



# How to Convert from a Xantrex XFR to an Agilent N5700

## Application Note 1503-2

### Introduction

This application note provides a high-level overview of the similarities and differences between the Agilent N5700 and the Xantrex XFR in order to help current Xantrex XFR owners easily convert from their XFR to the more capable N5700 Series. It has been designed to be used in conjunction with the N5700 User's Guide and datasheets as well as the Xantrex XFR User's Guide and datasheets. It is not a replacement for any of the manuals and it is recommended that a copy of all the documentation mentioned above be handy for reference when reading this document.<sup>1</sup>

<sup>1</sup> Please see the references section on page 8 for part numbers.

Three areas will be discussed in this document: electrical, programming/interfacing, and mechanical. These sections will cover such topics as the power supply's output power and protections (electrical), command compatibility and calibration (programming/interfacing), as well as size and connector type (mechanical).

Not much detail is provided comparing the advantages and disadvantages of the XFR when compared to the N5700 in this document. Please refer to the reference section provided on page 8 for details on how to obtain AN 1502-2, which is a side-by-side comparison of these power supplies.

### The N5700 System DC Power Supply

The Agilent N5700 Series System DC power supplies give you just the right performance at just the right price, in a compact (1 U) package. This family of affordable 750 W and 1500 W single output programmable DC power supplies simplifies system development and are ideal for simple DC power applications. All models offer GPIB, LAN, and USB 2.0 interfaces standard.

### Model Selection

**Table 1** below compares the voltage, current and power ratings of the N5700 and the XFR in order to indicate how the XFR 1.2 kW models map

#### Xantrex XFR 1.2 kW

#### Agilent N5700 1.5 kW<sup>2</sup>

Model	Voltage (V)	Current (A)	Power (W)	Model	Voltage (V)	Current (A)	Power (W)
XFR 6-200	6	200 <sup>3</sup>	1200	N5761A	6	180	1080
XFR 7.5-140	7.5	140	1050	N5762A	8	165	1320
XFR 12-100	12	100	1200	N5763A	12.5	120	1500
XFR 20-60	20	60	1200	N5764A	20	76	1520
XFR 35-35	35	35	1225	N5765A	30	50	1500
XFR 40-30	40	30	1200	N5766A	40	38	1520
XFR 60-20	60	20	1200	N5767A	60	25	1500
N/A	N/A	N/A	N/A	N5768A	80	19	1520
XFR 100-12	100	12	1200	N5769A	100	15	1500
XFR 150-8	150	8	1200	N5770A	150	10	1500
XFR 300-4	300	4	1200	N5771A	300	5	1500
XFR 600-2	600	2	1200	N5772A	600	2.6	1560

**Table 1.** XFR to N5700 Power Supply Mapping

<sup>2</sup> The N5700 Series also includes a family of 750-W power supplies.

<sup>3</sup> XFR6-200 derates 1.5 A for every °C above 30°C (example: 170 A at 50°C)



over to the N5700 1.5 kW power supplies. For example, if you own a Xantrex XFR60-20 power supply, it is easily replaced by an Agilent N5767A 60 V/25 A power supply. You can also see from the table that the N5700 voltage, current, and power ratings are a superset of the XFR except for the XFR 6-200 model. However, the XFR 6-200 derates 1.5 A for every degree Celsius above 30°C. The N5700 Series also covers 80 V where the XFR has no offering (N5768A).

#### **Option and Accessory Selection**

The XFR offers a few different options. Each XFR option is covered in the standard N5700 product so there is really no need to do anything beyond matching your current XFR to the N5700 that replaces it by using **Table 1**. The only exception is the RS-232 interface card option on the XFR. The N5700 does not have an RS-232 port, however, GPIB, LAN, and USB are all standard equipment.

The following is a list of the options available for the XFR and an explanation of how the N5700 covers these options:

#### **Isolated analog control (ISOL)**

The N5700 has analog programming standard. See the *Remote Analog Interface Characteristics* section for more details.

