Agilent Technologies
Innovating the HP Way

General Purpose, Low Current NPN Silicon Bipolar Transistor

Technical Data

AT-41532

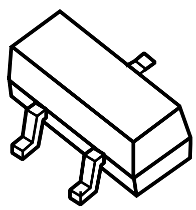
Features

- **General Purpose NPN Bipolar Transistor Optimized for Low Current, Low Voltage Applications at 900 MHz, 1.8 GHz, and 2.4 GHz**
- **Performance (5 V, 5 mA)**
  0.9 GHz: 1 dB NF, 15.5 dB G_A
  1.8 GHz: 1.4 dB NF, 10.5 dB G_A
  2.4 GHz: 1.9 dB NF, 9 dB G_A
- **Characterized for 3, 5, and 8 V Use**
- **Miniature 3-lead SOT-323 (SC-70) Plastic Package**
- **High Breakdown Voltage (can be operated up to 10 V)**

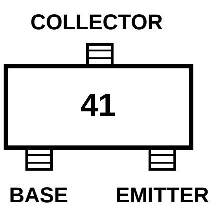
Applications

- **LNA, Oscillator, Driver Amplifier, Buffer Amplifier, and Down Converter for *Cellular and PCS Handsets and Cordless Telephones***
- **LNA, Oscillator, Mixer, and Gain Amplifier for *Pagers***
- **Power Amplifier and Oscillator for *RF-ID Tag***
- **LNA and Gain Amplifier for *GPS***
- **LNA for *CATV Set-Top Box***

3-Lead SC-70 (SOT-323) Surface Mount Plastic Package



Pin Configuration



Description

Agilent's AT-41532 is a general purpose NPN bipolar transistor that has been optimized for maximum f_t at low voltage operation, making it ideal for use in ***battery powered applications in cellular/PCS and other wireless markets***. The AT-41532 uses the miniature 3-lead SOT-323 (SC-70) plastic package.

Optimized performance at 5 V makes this device ideal for use in 900 MHz, 1.8 GHz, and 2.4 GHz systems. Typical amplifier design at 900 MHz yields 1 dB NF and 15.5 dB associated gain at 5 V and 5 mA bias. High gain capability at 1 V and 1 mA makes this device a good fit for ***900 MHz pager applications***. A good noise match near 50 ohms at 900 MHz makes this a very user-friendly device. Moreover, voltage breakdowns are high enough to support operation at 10 V.

The AT-41532 belongs to Agilent's AT-4XXXX series bipolar transistors. It exhibits excellent device uniformity, performance, and reliability as a result of ion-implantation, self-alignment techniques, and gold metalization in the fabrication process.

AT-41532 Absolute Maximum Ratings

Symbol	Parameter	Units	Absolute Maximum[1]
V_{EBO}	Emitter-Base Voltage	V	1.5
V_{CBO}	Collector-Base Voltage	V	20
V_{CEO}	Collector-Emitter Voltage	V	12
I_C	Collector Current	mA	50
P_T	Power Dissipation[2,3]	mW	225
T_j	Junction Temperature	°C	150
T_{STG}	Storage Temperature	°C	-65 to 150

Thermal Resistance:[2]
θ_{jc} = 350°C/W

Notes:
1. Operation of this device above any one of these parameters may cause permanent damage.
2. $T_{MOUNTING\ SURFACE}$ = 25°C.
3. Derate at 2.86 mW/°C for $T_{MOUNTING\ SURFACE}$ > 72°C.

Electrical Specifications, T_A = 25°C

Symbol	Parameters and Test Conditions		Units	Min	Typ	Max
h_{FE}	Forward Current Transfer Ratio	V_{CE} = 5 V I_C = 5 mA	-	30	150	270
I_{CBO}	Collector Cutoff Current	V_{CB} = 3 V	mA			0.2
I_{EBO}	Emitter Cutoff Current	V_{EB} = 1 V	mA			1.0

Characterization Information, T_A = 25°C

Symbol	Parameters and Test Conditions		Units	Min	Typ
NF	Noise Figure V_{CE} = 5 V, I_C = 5 mA	f = 0.9 GHz f = 1.8 GHz f = 2.4 GHz	dB		1.0 1.4 1.9
G_A	Associated Gain V_{CE} = 5 V, I_C = 5 mA	f = 0.9 GHz f = 1.8 GHz f = 2.4 GHz	dB		15.5 10.5 9.0
P_{1dB}	Power at 1 dB Gain Compression (opt tuning) V_{CE} = 5 V, I_C = 25 mA	f = 0.9 GHz	dBm		14.5
G_{1dB}	Gain at 1 dB Gain Compression (opt tuning) V_{CE} = 5 V, I_C = 25 mA	f = 0.9 GHz	dB		14.5
IP_3	Output Third Order Intercept Point, V_{CE} = 5 V, I_C =25 mA (opt tuning)	f = 0.9 GHz	dBm		25
$\|S_{21E}\|^2$	Gain in 50 Ω system; V_{CE} = 5 V, I_C = 5 mA	f = 0.9 GHz f = 2.4 GHz	dB	12.5	13.25 5.2

AT-41532 Typical Performance

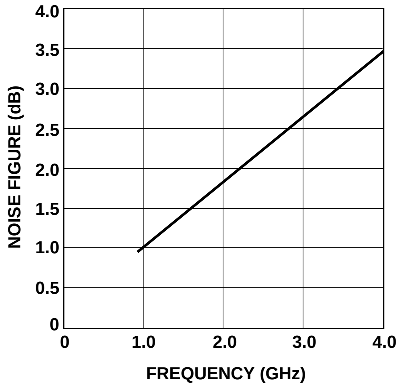


Figure 1. AT-41532 Typical Noise Figure vs. Frequency at 1 V, 1 mA.

