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Letter

# TIME MARKER GENERATOR USING OPERATIONAL TRANSCONDUCTANE AMPLIFIER

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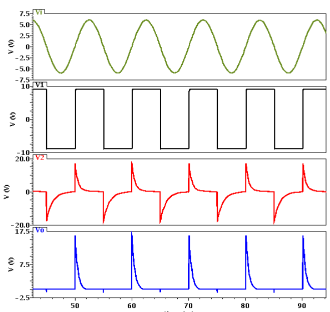
**Graphical abstract**



**Abstract**

This letter introduces time marker generator (TMG) using operational transconductance amplifier (OTA). It is composed of comparator (i.e. sine wave to square wave converter), integrator and clipper. The performance of the proposed circuit is examined using Cadence and the model parameters of a 180 nm technology process. Later, the circuit was built with commercially available OTA (LM 13600), passive components used externally and tested at the outputs of comparator, integrator and clipper. Simulations and experimental results are shown that verify the proposed circuit of time marker generator.

*Keywords*: OTA, time marker generator, current mode, clipper



## 1.0 INTRODUCTION

Time Marker Generator is applied for triggering the mono-shots, SCR, IGBT, GTO, sweep voltage of CRT etc [1]. Time marking is generated for sine wave input by using comparator, integrator and clipper. The square wave output from the comparator is applied to the input of an RC series circuit. If the time constant of the series circuit is less than the time period T of the sine wave input, the RC network acts as an integrator. So the output of the integrator is a series of positive and negative pulses. This series of pulses are applied to a clipper circuit with negative pulses stripped of, then the final output is a train of positive pulses, ensuring duration period equal to time period T of the input sinusoidal signal. In general, this circuit is readily implemented using an operational amplifier (Op-Amp), RC network and ideal diode clipper. In the last two decades the analog integrated circuit design using current mode circuits are accelerated and dominating the voltage mode circuits. The advantages of the current mode circuits are stated to be having higher bandwidth capability, greater linearity of output, wide dynamic range, better frequency stability, higher operating speed, less complexity, high slew rate and independent control of amplitude and frequency [2-18]. In this letter we present a novel circuit of time marker generator using OTA. This circuit may gain greater importance as it is bestowed with wider applications in machine drives and controls, and applications of power electronic circuits etc.

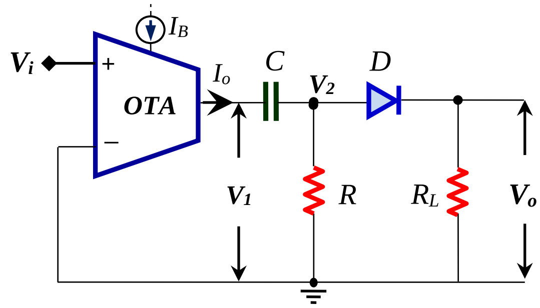



**Figure 1** Proposed circuit diagram of a time marker generator

## 2.0 CIRCUIT DESCRIPTION

The proposed time marker generator circuit using OTA is shown in Figure 1. The transconductance of the OTA can be controlled using bias current $I_B$. This stage converts the input sinusoidal signal into square wave. The second stage is integrator, which was processed using RC network. In this stage the square wave is converted into positive and negative spikes equally, when the time constant RC is less than time period T of the input wave form. The next stage is a clipper which was implemented using monolithic diode and a load resistor ($R_L$). The output of this stage is restricted to only positive pulses with period equal to time period of the input signal. So this circuit marks the period of the input signal, which can be implemented in practical applications like Radar and triggering applications.

## 3.0 RESULTS

The circuit in Figure 1 was simulated using Cadence and the model parameters of a 180 nm technology process. In the simulation profile, the circuit in Figure 1 was tested for sinusoidal input waveform of frequency 100 kHz with ±6 V and the values of the other passive components selected were $R$=1 kΩ, $R_L$=1 kΩ and $C$ = 1 nF. The simulation results obtained at a frequency f = 100 kHz with ±9 V is shown in Figure 2.

The experimental results with commercially available OTA LM13600 at a frequency f = 100 kHz with ±6 V is shown in Figure 3 with a supply rail voltage of ±9 V. From the results obtained, it was observed that TMG generator implemented using OTA output amplitude will depend on supply rail voltage of operational transconductance amplifier.

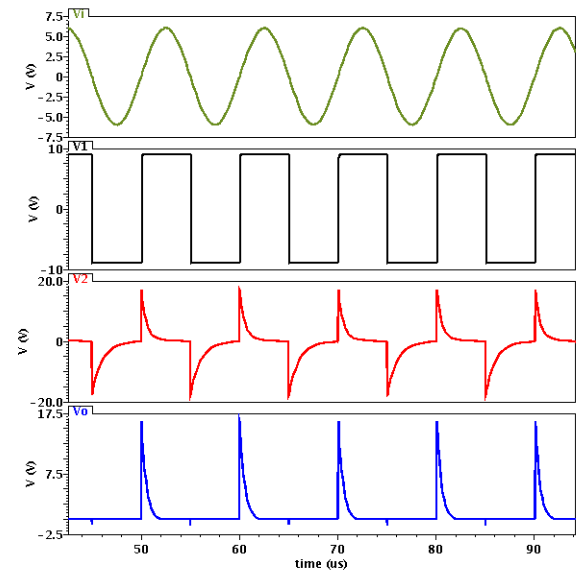



**Figure 2** Simulation results

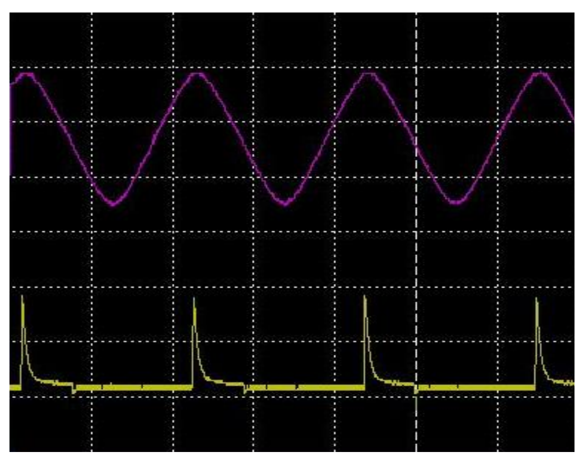


**Figure 3** Experimental results (above: input $V_i$ and bottom: output $V_o$; Scale: X-axis 5μs/div & Y-axis 5 V/div)

## 4.0 CONCLUSION

Time marker generator using OTA was described in this paper. The design principle and circuit configurations are simple. The experimental results presented demonstrated that the time marking is very impressive with sharp spikes. The proposed time marker generator can also be applied for triggering the monoshot, SCR, IGBT, GTO, and sweep voltage of CRT.

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