How to Convert from a Sorensen DLM to an Agilent N5700

Application Note 1503-1

Introduction

This application note provides a high-level overview of the similarities and differences between the Agilent N5700 and the Sorensen DLM in order to help current Sorensen DLM owners easily convert from their DLM to the more capable N5700A Series. It has been designed to be used in conjunction with the N5700 User's Guide and datasheets as well as the Sorensen DLM 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.[1]

[1] 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 DLM 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 1502-1, which is a side-by-side comparison of a DLM60-10 to an N5747A.

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 (1U) 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 DLM in order to indicate how the DLM 600 W models map

Sorensen DLM Series 600 W				Agilent N5700 Series 750 W[2]			
Model	**Voltage (V)**	**Current (A)**	**Power (W)**	**Model**	**Voltage (V)**	**Current (A)**	**Power (W)**
DLM 5-75	5	75	375	**N5741A**	6	100	600
DLM 8-75	8	75	600	**N5742A**	8	90	720
N/A	N/A	N/A	N/A	**N5743A**	12.5	60	750
DLM 20-30	20	30	600	**N5744A**	20	38	760
N/A	N/A	N/A	N/A	**N5745A**	30	25	750
DLM 40-15	40	15	600	**N5746A**	40	19	760
DLM 60-10	60	10	600	**N5747A**	60	12.5	750
DLM 80-7.5	80	7.5	600	**N5748A**	80	9.5	760
N/A	N/A	N/A	N/A	**N5749A**	100	7.5	750
DLM 150-4	150	4	600	**N5750A**	150	5	750
DLM 300-2	300	2	600	**N5751A**	300	2.5	750
N/A	N/A	N/A	N/A	**N5752A**	600	1.3	780

Table 1. DLM to N5700 Power Supply Mapping

[2] The N5700 Series also includes a family of 1500-W power supplies

Agilent Technologies

over to the N5700 power supplies. For example, if you own a Sorensen DLM5-75 5 V/75 A power supply it is easily replaced by an Agilent N5741A 6 V/100 A power supply. You can also see from the table that the N5700 voltage, current, and power ratings are a superset of the DLM even covering areas where the DLM has no offering, such as at 12.5 V/60 A and 100 V/7.5 A (N5743A and N5749A respectively).

Option and Accessory Selection

The DLM offers a few different options. Each DLM option is covered in the standard N5700 product so there is really no need to do anything beyond matching your current DLM to the N5700 that replaces it by using **Table 1**. The only exception is the RS-232 port on the DLM. 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 DLM and an explanation of how the N5700 covers these options:

M9G, GPIB/RS-232 Interface[3]
The N5700 does not have an RS-232 port, but does have GPIB along with LAN and USB all standard. Therefore, if you have a DLM with the M9G interface, an N5700 will easily replace your GPIB communication, while also offering you the ability to easily convert to the faster and more capable LAN and USB interfaces if desired. See the *Programming/Interfacing* section for more details.

M13, Locking shafts for front panel potentiometers
The N5700 has no need for locking shafts. The front panel knobs are rotating pulse generators (RPGs) and can be locked from use via the "SYSTem: COMMunicate:RLState RWLock" command. This command disables the use of the front panel for changing settings, however, the settings can be viewed even when the front panel is locked.

M51A, Analog Programming Interface[3]
The N5700 has an analog programming interface standard. See the *Remote Analog Interface Characteristics* section for more details.

M85, Multi-channel Slave Interface[3]
The N5700 has a slave interface standard. See the *Parallel Operation* section for more details.

Input Power Requirements
The DLM can be operated from an AC power source rated 90–132 VAC or 180–264 VAC at 43–63 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 DLM, while also providing operation to specification in the range of 132–180 VAC where the DLM will not function.

AC Line Fuses
Both units should not require fuse changes during normal operation.

Regulatory Agency Compliance
All DLM units comply with the requirements of the European Low Voltage Directive and EMC Directive as required for the CE mark.

All N5700 units comply with the same or similar directives as the DLM 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.

[3] When an M9G interface is installed in a DLM, the M51A and M85 interfaces cannot be installed and vice versa.

