What are the key benefits of the GENESYS+™ programmable power supplies?

Programmable power supplies are versatile test and simulation instruments. Here we discuss some key features and benefits that make the GENESYS+™ the optimal choice for powering effective testing.

This white paper is intended for electronics engineers working in various disciplines, including component, aerospace and automotive testing, semiconductor fabrication, water treatment, plating and solar array simulation.

References

www.emea.lambda.tdk.com/uk/genesysplus

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David Buck, Market Development Manager, TDK-Lambda UK

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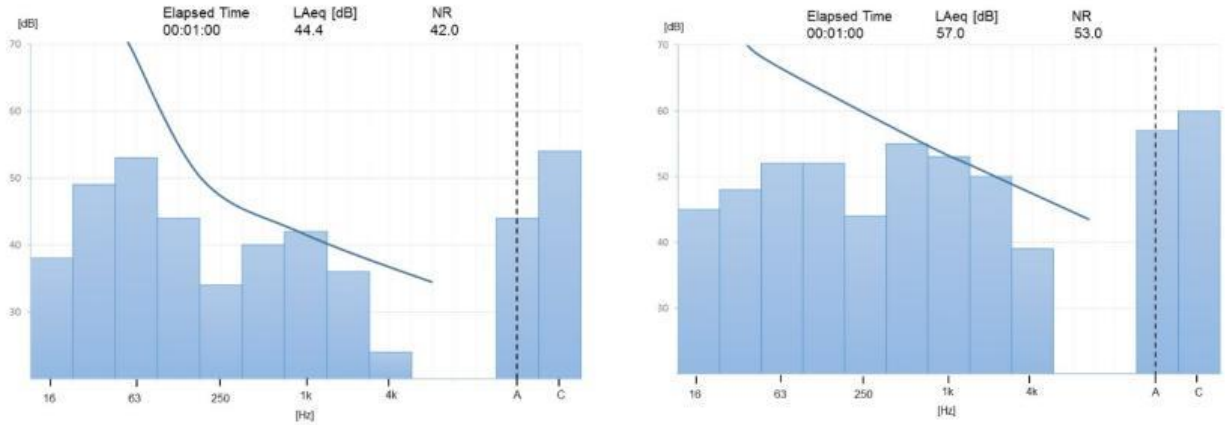
Why is the GENESYS+™ so quiet?

The GENESYS+™ has significantly lower levels of audible noise when compared to the first generation Genesys™ series. This is due to the utilisation of an ambient temperature sensor in one of the microcontrollers, located at the front of the power supply where the cool air is drawn in. The sensor provides temperature information that is processed by a fan speed control algorithm.

When operated in a room temperature of 20°C, power supply internal temperatures are lower than when operated in an ambient of 50°C. Similarly, operating at no load results in significantly lower internal temperatures than at full load. The fan control circuit processes both the ambient temperature data and the output load level, adjusting the fan speed accordingly to maintain safe and reliable component temperatures.

Reduced fan speeds lower the amount of audible noise produced, important when the power supply is used in a laboratory environment where engineers and technicians are present. When operated in a 50°C ambient, human presence will be minimal, and fan noise is less important. Lower speed fans also have two other benefits – longer fan life and less dust and contaminants are drawn in, increasing power supply reliability.



No load Full load

Figure 1 Fan noise at 30°C, measured 1m from the front of the power supply

The two columns on the right of the charts refer to A-weighting and C-weighting sensitivity scales for noise measurement. A-weighting follows the frequency sensitivity of the human ear at low noise levels and C-weighting at high noise levels.

As a reference, the older Genesys™ series, with fixed speed fans, has LAeq (Equivalent Continuous Level) audible noise levels of 52.1 [dB] at no load and 61.8 [dB] at full load. GENESYS+™ has LAeq levels of 44.4 [dB] and 57 [dB] respectively.

How do the size and weight of the GENESYS+™ compare to its predecessor?

The 5kW GENESYS+™ 1U high (44mm) programmable power supply is half the height of the previous generation 5kW Genesys™ 2U (88mm) models, freeing up valuable enclosure space. This is due in part to increased efficiency of 91% versus 88%, which reduces waste heat. When supplying a 5kW output only 495W is lost compared to 682W, a 27% reduction, allowing the heat sinks, components and fans to be smaller. The use of a modular construction and component miniaturisation has also helped.

With the reduction in size, comes a reduction in weight. The 5kW GENESYS+™ is less than 7.5kg, compared to 13kg for the 5kW Genesys™.

