OPERATING MANUAL

SAM-1c

BALANCING, DISTRIBUTION AND MATCHING AMPLIFIER

FUNK TONSTUDIOTECHNIK

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FOR YOUR SPECIAL ATTENTION

These operating instructions apply in principle to all versions of the **SAM-1C**, as long as no differences are pointed out.

ATTENTION :

Mains connection only to AC voltage 90..260 Volt/50 - 60 Hz !
To avoid fire and electric shock, do not expose the unit to rain or moisture!
If any liquid enters the interior of the unit, switch it off immediately and have it checked by the manufacturer or a specialist workshop before continuing to use it!

NOTES ON THE LINE UP :

Never place the unit near heat sources such as radiators or hot air outlets, or in places subject to a lot of dust, mechanical vibrations or shocks..

FOR CONDENSATION ACCUMULATION :

If the unit is moved immediately from a cold to a warm place, condensation may form inside and there is a risk that the unit will not work properly. In this case, leave the unit switched off for half an hour after transport.

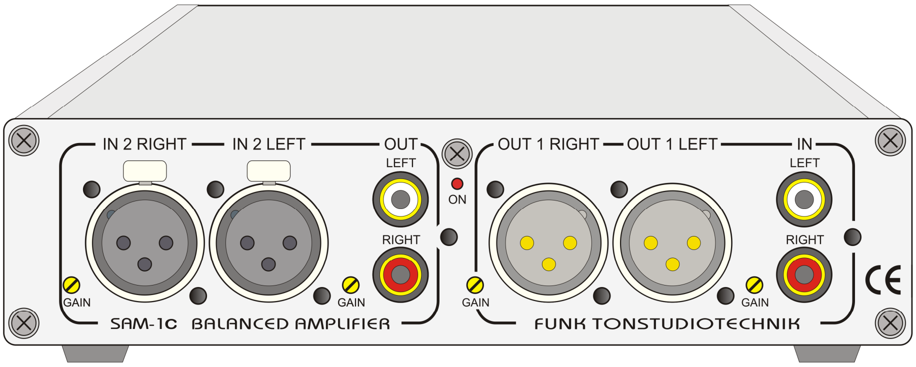
CLEANING :

Clean the cabinet and front panel with a soft cloth lightly moistened with a mild soap solution. Abrasive sponges, scouring powders and solvents such as alcohol or petrol must not be used as they may damage the surface of the cabinet.

WARRANTY :

The warranty period is 3 years. Defects that are due to manufacture or faulty material will be repaired free of charge during this period. The warranty claim expires after external intervention !

SAM-1C Balancing and matching amplifier



1. DESCRIPTION :

The SAM-1C is a universal, professional 4-channel matching and balancing/differential amplifier (instrumentation amplifier) in ironless circuit technology for use with the highest demands on sound quality. Asymmetrical "home recording" and PC inputs and outputs and hi-fi equipment signals can be matched to professional balanced or unbalanced studio equipment inputs/outputs. Level adjustments from -10 dBv to +6 dBu and vice versa as well as signal distribution is also possible, depending on the configuration.

The SAM-1C is the successor of the SAM-1B/SAM-1B with the additional possibility to mix signals. The audio signal quality, such as common-mode rejection (unbalance attenuation), THD distortion, headroom and overall dynamic range, has been further improved.

Compared to the SAM-1B, the SAM-1C version also has a precision switching power supply for operation with all mains supplies worldwide with operating voltages of 80..260 V and frequencies between 45..440 Hz. The mains cable of the SAM-1C is detachable.

The SAM-1C can enable the following functions simultaneously :

1. a high-impedance signal becomes low-impedance (impedance conversion).
2. an input signal can be amplifieda balanced signal becomes asymmetrical/attenuated
3. a balanced signal becomes asymmetrical
4. an asymmetrical signal becomes symmetrical
5. 2 balanced signals can be summed (mixed) (stereo > mono)
6. "hum loops" between unbalanced units can be eliminated
7. switch-on or switch-off crackles of a sound system can be eliminated ("power-down" mute)
8. configurations as balancing and distribution amplifier internally possible

1.1 Mode of action :

To ensure that the interference voltages induced or influenced on a line cause as little interference as possible in an input of an audio control system connected to this line, this input must be "symmetrical to earth", i.e. the two resistances measured between each of the input terminals and earth must be equal in magnitude and phase. The induced interference voltages, which are equal in magnitude and phase on both conductors, then cancel each other out in their effect with a symmetrical input and have no influence. If the symmetry is not exact, however, the induced voltage is not completely cancelled out and a residual interference voltage remains in the subsequent transmission path.

The balanced input stages SSIM-04Mc of the SAM-1C achieve a typical suppression of balanced interferences at 1 kHz in the ratio 1 000 000 / 1 approx. - 120 dB ! This extremely high symmetry also makes it possible to optimally suppress interference due to different ground potentials. This also applies to applications with otherwise asymmetrical cabling.

Auto-Mute :

The outputs of the amplifiers in the SAM-1C have a "power-down" mute relay in the output. This ensures a largely crack-free switching on and off of the unit even after a sudden drop or failure of the supply voltage.

The SAM-1C has a modular design and can therefore be offered in different versions. Due to the service-friendly design, the amplifier modules including all sockets can be exchanged or extended subsequently in a few minutes without soldering.

All inputs/outputs have spindle trimmers on the rear panel of the unit, with which the amplification can be adjusted very precisely for each channel separately from the outside.

During the development of the SAM-1C, special attention was paid to lowest noise (dynamic range at amplification 1 : typ. 136 dB !) and minimal distortion with a very broadband design of all amplifier stages. The THD distortions in the important mid-range are typically below - 130 dB at signal levels between -10 dB...+12 dB! This could only be achieved by using several operational amplifiers per balanced input and "instrumentation amplifier technology". An excellent phase response of typ. less than 1° in the range of 10 Hz...20 kHz and a large signal bandwidth of more than 100 kHz guarantee excellent impulse processing (see also chapter AUDIO SIGNAL QUALITY).

The SAM-1C can also be used for matching time code signals due to its exceptional bandwidth of over 200 kHz. The excellent crosstalk attenuation of over 125 dB at 1 kHz and 120 dB at 10 kHz between the two channels also allows the use of both signal paths for different mono signal sources simultaneously.

Due to the very high common-mode rejection of the balanced input amplifiers of typ. 120 dB at 1 kHz, interferences interfering with the balanced line are almost completely eliminated.

The prerequisite for the exceptionally high common-mode rejection or symmetry of the amplifiers used is our laser-trimmed precision networks on ceramic carriers.

The balanced inputs of the SAM-1C can also be operated asymmetrically at the input without any problems, e.g. for use as an asymmetrical catch-up amplifier/impedance converter, phase reversing stage or for "hum loop elimination" see also chapter HUMBLE ELEMENTS.

Once the output level has been set, it remains constant due to servo balancing with balanced and asymmetrical wiring of the XLR outputs. In contrast to many other balanced amplifier circuits, the maximum achievable output voltage (headroom) of the SAM-1C does not decrease with asymmetrical wiring of the balanced output! This results in a further improvement of the dynamic range compared to comparable balancing amplifiers of typ. 4..6 dB when the outputs are operated in unbalanced mode.

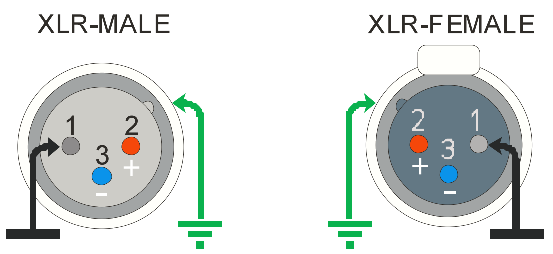
Flawless operation is guaranteed at all balanced outputs up to 300 Ohm output load.

The unbalanced inputs/outputs are connected via gold-plated cinch sockets. The balanced inputs/outputs are connected to XLR sockets with gold-plated contacts.

1.2 Pin assignment of the XLR sockets :

Pin 1 is audio ground
Pin 2 is the +in/output of the amplifiers
Pin 3 is the -input/output of the amplifiers

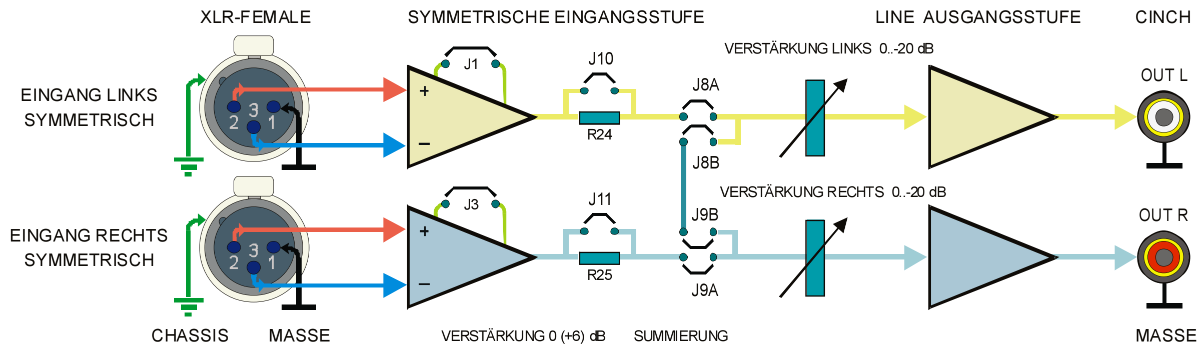
All balanced inputs and outputs are equipped with NEUTRIK XLR sockets. The pin assignment is as usual in professional technology (see picture). Circuit zero (ground) and earth (enclosure) are separated from each other to achieve greater freedom when installing in different systems.



1.3 Rear view SAM-1C :

Compared to the predecessor models SAM-1A and SAM-1B, the SAM-1C is equipped with a standard mains socket for mains cables. The power switch is also located on the back of the unit.

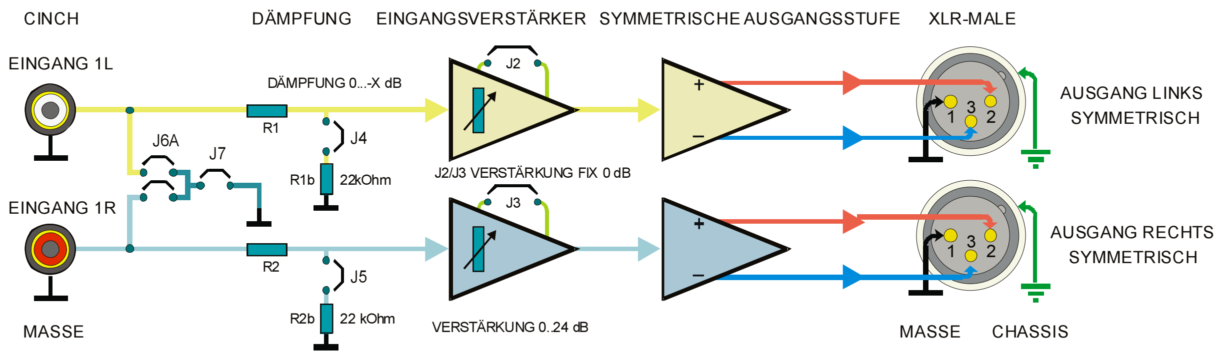
2-CHANNEL DIFFERENTIAL AMPLIFIER MODULE **SSIM-04Mc**



On analogue balanced audio lines, the signal level is often higher than on unbalanced cabling. When converting from balanced to unbalanced technology, an adjustable level reduction is therefore usually desired. The differential amplifiers (desymmetrical amplifiers) of the SAM-1C normally allow an attenuation in the range of -20...0dB, depending on the setting of the spindle trimmers. For special cases, however, amplification of the audio signal is also possible. For this purpose, solder jumpers J1 for the left and J3 for the right channel are provided on the SSIM-04Mc modules. If these are closed, the corresponding channel works with +6 dB amplification in the input stage. The gain adjustment range is then approx. -14..+6 dB. The max. permissible input voltage decreases by 6 dB to approx. +18 dBu when the jumpers are closed. Jumpers 8..11 allow summation or distribution of the input signals within the module.

Circuit zero and chassis are separated from each other in the SAM-1C. Pin 1 of the XLR socket is connected to circuit zero and the ground connection (shown in black in the diagram) of the corresponding RCA socket, the XLR housing is connected to the chassis (protective earth connection green).

2-CHANNEL BALANCING AMPLIFIER MODULE **SSOM-04Mc**



On unbalanced audio lines, the signal level is often lower than on analogue balanced cabling. When converting from asymmetrical to symmetrical technology, an adjustable gain will therefore usually be required. The SAM-1C's balancing amplifiers normally allow a gain in the range of 0...+24 dB, depending on the setting of the spindle trimmers.

For special cases, attenuation of the audio signal is also possible. For this purpose, solder jumpers J4 for the left and J5 for the right channel are provided on the SSOM-04c modules. When these are closed, the resistors R1 and R1b (R2 and R2b) work as voltage dividers of the corresponding channel. The attenuation achieved depends on the resistance ratio of these two resistors and must be calculated accordingly. The resistors R1b/R2b are 22 kΩ. For an input attenuation of 6 dB, for example, R1/R2 must also be changed to 22 kΩ. R1 and R2 have a resistance of 330 Ohm in the standard version.

Suitable resistors of the type "Micromelf" or SMD-0204 can be requested if required. After setting the damping jumpers, the input impedance of the corresponding channels is reduced to values between 22...220 kΩ, depending on the dimensioning of the resistors R1 or R2. Jumpers 6 and 7 enable the distribution of an input signal to both amplifier trains.

2. CONFIGURATIONS :

2.1 Type designation :

The SAM-1C is available with 4 or only partially equipped with 2 independent amplifier trains. In the type designation :

1st digit after slash = number of balancing channels,
2nd digit = number of differential channels (de-symmetrizer).

