

INTELLIGENT AUTOPROTECTED DRIVERS

by I.M.PETER and I.RATES

INTRODUCTION

In industrial applications, where digital control signals are provided by automation equipment, suitable **Drivers** are required to control various loads such as Relays, Lamps, Electrovalves, etc.

What are the essential main characteristics of these Drivers ?

- Primarily, they must be autoprotected, that is, they must be self-resistant to industry-originated disturbances, short-circuits, over-currents, accidental load and ground disconnection, and so on.
- Then, in case of fault occurrence, they must be capable of providing interactive dialogue with the central processor unit.
- And finally, they must meet the requirements of the standards currently in force and those of the forthcoming projects, imposing that one terminal of the load should be directly connected to ground (see figure 1).

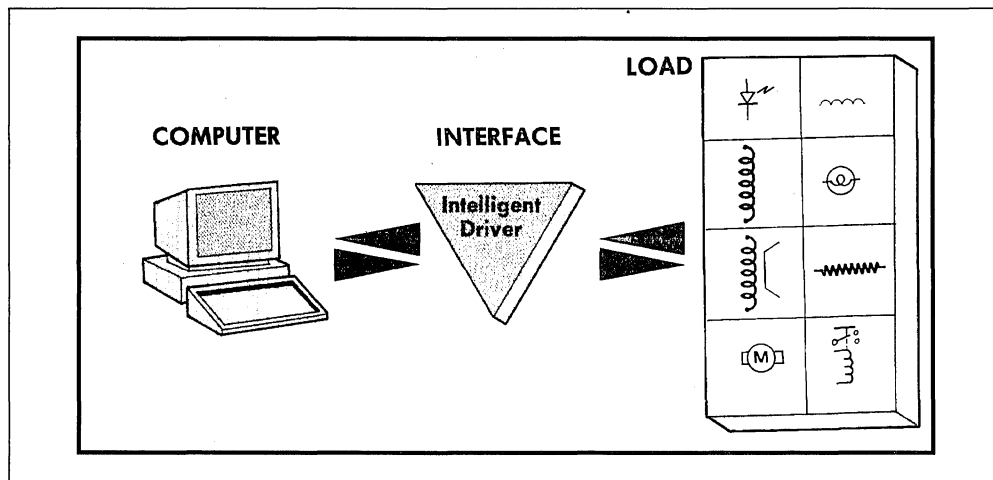
The objective of this note is to discuss and illustrate how a family of autoprotected control has been developed from basic concepts and also to outline the likely future trends.

FUNDAMENTALS

The control signal is applied to a comparator, the output of which drives a current source. This current source in turn drives the power transistor T1. A transistor T2 driven by the voltage drop across shunt R_{sc} is configured to provide feed-back to power transistor T1. As soon as the voltage drop across this shunt exceeds 0.7V, T1 T2 configuration will act as a current limiting-unit so that $I_{limit} = 0.8/R_{SC}$. This is how the device is protected against short-circuits.

Another internal unit monitors the junction temperature which varies as a function of dissipated power (i.e. $V_{CC} \times I_{CC}$) and cooling conditions. As soon as this temperature exceeds + 175°C (upper threshold), the protection until is activated and will sink the generator current I_B thereby turning the device off. In the off condition, the device will cool down, and when the junction temperature falls below + 140°C (lower threshold), the thermal protection unit is deactivated and the device is restored to its normal operating mode. However, if the overload conditions persist, the system will operate in low frequency relaxation mode with a frequency ranging from 1Hz to a few Hz according to the nature of the overload. Whatever the operating conditions :

- The current is limited at a programmable level.
- The junction temperature limit is never exceeded.



APPLICATION NOTE

Figure 1 : There are two possible configurations of load/controller combination. Some standards and forthcoming projects will require one end of the load to be directly connected to ground.

