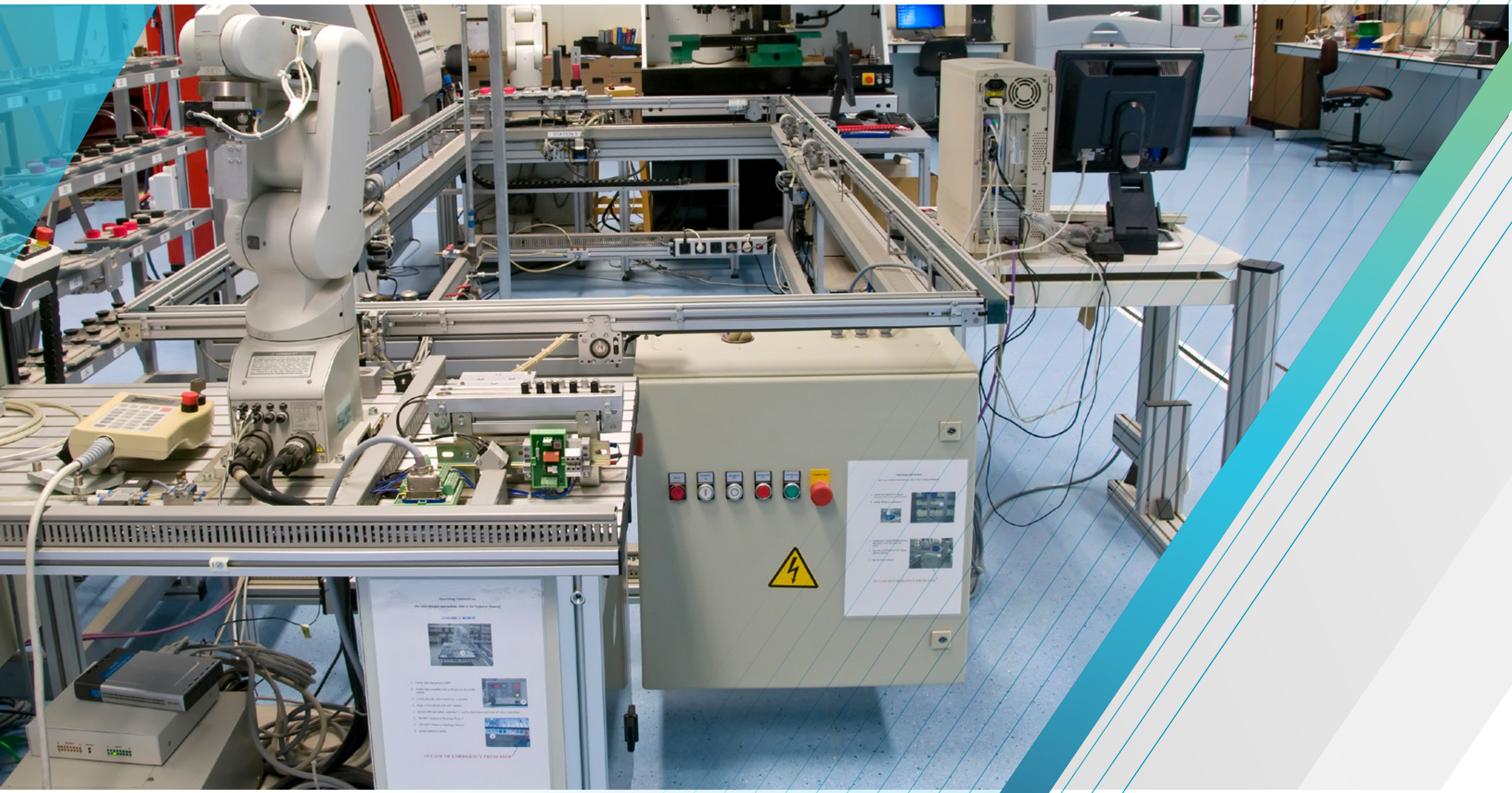
Efficient Power Supply Control for Minimizing Test Time and Test Costs in Automated Test Systems that use Multiple DC Power Supplies

APPLICATION NOTE



KEITHLEY
A Tektronix Company

Tektronix®

Power supplies are generally not instruments that are considered to operate at high speed. They are designed to both provide a stable output under any load condition and to have as little output noise as possible. To achieve this, standard power supplies have a very low output bandwidth. The trade-off with high stability and low noise is slow operation relative to measurement instruments and control instruments. Power supplies need time to change levels in a well-behaved manner so as not to have glitches or overshoot. A stable, controlled output avoids damaging devices that a supply is powering. Thus power supply settling times are generally, longer than communication and control times. Hence power supplies can be the limiting factor in test times. That may not always be the case; the device-under-test DUT) that the power supply is powering can be the limiting factor if the DUT needs time to settle after changes due to the application of different power voltage levels or different input signals.

