NEC

SILICON POWER TRANSISTOR
NEL2004F02-24

NPN SILICON EPITAXIAL TRANSISTOR
L Band Power Amplifier

DESCRIPTION AND APPLICATIONS

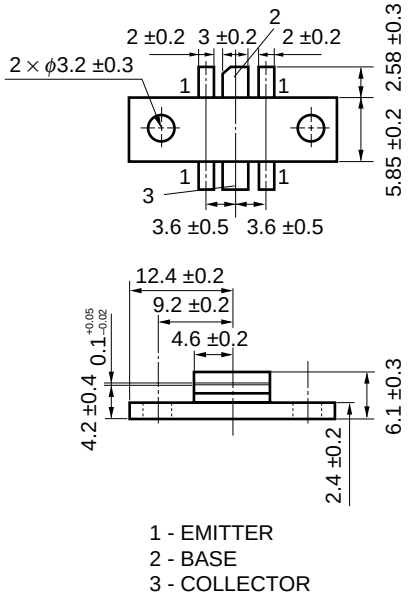
NEL2004F02-24 of NPN epitaxial microwave power transistors is designed for 1.8-2 GHz PHS/PCN/PCS base station applications.

It incorporates emitter ballast resistors, gold metallizations and offers a high degree of reliability.

FEATURES

- High Linear Power and Gain
- Low Internal Modulation Distortion
- High Reliability Gold Metallization
- Emitter Ballasting
- 24 V Operation

OUTLINE DIMENSIONS (Unit: mm)



1 - EMITTER
2 - BASE
3 - COLLECTOR

ABSOLUTE MAXIMUM RATING (T_A = 25 °C)

PARAMETER	SYMBOL	SPECIFIED CONDITION	RATINGS	UNIT
Collector to Base Voltage	V_{CBO}		45	V
Collector to Emitter Voltage	V_{CER}	R = 10 Ω	30	V
Emitter to Base Voltage	V_{EBO}		3	V
Collector to Emitter Voltage	V_{CEO}		18	V
Collector Current	I_C		1.5	A
Power Dissipation	P_T		19.4	W
Thermal Resistance	Rth(j-c)		9	°C/W
Junction Temperature	Tj		200	°C
Storage Temperature	T_{stg}		–65 to 150	°C

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ELECTRICAL CHARACTERISTICS (T_A = 25 °C)

PARAMETER	SYMBOL	SPECIFIED CONDITION	MIN.	TYP.	MAX.	UNIT
Collector to Emitter Cutoff Current	I_{CES}	V_{CE} = 24 V			3	mA
Collector to Emitter Voltage (Base to Emitter Registor = 10 Ω)	V_{CER}	I_C = 3 mA, R = 10 Ω	30	85		V
Collector to Emitter Voltage (Open Base)	V_{CEO}	I_C = 3 mA	18	22		V
Collector to Base Voltage (Open Emitter)	V_{CBO}	I_C = 3 mA	45	85		V
Emitter to Base Voltage (Open Collector)	V_{EBO}	I_C = 8 mA	3	4.4		V
DC Forward Current Gain	h_{FE}	V_{CE} = 5 V, I_C = 0.3 A	30	100	150	
Output Capacitance	C_{ob}	V_{CE} = 24 V, f = 1 MHz		6.2		pF

