Accuphase

DIGITAL FREQUENCY DIVIDING NETWORK

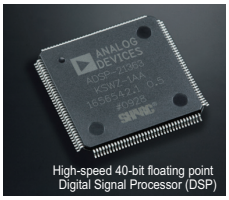
DF-55

●Channel divider units with high-speed DSP for fully digital signal processing ●Standard configuration allows 4-channel (4-way) system setup ●59 selectable cutoff frequency points ●Highly accurate 96 dB/oct attenuation slope ●Time alignment function allows delay time setting in 0.5-cm steps ●Delay compensator offsets signal delays in filter circuitry ●Further refined MDS++ D/A converter ●Output mode can be set to monophonic specifications

Multi-channel divider with fully digital signal processing – High-speed 40-bit floating point DSP provides the processing power for four channel units supplied in standard configuration. Highly accurate digital filters offer a choice of 59 cutoff frequency points and up to 96 dB/octave attenuation. Integrated time alignment function adjustable in 0.5-cm steps, and delay compensator for automatically offsetting any filter circuit delays. Output mode can be changed to monophonic specifications.

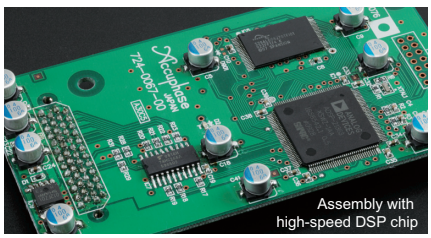
Multi-amplification is regarded as the pinnacle of the audio world. The term refers to dividing the musical spectrum into several distinct bands and handling each of these using a dedicated power amplifier and directly connected speaker unit. Such a system is necessarily more complex, but when configured and adjusted properly, it can achieve sound reproduction on a scale that is not possible by any other means. Sonic definition and sound quality can be optimized by the user to obtain exactly the desired result. Configuring a multi-amplified system affords truly one of the greatest pleasures of audio.

The Digital Frequency Dividing Network DF-55 represents a full model change of the model DF-45. A high-speed, high-precision DSP further minimizes any calculation errors, implementing accurate filtering of the highest order. Each bandwidth is handled by a dedicated divider unit, and a full array of functions including frequency dividing filters (low-pass, band-pass, high-pass) with 96 dB/octave attenuation, delay and delay compensation, level control, and phase switching are implemented in the digital domain. Digital as well as analog line and balanced inputs are provided, and the unit comes as a 4-channel device (for 4-way amplification) in its standard configuration.


High-speed 40-bit floating point Digital Signal Processor (DSP)

High-speed, high-precision DSP implements fully digital signal processing

The DF-55 features high-speed digital signal processing with amazing power. Latest digital circuit topology and advanced technology come together in a filtering DSP that has a 32-bit mantissa and 8-bit exponent section. The floating point principle enhances calculation accuracy by dividing numeric values into mantissa and exponent, thereby preventing errors even when handling very small values. This results in dramatically improved dynamic range and superior precision, allowing very steep cutoff slope settings of 48 dB or 96 dB per octave.


Assembly with high-speed DSP chip

59 selectable cutoff frequency points

Filter frequency points can be set over the range from 31.5 Hz to 22.4 kHz in 1/6-octave intervals. In addition, 10, 20, and 290 Hz points are also provided, resulting in a total of 59 points. Each divider unit is fully flexible and allows free selection of the lower and upper cutoff frequency.

Six filter slope characteristics up to 96 dB per octave

The filter attenuation characteristics can be set to 6 dB, 12 dB, 18 dB, 24 dB, 48 dB, or 96 dB per octave. The 96 dB/octave setting in particular allows the driver unit to reproduce only its intended frequency without being affected by adjacent frequency bands. This makes it possible to create a multi-amped system that takes musical accuracy to an unprecedented level.

