

## Low Noise and Medium Power GaAs FETs

### FEATURES

- Low Noise Figure: NF = 0.8 dB Typical at 12 GHz
- High Associated Gain: Ga = 10 dB Typical at 12 GHz
- High Dynamic Range: 1 dB Compression Power  $P_{-1}$  = 24.5 dBm at 12 GHz
- Breakdown Voltage:  $BV_{DGO} \geq 9$  V
- $L_g = 0.25 \mu\text{m}$ ,  $W_g = 600 \mu\text{m}$
- All-Gold Metallization for High Reliability
- Tight  $V_p$  ranges control
- High RF input power handling capability
- 100 % DC Tested

### PHOTO ENLARGEMENT



### DESCRIPTION

The TC1301 is a GaAs Pseudomorphic High Electron Mobility Transistor (PHEMT) chip, which has very low noise figure, high associated gain and high dynamic range. The device can be used in circuits up to 30 GHz and suitable for low noise and medium power amplifier applications including a wide range of commercial and military applications. All devices are 100% DC tested to assure consistent quality. All bond pads are gold plated for either thermo-compression or thermo-sonic wire bonding.

### ELECTRICAL SPECIFICATIONS ( $T_A=25^\circ\text{C}$ )

Symbol	Conditions	MIN	TYP	MAX	UNIT
NF	Noise Figure at $V_{DS} = 4$ V, $I_{DS} = 50$ mA, $f = 12$ GHz		0.8	1.0	dB
$G_a$	Associated Gain at $V_{DS} = 4$ V, $I_{DS} = 50$ mA, $f = 12$ GHz	9	10		dB
$P_{1dB}$	Output Power at 1dB Gain Compression Point, $f = 12$ GHz, $V_{DS} = 6$ V, $I_{DS} = 80$ mA	23.5	24.5		dBm
$G_L$	Linear Power Gain, $f = 12$ GHz, $V_{DS} = 6$ V, $I_{DS} = 80$ mA	9	10		dB
$I_{DSS}$	Saturated Drain-Source Current at $V_{DS} = 2$ V, $V_{GS} = 0$ V		180		mA
$g_m$	Transconductance at $V_{DS} = 2$ V, $V_{GS} = 0$ V		200		mS
$V_P$	Pinch-off Voltage at $V_{DS} = 2$ V, $I_D = 1.2$ mA		-1.0*		Volts
$BV_{DGO}$	Drain-Gate Breakdown Voltage at $I_{DGO} = 0.3$ mA	9	12		Volts
$R_{th}$	Thermal Resistance		60		$^\circ\text{C/W}$

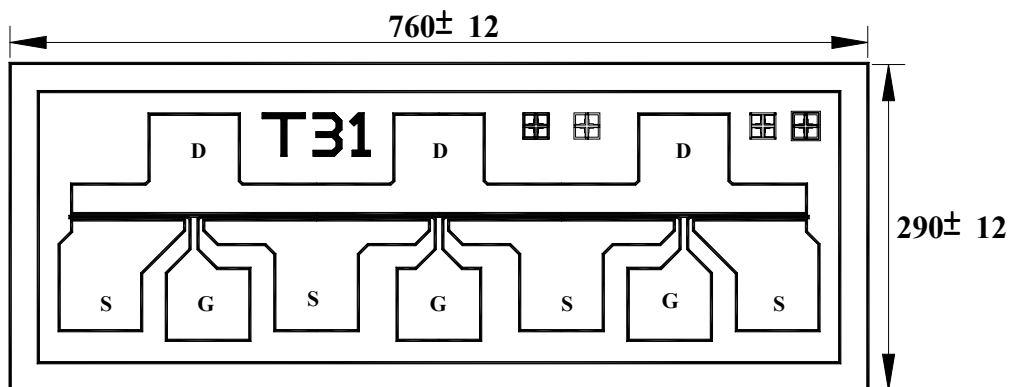
**Note:** \* For the tight control of the pinch-off voltage. TC1301's are divided into 3 groups:

- (1) **TC1301P0710** :  $V_p = -0.7$  V to  $-1.0$  V (2) **TC1301P0811** :  $V_p = -0.8$  V to  $-1.1$  V (3) **TC1301P0912** :  $V_p = -0.9$  V to  $-1.2$  V  
 In addition, the customers may specify their requirements.

