

Precision Video Filters

British Telecoms[®] Types

- ◆ Flat Insertion loss from DC to the defined passband edge.
- ◆ Bandwidths tailored to suit requirements of sampled data systems.
- ◆ Extremely well compensated group delay.
- ◆ Robustly constructed and suitable for plug-in mounting.

Background

These units were originally designed for use in sampling circuits associated with means for coding analogue television signals. Bandwidth options required of a practical range of filters are set by the system performance required. The range covers the needs of all types of system including those of highest studio quality. Frequency characteristics and group delay are tightly controlled but do not merely meet arbitrary objective standards.⁽¹⁾ On the contrary, the design of these units is strictly related to system requirements through criteria established by means of subjective assessments.

Basic Types

Two distinct circuit requirements are recognised.

Anti-Aliasing - Type LPP007 having a flat passband response up to approximately half the sampling frequency and good rejection thereafter, and

Interpolating - Type LPP008 having a passband shaped to compensate for $\frac{\text{Sinx}}{x}$ frequency distortion (sometimes called sinc function). These two types are described below in more detail.

N.B. The flat passband (Anti-Aliasing) types are also video delay lines.

Anti-Aliasing - Type LPP007/f

Comprises a 7th order Inverse Tschebyscheff lowpass filter and three delay equalising sections. All filters in the series are scalings of the same basic design. 3dB loss is at f.

Amplitude Response

This is shown in fig. 1 from which it will be seen that the response can be broadly characterised as follows:-

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August 1997

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Amplitude Response

| Frequency | Relative loss |
|-----------|---------------------|
| 0.80f | <0.1dB |
| 1.00f | Nominally 3 dB |
| 1.07f | Approximately 6 dB |
| 1.14f | Approximately 12 dB |
| 1.21f | Approximately 20 dB |
| 1.35f | ≥40 dB |

Return Loss

Exceeds 24dB for all frequencies up to 0.8f.

Pulse Response and Frequency Response Parameters

Lewis⁽²⁾ uses the term 'slot bandwidth' for that frequency at which the loss first reaches 40dB. In the case of an ideal lowpass, excited by a rectangular pulse of duration half the period of the slot bandwidth frequency, the output is a pulse of 87.27% of the full amplitude response. Lewis then defines the 'pulse bandwidth' of a non-ideal filter as the reciprocal of twice the duration of that rectangular pulse which produces a similar response. We thus have the concept of pulse-to-slot bandwidth ratio, unity in the case of an ideal lowpass, as a measure of filter performance. This ratio is 0.76:1 in the case of LPP007. It also happens that for these filters the following are nearly equal:-

- Ringing frequency
- Reciprocal of twice the rise time
- 6dB frequency (1.07f)
- Pulse bandwidth

Finally the response to a unit step approximates to that of an ideal lowpass in respect of the first few lobe amplitudes of ringing which precede and follow the output transition.

Interpolating - Type LPP008/f

Comprises a 5th order Cauer lowpass filter, three delay equalising sections and a constant impedance attenuation equaliser.

Amplitude Response

Relative loss in the passband is <0.1dB up to 0.8f, discounting the inbuilt sinc function compensation. In the case of these filters 2f is the intended sampling frequency. Stopband loss is ≥50dB at 1.25f and above and is ≥50dB at 2f. The absolute loss at DC is less than 4dB.

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Accuracy of SINC fn Compensation

Within ± 0.1 dB up to $0.8f$.

Other Features

Return loss and waveform responses discounting sinc fn compensation are as for LPP007.

Common Features

Impedance

75 Ω standard. 50 Ω non-standard.

Construction

High grade ferrite assemblies and polystyrene capacitors mounted on silicon-bonded laminate. Connection is by way of gold plated pins. The filter is supplied as a plug-in pcb.

Variants

Built-in gain equalising attenuators, special combinations of sinc compensation and filter characteristics etc.

