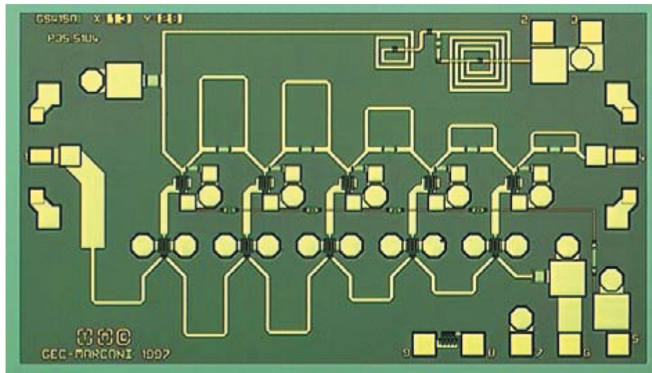
Data sheet

Bookham TECHNOLOGY

HEMT MMIC Low Noise Amplifier, 2 - 20GHz

The **P35-5104-000-200** and **P35-5104-000-301** are a high performance low noise 2 - 20GHz Gallium Arsenide monolithic travelling wave amplifiers. They are suitable for use in broadband communications, instrumentation and electronic warfare applications. The amplifiers require a supply of +3.5V and a first gate bias set to give 50% Idss. Gain is controlled by setting the second gain bias between the limits of -1V and +1V. An on chip diode is provided for temperature monitoring for automatic gain control.

The die is fabricated using Bookham's pHEMT process and is fully protected using Silicon Nitride passivation for excellent performance and reliability.



Features

- Cascode Configuration
- 10 dB Gain Typical (-200)
  10 dB Min (-301)
- pHEMT technology
- AGC control with gate bias
- Less than 4.0 dB noise figure
  2 - 18GHz

Electrical Performance

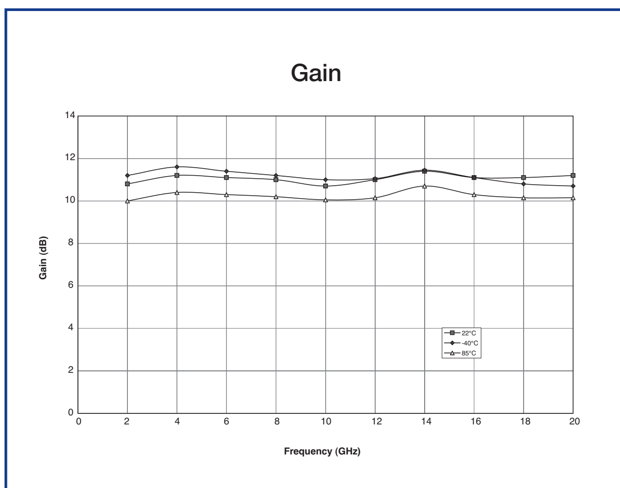
Ambient temperature = 22±3° C, Zo = 50Ω, Vdd = 3.5V, Vg1 set for Idd = 0.5 Idss, Vg2 = +1.0V

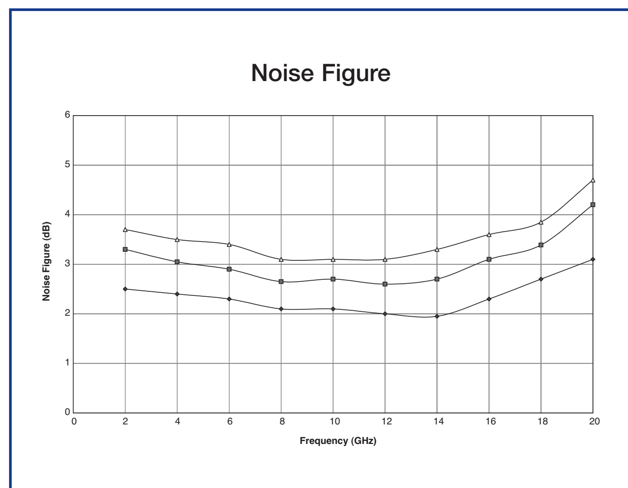
Parameter	Conditions	Min	Typ	Max	Units
Small signal gain (-200)	2GHz - 20GHz	8	10	-	dB
Small signal gain (-301)	2GHz - 20GHz	10	-	-	dB
Ripple on Gain slope	2GHz - 20GHz	-	0.6	±0.6	dB
Gain slope[2]	2GHz - 20GHz	-	+1	+1.5	dB
Input Return Loss	2GHz - 20GHz	9	12	-	dB
Output Return Loss	2GHz - 20GHz	9	15	-	dB
Output power at 1dB	10GHz	10	13	-	dBm
gain compression	18GHz `	7	8	-	dBm
Noise figure[1]	2GHz - 18GHz	-	-	4.0	dB
	18GHz - 20GHz	-	-	4.5	dB
IP3	10GHz	-	22	-	dBm
	18GHz	-	19	-	dBm
2nd Harmonic	Input Freq. = 9GHz	-	-25dBc	-	dBc
	Input Power = -18dBm				
Bias supply current (Idd)		-	70	110	mA

