CMM IV Manual

Current Measurement module

IRS Systementwicklung GmbH
Pfaffenthanner Weg 5 | 93179 Brennberg
+49 9484 9500-0 | info@irs.systems
www.irs.systems

DOCUMENT INFORMATION

Author: madi1

Date: 21.07.2023

Last saved: madi1 (21.07.2023)

File: CMM_IV.docx

Revision: 1.7

No Pages: 44

Version	Date	Author	Change Log
1.0	12.11.2020	madi1 miho1	Initial Release
1.1	16.12.2020	miho1 madi1	Added intended use and ambient conditions Added command UserText in Ethernet and IsoTP part Removed command Calibration from this document, because it is no intended to be used by customers Changed CmmOn flag to CmmOff flag Added new errorcodes / message for IsoTP and Ethernet Corrected some byte numbers in IsoTP description
1.2	17.12.2020	madi1	Added new errorcode “WaitingForReset” Moved description of Ethernet errorcodes to new section
1.3	03.02.2021	madi1	Added command TxFrameFormat in Ethernet and IsoTP part Removed 0 kBits setting for DataBaudrate Fixed wrong command ID for UserText command in IsoTP part Fixed wrong response of command “CanDataBaudrate?” in Ethernet part
1.4	10.03.2021	madi1	Added remarks to boot time of CMM IV
1.5	24.02.2022	masp1	Added command for TCP-ISOTP-Bridge
1.6	15.03.2022	madi1	Added info about new default IP address Added calibration recommendation
1.7	21.07.2023	madi1	Added chapter about CMM-IV-GUI Added recommended calibration interval

Content

Figures

1 Introduction

The current measurement module CMM-IV can be used to measure, evaluate and check current consumption of a dynamic DC load, typically an automotive electronic control unit. It can measure currents from 1µA to $100A_{DC}$ (190A range) with automatic range selection that switches within microseconds. The current range from 1µA to 190A is split into 7 ranges, i.e. seven decades.

Range	Nominal Range		Lower Range is selected at	Higher Range is selected at
	min	max		
0	1 µA	100 µA	-	110 µA
1	100 µA	1 mA	90 µA	1.1 mA
2	1 mA	10 mA	0.9 mA	11 mA
3	10 mA	100 mA	9 mA	110 mA
4	100 mA	1 A	90 mA	1.1 A
5	1 A	10 A	0.9 A	11 A
6	10 A	190 A	9 A	-

1.1 Intended use

This module is designed to be used as a current measurement device in an industrial environment. It is not designed to be used as a power switch.

1.2 Purpose of this document

The purpose of this document is to describe how to integrate the module in a test system and how to access it from the software point of view. Limits of application are shown in the technical data section.

This document is addressed to system integrators and the users, who are applying the module.

1.3 Document Overview

This documented contains 3 sections.

- The first section includes an introduction to this manual
- The second section includes description of the hardware
- The third section includes accessing the module from the software point of view.

2 Hardware

The following figure shows a block diagram of CMM-IV and its external connections

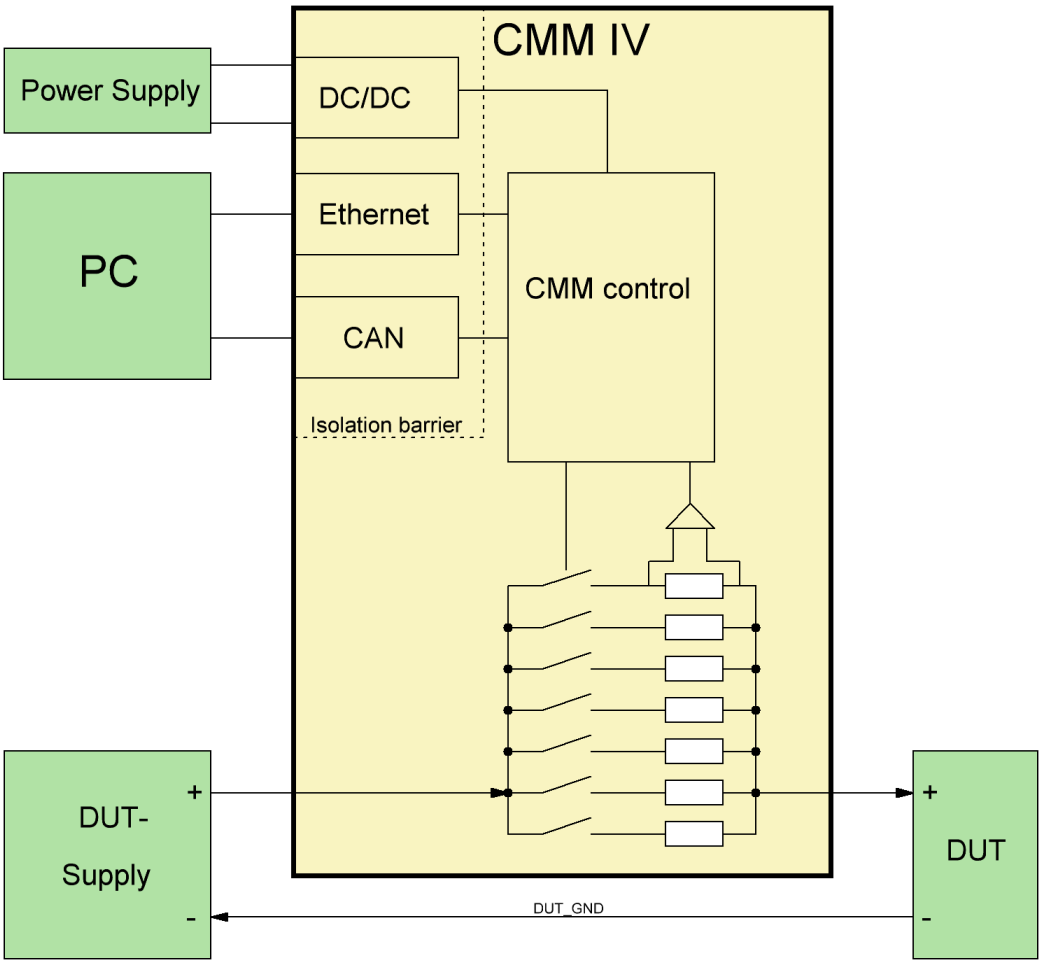

Figure 1: CMM-IV HW Overview

General setup:

- CMM-IV needs 12…24V power supply on PWR-CON/GND-CON
- The CMM-IV current path must be connected in series to the DUT as illustrated in figure 1

The measurement values can be read using one of the following possibilities:

- Ethernet TCP-Connection
    - Continuous High-Speed-Streaming with 125 kS/s
    - Text-Based-Protocol with Init-, Trigger- and Fetch-Command
- CAN
    - Cyclic Message (configurable ID and period) which contains the average value
    - ISO-TP-Protocol to read average, minimum and maximum value

Additional features are:

- The module can be configured via ethernet (CMM-IV-GUI or DLL) or CAN (ISO-TP protocol)
- Permanent parameter storage of the configuration in flash memory
- Calculation of average, minimum and maximum values
- The current path is electrically isolated from electronics supply and digital IO (up to 150V)
- Detection of reverse current

2.1 Connector Pinning

2.1.1 System connector

Interface	Signal	Pin	Recommended wire	Remarks
Module Power	**PWR-CON**	**C13**	0.14 … 0.5mm^2	
	GND-CON	**A13, A14, A16, A17, A18, A19, A20**	0.14 … 0.5mm^2	Connect at least 1 pin
On/Off	**On/Off**	**A15**	0.14 … 0.5mm^2	
CAN	**CAN_L**	**B14**	0.14 … 0.5mm^2 Twisted pair	Wire with ≈120Ω impedance
	CAN_H	**C14**		
Current Path	**Curr_In**	**4x High current pin A1-A12 B1-B12 C1-C12**	1…4 x 10mm^2	Depending on applied currents use 1 to 4 wires with appropriate diameter for both input and output, respectively. For currents above 60A use all 4 pins both for input and output.
	Curr_Out	**4x High current pin A21-A32 B21-B32 C21-C32**	1…4 x 10mm^2	

2.1.2 CAN Front Connector

The CAN front connector is a standard female D-Sub 9 (DE-9) connector.

Interface	Signal	Pin	Recommended wire	Remarks
CAN	**CAN-L**	**2**	0.14 … 0.5mm^2	
	CAN-H	**7**		
	GND-EXT	**3**		

2.1.3 Ethernet Front Connectors

The CMM-IV has two Ethernet ports and an integrated switch. This allows easy wiring without the need of an additional switch. Use CAT5e or CAT6 cables for wiring.

2.1.4 Mating system connector

The following components may be used for the mating connector on the test system. One connector with 8 high current pins is needed. Different versions for crimping or soldering from two manufacturers can be found in the following table.

Item	Quantity	Order Number	Manufacturer	Remarks
DIN41612 Type M 24+8	1	09 03 224 6804	Harting	
		354 116	ERNI	
High current pin	**8**	09 03 000 6115	Harting	Crimp version
		09 03 000 6103	Harting	Solder version
		594 182	ERNI	Crimp version
		594 176	ERNI	Solder version

Dimensions

CMM-IV is designed on a 160mmx 100mm Euro card, including front cover with a width of 25.4mm (5HP) and a standard DIN41612 connector. With these dimensions it fits in standard 19” / 3HU carriers and racks.

