APC

APPLICATION NOTE #165

Switched Outlet Groups on
SMT and SMX Smart-UPS®

By Neil Whiting

Abstract

The introduction of the SMT & SMX Smart-UPS, Line Interactive products, has seen a key feature enhancement across most
of the range in the form of Switched Outlet Groups. The benefit of this feature is that it allows the end-user to locally or
remotely reboot hung equipment, automatically shed less critical equipment to save power when on battery or the utility supply,
and to sequence both the start-up and shutdown of attached equipment. To facilitate these functions associated delays can be
defined by the end user to meet specific needs.

This document provides an overview of the applications and benefits of the Switched Outlet Group feature.

Table of Content

Introduction   Page 2
Outlet Group Control Overview   Page 3
     Individual Outlet Group Controls   Page 3
     Sequencing between Outlet Groups   Page 4
Using Controlled Outlet Groups   Page 4
     Load shed of less critical equipment when on battery to preserve battery capacity   Page 4
     Load shed under an overload condition to protect critical equipment   Page 5
     Reboot of a locked-up device on a Switched Outlet Group   Page 5
     Reboot of a locked-up device on a Main Outlet Group   Page 6
     Sequential switch-on of equipment to ensure system integrity at start-up   Page 6
     Sequential turning on of equipment to prevent potential supply overload at switch-on   Page 7
     Sequential shutdown of equipment to ensure system integrity   Page 7
Conclusions   Page 8

©2011 American Power Conversion. All rights reserved. No part of this publication may be used, reproduced, photocopied, transmitted,
or stored in any retrieval system of any nature, without the written permission of the copyright owner. *www.apc.com*   Rev 2011-0

Introduction

The switched outlet groups essentially allow connected equipment, such as servers and network switches, to be turned on and turned off in a controlled manner. Depending on how the control is configured, they can be used to achieve a number of end results. Simply turning off connected equipment can be used to preserve battery capacity or minimize utility use, prevent a utility overload situation at switch-on or allow the reboot of a locked-up device. The groups can be configured to allow the sequencing, both on and off, of connected equipment using configurable delays. Outlet groups can also be treated as virtual UPS units allowing most operations that historically were carried out by the UPS to be performed by an individual outlet group, thus facilitating a shutdown at low battery, the turning on, off or the reboot of connected equipment.

There are two types of outlet groups available on the SMT & SMX Smart-UPS products, Main Outlet Group and Switched Outlet Group, of which one or both can be present depending on the model.

> **Main Outlet Group** is tied directly to the UPS output and will always be turned on, before and turned off after, any Switched Outlet Group.

> **Switched Outlet Group** is also tied directly to the main UPS output, but is controllable separately. However, any Switched Outlet Group will only turn on once the main UPS output is on and will always turn off before the main UPS output goes off.

From this there are two basic configurations of the outlet groups:

    a.   Combination of both a Main Outlet Group and one or more Switched Outlet Groups.

    b.   Two or more Switched Outlet Groups.

The following diagram shows a basic configuration of a Smart-UPS having a Main Outlet Group and two independently Switched Outlet Groups.

Smart-UPS with "Switched Outlet Groups"