While optimizing systems for minimizing tests times will not focus on the power supply, there are actions that can be taken to minimize the test time with power supplies. Some power supplies have the ability to internally process a set of commands independent of a controller. For example, a supply could execute a routine to step its output at a fixed time interval through a range of values to test a device over its input voltage operating range. Once the controller has downloaded the command set to the power supply, the controller would not need to interact with the supply while it was executing the test routine. The test can run faster since the controller does not have to take time to transmit each individual command to the power supply during testing. This time savings can be increased further if multiple power supplies are in the system to test multiple DUTs. Power supplies with the ability to process a set of commands without external control greatly reduces the number of commands that the system controller must transmit to the power supplies and frees the controller to concentrate on more critical tasks.

If multiple power supplies can be connected in a master-slave or a daisy chain configuration, the test system gains additional benefits. The controller only needs one physical communication interface for all the power supplies. That can save on additional interfaces and hubs. Furthermore, the control cables between the power supplies are typically lower cost than individual computer interface cables.
Thus the master –slave or daisy-chain configurations can simplify test system wiring and reduce test system costs.

Additional cost savings can be realized if a power supply has other outputs. Some supplies can provide independent outputs to power external devices such as control relays, test fixtures, or system status lamps. These outputs also can free up the controller from managing external devices.

The Keithley Series 2268, 850W DC Power Supplies have an auto sequence feature that enables the supplies to execute a test routine downloaded from a controller. These sequences can consist of any of the power supply's commands. The Series 2268 supplies also have a daisy-chain configuration that allows up to 30 power supplies to be linked together reducing the number of physical connections required from the controller. The controller only needs to send one command to initiate the sequence and all the linked supplies will execute their pre-programmed sequences. Furthermore, the series 2268 power supplies have a 15V and 5V auxiliary outputs in addition to the main power output. These outputs can communicate with other devices or provide power to activate relays or power other components, such as test fixtures or status lamps, in a test system.

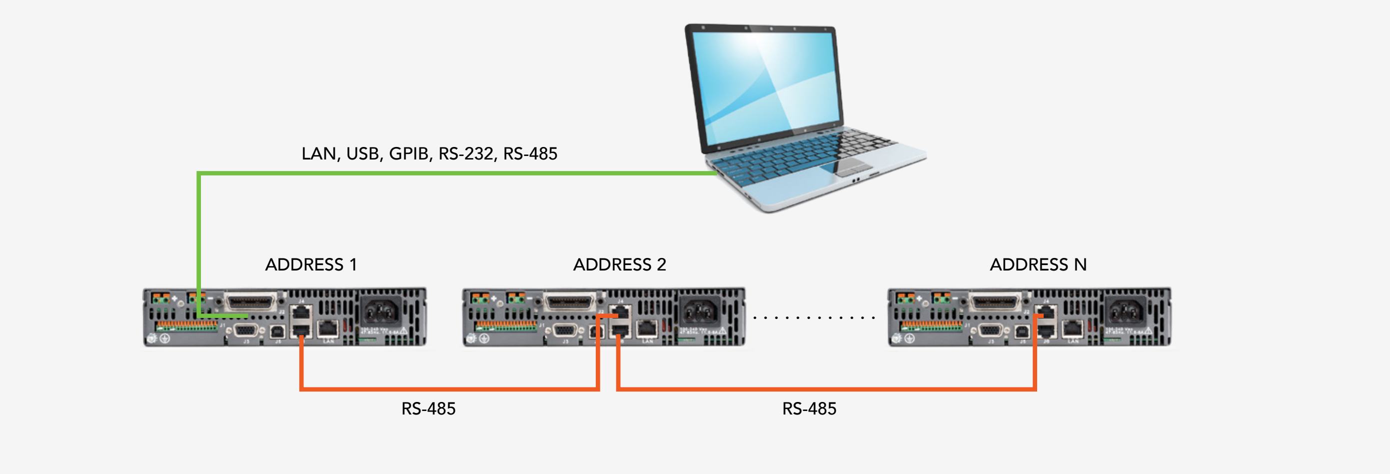


Figure 1: Series 2268 Power Supplies in a daisy-chain configuration. The supplies are linked through the RS-485 interface. The master can connect to the controller through any of its available interfaces.

