

Digitally-Controlled Quadruple Power Switch for Driving Electropneumatic Actuators

Version 1.20



User Manual

Document version A, created on Sep-04-2017

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Safety Information

- The device may be installed and used by authorized and instructed personnel only. Read this manual carefully before installing and using the device. Always follow the safety notes and warnings in this manual.
- The device is designed for indoor dry laboratory use only. Before powering the device on, the device temperature must accommodate to the ambient temperature to avoid moisture condensation. This is especially relevant after transportation.
- Do not operate the device if it is damaged or not functioning properly. Never use damaged cables or accessories.
- Do not open the device case, install replacement parts, or perform modifications to the device. There are no user serviceable parts inside.
- To avoid damage, connect the line cord to a properly wired and grounded receptacle only. Be sure that the mains voltage and the fuse rating match the device specification. Never operate the device during thunderstorms.
- Never use corrosive or abrasive cleaning agents or polishes, avoid the usage of organic solvents. If necessary, clean the device with a soft moist cloth. Make sure that the device is completely dry and free from contaminants before powering it on.

! **Warning:** The digital switch is an electronic device that is sensitive to electrostatic electricity. While manipulating with the switch, the ESD (*Electro-Static Discharge*) protection rules must be kept in mind.

Technical Data

Characteristics

- quadruple power switch providing high peak output current
- 10" case, bench top or rack mount

Power Switch

- output connector:
Amphenol Eco-Mate RM receptacle RT0014-12SNH
(panel socket with 12 female contacts)
- output voltage: 24 V (4 independent outputs)
- output current:
>2 A continuous (all channels together)
8 A pulsed typ.

Security

- interlock loop: two pins at the output connector
(short circuit enables the power switch)
- overcurrent protection: output current limiter (2.2 A typ.)
- overtemperature protection:
temperature sensor at the heatsink
(shutdown and restart temperatures freely programmable)

Trigger

- input switchable between TTL and optical
- TTL input:
connector: isolated BNC socket
levels: Low < 0.8 V, High > 2.0 V
input impedance: 51 k Ω (internal pull-down)
precision: better than 50 ns
- optical input:
connector according the *Versatile Link* standard
precision: better than 200 ns

Synchronization

- TTL or sine input:
 - connector: isolated BNC socket,
(galvanically connected to the TTL trigger input)
 - coupling: AC
 - level: $> 250 \text{ mV}_{pp}$, 5 V_{pp} maximum
 - input impedance: 50Ω or $51 \text{ k}\Omega$ (internal pull-down, switchable)
 - allowed frequency range: 5..20 MHz

Monitoring

- LEDs:
 - Power (+24V, +5V_D, and +5V_T),
 - Switch Activated, Interlock, Failure
- supply voltage monitoring
- temperature monitoring
- switch monitoring

Human Interface

- monochrome LCD display 128x64 pixel
 - pixel size: 0.5 mm
 - pixel color: yellow, background: blue
 - background illumination: white LED
- keypad: 5 keys: 4x direction + 1x "enter"
- rotary encoder: 24 positions per revolution, integrated press button
- press button for amplifier activation
- optional external shutdown button via the interlock loop

Power Supply

- rated voltage: 115/230 V $\pm 10\%$, 50/60 Hz
- power consumption:
 - standby (switch deactivated): $< 10 \text{ VA}$, 6 VA typ.
 - maximum: 90 VA
- main fuses:
 - 115 V: T 1.25 A, 230 V: T 0.63 A (slow acting, size $\varnothing 5 \times 20 \text{ mm}$)
- mains connection:
 - IEC inlet with EMC filter and integrated fuse holder

