

# The BlackBox

*Don't be left in the dark*



## G5DFR Multi-Functional Recorder User Manual

Version 1.1.4.15  
June 2023

## About This Manual

This manual describes how to install, configure, and operate the G5DFR Multi-Functional Recorder (G5DFR). This manual is intended for the following audiences –

- **Installation Personnel** – These people set up and connect the G5DFR.
- **Operations Personnel** – These people use the hardware and software on the G5DFR.
- **Managers** – These people are responsible for managing multiple G5DFR units remotely.

This user manual contains the following chapters –

- **Chapter 1, Introduction**, page 13, introduces the G5DFR Analyzer and describes how it works and its workflow.
- **Chapter 2, Hardware Description**, page 19, describes various G5DFR hardware features.
- **Chapter 3, Setup and Connection**, page 27, describes setting up and connecting the G5DFR Recorder.
- **Chapter 4, DFR Touch Screen**, page 43, describes the G5DFR unit touch screen icons.
- **Chapter 5, Web Interface**, page 59, describes the G5DFR web interface, enabling you to monitor and configure the G5DFR.
- **Chapter 6, Management Software Configuration**, page 113, describes the PQSCADA Sapphire management software tool.
- **Appendix A, Licensing**, page 115, describes G5DFR licensing and the ordering number of the G5DFR device.
- **Appendix B, Technical Specifications**, page 132, describes the technical specifications for the G5DFR device.
- **Appendix C, Firmware Upgrade**, page 138, describes how to upgrade the firmware on the G5DFR device.

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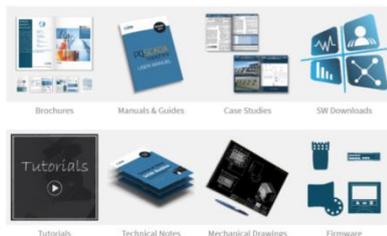
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Ticket

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Conduct the following routine tests as part of the production line –

- Dielectric strength test between the mains and ground. Test voltage should be 2,120 VDC or 1,500 VAC.
- Grounding continuity between the earth pin of the appliance inlet and the earth pin of the appliance outlet.

### Warnings –

- Protection provided by the equipment can be impaired if used in a manner not specified by the manufacturer.
- Review the entire manual before using the instrument and its accessories.
- Observe all warnings and cautions.
- Do not operate the instrument around explosive gas or vapor.
- Avoid working alone.
- Before use, inspect the instrument, leads, and accessories for mechanical damage, and replace when needed.
- Pay special attention to the insulation surrounding the connectors, ports, and plugs.
- Remove all accessories that are not in use.
- Make sure that the instrument is properly grounded to a protective earth ground.
- Do not insert power or any other connectors above the rating of the instrument, as shown on the name plate.
- During installation, ensure that the device is completely disconnected from any live points and/or plugs.
- Do not insert metal objects into connectors, ports, and openings.
- Never open the instrument's enclosure during operation, as dangerous voltages are present.
- Do not expose the instrument to extreme moisture and/or rain.
- Do not operate the instrument or its accessories when found wet for any reason.

# 1 Introduction

This chapter introduces the G5DFR Recorder, describes how it works and the workflow for using it.

## 1.1 What is the G5DFR Recorder?

The BlackBox G5DFR is a fully-featured multi-functional recorder embedded with PQZ technology. The G5DFR is a distributed multi-functional data acquisition device that continuously records all waveform signals at a sampling rate of up to 1,024 samples per cycle.



**Figure 1-1: G5DFR Multi-Functional Recorder**

### 1.1.1 Key Features

The G5DFR provides the following key features –

- 24-bit continuous acquisition of up to 1,024 samples per cycle (50/60 Hz)
- Modular design
- Centralized and decentralized architecture
- Supreme synchronization
- Compliance with IEC 61850 MMS, GOOSE messaging, Sample Value (SV), and Rapid Voltage Change (RVC)
- Comprehensive web interface
- 7" touch-screen LCD
- Scalable architecture

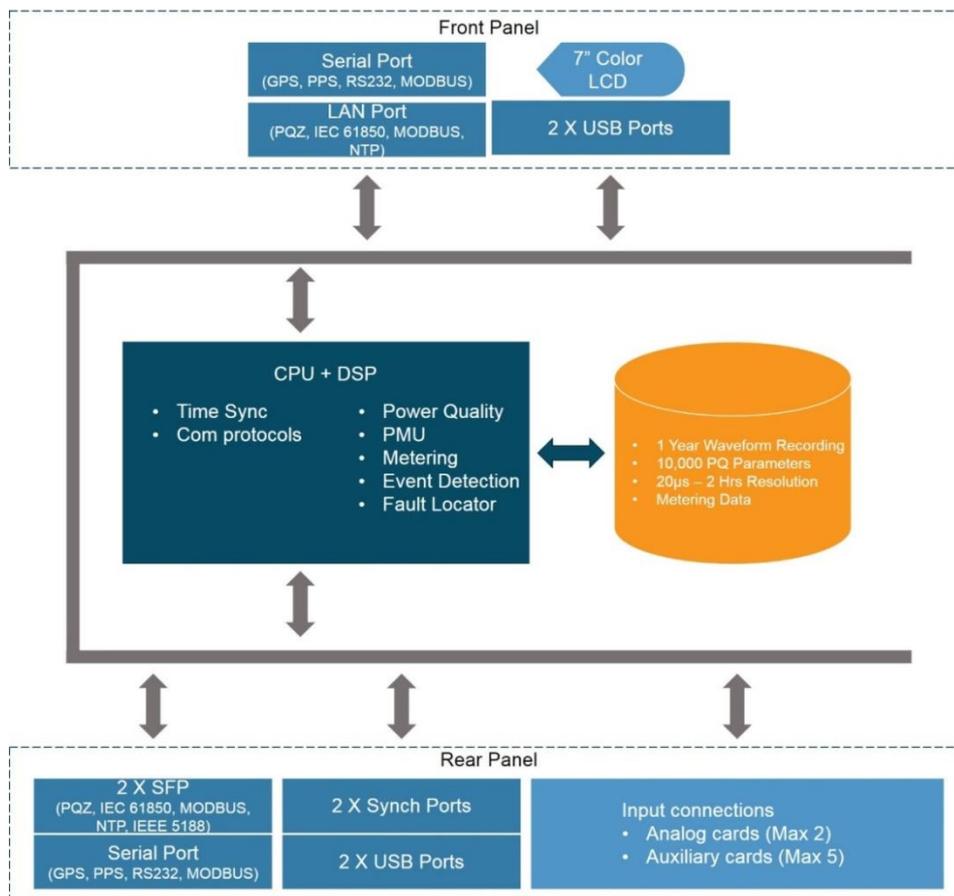
## 1.2 How Does the G5DFR Recorder Work?

The G5DFR is a multi-functional recorder that combines the features of a wide variety of power system monitoring instruments. These include operation protection, system stability, power quality, and Phasor Measurement Unit (PMU). The voltage and current waveforms of up to 16 channels are continuously recorded at 24-bit accuracy. The state of protection relays and switchgear can also be monitored via auxiliary switch contacts. Additionally, other transducers can be connected to the G5DFR in order to monitor a wide range of parameters.

By providing this complete range of functionality from a single connection to the power network, the G5DFR is a very cost-effective instrument. This recorder provides information for a wide range of departments within a utility. Recorders can be cross-triggered to extend the amount of data that is captured for each event. G5DFRs can also be coupled together to provide unlimited channels of recording. The G5DFR can include the functions of any combination of the systems listed below –

- Digital Fault Recorder (DFR)
- Phasor Measurement Unit (PMU)
- Power Quality Monitoring (PQM)
- Sequence of Event Recording (SER)
- Dynamic System Monitoring (DSM)
- Impedance-based Fault Location (IbFL)
- Energy Billing Measurement (EBM)

## 1.3 G5DFR Architecture



**Figure 1-2: G5DFR Architecture Input Connections**

A single G5DFR chassis can provide a maximum of 16 analog inputs to connect to standard protection or metering voltage and current transformers. Any input can be configured as a voltage or a current input when the system is ordered.

The following is also available in addition to the 16 analog inputs –

- **Digital Inputs** (32 inputs per card) for reading the state of protection relays and switchgear. The digital inputs require a wetting voltage from a source external to the G5DFR.
- **Status Relay Outputs** (eight relays per card) are available for connection to a SCADA or alarm system. The status relays are high-voltage types that require external supply.
- **Status Digital Output** (16 outputs per card) are available for connection to a SCADA or alarm system. The status digital output requires a wetting voltage from a source external to the G5DFR.

- **Current Loop Input** (32 inputs per card) are available to measure various signal types via a transducer. Any input can be configured as a  $\pm 10V$  or 4–20mA input on-site.

The power supply to the recorder can be AC or DC and must be specified at the time of order.

### 1.3.1 Recording Function

The G5DFR continuously measures and stores all voltage and current waveforms at a sampling rate of up to 1,024 samples/cycle, without the need to set any triggers or thresholds. In addition, the G5DFR samples and stores auxiliary signals at a sampling rate of 128 samples/cycle.

### 1.3.2 Real time Monitoring

The G5DFR includes the ability to view analog and auxiliary inputs and computed values in near real-time. Measured values and waveforms can be seen locally over the built-in 7" touch screen or remotely through the G5DFR web interface.

### 1.3.3 Network Capability

The BlackBox G5DFR rear panel is equipped with the following –

- Two SFP Ethernet ports for communication to an additional separate network or redundant communications. The SFP is a hot-swappable input/output device allowing multiple connectivity options.
- Two USB ports extend the DFR wireless communication capabilities by enabling the connection of standard USB communication sticks.
- One serial RS232 port.

Additional Ethernet, serial, and USB ports can be added to the front panel for use by field technicians.

## 1.3.4 Time Sync

Several available time synchronization algorithms can be selected by the user. Automatic mode can also be used, in which the most accurate time source is used.

When there is no available external source, the unit's internal clock is used.

The following table shows the accuracy of the G5DFR's individual BlackBox time sources.

**Table 1-1: Time Source/Accuracy**

Time Source	Accuracy
Internal Clock	±20 ppm
NTP	100 µseconds
GPS/IRIG B	0.5 µseconds
DSP Sync	0.1 µseconds

Standard synchronization methods (such as GPS, IRIG-B, NTP, IEEE1588) synchronize the time stamp of the signal. However, generally in a power quality application (and especially in continuous waveform recordings), the sampling frequency between devices must be synchronized as well.

Elspec's propriety time synchronization algorithm is a cost-effective, high-performance technology that can synchronize the sampling of hundreds of channels simultaneously using its decentralized, redundant architecture.

Each G5DFR black box acts as a Sync Master, and therefore can be used as a time reference to other units at a time accuracy of 50–100 nsec (when using the DSP Sync method).

## 1.4 G5DFR Workflow

The following describes the general workflow for working with the G5DFR.

Step 1	<b>Setup and Connection</b>	Page 27
	↓	
Step 2	<b>Settings</b>	Page 43
	↓	
Step 3	<b>Monitoring</b>	Page 113
	↓	
Step 4	<b>Management Software Configuration</b>	Page 113

**Figure 1-3: G5DFR Recorder Workflow**

# 2 Hardware Description

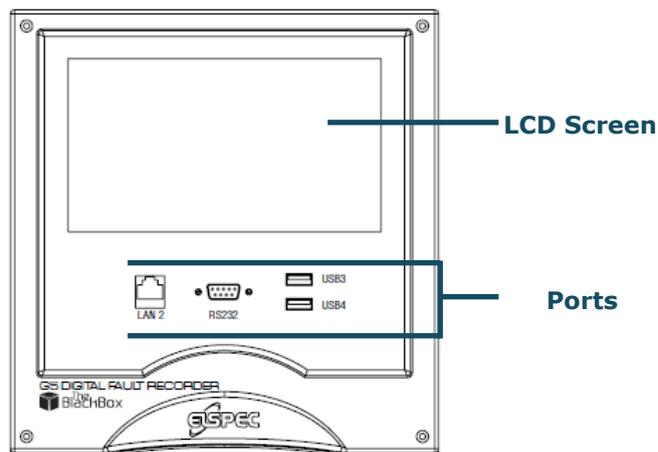
The G5DFR has five slots for cards and is provided with all cards already inside the device. The G5DFR has various features that affect the device's catalog number, such as the types and number of cards installed in the slots, communication port options, and the software features of the device, as described below.

This section describes various G5DFR features, as follows –

- **Front Panel**, page 19
- **Rear Panel**, page 20
- **Card Types**, page 21

## 2.1 Front Panel

Figure 2-1 shows the front panel of the G5DFR device. All the ports on the front panel are purchasable options and are not enabled by default. These ports provide additional and/or easier physical access and flexibility for connecting to the G5DFR. The G5DFR is also provided with an LCD screen.

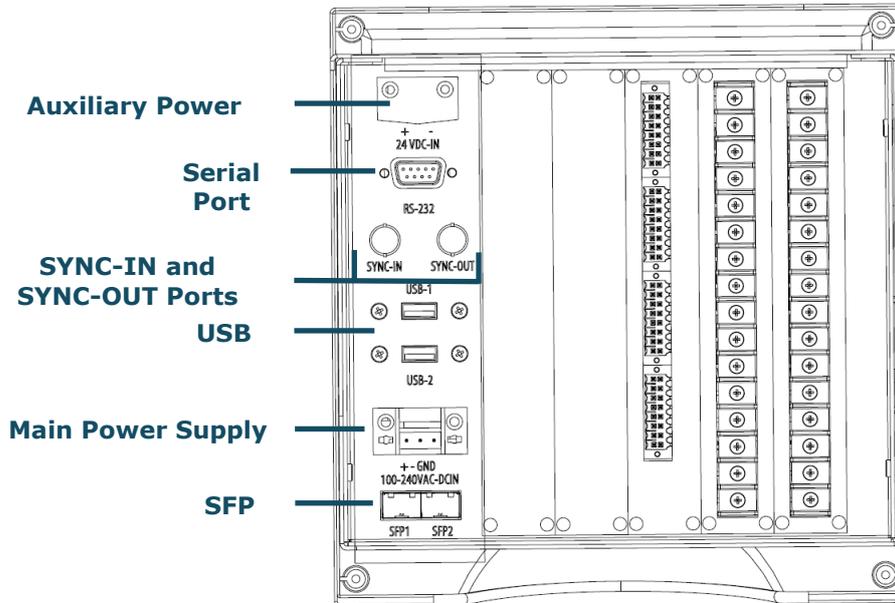


**Figure 2-1: G5DFR Front Panel**

- **LAN2** – For connecting to an additional network.
- **RS232** – DB9 port used for troubleshooting (Debug).
- **USB3 and USB4** – For extending communication capabilities and/or additional storage (N/A).

## 2.2 Rear Panel

The G5DFR is provided by default with the following connectors/ports on its rear panel –



**Figure 2-2: G5DFR Rear Panel**

- **Auxiliary Power Supply** – 24VDC power supply for redundancy.
- **Main Power Supply** – Accepts either 100–240 VAC or 120–370 VDC.
- **Serial Connector** – DB9 port for GPS, PPS, and troubleshooting.
- **SYNC-IN and SYNC-OUT** – Synchronization ports for synchronizing between multiple G5DFR devices (daisy chain devices).
- **USB-1 and USB-2** – Two USB ports to extend communication capabilities and/or extend the device’s storage capacity (N/A).
- **SFP1 and SFP2** – Two Small Form-factor Pluggables (SFPs) provide the G5DFR with a modular interface that the user can easily adapt to various fiber optic and copper network standard dongles.

## 2.3 Card Types

### 2.3.1 Five Card Slots

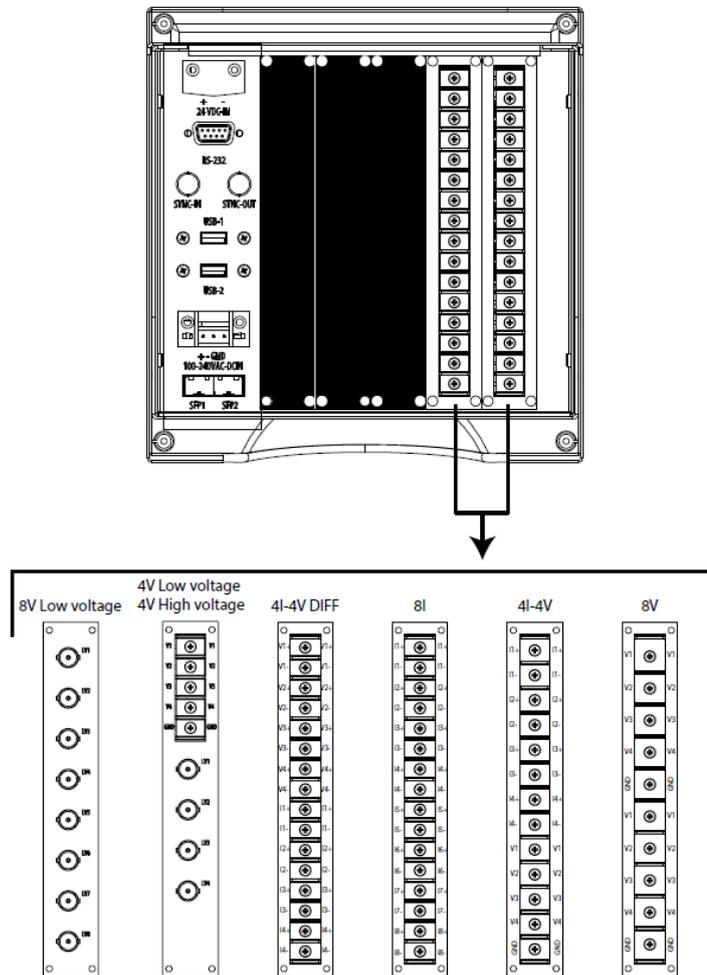
The G5DFR has five slots for input/output cards. These cards are provided preinstalled in the G5DFR based on the ordering information.

Various types of input/output cards can be provided in the five slots of the G5DFR, which are grouped into two types – Analog and Auxiliary. The installed cards affect the device's catalog number.

Both analog and auxiliary cards have a built-in memory chip that stores the calibration parameters. This means that replacing and/or adding new cards to the G5DFR can be performed on-site without needing to send the device for recalibration.

#### 2.3.1.1 Analog Cards

Analog cards enable the G5DFR to measure the voltage and current of a monitored power network at a specified sampling rate. Analog card types are comprised of different quantities and combinations of voltage channels (V) and current (I) channels. A G5DFR can have zero, one, or two analog cards inserted into slots 1 and 2.



**Figure 2-3: G5DFR Rear Panel – Analog Card Connectors**

### G5DFR Has a Maximum of 16 Channels

Each G5DFR can have a maximum number of 16 channels, meaning, for example, all voltage channels, all current channels, or a combination of both.

### Each Card Has Up to 8 Channels

Each Analog card has up to eight channels and can be comprised of voltage channels (V) and current (I) channels. For example –

- **4I 50A peak | 4V Diff 1,500 peak** – Has four voltage channels (V) and four current (I) channels.
- **8I 50A peak | 0V** – Has eight current (I) channels and no voltage channels (V).

## Combinations of Voltage and Current Channels

As mentioned, each card has up to eight channels, and these can be a combination of voltage and current channels. A card can have the following quantities/types of channels –

- Voltage – 0, Current – 8
- Voltage – 4, Current – 4
- Voltage – 8, Current – 0

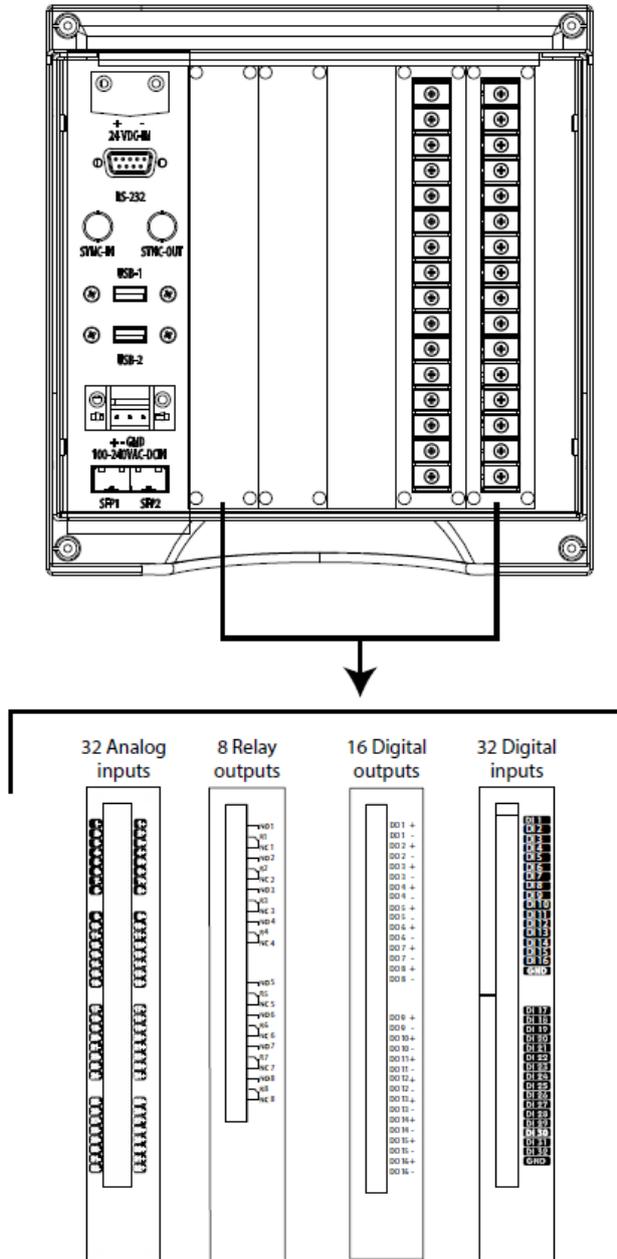
Because a G5DFR can have two analog cards, the G5DFR may have the following quantities/types of channels –

- Voltage – 0, Current – 16
- Voltage – 4, Current – 12
- Voltage – 8, Current – 8
- Voltage – 12, Current – 4
- Voltage – 16, Current – 0

In addition to the above, there are some additional unique combinations of cards. To check the actual specifications for a particular system, you may refer to [Appendix A, Licensing](#), on page 115.

### 2.3.1.2 Auxiliary Cards

The Auxiliary cards extend the G5DFR I/O capabilities. Each Auxiliary card can handle various signal types such as digital input, digital output, relay output, and current loop.



**Figure 2-4: G5DFR Rear Panel – Auxiliary Card Connectors**

A G5DFR can have between zero and five auxiliary cards, which can be inserted into any of the five slots.

The following Auxiliary cards are available –

## Hardware Description

---

- **Digital Inputs** (32 inputs per card) for reading the state of protection relays and switchgear. The digital inputs require a wetting voltage from a source external to the G5DFR.
- **Status Relay Outputs** (eight relays per card) are available for connection to a SCADA or alarm system. The status relays are high-voltage types that require an external supply.
- **Status Digital Outputs** (16 outputs per card) are available for connection to a SCADA or alarm system. The status digital output requires a wetting voltage from a source external to the G5DFR.
- **Current Loop Input** (32 inputs per card) are available to measure various signal types via a transducer. Any input can be configured as a  $\pm 10V$  or 4–20mA input on a site.

There are different combinations of cards. To check the actual specifications for a particular system, you may refer to [Appendix A, Licensing](#), on page 115.

## 2.4 Software Features

Various software features also affect the ordering information number, such as recording time (meaning how much data can be stored before overwriting the oldest data), sampling rates (such as 256 or 1,024), and communication gateways protocols.

### 2.4.1 Recording Time/Sampling Rate

The following shows a list of the recording time/sampling rate options available for the G5DFR –

- **Recording Time** – The amount of time (capacity) that defines the G5DFR’s capability to store data. For example, one week’s worth of data.
- **Sampling Rate** – Specifies the number of samples that can be recorded per cycle. Each sample stores 24 bits (three bytes) on the G5DFR.
- Recording Time | Sampling Rate Options –
  - 1 week | 256
  - 1 week | 512
  - 1 week | 1,024
  - 1 month | 256
  - 1 month | 512
  - 1 month | 1,024
  - 1 year | 512
  - 1 year | 512
  - 1 year | 1,024

### 2.4.2 Communication Gateway Protocols

The following is a list of the gateway protocols supported for monitoring the G5DFR –

- IEC 61850 – MMS server, Report server, GOOSE server
- DNP 3.0
- Modbus Slave

### 2.4.3 PMU

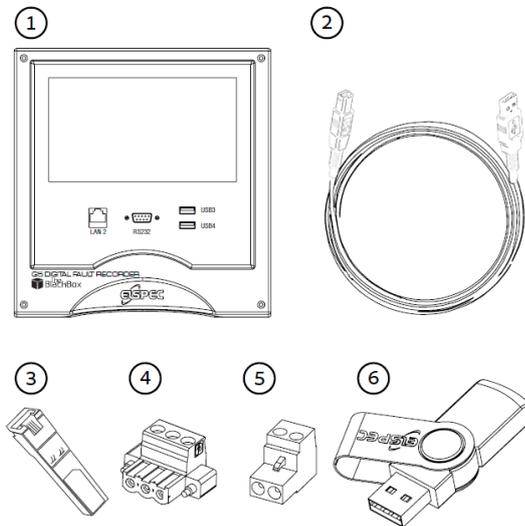
The PMU is a software option that can be enabled/disabled within the product license. The G5DFR fully supports the IEEE C37.118 -2011/2014 Synchro phasor standard.

