Data Sheet

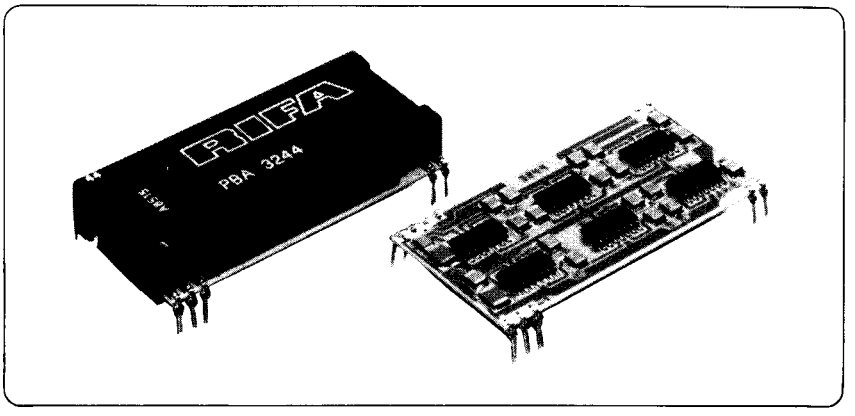
20 kHz Low-pass Filter for CD-systems

Introduction

The RIFA hybrid circuit PBA 3244 is a low-pass filter with a cut-off frequency of 19.8 kHz. Excellent characteristics are achieved at low cost by means of thick-film realisation of the active filter network.

The unit features flat frequency response typ within ±0.13 dB from DC to 19.8 kHZ. Extremely good group-delay variation response is accomplished with a built-in delay equalisation network. The group-delay is typ within ±7.0 µs for all frequencies up to 18.0 kHz.

The PBA 3244 is intended for use as an anti-aliasing, band-limiting and reconstruction filter in professional digital audio systems, like tape recording machines or digital mixers. It is specially adapted to the compact disk standard, using a sampling frequency of 44.1 kHz.



Key features

- Low-cost, thick-film hybrid technology.
- Small dimensions, 28 x 58 x 10.5 mm.
- Flat frequency response within ±0.13 dB.
- Excellent group-delay characteristics, typ ±7.0 µs delay variation for all frequencies up to 18.0 kHz.
- Dynamic range 108 dB
- Low distortion
- Low noise

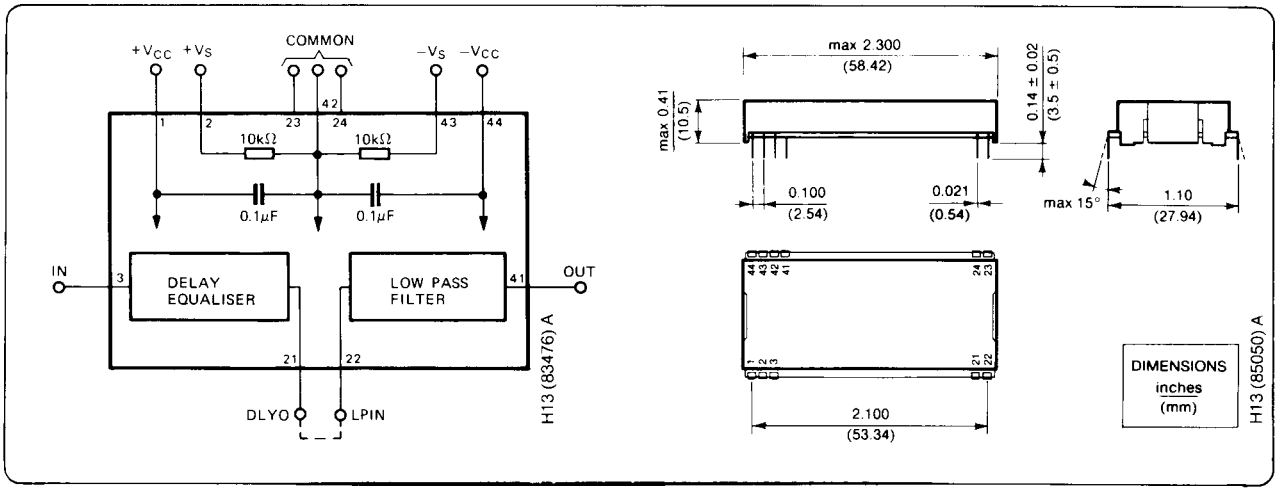


Fig 1. Functional diagram and pin configuration

Fig 2. Mechanical dimensions

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Specifications subject to change without notice
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Electrical specifications

