Digital FIR Controller

PRO C 28

Short Form Information

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(For additional in-depth information concerning the K + H Pro C 28 digital controller please refer to the user's manual)

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Digital FIR Controller

Concept

- Stereo-4-Way digital loudspeaker controller designed for use with studio- and PA-loudspeakers
- Special digital FIR filtering to realize a completely independent equalization of system amplitude and phase (FIR = Finite Impulse Response)
- Possibility to achieve a so-called “linear phase” equalisation which results in a constant group delay over the whole frequency range of the system!
- Additional IIR digital filter section included, providing user-definable equalization with real-time adoption of changed parameters:
    - Parametric EQ (PEQ) with 10 full parametric bands of equalization independently for each channel (standard option)
    - Room-EQ to allow an easy system setup in case of problematic speaker positioning (standard option)
- Four separate digital limiters included in every single output channel:
    - Peak limiter to avoid any distortion and loudspeaker damage by restricting the peak power of the power amplifier
    - RMS limiter to avoid any distortion and loudspeaker damage by restricting the continuous power of the power amplifier
    - Thermo limiter avoids any speaker damage caused by overheating of the voice coil
    - Excursion limiter avoids any speaker damage by preventing of too high cone excursion
- Compact 19“ 2U rackmount unit
- All important settings at system setup are done automatically by loading the stored parameter setup which is calculated individually for each studio monitor delivered together with the Pro C 28
- All settings in the different menus of the Pro C 28 can be stored in a system setup
- Possibility to maximize the system performance in a given installation by creating individual, so-called “room-specific” FIR filter setups which are able to consider nearly every desired room equalization

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Features

State-Of-The-Art Audio Technology and Performance

- Symmetric analogue input stage with lowest noise figures and distortion
- 2 stacked AD converters (Δ/Σ) on each channel (“Gain Ranging” technique) provide an input dynamic range of more than 130 dB
- Digital signal processing with 48 BIT precision
- Latest generation DA converters (Δ/Σ)
- Smooth LP filtering after DA conversion guarantees a very musical and clear sound
- High performance power supply provides double voltage regulation for each functional block
- Wide connection possibilities for analogue and digital signals
- Highest quality input transformer can be switched into the analogue inputs if desired (standard option)

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Wide Range of Applications:

1. PA-Controller with Type-Specific Parameter Setups

- Parameter Setups for use with K + H loudspeakers and amplifiers available
  → Almost every combination possible
  → Very comfortable adjustment of delay and level when using subwoofers
  → Because of FIR filters nearly every desired frequency response possible
- Room and positioning equalization can be achieved easily by using the included IIR EQs
- Possibility to realize the room and positioning equalization within individual calculated FIR filter setups to maximize system performance

2. Studio controller with speaker-specific parameter setups

- To upgrade analogue K + H studio monitors (i.e. K + H O 300 D)
- "Speaker specific" means: The parameter setup will be calculated and optimized individually for each monitor delivered
  → State-of-the-art precision in loudspeaker equalization in a way which was never possible before
  → Room and positioning equalization can either be done by using the IIR EQ section, but for maximum system performance it should be realized within the FIR filter setup (creation of room-specific parameter setup necessary!)
  → Simple connection between Pro C 28 and prepared K + H monitors like the model O 300 D via a single multicore cable with dedicated multiple pin XLR terminals
- Easy system enhancement with one or more additional subwoofers
  → Subwoofers will be considered in the parameter setup so that amplitude and phase equalization is extended down to the lowest frequencies
  → Very comfortable setting options to align level and phase between subwoofers and satellites

3. One-Way Full Range Operation Mode

- High end digital EQ with multiple delay options and a sophisticated limiter concept in a single unit
  → Equalization of non-K + H studio monitors and sound reinforcement systems
  → Possibility to use the IIR EQ section and / or the integrated FIR filters to realize filters with a linear run of the phase response

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Extensive limiter concept

Every output channel (4 outputs left channel and four outputs right channel) features the following limiter structures which work independently from another:

- Digital peak and RMS limiter in „look-ahead"-technology with digital modelling of the power amplifiers load-behaviour
  → Short attack time constant for safely prevention of power amplifier clipping
  → So-called „Controlled Overshoot" allows using the full peak power of the amplifier
  → RMS limiter restricts the maximum continuous power to the power amp's max. value
- Digital thermo and excursion limiter with modelling of voice-coil temperature run and cone excursion
  → Long attack time constant to match the heating of voice coil
  → Prevention of thermal loudspeaker damage
  → Prevention of too large cone excursion
- All limiter settings are included within the parameter setup and will be loaded automatically at system setup

Comfortable Operation

- Easy stand-alone operation via the front panel controls
- Alternatively operation via the remote control type RC-55 (optional feature)
- Operation via IBM-compatible PC possible (RS-232 port integrated)
- Software-based operating concept with only three menu trees:
  - MAIN Menu: Settings like Input Gain, Input Select, Mute, Parameter Setup,…
  - SYSTEM Menu: General system settings like Display Brightness, MIDI Settings, Software Version,…
  - EQ Menu: Settings of the integrated IIR filter section (PEQ and room EQ)
- Connection of several units via the internal MIDI port (IN, OUT, THROUGH) provides a synchronous variation of all parameters (i.e. volume within a 5.1 surround setup)
- New parameter setups can be transferred into the Pro C 28 by connecting a PC to the internal RS-232 port
- The internal memory is capable of storing up to 70 different parameter setups
- Switching between different parameter setups can be done in real time during normal operation
- Every setting of the Pro C 28 (even the selected parameter setup) can be stored within a general system setup
- The remote control provides direct-access selection of up to four different system setups
- Optional memory module available for storing system setups to provide easy and save system-recovering in case of failure

