Method for securing pay TV channels

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Abstract – **Since pay television is a demanded commodity, it is subject to theft by unauthorized subscribers. This theft of service is a problem for basic services and eyen to a higher degree for pay services. To combat this loss of revenue, several methods are available to deter the unauthorized subscribers. In this paper we present a new method and his circuitry realization.**

Keywords – **Pay TV, sweep generator, amplifier, CATV**

I. Introduction

It is a known fact that Pay television is a demanded commodity. The operator has to secure this pay programming from "free access" to every subscriber. There are several methods used to secure the pay channel. Some of which are more secure than others and some of which are more costly than others. The most costly may not necessarily be the most secure. A decision must be made as to the best method for a given situation [1], [2]. The information presented by this paper will expose the audience to the method of pay receiving of TV channels and its circuitry realization.

The purpose of choosing this method is to ensure secure of the investment and the secure from larceny – aspiration: maximum security with minimum complexity on the lowest prices. The main technical requirements are minimal aggravating of picture's quality and a lack of interference in other channels.

There are variations and degrees of securing a pay TV service. The method and hardware selected will depend on the specific applications. Some systems do not need the state-of-the-art interactive terminals for security. These systems are using traps or a single channel descrambler. The users of devices will select them based on the projected penetration of pay and the degree of security provided [3].

An economic analysis is made to determine the lowest price per pay subscriber for a security device. This indicates that a scrambled signal is less expensive. This is true only when projected pay penetration is low. A different result will be indicated if pay penetration is 75 %. It comes that it is more economical to use trap filters.

It is obvious from the simple analysis that the expense of securing multi-tier service would be directly related to the expected penetration. It becomes obvious that the more pay services offered, the more expensive and more cumbersome the trapping and single channel descrambler becomes. Systems having multi-packaged and multi-tiered services are selecting the converter/descrambler combinations.

Down described method for securing pay TV channels in the cable TV systems is based on using of the possibilities for inversion connecting of directional couplers in the subscriber distribution network (SDN). They are with insignificant frequency dependence in the whole spectrum (from 5 MHz to 862 MHz) and could ensure isolation loss for every subscriber about 30÷40 dB.

An additional device is not assembled in the subscriber's home, which in other methods for paid receiving of TV channels cause some discomfort. On the other hand there is no need of any changes in the Head End. Only in the subscriber distributing network, after the main directional coupler, to the respective output tap is added a new one, but connected by a definite way.

II. Essence and Circuit Realizations

On fig.1 is shown a block circuit of the active scrambled module (ASM), which is basic for the method of suppressing television channels, whose receiving is unwanted, i.e. it is not paid for them.

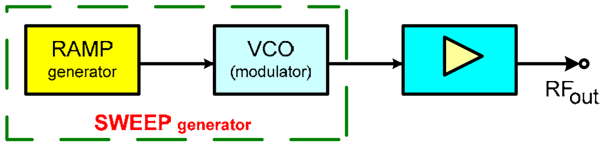

Fig.1. ASM block circuit

ASM and an additional directional coupler (AT) are being connected in the subscriber distribution network, as AT is plugged in by inversion between the existing directional coupler (ET) and the subscriber's television receiver (TV1). The output (OUT) of AT is being connected to an output TAP of ET by short coaxial cable with two F-connectors, and its input IN – by a coaxial cable with antenna coupling into the TV1 input (fig.2). To output TAP of AT, which in this case is used as an input, is being connected the disturbing signal from ASM.

To be reached the wanted effect in input IN of AT the two signals – the one from the cable television and the other from the ASM, must be commensurable.

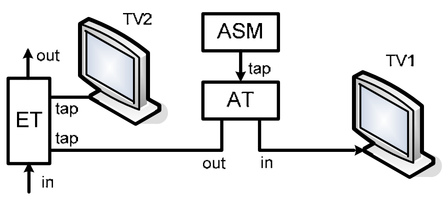

Fig.2. Schematic diagram for securing pay TV channels

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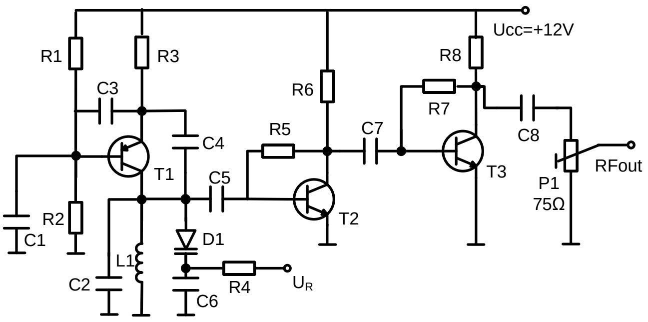


