NEC

Silicon Transistor
μPA836TF

NPN SILICON EPITAXIAL TRANSISTOR (WITH 2 DIFFERENT ELEMENTS) IN A 6-PIN THIN-TYPE SMALL MINI MOLD PACKAGE

DESCRIPTION

The μPA836TF has two different built-in transistors (Q1 and Q2) for low noise amplification in the VHF band to UHF band.

FEATURES

- Low noise
  Q1 : NF = 1.5 dB TYP. @f = 2 GHz, V_{CE} = 3 V, I_C = 3 mA
  Q2 : NF = 1.7 dB TYP. @f = 2 GHz, V_{CE} = 1 V, I_C = 3 mA
- High gain
  Q1 : $|S_{21e}|^2$ = 8.5 dB TYP. @f = 2 GHz, V_{CE} = 3 V, I_C = 10 mA
  Q2 : $|S_{21e}|^2$ = 3.5 dB TYP. @f = 2 GHz, V_{CE} = 1 V, I_C = 3 mA
- 6-pin thin-type small mini mold package
- 2 different transistors on-chip (2SC5193, 2SC4959)

ON-CHIP TRANSISTORS

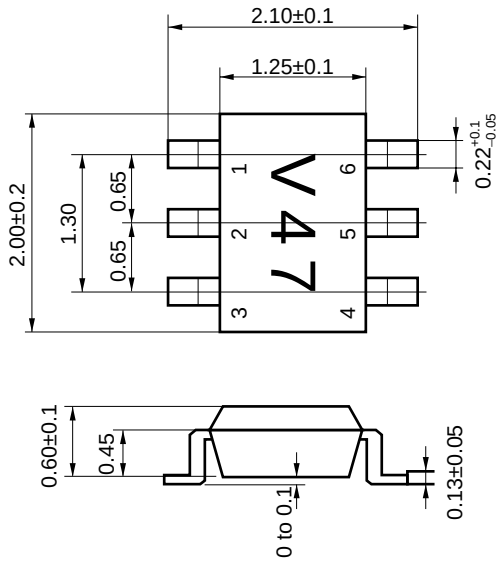
	Q1	Q2
3-pin small mini mold part No.	2SC4959	2SC5193

The μPA833TF features the Q1 and Q2 in inverted positions.

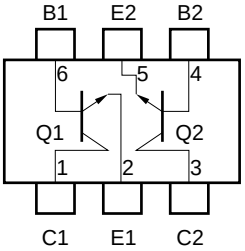
ORDERING INFORMATION

PART NUMBER	QUANTITY	PACKING STYLE
μPA836TF	Loose products (50 pcs)	8-mm wide embossed tape. Pin 6 (Q1 Base), pin 5 (Q2 Emitter), and pin 4 (Q2 Base) face perforated side of tape.
μPA836TF-T1	Taping products (3 kpcs/reel)	

PACKAGE DRAWINGS (Unit:mm)



PIN CONFIGURATION (Top View)



PIN CONNECTIONS

1. Collector (Q1)
2. Emitter (Q1)
3. Collector (Q2)
4. Base (Q2)
5. Emitter (Q2)
6. Base (Q1)

Caution is required concerning excess input, such as from static electricity because the high-frequency process is used for this device.

Document No. P12728EJ1V0DS00 (1st edition)
Date Published August 1997 N
Printed in Japan

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C)

PARAMETER	SYMBOL	RATING		UNIT
		Q1	Q2	
Collector to base voltage	V_{CBO}	9	9	V
Collector to emitter voltage	V_{CEO}	6	6	V
Emitter to base voltage	V_{EBO}	2	2	V
Collector current	I_C	30	100	mA
Total power dissipation	P_T	150 in 1 element	150 in 1 element	mW
		200 in 2 elements[Note]		
Junction temperature	T_j	150	150	°C
Storage temperature	T_{stg}	−65 to +150		°C

Note 110 mW must not be exceeded for 1 element.

(1) Q1

ELECTRICAL CHARACTERISTICS

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Collector cutoff current	I_{CBO}	V_{CB} = 5 V, I_E = 0			0.1	μA
Emitter cutoff current	I_{EBO}	V_{EB} = 1 V, I_C = 0			0.1	μA
DC current gain	h_{FE}	V_{CE} = 3 V, I_C = 10 mA[Note 1]	75		150	
Gain bandwidth product	f_T	V_{CE} = 3 V, I_C = 10 mA, f = 2 GHz		12		GHz
Feedback capacitance	C_{re}	V_{CB} = 3 V, I_E = 0, f = 1 MHz[Note 2]		0.4	0.7	pF
Insertion power gain	$\|S_{21e}\|^2$	V_{CE} = 3 V, I_C = 10 mA, f = 2 GHz	7	8.5		dB
Noise figure	NF	V_{CE} = 3 V, I_C = 3 mA, f = 2 GHz		1.5	2.5	dB

Notes 1. Pulse measurement: PW ≤ 350 μs, Duty cycle ≤ 2%

2. Collector to base capacitance when measured with capacitance meter (automatic balanced bridge method), with emitter connected to guard pin of capacitance meter.

(2) Q2

ELECTRICAL CHARACTERISTICS

PARAMETER	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Collector cutoff current	I_{CBO}	V_{CB} = 5 V, I_E = 0			0.1	μA
Emitter cutoff current	I_{EBO}	V_{EB} = 1 V, I_C = 0			0.1	μA
DC current gain	h_{FE}	V_{CE} = 1 V, I_C = 3 mA Note 1	100		145	
Gain bandwidth product (1)	f_T	V_{CE} = 1 V, I_C = 3 mA, f = 2 GHz	4.0	4.5		GHz
Gain bandwidth product (2)	f_T	V_{CE} = 3 V, I_C = 20 mA, f = 2 GHz		9.0		GHz
Feedback capacitance	C_{re}	V_{CB} = 1 V, I_E = 0, f = 1 MHz Note 2		0.75	0.85	pF
Insertion power gain (1)	$\|S_{21e}\|^2$	V_{CE} = 1 V, I_C = 3 mA, f = 2 GHz	2.5	3.5		dB
Insertion power gain (2)	$\|S_{21e}\|^2$	V_{CE} = 3 V, I_C = 20 mA, f = 2 GHz		6.5		dB
Noise figure (1)	NF	V_{CE} = 1 V, I_C = 3 mA, f = 2 GHz		1.7	2.5	dB
Noise figure (2)	NF	V_{CE} = 3 V, I_C = 7 mA, f = 2 GHz		1.5		dB

Notes 1. Pulse measurement: PW ≤ 350 μs, Duty cycle ≤ 2%

2. Collector to base capacitance when measured with capacitance meter (automatic balanced bridge method), with emitter connected to guard pin of capacitance meter.

