

# Indoor Rack Mount GaN Solid State Power Amplifiers 5RU Rack Height



**650W X-Band 5RU SSPA Chassis (requires 1RU power supply)**

**Teledyne Paradise Datacom** has a rich history in the design and production of Gallium Nitride (GaN) based SSPAs. Our engineers utilize innovative linearization techniques that enable GaN amplifiers to produce linear output power with the same efficiency as tube based amplifier systems. A complete family of Satcom amplifiers has been developed that cover S-Band through Ku-Band.

GaN amplifiers have a superior set of mutually beneficial characteristics, including:

- Higher Output Power
- Greater Power-Added Efficiency
- High Reliability

These GaN amplifier modules are installed in a 5RU (8.75 inch high) Chassis, which features a front panel display and five fault condition LEDs that reflect some of the SSPA major fault states. Local/Remote and Mute/Unmute LEDs show the current control mode and mute state of the amplifier.

A full compliment of remote monitor and control of the amplifier is available at the rear panel, including: RS-232/RS-485; Ethernet, with UDP and SNMP control; Web Browser TCP/IP; and Discrete hardware (parallel port) signals.

## FEATURES

- Extremely High Power Density:
  - to 2.0 kW S-Band
  - to 1.6 kW X-Band
  - to 1.6 kW C-Band
  - to 1.0 kW Ku-Band
- Removable Fan Tray and M&C Card Assembly
- Remote Communication via RS232/485 or Ethernet
- RF Output Sample Port
- 20 dB RF Gain Adjustment
- 1RU N+1 Power Supply
- True RF Output Power Measurement
- Built-in Maintenance Switch Controller

## OPTIONS

- Remote Control Panel
- L-Band Input operation
- Reflected Power Monitor
- Input Sample Port
- Exhaust Duct Adapters
- Redundant Systems
- Phase Combined Systems

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# Indoor Rack Mount

## GaN Solid State Power Amplifiers

### 5RU Rack Height

#### Specifications, S-Band SSPAs

PARAMETER	NOTES	LIMITS	UNITS
Frequency Range	Frequency selection "G" Frequency selection "A" Frequency selection "B"	1.750 to 2.120 2.020 to 2.120 2.200 to 2.300	GHz GHz GHz
Output Power Typical, $P_{sat}$ Guaranteed minimum, $P_{Linear}^1$	HPAS5500ARXXXXXG HPAS5600ARXXXXXG HPAS5800ARXXXXXG HPAS510KARXXXXXG HPAS512KARXXXXXG HPAS516KARXXXXXG HPAS520KARXXXXXG	$P_{sat} / P_{Linear}$ 57.0 (500) / 54.0 (250) 57.8 (600) / 54.8 (300) 59.0 (800) / 56.0 (400) 60.0 (1000) / 57.0 (500) 60.8 (1200) / 57.8 (600) 62.0 (1600) / 59.0 (800) 63.0 (2000) / 60.0 (1000)	dBm (W) dBm (W) dBm (W) dBm (W) dBm (W) dBm (W) dBm (W)
Power Requirements Line Frequency Line Power (Voltage) (typical @ 220 VAC)	power factor  HPAS5500ARXXXXXG HPAS5600ARXXXXXG HPAS5800ARXXXXXG HPAS510KARXXXXXG HPAS512KARXXXXXG HPAS516KARXXXXXG HPAS520KARXXXXXG	.98 47 to 63 @ $P_{sat} / P_{Linear}$ 2100 / 1500 (180 to 265) 2200 / 1700 (180 to 265) 2500 / 2000 (180 to 265) 4000 / 3500 (180 to 265) 4500 / 3700 (180 to 265) 5100 / 4100 (180 to 265) 7800 / 6500 (180 to 265)	Hz  W (VAC) W (VAC) W (VAC) W (VAC) W (VAC) W (VAC) W (VAC)
Receive Band Noise Power Density	without optional filter with optional filter	-95 -155	dBW / 4 KHz dBW / 4 KHz

**Note 1:**  $P_{Linear}$  = maximum output power at which third order intermodulation products < -25 dBc (for two tones separated by 5 MHz) or spectral regrowth on a single QPSK at 1.5 x symbol rate or OQPSK at 1.0 x symbol rate is < -30 dBc.