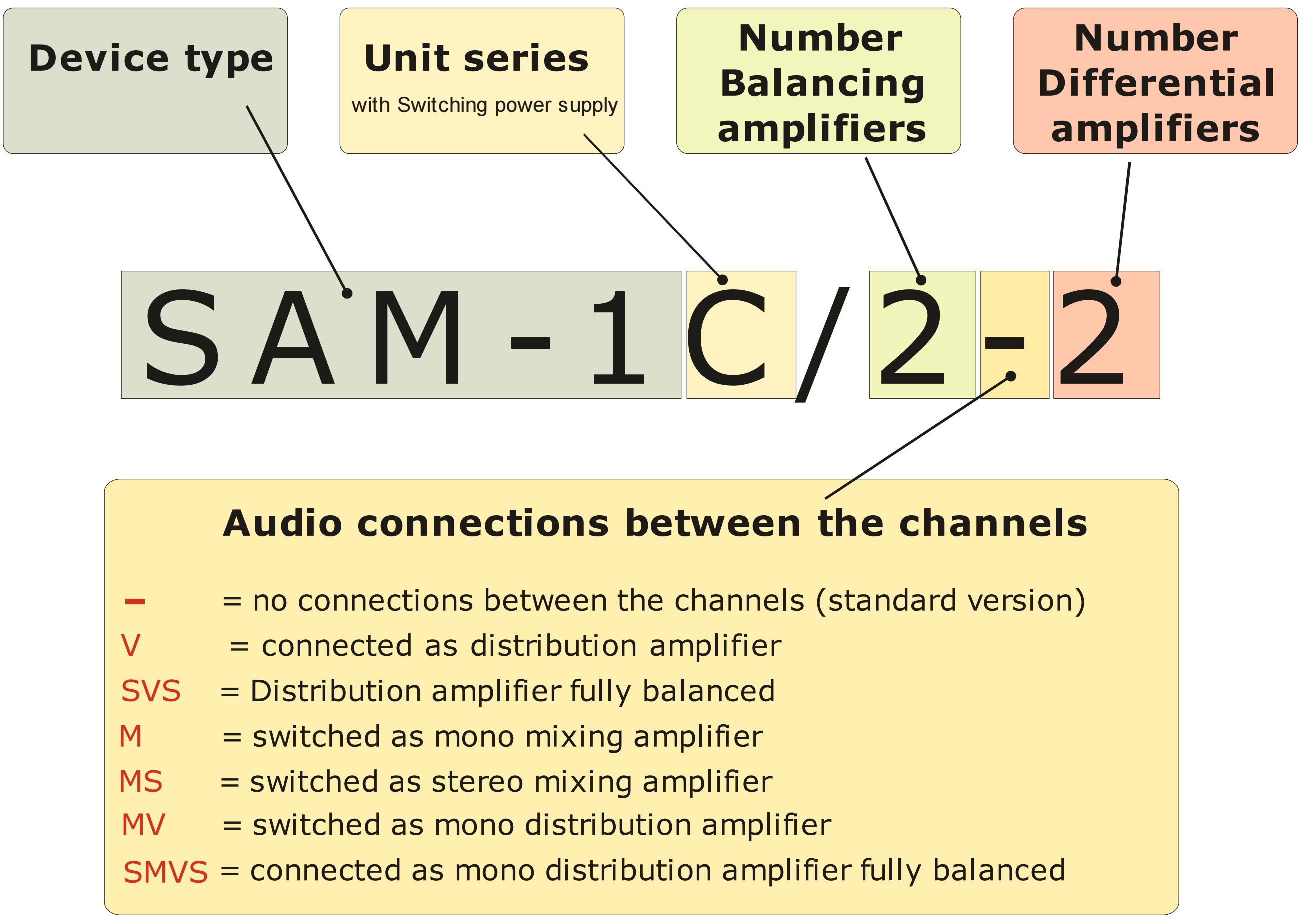
Example: SAM-1C/0-4 means: 0 balancing and 4 differential amplifier channels. The hyphen (-) between the digits means: no connection between the amplifier channels. If this hyphen is replaced by a letter or a combination of letters, all or some of the audio channels are internally interconnected (see following diagrams).

Example: SAM-1C/4V0 means: 4 balancing amplifier channels and 0 differential amplifier; the V between the digits means: the balancing channels are internally configured as distribution amplifiers.

The configuration of the input and output modules can be changed subsequently.

The 2-channel versions can also be subsequently expanded without soldering. The power supply and the necessary internal wiring are already available for this purpose.

2.1.1 Type designation key :



2.2 VARIANTS :

2.2.1 Configurations :

Available 2-channel versions :

SAM-1C/2-0	2x Cinch in	> 2x XLR sym. out
SAM-1C/0-2	2x XLR sym. in	> 2x Cinch out
SAM-1C/0M2	2x XLR sym. in	> 2x Cinch mono out (Summing amplifier)
SAM-1C/2M2	2x XLR sym. in	> 2x Cinch mono out + 2x sym mono out (Summing amplifier)
SAM-1C/2MV0	1x Cinch in	> 1x Cinch direct out + 2x sym. out XLR (Distribution amplifier)
SAM-1C/2SMVS1	1x XLR in	> 4x Cinch direct out + 2x sym. out XLR (Distribution amplifier)
SAM-1C/2SVS2	2x XLR sym. in	> 2x XLR sym. out (Fully balanced matching amplifier)

Available 4-channel variants :

SAM-1C/2-2	2x Cinch in	> 2x sym. out XLR + 2x XLR sym. in ⇒ Cinch out.
SAM-1C/4-0	4x Cinch in	> 4x sym. out XLR
SAM-1C/0-4	4x XLR sym. in	> 4x Cinch out
SAM-1C/0M4	2x XLR sym. stereo in	> 2x [2x Cinch mono out] (Summing amplifier 2-way/stereo)
SAM-1C/4V0	2x Cinch in	> 2x Cinch direkt out + 2x 2 sym. out XLR (Distribution amplif.)
SAM-1C/4MV0	1x Cinch in	> 3x Cinch direkt out + 4x sym. out XLR (Distribution amplifier)

In principle, up to 4 amplifier channels (2 modules) can be installed in the SAM-1C. Combinations of distribution or summing amplifier configurations and additional individual modules are also possible, depending on the space available. In this case, the functions of the modules can be specified individually, separated by slash /. Example :

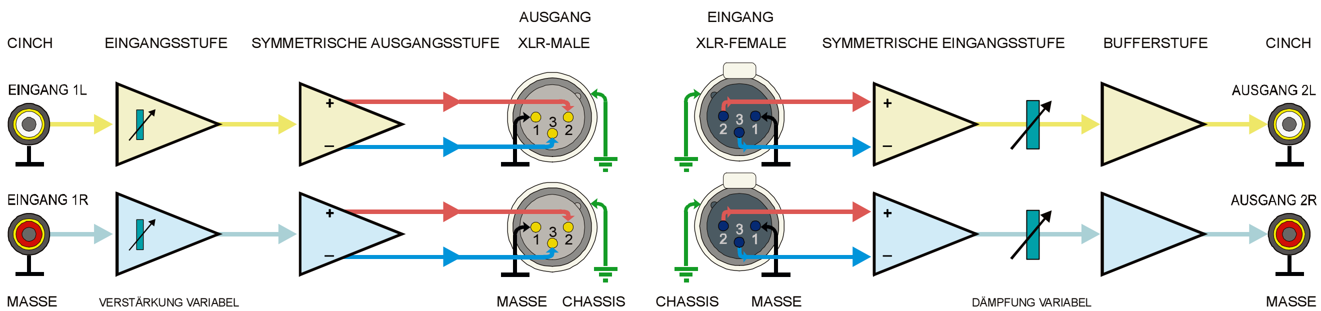
SAM-1C/0M2/2-0	2x XLR sym. in	> 2x Cinch mono out (Distribution amplifier, stereo > mono)
	+ 2x Cinch in	> 2x XLR sym. out

2.3 CONFIGURATION EXAMPLES :

2.3.1 2-channel differential and 2-channel balancing amplifier :

This configuration is used, for example, to adapt the recording and playback side of a stereo unit with RCA jacks to professional studio equipment with sym. XLR inputs and outputs. It follows that, for example, a professional unit with XLR connectors can also be matched to a system with RCA jacks. Level corrections are possible simultaneously and independently on all lines.

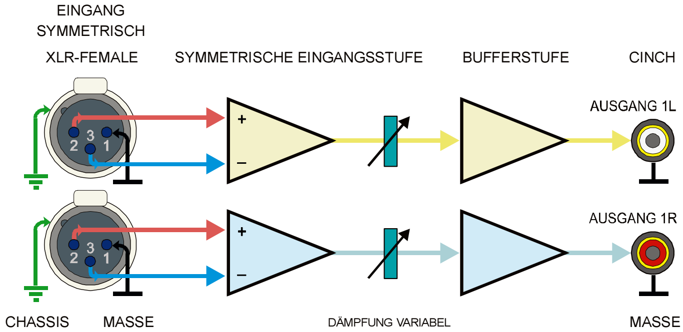
Signal flow : **SAM-1C/2-2** 1 differential amplifier module and 1 balancing amplifier module



2.3.2 2-channel differential amplifier :

This version enables the connection of 2 balanced audio signal sources to unbalanced inputs. Two independent amplifier channels are realised by using a differential amplifier module SSIM-04Mc. The gain of each output can be adjusted separately in the range of -20..0 dB, with jumpers J1 and J3 it is also possible to switch on gains of up to 6 dB.

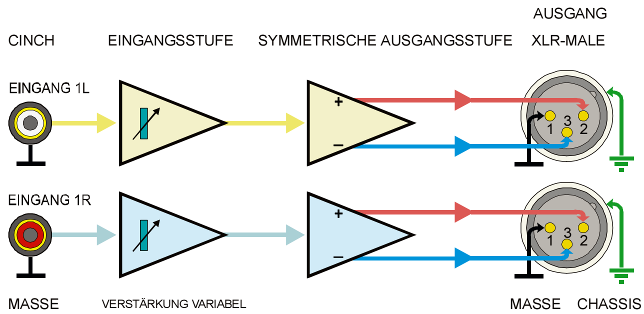
Signal flow : **SAM-1C/0-2** with 1 differential amplifier module SSIM-04Mc



2.3.3 2-channel balancing amplifier :

This version enables the connection of 2 unbalanced audio signal sources to balanced inputs. Two independent amplifier channels are realised by using a balancing amplifier module SSOM-04Mc. The gain of each output can be adjusted separately in the range of 0..+24 dB, level reductions can also be achieved with jumpers J4 and J5.

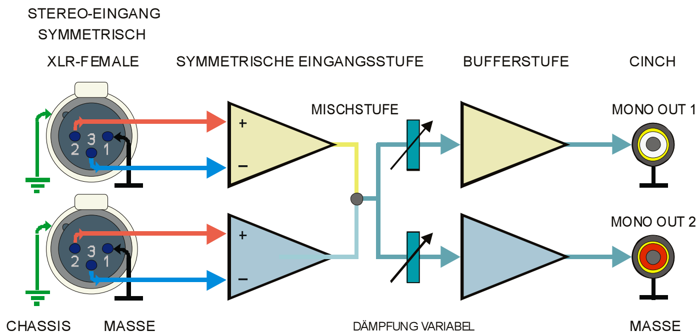
Signal flow : **SAM-1C/2-0** with 1 balancing amplifier module SSOM-04Mb



2.3.4 2-channel summing amplifier with balanced input :

This version enables the connection of 2 balanced audio signal sources which are mixed and available as an unbalanced mono signal at 2 unbalanced cinch outputs. The gain of each output can be adjusted independently in the range of -22..-2 dB. Versions with maximum amplification of -10 ..+10 dB are also available.

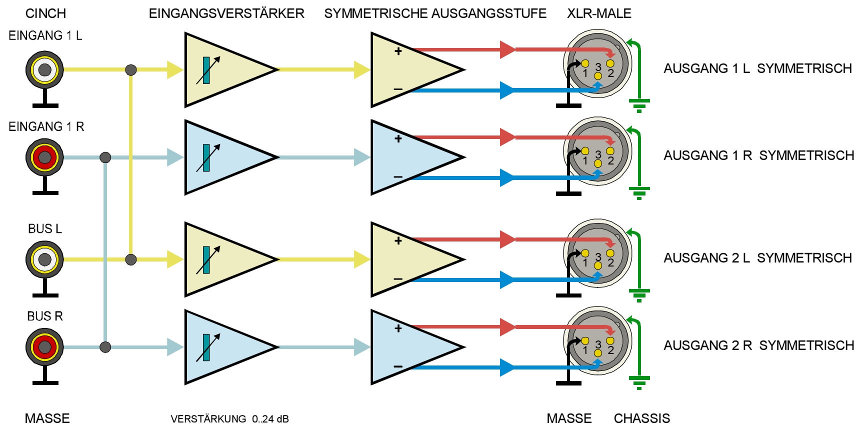
Signal flow : **SAM-1C/0M2** with an asymmetric amplifier module SSIM-04Mc



2.3.5 4-channel distribution and balancing amplifier :

The balancing amplifier modules SSOM-04Mc of the SAM-1C can also be configured internally as stereo distribution amplifiers (1 unbalanced RCA input to 2 balanced XLR outputs each). In this case, the input signals are applied in parallel to the involved RCA sockets of one channel, so that the second RCA socket can be used as a loop-through output (see diagram below). The gain of each balanced output can be adjusted separately. The following example shows a configuration 2x 1 to 2; inputs unbalanced, outputs balanced.