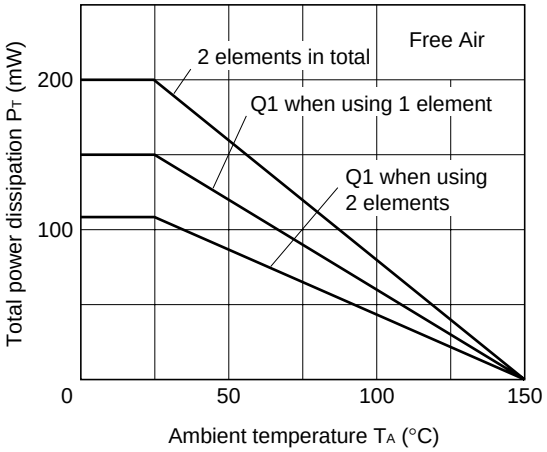
h_{FE} CLASSIFICATION

Rank	FB
Marking	V47
h_{FE} value of Q1	75 to 150
h_{FE} value of Q2	100 to 145

TYPICAL CHARACTERISTICS (T_A = 25°C)

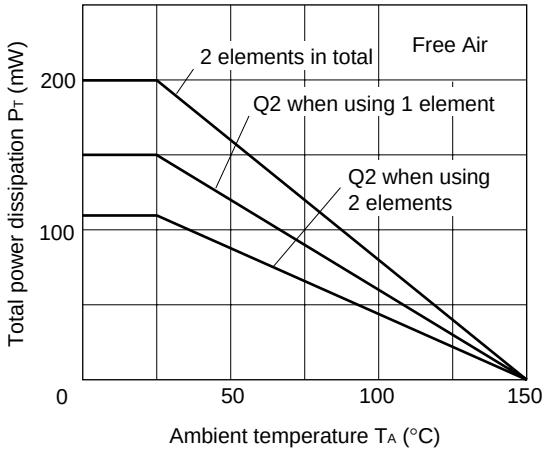
Q1

Total Power Dissipation vs. Ambient Temperature

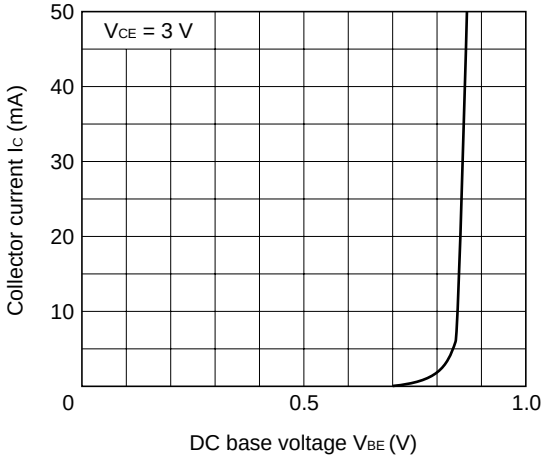


Q2

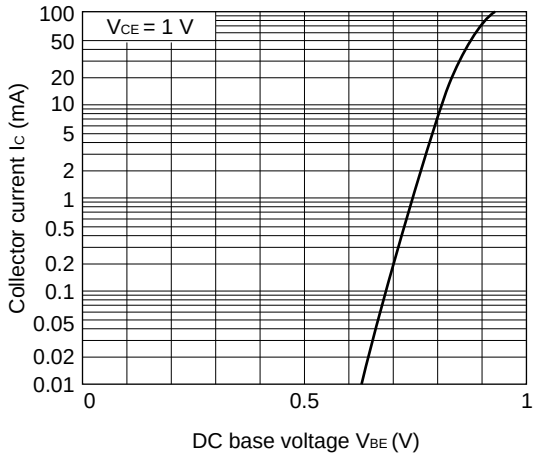
Total Power Dissipation vs. Ambient Temperature



