

# CF004 Series GaAs Pseudomorphic HEMT and MESFET Chips

- ❑ Super Low Noise: 1.5 dB at 18 GHz
- ❑ High Gain: Usable to 44 GHz
- ❑ Flat Gain for Distributed Amplifiers
- ❑ Active Layers Include:  
Pseudomorphic HEMT, Epitaxial  
and Ion Implanted
- ❑ Wafer Qualification Procedure
- ❑ Customer Wafer Selection Available

## Celeritek CF004 Series Chips

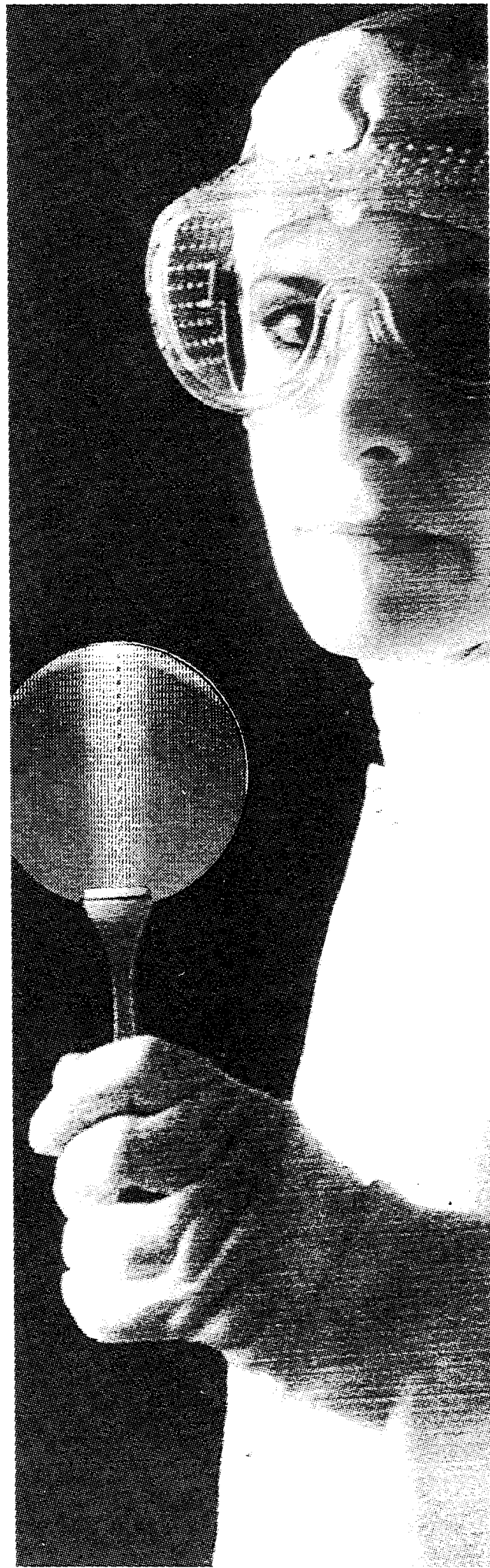
Celeritek CF004 Series chips are GaAs based transistors which include the CF004-01, CF004-02 and CF004-03 models. They are 150  $\mu\text{m}$  gate width, sub-half-micron gate length GaAs devices with Celeritek's proprietary Silicon Nitride passivation.

Celeritek's Wafer Qualification Procedure for CF004 Series FETs consists of DC, RF and reliability testing of both individual die and generic 6 to 18 GHz amplifier modules.

The CF004-01 provides unusually high gain in narrow- and wide-band applications up to 40 GHz. For example, 9 dB of gain is achievable in a 6 to 18 GHz balanced amplifier circuit; 5 dB of gain can be realized in an 18 to 40 GHz circuit.

The CF004-03 model is Celeritek's state-of-the-art GaAs Pseudomorphic HEMT device. It provides the lowest noise and highest gain attainable above 18 GHz. Its rugged construction allows it to withstand the same input power as conventional MESFETs.

All CF004 Series devices exhibit extraordinarily flat  $S_{21}$  vs frequency making them excellent for distributed amplifier circuits. These devices are available in chip form and are suitable for airborne, shipboard and ground-based equipment. Screening includes MIL-STD-750 Class B, Class S and commercial screening.



