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# HM8143
# Arbitrary Power Supply
# User Manual


5800448602


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CE

## DECLARATION OF CONFORMITY

HAMEG Instruments GmbH
Industriestraße 6 · D-63533 Mainhausen

The HAMEG Instruments GmbH herewith declares conformity of the product:

**Product name**: Arbitrary Power Supply
**Type**: HM8143
**with**: HO820
**Option**: HO880

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electrical equipment for use within defined voltage limits (2006/95/EC) [LVD]
- relating to electromagnetic compatibility (2004/108/EC) [EMCD]
- relating to restriction of the use of hazardous substances in electrical and electronic equipment (2011/65/EC) [RoHS].

Conformity with LVD and EMCD is proven by compliance with the following standards:

EN 61010-1: 04/2015
EN 61326-1: 07/2013
EN 55011: 11/2014
EN 61000-4-2: 12/2009
EN 61000-4-3: 04/2011
EN 61000-4-4: 04/2013
EN 61000-4-5: 03/2015
EN 61000-4-6: 08/2014
EN 61000-4-11: 02/2005

For the assessment of electromagnetic compatibility, the limits of radio interference for Class B equipment as well as the immunity to interference for operation in industry have been used as a basis.

**Date**: 8.6.2015

**Signature**:

Holger Asmussen
General Manager

## General Information Regarding the CE Marking

ROHDE & SCHWARZ measuring instruments comply with regulations of the EMC Directive. ROHDE & SCHWARZ is basing the conformity assessment on prevailing generic and product standards. In cases with potentially different thresholds, ROHDE & SCHWARZ instruments apply more rigorous test conditions. Thresholds for business and commercial sectors as well as small business are applicable for interference emission (class 1B). As to the interference immunity, the standard thresholds for the industrial sector apply. Measurement and data lines connected to the measuring instrument significantly affect compliance with specified thresholds. Depending on the respective application, utilized lines may differ. In regards to interference emission and immunity during measurements, it is critical that the following terms and conditions are observed:

### 1. Data Cables

It is imperative to only use properly shielded cables when connecting measuring instruments and interfaces to external devices (printers, computers, etc.). Unless the manual prescribes an even shorter maximum cable length, data cables (input/output, signal/control) may not exceed a length of 3m and may not be used outside of buildings. If the instrument interface includes multiple ports for interface cables, only one cable at a time may be connected. Generally, interconnections require double-shielded connecting cables. The double-shielded cable HZ72 (available at ROHDE & SCHWARZ) is well suitable as IEEE bus cable.

### 2. Signal Cables

In general, measuring cables for the transmission of signals between measuring point and measuring instrument should be kept as short as possible. Unless the manual prescribes an even shorter maximum cable length, signal cables (input/output, signal/control) may not exceed a length of 1m and may not be used outside of buil-dings. In general, all signal cables must be used as shielded conductors (coaxial cable- RG58/U). It is important to ensure proper ground connection. Signal generators require the use of double-shielded coaxial cables (RG223/U, RG214/U).

### 3. Impact on Instruments

If strong high-frequency electric and magnetic fields are present, it may occur despite diligent measurement setup that unwanted signal units are injected into the instrument via connected cables and lines. This does not result in destruction or shutdown of ROHDE & SCHWARZ instruments. In individual cases, external circumstances may cause minor variations in the display and measuring values beyond the selected specifications.

# Content

# 1 Important hints

(1) (2) (3)

## 1.1 Symbols

Symbol 1: Caution - Observe operating instructions
Symbol 2: Caution High Voltage
Symbol 3: Ground

## 1.2 Unpacking

While unpacking, check the package contents for completeness (measuring instrument, power cable, possibly optional accessories). After unpacking, check the instrument for mechanical damage occurred during transport and for loose parts inside. In case of transport damage, please inform the supplier immediately. The instrument must not be operated in this case.

## 1.3 Positioning

Two positions are possible: According to Fig. 1 the front feet are folded down and are used to lift the instrument so its front points slightly upward (approx. 10 degrees). If the feet are not used (Fig. 2) the instrument can be stacked safely with many other instruments. In case several instruments are stacked (Fig. 3) the feet rest in the recesses of the instrument below so the instruments can not be inadvertently moved..

Fig. 1

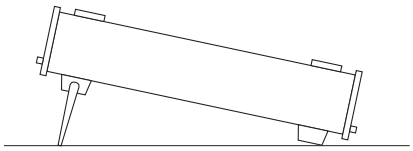


Fig. 2

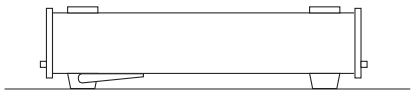
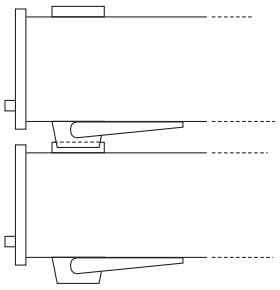


Fig. 3



Please do not stack more than 3 instruments. A higher stack will become unstable, also heat dissipation may be impaired

## 1.4 Transport and Storage

Please keep the original packaging for possible shipping at a later point. Damage during transport due to inappropriate packaging is excluded from the warranty. The instrument must be stored in dry, closed indoor premises. If the instrument was transported under extreme temperatures, it is advisable to allow a minimum of two hours to reach the appropriate temperature before operating the instrument.

## 1.5 Safety Instructions

This instrument was built in compliance with VDE0411 part 1, safety regulations for electrical measuring instruments, control units and laboratory equipment. It has been tested and shipped from the plant in safe condition. It is in compliance with the regulations of the European standard EN 61010-1 and the international standard IEC 61010-1. To maintain this condition and to ensure safe operation, the user must observe all instructions and warnings given in this operating manual. According to the regulations of protection class 1, all casing and chassis parts are connected to the protective earth conductor during operation.

**It is prohibited to disconnect the earthed protective connection inside or outside the instrument!**

If uncertainty exists about the function or safety of the power sockets, the outlets must be examined in accordance with DIN VDE 0100, part 610.

- The available mains voltage must correspond to the values specified on the instrument label.
- The instrument may only be opened by fully trained personnel.
- Prior to opening, the instrument must be turned off and isolated from all circuits.

In the following cases, remove the instrument from operation and secure it against unintentional operation:

- Visible damage to the instrument
- Cable damage
- Fuse holder damage
- Loose parts in the instrument
- The instrument is no longer working
- After an extended period of storage under unfavorable conditions (e.g. outdoors or in damp rooms)
- Rough handling during shipment.

**Exceeding the Low Voltage Protection!**
**For the series connection of all output voltages, it is possible to exceed the low voltage protection of 42 V. Please note that in this case any contact with live components is life-threatening. It is assumed that only qualified and trained personnel service the power supplies and the connected loads.**

Prior to switching on the product, it must be ensured that the nominal voltage setting on the product matches the nominal voltage of the AC supply network. If it is necessary to set a different voltage, the power fuse of the prod-

uct may have to be changed accordingly.

## 1.6 Intended Operation

The measuring instrument is intended only for use by personnel familiar with the potential risks of measuring electrical quantities. For safety reasons, the measuring instrument may only be connected to properly installed safety socket outlets. Separating the grounds is prohibited. The power plug must be inserted before signal circuits may be connected.