Group Delay

Propagation delay is given approximately by:-

for LPP007 : $2830/f$ nS

for LPP008 : $2850/f$ nS

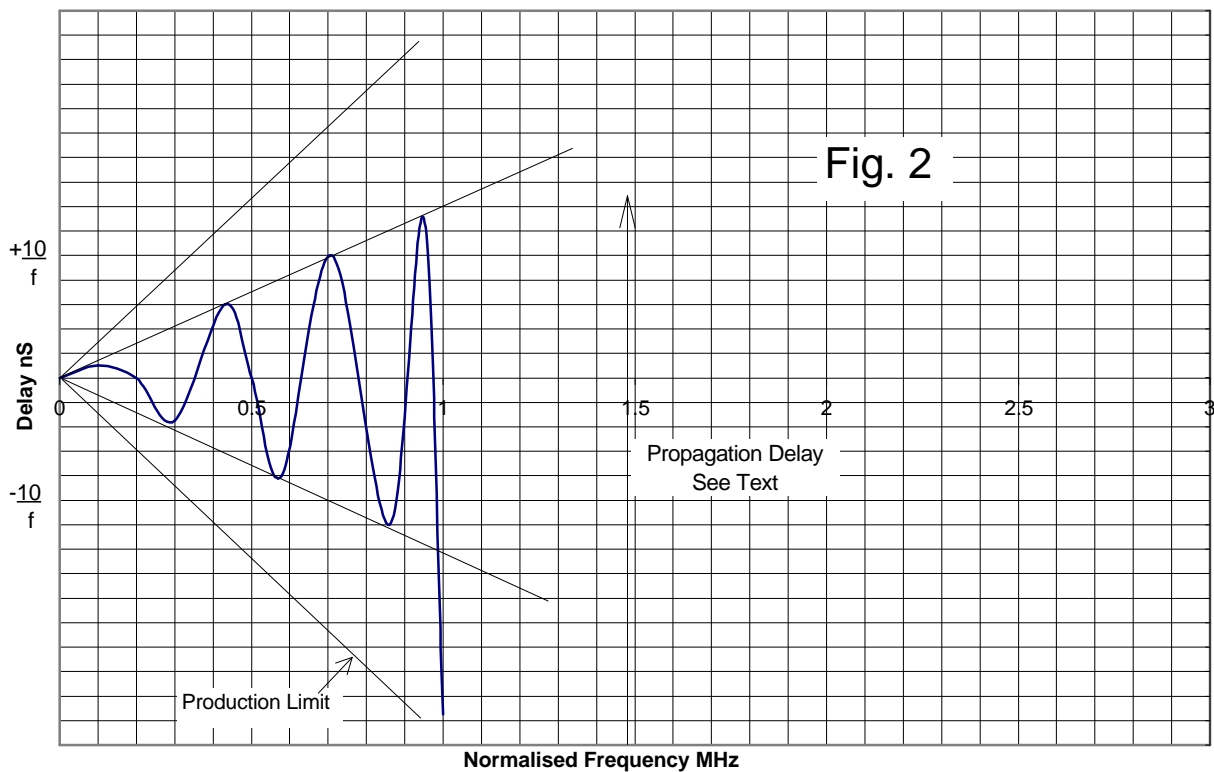
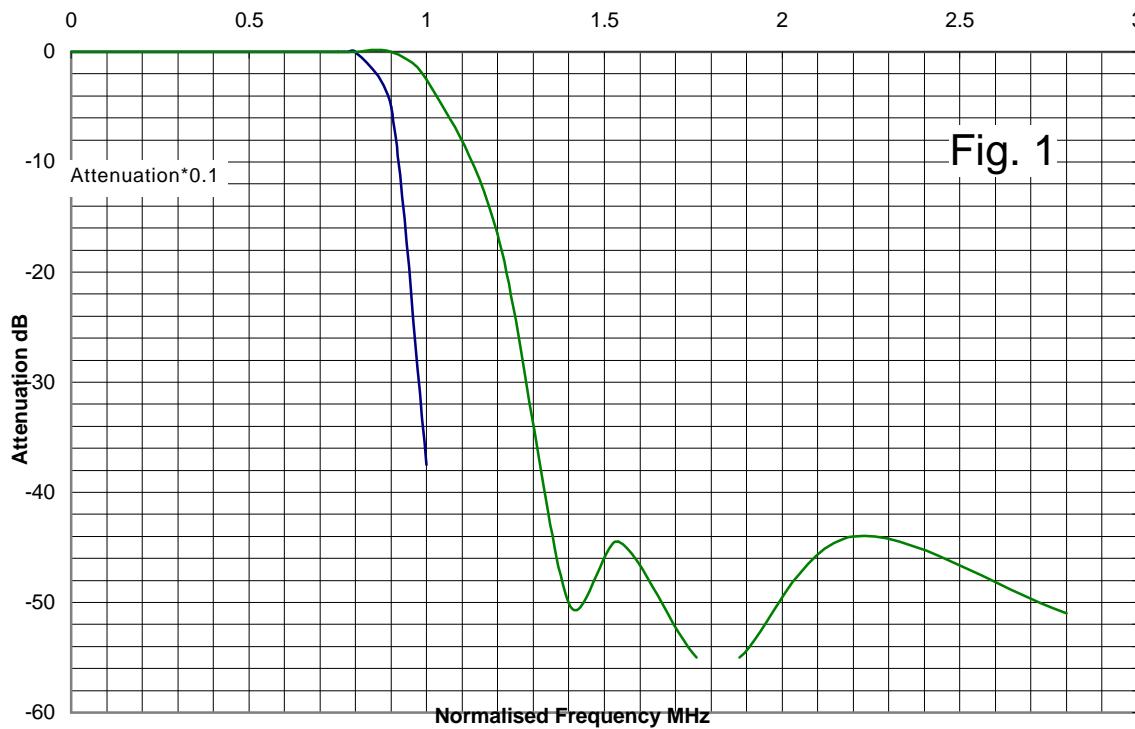
The spread to be expected amongst samples of the same cut-off frequency is $\pm 0.8\%$.