**ABSOLUTE MAXIMUM RATINGS ( $T_A=25\text{ }^\circ\text{C}$ ) TYPICAL NOISE PARAMETERS ( $T_A=25\text{ }^\circ\text{C}$ )**
 $V_{DS} = 4\text{ V}, I_{DS} = 50\text{ mA}$ 

Symbol	Parameter	Rating
$V_{DS}$	Drain-Source Voltage	7.0 V
$V_{GS}$	Gate-Source Voltage	-3.0 V
$I_{DS}$	Drain Current	$I_{DSS}$
$I_{GS}$	Gate Current	600 $\mu\text{A}$
$P_{in}$	RF Input Power, CW	24 dBm
$P_T$	Continuous Dissipation	800 mW
$T_{CH}$	Channel Temperature	175 $^\circ\text{C}$
$T_{STG}$	Storage Temperature	- 65 $^\circ\text{C}$ to +175 $^\circ\text{C}$

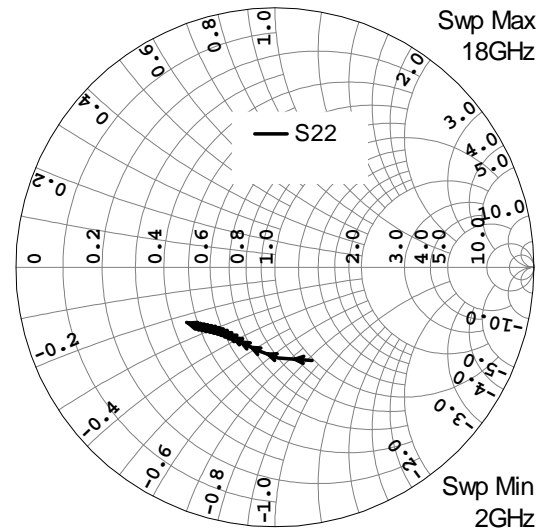
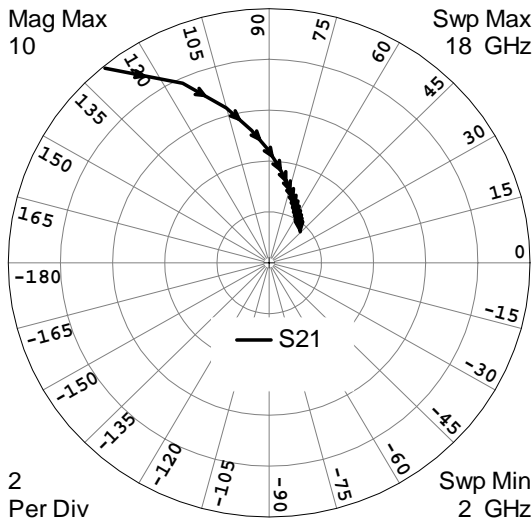
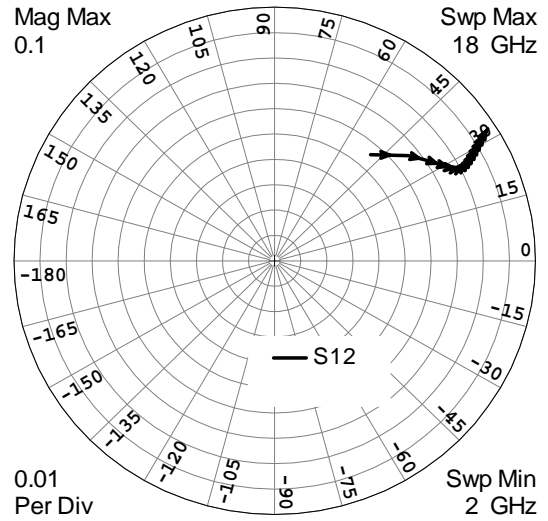
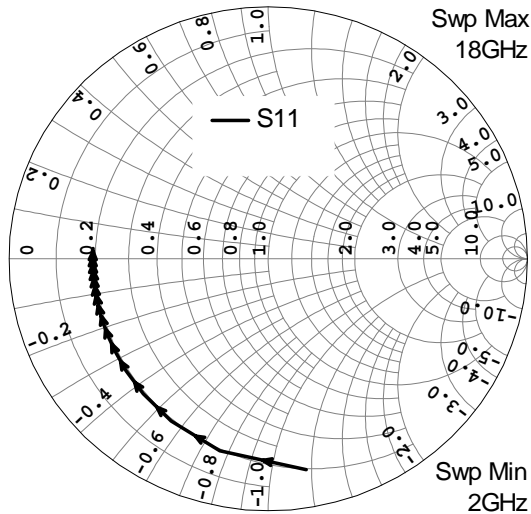
Frequency (GHz)	$NF_{opt}$ (dB)	$G_A$ (dB)	$\Gamma_{opt}$		Rn/50
			MAG	ANG	
2	0.36	19.7	0.88	15	0.28
4	0.48	16.6	0.74	39	0.18
6	0.59	14.3	0.62	64	0.15
8	0.70	12.7	0.55	92	0.12
10	0.78	11.7	0.50	120	0.09
12	0.85	10.9	0.49	148	0.06
14	0.98	10.4	0.50	174	0.04
16	1.12	9.8	0.51	-162	0.04
18	1.27	9.0	0.54	-141	0.07