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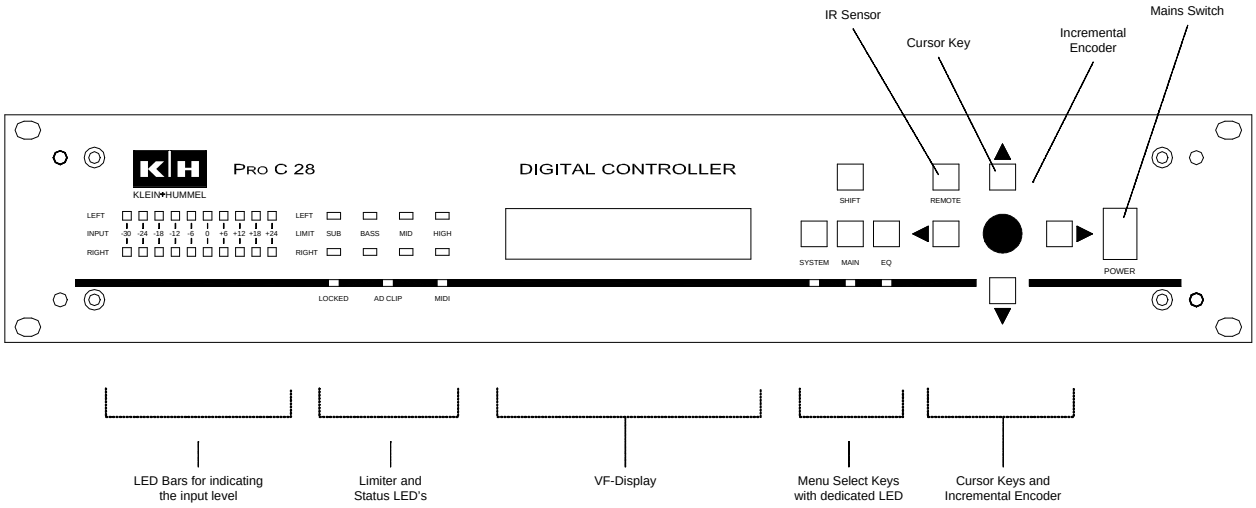
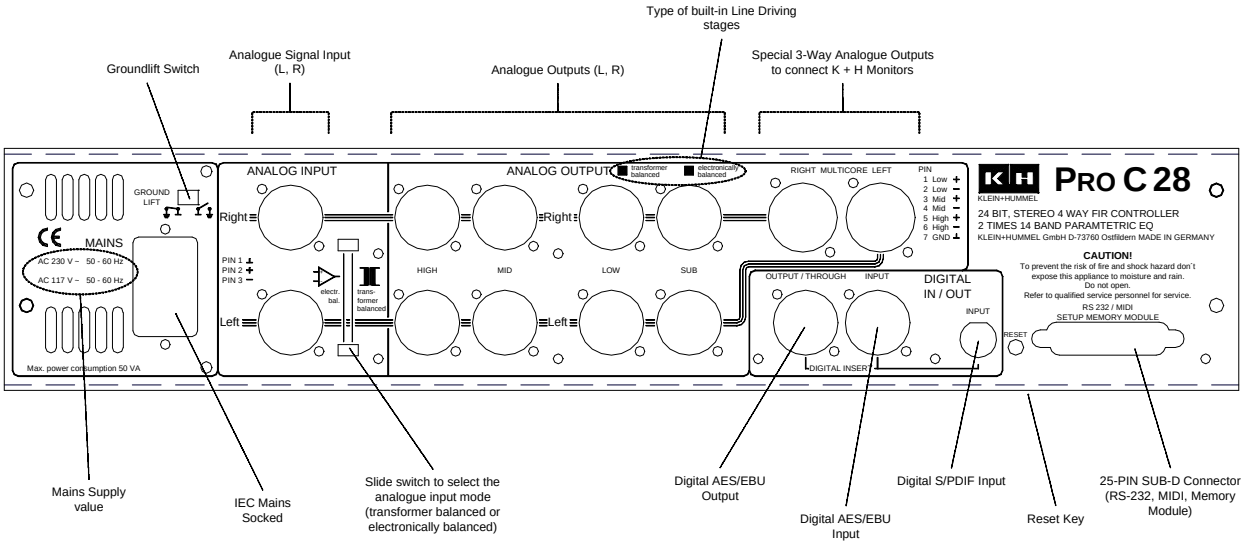
Front and Rear Controls and Connectors





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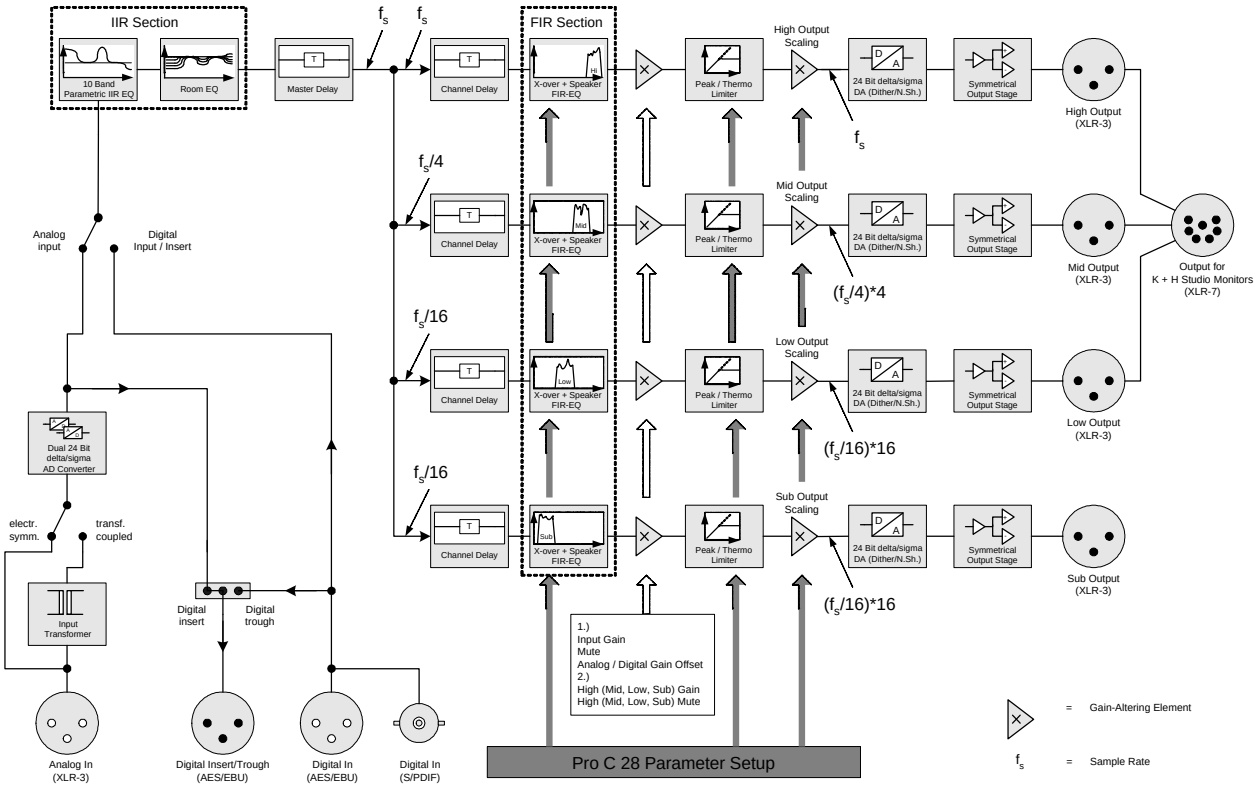
Signal Block Diagram (Simplified)



