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RF-FAIMS 1.7

FAIMS-Signal Generator

for electrostatic electrodes

Drive_FAIMS_1_1.doc
Oct 2018

Datasheet

Rev. 1.1

Model RF-FAIMS 1.7

Main Features:

- RF drive amplifier for FAIMS setups
- amplitude 0Vpp to 1500Vpp (differentially), 750Vpp each channel
- frequency 0.2 MHz to 1.7 MHz
- voltage stabilisation for ease of use

Purpose and Description of the Device

The purpose of the RF FAIMS drive is to create a rectangular high voltage signal, suited to apply the FAIMS (high-field asymmetric waveform ion mobility spectrometry) method for ion separation in the gas phase. The device essentially works as an amplifier: A rectangular 5V (TTL-style) signal is applied at the input (fixed 5V amplitude), which may vary in frequency and duty cycle. A corresponding high-voltage signal is created and presented at the output. The device's output consistst of two output lines, one of the lines having inverted phase in order to achieve a higher electric field by using the voltage difference between the lines. The output amplitude of both output lines is controlled by a separate DC control voltage with a fixed scaling factor of 100 (i.e. 0V control voltage → 0V output voltage; 7.5V control voltage → 750Vpp output voltage on each line, which is 1500Vpp differentially). See also illustration below.