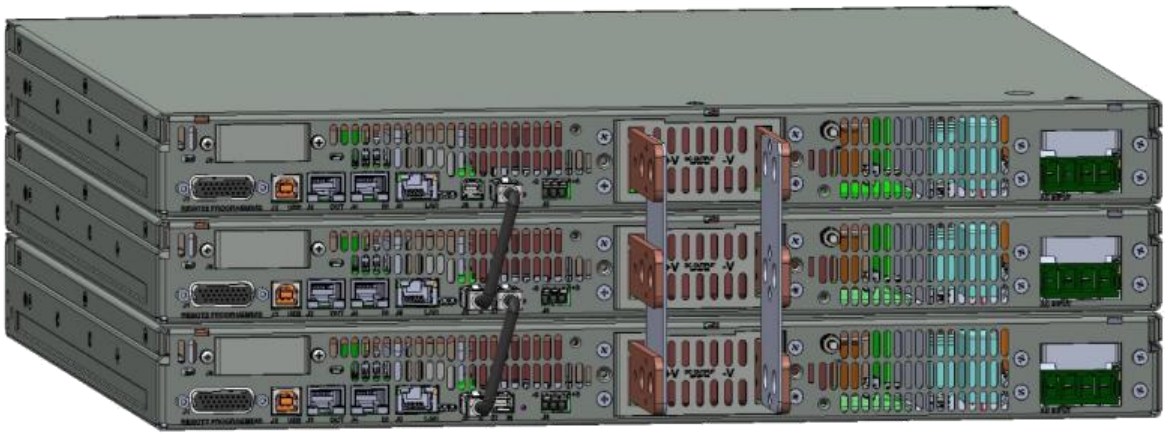
Although there are no formal maximum weight lifting restrictions in the workplace, guidelines are in place for no more than 25kg for a person lifting a load at around waist height.

As the GENESYS+™ can be easily paralleled, TDK-Lambda offers a “GENESYS+™ Scalable Power” (GSP) option where three units can be provided in a pre-configured 3U high rack assembly, saving engineers time and money. As each unit weighs less than 7.5kg, the total weight of the 3U rack is less than 22.5kg, below the recommended single person lifting amount.

How to operate the GENESYS+™ programmable power supplies in parallel

With the introduction of the GENESYS+™ programmable power supplies, parallel operation is easier and quicker compared to the first generation units with the inclusion of the smart parallel function as standard.

Previously, additional connections to the rear panel J1 connector and settings on the SW1 DIP switch were needed to allow them to operate in a master-slave configuration. The load current had to be programmed on the master unit by dividing the required current by the number of units being paralleled. The over voltage protection (OVP) of the slaves had to be set higher than the master, to avoid false triggering. The front panel buttons were then used to program the number of units being connected in parallel and identify which power supply was the master and which were the slaves.



With the GENESYS+™ series of programmable power supplies, on the other hand, simply plug the shielded 110mm long cable, which comes with each unit, into the rear panel. The power supplies then detect the parallel connection and set their parameters automatically. The display of the master then provides the total current of all the paralleled units.

When to use the GENESYS+™ blank panel option

As standard, the GENESYS+™ programmable power supply series is supplied with a display, two encoders and multiple push buttons on the front panel. This allows the user to visually see what the unit status is, manually adjust the output and access the programming menus.

In some applications, front panel control or monitoring is not always required. For example, when the power supply is in a hard to reach location or where all programming and communication functions are performed using the interfaces. For these situations, the Genesys™ series is available with an optional blank front panel (see below).

With this option fitted, all of the GENESYS+™ standard model functions and features are maintained. As the GENESYS+™ display microcontroller is used to monitor the ambient temperature, a simplified circuit board is fitted in its place. This continues to allow the fan speed to be controlled to reduce acoustic noise, increase fan life and the ambient temperature to be read back through the communication interfaces.

How to use GENESYS+™ Scalable Power (GSP) Systems to provide up to 20kW

The GENESYS+™ series of programmable power supplies has a smart parallel capability, making it easy to connect individual units together to provide additional power. When using the optional bus paralleling cable, the power supplies detect that connection and set their parameters automatically.

Two or three power supplies can be ordered as a single system preconfigured by the factory with a GSP (GENESYS+™ Scalable Power) prefix. Simply select the desired output voltage range between 0 – 10V and 0 – 600V, the output current / power, the input voltage range and any interface options. 10kW systems are 2U high and 15kW 3U high.

Figure 1: 3U high GSP 15kW front view

As the “master” (top unit) display shows the total current of all the units and can provide all the push button programming, the “slave” units are fitted with blank front panels. Optionally for systems where the front panel display is not reachable or needed, a blank front panel can be selected for the upper most unit as well.

The rear panel is pre-wired and fitted with a single input connector and either a single output connector for high voltage or paralleled busbars for high current outputs.

Figure 2: 3U high GSP 15kW rear view

An optional kit is available for self-configuration of four 5kW GENESYS+™ units into a 20kW 4U high power system. It includes the two busbars and the associated hardware.

Figure 3: 4U high GSP 20kW rear view

During the model selection of each individual unit, there is a choice of a display module on the front panel or no display (blank). All four units should have the same input voltage range and output ratings and be ordered with the paralleling cable (-P).

What is isolated analogue control and how does it benefit us?

Isolating analogue control lines on programmable power supplies avoids common mode noise issues, improves accuracy and simplifies any potential ground loops. A test system may operate perfectly well in a laboratory environment, but when placed on the shop floor of an industrial facility, noise issues can arise. One widely adopted solution is to use signalling and control lines that are isolated from the power supply output.

This is also beneficial when multiple power supplies are connected in series, as the programming and monitoring circuitry does not have to be separated and galvanically isolated from the individual power supply outputs.