# CELERITEK

# CF004 Series GaAs Chips

Specifications ( $T_A = 25^\circ\text{C}$ )				CF004-01			CF004-02			CF004-03		
Active Layer				Ion Implanted			Epitaxial			Pseudomorphic HEMT		
Symbol	Parameters and Conditions	Frequency (GHz)	Units	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max
$NF_{opt}$	Optimum Noise Figure $V_{DS} = 3.0\text{ V}, I_{DS} = 10\text{ mA}$	18.0	dB		2.2	3.0		1.8	2.4		1.5	2.0
<b>Ga</b>	Gain at $NF_{opt}$ $V_{DS} = 3.0\text{ V}, I_{DS} = 10\text{ mA}$	18.0	dB	7.0	8.0		8.0	9.0		9.0	10.0	
$ S_{21} ^2$	50 Ohm Insertion Gain $V_{DS} = 6.0\text{ V}, I_{DS} = 25\text{ mA}$	2.0	dB		8.0			9.0			10.0	
		10.0	dB		8.0			9.0			10.0	
		18.0	dB		7.0			8.0			9.0	
		26.0	dB		3.0			4.0			5.0	
$P_{1dB}$	Power Output @ 1 dB GC $V_{DS} = 6.0\text{ V}, I_{DS} = 25\text{ mA}$	12.0	dBm		15.0			13.0			13.0	
$g_m$	Transconductance $V_{DS} = 3.0\text{ V}, V_{GS} = 0\text{ V}$		mS		30			40			45	
$I_{DSS}$	Drain Current $V_{DS} = 3.0\text{ V}, V_{GS} = 0\text{ V}$		mA	20	30	60	15	30	60	15	30	60
$V_p$	Pinchoff Voltage $V_{DS} = 3.0\text{ V}, I_{DS} = 1\text{ mA}$		Volts	-0.7	-1.3	-2.5	-0.5	-1.3	-2.5	-0.5	-1.3	-2.5
$BV_{GD}$	Breakdown Voltage, Gate-Drain $I_{GD} = 100\text{ }\mu\text{A}$		Volts	-5.5	-8.0		-5.5	-8.0		-5.5	-8.0	
$R_{th}$	Thermal Resistance		$^\circ\text{C/W}$		300			300			300	

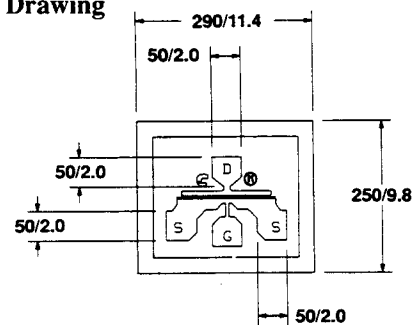
## Absolute Maximum Ratings

Parameter	Symbol	Ratings
Drain-Source Voltage	$V_{DS}$	8V
Gate-Source Voltage	$V_{GS}$	-5V
Drain Current	$I_{DS}$	$I_{DSS}$
Continuous Dissipation	$P_T$	400 mW
Channel Temperature	$T_{CH}$	175 $^\circ\text{C}$
Storage Temperature	$T_{STG}$	-65 $^\circ\text{C}$ to +175 $^\circ\text{C}$

## Typical Noise Parameters - CF004-03 $V_{DS} = 3.0\text{ V}, I_{DS} = 10\text{ mA}$

Frequency (GHz)	NF opt (dB)	Ga (dB)	Gamma opt (Mag)	Gamma opt (Ang)	Rn/50
2.0	0.44	18.9	0.94	4	1.60
4.0	0.55	16.7	0.86	9	1.10
6.0	0.67	14.9	0.78	17	0.81
8.0	0.80	13.6	0.72	28	0.64
10.0	0.93	12.5	0.66	41	0.54
12.0	1.08	11.8	0.60	52	0.46
14.0	1.23	11.1	0.53	62	0.39
16.0	1.40	10.6	0.43	72	0.32
18.0	1.57	10.1	0.32	86	0.25
20.0	1.75	9.6	0.22	110	0.20
22.0	1.94	9.0	0.16	146	0.17
24.0	2.14	8.3	0.19	-171	0.17
26.0	2.35	7.4	0.26	-152	0.19

