HARRIS SEMICONDUCTOR

HFA3102

August 1994

Dual Long-Tailed Pair Transistor Array

Features

- **High Gain-Bandwidth Product (f_T) 10GHz**
- **High Power Gain-Bandwidth Product 5GHz**
- **High Current Gain (h_{FE}) 70**
- **Noise Figure (Transistor) 3.5dB**
- **Low Collector Leakage Current . . . . . <0.01nA**
- **Excellent h_{FE} and V_{BE} Matching**
- **Pin-to-Pin to UPA102G**

Applications

- **Single Balanced Mixers**
- **Wide Band Amplification Stages**
- **Differential Amplifiers**
- **Multipliers**
- **Automatic Gain Control Circuits**
- **Frequency Doublers, Tripplers**
- **Oscillators**
- **Constant Current Sources**
- **Wireless Communication Systems**
- **Radio and Satellite Communications**
- **Fiber Optic Signal Processing**
- **High Performance Instrumentation**

Description

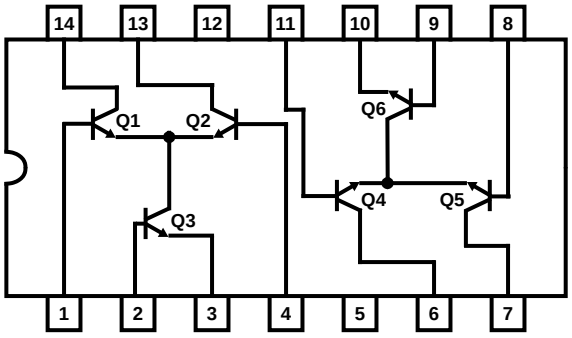
The HFA3102 is an all NPN transistor array configured as dual differential amplifiers with tail transistors. Based on Harris bonded wafer UHF-1 SOI process, this array achieves very high f_T (10GHz) while maintaining excellent h_{FE} and V_{BE} matching characteristics over temperature. Collector leakage currents are maintained to under 0.01nA.

Ordering Information

PART NUMBER	PRODUCT DESCRIPTION
HFA3102Y	Die
HFA3102B	14 Lead Plastic SOIC (N)
HFA3102B96	14 Lead Plastic SOIC (N) - Tape and Reel

Pinout/Functional Diagram

HFA3102
TOP VIEW



File Number **3635.1**

Absolute Maximum Ratings

V_{CEO} Collector to Emitter Voltage 8.0V
V_{CBO} Collector to Base Voltage 12.0V
V_{EBO} Emitterr to Base Voltage 12.0V
I_C, Collector Current 30mA
T_{STG}, Storage Temperature Range . . . . . -65^oC to $+150^oC$
Operating Temperature Range . . . . . -40^oC to $+85^oC$
T_J, Junction Temperature (Die) . . . . . $+175^oC$
T_J, Junction Temperature (Plastic Package) . . . . . $+150^oC$
Lead Temperature (Soldering 10s) . . . . . $+300^oC$
(Lead Tips Only)

Thermal Information

Thermal Resistance θ_{JA}
Plastic SOIC Package . . . . . $125^oC/W$
Maximum Package Power Dissipation at $+75^oC$
Any One Transistor 0.25W
Plastic SOIC Package 0.6W
Derating Factor Above $+75^oC$
Plastic SOIC Package . . . . . $8mW/^oC$