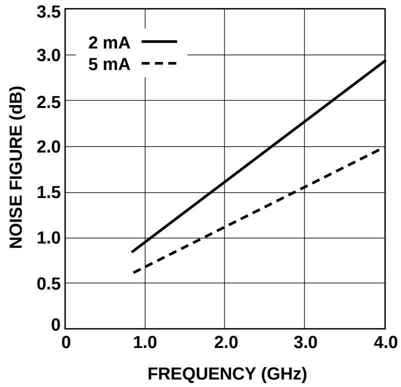


Figure 2. AT-41532 Typical Noise Figure vs. Frequency and Current at 2.7 V.

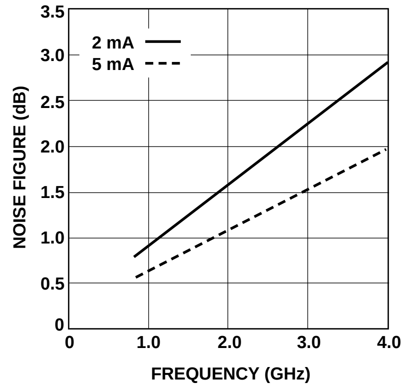


Figure 3. AT-41532 Typical Noise Figure vs. Frequency and Current at 5 V.

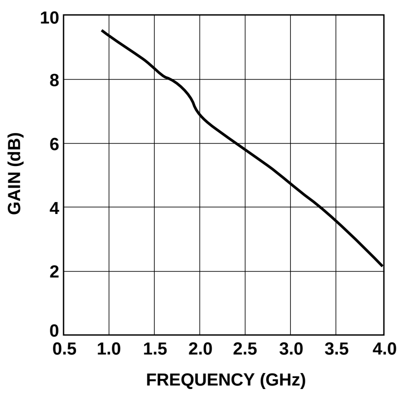


Figure 4. AT-41532 Associated Gain vs. Frequency at 1 V, 1 mA.

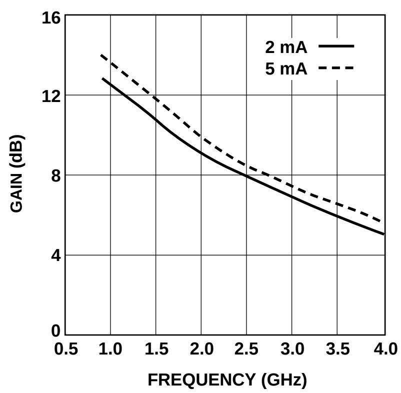


Figure 5. AT-41532 Associated Gain vs. Frequency and Current at 2.7 V.

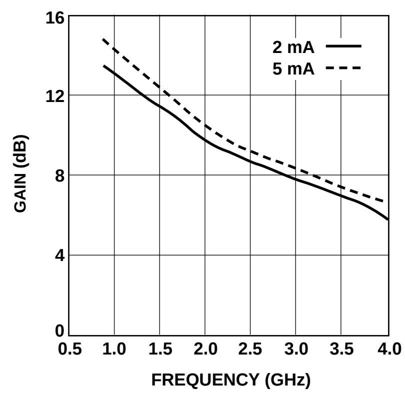


Figure 6. AT-41532 Associated Gain vs. Frequency and Current at 5 V.

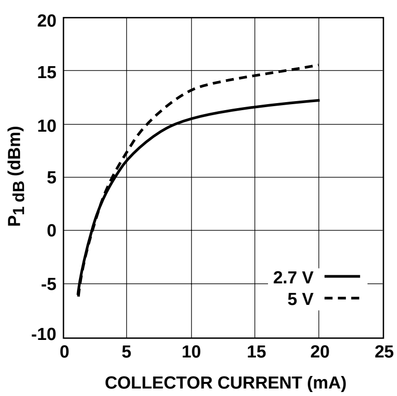


Figure 7. AT-41532 $P_{1\,dB}$ vs. Collector Current and Voltage (valid up to 2.4 GHz).

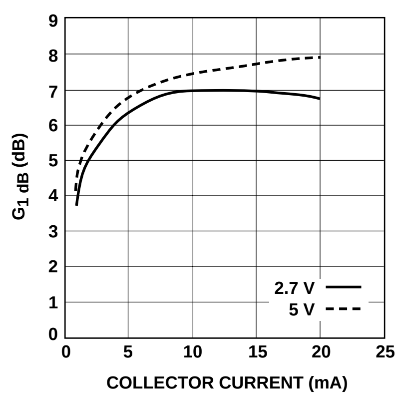


Figure 8. AT-41532 $G_{1\,dB}$ vs. Collector Current and Voltage (valid up to 2.4 GHz).

AT-41532 Typical Scattering Parameters, Common Emitter, $Z_O = 50\ \Omega$, $V_{CE} = 1$ V, $I_C = 1$ mA

Freq.	S_{11}		S_{21}			S_{12}			S_{22}	
GHz	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang	Mag	Ang
0.5	0.787	-75	8.79	2.750	125	-20.18	0.098	49	0.860	-22
0.75	0.697	-104	7.28	2.311	106	-18.74	0.116	38	0.785	-28
1.0	0.620	-128	5.84	1.960	90	-18.40	0.120	31	0.734	-32
1.5	0.554	-166	3.40	1.480	66	-18.80	0.115	30	0.678	-40
2.0	0.538	-164	1.52	1.191	48	-18.69	0.116	42	0.653	-50
3.0	0.543	118	-1.06	0.886	22	-13.30	0.216	60	0.620	-73
4.0	0.559	79	-2.61	0.741	5	-8.03	0.397	47	0.568	-102
5.0	0.561	47	-3.06	0.703	-7	-4.83	0.574	24	0.487	-137
6.0	0.545	28	-2.81	0.724	-20	-3.11	0.699	0	0.398	-180
7.0	0.534	14	-2.46	0.754	-35	-2.30	0.768	-23	0.362	130
8.0	0.544	2	-2.38	0.761	-52	-2.08	0.787	-44	0.407	88
9.0	0.563	-10	-2.49	0.751	-68	-2.18	0.778	-63	0.467	58
10.0	0.597	-23	-2.79	0.725	-84	-2.52	0.748	-80	0.523	35
11.0	0.655	-34	-3.39	0.677	-100	-3.15	0.696	-96	0.593	16
12.0	0.703	-42	-4.03	0.629	-112	-3.76	0.649	-110	0.665	-6

