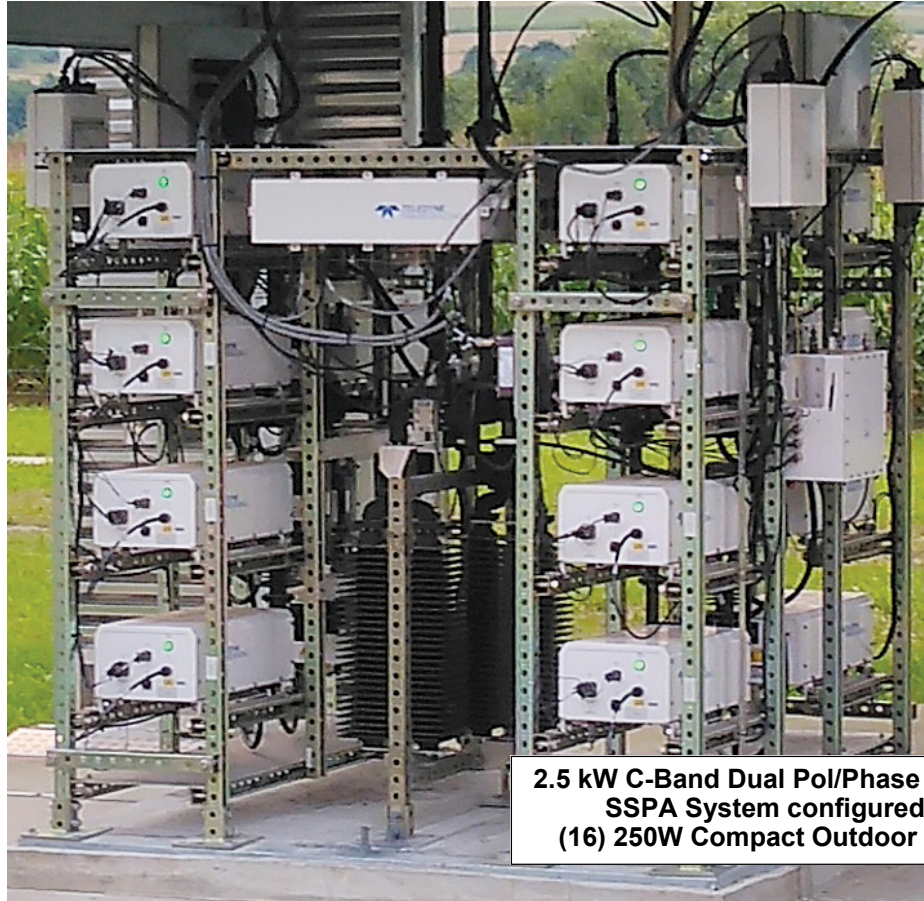


The Standard In Fault Tolerant High Power Outdoor Amplifier Systems



2.5 kW C-Band Dual Pol/Phase Combined SSPA System configured with (16) 250W Compact Outdoor Modules

FEATURES

- Gallium Nitride amplifiers, offering higher power density
- Each array of 4 HPAs features no active switching - all passive Power Combining
- Output Power sized for N+1 Redundancy
- Can be configured with any combination of 4 to 16 units
- 100% field maintainable
- CE mark / MIL-STD-461 compliant
- Removable fan trays
- System Monitor and Control emulates single SSPA Chassis operation
- Legacy RS-485 M&C
- Ethernet Port with UDP, SNMP, and internal web browser capability
- Accurate Output Power measurement
- Hot/Cold Standby operating modes for reduced power consumption
- RF Output Sample Port
- Optional Waveguide Arc Protection Kit
- Optional L-Band Input with Redundancy
- Reflected Power Monitor
- RF Gain Adjustment (42 dB - 62 dB) Ku-Band systems (50 dB - 70 dB) all others
- System is field scalable: i.e., can start out with (4) modules in system and upgrade to (8) modules.

PowerMAX is covered by U.S. Patent Nos. 8,189,338 B2 and 8,411,477 B2

System Operation

The Outdoor PowerMAX system maintains complete parallel redundancy down to the embedded control level. Therefore the loss of an entire amplifier will not interrupt remote communications with the system. Remote communications can be either RS-485 or Ethernet. The system will automatically correct its gain level in the event of one or more amplifier failures.

The sophisticated system monitor and control allows the system to be locally or remotely operated as if it were a “single” chassis amplifier. The system control maintains a hierarchical management that allows the operator to interface to a single chassis of the multi-module array.

