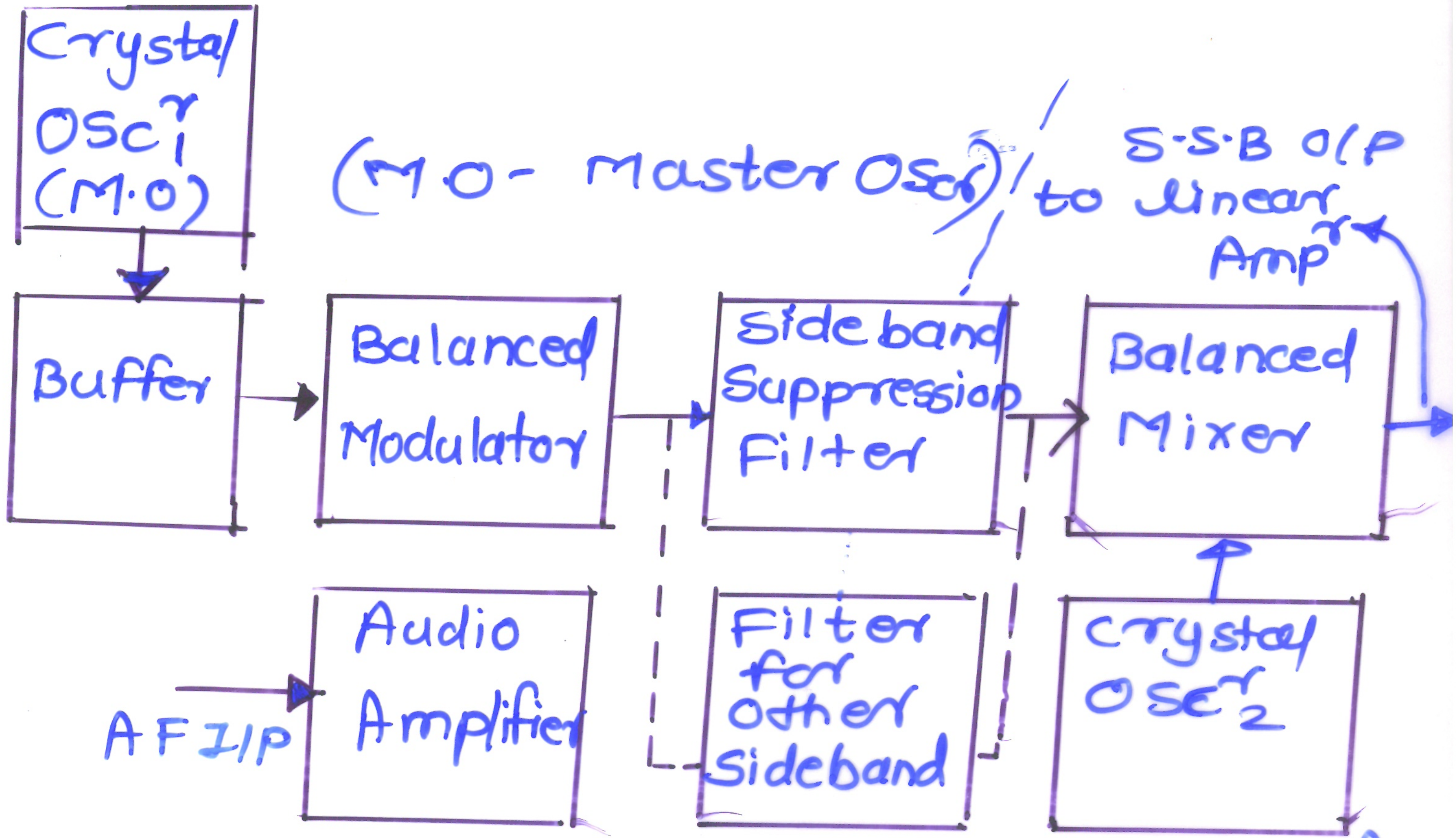
FILTER METHOD

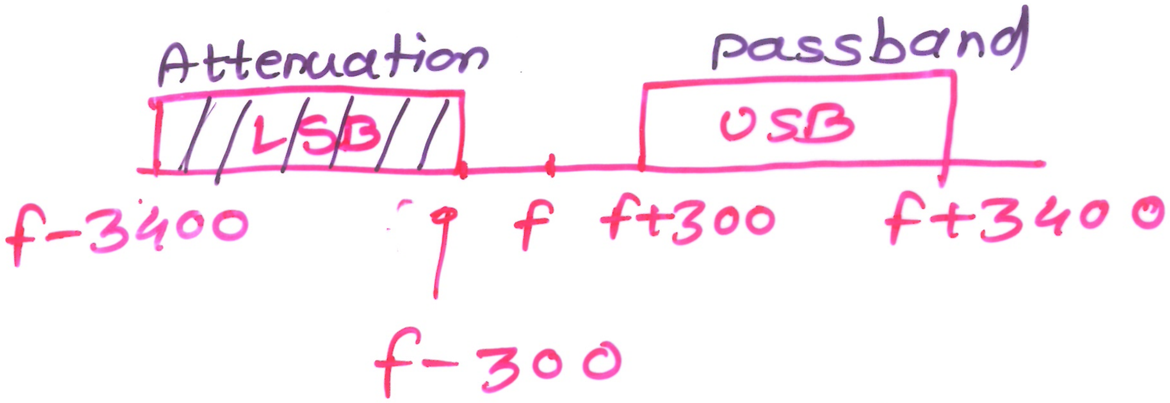


- Crystal Osc$^r_1$ → Generates carrier freq
- Buffer → Provides isolation b/n M·O and rest of the ckt.
  It has high I/P Impedance & low O/P Impedance.
  Avoids loading effect
- Balanced Modulator gives DSBSC signal.
- One of the sideband is selected by means of sideband suppression Filter.

- Filter must have a flat passband and extremely high attenuation outside the passband.

$$Q = \frac{f_r}{B \cdot W}$$, $f_m = 50\,Hz$, Q is very high

- for lower modulating freq 300Hz
  f+300 (USB) , f-300 (LSB)
  and higher modulating freq
  f+3400 (USB) , f-3400Hz



Filter response must change from Full attenuation to zero attenuation over a range of 600Hz

- Types of filter
  LC, crystal, ceramic, mechanical filter

- LC filter can not be used above 100 KHz as attenuation outside passband is insufficient.

- Crystal or ceramic filters are better only above 1MHz upto 20MHz.

- Mechanical filters are
  small size
  good passband and attenuation characteristics.
  Adequate upper freq limit (500kHz)
  Hence used for S.S.B

- Frequency upconversion
  Maximum operating freq is much below usual transmitting frequency so balanced Mixer is used for freq upconversion.
  (CS, filter cht)

- o/p Balanced mixer is given to linear amplifiers (class B or AB) so as it to avoid distortion