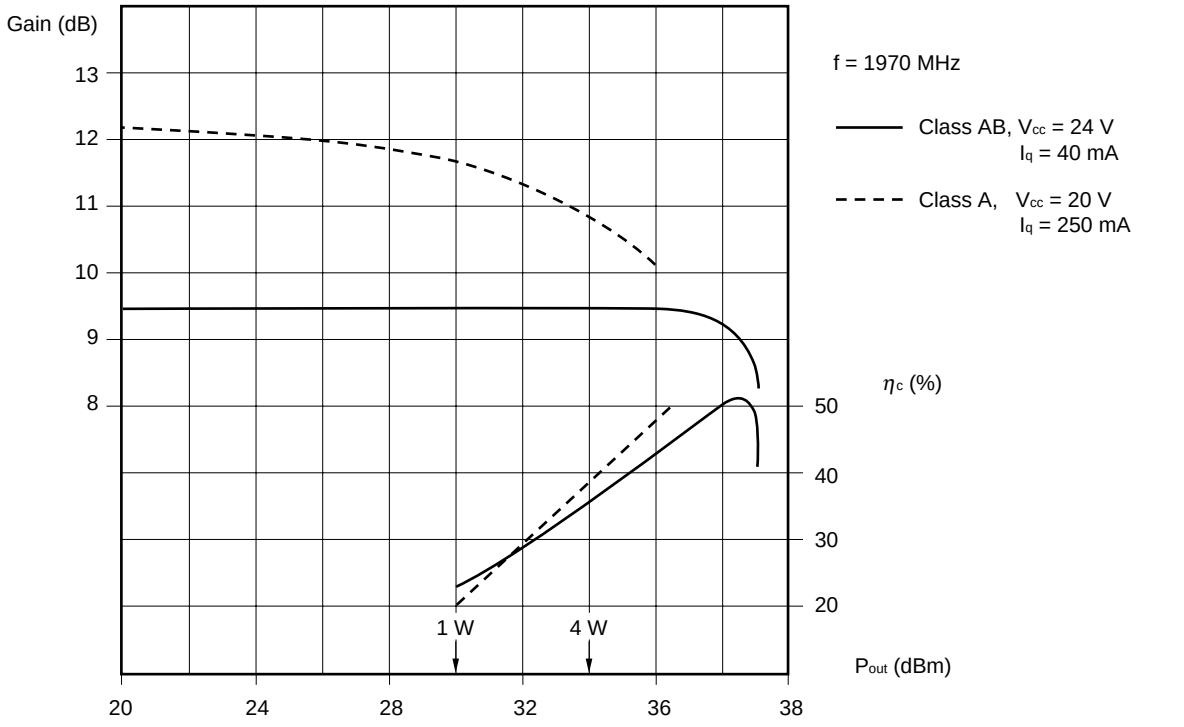
PERFORMANCE SPECIFICATIONS (T_A = 25 °C)

