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# DEVELOPMENT OF A COST-FRIENDLY HOME-RANGE TV TRANSMITTER TO PROVIDE SAFE TV CONTENT TO UNDERAGE UNSUPERVISED KIDS

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**ABSTRACT**
The security of a nation is directly linked to the moral conduct of her citizens, and this is affected by the kind of upbringing such citizens received as kids. Direct access of kids to video players and satellite TV receivers can lead to unwholesome programs being watched by the Kids especially when they are unsupervised, which can lead to character degradation and deformation. As a solution to this problem, this work is aimed at restricting unsupervised access of underage persons to programs on these electronics devices. Therefore, a low cost home range TV transmitter with pre-select channel-transmit capability, and auto timed turn-on and turn-off was designed. The designed Transmitter powers a Video player or Satellite TV Decoder at a preset time and transmits pre-selected programs on a Video player or Satellite TV Decoder in a restricted region in the house to a Television Set in an unrestricted region in the House that kids have access to for a preset duration. The Transmitter was tested, and it powered the Decoder and transmitted pre-selected programme at the preset time and for the preset duration.

**Keywords:** *Kids, TV Transmitter, Preset Duration, Restricted Region, Unrestricted Region words.*

## 1. INTRODUCTION

In this present day, Technology has grown to the level that information dissemination has been made easy and relatively cheap to such an extent that most homes now have access to cable TV and/or a video player. As a result, the level of information at our disposal has increased dramatically with time. Television can be a powerful learning and teaching tool. By means of it, we learn about lands and peoples we may never visit, we watch news as it happens across the globe and insights are gained into politics, history, current events and culture. In fact, Television entertains, instructs and inspires.

However, most of the programmes are neither wholesome nor educational with most portraying scenes of violence, sex, drugs and the use of strong language which might be detrimental to character development in kids in particular and under-aged in general. These scenes of violence are believed to induce aggressive behavior in people and make them less sympathetic towards victims of real life violence. Scenes of sex are also believed to promote promiscuity and undermine moral standards (Munni and Kana, 2010) (Awake, 2006). The duration spent watching TV can also be detrimental. According to the American Academy of Paediatrics, the average child watches three hours of TV a day, while two hours of quality programming is the maximum recommended by the Academy. Active play time is needed to develop mental, physical and social skills (Amin and Neda, 2011), (American Academy of Pediatrics, 2001), (Seline, 2011).

As a result of the variance in the content of programmes, a classification/rating system was designed to give parents more information about the content and age-appropriateness of TV programmes. But this rating system need to be simplified and made universal to enable parents choose appropriate programmes for kids (Munni and Kana, 2010). Also this rating system has not being effective in this environment (Nigeria) where most at times parents are out seeking for means of catering for the upkeep of the family, and kids are left at home with direct access to video machines and satellite decoders with almost no control as to what they watch. Most satellite decoders now

come with password settings that can be used to lock channels, but this still does not solve the issue of time spent to watch unlocked channels and access to other video players.

TV transmitter is an electronic device that can be used to rebroadcast video signals or Satellite TV throughout your house. TV transmitter is divided into two main components namely: the exciter and RF power amplifier. The exciter provides the signal processing functions required to convert baseband TV signal into a modulated RF signal on the assigned channel while the PA is used to amplify the modulated RF signal to the desired level for transmission (Gerald, Robert, 2011). The PA technology is available commercially in both the solid-state and tube devices. Solid state devices is mostly used for VHF channels but for UHF channels both solid-state and tube devices are used (Gerald, Robert, 2011). In (Marc, Spiwak, 1997) proposed a TV transmitter that combines line level audio and video signals with a transmission power of up to 300 feet. A power efficient Broadcast Facility Transmission was designed and developed by (Cavell, Martz, 2011). The analog transmitter operates with low power and the life of solid-state device used was improved. However, in our work, a low cost home range TV transmitter with pre-select channel-transmit capability, and auto timed turn-on and turn-off was designed. This work provides a means for only authorized wholesome TV programmes selected by parents to be made available to under aged unsupervised kids. This work is presented in the following order, section two presents the design and implementation, section three highlights the testing and results, section four presents the cost effectiveness and section five concludes the work.

## 1. DESIGN AND IMPLEMENTATION

This design is made up of basically three main blocks; the power supply, the timer and the transmitter. Each of these units carries out a pertinent task towards achieving the aim of this work. The complete circuit diagrams and the block diagrams are presented in Figures 1 and 2 respectively.

