NEC

SILICON TRANSISTOR
μPA828TF

HIGH-FREQUENCY LOW-NOISE AMPLIFIER
NPN SILICON EPITAXIAL TWIN TRANSISTOR
(WITH BUILT-IN 6-PIN 2 × 2SC5184) THIN-TYPE SMALL MINI MOLD

FEATURES

- Low noise
  NF = 1.3 dB TYP. @ V_{CE} = 2 V, I_C = 3 mA, f = 2 GHz
  NF = 1.3 dB TYP. @ V_{CE} = 1 V, I_C = 3 mA, f = 2 GHz
- 6-pin thin-type small mini mold package adopted
- Built-in 2 transistors (2 × 2SC5184)

ORDERING INFORMATION

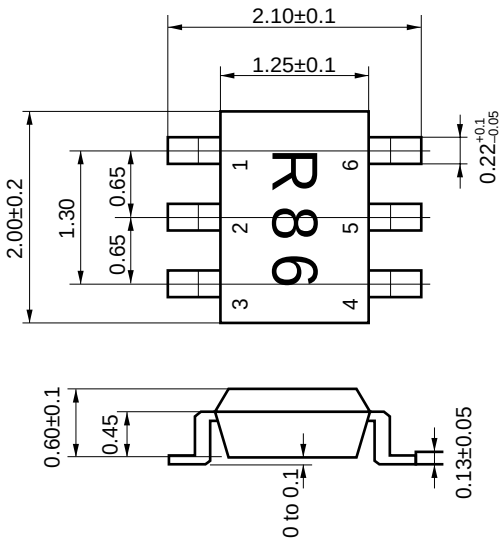
Part Number	Quantity	Packing Style
μPA828TF	Loose products (50 pcs)	Embossed tape 8 mm wide. Pin 6 (Q1 Base), Pin 5 (Q2 Emitter), Pin 4 (Q2 Base) face to perforation side of the tape.
μPA828TF-T1	Taping products (3 kpcs/reel)	

Remark If you require an evaluation sample, please contact an NEC Sales Representative (Unit sample quantity is 50 pcs).

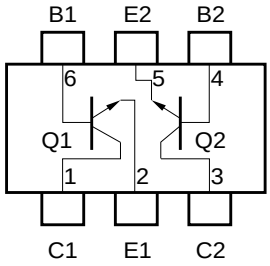
ABSOLUTE MAXIMUM RATINGS (T_A = 25°C)

Parameter	Symbol	Rating	Unit
Collector to Base Voltage	V_{CBO}	5	V
Collector to Emitter Voltage	V_{CEO}	3	V
Emitter to Base Voltage	V_{EBO}	2	V
Collector Current	I_C	30	mA
Total Power Dissipation	P_T	90 in 1 element 180 in 2 elements	mW
Junction Temperature	T_j	150	°C
Storage Temperature	T_{stg}	−65 to +150	°C

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, due to the high-precision fabrication processes used for this device.

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ELECTRICAL CHARACTERISTICS (T_A = 25°C)

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} = 2 V, I_C = 20 mA[Note 1]	70		140	
Gain Bandwidth Product (1)	f_T	V_{CE} = 2 V, I_C = 20 mA, f = 2 GHz	9	11		GHz
Gain Bandwidth Product (2)	f_T	V_{CE} = 1 V, I_C = 10 mA, f = 2 GHz	7	9		GHz
Feedback Capacitance	C_{re}	V_{CB} = 2 V, I_E = 0, f = 1 MHz[Note 2]		0.4	0.8	pF
Insertion Power Gain (1)	$\|S_{21e}\|^2$	V_{CE} = 2 V, I_C = 20 mA, f = 2 GHz	7	8.5		dB
Insertion Power Gain (2)	$\|S_{21e}\|^2$	V_{CE} = 1 V, I_C = 10 mA, f = 2 GHz	6	7.5		dB
Noise Figure (1)	NF	V_{CE} = 2 V, I_C = 3 mA, f = 2 GHz		1.3	2	dB
Noise Figure (2)	NF	V_{CE} = 1 V, I_C = 3 mA, f = 2 GHz		1.3	2	dB
h_{FE} Ratio	h_{FE1}/h_{FE2}	V_{CE} = 2 V, I_C = 20 mA $h_{FE}1$ = smaller h_{FE} value among Q1 and Q2 $h_{FE}2$ = larger h_{FE} value among Q1 and Q2	0.85			

Notes 1. Pulse measurement $P_W \leq 350$ μs, Duty cycle ≤ 2%

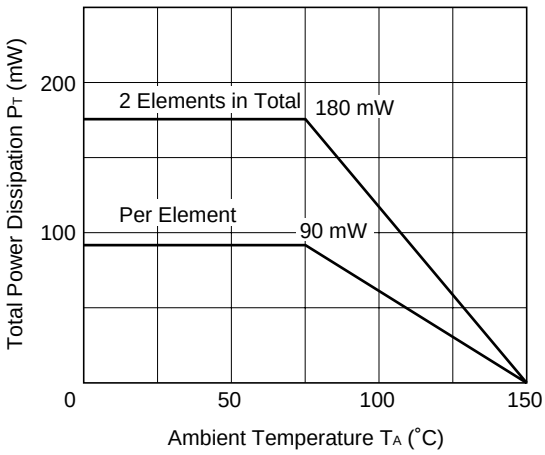
2. Capacitance between collector and base measured with a capacitance meter (auto-balancing bridge method). Emitter should be connected to the guard pin of capacitance meter.