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Description of Inputs and Outputs

- **Analog Input:** Accepts signal levels up to +24 dBu, switchable between electronically and transformer balanced operation
- **Analog Output:** electronically balanced output stages with max. output levels of +16, +10, +4 dBu (selectable inside), asymmetric operation possible by shorting PIN 3 and PIN1 without changing the gain
- **Multicore Output:** Carries the high, mid and low analogue output channel in a single 7-PIN XLR terminal
- **Digital input XLR:** To connect symmetric AES/EBU sources to the Pro C 28. This input is transformer-coupled
- **Digital input BNC:** To connect asymmetric AES/EBU Sources (1Vpp) and asymmetric S/PDIF (Consumer) sources to the Pro C 28
- **Digital output/through:** As delivered by factory, his AES/EBU transformer-coupled output carries the converted analogue input signal without any manipulation. Alternatively, this output can double the digital signal which is applied to either the BNC or XLR digital input. The desired option is selected internally.
- **25-PIN SUB-D Connector:** This connector accesses the following digital ports of the integrated microcomputer:
    - RS-232 port for connecting the Pro C 28 to a PC to transfer parameter setup files
    - MIDI IN/OUT/THROUGH ports to connect several Pro C 28's
    - EE-Data for accessing the external memory module

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The Integrated PEQ Section

The PEQ provides a 10 band equalization with switchable characteristics and full parametric variation and can be operated independently for the right and left channel.

The following plots show some of the possible settings:

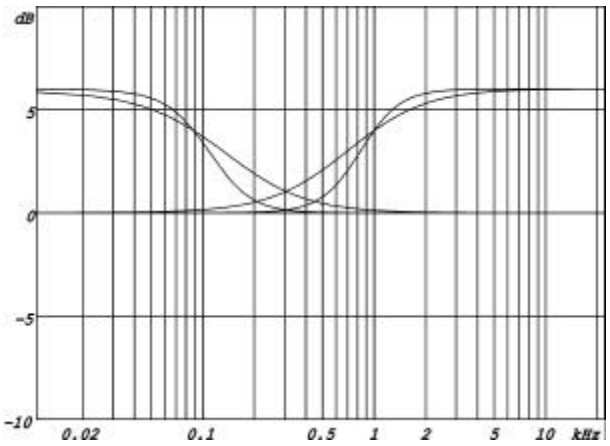

Fig. 1: *Low and high shelving filter; Slope = 6 and 12 dB/Oct.; Gain = +6 dB, Q = 0.7*

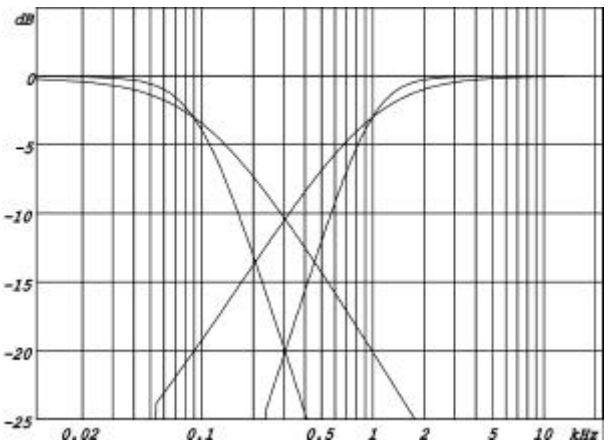

Fig. 2: *HP and LP filter; Slope = 6 and 12 dB/Oct.; Gain = 0 dB; Butterworth Char.*

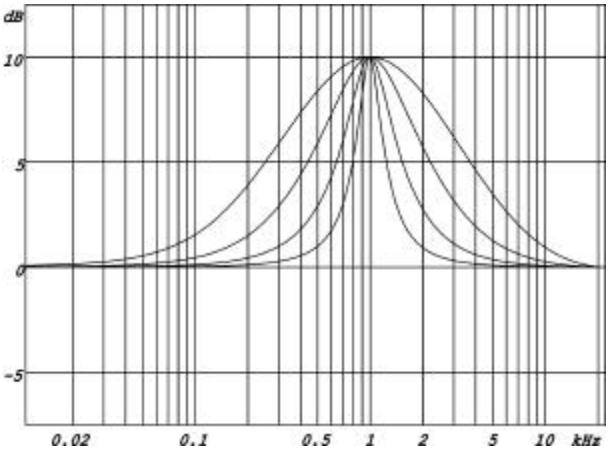

Fig. 3: *PEQ filter (bell); Q = 0.5, 1, 2, 4; Gain = +10 dB; frequency = 1 kHz*

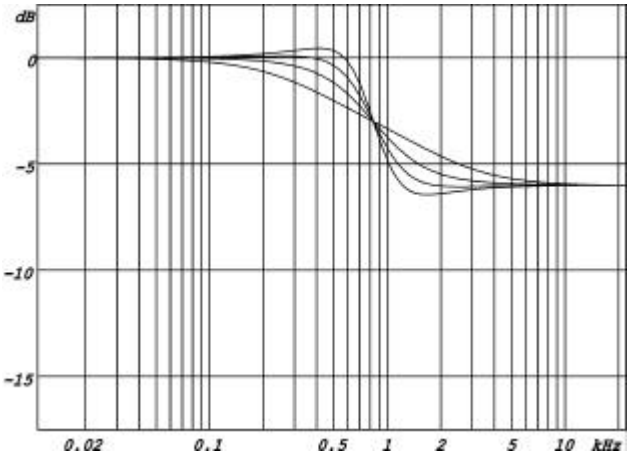

Fig. 4: *High shelving filter; Q = 0.4, 0.6, 0.8, 1.0; Gain = -6 dB; frequency = 1 kHz*