Fig.3. VCO and wideband amplifier electrical circuit diagram

The block circuit of ASM (fig.1) consist RAMP generator, VCO (voltage controlled oscillator) and amplifier. The RAMP generator generates saw-tooth voltage, which is being passed to a varicap D1 in VCO (fig.3), as his frequency is changing in a frequency range, in which the TV programs are, unwanted by the respective subscriber (fig.4 – the hatched area).

Voltage controlled oscillator is consists of transistor T1, connected by common base circuit with capacity feedback, which is being realized by a capacitor C4. High frequency oscillations from the generator go to the wideband amplifier's input by a capacitor C5, realized by transistors T2 and T3.

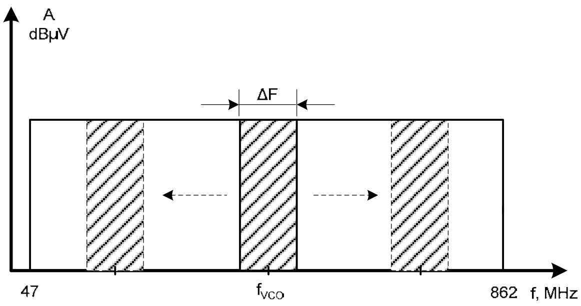


Fig.4. CATV frequency plan with scrambled channels

The RAMP generator is accomplished by two integral circuits IC1 and IC2 (fig.5). The IC1 monolithic timing circuit is a highly stable controller capable of producing accurate time delays or oscillation. In the time delay mode of operation, the time is precisely controlled by one external resistor and capacitor. For a stable operation as an oscillator, the tree running frequency and the duty cycle are both accurately controlled with two external resistors (R9, R10) and one capacitor (C9). At the provided circuit solution IC1

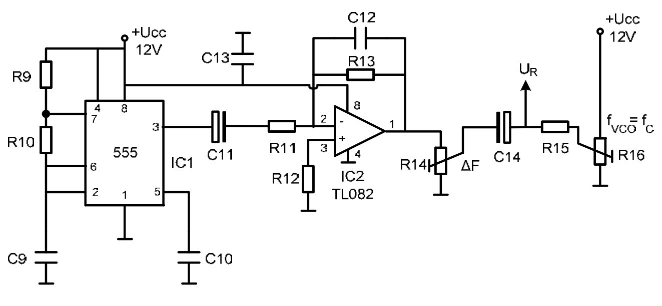


Fig.5. RAMP generator electrical circuit diagram

works as a rectangular-pulse generator, which frequency is being defined by formula [4]:

$$f = \frac{1{,}49}{(R_9 + 2R_{10}) \times C_9} \quad (1)$$

IC2 represents an operation amplifier included in a circuit of integrator for receiving a saw-tooth voltage. Its work is controlled by pulses, coming from the rectangular-pulse generator by C11.

The RAMP generator and VCO form a sweep generator, which central frequency f_c is being regulated by a trimmer R16. The frequency deviation of the generator is regulated by a trimmer R14, as it is changing the capacity of the varicap D1 in the tank circuit (C2, L1, D1, C6), depending on the amplitude of saw-tooth voltage. In the down offered results the frequency deviation is ± 8 MHz towards the chosen central frequency f_c, which in this case coincide with picture carrier frequency for a concrete TV channel.

Note: It should be considered that the maximum depth of the deviation essentially depends from the saw-tooth voltage's amplitude.

The FM sweep generator signal is increases to an optimal level, needed for a TV program disturbance at a concrete frequency range. The increasing is realized by a bipolar transistors T2 and T3, working on a common emitter circuit, which impose using transistors with high transit frequency $f_T \geq 5\,GHz$ (BFR91, BFR96 or similar). The output level is regulated by a P1, representing a attenuator (75 Ω), [5].

