

## Microwave Power Modules

Microwave Power Modules (MPMs) typically consist of a low-noise, high-gain solid-state power amplifier (SSPA) driving a relatively low-gain, high-efficiency Helix traveling-wave tube (TWT) with a control and protection module providing electrical power to both the SSPA and TWT. Many of CTT's high power GaN amplifiers are suitable for MPM as well as TWT replacement applications.

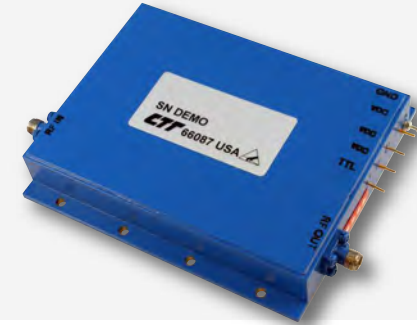
MPMs have found applications in systems ranging from satellite communications (SATCOM) to electronic warfare (EW) and synthetic aperture radar (SAR). Combining the best features of both solid-state and vacuum device technology, MPMs have been able to offer significant performance advantages in reduced size and weight, reduced noise coupled with large improvements in efficiency.

With the current state of development of GaN devices CTT has produced SSPAs that are effectivity an all "solid-state MPM" offering increased reliability and lower cost than conventional MPMs.

## GaN Power Amplifiers

### Wideband, Ultra-Wideband & Narrowband up to 1kW

- ▶ **High Power Density**
- ▶ **Reduced Footprint – Compact Size**
- ▶ **Increased Efficiency**
- ▶ **Lower Cost-per-Watt**
- ▶ **Custom Engineered Options (CEOs)** (See page 36)
- ▶ **Individual Driver & Power Amplifiers Available** (See page 22)



### 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
Model Number	Min	Min	Max	Max	Typ	Min	Max		Typ	Typ	
AGX/020-3545	0.1-2.0	45	2	4	36.0	35.0	2:1	30	300	700	HPC8
AGX/002025-3835	0.2-2.5	38	3.0	4	39.0	38.0	2:1	30	600	990	HPC8
AGM/030-4252	1.0-3.0	52	2.5	4	42.5	42.0	2:1	30	800	2400	HDS12
AGO/030-4045	1.5-3.0	45	2.0	5	40.0	40.0	2:1	30	800	1800	HDS12
AGO/030-4343	1.5-3.0	43	2.0	5	43.0	43.0	2:1	30	900	3700	HDS12
AGO/030-4646	1.5-3.0	46	2.0	5	46.0	46.0	2:1	30	1600	6600	HDS12
AGO/040-4045	2-4	45	2.0	5	40.0	40.0	2:1	30	800	1800	NDS12
AGO/040-4343	2-4	43	2.0	5	43.0	43.0	2:1	30	900	3700	NDS12
AGO/040-4646	2-4	46	2.0	5	46.0	46.0	2:1	30	1600	6600	NDS12
AGX/005060-4050	0.5-6	50	3.0	4.5	39.5	39.0	2:1	30	800	2400	HDS12
AGM/060-4343	2-6	43	2.5	5	43.0	43.0	2:1	30	1820	4200	NDS12
AGM/060-4356	2-6	56	2.5	5	43.0	43.0	2:1	30	1880	4260	NDS12
AGM/060-4646	2-6	46	2.5	5	46.0	45.5	2:1	30	3420	7700	NDS12
AGM/060-4658	2-6	58	2.5	5	46.0	45.5	2:1	30	3500	7800	NDS12
AGM/060-4955	2-6	55	2.5	5	50.0	49.0	2:1	30	6400	14200	SP
AGM/060-5056	2-6	56	2.5	5	50.5	50.0	2:1	30	6400	17200	SP
AGM/060-5257	2-6	57	3.0	5	52.0	52.0	2:1	30	11700	27000	SP
AGW/085-4655	5.5-8.5	55	3	5	46.0	46.0	2:1	30	3000	7200	SP
AGW/085-4952	5.5-8.5	52	3	5	49.0	48.5	2:1	30	5600	12800	SP

**New Products**

Continued on Next Page



# GaN Power Amplifiers

## Wideband Power Amplifiers (CW) up to 1kW

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

#### Expediting RF Design for TCDL

Originally designed for voice transmission, military tactical radios are now used to transmit and receive digital voice, data, and video between vehicles and command and control facilities. These data link radios are being interfaced with a variety of computers and monitors. Even while newly designed systems proliferate, a wide range of legacy platforms are undergoing upgrade to incorporate new data link capability. Clearly, the need for a common data link (CDL) solution to be used in multiple applications exists.

