

Using Gain to Optimize Weld Nugget Formation

WHAT IS "GAIN"?

"Gain" is an active component of closed-loop feedback systems which affects how closely system output follows programmed input. The best closed-loop control systems use a different Gain value for each programmed input to ensure that the output response closely matches it. The best way to picture Gain at work is to think of a car radio. Car radios employ closed-loop control to keep audio output volume at a constant level regardless of how far the car is from the transmitter. As the car moves farther away, Gain increases to maintain the same audio output volume. Similarly, in welding, the Gain feature adjusts the output of the weld control to achieve the desired results.

WHY GAIN IS IMPORTANT

Each combination of materials to be joined requires its own weld schedule defining the amount of time and current required for optimum heating, weld nugget formation and quality. Proper Gain setting can enhance the operator's ability to fine tune this process.

AMADA WELD TECH inverter welding power supplies employ Gain to maintain constant weld current, voltage, or power

at programmed weld settings. The actual Gain necessary to produce the best weld response, however, is different for every weld application.

Figure 1 (below, left) shows three different constant current weld responses at weld settings of 500, 1500, and 3000 amps. Note that the Gain value necessary to produce the best weld response is different for each weld.

programmed set point. This "spike" may or may not be beneficial in certain applications

A Gain value of "3" produces another weld response which is typical of most applications: rise time is short and weld response does not exceed the programmed setting. It is important to note that this Gain setting may vary for different materials or applications.

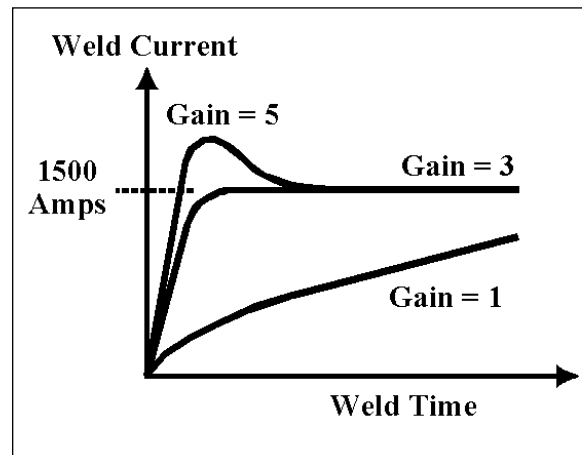


Figure 2

Figure 2 (above) shows the effect of three different Gain values on the weld response when weld current is set to 1500 amps.

GAIN AND UP SLOPE

Setting the Gain of the power supply to its lowest setting may be used in place of programming Up-Slope. Remember, however, to reset the Gain when changing weld schedules to a value that produces the fastest response with no overshoot.

SETTING THE CORRECT GAIN

There are several methods for setting the optimum Gain value. The following two-step process is often used successfully.

STEP ONE – FINE TUNING THE SCHEDULE AND GAIN

1. Set your weld schedule.
2. Record the actual weld current, voltage, or power.
3. Compare the built-in weld monitor reading with the programmed weld parameter. The monitor should read within +/-1% of the programmed weld parameter if the Weld 1 Up-Slope time is 0.
4. If Weld 1 Up-Slope is used, the built-in weld monitor readings will always be less than the programmed weld parameter. In this case, the optimum Gain setting will be achieved when the built-in weld monitor reading does not increase with additional increases in Gain.

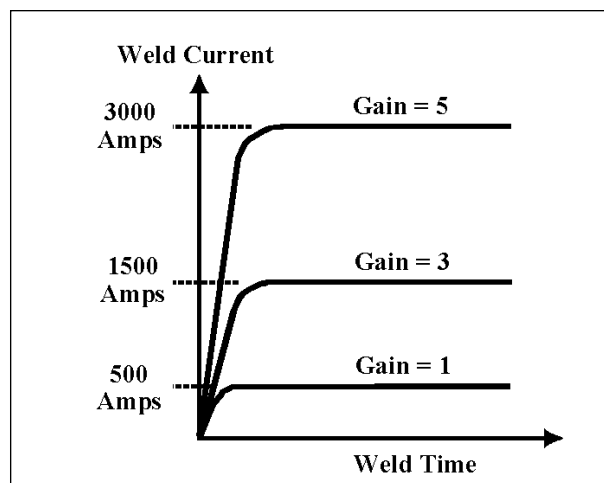


Figure 1

At a Gain value of "0" or "1," whichever is the lowest setting, the weld current has a very long rise time. In fact, the final weld current value doesn't even reach the programmed setting of 1500 amps within the time setting of the schedules.