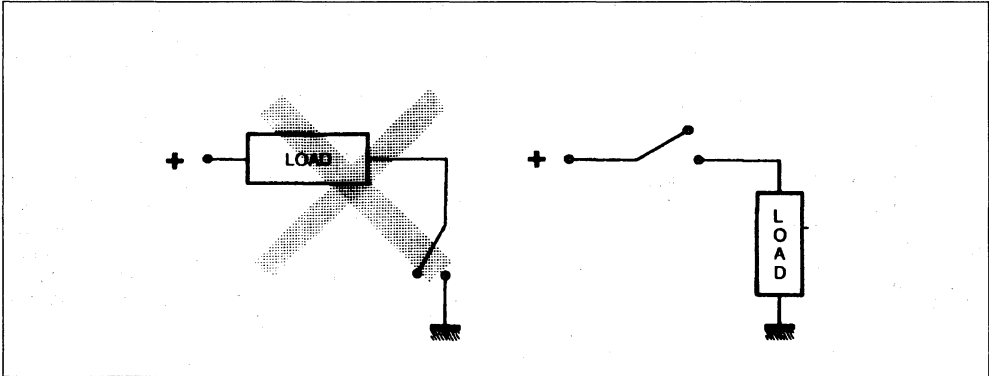
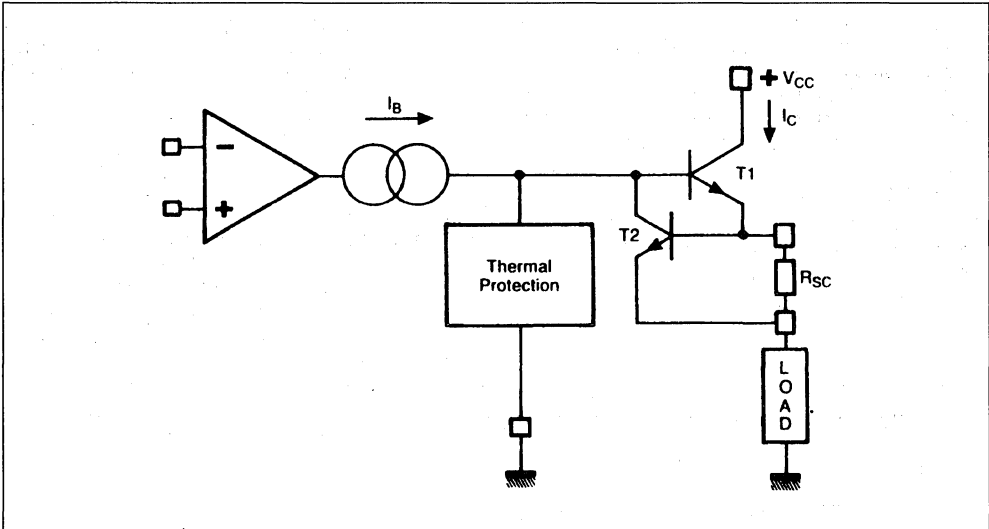


Figure 2 : Basic Functional Diagram of TDE 1647.



SHORT-CIRCUIT PROTECTION.

This device is protected against short-circuits by a current-limit feature operating exactly the same as the preceding device. Under overload conditions, the current is limited but the memory logic function is inactive.

POWER SUPPLY VOLTAGE LIMITS.

All of the devices of the entire family operate in a wide range of supply voltages : from + 6V to maximum voltage (between + 3V and + 6V, the protection logic is operational but the temperature detection circuit becomes inactive).

INDUCTIVE LOADS.

If a free wheel diode is connected across an inductive load, the voltage drop remains null while current decays slowly (figure 4). Two distinct solutions are possible to provide a rapid fall of this current :