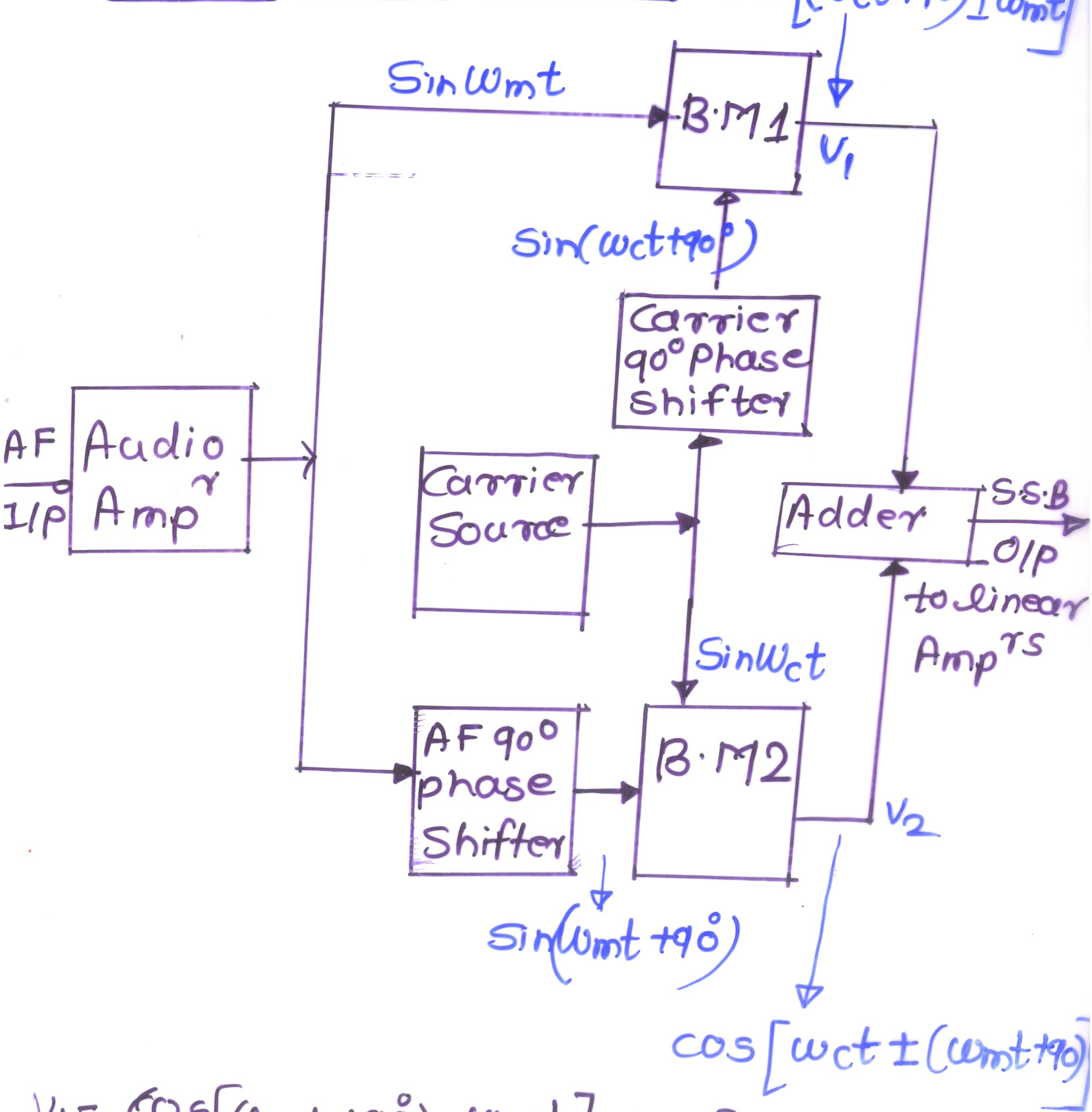
Advantages

1. Adequate sideband suppression (50 dB)
2. Sideband filter also helps to attenuate the carrier, adding safety feature which is absent from other two methods.
3. Bandwidth is sufficiently flat and wide.
4. Simpler as compared to other two methods.

Disadvantages

1. Frequency upconversion is needed.
2. Very low audio frequencies can not be transmitted (below 50 Hz) (Very large Q is required not possible practically)
3. 2, Expensive filters are required one for each sideband

Phase Shift Method



$$V_1 = \cos[(\omega_c t + 90^\circ) - \omega_m t] - \cos[\omega_c t + 90^\circ + \omega_m t]$$

$$= \cos(\omega_c t - \omega_m t + 90^\circ) - \cos[\omega_c t + \omega_m t + 90^\circ]$$

$$V_2 = \cos[\omega_c t - (\omega_m t + 90^\circ)] - \cos[\omega_c t + (\omega_m t + 90^\circ)]$$

$$= \cos[\omega_c t - \omega_m t - 90^\circ] - \cos[\omega_c t + \omega_m t + 90^\circ]$$

$V_o = V_1 + V_2$

$$\boxed{V_o = 2\cos[\omega_c t + \omega_m t + 90^\circ]}$$ USB.

