

made to measure

OPERATING INSTRUCTIONS AND SYSTEM DESCRIPTION OF THE

ISO-STIM 01M

STIMULUS ISOLATION UNIT FOR EPMS SYSTEMS



VERSION 4.4
npi 2021

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1. Safety Regulations

VERY IMPORTANT: Instruments and components supplied by npi electronic are **NOT** intended for clinical use or medical purposes (e.g. for diagnosis or treatment of humans), or for any other life-supporting system. npi electronic expressly disclaims any warranties for such purpose. Equipment supplied by npi electronic shall be operated only by selected, trained and adequately instructed personnel. For details please consult the **GENERAL TERMS OF DELIVERY AND CONDITIONS OF BUSINESS** of npi electronic, D-71732 Tamm, Germany.

- 1) **GENERAL:** This system is designed for use in scientific laboratories and should be operated by trained staff only. General safety regulations for operating electrical devices are to be considered.
- 2) **AC MAINS CONNECTION:** While working with the npi systems, always adhere to the appropriate safety measures for handling electronic devices. Before using any device please read manuals and instructions carefully.
The device is to be operated only at 115/230 Volt 60/50 Hz AC. Please check for appropriate line voltage before connecting any system to mains.
Always use a three-wire line cord and a mains power-plug with a protection contact connected to ground (protective earth).
Before opening the cabinet disconnect mains power-plug.
Disconnect mains power-plug when replacing the fuse or changing line voltage. Replace fuse only with an appropriate specified type.
- 3) **STATIC ELECTRICITY:** Electronic equipment is sensitive to static discharges. Some devices such as sensor inputs are equipped with very sensitive FET amplifiers, which can be damaged by electrostatic charge and must therefore be handled with care. This can be avoided by touching a grounded metal surface when changing or adjusting sensors. **Always turn power off when adding or removing modules, connecting or disconnecting sensors, headstages or other components from the instrument or 19" cabinet.**
- 4) **TEMPERATURE DRIFT / WARM-UP TIME:** All analog electronic systems are sensitive to temperature changes. Therefore, all electronic instruments containing analog circuits should be used only in a warmed-up condition (i.e. after internal temperature has reached steady-state values). In most cases a warm-up period of 20-30 minutes is sufficient.
- 5) **HANDLING:** Please protect the device from moisture, heat, radiation and aggressive chemicals.
- 6) **SPECIAL WARNING:** THIS INSTRUMENT HAS A HIGH VOLTAGE OUTPUT (PINS MARKED ISOLATED OUTPUT, CAUTION HIGH VOLTAGE). **Do not touch these pins, nor not insulated wires connected to these pins. Always turn power off if you manipulate devices connected to these pins.**

2. Special Safety Notice for High Voltage Instruments



**HIGH VOLTAGE!!
RISK OF ELECTROCUTION!!**

Observe extreme caution when working with this instrument!!!

- 1) Always connect high voltage power supplies to protective earth!!
- 2) Do not touch connections unless the instrument is turned off and the capacitance of both the load and power supply are earthed!!
- 3) Allow adequate time for discharge of internal capacitance of the power supply!!
- 4) Do not ground yourself or work under wet or damp conditions!!
- 5) Servicing should be only done by qualified personnel aware of the hazards!!
- 6) If in doubt, return to supplier for servicing!!

3. EPMS-07 Modular Plug-In System

3.1. General System Description / Operation

The npI EPMS-07 is a modular system for processing of bioelectrical signals in electrophysiology. The system is housed in a 19" rackmount cabinet (3U) has room for up to 7 plug-in units. The plug-in units are connected to power by a bus at the rear panel.

The plug-in units must be kept in position by four screws (M 2,5 x 10). The screws are important not only for mechanical stability but also for proper electrical connection to the system housing. Free area must be protected with covers.