**CHIP DIMENSIONS**


Chip Thickness: 100

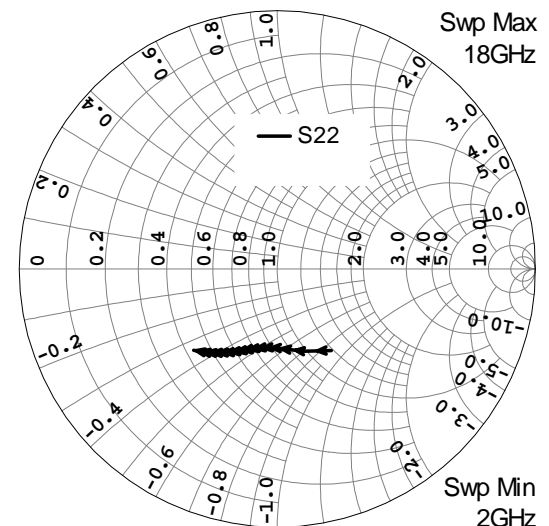
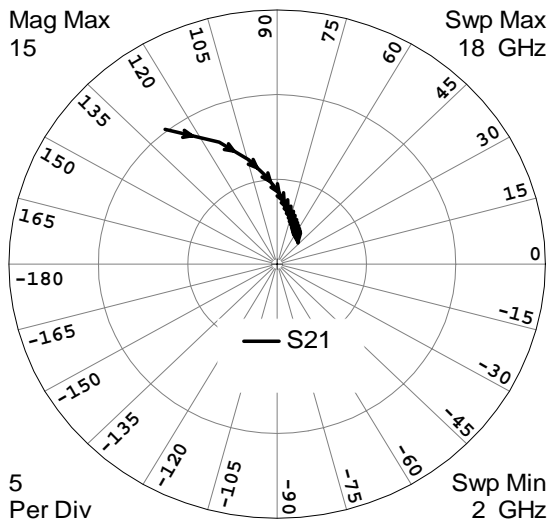
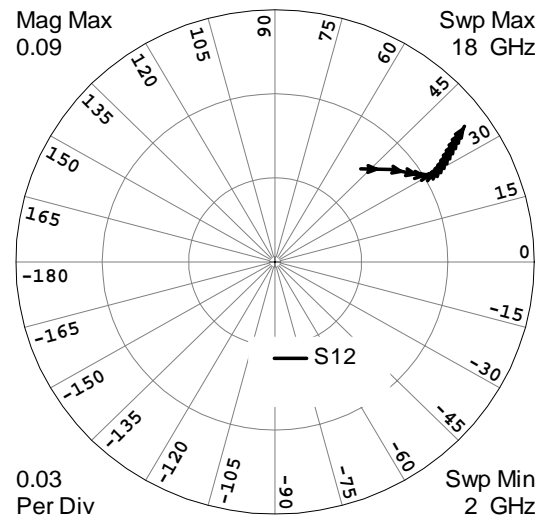
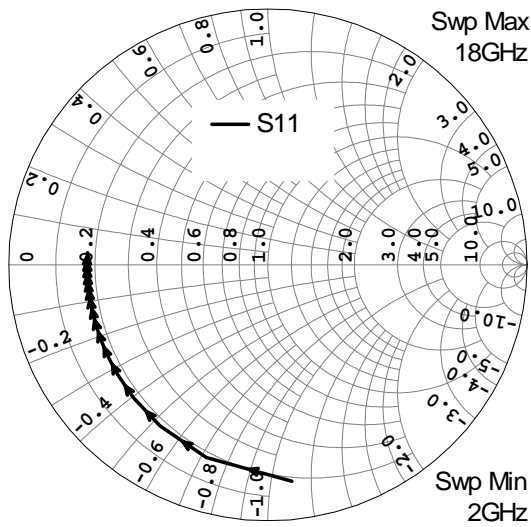
Drain Pad: 80 x 70

