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**ABSTRACT**

Schmitt Trigger, first presented by Schmitt in 1938 is extensively used in Pulse Width Modulation Circuits, Sensors, Square Wave Generators, buffers and Sub threshold SRAM. It utilizes the fundamental concept of bi-stable state i.e. for positive and negative going input signals, Schmitt Trigger shows different switching thresholds which is termed as Hysteresis. Slew rate and bandwidth of the op-amp restricts the performance of Schmitt Trigger based on op-amp. Schmitt Trigger using Current Conveyors lack electronically tuned hysteresis level. CDTA and CCCDTA based Schmitt Trigger are comparatively less efficient owing to excessive use of passive elements, devoid of dual hysteresis operations using same topologies, absence of electronic controllability of output levels and threshold. Keeping all in knowledge, the purpose of this paper is to introduce adaptive or Super Schmitt trigger based on Operational Trans-conductance amplifier with many adjustable parameters to tame input values. In this Differential input voltage to current converter is utilized to drive OTA's bias. To set the quiescent hysteresis and to compensate the amplifier offset, OTA and Trimmer plays a pivotal role. Using P-spice Software, results of experimental measurements and simulation are presented that authenticates the theoretical assumptions.

**KEYWORDS:** Schmitt Trigger, OTA, P-spice Software, Hysteresis adjustment.

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**INTRODUCTION**

In 1938, Schmitt Trigger has been first presented by Schmitt. It is a circuit employed widely in both analog and digital system. Its main application is to decrease noise effect in triggering devices and analog to digital conversion. Schmitt Trigger are basic currents that convert a varying voltage into a stable voltage signal (V<sub>dd</sub> or gnd). The fundamental idea is to create a bi-stable state which has a switching threshold as a function of the direction of input. They have been used extensively to improve on/off control, and reduce the sensitivity of noises and disturbances. The Schmitt Trigger is used in buffers, sub threshold SRAM, Sensors, square wave generator, monostable multivibrator and Pulse Width Modulation circuits.

The main difference between between Schmitt Trigger and Comparators lies in the Dc Transfer Characteristics. The Comparators show only one switching Threshold but while Schmitt Trigger shows different Switching Thresholds for positive going and negative going input signals. The characteristics is called Hysteresis. Hysteresis width is the one in which input changes depending on whether the input is falling or rising. Conventionally there are two techniques to implement the Schmitt Trigger. The first one is based on transistor level. It is found that these circuits have many merits such as low power consumption, high speed and high signal bandwidth. Unfortunately, their output amplitude and hysteresis levels depend on supply voltages. The second technique is based on a building block.

From literatures review, it is found that several implementations of the Schmitt Triggers using different high performance active building blocks have been proposed. The First modern Schmitt Trigger is based on Op-amp. This architecture is found that its high frequency performance is restricted by signal bandwidth and slew rate of the op-amp. In addition, its output threshold and magnitude cannot be controlled. Recently Schmitt Trigger based on Current Conveyors and Operational Trans-resistance amplifier have been subsequently reported. Their advantages are

followed: Each circuit uses only one active element. The output signals are temperature insensitive. Unfortunately they suffer from excessive use of passive elements. Since the floating resistor is used in the design for each circuit, it is not appropriate to further fabricate in IC. Moreover, their output amplitudes and hysteresis level cannot be tuned by electronic method, they are controlled by corresponding resistor. It means that they can be difficultly applied in an automatic control system via a micro-processor.

There has been much effort to reduce the supply voltage of analog systems since the last two decades. This is due to demand for portable and battery powered equipments. Since a low voltage operating circuit becomes necessary, the current mode technique is ideally suited for this purpose. Presently, there is a growing interest in synthesizing current mode circuits because of more their potential advantages such as larger dynamic range, higher signal bandwidth, greater linearity, simple circuitry and low power consumption.