3.2. EPMS-07 Housing

The following items are shipped with the EPMS-07 housing:

- ✓ EPMS-07 cabinet with built-in power supply
- ✓ Mains cord
- ✓ Fuse 2 A / 1 A, slow (inserted)
- ✓ Front covers

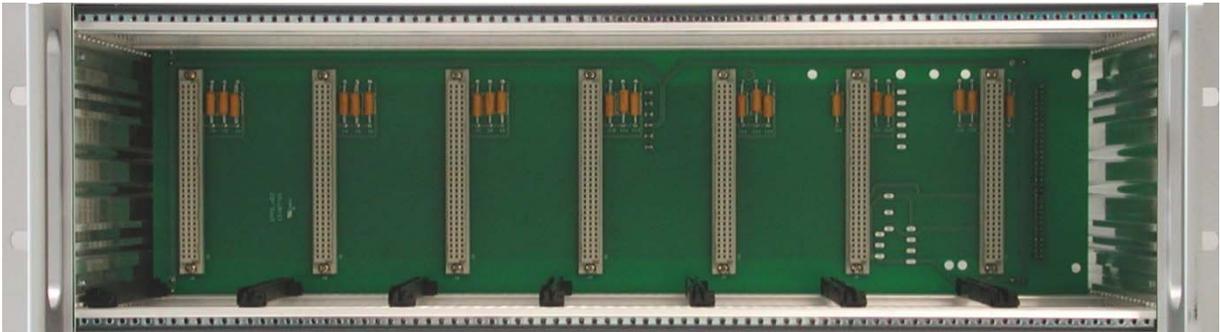


Figure 1: Left: front view of empty EPMS-07 housing.

In order to avoid induction of electromagnetic noise the power supply unit, the power switch and the fuse are located at the rear of the housing (see Figure 2, right).

3.3. EPMS-H-07 Housing

In addition to the standard power supply of the EPMS-07, the EPMS-H-07 has a built-in high voltage power supply. This is necessary for all MVCS / MVCC modules, the HVA-100, HV-TR150 and HVC-03M modules. The output voltage depends on the modules in use.

3.4. EPMS-E-07 Housing

The following items are shipped with the EPMS-E-07 housing:

- ✓ EPMS-E-07 cabinet
- ✓ External Power supply PWR-03D
- ✓ Power cord (PWR-03D to EPMS-E-07)
- ✓ Mains chord
- ✓ Fuse 1.6 A / 0.8 A, slow (inserted)
- ✓ Front covers

The EPMS-E-07 housing is designed for low-noise operation, especially for extracellular and multi channel amplifiers with plugged in filters. It operates with an external power supply to minimize distortions of the signals caused by the power supply.

3.5. EPMS-03

The following items are shipped with the EPMS-07 housing:

- ✓ EPMS-07 cabinet with built-in power supply
- ✓ Mains cord
- ✓ Fuse 034 A / 0,2 A, slow (inserted)
- ✓ Front covers



Figure 2: Left: front view of EPMS-03 housing. Right: rear panel detail of EPMS-03 and EPMS-07 housing.

In order to avoid induction of electromagnetic noise the power supply unit, the power switch and the fuse are located at the rear of the housing (see Figure 2, right).

3.6. PWR-03D

The external power supply PWR-03D is capable of driving up to 3 EPMS-E housings. Each housing is connected by a 6-pole cable from one of three connectors on the front panel of the PWR-03D to the rear panel of the respective EPMS-E housing (see Figure 3, Figure 4). A POWER LED indicates that the PWR-03D is powered on (see Figure 3, left). Power switch, voltage selector and fuse are located at the rear panel (see Figure 3, right).

Note: The chassis of the PWR-03D is connected to protective earth, and it provides protective earth to the EPMS-E housing if connected.



Figure 3: Left: PWR-03D front panel view. Right: PWR-03D rear panel view.

Note: This power supply is intended to be used with npI EPMS-E systems only.

3.7. System Grounding

EPMS-07/EPMS-03

The 19" cabinet is grounded by the power cable through the ground pin of the mains connector (= protective earth). In order to avoid ground loops, the internal ground is isolated from the protective earth. The internal ground is used on the BNC connectors or GROUND plugs of the modules that are inserted into the EPMS-07 housing. The internal ground and mains ground (= protective earth) can be connected by a wire using the ground plugs on the rear panel of the instrument. It is not possible to predict whether measurements will be less or more noisy with the internal ground and mains ground connected. We recommend that you try both arrangements to determine the best configuration.