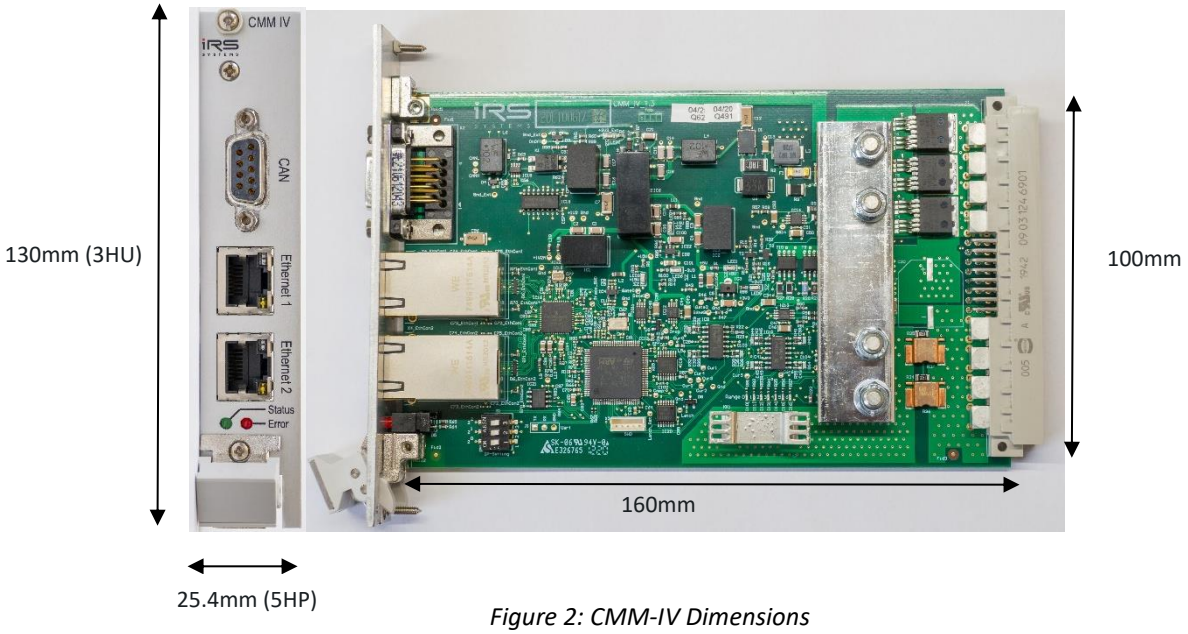

Figure 2: CMM-IV Dimensions

2.2 Technical data

2.2.1 Ambient conditions

Ambient operating temperature	5…50°C
Storage temperature	-20…70°C
Humidity	5…80% noncondensing

2.2.2 Current Path

Depending on the applied currents, the measurement current path must be wired with a low resistance to maintain low voltage drops. I.e. use short wires and as many high-current pins as possible – both for current input and current output.

Each high-current pin may carry up to 40A DC maximum. The more high-current pins (with wires of high diameter) are used, the lower the voltage drop and temperature of CMM-IV.

Item	Min	Typ	Max	Units	Remarks
DC current	0		100	A	operation under following conditions: - 25°C ambient temperature without airflow - 50° Ambient Temperature with airflow ≈2m/s
Worst case DC current			160	A	25° Ambient Temperature with airflow >6m/s on power devices and connector
DC current per high-current pin			40	A	50° maximum ambient temperature
Measurement range			190	A	Max. 3 seconds
Single pulse current			300	A	Max. 100ms
CMM-IV Voltage @ OFF			36	V	Module disconnects current path when PWR_Ext is below 5 V, or ON/Off is at low level
Leakage current @ OFF	0		20	µA	@ 36V
Voltage difference between GND-CON/GND-EXT and current path	-150		150	V	Limit is restricted by distance of wiring on the PCB. Electronic components are specified at least 250V
Reverse current detection threshold	50		1000	mA	Depending on temperature and components
Reverse current continuous	0		30	A	
Reverse current single pulse			200	A	Max. 1 second.

NOTE: Maximum voltage, applied at the DUT:
When the CMM-IV is switched off (i.e. no external power applied or On/Off-control input is at low level) the DUT supply voltage is applied fully across CMM-IV, which can handle up to 36V in OFF-state! To avoid damaging the module please make sure that CMM-IV is always turned ON when higher voltages than 36V are used for the DUT!

2.2.3 Module Supply

Connect the power supply for CMM-IV between PWR-CON and GND-CON. It is strongly recommended not to use the DUT power supply to power the CMM-IV.

Note that the current path is disconnected, when no power is applied.

Item	Min	Typ	Max	Units	Remarks
Supply voltage	11		26	V	PWR-CON to GND-CON
Supply DC current		130		mA	Supply Voltage = 24 V 1 Ethernet port active
Supply inrush current		1.0		A	Inrush current for approx.1ms @ dU/dt = 20V/ms

Typical current consumption

Supply Voltage	12 V	24 V
No Ethernet port active	210 mA	100 mA
1 Ethernet port active	280 mA	130 mA
2 Ethernet ports active	350 mA	160 mA

2.2.4 DC Accuracy

Accuracy of the module is verified for DC currents. Each module passes a calibration procedure at IRS. The module may of course be re-calibrated. See chapter 4 for recommendations.

	Min	Typ	Max	Units	Remarks
Accuracy uncalibrated		0.5	2	% of range	Max in % of respective range
Accuracy calibrated		0.2	1	% of range	Max in % of respective range
Resolution range 0			100	nA	Limited by output data format
Resolution range 1			404	nA	
Resolution range 2			4.04	µA	
Resolution range 3			40.3	µA	
Resolution range 4			403	µA	
Resolution range 5			4.03	mA	
Resolution range 6			46.8	mA	

2.2.5 DC Voltage Drop

Voltage drop is the voltage between current input and output, measured on the module connector. The drop on the mating power connector pins and the wiring is not included in the following values.

Item	Min	Typ	Max	Units	Remarks
Drop @ 100µA		70	80	mV	Range 0
Drop @ 1mA		70	80	mV	Range 1
Drop @ 10mA		70	80	mV	Range 2
Drop @ 100mA		70	80	mV	Range 3
Drop @ 1A		90	100	mV	Range 4
Drop @ 10A		100	120	mV	Range 5
Drop @ 40A		45	60	mV	Range 6
Drop @ 100A		120	150	mV	
Drop @ 160A		200	230	mV	

2.2.6 On/Off Interface

The digital input On/Off can be used to switch the current path of the CMM-IV on or off.

Item	Min	Typ	Max	Units	Remarks
On/Off Control – Low = OFF	-0.7		1.2	V	
On/Off Control – High = ON	3.0		25	V	
On/Off Control		150		kΩ	0…3.3V
Input Resistance	50		150	kΩ	3.3…25V

NOTE: Maximum voltage, applied at the DUT:

When the CMM-IV is switched off (i.e. no external power applied or On/Off-control input is at low level) the DUT supply voltage is applied fully across CMM-IV, which can handle up to 36V in OFF-state!

To avoid damaging the module please make sure that CMM-IV is always turned ON when higher voltages than 36V are used for the DUT!

2.2.7 LED Range Indicator

The CMM-IV (version of 1.3 and above) is equipped with a LED range indicator which is located close to the heat sink on the component side of the CMM-IV. See Figure 3 for details.

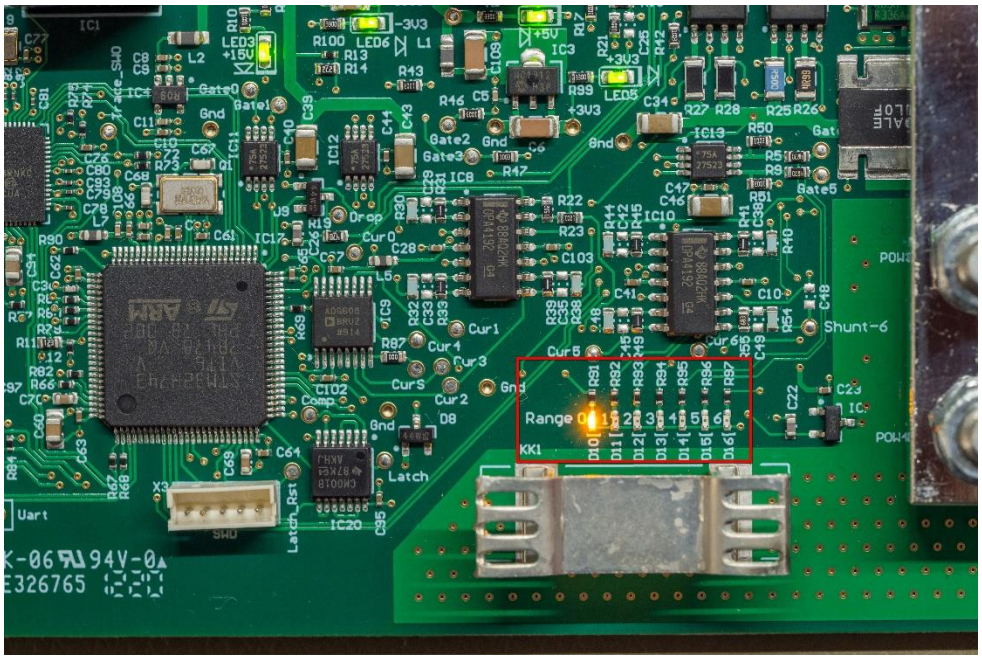

Figure 3: Location of LED range indicator

2.2.8 CAN Interface

The integrated CAN interface is a High-Speed CAN interface with FD-Support.

Item	Min	Typ	Max	Units	Remarks
Voltage at CAN_H or CAN_L	-14		14	V	Against GND-EXT
Dominant output level on CAN_H	2.45		3.3	V	
Dominant output level on CAN_L	0.5		1.25	V	
Recessive output level on CAN_H & CAN_L		1.85		V	
Nominal baud rate	100	1000	1000	kbit/s	
Data baud rate	1000	1000	4000	kbit/s	

For further details, see datasheet of TCAN332 and chapter 2.3.1

2.2.9 Ethernet-Interface

The CMM-IV is equipped with a 3-port Gigabit-Ethernet Switch. Two ports of the switch are connected to RJ45 jacks on the front panel. The third switch is connected to the microcontroller of the CMM IV. The connection between the switch and the microcontroller is limited to 100 Mbit/s.

Item	Min	Typ	Max	Units	Remarks
Datarate of switch (from one port to the other)			1000	MBit/s	
Datarate of the microcontroller			100	MBit/s	

For further details, see datasheet of KSZ9893RNX and chapter 2.3.2.

2.3 System Integration

The following section describes hardware prerequisites of the communication interfaces. For integration of the current path and the power supply, see the remarks in the technical data in section 2.2.

2.3.1 CAN

The High-speed CAN interface may be used to read measurement data.

Any High-Speed CAN interface from any vendor may be applied as counterpart for data acquisition. Make sure that termination of the entire bus is implemented properly with two 120Ω resistors at the respective far ends of the bus. No other termination resistors are included.

It is recommended to use a twisted pair with an impedance of 120Ω. Do not forget the GND connection. It is recommended to use the front D-Sub 9 connector for CAN communication because it uses GND-EXT which is directly connected to the CAN transceiver. GND-CON on the system connector is connected to GND-EXT and the CAN transceiver through an EMI filter which can lead to signal integrity problems especially at high baud rates.

Every CMM on the bus must run at the same baud rate and use different CAN IDs. CAN ID and baud rate may be configured via TCP-Text-Protocol or via CAN ISOTP and are stored permanently in flash memory.

For integration as a single module in a test system setup, please add a CAN counterpart with a termination resistor of 120Ω. CMM-IV includes 120Ω -termination which can be enabled or disabled by software.

