HAMEG®
Instruments

Arbitrary Power Supply HM8143

Manual

General information regarding the CE marking

HAMEG instruments fulfill the regulations of the EMC directive. The conformity test made by HAMEG is based on the actual generic- and product standards. In cases where different limit values are applicable, HAMEG applies the severer standard. For emission the limits for residential, commercial and light industry are applied. Regarding the immunity (susceptibility) the limits for industrial environment have been used.

The measuring- and data lines of the instrument have much influence on emmission and immunity and therefore on meeting the acceptance limits. For different applications the lines and/or cables used may be different. For measurement operation the following hints and conditions regarding emission and immunity should be observed:

1. Data cables
For the connection between instruments resp. their interfaces and external devices, (computer, printer etc.) sufficiently screened cables must be used. Without a special instruction in the manual for a reduced cable length, the maximum cable length of a dataline must be less than 3 meters and not be used outside buildings. If an interface has several connectors only one connector must have a connection to a cable.
Basically interconnections must have a double screening. For IEEE-bus purposes the double screened cables HZ72S and HZ72L from HAMEG are suitable.

2. Signal cables
Basically test leads for signal interconnection between test point and instrument should be as short as possible. Without instruction in the manual for a shorter length, signal lines must be less than 3 meters and not be used outside buildings.
Signal lines must screened (coaxial cable - RG58/U). A proper ground connection is required. In combination with signal generators double screened cables (RG223/U, RG214/U) must be used.

3. Influence on measuring instruments.
Under the presence of strong high frequency electric or magnetic fields, even with careful setup of the measuring equipment an influence of such signals is unavoidable.
This will not cause damage or put the instrument out of operation. Small deviations of the measuring value (reading) exceeding the instruments specifications may result from such conditions in individual cases.

HAMEG Instruments GmbH

Arbitrary Power Supply HM8143

2x 0-30 V/0-2 A 5 V/0-2 A

Display resolution 10 mV/1 mA

Arbitrary waveform power supply (1024 points, 12 bit)

Tracking mode for 30 V outputs

External modulation of output voltages

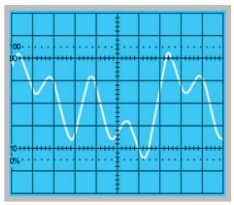
Electronic load up to 60 W per channel (max. 2 A)

SENSE lines

Multimeter mode for all adjustable outputs

RS-232 Interface, optional: USB, IEEE-488

AF arbitrary signal



HO880 IEEE-488 Interface

HO870 USB-Interface

Arbitrary Power Supply HM8143

Valid at 23 °C after a 30 minute warm-up period

Outputs	
2 x 0-30 V / 2 A 1 x 5 V / 2 A	On/off pushbutton control, Floating outputs (allowing parallel and series operation), current limit, electronic fuse, tracking mode

Channels I + III (0-30 V)	
Output voltage:	2 x 0 – 30 V
Setting resolution:	10 mV
Setting accuracy:	± 2 digits (typ. ± 1 digit)
Measurement accuracy:	± 2 digits (typ. ± 1 digit)
Residual ripple:	‹ 5 mV_{rms}
Recovery time:	‹ 50 µs
Compensation of line resistances (SENSE):	up to 300 mV
Output current:	2 x 0 - 2 A
Setting resolution:	1 mA
Setting accuracy:	± 2 digits (typ. ± 1 digit)
Measurement accuracy:	± 2 digits (typ. ± 1 digit)
Recovery time:	‹ 100 µs

Channel II (5 V)	
Accuracy:	5 V ± 50 mV
Output current:	max. 2 A
Recovery time:	‹ 100 µs

Arbitrary Function (Channel I only)	
Number of points:	1024
Resolution:	12 Bit
Parameters of points:	Dwell time and Voltage
Dwell time:	10 µs ... 60 s
Repetition rate:	1...255 and continuous

Inputs:	
Modulation input (BNC socket):	0-10 V
Accuracy:	1 % of full scale
Modulations bandwidth (- 3 dB):	‹ 50 kHz
Trigger input (BNC socket):	Triggering the arbitrary function
Level:	TTL