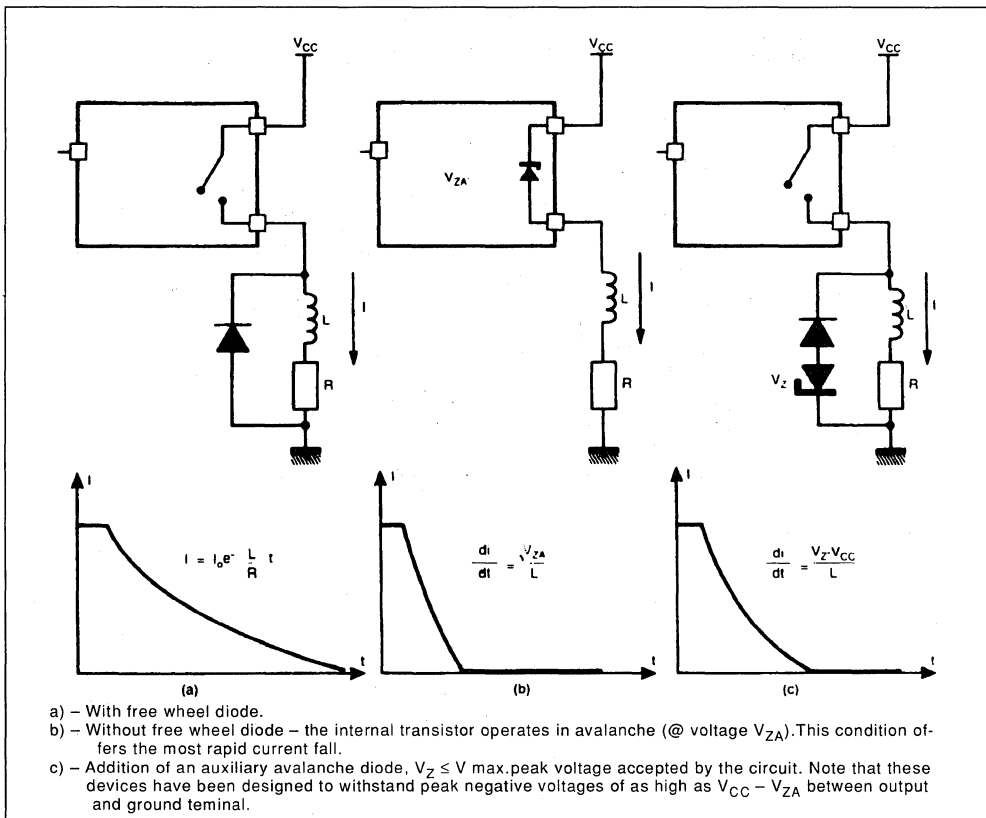
a)- Do not connect any additional device across the load. The output transistor of TDE1767/TDE1798 has been particularly designed to operate in avalanche mode and to clamp at voltage V_{ZA} . This outstanding feature eliminates the need of additional components in the case of inductive loads and automatically provides a rapid fall of load current.

As far as the users are concerned, this is an interesting feature. However, care must be taken not to exceed the operating limit of this transistor ; that is, energy dissipated in the transistor ($\frac{1}{2} L I^2$) should be less than 100mJ.

b)- In the case where energy stored in the load is very large, a Zener diode may be used to absorb this energy.

In case (b), the device and its internal logic circuits are protected against negative voltage peaks appearing between output and ground (figure 4).

Figure 4 : Current Decay in an Inductive Load.

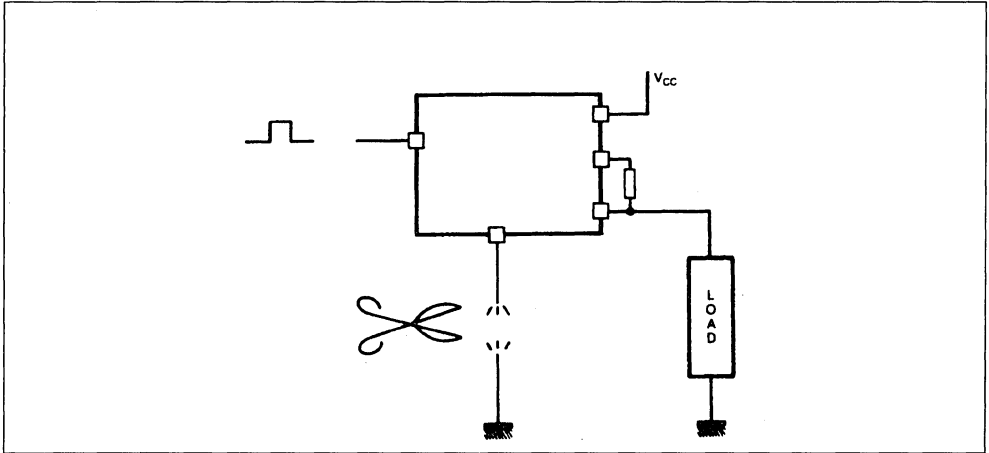


GROUND DISCONNECTION.

Besides the protection against disconnection of the power circuitry, these devices are also protected against accidental disconnection of ground return path. This is an outstanding security feature and the

TDE1798 was particularly developed to meet VDE422, the European standard which requires an instantaneous disabling of the output circuitry in case of accidental disconnection of ground (figure 5).

Figure 5 : The autoprotected control meet European security standard requirements. Output is automatically disabled in case of accidental disconnection of ground path.



ANOTHER PROGRAMMABLE CIRCUIT.

TDE1767 is another version of this circuit which in combination with an external resistor, implements a programmable short-circuit detection feature.

