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ISX-3 / ISX-3mini

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Table of Contents

1 Which products are covered by this manual

This manual is valid for:

- single channel impedance analyzer ISX-3
- miniature impedance analyzer ISX-3mini
- single channel impedance measurement module for ISX-5 and MSX-8 platform (refer to ISX-5 or MSX-8 platform manuals for technical details and use of this module within these systems)

2 General


Please pay attention to the comment.


Please pay attention to the note/warning.


Please pay attention to the warning.

2.1 Warranty

This product is warranted against defects in material and workmanship for a period of one year. During the warranty period any parts or services that show defects with a cause that was present before the transfer of risk shall – at the option of Sciospec – be replaced, reworked or re-performed free of charge (rectification).

For warranty service or repair, this product must be returned to a service facility designated by Sciospec. The buyer shall pay all shipping charges, duties, and taxes for products returned to Sciospec from another country.

Sciospec warrants that its software and firmware designated by Sciospec for use with an instrument will execute its programming instruction when properly installed on that instrument. Sciospec does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

Further details on the warranty and transfer of risk are described in the general terms and conditions of Sciospec. No other warranty is expressed or implied. Sciospec specifically disclaims the implied warranties of merchantability and fitness for a particular purpose. Further and/or divergent regulations require contractual agreements in written form.

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by the buyer, operation or service through unauthorized personnel, the buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside the environmental specifications for the product, or improper site preparation or maintenance.

2.2 Intended (normal/contractual) use

The product is intended for indoor use in qualified technical environments and laboratories with all necessary safety measures for electric installations and cabling in place. In order to fulfill the requirements towards electrical safety and electromagnetic compatibility the system is to be installed in a safe environment with electrical connections (especially power supply) according to general safety regulations. In addition to general safety regulations all safety measures and precautions noted in this document are to be followed.

For outdoor use separate precautions and safety measures are required. Specifically it might be required to mount the system into a protective housing according to the ambient/environmental conditions.

2.3 Non-intended use

Any form of use deviating from the intended use qualifies as non-intended use/misuse/maloperation. Other applications, modes of operations, modifications or types of installations can impair safety and functionality and are thus for safety reasons not permitted for the user or third parties.

2.4 Authorized personnel

In general different levels of qualification of operating and maintenance personnel have to be distinguished.

Danger through insufficient qualification of operating/service personnel.

The instrument may only be operated, functionally tested and serviced by sufficiently qualified personnel. Work reserved for professional technical personnel may only be done by staff authorized through Sciospec.

2.4.1 Users

Users are all personnel older than 18 years that have been instructed in the operation of the instrument by Sciospec or an authorized representative. They have to have read and understood this manual completely.

User may be tasked with the following:

- General operation of the system through externally accessible interfaces
- Operation of external controls on the instrument
- functional tests through externally accessible interfaces
- to some extent elimination of malfunctions or initiation of measures to eliminate malfunctions through externally accessible interfaces

2.4.2 Professional technical personnel

Professional technical personnel are all persons who in accordance to their professional education, professional experience and contemporary professional occupation

- posses respective knowledge of electrical impedance analyzers
- have been trained, authorized and instructed by Sciospec for maintenance, installation and service tasks on/for the instrument

Further the professional technical personnel have to be qualified for those tasks through their professional education, experience and technical knowledge on electrical impedance analyzers.

In addition to the authorization of users professional technical personnel may be tasked with

- Elimination of malfunctions exceeding the measures permissible for a user
- installations
- maintenance and service work as instructed by Sciospec

2.4.3 Unauthorized personnel

Through operation and service procedures executed by unauthorized personnel substantial danger up to danger to life may arise.

Defects and damage caused by measures performed by unauthorized personnel are not covered by warranty and Sciospec will not be made liable for these.

2.5 Danger and risks

Even with proper professional installation and proper condition of the instrument not all dangers can be covered. Following some of the remaining risks are described.

2.5.1 Electrical currents

Danger to life through electrical currents

- operation and maintenance only to be done by trained personnel
- no access to the instrument for other than authorized personnel
- never bypass fuses or protective parts
- maintenance and installation only in volt-free state
- keep moisture and excessive heat away from the instrument

2.5.2 Risk for danger to personnel

Increased risk for danger to the user exists

- when minors, elderly or disabled persons are allowed to operate the instrument
- when proper instruction, training and monitoring of the user is not possible
- when no authorized personnel exist
- when the number of users to the instrument are very high
- when modifications to the instrument or its installation are done

Modifications, extensions/additions to the instrument are not permissible without prior authorization through Sciospec. Any unauthorized technical or procedural modification voids the permission for operation and the warranty.

2.6 Safety information and precautions

When you notice any of the unusual conditions listed below, immediately terminate operation and disconnect the power cable. Contact Sciospec Scientific Instruments for repair of the instrument. If you continue to operate without repairing the instrument, there is a potential fire or shock hazard for the operator.

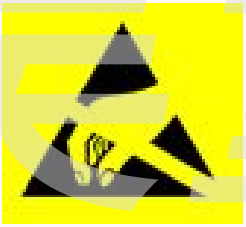
- Instrument operates abnormally.
- Instrument emits abnormal noise, smell, smoke or a spark-like light during the operation.
- Instrument generates high temperature or electrical shock during operation.
- Power cable, plug, or receptacle on instrument is damaged.
- Foreign substance or liquid has fallen into the instrument.

The following measures help assuring safe instrument operation and are to be followed in order to comply with intended use specifications.

⚠ Technical expertise is required. Risk of damage to the instrument exists through unintended use and wrong cabling/installation.

- Do not operate the instrument in the presence of inflammable gasses or fumes. Operation of any electrical instrument in such an environment clearly constitutes a safety hazard.

Electro static discharge warning



This product, like all electronic products, uses semiconductors that can be damaged by electrostatic discharge (ESD). Use care when handling the devices to prevent damage. Damage due to inappropriate handling is not covered by the warranty.

ESD damage is most likely to occur as the test fixtures are being connected or disconnected. Protect them from ESD damage by wearing a grounding strap that provides a high resistance path to ground. Alternatively, ground yourself to discharge any static charge built-up by touching the outer shell of any grounded instrument chassis before touching the test port connectors.

Do not exceed the operating input power, voltage, and current level and signal type appropriate for the instrument being used, refer to technical specifications sections in this manual.

2.7 Replacement parts and equipment

Obtain replacement parts only through Sciospec, authorized customer support services or authorized distributors.

Danger of injury through use of wrong or faulty replacement parts!

The use of wrong, faulty or unauthorized/unintended replacement parts can lead to danger of injury to the operating/service personnel, malfunction or complete failure of the instrument.

Use of unauthorized replacement parts voids the instruments warranty.

3 Technical Specifications

3.1 General overview

- single channel impedance measurement module
- multiplexed second channel (optional)
- impedance measurement capability
    - 10mHz...10MHz
    - mOhm...GOhm
    - connection for 4, 3 or 2 electrode configurations (software configurable)
    - one high resolution signal generator with selectable current or voltage excitation mode
- high resolution DC bias/offset generation (± 4.5 V, 19.5 bit)
- ExtensionPort for application specific frontends including highly flexible digital IO functions through the Sciospec ***InterfacePort*** standard
- high isolation, ultra-low parasitic reed relay switches for channel connect/disconnect with superior performance compared to semiconductor switches
    - >10 TΩ || 0.4 pF isolation at power off or software selected cell disconnect
    - extremely low parasitic capacitance < 0.7 pF offers close to no cell loading
    - max. series resistance 200 mΩ in connected state
    - zero leakage current in on state
    - zero charge injection, no distortion, no noise contributions beyond thermal noise
- additional peripherals (optional)
    - IOport (digital IOs with highly flexible digital IO functions through the Sciospec ***InterfacePort*** standard) + 2 NTC temperature measurement ports
    - Ultra-fast hardware synchronization through sync in/out ports (e.g. through low level isolated interface or optional isolated sync module)
    - 3 analog voltage measurement ports 0...12V
    - 1 additional NTC temperature sensor port
    - 3 low side switches (e.g. for fan or external switch control)
- interfaces:
    - isolated USB 2.0 (FS, 12 Mbits/s) with ESD protection (±12kV IEC 61000-4-2 contact ESD, clamp voltage 13V (min), break-down voltage 5.5V (min))
    - 10/100 Base-T Ethernet

All specifications are stated for a operating at temperatures of 0°C to 40°C unless specified otherwise.
Warm-up time must be greater than or equal to 30 minutes after power on to comply with all specifications.

Maximum Ratings

Stresses above the listed absolute maximum or maximum ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

3.2 Measurement specifications

All ports (C, R, WS, W) of channels 1 and 2 are available through BNC coaxial connectors.

measurement port protection

Be aware that the measurement terminals (Counter, Reference, Working Sense and Work Electrode Terminals, including the measurement terminals of the *ExtensionPort*) are very sensitive to electrostatic discharge, over-current and over-voltage. Protection of the terminals of the instrument and strict adherence to the specified maximum ratings has to be ensured by the user. For further information on how to connect specific device under test to the instrument contact Sciospec or an authorized representative directly.

3.2.1 Set point & excitation signal generator (C port)

- software selectable current or voltage source for excitation signal generation
- low distortion single sine signal and superimposed high resolution DC offset

- compliance voltage ±4.9 V (@ 10kΩ load)
- compliance current
  - 200% of selected current range
  - abs. max. ±50mA (continuous)
  - short circuit current max. 65 mA
- Voltage Excitation Mode:

- Abs. max. applied potential range ± 5 V
- DC potential set-point resolution 0.0001% of applied voltage range (~19.5bit @2ms settling time)
- DC potential set-point accuracy ≤ 0.1% || ±100 µV
- maximum uncalibrated DC offset error: ±40 mV

- Current excitation mode
  - Abs max. applied current range ± 50 mA
  - DC current set-point resolution 0.0001% of applied voltage range (~19.5bit @2ms settling time)
  - DC current set-point accuracy ≤ 0.1% || ±1 µA
  - maximum uncalibrated DC offset error: ±40 µA

- AC Excitation Signal Range
  - 1 mV … 1 V (peak amplitude), resolution 0.1 mV in voltage excitation mode
  - 10 µA … 10 mA (peak amplitude) in current excitation mode
  - EIS Excitation Amplitude Error (uncalibrated): ±1% typ. (±8% max.)
  - Excitation Signal Resolution 0.1% of range
  - Frequency Range 10mHz to 10MHz
  - Frequency Resolution
    - <10mHz @ f<10kHz
    - <25mHz @ 10kHz ≤ f < 100kHz
    - <150mHz @ f ≥ 100kHz
  - Frequency Precision
    - ±100ppm (@25°C)
    - additional ±10ppm over temperature range
    - additional ±5ppm during first year
- Number of Frequency Points per Sweep: 1 to 2048

3.2.2 potential measurement (R & WS ports)

- potential measurement ranges
  - ± 1 V
  - AC voltage measurement range equals selected potential measurement range
  - measured potential resolution < 0.008% of potential range
  - measured potential accuracy:
    - max uncalibrated gain error 1%
    - max uncalibrated offset error 2% of potential measurement range
  - electrometer amplifier input
    - input impedance ≈ 1 TΩ, 2.3 pF
    - ±1.5 pA input bias current typ. (50 pA max.)

3.2.3 Current measurement (W port)

- 4 current measurement ranges
  - ± 10 mA (100 Ohm range)
  - ± 100 µA (10 kOhm range)
  - ± 1 µA (1 MOhm range)
  - ± 10 nA (100 MOhm range)
- AC current measurement range equals selected current range

- measured current resolution < 0.008% of current range
- max uncalibrated gain error
  - 0.1% for ±10 mA range
  - 0.1% for ±100 µA range
  - 1% for ±1 µA range
  - 5% for ± 10 nA range
- max uncalibrated offset error 2% of current measurement range ± input bias current
- current amplifier input bias current ±10 pA typ. (max. ±1nA)

3.2.4 timing

- max. acquisition rate < 10000 points/s (> 100 µs per frequency)
- DC set point interval > 150 µs (“ramp time resolution”)

3.2.5 impedance spectroscopy

- Impedance Measurement Range: mΩ…GΩ
- Impedance Accuracy (for details refer to respective section)
  - |Z|/Z: 0.1%
  - |Phi|: 0.1°

3.3 Master interfaces

3.3.1 isolated Full Speed USB Interface

standard conformity	USB 2.0, FS (12 Mbits/s)
connector	Mini USB Type B
Protocol	High Speed USB 2.0
ESD Protection	Class 3A contact ESD performance per ANSI/ESD STM5.1-2007
isolation	2500 V rms for 1 minute per UL 1577 IEC 60950-1: 600 V rms (basic) DIN V VDE V 0884-10 (VDE V 0884-10):2006-12 VIORM = 560 V peak

3.3.2 Ethernet

standard conformity	10/100 Base-T, RJ45
protocol	TCP/IP

3.4 Sciospec ExtensionPort

connector type	Samtec FCS8 20 Pin
signal level standard	LVCMOS 3V
maximum input voltage[1]	3.6V
minimum input voltage	-0.3V
high level input voltage	≥1.7V
low level input voltage	0.8V
high level output voltage	≥2.8V
maximum output current	12mA
ESD protection of IOs	±12kV IEC 61000-4-2 contact ESD ±15kV IEC 61000-4-2 air-gap ESD clamp voltage 10.5V (min) break-down voltage 7V (min)
Digital IOs	8 software defined function digital input/output pins (IO1...8) with flexible configuration options through the Sciospec ***InterfacePort*** Standard (e.g. digital Inputs, digital Outputs, SPI Master, UART, I^2C)
measurement terminals	four (counter *C*, reference *R*, work *W*, working sense *WS*)
power terminals	+5V maximum current 500mA +5V maximum current 500mA
connector Layout	
pin assignment	C, R, WS, W: measurement terminals of the impedance analyzer module +5V, -5V: supply voltage terminals for use at external module IO1...IO8: digital input/output pins shielding is connected to board GND

PIN	1	2	3	4	5	6	7	8	9	10
function	W	+5V	+5V	+5V	+5V	WS	IO1	IO2	IO3	IO4
PIN	11	12	13	14	15	16	17	18	19	20
function	IO5	IO6	IO7	IO8	R	-5V	-5V	-5V	-5V	C

[1] Inputs are internally biased to 3V by a 1MOhm pull up resistor

3.5 Relation between the precision setting and the measurement time and measurement accuracy

The precision settings enables the user to adjust the trade off between measurement stability and measurement speed. For more information see chapter Functional Description.

The figure "*Accuracy over Precision Parameter*" shows the influence of the precision settings on the accuracy and time for the measurement of an impedance value at the specified frequency.

