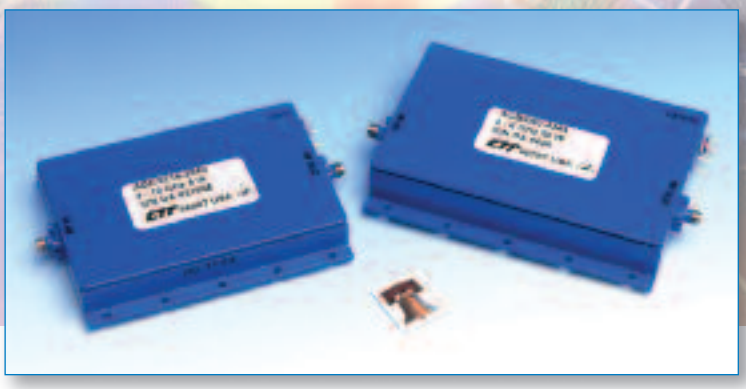
GaN & GaAs Power Amplifiers
for Radar, EW & Multi-Function Systems Design

Overall situational awareness is the goal of any sensor system. Radar in general, is unique in its ability to provide this capability under many environmental conditions. Specific radar configurations (i.e. SAR, Doppler, CW, Pulsed, AESA, etc.) have been optimized to suit specific applications. The characteristics of the portion of the electromagnetic spectrum selected for any of these particular system designs are perhaps the most important to the end user, as it has the greatest impact on the type of information required and received.



Radar systems in the lower microwave frequencies (below 4 GHz) provide the ability to detect objects at long ranges. Higher frequency systems (ie: X-band) have a reduced ability to search at longer ranges but can track and distinguish between items such as a rocket booster stage, debris or a satellite. Such high frequency systems require guidance via lower frequency systems in order to focus on specific search areas due to the relationship between frequency and resolution.

Both commercial and military radar systems will continue to be developed throughout the entire electromagnetic spectrum. Twenty-year federal spectrum requirements for radar bands L through Ku bear out the need for this requirement. With five to ten times the power handling capability, solid-state power amplifiers, employing GaN devices, are ideal for such applications making them suitable replacements in systems where TWTs are currently employed.

Although the use of GaN technology in these applications is growing, CTT's GaAs-based power amplifiers continue to offer specific benefits in low-power low-voltage systems, as well as in those system applications demanding high linearity – GaAs having established a long record of reliability, low cost, wide availability and excellent overall performance.

The nature of continuingly emerging applications rely on the complexities made possible by advancements from the digital arena, requiring electronic systems of the future to incorporate faithfully amplified complex wave forms, with multiple modulation schemes and pulse patterns distributed over wide bandwidths.

Multi-function systems will have to transmit and receive with maximum flexibility across a wide bandwidth, sometimes in adjacent channels and/or within the same frequency and/or time slot.

This evolution points toward multiple use hardware to maximize versatility and minimize multi-function cost, size, weight and power. In one specific application this versatility proves its value by limiting a radar's succeptibility to jamming by operating in a frequency-agile mode. This forces any jamming effort to spread its power over the whole bandwidth, even though the radar is only using a very narrow instantaneous bandwidth.

More advanced systems will employ "look ahead" frequency agility wherein the system selects the next operating frequency and checks to see that it is unoccupied. If clear, that frequency is used. If not, another frequency selection is checked, then made.

CTT engineers have developed a proprietary open architecture/common platform which relies

continues on back page

Narrowband Power Amplifiers (**CW**)

