Multiple Satellite Channel Transmission Through One Receiver: The Concept

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ABSTARCT:

Most of us are regular viewers of satellite channels. These channels come via the cable operator's control room. In the control room, are housed numerous satellite channel receivers or 'tuners'. These tuners can receive only one channel at a time. Hence larger the number of channels to be viewed, larger are the number of receivers.

In today's world, where we have devised newer technology for virtually every task, why not transmitting multiple channels through one receiver, or simply multiplexing. There are numerous problems associated with this concept. These have been discussed in greater detail in the following paper. Also discussed are reasons why we cannot multiplex the channels through one receiver.

Introduction:

A satellite channel receiver commonly called tuner 'can receive only one channel at a time. If one wants more than one channel, one must install more receivers. For five channels, there will be five receiver sets, for fifty there will be fifty receiver sets. And when there is a boom in the satellite channels, this will increase the number of electronic equipment required resulting in increased space and power consumption. The consumers pay more due to increase in investment and operating costs.

When there is a large amount of data to be communicated through a single channel, the technique of multiplexing is extensively used. This technique [1] transmits large number of information units or packets, for certain time duration, one after the other, over a smaller number of channels or lines. The receiving end makes sure that it is synchronized in demultiplexing the transmitted signal. These are then transferred to the various receiving stations.

If this technique of multiplexing is applied in our care, we can reduce the number of receiver sets required. Here the satellite is transmitting many signals at different frequencies. These have to be received (by the tuner), then multiplexed, then send through the processing circuit and then to the television.

All the practical fundamentals, circuitry, calculations, various drawbacks and their remedies have been discussed in great length.

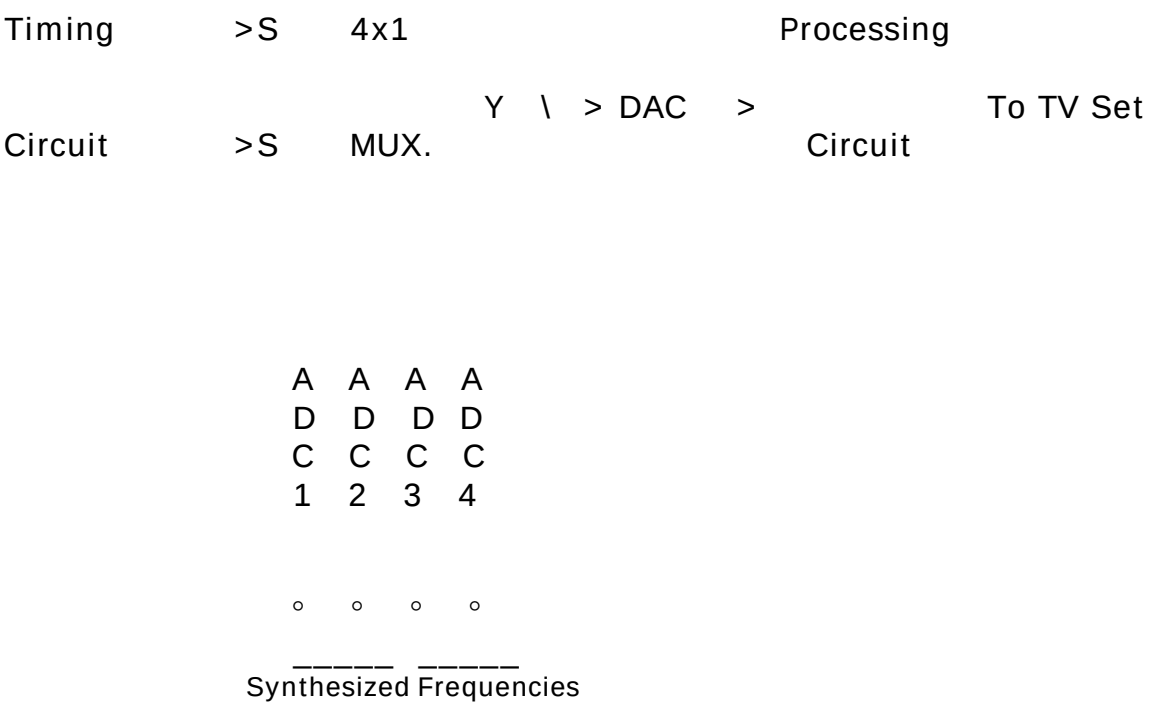
Basic Block Diagram Representation:

A basic satellite channel receiver set can be described by the following parts:

- A tuner
- Processing circuit (consisting of various filters, amplifiers, audio (video detectors etc.). [2]

A tuner and the processing circuit can be synthesized with minimal complexity. However, discussions about the processing circuit are beyond the scope of this paper. Also let us assume that we are multiplexing four signals through one receiver set.