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

Electrical Specifications at $+25^oC$

SYMBOLS	PARAMETER	TEST CONDITIONS	TEST LEVEL	ALL GRADES			UNITS
				MIN	TYP	MAX	
$V_{(BR)CBO}$	Collector-to-Base Breakdown Voltage (Q_1, Q_2, Q_4, and Q_5)	I_C = 100µA, I_E = 0	A	12	18	-	V
$V_{(BR)CEO}$	Collector-to-Emitter Breakdown Voltage (Q_1 thru Q_6)	I_C = 100µA, I_B = 0	A	8	12	-	V
$V_{(BR)EBO}$	Emitter-to-Base Breakdown Voltage (Q_3 and Q_6)	I_E = 50µA, I_C = 0	A	5.5	6	-	V
I_{CBO}	Collector Cutoff Current (Q_1, Q_2, Q_4, and Q_5)	V_{CB} = 5V, I_E = 0	A	-	0.1	10	nA
I_{EBO}	Emitter Cutoff Current (Q_3 and Q_6)	V_{EB} = 1V, I_C = 0	A	-	-	100	nA
h_{FE}	DC Current Gain (Q_1 thru Q_6)	I_C = 10mA, V_{CE} = 3 V	A	40	70	-	-
C_{CB}	Collector-to-Base Capacitance	V_{CB} = 5V, f = 1MHz	B	-	300	-	fF
C_{EB}	Emitter-to-Base Capacitance	V_{EB} = 0, f = 1MHz	B	-	200	-	fF
f_T	Current Gain-Bandwidth Product	I_C = 10mA, V_{CE} = 5V	C	-	10	-	GHz
f_{MAX}	Power Gain-Bandwidth Product	I_C = 10mA, V_{CE} = 5V	C	-	5	-	GHz
G_{NFMIN}	Available Gain at Minimum Noise Figure	I_C = 3mA, V_{CE} = 3	C	-	-	-	-
		f = 0.5GHz	-	-	17.5	-	dB
		f = 1.0GHz	-	-	12.4	-	-
NF_{MIN}	Minimum Noise Figure	I_C = 3mA, V_{CE} = 3V	C	-	-	-	-
		f = 0.5GHz	-	-	1.8	-	dB
		f = 1.0GHz	-	-	2.1	-	-
$NF_{50\Omega}$	50Ω Noise Figure	I_C = 3mA, V_{CE} = 3V	C	-	-	-	-
		f = 0.5GHz	-	-	3.3	-	dB
		f = 1.0GHz	-	-	3.5	-	-
h_{FE1}/h_{FE2}	DC Current Gain Matching (Q_1 and Q_2, Q_4 and Q_5)	V_{CE} = 3V, I_C = 10mA	A	0.9	1.0	1.1	-
V_{OS}	Input Offset Voltage (Q_1 and Q_2), (Q_4 and Q_5)	I_C = 10mA, V_{CE} = 3V	A	-	1.5	5	mV
I_{OS}	Input Offset Current (Q_1 and Q_2), (Q_4 and Q_5)	I_C = 10mA, V_{CE} = 3V	A	-	5	25	µA
dV_{OS}/dT	Input Offset Voltage TC (Q_1 and Q_2, Q_4 and Q_5)	I_C = 10mA, V_{CE} = 3V	C	-	0.5	-	$\mu V/^oC$
$I_{TRENCH-LEAKAGE}$	Collector-to-Collector Leakage (Pin 6, 7, 13, and 14)	ΔV_{TEST} = 5V	B	-	0.01	-	nA

Test Level: A. Production Tested B. Guaranteed Limit or Typical Based on Characterization C. Design Typical for Information Only