h_{FE} CLASSIFICATION

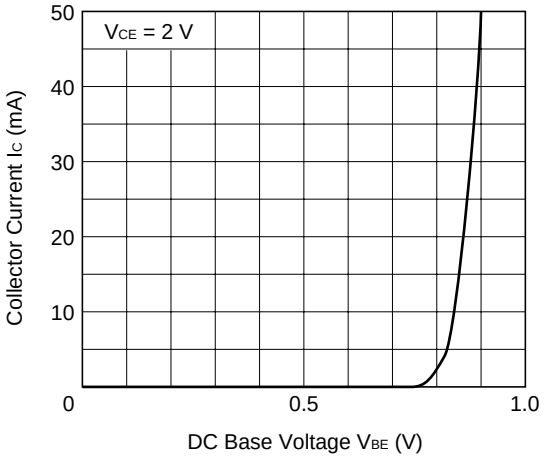
Rank	KB
Marking	R86
h_{FE} value	70 to 140

TYPICAL CHARACTERISTICS (T_A = 25 °C)

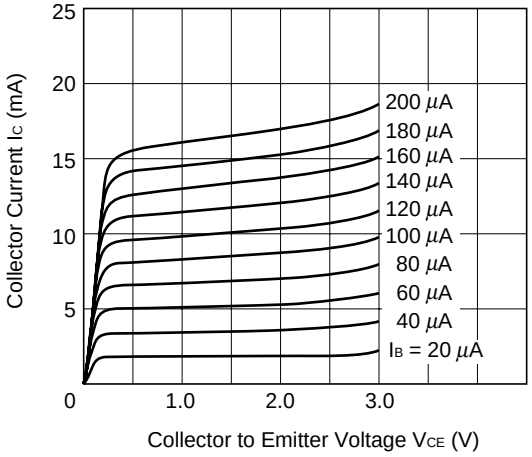
Total Power Dissipation vs. Ambient Temperature



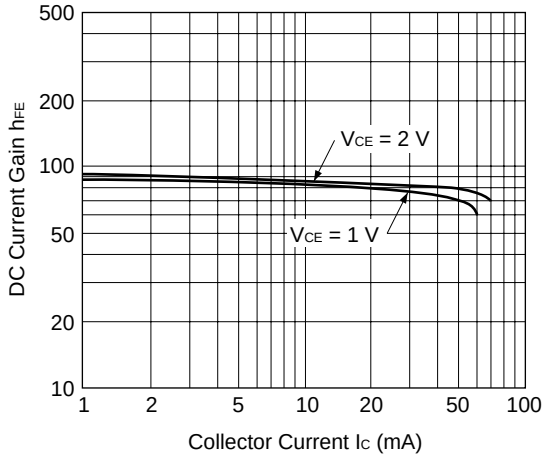
Collector Current vs. DC Base Voltage



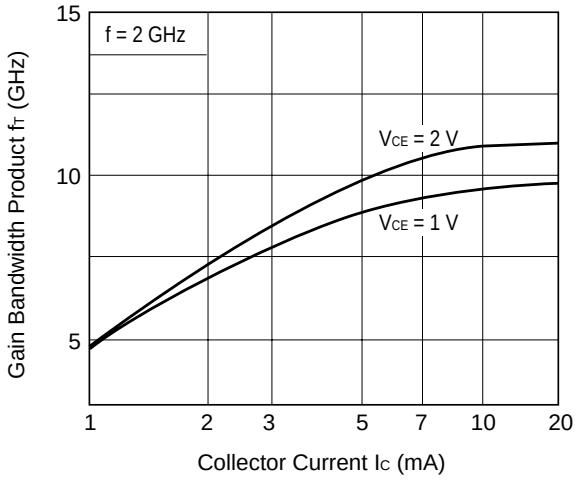
Collector Current vs. Collector to Emitter Voltage



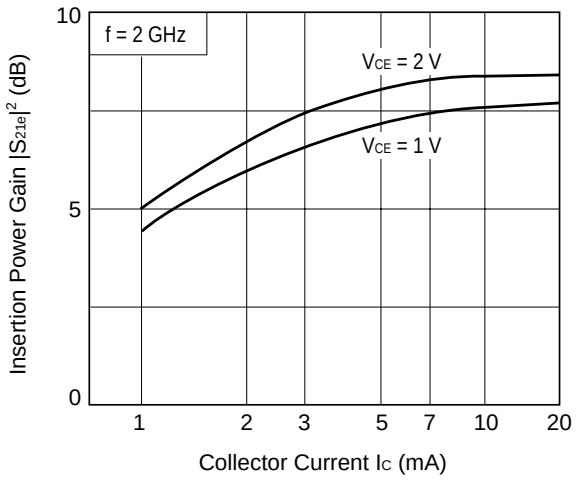
DC Current Gain vs. Collector Current



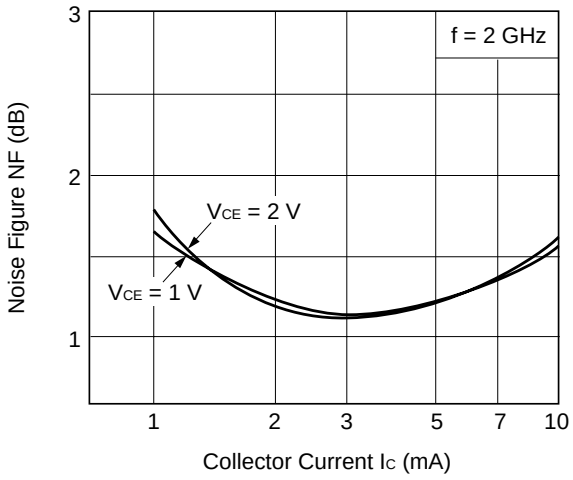
Gain Bandwidth Product vs. Collector Current