EPMS-E-07



The 19" cabinet is connected to the CHASSIS connector at the rear panel. It can be connected to the SYSTEM GROUND (SIGNAL GROUND) on the rear panel of the instrument (see Figure 4).

The chassis can be linked to PROTECTIVE EARTH by connecting it to the PWR-03D with the supplied 6-pole cable **and** by interconnecting the GROUND and PROTECTIVE EARTH connectors on the rear panel of the PWR-03D (see Figure 3). Best performance is generally achieved without connection of the chassis to protective earth.

Important: Always adhere to the appropriate safety measures.

Figure 4: Rear panel connectors of the EPMS-E-07

3.8. Technical Data

EPMS-07, EPMS-E-07 and EPMS-H-07

19" rackmount cabinet, for up to 7 plug-in units

Dimensions: 3U high (1U=1 3/4" = 44.45 mm), 254 mm deep

EPMS-07 and EPMS-H-07

Power supply: 115/230 V AC, 60/50 Hz, fuse 2 A / 1 A slow, 45-60 W

EPMS-E-07

External power supply (PWR-03D) 115/230 V AC, 60/50 Hz, fuse 1.6/0.8 A, slow

Dimensions of external power supply: (W x D x H) 247 mm x 180 mm x 90 mm

EPMS-03

Power supply: 115/230 Volts AC, 60/50 Hz, fuse 0.4 A / 0.2 A slow

Maximum current supply: 500 mA

Dimensions: 3U high (1U=1 3/4" = 44.45 mm), 245 mm deep, 265 mm wide

4. ISO-STIM 01M Stimulus Isolation Unit

4.1. System Description

The ISO-STIM 01M stimulus isolation unit is a plug-in unit for the npj EPMS-07 modular system. It is designed for application of extracellular stimuli, e.g., in brain slices.

The output signal is optically separated from ground and can either be a constant voltage up to ± 100 V or a constant current up to ± 10 mA. The ISO-STIM 01M has a built-in timing unit with adjustable pulse length, amplitude and polarity.

The ISO-STIM 01M has three modes of operation:

1. In the DIRECT input mode, the output signal follows exactly the input signal.
2. In the GATE TTL input mode the output signal is generated by the build-in timing unit and triggered either by a TTL trigger at the GATE TTL connector or manually with the MAN. TRIGGER switch.
3. In the ANALOG input mode, the output signal follows – like in direct mode – the input signal but is triggered by the input signal itself and the duration of the output stimulus is set at the ISO-STIM 01M.

Two LEDs to indicate if the amplifier is 10% below its positive or negative limit (limit is ± 100 V or ± 10 mA respectively), and one LED to indicate the application of a voltage or current stimulus.

Three trim-pots allow compensation of electrode artifacts (CAP.COMP., OFFSET) and for electronic offsets (BALANCE).

Important: Only connect **one** ISO-STIM-01M module per EPMS housing. Connecting more than one ISO-STIM-01M modules may lead to a current overload in the EPMS's power supply due the high current consumption of the ISO-STIM-01M module during start-up phase.

SPECIAL WARNING: THIS INSTRUMENT HAS A HIGH VOLTAGE OUTPUT (PINS MARKED ISOLATED OUTPUT, CAUTION HIGH VOLTAGE). Do not touch these pins nor bare wires connected to these pins. Always turn power off if you manipulate devices connected to these pins.