#### **RS-232 interface card**

The N5700 does not have an RS-232 port, but does have GPIB along with LAN and USB all standard. Therefore, if you have an XFR with the RS-232 interface, when switching to an N5700 you will be able to choose between GPIB, USB, or LAN. The commands you previously used with the XFR will work on an N5700. See the *Programming/Interfacing* section for more details.

#### **GPIB interface card**

The XFR's GPIB interface card option is a basic GPIB card. It supports a proprietary command set for the basic functions of the power supply. The N5700 GPIB interface, which is standard in all units, supports all the XFR's proprietary commands, as well as supporting functions above and beyond the basic functions of this XFR option.

#### **GPIB multichannel card (GPIB-M)**

The GPIB-M interface card on the XFR is similar to the basic GPIB option. It allows control of the power supply from a computer via the IEEE-488 bus. However, this control includes status reporting, settings query, and service request generation with user-designed conditions,

which is not available with the basic GPIB option. SCPI (Standard Commands for Programmable Instruments) must be used when communicating using this option; it does not support the proprietary commands of the basic GPIB option. The N5700's GPIB interface, which is standard in all units, offers the exact same functionality as the XFR's GPIB-M interface. The N5700 supports both the XFR's proprietary command set as well as SCPI without the need to do anything.

#### **Internal Ethernet and RS-232 interface (ENET-XFR)**

The XFR's LAN/RS-232 interface provides LAN or RS-232 communication. The interface employs an RS-232-to-LAN converter, which acts like an RS-232 port. The proprietary command set needs to be used with this interface. The N5700's standard LAN port will easily replace this interface, however, the N5700's LAN is a true LAN interface and your program will need to send commands to the LAN port of the computer instead of the emulated RS-232 port in the case of the ENET-XFR.

#### **Input Power Requirements**

The DLM can be operated from an AC power source rated 85–130 VAC or 190–264 VAC at 47–63 Hz.

The N5700 Series was designed with active power factor correction (PFC), which allows operation to its full specifications across one continuous range of voltage that spans 85 to 265 VAC at 47–63 Hz. This range covers both ranges of the XFR, while also providing operation to specification in the range of 130–190 VAC where the XFR will not function.

#### **AC Line Fuses**

Both units should not require fuse changes during normal operation.

#### **Regulatory Agency Compliance**

CE-marked XFR units are approved to IEC 1010-1 safety standard, EN50081-2 and EN50082-2 EMC standards, and are CSA certified to C22.2 No. 1010.1. CE-marked units are also approved to U.S. requirements of NRTL/C and are UL listed to UL3111-1, 1st edition, (up to 40°C). Additional standards met: FCC part 15, and Class A EMI standard.

All N5700 units comply with the same or similar directives as the XFR as well as a few others, such as the US and Canadian safety standards for test and measurement products and the Australian standard for the C-tick mark.

Please refer to both manuals for the complete list of directives.

## **Electrical**

### **Voltage, Current, and Power**

**Table 1** showed the models available in the Agilent N5700 and Xantrex XFR product families. It also showed that the N5700 Series covers more voltages and, looking only at models of similar voltage, has higher current and power ratings than any comparable XFR model, except for the XFR 6-200. However, the XFR 6-200's current derates quickly as the ambient temperature rises. Therefore, an N5700 can replace any XFR in terms of voltage, current, and power.

### **Protection Features**

#### **Overvoltage Protection (OVP) Operation**

The OVP circuit in the XFR protects the load in the event of a remote programming error, an incorrect voltage control adjustment, or a power supply failure. The protection circuit monitors the voltage at the output of the power supply and will shut down the main power converter whenever a preset voltage limit is exceeded. The OVP can be set using a screwdriver-adjustable potentiometer on the front panel or via one of the optional programming interfaces, excluding the analog input.

