A SECOND GENERATION CATV CONVERTER

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INTRODUCTION

Set top converters have been on the market for over five years. For the most part, they have performed their intended function admirably. However, due to changing requirements and more stringent specifications, we are moving into an era in which second generation converters are required.

BACKGROUND

Set top converters evolved as a means of solving the direct pickup problem prevalent in strong signal metropolitan areas.

The method used was to down convert the cable signals to a 44MHz I-F and then up convert to a channel that was unoccupied by a broadcast signal. The RF circuitry to perform this function was enclosed in a well shielded metal compartment. The basic tuning methods were well established VHF TV tuner concepts and hardware.

It soon became apparent that the set top converter did not have to be limited to a meager twelve channels. To achieve more channels, the initial attempts were to either add another TV type tuner or to expand the coverage of the existing tuner. In either case, the 44MHz I-F was retained. As a result, the local oscillator signal emanating from the tuner antenna terminals fell into the CATV signal band. When only twelve standard channels are used, this is relatively unimportant. When mid and super bands are used, it results in converter to converter "cross talk".

GAMUT 26 - DESIGN PHILOSOPHY

In reviewing optimum approaches to second generation converters, a number of factors should be considered.

GAMUT 26 - DESIGN PHILOSOPHY (cont'd.)

Unlike broadcast, the cable signal levels operate within a relatively narrow range (-6 to +12db mV). Thus a dynamic, AGC able front end is not a requirement.

The future of cable is dependent upon providing additional channels and services to the subscriber. It would seem prudent, therefore, to avoid any energy emanating from the converter that could penetrate into the cable system.

The customer interface must be simple to operate and non-ambiguous.

The cost/performance factor must be equivalent or better than first generation converters.

DESIGN APPROACH

In developing the Gamut 26, we abandoned the use of a "TV tuner" as a tuning element. Also, the use of a high frequency I-F is mandatory if oscillator energy is to be prevented from entering the cable system.

Our approach can best be illustrated by referring to the block diagram. Figure 1.

The cable signal flows through a set of filters into a passive double balanced mixer (DBM). It is combined with a local oscillator frequency to form an I-F of 330MHz. Twenty-six channel tuning is achieved by simply switching in the appropriate oscillator frequency.

The I-F amplifier provides gain and selectivity to the up converted signal. Combining with a fixed tuned 2nd local oscillator, the signal is down converted to the desired output channel.

DOUBLE BALANCED MIXER

Little trouble from intermodulation, in the form of sums and differences of the signal or from its harmonics, are experienced when using the standard twelve channel VHF frequency allocation. Historically, these frequencies were carefully chosen to avoid this.

With the use of multichannel coverage, second order distortion becomes a severe problem. In particular, the low band can react with the mid, high and superband to create spurious signals which manifest themselves in the TV receiver as "beats". For example, the sum of a channel 2 and a channel A signal will produce an interference in channel 7. It has been our experience, and that of others, that the suppression of these beats should be in the order of 60db. See Ref. 2. It is for this reason that we have used a double balanced mixer as a front end.

Its operation can be described by referring to Figure 2. The RF signal is applied at the input port and combining with a strong local oscillator at the second port is converted into two side bands, equally spaced about the local oscillator signal. These side bands are available at the third port. In the case of the Gamut 26 the lower sideband (330MHz) is used as the I-F. It will be noted that the images (upper side bands) are in UHF, well out of the cable signal band.

By virtue of its inherent balance, the double balanced mixer (DBM) is a device that automatically provides a great deal of suppression to second order beats. Good port to port isolation and excellent cross modulation characteristics makes the device well suited for CATV applications.

BACK TO BACK OSCILLATOR

To tune the DBM, twenty-six discrete, ultra high frequencies are required (386 to 572MHz). These local oscillator signals must be high level, accurate and repeatable.

This is achieved by using the basic hardware from a VHF tuner transistor oscillator. Two oscillators were mounted "back to back" on a common shaft. Instead of thirteen positions common to VHF tuners, twenty-six become available. The memory fine tuning mechanism became a means of aligning the oscil-

BACK TO BACK OSCILLATOR (cont'd.)

lators in production. The B+ was fed through the tuning coils thus providing automatic switching to the appropriate oscillator. See Fig. 3.

As there is a separate tuning inductance for each frequency, the sequence of operation is completely independent. This is an advantage in the Channel Selector readout as the numeric channels of the low and high bands can be arranged in sequence as can the letter channels of the mid and super bands.