At +25°C and ±15 V power supply

Parameters	Conditions	Min	Typ	Max	Units
Pass band			0 to 19.8		kHz
Absolute gain	@ 5 kHz	−0.5	0 ±0.05	+0.5	dB
Pass band ripple	0−19.75 kHz,*		±0.13	±0.25	dB
	0−19.8 kHz		±0.13	+0.3 −0.4	dB
Stop-band attenuation	22−100 kHz,*	68	70		dB
Absolute group delay	@ 5 kHz		222		µs
Group-delay variation	0.5−18.0 kHz		14	25	µs
	0.5−15 kHz		8	15	µs
Input, output					
Input impedance			10		kΩ
Output impedance			1		Ω
Max input level	0−19.8 kHz,**		+10		dB
Output noise voltage unweighted	20−20,000 Hz,**		−90		dB
THD	@ 1 kHz, 0 dB in,**		0.005		%
THD 1−18 kHz see fig. 4					
Output DC offset voltage			±20	±70	mV
Output DC offset voltage drift	0−60°C		<±0.15		mV/°C
Power Supply					
Supply voltage				±18	V
Supply drain	+/−15 V (Vin = 0 V)		50	60	mA
Temperature range					
Operating			0 to 60		°C
Storage			−40 to +125		°C

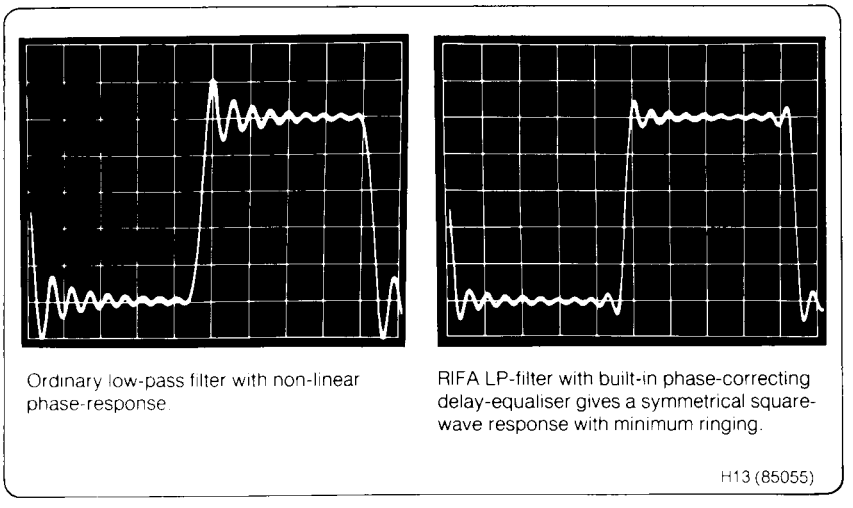
* relative gain at 5 kHz

** relative to 0.775 V_{rms}

Discussions of specifications

Phase response and group delay

The phase response of a low-pass filter in general is a non-linear function of frequency. Since the derivative of the phase function is a measure of the delay through the filter, a non-linear phase response means that the delay (or group delay) will vary with the frequency. The PBA 3244 however, incorporates a very efficient group delay equaliser, which gives the filter a group delay response which is constant within ±7.0 µs for all frequencies up to 18.0 kHz. The result of this is best demonstrated with a 1 kHz squarewave as the input signal. The squarewave will be reproduced with considerably less overshoot and much better symmetry than in the case where there is no equaliser.



Ordinary low-pass filter with non-linear phase-response.

RIFA LP-filter with built-in phase-correcting delay-equaliser gives a symmetrical square-wave response with minimum ringing.