If several CMM-IV are connected to the same CAN interface the termination resistor of each CMM-IV must be disabled. A single termination must be included at the far end of the CAN bus.

2.3.2 Ethernet connection

The IP address can be configured in the GUI described in chapter 3.4. Furthermore, the IP can be modified with a dip switch on the CMM-IV (see Figure 4). An offset between 0 and 6 is added, depending on the position off the switch. If all three switches are in the ON position the CMM IV uses its default IP which is 192.168.222.21.

The default IP address has changed in firmware version V2.5.

Older versions use default IP address: 192.168.200.1

Examples:

IP set in the GUI	Switch 2^0	Switch 2^1	Switch 2^2	Offset	Resulting IP
192.168.200.1	OFF	OFF	OFF	0	192.168.200.1
192.168.200.1	ON	OFF	OFF	1	192.168.200.2
192.168.200.3	OFF	ON	ON	6	192.168.200.9
192.168.200.10	ON	ON	ON	Use default IP	192.168.222.21

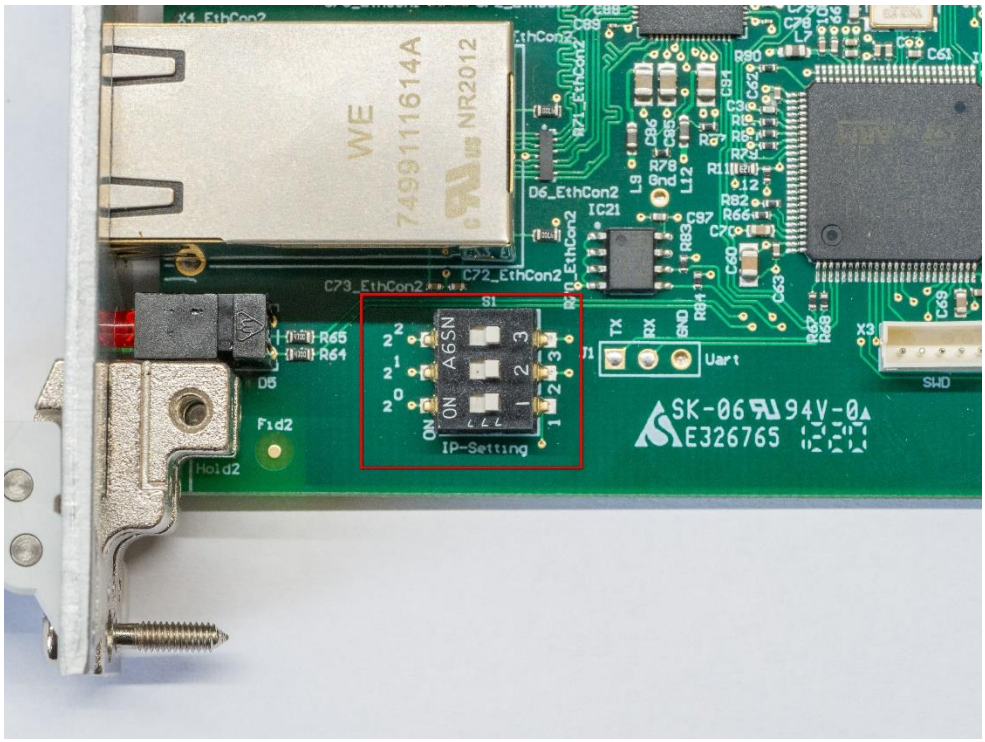

Figure 4: Switch for modification of IP address

3 Functional Description

The following section describes the internal measurement and gives a detailed description of the interfaces.

3.1 Current measurement

3.1.1 Measurement procedure

The current is measured internally at a sampling rate of 1MS/s, where 8 samples are averaged to 1 internal sample. Thus, a “real” internal sampling rate of 125kS/s is achieved. This “real” internal sampling rate can be streamed to a PC via Ethernet. The internal sampling rate can be further reduced in the CMM-IV-GUI. Possible values are 125, 50, 10 and 1 kS/s.

The current range is selected automatically, when the CMM is switched on. Large current steps can result in short-time voltage drops of a few hundred millivolts across the module. See Chapter 3.1.3 for dynamic behavior.

The CMM-IV transmits the average of the current for a configurable period via CAN. The standard value for this period is 5 ms.

Additionally, the average, the minimum and the maximum current can be read via CAN-Iso-TP. The calculation of the average, the minimum and the maximum value is reset with every readout. The following figure illustrates the averaging.

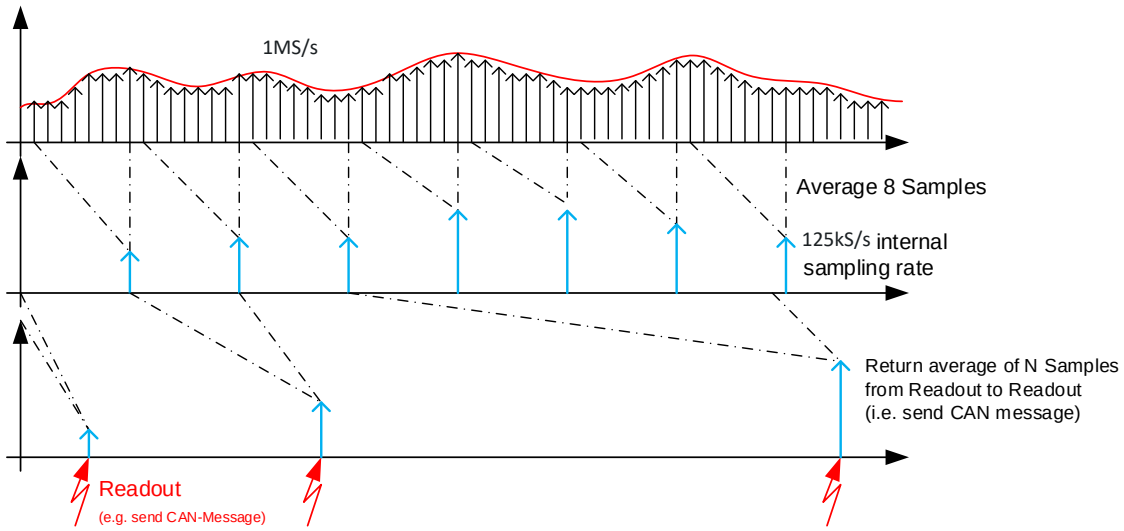

Figure 5: Measurement procedure

3.1.2 Reverse current detection

Reverse currents cannot be measured, but a flag signals when a current of several 100mA is applied in reverse direction. The output data is set to zero if reverse current is detected. The flag can be read via IsoTP-protocol and the TCP-Streaming mode.

3.1.3 Dynamic behavior

Switching between the ranges occurs very fast from low current range to high current ranges within less than 1µs (500ns typical) after the current range has been exceeded. This is significantly faster than the current can rise due to wiring inductance even with short wires.

The following figure shows the current (red) through the CMM and the voltage drop (yellow) across the CMM for a load current step from 0 to 100 A. The ringing on the voltage drop is caused by the wiring inductance.

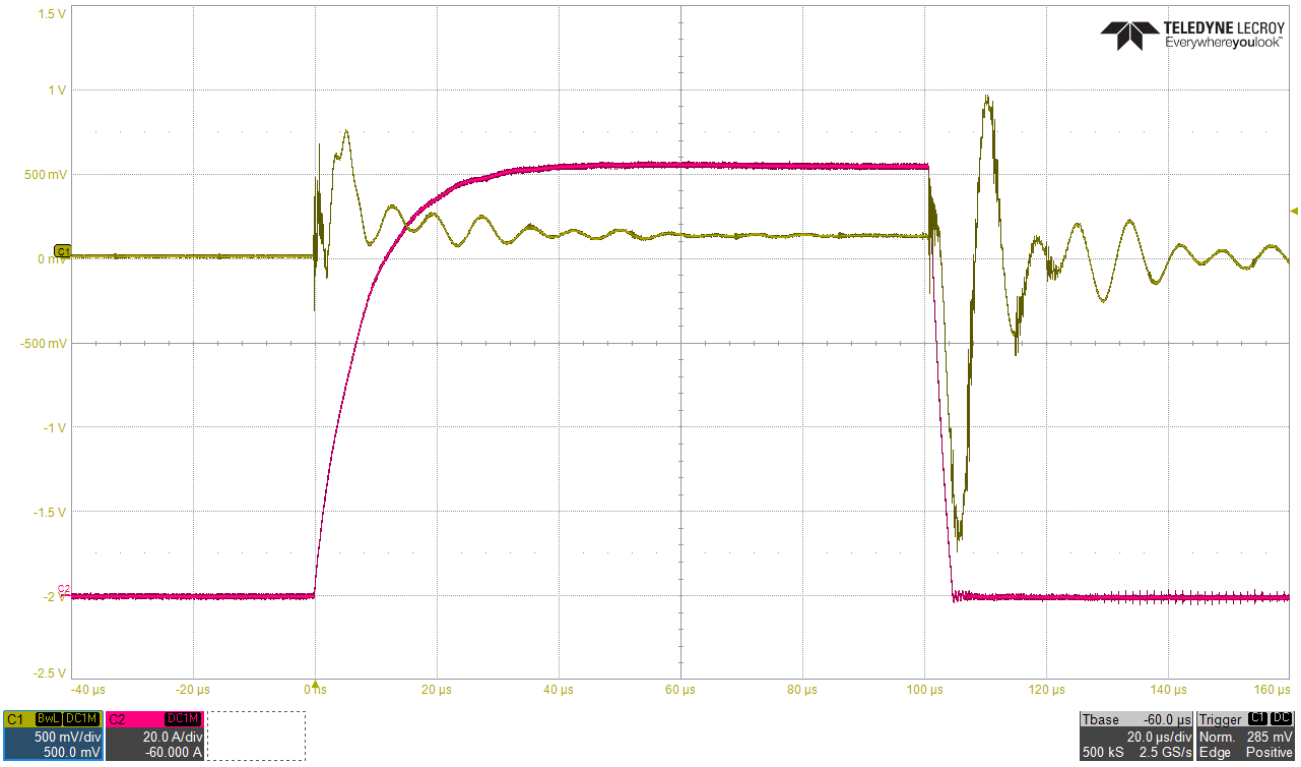

Figure 6: Dynamic switching behavior

3.2 ON/Off control

CMM-IV may be switched on or off by a hardware input or by software. The following parameters can be adjusted by configuration:

- Active level (high or low) of the hardware input
- Priority of hardware or software on/off-control

Configuration may be changed in the CMM-IV-GUI, by the command “OnOffMode = x” via Text-Based-Ethernet-Protocol or CAN using ISO-TP protocol, while x one of the following numbers 0…7:

ID	Name	HW input	SW setting	Description
0	ONOFF_Mode_ExtHighActive	YES	NO	CMM is ON, when high level is applied at HW input, SW setting ignored
1	ONOFF_Mode_ExtLowActive	YES	NO	CMM is ON, when low level is applied at HW input, SW setting ignored
2	ONOFF_Mode_Int	NO	YES	CMM is only controlled by SW
3	ONOFF_Mode_ExtHighActiveAndInt	YES	YES	CMM is ON when HW input is high **AND** SW setting is ON.
4	ONOFF_Mode_ExtLowActiveAndInt	YES	YES	CMM is ON when HW input is low **AND** SW setting is ON.
5	ONOFF_Mode_ExtHighActiveOrInt	YES	YES	CMM is ON when HW input is high **OR** SW setting is ON.
6	ONOFF_Mode_ExtLowActiveOrInt	YES	YES	CMM is ON when HW input is low **OR** SW setting is ON.
7	ONOFF_Mode_AlwaysOn	NO	NO	CMM is always ON.