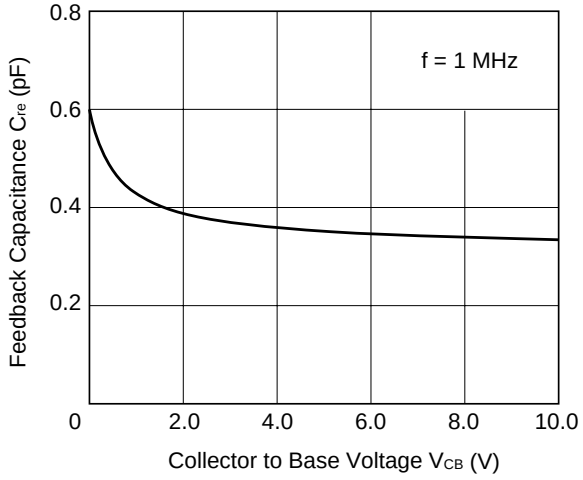
Insertion Power Gain vs. Collector Current



Noise Figure vs. Collector Current



Feedback Capacitance vs. Collector to Base Voltage



S PARAMETER Q1

V_{CE} = 2 V, I_C = 1 mA, Z_0 = 50 Ω

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.
.10	.98	–6.87	2.42	171.77	.02	84.43	.99	–4.42
.20	.96	–13.71	2.40	164.17	.04	79.61	.99	–8.84
.30	.95	–20.79	2.42	157.17	.07	74.54	.97	–12.97
.40	.92	–27.69	2.39	150.27	.09	69.50	.95	–17.23
.50	.90	–34.82	2.39	143.98	.10	65.17	.92	–21.05
.60	.87	–42.10	2.36	138.23	.12	60.29	.90	–25.13
.70	.83	–49.35	2.34	132.19	.14	56.25	.87	–28.47
.80	.80	–56.87	2.32	126.78	.15	52.12	.84	–32.22
.90	.76	–64.78	2.32	120.75	.16	48.48	.81	–34.98
1.00	.72	–72.15	2.26	115.35	.17	45.16	.77	–38.02
1.10	.68	–80.50	2.25	110.20	.18	41.64	.75	–40.84
1.20	.64	–88.71	2.22	104.80	.18	38.79	.72	–43.16
1.30	.60	–97.33	2.16	99.84	.19	35.82	.69	–45.68
1.40	.56	–106.17	2.13	94.75	.19	33.51	.66	–47.79
1.50	.53	–115.63	2.10	89.64	.20	31.12	.63	–49.93
1.60	.50	–124.41	2.04	84.89	.20	29.04	.61	–51.89
1.70	.47	–133.52	1.99	80.39	.20	27.37	.59	–53.75
1.80	.45	–142.93	1.93	75.97	.20	25.64	.57	–55.61
1.90	.44	–152.17	1.87	71.81	.20	24.28	.55	–57.34
2.00	.43	–161.16	1.81	68.21	.20	23.31	.53	–59.13
2.10	.42	–170.55	1.77	63.89	.20	22.18	.51	–60.65
2.20	.41	–179.15	1.72	60.35	.20	21.50	.50	–62.47
2.30	.42	173.21	1.66	56.62	.20	20.78	.48	–64.18
2.40	.42	165.82	1.61	53.39	.20	20.36	.47	–66.09
2.50	.43	158.63	1.57	50.02	.20	20.11	.46	–67.98
2.60	.44	152.11	1.52	47.07	.20	20.00	.45	–69.96
2.70	.45	146.49	1.47	43.96	.20	19.86	.43	–72.10
2.80	.46	140.70	1.43	41.06	.20	20.11	.43	–74.42
2.90	.47	135.62	1.39	38.16	.20	20.18	.42	–76.70
3.00	.48	131.49	1.35	35.61	.20	20.44	.41	–79.07

S PARAMETER Q1

V_{CE} = 2 V, I_C = 3 mA, Z_0 = 50 Ω

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.
.10	.92	–10.76	6.79	166.90	.02	81.64	.97	–8.65
.20	.88	–21.14	6.51	156.23	.04	74.96	.94	–16.65
.30	.83	–31.82	6.40	146.87	.06	68.78	.88	–23.55
.40	.78	–42.04	6.16	138.45	.07	63.27	.82	–29.88
.50	.71	–52.43	5.95	130.70	.09	59.72	.76	–34.56
.60	.65	–62.50	5.66	123.90	.10	55.61	.70	–39.19
.70	.58	–72.69	5.43	116.65	.10	53.36	.65	–42.35
.80	.51	–82.82	5.17	110.41	.11	51.17	.61	–45.67
.90	.45	–92.60	4.88	104.31	.12	49.32	.57	–48.15
1.00	.40	–102.47	4.60	98.90	.12	48.24	.53	–50.32
1.10	.36	–112.48	4.34	94.04	.13	47.06	.50	–52.49
1.20	.32	–122.73	4.09	89.32	.14	46.16	.47	–54.24
1.30	.30	–133.29	3.85	85.28	.14	45.46	.45	–56.10
1.40	.27	–144.06	3.64	81.23	.15	44.88	.43	–57.94
1.50	.26	–155.19	3.45	77.48	.15	44.14	.41	–59.86
1.60	.25	–165.56	3.26	74.10	.16	43.48	.39	–61.58
1.70	.25	–175.58	3.10	70.82	.16	42.97	.37	–63.35
1.80	.26	174.75	2.95	67.58	.17	42.46	.35	–65.35
1.90	.26	166.25	2.82	64.50	.17	41.71	.34	–67.39
2.00	.27	158.59	2.69	61.59	.18	41.41	.32	–69.29
2.10	.28	151.33	2.58	58.69	.19	40.78	.31	–71.31
2.20	.29	145.02	2.47	56.03	.19	40.10	.30	–73.78
2.30	.31	139.72	2.36	53.27	.20	39.55	.29	–76.10
2.40	.32	134.63	2.28	50.82	.20	39.01	.28	–78.86
2.50	.34	130.11	2.20	48.23	.21	38.47	.27	–81.85
2.60	.35	126.08	2.12	45.78	.21	37.90	.26	–84.98
2.70	.37	122.46	2.04	43.24	.22	37.28	.25	–88.17
2.80	.38	119.06	1.97	41.09	.22	36.67	.24	–91.66
2.90	.40	115.90	1.91	38.67	.23	35.90	.23	–95.45
3.00	.41	113.18	1.85	36.49	.23	35.19	.22	–99.22