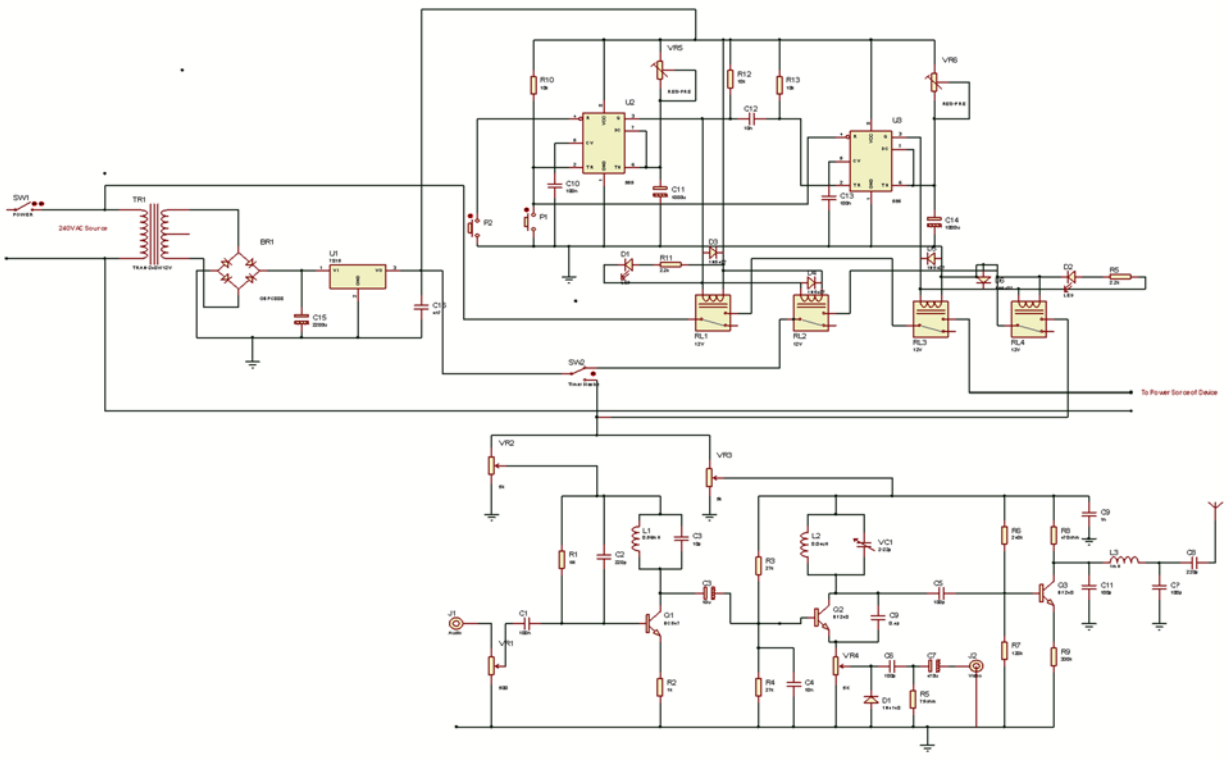

Figure 1: Circuit diagram of Designed Home-range Transmitter

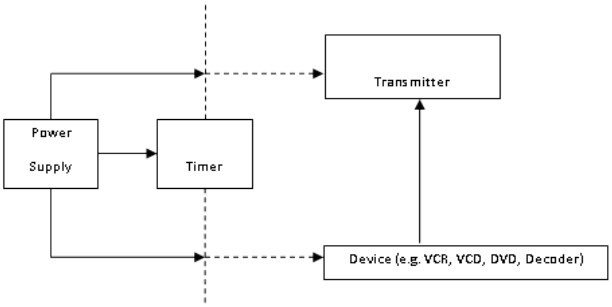


Figure 2: Block diagram of Home-range Transmitter

### *1.1. Design*

The system is powered by a regulated 15V source. It was observed that the quality of the transmitted image is sensitive to the power source voltage, as such a variable resistor was fixed after the regulator to give a variable power supply that can be adjusted to give the optimum transmitted image.

The timer is situated between the designed transmitter and the video source, and determines when and for what duration power gets to both of them. This Timer unit is made up of the wait duration timer, the transmit duration timer, the switching relays and the LED displays. The wait duration timer which is responsible for automatically turning on the transmitter and the video source after a set wait duration. This was achieved using cost friendly 555 timer IC in the monostable mode. The duration of the output pulse on Pin3 of the 555 timer IC depends on the values of the Resistor R1 (between Pin6 and Pin8) and Capacitor C2 (between Pin6 and Pin1) (Schuler, 1999).