**Use the measuring instrument only with original measuring equipment, measuring cables and power cord. Never use inadequately measured power cords. Before each measurement, measuring cables must be inspected for damage and replaced if necessary. Damaged or worn components can damage the instrument or cause injury.**

The product may be operated only under the operating conditions and in the positions specified by the manufacturer, without the product's ventilation being obstructed. If the manufacturer's specifications are not observed, this can result in electric shock, fire and/or serious personal injury, and in some cases, death. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed. The measuring instrument is designed for use in the following sectors: Industry, residential, business and commercial areas and small businesses. The measuring instrument is designed for indoor use only. Before each measurement, you need to verify at a known source if the measuring instrument functions properly.

**To disconnect from the mains, the low-heat device socket on the back panel has to be unplugged.**

## 1.7 Ambient Conditions

Permissible operating temperatures during the operations range from +5 °C to +40 °C. During storage or transportation the temperature may be between –20 °C and +70 °C. In case of condensation during transportation or storage , the instrument will require approximately two hours to dry and reach the appropriate temperature. It can then be operated. The measuring instrument is designed for use in a clean and dry indoor environment. Do not operate with high dust and humidity levels, if danger of explosion exists or with aggressive chemical agents. Any operating position may be used; however adequate air circulation must be maintained. For continuous operation, a horizontal or inclined position (integrated stand) is preferable.

The maximum operating altitude for the instrument is 2000 m. Nominal data with tolerance details apply once the ambient temperature of 23 °C has been reached after about 30 minutes. Values without tolerance details are reference values of an average instrument.

**Do not obstruct the ventilation holes!**

## 1.8 Cooling

The heat produced inside the power supply is guided to the exterior via temperature-controlled fan. This fan, combined with a cooling element, is located in a "cooling duct" which is positioned across the instrument. The air is drawn at the left side and exhausted at the right side of the instrument. This helps minimize the dust exposure to the instrument as much as possible. However, it is necessary to ensure that there is sufficient space on both instrument sides for the heat exchange. If the temperature inside the instrument still increases to more than 80°C, a channel-specific overheat protection intervenes. Affected outputs will automatically be switched off.

## 1.9 Warranty and Repair

ROHDE & SCHWARZ instruments are subject to strict quality controls. Prior to leaving the manufacturing site, each instrument undergoes a 10-hour burn-in test. This is followed by extensive functional quality testing to examine all operating modes and to guarantee compliance with the specified technical data. The testing is performed with testing equipment that is calibrated to national standards. The statutory warranty provisions shall be governed by the laws of the country in which the R&S® product was purchased. In case of any complaints, please contact your supplier.

**The product may only be opened by authorized and qualified personnel. Prior to working on the product or before the product is opened, it must be disconnected from the AC supply network. Otherwise, personnel will be exposed to the risk of an electric shock.**

Any adjustments, replacements of parts, maintenance and repair may be carried out only by authorized ROHDE & SCHWARZ technical personnel. Only original parts may be used for replacing parts relevant to safety (e.g. power switches, power transformers, fuses). A safety test must always be performed after parts relevant to safety have been replaced (visual inspection, PE conductor test, insulation resistance measurement, leakage current measurement, functional test). This helps ensure the continued safety of the product.

## 1.10 Maintenance

**Clean the outer case of the measuring instrument at regular intervals, using a soft, lint-free dust cloth.**

The display may only be cleaned with water or an appropriate glass cleaner (not with alcohol or other cleaning agents). Follow this step by rubbing the display down with a dry, clean and lint-free cloth. Do not allow cleaning fluid to enter the instrument. The use of other cleaning

**Before cleaning please make sure the instrument is switched off and disconnected from all power supplies.**

**No part of the instrument should be cleaned by the use of cleaning agents (as f.e. alcohol) as they may adversely affect the labeling, the plastic or lacquered surfaces.**

agents may damage the labeling or plastic and lacquered surfaces.

## 1.11 Measurement Categories

This instrument is designed for measurements on circuits that are only indirectly connected to the low voltage mains or not connected at all. The instrument is not intended for measurements within the measurement categories II, III or IV; the maximum potential against earth generated by the user must not exceed $150V_{DC}$ (peak value) in this application. The following information refers solely to user safety. Other aspects, such as the maximum voltage, are described in the technical data and must also be observed.

The measurement categories refer to transients that are superimposed on the mains voltage. Transients are short, very fast (steep) current and voltage variations which may occur periodically and non-periodically. The level of potential transients increases as the distance to the source of the low voltage installation decreases.

- **Measurement CAT IV**: Measurements at the source of the low voltage installations (e.g. meters)
- **Measurement CAT III**: Measurements in building installations (e.g. power distribution installations, power switches, firmly installed sockets, firmly installed engines etc.).
- **Measurement CAT II**: Measurements on circuits electronically directly connected to the mains (e.g. household appliances, power tools, etc.)
- **0** (instruments without measured measurement category): Other circuits that are not connected directly to the mains.

## 1.12 Switching the Mains Voltage and Replacing a Fuse

### Switching the Mains Voltage

Prior to operating the instrument, please check if the available mains voltage (115V or 230V) corresponds to the value indicated on the voltage selector of the instrument. If this is not the case, the main voltage will need to be switched. The voltage selector is located on the back of the instrument (see Fig. 1.1).

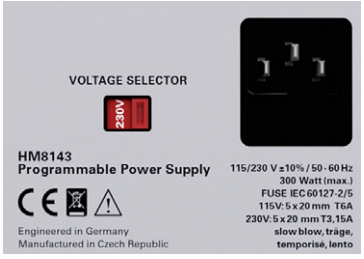



Fig. 1.1: Voltage selector for HM8143

### Replacing a Fuse

The input line fuses are accessible externally. The integral plug for a cooling unit and the fuse holder form a single unit. A fuse may only be replaced if the instrument has been disconnected from the mains first and if the power cable has been removed. The fuse holder and power cable must be undamaged. Use a suitable screwdriver (with a blade width of approximately 2 mm) to push the plastic locking mechanisms to the left and right side of the fuse holder inwards. The insertion point is marked by two slanted guides on the casing. When unlocking the mechanism, the fuse holder will be pushed outwards by compression springs and it can then be removed. The fuses are now accessible and can be removed as necessary.

**When changing the mains voltage, it is essential to replace the fuse. Otherwise the instrument may be destroyed.**

Please note that the protruding contact springs must not be deformed. It is only possible to insert the fuse holder if the guide points toward the connector. The fuse holder will be inserted against the spring pressure until both plastic locking mechanisms lock into place.

**It is hazardous and not permitted to repair a defective fuse or to use other tools to bypass the fuse. Resulting damage to the instrument are not covered by the warranty.**

**Types of fuses:**
Size 5 x 20 mm; 250V~,
IEC 60127-2/5
EN 60127-2/5

| Line voltage | Correct fuse type |
|---|---|
| 230 V | 2 x 3.15 A slow blow (T) |
| 115 V | 2 x 6 A slow blow (T) |

## 1.13 Batteries and Rechargeable Batteries/Cells

**If the information regarding batteries and rechargeable batteries/cells is not observed either at all or to the extent necessary, product users may be exposed to the risk of explosions, fire and/or serious personal injury, and, in some cases, death. Batteries and rechargeable batteries with alkaline electrolytes (e.g. lithium cells) must be handled in accordance with the EN 62133 standard.**

1. Cells must not be disassembled, opened or crushed.

2. Cells and batteries may not be exposed to heat or fire. Storage in direct sunlight must be avoided. Keep cells and batteries clean and dry. Clean soiled connectors using a dry, clean cloth.

3. Cells or batteries must not be short-circuited. Cells or batteries must not be stored in a box or in a drawer where they can short-circuit each other, or where they can be short-circuited by other conductive materials. Cells and batteries must not be removed from their original packaging until they are ready to be used.

4. Keep cells and batteries out of reach of children. Seek medical assistance immediately if a cell or battery was swallowed.