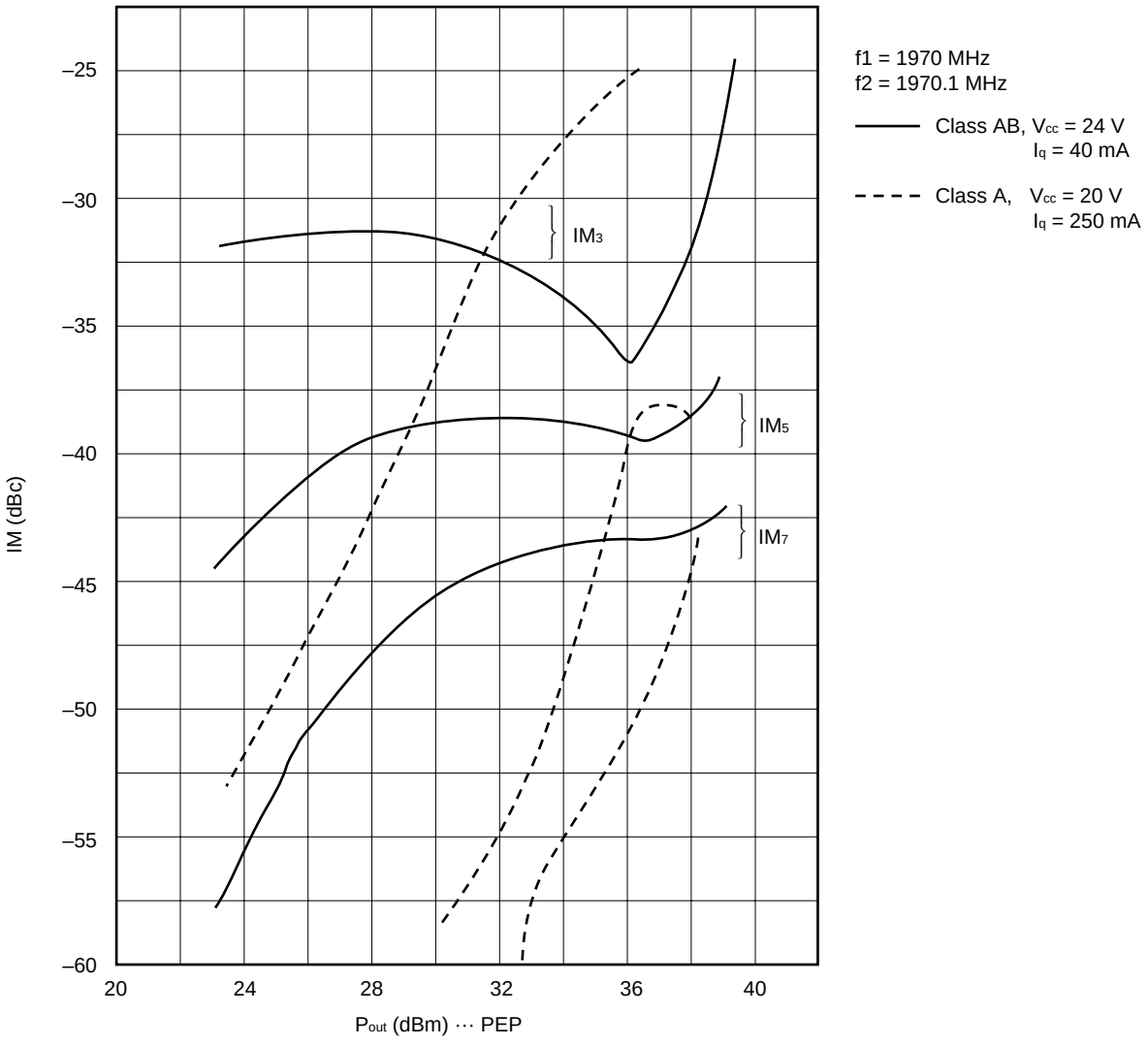
CLASS AB OPERATION

PARAMETER	SYMBOL	SPECIFIED CONDITION	MIN.	TYP.	MAX.	UNIT
Output Power	P_{1dB}	f = 1.97 GHz, Iq = 40 mA, V_{CC} = 24 V, CLASS AB	5	7		W
Collector Efficiency	ηc	f = 1.97 GHz, P_{out} = P_{1dB}, Iq = 40 mA, V_{CC} = 24 V, CLASS AB	40	46		%
Linear Gain	GL	f = 1.97 GHz, P_{in} = 0.2 W, Iq = 40 mA, V_{CC} = 24 V, CLASS AB		9.5		dB
3rd Order Intermodulation	IM_3	f = 1.97 GHz, Δf = 100 kHz, 5 W PEP, V_{CC} = 24 V, Iq = 40 mA, CLASS AB		–34		dBc

CLASS A OPERATION

PARAMETER	SYMBOL	SPECIFIED CONDITION	MIN.	TYP.	MAX.	UNIT
Output Power	P_{1dB}	f = 1.97 GHz, Iq = 250 mA, V_{CC} = 20 V, CLASS A		2		W
Collector Efficiency	ηc	f = 1.97 GHz, P_{out} = P_{1dB}, Iq = 250 mA, V_{CC} = 20 V, CLASS A		35		%
Linear Gain	GL	f = 1.97 GHz, P_{in} = 0.01 W, Iq = 250 mA, V_{CC} = 20 V, CLASS A		12		dB
3rd Order Intermodulation	IM_3	f = 1.97 GHz, Δf = 100 kHz, 1 W PEP, V_{CC} = 20 V, Iq = 250 mA, CLASS A		–37		dBc


Gain (dB)
13
12
11
10
9
8
20
24
28
32
36
38
1 W
4 W
50
40
30
20
ηc (%)
Pout (dBm)
f = 1970 MHz
Class AB, Vcc = 24 V
Iq = 40 mA
Class A, Vcc = 20 V
Iq = 250 mA


IM (dBc)
–25
–30
–35
–40
–45
–50
–55
–60
20
24
28
32
36
40
IM3
IM5
IM7
Pout (dBm) ··· PEP
f1 = 1970 MHz
f2 = 1970.1 MHz
Class AB, Vcc = 24 V
Iq = 40 mA
Class A, Vcc = 20 V
Iq = 250 mA