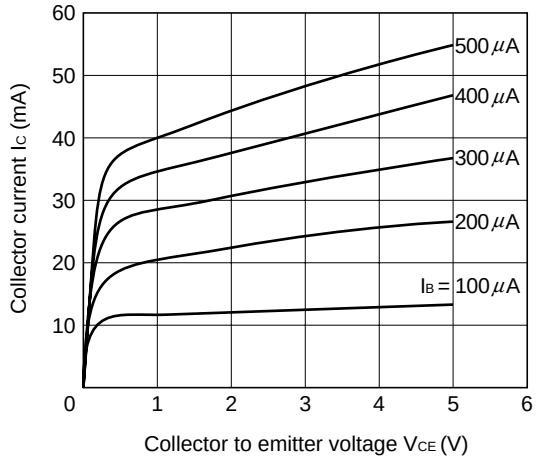
Collector Current vs. DC Base Voltage



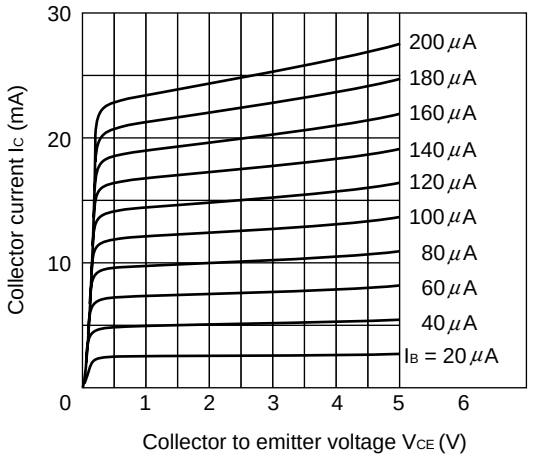
Collector Current vs. DC Base Voltage



Collector Current vs. Collector to Emitter Voltage

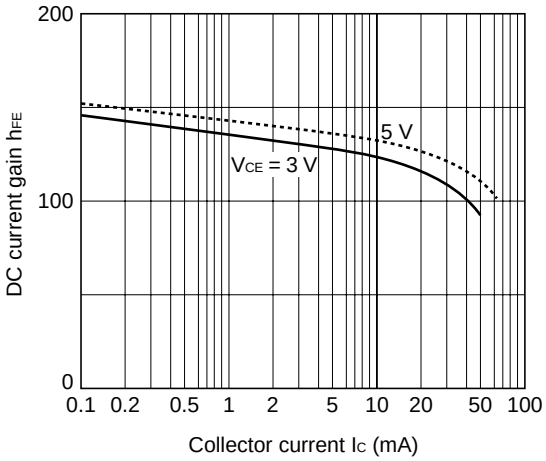


Collector Current vs. Collector to Emitter Voltage

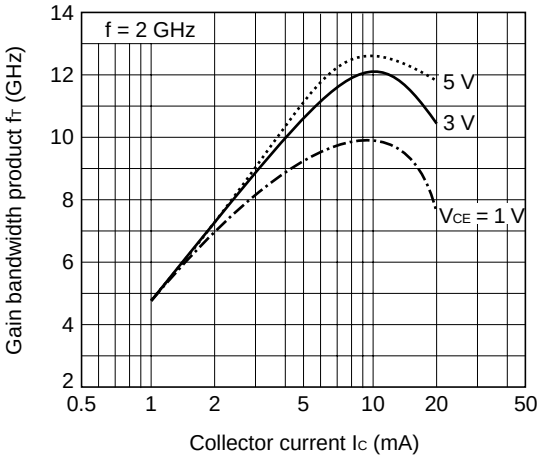


Q1

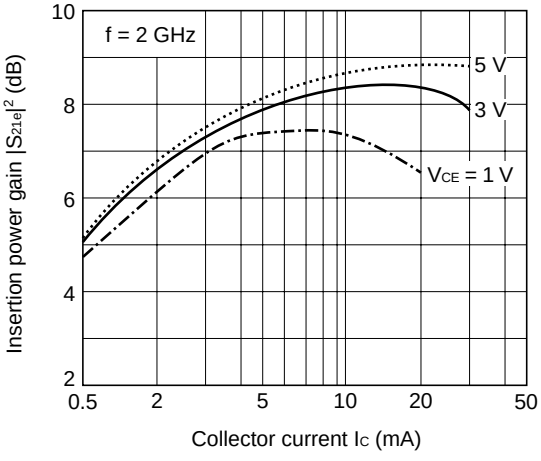
DC Current Gain vs. Collector Current



Gain Bandwidth Product vs. Collector Current

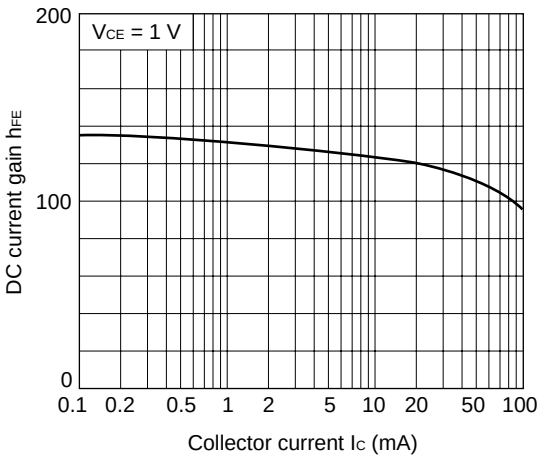


Insertion Power Gain vs. Collector Current

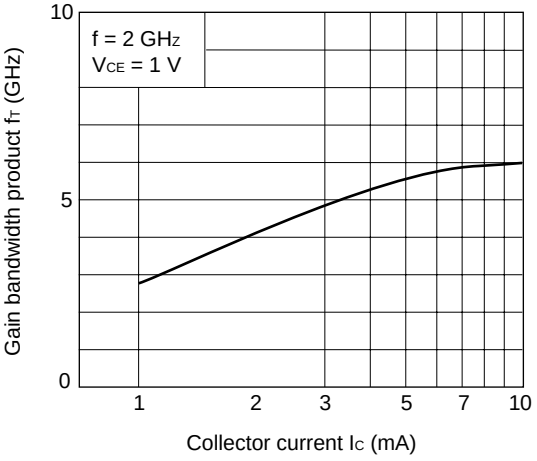


Q2

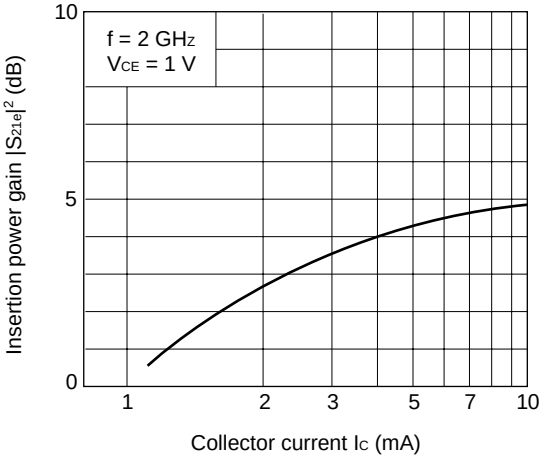
DC Current Gain vs. Collector Current



Gain Bandwidth Product vs. Collector Current

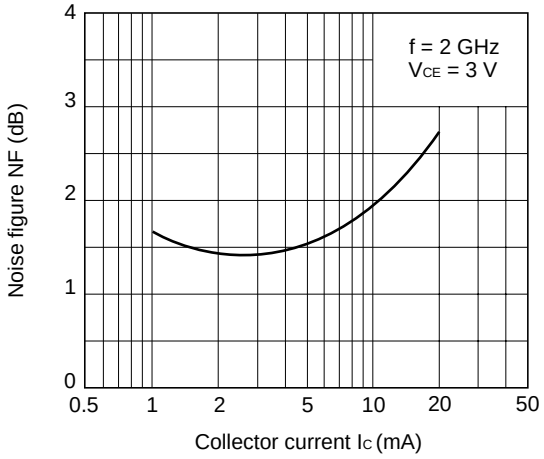


Insertion Power Gain vs. Collector Current



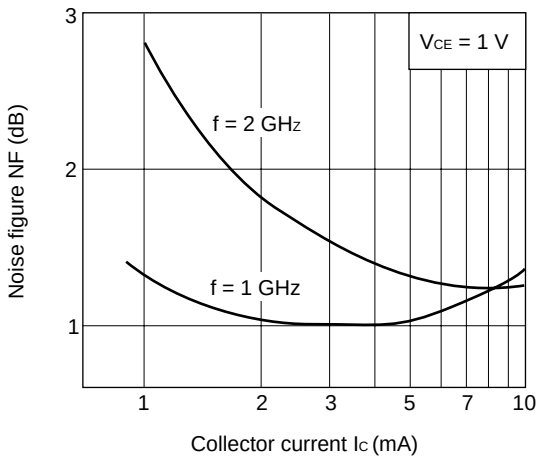
Q1

Noise Figure vs. Collector Current

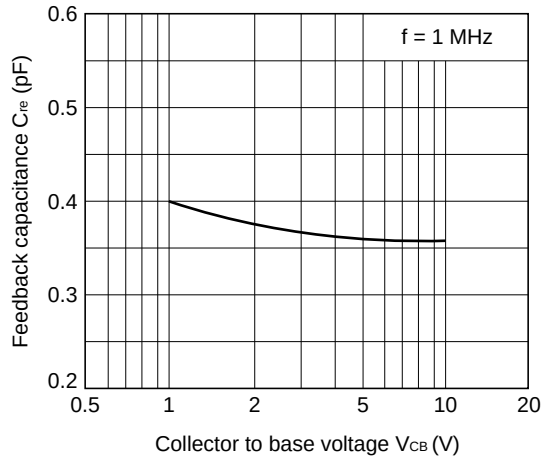


Q2

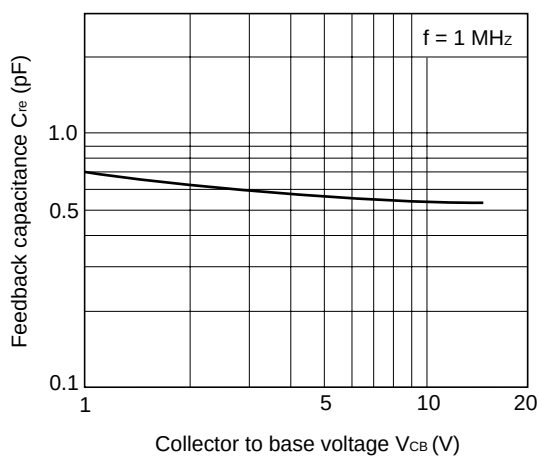
Noise Figure vs. Collector Current



Feedback Capacitance vs. Collector to Base Voltage

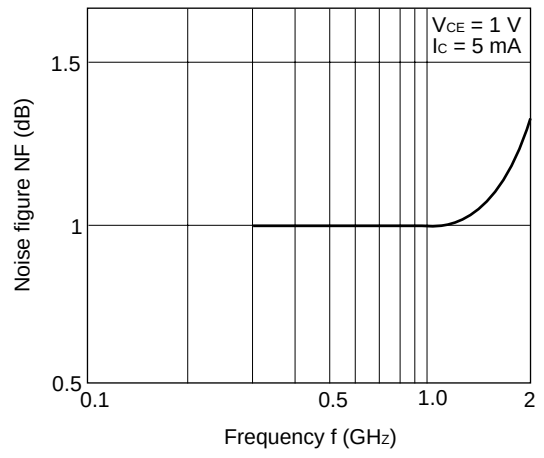


Feedback Capacitance vs. Collector to Base Voltage

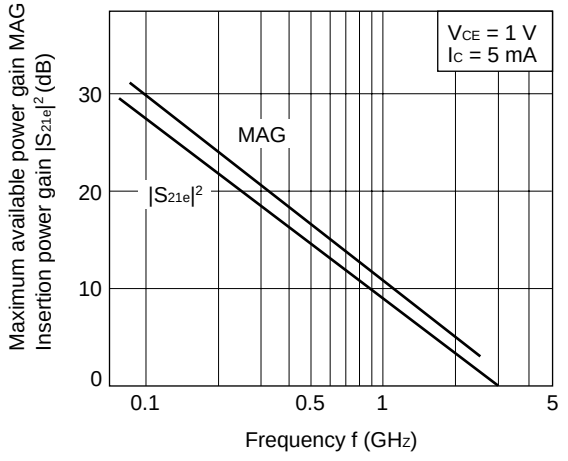


Q2

Noise Figure vs. Frequency



Maximum Available Gain,
Insertion Power Gain vs. Frequency



S-PARAMETERS Q1

V_{CE} = 3 V, I_C = 1 mA, Z_0 = 50 Ω

FREQUENCY	S11		S21		S12		S22	
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