#### Specifications, C-Band SSPAs

PARAMETER	NOTES	LIMITS	UNITS
Frequency Range	Frequency selection "L" Frequency selection "H" Frequency selection "C" <sup>2</sup> Frequency selection "A" Frequency selection "B" <sup>2</sup> Frequency selection "D"	4.400 to 5.000 5.715 to 5.790 5.750 to 6.670 5.850 to 6.425 5.850 to 6.725 6.425 to 7.025	GHz GHz GHz GHz GHz GHz
Output Power Typical, $P_{sat}$ Guaranteed minimum, $P_{Linear}^1$	HPAC5300ARXXXXXG HPAC5400ARXXXXXG HPAC5650ARXXXXXG HPAC5800ARXXXXXG HPAC513KARXXXXXG HPAC516KARXXXXXG	$P_{sat} / P_{Linear}$ 54.8 (300) / 51.8 (150) 56.0 (400) / 53.0 (200) 58.1 (650) / 55.1 (325) 59.0 (800) / 56.0 (400) 61.1 (1300) / 58.1 (650) 62.0 (1600) / 59.0 (800)	dBm (W) dBm (W) dBm (W) dBm (W) dBm (W) dBm (W)
Power Requirements Line Frequency Line Power (Voltage) (typical @ 220 VAC)	power factor  HPAC5300ARXXXXXG HPAC5400ARXXXXXG HPAC5650ARXXXXXG HPAC5800ARXXXXXG HPAC513KARXXXXXG HPAC516KARXXXXXG	.98 47 to 63 @ $P_{sat} / P_{Linear}$ 1500 / 1300 (180 to 265) 1800 / 1600 (180 to 265) 3300 / 2800 (180 to 265) 4000 / 3500 (180 to 265) 4200 / 3800 (180 to 265) 7800 / 7000 (180 to 265)	Hz  W (VAC) W (VAC) W (VAC) W (VAC) W (VAC) W (VAC)
Receive Band Noise Power Density	without filter	-155	dBW / 4 KHz

**Note 1:**  $P_{Linear}$  = maximum output power at which third order intermodulation products < -25 dBc (for two tones separated by 5 MHz) or spectral regrowth on a single QPSK at 1.5 x symbol rate or OQPSK at 1.0 x symbol rate is < -30 dBc.

**Note 2:** Output power decreases over the extended portion of the frequency range. Both  $P_{sat}$  and  $P_{Linear}$  de-rate by 1 dB from 5.85 to 5.75 GHz and from 6.425 to 6.725 GHz.

### Specifications, X-Band SSPAs

PARAMETER	NOTES	LIMITS	UNITS
Frequency Range	Frequency selection "F" Frequency selection "D" Frequency selection "A"	7.10 to 7.40 7.70 to 8.40 7.90 to 8.40	GHz GHz GHz
Output Power Typical, P <sub>sat</sub> Guaranteed minimum, P <sub>Linear</sub> <sup>1</sup>	HPAX5300ARXXXXXG HPAX5400ARXXXXXG HPAX5650ARXXXXXG HPAX5800ARXXXXXG HPAX513KARXXXXXG HPAX516KARXXXXXG	P <sub>sat</sub> / P <sub>Linear</sub> 54.8 (300) / 51.8 (150) 56.0 (400) / 53.0 (200) 58.1 (650) / 55.1 (325) 59.0 (800) / 56.0 (400) 61.1 (1300) / 58.1 (650) 62.0 (1600) / 59.0 (800)	dBm (W) dBm (W) dBm (W) dBm (W) dBm (W) dBm (W)
Power Requirements Line Frequency Line Power (Voltage) (typical @ 220 VAC)	power factor  HPAX5300ARXXXXXG HPAX5400ARXXXXXG HPAX5650ARXXXXXG HPAX5800ARXXXXXG HPAX513KARXXXXXG HPAX516KARXXXXXG	.98 47 to 63 @ P <sub>sat</sub> / P <sub>Linear</sub> 1500 / 1300 (180 to 265) 2000 / 1700 (180 to 265) 3300 / 2800 (180 to 265) 4000 / 3500 (180 to 265) 7000 / 6000 (180 to 265) 8000 / 7000 (180 to 265)	Hz  W (VAC) W (VAC) W (VAC) W (VAC) W (VAC) W (VAC)
Receive Band Noise Power Density	without optional filter with optional filter	-85 -155	dBW / 4 kHz dBW / 4 kHz