AT-41532 Typical Noise Parameters,

Common Emitter, $Z_O = 50\ \Omega$, $V_{CE} = 1$ V, $I_C = 1$ mA

Freq. GHz	F_{min} dB	Γ_{opt}		R_n ohms	G_{assoc} dB
		Mag	Ang		
0.9	1.4	0.44	92	12.4	9.4
1.8	1.8	0.57	-183	3.0	7.6
2.0	1.9	0.60	-169	3.3	6.7
2.5	2.2	0.66	-140	10.1	5.7
3.0	2.6	0.71	-116	27.6	4.6
3.5	3.1	0.75	-95	59.9	3.5
4.0	3.6	0.77	-77	103.0	2.1

gmax = maximum available gain (MAG) if k > 1
gmax = maximum stable gain (MSG) if k < 1
k = stability factor

$$\text{MAG} = \left|\frac{S_{21}}{S_{12}}\right| \left(k \pm \sqrt{k^2 - 1}\right)$$

$$\text{MSG} = |S_{21}| / |S_{12}|$$

$$k = \frac{1 - |S_{11}|^2 - |S_{22}|^2 + |D|^2}{2 * |S_{12}||S_{21}|} \; ; \; D = S_{11}S_{22} - S_{12}S_{21}$$

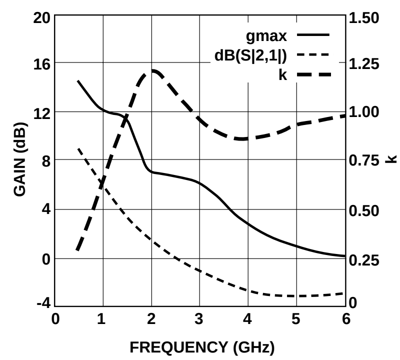


Figure 9. Gain vs. Frequency at 1 V, 1 mA.
Note: $dB(|S_{21}|) = 20 * \log(|S_{21}|)$

AT-32032 Typical Scattering Parameters, Common Emitter, $Z_O = 50\ \Omega$, $V_{CE} = 2.7$ V, $I_C = 2$ mA

Freq. GHz	S_{11}		S_{21}			S_{12}			S_{22}	
	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang	Mag	Ang
0.5	0.647	-82	13.45	4.702	119	-23.97	0.063	52	0.808	-21
0.75	0.532	-111	11.34	3.691	101	-22.60	0.074	46	0.737	-24
1.0	0.455	-134	9.54	3.000	88	-21.87	0.081	46	0.696	-27
1.5	0.394	-171	6.70	2.162	68	-20.48	0.095	52	0.658	-33
2.0	0.382	160	4.64	1.707	51	-18.50	0.119	59	0.643	-40
3.0	0.397	116	1.87	1.240	26	-13.56	0.210	61	0.627	-59
4.0	0.434	80	0.03	1.004	5	-9.26	0.344	50	0.604	-81
5.0	0.474	50	-1.20	0.871	-10	-6.05	0.498	32	0.556	-108
6.0	0.497	30	-1.81	0.812	-23	-3.84	0.643	11	0.470	-142
7.0	0.501	15	-1.88	0.805	-36	-2.40	0.759	-12	0.377	174
8.0	0.512	4	-1.89	0.804	-51	-1.73	0.819	-34	0.361	123
9.0	0.532	-9	-1.99	0.796	-67	-1.61	0.831	-55	0.411	82
10.0	0.569	-22	-2.31	0.767	-83	-1.86	0.808	-74	0.476	52
11.0	0.643	-32	-2.37	0.762	-97	-2.41	0.758	-93	0.562	27
12.0	0.687	-40	-3.51	0.668	-112	-3.10	0.700	-107	0.639	1

AT-32032 Typical Noise Parameters,

Common Emitter, $Z_O = 50\ \Omega$, $V_{CE} = 2.7$ V, $I_C = 2$ mA

Freq. GHz	F_{min} dB	Γ_{opt}		R_n ohms	G_{assoc} dB
		Mag	Ang		
0.9	1.2	0.35	100	8.7	12.9
1.8	1.6	0.48	-179	3.3	9.7
2.0	1.7	0.51	-165	3.7	9.1
2.5	1.9	0.60	-136	8.9	8.0
3.0	2.2	0.65	-112	21.0	6.9
3.5	2.5	0.70	-91	42.0	5.9
4.0	2.9	0.74	-74	72.0	5.1

gmax = maximum available gain (MAG) if k > 1
gmax = maximum stable gain (MSG) if k < 1
k = stability factor

$$\text{MAG} = \left|\frac{S_{21}}{S_{12}}\right|\left(k \pm \sqrt{k^2-1}\right)$$

$$\text{MSG} = |S_{21}| / |S_{12}|$$

$$k = \frac{1 - |S_{11}|^2 - |S_{22}|^2 + |D|^2}{2 * |S_{12}|\,|S_{21}|}\ ;\ D = S_{11}S_{22} - S_{12}S_{21}$$

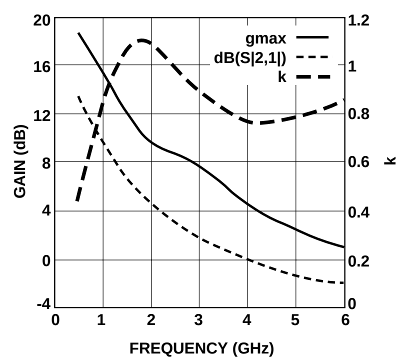


Figure 10. Gain vs. Frequency at 2.7 V, 2 mA.
Note: $dB(|S_{21}|) = 20 * \log(|S_{21}|)$

