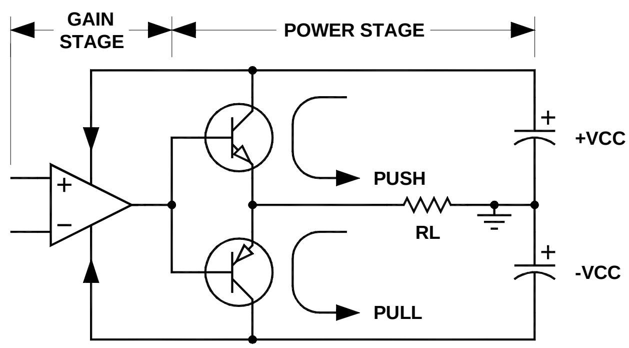
MULTIPURPOSE MODULE THEORY OF OPERATION

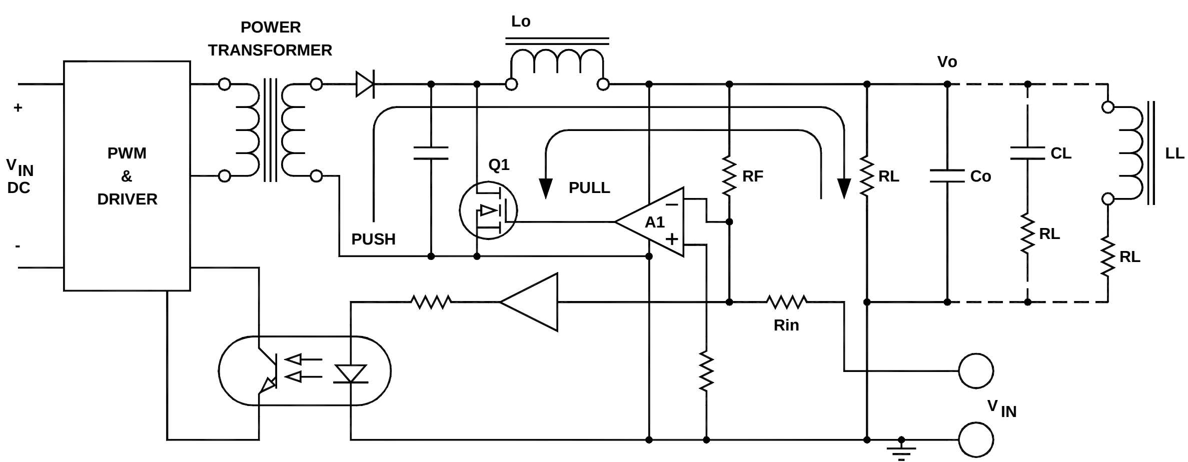
The multipurpose module RG3000 is an isolated power amplifier that combines switching and linear topologies to achieve high efficiencies and linearity over a wide input voltage range. The switching power converter delivers power to the load from the input power source, while the linear power amplifier at the output section assists the load during the discharging phase of the operation. The RG3000 operates similarly to a linear power amplifier with a push-pull power stage. Specifically, during the PUSH phase the power OPAM delivers power to the load from the positive supply source through the output power transistor, and during the PULL phase it sinks power from the load through the complimentary power transistor to the negative power supply as is shown in Figure 1.

The RG3000 needs only one power supply; its output is completely isolated from the input and offers very high efficiency and excellent linearity. The high efficiency is the product of the switching power transfer, while the linearity is due to the high open loop gain of both the converter and the linear amplifier. In Figure 2, a block diagram of the RG 3000 is given. During the PUSH phase, the DC/DC converter delivers power to the output under the command of V_{IN}, while the linear amplifier—which shares the same negative feedback loop—is OFF. During the PULL phase, the DC/DC converter is OFF and the linear amplifier turns ON, as needed depending on the output loading.



OP-AMP WITH PUSH-PULL OUTPUT

FIGURE 1



COMBINATION AMPLIFIER, PUSH PHASE SWITCHING PULL PHASE LINEAR

FIGURE 2

The following diagrams demonstrate the operation of the RG3000 module:

In Figures 3A & 3B, two oscillograms of the output of the RG3000 is presented. In Figure 3A, Ch1 shows the output of the RG3000 driven by a square wave input without the assistance of the linear amplifier. Note that the positive going output overshoots and then settles to its final value. When the input reverses, the output capacitance is discharged only from the resistive 1kΩ load (the PWM at the input is off during the discharge or pull phase). Ch2 displays the correction signal generated by A1, which drives Q1 with the drain of Q1 open (See Figure 2).