# 3 Setup and Connection

This chapter describes how to set up and connect the G5DFR Recorder.

## 3.1 Package Contents

The G5DFR is supplied with all cards already inside the device. All cables and connectors are provided based on the device ordering information (see page 115) for the device. The following items are included in your Recorder Kit –



**Figure 3-1: G5DFR Package Contents**

**Table 3-1: G5DFR Package Contents**

Item	Description
①	G5DFR Multi-Functional Recorder
②	RJ45 3M Communication Cable
③	SFP Dongle – SFP Copper Transceiver 10/100/1000 Base
④	Power Supply Connector – Green
⑤	DC Power Supply Connector – 2-pin, Black
⑥	Elspec BlackBox Installation Software – Disk on Key

**Note - Additional connectors are according to the assembled cards (based on the G5DFR part number).**

## 3.2 Connecting the G5DFR

The G5DFR is available in a 5U, 1/2 19" rack mounting enclosure. All main supply, input, and output connections are via screw terminals at the rear of the chassis. Communications and other auxiliary ports and connectors are also on the rear panel. The only exceptions are the optional front-panel communication ports, which are for temporary use.

The G5DFR is available in a wide range of configurations with a number of options. To check the actual specification of a particular system, you may refer to *Appendix A, Licensing*, on page 115.

### 3.2.1 Power Supply Connection

The main power supply is connected to the terminal block at the bottom-left corner of the rear panel, as shown in Figure 3-2. If a DC supply is being used, check the polarity. The required voltage is specified in *Appendix B, Technical Specifications* on page 132.

**IMPORTANT NOTE** – It is essential to use the specified voltage. Not doing so may cause damage.

The earth pin must be connected to the main system earth. This mandatory requirement is essential for ensuring the safe operation of the G5DFR.

In addition to the main power supply, the G5DFR has an Auxiliary 24VDC power supply for redundancy. The required voltage is shown in *Appendix B, Technical Specifications*, on page 132.

**IMPORTANT NOTE** – It is essential to use the specified voltage. Not doing so may cause damage.

Once the power supply is connected, the G5DFR turns on.

### 3.2.2 Connecting the Rear Panel

Figure 3-2 shows the rear-panel connectors and ports provided by default on the G5DFR device.

Connect them as needed (for Ethernet or other communication, the dongle should be inserted into the SFP port).

#### Rear Panel Connectors and Ports

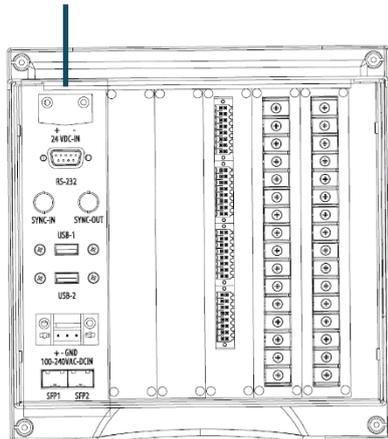


Figure 3-2: G5DFR Rear Panel Connectors and Ports – 1

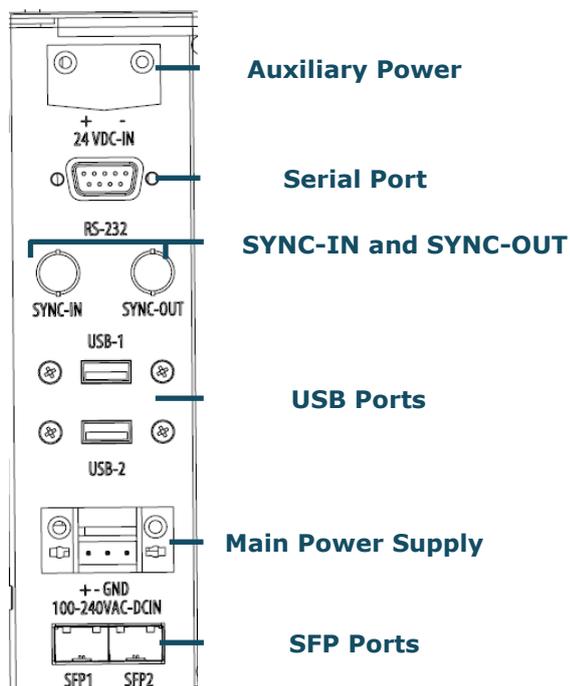


Figure 3-3: G5DFR Rear Panel Connectors and Ports – 2

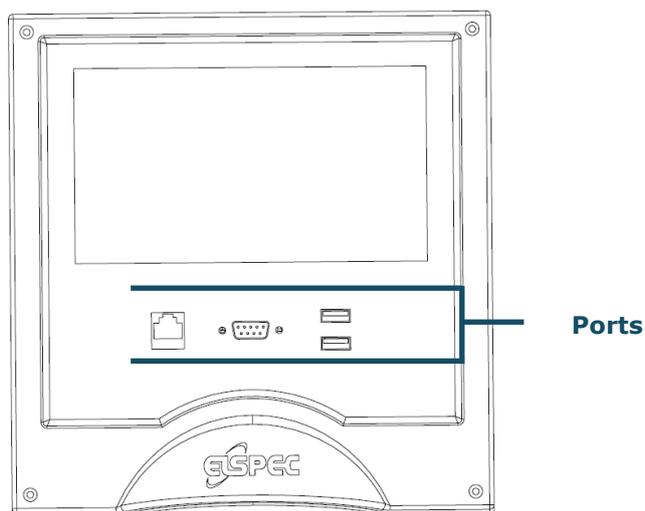
**Table 3-2: G5DFR Rear Panel – Connectors and Ports**

Connectors/Ports	Description
Auxiliary Power Supply	24VDC power supply. Connect this power supply to provide redundancy.
Main Power Supply	Accepts either 100–240 VAC or 120–370 VDC.
Serial	<ul style="list-style-type: none"> <li>• DB9 connector</li> <li>• Can be used for GPS time synchronization.</li> <li>• Can be used for PPS time synchronization.</li> <li>• Can be used for troubleshooting.</li> </ul>
SYNC-IN and SYNC-OUT	<p>Synchronization ports for synchronizing between multiple G5DFR devices (daisy chain).</p> <p>When connecting multiple G5DFR devices, connect the SYNC-OUT from one G5DFR device to the SYNC-IN on another G5DFR device. There is no need to close the loop.</p>
USB-1 and USB-2	Two USB ports to extend communication capabilities and/or extend the device’s storage capacity. (N/A)
SFP1 and SFP2	<p>Two Small Form-factor Pluggable (SFP) optical transceiver module ports that provide communication flexibility.</p> <p>These ports enable the G5DFR to communicate with different networks. Using SFP1, SFP2, and LAN2 (see page 31) ports, the G5DFR can communicate with three different networks simultaneously without any bridging.</p> <p>The relevant dongle must be inserted into the SFP1 and/or SFP2 slot(s). Industry-standard dongles are supported, and each may have a different wavelength, speed, and type of communication. The G5DFR is provided with a standard LAN dongle (P/N ENJ-1008-6100).</p>

### 3.2.3 Connecting the Front Panel (Optional)

Figure 3-4 shows the front panel of the G5DFR device and the ports that may be included on the front panel. All ports on the front panel are purchasable hardware options and are not provided by default.

Connect them as needed.



**Figure 3-4: G5DFR Front Panel Ports**

The optional ports that may be included on the front panel are described below.

**Table 3-3: G5DFR Front Panel – Ports**

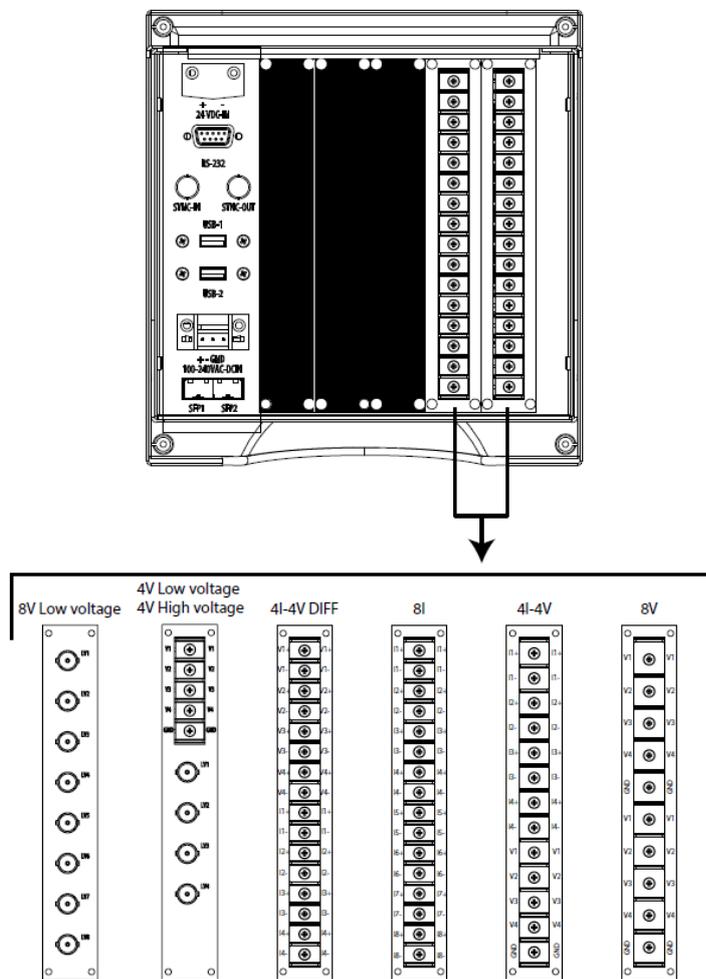
Ports	Description
LAN2	LAN connection, which enables connecting the G5DFR to an additional network. This port has its own MAC address.
RS232	DB9 port for troubleshooting.
USB3 and USB4	USB ports to extend communication capabilities and/or provide storage (N/A).

### 3.2.4 Connecting Analog Cards

The G5DFR can contain up to two analog cards. Each analog card can have up to eight channels. Analog cards can only be used in slots 1 and 2 of the G5DFR.

The process of connecting an analog card is the same for all analog cards, except for differential voltage cards. For more details about connecting differential voltage cards, see page 34.

The panel on the right of the rear panel shows a series of labels. These labels indicate whether the connection is for a current channel (I) or a voltage channel (V). These channels are numbered sequentially. For example, V1, V2, V3, I1+/-, I2+/-, I3+/-, and so on.



**Figure 3-5: G5DFR Rear Panel – Analog Card Connectors**

#### 3.2.4.1 Voltage Channels

This section is only relevant if the G5DFR has voltage channel connectors.

### Setup and Connection

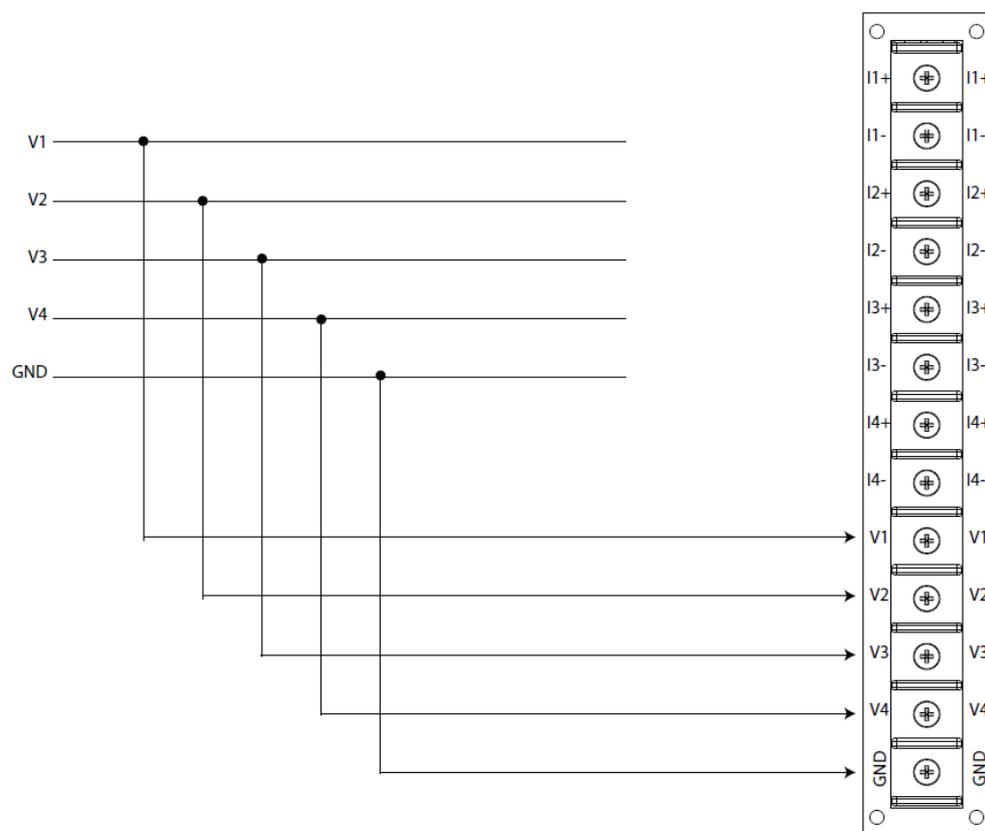
The voltage inputs are connected directly to the standard 57–120V secondary windings of protection or metering VTs. The primary nominal and full-scale voltages are specified in *Appendix B, Technical Specifications* on page 132.

Voltage channels (V) measure the potential difference between the network power line to which it is connected and GND.

**To connect differential voltage cards, refer to page 34 instead of the instructions below.**

**Note** – Your first step must be to connect the GND connector, as described below.

Connect as many voltage channels as needed according to the network power lines to be measured.



**Figure 3-6: Connecting the G5DFR to the Power and Network**

We recommend not leaving any voltage channel connectors floating. Short the unused connector by connecting it to the GND connector. For instance, when you connect only two phases of voltage and do not have a third one or do not have a Neutral line, then ground it (by connecting it to the GND connector) so that no connectors are left open.

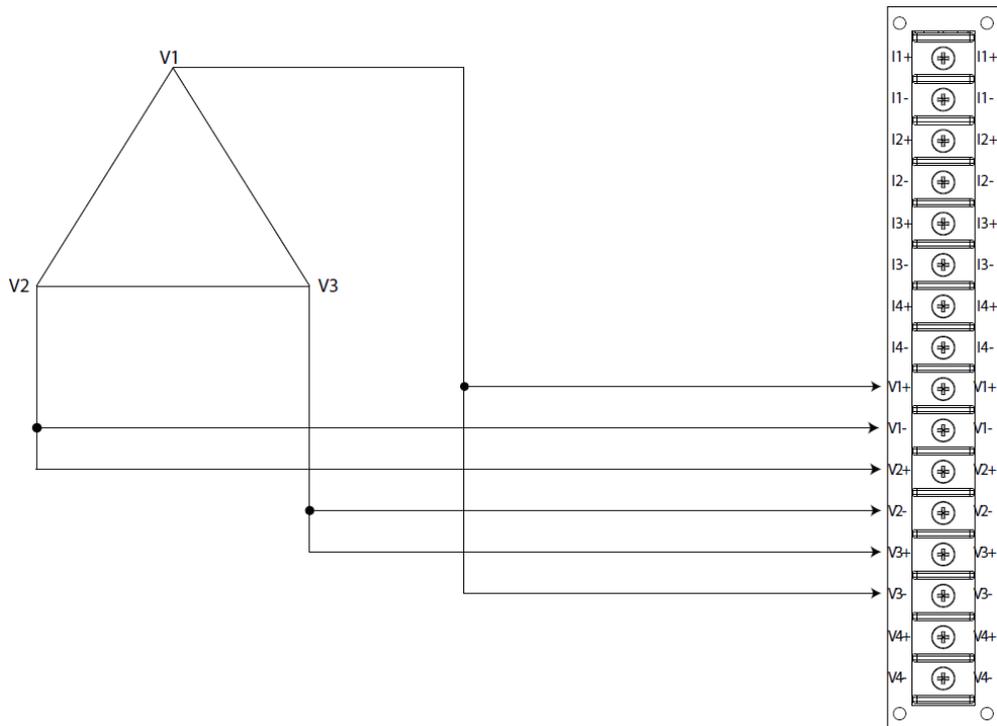
**Note** – It is not necessary to sequentially connect voltage channel connectors, meaning that you can connect V1, short V2, and then connect V3 to the power network being monitored.

### 3.2.4.2 Differential Voltage Cards

All the channels on non-differential voltage cards (as described in the sections above) measure using a common GND.

On a differential voltage card (described here), each voltage channel has two ports – V+ (which represents the phase) and V- (which represents its reference).

- Connect the V1 phase to V1+.
- Connect the V2 phase to V1-.
- Continue to connect other channels, as shown below.



**Figure 3-7: Differential Voltage Card**

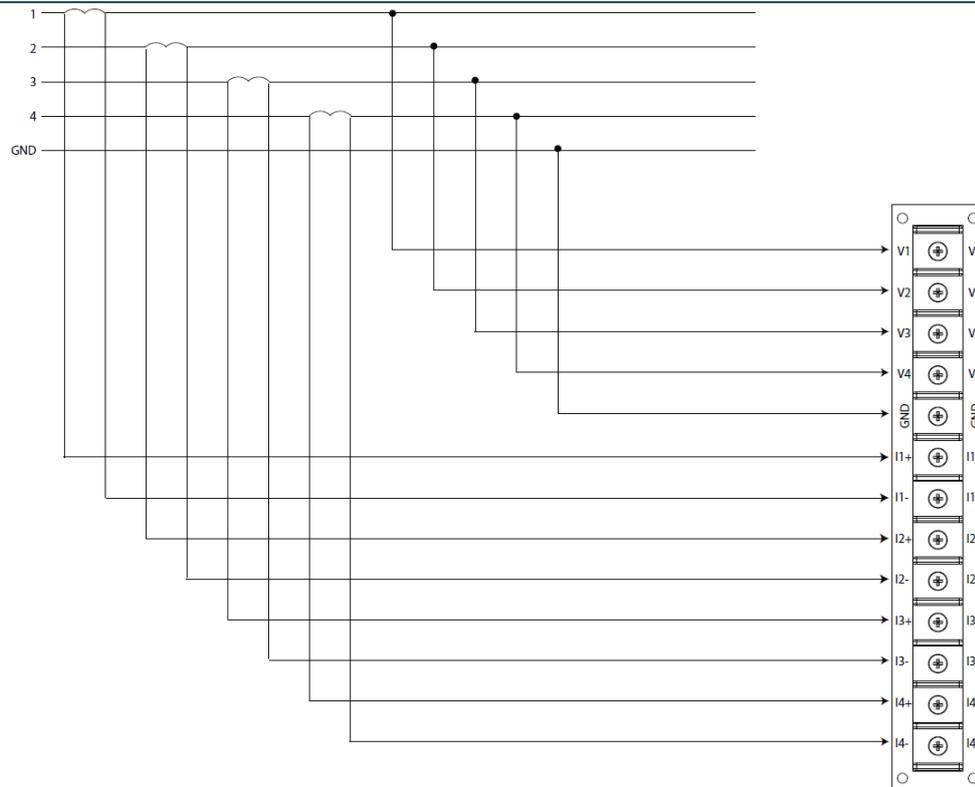
### 3.2.4.3 Current Channels

This section is only relevant if the G5DFR has current channels.

The current inputs are connected directly to the secondary windings of protection or metering CTs. The nominal and full-scale voltages are specified in *Appendix B, Technical Specifications* on page 132.

The current channels are labeled on the G5DFR with + and - indicating their signal polarity – I1+, I2+, I3+, I4+, I1-, I2-, I3-, I4-.

A lug fork is provided for each current channel connector.



**Figure 3-8: Current Channels Card**

### 3.2.4.4 Low-voltage Channels

This section is only relevant if the G5DFR has low-voltage (0–10 V) channels (either 4 or 8 such channels).

Low-voltage channels are used to measure current. Typically, such channels are used for measurements with current clamps, which convert current to a +/-10V signal.

You can connect a current clamp by plugging it into the relevant channel (BNC connector).

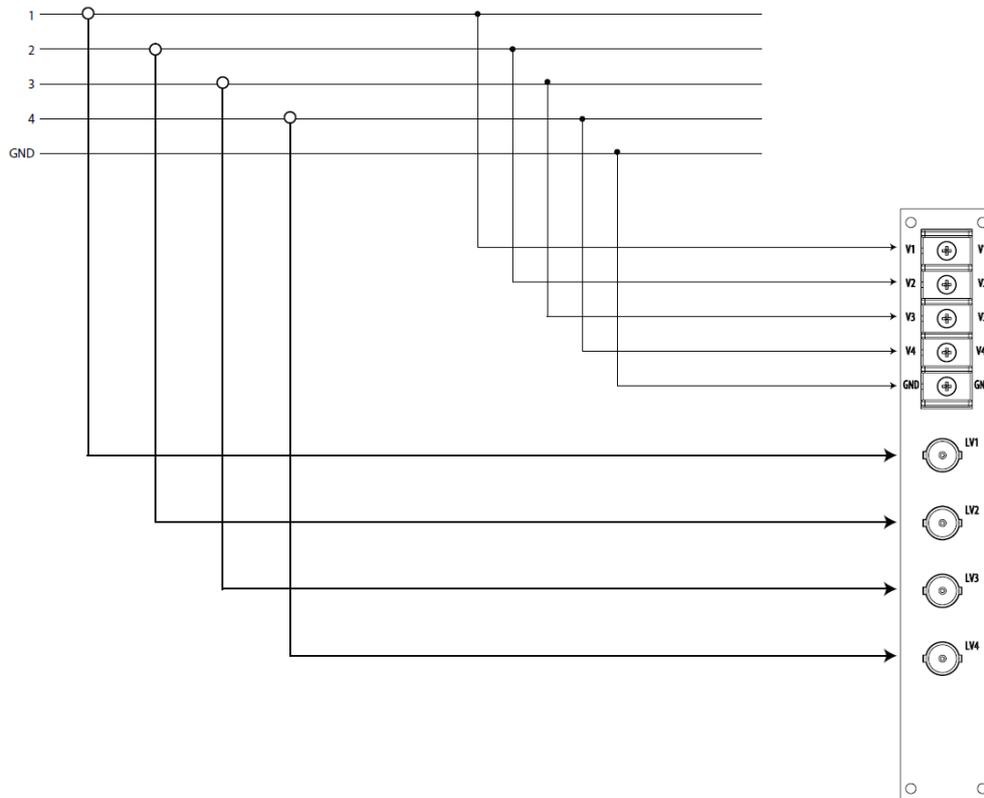
The following low-voltage cards options are available –

- 4 low-voltage channels and 4 standard-voltage channels of 500 V
- 4 low-voltage channels and 4 standard-voltage channels of 1,500 V
- 4 low-voltage channels and 4 standard-voltage channels of 4,000 V
- 8 low-voltage channels

A maximum of two low-voltage cards can be used in slots 1 and 2.

You can use two cards with low-voltage channels in a variety of channel combinations. For example –

- One card with 4 low-voltage channels and 4 standard-voltage channels and a second card with 8 standard-voltage channels for a total of 4 low-voltage channels and 12 standard-voltage channels
- Two cards with a total of 16 low-voltage channels (8 low-voltage channels per card)



**Figure 3-9: Low-voltage Channel Card**

### 3.2.5 Attaching the Measured Analog Channel Connector

The G5DFR is provided with a lug fork for the GND connector and each voltage channel connector, and each current channel connector on the G5DFR.

The procedure for connecting the GND, voltage, and current cables to the G5DFR is the same.

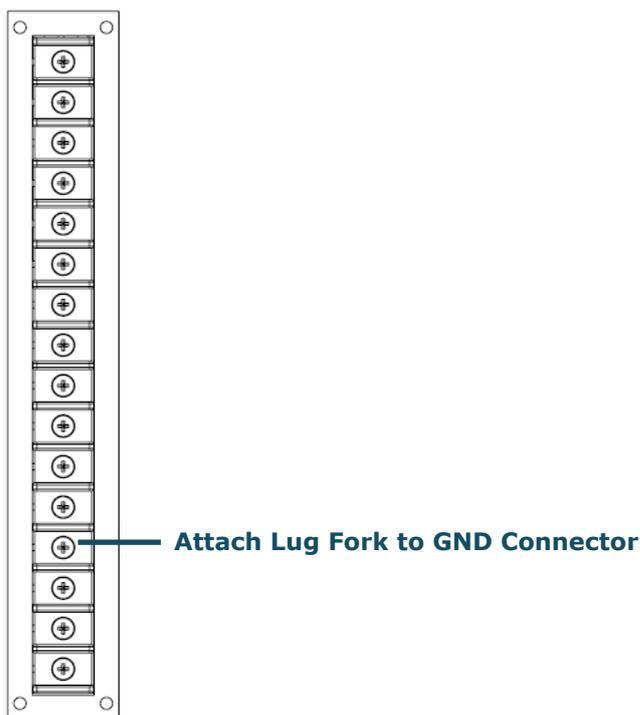
► **The following describes how to connect a GND cable to the G5DFR –**

- 1** Attach one of the provided lug forks to a GND cable.



**Figure 3-10: Lug Fork**

- 2 Unscrew the GND connector on the rear panel of the G5DFR, and then attach the GND lug fork to the GND connector.



**Figure 3-11: Connecting to the GND Connector**

- 3 Tighten the GND connector screw.
- 4 Repeat the steps above for all phases to connect the voltage and current signals.
- 5 Attach the protective plastic cover over the connectors.

