

# MAGPRO FAMILY

## User Guide



MagPro R30  
MagPro R30 with MagOption  
MagPro X100  
MagPro X100 with MagOption

MagPro software v.5.0

UK-edition



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At the time of printing this manual correctly described the device and its functions. However, as modifications may have been carried out since the production of this manual, the system package may contain one or more addenda to the manual. This manual including any such addenda must be thoroughly read, before using the device.

The following situations void any guarantee(s) and obligations for Tonica Elektronik A/S:

- The device is not used according to the enclosed manuals and other accompanying documentation
- The device is installed or modified by persons other than Tonica Elektronik A/S or other authorized service technicians

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# Safety Information

## Safety Requirements

This device has been designed and tested in accordance with IEC 60601-1 Medical Electrical Equipment. The present manual contains some information and warnings, which will have to be followed by the user to ensure safe operation and to retain the device in safe condition.

This device is intended to be used by qualified medical personnel, knowledgeable in the field of the device with the appropriate education and training.

This device has been designed for indoor use at room temperatures between +10°C and +30°C (+50°F to +86°F).

The mains plug must only be inserted in an appropriate mains socket outlet provided with a protective earth contact. It is forbidden to use extension cords.

**WARNING** Any interruption to the protective earth conductor inside or outside the device or disconnection of the protective earth connector terminal is likely to make the device dangerous. Intentional interruption is prohibited. The protective earth (ground) conductor should be checked regularly.

When the device is producing maximum output, power consumption is very high – up to 2300 VA. To prevent any equipment nearby from malfunctioning, the device must be supplied from a separate wall outlet. This is especially important if the total installed power is low. If a problem arises it is usually recommended to seek the advice of a local electrician on this matter. Make sure you use the correct power cord, supplied with the device.

For the combination of this device with other devices and / or for its connection to installations, the following applies:

- When connecting medical equipment being supplied from an outlet located in a non-medically used room, or when connecting non-medical electrical equipment to this device, please pay attention to the requirements of IEC 60601-1-1, Safety Requirements for medical electrical systems.
- When the device is connected to its mains supply, connectors may be live, and any opening of covers or removal of parts possible only with the aid of a tool is likely to expose live parts.
- The device must be disconnected from all voltage sources before being opened for any adjustment, replacement, maintenance or repair.
- Service must be referred to Tonica or other authorized service personnel, except for such works described in this manual as being performed by the operator.
- Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of makeshift fuses and the short-circuiting of fuse holders are prohibited.
- Where more than one piece of equipment is connected to a patient, attention must be paid to the summation of patient leakage currents.
- Whenever it is likely that the protection has been impaired, the device must be disconnected and be secured against any unintended operation.
- In that case, call qualified service personnel to conduct at least a functional test and additionally a safety check including 1) an insulation test, 2) a ground continuity test and 3) a leakage current test, according to IEC 60601-1.
- The protection is likely to be impaired if, for example, the device:
  - Shows visible damage.
  - Fails to perform the intended function.
  - Has been subjected to severe transport stresses.
  - Insufficient Earth connection.
  - Has been subjected to moisture.

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## Intended use

Magnetic stimulation is a non-invasive technique to be used under constant supervision by qualified medical personal, only on patients who are not anaesthetized and only for short term use.

The *MagPro* is intended as an electro-physiological aid to *assess diagnosis* and to *monitor diseases* of the central and peripheral nervous system, based on the use of Motor Evoked Potentials (MEP).

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## Contraindications

Do not use the equipment on patients with cardiac pacemakers, cochlear implants or other implanted electronic devices. Do not apply the magnetic stimuli to the head, neck or abdomen of pregnant women.

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## Adverse Reaction

Do not use this equipment for anything else than it is intended for by the manufacturer.

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## General Warnings



See the accompanying documentation and carefully read the following warnings

### *Warnings*

- Do not use this equipment for anything else than it is intended for by the manufacturer.
- The device is not compatible for use in an MR magnetic field. Please consult the manufacturer for available special solutions.
- Rapid cortical stimulation can induce seizures. Ensure that appropriate safety measures are taken, before using the equipment. (see page 36).
- To protect patients from excessive exposure to magnetic gradients keep the number of stimulations as low as possible.
- The device is not intended for use with anesthetic gases or any other flammable media – danger of electrical ignition.
- The operator must be protected against long-term magnetic fields (e.g. by using a holding device as the Flexible Arm).
- Hearing protection is recommended if the coil is used near the head or when operating with more than 100 stimuli a day.
- Not to be used on small children.
- Keep out of reach of children.
- Precautions should be taken when stimulating patients with suspected or diagnosed labile or hypertensive blood pressure.
- The field produced by this device can damage a cochlear implant, cardiac pacemaker and implanted electronic devices.
- The MagPro must only be used under the constant supervision of qualified medical personal, only on patients who are not anaesthetized and only for short term use.

## *Cautions*

- Before connecting, please read the instructions for use.
- Always carefully examine the coil handle, housing and cables for cracks, marks, deformations, color changes and other signs of damage before using it. Do not use the coil if there is any evidence of stress failure; otherwise it may disintegrate.
- Metallic (conductive) objects in the field may be propelled forcibly by the stimulus pulse. Make sure there are no rings, coins or similar metal objects near the coil when it is activated.
- Do not place the stimulation coil on or near: video monitors, watches, calculators, credit cards or computer disks. Damage or erasure may occur.
- Disable the device when it is not being used by pressing the Enable/Disable button. (see page 12).
- Before changing the stimulation coil, press Disable to avoid damage on personnel and equipment.
- Always use the Flexible Arm to hold the Magnetic Stimulation Coils of Fluid- or Cool types during stimulations.
- Changes in noise level or sound frequency from the coil during stimulation may indicate beginning damages inside the coil. Stop using the coil and contact a Service Center; otherwise it may disintegrate.
- The coil must not be submersed into any conductive liquid, including water. The encapsulation tolerates low levels of surface moist - but in general care should be taken to **keep all surfaces clean and dry**.

# *Introduction to Magnetic Stimulation*

Magnetic stimulation is a non-invasive technique for stimulating muscle, brain and neural tissue. The principle of magnetic stimulation is implicit in Faraday's law. The pulses of current are generated with a circuit containing a capacitor connected to the stimulating coil. With the capacitor charged to a certain level, the conducting state will cause the discharging of the capacitor through the coil. A magnetic field is generated proportional to this current. The rapid change in the magnetic field induces a current in conducting materials e.g. the body tissue. If the current induced in the human body is of sufficient amplitude and duration, it will excite neurones.

The method is - compared to electric stimulation - pain free. The lack of pain is due to a combination of greater depth of penetration, the absence of localized high current densities in the tissue and the ability of the magnetic field to penetrate high resistance structures such as the skull or bones.

Magnetic stimulation represents a form of "electrode less electrical stimulation", without the pain experienced with normal electrical stimulation.

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## **Application possibilities**

Magnetic stimulation has become an invaluable tool for the evaluation of the human motor system in both health and disease.

In clinical neurophysiology and neurology magnetic stimulation can be used to study central motor pathways and to examine patients with radiculopathies and plexopathies.

Magnetic stimulation is also applicable for purposes of mapping the cortical areas and their functions, for the study of connectivity in the neural networks and the functional significance of elements in a neural network for a given task.

It can be used to evaluate intra-cortical excitability and modulate the level of excitability of a given cortical target beyond the duration of the stimulation.

Magnetic stimulation may not only help in our understanding of the neurophysiology of the human brain, but it also promises to enhance the value of imaging studies by adding information regarding the functional role of different (brain) areas.



# Presentation

The MagPro family consists of different models with different level of features. This chapter describes the differences between the models.

The MagPro model name can be seen on the display during start-up.

All features are described in the following chapters. Pay attention to that not all models includes a given feature.

## Working Modes

The device can work in following different modes:

MagPro model	Modes
R30	Standard
R30 + MagOption	Standard Dual Twin
X100	Standard
X100 + MagOption	Standard Power Dual Twin

### *Standard Mode*

Typically chosen when operating with high repetition train sequence.

### *Twin/Dual Mode*

When running in twin/dual mode, the MagPro can provide up to 20 twin pulses per second with an inter pulse interval down to 1ms.

### *Power Mode*

The Power Pulse is the most powerful mode to date. It allows all waveforms to be extended in pulse width and peak with approximately 40%.

## Current Direction

Current Direction in the Magnetic coil can be selected in following directions.

MagPro model	Current Direction
R30	Normal
R30 + MagOption	Normal
X100	Normal or Reverse
X100 + MagOption	Normal or Reverse

## Waveforms

The device is a powerful and efficient magnetic stimulator, featuring following waveforms:

MagPro model	Waveform
R30	Biphasic (Full-Sine)
R30 + MagOption	Monophasic Biphasic (Full-Sine)
X100	Monophasic Biphasic (Full-Sine) Biphasic Burst
X100 + MagOption	Monophasic Biphasic (Full-Sine) Halfsine Biphasic Burst

## Repetition Rate

The device can operate up to following repetition rates:

MagPro model	Max. Rep. Rate
R30	30pps (60pps with 60pps Option)
R30 + MagOption	30pps
X100	100pps
X100 + MagOption	100pps

pps: pulses per second

## Features

### Software

The general user interface in MagPro is logical and well organized, enabling the operator to overview all functions.

The Status Area displays e.g. Coil Temperature, Available Stimuli and Coil Type. All the displayed information is shown in an easily readable form.

MagPro can save and load customized settings, storing all parameters in a stimulation sequence. The device can show the actual as well as the predefined settings.

The coil connectors of MagPro fit most of the stimulating coils from MagVenture (see the Accessories Catalogue).

The MagPro has the ability to combine and control external equipment via the In/Out triggers. If external triggers are selected, the device can be controlled from an external device e.g. the Keypoint<sup>®</sup>.



- 1 Magnetic Stimulating Coil
- 2 MagPro
- 3 MagOption
- 4 Cart
- 5 Flexible Arm for Coil

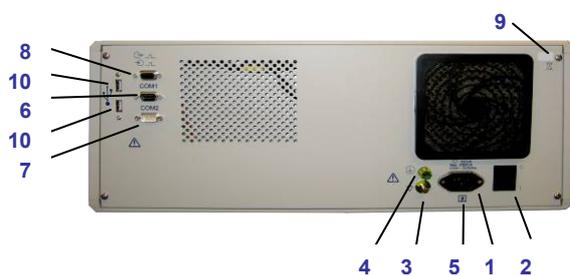
# Symbols and Connections

## Rear Panel



See the accompanying documentation.