Electrical

Voltage, Current, and Power

Table 1 showed the models available in the Agilent N5700 and Sorensen DLM 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 DLM model. Therefore, an N5700 can replace any DLM in terms of voltage, current, and power.

Protection Features

Overvoltage Protection (OVP) Operation

The OVP monitor in the DLM provides protection from overvoltage conditions that could be generated at the load due to improper adjustment of the output voltage or malfunction of the unit. The monitor measures the output voltage at the point where the sense leads are connected. When the OVP is tripped, the output converter is turned off and the output capacitors are discharged with a downprogrammer. The front panel OVP indicator is turned on. The OVP level can be set via the front panel potentiometer, analog control, or over the bus.

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 OV 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 DLM'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.

Current foldback on the N5700 is programmed and operates in the same manner as the DLM.

Fault Shutdown

Supervisory circuits in the DLM monitor for abnormal operation of internal circuits, such as overtemperature, logic supply fault, paralleling interface connection fault, cooling fan fault, and output converter driver fault. A fault condition will result in shutdown of the output converter and the output capacitors will be discharged with the downprogrammer.

The N5700 monitors similar conditions and will initiate a shutdown if any of the following faults occur: over-voltage, over-current, over-temperature, 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.

Current Sink (Downprogramming) Capability

Both the DLM and the N5700 have an active downprogrammer that provides for quick changes of voltage settings in the negative direction and quick shutdown.

Remote Voltage Sensing

The DLM 5–10 V units can compensate for a voltage drop of 1 V per load lead. The DLM 20–300 V units can compensate for a voltage drop of up to 2 V per load lead.

The N5700 meets or exceeds the voltage drop compensation of the DLM in all models except the 20 V (N5744A) model where the compensation is 1 V per load lead.

Parallel Operation
Up to four DLM units of the same model number can be connected in parallel. The paralleled units operate in a master/slave configuration, where the master controls the output voltage and total current, and provides control signals to the slaves to set their output current via a 4-wire connection.

The same capability as a DLM is available in an N5700. The main difference is that the N5700's master/slave interface involves one wire instead of the four wires required for the DLM. Set up is explained in the *Parallel Connections* section of the User's Guide.

Series Operation
Multiple units of the same DLM model can be connected in series to obtain a higher output voltage. The number of units is limited by the 300 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 ±60 VDC of chassis ground for models less than 60 VDC and ±600 V of chassis ground for models greater than 60 VDC.

Transient Response
The DLM's output voltage will recover within 500 µs to the steady-state voltage level (within 0.1% of full scale) for a 50–100% or 100–50% load step change.

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, USB, and LAN
The DLM's only digital interface is the optional GPIB interface. The N5700 has GPIB standard and also includes USB and LAN in the same package. The commands that were sent to a DLM via GPIB 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 DLM to work the same when using an N5700. Please see the *Command Compatibility* section below for more details.

Remote Analog Interface Characteristics
The DLM'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 kΩ. Other analog capabilities include output enable/disable and remote monitoring of voltage and current.

The N5700 Series has the same capabilities as the DLM, with the addition of resistance programming from 0-10 kΩ. The only difference is the OVP cannot be programmed via the analog interface, but it can be programmed by any of the other three interfaces. When analog programming an 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 N5700's analog interface also provides the output enable/disable and remote monitoring capabilities of the DLM. 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 DLM has a 3.5 digit, 7-segement LED display that normally indicates the output voltage, but also displays the set voltage when the V/I Preview 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.

Current Display
The DLM has a 3.5 digit, 7-segement LED display that normally indicates the output current, but also displays the programmed current limit when the V/I Preview button is pressed.

The N5700 has a 4 digit, 7-segemented 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 DLM 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 DLM uses a 20-turn 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.

The rest of the DLM's front panel buttons and indicators, such as the preview buttons and the Fault indicator, 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 DLM. 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.

SCPI Command Operation
The M9G option of the DLM adds GPIB and RS-232 communication to the unit. The SCPI command set can be used to communicate with the DLM when using this option. The N5700 supports the SCPI command set and is compatible with the most frequently used functions of the DLM, however, there are some functions that are not implemented or operate differently.

- *Functions that operate differently or are missing OVP/Foldback*
  When programming the DLM 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.