S-PARAMETER

NEL2004 Class A

V_{CC} = 20 V, I_{cq} = 0.25 A

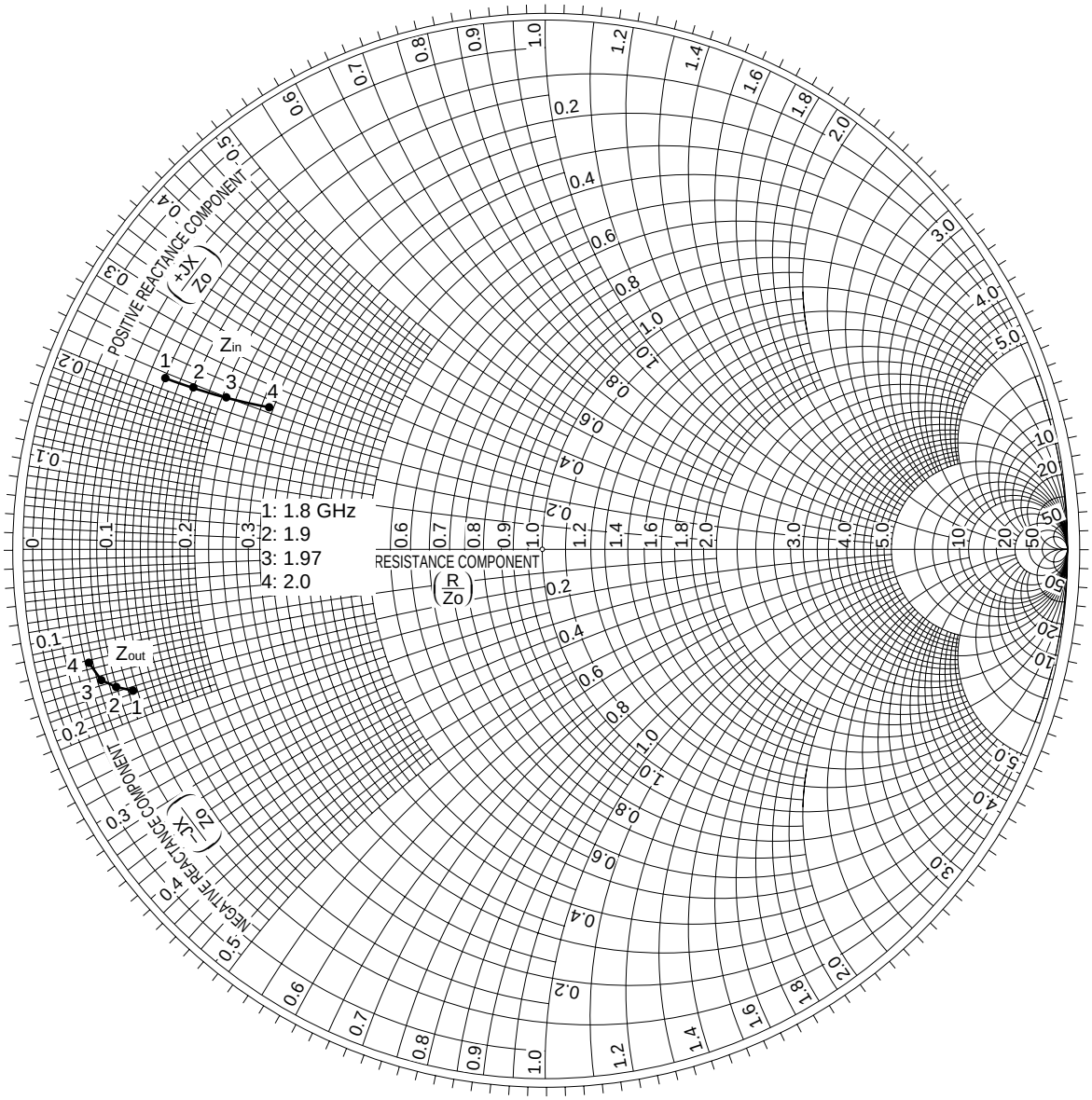
FREQUENCY	S_{11}		S_{12}		S_{21}		S_{22}	
GHz	MAG	ANG (DEG)	MAG	ANG (DEG)	MAG	ANG (DEG)	MAG	ANG (DEG)
1.70	0.70	171	0.05	–26	1.68	–16	0.77	–149
1.71	0.69	171	0.05	–26	1.70	–18	0.78	–150
1.72	0.69	172	0.05	–27	1.71	–19	0.79	–150
1.73	0.69	172	0.05	–29	1.71	–20	0.79	–150
1.74	0.69	172	0.05	–30	1.69	–22	0.80	–150
1.75	0.69	173	0.05	–31	1.67	–23	0.81	–151
1.76	0.69	173	0.05	–31	1.65	–24	0.81	–151
1.77	0.69	173	0.05	–32	1.66	–25	0.82	–151
1.78	0.69	173	0.05	–33	1.67	–26	0.83	–152
1.79	0.69	174	0.04	–35	1.67	–28	0.84	–152
1.80	0.69	174	0.04	–37	1.65	–30	0.84	–152
1.81	0.69	175	0.05	–37	1.62	–31	0.85	–153
1.82	0.69	175	0.05	–38	1.60	–32	0.85	–153
1.83	0.70	175	0.05	–45	1.61	–32	0.86	–153
1.84	0.69	175	0.04	–49	1.62	–34	0.87	–154
1.85	0.70	175	0.04	–50	1.62	–35	0.87	–154
1.86	0.70	176	0.04	–46	1.60	–38	0.88	–155
1.87	0.70	176	0.04	–46	1.56	–38	0.89	–155
1.88	0.70	176	0.04	–47	1.54	–39	0.89	–156
1.89	0.70	177	0.04	–49	1.55	–39	0.90	–156
1.90	0.71	177	0.03	–50	1.56	–41	0.90	–157
1.91	0.71	177	0.03	–51	1.56	–43	0.91	–157
1.92	0.71	177	0.03	–52	1.53	–46	0.92	–158
1.93	0.71	178	0.03	–54	1.50	–46	0.92	–158
1.94	0.72	178	0.03	–55	1.48	–47	0.92	–159
1.95	0.72	178	0.03	–57	1.48	–47	0.93	–159
1.96	0.73	178	0.03	–58	1.48	–49	0.93	–160
1.97	0.73	178	0.03	–60	1.47	–50	0.94	–160
1.98	0.73	179	0.03	–61	1.45	–52	0.94	–161
1.99	0.74	179	0.03	–62	1.44	–53	0.94	–161
2.00	0.74	179	0.02	–64	1.42	–54	0.95	–162