For LSB Generation

① carrier phase shift -90°

$V_1 = \cos[\omega_c t - 90^\circ - \omega_m t] - \cos[\omega_c t - 90^\circ + \omega_m t]$

$V_2 = \cos[\omega_c t - \omega_m t - 90] - \cos[\omega_c t + \omega_m t + 90^\circ]$

$$\boxed{V_o = V_1 + V_2 = 2\cos[\omega_c t - \omega_m t - 90^\circ]}$$

② Interchange position of carrier source and carrier 90° phase shifter.

$\cancel{V_1 = \cos(\omega_c t + 90 - \omega_m t) - \cos(\omega_c t + \omega_m t + 90^\circ)}$

$V_1 = \cos[\omega_c t - \omega_m t] - \cos[\omega_c t + \omega_m t]$

$V_2 = \cos[\omega_c t - \omega_m t + 90^\circ - 90^\circ] - \cos[\omega_c t + 90^\circ + \omega_m t + 90^\circ]$

$$\boxed{V_o = V_1 + V_2 = 2\cos[\omega_c t - \omega_m t]}$$

③ -90° phase shift to Audio signal

$V_1 = \cos[\omega_c t - \omega_m t + 90^\circ] - \cos[\omega_c t + \omega_m t + 90^\circ]$

$V_2 = \cos[\omega_c t - \omega_m t + 90] - \cos[\omega_c t + \omega_m t - 90^\circ]$

$$\boxed{V_o = 2\cos[\omega_c t - \omega_m t + 90^\circ]}$$

Advantages →

1. frequency upconversion is not needed.

2. Lower audio frequencies can be transmitted.

3. It is easy to switch from one sideband to other sideband.

Disadvantages →

1. Exact 90° phase shift is required otherwise unwanted sideband will be not be removed completely.

   Attenuation for unwanted sideband should be at least 40 dB.

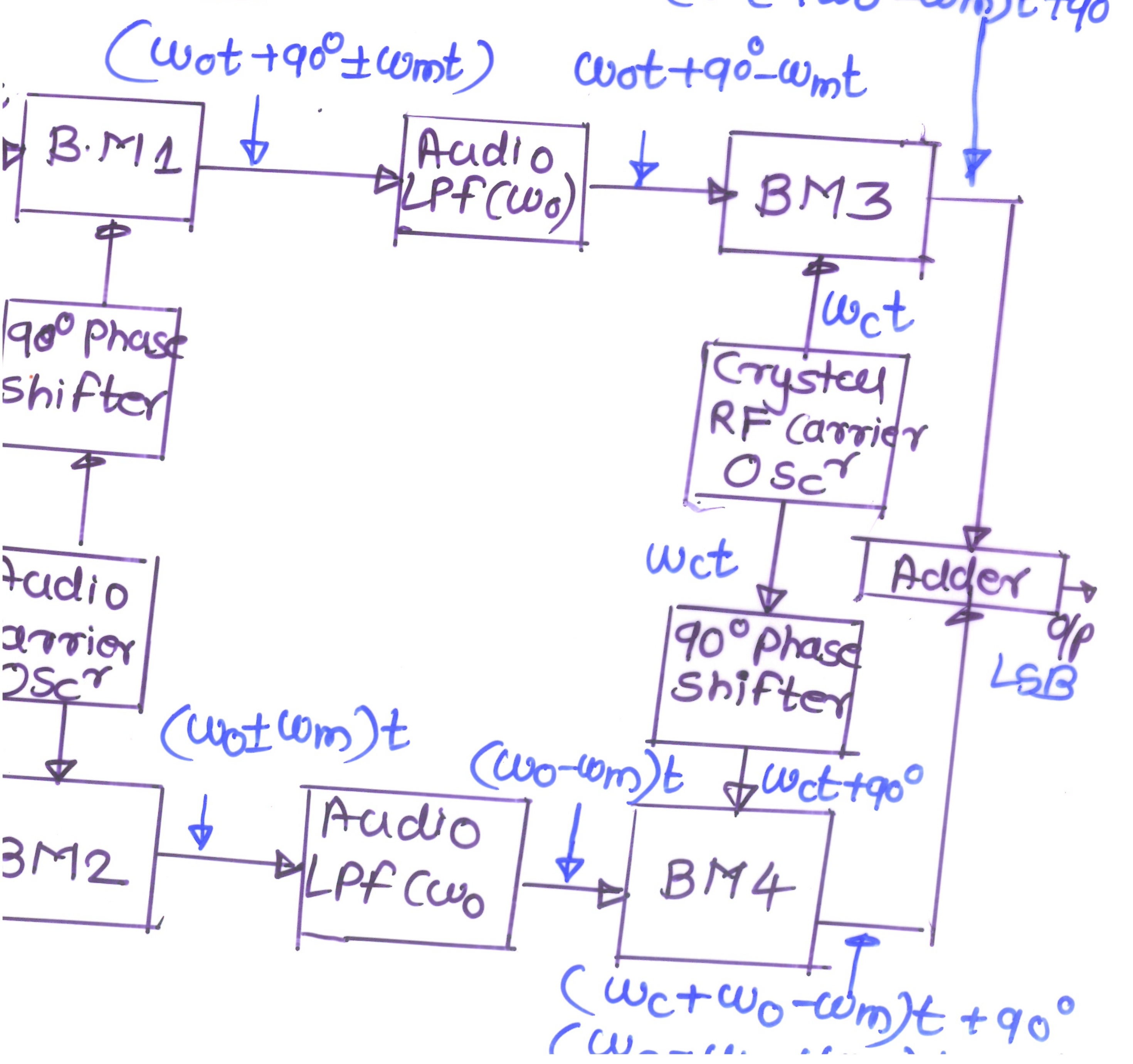
   so phase shift should be less than 1°

