TBP-Zero Circuit Technology

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TBP-Zero is a fully-balanced, DC-coupled amplifier with a balanced configuration from input to output. The basic configuration of a power amplifier is as shown in Fig. 1.

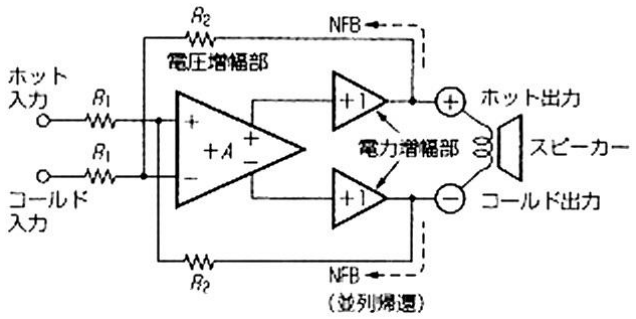

Fig. 1　Basic parallel feedback structure of a balanced amplifier

The differential VAS is followed by a unity-gain, triple-Darlington power buffer with a current gain of 100 million. The positive output is fed back to the negative input, and vice versa. By completely eliminating the emitter resistance from the output stage, and connecting in parallel, we realized an dynamic and open sound quality that sets it apart from existing amplifiers.

In the mid-1970s, the US GAS Ampzilla got a lot of attention for its good sound, and one of the secrets of its sound was that it could be connected in parallel with the output emitter resistor of 0.39R. This has the effect of preventing the current limiting effect of 0.39R at the time of high current output. Then, it should be better if the emitter resistance is banished, so the circuit that arrived after repeated trial and error is the patented technology shown in Fig. 2, which enables stable temperature compensation even if the emitter resistance of the output is eliminated. It is a "double temperature compensation circuit".

There are two types shown in the figure when explaining with Darlington SEPP, but the operating principle is the same. First, the conventional temperature compensation circuit using Q5 can handle only mild temperature changes such as ambient temperature changes, and is idle. The current adjustment is done here. Then, the second temperature compensation transistors Q6 and Q7, which can respond to sudden temperature changes of each output stage transistor, are added to the driver stage with low impedance, and real-time output temperature compensation is performed here. Since Q6 and Q7 are completely inserted in the low impedance circuit, the shadow guard of current hogging can be ignored even if they are placed in the immediate vicinity of the output stage transistor. Moreover, the same type of transistor as the output itself is used for Q6 and Q7, and the driver stage, and by adjusting the value of the emitter resistance, the temperature coefficients of Q6 and Q7 can be finely adjusted to correct the defect of thermal coupling, and the temperature can be compensated even if the emitter resistance of the output transistor is eliminated.

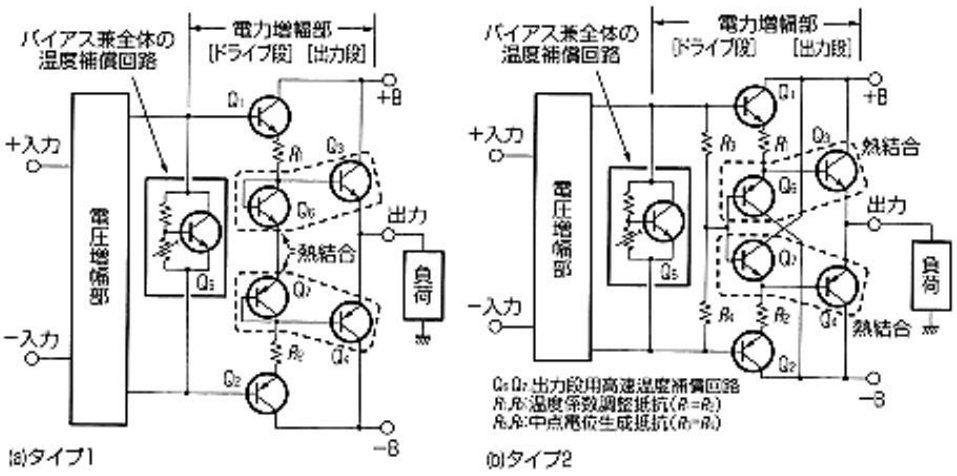

Fig. 2 Double thermal compensation circuit
(dotted line indicates thermal coupling)

As a countermeasure for connecting output transistors in parallel, a pulse current of several A is passed to select and pair the transistors whose Vbe is matched at 4 to 5 percent, and the emitter resistors of the 4-pair output stage transistors are completely eliminated.