AT-41532 Typical Scattering Parameters, Common Emitter, $Z_O = 50\ \Omega$, $V_{CE} = 2.7$ V, $I_C = 5$ mA

Freq.	S_{11}		S_{21}			S_{12}			S_{22}	
GHz	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang	Mag	Ang
0.5	0.400	-102	17.03	7.106	106	-25.97	0.050	59	0.671	-22
0.75	0.312	-130	14.15	5.101	91	-23.86	0.064	60	0.615	-24
1.0	0.270	-152	11.97	3.969	80	-22.09	0.079	61	0.588	-25
1.5	0.247	175	8.82	2.762	64	-19.10	0.111	63	0.564	-30
2.0	0.253	149	6.67	2.154	50	-16.60	0.148	62	0.553	-37
3.0	0.280	112	3.86	1.559	26	-12.48	0.238	55	0.535	-54
4.0	0.323	80	2.07	1.269	6	-9.19	0.347	43	0.514	-75
5.0	0.379	55	0.80	1.097	-12	-6.55	0.471	27	0.472	-99
6.0	0.434	38	-0.13	0.986	-28	-4.50	0.595	9	0.398	-130
7.0	0.480	24	-0.72	0.920	-43	-2.96	0.711	-11	0.309	-174
8.0	0.522	10	-1.20	0.871	-58	-2.07	0.788	-32	0.299	131
9.0	0.557	-5	-1.64	0.828	-72	-1.73	0.820	-53	0.366	87
10.0	0.595	-19	-2.17	0.779	-87	-1.86	0.808	-73	0.449	55
11.0	0.662	-29	-2.38	0.761	-99	-2.43	0.756	-92	0.533	27
12.0	0.709	-39	-3.56	0.664	-115	-3.03	0.705	-107	0.633	3

AT-41532 Typical Noise Parameters,

Common Emitter, $Z_O = 50\ \Omega$, $V_{CE} = 2.7$ V, $I_C = 5$ mA

Freq. GHz	F_{min} dB	Γ_{opt} Mag	Γ_{opt} Ang	R_n ohms	G_{assoc} dB
0.9	1.2	0.283	106	7.3	14.0
1.8	1.4	0.41	-165	3.9	10.7
2.0	1.5	0.44	-151	4.8	9.8
2.5	1.7	0.53	-126	9.2	8.5
3.0	1.9	0.60	-106	18.4	7.5
3.5	2.2	0.67	-86	35.0	6.6
4.0	2.5	0.71	-69	58.0	5.8

gmax = maximum available gain (MAG) if k > 1
gmax = maximum stable gain (MSG) if k < 1
k = stability factor

$$MAG = \left|\frac{S_{21}}{S_{12}}\right| (k \pm \sqrt{k^2-1})$$

$$MSG = |S_{21}| / |S_{12}|$$

$$k = \frac{1 - |S_{11}|^2 - |S_{22}|^2 + |D|^2}{2 * |S_{12}|\,|S_{21}|}\ ;\ D = S_{11}S_{22} - S_{12}S_{21}$$

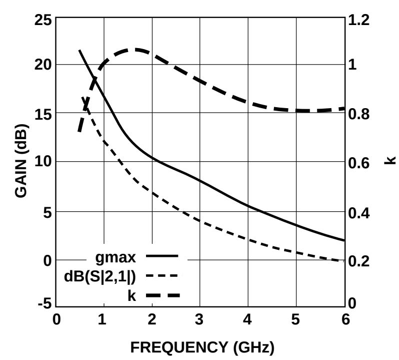


Figure 11. Gain vs. Frequency at 2.7 V, 5 mA.
Note: $dB(|S_{21}|) = 20 * \log(|S_{21}|)$

AT-41532 Typical Scattering Parameters, Common Emitter, $Z_O = 50\ \Omega$, $V_{CE} = 2.7$ V, $I_C = 10$ mA

Freq. GHz	S_{11} Mag	S_{11} Ang	S_{21} dB	S_{21} Mag	S_{21} Ang	S_{12} dB	S_{12} Mag	S_{12} Ang	S_{22} Mag	S_{22} Ang
0.5	0.243	-122	18.39	8.310	97	-26.90	0.045	68	0.586	-21
0.75	0.199	-149	15.19	5.751	85	-23.99	0.063	69	0.552	-21
1.0	0.184	-169	12.88	4.408	76	-21.74	0.082	69	0.536	-23
1.5	0.186	161	9.64	3.034	62	-18.35	0.121	67	0.520	-28
2.0	0.199	139	7.44	2.354	49	-15.79	0.162	63	0.510	-35
3.0	0.232	107	4.61	1.700	27	-11.93	0.253	52	0.491	-52
4.0	0.275	79	2.84	1.387	6	-9.00	0.355	39	0.467	-72
5.0	0.334	56	1.60	1.202	-12	-6.66	0.465	24	0.424	-95
6.0	0.399	41	0.66	1.079	-29	-4.79	0.576	7	0.349	-125
7.0	0.462	27	-0.02	0.997	-45	-3.30	0.684	-12	0.261	-167
8.0	0.521	14	-0.67	0.926	-60	-2.34	0.764	-32	0.251	134
9.0	0.566	-2	-1.26	0.865	-75	-1.89	0.805	-52	0.328	88
10.0	0.609	-18	-1.88	0.805	-90	-1.92	0.802	-72	0.422	56
11.0	0.678	-28	-2.97	0.711	-101	-2.32	0.766	-91	0.485	29
12.0	0.722	-39	-3.38	0.678	-116	-3.02	0.706	-106	0.620	3

gmax = maximum available gain (MAG) if k > 1
gmax = maximum stable gain (MSG) if k < 1
k = stability factor

$$MAG = \left|\frac{S_{21}}{S_{12}}\right|(k \pm \sqrt{k^2-1})$$

$$MSG = |S_{21}|/|S_{12}|$$

$$k = \frac{1 - |S_{11}|^2 - |S_{22}|^2 + |D|^2}{2 * |S_{12}|\,|S_{21}|}\ ;\ D = S_{11}S_{22} - S_{12}S_{21}$$