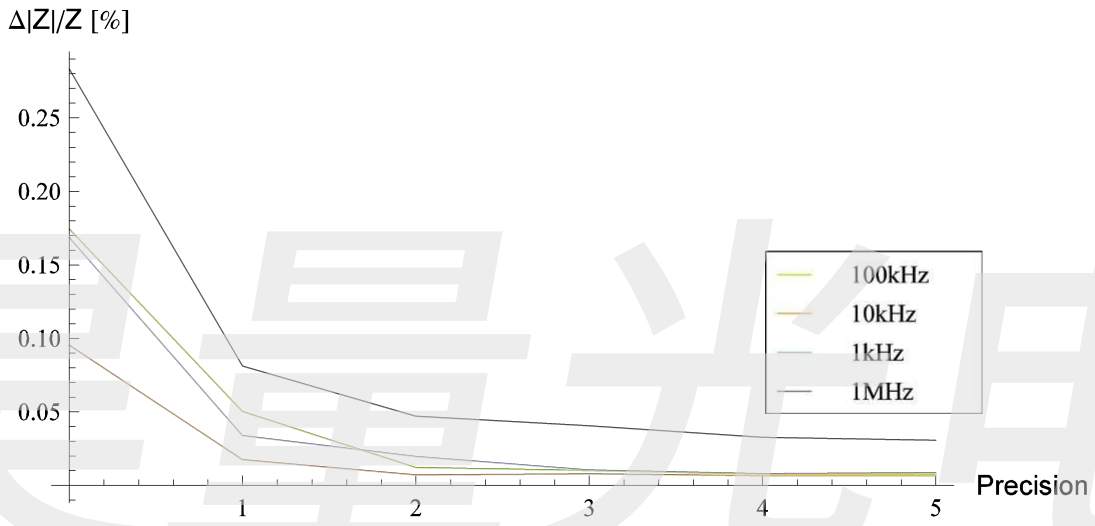


Fig: Accuracy over Precision Parameter

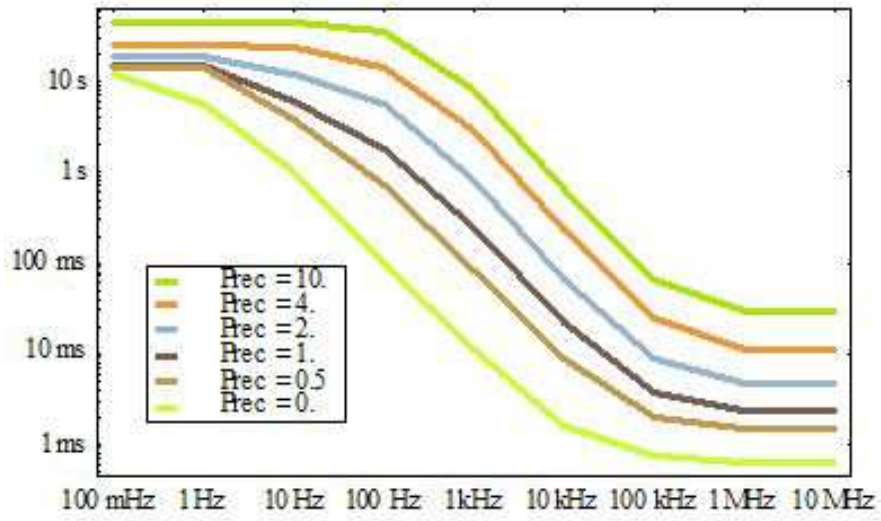


Fig: Measurement Time over Precision Parameter

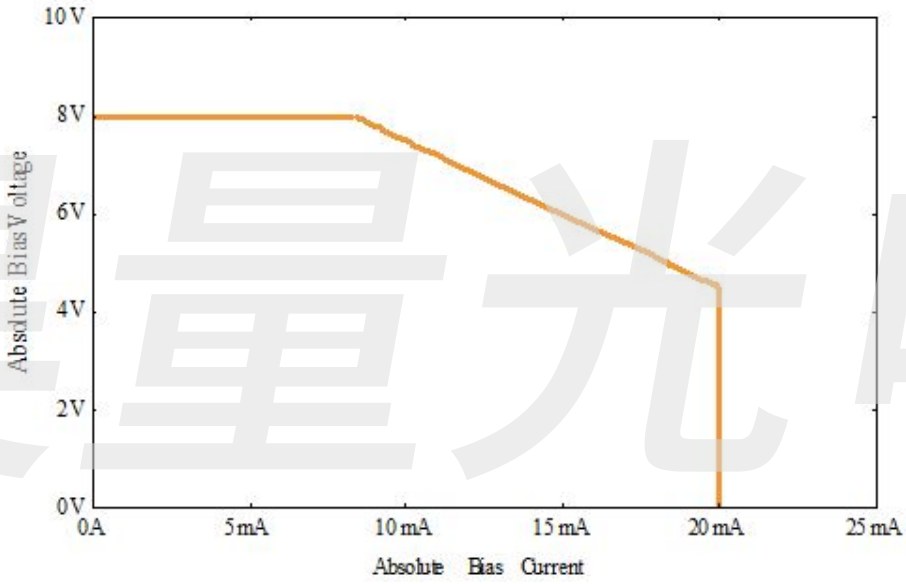
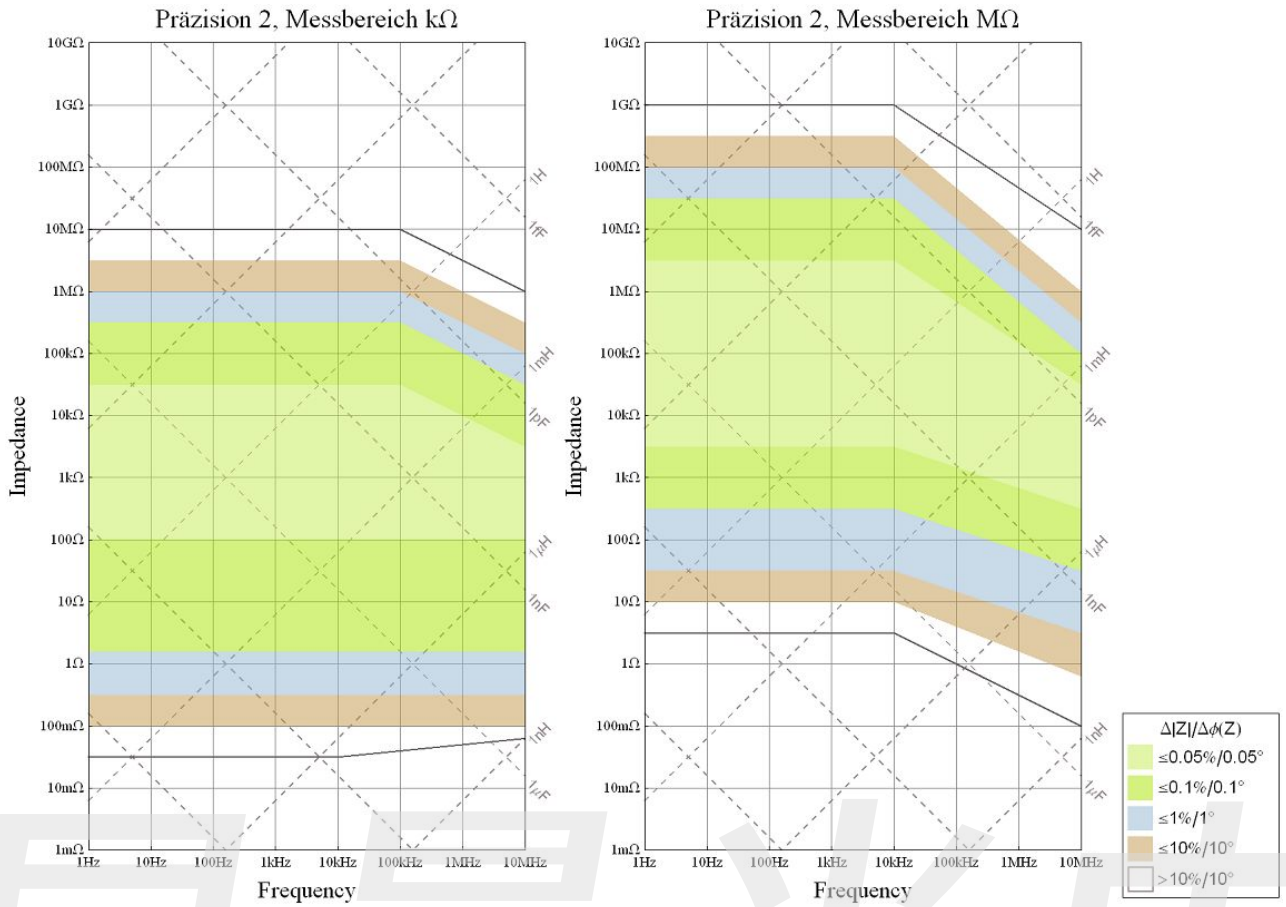
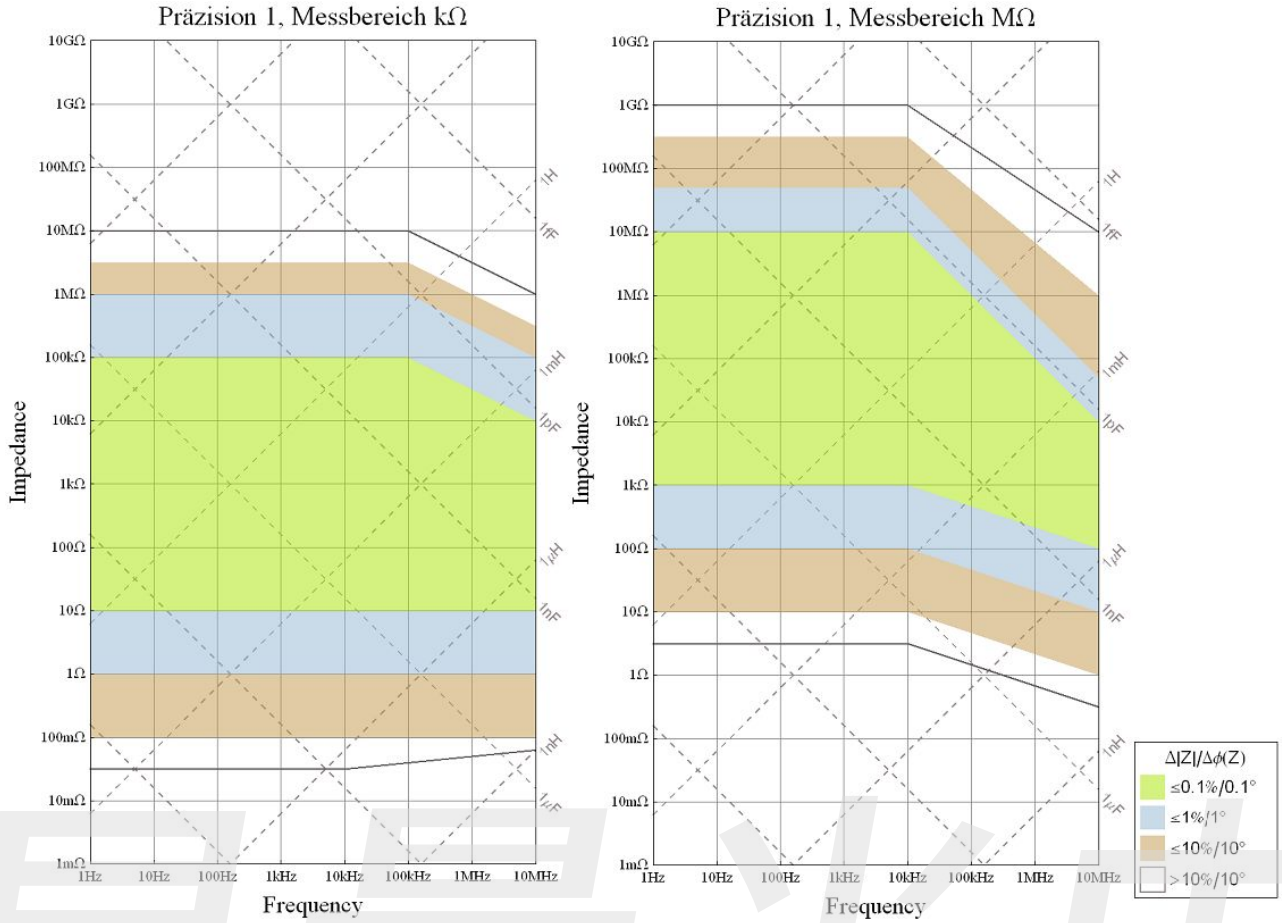


Fig: DC Bias Range

3.6 Overview of the different range and precision settings





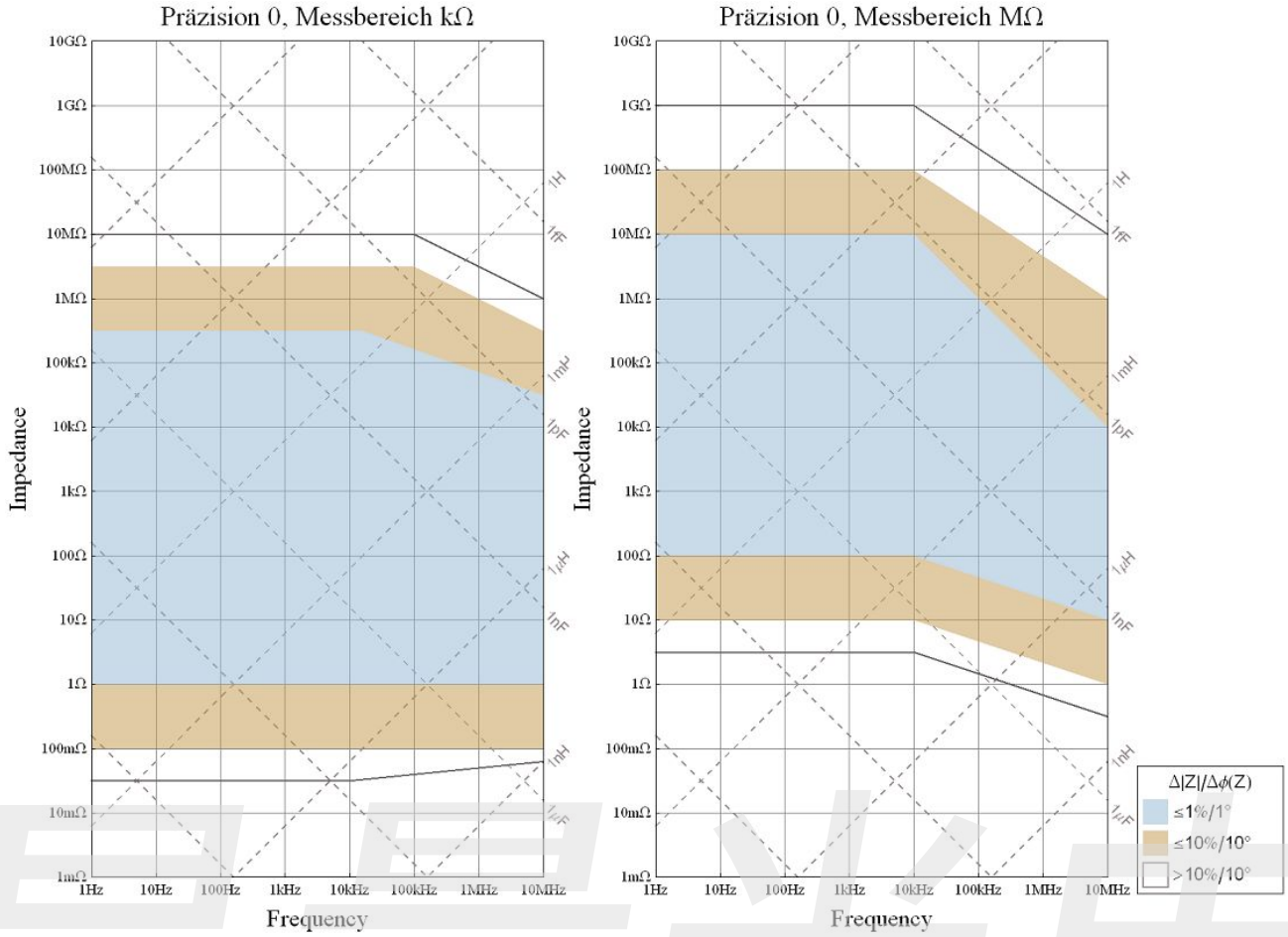
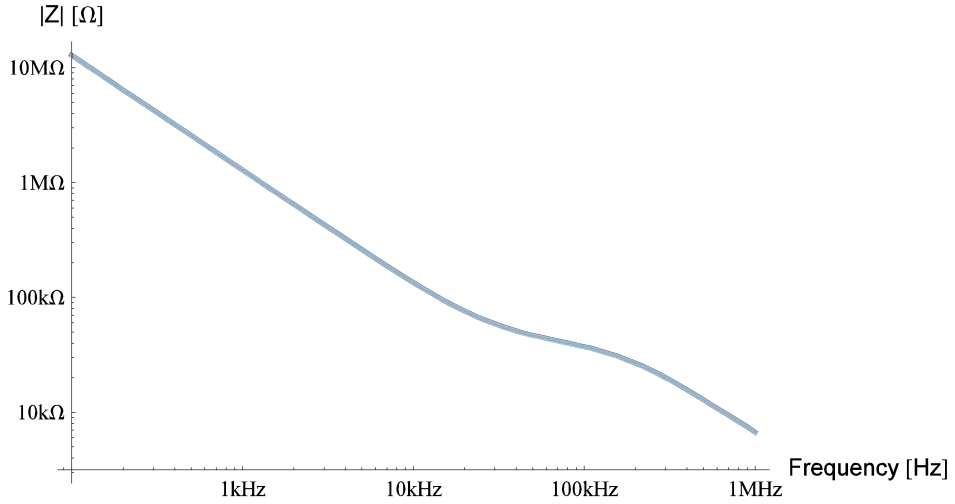


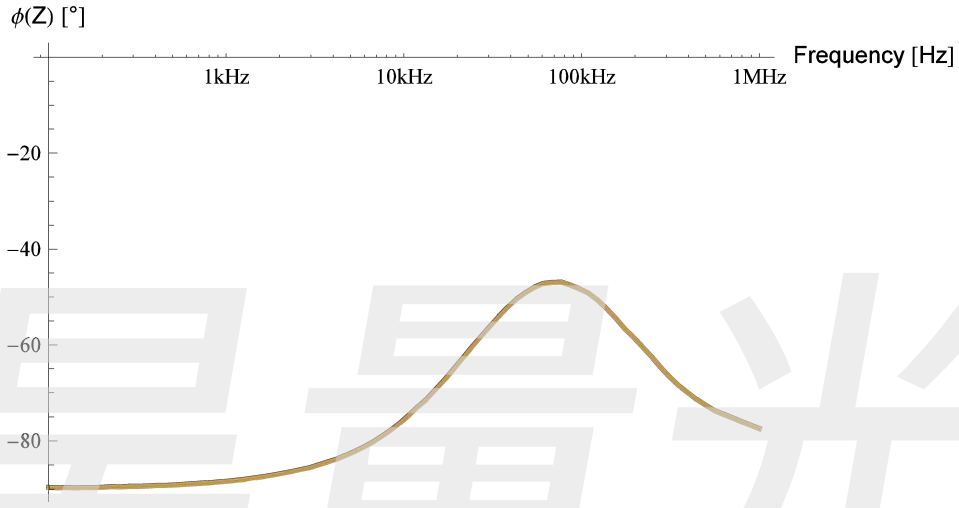
Fig: Precision-Range Plot

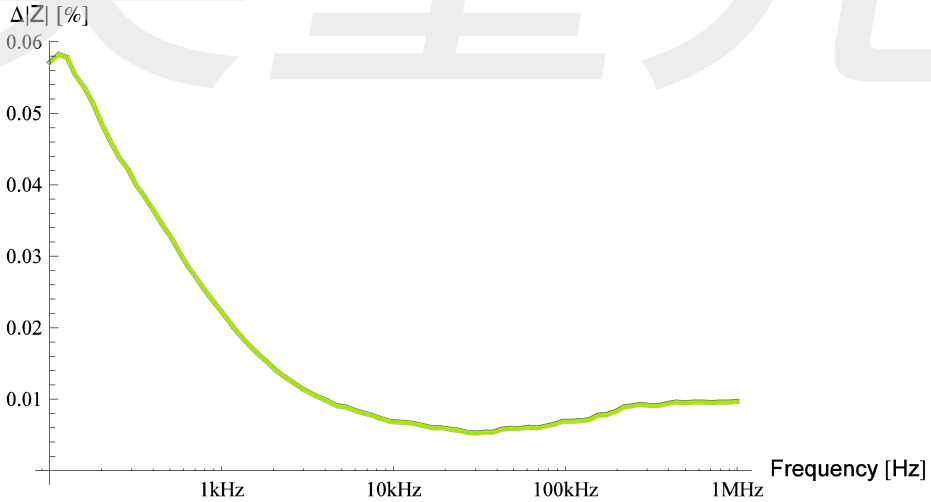
Note: The accuracy contour plot was determined under lab conditions and should be used for reference purposes. Please note that the true limits of an impedance measurement are influenced by all components in the system, like cables, cell, and the instrument.

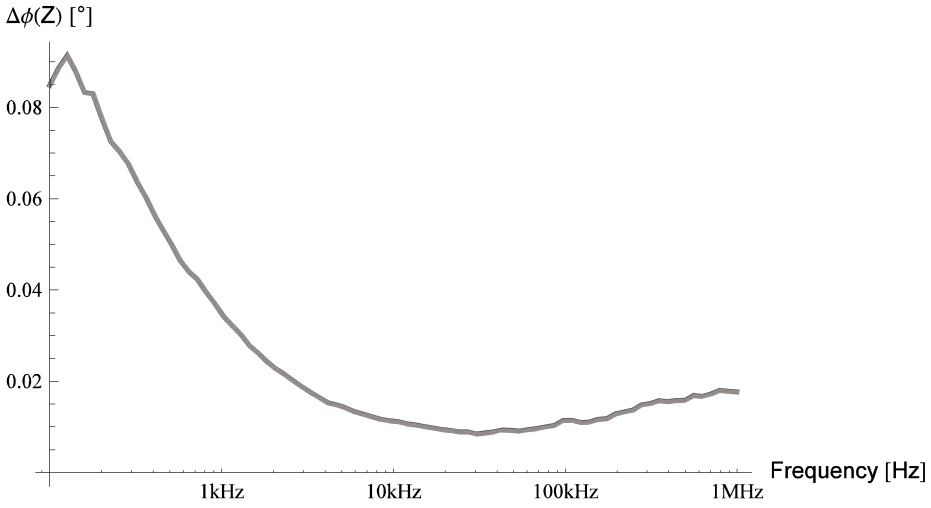
3.7 Example Measurement

Frequency sweep: 100Hz - 1MHz, 80 logarithmic Frequency steps, precision 1, amplitude 100mV, measurement range MΩ
Measurement instrument: Sciospec ISX-3v2 with connected Sciospec MEArack
DUT: multi electrode array, 40µm electrodes, 200µm apart, platinum PBS buffer solution









3.8 General Specifications ISX-3v2

power requirements	100-240V AC (typ.), 50/60Hz, 60W (max)
Input fuse	Miniature Fuse, 5 x 20 mm, 1A, 250V, Fast Blow
Timing accuracy	1% accuracy over the full temperature range
dimensions	248.67mm x 97.1mmx 193.2mm (width x height x depth) see *Fig: ISX-3v2 front/side view*
weight	2.5kg (typical)
operating conditions	0°C to 40°C, <80% relative humidity non condensing, 0...3000m altitude
non-operating conditions	-25°C to 80°C, <80% relative humidity non condensing The temperature gradient should not exceed 1K/min to reach operating conditions.

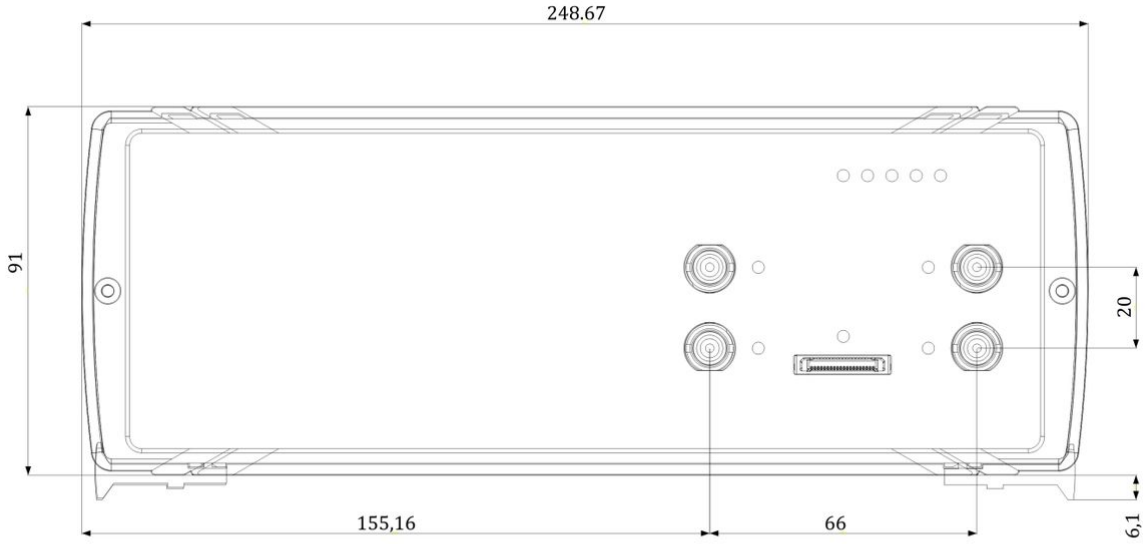


Fig: ISX-3v2 front/side view

3.9 General Specifications ISX-3mini

power requirements	12VDC (typ.), 15W (max), Connector DC Jack (Type: Switchcraft PN: 712A)
Timing accuracy	1% accuracy over the full temperature range
dimensions	184.0mm x 54.8mmx 113.1mm (width x height x depth) see *Fig: ISX-3mini front/side view*
weight	1.0kg (typical)
operating conditions	0°C to 40°C, <80% relative humidity non condensing, 0...3000m altitude
non-operating conditions	-25°C to 80°C, <80% relative humidity non condensing The temperature gradient should not exceed 1K/min to reach operating conditions.

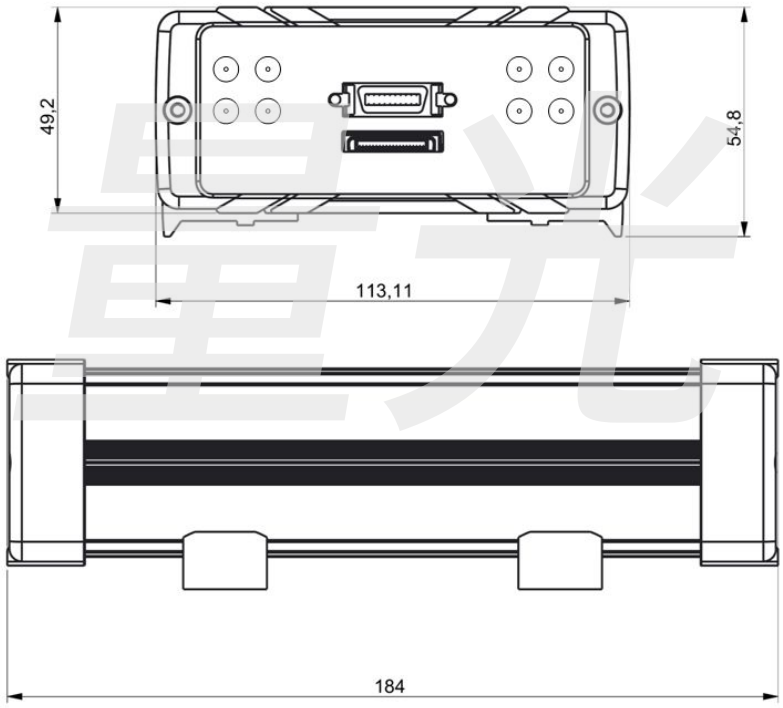


Fig: ISX-3mini front/side view

4 Functional Description

4.1 Master Interfaces

4.1.1 Full Speed USB

The device creates a virtual COM port named "serial USB device", which can be used like a serial port.

Any COM port obtains a unique number by the operating system. (i.e. "COM6") Which number is assigned to a certain port is decided by the operating system and can not be altered.

The port can be used either to connect the Sciospec Software or any terminal program to the device. There is no need to configure the general settings for the serial port (e.g. baud rate, stop bit count, etc.). Any setting of your terminal program will work.

To connect the Sciospec Software to the virtual COM port, choose "serial" in the connection dialog and then choose the desired port.

Driver installation

For Microsoft Windows 8 or more recent versions, there is no need to install any driver to connect to the device. After establishing a USB connection between the device and a PC, the new serial COM port will be available.

For Microsoft Windows 7 or XP, the driver named "Sciospec FS USB driver" provided in the Sciospec Software package, has to be installed before connecting the device to the PC. If you encounter a compatibility or verification warning during installation, choose to continue and install the driver anyway. When the installation has finished, you can connect the device to your PC. The new serial COM port will then be available.

