

# Continuous Power Systems

NEW

*Hot-swappable continuous power systems offer reliability, efficiency and high linear power!*

## Introduction

For high power requirements, combining amplifiers is often required. The common combining approach is 2x, 4x, 8x etc due to efficient 2 way waveguide combiners or hybrids. As these higher power systems are generally for gateways in Direct to Home applications, redundancy is also a must. The traditional redundancy approach is to have another high power amplifier system and switch between them, or have individual 1:1 or 1:2 amplifier systems combined. The later provides a higher level of availability but the complexity of the system is also higher. In all the 1:1 approaches, half of the amplifiers are not contributing to the output power while consuming AC power. The additional power consumption may be acceptable when providing 1:1 redundancy for a single amplifier but is far less acceptable for 4 or 8 way combined amplifier systems. The number of standby amplifiers also drives up the cost of the system. Another undesirable aspect of these switching approaches to redundancy is that the transmission is interrupted.

An innovative approach is recommended by Comtech Xicom Technology called the Continuous Power System (CPS) which overcomes the problems associated with the traditional approaches just described. The CPS approach is applicable to both SSPAs and TWTAs.

## The Continuous Power System

Consider the combining of 4 amplifiers. If a single amplifier was to go off-line, the output power of the combined system would drop by 2.50dB. This is called the soft-fail condition. As the fade margin on an uplink is generally more than this, some of the fade margin can be used to recover to the original power. Hence, the 3 remaining amplifiers increase their output to compensate for the loss of the 4<sup>th</sup> amplifier output which is off-line. This is called "auto-recovery". Once the off-line amplifier has been replaced, all amplifiers return to their normal output power restoring the original fade margin. CXTI has implemented a servicable solution based on this principle as shown in Figure 1.

## Benefits

- ◆ *No break in transmission when HPA goes off-line*
- ◆ *No mechanical switches*
- ◆ *Auto-recovery to normal operating power*
- ◆ *Standard HPA products are the building blocks*
- ◆ *Simplified phase adjustment*
- ◆ *Management via touch screen remote controller*
- ◆ *Easy service, including*
  - ◇ *Quick waveguide disconnects*
  - ◇ *Slide mounting of HPAs*
  - ◇ *Hinged panel access to HPA*

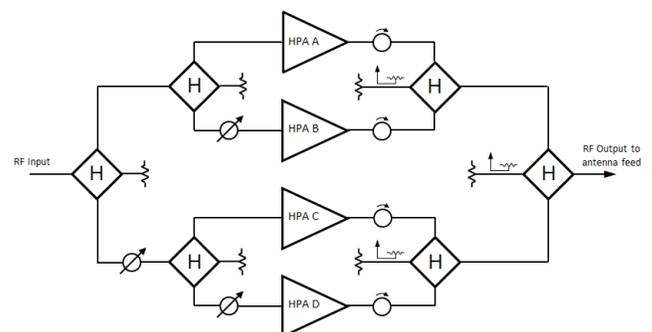


Figure 1 – 4 Way Continuous Power System – Block Diagram



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The CXTI Continuous Power System (CPS) approach utilizes standard CXTI product and passive waveguide combiners to achieve the high power. This approach is equally applicable to rack mounted and antenna mounted amplifiers. However, the greatest advantage can be gained with antenna mounted amplifiers as the waveguide transmission line losses to the antenna feed can be significantly reduced.

When looking at the CPS approach for an uplink requirement, two operational approaches to the available power and fade margin can be considered:

1. The required fade margin is achieved under soft-fail conditions. Hence, under normal conditions, the fade margin is increased beyond that required. Alternatively,
2. The required fade margin is achieved under normal conditions and a lower fade margin is accepted during the soft-fail condition.

The return to normal system output power capability requires the off-line amplifier to be replaced while the rest of the system is operational. To achieve this safely, isolators are included between the amplifier outputs and the inputs to the combining network. The amplifiers in the CPS, including spares, are phase matched so that only minor phase adjustments are required when an amplifier is replaced.

The outline drawing of a TWTA based CPS is shown in Figure 2. The amplifiers are mounted in a staggered configuration on opposite sides of the vertical mounting plate so all 4 amplifier outputs are close, providing short and equal combiner waveguide connections.