- *Average Measurements*
  The DLM supports the averaging of 2–5 measurements. The N5700 does not have this feature.

- *The Ramp Function*
  The DLM's M9G allows the user to transition from one voltage to another linearly in a specified time period. The N5700 does not have this feature.
- *Front Panel Local Lockout*
  The ability to lock the front panel exists in both the DLM and the N5700; however, the commands to implement lockout differ. For more information, look up the "SYSTem:COMMunicate: RLState <LOCal|REMote|RWLock>" command in the N5700 User's Guide.

SCPI Status Model
The SCPI status models that are implemented by both the DLM and N5700 are very similar, but not identical. The N5700 is capable of handling any status programming that was implemented in the DLM, but the structure may be slightly different. If your program uses the SCPI status model of the DLM, please refer to the N5700 User's Guide in order to properly map over the status structure from the DLM to the N5700.

M9A Command Operation
The DLM M9 option supports a command set called M9A. This command set is nearly identical to the Agilent 603xA Series' command set. Since the N5700 is compatible with the Agilent 603xA Series' commands it is compatible with the M9A command set. Incompatibilities occur only with the DLY, OVP, and MASK commands. If used with the N5700, the DLY command produces error 203, the OVP is set with the OVSET command instead, and the MASK settings are set using the UNMASK command. This command set is explained in the DLM's M9 Option Programming Manual and in the N5700's User's Guide in Appendix D (referred to as compatibility with the Agilent 603xA). Please refer to these manuals for further details.

Operation with M85 Option
The DLM's M85 option enables the unit to be uses as an auxiliary, or slave, unit using a 4-wire connection. The N5700's slave capability is standard in all units and uses a 1-wire connection. Setup and operation are somewhat different than the DLM, but you should find them much easier. Both topics are covered in the *Parallel Connections* section of the N5700's User's Guide.

Calibration
The DLM and the 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 DLM are similar. The major difference is the width of the N5700 is roughly one rack width while the width of the DLM is roughly one-half rack width.

Size
The overall physical size of the N5700 is approximately the same except the DLM is about half the width of the N5700. Please see **Table 2** below. Positive deltas indicated smaller or lighter.

	DLM 600	N5700	Delta
Height	43.69mm (1.72in)	43.6mm (1.72in)	0.09mm (0.004in)
Width	214.38mm (8.16in)	422.8mm (16.66in)	-208.42mm (-8.21in)
Depth	460mm (18.12in)	481.6mm (18.96in)	-21.6mm (-0.85in)
Weight	4.4kg (9.7lbs)	7—8.5kg (15.43—18.74lbs)	-2.6 — -4.1kg (-5.73 — -9.04lbs)

Table 2. Dimensions and Weight

Location and Cooling
A DLM is cooled by forced convection cooling with an internal fan. The fan speed is variable as a function of ambient temperature and load to extend the fan's life and reduce ambient noise. Air intake is at the front and sides of the chassis and the exhaust is at the rear and sides of the chassis.

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 10cm (4in) 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 terminations of each unit are similar in location, but when switching from a DLM 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 Terminations/Load Connections
The DLM has bus bars with #10-32 screws for models rated from 5-60 V (low-voltage) and a terminal block for models rated from 80-300 V (high voltage). The N5700 has bus bars with M8X15 screws for models rated from 6-60 V and a terminal block for models rated from 80-600 V.

AC Input Connector
Both the DLM and the N5700 (models 750 W or less) have an IEC 320 male AC input connector. N5700 models greater than 750 W have a different AC input connector, which is a 3-terminal wire clamp located on the rear panel.

AC Input Line Cord
Both the DLM and the N5700 use the IEC 320 female connector. The N5700 uses this connector for models less than 750 W only. N5700 models greater than 750 W require a different 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.

Ground Stud
The DLM has a #6-32 stud on the rear panel for terminations to chassis ground. The N5700 has two M4X8 screws located on the rear panel for making chassis ground connections.

Remote Analog Interface Connector
The DLM has a 25-position female subminiature-D connector. The N5700 has the same style 25-position connector, however, the pin-outs 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.