In 2008, the current input Schmitt trigger based on OTRA has been reported. It can operate on CCW and CW Schmitt Triggers in the same topology. Unfortunately each output provides in voltage form. It means that this output is not completely current mode circuit. Furthermore, its output amplitude and threshold cannot be independently/electrically controlled. They are also dependent on supply voltages. Afterward, the current mode Schmitt trigger using current controlled current conveyor transconductance (CCCCTA) and multiple output current through transconductance amplifier (MO-CCTA) have been presented. The features of these circuits are that the output magnitude and hysteresis level can be controlled via electronic method. In addition, their output signals are independent of temperature variation. Anyhow, they cannot provide CCW and CW Schmitt triggers from the same topology.

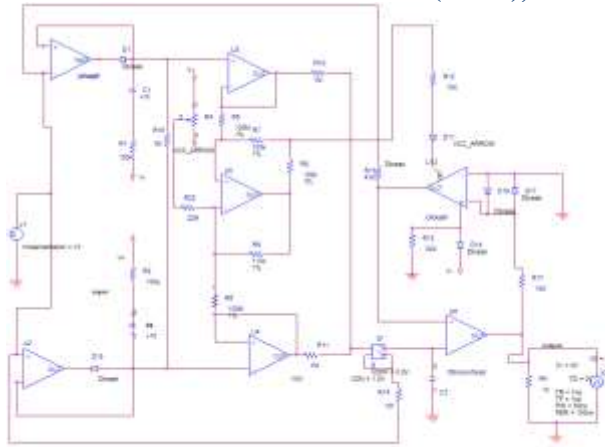
The current differencing transconductance amplifier seems to be a versatile component in the realization of a class of analog signal processing circuits. It is really Current mode element whose input and output signals are currents. In addition, the current gain can be adjusted by corresponding bias current. However, it is seen that the CDTA cannot be controlled by the parasitic resistances at 2 current input ports so when it is used in some circuits, it must unavoidably require some external passive components, especially the resistors. This makes it not ideally appropriate for IC implementation due to occupying more chip area and consuming more power.

Recently, Siri Prunchyanan and Jaikla have proposed the modified versions CDTA whose parasitic resistances at 2 current input ports can be controlled by an input bias current and it is newly named Current Controlled Differencing Transconductance amplifier (CCCDTA). From the advantages of the CDTA and CCDTA, the Schmitt triggers based on CDTA and CCCDTA have been also introduced. However they still suffer from excessive use of passive elements, lack of electronic/independent controllability of threshold and output levels and absence of dual hysteresis operations with same topologies. These factors are not desirable for a modern electronic circuit diagram.

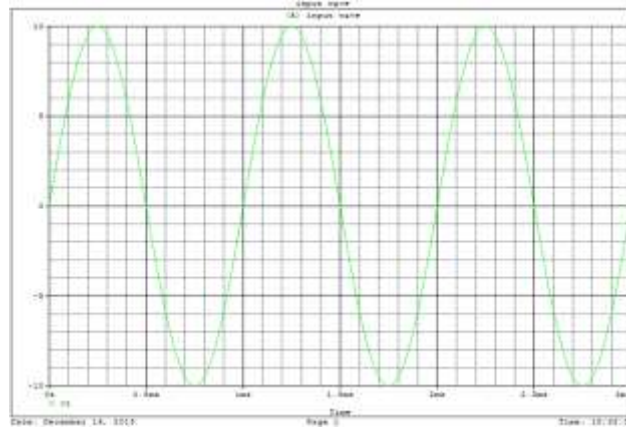
The purpose of this report is to introduce adaptive Schmitt Trigger tames unruly signals. In biomedical instrumentation (for example), we are sometimes faced with very noisy or badly behaved signals from which we need to derive information. In this example I needed to “square up” a respiration signal, which can exhibit wide variations in amplitude and frequency, along with a wanderline baseline. Shown here is an adaptive “Super Schmitt” with many adjustable parameters that did an extremely good job of taming the input values. In this report, I have presented the Schmitt trigger based on Operational Transconductance amplifier. The advantage of this is that its output amplitude and threshold level can be independently (electronically tuned). Furthermore, the output signal is ideally temperature insensitive. OTA helps in hysteresis adjustment. For driving the OTA’s bias, differential input voltage to current converter has been used. Trimmer used in this circuit sets the quiescent hysteresis and compensates for any amp offsets.