S PARAMETER Q1

V_{CE} = 2 V, I_C = 5 mA, Z_0 = 50 Ω

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.
.10	.87	–14.09	10.64	163.29	.02	79.93	.95	–11.97
.20	.81	–27.42	9.95	150.51	.04	72.08	.88	–22.31
.30	.73	–40.88	9.52	139.49	.05	66.23	.79	–30.28
.40	.64	–53.67	8.93	129.93	.06	61.90	.71	–36.76
.50	.55	–65.97	8.31	121.13	.07	59.41	.64	–41.09
.60	.48	–77.45	7.63	113.73	.08	57.14	.58	–45.05
.70	.40	–88.32	7.00	106.72	.09	55.84	.53	–47.68
.80	.34	–99.03	6.43	100.97	.10	55.02	.49	–50.09
.90	.30	–109.36	5.89	95.86	.11	54.11	.45	–52.09
1.00	.26	–120.28	5.43	91.26	.11	53.70	.43	–53.78
1.10	.23	–131.28	5.02	87.25	.12	53.10	.40	–55.60
1.20	.21	–143.41	4.67	83.34	.13	52.72	.38	–57.08
1.30	.20	–155.46	4.36	79.89	.13	52.14	.36	–58.90
1.40	.20	–167.22	4.08	76.55	.14	51.70	.34	–60.77
1.50	.20	–178.69	3.84	73.31	.15	50.94	.32	–62.84
1.60	.20	171.39	3.62	70.48	.15	50.53	.31	–64.74
1.70	.21	162.38	3.42	67.63	.16	49.64	.30	–66.88
1.80	.22	154.33	3.24	64.82	.17	48.93	.28	–69.18
1.90	.23	147.57	3.08	62.01	.18	48.25	.27	–71.53
2.00	.25	141.55	2.93	59.55	.18	47.47	.26	–74.05
2.10	.26	136.15	2.81	57.06	.19	46.67	.25	–76.68
2.20	.28	131.40	2.69	54.66	.20	45.88	.24	–80.23
2.30	.29	127.31	2.58	52.10	.20	44.80	.23	–83.11
2.40	.31	123.63	2.48	49.88	.21	44.22	.22	–86.87
2.50	.32	120.25	2.38	47.59	.22	43.28	.21	–90.62
2.60	.34	117.23	2.29	45.27	.22	42.22	.20	–94.98
2.70	.36	114.23	2.21	42.96	.23	41.37	.19	–99.37
2.80	.37	111.67	2.13	40.88	.23	40.49	.19	–104.32
2.90	.39	109.21	2.07	38.78	.24	39.37	.18	–109.07
3.00	.40	107.18	1.99	36.87	.25	38.39	.18	–114.10

S PARAMETER Q1

V_{CE} = 2 V, I_C = 7 mA, Z_0 = 50 Ω

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.
.10	.82	–17.05	14.01	160.40	.02	78.68	.92	–14.71
.20	.74	–33.00	12.83	146.00	.04	70.70	.83	–26.46
.30	.63	–48.73	11.93	133.68	.05	65.62	.72	–34.67
.40	.53	–63.25	10.85	123.20	.06	62.00	.63	–40.72
.50	.44	–76.15	9.73	114.26	.07	60.73	.56	–44.46
.60	.36	–87.70	8.66	107.33	.08	59.44	.50	–47.65
.70	.30	–98.68	7.74	101.13	.08	58.70	.46	–49.83
.80	.26	–109.94	6.98	96.02	.09	58.45	.42	–51.77
.90	.22	–121.35	6.33	91.57	.10	58.02	.39	–53.47
1.00	.20	–133.61	5.79	87.48	.11	57.58	.37	–54.96
1.10	.18	–146.14	5.31	83.89	.12	57.18	.35	–56.63
1.20	.17	–159.26	4.92	80.50	.12	56.65	.33	–58.16
1.30	.17	–171.86	4.58	77.32	.13	55.98	.31	–59.87
1.40	.17	176.63	4.27	74.26	.14	55.31	.30	–61.97
1.50	.18	166.28	4.01	71.38	.15	54.65	.28	–64.19
1.60	.19	157.38	3.77	68.66	.15	53.86	.27	–66.38
1.70	.20	149.88	3.56	66.07	.16	53.13	.26	–68.92
1.80	.21	143.24	3.38	63.48	.17	52.19	.25	–71.37
1.90	.23	137.70	3.21	60.92	.18	51.24	.24	–74.34
2.00	.24	132.73	3.06	58.46	.18	50.37	.23	–77.26
2.10	.26	128.44	2.92	56.09	.19	49.52	.22	–80.38
2.20	.27	124.40	2.79	53.79	.20	48.39	.21	–84.26
2.30	.29	121.31	2.67	51.50	.21	47.37	.20	–88.09
2.40	.30	118.20	2.57	49.41	.21	46.22	.19	–92.30
2.50	.32	115.34	2.47	47.18	.22	45.21	.18	–97.03
2.60	.34	112.78	2.38	45.18	.23	44.15	.18	–101.80
2.70	.35	110.25	2.29	42.82	.23	43.16	.17	–107.33
2.80	.37	108.03	2.21	40.87	.24	42.05	.17	–112.84
2.90	.38	105.94	2.14	38.86	.25	40.88	.17	–118.72
3.00	.39	104.18	2.06	36.86	.25	39.80	.16	–124.46