Source Pad: 75 x 80

**TYPICAL SCATTERING PARAMETERS (T<sub>A</sub>=25 °C) V<sub>DS</sub> = 4 V, I<sub>DS</sub> = 50 mA**


FREQUENCY (GHz)	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
2	0.8504	-80.07	9.9111	129.43	0.0557	48.67	0.3868	-68.29
3	0.7843	-103.76	7.8038	115.14	0.0659	38.99	0.3487	-88.15
4	0.7445	-120.17	6.3123	105.04	0.0713	33.48	0.3277	-101.61
5	0.7206	-132.00	5.2595	97.31	0.0745	30.31	0.3178	-111.02
6	0.7058	-140.93	4.4944	91.01	0.0767	28.54	0.3147	-117.84
7	0.6961	-147.93	3.9201	85.60	0.0785	27.63	0.3159	-122.98
8	0.6897	-153.62	3.4764	80.80	0.0800	27.27	0.3198	-127.02
9	0.6853	-158.39	3.1248	76.43	0.0814	27.29	0.3256	-130.30
10	0.6822	-162.46	2.8405	72.38	0.0828	27.56	0.3327	-133.08
11	0.6800	-166.03	2.6065	68.56	0.0843	28.01	0.3406	-135.50
12	0.6785	-169.21	2.4110	64.93	0.0858	28.56	0.3490	-137.67
13	0.6776	-172.07	2.2456	61.46	0.0875	29.19	0.3577	-139.65
14	0.6769	-174.69	2.1042	58.11	0.0892	29.86	0.3667	-141.49
15	0.6766	-177.11	1.9821	54.87	0.0910	30.55	0.3756	-143.23
16	0.6765	-179.36	1.8759	51.72	0.0928	31.23	0.3845	-144.89
17	0.6766	-178.52	1.7827	48.65	0.0948	31.89	0.3933	-146.47
18	0.6768	-176.52	1.7005	45.65	0.0969	32.53	0.4020	-148.00

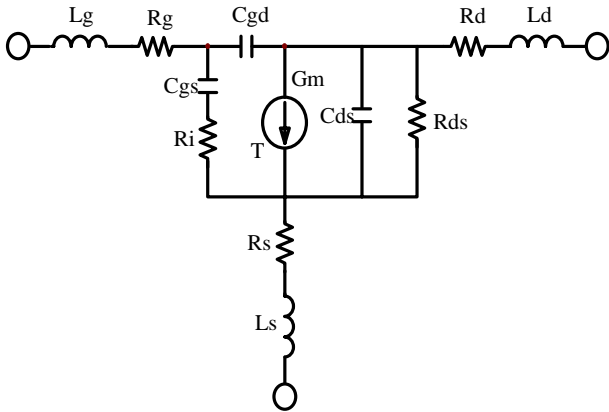
\* The data does not include gate, drain and source bond wires.