GaN Power Amplifiers	Frequency Response (GHz)	Gain (dB)	Gain Flatness (±dB)	Noise Figure (dB)	Psat (+dBm)	Psat CW (Watts)	VSWR In/Out	Volts (DC)	Current @SSG (mA)	Current @Psat (mA)	CTT Case Outline	Case Dimensions (L x W x H)
Model Number	**Min**	**Min**	**Max**	**Max**	**Min**	**Min**	**Max**		**Typ**	**Typ**		**Inches**
AGW/027-4145	2.1-2.7	45	2	6	41	12.5	2:1	30	930	1930	HDS12	4.71 x 3.5 x .84
AGW/027-4346	2.1-2.7	46	2	6	43	20.0	2:1	30	1700	3800	HDS12	4.71 x 3.5 x .84
AGW035-4145	2.7-3.5	45	2	6	41	12.5	2:1	30	930	1930	HDS12	4.71 x 3.5 x .84
AGW/035-4346	2.7-3.5	46	2	6	43	20.0	2:1	30	1700	3800	HDS12	4.71 x 3.5 x .84
AGN/037-4145	3.1-3.65	45	2	6	41	12.5	2:1	30	930	1930	HDS12	4.71 x 3.5 x .84
AGN/037-4346	3.1-3.65	46	2	6	43	20.0	2:1	30	1700	3800	HDS12	4.71 x 3.5 x .84
AGW/058-3740	4.4-5.8	40	2.5	6	37	5.0	2:1	30	550	1100	HPC10	4.09 x 1.96 x .50
AGW/058-4044	4.4-5.8	44	2.5	6	40	10.0	2:1	30	930	1930	HDC12	4.71 x 3.5 x .84
AGW/058-4345	4.4-5.8	45	2.5	6	43	20.0	2:1	30	1700	3800	HDC12	4.71 x 3.5 x .84
AGN/059-4145	5.2-5.93	45	2	6	41	12.5	2:1	30	930	1930	HDC12	4.71 x 3.5 x .84
AGN/059-4346	5.2-5.93	46	2	6	43	20.0	2:1	30	1700	3800	HDC12	4.71 x 3.5 x .84
AGN/064-4145	5.9-6.4	45	2	6	41	12.5	2:1	30	930	1930	HDC12	4.71 x 3.5 x .84
AGN/064-4346	5.9-6.4	46	2	6	43	20.0	2:1	30	1700	3800	HDC12	4.71 x 3.5 x .84
AGW/085-3740	6.4-8.5	40	2.5	7	37	5.0	2:1	30	550	1300	NGX15	4.23 x 3.5 x .67
AGW/085-4145	6.4-8.5	45	2.5	7	41	12.5	2:1	30	930	1930	NGX15	4.23 x 3.5 x .67
AGW/085-4346	6.4-8.5	46	2.5	7	43	20.0	2:1	30	1700	3800	NDX14	4.14 x 3.5 x .68
AGN/093-4145	8.5-9.3	45	2	6	41	12.5	2:1	30	930	1930	NGX15	4.23 x 3.5 x .67
AGN/093-4346	8.5-9.3	46	2	6	43	20.0	2:1	30	1700	3800	NDX14	4.14 x 3.5 x .68
AGN/093-4552	8.5-9.3	52	2	6	45	32.0	2:1	30	2200	7000	NDX14	4.14 x 3.5 x .68
AGN/093-4855	8.5-9.3	55	2	6	47.5	56.0	2:1	30	3000	11000	NQX14	4.32 x 4.5 x .68
AGN/099-4145	9.0-9.9	45	2	6	41	12.5	2:1	30	930	1950	NGX15	4.23 x 3.5 x .67
AGN/099-4346	9.0-9.9	46	2	6	43	20.0	2:1	30	1700	3800	NDX14	4.14 x 3.5 x .68
AGN/099-4552	9.0-9.9	52	2	6	45	32.0	2:1	30	2200	7000	NDX14	4.14 x 3.5 x .68
AGN/099-4855	9.0-9.9	55	2	6	47.5	56.0	2:1	30	3000	11000	NQX14	4.32 x 4.5 x .68
AGW/105-3738	8.5-10.5	38	2.5	7	37	5.0	2:1	30	550	1300	NGX15	4.23 x 3.5 x .67
AGW/105-4144	8.5-10.5	44	2.5	7	41	12.5	2:1	30	930	1930	NGX15	4.23 x 3.5 x .67
AGW/105-4345	8.5-10.5	45	2.5	7	43	20.0	2:1	30	1700	3800	NDX14	4.14 x 3.5 x .68
AGW/105-4551	8.5-10.5	51	2.5	8	45	32.0	2:1	30	2800	7400	NDX14	4.14 x 3.5 x .68
AGN/105-4145	9.5-10.5	50	2	6	41	12.5	2:1	30	950	1950	NGX15	4.23 x 3.5 x .67
AGN/105-4346	9.5-10.5	46	2	6	43	20.0	2:1	30	1700	3800	NDX14	4.14 x 3.5 x .68
AGN/105-4552	9.5-10.5	52	2	6	45	32.0	2:1	30	2200	7000	NDX14	4.14 x 3.5 x .68
AGN/105-4855	9.5-10.5	55	2	6	47.5	56.0	2:1	30	3000	11000	NQX14	4.32 x 4.5 x .68
AGN/107-4145	9.9-10.7	45	2	6	41	12.5	2:1	30	950	1950	NGX15	4.23 x 3.5 x .67
AGN/107-4346	9.9-10.7	46	2	6	43	20.0	2:1	30	1700	3800	NDX14	4.14 x 3.5 x .68
AGN/107-4552	9.9-10.7	52	2	6	45	32.0	2:1	30	2200	7000	NDX14	4.14 x 3.5 x .68
AGN/107-4855	9.9-10.7	55	2	6	47.5	56.0	2:1	30	3000	11000	NQX14	4.32 x 4.5 x .68
AGW/110-3739	7.0-11.0	38	2.5	7	37	5.0	2:1	30	550	1100	NGX15	4.23 x 3.5 x .67
AGW/110-4044	7.0-11.0	44	2.5	7	41	12.5	2:1	30	930	1950	NGX15	4.23 x 3.5 x .67
AGW/110-4245	7.0-11.0	45	2.5	7	42	15.0	2:1	30	1700	3800	NDX14	4.14 x 3.5 x .68