S PARAMETER Q1

V_{CE} = 2 V, I_C = 10 mA, Z_0 = 50 Ω

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.
.10	.75	–21.25	18.39	156.90	.02	77.20	.89	–17.80
.20	.64	–40.55	16.34	140.45	.03	69.69	.77	–30.80
.30	.51	–58.49	14.49	126.78	.04	65.76	.65	–38.64
.40	.41	–73.72	12.55	116.10	.05	64.03	.56	–43.82
.50	.32	–86.53	10.81	107.94	.06	63.08	.49	–46.87
.60	.26	–98.65	9.39	101.73	.07	62.52	.44	–49.28
.70	.22	–110.38	8.27	96.47	.08	62.35	.40	–50.98
.80	.19	–122.98	7.38	92.04	.09	62.04	.37	–52.53
.90	.16	–136.32	6.63	88.10	.10	61.54	.34	–53.99
1.00	.15	–150.20	6.04	84.48	.10	61.35	.32	–55.48
1.10	.14	–164.12	5.53	81.17	.11	60.66	.30	–57.10
1.20	.14	–177.47	5.10	78.09	.12	59.95	.29	–58.71
1.30	.15	170.71	4.73	75.15	.13	59.15	.27	–60.60
1.40	.16	160.52	4.41	72.39	.14	58.38	.26	–62.90
1.50	.17	152.02	4.13	69.70	.15	57.49	.25	–65.42
1.60	.18	144.85	3.88	67.17	.16	56.48	.24	–68.02
1.70	.20	138.84	3.67	64.75	.16	55.54	.23	–70.84
1.80	.21	133.45	3.47	62.20	.17	54.52	.22	–74.09
1.90	.23	129.28	3.29	59.90	.18	53.48	.21	–77.36
2.00	.24	125.28	3.13	57.58	.19	52.37	.20	–80.75
2.10	.26	121.80	2.99	55.23	.20	51.30	.19	–84.72
2.20	.27	118.50	2.85	53.15	.20	50.15	.18	–89.55
2.30	.28	116.06	2.73	50.91	.21	48.75	.18	–94.27
2.40	.30	113.97	2.63	49.04	.22	47.87	.17	–99.35
2.50	.32	111.91	2.53	46.95	.22	46.88	.16	–104.52
2.60	.33	109.85	2.43	45.01	.23	45.56	.16	–110.37
2.70	.35	107.73	2.35	42.94	.24	44.64	.15	–116.16
2.80	.36	105.72	2.26	40.96	.25	43.33	.15	–122.09
2.90	.38	103.86	2.19	38.82	.25	42.06	.15	–128.50
3.00	.39	102.41	2.12	36.99	.26	40.73	.15	–134.83

S PARAMETER Q1

V_{CE} = 2 V, I_C = 20 mA, Z_0 = 50 Ω

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.
.10	.56	–32.81	27.95	148.87	.02	75.30	.81	–23.54
.20	.42	–58.87	22.23	128.52	.03	70.35	.64	–37.09
.30	.30	–78.37	17.58	115.09	.04	68.59	.51	–43.16
.40	.23	–94.58	14.16	106.19	.05	68.35	.43	–46.08
.50	.18	–109.66	11.73	99.79	.06	68.61	.38	–47.60
.60	.15	–124.96	9.97	94.85	.07	68.48	.34	–48.85
.70	.13	–140.67	8.66	90.57	.08	68.04	.31	–49.86
.80	.12	–156.60	7.65	86.95	.08	67.57	.29	–51.00
.90	.12	–171.52	6.85	83.61	.09	66.89	.27	–52.09
1.00	.13	175.13	6.20	80.43	.10	66.27	.26	–53.64
1.10	.13	163.97	5.66	77.71	.11	65.45	.25	–55.27
1.20	.15	154.42	5.21	74.78	.12	64.40	.24	–57.12
1.30	.16	147.03	4.83	72.31	.13	63.42	.23	–59.41
1.40	.17	140.47	4.49	69.76	.14	62.32	.22	–62.02
1.50	.19	135.04	4.20	67.22	.15	61.17	.21	–65.08
1.60	.20	130.59	3.95	64.99	.16	59.98	.20	–68.14
1.70	.21	126.81	3.73	62.80	.17	58.57	.19	–71.65
1.80	.23	123.18	3.52	60.44	.17	57.56	.18	–75.39
1.90	.24	120.21	3.34	58.24	.18	56.02	.17	–79.66
2.00	.26	117.40	3.17	55.90	.19	55.05	.17	–83.64
2.10	.27	114.82	3.03	53.92	.20	53.52	.16	–88.38
2.20	.28	112.46	2.89	51.91	.21	52.23	.15	–94.64
2.30	.30	110.58	2.77	49.69	.21	50.93	.15	–100.20
2.40	.31	108.94	2.66	47.74	.22	49.90	.14	–106.66
2.50	.33	107.46	2.55	46.23	.23	48.66	.14	–112.73
2.60	.34	105.83	2.46	44.04	.24	47.36	.14	–119.23
2.70	.36	104.14	2.38	42.09	.24	46.17	.14	–126.19
2.80	.37	102.49	2.29	39.95	.25	44.61	.14	–132.72
2.90	.39	100.92	2.22	38.17	.26	43.48	.14	–139.72
3.00	.40	99.59	2.14	36.41	.27	42.04	.14	–146.05