The value of the Capacitance was kept fixed at 1000μF, and the Resistance to achieve time durations of 1minute, 30minutes, 1hour and 1hour 30minutes was determined using

$$R = \frac{t}{1.1C} \quad (1)$$

For t = 1 minute, R1 = 54 545 Ω ≈ 6.9K + 47K.

For t = 30 minutes, R2 = 1 636 364Ω ≈ R1 + 1.5M.

For t = 1 hour, R3 = 3 272 727Ω ≈ R2 + 1.5M.

For t = 1 hour 30 minutes, R 4= 4 909 091Ω ≈ R2 + 1.5M.

Each of the calculated resistance was approximated to easily sourced resistance values and values that have already been used in the circuit to reduce cost and avoid duplication of components. The output of the wait duration timer was coupled through a resistor-capacitor network to pin 2 of the transmit duration timer to achieve edge triggering.

The Transmit duration timer determines the duration that power is supplied to the transmitter and the video source and is similar to the wait timer except that it is edge triggered by the output of the wait duration timer (comes on the instant the input to its pin2 goes low). The time duration of transmission is similar to that of the wait timer analyzed above with variable resistor RV2 (transmit duration variable resistance) having the values as RV1 (wait duration variable resistance).

The time duration is activated with the aid of two Push buttons P1 and P2. Push button P1 starts the wait duration timer and resets the transmit duration timer, while P2 resets or stops the wait duration timer.

Between the timers and the transmitter and video source are situated four relays: RL1, RL2, RL3 and RL4. The first two relays (wait duration relays) are normally open and become closed only when there coils are excited by a voltage greater than their excitation voltage of 12V. The coils are connected to the Vcc and Pin 3 (output) of the delay timer. As such these relays become activated only when delay timer output goes low. At this instant power is fed to the other two relays. The two other relays (transmit duration relays) are also normally closed, but these are activated as the transmit timer comes on because the coils are connected between pin 3 (output) of second 555 timer and the ground. When activated, RL3 and RL4 supplies power to the video source and the transmitter respectively (Thomas, 2007).

The transmitter was designed to be a low cost, low range of 15 meters and a variable frequency transmitter and comprises of the following sections: pre-modulation module, modulation module and the post modulation module. The pre-modulation module was designed to handle signal processing functions to be carried out on the signal in order to achieve efficient radiation of the electromagnetic signal generated at the end. This module takes care of filtering of the input signals (for both the audio and video signals), load matching and DC restoration of the video signal and finally the variable control for the input video and audio input to act as a variable control of the amount of the output of the source that is been fed into the transmitter (Adediran, 2005). The modulation module is responsible for combining both the audio and video signals with high frequency carrier signals to enable efficient radiation.

The audio signal is frequency modulated. The carrier frequency is generated with the use of an oscillator with an LC tank circuit. Setting a carrier frequency of 4.5MHz and using a ceramic capacitor, C3 of capacitance 1nF, the value of the inductance of L1 can be calculated thus (Theraja, 2002):

$$L = \frac{1}{4\pi^2 f_c^2 C} = \frac{1}{4\pi^2 \times (4.5\times10^6) \times (1\times10^{-9})}$$
$$= 1.25\mu \qquad (2)$$

This inductance was obtained by coiling an SWG 24 coil which has a diameter of 0.56mm. Therefore the number of turns required to achieve that inductance was calculated thus

$$N = \sqrt{\frac{LI}{\mu_o \mu_r A}} = \sqrt{\frac{1.25\times10^{-6}\times0.01}{4\pi\times10^{-7}\times1\times7.854\times10^{-7}}}$$
$$= 112\ turns \qquad (3)$$

For the video modulation, amplitude modulation was employed. The radio frequency of the video channel has a bandwidth of 7.625MHz, with an attenuation of 20dB at 1.25 and 6.375MHz (Green, 1992). Due to the large bandwidth of the visual signal, it would be unwise to use frequency modulation. The carrier frequency was generated by a tank circuit comprising of inductor, L2 and variable capacitor, VC1. A variable capacitor was used so as to make the frequency of transmission variable. A variable capacitance of 2-22pF was used and an already wound inductor of inductance of 0.04uH was purchased and used. This gives a carrier frequency varying from $f_1$ to $f_2$ which are calculated thus:

$$f_1 = \frac{1}{2\pi\sqrt{LC_{max}}} = \frac{1}{2\pi\sqrt{0.04\times10^{-6}\times22\times10^{-12}}}$$
$$= 169\,659\,739.4Hz \approx 170MHz \qquad (4)$$

$$f_2 = \frac{1}{2\pi\sqrt{LC_{min}}} = \frac{1}{2\pi\sqrt{0.04\times10^{-6}\times2\times10^{-12}}}$$
$$= 562\,697\,697.6Hz \approx 563MHz \qquad (5)$$

The output of the transmitter section comprises of the carrier wave; which is amplitude modulated by the video signal and the already frequency modulated audio at a frequency of *fc+ 4.5MHz.* This output is then amplified using a common emitter amplifier using BF240 transistor. After which it is then passed through a low pass filter to remove the low frequency noise from the output before it is radiated using a 75Ω antenna.