**CAUTION** Electric shock hazard. Do not remove cover. Refer servicing to qualified service personnel.



	<b>1</b> Mains Socket
	<b>2</b> ON / OFF button
	<b>3</b> Equipotentiality
	<b>4</b> Earth Connector
	<b>5</b> Apparatus is of type BF, i.e. the applied part is electrically isolated.
COM1	<b>6</b> COM1 Serial Port (MEP Monitor)
COM2	<b>7</b> COM2 Serial Port (Data Export)
	<b>8</b> Trig in/Trig out
	Storage temperature range. Packaging label
SN xxx	<b>9</b> Serial Number
P/N	Part Number
	The device complies with the EC directive 93/42/EEC on medical device.
	Waste Electrical and Electronic Equipment: Compliance information.
	<b>10</b> USB Port

## Power ON/OFF button (2)

The power switch is located in the lower right part of the rear panel to allow easy access, when turning the device on.

## Earth Connectors / Equipotentiality (3 + 4)

To ensure a safe patient environment, we strongly recommend effective grounding of the various items of the equipment. For this purpose, two connectors are provided. When connecting additional pieces of equipment to the device, please pay attention to the maximum permissible leakage currents as per IEC 60601-1.

## Interference

Always use shielded power line cables to avoid line interference.

**WARNING** Electrical equipment for medical use requires special EMC precautions and needs to be installed and serviced according to the EMC documentation of the device.

## Serial ports (6 + 7)

The serial COM1 and COM2 connectors are used for interface to other equipments. COM1 is used for interface to a MEP Monitor unit and COM2 for data export to an external computer.

## Trig in/Trig out connector (8)

Triggering of other equipment from MagPro or triggering of MagPro from other equipment is possible. Special trigger cable must be used.

## USB ports (10)

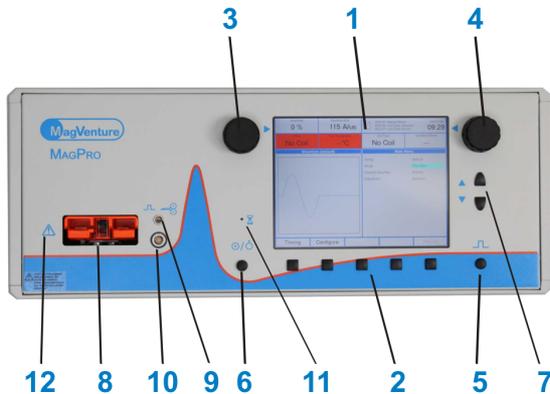
These ports must only be used for export of data supported by the Data Transfer program. See separate documentation.

The USB port is also used for updating of the MagPro software.

The USB memory stick must maximum be of size 2 GB and it must be formatted with the FAT16 file allocation system.

# Controls

## Front Panel



- |   |                        |    |                                    |
|---|------------------------|----|------------------------------------|
| 1 | Display Area           | 7  | Arrow Buttons                      |
| 2 | Soft Keys              | 8  | Coil Connector                     |
| 3 | Pulse Wheel, Amplitude | 9  | Upper Lemo Connectors              |
| 4 | Pulse Wheel, Options   | 10 | Lower Lemo Connector               |
| 5 | Trigger Button         | 11 | Start Up Indicator                 |
| 6 | Disable/Enable Button  | 12 | See the accompanying documentation |

**WARNING** Never Touch the metal pads in the large orange connector.

### Display and Soft Keys Area (1 + 2)

The device has a front panel including a TFT Display (1), and 5 Soft Keys (2). The functions of the Soft Keys are illustrated above in the bottom of the display.

### Pulse Wheels (3 + 4)

There are two Pulse Wheels: one for adjusting the *Amplitude* (3), and one for toggling between the *Options* in each line (4).

### Trigger Button (5)

On each side of the Soft Keys, two small black round buttons are situated. The button to the right of the Soft Keys, is the Trigger Button Function. The Trigger Function is also available in the coil handle enabling stimulation with single pulse.

### Enable/Disable Button (6)

The Enable/Disable function is used to enable the device, when starting to operate and is used to disable the device, when operation is terminated. The device must be disabled, before changing the coils.

The Enable function can also be activated from the trigger button on the coil handle. See section for coils below.

### Arrow Buttons (7)

The functions of the arrow buttons are to toggle between the lines in the display menu.

### Coil Connector (8)

The large orange plug carries the very high current for stimulation as well as the coil temperature measurement signals.

### Lemo Connectors (9 + 10)

The small Lemo connector carries control signals. The Lemo connection must be used, if the controls in the coil handle needs to be applied. The Lemo connector must always be connected to allow the measurement of “Available Stimuli” – and to enable TrainMode, if not only single stimuli is possible.

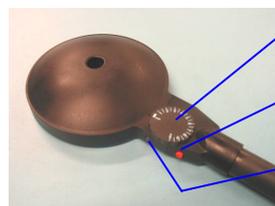
The *Upper Lemo Connection* (9) matches the standard coils without intensity control.

The *lower Lemo connection* (10) matches the standard coils with intensity control.

### Start Up Indicator (11)

The green indicator next to the hourglass symbol flashes during the start up period.

## Coils



- Amplitude control button
- Orange trigger button
- LED Red: disabled
- Green: enabled

### Enabling of MagPro from coil:

Coils with amplitude control button: Turn control button to minimum and press trigger button for 2 seconds.

Coils without amplitude control button: Press trigger button for 2 seconds.

# Software Controls

## Status Area (1)

Amplitude 50 %	Realized di/dt 75 A/us	 09:23:34 - Coil Type: MCF-75 09:23:35 - Coil Type: Unknown 09:23:38 - Coil Type: MCF-B70	2010-01-08 09:24
Status Enabled	Coil Temperature 24°C	Coil Type MCF-B70	Available Stimuli 2652

The *Status Area* in the upper section of the display consists of fixed states fields. In this section the following parameters can be read:

### Amplitude

The amplitude is an expression for the power output level. When changing the coil the device will automatically turn the amplitude down to 0 %.

### Realized di/dt

Realized di/dt is the actual measured value (A/ $\mu$ s) of the coil current gradient. When stimulating with twin pulses or biphasic burst pulses, the realized di/dt will show the parameters A and B, indicating the amplitude of the first pulse (A) and second pulse (B) for twin pulses and last burst pulse (B) for biphasic burst pulses.

Realized di/dt	
A:	82 A/usec
B:	66 A/usec

### Status: Enable/Disable

Enable/Disable is a manual function which indicates whether, or not the device can be activated. The device must be Enabled before it can be activated. The device will automatically disable when one of the following things occur:

- Overheating of coils
- Overheating of the device
- Disconnection of the Stimulation Coil
- Auto Discharge Time, no activity for the selected time

### Coil Temperature

The Coil Temperature shows the actual measured coil temperature. The field will turn yellow at 35°C (95°F), indicating a warning for overheating.

When the temperature exceeds 41°C (106°F), the system will automatically be disabled and the field change from yellow to red. To use the device again, simply change the coil or wait for the coil to cool down.

Be aware that high amplitude and high repetition rates will heat up the coil faster.

As an extra precaution there is implemented an ITP algorithm (ITP – Intelligent Temperature Prediction) that predicts the temperature of the coil even faster than the temperature sensor placed in the coil. It is indicated by a ! sign when ITP is active – see picture below.



### Coil Type

All present types of MagVenture Stimulating Coils can be used with the MagPro. The device automatically identifies the coil type connected to the coil connectors.

If a new coil type is released and the software on MagPro does not recognize it with its real name a coil group name will be displayed instead.

### Available Stimuli

The number of available stimuli is calculated based on coil type, actual temperature and stimulation amplitude. See also "Defined Number of Stimuli" in the section on *Information Area*.

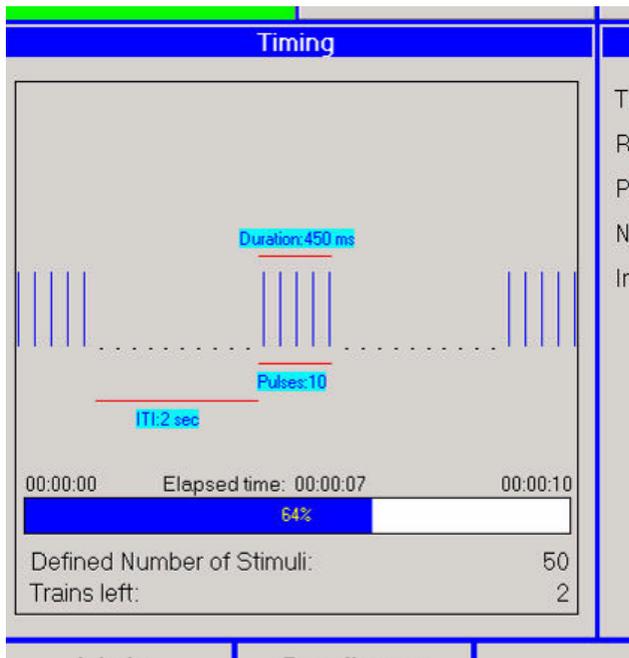
### Event log information and date/time

In the upper right corner of the status area following information is shown:

- Availability of USB memory stick
- Log data (newest data on the bottom line)
- Time and date

For more information about USB memory stick and log data see accompanying documentation regarding Data Transfer.

## Information Area (2)



The left-hand side of the display is the *Information Area*. This area is reserved for illustrations of chosen setups, i.e. waveform, amplitude and sequence. Information is concurrently given about, e.g. Defined Number of Stimuli and train duration.

On the right-hand side of the display, all possible options are listed.

This section is arranged in four different menus selectable with the appropriate Soft Key. The device always starts up in the Main Menu.

Each menu is subdivided into multiple lines of options (i.e. Rep.Rate and Number of Trains) can be controlled by the Arrow Buttons.