Performance Curves

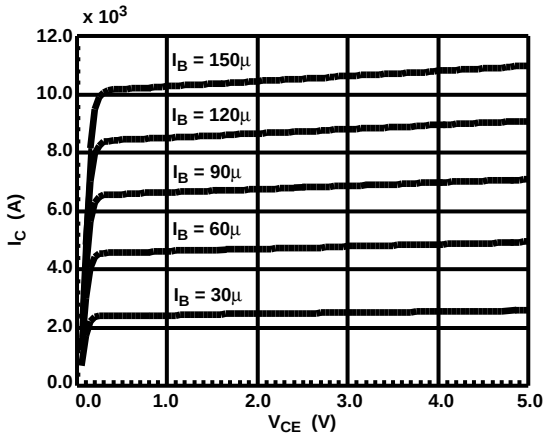


FIGURE 1. I_C vs V_{CE}

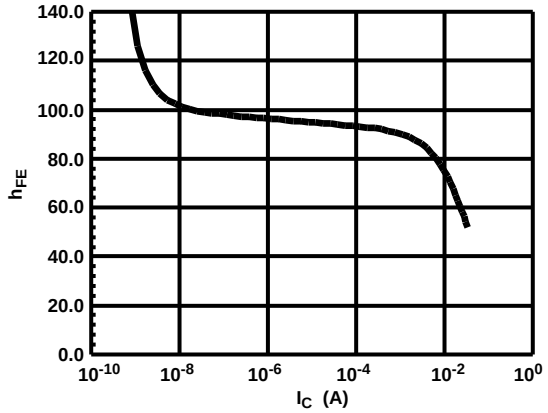


FIGURE 2. h_{FE} vs I_C

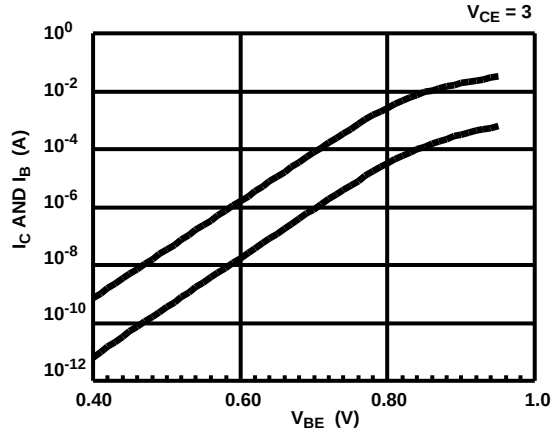


FIGURE 3. GUMMEL PLOT

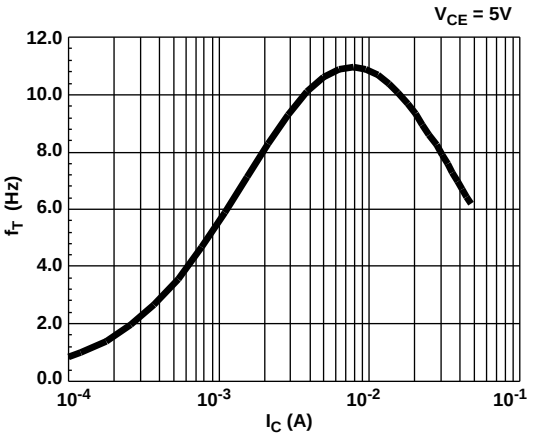


FIGURE 4. f_T vs I_C

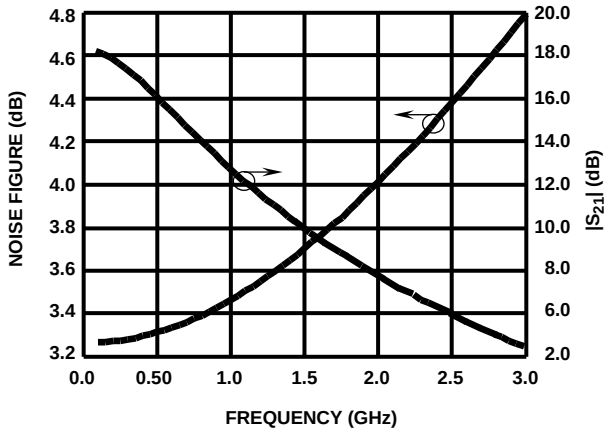


FIGURE 5. GAIN AND NOISE FIGURE vs FREQUENCY

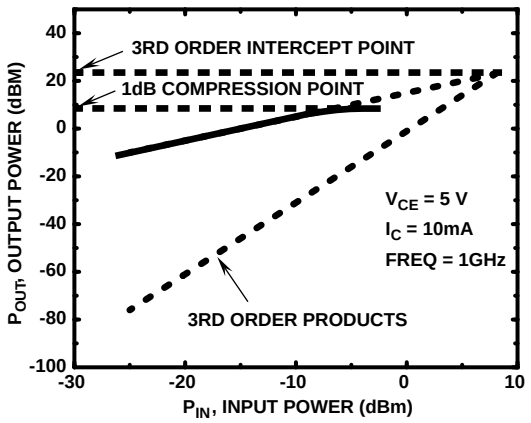


FIGURE 6. P_{1dB} AND 3RD ORDER INTERCEPT

PSPICE Model for a Single Transistor

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+  ( IS= 1.840E-16    XTI= 3.000E+00     EG= 1.110E+00    VAF= 7.200E+01
+ VAR= 4.500E+00     BF= 1.036E+02    ISE= 1.686E-19     NE= 1.400E+00
+ IKF= 5.400E-02    XTB= 0.000E+00     BR= 1.000E+01    ISC= 1.605E-14
+ NC= 1.800E+00    IKR= 5.400E-02     RC= 1.140E+01    CJC= 3.980E-13
+ MJC= 2.400E-01    VJC= 9.700E-01     FC= 5.000E-01    CJE= 2.400E-13
+ MJE= 5.100E-01    VJE= 8.690E-01     TR= 4.000E-09     TF= 10.51E-12
+ ITF= 3.500E-02    XTF= 2.300E+00    VTF= 3.500E+00    PTF= 0.000E+00
+ XCJC= 9.000E-01    CJS= 1.689E-13    VJS= 9.982E-01    MJS= 0.000E+00
+ RE= 1.848E+00     RB= 5.007E+01    RBM= 1.974E+00     KF= 0.000E+00
+ AF= 1.000E+00)
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Common Emitter S-Parameters

V_{CE} = 5V and I_C = 5mA

FREQ. (Hz)	|S11|	PHASE(S11)	|S12|	PHASE(S12)	|S21|	PHASE(S21)	|S22|	PHASE(S22)
1.0E+08	0.833079	-11.7873	1.418901E-02	78.8805	11.0722	168.576	0.976833	-11.0509
2.0E+08	0.791776	-22.8290	2.695740E-02	68.6355	10.5177	157.897	0.930993	-21.3586
3.0E+08	0.734911	-32.6450	3.750029E-02	59.5861	9.75379	148.443	0.868128	-30.4451
4.0E+08	0.672811	-41.0871	4.572138E-02	51.9018	8.91866	140.361	0.799886	-38.1641
5.0E+08	0.612401	-48.2370	5.194147E-02	45.5043	8.10511	133.569	0.734033	-44.5998
6.0E+08	0.557126	-54.2780	5.659943E-02	40.2112	7.35944	127.882	0.674392	-49.9370