APC
by Schneider Electric
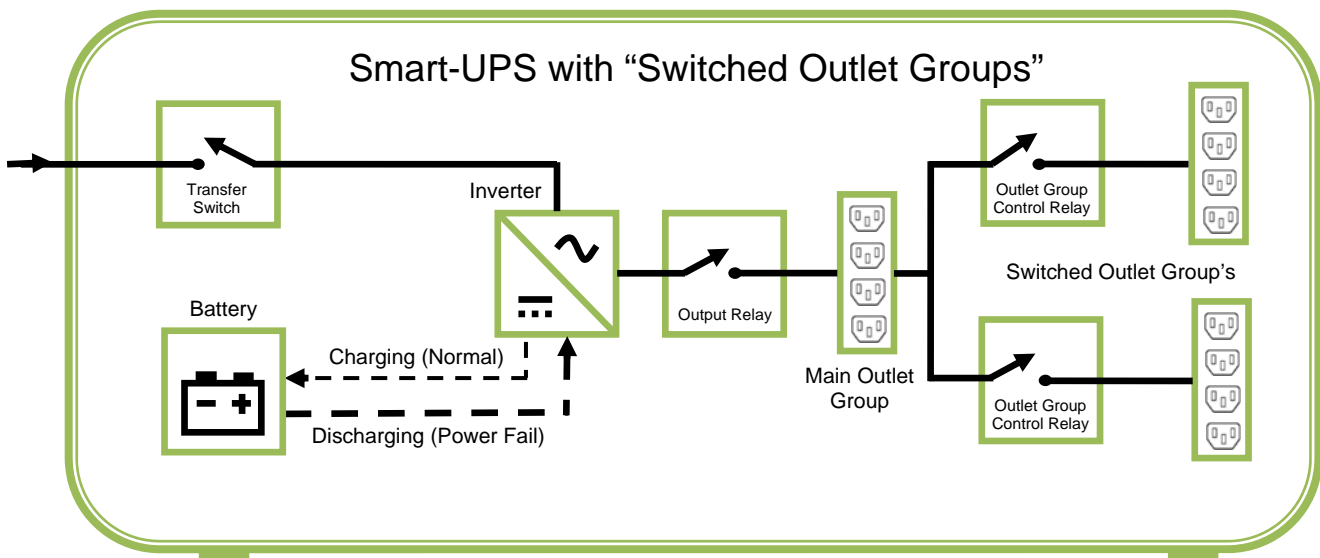
Outlet Group Control Overview

How the outlet groups respond is user configurable by the setting of various parameters including associated delays, which can be set locally via the UPS intuitive user interface panel, through a connected computer in association with APC PowerChute software using the UPS USB or serial port, or over a network when a UPS Network Management card is installed.

The key functions of the switched outlet groups are as follows:

Note : Some options are only offered via a connected computer and not the UPS intuitive user interface panel, due to their complexity.

Individual Outlet Group Controls

1. **Turning On** – This is the basic function that allows all or specific outlet groups to be turned on, with or without user configurable delays, examples of which are "Power Off Delay", "Power On Delay", "Load Shed Time On Battery" and "Reboot Duration".

2. **Turning Off** – This is the basic function that allows all or specific outlet groups to be turned off, with or without user configurable delays.

3. **Reboot** - This forces an outlet off and back on again using a user configurable "Reboot Duration", which can be set to a period of up to 5 minutes, thus ensuring that the attached equipment has time to reset before the AC is reapplied. This facility allows a locked-up device to reboot.

4. **Sleep** - Turns the unit or selected outlet group(s) off, with or without defined delays, but allows them to turn back on automatically after a user definable period of time, usually greater than 5 minutes but up to 359.9 hours. This function primarily allows energy to be conserved when the unit is not required.

5. **Shutdown** - Turns the UPS or selected outlet group(s) off, with or without defined delays, but allows them to turn back on automatically when user configured conditions are met. Typical conditions for turning back on automatically are when the AC power returns or when the user configurable minimum battery capacity has been reached following a power outage. With the appropriate time delays set the loads to be shutdown can be sequenced off in a predetermined order and back on again in a different order to ensure equipment is turned off and on in the correct order.

6. **Load Shed** - Allows less critical equipment, which does not have the ability to communicate with the UPS, to be turned off if required. This can be used to save energy when being fed from the utility supply, to preserve battery capacity for critical loads when operating from the unit's battery or to reduce the overall loading should the total demand on the UPS exceed its limits. A typical example of the type of load that this facility can be used with is a monitor, where a graceful shutdown is not a requirement.

APC
by Schneider Electric

Sequencing between Outlet Groups

7. **Sequencing On of Outlet Group(s)** - This allows outlets to be "Turned On" in a set sequence by configuring the associated "Turn On delay" of individual outlet groups, when the system is started up initially or after the return of the supply following a power outage. This helps to avoid overload conditions that can occur when all the equipment tries to turn on at the same time. It can also be used to ensure that certain equipment, such as network devices "Turn On" before other equipment, such as servers, ensuring the communications path is established first.