Equalisation extends fractionally higher than f after which it decreases monotonically to $1.35f$. The dispersion of group delay about its nominal value is contained within the envelope described by

$$T = \pm K \left[\frac{13}{f} \cdot \frac{h}{f} \right] \text{ ns}$$

Where h =frequency within waveband

The design envelope is given by $K=1$; the value of K necessary to describe any production unit will not exceed 2. (Fig. 2 refers.)

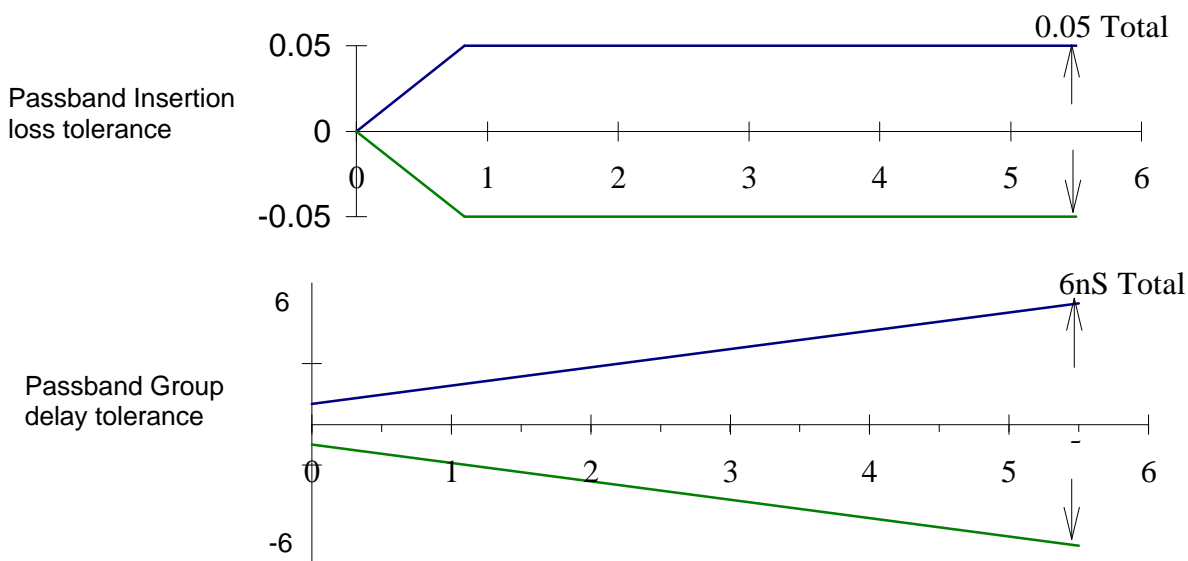
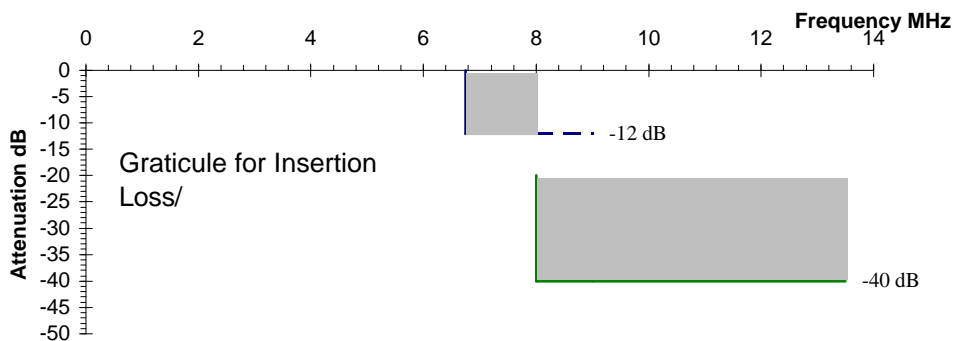


Type LPP012/6.75

One specific design, coded LPP012/6-75, is suitable for signal-processing of broadcast TV. This design meets the specifications illustrated which are for pre- or post-sampling filters for either the luminance signal, or the composite system PAL signal. The dimensions of this filter are given on page 8

The range includes a set suitable for sampled broadcast TV signals.

TYPE LPP012/6.75



Definition of Pulse-to-Slot Bandwidth Ratio

The sharpness of a lowpass filter is expressed as a ratio of about 3dB loss-frequency to 40 dB loss-frequency or more precisely as a pulse-to-slot bandwidth ratio, pbw/sbw, after N.W. Lewis⁽²⁾. The pulse and slot bandwidths are readily measurable parameters and directly related to definition achieved in a channel. For a given sharpness of the filter the pbw/sbw ratio has a maximum value when the group-delay response is equalised up to the ringing frequency and equalling the pulse bandwidth. In this case the pulse bandwidth equates to the reciprocal of twice the rise-time and occurs at about 3 dB loss-frequency.

Pulse bandwidth is defined by Lewis as the reciprocal of twice the duration of the rectangular pulse whose response has a peak amplitude of 87.27% of the full amplitude response. This particular amplitude equates pulse and 40 dB slot bandwidths for an ideal lowpass filter.

Selection guidelines for use in sampling of television signals

In theory filtering requirements for one dimensionally sampled video signals are straightforward. Given ideal pre- and post-sampling filters, the pbw/sbw ratio is unity. In practice however such filters do not exist and are not necessarily the best choice.

For very demanding BROADCAST-TV TRANSMISSION applications, a pre- or post-sampling filter with the following characteristics is recommended.

- a] pbw/sbw ratio in the range 0.8 to 0.9.
- b] loss at half-sampling frequency 12dB.
- c] ± 0.25 dB passband 5.5 MHz
- d] delay equalisation ± 3 nS up to 5.5 MHz
- e] 40 dB loss-frequency 8 MHz

The specification represents a feasible high performance target for sampling of luminance component or composite system I PAL signals. This stringent requirement is essential for transmission systems where PAL operation or cascading of codecs is foreseen, and will be met by the filter design coded LPP012/6.75 MHz. For the chrominance components filter design coded LPP012/3.375 MHz is recommended.