Miscellaneous	
Display:	4 x 4-digit 7-segment LEDs
Interface:	RS-232 (standard), IEEE-488 (option), USB (option)
Protection class:	I acc. to EN 61010 (IEC 61010) with protective earth
Power supply:	115 / 230 V ± 10 %; 50 / 60 Hz
Mains fuse:	115 V: 2 x 6 A slow blow 5 x 20 mm 230 V: 2 x 3.15 A slow blow 5 x 20 mm
Power consumption:	approx. 300 VA
Operating temperature:	0 °C...40 °C
Storage temperature:	- 20 °C...+70 °C
Max. relative humidity:	‹ 80 % (without condensation)
Dimensions (WxHxD):	285 x 75 x 365 mm
Weight:	approx. 9 kg

Accessories supplied: Operator's Manual and power cable

Important hints

(1) (2) (3) (4) (5)

Symbols

Symbol 1: Attention, please consult manual
Symbol 2: Danger! High voltage!
Symbol 3: Ground connection
Symbol 4: Important note
Symbol 5: Stop! Possible instrument damage!

Unpacking

Please check for completeness of parts while unpacking. Also check for any mechanical damage or loose parts. In case of transport damage inform the supplier immediately and do not operate the instrument.

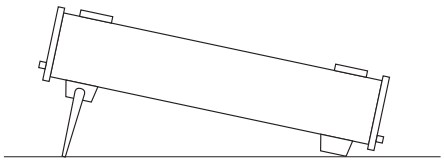
Positioning

Two positions are possible: According to picture 1 the front feet are used to lift the instrument so its front points slightly upward. (Appr. 10 degrees)

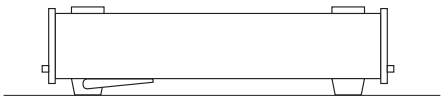
If the feet are not used (picture 2) the instrument can be combined with many other HAMEG instruments.

In case several instruments are stacked (picture 3) the feet rest in the recesses of the instrument below so the instru-ments can not be inadvertently moved. Please do not stack more than 3 instruments. A higher stack will become unstable, also heat dissipation may be impaired.

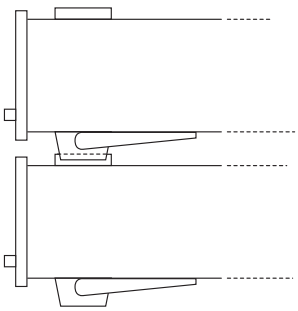
picture 1



picture 2



picture 3



Transport

Please keep the carton in case the instrument may require later shipment for repair. Losses and damages during transport as a result of improper packaging are excluded from warranty!

Storage

Dry indoors storage is required. After exposure to extreme temperatures 2 h should held off on turning the instrument on.

Safety instructions

The instrument conforms to VDE 0411/1 safety standards applicable to measuring instruments and left the factory in proper condition according to this standard. Hence it conforms also to the European standard EN 61010-1 resp. to the international standard IEC 61010-1. Please observe all warnings in this manual in order to preserve safety and guarantee operation without any danger to the operator. According to safety class 1 requirements all parts of the housing and the chassis are connected to the safety ground terminal of the power connector. For safety reasons the instrument must only be operated from 3 terminal power connectors or via isolation transformers. In case of doubt the power connector should be checked according to DIN VDE 0100/610.

Do not disconnect the safety ground either inside or outside of the instrument!

- The line voltage of the instrument must correspond to the line voltage used.
- Opening of the instrument is allowed only to qualified personnel
- Prior to opening the instrument must be disconnected from the line and all other inputs/outputs.

In any of the following cases the instrument must be taken out of service and locked away from unauthorized use:

- Visible damages
- Damage to the power cord
- Damage to the fuse holder
- Loose parts
- No operation
- After longterm storage in an inappropriate environment , e.g. open air or high humidity.
- Excessive transport stress

Exceeding 42 V
By series connecting all outputs the 42 V limit can be exceeded which means that touching live parts may incur danger of life! It is assumed that only qualified and extensively instructed personnel are allowed to operate this instrument and/or the loads connected to it.

Proper operating conditions

The instruments are destined for use in dry clean rooms. Operation in an environment with high dust content, high humidity, danger of explosion or chemical vapors is prohibited. Operating temperature is 0 ... +40 degrees C. Storage or transport limits are –10 ... +70 degrees C. In case of condensation 2 hours are to be allowed for drying prior to operation. For safety reasons operation is only allowed from 3 terminal connectors with a safety ground connection or via isolation transformers of

class 2. The instrument may be used in any position, however, sufficient ventilation must be assured as convection cooling is used. For continuous operation prefer a horizontal or slightly upward position using the feet.

Do not cover either the holes of the case nor the cooling fins.