.10	.98	–5.93	2.38	172.32	.02	85.76	1.00	–3.86
.20	.97	–11.90	2.36	165.08	.04	81.15	.99	–7.44
.30	.95	–18.17	2.39	158.35	.06	76.27	.97	–11.14
.40	.93	–24.00	2.35	151.83	.07	72.22	.96	–14.73
.50	.90	–30.10	2.35	145.70	.09	68.30	.94	–18.02
.60	.87	–36.17	2.33	140.22	.10	64.18	.92	–21.42
.70	.84	–42.49	2.30	134.45	.12	60.68	.89	–24.18
.80	.80	–48.69	2.29	129.32	.13	56.90	.87	–27.47
.90	.76	–55.28	2.29	123.53	.14	53.94	.84	–29.94
1.00	.73	–61.26	2.24	118.31	.15	51.07	.81	–32.50
1.10	.68	–68.07	2.22	113.44	.16	48.11	.79	–34.89
1.20	.64	–74.79	2.19	108.30	.16	45.85	.76	–36.89
1.30	.60	–81.83	2.15	103.55	.17	43.33	.74	–39.11
1.40	.55	–89.00	2.12	98.67	.17	41.40	.72	–40.93
1.50	.51	–96.77	2.10	93.80	.18	39.24	.69	–42.90
1.60	.47	–104.09	2.05	89.19	.18	37.66	.67	–44.72
1.70	.43	–112.09	2.00	84.74	.19	36.24	.65	–46.39
1.80	.40	–120.45	1.95	80.45	.19	34.56	.63	–48.25
1.90	.37	–129.41	1.90	76.40	.19	33.39	.61	–49.75
2.00	.35	–138.38	1.84	72.75	.19	32.40	.60	–51.51
2.10	.33	–148.11	1.81	68.64	.19	31.72	.58	–52.83
2.20	.32	–157.58	1.76	64.92	.20	30.93	.57	–54.63
2.30	.31	–166.88	1.71	61.22	.20	30.18	.55	–56.25
2.40	.31	–176.01	1.66	58.06	.20	30.03	.54	–58.11
2.50	.31	175.03	1.62	54.64	.20	29.55	.53	–59.91
2.60	.31	166.46	1.58	51.50	.20	29.28	.51	–61.71
2.70	.32	159.62	1.53	48.49	.20	29.00	.50	–63.72
2.80	.33	152.04	1.49	45.40	.21	28.82	.49	–65.70
2.90	.34	145.83	1.46	42.65	.21	28.80	.48	–67.81
3.00	.35	140.64	1.41	40.02	.21	28.96	.47	–69.74

