequence.

2.2.2 Read Commands

Most commands support a **read (query)** form, obtained by sending ? as the last parameter field, e.g. `MODE:?\r`. The unit replies with the current value of the requested setting, terminated by `\r\n`.

2.2.3 Write Commands

Write commands carry the value(s) to be applied as parameter field(s), e.g. `MODE:OSC\r`, and are answered with ACK or NAK:x.

Each command description in this manual lists the exact command and reply formats in a dedicated **Command Format** table.

2.3 Modes of Operation

Three modes of operation can be selected for measurement purposes with the *MODE* command.

2.3.1 OSCILLOSCOPE (OSC) Mode

OSC mode allows obtaining measurements at the acquisition rate of **100 kHz** (the ADC sampling rate), thus making it possible to acquire high-frequency components and fast current transients, as well as to perform an average over a large number of samples (thus reducing the output data rate).

In this mode the data can be read using **only the Ethernet communication interface** and data saving to the SD card is **not allowed**. The measurements are sampled at 100 kHz; if such speed is not needed, the output data rate can be reduced down to 1 Hz by averaging the fixed 100 kHz samples, using the *TS* command. Data is streamed out using the **UDP** protocol.

2.3.2 DATA-LOGGER (DLOG) Mode

DLOG mode is dedicated to long-time acquisitions with a slower output data rate. The current measurements can be read over the communication interface and/or stored on the connected SD card. Optionally, it is also possible to read and/or store the temperature of the DCCT and/or the external temperature (measured with an external sensor attached to the D-SUB DA-15S (female) connector on the back of the CT-BOX unit – see *ACQT*).

In this mode of operation, the output data frequency can be set in the range **0.1 Hz – 10 Hz** using the *FREQ* command. In this mode an average is always computed.

2.3.3 DIGITAL-MULTIMETER (DMM) Mode

DMM mode allows the CT-BOX to operate as a digital multimeter, providing DC, AC and ACDC (true RMS) measurements. Samples are always acquired at a fixed rate of 100 kHz. Each output value is computed over a measurement window whose length is set by two commands (*DMM:FREQ* and *DMM:NOP*):

Window length	= DMM:NOP / DMM:FREQ
Output data frequency	= DMM:FREQ / DMM:NOP

With `DMM:FREQ = 47 – 63 Hz` and `DMM:NOP = 1, 10, 20 or 100`, the output data frequency ranges from **0.47 Hz to 63 Hz**. For example, `DMM:FREQ:50` and `DMM:NOP:10` give a 200 ms window (20 000 samples) and one output value every 200 ms (5 Hz).

Because the window always covers a whole number of periods, components at `DMM:FREQ` and its harmonics are rejected (DC) or integrated without partial-cycle errors (AC, ACDC).

2.3.3.1 DMM:DC

Output data is the mean of the samples in the window. Set `DMM:FREQ` to the power grid frequency to reject grid noise and its harmonics. `DMM:NOP` is equivalent to the NPLC (Number of Power Line Cycles) setting of a conventional multimeter: higher values give lower noise but a slower output rate.

2.3.3.2 DMM:ACDC

Output data is the true RMS of the samples in the window, including both DC and AC components. Set `DMM:FREQ` to the frequency of the measured signal (47 – 63 Hz) so the window spans an exact number of signal periods. `DMM:NOP` sets how many periods the window covers.

2.3.3.3 DMM:AC

Output data is the RMS of the samples after the mean value over the same window has been removed, i.e. only the AC component is measured. `DMM:FREQ` and `DMM:NOP` work as in ACDC mode.

2.3.4 Comparison Between the Three Modes

Parameter	OSC mode	DLOG mode	DMM mode
Sampling frequency (fixed)	100 kHz	100 kHz	100 kHz
Output data frequency	1 Hz – 100 kHz	0.1 Hz – 10 Hz	0.47 Hz – 63 Hz
Data representation	Binary	ASCII	ASCII
Representation length	Fixed	Variable	Variable
Acquisition values	Index, status, current	Index, status, current, 2 optional temperatures	Index, status, current
Saving data to the SD card	Not allowed	Allowed	Allowed
Communication interfaces	Ethernet only (UDP stream)	Ethernet, USB 2.0, RS-232	Ethernet only (TCP/IP)

2.3.5 Commands per Mode

Most CT-BOX commands apply in all three modes. The following commands apply only in some modes:

Mode	Mode-specific commands
OSC	<i>TS</i> , <i>PORT</i> , <i>GET</i> , TRG:IN / TRG:OUT
DLOG	<i>FREQ</i> , <i>ACQT</i> , <i>GET</i> , <i>SD</i> , <i>SAVE</i> , <i>DATE</i> , <i>TIME</i> , TRG:IN / TRG:OUT
DMM	<i>DMM</i> , <i>SD</i> , <i>SAVE</i> , <i>DATE</i> , <i>TIME</i> , TRG:GATE

Except for *ACQT*, a command that only changes a setting (for example *FREQ*, *TS* or *DMM*) is accepted in every mode, so all settings can be prepared before switching mode with *MODE*; the setting takes effect only in the mode(s) it applies to. The *SD* commands are also accepted in every mode, but data is saved to the SD card only in DLOG and DMM modes. *GET* is rejected with *NAK:5* in DMM mode, and *ACQT* in OSC and DMM modes. A TRG submode selected outside its modes is rejected with *NAK:27*.

The commands are documented grouped by purpose in *Commands*. The applicable mode is stated at the top of each command page and summarized in the *Command Table Summary*.

2.4 Data Representation

The data representation depends on several parameters, such as the acquisition mode and other related settings. The various representations are described in detail hereafter.

2.4.1 OSCILLOSCOPE Mode

In this mode of operation the data output rate can be reduced by setting the desired averaging interval in microseconds (see the *TS* command). The output transfer rate can thus be set from 1 to 100 000 sps.

In order to optimize the communication bandwidth and to reduce the computational time required to elaborate the received data, an acquisition is represented in **binary format**. Binary representation improves the data transmission rate, as it avoids the overhead due to the ASCII format conversion and reduces the amount of sent data.

Every acquisition at the selected output data rate is represented with three numbers, of **fixed length of 64 bits (8 bytes)** in total:

Field	Width	Format
Sequence number	24-bit int	Unsigned binary
Status code	8-bit	See <i>Status Code</i>
Current measurement	32-bit	IEEE 754 single-precision floating point

```
0x01 0203  0x00  0x0A0B 0C0D
^sequence ^status ^current
```

Important: The sequence number and the current measurement are sent **least significant byte first**. In the example above, the datagram socket would actually read the data from the receiving buffer in the following order:

```
0x03 0x02 0x01 0x00 0x0D 0x0C 0x0B 0x0A
```

The first 24-bit number (3 bytes) is the **sequence number**, starting from #1 (0x00 0001), which is reset at every acquisition (the acquisition is started and terminated by the *ACQ* command). This number is represented in unsigned binary format, so for example 0x00 001F represents acquisition #31.

The fourth byte is the **status code** of the CT-BOX (see below).

The last 32 bits (4 bytes) indicate the **measured current in Ampere [A]**, represented as a single-precision floating point number (IEEE 754); for example the hexadecimal value 0x4120 0000 represents +10 A.

Note: This is the only possible representation in OSC mode. The output data rate is settable using the *TS* command. In this mode of operation the data can only be sent to the communication stream: data saving to the SD card is **not allowed**, due to the high acquisition speed.

2.4.2 Status Code

The status-code byte transmitted with every acquisition (in all OSC, DLOG and DMM modes) has the following bit meanings (#8 is the MSB):

Status Code Bit #	Bit Name	Description
#1	Error	CT-BOX is not acquiring correctly
#2	DCCT Fault	The DCCT has experienced a fault
#3	Buffer Overrun	The CT-BOX cannot send data to the host computer
#4	SD-Card Full	The SD-Card is full and no data can be saved
#5	SD Error	General SD-Card error
#6	ADC Temp OK	The temperature of the CT-BOX is OK
#7	Alarm	The current is outside the limits (see ALARM)
#8	Alarm Direction	If this bit is high the current is over the limit, if low it is under the limit

Note: This per-acquisition status code is **not** the internal Status Register read with [STATUS:?](#); the latter is a 32-bit register described in [Status Register](#).

2.4.3 DATA-LOGGER Mode

This mode of operation is suitable for longer data acquisitions with a lower output data rate. The acquisitions are represented in **ASCII** with three numbers separated by a space character \s, and every acquisition is terminated with the carriage return / line feed sequence \r\n:

```
12245\s00\s-12.4567877\r\n
```

- 12245 is the acquisition sequence number, in ASCII decimal format;
- 00 is the status code, in ASCII hexadecimal format (see [Status Code](#));
- -12.4567877 is the measured current, in ASCII decimal format, in Ampere [A].

Due to the lower output data rate, it is possible to acquire not only the measured current but also **additional temperature information** (optional fields). For this reason, the data representation also depends on the number of additional temperature fields (none, one or two), selectable with the [ACQT](#) command. The values are again separated by a space \s and every acquisition is terminated with \r\n.

The following example shows an acquisition with **two temperature fields** enabled:

```
12245\s00\s-12.4567877\s45.7\s27.8\r\n
```

- the first field is the acquisition sequence number, in ASCII integer decimal representation; this value is reset at every acquisition start;
- the second field is the 8-bit status of the CT-BOX, as described above;
- the third, fourth and fifth fields are the measurements, in ASCII fractional decimal representation: the current in Ampere [A] and the optional temperature(s) in degrees Celsius [°C].

