Getting Started with the GA-2500A

AN-07

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Getting started

Below is a short procedure on getting started with the GA-2500A. The GA-2500A is never used in isolation; other instruments, such as a signal generator and an oscilloscope, are required to use and monitor the instrument. Depending upon the particulars of the supporting instruments different details will be required to successfully complete each of the steps below. However, this general outline can be used to systematically get up and running with the GA-2500A gated amplifier.

1. Set up the function generator

The GA-2500A requires two input signals:

1. RF input – this is the signals to be amplified.
2. Gate – this is the signal that turns power stage of the amplifier

FIGURE 1 shows the basic requirements for each input signal. It is important to understand that the GA-2500A is a 'gated amplifier'. In this context the term 'gated' means that the amplifier is enabled only for a short period of time. This is different from many 'standard' power amplifiers which are essentially on and amplifying continuously. By gating the amplifier on for only a short fraction of the time, the power consumed is greatly reduced and the thermal management becomes much simpler.

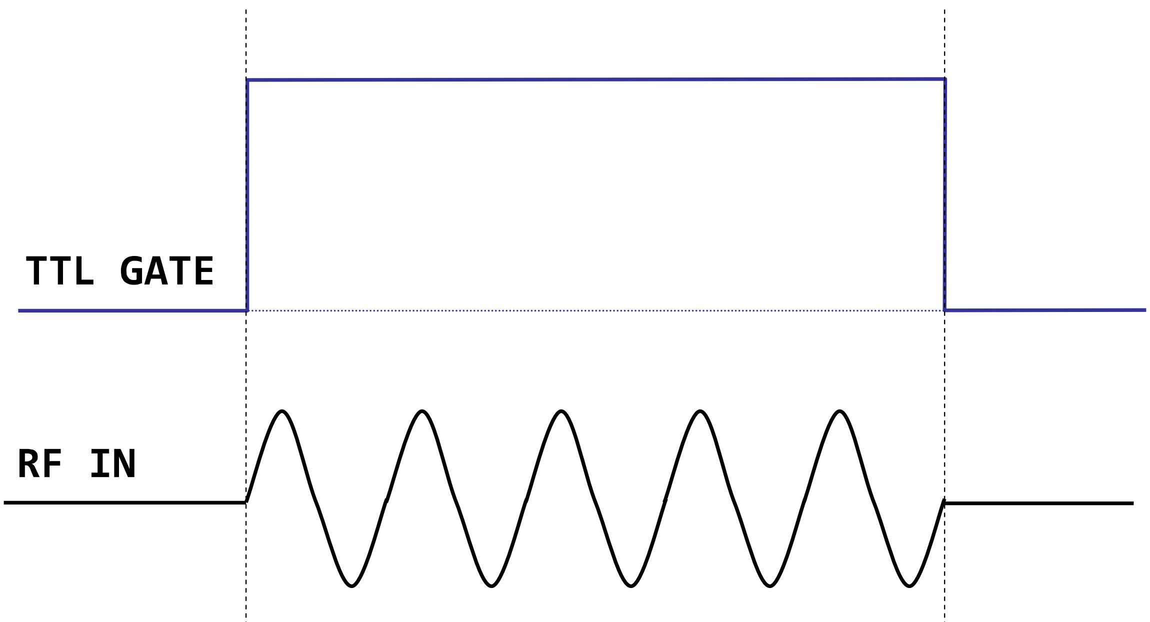

Figure 1: Input signals required for operation of the GA-2500A. The RF IN signal is the signal to be amplified. The amplitude should be 800 mV to 1 V peak to peak maximum. The Gate signal should be a positive going TTL level logic signal that goes high at the start of the RF burst and goes low at the end of the burst.

There is a wide array of signal, function, and waveform generators available, each with its own capabilities and limitations. For those who are either first time GA-2500A users or new to electronics, it is strongly advised to start with simple waveforms. Once you have managed to program and amplify simple waveforms then proceed to more complicated ones if desired.

It is incumbent upon the user to program the signal generator correctly. However, if you need assistance convincing your signal generator to generate the correct signals, then please contact RITEC; we would be happy to assist you.

The requirements described are for the 'standard' versions of the GA-2500A. However, there are options available for different gating options, including a self-gating model of the GA-2500A. Please contact RITEC for more details.

2. Verify signals on oscilloscope scope

Before connecting the signals to the GA-2500A and attempting to amplify anything it is prudent to directly view these signals with a suitable oscilloscope or digitizer and verify that you have indeed programmed the signal generator correctly.

