magstim®

**Magstim Rapid²
Operating Manual**

**MOP03-EN
Revision 03**

CE
0086

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GUARANTEE

The Magstim Company Limited guarantees the effectiveness of both materials and workmanship for a period of two years from the date of shipment; for the following products;

Magstim Rapid²	- P/N: 3012-00
Single Power Supply Unit (PSU)	- P/N: 3013-00
Dual Power Supply Unit (PSU)	- P/N: 3014-00
Magstim Plus¹ Unit	- P/N: 4040-00
Rapid² User Interface (UI)	- P/N: 3022-00
Rapid² MEP Pod	- P/N: 3526-00

For a period of one year from the date of shipment; for the following products;
Foot switch   - P/N: 9525-01

The Capacitor is guaranteed for a period of two years from the date of shipment; or up to a maximum of 1 million discharges; whichever is reached first.

The Magstim Company Ltd. reserves the right to perform guarantee services in its factory, at an authorised repair station, or at the customer's installation; at the discretion of the company.

The Magstim Company Ltd. guarantees to repair or replace defective equipment or parts, free of charge within the guarantee period; provided that the said defects occur during normal service. Replacement will be only at the company's discretion where a repair is not possible and/or not feasible.

Claims for damages during shipment must be filed promptly with the transportation company. All correspondence concerning the equipment must specify the model name and/or number, as well as the serial number, exactly as they appear on the equipment invoice.

Improper use, mishandling, tampering with, or operation of the equipment without following operating instructions will void this guarantee and release The Magstim Company Limited from any further obligations under this guarantee.

The Magstim Company Limited will only accept responsibility for effects on safety, reliability and performance of the equipment if:

- modifications or repairs are carried out by persons authorised by The Magstim Company Limited;

- the electrical installation of the relevant room complies with local regulations; and

- the equipment is used in accordance with the instructions for use.

SECTION 1   INTRODUCTION

1.1   Indications for Use

The Magstim Rapid² systems (Standard Rapid², Super Rapid² & Rapid² Plus¹) are magnetic stimulators intended for non-invasive stimulation of neuromuscular tissue, by inducing small currents in the tissue using a brief pulse of electromagnetic energy.

This method of stimulation enables deep, and otherwise inaccessible, nerves to be stimulated easily and relatively painlessly. In addition, no skin preparation is required and stimulation can be achieved through clothing.

The Magstim Rapid² systems are intended for use by, or under the supervision of, a medical practitioner or investigator who has knowledge about the principles of TMS, physiology and potential side effects of TMS.

The Magstim Rapid² systems are non-sterile reusable medical device intended for multi-patient use, however is not intended to come into contact with the patient as this achieved through use of a stimulating coil.

The Magstim Rapid² systems are intended to be stationary during use however, can be moved if necessary when not in use.

The Rapid² systems are intended to be used on adults and children above the age of 2 years who do not meet any of the contraindications listed in section 1.2. In all cases the subject is in a conscious state.

USA Only: The Magstim Rapid² systems have not been cleared by the FDA for cortical stimulation. Investigational uses require an IDE.

1.2   Contraindications

The Magstim Rapid² systems should not be;

- used on or in the vicinity of patients or users with cardiac demand pacemakers, implanted medication pumps, cochlear devices, implanted defibrillators and/or implanted neurostimulators
- used on or in the vicinity of patients with implanted metal objects
- used on patients where the skin in the area to be contacted is broken
- used on patients who suffer from multiple sclerosis
- used on those with large ischaemic scars
- used on pregnant women
- used on infants under the age of 2 years
- used on epileptic individuals
- used on those with a family history of convulsions
- used on individuals with brain lesions that could affect seizure threshold
- used on individuals suffering from multiple sclerosis
- used on individuals taking tricyclic antidepressants, neuroleptic agents or any other drug that could lower seizure threshold,
- used on individuals suffering from sleep deprivation during rTMS procedures
- used on individuals with a heavy consumption of alcohol or those using epileptogenic drugs
- Used on individuals with severe heart disease or with increased intracranial pressure be used on those who have uncontrolled migraines

Magstim concurs with the recommendations given in the paper titled "Safety, ethical considerations, and application guidelines for the use of transcranial magnetic stimulation in clinical practice and

research" by Rossi et al (2009) and recommends the use of a standard questionnaire to screen candidates prior to administering TMS.

1.3 Devices Covered

This document is applicable to the following device:

- Magstim Rapid² System

This consists of:

- Magstim Standard Rapid² System (P/N: 3004-00)

- Magstim Super Rapid^2 System (P/N: 3005-00)

- Magstim Rapid^2 Plus^1 System (P/N: 4100-00)

- Rapid^2 UI Controller (P/N: 3022-00)

- MEP Pod Assembly (P/N: 3526-00)

- Footswitch (P/N: 9525-01)

and may also consist of the following optional parts:

- Rapid² Printer Package (P/N: 3804-00)

If a Magstim Rapid² UI Controller is not used, a remote control will need to be used.

Note: Please also consult any labelling and information accompanying stimulating coils and other accessories for safety and use information regarding these devices.

1.4 Frequently Used Functions

Frequently used functions as defined during Magstim's usability process are identified with (*). Frequently used functions are functions of the Rapid² that frequently involve user interaction.

SECTION 2   WARNINGS AND PRECAUTIONS

Attention Consult Operating Manual: Consult the operating manual before using this device. Ensure you are familiar with all sections of this operating manual prior to using the Rapid² system.

Operating Manual: Further information can be located in the operating manual. Where this symbol is adjacent to a particular function on the Rapid² labelling, further information on this function can be found in this operating manual.

Type BF Applied Part: Refer to Section 6.1 for further information.

Warning High Voltages: High voltages are present in the Magstim Rapid² system and accessories during operation and for up to 20 minutes following operation. Therefore:

- do not remove covers. Refer servicing to qualified personnel.

- if there is any sign of external damage or if any parts are damp or wet, they must not be used. Ensure that the System is not subject to conditions where water/ liquid may be tipped on it, including the UI Controller.

- ensure that the system is switched off prior to removing the HV cables at the rear of the system*.

High Voltages: High voltages are present in the Magstim Rapid² system and accessories during operation and for up to 20 minutes following operation. Therefore:

- ensure that the system is disarmed prior to disconnecting the stimulating coil.

Coil Temperature: The system monitors the coil temperature and if this reaches 40°C, the stimulator will be disabled. The coil surface temperature may continue to rise after this point; therefore, the coil must be removed from the subject.

Rear Panel Outputs*: Only equipment that meets the relevant IEC standard should be connected to the Magstim Rapid² system.

This connection must be configured in compliance with Clause 16 of IEC 60601-1:2005 with the following interface voltage limitation: Max signalling voltage +5.3V; Max voltage with respect to protective earth potential 30V peak

Magnetic Pulses: the system generates high intensity magnetic pulses through its coils, which induce eddy currents in any conductive medium, such as the human body, nearby metallic objects or electronic devices. Therefore, the system:

- must not be used on, or in the vicinity of subjects with cardiac demand pacemakers, implanted defibrillators, or other electronic or metallic implants;

- must not be used in a position where the current can be induced in cables or wires that are directly connected to the subject;

- must not be used in the vicinity of objects that are sensitive to magnetic fields, such as watches, credit cards and electronic equipment; and

- must not be used when in contact with metallic objects, as these objects may be propelled or damaged by the magnetic field of the coil.

Damage: If there are any signs of damage to the Magstim Rapid² system, or if any parts are damp or wet, the stimulator must not be used. If damaged, the Magstim Rapid² should be returned to the Magstim Company Limited for servicing and repair (see Section 7.2 for contact details).

Explosive and Flammable Atmospheres: The Magstim Rapid² system and accessories must not be used in an explosive atmosphere, around explosive gases or in the presence of flammable anaesthetics.

Protective Earth: To avoid the risk of electric shock, the Magstim Rapid² system must only be connected to supply mains with protective earth.

Note: Each of the mains connections for the Rapid[2] system must be made via separate, permanent, mains outlets. On no account should a multi-way extension lead be used to connect more than one mains connector to a single mains outlet.

Modification: No modification of this equipment is allowed.

Mains Leads: The Rapid[2] system must be used only with the supplied mains leads fitted with an integral filter, as they are required to maintain the system's compliance with EN 60601-1-2 regarding Electro-Magnetic emissions.

Earth Strap: The Rapid[2] system must only be used when fitted with the supplied earth straps, this is to maintain the system's compliance with EN 60601-1-2 regarding Electro-Magnetic emissions. The strap is fitted between the stimulator and the power supply unit (PSU). In the case of the Super Rapid[2] Plus[1] there are two earth straps. The first between the stimulator and the Magstim Plus[1], the second between the Magstim Plus[1] and power supply unit (PSU).

Discharge noise: when the magnetic pulse is delivered, a discharge click is produced that may startle. The use of ear protection is recommended.

Ear protection must be worn by the patient when using the Rapid² Plus[1] system for cortical stimulation at power levels above 70%.

Seizures: cortical magnetic stimulation runs the risk of inducing seizures. Magstim concurs with the advice given in the paper titled "Safety, ethical considerations and application guidelines for the use of TMS in clinical practice and research" by Rossi et al (2009) in respect to screening candidates prior to administering TMS.

Safe levels of stimulation: For reasons of safety and reliability, if the system is set at 100% power, the user must not exceed 250 stimuli per minute, or 4000 stimuli per hour or 24,000 stimuli for every 24 hour period. This limitation is in addition to any other limitation imposed by the dedicated controller, or heating effects on the stimulating coil and charger circuitry.

When stimulating at 100Hz, the Rapid² system must not be used for cortical stimulation,and is for peripheral use only. For safety guidelines relating to transcranial stimulation, see Section 6.3 of this Operating Manual.

Environmental Conditions*: The system must not be used or stored under environmental conditions that fall outside those specified in Section 6.4 of this operating manual.

Stacking Limit: Please observe the stacking limit of the system. An assembled Rapid[2] system can have a weight of up to 55kg. Ensure that the surface upon which the system is to be placed is capable of supporting this weight. Failure to do so may result in injury or damage. The weight for each individual module within the Rapid[2] system can be found in Section 6.5 of this manual.

MEP Pod: The MEP Pod is designed to be fitted to the Magstim Rapid² UI only. Do not attempt to connect it to a computer, or any other equipment, with a similar connector. To do so could result in electric shock/ burns to the patient at the site of electrode attachment. The MEP Pod connector has a hole deliberately blocked to prevent incorrect connection.

SECTION 3   PRODUCT DESCRIPTIONS

The Rapid² systems operate by inducing electrical currents in tissue using a non-invasive stimulating coil at frequencies of up to 100Hz. The stimulating coil is placed near the intended site of stimulation and trigger pulses initiate brief magnetic pulses. The magnetic fields can pass through clothing, tissue and bone to reach otherwise inaccessible areas. One feature of magnetic stimulation is that it is less likely to stimulate pain fibres at the skin surface, reducing the discomfort when compared with conventional electrical stimulation. Magstim Rapid² magnetic stimulators combine stimulation frequencies from 1Hz to 100Hz with a touch screen interface which controls every aspect of the stimulator's control and operation.

3.1   **Magstim Standard Rapid² & Super Rapid²**

The Standard Rapid² consists of a Single PSU, Rapid² Stimulator, Rapid² UI and can use an optional Rapid² MEP Pod for recording motor evoked potentials.

The Super Rapid² uses the same modules with the exception of the Single PSU which is replaced by the Dual PSU. This allows stimulation to occur at higher frequencies for a given power level to be delivered to the patient.

3.1.1   **Front view**

The front panel, shown below, allows control of the Standard Rapid² and Super Rapid² and provides the connection for the stimulating coil.

 All operating functions described in this section assume that the mains power switch, located on the rear panel, is switched on.
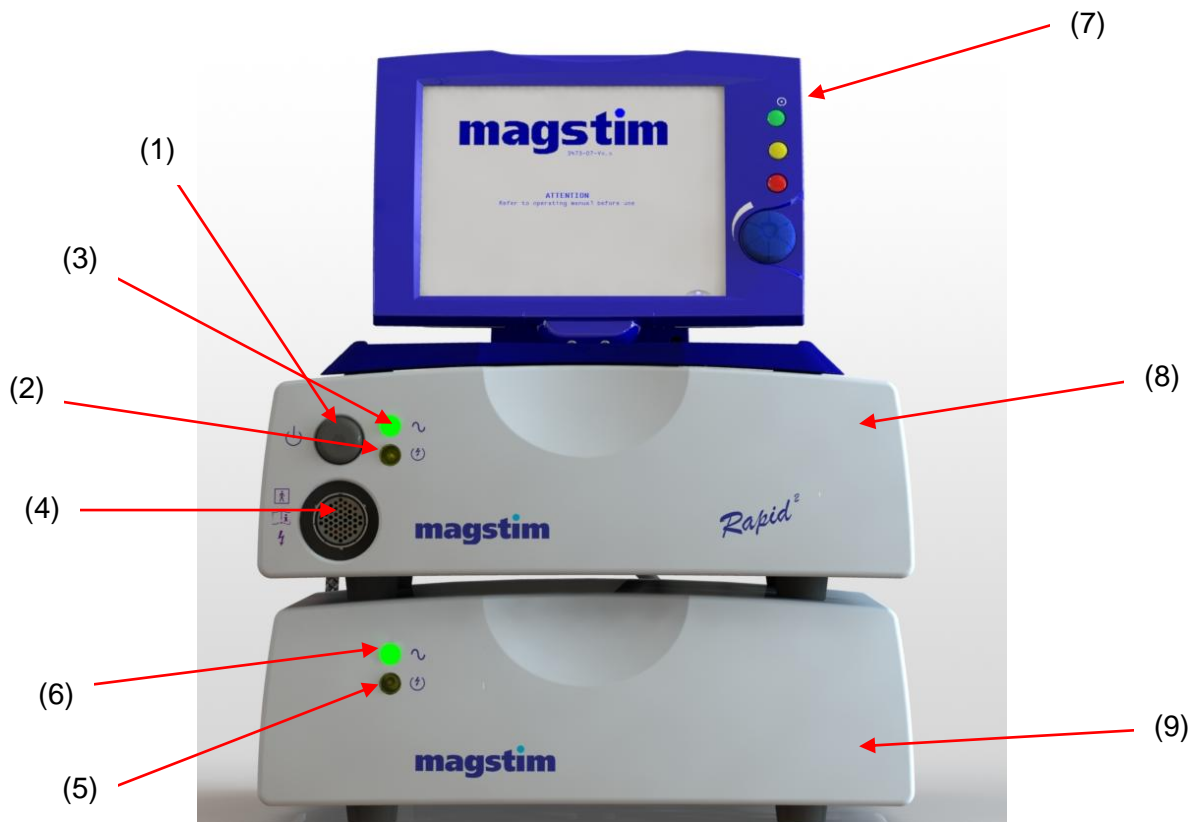
Figure 3.1: Detailed front panel of Standard Rapid² and Super Rapid²

3.1.1.1 **On/Off/Standby* (1)**

This switch toggles the operational state of the Rapid[2.]

3.1.1.2 **Armed Indicator* (2)**

The armed indicator illuminates when the unit is armed and high voltages are present on the system.

3.1.1.3 **Power Indicator* (3)**

The power indicator flashes when the Magstim Rapid² is in standby, and illuminates when the Magstim Rapid² is on.

3.1.1.4 **Coil Output Socket* (4)**
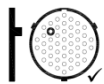
This socket is used to connect the stimulating coil to the Magstim Rapid².

Note: It is normal for the pin indicated on the label to protrude from the coil socket. This is an intentional design feature.
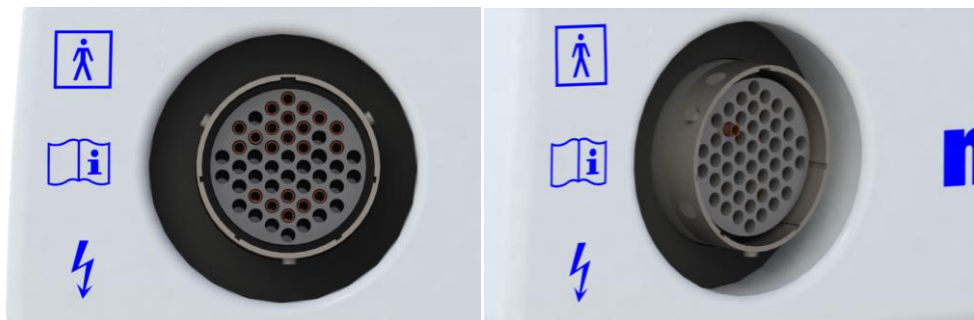
Figure 3.2: Coil output socket front view   Figure 3.3: Coil output socket angled view

3.1.1.5 **Armed/Fault Indicator* (5)**

This LED is continuously illuminated when the Magstim Rapid[2] is armed and high voltages are present on the system. This LED turns RED when a fault is detected in the PSU.

3.1.1.6 **PSU Power Status Indicator* (6)**

The PSU power indicator is OFF when the system is in standby or OFF. It is continuously illuminated when the system is on.

3.1.1.7 **Rapid² UI (7)**

This is the interface by which the user controls the stimulator. See Section 3.3 for further details.

3.1.1.8   Mainframe (8)

This Mainframe contains the circuitry that allows the stimulator to deliver energy as specified using the UI.

3.1.1.9   Power Supply Unit (PSU) (9)

The PSU contains the electronic circuitry that powers the stimulator.