5. Cells and batteries must not be exposed to any mechanical shocks that are stronger than permitted.

6. If a cell develops a leak, the fluid must not be allowed to come into contact with the skin or eyes. If contact occurs, wash the affected area with plenty of water and seek medical assistance.

7. Improperly replacing or charging cells or batteries can cause explosions. Replace cells or batteries only with the matching type in order to ensure the safety of the product.

8. Cells and batteries must be recycled and kept separate from residual waste. Cells and batteries must be recycled and kept separate from residual waste. Rechargeable batteries and normal batteries that contain lead, mercury or cadmium are hazardous waste. Observe the national regulations regarding waste disposal and recycling.

## 1.14 Product Disposal

Fig. 1.2: Product labeling in accordance with EN 50419

The Electrical and Electronic Equipment Act implements the following EG directives:

- 2002/96/EG (WEEE) for electrical and electronic equipment waste and
- 2002/95/EG to restrict the use of certain hazardous substances iin electronic equipment (RoHS directive).

Once its lifetime has ended, this product should be disposed of separately from your household waste. The disposal at municipal collection sites for electronic equipment is also not permitted. As mandated for all manufacturers by the Electrical and Electronic Equipment Act (ElektroG), ROHDE & SCHWARZ assumes full responsibility for the ecological disposal or the recycling at the end-of-life of their products.

Please contact your local service partner to dispose of the product.

# 2 Controls and display

## Front panel

[1] POWER (button)
Mains connector at rear panel

[2] REMOTE (LED)
The REMOTE LED is lit when the instrument is operated via interface.

[3] [13] CV (green LED)
If the CV LED is lit, the HM8143 is in constant voltage mode.

[4] [12] CC (red LED)
If the CC LED is lit, the HM8143 is in constant current mode.

[5] [11] Digital display (2 x 4 digit)
Display of nominal or measurement values of the output voltage and the output current.

[6] [10] VOLTAGE (pushbutton and LED)
Setting of output voltage via frontpanel. By pushing the button the setting function is active.

[7] CURRENT (pushbutton and LED)
Setting of current limit via frontpanel. By pushing the button the setting function is active.

[8] Rotary knob
Parameter setting of voltage and current values.

[9] CURRENT (pushbutton and LED)
Setting of current limit via frontpanel. By pushing the button the setting function is active.
Beep off: While turning on the instrument keep the CURRENT button depressed.

[14] TRACKING (pushbutton and LED)
Activation of the tracking function of the 30 V outputs

[15] FUSE (pushbutton and LED)
Button for activation of the electronic fuse

[16] [18] 0-30 V / 2 A (Adjustable)
4mm banana sockets for SOURCE and sense

[17] 5 V / 2 A (Fixed)
4 mm banana sockets

[19] OUTPUT (pushbutton and LED)
ON/OFF key for all channels

## Rear panel

[20] MODULATION R / L (BNC sockets)
Analog modulation inputs for the 30 V outputs, 0-10 V, max. 50 kHz

[21] USB/RS-232 Interface (HO820)
Options: HO880, IEEE-488 (GPIB)

[22] TRIGGER IN/OUT (BNC socket)
Input/output for start and trigger signals to/from the HM8143, TTL level

[23] Voltage selector (115 V / 230 V)

[24] Power receptacle with line fuse

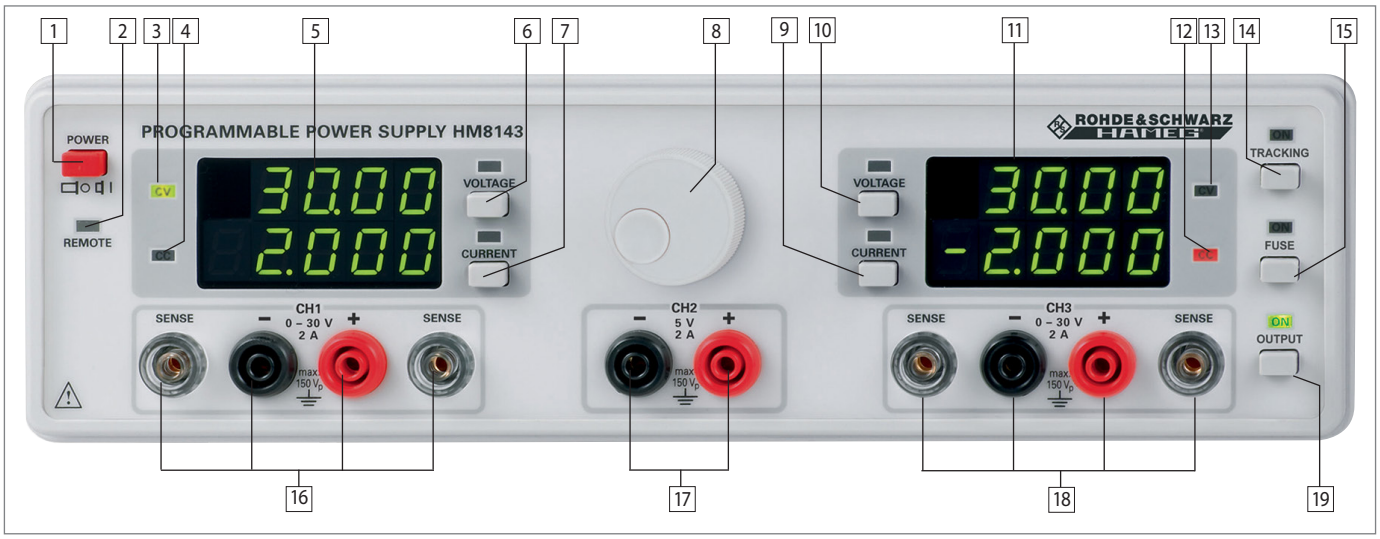



Fig. 2.1: Front panel of the HM8143

# 3 Basics of power supplies

## 3.1 Linear power supplies

Linear regulated power supplies excel by their highly constant output voltage, low ripple and fast regulation, even under high line and load transients. Good power supplies feature a ripple of less than 1 $mV_{rms}$ which is mostly negligible. Further they are free from EMI emission in contrast to SMPS.

A conventional mains transformer isolates the line from the secondary which is rectified and supplies an unregulated voltage to a series pass transistor. Capacitors at the input and output of the regulator serve as buffers and decrease the ripple. A high precision reference voltage is fed to one input of an amplifier, the second input is connected mostly to a fraction of the output voltage, the output of this amplifier controls the series pass transistor. This analog amplifier is generally quite fast and is able to keep the output voltage within tight limits.

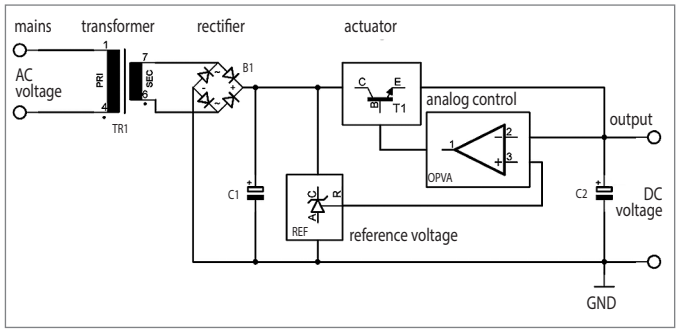



Fig. 3.1: Linear power supply

## 3.2 Switched-mode power supplies (SMPS)

SMPS operate with very much higher efficiencies than linear regulated power supplies. The DC voltage to be converted is chopped at a high frequency rate thus requiring only comparatively tiny and light ferrite chokes or transformers with low losses, also, the switching transistor is switched fully on and off hence switching losses are low. In principle regulation of the output voltage is achieved by changing the duty cycle of the switch driving waveform.