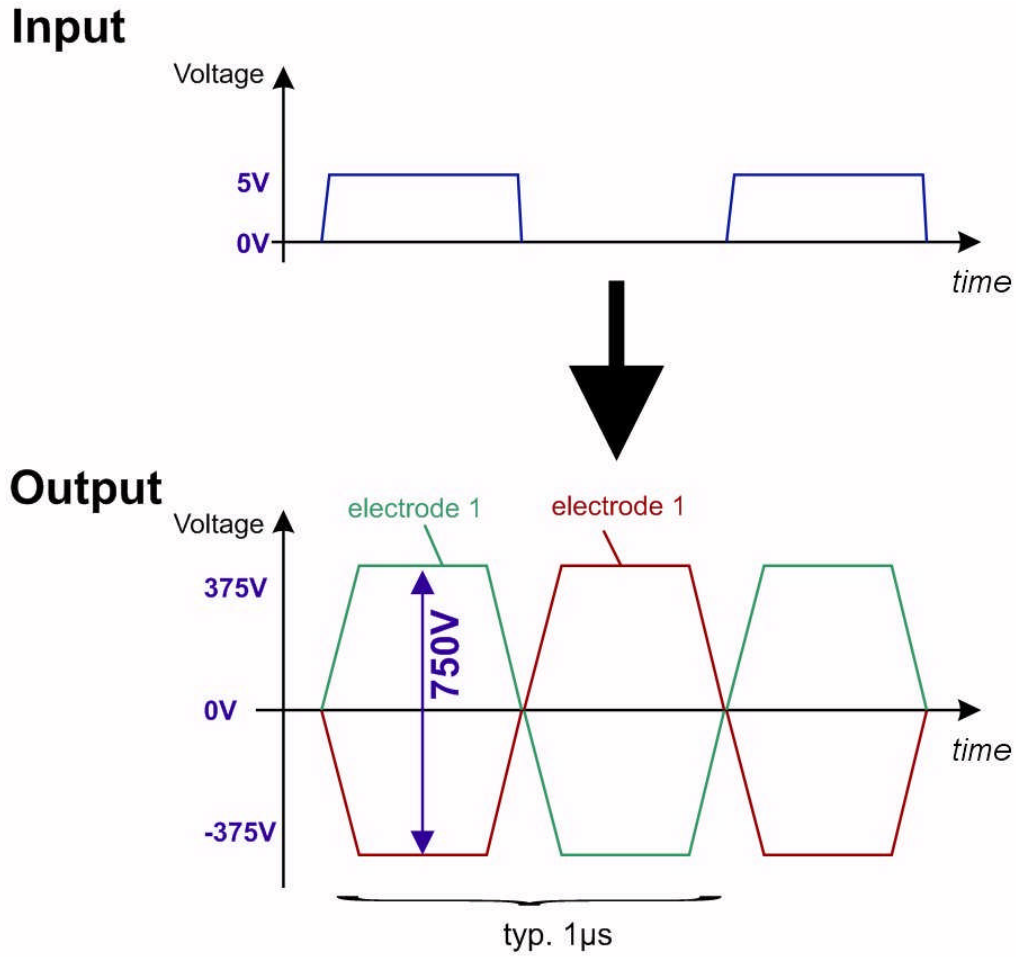

Fig.1: Functional principle of the FAIMS drive

Additonally the device features an offset input. DC voltages being applied here will shift the DC level of both output lines correspondingly. The frequency range of the device spans 0.2MHz to 1.7MHz (highest frequencies with reduced amplitudes, see data shown below). Note that the duty cycle of input signal is on ppurpose transferred to the output line. A range of 20% to 80% may be applied here. A standard square signal (see fig. 1) repsesents 50% duty cycle, others represent non-symmetric rectangular waveforms.

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The following picture (fig. 2) displays a block diagram of the internal structure, illustrating the circuit principle. An input stage buffers the rectangular input signal, and a driver stage controls electronic switches, to form a rectangular waveform (up to 750Vpp each output line) at the outptus. An inverter circuit creates the inverted signal, or in other words a 180° shift betweeen the output lines. The device features an offset DC input, by which the output voltages can be shifted. A microconcontroller section allows for control of essential functions and displays warning messages eventually.

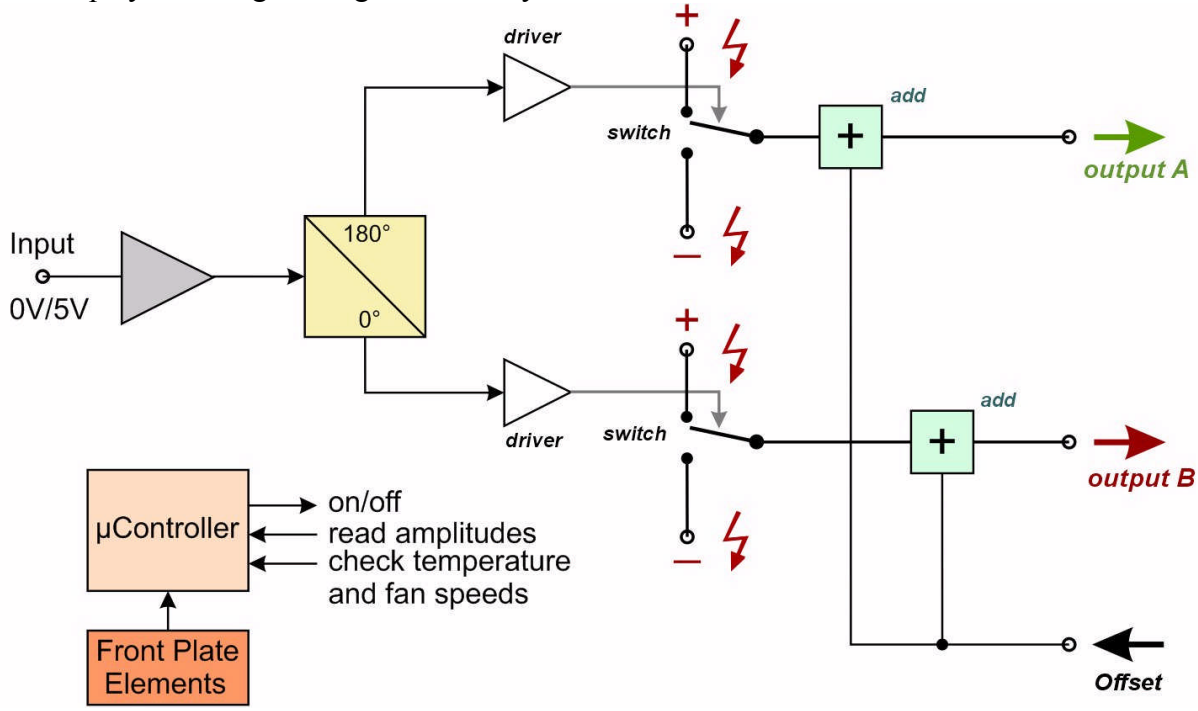

Fig. 2: Block diagram of the internal structure, illustrating the functional principle.
The DC control input (front side of device) is not shown, its voltage controls the output amplitude.