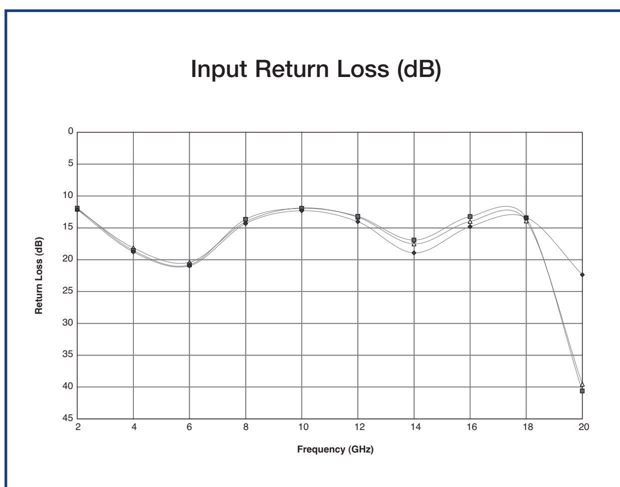
Notes

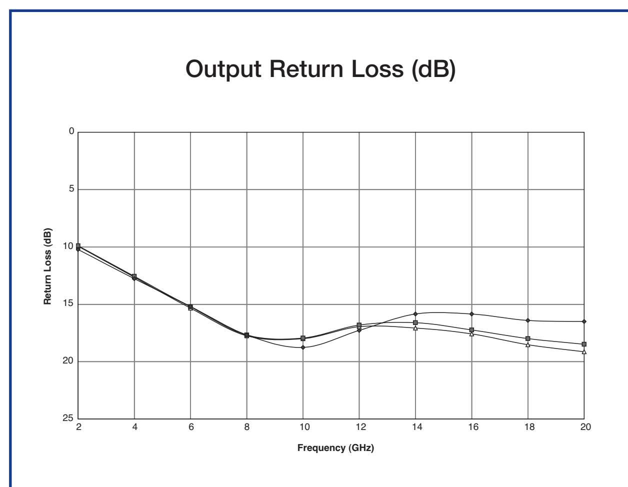
1. Noise Figure assumes inclusion of bond wire inductance at input
2. Least Squares Linear fit.