Specifications with tolerances are valid after a 30 minute warm-up period and at 23 degrees C. Specifications without tolerances are typical values of an average instrument.

Warranty and Repair

HAMEG instruments are subjected to a rigorous quality control. Prior to shipment each instrument will be burnt in for 10 hours. Intermittent operation will produce nearly all early failures. After burn in, a final functional and quality test is performed to check all operating modes and fulfilment of specifications. The latter is performed with test equipment traceable to national measurement standards.

Statutory warranty regulations apply in the country where the HAMEG product was purchased. In case of complaints please contact the dealer who supplied your HAMEG product.

Maintenance

The instrument does not require any maintenance. Dirt may be removed by a soft moist cloth, if necessary adding a mild detergent. (Water and 1 %.) Grease may be removed with benzine (petrol ether). Displays and windows may only be cleaned with a moist cloth.

Do not use alcohol, solvents or paste. Under no circumstances any fluid should be allowed to get into the instrument. If other cleaning fluids are used damage to the lacquered or plastic surfaces is possible.

Mains voltage

A main voltage of 115V and 230V can be chosen. Please check whether the mains voltage used corresponds with the voltage indicated by the mains voltage selector on the rear panel. If not, the voltage has to be changed. In this case the line fuse has to be changed, too.

Please note:
After changing the main voltage, the line fuse has to be changed. Otherwise the instrument may be destroChanging the line fuse

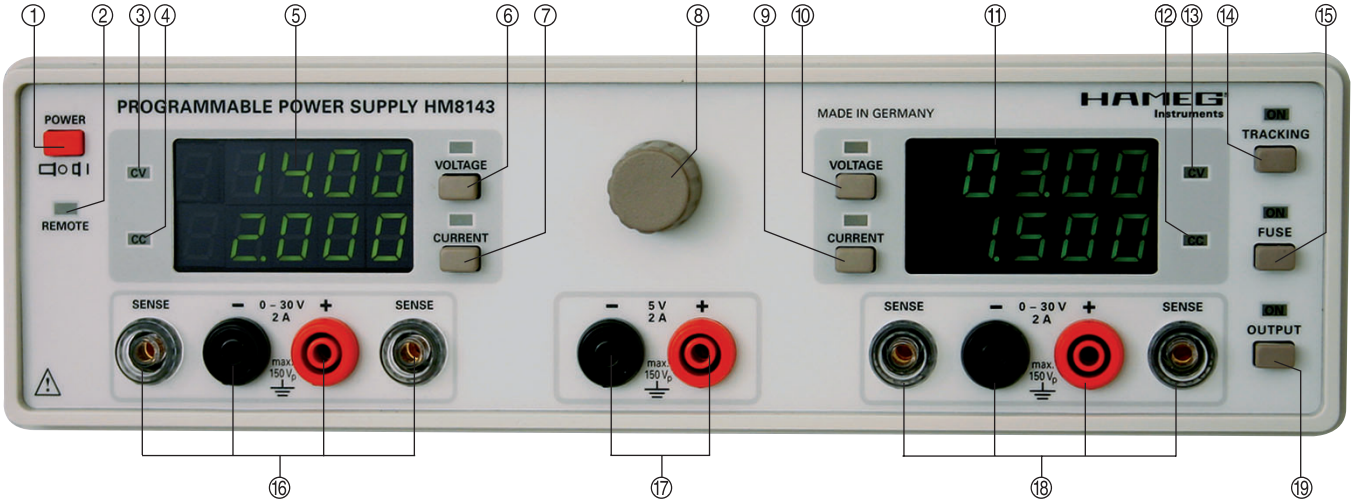
Changing the line fuse

The fuses are accessible from the outside and contained in the line voltage connector housing. Before changing a fuse disconnect the instrument from the line, the line cord must be removed. Check fuse holder and line cord for any damages. Use a screw driver to loosen the fuse holder screw counter-clockwise while pressing the top of the fuse holder down. The top holding the fuse will then come off. Exchange the defective fuse against a correct new one.

It is forbidden to repair defective fuses or to bridge them by any means. Any damage caused this way will void 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 1.6 A slow blow
115 V	2 x 3.2 A slow blow



Controls and display

① **POWER** (button)
Mains connector at rear panel

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

③⑬ **CV** (green LED)
If the CV LED is lit, the HM8143 is in constant voltage mode.

④⑫ **CC** (red LED)
If the CC LED is lit, the HM8143 is in constant current mode.