GaAs Power Amplifiers	Frequency Response (GHz)	Gain (dB)	Gain Flatness (±dB)	Noise Figure (dB)	P1dB (+dBm)	Psat (+dBm)	VSWR In/Out	Volts (DC)	Current (A)	CTT Case Outline	Case Dimensions (L x W x H)
Model Number	**Min**	**Min**	**Max**	**Max**	**Min**	**Min**	**Max**		**Typ**		**Inches**
ASN/142-4045	13.2-14.2	45	1	6	–	40	2:1	10~12	12	SP	Contact CTT
APW/175-4042	13.5-17.5	42	2	7	40	–	2:1	10~12	12	SP	Contact CTT
APN/145-4044	14.0-14.5	44	0.5	6	40	–	2:1	10~12	12	SP	Contact CTT
APN/154-4043	14.0-15.4	43	1	7	40	–	2:1	10~12	12	SP	Contact CTT
ASN/173-4042	15.4-17.3	42	1.5	7	–	40	2:1	10~12	12	SP	Contact CTT

CTT INC.

CTT Inc. • 241 East Java Drive • Sunnyvale • California 94089
Phone: 408-541-0596 • Fax: 408-541-0794
www.cttinc.com • E-mail: sales@cttinc.com

Narrowband Power Amplifiers (**Pulsed**)* [≤ 100 µS pulse width or 10% duty cycle.]

GaN Power Amplifiers	Frequency Response (GHz)	Gain (dB)	Gain Flatness (±dB)	Noise Figure (dB)	Psat (+dBm)	Psat Peak (Watts)	VSWR In/Out	Volts (DC)	Current Psat (mA)	CTT Case Outline	Case Dimensions (L x W x H)
Model Number	**Min**	**Min**	**Max**	**Max**	**Min**	**Min**	**Max**		**Typ**		**Inches**
AGN/035-4959-P	3.1-3.5	59	2	6	49.0	80 W	2:1	30	–	SP	Contact CTT
AGN/035-5262-P	3.1-3.5	62	2	6	51.8	150 W	2:1	30	–	SP	Contact CTT
AGN/035-5565-P	3.1-3.5	65	2	6	54.5	280 W	2:1	30	–	SP	Contact CTT
AGW/085-4858-P	5.5-8.5	58	3	6	47.8	60 W	2:1	30	–	SP	Contact CTT
AGW/085-5060-P	5.5-8.5	60	3	6	50.0	100 W	2:1	30	–	SP	Contact CTT
AGN/093-4652-P	8.5-9.3	52	2	6	46.0	40 W	2:1	30	7000	NDX14	4.14 x 3.5 x .68
AGN/093-4957-P	8.5-9.3	57	2	6	49.0	80 W	2:1	30	13800	NQX14	4.32 x 4.5 x .68
AGN/093-5260-P	8.5-9.3	60	2	6	52.0	160 W	2:1	30	27000	SP	Contact CTT
AGN/096-4652-P	8.5-9.6	52	2	6	46.0	40 W	2:1	30	7000	NDX14	4.14 x 3.5 x .68
AGN/096-4957-P	8.5-9.6	57	2	6	49.0	80 W	2:1	30	13800	NQX14	4.32 x 4.5 x .68
AGN/096-5260-P	8.5-9.6	60	2	6	52.0	160 W	2:1	30	27000	SP	Contact CTT
AGN/096-5360-P	8.5-9.6	60	2	6	53.0	200 W	2:1	42	–	SP	Contact CTT
AGN/096-5660-P	8.5-9.6	60	2	6	56.0	400 W	2:1	42	–	SP	Contact CTT
AGN/099-4652-P	9.0-9.9	52	2	6	46.0	40 W	2:1	30	7000	NDX14	4.14 x 3.5 x .68
AGN/099-4957-P	9.0-9.9	57	2	6	49.0	80 W	2:1	30	13800	NQX14	4.32 x 4.5 x .68
AGN/099-5260-P	9.0-9.9	60	2	6	52.0	160 W	2:1	30	27000	SP	Contact CTT
AGN/100-5360-P	9.0-10.0	60	2	6	53.0	200 W	2:1	42	–	SP	Contact CTT
AGN/100-5660-P	9.0-10.0	60	2	6	56.0	400 W	2:1	42	–	SP	Contact CTT
AGN/105-4652-P	9.5-10.5	52	2	6	46.0	40 W	2:1	30	7000	NDX14	4.14 x 3.5 x .68
AGN/105-4957-P	9.5-10.5	57	2	6	49.0	80 W	2:1	30	13800	NQX14	4.32 x 4.5 x .68
AGN/105-5260-P	9.5-10.5	60	2	6	52.0	160 W	2:1	30	27000	SP	Contact CTT
AGN/107-4652-P	9.9-10.7	52	2	6	46.0	40 W	2:1	30	7000	NDX14	4.14 x 3.5 x .68
AGN/107-4957-P	9.9-10.7	57	2	6	49.0	80 W	2:1	30	13800	NQX14	4.32 x 4.5 x .68
AGN/107-5260-P	9.9-10.7	60	2	6	52.0	160 W	2:1	30	27000	SP	Contact CTT