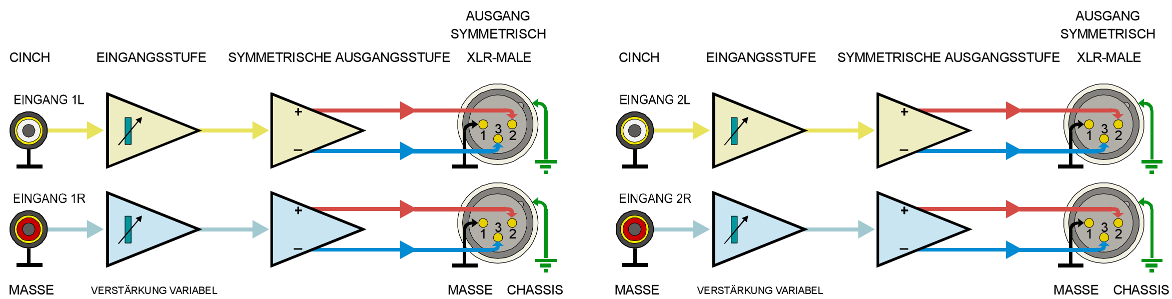
Signal flow : **SAM-1C/4V0** 2 stereo output modules as balancing and distribution amplifiers



2.3.6 4-channel balancing amplifier :

This version allows the connection of up to 4 unbalanced audio signal sources to balanced inputs. Four independent amplifier channels are realised by using 2 balancing amplifier modules SSOM-04Mc. The gain of each output can be adjusted separately in the range of 0..+24 dB, level reductions can also be achieved with jumpers J4 and J5.

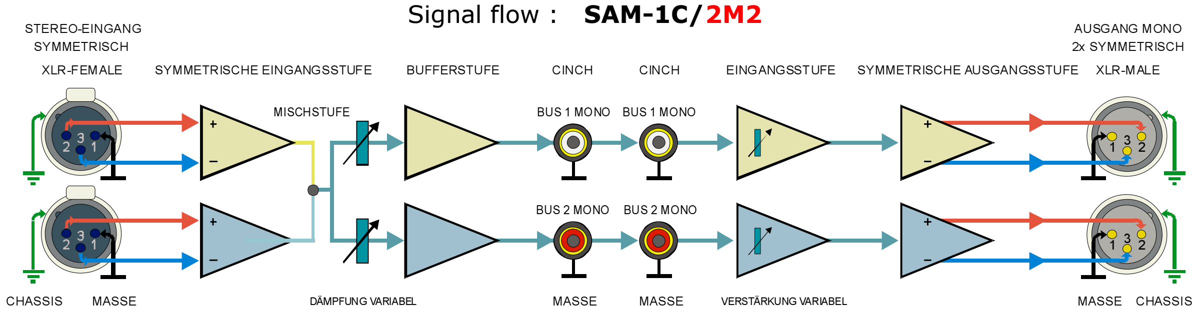
Signal flow : **SAM-1C/4-0** 2 stereo output modules SSOM-04Mc as balancing amplifier



2.3.7 2-channel summing amplifier fully balanced :

This version allows the connection of 2 balanced audio signal sources which are mixed and available as an unbalanced mono signal at 2x 2 unbalanced cinch outputs and additionally balanced mono at two XLR connectors. The gain for the balanced outputs can be adjusted independently of each other in the range of -22..+18 dB.

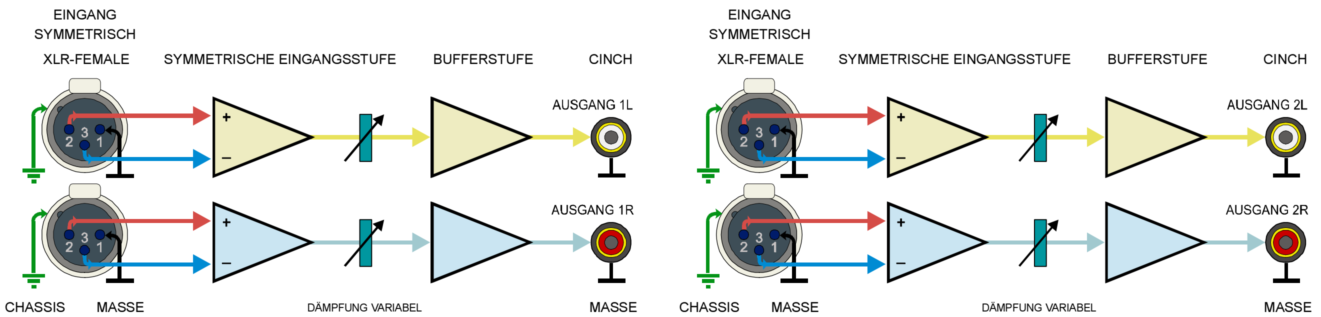
Signal flow : **SAM-1C/2M2**



2.3.8 4-channel differential amplifier :

This version allows connecting up to 4 balanced audio signal sources to unbalanced inputs. Four independent amplifier channels are realized by using 2 differential amplifier modules SSIM-04Mc. The gain of each output can be adjusted separately in the range of -20..0 dB, with jumper J1 and J3 also gains up to 6 dB can be switched on.

Signal flow : **SAM-1C/0-4** with 2 stereo differential amplifier modules SSIM-04Mc



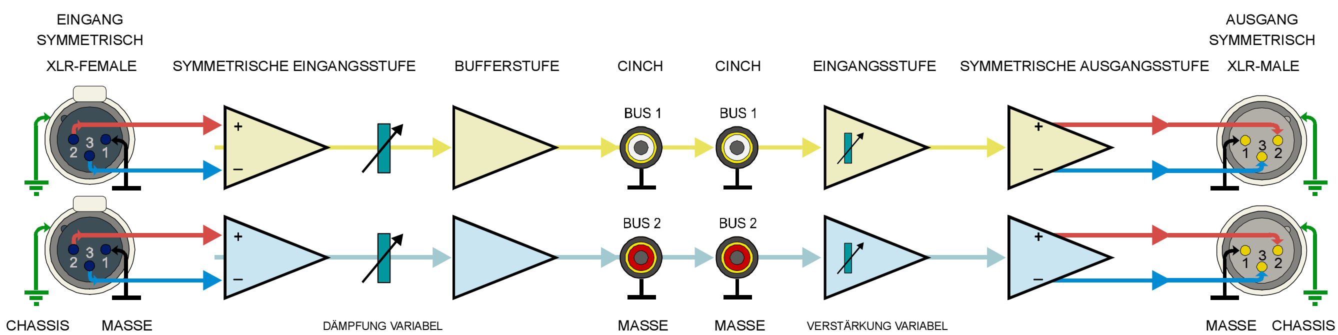
2.3.9 2-channel matching amplifier fully balanced :

The SAM-1C is also available as a 2-channel fully balanced matching amplifier. In this configuration 2 balanced audio signals can be level corrected. In the input amplifiers a level reduction between 0...-21 dB can be set. For each output a gain of 0...+23 dB can be adjusted independently via the spindle trimmers. A short circuit at one output has no influence on other outputs.

In addition, an unbalanced signal can be taken from the RCA sockets. However, long cables should not be connected here, as the capacity of the cables connected here can also have a slight influence on the balanced outputs.

The following block diagram shows as an example a configuration 2x 1 on 1. The SSIM-04Mc module works as a differential amplifier. The output signal of this amplifier is fed to both RCA sockets of the corresponding channel and the input stages of the SSOM-04Mc module. The symmetry of the input signals has no influence on the symmetry of the output signals and vice versa.

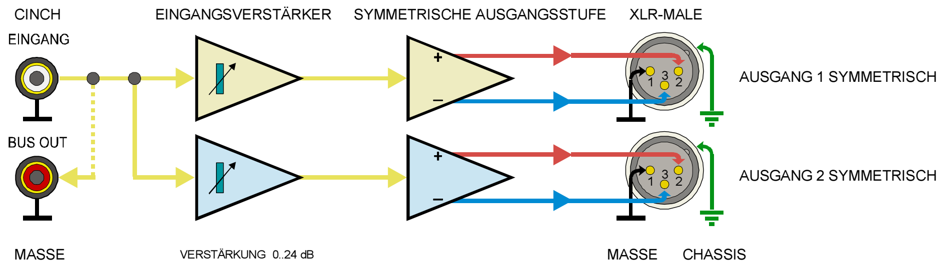
Fully balanced matching amplifier **SAM-1C/2SVS2** with 1 each SSIM-04Mc and SSOM-04Mc



2.3.10 Mono distribution and balancing amplifier 1 on 2 :

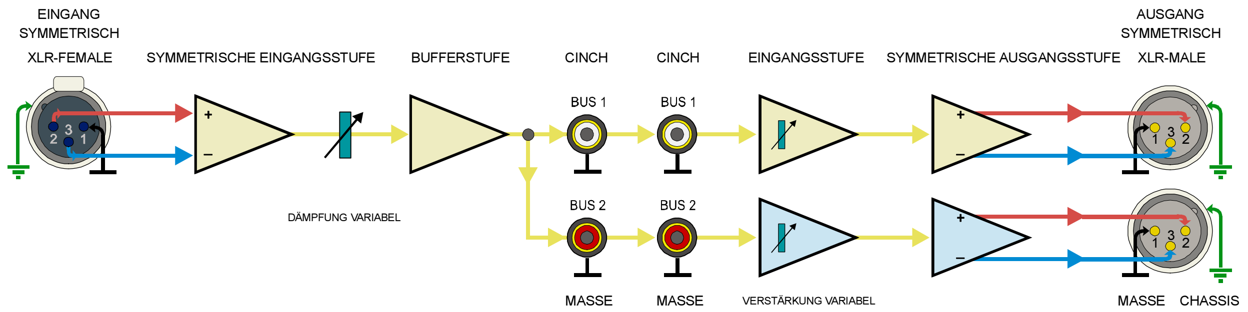
The **SSOM-04Mc** balancing amplifier modules can also be configured internally as mono distribution amplifiers (1 unbalanced RCA input to 2 balanced XLR outputs). In this case, the input signal is also applied in parallel to the second RCA socket of a channel, so that this second RCA socket can be used as a loop-through output "BUS-OUT". The gain of each balanced output can be adjusted separately. As the following example a configuration 1x 1 on 2; inputs unbalanced, outputs balanced.

Signal flow : **SAM-1C/2 MV 0 1 SSOM-04Mc module as distribution and balancing amplifier**



2.3.11 Mono distribution amplifier 1 to 2 fully balanced :

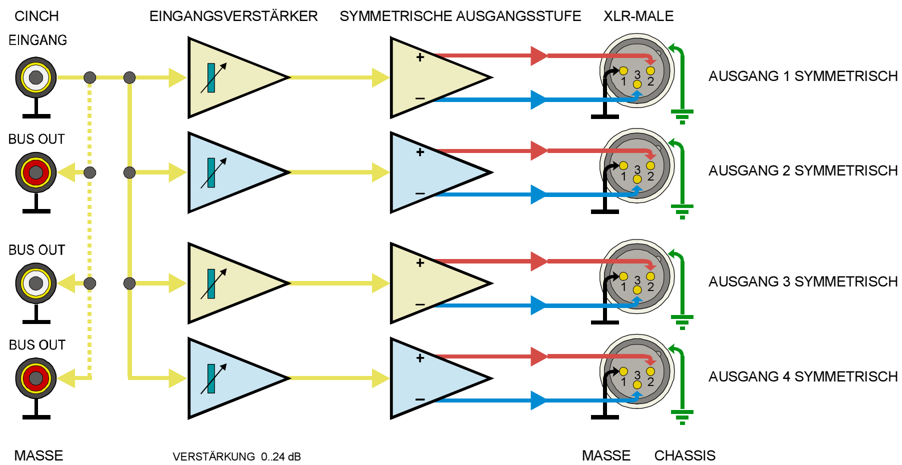
Signal flow : **SAM-1C/2 SMVS 1** with one module each **SSOM-04Mc** and **SSIM-04Mc**



2.3.12 4-channel mono distribution and balancing amplifier :

The balancing amplifier modules **SSOM-04Mc** of the SAM-1C can also be configured internally as mono distribution amplifiers (1 unbalanced RCA input to 4 balanced XLR outputs). In this case, the input signals are applied in parallel to the involved RCA sockets of one channel, so that the second, third and fourth RCA sockets can be used as loop-through outputs ("BUS-OUT" see diagram below). The gain of each balanced output can be adjusted separately. The following is a configuration 1x 1 on 4; inputs unbalanced, outputs balanced.

Signal flow : **SAM-1C/4 MV 0 2** modules **SSOM-04Mc** as distribution and balancing amplifier



3. Ripple loops :

Often, hum disturbances are not caused by electrical or magnetic interference fields alone. Ground potential differences between the connected devices, e.g. due to double grounding, result in "hum loops", which can sometimes cause considerable interference currents due to the low-impedance shields of the cables of the wired devices. Depending on the circuit design, these currents also generate hum voltages within the connected audio devices and add to the already disturbed audio signals. Balanced circuitry can easily remedy this situation.

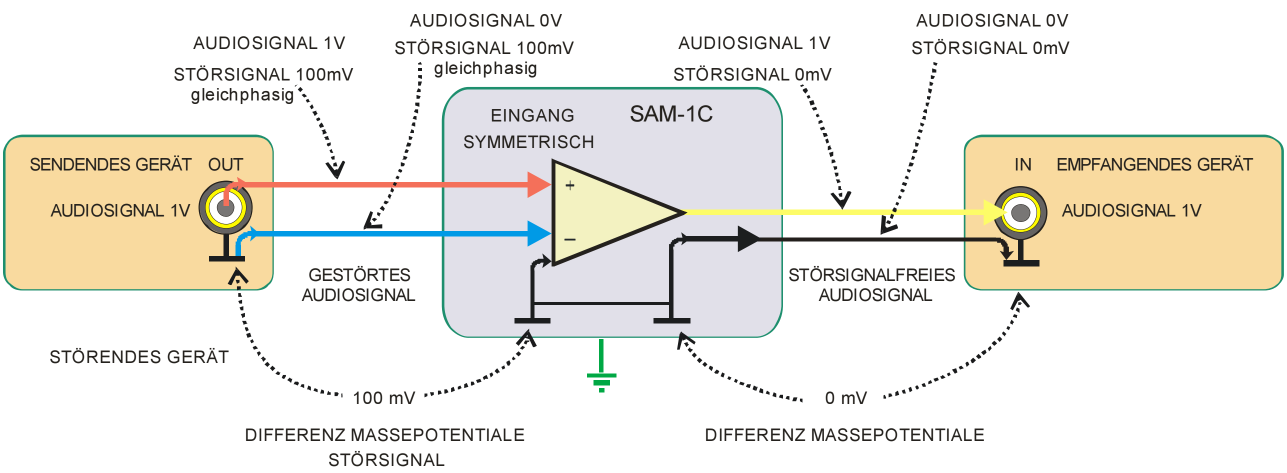
3.1 Ground loops with asymmetrical circuitry :

A real remedy can only be achieved by disconnecting this ground connection and using a LF transformer or differential amplifier.