HIGHER POWER – OPTIMUM SECURITY

The control discussed so far are specified for output currents of 0.3A to 0.5A. TDF1778 & TDF1779 are dual autoprotected control capable of handling up to 2 x 2A. These monolithic devices contain 2 individual drivers which share a common monitoring logic circuitry (figure 6).

Protection features offered by these circuits are :

A thermal protection feature similar to circuits mentioned earlier.

Signalling Logic, Fault Memory and the availability of a Reset input (similar to preceding circuit).

Short-circuit protection. If the device is operated with current of the order of 2A, safe operating

area of the transistor must be taken into account. Figure 7 illustrates the characteristics of the integrated protection unit. The fault memory feature is inactive when device is in current limit mode.

The output transistor of these circuits is not protected in avalanche. However, in the case of TDF1778, a 42V Zener diode inserted between the positive supply and the base of the output transistor, will transform it to an avalanche protected transistor.

An additional feature, detection of load disconnection, is also offered by these circuits. A high-value resistor (not shown in the figure 6) is connected between the power supply terminal and the outputs. As long as the load remains connected to the output and the input is blocked, the output potential is practically null. If the load is disconnected, this potential will rise and correspondingly, a signal is sent to the central unit through the Sense Output terminal.

Figure 6 : TDF1778 Autoprotected Control.

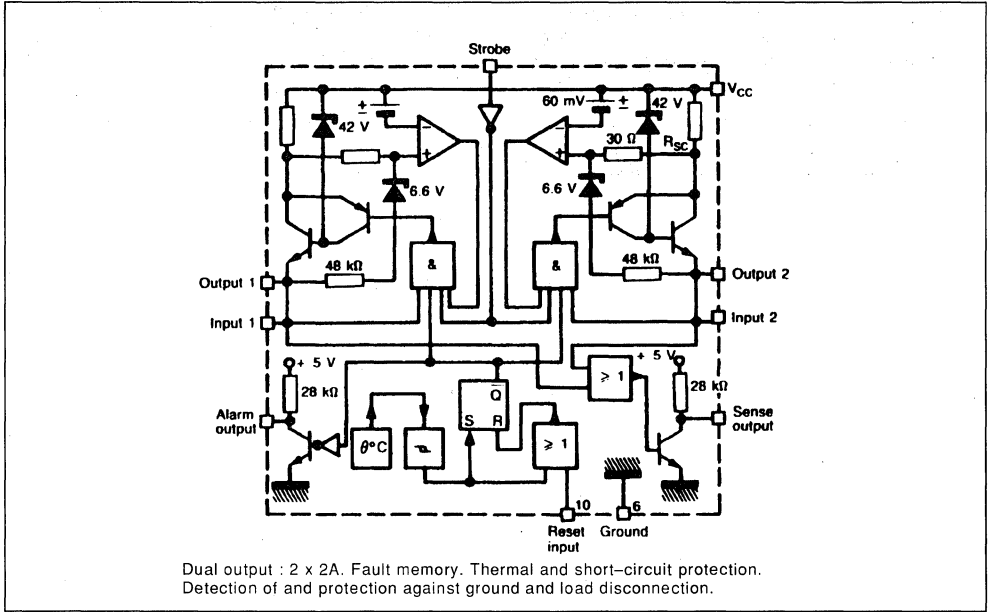
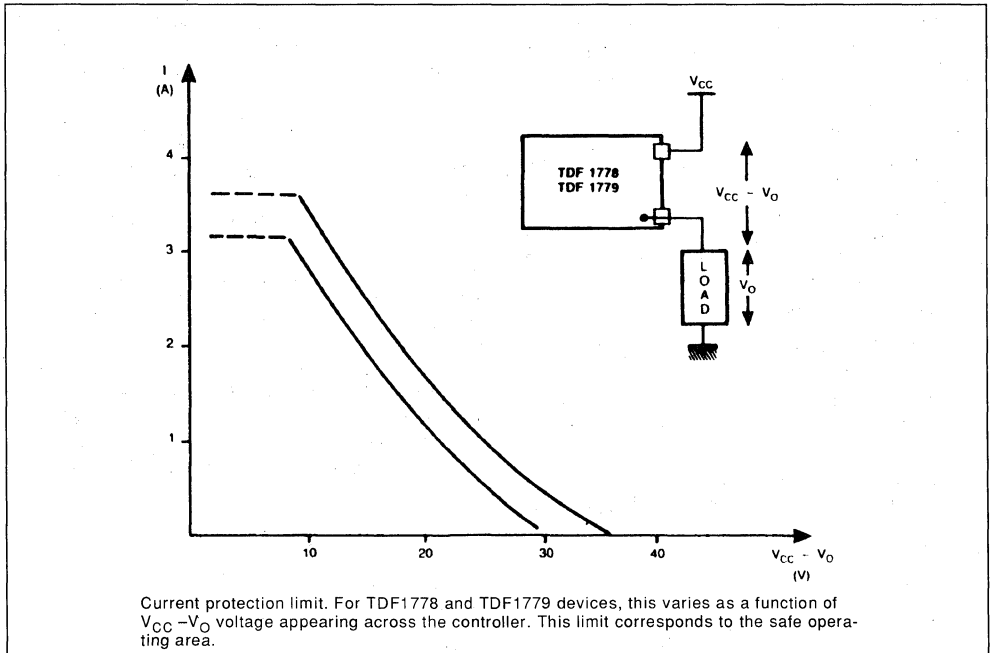