4.2. Description of the Front Panel

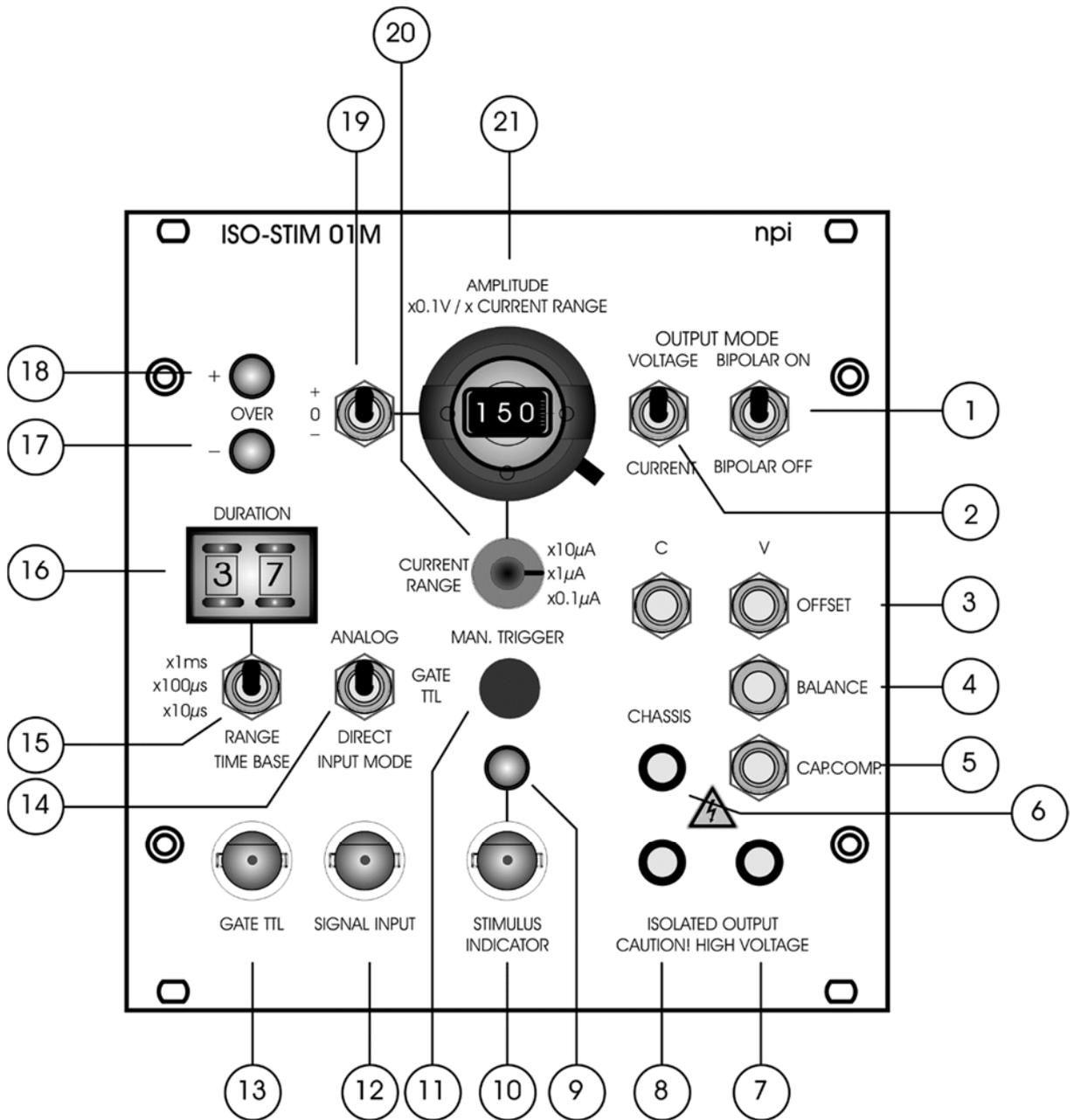
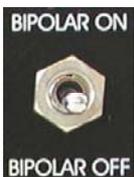


Figure 5: ISO-STIM 01M front panel view

(1), (2) OUTPUT MODE switches

(1) BIPOLAR ON / BIPOLAR OFF switch



Two position switch for selecting the signal OUTPUT mode. Upper position: BIPOLAR ON, Lower position: BIPOLAR OFF.

(2) VOLTAGE / CURRENT switch



Two position switch for selecting the isolator OUTPUT mode. Upper position: VOLTAGE, Lower position: CURRENT.

Important: If the CAP.COMP. (#5) is overcompensated in CURRENT MODE the stimulus isolator will ring and not work properly!