The GENESYS+™ series of programmable power supplies has isolated analogue programming and monitoring as a standard feature, rather than an option. The modular construction of the GENESYS+™ has an integrated interface assembly containing the isolated analogue circuitry in addition to LAN, USB and RS 232/485 communication interfaces.

The analogue control allows the output voltage and current to be controlled and programmed remotely - from 0 to 100% of the rated output of the power supply - using an external resistance (selectable between 0-5kΩ or 0-10kΩ) or voltage (selectable between 0-5V or 0-10V). The GENESYS+™ series provides high accuracy programming and monitoring (0.15% Voltage programming, 0.4% Current programming, 0.5% Voltage and Current monitoring). The output voltage and current levels can also be monitored using selectable 0-5V or 0-10V signals.

All the control and monitoring signals are accessible through the J1 DB26HD rear panel connector and are SELV (up to 600V) as are the serial communication ports (RS232/485 and USB) and the “Daisy-Chain Connection” which can be used to shut down all the power supplies in the system if a fault occurs.

What is power supply slew rate and can it be programmed?

Slew rate is defined as rate of change of voltage or current in a period of time. It is a frequently used term in operational amplifier specifications, but it also applicable when discussing programmable power supplies.

When performing repetitive production testing on say a vehicle engine management system, many manufacturers will perform full function testing at multiple input voltages to simulate varying battery conditions. For an automobile that battery range is typically 9V to 16V, but may drop down to 3V when the engine is first started in cold ambient conditions (cold-crank). Figure 1 shows a typical battery voltage profile under that condition.

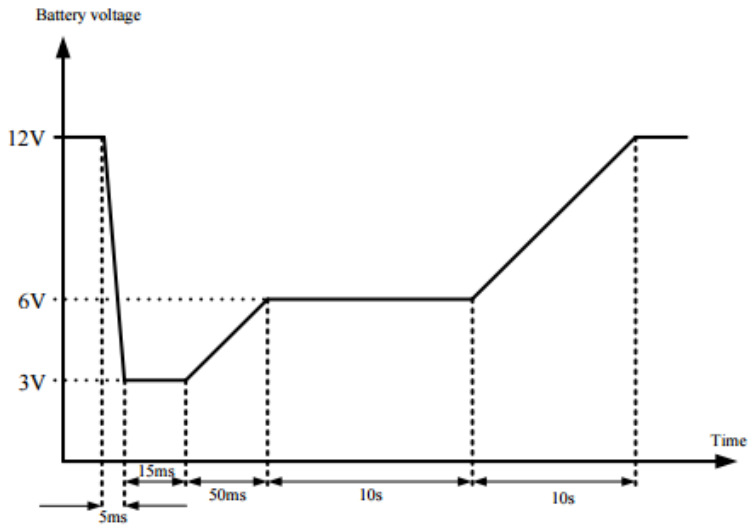


Figure 1: Typical battery voltage profile for "cold crank"

To exactly reproduce the cold crank characteristic in Figure 1, prior generations of programmable power supplies would have to be modified at the factory, as the response time of the supply is primarily determined by the value of the output capacitors. This can then involve making a trade-off between a faster slew rate at the expense of higher ripple voltages and currents.

TDK-Lambda's new GENESYS+™ series of programmable power supplies, however, utilises DSP (Digital Signal Processing) allowing the user to individually set both the voltage and current slew rates. Separate values for both the up and down control can also be programmed. For maximum flexibility, a programming range of 0.001 to 999.9 volts or amps/ms can be set, in steps of 0.0001 volts or amps/ms.

For example; Figures 2 and Figure 3 show the results of the same GENESYS+™ model programmed for different up control slew rate times.

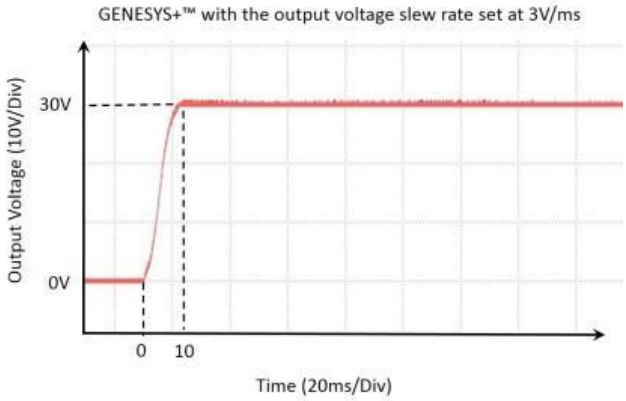


Figure 2

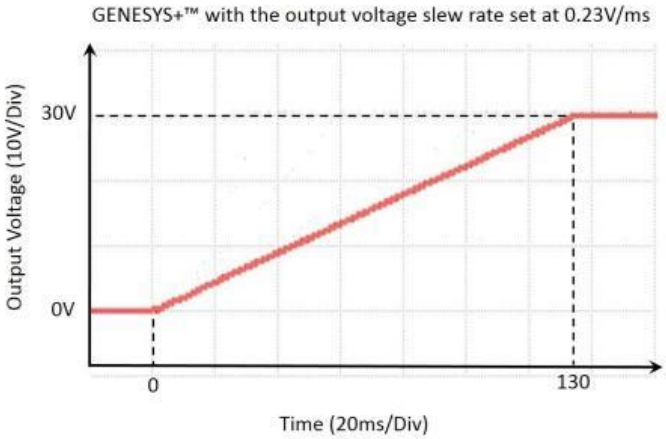


Figure 3

When testing high volume parts where a defined slew rate is not required, using a programmable power supply with a slow fixed up / down program response time can significantly extend device test time. This results in less parts per hour being tested, or additional test stations having to be installed; both of which can impact manufacturing costs. The ability to program the GENESYS+™ slew rates provides cost savings, as the same programmable power supply can be used to test multiple products requiring both fast and slow response times.