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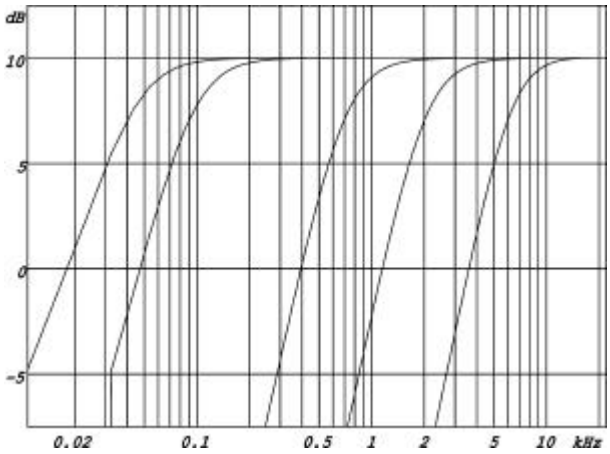

Fig. 5: *HP filters, frequency = 50, 100, 700, 2000, 6000 Hz; Slope 12 dB/Oct.; Gain = +10 dB; Butterworth-Char.*

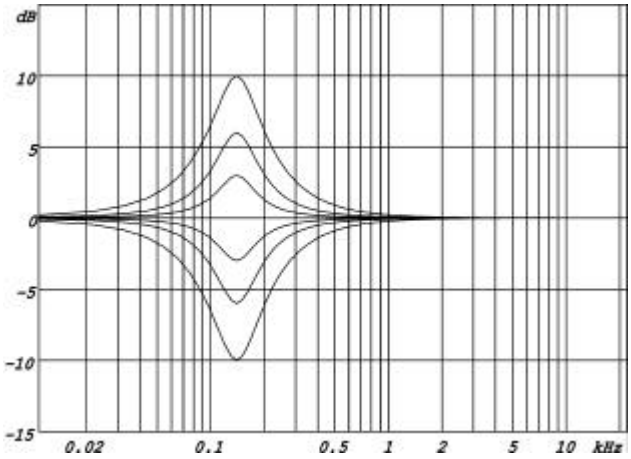

Fig. 6: *PEQ filters (bell); Gain = -10, -6, -3, 0, +3, +6, +10 dB; frequency = 150Hz Q = 2*

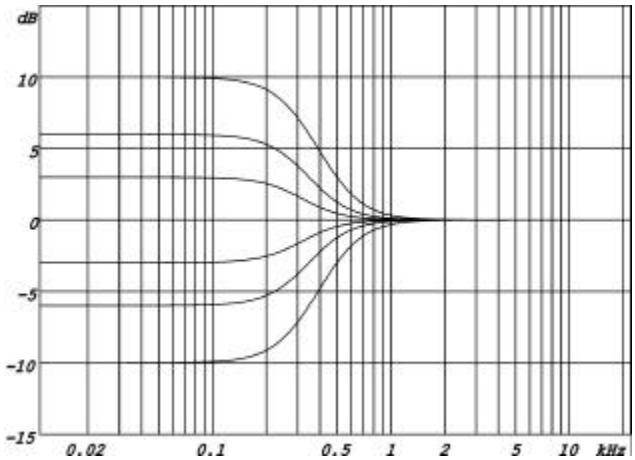

Fig. 6: *Low shelving filters; Gain = -10, -6, -3, 0, +3, +6, +10 dB; frequency = 300 Hz; Q = 0.7*

Possible PEQ Settings and Ranges, Available in Each Band:	
Parameter	**Setting / Range of Setting**
Channel	L, R, L+R
Type	HS 12: high shelving 12 dB/Oct HS 6: high shelving 6 dB/Oct LS 12: low shelving 12 dB/Oct LS 6: low shelving 6 dB/Oct Peak: (bell) HP 12: high pass 12 dB/Oct HP 6: high pass 6 dB/Oct LP 12: low pass 12 dB/Oct LP 6: low pass 6dB/Oct
Q	0,1...6355
Frequency	10 Hz ... 20 kHz
Gain	-99…12 dB

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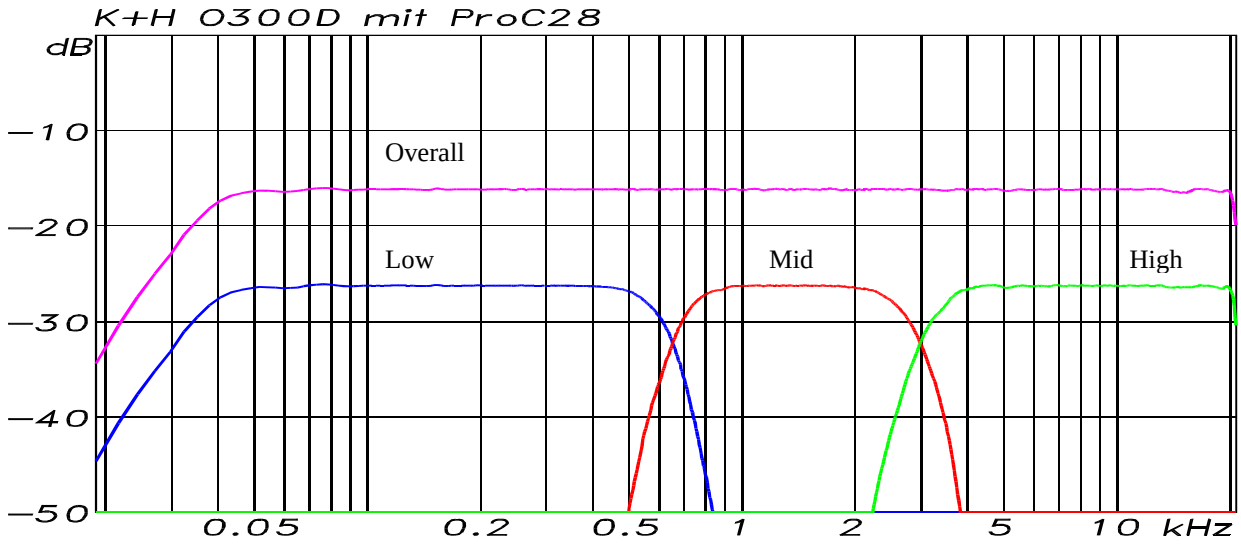
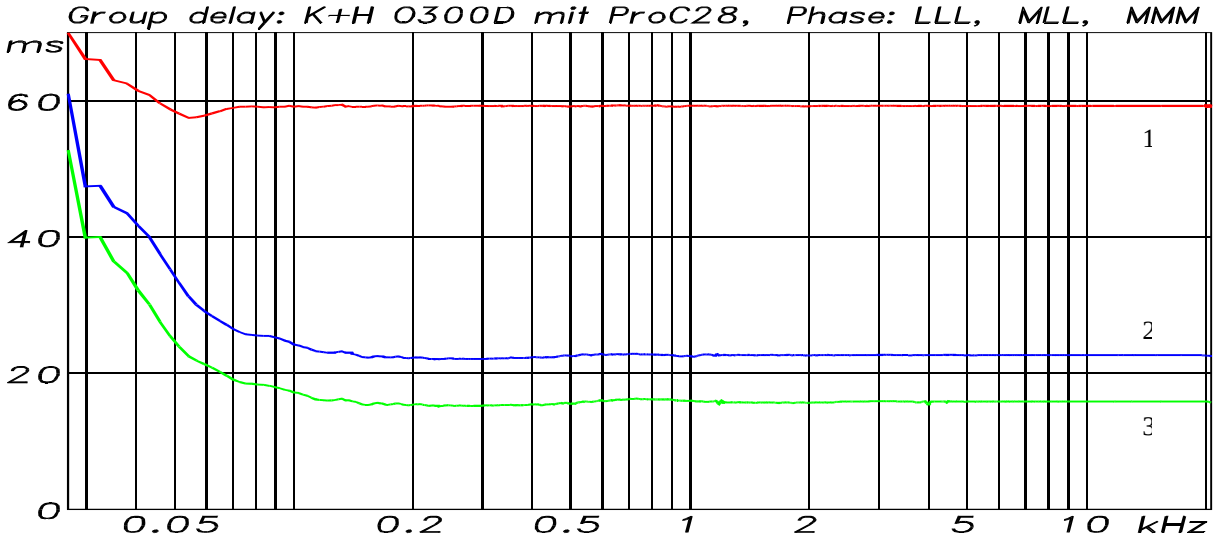
Performance Plots of the O 300 D Monitor with Pro C 28 Controlling



