Automotive Alarm Siren Driver

2A DC Rated Super-ß Transistors Provide Reduced Component Count 'H' Bridge

Introduction

The majority of modern automotive alarm sirens employ a moving coil loudspeaker, that is driven by an 'H'-bridge output stage. This output driver circuit is commonly effected with TO-126/TO-220 packaged power transistors, as the currents involved and the resulting power dissipation are both in excess of common smaller package products. Zetex Super E-Line (TO-92 style) transistors however, due to their superior device geometries and silicone packaging, can, and have been used in this application to provide a minimal drive circuitry topology, and a size, cost and performance advantage.

Background

The circuit diagrams presented in Figures 1 and 2, show two common methods of effecting a siren driver circuit. These circuits include collector-emitter (C-E) diodes to protect the transistor in the event of negative rail excursions, due to inductive load transients, and base-emitter (B-E) resistors to provide a path for any transistor leakage current. This latter point is an important consideration when using the usual TO-126/TO-220 power products, as their high $V_{CE(sat)}$ can lead to appreciable temperature rises.

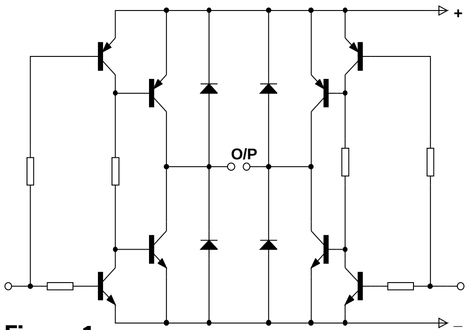


Figure 1.
Conventional Siren Driver Circuit using Separate Pre-driver Transistors.

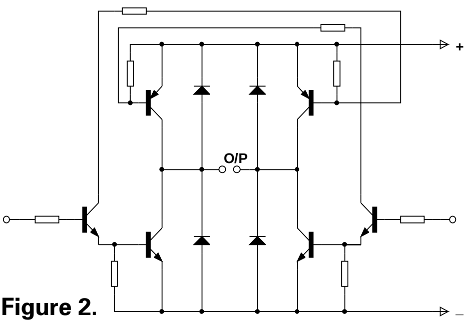


Figure 2.
Conventional Siren Driver Circuit using Cross-coupled Darlington Pre-driver Configuration.

Zetex E-Line transistors are optimised to possess a very low $V_{CE(sat)}$, and are therefore much more efficient in high current switching applications than conventional power products.

Some siren manufacturers use TO-220 packaged Darlington power transistors. While this can reduce the component count, (though can also increase the component cost), as the C-E diodes are sometimes integral to the Darlington, the intrinsic high on-state voltage of the Darlington configuration increases device dissipation. Consequently the circuit requires B-E resistors, and also reduces the power delivered to the load.

Circuit description

The circuit shown in Figure 3 has been devised using Zetex Super E-Line transistors. It is basically a modified version of figure 2. There are two important differences to note:

i) As the devices employ an efficient matrix die geometry, they produce low $V_{CE(sat)}$ values, this leads to very low device dissipation, and therefore low temperature rise. (Viz. ZTX690B: $V_{CE(sat)}$ = 0.3V at I_C=2A, I_B =20mA and ZTX790A: $V_{CE(sat)}$ = 0.4V at I_C=2A, I_B =50mA, please consult ZTX688B-ZTX696B and ZTX788B - ZTX796A series datasheets). This can be very important in automotive applications, where the operating environment can reach high ambient temperatures. It follows that in this case, the usual base-emitter resistors employed to aid turn-off, and to divert leakage currents at high junction temperature, are no longer required.

ii) The Zetex devices chosen, possess a reasonable h_{FE}, (strictly termed h_{FC}) when used in the inverted mode, Eg. with the collector/emitter terminals reversed. Typical peak values being 125 for the ZTX690B and 100 for the ZTX790A . This feature means that they are still capable of operating when subjected to reverse transients, such as when driving an inductive load, and therefore do not always require protection diodes. For the siren driver application, the C-E diodes may be confidently omitted.