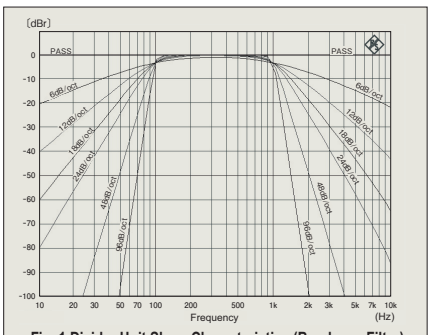
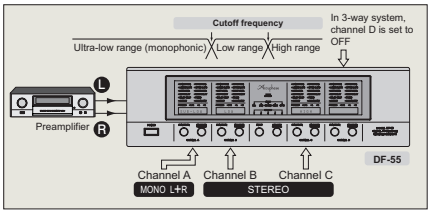


Fig. 1 Divider Unit Slope Characteristics (Bandpass Filter)
[Cutoff frequency setting 100 Hz for lower and 1 kHz for upper range]

Output mode of each divider unit can be set to STEREO, MONO L+R, MONO L, or MONO R

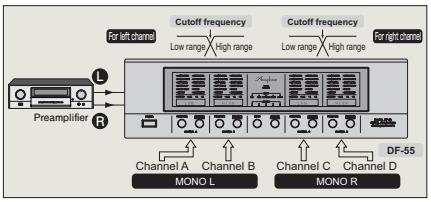
In normal use, the divider units will be set to the STEREO position, but by changing the setting to monophonic (MONO) operation, the left-channel and right-channel DAC outputs within the unit are added up, resulting in a parallel drive configuration that further reduces residual noise.

❶Use for a subwoofer (3D) system



In this example, the left and right signals in the ultra-low frequency range are mixed (channel A output mode is set to "MONO L+R" position), for configuring a three-way system with a subwoofer.

❷2-way system for left and right 2-way monophonic setup



Two of the four divider units in the DF-55 are set to the "MONO L" position and the other two units to the "MONO R" position. This allows setting up a 2-way monophonic spec system.

❸2-way to 4-way system, using two DF-55 units

The divider units of one DF-55 are set to the "MONO L" position, and the units of the other DF-55 to the "MONO R" position. This allows setting up a 2-way to 4-way monophonic spec multi-amped system.

Time alignment function allows delay adjustment in 0.5-cm steps

The sound emanating from a speaker travels through the air at a speed of about 343.5 meters per second (when the ambient temperature is 20 degrees centigrade). Compared to the propagation speed of light or of electrical signals, this is extremely slow. When multiple speaker units are used, necessarily located at different positions, there will be differences in the time required for the sound to reach the ear of the listener. In a multi-speaker system, each sound source position, namely the position of the diaphragm in the respective driver unit, is not aligned on the front/back plane, also leading to different arrival times of the sound. Compensating for such differences is called time alignment (see Figure 3). The DF-55 incorporates a DELAY function that uses digital signal processing to electrically adjust the time when the sound from each driver reaches the listener. Normally, a delay would be expressed as a time value, but since the delay here is caused by spatial distance, the DF-55 converts the delay into a distance value (cm) for easier understanding.

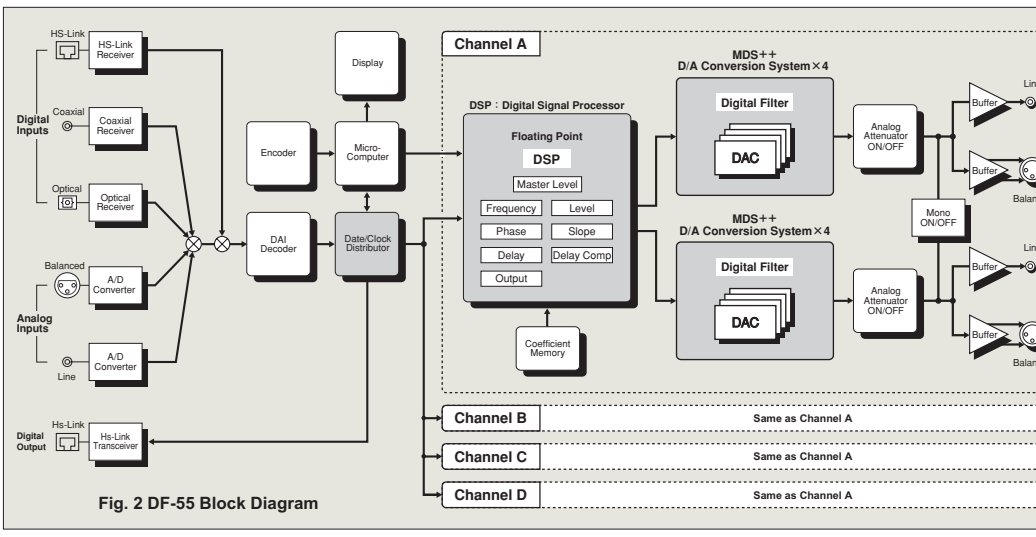
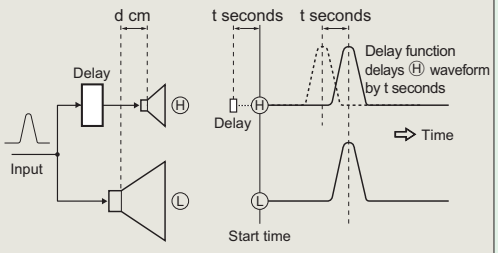