Overall transfer function and transfer functions of the three ways



Group delay response of O 300D with the following phase equalizations:
Low, mid and high linear phase (Curve 1)
Low minimum phase, mid and high linear phase (Curve 2)
Low, mid and high minimum phase (Curve 3)

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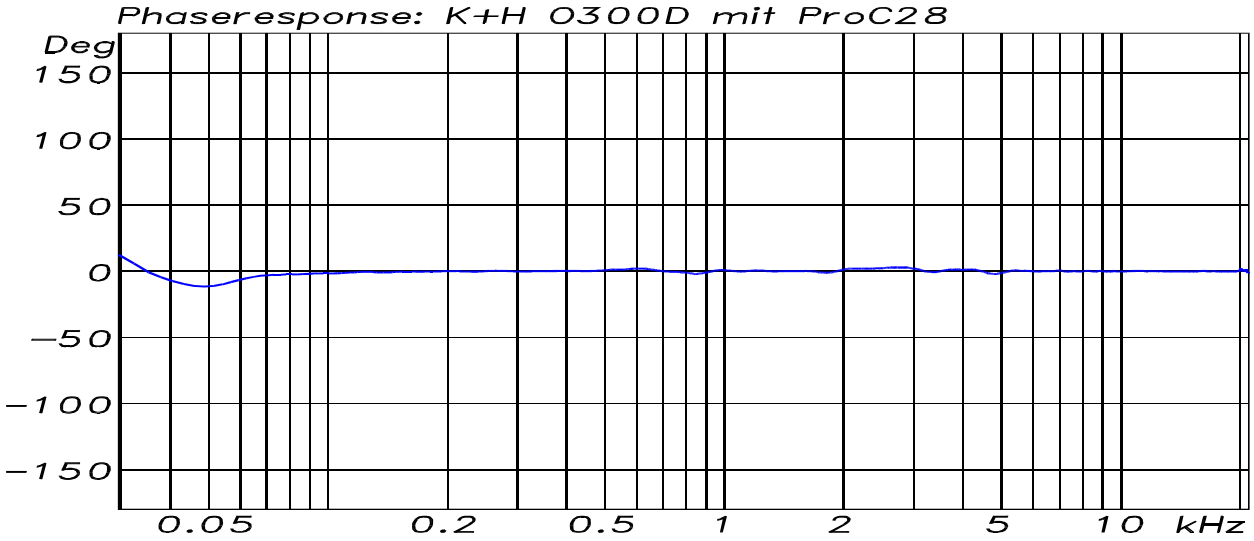
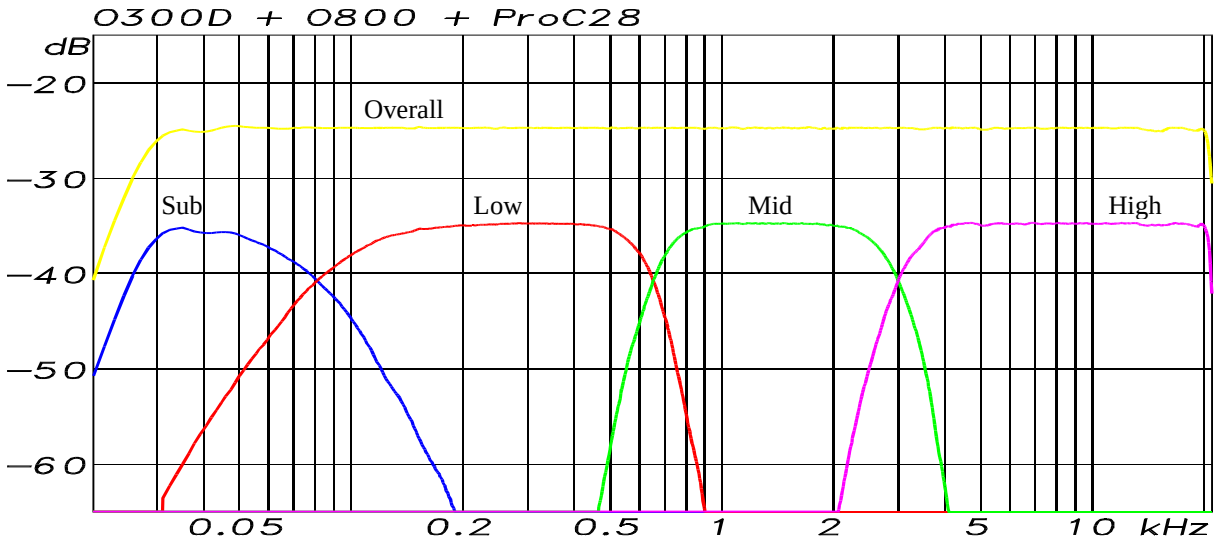