Finding the correct COM port

If more than one COM is active on the PC, you have to determine which one belongs to the Sciospec device. An overview of known COM ports is given by the Windows device manager (Shortcut for Windows 8 or more recent: 'WIN + X') under "Ports (COM & LPT1)". Plugging in the USB cable while observing the port list shows which number is assigned to it.

Example: C-Code for establishing a connection

```
Handle hSerial = CreateFile(  "\\\\.\\COM6",
                              GENERIC_READ|GENERIC_WRITE,
                              0,
                              NULL,
                              OPEN_EXISTING,
                              FILE_ATTRIBUTE_NORMAL,
                              NULL );
          if (hSerial == INVALID_HANDLE_VALUE)
          {
                  fprintf(stderr, "Error\n");
                  return 0;
          }
            return 1;
```

4.1.2 Ethernet

The Sciospec device is delivered with a ready to use ethernet configuration. Since DHCP is enabled by default, the device will obtain an IP address if you connect it to your ethernet router and can instantly be operated via this interface.

The device uses a bidirectional socket communication in which it implements the socket server and the connected PC the socket client. It supports DHCP to receive an IP address from a DHCP server. This is the default setting but can be deactivated using the or the “set Ethernet configuration” command. When DHCP is deactivated a static IP address must be set by the user.

port	5000

Example: Establishing a connection using the COMinterface

1. Connect the device Ethernet network and via USB to your computer.
2. Open terminal program and connect to the USB port of the device. (see "Setting up a connection to the device via USB")
3. Send the "get IP address" command **[BE] [01] [01] [BE]**.
4. The device will return the IP address, which it received from the DHCP server. (See command description for return syntax or disabling DHCP.)
5. Disconnect the terminal programm.
6. Use the obtained IP address and the port to establish a socket connection from your software to the device.
7. From now on the device can be controlled by regular COMinterface commands.

Example: C-Code for establishing a connection

```
    int sock;

/**This block is needed only if using WinSocket (Windows) to initialize the socket*/
    printf("\nInitialising Winsock...\n\n");
    WSADATA wsa;
    if (WSAStartup(MAKEWORD(2,2),&wsa) != 0){
        printf("Failed. Error Code : %d",WSAGetLastError());
        return 1;
    }
/** End of WinSocket initializing*/


    if( (sock = socket(AF_INET, SOCK_STREAM , 0)) == INVALID_SOCKET ){
         printf("Could not create socket");
         return -1;
    }

    /*Initialize address of device
     * IP address needs to be adapted, depending on local network and Ethernet
settings of the device*/
    struct sockaddr_in server;
    server.sin_addr.s_addr = inet_addr("192.168.100.115");
    server.sin_family = AF_INET;
    server.sin_port = htons( 5000 );

    //Connect to remote server
    if (connect(sock , (struct sockaddr *)&server , sizeof(server)) < 0){
        printf("connect error");
        return -1;
    }
```

4.2 Impedance Spectroscopy

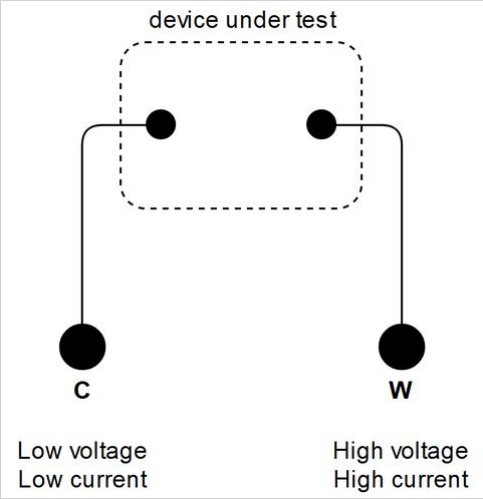
The impedance of an object depends on its resistance, capacitance and inductance. It is measured by applying a sinusoidal AC excitation signal and capturing the voltage and current values at the object for a certain time. An impedance spectrum is obtained by varying the frequency of the excitation signal over a given range. The frequency is normally increased in discrete steps, where the impedance of every step represents a singe point in the impedance spectrum.

There are three typical topologies used to measure the impedance:

- 2-Point-Configuration
- 3-Point-Configuration
- 4-Point-Configuration

4.2.1 2-Point-Configuration

The system topology in 2 point configuration includes one current injecting COUNTER electrode port (C-port) and one WORK port (W-port). Voltage measurement and excitation of the device under test is both done with the same wires.

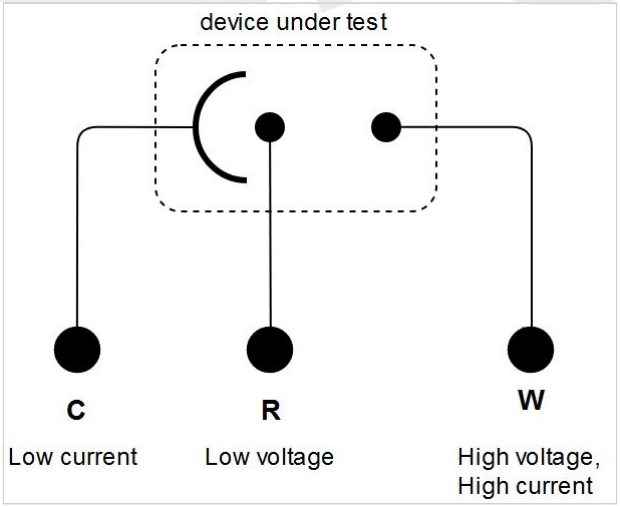


On devices with separate C, R, W and WS ports a common C port is established by shorting C and R and a common W port is established by shorting W and WS.

In some cases the potential drop of the wires, caused by the excitation signal, may reduce the accuracy of the measurement.

4.2.2 3-Point-Configuration

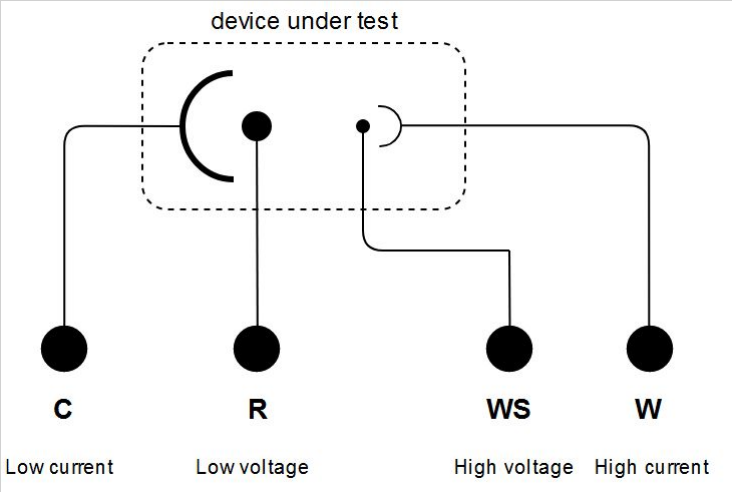
The system topology in 3 point configuration includes one current injecting COUNTER electrode port (C-port), one high impedance REFERENCE (R) port and one WORK port. Voltage measurement is performed by measuring the R-port potential against potential of the W port giving in result the potential drop/difference from REFERENCE to WORK.



On devices with separate W and WS ports a common W port is established by shorting W and WS.

4.2.3 4-Point-Configuration

The system topology in 4 point configuration includes one current injecting COUNTER electrode port (C-port), one high impedance REFERENCE (R) port, one high impedance WORKING SENSE (WS) port and one WORK port. Voltage measurement is performed by measuring the R-port potential against potential of the WS port giving in result the potential drop/difference from REFERENCE to WORKING SENSE.



Usually this configuration gives the most accurate results, because the error introduced by the wires is reduced to a minimum due to the high impedance characteristic of the voltage measurement path.

4.3 Settings description

4.3.1 DC-bias

The "DC-bias" functionality allows to adjust the DC-offset-voltage across the measuring object. More precisely, the offset voltage between the R (reference) an Ws (work sense) ports will be adjusted. The DC-bias can be activated/deactivated and the desired value set from the software or using the Sciospec COMInterface. When the DC-bias is activated, the system regulates the DC-bias to the set value one single time. If the measuring section or the measuring object changes, this procedure has to be repeated to regulate the system to the new conditions. Please refer to the Technical Specifications for a diagram of the DC bias range (Absolute Bias Voltage vs. Absolute Bias Current).

Prerequirements for DC-bias adjustment

- The measurement object must be connected to the device before DC-bias adjustment is performed.
- A measurement setup must be set.
- No measurement may be active.
- Current direction: C = + , W = -

⚠ DC-Bias is only available on the measurement port 1 (BNC). It is not available for the ExtensionPort.

4.3.2 Precision

The precision settings enables the user to adjust the trade off between measurement stability (low standard deviation of measured impedance values) compared to high measurement speed. A low precision settings correspond to fast measurements with lower stability. High precision setting corresponds to greater stability at longer measurement times. The precision setting is directly correlated to the relative bandwidth of the measurement. The setting can be found in the measurement setup config panel in the software or alternatively in the set setup command (0xB6) of the Sciospec ComInterface.

ⓘ For relation between the precision setting, accuracy, measurement timing and the range setting see Technical Specification chapter.

4.3.3 Measurement delay options and phase synchronization

There are different options to define delays during a measurement. Basically there are two possibilities. Either way the measurement pauses after a full sweep is completed (sweep delay, synchronization time) or after a specific frequency point has been measured (point delay). In the case of a none zero point delay, the next frequency excitation will be used and before the actual measurement starts the defined time will elapse. Both parameters can be set in the software or by a corresponding command via USB or Ethernet (see Command description command 0xB9 and command 0xB6).

The optional phase synchronization feature ensures that change of frequency in the excitation signal, which is exerted on the device under test, with no change in phase and without any glitches. This is for example needed for precise measurements of the impedance of resonant devices under test. The disadvantage of this option is that a longer time for the measurement is needed (see Command description command 0xB6).

4.4 Sciospec Extension Port

At present the Sciospec ExtensionPort is only usable to connect an extension module to the device. It makes use of the Sciospec Interface Port standard. If you need access to one of the features described in the *Sciospec Interface Port standard* section or you would like to see some other functionality available, just get in contact with Sciospec customer service.

4.5 Sciospec *InterfacePort* standard

The *Sciospec InterfacePort* standard provides up to 32 I/Os per bank, which can be freely configured to serve as a number of different interface types. These particular interface functionalities are described below. However, in some applications just a subset of these functions may be available and some parameter borders can vary too and may differ from standard values. Thus all these variable parameters are described in the particular application documentation.

Multiple independent *InterfacePort* instances may exist in a project. Each instance can be addressed by its bank address and the command code.

4.5.1 Interfaces

Digital Inputs

- This is the default configuration of every I/O, if no other interface is configurated on it.
- A weak pull up resistor (25kΩ) to VDD is connected to each I/O.
- The logic stack of all I/Os can be read out by command ("get IO state register"). The command provides a bit vector, where every bit represents the actual logic state of one certain I/O, even if it is configured as "digital output".

Digital Outputs

- The logic state of each pin can be set independently, using the "set output register" command.
- Default state of this register ist 0 for every I/O.

SPI Master

- Type: 4-wire (MOSI as well as MISO can be left unused).
- The polarity of the SPI (CPOL) is configurable by command ("set SPI polarity").
- CPHA = 0
- The SCLK-frequency is configurable within the range (mSPI_f_SCLK_source ÷ 2) ≥ f_SCLK ≥ mSPI_f_SCLK_min
- Word length = 8 Bit
- Send and receive a maximum of "mSPI_max_byte" Byte in a single communication process framed by #CS = '0'.
- Data, read from MOSI, always will be transmitted to the master interface where the command came from, which initialized the communication process.
- Application dependend parameters:
    - mSPI_f_SCLK_source
    - mSPI_f_SCLK_min
    - mSPI_max_byte

UART

- Parameters:
    - Baud is rate configurable from BaudrateMin to BaudrateMax (Baudrate = BaudrateMax/ BaudrateDivider).
    - Parity configurable (odd, even, no parity)
    - Startbit = 1
    - Stopbit = 1
    - Idle state = high
    - Receive timeout always is 10 word durations.
    - Send and receive a maximum of 128 Bytes in one continuous transmission.
- Fully asynchronous reception
- Configurable output interface for received data (any of the master interfaces)

I^2C

- SCK and SCL line open drain
- Parameters:
  - fSCK = 100kBaud
  - Send and Receive a maximum 15 Bytes

5 Measurement Software description

5.1 Use of measurement module within ISX-5 / MSX-8

For use of the impedance measurement module within a ISX-5/MSX-8 platform system refer to the respective system manual for guidance on general software use (setting up connection, handling data, etc.). The measurement module specific dialogs (configuration of setups) are equivalent to the here described software (e.g. refer to Configuring a measurement setup in the Advanced Mode and sections Handling setups and spectra to Saving and loading of a PlotterGrid).

5.2 Installation

5.2.1 System requirements

- Windows XP® or more recent

> ⓘ The delivered software package contains the needed Java Runtime Environment 7 (jre7) 32bit or more recent. This has not to be installed separately.

> ⓘ Attach all required extension modules to your device before turn on the device.

5.2.2 Run the installation for full speed USB devices

- driver for full speed USB devices are standard drivers for standard operating system (Windows, Linux, macOS)
- no additional installation needed

5.2.3 Start the Software

- Click on „Start.bat“

> ⓘ Logfiles are stored at the user directory "%APPDATA%\SciospecSoftware"

5.3 Setting up a connection to the device via USB

After the software has started, one can choose the type of connection USB, Ethernet or Serial.

> Using the USB port at the back of the device requires the use of the [Serial] or [USB] button. For ISX-3v2/ISX-3mini use the [Serial] button.

By clicking on [Serial]/[USB] all by Serial/USB connected devices are shown in the connection window. If the socket connection is successfully established the device ID will be shown in the devices list of the connection dialog. Select the desired device and press [connect]. In case no device is listed, try to replug the USB cable and restart the software again.

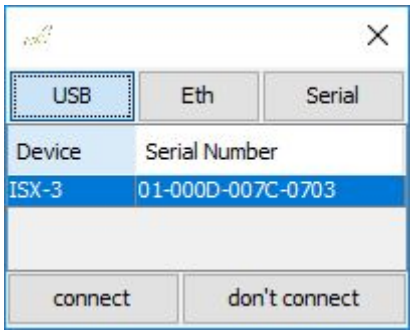


Fig: software connection dialog

The option [not connect] gives you the opportunity to load and visualize the data without the need of a connected device.

5.4 Setting up a connection to the device via Ethernet

IP configuration using the Sciospec Software

1. Connect the device via USB and Ethernet at the back of the device.
2. Open the Sciospec Software and connect via USB, see Setting up a connection to the device via USB.
3. Open the "Eth configuration" dialog by clicking on [Extra] → [Eth Config] in the Main Window. The Mac address of the device is displayed in the lower part.
4. If the device is connected to a network and successfully obtained an IP address, the address will be shown in the dialog. Otherwise the displayed IP address is 0.0.0.0. Keep the IP-address in mind.
5. To set a static IP address for the device, uncheck "DHCP enabled", enter the desired address and press [OK].

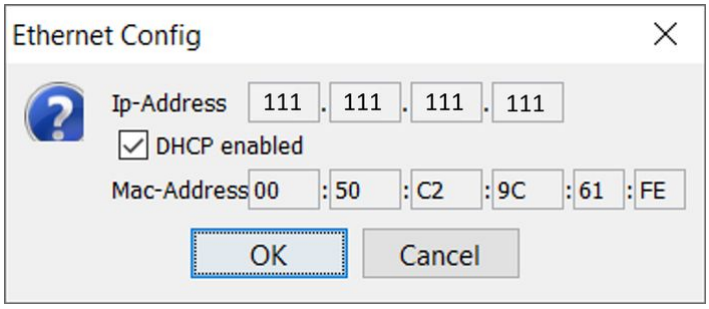


Fig: Ethernet Configuration

To connect to a Sciospec device via Ethernet click the [Eth] button in the Software connection dialog.

The IP-address and port window opens.

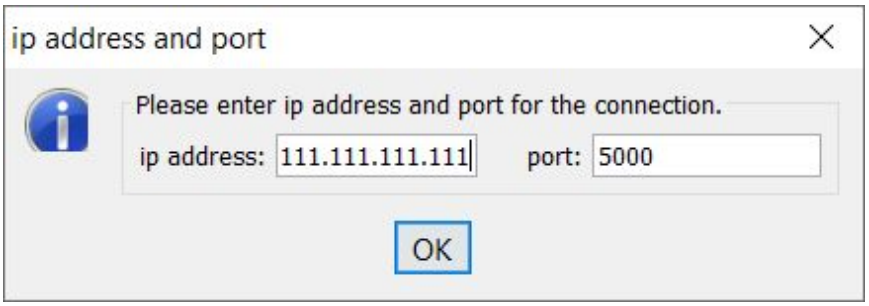


Fig: IP-address and port window

Enter the desired IP address and the port number and push [OK]. The port number for all Sciospec devices is fixed to 5000.

If the socket connection is successfully established the device ID will be shown in the devices list of the connection dialog.

Afterwards the software can be used in the same way as using the USB connection.

5.5 General software window description

In the software the user has options for configuring a measurement, displaying, editing and saving of measured impedance spectra.

The main window is broadly separated into two parts. On the left side is the control panel of the software. On the right side (blank space) windows will show up displaying status information of measurements as well as plotter windows displaying data, both of live data and already acquired data. In the control panel every device interaction and data saving interaction is handled. In the top part of the control panel are the interaction activities concerning setting up a measurement, loading and saving measurement setups. Below everything concerning measurements is displayed, including the measurement tree, the autosave feature, setup information as well as a section handling device interaction, i.e. start and stop a measurement and perform or reset a calibration.

In the menu bar there are multiple menu items displayed. In the "File" menu, the user can disconnect and reconnect the software from the device. To reconnect the software to the device the connection dialog will be opened again. Furthermore there is an option to close the software and the option to "set Synctime".

> ⓘ The Sync time is the time between the measurement of two spectra. Maximum value is 180s. It is described in the functional description of this document.

The "View" menu enables the user to switch between Simple Mode, Advanced Mode or Kinetic Mode.

The "Extra" menu includes a dialog to show configuration for ethernet connection. Here the IP address as well as the MAC address are displayed. Additionally the user can enable/disable DHCP.

Moreover the "Extra" menu provides a dialog to configure the DC-bias, as shown in Figure 1. Please refer to the functional description of this funtionality for functional description and prerequirements!

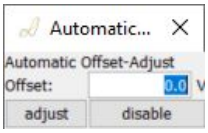


Figure 1: DC-bias dialog

Depending on the features of the device, the "Extra" menu provides dialogues for Wifi Configuration, IO Configuration or Battery Mode.

Clicking the "About" menu item will open a new window, showing information of the connected device. This includes the device ID, its firmware version and the software version.

> In the right click menu of the "About" the device information can be copied to the clipboard.

5.6 Simple Mode

This mode is designed for an easy and fast setup of the instrument. The measured data will be visualized in a plotter. The data cannot be stored or analyzed; this is only available in the “Advanced Mode”.

This mode can be selected be choosing [simple] under [View] in the upper software dialog.

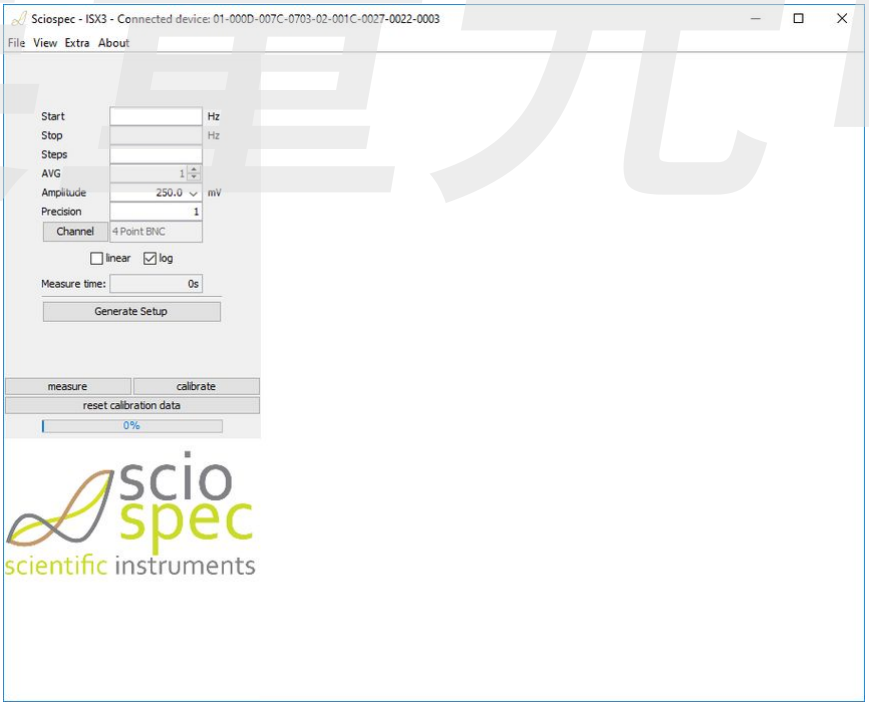


Fig: Simple Mode

Enter the following parameters to start the measurement

- Start frequency in Hz (for example 500k for 500kHz is possible)
- Stop frequency in Hz
- Number of frequency steps
- Number of averages taken
- Amplitude of the excitation signal in mV
- Setup of the desired [Precision] (≥0):
    - 1 → Standard configuration (max relative Deviation < 0.1%)
    - < 1 faster measurement but less precise
    - > 1 more precise but slower measurements
- Setting of the measurement channels
- Setting of the type of frequency distribution over the given interval

Once all parameters are set this has to be completed by selecting [generate setup]. The estimated measurement time per spectrum is displayed. By selecting [measure] the measurement starts. The measured spectra are displayed and continuously updated. By pressing [measure] again the acquisition of the data stops.

5.7 Advanced Mode

The main window opens by default in the “Advanced Mode”.

Fig: Main Window

In advanced mode the user has far more options for configuring a measurement, displaying, editing and saving of measured impedance spectra.