2. 2 Balanced Modulators must give exactly same output. (This assumption was made in proof) otherwise cancellation will be incomplete

(i) Design of 90° phase shifting N/W for the modulating signal is extremely critical. 15

Because of these reasons it is not used commercially. But used widely by amateurs, since filter tends to be rather expensive.

Third Method



) Design of 90° phase shifting N/W (15)
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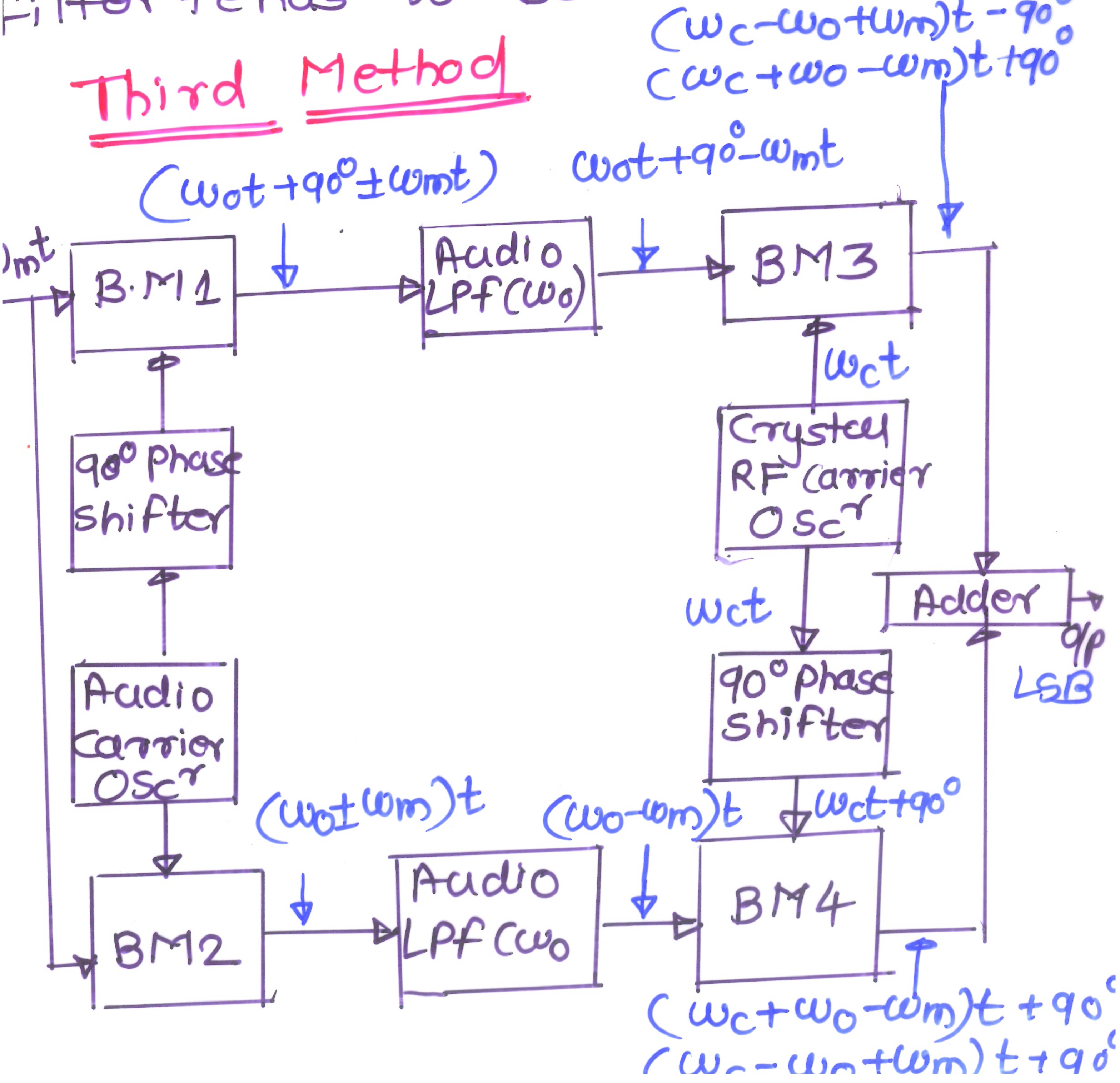
Third Method