3.3 CAN data output

CAN data is sent cyclically on a specified CAN ID. This CAN ID is adjustable via text-based Ethernet-Protocol or CAN using ISO-TP protocol.

Value	Min	Typical	Max	Unit	Remarks
CAN Type	-	High Speed	-	-	CAN transceivers are always active. No sleep mode is applied.
CAN Termination		120		Ω	Termination resistor is switchable via software command.

CAN nominal Baud rate	100	1000	1000	kBit/s	Default baud rate is 1MBit/s
CAN-FD data Baud rate	1000	4000	4000	kBit/s	Default baud rate is 0, which means Classic CAN is used
CAN ID		0x1C2		Hex	Identifier may be adjusted by software command
Extended ID		No			11-Bit or 29-Bit identifier may be adjusted by software command
CAN transmit interval	1	5	30000	ms	Transmit interval may be adjusted by software command
CAN data length		5			4 Bytes for current and 1 Byte for range
CAN data resolution		100		nA	One bit of the returned current represents 100nA of real measured current

Content of the transmitted CAN message is as follows:

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6...7
Current Bit 7..0	Current Bit 15..8	Current Bit 23..16	Current Bit 31..24	Range	Flags	Padding
0x00000000 … approx. 0x7270 E000				0 … 6	0…0x07	0

The CAN Message has a DLC (Data Length Code) of 8. Only Bytes 0 – 5 are used, Bytes 6 – 7 are padded with 0. Current is returned as 32 Bit unsigned long value in steps of 100nA split into the first 4 bytes of the CAN message. When CMM-IV is in off state, the returned value is zero. When CMM-IV is in on state, but reverse current is applied, the returned value is zero and “Negative Current Flag” (0x01) is set.

Flags:

- 0x01: Negative Current
- 0x02: Drop Voltage
- 0x04: Ringbuffer Warning
- 0x08: Cmm Off (0 = On; 1 = Off)

3.4 Configuration tool CMM-IV-GUI

The tool CMM-IV-GUI can be used to configure a CMM-IV and can also trigger measurements or stream all measured values to a PC. The current version of the CMM-IV-GUI can be downloaded from:

https://docs.irs.systems/cmm4/downloads/

After installation the installation folder contains (among others) the following subfolders and files:

File/Folder	Description
IRS.CMM-IV.GUI.exe	The configuration tool
IRS.CMM-IV.Lib.dll	A C# library which can be used to include the CMM into your software
Examples	Containing am example NI TestStand sequence which illustrates the use of important functions
LabVIEW	Containing the NI LabVIEW VIs which are used by the example test sequence
Firmware	Contains a firmware image which can be used to update the microcontroller on the CMM-IV

3.4.1 Connect and update a CMM-IV

The CMM-IV-GUI use Ethernet and TCP/IP to communicate with the CMM-IV. Therefore, it is necessary to enter the IP-address of CMM-IV into the GUI. The default IP-address is 192.168.222.21. See section 2.3.2 for details on IP configuration. If you do not know the IP-address of the CMM-IV, you can use "Tools → Detect module".

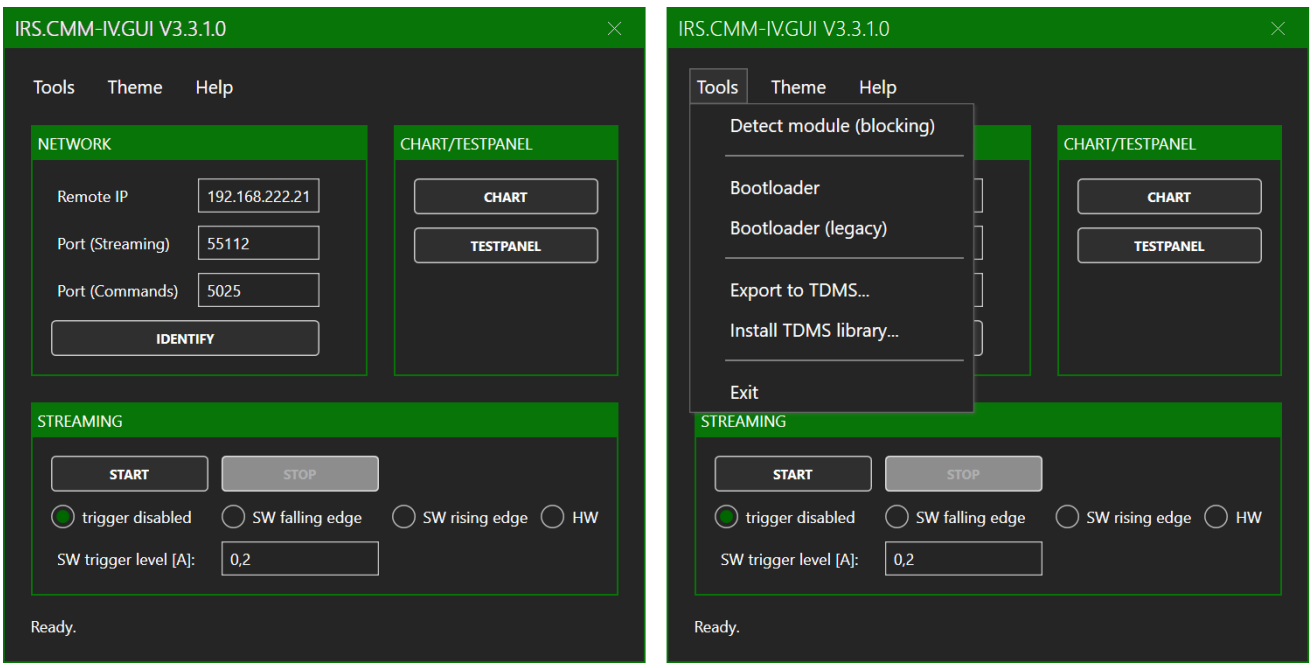

Figure 7: Find IP address of CMM-IV in CMM-IV-GUI

If “Detect module” does not find an IP address, make sure that the subnet mask of your network card is configured correctly and check your firewall settings.

After entering the IP address under “Remote IP” you can check the connection with “IDENTIFY”. This button opens a window which lists information about the connected CMM-IV. This information include the serial number and the firmware version of the connected CMM-IV. If the firmware version is outdated, you can update the microcontroller under “Tools → Bootloader”. The latest firmware version can be found with “Help → Check for update”.

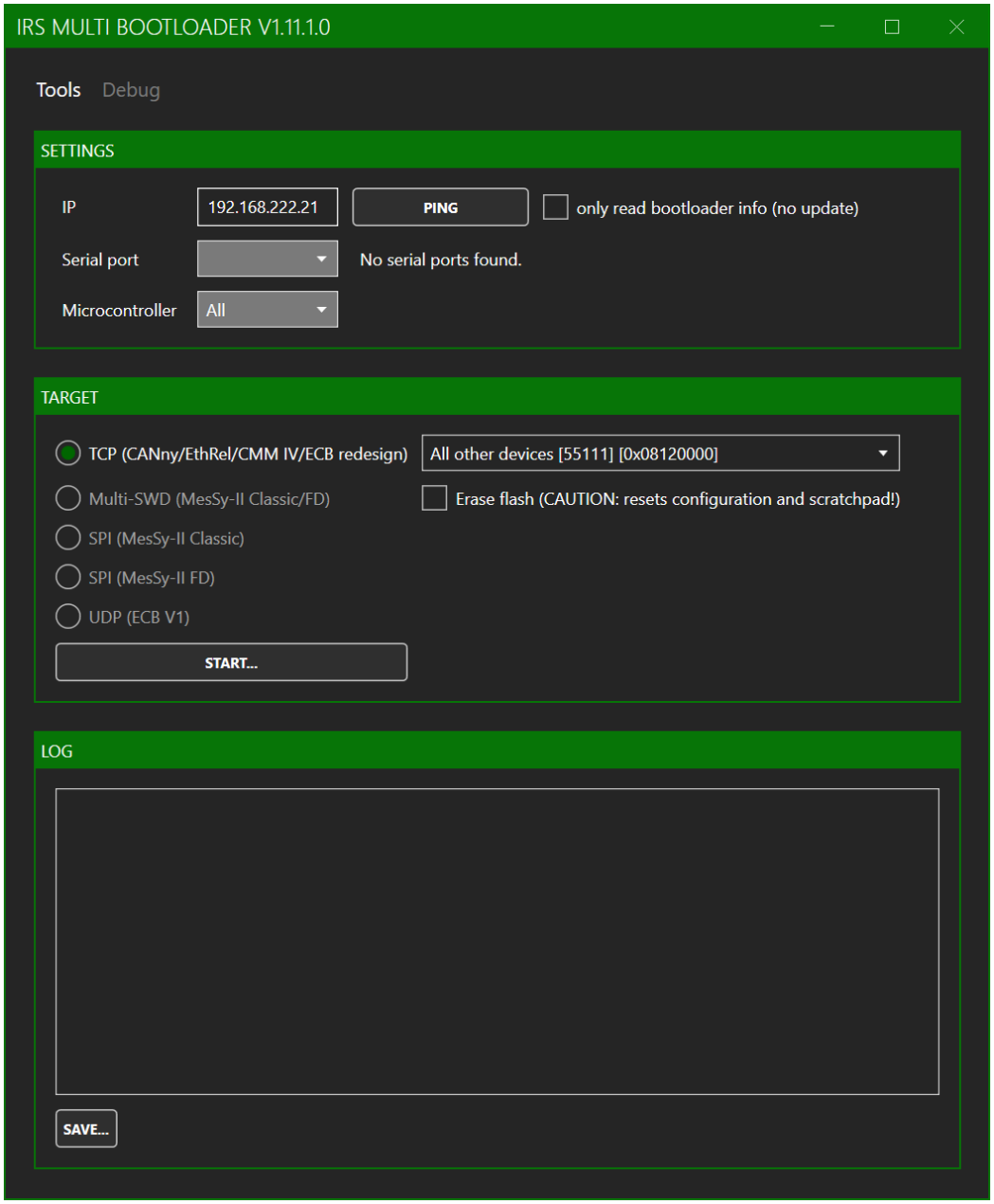

Figure 8: User interface of the bootloader

The bootloader is simple to use. Just enter the IP address of the CMM IV and click “START…”. Then select the firmware image from the installation folder mentioned above.