H13 (85055)

Fig 3. LP-filter squarewave response

Frequency response

The PBA 3244 is a 10:th order elliptic low-pass filter with a cut off frequency of 19.8 kHz. It is designed to give a nearly flat amplitude response with a typical passband ripple of ±0.13 dB (max +0.25 and −0.35 dB). The stop-band attenuation is better than 68 dB (70 dB typ.) from 22 to 100 kHz.

Noise and dynamic range

The dynamic range of the filter is limited by two parameters:
- the maximum output level and
- the noise level.

The maximum output level is limited by internal clipping in the filter network and will vary with the frequency. In the lower part of the passband, below 10 kHz, the maximum level is limited only by the supply voltage and the OP-amps to approx. 8.7 Vp or +18 dB (ref. 0 dB = 0.775 V_{rms}) at ±15 V supply voltage. In the upper part of the pass-band, internal nodes in the filter may be driven to clipping levels, although the output signal level is low.

The maximum output level at 19.8 kHz is therefore limited to approx. 3.5 V_p or +10 dB (ref. 0dB = 0.775 V_{rms}) before internal clipping will occur.

The noise level of the PBA 3244 is very low, approx −90 dB down from 0.775 V_{rms}, measured unweighted, 20 to 20,000 Hz (−94 dB A-weighted).

This means that the available dynamic range equals 108 dB at frequencies below 10 kHz and 100 dB at 19.8 kHz. To achieve the maximum dynamic range, the max input voltage should be scaled as close as possible to the maximum output level of the filter.