phase shift is not given to whole range of audio band. 16

Audio signal is first modulated onto an audio subcarrier f_o.

This audio subcarrier is in the middle of audio band. say 1650Hz.

Phase shift is first applied to this frequency only.

O/P of B.M 1 & B.M 2 contains USB & LSB both shifted in phase by 90° and LSB & USB respectively.

Lower sidebands are selected and and given as I/P to B.M 3 & BM 4

O/P of BM3 and BM 4 are as follows

BM 3 → $f_c + f_o - f_m + 90^\circ$

$f_c - f_o + f_m - 90^\circ$ X

BM 4 → $f_c + f_o - f_m + 90^\circ$

$f_c - f_o + f_m + 90^\circ$ X

Adder o/p is LSB with $\boxed{f_c + f_o - f_m + 90^\circ}$ having carrier freq $f_c + f_o$ and phase shift of 90°. USB and other sideband is suppressed.

USB Generation

Interchange carrier I/p to BM3 & BM4

o/p of BM3 is

$$ct + 90 - \omega_0 t - 90 + \omega_m t) \; \&$$

$$\omega_c t + 90 + \omega_0 t + 90 - \omega_m t) \; \times$$

o/p BM4 is

$$\omega_c t - \omega_0 t + \omega_m t) \; \& \; (\omega_c t + \omega_0 t - \omega_m t) \; \times$$

At adder o/p we get USB with freq $f_c - f_0 + f_m$

we get upper sideband with carrier freq $f_c - f_0$

~~Advantages of Third method~~

① Adequate ~~attenuation (50dB) for unwanted sideband.~~

②

Advantages of Third Method

1. Does not require sideband suppression filter nor a wideband audio phase shift
2. Low audio frequencies can be transmitted
3. No need for frequency up conversion.
4. Easy to switch from one sideband to other sideband.

Disadvantages of Third Method

1. Whistle will exist at that frequency if the balance of the low frequency balanced modulator deteriorates
2. Most complex.
3. 4 B.M are used where we assumed perfect o/p

Filter Method works well for present requirement.