Detenting is provided by a large index wheel mounted mid-way down the shaft. By devoting careful attention to this detail we have achieved reset accuracies superior to VHF tuners even though the oscillators are working at UHF frequencies.

The circuits are basic, temperature compensated, Clapp type oscillators using high F_T transistors.

PASS/STOP FILTER

As well as the DBM functioned, we found that we could not maintain the proper balance in production to guarantee the 60db suppression of beats with an input signal level of +12db mv.

To ensure compliance to this specification we found it necessary to insert, what we term, a pass/stop filter into the circuit prior to the DBM. This device acts as a lowband filter when the converter is tuned to channels 2 thru 6. At any other channel the filter is switched to an elliptic function high pass with its zero of transmission tuned to the low band. Thus, any potential for forming sums and differences of the input frequencies is completely removed.

The low pass filter connected to the input terminal has a cutoff of 300MHz and is used to help prevent any oscillator energy from leaking out into the system.

PARTITION FILTER

The output of the DBM is fed to the I-F via a filter mounted in a metal partition wall. This broadly tuned bandpass filter has its center tuned to 330MHz. It primary function is to provide good selectivity at frequencies far removed from the I-F.

Another feature of this filter is the use of an open circuit quarter wave transmission line as a circuit element. At 330MHz the stub looks essentially like a capacitor. At the frequency of the 2nd LO, and its third harmonic, the stub behaves like a short circuit and provides a zero of transmission to these frequencies. This is invaluable in preventing the 2nd LO from penetrating into the DBM, and causing internally generated beats.

INTERMEDIATE FREQUENCY AMPLIFIER

The I-F video frequency is 331MHz and the sound is 326.5MHz. These particular frequencies were chosen so that the sums of the R-F signal frequencies that fall in this vicinity are converted into the sound trap and the adj.-channel sound traps in the TV receiver's I-F.

The input to the I-F is tied directly to the base of a common emitter transistor amplifier. The low noise transistor operates under self bias conditions with a large voltage drop in the collector circuit. This method was used so as to foil any instabilities due to feeding the collector with a choke - a problem with high FT devices.

The selectivity prior to the 2nd mixer is achieved with double tuned capacity coupled circuits. Attempting to achieve high selectivity (1.5% bandwidths) at 330MHz with lumped LC filters results in high insertion losses. To overcome these losses two stages of gain are used.

The mixer is a common emitter transistor whose output is tuned to desired output channel. In most cases this is channel 12. The output filter is again a two pole, high side capacity coupled circuit.

The 2nd LO is a Clapp type oscillator operating at 536.25MHz (when using Channel 12 as the output). Fine tuning is achieved

INTERMEDIATE FREQUENCY AMPLIFIER (cont'd.)

by varying the base current by means of a fine tuning pot. This changes the capacity of the depletion area of the p-n junction which in turn changes the frequency of oscillation to the point that fine tuning is achieved.

The output from the mixer tank is connected to the output terminal via an attenuator pad. The value of this pad is such that the overall gain is limited to an average of 6db.

The I-F amplifiers, 2nd LO and the mixer circuitry are all mounted on one printed circuit board. Although the frequencies used would normally preclude the use of a PC board, careful placement of parts and the optimum use of the ground plane has resulted in a circuit that is stable and uniform in production.

POWER SUPPLY

The power supply is a 24v, series regulated type drawing 35ma. To prevent direct pickup the entire supply is placed in a separate compartment and completely shielded from the rest of the circuitry.

An AC convenience outlet, controlled by the ON-OFF switch, enables the converter to be used as a remote control device.

FUTURE USES

We feel that we have fulfilled the design criteria and have produced a viable product that not only fulfills todays needs but it also can serve as a fundation for other services.

For example: By changing the output channel to 44MHz we would have a tuner for an All CATV receiver.

The addition of decoder modules would permit the use of pay TV channels.

The basic unit can serve as the subscriber interface in two way systems.