The requirements about ASM are: stable amplitude, regulative between 70 dBμV and 100 dBμV; easy frequency adjustment; hopeful and stable work; compact size; low consumption; pure spectrum out of the working range. The consumption of the ASM is very low, which do not require powerful supply units and a big consumption of electricity. In some cases the ASM feeding could be made of the home amplifier's supply unit.

III. Results and Aplications

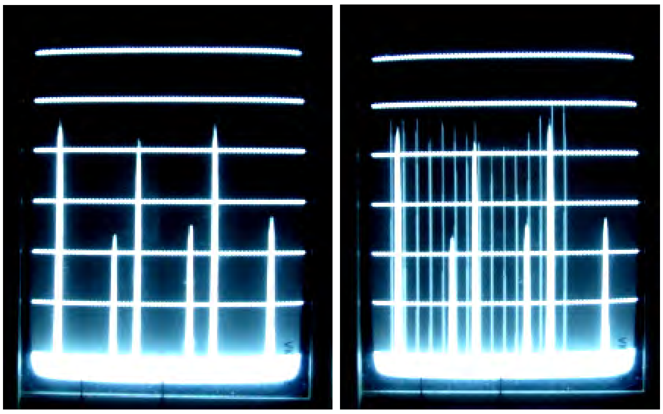
The provided circuit suggestions for ASM are realized in practice and studied in real structures of subscriber distribution network (SDN), and the results are underneath shown with pictures and graphics. During the studies is chosen UHF band, as the central frequency is $f_c = 511{,}25$ MHz (C26). The deviation is ± 8 MHz, i.e. three neighbour channels are scrambling. Changing of the disturbing signal's level (with P1) is ± 10 dB according to the normal level of useful signal. Effects of the disturbing signal are presented in Table 1.

On fig .6 is shown a spectrum of the CATV system for three scrambled channels al lack and presence of ASM. On fig.6b could be clearly seen the spectral components of the disturbing channel, and its influence on the image is visible from fig.7 and fig.8.

On fig.9 is presented a spectrum of the CATV system in the frequency range of 0÷1000 MHz at lack of TV channels, but with connected and working ASM. Left orientated and the highest is the pick of 0 MHz, and most right orientated is the end of the frequency range (1000 MHz). In the middle is the

TABLE 1

CATV f_c= 511,25 MHz	ASM f_c= 511,25 MHz	TV1 screen picture	Figure
U, dBμV	U, dBμV		
70	57	Normal picture	Fig.6a no
70	60	Bold white and black horizontal lines. Frame flicking picture.	Fig.6b Fig.7a
70	65	Bold white and black horizontal lines. Frame turning picture, the one half is noisy. Sound hum.	Fig.6b Fig.7b
70	70	A close-meshed variegated net. The picture transparent through the net. Sound hum. Not possible for watching.	Fig.6b Fig.8a
70	75	A close-meshed variegated net. Sound hum. No program picture.	Fig.6b Fig.8b
70	80	A close-meshed variegated net. Sound hum. No program picture.	Fig.6b Fig.8b Fig.9



a) no ASM b) with ASM

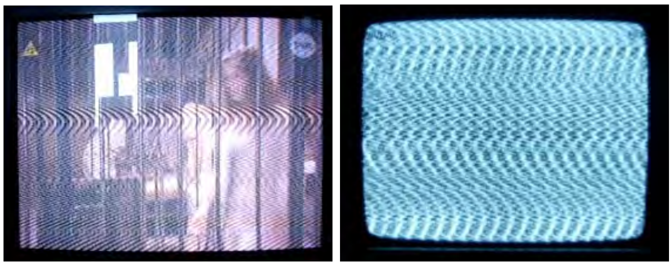
Fig.6. Spectrum of CATV channels investigate

a) flicker b) turn and sound hum

Fig.7. Break frame synchronization

pick of disturbing signal (f_c = 511,25 MHz). Around 100 MHz is noticed a little pick, which represents a spectrum of the parasite penetrating by the connecting cables signals from the terrestrial radio transmitters (87,5÷108 MHz). The rest of the spectrum is acceptable pure from disturbance and nonlinear products, which is visible from the graphics of the amplitudes' changing of intermodulation nonlinear products from 2nd and 3rd order (Fig.10).