### Primary SMPS

The line voltage is rectified, the buffer capacitor required is of fairly small capacitance value because the energy stored is proportional to the voltage squared (E = 1/2 x C x $U^2$).

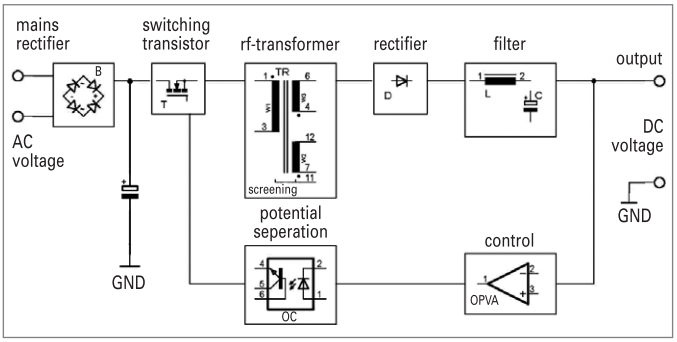



Fig. 3.2: Primary switched-mode power supply

### Secondary SMPS

These still require a 50 or 60 Hz mains transformer, the secondary output voltage is rectified, smoothed and then chopped. The capacitance values needed here for filtering the 100 resp. 120 Hz ripple are higher due to the lower voltage.

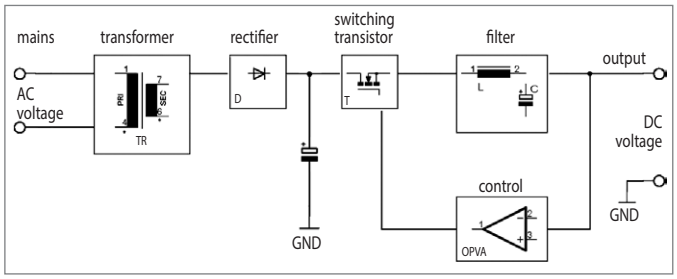



Fig. 3.3: Socondary switched-mode power supply

All SMPS feature a very much higher efficiency from appr. 70 up to over 95 % compared to any linear supply. They are lighter, smaller. The capacitors on the output(s) of a SMPS may be quite small due to the high frequency, but the choice depends also on other factors like energy re-


Fig. 2.2: Rear panel of the HM8143

quired for buffering or AC ripple from the load (e.g. motors). In principle the size of the major components decreases with increasing operating frequency, however, the efficiency drops apppreciably above appr. 250 kHz as the losses in all components rise sharply. .

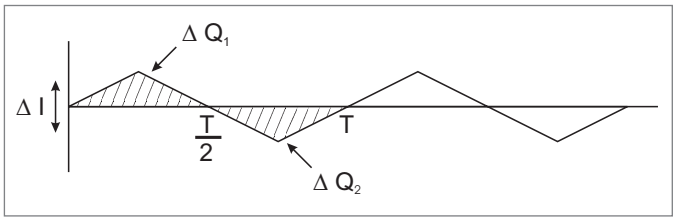



Fig. 3.4: The load of a switch mode powersupply

## 3.3 Parallel and series operation

It is mandatory that the power supplies used are definitely specified for these operating modes. This is the case with all HAMEG supplies. As a rule, the output voltages to be combined are independent of each other, hence, it is allowed to connect the outputs of one supply with those of another or more.

### Series operation

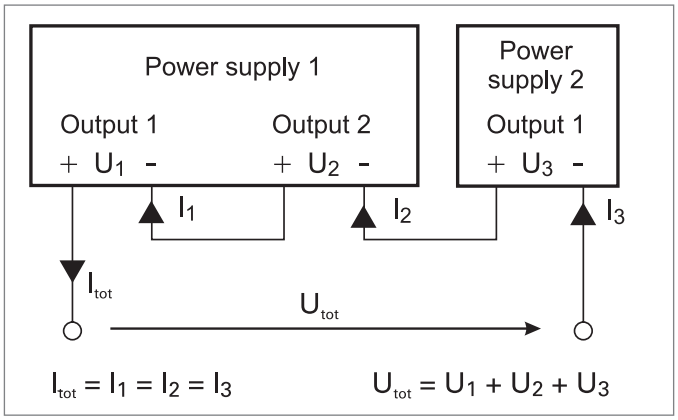



Fig. 3.5: Series operation

In this mode the output voltages add, the output current is the same for all supplies. As the sum of all voltages may well surpass the 42 V limit touching of live parts may be fatal! Only qualified and well instructed personnel is allowed to operate such installations. The current limit of the outputs in series should be adjusted to the same value. If one output reaches the current limit the total voltage will break down.

### Parallel operation

In order to increase the total available current the outputs of supplies can be paralleled. The output voltages of the supplies involved are adjusted as accurately as possible to the same value. In this mode it is possible that one or more supplies enter the current limit mode. The output voltage remains in regulation as long as still at least one supply is in the voltage control mode. It is recommended but not absolutely necessary to fine adjust the voltages such that

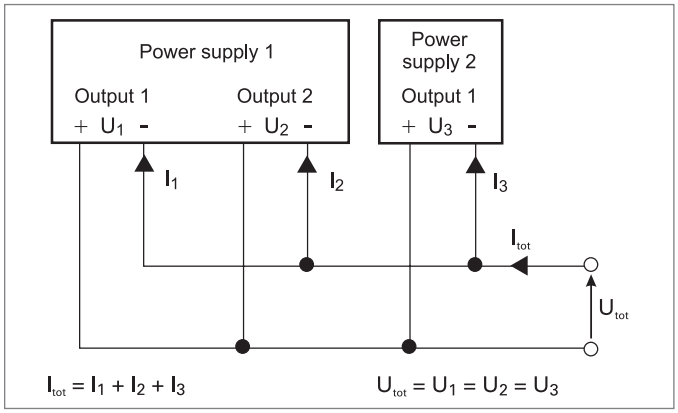



Fig. 3.6: Parallel operation

the individual current contributions remain nearly equal. Of course, the maximum available output current is the sum of the individual supplies' maximum currents.

**If using the parallel setup, it is not allowed to use the modulation at the same time, otherwise the instrument may be destroyed.**

**Example:**

A load requires 12 V at 2.7 A. Each 30 V output of the HM8143 can deliver 2 A. First set both channels to 12 V. Then connect both black and red safety connectors respectively in parallel. The load is connected to one of the supplies. With the pushbutton OUTPUT the voltage will be turned on. It is normal that one output will current limit at 2 A while the other will contribute the balance of 0.7 A in voltage regulation.

**In case you should parallel power supplies of other manufacturers with Hameg supplies make sure all are specified for this mode of operation. If one supply of those connected in parallel should have insufficient overload protection it may be destroyed. Hameg supplies are specified for series and parallel operation.**

## 3.4 Current limit

Current limit means that a maximum current can be set. This is e.g. useful in order to protect a sensitive test circuit. In case of an inadvertent short in the test circuit the current will be limited to the value set which will in most cases prevent damage.