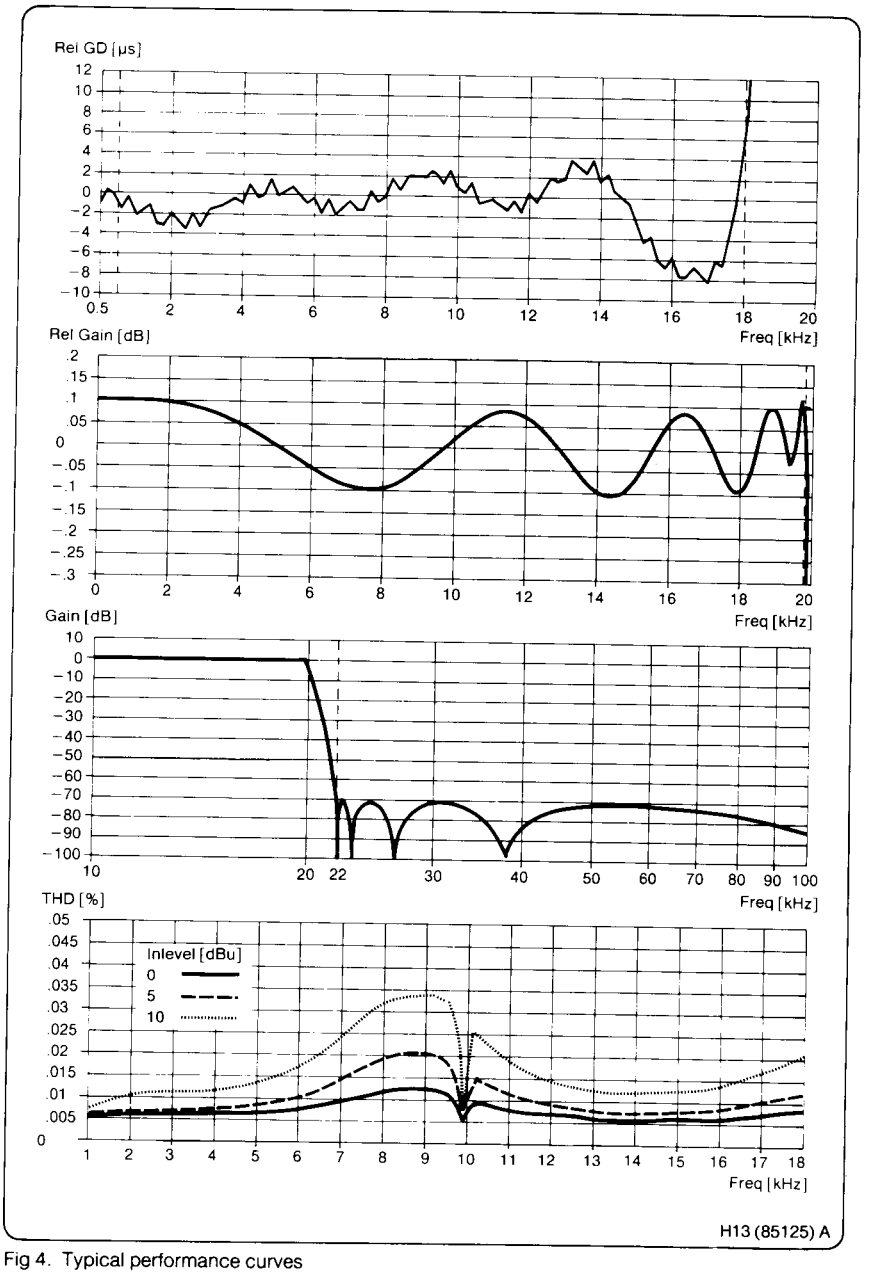


Fig 4. Typical performance curves

Applications information

Power supply

The PBA 3244 normally requires a dual ±15 V power supply, but an internal voltage divider is provided for use with single supply systems with a maximum voltage of 36 V. In the case of single supply operation, the input and output must be connected via capacitors to allow for a DC-offset of half the supply voltage at these pins, see fig. 6. The power supply should be bypassed with electrolytic capacitors as shown in fig. 5 and 6. There is no need for high frequency decoupling outside the PBA 3244, since 0.1 µF ceramic capacitors are connected to the supply rails internally.

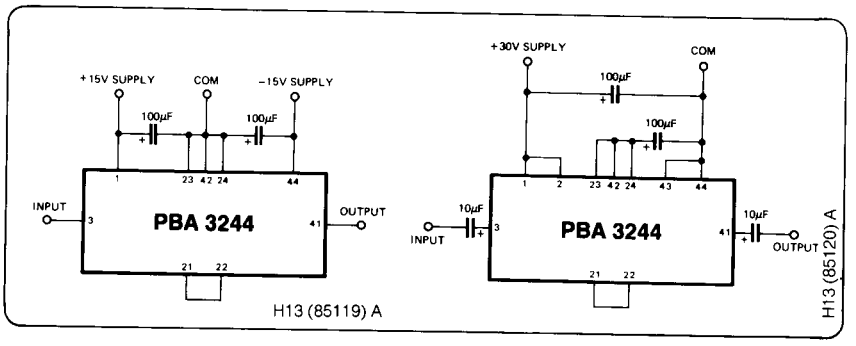


Fig. 5 Connection for dual supply operation

Fig. 6 Connections for single supply operation

Shielding practice

To achieve the maximum dynamic range it is important to minimise AC noise pickup from external sources. It is recommended to shield the filter by a ground plane on the printed circuit board. In situations where excessive pickup due to strong electrical fields can be expected, an additional grounded metal enclosure will provide improved shielding. A suitable enclosure is available for this purpose.

Input and output connections

The PBA 3244 is separated into a low-pass filter and a delay equaliser section. To minimise high-frequency noise above 19.8 kHz, the two sections shall be interconnected as shown in fig. 1. If the filter is used without the delay equaliser, it is possible to connect the signal directly to pin 22. Input impedance is 10 kohms. The outputs on pins 21 and 41 are both fully buffered, but to keep the high performance of the filter, the load resistance should be greater than 3 kohms. It is also essential to keep the capacitive load small to ensure full stability of the output stage.

Ordering instructions

RIFA type No.	Description
PBA 3244	20 kHz low-pass filter for CD-systems
PYC 8097	Metal filter enclosure

Also available

RIFA type No.	Description
PBA 3179/3	15 kHz low-pass filter
PBA 3167/3	20 kHz low-pass filter
PBA 3257	7 kHz low-pass filter

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