Phase response with linear phase equalization



Configuration of Pro C 28 / O 300 D with additional subwoofer K + H Type O 800:
Overall transfer function of the whole system and the transfer functions of each way

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Peak / RMS Limiter Function

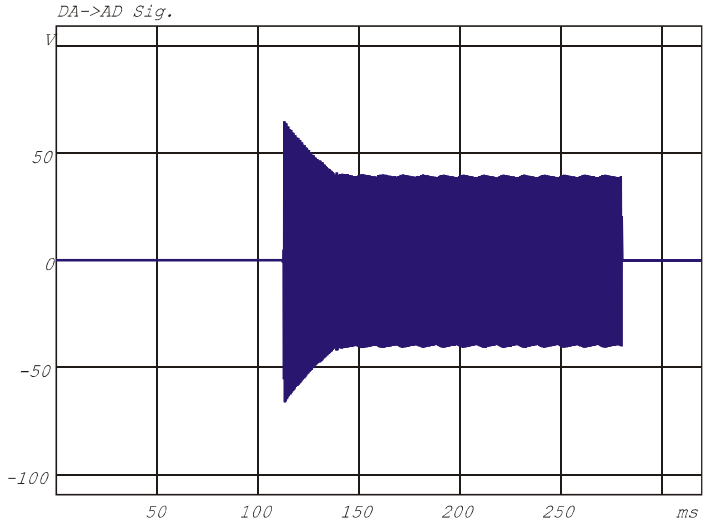

Fig. 1: *A sine burst signal, reproduced by an average power amplifier: Output power decreases from maximum peak power to the maximum continuous power of the amp. This degradation follows an amplifier type – dependant time constant and depends on the load condition of the amp's power supply.*

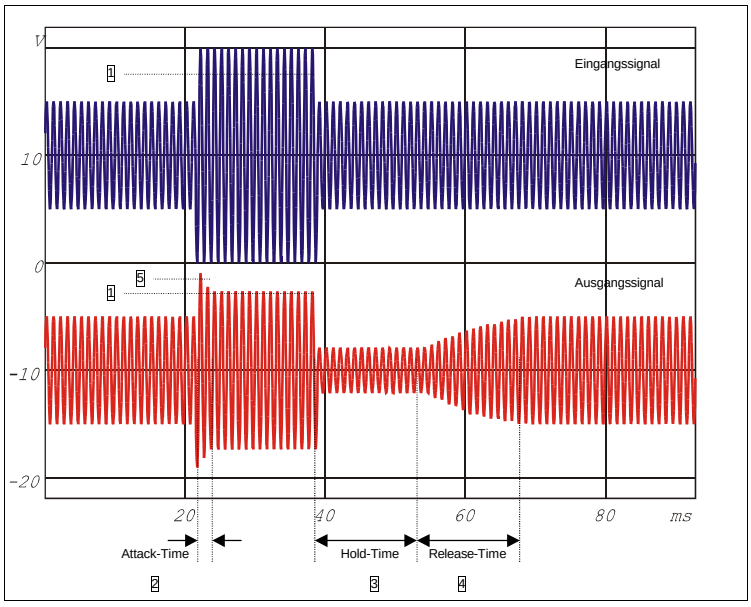

Fig. 2: *Reaction of the Pro C 28-internal peak limiter (curve below) when loaded with a sin burst signal (curve above): A controlled overshoot will be allowed according to the actual load condition of the power amplifier's supply, which is digitally modelled by the Pro C 28. Additionally both hold time and release time are affected by this internal simulation.*

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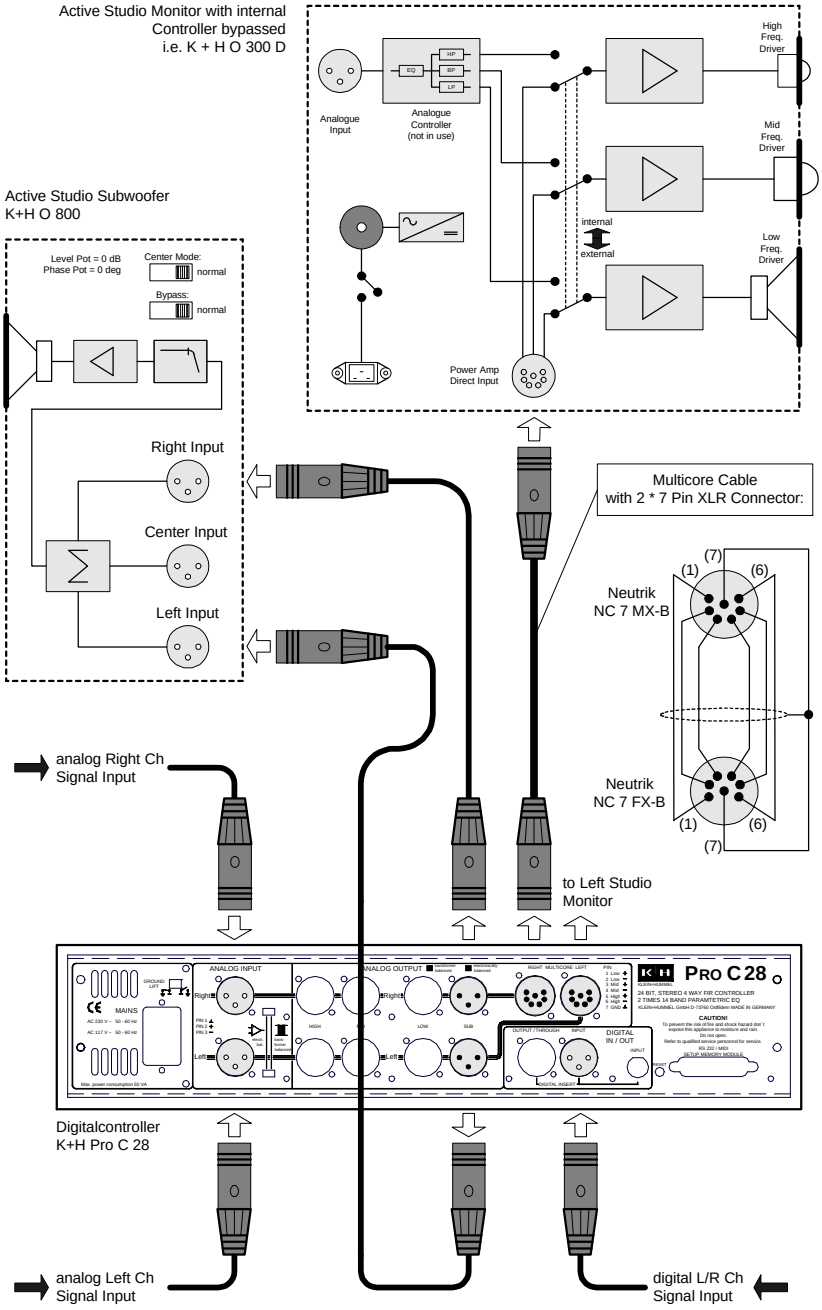
Connecting K + H Monitors and Subwoofers

Shown example: K + H Monitor Type O 300 D und K + H Subwoofer Type O 800.