If the analogue channel delays need to be made equal, care should be taken to ensure that the luminance channel performance is not sacrificed. Most commercially available delay lines will not meet the passband specifications. An additional luminance filter can be used in the luminance channel as a delay line resulting in the passband tolerances being only doubled. If this is not permitted digital methods of producing delay coincidence should be used.

It has been recognised that ringing on fast transitions may be caused by sharp cut-off filters and by cascading of codecs. This problem should not be allowed to restrict the design unduly and solutions adopted must not result in sacrifice of codec performance. The requirements of viewing or chromakey operation should be met by a suitable separate provision, so that the primary transmission path remains unaffected. Where ringing impairment resulting from bandlimiting is a problem it should be controlled by tandem connection of a shaper, suitable buffered from the post-sampling filter, separate from the main transmission path. An attempt to combine sharp cut-off characteristics and inband shaping into one network is not recommended because it:-

- rules out the possibility of tandem connection of codecs.
- requires complex and expensive custom design filters.
- does not allow flexibility to accommodate differing source and display characteristics.

A suitable shaper for the job is a sine-squared network. A sine-squared shaper of half-amplitude -duration $0.8/f_s$, where f_s is the sampling frequency, halves the amplitude; a shaper $\times\sqrt{2}$ this value reduces it to a quarter.

For lower definition tv applications ranging from the nominal broadcast bandwidths to fractional bandwidths, pbw/sbw ratio of 0.76 with a 3 to 6 dB loss at half-sampling frequency is generally adequate. However, where tandem connection of transmission equipments is foreseen, individual sections in the chain should not contain any inband shaping. Where ringing is a problem, it should be dealt with as in the broadcast-TV transmission application.

| Pattern LPP/ | f | Format Note 1 | A Note 2 | B Note 3 | Loss at f (dB) | Flat PB Delay BW nS - MHz | Dimensions l*w*h (mm) Note 4 | Notes |
|--------------|------------|---------------|----------|----------|----------------|---------------------------|------------------------------|-------|
| 003 | f | M | 0.70 | 0.80 f | 3 | 1632 | 50*32*12 | 5 |
| 004 | 3.375 Sinc | M | 0.70 | 0.68 f | 18 | | 50*48*12 | 5 |
| 007 | f | M | 0.76 | 0.80 f | 3 | 2264 | 80*32*12 | 5 |
| 008 | f Sinc | M | 0.76 | 0.80 f | 3 | | 80*32*12 | 5 |
| 012 | 6.75 | M | 0.87 | 0.86 f | 12 | 4466 | 100*32*12 | 5 |
| 012 | 3.375 | M | 0.87 | 0.86 f | 12 | 4466 | 100*32*12 | 5 |
| 013 | 6.75 Sinc | M | 0.89 | 0.87 f | >12 | | 100*32*12 | 5 |

Notes

1. Format M: PCB with gold plated plug pins.
2. A: Pulse to slot bandwidth ratio
3. B: Bandwidth 0.1 dB down.
4. Dimensions: Length, Width, Height of open PCB.
5. Available with f in the range 0.500 to 13.50 MHz

All filters are designed for 75Ω Impedance.