A relatively new common data link (CDL) compliant system is the tactical common data link (TCDL) which embodies characteristics most likely to meet the needs of the rapidly evolving demand envelope for both UAV and manned platforms. TCDL is a Ku-band digital data link that transmits wide-bandwidth information using CDL wave-form standards.

GaN Power Amplifiers	Frequency Response (GHz)	Gain (dB)	Gain Flatness ( $\pm$ dB)	Noise Figure (dB)	Psat (+dBm)	Psat Band Edge (+dBm)	VSWR In/Out	Volts (DC)	Current @SSG (mA)	Current @Psat (mA)	CTT Case Outline
	Model Number	Min	Min	Max	Max	Typ	Min	Max	Typ	Typ	
AGW/105-4045	8.5-10.5	45	2.5	7	40.0	40.0	2:1	30	1100	2150	NGX15A
AGW/105-4344	8.5-10.5	44	3.0	7	43.0	43.0	2:1	30	1500	3800	NGX15A
AGW/105-4650	8.5-10.5	50	3.0	7	46.5	46.0	2:1	30	3000	7000	NDX14A
AGW/105-4855	8.5-10.5	55	3.0	7	49.0	48.0	2:1	30	4700	15800	NQX14A
AGW/105-5061	8.5-10.5	61	3.0	7	52.0	50.0	2:1	30	6080	15900	SP
AGW/110-4045	7.0-11.0	45	2.5	7	40.0	40.0	2:1	30	1100	2150	NGX15A
AGW/110-4344	7.0-11.0	44	3.0	7	43.5	43.0	2:1	30	1500	3800	NGX15A
AGW/110-4650	7.0-11.0	50	3.0	7	46.5	46.0	2:1	30	3000	7000	NDX14A
AGW/110-4855	7.0-11.0	55	3.0	7	49.0	48.0	2:1	30	4700	15800	NQX14A
AGW/110-5061	7.0-11.0	61	3.0	7	52.0	50.0	2:1	30	6080	15900	SP
AGO/120-4450	6-12	50	3.0	7	46	44.0	2:1	30	1700	6000	NQX14A
AGO/120-4750	6-12	50	3.0	7	49	47.0	2:1	30	2700	12000	SP
AGO/120-5050	6-12	50	3.0	7	52	50.0	2:1	30	6000	15800	SP
AGO/120-5061	6-12	61	3.0	7	52	50.0	2:1	30	6080	15900	SP
AGX/0218-3735	2-18	35	3.0	7	37	36.5	2.2:1	28	850	1500	NGX15A
AGX/0218-3747	2-18	47	3.0	7	37	36.5	2.2:1	28	950	1600	NGX15A
AGX/0218-3942	2-18	42	3.0	7	39	38.5	2.2:1	32	1350	2800	NGX15A
AGX/0218-3954	2-18	54	3.0	7	39	38.5	2.2:1	32	1400	2900	NGX15A
AGX/0318-4242	3-18	42	3.5	7	42	41	2:1	32	1900	4200	NDX14A
AGX/0318-4252	3-18	52	3.5	7	42	41	2:1	32	1980	4280	NDX14A
AGX/0318-4453	3-18	53	3.5	7	44	43	2:1	32	3400	8000	NQX14A
AGX/0318-4465	3-18	65	3.5	7	44	43	2:1	32	3500	8100	NQX14A
AGM/180-3745	6-18	45	2.5	6	37	36.5	2:1	30	850	1600	NGX15A
AGM/180-3948	6-18	48	2.5	6	39	38	2:1	30	1700	2900	NGX15A
AGM/180-4243	6-18	43	3.0	6	42	41	2:1	30	3000	4800	NDX14A
AGM/180-4252	6-18	52	3.0	6	42	41	2:1	30	3050	4860	NDX14A
AGM/180-4442	6-18	42	2.5	6	44	43	2:1	30	5600	11000	NQX14A
AGM/180-4450	6-18	50	3.0	6	44	43	2:1	30	5700	11060	NQX14A
AGM/180-4648	6-18	48	3.0	6	46	45.5	2:1	30	12800	17950	SP
AGM/180-4655	6-18	55	3.0	6	46	45.5	2:1	30	12900	18000	SP
AGO/180-3745	8-18	45	2.5	6	37	36.5	2:1	30	850	1600	NGX15A
AGO/180-3948	8-18	48	2.5	6	39	38	2:1	30	1400	2800	NGX15A
AGO/180-4243	8-18	43	3.0	6	42	41	2:1	30	3000	4860	NDX14A
AGO/180-4450	8-18	50	3.0	6	44	43	2:1	30	5700	11060	NQX14A
AGO/180-4648	8-18	48	3.0	6	46	45.5	2:1	30	12800	17950	SP