5.7.1 Configuring a measurement setup in the Advanced Mode

By choosing [create setup] a new configuration of the system can be created. The selection of the frequency list can be configured block wise, which enables a very freely distribution of the selected frequency points. First organize the complete setup by selection of the frequency range, measurement range, amplitude of the excitation signal and number of repeats.

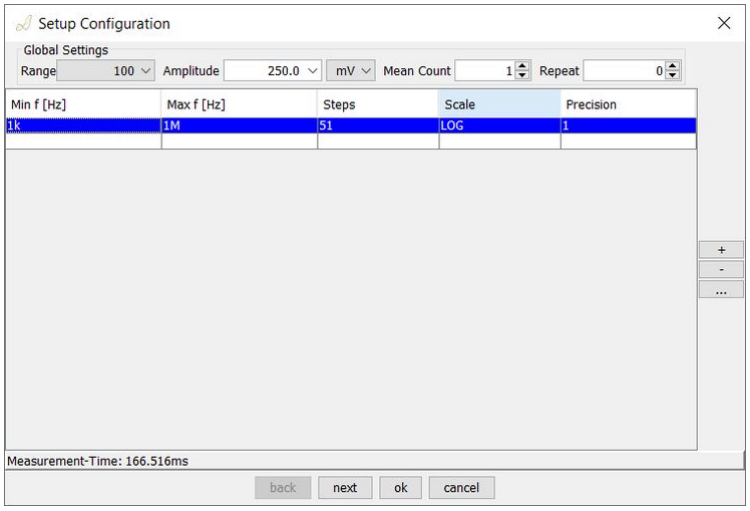


Fig: Setup Configuration Dialog

- Amplitude:
  - Amplitude of the excitation signal in mV (peak amplitude = half of peak-peak value)
- Measurement Range:
  - 100OHM for impedance values up to 1kΩ
  - 10kOHM for impedance values up to 100kΩ
  - 1MOHM for impedance values greater than 100kΩ

The following settings have to be made for each frequency block. It is possible to combine as many frequency blocks as needed. The total number of frequency points is limited to 2048. Duplicated frequencies are eliminated automatically.

- Choosing the minimal [Min f], maximal [Max f] frequency and the number of points in between [Steps]
- Selection of the type of scale [Scale] (logarithmic or linear distribution)
- Setting of the precision value [Precision] (0 ≤ precision ≥ 10):
  - 1 → Standard configuration (max relative Deviation < 0.1%)
  - < 1 faster measurement but less precise
  - > 1 more precise but slower measurements

The button [...] enables additional, optional configurations. A description of the additional "Measurement delay options and phase synchronization" can be found in the section "Functional description".

- Setting the point delay in µs. (Time between two consecutive frequency measurements)
  - Minimum 0 µs (default)
  - Maximum 180E6 µs (= 3 min)
- Configuring the Phase Synchronization
  - Disabled: Standard
  - Enabled: Use for resonant sensors only

Switch to the channel selection panel by clicking on [next]

- Select the measurement channel (ExtensionPort Modules have a specific setup dialog)
  - PORT 1 – Standard Configuration – (ISX-3mini → Port 1)
  - MUX32
  - MeaModule
  - EXT2 - (ISX-3mini → Port 2, InternalMUX)
- Setting the configuration to 2, 3 or 4 point. Options depends on the device and Extension- / InternalModule.

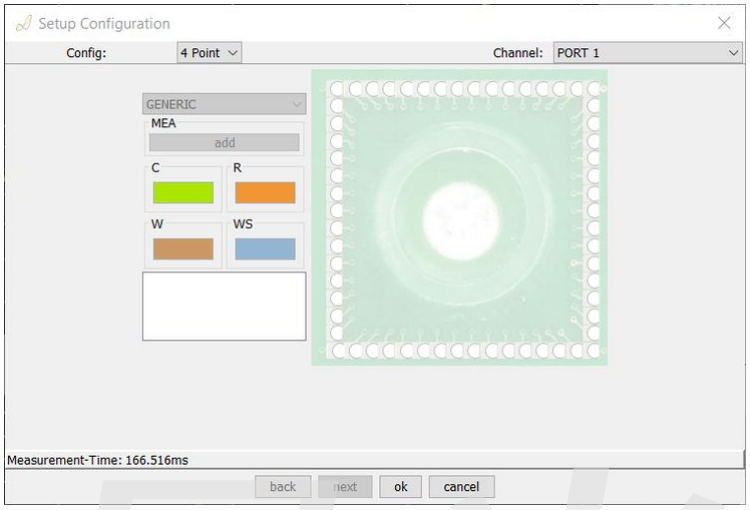


Fig: Channel selection panel

Confirm the parameters by pressing [Ok].

5.7.2 Running a measurement in the "Advanced Mode"

- Choose [measure] to start the measurement
- To stop the measurement press [measure] again
- Additionally a user defined averaging can be selected in the field [mean count].
- The measurement can by paused any time by clicking on [pause]. To start again click on [pause] once more.
- It is possible to start multiple setups at once. Select them by holding the control key while clicking on each one. Now press [measure]. A measurement option window opens.
  - "Loop setups": Once the measurement has been started with the option loop setup each setup will run one after another. A selection of a repeat count of 0 in one of the setups will result in never reaching the next setup, therefore this is not possible. Select a number of 1 or higher for repeat in the setups. The Repeat counter in the Measurement option window defines how many times a loop of the setups is done. A loop repeat of 0 results in a never ending measurement.
  - The option stitch spectra creates an additional stitched spectra.

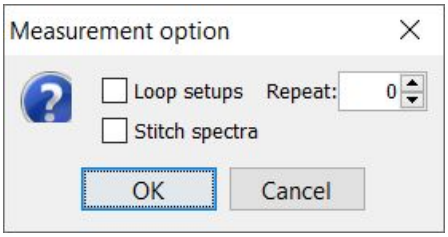


Fig: measurement option window

5.7.3 "Autosave" feature

The [Autosave] Option allows to automatically saving the measured data to a previously selected folder.

- Select the path of the folder by clicking on [directory]. (By default is the folder "Data" in the Sciospec ISX-3v2 folder selected)
- Following file extensions are possible (drop down menu): .spec / .xls / .dat
- If the checkbox [Show measured data in tree too] is checked, the data will be displayed in the data tree too.
- If the checkbox [Show measured data in tree too] is unchecked, the data will not be displayed in the data tree, to reduce the amount of memory needed by the software.
- Once a measurement is started a subfolder with the name of the setup configuration will be created and all data will be saved there.
- The saved data can be displayed by loading them into the software.
- It is also possible to display the current data by creating a PlotterGrid as described above.
- The major advantage of this feature is that the required program memory will not increase significantly over the runtime of the experiment and all measured data is stored to the hard drive. A fault condition will not compromise the already measured spectra. In case the "Autosave" feature is not active the measured data will only be held in the program memory.

ⓘ It is highly recommended to use the "Autosave" feature when performing long experiments.

5.7.4 Performing a calibration routine for a setup

To compensate for parasitic impedance effects induced by the cabling it is possible to calibrate the system with an easy open-short-load compensation. The calibration procedure has to be done for each setup used, but can be stored with the setup to the device and reloaded for later use.

The calibration requires arranging three different cabling connections. For all following configurations Counter and Reference-Terminals have to be shorted and Working Sense and Work-Terminals have to be shorted separately. Use the same cables as in the actual device und test measurement.

“short” both terminal groups (CR and WSW) have to be shorted
“open” both groups must not be connected
“load” connect a well known resistor or capacitor to both groups.

The calibration routine can be started in the software by selecting the setup configuration and click on calibrate. The software then prompts to set the open arrangement as described above and showed below. Followed by short and load arrangement.

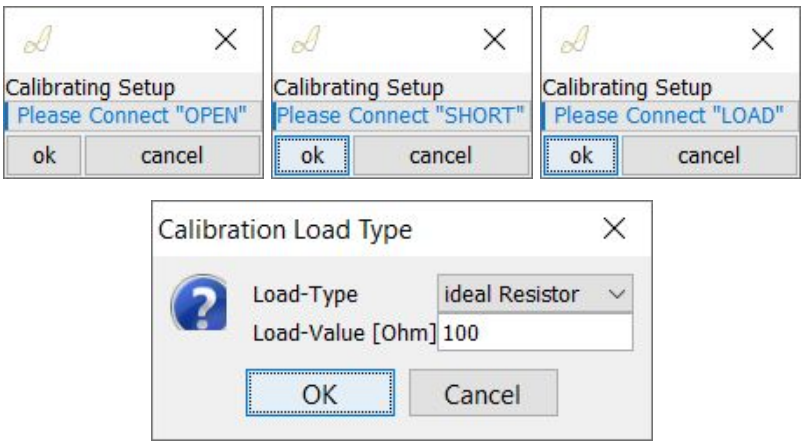


Fig: Calibration Dialog

Choose a load device in the impedance range of your device under test. It is possible to use an ideal resistor or a capacitor as a standard load device.

5.8 Kinetic Mode

The Kinetic-Mode is an easy-to-use tool to track the impedance measured at a multiple frequencies points over a period of time. It can be configured for one or for multiple channels.

Fig: Kinetic Mode Main Window

The Kinetic Mode can be configured just like a normal measurement in advanced mode.
Press “create setup” and configure a setup as described in **Configuring a measurement setup in the Advanced Mode**.

> ⓘ The total number of different frequencies in the setup is limited to 16 in the Kinetic Mode.

To start a measurement in kinetic mode, press measure.

5.9 Handling setups and spectra

Setup and spectrum datasets can be renamed by pressing F2.

5.9.1 Spectra

- Saving spectra
  - Select the datasets you want to save
  - Press [save]
  - The files will be stored in the selected directory including a number and with the file extension “spec” (see **File description ".spec"**)
- Loading spectra
  - Press [load]
  - Select the datasets you want to load and confirm by pressing [Open]
  - You can also “Drag and Drop” the data files into the software
- The [Autosave] option allows for automatic saving of files to the hard drive.
- By selecting [show Info] from the right click drop down menu from a dataset additional information can be stored with a dataset

5.9.2 File description ".spec"

Basically the files can be interpreted as a plain text comma separated (csv) file with a header and a main part.

Row	Content
1	Number of header rows N (including this one)
2	Name of file
3 to N-3	Comment
N-2	Channel
N-1	Time of the measurement
N	Column labels
N+ to End	Data according to the column labels

5.9.3 Setups

- Saving setup configurations
  - Right click a setup or press on [save] after a setup is selected.
  - You can automatically save all data obtained with this setup by selecting “include sub data”
  - The file extension is „setUp“.
- Loading setup configurations
  - Press [load]
  - Select the file extension „setUp“ from the file filter drop down menu
  - Select the setup file you want to load and confirm by pressing [Open]
  - Or „Drag and Drop“ a setup file into the software

5.10 Visualization of the data

5.10.1 Plotter

Options to visualize the data in a static plotter:

- In a plotter (with **absolute value and phase**, called Bode plot) by
  - double clicking on the measured dataset in the data tree
  - right click on the data and select "open in new Window"
  - dragging a dataset into the display area
- In a plotter (with **phase**) by dragging a dataset into the display area while pressing the control key.
- Open the data in a **Nyquist** plot by right click on the data and select "open Nyquist-Plot"
- Right click and select "show difference" gives the option to visualize the **difference** between spectra.
- The **kinetic** between spectra can be visualize by right click and select "show kinetic"

Plotter configuration

The diagram configuration dialogue can be opened by right click in the plotter area and select "Diagram configuration". The diagram configuration enables the user to customize the axes and signals of the plotter. For example scale, labels, colors, intervals, markers and much more. The diagram configuration dialogue is displayed in below.

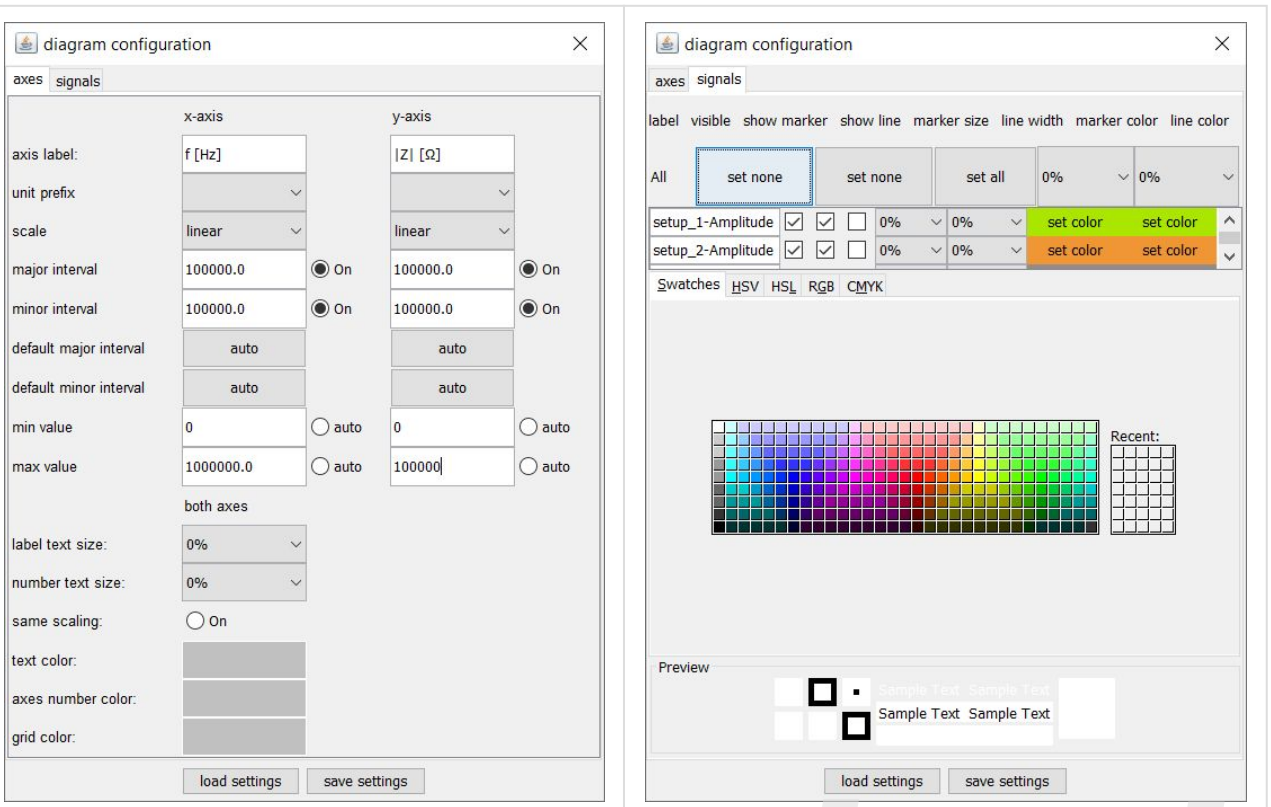


Fig: Diagram configuration dialogue

The general diagram configurations as diagram background color, caption, height and width can be customize in the general diagram configuration window. It can be opened by click on the button  at the top right corner of the plotter. The diagram configuration window will open as shown below.

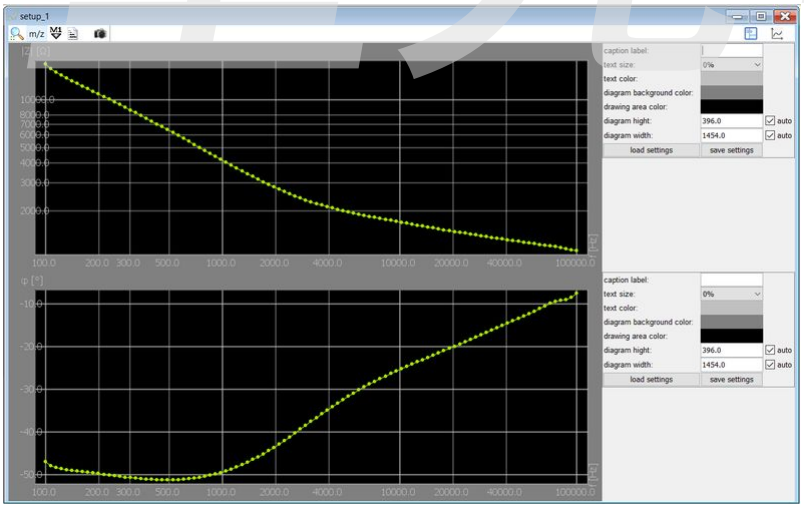


Fig: Plotter window with diagram configuration window

Plotter functions

Action to perform	Function / Result
Middle mouse button or 	Auto zoom
Mouse Wheel or  / 	Zoom
Left mouse button or  and drag	Zooms into selected rectangle
	open diagram configuration window
Right mouse button and drag	Moving the displayed area
	Copy the current zoom setting
	Paste a copied zoom setting
	Saving the displayed data to a ".csv" file
	Creating a new marker
	Taking a snapshot as a „png" file
Double click on a dataset	The absolute value and the phase will be displayed
Holding [shift] while opening data	Only the absolute value will be displayed
Holding [ctrl] while opening data	Only the phase value will be displayed
Holding [ctrl] while operating mouse wheel	Zoom with a lower magnification
Dragging a dataset into an active Plotter	The absolute value and the phase value will be added to the plotter
Double click on the plotter	Full screen mode (Escape to exit full screen)

Graphs menu

Right click on the data	Disabling or enabling the visualization and computing methods of the data
	Hiding the graphs menu

5.10.2 PlotterGrid

The PlotterGrid gives more options for displaying of measured data.

Setting up a live PlotterGrid

- Right click on desired setup opens a drop down menu.
- Select one of the "add new PlotterGrid" options.
- A PlotterGrid with the currently measured data will be displayed.

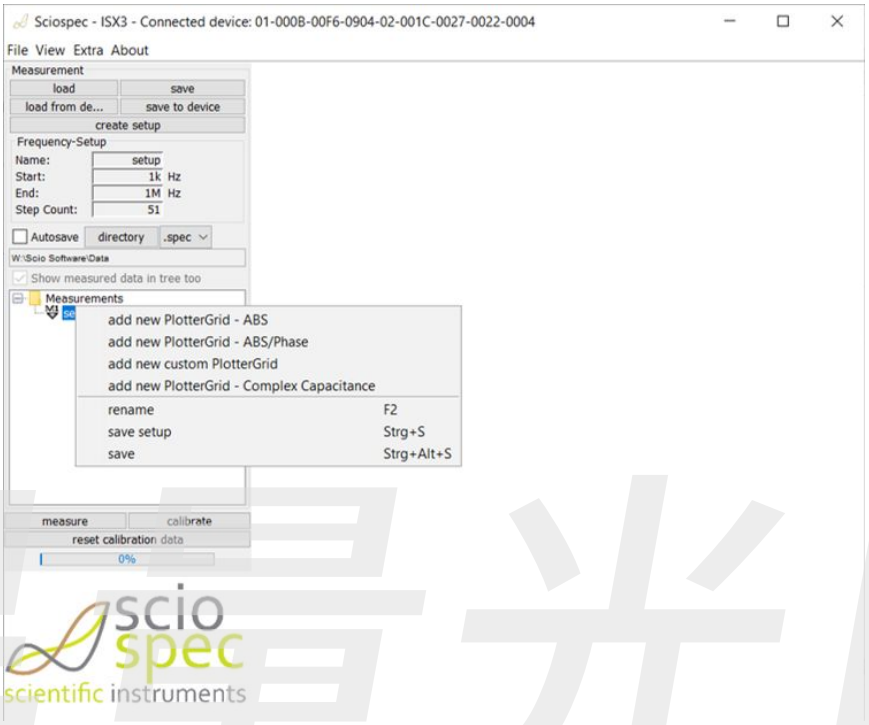


Fig: Setting up a live PlotterGrid

Setting up a PlotterGrid

- Right click in the white empty area of the software
- Select [new PlotterGrid] or [default PlotterGrid]

Fig: Setting up a PlotterGrid

- State the number and the arrangement of the desired Plotters (maximal 8 rows and 8 columns)
  - for example: row 1 → 2 columns, row 2 → 1 columns

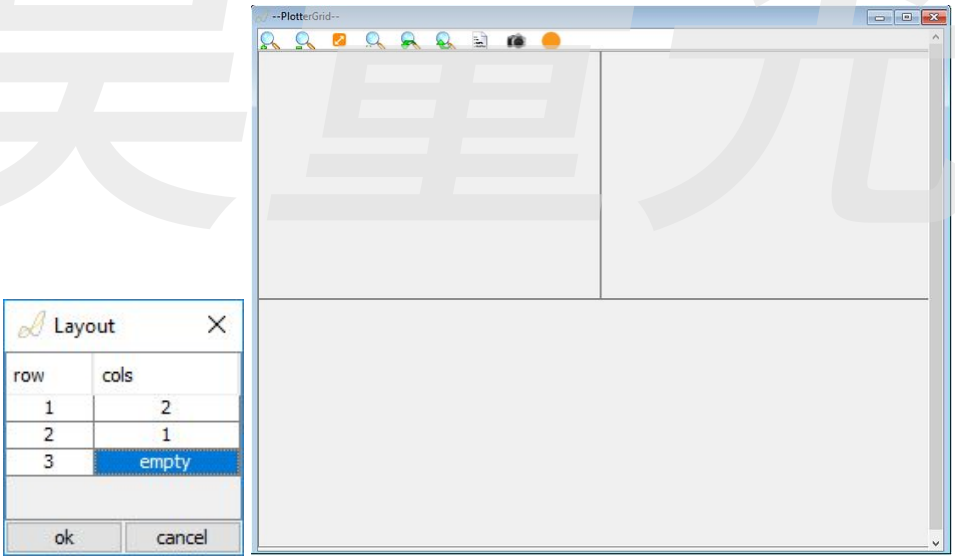


Fig: PlotterGrid layout

Every created part can now be filled with data. Configure each one by right clicking it and selecting [configure]. The following dialog appears.