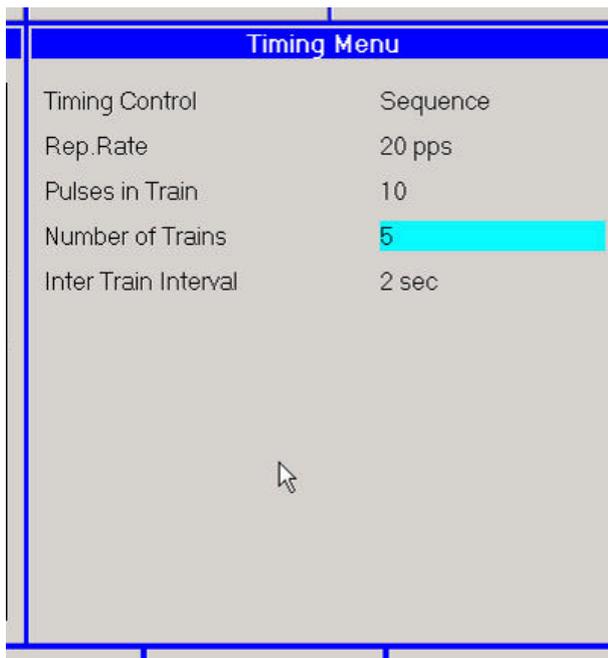
In each line, all settings are represented (controlled from the right-hand side Pulse Wheel). Please see the details in the section on "Getting Started", or see page 31 where all settings are scheduled.

## Soft Key Area (4)



The bottom area of the screen shows the five Soft Keys. The function of each soft key is shown in the display just above the key. See also the chapter on "Getting Started".

## Selection Area (3)



# Getting Started

## General Workflow

- Select the appropriate coil, and connect it to the device. Turn on the device.
- Choose a setup in the Main Menu, and position the coil near the stimulation spot. Enable the device.
- Press the trigger button to make a single stimulus, and gradually turn up the amplitude.

**NOTE** For an advanced use, stimulation sequences can be selected in the Timing Menu.

## Single Stimulation

The single stimulation function is placed in the trigger button of the device. The user is always able to activate a single pulse, either from the trigger buttons of the device or the coil handle, even in the time period between two train sequences, e.g. for determining motor threshold.

## Create Setup

When creating a setup, the operator is basically selecting from two menus: the Main Menu and the Timing Menu.

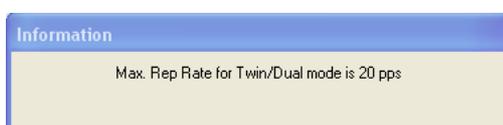
When setting fixed parameters, the operator must select from the Configuration Menu and the Timing Menu.

An overview of all selectable parameters can be found in the "Menu Tree" on page 27.

## Information box

An Information Box will appear when operating with incompatible settings. The Information Box will contain a report of the error.

Example:



## Main Menu

Amplitude <b>33 %</b>	Realized d/dt A: 50 AUsec B: 0 AUsec	09:23:38 - Coil Type: MCF-B70 12:37:37 - Started in Pulse Mode 12:37:43 - Stopped in Pulse Mode	2010-01-08 <b>12 43</b>
Status <b>Enabled</b>	Coil Temperature <b>24 °C</b>	Coil Type <b>MCF-B70</b>	Available Stimuli <b>13269</b>
Waveform (Default)		Main Menu	
		Setup Mode Current Direction Waveform Burst Pulses Inter Pulse Interval Pulse B/A Ratio	Default Standard Normal Biphasic Burst 4 <b>10.0 msec</b> 1.0
Timing	Configure		Recall

The selected menu is indicated in the status section right above the selection area.

## Setup

### Default Setup

The device automatically starts in the Default setup. To stimulate with default settings, simply press the start button in the Timing Menu.

### Predefined Setups

Besides the Default Setup, you can choose between 26 predefined setups created in the Configuration Menu (letter A-Z). The present setup can be seen in the Information Area. The setups listed in the information area shows the selected setup, but it is not loaded until the Recall button (one of the Soft Keys to the far right) is pressed (to save a customized setup, see the Configuration Menu, Setup).

### Factory Setup

With the Factory Setup it is possible to recall the original factory settings for the device.

## **Mode**

### **Standard Mode**

Standard Mode can be chosen in all four waveforms:

- Monophasic
- Biphasic
- Halfsine
- Biphasic Burst

When choosing the Standard Mode, the device operates with one energy storage only. The Standard Mode is normally chosen, when running single stimulation, or train sequences, where power pulse and twin pulses are not required.

### **Power Mode**

In this mode the two energy storages are added together. Power Pulses can be chosen in all four waveforms:

- Monophasic
- Biphasic
- Halfsine
- Biphasic Burst

The pulse width and the amplitude outlet are extended with approximately 40 % relative to Standard Mode.

### **Twin Mode**

When stimulating with Twin Pulses (double Pulses), the two energy storages are working side by side. The device is able to fire 20 Twin Pulses per second (tpps) for X100 + MagOption and 5tpps for R30 + MagOption. Twin Pulses enable two pulses with a variable Inter Pulse Interval in each stimulation. When choosing the Twin Mode, the line *Ratio B/A amplitude* will automatically appear. The amplitude of the two pulses A and B are then controlled in an adjustable ratio between 0.2-5.0. "Pulse B" is now adjusting in a selected percent ratio proportional to "Pulse A". The B/A Ratio amplitude is calculated by dividing pulse B with Pulse A. The "Pulse A" amplitude is controlled with the amplitude pulse wheel.

### **Dual Mode**

This mode is similar to Twin Mode. It differs from the Twin Mode in selecting the pulse amplitude. When choosing Dual Mode, the line *Pulse B Amplitude* will automatically appear in the selected Main menu indicating that both "Pulse A" and "Pulse B" are independently adjustable. "Pulse B" is the basic pulse in this selection choosing from 0-100%. The "Pulse A" amplitude is controlled with the amplitude pulse wheel.

Twin and Dual Mode can be selected in three different waveforms:

- Monophasic
- Biphasic
- Halfsine

## **Current Direction**

Some studies require a change in the Current Direction. Instead of changing the coil position the operator is able to choose between *Normal* and *Reverse*.

### **Normal**

In Normal direction, the current flows through the coil following the direction of the arrows shown on the coil encapsulation.

### **Reverse**

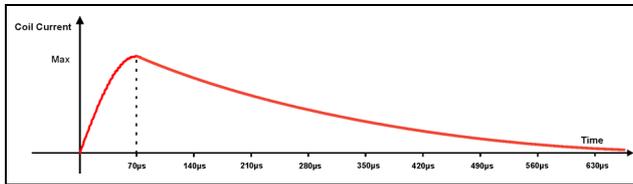
In Reverse, the current flows through the coil opposite to the direction of the arrows shown on the coil encapsulation

The induced current direction in the tissue is always the opposite of the coil current direction.

## Waveform

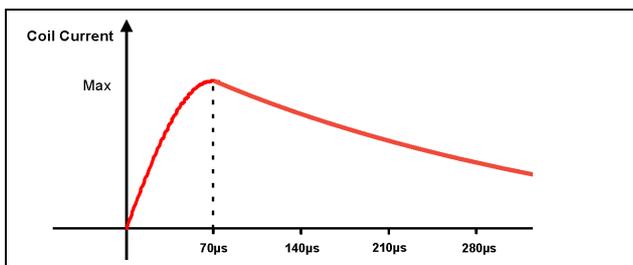
In this line different waveforms can be selected:

### Monophasic



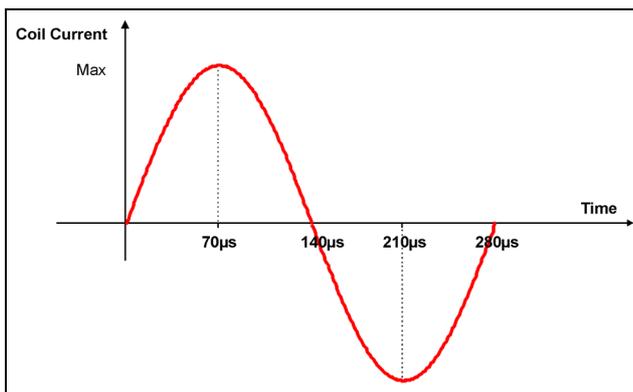
*Monophasic, Full Length*

The Monophasic waveform is typically chosen where single stimulus is needed. The Monophasic waveform deposits a large amount of energy in the coil, which explains the comparatively faster heating of the coil.



*Monophasic, Shortened for Comparison with other Waveforms*

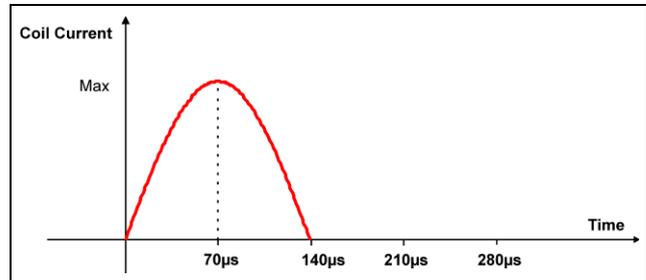
### Biphasic (Full-Sine)



The Biphasic Waveform is normally chosen when operating with high frequency repetitive stimulations, e.g. in studies with rTMS. The biphasic waveform is very powerful. There is a smaller amount of energy disposed in the coil, which means that the coil can provide a larger amount of stimulation, before it heats up. Consequently,

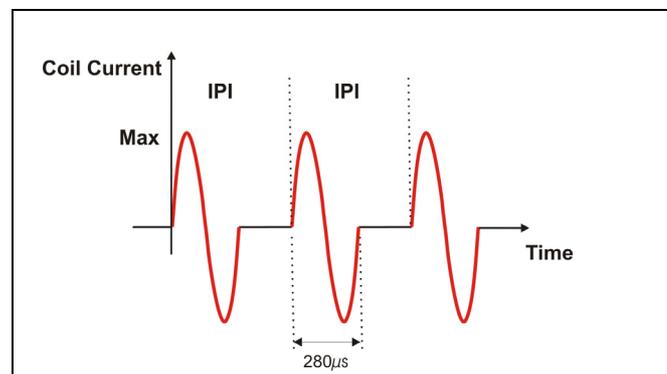
the Biphasic waveform is relatively effective before roll off in comparison to the Monophasic waveform.

### Halfsine



The Halfsine waveform requires a comparatively small amount of energy compared to all the other waveforms. The Halfsine waveform is not as powerful as the biphasic waveform, thus only a fairly small amount of energy is disposed in the coil (approximately half of the amount disposed by the biphasic waveform).