**Note 1:** P<sub>Linear</sub> = maximum output power at which third order intermodulation products < -25 dBc (for two tones separated by 5 MHz) or spectral regrowth on a single QPSK at 1.5 x symbol rate or OQPSK at 1.0 x symbol rate is < -30 dBc.

### Specifications, Ku-Band SSPAs

PARAMETER	NOTES	LIMITS	UNITS
Frequency Range	Frequency selection "F" Frequency selection "B" Frequency selection "A" Frequency selection "G"	12.75 to 13.25 13.75 to 14.50 14.00 to 14.50 14.75 to 15.25	GHz GHz GHz GHz
Output Power Typical, P <sub>sat</sub> Guaranteed minimum, P <sub>Linear</sub> <sup>1</sup>	HPAK5300ARXXXXXG HPAK5400ARXXXXXG HPAK5500ARXXXXXG HPAK5600ARXXXXXG HPAK5800ARXXXXXG HPAK510KARXXXXXG	P <sub>sat</sub> / P <sub>Linear</sub> 54.8 (300) / 51.8 (150) 56.0 (400) / 53.0 (200) 57.0 (500) / 54.0 (250) 57.8 (600) / 54.8 (300) 59.0 (800) / 56.0 (400) 60.0 (1000) / 57.0 (500)	dBm (W) dBm (W) dBm (W) dBm (W) dBm (W) dBm (W)
Power Requirements Line Frequency Line Power (Voltage) (typical @ 220 VAC)	power factor  HPAK5300ARXXXXXG HPAK5400ARXXXXXG HPAK5500ARXXXXXG HPAK5600ARXXXXXG HPAK5800ARXXXXXG HPAK510KARXXXXXG	.98 47 to 63 @ P <sub>sat</sub> / P <sub>Linear</sub> 2000 / 1500 (180 to 265) 2500 / 1700 (180 to 265) 3000 / 2000 (180 to 265) 4000 / 3000 (180 to 265) 5000 / 3400 (180 to 265) 6000 / 4000 (180 to 265)	Hz  W (VAC) W (VAC) W (VAC) W (VAC) W (VAC) W (VAC)
Receive Band Noise Power Density <sup>2</sup>		-155	dBW / 4 kHz

**Note 1:** P<sub>Linear</sub> = maximum output power at which third order intermodulation products < -25 dBc (for two tones separated by 5 MHz) or spectral regrowth on a single QPSK at 1.5 x symbol rate or OQPSK at 1.0 x symbol rate is < -30 dBc.

**Note 2:** All Ku-Band SSPAs are fitted with a receive band reject bulkhead filter, standard. An optional pressure window is available.