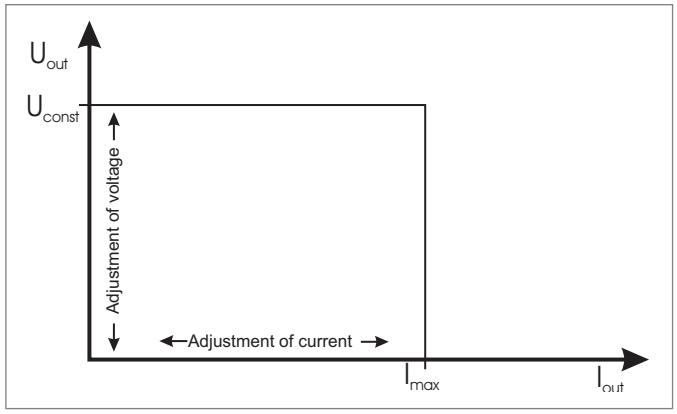



Fig. 3.7: Current limit

The picture shows that the output voltage $V_{out}$ remains stable, while the current $I_{out}$ increases until the current li-

mit selected $I_{max}$ will be reached. At this moment the instrument will change from constant voltage regulation to constant current regula-tion. Any further load increase will cause the current to remain stable while the voltage $U_{out}$ decreases ultimately to zero.

### 3.5 Electronic fuse

In order to provide a better protection than current limiting, the HM8143 features an electronic fuse. As soon as Imax is reached all outputs will immediately be disabled (Output LED is off). They may be turned on again by depressing OUPUT.

# 4 Connecting the load

The load has to be connected to the middle safety terminals. For the connection please use 4 mm banana plugs.

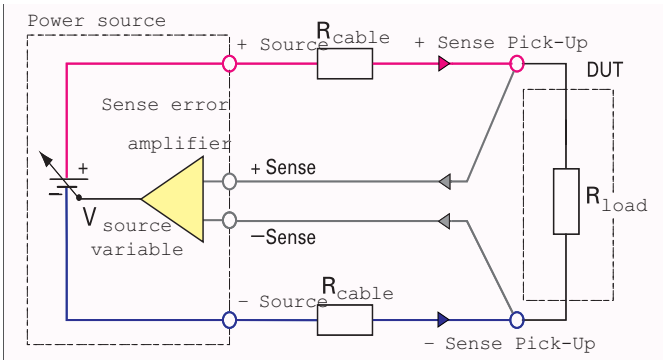



Fig. 4.1: Compensating the voltage drops in diagram

The transparent terminals are the SENSE inputs. With these SENSE terminals the voltage loss across the cables can be compensated. The HM8143 balances this voltage loss automatically and the load will see the voltage set. Connect two separate measurement cables in parallel to the connecting cables of the load.

**Please note the polarity of the load terminals: the red terminal is the positive, the black terminal is the negative connector.**

**Example:**

If you want to connect low loads please notice that the „not used" power is transformed into heat. If you set 4 V x 2 A = 8 W at the 32V channels, the rest of the instrument power of 26 V x 2 A = 52 W (per channel) will be transformed into heat (= 104 W). This is a typically behaviour of a linear regulated power supply. In this case, the heat can not be transported out of the HM8143 chassis continuously. Based on this the instrument shuts down the channels to protect the internal circuitry. For connecting low loads we recommend using a switching power supply (e.g. HMP series). A switching power supply is creating heat for the used power only, not for the „not used" power.

**For continuously usage of low loads a switching power supply is recommended. The bigger the load, the more suitable a linear regulated power supply.**

# 5 Operation of the HM8143

## 5.1 First time operation

Please observe especially the following notes:

- The line voltage indicated on the rear panel corresponds to the available line voltage, also, the correct fuses for this line voltage are installed. The fuses are contained in the line voltage connector housing.
- The connection to the mains is either by plugging into a socket with safety ground terminal or via an isolation transformer of protection class II.
- No visible damage to the instrument.
- No visible damage to the line cord.
- No loose parts floating around in the instrument.

**Attention:**
**The HM8143 is not protected against reverse polarity!**
**For example, if you use the instrument in series operation the + pole of the first output is interconnected to the - pin of the second output. To avoid damage of the instrument, make sure that the circuit to be supplied is not shorted. Otherwise, the device wired the wrong way and may be destroyed.**

## 5.2 Turning on the HM8143

Turn on the instrument by operating the POWER button. During power up the HM8143 automatically performs a selftest routine, which checks all of the unit's important functions and the contents of the internal memories and registers. While self-testing is going on, the instrument identification and the version number of the firmware is shown on the two displays (e.g. HM8143 1.15).

**ATTENTION:**
**Do not switch off the instrument, while the output is still activated (LED of the OUTPUT button highlighted)! It may destroy your device under test (DUT).**

The values of the nominal output voltages and current limits are stored in a non-volatile memory and are read back after power-on. After turning on the HM8143, the outputs and the functions TRACKING and FUSE are deactivated by default in order to prevent damage being inadvertently caused to connected loads because the stored voltage or current setting might be too high for the application at hand.

From firmware version 2.40 the display refresh rate and the baud rate are shown on the right display during the boot-up prodcedure. For more information please see chapters "Change of the baud rate" and "Change of the display refresh rate".

## 5.3 Turning off the button beep

The HM8143 offers the possibility to turn ON/OFF the button beep. While turning on the instrument keep the CURRENT button of the right channel depressed to turn off the beeper constantly. This setting will be stored inside the EEPROM. The button beep can be restored in the same way.

## 5.4 Setting output voltages and the current limits

The changeable parameters (output voltages and current limit) are set using the rotary knob [8]. To change values, first select the appropriate parameter with the VOLTAGE [6] [10] and CURRENT [7] [9] buttons. Then use the rotary knob [8] to set the desired value.

If the outputs are on (OUTPUT LED [19] is on) the HM8143 displays will show the actual values, that means the power supply will show the measured values of voltage and current (Vout and Iout). Operating the VOLTAGE [6] [10] or the CURRENT button [7] [9] will switch the HM8143 to setting mode, which is being indicated by glowing of one of the LEDs above the buttons VOLTAGE [6] [10] or CURRENT [7] [9]. The corresponding display will show the nominal value of the output voltage or current limit. Now the desired value of the output voltage or current limit can be adjusted with the rotary knob [8]. This mode will be left after about 2 seconds after the last operation of the rotary knob. The HM8143 will then display the measured values of the output voltage and current again.

## 5.5 Trigger Input + Trigger Output (Start/Stop)

In order to permit easy triggering of an oscilloscope connected to the output of the HM8143, especially in arbitrary mode, the instrument is equipped with a BNC socket TRIGGER IN/OUT [22] on its rear panel. This is configured as a tri-state output and permits a trigger signal to be taken after each signal period in arbitrary mode, or the arbitrary function to be activated by an external trigger signal (TTL level).

## 5.6 Modulation inputs

By virtue of the modulation inputs MODULATION R/L [20] on the rear panel of HM8143, it can be also be used as a modulation power amplifier. The input voltage is amplified with factor 3. The frequency range (-3 dB) goes from DC to 50 kHz. The allowable external voltage ranges from 0 V to 10 V.