V_{CE} = 3 V, I_C = 3 mA, Z_0 = 50 Ω

FREQUENCY	S11		S21		S12		S22	
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
.10	.94	–9.29	6.55	168.08	.02	84.10	.98	–6.91
.20	.90	–18.39	6.32	157.85	.04	76.93	.95	–13.21
.30	.85	–27.47	6.21	148.76	.05	71.79	.91	–18.80
.40	.80	–36.15	5.98	140.53	.06	66.81	.86	–23.80
.50	.74	–44.62	5.77	133.00	.07	63.60	.81	–27.41
.60	.67	–52.69	5.51	126.23	.08	60.13	.76	–31.19
.70	.60	–60.71	5.28	119.27	.09	58.07	.72	–33.67
.80	.54	–68.45	5.03	113.12	.10	55.93	.68	–36.31
.90	.47	–75.60	4.76	107.23	.11	54.62	.64	–38.10
1.00	.42	–82.57	4.50	101.99	.11	53.45	.61	–39.74
1.10	.36	–89.81	4.25	97.09	.12	52.36	.58	–41.44
1.20	.32	–96.78	4.02	92.52	.13	51.59	.56	–42.63
1.30	.28	–104.70	3.80	88.51	.13	50.82	.54	–44.03
1.40	.24	–112.82	3.60	84.54	.14	50.32	.52	–45.49
1.50	.21	–122.39	3.42	80.83	.15	49.61	.50	–46.74
1.60	.19	–132.58	3.25	77.42	.15	48.93	.48	–48.15
1.70	.17	–143.90	3.10	74.15	.16	48.63	.46	–49.50
1.80	.16	–156.26	2.96	70.97	.16	47.95	.45	–51.09
1.90	.16	–168.80	2.83	67.97	.17	47.25	.44	–52.53
2.00	.16	179.12	2.70	64.83	.18	46.70	.42	–54.02
2.10	.16	167.80	2.60	62.14	.18	46.24	.41	–55.57
2.20	.17	157.86	2.50	59.47	.19	45.72	.40	–57.43
2.30	.19	149.77	2.40	56.62	.19	44.99	.39	–59.14
2.40	.20	142.43	2.31	54.07	.20	44.36	.37	–61.28
2.50	.22	136.13	2.24	51.62	.21	43.76	.36	–63.34
2.60	.23	130.97	2.16	49.11	.21	42.91	.35	–65.48
2.70	.25	126.43	2.09	46.64	.22	42.33	.34	–67.77
2.80	.26	122.06	2.02	44.41	.22	41.59	.33	–70.30
2.90	.28	118.64	1.96	42.02	.23	40.99	.32	–72.81
3.00	.29	115.80	1.89	39.81	.23	40.27	.31	–75.36

S-PARAMETERS Q1

V_{CE} = 3 V, I_C = 5 mA, Z_0 = 50 Ω

FREQUENCY	S11		S21		S12		S22	
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
.10	.90	–12.12	10.05	165.07	.02	82.08	.97	–9.12
.20	.84	–23.51	9.49	152.86	.03	74.99	.92	–17.06
.30	.77	–34.84	9.08	142.06	.05	69.42	.85	–23.23
.40	.69	–45.03	8.52	132.57	.06	65.57	.78	–28.22
.50	.60	–54.58	7.94	123.96	.07	63.02	.72	–31.57
.60	.52	–62.89	7.32	116.79	.08	60.80	.66	–34.45
.70	.44	–70.48	6.74	109.99	.08	59.78	.62	–36.34
.80	.38	–77.63	6.21	104.22	.09	58.73	.58	–38.08
.90	.32	–84.12	5.71	99.08	.10	57.98	.55	–39.38
1.00	.28	–90.92	5.28	94.41	.11	57.45	.53	–40.58
1.10	.23	–97.81	4.90	90.40	.11	56.92	.50	–41.81
1.20	.20	–105.44	4.56	86.53	.12	56.41	.48	–42.73
1.30	.17	–114.52	4.27	83.13	.13	55.94	.46	–43.87
1.40	.14	–124.74	4.01	79.77	.13	55.49	.45	–45.20
1.50	.13	–137.90	3.78	76.56	.14	54.85	.43	–46.37
1.60	.11	–152.33	3.58	73.63	.15	54.15	.42	–47.87
1.70	.11	–167.88	3.39	70.79	.15	53.69	.40	–49.23
1.80	.11	177.28	3.23	67.93	.16	52.89	.39	–50.80
1.90	.12	163.98	3.08	65.32	.17	52.20	.38	–52.29
2.00	.13	152.80	2.93	62.58	.18	51.42	.37	–54.00
2.10	.14	143.82	2.81	60.07	.18	50.75	.36	–55.75
2.20	.16	136.52	2.70	57.67	.19	50.10	.35	–57.73
2.30	.17	130.81	2.59	55.05	.20	49.15	.33	–59.61
2.40	.19	126.04	2.50	52.83	.20	48.36	.32	–62.01
2.50	.21	121.76	2.41	50.64	.21	47.56	.31	–64.32
2.60	.22	118.20	2.33	48.15	.22	46.64	.30	–66.89
2.70	.24	115.10	2.25	45.92	.22	45.70	.29	–69.48
2.80	.25	111.94	2.17	43.83	.23	44.66	.28	–72.54
2.90	.27	109.74	2.10	41.74	.24	43.87	.27	–75.25
3.00	.28	107.74	2.03	39.80	.24	42.91	.26	–78.22