### Biphasic Burst (Theta Burst)



The biphasic burst waveform is able to provide a powerful stimulation. Biphasic Burst can be selected with 2, 3, 4 or 5 pulses in each stimulation with very low IPI (Inter Pulse Interval).

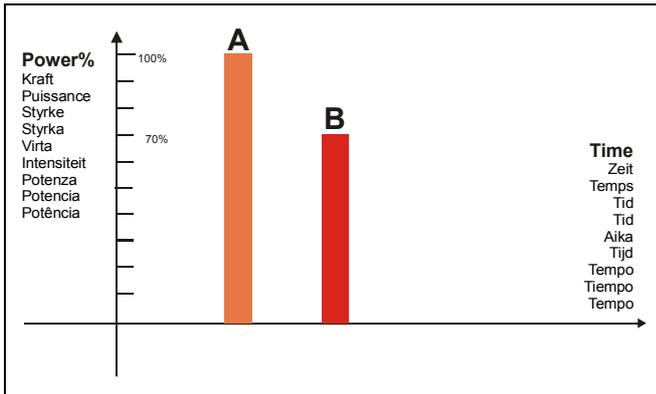
The biphasic burst mode can be used to define Theta Burst stimulations. For further description of Biphasic Burst and Theta Burst see page 20.

## Inter Pulse Interval (IPI)

Inter Pulse Interval is the duration between the beginning of the first pulse to the beginning of the second pulse. The IPI is adjustable (Overview of setting possibilities on page 31).

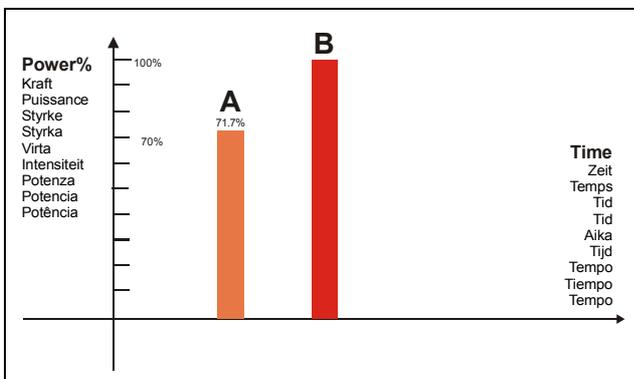
### Absolute Amplitude

Both pulses (A and B) are individually adjustable. In this example the B pulse is set to 70 % of max. output.



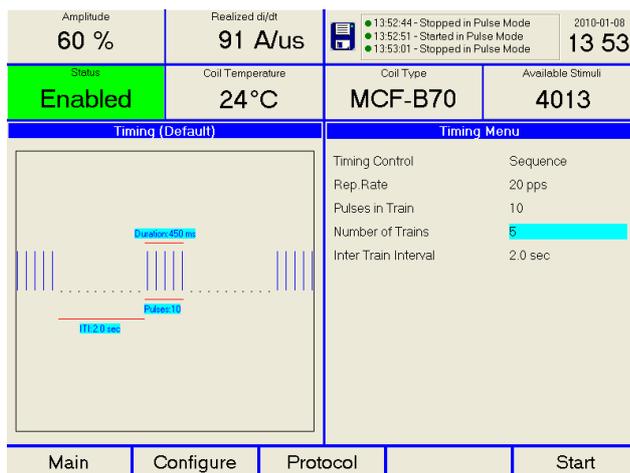
### Relative Amplitude

The two pulses (A and B) are adjusted in a selected ratio. In this example the ratio is set to 1.4.



The first pulse can activate both inhibitory and facilitator mechanisms and modify the threshold and readiness of the second pulse. Twin Pulses allow for a detailed study of the inhibitory and facilitator mechanisms in the brain and the spinal cord.

## Timing Menu



The Timing Menu is chosen for multiple stimulation e.g for study or treatment.

## Timing Control

### External Triggers

If external triggers are selected, the device will now be controlled from an external device e.g. the Keypoint<sup>®</sup>.

With the external trigger it is possible to trigger start of a sequence line in the protocol tool. External Trig must be selected in the Timing Menu for this option in the Protocol Tool. For further information see separate User Guide for Protocol Tool.

### Sequence

If Sequence is selected, the following options must be set:

### *Rep. Rate*

The repetition rate refers to the number of pulses per second (pps.) at which the pulses are generated.

### *Pulses in Train*

The number of pulses in each train. The Train Duration is automatically calculated by dividing the number of pulses in a train with the Rep. Rate.

## *Number of Trains*

The total amount of trains arriving in one sequence.

## *Inter Train Interval (ITI)*

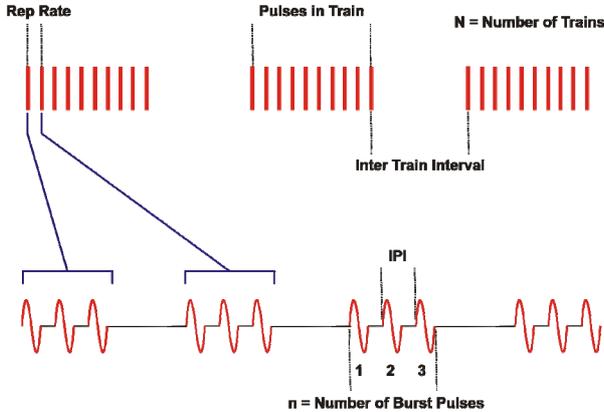
The time interval between two trains described as the time period between the last pulse in the first train to the first pulse in the next train.

In the *Information Area*, the present actions will be illustrated. These pieces of information concern:

- The time duration of a sequence
- The train duration
- Inter train interval (ITI)
- The defined Number of Stimuli
- The trains Remaining

# Biphasic Burst (Theta Burst) stimulation

Biphasic Burst mode can be used in conjunction with the normal sequence timing.



Special burst modes are also called Theta Burst and a very common used protocol is:

*A Theta Burst of 3 pulses with 20ms (50Hz) interval repeated as a train of 10 bursts with a repetition rate of 5Hz. The trains are repeated 20 times with an interval of 8 seconds. Total number of bursts 200.*

Following settings on the MagPro will generate the commonly used Theta Burst protocol.

### Main Menu

Waveform: Biphasic Burst  
 Burst Pulses: 3  
 Inter Pulse Interval: 20 msec

### Timing Menu

Rep Rate: 5pps  
 Pulses in Train: 10  
 Number of Trains: 20  
 Inter Train Interval: 8.0 sec

## Main Menu

Amplitude <b>70 %</b>	Realized dI/dt A: 1.02 A/usec B: 1.02 A/usec	11:56:40 - Coil Type is Cool-B65 11:56:47 - Model is X100+Option 11:56:47 - Date 2009-02-13	2009-02-13 <b>11:59</b>
Status <b>Enabled</b>	Coil Temperature <b>24°C</b>	Coil Type <b>Cool-B65</b>	Available Stimuli <b>8673</b>
Waveform 		Main Menu	
Timing		Configure	
		Recall	

Setup: Default  
 Mode: Standard  
 Current Direction: Normal  
 Waveform: **Biphasic Burst**  
 Burst Pulses: 3  
 Inter Pulse Interval: 20 msec

In the Main Menu the Biphasic Burst Waveform is selected.

Number of pulses in the Theta burst is defined in the Burst Pulses selection.

The Inter Pulse Interval between each pulse is selected.

## Timing Menu

Amplitude <b>70 %</b>	Realized dI/dt A: 1.02 A/usec B: 1.02 A/usec	11:56:40 - Coil Type is Cool-B65 11:56:47 - Model is X100+Option 11:56:47 - Date 2009-02-13	2009-02-13 <b>12:12</b>
Status <b>Enabled</b>	Coil Temperature <b>24°C</b>	Coil Type <b>Cool-B65</b>	Available Stimuli <b>8673</b>
Timing 		Timing Menu	
Main		Configure	
		Protocol	
		Start	

Timing Control: **Sequence**  
 Rep. Rate: 5 pps  
 Pulses in Train: 10  
 Number of Trains: 20  
 Inter Train Interval: 8.0 sec

In the Timing Menu the Rep Rate for the Theta Bursts is selected.

The number of Theta Burst pulses in each train is defined in the Pulses in Train selection.

Number of Trains and Inter Train Interval is selected.

When ready, enable the stimulator and turn up the Amplitude to the required level.

Press the Start button to start the protocol.

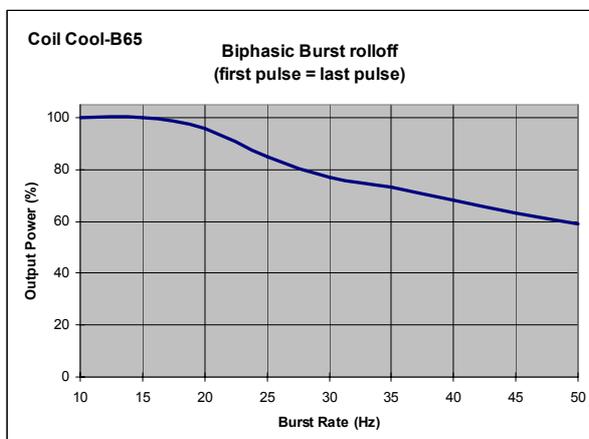
Amplitude <b>70 %</b>	Realized di/dt A: 102 A/usec B: 102 A/usec	11:56:47 - Date 2009-02-13 12:13:35 - Started in Pulse Mode 12:13:35 - Coil Temperature is 24°C	2009-02-13 <b>12 14</b>
Status <b>Enabled</b>	Coil Temperature <b>24 °C</b>	Coil Type <b>Cool-B65</b>	Available Stimuli <b>8673</b>
Timing		Timing Menu	
		Timing Control: <b>Sequence</b> Rep. Rate: 5 pps Pulses in Train: 10 Number of Trains: 20 Inter Train Interval: 8.0 sec	
Elapsed time: 00:00:43 23% Defined Number of Stimuli: 200 Trains left: 15			
Main	Configure	Protocol	Stop

The amplitude of the first pulse (A) and last pulse (B) in the Biphasic Burst waveform is measured during stimulation and displayed on the display.

Realized di/dt	
A:	102 A/usec
B:	102 A/usec

For the commonly used TBS protocol the amplitude of the 3 Biphasic Burst pulses will be equal up to approximately 60% output power on MagPro.