Note: For decreasing of the nonlinear products in the spectrum of group signal is advisable to work in the UHF band. At a couplers is possible to be scrambled channels in the VHF band. Otherwise it is necessary to be connected a bandpass filter between the ASM and AT, letting through only the spectrum of scrambled channels and strongly limiting the RF signal harmonics and subharmonics.



a) the picture transparent through the net b) picture lack

Fig.8. A close-meshed variegated net

As an AT is used directional coupler 1 - WAY TAP 12dB /5-862MHz/ BZT G 687 670E. His isolation loss in the VHF range is 31 dB and 22 dB in the UHF range. Even in this low values for the AT isolation loss, on the experimental television receiver's screen TV1 are missing the programs, which must not be watched by the subscriber. On the screens of the other television receivers (receiving the full volume of programs from the cable television) are not watched any disturbances, i.e. nonlinear distortions are enough suppressed (see Fig.9 and Fig.10). This is a result of the big summery attenuation of the directional couplers (AT+ET) for the amplitude of the ASM signal. In the antenna's input of TV2, receiving the full volume of programs, the maximum amplitude of the ASM signal will be about 30 dBμV. This could cause a visible disturbance on the screen. At bigger isolation loss of the AT (30÷40 dB), the disturbing signal will be missing on the input of TV2.

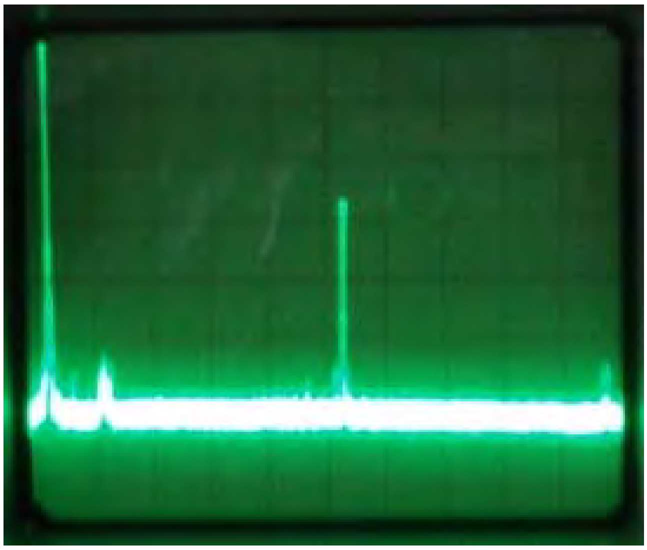


Fig.9. CATV spectrum (0-1000 MHz) with ASM at missing TV channels

On fig.11 and fig.12 are provided schemes of SDN with a radial structure. All devices are in one cabinet. The supply of ASM is being accomplished from adapter (= 12 V). The sub-

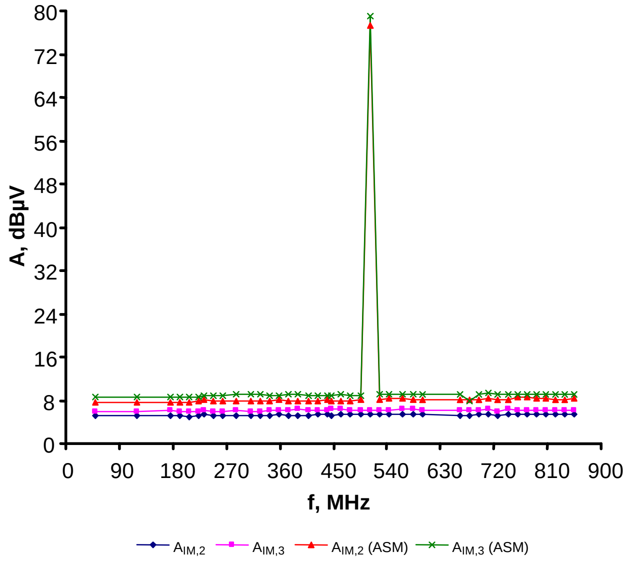


Fig.10. CATV spectrum with and no ASM

ted to the end of the subscribers branch by a splitters. The applied scheme from fig.11 is a characteristic for a block of flats with eight floors, as on every floor there are two apartments and 1/4 of the subscribers do not use the Pay-TV service.