3.4.2 Use the test panel to configure the CMM-IV and to get current measurements

The test panel can be opened by clicking “TESTPANEL” in the main window. It can be used to configure the different communication interfaces and the measurement behavior of the CMM-IV.

“ON/OFF CONTROL” can be used to select the modes described in section 3.2.

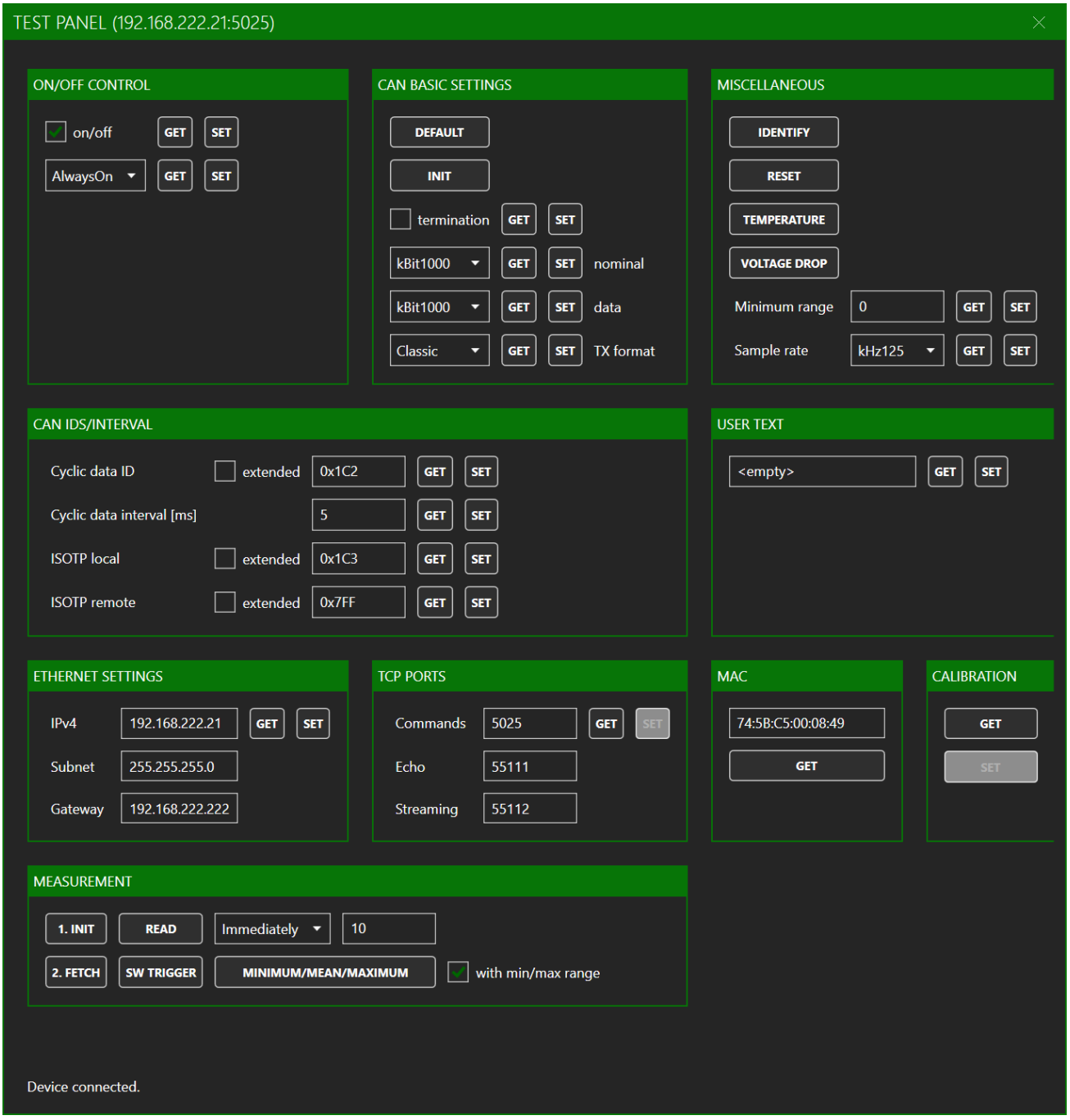

Figure 9: Test panel of the CMM-IV-GUI

There are three different methods of getting measurement values.

The first method simply uses the “READ” button This immediately returns the requested number of current samples.

The second method is more advanced and uses the Buttons “INIT”, “SW TRIGGER” and “FETCH”. The button “INIT” sets the trigger method selected in the dropdown menu and the number of samples that shall be read. The maximum number of samples for this method is 100. The button “SW TRIGGER” must be used to trigger the measurement if trigger mode “Internal” is selected. In “External” trigger mode the measurement is triggered by a positive edge on the ON/OFF pin and in mode “Immediately“ no trigger is needed and measurement starts immediately after “INIT”. The button “FETCH” returns the configured number of current samples when the measurement is completed.

The third method uses the button “MINIMUM/MEAN/MAXIMUM”. A click on this button returns the minimum, mean and maximum current since the last use of this button.

The test panel offers two possibilities to configure the measurement behavior under “MISCELLANEOUS”.

“Minimum range” can be used to avoid undesired switching between ranges. The minimum range is reset to zero when rebooting the CMM-IV. A maximum range can not be set because it could easily lead to accidentally exceeding the maximum allowed current of the selected range.

“Sample rate” can be used to reduce the sample rate of the CMM IV. This could especially be helpful to reduce the size of the saved data, when using streaming of measurement values for longer time periods.

3.4.3 Streaming of measured values

Streaming of measured values can be started in the main window of the CMM-IV-GUI. When “trigger disabled” is selected, streaming starts with a click on “START” and ends with a click on “STOP”. When “SW falling edge” or “SW rising edge” is selected, streaming starts but not data is saved until the selected edge is detected[1]. The level for the edge detection can be configured under “SW trigger level [A]”. When an edge is detected 12500 samples before and 12500 samples after the edge are saved. With the default sample rate of 125 kS/s this results in 100 ms before and after the trigger event. In trigger mode “HW” a rising edge on the ON/OFF pin is used as trigger. After the click on “START” the microcontroller on the CMM-IV is set in a waiting mode and only starts streaming after the rising edge on pin ON/OFF is detected.

The streamed measurement data is saved in the proprietary “cmm4” format. This is a binary format which unloads the PC from data conversion and therefore allows streaming from multiple CMM-IV in parallel. The conversion to the TDMS format from National Instruments can be done from the menu (Tools → Export to TDMS). To use the export function, you first need to install a TDMS library from National Instruments (Tools → Install TDMS library).

[1] Technically the streaming to the cmm4 file starts with a click on “START” and the trigger event is saved as a marker in this file. The values which are more than 12500 samples before the trigger event are removed in the export to TDMS.

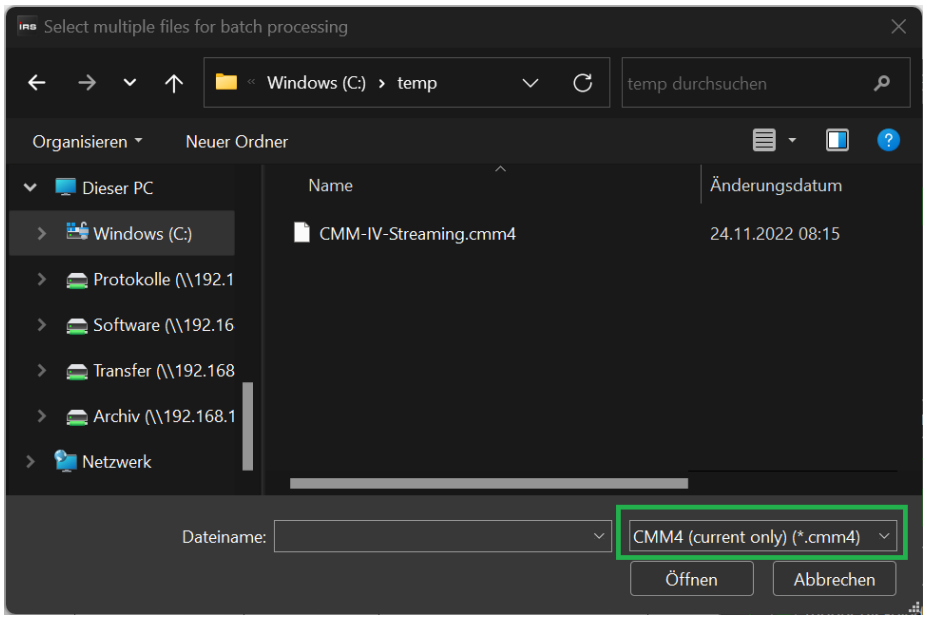

Figure 10: Dialogue Window for TDMS export

"Export to TDMS" opens the dialogue window shown in

Figure 10. In this window you can select the cmm4 file which should be converted to TDMS format. The TDMS file is saved with the same name as cmm4 file. The marked selection offers three possibilities. "CMM4 (current only)" exports only the measured current values. "CMM4 (all channels)" also includes the drop voltage, range and flags. "CMM4 (ignore trigger event)" exports all data from the click on "START" until the end of the cmm4 file which is 12500 samples after the trigger event. This is possible because all data is stored in the cmm4 file (including the trigger event) and the trigger is only used when exporting to TDMS.

3.4.4 Live view of measured values

A click on "CHART" in the main window opens the window shown in Figure 11. The measured values are update every second and displayed in the chart.