Note: The acquisitions in DLOG mode have a **variable character length**. For additional information regarding the optional temperature fields, see the [ACQT](#) command.

2.4.4 DIGITAL-MULTIMETER Mode

DMM mode allows the CT-BOX to operate as a digital multimeter. The acquisitions are represented in **ASCII** with three numbers separated by a space character \s, and every acquisition is terminated with the carriage return / line feed sequence \r\n:

```
12245\s00\s-12.4567877\r\n
```

- 12245 is the acquisition sequence number, in ASCII decimal format;
- 00 is the status code, in ASCII hexadecimal format (see *Status Code*);
- -12.4567877 is the measured current, in ASCII decimal format, in Ampere [A].

Note: This is the only possible representation in DMM mode. The output data rate is settable using the *DMM* command. In this mode of operation data saving to the SD card is **allowed**, but no temperature data is acquired.

2.5 Communication Examples

2.5.1 Python Example (DLOG mode, TCP)

The following example shows how to open a TCP socket towards a CT-BOX unit using its factory-default IP address and port, configure a data-logger acquisition and read a few measurements:

```
import socket

CTBOX_IP = "192.168.0.10"
CTBOX_PORT = 10001

sock = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
sock.connect((CTBOX_IP, CTBOX_PORT))

def command(cmd):
    sock.sendall(cmd.encode() + b"\r")
    return sock.recv(4096).decode()

# Query the firmware version
print(command("VER:?"))

# Select the data-logger mode and a 1 Hz output rate
print(command("MODE:DLOG"))
print(command("FREQ:1"))

# Read a single current value [A]
print(command("GET"))

# Read an array of 5 consecutive measurements
print(command("GETA:5"))

sock.close()
```

2.5.2 Python Example (OSC mode, UDP data stream)

In oscilloscope mode commands are still sent over the TCP connection, while the acquired samples are streamed out over **UDP** to port 10002. Each sample is 8 bytes long: a 24-bit little-endian sequence number, an 8-bit status code and a 32-bit little-endian IEEE 754 float (see [Data Representation](#)).

```
import socket
import struct

CTBOX_IP = "192.168.0.10"
CTBOX_PORT = 10001
UDP_PORT = 10002

tcp = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
tcp.connect((CTBOX_IP, CTBOX_PORT))

udp = socket.socket(socket.AF_INET, socket.SOCK_DGRAM)
udp.bind(("", UDP_PORT))

def command(cmd):
    tcp.sendall(cmd.encode() + b"\r")
    return tcp.recv(4096).decode()

command("MODE:OSC")
command("TS:1000")      # 1000 us averaging interval -> 1 kHz output rate
command("PRINT:ON")
command("ACQ:ON")

data, _ = udp.recvfrom(65536)
for offset in range(0, len(data) - 7, 8):
    seq_lo, seq_hi, status, current = struct.unpack_from("<HBBf", data, offset)
    print((seq_hi << 16) | seq_lo, hex(status), current)

command("ACQ:OFF")

tcp.close()
udp.close()
```

2.5.3 Python Example (DMM mode, TCP)

The following example shows how to open a TCP socket towards a CT-BOX unit using its factory-default IP address and port, configure a DMM:DC acquisition and read a few measurements:

```
import socket

CTBOX_IP = "192.168.0.10"
CTBOX_PORT = 10001

sock = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
sock.connect((CTBOX_IP, CTBOX_PORT))

def command(cmd):
    sock.sendall(cmd.encode() + b"\r")
```

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```
return sock.recv(4096).decode()

# Query the firmware version
print(command("VER:"))

# Select the DMM:DC mode, a 50 Hz DMM:FREQ and a 10 DMM:NOP
print(command("MODE:DMM"))
print(command("DMM:DC"))
print(command("DMM:FREQ:50"))
print(command("DMM:NOP:10"))

# Read a single current value [A]
print(command("GETA:1"))

sock.close()
```

2.5.4 Terminal Example

The CT-BOX ASCII protocol can also be exercised interactively using any raw TCP terminal client (e.g. PuTTY on Windows, or nc -C on Linux), by opening a **Raw** (not Telnet-negotiated) connection to the unit's IP address and port:

```
$ nc -C 192.168.0.10 10001
VER:?
CT-BOX VER: 3.1.0

CTBOX:SN:?
150012

MODE:?
DMM

DMM:?
DC

STATUS:?
0X08111001
```

Tip: When using PuTTY, select connection type **Raw**, set **Host Name** to the CT-BOX IP address and **Port** to 10001, then type commands directly in the terminal window.

Over **USB** or **RS-232** (DLOG mode only) the same commands can be issued from a standard serial terminal (PuTTY, Minicom) configured at **115 200 baud** for RS-232, or on the virtual COM port created by the ST VCP driver for USB.

COMMANDS

The CT-BOX commands are grouped by purpose. The mode(s) of operation in which each command applies (see *MODE* and *Modes of Operation*) are stated at the top of each command page and in the **Mode** column of the *Command Table Summary*.

Most settings can be written and read in any mode, and take effect only in the mode(s) in which they apply. Only GET and ACQT are rejected outside their modes.

- *Mode and Acquisition* – MODE, ACQ, PRINT.
- *Reading* – GET, GETA, GETT.
- *Output Data Rate and Acquisition Settings* – TS, FREQ, DMM, ACQT.
- *Measurement Setup* – PTURNS, OFFSET.
- *Alarm and Trigger* – ALARM, TRG.
- *SD Card* – SD, SAVE.
- *Real-Time Clock* – DATE, TIME.
- *Network* – IP, MASK, GATE, PORT.
- *Device Information and Reset* – VER, CTBOX, DCCT, HWRESET.
- *Status and Errors* – STATUS, ERR.
- *Calibration (Password Protected)* – PASSWORD, SCALE, GAIN.

A quick-reference *Command Table Summary* listing every command and its parameters is also provided at the end of this chapter.

3.1 Mode and Acquisition Commands

These commands select the mode of operation and start, stop and print the acquisition.

3.1.1 MODE Command

Applies to: ALL modes (general purpose).

The MODE command selects the operation mode of the CT-BOX device. Three operation modes can be selected for measurement acquisition:

- **OSC**: allows obtaining measurements up to a maximum output data frequency of 100 kHz, making it possible to acquire high-frequency components and fast current transients;
- **DLOG**: ideal for long-time acquisitions with a slower output data rate; in this mode it is allowed to save data on the SD card;
- **DMM**: in this mode the CT-BOX operates as a digital multimeter; in this mode it is allowed to save data on the SD card.

See *Modes of Operation* for a detailed comparison of the three modes.

Command Format:

R/W	Command	Response	Description
W	MODE:OSC	ACK / NAK:x	Set the device in OSC mode
W	MODE:DLOG	ACK / NAK:x	Set the device in DLOG mode
W	MODE:DMM	ACK / NAK:x	Set the device in DMM mode
R	MODE:?	OSC / DLOG / DMM	Read the device acquisition mode

If the command is not accepted, the unit replies with a NAK:x string, where the x field indicates the error code (see *List of the Error Codes*).

Changing the mode can disable the active trigger setting (see *TRG*).

Example(s):

```
MODE:OSC
ACK

MODE:?
OSC
```

3.1.2 ACQ Command

Applies to: **ALL modes** (general purpose).

The ACQ command starts or stops the current measurement acquisition from the CT-BOX device. The device starts to acquire measurements as soon as the command ACQ:ON is received; a stop command ACQ:OFF has to be sent in order to terminate the data acquisition.

Note: The acquisition state at power-up depends on the start-up configuration of the device: in *Saved* configuration the acquisition is **not active**, while in *Desktop* configuration the acquisition starts automatically. For details, refer to the **CT-BOX User's Manual**.

If a client disconnects from the CT-BOX, the unit responds in two different ways, according to its operation mode:

- **DLOG and DMM modes:** the acquisition is **not** stopped, thus allowing to save data on the SD card and/or to see acquired data on the CT-BOX display;
- **OSC mode:** the acquisition is stopped immediately.

Command Format:

R/W	Command	Response	Description
W	ACQ:ON	ACK / NAK:x	Start the measurements acquisition
W	ACQ:OFF	ACK / NAK:x	Stop the measurements acquisition
R	ACQ:?	ON / OFF	Read the acquisition status

If the command is not accepted, the unit replies with a NAK:x string, where the x field indicates the error code (see *List of the Error Codes*).

Important: The data stream to the communication interface is visible only if **both** the acquisition (ACQ) and the printing (*PRINT*) are enabled. For more detail regarding the data representation, see *Data Representation*.

Example(s):

ACQ:ON in OSC mode with PRINT enabled:

```
ACQ:ON
ACK
0x0000001 0x00 0x41200000
0x0000002 0x00 0x41200000
.....
```

ACQ:OFF in OSC mode with PRINT enabled:

```
.....
0x00AB03 0x00 0x41200000
0x00AB04 0x00 0x41200069
0x00AB05 0x00 0x41200073
ACQ:OFF
ACK
```

ACQ:ON in OSC mode with PRINT enabled **afterwards** (note that in this case the first acquisitions 0x01 – 0x10 are not displayed, because the PRINT command is enabled later):