Figure 7.



APPLICATIONS

Main characteristics of this family of AUTOPROTECTED CONTROL are :

- Particularly suited to 24V to 48V - 0.3A to 4A systems.
 - Operation from + 6V to maximum voltage.
 - Can be used in parallel configuration.
- Protection against :
 - Over-currents.
 - Excessive heating.
 - Accidental ground disconnection.
 - Interactive dialogue with central processor unit (ALARM & RESET) terminals available on certain series.
 - Detection of load disconnection (TDF1778 & TDF1779).
 - Protection of output transistor by avalanche (some families).
 - μ P and TTL compatible inputs.

Figure 8 illustrates some conventional industrial automation applications built around these devices.

Power handling capability of these devices can be readily enhanced by the addition of an external power transistor as shown in figure 9. Further to these conventional applications, autoprotected control are also well suited for the implementation of choppers (figure 10) and more complex circuits (Bridge, Half bridge...).

FUTURE EVOLUTION

Two trends for these circuits :

- Enhancement of power handling capability.
- Reduction of losses - A new circuit offering considerable reduction of voltage drop and thus the losses, is forecast to be available in 1986. One of the consequences will be improving the circuit density in the equipment, thus achieving size reduction.

CONCLUSION

This new family of devices opens a new era of controllers which are :

- On one hand stand-alone, i.e. self-protected against external disturbances. If operated in this mode, in case of fault occurrence, the device itself will make the appropriate decision without the intervention of the central processor unit.
- On the other hand, capable of interactive dialogue, which means they are readily associated to processors and monitored by digital systems.

Figure 8 : Some Typical Applications of Autoprotected Controllers.