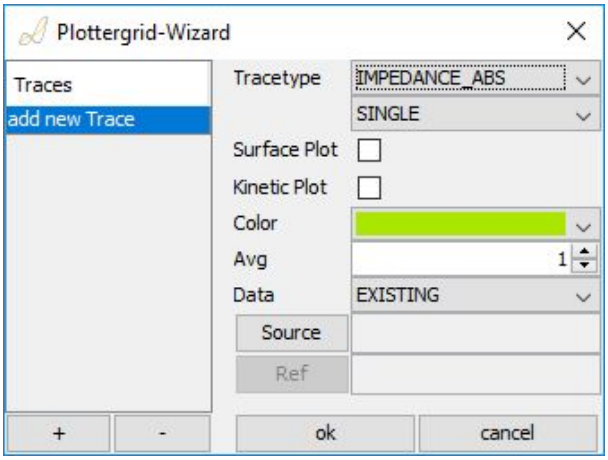


Fig: PlotterGrid Wizard

Trace type	Type of the data to be visualized. Real part, imaginary part, absolute value or phase over frequency can be selected. Additionally a Nyquist plot (negative imaginary over real part) is possible. „Single“, „Difference“ and „Relative Difference“ gives you the ability to track changes in the impedance. A reference spectrum has to be selected.
Color	Color of the plotted points
Avg	Number of Points used for a moving average.
Data	Selection of existing or currently .measured data to be displayed
Source	Select the data to be visualized. For existing data select the datasets from the data tree. For currently measured data select the channel of interest.
Ref	Select the reference spectrum for the “Difference” and “Relative Difference” modes.

Saving and loading of a PlotterGrid

It is possible to save a PlotterGrid to a file and load it again later.

- To save press the button in the active PlotterGrid. State the save path of the file. The file extension is “.grid”
- To load a PlotterGrid right click into the empty display area a select [load PlotterGrid] from the drop down menu

5.10.3 Surface Plot

The Surface Plot gives more options for displaying the measured, time dependence data.

- Select the datasets you want to show in the surfacePlot and right click on it
- Select [surfacePlot]
- Choose one of the available surface types, which are shown in *Fig: Select surface type window* and confirm by pressing [OK]

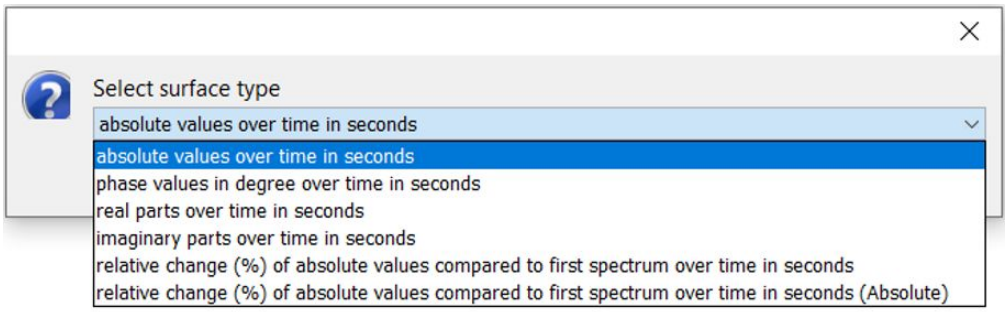


Fig: Select surface type window

- The surfacePlot will open as shown in *Fig: Surface Plot Example - visualization options*
- Right click on the surface plot area opens possible options to change the visualization, as shown in *Fig: Surface Plot Example - visualization options*
- Zoom functionality is available as described in Plotter functions

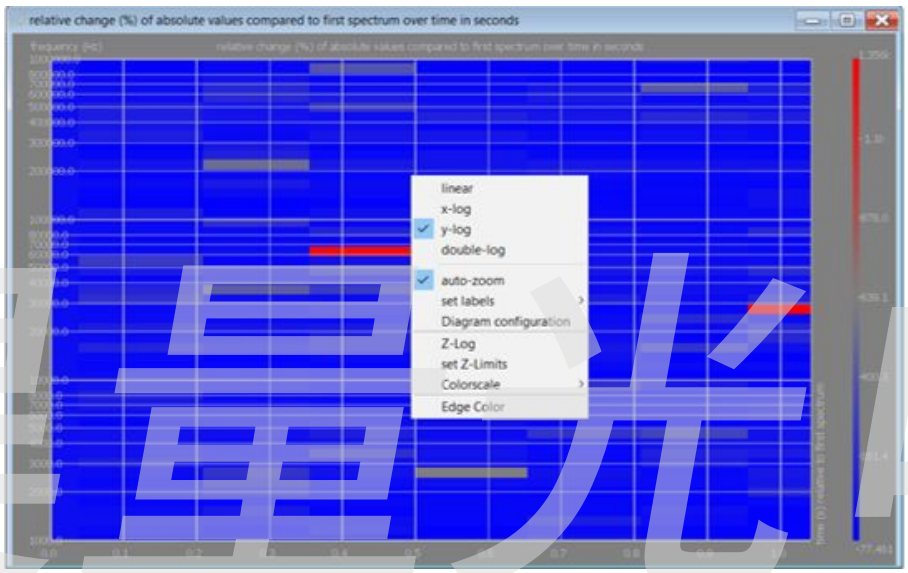


Fig: Surface Plot Example - visualization options

5.11 Error Messages

When the software encounters a problem, a message window appears, which shows the respective error code and the failed command. The complete list of error codes can be found in subsequent table. For detailed description of the relevant command see Sciospec COMInterface section of the device.

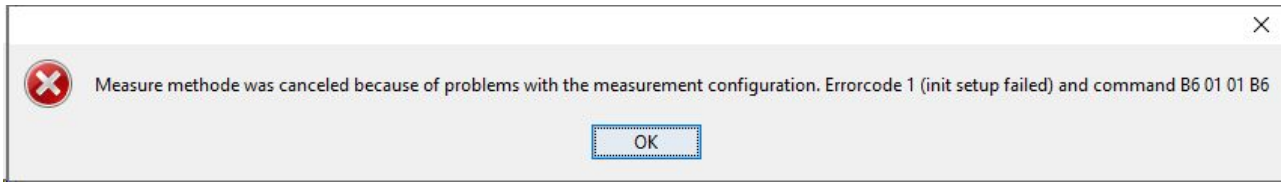


Fig: Error Message window

error code	description
1	init setup failed
2	add frequency block failed
3	set parasitic parameters failed
4	set acceleration settings failed
5	set sync time failed
6	set channel settings failed
7	set calibration data failed
8	set timestamp failed
9	start measurement failed
34	set amplitude failed

6 Sciospec Communication Interface

The Sciospec Communication Interface (COMinterface) enables the user to access all functions of the device by using any of the available master interfaces. The actual command structure is identical in all connection types.

6.1 Syntax

The general structure of each communication with a Sciospec device:

- The communication is done by frames
- Each communication frame is constructed as follows

- 1 byte command-Tag (Frame-Start)
- 1 byte number of data-bytes (0...255)
- 0...255 data-bytes
- 1 byte Command-Tag (Frame-End)

- The command-tag identifies the command (see Command list)
- Frame-Start and –End must be identical

Example: "System-Ready-Message"

CMD-Tag	Number of bytes	Data	CMD-Tag
0x18	0x01	0x84	0x18

6.2 Acknowledge messages

- Communication-frames with incorrect syntax will cause a “Frame-Not-Acknowledge” message
- If the transmission of a communication-frame is interrupted for more than 10 ms a “Timeout” message is send
- Every invalid command-tag will cause a “Not-Acknowledge” message
- Every valid commandis acknowledged with an acknowledge command [ACK]
- For commands with a return value the returning frame comes before the acknowledge message
- When commands are sent during the current measurements, measurement data can be transmitted between the command and the following returning frame and the acknowledge-message (commands are handled asynchronously)
- Before sending a new command, the resulting acknowledge or not acknowledge of the previous command has to be awaited.

The ACK-Frame:

0x18	0x01	[ACK]	0x18

General System Messages	
0x01	Frame-Not-Acknowledge: Incorrect syntax
0x02	Timeout: Communication-timeout (less data than expected)

General System Messages	
0x04	Wake-Up Message: System boot ready
0x81	Not-Acknowledge: Command has not been executed
0x82	Not-Acknowledge: Command could not be recognized
0x83	Command-Acknowledge: Command has been executed successfully
0x84	System-Ready Message: System is operational and ready to receive data
Device Specific System Messages	
0x90	Overcurrent Detected Value of DC current on W-ports exceeds capabilty of configured current range
0x91	Overvoltage Detected Value of DC voltage difference between R and WS port exceeds capabilty of configured voltage range

ⓘ For use of the impedance measurement module within a ISX-5/MSX-8 platform system refer to the respective system manual for guidance on specific communication within those systems. Commands and functionality are the same as described here, but additional framing and setup commands will be required due to the multi slot system structure within ISX-5/MSX-8.

6.3 Abbreviations

abbreviation	full name
[CT]	command tag
[LE]	length
[OB]	option byte
[CD]	command data

6.4 Command list

The leading hex code of each command heading represents the [command code] of the respective function.

- 0xB8 - Start Measure
- 0xBA - Get Sync Time
- 0xBD - Set Ethernet Configuration
- 0xBE - Get Ethernet Configuration
- 0xD0 - Get ARM firmware ID
- 0xD1 - Get Device ID
- 0xD2 - Get FPGA firmware ID
    - 0xB3 - Get ExtensionPort Channel

6.5 Command description

6.5.1 0x90 - Save Settings

General Syntax

[CT] 00 [CT]

Return

ACK

Description

Saves the following parameters permanently into the flash memory of the ISX-3v2:

- NTC Parameters 1 and 2
- Parameter stack synchronization time

This command can only be used if no measurement is currently running.

6.5.2 0x97 - Set Options

General Syntax

[CT] [LE] **[OB]** **[CD]** [CT]

Return

ACK

[OB]

Function	code
Activate time stamp	0x01

Active time stamp

Configuration of the Instrument. Activate time stamp of measured data.

Syntax

- Syntax set: **[CT] 02 01 [CD] [CT]**

[CD]

- 0x01 Enable Time Stamp

- 0x00 Disable Time Stamp

Depending on this setting the return frame of the measured data changes (see command B8)

Remarks:
It is not possible to change this setting while a measurement is running. This setting cannot be saved persistently.

6.5.3 0x98 - Get Options

General Syntax

[CT] [LE] **[OB]** [CT]

Return

[CT] [LE] **[OB] [CD]** [CT]

ACK

[OB]

Function	code
Time stamp	0x01

Time stamp

Returns the currently configured options of the instruments.

Syntax

- Syntax get: **[CT] 01 01** [CT]
  - Return: **[CT] 02 01** [CD] [CT]

[CD]

- Currently configured option depending on option byte

6.5.4 0xA1 - Reset System

complete restart of the system

General Syntax

[CT] 00 [CT]

Return

ACK
Wake-Up Message
System-Ready-Message

6.5.5 0xB0 - Set FE Settings

Frontend configuration

The device has a stack length of 1 (ISX-3) or 2 (ISX-3 mini or ISX-3 with second channel option or InternalMux). So only 1 (or 2) FE settings can be stored. Sending the set FE settings command more than 1 (or 2) times results in a NACK return. Send following command to empty the stack: **B0 03 FF FF FF B0**

General Syntax

[CT] 03 **[measurement mode] [measurement channel] [range settings]** [CT]

Return

ACK

[measurement mode]

Function	code
4 point configuration	0x02

[measurement channel]

Function	code
BNC Port (ISX-3mini: Port 1)	0x01
ExtensionPort	0x02
ExtensionPort2 (ISX-3mini: Port 2, ISX-3v2: optional, *InternalMux*)	0x03

[range settings]

Function	code
100Ohm	0x01
10kOhm	0x02
1MOhm	0x04

6.5.6 0xB1 - Get FE Settings

Returns the currently selected frontend configuration

General Syntax

[CT] 00 [CT]

Return

[CT] 03 **[measurement mode] [measurement channel] [range settings]** [CT]

ACK

[measurement mode]

Function	code
4 point configuration	0x02

[measurement channel]

Function	code
BNC Port (ISX-3mini: Port 1)	0x01
ExtensionPort	0x02
ExtensionPort2 (ISX-3mini: Port 2, ISX-3v2: optional, *InternalMux*)	0x03

[range settings]

Function	code
100Ohm	0x01
10kOhm	0x02
1MOhm	0x04

6.5.7 0xB2 - Set ExtensionPort Channel

Set the ExtensionPort channel settings.

General syntax

[CT] 04 **[CP]** [RP] **[WS]** **[WP]** [CT]

Return

ACK

ExtensionPort- channel settings

[CP]	(C-Port): Counter - Port Selection
[RP]	(R-Port): Reference - Port Selection
[WS]	(WS-Port): Working Sense - Port Selection
[WP]	(W-Port): Work - Port Selection

See documentation of the connected extension module for detailed information.

6.5.8 0xB3 - Get ExtensionPort Channel

Read the currently set ExtensionPort configuration.

General syntax

[CT] 00 [CT]

Return

[CT] 04 **[CP]** **[RP]** **[WS]** **[WP]** [CT]
ACK

ExtensionPort- channel settings

CP	(C-Port): Counter - Port Selection
RP	(R-Port): Reference - Port Selection
WS	(WS-Port): Working Sense - Port Selection
WP	(W-Port): Work - Port Selection

See documentation of the connected extension module for detailed information.

6.5.9 0xB5 - Get ExtensionPort Module

Read the type of the currently connected extension module.

General syntax

[CT] 00 [CT]

Return

[CT] 02 **[ExtensionModule] [InternalModule]** [CT]
ACK

[ExtensionModule]

This code represents the connected extension module.

Function	code
no module connected	0x00
MEArack	0x01
MuxModule32	0x02
ECIS Adapter	0x03
ExtensionPortAdapter	0x05
SlideChipAdapter	0x06
Mux32any2any (external)	0x07

[InternalModule]

This code represents the internal module.

Function	code
no module connected	0x00
MuxModule16x4	0x01
MuxModule32x2	0x02
Mux32any2any (internal)	0x07

6.5.10 0xB6 - Set Setup

General syntax

[CT] [LE] **[OB] [CD]** [CT]

Return

ACK

[OP]

	Function	code
Initialization and Configuration Commands	Init	0x01
	Add single frequency point	0x02
	Add frequency list	0x03
	Set amplitude	0x05
Calibration Commands	start calibration	0x10
	calibration acknowledge	0x11
	calibration not-acknowledge	0x12
	calibration-interaction-request Open	0x13
	calibration-interaction-request Short	0x14
	calibration-interaction-request Load	0x15
	calibration-interaction-request Load value	0x16
	set calibration data	0x17
Saving to Slot	saving to slot	0x20
DC-bias	DC-bias	0x30
	DC-bias not-acknowledge	0x32
	DC-bias set value	0x33

Init

This option resets the currently configured setup and an empty setup is initialized.

Syntax:

- Syntax set: **[CT] 01 01 [CT]**

Add single frequency point

This command is used to add a single frequency point to the currently configured setup.

Syntax

- Syntax set: **[CT] [LE] 02 [CD] [CT]**

[CD]

- [LE] = 13 (frequency, precision, amplitude)

frequency			precision			amplitude		
MSB	...	LSB	MSB	...	LSB	MSB	...	LSB

In this case the point delay (= 0 ms) and phase sync is not used.

- [LE] = 13 + extended options length

frequency			precision			amplitude			point delay				use phase sync			
MSB	...	LSB	MSB	...	LSB	MSB	...	LSB	EOP =01	MSB	...	LSB	EOP =02	MSB	...	LSB
obligatory									optional				optional			

Frequency: frequency in Hz (4Byte float)

Precision: precision value (4Byte float)

Amplitude: amplitude in V (peek value, 4Byte float)

Extended Options EOP:

- For each optional additional setting an EOP identifier needs to be send before the actual setting. Therefore any of the following options or multiple can be send.
- Point delay (EOP=01): delay between this frequency and the next frequency in µs (4Byte unsigned integer)
- Use phase sync (EOP=02): phase synchronous switch between this and the next frequency
  - Use: 0x0000001
  - Don't use: 0x00000000

Examples

- B6 0D 02 46 FA 00 00 3F 80 00 00 3E 80 00 00 B6
  - Frequency = 32 kHz
  - precision = 1.0
  - amplitude = 0.25 V
  - NO extended options have been used
- B6 12 02 46 FA 00 00 3F 80 00 00 3E 80 00 00 **02** 00 00 00 01 B6
  - Frequency = 32 kHz
  - precision = 1.0
  - amplitude = 0.25 V
  - phase synchronization = used
  - One extended option has been used

Add frequency list

This command is used to add multiple frequencies to the currently configured setup.

Syntax

- Syntax set: **[CT] [LE] 03 [CD] [CT]**

[CD]

- [LE] = 22

start-frequency			stop-frequency			count			scale	precision			amplitude		
MSB	...	LSB	MSB	...	LSB	MSB	...	LSB	MSB	MSB	...	LSB	MSB	...	LSB

In this case the point delay (= 0 ms) and phase sync is not used.

- [LE] = 22 + extended options length

start-frequency			stop-frequency			count			scale	precision			amplitude			point delay				use phase sync			
MSB	...	LSB	MSB	...	LSB	MSB	...	LSB	MSB	MSB	...	LSB	MSB	...	LSB	EOP=01	MSB	...	LSB	EOP=02	MSB	...	LSB
obligatory																optional				optional			

- Start-Frequency: start-frequency of the frequency block in Hz (4Byte float)
- Stop-Frequency: stop-frequency of the frequency block in Hz (4Byte float)
- Count: number of frequency steps used (4Byte float, rounded to the next smaller integer)
- Scale: linear or logarithmic scale (1Byte integer)
  → linear: 0
  → logarithmic: 1
- Precision: precision value (4Byte float)
- Amplitude: amplitude in V (peek value, 4Byte float)

Extended Options EOP:

- For each optional additional setting an EOP identifier needs to be send before the actual setting. Therefor any of the following options or multiple can be send.
- Point delay: delay between this frequency and the next frequency in µs (4Byte unsigned integer)
- Use phase sync: phase synchronous switch between this and the next frequency
  - Use: 0x0000001
  - Don't use: 0x00000000

Example

- B6 20 03 44 7A 00 00 4B 18 96 80 41 20 00 00 01 3F 80 00 00 3D CC CC CD **01** 00 00 03 E8 02 00 00 00 00 B6
- start frequency = 1 kHz
- stop frequency = 1 MHz
- count = 10
- scale = logarithmic
- precision = 1.0
- amplitude = 0.25 V
- point delay = 1000 µs
- phase sync = disable

Set amplitude

This command sets the amplitude.

Syntax

Two options are available:

- Syntax set all amplitudes with one command: **[CT] 06 05 [ExcitationType] [Amplitude] [CT]**
- Syntax set amplitudes row-wise: **[CT] 08 05 [Row] [ExcitationType] [Amplitude] [CT]**

[ExcitationType]

- Length: 1 byte
- 0x01 - voltage
- 0x02 - current

[Amplitude]

- Length: 4 byte
- Data format: float

[Row]

- Length: 2 byte
- 0 ≤ row ≤ maximum row count

start calibration

A detailed example of the required communication necessary to calibrate a setup can be found in Example of impedance calibration procedure.

This command starts the calibration of the setup.

Syntax

- Syntax set: **[CT] 01 10 [CT]**

calibration acknowledge

The calibration acknowledge (CACK) is used to answer a “Calibration-Interaction-Request”

Syntax

- Syntax: **[CT] 01 11 [CT]**

calibration not-acknowledge

The calibration acknowledge (CNACK) is used to answer a “Calibration-Interaction-Request”

Syntax

- Syntax: **[CT] 01 12 [CT]**

calibration-interaction-request Open

This is a message from the ISX-3v2 to request an open configuration on the measurement channel. This request must be answered with a CACK to continue the calibration or with a CNACK to abort the calibration.

calibration-interaction-request Short

This is a message from the ISX-3v2 to request a short configuration on the measurement channel. This request must be answered with a CACK to continue the calibration or with a CNACK to abort the calibration.

calibration-interaction-request Load

This is a message from the ISX-3v2 to request a load configuration on the measurement channel. This request must be answered with a CACK to continue the calibration or with a CNACK to abort the calibration.

Before the answer to this request is send the load value and type must have been send to the device (Option 0x16).

calibration-interaction-request Load value

The connected load value must have been send in the command data part [CD] of the command.

Syntax

- Syntax set: **[CT] 06 16 [LoadType] [Value] [CT]**

[LoadType]

- Length: 1 byte
- 0x01 - resistance
- 0x02 - capacitor

[Value]

- Length: 4 byte
- Data format: float
- Unit: Ohm for [LoadType] = resistance, Farad for [LoadType] = capacitor

Example

- [CT] 06 16 01 44 7A 00 00 [CT] → resistance = 1000 Ohm

set calibration data

This command configures the calibration data of the configured setup.

Syntax

- Syntax reset calibration data: **[CT] 02 17 01 [CT]**
- Syntax set data: **[CT] [LE] 17 02 [Channel] [Row] [Open Re] [Open Im] [Short Re] [Short Im] [Load Re] [Load Im] [CT]**

[Channel]	[Row]	[Open Re]	[Open Im]	[Short Re]	[Short Im]	[Load Re]	[Load Im]
1 byte	2 byte	4 byte float	4 byte float	4 byte float	4 byte float	4 byte float	4 byte float

saving to slot

It is possible to load all information required for a measurement from the internal storage of the impedance analyzer. The system holds up to 255 setup configurations including any calibration data. For addressing, the configurations are numerated from slot 1 to slot 255.

Syntax

- Syntax saving to slot: **[CT] 02 20 [Slot] [CT]**

[Slot]

- Length: 1 byte

Example

- [CT] 02 20 05 [CT] → load configuration from slot 5

DC-bias

This command activates or deactivates the DC-bias on the configured channel. When the DC-bias is activated DC-bias is set to 0V and then regulated towards the selected value. This process can be aborted by sending the "DC-bias-Not-Acknowledge".