Typical RFOW Performance

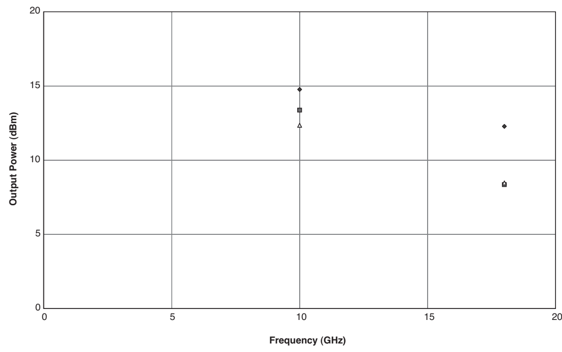




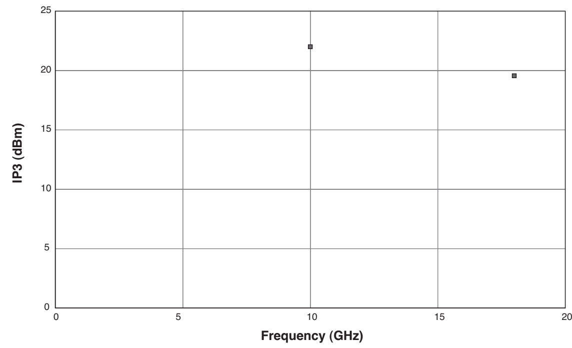




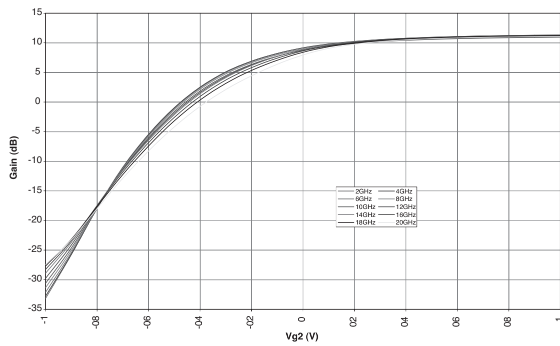
Output power at 1dB compression



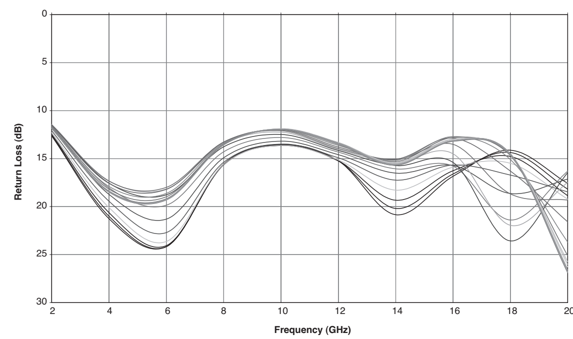
Third Intercept (dBm)



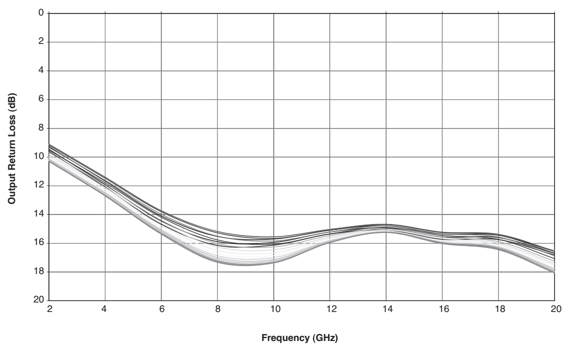
Gain +22° C
Vg2 - 1V to +1V step 0.1V



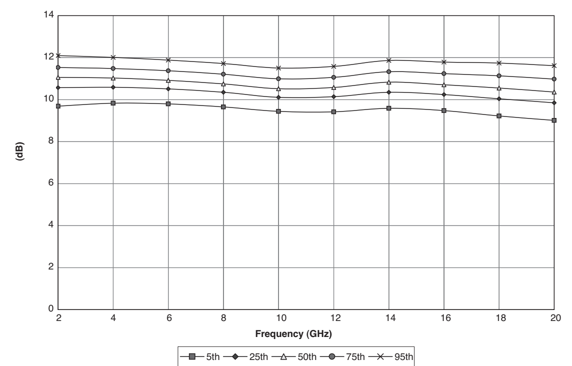
Input Return Loss (dB) +22° C
Vg2 - 1V to +1V step 0.1V

