# INTERMEDIATE PROTECTION CIRCUIT FOR AUTOMOTIVE SUPPLY

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**Abstract**
**The electronic circuits used in automotive need to with stand environmental conditions like electromagnetic interferences and high voltage pulses etc. International Organization for Standardization (ISO) set forth requirements for automotive electronics. Many times the need comes to operate normal circuitry in the harsh electric environment of automotive which may damage or destroy the electronic components. An intermediate circuit is designed to allow non-automotive circuit to operate in such environment. An analysis is made with simulation to study the response of the intermediate circuit by applying all expected faults.**

**KEY WORDS: Automotive environment, harness coupling, inductive loads, LTSpice, test pulses, load dump, transients, TVS diode.**

## 1. INTRODUCTION

This paper helps in building the intermediate protection circuit which can be used between the supply and the load in automotive electronic circuits. Lot of transients generated from a number of various sources, from common static discharges to disconnecting battery that impact on electronic-system performance. The proposed circuit provides protection for the sensitive electronic components from automotive pulses or transients as defined by the ISO ([3] ISO 16750 applies to road vehicles, covering environmental conditions and testing for electrical and electronic equipment Released in 2010. [2] ISO 16750-2 was proposed for load dump). Load dump is a result of abrupt disconnection of load from a generator delivering current. In this paper the ISO defined test pulses are used as input for the designed circuit and the output is observed by simulation.

## 2. LITERATURE SURVEY.

[5]Texas instrument proposed a circuit for load dump protection which is applicable for the circuits which are not consuming more power. [8]Use of TVS (Transient voltage suppressor) diode is the most common way to provide protection to the circuits as shown in figure 1.

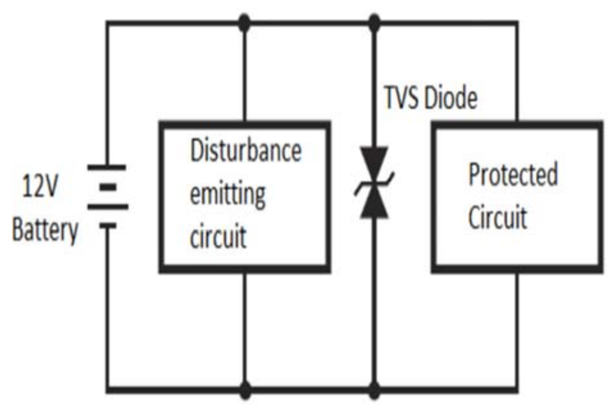


Figure1. Protection with TVS Diode

A load dump occurs when the load to which a generator is delivering current is abruptly disconnected these test pulse has the duration of 500ms which is not possible to attain protection from TVS diode.

In this situation there are two chances of solution:

I. Breaking the connection between protected circuits when the input voltage crosses the threshold value.
II. Series voltage regulation method. In this method may lead to considerable amount of power dissipation but it is advantageous since it provides uninterrupted power to the load circuit.

## 3. COMMON TRANSIENTS PRESCRIBED BY ISO-16750

Table 1 shows the automotive transients prescribed by the ISO for testing. ISO 7637-2:2011 and ISO 16750-2 prescribes different types of pulses for testing of automotive electronics. Major pulses from the list are collected here,

TABLE 1: ISO Prescribed Transients

| Transient | Cause | Voltage amplitude | Time duration |
|---|---|---|---|
| Test pulse 1 | Disconnection of inductive loads | -150V | <2ms |
| Test pulse 2a / 2b | Harness coupling | +112V | <50µs |
| Test pulse 3a / 3b | Switching processes | -112V | 150ns |
| Test pulse 5a/ 5b | Load dump | +35V | 500ms |
| -- | Reverse battery polarity | -- | 1m |

## 4. METHODOLOGY AND CIRCUIT DESCRIPTION

The ISO prescribed test pulses are applied to the proposed circuit by simulation. The output response is observed for each pulse. The circuit is provides protection to the load from all the voltage transients. Each pulse is applied individually and the response is noted.

Figure 2 shows the proposed circuit diagram. The circuit contains the functional parts like TVS (D101) circuitry, MOS (Q106) circuitry and MOS (Q107) circuitry. The functions of each part are given below.