(3) OFFSET trim-pots



OFFSET (C) trim-pot

Trim-pot to compensate for the CURRENT OFFSET of the stimulating electrode in all input modes. It is recommended to compensate the offsets only in a completely warmed up condition, i.e., after 30 minutes warm-up time.

OFFSET (V) trim-pot

Trim-pot to compensate for the VOLTAGE OFFSET of the stimulating electrode in TTL mode. It is recommended to compensate the offsets only in a completely warmed up condition i.e. after 30 minutes warm-up time. Compensation procedure is the same for current and voltage in the TTL MODE.

(4) BALANCE trim-pot



Trim-pot for compensating for baseline differences of the stimulus when switching from DIRECT to GATE TTL mode or vice versa. Even if no stimulus is applied in DIRECT MODE or ANALOG MODE, the baseline of the stimulus isolator may not be zero. Using this trim pot, the stimulus output can be balanced to zero.

OFFSET / BALANCE adjustment

First, the voltage source OFFSET is compensated in TTL mode using the VOLTAGE OFFSET trim pot #18. The same procedure is repeated in TTL mode for current source OFFSET, if the ISO-STIM 01D is in CURRENT mode using the CURRENT OFFSET trim pot #17.

If these baselines are set, the isolation amplifiers may still produce a signal in ANALOG or DIRECT mode even if no stimulus is applied. This offset signal is balanced to zero using the BALANCE trim pot.

(5) CAP.COMP. trim-pot



Potentiometer that compensates for the input capacitances in isolated current output operation. Capacity compensation is achieved by turning the potentiometer with a small screwdriver clockwise until the current signal at the oscilloscope is as square as possible.

Important: If the CAP.COMP. is overcompensated in CURRENT MODE the stimulus isolator will ring and not work properly!

(6) CHASSIS jack



Jack linked to the CHASSIS. The green banana connector of the supplied cable is connected here.

(7), (8) ISOLATED OUTPUT jacks



Jacks providing the ISOLATED OUTPUT signal. The polarity of the input of the +,0,- switch (#19, Figure 5) respectively is not changed, i.e. the red plug is positive (+) if the output polarity switch is set to + or the input signal is positive. This signal is completely isolated from earth. The black jack serves as reference point for the isolated output signal. The black banana connector of the supplied cable is connected to the black jack and the red to the red jack.

WARNING: THIS INSTRUMENT HAS A HIGH VOLTAGE OUTPUT (UP TO ± 100 V). Do not touch these pins or bare wires connected to these pins. Always turn power off if you manipulate devices connected to these pins.

(9), (10) STIMULUS INDICATOR



(9) STIMULUS INDICATOR LED

Yellow LED indicating that a stimulus is applied.

(10) STIMULUS INDICATOR BNC

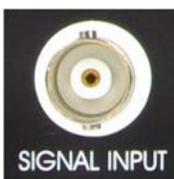
BNC connector providing a TTL signal whenever a stimulus is applied.

(11) MANUAL TRIGGER button



Button for triggering the isolator in GATE TTL INPUT MODE manually.

(12) SIGNAL INPUT BNC



BNC connector for the analog INPUT SIGNAL. The signal is transformed into the isolated output signal and amplified by a factor of ten (see also chapter 5).

(13) GATE TTL BNC



BNC connector for triggering the stimulus isolator in GATE TTL INPUT MODE (see also chapter 5).

(14) INPUT MODE switch



Three position switch to set the operating mode of the stimulus isolator either to ANALOG, to GATE TTL or to DIRECT INPUT MODE (see also chapter 5).

(15) TIME BASE RANGE switch



Three position switch to set the time base of the built-in timing unit. Available ranges: 10-99 μ s (lower position), 100-999 μ s (middle position), 1-99 ms (upper position).

(16) DURATION potentiometer



2-digits, digital potentiometer to set the stimulus duration in GATE TTL INPUT MODE. The stimulus duration is the reading of this potentiometer multiplied by the factor set with switch #16.

Note: Setting of 00 as duration is **not** defined and should **not** be set!!

(17, 18) OVER LEDs



LEDs indicating when the isolator exceeds it's linear range limit (± 90 V or ± 9 mA respectively).