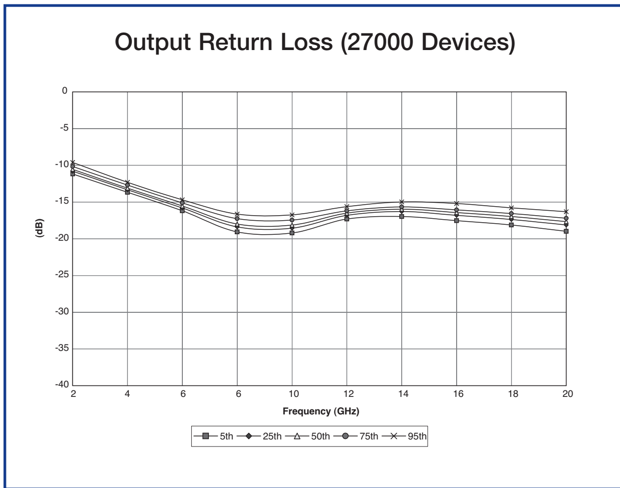


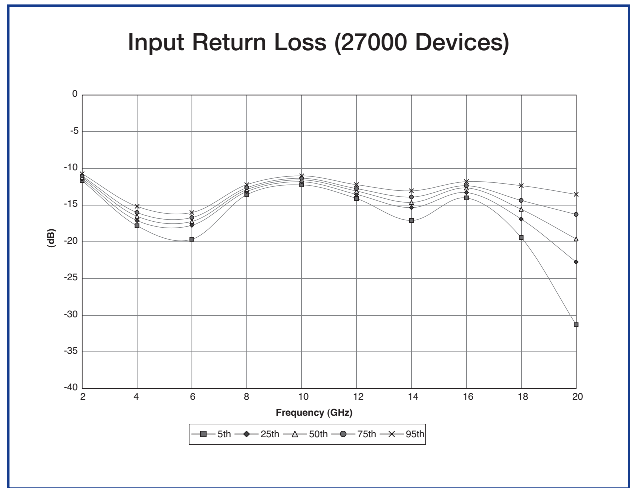
Output Return Loss (dB) +22° C
Vg2 - 1V to +1V step 0.1V



Gain (27000 Devices)