The following diagram shows the effect of a ground loop separation within an asymmetrical cabling by interposing a balanced amplifier input (differential amplifier SAM-1c).

A differential amplifier or a high-impedance "instrumentation amplifier" ideally takes into account only the difference between its two inputs. If the two inputs are connected to each other and then modulated together, no signal is produced at the output. If you now connect the -input to the ground or shield pin of the transmitting device and the **+**input to the hot pin of the signal output, an in-phase modulation of both inputs of the balanced receiver occurs; in our example with 100 mV noise signal. However, the output signal remains at 0 Volt, since there is no difference between **+**and **-**input.

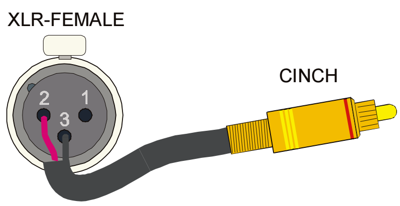
If now the output of the transmitting device is modulated with an audio signal of 1 V, there will be a difference of 1 V at the balanced input of the SAM-1C as well. Consequently this audio signal will also be present at the output of the SAM-1C, but freed from the ripple voltage. This principle also works if the two wires (blue and red) would be swapped. Only the phase position for the useful signal would turn by 180°. This can also be used to compensate for "phase shifts".



No amplifier works ideally. Common circuits achieve a suppression of the interference signal to 1/100..1/10.000 (40..80 dB). Therefore, a small amount of noise residual will often be detectable in the output signal of the differential amplifier. Due to careful development, laser-trimmed circuits and instrumentation amplifier technology, suppressions of up to 1/1,000,000 (120 dB) can be expected with the SAM-1C. So in our example still approx. 0.1µV (~ -140 dB compared to useful signal) and thus far below the background noise of connected devices.

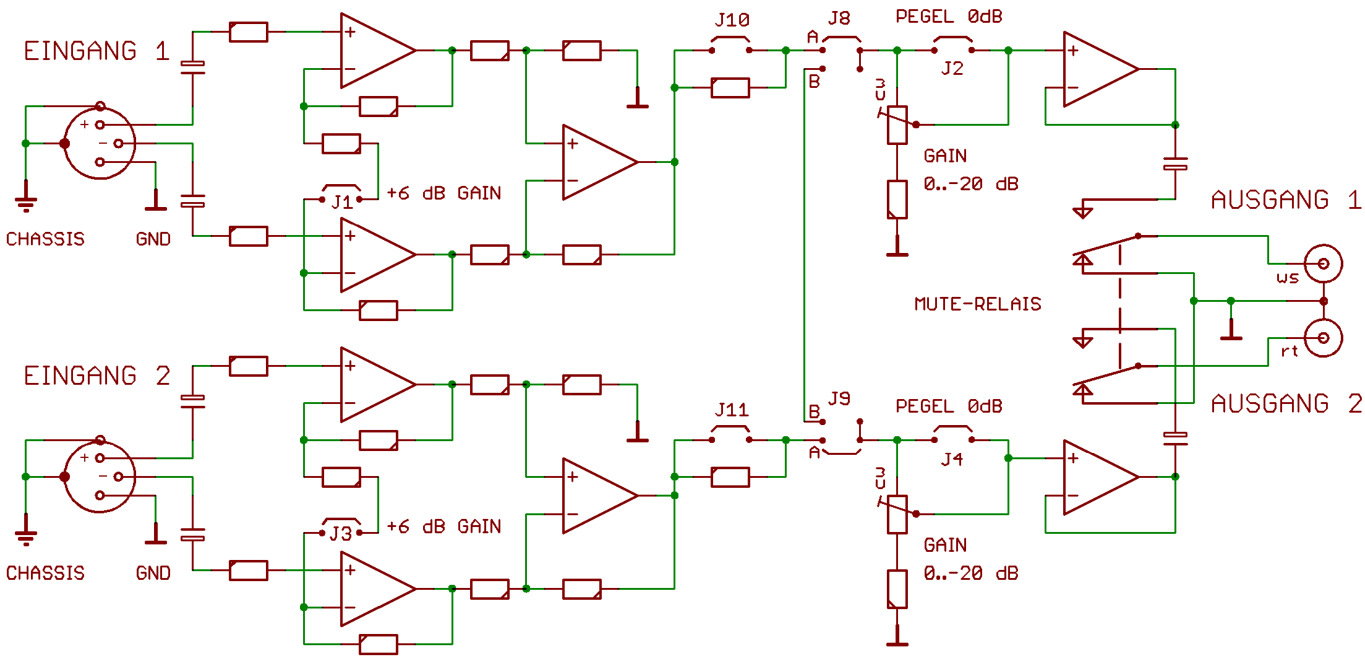
In the SAM-1C housing (ground or protective earth potential) and circuit zero (ground) are separated from each other in order not to create additional risk of ground loops.

The drawing on the left explains the practical connection of the unbalanced signal source to the balanced input of the SAM-1C. Pin 1 remains open and pin 3 is connected to the shield.



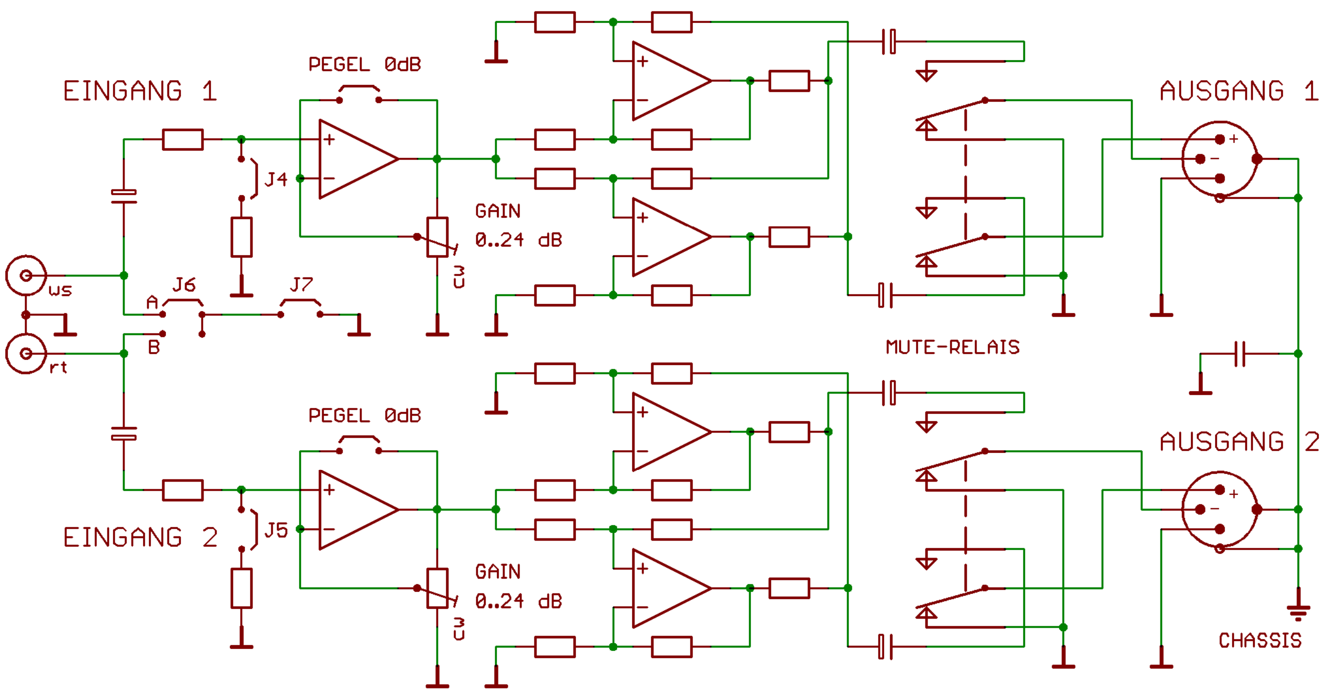
Block diagram Audio 2-channel module SSIM-04Mc

balanced XLR inputs to unbalanced RCA outputs

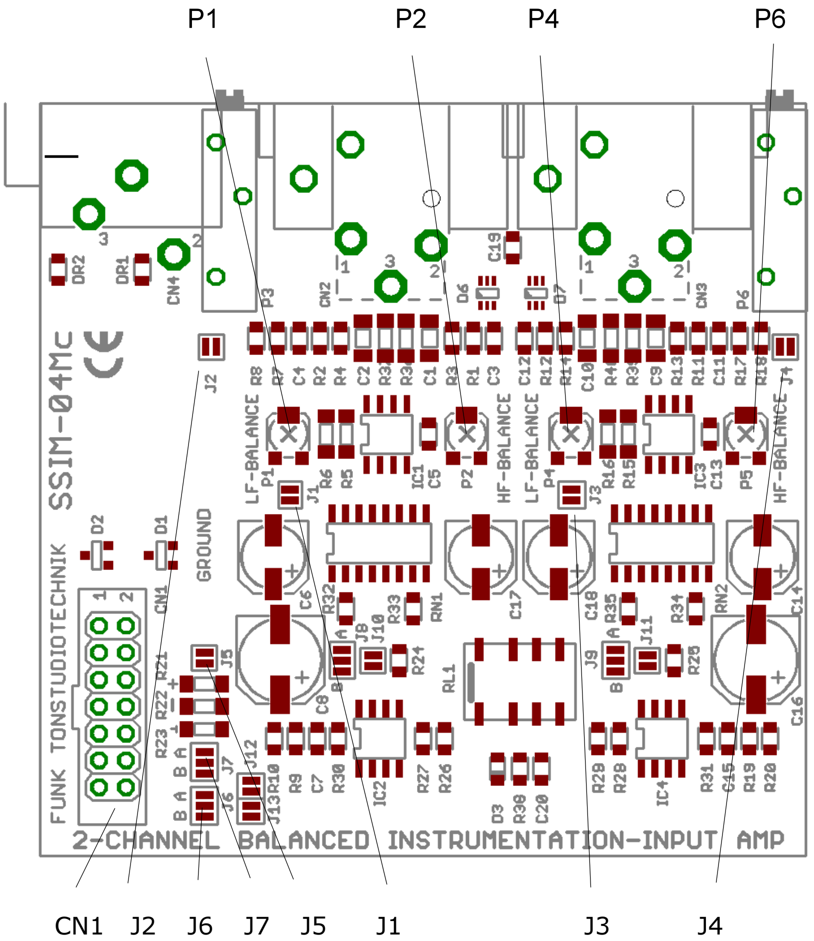


Block diagram Audio 2-channel module SSOM-04Mc

unbalanced RCA inputs to balanced XLR outputs



DIFFERENTIAL AMPLIFIER   SSIM-04Mc



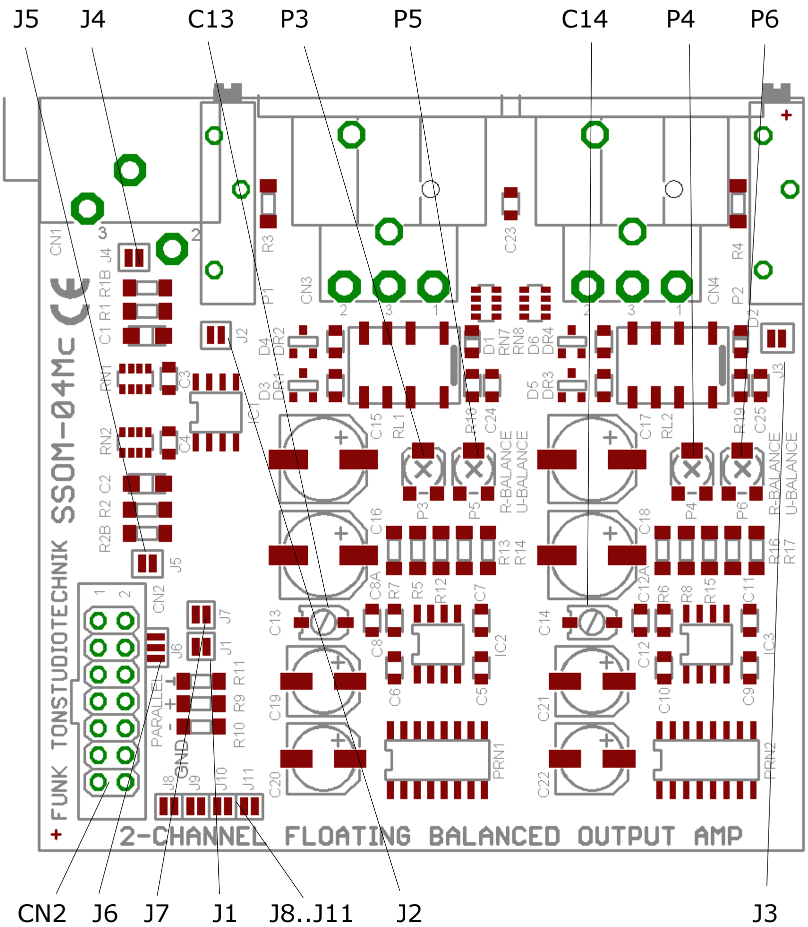
Function of the trimmers and jumpers :

J1	additional gain +6 dB left channel
J3	additional gain +6 dB right channel
J2	Gain left channel fixed 0 dB
J4	Gain right channel fixed 0 dB
J5	0-Ω-Bridge (0-volt power supply / ground)
J6	Control „Power-Down-Mute“
J7	Control „Power-Down-Mute“
J8	Stereo mono mode L (J8 A = stereo, A+B = mono)
J9	Stereo mono mode R (J9 A = stereo, A+B = mono)
J10	Impedance L internal to 1.5 kΩ (for summation)
J11	Impedance R internal to 1.5 kΩ (for summation)
J12	Mute relay always to ground (Circuit ground)
J13	Mute relay always on +supply (+12..20V)
P1	CMRR adjustment symmetry 1 kHz input left
P2	CMRR adjustment symmetry 10 kHz input left
P4	CMRR adjustment symmetry 1 kHz input right
P5	CMRR adjustment symmetry 10 kHz input right

