Practical Selection of Periodic Pulse Reverse Rectifiers

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Jobs are becoming more difficult to complete to specifications as the complexity of parts increases. Other indicators include metal prices on the rise, nanotechnology, applications of PCBs on the rise again and many other developments in pulse and reverse pulse technology. With electronic power components getting more advanced everyday, reverse pulse technology is offering a great solution in today's metal finishing shops. From five or even one year ago, there have been many improvements in reverse pulse power supplies. We are seeing very high quality pulses with repeatability. Some manufacturers are integrating intelligent pulse optimization systems (IPOS) into their power supplies. All of these functions increase the reverse pulse process from 30% to 40% better than before. The prices of these units are becoming more affordable and make reverse pulsing an even more attractive option to complete those hard-to-do jobs. With the latest developments in user interface and IPOS in reverse pulse power supplies, this integration into your facilities makes an easy transition from your old system to a new one. With today's reverse pulse power supply technology and our global economy, could reverse pulse be one of the solutions for your shop?

The constant improvement of electronic components has resulted in many advantages for pulse and pulse reverse power supplies. Some advantages include higher output currents to meet the larger scale production facilities' needs. With the latest designs, there is no more of the 300-Hz ripple that we have seen in DC supplies. The integration of intelligent pulse optimization systems imbedded into the core software enables us to see pulse shape monitoring to achieve repeatability and self-optimizing control loops to adapt to bath characteristics. All of these functions produce a repeatable waveform as well as the ability to repeat the process and adjust for changing bath conditions.

When working with a current range (ΔI) of 10,000A with a slew rate of 100 μ-sec or less, the inductance must be addressed in order to maintain a repeatable pulse form. In order to understand the problem a little better, inductance is defined as the following: "The property of a circuit or circuit element that opposes a change in current flow, thus causing current changes to lag behind voltage changes. It is measured in Henrys [H]." With this in mind there has to be consideration of how to compensate for this in the control of the power supply. IPOS and the most recently designed power supplies are using separate voltage and current loops simultaneously, thus keeping the over- and under-shoot to a minimum. The next thing to be considered is the connection between the power supply and the plating cell. Depending on the current and the placement of the rectifier, either coaxial cable or twisted pairs should be considered. If the distance is not that significant, twisted pairs would be sufficient. If the distance is significant, coaxial cable should be considered. Coaxial cable has a lower inductance when compared to twisted pairs.

Most rectifier suppliers should have two types of cooling available when choosing reverse pulse. The first type is air-cooled. The size of the rectifier will determine whether the unit will be convection or forced air-cooled. The other option would be water-cooled. Things to consider when choosing air cooling are the environment it will be placed in, the ambient temperature and cable length. If choosing water cooling, you are able to place the power supply right next to the plating cell to achieve lower inductance. However, water temperature and water quality also need to be considered.

The human interface is one of the most important aspects of pulse and pulse reverse power supplies. A few options that should be in the interface to ensure smooth operation of the power supply are as follows:

- Current density calculator
- Batch programming stored in the power supply
- Operator screen / Password protection
- Data logging
- Clear parameter setup
- Ampere-hour counter

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The current density calculator calculates the effective current of the waveform being used. For example, consider a rack of parts at 20 A/ft^2 with 50 ft^2 on the rack. Depending on your duty cycle, forward- and reverse-ratio, your forward and reverse currents will not equal 1,000 A. In order for the user not to have to calculate every load going into the plating bath, the user interface should have this function built in. Once the unit and process has been set up, the operator can simply input the total amount of area going into the plating cell and the interface does the rest.

Batch programming is used in many different applications. Batch programming allows you to use multiple waveforms during one process. Here are a few things to consider if batch programming is needed for your application. First, you would need the current density calculator within the batch for every waveform. You should also consider that the batch is stored inside the power supply, not in a PC or laptop. If the power supply should lose communication or if the PC or laptop should go down, your parts in the tank will not come out the proper way. If this data is stored inside the power supply, the process will continue to run without any communication or external source.

When dealing with day-to-day operation, some type of operator screen should be considered for the successful operation of a reverse pulse power supply. An operator screen is a good idea because of the many different parameters available in a reverse pulse rectifier and their effects on the process. This screen should only have current density adjustments and file selection, and should not have access to management functions within the supply. This will ensure that the correct waveform for the given process is run every time.

A data logger should be used for storing data. If something should change in your process, you can verify during that cycle of parts whether or not the rectifier was set and running correctly. Different pulse regimes can change results drastically. This gives the plant manager the ability to see what has been done for the day and if all of the parts were run correctly.

As pointed out above there are many things to consider when choosing a pulse rectifier for your process. If all of these points are evaluated for your process needs, you will have a successful reverse pulse process. The entire system is not just dependent on the pulse shape, but also on the integration and interface of the pulse supply. ***P&SF***

About the Author

Waasy Boddison is a co-owner of American Plating Power, LLC., who holds a bachelors degree in electrical engineering. He has been working in the field of power electronics for the past 7 years. Waasy has been worked on the development of reverse pulse power supplies in the general metal finishing industry for the past 5 years.