FIGURE 2 shows a screen capture of some appropriate input signals for the GA-2500A. For the best linearity, the RF IN signal should be kept to 800 mV peak to peak (when terminated into 50 Ω) The gate signal goes high at the start of the RF burst and low at the end of the burst to be amplified.

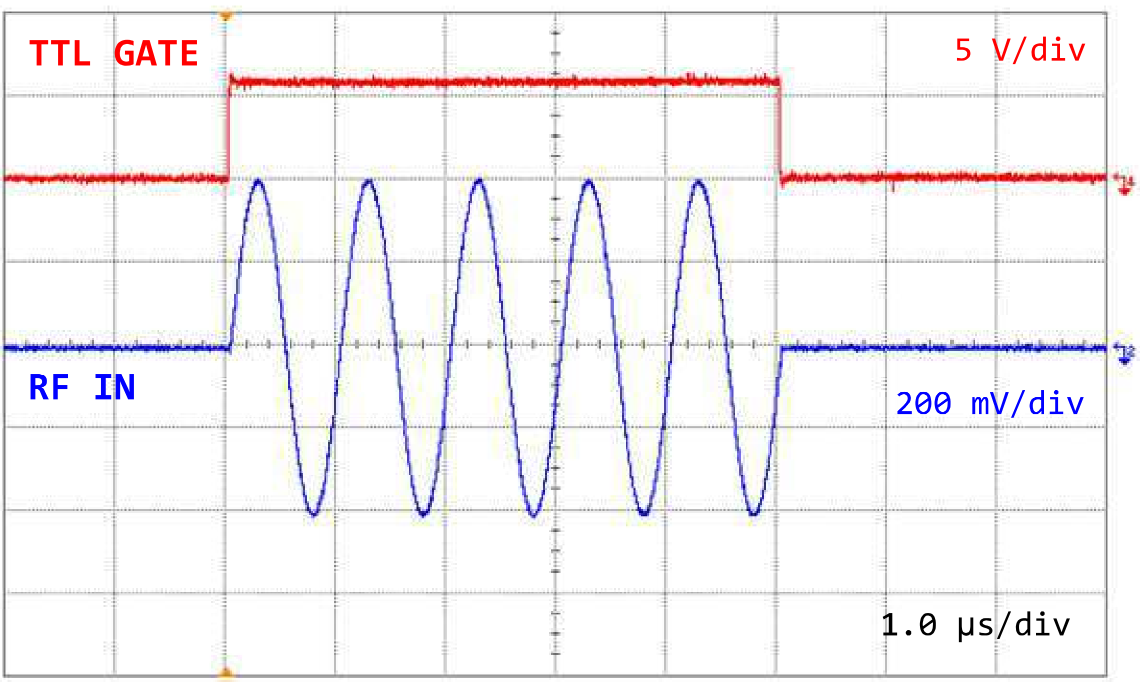

Figure 2: Screen capture of the input signals required for the GA-2500A.

There is an even greater variety of oscilloscopes, digitizers, and waveform viewing devices available, each with its own characteristics and user interface. The one concept that gives users new to electronics the most difficulty seems to be trigger settings. Be certain to set the trigger source to be the channel/connector that the GATE signal is connected to, and set the trigger level to be in the range of 2 to 3 V.

3. Make the connections

Make the connections shown in FIGURE 3. Some further comments about each connection are given below:

Connection (1): Function generator out to RF IN

The optimal amplitude for this signal is 800 mV pp. Do not go above 1 V pp levels at the input, otherwise significant distortion may appear in the output as the low level stages are overdriven.

Connection (2): Function generator gate signal to TTL GATE IN

It can be a challenge to convince a signal generator to generate the required gate signal. Some signal generators have a gate signal available as an auxiliary output. Another option is to use a dual channel function generator and program the second channel to generate the necessary gate signal.

Connection (3): Oscilloscope trigger connection

The connections in figure 3 show the gate signal connected to a BNC 'T' connector and then split to the GA-2500A and the oscilloscope trigger input (either a free channel on the oscilloscope or an 'EXT' trigger input connector. There are several ways to successfully trigger the scope; the method shown in the figure is relatively robust and stable. New users sometimes have difficulties triggering their oscilloscope.

Connection (4): RF PULSE MONITOR to oscilloscope input

The signal from this port on the GA-2500A is a scaled down version of the high voltage output. This provides a means of 'seeing' what the output is doing without damaging your oscilloscope (or using a high voltage probe)

Connection (5): HIGH POWER RF PULSE OUTPUT to suitable load

Depending upon your application you may or may not need a resistive termination. When getting started using the GA-2500A for the first time (or when using a particular transducer with the GA-2500A for the first time) it is a good idea to use a resistive termination like an RT-50.