**TYPICAL SCATTERING PARAMETERS** ( $T_A=25\text{ }^\circ\text{C}$ )  $V_{DS} = 6\text{ V}$ ,  $I_{DS} = 80\text{ mA}$ 


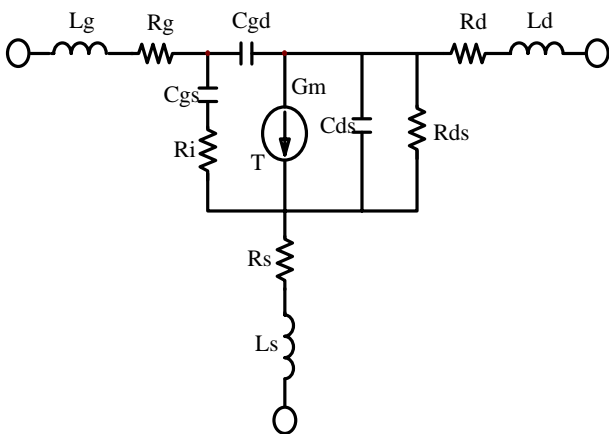
FREQUENCY (GHz)	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
2	0.8511	-83.76	10.1160	128.27	0.0446	48.15	0.3787	-56.54
3	0.7902	-107.47	7.8891	114.27	0.0523	39.06	0.3349	-72.15
4	0.7549	-123.54	6.3492	104.51	0.0564	34.17	0.3133	-82.94
5	0.7342	-134.97	5.2766	97.09	0.0590	31.58	0.3059	-90.91
6	0.7214	-143.52	4.5034	91.05	0.0609	30.31	0.3072	-97.18
7	0.7133	-150.20	3.9260	85.88	0.0626	29.84	0.3138	-102.35
8	0.7078	-155.61	3.4814	81.28	0.0641	29.86	0.3237	-106.81
9	0.7041	-160.12	3.1301	77.07	0.0655	30.19	0.3356	-110.76
10	0.7015	-163.98	2.8465	73.16	0.0671	30.73	0.3485	-114.34
11	0.6998	-167.36	2.6134	69.46	0.0686	31.38	0.3620	-117.64
12	0.6986	-170.36	2.4188	65.92	0.0703	32.10	0.3757	-120.71
13	0.6978	-173.08	2.2542	62.52	0.0720	32.85	0.3893	-123.59
14	0.6973	-175.55	2.1134	59.23	0.0738	33.60	0.4027	-126.31
15	0.6971	-177.85	1.9919	56.03	0.0756	34.33	0.4157	-128.89
16	0.6971	-179.98	1.8860	52.90	0.0775	35.03	0.4283	-131.35
17	0.6973	-178.01	1.7930	49.83	0.0795	35.70	0.4404	-133.69
18	0.6976	-176.11	1.7109	46.82	0.0816	36.32	0.4520	-135.92

\*The data does not include gate, drain and source bond wires.