3.1.2   Rear view
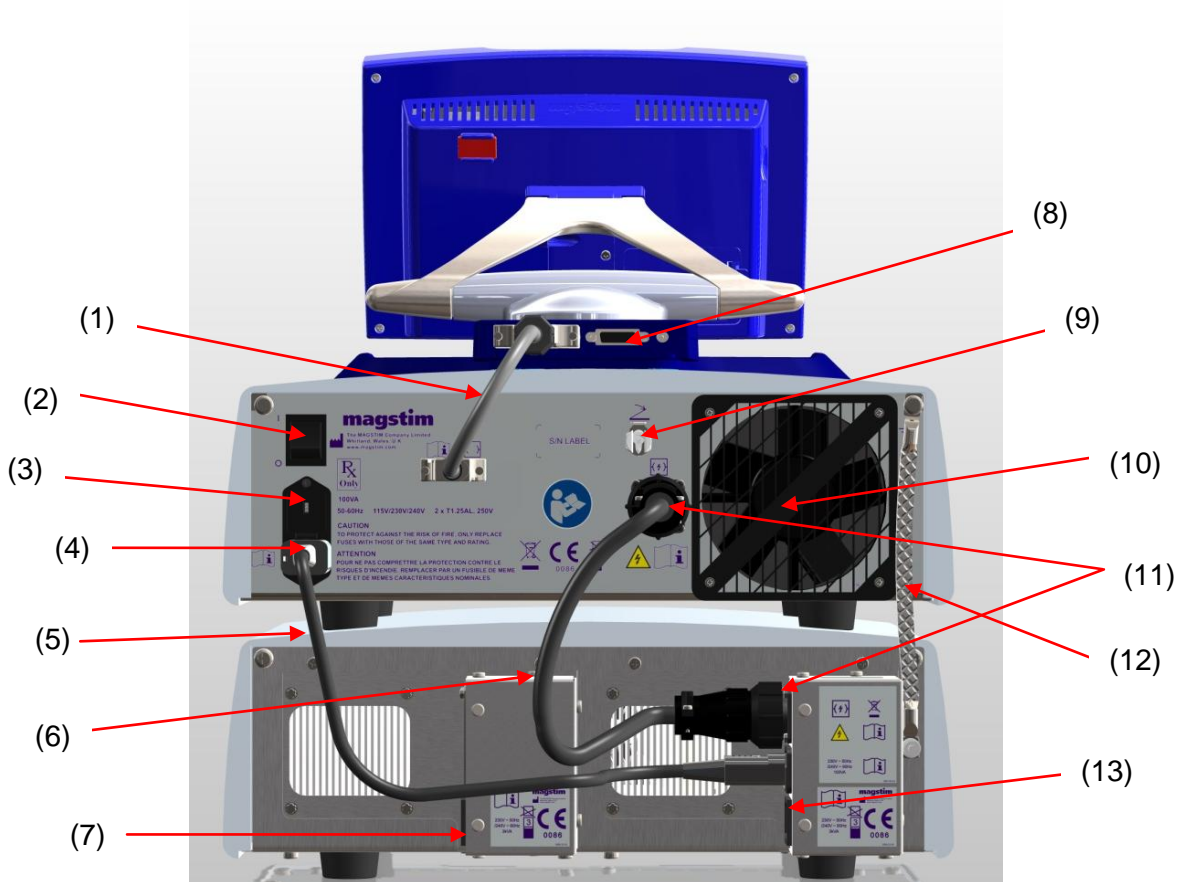
Figure 3.4: Detailed rear panel of Super Rapid²

Note: The only difference between connections on the Standard Rapid² compared to the Super Rapid² is the additional mains inlet on the left hand side of the PSU.

Note: 115V units are identical in appearance to the 230V units, with the exception of the voltage/power rating labels sited to the rear

3.1.2.1   UI Cable* (1)

The UI cable connects the Rapid² UI to the Rapid² mainframe.

3.1.2.2 Mains Power Switch* (2)

The Power switch allows the power supplying the unit to be switched on (labelled I) or off (labelled O).

3.1.2.3 Fuse Access and Voltage Selector* (3)

Access for fuse replacement and changing the voltage selector setting. See Section 5.3 for further details.

3.1.2.4 Power Entry Module* (4)

Power input port on the Rapid² mainframe.

3.1.2.5 Link Lead* (5)

The 10A link lead provides powers to the mainframe from the PSU.

3.1.2.6 HV Cable* (6)

The HV cable is used to interconnect the high voltage power between the mainframe and the PSU.

3.1.2.7 Mains input to PSU (Super Rapid² Only)* (7)

Mains input port on the Super Rapid² PSU.

3.1.2.8 Isolated Trigger Port* (8)

This 26 way D-Type connector is situated on the rear of the UI and has three rows of pins. It provides trigger input and output signals. (see Appendix B).

3.1.2.9 Foot Switch Pneumatic Socket* (9)

This socket is used to connect the pneumatic foot switch to the Magstim Rapid² system. The foot switch can be used to trigger the instrument when one of the trigger buttons located on the coil is also pressed. The instrument will continuously charge and discharge if the trigger buttons are pressed and held.

3.1.2.10 Cooling Fan Outlet (10)

With the Magstim Rapid² system turned on, air is drawn through slots at the bottom of the instrument and expelled through the fan outlet. There should be no obstructions placed closer than 50mm to the fan outlet.

3.1.2.11 HV Power Entry Socket (11)

The HV cable is connected to this connector to interconnect the high voltage power between the mainframe and the PSU.

Note: High voltage can be present on this connector.

3.1.2.12 Earth Strap (12)

The Rapid² system must only be used when fitted with the supplied earth straps, this is to maintain the system's compliance with EN 60601-1-2 regarding Electro-Magnetic emissions. The strap is fitted between the stimulator and the PSU.

3.1.2.13 Mains input to PSU* (13)

Mains input port on the Standard Rapid² PSU and Super Rapid² PSU.

3.2 Magstim Rapid² Plus¹

The Rapid² Plus¹ uses the same modules as the Super Rapid² with the addition of the Plus¹ module which has an additional PSU. This allows stimulation to occur at higher frequencies for a given power level to be delivered to the patient.

3.2.1 Front view

The front panel, shown below, allows control of the Standard Rapid² Plus¹ and provides the connection for the stimulating coil.

All operating functions described in this section assume that the mains power switch, located on the rear panel, is switched on
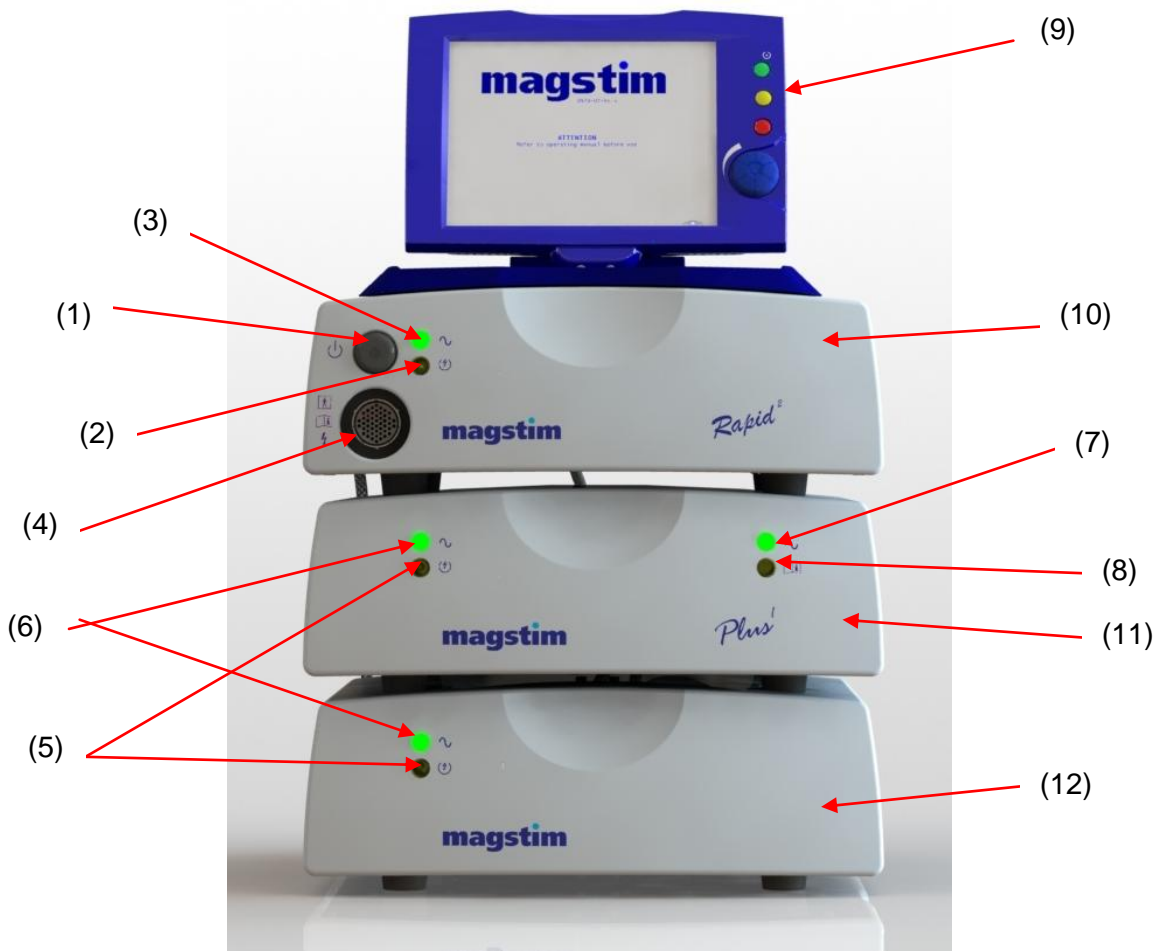
Figure 3.5: Detailed front panel of Rapid² Plus¹.

3.2.1.1 On/Off/Standby* (1)

This switch toggles the operational state of the Rapid².

3.2.1.2 Armed Indicator* (2)

The armed indicator illuminates when the unit is armed and high voltages are present on the system.

3.2.1.3 Power Indicator* (3)

The power indicator flashes when the Magstim Rapid² is in standby, and illuminates when the Magstim Rapid² is on.

3.2.1.4 Coil Output Socket* (4)

This socket is used to connect the stimulating coil to the Magstim Rapid². Note that the unit

Note: It is normal for the pin indicated on the label to protrude from the coil socket. This is an intentional design feature.
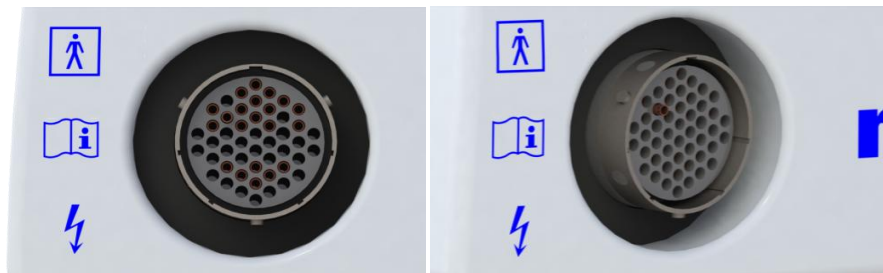
Figure 3.6: Coil output socket front view   **Figure 3.7: Coil output socket angled view**

3.2.1.5 Armed/Fault Indicator* (5)

This LED is continuously illuminated when the Magstim Rapid[2] is armed and high voltages are present on the system. This LED turns RED when a fault is detected in the PSU.

3.2.1.6 PSU Power Status Indicator* (6)

The PSU power indicator is OFF when the system is in standby or OFF. It is continuously illuminated when the system is on.

3.2.1.7 Power Indicator* (7)

This LED is continuously illuminated green when the Plus[1] module is powered on.

3.2.1.8 Status/Fault Indicator* (8)

This LED is continuously illuminated green when system is operating correctly. This LED turns RED when a fault has been detected in either the Dual PSU or Plus[1] Module.

3.2.1.9 Rapid² UI (9)

This is the interface by which the user controls the stimulator. See Section 3.3 for further details.

3.2.1.10 Main Frame (10)

This Mainframe contains the circuitry that allows the stimulator to deliver energy as specified using the UI.

3.2.1.11 Plus[1] Module (11)

This module is a combination of PSU and control circuitry that allows additional performance compared to that of a Standard or Super Rapid[2] system.

3.2.1.12 Dual Power Supply Unit (PSU) (12)

The dual PSU contains the electronic circuitry that powers the stimulator.

3.2.2 Rear view
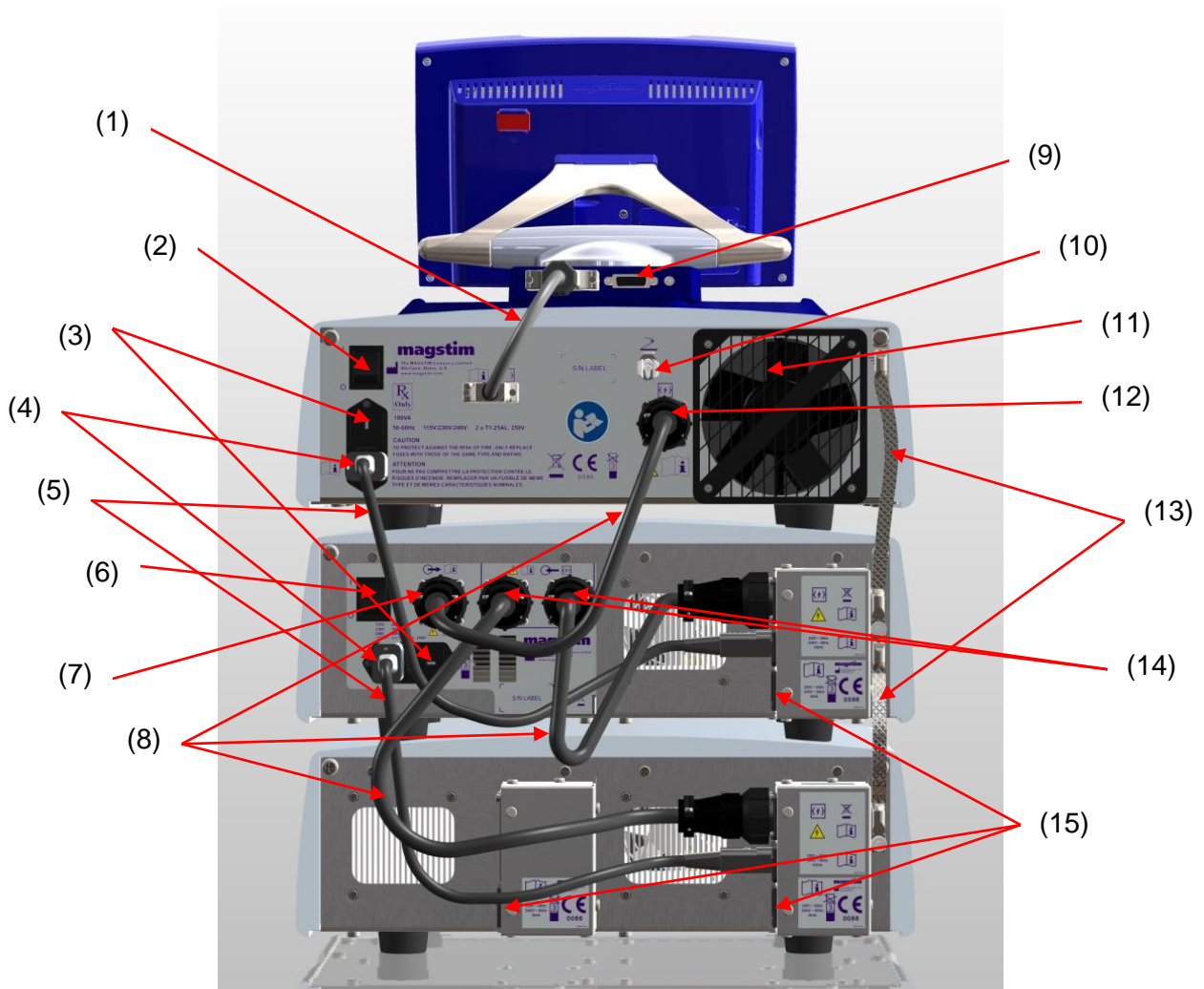
Figure 3.8: Detailed rear panel of Rapid² Plus¹.

Note: 115V units are identical in appearance to the 230V units, with the exception of the voltage/power rating labels sited to the rear

3.2.2.1 UI Cable* (1)

The UI cable connects the Rapid² UI to the Rapid² mainframe.

3.2.2.2 Mains Power Switch* (2)

The Power switch allows the power supplying the unit to be switched on (labelled I) or off (labelled O).

3.2.2.3 Fuse Access and Voltage Selector* (3)

Access for fuse replacement and changing the voltage selector setting. See section 5.3 for further details.

3.2.2.4 Power Entry Module* (4)

Power input port on the Rapid² mainframe and Plus¹ module.

3.2.2.5 Link Lead* (5)

The 10A link lead provides powers to the Plus¹ from the PSU and to the mainframe from the Plus¹.

3.2.2.6 Plus¹ Mains Power Switch* (6)

The Power switch allows the power supplying the Plus¹ module unit to be switched on (labelled I) or off (labelled O).

3.2.2.7 Plus¹ HV Power Output Socket* (7)

This connector is the HV output on the Plus¹ which interconnects the high voltage power between the mainframe and the Plus ¹ module.

Note: High voltage can be present on this connector.

3.2.2.8 HV Cable* (8)

The HV cable is used to interconnect high voltage power between the mainframe, Plus¹ and the PSU.

3.2.2.9 Isolated Trigger Port* (9)

This 26 way D-Type connector is situated on the rear of the UI and has three rows of pins. It provides trigger input and output signals. (see Appendix B).

3.2.2.10 **Foot Switch Pneumatic Socket* (10)**
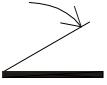
This socket is used to connect the pneumatic foot switch to the Magstim Rapid² system. The foot switch can be used to trigger the instrument when one of the trigger buttons located on the coil is also pressed. The instrument will continuously charge and discharge if the trigger buttons are pressed and held.

3.2.2.11 **Cooling Fan Outlet (11)**

With the Magstim Rapid² system turned on, air is drawn through slots at the bottom of the instrument and expelled through the fan outlet. There should be no obstructions placed closer than 50mm to the fan outlet.

3.2.2.12 **HV Power Entry Socket (12)**

The HV cable is connected to this connector to interconnect the high voltage power between the mainframe and the PSU.

Note: High voltage can be present on this connector.

3.2.2.13 **Earth Strap (13)**

The Rapid² system must only be used when fitted with the supplied earth straps, this is to maintain the system's compliance with EN 60601-1-2 regarding Electro-Magnetic emissions. The strap is fitted between the stimulator and the Plus¹ unit and between the Plus¹ unit and the PSU.

3.2.2.14 **Plus¹ HV Power Input Socket* (7)**

This connector is the HV input on the Plus¹ which interconnects the high voltage power between the PSU and the Plus ¹ module.

Note: High voltage can be present on this connector.

3.2.2.15 **Mains input to PSU and Plus¹* (15)**

Mains input port on the PSU and Plus¹ module.

3.3 Magstim Rapid² User Interface

The Rapid² UI is a touch screen user interface by which the user controls the Magstim Rapid² system.

3.3.1 Front view

All operating functions described in this section assume that the mains power switch, located on the rear panel of the Rapid², is switched on

Figure 3.9: Detailed front panel of Rapid² UI.

3.3.1.1 Run Button* (1)

The Magstim Rapid² system can be put into the armed mode by momentarily pushing the Green **RUN** button. This can only be achieved if the stimulating coil is connected to the coil output socket.

3.3.1.2 Trigger Button* (2)

The Magstim Rapid² can be triggered to deliver the protocol by pressing the yellow **TRIGGER** button.

Note: It may be necessary to also activate the coil interlock buttons with some Magstim stimulating coils in order to trigger the system.

3.3.1.3 System Stop Button* (3)

The Magstim Rapid² can be disarmed and put into a safe state by pushing the red STOP button. In this mode the system will discharge internally.

3.3.1.4 Output Control* (4)

This control allows the user to change the screen-selected parameter to the desired value. It is therefore used to alter screen settings as well as changing the power output of the stimulator.

3.3.1.5 Touch-Sensitive Screen/ System Display * (5)

Button

All selections are made via the touch-screen. To select, touch the centre of the button symbol next to the desired menu option. Do not press hard, or use a sharp or pointed object to make the selection, as this may damage the touch screen.