*The AGN-P pulse mode series can only operate at pulse mode, requiring an external TTL signal to turn On/Off the amplifier. The delay plus rise time, or delay plus fall time is less than 2 µS. Shorter response times are available, ie: 500 ns or faster. Contact the factory.

Wideband & Ultra-Wideband Power Amplifiers (**CW**)

GaN Power Amplifiers	Frequency Response (GHz)	Gain (dB)	Gain Flatness (±dB)	Noise Figure (dB)	Psat (+dBm)	Psat Band Edge (+dBm)	VSWR In/Out	Volts (DC)	Current @SSG (mA)	Current @Psat (mA)	CTT Case Outline	Case Dimensions (L x W x H)
Model Number	**Min**	**Min**	**Max**	**Max**	**Typ**	**Min**	**Max**		**Typ**	**Typ**		**Inches**
AGX/020-3545	0.1-2	45	2.0	4	36.0	35.0	2:1	30	300	700	HPC8	3.42 x 1.96 x .50
AGX/060-4050	0.5-6	50	3.0	4.5	39.5	39.0	2:1	30	800	2400	HDS12	4.71 x 3.5 x .84
AGM/030-4252	1-3	52	2.5	4	42.5	42.0	2:1	30	1350	4100	HDS12	4.71 x 3.5 x .84
AGM/060-4343	2-6	43	2.5	6	43.0	43.0	2:1	30	1820	4200	NDS12	4.71 x 3.5 x .84
AGM/060-4356	2-6	56	2.5	6	43.0	43.0	2:1	30	1880	4260	NDS12	4.71 x 3.5 x .84
AGM/060-4646	2-6	46	2.5	6	46.0	45.5	2:1	30	3420	7700	NDS12	4.71 x 3.5 x .84
AGX/0218-3946	2-18	46	3	8	39.0	38.0	2.2:1	32	1350	3100	NGX15	4.23 x 3.5 x .67
AGM/180-3940	6-18	40	2.5	7	39.0	38.0	2:1	32	1300	3100	NGX15	4.23 x 3.5 x .67
AGM/180-4250	6-18	50	2.5	7	42.0	41.0	2:1	32	2500	5200	NDX14	4.14 x 3.5 x .68
AGM/180-4444	6-18	44	2.5	7	44.0	43.0	2:1	32	4000	8500	NQX14	4.32 x 4.5 x .68
AGM/180-4458	6-18	58	2.5	7	44.0	43.0	2:1	32	4100	8600	NQX14	4.32 x 4.5 x .68

CTT Power Amplifier Comments:

1. Heat sinking is MANDATORY to keep the CASE temperature below +70°C, otherwise, permanent damage or degradation may occur. Units can operate at -30°C to +70°C. Consult the factory for higher temperature operational requirements.
2. For CW amplifiers TTL control, pulsed amplification, monitor, detector and DC-DC power supplies are optional.
3. Consult the factory for additional gain, power, frequencies, temperature compensation, special functions, or customer-specified supply voltages.
4. Detailed amplifier case outline drawings are available from CTT's Website. SP = Special Enclosure. Please contact the factory for outline drawing.
5. Specifications listed are subject to change without notice.