7.0E+08	0.508133	-59.4102	6.009507E-02	35.8226	6.69712	123.102	0.622181	-54.3777
8.0E+08	0.465361	-63.8123	6.274213E-02	32.1594	6.11750	119.047	0.577269	-58.1022
9.0E+08	0.428238	-67.6313	6.477134E-02	29.0743	5.61303	115.571	0.538952	-61.2587
1.0E+09	0.396034	-70.9834	6.634791E-02	26.4506	5.17405	112.556	0.506365	-63.9647
1.1E+09	0.368032	-73.9591	6.758932E-02	24.1974	4.79104	109.913	0.478663	-66.3116
1.2E+09	0.343589	-76.6285	6.857937E-02	22.2441	4.45546	107.570	0.455091	-68.3702
1.3E+09	0.322155	-79.0462	6.937837E-02	20.5358	4.15997	105.472	0.435008	-70.1958
1.4E+09	0.303268	-81.2548	7.003020E-02	19.0293	3.89845	103.576	0.417872	-71.8314
1.5E+09	0.286542	-83.2880	7.056718E-02	17.6908	3.66577	101.849	0.403238	-73.3108
1.6E+09	0.271660	-85.1723	7.101343E-02	16.4930	3.45770	100.262	0.390735	-74.6609
1.7E+09	0.258359	-86.9292	7.138717E-02	15.4143	3.27074	98.7956	0.380056	-75.9030
1.8E+09	0.246420	-88.5759	7.170231E-02	14.4370	3.10197	97.4307	0.370947	-77.0544
1.9E+09	0.235659	-90.1265	7.196964E-02	13.5469	2.94897	96.1533	0.363195	-78.1288
2.0E+09	0.225923	-91.5925	7.219757E-02	12.7319	2.80969	94.9515	0.356623	-79.1377
2.1E+09	0.217085	-92.9836	7.239274E-02	11.9824	2.68243	93.8156	0.351081	-80.0903
2.2E+09	0.209034	-94.3076	7.256046E-02	11.2901	2.56573	92.7373	0.346442	-80.9942
2.3E+09	0.201678	-95.5713	7.270498E-02	10.6480	2.45837	91.7097	0.342599	-81.8557
2.4E+09	0.194939	-96.7803	7.282977E-02	10.0503	2.35928	90.7271	0.339458	-82.6802
2.5E+09	0.188747	-97.9395	7.293764E-02	9.49212	2.26756	89.7844	0.336942	-83.4719
2.6E+09	0.183044	-99.0530	7.303093E-02	8.96908	2.18243	88.8775	0.334982	-84.2347
2.7E+09	0.177780	-100.124	7.311157E-02	8.47753	2.10322	88.0026	0.333518	-84.9716
2.8E+09	0.172909	-101.156	7.318117E-02	8.01430	2.02934	87.1565	0.332499	-85.6853
2.9E+09	0.168394	-102.152	7.324107E-02	7.57661	1.96027	86.3366	0.331879	-86.3781
3.0E+09	0.164200	-103.114	7.329243E-02	7.16204	1.89556	85.5404	0.331620	-87.0518