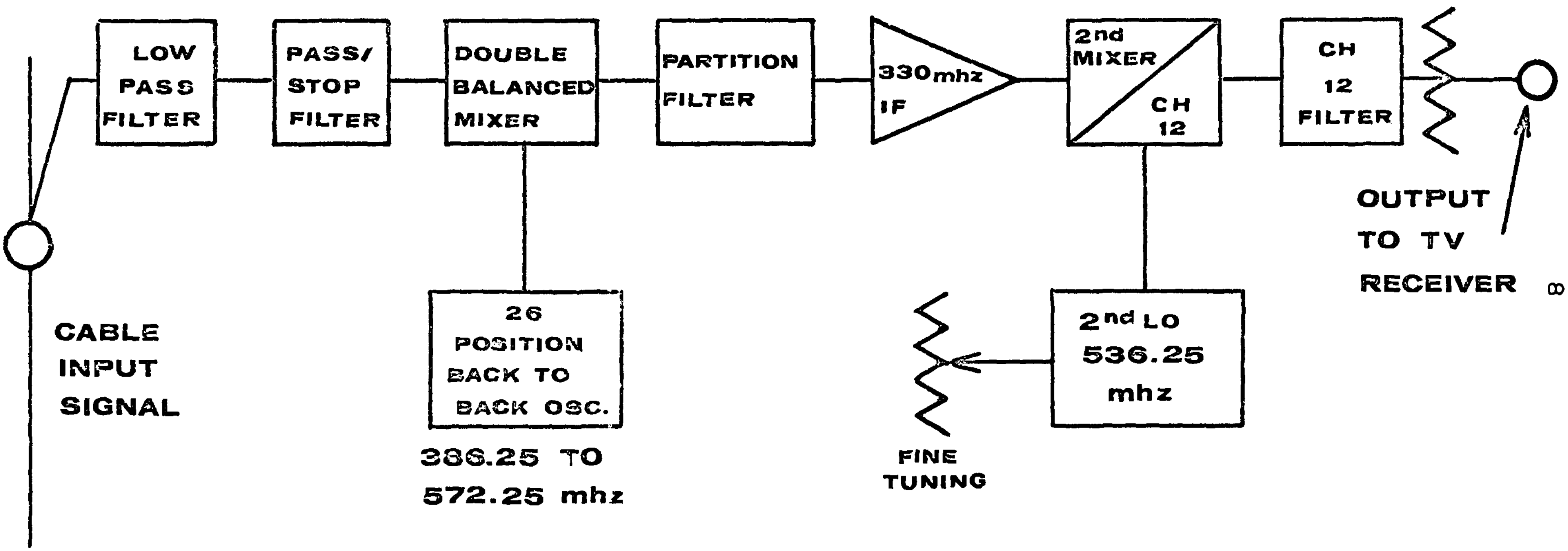


FIG.1

BLOCK DIAGRAM

GAMUT 26 CONVERTER
(CH 12 OUTPUT)