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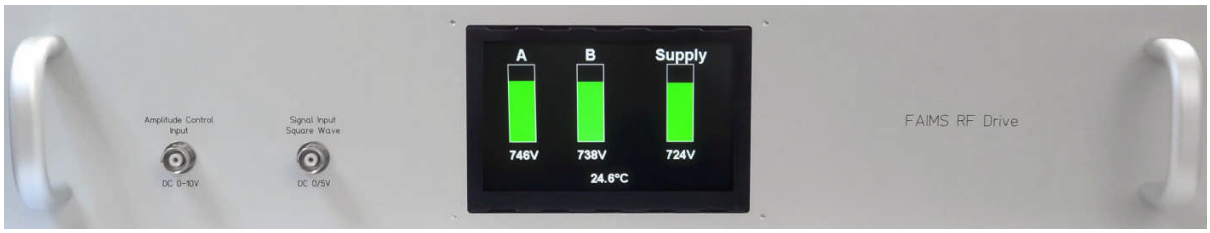
Safety Hints

Read all installation, operation, and safety instructions	Prior to operation, thoroughly review all safety, installation, and operating instructions accompanying this equipment.
Rear side switch turns device completely off	If the device is not in use for a longer time, it is recommended to turn the mains switch at rear side off.
This equipment must be connected to an earth safety ground	This product is grounded through the grounding conductor of the power cord. To avoid electrical hazard, the grounding conductor must be connected to protective earth ground.
Do not modify the unit	Do not make electrical or mechanical modifications to this unit.
Change cabling only when device is off	Changing the cabling, when voltages are present at the outputs can lead to formation of harmful sparks.
Do not operate in wet/damp conditions	To avoid electric shock hazard, do not operate this product in wet or damp conditions. Protect the device from humidity and direct water contact.
Beware of external magnetic fields	External magnetic fields can impair, damage or even destroy this device. A maximum external field strength of no more than B = 5mT is admissible. Having placed the device at any time into an external magnetic of bigger B = 5mT (regardless if power was turned on or off) can lead to severe overheating of the device and severely increased hazard of fire.
Service is to be performed by qualified service persons only	All servicing on this equipment must be carried out by factory-qualified service personnel only.
Do not block chassis ventilation openings	Slots and openings in the chassis are provided for ventilation purposes to prevent overheating of the equipment and must not be restricted. All case vents should continuously be cleared, in order to prevent overheating. If in doubt about the sufficiency of air ventilation, provide a software readout of the internal temperature sensor for regular inspection, e.g. every 2 minutes. A temperature over 55°C indicates inadequate air ventilation.
Operate carefully with respect to risk of electrical shock	**This device can produce high voltages at its output lines, which is harmful in case of direct touch with the human body. These voltage may be even increased by adding an additional external voltage at the offset input. Great care must be taken to avoid unintentional touching of any output line to the human body or any devices which might be endangered by high voltages.**
Routinely cleaning from dust	After long operation, or operation in a dusty environment it is strongly recommended to have the internal parts of the device cleaned by the manufacturer, or an appropriately qualified workshop in order to reduce the hazard of overheating.
No outdoor operation	Outdoor operation of the device is not admissible.

Operation and Control elements



DC Control Input Clock Input LCD Display

Fig. 3: FAIMS Drive, front side. The dedicated power supply is located in another 19”-box (not depicted)

The front plate contains the main control elements of the device:

DC Control Input

This DC input defines the output voltage of both output channel. A DC voltage being applied here is amplified by a factor of 100 and the resulting value corresponds to the peak-peak Voltage at each output line (rear side of the device). It is a high-impedance input.

Clock Input

The clock input accepts 0V / 5V (TTL-style) signals, which are amplified to achieve the AC signal at the output lines. Therefor, a rectangular waveform being applied here, results in a rectangular waveform ar the output. One may also vary the duty cycle of the reactangular input wave, from 25% to 75%, corresponding to a variation of duty cycle at the outputs.