The entire amplifier circuit has the configuration shown in Fig. 3. Not only the emitter resistors of the output stage, but also the output relay is eliminated. The current amplifier is a tripe Darlington. The configuration in Fig. 2 is such that one stage was added to the circuit, and the machine is a type 1 circuit with a temperature compensation transistor connected by a diode, but the volume-production amplifier is changed to a type 2 circuit with a current mirror. As shown in Fig. 4, Toshiba 25C5200 and 25A1243 with Pc of 150W and Ic of 15A are used for the output, and an idle current of 150mA is applied per transistor.

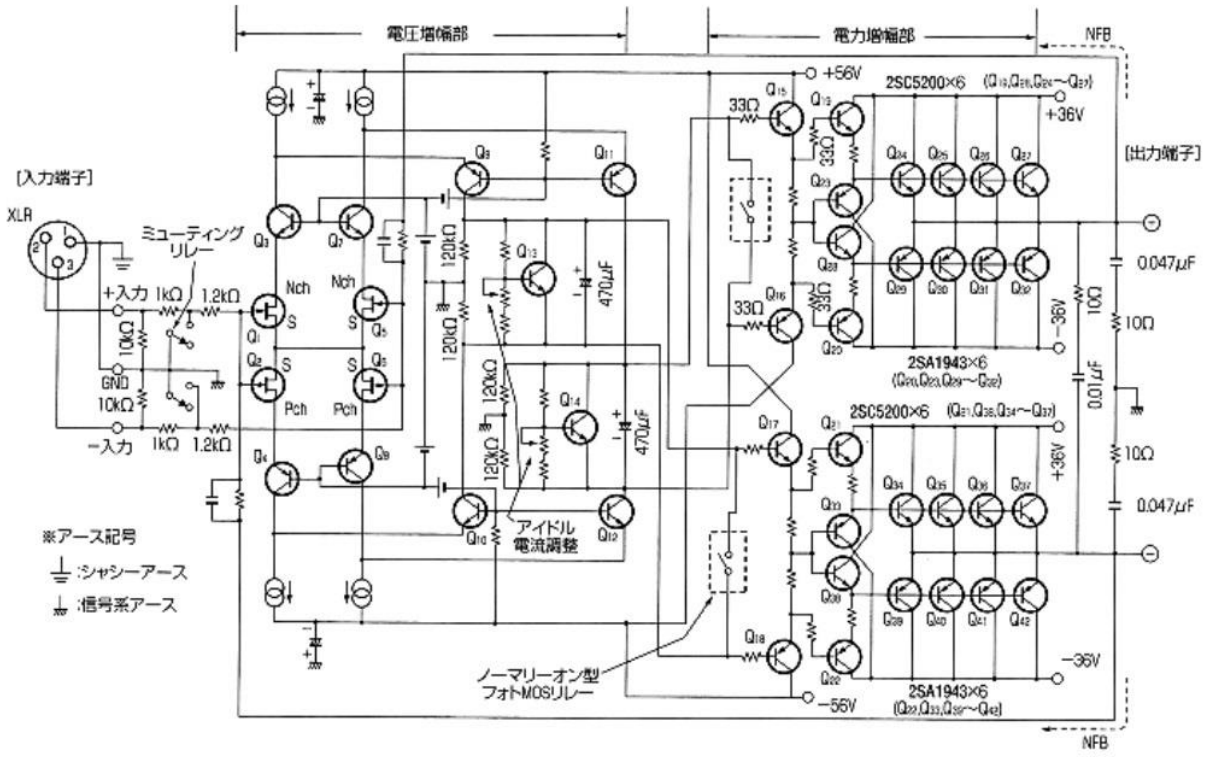

Fig. 3 Basic configuration of the amplifier section of TBP-Zero

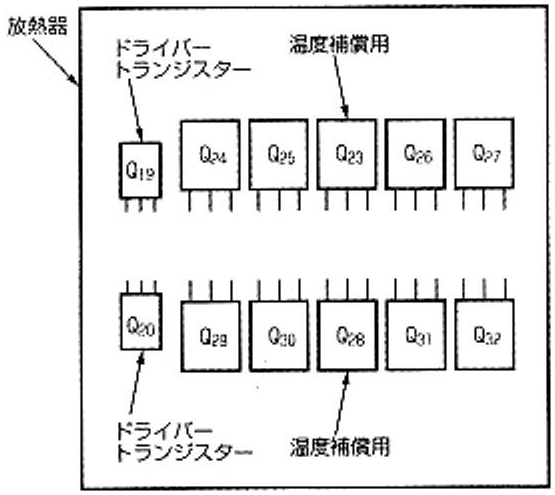

Fig. 4 Device placement on heatsink (Q23,28 are thermal compensation devices)

As shown in Fig. 5, the voltage amplification unit has a current limiting effect in a general differential amplifier, and if there is a capacity such as the inter-connection capacitance or stray capacitance of the transistors in the next stage, the current will be generated when a pulsive signal is input. It is saturated and easily distorted. Therefore, the Pioneer Exclusive M10, which appeared in 1979, uses a differential amplifier that does not have a current limiting effect as shown in Fig. 6. This unit folds the first stage of this circuit from a general cascode connection. A one-stage amplifier with a configuration changed to a cascode connection, redrawn as shown in Fig. 8. The input signal voltage is once converted to a current signal…..