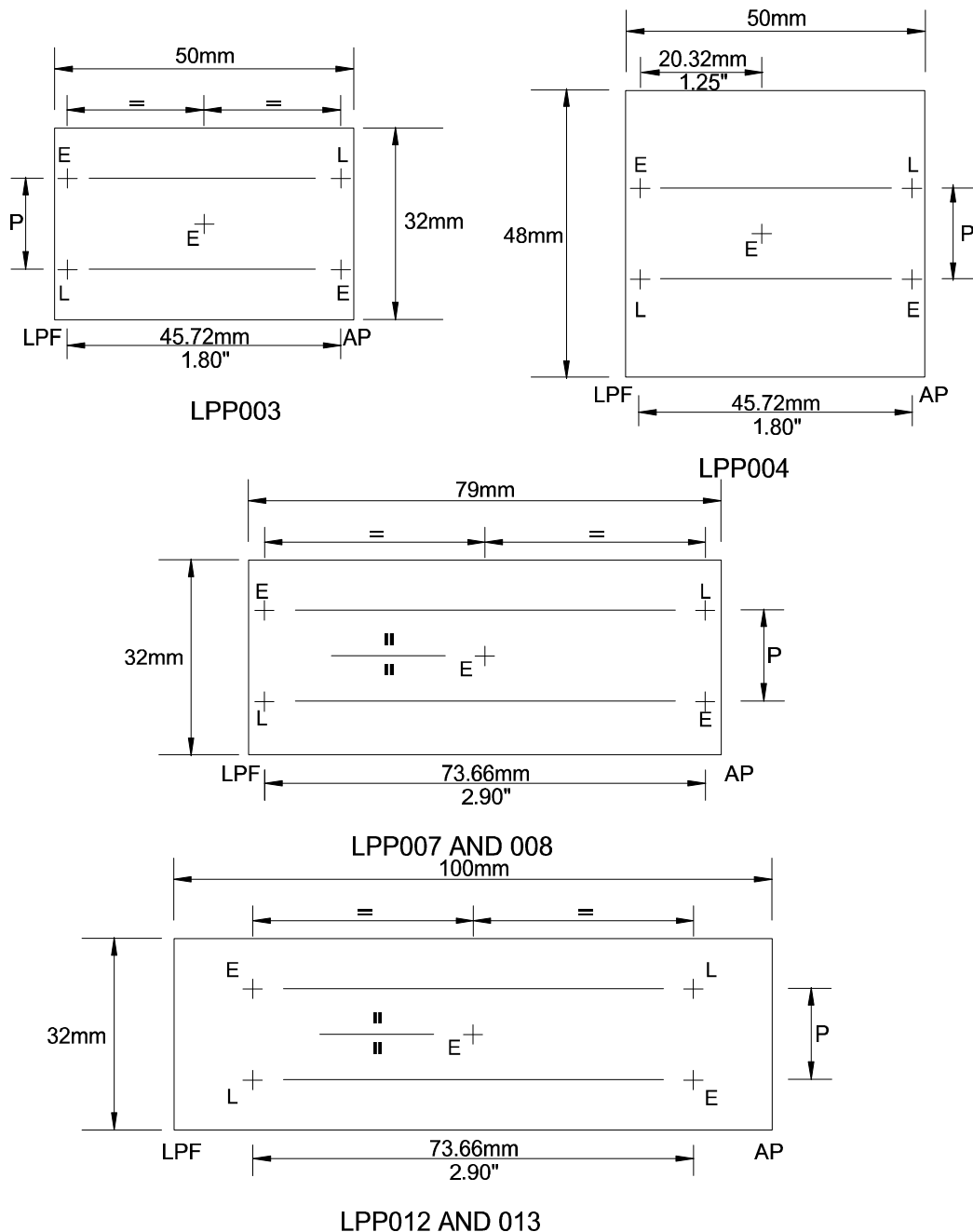
Availability

Many standard scalings are available are between 0.500 MHz and 13.50 MHz. Special scalings between these limits can be designed on request.

Dimensions and Connections

Overall sizes are maximum. Pitch P is 15.24mm (0.60") and is the same for each board.

Mounting is through hole soldered or pins fit Cambion socket 450-3388-01-06 or equivalent. Diagrams show view from underside.



Referenc

es

1. T. A. White, B. R. Patel, 'Subjective assessment of bandwidth limitation of the 625 line luminance signal' Image Processing Convention, York, July 1982, proceedings.

2. N. W. Lewis, 'Television Bandwidth and the Kell Factor,' Electronic Technology 1962 vol.39 No.2 pp 44-47.