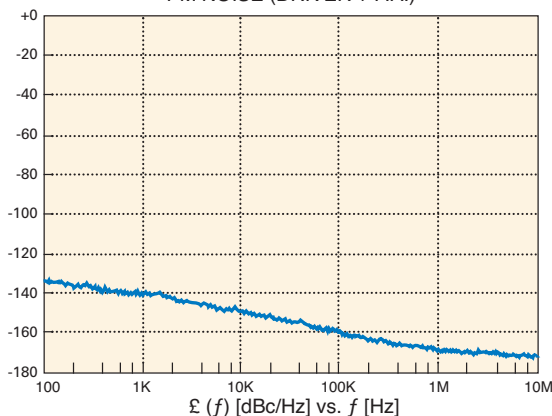
#### New Products



# GaN Power Amplifiers

## Narrowband Power Amplifiers (CW) up to 1kW

CTT GaN Power Amplifier  
Phase Noise Performance  
PM NOISE (DRIVER + P.A.)



### Narrowband Power Amplifiers (CW)

GaN Power Amplifiers	Frequency Response (GHz)	Gain (dB)	Gain Flatness ( $\pm$ dB)	Noise Figure (dB)	Psat (+dBm)	Psat CW (Watts)	VSWR In/Out	Volts (DC)	Current @SSG (mA)	Current @Psat (mA)	CTT Case Outline
Model Number	Min	Min	Max	Max	Min	Min	Max	Typ	Typ		
AGW/025-3814	1.6-2.5	14	1.0	6	38.0	6.3	2:1	30	250	650	SP
AGW/025-3840	1.6-2.5	40	2.0	6	38.0	6.3	2:1	30	600	1100	SP
AGW/025-4045	1.6-2.5	45	2.0	5	40.0	10.0	2:1	30	800	1500	HDS-12
AGW/025-4343	1.6-2.5	43	2.0	5	43.0	20.0	2:1	30	900	3700	HDS-12
AGW/025-4646	1.6-2.5	46	2.0	5	46.0	40.0	2:1	30	1600	6600	HDS-12
AGW/035-4346	2.7-3.5	46	2.0	6	43.0	20.0	2:1	30	1700	3800	HDS-12
AGW/035-4658	2.7-3.5	58	2.5	6	46.0	40.5	2:1	30	3500	7800	NDS-12
AGW/035-5055	2.7-3.5	55	2.5	5	50.0	100.0	2:1	30	6400	14200	SP
AGW/060-3740	4.0-6.0	40	2.5	6	37.0	5.0	2:1	30	550	1100	HPC-10
AGW/060-4044	4.0-6.0	44	2.5	6	40.0	10.0	2:1	30	930	1930	HDC-12
AGW/060-4345	4.0-6.0	45	2.5	6	43.0	20.0	2:1	30	1700	3800	HDC-12
AGW/060-4658	4.0-6.0	58	2.5	6	46.0	40.0	2:1	30	3500	7800	NDS-12
AGW/060-4955	4.0-6.0	55	2.5	5	49.0	80.0	2:1	30	6400	14200	SP
AGW/060-5056	4.0-6.0	56	2.5	5	50.0	100.0	2:1	30	6400	17200	SP
AGW/060-5257	4.0-6.0	57	3.0	5	52.0	160.0	2:1	30	11700	27000	SP
AGN/064-4145	5.9-6.4	45	2.0	6	41.0	12.5	2:1	30	930	1930	HDC-12
AGN/064-4346	5.9-6.4	46	2.0	6	43.0	20.0	2:1	30	1700	3800	HDC-12
AGW/085-3740	6.4-8.5	40	2.5	7	37.0	5.0	2:1	30	550	1300	NGX15A
AGW/085-4346	6.4-8.5	46	2.5	7	43.0	20.0	2:1	30	1700	3800	NDX14A
AGW/085-4646	6.4-8.5	46	2.5	7	46.0	40.0	2:1	30	1700	3800	NDX14A
AGN/093-4346	8.5-9.3	46	2.0	6	43.0	20.0	2:1	30	1700	3800	NDX14A
AGN/093-4652	8.5-9.3	52	2.0	6	46.0	40.0	2:1	30	2200	7000	NDX14A
AGN/093-4855	8.5-9.3	55	2.0	6	48.0	63.0	2:1	30	3000	11000	NQX14A
AGN/099-4145	9.0-9.9	45	2.0	6	41.0	12.5	2:1	30	930	1950	NGX15A
AGN/099-4346	9.0-9.9	46	2.0	6	43.0	20.0	2:1	30	1700	3800	NDX14A
AGN/099-4652	9.0-9.9	52	2.0	6	46.0	40.0	2:1	30	2200	7000	NDX14A
AGN/099-4855	9.0-9.9	55	2.0	6	48.0	63.0	2:1	30	3000	11000	NQX14A
AGN/100-4145	9.1-10.0	45	2.0	6	41.0	12.5	2:1	30	930	1950	NGX15A
AGN/100-4346	9.1-10.0	46	2.0	6	43.0	20.0	2:1	30	1700	3800	NDX14A
AGN/100-4652	9.1-10.0	52	2.0	6	46.0	40.0	2:1	30	2200	7000	NDX14A
AGN/100-4855	9.1-10.0	55	2.0	6	48.0	63.0	2:1	30	3000	11000	NQX14A