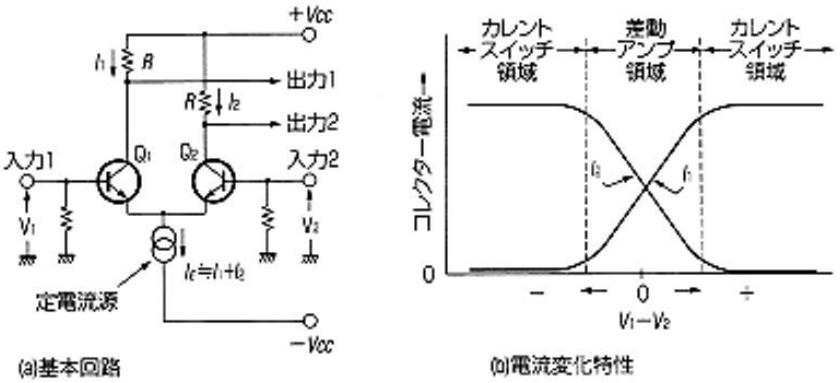

Fig. 5 Differential amplifier and its characteristics

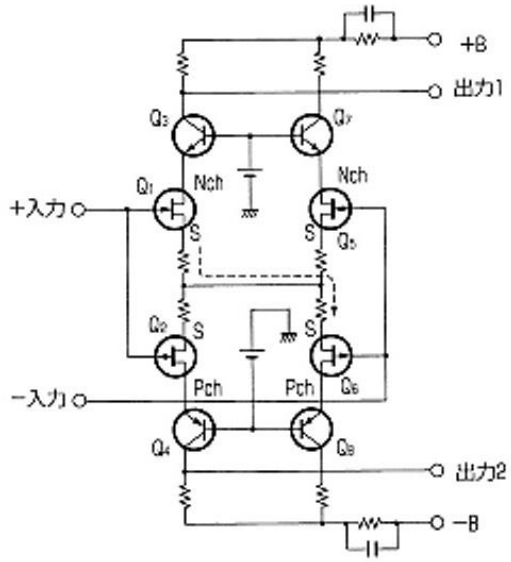

Fig. 6　Pioneer M-10 differential input stage

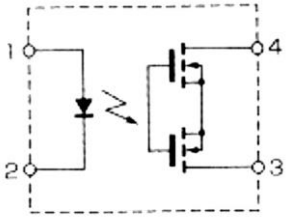

Fig. 7　Equivalent circuit of opto-MOS relay