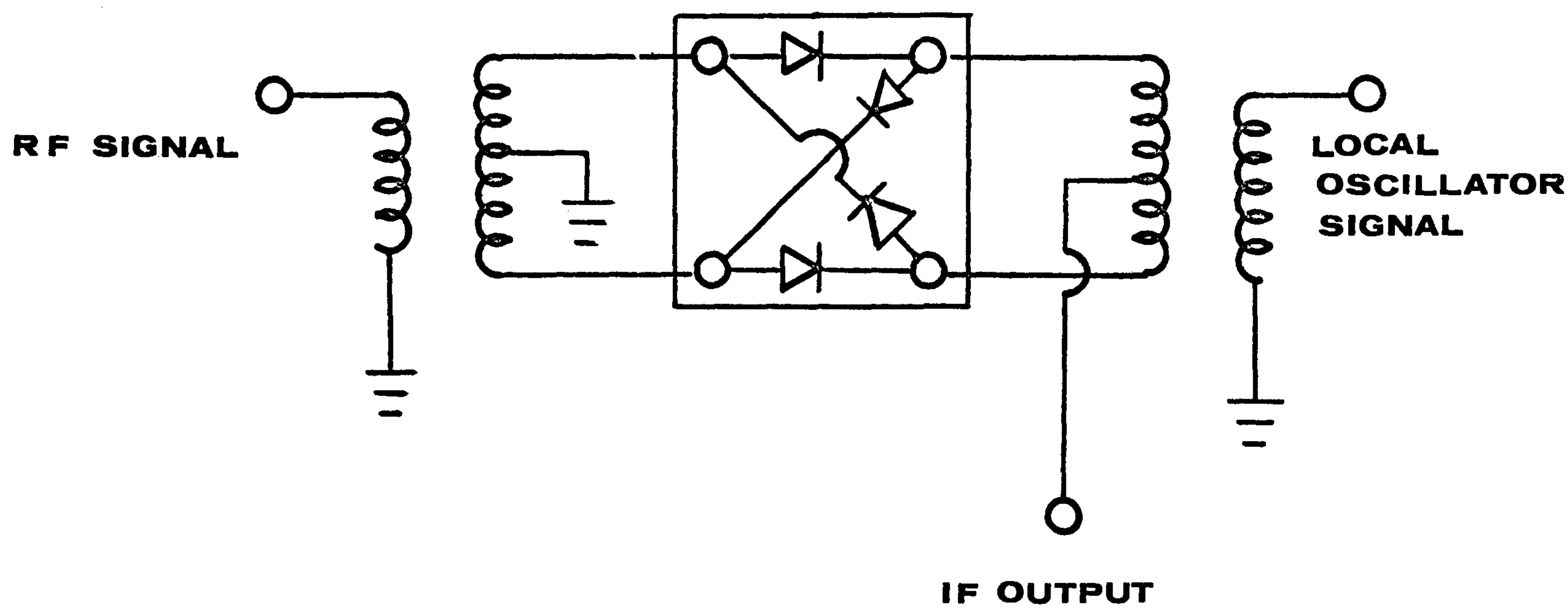
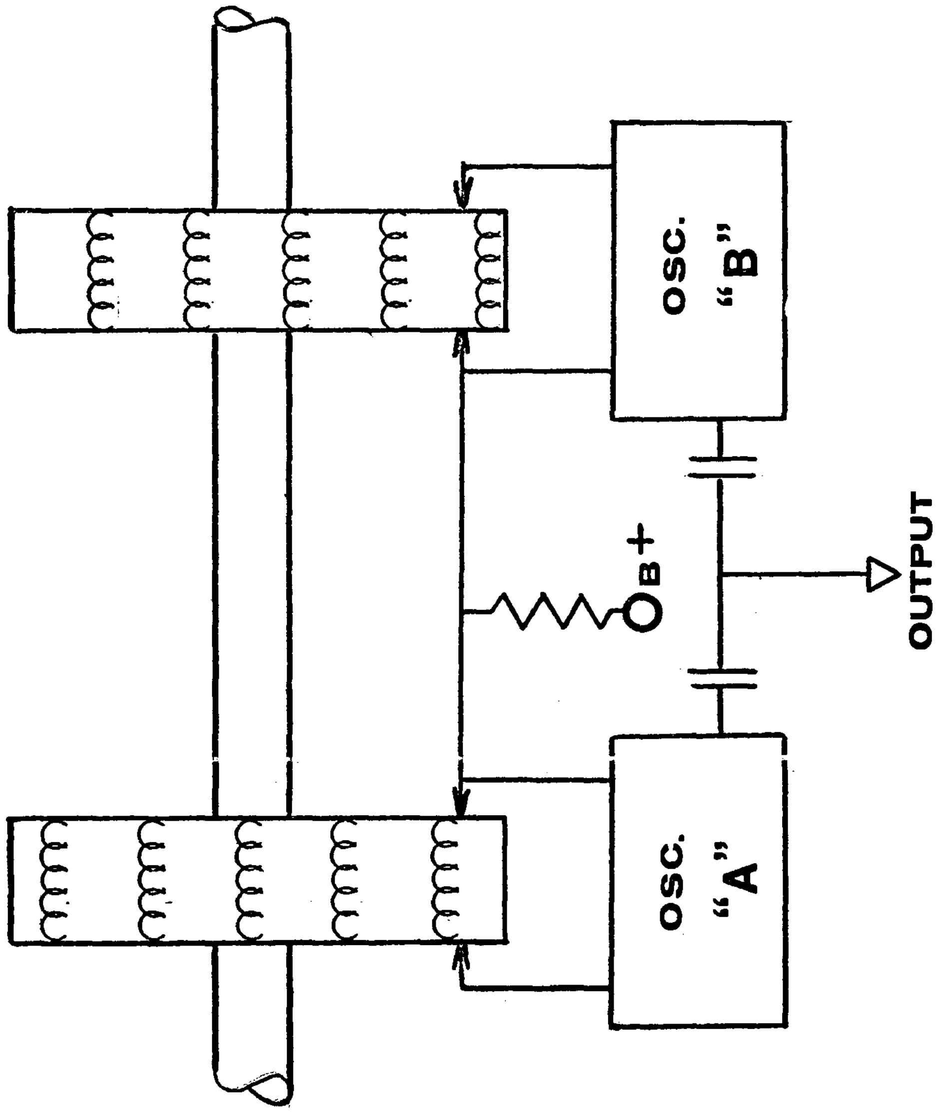


FIG. 2 DOUBLE BALANCED MIXER



BACK TO BACK OSC.

FIG. 3

REFERENCES

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