Another feature unique to Teledyne Paradise Datacom’s Outdoor PowerMAX is the introduction of “true rms” output power measurement. Unlike other amplifier systems that utilize diode detection schemes, the Outdoor PowerMAX reports the true rms output power of the system independent of the number of carriers and modulation schemes.

Proprietary waveguide combining techniques are employed so that maximum power combining efficiency is optimized within the operating frequency band.

System Output Power and Configurations

The Outdoor PowerMAX system is typically used as a “self-redundant” system. The output power is sized such that the loss of (1) RF module’s power will still allow the system to maintain its minimum required output power. This type of system architecture is described as n+1 redundant. The system can be configured with any number of modules, but best overall efficiency is obtained with the popular binary combinations of 4 or 8 modules.

It is very easy to upgrade the PowerMAX system from 4 modules to 8 modules in the field. It is not necessary to fully populate the system at the time of initial purchase. This provides the user a path to upgrade output power capability as system requirements grow, thus keeping capital investment minimized. For sizing redundant output power capability use the following guideline to determine the output power of the system with the loss of (1) module.

4 Module System - 3 of 4 Modules Operable = 2.5 dB loss in output power capability

8 Module System - 7 of 8 Modules Operable = 1.2 dB loss in output power capability

16 Module System - 15 of 16 Modules Operable = 0.6 dB loss in output power capability

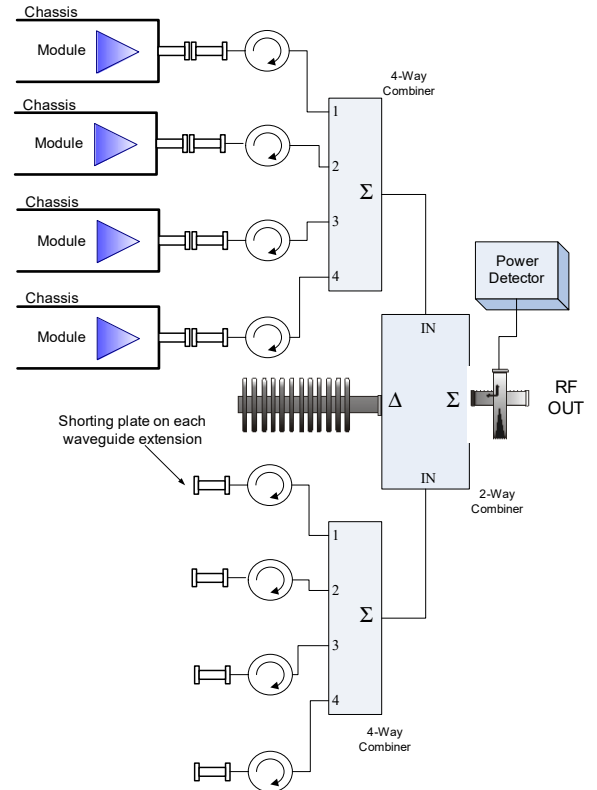
Hitless Redundancy

For mission critical systems in which no power outage can be tolerated, an eight module Outdoor PowerMAX system can be operated with only four modules installed. In this way, the additional four modules can be installed without requiring the system to be powered off.

The only disadvantage of operating the eight module Outdoor PowerMAX system with four modules is the additional 3 dB loss that the four module (half-system) system experiences by going through the final hybrid combiner as shown at right. The overall output power is therefore actually 6 dB below what it would be with all eight modules present.

If the module output power is sized such that this reduction in output power can be tolerated, the system shown at right is an effective means of scaling the system from four to eight modules and maintaining true hitless operation.

With parallel system architectures, the amplifier output power capability and gain will change as the number of active modules vary. The Outdoor PowerMAX system is designed with an Auto-Gain Control mode so that the overall system gain will remain constant in the event of a single module failure. See the table below.