1.0 s
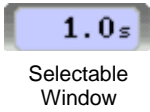
Selectable Window

In the set-up screens, all selectable items are coloured in pale blue; white items are non-selectable. The Rotary Control Knob can only be used to change parameters already selected. Details regarding the contents and operation of the UI Screens are given in Sections 4.4

20

Non-Selectable Window

Note: If the UI is not used for 30 minutes it will go into a standby condition. In standby, the screen will appear blank and the blue LED in the upper right corner of the front bezel will pulse. Touch the screen to restore the UI.

3.3.2 Rear view
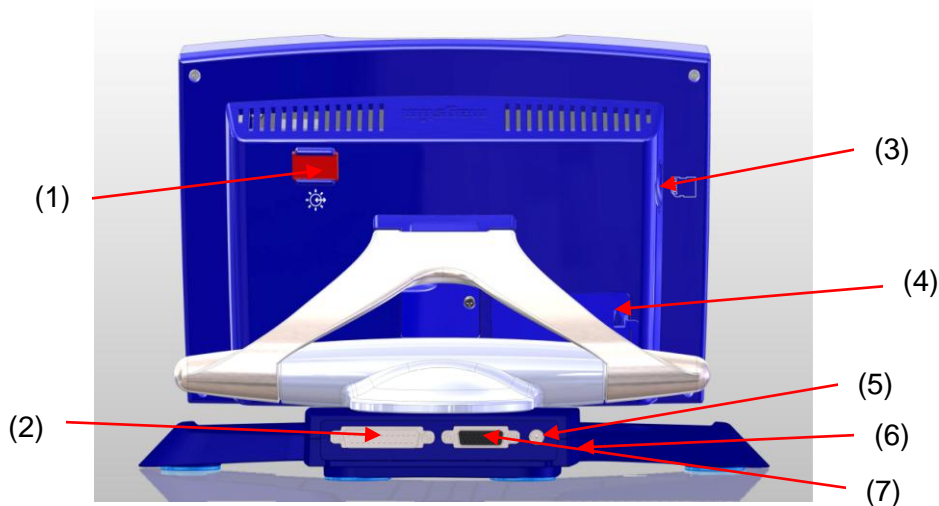
Figure 3.10: Detailed front panel of Rapid² UI.

3.3.2.1 Printer Connection* (1)

The Printer is attached to the User Interface via an Optical/RS232 Interface Cable which slides into place on the right hand side at the rear of the UI.

3.3.2.2 25 Way D-Type Connector* (2)

This connector is situated on the rear of the UI, and has 2 rows of pins. The connector links the UI to the Magstim Rapid² as shown in figures 3.4 and 3.8.

3.3.2.3 SD Card Insertion Point* (3)

This socket is situated on the rear of the left hand side panel of the UI. This allows connection of an SD Card. This removable memory storage facility enables transfer of data between the UI and external devices, such as PCs.

3.3.2.4   15 Way D-Type Connector* (4)

This connector is situated on the rear of the UI behind the removable cover. It is designed to accept the Motor Evoked Potential (MEP) pod, available as a separate item. It has type BF connection.

3.3.2.5   DC Power Jack* (5)

The DC Power Jack is situated on the rear of the UI. This connector allows an external 24V, 750mA DC power supply to be attached. A suitable medical grade supply must be used, conforming to IEC 60601-1. This is NOT required when the UI is connected to the Magstim Rapid[2].

3.3.2.6   Batteries* (6)

The battery compartment is accessed from the base of the UI. The batteries are required to maintain configuration details such as time and date following power cycles.

3.3.2.7   26 Way D Type Connector* (7)

This connector is situated on the rear of the UI, and has 3 rows of pins. It provides trigger input and output signals (see Appendix B).

3.4   Accessories

The use of the correct accessories is essential to the functioning of the Magstim Rapid². The Magstim Company Limited cannot guarantee the instrument's performance unless accessories used are obtained from The Magstim Company Limited. Only Magstim accessories purchased from The Magstim Company Limited should be used with the Magstim Rapid².

Note: The Magstim Rapid² system should only be powered using the power leads supplied by The Magstim Company Ltd.

3.4.1   Stimulating coils

A range of stimulating coils is available for use with the Magstim range of products. For more details, please contact the Sales department. Contact details are shown in Section 7.3.

3.4.2   MEP Pod

NOTE. The Rapid[2] must be switched off before connecting or disconnecting the MEP Pod.

The Motor Evoked Potential (MEP) Pod is an optional component which allows the user to capture EMG signals and display them on the UI. 2 channels are available. The MEP Pod should be mounted

as close as possible to the subject but should be kept away from sources of interference, such as power cables. It is recommended that all EMG cables are screened to minimise interference.

Figure 3.11: MEP Pod

The MEP Pod is designed to be used with surface electrodes only.

The MEP Pod is designed to be fitted to the Magstim Rapid² UI only. Do not attempt to connect it to a computer, or any other equipment, with a similar connector. To do so could result in electric shock/ burns to the patient at the site of electrode attachment. The MEP Pod connector has a hole deliberately blocked to prevent incorrect connection.

3.4.3 Printer

The printer makes it possible to generate copies of the majority of the information that is stored within the Magstim Rapid². The Print option allows for screen or file information to be obtained on paper.

Figure 3.12: Printer

In any screen where the 'Print' Button is visible the Printer can produce a reproduction of the information that is displayed on screen. This option is available in:

Note: The printer should be placed outside the patient environment during use (1.5m in all directs from the patient.

3.4.4 SD Card

An SD Card provides the opportunity for information that is stored on the Magstim Rapid² to be transferred to a PC and viewed using any standard PC text editing software package. Information is transferred onto the SD Card via the 'File Maintenance' Screen.

The Rapid² is only compatible FAT 16 formatted SD cards.

SECTION 4   OPERATING INSTRUCTIONS

Note: to avoid problems with interference, the stimulating coils should not be used in the vicinity of any equipment not in compliance with the EMC Standard EN 60601-1-2, including mobile phones.

Note: Please ensure you are familiar with all sections of this operating manual prior to following these operating instructions. Refer to section 3 for identification and descriptions of Rapid² connecting parts and functions.

Note: Please consult any labelling and information accompanying stimulating coils and other accessories for safety and use information regarding these devices.

4.1   Preparation

1. At the start of each session the operator must check the Magstim Rapid² and any accessories used for any signs of external damage and to identify any cleaning required*. If any cracks are visible in the housing, or there is damage to any of the cables, the items must not be used and should be returned to The Magstim Company Limited for servicing and repair. If cleaning is required, please follow the instructions in Section 5.4 of this Operating Manual.

    Note: The contacts in the coil connector, and the stimulator coil output socket should be checked regularly for any signs of tarnishing or burning. See Section 5.2 for an example of contact burning.

4.2   Rapid² Set-Up

Note: The Magstim Rapid² system should be assembled following the instructions provided within this section to ensure continued compliance of IEC 60601-1:2005.

Note: ensure not to position the Magstim Rapid² system, so it is difficult to disconnect the power lead.

Before using the instrument, ensure that the correct fuses are fitted and that the voltage selector is set to suit the country's supply voltage (this statement applies to the Rapid² Main Frame and Magstim Plus[1] only). See Section 5.3 for further information.

1. Place the system in a room near multiple power sockets and ensure easy access to and around the equipment. Make sure to stack the system as shown in Section 3.

2. Label the entrances to the room to warn of the presence of strong magnetic fields and to exclude those wearing pacemakers and/or electronic implants.

3. Attach the coil holder to the mainframe by removing the two blanking plugs from the threaded inserts on the right-hand side of the mainframe.

    Insert the two M6x12 hexagon bolt into the mounting holes on the coil holder. Place the coil holder against the right-hand side of the mainframe so that the bolts locate in the threaded inserts. (See Figure 4.1).

    Using the supplied hexagon key tighten the bolts so as to secure the coil holder to the right-hand side of the main frame. Do not over tighten the bolts as this may damage the cases of the units.
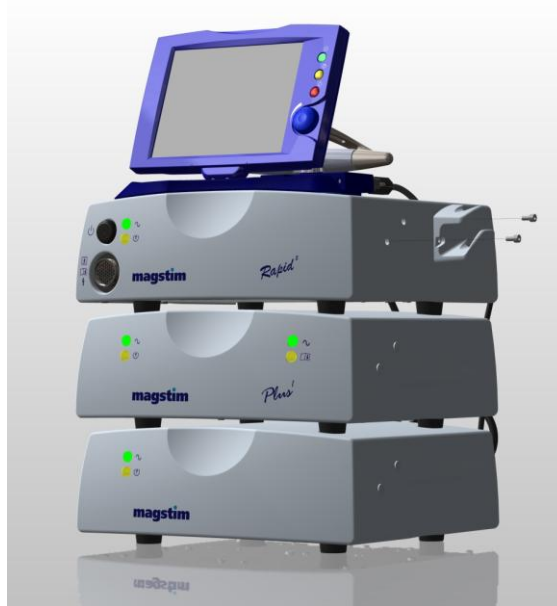
Figure 4.1: Attaching the coil holder to Rapid² Plus¹ System

4. Connect the HV cable(s) provided (See Figure 4.2 for reference).
   Standard Rapid² & Super Rapid²: Connect the HV cable from the PSU to the rear panel of the Main Frame.
   Rapid² Plus²: Connect two of the HV cables from the two the PSUs to the two HV inputs (indicated by the ⮜ symbols) located on the rear panel of the Magstim Plus1. Connect the third HV cable between the HV output (indicated by the ⮞ symbol) on the rear panel of the Magstim Plus1 to the HV input on the rear of the Main Frame.

5. Connect the 10A link leads provided (See Figure 4.2 for reference).
   Standard Rapid² & Super Rapid²: Connect the 10A link lead between the PSU Module and the stimulator Main Frame. Please refer to section 3 for reference.
   Rapid² Plus²: Connect a 10A link lead from the Dual PSU Module to the Magstim Plus1 and from the Magstim Plus1 PSU module and the stimulator Main Frame. Please refer to section 3 for reference.
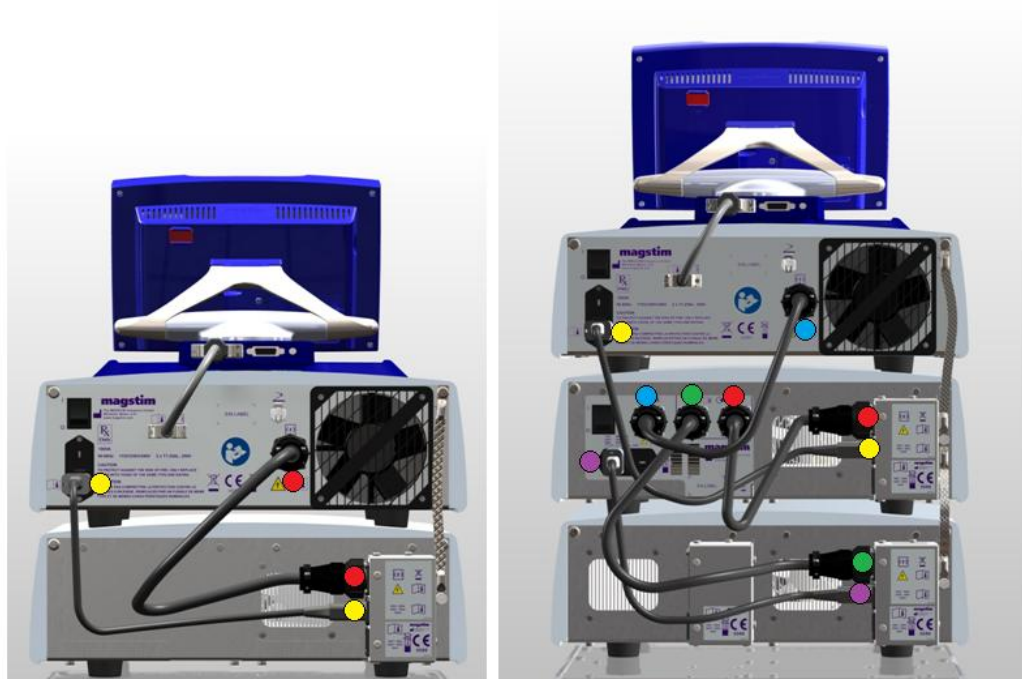

Figure 4.2: Colour coded cable connection (Left Rapid²/Super Rapid, Right Rapid² Plus¹)

6. Connect the UI Controller to the Magstim Rapid² Main Frame via the UI cable supplied.

7. If a foot switch is to be used, insert the pneumatic connector of the foot switch to the rear panel Foot Switch Socket on the mainframe*.

8. Attach the earth straps provided as illustrated in figure 4.3.
   Standard Rapid² & Super Rapid²: Single earth strap between main frame and PSU.
   Rapid² Plus²: Two earth straps, one between the main frame and the plus[1], the second between the Plus[1] and the PSU.
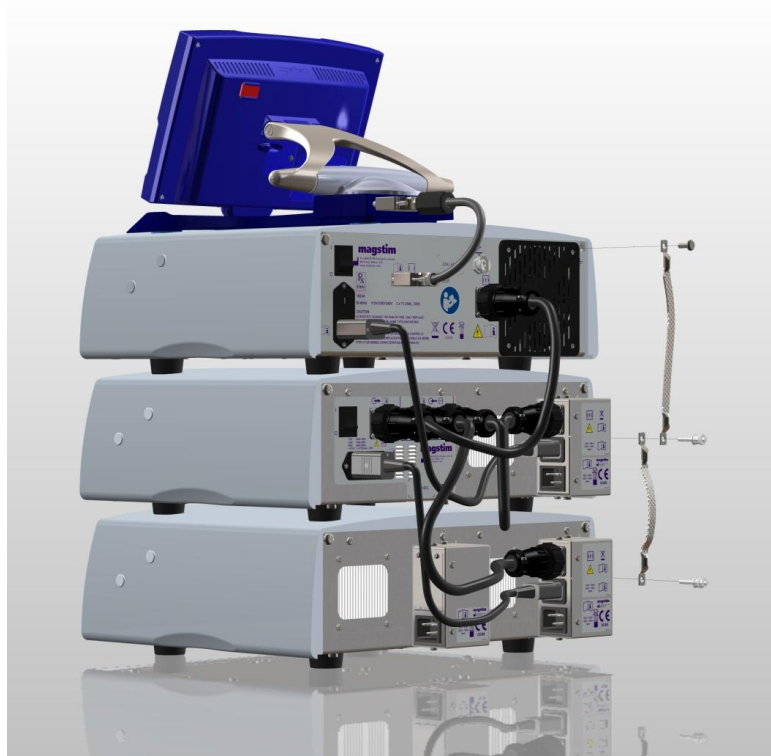

Figure 4.3: Attaching the earth strap

9. Connect the power cables provided to the power supply socket(s) on the rear of the PSU (and Plus[1] when in Rapid² Plus[1] configuration). The power requirement of the Magstim Rapid2 depends on the PSU used and the parameters set by the UI.

   Standard Rapid²: A single power lead connected to the PSU.
   Super Rapid²: Two power leads connected to the PSU.
   Rapid² Plus²: Three power leads. Two connected to the PSU and one connected to the Plus[1].

   Note: The power cables must be connected directly to wall power outlet sockets, and not via a terminal block. The Rapid[2] System must be used only with the supplied mains leads fitted with an integral filter, as they are required to maintain the System's compliance with EN 60601-1-2 regarding Electro-Magnetic emissions.

4.3 Connection of Accessories

4.3.1 Stimulating Coil

1. Place the stimulating coil to be used into the coil holder on the right hand side of the stimulator as instructed in Figure 4.4*. If using a stand held coil, place the coil in the stand.
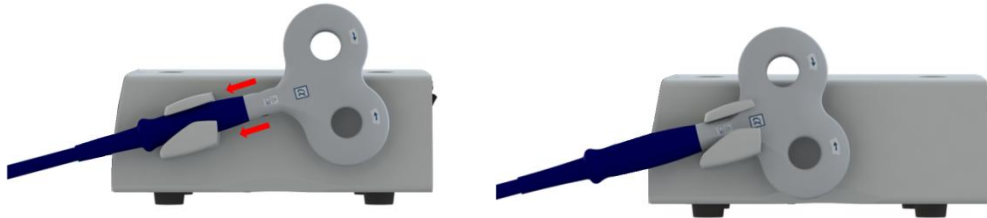

Figure 4.4: Attaching the coil to the coil holder

2. Connect the stimulating coil to be used to the Magstim Rapid² unit*.

    Note: There is locating key on the coil connector, which needs to be aligned with the corresponding receptor on the stimulator coil socket. It is then possible to rotate the outer collar of the coil connector clockwise in order to lock the coil to the stimulator. (See Figure 4.5)
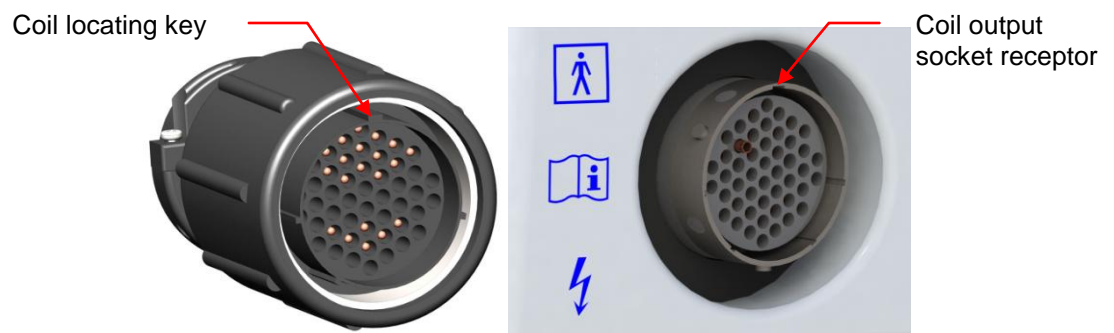

Coil locating key

Coil output socket receptor

Figure 4.5: Locating key on the coil connector (left) and the receptor on the stimulator coil output socket (right)

Care must be taken to attach the coil connector to the stimulator correctly (see Figure 4.6). Failure to do so can cause damage to the connector pins and in severe cases, internal damage to the coil and the stimulator.
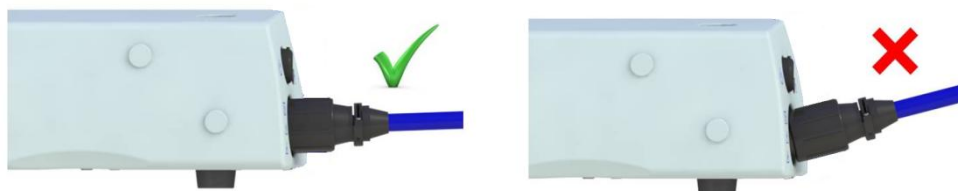

Figure 4.6: Diagram showing correct and incorrect ways to connect the coil to the stimulator

4.3.2 **MEP Pod**

1. The MEP Pod is attached to the rear right hand side of the UI when viewed from the rear. Remove the plastic cover to expose a 15 way D Type socket.

2. Attach the MEP Pod cable, ensuring that the plug is properly inserted.

3. Replace the plastic cover and ensuring that the cable is passed through the notch on the lower edge of the cover.

    Note: This cover, when replaced, provides strain relief for the connector. Do not operate the equipment without replacing this cover, as damage to the connector and the internal electronics of the UI is likely.