TVS (D0101) and associate circuit elements are placed at the first stage. This provides protection against transient pulses 1, 2 and 3. MOS (Q106) circuitry provides protection from the transient pulses caused by reverse battery connection. It is activated only when the 5V supply is active (not in the figure). When negative pulse is encountered transistor Q101 discharges $V_{gs}$ of Q106 which deactivates the MOS hence providing protection to the load. The pulse 5 is a transient due to load dump. The load is protected by this pulse through MOS (Q107) and associated circuitry. Zener diode is used to limit the output voltage to 27V.

## 5. SIMULATION

LTSpice simulator is used for the simulation. The components are used from the standard LTSpice models[1]. The automotive transients are created by the built-in transient generators. The main power source used is a standard 14V battery model. The above defined automotive voltage transients are applied to the circuit.

Pulse 1: -135 V, $R_s$ 10Ω, td 2ms

Pulse 2: +115 V, $R_s$ 2Ω, td 50µs

To test overall characteristics of protection circuit a triangular wave is applied which is used to test the reverse polarity battery pulse.

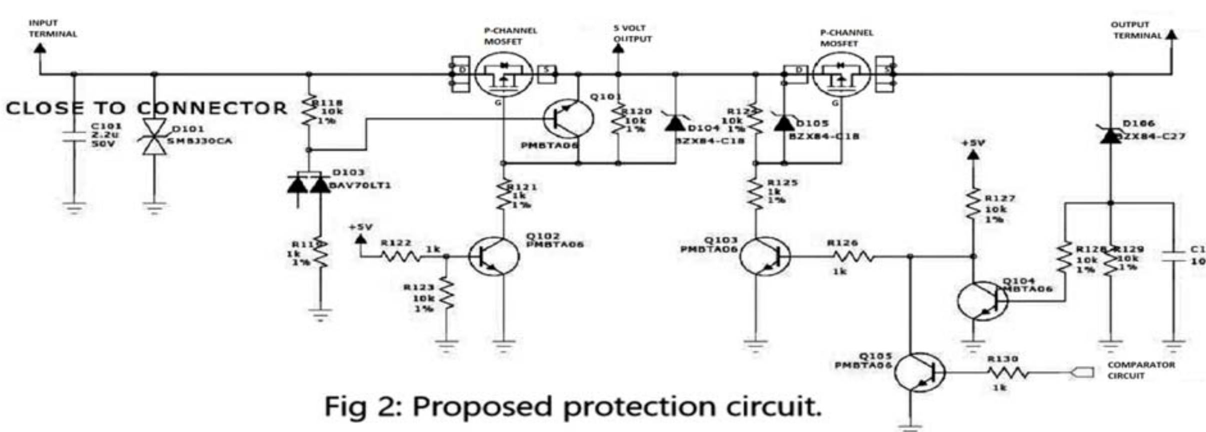


Fig 2: Proposed protection circuit.

## 6. RESULTS

The input pulses and output response is given one after the other.

Figure 3 shows the input output of the circuit for test pulse 1. The negative pulse is suppressed by capacitor (C101) dropping the voltage to 4V.

Figure 4 shows the pulse 2 input and response. In the simulation result, the positive 115 V pulse is clamped to 45 V by the TVS diode (D101). On the real circuit however, the pulse rises up to 21 V due to C101 capacitor filtering the pulse.