**Note** – After connecting all G5DFR measurement channels, you must log into the device web interface (as described on page 60) to configure the device, including all channels and feeders, as described in *Settings* on page 61.

### 3.2.6 Connecting Auxiliary Cards

The Auxiliary cards extend the G5DFR I/O capabilities. Each Auxiliary card can handle various signal types, such as digital input, digital output, relay output, and current loop.

A G5DFR can have between zero and five auxiliary cards, which can be inserted into any of the five slots.

Digital input cards consist of 32 digital input channels. Digital input cards are available in the following configurations, and all have a sampling rate of 128 samples/cycle –

- 32 digital inputs, 48 V
- 32 digital inputs, 115 V
- 32 digital inputs, 230 V

A digital output card consists of 16 outputs (DO1–DO16).

A relay card has eight relay channels in a single card.

An analog input card has 32 inputs. It uses a 4–20 milliampere sensor.

Different connectors are available for the different Auxiliary cards.

Connectors are provided per specific order. For example, if the G5DFR includes a Digital Input card, it will include an 18-pin connector (16 channels, Ground, and an additional non-connected pin).

For a complete list of Elspec auxiliary cards, see page [127](#).

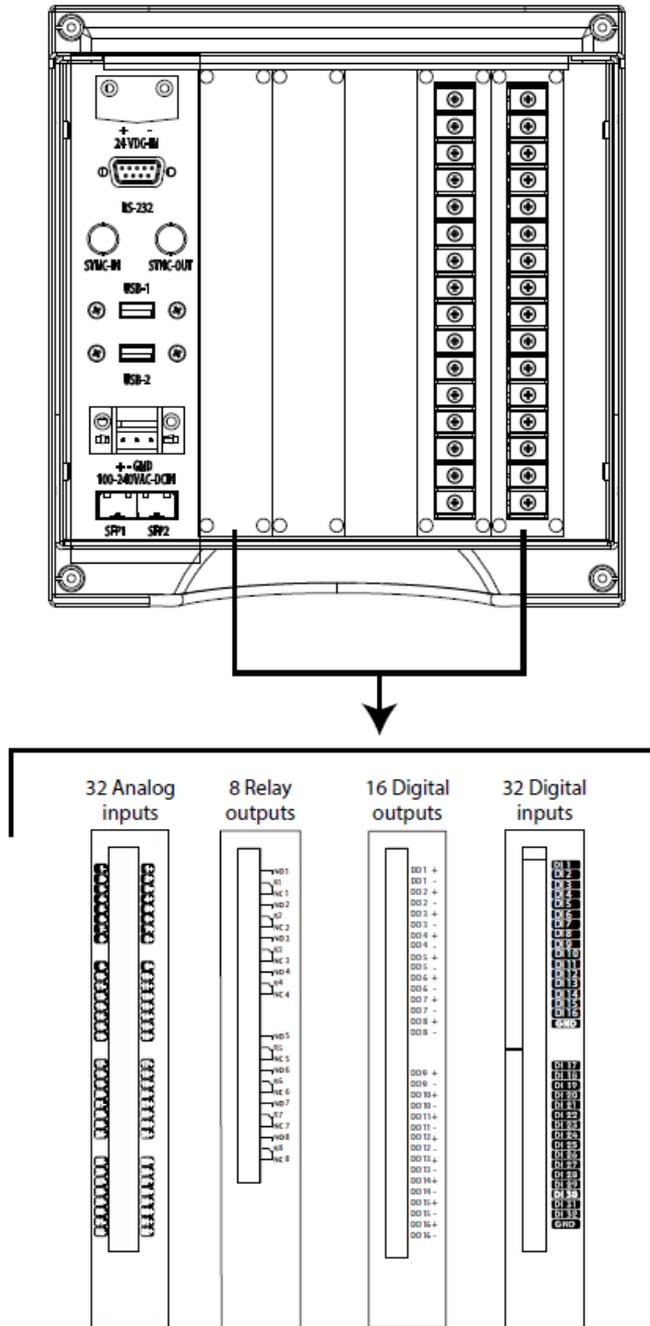
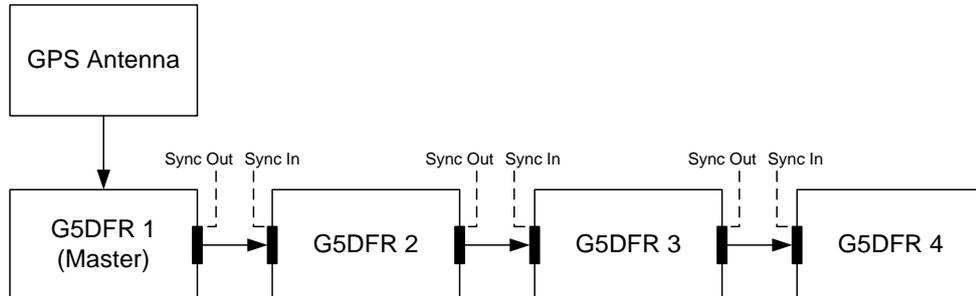


Figure 3-12: G5DFR Rear Panel – Auxiliary Card Connectors

### 3.2.7 Daisy Chain – Multiple Devices

A series of G5DFRs can be strung together in a daisy chain by connecting the Sync In of the first device in the chain to the Sync Out of the next G5DFR in the

chain. This enables you to use a single external time source to synchronize the clocks of all the G5DFRs. This external time source only needs to be connected to the master G5DFR (the first G5DFR in the chain).



**Figure 3-13: Multiple Devices in a Daisy Chain**

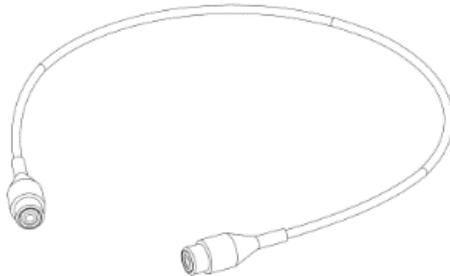
As shown in Figure 3-13, the GPS antenna synchronizes the clock of the first G5DFR in the chain (G5DFR 1 – the master). The Sync Out of the G5DFR 1 connects to the Sync In of the second G5DFR in the chain (G5DFR2) and so on.

**Note** – The GPS antenna shown in Figure 3-13 is optional. Alternatively, the G5DFR master can use another external time source or its own internal clock instead of being synchronized to another device, such as a GPS antenna.

To connect multiple devices in a daisy-chain configuration, all the devices must be physically located together. Use the double-ended cable shown in Figure 3-14 to connect the master G5DFR Sync Out (the time source device) to the Sync In of the next G5DFR in the chain.

To configure a daisy-chain configuration, see page 112.

Once connected and configured, wait several seconds to verify that the new source is recognized (on the front LCD screen).



**Figure 3-14: Cable to Connect Devices in a Daisy Chain**

## 3.2.8 Connecting GPS + PPS

The G5DFR can be connected to a GPS antenna to provide a GPS time source.

The GPS antenna should be placed outdoors with a clear sky view.

The GPS antenna should be connected to the rear panel RS232 port.

If a PPS signal is also needed, the two additional wires should be connected to the + and - of a 5V power supply.

▶ **To connect a GPS antenna –**

- 1** Set the time source in the web interface, as described on page 39.
- 2** Connect the RS232 cable from the output of the antenna to the back panel of the G5DFR.
- 3** Wait 30 seconds and then verify by checking the G5DFR time source, as indicated in the G5DFR Web user interface information on the front LCD.

## 3.3 USB Ports

The G5DFR has USB ports on its rear and front panels. The following two operations can be performed when connecting a USB drive:

- Restore the Username and Password.
- Copying the PQZ file from the unit to the USB drive.

### 3.3.1 Restoring the Username and Password

► **To restore the username and password:**

- 1** Contact Elspec's support and request them to send you the username and password recovery file.
- 2** Copy the file to the USB drive.
- 3** Insert the USB drive into the USB port and leave it in for at least 60 seconds.

The username and password are restored.

### 3.3.2 Copying the Unit's PQZ file

► **To copy the Unit's PQZ file:**

- 1** Verify the USB drive is empty (has no files or folders).
- 2** Create a folder named PQZ (capital letters) on the USB drive.
- 3** Insert the USB drive into the USB port.

The PQZ file is copied to the created PQZ folder.

Note – during this time, the G5DFR **Status** changes from **Export** to **USB**. (see Figure 4-3 in section 4.1.1.1).

# 4 Touch Screen

The touch screen is available in G5DFR units produced from 2017 that have a 7-Inch LCD screen. The touch screen feature is enabled on Firmware versions 1.1.0.xx and more advanced.

## 4.1 Home Page

The home page is the screen that is displayed after powering up the G5DFR unit.



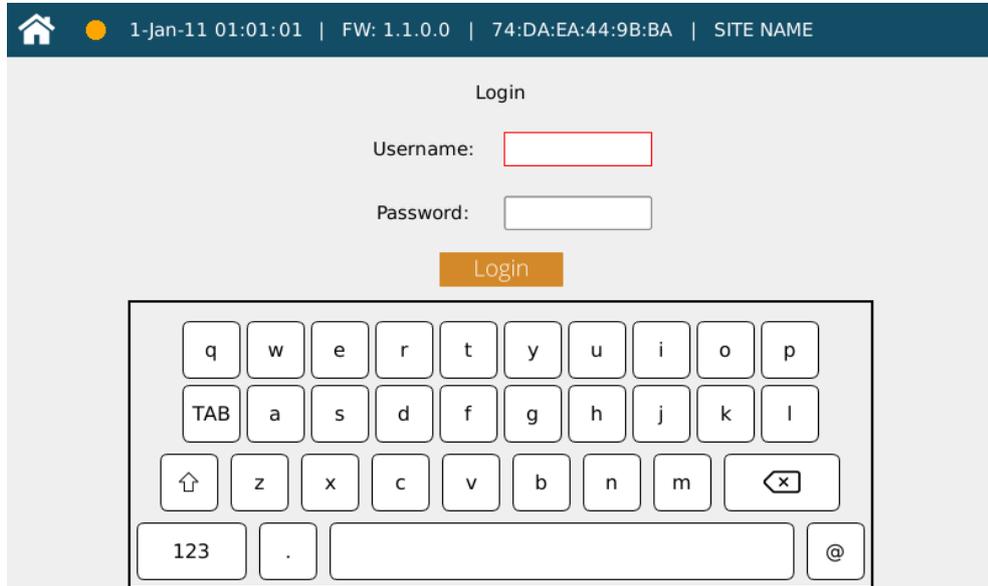
**Figure 4-1: Home page**

The upper part of the screen includes general information:

- Home  icon. Pressing the Home icon on any page returns to the home page.
- Status indication (green=ok, Orange=Warning, Red=Error), further information is available in the device web UI
- Date and time (configure in the device web UI or when selecting self in the time sync settings screen)
- Device Firmware version
- Device serial number
- Device name (configure in the device web UI. Max length of 15 symbols)

The only DFR page that does not require a touch screen is the Overview page, described in the following section 4.1.1.

Opening any of the offered pages, except the overview page, requires entering a **Username** and **Password** (defaults are user0/aA123123).



**Figure 4-2: Login screen**

## 4.1.1 Overview Page



This is the only page available for devices that do not support the touch screen. Selecting the Overview page opens the following screen.



Figure 4-3: Overview screen

### 4.1.1.1 System Status

- **Status:** Displays the current status of the G5DFR device (e.g., Initialize/Upgrade/Recording/Events only/Export to PQZ)
- **Oldest Data:** The date of the oldest data from the internal database
- **Newest Data:** The date of the newest data from the internal database
- **Time source:** Internal or external time source (e.g., SNTP/GPS/IRIG-B/Sync In/IEEE1588)
- **Time quality:** The quality of the time synchronization:
  - Green
    - Perfect < 1 microsecond
    - Excellent < 10 microseconds
    - Good < 100 microseconds
  - Orange

- Fine < 1 millisecond
- Moderate < 10 milliseconds
- Poor < 1 second
- Red
  - Bad  $\geq 1$  sec (yet still some external source is available)
  - No Sync Use the internal clock
- **Frequency:** As calculated over the 10/12 cycles aggregation for 50/60Hz (app 200 milliseconds)
  - Green – Frequency is synced from measurements
  - Red – Frequency is not synced
- **FW Version:** The firmware version

The Overview screen values are refreshed every 2 seconds.

#### 4.1.1.2 Cards in Slots

A visual description of the installed cards in the G5DFR unit slots.

The cards display has a color code that indicates their status.

- Analog Cards (Voltage):  
The threshold is 10% from the nominal value of the primary source.
  - White – the primary source is 10% below its nominal value.
  - Green – the primary source is 10% above its nominal value.
- Analog Cards (Current):  
For values lower than 1, the threshold is 10%. For values higher than 1, the threshold is 2.5%.
  - White – the primary source is 2.5% or 10% below its nominal value.
  - Green – the primary source is 2.5% or 10% above its nominal value.
- Aux Cards (Analog-in):  
Values are (0–10) V or (4–20) mA.
  - White – the measured (not converted) voltage/current is below 1V/4mA.
  - Green – the measured (not converted) voltage/current is within the range of (0–10) V or (4–20) mA.
  - Red – the measured (not converted) voltage/current is above 10V/20mA.

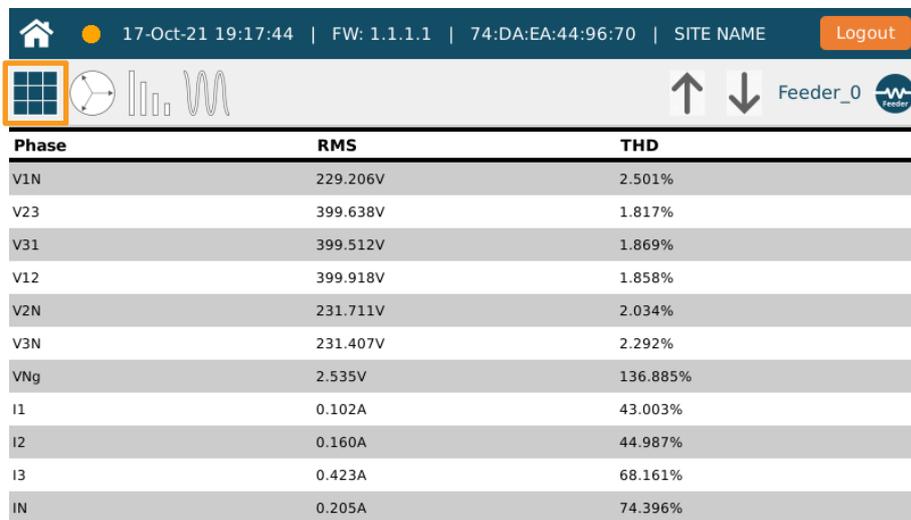
## 4.1.2 Monitoring Page



Selecting the Monitoring page allows the user to select from the following options.

- **Feeder** ( ): selecting feeder opens a list of feeders for selection (when there are more than one).

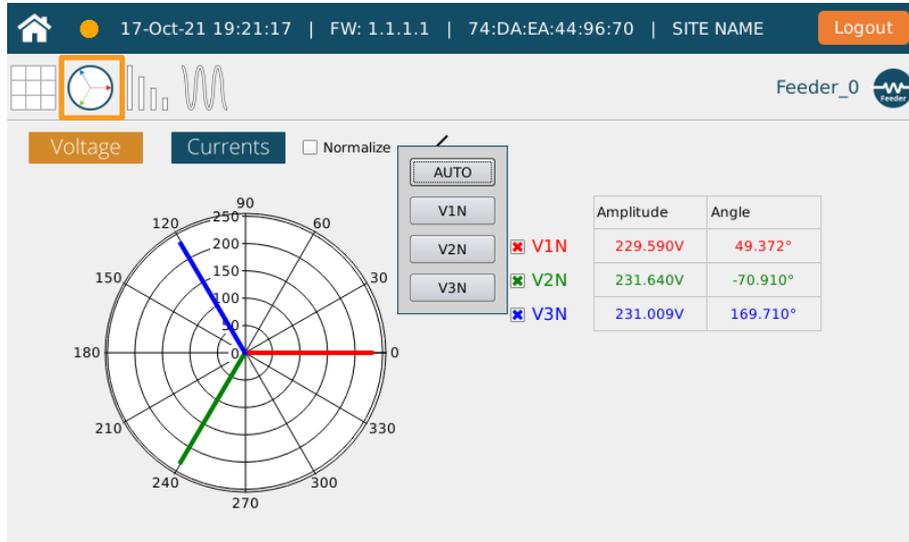
Note: non-English names are supported.



**Figure 4-4: Grid screen**

- **Grid** ( ): to view RMS & THD (columns) per feeder channels selection (rows).

- Phase & angle diagram** (📐): to view the phase angle & amplitude. The normalized option changes the values to percentage with reference to the configured nominal. The reference can also be set.



**Figure 4-5: Phase & Angle diagram screen**

- Spectrum** (📊): to view the harmonics (up to the 25th) as Bars. The user can "remove DC" or "remove fundamental" to allow a better view of the 2nd and higher harmonics, which are typically lower than the fundamental.

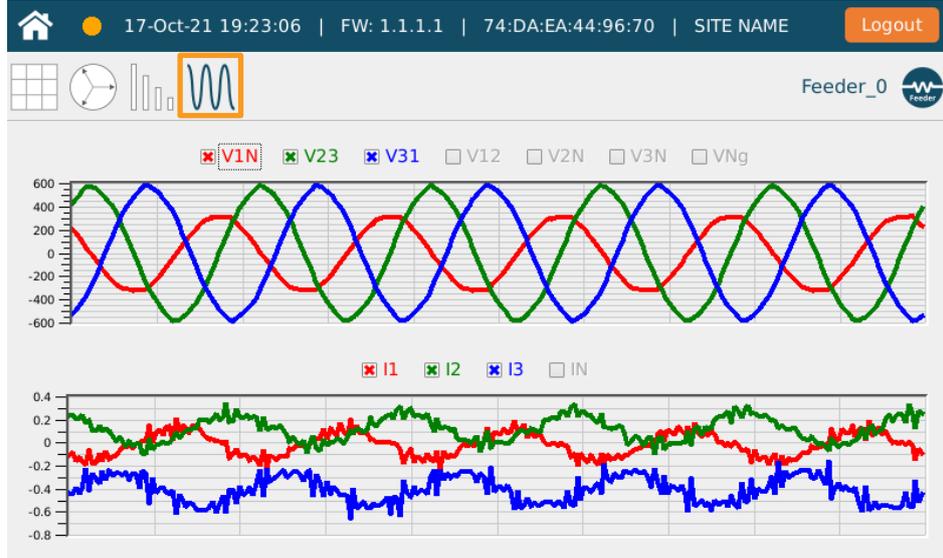


**Figure 4-6: Spectrum screen**

Note: Only 3 parameters can be selected.

Note: Higher harmonics up to the 511th can be viewed in the PQZ files.

- Waveform** (📈): to view both Voltage & current waveform.



**Figure 4-7: Waveform screen**

The Monitoring screen values are refreshed every 3 seconds.

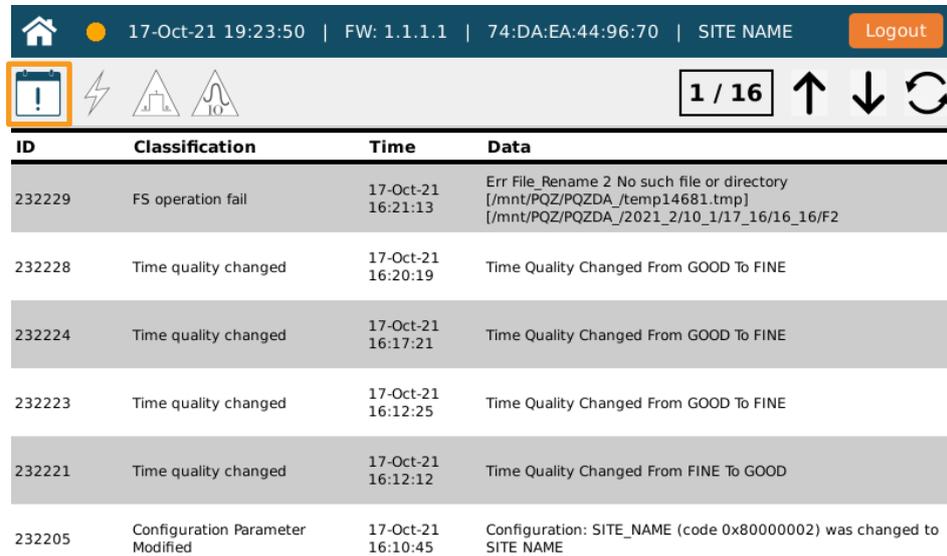
### 4.1.3 Event Page



Selecting the Event page displays the current page number, enables switching between pages, and refreshing the page.

On the left side, the user can select to show specific event types as follows: (from the last 96 events of the selected event type):

- **System Events:** to open system events such as time source change, configuration change, etc.



ID	Classification	Time	Data
232229	FS operation fail	17-Oct-21 16:21:13	Err File_Rename 2 No such file or directory [mnt/PQZ/PQZDA_/temp14681.tmp] [mnt/PQZ/PQZDA_/2021_2/10_1/17_16/16_16/F2
232228	Time quality changed	17-Oct-21 16:20:19	Time Quality Changed From GOOD To FINE
232224	Time quality changed	17-Oct-21 16:17:21	Time Quality Changed From GOOD To FINE
232223	Time quality changed	17-Oct-21 16:12:25	Time Quality Changed From GOOD To FINE
232221	Time quality changed	17-Oct-21 16:12:12	Time Quality Changed From FINE To GOOD
232205	Configuration Parameter Modified	17-Oct-21 16:10:45	Configuration: SITE_NAME (code 0x80000002) was changed to SITE_NAME

**Figure 4-8: System events screen**

**Touch Screen**

- **Power quality events:** to open power quality events such as Dip, Frequency, Harmonic, flicker, etc.

ID	Name	Classification	Phase	Start Time	Duration	Deviation	Value
232227	EVE_0	Custom Event		17-Oct-21 16:19:29	0:00.119	0	50.00482
232226	EVE_0	Custom Event		17-Oct-21 16:19:18	0:00.20	0	50.00025
232225	EVE_0	Custom Event		17-Oct-21 16:19:18	0:00.40	0	50.00069
232222	EVE_0	Custom Event		17-Oct-21 16:12:22	0:00.39	0	50.05259
232220	EVE_0	Custom Event		17-Oct-21 16:12:12	0:00.19	0	50.04502
232219	EVE_0	Custom Event		17-Oct-21 16:12:12	0:00.19	0	50.0789

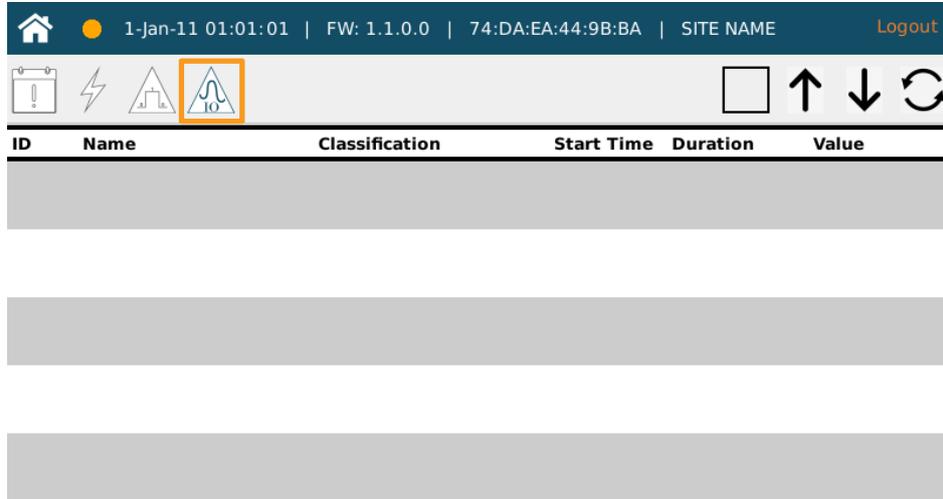
**Figure 4-9: Power quality events screen**

- **Digital IO events:** to open Digital IO events (available in DFR units that have a Digital IO card).

ID	Name	Classification	Time	Value

**Figure 4-10: Digital IO events screen**

- **Analog IO events:** to open Analog IO events (available in DFR units that have an Analog IO card).



**Figure 4-11: Analog IO events screen**

## 4.1.4 Energy Page

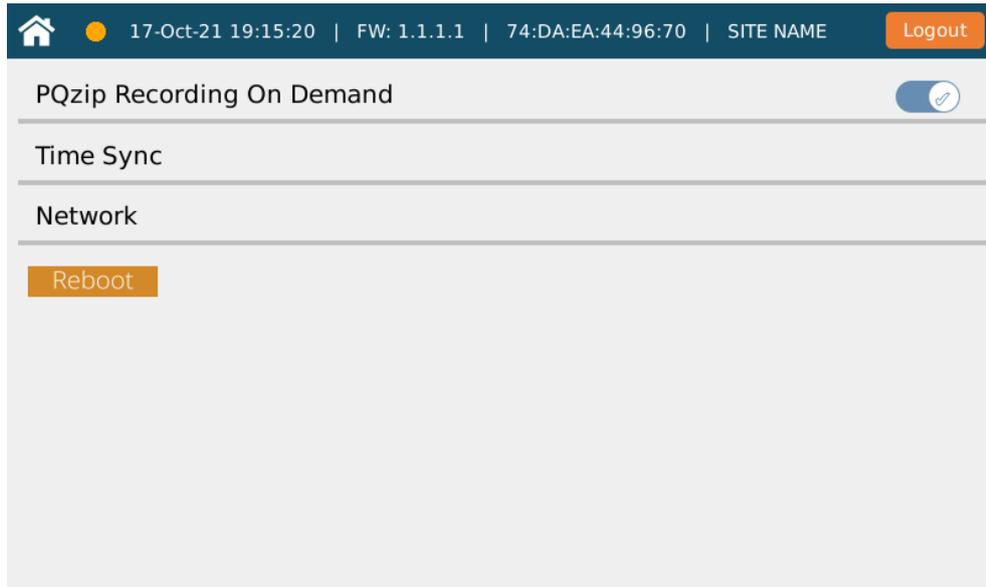


Currently not available.