Connection (6): Transducer connection

When first getting started it may be helpful to only connect a resistive termination such as an RT-50 to the high voltage RF output of the GA-2500A, adding the transducer later.

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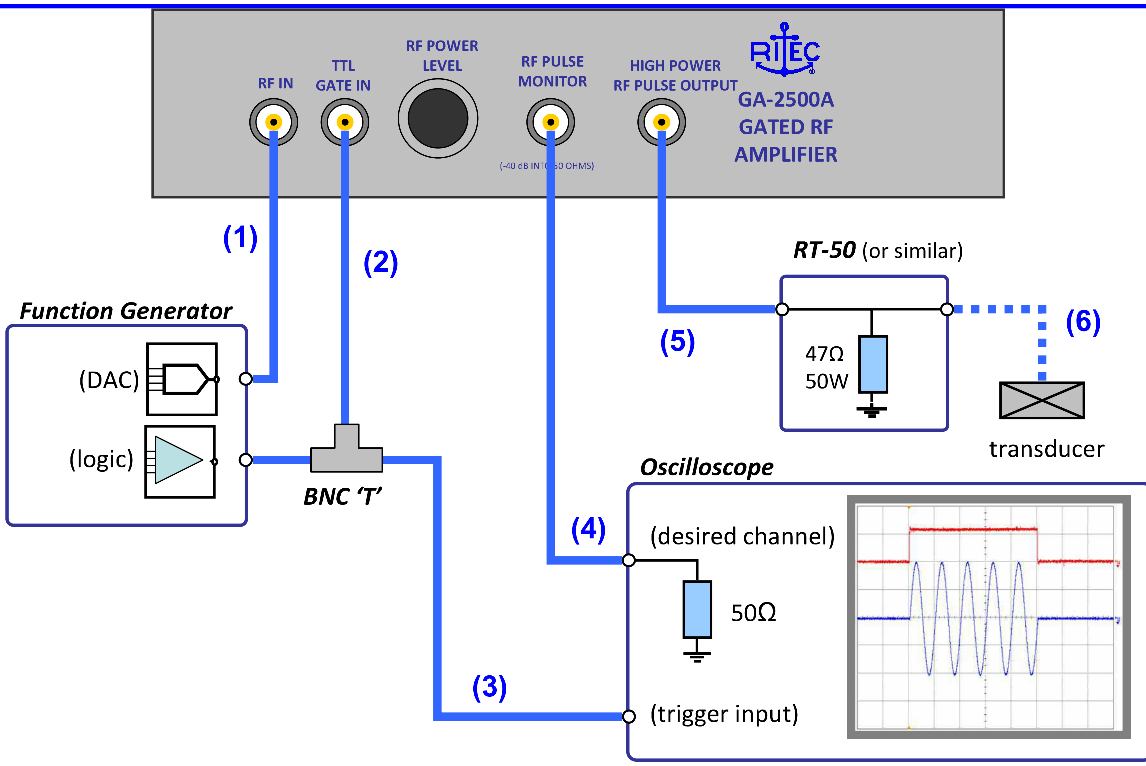

FIGURE 3: To use the GA-2500A, you will need a suitable function generator, and oscilloscope, and a load. Make the connections shown in blue. Individual connections are numbered and discussed in the text.

Set the dial on the front panel to read 5.00 as shown in FIGURE 4.

FIGURE 4: The main level, or gain, control for the GA-2500A is this 10 turn knob. When first getting started, set this to a mid-range value (5.00 is a good place to start)

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4. Check the connections

BEFORE turning on the HV, double check the HV connections. A good practice is to physically trace with your fingers all the HV connections from the gated amplifier output to wherever it is terminated, usually a transducer.

5. Turn on HV power switch

Flip on the switch labeled "High Voltage" to the ON position. It takes about 7-10 seconds for the HV power supply inside the unit to be energized.

What should happen:

-Blue LED comes on.
-The Fault indicator LED's labeled "Over Temp Shutdown"
and "Over Current Shutdown" remain off

IF either of the Fault indicator LED's come on, turn off the high voltage switch for at least 10 seconds. Double check the connections and verify again that the input signals are not exceeding the duty cycle limit of the GA-2500A.

6. View monitor signal on scope

The GA-2500A is capable of generating high voltage pulses that can damage oscilloscopes. An RF monitor port is supplied to conveniently view these high voltage signals without need of external attenuators. The monitor point on the GA-2500A is a resistive divider. When this port is connected into an oscilloscope input and terminated into 50 Ω, then the signal present at this port is 100 times smaller (-40 dB) than that present at the HV output port.

7. Make desired adjustments

At this time you can make adjustments to either the GA-2500A or the signal generator to achieve the desired waveform. Some examples of typical adjustments are shown below.