General

- 3 U 10" bench-top case:
 - height: 133 mm, width: 236 mm, depth: 315 mm,
 - total depth with handles and connectors: 367 mm,
 - total width with handles: 249 mm,
 - total height with case feet: 140 mm,
 - cover strips, horizontal rails: anthracite gray,
 - cover, bottom, and side panels: white aluminum
 - front and rear panels: clear anodized
- forced cooling:
 - 80-mm fan at the rear panel, temperature-dependent switching,
 - monitored fan operation, warning on fan failures
- weight: 6.2 kg
- cleaning: use moist cloth only, avoid use of organic solvents

Shipment Contents

- quadruple power digitally-controlled switch DAFG-PS4-24V
- line cord (universal IEC mains lead, length 1.8 m)
- output cable with connectors
 - RT061412PNH-K and RT061412SNH-K
- control and diagnostic software
- user manual in electronic form

Description

General

This document describes the digitally-controlled power switch. A complete measurement system suited for driving electropneumatic actuators consists of the abovementioned device, connection cable(s), and up to four solenoid valves.

The power switch is a combination of four high-current power switches with a dedicated power supply unit and a programmable digitally-controlled waveform generator. It is fitted into a metallic 10" case, the front and rear panels are shown in Fig. 1 and Fig. 2.

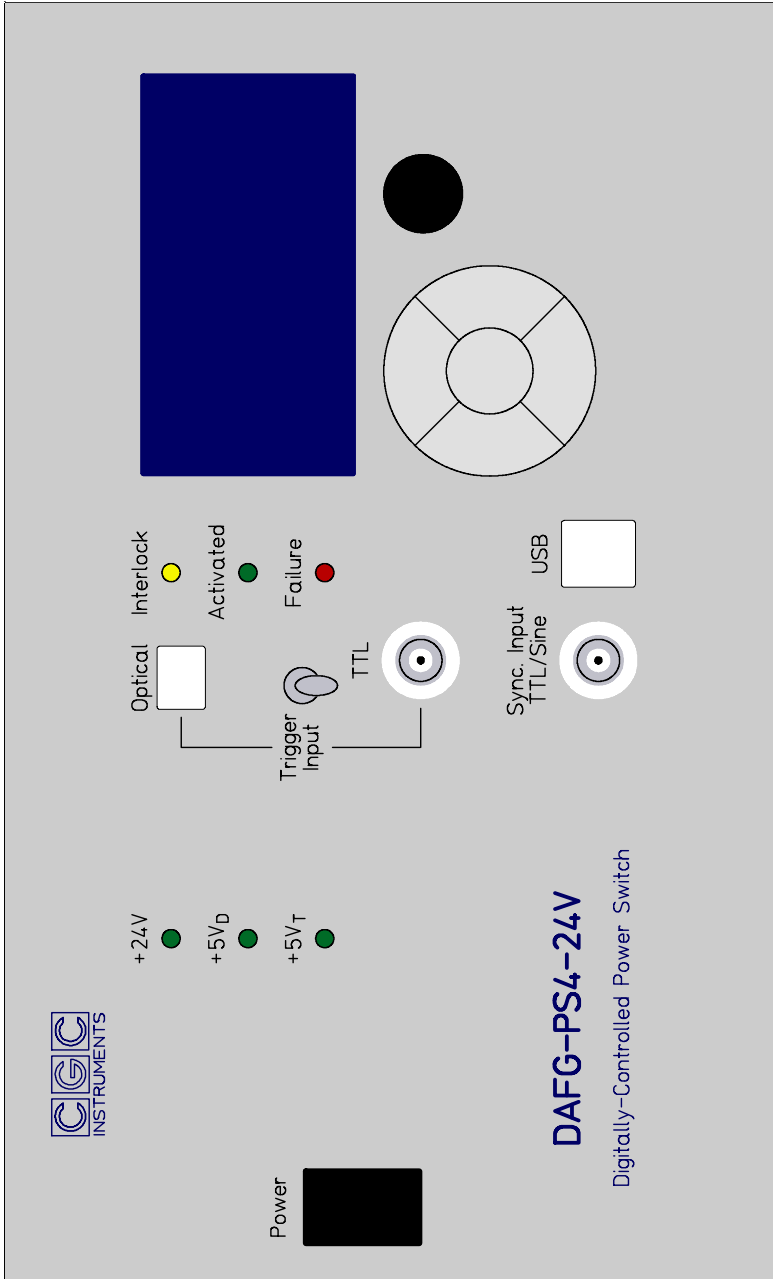
The waveform generator and the actuator are described in individual manuals (see the device homepage at www.cgc-instruments.com/AF-RF/DAFG-PS4-24V). Beside its intrinsic function, the waveform generator contains also control and monitoring circuits of the power switch. The function of them is briefly described in this document, for further details, please consult the manual of the waveform generator.