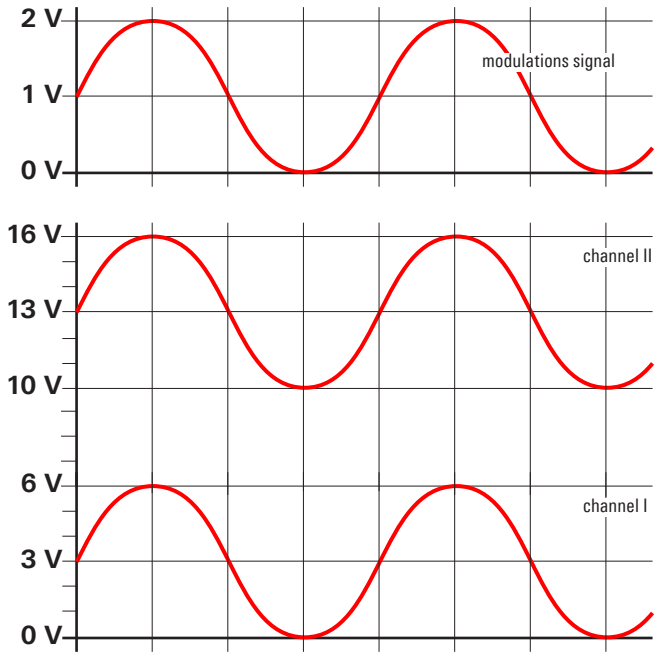
**If you are using the modulation, it is not allowed to use parallel setup, otherwise the instrument may be destroyed.**

The output voltage of HM8143 will be the sum of:
$V_{out} = (V_{modin} \times 3) + V_{set}$

**Please note that the sum $V_{out} = (V_{modin} \times 3) + Vset$ must not exceed the value of 30 V, as then the proper functionality of the current regulation is not ensured and the connected load can be destroyed.**

**If the ground of the modulations source is connected with the safety ground terminal , the modulation source has to be operated via an isolation transformer, as there will be no electrical isolation of the power supply.**

**Example**: Modulation source $V_{mod}$ = 2,0 $V_{ss}$
$f_{mod}$ = 50 Hz
channel 1 $V_{set}$ = 0 V
channel 3 $V_{set}$ = 10 V




**If a modulation voltage of 2 Vpp is applied, the nominal value of the output voltage of the HM8143 must not exceed 24.00 V.**

## 5.7 Tracking

With the aid of the tracking function, it is possible to simultaneously vary 2 setting parameters of the two 30 V-channels. In other words, either both output voltage settings or both current limits can be varied at the same time by using the tracking function. This function is activated by pressing the TRACKING button [14]. The TRACKING LED is lit. To exit the tracking mode, press the TRACKING button [14] again .

This has the effect of clearing all previously activated functions, and from then on whenever a value is called and changed both channels of the instrument are identically affected (the 5 V output remains unchanged). It does not matter which values had been set prior to changing one of the parameters; in the tracking mode, the HM8143 always retains the respective differences between the voltages values and the current limits, except if the minimum or maximum values of current limit (0.005 A or 2 A) or of the output voltage (0 V or 30 V) is reached. In this case, the difference of voltage or current will be reduced as long as it will be zero. That means until the values of the output voltage or current limit of both channels have set to the minimum or maximum values.

## 5.8 Change of the display refresh rate

From firmware version 2.40 the display refresh rate of the measured voltages and currents can be varied. The selected display rate is shown during boot procedure in the voltage display of channel 2 [11].

L = Low display rate, i.e. the displayed value corresponds to the average value from 8 measurements. Approx. 3 values per second are displayed.

H = High display rate, i.e. the measured values are shown directly the display. Approx. 24 values per second Are displayed.

To change the display refresh rate, hold the TRACKING key [14] when switching on the instrument, until you hear 3 beeps. The display refresh rate is changed according to the following pattern: L → H → L etc.

Please note that the data which are sent via remote control (e.g. with command MI1) are transmitted according to the display refresh rate.

# 6 Operation modes 7 Safety features

## 6.1 Constant voltage operation (CV)

The HM8143 programmable power supply features various different operating modes. Of these, it is probably used most often as a voltage source. This is the normal mode and is indicated by the CV (constant voltage) LEDs or beside the displays (in this mode $V_{actual} = V_{set}$ and $I_{actual} < I_{limit}$. Here, the displayed values represent the measured output voltages and the measured output current.

## 6.2 Constant current operation (CC)

As soon as the output current reaches the programmed current limit value, the power supply automatically switches into its current source mode, if the electronic fuse is not activated (see chapter Electronic Fuse). This mode is indicated by the CC (constant current) LEDs or (now $I_{actual} = I_{limit}$ and $V_{actual} > V_{set}$); the CV LEDs or extinguish. The measured output voltage generally drops below the programmed voltage. The actual measured value can be read off the display. This mode is only possible if the electronic fuse is not active (FUSE LED is off) see chapter electronic fuse.

## 6.3 Electronic load

The HM8143 also offers a mode in which it functions as an electronic load (current sink). The instrument goes into this mode automatically, and it can be recognized by a negative sign (–) in front of a displayed current value. The same limit values apply to voltage and current as in normal operating mode. In this operation mode the output voltage measured is normally greater than the nominal value ($V_{actual} > V_{set}$)

## 6.4 Series and parallel mode

To increase the output voltages and currents, the two channels of the power supply can be connected either in series or in parallel.

**If you are using the modulation then it is not allowed to use parallel setup, otherwise the instrument may be destroyed.**

It is important to keep in mind that when the two output circuits are connected in series a greater voltage than that ordinarily permitted for safety reasons can develop. The HM8143 may therefore be used only by personnel who are familiar with the associated risks.

## 6.5 Arbitrary waveform mode

By interface the HM8143 can also be made to generate freely programmable waveforms within the limit values set (arbitrary mode). See chapter Arbitrary.

The HM8143 is equipped with a variety of safety features to prevent damage being caused to the instrument by short circuits or overheating.

## 7.1 Current limit

If one of the output voltages is short circuited, the current limiter automatically keeps the current from rising beyond the programmed maximum output current. The response time is approx. 200µs that means during this time the maximum current value set can be exceeded.

## 7.2 Electronic fuse

In order to provide a still better protection than current limiting offers the HM8143 features an electronic fuse. As soon as $I_{max}$ is reached all outputs will be immediately simultaneously disabled.
They may be turned on again by depressing OUPUT. The electronic fuse is activated by operating the FUSE button. The FUSE LED is on. By pushing the FUSE button again, the electronic fuse is deactivated. The fuse LED is dark.

## 7.3 Cooling

The heat generated in the HM8143 is removed by a temperature controlled fan. This is located together with the heat sink in a “cooling channel“ that runs straight through the instrument. Air is drawn in on the righthand side of the unit and blown out again on the lefthand side. This also prevents excessive dust accumulation. Always make sure that there is sufficient open space for cooling on both sides of the HM8143.

**In no case may the cooling holes on the sides of the unit be covered.**

If the temperature inside the HM8143 should nevertheless rise to above 80°C, an automatic temperature-controlled safety circuit is activated. The outputs are put off. After the unit has cooled down sufficiently, operation can be resumed by pressing the OUTPUT button.

## 7.4 Error messages

In case of a mal function the HM8143 will display an error message on the left display (channel 1):

| Display | Meaning |
|---|---|
| E1 | Error channel 1 |
| E3 | Error channel 2 |
| E2 | Error channel 3 |

Please turn off the instrument if one of these errors occurs. If the error is still displayed after resetting the instrument, it has to be sent in. Please contact the HAMEG service department (Tel: +049 (0) 6182 800 500, E-Mail: service@hameg.com).

# 8 Remote control

## 8.1 Interfaces

The HM8143 comes with an USB/RS-232 interface, as an option the IEEE-488 GPIB interface is available. We recommend the installation ex factory.

**RS-232 Interface parameters:**
9600 baud, no paritybit, 8 data bits, 1 stop bit

**USB interface**
You do not have to change the configuration. If required, the baud rate can be changed. Connect the HM8143 with your PC using a USB cable and install the USB drivers like described in the manual of the USB interface HO820.

**GPIB interface**
It is necessary to change the GPIB adress of the function generator to the desired value. The adress is changed at the interface on the back panel. Connect the HM8143 with your PC using a GPIB cable and set the baud rate to 9600 baud.