8. **Sequencing Off of Outlet Group(s)** – This allows outlets to be "Turned Off" in a set sequence by configuring the associated "Turn Off delay" of individual outlet groups, when a power outage occurs. With the delays configured on specific outlet groups the UPS can then ensure that certain equipment turns off after other equipment has shutdown.

Using Switched Outlet Groups

The following scenarios demonstrate how the switched outlet groups can be used to achieve various end results.

The timing periods used in the following scenarios have been chosen to simplify the graphs in order to clearly demonstrate the relationship between the outlet group actions under the given conditions.
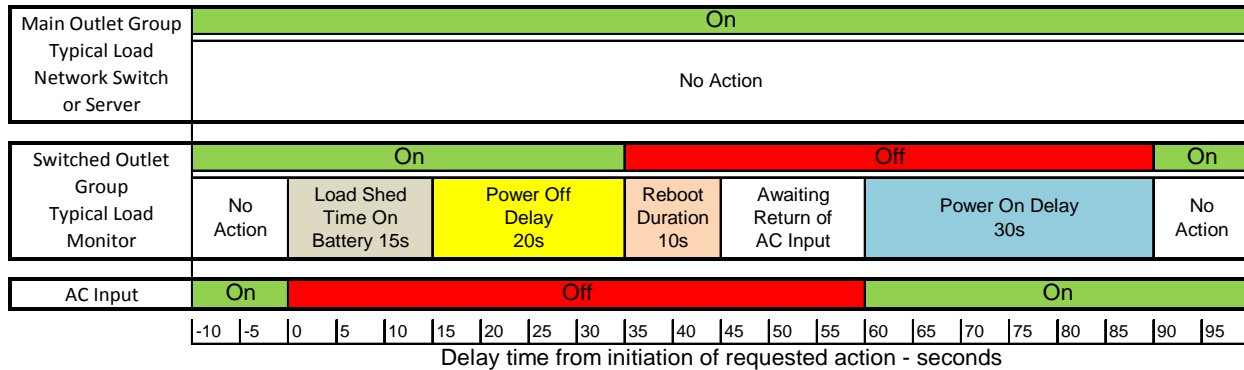
Load shed of less critical equipment when on battery to preserve battery capacity

This scenario looks at the ability of the Switched Outlet Group to disconnect less critical and unintelligent equipment, such as a monitor, to preserve battery capacity. This allows a greater runtime to support more critical loads, typically network switches and servers. However, this does not provide any form of graceful shutdown, equipment will simply be turned off, so must be used cautiously and only for less critical and unintelligent equipment.

The key configurable setting in this example is the "Load Shed Time on Battery", which is the length of time the Switched Outlet Group is set to run on battery before the equipment is shed and turned off. The "Load Shed Time on Battery" must be set to a value that is less than the available runtime otherwise the battery will simply drain and the UPS turn off before the shed process has completed.

Figure 1 shows just the Switched Outlet Group being controlled and how other settings, such as the "Power Off Delay", also influence how it responds.

Figure 1 – *Timing chart for load shed on the Switched Outlet Group during a power outage*

Main Outlet Group Typical Load Network Switch or Server	On						
	No Action						

Switched Outlet Group Typical Load Monitor	On			Off			On
	No Action	Load Shed Time On Battery 15s	Power Off Delay 20s	Reboot Duration 10s	Awaiting Return of AC Input	Power On Delay 30s	No Action

AC Input	On	Off		On	

| -10 | -5 | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 |

Delay time from initiation of requested action - seconds

A load shed sequence can also be initiated by using the "Load Shed Runtime Remaining" threshold, which activates the load shed when the units estimated runtime remaining reaches a user configurable level. Both "Load Shed Time on Battery" and "Load Shed Runtime Remaining" can be used with each other, however, whichever threshold is reached first will initiate the load shed, turning the connected equipment off.