Power Switch

The power switch is able to provide a continuous output current of about 2 A to loads like electropneumatic actuators that require high peak currents for their operation. The output terminals provide rectangular voltages with a fixed amplitude of 24 V. The output voltages are unipolar, the negative terminals are galvanically connected to the device ground (PE).

The typical output load of the device are electropneumatic actuators. The power switch has been optimized to drive the solenoid fast-switching valves MHE4 produced by FESTO.

The power switch produces rectangular signals with a limited slew rate, the typical rise and fall times are 50-100 μ s. Furthermore, the output signals are filtered by LC filters effectively suppressing high frequencies. This results in low emission level of electromagnetic radiation from the device. The power switch uses linear power supplies equipped with a toroidal transformer; this design produces only a weak stray magnetic field. Due to the low electromagnetic radiation, the device should not disturb even sensitive instruments located in the proximity of the device.



DAFG-PS4-24V

Digitally-Controlled Power Switch

Fig. 1. The front panel of the power switch.

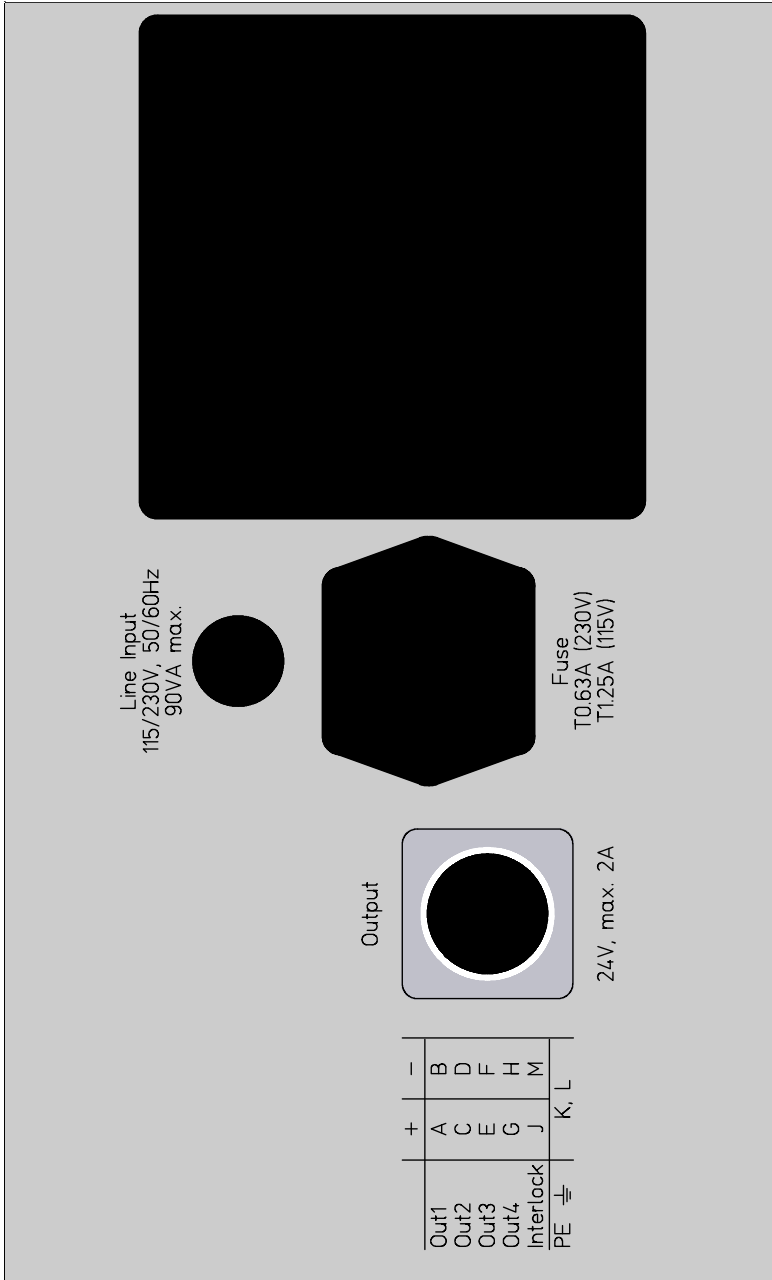


Fig. 2. The rear panel of the power switch.

Embedded Safety Precautions

The system is equipped with an interlock loop that disables the output if the loop is opened. The terminals of the interlock loop are located at the output connector. They are typically fed by the output cables to the actuator where they are either shorted or wired to an emergency push button or switch with a breaking contact. The output is disabled if the interlock connection is opened, thus if the output cable is disconnected or broken, or if the emergency push button or switch is activated, i.e. opened. The sensing of the interlock loop can be disabled in system settings (see the manual of the waveform generator for more details) if its function is not required.

The power supplies of the power switch are cooled by a heatsink located in the device housing. The heatsink is actively cooled by a fan at the rear panel. The fan is controlled by the temperature of the power semiconductor devices. Thus, in the standby state with disabled output, the device produces only minimal acoustic noise, since the fan is typically turned off. With heavy output loads, the heatsink temperature increases and the fan is activated. Under certain conditions, the cooling power of the device is not sufficient and the power semiconductor devices could overheat. This may happen if the output is overloaded or even shorted, if the ambient temperature is high, or if the fan fails. To prevent this from happening, the power switch is deactivated if the temperatures exceed a preset level (see the manual of the waveform generator for more details).