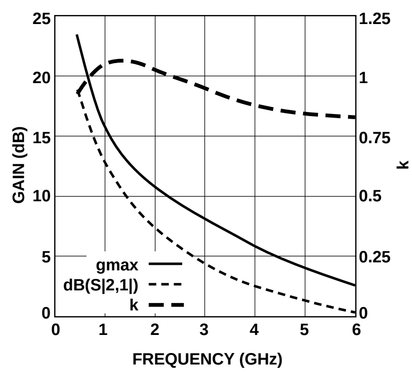


Figure 12. Gain vs. Frequency at 2.7 V, 10 mA.
Note: $dB(|S_{21}|) = 20 * \log(|S_{21}|)$

AT-41532 Typical Scattering Parameters, Common Emitter, $Z_O = 50\ \Omega$, $V_{CE} = 5$ V, $I_C = 2$ mA

Freq.	S_{11}		S_{21}			S_{12}			S_{22}	
GHz	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang	Mag	Ang
0.5	0.659	-79	13.43	4.696	121	-25.16	0.055	53	0.836	-18
0.75	0.540	-108	11.41	3.720	103	-23.78	0.065	48	0.774	-22
1.0	0.456	-131	9.64	3.034	89	-23.06	0.070	48	0.738	-24
1.5	0.387	-169	6.81	2.190	69	-21.69	0.082	55	0.705	-30
2.0	0.371	162	4.74	1.726	53	-19.63	0.104	63	0.694	-37
3.0	0.387	116	1.91	1.247	27	-14.40	0.191	67	0.685	-54
4.0	0.428	79	0.01	1.001	7	-9.89	0.320	56	0.673	-75
5.0	0.472	49	-1.31	0.860	-8	-6.47	0.475	38	0.635	-100
6.0	0.494	28	-1.96	0.798	-20	-4.05	0.627	17	0.556	-131
7.0	0.490	13	-1.95	0.799	-33	-2.36	0.762	-5	0.448	-170
8.0	0.489	2	-1.81	0.812	-48	-1.51	0.840	-29	0.388	141
9.0	0.506	-10	-1.84	0.810	-64	-1.28	0.863	-51	0.408	96
10.0	0.541	-22	-2.07	0.788	-80	-1.51	0.841	-71	0.462	62
11.0	0.634	-33	-2.46	0.754	-94	-2.09	0.786	-90	0.539	35
12.0	0.670	-39	-3.23	0.689	-109	-2.75	0.729	-105	0.625	6

AT-41532 Typical Noise Parameters,
Common Emitter, $Z_O = 50\ \Omega$, 5 V, $I_C = 2$ mA

Freq. GHz	F_{min} dB	Γ_{opt}		R_n ohms	G_{assoc} dB
		Mag	Ang		
0.9	1.2	0.35	100	8.5	13.5
1.8	1.5	0.48	178	3.4	10.6
2.0	1.6	0.51	-166	3.7	9.7
2.5	1.9	0.60	-137	8.8	8.8
3.0	2.2	0.65	-112	21.7	7.8
3.5	2.5	0.70	-92	44.6	7.1
4.0	2.9	0.74	-73	79.5	6.0

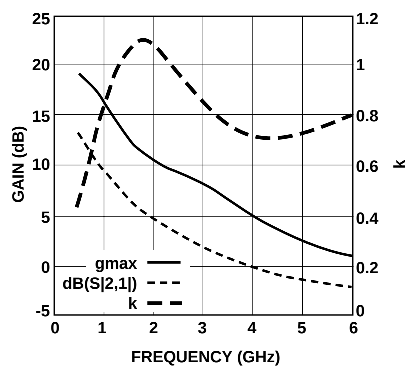


Figure 13. Gain vs. Frequency at 5 V, 2 mA.
Note: $dB(|S_{21}|) = 20 * \log(|S_{21}|)$

gmax = maximum available gain (MAG) if k > 1
gmax = maximum stable gain (MSG) if k < 1
k = stability factor

$$MAG = \left|\frac{S_{21}}{S_{12}}\right| (k \pm \sqrt{k^2 - 1})$$

$$MSG = |S_{21}| / |S_{12}|$$

$$k = \frac{1 - |S_{11}|^2 - |S_{22}|^2 + |D|^2}{2 * |S_{12}|\,|S_{21}|}\ ;\ D = S_{11}S_{22} - S_{12}S_{21}$$

AT-41532 Typical Scattering Parameters, Common Emitter, Z_O = 50 Ω, V_{CE} = 5 V, I_C = 5 mA

Freq.	S_{11}		S_{21}			S_{12}			S_{22}	
GHz	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang	Mag	Ang
0.5	0.402	-98	17.27	7.303	107	-27.15	0.044	60	0.713	-19
0.75	0.304	-124	14.42	5.260	92	-25.04	0.056	61	0.663	-21
1.0	0.255	-147	12.25	4.095	82	-23.26	0.069	63	0.640	-23
1.5	0.225	178	9.09	2.848	65	-20.23	0.097	66	0.621	-28
2.0	0.227	151	6.92	2.218	52	-17.66	0.131	65	0.613	-34
3.0	0.256	111	4.06	1.596	28	-13.38	0.214	59	0.603	-51
4.0	0.301	79	2.22	1.291	8	-9.92	0.319	48	0.592	-69
5.0	0.359	53	0.92	1.111	-10	-7.07	0.443	33	0.562	-92
6.0	0.414	36	-0.02	0.997	-26	-4.78	0.577	16	0.498	-120
7.0	0.457	22	-0.60	0.933	-40	-2.97	0.711	-4	0.401	-156
8.0	0.496	10	-1.00	0.891	-55	-1.84	0.809	-26	0.344	154
9.0	0.531	-4	-1.42	0.849	-70	-1.37	0.854	-49	0.374	105
10.0	0.573	-19	-1.89	0.805	-85	-1.44	0.847	-69	0.441	67
11.0	0.633	-28	-2.40	0.759	-95	-2.03	0.792	-88	0.516	38
12.0	0.696	-38	-3.32	0.682	-113	-2.63	0.739	-105	0.624	8