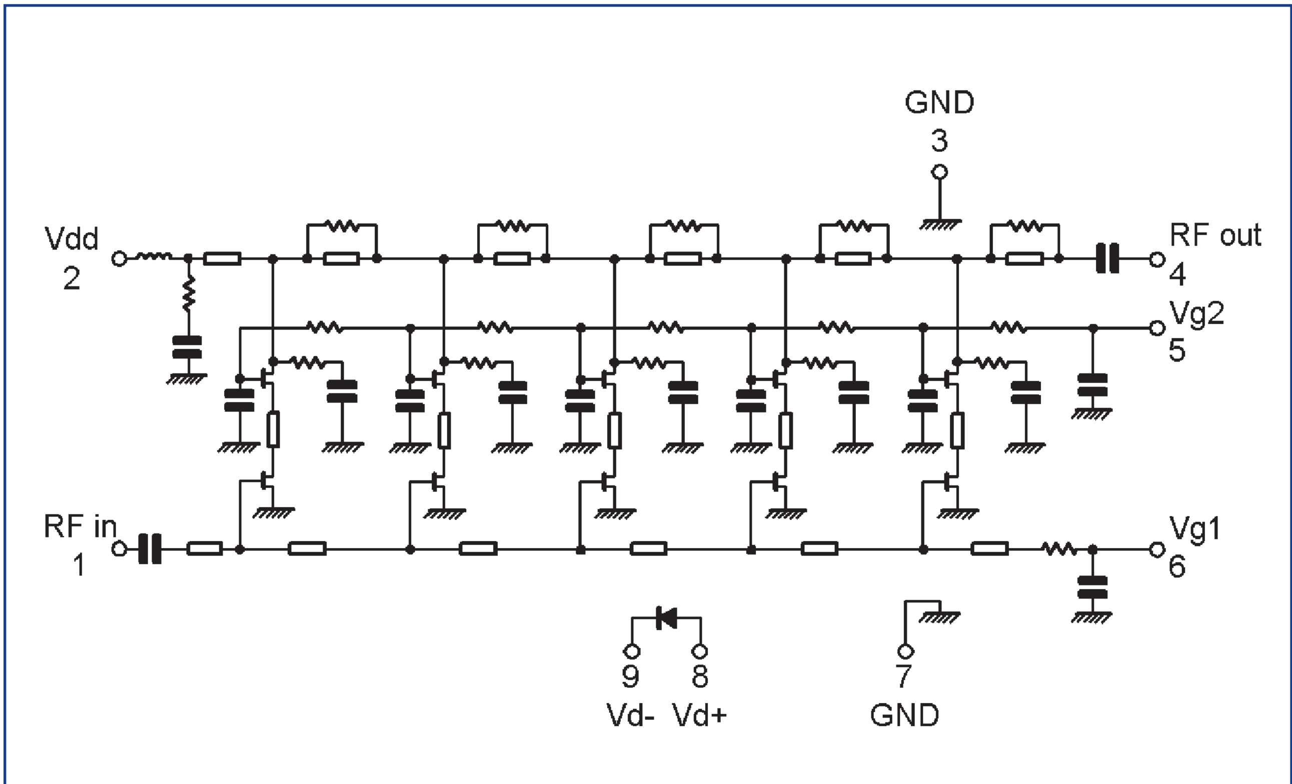




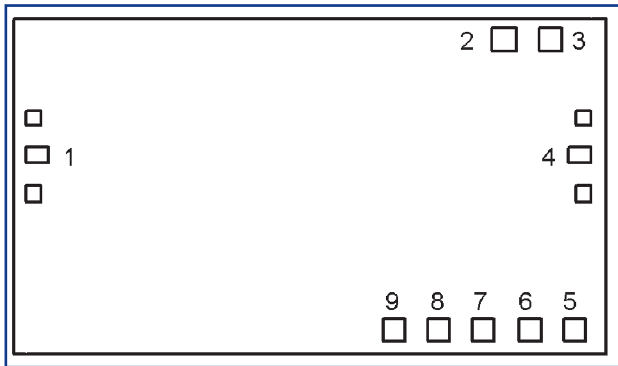
Gain Control

Parameter	Conditions	Min	Typ	Max	Units
Gain change at 10GHz	Vg2 = -0.5V	-	-7	-	dB
with respect to Vg2=0V	Vg2 = +1V	-	+2	-	dB
Gate voltage gain control range	Vg2	-1	-	+1	Volts

Electrical Schematic



Chip Outline



Die size	3.15 x 1.78mm
Bond pad size	120µm x 80µm
All oyther bond pads	120µm x 120µm
Die thickness:	100µm

Pad Details

Pad	Function
1	RF Input
2	Vdd
3	GND
4	RF Output
5	Vg2 (Gain control)
6	Vg1
7	GND
8	Diode Vd+
9	Diode Vd-

Handling and Assembly Information

Gallium Arsenide (GaAs) devices are susceptible to electrostatic and mechanical damage. Dice are supplied in antistatic containers, which should be opened in cleanroom conditions at an appropriately grounded anti-static workstation. Devices need careful handling using correctly designed collets, vacuum pickups or, with care, sharp tweezers.

GaAs Products from Caswell Technology's pHEMT Foundry process are 100 µm thick and have through GaAs vias to enable grounding to the circuit. Windows in the surface passivation above the bond pads are provided to allow wire bonding to the die.

The surface to which the die are to be attached should be cleaned with a proprietary de-greasing cleaner. Conductive epoxy mounting is recommended for the assembly of pHEMT circuits. Recommended epoxies are Ablestick 84-1LMI or 84-1LMIT cured at 150 °C for 1 hour in a nitrogen atmosphere. The epoxy should be applied sparingly to avoid encroachment of the epoxy on to the top surface of the die. An epoxy fillet should be visible around the total die periphery.

Eutectic mounting can also be used and entails the use of a gold-tin (AuSn) preform, approximately 0.001" thick, placed between the die and the attachment surface. The preferred method of mounting is the use of a machine such as a Mullins 8-140 die bonder. This utilises a heated collet and workstation with a facility for applying a scrubbing action to ensure total wetting and avoid the formation of voids. Dry nitrogen gas is directed across the work piece.

The gold-tin eutectic (80% Au 20% Sn) has a melting point of approximately 280 °C(Note: Gold Germanium with a higher melting temperature should be avoided, in particular for MMICs). The work station temperature should be 310 °C ± 10 °C. The collet should be heated, and the die pre-heated to avoid excessive thermal shock. The strength of the bonding formed by this method will result in fracture of the die, rather than the bond under die strength testing.