CN1   Pin assignment :

Pin 1	Ground
Pin 2	Output left channel unbalanced
Pin 3	Ground
Pin 4	Ground
Pin 5	Ground
Pin 6	Output right channel unbalanced
Pin 7	NC 8 (Not connected)
Pin 8	Power supply +12,0...20,0 Volt
Pin 9	Power supply 0 Volt
Pin 10	Power supply -12,0...20,0 Volt
Pin 11	Power supply Mute-Relais A +
Pin 12	Power supply Mute-Relais A -
Pin 13	Power supply Mute-Relais B +
Pin 14	Power supply Mute-Relais B -

BALANCING AMPLIFIER SSOM-04Mc



Function of the trimmers and jumpers :

J2	Gain left channel fixed 0 dB (J2 closed)
J3	Gain right channel fixed 0 dB (J3 closed)
J4	Input level attenuation left active (J4 closed)
J5	Input level attenuation right active (J5 closed)
J6	Inputs directly linked (J6 A+B closed, J7 open)
J7	Ground to input bridge (J7 closed)
J8	close when used outside SAM-1C (Mute-Relais)
J9	close when used outside SAM-1C (Mute-Relais)
J10	close when used outside SAM-1C (Mute-Relais)
J11	close when used outside SAM-1C (Mute-Relais)
J1	0-Ω- Jumper (0-volt power supply / ground)
P3	CMRR adjustment Symmetry impedance left
P5	CMRR adjustment Symmetry output voltage left
C13	CMRR adjustment symmetry 10 kHz left
P4	CMRR adjustment Symmetry impedance right
P6	CMRR adjustment Symmetry output voltage right
C14	CMRR adjustment symmetry 10 kHz right

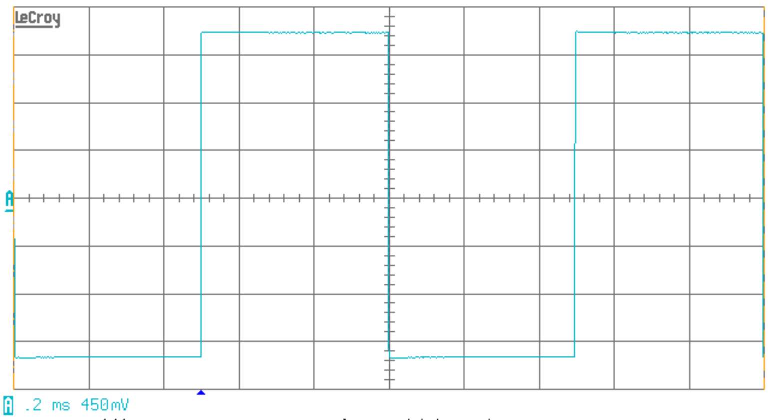
CN2 Pin assignment :

Pin 1	Ground
Pin 2	Input left channel asymmetrical
Pin 3	Ground
Pin 4	Ground
Pin 5	Ground
Pin 6	Input right channel asymmetrical
Pin 7	NC 8 (Not connected)
Pin 8	Power supply +20,0 Volt
Pin 9	Power supply 0 Volt
Pin 10	Power supply -20,0 Volt
Pin 11	Power supply Mute-Relais links +
Pin 12	Power supply Mute-Relais links -
Pin 13	Power supply Mute-Relais rechts +
Pin 14	Power supply Mute-Relais rechts -

4. AMPLIFIER PATHWAYS :

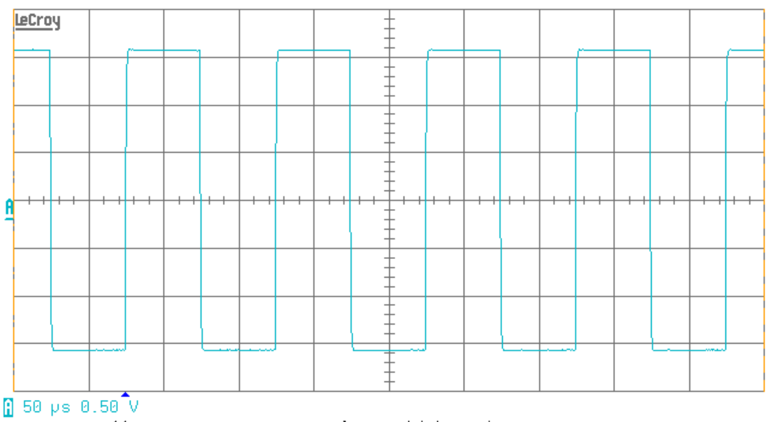
The SAM-1C is equipped with very broadband amplifier trains that ensure an exceptional, very phase-clean signal transmission. This is impressively proven by the following measurement reports. The balancing amplifier module SSOM-04Mc, set to 0 dB gain (input signal level = output signal level), was driven by square wave signals from a fast pulse generator.

Test signal Fig. 1: 1 kHz at a level of approx. 1.5V RMS (corresponds to +6 dBu line level) at a usual load resistor of 10 kΩ. The wide frequency and phase response in the bass range and the clean processing of even the deepest bass impulses can be seen from the barely visible slope of the roof.



	141 sweeps:	average	low	high	sigma
Freq(1)	ꟻЛ	1.00291 kHz	1.00288	1.00294	0.00001
rise(1)	ꟻЛ	828 ns	788	871	16
fall(1)	ꟻЛ	890 ns	860	921	11
rms(1)		1.5282 V	1.5278	1.5286	0.0002
pkpk(1)		3.147 V	3.136	3.164	0.010

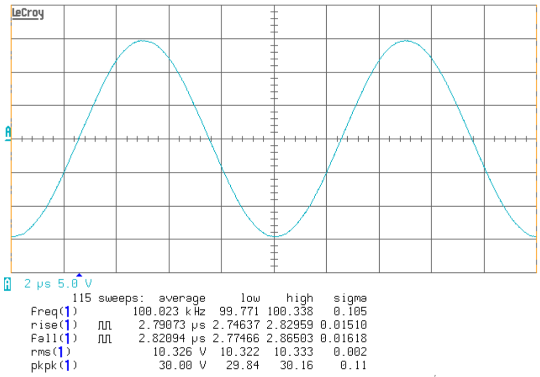
Test signal Fig. 2: 10 kHz at a level of approx. 1.5V RMS. Load resistance of the oscilloscope during this measurement: 300 Ohm. The very steep edges show the wide frequency response of the balancing amplifier in the high frequency range. Even the fastest pulses are reproduced exactly!



	44 sweeps:	average	low	high	sigma
Freq(1)	ꟻЛ	10.0072 kHz	10.0065	10.0079	0.0003
rise(1)	ꟻЛ	774.5 ns	753.6	792.3	7.8
fall(1)	ꟻЛ	784.9 ns	746.4	813.8	11.3
rms(1)		1.5658 V	1.5656	1.5659	0.0001
pkpk(1)		3.242 V	3.234	3.250	0.008

Amplifier paths :

Test signal Fig. 3: Large signal bandwidth of the SAM-1C. Sine signal 100 kHz at a level of approx. 10 V RMS or 30 Vpp (corresponds to approx. +22 dBu line level). Even largest audio signals with highest frequencies far above the audible range can be transmitted cleanly by the amplifiers. This measurement curve shows that the SAM-1C can also be ideally used for signal balancing of the latest digital audio sources, which today operate at up to 384 kHz sampling rate.

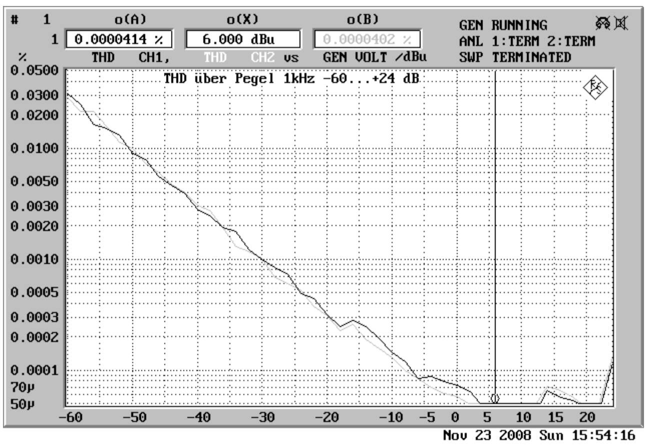


4.1 THD- Distortions :

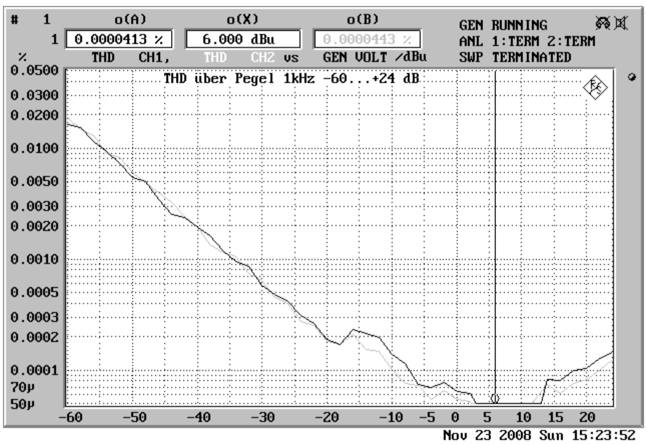
This measurement record shows the typical, extremely low non-linearities at different input levels at the balancing amplifier module SSOM-04Mc. The measurement was performed with a signal of 1 kHz, at a set gain of 1 (0 dB) at the SAM-1C (level trimmer at left stop). From -6 dBu to +11 dBu line level the THD values of both channels are below 0.0001%! Even with signals around -60 dB (relative to the overall dynamic range of the SAM-1C -84 dB), this corresponds e.g. to very quiet parts in a Symphony recording, the total THD distortions from the 2nd-9th harmonic are less than 0.03%. Good CD players have distortions of more than 100 times at this level! The minimum is in the order of 0.00005% or 126 dB below useful signal at input signals of +6 dBu (approx. 1.55 volts).

The left diagram shows the measured values of the SAM-1C, the right diagram shows the self-measurement of the used analyzer which already belongs to the best measuring devices for such audio measurements. Especially at higher signal levels the THD distortions of the SAM-1C are close to the limits of what can be measured today.

The fact that in the right measurement record of the analyzer's self-measurement the distortions at high levels are higher than with SAM-1C interconnected is not a measurement error! It is interesting that the balanced signals can be processed more cleanly by the balanced input stages of the analyzer than the asymmetrical test signals connected directly from the analyzer output to the input. This clearly shows that balanced inputs operate cleaner with balanced drive than with unbalanced drive. In principle, this is true for all devices with electronically balanced inputs on the market and varies depending on the circuit technology. Many microphone preamps are also affected by this! Unfortunately, this problem is little known today.



Analyzer and SAM-1C



Self-measurement only Analyzer

5. LEVEL ADJUSTMENT :

By default the modules with sym. input are adjusted to a gain of 0 dB. Any values between -21 dB...+6 dB are adjustable (+6 dB only with set internal jumpers).

The modules with sym. output are preset to a gain of +10 dB. Any values between 0...+23 dB are adjustable. Level reductions are also possible on the SSOM-04Mc module after activating the jumpers J4/J5. Clockwise rotation of the spindle trimmer screw increases the gain. Use only slotted screwdrivers with 2...2.5 mm blade width.

For special cases **jumper 1** (left channel) and **jumper 3** (right channel) of the modules SSIM-04Mc activate an additional gain of 6 dB at the input of the differential amplifiers. This allows to achieve even higher dynamics at usual signal levels of "HiFi devices". If jumper 2/4 is set, the max. input voltage at the balanced input must not exceed + 18 dBu. Higher input signals will not damage the amplifier stages, but will cause clipping of the output amplifiers. Jumper 1/3 are not set by default (solder bridge open).

Important : As with most analog input amplifiers, no higher level signals should be present at the inputs when the unit is switched off. This is especially true for preamps with extremely low noise floor like the SAM-1A/SAM-1B/SAM-1Bs. Input voltages greater than +12 dBu (approx.3V) to these units when powered off can damage the 1st amplifier stage! In contrast, the SAM-1C series is now equipped with protection circuits against overvoltages and phantom power voltages for microphone supplies. This measure once again increases the operational safety of the SAM-1C series.

6. GROUND CONCEPT :

Protective earth and operating earth are separated from each other in the SAM-1C and only connected via an RC element consisting of a 0.1µF capacitor and a 2.2kΩ resistor. This creates a low impedance connection for high frequencies as an RF shield, on the other hand this way there is no ground loop for the mains frequency and its harmonics. This means that the SAM-1C works properly even when touching other metal housings with "unclean" ground reference and thus no "hum loop" is created. The housings of the XLR connectors are directly connected to the chassis (mains ground) in the SAM-1C.

To avoid hum loops via circuit zero (pin 1), the shielding at the *balanced inputs* and outputs should only be connected to the housing of the XLR connector. Otherwise, interference currents via pin 1 could generate a voltage drop via the internal resistance of the ground wiring in the device, which under unfavorable circumstances would become noticeable as an interference signal.

If the balanced inputs or outputs of the SAM-1C are used as converters balanced < > asymmetrical, it is often useful to connect the shield to pin 1 and 3 of the XLR connectors. If a hum loop occurs with this connection, the shield is only connected to pin 3. Pin 1 then remains open.

7. ELECTRICAL FUSES :

The SMPS-12T integrated precision switched-mode power supply is primarily equipped with an electronic current limiter. The fuse for the primary circuit is located on the circuit board and may only be replaced by qualified personnel. On the secondary side the power supply has no fuses. The internal supply voltages are also protected against short circuit or overload by a current limiter.

If the LED for monitoring the supply voltage on the front panel does not light up in the event of a fault, the mains power supply is probably either interrupted, the internal mains fuse on the power supply board is defective or there is an overload due to a defective audio board. If you are sure that an overload is not caused by the audio circuits, the power supply should be replaced by a specialist.