AT-41532 Typical Noise Parameters,

Common Emitter, Z_O = 50 Ω, V_{CE} = 5 V, I_C = 5 mA

Freq. GHz	F_{min} dB	Γ_{opt}		R_n ohms	G_{assoc} dB
		Mag	Ang		
0.9	1.1	0.29	110	7.0	14.8
1.8	1.4	0.41	-167	3.9	11.3
2.0	1.5	0.44	-153	4.7	10.5
2.5	1.7	0.53	-127	9.3	9.3
3.0	1.9	0.60	-106	18.6	8.4
3.5	2.2	0.67	-86	36.8	7.5
4.0	2.4	0.71	-70	59.5	6.7

gmax = maximum available gain (MAG) if k > 1
gmax = maximum stable gain (MSG) if k < 1
k = stability factor

$$\text{MAG} = \left|\frac{S_{21}}{S_{12}}\right| \left(k \pm \sqrt{k^2 - 1}\right)$$

$$\text{MSG} = |S_{21}| / |S_{12}|$$

$$k = \frac{1 - |S_{11}|^2 - |S_{22}|^2 + |D|^2}{2 * |S_{12}|\,|S_{21}|} \; ; \; D = S_{11}S_{22} - S_{12}S_{21}$$

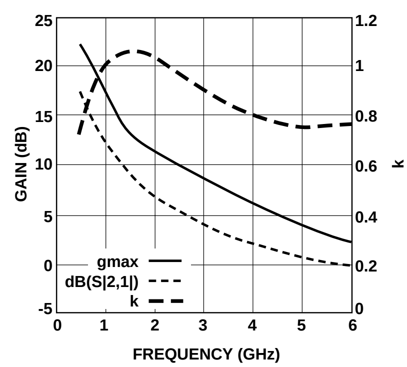


Figure 14. Gain vs. Frequency at 5 V, 5 mA.
Note: $dB(|S_{21}|) = 20 * \log(|S_{21}|)$

AT-41532 Typical Scattering Parameters, Common Emitter, Z_O = 50 Ω, V_{CE} = 5 V, I_C = 10 mA

Freq.	S_{11}		S_{21}			S_{12}			S_{22}	
GHz	Mag	Ang	dB	Mag	Ang	dB	Mag	Ang	Mag	Ang
0.5	0.239	-113	18.69	8.601	98	-28.05	0.040	69	0.641	-18
0.75	0.182	-140	15.51	5.966	86	-25.18	0.055	70	0.611	-19
1.0	0.160	-162	13.20	4.571	78	-22.94	0.071	71	0.597	-20
1.5	0.155	164	9.95	3.144	63	-19.50	0.106	69	0.585	-26
2.0	0.167	140	7.75	2.440	51	-16.89	0.143	66	0.578	-33
3.0	0.201	105	4.87	1.751	29	-12.90	0.226	57	0.566	-49
4.0	0.246	76	3.05	1.421	9	-9.80	0.324	45	0.553	-67
5.0	0.306	54	1.79	1.229	-10	-7.24	0.434	31	0.523	-88
6.0	0.369	40	0.86	1.105	-26	-5.11	0.555	14	0.461	-115
7.0	0.430	27	0.23	1.027	-42	-3.33	0.682	-5	0.366	-149
8.0	0.489	14	-0.35	0.961	-58	-2.11	0.785	-26	0.308	161
9.0	0.539	-1	-0.91	0.900	-73	-1.49	0.842	-47	0.342	110
10.0	0.588	-16	-1.58	0.834	-88	-1.45	0.846	-68	0.419	70
11.0	0.638	-29	-3.09	0.701	-102	-1.93	0.801	-88	0.501	40
12.0	0.713	-38	-3.24	0.689	-115	-2.58	0.743	-104	0.616	9

gmax = maximum available gain (MAG) if k > 1
gmax = maximum stable gain (MSG) if k < 1
k = stability factor

$$\text{MAG} = \left|\frac{S_{21}}{S_{12}}\right|\left(k \pm \sqrt{k^2-1}\right)$$

$$\text{MSG} = |S_{21}| / |S_{12}|$$

$$k = \frac{1-|S_{11}|^2-|S_{22}|^2+|D|^2}{2*|S_{12}|\,|S_{21}|}\ ;\ D = S_{11}S_{22}-S_{12}S_{21}$$

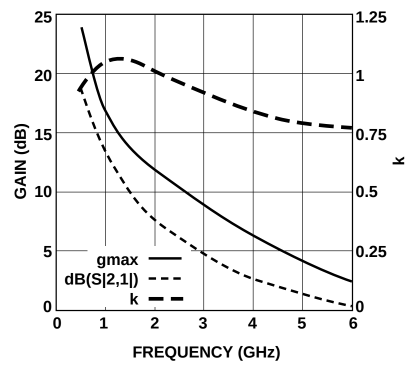


Figure 15. Gain vs. Frequency at 5 V, 10 mA.
Note: dB(|S_{21}|) = 20 * log(|S_{21}|)

AT-41532 Application Information

The AT-41532 is described in a low noise amplifier for use in the 800 to 900 MHz frequency range. The amplifier is designed for use with .032 inch thickness FR-4 printed circuit board material.

900 MHz LNA Design

The amplifier is designed for a V_{CE} of 5 volts and I_C of 5 mA. and a minimum power supply voltage of 5.25 volts. Higher power supply voltages will require an additional resistance to be inserted at the power supply terminal. The amplifier schematic is shown in Figure 16.