In Figure 3B, Ch1 is the final product of the corrected output and Ch2 is the output error signal of A1with the drain of Q1 connected. At the negative transition of the output (Ch1), A1 turns Q1 hard on (overshoots) then settles down to its linear operating mode. The overshoot during the positive transition in Ch1 is removed.

In Figure 4A through 4D, Ch1 is the output of the RG3000 shown under different loads. The output of A1 is in Ch2. Specifically, Figure 4A shows the no load V_{OUT} and the output error signal of A1. When V_{OUT} saturates, the A1 output steps up to 15 volts trying to correct V_{OUT}.

Figure 4B shows V_{OUT} loaded with a 1kΩ resistor. In Ch2, A1 turns on only during the end of the cycle to assist the load in removing the charge from the output capacitor and steps up when V_{OUT} saturates.

In Figure 4C, the analog input is offset to remove the negative saturation of V_{OUT} (Ch1). The step of $A1_{OUT}$ is also removed (Ch2).

In Figure 4D, V_{OUT} is loaded with one 100µF capacitor in series with one 510Ω resistor. The output of A1 is inverted and is on during the lower half cycle.

Figure 5 shows the input and output of RG3000 connected as an inverting amplifier (Ch1 is V_{OUT}).

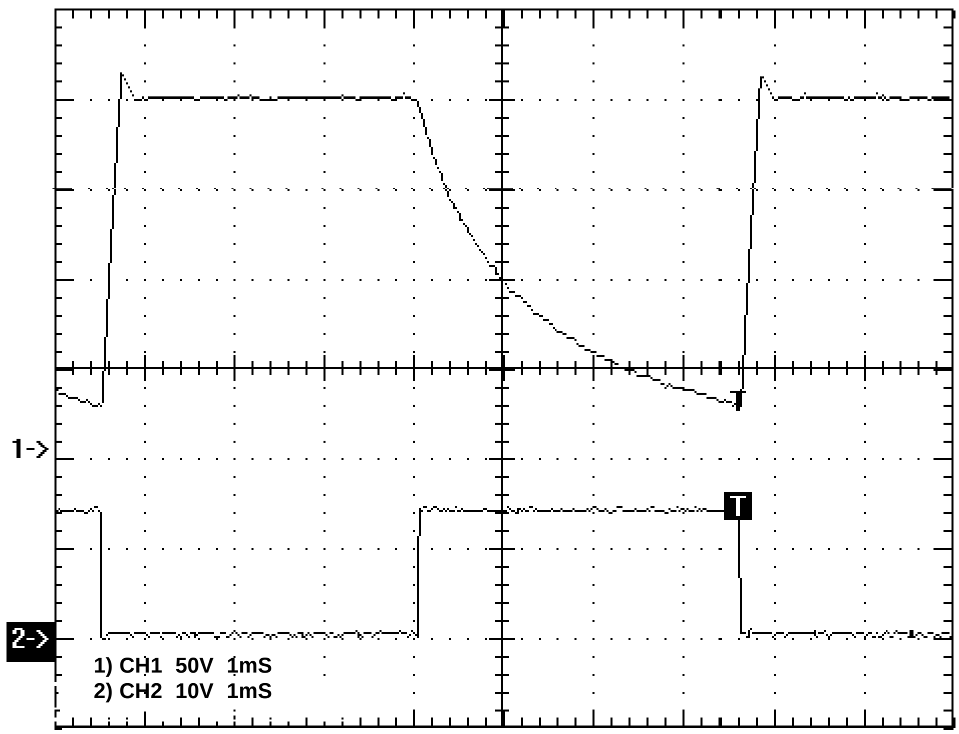


FIGURE 3A

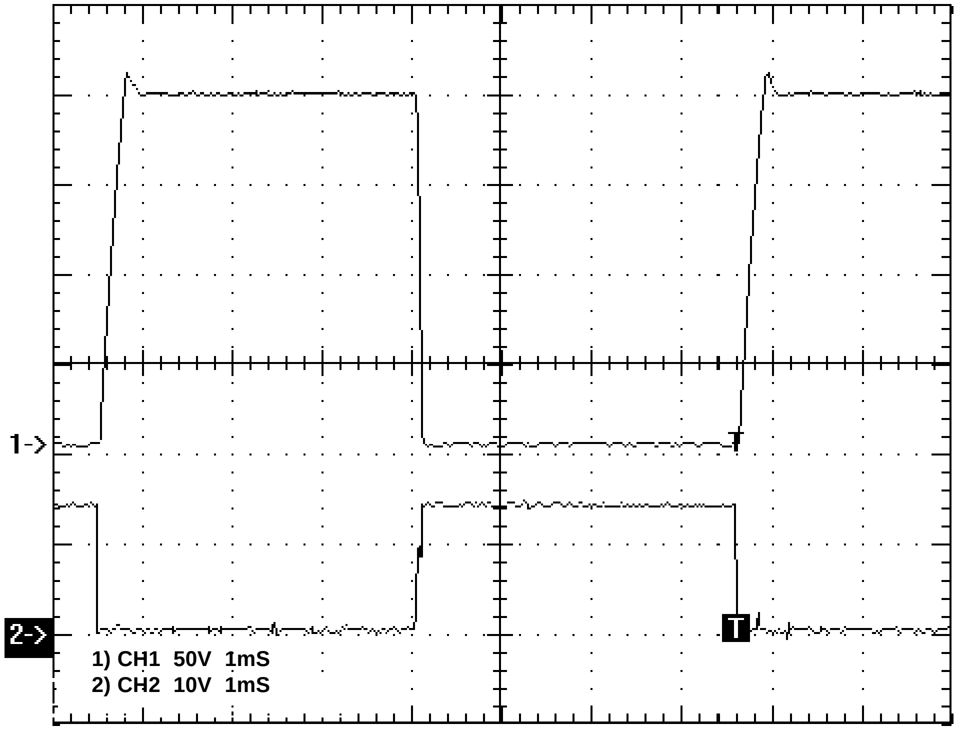


FIGURE 3B

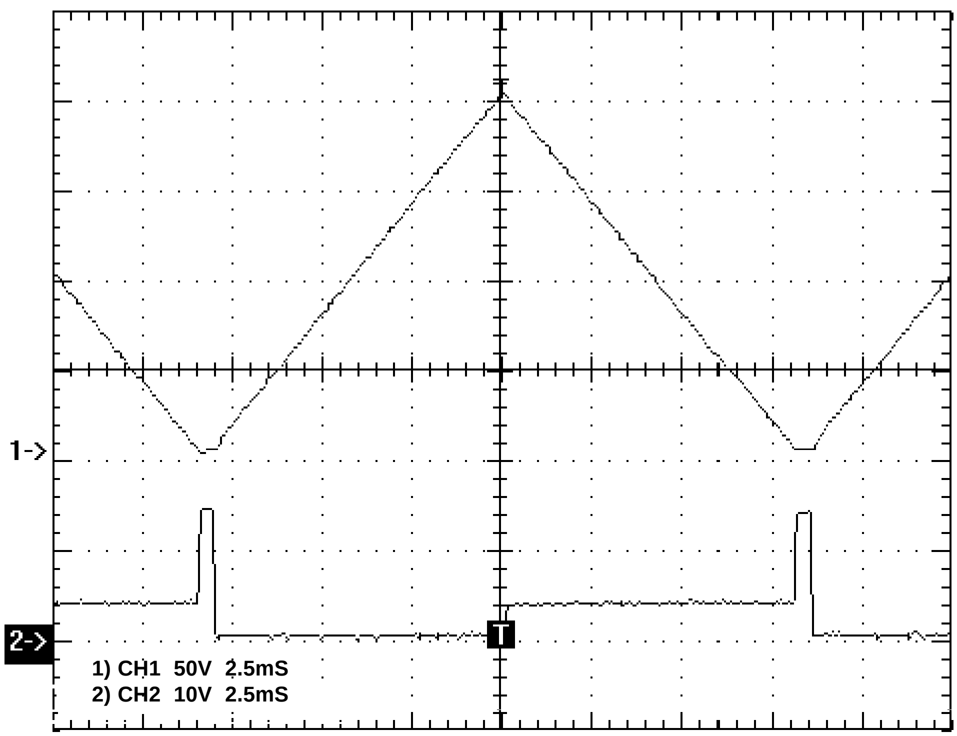


FIGURE 4A

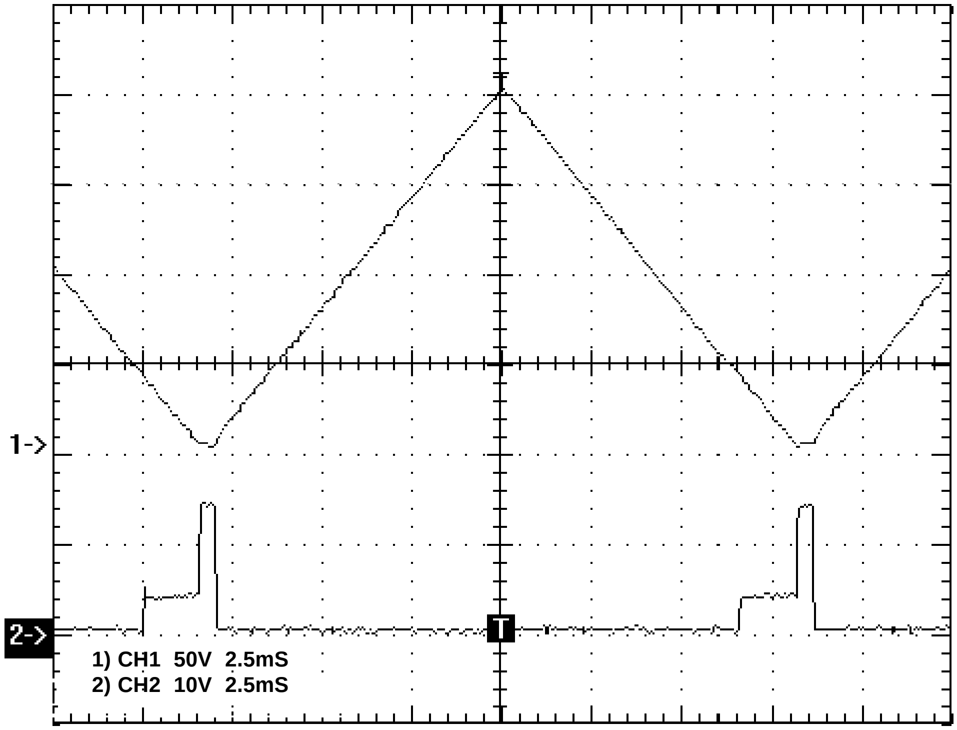


FIGURE 4B

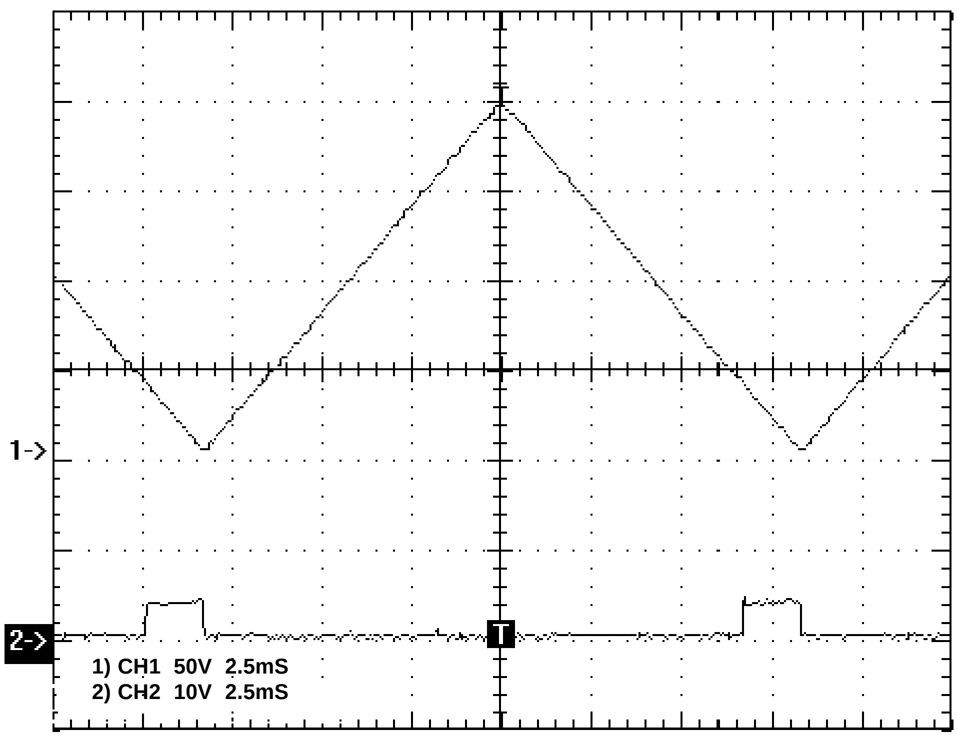


FIGURE 4C

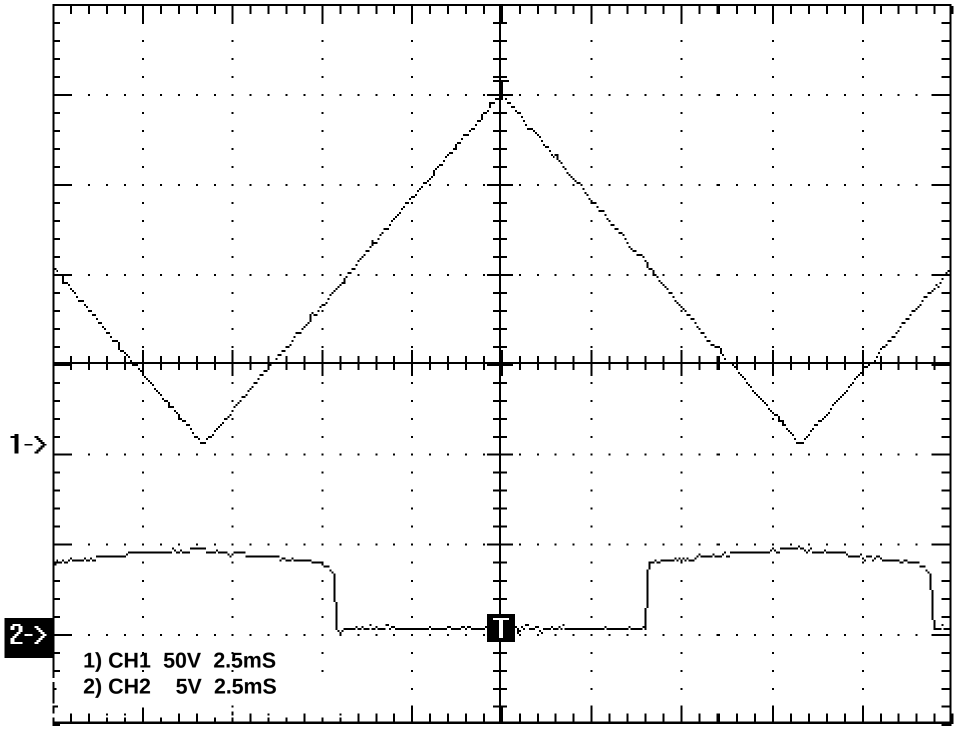


FIGURE 4D

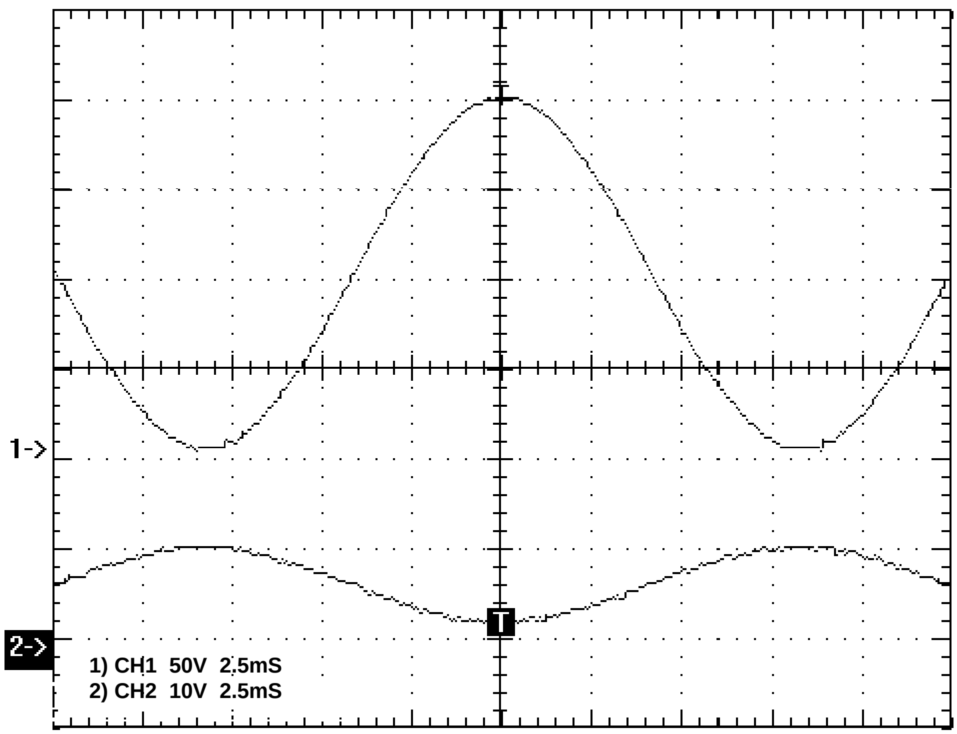


FIGURE 5