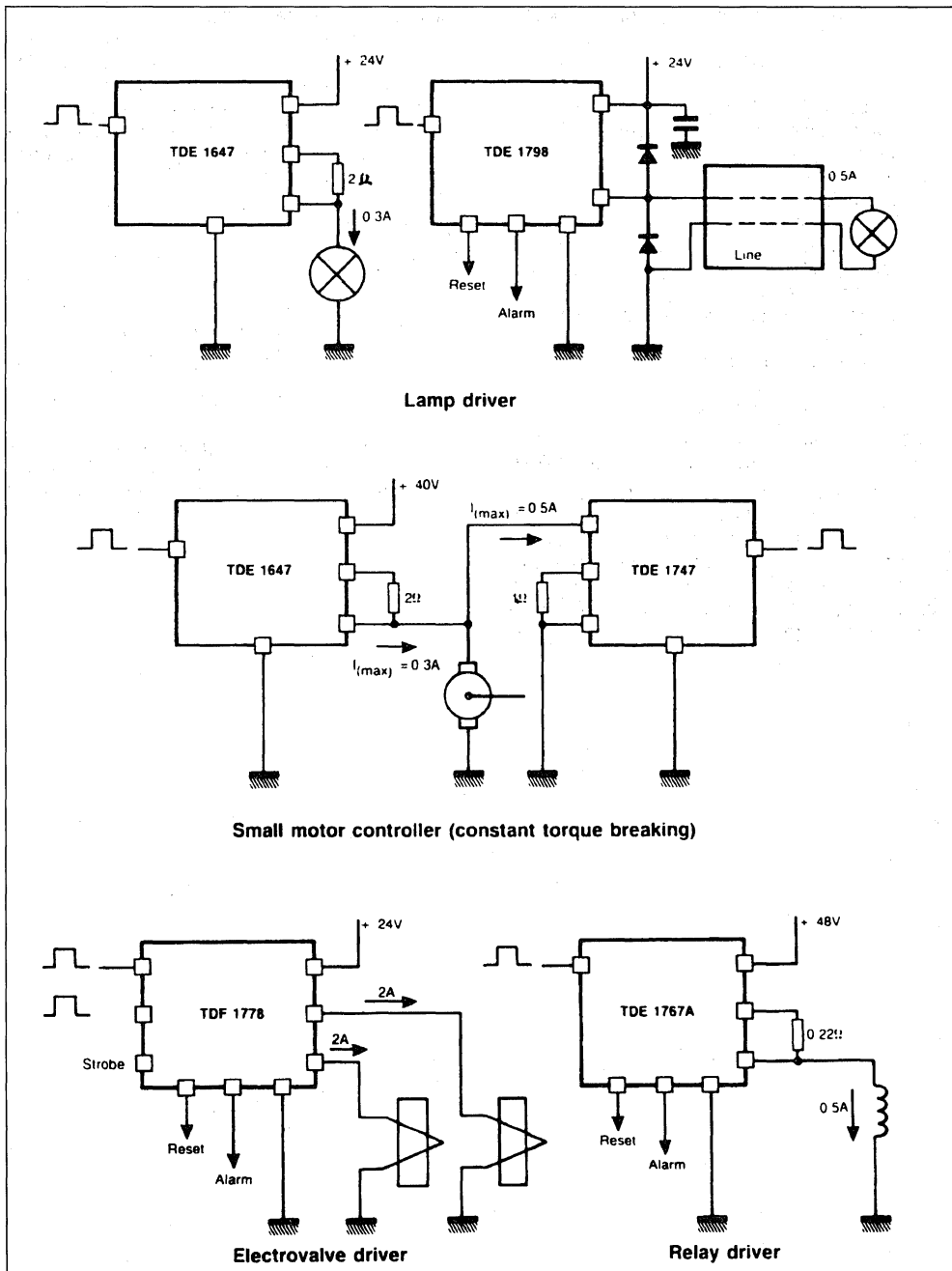
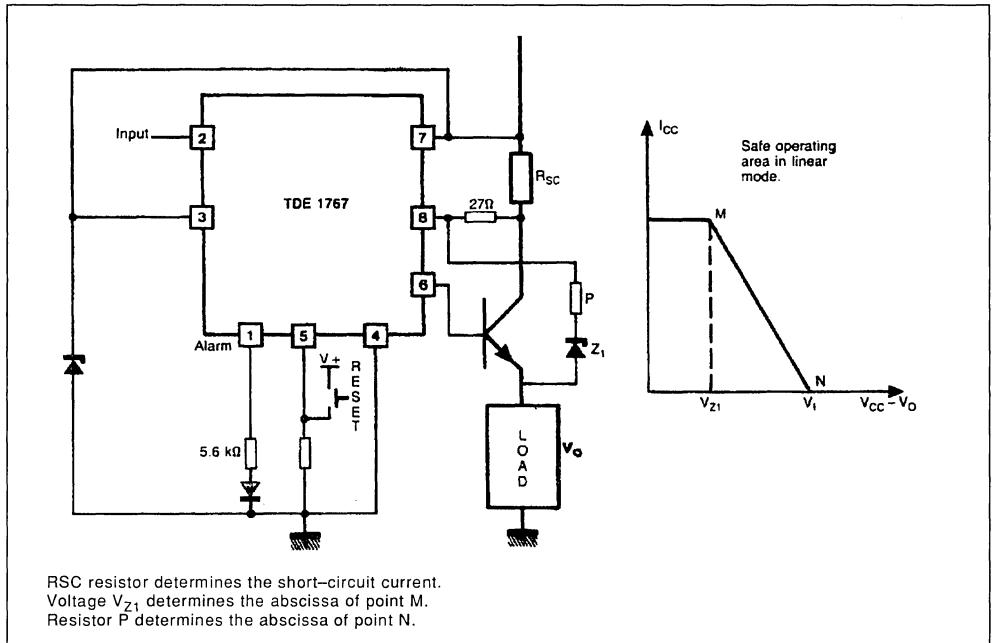


Figure 9 : TDE1767 Power Boosting.



V _I (V)	R ₁ (KΩ)	R ₂ (KΩ)	V _O (V)
+ 12	62	1.5	+ 5
+ 18	91	3.5	+ 12

Figure 10 : Voltage Step-Down Chopper.