Cabling to Setup

Before using the device, the cabling to FAIMS electrodes must be completed and it must be ensured that the capacitive load on each output does not exceed approx. 25pF. The DC resistive load on each output should be > 10MΩ. Please check with appropriate multimeter compliance to these boundaries before turning the device on.

LCD Display

The LCD Display shows the main functions and parameters of the device. At the right hand side the internal driving voltage is shown (only for reference), on the left hand side the two output voltages (peak-peak-values) are displayed. Please note that the display voltage calibration applies für a symmetric waveform (50% rectancal duty cycle). In case of a overload condition the internal driving voltage may drop, being indicated by temporarily a red bar on the display and short warning sound.

Output loads

Due to the high power in the output section, one must make sure, never to overload the device. The subsequent load diagram shows the range of maximum admissible frequency and capacitive loads on an output line. **Note that exeeceding the admissible range will damage the device.**

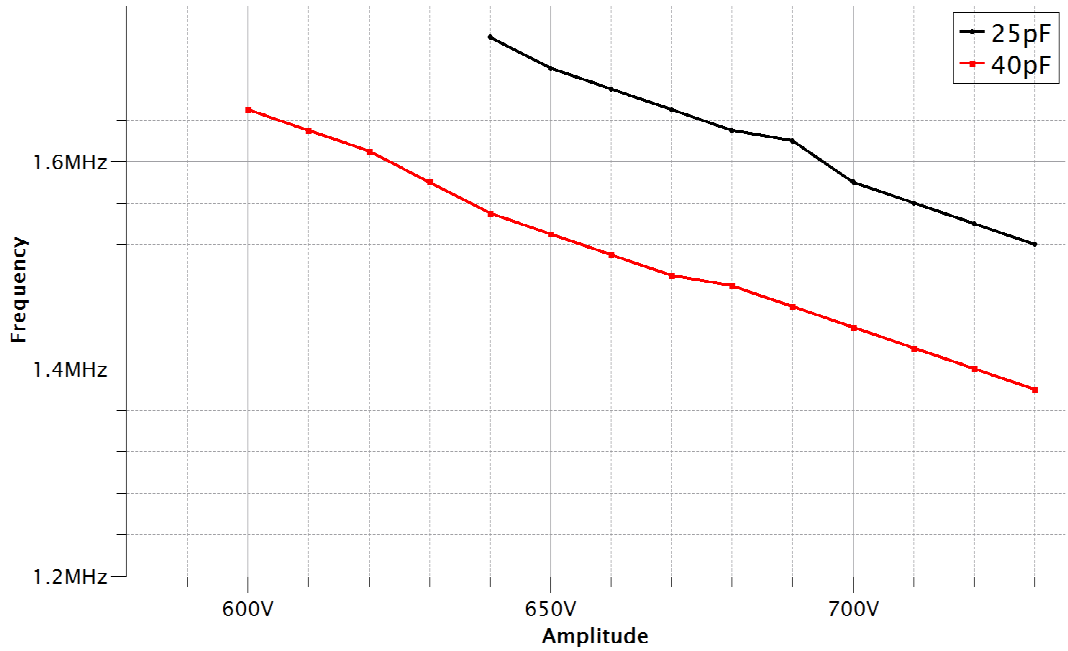
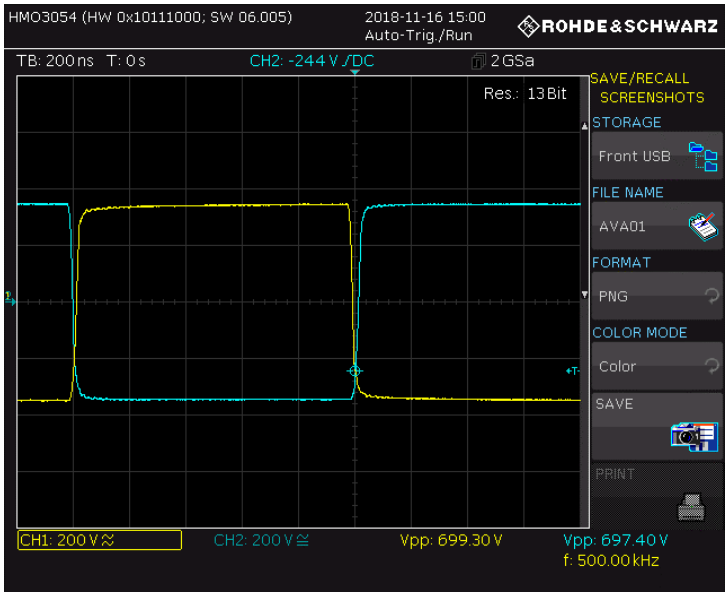