Control and Indication Elements

All control elements are located on the front panel of the power switch (see Fig. 1).

Using the rocker switch "Power", you can power the device on or off. When powered on, the three LEDs beside the power switch (+24V, +5V_D, and +5V_T) light green and the display turns on.

The LED "Interlock" shows the state of the interlock loop. It lights yellow, if the interlock loop is closed, i.e. if the corresponding contacts on the output are shorted. When the loop is open, the LED "Interlock" is off and the power switch cannot be activated, unless the interlock loop is deactivated in system settings (see the manual of the waveform generator for more details).

The LED "Activated" lights green if the switch output is active. This indicates a running waveform output and shows that no failure has occurred. If the device cannot be activated, check the error message on the LCD. The most probable reason is an opened interlock loop or a wrong setting of it.

The LED "Failure" lights red if any failure occurs, i.e. if the device overheats or the fan fails. You can identify the reason for the indicated failure by inspecting the dialog boxes for monitoring the device function (see the manual of the waveform generator for more details). On a fan failure, the device continues to operate, you should, however, replace the fan as soon as possible since overheating may occur. This happens if one of the power semiconductor devices of the power supply units reaches the critical temperature. In such case, the power switch is deactivated and any running output is stopped. The temperature threshold can be modified, you can also check the current temperatures by opening the dialog box for temperature monitoring on the LCD (see the manual of the waveform generator for more details).

Human Interface

The device is equipped with a graphic liquid crystal display (LCD), a set of keys (keypad), and a rotary encoder. The keys are arranged in a circle symbolizing the key function: There are four direction keys ("left", "right", "up", and "down") and a middle key for confirmation or selection ("enter").

