# Marconi Broadcasting Transmitter Systems

# F.M Combining Units

B8120
B8121

## Features

**Combines several F.M channels into a common output**

**Rugged coaxial construction**

**High power versions**

**Frequency range 87·5 to 108MHz**

**Channel spacing as low as 800kHz**

**Air cooled**

**Good isolation between inputs (typically greater than 30db)**

**Good input match (typically better than 5% reflection)**

## Description

It is common in F.M broadcasting to radiate more than one programme from the same transmitting site. While it is possible to do this using separate antennas for each programme, it is more economical to employ a common antenna system and combine the separate transmissions on to a single transmission line at ground level.

Marconi Communication Systems Ltd have for many years specialized in the supply of equipment for combining separate F.M programmes for radiation from a common antenna.

Such combining units must satisfy three main requirements:
1) Low insertion loss between each transmitter and the antenna;
2) Adequate isolation between any two transmitters connected to the combining unit;
3) A satisfactory match at each transmitter input.

In addition the criteria applying to all types of capital equipment such as minimum size, minimum power consumption, maximum reliability, ease of access, etc. apply equally to F.M combining units.

Various design approaches are possible to achieve the electrical requirements above and the optimum solution for one case will not necessarily be satisfactory in another. The differences arise mainly as a result of the frequency spacing between the channels being combined. Because of this, no one design will be satisfactory for all users. It has therefore been the custom of M.C.S.L to propose individual solutions to the particular combining problems presented by customers.

Nevertheless the resulting equipment usually embodies one of two design types, and sometimes both in combination. These may be described in general terms as 'star-connected' and Lorenz 'ring-type'.

### Star-connected combining unit

In this design (see Figs. 1 and 2 for a typical example) the transmission lines from the transmitters to be combined are joined together with the line to the antenna at a common point, thus forming a 'star' connection. In the lines between each transmitter and the star point are connected resonator-filters. Typically these comprise two shunt-connected resonators spaced by an odd number of quarter wavelengths at the channel frequency involved. Each of these resonators is equivalent to a parallel resonant circuit across the line and is adjusted to provide a high shunt impedance at the frequency of the transmitter connected to that line. It will therefore not significantly affect that transmission which continues to the star point. At the frequencies of the other transmitters however the resonators present a considerable shunt susceptance and therefore substantially absorb the other transmissions arriving from the star point. The second resonator in each line reinforces the action of the first.

At the star point each transmitter input only 'sees' the antenna connection, because of the effect of the resonators in the lines from the other transmitters.

In practice, realization of simple theory is imperfect. The shunt impedances presented by the resonators are not totally without loss at the resonant frequency and some power is therefore dissipated in the resonators, this power coming from the associated transmitter. This represents an insertion loss in the system and may, depending upon the transmitter powers, require assisted cooling.

This type of combining unit is basically simple and robust but has the disadvantage that it is difficult to maintain a high cross-insertion loss when the frequency spacing between different programmes is small. Nevertheless this type of combining unit is sometimes suitable for frequency separations as small as 1·5MHz.

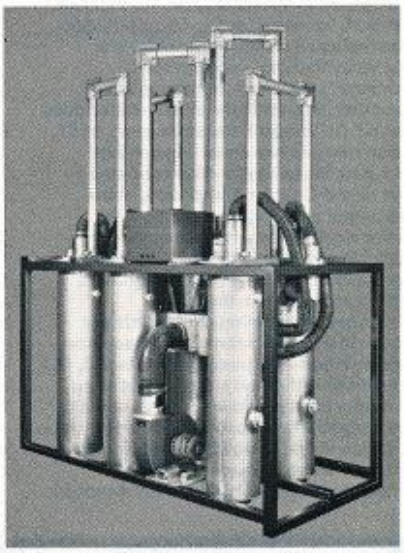

*Fig. 1 Three channel star-connected combiner*

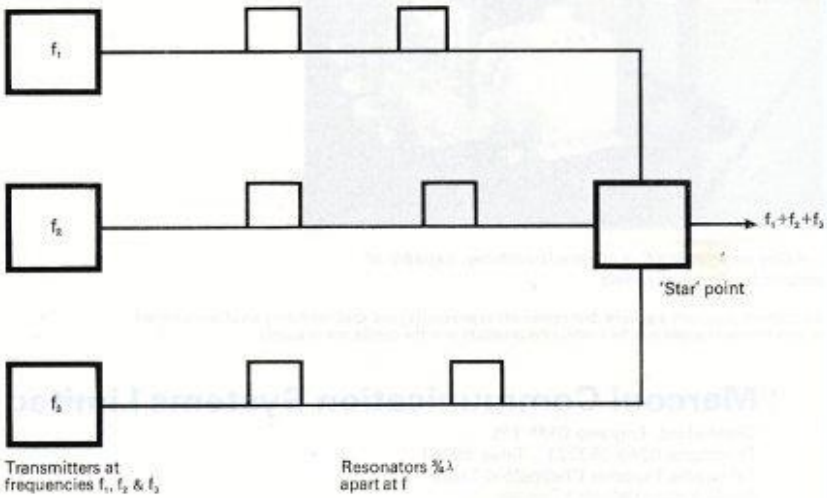


*Fig. 2 Typical 'star'-connected combining unit (schematic)*

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## Ring-type combining unit

Where the frequency separation between programmes is so small that the method of combining described above becomes unsatisfactory, a ring-type combining unit may be employed. This takes its name from the ring configuration of two interconnected 3dB couplers, with resonator-filters incorporated in the two connecting arms. This is shown diagrammatically in Fig.3.