System Type	# Modules in System	Gain Change Auto Gain Control On	Gain Change Auto Gain Control Off	Maximum Output Power
4 Units	3 of 4	0 dB	-2.5 dB	-2.5 dB
4 Units	2 of 4	-1.0 dB	-6.0 dB	-6.0 dB
4 Units	1 of 4	-7.0 dB	-12.0 dB	-12.0 dB
8 Units	7 of 8	0 dB	-1.2 dB	-1.2 dB
8 Units	6 of 8	0 dB	-2.4 dB	-2.4 dB
8 Units	5 of 8	0 dB	-4.0 dB	-4.0 dB
8 Units	4 of 8	-1.0 dB	-6.0 dB	-6.0 dB
8 Units	3 of 8	-3.5 dB	-8.5 dB	-8.5 dB
8 Units	2 of 8	-7.5 dB	-12.5 dB	-12.5 dB

SSPA Module Population Options

The Outdoor PowerMAX system is available in a variety of system GaN module configurations and output power levels. The system is based on Teledyne Paradise Datacom's popular Compact Outdoor SSPA. The units can be configured with a wide variety of SSPA frequency bands and power levels, and can be fitted with the following SSPA modules:

- **S-Band:** 300W, 400W, 500W
- **C-Band:** 300W, 400W
- **X-Band:** 300W, 400W
- **Ku-Band:** 200W, 250W



Single Unit Mechanical & Environmental Specifications

PARAMETER	NOTES	LIMITS	UNITS
Size	width X length X height	9.0 X 12.0 X 6.5 229 X 305 X 165	inches mm
Weight	Base unit (C-, X-bands) Base unit (Ku-Band)	24.5 (11.2) 19.6 (8.9)	lbs. (kg) lbs. (kg)
Finish		powder coat	white
Operating Temperature	Ambient	-40 to +60	°C
Relative Humidity	Condensing	100	%
Cooling System	Integrated	Forced air	
Ingress Protection Rating	With connectors properly sealed	IP54	
Altitude	No temperature de-rating up to 10,000 ft. (3,000 m) De-rate maximum temperature by 2 °C per 1,000 ft (300 m) beyond 10,000 ft.		
Shock	50 g p-p, 11 msec pulses		
Vibration	3g rms 30 min. 5-2000 Hz		

Outdoor PowerMAX

Modular N+1 Soft-Fail, GaN Phase Combined System

SSPA Module Power Level	4 Module RF Output Power		AC Input Power (W)	3 Module Redundant RF Output Power	
	P_{sat} , typical dBm (W)	P_{Linear} , min. dBm (W)	P_{sat} / P_{Linear}	P_{sat} , typical dBm (W)	P_{Linear} , min. dBm (W)
4-Module S-Band System Power Specifications					
300 W	59.9 (970)	56.9 (484)	5,200/4,000	57.5 (560)	54.5 (280)
400 W	61.1 (1280)	58.1 (638)	6,400/5,200	58.7 (733)	55.7 (367)
500 W	62.1 (1600)	59.1 (803)	7,200/6,000	59.7 (923)	56.7 (462)
4-Module C-Band System Power Specifications					
300 W	60.2 (1035)	57.2 (520)	6,000/5,200	57.8 (600)	54.8 (300)
400 W	61.2 (1300)	58.2 (653)	7,200/6,400	58.8 (750)	55.8 (380)
4-Module X-Band System Power Specifications					
300 W	60.2 (1035)	57.2 (520)	6,000/5,200	57.8 (600)	54.8 (300)
400 W	61.2 (1300)	58.2 (653)	8,000/6,800	58.8 (750)	55.8 (380)
4-Module Ku-Band System Power Specifications					
200 W	58.3 (676)	55.3 (339)	4,800/3,680	56.0 (398)	53.0 (200)
250 W	59.1 (812)	56.1 (407)	6,000/4,000	56.7 (468)	53.7 (234)

Notes

P_{linear} is the linear power as defined by MIL-STD-188-164 for two tones separated by 5 MHz or ≤ -30 dBc spectral regrowth on a single OQPSK signal at 1.0x symbol rate.

For C-Band Frequency selection "B", de-rate output power by 1.0 dB linearly from 6.425 to 6.725 GHz.

For C-Band Frequency selection "C", de-rate output power by 1.0 dB linearly from 5.850 to 5.750 GHz and by 1.0 dB linearly from 6.425 to 6.670 GHz.

For Ku-Band Frequency selection "B", de-rate output power by 1.0 dB linearly from 14.00 to 13.75 GHz.

Continuous operation at saturated power can negatively impact the life of the amplifier and will not be covered by warranty. Normal operating output should be limited to P_{linear} (3dB backed off from the full rated power, P_{sat}).