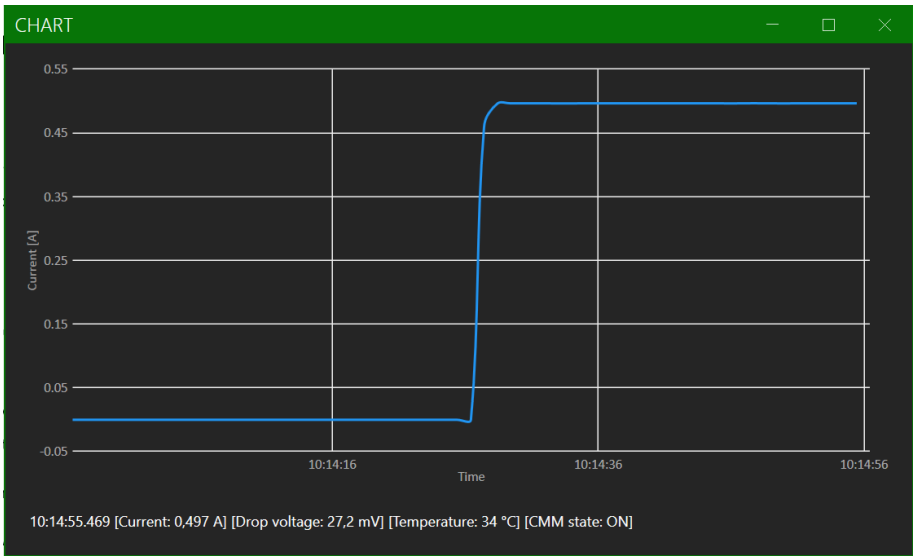

Figure 11: Live view of measured values

3.5 Text-Based Ethernet-Protocol

The following sections describes the text-based Ethernet-protocol which is used by the CMM-IV-GUI and the C#-DLL. It is recommended to use the CMM-IV-GUI or the C#-DLL (which is part of the CMM-IV-GUI download package, see section 3.4 for details).

The protocol is based on TCP and uses 0-terminated strings. This means the last character of each command hast to be NUL (= 0x00).

3.5.1 Commands to measure currents, voltage drop and temperature of CMM IV

The text-based Ethernet protocol supports two different methods of reading currents. The first method is to simply use the “ReadCurrent” command with TriggerMode “IMM”. This immediately returns the requested number of current samples. The second method is more advanced and uses the commands “InitCurrent”, “TriggerCurrent” and “FetchCurrent”. “InitCurrent” sets the trigger method and the number of samples that shall be read. “TriggerCurrent” is used to trigger the measurement if trigger mode “INT” is selected. “FetchCurrent” returns the requested number of current samples when the measurement is completed.

The following commands can be sent as strings on TCP port 5025 and must be finished with the NUL-character (0x00). Erroneous commands are answered by an error message, see section 3.5.4 for details.

Command	Parameters	Description	Remarks
ReadCurrent =	1 … 100 INT/EXT/IMM	Sets the number of samples and the trigger source. Values are sent directly after the measurement.	Trigger sources: INT: Wait for command “TriggerCurrent” EXT: Wait for rising edge on Pin On/Off IMM: Start measurement immediately
InitCurrent =	1 … 100 INT/EXT/IMM	Sets the number of samples and the trigger source. Values are sent after the measurement has been completed and command “FetchCurrent” was received.	Trigger sources: INT: Wait for command “TriggerCurrent” EXT: Wait for rising edge on Pin On/Off IMM: Start measurement immediately
TriggerCurrent		Must be used to trigger the measurement if trigger source “INT” is selected.	
FetchCurrent		Returns the measured values when the measurement is completed	Response: 0.0005027 A 0.0005031 A … If negative Current is detected, the response is: -0.0000001 A

Command	Parameters	Description	Remarks
Voltage?		Queries the current drop voltage value in µV	Response: Voltage = 30156 µV
Temperature?		Reads out current module temperature in °C	Response: Temperature = 26 °C
MinMaxMean?		Returns min, max and mean current since last use of this command.	Response: Min = 0.0005027 A Mean = 0.0005031 A Max = 0.0005034 A Samples = 12756

3.5.2 Commands to query configuration parameters

The following commands can be sent as strings on TCP port 5025 and must be finished with the NUL-character (0x00). Erroneous commands are answered by an error message, see section 3.4.4 for details.

Command	Description	Response	Remarks
Identify?	Queries the name, HW-Revison, SW-Revison and Serial Number of the device	IRS CMM IV; HW Revision: 3; SW Version: 1.2; Serial Number: 20BG00001	
CanCyclicInterval?	Queries the current CAN transmission interval in milliseconds	CanCyclicInterval = 5 ms	Default return value is 5ms
CanBaudrate?	Queries the CAN nominal baudrate in kBit/s	CanBaudrate = 1000 kBits	Default nominal baudrate is 1000 kBit/s
CanDataBaudrate?	Queries the CAN-FD data baudrate in kBit/s	CanDataBaudrate = 4000 kBits	Default data baudrate is 1000 kBit/s
TxFrameFormat?	Queries the format in which CAN message are sent by the CMM	TxFrameFormat = 0	0: Classic CAN frame 1: CAN FD frame without BRS 2: CAN FD frame with BRS
CanCyclicId?	Queries the CAN ID for cyclic messages	CanCyclicId = 0x1C2	“EXT” is added for extended IDs Default Can ID is 0x1C2
Temperature?	Reads out current module temperature in °C	Temperature = 26 °C	
OnOffMode?	Queries the On/Off control configuration	OnOffMode = 0…7	See chapter 3.2 for description of OnOffMode?.

Command	Description	Response	Remarks
OnOff?	Queries the ON/Off state of the device	OnOff = 0/1 0 => Off / 1 => On	This state is the result of the OnOffMode, the hardware input and the software on/off setting.
IsoTpLocalId?	Queries local CAN-ID for ISO-TP	IsoTpLocalId = 0x7FF	Local ID is sent by CMM Default is 0x1C3 “EXT” is added for extended IDs
IsoTpRemoteId?	Queries remote CAN-ID for ISO-TP	IsoTpRemoteId = 0x1C3	Remote ID is sent by system Default is 0x7FF “EXT” is added for extended IDs
CanTermination?	Queries state of switchable CAN termination	CanTermination =0/1	Default is 0 (CAN termination off)
IpSettings?	Queries the IP settings of the device	IP = 192.168.200.1 Mask = 255.255.255.0 Gateway = 192.168.200.10	These are the default IP settings. IP can be reset by hardware switch (see section 2.3.2).
Ports?	Queries the TCP ports	Port TcpCommands = 5025 Port TcpEcho = 55111 Port TcpStreaming = 55112	These are the default port settings.
MacSettings?	Queries the MAC address of the device	MAC = 74:5B:C5:00:00:01	
CalDate?	Queries the calibration date	CalDate = 2020-06-18	
MinRange?	Queries the minimal range set by the user	MinRange = 0	See corresponding command in following section for details
UserText?	Queries the string previously stored with the command “UserText =“	UserText =<string>	

3.5.3 Commands to set configuration parameters

The following commands can be sent as strings on TCP port 5025 and must be finished with the NUL-character (0x00). Erroneous commands are answered by an error message, see section 3.4.4 for details. If a command uses multiple parameters, the parameters must be separated by a whitespace. Optional parameters are noted in square brackets.

Command	Para-meters	Description	Response	Remarks
Reset		Reboots CMM IV	Ok	Reboot of CMM IV may take up to 10 seconds
Default =	CAN	Restore default settings for CAN interface	Ok	
CanCyclicInterval =	1 ms … 1 000 000 ms	Sets the current CAN transmission interval in milliseconds	Ok	Max. interval is 1 000 sec = 1 000 000 ms
CanBaudrate =	100 kBits … 1000 kBits	Sets the CAN nominal baud rate in kBit/s	Ok	First parameter must be a value between 100 and 1000. Second parameter must be “kBits”
CanDataBaudrate =	1000 kBits … 4000 kBits	Sets the CAN-FD data baud rate in kBit/s	Ok	First parameter must be a value between 1000 and 4000. Second parameter must be “kBits”.
TxFrameFormat =	0, 1 or 2	Sets the format in which CAN message are sent by the CMM	Ok	0: Classic CAN frame 1: CAN FD frame without BRS 2: CAN FD frame with BRS
InitCan		Reinitializes CAN interface	Ok	Reinitialization of CAN interface is necessary if baudrate was changed
CanCyclicId =	0x0 … 0x7EF [EXT]	Sets the CAN ID for cyclic messages	Ok	Optional parameter EXT must be used for extended IDs Max. extended ID is 0x1FFFFFEF
OnOffMode =	0 … 7	Sets the On/Off control configuration	Ok	See chapter 3.2 for description of OnOffMode.
OnOff =	0 … 1	Sets the software ON/Off state of the device	Ok	Depending on the OnOffMode this settings is used or ignored. See chapter 3.2 for details.
IsoTpLocalId =	0x0 … 0x7FF [EXT]	Sets local CAN-ID for ISO-TP	Ok	Optional parameter EXT must be used for extended IDs Max. extended ID is 0x1FFFFFEF

Command	Para-meters	Description	Response	Remarks
IsoTpRemoteId =	0x0 … 0x7FF [EXT]	Sets remote CAN-ID for ISO-TP	Ok	Optional parameter EXT must be used for extended IDs Max. extended ID is 0x1FFFFFEF
CanTermination =	0 … 1	Sets state of switchable CAN termination	Ok	
IpSettings =	Example: 192.168.200.1 255.255.255.0 192.168.200.10	Sets the IP settings of the device	Ok	Ip, Mask and Gateway must be separated by whitespaces.
Ports =	Example: 5025 55111 55112	Sets the TCP ports	Ok	Port numbers must be separated by whitespaces.
MinRange =	0…6	Sets the minimal range, the CMM IV can switch to	Ok	This command can be used to minimize switching with dynamic signals. Internal MinRange value is reset to 0 before the CMM is switched on by software or hardware pin.
UserText =	<string>	The user can permanently store a string of up to 64 Bytes in the CMMs storage.	Ok	This could for example be used to store the date of the next calibration, an inventory number or anything else.

3.5.4 Error messages

Erroneous commands are answered by one of the following strings (where it is appropriate, the error message contains the received string to simplify debugging):

- !Incorrect number of arguments: <received string>
- !This command is not supported: <received string>
- !This action is not supported: <received string>
- !Values out of range: <received string>
- !FRAM write failed.
- !No data available, maybe there was no trigger.
- !Error: <errorcode>
- !Waiting for reset to complete, commands are ignored.