OVP in the N5700 is implemented in a very similar way and provides the same protection. When an OVP condition is detected, the output is disabled, the display shows “OVP”, the PROT indicator blinks, and the OV bit is set in the Questionable Condition status register. The OVP level can be set via the front panel or over the bus.

#### **Current Foldback**

The XFR's current foldback operation, when enabled, will disable the power supply's output if the output current meets or exceeds the programmed current limit value. This feature is only available with either the GPIB or RS-232 option.

Current foldback on the N5700 is programmed and operates in the same manner as the XFR. Since all the interfaces are standard, no option is required for this operation.

#### **Fault Shutdown**

The XFR with the GPIB, RS-232, or LAN/RS-232 interface monitors fault conditions such as overvoltage and over-temperature. When a fault is recognized an output signal is created that can shutdown the power supply or other XFR units, however, the unit must be wired correctly in order to do this. If the power supply is set up in this configuration and a fault condition occurs, the unit will be shutdown by disabling the output.

The N5700 also monitors fault conditions and will initiate a shutdown if any of the following faults occur: overvoltage, overcurrent, overtemperature, and remote interface failure. The power supply responds to a fault by shutting down the output, the output capacitors are discharged with the downprogrammer, and “SO” is displayed on the front panel. This is all accomplished internally and does not require extra wiring although an output signal is created that can be used to shutdown other N5700 units.

#### **Remote Voltage Sensing**

The XFR manual states that units can compensate for a voltage drop of 5 V per load lead, which would subtract from the total voltage available at the output. However, the lower voltage models would have no voltage left if the line drop was 10 V total, which can easily occur in low-voltage/high-current models. The manual does not address this.

The N5700 can compensate from 1 V to 5 V per load lead depending on the model. Please refer to the supplemental characteristics in the User’s Guide.

#### **Parallel Operation**

When the GPIB-M option is installed in the XFR, up to five units with the same model number can be connected in parallel. The parallel operation requires the use of a CANbus 4-wire configuration between the paralleled units.

The same capability as is available in an N5700, but only four units can be paralleled. The main difference is that the N5700’s master/slave interface involves one wire instead of the four wires required for the XFR. Set up is explained in the *Parallel Connections* section of the User’s Guide.

#### **Series Operation**

Multiple XFR units can be connected in series to obtain a higher output voltage. The number of units is limited by the 600 V maximum floating voltage. Each unit is individually adjusted, with the total output voltage being the sum of the individual outputs.

Two N5700 units of the same model number can be connected in series to provide up to two times the output voltage capability within  $\pm 60$  VDC of chassis ground for models less than 60 VDC and  $\pm 600$  V of chassis ground for models greater than 60 VDC.

#### **Transient Response**

The XFR’s output voltage will recover within 3 ms to within 0.5% of its rated value after a step change in load current of 10% to 90% of rated output with an output set point between 50–100% of rated value.

All N5700 units’ output voltage will recover within 2 ms to the steady-state voltage level (within 0.5% of full scale) for a 10–90% load step change. Some units recover faster than 2 ms. Please see the User’s Guides of both power supplies for exact specifications.

#### **Programming/Interfacing**

##### **Remote Interfaces**

##### **GPIB, RS-232, USB, and LAN**

The XFR has four optional digital interfaces: GPIB, GPIB-M, RS-232, and LAN/RS-232. The N5700 has GPIB standard and also includes USB and LAN in the same package. The commands that were sent to an XFR via any of the optional interfaces can be sent to an N5700 via GPIB, USB, or LAN. There is also a compatibility mode built into the N5700, which allows the use of the code used with the XFR to work the same when using an N5700. Please see the *Command Compatibility* section below for more details.

### **Remote Analog Interface Characteristics**

The XFR's output voltage, current, and OVP can be programmed using the analog interface either through an external voltage signal or external resistance. The voltage programming can be done between 0–5 V or 0–10 V and the resistance programming can be done between 0–5 k $\Omega$  or 0–10 k $\Omega$ . Other analog capabilities include output enable/disable and remote monitoring of voltage and current.