⑤⑪ **Digital display** (2 x 4 digit)
Display of nominal or measurement values of the output voltage and the output current.

⑥⑩ **VOLTAGE** (pushbutton and LED)
Setting of output voltage via frontpanel. By pushing the button the setting function is active and the appertaining LED is lit.

⑦⑨ **CURRENT** (pushbutton and LED)
Setting of current limit via frontpanel. By pushing the button the setting function is active and the appertaining LED is lit.

⑧ **Rotary knob**
Parameter setting of voltage and current values.

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

⑯⑱ **0-30 V / 2 A** (Adjustable)
4mm banana sockets for SOURCE and SENSE

⑰ **5 V / 2 A** (Fixed)
4mm 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 **RS-232 Interface**
Options: IEEE-488 (HO880), USB (HO870)

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

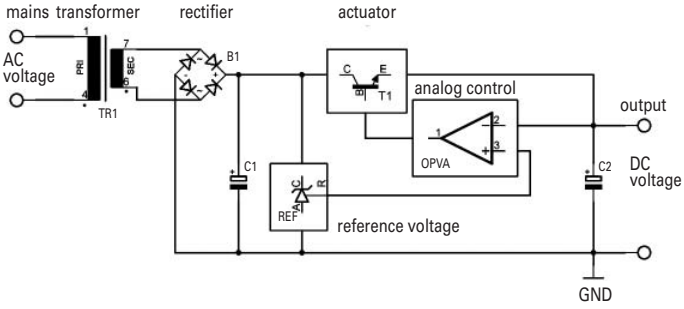
㉓ **Voltage selector** (115 V / 230 V)

㉓ **Power receptacle** with line fuse

Basics of power supplies

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 neglegible. 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.

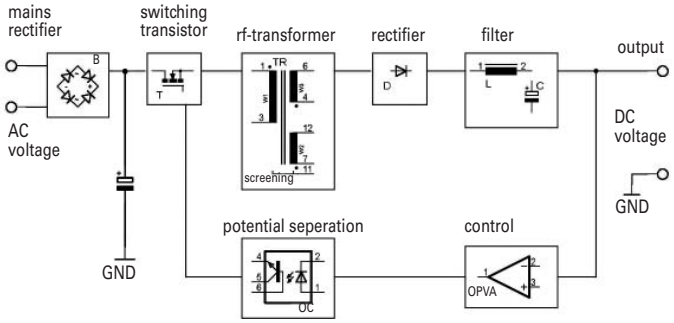


Switched-mode power supplies (SMPS)

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.

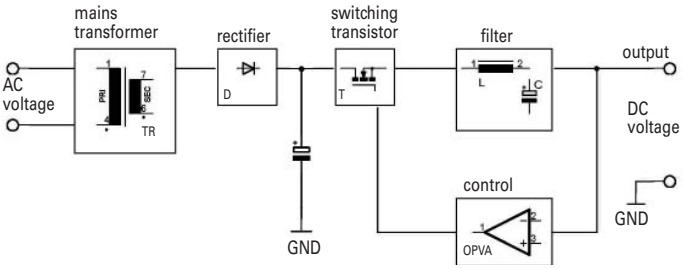
1st Off-line SMPS

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).

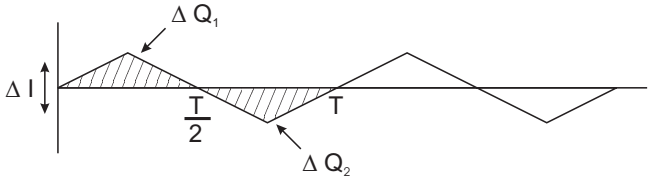


2nd Secondary SMPS

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.
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



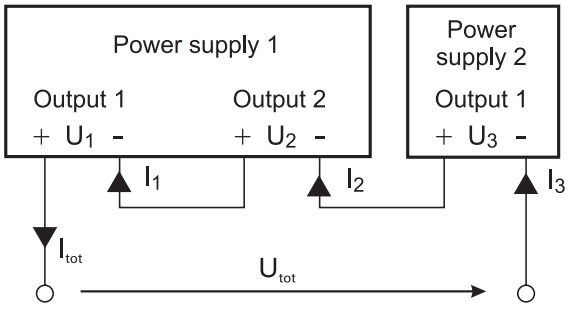
small due to the high frequency, but the choice depends also on other factors like energy required for buffering or ac ripple from the load (e.g. motors). In principle the size of the major components decreases with increasing operating frequency, however, the efficiency drops apppreciably above appr. 250 kHz as the losses in all components rise sharply.