## 4.1.5 Configuration Page

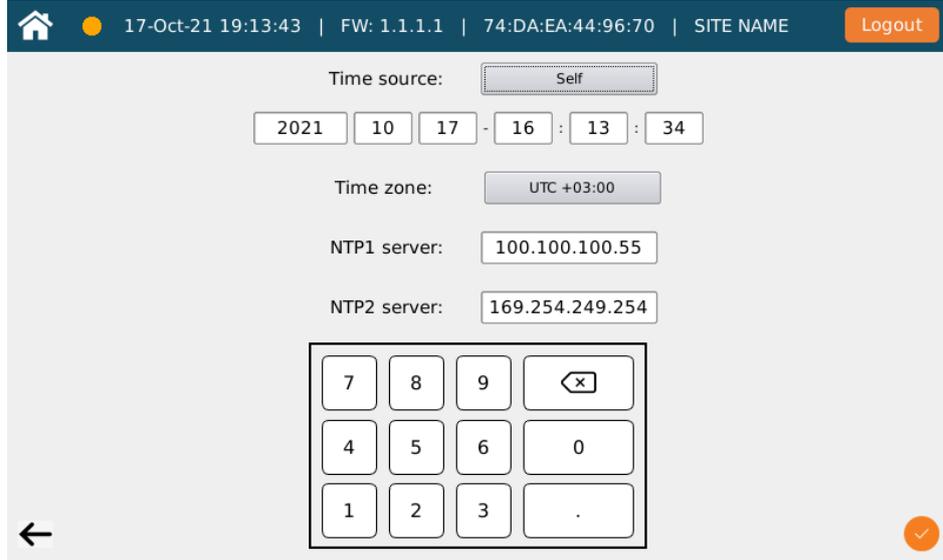


Selecting the Configuration page allows the user to select from the following options.



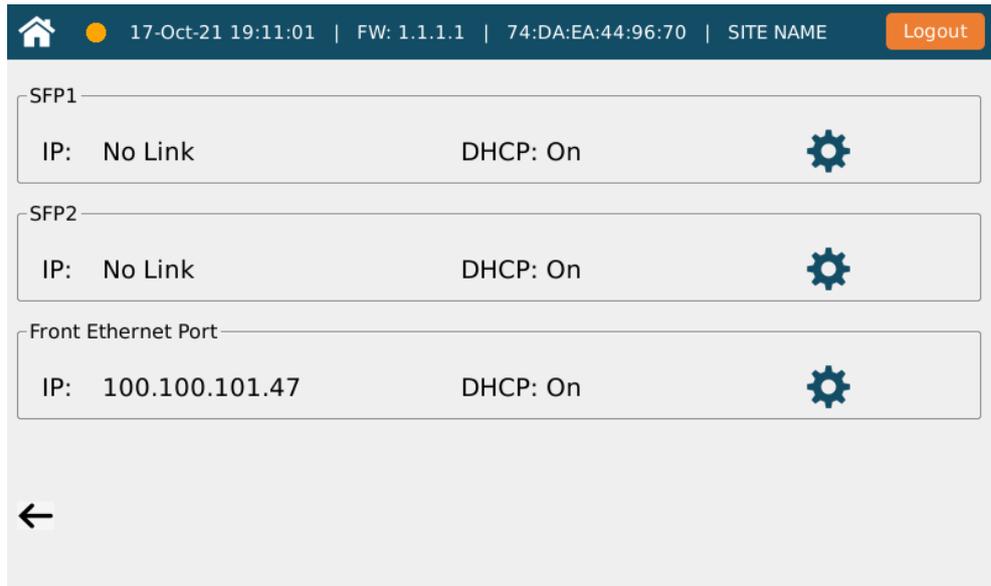
**Figure 4-12: Configuration page**

- **Logout:** Pressing Logout on the top right corner of the screen logs out of the application.
- **PQZ recording On Demand:** Optional Enable/Disable button.  
The Enable/Disable button is available only when the license does not include continuous recording.
- **Time Sync:** Allows the user to select the time source for setting the Unit time region (when choosing self).  
If an SNTP server is used, the Server IP (the main server and additional Backup source if such is available) can be configured on this page.



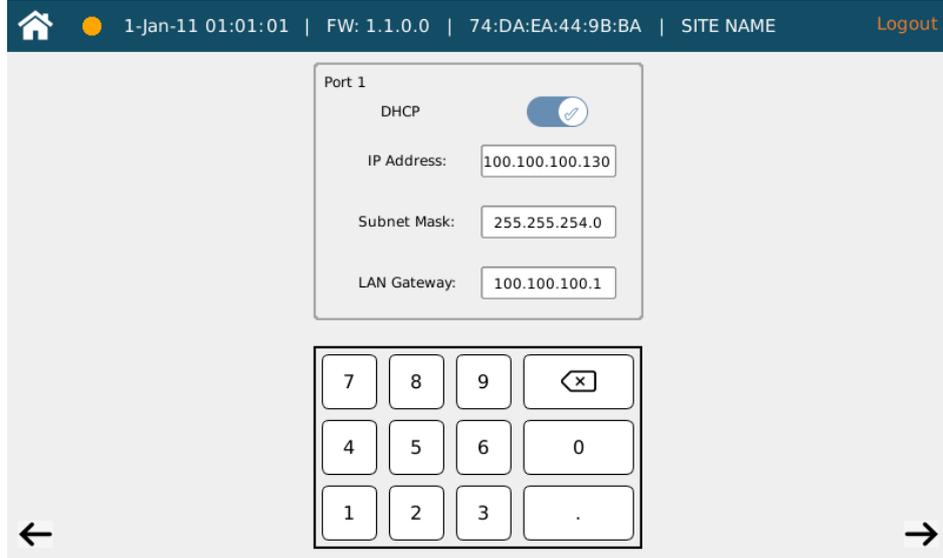
**Figure 4-13: Time Sync screen**

- **Network:** Shows the Network settings such as the IP address, DHCP enable/disable.



**Figure 4-14: Network screen**

The setting option (⚙️ on the right) allows the user to configure the network parameters:



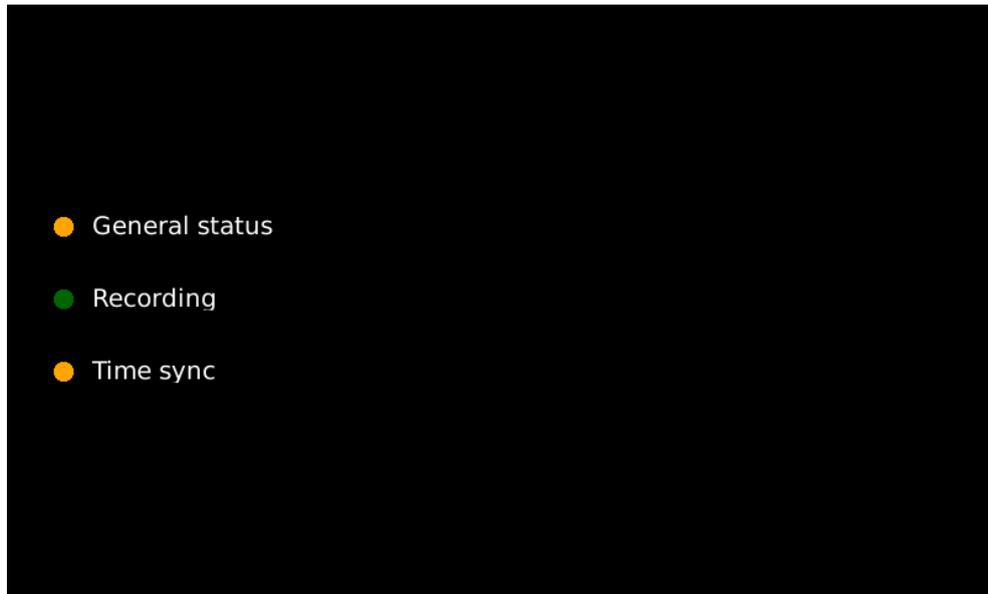
**Figure 4-15: Network parameters screen**

- **Reboot:** Pressing Reboot reboots the application.

## 4.2 Sleep Mode

The LCD will enter sleep mode after it is not used for a defined time. The time can be configured in the Web UI under “settings” → “General”); the default value is 5 minutes.

The sleep mode page only offers the following color indications:



**Figure 4-16: Sleep mode indications**

### 4.2.1 General Status

Offers the possible statuses:

- Green – OK
- Orange – System-related warnings
- Red – System-related Errors

Further information on these statuses is available in the device web UI.

### 4.2.2 Recording

- Green – PQZ Recording is on
- Red – PQZ Recording is off

### 4.2.3 Time Sync

- Green
  - Perfect < 1 microsecond
  - Excellent < 10 microseconds
  - Good < 100 microseconds
- Orange
  - Fine < 1 millisecond
  - Moderate < 10 milliseconds
  - Poor < 1 second
- Red
  - Bad  $\geq 1$  sec (yet still some external source is available)
  - No Sync Use the internal clock

### 4.2.4 Custom

The User can add up to 5 additional custom indications in the Sleep mode page (not implemented yet).

# 5 Web Interface

This chapter describes the G5DFR web interface, which enables you to configure the G5DFR and monitor your recordings.

## 5.1 Launching the G5DFR Web Interface

Two options are provided for launching the G5DFR web interface –

- **DeviceSearch Application**, page 59
- **Directly via a Web Browser**, page 60

### 5.1.1 Using the DeviceSearch Application

A link to the DeviceSearch application is provided by Elspec. It is also on the USB stick provided with the G5DFR.

► **To launch the G5DFR DeviceSearch application –**

- Click this desktop icon –



**Figure 5-1: Launching the DeviceSearch Application**

This application broadcasts a request to detect all Elspec devices connected to the network and then lists them in the *Device Search* window.

Each row displays information about one Elspec device. Most columns are self-explanatory –

- **Product Type** – Shows **G5** for G5DFR devices and the product type for other devices.
- **WEB** – Launches the G5DFR web interface on your default browser, as described on page 60.
- **IP Mode** – Indicates whether the IP address of the G5DFR is received from a DHCP server or whether it was configured in the web interface (Fixed IP), as described on page 91.

## 5.1.2 Web Browser

Enter the IP address of the G5DFR device directly into your browser. The IP address of the G5DFR device is displayed on the device’s screen.

## 5.1.3 Logging In to the G5DFR Web Interface

► **To log in to the G5DFR web interface –**

- 1 Click the **Web** column in the row of the desired G5DFR device in the *Device Search* window to launch the web interface of that G5DFR device. Alternatively, you can simply enter the IP address of the G5DFR device directly into your browser. The IP address of the G5DFR device is displayed on the device’s screen.

The Login window displays.

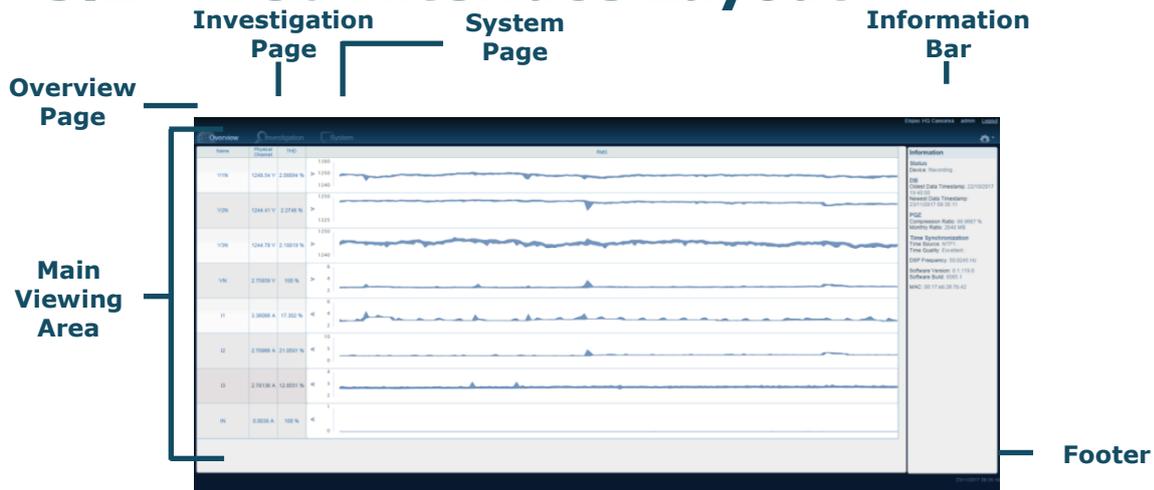
- 2 In the **Select Language** field, select the language to be displayed in the web user interface.
- 3 Enter the username and password.

The default is **Username – user0** and **Password – aA123123**, which is an administrator user with all permissions.

- 4 Click the **Login** button to access the device Web user interface.

**Note –** The main part of the login page is displayed empty the first time you use the web interface and remains so until you configure Virtual Channels, as described on page 66.

## 5.2 Web Interface Layout



### Figure 5-2: Web Interface Layout

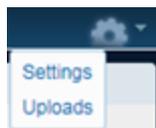
To fully understand how to operate the web interface, it is important to know how items on the screen are tied together and how to manipulate them.

The G5DFR web interface consists of the following areas –

- **Header** – Consists of the following two areas –
  - **Information Bar** – Displays the logged-in user on the top-right corner and provides the option to log out.  
A yellow or red dot may show at the top left corner, indicating that a warning or an error has occurred on the G5DFR. In addition, a description of the latest warning or error is displayed in the information area on the right of the Overview window (page 60).
  - **Main Menu** – The main menu enables you to navigate between the main pages of the G5DFR web interface. The main pages are –
    - **Overview (Default)** – page 60 – Displays an at-a-glance overview of the system’s condition.
    - **Investigation** – page 101 – Enables you to monitor the value of real-time and historical parameters over time.
    - **System** – page 111 – Enables you to view the configuration of the connected G5DFR device according to the logged-in user permissions.
    - **Settings** – page 61 – The Settings window provides a variety of tabs across the top of the window, each containing different groups of settings. After setup and configuration, the default settings in the G5DFR must be configured.
- **Main Viewing Area** – Displays information and provides operations related to the selected page.
- **Footer** – Displays the date and time of the G5DFR device.

## 5.3 Uploads

Click the Cogwheel in the top-right corner of the main menu to display the following dropdown menu.



### Figure 5-3: Uploads

**Note** – Uploaded files are not applied automatically. Both the upload and the execution are initiated and approved by the user in two separate steps. Files uploaded via the web interface must be applied via the web interface.

Selecting **Uploads** opens the Uploads window.

- Each file category has its own table (upgrade files, XML config files, etc.)
- Uploaded files are displayed in table

► **Upload process –**

- 1** Open the requested upload category.
- 2** Press the **Select** file button and select the file to upload.
- 3** Press the **Upload** button.
- 4** Press **OK** on the pop-up message.
- 5** Select what to do with the uploaded file on the Apply pop up message:
  - **Apply** now
  - **Cancel** (Apply later)

A file that was not applied is stored in the device and displayed in a table that includes the file name, type, size, last modified and actions (Apply, remove).

File name	File Type	File size	Last modified	Actions
Calibration_File	PQZ	4 kb	18/04/2023 16:32:53	Apply Remove

Many files can be uploaded to the device and have no expiration date. Files are automatically removed after they are successfully applied.

The Web interface includes the following fields:

- **Upgrade**  
For Upgrading the device to a newer version. The file format is **.tar**.
- **License**  
Requires selecting a file and receiving a License Key. For details, see Appendix A, Licensing, on page 115.
- **XML Configuration**  
The User can Download and Upload configuration files.  
When downloading configurations, the user can select specific configuration sections and can transfer configuration files from one unit to another.  
**Note** – when selecting some configurations (e.g., Events: PQ) others are marked automatically.  
It should be noted that different devices **MUST** have the same cards and in the same slot order.
- **Unit calibration**  
The user can Download and Upload calibration files from or to the device. The calibration file format can be **cal** or **pqz**, and the calibration values are updated in the end.
- **CA certificates**  
For adding an entry to the Certificate Authority database, so the G5DFR device (as a client) will know which authorities to trust when communicating with a server (PQSCADA). It needs to be in pem format.
- **Certificates**

## **Web Interface**

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For uploading the G5DFR server certificate. It needs to be a pfx file, and a password is needed.

## 5.4 Settings

The Settings window provides a variety of tabs across the top of the window, each containing different groups of settings. After setup and connection (as described in *Chapter 3, Setup and Connection*, on page 27) and connecting to the web interface (as described on pages 43 through 60), the default settings in the G5DFR must be configured as described in this section. Typically, device configuration needs to be performed only once. However, the configuration can be changed thereafter, as needed.

Click the Cogwheel in the top-right corner of the main menu to display the following dropdown menu.



**Figure 5-4: Settings**

When selecting **Settings**, the Settings window opens.

The Settings window provides a variety of tabs across the top of the window. You can configure these parameters in any order. We suggest you start from the leftmost tab called **General**, configure it, and then progress through the parameters of each tab using the **Next** button. The following configuration tabs are provided –

- **General Tab**, page 65
- **Analog V/I Tab**, page 65
- **GPS & Time Tab**, page 70
- **PQ Recording Tab**, page 72
- **Events Tab**, page 73
- **PMU Tab**, page 82
- **Protocols Tab**, page 84
- **Users Tab**, page 90
- **Network Tab**, page 91
- **Auxiliary Tab**, page 92
- **Energy Tab**, page 94

## 5.4.1 General Tab

The following describes the fields in this window –

- **Site Name, Site Description, Operators Name, and Company Name –**  
Enter a free-text description of the site, operator, and company of the G5DFR.
- **Error and Warning Notifications –** The selected types of errors and warnings to be displayed, as described on page 99.
- **Unit settings –** Set the timeout for the LCD to go into sleep mode.
- **Reboot System –** Reboots the system. This may be necessary to have configuration changes take effect and to reboot the hardware.
- **System log –** Display list of available log files in directory, After upgrade the system log should be disabled (Only for admin permission)

## 5.4.2 Analog V/I Tab

The **Analog V/I** tab is a very important tab that enables you to define the channel mapping of the G5DFR device.

### General Parameters

► **To define general parameters –**

- 1** In the **Nominal Frequency** field, select whether the network is 50 or 60 Hz.
- 2** In the **Nominal Flicker** field, select 120 or 230 according to the low-voltage rating of the power network.

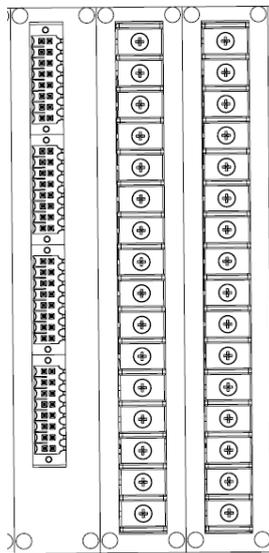
### Physical Channels

This area displays a row for each physical channel of the G5DFR and enables you to assign them a name and their Primary and Secondary factor values. The number of physical channels and their type is defined automatically according to the installed analog cards.

► **To define physical channels –**

- 1** Expand the horizontal blue bar labeled **Physical Channels** to display the physical channels of the G5DFR device.

These rows represent the physical channels of the G5DFR device from top to bottom. For example, as shown below.



**Figure 5-5: G5DFR Voltage and Current Channel Connectors**

- 2** In the **Channel Name** field of each channel row, type in a descriptive name.
- 3** Set the **Primary** and **Secondary** factor values of each physical channel row. These values and their units are according to whether the channel is a voltage channel (measured in Volts) or a current channel (measured in Amps). The window and photograph above show four voltage channels and four current channels.

**Note** – The **Channel Type** column indicates whether each of the physical channels is a Voltage or a Current channel. This designation is determined by the hardware.

**Exclusion:**

**Low voltage** card channels can be configured by user as **Voltage** or **Current**, by default, the first channels will be Current and the next 4 will be Voltage.

The device will need a **reboot** to apply the changes.

**Virtual Channels**

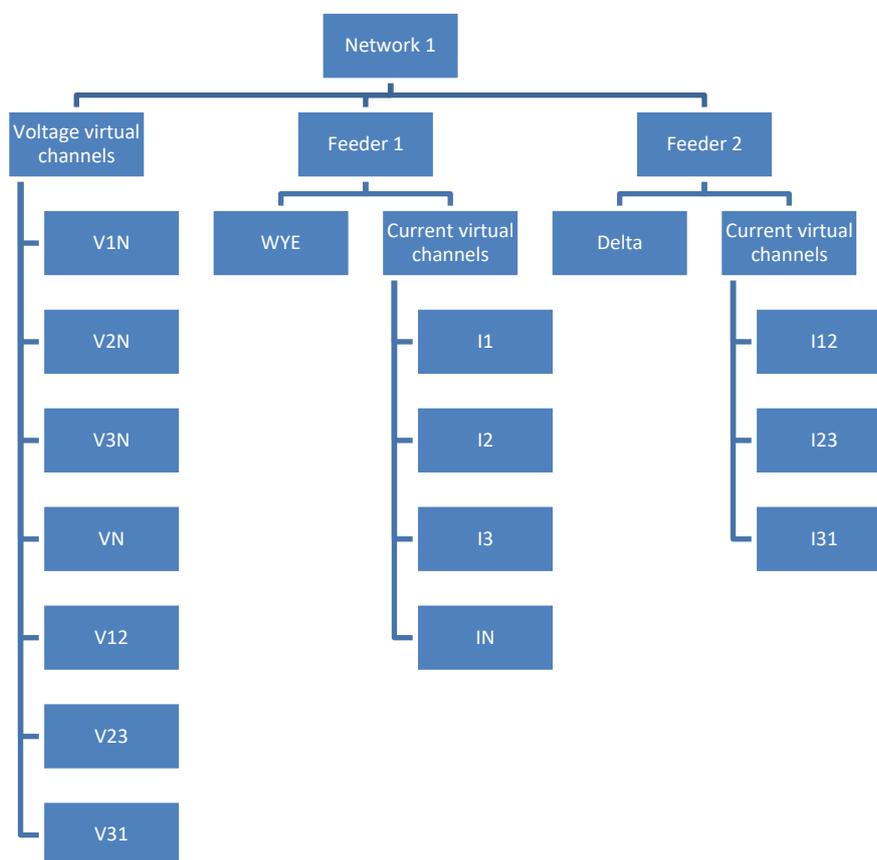
Measuring 16 physical channels in a variety of voltage and current combinations can result in many different power topologies. For example, four voltage and four current channels can be used to monitor either of the following –

- A single WYE system that has three phases and is Neutral for voltage and current.
- OR –

## Web Interface

- Four single-phase lines with one phase for voltage and one phase for current.

The Virtual Channels area of the page enables you to map the physical channels to a variety of power topologies of the monitored system.



**Figure 5-6: Example Network Topology**

The hierarchical topology mapping comprises the following elements –

- **Network** – The network element groups the feeder and voltage virtual channels.
- **Feeder** – The feeder element defines the power topology (WYE, Delta, and so on) and groups the current virtual channels.
- **Virtual Channels** – The virtual channels element is calculated from one or more physical channels, according to the following formula –
  - $Virtual\ Channel = \sum_{N=1}^4 (Physical)_N X (Factor)_N$

For example –

- To calculate V12, the formula is  $V1 \times 1 + V2 \times (-1)$ .
- To calculate VLEAK, the formula is  $V1 \times 1 + V2 \times 2 + V3 \times 1$ .

► **To define a virtual channel –**

**1 Network Element** – Click the **Virtual Channels** blue bar to expand it and display the Virtual Channels area. In the Virtual Channels area, click the  button at the top to add a new network.

**2** In the **Network Name** field, enter a name for the network.

The next two steps describe how to define the Virtual Voltage Channels and Feeders (Current Channels) of this Network.

**3 Channels** – Define the Virtual Voltage Channels of this Network Topology, as follows –

- In the Channels area, click the  button to add a new Virtual Channel row.
- From the **Tag** dropdown menu, select one of the Virtual Channel Classifications. These classifications specify the electrical meaning that you will define in the steps below.  
The following describes the measure represented by each option in this dropdown menu –
  - **V1G** – Voltage phase 1 relative to GND
  - **V2G** – Voltage phase 2 relative to GND
  - **V3G** – Voltage phase 3 relative to GND
  - **V1N** – Voltage phase 1 relative to Neutral
  - **V2N** – Voltage phase 2 relative to Neutral
  - **V3N** – Voltage phase 3 relative to Neutral
  - **V12** – Voltage phase 1 relative to Voltage phase 2
  - **V23** – Voltage phase 2 relative to Voltage phase 3
  - **V31** – Voltage phase 3 relative to Voltage phase 1
  - **VNG** – Neutral relative to GND
  - **VLEAK** – Voltage phase 1 + Voltage phase 2 + Voltage phase 3
  - **VDC** – DC signal relative to ground
- In the **Channel Name** column, enter a free-text descriptive name for this new Virtual Channel. You might want to enter the same text in this field as the **Tag** field.
- In the **Nominal** column, enter the nominal value of this Virtual Channel.
- From the **Physical Channel 1** dropdown menu, select one of the Physical Voltage Channels listed in the Physical Channels area, as defined on page 112. Only channels that have Signal Type = Voltage can be selected.  
**Note** – If you change the name of a Physical Channel in the **Channel Name** column of the Physical Channels area, then this new name only appears in this dropdown menu after you click the **Apply** button.
- In the **Factor 1** column, specify the factor by which to add or subtract the measurement of the physical channel that you selected in the **Physical Channel** column. The default value is 1.