### 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
	full band (S-Band)	± 0.75	dB
Gain Slope	per 40 MHz	± 0.3	dB/40 MHz
	per 10 MHz (S-band)	± 0.3	dB/10 MHz
Gain Variation vs. Temperature	0 °C to +50 °C	± 1.0	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)	At P <sub>Linear</sub> (P <sub>sat</sub> - 3 dB)	-25	dBc
AM/PM Conversion	@ rated P <sub>Linear</sub>	≤ 1.0	°/dB
Spurious Harmonics (SSPA only)	@ rated P <sub>Linear</sub>	-65	dBc
	@ rated P <sub>Linear</sub>	-50	dBc
	@ rated P <sub>Linear</sub> (S-Band)	-30	dBc
Input/Output VSWR	Extended C-Band	1.30:1	
	Output VSWR: Ku-Band with bulkhead filter	1.50:1	
		1.40:1	
Noise Figure	at maximum gain	10	dB
	at maximum gain (S-Band)	8	dB
Group Delay (per 40 MHz segment)	Linear	0.01	ns/MHz
	Parabolic	0.003	ns/MHz <sup>2</sup>
	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 <sub>sat</sub> to (P <sub>sat</sub> - 20)	dB
	Accuracy	± 0.75	dBm

### 1RU N+1 Redundant Power Supply

The combination of a separate, fully redundant power supply is an excellent means of obtaining the ultimate in system reliability. The power supply is an N+1 redundant configuration, meaning that there is one more power supply module available than required to operate the SSPA. A failure of one power supply module will not take the amplifier off the air.



## L-Band Operation

Teledyne Paradise Datacom amplifiers are available with an integrated L-Band Block Up Converter. L-Band units utilize Teledyne Paradise Datacom's proprietary zBUC technology. The addition of a zBUC<sup>®</sup> converter to the SSPA typically increases the gain by 2-4 dB. The advantages of zBUC technology include:

- zBUC converter can detect and switch to an externally supplied reference.
- Optional internal high stability (10MHz) reference.
- zBUC converter can lock to an externally supplied reference of 10 or 50 MHz.
- zBUC converter can accept a wide range of external reference power (-10 to +5 dBm).

### Available Frequency Plans

Band	Frequency Band	IF Input	LO Frequency	RF Output	Gain Change
C	Standard C-Band	950 - 1525 MHz	4.900 GHz	5.850 - 6.425 GHz	0-4 dB
C	Extended C-Band	950 - 1825 MHz	4.900 GHz	5.850 - 6.725 GHz	0-4 dB
C	Palapa Band	950 - 1250 MHz	5.475 GHz	6.425 - 6.725 GHz	0-4 dB
C	Insat Band	950 - 1250 MHz	5.775 GHz	6.725 - 7.025 GHz	0-4 dB
C	Extended C-Band 2	950 - 1675 MHz	4.800 GHz	5.750 - 6.475 GHz	0-4 dB
C	Low C-Band	840 - 1000 MHz	4.250 GHz	5.090 - 5.250 GHz	0-4 dB
X	Standard X-Band	950 - 1450 MHz	6.950 GHz	7.900 - 8.400 GHz	0-2 dB
Ku	Standard Ku-Band	950 - 1450 MHz	13.050 GHz	14.00 - 14.50 GHz	0-2 dB
Ku	Extended Ku-Band	950 - 1700 MHz	12.800 GHz	13.75 - 14.50 GHz	0-2 dB

### Electrical Specifications for 5RU RM SSPA with ZBUC converter

PARAMETER	NOTES	LIMITS				UNITS
Gain	Nominal setting	75				dB
Gain Flatness	full band (C-,X-,Ku-bands)	± 2.0				dB
Gain Slope	per 40 MHz (C-,X-,Ku-bands)	± 0.5				dB/40 MHz
Gain Adjusted Range		20				dB
	Typical C-Band Adj. Range	60 - 80				dB
	Typical Ku-Band Adj. Range	57 - 77				dB
Gain Stability	-40 to +60 °C	± 1.5				dB
Phase Noise	Offset frequency from carrier	<u>Absolute max.</u>	<u>C-band (typ.)</u>	<u>X-band (typ.)</u>	<u>Ku-band (typ.)</u>	
	10 Hz	-30	-60	-60	-50	dBc/Hz
	100 Hz	-60	-80	-75	-65	dBc/Hz
	1 KHz	-70	-80	-75	-72	dBc/Hz
	10 KHz	-80	-85	-100	-90	dBc/Hz
	100 KHz	-90	-120	-110	-110	dBc/Hz
	1 MHz	-90	-125	-122	-120	dBc/Hz
Spurious	In-Band Signal Related (C-/Ku-Band) (Extended C-Band)	-50				dBc
	Close to Carrier Spurious (≤ 20 MHz)	-40				dBc
	Local Oscillator	-50				dBc
		-30				dBm
Noise Figure	At 75 dB gain setting	20				dB
Input VSWR	L-Band	1.5 : 1				
Internal Reference Option	Reference Accuracy (initial)	± 1 • 10 <sup>-8</sup>				
	Aging per day (after 30 days)	± 1 • 10 <sup>-9</sup>				
	Aging per year (after 30 days)	± 6 • 10 <sup>-8</sup>				
	Reference Stability over Temperature (-40 to +40 °C, ambient)	± 1 • 10 <sup>-8</sup>				