Slew rate programming for the GENESYS+™ can be programmed by using the front panel controls or through one of the communication interfaces. USB, RS232/485 and LAN are fitted as standard, with the option of GPIB or Anybus® interfaces.

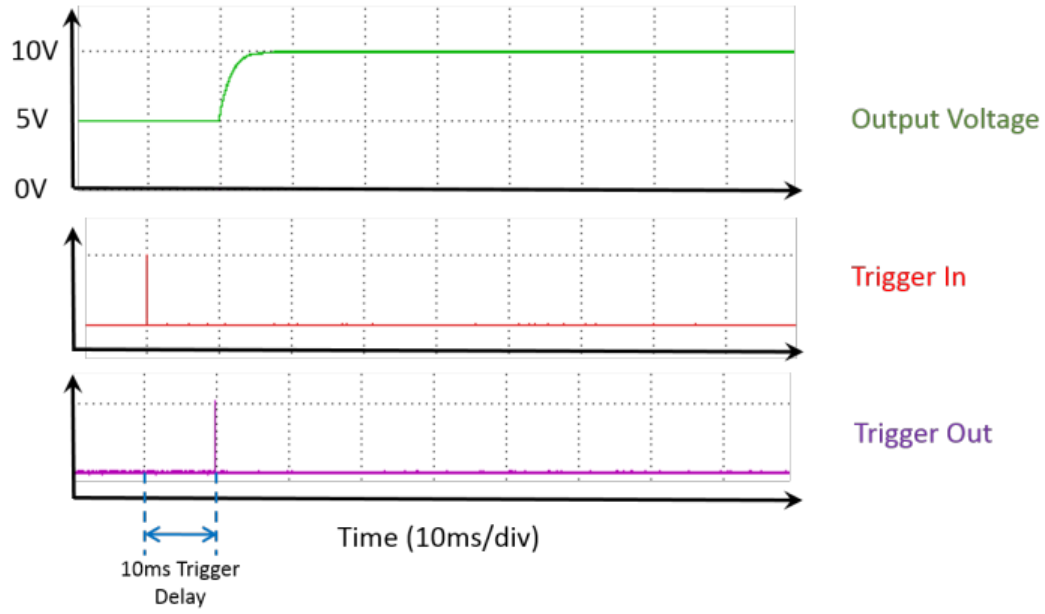
As a note, slew rate is not to be confused with the power supply's transient response characteristics.

How does the trigger function work on the GENESYS+™?

The GENESYS+™ series of programmable power supplies features new trigger functions to allow the user to initiate either single or multiple actions or send a signal to indicate that an action has been completed. Two trigger signals are available; Trigger In and Trigger Out. These signals can be used to synchronise the GENESYS+™ with other equipment in the system or with another programmable power supply. This function can be used in Constant Voltage or Constant Current mode.

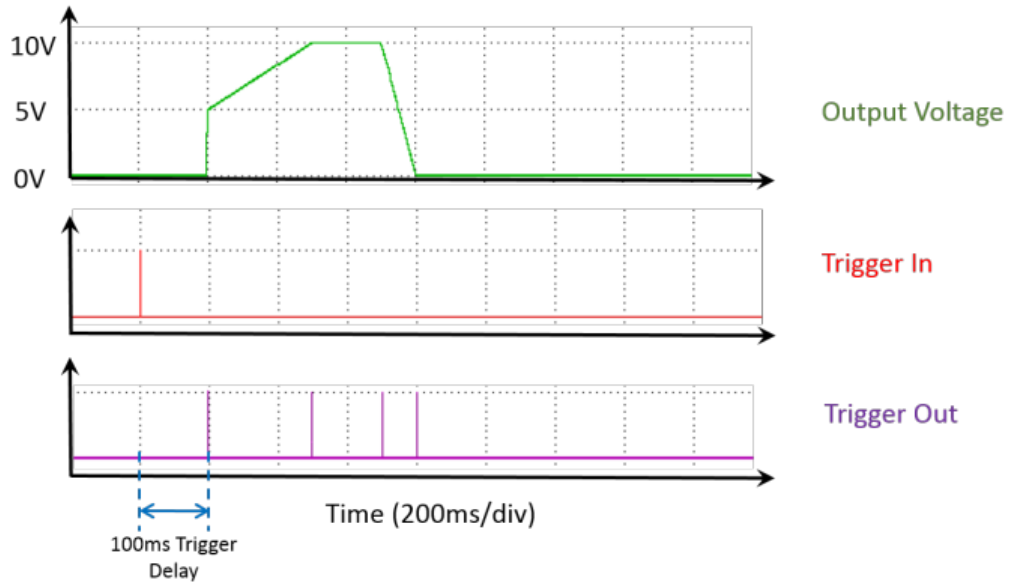
Upon receipt of a Trigger In signal, the output will turn on and start any pre-programmed sequence. A delayed start parameter can be programmed from 0 to 10 seconds. A trigger can be generated from the communication interface by pressing the output current adjustment encoder or by an analogue signal. A Trigger Out signal can be generated when the output status changes, when the programmed output voltage or current changes, or when a pre-set program sequence is completed. In “Function Strobe” mode, a trigger pulse is generated at every step in the program.