Figure 4.7: Connection of the MEP Pod

4. Attach the EMG cable to the MEP Pod and snap the free connectors onto surface type electrodes (for example, Kendall ARBO H124). Suitable electrodes are available from many medical supply companies, and no recommendation is made as to a particular type. Electrodes should be chosen which are suitable for the collection of EMG data, have snap connectors, and which are compliant with local regulations. When connecting the electrodes, follow the colour code on the MEP Pod.

5. The EMG connection cable should be screened and should be suitable for use when in direct contact with the skin. No latex should be present in the cable.

6. The electrodes should be positioned on the target muscle which is controlled by the neurons being stimulated. For example, if the area of the motor cortex which controls the hand is to be stimulated, the surface electrodes should be placed on abductor digiti minimi, about 1cm apart. The ground electrode should be placed on the wrist. Care should be exercised when placing surface electrodes. It is important that a consistent approach is observed, as the amplitude of the EMG signal is dependent on the position of the electrodes. Good practice in relation to skin cleaning should be observed.

    Caution: For safety reasons, do not leave patient cables attached to the MEP Pod if they are not being used. If an unused cable is left connected, and the patient is connected to the other channel, there is the possibility that the unused cable may touch an earthed surface which could allow current to flow through the patient to ground.

    Caution: Do not allow the coil or the coil cable to come into close proximity with the MEP Pod patient cables. During discharge, current may be induced in these cables.

4.3.3 **Printer**

1. The printer should be placed on a flat surface 1.5 meters away from the patient.

2. Insert the cable connector straight into the Printers Serial Port to power the printer via the Mains

3. Connect the other end of the cable to the back of the UI via an optical RS/232 Interface cable by sliding the connector into the slot until tight. Connect the printer to its power supply and the power supply to the mains.

Figure 4.8: Connecting the printer to the Rapid² system

4. Switch the printer on via the green button on the left hand side of the printer. The 'Power' LED should now be illuminated green.

5. To load paper, push the cover buttons on the side of the printer; this will open the Roll Paper Cover.

6. Align the edges of the paper roll against the paper holders and push down gently.

7. Pull the paper through and close the cover. The printer is now ready to be used.

Figure 4.9: Printer

4.4 **Operation**

1. Apply mains power to the Rapid² system by switching the mains power switch on the rear panel of the Rapid² Main Frame and, if relevant the mains power switch on the rear panel of the Magstim Plus1 to the ON (I) position.

2. Switch on the system using the ON/OFF/ STANDBY button on the front of the Rapid² Main Frame. The UI will activate automatically and will display the welcome screen (Figure 4.10).

   Note: The system will fully initialise and the Options Menu will appear after 15 seconds. Pressing the Continue Button before the system has fully initialised gives access to the following options:

   - Single Pulse Mode,
   - System,
   - File Maintenance

Figure 4.10: Welcome Screen

The system needs to be fully initialised before Repetitive mode and Session mode are accessible.

3. When in the Main Options Menu (Figure 4.10), select the desired mode of operation. These modes of operation being:

   Single Pulse (MEP):

   Selecting this option will call up the *Single Pulse Mode* Screen. (See Section 4.4.1)

   This allows the system to be fired at a maximum rate of 1Hz, up to 100% power and 0.5 Hz from 101-110%. It also allows an MEP module to be configured.

   Repetitive Mode

   Selecting this option will call up the Repetitive Mode Set-up Screen. (See section 4.4.2 & 4.4.3) This allows the system to run a user defined train of pulses from a single trigger.

Figure 4.11: Main Options Menu

   Session Mode

   Selecting this option will call up the Session Mode Setup Screen. (See section 4.4.4) This allows the system to run a series of separately defined trains of pulses from a single trigger.

4. If required, system options and file maintenance can also be accessed from this window.

   System

   Selecting this option will call up the Systems Options Menu Screen. (See Section 4.4.5)

   File Maintenance

   Selecting this option will call up the File Maintenance Screen. (See section 4.4.6)

5. When in the desired mode of operation, select the desired protocol to be delivered, (e.g. stimulating power, stimulation frequency, train duration and inter-train delay).

6. Press the green RUN button on the Rapid² UI to arm the Magstim Rapid²*. The system will charge and the UI will display READY in the system status window.

   Note: The system cannot be armed if the footswitch is active.

7. Position the stimulating coil on the desired area of tissue.

8. When ready to trigger the system, engage and hold one of the trigger/interlock switches located on the stimulating coil, then press either the yellow TRIGGER button on the on the Rapid² UI or the foot switch*.

   A clicking noise should be heard from both the stimulating coil and the Magstim Rapid² system each time the system is triggered. This indicates that a magnetic pulse is being delivered by the stimulating coil, which is stimulating the nerves beneath it.

   Note: The Magstim Air Film Coil or Magstim Placebo Air Film Coil do not utilise trigger/interlock buttons. Therefore the system can be triggered by pressing the yellow TRIGGER button on the Rapid² UI.

   Note: The Rapid² can only be fired when one of the following UI screens is displayed:

   - Single Pulse Mode,
   - Repetitive Mode,
   - Session Mode.

9. When necessary, it is possible to reposition the stimulating coil and/or to modify the power level on the UI to suit the requirements for the next stimulus. Meanwhile, the system will have recharged and can be triggered once again in the normal manner.

10. At the end of the session, engage the red STOP button of the Rapid² UI to discharge the stimulator internally and put it into stopped mode*.

11. Place the Rapid² system into standby by pressing the ON/OFF/STANDBY button.

12. Set the power switch on the rear of the mainframe to the (O) position to remove mains from the system*.

    Note: The temperature of the internal components become elevated during operation. The system should be left on, and uncovered, for approximately ten minutes following completion of stimulation to enable the fan to cool the internal system components.

13. Sections 4.3 and 4.2 should be repeated in reverse to disconnect the Magstim Rapid² and accessories*.

    Note: Ensure that the system is disarmed prior to disconnecting the stimulating coil.

4.4.1 Single Pulse Mode (MEP)

The trace window is always active on this screen and is intended to display EMG response information from the MEP Pod. If no MEP pod is connected, the screen message will show 'MEP NOT INSTALLED.'

Note: The Rapid² must be switched off before connecting or disconnecting the MEP Pod.

The MEP pod must be connected to access the following options:

- Parameters,
- Time Cursors,
- Amplitude Cursors,

- Display,
- Save Traces

Note: The Charge Delay Function is still available when the MEP Pod is not connected.
To alter the settings, touch the window next to the required setting. A dark blue margin will appear within the selected window. The settings can be quickly altered using the Rotary Control Knob. Windows with a white background are not selectable.

4.4.1.1 Power Panel

The Power Panel is selected by pressing the Power button. When Power is selected, the button turns green.

Stimulator Output: To adjust the system power level, touch the Stimulator Output window on the Power Panel. The power level is set to the default value of 30%.   The power can be increased, or decreased, in 1% increments by using the Rotary Control Knob. Each complete 360⁰ rotation changes the output level by approximately 20%.

%MT: The %MT (Motor Threshold) window, displays the percentage of stimulator output which is to be transferred to the Protocol Intensity window. The %MT cannot be adjusted to give more than the 100% in the Protocol Intensity window.

Figure 4.12: Power Panel Window

Enhanced: This option enables the power level to be increased up to 110% power. This option is only available in Single Pulse Mode.

Note: If Repetitive Mode or Session Mode is accessed via Single Pulse Mode, the Protocol intensity value will be carried over into these modes.

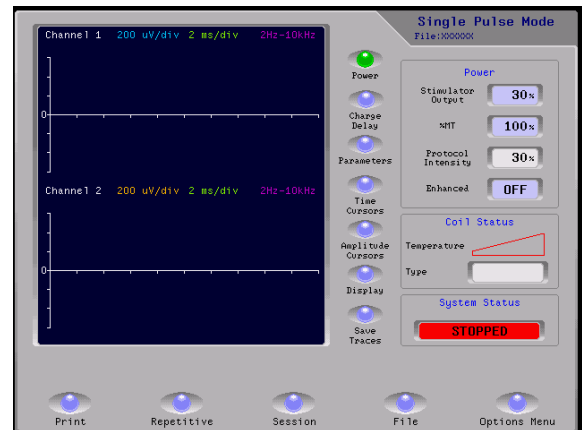**Note:** Enhanced mode is not available when using an Air Film Coil (P/N 3950-00)

4.4.1.2 Charge Delay Panel

The Charge Delay Panel is selected by pressing the Charge Delay button. When Charge Delay is selected, the button turns green.

Status: Selects the status window to turn the charge delay ON or OFF. When the status window displays ON, a stopwatch symbol is displayed in the System Status panel. The default setting is OFF.

Duration: When the charge delay window displays OFF, the duration window is not selectable and can not be adjusted. When the charge delay displays ON, the duration window allows the duration of the charge delay to be adjusted between 1ms and 10000ms in 1ms increments using the Rotary Control Knob.
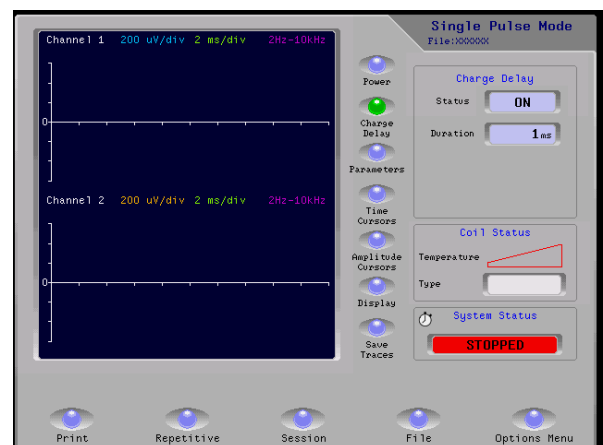

Figure 4.13: Charge Delay Panel Window

Turning the charge delay OFF causes the duration window to display 0ms. Turning the charge delay ON will restore any previously set charge delay duration since power-up. The default duration on power-up is 0ms.

Note: After each delivered pulse, the system will not begin to re-charge until the specified charge delay duration has elapsed. Any attempt to trigger the system during this charge delay period will be ignored.

Note: If Repetitive Mode or Session Mode is accessed via Single Pulse Mode, the Charge Duration set will be carried over into these modes.

Note: Charge Delay mode is not supported in Session Mode.

4.4.1.3 **Parameters Panel**

Press the Parameters button (green when selected) to access the MEP Configuration panel.

Time Base: Selecting the Time Base window allows the user to set the MEP total sample period. The selectable options are; 20ms, 50ms, 100ms, 200ms and 500ms and are selected using the Rotary Control Knob. The trace width will show the whole of the selected sample period.

Filters: Selecting the Filters window allows the user to set the MEP Filter using the Rotary Control Knob. Selectable options: 2Hz-10kHz and 20Hz-10kHz.

Figure 4.14: Parameters Panel Window

Volts/Div Trace 1: Selecting the Volts/Div Trace window allows the user to set the scaling factor for channel 1. Selectable options: 50µV, 100µV, 200µV, 500µV, 1mV, 2mV, 5mV and 10mV. The default setting is 200µV.

Volts/ Div Trace 2 : Selecting the Volts/Div Trace window allows the user to set the scaling factor for channel 2. Selectable options: 50µV, 100µV, 200µV, 500µV, 1mV, 2mV, 5mV and 10mV. The default setting is 200µV.
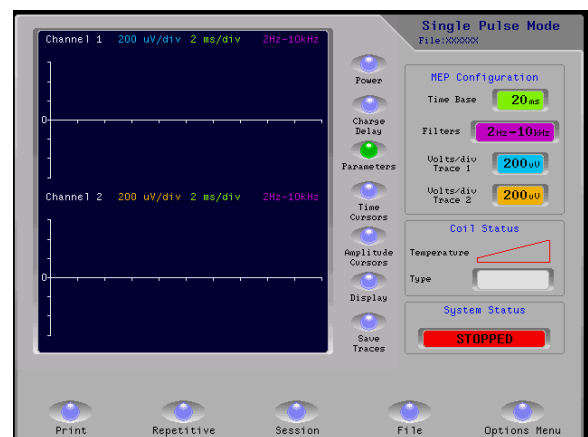
4.4.1.4 Time Cursor Panel

Press the Time Cursors button (green when selected) to access the Time Cursors panel.

Status: Select the Status window to turn the Latency Cursors on and off. The default setting is OFF.

Channel 1 Latencies: Select L1 or L2 to activate a cursor for adjustment. When the cursors are active, their current screen time value will be displayed on the trace window. The trace of the selected cursor can be moved using the Rotary Control Knob, for example to identify the time of an event.

Figure 4.15: Time Cursors Panel Window

Channel 2 Latencies: Select L1 or L2 to activate a cursor for adjustment. When the cursors are active, their current screen time value will be displayed on the trace window. The trace of the selected cursor can be moved using the Rotary Control Knob, for example to identify the time of an event.
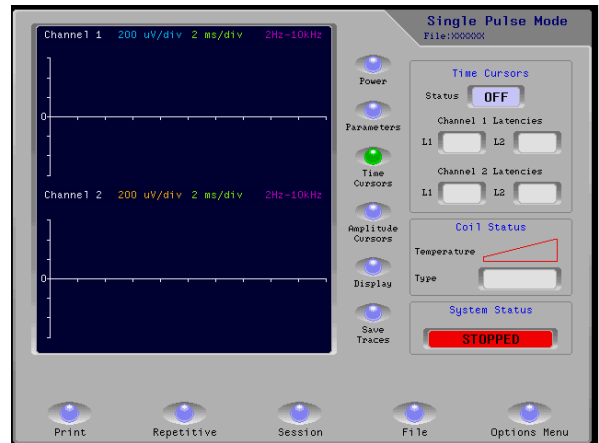
4.4.1.5 Amplitude Cursors Panel

Press the Amplitude Cursors button (green when selected) to access the Time Cursors panel.

Status: Select the Status window to turn the Amplitude Cursors on and off. The default setting is OFF.

Auto Peak: Select the Auto Peak window to turn auto peak on and off. The default value is ON. With this option ON, each time a new set of MEP waveforms are displayed, the cursors will automatically move to the peak values for each trace. With the option OFF, the amplitude cursors will remain at their previous values. Amplitude Cursors must be ON for this option to become available.
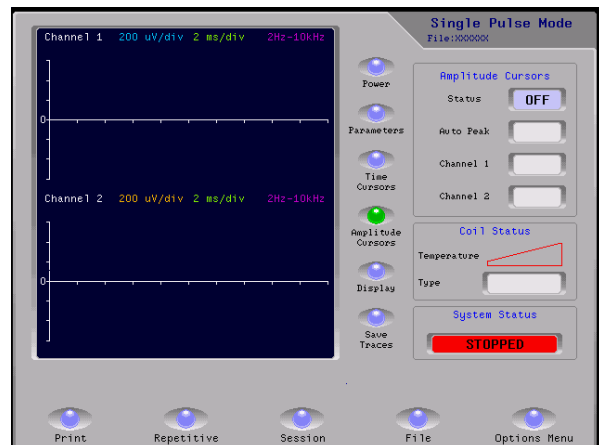
Figure 4.16: Amplitude Cursors Panel Window

Channel 1: This window allows the Amplitude Cursor on Channel 1 to be moved, for example to mark peaks. Amplitude Cursors must be ON for this option to become available.

Channel 2: This window allows the Amplitude Cursor on Channel 2 to be moved, for example to mark peaks. Amplitude Cursors must be ON for this option to become available.

Note, in Repetitive Mode or Session Mode, the Amplitude Cursor positions set in Single Pulse Mode will remain marked by the Amplitude Cursor on the trace.

4.4.1.6 Display Panel

Press the Display button (green when selected) to access the Display panel.

Status: Select the Status window to turn the Amplitude Cursors on and off. The default setting is OFF.

Channel 1: Select the Channel 1 window to show Channel 1 only in the trace window.

Channel 2: Select the Channel 2 window to show Channel 2 only in the trace window.

Both: Select the Both window to show both traces simultaneously in the trace window.
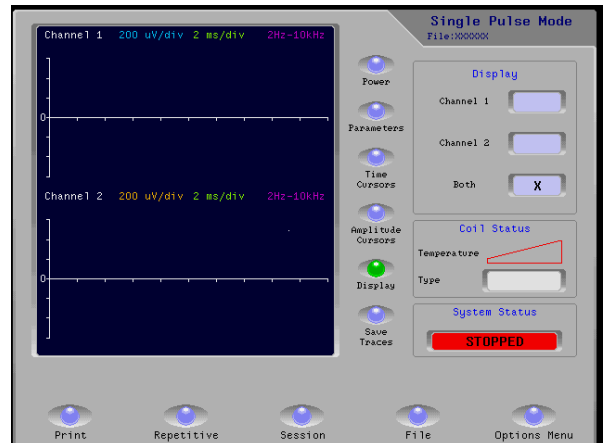
Figure 4.17: Display Panel Window

4.4.1.7 Save Traces

Select Save Traces to save the current trace. If a file is already open, the trace will be saved to this file. Alternatively, go to File Maintenance and save the trace to a file. (See Section 4.4.6)

4.4.1.8 Coil Status Panel

The Coil Status panel will show the temperature and type of coil.

4.4.1.9 System Status Panel

The System Status panel shows the system status. If a charge delay has been set, a stopwatch symbol (⏱) will be displayed.

4.4.1.10 Trace Window

The Trace window will be updated when stimulation occurs. The maximum update rate for the trace window is 4 times a second, depending on the amount of information to be displayed.

Print: For Print operations see Section 4.6.8

Repetitive: This takes the user to the *Repetitive Setup* Screen. (See Section 4.4.2 & 4.4.3)

Session: This takes the user to the *Session Setup* screen (see Section 4.4.4)

File: This takes the user to the *File Maintenance* screen (see Section 4.4.6).

Options Menu: Selection of this option will return the user to the *Options Menu* screen.

4.4.2 **Repetitive Mode: Standard**

4.4.2.1 **Repetitive Setup: Standard**

The Repetitive Setup Screen allows the user to set the following adjustable parameters to the desired values to enable a session to be run. If Repetitive Setup is accessed from Single Pulse Mode, the protocol intensity value established in Single Pulse Mode will be carried over into the power window.

To enter Standard Mode, select the 'Standard' button on the Repetitive Setup screen which allows the listed adjustable parameters to be set.

To alter the settings, touch the window next, or below, the required setting. A dark blue margin will appear within the selected window. The

Figure 4.18: Repetitive (Standard) Setup Window

settings can be quickly altered using the Rotary Control Knob. Windows with a white background can not be altered.