```
ACQ:ON
ACK

PRINT:ON
ACK
0x0000011 0x00 0x41200000
0x0000012 0x00 0x41200073
.....
```

3.1.3 PRINT Command

Applies to: ALL modes (general purpose).

The PRINT command enables or disables the printing of the measured data to the communication stream. The printing is enabled as soon as the command PRINT:ON is received; a disable command PRINT:OFF has to be sent in order to stop the printing.

Warning: In DLOG and DMM modes (TCP stream), if any command other than ACQ:ON / ACQ:OFF is received during the acquisition (for example STATUS:?), the printing is **automatically stopped**. To resume printing, send PRINT:ON again.

In OSC mode the data is streamed over UDP, so commands sent over TCP do **not** stop the printing.

Command Format:

R/W	Command	Response	Description
W	PRINT:ON	ACK / NAK : x	Enable printing on the communication stream
W	PRINT:OFF	ACK / NAK : x	Disable printing on the communication stream
R	PRINT:?	ON / OFF	Read the printing configuration

Important: The communication stream does not depend on the PRINT command alone: it also depends on the ACQ command, which starts or stops the data acquisition. For example, if printing is enabled but the acquisition

is disabled, the device will not send any data to the communication stream.

Example(s):

PRINT in OSC mode with the acquisition enabled beforehand (note that in this case the first acquisitions 0x01 – 0x10 are not displayed, because the PRINT command is enabled afterwards). Note that the error bit is set:

```
PRINT:ON
ACK
0x000011 0x01 0x41200000
0x000012 0x01 0x41200073
.....
```

3.2 Reading Commands

These commands read current and temperature measurements on request.

3.2.1 GET Command

Applies to: DLOG-OSC modes only; rejected in DMM mode with NAK: 5.

The purpose of the GET command is to read back a single actual measured current. The returned data depends on the selected operation mode and on the relative output data frequency.

The format of the returned measurement is always expressed as an ASCII floating point number with 7 decimal digits, in Ampere [A], terminated by \r\n.

Command Format:

R/W	Command	Response	Description
R	GET	<current>	Get the current reading in Amps

Note: GET does not require the acquisition to be started with *ACQ:ON*: the command itself starts a single acquisition and returns its result.

Example(s):

```
MODE: ?
DLOG

GET
-14.1234567
```

```
MODE: ?
DMM

GET
NAK: 5
```

3.2.2 GETA Command

Applies to: ALL modes (general purpose).

The purpose of the GETA (GET Array) command is to read back an array of n elements of the actual measured current.

Unlike the *GET* command, the format of the returned measurements depends on the operation mode (see *Data Representation*). The output data frequency depends on the selected operation mode and on the *TS*, *FREQ* and *DMM* commands.

Important: GETA is available **only over Ethernet TCP/IP**, in all modes; it cannot be used over the USB or RS-232 interfaces. The reply is always sent over the TCP connection, also in OSC mode.

Note: In OSC mode the GETA reply is **binary**, in the same 8-byte format as the OSC UDP data stream (24-bit sequence number, 8-bit status code and IEEE 754 current, least significant byte first; see *Data Representation*). The only difference is that it is sent over the TCP connection instead of UDP: the reply is $8 \times n$ bytes, with no `\r\n` terminator.

Command Format:

R/W	Command	Response	Description
R	GETA:<n>	<n> measurements	Get n current readings in Amps

Parameter(s):

Name	Type	Allowed values	Description
<n>	int	1 – 5000	Number of current measurements to read

Note: GETA does not require the acquisition to be started with *ACQ:ON*: the command itself starts a single acquisition and returns the n measurements.

Example(s):

GETA in DLOG mode:

```
GETA:1
1 00 -1.1234567
```

GETA in OSC mode: the reply is 16 binary bytes, shown here in hexadecimal (sequence numbers 1 and 2, status 0x00, currents of about +10 A):

```
GETA:2
01 00 00 00 00 00 20 41 02 00 00 00 69 00 20 41
```

GETA in DMM mode:

```
GETA:3
1 00 -1.1234567
2 00 -1.1265437
3 00 -1.1245632
```

3.2.3 GETT Command

*Applies to: **ALL modes** (general purpose).*

The purpose of the GETT command is to read the temperature of the DCCT or of the connected external temperature sensor.

The format of the returned temperature is always expressed as an ASCII floating point number with one decimal digit, in degrees Celsius [°C], terminated by \r\n.

Command Format:

R/W	Command	Response	Description
R	GETT:HEAD	<temperature>	Read the temperature of the DCCT
R	GETT:EXT	<temperature>	Read the temperature of the external temperature sensor

Note: If the DCCT is not connected, GETT:HEAD returns -9999.0. Likewise, if the external sensor is not connected, GETT:EXT returns -9999.0.

Note: The external temperature sensor is attached to the D-SUB DA-15S (female) connector on the back of the CT-BOX unit; refer to the **CT-BOX User's Manual** for the connector pinout.

Example(s):

```
GETT:HEAD
36.7

GETT:EXT
25.3
```

3.3 Output Data Rate and Acquisition Settings

These commands set the output data rate and the acquired channels. Each mode of operation has its own setting: TS in OSC mode, FREQ and ACQT in DLOG mode, DMM in DMM mode.

3.3.1 TS Command

*Applies to: **OSC mode**. Can be set and read in any mode; takes effect only in OSC mode.*

The TS (Time Sampling) command sets the averaging interval of the data sent to the communication interface in OSC mode. This command does not affect the behaviour of the DLOG and DMM modes. Since the ADC works at a fixed frequency of 100 kHz, an average of samples is computed to adjust the output data rate.

The allowed averaging interval goes from **10 µs** (no average) up to **1 000 000 µs** (1 s, i.e. 100 000 averaged samples), with an incremental step of **10 µs**. Values with a different incremental step or outside this range are not accepted.

For example, if a 0.5 s interval is needed, the averaging interval has to be set to 500 000 µs. Data is always acquired at 100 kHz, so in this case the output data is an average of 50 000 samples.

Command Format:

R/W	Command	Response	Description
W	TS:<interval>	ACK / NAK:x	Set the averaging interval used in OSC mode
R	TS:?	<interval>	Read the averaging interval used in OSC mode

Parameter(s):

Name	Type	Allowed values	Step	Default	Description
<interval>	int	10 – 1 000 000	10	1000	Averaging interval in μ s

Example(s):

Set the averaging interval in oscilloscope mode to 50 μ s (the data stream in this case will have a frequency of $1/50 \mu\text{s} = 20 \text{ kHz}$):

```
TS:50
ACK

TS:?
50
```

3.3.2 FREQ Command

*Applies to: **DLOG mode**. Can be set and read in any mode; takes effect only in DLOG mode.*

The FREQ command sets the output data frequency in DLOG mode. This command does not affect the behaviour of the OSC and DMM modes.

The command accepts output data frequencies from **0.1 Hz to 0.9 Hz** in steps of 0.1 Hz, and integer frequencies from **1 Hz to 10 Hz**. Any other value is rejected with NAK:x. Note that the ADC is fixed at 100 kHz, so an average is computed in order to obtain the desired output data frequency. The average depends on the FREQ value: if FREQ = 1, then 100 000 samples are averaged to produce the output current value.

Command Format:

R/W	Command	Response	Description
W	FREQ:<output_freq>	ACK / NAK:x	Set the DLOG output frequency
R	FREQ:?	<output_freq>	Read the DLOG output frequency

Parameter(s):

Name	Type	Allowed values	Step	Default	Description
<output_freq>	float	0.1 – 0.9 1 – 10	0.1 1	10	Output frequency in Hz

Example(s):

Set the output data frequency in DLOG mode to 0.5 Hz:

```

FREQ:0.5
ACK

FREQ:?
0.5

```

3.3.3 DMM Command

*Applies to: **DMM mode**. Can be set and read in any mode; takes effect only in DMM mode.*

The DMM command sets the DMM submode (AC, DC and ACDC), DMM frequency (DMM:FREQ) and DMM number of periods (DMM:NOP). This command does not affect the behaviour of the DLOG and OSC modes.

Command Format:

R/W	Command	Response	Description
R	DMM:?	<dmm_submode>	Read the DMM submode
W	DMM:<dmm_submode>	ACK / NAK:x	Set the DMM submode
R	DMM:FREQ:?	<dmm_freq>	Read the DMM frequency
W	DMM:FREQ:<dmm_freq>	ACK / NAK:x	Set the DMM frequency
R	DMM:NOP:?	<dmm_nop>	Read the DMM number of periods
W	DMM:NOP:<dmm_nop>	ACK / NAK:x	Set the DMM number of periods

Parameter(s):

Name	Type	Allowed values	Default	Description
<dmm_submode>	string	DC	DC	DC is used to measure a Direct Current
<dmm_submode>	string	AC		AC is used to measure an Alternating Current removing its mean value
<dmm_submode>	string	ACDC		ACDC is used to measure an Alternating Current including its mean value
<dmm_freq>	float	47.00 – 63.00	50	Grid / signal frequency in Hz
<dmm_nop>	int	1; 10; 20; 100	1	Allowed DMM number of periods

The DMM:FREQ and DMM:NOP commands determine the output data frequency in DMM mode:

```
Output data frequency = DMM:FREQ / DMM:NOP
```

Example(s):

Set the DMM submode DC, set output data frequency to 5 Hz:

```

MODE:DMM
ACK

MODE:?
DMM

DMM:DC
ACK

DMM:?
DC

DMM:FREQ:50

```

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```

ACK

DMM:FREQ:?
50

DMM:NOP:10
ACK

DMM:NOP:?
10

```

3.3.4 ACQT Command

*Applies to: **DLOG mode** only; rejected in OSC and DMM modes with NAK: 5.*

The ACQT (ACQuisition Temperature) command sets the number (none, one or two) and the type of acquired temperature channels (DCCT and external sensor) in DLOG mode. This command does not affect the behaviour of the OSC and DMM modes.