The following paragraphs describe an example showing how to wire and to code the control of Series 2268 power supplies in a multiple power supply test system for test time and test cost optimization. In this example the supplies are daisy-chained through their RS-485 interfaces. The first supply can interface with the main controller through any of the Series 2268 supply's standard interfaces, LAN, USB, GPIB, RS-485, and RS-232. The setup of the supplies is shown in Figure 1.

In this specific example, the supplies will test DUTs at a nominal voltage then a minimum operating voltage and a maximum operating voltage. The supplies will start with the output off. Then they will be programmed to output the nominal voltage, the low voltage, and the high voltage at a programmed time interval for each voltage level. The output will be returned to the nominal voltage; then the supplies will be de-energized. The auxiliary output will be turned on for the duration of the test.

The output of the supplies dictated by the control code is shown in Figure 2.

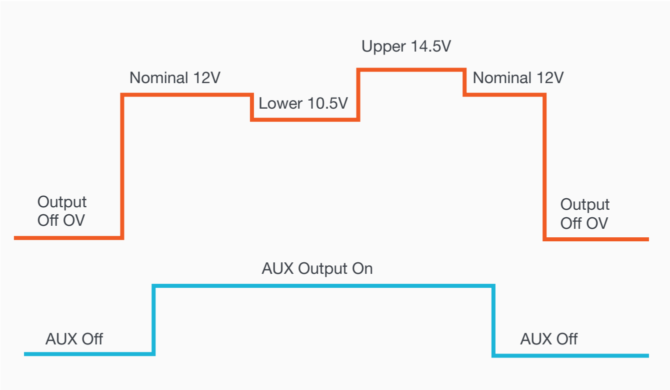


Figure 2: Voltage vs time plot of the output of the power supplies. The auxiliary output of each supply is activated for the duration of the test sequence.

The example program to control "n=3" supplies is listed in Appendix A. The program is written in Python. The Auto Sequence routine is downloaded into each of the power supplies. This command set, nineteen commands, is under the "Create a new Auto Sequence Program" comment in the program. The controller only needs to send the command: viWrite(ke2268, ':INIT0:IMM') once, to have all of the power supplies simultaneously execute their pre-programmed Auto-Sequence routine.

The simple program and the capabilities of the Series 2268 power supplies including internal execution of a sequence of instructions, a daisy-chain configuration, and auxiliary outputs free the system controller for other tasks and contribute to minimizing system test time.