New Products

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### Turn ON Sequence: GaN & GaAs SSPAs

1. Mount the SSPA to the heat sink as described in **Heat Sinking Requirements**.
2. Connect the amplifier to the RF Input and RF Output cables. Ensure there is enough padding or attenuation between the amplifier and the load, so the SSPA (or test equipment) will not be damaged by high VSWR or high power.
3. Adjust the DC power supply voltage(s) to the value(s) specified for the particular SSPA. For example, this might be +30 VDC (or +28 to +50 VDC), +12 VDC, and -5 VDC.
4. Connect the DC power to the SSPA. Apply **ALL NEGATIVE** voltages to the SSPA **FIRST**, before applying the positive voltages. For this example, the sequence can be: -5V first, +12V and then +30V. **DO NOT** slowly turn up the voltages to the SSPA with the power supply or supplies connected.
5. If the unit is a CW SSPA, skip Step 5 and go directly to Step 6. If the unit is a Pulsed SSPA, the amplifier will be ON when the TTL is low; the amplifier will be OFF when the TTL is high or floating. If a different condition is required, consult the factory. Be sure to follow the specified conditions for maximum pulse width and duty cycle when setting the pulsed waveform parameters. If the maximum pulse width and duty cycle are exceeded, permanent damage or degradation may occur.
6. Set the RF generator to small signal level, turn on the RF signal generator to apply RF to the SSPA. Adjust the input power level to the desired range to get full output power.

### Turn OFF Sequence (Pulsed & CW)

1. Turn OFF the signal generator.
2. If this is a Pulsed SSPA, turn OFF the pulse generator.
3. **ALL** external negative voltages should be left **ON and CONNECTED** until ALL positive voltages have been disconnected.
4. Disconnect positive voltages **FIRST**.