Example 1, Fixed Mode: The GENESYS+™ output voltage is initially set to 5V, and is programmed to rise to 10V, 10ms after receipt of a Trigger In signal. The Trigger Out signal is sent when the output voltage programming instruction occurs.



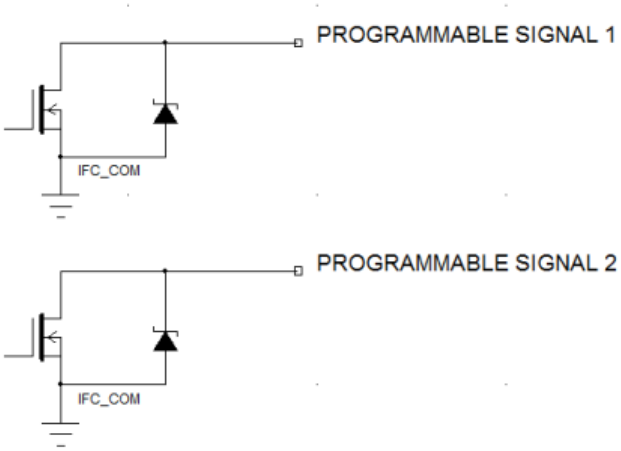
Example 2, Wave Mode (Strobe): The GENESYS+™ output voltage is initially set to 0V, and is programmed to rise to 5V, 100ms after receipt of a Trigger In signal, then rising gradually to 10V over 300ms. After 100ms, the output is programmed to decrease linearly to 0V over 100ms. The Trigger Out

signal is programmed to be sent when any output programming voltage instruction occurs and when the sequence has finished.



How to use the GENESYS+™ programmable signals

The GENESYS+™ series of programmable power supplies includes two independent auxiliary “open drain” signals that can be programmed by the user to operate external devices. Accessible from the J1 rear panel DB26 connector, these signals have a maximum input voltage of 25Vdc and a maximum sink current of 100mA. Note, a series resistor must be used with the external voltage to limit the sink current.



Pin J1-21 and J1-20 are the drain connections for signal 1 and 2 respectively, and have a shared common return on either J1-17 or J1-18.

The signals can be programmed via the front panel (using the “SYST” button) or via the communication software commands. Selecting “OFF” (MOSFET conducts) will result in a low output signal level (at the MOSFET drain terminal, pull up resistor used), or selecting “ON” (MOSFET does not conduct) will give a high output level. The factory default setting is “OFF”.

One example of the use of the programmable signals (See Figure 1) is to operate relays to reverse the power supply polarity to a load. With the signals and relays both off, the load has a positive voltage applied. With the signals and relays both on, the load and the remote sense connections are reversed.

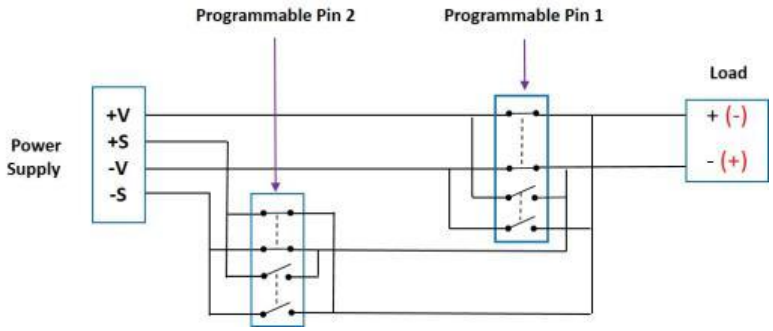


Figure 1: Using the programmable outputs to reverse polarity

Another example is to disconnect a load circuit, while keeping the power supply output present. See Figure 2.

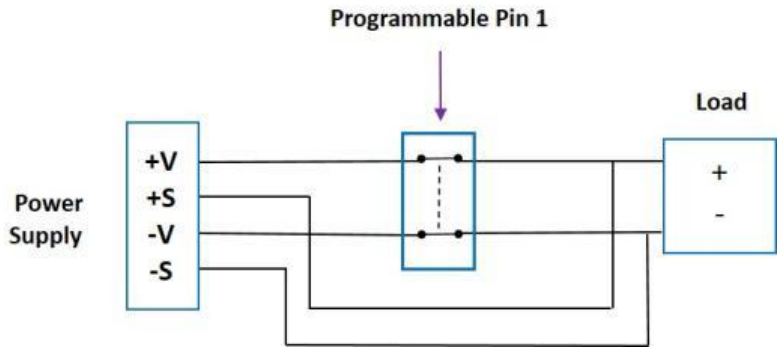


Figure 2: Using a programmable output to disconnect a load

With the signal and relay both off, the load is connected to the output of the power supply. With the signal and relay both on, the load is disconnected.