A component list is shown in Figure 17. The artwork including component placement is shown in Figure 18.

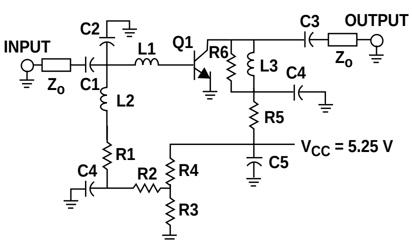


Figure 16. Schematic Diagram.

C1,C4	10 pF chip capacitor
C2	Open circuited stub – see text
C3	2.7 pF chip capacitor
C5	1000 pF chip capacitor
L1	8 nH chip inductor (Coilcraft 1008CS-080)
L2	Optional (see R1)
L3	15 nH chip inductor (Coilcraft 1008CS-150)
Q1	Agilent AT-41532 Silicon Bipolar Transistor
R1	10K Ω chip resistor (may want to substitute a 180 nH chip inductor and 50 Ω resistor for lower noise figure , better low freq stability, then readjust R2)
R2	48 K Ω chip resistor (adjust for rated Ic)
R3	3.32 K Ω chip resistor
R4	3.32 K Ω chip resistor
R5	51.1 Ω chip resistor
R6	1.1K Ω chip resistor (see text)
Z_O	50 Ω microstripline

Figure 17. Component Parts List.

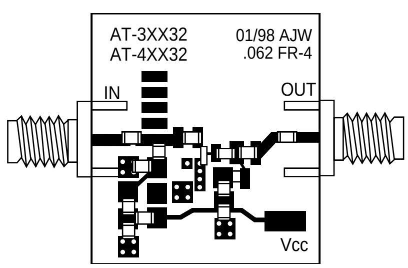


Figure 18. 1X Artwork showing Component Placement.

The input matching network uses a series inductor for the noise match. Some fine tuning for lowest noise figure and improved input VSWR can be accomplished by adding capacitance at C2. The shunt C is accomplished with an open circuited stub while a chip inductor is used for the series element. The output impedance matching network is a high pass structure consisting of a series capacitor and shunt inductor. A resistor is paralleled across the shunt inductor to enhance broad band stability through 10 GHz. Bias insertion is accomplished through the use of the shunt inductor appropriately bypassed. Surface mount Coilcraft inductors were chosen for their small size.

Biasing

The bias network is designed for a nominal power supply voltage of 5.25 volts. Resistors R1 and R2 are used to adjust collector current. Resistor R4 can be attached to the junction of R5 and C5 to improve bias point stability.

Performance

The measured gain of the completed amplifier is shown in Figure 19. The gain varies from 14 to 15 dB over the 800 to 900 MHz frequency range. Noise figure versus frequency is shown in Figure 20. Best performance occurs at 850 MHz providing a near 1 dB noise figure.

Measured input and output return loss is shown in Figure 21. The input return loss is 10 dB at 850 MHz and can be improved with slight tuning at C2. Output return loss was measured at almost 10 dB at 850 MHz.

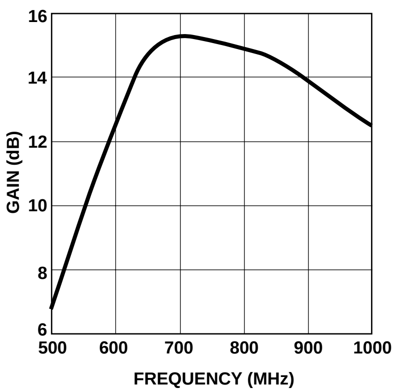


Figure 19. Gain vs Frequency.

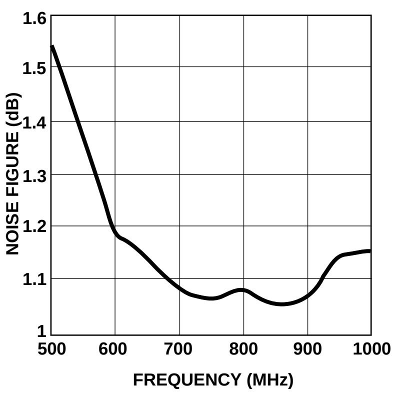


Figure 20. Noise Figure vs Frequency.

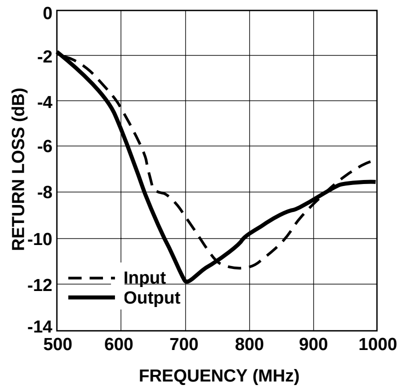


Figure 21. Input/Output Return Loss.

There is considerable tuning interaction between input and output matching networks in any single stage amplifier. Having a somewhat better input return loss coincident with low noise figure may necessitate a compromise in output return loss.

Output intercept point, IP_3, was measured at 850 MHz to be +12 dBm. Removing the 1.1 KΩ resistor at R6 increases IP_3 to +13.6 dBm. Resistor R6 was originally added to enhance stability; caution is urged when removing this resistor or increasing its value without careful analysis. Another alternative to the shunt resistor R6 would be to incorporate a resistor in series with the transistor collector lead. This resistor would be in the 10 to 27 Ω range and has similar effects on circuit stability. A third alternative is to re-optimize the output match for power as opposed to matching for lowest output VSWR. This may make the output return loss less than 10 dB but it would enhance power output.

Modifications to Original Demo Board

The original demo board dated 01/98 requires some modification to work as described in this application note. The modification is to add resistor R6 in series with the collector lead. This is accomplished by cutting the etch at the output of Q1 such that resistor R6 can be placed on the circuit board as shown in Figure 17. Inductor L3 will then have be placed at a 90 degree angle with respect to its original intended location. L3 is then connected to the junction of R6 and L4 with a small piece of wire or etch.