### Mechanical Specifications

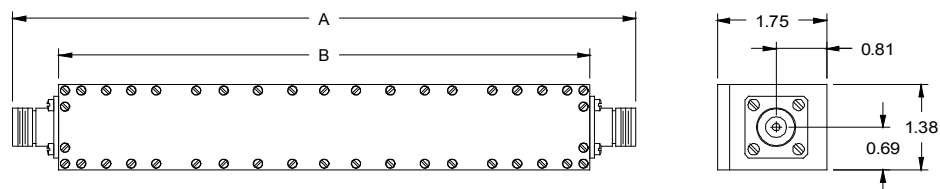
PARAMETER	NOTES	LIMITS	UNITS
Size (SSPA)	width X height X depth	19.0 x 8.75 x 30.0 483 x 222 x 762	inches mm
Size (Power Supply)	width X height X depth	19.0 x 1.75 x 15.97 483 x 45 x 406	inches mm
Weight (SSPA)	With integrated zBUC converter	120 (54.5) +1.7 (+0.8)	lbs. (kg) lbs. (kg)
Weight (Power Supply)	with four (4) power supply modules	29 (13.2)	lbs. (kg)
Finish		Paint	Gray; powder coat
Connectors	RF Input RF Output (S-Band) RF Output (C-Band) RF Output (X-Band) RF Output (Ku-Band) RF Output Sample	Type N WR430 WR137 Waveguide WR112 Waveguide WR75 Waveguide Type N	Female CPR430G Flange (PDR-22) CPR137G Flange (PDR-70) CPR112G Flange (PDR-84) Grooved flange (PBR-120) Female

### Environmental Specifications

PARAMETER	NOTES	LIMITS	UNITS
Operating Temperature	Ambient	0 to +50	°C
Relative Humidity	Non-condensing	95	%
Cooling System	Forced Convection Air Cooling	Front Panel - Intake Rear Panel - Exhaust	
Audible Noise	Measured 1m from unit, at P <sub>sat</sub>	61	dBA
Altitude	No temperature de-rating up to 10,000 ft. (3000 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		