V_{CE} = 5V and I_C = 10mA

FREQ. (Hz)	|S11|	PHASE(S11)	|S12|	PHASE(S12)	|S21|	PHASE(S21)	|S22|	PHASE(S22)
1.0E+08	0.728106	-16.4319	1.273920E-02	75.4177	15.1273	165.227	0.959692	-14.2688
2.0E+08	0.670836	-31.2669	2.342300E-02	62.8941	13.9061	152.045	0.886232	-26.9507
3.0E+08	0.600268	-43.7663	3.132521E-02	52.5891	12.3970	141.185	0.796016	-37.3172
4.0E+08	0.531768	-54.0028	3.681579E-02	44.5019	10.9257	132.570	0.708892	-45.4503
5.0E+08	0.471795	-62.3880	4.057046E-02	38.2308	9.62995	125.781	0.633146	-51.7704
6.0E+08	0.421506	-69.3569	4.316292E-02	33.3405	8.53559	120.378	0.570209	-56.7206
7.0E+08	0.379961	-75.2612	4.499071E-02	29.4764	7.62375	116.005	0.518803	-60.6598
8.0E+08	0.345693	-80.3608	4.631140E-02	26.3755	6.86423	112.398	0.476987	-63.8540
9.0E+08	0.317301	-84.8420	4.728948E-02	23.8481	6.22797	109.365	0.442915	-66.4948
1.0E+09	0.293608	-88.8381	4.803091E-02	21.7581	5.69057	106.771	0.415044	-68.7193
1.1E+09	0.273680	-92.4452	4.860515E-02	20.0070	5.23257	104.518	0.392146	-70.6269
1.2E+09	0.256782	-95.7336	4.905871E-02	18.5224	4.83873	102.532	0.373261	-72.2899
1.3E+09	0.242344	-98.7555	4.942344E-02	17.2505	4.49716	100.759	0.357640	-73.7620
1.4E+09	0.229918	-101.551	4.972158E-02	16.1506	4.19854	99.1602	0.344698	-75.0832
1.5E+09	0.219152	-104.150	4.996903E-02	15.1915	3.93554	97.7028	0.333974	-76.2840
1.6E+09	0.209767	-106.577	5.017730E-02	14.3490	3.70234	96.3629	0.325102	-77.3877
1.7E+09	0.201539	-108.851	5.035491E-02	13.6040	3.49428	95.1215	0.317789	-78.4122
1.8E+09	0.194288	-110.988	5.050825E-02	12.9411	3.30758	93.9633	0.311800	-79.3715
1.9E+09	0.187867	-113.001	5.064218E-02	12.3482	3.13919	92.8761	0.306940	-80.2768
2.0E+09	0.182157	-114.902	5.076045E-02	11.8151	2.98658	91.8500	0.303051	-81.1365
2.1E+09	0.177056	-116.698	5.086598E-02	11.3338	2.84766	90.8766	0.300003	-81.9578
2.2E+09	0.172484	-118.399	5.096107E-02	10.8974	2.72068	89.9494	0.297686	-82.7460
2.3E+09	0.168370	-120.012	5.104755E-02	10.5001	2.60420	89.0626	0.296007	-83.5057
2.4E+09	0.164656	-121.542	5.112690E-02	10.1373	2.49697	88.2115	0.294889	-84.2405
2.5E+09	0.161293	-122.996	5.120031E-02	9.80479	2.39793	87.3920	0.294266	-84.9533
2.6E+09	0.158239	-124.378	5.126876E-02	9.49919	2.30619	86.6007	0.294081	-85.6466
2.7E+09	0.155458	-125.694	5.133304E-02	9.21750	2.22098	85.8348	0.294285	-86.3223
2.8E+09	0.152919	-126.947	5.139381E-02	8.95716	2.14162	85.0916	0.294836	-86.9822
2.9E+09	0.150595	-128.140	5.145164E-02	8.71595	2.06753	84.3690	0.295696	-87.6275
3.0E+09	0.148463	-129.279	5.150697E-02	8.49194	1.99820	83.6651	0.296834	-88.2595