S PARAMETER Q2

V_{CE} = 2 V, I_C = 1 mA, Z_0 = 50 Ω

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.
.10	.98	–6.74	2.44	171.33	.02	84.61	.99	–4.39
.20	.96	–13.51	2.41	163.49	.04	79.80	.98	–8.74
.30	.94	–20.37	2.43	156.32	.06	74.82	.96	–12.93
.40	.92	–27.07	2.39	149.41	.08	69.91	.94	–17.05
.50	.89	–33.96	2.39	143.02	.10	65.85	.91	–20.67
.60	.86	–40.84	2.37	137.27	.12	61.45	.88	–24.51
.70	.83	–47.75	2.34	131.22	.13	57.88	.85	–27.55
.80	.80	–54.58	2.32	125.82	.14	54.28	.81	–30.99
.90	.76	–61.78	2.31	119.93	.15	51.24	.78	–33.61
1.00	.72	–68.15	2.25	114.65	.16	48.38	.74	–36.17
1.10	.68	–75.40	2.24	109.63	.17	45.66	.71	–38.83
1.20	.64	–82.34	2.20	104.41	.18	43.56	.68	–40.86
1.30	.61	–89.46	2.15	99.72	.18	41.47	.65	–43.15
1.40	.57	–96.54	2.12	94.60	.19	39.81	.62	–45.20
1.50	.54	–103.94	2.09	90.06	.19	38.22	.60	–47.35
1.60	.51	–110.51	2.04	85.69	.20	36.90	.57	–49.18
1.70	.48	–117.50	1.98	81.41	.20	35.84	.54	–51.11
1.80	.46	–124.73	1.94	77.28	.20	34.52	.52	–53.17
1.90	.44	–131.81	1.89	73.42	.20	34.12	.50	–54.98
2.00	.43	–138.81	1.84	69.85	.21	33.47	.48	–57.05
2.10	.41	–145.59	1.81	65.84	.21	33.15	.46	–58.98
2.20	.40	–152.38	1.76	62.18	.21	32.61	.44	–61.35
2.30	.40	–158.62	1.71	58.78	.21	32.49	.42	–63.57
2.40	.39	–164.92	1.67	55.63	.22	32.58	.40	–66.15
2.50	.39	–171.15	1.64	52.42	.22	32.53	.38	–68.86
2.60	.39	–176.91	1.60	49.27	.22	32.66	.36	–71.68
2.70	.40	177.60	1.56	46.17	.23	32.73	.35	–74.91
2.80	.40	172.40	1.53	43.05	.23	32.98	.33	–78.55
2.90	.40	167.39	1.49	40.32	.23	33.06	.31	–82.01
3.00	.41	163.33	1.45	37.62	.24	33.20	.30	–86.04

S PARAMETER Q2

V_{CE} = 2 V, I_C = 3 mA, Z_0 = 50 Ω

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.
.10	.92	–10.47	6.76	165.93	.02	82.05	.97	–8.45
.20	.88	–20.49	6.45	154.91	.04	75.09	.93	–16.14
.30	.83	–30.63	6.30	145.29	.06	70.11	.86	–22.48
.40	.77	–40.22	6.03	136.75	.07	65.40	.80	–27.91
.50	.70	–49.54	5.79	128.87	.08	62.38	.73	–31.76
.60	.64	–58.45	5.49	121.94	.09	59.22	.68	–35.44
.70	.57	–66.75	5.22	114.90	.10	57.58	.62	–37.62
.80	.51	–74.87	4.94	108.77	.11	56.19	.58	–39.97
.90	.46	–82.13	4.64	102.99	.12	54.96	.54	–41.46
1.00	.41	–89.08	4.36	97.91	.13	54.27	.50	–42.75
1.10	.37	–95.99	4.10	93.32	.13	53.56	.47	–44.04
1.20	.34	–102.50	3.87	88.99	.14	53.02	.44	–44.99
1.30	.31	–109.65	3.65	85.09	.15	52.49	.42	–45.98
1.40	.29	–116.40	3.45	81.35	.16	51.99	.39	–47.12
1.50	.27	–123.57	3.28	77.89	.16	51.26	.37	–48.16
1.60	.25	–130.78	3.12	74.56	.17	50.83	.35	–49.18
1.70	.24	–137.88	2.97	71.50	.18	50.47	.33	–50.34
1.80	.24	–145.39	2.84	68.40	.19	49.91	.31	–51.49
1.90	.23	–152.42	2.72	65.48	.20	49.22	.29	–52.79
2.00	.23	–159.55	2.61	62.61	.20	48.79	.28	–54.18
2.10	.23	–166.12	2.52	59.74	.21	47.95	.26	–55.52
2.20	.23	–172.60	2.42	57.16	.22	47.35	.24	–57.44
2.30	.24	–178.44	2.34	54.38	.23	46.58	.22	–59.36
2.40	.25	175.70	2.26	51.87	.24	45.96	.21	–61.25
2.50	.26	170.52	2.19	49.35	.24	45.28	.19	–64.05
2.60	.27	165.72	2.12	46.80	.25	44.33	.17	–66.72
2.70	.28	161.24	2.06	44.31	.26	43.50	.16	–70.25
2.80	.29	157.30	2.00	41.90	.27	42.65	.14	–74.78
2.90	.30	153.21	1.95	39.57	.28	41.59	.12	–80.10
3.00	.31	150.49	1.89	37.22	.29	40.55	.11	–86.71