As described in [Data Representation](#), in DLOG mode it is possible to acquire also the temperature of the DCCT and/or the temperature of the externally connected temperature sensor. This setting takes effect on the communication data stream **and** on the SD-card savings.

Unlike the other mode-specific settings, ACQT can be set and read only in DLOG mode: in OSC and DMM modes it is rejected with NAK: 5.

Command Format:

R/W	Command	Response	Description
W	ACQT:<xxx>	ACK / NAK: x	Set the number and type of the temperature acquisition
R	ACQT: ?	<xxx>	Read the temperature acquisition setting

Parameter(s):

<xxx>	Description
000	The optional temperature readings are disabled
010	External temperature sensor readings enabled
100	DCCT temperature readings enabled
110	External sensor and DCCT temperature readings enabled

The first digit enables the DCCT temperature, the second digit enables the external sensor temperature, and the third digit is reserved and must be 0.

Example(s):

Enable the temperature acquisition only from the DCCT:

```

ACQT:100
ACK

ACQT:?
100

```

3.4 Measurement Setup Commands

These commands adapt the measurement to the physical set-up of the DCCT.

3.4.1 PTURNS Command

*Applies to: **ALL modes** (general purpose).*

The PTURNS (Primary Turns) command sets the number of primary turns. When the primary conductor is wound *N* times through the hole of the DCCT, the DCCT measures *N* times the conductor current. This increases the sensitivity to small currents, while the full-scale current of the conductor is divided by *N*.

The full-scale current depends on the connected DCCT (see [DCCT](#)). As an example, with a 200 A DCCT the full-scale current of the conductor is 100 A with two primary turns, and about 66.7 A with three primary turns.

Warning: Do **not** apply the rated nominal full-scale primary current (for example 600 A for a CT-600) when carrying out multiple turns on the primary conductor hole.

The value *N* given to the command has to be **equal to the number of turns physically applied** to the DCCT, so that the CT-BOX divides the readings by the same factor and reports the current flowing in the conductor. The factory-defined number of turns is 1 (no turns applied to the primary conductor).

Note: The number of primary turns is stored in the unit's flash memory and is retained after a power cycle. Set it back to 1 when the additional turns are removed from the DCCT.

Command Format:

R/W	Command	Response	Description
W	PTURNS:<N>	ACK / NAK:x	Set the number of turns applied to the DCCT
R	PTURNS:?	<N>	Read the configured number of turns

Parameter(s):

Name	Type	Allowed values	Default	Description
<N>	int	1 – 100	1	Number of primary turns

Example(s):

Set the number of turns to 3:

```
PTURNS:3
ACK

PTURNS:?
3
```

3.4.2 OFFSET Command

*Applies to: **ALL modes** (general purpose).*

The CT-BOX device is already factory-calibrated during the production process. However, at power-up the device has a very small offset error (< 10 ppm), due to the intrinsic magnetic properties of the DCCT technology. In order to obtain a very accurate measurement, it is possible to nullify this offset.

Command Format:

R/W	Command	Response	Description
W	OFFSET:ZERO	ACK / NAK:x	Set the currently measured current as zero of the device

Warning: The offset compensation must be performed when the **primary current is equal to 0**, i.e. when no current is flowing through the DCCT.

Note: If the detected offset value is too big it is not accepted, and the unit replies with error code 24 (see [List of the Error Codes](#)).

Note: The offset compensation is stored in the unit and is retained after a power cycle.

Example(s):

```
OFFSET:ZERO
ACK
```

3.5 Alarm and Trigger Commands

These commands configure the current alarm and the external trigger signals.

3.5.1 ALARM Command

*Applies to: **ALL modes** (general purpose).*

The CT-BOX can detect when the measured current is outside a desired current range. The command that configures this functionality is **ALARM**.

The alarm check is performed once for every output value, so the check rate is equal to the output data frequency set by:

- the *TS* setting in OSC mode;
- the *FREQ* setting in DLOG mode;
- the *DMM:FREQ* and *DMM:NOP* settings in DMM mode.

Example(s):

Mode	Setting	Output data frequency	Alarm checked every
OSC	TS:1000	1 kHz	1 ms
DLOG	FREQ:1	1 Hz	1 s
DMM	DMM:FREQ:50, DMM:NOP:10	5 Hz	200 ms

Command Format:

R/W	Command	Response	Description
W	ALARM:ON	ACK / NAK:x	Enable the alarm check functionality
W	ALARM:OFF	ACK / NAK:x	Disable the alarm check functionality
W	ALARM:CLR	ACK / NAK:x	Clear the alarm condition
R	ALARM:?	ON / OFF	Read the alarm check setting

3.5.1.1 Threshold Configuration**Command Format:**

R/W	Command	Response	Description
W	ALARM:ULIM:<current>	ACK / NAK:x	Set the upper limit current threshold
R	ALARM:ULIM:?	<current>	Read the upper limit current threshold
W	ALARM:LLIM:<current>	ACK / NAK:x	Set the lower limit current threshold
R	ALARM:LLIM:?	<current>	Read the lower limit current threshold

Parameter(s):

Name	Type	Allowed values	Default	Description
<current> ULIM	for float	-1200.0 – 1200.0	1200.0	Upper current threshold in Ampere [A]
<current> LLIM	for float	-1200.0 – 1200.0	-1200.0	Lower current threshold in Ampere [A]

LLIM must always be lower than ULIM. A command that would set $LLIM \geq ULIM$ is rejected with NAK:2.

3.5.1.2 Alarm Behaviour

The alarm checking is performed **only when the acquisition is enabled** (*ACQ:ON*). When the acquired current is outside the configured range, the alarm condition is set. In this condition:

- the *Alarm* line of the D-SUB DA-15S (female) connector is driven high;
- the magnetic relay is switched, so its Normally Open contact (*Relay NO*) closes.

For the connector pinout, refer to the **CT-BOX User's Manual**.

The alarm condition is also reported on the *Status Register*:

- the **Alarm flag** bit indicates the alarm condition (0 = no alarm; 1 = alarm condition);
- the **Alarm Direction** bit indicates the alarm direction (0 = detected a current under the LLIM; 1 = detected a current over the ULIM).

Important: Whenever the alarm condition occurs, it is **latched**: the *Alarm flag* bit in the Status register and the *Alarm* line stay set even after the current returns inside the configured range. The relay is driven by the *Alarm* line,

so it also stays switched. Only the command `ALARM:CLR` clears the alarm condition, the *Alarm flag* bit and the *Alarm* line, and switches the relay back.

Example(s):

Enable the alarm checking:

```
ALARM:ON
ACK
```

Set the upper threshold limit to 100 A:

```
ALARM:ULIM:100
ACK

ALARM:ULIM:?
100
```

3.5.2 TRG Command

Applies to: ALL modes. The IN and OUT submodes apply only in DLOG and OSC modes, GATE only in DMM mode.

The CT-BOX has two external trigger signals (**trigger in** and **trigger out**), which can be used to synchronize the acquisition of different CT-BOX units, or to relate the acquisition to an external event (triggered acquisition). **Trigger in** signal has two modes: rising edge and GATE. **Trigger out** signal has just one mode: rising edge.

The TRG command is available in all modes, but each trigger submode can only be used in specific modes of operation:

Submode	OSC	DLOG	DMM
TRG:IN	✓	✓	–
TRG:OUT	✓	✓	–
TRG:GATE	–	–	✓
TRG:OFF	✓	✓	✓

If a submode is selected in a mode of operation where it is not available, the unit replies with `NAK:27` (*Trigger mode is not valid*; see [List of the Error Codes](#)).

Changing the mode of operation with *MODE* affects the trigger setting as follows:

New mode	Trigger setting
MODE:DMM	All triggers are disabled (TRG:OFF)
MODE:DLOG	TRG:GATE is disabled (TRG:OFF); TRG:IN / TRG:OUT are kept
MODE:OSC	TRG:GATE is disabled (TRG:OFF); TRG:IN / TRG:OUT are kept

After a mode change, check the trigger setting with `TRG:?` and set it again if needed (e.g. `TRG:GATE` after `MODE:DMM`).

The trigger submode cannot be changed while the CT-BOX is acquiring data; the unit replies with `NAK:6`. Stop the acquisition with *ACQ:OFF* first.

To exit the triggered acquisition mode, use `TRG:OFF`.

Command Format:

R/W	Command	Response	Description
W	TRG:IN	ACK / NAK:x	Set the trigger as input in rising edge mode
W	TRG:OUT	ACK / NAK:x	Set the trigger as output
W	TRG:OFF	ACK / NAK:x	Disable the trigger function
W	TRG:GATE	ACK / NAK:x	Set the trigger as input in GATE mode
R	TRG:?	IN / OUT / GATE / OFF	Read the trigger status

3.5.2.1 Trigger Input (DLOG and OSC modes)

To relate the acquisition to an external event it is necessary to enable the trigger input with TRG:IN. This trigger mode can only be used in DLOG and OSC operation modes and its behaviour depends on the mode of operation:

DLOG mode: the CT-BOX waits for a **rising edge** of the trigger input signal to start the acquisition. The device does not start acquiring immediately after **ACQ:ON**, but waits for a trigger pulse. When the device receives a rising edge on the trigger input signal, it starts the data acquisition over the selected period and then returns the averaged acquisition of that period. Once the acquisition is finished, the unit waits for a successive rising edge on the trigger input to start the next acquisition. A rising edge that arrives while an acquisition is still running has no effect.

```
TRG:IN
ACK

ACQ:ON
ACK

<trigger edge>
1 00 -10.1234567

<trigger edge>
2 00 -10.1234587
```

OSC mode: the device starts acquiring immediately after the ACQ:ON command, and the rising edge of the trigger input **resets the sequence number to 1**.

```
TRG:IN
ACK

ACQ:ON
ACK
0x000001 0x00 0x41200000
0x000002 0x00 0x41200000
.....
0x0007F8 0x00 0x41500000

<trigger edge>
0x000001 0x00 0x41400000
0x000002 0x00 0x41300000
.....
```

3.5.2.2 Trigger GATE (DMM mode only)

TRG:GATE synchronizes acquisition with an external gate signal. This mode is only available in DMM operation mode.

