CIRCUIT IDEAS

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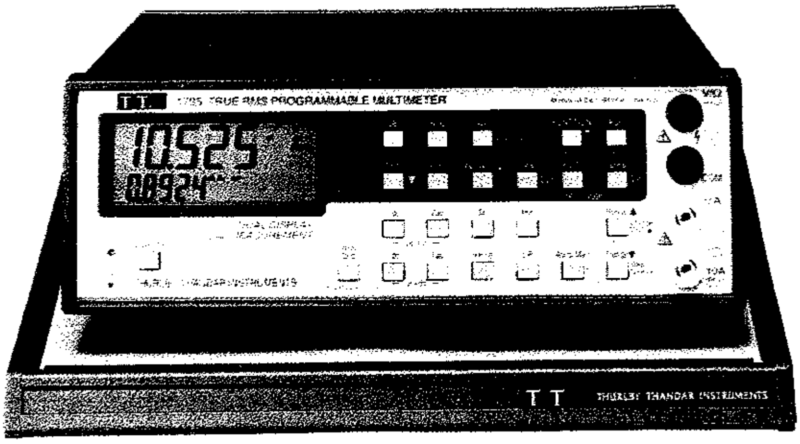
WIN A TTI PROGRAMMABLE BENCH MULTIMETER

"High accuracy, resolution and bandwidth – performance beyond the capability of hand-helds"



This high-performance bench multimeter could be yours in exchange for a good idea. Featuring a dual display, the 4.5-digit 1705 multimeter resolves down to 10μV, 10mΩ and 0.1μA and has a basic dc accuracy of 0.04%. Frequency measured is 10Hz to 120kHz with an accuracy of 0.01% and resolution to 0.01Hz. Capacitor and true rms measurements are also featured.

Recognising the importance of a good idea, Thurlby Thandar Instruments will be giving away one of these excellent instruments once every six months. This incentive is in addition to our monthly £100 'best circuit idea' award and £35 awards for each circuit published.

£100 *WINNER*

Frequency-programmable analogue band-pass filter

Centre frequency of this filter is linearly proportional to the digital inputs of an a-to-d *R*-2*R* ladder converter.

Two main elements comprise the circuit: a gyrator and a band-pass filter. **Figure 1** shows the gyrator, the input impedance of which is given by,

$$z_{in}(s) = sR_1R_2$$

which appears as an equivalent inductor with a value of $L_{eq}=LR_1R_2$.

Figure 2 is a basic band-pass filter, whose transfer function is,

$$H(s) = s/CR'/(s^2 + s/CR' + 1/LC)$$

compared with that of a second-order band-pass, which is,

$$H(s) = \omega_0 A_0 s/Q(s^2 + s\omega_0/Q + \omega_0^2)$$

Pass-band gain is 1 and centre frequency

$$f_0 = 1/(2\pi LC) = \omega_0/2\pi$$

Bandwidth is $f_0/Q = 1/(2\omega CR)$.

An analogue-to-digital converter is represented in **Fig. 3**, in which b_{n-1}, b_{n-2} ... b_0 are the digital inputs to an *n*-bit *R*-2*R*

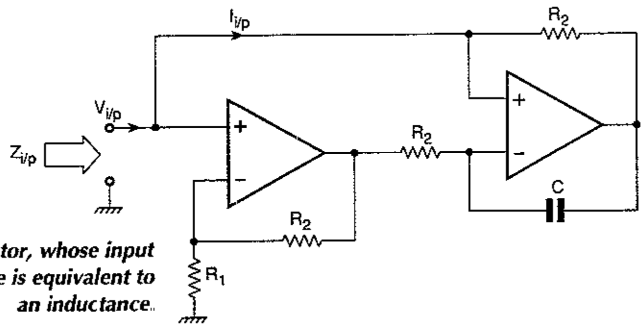


Fig. 1. A gyrator, whose input impedance is equivalent to an inductance.

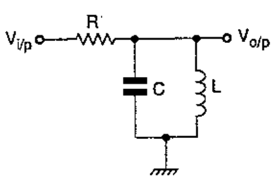


Fig. 2. Band-pass filter.

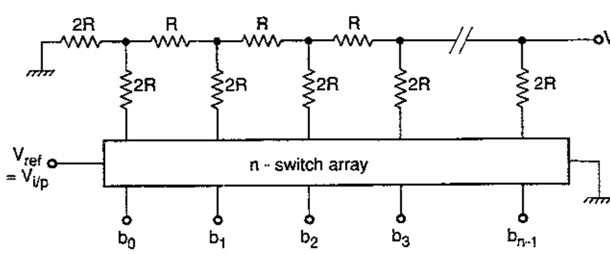


Fig. 3. N-bit ladder network used in an analogue-to-digital converter, the input voltage being represented by the resistor switches.

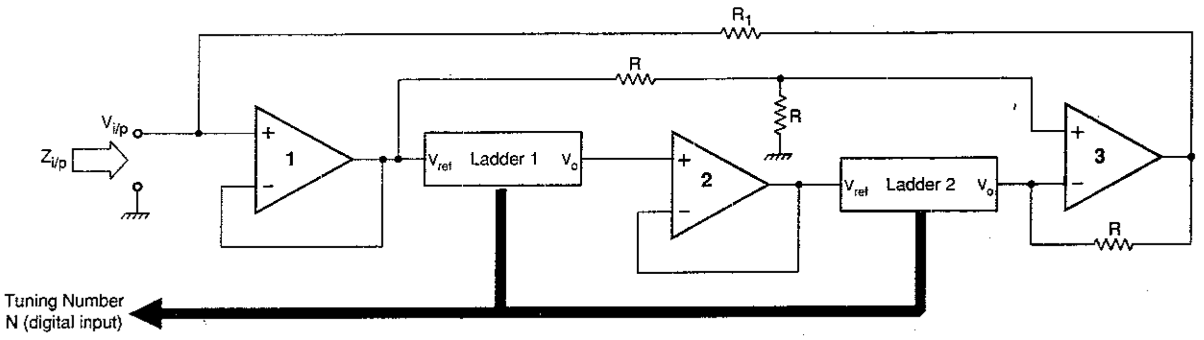


Fig.4. Input impedance of this arrangement is resistive and varying inversely with N^2.