The diagram shows the combination of one transmission, on frequency $f_1$, with an already combined pair of frequencies ($f_2+f_3$). Two single frequencies can be combined in the same way. With the configuration shown in the diagram the resonator filters are adjusted to reflect $f_1$ but pass $f_2$ and $f_3$. Coupler A splits $f_1$ into two equal components which are reflected by the filter-resonators and recombine in Coupler A, appearing at the output port because of the phase relationships involved. At Coupler B transmissions $f_2$ and $f_3$ are also split into two equal components which pass the resonator-filters and also recombine in Coupler A, appearing at the same output port as $f_1$. Imperfections in practice result in some of $f_1$ passing on to Coupler B, and also some of ($f_2+f_3$) being reflected to Coupler B. These components combine and appear in the load.

This type of combining-unit will clearly function in a similar manner if the resonator-filters are adjusted to pass $f_1$ and reflect ($f_2+f_3$), but in this case the load and the combining-unit output ports as shown in Fig.3 would be interchanged. The actual configuration chosen in practice will be decided by weighing up a number of factors concerned with the practical realization of the theoretical concept.

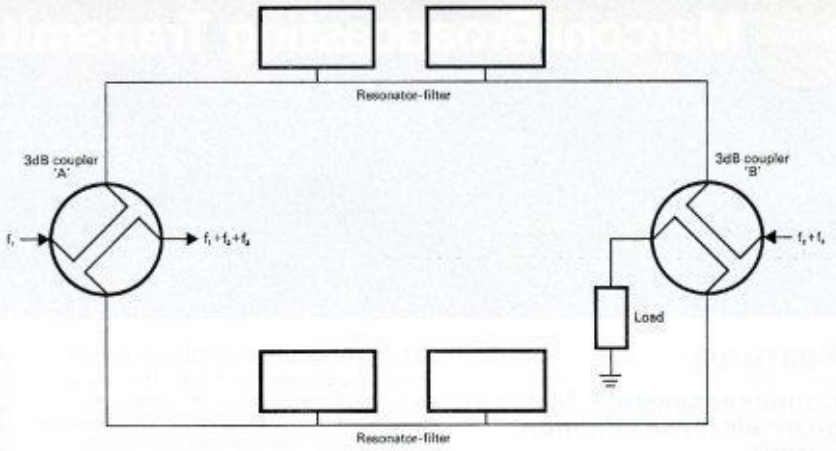


*Fig. 3 Typical 'ring'-type combining unit (schematic)*

## Practical designs

M.C.S.L have supplied many F.M combining units using basic design concepts similar to those described above. Two examples are shown in the photographs, Fig.1 showing a three channel forced air-cooled star-connected type of equipment capable of handling 10kW per channel. Figure 4 shows one unit of a complex ring-type combiner designed to a very stringent specification capable, in combination with other similar units, of combining up to eleven programmes at powers of up to approximately 20kW on some channels.

The latter illustrates the possibility of providing complete combining unit systems, i.e providing not only combining units, complete with cooling where necessary, but also by-pass arrangements with automatic control if required. Special accommodation requirements can also be taken into account. For example, many units have been supplied in a form suitable for mounting on a wall.

Connections are usually made with standard EIA flanges but other more specialized designs can also be specified, especially on low power units.

## Ordering Information

When ordering or enquiring about this equipment, the following details will enable your requirements to be dealt with promptly :

- Frequency of channels to be combined
- Power of channels to be combined
- Minimum isolation required between channels
- Characteristic impedance required
- Ambient temperature range of site
- Altitude of site.
- Voltage and frequency of available power supply.
- Space available for accommodating unit.

If more than two channels are involved, can the unit be split into two or more mechanical units ?

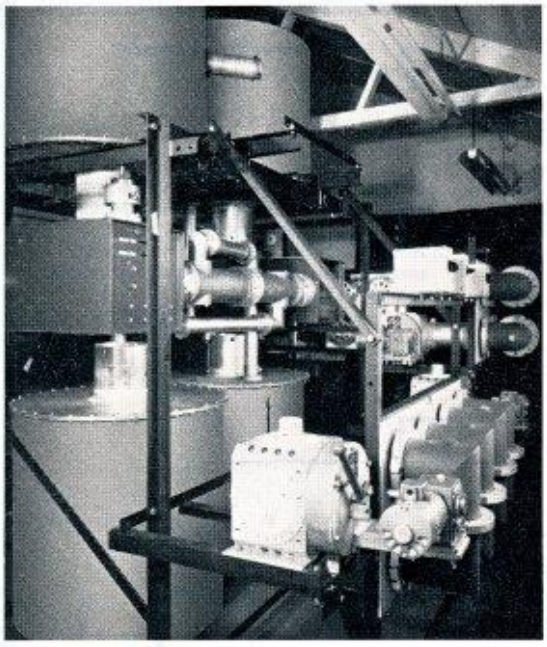

*Fig. 4 One section of a five channel combiner, capable of extension to eleven channels*



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