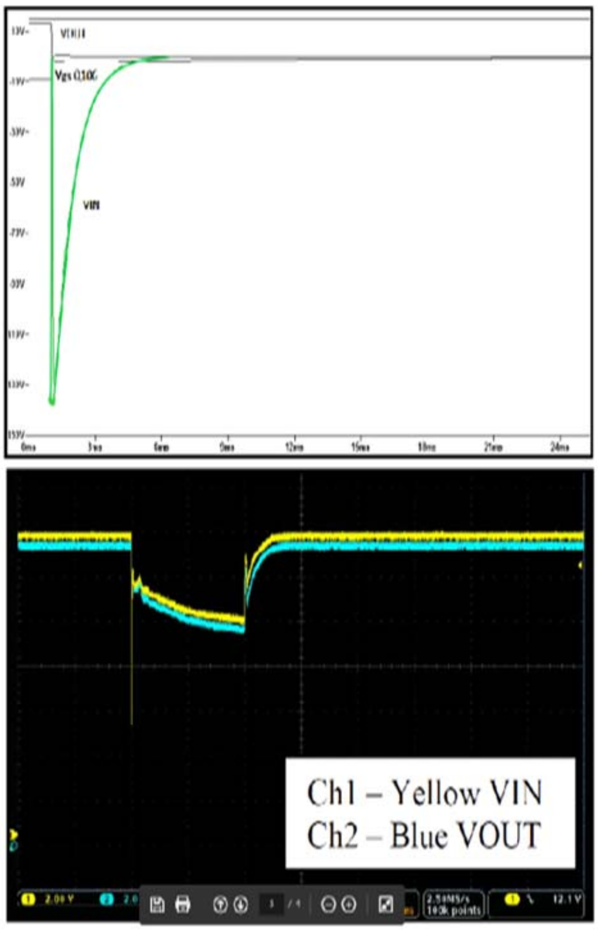


Fig3: Test Pulse 1 input and output response

In Figure 5 shows the triangular pulse is applied to check the reverse battery voltage. When input voltage is higher than 27 V, the linear regulator is operating properly. When the input voltage is decreases below 0V the output voltage remains at 0V.

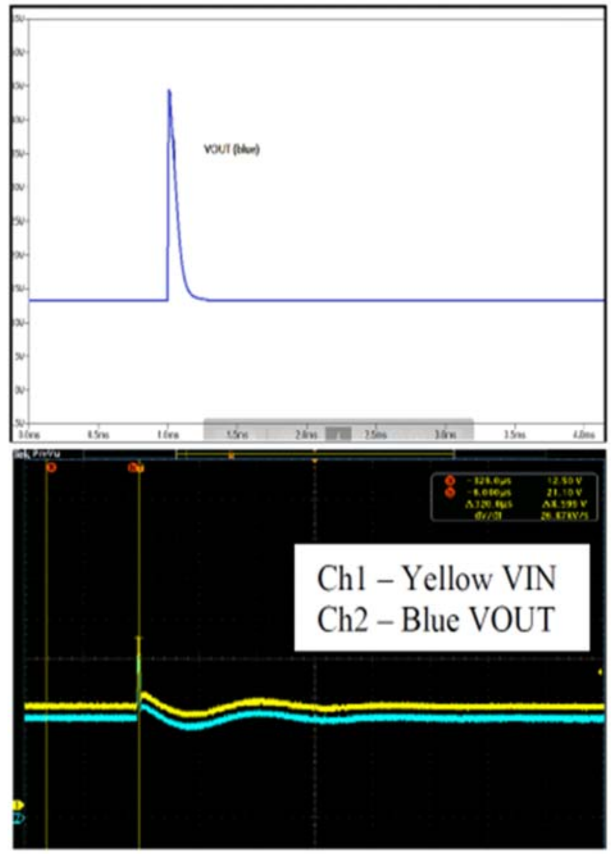


Fig4: Test Pulse 2 input and output response

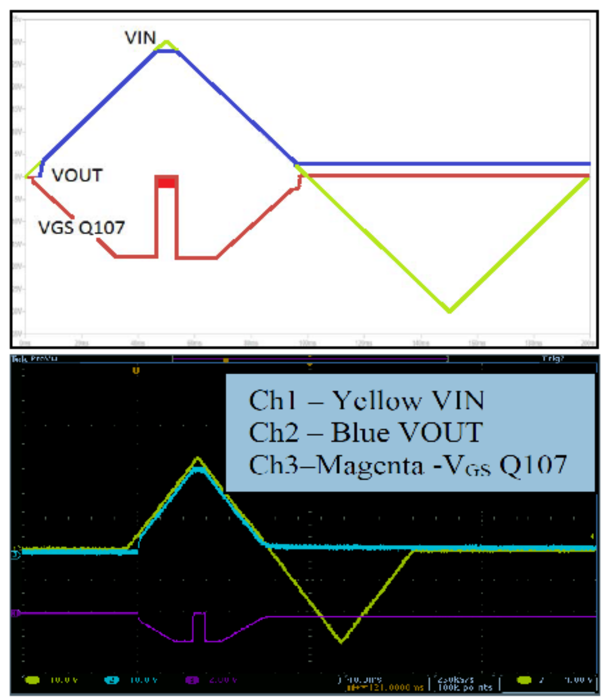


Fig5: Triangular pulse input and output response

## 7. CONCLUSION

The circuit proposed in the paper can efficiently control the transients prescribed by ISO and the responses show that the load is not harmed due to the transients.

## 8. REFERENCES

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