Outdoor PowerMAX

Modular N+1 Soft-Fail, GaN Phase Combined System

SSPA Module Power Level	8 Module RF Output Power		AC Input Power (W)	7 Module Redundant RF Output Power	
	P_{sat} , typical dBm (W)	P_{Linear} , min. dBm (W)	P_{sat} / P_{Linear}	P_{sat} , typical dBm (W)	P_{Linear} , min. dBm (W)
8-Module S-Band System Power Specifications					
300 W	62.3 (1700)	59.3 (851)	10,400/8,000	61.1 (1300)	58.1 (646)
400 W	63.5 (2240)	60.5 (1100)	12,800/10,400	62.3 (1700)	59.3 (851)
500 W	64.5 (2800)	61.5 (1400)	14,400/12,000	63.3 (2100)	50.3 (1100)
8-Module C-Band System Power Specifications					
300 W	63.0 (1995)	60.0 (1000)	12,000/10,400	61.9 (1549)	58.9 (776)
400 W	64.3 (2692)	61.3 (1349)	14,400/12,800	63.1 (2042)	60.1 (1023)
8-Module X-Band System Power Specifications					
300 W	63.0 (1995)	60.0 (1000)	12,000/10,400	61.9 (1549)	58.9 (776)
400 W	64.2 (2630)	61.2 (1318)	16,000/13,600	63.0 (1995)	60.0 (1000)
8-Module Ku-Band System Power Specifications					
200 W	61.0 (1259)	58.0 (631)	9,600/7,360	59.8 (955)	56.8 (479)
250 W	61.8 (1514)	58.8 (759)	12,000/8,000	60.6 (1148)	57.6 (575)

Notes

P_{linear} is the linear power as defined by MIL-STD-188-164 for two tones separated by 5 MHz or ≤ -30 dBc spectral regrowth on a single OQPSK signal at 1.0x symbol rate.

For C-Band Frequency selection "B", de-rate output power by 1.0 dB linearly from 6.425 to 6.725 GHz.

For C-Band Frequency selection "C", de-rate output power by 1.0 dB linearly from 5.850 to 5.750 GHz and by 1.0 dB linearly from 6.425 to 6.670 GHz.

For Ku-Band Frequency selection "B", de-rate output power by 1.0 dB linearly from 14.00 to 13.75 GHz.

Continuous operation at saturated power can negatively impact the life of the amplifier and will not be covered by warranty. Normal operating output should be limited to P_{linear} (3dB backed off from the full rated power, P_{sat}).

Outdoor PowerMAX

Modular N+1 Soft-Fail, GaN Phase Combined System

SSPA Module Power Level	16 Module RF Output Power		AC Input Power (W)	15 Module Redundant RF Output Power	
	P_{sat} , typical dBm (W)	P_{Linear} , min. dBm (W)	P_{sat} / P_{Linear}	P_{sat} , typical dBm (W)	P_{Linear} , min. dBm (W)
16-Module S-Band System Power Specifications					
300 W	65.6 (3600)	62.6 (1800)	20,800/16,000	65.0 (3125)	62.0 (1570)
400 W	66.8 (4800)	63.8 (2400)	25,000/20,800	66.2 (4120)	63.2 (2065)
500 W	67.8 (6000)	64.8 (3000)	28,800/24,000	67.2 (5200)	64.2 (2600)
16-Module C-Band System Power Specifications					
300 W	65.8 (3800)	62.8 (1900)	24,000/20,800	65.2 (3300)	62.2 (1640)
400 W	66.8 (4730)	63.8 (2370)	28,800/25,600	66.2 (4120)	63.2 (2065)
16-Module X-Band System Power Specifications					
300 W	65.8 (3800)	62.8 (1900)	24,000/20,800	65.2 (3300)	62.2 (1640)
400 W	66.8 (4730)	63.8 (2370)	28,800/25,600	66.2 (4120)	63.2 (2065)
16-Module Ku-Band System Power Specifications					
200 W	63.8 (2400)	60.8 (1200)	19,200/14,720	63.2 (2070)	60.2 (1035)
250 W	64.8 (3000)	61.8 (1500)	24,000/16,000	64.2 (2600)	61.2 (1300)

Notes

P_{linear} is the linear power as defined by MIL-STD-188-164 for two tones separated by 5 MHz or ≤ -30 dBc spectral regrowth on a single OQPSK signal at 1.0x symbol rate.

For C-Band Frequency selection "B", de-rate output power by 1.0 dB linearly from 6.425 to 6.725 GHz.

For C-Band Frequency selection "C", de-rate output power by 1.0 dB linearly from 5.850 to 5.750 GHz and by 1.0 dB linearly from 6.425 to 6.670 GHz.

For Ku-Band Frequency selection "B", de-rate output power by 1.0 dB linearly from 14.00 to 13.75 GHz.