## CIRCUIT SIMULATION

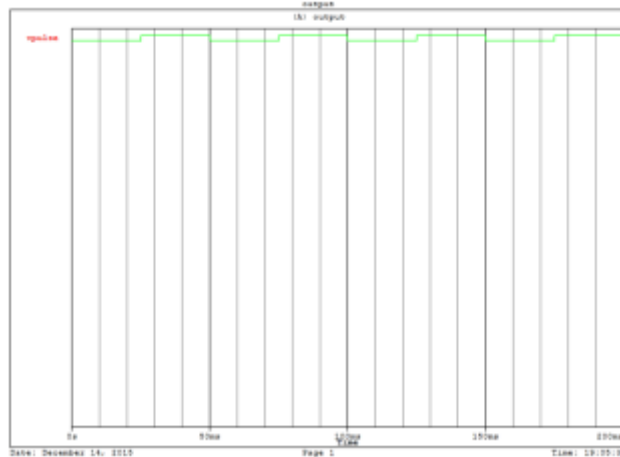
The design values are tweaked for an expected input range of 50mV to 1V P-P and 0.07Hz to 2Hz. U1 & U2 detect the positive & negative peaks of the input. R1 & R2 in conjunction with R16 determine how quickly the held peaks delay. The P-P amplitude tracked by these detectors is used to both adjust the hysteresis band of the final comparator U6 and to provide a zero crossing reference.



**Fig. Adaptive Schmitt Trigger**



**Fig. Input Waveform**



**Fig. Output Waveform**

**CONCLUSION**

Modelling and Simulation of various Circuits are carried out using PSPICE software. The advantage of Schmitt Trigger based on Operational Trans-conductance amplifier is that its output amplitude and threshold level can be independently (electronically) tuned. Furthermore, the output Signal is temperature insensitive. This paper presents the performance and applicability of these circuits in the noisy environment. It also gives the conclusion that Schmitt

Trigger using operational Trans-conductance amplifier is better not only in overcoming hysteresis and noise but also it is temperature insensitive. To justify this fact adaptive Schmitt Trigger based on OTA is compared with other circuits. It has been observed that Schmitt Triggers based on current conveyors and Operational Trans-resistance amplifier can be difficultly applied in automatic control system via a micro-processor. While the output, amplitude and threshold of Schmitt Trigger based on OTRA cannot be electronically controlled. In Schmitt Trigger using Current Controlled Current Conveyor Trans-conductance amplifier CCW and CW Schmitt Trigger cannot be provided from the same topology. Also Current differentiating Trans-conductance amplifier are not ideally appropriate for IC implementation due to occupying more chip area and consuming more power. Recently modified CDTA by Siri Prunchyanan and Jaikla also suffer from excessive use of passive elements, lack of electronic/independently controllability of threshold and output levels and absence of dual hysteresis operations with the same topologies. Compared to all Adaptive Schmitt Trigger is better not only in efficiency but also in deriving its output current. In this OTA acts more like a polarity reversal switch which mirrors the bias current to the output. The trimmer used in this sets the quiescent hysteresis and compensates for any op-amp offsets.

### FUTURE WORK

There is lot of scope for the future work which can be done on this project. In this project, I have implemented only software model of the various circuits but its hardware model can also be implemented. Also, I have done work for the Schmitt Trigger but this work can be extended to other circuits like Op-amp, Triangular Wave generator etc. Not only for this, the work can be extended to transistors like BJT and unipolar devices like MOSFETS. There will not be much difference in their circuits

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