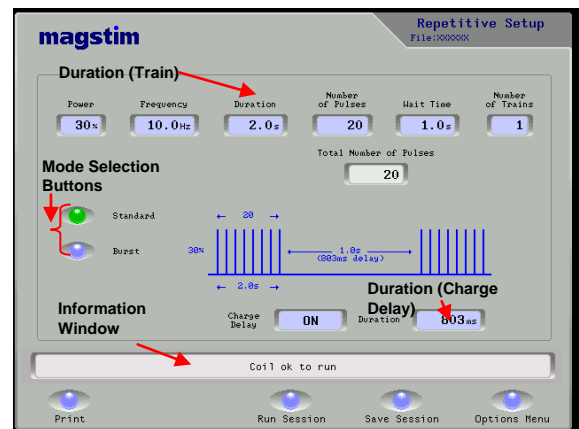The status of the charge delay and duration are synchronised between Single Pulse Mode and Repetitive Mode. That is, any changes made to the charge delay settings in Repetitive Mode will be reflected in Single Pulse Mode.

Power: Select the power window and use the Rotary Control Knob to adjust the System Power Level. The power can be increased, or decreased, in 1% increments.

Frequency: Selecting the Frequency window allows the user to set the frequency of the pulses to a value between 0 and F_{Max}Hz in 0.1Hz increments up to 30Hz, 1.0Hz thereafter. The maximum frequency can be up to 100Hz depending on the power level set and the system configuration. A table detailing the available power/ frequency combinations is included in Appendix

Duration (Train): Selecting the Duration window allows the user to set the duration of the pulse train to between 0.1 up to a maximum of 600 seconds, in 0.1 second increments up to 30 seconds, and in 1.0 second increments thereafter. The maximum duration allowed depends on the power and frequency settings and the connected coil (see Appendix E for coil compatibility information). On entering the duration and frequency, the number of pulses is automatically calculated by the UI and displayed.

Number of pulses: Selecting the Number of Pulses window allows the user to set the number of pulses in a train to between 1 and 60000 in steps of 1. The number of pulses cannot be set to exceed the maximum allowed duration. If the frequency is altered, the system will automatically adjust the duration to fit the current number of pulses.

Wait Time: Selecting the 'Wait Time' allows the user to set the wait time to between 1 and 540 seconds, in 0.1 second steps. However, if the minimum wait time required for the selected protocol is greater than that selected, the UI will display a message 'Wait period too short, auto-set to minimum'. Select 'YES' to set the wait delay to the minimum allowed for the chosen protocol. Select 'NO' to reset the protocol parameters manually.

No. of Trains: Selection of this option allows the user to set the number of times that the specified train runs to a value between 1 and 999 in steps of 1. The number of trains cannot be set to exceed the maximum total number of pulses of 65000.

Charge Delay: Select the 'Charge Delay' window to turn the Charge Delay on and off. The default setting is OFF.

Duration (Charge Delay): When the Charge Delay is OFF, the duration window associated with the charge delay is not selectable and can not be adjusted. A value of 0ms is displayed in the Duration window. With the Charge Delay is ON, this window will display any previously set charge delay since power-up. Selecting this window allows the duration of the charge delay to be adjusted using the Rotary Control Knob between 1ms and 10000ms in 1ms increments. The default duration on power-up is 0ms.

Charge Delay Operation: When incrementing the charge delay duration, the 'Wait Time' will automatically be adjusted if required. The charge delay duration is included as part of the overall wait time (this is shown graphically in brackets underneath the wait time).

The charge delay becomes active after the last pulse of a pulse train. After the last pulse, the system will not begin re-charging until the specified charge delay duration has elapsed. Any attempt to trigger the system during this charge delay period will be ignored.

Information Window: Appears at the bottom of the screen. The Information Window provides information such as 'Coil OK to run,' and alerts the user to actions required, protocols that are unable to be completed, or equipment which needs to be attached.

Print: For Print operations see Section 4.4.8

Save Session: Save Session takes the user to the File Maintenance screen (See section 4.4.6)

Options Menu: Selection of this option will return the user to the Options Menu screen.

Run Session: This screen takes the user to the Repetitive Mode screen in order to run a session.

4.4.2.2 Repetitive Run Mode: Standard

Session Details Panel: The Session Details panel shows a pictorial representation of the train currently running, and shows the settings established in Repetitive Setup and any associated charge delay duration if appropriate.

Channels 1, 2 and Both: Selecting Channel 1, Channel 2 or both determines whether both traces are shown simultaneously or individually.

Coil Status Panel: The Coil Status panel will show the temperature and type of coil.

System Status: The System Status panel shows the system status. If a charge delay has been set, a stopwatch symbol (⊘) will be displayed.
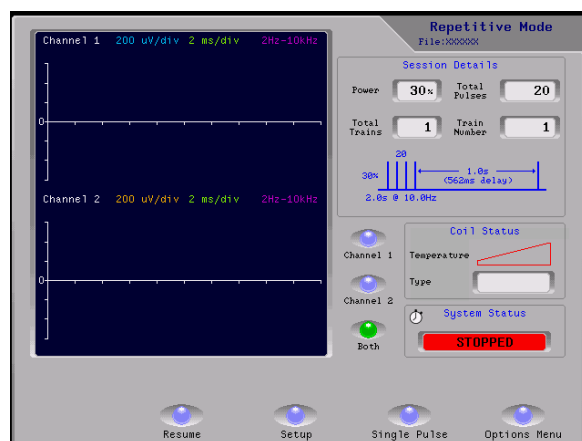
Figure 4.19: Repetitive Mode (Standard) Window

Trace Window: The Trace window will be updated when a stimulation occurs. The maximum update rate for the trace window is, 4 times a second, depending on the amount of information to be displayed.

If the amplitude cursors are active then the last position set for each cursor in Single Pulse Mode will be displayed. The cursor position will remain fixed until Single Pulse Mode is re-entered

In order to save the traces it is necessary to return to Single Pulse Mode and save the data as before. The information will remain on each trace window until a new trace is generated, when the new trace will overwrite the previous trace.

Resume: This option is available if the system is armed and the previous session was not completed. Selecting Resume will return the session to the point at which it was stopped, beginning at the start of the next train regardless of when the last train was stopped.

Setup: Selection of this option will return the user to the Repetitive Setup screen.

Single Pulse: Selecting this option will return the user to the Single Pulse Mode screen.

Options Menu: Section of this option will return the user to the Options Menu screen.

4.4.3 Repetitive Mode: Burst

4.4.3.1 Repetitive Setup: Burst

Select Burst Mode from the Repetitive Setup screen to allow the following adjustable parameters to be set.

If Repetitive Setup is accessed from Single Pulse Mode, the protocol intensity value established in Single Pulse Mode will be carried over into the power window.

To enter Burst Mode, select the 'Burst' mode selection button on the Repetitive Setup screen which allows the listed adjustable parameters to be set.
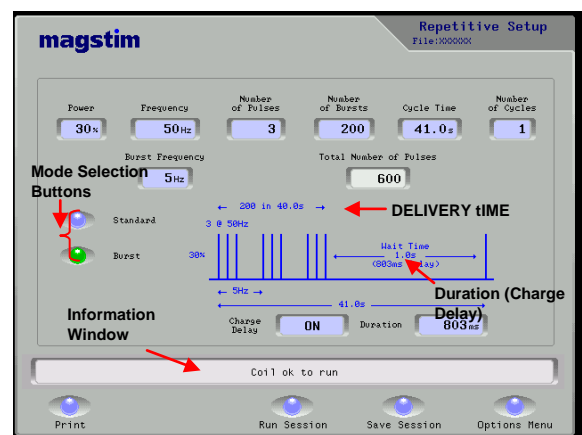
To alter the settings, touch the window next, or below, the required setting. A dark blue margin

Figure 4.20: Repetitive (Burst) Setup Window

will appear within the selected window. The settings can be quickly altered using the Rotary Control Knob. Windows with a white background can not be altered.

The status of the charge delay and duration are synchronised between Single Pulse Mode and Repetitive Mode. That is, any changes made to the charge delay settings in Repetitive Mode will be reflected in Single Pulse Mode.

Power: Selecting the Power window allows you to adjust the power level between 0% and 100% using the Rotary Control knob.

Frequency: Selecting the Frequency window will allow the user to set the frequency of the pulses to a value between 0 and FMaxHz in 1Hz increments. The maximum frequency can be up to 100Hz depending on the power level set and the system configuration. A table detailing the available power/ frequency combinations is included in Appendix D.

Number of Pulses: Selecting the 'Number of Pulses' window allows the user to set the number of pulses per Burst. The Number of Pulses can be set between 1 and 10 using the Rotary Control Knob.

Number of Bursts: Selecting the 'Number of Bursts' window allows the user to set the number of bursts in a cycle. The number can be set between 1 and 500 in increments of 1

Burst Frequency: Selecting the 'Burst Frequency' window allows the user to set the Burst frequency between 1Hz and 10Hz.

Cycle Time: Selecting the 'Cycle Time' window allows the user to set the time for each cycle in seconds. The time can be set between 1 and 500 seconds in increments of 0.1 seconds. The cycle time represents the sum of the 'Delivery Time' and the 'Wait Time'. The delivery time is dependant

only on the burst frequency and the number of bursts that have been selected. The wait time is dependant on the charge delay duration. The minimum wait time is 0.1s longer than the charge delay duration (if enabled), or 1.0s, whichever is greater.

However, if the minimum cycle time required for the selected protocol is greater than that selected, the UI will display a message 'Cycle time too short, auto-set to minimum'. Select 'YES' to set the cycle time to the minimum allowed for the chosen protocol. Select 'NO' to reset the protocol parameters manually.

Number of Cycles: Selecting the 'Number of Cycles' window allows the user to set the number of cycles in a session. The value may be set between 1 and 999 in increments of 1. The number of cycles cannot be set to exceed the maximum total number of pulses of 65000.

Charge Delay: Selects the 'Charge Delay' window to turn the Charge Delay on and off. The default setting is OFF.

Duration: When the Charge Delay is OFF, this window is not selectable and can not be adjusted. When the Charge Delay is ON, the 'Duration' window allows the duration of the charge delay to be adjusted between 1ms and 10000ms in 1ms increments using the Rotary Control Knob. Turning the charge delay OFF causes the duration window to display 0ms. Turning the charge delay ON will restore any previously set charge delay duration. The default duration is 0ms.

Charge Delay Operation: When incrementing the charge delay duration, the 'Wait Time' and hence the 'Cycle Time' will automatically be adjusted if required.

The charge delay becomes active after the last pulse of the last burst in a cycle. The system will not begin re-charging until the specified charge delay duration has elapsed. Any attempt to trigger the system during this charge delay period will be ignored.

Information Window: Appears at the bottom of the screen. The Information Window provides information such as 'Coil OK to run,' and alerts the user to actions required, protocols that are unable to be completed, or equipment which needs to be attached.

Print: For Print operations See Section 4.4.8.

Run Session: This screen takes the user to the Repetitive Mode Screen to run a session.

Save Session: Save Session takes the user to the File Maintenance screen (See section 4.4.6).

Options Menu: Selection of this option will return the user to the Options Menu screen.

4.4.3.2   Repetitive Run Mode: Burst

Session Details Panel: The Session Details panel shows a pictorial representation of the cycle currently running, and shows the settings established in Repetitive Setup and any associated charge delay duration if appropriate.

Channels 1, 2 and Both: Selecting Channel 1, Channel 2 and Both determines whether both traces are shown simultaneously, or individually.

Coil Status Panel: The Coil Status panel will show the temperature and type of coil.

System Status Panel: The System Status panel shows the system status. If a charge delay has been set, a stopwatch symbol ( ) will be displayed.

Trace Window: The Trace Window will be updated when stimulation occurs. The maximum update rate for the trace window is, 4 times a second, depending on the amount of information to be displayed.
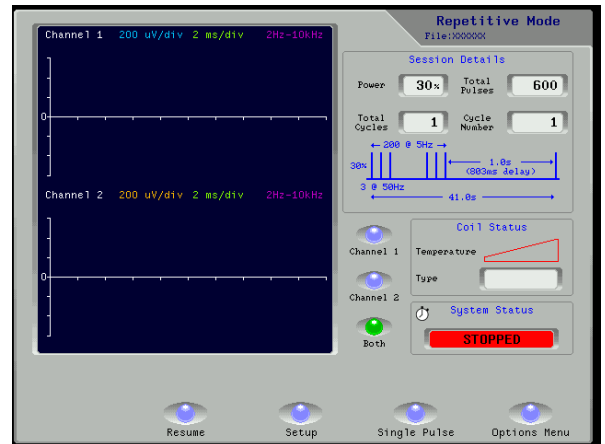

Figure 4.21: Repetitive Mode (Burst) Window

If the amplitude cursors are active then the last position set for each cursor in Single Pulse Mode will be displayed. The cursor position will remain fixed until Single Pulse Mode is re-entered.

In order to save the trace, it is necessary to go back to Single Pulse Mode and save the data as before. The information will remain on each trace window until a new trace is generated, when the new trace will overwrite the previous trace.

Resume: This Option is available if the system is armed and the previous session was not completed. Selecting Resume will return the session to the point at which it was stopped at the beginning, at the start of the next cycle regardless of when the last cycle was stopped.

Setup: Selection of this option will return the user to the Repetitive Setup screen.

Single Pulse: Selecting this option will return the user to the Single Pulse Mode screen.

Options Menu: Selection of this option will return the user to the Options Menu screen.

4.4.4 Session Run Mode:

4.4.4.1 Session Run Mode: Setup

This screen allows the user to set up a series of individual lines, each with different Power, Frequency, Duration and Number of Pulses parameters. See section 4.4.2 for limits. If Session Setup is accessed from Single Pulse Mode, the protocol intensity value established in Single Pulse Mode will be carried over into the power window.

To alter the settings, touch the window of the required setting. A dark blue margin will appear within the selected window. The settings can be quickly altered using the Rotary Control Knob.

To alter the settings of a subsequent line, touch the window of the required setting on that particular line. Subsequent lines cannot be selected if the required settings have not been set on the previous line.
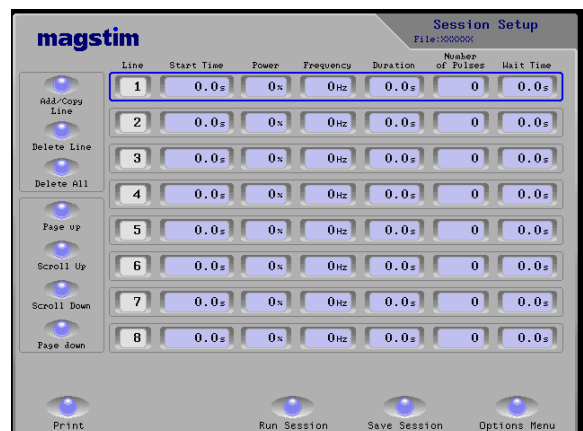

Figure 4.22: Session Mode Setup Window

Add/Copy Line: Selection of this option (press the window to select) enables the user to copy the session line settings of the selected line and copy them into the next line.

Delete Line: Selection of this option will delete the highlighted line.

Delete All: This button will delete all lines, allowing the user to start writing a new protocol.

Page Up: Pressing this button will allow the user to move up pages if the protocol has more lines than will fit on a single screen.

Scroll Up: This allows the user to move up one line at a time.

Scroll Down: Selection of this option allows the user to scroll down one line at the time to view train lines below those displayed on the screen. There are up to 30 lines available.

Page Down: Moves down a page at a time if the Protocol has more lines than will fit on a single screen.

Print: For Print operations see Section 4.4.8.

Run Session: Selection of this option will call up the Session Mode screen.

Save Session: Selection of this option will call up the File Maintenance screen (See section 4.4.6) and allows the user to save the session set up.

Options Menu: Selection of this option will return the user to the Options Menu screen.

4.4.4.2   Session Run Mode

Session Details: Session Details shows a pictorial representation of 3 lines of the session running currently and shows the power and total pulses settings established in the session setup window.

Channels 1,2 and Both: Selecting Channel 1, Channel 2 and Both determines whether both traces are shown simultaneously, or individually.

Trace Window: The Trace Window will be updated when stimulation occurs. The maximum update   rate for the trace window is, 4 times a second, depending on the amount of information to be displayed.
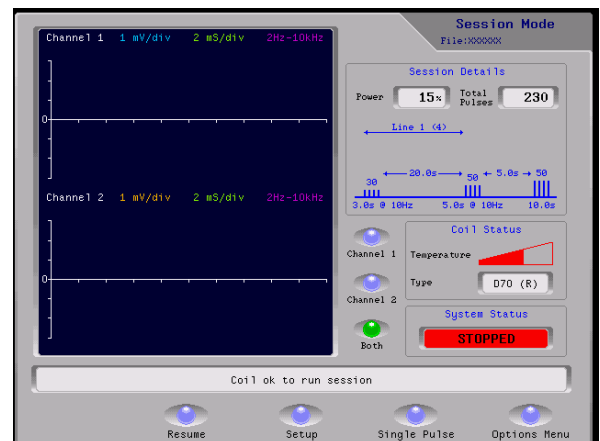
Figure 4.23: Session Mode Window

If the amplitude cursors are active then the last position set for each cursor in Single Pulse Mode will be displayed. The cursor position will remain fixed until Single Pulse Mode is re-entered.

In order to save the trace, it is necessary to go back to Single Pulse Mode and save the data as before. The information will remain on each trace window until a new trace is generated, when the new trace will overwrite the previous trace.

Resume: This Option is available if the system is armed and the previous session was not completed. This option will return the session to the point at which it was stopped. This will always begin at the start of the next session line regardless of when the last session line was stopped.

In order to save the traces, it is necessary to go back to Single Pulse Mode and save the data as before. The information will remain on each trace window until a new trace is generated. Then it will be overwritten by a new one.

Setup: Selection of this option will return the user to the Repetitive Setup screen.

Single Pulse: Selecting this option will return the user to the Single Pulse Mode screen.

Options Menu: Selection of this option will return the user to the Options Menu screen.

4.4.5 System Options:

User Configuration: Selection of this option will call up the User Configuration Screen.

System Details: Selection of this option will call up the System Details Screen.

System Configuration: Selection of this option will call up the System Configuration Screen.

Options Menu: Selection of this option will return the user to the Options Menu Screen.
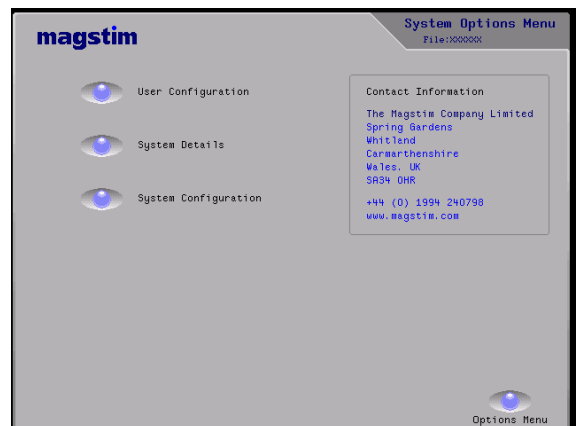
Figure 4.24: System Options Menu Window

4.4.5.1 User Configuration

This screen allows the user to set system parameters, which are stored in an area of the UI's memory which is battery powered.

Volume: This allows the user to set the screen selection beep volume by selecting the window and using the Rotary Control Knob.

Contrast : This allows the user to adjust the TFT contrast option from 1 - 10, in steps of 1.

Coil Switch Option: This gives the user the choice to use the coil safety switch or not each time the system is armed. When ON the System will prompt the user on a Run Screen to state if they wish to use the coil safety switch.