Always view the RF signal monitor when making adjustments. This is especially important when changing either the frequency or pulse-width, since the resulting peak excitation amplitude can change rapidly with either of these parameters.

Examples of typical adjustments

Since the GA-2500A is used in conjunction with a signal generator, adjustments may be made to either units in order to optimize the generated waveform. Comments on adjusting the output level and fine adjustments to the relative timing of the input signals are described below.

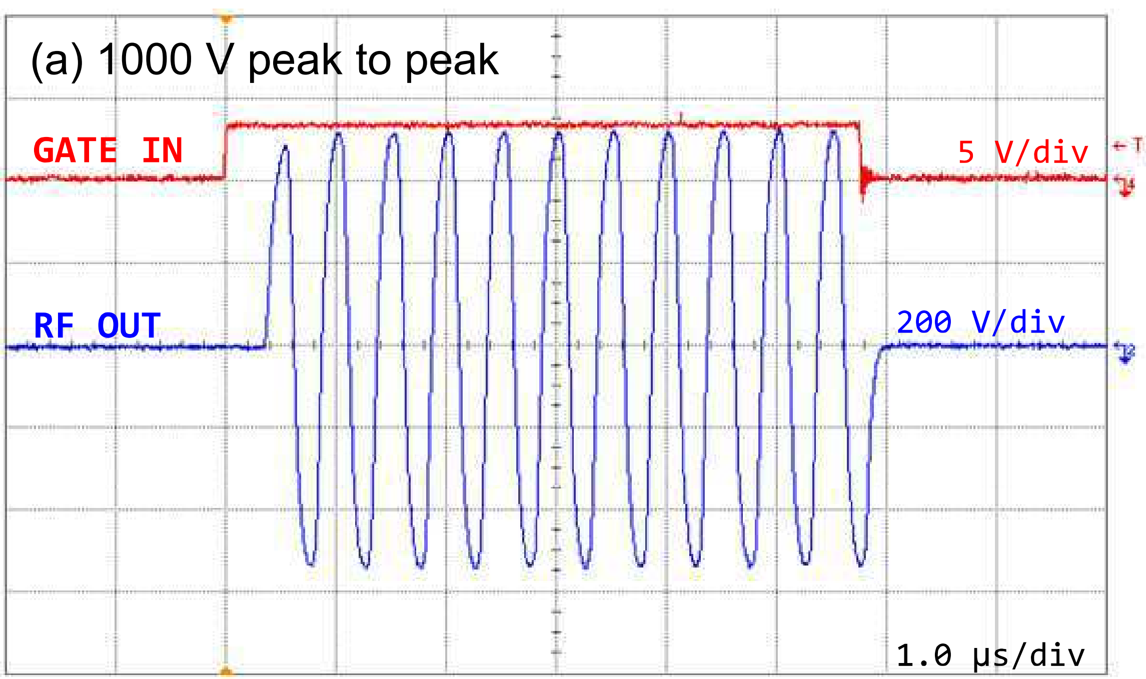
Controlling amplitude

There are three methods of controlling the output amplitude:

1. Using the RF Power Level dial on the front panel of the unit
2. Adjusting the input amplitude
3. Using high power attenuators

The GA-2500A is a variable gain amplifier. The gain is controlled using the dial on the front panel labeled "RF Power Level." This is the main gain control. However, the output level can also be adjusted by simply reducing the amplitude of the RF input signal from the signal generator.

FIGURE 5 shows some typical waveforms for a GA-2500A-0.25-7-5KW, which is a 5 kW model optimized for operation between 250 kHz and 7 MHz. Each of the waveforms in FIG. 5 shows the GA2500A amplifying a 10 cycle tone burst with a center frequency of 2.0 MHz. FIG 5a shows an output of 1000 V pp for reference. Figures 5b and 5c show the output reduced to 100 Vpp by either turning down the RF Power Level dial (FIG 5b) or by reducing the RF input amplitude from 1 Vpp to 80 mV pp. Both of the waveforms in FIG 5b and 5c would be acceptable for most ultrasonic applications. The cleanest waveforms result when front panel dial "RF Power Level" is used for output level adjustments.