## Chip Outline Drawing



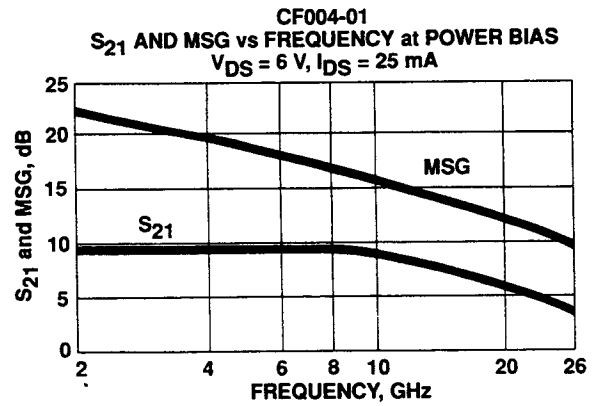
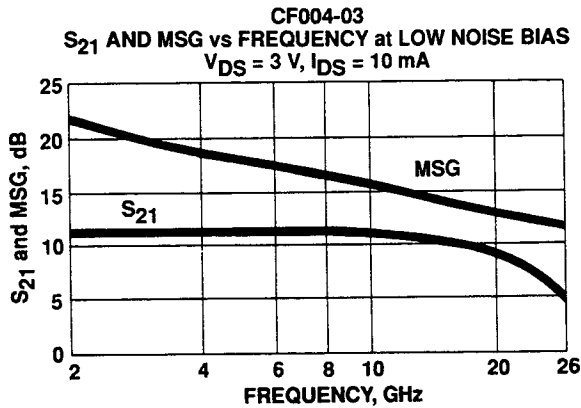
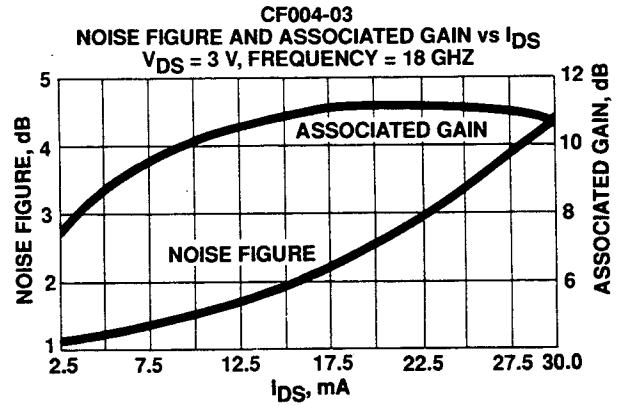
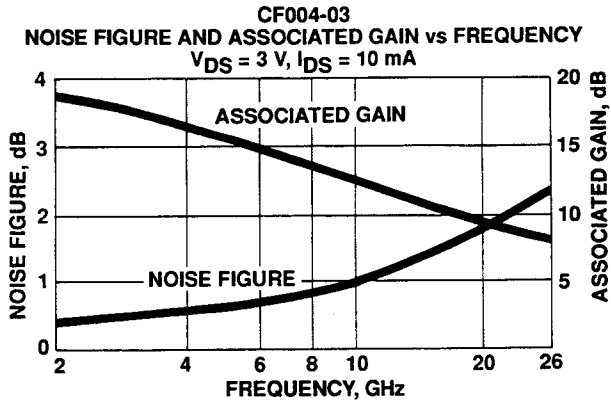
CF004 CHIP (UNITS IN MICRONS/MILS)  
THICKNESS: 110 MICRONS/4.3 MILS

## Die Attach and Bonding Procedures

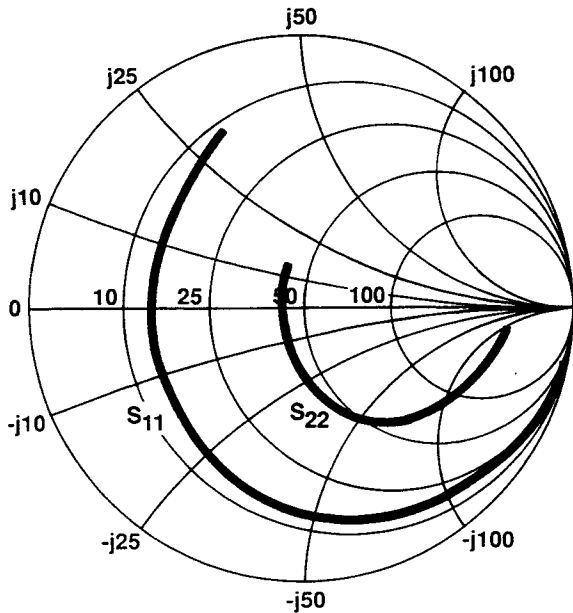
**Die Attach:** Conductive epoxy or eutectic die attach is recommended. For eutectic die attach: Preform: AuSn (80% Au, 20% Sn); Stage Temperature: 290 $^\circ\text{C}$ ,  $\pm 5^\circ\text{C}$ ; Handling Tool: Tweezers; Time: 1 min or less.