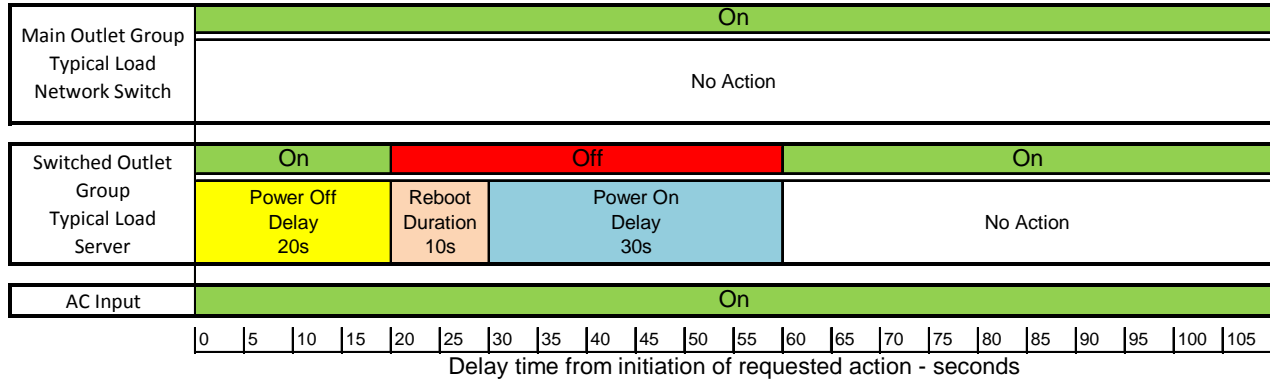## Load shed under an overload condition to protect critical equipment

Load shed on overload allows continued support of more critical equipment by turning off less critical devices, such as monitors, on a Switched Outlet Group, thus reducing the overall loading on the UPS. The Switched Outlet Group will quickly disconnect its connected equipment when detecting an overload on the UPS, which does not use any of the configured delays. The Switched Outlet Group can then only be turned back on manually, either at the UPS or through a connected computer, thus allowing the cause of the overload to be investigated prior to turning the Switched Outlet Group back on.

Reboot of a locked-up device on a Switched Outlet Group

This scenario covers the reboot of a server connected to a Switched Outlet Group that has locked-up, an action that can be initiated remotely over the network, removing the need to physically go to the location of the equipment.

The critical setting in this scenario is the "Reboot Duration" and this must be set to meet the needs of the specific device attached, being long enough to ensure that it is completely turned off and in its stable off state before being restarted. The "Power On Delay" will also be included in the sequence, as can be seen in Figure 2 below.

Figure 2 – Timing chart for the reboot of a locked-up device on a Switched Outlet Group.

Main Outlet Group Typical Load Network Switch	On		
	No Action		

Switched Outlet Group Typical Load Server	On	Off	On
	Power Off Delay 20s / Reboot Duration 10s / Power On Delay 30s		No Action

AC Input	On

Delay time from initiation of requested action - seconds
(0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105)
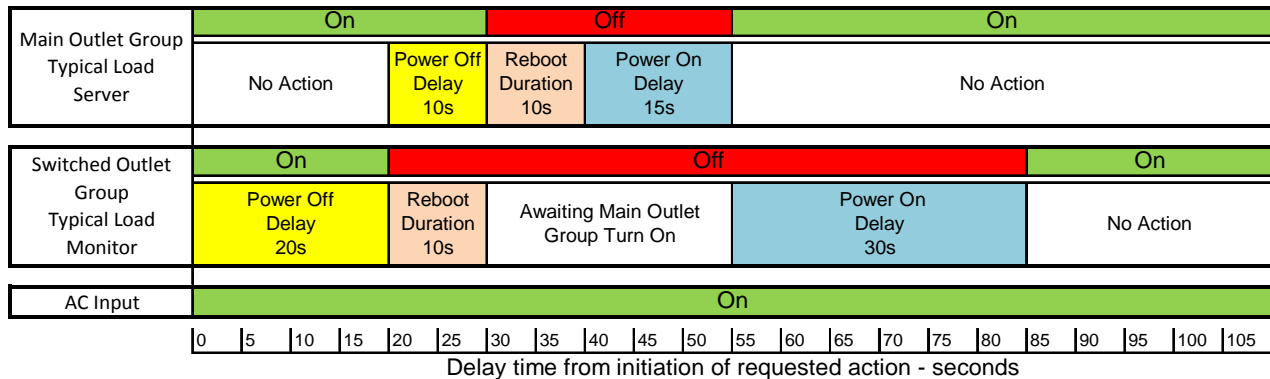
Reboot of a locked-up device on a Main Outlet Group