The keys are used for navigation in menus, for selecting dialog items, or for changing values. The function of the keypad in every device state is symbolized on the LCD immediately above the keypad. A text describes the function of the middle key, alternatively just the symbol "☒" is displayed showing that the middle key can be used. Similarly, arrows show which of the keys has an influence on the operation in the current state. When a menu is active, the vertical direction keys are used to change the current selection. The right direction key as well as the middle key opens a submenu, provided it is available. The left direction key closes the submenu or the main menu if there was no opened submenu. The middle key selects the menu item and launches the corresponding action.

The rotary encoder is used to change numerical values or select items. The function of the encoder is symbolized on the LCD immediately above the encoder knob in every device state. In most situations,

the encoder uses an enhanced speed control. This enables you to precisely set any desired value or rapidly make large changes, since the value steps are proportional to the rotational speed of the encoder. You can change the corresponding value in small steps when you rotate the encoder slowly or make large changes when you spin the encoder knob rapidly. To set large numbers, the encoder speed can be further increased by pressing the direction key "left". If this feature is available, the left arrow is shown above the keys. In some situations, the encoder's push button is used to confirm the selected value or to switch the encoder function. In such cases, the symbol "☐" is shown on the LCD above the encoder knob.

For more details about the operation, see the manual of the waveform generator.

Terminals

The output terminals are located in the connector "Output" at the rear panel (see Fig. 2). The connector is a robust Amphenol Eco-Mate RM receptacle with 12 pins (for the pin layout, see Fig. 3 and Tab. 1). The switch outputs are connected to four pin pairs. The middle pins are connected to the protection ground of the device (wire PE), they can be used to ground the actuators and screen the cable. Two pins of the output connector are used for the interlock loop, they must be shorted in order to enable the device output.

The digital trigger signal can be connected either to the isolated BNC socket as a standard TTL signal or the optical input according the

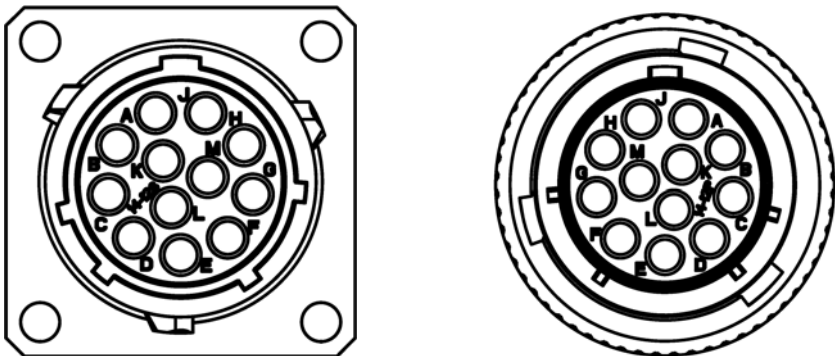


Fig. 3. The output connector.
Left the panel receptacle (female), right the cable plug (male).

Tab. 1. Pin layout of the output connector.

Pin	Signal	Description
A	Out1-Pos	Switch Output #1 - Positive Terminal
B	Out1-Neg	Switch Output #1 - Negative Terminal
C	Out2-Pos	Switch Output #2 - Positive Terminal
D	Out2-Neg	Switch Output #2 - Negative Terminal
E	Out3-Pos	Switch Output #3 - Positive Terminal
F	Out3-Neg	Switch Output #3 - Negative Terminal
G	Out4-Pos	Switch Output #4 - Positive Terminal
H	Out4-Neg	Switch Output #4 - Negative Terminal
J	Interlock-Pos	Interlock Loop - Positive Terminal
M	Interlock-Neg	Interlock Loop - Negative Terminal
K	PE	Protective Ground
L	PE	Protective Ground

standard *Versatile Link* can be utilized. The desired input can be selected using the toggle switch "Trigger Input". The switch has three positions, in the middle one, both trigger inputs can be used simultaneously - the system is triggered by the active one. The optical input provides the best isolation between the trigger source and the power switch, thus should be preferably used. However, the BNC trigger input is galvanically isolated from the device too, thus there is no risk of ground loops even with this input.