Fig. 2 DF-55 Block Diagram

＜Time alignment using delay＞



Speaker unit Ⓛ and Ⓗ sound source (diaphragm) are d centimeters apart

Delay ensures that Ⓛ and Ⓗ signals arrive at the ear at the same time

Fig. 3 Time Alignment Principle

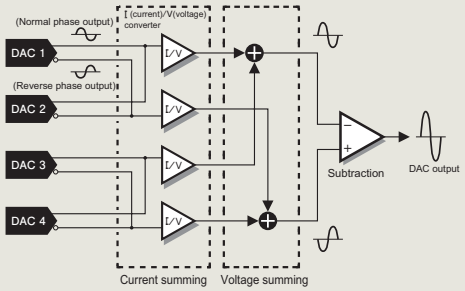
Speed of sound = 331.5 + 0.607 T [m/sec] T: temperature (°C)
Consequently, at 20°C, sound travels at about 343.5 m/sec.

In the example above, when DELAY function for Ⓗ is set to d cm, the signal start for Ⓗ will be delayed by t = d/34,350 seconds, causing the sound from Ⓛ and Ⓗ to reach the listener at the same time.

High-performance Hyperstream™ DAC used for MDS++

MDS (Multiple Delta Sigma) is a revolutionary design which employs several delta sigma type converters in a parallel configuration. In the combined output of these multiple converters, the ratio of conversion errors to the audio signal becomes larger, resulting in a drastic improvement in all relevant aspects of converter performance, such as accuracy, S/N ratio, dynamic range, linearity, and THD. (When the number of converters is taken as "n", the improvement is $\sqrt{n}$.)
Because the performance improvement afforded by the MDS principle is not dependent on signal frequency or signal level, noise at very low levels that plagues the output of conventional converters can also be reliably reduced.

In the DF-55, four Hyperstream™ DAC chips (ES9008 made by ESS Technology) of the latest generation are driven in parallel. Compared to a single converter, this results in an overall performance improvement by a factor of 2 (= $\sqrt{4}$). As shown in the diagram, the MDS++ circuit features an enhanced current-to-voltage (I/V) converter for processing the D/A converter output current. A combination of current summing and voltage summing is used, for optimized operation.
The overall result is improved stability and top-notch performance. The music emerges from a totally silent background, with breathtaking detail resolution and accurate spatial information.



Block diagram of MDS++ converter

Other Functions and Features

- Digital attenuator with setting range from -40.0 dB to +12.0 dB (in 0.1-dB steps) allows precise level adjustments for left and right channels.
- "Analog ATT" function can be activated for specific channels to reduce residual noise when using high-efficiency midrange or high range speaker units (ON: -10 dB).
- Versatile choice of input connectors. Digital signals can be supplied via coaxial, optical, and HS-Link inputs. Line and balanced inputs are available for analog signals.
- "Full Level Output Protection" function safeguards the speakers if a digital signal without volume control data is input (Output level reduction -40 dB).
- Unused divider units can be set to OFF (all display elements and LED indicators are out).
- Safety Lock prevents inadvertently changing any settings.
- Display indication can show predefined strings or custom strings entered by the user (max. 8 characters, character set 97 characters).
- Independent phase switching for left and right channel (4 patterns).

◆ The DF-55 comes standard with four units named CHANNEL A - D (4-way configuration). The assembly shown here carries the coaxial digital input and output connectors, line/analog input connectors, MDS++ D/A converter modules for 4 channels, and line/analog output connectors.