- While the gate is **high**, the CT-BOX acquires samples.
- On the **falling edge**, it computes the Average / RMS and sends one result frame while the gate is low.

Acquisition always starts on a **rising edge** of the gate. If the gate is already high when ACQ:ON is sent, the CT-BOX ignores the current gate pulse and waits for the next rising edge.

The gate high time (TON) must match the configured acquisition window:

$$\text{TON} = \text{DMM:NOP} / \text{DMM:FREQ} \quad (\text{tolerance } \pm 2\%)$$

where DMM:NOP is the number of periods and DMM:FREQ the grid / signal frequency. The gate period may vary freely, as long as TON stays within tolerance and TOFF respects the minimum below.

If TON is outside tolerance, the result is still sent, but the measured value contains a large error. The CT-BOX gives no warning, so the user must make sure the gate timing is correct.

Parameter	Value
TON	$\text{DMM:NOP} / \text{DMM:FREQ} \pm 2\%$
TON min	$1 / \text{DMM:FREQ}$ (i.e. NOP = 1)
Gate-high timeout	95 s (safety cap, see below)
TOFF min	1 ms (processing + transmission)
TOFF max	unlimited

Note: The gate-high timeout is a safety cap: if the gate stays high for 95 s, the acquisition is stopped and the CT-BOX waits for the next rising edge of the gate signal.

In the following example, user sets DMM:FREQ = 50 Hz and DMM:NOP = 10, so TON must be 200 ms $\pm 2\%$

```
DMM:FREQ:50
ACK

DMM:NOP:10
ACK

TRG:GATE
ACK

ACQ:ON
ACK

<gate high - acquiring for 200 ms>
<gate low>
1 00 0.0012345

<gate high - acquiring for 200 ms>
<gate low>
2 00 0.0001321
.....
```

3.5.2.3 Trigger Output (DLOG-OSC modes)

The CT-BOX can also generate a trigger signal (TRG:OUT). This trigger signal can be used by other CT-BOX units as their trigger input signal, thus synchronizing the acquisition of every CT-BOX. This trigger mode can only be used in DLOG and OSC operation modes (it is **not available in DMM mode**) and its behaviour depends on the mode of operation:

Mode	Trigger out signal
DLOG	Short pulse, repeated at the set output data frequency (see FREQ)
OSC	Square wave, fixed at 10 Hz with duty cycle 50%

```
TRG:OUT
ACK
```

3.6 SD Card Commands

These commands manage the SD card and the saving of acquired data to it. Data is saved to the SD card only in DLOG and DMM modes.

3.6.1 SD Command

*Applies to: **DLOG-DMM modes**. Can be used in any mode; data is saved to the SD card only in DLOG and DMM modes.*

The SD command manages the SD memory card. When the SD card is inserted in the appropriate slot it must be **mounted** before the CT-BOX can use it; likewise, the SD card must be **unmounted** before it is removed from the CT-BOX device.

Command Format:

R/W	Command	Response	Description
W	SD:MOUNT	ACK / NAK:x	Mount the SD card
W	SD:UNMOUNT	ACK / NAK:x	Unmount the SD card
R	SD:?	MOUNT / UNMOUNT	Read the SD card status
W	SD:RST	ACK / NAK:x	Reset the SD card
R	SD:LS	list of files + ACK / NAK:x	List all files on the SD card
W	SD:RM:<filename>	ACK / NAK:x	Remove the selected file
R	SD:SIZE:<filename>	<size> / NAK:x	Show the file size, in bytes
R	SD:READ:<filename>	file contents + ACK / NAK:x	Read the contents of the file

Parameter(s):

Name	Type	Description
<filename>	string	Name of the file on the SD card

3.6.1.1 SD Card Reset

If needed, the SD memory card can be remotely reset using the `SD:RST` command. The remote reset action is equivalent to removing the SD card from its slot and inserting it again.

Important: After a remote SD card reset the user must issue an `SD:MOUNT` command, so that the CT-BOX prepares the card for use.

3.6.1.2 File Naming

When data saving is enabled (see [SAVE](#)), the CT-BOX creates a new text file at every *ACQ:ON*, whose name is built from the CT-BOX name, the mode of operation and the date and time:

```
<name>_<mode>_<year><month><day>_<hour><minutes><seconds>.txt
```

- `<name>` is the first 8 characters of the user-defined CT-BOX name (see [CTBOX:NAME](#)); a shorter name is used as it is;
- `<mode>` is DLOG or DMM, according to the mode of operation;
- the date and time are taken from the Real-Time Clock (see [DATE](#) and [TIME](#)).

Example: with the CT-BOX name set to DIPOLE, a DLOG acquisition saved on 25.09.26 at 14:35:07 is stored in the file:

```
DIPOLE_DLOG_260925_143507.txt
```

3.6.1.3 SD Data Management

Four commands are available for the management of the SD data contents:

- **SD:LS** lists all the files that are on the SD card. The reply is in the form `<filename1>\r\n<filename2>\r\n...`; after the last filename is printed, the CT-BOX sends an ACK to inform the user that the list of files has reached the end.
- **SD:RM:<filename>** removes the selected file from the SD card. After the file is removed, the CT-BOX sends an ACK to inform the user that the operation succeeded.
- **SD:SIZE:<filename>** returns the size of the selected file, expressed in bytes.
- **SD:READ:<filename>** reads the content of the selected file and prints the data on the active communication stream. After the data is printed, the CT-BOX sends an ACK to inform the user that the operation succeeded.

3.6.1.4 Errors

When an SD command fails, the CT-BOX replies with one of the following error codes (see [List of the Error Codes](#)). Some failures also set a bit of the [Error Register](#), which stays high until `ERR:CLR`.

Command	Reply	Cause	Error bit	Register
SD:MOUNT	NAK: 18	The SD card is already mounted	—	
SD:MOUNT	NAK: 18	The SD card cannot be mounted (missing, not formatted, ...)	#1 SD mount error	
SD:UNMOUNT	NAK: 19	The SD card is not mounted	—	
SD:UNMOUNT	NAK: 19	The SD card cannot be unmounted	#1 SD mount error	
SD:LS	NAK: 16	The SD card is not mounted	—	
SD:LS	NAK: 17	The files cannot be listed	—	
SD:RM:<filename>	NAK: 16	The SD card is not mounted	—	
SD:RM:<filename>	NAK: 20	The file cannot be removed (e.g. it does not exist)	—	
SD:SIZE:<filename>	NAK: 16	The SD card is not mounted	—	
SD:SIZE:<filename>	NAK: 21	The file cannot be opened (e.g. it does not exist)	#2 SD open error	
SD:READ:<filename>	NAK: 16	The SD card is not mounted	—	
SD:READ:<filename>	NAK: 21	The file cannot be opened (e.g. it does not exist)	#2 SD open error	
SD:READ:<filename>	NAK: 22	The file cannot be read	#7 SD read error	

SD:MOUNT and SD:UNMOUNT are not repeatable: issuing them when the card is already in the requested state is answered with a NAK. Read the state with SD:? first if it is not known.

NAK:22 is sent when a read fails part-way through the file: the data read until then has already been printed, and NAK:22 takes the place of the final ACK.

The SD commands are accepted in every mode, but data is saved to the SD card only in DLOG and DMM modes (see [SAVE](#)). While the CT-BOX is acquiring data, every SD command except SD:? replies with NAK:6; in DLOG mode with the printout active, the command instead stops the printout and replies with NAK:4.

Example(s):

Mount the SD card and read back its status:

```
SD:MOUNT
ACK

SD:?
MOUNT
```

3.6.2 SAVE Command

*Applies to: **DLOG-DMM modes**. Can be set and read in any mode; takes effect only in DLOG and DMM modes.*

The SAVE command enables or disables saving the measured data to the external SD card. Data is saved only in DLOG and DMM modes: SAVE can also be set in OSC mode, but no data is saved there, because the acquired data quantity is too large to be transferred onto the SD card.

Saving to the SD memory card is enabled as soon as the command SAVE:ON is received; a disable command SAVE:OFF has to be sent in order to stop the data saving function.

Command Format:

R/W	Command	Response	Description
W	SAVE:ON	ACK / NAK:x	Enable saving to the SD card
W	SAVE:OFF	ACK / NAK:x	Disable saving to the SD card
R	SAVE:?	ON / OFF	Read the saving configuration

Warning: The SD card must be **mounted before starting the acquisition** with the SAVE function enabled; see the [SD:MOUNT](#) command.

Note: If an error happens during the data saving (for example the SD card is full, or an SD card write error occurs), SAVE is **automatically stopped**, the relative error condition is signalled in the [Error register](#) and the *Error condition* bit is set in the [Status register](#). This error does not affect the acquisition. To resume the saving, the acquisition has to be stopped and the fault solved; at this point SAVE can be enabled again.

3.6.2.1 File Format

Every [ACQ:ON](#) with SAVE:ON creates a new text file (see [File Naming](#)). The file starts with a header, which records the settings of the acquisition, followed by the DATA: line and then one line per acquisition. Lines end with \r\n.