V_{CE} = 3 V, I_C = 10 mA, Z_0 = 50 Ω

FREQUENCY	S11		S21		S12		S22	
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
.10	.82	–17.52	16.52	159.99	.02	80.28	.94	–12.68
.20	.72	–33.22	14.93	144.21	.03	72.82	.85	–22.43
.30	.60	–46.83	13.32	131.03	.04	68.07	.75	–28.43
.40	.49	–57.62	11.65	120.45	.05	65.62	.67	–32.14
.50	.40	–65.90	10.15	112.22	.06	65.03	.60	–34.25
.60	.33	–72.93	8.90	105.22	.07	63.86	.56	–35.78
.70	.27	–79.33	7.89	100.37	.08	63.74	.52	–36.80
.80	.22	–85.38	7.07	95.73	.08	63.50	.49	–37.69
.90	.18	–91.73	6.39	91.61	.09	63.16	.46	–38.46
1.00	.15	–98.81	5.83	87.88	.10	62.77	.45	–39.30
1.10	.12	–107.45	5.35	84.47	.11	62.22	.43	–40.19
1.20	.10	–118.22	4.95	81.32	.11	61.85	.41	–41.01
1.30	.08	–133.80	4.62	78.49	.12	61.19	.40	–42.05
1.40	.07	–153.77	4.31	75.63	.13	60.72	.39	–43.42
1.50	.07	–176.19	4.05	72.83	.14	59.79	.38	–44.69
1.60	.07	164.45	3.82	70.28	.15	59.22	.36	–46.17
1.70	.08	149.79	3.61	67.81	.15	58.31	.35	–47.69
1.80	.10	138.91	3.42	65.32	.16	57.24	.34	–49.53
1.90	.11	131.52	3.26	62.88	.17	56.34	.33	–51.25
2.00	.13	125.94	3.12	60.46	.18	55.55	.32	–53.15
2.10	.15	121.31	2.98	58.25	.19	54.57	.31	–55.05
2.20	.16	117.28	2.85	56.06	.19	53.65	.30	–57.33
2.30	.18	114.88	2.74	53.72	.20	52.42	.29	–59.70
2.40	.20	111.75	2.64	51.59	.21	51.55	.28	–62.40
2.50	.21	109.57	2.54	49.58	.22	50.37	.27	–65.07
2.60	.23	107.60	2.45	47.36	.22	49.19	.26	–67.95
2.70	.24	105.45	2.36	45.20	.23	48.18	.25	–71.01
2.80	.26	103.59	2.29	43.25	.24	47.05	.24	–74.44
2.90	.27	102.11	2.21	41.26	.25	45.94	.23	–78.01
3.00	.29	100.79	2.14	39.46	.25	45.03	.21	–81.46

S-PARAMETERS Q2

V_{CE} = 3 V, I_C = 1 mA, Z_0 = 50 Ω

FREQUENCY	S11		S21		S12		S22	
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
.10	.97	–14.32	2.42	166.29	.04	80.18	.99	–7.24
.20	.95	–28.41	2.36	154.31	.07	70.77	.96	–14.16
.30	.91	–42.45	2.34	143.61	.10	62.19	.91	–20.19
.40	.88	–55.88	2.25	133.74	.13	54.42	.87	–25.69
.50	.83	–69.17	2.21	124.69	.14	48.08	.81	–30.13
.60	.79	–81.80	2.14	116.51	.16	42.00	.77	–34.32
.70	.75	–93.67	2.06	108.52	.17	37.41	.72	–37.52
.80	.72	–104.67	1.98	101.49	.17	33.30	.68	–40.84
.90	.69	–115.37	1.91	94.57	.18	29.92	.65	–43.52
1.00	.67	–124.80	1.81	88.40	.18	27.31	.62	–46.09
1.10	.65	–133.94	1.74	82.84	.18	25.22	.59	–48.86
1.20	.63	–142.25	1.66	77.30	.18	23.77	.57	–51.18
1.30	.62	–149.96	1.59	72.44	.17	22.66	.55	–53.96
1.40	.61	–157.13	1.52	67.64	.17	22.22	.53	–56.90
1.50	.61	–163.80	1.46	63.16	.17	22.24	.51	–59.93
1.60	.61	–169.92	1.40	58.91	.17	22.91	.49	–63.04
1.70	.61	–175.60	1.35	54.92	.16	24.02	.48	–66.60
1.80	.61	179.06	1.30	51.14	.16	25.66	.46	–70.43
1.90	.61	174.00	1.25	47.55	.16	27.51	.45	–74.41
2.00	.61	169.35	1.21	43.93	.16	30.08	.44	–78.77
2.10	.62	165.00	1.17	40.40	.16	32.69	.43	–83.40
2.20	.62	160.73	1.13	37.13	.17	35.27	.42	–88.74
2.30	.63	156.90	1.09	33.87	.17	37.61	.41	–94.25
2.40	.64	153.27	1.06	30.94	.18	40.19	.40	–100.25
2.50	.64	149.69	1.02	28.22	.19	41.91	.39	–106.64
2.60	.65	146.37	.99	25.33	.20	43.39	.38	–113.50
2.70	.66	143.12	.96	22.63	.21	44.65	.38	–120.35
2.80	.67	140.20	.93	20.16	.23	45.36	.38	–127.21
2.90	.67	137.30	.91	17.86	.24	45.73	.38	–134.04
3.00	.68	134.75	.88	15.55	.26	45.51	.39	–141.18