Delay compensator function of DF-55 (providing automatic compensation for signal delays)

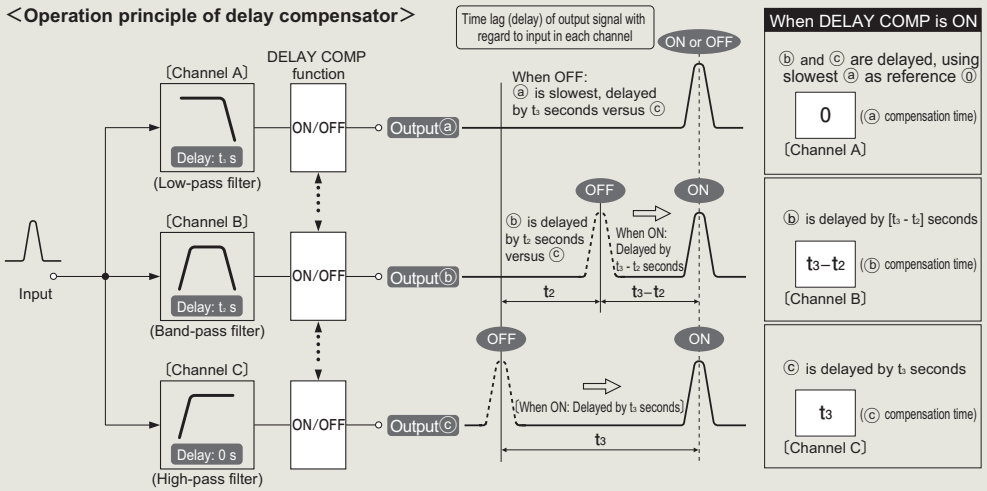
Besides delays caused by speaker placement, a certain delay will also occur when a signal passes through a filter circuit. The DF-55 incorporates a function called "DELAY COMP" that compensates for such delays. As an example, the illustration at right shows a simplified representation of how the delay compensator function works in a 3-way system.

- Regardless of whether a circuit is analog or digital, when the signal has to pass through a filter, the output will be delayed by a certain amount, causing a delay in step response and impulse response.
- Generally, a low-pass filter will have more delay. The DF-55 therefore only provides compensation when low-pass filtering is used.
- The lower the filter frequency and the steeper the filter slope, the longer the delay.

ON The DF-55 calculates and displays the theoretical delay time, and automatically provides compensation. (Default setting)

OFF The DF-55 calculates and displays the theoretical delay time for reference, and the user can manually set any desired value.

＜Operation principle of delay compensator＞



As shown above, the signal will be delayed by a different duration when passing through different filter circuits.

When DELAY COMP is OFF, the output signals in each channel will be shifted, causing time misalignment. Output signal vs input signal time lag (delay)

When DELAY COMP is ON, the time difference between output signals ⓐ, ⓑ, and ⓒ is eliminated.

Actual delay compensator indication is in cm, converted from the above compensation time value.

■ DF-55 default settings and display indication

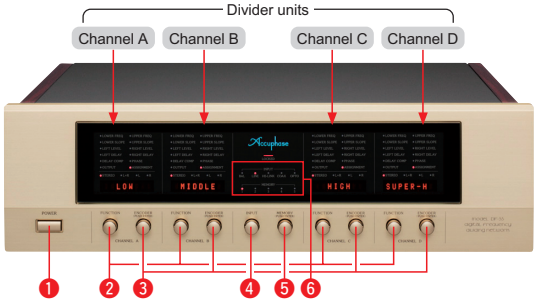
Function		Display indication	
LOWER FREQUENCY	UPPER FREQUENCY	7100Hz	PASS
LOWER SLOPE	UPPER SLOPE	12dB/oct	----
LEFT LEVEL	RIGHT LEVEL	-40.0dB*	-40.0dB*
LEFT DELAY (cm)	RIGHT DELAY (cm)	0.0	0.0
DELAY COMP	PHASE	ON 0	NOR NOR
OUTPUT	ASSIGNMENT	ON	SUPER-H
STEREO		STEREO	

* (▀) symbol at top right of level indication is shown when "Full Level Output Protection" function is set to ON.