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.

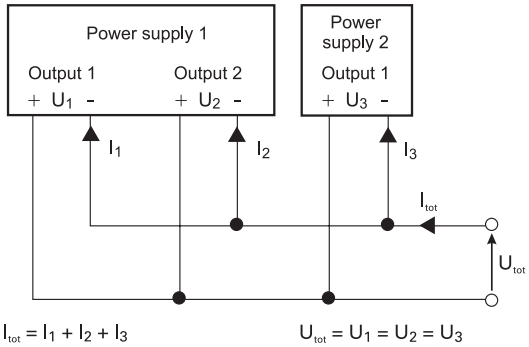
Series operation



$I_{tot} = I_1 = I_2 = I_3$ $\quad U_{tot} = U_1 + U_2 + U_3$

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.



$I_{tot} = I_1 + I_2 + I_3$ $\quad U_{tot} = U_1 = U_2 = U_3$

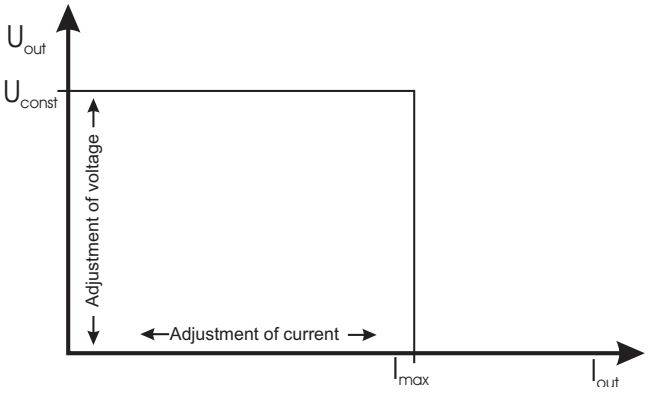
In order to increase the total available current the outputs of supplies can be paralleled. The output voltages of the supplies involved are adjusted as accurately as possible to the same value. In this mode it is possible that one or more supplies enter the current limit mode. The output voltage remains 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 the individual current contributions remain nearly equal. Of course, the maximum available output current is the sum of the individual supplies' maximum currents.

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 ⑲ 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.

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.



The picture shows that the output voltage V_{out} remains stable, while the current I_{out} increases until the current limit selected I_{max} will be reached. At this moment the instrument will change from constant voltage regulation to constant current regulation. Any further load increase will cause the current to remain stable while the voltage U_{out} decreases ultimately to zero.

Electronic fuse

In order to provide a better protection than current limiting, the HM8143 features an electronic fuse. As soon as I_{max} is reached all outputs will immediately be disabled (OUTPUT LED ⑲ is off).
They may be turned on again by depressing OUPUT ⑲.

Introduction to the operation

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.

Turning on the HM8143
Turn on the instrument by operating the POWER button ①. 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). 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 ⑭ and FUSE ⑮ 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.

Operation modes

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 ③ or ⑬ 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.

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 ④ or ⑫ (now $I_{actual} = I_{limit}$ and $V_{actual} = V_{set}$); the CV LEDs ③ or ⑬ 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 ⑮ is off) see chapter electronic fuse.

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 ($V_{actual} > V_{set}$)

Serial or parallel operation

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

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.

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.

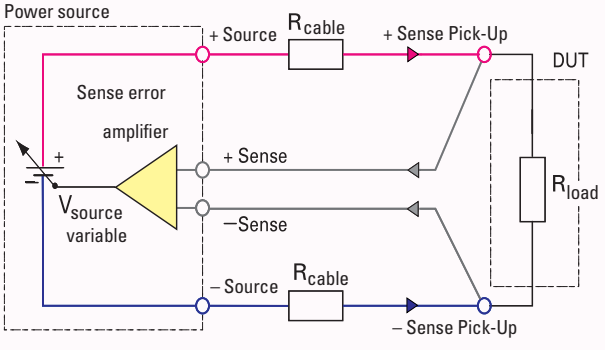
Connecting the load

The load has to be connected to the middle safety terminals ⑯, ⑰ or ⑱. For the connection please use 4 mm banana plugs.

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

The transparent terminals ⑯/⑱ 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.

Compensation of the voltage drop across the cables



Operation of the HM8143

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.

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 tristate 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).