Fig. 4: load diagram; please ensure never to exceed the admissible range; the X-axis refers to peak-peak voltage each channel

Output Waveforms

The subsequent graphs dipict typical output waveforms at frequencies of 500kHz, 1MHz and 1.5MHz



Output waveform at 500kHz, 700Vpp each output at 25pF load

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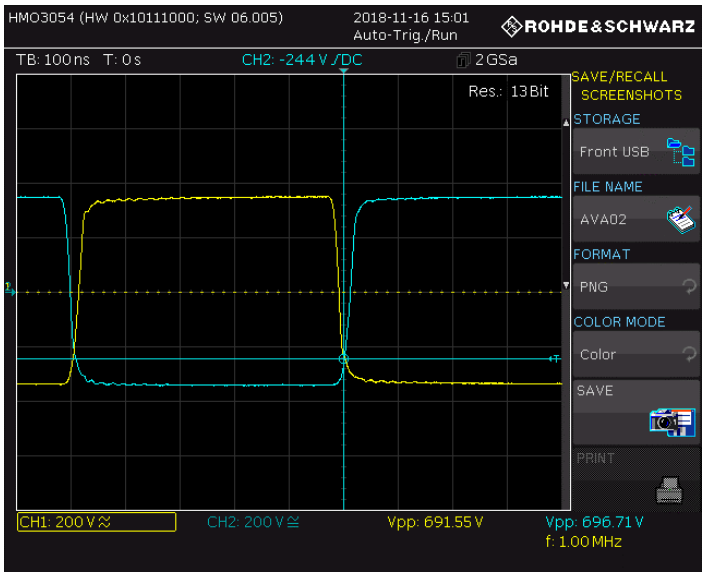
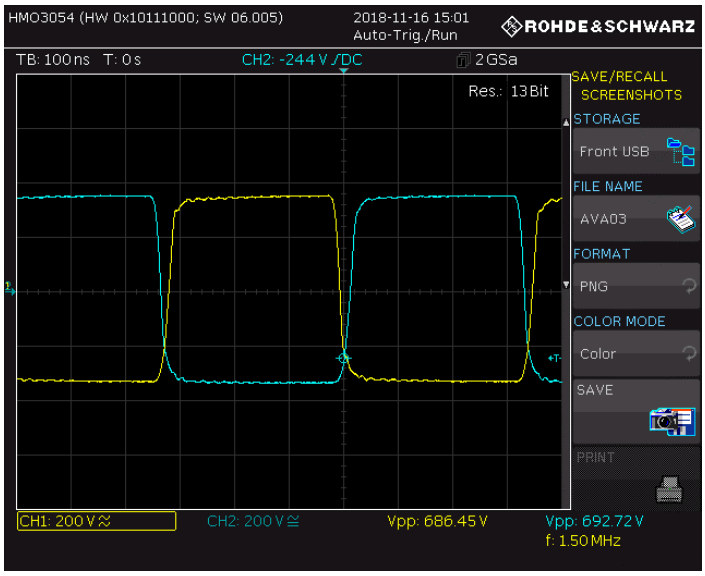
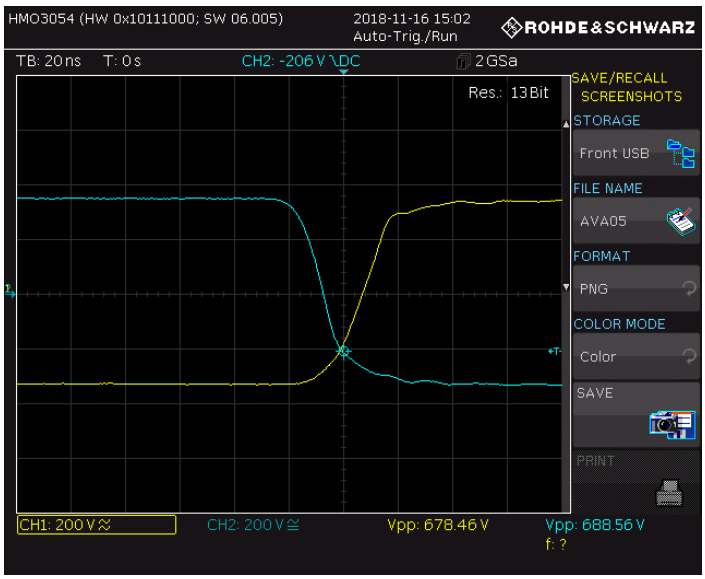