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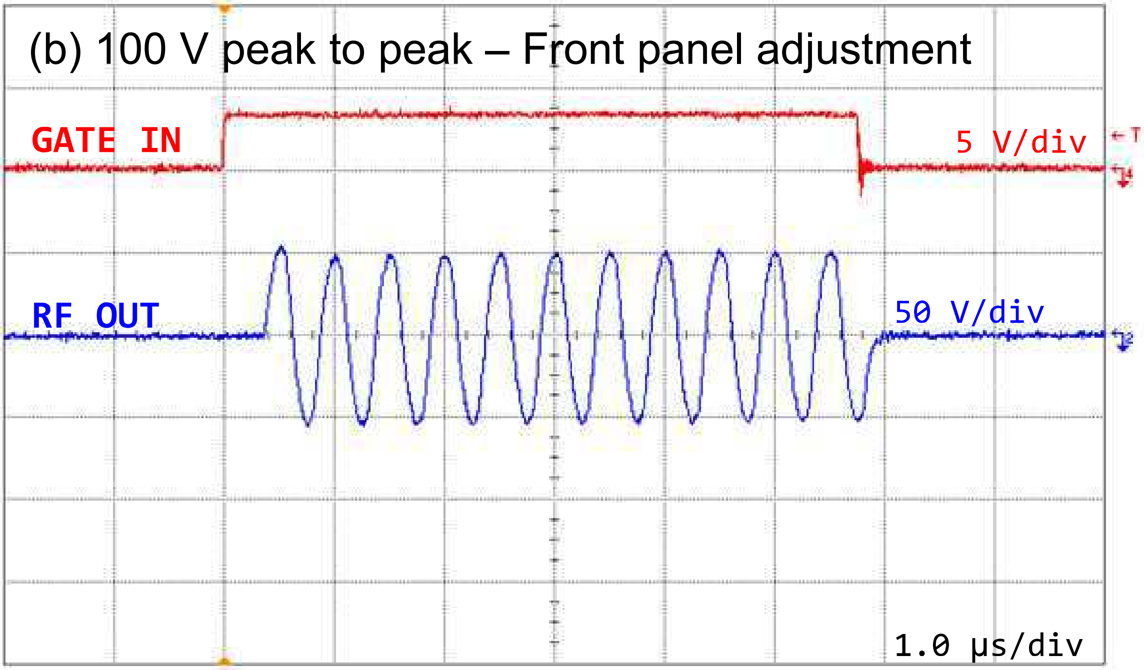

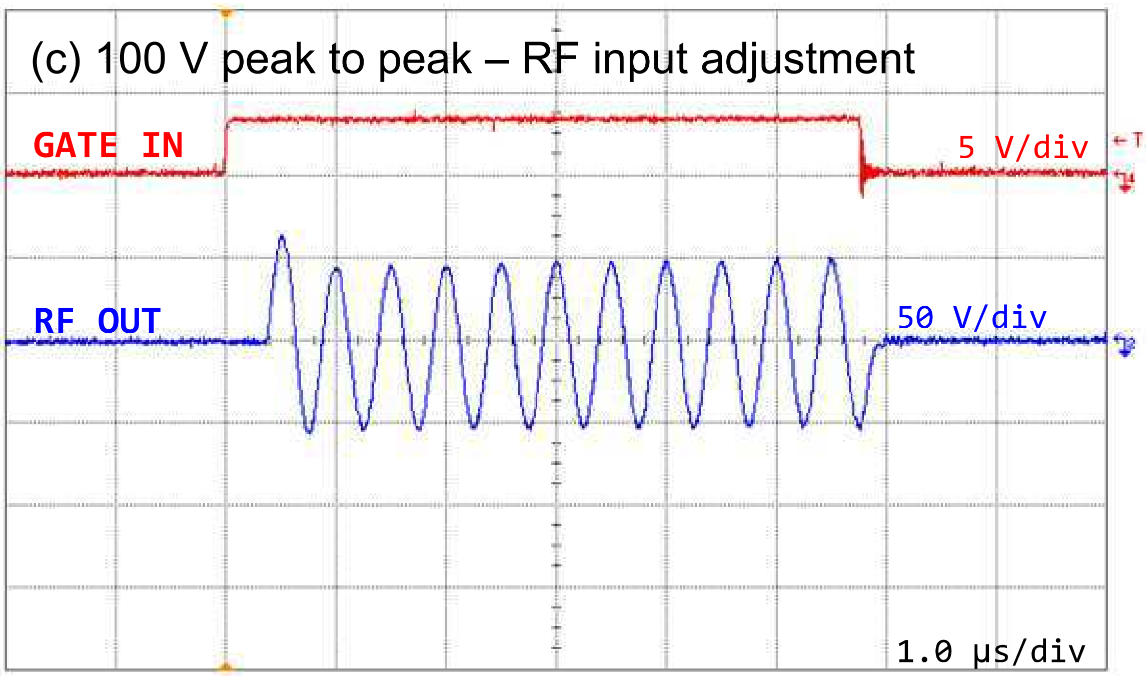

FIGURE 5: Typical waveforms at 2.0 MHz for a GA2500A-0.25-7-5KW. (a) 1000 V peak to peak output. (b) 100 V peak to peak output achieved using the front panel adjustment and (c) 100 V peak to peak output achieved by starting from (a) and reducing the RF input amplitude. We recommend using the front panel adjustment to achieve the cleanest waveforms.