On fig.12 is given a scheme circuit of SDN for a block of flats, but with three apartments on each floor and 1/3 of the subscribers do not use the Pay-TV service.

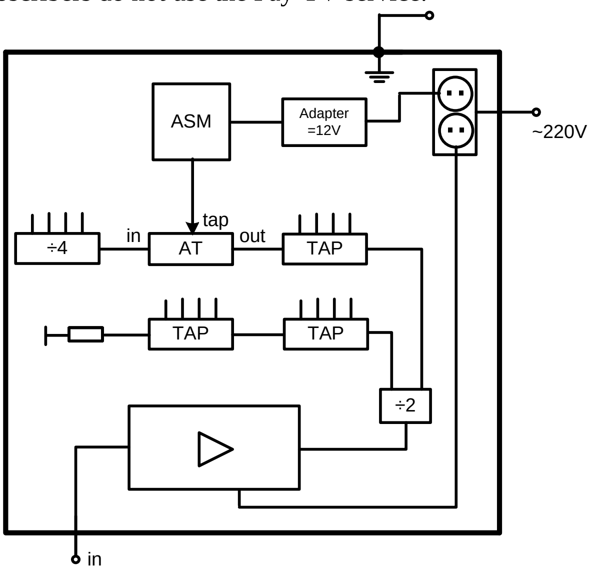


Fig.11. SDN schematic diagram 1/4 of the subscribers does not use the Pay-TV service

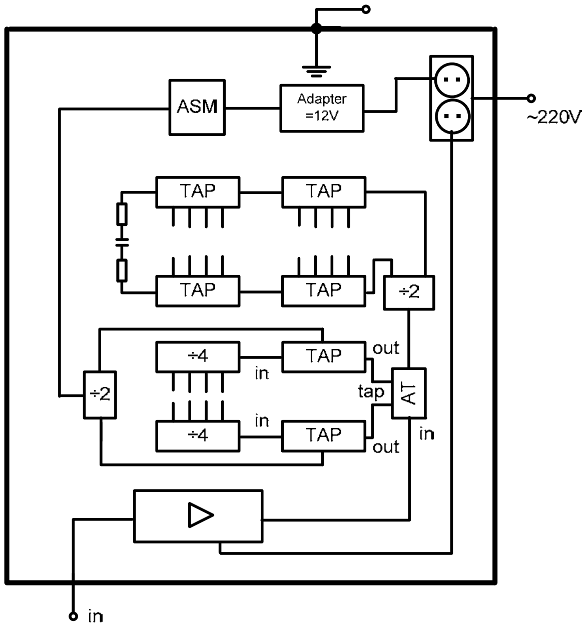


Fig.12. SDN schematic diagram 1/3 of the subscribers does not use the Pay-TV service

IV. Conclusion

The presented method for securing pay TV channels gives an opportunity for protecting the interests of cable operator from illegal receiving of TV programs, fro which is needed an extra payment from each subscriber. At the same time because of the disturbing signal is being put with the useful signals only in SDN, the level of nonlinear products is much lower then that, which is being received from the method of scrambling in the Head End (widespread now days).

As a work with a future science-applied character is necessary to be made a study about the influence of ASM onto the spreading of digital signals (i.e. the influence on the C/N and BER) in HFC/CATV networks, as well as for scrambling of the free digital TV programs.

Other direction for future work is the usage of FPAA integrated circuit [6] as a programmable RAMP generator and at the same time for regulating the level of saw-tooth voltage, and then for the deviation (number of the scrambled channels). The control of these parameters could be possible realized from the Head End by digital signals.

References

[1] W. Ciciora, *Cable Television in the United States - An Overview*. Cable TV Labs. Inc., Louisville, 1999.
[2] I. Brown, "End-to-end security in active networks", Thesis, Dep. of Comput. Science, Univ. College London, Sept. 2001.
[3] D. Lindstrom, "Sniffing A Cable Modem Network: Possible or Myth?", SANS Institute, 2002.
[4] 555. Product specification. Philips semiconductors, 1998.
[5] Ceramic/Cermet Attenuator M2001C. Vishay Draloric. Doc. No. 20152, Rev. 14-Jan-2003.
[6] www.anadigm.com