Continuous operation at saturated power can negatively impact the life of the amplifier and will not be covered by warranty. Normal operating output should be limited to P_{linear} (3dB backed off from the full rated power, P_{sat}).

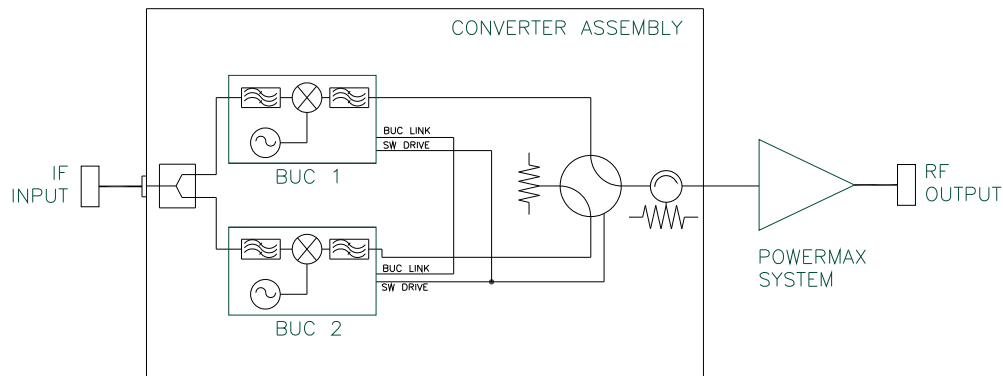
Common Electrical Specifications

PARAMETER	NOTES	LIMITS	UNITS
Gain	range	55-75	dB
Gain Flatness	full band	± 1.0	dB
	full band (Extended C-Band)	± 1.5	dB
Gain Slope	per 40 MHz	± 0.3	dB/40 MHz
Gain Variation vs. Temperature	-30 °C to +50 °C	± 1.5	dB
Gain Stability	at constant temperature	± 0.25	dB/24 hours
Gain Adjustment	0.1 dB resolution	20	dB
Intermodulation Distortion (Two-tone, 5 MHz spacing)	@ P _{Linear} (P _{sat} - 3 dB)	-25	dBc
AM/PM Conversion	@ rated P _{Linear}	≤ 1.0	°/dB
Spurious	@ rated P _{Linear}	-65	dBc
Harmonics (SSPA only)	@ rated P _{Linear}	-50	dBc
Input VSWR	Extended C-Band	≤ 1.30 : 1	
Output VSWR		≤ 1.50 : 1	
	Output VSWR: Ku-Band with bulkhead filter	≤ 2.00 : 1	
		≤ 1.40 : 1	
Group Delay (per 40 MHz segment)	Linear	0.01	ns/MHz
	Parabolic	0.003	ns/MHz ²
	Ripple	1.0	ns p-p
Transmit Band Noise Output Power Density	TX Band	-75	dBW/4 KHz
Residual AM Noise, typical	Offset frequency from carrier		
	1 Hz	-110	dBc/Hz
	10 Hz	-120	dBc/Hz
	100 Hz	-130	dBc/Hz
	1 KHz	-135	dBc/Hz
	10 KHz	-140	dBc/Hz
	100 KHz	-140	dBc/Hz
	1 MHz	-140	dBc/Hz
Residual Phase Noise, typical (SSPA only)	Offset frequency from carrier		
	10 Hz	-90	dBc/Hz
	100 Hz	-100	dBc/Hz
	1 KHz	-110	dBc/Hz
	10 KHz	-120	dBc/Hz
	100 KHz	-125	dBc/Hz
	1 MHz	-130	dBc/Hz
True RF Power Detector	Range	P _{sat} to (P _{sat} - 20)	dB
	Accuracy, P _{sat} to (P _{sat} - 10 dB)	± 0.75	dB
	Accuracy, (P _{sat} - 10 dB) to (P _{sat} - 20 dB)	± 1.0	dB
	L-/S-Band units, Accuracy (full band)	± 1.0	dB

Specifications are subject to change without notice.

L-Band Input Option

The Outdoor PowerMAX system can be configured for L-Band Input Operation. For optimum RF phase combining over the entire bandwidth of a communication amplifier system, the frequency translation part of the system must be separated from the phase combined loop. Therefore, systems with L-Band input are configured with a separate L-Band block up converter system that feeds the PowerMAX system.