The header contains the following lines, in this order:

Line	Mode	Content
NAME: <name>	both	CT-BOX name (see CTBOX:NAME)
DATE: <yy>. <mm>.<dd>	both	Date of the ACQ:ON, year first (see DATE)
TIME: <hh>: <mm>:<ss>	both	Time of the ACQ:ON (see TIME)
FREQ: <f> Hz	DLOG	Output data rate, one decimal (see FREQ)
DMM: <AC/DC/ ACDC>	DMM	Measurement type (see DMM)
DMM:FREQ: <f> Hz	DMM	Grid / signal frequency, two decimals (see DMM)
DMM:NOP: <n>	DMM	Number of periods (see DMM)
PTURNS: <n>	both	Number of primary turns (see PTURNS)
ACQT: <e><h>	DLOG	Temperature fields: <e> is 1 if the external sensor is acquired, <h> is 1 if the DCCT is (see ACQT)

Note: The digits of the ACQT: header line are in the opposite order to the first two digits of the ACQT command: the header reports the external sensor first.

The acquisition lines have the same format as the DLOG and DMM printout (see [Data Representation](#)): sequence number, status code, current and, in DLOG mode, the optional temperatures.

To speed up the writes to the SD card, the DATA: line and each acquisition line are padded with **spaces** to a multiple of 4 bytes, before the final \r\n. Remove the trailing spaces before parsing a line.

Example: a DLOG file with both temperature fields enabled (␣ marks a padding space):

```
NAME: CT-BOX
DATE: 26.08.25
TIME: 23:12:14
FREQ: 10.0 Hz
PTURNS: 1
ACQT: 11
DATA: ␣␣␣
1 23 0.0000397 -9999.0 -9999.0␣␣␣
2 23 -0.0000431 -9999.0 -9999.0␣␣␣
3 23 -0.0000704 -9999.0 -9999.0␣␣␣
```

Example(s):

```
SAVE:ON
ACK

SAVE:?
ON
```

3.7 Real-Time Clock Commands

These commands set and read the real-time clock, which provides the date and time in the names and headers of the files saved to the SD card.

3.7.1 DATE Command

*Applies to: **DLOG-DMM modes**. Can be set and read in any mode; takes effect only in DLOG and DMM modes.*

The DATE command reads or sets the date of the CT-BOX Real-Time Clock (RTC). This setting is used in DLOG and DMM modes (e.g. for SD-card data logging).

Command Format:

R/W	Command	Response	Description
R	DATE:?	<date>	Read the RTC date
W	DATE:<date>	ACK / NAK:x	Set a new RTC date

Parameter(s):

Name	Type	Format	Description
<date>	string	dd.mm.yyyy	RTC date

The day and month have two digits and the year has four digits. A date in any other format, or one that does not exist (e.g. 30.02.2026), is rejected with NAK:x.

Example(s):

```
DATE: ?
03.06.2026

DATE: 04.06.2026
ACK
```

3.7.2 TIME Command

*Applies to: **DLOG-DMM modes**. Can be set and read in any mode; takes effect only in DLOG and DMM modes.*

The CT-BOX contains a Real-Time Clock (RTC). The TIME command reads or sets the RTC time. This setting is used in DLOG and DMM modes (e.g. for SD-card data logging).

Command Format:

R/W	Command	Response	Description
R	TIME:?	<time>	Read the RTC time
W	TIME:<time>	ACK / NAK:x	Set a new RTC time

Parameter(s):

Name	Type	Format	Description
<time>	string	hours.minutes.seconds	RTC time

Example(s):

```
TIME: ?
14.35.07

TIME: 09.00.00
ACK
```

3.8 Network Commands

These commands configure the Ethernet interface and the UDP data stream.

3.8.1 IP Command

*Applies to: **ALL modes** (general purpose).*

The IP address of the CT-BOX can be changed with the IP command.

Command Format:

R/W	Command	Response	Description
R	IP:?	<ip_address>	Read the actual IP address
W	IP:<ip_address>	ACK / NAK:x	Set a new IP address

Parameter(s):

Name	Type	Description
<ip_address>	string	IP address in ASCII dotted-decimal format

Important: The new IP address takes effect **after a CT-BOX reset** (see [HWRESET](#)).

The factory-default IP address is 192.168.0.10; see [Physical Interfaces](#).

Example(s):

```
IP: ?
192.168.1.10

IP: 192.168.0.25
ACK
```

3.8.2 MASK Command

Applies to: ALL modes (general purpose).

The Ethernet subnet mask of the CT-BOX can be changed with the MASK command.

Command Format:

R/W	Command	Response	Description
R	MASK: ?	<subnet_mask>	Read the actual subnet mask
W	MASK: <subnet_mask>	ACK / NAK: x	Set a new subnet mask

Parameter(s):

Name	Type	Description
<subnet_mask>	string	Subnet mask in ASCII dotted-decimal format

Important: The new subnet mask takes effect **after a CT-BOX reset** (see [HWRESET](#)).

The factory-default subnet mask is 255.255.255.0.

Example(s):

```
MASK: ?
255.255.255.0

MASK: 255.255.0.0
ACK
```

3.8.3 GATE Command

*Applies to: **ALL modes** (general purpose).*

The default gateway of the Ethernet communication can be changed with the GATE command.

Command Format:

R/W	Command	Response	Description
R	GATE:?	<gateway>	Read the actual gateway
W	GATE:<gateway>	ACK / NAK:x	Set a new gateway

Parameter(s):

Name	Type	Description
<gateway>	string	Gateway in ASCII dotted-decimal format

Important: The new gateway takes effect **after a CT-BOX reset** (see [HWRESET](#)).

The factory-default gateway is 192.168.0.1.

Example(s):

```
GATE:?  
192.168.0.1  
  
GATE:192.168.1.1  
ACK
```

3.8.4 PORT Command

*Applies to: **OSC mode**. Can be set and read in any mode; takes effect only in OSC mode.*

By default, in OSC mode the data is sent out using the UDP protocol to remote host port **10002**. The data is sent to the IP address of the connected TCP client. The application that receives the data must bind a datagram socket to this port.

If required, this port can be changed with the PORT command to satisfy specific user needs; for example, if multiple CT-BOX units are connected to the same host, each one can send data to a different port.

Command Format:

R/W	Command	Response	Description
R	PORT:?	<port>	Read the current port number
W	PORT:<port>	ACK / NAK:x	Set a new port number

Parameter(s):

Name	Type	Default	Description
<port>	int	10002	UDP remote host port for the data stream

Note: Unlike the *IP*, *MASK* and *GATE* settings, the new port takes effect immediately: no CT-BOX reset is required.

Example(s):

```
PORT: ?
10002

PORT: 10012
ACK
```

3.9 Device Information and Reset Commands

These commands read the firmware release and the identification of the CT-BOX and of the DCCT, and reset the unit.

3.9.1 VER Command

Applies to: ALL modes (general purpose).

The VER command reads the information about the CT-BOX firmware version.

Command Format:

R/W	Command	Response	Description
R	VER: ?	CT-BOX VER: <firmware_release>	Read the installed firmware release

Example(s):

```
VER: ?
CT-BOX VER: 3.1.0
```

3.9.2 CTBOX Command

Applies to: ALL modes (general purpose).

The CTBOX command reads some information related to the CT-BOX unit and sets an identification name for the device.

Command Format:

R/W	Command	Response	Description
R	CTBOX: SN: ?	<serial_number>	Read the producer-defined serial number of the CT-BOX unit
W	CTBOX: NAME: <des>	ACK / NAK: x	Set the user-defined CT-BOX name or description
R	CTBOX: NAME: ?	<name>	Read the user-defined CT-BOX name or description
R	CTBOX: CDATE: ?	dd.mm.yyyy	Read the calibration date of the CT-BOX unit

Parameter(s):

Name	Type	Allowed values	Description
<des>	string	max 15 characters	User-defined name or description of the unit

Note: The serial number and the calibration date are factory-defined, and the corresponding commands are therefore **read-only**.

Tip: The user-defined name is useful to identify a specific unit in the case of a larger installation.

Note: If the name parameter string exceeds 15 characters, the unit replies with error code 10 (see [List of the Error Codes](#)).

Example(s):

Read the CT-BOX serial number:

```
CTBOX:SN:?
150012
```

Set the CT-BOX user-defined name to DIPOLE:

```
CTBOX:NAME:DIPOLE
ACK

CTBOX:NAME:?
DIPOLE
```

Read the calibration date:

```
CTBOX:CDATE:?
02.03.2026
```

3.9.3 DCCT Command

*Applies to: **ALL modes** (general purpose).*

The DCCT command reads some information related to the DCCT connected to the device. Each CT-BOX is factory-calibrated together with one DCCT, called the *matched* DCCT. Both parameters are factory-defined, so the command is **read-only**.

Command Format:

R/W	Command	Response	Description
R	DCCT:SN:?	<sn>	Read the serial number of the matched DCCT
R	DCCT:MODEL:?	<model> <sn>	Read the model and serial number of the currently connected DCCT

For DCCT:MODEL:?, <sn> reports the last 3 digits of the connected unit serial number and <model> identifies the DCCT model:

<model>	DCCT model
0	CT-100
1	CT-150
2	CT-200
3	CT-300
5	CT-400
6	CT-600
7	CT-1000

Note: If the DCCT is not connected, or is not the matched DCCT, the unit reports error codes 8 / 9 and sets the corresponding bits in the *Error Register*.

Example(s):

```
DCCT:SN:?
24Y48W0925

DCCT:MODEL:?
3 925
```

3.9.4 HWRESET Command

Applies to: ALL modes (general purpose).