Appendix A.
Python Program to Control the Master - Slave Power Supply Configuration

```
#*********************************************************************************
# Title: 2268 Multi Channel Auto Sequence Test
#
# Note: This python script was written for PyVISA 1.4.  If you are using PyVISA
# 1.5 or later, you will need to modify some of the PyVISA calls in this script
# for it to work.  See http://pyvisa.readthedocs.org/en/master/migrating.html
# for details.
#*********************************************************************************
import time
import visa
# Change this number to match the number of connected channels
numChannels = 3
# The 2268 requires some delay between commands to avoid input overrun
# These functions will be used so we don't have to insert delays manually
def viWrite(vi, buf):
    vi.write(buf)
    time.sleep(0.1)
def viQuery(vi, buf):
    result = vi.ask(buf)
    time.sleep(0.1)
    return result
ke2268 = visa.instrument('COM8')
foundErr = False
# Configure each channel one at a time
for x in range(1,numChannels + 1):
    # Select a multi channel address
    starADR = '*ADR %d' % (x)
    print(starADR)
    viWrite(ke2268, starADR)
    # Query the instrument ID
    print(viQuery(ke2268, '*IDN?'))

    # Perform the inital configuration
    viWrite(ke2268, ':SOUR:POW:MODE OFF')
    viWrite(ke2268, ':VOLT 0')
    viWrite(ke2268, ':VOLT:PROT 18')
    viWrite(ke2268, ':CURR 5')
```

```
    viWrite(ke2268, ':OUTP:PROT:FOLD:DEL 1')
    viWrite(ke2268, ':OUTP:PROT:FOLD CC')
    # Create a new Auto Sequence Program
    viWrite(ke2268, ':PROG:DEL:ALL')# Delete any existing program
    viWrite(ke2268, ':PROG:STAR')   # Start recording sequence
    viWrite(ke2268, ':PROG:DWEL 0')
    viWrite(ke2268, ':OUTP ON')     # Turn output on
    viWrite(ke2268, ':VOLT 12')     # Output nominal voltage
    viWrite(ke2268, ':PROG:DWEL 2') # Wait for device to power up
    viWrite(ke2268, ':PROG:DWEL 0')
    viWrite(ke2268, ':OUTP:AUX ON') # Turn AUX output on
    viWrite(ke2268, ':PROG:DWEL 5') # Set time each level will be tested for
    viWrite(ke2268, ':VOLT 10.5')   # Test at lower limit voltage
    viWrite(ke2268, ':VOLT 14.5')   # Test at upper limit voltage
    viWrite(ke2268, ':PROG:DWEL 0')
    viWrite(ke2268, ':VOLT 12')     # Return to nominal voltage
    viWrite(ke2268, ':PROG:DWEL 1')
    viWrite(ke2268, ':PROG:DWEL 0')
    viWrite(ke2268, ':OUTP:AUX OFF')# Turn the auxilary output off
    viWrite(ke2268, ':PROG:DWEL 2') # Give device time to respond to AUX off
    viWrite(ke2268, ':OUTP OFF')    # Turn output off
    viWrite(ke2268, ':PROG:STOP')   # Stop recording sequence
    # Check for any errors during configuration
    splitErr = ['-1']
    while splitErr[0] != '0':
        errLine = viQuery(ke2268, ':SYST:ERR?')
        print(errLine)
        splitErr = str.split(errLine, ',')
        if splitErr[0] != '0':
            foundErr = True
if foundErr:
    print("Errors occured during setup.  Please fix then run again.")
else:
    # Start the Auto Sequence on all channels at the same time
    viWrite(ke2268, ':INIT0:IMM')
# Once the Auto Sequence program is loaded, you can start the test again and
# again by simply sending the ':INIT0:IMM' command.
# After running this script you can just type viWrite(ke2268, ':INIT0:IMM') into
# the python console to start the test again.
```

Contact Information:

Australia* 1 800 709 465

Austria 00800 2255 4835

Balkans, Israel, South Africa and other ISE Countries +41 52 675 3777

Belgium* 00800 2255 4835

Brazil +55 (11) 3759 7627

Canada 1 800 833 9200

Central East Europe / Baltics +41 52 675 3777

Central Europe / Greece +41 52 675 3777

Denmark +45 80 88 1401

Finland +41 52 675 3777

France* 00800 2255 4835

Germany* 00800 2255 4835

Hong Kong 400 820 5835

India 000 800 650 1835

Indonesia 007 803 601 5249

Italy 00800 2255 4835

Japan 81 (3) 6714 3010

Luxembourg +41 52 675 3777

Malaysia 1 800 22 55835

Mexico, Central/South America and Caribbean 52 (55) 56 04 50 90

Middle East, Asia, and North Africa +41 52 675 3777

The Netherlands* 00800 2255 4835

New Zealand 0800 800 238

Norway 800 16098

People's Republic of China 400 820 5835

Philippines 1 800 1601 0077

Poland +41 52 675 3777

Portugal 80 08 12370

Republic of Korea +82 2 6917 5000

Russia / CIS +7 (495) 6647564

Singapore 800 6011 473

South Africa +41 52 675 3777

Spain* 00800 2255 4835

Sweden* 00800 2255 4835

Switzerland* 00800 2255 4835

Taiwan 886 (2) 2656 6688

Thailand 1 800 011 931

United Kingdom / Ireland* 00800 2255 4835

USA 1 800 833 9200

Vietnam 12060128

*** European toll-free number. If not accessible, call:** +41 52 675 3777

KEITHLEY
A Tektronix Company

Find more valuable resources at TEK.COM

092616 1KW-60884-0