Figure 4.25: User Configuration Window

Note: If the coil switch option is set to **ON**, each time the system is armed the user will have a **YES/NO** option on the screen to ignore the switches before the system can fire. When the '**YES**' button is selected a small yellow button will appear in the top right hand corner of the system status panel to indicate 'ignore' option is active.
It is important that those in the vicinity of the system are made aware that the system is in this mode of operation, to ensure that inadvertent triggering does not occur.

Date: Use 'Modify' to alter the 'Date Settings'

Time: Use 'Modify' to alter the 'Date Settings'

Modify: To change the date and the time settings, select the Modify button. Individual windows appear to allow date, month, year, hour, minute and second to be altered. Press to select a window and alter the information using the Rotary Control Knob. To save press the Set Time button.

Language Setup: This option allows the user to change the language of the displays. German, English and French are available. English is the Default language.

Battery Voltage: This window displays the UI's backup battery voltage.

Back: Selection of this option takes you back to Systems Options Menu*.*

**Options Menu:** Selection of this option will return the user to the Options Menu Screen.

4.4.5.2 System Details

This screen shows the part numbers, revision and serial number information for UI, MEP Pod, Main Frame, PSU, Plus[1] module (if applicable) and attached coil.

Print: For Print Operations See Section 4.4.8.

Back: Returns the user to the System Options Menu*.*
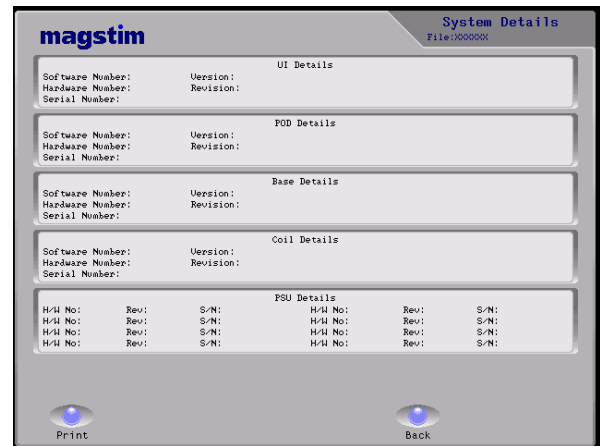
Figure 4.26: System Details Window

4.4.5.3 System Configuration

This screen is intended for Service Personnel.

Clear: This button clears the password window.

Enter: This button enters the current number in the password window for verification. If correct, the service menus are displayed.

Back: This option returns the user to the System Options Menu screen.
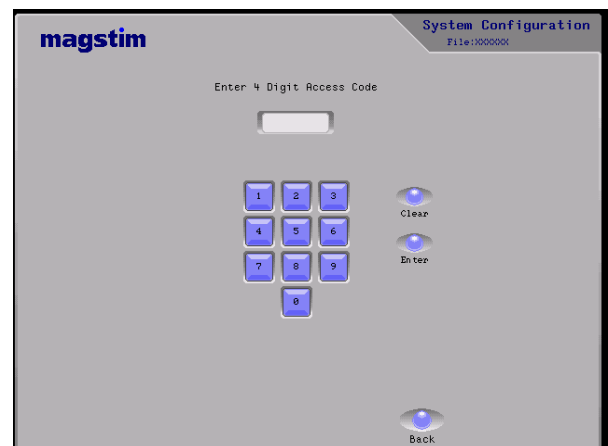
Figure 4.27: System Configuration Window

4.4.6 **File Maintenance Window**

The file maintenance window allows the user to enter a file name and store protocols. These may be generic protocols which are chosen for a patient. The protocols may be stored internally, or may be stored on a memory card. (See section 4.4.6.2)

Figure 4.28: File Maintenance Window

Keyboard: The keyboard is touch sensitive. A file name needs to be selected in order to edit it. Select the Local Store screen and use the Rotary control knob to scroll between files.

View: Selection of 'View' reloads the data stored in the selected file located in the local store window. The file name will be displayed in the top right hand corner of the screen.

New: Selection of 'New' allows the user to create a new file in the local store window. The file name entered must be between 1 and 18 characters long, and different from any other file name.

Open: Selection of 'Open' will reload the data stored in the selected file. Once the file is opened the 'Open' button will change to 'Close' to enable the file to be closed. The file name will be displayed in the top right hand corner of the screen.

Rename: Selection of this option will allow the user to enter a new name for a chosen File Name. Use the keyboard to make changes to the file name and press save (on the keyboard) to confirm.

Delete: Selection of this option will allow the user to delete the selected file from the local store window after a 'Yes' confirmation.

Export: Export allows the user to export the selected File name in the Local Store window to the multi-media card. (See section 4.4.6.2)

Import: Import transfers the selected file from the multimedia card, to the Local Store window.

Print: For Print operations See Section 4.4.8.

Patient Details: Selection of this option will call up the Patient Details Screen. See Section 4.4.6.1

Back: Selection of this option returns the user to the previous screen.

Options Menu: Selection of this option will return the user to the Options Menu Screen.

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4.4.6.1 **Patient Details**

Press **File** at any time to return to **File Maintenance.**

Keyboard: The Keyboard is touch sensitive**.** To enter details into a field, first select the required field window so that it becomes active, showing a dark blue line around the window.

Save: The 'Save' key on the keyboard de-selects the active window and saves the information is saved in the current window.

Name: Press the window to select. The Patient 'Name' window can accept up to 40 characters. Enter details using the on-screen keyboard
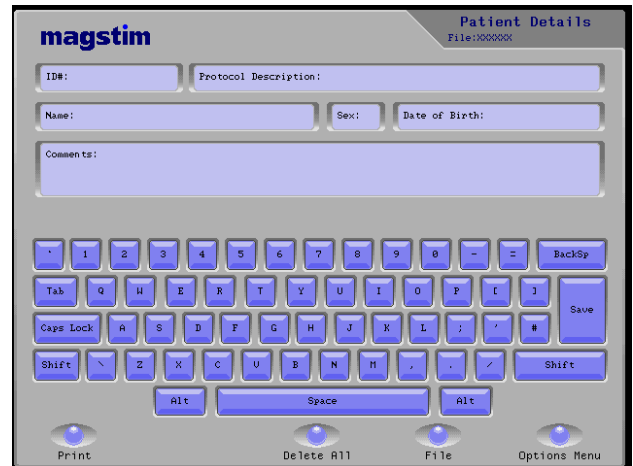
Figure 4.29: Patient Details Window

Sex: Press the window to select. The Patient 'Sex' window can accept only 1 character. Enter details using the on-screen keyboard

ID#: Press the window to select. The Patient 'ID' window can accept up to 18 characters. Enter details using the on-screen keyboard

Date of Birth: Press the window to select. The Patient 'Date of Birth' window can accept up to 18 characters. Enter details using the on-screen keyboard

Protocol Description: Press the window to select. Enter details using the on-screen keyboard.

Comments: Press the window to select. The 'Comments' window can accept up to 273 characters. Enter details using the on-screen keyboard.

Once the details have been entered into a window, further selection of the window will produce a 'Save changes in the last window?' box. The changes made can be saved by selecting 'Yes.' To disregard the information entered, press 'No.'

Print: For Print Operations See Section 4.4.8

Delete All: Selection of this option will clear the contents of all the patient details windows, after a 'Yes' been entered. If a patient file is open, the patient details will be removed from the file.

File: Selection of this option will call up the File Maintenance screen.

Options Menu: Selection of this option will return the user to the Options Menu Screen**.**

4.4.6.2 Creating and Using Files

Creating a File:

1. Go to File Maintenance.

2. Press the Local Store panel to select (a black line appears around the panel)

3. Press New

4. In the Local Store, an arrow will point to a blank line.

5. Enter the new file name, using the on screen keyboard

6. Press Save on the Keyboard.

7. Make sure that the Local Store Screen is selected; use the Rotary control knob to move the arrow to point to a new file name.

Figure 4.30: File Maintenance Window

8. Press Open, then Patient Details. The File name will appear in the top right-hand corner.

9. Select the required windows and enter details using the on- screen keyboard. Press Save on the Keyboard when the information is complete.

10. Press File to return to File Maintenance.

11. Press Close.

To View a File:

1. In file Maintenance select the Local Store Window. Use the Rotary Control Knob to select a file.

2. Press View, then Patient Details.

3. Press File to return to File Maintenance.

To Open and Edit a File:

1. Select the Local Store Panel in File Maintenance

2. Use the Rotary Control Knob to select a file

3. Press 'Open', then Patient Details

4. Select the required window and make changes using the on-screen keyboard.

5. Press 'Save' on the keyboard to confirm

6. Press 'File' to return to File Maintenance

7. Press 'Close'

To Rename a File:

1. Select the File in the Local Store panel using the Rotary Control Knob.

2. Press 'rename' and use the on-screen keyboard to make changes.

3. Press 'Save' on the keyboard to confirm

To Delete a File:

1. Select the file in the Local Store panel using the Rotary Control Knob.

2. Press 'Delete'

3. The on screen prompt will ask 'Are you sure you wish to delete selected file?'

4. Press 'Yes' or 'No'

Managing Single Pulse Mode, Repetitive Mode, and Session Mode Files:

1. To save settings created in, for example, Single Pulse Mode, go to File Maintenance.

2. Press New.

3. Select the Local Store Panel and add the new file name using the keyboard.

4. Press Save on the keyboard.

5. Move the arrow to the new file name using the Rotary Control Knob.

6. Press Save As.

7. The prompt 'Are you sure you wish to overwrite the selected file?' will appear whether the file currently contains information or not.

8. Select 'Yes'

9. Use the on-screen buttons to navigate back to, for example, Single Pulse Mode.

4.4.7 SD Card

4.4.7.1 Saving to the SD Card

To save a stored file onto an SD Card, insert the SD Card into the socket situated on the side of the UI (see Section 3.3). Select the 'File Maintenance' screen and select the 'Local Store' panel. Select a file by turning the Rotary Control Knob until the arrow points at the chosen file. Press the 'Export' Button. The screen will display the command 'Please wait, Data Transfer in Progress' the file will appear in the 'Memory Card' store panel. The file is now saved onto the SD Card.

The UI only supports the short DOS file name convention of 8 characters for the file name and 3 characters for the file extension when reading from or writing to the SD Card. Long file names on the UI will automatically be reduced down to 8 letters for export purposes onto the card. All Files exported from the UI onto the card will have the file extension 'MRF.' When the file is returned to the UI via the SD Card, its original file name will be displayed. See Appendix C for saved data format.

The Rapid² is only compatible FAT 16 formatted SD cards.

The UI can only be used to read or to write a file from the card. It can not format, create directories or delete any data stored on the card

4.4.7.2 Formatting an SD Card with a PC

Make sure an SD Card Reader is connected to the system. Insert the SD card.

1. Using Windows Explorer select the drive associated with the SD card.

2. Select the Format option.

3. Under File System select the FAT option.

4. Follow the instructions on screen.

4.4.8 Print Options

The printer makes it possible to generate copies of the majority of the information that is stored within the Magstim Rapid². The Print option allows for screen or file information to be obtained on paper.

In any screen where the 'Print' Button is visible the Printer can produce a reproduction of the information that is displayed on screen. This option is available in:

- Single Pulse Mode Power Screen
- Repetitive Setup
- Session Setup
- System Details
- File Maintenance and Patient Details

Once the **'**Print' Button is pressed the selected item automatically begins to print, unless the previous print process was cancelled, in which case, follow the instructions on screen. The print process may be cancelled at any time by pressing the 'Cancel' button.
EXAMPLE: SINGLE PULSE MODE

Once the chosen information is generated up on screen the 'Print' button can be pressed to produce a printout, see below.
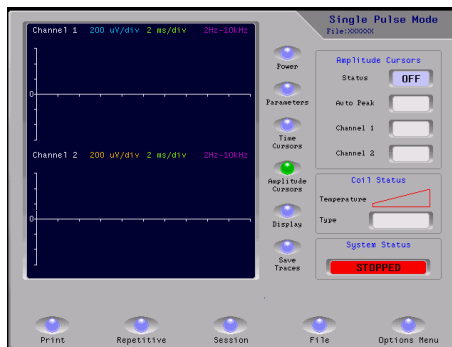
Screen   Printout
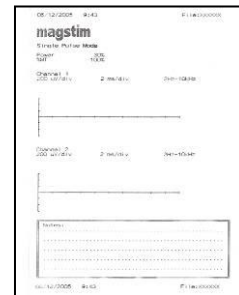
EXAMPLE: PATIENT DETAILS
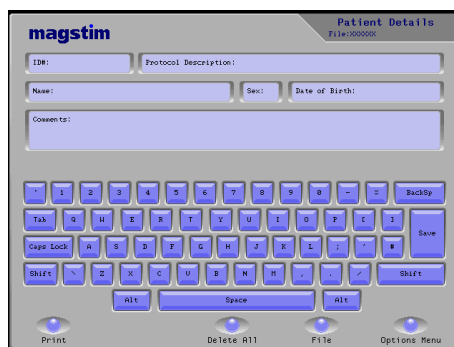
Screen   Printout
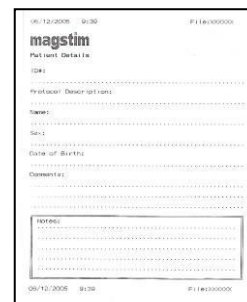
4.4.9 **External Triggering**

If an external triggering device is used, the Rapid[2] uses the power set to govern the maximum discharge frequency. Therefore, if the external frequency is set higher than the power set will allow, the stimulator will discharge at the maximum rate the stimulator can achieve for the power set, and not at the rate from the external trigger source. In these situations, reducing the power will allow the discharge frequency to increase. However, during external triggering there are no duration limits on the trains. Therefore, it is probable under high frequency operation that enough energy will be discharged into the coil to result in its temperature rising rapidly above $40^{o}C$ following the system going into a coil over-temp condition and reverting to its discharged state.

It is important that if this type of operation is intended the protocol be run prior to use on a patient and the surface temperature of the coil monitored to ensure that the patient is not exposed to excessive temperatures.

Not: If the external trigger is set to the level triggering option it is possible for auto-triggering to occur. Also note than when using a Rapid[2] Plus[1] with external triggering, the performance is limited to that of the Super Rapid[2].

<u>**IMPORTANT**</u>

The temperature of the internal components become elevated during operation. The system should be left on, and uncovered, for approximately ten minutes following completion of stimulation to enable the fan to cool the internal system components.

SECTION 5 MAINTENANCE

5.1   User Maintenance and Calibration

At the start of each session the Operator must check the Magstim Rapid², PSU, UI and the stimulating coil for any signs of damage, paying particular attention to the plastic casing. If there are any signs of physical damage to the Magnetic Stimulator, PSU, UI, stimulating coil, or any Magstim accessories, including cables, they must not be used and should be returned to The Magstim Company Limited for servicing and repair (see Section 7.2 for contact details).*

The cooling vents should also be checked to ensure that they have not become blocked, or obstructed.

The UI contains 2 AA cell batteries. These are not rechargeable, and will need to be replaced if patient information is stored on the system. It is important that regular checks are carried out to ensure that the batteries are replaced when necessary. Failure to do so will result in the information being lost. The Battery voltage can be viewed in the User Configuration Screen.

5.2   Technical Maintenance

The contacts in the coil connector and the stimulator coil socket should be checked regularly for any signs of tarnishing or burning*. Under conditions of exceptionally intense use, it is possible for localised heating to manifest itself in the connector, which causes damage to the contacts. Continued use in this condition will eventually cause the contacts to deteriorate and loose electrical connection, which will cause damage to the system.

Repair is a specialised procedure and can only be undertaken by The Magstim Company Limited or an authorised service centre. If any pins show damage, however slight, contact The Magstim Company Limited service department for further advice or to arrange a return (see Section 7.2 for contact details).

Warning: contact burning is communicable, so any coil with damaged contacts will infect a stimulator with healthy contacts and vice-versa. Therefore, if damage is noticed on any coil connector or stimulator coil socket the entire system must not be used until all contacts are carefully examined and repaired where appropriate. If this is not done thoroughly there is a risk that the cycle of pin damage will continue.

5.3   Voltage Selection and Fuse Rating

The Magstim Rapid[2] may be operated from supplies in the range of 115V ± 10% ~ 60Hz, 230V ± 10% ~ 50Hz and 240V ± 10% ~ 60Hz. The voltage selector on the rear panel of the Main Frame and if relevant, the Magstim Plus[1] along with the associated fuses must correspond to the supply voltage as indicated in the table below. The PSU, however, is not voltage selectable and is manufactured as either a 230V (240V) ± 10% unit, or a 115V ± 10% unit. The two are not interchangeable.

Supply Voltage	Voltage Selector Setting	Main Frame Fuse Rating	Quantity	Magstim Plus[1] Fuse Rating	Quantity
115V ±10%~60Hz	115V	T1.25AL	2	T250mAL	2
230V ±10%~50Hz	230V	T1.25AL	2	T250mAL	2
240V ±10%~60Hz	230V	T1.25AL	2	T250mAL	2

T denotes timed or antisurge fuses. Fast acting fuses are not recommended.
H denotes high breaking capacity (ceramic fuse).

Note: Only replace fuses with those of the correct rating, and only operate the instrument with the voltage selector set at the appropriate voltage. Failure to do so may cause serious damage to the device(s).
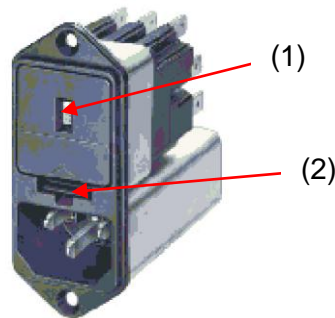
Figure 5.2: Power Entry Module

5.3.1   Fuse Replacement:

1. The Magstim Rapid² must be disconnected from the mains by disconnecting the power cord from the PSU.

2. Insert the tip of a small blade screwdriver or similar tool into the slot (2) (refer to diagram 5.2) and gently lever up the retaining lip of the fuse holder. The fuse holder will then slide out.

3. Replace the damaged fuse(s) with one of the correct rating (See above to ensure the correct fuse is replaced) and locate and push home the tray ensuring the retaining lip clicks into place.

5.3.2   Changing the Voltage Selector Setting:

1. The Magstim Rapid² must be disconnected from the mains by disconnecting the power cord from the PSU.

2. Remove the fuse tray as instructed above,

3. Using a pair of narrow nosed pliers, grip the voltage selector unit on one of the metal connection plates and remove it from the Power Entry Module.

4. Orient the voltage selector unit, such that the desired voltage is facing out from the Power Entry Module.

5. Re-insert the voltage selector unit into the Power Entry Module.

6. Replace the fuse holder, ensuring that the retaining lip is properly home, and verify that the voltage window (1) displays the correct voltage value.

5.3.3 Backup Batteries

Battery status can be checked on the user configuration screen and when low, is reported on the main Options Menu screen.