Note that the O 300 D's internal analogue controller is deactivated in this mode!



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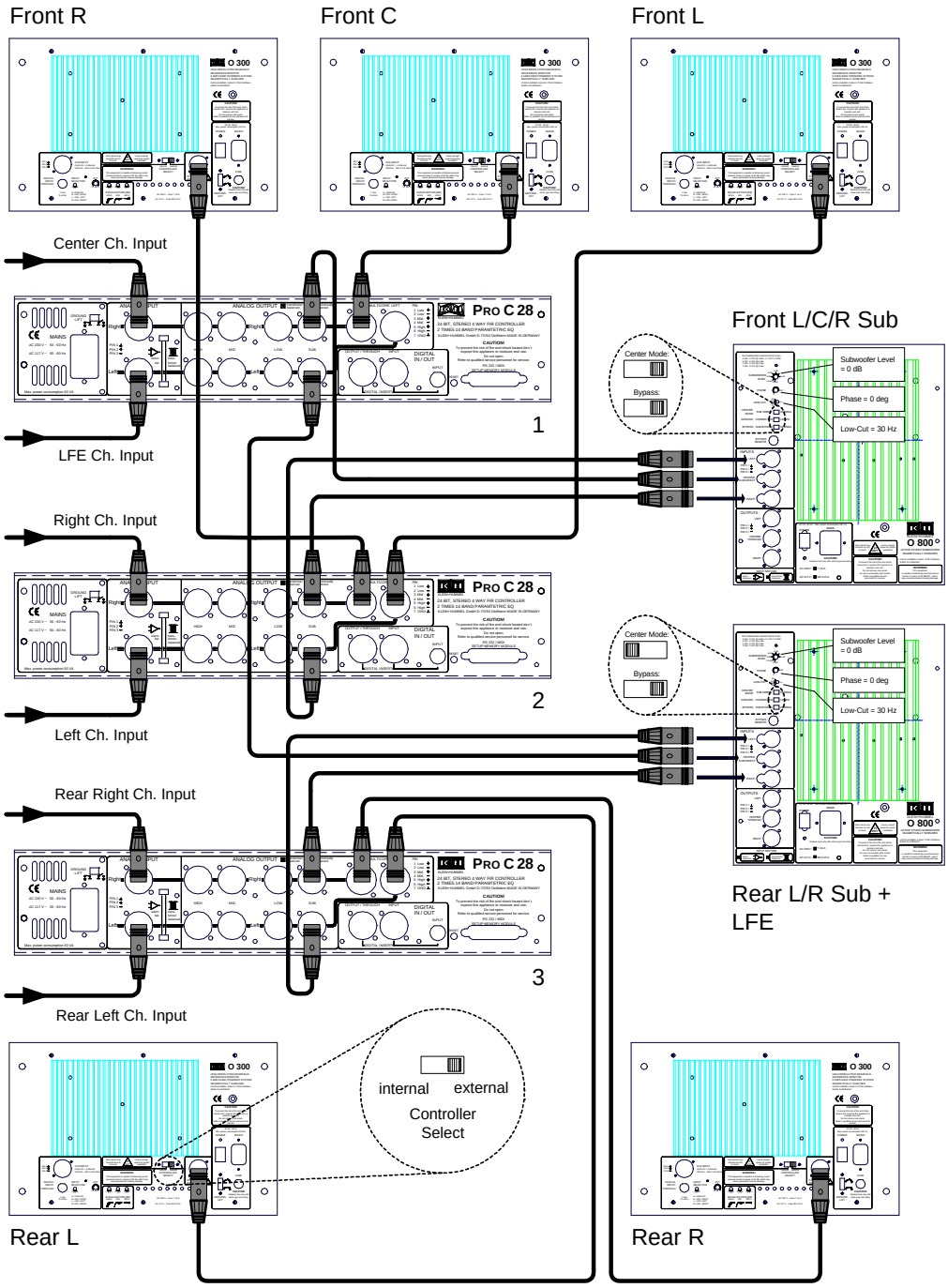
5.1 Surround System Setup

Shown Example: 5 x K + H Monitor O 300 D and 2 x K + H Subwoofer O 800



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Operating Software (Overview)

0 **K+H Pro C 28 Main Menu**

No. / Name of Menu Step	Selectable Options	Units	Default Setting	Hierarchy Level 0	1	2	3	4	5
1 Load Setup	No. / Name	---	000 Default Setup		X	X	X	X	X
2 Save Setup	Enter Setup Name / Enter Setup No.	---	---					X	X
3 Input Gain	Gain [dB]	-83...0...+45 dB	+20			X	X	X	X
	Balance L [dB] / R [dB]	-16...0...+16 dB	L = R = 0						
4 Gain Offset	Analog [+/- dB]	-30...30 dB	0						X
	Digital [+/- dB]	-30...30 dB	-13						
5 Mute	Mute on / Mute off	---	off				X	X	X
	Mute Attenuation [-dB]	-40...0 dB	-20						
6 Input Select	Analog / Digital / DigitalInsert	---	Analog					X	X
7 Digital Output	on / off	---	on				X		X
8 Input Routing	Normal / Reverse / Mono	---	Normal					X	X
9 Speaker Select (Matrix)	Top	---	---				X	X	X
	Subwoofer	---	---						
10 Master Delay	Delay Time [ms]	0...999 ms	0					X	X
	Distance [m]	0...339,9 m	0						
11 Delay Offset	Left / Right	0...5759 us	0 / 0						X
12 Channel Mute	High, Mid, Low, Sub: L, R, L+R [yes/no]	---	no						X
13 Channel Gain	High, Mid, Low, Sub: L, R, L+R [dB]	-18...6 dB	0.0						X
14 Channel Phase Invert	High, Mid, Low, Sub: L, R, L+R [yes/no]	---	no						X
15 Channel Delay	High, Mid, Low, Sub: L, R, L+R [ms]	0...92,1 ms	0.0						X
16 Delay Link	off / Mid+Hi / Low+Mid+Hi	---	Low+Mid+Hi						X
17 Limiter	Lim. Release [dB/s]	10...250 dB/s	250						X
	Display Test (via Enter)	---	---						