The P35-5104-000-200 amplifier die has gold bond pads. The recommended wire bonding procedure uses 25 µm (0.001") 99.99% pure gold wire with 0.5-2% elongation. Thermo-compression wedge bonding is preferred though thermosonic wire bonding may be used providing the ultrasonic content of the bond is minimised. A work station temperature of 260 °C ± 10 °C with a wedge tip temperature of 120 °C ± 10 °C is recommended. The wedge force should be 45 ± 5 grams. Bonds should be made from the bond pads on the die to the package or substrate.

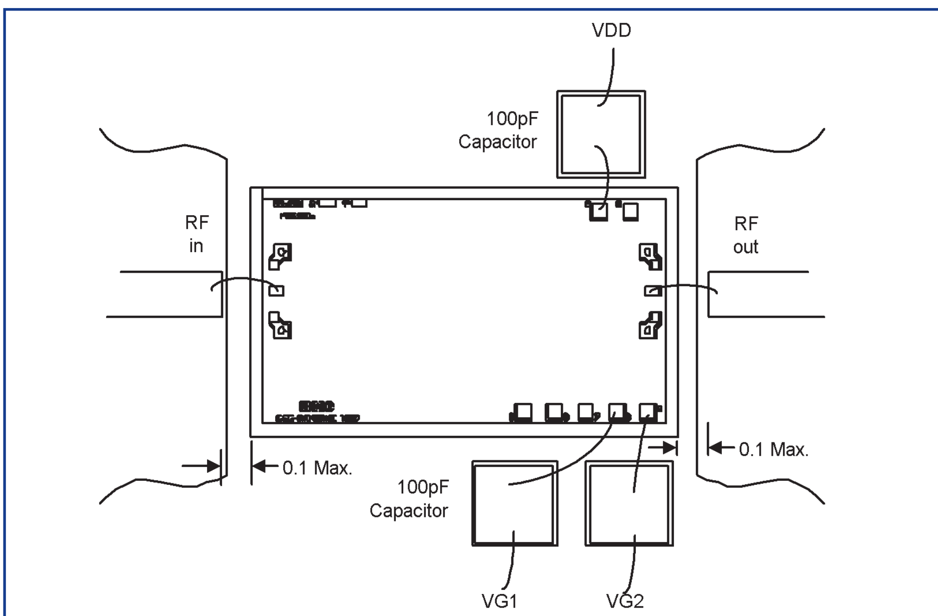
The RF bond pads at the input and output are 80 µm x 120 µm; all other bond pads are 120 µm x 120 µm.

The P35-5104-000-200 has been designed to include the inductance of a single 0.3mm length of 25 µm bond wire at both the input and output, facilitating the integration of the die into a 50 Ω environment. The design is tolerant to small changes in the length of these bondwires.

Operating and Biasing of the P35-5104-000-200 & P35-5104-000-301

The P35-5104-000-200 is a five-stage cascode travelling wave amplifier. The drain bias (Vdd) is common to all stages and should be set to 3.5 volts. The first gate voltage (Vg1) is adjusted to set Id at 50% of Idss with the second gate voltage (Vg2) set to +1 volt. Vg2 is then adjusted over the range -1 volt to +1 volt to achieve the desired gain setting. The maximum gain is for Vg2 = +1 volt. Typical current consumption will be in the range 60-80mA. DC bias supplies should be decoupled to ground using 100pF chip capacitors placed close to the chip with short bondwire to the amplifier bond pads.

Typical Bonding Detail



Absolute maximum Ratings

Max Vds	+5V @ Vgs = -2V
Max Vgs	-2V
Max I/P power	+13 dBm
Operating temperature	-55 °C to +125 °C
Storage temperature	-55 °C to +150 °C
Thermal resistance	25 °C/W

Ordering Information

P35-5104-000-200
P35-5104-000-301

MMICS

Bookham Technology plc
Caswell
Towcester
Northamptonshire
NN12 8EQ
UK

- **Tel: +44 (0) 1327 356 789**
- **Fax: +44 (0) 1327 356 698**

rfsales@bookham.com

Important Notice

Bookham Technology has a policy of continuous improvement. As a result certain parameters detailed on this flyer may be subject to change without notice. If you are interested in a particular product please request the product specification sheet, available from any RF sales representative.

22735

© Bookham Technology 2003 Bookham is a registered trademark of Bookham Technology plc