## 8.2 General

When being controlled by interface, the HM8143 immediately goes into remote mode as soon as a command arrives at the interface. The REMOTE LED is on and all operating controls ar disabled. Mixed operation, in which the instrument can also be manually operated using the frontpanel controls although it is connected to an interface, is possible by using the command MX1. The commands have to be terminated with CR (0x0D). The commands may contain upper and lower case characters.

## 8.3 Change of the baud rate

(valid from version 2.40)

From firmware version 2.40 the baud rate of the HM8143 can be varied. The selected transmission rate is indicated during the boot procedure in the current display of channel 2. If the baud rate is set to 19200 baud, the instrument shows „19.2“. To change the baud rate, keep the OUTPUT button pressed when switching on the instrument until you hear 3 beeps.

The baud rate is changed according to the following pattern: 9600 → 19200 → 4800 → 9600 etc.

Only one step is possible for every boot procedure , i.e. to change the baud rate from 4800 baud to 19200 baud, the HM8143 must be powered on two times with the OUTPUT button pressed.

Please note, that the data transmission rate has to be set to 9600 Baud when using the IEEE-488 (GPIB) interface.

## 8.4 Command reference

**RM1 + RM0**
Format: RM1
Function: Puts the power supply in remote mode. The frontpanel controls are disabled. In this mode, the power supply can only be operated by interface. This mode can be terminated by sending a RM0 command.

Format: RM0
Function: Disables the remote mode, returning the power supply to local mode (permitting operation using the front panel controls).

**MX1 + MX0**
Format: MX1
Function: Switches the power supply from remote mode into mixed mode. In mixed mode, the instrument can be operated either by interface or using the frontpanel controls.

Format: MX0
Function: Terminates mixed mode and returns the instrument to remote mode.

**SU1 + SU2**
Format: SU1:VV.mVmV or SU2:01.34
SU1 VV.mVmV or SU2 01.34
Function: Sets voltage 1 or voltage 2 to the indicated value (SET value; BCD format)
Example: SU1:1.23 → U1 = 1.23 V
SU2:12.34 → U2 = 12.34 V

**SI1 + SI2**
Format: SI1:A.mAmAmA or SI1:0.123
SI1 A.mAmAmA or SI1 0.123
Function: Sets current limit 1 or current limit 2 to the indicated value (LIMIT value; BCD format)
Example: SI1:1.000 → I1 = 1.000 A
SI2:0.123 → I2 = 0.123 A

**RU1 + RU2**
Format: RU1 or RU2
Reply: U1:12.34V or U2:12.34V
Function: The voltage values sent back by the HM8143 are the programmed voltage values. Use the MUx commands to query the actual values.

**RI1 + RI2**
Format: RI1 or RI2
Reply: I1:+1.000A or I2:–0.012A
Function: The current values sent back by the HM8143 represent the programmed limit values for the current. Use the MIx commands to query the actual current values.

**MU1 + MU2**
Format: MU1 or MU2
Reply: U1:12.34V or U2:12.24V
Function: The voltage values sent back by the HM8143 represent the actual voltage values last measured at the outputs. Use the RUx commands to query the voltage values set.

**MI1 + MI2**
Format: M11 or M12
Reply: I1=+1.000A or I2=–0.123A
Function: The current values sent back by the HM8143 represent the actual current values last measured. Use the RIx commands to query the programmed current limit value. If the outputs are switched off, then the reply will be I1: 0.000 A.

**TRU**
Format: TRU:VV.mVmV
TRU VV.mVmV
Function: Sets voltage 1 and voltage 2 to the indicated value (voltage values in TRACKING mode). The values must follow the BCD format.
Examples: TRU:1.23 → U1 = U2 = 1.23 V
TRU:01.23 → U1 = U2 = 1.23 V
TRU:12.34 → U1 = U2 = 12.34 V

**TRI**
Format: TRI:A.mAmAmA
TRI A.mAmAmA
Function: Sets current 1 and current 2 to the indicated value (LIMIT values in TRACKING mode). The values must follow the BCD format.
Examples: TRI:1.000 → I1 = I2 = 1.000 A
TRI:0.123 → I1 = I2 = 0.123 A

**STA**
Format: STA
STA?
Reply: OP1/0 CV1/CC1 CV2/CC2 RM0/1
Function: This command causes the HM8143 to send a text-string containing information of the actual status.

OP0 The outputs are switched off.
OP1 The outputs are switched on.
CV1 Source 1: constant voltage operation
CC1 Source 1: constant current operation
CV2 Source 2: constant voltage operation
CC2 Source 2: constant current operation
RMI Device in remote control mode
RM0 Device not in remotecontrol mode

Example: If the outputs are on, the HM8143 answers for example with the following string (channel I is in constant voltage mode and channel II is in constant current mode:
OP1 CV1 CC2 RM1
If the outputs are off, the answer string contains instead of the status of channels I and II two times three dashes (––– –––).
OP0 ––– ––– RM1

**OP1 + OP0**
Format: OP1
Function: The outputs are switched on.

Format: OP0
Function: The outputs are switched off.

**SF + CF**
Format: SF
Funktion: Activation of the electronic fuse.
(Set fuse)

Format: CF
Funktion: De-activation of the electronic fuse.
(Clear fuse)

**Clear**
Format: CLR
Function: This command interrupts all functions of the HM8143. The outputs are switched off, the voltages and currents are set to 0.

**VER**
Format: VER
Reply: x.xx
Function: Displays the software version of HM8143.
Example: 1.15

**ID?**
Format: ID?
*IDN?
Reply: HAMEG Instruments, HM8143,x.xx
Function: HAMEG device identification
Example: HAMEG Instruments, HM8143,1.15

## 8.5 Arbitrary

The arbitrary waveform mode can be used for generation of virtually any desired waveforms. For this purpose, a table comprising up to 1024 voltage and time values (software limitation) can be defined. This table is stored in non-volatile memory with a backup battery, and is not lost for several days when the instrument is powered down. The following commands are available for operating and programming this function by interface:

ABT Transfer of arbitrary values
RUN Start waveform generation
STP Stop waveform generation

**Attention: The arbitrary waveform mode only effects the left channel of the power supply; rapid waveform generation is possible with this channel only.**

The arbitrary mode can be terminated by 3 different means:

- By pressing the OUTPUT key (only in mixed-mode)
- By means of the command STP
- By means of the command OP0

While a waveform is being generated, the front panel controls are disabled, except in mixed mode. The arbitrary mode can be terminated by pressing the OUTPUT button in mixed mode, but the arbitrary-signal proceeds internal. This also has the effect of switching off the outputs. Pressing this button again switches the outputs of the power supply on.

The waveform generation starts either after the receiption of the command RUN or if the signal at the BNC-socket (TRIGGER IN/OUT) changes from HIGH to LOW.

**If the arbitrary-function is started by an external trigger signal, only one signal period will be generated.**

Eine Kurvenform wird entweder nach Empfang des Befehls RUN oder wenn das Signal an der BNC-Buchse (TRIGGER IN/OUT) von HIGH nach LOW wechselt, erzeugt.

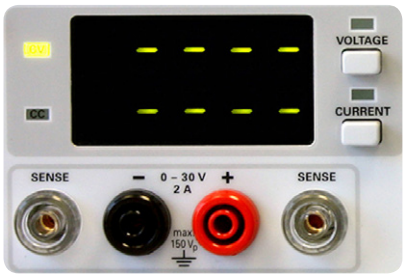



Fig. 8.1: Display of channel I in arbitrary mode

During arbitrary mode the right display shows the actual values of channel II, if the outputs are activated or the nominal values are displayed of the outputs are offf.