### *1.2. Mode of Operation*

The designed system is aimed at preventing unsupervised kids and unauthorized persons from having direct access to video machines, thereby curtailing the duration spent in front of the TV and also providing a means for restricting the programmes watched to those pre-screened by parents. The device has an audio and video input jack where the video machine's output can be connected to and also has a 240V power socket which powers the video machine. It also has two knobs for setting the timer durations. The first knob determines the duration that the device waits before it powers on both its transmitter and the video machine. Likewise the second knob determines the duration that the

device transmits and powers the video machine. Both knobs have setting for 1minnute (for testing purpose), 30 minutes, and 1 hour and 1 hour 30 minutes durations. The device set-up is depicted in Figure 3.

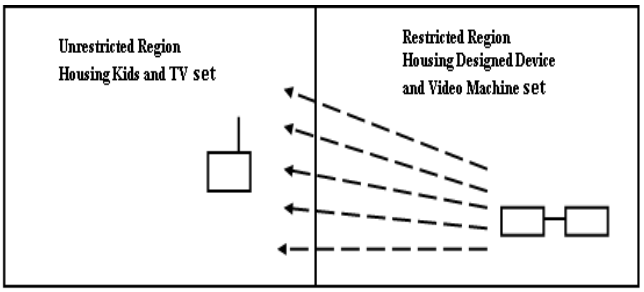


Figure 3: Setting up of designed device

The device and the video machine are situated in a restricted region of the house and TV set is situated in an unrestricted region of the house where kids can have access to. The already screened video or channel is loaded on the video machine, and the duration of both the waiting and transmission is set on the device. At the set time, the device comes on and also powers the video machine, which plays the cued video. The video being played is then transmitted wirelessly to unrestricted regions where kids can watch on a TV set tuned to the frequency of transmission of the device. After the set duration has elapsed, the device turns itself off and cuts power supply to the video machine.

## 2. RESULTS AND DISCUSSIONS

The designed and constructed circuit was subjected to a series of tests and the results obtained were analyzed and relevant deductions made. The following tests were carried out: Frequency selection test, Range of coverage test, Time duration test. Due to the limitation of unavailability of spectrum analyzer, a physical eye test was carried out for both the frequency and range of coverage test.

The frequency selection test was performed to determine the frequency at which the transmitted signal was strongest. A video player was connected to the designed circuit and then powered and television set at some distance away was tuned until the best picture and sound was obtained. The frequency at which the best picture and sound was obtained was saved on the set and taken as the frequency of transmission. Figure 4 are pictures of the received image at different reception frequencies. The frequency of the Figure 3(c) was set as the transmission frequency.

The range of coverage test was carried out to determine the range of transmission of the transmitter. A video machine was connected to the designed circuit and then powered. A television set tuned to the frequency of transmission of the transmitter is then moved gradually away from the point of transmission until the maximum distance at which an acceptable image/audio is received at the television. The following images were obtained at the stipulated ranges from the transmission point. From the images as shown in Figure 5, it is best the TV set is placed at a distance of not more than 25 meters from the device, optimal images are received at range less than 15meters


(a) Poor image received


(b) Better image received


(c) Best image received

Figure 4 Images received at various transmission frequencies.


(a) Range<15m


(b) 15m<Range<25m

(c) Range>25m

Figure 5 Images received at various transmission ranges

The last test performed was the timer duration test and was performed to determine the actual time at which the device automatically comes on or off as the case may be. The video player was connected to the designed circuit and then powered. A television set was tuned to the frequency of transmission and placed within the range of transmission. The timer knob for both the wait duration and the transmit duration was gradually increased from the 1 minute to the 1 hour 30 minutes duration and the actual time of trip on and off measured with a stopwatch. In Table 1 are the various results on the measured wait and the transmission times as against the calculated or theoretical time.

Table 1: Time Duration Test Results.

| THEORETICAL TIME(HR:MM:SS) | WAIT DURATION (HR:MM:SS) | TRANSMIT DURATION(HR:MM:SS) |
|---|---|---|
| 0:01:00 | 0:01:02 | 0:01:00 |
| 0:30:00 | 0:35:01 | 0:38:38 |
| 1:00:00 | 1:08:40 | 1:12:20 |
| 1:30:00 | 1:45:10 | 1:49:05 |

It can be observed that the actual duration time of the timer differs from the calculated values. This is due to deviances in the values of resistors R and capacitance C, which determine the time, from their stipulated values. Figure 6 shows the resulting errors in the wait time durations and transmit time durations.