The device is designed in protection class 1.

7.1 POWER SUPPLY :

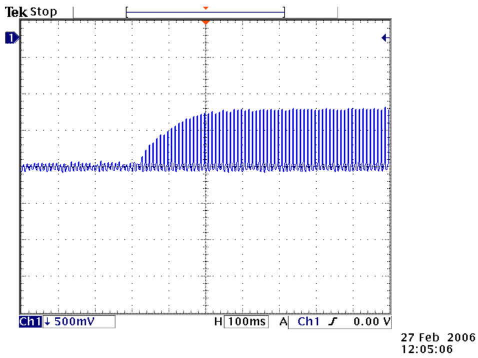
The SAM-1C is equipped with the SMPS-12T low drop switching power supply for operation on 80...265 Volt / 50...400 Hz AC voltage. Operation on 110V AC mains is therefore guaranteed without conversion. An LED on the front panel is used to monitor the supply voltage.

7.2 Power supply unit :

The current versions of the SAM-1C are equipped with the "ultra-low-drop" precision power supply SMPS-12. This modern switching power supply produces extremely stable and pure supply voltages with minimized power consumption and lower heating compared to conventional power supplies. Magnetic interference fields, which can lead to hum in neighboring devices, are reduced by approx. 90% in this power supply compared to conventional power supplies. The power consumption and thus also the heating is reduced by this switching power supply technology by typ. 30..40%, the life span of the components is thereby increased. The SAM-1C with switching power supply has fully equipped with 4 channels only a typ. Power consumption of 4.0 W.

The output voltages can be loaded up to 250 mA. At higher currents, the current limitation becomes active and lowers the supply voltages. At the same time this is indicated by the "**Power**" **LED** on the front going out. The internal supply voltages of the amplifiers are +/- 19.7 volts. Short-circuiting the output voltages will not damage the power supply.

When the power supply is switched on, it is gently boosted to full supply voltage in approx. 0.2 seconds. Switching on the power supply does not cause any crackling noise on the mains side or in other audio devices. The adjacent measurement chart shows the power consumption during the switch-on process. No interference peaks can be detected.

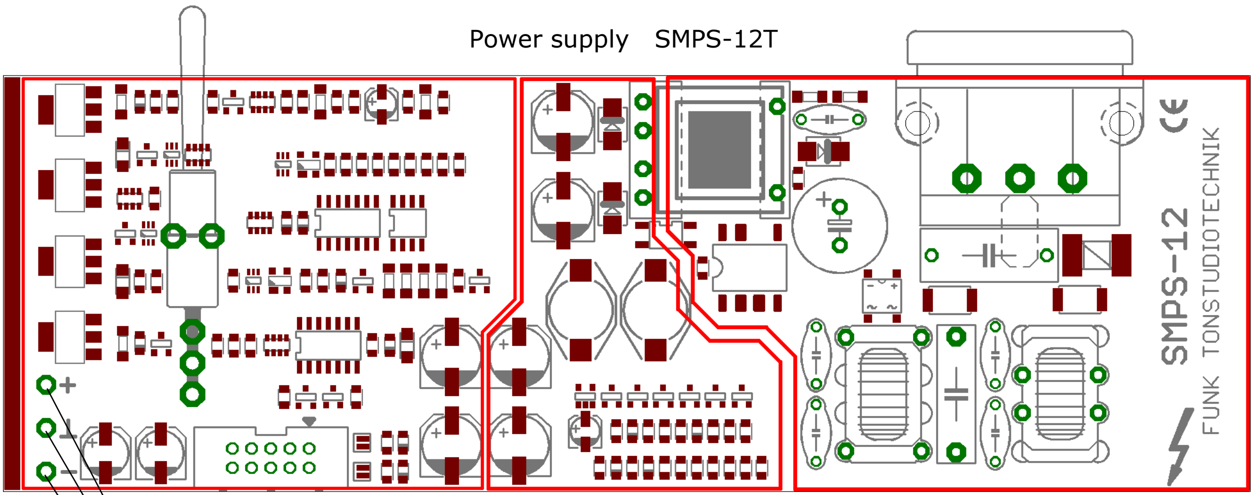


To prevent damage to amplifiers and loudspeakers in case of overload or short-circuit of a supply voltage, the power supply has a monitoring of the symmetry of the output voltages. If a defined limit value for the symmetry is exceeded even minimally, the device switches off. The red power LED goes out.

Timer:

the SMPS-12T power supply has a "Power-Down-Mute" circuit that controls relays on the audio board outputs. This largely avoids "power-on crackles" when switching a sound system on and off, or eliminates existing power-on noises. The switch-on time is about 6 seconds, the switch-off time a few milliseconds after falling below the minimum bias voltage. These control voltages are applied to the 10-pin connector pin 7..10.

Power supply SMPS-12T



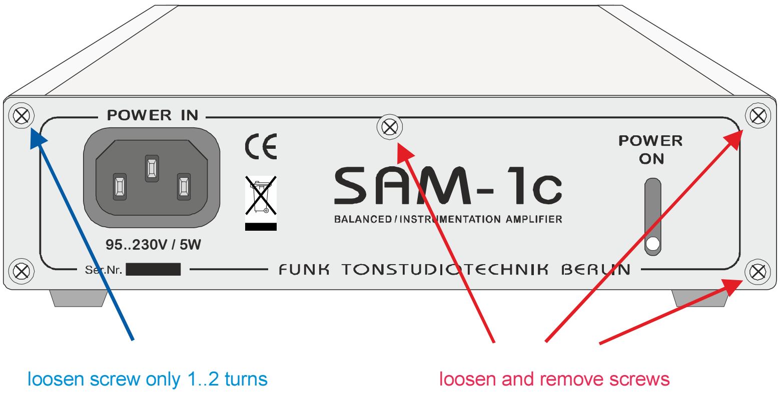
TESTPUNKT +19,7V
TESTPUNKT GND
TESTPUNKT –19,7V

CONNECTOR PIN ASSIGNMENT CN2 10-pol.

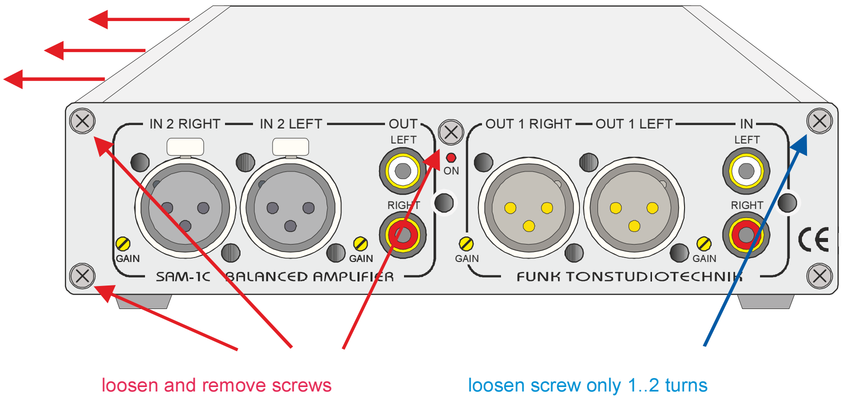
Pin 1	+ 19,7V Power-On-LED +(Rv= 8k25)
Pin 2	GND LED
Pin 3	- 19,7V Power-On-LED - (Rv= 8k25)
Pin 4	+ 19,7V Audio
Pin 5	GND Audio
Pin 6	- 19,7V Audio
Pin 7	+ 19,7V Mute-Relais A
Pin 8	GND Mute-Relais A
Pin 9	GND Mute-Relais B
Pin 10	- 19,7V Mute-Relais B

8.0 Device preparation:

If the configuration of the device is to be changed, a housing opening is required for this. Before doing so, be sure to **remove the power supply cable**. The current versions of the SAM-1C with switching power supply are accessed by loosening and removing 6 screws and loosening 2 additional screws on the front and rear panel. A Philips size 1 Phillips screwdriver is required as a tool.



A On the plug connection side, remove the two left and the middle Phillips screws and loosen the upper right screw by approx. 1..2 turns; on the mains connection side, remove the two right and the middle screws and loosen the upper left screw only.



8.1 Opening:

Pull off the left side profile to the left as seen from the connector side. Lift the cover on the left side by approx. 30 mm and remove the cover plate from the right side profile, also to the left.

8.2 Expand modules:

each module is held by 5 Phillips screws. These 5 black screws are arranged as follows: 2 screws each diagonally to the XLR sockets and one centrally to the right of the RCA sockets. After loosening these 5 screws and pulling off the internal connector on each board, the corresponding module can be removed. In the case of the right-hand module, the protective earth connection attached to the front from the inside must also be loosened.

8.3 Install modules:

Mount the device in reverse order. Do not forget the internal yellow/green protective conductor cable on the front inside!

9.0 Mains fuse:

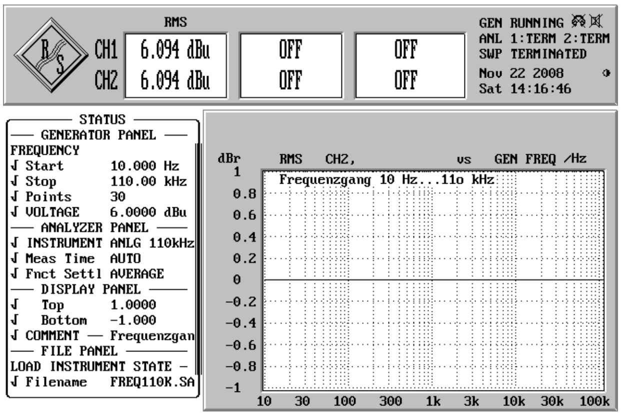
Important: the device may only be operated as a protection class 1 device, i.e. it may only be used with a mains cable with a protective earth connection.

Electronic current limiters monitor all output currents and limit them to a fixed value. Due to this measure the power supply survives short circuits between the outputs and ground or damage to the audio electronics permanently without damage. The outputs are ready for operation again immediately after a short circuit has been eliminated. It is not necessary to change fuses.

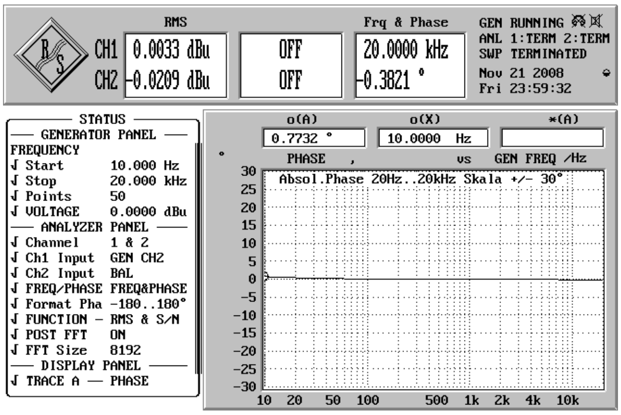
In addition, a primary fuse is provided on the power supply board for safety reasons. This fuse does not respond under normal circumstances (even in the event of a short circuit) and cannot be replaced by the user. In the event of a fault, it is essential to have this fuse replaced by a specialist or to replace the power supply unit!

TYPICAL PROPERTIES BALANCING AMPLIFIER SSOM-04Mc

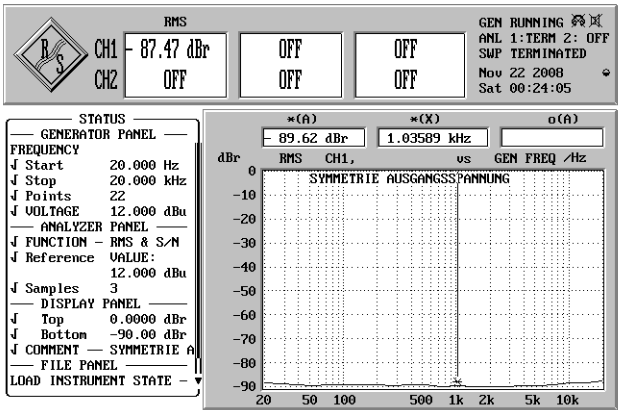
The following typical measurement results were measured on a SAM-1C series unit equipped with SSOM-04Mc module. Usual load resistance of 10 kΩ at line levels of +6 dBu and 0.0 dB gain, unless otherwise specified. The configuration of the analyzer is indicated in the left block in each case. Feed via cinch socket, measured at the XLR output. Analyzer : R&S UPL



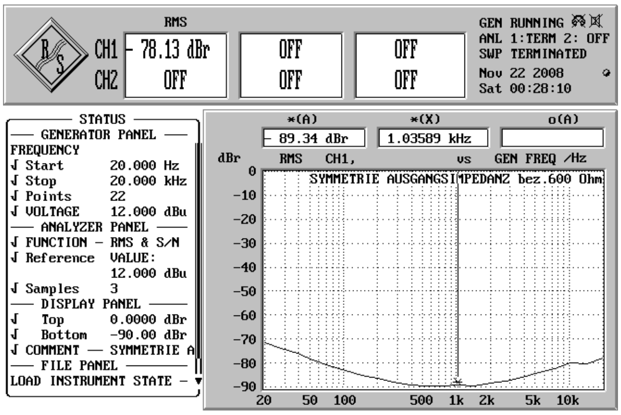
Frequency response 10 Hz...110 kHz, Scale +/- 1 dB



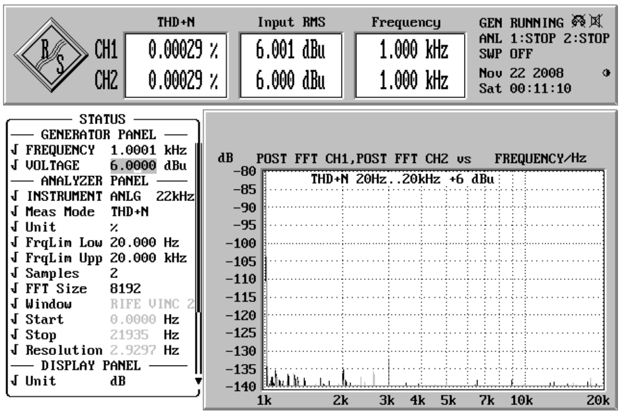
Phase response 10 Hz...20 kHz, Scale +/- 30°