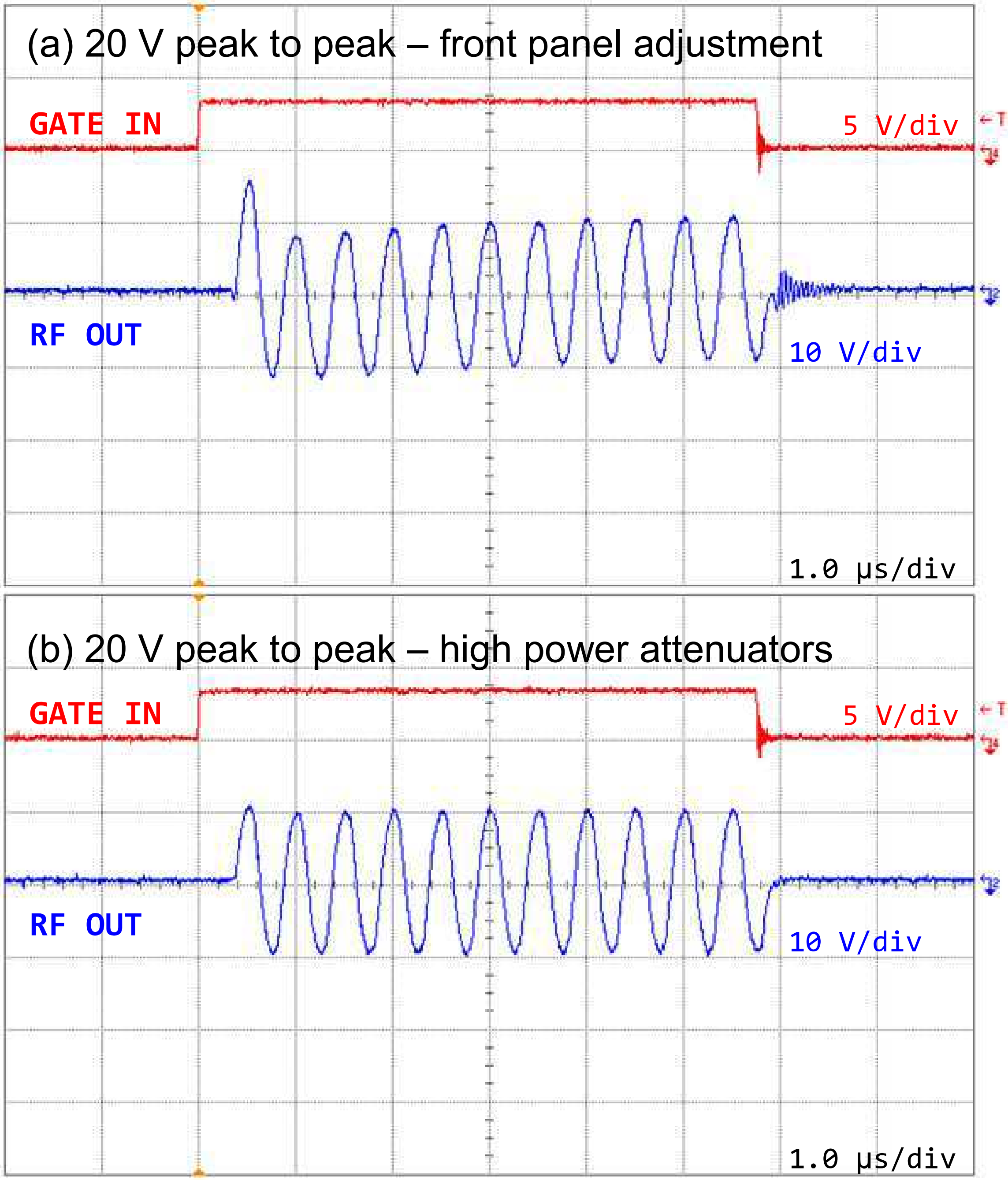

FIGURE 6: Typical low power waveforms at 2.0 MHz for a GA2500A-0.25-7-5KW. (a) 20 V peak to peak output achieved using the front panel adjustment and (c) 20 V peak to peak output achieved by using a high power 16 dB attenuator on the RF Output.