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- If needed, repeat the same, as described above, in the **Physical Channel 2** dropdown menu and the **Factor 2** column.
- If needed, repeat the same, as described above, in the **Physical Channel 3** dropdown menu and the **Factor 3** column.

### Example 1 – V1N

This example describes how to build the formula for V1N (meaning Voltage phase 1 relative to Neutral).

This example is for a G5DFR that has four current channels and four voltage channels.

In this G5DFR, the first four channels (1–4) are current channels (I1–I4), and the next four channels (channels 5–8) are voltage channels (V1–V4).

The last voltage channel (Channel 8 V4) is connected to Neutral.

**Channel 1** – I1 +/-.

**Channel 2** – I2 +/-.

**Channel 3** – I3 +/-.

**Channel 4** – I4 +/-.

**Channel 5** – V1 – is connected to phase 1.

**Channel 6** – V2 – is connected to phase 2.

**Channel 7** – V3 – is connected to phase 3.

**Channel 8** – V4 – is connected to Neutral.

If Physical Channel 5 (V1) is connected to phase 1 and the Physical Channel 8 (V4) is connected to Neutral, then in order to calculate V1N, you need to subtract channel 8 from channel 5 (V1 minus V4). To do so –

- Select the name of Physical Channel 5 (V1) in the **Physical Channel 1** field.
- Enter -1 in the **Factor 1** field.
- Select the name of Physical Channel 8 (V4) in the **Physical Channel 2** field.

**IMPORTANT NOTE** – This configuration option enables you to compensate for connection errors made during installation, such as swapped phases or reverse polarity.

#### 4 Feeders – Define the Feeders of this network topology by mapping the Virtual Volage and Current Channels to the Feeder and specifying its network topology, such as single-phase or three-phase, and whether it has a Y or Delta connection.

- In the Feeders area, click the  button to add a new Feeder row.
- Specify the following fields for the Feeder row –
  - **Tag** – Select the channel in the dropdown list.

- **Channel Name** – Enter a free-text descriptive name for this new Feeder channel. You can rename the channel if preferred.
- **Nominal** – Enter the nominal value of this Feeder channel. In most cases, this value should be configured to the average current within the recording period.
- **Physical Channel** – Specify the physical channel of the signal being measured.
- **Factor** – Specify how to add or subtract the measurement of the physical channel you selected in the Physical Channel column.

### 5.4.3 GPS & Time Tab

The internal clock of the G5DFR has an accuracy of 20 PPM. The **GPS & Time** tab enables you to synchronize this internal clock to an external time source.

**Note** – The G5DFR GPS connection can be used with or without a power supply. Using GPS with a power supply affects accuracy.

#### Configured Source

The clock can be synchronized to the following types of external time sources –

- Auto – The G5DFR automatically selects the best time source option.
- Self – The G5DFR uses its own internal clock.
- Sync In – One G5DFR can be synchronized to another G5DFR by connecting its Sync Into the Sync Out of another G5DFR (the G5DFR that has its Sync Out connected becomes the master and determines the time for both units). In this case, the slave G5DFR must be configured to Sync In, and the master G5DFR must be configured to one of the time sources listed above.

A series of G5DFRs can be strung together in a daisy chain by connecting the Sync In of the first device in the chain to the Sync Out of the next G5DFR in the chain. This enables you to use one external time source to synchronize the clocks of all the G5DFRs. This external time source only needs to be connected to the master G5DFR (the first G5 in the chain). For connecting multiple devices in a daisy-chain configuration, see page 39.

- GPS – Requires connecting a serial Cable from the GPS Antenna to the RS232 port of the device.
- IRIGB
- NTP1 or NTP2 – The IP address of the primary NTP server must be entered for this option. The IP address of a secondary NTP server can also be entered to be used when the primary NTP server is not available.
- IEEE1588
- GPS (No PPS – Pulse Per Second)

The following additional options are provided –

#### Time Zone

Select the time zone in which the G5DFR unit is located.

## Web Interface

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### NTP Servers

The address of the NTP servers.

### PTP Network Protocol

- UDP/IPv4 (I3)
- IEEE 802.3 (L2)

### PTP Delay Mechanism

- P2P
- E2E
- Auto

### PTP Timestamping

- Hardware
- Software

### PTP Domain

### Net Interface

The connected port (SFP 1/2, Lan).

- SFP1
- SFP2
- Front LAN

## 5.4.4 PQ Recording Tab

**Monthly ratio** – Determine what is the monthly ratio value.

**Note** - If the Monthly Ratio exceeds the set value, and **Recording exceeded monthly rate** is marked in the **General** tab (**Show a Notification for these Errors & Warning**) a warning message is displayed. The recording continues.

**CBC Frequency** (Cycle-by-Cycle) can be set to:

- Disable – CBC is not used.
- System – Calculated by the internal mechanism of the unit.
- PMU – Calculated according to phasor measurement unit (PMU) protocol.

### Comtrade Recording

DFR can export comtrade data and configuration files in a specific format (IEC 60255-24:2013). The generation of Comtrade files will be triggered by PQ events.

These files will be stored in a dedicated folder that can hold up to 4GB of data. The folder is organized by the date on which the comtrade files were recorded.

This Feature **must** be turned ON in the license (OFF by default)

- **Comtrade Sample Rate** - The following options are available for Comtrade Sample Rate: 256, 128, 64, and 32 samples/cycle.

To create a new instance, click on the "**Add new Comtrade**" button.

Note that only 32 COMTRADE instances can be defined.

The following actions are available:

- Actions – Remove comtrade instance
- Enable – Enable\Disable Comtrade instance
- Events – Select a PQ event per comtrade instance, only one event can be selected, with a total of 32 PQ events allowed for all instances, Each event can only be chosen once and associated with a specific instance.
- VI channels – Select the Virtual channels that will be included in the Comtrade file. A total of 14 virtual channels are available for all instances.
- DI channels – Select the digital channels that will be included in the Comtrade file. A total of 32 DI channels are available for all instances.
- Pre trigger duration [s] – Set the pre-trigger duration in seconds. This refers to the time to record before the event start time (Range 0-100).
- Post type - Select the post type
  - Post trigger - the time to record after the event **starts**
  - Post event - the time to record after the event **ends**

- **Post duration [s]** - Set the post duration in seconds. This refers to the time to record after the event end time (Range 0-100).

The following actions are available to manage all Comtrade instances:

- **Remove All** – Remove all comtrade instances
- **Disable All** – Disable all comtrade instances
- **Enable All** - Enable all comtrade instances

## 5.4.5 Events Tab

The **Events** tab enables you to define and configure the events that are captured by the G5DFR. The system is provided without any default events defined.

Each event category (type) is displayed as a blue bar in the window.

The following procedures are described for this window –

- **Adding an Event**, page 73
- **Modifying an Event**, page 76
- **Editing a Digital Input Event**, page 76
- **Editing a Group of Events**, page 77
- **Defining Aggregated Events**, page 78
- **Defining Custom Events**, page 80

### 5.4.5.1 Adding an Event

Events can be added according to the card type configured in the G5DFR.

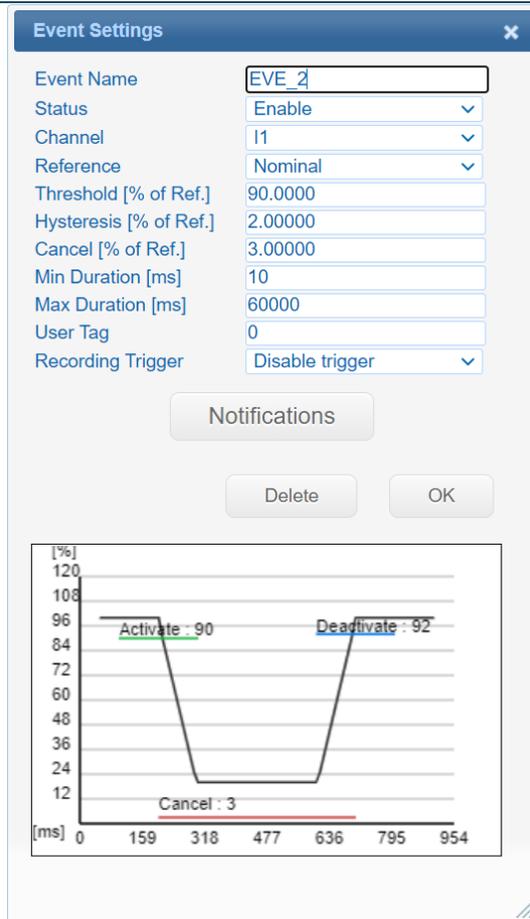
**Note** – The displayed event fields depend on the hardware configuration and are event-related. Therefore, some fields will be shown only if required for that event.

#### ► To add a new event –

- 1** Click the **Add New Event** button.
- 2** Select the classification (type) of the event by clicking one of the displayed buttons. Figure 5-7 shows a new event with the Event Name created when clicking Add New Event and selecting a **Dip** event type.

**Note** – The new event appears as a yellow box inside the expanded event type area. Click the event type blue bar to expand it and see the new event.

- 3** To configure this event, click the new yellow box. The following displays for a DIP, Swell, Interruption, and RVC event types–



**Figure 5-7: Event Settings Window – 1**

**Note** – For Swell, all fields are the same, but the graph is flipped 180°.

In this example, we are configuring a new Dip event. A Dip event is triggered when the voltage level of a specific voltage channel goes below the threshold that you define, as described below.

- 4 Fill in the fields of this window (as described below) and then click the **OK** button –
  - **Event Name** – The event name is a user-defined name that contains the test to be registered with the event.
  - **Status** – Enables you to enable or disable this event. Disabled events are not detected by the G5DFR.
  - **Channel** – Specifies the channel to monitor for this event.
  - **Reference** – Specifies the reference that the threshold of the measured value is compared to:
    - **Nominal** - if the **Threshold** value is 90, the event is triggered when the voltage drops below 90% of the nominal value.

- **USR** – if the **Threshold** value is 90, the event is triggered when the voltage drops below 90% of the **Previous sample** value.
- **Threshold (% of Ref.)** – Specifies the threshold under which this event is triggered.
- **Hysteresis (% of Ref.)** – Specifies when the event is deactivated. This value is only relevant after the event has been activated. For example, if the threshold was set to 90%, then the event was activated when the voltage went below 90% of the nominal value. If the Hysteresis is set to 2%, then the event is deactivated when the voltage goes over 92%.
- **Cancel (% of Ref.)** – An event starts when the **Threshold** (described above) is breached. That event ends when the threshold defined in the **Hysteresis** field is breached. The **Cancel** field specifies the threshold under which this event is totally canceled (meaning it is not logged at all and most likely categorized as another type of event).
- **Min Duration (ms)** – Specifies the minimum amount of time that the condition of the event should exist to activate the event. For example, if the **Threshold** (described above) is set to 90%, the value specifies the minimum amount of time the voltage should be under 90% before this event is triggered. 10 ms is the minimum amount of time for an RMS-based event to exist to be considered such an event.
- **Max Duration (ms)** – Specifies the amount of time that this event is activated after which the event is detected (captured), regardless of when it ends. This means that after this amount of time, the event will fall under another definition of another type of event.
- **User Tag** – Enables you to define metadata that is added to an event. This metadata enables you to differentiate between events of the same type so that they can be filtered. For example, a different **User Tag** can be added to a Dip event defined with a **Threshold** of 90%, then to a Dip event defined with a **Threshold** of 85%.
- **Recording Trigger** – Enables to select if to enable or disable the recording trigger. This option is intended for the IEC61850 goose protocol, or to Push event files immediately to the Sapphire.
- **Notifications Button** – Specifies the destination to which to send a notification of this event. A window is displayed in which you can select the users to which to send it automatically. Select the users and click the **OK** button.

### 5.4.5.2 Modifying an Event

The following describes how to modify events that have already been created.

► **To configure an event –**

- 1 Click the blue bar of an event type to expand it. A box is displayed for each event of that type –
  - **Green** – This event is enabled (in the **Status** field).
  - **Red** – This event is disabled (in the **Status** field).
  - **Yellow** – This event has not been applied yet, meaning that it is still being edited. Click the **Apply** button at the bottom of the page to apply the changes.

To display the events as a table, click the **Table View** button.

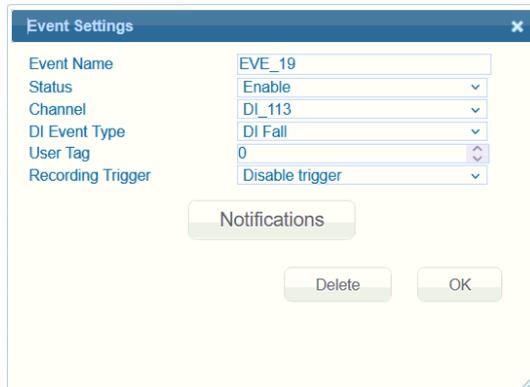
To configure an event, double-click its box or row in the table.

- 2 Modify the fields as described on page 111 and click the **OK** button.

**Note** – You can delete an event by clicking the **Delete** button.

### 5.4.5.3 Editing a Digital Input Event

The following window displays for a DI (digital input) event –



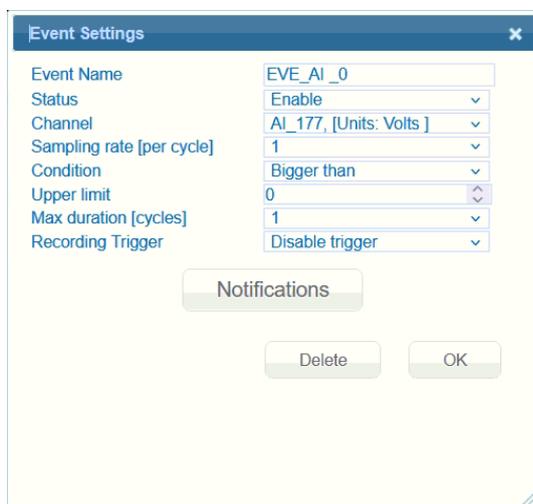
**Figure 5-8: Digital Input Event**

This window contains the same fields as described above, except for the following –

- **DI Event Type** – Enables you to select when the digital input is triggered, as follows –
  - **DI Change** – Voltage changes from 1 to 0 or from 0 to 1.
  - **DI Rise** – Voltage changes from 0 to 1.
  - **DI Fall** – Voltage changes from 1 to 0.

### 5.4.5.4 Editing an Analog Input Event

The following window displays for an AI (analog input) event –



**Figure 5-9: Analog Input Event**

This window contains the same fields as described above, except for the following –

- **Sampling rate [per cycle]** – Enables you to select if the sampling rate is 1 or 128 per cycle.
  - Note** - Up to 8 events can be configured with 128 samples per cycle.
- **Condition** – defines when the event is triggered:
  - **Bigger than** – When the value is bigger than the set limit.
  - **Smaller than** – When the value is smaller than the set limit.
  - **Between** – When the value is between set values.
  - **Out of range** – When the value is between set values.
  - **Max duration [cycles]** – The number of cycles for the event (up to 10 cycles).

### 5.4.5.5 Editing a Group of Events

The following describes how to modify the settings of multiple events at the same time.

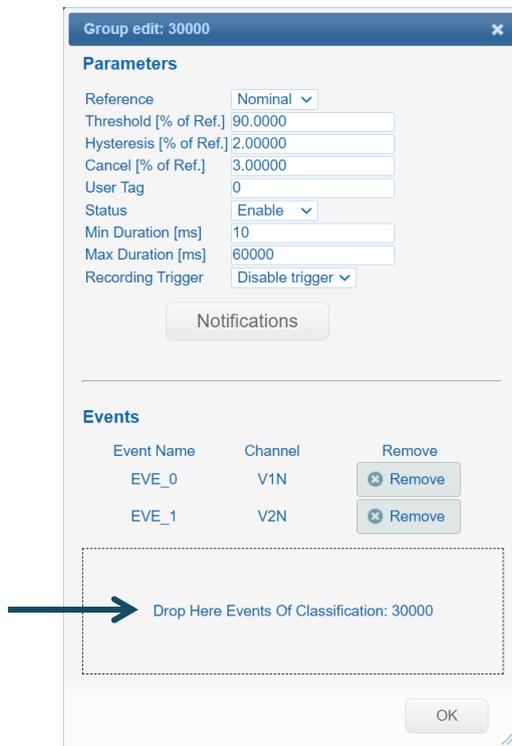
► **To edit a group of events –**

- 1** Expand the display of the relevant event type by clicking its blue bar.



**Figure 5-10: Edit Event Group – 1**

- 2 Click the **Group Edit** button. The following displays (depending on the type of event)–



**Figure 5-11: Edit Event Group – 2**

- 3 Define which events are included in this group by dragging and dropping the event boxes into the Drop Here Events Of Classification area.

**Notes** - Dragged events must have the same classification.  
You can drag and drop a yellow or a red event box.

- 4 Modify the settings at the top of the window as needed, and then click the OK button.

### 5.4.5.6 Defining Aggregated Events

An Aggregated Event consists of two or more other events (as described above). This means that when Operator = AND, all the conditions of up to four events

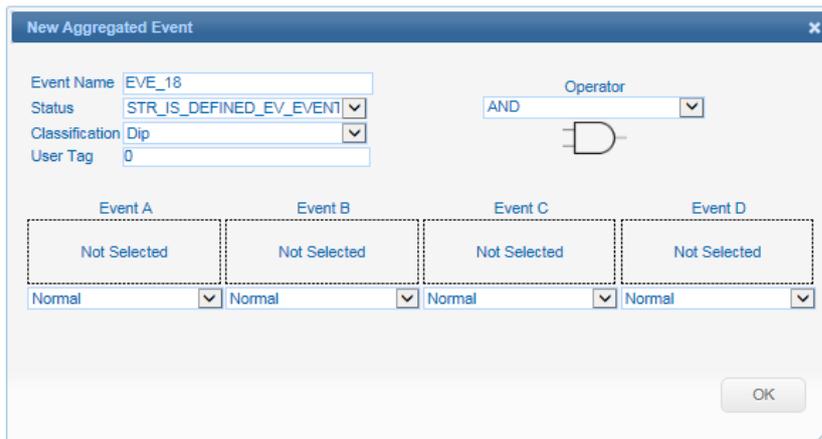
## Web Interface

must exist to detect this event. Alternatively, this event can be detected when any one of the conditions of up to four events exists (Operator = XOR) or when any combination of these events exists (Operator = OR).

An Aggregated Event can also contain other Aggregated Events.

### ► To add a new Aggregated Event –

- 1 Click the **Add New Aggregated Event** button. The following displays –



**Figure 5-12: Aggregated Event**

- 2 Drag and drop the event boxes (green boxes) to be included in this aggregated event into the **Not Selected** boxes at the bottom of the window.
- 3 Modify the settings of this event as needed and click the **OK** button.

### 5.4.5.7 Defining Custom Events

Custom events are designed to meet specific requirements and provide a to extend the functionality of the device.

Defining a Custom Event includes four windows for selecting and inserting the event-defined data.

#### ► **To add a new Custom Event –**

**1** Click the **Add New Custom Event** button

#### **2 General Window**

The General page provides essential settings for configuring your custom event. Here's a breakdown of the options available:

- **Name:** Specify a descriptive name for your event. This name will help you identify and differentiate the event from others.
- **Status:** Enable or disable the event using this option. When an event is disabled, it will not be detected by the G5DFR
- **Min duration:** Set the minimum time for the start of the event.
- **Max duration:** Define the maximum time for the end of the event.
- **Recording trigger:** Choose whether to enable or disable the recording trigger. This option is specifically designed for the IEC61850 GOOSE (Generic Object-Oriented Substation Event) protocol or to immediately push event files to the Sapphire system.
- **Notifications:** Specifies the destination to which to send a notification of this event. A window is displayed in which you can select the users to which to send it automatically. Select the users and click the OK button.

Once you have configured the desired settings on the General page, click **"Next"** to proceed to the next window, which is the Activate window.

#### **3 Activate Window**

The Activate page allows you to configure the activation behavior of an event. This includes defining the activation mode, setting parameters, selecting reference modes, specifying operators, determining reference types, and setting the minimum duration for event activation.

- **Parameter:** Select the parameter and channel associated with the event.

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- This defines the specific aspect of the system that the event will monitor or evaluate.
- **Calc. average #samples:** Use the Calc. average #samples feature to define the number of samples that need to be collected and averaged before the event is triggered.
- **Reference mode:** Determines how the event is triggered or measured in relation to a reference point or value.

It allows you to define the criteria for when the event should be considered active or triggered based on a specific reference.

- **Percentage:** Events triggered based on a percentage change from a selected reference type and according to predefined values.
  - **Deviation:** Events triggered based on the magnitude of the deviation of a parameter from a reference type and according to predefined values.
  - **Const:** Events triggered based on the constancy or stability of a parameter's value.
- **Operator:** The operator determines how a condition or expression is evaluated within the event triggering process.

It defines the relationship between values and criteria

- **Reference type:** defines the basis upon which the event is compared or evaluated to determine if it should be triggered based on the defined criteria
  - **Nominal:** nominal reference type is particularly useful when you want to monitor variations or deviations from a known or expected value
  - **Average:** average reference type is particularly useful when you want to monitor the overall trend or behavior of a parameter rather than focusing on instantaneous values
  - **Previous sample:** used to compare the current value of a parameter with its immediately preceding value
- **Min duration:** refers to the minimum amount of time that an event must remain active or meet specific conditions before it is considered triggered or activated.

This helps prevent false positives by requiring sustained occurrences of the event.

Press the **"Next"** button to proceed to the next window, which is the Deactivate window.

#### **4 Deactivate Window**

allows you to configure the deactivation behavior of an event. Once an event is triggered and active, the deactivation settings determine when and how the event will be deactivated based on specific conditions or events occurring within the system.

- **Operator:** determines how the deactivation condition or expression is evaluated and when the event should be deactivated
- **Min duration:** refers to the minimum amount of time that an event must remain deactivated or meet specific conditions before it is considered deactivated.

Press the "Next" button to proceed to the next window, which is the Cancel window.

#### **5 Cancel Window**

Ensures that events are not triggered or activated under certain circumstances, even if the criteria for event activation are met. By defining a cancel window, you can specify conditions or events that, when occurring within the defined timeframe, prevent the event from being triggered.

- **Cancel status:** Enable or disable the event cancelation by using this option. When this option is disabled, cancelation will not be detected by the G5DFR
- **Min duration:** refers to the minimum amount of time that an event must remain canceled or meet specific conditions before it is considered canceled.

To finalize the Custom event configuration and close the wizard, simply click the **"OK"** button

### **5.4.6 PMU Tab**

The G5DFR measures the electrical waves on the grid using a common time source for synchronization. Time synchronization enables synchronized real-time measurements of multiple remote measurement points on the grid. The resulting measurement is known as a synchrophasor. This feature is commonly

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implemented in the design of next-generation power systems and smart grids. The PMU function can be incorporated into many protection implementations. The G5DFR complies with both the IEEE C37.118. 2011 and 2014 standards.

When setting up and configuring the PMU, the following should be noted:

- PMU should be included in your License.
- Only SFP1 port can transmit PMU data.
- Make sure both the device and the client are using the same protocol and settings.
- Make sure the Virtual channels are configured (Phase to Phase & Phase to neutral), and there is no "Invalid topology" message on the summary page.
- Verify that the Computation rate is well selected.
- In case Stream 2 is not used, set it with the same settings as Stream 1 or set it to the other type (P type if M type is used in Stream 1 or vice versa).
- The Date and Time in the device and on the client side must be synchronized; otherwise, data issues can occur.

The following fields are configurable in this tab –

- **STN name** – The name of the station.
- **Command Channel Transmission (Type/Port)** – The command channel can work over TCP and UDP. The port range is 0–65535.
- **Class P Computation Rate** – Determines the speed of calculating Class P.

Values when F<sub>nom</sub> (nominal frequency, set in the Analog V/I tab) is 50Hz:

Transmission Rate	Computation Rate
10	10
25	25
50	100

Values when F<sub>nom</sub> (nominal frequency, set in the Analog V/I tab) is 60Hz:

Transmission Rate	Computation Rate
10	10
12	12
15	15
20	20
30	30
60	120

**Note** – This field does not determine the transmission rate. The transmission speed is determined by the **Data Transmission Rate** field (see below).

- **Class M Computation Rate** – Determines the speed of calculating Class S. Values are 10, 25, and 50.

**Note** – This field does not determine the transmission rate. The transmission speed is determined by the **Data Transmission Rate** field (see below).

- **ENABLE Command** – Indicates whether the unit configuration can be changed via the control channel.
- **Streams** –
  - **Is Enabled** – Indicates whether the connection between client and server in stream is On/Off. This field is not selectable, it is changed automatically when a connection is detected. But it can be set to Off.  
**Note - Only 1 connection is allowed per stream!**
  - **Source UDP Port** – Specifies the port of the unit. The port range is 0–65535.
  - **Target UDP Port** – Specifies the port of the device/program that wants to communicate with the unit. The port range is 0–65535.
  - **Data Transmission Rate** – Specifies the speed of the transmission. The calculation speed is determined in other fields.