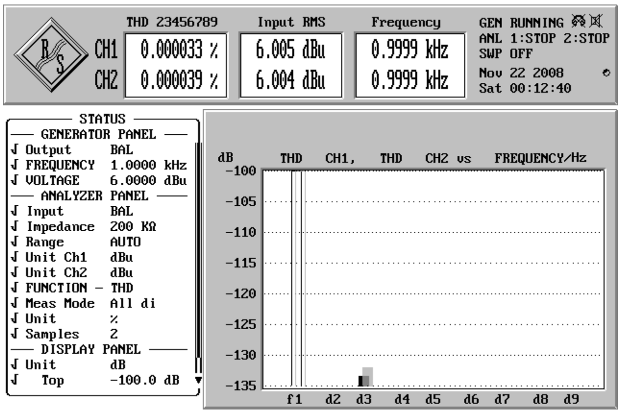
Symmetry of the output voltage at Ua +12 dBu $R_L = 10k\Omega$



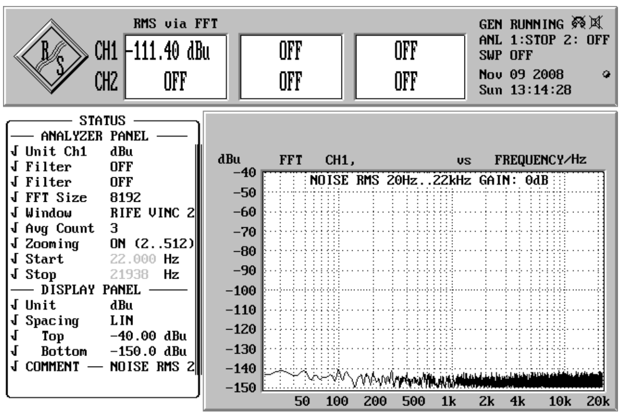
Symmetry of the output impedance at Ua +10 dBu $R_L = 600\ \Omega$



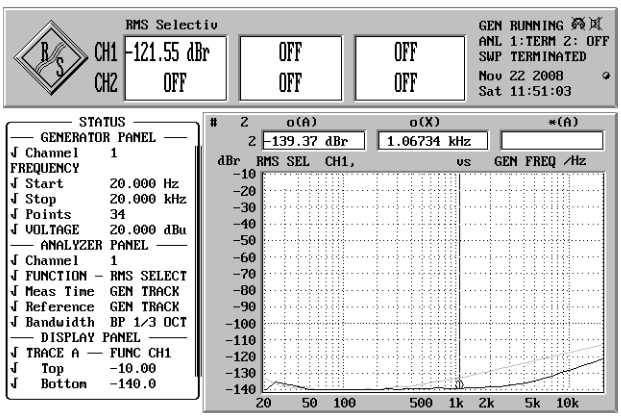
THD+N at 1 kHz Measuring bandwidth 22 Hz...22 kHz



THD at 1 kHz Harmonics measured from $K_2...K_9$



RMS-Noise- Spectrum at output with amplification 0,0 dB

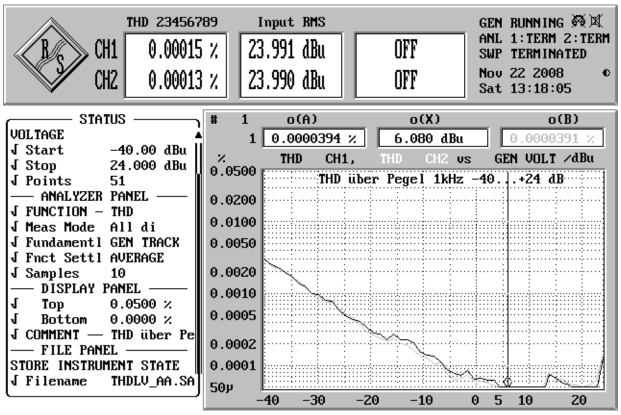


Crosstalk left channel < > right channel

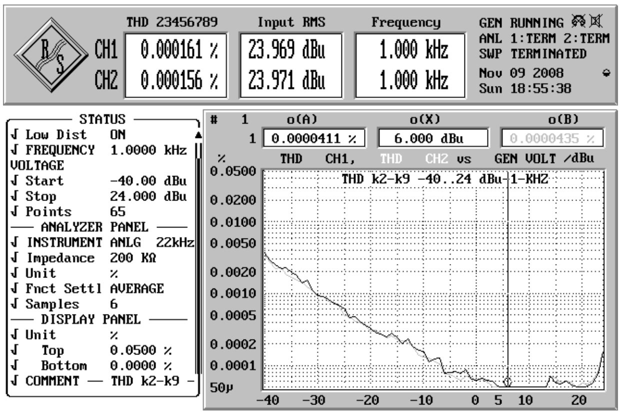
Crosstalk left channel < > right channel. The graphs on the left show the SSOM-04Mc balancing amplifier module, those on the right the corresponding measurements on the SSIM-04Mc differential amplifier (instrumentation amplifier). Analyzer: R&S UPL

Balancing amplifier SSOM-04Mc

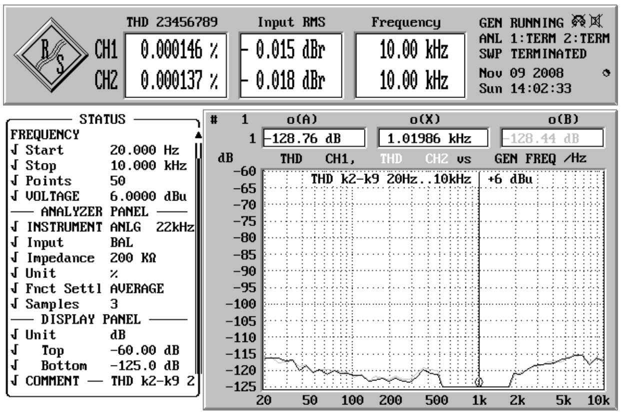
Difference/Instrument Amplifier SSIM-04Mc



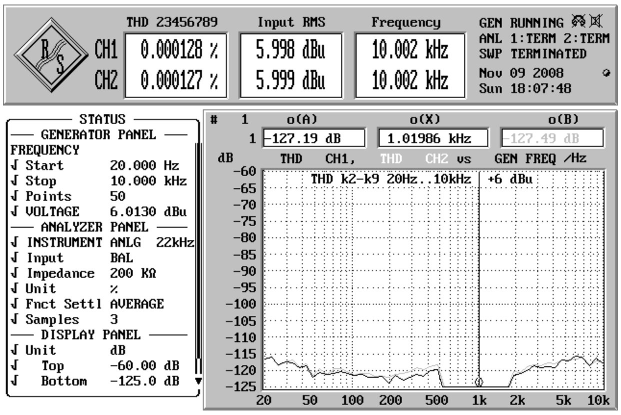
THD k2..k9 above levels of -40 dBu...+24 dBu SSOM-04Mc



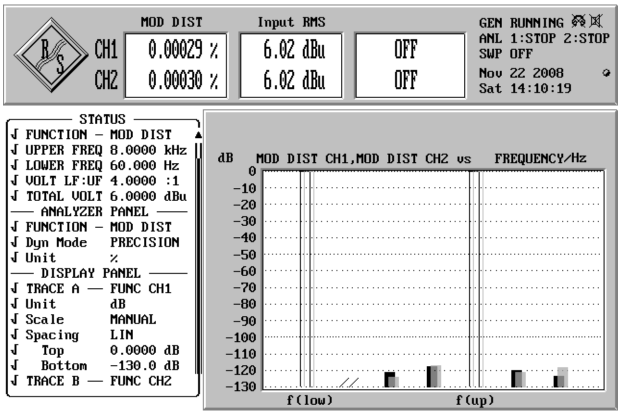
THD k2..k9 above levels of -40 dBu...+24 dBu SSIM-04Mc



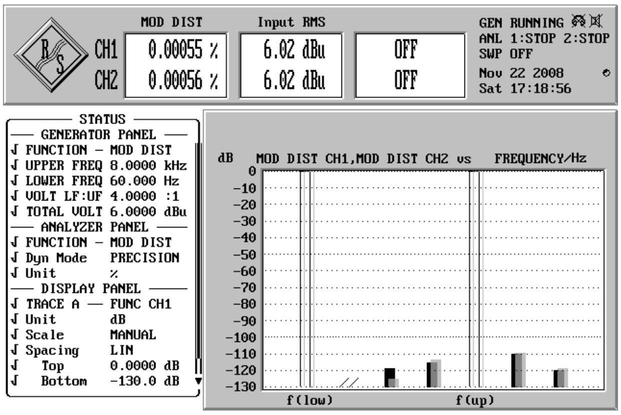
THD k2..k9 from 20 Hz...10 kHz (400 Hz-Tip comes from Analyzer)



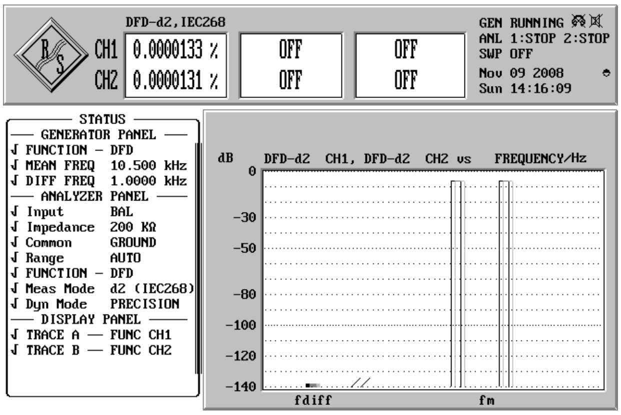
THD k2..k9 von 20 Hz...10 kHz (400 Hz-Tip comes from Analyzer)



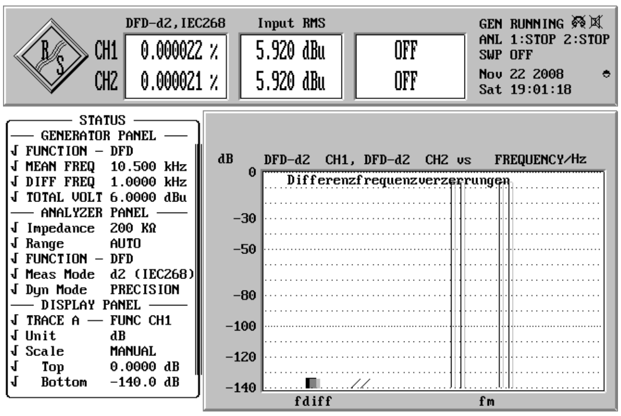
Intermodulation distortion 8kHz/60Hz Ratio: 4:1 SSOM-04Mc



Intermodulation distortion 8 kHz/60 Hz Ratio: 4:1 SSIM-04Mc



Differential frequency distortion 10,5 kHz, Diff.=1 kHz SSOM-04Mc



Differential frequency distortion 10,5 kHz Diff.=1 kHz SSIM-04Mc

TYPICAL PROPERTIES BALANCING AMPLIFIER SSIM-04Mc

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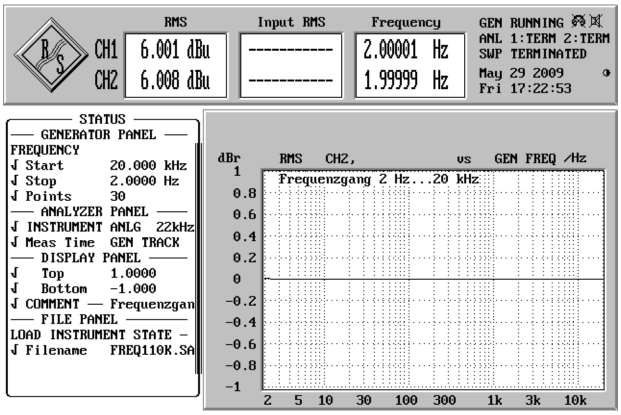
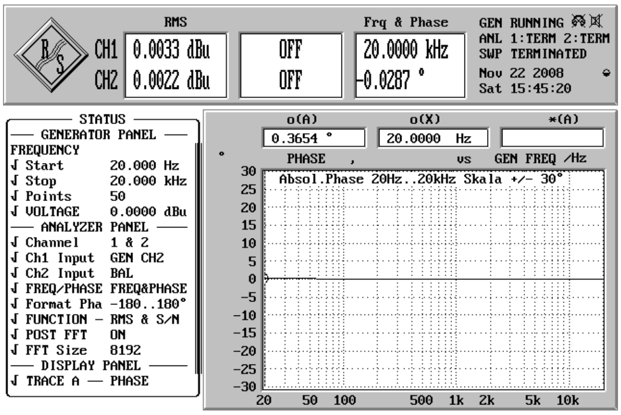
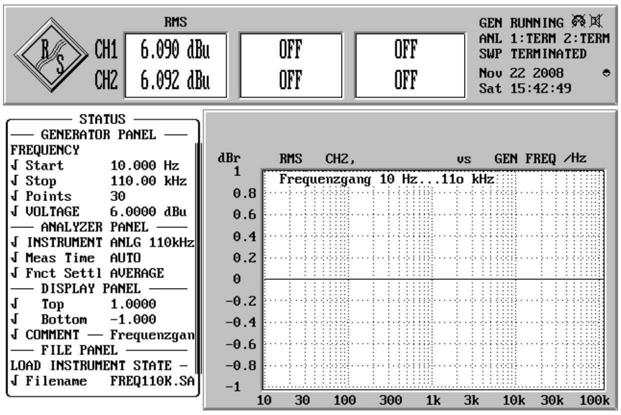