The maximum output power where the first and the last pulse are equal is shown in table below. For output power above the curve the last pulse will begin to be lower than the first pulse.



Coil type, output level and Inter Pulse Interval (IPI) will influence on the di/dt values.

## Protocol Tool

From the Timing Menu it is possible to select the Protocol Tool for advanced sequencing of multiple stimulations. See separate User Guide for this software tool.

Amplitude <b>42 %</b>	Realized di/dt <b>63 A/us</b>	14:04:22 - Delay 20s 14:04:22 - Rec Ampl Data (1-640) 14:04:26 - Protocol stopped	2010-01-06 <b>14:05</b>							
Status <b>Enabled</b>	Coil Temperature <b>27 °C</b>	Coil Type <b>Cool-B65</b>	Available Stimuli <b>79365</b>							
Protocol Menu										
Delay	Ampl A	Mode	Curr Dir	Waveform	BurstPulses	IPI	B/A Ratio	Rep. Rate	TrainPulses	
1	10 sec	0.8	Standard	Normal	Biphasic	2	1.0 msec	1.0	20 pps	20
2	20 sec	1.0	Standard	Normal	Biphasic	2	1.0 msec	1.0	20 pps	20
3	20 sec	1.0	Standard	Normal	Biphasic	2	1.0 msec	1.0	20 pps	20
4	20 sec	1.0	Standard	Normal	Biphasic	2	1.0 msec	1.0	20 pps	20
5	20 sec	1.0	Standard	Normal	Biphasic	2	1.0 msec	1.0	20 pps	20
6	20 sec	1.0	Standard	Normal	Biphasic	2	1.0 msec	1.0	20 pps	20
7	30 sec	1.2	Standard	Normal	Biphasic	2	1.0 msec	1.0	20 pps	20
8	30 sec	0.8	Standard	Normal	Biphasic Burst	3	20 msec	1.0	5 pps	10
9	8 sec	0.8	Standard	Normal	Biphasic Burst	3	20 msec	1.0	5 pps	10
10	8 sec	0.8	Standard	Normal	Biphasic Burst	3	20 msec	1.0	5 pps	10
11	8 sec	0.8	Standard	Normal	Biphasic Burst	3	20 msec	1.0	5 pps	10
12	8 sec	0.8	Standard	Normal	Biphasic Burst	3	20 msec	1.0	5 pps	10
Line progress: 00:00:00		00:00:20		Amplitude A		Total time: 00:01:27		00:03:38		
2%		42%		40%						
Exit	Left	Right	Delete	Start						

## Data Transfer

The MagPro Data Transfer feature gives the possibility to extract data for documentation to an USB memory stick. The Event log contains details as:

- when did a train start
- how many stimuli did it produce
- and at which amplitude did the train run

Following data will be exported:

- Event log
- MEP log (if MEP monitor available)
- Amplitude log

For further information see separate Data Transfer User Guide.

## Configuration Menu

Amplitude <b>0 %</b>		Realized d/dt A: 82 A/Usec B: 66 A/Usec		<ul style="list-style-type: none"> <li>● 13:52:44 - Stopped in Pulse Mode</li> <li>● 13:52:51 - Started in Pulse Mode</li> <li>● 13:53:01 - Stopped in Pulse Mode</li> </ul>		2010-01-08 <b>14:32</b>	
Status <b>Disabled</b>		Coil Temperature <b>24 °C</b>		Coil Type <b>MCF-B70</b>		Available Stimuli <b>100000</b>	
Actual Settings				Configuration Menu			
Settings		Timing Menu		Save Setup		A	
Mode	Twin	Timing Control	Sequence	Charge Delay	0 msec		
Current Direction	Normal	Rep. Rate	20 pps	Auto Discharge Time	5 min		
Wave Form	Biphasic	Pulses In Train	44	Prior Warning Sound	On		
Inter Pulse Interval	1.0 msec	Number of Trains	5	Coil Type Display	On		
Burst Pulses	4	Inter Train Interval	0.1 sec				
Pulse B/A Ratio	0.8						
Trigger Menu		Configuration Menu					
Trig Output	Pulse A	Charge delay	0 msec				
Twin Trig Output	Pulse A	Auto Discharge time	5 min				
Twin Trig Input	Pulse A	Prior Warning Sound	On				
Polarity, Input	Falling Edge	Coil Type Display	On				
Polarity, Output	Falling Edge						
Delay, input trig	0.0 msec						
Delay, output trig	0.0 msec						
Protocol Tool							
Number of lines		1					
Exit		Service		MEP		Trigger	
						Save	

The **Configuration Menu** is selected when setting up the basic parameters. In this menu the Trigger Menu will appear in the Soft Key Area (see the “Menu tree” on page 27).

### Save Setup

To save the present setup under a new letter in the setup list, choose a letter (A-Z) or Default. The setup to be saved is listed in the Information Area. Setups can only be saved in the Configuration Menu and then be recalled in the Main Menu.

The basic sequence setup of the most common study would be an obviously choice for the Default Setup.

**NOTE** Any previous setup saved using the letter you choose, will be overwritten.

After saving the settings on the MagPro, make sure not to switch off the MagPro within 30 seconds, to make sure the settings are saved.

### Charge Delay

After each stimulation, the device recharges the energy storage. During the recharging period, the device consumes and transfers very high amounts of energy. This transfer can produce unwanted noise, interfering with signal pickup wires and electrodes. To suppress this noise, the Charge Delay feature can be used, i.e. making the device wait for a while, before recharging. For ordinary use, set the Charge Delay to zero.

### Auto Discharge Time

To protect against non-intended stimulation of magnetic pulses, the device automatically discharges a preset time after the last stimulation is made or handling of buttons.

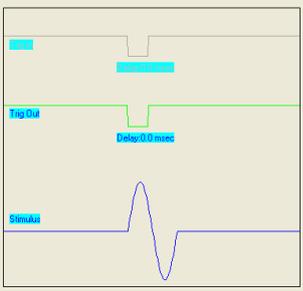
### Prior Warning Sound

The "Train Warning" is a sound preparing the patient for the next train sequence, when ITI is greater than 5 seconds. When on, the Prior Warning will sound two seconds before each train starts. The Prior Warning only applies to train sequences.

### Coil Type Display

The Coil Type Display can be set to On or Off. This function is relevant in relation to, e.g. double-blind tests. When turning the Coil Type Display off, the Coil Type area will be blank.

## Trigger Menu

Amplitude 0 %	Realized d/dt A: A/usec B: A/usec	15:35:23 - Coil Type: Cool-B65 15:35:30 - Model: X100+Option 15:35:30 - Date: 2010-01-08	2010-01-08 15 36
Status <b>Disabled</b>	Coil Temperature 22 °C	Coil Type Cool-B65	Available Stimuli 100000
Trigger (Default)		Trigger Menu	
		Trig Output: Enabled Twin Trig Output: Pulse A Twin Trig Input: Pulse A Polarity, Input: Falling Edge Polarity, Output: Falling Edge Delay, Input Trig: 0.0 msec Delay, Output Trig: 0.0 msec	
Exit			

The *Trigger Menu* is selected when the device is combined with external devices.

### Trigger Output

#### Enable

When the Trigger Output is *Enabled* an external trigger is given for each magnetic stimulus.

#### Disabled

When the Trigger Output is *Disabled*, no external trigger outputs are provided.

### Twin Trig Output

Only enabled in Twin/Dual mode. When making twin pulses, this option selects the timing and number of external triggers provided.

#### Pulse A

Select Pulse A to have an external trig out, only at the time of the first stimulus (A).

#### Pulse B

Select Pulse B to have an external trig out, only at the time of the second stimulus (B).

#### Pulse A+B

Select Pulse A+B to enable trigger on both stimulus.

### Twin Trig Input

Only enabled in Twin/Dual mode. When making twin pulses, this option selects the timing and number of external trigger inputs required:

#### Pulse A

Select Pulse A to require only one external trig input. The Inter Pulse Interval is then controlled by the device itself.

#### Pulse A+B

Select Pulse A+B to enable full external control of the timing: two external trigger inputs are required. Pulse A is provided at the time for the first external trigger to arrive – Pulse B accordingly, when the second trigger arrives.

### Polarity Input

Choose between *Falling Edge* and *Rising Edge*. The magnetic stimulation can be selected to be either at the time, when the external trigger voltage is rising or falling.

### Polarity Output

Choose between *Falling Edge* and *Rising Edge*. The external trigger output voltage can be selected to be either rising or falling at the time of the magnetic stimulation.

### Delay, Input Trig

This feature allows setting a delay from the time of arrival of an external trigger input to the time for the magnetic stimulation to be provided.

### Delay, Output Trig

When selecting the internal trigger generation, (i.e. when using trains generated by the device, or when pressing one of the manual trigger buttons) this feature allows setting a delay from the time of the magnetic stimulation to the time of the external trigger to be provided. Accordingly, the external trigger output can be provided prior to the magnetic stimulation. This feature allows other equipment to be activated, before the magnetic stimulation occurs.

## Service Menu

Amplitude 0 %	Realized di/dt A/us	<ul style="list-style-type: none"> <li>● 14:41:06 - Coil Type: Cool-B65</li> <li>● 14:41:13 - Model: X100+Option</li> <li>● 14:41:13 - Date: 2010-01-08</li> </ul>		2010-01-08 14:55
Status <b>Disabled</b>	Coil Temperature 22 °C	Coil Type Cool-B65	Available Stimuli 100000	
<b>Service Mode</b>		<b>Service Mode</b>		
Product Name:	Unknown	Language	<b>English</b>	
Release Number:	Unknown	Event Log Enabled	<input type="checkbox"/> ON	
Release Date:	yyyy/mm/dd	Amplitude Log Enabled	<input type="checkbox"/> ON	
Model:	X100+Option	Coil Temperature events	<input type="checkbox"/> OFF	
Serial number:	Unconfigured	Temperature scale	<input type="checkbox"/> °C	
GUI SW version:	5.0.1	24 hour representation		
PIC1 SW version:	255.255.255	2010 / 01 / 08	14	: 55 : 57
PIC2 SW version:	255.255.255	Year Month Day	Hour	Minute Second
Nimbus SW version:	255.255.255			
Language version:	English 1.1.0			
Exit				

### System Information

On the left side system information is displayed with information about the MagPro model, serial number and software versions.