Die Characteristics

PROCESS:
UHF-1

DIE DIMENSIONS:
53 x 52 x 14 ±1mils
1340µm x 1320µm x 355.6µm ± 25.4µm

METALIZATION:
Type: Metal 1: AlCu(2%)/TiW
Thickness: Metal 1: 8kÅ ± 0.5kÅ
Type: Metal 2: AlCu(2%)
Thickness: Metal 2: 16kÅ ± 0.8kÅ

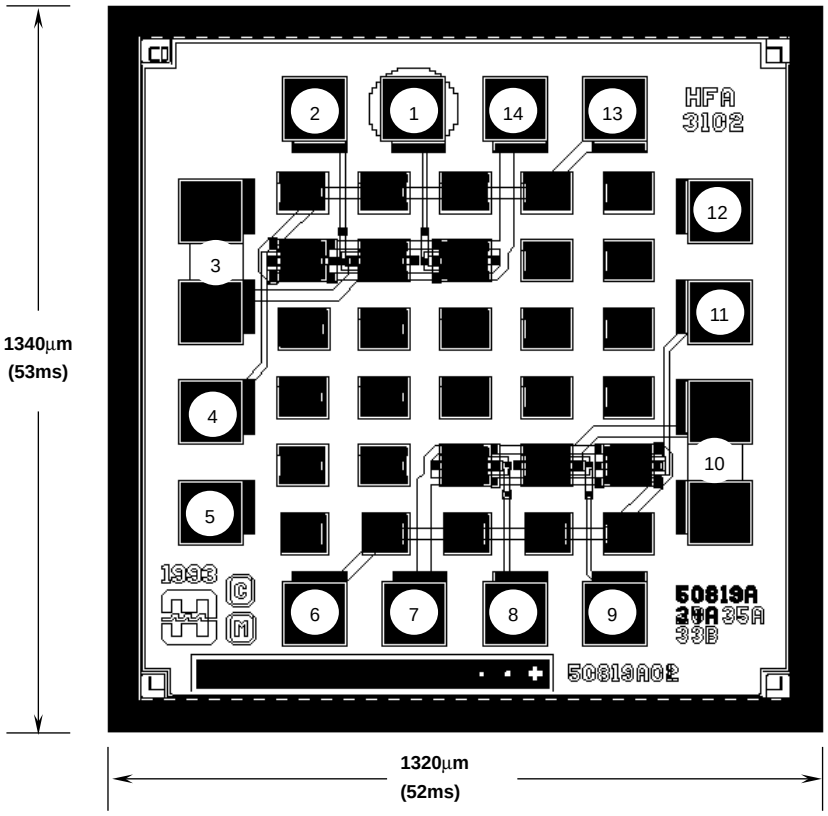
GLASSIVATION:
Type: Nitride
Thickness: 4kÅ ± 0.5kÅ

DIE ATTACH:
Material: Epoxy

WORST CASE CURRENT DENSITY:
1.50×10^5 A/cm^2

Metallization Mask Layout

HFA3102
TOP VIEW



Pad numbers correspond to the 14 pin SOIC pinout.