The N5700 Series has the same capabilities as the XFR. When analog programming the N5700, all functions except for voltage and/or current programming (depending on whether analog programming is being done on voltage, current, or both) are available for use over the other three interfaces. The details of how to use the analog programming interface are covered in the *Analog Programming of Output Voltage and Current* section of the N5700's User's Guide.

### **Front Panel Controls and Indicators**

#### *Voltage Display*

The XFR has a 3 digit, 7-segment LED display that normally indicates the output voltage, but also displays the set voltage when the V/I button is pressed, or the OVP set voltage when the OVP Preview button is pressed.

The N5700 has a 4 digit, 7-segmented LED display that normally indicates the output voltage measured at the sense leads, but also displays the programmed voltage when the LIMIT button is pressed, the OVP or UVL setting when the OVP/UVL button is pressed, or the GPIB address when the REM button is pressed and held.

#### *Current Display*

The XFR has a 3 digit, 7-segment LED display that normally indicates the output current, but also displays the programmed current limit when the V/I button is pressed.

The N5700 has a 4 digit, 7-segmented LED display that normally displays the current measured at the output terminals, but also displays the programmed current limit when the LIMIT button is pressed.

#### *Voltage Control*

The XFR has a 10-turn potentiometer for adjusting the output voltage.

The N5700 has a rotating pulse generator (RPG) for adjusting the output voltage. There is also a FINE button that toggles between Coarse and Fine adjustment modes.

#### *Current Control*

Current control for both units is accomplished in the same manner as described above for Voltage Control.

#### *OVP Set Control*

The XFR uses a trimmer potentiometer for adjusting overvoltage protection.

The N5700 uses the same method as for Voltage or Current Control to adjust the OVP setting after the OVP/UVL button has been pressed once.

The rest of the XFR's front panel switches and indicators, such as the preview buttons, are similar enough in operation to the N5700 to not need mention in this document. Please refer to the appropriate user's guide if more detail is needed.

#### **Command Compatibility**

The N5700 commands are compatible with the most frequently used functions of the XFR. The main compatibility

gap is in the calibration procedure, which must be performed as described in the N5700 user’s guide. There are also a few other exceptions that are explained below.

**Command Operation**

The XFR has four different digital interface options. The command set used varies with each interface. These commands can be used to communicate with and control the XFR. The N5700 is compatible with the most frequently used commands of the XFR, however, there are some functions that are not implemented or operate differently.

**Functions that operate differently or are missing**

- *AUXA and AUXB*  
The AUX commands are used to control the two output signals on the rear panel of the XFR (signals A and B). The N5700 does not have auxiliary output signals.

- *GTL, LLO, and REN*  
These XFR commands all revolve around local versus remote operation. The N5700 does not accept these commands. However, the “SYSTem:COMMunicate:RL State<LOCal|REMote|RWLock>” command serves the same purpose.
- *MASK/UNMASK*  
The MASK and UNMASK settings in the XFR are configured differently when using the N5700. The N5700 implements the same function as the XFR, but uses only the UNMASK command. This is done by using bit weights instead of mnemonics when masking or unmasking status indicators. This command is explained in the N5700’s User’s Guide in Appendix D (referred to as compatibility with the Agilent 603xA).
- *Voltage Foldback*  
When programming the XFR there are two redundant ways to protect against

overvoltage conditions. OVP can be programmed along with voltage foldback. The N5700 does not implement voltage foldback. Programming “FOLD 1” or “FOLD CV” on an N5700 will result in an error. Use OVSET instead.

**Calibration**

The XFR and N5700’s calibration procedures are different. In order to properly calibrate the N5700 please follow the instructions in the *Calibration* section of the N5700’s User’s Guide.

**Mechanical/Physical**

Mechanically the N5700 and the XFR are extremely similar. The sections below provide more details.