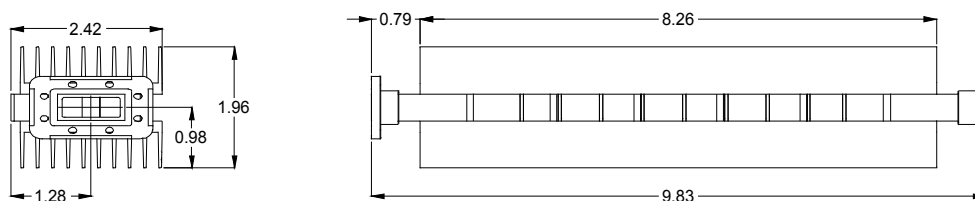
### Receive Band Filter Options

S-Band



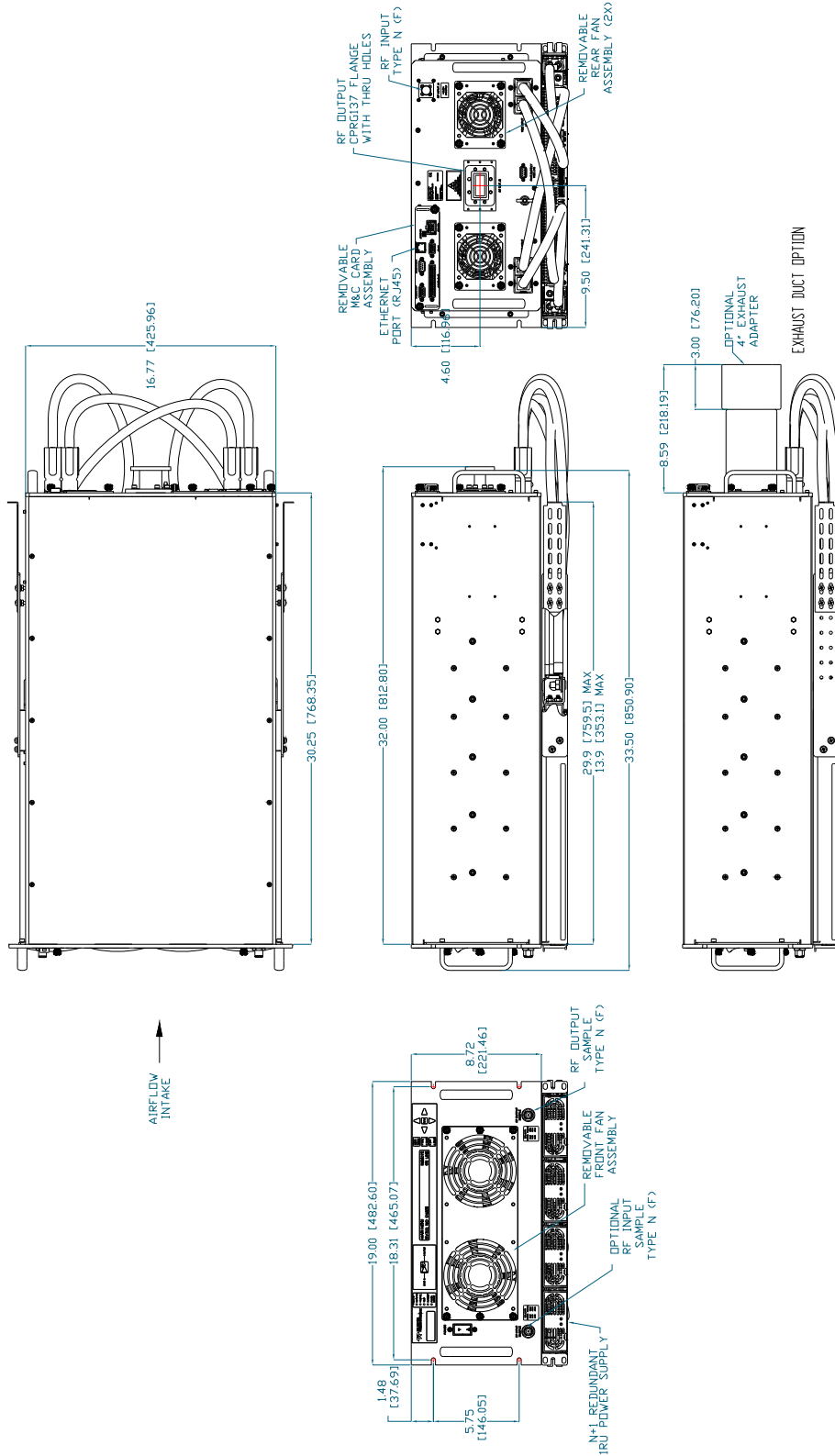
- 2.020-2.120 GHz (Band A) : Filter L205250-S3-TX Dimensions: A=9.972 , B=8.500
- 2.200-2.300 GHz (Band B) : Filter L205250-S4-TX Dimensions: A=12.222 , B=10.750
- 1.750-2.120 GHz (Band G) : Filter L205250-S11-TX Dimensions: A=4.730 , B=3.250

X-Band



# Indoor Rack Mount GaN Solid State Power Amplifiers 5RU Rack Height

## Outline Drawing, Typical C-Band SSPA Chassis



## Redundant and Phase Combined Systems

Teledyne Paradise Datacom's 5RU Rack Mount SSPAs can be configured in a variety of redundant and phase combined configurations.