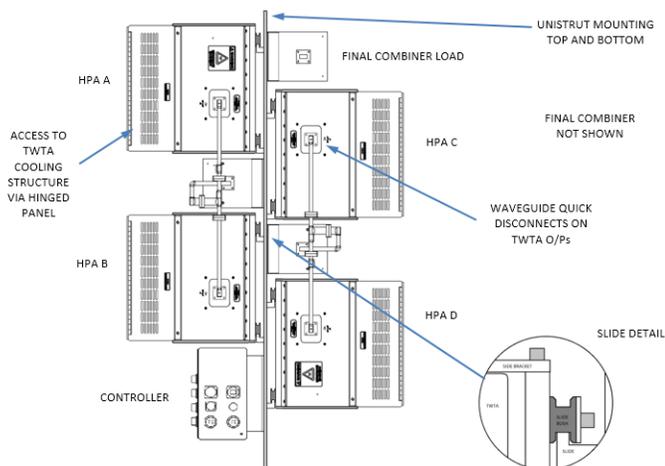


Figure 2 - 4 Way Continuous Power System - Outline (Output Elevation)

The ease and speed of amplifier replacement is a critical factor. A number of features are included in the CXTI CPS solution to make this simple and quick:

- ◆ Quick-disconnect waveguide connections are provided to speed amplifier replacement; no small screws, nuts and washers to deal with on the amplifier output waveguide connection!
- ◆ Slide mounting of the amplifiers simplify the removal and installation of amplifiers. The amplifier stays in place until all connections and locking hardware have been removed; the amplifier can then be easily slid on nylon bushes out of position and removed; no need for one person to hold the amplifier while another removes or installs mounting hardware!

A separate antenna mounted controller is used to monitor all the amplifiers in the CPS and manage the auto-recovery. The controller also provides the forward and reverse power monitoring of the system output, and load and/or polarity switching if required. Although the controller provides many additional features, it does not prevent the inherent redundancy provided by the passive combined system approach.

The control of the numerous amplifiers in the CPS is also simplified. A single control is provided to enable or disable the system RF inhibit, and output power (gain control) can be changed in a single operation. No need to adjust multiple amplifiers individually.

Amplifiers require routine service involving the cleaning of the amplifier cooling structure. Easy access to the cooling structure is possible via a hinged cover which is secured by ¼ turn captive screws. The cooling structure can be cleaned with high pressure air without interrupting service.

A Unistrut support structure is recommended at the base of the antenna. The Unistrut structure can also support a top cover which protects the system from direct rain and sun.

Locating pins are provided at the waveguide output end to securely locate the HPA output to the system mounting plate and the waveguide combining system. A captive locking screw is provided at the HPA input end to lock the HPA in position. No tools are required to replace a HPA.



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A single mounting plate design is offered that can accommodate XTD-750K, XTD-1250KHE, XTD-750DBS, and XTD-1250DBSHE TWTAs. Another smaller mounting plate design suitable for the smaller XTD-750KHE TWTA and XTSLIN-200K SSPA is also offered.

As most applications requiring high power will be transmitting multiple carriers, the use of CXTI high efficiency TWTAs is recommended. This further improves the system efficiency with no compromise in the available linear power compared to CW TWTAs.

## Auto-Recovery

Auto recovery to the original output power is possible by automatically adjusting the remaining amplifier outputs up by the soft fail condition power drop. Considering that a reasonable margin is often built into the link margin for rain-fade conditions, the 2.5dB down level in the fade margin is considered acceptable while the off-line amplifier is replaced. The auto-recovery function is shown in Figure 3.

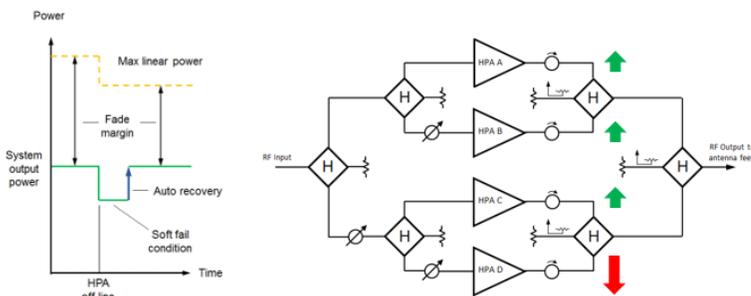


Figure 3 – Auto-Recovery Function

## Remote Control

Control of the Continuous Power System is via the touch screen remote controller, XTRT-124D, or via a laptop accessing the system with a web browser. A screen shot using the touch screen controller of the system under normal conditions is shown in Figure 4.

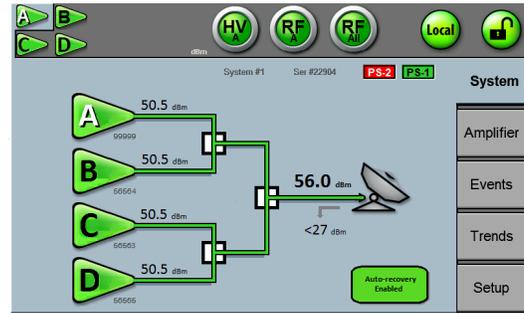


Figure 4 – 4 Way Continuous Power System – Touch Screen Display

Adjustment of the system is kept simple by the inclusion of a RF Inhibit All button and the ability to adjust the gain of all amplifiers simultaneously by selecting the system output power. Auto-recovery can be enabled or disabled. When enabled, the application of the auto-recovery correction is indicated by the associated amplifier output readings changing to red. This is shown in the screen shot in Figure 5 below.