**Size**

The overall physical size of the N5700 is approximately the same. Please see **Table 2** below. Positive deltas indicated smaller or lighter.

	<b>XFR</b>	<b>N5700</b>	<b>Delta</b>
<b>Height</b>	43.4mm (1.71in)	43.6mm (1.72in)	-0.2mm (-0.01in)
<b>Width</b>	429mm (16.9in)	422.8mm (16.66in)	6.2mm (0.24in)
<b>Depth</b>	469.4mm (18.48in)	481.6mm (18.96in)	-21.6mm (-0.48in)
<b>Weight</b>	8.2kg (18.0lbs)	7—8.5kg (15.43—18.74lbs)	0.8 — -0.3kg (2.47 — -0.74lbs)

**Table 2.** Dimensions and Weight

**Location and Cooling**

The XFR draws air in from the top and sides of the unit and exhausts it out the rear of the unit. There must be at least 4 inches (100 mm) of unrestricted space at the rear of the unit.

An N5700 is cooled by fans that draw air in through the front and exhaust it out the rear. The fan speed is also variable to reduce noise and extend fan life. The instrument must be installed in a location that allows sufficient space of at least 4 in (100 mm) at the front and rear of the unit for adequate air circulation.

**Rack Mounting**

Both units can be rack mounted. The N5700 only requires the N5740A Rack-mount Slide Kit for installing in system II style cabinets. You will need to purchase the N5740A kit in order to rack mount the unit.

**Input/Output Terminations**

The input and output connectors of each unit are similar in location, but when switching from an XFR to an N5700 you will need to refer to the User's Guides of both units in order to properly locate each connection. Below is a comparison of the important connections.

*Output Connectors*

The XFR 6 V to 40 V models have bus bars. The bus bar holes are 0.332 in. (8.17 mm) in diameter. The 60 V to 600 V models have a 4-terminal wire clamp connector. The N5700 has bus bars with M8X15 screws for models rated from 6–60 V and a 4-terminal wire clamp for models rated from 80–600 V.

*AC Input Connector*

Both the XFR 1.2 kW and N5700 1.5 kW have a 3-terminal wire clamp connector for AC input. N5700 models of 750 W or less have an IEC 320 male AC input connector.

*AC Input Line Cord*

Line cords for both power supplies will vary with the country where it is shipped. When ordering an N5700, your line cord will be appropriate to your model and destination country.

*Chassis Ground*

The XFR has two chassis ground screws located on the rear panel. The N5700 also has two chassis ground screws (M4X8) located on the rear panel.

*Analog Programming Connector*

The XFR has a 15-terminal wire clamp connector (2 piece) for analog programming. The N5700 has a 25-position female subminiature-D connector. The pin-outs of these connectors are different. Please refer to the N5700 User's Guide *The Rear Panel - At a Glance* section for the pin-outs for the J1 analog programming connector.

*Sense Connector*

The XFR has a 5-terminal wire clamp connector (2 piece) for remote sensing. The N5700 also has a 5-terminal wire clamp connector. It is also located in the same area on the rear panel.

## References:

- [1] *How to Convert from a Sorensen DLM to an Agilent N5700*  
AN 1503-1  
5989-1629EN
- [2] *Side-by-Side Comparison: Agilent N5700 Series System DC Source and Sorensen DLM Power Supply*  
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<http://cp.literature.agilent.com/litweb/pdf/5989-1628EN.pdf>
- [3] *Side-by-Side Comparison: Agilent N5700 Series System DC Source and Xantrex XFR System DC Power Supplies*  
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<http://cp.literature.agilent.com/litweb/pdf/5989-1330EN.pdf>
- [5] *Trends in Medium Power (~1 kW) DC Power Supplies*  
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- [6] *Agilent N5700 System DC Power Supply User's Guide*  
5969-2917EN
- [7] *Agilent N5700 Product Reference CD-ROM*  
5969-2918EN

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