Remote Sense Connector
The remote sense switch on the back of the DLM must be switched to the on position for the DLM to use remote sensing. There is a 2-positon Molex connector that connects the + and – remote sense leads to the DLM.

The N5700 does not require the use of a switch to go from remote to local sensing and vice versa. There is a remote sense connector on the rear of the unit with wires jumpered between the + and – local and remote sense leads. The connector is a 5-position quick disconnect Phoenix.

Paralleling Interface Connector
The DLM uses two six-position Molex connectors for use with the Paralleling Cable, Sorensen part number DLMP1. The N5700 uses pin 25 of the J1 analog programming connector for parallel operation.

References:

[1] *How to Convert from a Xantrex XFR to an Agilent N5700*
AN 1503-2
5989-1631EN

[2] *Side-by-Side Comparison: Agilent N5700 Series System DC Source and Sorensen DLM Power Supply*
AN 1502-1
5989-1628EN
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*
AN 1502-2
5989-1630EN
http://cp.literature.agilent.com/litweb/pdf/5989-1630EN.pdf

[4] *Agilent N5700 Series Data Sheet*
5989-1330EN
http://cp.literature.agilent.com/litweb/pdf/5989-1330EN.pdf

[5] *Trends in Medium Power (~1 kW) DC Power Supplies*
5989-1331EN
http://cp.literature.agilent.com/litweb/pdf/5989-1331EN.pdf

[6] *Agilent N5700 System DC Power Supply User's Guide*
5969-2917EN

[7] *Agilent N5700 Product Reference CD-ROM*
5969-2918EN

Agilent Technologies' Test and Measurement Support, Services, and Assistance

Agilent Technologies aims to maximize the value you receive, while minimizing your risk and problems. We strive to ensure that you get the test and measurement capabilities you paid for and obtain the support you need. Our extensive support resources and services can help you choose the right Agilent products for your applications and apply them successfully. Every instrument and system we sell has a global warranty. Support is available for at least five years beyond the production life of the product. Two concepts underlie Agilent's overall support policy: "Our Promise" and "Your Advantage."

Our Promise

Our Promise means your Agilent test and measurement equipment will meet its advertised performance and functionality. When you are choosing new equipment, we will help you with product information, including realistic performance specifications and practical recommendations from experienced test engineers. When you receive your new Agilent equipment, we can help verify that it works properly and help with initial product operation.

Your Advantage

Your Advantage means that Agilent offers a wide range of additional expert test and measurement services, which you can purchase according to your unique technical and business needs. Solve problems efficiently and gain a competitive edge by contracting with us for calibration, extra-cost upgrades, out-of-warranty repairs, and onsite education and training, as well as design, system integration, project management, and other professional engineering services. Experienced Agilent engineers and technicians worldwide can help you maximize your productivity, optimize the return on investment of your Agilent instruments and systems, and obtain dependable measurement accuracy for the life of those products.

Agilent Email Updates

www.agilent.com/find/emailupdates
Get the latest information on the products and applications you select.

Agilent T&M Software and Connectivity

Agilent's Test and Measurement software and connectivity products, solutions and developer network allows you to take time out of connecting your instruments to your computer with tools based on PC standards, so you can focus on your tasks, not on your connections. Visit
www.agilent.com/find/connectivity
for more information.

For more information on Agilent Technologies' products, applications or services, please contact your local Agilent office. The complete list is available at:

www.agilent.com/find/contactus

Phone or Fax

United States:
(tel) 800 829 4444
(fax) 800 829 4433

Canada:
(tel) 877 894 4414
(fax) 905 282 6495

China:
(tel) 800 810 0189
(fax) 800 820 2816

Europe:
(tel) 31 20 547 2111

Japan:
(tel) (81) 426 56 7832
(fax) (81) 426 56 7840

Korea:
(tel) (080) 769 0800
(fax) (080)769 0900

Latin America:
(tel) (305) 269 7500

Taiwan:
(tel) 0800 047 866
(fax) 0800 286 331

Other Asia Pacific Countries:
(tel) (65) 6375 8100
(fax) (65) 6755 0042
Email: tm_ap@agilent.com

Product specifications and descriptions in this document subject to change without notice.

Printed in USA, January 28, 2005
5989-1631EN

Agilent Technologies