If the DC-bias is reached a "DC-bias-Acknowledge" is send from the ISX-3v2 / ISX-3 mini.

If the DC-bias could not reached "DC-bias-Not-Acknowledge" is send from the ISX-3v2 / ISX-3 mini.

Syntax

- Syntax set: **[CT] 02 30 [CD] [CT]**

[CD]

- Length: 1 byte
- 0x01 - activate
- 0x02 - deactivate

DC-bias not-acknowledge

This command is to abort the DC-bias regulation.

Syntax

- Syntax: **[CT] 01 32 [CT]**

DC-bias set value

This command sets the value for the DC-bias.

Syntax

- Syntax set: **[CT] 05 33 [bias value] [CT]**

[bias value]

- Length: 4 byte
- Data format: float
- Unit: V (volt)

Example

- [CT] 05 33 3F 80 00 00 [CT] → Sets the bias value to 1 V.

How to regulated the DC-bias after the measuring section or the measuring object changed:

- send the **DC-bias set value** command (Syntax set: [CT] 05 33 [bias value] [CT]) → not necessary if the set value doesn't change
- send the **DC-bias** command (Syntax: [CT] 02 30 [CD] [CT])

6.5.11 0xB7 - Get Setup

General syntax

[CT] [LE] **[OB] [CD]** [CT]

Return

[CT] [LE] **[OB] [CD]** [CT]

ACK

[OP]

Function	code
Get total number of frequencies	0x01
Get information of frequency point	0x02
Get frequency list	0x04
calibration-interaction-request Open	0x13
calibration-interaction-request Short	0x14
calibration-interaction-request Load	0x15
save setup to slot	0x20
Get DC-bias	0x33

Get total number of frequencies

This command reads the total number of frequencies configured in the setup.

Syntax

- Syntax get: **[CT] 01 01 [CT]**
  - Return: **[CT] 03 01 [CD] [CT]**

[CD]

- number of rows configured
- Length: 2 byte
- Data format: unsigned integer

Get information of frequency point

This command gets information of a configured point of the setup.

Syntax

- Syntax get: **[CT] 03 02 [CD] [CT]**
  - Return: **[CT] 13 02 [Frequency] [Precision] [Signal amplitude] [CT]**

[CD]

- row number
- Length: 2 byte
- Data format: unsigned integer

[Frequency]

- Length: 2 byte
- Data format: float
- Unit: Hz

[Precision]

- Length: 2 byte
- Data format: float

[Signal amplitude]

- Length: 2 byte
- Data format: float

Get frequency list

This command gets a list of frequencies configured in this setup.

Syntax

- Syntax get: **[CT] 01 04 [CT]**
  - Return: **[CT] [LE] 04 [4 Byte float frequency$_1$] [...] [4 Byte float frequency$_N$] [CT]**

[4 Byte float frequency$_1$] [...] [4 Byte float frequency$_N$]

- *Since one data frame is limited to a total of 255 bytes of data the returning command will be split into multiple separate frames. For example if the setup contains 64 frequency points the first 63 will be transmitted in a frame containing 253 bytes (=63*4+1) and in a separate frame containing 5 bytes (=1*4+1) bytes of data.*

calibration-interaction-request Open

This is a message send by the ISX-3v2 to request an open configuration on the measurement channel. This request must be answered with a CACK to continue the calibration or with a CNACK to abort the calibration.

calibration-interaction-request Short

This is a message send by the ISX-3v2 to request a short configuration on the measurement channel. This request must be answered with a CACK to continue the calibration or with a CNACK to abort the calibration.

calibration-interaction-request Load

This is a message send by the ISX-3v2 to request a load configuration on the measurement channel. This request must be answered with a CACK to continue the calibration or with a CNACK to abort the calibration.

Before the answer to this request is send the load value and type must have been send to the device (Option 0x16).

save setup to slot

This command saves the setup-configuration.

Syntax

- Syntax: **[CT] 02 20 [Slot] [CT]**

[Slot]

- Slot number
- Length: 1 byte

Get DC-bias

This command reads the currently configured DC-bias from the device.

Syntax

- Syntax get: **[CT] 01 33 [CT]**
  - Return: **[CT] 05 33 [DC-bias] [CT]**

[DC-bias]

- Length: 4 byte
- Data format: float
- Unit: V

6.5.12 0xB8 - Start Measure

Starts the measurement.

General syntax

[CT] [LE] **[OB] [CD]** [CT]

Return

If time stamp is disabled (see command 0x97 and 0x98)

[CT] 0A **[ID] [Real part] [Imaginary part]** [CT]
ACK

Else

[CT] 0E **[ID] [Time stamp] [Real part] [Imaginary part]** [CT]
ACK

[ID]

- ID number of the frequency point
- Length: 2 byte
- Data format: integer

[Time stamp]

- time stamp of the frequency point
- Length: 4 byte
- Data format: integer
- Unit: ms

[Real part]

- real part of impedance
- Length: 4 byte
- Data format: float

[Imaginary part]

- imaginary part of impedance
- Length: 4 byte
- Data format: float

[OP]

Function	code
Stop measurement	0x00
Start measurement	0x01

Stop measurement

Stops the measurement.

Syntax

- Syntax: **[CT] 01 00 [CT]**

Start measurement

Starts the measurement.

Syntax

- Syntax: **[CT] 03 01 [CD] [CT]**

[CD]

- number of spectra to be measured
- Length: 2byte
- Data format: integer value
- The setting 0 starts a continuous measurement. Send the command (B8 01 00 B8) to stop the continuous run.

ⓘ If the measurement has been started with a repeat greater than 0 no stop command is required. The data will be transmitted as soon as each frequency point has been measured. The system therefore **does not** wait for the spectrum to be completed before it will send the data.

0xB9 - Set Sync Time

Set the synchronization time in µs. (Time between the measurement of two spectra)

ⓘ This is also the time the SyncOut signal is in its low state between two measurements.
Use save settings command (0x90) to save this parameter persistent.

General syntax

[CT] [LE] **[Sync time]** [CT]

Return

ACK

[Sync time]

- Length: 4 byte
- Data format: integer value
- Unit: µs
- Default: 0µs
- Min: 0µs
- Max 180s = 180E6 µs (0x0ABA9500)

6.5.13 0xBA - Get Sync Time

Reads the currently configured synchronization time.

General syntax

[CT] 00 [CT]

Return

[CT] 04 **[Sync time]** [CT]

ACK

[Sync time]

- Length: 4 byte
- Data format: integer value
- Unit: µs

6.5.14 0xBD - Set Ethernet Configuration

Configure DHCP setting and IP address.

General Syntax

[CT] **[LE] [OB] [CD]** [CT]

Return

ACK

[LE]

- Represents the byte count of the command frame and varies with the amount [data] bytes. [length] is always the amount of [data]-bytes + 1.

[CD]

- Command data whose syntax and content depends on the used [option byte].

[OB]

Function	code
IP address	0x01
DHCP on/of	0x03

IP address

- Set static IPv4 address of the device.
- This address will only be used, when DHCP is disabled.
- The default setting is 0.0.0.0
- Syntax: **[CT] [05] [01] [address] [CT]**
- [address]
  - Desired address.
  - Length: 4 byte
  - Data format: byte-wise unsigned integer
  - Value range of each byte: 0 ... 255

DHCP on/off

- Activate/deactivate DHCP usage.
- To apply this setting, a system reboot is required.
- Syntax: **[CT] [02] [03] [switch] [CT]**
- [switch]
  - Length: 1 byte
  - Values:
    - 0x00 - off
    - 0x01 - on (default)

To save these settings persistently, the "save settings" command must be sent before powering off the device.

6.5.15 0xBE - Get Ethernet Configuration

Read out parameters like DHCP setting, MAC and IP address.

General Syntax

[CT] **[LE] [OB]** [CT]

Return

[CT] **[LE] [OB] [CD]** [CT]
ACK

[LE]

- Represents the byte count of the command frame and varies with the amount [data] bytes. [length] is always the amount of [data]-bytes + 1.

[CD]

- Command data whose syntax and content depends on the used [option byte].

[OB]

Function	get
IP address	0x01
MAC address	0x02
DHCP on/off	0x03

IP address

- Read out currently allocated IPv4 address of the device. This is the actual address the device
- Get syntax: **[CT] [01] [01] [CT]**
- Return syntax: **[CT] [05] [01] [address] [CT]**
- [address]
  - Current address.
  - Length: 4 byte
  - Data format: byte-wise unsigned integer

MAC address

- Read out currently allocated MAC address of the device. This is the actual address the device
- Get syntax: **[CT] [01] [02] [CT]**
- Return syntax: **[CT] [07] [02] [address] [CT]**
- [address]
  - MAC address.
  - Length: 6 byte
  - Data format: byte-wise unsigned integer

DHCP on/off

- Read out the current DHCP setting.
- Get syntax: **[CT] [01] [03] [CT]**
- Return Syntax: **[CT] [02] [03] [switch] [CT]**
- [switch]
  - Length: 1 byte
  - Values:
    - 0x00 - off
    - 0x01 - on

6.5.16 0xD0 - Get ARM firmware ID

Syntax

D0 00 D0

Return

D0 06 [developer information] **[revision number] [build number]** D0
ACK

Description

- Reads out version number of ARM firmware.

[developer information]

- This information is for internal development purposes only.
- Length: 2 Byte

[revision number]

- Length: 2 Byte
- Data format: unsigned integer

[build number]

- Length: 2 Byte
- Data format: unsigned integer

6.5.17 0xD1 - Get Device ID

Syntax

[CT] 00 [CT]

Return

[CT] [LE] **[general information]** [developer information] [CT]
ACK

Description

- Read out device information
- Includes all information necessary to identify a Sciospec device.

[general information]
This information can also be found on the serial number label on the case of the device.

Byte	Description	Comments
1	version of the general information part	• Defines the format of the following items. There is only version 1 so far. • data format: unsigned integer
2-3	device identifier	• Unique number, which identifies the device types. • data format: unsigned integer
4-5	serial number	• Unique identifying number for all Sciospec devices. • data format: unsigned integer
6-7	date of delivery	• Byte 6: Year since 2010 (0x00 = 2010, ..., 0xFF = 2265) • Byte 7: Month (0x01 = january, ..., 0x0C = december)

[developer information]

This information is for internal development purposes only.

6.5.18 0xD2 - Get FPGA firmware ID

Syntax

D2 00 D2

Return

D2 09 [developer information] **[revision number] [build number]** D2
ACK

Description

- Reads out version number of ARM firmware.

[developer information]

- This information is for internal development purposes only.
- Length: 5 Byte

[revision number]

- Length: 2 Byte
- Data format: unsigned integer

[build number]

- Length: 2 Byte
- Data format: unsigned integer

6.5.19 Example of impedance calibration procedure

This example demonstrates the communication required to calibrate an already configured setup.

Direction of communication:

PC to ISX-3v2 / ISX-3mini

ISX-3v2 / ISX-3mini to PC

↓	#	Command	Communication			
	1	Initiating the calibration routine	B6	01	10	B6
	2	Acknowledge	18	01	83	18
	3	Request to leave the terminals open	B7	01	13	B7
	4	Calibration acknowledge	B6	01	11	B6
	5	Acknowledge	18	01	83	18
	Calibration measurement on open terminal is performed					

	6	Request to short all terminals	B7 01 14 B7
	7	Calibration acknowledge	B6 01 11 B6
	8	Acknowledge	18 01 83 18
	Calibration measurement of shorted terminals is performed		
	9	Request to connect a known load impedance to the device	B7 01 15 B7
	10	Set known value of the load impedance (e.g. 1000hms)	B6 06 16 01 42 C8 00 00 B6
	11	Acknowledge	18 01 83 18
	12	Calibration acknowledge	B6 01 11 B6
	13	Acknowledge	18 01 83 18
	Calibration measurement of shorted terminals is performed		
	14	Calibration done	B7 01 10 B7

6.5.20 Example of dc bias calibration procedure

This example demonstrates the communication required to calibrate an already configured setup. It is essential the frontend settings (channel, measurement mode and range) are correctly initialized before starting the dc bias calibration routine

Direction of communication:

PC to ISX-3v2 / ISX-3mini

ISX-3v2 / ISX-3mini to PC

↓	#	Command	Communication
	1	Setting the dc bias voltage	B6 05 33 3F 00 00 00 B6
	2	Acknowledge	18 01 83 18
	3	Init the dc bias calibration	B6 01 30 B6
	4	Acknowledge	18 01 83 18
	Calibration measurement is performed		
	5	Calibrate DC Bias acknowledge	B7 01 31 B7

	6	Getting the dc bias voltage	**B7** **01** **33** **B7**
	7	DC Bias	**B7** **05** **33** **3E** **FF** **FE** **B0** **B7**
	8	Acknowledge	**18** **01** **83** **B18**

6.6 Code Example (ANSI C)

```
/*
============================================================================
 Name        : ISX3ComDemo.c
 Author      : Sciospec
 Version     : Revision 1
 Copyright   : Sciospec 2014
 Description: ISX3 Communication Demo in C, Ansi-style
============================================================================
 */


#include <stdio.h>
#include <stdlib.h>


#include "windows.h"    //'windows.h' is needed for ftd2xx.h
#include <ftd2xx.h>

#define ISX3_PID    0x89D0


byte connectToIsx3(FT_HANDLE* handle);
byte readAck(FT_HANDLE handle);
void writeDataToDevice(FT_HANDLE handle, byte* data, DWORD dataCount);


int main(void) {


    FT_HANDLE handle;
    if(!connectToIsx3(&handle))
        return -1;
    printf("Connection established\n");


    byte *cmd, *readBuffer;




    /* ************************ *
     *     Reading DeviceID     *
     * ************************ */
    int numberOfBytes = 3;
    cmd = (byte*)malloc(sizeof(byte)*numberOfBytes);
        cmd[0] = 0xD1;    cmd[1] = 0x00; cmd[2] = 0xD1;
```

```
        writeDataToDevice(handle, cmd, numberOfBytes);
    free(cmd);


    DWORD availableBytes = 0, bytesToWrite, currentStatus, bytesRead;


    while(availableBytes != 15)
        FT_GetStatus(handle, &availableBytes, &bytesToWrite,
&currentStatus);


    readBuffer = (byte*)malloc(sizeof(byte)*availableBytes);
    FT_Read(handle, readBuffer, availableBytes, &bytesRead);


    printf("DeviceID: ");
    int i;
    for(i=0; i<availableBytes;i++){
        printf("%.2X ", readBuffer[i]);
    }
    printf("\n\n");
    free(readBuffer);



    /* ************************** *
     *     Initialize setup       *
     * ************************** */
    printf("Initialize setup.\n");
    numberOfBytes = 4;
    cmd = (byte*)malloc(sizeof(byte)*numberOfBytes);
        cmd[0] = 0xB6;    cmd[1] = 0x01; cmd[2] = 0x01; cmd[3] = 0xB6;
        writeDataToDevice(handle, cmd, numberOfBytes);
    free(cmd);
    readAck(handle);
    printf("\n");



    /* ************************** *
     *     Initialize Freq.Block    *
     * ************************** */
    printf("Set setup-config: frequency-block (500Hz .. 5MHz, log-scale,
prec=1,
    amplitude=1V)\n");
    float startFrequency    = 500;    //Hz
    float stopFrequency        = 5e6;    //MHz
    float frequencyCount    = 80;
    float precision        = 1;
    float amplitude        = 1;    //V
    byte   scale            = 1;    //log
    numberOfBytes = 0x16 + 3;
```

```
    cmd = (byte*)malloc(sizeof(byte)*numberOfBytes);
        cmd[0] = 0xB6; cmd[1] = numberOfBytes-3; cmd[numberOfBytes-1] =
0xB6;        cmd[2] = 0x03;        // add multi frequency block


        unsigned long tmp = *(unsigned long*)&startFrequency;
        byte counter = 3;
        cmd[counter++] = (tmp>>24)&0xFF;
        cmd[counter++] = (tmp>>16)&0xFF;
        cmd[counter++] = (tmp>>8)&0xFF;
        cmd[counter++] = (tmp)&0xFF;


        tmp = *(unsigned long*)&stopFrequency;
        cmd[counter++] = (tmp>>24)&0xFF;
        cmd[counter++] = (tmp>>16)&0xFF;
        cmd[counter++] = (tmp>>8)&0xFF;
        cmd[counter++] = (tmp)&0xFF;


        tmp = *(unsigned long*)&frequencyCount;
        cmd[counter++] = (tmp>>24)&0xFF;
        cmd[counter++] = (tmp>>16)&0xFF;
        cmd[counter++] = (tmp>>8)&0xFF;
        cmd[counter++] = (tmp)&0xFF;


        cmd[counter++] = scale;


        tmp = *(unsigned long*)&precision;
        cmd[counter++] = (tmp>>24)&0xFF;
        cmd[counter++] = (tmp>>16)&0xFF;
        cmd[counter++] = (tmp>>8)&0xFF;
        cmd[counter++] = (tmp)&0xFF;


        tmp = *(unsigned long*)&amplitude;
        cmd[counter++] = (tmp>>24)&0xFF;
        cmd[counter++] = (tmp>>16)&0xFF;
        cmd[counter++] = (tmp>>8)&0xFF;
        cmd[counter++] = (tmp)&0xFF;

        writeDataToDevice(handle, cmd, numberOfBytes);
    free(cmd);


    readAck(handle);
    printf("\n");
    /* ***************************** *
     *     Set FrontEnd Settings     *
     * ***************************** */
    printf("Set Frontend configuration: 4Pt-config, BNC, 100kOhm-
Range\n");
```

```
146     numberOfBytes = 6;
147     cmd = (byte*)malloc(sizeof(byte)*numberOfBytes);
148     cmd[0] = 0xB0;    cmd[1] = 0x03;    cmd[numberOfBytes-1] = 0xB0;
149     cmd[2] = 0x02;    //MeasureMode = 4PointMode
150     cmd[3] = 0x02;    //Channel = BNC
151     cmd[4] = 0x03;    //RangeSetting = 100kOhm
152     writeDataToDevice(handle, cmd, numberOfBytes);
153     free(cmd);
154     readAck(handle);
155     printf("\n");
156
157
158     /* *************************** *
159      *     Start Measurement       *
160      * *************************** */
161     byte numberOfSpecs = 5;
162     printf("Start Measurement: Burstmode, Burstlength=%d\n",
    numberOfSpecs);
163     numberOfBytes = 6;
164     cmd = (byte*)malloc(sizeof(byte)*numberOfBytes);
165     cmd[0] = 0xB8;    cmd[1] = 0x03; cmd[numberOfBytes-1] = 0xB8;
166     cmd[2] = 0x01;
167     cmd[3] = (numberOfSpecs>>8)&0xFF;
168     cmd[4] = (numberOfSpecs)&0xFF;
169     writeDataToDevice(handle, cmd, numberOfBytes);
170     free(cmd);
171     readAck(handle);
172     printf("\n");
173
174
175     /* ******************** *
176      *     Receive Specs    *
177      * ******************** */
178     readBuffer = malloc(13);    //3Byte Framing, 2Byte idNumber, 4Byte RE,
    4Byte Im
179     byte j;
180     UINT16 id;
181     UINT32 tmp32;
182     float re, im;
183     for(j=0; j<numberOfSpecs; j++){
184         printf("Spec#%i:\n", j+1);
185         printf("id\tre\tim\n");
186         for(i=0; i<frequencyCount;i++){
187             while(availableBytes != 13)
188                 FT_GetStatus(handle, &availableBytes, &bytesToWrite,
189     &currentStatus);
190
191
192             FT_Read(handle, readBuffer, availableBytes, &bytesRead);
193
194
195             id = (readBuffer[2]<<8) + readBuffer[3];
196             tmp32 = (readBuffer[4]<<24) + (readBuffer[5]<<16) +
197     (readBuffer[6]<<8) + (readBuffer[7]);
```

```
            re = *(float*)&tmp32;
            tmp32 = (readBuffer[8]<<24) + (readBuffer[9]<<16) +
    (readBuffer[10]<<8) + (readBuffer[11]);
            im = *(float*)&tmp32;


            printf("%i\t%f\t%f\n", id, re, im);
        }
        printf("\n");
    }


    FT_Close(handle);


    return 1;
}


/* ************************************************************ *
 * Finds available devices and connect to first available ISX3   *
 * @param handle - the pointer to USB-Conection-Hanlde           *
 * @return True if connection was successfull else false        *
 * ************************************************************ */
byte connectToIsx3(FT_HANDLE* handle){


    FT_STATUS ftStatus;
    FT_DEVICE_LIST_INFO_NODE* devInfo;
    DWORD numDevs; // create the device information list
    ftStatus = FT_CreateDeviceInfoList(&numDevs); // allocate storage for
list
    based on numDevs


    devInfo =
    (FT_DEVICE_LIST_INFO_NODE*)malloc(sizeof(FT_DEVICE_LIST_INFO_NODE)*num
Devs);
    // get the device information list
    ftStatus = FT_GetDeviceInfoList(devInfo,&numDevs);
    if(ftStatus != FT_OK){
        printf("Error while reading device-count");
        return FALSE;
    }


    printf("Number of devices found: %d\n\n", (int)numDevs);
    int i;
    for (i = 0; i < numDevs; i++) {
        printf("#%i\t%#.4X\t%#.4X\n", i, ((int)devInfo[i].ID>>16)&0xFFFF,
    ((int)devInfo[i].ID)&0xFFFF);
    }


```

```
250     for (i = 0; i < numDevs; i++) {
251         if((devInfo[i].ID & 0xFFFF) == ISX3_PID){
252             ftStatus = FT_Open(i, handle);
253             if(ftStatus != FT_OK){
254                 printf("Error while connecting to device");
255                 return FALSE;
256             }
257 
258 
259             ftStatus = FT_SetBitMode(*handle, 0x00, 0x40);
260             break;
261         }
262     }
263     if(i == numDevs){
264         printf("No ISX3 found");
265         return FALSE;
266     }
267 
268 
269     return TRUE;
270 
271 
272 }
273 
274 
275 /* ****************************************** *
276  * Tries to Write Data to the device          *
277  * ****************************************** */
278 
279 
280 void writeDataToDevice(FT_HANDLE handle, byte* cmd, DWORD dataCount){
281 
282 
283     DWORD bytesWritten;
284     byte i;
285     for(i=0; i<dataCount;i++)
286         printf("%.2X ", cmd[i]);
287     printf("\n");
288     FT_Write(handle, cmd, dataCount, &bytesWritten);
289 
290 
291 }
292 
293 
294 
295 /* ****************************************** *
296  * Tries to Read ACK Frame                    *
297  * @return true if ACK is received, else false   *
298  * ****************************************** */
299 byte readAck(FT_HANDLE handle){
300 
301 
302     DWORD availableBytes = 0;
303     DWORD bytesToWrite = 0;
```

```
304     DWORD currentStatus = 0;
305     DWORD bytesRead = 0;
306
307
308     byte* readBuffer;
309
310
311     while(availableBytes != 4)
312         FT_GetStatus(handle, &availableBytes, &bytesToWrite,
    &currentStatus);
313     readBuffer = (byte*)malloc(sizeof(byte)*availableBytes);
314     FT_Read(handle, readBuffer, availableBytes, &bytesRead);
315
316
317     printf("ACK-Frame: ");
318     UINT8 i;
319     for(i=0; i<availableBytes;i++){
320         printf("%.2X ", readBuffer[i]);
321     }
322     printf("\n");
323
324
325     if(readBuffer[2] == 0x83){
326         free(readBuffer);
327         return TRUE;    //ACK
328     }else{
329         free(readBuffer);
330         return FALSE;    //NOT ACK
331     }
332 }
```

7 Options

The Sciospec ISX-3v2 and partially the ISX-3mini can be equipped with a variety of different additional Hard- and Software options. The Sciospec ISX-3mini is already equipped with the SecondChannelOption and the IOPort option.