S PARAMETER Q2

V_{CE} = 2 V, I_C = 5 mA, Z_0 = 50 Ω

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.
.10	.87	–13.54	10.54	162.00	.02	80.48	.94	–11.69
.20	.80	–26.19	9.77	148.74	.04	73.48	.87	–21.26
.30	.72	–38.63	9.27	137.38	.05	68.44	.77	–27.99
.40	.63	–49.88	8.60	127.63	.06	65.14	.69	–32.99
.50	.54	–59.78	7.92	118.86	.07	63.41	.62	–35.87
.60	.47	–68.54	7.20	111.69	.08	61.89	.56	–38.30
.70	.41	–75.97	6.55	105.17	.09	61.08	.51	–39.59
.80	.35	–82.95	5.99	99.70	.10	60.63	.47	–40.79
.90	.31	–89.34	5.47	94.96	.11	60.13	.44	–41.55
1.00	.28	–95.57	5.05	90.71	.12	59.77	.41	–42.06
1.10	.25	–102.01	4.67	86.94	.13	59.22	.38	–42.76
1.20	.23	–108.52	4.35	83.30	.14	58.88	.36	–43.16
1.30	.21	–115.80	4.07	80.07	.15	58.01	.34	–43.71
1.40	.20	–122.99	3.82	76.85	.16	57.68	.32	–44.42
1.50	.18	–130.79	3.60	73.93	.16	56.83	.30	–45.15
1.60	.18	–138.76	3.41	71.07	.17	56.28	.28	–45.88
1.70	.17	–146.39	3.24	68.27	.18	55.32	.27	–46.69
1.80	.17	–154.38	3.09	65.56	.19	54.45	.25	–47.67
1.90	.18	–161.58	2.95	63.00	.20	53.52	.23	–48.82
2.00	.18	–168.80	2.83	60.37	.21	52.64	.21	–49.56
2.10	.18	–175.19	2.72	57.83	.22	51.72	.20	–51.08
2.20	.19	178.38	2.61	55.48	.23	50.71	.18	–52.53
2.30	.20	173.15	2.51	53.00	.24	49.69	.17	–53.99
2.40	.21	168.10	2.42	50.71	.25	48.71	.15	–55.88
2.50	.22	163.35	2.35	48.33	.26	47.65	.13	–58.20
2.60	.24	159.17	2.27	45.94	.26	46.48	.12	–60.77
2.70	.25	155.13	2.20	43.64	.27	45.46	.10	–63.87
2.80	.26	151.66	2.13	41.53	.28	44.18	.08	–69.81
2.90	.28	148.18	2.08	36.18	.29	42.92	.07	–75.78
3.00	.29	145.87	2.02	37.27	.30	41.79	.05	–87.46

S PARAMETER Q2

V_{CE} = 2 V, I_C = 7 mA, Z_0 = 50 Ω

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.
.10	.82	–16.31	13.83	158.85	.02	80.20	.92	–14.08
.20	.73	–31.08	12.52	143.87	.04	72.60	.81	–24.73
.30	.62	–44.88	11.48	131.26	.05	68.63	.70	–31.03
.40	.52	–56.37	10.28	120.77	.06	66.33	.61	–35.17
.50	.43	–65.51	9.08	112.24	.07	65.41	.55	–37.29
.60	.37	–73.22	8.02	105.64	.08	64.65	.49	–38.81
.70	.31	–79.68	7.15	99.96	.09	64.16	.45	–39.42
.80	.27	–85.85	6.43	95.22	.10	63.84	.41	–39.69
.90	.24	–91.96	5.83	91.06	.11	63.27	.38	–40.33
1.00	.21	–97.97	5.33	87.23	.12	63.10	.36	–40.45
1.10	.19	–104.32	4.91	83.95	.13	62.37	.34	–40.77
1.20	.17	–111.26	4.56	80.63	.14	61.78	.32	–40.91
1.30	.16	–119.09	4.25	77.69	.15	60.94	.30	–41.30
1.40	.15	–126.82	3.98	74.75	.16	60.35	.28	–41.80
1.50	.14	–135.36	3.75	71.91	.17	59.27	.27	–42.41
1.60	.14	–143.98	3.54	69.32	.18	58.46	.25	–43.05
1.70	.14	–152.02	3.36	66.71	.19	57.56	.23	–43.89
1.80	.14	–160.48	3.20	64.28	.20	56.54	.22	–44.59
1.90	.15	–167.52	3.06	61.81	.20	55.40	.20	–45.49
2.00	.16	–174.81	2.93	59.35	.21	54.51	.19	–46.25
2.10	.16	179.19	2.80	57.01	.22	53.36	.17	–47.28
2.20	.17	173.23	2.69	54.64	.23	52.09	.15	–48.52
2.30	.19	168.26	2.59	52.26	.24	50.84	.14	–49.66
2.40	.20	163.59	2.50	50.03	.25	49.75	.12	–51.03
2.50	.21	159.22	2.42	47.84	.26	48.61	.11	–53.42
2.60	.22	155.66	2.34	45.62	.27	47.35	.09	–55.58
2.70	.24	151.91	2.27	43.50	.28	46.19	.07	–57.80
2.80	.25	148.68	2.20	41.24	.29	44.87	.05	–63.33
2.90	.27	145.44	2.14	39.10	.30	43.57	.04	–71.16
3.00	.28	143.38	2.07	37.17	.31	42.15	.02	–89.77