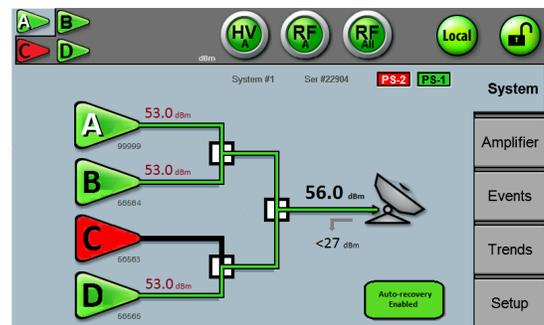


Figure 5 – 4 Way Continuous Power System – Touch Screen Display with Soft-Fail Condition

## SSPA or TWTA CPS Solution?

A number of SSPA manufacturers currently provide “soft-fail” system solutions. This approach is necessary with SSPAs as multiple lower power SSPA modules must be combined to achieve higher power. Competitor rack mounted solutions use a complex module approach requiring a rack system with backplane. Concern over the backplane system connectivity and the complexity of the system often drives customers to fear a failure with a single system approach. As a result, customers are driven to use two



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systems, allowing one of the systems to be taken off-line. This more than doubles the cost of the overall system and reduces the overall efficiency. Additionally, testing of the modules requires an off-line system or special test fixtures; RF modules and power supplies cannot be tested as stand-alone items. The rack mounted solution can also suffer with much of the output power being wasted in waveguide path loss between the indoor transmission room to the antenna feed.

The CXTI Continuous Power System approach is focused on outdoor solutions. SSPA solutions are available using the CXTI XTSLIN-200K SSPAs. For very high power requirements, capable of replacing multiple Klystron power amplifiers, the CXTI CPS approach with TWTA is recommended. The high efficiency advantage of TWTA over SSPAs becomes even more significant at the very high power levels. More power is possible with the combination of two 4-way CPS assemblies, creating a 8-way CPS solution. The significant advantages of the CPS approach with TWTA over a competitor's SSPA solution is shown in Table 1.

	Competitor Ku-Band 2500W SSPA			CXTI 8 Way TWTA CPS (with XTD-750KHE)			CXTI CPS TWTA Advantage
Linear Power (dBm)	60.5			62.5			
Linear Power (W)	1122			1778			58% more linear power!
Weight (lbs)	1320			473			64% less weight!
Size (inches)	81	63	47	60	38	28	
Volume (cubic inches)	239,841			63,840			73% less volume!
Power Consumption (kW)	20.0			11.8			41% less power consumption!

Table 1 – Comparison between 8-Way SSPA System (Competitor) and 8-Way TWTA CPS Solution (CXTI)

Figure 6 shows a custom CPS using XTD-750DBS TWTA. This compact system is mounted in an antenna hub and features many custom interlocks and remote operation capabilities, including output load switch.

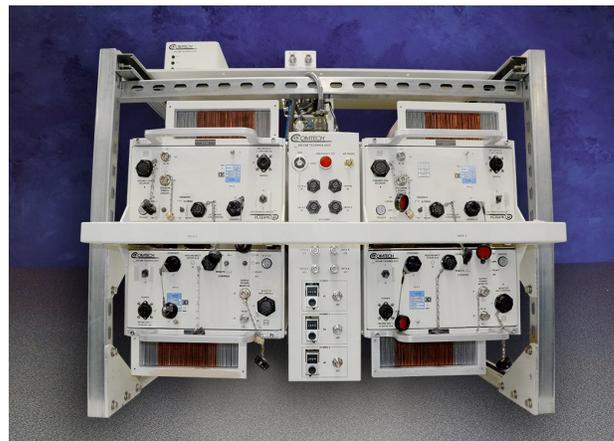


Figure 6 – Custom 4-Way 750W TWTA CPS Solution

## Summary

The CXTI Continuous Power System provides the following advantages:

- ◆ No break in transmission when HPA goes off-line
- ◆ Auto-recovery to normal operating power under soft-fail condition
- ◆ Both rack mounted and antenna mounted systems possible
- ◆ Standard TWTA and SSPA products used to create the Continuous Power Systems
- ◆ 4-way and 8-way systems available
- ◆ The only common parts are the passive power combiner and controller
- ◆ Simple manual phase adjustment
- ◆ Remote controller off-line does not cause loss of transmission
- ◆ No mechanical switches
- ◆ Easy system management via touch screen remote controller
  - ◇ Single point RF Inhibit control
  - ◇ Single point output power/gain control
- ◆ Many features to improve the servicability and maintainability of the system:
  - ◇ Quick waveguide disconnects
  - ◇ Slide mounting of TWTA
  - ◇ Hinged panel access to TWTA cooling structure
  - ◇ TWTA/SSPA products can be tested without special test fixtures

CXTI offers both SSPA and TWTA based CPS solutions. At high power levels, the TWTA based systems offer additional advantages in size, weight, power consumption, efficiency and cost.



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