- 1:1 Redundant System with Internal Redundancy Control
- 1:1 Redundant System with RCP2-1100 Redundant System Controller
- 1:1 Fixed Phase Combined System with FPRC-1100 Phase Combined System Controller
- 1:2 Redundant System with Internal Redundancy Control
- 1:2 Redundant System with RCP2-1200 Redundant System Controller
- 1:2 Fixed Phase Combined System with FPRC-1200 Phase Combined System Controller

## System Output Power Capacity

Due to residual losses inherent in redundant system configurations (waveguide bends; switch and coupler losses), reduce the typical output power specification of a single amplifier by approximately 0.2 dB for 1:1 and by 0.4 dB for 1:2 systems.

In phase combined systems, these same losses result in slightly less than the ideal addition of 3 dB to the output power of a single HPA unit. For 1:1 phase combined systems, the typical additive output power is approximately 2.70 dB above the output power of a single HPA. For 1:2 phase combined systems, the typical additive output power is approximately 2.50 dB above the output power of a single HPA.

Actual system losses will vary based on the system options.

## System Controllers

The RCP2/FPRC-1100/1200 system controller provides an extremely user friendly interface for complete monitor and control of the amplifier system.



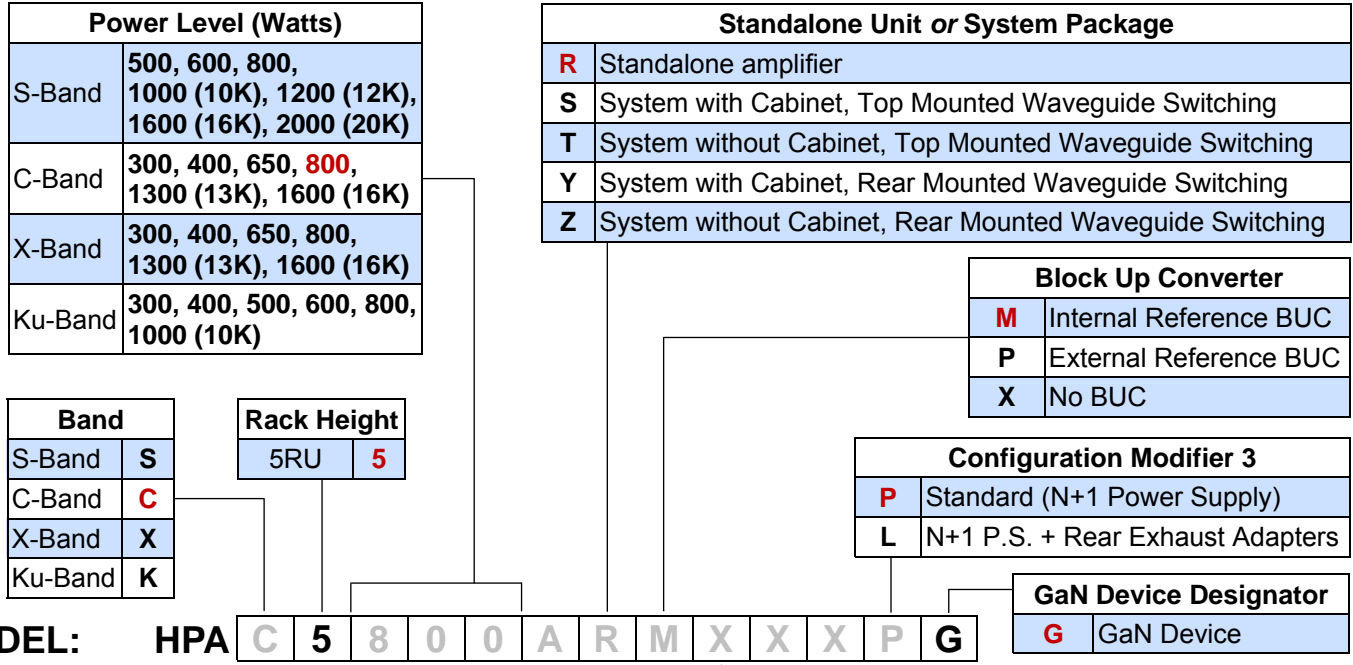
**RCP2-1100 Redundant System Controller**