S PARAMETER Q2

V_{CE} = 2 V, I_C = 10 mA, Z_0 = 50 Ω

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.
.10	.75	–19.94	18.04	155.05	.02	78.63	.88	–16.88
.20	.63	–37.17	15.75	137.91	.03	72.31	.75	–27.99
.30	.50	–51.43	13.66	124.24	.04	69.65	.63	–33.45
.40	.40	–61.93	11.63	113.99	.06	68.34	.54	–36.33
.50	.33	–69.47	9.93	106.39	.07	68.06	.48	–37.48
.60	.28	–76.10	8.60	100.66	.08	67.81	.43	–38.05
.70	.24	–81.76	7.55	95.75	.09	67.13	.40	–38.12
.80	.21	–87.66	6.74	91.57	.10	66.95	.37	–38.22
.90	.18	–93.58	6.07	87.88	.11	66.28	.34	–38.12
1.00	.16	–99.63	5.53	84.54	.12	65.72	.32	–38.04
1.10	.14	–106.61	5.07	81.36	.13	65.07	.30	–38.26
1.20	.13	–113.93	4.70	78.47	.14	64.27	.29	–38.23
1.30	.12	–122.95	4.38	75.61	.15	63.38	.27	–38.44
1.40	.12	–131.42	4.09	72.98	.16	62.56	.25	–38.92
1.50	.11	–140.96	3.85	70.36	.17	61.30	.24	–39.44
1.60	.12	–150.17	3.64	68.00	.18	60.41	.22	–39.88
1.70	.12	–158.80	3.45	65.54	.19	59.28	.21	–40.33
1.80	.12	–167.29	3.27	63.09	.20	58.03	.19	–40.98
1.90	.13	–174.00	3.13	60.80	.21	56.82	.18	–41.90
2.00	.14	179.16	2.99	58.43	.22	55.73	.16	–42.20
2.10	.15	173.55	2.86	56.12	.23	54.42	.15	–43.12
2.20	.16	168.05	2.76	53.85	.24	53.25	.13	–43.66
2.30	.17	163.79	2.66	51.62	.25	51.73	.12	–44.54
2.40	.19	159.55	2.56	49.61	.26	50.61	.10	–45.17
2.50	.20	155.56	2.48	47.37	.27	49.39	.08	–46.33
2.60	.21	152.29	2.38	45.19	.28	47.95	.07	–46.51
2.70	.23	148.78	2.31	42.99	.29	46.76	.05	–47.10
2.80	.24	146.04	2.24	40.81	.30	45.28	.03	–50.69
2.90	.26	143.20	2.18	38.94	.31	43.89	.01	–48.82
3.00	.27	141.08	2.11	36.88	.31	42.38	0.00	134.74

S PARAMETER Q2

V_{CE} = 2 V, I_C = 20 mA, Z_0 = 50 Ω

FREQUENCY	S_{11}		S_{21}		S_{12}		S_{22}	
GHz	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.	MAG.	ANG.
.10	.56	–29.15	27.12	146.32	.02	77.78	.80	–21.74
.20	.41	–48.92	20.90	125.74	.03	74.05	.63	–31.76
.30	.31	–60.35	16.10	113.19	.04	72.89	.51	–34.75
.40	.24	–68.27	12.87	104.89	.05	73.12	.44	–35.38
.50	.19	–74.29	10.65	98.93	.06	72.74	.39	–34.92
.60	.16	–80.26	9.05	94.42	.07	72.28	.36	–34.40
.70	.14	–85.96	7.87	90.42	.08	71.80	.33	–33.68
.80	.12	–92.36	6.97	86.91	.09	71.03	.31	–33.35
.90	.11	–99.97	6.25	83.77	.11	70.29	.29	–33.01
1.00	.10	–107.48	5.67	80.84	.12	69.37	.28	–32.76
1.10	.09	–116.81	5.19	78.17	.13	68.41	.26	–32.72
1.20	.08	–126.82	4.79	75.44	.14	67.25	.25	–32.69
1.30	.08	–138.28	4.46	73.03	.15	66.21	.24	–32.69
1.40	.08	–148.91	4.17	70.45	.16	65.13	.22	–33.03
1.50	.09	–159.16	3.92	68.12	.17	63.75	.21	–33.54
1.60	.09	–168.23	3.69	65.84	.18	62.57	.20	–33.82
1.70	.10	–175.51	3.50	63.56	.19	61.27	.18	–34.18
1.80	.11	177.57	3.33	61.31	.20	59.98	.17	–34.31
1.90	.12	172.34	3.17	59.18	.21	58.56	.16	–34.89
2.00	.13	167.06	3.03	56.95	.22	57.22	.14	–34.48
2.10	.15	163.12	2.91	54.84	.23	55.75	.13	–34.89
2.20	.16	158.95	2.79	52.71	.24	54.34	.11	–34.41
2.30	.17	155.66	2.68	50.45	.25	53.02	.09	–33.91
2.40	.19	152.47	2.58	48.31	.26	51.60	.08	–32.52
2.50	.20	149.55	2.50	46.34	.27	50.20	.06	–30.22
2.60	.22	146.94	2.42	44.20	.28	48.59	.05	–25.48
2.70	.23	144.10	2.33	42.05	.29	47.38	.03	–14.13
2.80	.25	141.69	2.26	40.12	.30	45.92	.02	4.75
2.90	.26	139.23	2.20	38.08	.31	44.36	.02	62.68
3.00	.28	137.58	2.13	35.99	.32	42.85	.03	93.61

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