**Wire Bonding:** Wire Size: 0.7 to 1.0 mil in diameter (pre-stressed); Thermocompression bonding is preferred over thermosonic bonding. For thermocompression bonding: Stage Temperature: 250 $^\circ\text{C}$ ; Bond Tip Temperature: 150 $^\circ\text{C}$ ; Bonding Tip Pressure: 18 to 40 gms depending on size of wire.

## Typical Performance ( $T_A = 25^\circ\text{C}$ )

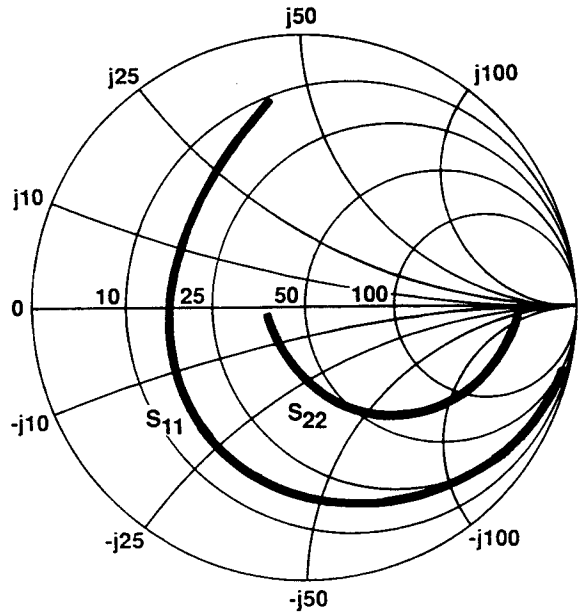


**CF004-03**  
 $S_{11}$  AND  $S_{22}$  vs FREQUENCY at LOW NOISE BIAS  
 $V_{DS} = 3\text{ V}, I_{DS} = 10\text{ mA}$



FREQUENCY 2.0 to 26.0 GHz

**CF004-01**  
 $S_{11}$  AND  $S_{22}$  vs FREQUENCY at POWER BIAS  
 $V_{DS} = 6\text{ V}, I_{DS} = 25\text{ mA}$



FREQUENCY 2.0 to 26.0 GHz

# CF004 Series GaAs Chips

Typical Scattering Parameters, Common Source (S-Parameters Include Bonding Wire Parasitics)

CF004-01 at Power Bias

$V_{DS} = 6\text{ V}$ ,  $I_{DS} = 25\text{ mA}$

Frequency (GHz)	$S_{11}$		$S_{21}$		$S_{12}$		$S_{22}$		K	MSG (dB)		
	(Mag)	(Ang)	(dB)	(Mag)	(Ang)	(dB)	(Mag)	(Ang)				
2.0	0.97	-14	9.5	2.99	156	-35.3	0.02	78	0.77	-2	0.39	22.4
4.0	0.93	-30	9.7	3.04	150	-29.4	0.03	76	0.76	-7	0.43	19.5
6.0	0.86	-49	9.5	3.00	133	-26.2	0.05	67	0.75	-13	0.57	17.9
8.0	0.77	-73	9.4	2.97	114	-24.2	0.06	58	0.70	-21	0.70	16.8
10.0	0.67	-97	8.9	2.78	95	-23.4	0.07	43	0.65	-30	0.99	16.1
12.0	0.61	-120	8.4	2.62	78	-22.1	0.08	39	0.62	-40	1.00	15.2
14.0	0.55	-142	7.9	2.48	62	-21.3	0.09	34	0.60	-48	1.07	14.6
16.0	0.49	-168	7.5	2.36	47	-20.5	0.09	27	0.57	-54	1.15	14.0
18.0	0.49	157	7.0	2.24	30	-19.3	0.11	19	0.50	-61	1.12	13.1
20.0	0.55	125	6.2	2.05	12	-18.1	0.13	8	0.42	-68	1.06	12.2
22.0	0.66	109	5.1	1.79	-4	-18.1	0.13	1	0.29	-80	1.10	11.6
24.0	0.72	101	3.9	1.56	-17	-17.3	0.14	1	0.18	-105	1.08	10.6
26.0	0.78	98	2.8	1.38	-29	-16.4	0.15	-6	0.14	-164	0.95	9.6