Other fields such as the channel, IP, and P/M class are self-explanatory.

## 5.4.7 Protocols Tab

### IEC 61850

International standard for communication and interoperability in power utility automation systems. It defines a comprehensive set of protocols and data models that enable seamless communication and integration between various devices and systems used in the electrical power grid.

#### **G5DFR IEC61850 Support**

- **Enable\Disable** DNP3 in device
- **MMS** (Manufacturing Message Specification)
- **SV** (Sampled Value)
- **GOOSE** (Generic Object-Oriented Substation Event)
- **TCP/IP** Communication mode
- Edition 1 & 2 for SV
- Read and write of Real-Time data

## Mapping files

### Download ICD (template)

- This will initiate the download of a pre-edited CID (Configured IED Description) file.
- The downloaded file serves as a template that can be modified and customized by the user to create a new CID file.
- The template provides a starting point for configuring the IED (Intelligent Electronic Device) description.

### Download CID

- This will initiate the download of the current CID file from the G5DFR device.
- The CID file contains the specific configuration and description of the G5DFR device, including its settings, parameters, and associated information.
- The downloaded CID file represents the current state of the G5DFR device and can be used for reference, analysis, or archival purposes.

### Upload CID

- This functionality allows you to upload a CID (Configured IED Description) file to the device.
- Changes take effect immediately, and no restart is required.

### Intelligent Configuration Tool (ICT)

To create a new CID file, you can utilize our ICT.

This tool is designed to assist in the configuration and creation of CID files specific to your requirements.

For access to the ICT tool and guidance on its usage, we recommend reaching out to our dedicated tech support team. They will provide the necessary assistance and ensure that you have the resources needed to generate a new CID file tailored to your needs.

### Key terms

**MMS** – MMS is used for communication and messaging between devices in substation automation systems that adhere to the IEC 61850 standard.

It is essential to ensure that MMS is enabled.

**SV** – To utilize the GOOSE (Generic Object-Oriented Substation Event) messaging protocol within an IEC 61850-based substation automation system.

It is crucial to ensure that SV (Sampled Value) is enabled.

**IEDNAME** - The IED name is used to uniquely identify and differentiate each device within the system.

**APN (Access Point Number)** – The APN provides a standardized and unique identifier that helps in referencing and establishing communication between various devices or components within the IEC 61850-based substation automation system.

**Use Non-Legacy** – The "Use Non-Legacy" settings or option allows the user or system administrator to specify whether they want to enable and utilize these newer, non-legacy functionalities within the IEC 61850 protocol implementation.

By enabling this setting, the system takes advantage of the extended capabilities provided by the non-legacy features.

#### **Note**

**MUST** be enabled in the license

Protocol won't function until a valid CID will be uploaded

### DNP3 (Distributed Network Protocol)

DNP is a widely used communication protocol in the utility and automation industries for remote monitoring and control applications.

#### **G5DFR DNP3 Support**

- **Enable\Disable** DNP3 in device
- **TCP/IP** Communication mode
- **Download & Upload** of XML mapping file
- Binary and Analog values, Status info, control setpoints and time synchronization
- Read and write of data

**Communication ports**

To establish communication between the client and server devices, an **IP** (Internet Protocol) network connection is required in addition to **RemotePort**, **LocalAddress** and **RemoteAddress**

- **RemotePort** – network port number associated with a remote client
- **LocalAddress** – network address assigned to the device (range: 1-65535)
- **RemoteAddress** – network address assigned to the Client (range: 1-65535)

**Enable DNP3** – allows users to enable or disable the support for DNP

**Mapping file**

In DNP3, A mapping file is a structured representation of the data points or objects within a DNP3 device that can be accessed and communicated with by a master device.

**Download DNP3 (XML file)**

- This will initiate the download of the current DNP3 file from the G5DFR device.
- The DNP3 file contains the specific configuration and description of the G5DFR device, including its settings, parameters, and associated information.
- The downloaded DNP3 file represents the current state of the G5DFR device and can be used for reference, analysis, or archival purposes.

**Upload DNP3**

- This functionality allows you to upload a DNP3 file to the device.
- Changes take effect immediately, and no restart is required.

**DNP3 XML file also contains:**

- **Binary** parameters details
- **Analog** parameters details

Each analog parameter contains:

- **ClassGroup** – each parameter can be connected to a group
- **DeadbandAsPercent** – defines when an event is triggered
- **LowThreshold** – defines when an event is triggered

**Note** - MUST be enabled in the license.

## Modbus

Modbus is a Client-Server communication protocol that enables communication between devices over a network.

It defines a simple and efficient way for devices to exchange data and control information.

### **G5DFR Modbus protocol Support**

- **Enable\Disable** Modbus in device
- **TCP/IP** Communication mode
- **Upload** of CSV mapping file
- Function code types: **FC3** & **FC4**
- **Standard** and **Fast** modes
- **Analog** and **Digital** parameters
- Read and write of data
- Display Real-time data
- Only 1 connection per mode (Standard\Fast)
- Error checking mechanism

### **Communication ports**

To establish communication between the client and server devices, an **IP** (Internet Protocol) network connection is required in addition to a **Slave address** and **Modbus port**.

#### **Standard and Fast Modbus**

##### Slave address

Used to identify individual devices on a Modbus network

- Standard default value is 159
- Fast default value is 160

##### Modbus port

Serves as the entry point for data exchange between the master (client) device and the slave (server) device

- Standard default value is 502
- Fast default value is 503

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### Mapping file

Refers to a structured representation of the memory locations or registers within the G5DFR device that can be accessed by a master device. The mapping file defines the organization and availability of data points within the device.

User can generate a CSV mapping file effortlessly using our dedicated tool <https://www.elspec-ltd.com/support/g5-modbus-mapping-file-generator/>

### Upload Mapping file (CSV format)

- Should be uploaded to a specific FC
- 'Fast' term should be added for using the fast modbus
- This functionality allows you to upload a Modbus file to the device
- Changes take effect immediately, and no restart is required.

### Note

Must be **Enabled** in the license

Fast Modbus refresh rate is 10ms

### Communication protocols (admin unit configuration)

- IEC 61850 MMS – On/Off
- IEC 61850 SV – On/Off
- DNP3 – On/Off
- Modbus – set to **Disable** (shut down the Modbus), **Read only**, **Read/Write**

## 5.4.8 Users Tab

The **Users** tab enables you to define the users that are allowed to log into the G5DFR web interface (as described on page 60). This window also enables you to define the email address of these users, the permissions awarded to these users, and the notifications that the users receive.

The system is provided with a default administrator user who has all permissions. The default user name for the administrator is user0, and the default password is aA123123.

### Editing Permissions

An administrator user can click the **Edit Permissions** button to modify the permissions to be awarded to a user –

- **Interfaces** – Specifies the interfaces that are displayed for this user to select in the web interface.
- **Write Permissions** – Select the **Settings** tabs that this user is allowed to modify, as described on page 111.
- **Read Permissions** – Select the read permissions (viewing) to be awarded to this user, as follows –
  - **Configuration** – Specifies whether this user is allowed to view the **Settings** tabs, as described on page 61.
  - **Measurement** – Specifies whether this user is allowed to view the Overview window (page 97) and the Investigation window (page 101).

### Editing Notifications

Click the **Edit Notifications** link to view the hardware and system-related events for which this user receives an email notification.

### Admin

Mark if the user should be an Admin. Only top-level users can mark this checkbox. The Admin (Administrator) has all permissions and can edit permissions for other users. By default, user0 is an Admin.

## 5.4.9 Network Tab

The system is provided with a variety of communication ports on the rear panel, such as SFP ports, as described on page 20. The ports on the front panel are purchasable hardware options and are not provided by default.

This **Network** tab enables you to configure the actual hardware ports provided with your G5DFR and the level of security.

### General Network Configuration

- Default Gateway Interface (Port1/2, USB Port1/2)
- HTTPS (On/Off)

### Port 1/2 and USB Port 1 Configuration

- DHCP (On/Off) – Off for static address, On for address from the router
- IP Address
- Subnet
- LAN or USB 1/2 Gateway

### SMTP Configurations

The SMTP server must be configured in this window to enable the system send email notifications.

### PQZ Notify Configuration

Configuration for the PQSCADA for notifications.

The G5DFR generates a file every minute. However, in case of an event, the file is closed immediately and sent (push).

The values are those of the unit in the PQSCADA.

### Network protocols

The available network protocols.

## 5.4.10 Auxiliary Tab

In the given tab, users have the capability to configure the details of different types of cards, including Digital In, Digital Out, Relay, and Analog In.

Here's an explanation of each card type:

- Common columns:
  - **ID** – unique identifier assigned to each channel
  - **Channel Name** – displays the name or label assigned to each channel
- Digital input (32 channels):
  - **Type**
  - **Debounce delay time:** the time to ignore when the value is not stable (range of 0–60,000)
- Digital Out (16 channels):
  - **Type**
  - **User Mode**
    - Disable: Channel turned OFF
    - Manual value OFF: Value of DO channel is 0
    - Manual value ON: Value of DO channel is 1
    - Auto: By enabling the Auto mode, you gain access to additional configuration options
  - **Events** - Select the events that will trigger the DO channel's actions.
    - Event types: Choose from a range of event types including PQ, DI, AI, AGG, and Custom events.
    - Multiple selection: You can select multiple events for the DO channel, with the flexibility to choose up to 32 events per channel.
    - Reusability: An event can be assigned to multiple DO channels.
  - **Inhibited by** - Preventing DOs from being triggered by false alarms
    - DI channel: Choose a specific Digital Input (DI) channel that will determine the inhibiting condition for the DO channel
    - DI state: Specify the desired state (such as ON or OFF) of the selected DI channel that will inhibit the DO channel from being triggered in case of a false alarm
  - **Signal Type**
    - No operation: Channel triggering is inactive
    - 1=>0=>1: Represents a transition or change in the state of a binary value from 1 to 0 and then back to 1
    - 0=>1=>0: Represents a transition or change in the state of a binary value from 0 to 1 and then back to 0

- **KYZ**: Represent a transition or change in the state of a binary value from last value.
- **Trigger type** – Determine when DO channel will be triggered
- **Duration** – Specifies the length of time for which the DO channel will remain in an active or triggered state once it has been activated
- Analog in/out (32 channels):
  - **Channel Type** - Ampere (A) or Volts (V)
  - **Analog min.** – the minimum value of the analog input (e.g., 4 mA).
  - **Analog max.** – the maximum value of the analog input (e.g., 20 mA).
  - **Channel units** – select the units to display the measurement. This combo box contains a list of optional units (e.g., Hz, °C, etc.).
  - **Converted min.** – select the value to display when the reading is equal to the analog min value.
  - **Converted max.** – select the value to display when the reading is equal to the analog max value.
- Relay ports (8 channels)

Relay channels can be triggered (activated) when a PQ event , selected Error or Warning occurs (from general tab), and when a Hardware Watchdog occurs.

  - **Type**
  - **Enable** - Select if channel is ON or OFF
  - **Events** - Select the events that will trigger the Relay channel's actions.
    - **Event types**: Choose from a range of event types including PQ, DI, AI, AGG, and Custom events.
    - **Multiple selection**: You can select multiple events for the Relay channel, with the flexibility to choose up to 32 events per channel.
    - **Reusability**: An event can be assigned to multiple DO channels.
  - **Inhibited by** - Preventing Relays from being triggered by false alarms
    - **DI channel**: Choose a specific Digital Input (DI) channel that will determine the inhibiting condition for the Relay channel
    - **DI state**: Specify the desired state (such as ON or OFF) of the selected DI channel that will inhibit the Relay channel from being triggered in case of a false alarm
  - **Misc. Trigger** - Select the Misc. events that will trigger the Relay channel's actions.
    - **Event types**: Choose from a range of event types including Errors, Warning, or watchdog.
    - An event can be assigned Once per channels.
  - **State** – Represents a transition or change in the state of a binary value from 1 to 0 or reversed

## 5.4.11 Energy Tab

For configuring the **Energy** data.

- Energy Interval – the duration for calculating the energy
- Energy Subinterval – the refresh rate

Example: if the Energy Interval is 15 minutes and the Subinterval is 1 minute, we will get an Energy summation of the last 15 minutes every 1 minute (it is like a “sliding window”).

- Rest energy counters – resets the counter of the measured energy levels.

## 5.4.12 Compliance Tab

**Note – The compliance tab is available only for admin users!**

- RVC (Rapid Voltage Change) compliance support:
  - Based on the IEC 61000-4-30 standard
  - Compliance parameters are available via Web, Telnet, and Modbus
  - Two RVC compliances can run simultaneously
  - The following can be configured:
    - Four threshold per compliance
    - Number of allowed occurrences per threshold
    - One RVC type per compliance (Umax or Uss)
  - RVC's modbus configuration (registers) can be exported (CSV)

### ► Settings the compliance –

**Compliance module** – Setting the compliance requires first enabling the compliance module (its default setting is Disabled).

**1** Click the **Compliance** line to add a compliance and click **Add New Compliance**.

**2** Fill and select the variables to configure the compliance:

- **Name** – select a name for the compliance.
- **Status** – select if the status is Enabled or Disabled.
- **Type** – RVC (Rapid Voltage Change).

There are two RVC compliance types: **RVC-Umax** and **RVC-Uss**.

**3** Set the compliance parameters:

- **Observation window** – the timeframe for the compliance calculations:
  - 1 Hour (5 seconds refresh rate)
  - 1 Day (10 seconds refresh rate)
  - 1 Week (1-hour refresh rate).
- **Feeders** – the defined feeders. Up to four feeders can be selected that use the compliance calculations of the parameters in the table above them.

The compliance counters and thresholds are defined in the table:

- **Compliance condition** – select up to four conditions.
- **Event of dV > %** – if the dV is greater than #%
- **Allowed up to** – acceptable number of event occurrences.

**4** Click **Apply** to save the settings.

The results are seen through the **Compliance Tab** in the **System** module or through **Modbus**.

Selecting the **Compliance** tab on the **System** module displays tables showing the **Compliance Configuration** and the **Compliance Monitor**.

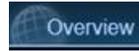
The **Status** is **0** if the threshold did not exceed the allowed occurrences, or **1** if the threshold exceeded the allowed occurrences.

To read the values through the **Modbus**, click the **Export Modbus Registers** button (a csv file is downloaded). Then, click the Cogwheel icon, click the **Protocols** tab, from the **Modbus** select the required type (**FC3** or **FC4**), find the downloaded file, and click **Apply**.

## 5.5 Overview Page

The Overview window is displayed after logging in to the G5DFR web interface.

To return to the Overview window from another window, click the **Overview**



icon in the main menu.

### 5.5.1 Overview Window Layout

The Overview main viewing area is divided into two areas –

- **Analog Channels** – page 97 – The left side of this page displays a table in which each row represents one of the configured virtual (calculated) channels. Each row shows the real-time RMS and THD values at half-cycle resolution and the last 10-minute trend graph, as described below.
- **Information** – page 99 – The right side of this window shows general information about the G5DFR device, as described on page 99.

If you have not yet configured the G5DFR settings (as described on page 111), then this table is displayed empty.

### 5.5.2 Channels Info (Analog Channels)

The Channels Info tab displays a row for each channel of the G5DFR showing the following columns –

#### **Name**

This is the name that you assigned to the Virtual Channel, as described on page 66.

#### **RMS**

The Root Mean Square (RMS), measured for each channel.

#### **THD**

The Total Harmonic Distortion (THD), measured for each channel.

#### **Trend Graph**

Shows the range of Voltage (V) or Current (A) displayed in the trend graph. The scale is dynamic according to the values measured and displayed during the last 10 minutes.

The G5DFR device measures (samples) the power network's RMS and represents the minimum and maximum value of each three seconds as two **points** (comprised of multiple pixels) on the graph. This window shows the last 10 minutes of RMS measurements along a trend timeline graph.

The following describes the trend timeline graph that shows the last 10 minutes of RMS measurements.

### 200 Points Displayed in the Window

A **point** (comprised of multiple pixels) is displayed on the graph representing the minimum or maximum value of each three seconds within the last 10 minutes. Therefore, 200 points are displayed – one for every three seconds according to the following calculation –

- 10 minutes is comprised of 600 seconds.
- $600 \text{ seconds} / 3 \text{ seconds} = 200 \text{ points}$ .

### Number of RMS Measurements in Three Seconds

RMS is a real-time value at half-cycle resolution. The quantity of RMS measurements is based on the system frequency –

In a 50Hz system, a half cycle is approximately 10 milliseconds.

In a 60Hz system, a half cycle is approximately 8.3 milliseconds.

To understand the concepts shown in this graph, let's assume that a half-cycle is every 10 milliseconds. This means that every three seconds (which is 3,000 milliseconds), 300 half-cycle RMS samples (measurements) are taken according to the following calculation –  $3,000 \text{ milliseconds} / 10 \text{ milliseconds} = 300$  measurements, from which the minimum and maximum values are displayed.

### Number of Pixels Representing Each Point

The number of pixels used to represent each point (every three seconds) is determined by the number of pixels along the width of the window. The number of pixels along the width of the window is determined by the screen resolution and the size to which the window is expanded.

#### **1-Pixel Width Example**

If the width of a window is 200 pixels (which must be used to represent 200 points as described above), then one-pixel width is used to represent each point according to the following calculation –  $200 \text{ pixels} / 200 \text{ points} = 1 \text{ pixel}$ .

#### **5-Pixel Width Example**

If the width of a window is 1,000 pixels (which must be used to represent 200 points as described above), then five-pixel width is used to represent each point according to the following calculation –  $1,000 \text{ pixels} / 200 \text{ points} = 5 \text{ pixels}$ .

### Trend Display of Minimum and Maximum Value

Each point in the graph represents both the minimum and maximum RMS value during a three-second interval. The number of pixels used to represent the minimum, and maximum RMS value point is determined by the number of pixels in the window's width, as described above.

This number of pixels representing each of the 200 points in the window determines whether a series of vertical lines or a thick line (with peaks and valleys) is displayed.

### 5.5.3 Information Pane

The right side of the window shows general information about the G5DFR. A description of the most recent warning or error is displayed in the information area on the right of the Overview window, as shown below –



**Figure 5-13: Warning and Error Indications**

- **Status** – the status of the device.
- **DB** – the oldest and most recent data, the status of both SDs (SD1 is the PQXip data, SD2 is the System data). Truncating means FIFO.
- **PQZ** – the compression ratio of the recorded data
- **Time Synchronization** – the source of the time and its quality
- **Other** – the frequency, software version, and its build
- **Warnings** – lists warning

## 5.5.4 Energy

The Energy tab includes four field with the following Energy details:

- **System energy**
- **Networks energy**
- **Feeder total energy**
- **Feeders phases energy**

### System energy

The Systems energy field includes tables that display the system energy levels (Active Energy Consumption, Active Energy Production, Reactive Energy Consumption, Apparent Energy):

- System energy
- System peak demand
- System current period

### Networks energy

The Networks energy field includes tables that display the networks energy levels (Name, Active Energy Consumption, Active Energy Production, Reactive Energy Consumption, Reactive Energy Production, Apparent Energy):

- Networks energy
- Networks peak demand
- Networks current period

These are the transformers on the same voltage level.

### Feeder total energy

The Feeders energy field includes tables that display the feeder's energy levels (Name, Active Energy Consumption, Active Energy Production, Reactive Energy Consumption, Reactive Energy Production, Apparent Energy):

- Feeders total energy
- Feeders total peak demand
- Feeders total current period

These are the values for each transformer.

### Feeders phases energy

The Feeders phase energy field includes tables that display the feeder's phase energy levels (Phase, Active Energy Consumption, Active Energy Production, Reactive Energy Consumption, Reactive Energy Production, Apparent Energy):

- Feeders phases energy
- Feeders phases peak demand
- Feeders phases current period

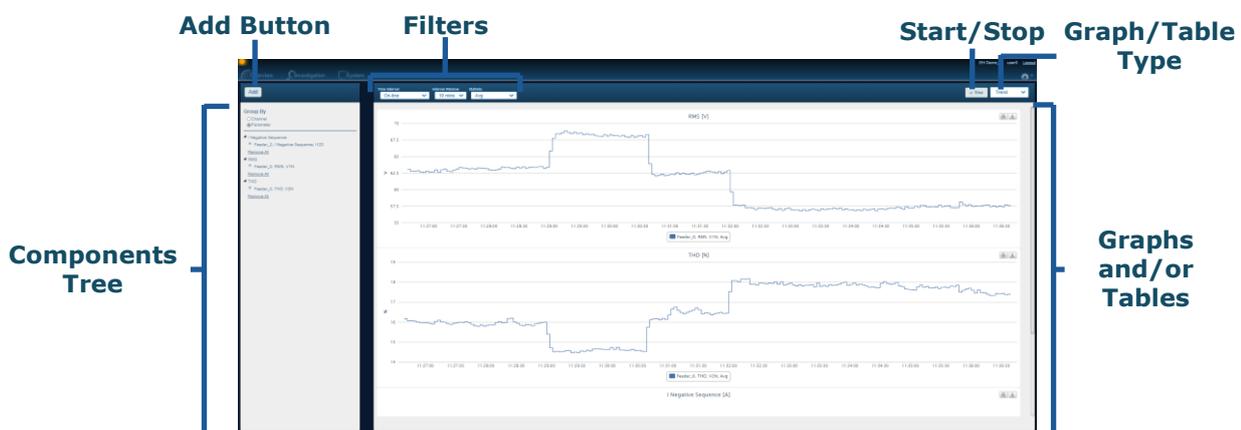
## 5.6 Investigation Page

The Investigation window enables you to analyze recorded data. It provides a variety of options for you to specify and filter the type of information to be displayed.

### ► To display the Investigation window –

- Click the **Investigation**  icon in the main menu.

### 5.6.1 Investigation Window Layout



**Figure 5-14: Investigation Window**

If you have not yet configured the G5DFR settings (as described below), then this window is displayed empty.

The Investigation main viewing area consists of the following areas –

- **Add Button** – Enables you to add the type of information to be displayed.
- **Filters** – Enables you to filter the displayed information.
- **Start/Stop Button** – Enables you to start/stop the display of information in this window.
- **Graph Type** – Selects the type of graphs to display, as follows –
  - **Trends**, page 102
  - **Events**, page 106
  - **Spectrum**, page 106
  - **PMU**, page 108
  - **Grid**, page

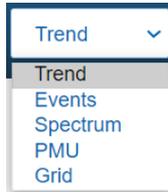
The data is displayed as a graph or table according to the selected type.

The graphs can be printed and saved by clicking the icons on the graph corner.

## 5.6.2 Investigating Trends

► **To investigate trends –**

- 1 In the dropdown menu in the top right of the window, select **Trends**.



**Figure 5-15: Investigate Trends – 1**

- 2 If no parameters were added previously, use the **Add** button on the upper-left side to add the parameters to be displayed as a trend, as described on page 103. After you add them, the parameters appear listed in the left pane of the Investigation window, as shown below (Figure 5-16).

You can group the display of this list by **Channels** or **Parameters** by clicking the associated radio button.

- 3 Click the **Start**  button to start the displays of Trends. For example, as shown below –



**Figure 5-16: Investigate Trends – 2**

- 4 Use the filter fields at the top of the window to filter the displayed data –



**Figure 5-17: Investigate Trends – 3**

The system optimizes the resolution according to the selected interval and the available hardware (number of pixels).

- **Time Interval** – Shows the parameter’s online value. This field enables you to select the time interval that is displayed, such as –

## Web Interface

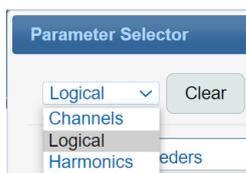
- **On-line** – Enables you to display real-time information and specify this interval, such as half cycle, 10/12 cycles, 150/180 cycles, or 1-minute cycles.
  - **Selected interval** – Enables you to select a range of specific dates and times to be displayed.
  - **Interval Window** – Select whether to show the data in intervals of ten minutes, two hours, or a day of values.
  - **Statistic** – Select whether to show the average values, minimum/maximum values, or both.
- 5** Click the **Chart View/Table View**  according to whether you want to display a chart or table.

### 5.6.2.1 Adding Parameters to a Trend

By default, no parameters are defined to be displayed in the trends. The following describes how to add them.

#### ► To add parameters to the trend –

- 1** Click the **Add** button.
- 2** Select one of the groups of parameters from the dropdown menu in the top left of the window –



**Figure 5-18: Parameter Groups**

**The definition of each of these types of parameter groups is slightly different, as follows –**

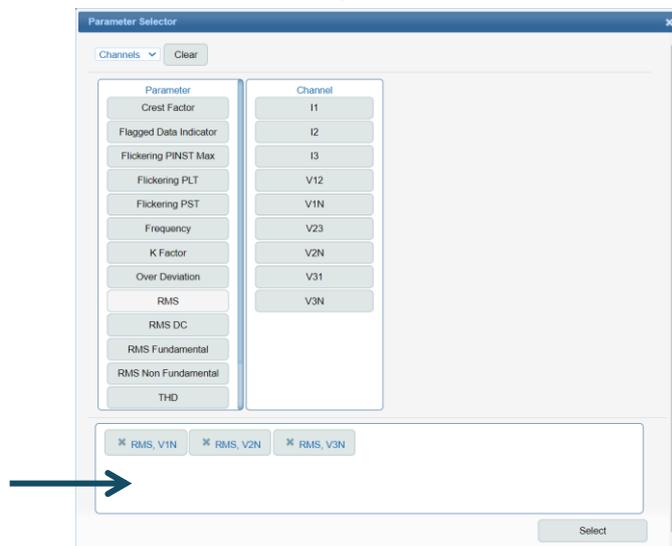
- **Channels** – Enables you to investigate physical channels, as described below.
- **Logical** – Enables you to investigate virtual channels, as described below. Virtual Channels map to an electrical meaning.
- **Harmonics** – Enables you to investigate individual Harmonics components of a channel.

