256-CHANNEL, 2 MHz PER CHANNEL, FILTER RECEIVER

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Introduction

This report covers the new 256-channel, 2 MHz per channel, filter system, an updated version of the systems described in EDIR No. 146. The general design and construction is the same though most of the printed circuit boards have been changed to accommodate the wider bandwidth and higher frequencies. Figures 1 and 2 show the spectrum processing for the series and parallel modes and the block diagram.

IF Processor Unit

The IF Processor, Figure 3, is used for changing the series spectrum into the parallel mode. Switching between series and parallel is done by a TO-5 relay assembly under control of a TTL signal fed in the back panel. This signal also changes the digital card to accommodate the inverted channel counting in the series mode. The processor schematic shows a small capacitor on the second mixer output line. Other components not shown were added around some of the mixers to suppress the feedthru level to more than 30 dB below the desired output. Extensive shielding was also added.

Oscillator-Multiplier Unit

The two processor associated LO's are generated from a crystal oscillator operating just above 100 MHz followed by three active doublers, a filter and power amplifier. One of these circuits is also shown in Figure 3. Tuned matching circuits are used between multiplier stages, and the final multiplier output is bandpass filtered to provide suppression of the unwanted harmonics. The output amplifier provides +10 dBm to the mixers. During system testing it was discovered that "birdies" were showing up in some channels. Most of these
could be traced to subharmonics of the processor LO's. The filter in the LO's was not doing an adequate job because of its close proximity to the multiplier chain. External filters were added to provide the very high rejection required.

**Amplifier-Splitter Unit**

The Amplifier-Splitter Unit, Figure 4, contains a 520 MHz low pass filter, amplifier and power splitter for each section. A trap was added to the A section to prevent the 128 MHz difference frequency from generating in-band harmonics in the following amplifier. The 128 MHz is the result of incomplete LO rejection in the first mixer of the processor unit.

**Splitter Unit**

The Splitter Units are a new design to give adequate gain, match and isolation to 470 MHz. These circuits use a grounded base stage with matching transformer on the output. See Figure 5. Reflection from an out-of-band bandpass filter back into an in-band circuit is down 40 dB or more at other outputs. The very low output VSWR prevents deterioration of the shape of the following bandpass filters.

**Oscillator-Mixer Unit**

The Oscillator-Mixer Units use circuits similar to the oscillator-multipliers except that only two doublers are required. A representative circuit is shown in Figure 5. A power amplifier and divider furnish +7 dBm to the four mixers. Shunt capacitors and series resistors were added on the mixer inputs to improve the match. Small attenuators on the mixer outputs are chosen to compensate for loss variations in the mixers and all previous units. With levels normalized at this point the filter cards need not be gain trimmed for a particular slot.
Filter Card

The filter cards were redesigned to provide sockets for the op amp and detector diode, provide a new input amplifier and to eliminate ground and power jumpers. The filter and detector circuits are the same except for space for loading the DC side of the detector. See Figures 6 and 7. This loading allows use of some diodes that would otherwise be rejected for poor square law accuracy. The op amps may be either Fairchild μA 714C or Harris HA-5135-5. The Fairchild unit is equivalent to an OP-07C and the most economical but is available only in a TO-99 can at this time. These units provide an offset temperature coefficient of less than 1.8 μV/°C compared to 15 μV/°C for the 741 KN previously used at about the same cost. Some improvement in stability may have been gained by using metal film resistors. Corning type C4 resistors are better than ±100 ppm/°C, physically interchangeable with 1/4 W carbon compositions and have better long-term stability at a cost 20% above the molded carbons.

The filter cards operate over the input frequency range of 16 to 48 MHz. At the higher frequencies the signal distribution line down the middle of the board produced a significant standing wave. This problem was eliminated by terminating the line in 43 ohms. This lower impedance increased the signal loss but was offset by a higher gain, wider band input amplifier. See Figure 6. Temperature tests were made on a channel circuit to determine gain instability. The coils measured worse than predicted from data on the core material. Unfortunately, the amplifier also drifted in the negative direction. These errors exceed the positive coefficient of the detector by about two times. The first inclination was to compensate one of the stages with a temperature sensitive resistor but a satisfactory type was not found. Also, the compensation required at 48 MHz is considerably higher than at the low end. This would
imply separate and different compensation for each channel, a significant com-

plication. The solution was to provide circuit space for a temperature/fre-

quency compensation network at the output of the input amplifier using a

thermistor-capacitor-resistor combination. The necessity for compensation

will be determined later.

Monitor Controller Card

The Channel Monitor Digital Controller is unchanged. A schematic and de-

scription are given in the previous report. Figure 9 relates channel number to

input frequency and card channel number.

Buffer and Monitor Card

The Power Monitor card of the previous system has become the Buffer and

Monitor card of this system. In addition to providing single channel or A

and B section total power monitoring to the front panel meter and coax jack,

it provides simultaneously buffered total power outputs from each card (16

channels summed) to OSM connectors on the back panel. The schematic is given

in Figure 8.

Cost

Since 1973 the cost of components for this system has increased about 1.5X
to around $13,000. The BD4 back diodes were one of the major factors, increas-
ing from $3.30 to $8.66 each.

Acknowledgements

I wish to recognize L. Beale for his construction efforts again. A.

Weinreb and R. Lacasse provided an automated square law measuring system
to speed up testing and D. Ross and D. Webb were very helpful in arranging

for purchase of printed circuit boards and in contracting for the assembly of

parts on the filter boards.
SPECTRUM PROCESSING

Figure 1
Gain = Approx. 0 dB
Amplifiers - Avantek GPD-1002
Mixers - Vari-L DBM-142
Power Divider - Engelmann PSP-210

IF PROCESSOR

Oscillator - Multiplier
SYSTEM POWER LEVELS

AMPLIFIER - SPLITTER

Figure 4
SPLITTER

OSCILLATOR-MIXER

Figure 5
Input Amplifier

Channel Circuit

FILTER CARD

Figure 6
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**CHANNEL FILTER CIRCUIT VALUES**

**Figure 7**
Figure 8

BUFFER & MONITOR CARD

Total Power From each Card

Card Power To back panel

Card Power To back panel

A

B

Channel Power

From Card Sw. Outputs

Function Sw.