The GA-2500A series is optimized for high power operation. However, in some situations the user may wish to generate low level (less than 50 V peak to peak) signals. The methods described above may be used to do this, but the use of a high power attenuator on the RF Pulse Output will usually result in cleaner waveforms. An example is shown in FIGURE 6. In FIG 6a, a 20 V pp output is achieved using only the front panel adjustment, while in FIG 6b a high power attenuator

(16 dB) is inserted between the GA-2500A and the load. The resulting waveform (sampled at the load) is much cleaner.

Adjustments to gate timing

One aspect of the gated amplifier not discussed above was its finite turn-on and turn-off time. After the gate signal transitions from low to high it takes the amplifier approximately 400 ns to be fully enabled. If the user is unaware of this finite turn-on time then some confusion may result, especially in situations involving short pulse widths or high frequency operation.

The relative timing of the gate signal to the RF input signal can be adjusted to compensate for the finite turn-on and turn-off times of the amplifier. FIGURE 7 is a diagram showing the definitions of 't-on' and 't-off'. For the most faithful amplification of the input signal, the recommend value for 't-on' is 400 ns, and t-off 0 to 100 ns. The optimal values will depend upon the frequency, input waveform, and in some cases output level and load impedance. As a result, some trial and error may be required to find the optimal values for a given setup.

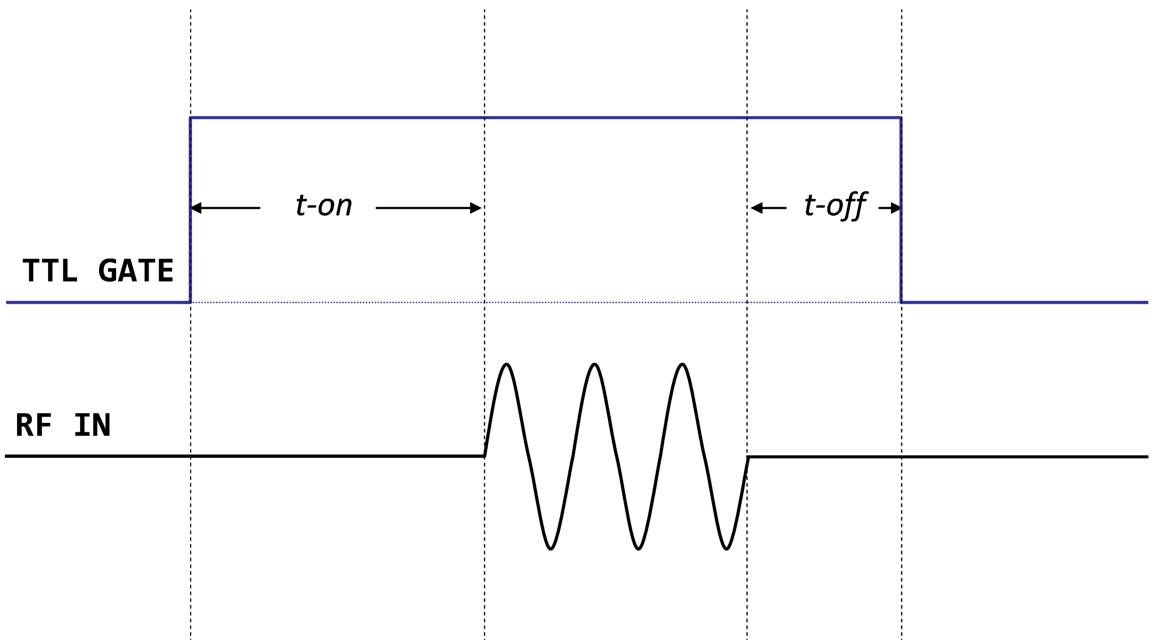

FIGURE 7: Definitions of the time delays 't-on' and 't-off'. The fidelity of the output signal to that applied to the RF input can be improved by making adjustments to the times 't-on' and 't-off'.

Some more advanced signal generators will allow you to program outputs with non-zero values for t-on and t-off. An alternative is to use a dual channel function generator, with channel 1 used to synthesize the RF signal of interest and channel 2 dedicated to generating an appropriate gate signal.

FIGURE 8 shows some typical waveforms for a GA-2500A amplifying a 5 cycle tone burst with a center frequency of 5 MHz with (a) t-on = 0 and (b) t-on = 400 ns. With no delay between the RF and the gate signal the amplifier 'misses' the first two cycles, since it takes about this much time for the amplifier to be fully gated on. With a 400 ns delay introduced between the gate low to high transition and the start of the RF burst, the output faithfully follows the input and all 5 cycles are amplified.