The batteries in the UI will require to be replaced every 2 years. To do so:

1. Orient the voltage selector unit, such that the desired voltage is facing out from the Power Entry Module.

2. Unplug the UI connector and turn the UI upside down,

3. Remove the 4 cross-head screws visible, and detach the plastic bottom of the UI.

   Note: The UI has a small capacitor which will maintain the internal settings for about 20 seconds once the old batteries are removed. It is important that the batteries are replaced within the 20 seconds if data is not to be lost.

4. Before removing the old batteries, ensure you have the correct replacements, and that you are clear about the orientation of the batteries.

5. Once inserted, replace the bottom of the UI and fix using the screws. Do not over-tighten.

   Note: Do not use re-chargeable batteries. When spent, the batteries should be disposed of under the appropriate environmental regulations

   Note: It is advisable that the batteries be removed from the UI if the equipment is likely to be un-used for a long period of time.

5.4   Cleaning and Disinfecting*

The Magstim Rapid² exterior, UI, PSU, stimulating coil, MEP pod and MEP pod patient cables, footswitch and accessories cannot be sterilised; therefore, do not allow them to become contaminated with bodily fluids. They may be cleaned using a cloth moistened with isopropyl alcohol, however ensure that the Magstim Rapid² and accessories have dried thoroughly before use.

It is the responsibility of the user to ensure the Magstim Rapid² is cleaned when necessary.

Note: Do not clean or wipe the touch screen with anything abrasive as it will cause permanent damage

Note: The Magstim Company Ltd recommends that a lint free cloth moistened with 70% isopropyl alcohol should be used.

5.5   **Servicing**

The Magstim Rapid² contains no user serviceable parts. Servicing of Magstim Rapid² and accessories must only be carried out by The Magstim Company Limited or one of its authorised service centres. To arrange a return or for further information, contact the service department at The Magstim Company Limited (see Section 7.2 for contact details).

It is recommended that an annual PAT (Portable Appliance Test) test be carried out on the Magstim Rapid^2.

Important: The Rapid^2, PSU, Plus^1 and UI contain circuitry that is at mains/ HV potential during operation. Some HV/ hazardous potentials will continue to be present for some time after the system has stopped operating. Therefore, under no circumstances must un-authorised persons remove the screws securing the covers of the Magstim Rapid^2, PSU, Plus^1 or UI. In addition to the risk of electric shock, removal of any of the system covers will automatically render the guarantee void.

Service training courses are available on request. For further information contact the Magstim Company Service Manager.

5.6   **Device Lifetime**

The lifetime of the Magstim Rapid² and accessories is defined as being five years from the date of shipment. The Magstim Company Limited will support the products for the duration of their lifetime.

5.7   **Disposal**

When a Magstim Rapid² Unit or accessory reaches the end of its serviceable life, it should **<u>not</u>** be disposed of in general waste. The Magstim Company Limited should be contacted (see Section 7.2 for contact details) for advice on its disposal in compliance with the appropriate environmental regulations. Failure to do so could cause an environmental hazard as a result of decomposition of materials used in its construction.

SECTION 6 SPECIFICATIONS

6.1 General Specifications

During use, the type of protection against electric shock provided by the Magstim Rapid² system is classified as Class 1.

The degree of protection against electric shock for applied part accessories is classified as Type BF Applied Parts. This means that the stimulating coils and MEP Pod are electrically isolated from the other parts of the equipment and meet Type BF leakage current limits as required by IEC 60601-1.

The Magstim Rapid² system and accessories comply with the requirements of Safety Standard IEC 60601-1 and with EMC Standard EN 60601-1-2, with the exception of immunity clause 36.202.5 "Surges."

The Magstim Rapid² System needs special precautions regarding EMC and needs to be installed and put into service according to the EMC information provided in Appendix F of this Operating Manual. NB. When the system is exposed to radiated RF between 80MHz and 100MHz, or conducted RF between 30MHz and 80MHz, when used with Coil Adapter P/N 3110-00 and Cooled Coil P/N 3380-00 system errors may occur, setting system into safe mode.

The Magstim Rapid² System should not be used adjacent to, or stacked with, other equipment and that if adjacent or stacked use is necessary, the equipment should be observed to verify normal operation in the configuration in which it will be used.

To avoid problems with EMC interference, the Magstim Rapid² system and accessories should not be used in the vicinity of any equipment that does not comply with EMC Safety Standard EN 60601-1-2, including mobile phones. Any interface cable which connects the Magstim Rapid² unit to an external piece of equipment must be no more than 1.5m in length.

Only equipment that meets the relevant IEC standard should be connected to the Magstim Rapid².

This connection must be configured in compliance with Clause 16 of IEC 60601-1:2005 with the following interface voltage limitation: Max signalling voltage +5.3V; Max voltage with respect to protective earth potential 30V peak

The Magstim Rapid² system and accessories are classified as IPX0 (Not Protected), as there is no specialised protection provided against the ingress of liquids.

The Magstim Rapid² system and accessories are not protected against flammable anaesthetic mixtures. They are not suitable for use in the presence of a flammable anaesthetic mixture with air, oxygen or nitrous oxide.

The mode of operation of the Magstim Rapid² system and accessories is classified as continuous.

6.2 Additional Safety Specifications

6.2.1 Coil Temperature Protection

An indication of the coil temperature is given by the Coil Temperature information display on the User Interface. If the coil surface temperature reaches its set limit, the display information will inform the user that this condition has occurred. The normal operation of the equipment can then be resumed by allowing the coil to cool, or alternatively, by replacing the coil with a cool one.

6.2.2 Other Safety Measures

If the instrument has not been triggered for over 10 minutes after the system status window has displayed **READY,** the unit will automatically select the default mode and discharge internally The Magstim Rapid² is capable of recognising automatically the type of stimulating coil being used.

6.3 Technical Specifications

Stimulator Output:

Output Range and Accuracy:	0% - 100% of Maximum Voltage ±2%
Stimulation Frequency:	See Appendix D
Pulse Characteristics:	Biphasic Single Cosine Cycle - 400µs period

Note: Magnetic field strength and maximum number of stimulations produced before coil exceeds operating temperature are dependent on the stimulation coil being used. Please refer to the appropriate coil operating manual.

Capacitor Life Expectancy:

Life expectancy:	2×10^6 discharges at 70% power level
	8×10^5 discharges at 80% power level
	4×10^5 discharges at 90% power level
	2×10^5 discharges at 100% power level

Isolated Interface:

Logic High Voltage:	>4.0V
Max Voltage:	5.3V
Logic Low Voltage:	<0.8V
Min Voltage:	-0.3V

All voltages are with respect to Aux Gnd signal on the isolated interface connecter

Power Supply:

Power:	115V ±10% ~ 60Hz
	230V ±10% ~ 50Hz
	240V ±10% ~ 60Hz

Maximum Power:
230V/240V Rapid² Systems:

Standby:	All Systems:	20VA
During Discharge	Standard Rapid²:	3kVA
	Super Rapid²:	6kVA
	Rapid² Plus¹:	9kVA

115V Rapid² Systems:

Standby:	All Systems:	20VA
During Discharge	Standard Rapid²:	2.3kVA
	Super Rapid²:	4.6kVA
	Rapid² Plus[1]:	6.9kVA

Input Fuse(s) Rating:

Rapid² mainframe:	2 x T1.25AL, 250V 20x5mm for 115V-240V~
Plus[1] unit:	2 x T250mAL, 250V 20x5mm for 115V-240V ~

Equipment should be used with the line cord provided. Where a fused line cord is used, the appropriate fuse should be fitted.

General Specifications:

Rapid² Main Frame (3012-00):

Dimensions:	460mm x 160mm x 375mm
Weight:	13.1kg
Stacking limit:	4 Units stacked on top of each other

Rapid² Single PSU (3013-00):

Dimensions:	460mm x 160mm x 375mm
Weight:	13.2kg
Stacking limit:	4 Units stacked on top of each other

Rapid² Dual PSU (3014-00):

Dimensions:	460mm x 160mm x 375mm
Weight:	23.4kg
Stacking limit:	4 Units stacked on top of each other

Rapid² Plus[1] (4040-00):

Dimensions:	460mm x 160mm x 375mm
Weight:	15.7kg
Stacking limit:	4 Units stacked on top of each other

Rapid² UI (3022-00):

Dimensions:	360mmx x 240mm x 280mm
Weight:	2.6kg

Software:

Base Software:	Version 9.0 (Software ref: 3056)
UI Controller Software:	Version 11.0 (Software ref: 3473)
MEP Pod Software:	Version 2.0 (Software ref: 3519)

Please note: All specifications are subject to alteration.

Accessory Specifications:

Stimulating Coils:

Compatibility:	See Appendix E

MEP Pod:

Class Type:	Class 1, BF
Channels:	2
CMMR:	> 90dB
Dynamic Range:	± 30mV ±10%

Amplitude Accuracy:	±10% at ½ full scale
Display Resolution:	< 2%
Cursor Resolution:	< 2%
Timebase Accuracy:	<±1% of sample period
Timebase Resolution:	0.33% of sample period
Calibration:	Calibration is not required.

6.4   Output Safety, Repetition Rate of Stimulus

The following Table is taken from Eric M. Wassermann's paper – Risk and Safety of Repetitive Transcranial Magnetic Stimulation: Report and recommendations from the International workshop on the safety of Repetitive Transcranial Magnetic Stimulation June 5-7, 1996. It gives the maximum safe duration (in seconds) of single trains of rTMS based on the NINDS experience.

Frequency (Hz)	Intensity (% of MEP threshold)												
	100	110	120	130	140	150	160	170	180	190	200	210	220
1	>1800	>1800	360	>50	>50	>50	>50	27	11	11	8	7	6
5	>10	>10	>10	>10	7.6	5.2	3.6	2.6	2.4	1.6	1.4	1.6	1.2
10	>5	>5	4.2	2.9	1.3	0.8	0.9	0.8	0.5	0.6	0.4	0.3	0.3
20	2.05	1.6	1.0	0.55	0.35	0.25	0.25	0.15	0.2	0.25	0.2	0.1	0.1
25	1.28	0.84	0.4	0.24	0.2	0.24	0.2	0.12	0.08	0.12	0.12	0.08	0.08

Numbers preceded by the symbol > are the longest durations tested. No after discharge or spread of excitation has been encountered with single trains of rTMS at these combinations of stimulus frequency and intensity.

6.5   Environmental Conditions*

Operating temperature:	5°C to 40°C
Transport and storage temperature:	-19°C to 60°C
Operating, transport and storage relative humidity:	10% to 80% (non-condensing)
Operating atmospheric pressure:	80kPa to 106kPa
Transport and storage atmospheric pressure:	50kPa to 106kPa

6.6 **Handling**

The system must be disassembled prior to being moved. The parts of the system are not locked together in any way and are likely to fall if moved together, resulting in damage to the equipment and possible injury to those near to or those transporting it.

The Magstim Rapid² unit weighs in excess of 20kg. If it is necessary to move the units for any reason, the weight must be distributed between at least two persons. Please see diagram below for recommended manual handling methods.

Note: The weight of Magstim Rapid² unit is unevenly distributed with the right hand side of the unit being considerably heavier than the left. Care should be taken when transporting the unit to ensure that this heavier side is adequately supported.
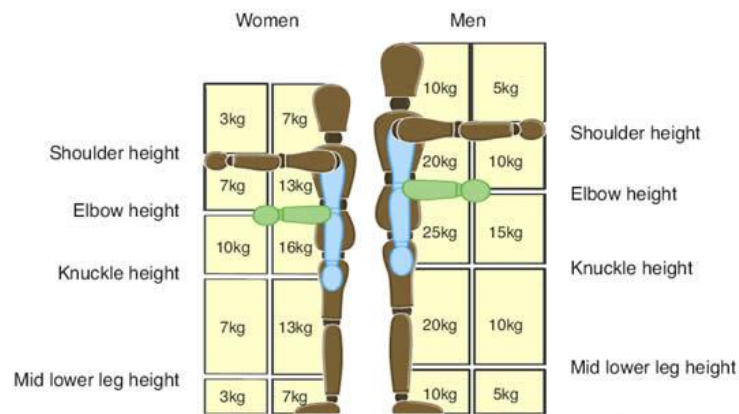
Figure 6.1: Guidelines on lifting and lowering

6.7 **Packing Instructions**

If, for any reason, it is necessary to return your Magstim Rapid² unit care should be taken to ensure that the equipment is adequately packed to prevent transit damage. Ideally the equipment should be returned in its original packing. If this or an adequate replacement is not available, replacement shipping cartons can be obtained from the Magstim Company Limited.

The Magstim Rapid² System must be completely disconnected before shipping, including removal of the coil holder on the side of the Magstim Rapid². Failure to do so is likely to result in transit damage to the casing.

SECTION 7 CONTACT DETAILS

7.1 Product Enquiries

The Magstim Company Limited
Spring Gardens, Whitland, Carmarthenshire, SA34 0HR

Telephone: +44 (0)1994 240798
Fax: +44 (0)1994 240061
E-mail: info@magstim.com
Website: www.magstim.com

7.2 Servicing Enquiries

Telephone: +44 (0)1994 242900
Fax: +44 (0)1994 240061
E-mail: service@magstim.com

7.3 Sales Enquiries

Telephone: +44 (0)1994 241111
Fax: +44 (0)1994 242917
E-mail: sales@magstim.com

APPENDIX A – SYSTEM ERROR CODES

A1. **Base Controller Error Codes produced by the User Interface**

Error Code	Description
U24	UI Power Supply Failure
U25	Stack underflow
U26	Stack overflow
U27	RTS overrun
U28	Watchdog Timeout
U29	ROM Checksum Incorrect
U34	No serial communications
U35	Loss of communication
U36	Bad NVRAM Checksum
U37	Battery Voltage Low
U38	Bad External Flash Checksum Detected.

A2. **Error Codes produced by the Coil**

Error Codes	Description
C01	ROM Checksum Incorrect.
C02	EEPROM Checksum Incorrect.
C03	Invalid coil Category.
C04	Invalid Power Identification .
C05	Temperature sensor circuit failure.
C06	Bad Serial command or received data checksum.
C07	Internal Software Error.
C08	Invalid Coil Temperature ID.
C09	Invalid temperature algorithm coefficient.
C10	Coil controller malfunction.
C11	Rapid coil algorithm constant checksum incorrect.
C12	Invalid enhanced power byte. (1's compliment comparison test failed)
C13	Average power checksum incorrect.
C21	Coil Disconnected/ Coil Under Temperature.
C22	Brown Out Detected.
C23	No serial Communications.
C24	Bad Serial command of received data checksum (outside TRIGGATE).
C25	EMC Detected (Coil adapter only).
C26	Invalid Coil Power Identification (Coil adapter only).
C27	Hardware Stop activated.
C28	Watchdog Timeout.
C29	Temperature Interlock 3 activation.
C30	Coil stop line fault.
C31	Air Extraction Unit Not Operating Correctly (3530-00 coil only)

A3. **Error Codes produced by base system.**

| Error Codes	Description
E61	Power fail
E62	Stack underflow
E63	Stack overflow
E64	RTS overrun
E65	WD Timeout
E66	Unexpected reset
E67	Bad checksum
E68	SYS debug error
E70	Coil under temperature
E71	Coil max difference
E72	Stack over temperature
E73	Stack under temperature
E74	Stack max difference
E75	HVCAP over temperature
E76	HV Transformer over temperature
E77	Charge threshold failure
E78	VREF check failure
E79	HVCAP voltage comparison failure
E80	Charging fault
E81	HV over voltage
E82	Invalid system configuration
E83	Stop line fault
E84	Base coil stop line fault
E85	UI stop line fault
E86	Dump system fault
E87	Invalid coil category for current system configuration.
E88	Invalid NVRAM Checksum.
E89	Faulty charging relay detected
E90	Base arm LED drive failure
E91	External PSU Fault
E92	Base over temperature
E93	Snubber board over temperature
E94	Base under temperature
E95	HV CAP under temperature
E96	Snubber board under temperature
E97	Ambient over temperature
E98	System failed to produce protocol

For diagnosis, contact The Magstim Company Limited service department (see Section 7.2 for contact details).

APPENDIX B – TRIGGER INPUT / OUTPUT

The Isolated Interface on the rear of the Magstim Rapid² stimulator and Rapid² UI allow external equipment to be connected to enable synchronisation with an external device.

Connection to the rear of the stimulator must be made via the Stimulator Interface Module P/N 3901-00.

Voltage levels for the signals are as specified in Section 6.2.
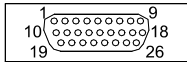
The Isolated Interface is a 26 Way High Density D-Type Female Connector.

The following tables detail the interface pins:

Location		Rear of Stimulator and rear of Rapid² UI
Type		26 Way D-Type (Female)
Signal Levels		CMOS
Pin Signals	Tout – O/C	Pin 3 – will be connected to Aux. Gnd. when the system is triggered. (Open collector output, maximum external pull up voltage +5V, maximum sink current 50mA)
	Tin +	Pin 5 – will trigger the system when a logic high is applied.
	Tin -	Pin 6 – will trigger the system when a logic low is applied.
	Tout +	Pin 7 – a logic high will be visible when the system is triggered.
	Tout -	Pin 8 – a logic low will be visible when the system is triggered.
	Trigger Edge / Level	Pin 24 – unconnected sets to an edge trigger connected to Aux. Gnd. provides a level trigger.
	Aux. Gnd.	Pins 1, 11 & 19
	Aux. +5V	Pin 10
	End Train	Pin 20

Trigger Edge / Level
When set to edge trigger, the Magstim Rapid² will only be triggered when the logic level being applied on the Tin+ or Tin- pin is changed. On the Tin+ pin, triggering will occur when the logic level is changed from low to high. On the Tin- pin, triggering will occur when the logic level is changed from high to low. Edge triggering will only allow one trigger per logic level change.

When set to level trigger, the Magstim Rapid² will be triggered when the appropriate logic level is applied to the Tin+ or Tin- pins. On the Tin+ pin, a logic high will need to be applied. On the Tin- pin, a logic low will need to be applied. The system re-fire when the system is ready until the logic state being applied changes or is removed.

Note: For the Tin trigger pulse to fire the system, it need to be in an armed state when the trigger is applied and another trigger will need to be applied i.e. coil switch.

Tout O/C
Tout O/C is connected to an open collector device inside the Magstim Rapid² meaning a pulled up resistor is required to use this feature.

Please Note: Only equipment that meets the relevant IEC standard should be connected to the Magstim Rapid²*.

This connection must be configured in compliance with Clause 16 of IEC 60601-1:2005 with the following interface voltage limitation: Max signalling voltage +5.3V; Max voltage with respect to protective earth potential 30V peak

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APPENDIX C – SD CARD FILE DETAILS

<u>**General**</u>

Each line of the file starts with a text string that describes the data that follows on that line.

Each line of data ends with a carriage return line feed request, <CR>.

<u>**File Layout**</u>

The following details the order the data is stored in the Magstim UI generated file.