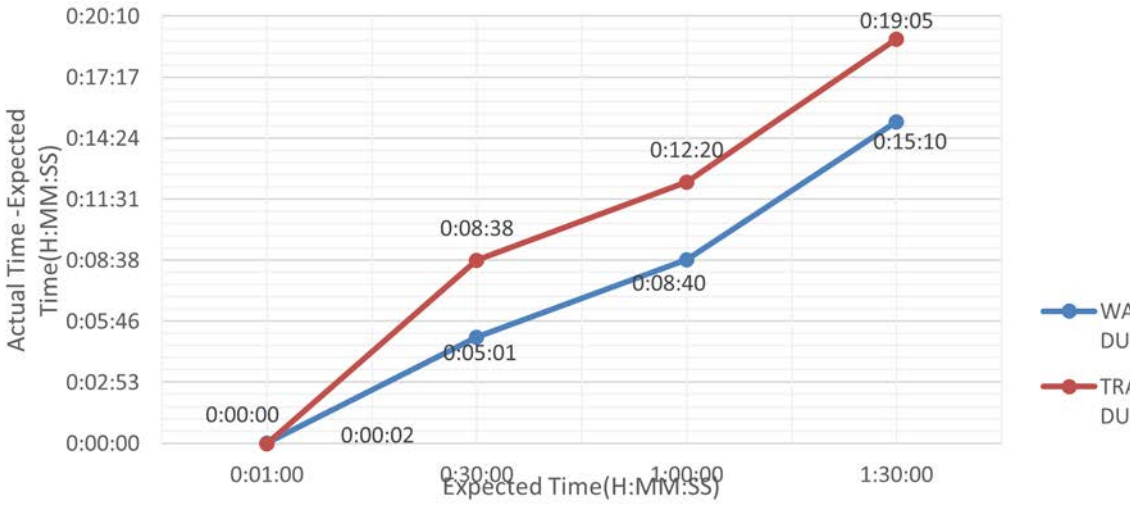


Figure 6 Plot of the Error in Time Durations

This increases as the time duration increases and a maximum value of 19:05 achieved in the 1:30:00 transmit duration. To achieve a higher accuracy level in the timing, a crystal oscillator should be used, but this will increase the cost of the device.

## 4. COST EFFECTIVENESS

One of the aims of this work is to provide a cost friendly device that would provide parents with a means of providing wholesome TV programs only to unsupervised under aged kids for a set duration of time. The design and implementation of the device made use of easily available and cost effective components. Table 2 shows the components used and the final cost of the device which confirms its cost effectiveness.

Table 2: Cost of Components Used.

| S/n | Item | Qty | Unit Cost (Naira) | Total cost (Naira) |
|---|---|---|---|---|
| 1 | 12V Relay | 4 | 70 | 280 |
| 2 | 12V, 500mA step down Transformer (centre tap) | 1 | 100 | 100 |
| 3 | Variable Resistors | 6 | 30 | 180 |
| 4 | 555 timer | 2 | 70 | 140 |
| 5 | Resistors | 13 | 10 | 130 |
| 6 | Diodes | 4 | 10 | 40 |
| 7 | LED | 2 | 10 | 20 |
| 8 | Casing | 1 | 100 | 100 |
| 9 | Veroboard | 1 | 50 | 50 |
| 10 | Capacitors | 16 | 20 | 320 |
| 11 | Inductors | 2 | 20 | 40 |
| 12 | 7815 Regulator | 1 | 60 | 60 |
| 13 | Variable Capacitors | 1 | 80 | 80 |
| 14 | Switches | 2 | 20 | 40 |
| 15 | Input Jacks | 1 | 30 | 30 |
| 16 | Push buttons | 2 | 10 | 20 |
| 17 | Transistors | 3 | 100 | 300 |
| | **TOTAL** | | | **1,930** |

The total cost of 1,920 Naira ($9.7) was achieved. Similar home range devices available on online stores were more expensive with price ranging from $20 to $30 (Ebay Online Stores).

## 5. CONCLUSION

A cost friendly device was designed and developed to provide safe TV content to under aged unsupervised kids. The circuit was realized with easily available components and a simple but effective circuit design. The device designed met the set objectives, but there is still room for improvements. Further work would concentrate on achieving the timing using a microcontroller so that the durations are not restricted to set times and improving the quality of the transmission image.

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