## GaN Power Amplifiers

### Narrowband Power Amplifiers (CW) up to 1kW (continued)

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
	Model Number	Min	Min	Max	Max	Min	Max	Typ	Typ	Typ	
AGN/105-4145	9.5-10.5	50	2.0	6	41.0	12.5	2:1	30	950	1950	NGX15A
AGN/105-4346	9.5-10.5	46	2.0	6	43.0	20.0	2:1	30	1700	3800	NDX14A
AGN/105-4652	9.5-10.5	52	2.0	6	46.0	40.0	2:1	30	2200	7000	NDX14A
AGN/105-4855	9.5-10.5	55	2.0	6	48.0	63.0	2:1	30	3000	11000	NQX14A
AGN/105-4866	9.5-10.5	66	2.0	6	48.0	63.0	2:1	30	3080	11000	NQX14A
AGN/107-4145	9.9-10.7	45	2.0	6	41.0	12.5	2:1	30	950	1950	NGX15A
AGN/107-4346	9.9-10.7	46	2.0	6	43.0	20.0	2:1	30	1700	3800	NDX14A
AGN/107-4652	9.9-10.7	52	2.0	6	45.5	32.0	2:1	30	2200	7000	NDX14A
AGN/107-4855	9.9-10.7	55	2.0	6	47.5	56.0	2:1	30	3000	11100	NQX14A
AGN/145-4445	13.5-15.5	45	2.0	6	44.0	25.0	2:1	30	1500	6000	NGX15A
AGN/154-4752	13.5-15.5	52	2.0	6	47.0	50.0	2:1	30	2400	12000	NDX14A
AGN/154-5055	13.5-15.5	55	2.0	6	50.0	100.0	2:1	30	4600	24000	NQX14A

### New Products

#### Heat Sinking Requirements for GaN & GaAs SSPAs

1. Units can operate at CASE temperature between -30°C to +70°C. For wider temperature range requirements contact the factory.
2. Proper heat sinking is **ABSOLUTELY** required, otherwise, permanent damage or degradation may occur. Heat sinks should be selected based on the dissipated power within the PA (ie: DC power into the unit in Watts, minus the RF output that is delivered to the load).
3. Thermal grease or some alternate highly-conductive thermal interface material should be applied between the mounting surface of the amplifier and the heat sink.
4. Good mechanical pressure is imperative to guarantee effective thermal transfer to the heat sink for reliable operation. Customers should use all mounting features provided on the amplifier units to apply this mechanical pressure.

#### Heat Sink Selection Example

ie: Amplifier Model AGW105-4855

- $P_{diss} =$  Dissipated Power within the SSPA (AKA Heat)
- $P_{diss} = P_{DC}$  (Watts) -  $P_{out}$  (Watts) +  $P_{in}$  (Watts)
- $P_{DC} = +30$  VDC 13.0 Amps = 350 Watts
- $P_{out} =$  RF Output Power = 63 Watts
- $P_{in} \approx 0$  dBm = 1 Milliwatt - 0.001 Watt is negligible
- $P_{diss} = 390$  Watts - 63 Watts - 327 Watts

In this example a heat sink is selected for a temperature rise of +20°C, or less, due to ambient temperature and maximum allowable case temperature boundary conditions. Thermal resistance of the heat sink must therefore be: 20°C/247 Watts = 0.08°C/W or lower. Conclusion: A thermal resistant 0.08°C/W heat sink is needed for this amplifier. Based on this number, forced air cooling is necessary.

#### Optional Gating or Blanking Function

For CTT's CW amplifiers the blanking function can be built-in. In this case there is a TTL pin on the amplifier. When +5V (TTL high) or no voltage (floating) is applied, the amplifier is ON all

the time. If the TTL is 0V (shorted to ground), the amplifier is turned OFF (the majority of DC current will be cut off while the bias, delay and protection circuits remain on). This turn ON/OFF time can vary from 250ns to 10ms. If faster speed is required consult the factory.



**Engineered specifically** to meet the stringent requirements imposed by many modern system designs, CTT's family of GaN power amplifiers, perform a wide range of functions making them ideal for applications in cutting-edge multi-function systems. Whether the application is narrowband, wideband or ultra-wideband, operating in pulsed or CW mode, CTT's GaN power amplifiers are an especially attractive choice for new multi-functioned systems that effectively conserve weight, space and power consumption.

The export of some CTT Inc. products are subject to current International Trade Regulations and Export Administration Regulations. Contact CTT for additional information.