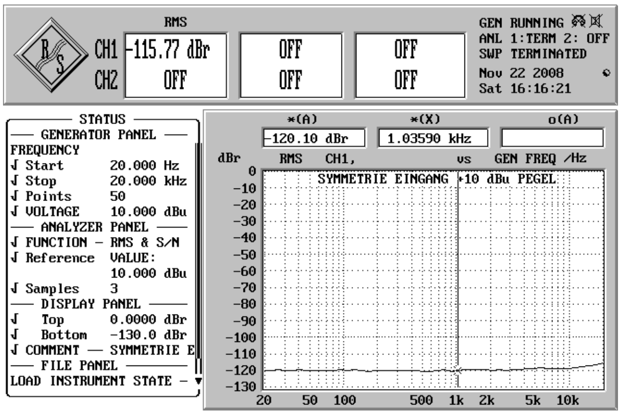
Frequency response 2 Hz...20 kHz Scale: ± 1 dB



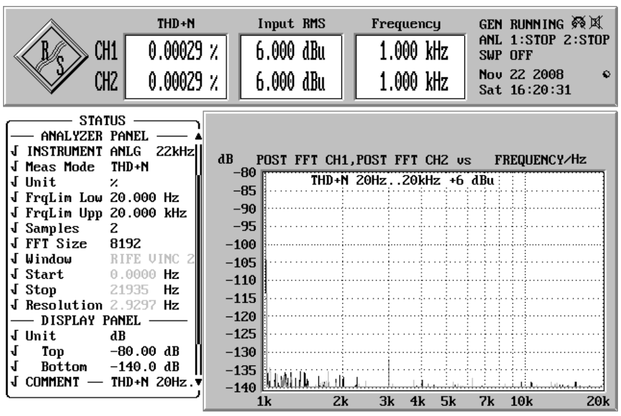
Phase response 20 Hz...20 kHz Scale: ± 30°



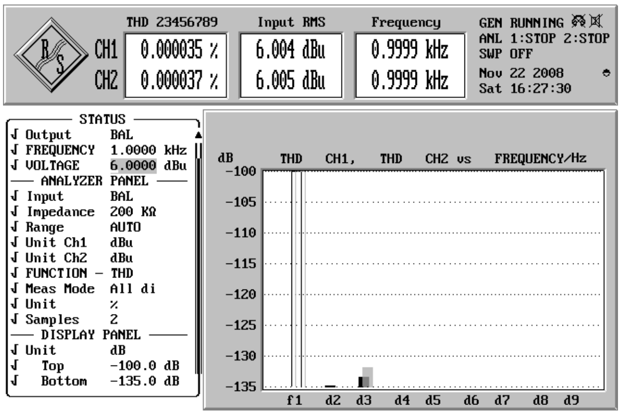
Frequency response 10 Hz...110 kHz Scale: ± 1 dB



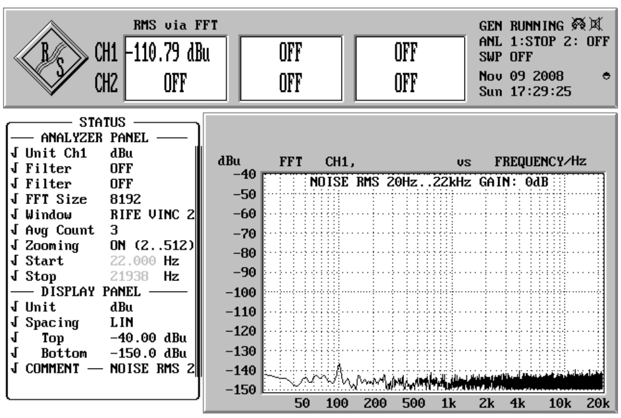
Common mode rejection ratio balanced input



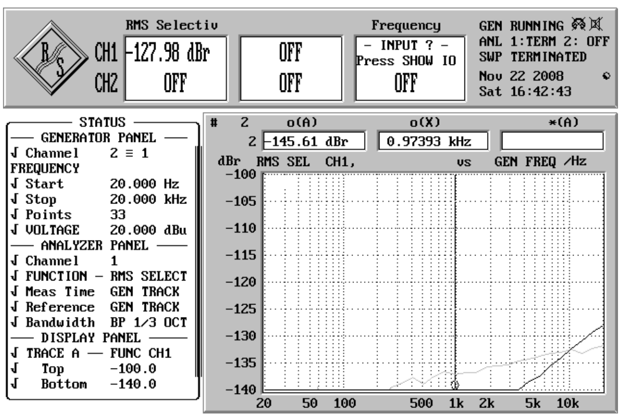
THD+N at 1 kHz Measuring bandwidth 20 Hz...20 kHz



THD at 1 kHz Harmonics measured from $k_2 ... k_9$



RMS Noise- Spectrum at output with amplification 0,0 dB



Crosstalk left channel ⇔ right channel

SSOM-04Mc-Modul unbalanced inputs to balanced outputs (balancing amplifier)

(unless otherwise stated with gain 0 dB, Ue = + 6 dBu [in brackets + 18 dBu], R_L = 10 kΩ),

all measurements determined with the following audio analyzers : Audio Precision System 2722 and Rohde & Schwarz UPL and UPV

Gain :	0...+ 24 dB adjustable by spindle trimmer (level reductions also possible) Set to + 10 dB on delivery, exception : distribution and summing versions
Input resistance :	250 kΩ
Max. Input voltage :	+ 24,5 dBu
Output internal resistance :	25 Ω
Max. Output voltage :	+ 24,4 dBu at 10 kΩ + 22,5 dBu at 600 Ω + 18,0 dBu at 300 Ω
Output level change idle / 600 Ω:	≤ 0,35 dB
Output level change symmetrical / asymm..:	≤ 0,1 dB
Symmetry of the output voltage :	> 80 dB (20 Hz...20 kHz), typ. > 85 dB bei 1 kHz
Symmetry of the output impedance :	> 70 dB (100 Hz...10 kHz), typ > 80 dB referenced to 600 Ω at 1 kHz
THD (K_2...K_9) non-linear harm. Distortions **:**	1 kHz ≤ 0,000018 %, [1 kHz < 0,00004 %]
THD+N non-linear harm. Distortions (Bw 22k) **:**	≤ 0,00018 % (0,0001 % at 600 Ω) 20 Hz...10 kHz [0,0008 %)]
Differential distortions 10,5 kHz Δf 1 kHz **:**	≤ 0,0001 % (0,0001 % at 600 Ω) [< 0,00008 % (0,00008 % at 600 Ω)]
Intermodulation 60 Hz/7 kHz **:**	≤ 0,0004 % (0,0004 % at 600 Ω) [< 0,0004 % (0,0005 % at 600 Ω)]
Frequency response :	5 Hz...20 kHz ± 0,01 dB (20 Hz...20 kHz +/- 0,03 dB at 600 Ω Last)
Phase response absolute :	≤ ± 0.5° from 20 Hz...20 kHz (R_L = 10 kΩ) (≤ - 4,5° 20 Hz at R_L = 600 Ω)
Max. capacitive output load :	25 nF
Crosstalk attenuation L ⇔ R :	1 kHz : > 130 dB, 10 kHz : 117 dB, 20 kHz : 112 dB (generator R_i = 50 Ω)
Noise at the output :	Input terminated with 50 Ω :

Gain :	0 dB	+ 10 dB	+ 20 dB
Output noise voltage 20 Hz...20 kHz $_{eff.}$:	- 112,0 dBu	- 107,3 dBu	- 100,2 dBu
Noise voltage A- weighting $_{eff.}$	- 115,0 dBu	- 110 ,0 dBu	- 103,0 dBu
Noise voltage quasi-peak CCIR $_{468/3\ qp.}$:	- 101,8 dBu	- 96,5 dBu	- 89,5 dBu

Dynamic range at 0 dB gain :	136,5 dB $CCIR_{468}$ eff. unweighted, 139.5 dB A-weighting
Output offset voltage :	< 1 mV

SSIM-04Mc-Modul balanced inputs to unbalanced outputs (differential amplifier)

(unless otherwise stated with gain 0 dB, Ue = + 6 dBu [in brackets + 18 dBu], R_L = 10 kΩ)

Gain :	- 21...0 dB Adjustable by spindle trimmer, set to 0 dB on delivery
Input resistance :	500 kΩ balanced, 250 kΩ with asymmetrical wiring
Max. Input voltage :	+ 24,5 dBu (+18,5 dBu when jumpers 1/3 are set)
Common-mode rejection ratio :	> 115 dB at 100 Hz, > 115 dB at 1 kHz, > 115 dB at 10 kHz (typ. 120 dB/1 kHz)
Max. Output voltage :	+ 24,5 dBu at 10 kΩ + 23,8 dBu at 600 Ω + 21,5 dBu at 300 Ω
Output internal resistance :	≤ 1 Ω
Output level change idle / 600 Ω:	< 0,02 dB
THD (K_2...K_9) non-linear harm. Distortions **:**	1 kHz < 0,000025 % , typ. 0,00002 % [1 kHz < 0,00005 %]
THD+N non-linear harm. Distortions (Bw 22k):	≤ 0,00025 % from 20 Hz...10 kHz [0,00025 %]
Differential distortion 10,5 kHz Δf 1 kHz **:**	≤ 0,0001 % [< 0,0001 %]
Intermodulation 60 Hz/7 kHz **:**	≤ 0,0004 % [< 0,0005 %]
Transient intermodulation DIM 100 **:**	≤ 0,001 % [< 0,001 %]
Frequency response :	5 Hz...20 kHz < ± 0,01 dB, 5 Hz...110 kHz < ± 0,02 dB
Phasengang absolut :	≤ +/- 0,5° from 20 Hz...20 kHz
Max. capacitive output load :	15 nF
Crosstalk attenuation L ⇔ R **:**	1 kHz > 135 dB, 10 kHz > 130 dB, 20 kHz > 125 dB (generator R_i = 50 Ω)
Output noise :	Input terminated with 50 Ω :

Gain :	- 10 dB	0 dB	+ 6 dB (J 1/3 ein)
Output noise 20 Hz...20 kHz $_{eff.}$:	- 114,6 dBu	- 111,5 dBu	- 109,6 dBu
Output noise A- weighting $_{eff.}$:	- 117,5 dBu	- 114,3 dBu	- 112,4 dBu
Output noise quasi-peak CCIR $_{468/3\ qp.}$:	- 104,6 dBu	- 101,0 dBu	- 99,0 dBu

Dynamic range with 0 dB gain :	136 dB CCIR unweighted, 139,0 dB A- weighting
Output offset voltage :	< 1 mV

Power consumption SAM-1C :	80..265V / 50...400 Hz typ. 4 W , max. 6 W fully loaded, Stand-By: below 0,2 W
Protection class :	1
Housing design :	Aluminium profile housing white or black coated B x H x T (169 x 42 x 169 mm)
Warranty :	3 years on labour and material

10. Interference radiation and immunity

The unit complies with the protection requirements in the field of electromagnetic compatibility, which are listed in Directives 89/336/EEC and FCC, Part 15, among others. :

The electromagnetic emissions generated by the unit are limited to such an extent that other devices and systems can be operated as intended.

The unit has adequate immunity to electromagnetic interference so that it can be operated as intended.

The unit has been tested and meets the following conditions :

Safety : Protection class 1 according to EN60950; 1992 + A1/A2; 1993 (UL1950)

EMV : Audio, video and audiovisual equipment and for

Studio lighting control equipment for professional use.

Interference emission : EN55103-1

Interference immunity : EN55103-2

Consideration of these standards ensures with a reasonable probability both protection of the environment and appropriate immunity of the unit. However, there is no absolute guarantee that no unauthorised electromagnetic interference will occur during operation of the unit.

In order to largely exclude the likelihood of such impairments, the following measures must be observed:

When installing the unit, follow the instructions in this manual.

Use shielded cables for all audio paths. Make sure that the shielding is connected to the corresponding connector housing in a flawless, large-surface, corrosion-resistant manner. A cable shield connected at only one end can act as a receive/transmit antenna.

Only use components (installations, devices) in the system and in the environment in which the unit is used that in turn meet the requirements of the standards mentioned above.

Provide an earthing concept for the system that takes into account both safety requirements and EMC concerns. When deciding between star or surface or combined earthing, weigh up the advantages and disadvantages.

Avoid the formation of current loops or reduce their undesirable effect by keeping their area as small as possible (no unnecessarily long cables) and reducing the current flowing in them by inserting a common-mode choke, for example.

11 Safety

The unit may only be tampered with by qualified personnel in compliance with the applicable regulations.

Before removing parts of the housing, the unit must be switched off and disconnected from the mains.

When carrying out maintenance work on the open, live unit, bare circuit parts and metal semiconductor housings must not be touched either directly or with a non-insulated tool.

For maintenance and repair of the safety-relevant parts of the unit, only replacement material according to the manufacturer's specifications may be used.

In the event of faults in the SMPS-12 power supply, always replace the entire power supply unit. This power supply unit contains several safety-relevant components. In addition, an accurate check requires complex measurement technology.

11.1 Electrostatic Discharge (ESD)

Integrated circuits and other semiconductors are sensitive to electrostatic discharge (ESD). Improper handling of assemblies with such components during maintenance and repair can impair their technical properties or service life or lead to total failure.

The following rules must therefore be observed when handling ESD-sensitive components :

ESD-sensitive components may only be stored and transported in packaging intended and designated for this purpose.

Unpackaged ESD-sensitive components may only be handled in the protective zones set up for this purpose (EPA, e.g. area for field service, repair or service station) and may only be touched by persons who are connected to the earth potential of the repair or service station. The serviced or repaired unit as well as tools, aids, EPA-suitable (electrically semi-conductive) work, storage and floor mats must also be in contact with metallic surfaces (shock discharge hazard).

To avoid undefined transient stress on the components and their possible damage due to unauthorised voltage or equalising currents, electrical connections may only be made or disconnected when the unit is switched off and after any capacitor charges have dissipated.

CE DECLARATION OF CONFORMITY

FUNK TONSTUDIOTECHNIK
10318 Berlin

declares on its own responsibility that the product

4-CHANNEL - BALANCING / DIFFERENTIAL AMPLIFIER

SAM-1C

complies with the following standards in accordance with the provisions of the EU directives and their supplements :

Security :

Protection class 1, EN60950; 1992 + A1/A2; 1993

EMV :

EN55103-1 EN55103-2

Evaluation criterion B electromagnetic environment E4

Berlin, 3.09.2020

Th. Funk, Owner

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