### Language

Select language in the list of available languages.

### Event Log Enabled

Data export of event log to USB memory stick. Export of event log to RAM is also possible, which will store the data to RAM until the MagPro is disabled and the data in RAM will be exported to the USB memory stick. This will help the MagPro interface from slowing down.

### Amplitude Log Enabled

Data export of Amplitude Log to USB memory stick.

### Coil Temperature events

Data export of Coil Temperature data to USB memory stick.

Three different choices in Coil Temperature are available:

#### OFF

No coil Temperatures events are logged and saved

#### ON

Coil temperature events are only logged when the MagPro are active and running a sequence of stimulations

#### Advanced

All Coil temperature events are logged; also the temperature events between stimulations (For saving directly to memory stick: be aware that an error will occur if the memory stick is removed when the MagPro is writing data to it).

### Temperature scale

Select temperature scale on the display in Celsius (°C) or Fahrenheit (°F).

### Date and time

Adjust date and time by highlight the field that is to be changed and use the right wheel to adjust.

## Export of data (COM2)

Export of data from the COM2 serial port on the rear panel to an external computer is possible. The used protocol consists of 8 bytes sent for di/dt values, amplitude changes or temperature/coil type changes.

Byte	Values	Description
1	0xFE	Start flag
2	4	Length (always value: 4)
3	0x01 .. 0x03	Type: 1: Amplitude 2: di/dt 3: Temperature
4	0 .. 199	Type 1: Value A amplitude in % Type 2: Value A di/dt Type 3: Temperature in °C
5	0 .. 199	Type 1: Value B amplitude in % Type 2: Value B di/dt Type 3: Coil type no
6	0..0x0F	Bit 0..1 Mode: 0: Standard 1: Power 2: Twin 3: Dual Bit 2..3 Waveform: 0: Monophasic 1: Biphasic 2: Halfsine 3: Biphasic Burst
7	0 .. 255	CRC8 calculated for byte 3,4,5,6 (see below)
8	0xFF	End flag

A checksum is calculated as follows:

The checksum is a CRC8 (Dallas/Maxim) checksum using the polynomial  $X^8 + X^5 + X^4 + 1$ .  
(See: [http://en.wikipedia.org/wiki/Cyclic\\_redundancy\\_check](http://en.wikipedia.org/wiki/Cyclic_redundancy_check))

Examples (Hex values):

- FE 04 01 2A 41 07 AD FF CRC8 equals AD; calculated for 01, 2A, 41 and 07  
(amplitude A: 42%, amplitude B: 65%, Mode: Dual, Waveform: Biphasic)
- FE 04 02 33 19 02 DF FF CRC8 equals DF; calculated for 02, 33, 19 and 02  
(di/dt A: 51uA/S, di/dt B: 25uA/S, Mode: Twin, Waveform: Monophasic)
- FE 04 03 18 48 0C A9 FF CRC8 equals A9; calculated for 03, 18, 48 and 0C  
(Temp: 24 °C, CoilType: 72=C-B60, Mode: Standard, Waveform: Biphasic Burst)

### NOTE:

- When MagPro starts up some bytes are sent on COM2 before the equipment is ready for stimulation. These bytes should be ignored.
- For Biphasic Burst waveform MagPro might send several di/dt values for each burst depending on timing settings.
- For Twin or Dual mode MagPro sends a di/dt value for each pulse where Value A (byte 4) should be used for the first pulse and Value B (byte 5) should be used for the second pulse.

## Magnetic Stimulation Coils

All MagVenture stimulating coils can be used with the MagPro. Different sizes and types are available.

### Selection Criteria for Magnetic Stimulating Coils

#### *Large or Small Coils?*

Large coils provide a high penetration depth, but cannot be very focused at the same time. The small coils, however, are more focused, but have a relatively feeble penetration depth.

The coils come in many sizes and shapes. The two most commonly used coils are the circular shaped coil and the butterfly shaped coil (or the “figure of 8” coil).

#### *Circular Coils*



The induced current in the tissue occurs under the windings, when applying the circular coil. A fairly large area of body tissue will be stimulated. The circular coil may be positioned conveniently over many parts of the body, and usually serves well as a “general purpose coil”.

#### *Butterfly Coils*



The Butterfly coils are more focused in comparison with the circular coils. The two windings are placed side-by-side, enabling the coil to stimulate structures with focus right under its center. The butterfly coil is useful in focused stimulation of deep structures.

#### *Coils with Fluid*

Magnetic stimulating coils become warm during use, because energy is deposited in the coil due to electrical resistance. To prevent fast overheating in the coil, coils with a reservoir of fluid (F-coils) have been developed. The fluid partially absorbs the heat, enabling the coil to perform more stimuli.

#### *Coils with External Cooling*

Where a very high number of stimuli are required at High Repetition Rates and long pulse trains, extra cooling is necessary. Cool-Coils with external Cooler Unit fulfill these requirements.

---

## Magnetic Stimulation Accessories Catalogue

A number of stimulating coils are available. For more information about appropriate stimulating coils, look in the separate Magnetic Stimulation Accessories Catalogue, separate User Guides for coils or contact your local distributor.

# Menu tree

## MagPro R30

Main			Timing	Configure
Mode	Standard		Timing control	Save Setup
			Rep.Rate	Charge Delay
			Pulses in Train	Auto Discharge Time
			Number of Trains	Prior Warning Sound
			Inter Train Interval	Coil Type Display
			Protocol	Trigger
Current Direction	Normal		Delay	Trig Output
			Amplitude A	Polarity Input
			Rep.Rate	Polarity Output
Waveform	Biphasic		Train Pulses	Delay, Input Trig
				Delay, Output Trig
			Service	
				Language
				Event Log Enabled
				Amplitude Log Enabled
				Coil Temperature events
				Temperature scale
				Date and Time
			MEP (option)	
				Time Base
				Sensitivity
				Panning
				Curve No
				Common Baseline
				Lower Frequency Limit
				Upper Frequency Limit
				Trigger Mode
				Display Size
				Stay On Top
				Save

## MagPro R30 incl. MagOption

Main			Timing	Configure
Mode	Standard		Timing control	Save Setup
			Rep.Rate	Charge Delay
	Twin	IPI B/A Ratio	Pulses in Train	Auto Discharge Time
			Dual	IPI B Amplitude %
		Inter Train Interval		
Current Direction	Normal		<b>Protocol</b>	<b>Trigger</b>
			Delay	Trig Output
			Amplitude A	Twin Trig Output
Waveform	Monophasic		Mode	Twin Trig Input
			Waveform	Polarity Input
	Biphasic		IPI	Polarity Output
			B/A Ratio	Delay, Input Trig
			Rep.Rate	Delay, Output Trig
		Train Pulses	<b>Service</b>	
			Language	
			Event Log Enabled	
			Amplitude Log Enabled	
			Coil Temperature events	
			Temperature scale	
			Date and Time	
			<b>MEP (option)</b>	
			Time Base	
			Sensitivity	
			Panning	
			Curve No	
			Common Baseline	
			Lower Frequency Limit	
			Upper Frequency Limit	
			Trigger Mode	
			Display Size	
			Stay On Top	
			Save	

## MagPro X100

Main			Timing	Configure
Mode	Standard		Timing control	Save Setup
			Rep.Rate	Charge Delay
			Pulses in Train	Auto Discharge Time
			Number of Trains	Prior Warning Sound
			Inter Train Interval	Coil Type Display
			Protocol	Trigger
Current Direction	Normal	IPI Burst Pulses	Delay	Trig Output
	Reverse		Amplitude A	Polarity Input
Waveform	Monophasic		Current Direction	Polarity Output
	Biphasic		Waveform	Delay, Input Trig
	Biphasic Burst		Burst Pulses	Delay, Output Trig
		IPI	Service	
		Rep.Rate	Language	
		Train Pulses	Event Log Enabled	
			Amplitude Log Enabled	
			Coil Temperature events	
			Temperature scale	
			Date and Time	
			MEP (option)	
			Time Base	
			Sensitivity	
			Panning	
			Curve No	
			Common Baseline	
			Lower Frequency Limit	
			Upper Frequency Limit	
			Trigger Mode	
			Display Size	
			Stay On Top	
			Save	

## MagPro X100 incl. MagOption

Main			Timing	Configure
Mode	Standard		Timing control	Save Setup
	Power		Rep.Rate	Charge Delay
	Twin*	IPI B/A Ratio	Pulses in Train	Auto Discharge Time
	Dual*	IPI B Amplitude %	Number of Trains	Prior Warning Sound
	*) Biphasic Burst not available	IPI Burst Pulses	Inter Train Interval	Coil Type Display
Current Direction			<b>Protocol</b>	<b>Trigger</b>
			Delay	Trig Output
Reverse			Amplitude A	Twin Trig Output
Waveform			Monophasic	Mode
		Biphasic	Current Direction	Polarity Input
	Halfsine	Waveform	Polarity Output	
	Biphasic Burst	Burst Pulses	Delay, Input Trig	
		IPI	Delay, Output Trig	
		B/A Ratio	<b>Service</b>	
		Rep.Rate	Language	
		Train Pulses	Event Log Enabled	
			Amplitude Log Enabled	
			Coil Temperature events	
			Temperature scale	
			Date and Time	
			<b>MEP (option)</b>	
			Time Base	
			Sensitivity	
			Panning	
			Curve No	
			Common Baseline	
			Lower Frequency Limit	
			Upper Frequency Limit	
			Trigger Mode	
			Display Size	
			Stay On Top	
			Save	

# Setting the Scale

## MagPro R30

Main	
Timing	
Setup	A, B...Z and Default
Rep Rate	0.1, 0.2, 0.3, 0.4... 1, 2, 3, 4, 5, 6...30pps (...60pps with 60pps Option)
Pulses in Train	1, 2, 3, 4...1000
Number of Trains	1, 2, 3, 4...500
Inter Train Interval	0.1, 0.2, 0.3, 0.4...120s
Configure	
Charge Delay	0, 10, 20, 30...100, 200, 300...1000, 2000, 3000...10000ms
Auto Discharge Time	5, 10, 15 ... 60min
Trigger	
Delay, Input Trig	0, 0.1, 0.2 ... 1, 2, 3...100ms
Delay, Output Trig	-100, -99, -98...-10.0, -9.9, -9.8...0.0, 0.1, 0.2, 0.3...10, 11, 12...100ms