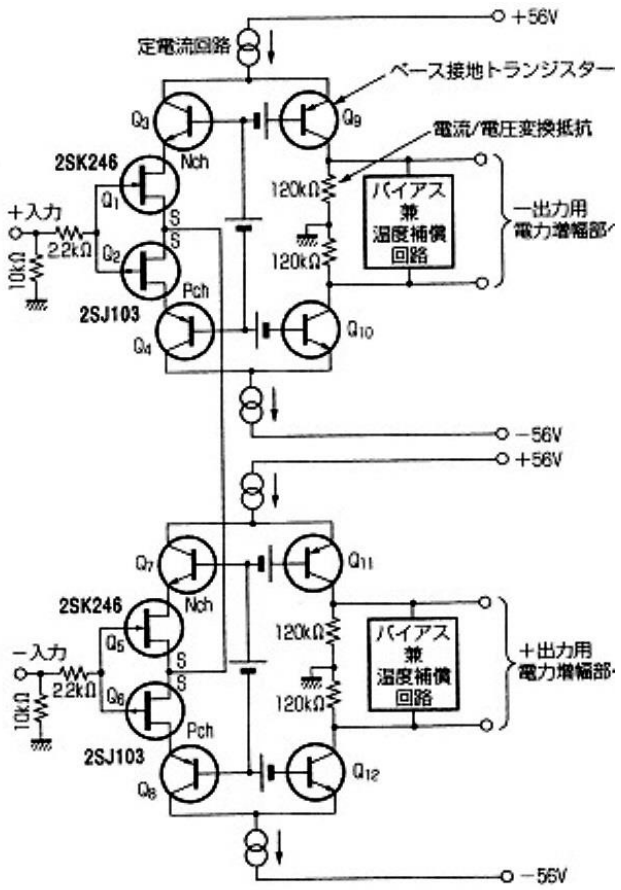

Fig. 8　Basic structure of the VAS

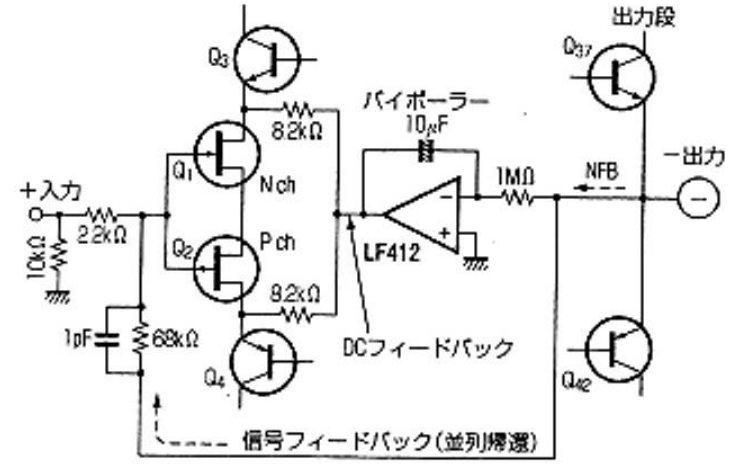

Fig. 9　DC servo circuit used in TBP-Zero prototype

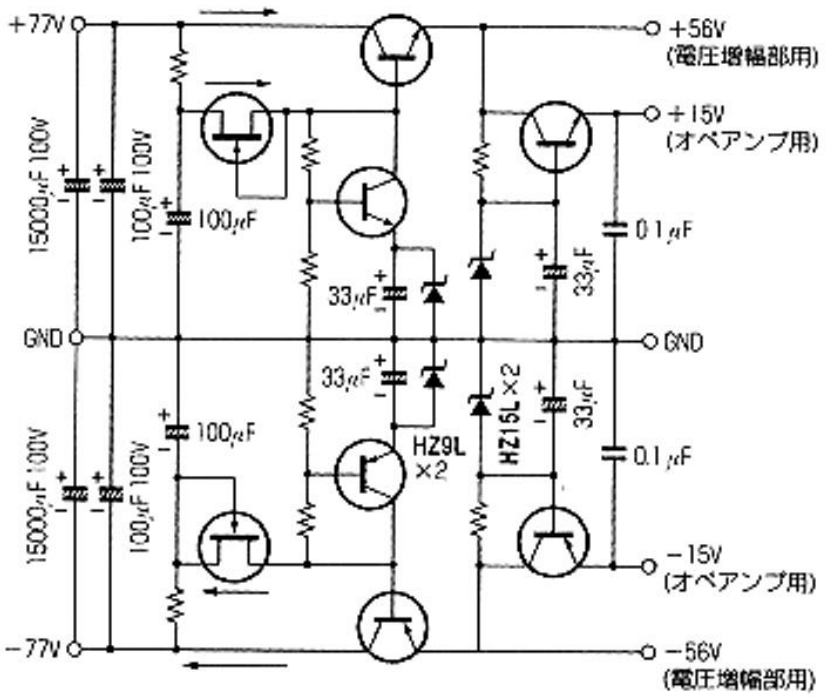