This scenario covers the reboot of a server connected to the Main Outlet Group that has locked-up. However, this will reboot equipment on all the outlet groups, using their associated delays when configured. A reboot of the equipment on the Main Outlet Group can be initiated locally via the UPS or over a network remotely, removing the need to go to the location of the equipment.

The critical setting in this scenario is the "Reboot Duration" and this must be set to meet the needs of the specific device attached, being long enough to ensure that it is completely turned off and in its stable off state before being restarted. The action can be initiated either with or without the associated "Power Off Delay", which is a choice presented to the user when initiating the reboot via a connected computer. Once a reboot has been initiated any Switched Outlet Group will be turned off before the Main Outlet Group. With all the outlet groups turned off and the configured "Reboot Duration" period met the Main Outlet Group will then turn back on followed by any Switched Outlet Group. The associated timings can be seen in Figure 3 below.

Figure 3 – Timing chart for the rebooting of a "Locked-up" device on a Main Outlet Group

Main Outlet Group Typical Load Server	On	Off	On
	No Action / Power Off Delay 10s	Reboot Duration 10s / Power On Delay 15s	No Action

Switched Outlet Group Typical Load Monitor	On	Off	On
	Power Off Delay 20s / Reboot Duration 10s	Awaiting Main Outlet Group Turn On / Power On Delay 30s	No Action

AC Input	On

Delay time from initiation of requested action - seconds
(0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105)

6

Sequential switch-on of equipment to ensure system integrity at start-up

The ability to sequence the turn-on of equipment can be useful to ensure that certain devices are up and running before others. An example of this would be to ensure that the network switch on the Main Outlet Group has started and is functioning correctly before a server on a Switched Outlet Group, which would need to communicate via the network switch.

The critical setting in this scenario is the "Power On Delay", as is shown in Figure 4, where a Main Outlet Group and a single Switched Outlet Group are turning-on with their associated delays. Units with additional Switched Outlet Groups would be sequenced to turn-on according to their delay configurations.

Figure 4 – Timing chart for the sequential turning-on of a Main and Switched Outlet Group.
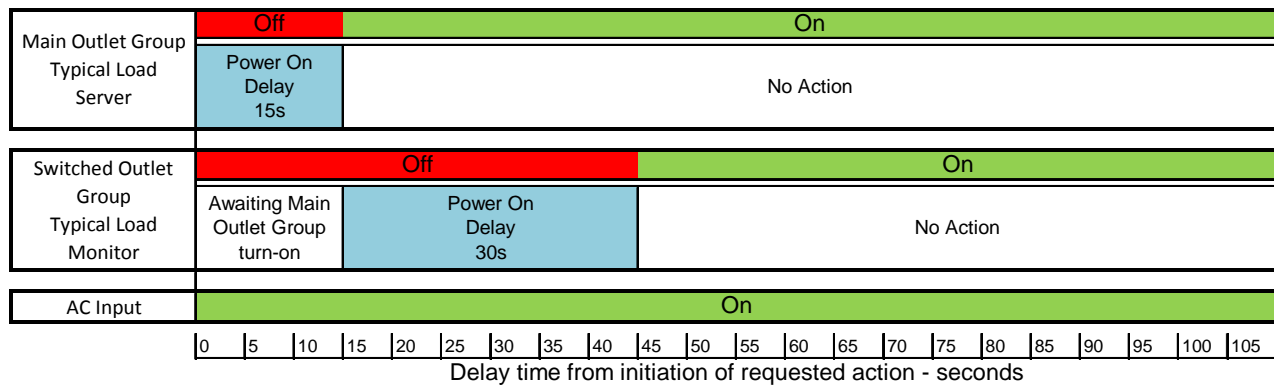
Sequential turning on of equipment to prevent potential supply overload at switch-on