3.6 CAN configuration

Configuration of CMM may be performed using the CAN interface. For this configuration ISO-TP protocol is applied, according to ISO 15765-2. Normal addressing mode is used.

Configuration is performed by sending commands to CMM. Every command is acknowledged by a response.

By default, CMM IV uses the following IDs for ISO-TP:

CMM IV listens on Local-ID (TPLID) for **Commands**: 0x1C3

CMM IV sends **Responses** on Remote-ID (TPRID): 0x7FF

ISO TP Header:

3.6.1.1 Single frame commands

Most commands and responses fit into a single CAN message. I.e. single frames according to ISO-15765-2 may be used. The respective CAN message carries the following data:

CAN ID	CAN Data							
		Command Header						
	Data_1	Data_2	Data_3	Data_4	Data_5	Data_6	Data_7	Data_8
TPLID (command) **TPRID** (response)	**SF_N_PCI = Length** 0x04…0x07	**Command**	**Action**	**Error-Code**	Reserved	*Command dependent data*		

3.6.1.2 Multiple frame commands

If more than one message is necessary for a command, first frames, flow-control and consecutive frames are used in the following order from top to bottom:

CAN ID	CAN Data							
TPLID Command First Frame	Data_1	Data_2	Data_3	Data_4	Data_5	Data_6	Data_7	Data_8
	FF_N_PCI ID+(Length MSB)	(Length LSB)	Command Header					
	0x10	**Length**	**Command**	**Action**	**Error-Code**	Reserved	*Command dependent data*	
TPRID Response Flow control	FC_N_PCI	Data_2	Data_3					
	0x30	**BS** Block size = 0	**ST_min** Separation time = 0					
TPLID Command Consecutive frame	CF_N_PCI	Data_2	Data_3	Data_4	Data_5	Data_6	Data_7	Data_8
	0x20	*Command dependent data*						
	0x21	*Command dependent data*						
	:	:						

If the multiple frame message is a response, exchange the CAN-IDs TPRID and TPLID.

3.6.1.3 Data Byte 1/2 xx_N_PCI:

Data byte 1 contains frame type and data length information according to ISO 15765-2.

For Single frames the values 0x04…0x07 are valid, which represent the number of following data bytes. 4 bytes minimum for Command, Action, Error-code, and Reserved - 7 bytes maximum including 3 command depending data bytes.

For first frames 0x10 in byte 1 is added to the command length, which can be found in byte 2.

For consecutive frames 0x20 is added to a message counter in byte 1.

3.6.2 Command Header

3.6.2.1 Data Byte 2/3 Command:

Byte 2 for single frames, byte 3 for multiple frames

Command ID	Command	Description
0x00	CAN_Cmd_NOOPR	No operation
0x01	CAN_Cmd_RESET	Resets the CMM internal microcontroller (Reboot of CMM IV may take up to 10 seconds)
0x02	CAN_Cmd_SWVER	Reads out software version
0x03	CAN_Cmd_DEFLT	All configuration parameters will be set to their default values
0x04	CAN_Cmd_ONMOD	Queries or sets the On/Off control configuration
0x05	CAN_Cmd_CMMON	Queries or sets the state of the internal ON/Off state
0x06	CAN_Cmd_GLVAL	Queries the latest values min, max and average
0x07	CAN_Cmd_TEMPR	Reads out current module temperature in °C
0x08	CAN_Cmd_SINTV	Queries or sets the serial transmission interval in milliseconds
0x09	CAN_Cmd_CANBD	Queries or sets the CAN baud rate in kBit/s
0x0A	CAN_Cmd_CIDIN	Queries or sets both CAN identifier and interval (combines commands CANBD and CANID of serial configuration)
0x0B	CAN_Cmd_TPLID	Queries or sets both CAN identifier and Extended-flag of Identifier (combines commands TPLID and TPLXT of serial configuration)
0x0C	CAN_Cmd_TPRID	Queries or sets both CAN identifier and Extended-flag of Identifier (combines commands TPLID and TPLXT of serial configuration)
0x0D	CAN_Cmd_INITC	Initializes CAN interface
0x0E	SerialNumber	Queries the serial number.
0x0F	CalDate	Queries the calibration date
0x10	CanTermination	Queries or sets the state of the switchable CAN termination resistor.

Command ID	Command	Description
0x11	IpSettings	Queries or sets the IP, Mask and Gateway for the Ethernet connection
0x12	PortSettings	Queries or sets the ports for the Ethernet connection
0x13	MacSettings	Queries the MAC address of the Ethernet connection
0x14	HwVersion	Queries the hardware revision
0x15	CanDataBaudrate	Queries or sets the CAN-FD data baud rate in kBit/s.
0x16	TxFrameFormat	Queries or sets in which CAN message are sent 0: Classic CAN frame 1: CAN FD frame without BRS 2: CAN FD frame with BRS
0x20	UserText	The user can permanently store a string of 64 Bytes in the CMMs storage.
0x30	TCP-ISOTP-Bridge	Encapsulates TCP commands into ISOTP frames

3.6.2.2 Data Byte 3/4 Action:

Byte 3 for single frames, byte 4 for multiple frames

Command ID	Command	Valid for Direction	Description
0x00	CAN_Action_Get	Command to CMM	Query operation to read data from CMM
0x01	CAN_Action_Set		Set operation
0x02	CAN_Action_Exe		Execute without data read or write.
0x03	CAN_Action_Ret	Response from CMM	

3.6.2.3 Data Byte 4/5 Error-code:

Byte 4 for single frames, byte 5 for multiple frames

This data byte is only valid for responses from CMM. In commands to CMM this byte should always be 0x00 = No error.

Command ID	Command	Description
0x00	CAN_Error_None	Command has been accepted, no error
0x01	CAN_Error_HeaderLength	Header Bytes 1..4 were not complete
0x02	CAN_Error_DataLength	Number of data bytes did not fit to command
0x03	CAN_Error_UnknownCmd	Unknown command
0x04	CAN_Error_Action	Action not supported for this command
0x05	CAN_Error_VOOR	Value out of range (an invalid parameter has been passed)
0x06	CAN_Error_InvalidHeader	Errorcode or ReservedByte of Command Header were not 0.
0x07	FRAM_Error_WriteFailed	Writing to the FRAM storage on the CMM failed
0x08	CMM_Error_WaitingForReset	Commands are locked while a reset is pending.

3.6.2.4 Data Byte 5/6 Reserved:

Byte 5 for single frames, byte 6 for multiple frames. This byte is reserved for future use.

3.6.3 Command overview:

The following commands are available:

Command	Length	Command Header				*Command dependent data*	
		Command	Action	Error-code	Reserved		
CAN_Cmd_NOOPR	4	**0x00**	**0x02** (Exe)	**0x00**	**0x00**		
CAN_Cmd_RESET	4	**0x01**	**0x02** (Exe)	**0x00**	**0x00**		
CAN_Cmd_SWVER	4	**0x02**	**0x00** (Get)	**0x00**	**0x00**		
CAN_Cmd_DEFLT	4	**0x03**	**0x02** (Exe)	**0x00**	**0x00**		
CAN_Cmd_ONMOD	4	**0x04**	**0x00** (Get)	**0x00**	**0x00**		
	5		**0x01** (Set)			**OnMode** = 0…7	
CAN_Cmd_CMMON	4	**0x05**	**0x00** (Get)	**0x00**	**0x00**		
	5		**0x01** (Set)			**0 / 1**	
CAN_Cmd_GLVAL	4	**0x06**	**0x00** (Get)	**0x00**	**0x00**		
CAN_Cmd_TEMPR	4	**0x07**	**0x00** (Get)	**0x00**	**0x00**		
CAN_Cmd_CANBD	4	**0x09**	**0x00** (Get)	**0x00**	**0x00**		
	6		**0x01** (Set)			**CAN nominal Baud rate kBit/s**	
						Bit 7..0	Bit 15..8
CanDataBaudrate	4	**0x15**	**0x00** (Get)	**0x00**	**0x00**		
	6		**0x01** (Set)			**CAN data Baud rate kBit/s**	
						Bit 7..0	Bit 15..8
CAN_Cmd_INITC	4	**0x0D**	**0x02** (Exe)	**0x00**	**0x00**		

Please note, that only command header and command dependent data is shown. ISO 15765 header must be added and messages have to be split into several messages, if necessary.

PLEASE NOTE: Changing CAN baud-rate may cause bus errors. CMM should be restarted afterwards.

Command	Length	Command Header				*Command dependent data*
		Command	Action	Error-code	Reserved	
CAN_Cmd_CIDIN	4	**0x0A**	**0x00** (Get)	**0x00**	**0x00**	
	12		**0x01** (Set)			

Byte 0 … 4					Byte 5…8			
CAN ID				**Xtended** = 0 / 1	**CAN Interval [ms]**			
Bit 7…0	Bit 15..8	Bit 23…16	Bit 30…24	Bit 31	0..	..	..	31

Command	Length	Command Header				*Command dependent data*
		Command	Action	Error-code	Reserved	
CAN_Cmd_TPLID	4	**0x0B**	**0x00** (Get)	**0x00**	**0x00**	
	8		**0x01** (Set)			Byte 0 … 4: **CAN ID** | **Xtended** = 0 / 1 — Bit 7…0 | 15..8 | 23…16 | 30…24 | Bit 31
CAN_Cmd_TPRID	4	**0x0C**	**0x00** (Get)	**0x00**	**0x00**	
	8		**0x01** (Set)			Byte 0 … 4: **CAN ID** | **Xtended** = 0 / 1 — Bit 7…0 | 15..8 | 23…16 | 30…24 | Bit 31
SerialNumber	4	**0x0E**	**0x00** (Get)	**0x00**	**0x00**	
CalDate	4	**0x0F**	**0x00** (Get)	**0x00**	**0x00**	
CanTermination	4	**0x10**	**0x00** (Get)	**0x00**	**0x00**	
	5		**0x01** (Set)			0/1
IpSettings	4	**0x11**	**0x00** (Get)	**0x00**	**0x00**	
	16		**0x01** (Set)			

Byte 0…3				Byte 4…7				Byte 8…11			
Ip				**Mask**				**Gateway**			
192	168	200	1	255	255	255	0	192	168	200	10

Command	Length	Command Header				*Command dependent data*
PortSettings	4	**0x12**	**0x00** (Get)	**0x00**	**0x00**	
	10		**0x01** (Set)			

Byte 0…1		Byte 2…3		Byte 4…6	
Port Commads (5025)		**Port Echo (55111)**		**Port Streaming (55112)**	
Bit 7…0	Bit 15…8	Bit 7…0	Bit 15…8	Bit 7…0	Bit 15…8

MacSettings	4	**0x13**	**0x00** (Get)	**0x00**	**0x00**	
HwVersion	4	**0x14**	**0x00** (Get)	**0x00**	**0x00**	
TxFrameFormat	4	**0x16**	**0x00** (Get)	**0x00**	**0x00**	
	5		**0x01** (Set)			0 … 2 — 0: Classic CAN 1: CAN FD without BRS 2: CAN FD with BRS
UserText	4	**0x20**	**0x00** (Get)	**0x00**	**0x00**	
	68		**0x01** (Set)			Byte 0 … 63 **UserText string**
TCP-ISOTP-Bridge	????	**0x30**	**0x00** (Get)	**0x00**	**0x00**	
						Byte 0 … ???? **TCP command (from PC)**

3.6.4 Response overview:

Every command is acknowledged by a response.