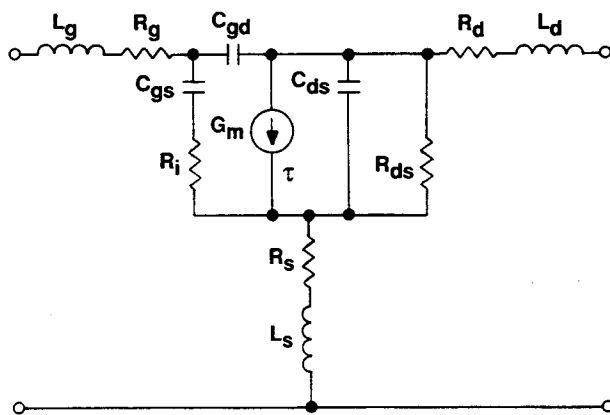
CF004-03 at Low Noise Bias

$V_{DS} = 3\text{ V}$ ,  $I_{DS} = 10\text{ mA}$

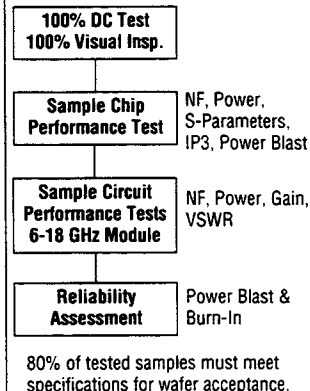
Frequency (GHz)	$S_{11}$		$S_{21}$		$S_{12}$		$S_{22}$		K	MSG (dB)		
	(Mag)	(Ang)	(dB)	(Mag)	(Ang)	(dB)	(Mag)	(Ang)				
2.0	0.98	-13	11.2	3.62	165	-32.8	0.02	82	0.76	-5	0.23	22.0
4.0	0.94	-26	11.1	3.60	153	-27.0	0.05	74	0.74	-11	0.31	19.1
6.0	0.90	-42	11.0	3.54	138	-23.8	0.06	65	0.71	-19	0.39	17.4
8.0	0.85	-61	11.0	3.53	122	-21.6	0.08	52	0.65	-30	0.47	16.3
10.0	0.77	-80	10.5	3.36	106	-20.5	0.09	37	0.59	-42	0.63	15.5
12.0	0.72	-97	10.2	3.25	91	-19.1	0.11	29	0.56	-54	0.63	14.7
14.0	0.66	-113	10.0	3.18	77	-18.3	0.12	20	0.53	-63	0.70	14.2
16.0	0.59	-136	10.0	3.15	63	-17.4	0.14	8	0.47	-71	0.77	13.7
18.0	0.55	-171	9.8	3.10	45	-16.2	0.16	-4	0.35	-82	0.80	13.0
20.0	0.57	149	9.2	2.89	24	-15.6	0.17	-17	0.20	-89	0.85	12.4
22.0	0.65	123	7.6	2.40	7	-15.9	0.16	-29	0.04	-131	0.93	11.7
24.0	0.68	112	5.9	1.97	-5	-16.5	0.15	-32	0.09	110	1.06	11.2
26.0	0.72	111	4.9	1.76	-13	-16.4	0.15	-35	0.18	111	1.02	10.7

## Device Model

Parameters	CF004-01 $V_{DS} = 6\text{ V}$ , $I_{DS} = 25\text{ mA}$	CF004-03 $V_{DS} = 3\text{ V}$ , $I_{DS} = 10\text{ mA}$	Units
$L_g$	0.41	0.36	nH
$R_g$	2.0	2.0	$\Omega$
$C_{gs}$	0.21	0.14	pF
$R_i$	6.6	2.5	$\Omega$
$C_{gd}$	0.013	0.019	pF
$G_m$	38	45	mS
$\tau$	2.2	2.1	ps
$C_{ds}$	0.060	0.060	pF
$R_{ds}$	357	359	$\Omega$
$R_d$	2.7	2.7	$\Omega$
$L_d$	0.37	0.33	nH
$R_s$	3.0	2.7	$\Omega$
$L_s$	0.08	0.08	nH



## Wafer Qualification Procedure



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Specifications subject to change.

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