The front panel mimic display shows the on-line amplifiers and the switch positions. Fault lights are provided for easy identification of system status. All system monitor and control is available locally at the front panel LCD display, as well as remotely by the RS232, RS485, or Ethernet interface ports. Audible alarms and a full compliment of parallel I/O signal are available at the rear panel of the controller.



# Indoor Rack Mount GaN Solid State Power Amplifiers 5RU Rack Height

## Part Number Configuration Matrix



Frequency Sub Band			
S-Band		X-Band	
<b>A</b>	2.02 to 2.12 GHz	<b>A<sup>1</sup></b>	7.90 to 8.40 GHz
<b>B</b>	2.20 to 2.30 GHz	<b>D</b>	7.70 to 8.40 GHz
<b>G</b>	1.75 to 2.12 GHz	<b>F</b>	7.10 to 7.40 GHz
C-Band		Ku-Band	
<b>A<sup>1</sup></b>	5.850 to 6.425 GHz	<b>A<sup>1</sup></b>	14.00 to 14.50 GHz
<b>B<sup>1</sup></b>	5.850 to 6.725 GHz	<b>B<sup>1</sup></b>	13.75 to 14.50 GHz
<b>C</b>	5.750 to 6.670 GHz	<b>F<sup>1</sup></b>	12.75 to 13.25 GHz
<b>D<sup>1</sup></b>	6.425 to 7.025 GHz	<b>G<sup>1</sup></b>	14.75 to 15.25 GHz
<b>H</b>	5.715 to 5.790 GHz		
<b>L</b>	4.400 to 5.000 GHz		

<sup>1</sup> Available with optional BUC

Configuration Modifier 2	
<b>X</b>	Standard
<b>R<sup>1</sup></b>	Rx Band Reject Filter
<b>V</b>	Reflected Power Monitor

<sup>1</sup> S-Band and X-Band units only

Configuration Modifier 1	
<b>X</b>	Standard
<b>S</b>	Input Sample Port

Standalone Unit or System Configuration	
<b>X</b>	Standalone amplifier
<b>A<sup>1</sup></b>	1:1 System, Input Switching, Internal Control
<b>B</b>	1:1 System, Input Splitter, Internal Control
<b>C<sup>1</sup></b>	1:2 System, Input Switching, RCP2-1200 <sup>2</sup>
<b>D<sup>1</sup></b>	1:2 System, Input Switching, Internal Control
<b>E</b>	1:2 Phase Combined System, Input Splitter, FPRC-1200 <sup>2</sup>
<b>F</b>	1:1 System, Input Splitter, RCP2-1100 <sup>2</sup>
<b>G</b>	1:1 Phase Combined system, Input Splitter, FPRC-1100 <sup>2</sup>
<b>H<sup>1</sup></b>	1:1 System, Input Switching, RCP2-1100 <sup>2</sup>
<b>J</b>	1:2 Phase Combined system, Input splitter, Internal Control

1 Switched input with external reference BUC requires reference distribution box.  
2 Standard location for controller is directly above HPA1.

**Example** - A standalone 800W GaN C-Band 5RU Rack Mount GaN SSPA with standard N+1 external power supply and an optional internal reference block up converter is part number: **HPAC5800ARMXXXP**G.

**Use and Disclosure of Data**

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