The CT-BOX can be remotely reset with the HWRESET command.

Command Format:

R/W	Command	Response	Description
W	HWRESET:FORCE	ACK / NAK:x	Reset the CT-BOX

Note: The unit replies with ACK **before** performing the reset.

Tip: A reset is required for a new *IP address*, *subnet mask* or *gateway* to take effect.

Example(s):

```
HWRESET:FORCE
ACK
```

3.10 Status and Error Commands

These commands read the internal Status and Error registers.

3.10.1 STATUS Command

Applies to: ALL modes (general purpose).

The CT-BOX has an internal status register that shows the actual status and configuration of the instrument. This is a **read-only** register.

Command Format:

R/W	Command	Response	Description
R	STATUS:?	<status_register>	Read the internal status register (ASCII hexadecimal)

The full bit-by-bit description of the register is given in *Status Register*.

Example(s):

The value 0X00110001 indicates that the ACQ status is enabled (bit #1 is 1), the mode of operation is data-logger (bit #17 is 1 and bit #13 is 0) and the printing is enabled (bit #21 is 1):

```
STATUS:?
0X00110001
```

3.10.2 ERR Command

Applies to: ALL modes (general purpose).

The CT-BOX has an internal Error register that shows the error status of the device that may have occurred during normal device operation. Reading this register allows identifying the actual error(s) of the device.

Command Format:

R/W	Command	Response	Description
R	ERR:?	<error_register>	Read the Error register (ASCII hexadecimal)
W	ERR:CLR	ACK / NAK:x	Reset (clear) the Error register

The full bit-by-bit description of the register is given in *Error Register*.

Important: The bits of this register act as **latches**: when an error occurs, the corresponding bit remains high until the error clear command ERR:CLR is sent to the unit. If the errors have been solved, the relative bits remain 0 after the clear; otherwise the error bits return high at the next error check, within about 1 s.

The *Error condition* bit of the *Status Register* is a logical OR of the bits of the Error Register, so it is high when one or more bits of the Error Register are high.

Example(s):

The value 0X00010001 indicates that an SD mount error occurred (bit #1 is high) and that a buffer overflow occurred (bit #17 is high):

```
ERR: ?
0X00010001
```

Clearing the Error register:

```
ERR: CLR
ACK

ERR: ?
0X00000000
```

3.11 Calibration Commands (Password Protected)

These commands calibrate the CT-BOX. They are password protected, to avoid accidental loss of the factory calibration.

3.11.1 PASSWORD Command

*Applies to: **ALL modes** (general purpose).*

The PASSWORD command unlocks or locks the access to the protected commands, namely *SCALE* and *GAIN*.

Command Format:

R/W	Command	Response	Description
W	PASSWORD:<password>	ACK / NAK:x	Unlock the protected commands
W	PASSWORD:LOCK	ACK / NAK:x	Lock the protected commands

Parameter(s):

Name	Type	Value	Description
<password>	string	CAL-ADMIN	Password enabling the protected commands

Note: A wrong password is rejected with error code 25 (*Wrong password*); issuing a protected command while it is locked returns error code 23 (*Password required*). See [List of the Error Codes](#).

Example(s):

```
PASSWORD:CAL-ADMIN
ACK

PASSWORD:LOCK
ACK
```

3.11.2 SCALE Command

Applies to: ALL modes (general purpose). Password protected.

The SCALE command is used when performing a calibration. At full-scale reference primary current, this command calculates and stores the proper positive and negative gain values. The calculated gains are stored automatically and can be read back with the [GAIN](#) command (GAIN:POS:? / GAIN:NEG:?).

Warning: This command **overwrites the factory calibration data**. It is therefore to be used only in special cases, and it can be used only after having unlocked the password protection with the [PASSWORD](#) command, in order to avoid accidental calibration loss.

Calibration is performed separately for positive and negative current: the first argument of the command is the primary current direction, the second argument is the reference current measurement value.

Command Format:

R/W	Command	Response	Description
W	SCALE:POS:<current>	ACK / NAK:x	Calculate the calibration parameters for positive current
W	SCALE:NEG:<current>	ACK / NAK:x	Calculate the calibration parameters for negative current

Parameter(s):

Name	Type	Description
<current>	float	Reference current measurement in Ampere [A]

Note: If the password protection has not been unlocked, the unit replies with error code 23 (*Password required*); see [List of the Error Codes](#).

3.11.3 GAIN Command

Applies to: ALL modes (general purpose). Password protected.

The GAIN command reads or stores the calibration parameters. It is password-protected to avoid accidental calibration loss; see the [PASSWORD](#) command.

Command Format:

R/W	Command	Response	Description
W	GAIN:POS:<gain>	ACK / NAK:x	Store the positive-gain calibration parameter
R	GAIN:POS:?	<gain>	Read the positive-gain calibration parameter
W	GAIN:NEG:<gain>	ACK / NAK:x	Store the negative-gain calibration parameter
R	GAIN:NEG:?	<gain>	Read the negative-gain calibration parameter

Parameter(s):

Name	Type	Description
<gain>	float	Positive or negative gain value

Note: If the password protection has not been unlocked, the unit replies with error code 23 (*Password required*); see *List of the Error Codes*.

3.12 Command Table Summary

The following table lists every CT-BOX command, its purpose, its parameter(s) and the mode(s) of operation in which it applies, for quick reference.

In the **Mode** column: *ALL* means a general-purpose command usable in all three acquisition modes, *OSC* means the command applies only in oscilloscope mode, *DMM* means the command applies only in digital-multimeter mode, *DLOG* means it applies only in data-logger mode, *DLOG-DMM* means it applies in both data-logger and digital-multimeter modes, *DLOG-OSC* means it applies in both data-logger and oscilloscope modes. Settings of mode-specific commands can be written and read in any mode; only GET and ACQT are rejected outside their modes. Data is saved to the SD card only in DLOG and DMM modes.

3.12.1 Mode and Acquisition

Command	Purpose	Parameters	Mode
MODE	Set the device in OSC / DLOG / DMM mode	:OSC / :DLOG / :DMM	ALL
	Read the device operation mode	:?	ALL
ACQ	Start / stop the measurements acquisition	:ON / :OFF	ALL
	Read the acquisition status	:?	ALL
PRINT	Enable / disable printing on the communication stream	:ON / :OFF	ALL
	Read the printing configuration	:?	ALL

3.12.2 Reading

Command	Purpose	Parameters	Mode
GET	Get a single current reading, in Amps	(none)	DLOG-OSC
GETA	Get an array of n current readings (Ethernet only)	: [1 - 5000]	ALL
GETT	Read the DCCT / external sensor temperature	:HEAD / :EXT	ALL

3.12.3 Output Data Rate and Acquisition Settings

Command	Purpose	Parameters	Mode
TS	Set the averaging interval, in μs	: [10 - 1000000]	OSC
	Read the averaging interval	: ?	OSC
FREQ	Set the output data frequency, in Hz	: [0.1 - 0.9] (step 0.1) / : [1 - 10] (step 1)	DLOG
	Read the output data frequency	: ?	DLOG
DMM	Set the DMM submode	: DC / : AC / : ACDC	DMM
	Read the DMM submode	: ?	DMM
	Set the DMM frequency	: FREQ: [47.00 - 63.00]	DMM
	Read the DMM frequency	: FREQ: ?	DMM
	Set the DMM number of periods	: NOP: {1; 10; 20; 100}	DMM
	Read the DMM number of periods	: NOP: ?	DMM
ACQT	Set the temperature acquisition configuration	: 000 / : 010 / : 100 / : 110	DLOG
	Read the temperature acquisition configuration	: ?	DLOG

3.12.4 Measurement Setup

Command	Purpose	Parameters	Mode
PTURNS	Set the number of primary turns	: [1 - 100]	ALL
	Read the configured number of primary turns	: ?	ALL
OFFSET	Zero the offset at null primary current	: ZERO	ALL

3.12.5 Alarm and Trigger

Command	Purpose	Parameters	Mode
ALARM	Enable / disable the alarm check functionality	:ON / :OFF	ALL
	Clear the alarm condition	:CLR	ALL
	Read the alarm check setting	:?	ALL
	Set / read the upper current threshold, in Amps	:ULIM:<current> / :ULIM:?	ALL
	Set / read the lower current threshold, in Amps	:LLIM:<current> / :LLIM:?	ALL
TRG	Set the trigger as input / output / gate or disable it	:IN / :OUT / :OFF / :GATE	IN / OUT: DLOG-OSC; GATE: DMM; OFF: ALL
	Read the trigger status	:?	ALL

3.12.6 SD Card

Command	Purpose	Parameters	Mode
SD	Mount / unmount the SD card	:MOUNT / :UNMOUNT	DLOG-DMM
	Read the SD card status	:?	DLOG-DMM
	Reset the SD card	:RST	DLOG-DMM
	List all files on the SD card	:LS	DLOG-DMM
	Remove / size / read a file on the SD card	:RM:<filename> / :SIZE: <filename> / :READ: <filename>	DLOG-DMM
SAVE	Enable / disable saving to the SD card	:ON / :OFF	DLOG-DMM
	Read the saving configuration	:?	DLOG-DMM

3.12.7 Real-Time Clock

Command	Purpose	Parameters	Mode
DATE	Set / read the RTC date (dd.mm.yyyy)	:<date> / :?	DLOG-DMM
TIME	Set / read the RTC time (hours. minutes.seconds)	:<time> / :?	DLOG-DMM