Simplified Block Diagram, Redundant Converter Assembly with Outdoor Controller

The block up converter system is a 1:1 redundant block up converter assembly with internal redundancy control. The Teledyne Paradise Datacom converter architecture allows a converter that is fitted with an internal reference oscillator to automatically detect and switch to an externally applied 10 MHz reference signal.

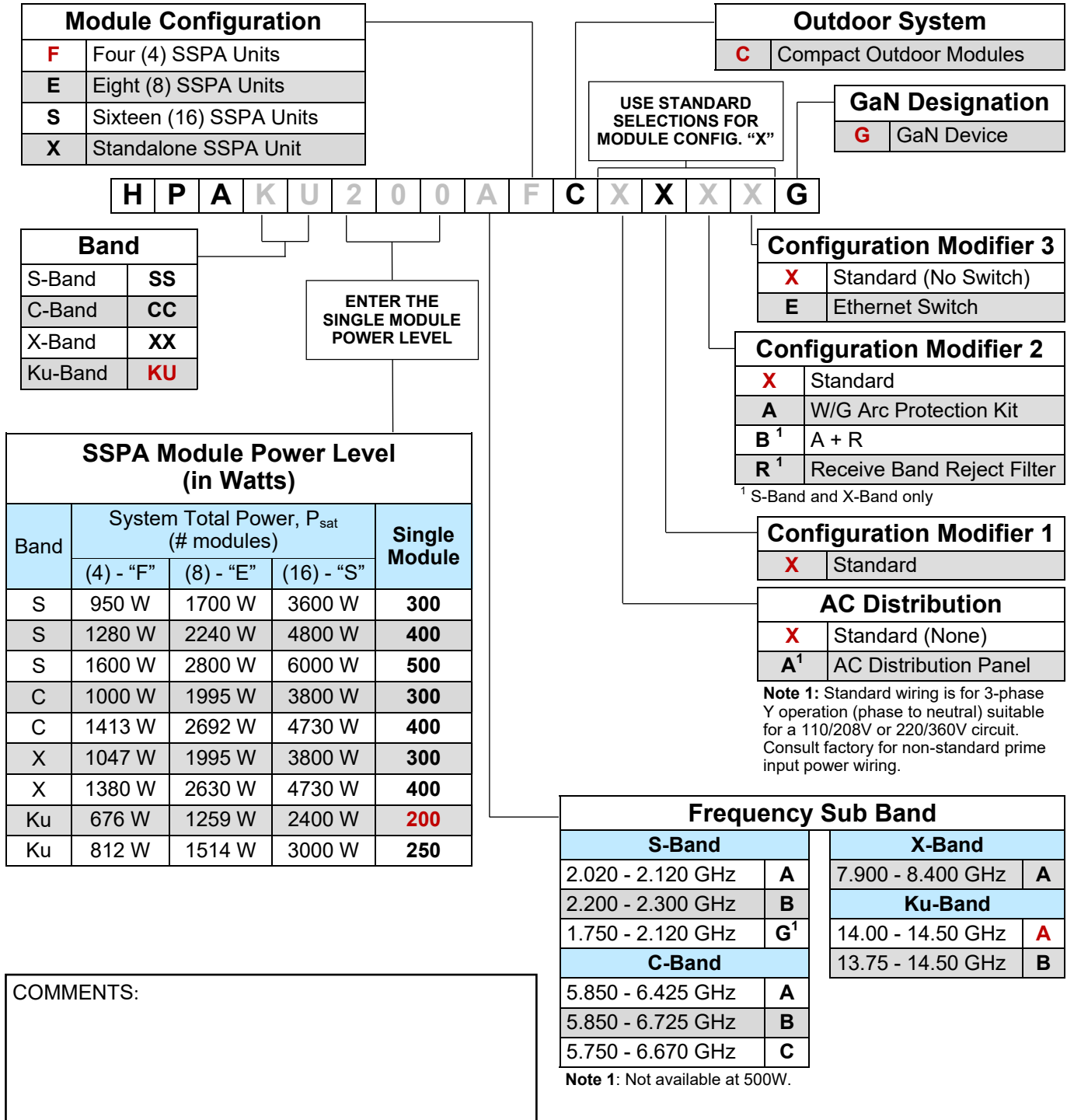
When a fault is detected in the online converter, the redundancy controller drives the switch to place the standby BUC online without user intervention.

If L-Band redundancy is not required, the system can be configured with a single thread block up converter.

Outdoor PowerMAX

Modular N+1 Soft-Fail, GaN Phase Combined System

System Part Number Configuration Matrix



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