The remote sense terminals can be left connected at the load, provided that the Local / Remote sense function is programmed to switch to local sense before the relay contacts are opened.

How to generate arbitrary waveforms

Arbitrary waveform generators are used to test electrical and electronic equipment to ensure that the product operates properly, or to pinpoint a particular fault. These can be used either repetitively or as a once only event (single-shot). The waveforms can be triggered to run by an external event, a signal from another piece of equipment for example, or manually. An arbitrary waveform generator is different to a function generator in that specific points in the waveform can be programmed to create custom waveforms.

The GENESYS+™ series of programmable power supplies allows the storage of up to four arbitrary waveforms in internal memory cells to control the output voltage or current. Profiles can contain up to 100 steps and be triggered to operate using the communication interfaces or via the front panel.
These arbitrary waveforms can be easily created by using the Waveform Creator application provided on the CD-ROM (or downloaded from the website)

There are two programmable modes; LIST and WAVE.

LIST allows a step function to be entered using up to 100 points. The example in Figure 1 is setting the output from 0V to 5V after a 20ms delay from an external trigger. After 50ms the output is increased to 10V for 60ms before reducing back to 0V.

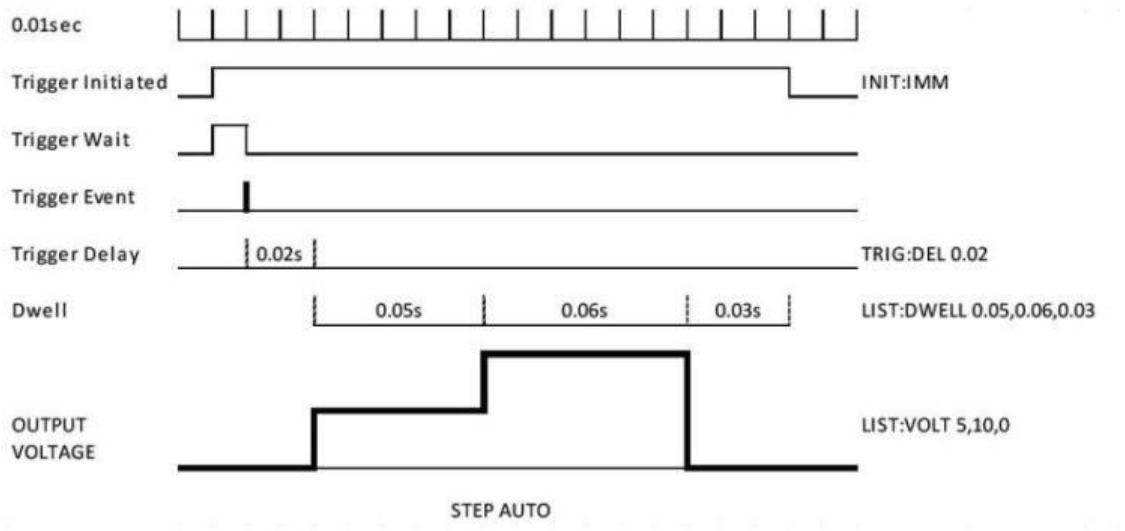


Figure 1: LIST waveform example

WAVE also allows gradual output voltage or current changes. In Figure 2 the output is again set from 0V to 5V after a 20ms delay from an external trigger. This time it is gradually increased to 10V over a

30ms time period. It remains at 10V for 20ms before being programmed to gradually reduce to zero in 30ms. In this case, the output is programmed to repeat this routine twice (COUN 2).