# GaN Power Amplifiers

## Narrowband Power Amplifiers (Pulsed) up to 1kW

- ▶ **High Power Density**
- ▶ **Increased Efficiency**
- ▶ **Low Average Power Consumption**
- ▶ **Excellent Phase Linearity & Phase Linearity**
- ▶ **Low Thermal Noise**
- ▶ **Custom Engineered Options (CEOs)** (See page 36)



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

GaN Power Amplifiers Model Number	Frequency Response (GHz) Min	Gain (dB) Min	Gain Flatness (±dB) Max	Noise Figure (dB) Max	Psat (+dBm) Min	Psat Peak (Watts) Min	VSWR In/Out Max	Volts (DC)	Current Psat (mA) Typ	CTT Case Outline
AGN/035-4959-P	3.1-3.5	59	2.0	6	49.0	80	2:1	30	—	SP
AGN/035-5262-P	3.1-3.5	62	2.0	6	51.8	150	2:1	30	—	SP
AGN/035-5565-P	3.1-3.5	65	2.0	6	54.5	280	2:1	30	—	SP
AGW/085-4858-P	5.5-8.5	58	3.0	6	47.8	60	2:1	30	—	SP
AGW/085-5060-P	5.5-8.5	60	3.0	6	50.0	100	2:1	30	—	SP
AGN/093-4652-P	8.5-9.3	52	2.0	6	46.0	40	2:1	30	7000	NDX14A
AGN/093-4957-P	8.5-9.3	57	2.0	6	49.0	80	2:1	30	13800	NQX14A
AGN/093-5260-P	8.5-9.3	60	2.0	6	52.0	160	2:1	30	27000	SP
AGN/096-4652-P	8.5-9.6	52	2.0	6	46.0	40	2:1	30	7000	NDX14A
AGN/096-4957-P	8.5-9.6	57	2.0	6	49.0	80	2:1	30	13800	NQX14A
AGN/096-5260-P	8.5-9.6	60	2.0	6	52.0	160	2:1	30	27000	SP
AGN/096-5360-P	8.5-9.6	60	2.0	6	53.0	200	2:1	42	—	SP
AGN/096-5660-P	8.5-9.6	60	2.0	6	56.0	400	2:1	42	—	SP
AGN/096-5360-P	8.5-9.6	60	2.5	7	53.0	200	2:1	40	24 A	SP
AGN/096-5664-P	8.5-9.6	64	2.5	7	56.0	400	2:1	40	45 A	SP
AGN/098-5864-P	8.5-9.8	64	2.5	7	58.0	600	2:1	50	58 A	SP
AGN/098-6060-P	8.5-9.8	60	3.0	7	60.0	1000	2:1	50	116 A	SP
AGN/099-4652-P	9.0-9.9	52	2.0	6	46.0	40	2:1	30	7000	NDX14A
AGN/099-4957-P	9.0-9.9	57	2.0	6	49.0	80	2:1	30	13800	NQX14A
AGN/099-5260-P	9.0-9.9	60	2.0	6	52.0	160	2:1	30	27000	SP
AGN/100-5360-P	9.0-10.0	60	2.0	6	53.0	200	2:1	42	—	SP
AGN/100-5660-P	9.0-10.0	60	2.0	6	56.0	400	2:1	42	—	SP
AGN/105-4652-P	9.5-10.5	52	2.0	6	46.0	40	2:1	30	7000	NDX14A
AGN/105-4957-P	9.5-10.5	57	2.0	6	49.0	80	2:1	30	13800	NQX14A
AGN/105-5260-P	9.5-10.5	60	2.0	6	52.0	160	2:1	30	27000	SP
AGN/107-4652-P	9.9-10.7	52	2.0	6	46.0	40	2:1	30	7000	NDX14A
AGN/107-4957-P	9.9-10.7	57	2.0	6	49.0	80	2:1	30	13800	NQX14A
AGN/107-5260-P	9.9-10.7	60	2.0	6	52.0	160	2:1	30	27000	SP

**New Products** \*AGN-P pulse mode series amplifiers 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 500μS. Shorter response times are available, ie: 250μS or faster. Contact the factory. \*\*Exceeding 10% duty will damage the amplifier.