**SMALL SIGNAL MODEL,  $V_{DS} = 4\text{ V}$ ,  $I_{DS} = 50\text{ mA}$**

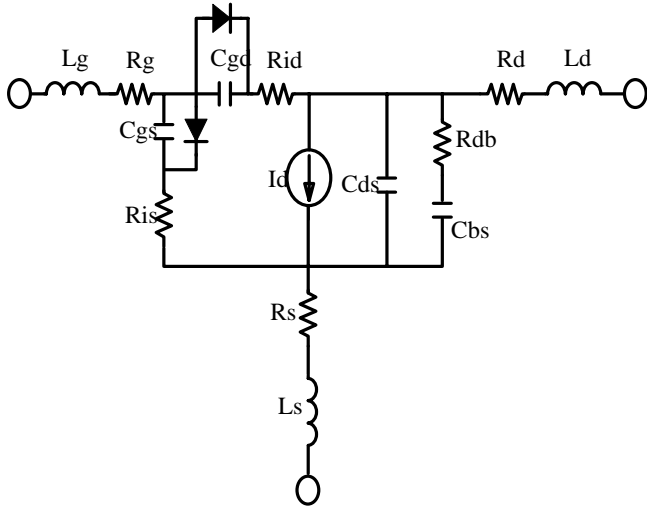
**SCHEMATI**

**PARAMETERS**

<b>Lg</b>	0.057 nH	<b>Rs</b>	1.66 Ohm
<b>Rg</b>	2.08 Ohm	<b>Ls</b>	0.019 nH
<b>Cgs</b>	0.959 pF	<b>Cds</b>	0.167 pF
<b>Ri</b>	5.78 Ohm	<b>Rds</b>	93.2 Ohm
<b>Cgd</b>	0.074 pF	<b>Rd</b>	1.358 Ohm
<b>Gm</b>	284.0 mS	<b>Ld</b>	0.038 nH
<b>T</b>	5.54 psec		

**SMALL SIGNAL MODEL,  $V_{DS} = 6\text{ V}$ ,  $I_{DS} = 80\text{ mA}$** 
**SCHEMATI**

**PARAMETERS**

<b>Lg</b>	0.056 nH	<b>Rs</b>	1.808 Ohm
<b>Rg</b>	1.954 Ohm	<b>Ls</b>	0.016 nH
<b>Cgs</b>	1.33 pF	<b>Cds</b>	0.185 pF
<b>Ri</b>	5.58 Ohm	<b>Rds</b>	90.1 Ohm
<b>Cgd</b>	0.052 pF	<b>Rd</b>	1.422 Ohm
<b>Gm</b>	315 mS	<b>Ld</b>	0.036 nH
<b>T</b>	5.63 psec		

**LARGE SIGNAL MODEL,  $V_{DS} = 6\text{ V}$ ,  $I_{DS} = 80\text{ mA}$**

**SCHEMATIC**

**TOM2 MODEL PARAMETERS**

Parameters		Parameters	
VTO	-0.43283 V	VMAX	0.5 V
ALPHA	9.54	CGD	0.0554 pF
BETA	0.49	CGS	6.018 pF
GAMMA	0.0416	CDS	0.1599 pF
DELTA	0.3091	RIS	5.755 Ohm
Q	0.84	RID	0.001 Ohm
NG	0.1	VBR	9 V
ND	0.01	RDB	94.333 Ohm
TAU	5.558 ps	CBS	0.0463 pF
RG	2.0833 Ohm	TNOM	25 °C
RD	1.358 Ohm	LS	0.01893 nH
RS	1.662 Ohm	LG	0.0576 nH
IS	1E-11 mA	LD	0.038 nH
N	1	AFAC	1
VBI	1 V	NFING	1
VDELTA	0.2 V		

**CHIP HANDLING**

**DIE ATTACHMENT:** Conductive epoxy or eutectic die attach is recommended. Eutectic die attach can be accomplished with Au-Sn (80% Au-20% Sn) perform at stage temperature: 290°C ± 5°C; Handling Tool: Tweezers; Time: less than 1min.

**WIRE BONDING:** The recommended wire bond method is thermocompression bonding with 0.7 to 1.0 mil (0.018 to 0.025 mm) gold wire. Stage temperature: 220°C to 250°C; Bond Tip Temperature: 150°C; Bond Force: 20 to 30 gms depending on size of wire and Bond Tip Temperature.

**HANDLING PRECAUTIONS:** The user must operate in a clean, dry environment. Care should be exercised during handling avoid damage to the devices. Electrostatic Discharge (ESD) precautions should be observed at all stages of storage, handling, assembly, and testing. The static discharge must be less than 300V.