Theory of class TD

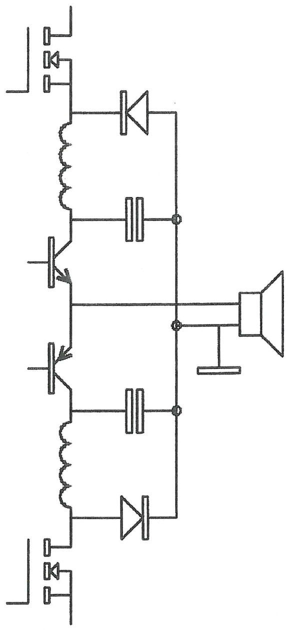

Figure 1, TD amplifier output stage

Class TD tracking Supply

The amplifier class used in Lab.gruppens high power models is referred to as Class TD.
TD is short for "Tracking Class D" and the name comes from the fact that a ***Class D*** amplifier is used to produce a supply voltage that ***track*** the output signal in a class AB audio amplifier.

A short description of Class TD is to say that it's a standard class AB amplifier with greatly improved efficiency.

The higher efficiency is achieved by adding two switch mode converters to reduce the power losses in the normal class AB amplifier.
The Switch mode converters, or TD supplies, supply the class AB amplifier with a voltage that will track the output audio signal with an offset of approx. +/- 6V.

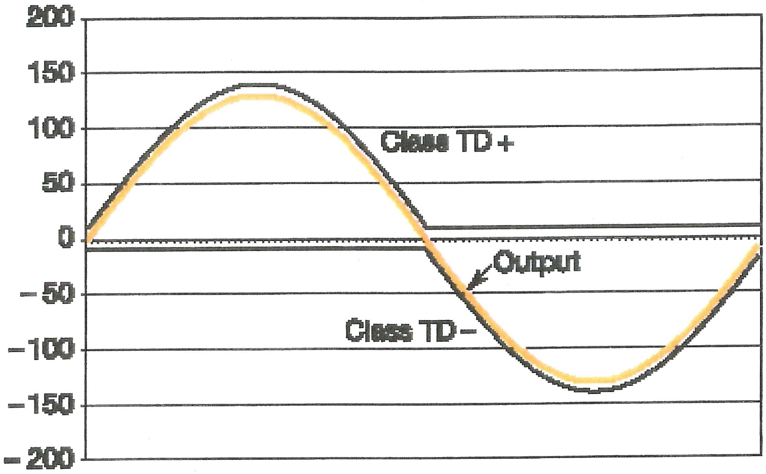

Figure 2, Amplifier output voltage and TD voltages

The linear output stage will behave exactly as a class AB amplifier working on a +/- 6 volt power supply.

The class AB output stage also acts as a filter that reduces EMC noise from the TD supplies. In a standard class D amplifier this filter would be an LC filter.

When the TD amplifier works in reactive loads, the energy going back into the amplifier is handled in the linear stage.

TD supplies

The switch mode topology used in the TD supply is "step down" or "buck converters".

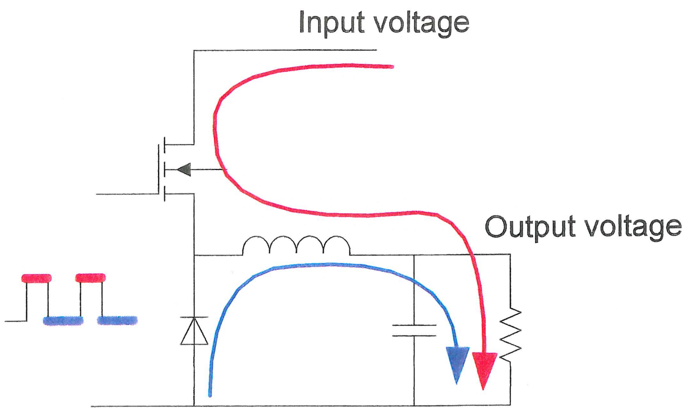

Figure 3, Currents in the buck converter

In Figure 3, Currents in the buck converter, the switch transistor (FET) is controlled by a PWM signal. The input voltage is the "Vrail" in the amplifier, and the output voltage is the supply for the Class AB stage.

When the FET transistor is turned on, the current will flow accordingly to the red arrow, through the FET, inductor and the load. When the FET is turned off, the voltage across the inductor will reverse but the current will continue to flow through the free wheeling diode due to the properties of the inductor.
One can easily see that if the FET is turned constantly on, the output voltage will be the same as the input voltage. If the FET is turned off, the output voltage will be zero.
If the duty cycle of the signal in 50%, the output voltage will be half of the input voltage in a correctly designed buck converter.

One advantage of the Buck converter (this applies to other switch mode converters as well) is that it's a "power converter". This means that the power in to the converter equals the power out of the converter.
For example:

> The converter is switched at a 50% duty cycle.
> The input voltage to the converter is 160V. The input current is 10A. Input power is 1600W.
> This will give an output voltage of 80V and a current of 20A. The output power will then be 1600W.

This fact gives us an advantage when it comes to driving loudspeakers. A two ohm speaker will require more current and less voltage than an eight ohm speaker (with the same power rating). This is how we utilize our MLS (matching load system.). If a low impedance load is to be driven, we simply limit the output voltage of the converters to increase current headroom.