V_{CE} = 3 V, I_C = 3 mA, Z_0 = 50 Ω

FREQUENCY	S11		S21		S12		S22	
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
.10	.91	–20.77	6.78	160.00	.04	76.08	.95	–14.28
.20	.84	–40.45	6.30	145.15	.06	64.72	.86	–26.08
.30	.76	–59.61	5.98	132.53	.08	56.56	.75	–34.42
.40	.69	–77.35	5.54	121.70	.10	50.58	.66	–41.09
.50	.62	–93.52	5.09	112.12	.11	47.02	.58	–45.13
.60	.57	–107.23	4.61	104.36	.12	44.57	.51	–48.78
.70	.53	–119.29	4.20	97.25	.12	43.10	.46	–51.09
.80	.50	–129.99	3.84	91.32	.13	42.46	.42	–53.42
.90	.48	–139.30	3.51	85.88	.13	41.93	.38	–55.21
1.00	.47	–147.65	3.25	80.98	.14	42.00	.36	–56.92
1.10	.46	–155.28	3.00	76.59	.15	42.04	.33	–58.86
1.20	.46	–161.91	2.80	72.45	.15	42.33	.31	–60.52
1.30	.46	–168.23	2.62	68.51	.16	42.54	.28	–62.72
1.40	.46	–173.80	2.46	64.85	.16	43.09	.26	–65.15
1.50	.46	–179.07	2.33	61.22	.17	43.12	.25	–67.97
1.60	.47	176.01	2.20	57.78	.18	43.42	.23	–70.92
1.70	.47	171.72	2.10	54.61	.18	43.54	.21	–74.72
1.80	.48	167.62	2.00	51.39	.19	43.72	.20	–78.93
1.90	.49	163.82	1.91	48.33	.20	43.74	.19	–83.74
2.00	.49	160.12	1.83	45.19	.21	43.70	.17	–89.34
2.10	.50	156.73	1.76	42.17	.22	43.54	.16	–95.60
2.20	.51	153.44	1.69	39.41	.23	43.20	.15	–103.80
2.30	.52	150.43	1.63	36.46	.23	42.72	.14	–112.05
2.40	.53	147.65	1.58	33.95	.24	42.35	.14	–122.10
2.50	.54	144.71	1.52	31.01	.25	42.00	.13	–132.57
2.60	.55	142.10	1.47	28.44	.26	41.31	.14	–143.43
2.70	.56	139.53	1.42	25.86	.27	40.67	.14	–154.35
2.80	.57	137.12	1.37	23.37	.28	40.00	.15	–163.63
2.90	.58	134.87	1.34	21.21	.29	39.04	.16	–171.94
3.00	.59	132.90	1.29	18.97	.30	38.08	.17	–179.42

S-PARAMETERS Q2

V_{CE} = 3 V, I_C = 5 mA, Z_0 = 50 Ω

FREQUENCY	S11		S21		S12		S22	
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
.10	.84	–26.28	10.60	155.28	.03	73.62	.91	–19.87
.20	.75	–50.58	9.48	138.37	.06	62.12	.77	–34.36
.30	.64	–73.48	8.58	124.39	.07	55.68	.63	–43.20
.40	.56	–93.24	7.56	113.09	.08	52.30	.53	–49.31
.50	.49	–109.26	6.59	104.26	.09	50.89	.45	–52.83
.60	.45	–122.23	5.76	97.42	.10	50.06	.39	–55.78
.70	.43	–133.23	5.10	91.52	.11	49.97	.34	–57.54
.80	.41	–142.94	4.57	86.44	.12	50.11	.31	–59.42
.90	.40	–151.05	4.13	81.93	.13	50.05	.27	–60.94
1.00	.40	–158.37	3.78	77.69	.13	50.37	.25	–62.43
1.10	.40	–164.99	3.47	73.94	.14	50.41	.23	–64.37
1.20	.40	–170.84	3.22	70.16	.15	50.44	.20	–66.17
1.30	.40	–176.20	3.00	66.81	.16	50.23	.18	–68.33
1.40	.41	178.98	2.81	63.48	.17	49.93	.17	–71.42
1.50	.41	174.38	2.64	60.16	.18	49.56	.15	–75.30
1.60	.42	170.27	2.50	57.17	.19	49.03	.13	–79.54
1.70	.43	166.51	2.37	54.26	.20	48.51	.12	–85.04
1.80	.44	162.78	2.25	51.23	.21	48.06	.10	–91.47
1.90	.44	159.51	2.15	48.45	.22	47.32	.09	–100.05
2.00	.45	156.30	2.05	45.69	.23	46.68	.08	–111.15
2.10	.46	153.32	1.97	42.82	.24	45.83	.08	–122.79
2.20	.47	150.34	1.89	40.28	.25	44.90	.07	–139.24
2.30	.49	147.64	1.82	37.34	.26	43.80	.08	–153.84
2.40	.50	145.08	1.76	34.99	.27	43.04	.08	–167.79
2.50	.51	142.45	1.69	32.37	.28	41.96	.09	–179.51
2.60	.52	140.11	1.63	29.82	.28	40.68	.11	170.08
2.70	.53	137.76	1.58	27.34	.29	39.87	.12	161.83
2.80	.54	135.51	1.53	25.00	.30	38.78	.14	156.48
2.90	.55	133.53	1.48	22.88	.31	37.50	.15	151.05
3.00	.56	131.71	1.44	20.88	.32	36.35	.17	146.82

V_{CE} = 3 V, I_C = 7 mA, Z_0 = 50 Ω

FREQUENCY	S11		S21		S12		S22	
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
.10	.78	–31.29	13.97	151.51	.03	71.78	.87	–24.42
.20	.66	–59.66	12.04	132.90	.05	60.97	.70	–40.28
.30	.54	–84.82	10.35	118.21	.07	56.44	.55	–48.33
.40	.47	–104.53	8.72	107.56	.08	55.05	.45	–54.30
.50	.42	–119.83	7.38	99.69	.09	54.45	.37	–57.44
.60	.39	–132.03	6.34	93.65	.10	54.56	.32	–60.00
.70	.37	–142.05	5.56	88.39	.11	54.88	.28	–61.66
.80	.36	–150.83	4.94	83.86	.11	55.01	.24	–63.45
.90	.36	–158.17	4.45	79.83	.12	55.07	.21	–65.04
1.00	.36	–164.78	4.05	75.94	.13	55.03	.19	–66.66
1.10	.36	–170.73	3.71	72.52	.15	54.76	.17	–68.84
1.20	.37	–175.89	3.43	69.04	.15	54.31	.15	–71.21
1.30	.37	179.16	3.19	65.94	.17	53.90	.13	–74.02
1.40	.38	174.81	2.98	62.71	.18	53.37	.12	–78.28
1.50	.39	170.80	2.80	59.72	.19	52.52	.10	–83.83
1.60	.40	166.95	2.64	56.84	.20	51.77	.09	–90.66
1.70	.40	163.55	2.51	54.06	.21	50.73	.07	–100.27
1.80	.42	160.17	2.38	51.26	.22	49.92	.06	–113.19
1.90	.42	157.10	2.27	48.51	.23	48.83	.06	–128.68
2.00	.43	154.21	2.17	45.65	.24	47.90	.05	–148.70
2.10	.45	151.39	2.08	43.23	.25	46.78	.06	–164.37
2.20	.46	148.60	1.99	40.65	.26	45.58	.07	179.05
2.30	.47	146.09	1.91	38.02	.27	44.32	.08	168.05
2.40	.48	143.75	1.85	35.58	.28	43.15	.09	159.41
2.50	.49	141.28	1.78	33.14	.29	41.96	.11	152.83
2.60	.50	138.97	1.72	30.76	.29	40.73	.13	147.19
2.70	.51	136.66	1.65	28.32	.30	39.56	.15	142.36
2.80	.53	134.75	1.61	26.15	.31	38.16	.16	139.39
2.90	.54	132.61	1.56	23.94	.32	36.97	.18	135.62
3.00	.55	131.03	1.51	21.87	.33	35.50	.19	132.79