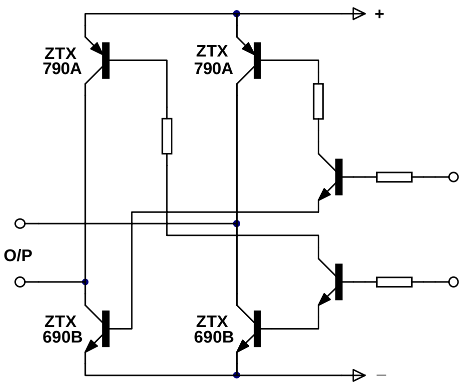
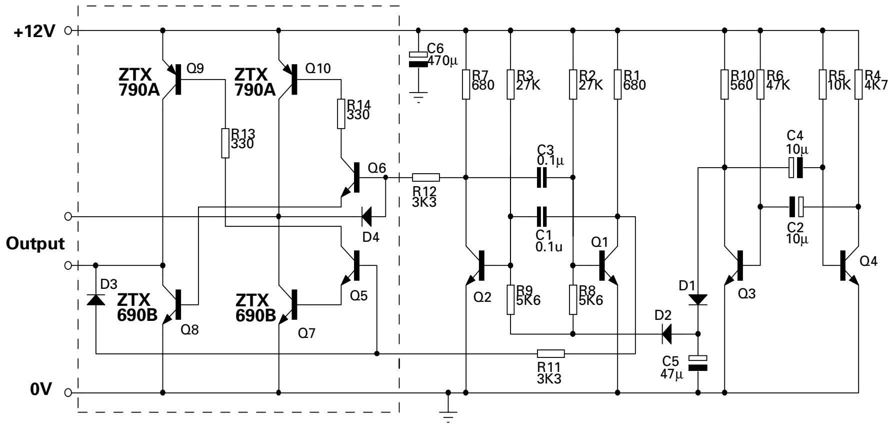


Figure 3.
ZETEX Reduced Component Count 'H'-Bridge Circuit.



'H' BRIDGE OUTPUT STAGE — SIGNAL GENERATION CIRCUITRY

Q_1 - Q_6 MPS2222A — Q_9 - Q_{10} ZTX790A

Q_7 - Q_8 ZTX690B — D_1 - D_4 1N4148

Figure 4 .
Example Circuit (Note 1).

The modified 'H'- bridge siren driver stage has been incorporated into a complete siren driver circuit, in order to demonstrate the capability of Zetex Super E-Line transistors. The demonstration circuit is shown in figure 4, and consists of two sections; the signal generation circuitry, and the 'H' bridge output stage. The former comprises a slow running astable multivibrator to generate a ramp signal, that is then used to modulate a second multivibrator, causing it to sweep over a range of frequencies. This section drives the 'H'-bridge output stage described previously.

While the multivibrator method is valid, (some manufacturers use a similar circuit, while others favour op-amp derived circuits, or even small micro-controllers - see Note 2), there can be a problem with cross-conduction, Eg. Simultaneous conduction by both NPN and PNP devices during switch-over, thus leading to excessive power dissipation. To prevent this, the output stage on the demonstration circuit has two additional signal diodes, D3 and D4. These components inhibit the driver transistors Q5 and Q6, until the opposing half of the 'H'-bridge has started to switch off. More elaborate signal generators incorporate delays between changes of output state, (using an extra gate or software) so would not require these extra diodes.

The circuit has been designed assuming a load impedance of 6 Ohms; a common value for the drive units used. Lower loads can be driven but may require either a change to the bias resistors, R13/14, to provide sufficient base current, or for very low impedance loads, a change of output transistors:- the ZTX851/ZTX951 with a continuous current rating of 5 Amps and 4 Amps respectively are eminently suitable.

Example Circuit Specification

Supply Voltage Range	2 – 25V	Load dependent; 14.2V nominal
Output Stage Efficiency	98.5%	6 Ohm moving coil load
		Average $V_{CE(sat)}$ =0.1V
		V_{supply} =14.2V
		$I_{(dc)}$ =1.2A
Output Stage Efficiency	91.5%	6 Ohm Resistive load
		Average $V_{CE(sat)}$ =0.55V
		V_{supply} =14.2V
		$I_{(dc)}$ =2.12A
Junction Temperature Rise	19°C	6 Ohm moving coil load
		V_{supply} =14.2V
Control ramp	1 to 9V, 4Hz	V_{supply} =14.2V
Swept frequency range	870Hz – 1.9kHz	V_{supply} =14.2V

Note 1:
D3 and D4 are not required for signal generation circuits possessing output/$\overline{\text{output}}$ deadtime.

Note 2:
ZETEX now offer an IC solution for the signal generation circuitry - namely the ZSD100.