The display of channel II shows 8 dashes. After the arbitrary function has finished, the arbitrary mode is left automatically and the left display shows the values set. A re-start of the arbitrary function begins whith the first value.

While the arbitrary function is running, the current limit set cannot be changed. The current in either direction cannot exceed the programmed value. In order to prevent jitter of the waveform, no data should be transferred via the interface while the function is running.

Exception: the terminating command STP and the commands OP1 and OP0.

**ABT:**

Format: ABT:<list of values>N<number of repetitions>
ABT:tVV.mVmV tVV.mVmV .... Nn or
ABT tVV.mVmV tVV.mVmV .... Nn

t = time code 0–9, A, B,C, D, E, F; VV.mVmV = 0–30 V
N = end of table character
n = number of repetitions
0 : Continuous repetition
1-255: Waveform is repeated 1-255 times

Function: Programming of the arbitrary waveform function.
The power supply permits creation of a data list containing up to 1024 voltage values along with the corresponding time duration values. This list is transferred in the form of a series of alternating values for voltages in the range between 0.00 and 30.0 V and codes representing the time duration of each voltage; at the end of the list, the number of repetitions is indicated.

How long each voltage appears at the outputs of the HM8143 is derived from the following table:

| | | |
|---|---|---|
| $0_h$ | = | 100 µs |
| $1_h$ | = | 1 ms |
| $2_h$ | = | 2 ms |
| $3_h$ | = | 5 ms |
| $4_h$ | = | 10 ms |
| $5_h$ | = | 20 ms |
| $6_h$ | = | 50 ms |
| $7_h$ | = | 100 ms |
| $8_h$ | = | 200 ms |
| $9_h$ | = | 500 ms |
| $A_h$ | = | 1 s |
| $B_h$ | = | 2 s |
| $C_h$ | = | 5 s |
| $D_h$ | = | 10 s |
| $E_h$ | = | 20 s |
| $F_h$ | = | 50 s |

Example: It is wished to program the following waveform:

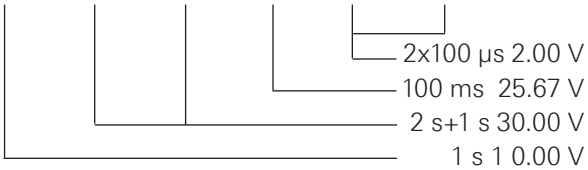
| | |
|---|---|
| 1 s | 10.00 V |
| 3 s | 30.00 V |
| 100 ms | 25.67 V |
| 200 µs | 2.00 V |

It is also wished to repeat this sequence 10 times. The required data table is as follows:

ABT:A10.00_B30.00_A30.00_725.67_002.00_002.00_N10

or

ABT A10.00_B30.00_A30.00_725.67_002.00_002.00_N10




Please act like the following description of the operational sequence:

1. ABT
   A10.00_B30.00_A30.00_725.67_002.00_002.00_N10
   Load of the arbitrary function
2. OP1: Switching of the output relay
3. Holding time/pause not less than 20ms
   Bounce time of the relay
4. RUN: Start of the Arb-Function
   (Signal output works)
5. STP: Stop of the internal arbitrary signals
6. OP0: Switch off of the output relay

During the arbitrary function you should avoid the „mixed mode“ because in this mode you switch on the signal at a random point of the signal trace with the output button. At the switch off of the relay the signal will internally continue.

**RUN/STP**
Format: RUN
Function: Starts waveform generation in ARB mode

Format: STP
Function : Interrupts the arbitrary function while running.

# 9 Technical Data

**HM8143**
**Three-Channel Arbitrary Power Supply**

**from firmware version 2.45**

| **Electrical Specifications** | |
|---|---|
| Total power output | 130 W |
| Number of outputs | 3 |
| Front connectors | 4 mm saftey sockets |
| Maximum power per channel | |
| CH1, CH3<br>CH2 | 60 W<br>10 W |
| Voltage output | |
| CH1, CH3 | 0 V to 30 V |
| CH2 | 5 V (±50 mV) |
| Current output | |
| all channels | max 2 A |
| Current sinking | |
| CH1, CH3 | max 2 A |
| Line & load regulation | |
| Constant voltage mode | |
| CH1, CH3 | <0.02% + 5 mV |
| CH2 | <0.25% + 10 mV |
| Constant current mode | |
| CH1, CH3 | <0.02% + 5 mA |
| CH2 | (no constant current mode) |
| Voltage ripple 3 Hz to 300 kHz (front connectors) | |
| CH1, CH3 | <5 $mV_{rms}$ |
| CH2 | <1 $mV_{rms}$ |
| Transient response time (10 % to 90 % load change) | |
| CH1, CH3 | <45 µs in a band of ±20 mV of $V_{set}$<br>max. deviation: <800 mV |
| CH2 | <45 µs in a band of ±20 mV of $V_{set}$<br>max. deviation: <200 mV |
| SENSE connectors available for | CH1, CH3 |
| Max. SENSE compensation | 300 mV |
| Programming accuracy (23° C ±5° C) | |
| Voltage / Current | |
| CH1, CH3 | ±3 digits (typ. ±2 digits) |
| Readback accuracy (23° C ±5° C) | |
| Voltage / Current | |
| CH1, CH3 | ±3 digits (typ. ±2 digits) |
| Resolution | |
| Voltage | |
| CH1, CH3 | 10 mV |
| Current | |
| CH1, CH3 | 1 mA |
| Voltage to earth | max. 150 $V_{DC}$ |
| Over current protection (electronic fuse) | Yes |

| Modulation Input (CH1, CH3) | |
|---|---|
| Rear connectors | 2x BNC |
| Input level | 0 V to 10 V |
| Accuracy | 1 % of full scale |
| Modulation bandwidth | DC to 20 kHz |
| **Trigger Input (BNC)** | |
| Function | Triggering the arbitrary function |
| Trigger level | TTL |
| Edge direction | rising, falling |
| **Arbitrary Function (CH1)** | |
| Parameter | Voltage, dwell time |
| Number of Points | max. 4,096 |
| Dwell time | 100 µs to 60 s |
| Repetition rate | continous or burst mode with 1 to 255 repetitions |
| Resolution | 12 Bit |
| Trigger | interface, trigger input |
| **Remote Interfaces** | |
| Standard | Dual interface RS-232 / USB (HO820) |
| Optional | IEEE-488 (GPIB) interface (HO880) |
| **Miscellaneous** | |
| Input power option | 115 $V_{AC}$ / 230 $V_{AC}$ (±10 %), 50 Hz to 60 Hz, CAT II |
| Power consumption | 300 VA |
| Mains fuses | |
| 115 $V_{AC}$ | 2x 6 A, slow blow (5 mm x 20 mm) |
| 230 $V_{AC}$ | 2x 3.15 A, slow blow (5 mm x 20 mm) |
| Operating temperature | +5 °C to +40 °C |
| Storage temperature | -20 °C to +70 °C |
| Humidity | 5 % to 80 % |
| Display | 4x 4 digits, 7-segment LEDs |
| Dimensions (H x W x D) | 75 x 285 x 365 mm |
| Rack mount capability (19" rack mount kit, 2RU) | Yes (HZ42) |
| Weight | 9 kg |

The specifications are based on a 30 min warm-up period.

**标准附件:**
Line cord, operating manual

**推荐附件:**
HZ42 19" rackmount kit, 2 RU HO880 IEEE-488 (GPIB) interface card
OI10A-* 1米长两端叠加香蕉插头 连接线，红黑可选

# 10 Appendix

## 10.1 List of figures