Similarly to the trigger signal, a digital synchronization signal can be connected to the isolated BNC socket as a standard TTL signal. The device expects a rectangular or a sinusoidal signal in the frequency range between 5 and 20 MHz (for more details, see the manual of the waveform generator). The synchronization input is isolated from the device, but galvanically connected to the TTL trigger input (the BNC socket). This minimizes the risk of ground loops, provided the trigger and the synchronization signals are sourced from the same control device.

Take care about the proper termination of the connected cables. The device is equipped with an optional termination resistor of 50 Ω at the

synchronization input. If enabled, it serves for the proper termination, thus for clean signal transitions. Since several signal sources are not able to provide a sufficiently high signal amplitude necessary for driving the input impedance of $50\ \Omega$, the termination is disabled per default.[†] In contrary to that, the TTL trigger input has only a weak pull-down resistor of $51\ \text{k}\Omega$, thus does not provide any signal termination. When you use longer cables to connect the trigger signal, prove the signal quality for overshoots and ringing. If the signal quality is poor, use an external termination resistor of $50\ \Omega$ and check the signal quality again. Note that especially ringing caused by fast signal transitions may prevent the trigger input from the proper function.

For the mains connection, an IEC inlet with an EMC filter and integrated fuse holder is located on the rear panel. Use a standard line cord with the universal IEC mains lead to connect the device to the mains. To replace the fuse, remove the line cord and open the fuse holder. Insert the new fuse, close the fuse holder, and connect the line cord back to the IEC inlet.

[†] The corresponding jumper that enables the termination is located in the device housing, contact the manufacturer or the distributor for detailed instructions if you wish to activate it.

Installation

! Before powering on the system, read the user manual carefully.

To install the power switch, a space of at least $24 \times 40 \times 14 \text{ cm}^3$: (width \times depth \times height) on top of a stable table is required. The device weighs about 6 kg, the supporting surface must guarantee mechanical stability under this load. The installation area must be kept dry and the temperature within the range specified in the section "Technical Data". Avoid exposing the device to direct sun light since this may substantially increase the device temperature.

During operation, only the front panel of the power switch has to be accessible. Before installing the device in its final position, you should attach the line cord; it is connected to the IEC inlet on the rear panel. To power the device, a power mains socket with proper grounding is required. Check the voltage selector at the rear panel before powering on the device.

! **Warning:** A wrong setting of the voltage selector may permanently damage the device.

The air filter at the rear panel must not be covered or obstructed during device operation, it must be provided with sufficiently cool air for active cooling of the device. Take necessary precautions to ensure a sufficient supply of cool air when installing the device in closed racks. Inspect and clean the fan filter regularly. Furthermore, use a vacuum cleaner to remove dust from the fan and from the heatsink in the device housing. Large dust layers substantially lower the cooling power of the heatsink (the device may overheat if the heatsink is extremely dirty). Also the lifetime of a dirty fan can be significantly shortened.

If already connected, disconnect the load and power on the device by toggling the rocker switch "Power". The three LEDs beside the power switch (+24V, +5V_D, and +5V_T) will light green and the display will turn on. During the startup, the three LEDs beside the LCD ("Interlock", "Activated", and "Failure") will light for 1-2 seconds. When the device startup completes, the LED "Interlock" indicates the state of the interlock loop. The other two LEDs ("Activated" and "Failure") should be inactive. If the device behaves properly, proceed with installing the waveform generator as described in the manual of the waveform generator.

Please consult the manual in case of any discrepancy with this description. Should that not resolve the problem, contact the distributor or the manufacturer.