CTT INC.

CTT Inc. • 241 East Java Drive • Sunnyvale • California 94089
Phone: 408-541-0596 • Fax: 408-541-0794
www.cttinc.com • E-mail: sales@cttinc.com

GaN & GaAs Power Amplifiers
for Radar, EW & Multi-Function Systems Design

on advanced multi-octave combiner design and unique substrate material selection. The result is adaptable, modular amplifiers requiring only a single supply voltage.

CTT's family of amplifiers are finding applications in many of the next generation of high-performance communications, instrumentation and medical systems where high power is required. CTT's new GaN power amplifiers – with 20% operating efficiencies – offer cost-effective performance solutions.

Whether commercial or military, radar system power consumption is an increasingly important design criteria. CTT offers TTL-controlled main bias shut-off circuitry matched to the system's pulse operation. With the amplifier drawing much less power between pulses, both total power consumption and temperature rise is reduced.

In general, most pulse radars operate at a duty cycle of 10% or less. As such, CTT's pulsed power amplifiers are an attractive solution. Using a TTL control, by turning off the FETs (drain) the amplifier only consumes 100 to 200 mA for the logic and bias circuit. When the TTL is turned on, the unit will operate after a short rise time. During this "on time" the amplifier's power consumption is identical to that in CW operation. Thus, when the duty cycle is 10% or less, the unit will consume much less power. Therefore, the amplifier's heat sink and power supply can be significantly smaller.

Engineered specifically to meet the stringent requirements imposed by many modern system designs, CTT's family of power amplifiers, perform a wide range of functions. Whether the application is narrowband, wideband or ultra-wideband, operating in pulsed or CW mode, CTT's power amplifiers are an especially attractive choice for new multi-function systems that effectively conserve weight, space and power consumption though the combination of several stand-alone functions into a single system.

These amplifiers are designed for commercial, industrial and military applications. For military applications CTT power amplifiers are manufactured to meet the requirements of MIL-STD-883, Methods 2010 and 2017, with soldering compliant to J-STD-001. These procedures also make the amplifiers excellent choices for applications requiring MIL-E-5400.

CTT has shipped thousands of amplifiers into many radar, communications, EW, UAV and data link programs. CTT's proprietary power amplifier designs are the refinement of decades of amplifier and subas-sembly experience. In addition to this design heritage, these amplifiers take full advantage of the repeatability and cost effectiveness of CTT's fully automated in-house production line.

20-Year Federal Spectrum Radar Requirement for Specific Bands

Band	Frequency	Usage
L	1215–1390 MHz	ATC (Air Traffic Control), SAR (Synthetic Aperture Radar), DoD early warning air defense, battlefield, shipborne long-range surveillance
S	2700–3100 MHz	ATC, maritime, weather, DoD shipborne, airborne, ground surveillance
S	3100–3650 MHz	DoD surveillance and air defenses (airborne, shipborne, land-based), ATC, SAR
C	5250–5925 MHz	NOAA weather, FAA TDWR; DoD surveillance and air defenses (airborne, shipborne, land-based)
X	8.5–10.55 GHz	Airborne and shipborne surveillance and navigation fire control, battlefield, maritime, weather, test range, airborne radio navigation, ATC, SAR
Ku	13.25–14.20 GHz	Airborne and shipborne search and acquisition Doppler, airborne weather, environmental research
Ku	15.40–17.30 GHz	Airborne and shipborne multi-mode search, battlefield, fire-control, precipitation, atmospheric research

Radar Bandwidth Defined

Three classes of radar are recognized by signal fractional bandwidth: **Narrowband** (NB), where fractional bandwidth is less than 1%; **Wideband** (WB), with a fractional bandwidth from 1% to 25%; and **Ultra-Wideband** (UWB), where any radar whose fractional bandwidth is greater than 25%, regardless of the center frequency.

CTT is in compliance with all applicable U.S. Export control laws and regulations, including EAR and ITAR.

CTT Inc. • 241 East Java Drive • Sunnyvale • California 94089
Phone: 408-541-0596 • Fax: 408-541-0794
www.cttinc.com • E-mail: sales@cttinc.com