Fig. 10 Stabilised power supply circuit of the TBP-Zero

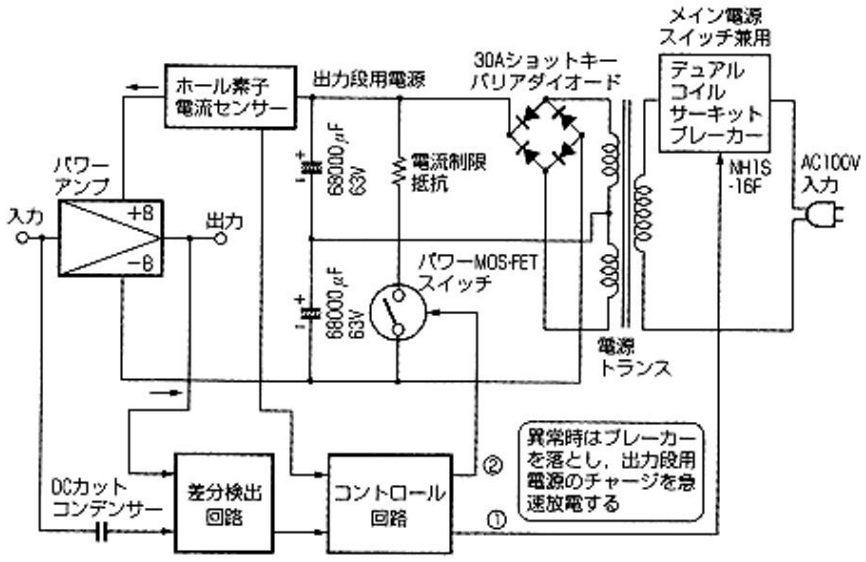

Fig. 11 Basic configuration of TBP-Zero protection circuit

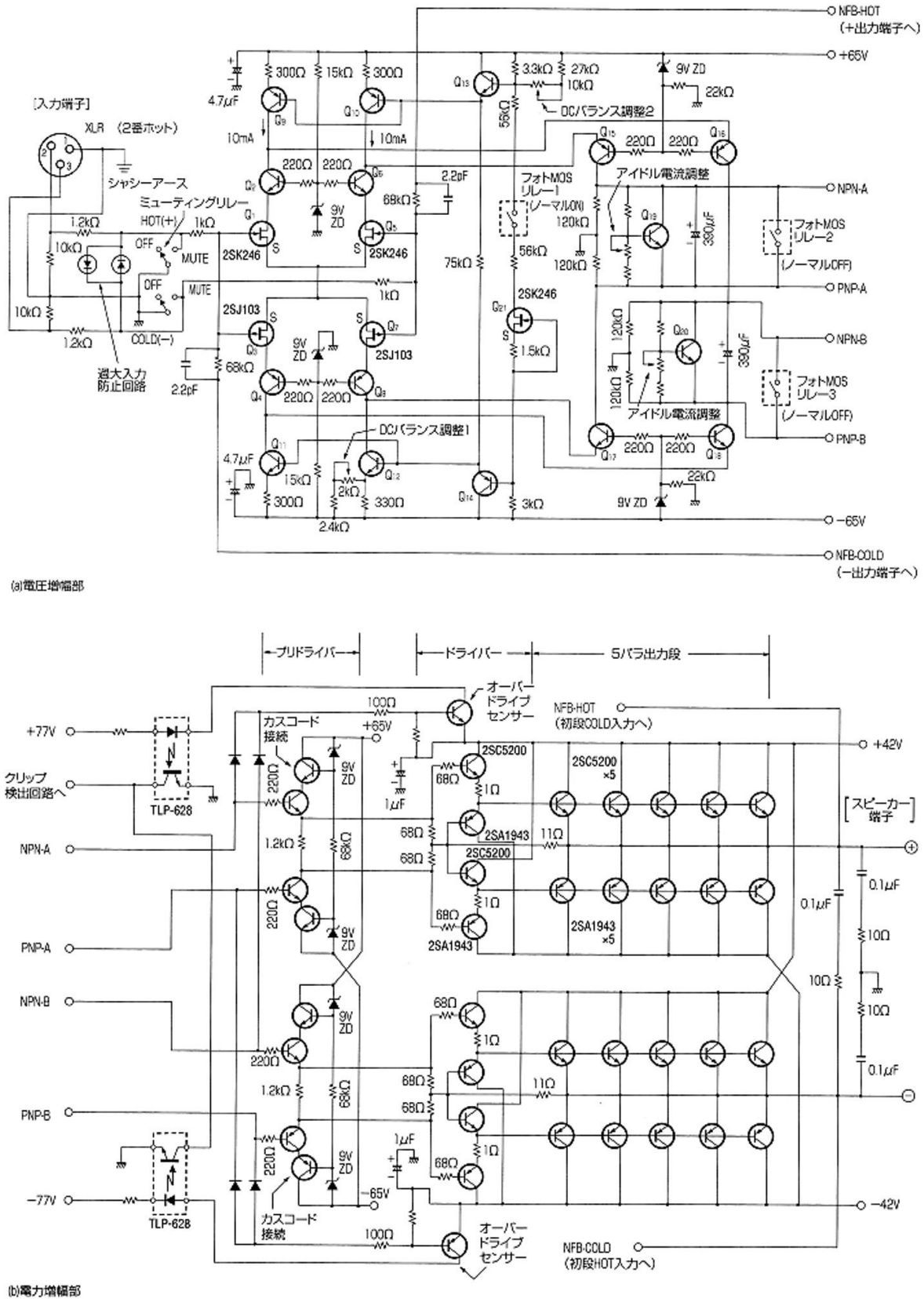

Fig. 12 Schematics of TBP-Zero Version 2
a) VAS; b) Current amplifier