As with the previous scenario, the sequential switching-on of equipment can also be useful on sites where there are multiple UPS units that can start-up together, potentially overloading the incoming supply, be that from the local utility or, more importantly, from a generator that may not be able to cope with a high peak demand.
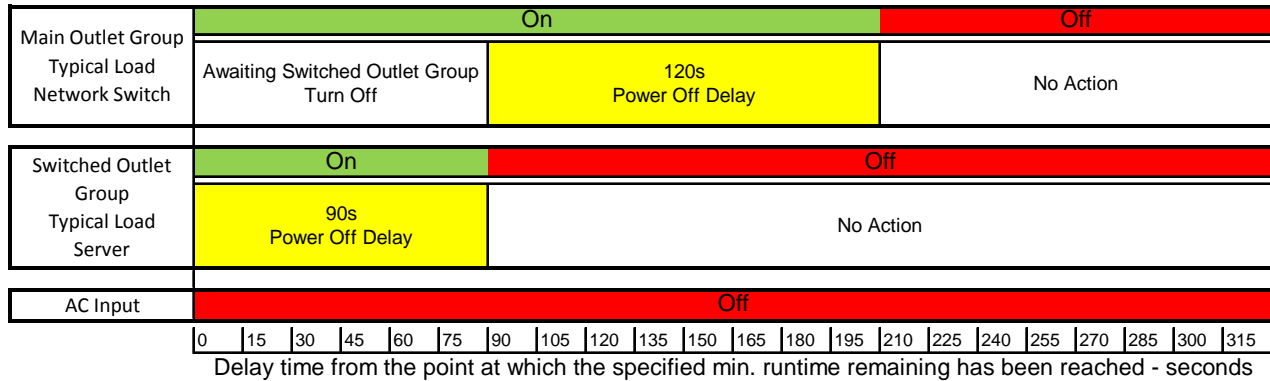
Sequencing the turn-on of the UPS units allows the initial start-up demand to be spread over a manageable period of time, reducing the peak demand on the supply.

Sequential shutdown of equipment to ensure system integrity

The ability to shutdown equipment in a set sequence ensures that equipment such as servers can be shutdown prior to the network switch over which they are communicating.

The key configurable setting in this case is the "Power Off Delay", as is shown in Figure 5, for both the Main & Switched Outlet Group. The shutdown also allows for the graceful closure of systems through the APC PowerChute software.

7

Figure 5 – *Timing chart for the sequential turning-off of a Main and Switched Outlet Group due to a power outage*

Main Outlet Group Typical Load Network Switch	On		Off	
	Awaiting Switched Outlet Group Turn Off	120s Power Off Delay	No Action	

Switched Outlet Group Typical Load Server	On	Off	
	90s Power Off Delay	No Action	

AC Input	Off
	0 15 30 45 60 75 90 105 120 135 150 165 180 195 210 225 240 255 270 285 300 315

Delay time from the point at which the specified min. runtime remaining has been reached - seconds

Conclusions

Switched outlet groups on a UPS greatly enhance the manageability of power to attached equipment, from unlocking hung devices to the load shed of less critical loads, in order to reduce energy consumption or maintain essential equipment and facilities for a longer period when operating on battery by reducing the load.

The ability to control the outlet groups either locally via the UPS intuitive user interface panel, through a connected computer via PowerChute software using the UPS USB or serial port, or over a network if a Network Management card is installed, provides flexible and easy management of power to the connected equipment.

About the Author:

Neil Whiting is a Product Manager with APC based in the UK, just north of London. He has worked in the power solution industry for over 30 years starting with AC/DC power supply design through to DC power systems for the Telecommunications industry and more recently AC power solutions for the converging IT and Telecommunications industry. He has a HND in Electrical, Electronic and Control Engineering and joined APC in April 2000, when APC acquired Advance Power Systems, during which time he has fulfilled both product management and application engineering roles.

APC
by Schneider Electric