3.12.8 Network

Command	Purpose	Parameters	Mode
IP	Set / read the IP address	:<ip_address> / :?	ALL
MASK	Set / read the subnet mask	:<subnet_mask> / :?	ALL
GATE	Set / read the default gateway	:<gateway> / :?	ALL
PORT	Set / read the UDP data-stream port	:<port> / :?	OSC

3.12.9 Device Information and Reset

Command	Purpose	Parameters	Mode
VER	Read the installed firmware release	:?	ALL
CTBOX	Read the unit serial number	:SN:?	ALL
	Set / read the user-defined unit name (max 15 chars)	:NAME:<des> / :NAME:?	ALL
	Read the unit calibration date	:CDATE:?	ALL
DCCT	Read the matched DCCT serial number	:SN:?	ALL
	Read the connected DCCT model and serial number	:MODEL:?	ALL
HWRESET	Perform a hardware reset of the unit	:FORCE	ALL

3.12.10 Status and Errors

Command	Purpose	Parameters	Mode
STATUS	Read the internal Status register	:?	ALL
ERR	Read the internal Error register	:?	ALL
	Clear the internal Error register	:CLR	ALL

3.12.11 Calibration (Password Protected)

Command	Purpose	Parameters	Mode
PASSWORD	Unlock / lock the protected commands	:CAL-ADMIN / :LOCK	ALL
SCALE	Calculate the calibration parameters	:POS:<current> / :NEG: <current>	ALL
GAIN	Store / read the calibration parameters	:POS:<gain> / :POS:? / : NEG:<gain> / :NEG:?	ALL

INTERNAL REGISTERS

The CT-BOX exposes two internal registers:

- the **Status Register**, readable through the *STATUS Command*, which reports the actual status and configuration of the instrument;
- the **Error Register**, readable and clearable through the *ERR Command*, which latches the error conditions that occurred during operation.

Note: Both registers are 32 bits wide and are returned as an ASCII hexadecimal string. They are distinct from the 8-bit *status code* transmitted with every single acquisition.

4.1 Status Register

The internal status register shows the actual status and configuration of the CT-BOX instrument. It is **read-only**, is read with *STATUS:?* and is returned as an ASCII hexadecimal value.

The register has the following structure, where bit #32 is the MSB:

Bit #	Bit name	Description
#1	ACQ status	Indicates that the unit is acquiring data (see <i>ACQ</i>)
#2	Error condition	Indicates that an error occurred; see the <i>Error Register</i> for detailed information
#3	Alarm flag	Indicates the alarm flag (see <i>ALARM</i>)
#4	Alarm direction	High when an over-current event happened, low in case of an under-current event. Meaningful only if <i>Alarm status</i> is high
#5	SD write	Indicates that the SD card is being used for saving the measured data
#6	SD mounted	Indicates that the SD card is mounted (see <i>SD</i>)
#7 – #12	Reserved	For internal or future use
#13	MODE_MSB	MSB of the <i>MODE</i> setting (see table below)
#14	Calibration password	Indicates the status of the <i>PASSWORD</i> setting (1 = correct password entered, protected commands unlocked; 0 = locked)
#15	Reserved	For internal or future use
#16	Reserved	For internal or future use
#17	MODE_LSB	LSB of the <i>MODE</i> setting (see table below)
#18 – #19	ACQT setting	Indicates the status of the <i>ACQT</i> setting (see table below)
#20	Reserved	For internal or future use
#21	PRINT setting	Indicates the status of the <i>PRINT</i> setting (1 = enabled)
#22	SAVE setting	Indicates the status of the <i>SAVE</i> setting (1 = enabled)
#23	ALARM setting	Indicates the status of the <i>ALARM</i> setting (1 = enabled)
#24	Trigger setting	Indicates the status of the <i>TRG</i> setting (1 = enabled, 0 = disabled). When 0, bits #25 and #29 are not meaningful (see table below)
#25	TRG_MSB	MSB of the <i>TRG</i> setting (see table below). Meaningful only if bit #24 is 1
#26	ADC temp OK	The temperature of the CT-BOX is OK
#27	DMM_MSB	MSB of the <i>DMM</i> setting (see table below)
#28	DMM_LSB	LSB of the <i>DMM</i> setting (see table below)
#29	TRG_LSB	LSB of the <i>TRG</i> setting (see table below). Meaningful only if bit #24 is 1
#30 – #32	Reserved	For internal or future use

4.1.1 MODE Setting Bits (#13 & #17)

Bit 13	Bit 17	Meaning
0	0	MODE = OSC
0	1	MODE = DLOG
1	0	NOT USED
1	1	MODE = DMM

4.1.2 ACQT Setting Bits (#19 – #18)

Bit 19	Bit 18	Meaning
0	0	Optional temperature readings are disabled
0	1	External temperature sensor readings enabled
1	0	DCCT temperature readings enabled
1	1	External temperature and DCCT temperature readings enabled

4.1.3 TRG Setting Bits (#24, #25 & #29)

Bit #24 tells whether the trigger is enabled. Only when bit #24 is 1 do bits #25 and #29 give the trigger configuration (IN, OUT or GATE). When bit #24 is 0 the trigger is disabled and bits #25 and #29 carry no information; ignore them.

Bit 24	Bit 25	Bit 29	Meaning
0	x	x	Trigger disabled (bits 25 and 29 ignored)
1	0	0	Trigger enabled, TRG:IN
1	0	1	Trigger enabled, TRG:GATE
1	1	0	Trigger enabled, TRG:OUT
1	1	1	NOT USED

4.1.4 DMM Setting Bits (#27 – #28)

Bit 27	Bit 28	Meaning
0	0	NOT USED
0	1	DMM:DC
1	0	DMM:AC
1	1	DMM:ACDC

Example:

The read value 0X00110001 indicates that the ACQ status is enabled (bit #1 is 1), the mode of operation is data-logger (bit #17 is 1 and bit #13 is 0) and the printing is enabled (bit #21 is 1):

```
STATUS: ?
0X00110001
```

4.2 Error Register

The internal error register shows the error status of the CT-BOX device that may have occurred during normal device operation. Reading this register allows identifying the actual error(s) of the device. It is read with *ERR:?* and cleared with *ERR:CLR*.

The register has the following structure:

Bit #	Bit name	Description
#1	SD mount error	Error in mounting the SD card
#2	SD open error	Error in opening the SD card
#3	SD write error	Error in writing on the SD card
#4	SD sync error	Error in sync operation on the SD card
#5	SD close error	Error in closing operation on the SD card
#6	SD full error	Error that occurs when the SD card is full
#7	SD read error	Error in reading the SD card
#8	Reserved	For internal or future use
#9	DCCT error	Indicates that the DCCT is not connected or is not working properly
#10 – #16	Reserved	For internal or future use
#17	Buffer overflow error	A buffer overflow occurred; to solve this problem it is suggested to reduce the acquisition frequency
#18	DCCT match error	Indicates that the DCCT is not connected, or that it is not the matched DCCT
#19 – #32	Reserved	For internal or future use

Important: The bits of this register act as **latches**: when an error occurs, the corresponding bit remains high until the general error clear command **ERR:CLR** is sent to the unit. If the errors have been solved, the relative bits remain 0 after the error clear; otherwise the error bits return high at the next error check, within about 1 s.

The *Error condition* bit (#2) of the *Status Register* is a logical OR of the bits of the Error Register, so it is high when one or more bits of the Error Register are high.

Example:

The value **0X00010001** indicates that an SD mount error occurred (bit #1 is high) and that a buffer overflow occurred (bit #17 is high):

```
ERR: ?
0X00010001

ERR: CLR
ACK

ERR: ?
0X00000000
```

5.1 List of the Error Codes

The CT-BOX unit replies with a **Not Acknowledge** (NAK) if the received command is not correct, or is not accepted. The NAK reply is followed by an **error code** field, which indicates the error cause and/or type.

Error Code	Brief description of error
0	Command not valid
1	Parameter not valid
2	Parameter is out of expected range
3	Parameter cannot be modified when the CT-BOX is acquiring data
4	Printout stream has been interrupted (DLOG/DMM only): repeat the issued command or restart the printout stream with <i>PRINT:ON</i>
5	Command is not supported in the current mode (see <i>MODE</i>)
6	Command cannot be executed when the CT-BOX is acquiring data
7	RS-232 communication is only supported in DLOG mode
8	DCCT is not connected to the CT-BOX
9	Other DCCT error
10	CT-BOX name parameter string is too long (see <i>CTBOX</i>)
11	CT-BOX is already acquiring data
12	SD-Card file create error
13	SD-Card file close error
14	SD-Card write to file error
15	SD-Card file cannot be synchronized
16	SD-Card is not mounted (see <i>SD</i>)
17	SD-Card cannot list files
18	SD-Card cannot be mounted
19	SD-Card cannot be unmounted
20	It is not possible to remove the file
21	It is not possible to open the file
22	It is not possible to read the file
23	Password required (see <i>PASSWORD</i>)
24	OFFSET detected value is not accepted, because it is too big (see <i>OFFSET</i>)
25	Wrong password
26	USB communication is only supported in DLOG mode
27	Trigger mode is not valid

DOCUMENT REVISION

This Command Reference Manual is derived from the **CT-BOX User's Manual**, Rev. 4 (September 2026), published by ELS Instruments srl, and is compatible with CT-BOX firmware $\geq$ **3.1.0**.

Revision	Date	Comment
1.0.0	2026	First release of the standalone Command Reference Manual, extracted and reorganized from the CT-BOX User's Manual Rev. 4.

Note: For the full revision history of the CT-BOX device and of the User's Manual (models, options, ordering codes, hardware changes, compliance), please refer to the **CT-BOX User's Manual**.