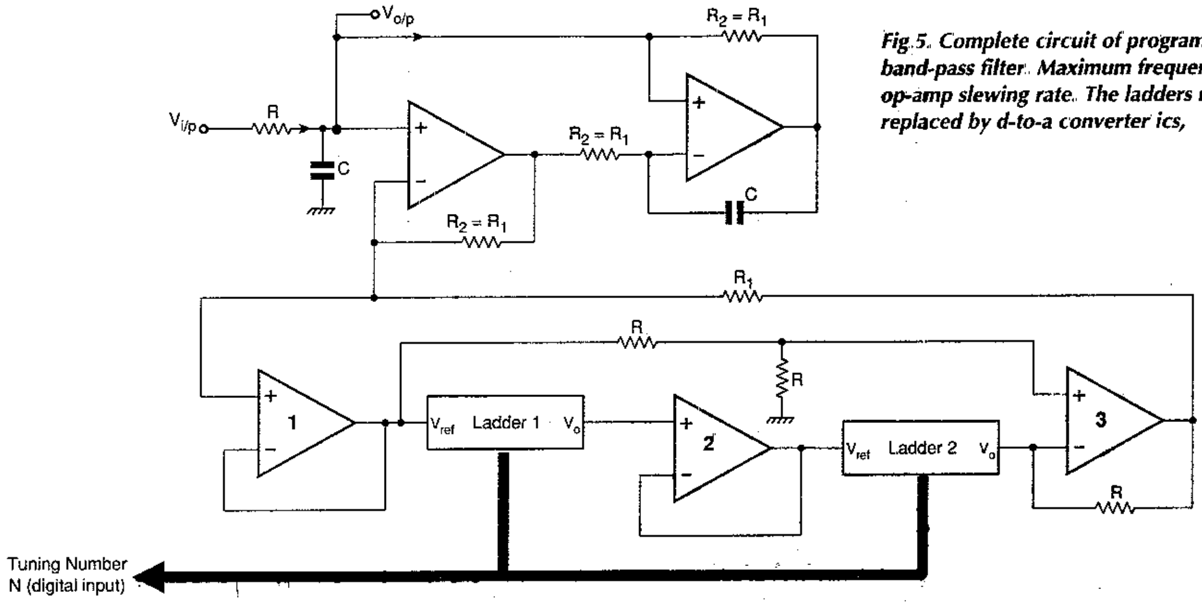


Fig.5. Complete circuit of programmable band-pass filter. Maximum frequency is set by op-amp slewing rate. The ladders may be replaced by d-to-a converter ics,

ladder network, whose output is $v_o = N/2^n v_{in}$. Output impedance is R.

Figure 4 is a development of this, in which the op-amps are simply buffers and both ladders have the same digital input. Output voltage of ladder 1 is $(N/2^n)v_{in}$, which is also the input to ladder 2, whose output is therefore $(N/2^n)2v_{in}$. The output impedance of the ladders being R, op-amp 3 output voltage is Av_{in}.

Now connecting R_I from input to output produces an input impedance,

$$z_{in} = R_{1/}(1-A) = R_1/(1-(1-N/2^n)^2)$$
$$= R_1(2^n/N)^2$$

which is a resistance varying inversely as the square of N.

If now the resistor R_I in the gyrator circuit of Fig.1 is replaced with the circuit of Fig 3 and this new gyrator is used as the inductor in the circuit of Fig 2, the whole being shown in **Fig.4**, the centre frequency becomes,

$$f_0 = 1/(2\pi(R_2R_1(2^n/N)^2 - C)^{1/2})$$

If $R_2 = R_1$,

$$f_0 = N/(2\pi R_1 C * 2^n),$$

the centre frequency being proportional to the tuning number N, independently of bandwidth.

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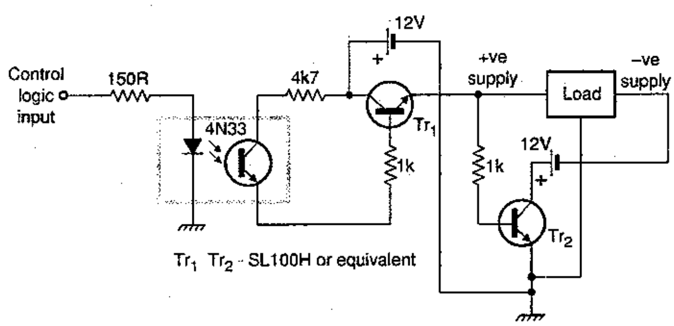

Both rails of a dual power supply are switched by logic input.

Switch two supply rails at once, digitally

Logic-level signals control the on/off switching of dual power supplies.

Input switching logic signals go to an opto-isolator which, when conducting, supplies base current to Tr_1 and completes the path from the +12V supply through the load to ground. At the same time, Tr_2 receives base current via Tr_1 and provides the path for the negative 12V supply. In the absence of drive to the opto-isolator, both transistors are off and neither power supply is connected.

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