(19) + / 0 / - switch



Switch for setting the polarity of the output signal in GATE TTL INPUT MODE. In “0” position the internal stimulus generation is disabled

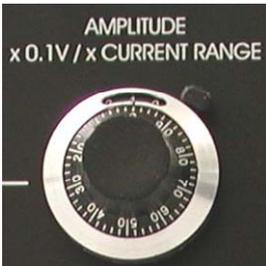
Note: In ANALOG or DIRECT INPUT MODE this switch must be in 0 position.

(20) CURRENT RANGE switch



Three position rotary switch to set the current range of the build-in timing unit. Available ranges: 0.1-99.9 μA (lower position), 1-999 μA (middle position), 10-9999 μA (upper position).

(21) AMPLITUDE potentiometer



Ten-turn potentiometer for setting the AMPLITUDE of the output signal. Range in VOLTAGE mode: 0.1-99.9 V. Amplitude in CURRENT mode is the reading of this potentiometer multiplied by the factor set with switch #20.

5. Modes of Operation

GATE TTL INPUT MODE:

In this mode the output signal is generated by the build-in timing unit. It is triggered either manually via the MANUAL TRIGGER switch or via a TTL pulse at the GATE TTL BNC connector. The duration of the pulse is set at the DURATION thumb wheel switch and the 3-position range switch below. The duration time is determined by reading of the thumb wheel switch multiplied by the factor set via the range switch. The minimum duration is 10 μ s, the maximum is 99 ms.

The amplitude of the pulse is set by the AMPLITUDE thumb wheel switch. The reading of this switch is multiplied by 0.1 V in VOLTAGE OUTPUT MODE. In CURRENT OUTPUT MODE the reading is multiplied by the factor set with the CURRENT RANGE switch. For example, 250 at the thumb wheel switch will give 25 V or 250 μ A (CURRENT RANGE switch in position x1 μ A) at the output plugs depending on the setting at the OUTPUT MODE switch. If the CURRENT RANGE switch is in position x10 μ A, 250 at the thumb wheel switch will give 2.5 mA at the output plugs.

DIRECT INPUT MODE:

The signal fed into the SIGNAL INPUT connector is transformed into the isolated output signal and scaled as specified in Table 1 below.

Table 1: Output scaling in DIRECT mode

CURRENT RANGE	Scaling	example (@ 8 V input)
x 10 μ A	1 mA/V	8 mA
x 1 μ A	0.1 mA/V	800 μ A
x 0.1 μ A	10 μ A/V	80 μ A
VOLTAGE mode	10 V/V	80 V

The polarity switch must be in 0 position! The frequency of the input signal should not exceed 4 kHz.

ANALOG INPUT MODE:

The signal fed into the SIGNAL INPUT connector will be isolated from earth and amplified (OUTPUT MODE: voltage) as in the DIRECT INPUT MODE. The trigger level is set to 300 mV, i.e., the input signal must have an amplitude of 300 mV or more. If the trigger level is exceeded the input signal is transformed to the isolated output plugs, and the output stimulus follows the input signal as long as set by the DURATION thumb wheel.

Figure 7 gives some examples how the different input modes work.

Please note that this figure does not show original recorded data. It's for illustration only

BIPOLAR

The isolator is capable to generate biphasic stimuli by switching the stimulus mode switch to BIPOLAR ON. In this mode, the stimulus that is set by the user, will be followed by a second stimulus with the same amplitude and duration, but with reverse polarity. There is no delay between first and second part of the stimulus. For instance, if the user sets a positive stimulus of +1 V amplitude and 100 μ s duration, this stimulus will be followed immediately by a negative stimulus of -1 V and 100 μ s duration.

OPERATION IN THE 10 mA (max.) RANGE

According to Ohm's law, with 100 V voltage 10 mA current can be achieved **only** if the resistance of the stimulus electrode is not higher than 10 k Ω . Otherwise, the current will be less.

The output is short-circuit protected with a 1 k Ω resistor. This implicates that when using low resistance stimulation electrodes with high current flow, there is a voltage drop at this resistor.