Figure 1



A satellite dish at a particular inclination, receives a set of signals through the LNB (Low Noise Block). This is then send to various receiver sets for individual processing of different signals. These processed signals are then mixed through the mixer, which is then transmitted to the Television Set.

Here the multiplexer gets various signals through the tuner set. These are selected with the help of appropriate tuning signals (generated by the tuning circuit keeping in mind the persistence of vision). These are then processed and then given to the mixer circuit and then passed on to the television set.

Persistence of Vision (3) :

The phenomenon of a visual impression upon the retina of the eye, after the exciting cause is removed is called Persistence of Vision. It is the cause of many phenomenon in optics, for example Cinematograph shows in rapid sequence a series of views representing closely,

successive phases of a moving object and persistence of vision creates the illusion that the object is moving. Visual sensation has persistence of $1/10^{th}$ of a second.

If in our case, signals must be send in packets of duration less than the time of persistence of vision, i.e. one cycle of transmitting all the signals should not take time greater than $1/10^{th}$ of a second.

Timing Circuit :

We have to generate two square wave pulses each of wavelength 20 ms and 40 ms respectively. The first one is generated using the free-running or astable multivibrator and this, here has been incorporated using IC 555 [4]. The output of this circuit is fed to a JK flip-flop, which acts as a unity bit counter [5].

- IC 555 as an Astable Multivibrator [4] :

Figure 2 shows IC 555 as an astable multivibrator initially when the output is high capacitor C starts charging towards V_{cc} through R_A & R_B. However as soon as voltage across C equals $V_{cc}*(2/3)$, capacitor starts discharging through R_B when voltage across C is $(1/3)* V_{cc}$, the output goes high again and the cycle repeats. If t_c and t_d are charging and discharging times respectively, then:

$$t_c = 0.69 (R_A+R_B)C$$
$$t_d = 0.69 (R_B)C$$

Thus total period of output wave is

$$T = 0.69 (R_A+2R_B)C$$

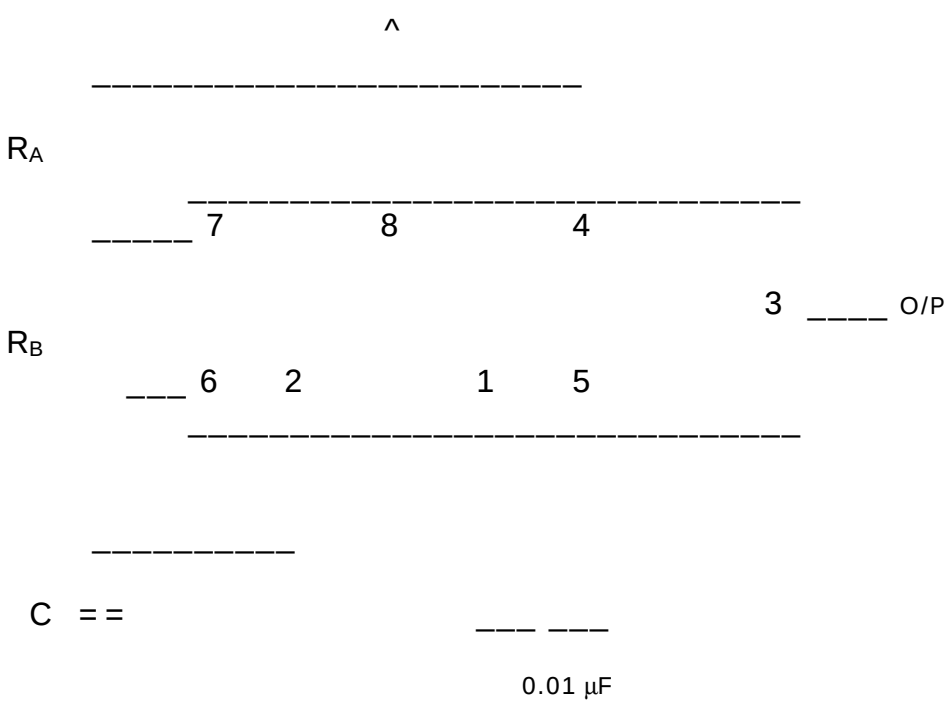
Duty cycle is given by

$$D = t_c/T = R_A+R_B/R_A+2R_B$$

Now assuming a duty cycle of 60%, and capacitor value of 1 μF, our T is 20 ms.

Hence if $R_A = 100\ k\Omega$
$R_B = 189.85\ k\Omega$

Figure 2



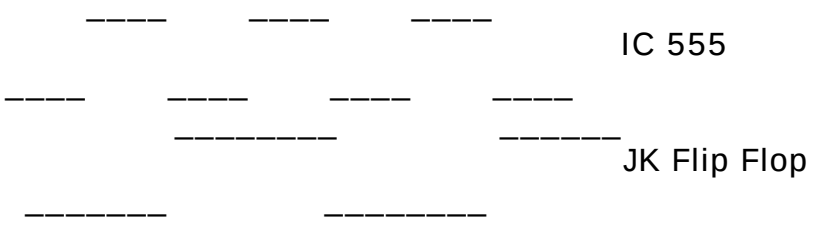
- Unity Bit counter [1] :

This circuit is implemented using the ripple counter technique wherein the output of first circuit is fed at the clock pulse input of a JK flip-flop. With both J=K=1, the output is complemented on the negative edge of every clock pulse. The characteristic table of a JK flip-flop (IC 7473) is given below :

J	***K***	***Q(t+1)***
0	0	Q(t)
0	1	0
1	0	1
1	1	Q(t+1) ’

The output of the astable multivibrator is of time period 20 ms. Hence that of the unity bit counter is 40 ms. When the two are compared it is as in Figure 3.

Figure 3



Hence these two outputs are fed to the select lines of the 4x1 Multiplexer. Where output from the multivibrator goes to the S_o or LSB while output from the unity bit counter goes to the S1 or MSB.

Multiplexing Unit :

Since we are multiplexing four signals through one channel we will need 4x1 multiplexer (1C 74151). The select lines S_0 and S_1, receive signals from output of 1C 555 and 1C 7473 respectively, while the input lines get their signal from the tuner set.

Say the 4 signals are I_1, I_2, I_3, I_4. If output of multiplexer is Y, then the truth table can be given as

S_1	S_0	Y
0	0	I_1
0	1	I_2
1	0	I_3
1	1	I_4

The output, which is fed to the DAC, gets converted to analog signal. It is then fed to processing circuit.

The processed signals are then fed to the mixer unit, which may be receiving signals from many processing circuits. The output is then fed to the television set.

Converters :

Each individual signal is digitized using an Analog to Digital Converter (ADC). One can use IC DM 2502, which is an 8 bit TTC register, successive approximation analog to digital converter.

Since we have 8 bits per signal, we will need 8 multiplexers to select one bit at a time.

These selected bits are then passed on to a Digital to Analog Converter (DAC) which reconverts the digital signal to analog for further processing by the processing circuit.

Drawbacks and Remedies :

We are using an 8-bit ADC circuit. This can distort the original signal to a noticeable level. To overcome this one can easily use more bits, with minor modification to the above design. Say if we have 16 bits ADC, we will have to use 16 multiplexer. Thus the circuit size and cost increase. But the picture quality will be of superior quality.

Conclusions :

Using the multiplexing, we were able to process and transmit many signals through one receiver. The signals were picked up in packets for particular time duration (say $1/5^{th}$ of the duration of persistence of vision). As the same signals was picked up again before the persistence of vision expired, it did create the illusion of continuous motion. Also note that there will be no flickering or the frame by frame effect.

References :

1. "Digital Logic And Computer Design" Moris Mano
2. "Electronic Communication System", G. Kennedy
3. "British Oxford Dictionary"
4. "Op-amps and Linear Integrated Circuits", R.A. Graykwad.