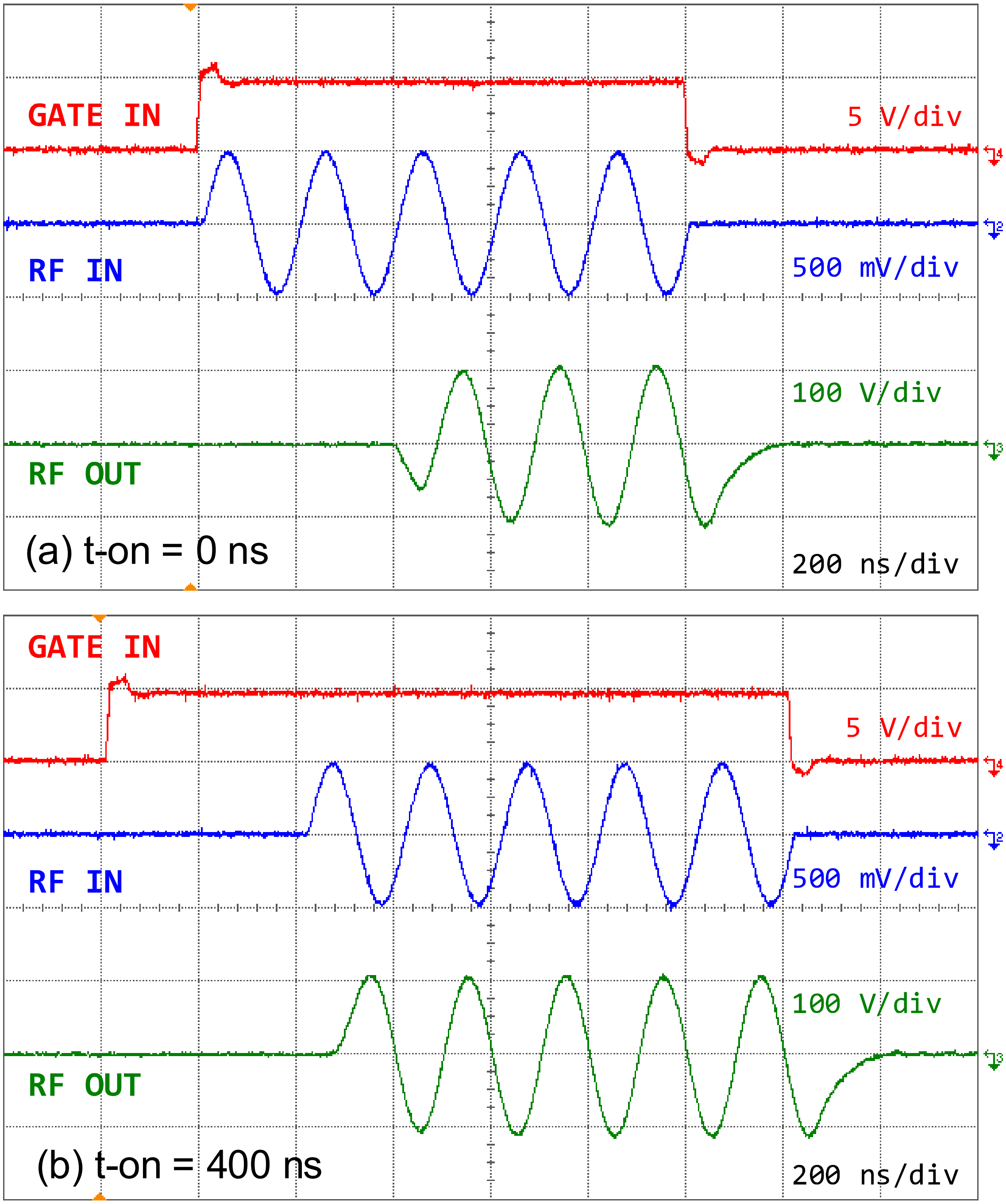

FIGURE 8: Typical output signals for amplifying a 5 cycle tone burst at 5.0 MHz. (a) the signals 'GATE' and 'RF-IN' start at the same time, and the amplifier 'misses' the first 2 cycles or so, (b) introducing a delay between the GATE and RF-IN of 400 ns allows the amplifier to be fully enabled by the time the RF input signal arrives.

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Adjustments to the time 't-off' are normally not required, but some situations may show improvement after a small adjustment (on the order of 100 ns) to the time t-off. As an example, pulse-echo measurements (using the same transducer for both transmission and reception) may show an improved recovery time of the received signal after the parameter 't-off' is optimized. For more information please contact RITEC.

Final comments

The GA-2500A was designed to be a robust gated RF amplifier for pulsed ultrasound applications. Many adjustments can be made to optimize the performance of the unit in a particular setup. If you need help please do not hesitate to contact RITEC.