0 **K+H Pro C 28 System Menu**

No. / Name of Menu Step	Selectable Options	Units	Default Setting	Hierarchy Level 0	1	2	3	4	5
1 Brightness	LEDs [%]	0,50,75,100 %	100			X	X	X	X
	Display [%]	25,50,100 %	100						
2 Midi Settings	Channel	1...16	1						X
	out [out only / out-trough / loop]	---	out only						
	Baudrate [Midi / RS232]	31250 / 9600	RS-232 (9600)						
	ParaChg [on / off]	---	off						
	TX-Chn	1...16, OCM	1						
	TMP	38...255 BMP	100						
	Midi-Monitor [start]	---							
3 Security Level / Password	Load Level Nr.	0...5	5	X	X	X	X	X	X
	Password	---	0000						
4 Change Password	(Name)	---	0000						X
5 IR Control	[on / off]	---	on				X	X	X
6 AES Stat./ Sample Rate	S.Rate [kHz]	---	---					X	X
7 Version No. (Betriebssystem)	Reeboot	---	---						X
	Initialize	---	---						
8 Service Section	Check LED Bargraph	---	---						X
9 Version No. (Eprom)	---	---	App. V KH 1.0XX	X	X	X	X	X	X

0 **K+H Pro C 28 EQ Menu**

No. / Name of Menu Step	Selectable Options	Units	Default Setting	Hierarchy Level 0	1	2	3	4	5
1 EQ Set	Low Cut [Hz]	30...80 [10] Hz	30						X
	Bass EQ [dB]	-10...0 [2] dB	0						
	Mid EQ [dB]	-5...0 (1) dB	0						
	High EQ [dB]	-4...1 (1) dB	0						
2 EQ	Gain [dB]	-24...0 dB	-3						X
	EQ [on / off]		on						
3 EQ 1	Channel [L, R, L+R]	---	LR						X
	Type [HS12, HS6, LS12, LS6, Peak,	---	Peak						
	HP12, HP6, LP12, LP6]	---							
... ...	Güte	0,1...6355	2						
	Frequenz [Hz]	---	(different)						
12 EQ 10	Gain [dB]	-99...12 dB	0.0						
13 Load EQ Setup	No. / Name	---	000 Default Setup						X
14 Save EQ Setup	Enter Setup Name / Enter Setup No.	---	Default Setup						

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Organization of Stored Parameter Setups

(All Parameter Setups are stored in the internal flash rom chip, which is capable of max. 70 different parameter setup files)

- **Typical display shot when entering the "Speaker Select" – Menu Step belonging to the MAIN Menu**

TOP	SUBWOOFER
PRO X 6	PRO X SUB S

- **Organization of all stored parameter setups according to a matrix structure**
  (Example with 6 x 3 = 18 parameter setup files, max. > 70 files)

---------- Subwoofer ----------

---- Top ----	None	Pro X Sub S	RB 480
Pro X 6	1.blk	1.blk	3.blk
RX 60	4.blk	5.blk	6.blk
RX 120	7.blk	8.blk	9.blk
RX 180	10.blk	11.blk	12.blk
RX 240	13.blk	14.blk	15.blk
Neutral	neut1.blk	neut2.blk	neut2.blk

(*.blk = single parameter setup file)

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Room-Specific Parameter Setups

General:

Standard parameter setups as delivered by K + H together with a studio monitor like the model O 300 D are optimized by the K + H acoustic laboratory to achieve a flat overall frequency response of the whole system. This proceeding is the same like with all analogue controlled studio monitors at K + H.

Additionally at the Pro C 28, the phase response is equalized to a linear or a minimum run which is only possible with the Pro C 28's proprietary digital FIR filtering concept.

To adapt a given controller-monitor setup to a listening environment (i.e. studio), the end customer can use the possibilities of the integrated 10 Band PEQ and / or the room EQ. Because of the conventional IIR filtering in this section, it is possible to listen / measure the changes in real-time like with an analogue PEQ.

To maximize system performance, it is highly recommended to create an individual FIR parameter setup which provides the desired room equalization without affecting the phase response of the system like the IIR digital filters do and any of course any other analogue EQ does.

There are two different options how to get the necessary room EQ setting to create the room-specific parameter setup:

Option A (for the very best system performance)**:**

System set up and measuring of the system done by K + H or specially authorized sub contractors on customer's location:

1. Set up of the system (consists of Pro C 28 and K + H active powered studio monitor)
2. Measuring the system's frequency response up to 30 times at different points in the surrounding area of the main listening position. After that all plots are averaged to get one representative plot for the behaviour of the system. In this way each speaker has to be analyzed. It is definitely not sufficient to take only one single measurement, for example at the audio engineer's position, to get the desired result!
3. Correction of unlinearities in the averaged plots using the internal PEQ filters
   ⇒ The resulting equalization curve of the PEQ affects the target function of the new FIR filter setup
4. Calculation of the new, room-specific FIR filter setup using a proprietary loudspeaker measuring and filter calculating software
5. Transferring the new parameter setup to the Pro C 28 and resetting the PEQ.

Þ A room equalization of a stereo setup takes about one day inclusive all music listening tests

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Option B (less priced than Option A)**:**

System set up and measuring done by the customer, calculation of the new parameter setup done by K + H

1. Customer sets up the system
2. Measuring the system's frequency response along to the customer's method with adequate measuring equipment, registering the unlinearities caused by the listening environment
3. Correction of the unlinearities in the averaged plots using the internal PEQ filters
4. Sending the PEQ Parameters via e-Mail to K + H
5. K + H creates the new parameter setup by using the information received
6. The new parameter setup files will be sent to the customer (CD-Rom or via e-mail)
7. Customer transfers the received files into his Pro C 28
8. Bypassing the PEQ section and loading the new room-specific parameter setup

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Optional IR Remote Control RC-55

(Label shown)