## MagPro R30 incl. MagOption

Main	
Twin and Dual	
Monophasic IPI	2.0, 2.1, 2.2...10.0, 10.5, 11.0...20, 21, 22... 100ms...3s
Biphasic IPI	1.0, 1.1, 1.2...10.0, 10.5, 11.0...20, 21, 22...100ms...3s
Pulse B/A Ratio	0.2, 0.3, 0.4 ... 5
Pulse B Amplitude	1, 2, 3...100%
Timing	
Setup	A, B...Z and Default
Rep Rate	0.1, 0.2, 0.3, 0.4... 1, 2, 3, 4, 5, 6...30pps
Rep Rate in Twin and Dual mode	0.1, 0.2, 0.3, 0.4...1, 2, 3, 4, 5tpps
Pulses in Train	1, 2, 3, 4...1000
Number of Trains	1, 2, 3, 4...500
Inter Train Interval	0.1, 0.2, 0.3, 0.4...120s
Configure	
Charge Delay	0, 10, 20, 30...100, 200, 300...1000, 2000, 3000...10000ms
Auto Discharge Time	5, 10, 15 ... 60min
Trigger	
Delay, Input Trig	0, 0.1, 0.2 ... 1, 2, 3...100ms
Delay, Output Trig	-100, -99, -98...-10.0, -9.9, -9.8...0.0, 0.1, 0.2, 0.3...10, 11, 12...100ms

## MagPro X100

Main	
Biphasic Burst IPI	0.5, 0.6, 0.7...10.0, 10.5, 11.0... 20, 21, 22... 100ms
No of Biphasic Bursts	2, 3, 4 or 5
Timing	
Setup	A, B...Z and Default
Rep Rate	0.1, 0.2, 0.3, 0.4...1, 2, 3, 4, 5, 6...100pps
Rep Rate in Biphasic Burst mode	0.1, 0.2, 0.3, 0.4...1, 2, 3, 4, 5, 6...20tpps
Pulses in Train	1, 2, 3, 4...1000
Number of Trains	1, 2, 3, 4...500
Inter Train Interval	0.1, 0.2, 0.3, 0.4...120s
Configure	
Charge Delay	0, 10, 20, 30...100, 200, 300...1000, 2000, 3000...10000ms
Auto Discharge Time	5, 10, 15 ... 60min
Trigger	
Delay, Input Trig	0, 0.1, 0.2 ... 1, 2, 3...100ms
Delay, Output Trig	-100, -99, -98...-10.0, -9.9, -9.8...0.0, 0.1, 0.2, 0.3...10, 11, 12...100ms

## MagPro X100 incl. MagOption

Main	
Biphasic Burst IPI	0.5, 0.6, 0.7...10.0, 10.5, 11.0... 20, 21, 22... 100ms
No of Biphasic Bursts	2, 3, 4 or 5
Twin and Dual	
Monophasic IPI	2.0, 2.1, 2.2...10.0, 10.5, 11.0...20, 21, 22... 100ms...3s
Biphasic and Halfsine IPI	1.0, 1.1, 1.2...10.0, 10.5, 11.0...20, 21, 22...100ms...3s
Pulse B/A Ratio	0.2, 0.3, 0.4 ... 5
Pulse B Amplitude	1, 2, 3...100%
Timing	
Setup	A, B...Z and Default
Rep Rate	0.1, 0.2, 0.3, 0.4...1, 2, 3, 4, 5, 6...100pps
Rep Rate in Biphasic Burst, Twin and Dual mode	0.1, 0.2, 0.3, 0.4...1, 2, 3, 4, 5, 6...20tpps
Pulses in Train	1, 2, 3, 4...1000
Number of Trains	1, 2, 3, 4...500
Inter Train Interval	0.1, 0.2, 0.3, 0.4...120s
Configure	
Charge Delay	0, 10, 20, 30...100, 200, 300...1000, 2000, 3000...10000ms
Auto Discharge Time	5, 10, 15 ... 60min
Trigger	
Delay, Input Trig	0, 0.1, 0.2 ... 1, 2, 3...100ms
Delay, Output Trig	-100, -99, -98...-10.0, -9.9, -9.8...0.0, 0.1, 0.2, 0.3...10, 11, 12...100ms

# Technical Data

## Electromagnetic Data

### Stimulation Waveforms and Pulse width

#### Standard Mode:

Waveform	MagPro model	Pulse width
Biphasic	R30 R30 + MagOption X100 X100 + MagOption	280µs
Monophasic	R30 + MagOption X100 X100 + MagOption	70µs
Halfsine	X100 + MagOption	140µs

#### Power Mode:

Waveform	MagPro model	Pulse width
Biphasic	X100 + MagOption	400µs
Monophasic	X100 + MagOption	100µs
Halfsine	X100 + MagOption	200µs

### Magnetic Gradient from Stimulation Coils

Magnetic Gradient and number of stimuli before coil overheats depend on the specific coil used.

## Mechanical Data

### Dimensions

MagPro: (HxWxD)	210 x 530 x 400mm
MagOption: (HxWxD)	130 x 530 x 400mm
Cart: (HxWxD)	800 x 610 x 550mm
System height with cart:	102cm

### Weight

MagPro R30:	33kg / 73 lbs
MagPro X100:	35kg / 77 lbs
MagOption:	25kg / 55 lbs
Cart:	16kg / 35 lbs

## Environmental Data

Operating Temperature:	10 – 30°C (50 – 86°F)
Storage Temperature:	5 – 50°C (41 – 122°F)

Operating Humidity:	30 – 60 % RH
Storage Humidity:	20 – 80 % RH

## Power Supply

Mains Voltage:	230V~, 50/60Hz according to IEC 60601-1
----------------	--

Mains impedance:	< 1 Ω
Maximum Power Consumption:	2300VA
Standby Power Consumption:	<150VA

Operation from 100-120V through Transformer.

## Options

9016B017-	Flexible arm for magnetic coil positioning
9016B010-	Cart for MagPro
9016D001-	100-120V to 230V Transformer
9016C070-	MEP Monitor, 1 ch. EMG

Please refer to:  
Magnetic Stimulation Accessories Catalogue.

## Connections

### *Trigger Connector*

DSUB 9 pin Female

Pin 1: Trigger Input

Pin 2: Trigger Output

Pin 3: Ground. (Reference)

9016E455- Trigger cable for Keypoint®

9016E456- Trigger cable with BNC connectors

### *Trigger Input*

Pulse width > 5µs

TTL + CMOS levels accepted

Input Impedance > 10 kΩ

Polarity: User Defined

Default: Falling

### *Trigger Output*

Pulse width: 50µs

TTL-levels

Output Impedance < 200 Ω

Polarity: User Defined

Default: Falling

### *Serial Ports*

PC-style: COM1 for MEP Monitor Interface

DSUB Connector 9 pin Male

Standard RS232 connectivity

PC-style: COM2

DSUB Connector 9 pin Male

Standard RS232 connectivity

Setting	Value
Baudrate	38400
Databits	8
Parity	None
Stopbits	1
Flow control	None

### *USB Ports*

PC-style: USB

Standard USB connectivity

## Performance Data – Amplitude Roll-Off

Output Power versus Repetition Rate, depending on Waveform, shown for coil C-B60:

### *Standard and Power Pulses*

Waveform	Repetition Rate						
	5 pps	10 pps	20 pps	30 pps	50 pps	75 pps	100 pps
<i>Standard Mode</i>							
Biphasic	100 %	100 %	80 %	65 %	50 %	35 %	30 %
Halfsine	100 %	100 %	80 %	65 %	50 %	35 %	30 %
Biphasic Burst (N=3)	100 %	100 %	70 %	50 %	35 %	25 %	20 %
Monophasic	100 %	70 %	50 %	40 %	30 %	25 %	20 %
<i>Power Mode</i>							
Biphasic	100 %	75 %	55 %	45 %	35 %	25 %	20 %
Halfsine	100 %	75 %	55 %	45 %	35 %	25 %	20 %
Biphasic Burst (N=3)	100 %	70 %	45 %	35 %	25 %	20 %	15 %
Monophasic	75 %	50 %	35 %	25 %	20 %	15 %	10 %

**pps** = Pulses Per. Second

**N** = Number of Pulses (N=2, 3, 4, 5)

### *Twin and Dual Pulses*

Waveform	Repetition Rate					
	1 tpps	2 tpps	5 tpps	10 tpps	15 tpps	20 tpps
<i>Twin and Dual Mode</i>						
Biphasic	100 %	100 %	100 %	75 %	60 %	50 %
Halfsine	100 %	100 %	100 %	75 %	60 %	50 %
Monophasic	100 %	100 %	70 %	45 %	35 %	30 %

**tpps** = Twin Pulses Per. Second

## Error messages

Different error messages can be displayed in the Enable/Disable status field.

Error message	Cause
Curr.Error	Power supply output is shorted or power supply is defective.
Disch1 hot	Discharging circuit is hot, should disappear within a few minutes after cooling down.
Disch hot	Discharging circuit in MagOption is hot, should disappear within a few minutes after cooling down.
MonoRes hot	Monophasic resistor is hot, should disappear within a few minutes after cooling down.
Reposition.	Internal power switch is moving should disappear within 10 sec.

## *Patient Safety*

It is important to understand, that the “Intended Use” of the MagPro applies for diagnostic purpose only - and the information provided below therefore does not endorse the use of the MagPro for any kind of treatment nor for therapeutic use.

However using the technique “Repetitive Transcranial Magnetic Stimulation” referred to as “rTMS”, is relevant in several cases, when used as a diagnostic or monitoring tool. When using rTMS, please take the following information as a general guideline. For more information on the subject always consult the literature, eg. the articles referred below.

A note of caution must be sounded concerning the use of fast repetition rate cortical stimulation. Low repetition rate cortical stimulation is generally safe and has been used on many thousands of subjects, both patients and normal volunteers, with few adverse effects. Fast repetition rate cortical stimulation, at intensities above motor threshold, has however been reported to cause seizures in persons whether any prior abnormality exists (Pascual-Leone et al., 1992; Wassermann et al., 1996). Because of the number of technical variables involved (stimulus strength, pulse repetition rate, pulse burst length, inter-burst interval, coil geometry, coil position and stimulator waveform) as well as possible seizure threshold variations between subjects, it may be very difficult to predict with accuracy a safe upper limit for any given stimulation protocol. Until further progress is made in defining safe regimes, the use of rapid rate cortical magnetic stimulation at levels approaching motor threshold should be treated with considerable caution.