CAUTION: This means that in voltage operation mode the output swing is reduced due to the voltage divider between the electrode resistance and the protection resistor.

6. ISO-CAB (optional accessory)

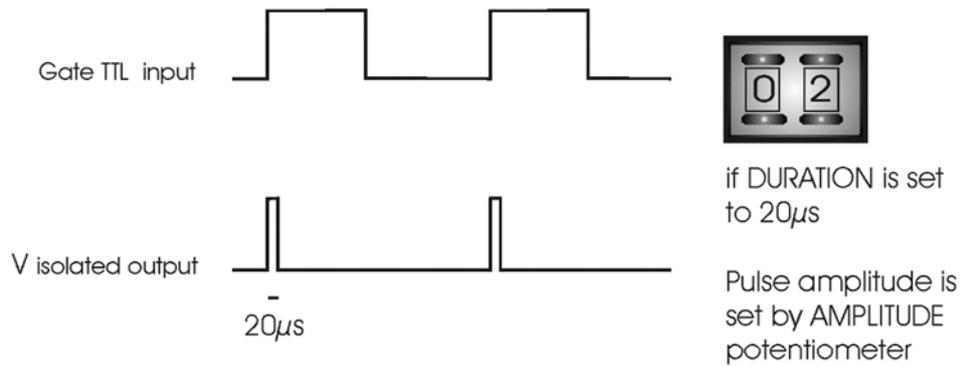
mpi provides an optional shielded cable for connection of stimulation electrodes. One end is equipped with three color coded cables with 2 mm connectors. The red and yellow cables with are connected to the ISOLATED OUTPUT connectors on the front panel of the ISO-STIM-01 M. Each of these stimulation lines has a shield which is connected to the common SHIELD connector at the green cable. To reduce noise during recordings, this connector can be connected to the CHASSIS connector at the ISO-STIM-01 M front panel

The other end of the cable provides open wires, to which different connector types can be soldered by the user. The red cable is +STIM, the yellow cable is -STIM. The shield is present as bare wire. Usually, these shield wires are left unconnected on this end of the cable.

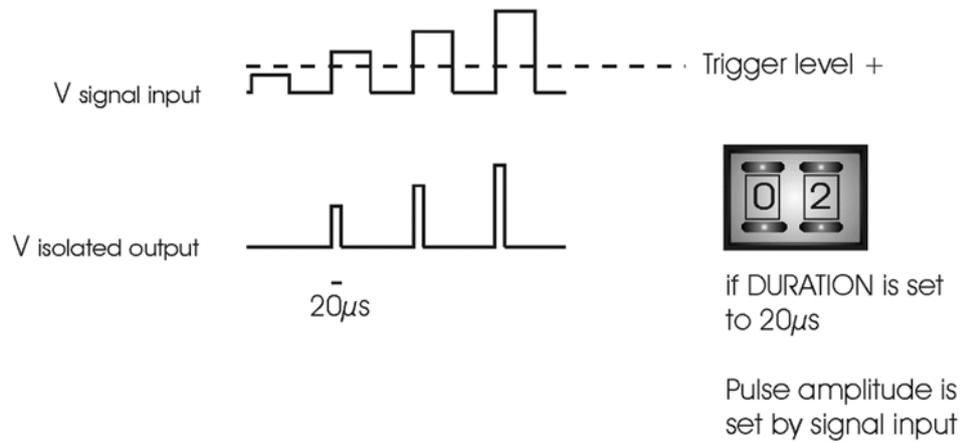


Figure 6: ISO-CAB - shielded cable for connection of stimulation electrodes.