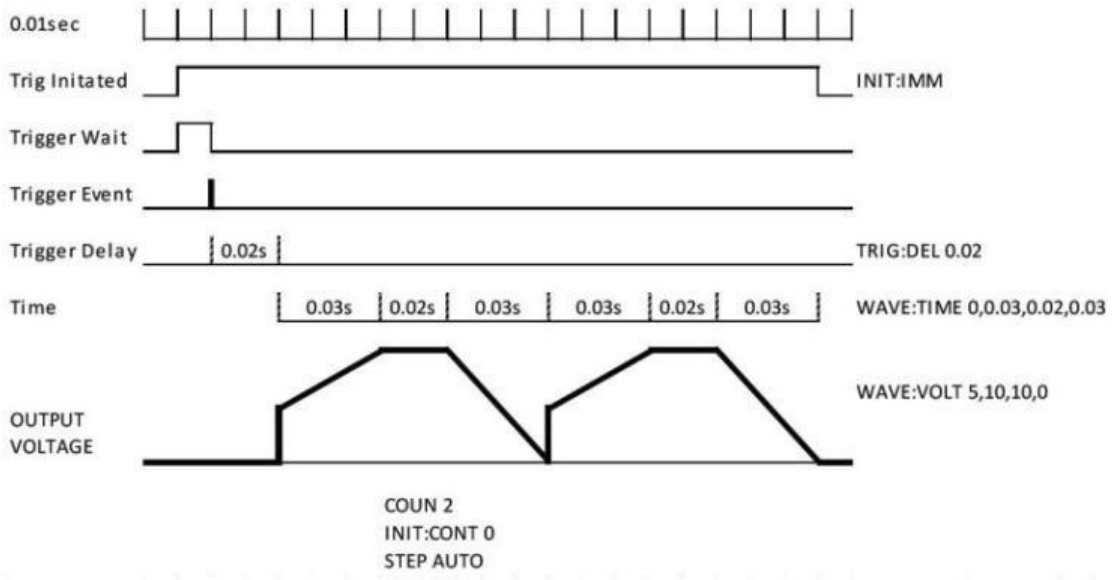


Figure 2: WAVE waveform example

The Waveform Creator on the CD provided with the power supply allows complex waveforms to be developed and all the values, trigger and repeat actions to be easily set, viewed and stored. See Figure 3.

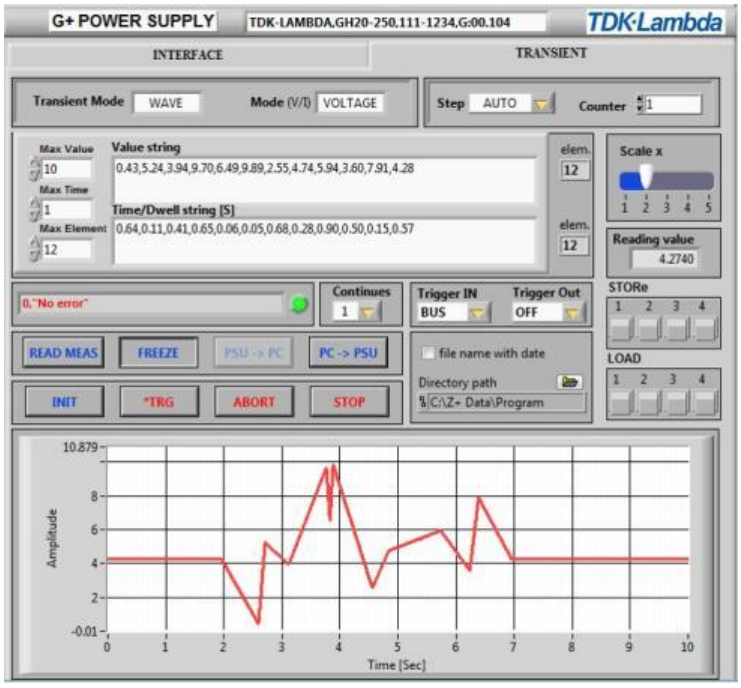


Figure 3: Waveform creator

The active memory cell number (1-4) is indicated on the GENESYS+™ front panel display.

The Graphical User Interface (GUI), which can also be downloaded from the website, contains a Waveform Profile Generator which can be used for more complex waveforms, including sine, triangle and saw tooth. See Figure 4.

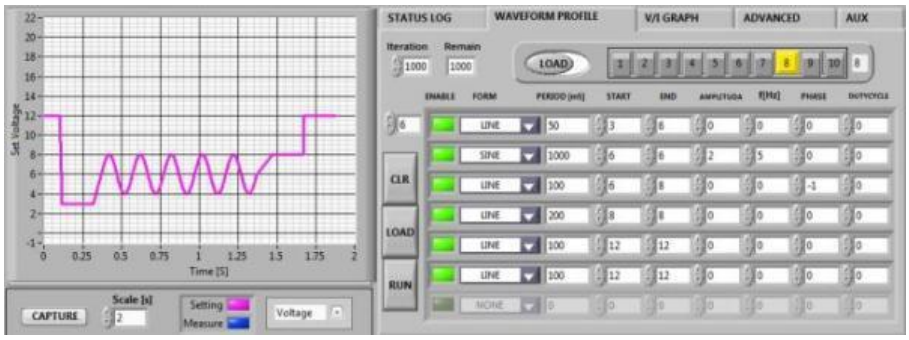


Figure 4: Waveform Profile Generator

The arbitrary waveforms can be used for a variety of applications including vehicle battery starting profiles to test automotive components and assemblies. See Figure 5.