Version, <file format number>, <CR>

File, <system filename>, <CR>

Status, <system file status when exported>, <CR>

File Time, <seconds>, <minutes>, <hours>, <day>, <month>, <year>, <CR>

Name, <patient name>, <CR>

Sex, <patient sex>, <CR>

ID#, <patient ID>, <CR>

Date or birth, <patient date of birth>, <CR>

Protocol description, <patient protocol description text string>, <CR>

Comments, <patient comments string>, <CR>

Train, <power>, <frequency>, <duration>, <number of pulses>, <wait time>, <number of trains>, <CR>

Burst, <power>, <frequency>, <number of pulses>, <burst frequency>, <number of bursts>, <cycle time>, <number of cycles>, <CR>   *see note1.

Session 1, <start time>, <power>, <frequency>, <duration>, <number of pulses>, <wait time>, <CR>

Session 2, <start time>, <power>, <frequency>, <duration>, <number of pulses>, <wait time>, <CR>

   .   .   .   .

   .   .   .   .

Session 30, <start time>, <power>, <frequency>, <duration>, <number of pulses>, <wait time>, <CR>

MEP 0, Trace 1,**Trace 2**, <CR>

MEP 1, <reading 1 trace1>, <reading 1 trace2>, <CR>

MEP 2, <reading 2 trace1>, <reading 2 trace2>, <CR>

MEP 3, <reading 3 trace1>, <reading 3 trace2>, <CR>

MEP 4, <reading 4 trace1>, <reading 4 trace2>, <CR>

.   .   .   .   .

.   .   .   .   .

MEP 300, <reading 300 trace1>, <reading 300 trace2>, <CR>

MEP Configuration, <time base index>, <channel 1 voltage range index>, <channel 2 voltage range index>, <special feature>, <filters index>, <CR>

Note 1. Line only added to files by UI software version V6.0 or greater.

File line Details

The following details the content and data range limits for each data lines contained in the Magstim UI generated file.

Version.

This number is created by the UI and must be present in the file and "**must not be altered"**. An invalid number will result in the file not being imported correctly.

File.

This is the file name used on the UI and must contain at least one character and not more than 18 characters. The file name can contain any standard alphanumeric character except a comma.

Status.

This number is used by the UI to determine what state the file was in when it was exported and "**must not be altered"**. An invalid number will result in the file not being imported correctly.

File Time.

This line defines when the file was created on the UI. The range for each value is a follows: seconds 0-59, minutes 0-59, hours 1-23, day 1-31, month 1-12, year 1970 – 2100.

Name.

This is the name that appears in the patient data name window on the UI and must not exceed 40 characters. The name can contain any character except a comma.

Sex.

This is the character that appears in the patient data sex window and must not exceed 1 character. The character can be any character except a comma.

ID#.

This is the string that appears in the patient ID window on the UI and must not exceed 18 characters. The string can contain any character except a comma.

Date of birth.

This is the string that appears in the patient date of birth window on the UI and must not exceed 18 characters. The date string can contain any character except a comma.

Protocol description.

This is the string that appears in the patient protocol description window on the UI and must not exceed 46 characters. The string can contain any character except a comma.

Comments.

This is the string that appears in the patient comments window on the UI and must not exceed 273 characters. The string can contain any character except a comma.

Train.

This line contains the parameters displayed on the repetitive set up screen on the UI, (Standard mode). The individual parameter value ranges are as follows:

Power 0 - 100% at a resolution of 1%.

Frequency 1 - 100 Hz at a resolution of 0.1Hz up to 30.0Hz, and at 1.0Hz thereafter.

Note the settable power to frequency values is determined by the system configuration, see user manual for Rapid system for more details.

Duration 0.1 - 600.0 seconds at a resolution of 0.1 seconds, up to 30.0s, and at 1.0s thereafter.

Number of pulses 1 – 60000 at a resolution of 1.

Wait time 1.0 – 540.0 seconds at a resolution of 0.1 seconds.

Number of trains 1 – 999 at a resolution of 1.

Note all time periods are specified in multiples of tenths of a second i.e. if a time period of 6.5 seconds is required then a value of 65 is entered between the commas.

Burst.

This line contains the parameters displayed on the repetitive set up screen on the UI, (Burst mode). The individual parameter value ranges are as follows:

Power: 0 - 100% at a resolution of 1%.

Frequency : 1 - 100 Hz at a resolution of 1Hz.

Note the settable power to frequency values is determined by the system configuration, see user manual for Rapid system for more details.

Number of pulses: 1 – 10 at a resolution of 1.

Burst frequency: 1 – 10 Hz at a resolution of 1Hz.

Number of bursts: 1 – 500 at a resolution of 1.

Cycle time: 1.0 – 500.0 seconds at a resolution of 0.1 seconds.

Number of cycles: 1 – 999 at a resolution of 1.

Note all time periods are specified in multiples of tenths of a second i.e. if a time period of 6.5 seconds is required then a value of 65 is entered between the commas.

Session x. These lines contain the parameters displayed on the session set up screen on the UI. The individual parameter value ranges for line 1 are the same for all 30 lines and are as follows:

Start time for line 1 has to be zero. The start time on the other lines should be determined using the following equation, start time = previous line (start time + duration + wait time).

Power: 0 - 100% at a resolution of 1%.

Frequency: 1 - 100 Hz at a resolution of 1Hz.

Note the settable power to frequency values is determined by the system configuration, see user manual for Rapid system for more details.

Duration: 0.1 - 10.0 seconds at a resolution of 0.1 seconds.

Number of pulses: 1 – 1000 at a resolution of 1.

Wait time: 1.0 – 60.0 seconds at a resolution of 0.1 seconds.

Note all time periods are specified in multiples of tenths of a second i.e. if a time period of 6.5 seconds is required then a value of 65 is entered between the commas.

MEP 0. This line contains the MEP data column headings.

MEPS x. These lines contain a single reading for each trace stored in the file.

Trace 1 column contains the MEP waveform that was displayed on the UI for channel 1 when the "save traces" button on the single pulse screen on the UI was selected and the exported file was open for modification. Each of the 300 data values is within the range 0 – 255.

Trace 2 column contains the MEP waveform that was displayed on the UI for channel 2 when the "save traces" button on the single pulse screen on the UI was selected and the exported file was open for modification. Each of the 300 data values is within the range 0 – 255.

To determine the actual voltage recorded for each MEP data value, the value has to be scaled according to the voltage range that was selected at the time the reading was made. The voltage range setting for each channel is recorded on the "MEP Configuration" data line of the file.

MEP Configuration. This line contains the details of how the MEP was configured when the MEP waveforms were saved using "save traces" button on the single pulse screen on the UI. The meaning for each value are as follows:

Time base index, possible values and meanings are as follow:

0 = 20 ms; 1 = 50 ms; 2 = 100 ms; 3 = 200 ms; 4 = 500 ms.

Channel 1 voltage range index, possible values and meanings are as follows:

0 = ±150μV; 1 = ±300μV; 2 = ±600μV; 3 = ±1.5mV; 4 = ±3mV; 5 = ±6mV;

6 = ±15mV; 7 = ±30mV.

Channel 2 voltage range index, possible values and meanings are as follows:

0 = ±150μV; 1 = ±300μV; 2 = ±600μV; 3 = ±1.5mV; 4 = ±3mV; 5 = ±6mV;

6 = ±15mV; 7 = ±30mV.

Special feature, always 0.

Filters index, possible values and meanings are as follows:

0 = 2Hz – 10KHz; 1 = 20Hz – 10KHz.

Note: The information stored on the SD Card is of the text format, comma delimited. The file can be imported into any text editor to view or to modify the contents. The files may also be imported into spreadsheets, make sure the delimited option is highlighted and the file origin is set to "Arial- western European"

APPENDIX D – POWER/FREQUENCY

230V/240V Rapid² Systems

Available Output Power (%)	Operating Frequency (Hz) Max. 100Hz		
	Standard Rapid²	Super Rapid²	Super Rapid² Plus[1]
0 – 30%	50	100	100
31	46	98	100
32	45	95	100
33	44	93	100
34	42	90	100
35	41	88	100
36	41	85	100
37	39	83	100
38	39	80	100
39	38	78	100
40	37	75	100
41	36	73	100
42	34	70	100
43	33	68	100
44	33	65	100
45	33	63	100
46	33	60	100
47	33	58	100
48	32	55	100
49	31	53	98
50	30	50	97
51	30	50	95
52	29	49	93
53	29	49	91
54	28	48	88
55	28	48	88
56	27	47	87
57	27	47	85
58	26	46	84
59	26	46	82
60	25	45	80
61	25	45	79
62	24	44	77
63	24	44	74
64	23	43	74
65	23	43	74
66	22	42	74
67	22	42	71
68	21	41	70
69	21	41	69
70	20	40	68
71	20	40	68
72	20	39	66
73	20	39	65
74	19	38	62
75	19	38	62
76	19	37	62
77	19	37	60
78	19	36	59

Available Output Power (%)	Operating Frequency (Hz) Max. 100Hz		
	Standard Rapid²	Super Rapid²	Super Rapid² Plus[1]
79	18	36	58
80	18	35	57
81	18	35	57
82	18	34	56
83	18	34	55
84	18	33	55
85	17	33	53
86	17	32	52
87	17	32	51
88	17	31	50
89	17	31	50
90	17	30	49
91	17	30	48
92	16	29	47
93	16	29	46
94	16	28	46
95	16	28	45
96	16	27	44
97	16	27	43
98	15	26	42
99	15	26	42
100	15	25	41

115V Rapid² Systems

Available Output Power (%)	Operating Frequency (Hz) Max. 60Hz		
	Standard Rapid²	Super Rapid²	Standard Rapid²
0-30	36	60	60
31	35	60	60
32	35	60	60
33	34	60	60
34	33	60	60
35	32	60	60
36	32	60	60
37	31	60	60
38	30	59	60
39	29	57	60
40	28	55	60
41	28	54	60
42	27	53	60
43	26	52	60
44	26	51	60
45	25	50	60
46	25	49	60
47	24	47	60
48	24	46	60
49	23	45	60
50	23	44	58
51	22	43	56
52	22	42	56
53	21	42	54
54	21	41	53
55	21	40	52
56	20	40	51
57	20	39	50
58	19	38	49
59	19	38	48
60	19	37	47

Available Output Power (%)	Operating Frequency (Hz) Max. 60Hz		
	Standard Rapid²	Super Rapid²	Standard Rapid²
61	18	36	46
62	18	36	46
63	18	35	45
64	18	35	44
65	17	34	43
66	17	34	43
67	17	33	42
68	16	33	41
69	16	32	40
70	16	32	40
71	16	31	39
72	16	31	39
73	15	30	38
74	15	30	37
75	15	29	37
76	15	29	36
77	14	28	36
78	14	28	35
79	14	28	35
80	14	27	34
81	14	27	34
82	13	27	33
83	13	26	33
84	13	26	33
85	13	26	32
86	13	26	32
87	12	25	31
88	12	25	31
89	12	25	30
90	12	24	30
91	12	24	30
92	12	24	29
93	12	24	29
94	12	23	28
95	11	23	28
96	11	23	28
97	11	22	27
98	11	22	27
99	11	22	27
100	11	22	25

APPENDIX E – COIL COMPATIBILITY

Only standard production coils can be used with our Rapid Rate Stimulators unless a compatible custom coil, with a high inductance, is specifically made for the customer. Low inductance coils are likely to damage the Rapid Rate Stimulator.

Only the Remote Control and 2nd Generation Coils can be connected directly to the Rapid² System. All other coils must be connected via Coil Adapter P/N 3110-00.

Coil Description	Part Number	Average Inductance	Use with Rapid System	Extended Train Duration on UI
90mm Coil	3193-00	23.47µH	Compatible	Compatible
90mm Remote Control Coil	3192-00	23.47µH	Compatible	Compatible
Double 70mm Remote Control Coil	3190-00	15.50µH	Compatible	Compatible
Double 70mm 2nd Generation Coil	3191-00	15.50µH	Compatible	Compatible
2nd Generation Double 70mm Cooled Coil	3530-00	15.00µH	Compatible	Compatible
Double 70mm Air Film Coil	3910-00	12.00µH	Compatible	Compatible
Small 50mm Coil	9999-00	13.50µH	Not Compatible	**Not Compatible**
Medium 70mm Coil	9762-00	16.25µH	Compatible	**Not Compatible**
Large HP 90mm Coil	9784-00	23.30µH	Compatible	**Not Compatible**
Double 25mm Coil	1165-00	10.35µH	**Not Compatible**	**Not Compatible**
Double 70mm Cooled Coil	1640-00	15.00µH	**Not Compatible**	**Not Compatible**
Double 70mm Coil	9925-00	16.35µH	Compatible	**Not Compatible**
110mm Double Cone Coil	9902-00	17.85µH	Compatible	**Not Compatible**

Coil Operating Duration at 20°C in Single Shot Mode using the Rapid² System

Coil	Average Inductance	Max. No. of Stimulations at 50% Power	Max. No. of Stimulations at 80% Power	Max. No. of Stimulations at 100% Power
90mm Coil 3192-00/3193-00	23.47µH	927	420	311
Double 70mm Coil 3190-00/3191-00	15.50µH	638	264	212

Coil	Average Inductance	Max. No. of Stimulations at 50% Power	Max. No. of Stimulations at 80% Power	Max. No. of Stimulations at 100% Power
HP 90mm 9784-00	23.30μH	1935	539	406
70mm 9762-00	16.25μH	428	282	155
Db 70mm 9925-00	16.35μH	1576	448	392
DC 110mm 9902-00	17.85μH	1419	806	406

APPENDIX F – EMC EMISSIONS AND IMMUNITY

Guidance and Manufacturer's Declaration – Electromagnetic Emissions		
The Magstim Rapid² System is intended for use in the electromagnetic environment specified below. The customer or the user of the equipment should assure that it is used in such an environment.		
Emissions Test	**Compliance**	**Electromagnetic environment - guidance**
RF emissions EN60601-1-2	Group 1	The Magstim Rapid² System must emit electromagnetic energy in order to perform its intended function. Nearby electronic equipment may be affected.
RF emissions EN60601-1-2	Class A	The Magstim Rapid² System is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic Emissions EN60601-1-2	Class A (by equipment type)	
Voltage fluctuations/ flicker emissions IEC 61000-3-3	Complies	

Guidance and Manufacturer's Declaration – Electromagnetic Immunity			
The Magstim Rapid² System is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the Magstim Rapid² System can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the Magstim Rapid² System as recommended below, according to the maximum output power of the communications.			
Rated maximum output power of transmitter W	**Separation distance according to frequency of transmitter** m		
	150 kHz to 80 MHz $d = [\dfrac{3{,}5}{V_1}] \sqrt{P}$ Where $V_1 = 3$	**80 MHz to 800 MHz** $d = [\dfrac{3{,}5}{E_1}] \sqrt{P}$ Where $E_1 = 3$	**800 MHz to 2,5 GHz** $d = [\dfrac{7}{E_1}] \sqrt{P}$ Where $E_1 = 3$
0,01	0,117	0,117	0,233
0,1	0,369	0,369	0,738
1	1,167	1,167	2,333
10	3,689	3,689	7,379
100	11,667	11,667	23.333
For transmitters rated at a maximum output power not listed above, the recommended separation distance d in metres (m) can be estimated using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer. **NOTE 1** At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies. **NOTE 2** These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.			

Guidance and Manufacturer's Declaration – Electromagnetic Immunity				
The Magstim Rapid² System is intended for use in the electromagnetic environment specified below. The customer or the user of the equipment should assure that it is used in such an environment.			
Immunity Test	**IEC 60601 Test Level**	**Compliance Level**	**Electromagnetic environment - guidance**
Electrostatic discharge (ESD) IEC 61000-4-4	± 6 kV contact ± 8 kV air	Meets requirement	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical fast Transient/ burst IEC 61000-4-11	± 2 kV for power supply lines ± 1 kV for input/ output lines	Meets requirement (Resetting of the MEP Pod may be experienced during single shot mode under these conditions.)	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	± 1 kV differential mode ± 2 kV common mode	Differential mode compliant. Common mode compliant to ± 1kV only.	Anti surge protection needs to be incorporated into the main supply to the equipment if surge protection is to be guaranteed.
Voltage dips, short interruptions and voltage variations on power supply input lines. IEC 61000-4-11	<5 % U_T (>95 % dip in U_T) for 0,5 cycle 40 % U_T (60 % dip in U_T) for 5 cycles 70 % U_T (30 % dip in U_T) for 25 cycles <5 % U_T (>95 % dip in U_T) for 5 sec	Meets requirement	Mains power quality should be that of a typical commercial or hospital environment. If the user of the Magstim Rapid² System requires continued operation during power interruptions, it is recommended that the Magstim Rapid² System be powered from an interruptible power supply.
Power Frequency (50/60Hz) Magnetic Field IEC 61000-4-8	3 A/m 50Hz	Meets requirement	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment
Radiated RF Immunity EN61000-4-3	80MHz – 2.5GHz 2Hz 80% amplitude modulation	Coil adapter P/N 3110-00 and Cooled Coil P/N 3380-00 between 80MHz and 100MHz may produce system errors setting system into safe mode.	Equipment should only be used in the vicinity of other equipment compliant with EN60601-1-2.
Conducted RF Immunity EN61000-4-6	0.15MHz – 80MHz 2Hz 80% amplitude modulation	Coil adapter P/N 3110-00 and Cooled Coil P/N 3380-00 between 30MHz and 80MHz may produce system errors setting system into safe mode.	Equipment should only be used in the vicinity of other equipment compliant with EN60601-1-2.
NOTE U_T is the a.c. mains voltage prior to application of the test level			

Guidance and Manufacturer's Declaration – Electromagnetic Immunity			
The Magstim Rapid[2] System is intended for use in the electromagnetic environment specified below. The customer or the user of the equipment should assure that it is used in such an environment.			
Immunity Test	**IEC 60601 Test Level**	**Compliance Level**	**Electromagnetic environment - guidance**
Conducted RF IEC 61000-4-6	3 Vrms 150 kHz to 80 MHz	$[V_1]$ V	Portable and mobile RF communications equipment should be used no closer to any part of the Magstim Rapid[2] System, including cables, than the recommended separation distance calculated from the equation applicable to the frequency transmitter. **Recommended separation distance** $$d = [\frac{3{,}5}{V_1}] \sqrt{P}$$ $$d = [\frac{3{,}5}{E_1}] \sqrt{P} \quad \text{80 MHz to 800 MHz}$$
Radiated RF IEC 61000-4-3	3 V/m 80 MHz to 2,5 GHz	$[E_1]$ V/m	$$d = [\frac{7}{E_1}] \sqrt{P} \quad \text{800 MHz to 2,5 GHz}$$ Where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in metres (m). Field Strengths from fixed RF transmitters, as determined by an electromagnetic site survey, [a] should be less than the compliance level in each frequency range.[b] Interference may occur in the vicinity of equipment marked with the following symbol:
NOTE 1 At 80 MHz and 800 MHz, the higher frequency range applies. **NOTE 2** These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.			
[a] Field strengths from fixed transmitters, such as base stations for radio (cellular/ cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured filed strength in the location in which the Magstim Rapid[2] System is used exceeds the applicable RF compliance level above, the Magstim Rapid[2] System should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating the Magstim Rapid[2] System. [b] Over the frequency range 150 kHz to 80 MHz, field strengths should be less than $[V_1]$ V/m.			