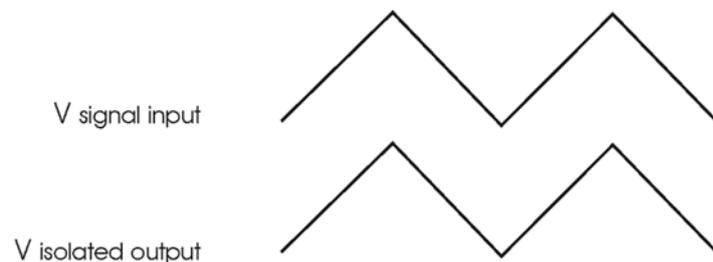
Gate TTL mode (input at GATE TTL BNC)



Analog input mode (input at SIGNAL INPUT BNC)



Direct mode (input at SIGNAL INPUT BNC)



amplification of the output signal is not shown

Figure 7: Modes of operation (illustration only)

7. Test Procedures

For the following test procedures, a function generator is required. The frequency for testing should be around 100 Hz, waveform is triangle. The value of the test pulse amplitude is always described detailed in each of the following steps. In this test condition a load resistor of 100 k Ω is connected to the output plugs (red and black plugs).

7.1. DIRECT mode

Settings: INPUT MODE switch is in position DIRECT, OUTPUT MODE switch in position VOLTAGE. Analog input voltage from a function generator is ± 2 V and connected to the SIGNAL INPUT BNC. Max. output voltage has to be ± 20 V.

Caution: If you measure the output signal with an oscilloscope take care that the function generator has not the same ground connection because of the isolation of the output. It is important to realize that a connection is also possible through the protective ground connections between oscilloscope and function generator (most mains supplied oscilloscopes have a connection between ground and protective earth)! Thus, we recommend to use a battery driven oscilloscope for test measurements to avoid unwanted grounding!

Now the OUTPUT MODE switch is set in position CURRENT (CURRENT RANGE switch set to $\times 1$ μ A) and the amplitude of the input signal is ± 2 V. The max. signal at the isolated output plugs has to be ± 20 V according to the current of ± 200 μ A flowing through the load resistance of 100 k Ω .

7.2. TTL trigger mode

Settings: INPUT MODE switch is in position GATE TTL, OUTPUT MODE switch in position VOLTAGE. The TTL output of the function generator has to be connected to the GATE TTL BNC, the SIGNAL INPUT BNC is not connected. The output voltage will be preset from the value dialed at the AMPLITUDE potentiometer and the polarity from the position of the corresponding toggle switch. Remember at any time Ohm's law to realize what potentials should be generated theoretically; the maximum output voltage of the system is ± 100 V.

7.3. ANALOG trigger mode

Settings: INPUT MODE switch is in position ANALOG TRIG, OUTPUT MODE switch in position VOLTAGE. Toggle switch for DURATION range in position 100 μ s, TIME potentiometer dialed on value 3. Input voltage from a function generator has to be positive referring to ground, value 5 V and connected to the ANALOG INPUT BNC. Output voltage will occur if the input voltage is higher than 300 mV (this is the internal analog trigger level) and only for the desired time (here 300 μ s). The output signal can be varied by using other input amplitude values and / or several time settings.

Caution: If you are working in CURRENT MODE realize that the input resistance of an oscilloscope is normally 1 M Ω , e.g., an oscilloscope connected to the outputs is a 1 M Ω load for the current source producing an output signal that is measured.

8. Technical Data

Input operating modes:	DIRECT, ANALOG TRIGGER, TTL TRIGGER selectable with toggle switch
Function modes:	voltage source, current source selectable with toggle switch
Source ranges:	$\pm 100 \mu\text{A}$, $\pm 1 \text{ mA}$, $\pm 10 \text{ mA}$ (current source), range selectable with 3-position rotary switch $\pm 100 \text{ V}$ (voltage source)
Time range factor:	$\times 10 \mu\text{s}$, $\times 100 \mu\text{s}$, $\times 1 \text{ ms}$ selectable with toggle switch, time range up to 99 ms
Amplitude potentiometer:	3 digits, $\pm 10 \text{ V}$, amplified internally with gain of 10 (voltage source) or scaled with source range switch (current source); polarity selectable with toggle switch
Time potentiometer:	2 digits, 0 – 99 as multiplication factor selectable
Input voltage range:	$\pm 10 \text{ V}$, amplified internal with gain of 10
Input impedance:	10 k Ω
Output:	monopolar or bipolar, selected by toggle switch
Output voltage:	$\pm 100 \text{ V max.}$, isolated
Output current:	$\pm 10 \text{ mA max.}$, isolated