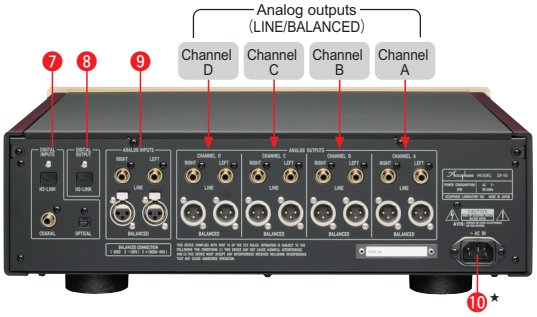
Cutoff frequency settings (Hz) (Cutoff characteristics: -3.0 dB, 59 points)

10	20	31.5	35.5	40	45	50	56	63	71	80	90
100	112	125	140	160	180	200	224	250	280	290	315
355	400	500	560	630	710	800	900	1000	1120	1250	1400
1600	1800	2000	2240	2500	2800	3150	3550	4000	5000	5600	6300
7100	8000	9000	10k	11.2k	12.5k	14k	16k	18k	20k	22.4k	

■ Front panel



■ Rear panel



1. POWER switch
2. FUNCTION knob (To select a function)
3. ENCODER knob (To set the value)
4. Input selector
5. Memory selector
6. Display
   INPUT: BAL, LINE, HS-LINK, COAX, OPTO
   MEMORY: 1, 2, 3, 4, 5
7. Digital inputs
   HS-LINK, COAXIAL, OPTICAL
8. Digital output
   HS-LINK
9. Analog inputs
   LINE, BALANCED
10. AC power connector ★
    (for supplied power cord)

DF-55 Guaranteed Specifications

[Guaranteed specifications measured in compliance with JEITA standard method CP-2402A]

- **Digital inputs**
  - COAXIAL — Format: IEC 60958/AES3 compliant; Sampling frequencies 32 kHz to 192 kHz (16 - 24 bit 2-channel PCM)
  - OPTICAL — Format: JEITA CP-1212; Sampling frequencies 32 kHz to 96 kHz (16 - 24 bit 2-channel PCM)
  - HS-LINK — Connector: RJ-45, HS-Link cable; Sampling frequencies 32 kHz to 192 kHz (24 bit 2-channel PCM)
- **Analog inputs** — Maximum input level 3.7 V (1 kHz, 2.5 V output)
  A/D converter — Principle: 1-bit delta sigma modulation; Sampling frequency: 176.4 kHz; Quantization: 24 bit
- **Digital outputs** — HS-LINK Connector: RJ-45, HS-Link cable; COAXIAL Format: IEC 60958
- **Frequency response** — HS-Link 2.0 - 50,000 Hz +0 -3 dB
- **D/A converter** — Quantization: 24 bit; STEREO operation: 4MDS++ type; MONO operation: 8MDS++ type
- **THD** — 0.001% (20 - 20,000 Hz)
- **S/N ratio**

	STEREO operation	MONO operation
COAXIAL/OPTICAL	120 dB	122 dB
HS-LINK	120 dB	122 dB
Analog input	113 dB	114 dB

- **Dynamic range** — "Analog ATT" OFF: 117 dB, "Analog ATT" ON: 114 dB
- **Channel separation** — 108 dB (20 - 20,000 Hz)
- **Slope characteristics** — 6 dB/octave, 12 dB/octave, 18 dB/octave, 24 dB/octave, 48 dB/octave, 96 dB/octave
  * When cutoff frequency is 10 Hz: 48 dB/octave, 96 dB/octave not available
  20 Hz: 96 dB/octave not available
- **Delay setting range (converted into distance)** — -3,000 to +3,000 cm (0.5-cm steps)
- **Level adjustment range** — "Analog ATT" OFF: -40 to +12.0 dB (0.1-dB steps)
  "Analog ATT" ON: -50 to +2.0 dB (0.1-dB steps)
- **Output voltage/output impedance** — LINE: 2.5 V, 50 ohms, RCA-type phono connector
  BALANCED: 2.5 V, 50 ohms, balanced XLR connector
- **Minimum load impedance** — LINE/BALANCED 600 ohms
- **Power requirements** — AC 120 V/230 V, 50/60 Hz (Voltage as indicated on rear panel)
- **Power consumption** — 29 watts
- **Max. dimensions** — Width 465 mm (18-5/16"); Height 151 mm (5-15/16"); Depth 396 mm (15-9/16")
- **Mass** — 14.7 kg (32.4 lbs) net; 20.0 kg (44.1 lbs) in shipping carton

Remarks

★ *This product is available in versions for 120/230 V AC. Make sure that the voltage shown on the rear panel matches the AC line voltage in your area.*

★ *The shape of the AC inlet and plug of the supplied power cord depends on the voltage rating and destination country.*

■ Supplied accessory
• AC power cord

• Specifications and design subject to change without notice for improvements.

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