- IOPort
- SecondChannelOption
- AcCoupling internal
- InternalMUX32
- Synchronization Ports
- Battery Operation

7.1 IOPort

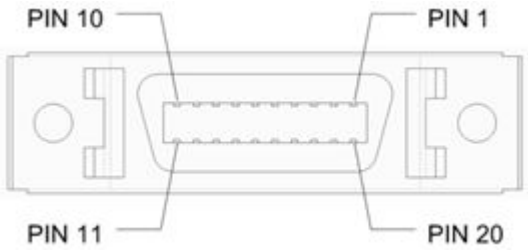
7.1.1 Technical Specifications

The Sciospec IOPort provides 8 individually controllable general purpose digital inputs / outputs (GPIO) and additionally two connections for temperature sensors of type NTC. The GPIOs may serve as input, output, I^2C, UART or SPI serial interface.

Revision	1
connector type	D-Sub-Mikro-D 20Pin
signal level standard	LVCMOS 3V
absolute maximum input voltagei	3.6V
absolute minimum input voltage	-0.3V
high level input voltage	≥1.7V
low level input voltage	≤0.8V
high level output voltage	≥2.8V
low level output voltage	≤0.2V
maximum output current	12mA
ESD Protection of IOs	±12kV IEC 61000-4-2 contact ESD ±15kV IEC 61000-4-2 air-gap ESD clamp voltage 10.5V (min) break-down voltage 7V (min)
number of GPIOs	eight (freely distributable)
number of IOs	eight (freely distributable between input and output)
IO configuration	GPIO, SPI, UART, I^2C
UART configuration	115.2kBaud, 1 start bit, 8 data bits, 1 stop bit, even parity, idle high
I^2C configuration	100kbit, 7bit address, standard mode, device behaves as master, max. 15 data bytes

SPI configuration	SPI master, type: SPI 4-wire, data valid on rising SCLK edge, SCLK frequency = 60MHz ... 1kHz, SCLK frequency default = 20MHz, 8 bit wide words, send and receive a maximum of 2^16 byte in one continuous sending
number of temperature sensors	2
temperature sensor type	Negative temperature coefficient (NTC) configurable: Reference resistance, reference temperature, Beta value

IOPort Connector Layout



IOPort pin assignment

PIN	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Funktion	GND	NTC1	GND	NTC2	GND	GPIO1	GND	GPIO2	GND	GPIO3	GND	GPIO4	GND	GPIO5	GND	GPIO6	GND	GPIO7	GND	GPIO8

7.1.2 Functional Description

At present the Sciospec IOPort can only be used to control the GPIO pins of the port. It makes use of the Sciospec Interface Port standard. If you need access to one of the features described in the *Sciospec Interface Port standard* section, the NTC ports or you would like to see some other functionality available, just get in contact with Sciospec customer service.

7.1.3 Measurement software description

The IOport configuration window can be found in the software under [Extra] → [IO Config]

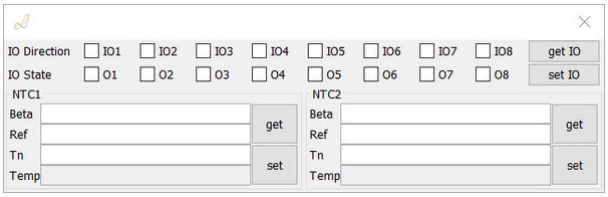


Figure 2: IO Config window

In this window the direction (checked: output | not checked: input) and the state (checked: high | not checked: low) of the IOs can be set or read out. In the lower part of the window the NTC parameter can be set or read out.

7.1.4 Sciospec COMInterface

- 0x99 - Set IOPort Configuration
- 0x9A - Get IOPort Configuration

- 0x9B - Set NTC Parameter 1
- 0x9C - Get NTC Parameter 1
- 0x9D - Set NTC Parameter 2
- 0x9E - Get NTC Parameter 2

0x99 - Set IOPort Configuration

General Syntax

[CT] [LE] **[OB]** [CT]

Return

ACK

[OB]

Function	code
GPIO direction	0x01
Port state	0x02

GPIO direction

Configure GPIOs independently as input or output port.

Syntax

- Syntax set: **[CT] [02] [01] [IO vector] [CT]**

[IO vector]

- Hot bit vector for all 8 IOs
- Length: 1 Byte
- Order: MSB first ([[IO8] [IO7]] [IO6] [IO5]] [[IO4] [IO3]] [[IO2] [IO1]])
- Hot bit interpretation:
  - 0 - IO is configured as input (Default)
  - 1 - IO is configured as output

Port state

Set state of output ports for every IO separately.

Syntax

- Syntax set: **[CT] [02] [02] [IO vector] [CT]**

[IO vector]

- Hot bit vector for all 8 IOs
- Length: 1 Byte
- Order: MSB first ([[IO8] [IO7]] [IO6] [IO5]] [[IO4] [IO3]] [[IO2] [IO1]])
- Hot bit interpretation:
  - 0 - output is set to logic low (Default)
  - 1 - output is set to logic high

0x9A - Get IOPort Configuration

Read the configuration data of the IOPort.

General Syntax

[CT] [LE] **[OB]** [CT]

Return

[CT] [LE] **[OB] [CD]** [CT]
ACK

[OB]

Function	code
GPIO direction	0x01
Port state	0x02

GPIO direction

Configure GPIOs independently as input or output port.

Syntax

- Syntax get: **[CT] 01 01 [CT]**
  - Return: **[CT] 02 01 [IO vector] [CT]**

[IO vector]

- Hot bit vector for all 8 IOs
- Length: 1 Byte
- Order: MSB first ([[IO8] [IO7]] [IO6] [IO5]] [[IO4] [IO3]] [[IO2] [IO1]])
- Hot bit interpretation:
  - 0 - IO is configured as input (Default)
  - 1 - IO is configured as output

Port state

Set state of output ports for every IO separately.

Syntax

- Syntax get: **[CT] 01 02 [CT]**
- Return: **[CT] 02 02 [IO vector] [CT]**

[IO vector]

- Hot bit vector for all 8 IOs
- Length: 1 Byte
- Order: MSB first ([[IO8] [IO7]] [IO6] [IO5]] [[IO4] [IO3]] [[IO2] [IO1]])
- Hot bit interpretation:
  - 0 - output is set to logic low (Default)
  - 1 - output is set to logic high

0x9B - Set NTC Parameter 1

General Syntax

[CT] [LE] **[OB] [CD]** [CT]

Return

ACK

[OB]

Function	code
beta parameter [K]	0x01
nominal resistance at T_N [Ω]	0x02
operating temperature T_N [K]	0x03

For standard NTC parameters see Appendix.

beta parameter [K]

Syntax

- Syntax set: **[CT] 05 01 [CD] [CT]**

[CD]

- 32Bit Fload value

nominal resistance at T_N [Ω]

Syntax

- Syntax set: **[CT] 05 02** [CD] [CT]

[CD]

- 32Bit Fload value

operating temperature T_N [K]

Syntax

- Syntax set: **[CT] 05 03 [CD] [CT]**

[CD]

- 32Bit Fload value

0x9C - Get NTC Parameter 1

Returns the currently configured NTC-parameters 1.

General Syntax

[CT] [LE] **[OB]** [CT]

Return

[CT] [LE] **[OB] [CD]** [CT]

ACK

[OB]

Function	code
beta parameter [K]	0x01
nominal resistance at T_N [Ω]	0x02
operating temperature T_N [K]	0x03
current temperature [°C]	0x04

For standard NTC parameters see Appendix.

beta parameter [K]

Syntax

- Syntax get: **[CT] 01 01 [CT]**
  - Return: **[CT] 05 01 [CD] [CT]**

[CD]

- 4 byte float value

nominal resistance at T_N [Ω]

Syntax

- Syntax get: **[CT] 01 02 [CT]**
  - Return: **[CT] 05 02 [CD] [CT]**

[CD]

- 4 byte float value

operating temperature T_N [K]

Syntax

- Syntax get: **[CT] 01 03 [CT]**
  - Return: **[CT] 05 03 [CD] [CT]**

[CD]

- 4 byte float value

current temperature [°C]

Syntax

- Syntax get: **[CT] 01 04 [CT]**
  - Return: **[CT] 05 04 [CD] [CT]**

[CD]

- 4 byte float value

0x9D - Set NTC Parameter 2

General Syntax

[CT] [LE] **[OB] [CD]** [CT]

Return

ACK

[OB]

Function	code
beta parameter [K]	0x01
nominal resistance at T_N [Ω]	0x02
operating temperature T_N [K]	0x03

For standard NTC parameters see Appendix.

beta parameter [K]

Syntax

- Syntax set: **[CT] 05 01 [CD] [CT]**

[CD]

- 32Bit Fload value

nominal resistance at T_N [Ω]

Syntax

- Syntax set: **[CT] 05 02** [CD] [CT]

[CD]

- 32Bit Fload value

operating temperature T_N [K]

Syntax

- Syntax set: **[CT] 05 03 [CD] [CT]**

[CD]

- 32Bit Fload value

0x9E - Get NTC Parameter 2

Returns the currently configured NTC-parameters 2.

General Syntax

[CT] [LE] **[OB]** [CT]

Return

[CT] [LE] **[OB] [CD]** [CT]

ACK

[OB]

Function	code
beta parameter [K]	0x01
nominal resistance at T_N [Ω]	0x02
operating temperature T_N [K]	0x03
current temperature [°C]	0x04

For standard NTC parameters see Appendix.

beta parameter [K]

Syntax

- Syntax get: **[CT] 01 01 [CT]**
  - Return: **[CT] 05 01 [CD] [CT]**

[CD]

- 4 byte float value

nominal resistance at T_N [Ω]

Syntax

- Syntax get: **[CT] 01 02 [CT]**
  - Return: **[CT] 05 02 [CD] [CT]**

[CD]

- 4 byte float value

operating temperature T_N [K]

Syntax

- Syntax get: **[CT] 01 03 [CT]**
  - Return: **[CT] 05 03 [CD] [CT]**

[CD]

- 4 byte float value

current temperature [°C]

Syntax

- Syntax get: **[CT] 01 04 [CT]**
  - Return: **[CT] 05 04 [CD] [CT]**

[CD]

- 4 byte float value

7.2 SecondChannelOption

The Sciospec ISX-3v2 can be equipped with an additional multiplexed measurement channel, which can be used for an additional experiment. The second channel can be equipped with almost any type of connector. By default BNC, SMA and MCX are available. Connect Sciospec for further details.

7.3 AcCoupling internal

The AcCouplingOption - Internal adds a second multiplexed channel to the Sciospec ISX-3v2 which is fully galvanic isolated by the circuit shown in *Fig: Circuit - AcCouplingOption*.

Only BNC connectors are available for this option.

The SecondChannelOption is automatically added for the AcCouplingOption.

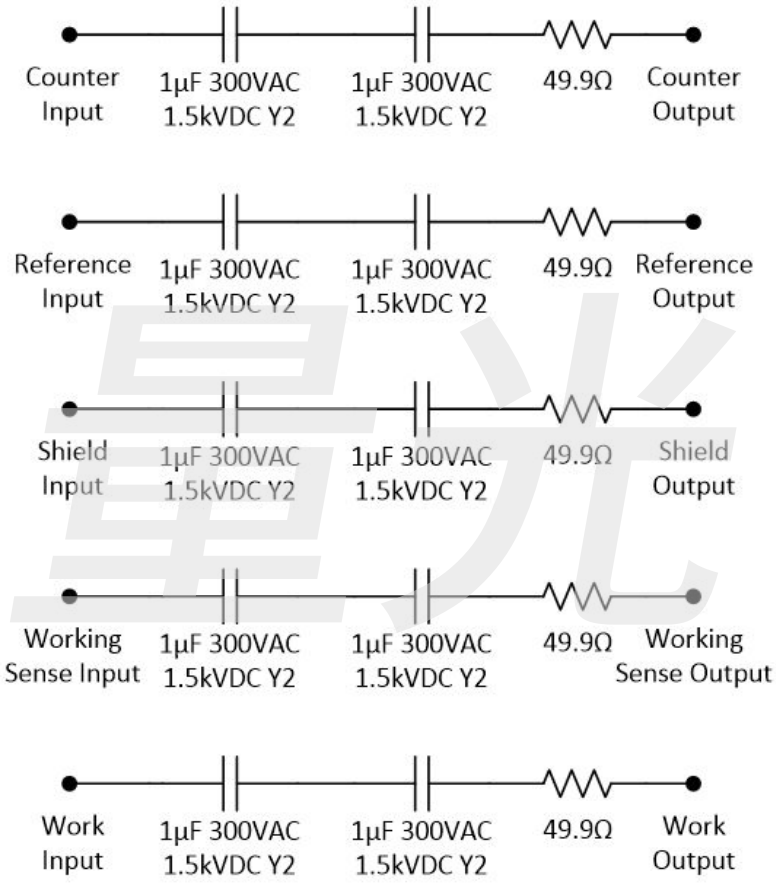


Fig: Circuit – AcCouplingOption (additional each input terminal is connected with a 1MOhm resistor to the cable shield of the input cable.)

7.4 InternalMUX32

The Sciospec ISX-3v2 can be equipped with a 32 channel any to any multiplexer module.

7.4.1 Technical Specifications

General Overview

The 32any2anyMUX is a multiplexer module which offers 32 channels. Every channel can be any of the functions: Counter, Reference, Working Sense or Work in 2, 3 or 4 point configuration. Measurements can be configured from any to any other channel(s). Measurements are acquired sequentially (multiplexed).

- 32 channel multiplexer module with any to any functional multiplexing for 2, 3 and 4 electrode configurations
- high isolation, ultra-low parasitic reed relay switches with superior performance compared to semiconductor switches
  - >10 TΩ || 0.4 pF isolation at power off or software selected cell disconnect
  - extremely low parasitic capacitance < 0.7 pF offers close to no cell loading
  - max. series resistance 200 mΩ in connected state
  - zero leakage current in on state
  - zero charge injection, no distortion, no noise contributions beyond thermal noise
- available frontpanel connectors: edge-card connector (MEC1-150-02-F-D-EM2), MDR40 connector (10240-1210PE)

All specifications are stated for a operating at temperatures of 0°C to 40°C unless specified otherwise.
Warm-up time must be greater than or equal to 30 minutes after power on to comply with all specifications.

measurement port protection

Be aware that the measurement terminals are very sensitive to electrostatic discharge, over-current and over-voltage. Protection of the terminals of the instrument and strict adherence to the specified maximum ratings has to be ensured by the user. For further information on how to connect specific device under test to the instrument contact Sciospec or an authorized representative directly.

7.4.2 General Specifications

operating conditions	0°C to 40°C, <80% relative humidity non condensing, 0...3000m altitude
non-operating conditions	-25°C to 80°C, <80% relative humidity non condensing The temperature gradient should not exceed 1K/min to reach operating conditions.

7.4.3 Channel Selection

Pinout - Edge-card connector (MEC1-150-02-F-D-EM2)

Pin (MEC1, bottom side)	Function		Pin (MEC1, top side)	Function
1	1		2	2
3	3		4	4
5	5		6	6
7	7		8	8
9	d.n.c.		10	d.n.c.
11	9		12	10
13	11		14	12
15	13		16	14
17	15		18	16

Pin (MEC1, bottom side)	Function		Pin (MEC1, top side)	Function
19	d.n.c.		20	d.n.c.
21	17		22	18
23	19		24	20
25	21		26	22
27	23		28	24
29	d.n.c.		30	d.n.c.
31	25		32	26
33	27		34	28
35	29		36	30
37	31		38	32
39	d.n.c.		40	d.n.c.
41, 43, 45, 47, 49, 53, 55	GND		remaining pins	d.n.c.

Pinout - MDR40 connector (10240-1210PE)

Pin MDR40	Function		Pin MDR40	Function
1	GND		21	d.n.c
2	d.n.c.		22	d.n.c.
3	d.n.c.		23	d.n.c.
4	GND		24	GND
5	32		25	31
6	30		26	29
7	28		27	27
8	26		28	25
9	24		29	23
10	22		30	21
11	20		31	19
12	18		32	17
13	16		33	15
14	14		34	13
15	12		35	11
16	10		36	9

Pin MDR40	Function		Pin MDR40	Function
17	8		37	7
18	6		38	5
19	4		39	3
20	2		40	1

Configuring the Measurement Port of the *InternalMUX32* in the Software

The configuration of the setup has to be done accordingly to the manual of the corresponding impedance analyzer Sciospec ISX-3v2, Sciospec ISX-3mini or Sciospec ISX-5.

The measurement channel of the *InternalMUX32* is done in the Channel-Settings dialog by selecting **EXT2** for InternalMUX32 or **MUX32** for external MUX as the primary channel, see Figure 3. Now the 2/3 or 4 point configuration and channel selection can be configured.

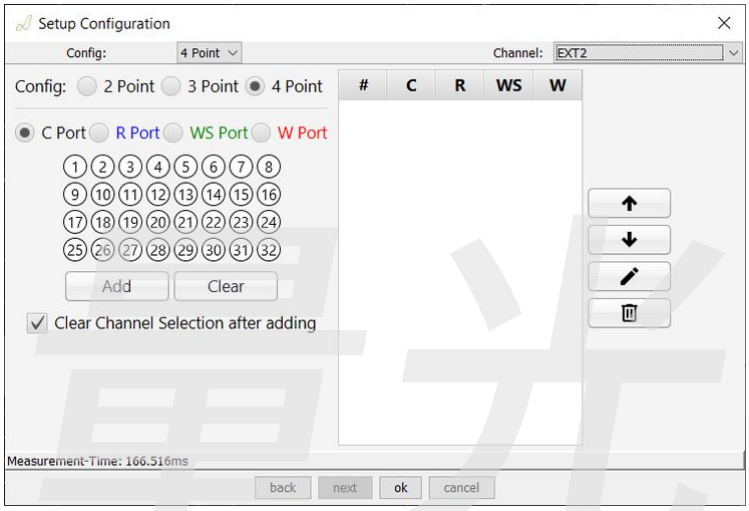
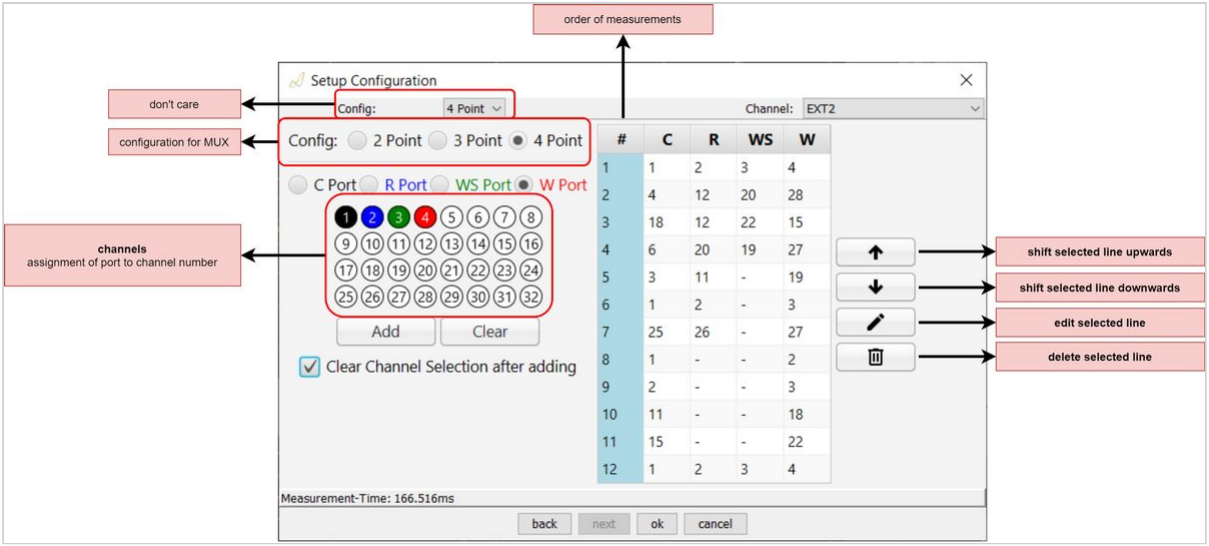


Figure 3: Channel configuration dialog



7.4.4 Sciospec COMInterface

Command list

The leading hex code of each command heading represents the [command code] of the respective function.