Using the AT-41532 at Other Frequencies

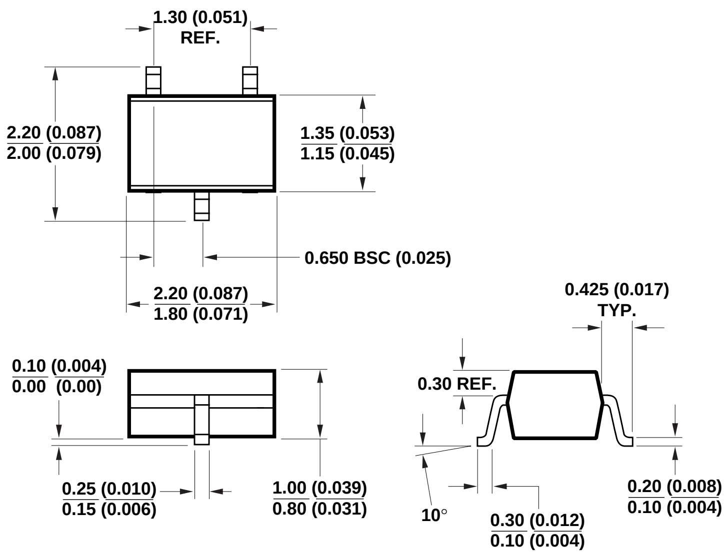
The demo board and design techniques presented here can be used to build low noise amplifiers for other frequencies in the VHF through 1.9 GHz frequency range.

Ordering Information

Part Number	Increment	Comments
AT-41532-BLK	100	Bulk
AT-41532-TR1	3000	7" Reel
AT-41532-TR2	10000	13" Reel

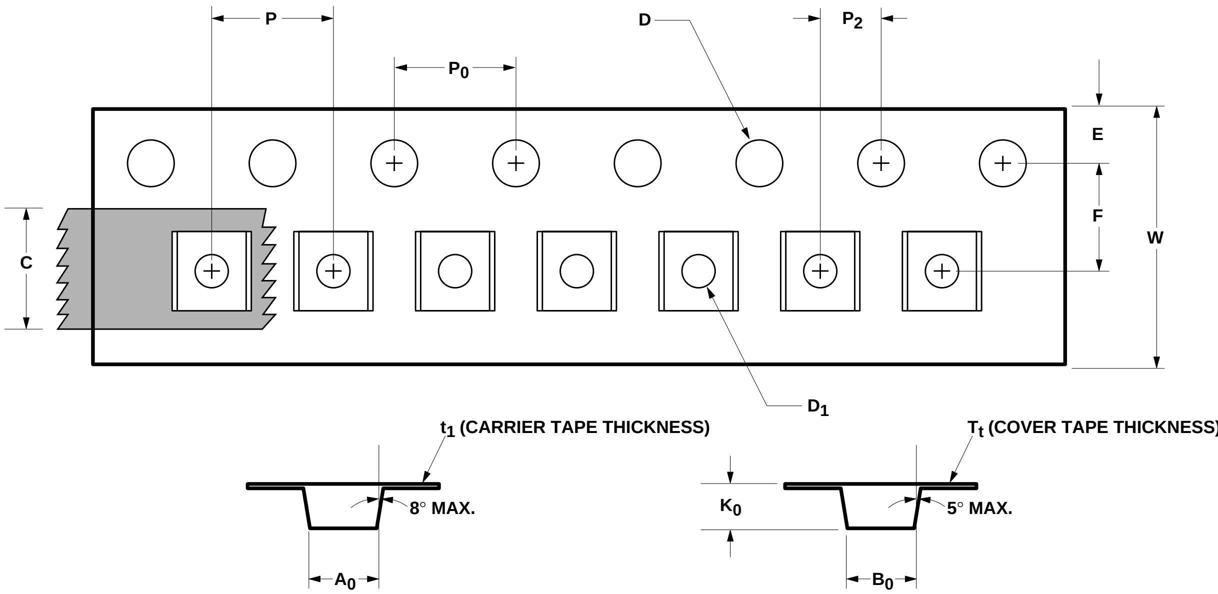
Package Dimensions

SOT-323 Plastic Package



Tape Dimensions and Product Orientation

For Outline SOT-323 (SC-70 3 Lead)



DESCRIPTION		SYMBOL	SIZE (mm)	SIZE (INCHES)
CAVITY	LENGTH	A_0	2.24 ± 0.10	0.088 ± 0.004
	WIDTH	B_0	2.34 ± 0.10	0.092 ± 0.004
	DEPTH	K_0	1.22 ± 0.10	0.048 ± 0.004
	PITCH	P	4.00 ± 0.10	0.157 ± 0.004
	BOTTOM HOLE DIAMETER	D_1	1.00 + 0.25	0.039 + 0.010
PERFORATION	DIAMETER	D	1.55 ± 0.05	0.061 ± 0.002
	PITCH	P_0	4.00 ± 0.10	0.157 ± 0.004
	POSITION	E	1.75 ± 0.10	0.069 ± 0.004
CARRIER TAPE	WIDTH	W	8.00 ± 0.30	0.315 ± 0.012
	THICKNESS	t_1	0.255 ± 0.013	0.010 ± 0.0005
COVER TAPE	WIDTH	C	5.4 ± 0.10	0.205 ± 0.004
	TAPE THICKNESS	T_t	0.062 ± 0.001	0.0025 ± 0.00004
DISTANCE	CAVITY TO PERFORATION (WIDTH DIRECTION)	F	3.50 ± 0.05	0.138 ± 0.002
	CAVITY TO PERFORATION (LENGTH DIRECTION)	P_2	2.00 ± 0.05	0.079 ± 0.002

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Data subject to change.

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