*(Nilsson, Panizza, Grandofi)*

To read more about Safety, please refer to the following references:

**1** “Safety of different inter train intervals for repetitive transcranial magnetic stimulation and recommendations for safe ranges of stimulation parameters” by: Robert Chen, Christian Gerloff, Joseph Classen, Eric M. Wassermann, Mark Hallett, Leonardo G. Cohen.

[Electroencephalography and clinical neurophysiology](#). 1997 Dec; 105(6):415-21.

**2** “Risk and Safety of Repetitive Transcranial Magnetic Stimulation: Report and suggested guidelines from the International Workshop on the safety of Repetitive Magnetic Stimulation”, June 5-7, 1996 ” by Eric M. Wassermann.

[Electroencephalography and clinical neurophysiology](#). 1998 Jan; 108(1):1-16.

**3** “Tolerability and Safety of High Daily Doses of Repetitive Transcranial Magnetic Stimulation in Healthy Young Men” by: Anderson B, Mishory A, Nahas Z, Borckardt JJ, Yamanaka K, Rastogi K, George MS.

[The journal of ECT](#). 2006 Mar; 22(1):49-53

The articles are available at the Pubmed online database ([www.pubmed.gov](http://www.pubmed.gov)).

## Maximum duration (in seconds), single train of rTMS

The data below are taken from "Safety of different inter train intervals for repetitive transcranial magnetic stimulation and recommendations for safe ranges of stimulation parameters" by Robert Chen, Christian Gerloff, Joseph Classen, Eric M. Wassermann, Mark Hallett, Leonardo G. Cohen.

RepRate pps	<i>Amplitude relative to Motor Threshold (% of MT)</i>												
	100	110	120	130	140	150	160	170	180	190	200	210	220
<b>1</b>	270/270	270/270	180/180	50/50	50/50	50/50	50/50	20/20	8/8	8/8	6/6	5/5	4/4
<b>5</b>	10/50	10/50	10/50	10/50	5.7/28	3.9/19	2.7/13	1.95/9	1.8/9	1.2/6	1.1/5	1.2/6	0.9/4
<b>10</b>	5/50	5/50	3.2/32	2.2/22	1.0/10	0.6/6	0.7/7	0.6/6	0.4/4	0.5/5	0.3/3	0.2/2	0.2/2
<b>20</b>	1.5/30	1.2/24	0.8/16	0.4/8	0.3/6	0.2/4	0.2/4	0.1/2	0.2/4	0.2/4	0.2/4	0.1/2	0.1/2
<b>25</b>	1.0/25	0.7/17	0.3/7	0.2/5	0.2/5	0.2/5	0.2/5	0.1/2	0.1/2	0.1/2	0.1/2	0.1/2	0.1/2

Table of train duration (seconds/number of pulses) for single train of rTMS in normal volunteers. The maximum train duration (seconds) is shown followed by the number of pulses.

The stimuli are applied with a water-cooled 8-shaped coil each loop measured 7.5 cm at its inner diameter.

Inter train Interval (s)	<i>Stimulus Intensity (% of MT)</i>			
	100	105	110	120
<b>5</b>	Safe	Safe	Safe	Insufficient data
<b>1</b>	Unsafe (3)	Unsafe	Unsafe (2)	Unsafe (2)
<b>0.25</b>	Unsafe	Unsafe	Unsafe (2)	Unsafe (3)

Table of Safety recommendation studied in 10 healthy volunteers stimulated with 10 rTMS trains.

**CAUTION** should be exercised when extrapolation the data for rTMS studies involving more than 10 trains.

The number of trains that caused spread of excitation or post-TMS EMG activity are indicated in the parentheses.

# Maintenance

## Cleaning and Disinfecting Procedures

The maintenance that can be performed by the operator is limited to cleaning and disinfecting the device.

**NOTE** Any maintenance inside the device must be performed by qualified service personnel.

### ■ The MagPro, Coil and Cart:

- Before cleaning the device units, switch off the mains. Use a cloth gently wrung in a recommended disinfectant as listed below.
- Dilute the disinfectant properly, as stated by the manufacturer.

### *For routine cleaning use*

Phenoles (Bacillotex<sup>®</sup> etc.) or 70% alcohol, 0.5% chlorohexidine.

If hepatitis or any other dangerous virus contamination is suspected: Aldehydes (Cidex<sup>®</sup>, Korsolin<sup>®</sup>) or chlorinates (Diversol BX<sup>®</sup>).

Be careful not to drip water or disinfectant directly into the input and output plugs and other openings in the cover. Remove excess disinfectant with a dry cloth.

Do not use solvent silicon-based or abrasive cleaning agents.

Before using disinfectants other than those specified, please contact your local distributor for further information.

## Waste Management

The device and its accessories must be disposed of separately as electronic waste.



### **Waste Electrical and Electronic Equipment, user information:**

Do not dispose of this product in the unsorted municipal waste stream. Dispose of this product according to local regulations.

## Safety Checks

The following safety checks should be conducted before use daily:

- Inspection for visible damage to device.
- Inspection of mains cord and connecting cables.
- Check the coil for damages, cracks, marks, deformations, color changes and other irregularities. Do not use the coil if there is any evidence of stress failure and contact a Service Center.

The following safety checks should be conducted (by qualified personnel) at least once a year and in the event of repair:

- Insulation resistance.
- Measurement of leakage currents.
- Measurement of resistance of protective earth conductor.
- Inspection and cleaning of the fan filter.

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## IEC 60601-1-1

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### CAUTION

When connecting, attention must be paid to:

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### IEC 60601-1-1

#### **Medical Electrical Equipment, Part 1: General Requirements for Safety.**

##### **1. Collateral Standard**

#### ***Safety Requirements for Medical Electrical Systems.***

When connecting to a medical appliance with an F-type applied part or some additional equipment complying not with IEC 60601-1 but with the relevant safety standard for such equipment, the additional equipment:

1) Must either be placed outside the patient environment (the patient environment is any area in which intentional or unintentional contact can occur between patient and parts of the system (e.g. a printer) or as a result of some other person touching parts of the system)

**or**

2) If placed within the patient environment, must be:

a) Provided with additional protective earthing,

**or**

b) Supplied from an extra isolating transformer, limiting the enclosure leakage current to a value not exceeding 0.5 mA,

**or**

c) Supplied from a floating power supply, limiting the enclosure leakage current to a value not exceeding 0.5 mA

Please refer to IEC 60601-1-1.

# Classification

---

## Classification requirements

IEC 60601-1

### Type of protection against electric shock:

- *Class I:* Equipment in which protection against electric shock does not rely on basic insulation only, but which includes an additional safety precaution in that means are provided for the connection of the equipment to the protective earth conductor in the fixed wiring of the installation in such a way that accessible metal parts cannot become live in the event of a failure of the basic insulation.

### Method(s) of sterilization or disinfecting recommended by the manufacturer:

- Please, see section on "Maintenance".

### Degree of protection against electric shock:

- *Type BF:* Applied part providing a particular degree of protection against electric shock, Particularly regarding:
  - Allowable leakage current
  - The applied part is electrically isolated (floating).
  - Not intended for direct cardiac application.

### Degree of protection against harmful ingress of water:

- *MagPro:*  
*IP20:* Ordinary equipment (enclosed equipment without protection against ingress of water).
- *Coils:*  
*IP24:* Ordinary equipment (enclosed equipment with protection against liquid splashing).

### Degree of safety of application in the presence of a flammable anesthetic mixture with air or with oxygen or nitrous oxide:

- Equipment not suitable for use in the presence of such a mixture.

### Mode of operation:

- Continuous operation

# Glossary

## *Brain Mapping*

Functional brain mapping using Transcranial Magnetic Stimulation (TMS) is the mapping of motor cortex representation.

## *Biphasic Burst*

Stimulation with 2, 3, 4 or 5 pulses in a burst, where each consequent pulse in the burst is reduced to about 70% of the amplitude of the previous pulse.

## *Capacitor*

A device for holding and storing charges of electricity.

## *CMCT*

Central Motor Conduction Time. Used when estimating the central motor conduction latency by subtracting the cortical to muscle conduction latency from peripheral conduction latency. The CMCT is abnormal in many disorders of the nervous system.

## *Cortical*

Pertaining to or of the nature of a cortex or bark. The outer part of the brain.

## *Excitability*

Readiness to respond to a stimulus; irritability.

## *Facilitation*

The promotion or hastening of any natural process; the reverse of inhibition.

## *Inhibition*

Arrest or restraint of a process.

## *Inter Pulse Interval (IPI)*

The time duration between two pulses.

## *Inter Train Interval (ITI)*

The time duration between two trains.

## *Motor neuron*

A neuron with a motor function; an efferent neuron conveying motor impulses.

## *Motor Threshold*

The minimum magnetic intensity required to elicit a motor evoked potential in a target muscle.

## *Neural Network*

A mesh like structure of interlocking nerves.

## *Power Pulse*

Two capacitors added developing a powerful pulse. The stimulation is 40% wider and with a larger peak compared to twin and standard pulses.

## *Pulse B Amplitude*

Setting the "B pulse" amplitude selecting between 1-100% (Dual Mode).

## *Ratio B/A Amplitude*

A fixed ratio between the two pulses between 0.1-10.0 (Twin Mode).

## *Rep. Rate*

Pulse per second (pps) or frequency (Hz).

## *rTMS*

Repetitive Transcranial Magnetic Stimulation.

## *Seizures*

A single episode of epilepsy.

## *TMS*

Transcranial Magnetic Stimulation is used when examine functional alterations on cortex in addition to mapping cortical representations.

## *Train Duration*

The length of a train measured in time.

## *Twin Amplitude*

Refer to the amplitude inside each of the pulses A and B inside a twin stimulation.

## *Twin Pulses/Dual Pulses*

Also named Paired Pulse, Double Pulse, Pulse Pair is enabling two pulses of magnetic stimulation with a variable inter stimuli interval. Tpps refers to the number of twin—or Dual pulses per second in a train sequence.

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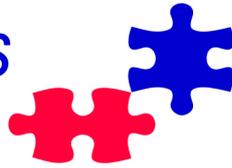
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