## Channels

Physical channels are described on page 112.

### ► To select the physical channels to investigate –

- Select **Channels** to display a list of parameters.
- Select a parameter (for example, RMS) to display a list of physical channels.
- Select one or more Channels to be displayed, such as **V1N** and **I3**.
- Repeat the steps above to select additional Parameter/Channel combinations. Each combination is displayed as balloons at the bottom of the window. For example, as shown below –



**Figure 5-19: Investigate Physical Channels**

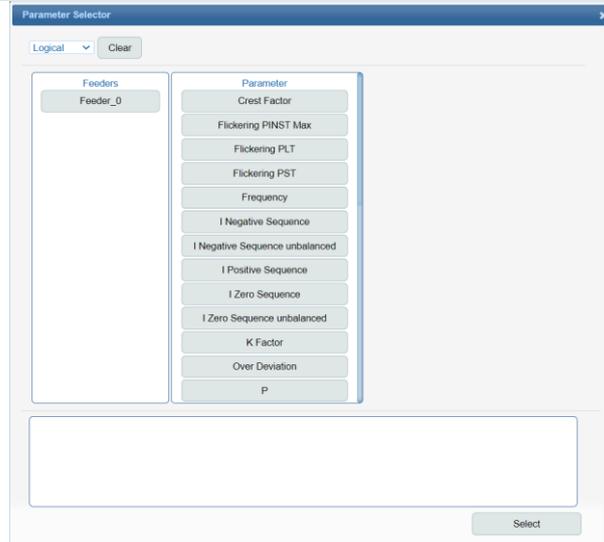
- Click the **Select** button. These channels are then listed in the left pane of the Investigation window.

## Logic

Logical (virtual) channels are described on page 66.

### ► To select the virtual (calculated) channels to investigate –

- Select **Logic** to display a list of feeders.
- Select one of the displayed Feeders. A **Parameter** list is then displayed.
- Select one of the **Parameters** to display a list of **Tags**, which is a list of Virtual Channels.
- Select a Tag.
- Repeat the steps above to select additional Channel/Parameter/Tag combinations. Each combination is displayed as balloons at the bottom of the window. For example, as shown below –

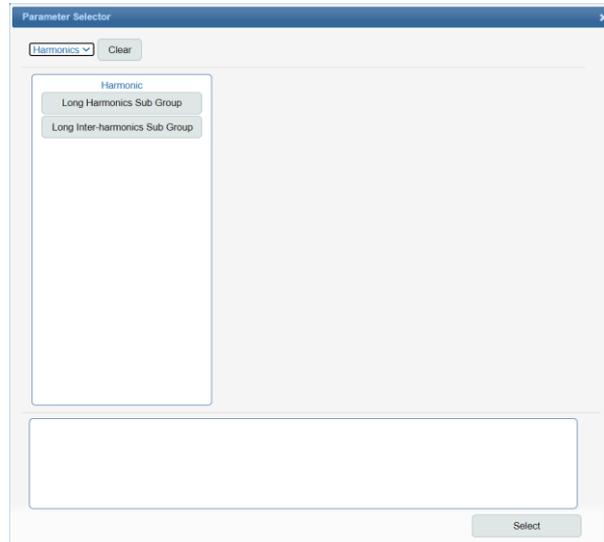


**Figure 5-20: Investigate Virtual Channels**

- Click the **Select** button at the bottom of the window.

### Harmonics

- Select **Harmonics** to display a list of harmonics, as shown below –



**Figure 5-21: Investigate Harmonics**

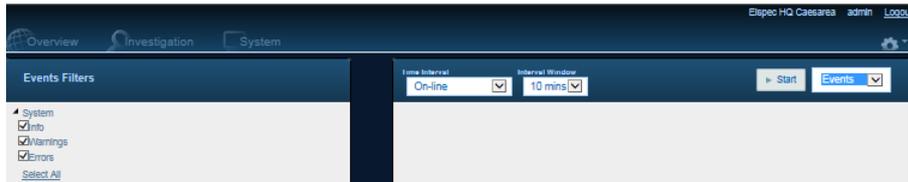
- Select a channel to investigate its harmonics.
- Select the index of the harmonics to investigate.
- Repeat the step above to select additional harmonics, which are displayed as balloons at the bottom of the window.
- Click the **Select** button at the bottom of the window.

### 5.6.3 Investigating Events

► **To investigate events –**

- 1 In the dropdown menu in the top right of the window, select **Events**.

The following displays –



**Figure 5-22: Investigate Events – 1**

- 2 Select the events type from the pane on the left.
- 3 Click the **Start** button to start the display of events.

For each event, the following columns are displayed: ID, Name, Classification, Phases, Severity, Start time, End time, Duration, Value. As shown in figure 4-22 below.

ID	Name	Classification	Phases	Severity	Start Time	End Time	Duration	Value
26952	EVE_1	Interruption	V1N	155	7/4/2021 16:18:39.619	7/4/2021 16:18:41.768	00:00:02.150	2.707 V
25707	EVE_1	Interruption	V1N	114	7/4/2021 16:12:15.077	7/4/2021 16:12:15.667	00:00:00.590	2.910 V
24066	EVE_1	Interruption	V1N	155	7/4/2021 16:09:55.991	7/4/2021 16:09:57.992	00:00:01.990	2.862 V
21823	EVE_1	Interruption	V1N	155	7/4/2021 16:01:10.210	7/4/2021 16:01:12.361	00:00:02.151	2.912 V
21817	EVE_1	Interruption	V1N	155	7/4/2021 15:58:33.364	7/4/2021 15:58:35.645	00:00:02.280	2.862 V
21262	EVE_1	Interruption	V1N	155	7/4/2021 15:57:14.427	7/4/2021 15:57:15.596	00:00:01.079	2.735 V
19742	EVE_1	Interruption	V1N	122	7/4/2021 15:54:42.811	7/4/2021 15:54:43.482	00:00:00.670	2.587 V
19672	EVE_1	Interruption	V1N	155	7/4/2021 15:51:22.107	7/4/2021 15:54:36.889	00:03:14.781	2.672 V

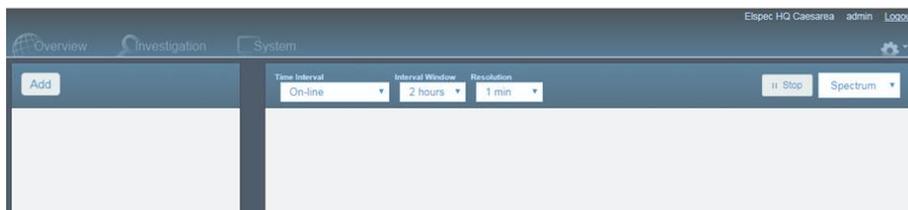
**Figure 4-22: Events list**

### 5.6.4 Investigating Spectrums

► **To investigate a spectrum –**

- 1 In the dropdown menu in the top right of the window, select **Spectrum**.

The following displays –



**Figure 5-23: Investigate Spectrums – 1**

## Web Interface

- 2 If no parameters were added previously, use the **Add** button to add the parameters to be displayed as a spectrum, as described on page 107. These parameters appear listed in the left pane of the window.
- 3 Click the **Start**  button to start the display of Spectrums. For example, as shown below –



**Figure 5-24: Investigate Spectrums – 2**

- 4 Use the filter fields at the top of the window to fine-tune the displayed data–



**Figure 5-25: Investigate Spectrums – 3**

- **Time Interval** – Shows the parameter’s online value. This field enables you to select the time interval that is displayed, such as –
  - **On-line** – Shows the most recent recordings.
  - **Selected interval** – Enables you to select a range of specific dates and times to be displayed.
- **Interval Window** – Select whether to show the data in intervals of the last ten minutes, two hours, or day of values.
- **Resolution** – Select the resolution of the displayed sample data – three seconds and 10 seconds.

### 5.6.4.1 Adding Parameters to a Spectrum

By default, no parameters are defined to be displayed in the spectrums. The following describes how to add them.

#### ► To add parameters to a spectrum –

- 1 Click on the **Add** button.
- 2 Define the spectrum information that is displayed for this parameter.
- 3 Click the **Select** button in the window shown above.

## 5.6.5 Investigating PMUs

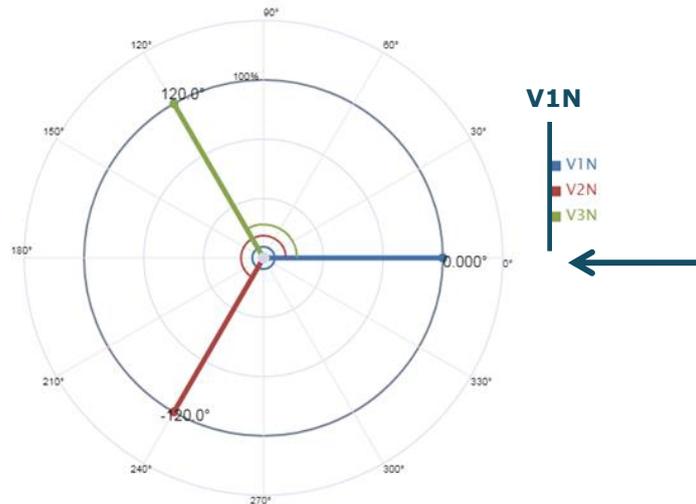
► **To investigate PMUs –**

- 1 In the dropdown menu in the top right of the window, select **PMU**.
- 2 The left pane enables you to specify the PMU data to be displayed –



**Figure 5-26: Investigate PMUs – 1**

- **Virtual Channels** – Select the channels to display in the phasors (waveform) graph.
- **Reference** – Select the reference of the phasor diagrams angle, as follows –
  - **None** – When **None** is selected, there is no phase reference.
  - **Virtual Channels** – Alternatively, you can select any one of the virtual channels that you checked in the virtual channels field (described above) to be used as a reference for the angle of the other virtual channels shown in the phasor graph. For example, V1N can be used as a reference for the phasor graph’s angle. If **V1N** is selected (for example) as the **Reference**, then the angles of all other channels are shown relative to V1N; and V1N is shown as zero, as shown below.



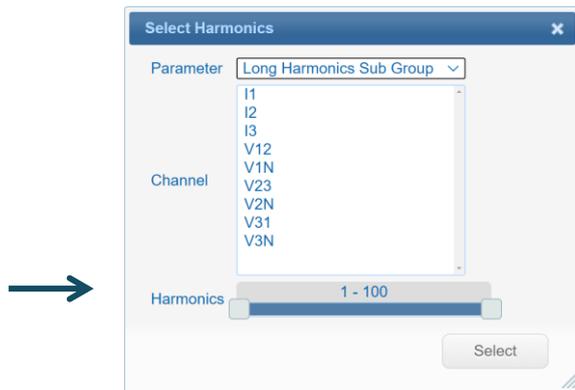
**Figure 5-27: Investigate PMUs – 2**

- **Normalize** – This option enables you to normalize the displayed graph values to **Maximum Amplitude** or **Nominal**.
    - **Maximum Amplitude** – The displayed data is normalized to the maximum amplitude of the selected reference (described above). This means (for example) that V1N is 100% and that the other virtual channels (for example, V2N and V3N) are shown as a percentage of V1N.
    - **Nominal** – The graph is normalized to the nominal configuration of the virtual channel so that the values are displayed as a percentage of this nominal value.
- 3** Click the **Start**  button to start the display of PMUs.

## 5.6.6 Investigating Grid

For investigating harmonic and inter harmonic values. The grid provides a table where the columns are the selected parameters and the rows are the harmonics order, so that the result will be the real-time measured harmonics values.

- 1 In the dropdown menu, select **Grid** in the top right of the window.
- 2 If no parameters were added previously, use the **Add** button on the upper-left side to add the parameters to be displayed.



**Figure 5-28: Investigate Grid – 1**

- 3 Select the **Parameter** type from the dropdown:
  - Long Harmonics Sub Groups
  - Long inter-harmonics Sub Groups
- 4 Select the **Channels**. Press the Ctrl keyboard key and right-click the mouse to select more than one channel.
- 5 Slide the **Harmonics** scrollbar to select the number of harmonics.
- 6 Click the **Select** button at the bottom of the window. The selected channels are displayed in the Investigation left pane.
- 7 Click the **Start**  button to start the display of Grids.

## 5.7 System Page

The System page displays some of the settings described in *Section 5.3, Settings* in view-only mode, including the License tab.

### 5.7.1 General Tab

- General Info
- Power Info
- Temperature Info
- Time Info
- Unit Settings

### 5.7.2 Analog V/I Tab

- Nominal frequency and voltage
- Physical Channels
- Virtual Channels

### 5.7.3 GPS & Time Tab

- Configured Source
- Time source
- Time zone

### 5.7.4 PQ Recording Tab

- PQZ
- Tolerance Mode
- Records Per File
- Data Record Length
- Compress Mode
- Compression Ratio
- Monthly Ratio
- Last File Recorded
- CBC Frequency

### 5.7.5 PMU Tab

- PMU General Parameters
- PMU Stream 1 and 2

## 5.7.6 Protocols Tab

- IEC 61850
- Modbus

## 5.7.7 Network Tab

- General Network Configuration
- Poet 1 and 2 Configuration
- Front Port
- SMTP Configurations
- PQZ Notify Configuration
- Network protocols

## 5.7.8 License Tab

- Enabled Protocols
- Enabled Modules
- Recording
- Enabled Parameters

## 5.7.9 Auxiliary Tab

- Digital In/Out Ports
- Analog In/Out Ports
- Relay Ports

# 6 Management Software Configuration

This chapter introduces the PQSCADA Sapphire management software tool.

## 6.1 Overview

PQSCADA Sapphire is a proprietary Elspec analytical software tool that enables you to view historical information recordings to investigate grid phenomena, analyze trend statistics, support troubleshooting, and generate power-quality compliance reports. PQSCADA Sapphire enables both historical and real-time data and event investigations, providing you with automated reports and assessments as needed. PQSCADA Sapphire supports all Elspec products, as well as those of other vendors.

PQSCADA Sapphire is the only software tool that can read the proprietary format of Elspec's PQZ files. The G5DFR generates PQZ files, which are periodically fetched and automatically downloaded by PQSCADA Sapphire via FTP or another communication protocol. PQSCADA Sapphire stores all data generated by G5DFR recording functions in a database, which can be exported to various data formats either manually or via scheduled exports.

The PQSCADA Sapphire application provides –

- A Single Interface to Any Device –
  - Acquires processes and stores recorded data from any recording device through a variety of communication protocols and file formats.
  - Simplifies your IT environment by eliminating the need to purchase, install, train users, and maintain multiple systems.
- Alarms and Notifications –
  - Emails, SMS, and pop-up notifications to users according to preconfigured scenarios.
- Grid Code Compliance –
  - PQSCADA Sapphire has a flexible reporting and compliance engine, enabling the design of report templates and compliance policies according to various standards or custom requirements.
  - Reports can be generated manually or scheduled on a daily, weekly, monthly, or yearly basis. Reports can also be triggered by compliance policy violations or the occurrence of an event.
- Comprehensive Data Visualization –

- Provides valuable insights from your data. PQSCADA Sapphire has a unique set of charts and reports empowering your ability to plan, control, and make data-driven decisions.
- Provides an overview of your electrical network and measuring devices over a geographic map.

## 6.2 Setup

This tool is not part of the G5DFR and must be installed separately on your server.

▶ **To download the PQSCADA Sapphire application –**

- Go to [http://elspec-ltd.com/support/sw\\_downloads/](http://elspec-ltd.com/support/sw_downloads/).

▶ **To associate a G5DFR with a PQSCADA Sapphire license (for some additional features, a software license may be required) –**

- Create a component for that G5DFR in PQSCADA Sapphire. To do so, see *Section 7.4, Add Component* in the *PQSCADA Sapphire User Manual*.

For more details about the PQSCADA Sapphire tool, see the *PQSCADA Sapphire User Manual*. You can download the *PQSCADA Sapphire User Manual* from the following link – <http://elspec-ltd.com/support/manuals/>

### 6.2.1 Licensing

PQSCADA Sapphire supports three license levels –

- **Express (Free of Charge)** – Provides basic functionality for investigations of power quality data
- **Professional** – Enables you to connect to multiple devices and to download data and geographic maps
- **Enterprise** – Supports sharing of data and management of multiple users

# A Licensing

This appendix describes the G5DFR license and the ordering number of the device.

The G5DFR ordering number defines the features and components included in the device license. The G5DFR has various features that affect the ordering number (license) of the device, such as the types of cards installed in the slots, enabled communication protocols, and the software features of the device.

## A.1 Updating a License

At some point, you may need to update the license for a G5DFR device. For example, when increasing the sampling rate for the device from 512 to 1,024, when adding a feature such as a PMU or Modbus communication to the device, or when increasing device storage capacity from one week to one month.

Contact Elspec to obtain the appropriate license upgrade. A license key will be provided by Elspec. After receiving the license key, you must activate the license upgrade, as described below.

Upgraded files are digitally signed to enhance security.

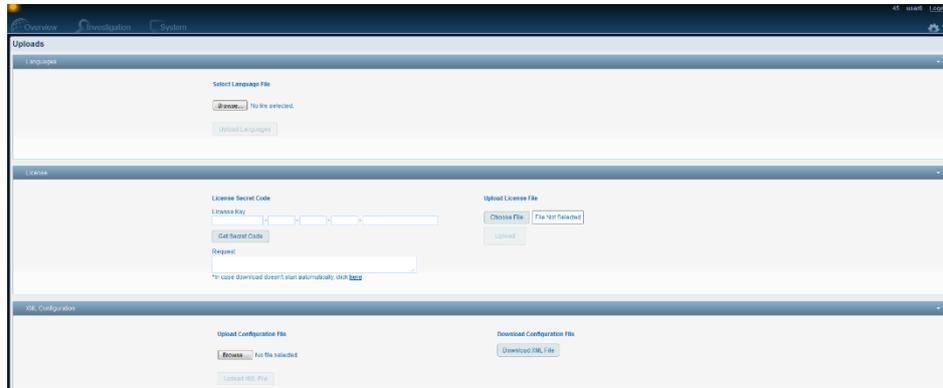
### ► To activate a license upgrade –

- 1 Log into the web interface. You must login from a computer that is on the same network as the G5DFR.
- 2 Click the down arrow next to the cogwheel at the far right, and then select **Uploads**.



**Figure A-1: Network Tab**

The following window displays –



**Figure A-2: Uploads Window**

- 3** Expand the **License** field.
- 4** In the **License Key** field, enter the license key that you received from Elspec. It is recommended to use the Ctrl C and Ctrl V keys to enter the value, as the license key is a very long string.
- 5** Click the **Get Secret Code** button. This action generates a license request file that is saved locally on your server.
- 6** From any computer with a web connection, navigate to the Elspec website using the following link – <http://elspec-ltd.com/sw-license-web-site/>.
- 7** Click the **ACTIVATE LICENSE** button.
- 8** Drag and drop the license request to the web page. This action generates a license request file that is saved locally on your server.
- 9** From the G5DFR web interface (<http://elspec-ltd.com/sw-license-web-site/> page), select **Upload License File** and browse for the response file that was saved locally on your server.
- 10** Wait for the license to finish uploading.

## A.2 Ordering Number String

SDD-AA-BBBBBBBB-CC-DD-EE-FF-GG-HH-II-JJJ-KK-LLL

The following describes the various features of the Software Design Descriptor (SDD) ordering number –

- **AA** – Represents the recording time/sampling rate option of the G5DFR. See page 26.
- **BBBBBBBB** – This represents the gateway protocols supported for monitoring the G5DFR and other software features, such as PMU. See page 26.
- **CC** – Represents the card in slot one, which can be an analog card (see page 21) or an auxiliary card (see page 23).
- **DD** – Represents the card in slot two, which can be an analog card (see page 21) or an auxiliary card (see page 23).
- **EE** – Represents the card in slot three, which can only be an auxiliary card (see page 23).
- **FF** – Represents the card in slot four, which can only be an auxiliary card (see page 23).
- **GG** – Represents the card in slot five, which can only be an auxiliary card (see page 23).
- **HH** – Represents the connection options on the front panel (see page 19) –
  - USB – 0C
  - Ethernet – 0A
  - Serial – 0K
  - USB + Ethernet – 0E
  - USB + Serial – 0D
  - Ethernet – Serial – 0B
- **II** – Represents the following options in the rear panel –
  - Power supply cable type
  - Communication dongle (RJ45, SFP)
- **JJJ** – Cable kit (Digital In, 16-pin cable, power supply cable, RJ45)
- **KK** – Label
- **LLL** – Custom

## A.3 Analog Card Type List

The following is a list of the types of Analog cards provided by Elspec. Each shows the card number that is included in the G5DFR's SDD ordering number (see page 115).

### G5 DFR Analog Card, 4I-4V (4,000V peak)

- Card Number – 1
- Current – 4I 50A peak
- Voltage – 4V 4,000V peak
- Text for combo box – 4I 50A peak | 4V 4,000V peak
- Part Number (Elspec) – EBO-0056-4190
- Board Number – 30

### G5 DFR Analog Card, 4I-4V (1,500V peak)

- Card Number – 6
- Current – 4I 50A peak
- Voltage – 4V 1,500 peak
- Text for combo box – 4I 50A peak | 4V 1,500 peak
- Part Number (Elspec) – EBO-0056-4290
- Board Number – 31

### G5 DFR Analog Card, 4I-4V (500V peak)

- Card Number – 7
- Current – 4I 50A peak
- Voltage – 4V 500 peak
- Text for combo box – 4I 50A peak | 4V 500 peak
- Part Number (Elspec) – EBO-0056-4390
- Board Number – 32

### G5 DFR Analog card, 4I (Include Hall effect & DC up to 50A peak)-4V (4,000V peak)

- Card Number – 8
- Current – 4I hall effect 50A peak
- Voltage – 4V 4,000V peak
- Text for combo box – 4I hall effect 50A peak | 4V 4,000V peak
- Part Number (Elspec) – EBO-0104-4190
- Board Number – D0

### G5 DFR Analog card, 4I (Include Hall effect & DC up to 50A peak)-4V (1,500V peak)

- Card Number – 9
- Current – 4I hall effect 50A peak
- Voltage – 4V 1,500 peak
- Text for combo box – 4I hall effect 50A peak | 4V 1,500 peak
- Part Number (Elspec) – EBO-0104-4290
- Board Number – D1

### G5 DFR Analog card, 4I (Include Hall effect & DC up to 50A peak)-4V (500V peak)

- Card Number – 0
- Current – 4I hall effect 50A peak
- Voltage – 4V 500V peak
- Text for combo box – 4I hall effect 50A peak | 4V 500V peak
- Part Number (Elspec) – EBO-0104-4390
- Board Number – D2

### G5 DFR Analog card, 4I (Include Hall effect & DC up to 100A peak)-4V(4,000V peak)

- Card Number – OB
- Current – 4I hall effect 100A peak
- Voltage – 4V 4,000V peak
- Text for combo box – 4I hall effect 100A peak | 4V 4,000V peak
- Part Number (Elspec) – EBO-0104-4490
- Board Number – D3

### G5 DFR Analog card, 4I (Include Hall effect & DC up to 100A peak)-4V(1,500V peak)

- Card Number – OC
- Current – 4I hall effect 100A peak
- Voltage – 4V 1,500 peak
- Text for combo box – 4I hall effect 100A peak | 4V 1,500 peak
- Part Number (Elspec) – EBO-0104-4590
- Board Number – D4

### G5 DFR Analog card, 4I (Include Hall effect & DC up to 100A peak)-4V(0,500V peak)

- Card Number – OX

- Current – 4I hall effect 100A peak
- Voltage – 4V 500 peak
- Text for combo box – 4I hall effect 100A peak | 4V 500 peak
- Part Number (Elspec) – EBO-0104-4690
- Board Number – D5

#### G5 DFR Analog Card, A-8I-0V

- Card Number – 2
- Current – 8I 50A peak
- Voltage – 0V
- Text for combo box – 8I 50A peak | 0V
- Part Number (Elspec) – EBO-0075-4190
- Board Number – 40

#### G5 DFR Analog card, 8I (Include Hall effect & DC up to 50A peak)

- Card Number – 0E
- Current – 8I hall effect 50A peak
- Voltage – 0V
- Text for combo box – 8I hall effect 50A peak | 0V
- Part Number (Elspec) – EBO-0107-4190
- Board Number – E0

#### G5 DFR Analog card, 8I (Include Hall effect & DC up to 100A peak)

- Card Number – 0F
- Current – 8I hall effect 100A peak
- Voltage – 0V
- Text for combo box – 8I hall effect 100A peak | 0V
- Part Number (Elspec) – EBO-0107-4290
- Board Number – E1

#### G5 DFR Analog card 0I-8V (4,000V peak)

- Card Number – 3
- Current – 0I
- Voltage – 8V 4,000V peak
- Text for combo box – 0I | 8V 4,000V peak
- Part Number (Elspec) – EBO-0108-4190
- Board Number – F0

### G5 DFR Analog card 0I-8V (1,500V peak)

- Card Number – 0D
- Current – 0I
- Voltage – 8V 1,500 peak
- Text for combo box – 0I | 8V 1,500 peak
- Part Number (Elspec) – EBO-0108-4290
- Board Number – F1