Output waveform at 1MHz, 700Vpp each output at 25pF load



Output waveform at 1.5MHz, 700Vpp each output at 25pF load



Output waveform, zoomed to the signal edges (typ 20ns rise time/ fall time at 25pF load)

Fan/Temperature Warning

In case there is a problem with the ventilation fans or signs of overheating inside the device, the latter is indicated by a display reading. Eventually the output is intentionally disabled for safety reasons.

Specifications

Amplifier and Output		
Output voltage (rectangular waveform)	0 to 750Vpp (Volts-peak-peak) @ max 25pF load each channel, i.e. max. 1500Vpp (Volts-peak-peak) between the two output lines * Rise time / fall time on 25pF load typ. 20ns	
Input voltage Clock	rectangular signals, 0V and 5V level (e.g. from function generator or HCMOS logic (5V)) Low level must be 0.8V or less, '5V' (high) level must be > 2.8V Input resistance approx. 2kOhm	
Input voltage DC	DC control voltage 0V to 7.5 V This voltage is translated into the output peak-peak Voltage Input resistance approx. 100kOhm Scaling Factor: 100 V/V +/-0.5% typ.	
Frequency	0.2MHz to 1.7MHz *	
Output connector type (customized)	SHV sockets	
DC Offset	max. +/-350V DC vs. GND (BNC socket) Note: only DC voltages, no pulsing is admissible. The DC Offset is connected to both outputs by 1MΩ resistors each.	
Load capability each output	nominally capacitive part max. 25pF vs. GND max. 40pF at restricted frequency and amplitude range (see load diagram) resistive part larger 10MΩ to GND	
Front Plate Display Readings (at 50 % duty cycle)		
Voltage Accuracy: (voltage larger 200Vpp)	typical	maximum error
Scale error	2%	5%
Environmental Conditions		
Magnetic Field	max. 5mT admissible	
Storage Temperature	-55 °C to +85 °C	
Operating Humidity & Temperature	noncondensing relative humidity up to 80% temperatures between +0°C to +25°C.	
Power Supply		
AC Supply Rating	AC input voltage 230V_{AC} at 50Hz or 60Hz. The power entry module is EMI/RFI-filtered. Fuse: medium fast blow 2A typ. 260W consumption at max. amplitude	
Case dimensions	19.00" wide x 10" deep. Front-panel mounting holes are configured for M6 rack configurations	
Weight	approximately 5 kg	

*: see also load diagram

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DECLARATION OF CONFORMITY

Manufacturer's Name: **Dr. Stefan Stahl**
- Electronics for Science and Research -

Manufacturer's Address: **Kellerweg 23**
67582 Mettenheim
Germany.

Declares, that the product

Product Name: **HF-Drive (RF-FAIMS)**
Model Number: **RF-FAIMS 1.7**

Product Options: **This declaration covers all options of the above product(s)**

Conforms with the following European Directives:

The product herewith complies with the requirements of the:

1. Low Voltage Directive 73/73EEC;

2. EMC Directive 89/336/EEC (including 93/68/EEC) and carries the CE Marking accordingly

Date Of Issue _____

21. Oct 2018 **General Director**

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