S-PARAMETERS Q2

V_{CE} = 3 V, I_C = 10 mA, Z_0 = 50 Ω

FREQUENCY	S11		S21		S12		S22	
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
.10	.70	–38.41	18.28	146.82	.03	69.80	.82	–29.66
.20	.56	–71.49	14.88	126.35	.05	61.45	.61	–46.31
.30	.45	–97.54	11.94	112.07	.06	58.70	.46	–54.40
.40	.39	–116.40	9.67	102.58	.07	58.67	.37	–59.06
.50	.35	–130.54	8.00	95.72	.08	59.11	.30	–61.94
.60	.34	–141.64	6.81	90.48	.09	59.40	.26	–64.34
.70	.33	–150.51	5.91	85.85	.10	59.73	.22	–65.99
.80	.33	–158.31	5.24	81.79	.11	59.53	.19	–68.05
.90	.33	–164.94	4.70	78.04	.12	59.10	.16	–70.00
1.00	.33	–170.77	4.27	74.52	.14	58.94	.14	–72.05
1.10	.34	–176.02	3.90	71.29	.15	58.12	.12	–75.15
1.20	.34	179.29	3.60	68.08	.16	57.53	.11	–78.53
1.30	.35	175.03	3.35	65.10	.17	56.63	.09	–83.55
1.40	.36	171.11	3.12	62.00	.18	55.78	.07	–91.04
1.50	.37	167.43	2.93	59.24	.19	54.68	.06	–101.03
1.60	.38	163.97	2.76	56.49	.20	53.56	.05	–116.44
1.70	.39	160.78	2.62	53.77	.21	52.45	.05	–135.60
1.80	.40	157.85	2.49	51.11	.22	51.12	.05	–157.62
1.90	.41	155.01	2.37	48.55	.24	49.98	.05	–175.46
2.00	.42	152.28	2.26	45.88	.25	48.84	.06	168.53
2.10	.43	149.67	2.17	43.38	.26	47.60	.08	160.16
2.20	.44	147.06	2.08	40.98	.27	45.92	.09	151.50
2.30	.45	144.72	2.00	38.47	.28	44.63	.11	146.27
2.40	.47	142.40	1.92	36.25	.29	43.30	.12	141.74
2.50	.48	140.09	1.85	33.78	.30	41.93	.14	138.30
2.60	.49	137.98	1.79	31.35	.30	40.49	.16	134.62
2.70	.50	135.73	1.72	29.17	.31	39.21	.18	131.40
2.80	.51	133.91	1.66	27.03	.32	37.72	.19	129.30
2.90	.53	131.85	1.61	24.92	.33	36.31	.21	126.68
3.00	.54	130.31	1.57	22.81	.34	34.93	.22	124.44

V_{CE} = 3 V, I_C = 20 mA, Z_0 = 50 Ω

FREQUENCY	S11		S21		S12		S22	
GHz	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
.10	.51	–57.90	27.75	136.02	.02	69.14	.70	–39.87
.20	.37	–97.17	19.04	114.46	.04	64.83	.46	–56.12
.30	.31	–120.97	13.81	103.21	.05	65.82	.33	–62.80
.40	.29	–137.00	10.72	95.92	.06	66.30	.26	–66.88
.50	.28	–148.56	8.73	90.60	.08	66.42	.21	–69.42
.60	.28	–157.11	7.34	86.37	.09	66.46	.17	–72.27
.70	.28	–164.14	6.36	82.37	.10	66.07	.14	–74.72
.80	.29	–170.13	5.60	78.94	.11	65.59	.12	–78.14
.90	.29	–175.24	5.00	75.67	.13	64.35	.10	–82.37
1.00	.30	–179.80	4.54	72.57	.14	63.61	.08	–87.43
1.10	.31	176.11	4.14	69.68	.15	62.44	.06	–95.70
1.20	.32	172.24	3.81	66.74	.16	61.26	.05	–106.92
1.30	.33	168.89	3.54	64.03	.18	60.00	.04	–125.19
1.40	.33	165.67	3.30	61.30	.19	58.62	.04	–147.69
1.50	.34	162.54	3.09	58.59	.20	57.19	.04	–169.73
1.60	.36	159.63	2.92	56.05	.21	55.87	.05	172.11
1.70	.37	156.95	2.75	53.51	.22	54.21	.06	160.94
1.80	.38	154.25	2.62	50.89	.24	52.77	.08	151.72
1.90	.39	151.91	2.49	48.43	.25	51.15	.09	146.45
2.00	.40	149.52	2.37	46.16	.26	49.78	.11	140.92
2.10	.41	147.23	2.28	43.59	.27	48.30	.12	137.70
2.20	.43	144.75	2.18	41.14	.28	46.71	.14	134.44
2.30	.44	142.69	2.08	38.93	.29	44.97	.15	131.54
2.40	.45	140.59	2.01	36.56	.30	43.43	.17	129.29
2.50	.46	138.42	1.94	34.42	.31	41.99	.19	127.04
2.60	.48	136.43	1.86	32.01	.32	40.23	.21	124.65
2.70	.49	134.31	1.79	29.91	.32	38.85	.22	122.41
2.80	.50	132.45	1.74	27.72	.33	37.40	.24	120.79
2.90	.51	130.66	1.68	25.97	.34	35.83	.25	118.94
3.00	.52	129.12	1.63	23.88	.35	34.25	.27	117.03

M4 96.5