### G5 DFR Analog card 0I-8V (500V peak)

- Card Number – 0T
- Current – 0I
- Voltage – 8V 500 peak
- Text for combo box – 0I | 8V 500 peak
- Part Number (Elspec) – EBO-0108-4390
- Board Number – F2

### G5 DFR Analog Card, 8V - low Voltage

- Card Number – 0N
- Current – 0I
- Voltage – 8V low voltage 10 peak
- Text for combo box – 0I | 8V low voltage 10 peak
- Part Number (Elspec) – EBO-0130-4190
- Board Number – A0

### G5 DFR Analog Card, 4V low - 4V (4,000V peak)

- Card Number – 4
- Current – 0I
- Voltage – 4V 4,000 peak & 4V low voltage 10 peak
- Text for combo box – 0I | 4V 4,000 peak & 4V low voltage 10 peak
- Part Number (Elspec) – EBO-0113-4190
- Board Number – F8

### G5 DFR Analog Card, 4V low - 4V (1,500V peak)

- Card Number – 5
- Current – 0I
- Voltage – 4V 1,500 peak & 4V low voltage 10 peak
- Text for combo box – 0I | 4V 1,500 peak & 4V low voltage 10 peak
- Part Number (Elspec) – EBO-0113-4290
- Board Number – F9

### G5 DFR Analog Card, 4V low - 4V (500V peak)

- Card Number – 0A
- Current – 0I
- Voltage – 4V 500 peak & 4V low voltage 10 peak
- Text for combo box – 0I | 4V 500 peak & 4V low voltage 10 peak
- Part Number (Elspec) – EBO-0113-4390
- Board Number – FA

### G5 DFR Diff. Analog Card 4I-4V (4,000V peak)

- Card Number – 10
- Current – 4I 50A peak
- Voltage – 4V Diff 4,000 peak
- Text for combo box – 4I 50A peak | 4V Diff 4,000 peak
- Part Number (Elspec) – EBO-0139-4190
- Board Number – F4

### G5 DFR Diff. Analog Card 4I-4V (1,500V peak)

- Card Number – 11
- Current – 4I 50A peak
- Voltage – 4V Diff 1,500 peak
- Text for combo box – 4I 50A peak | 4V Diff 1,500 peak
- Part Number (Elspec) – EBO-0139-4290
- Board Number – F5

### G5 DFR Diff. Analog Card 4I-4V (500V peak)

- Card Number – 12
- Current – 4I 50A peak
- Voltage – 4V Diff 500 peak
- Text for combo box – 4I 50A peak | 4V Diff 500 peak
- Part Number (Elspec) – EBO-0139-4390
- Board Number – F6

### G5 DFR Diff. Analog Card 2I (50A peak)-6V(500V peak)

- Card Number – 0V
- Current – 2I 50A peak
- Voltage – 6V 500 peak
- Text for combo box – 2I 50A peak | 6V 500 peak
- Part Number (Elspec) – EBO-0140-4390
- Board Number – E2

### G5 DFR Diff. Analog Card 2I (50A peak)-6V(1,500V peak)

- Card Number – OU
- Current – 2I 50A peak
- Voltage – 6V 1,500 peak
- Text for combo box – 2I 50A peak | 6V 1,500 peak
- Part Number (Elspec) – EBO-0140-4290
- Board Number – E3

### G5 DFR Diff. Analog Card 2I (50A peak)-6V(4,000V peak)

- Card Number – 0W
- Current – 2I 50A peak
- Voltage – 6V 4,000 peak
- Text for combo box – 2I 50A peak | 6V 4,000 peak
- Part Number (Elspec) – EBO-0140-4190
- Board Number – E4

### G5 DFR Analog card, 4I (Include Hall effect & DC up to 50A peak)-4V Diff. (4,000V peak)

- Card Number – 13
- Current – 4I hall effect 50A peak
- Voltage – 4V Diff 4,000 peak
- Text for combo box – 4I hall effect 50A peak | 4V Diff 4,000 peak
- Part Number (Elspec) – EBO-0134-4190
- Board Number – B6

### G5 DFR Analog card, 4I (Include Hall effect & DC up to 50A peak)-4V Diff. (1,500V peak)

- Card Number – 14
- Current – 4I hall effect 50A peak
- Voltage – 4V Diff 1,500 peak
- Text for combo box – 4I hall effect 50A peak | 4V Diff 1,500 peak
- Part Number (Elspec) – EBO-0134-4290
- Board Number – B1

### G5 DFR Analog card, 4I (Include Hall effect & DC up to 50A peak)-4V Diff. (500V peak)

- Card Number – 15
- Current – 4I hall effect 50A peak
- Voltage – 4V Diff 500 peak
- Text for combo box – 4I hall effect 50A peak | 4V Diff 500 peak

- Part Number (Espec) – EBO-0134-4390
- Board Number – B2

#### G5 DFR Analog card, 4I (Include Hall effect & DC up to 100A peak)-4V Diff. (4,000V peak)

- Card Number – 16
- Current – 4I hall effect 100A peak
- Voltage – 4V Diff 4,000 peak
- Text for combo box – 4I hall effect 100A peak | 4V Diff 4,000 peak
- Part Number (Espec) – EBO-0134-4490
- Board Number – B3

#### G5 DFR Analog card, 4I (Include Hall effect & DC up to 100A peak)-4V Diff. (1,500V peak)

- Card Number – 17
- Current – 4I hall effect 100A peak
- Voltage – 4V Diff 1,500 peak
- Text for combo box – 4I hall effect 100A peak | 4V Diff 1,500 peak
- Part Number (Espec) – EBO-0134-4590
- Board Number – B4

#### G5 DFR Analog card, 4I (Include Hall effect & DC up to 100A peak)-4V Diff. (0,500V peak)

- Card Number – 18
- Current – 4I hall effect 100A peak
- Voltage – 4V Diff 500 peak
- Text for combo box – 4I hall effect 100A peak | 4V Diff 500 peak
- Part Number (Espec) – EBO-0134-4690
- Board Number – B5

#### G5 DFR Analog Card, 4V Diff. (4000V peak) - 4V low

- Card Number – ??
- Current – 0I
- Voltage – 4V Diff 4000 peak & 4V low voltage 10 peak
- Text for combo box – 0I | 4V 4000 peak & 4V low voltage 10 peak
- Part Number (Espec) – EBO-0144-4190
- Board Number – A1

#### G5 DFR Analog Card, 4V Diff. (1500V peak) - 4V low

- Card Number – ??

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- Current – 0I
- Voltage – 4V Diff 1500 peak & 4V low voltage 10 peak
- Text for combo box – 0I | 4V 1500 peak & 4V low voltage 10 peak
- Part Number (Elspec) – EBO-0144-4290
- Board Number – A2

### G5 DFR Analog Card, 4V Diff. (500V peak) - 4V low

- Card Number – ??
- Current – 0I
- Voltage – 4V Diff 500 peak & 4V low voltage 10 peak
- Text for combo box – 0I | 4V 500 peak & 4V low voltage 10 peak
- Part Number (Elspec) – EBO-0144-4390
- Board Number – A3

### G5 DFR Analog Card, 4V Diff. (4000V peak) - 4V low Terminal block connector

- Card Number – ??
- Current – 0I
- Voltage – 4V Diff 4000 peak & 4V low voltage 10 peak (Terminal block connector)
- Text for combo box – 0I | 4V 4000 peak & 4V low voltage 10 peak (Terminal block connector)
- Part Number (Elspec) – EBO-0163-4190
- Board Number – C4

### G5 DFR Analog Card, 4V Diff. (1500V peak) - 4V low Terminal block connector

- Card Number – ??
- Current – 0I
- Voltage – 4V Diff 1500 peak & 4V low voltage 10 peak (Terminal block connector)
- Text for combo box – 0I | 4V 1500 peak & 4V low voltage 10 peak (Terminal block connector)
- Part Number (Elspec) – EBO-0163-4290
- Board Number – C5

### G5 DFR Analog Card, 4V Diff. (500V peak) - 4V low Terminal block connector

- Card Number – ??
- Current – 0I

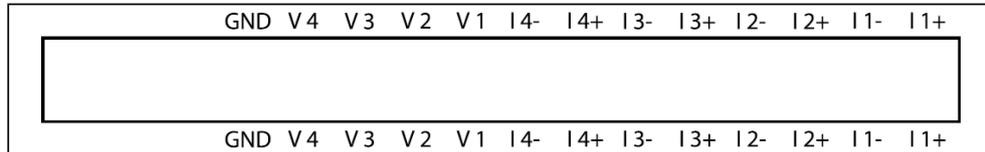
- Voltage – 4V Diff 500 peak & 4V low voltage 10 peak (Terminal block connector)
- Text for combo box – 0I | 4V 500 peak & 4V low voltage 10 peak (Terminal block connector)
- Part Number (Elspec) – EBO-0163-4390
- Board Number – C6

### G5 DFR Analog Card, 8V - low Voltage Terminal block connector

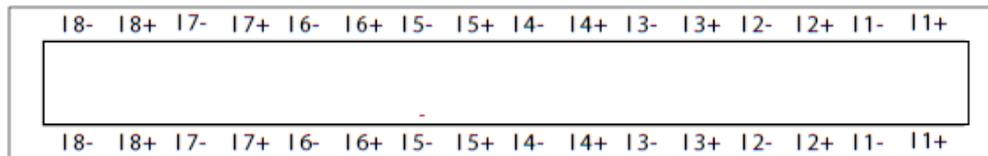
- Card Number – ??
- Current – 0I
- Voltage – 8V low voltage 10 peak (Terminal block connector)
- Text for combo box – 0I | 8V low voltage 10 peak (Terminal block connector)
- Part Number (Elspec) – EBO-0161-4190
- Board Number – 50

# A.4 Analog Card Configurations

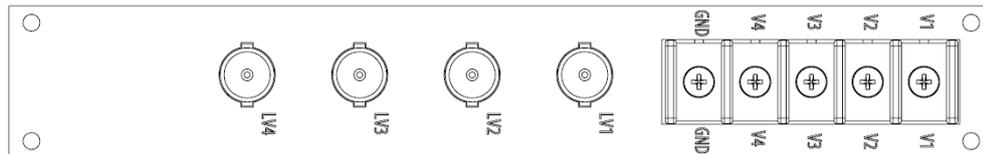
Analog cards can have the following possible configurations, as shown in the figures below.



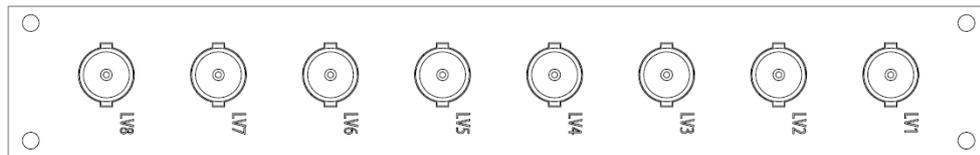
**Figure A-3: Analog Card Configuration – 4I 4V Cards**



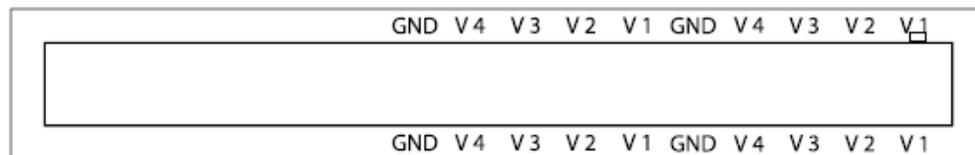
**Figure A-4: Analog Card Configuration – 8I Cards**



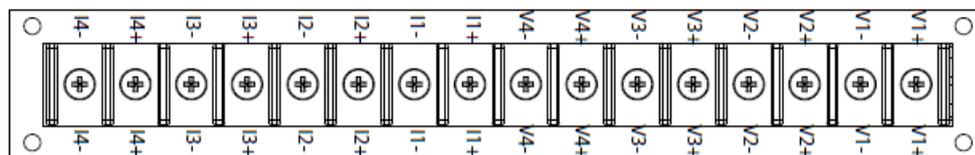
**Figure A-5: Analog Card Configuration – 4V LV 4V HV Cards**



**Figure A-6-6: Analog Card Configuration – 8V LV Cards**



**Figure A-7: Analog Card Configuration – 8V Cards**



**Figure A-8: Analog Card Configuration – Differential 4V 4I Current Cards**

## A.5 Auxiliary Cards Type List

The following is a list of the types of Auxiliary cards provided by Elspec. Each shows the card number that is included in the G5DFR's SDD ordering number (see page 115).

### G5 DFR Digital Inputs Card (24-48V), DI-32 (19.2÷57.6) V

- Card Number – 0H
- Current – DI-32 Inputs - (24-48V) – (19.2÷57.6) V, 128S/C
- Text for combo box – DI-32 Inputs - (24-48V) – (19.2÷57.6) V, 128S/C
- Part Number (Elspec) – EBO-0077-4390
- Board Number – 22

### G5 DFR Digital Inputs Card (115V), DI-32 (92÷138) V

- Card Number – 0I
- Current – DI-32 Inputs - (115V) – (92÷138) V , 128S/C
- Text for combo box – DI-32 Inputs - (115V) – (92÷138) V , 128S/C
- Part Number (Elspec) – EBO-0077-4490
- Board Number – 23

### G5 DFR Digital Inputs Card (230V), DI-32 (176÷264) V

- Card Number – 0J
- DI-32 Inputs - (230V) – (176÷264) V, 128S/C
- DI-32 Inputs - (230V) – (176÷264) V, 128S/C
- Part Number (Elspec) – EBO-0077-4590
- Board Number – 24

### G5 DFR Digital output card, DO-16

- Card Number – 0K
- Current – DO-16
- Text for combo box – DO-16
- Part Number (Elspec) – EBO-0102-4190
- Board Number – B0

### G5 DFR Relay card, RELAY-8

- Card Number – 0L
- Current – RELAY-8
- Text for combo box – RELAY-8
- Part Number (Elspec) – EBO-0103-4190

- Board Number – C0

#### G5 DFR AI 4-20mA Card

- Card Number – 0M
- Current – AI - 32 input (mA/Vdc)
- Text for combo box – AI - 32 input (mA/Vdc)
- Part Number (Elspec) – EBO-0091-4190
- Board Number – 90

#### G5 DFR AI 4-20mA Card Low impedance (Only current)

- Card Number – 0M
- Current – AI - 32 input (mA)
- Text for combo box – AI - 32 input (mA)
- Part Number (Elspec) – EBO-0091-4290
- Board Number – 91

#### G5 DFR Digital Inputs Card DIFF (24-48V), DI-32 (19.2÷57.6V)

- Card Number – 0Q
- Current – DI-32 Inputs Diff - (24-48V) – (19.2÷57.6) V
- Text for combo box – DI-32 Inputs Diff - (24-48V) – (19.2÷57.6) V
- Part Number (Elspec) – EBO-0133-4390
- Board Number – FD

#### G5 DFR Digital Inputs Card DIFF (115V), DI-32 (92÷138V)

- Card Number – 0R
- Current – DI-32 Inputs Diff - (115V) – (92÷138) V
- Text for combo box – DI-32 Inputs Diff - (115V) – (92÷138) V
- Part Number (Elspec) – EBO-0133-4490
- Board Number – FE

#### G5 DFR Digital Inputs Card DIFF (230V), DI-32 (176÷250V)

- Card Number – 0S
- Current – DI-32 Inputs Diff - (230V) – (176÷264) V
- Text for combo box – DI-32 Inputs Diff - (230V) – (176÷264) V
- Part Number (Elspec) – EBO-0133-4590
- Board Number – FB

#### G5 DFR Digital Inputs Card DIFF (230V), DI-16 (176÷250V)

- Card Number – 0U

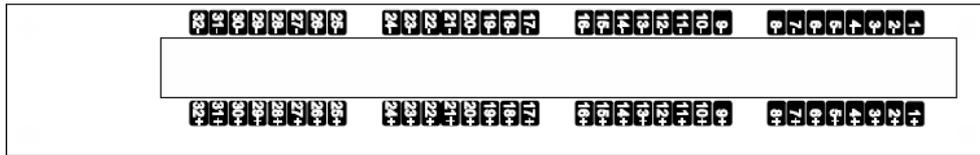
- Current – DI-16 Inputs Diff - (230V) – (176÷250) V
- Text for combo box – DI-16 Inputs Diff - (230V) – (176÷250) V
- Part Number (Elspec) – EBO-0133-4690
- Board Number – 25

# A.6 Auxiliary Card Configurations

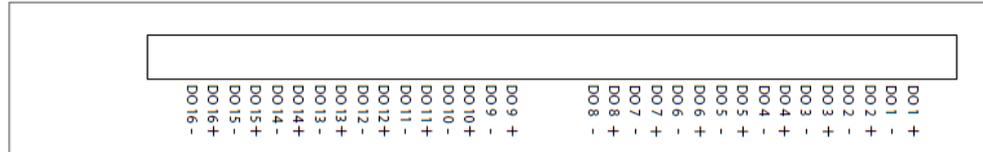
Auxiliary cards can have the following possible configurations, as shown in the figures below.



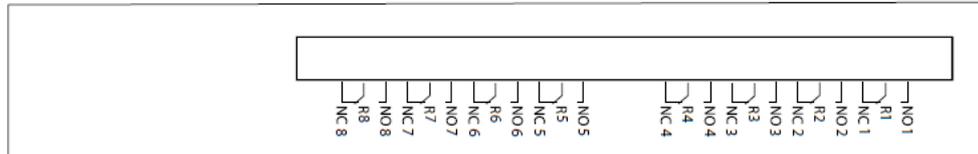
**Figure A-9: Auxiliary Card Configuration – 32 Digital Inputs Cards**



**Figure A-10: Auxiliary Card Configuration – 32 Analog Inputs Cards**



**Figure A-11: Auxiliary Card Configuration – 16 Digital Inputs Cards**



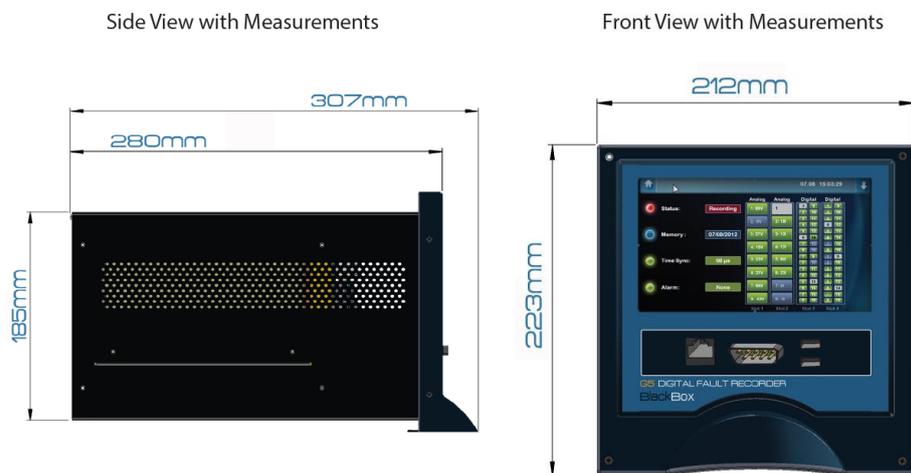
**Figure A-12: Auxiliary Card Configuration – 8 Relay Outputs Cards**

# B Technical Specifications

This appendix describes the technical specifications for the G5DFR device.

## B.1 Mechanical Dimensions

- Size – as shown in the following figure. It can fit a 19" rack.



**Figure B-1: Mechanical Dimensions**

- Weight – 3.5 kg (Unit without additional cards).
- Card – 200–400 grams per card (depending on card type).

## B.2 Specifications

**Table B-1: Specifications**

Basic Unit		
Data Acquisition		1 Week
		1 Month
		1 Year
Analog Channels Sampling Rate		256 Samples/Cycle
		512 Samples/Cycle
		1,024 Samples/Cycle
Digital and Auxiliary Channels Sampling Rate		128 Samples/Cycle
Frequency		
Fundamental Frequency		37–70 Hz
Frequency Resolution		1 MHz
Frequency Accuracy		±1 MHz
Type of Analog-to-Digital Converter		24 Bit
PMU		
Applicable Standard	The G5DFR fully supports the IEEE C37.118 – 2011/2014 Synchro phasor standard.	
M Class Transmission Maximum Rate	100/second for 50 Hz 120/second for 60 Hz	
P Class Transmission Rate	200/second for 50 Hz 240/second for 60 Hz	
Communication		
Rear Panel	SFP Ports (100/1,000 MB/second)	2
	Serial Ports	1
	USB Ports	2
	PPS	1
Front Panel	USB Ports	2
	Ethernet Port (10/100 MB/second)	1
	Serial	1
Communication Protocols		
IEC 61850	MMS, GOOSE, Sample Value	
MODBUS	TCP/IP	
DNP.3		

Power Supply	
Main	100–240 VAC @50/60 Hz or 120–370 VDC
Auxiliary	24 VDC
Time	
Internal Real time Clock	20 PPM
GPS	0.5 μseconds
IRIG B	0.5 μseconds
NTP	100 μseconds
Environmental Conditions	
Operation Temperature	-20°C to 70°C (-4°F to 158°F)
Storage Temperature	-40°C to 85°C (-40°F to 185°F)
Relative humidity	90%
Human Machine Interface	
Built-in 7" 1MP LCD. Additional, comprehensive web server for local and remote real-time monitoring, historical data analysis, and control.	

## B.3 Software Features

- MODBUS interface
- IEC 61850 – MMS, GOOSE, Sample Values
- Phasor Measurement Unit (PMU)

## B.4 Front Panel Communication Ports

- 2 x USB
- 1 x Serial
- 1 x LAN

## B.5 Analog Cards

**Table B-2: 4V/4I (50 A)**

Voltage Full-range Scale	500 V/1,500 V/4,000 V
Voltage Accuracy	0.1% from Nominal
Current Sensor Type	CT/Hall Effect
Capacity (for 5 Seconds)	50 A
Thermal Withstand	10 A continuous

## Technical Specifications

Current Accuracy	0.1% from Nominal
Current Full Scale	5 A

**Table B-3: Analog Cards – 4V/4I (100 A)**

Voltage Full-range Scale	500 V/1,500 V/4,000 V
Voltage Accuracy	0.1% from Nominal
Current Sensor Type	CT/Hall Effect/Shunt
Capacity (for 5 Seconds)	100 A
Thermal Withstand	10 A continuous
Current Accuracy	0.1% from Nominal
Current Full Scale	5 A

**Table B-4: Analog Cards - 8I (50 A)**

Current Sensor Type	CT/Hall Effect
Capacity (for 5 Seconds)	50 A
Thermal Withstand	10 A continuous
Current Accuracy	0.1% from Nominal
Current Full Scale	5 A

**Table B-5: Analog Cards - 8I (100 A)**

Current Sensor Type	Hall Effect
Capacity (for 5 Seconds)	100 A
Thermal Withstand	10 A continuous
Current Accuracy	0.1% from Nominal
Current Full Scale	5 A

**Table B-6: Analog Cards – 8V**

Voltage Full-range Scale	500 V/1,500 V/4,000 V
Current Accuracy	0.1% from Nominal

**Table B-7: Analog Cards – 4LV 4V**

Number of High-voltage Channels	4
Voltage Full-range Scale	500 V/1,500 V/4,000 V
Current Accuracy	0.1% from Nominal
Number of Low-voltage Channels	4
Voltage Full-range Scale	± 10V
Accuracy	0.1% from Nominal

## B.6 Auxiliary Cards

The G5DFR can have up to five auxiliary cards per unit.

**Table B-8: Digital Input**

Number of Channels	32			
Range	5 VDC	48 VDC	115 VDC	220 VDC
Activation Threshold	4 VDC	4 VDC	92 VDC	176 VDC

**Table B-9: Digital Output**

Number of Channels	16
Range	115 VDC ( $\pm 20\%$ )
Activation Threshold	92 VDC
Undefined Range	5–92 VDC

**Table B-10: Relay Output**

Number of Contacts	8
Contact Arrangement	1 form C (CO)
Rated Voltage	250 VAC
Maximum Switching Voltage	400 VAC
Rated Current	16 A
Limiting Continuous Current	16 A
Maximum 4-second, Duty Factor 10%	30 A
Breaking Capacity Maximum	4,000 VA
Operate/Release Time Maximum, DC Coil	8/6 ms

**Table B-11: Analog Input**

Number of Channels	32
Range	4–20 mA

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# C Firmware Upgrade

This appendix describes how to upgrade the firmware on the G5DFR device.

## ► To upgrade the firmware –

- 1** Open the device Web User Interface.
- 2** Click the cogwheel in the top-right corner of the main menu and select uploads (see section 5.3 on page 61 for reference).
- 3** Open the Upgrade section and select the upgrade file.
- 4** Click Apply upgrade.

Upgrading from an older firmware version requires using FTP. Any FTP client can be used.

## ► To perform a firmware upgrade (older firmware versions) –

- 1** Connect via FTP using your user credentials. Your user definition must have been given FTP and upgrade permissions by the administrator. For more details, see the *Users Tab* section on page 90.
- 2** Copy the \*.tar file to the upgrade folder that is available when accessing via FTP.
- 3** Wait for the upgrade process to complete. A reboot occurs at the end of the process. The upgrade process takes some time to complete.

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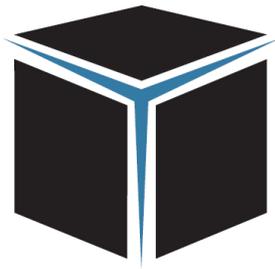
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