Most commands are executed first and a response is sent after execution. Exceptions from this rule are as follows:

- RESET:
  - The response is sent immediately.
  - Reset is performed afterwards.
  - Reboot of CMM IV may take up to 10 seconds
- TPLID, TPRID:
  - The response is sent with the previous CAN ID.
  - Respective CAN ID for ISO-TP is changed after the response has been sent.
- CANBD:
  - Baud rate is changed after response has been sent.

- Please note that bus errors may occur after baud rate has been changed. CMM should be restarted afterwards.

3.6.4.1 Negative Responses

Negative responses are returned when a failure has occurred. I.e. the command was invalid and has been rejected.

Response To Command	Length	Response Header			
		Command	Action	Error-code	Reserved
Any	4	**0xXX**	**0x03 (Ret)**	**0xYY** (see chapter 3.6.2.3)	**0x00**

3.6.4.2 Positive Responses

Positive responses to the respective commands are as follows. Please note that only command header and command dependent data is shown. ISO-TP header must be added and messages have to be split into several messages, if necessary.

Response to Command	Length	Response Header				*Command dependent data*
		Command	Action	Error-code	Reserved	
CAN_Cmd_NOOPR	4	**0x00**	**0x03** (Ret)	**0x00**	**0x00**	
CAN_Cmd_RESET	4	**0x01**	**0x03** (Ret)	**0x00**	**0x00**	
CAN_Cmd_SWVER	18	**0x02**	**0x03** (Ret)	**0x00**	**0x00**	*SW Version ASCII string (14 Bytes)*
CAN_Cmd_DEFLT	4	**0x03**	**0x03** (Ret)	**0x00**	**0x00**	
CAN_Cmd_ONMOD	5	**0x04**	**0x03** (Ret)	**0x00**	**0x00**	**OnMode** = 0…7
CAN_Cmd_CMMON	5	**0x05**	**0x03** (Ret)	**0x00**	**0x00**	0 / 1
CAN_Cmd_TEMPR	4	**0x07**	**0x03** (Ret)	**0x00**	**0x00**	**Temperature [°C]** Bit 0…7 | 8…15
CAN_Cmd_CANBD	6	**0x09**	**0x03** (Ret)	**0x00**	**0x00**	**CAN nominal Baud rate kBit/s** Bit 7…0 | 15..8
CanDataBaudrate	6	**0x15**	**0x03** (Ret)	**0x00**	**0x00**	**CAN-FD data Baud rate kBit/s** Bit 7…0 | 15..8
CAN_Cmd_INITC	4	**0x0D**	**0x03** (Ret)	**0x00**	**0x00**	

Response to Command	Length	Response Header				*Command dependent data*
		Command	Action	Error-code	Reserved	
CAN_Cmd_GLVAL	23	**0x06**	**0x03** (Ret)	**0x00**	**0x00**	

Byte 0	Byte 1	Byte 2	Byte 3…6				Byte 7…10				Byte 11…14				15…18			
CMMON	**Negative**	**Range**	**Average** [100nA steps]				**Min** [100nA steps]				**Max** [100nA steps]				**Nr Samples**			
			Bit 7…0	15..8	23…16	31…24	0..	..	..	31	0..	..	..	31	0..	..	..	31
0/1	0/1	0…6																

Command	Length	Command Header				*Command dependent data*
		Command	Action	Error-code	Reserved	
CAN_Cmd_CIDIN	12	**0x0A**	**0x03** (Ret)	**0x00**	**0x00**	

Byte 0 … 4					Byte 5…8			
CAN ID				**Xtended** = 0 / 1	**CAN Interval [ms]**			
Bit 7…0	Bit 15..8	Bit 23…16	Bit 30…24	Bit 31	0..	..	..	31

Response to Command	Length	Response Header				*Command dependent data*
		Command	Action	Error-code	Reserved	
CAN_Cmd_TPLID	8	**0x0B**	**0x03** (Ret)	**0x00**	**0x00**	Byte 0 … 4
CAN_Cmd_TPRID	8	**0x0C**	**0x03** (Ret)	**0x00**	**0x00**	Byte 0 … 4
SerialNumber	20	**0x0E**	**0x03** (Ret)	**0x00**	**0x00**	

CAN ID				**Xtended** = 0 / 1
Bit 7…0	15..8	23…16	30…24	Bit 31

Byte 0…15															
Serial Number as ASCII String (padded with space characters)															
2	0	E	T	0	0	1	2	3							

CalDate	8	**0x0F**	**0x03** (Ret)	**0x00**	**0x00**	Byte 0 … 3			
						Year (uint16)		**Month (uint8)**	**Day (uint8)**
						Bit 7…0	15..8	Bit 7…0	Bit 7…0
CanTermination	5	**0x10**	**0x03** (Ret)	**0x00**	**0x00**	0 / 1			
IpSettings	17	**0x11**	**0x03** (Ret)	**0x00**	**0x00**				

Byte 0…3				Byte 4…7				Byte 8…11				Byte 12
Ip				**Mask**				**Gateway**				**Default**
192	168	200	1	255	255	255	0	192	168	200	10	0/0xDF

PortSettings	17	**0x12**	**0x03** (Ret)	**0x00**	**0x00**	

Byte 0…1		Byte 2…3		Byte 4…6	
Port Commads (5025)		**Port Echo (55111)**		**Port Streaming (55112)**	
Bit 7…0	Bit 15…8	Bit 7…0	Bit 15…8	Bit 7…0	Bit 15…8

MacSettings	10	**0x13**	**0x03** (Ret)	**0x00**	**0x00**	Byte 0 … 5 **MAC-Address** Octet 1 | Octet 2 | Octet 3 | Octet 4 | Octet 5 | Octet 6 0x74 | 0x5B | 0xC5 | 0x00 | 0x00 | 0x01
HwVersion	9	**0x14**	**0x03** (Ret)	**0x00**	**0x00**	Byte 0 … 4 **Hw-Version** | **Silicon Revision of Microcontroller** Bit 7…0 | Bit 7…0 | 15..8 | 23…16 | 31…24
TxFrameFormat	5	**0x16**	**0x03** (Ret)	**0x00**	**0x00**	Byte 0 0 … 2 0: Classic CAN 1: CAN FD without BRS 2: CAN FD with BRS
UserText	68	**0x20**	**0x03** (Ret)	**0x00**	**0x00**	Byte_0 … 63 **UserText string**
TCP-ISOTP-Bridge	????	**0x30**	**0x03** (Ret)	**0x00**	**0x00**	Byte_0 … ???? **TCP response (from CMM IV)**

3.6.5 Example CAN traces

The following CAN traces should help understand the tables above. The command and responses are marked in the respective colors: Command / Response. Please note, that flow control frames are integrated in the respective command or response, but they are sent by the respective counterpart.

CMMON: switch ON

2014.12.11 - 13:52:21.724	0x1C3	0x05 0x05 0x01 0x00 0x00 0x01 0x00 0x00
2014.12.11 - 13:52:21.724	0x7FF	0x04 0x05 0x03 0x00 0x00 0x00 0x00 0x00

CMMON: switch OFF

2014.12.11 - 13:52:29.924	0x1C3	0x05 0x05 0x01 0x00 0x00 0x00 0x00 0x00
2014.12.11 - 13:52:29.924	0x7FF	0x04 0x05 0x03 0x00 0x00 0x00 0x00 0x00

SWVER (Read SW Version)

2014.12.11 - 13:53:59.118	0x1C3	0x05 0x02 0x00 0x00 0x00 0x00 0x00 0x00
2014.12.11 - 13:53:59.118	0x7FF	0x10 0x12 0x02 0x03 0x00 0x00 0x43 0x4D
2014.12.11 - 13:53:59.122	0x1C3	0x30 0x00 0x00 0x00 0x00 0x00 0x00 0x00
2014.12.11 - 13:53:59.122	0x7FF	0x21 0x4D 0x5F 0x49 0x49 0x49 0x5F 0x56
2014.12.11 - 13:53:59.122	0x7FF	0x22 0x5F 0x31 0x5F 0x32 0x00 0x00 0x00

SINTV (set serial interval)

2014.12.11 - 13:56:46.436	0x1C3	0x10 0x08 0x08 0x01 0x00 0x00 0x80 0x00
2014.12.11 - 13:56:46.437	0x7FF	0x30 0x00 0x01 0x00 0x00 0x00 0x00 0x00
2014.12.11 - 13:56:46.440	0x1C3	0x21 0x00 0x00 0x00 0x00 0x00 0x00 0x00
2014.12.11 - 13:56:46.442	0x7FF	0x04 0x08 0x03 0x00 0x00 0x00 0x00 0x00

4 Calibration Recommendation

IRS recommends a recalibration within 2 years.

The calibration should be performed at multiple calibration points for all 7 ranges. IRS recommends measuring at least the following currents.

Range	Calibration points				
100 uA	20 uA	40 uA	60 uA	80 uA	100 uA
1 mA	0.2 mA	0.4 mA	0.6 mA	0.8 mA	1 mA
10 mA	2 mA	4 mA	6 mA	8 mA	10 mA
100 mA	20 mA	40 mA	60 mA	80 mA	100 mA
1 A	0.2 A	0.4 A	0.6 A	0.8 A	1 A
10 A	2 A	4 A	6 A	8 A	10 A
100 A	20 A	40 A	60 A	80 A	100 A

CMM values should be captured with the function (IRS.CmmIV.Lib.CmmCommands).ReadMinimumAverageMaximum. This function returns the value averaged since last read.

Before capturing a valid value, enable the calibration current, perform a dummy read and wait 100 ms.

The fluctuations of the power source used should not exceed 0.1% of the nominal value.