Setting the Gain value to "5" on the other hand, results in a very fast rise time and overshoots the

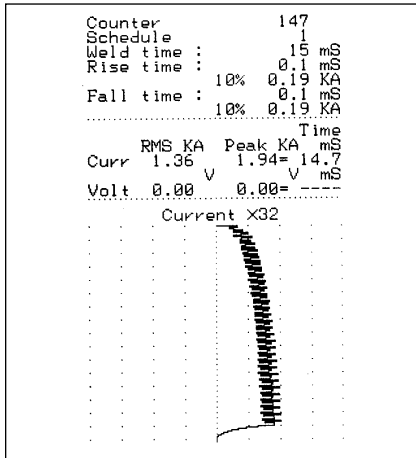


Figure 3: Lowest gain setting

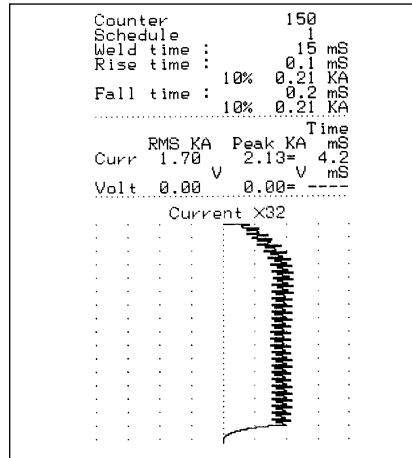


Figure 4: Gain setting of 3

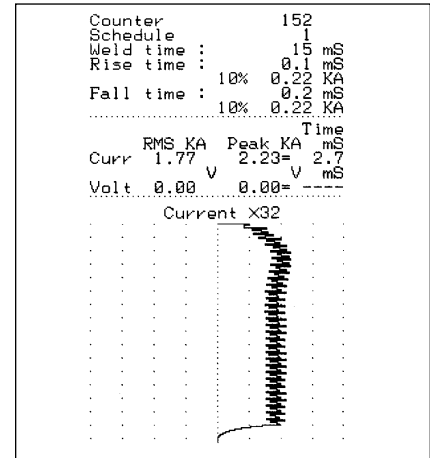


Figure 5: Gain setting of 5

5. If necessary, re-adjust the Gain and repeat steps 1 through 3.

STEP TWO - GRAPHICAL CONFIRMATION

Use a weld checker, such as the MM-336A, to provide a graphical confirmation of the Gain setting. A graph of the weld output is especially useful when using Up-Slope.

Figures 3, 4, and 5 show a constant current weld using the IP-217A inverter and IT-510A weld transformer. Weld parameters can be set to milliseconds. The effect on the weld current 1.5 KA (1500 amps) with a weld time of 15 ms profile is shown at three different Gain values: 0 or 1, 3, and 5. The optimum Gain value is 3.

FIGURE 3: LOWEST GAIN SETTING

The rise time is approximately the entire

weld period. The MM-336A weld monitor recorded the RMS weld current at 1.36 KA.

FIGURE 4: GAIN SETTING OF 3

The rise time is now approximately 3 milli-seconds. The MM-336A weld monitor recorded the RMS weld current at 1.70 KA.

FIGURE 5: GAIN SETTING OF 5

The rise time is now approximately 2.5 milli-seconds. Note that the peak weld current overshoots the programmed value of 1.5 KA. The MM-336A weld monitor recorded the RMS weld current at 1.77 KA.

SUMMARY:

The ability for the weld process engineer to optimize both weld time and the amount of heat required to resistance weld specific materials is critical to the

success of an application. The Gain setting built into AMADA WELD TECH inverter controls provides the engineer with the tools needed to establish the best weld schedules for each material resulting in consistent nugget formation, improved product quality and reduced downtime and manufacturing costs. AMADA WELD TECH products incorporate many features, such as Gain, to control the weld process. This Connection has demonstrated how to establish different Gain settings and how both current rise-time and heat can be controlled by altering the Gain settings. Contact your local AMADA WELD TECH sales representative to discuss Inverter technology and the many benefits of using AMADA WELD TECH Controls.