Command description

0xB2 - Add ExtensionPort Channel

Adding an ExtensionPort channel configuration to the stack.

> The device has a stack length of **128** (for InternalMux). So only 128 ExtensionPort Channel configurations can be stored. Sending the set ExtensionPort Channel command more than 128 times results in a NACK return. The stack will be emptied using the "empty FE settings" command: **B0 03 FF FF FF B0**

General syntax

[CT] 04 **[CP] [RP] [WS] [WP]** [CT]	for 4 point configuration
[CT] 03 **[CP] [RP] [WP]** [CT]	for 3 point configuration
[CT] 02 **[CP] [WP]** [CT]	for 2 point configuration

Return

ACK

ExtensionPort- channel settings

[CP]	(C-Port): Counter - Port Selection
[RP]	(R-Port): Reference - Port Selection
[WS]	(WS-Port): Working Sense - Port Selection
[WP]	(W-Port): Work - Port Selection

All Ports numbers are send in integer straight binary numbers running from 1 to 32.

Example

- B2 04 **01 02 03 04** B2
  Adding the channel configuration C1, R2, WS3 and W4 for 4 point configuration
- B2 02 **01 02** B2
  Adding the channel configuration C1 and W2 for 2 point configuration

0xB3 - Get ExtensionPort Channel

Read the currently set ExtensionPort configuration stack.

General syntax

[CT] 00 [CT]

Return

[CT] [LE] [channel config 1] [channel config 2] .... [channel config n] [CT] *

ACK

** One data frame is limited to a total of 255 bytes of data. If the returned data exceed this amount of bytes, the returning command will be split into multiple separate frames.*

[LE]

- Length: 1 byte
- depends on the number of configuration currently set

[channel config #]

- # = 1, 2 ... n
- Length: 4 byte (for 2 /3 and 4 point configuration, not used ports are filled with 00)
- **[channel config #] = [CP] [RP] [WS] [WP]**

CP	(C-Port): Counter - Port Selection
RP	(R-Port): Reference - Port Selection
WS	(WS-Port): Working Sense - Port Selection
WP	(W-Port): Work - Port Selection

Example:

B3 0C 01 02 03 04 09 0A 0B 0C 11 00 00 14 B3

- 01 02 03 04 → C = 1, R = 2, Ws = 3, W = 4
- 09 0A 0B 0C → C = 9, R = 10, Ws = 11, W = 12
- 11 00 00 14 → C = 17, W = 20 - 2-point config

7.5 Synchronization Ports

The Sciospec ISX-3v2 can be equipped with the synchronization ports option for synchronization with other customer hardware. It enables ultra-fast hardware synchronization through sync in/out ports (e.g. through low level isolated interface or optional isolated sync module).

7.5.1 Technical Specifications

All specifications are stated for a operating at temperatures of 0°C to 40°C unless specified otherwise.
Warm-up time must be greater than or equal to 30 minutes after power on to comply with all specifications.

Maximum Ratings

Stresses above the listed absolute maximum or maximum ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

sync ports	two inputs, two outputs
sync input type	point hold off, sweep hold off, immediate stop
sync output type	sweep complete, point complete
connectors	four SMA (female, standard polarity)
absolute maximum input voltage	3.8 V for 3.3V logic (default) 5.5 V for 5V logic option
absolute minimum input voltage	-0.5 V
high level input voltage	≥2 V
low level input voltage	≤0.8 V
high level output voltage	≥2.9 V (typ. 3.1 V) for 3.3V logic (default) ≥4.6 V (typ. 4.8 V) for 5V logic option
low level output voltage	typ. 0.2 V
Output impedance	50 Ω
maximum output current	10 mA
Input leakage current	±10 µA
ESD protection	±12kV IEC 61000-4-2 contact ESD ±15kV IEC 61000-4-2 air-gap ESD clamp voltage 10.5V (min) break-down voltage 7V (min)
Isolation	Maximum Isolation (Input to Output) (1 sec) 4500 V RMS 60950-1: Up to 125 VRMS reinforced insulation working voltage; up to 250 VRMS basic insulation working voltage

Transient Immunity	50 kV/µs
Timing	Minimum Pulse Width 5 ns (max) Propagation Delay 8 ns (typ.) Output rise time 2.5 ns (typ. @C_L = 15 pF)

ⓘ Inputs are internally biased to 3.3V by a 10kΩ pull up resistor.

7.5.2 Functional Description

For synchronization with other customer hardware the Sciospec ISX-3v2 can be equipped with the Synchronization Module. It offers two "Sync Out" and two "Sync In" ports located at the back of the instrument. Use standard SMA cables to connect your hardware. Each port is equipped with an open drain buffer to allow different logic voltage levels.

ⓘ The outputs are equipped with a 10kΩ pull up resistor to 3.3V.

If you require different voltage levels please contact Sciospec directly for support.

The "Sync Out I" port gives information about the current state of the measurement.

- Logic high → Measurement is running
- Logic low → Measurement is paused between two measurement sweeps. This time can be configured by setting the sync time in the range 0s to 200s in 1µs steps. Default is 0 seconds.
- The setting 0 seconds results in no change of the signal between two measurements

If an average count higher than 1 is configured there will be a change in between one measured spectrum.

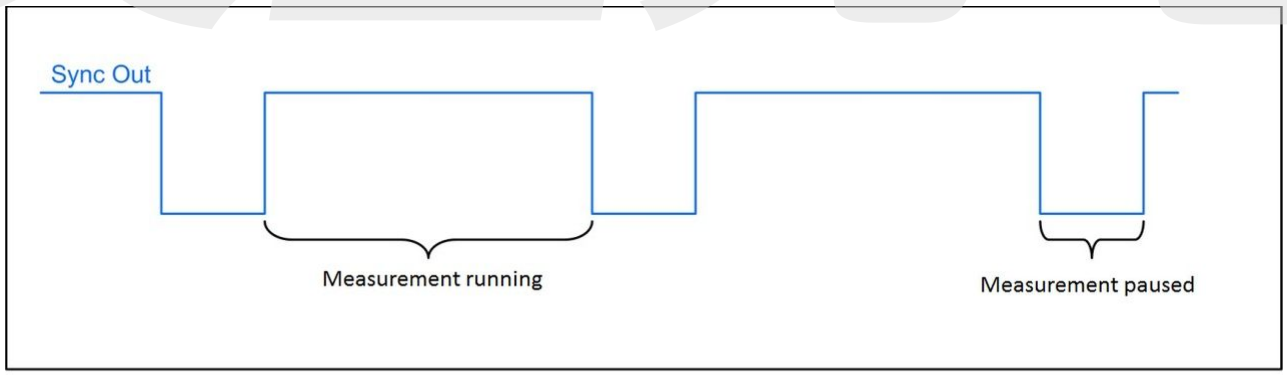


Fig: Sync Out Signal

- The "Sync In" port allows to control the measurement process
  - By default the signal is logic high, which allows for a continuous measurement.

- By connecting this port to ground (logic low) the next measurement will be paused until the signal is released again.
- An already running sweep will not be interrupted by the “Sync In 1” signal.
- Do not apply any voltage source directly to the synchronization ports

- The ports “Sync In II” and “Sync Out II” are not used by default. Please contact Sciospec directly for further assistance when requiring different types of synchronization.

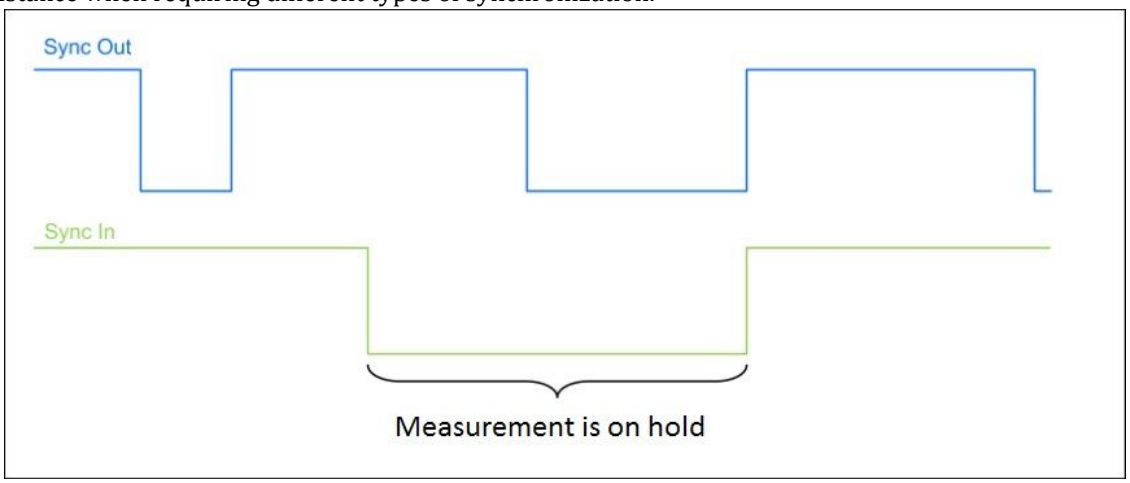


Fig: Sync In Signal

7.6 Battery Operation

The Sciospec ISX-3v2 and ISX-3mini can be equipped with an integrated battery pack for measurements up to 2-3 h.

7.6.1 Technical Specifications

Battery Pack

- Lithium Ion battery pack
- no. of cells: 3 cells; 1S3P
- capacity nom. 10500 mAh
- 28 Wh
- measurement time ~2-3h (determined under certain circumstances, not generally valid!)
- ambient temperature range

0°C to +45°C	charge
-20°C to +60°C	discharge
-20°C to +30°C	storage max. 1 year
-20°C to +45°C	storage max. 3 month

7.6.2 Functional Description

The Sciospec ISX-3v2 / ISX-3mini can be configurated to measure on battery operation or mains operation. The configuration can be done in the Sciospec software (see Measurement Software Description) or using the

Sciospec COMInterface (see Sciospec COMInterface). If the device is measuring on battery operation a minimum capacity can be configured, where the device changes to mains operation but the measurement continuous. The minimum capacity can be changed between 5 % and 100 %. By default 10 % is configured.

ⓘ Please charge the device at 10% remaining capacity. Please do not fully discharge the battery.

7.6.3 Sciospec COMInterface

0xC2 - Set BatMod

General Syntax

[CT] [LE] **[OB] [CD]** [CT]

Return

ACK

[OB]

Function	set
Measure on Battery	0x02
Measure on Battery min capacity	0x03

Measure on Battery

Set the Battery Mode to measure on battery.

Syntax

- Syntax set: **[CT] 02 02 [CD] [CT]**

[CD]

- 0x00: Disable
- 0x01: Enable

Measure on Battery min capacity

Set the Battery Mode to change to external power supply when the battery min capacity is reached. Measurements will be continued.

Syntax

- Syntax set: **[CT] 02 03 [CD] [CT]**

[CD]

- minimum state of charge in percent (≤ 100)

0xC3 - Get BatMod

General Syntax

[CT] [LE] **[OB] [CD]** [CT]

Return

[CT] [LE] **[OB] [status] [remaining capacity]** [CT]

ACK

[OB]

Function	get
Status / remaining capacity	0x01

Status / remaining capacity

Gets Status of Battery Mode and remaining capacity of battery.

Syntax

- Syntax get: **[CT] 01 01 [CT]**
  - Return: **[CT] [LE] 01 [status] [remaining capacity] [CT]**

[status]

1 Byte bit coded

MsBit - Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	LsBit - Bit 0
d. c.	d. c.	d. c.	d. c.	d. c.	d. c.	powers source	charging

power source:

- 1 = battery
- 0 = external

[remaining capacity]

- 1 byte hexadecimal remaining capacity in percent (≤ 100 percent)

7.6.4 Measurement Software Description

If the Sciospec ISX-3v2 or ISX-3mini contains a battery pack, the main window of the software will show the battery status at the right top, see *Fig: Main Window battery operation.* By hovering over the battery status symbol with the mouse pointer, the capacity left in % will be displayed. The possible battery statuses are shown in *Tab: Battery statuses*.

Fig: Main Window battery operation

symbol	status	remaining capacity		symbol	status	remaining capacity
	battery	100%-75%			charging	100%-75%
	battery	75%-50%			charging	75%-50%
	battery	50%-25%			charging	50%-25%
	battery	25%-0%			charging	25%-0%

Tab: Battery statuses

Battery Operation Configurations

Under [Extra] → [Battery Mode] a Battery Mode Configuration Window can be opened.

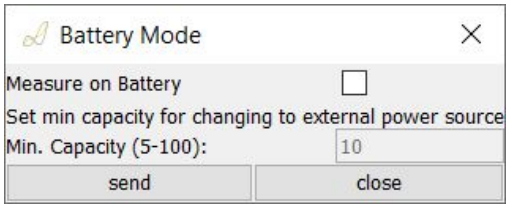


Fig: Battery Mode Configuration Window

Following configurations are available:

- Measure on Battery
- Set minimum capacity for changing to external power supply, **measurements will be continued**
    - selectable between 5-100%

8 Appendix

8.1 Data formats

All data sent to the device or sent from the device is either “Integer-Straight-Binary” or 32 Bit Float coded (according to IEEE 745). Either way the data is in Big-Endian format.

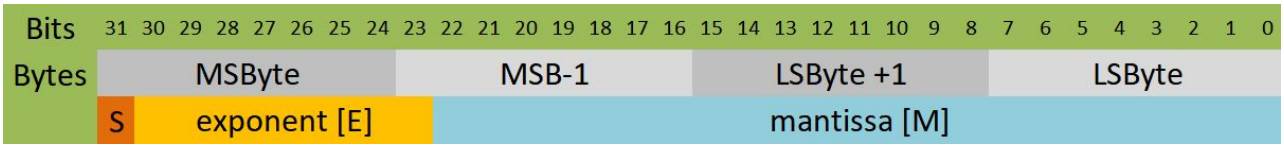
Big-Endian means that if a value consists of more than one byte the byte order is according to their value:

Example 4 byte Big-Endian Value: [MSByte] [MSByte-1] [LSByte-1] [LSByte]

The bit order is within one byte MSBit-first:

[MSBit] [MSBit-1] [MSBit-2] [MSBit-3] [LSBit+3][LSBit+2] [LSBit+1] [LSBit]

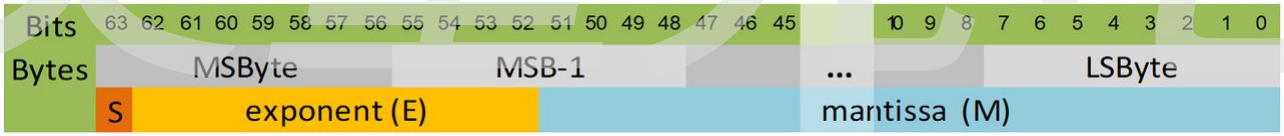
8.1.1 Float data format - single precision



The float value is calculated as follows:

$$float = (-1)^S * (1 + M * 2^{-23}) * 2^{E-127}$$

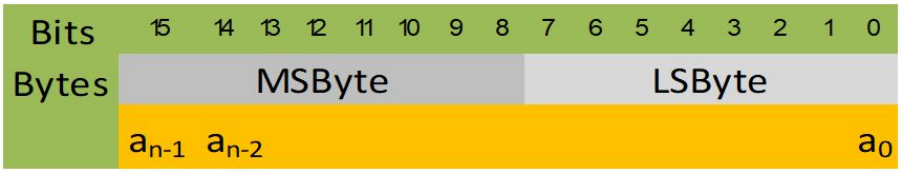
8.1.2 Float data format - double precision



The double precision value is calculated as follows:

$$float = (-1)^S * (1 + M * 2^{-52}) * 2^{E-1023}$$

8.1.3 Integer straight binary data format



The numerical value is calculated as follows:

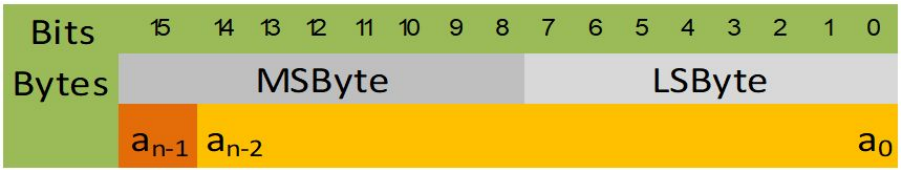
$$x_{ISB} = 2^{n-1} * a_{n-1} + 2^{n-2} * a_{n-2} + \cdots + 2^1 * a_1 + 2^0 * a_0$$

with

- n - bit width (in this example n=16)
- a_i - bit numbering i (a_{n-1}...most significant bit; a_0...least significant bit)

8.1.4 Two's complement data format

Example: 16bit two's complement



The numerical value is calculated as follows:

$$x_{twos} = -2^{n-1} * a_{n-1} + 2^{n-2} * a_{n-2} + \cdots + 2^1 * a_1 + 2^0 * a_0$$

with

- n - bit width (in this example n=16)
- a_i - bit numbering i (a_{n-1}...most significant bit; a_0...least significant bit)

8.2 Temperature Sensors - negative temperature coefficient (NTC) thermistor

The temperature measurement works by connecting a NTC thermistor to the specified port. The instruments needs to know the following characteristics of the connected thermistors to calculate the temperature correctly

name	symbol	description	unit	typical value
Beta parameter	β	material constant, refer to the datasheet of the thermistor	K	3800K
Reference temperature	T_N	operating temperature	K	298,15K (25°C)
resistance at T_N	R_N	Nominal resistance at the operating temperature	Ω	10kΩ

The conversion formula for the temperature ϑ is:

$$\vartheta = \frac{\beta * T_N}{\beta + \ln\left(\frac{R}{R_N}\right) * T_N} - 273{,}15$$

8.3 Declaration of Conformity

scio spec scientific instruments	**Declaration of Conformity** **According to EN ISO/IEC 17050-1:2010**	CE
Manufacturer's Name	Sciospec Scientific Instruments GmbH	
Manufacturer's Address	Leipziger Str. 43b, 04828 Bennewitz Germany	
Declares under sole responsibility that the product as originally delivered		
Product Name	Impedance Analyzer	
Model Number	ISX-3, ISX-3mini	
Product Options	This declaration covers all options, cables and accessories of the above products(s).	
Serial Number	Covers all products • 01-000B-XXXX-XXXX (ISX-3) • 01-000D-XXXX-XXXX (ISX-3mini)	
complies with the essential requirements of the following applicable European Directives, and carries the CE marking accordingly		
	Low Voltage Directive (LVD)	**2014/35/EU**
	Electromagnetic compatibility Directive (EMC)	**2014/30/EU**
	Restriction of Hazardous Substances Directive (RoHS2)	**2011/65/EU**
and confirms with the following product standards		
	EMC	**DIN EN 61326-1:2013-07**
	Safety	**DIN EN 61010-1:2020-03**
	RoHS	**DIN EN IEC 63000:2019-05**
The product is to be used for the intended purpose. This product were tested in a typical configuration with Sciospec test systems. When used under conditions other than the specified conditions appropriate protective measures by the user must be taken.		
This DoC applies to above-listed products placed on the EU market after		
Date	April 15th, 2021	
Place	Bennewitz, Germany	
Name	Martin Bulst	
Signature		

9 Changelog

Revision 1.0

- Initial Release of this document

Revision 1.1

- Example code for establishing USB connection corrected
- Documentation of “add frequency block” corrected
- Added C-code example of a whole measurement

Revision 1.2

- Added Calibration Routines
- Added ability to store setup configurations in the device
- Added IP and MAC address commands for Ethernet communication

Revision 1.3

- Added point delay and phase synchronization options
- Updated set setup and get setup command description
- Updated Synchronization ports description
- Added Ethernet functionality

Revision 1.4

- Correction on "set Ethernet configuration" command

Revision 1.5

- Added ideal capacitor as possible load impedance
- Added description for use of measurement module within ISX-5/MSX-8

Revision 1.6

- Updated Kinetic Mode description

Revision 1.7

- Added Time Stamp Option (commands 0x97 & 0x98)
- Added External Temperature Control compatibility
- Minor Bugfixes
- More detailed description of the "Autosave" feature

Revision 1.8

- Changed Command "get ExtPort module" (0xB5)
- Minor Bugfixes

Revision 1.9

- Added Options section

Revision 1.10

- Added AcCoupleOption - External

Revision 1.11

- Updated description of B6 command regarding extent options (EOP)
- Update company contact details

Revision 1.12

- Fixed wrong order in of Ports in B2 and B3 command

Revision 53

- changed revision numbering system.
- Reworked whole document structure.
- Reworked Ethernet documentation. Added C-Code example to Appendix.
- Updated TechSpecs

Revision 72

- Added Error messages
- Added save directory of Logfiles
- Added the show measured data in tree too functionality
- Added stitch spectra option
- Added Full speed USB
- Updated Installation
- Added Surface Plot
- Excluded Synchronization Ports
- Updated photographs

Revision 74

- Updated measurement software description
- Changed position of section "Measurement delay options and phase synchronization"

Revision 80

- Changed formatting of commands in COMInterface section
- Added copy About screen functionality
- Updated Declaration of Conformity
- restructured documentation of optional Add-Ons
- Added section Battery Operation

Revision 81

- Added Details to Technical Specifications
- Added possible file extensions to autosave description
- Added General software window description
- Added firmware information readout functionality to COMInterface. (commands 0xD0 and 0xD2)
- Added additional data formats to appendix
- Updated installation section
- Excluded High Speed USB description
- Updated DC-Bias description
- Updated technical specifications Synchronization module
- Updated commands 0xB0, 0xB5, 0xB6 and 0xB7
- Shifted position of 0x99, 0x9A, 0x9B, 0x9C, 0x9D, 0x9E commands to Options IOport
- Updated IOPort description

- Excluded documentation of InternalMux

Revision 82

- Added documentation of InternalMux32
- Updated channel selection dialog in software description

Revision 83

- Corrected picture in measurement software description
- Added description of device specific ACK messages

Revision 86

- Updated page formatting
- Updated Documentation of 32any2anyMUX COMInterface