Modulation inputs

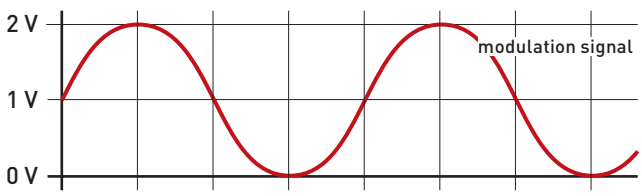
By virtue of the modulation inputs MODULATION R/L ⑳ on the rear panel of HM8143, it can be also be used as a modulation power amplifier. The input voltage is amplified with factor 3. The frequency range (-3 dB) goes from DC to 50 kHz. The allowable external voltage ranges from 0 V to 10 V.

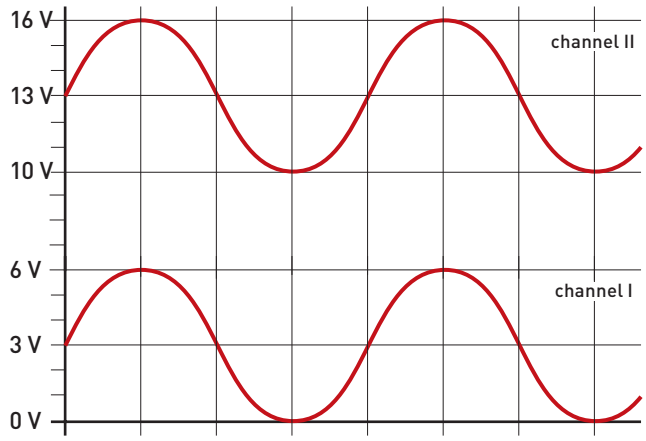
The output voltage of HM8143 will be the sum of:

$V_{out} = (V_{modin} \times 3) + V_{set}$

Please note that the sum $V_{out} = (V_{modin} \times 3) + V_{set}$ 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.

Example: Modulationsource: V_{mod} = 2,0 V_{ss}
f_{mod} = 50 Hz
channel I V_{set} = 0 V
channel II V_{set} = 10 V





If a modulation voltage of 2 V_{pp} is applied, the nominal value of the output voltage of the HM8143 must not exceed 24.00 V.

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

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.

Safety features

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

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. 200 µs that means during this time the maximum current value set can be exceeded.

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 ⑲. The electronic fuse is activated by operating the FUSE button ⑮. The FUSE LED is on. By pushing the FUSE button ⑮ again, the electronic fuse is deactivated. The fuse LED is dark.

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 ⑲.

Error messages

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

Display	Meaning
E1	Error channel I
E2	Error channel III
E3	Error channel II

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.de).

Remote control

General

The HM8143 comes with a RS-232 interface, which optionally can be replaced by a IEEE-488 (HO880) or an USB interface (HO870). We recommend the installation ex factory.

Interface parameters:

9600 baud, no paritybit, 8 data bits, 1 stop bit

When being controlled by interface, the HM8143 immediately goes into remote mode as soon as a command arrives at the interface. The REMOTE LED ② 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.

Commands 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)
Examples: 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

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 can be defined. This table is stored in nonvolatile 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:

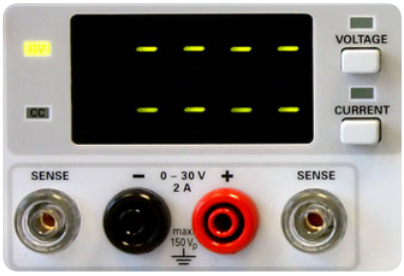
ABT	Transfer of arbitrary values
RUN	Start waveform generation
STP	Stop waveform generation

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 ⑲ 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 ㉒) changes from HIGH to LOW.

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



Display of channel I in arbitrary mode

During arbitrary mode the right display ⑪ 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 ⑤ 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

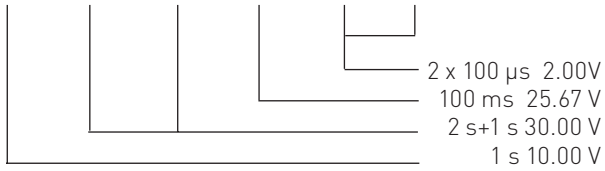
6_h = 50 ms
7_h = 100 ms
8_h = 200 ms
9_h = 500 ms
A_h = 1 s
B_h = 2 s
C_h = 5 s
D_h = 10 s
E_h = 20 s
F_h = 50 s

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 us	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



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

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