Advantages of the class TD amplifiers

- Efficiency is high (typically 80% at 1/3 output power)
- The sonic characteristics is the same as in a normal Class AB amplifier
- Output impedance is low at high frequency
- The frequency response is good
- High output powers are possible
- Bridge mode operation is possible
- The noise is low
- Distortion is low
- High reliability (no cross conduction in TD supplies due to two "output filters" (class AB amplifiers))
- Good handling of reactive loads (no supply pumping as in some class D solutions).

Theory of a flyback converter

General

The power supply in all of our high power, light weight amplifiers is a flyback switch mode converter.
This topology can give several stabilized output voltages with very few components.

Two of the main reasons for using the flyback topology are simplicity and reliability. Since the converter only utilizes one primary switch element there is no risk for cross conduction.

Advantages of the flyback converter topology

- High reliability
- Simplicity (few components)
- Stabilized output voltage
- Adjustable output voltage
- Adjustable output current
- Overload with constant power

Function of the flyback converter

In Figure 1, the basics of a flyback converter are shown. The voltage Vin is a 230Vac mains that is full wave rectified.
The switch element is driven by a PWM signal.

When V1 turns high, current will start to flow in the primary side of the main transformer.
When V1 goes low, the primary winding of the transformer will reverse and Vce of Q1 will reach a very high voltage.
In a real world implementation of a flyback converter snubber circuits will be added. They will keep the main semiconductors from exceed their ratings.
Without snubbers in the circuit, the Vce of Q1 would rise far beyond the specified Vce of the switch element.

When Q1 stops conducting, a current in the secondary winding of the transformer will start to flow.
It can be seen that the energy transfer from primary to secondary is made in a cyclic manner.
No current flows in the secondary while current flows in the primary.

To add more output voltages, simply add secondary windings in the transformer.

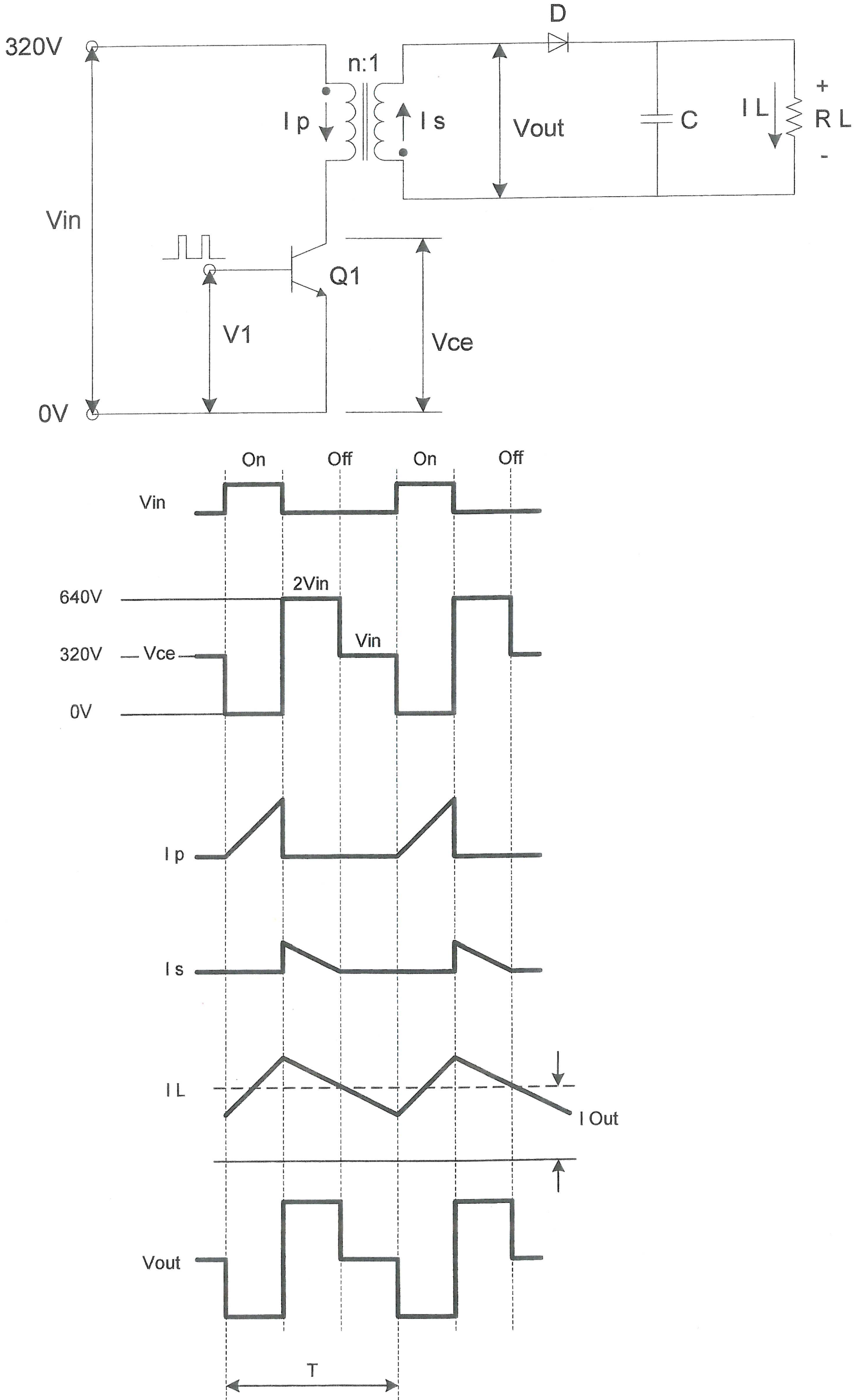

Figure 1, The isolated flyback converter with associated waveforms