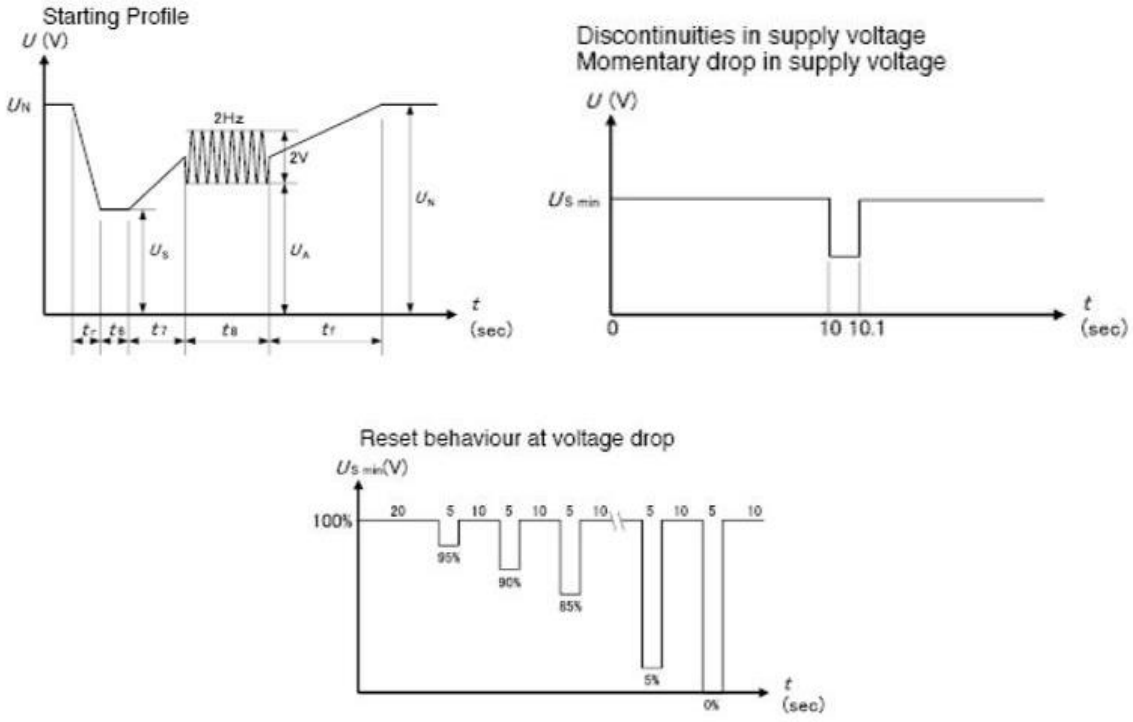
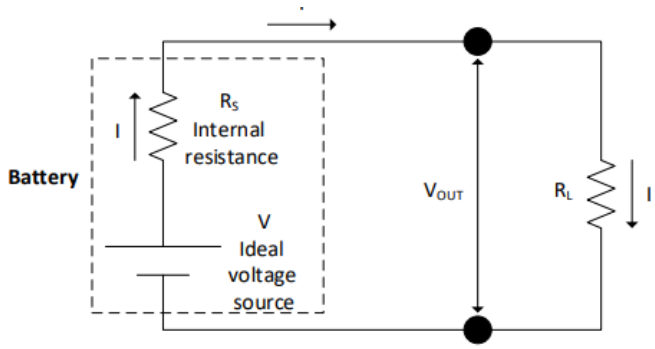


Figure 5: Examples of arbitrary waveforms

How to simulate a battery's internal resistance using the GENESYS+™ programmable power supply

Over its full lifetime the battery is not an ideal voltage source. This is due to its internal resistance, caused by its construction, which can rise over time, particularly with a lead-acid type. As the cells age, the size of the metal plates decreases and so the voltage drop increases. In addition to this, the cell separators tend to clog up and the chemical structure of the electrolyte changes.



Simple circuit of a battery's resistance

When a load is applied to a battery, the voltage at the terminals will change – this is due to Ohm's law [Vout = I x Rs]. As more power is consumed by the load, the battery voltage will drop further.

To test battery powered equipment, using an actual battery is inconvenient and time consuming. The GENESYS+™ series of programmable power supplies is able to simulate the battery voltage drop, allowing the equipment to be tested thoroughly before deployment.

The internal resistance can be set and adjusted manually using the front panel menu or through any of the standard communication interfaces (USB, LAN, RS-232 and RS-485). Values from 1mΩ to 1Ω are possible, and can be programmed in steps of 1mΩ. This function can also be used to simulate the effect of voltage drops over long load cable lengths.

How to simplify communication with Anybus

Anybus is described as the world's most widely used product family for industrial network connectivity. It provides a gateway to allow communication between a number of devices and networks.

All models in the GENESYS+™ series of programmable power supplies have an optional interface location on the rear panel in which various communication interface modules based on the Anybus CompactCom platform can be factory installed at time of ordering.

Modbus-TCP (option code MDBS)

The Modbus® protocol is used for serial transmission of information between electronic devices for the supervision and control of automation equipment. This GENESYS+™ option allows users to remotely program, measure and check status of the power supply by sending information using a TCP/IP protocol over a Modbus-TCP network via two RJ45 connectors.

EtherCAT (option code ECAT)

EtherCAT® is an industry standard version of Ethernet for control automation technology. It offers more functional safety, flexibility, ease of use, lower cost and faster response times. The EtherCAT option can be used to remotely program, measure and check status of the power supply over an EtherCAT network via two RJ45 connectors.

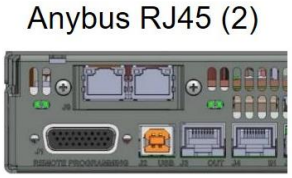


Figure 1: Rear view of the GENESYS+™ Anybus RJ45 connectors

Please visit the TDK-Lambda website or contact your sales office for availability for PROFIBUS, POWERLINK, PROFINET IRT, CC-Link + CC-Link IE Field and DeviceNet interfaces.

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For more information about the TDK-Lambda GENESYS+™ programmable power supplies, please visit: www.emea.lambda.tdk.com/uk/genesysplus

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