NEL2004 Class AB

V_{CC} = 24 V, I_{cq} = 0.04 A

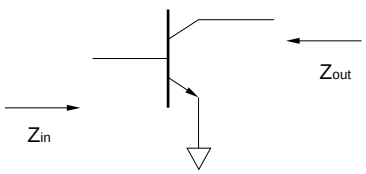
FREQUENCY	S_{11}		S_{12}		S_{21}		S_{22}	
GHz	MAG	ANG (DEG)	MAG	ANG (DEG)	MAG	ANG (DEG)	MAG	ANG (DEG)
1.70	0.75	167	0.04	–26	1.09	–25	0.87	–148
1.71	0.75	167	0.04	–27	1.11	–26	0.87	–149
1.72	0.75	167	0.04	–28	1.11	–28	0.88	–149
1.73	0.75	167	0.04	–29	1.12	–29	0.88	–149
1.74	0.74	167	0.04	–30	1.11	–31	0.88	–149
1.75	0.74	167	0.04	–30	1.10	–32	0.89	–150
1.76	0.74	168	0.04	–30	1.09	–33	0.89	–150
1.77	0.73	168	0.04	–31	1.09	–33	0.89	–150
1.78	0.73	168	0.04	–33	1.11	–34	0.90	–151
1.79	0.73	168	0.04	–35	1.11	–36	0.90	–151
1.80	0.73	168	0.04	–36	1.10	–39	0.91	–152
1.81	0.73	169	0.04	–39	1.09	–40	0.91	–152
1.82	0.73	169	0.04	–41	1.08	–41	0.91	–152
1.83	0.73	169	0.03	–42	1.08	–41	0.92	–153
1.84	0.72	169	0.03	–42	1.09	–42	0.92	–153
1.85	0.72	169	0.03	–43	1.10	–44	0.92	–153
1.86	0.72	169	0.03	–45	1.08	–46	0.93	–154
1.87	0.72	170	0.03	–45	1.06	–47	0.93	–154
1.88	0.72	170	0.03	–46	1.05	–48	0.94	–155
1.89	0.72	170	0.03	–48	1.06	–48	0.94	–155
1.90	0.72	170	0.03	–50	1.07	–50	0.94	–155
1.91	0.72	170	0.03	–52	1.07	–52	0.94	–156
1.92	0.72	171	0.03	–52	1.06	–54	0.95	–156
1.93	0.72	171	0.03	–53	1.04	–55	0.95	–157
1.94	0.72	171	0.03	–54	1.03	–56	0.95	–157
1.95	0.72	172	0.03	–57	1.03	–56	0.95	–158
1.96	0.72	172	0.03	–59	1.04	–58	0.96	–158
1.97	0.72	172	0.02	–61	1.03	–60	0.96	–159
1.98	0.72	173	0.02	–62	1.02	–61	0.96	–159
1.99	0.72	173	0.02	–64	1.01	–63	0.96	–160
2.00	0.72	173	0.02	–66	1.00	–64	0.97	–160

NEL2004F02-24 Z_{in}/Z_{out}

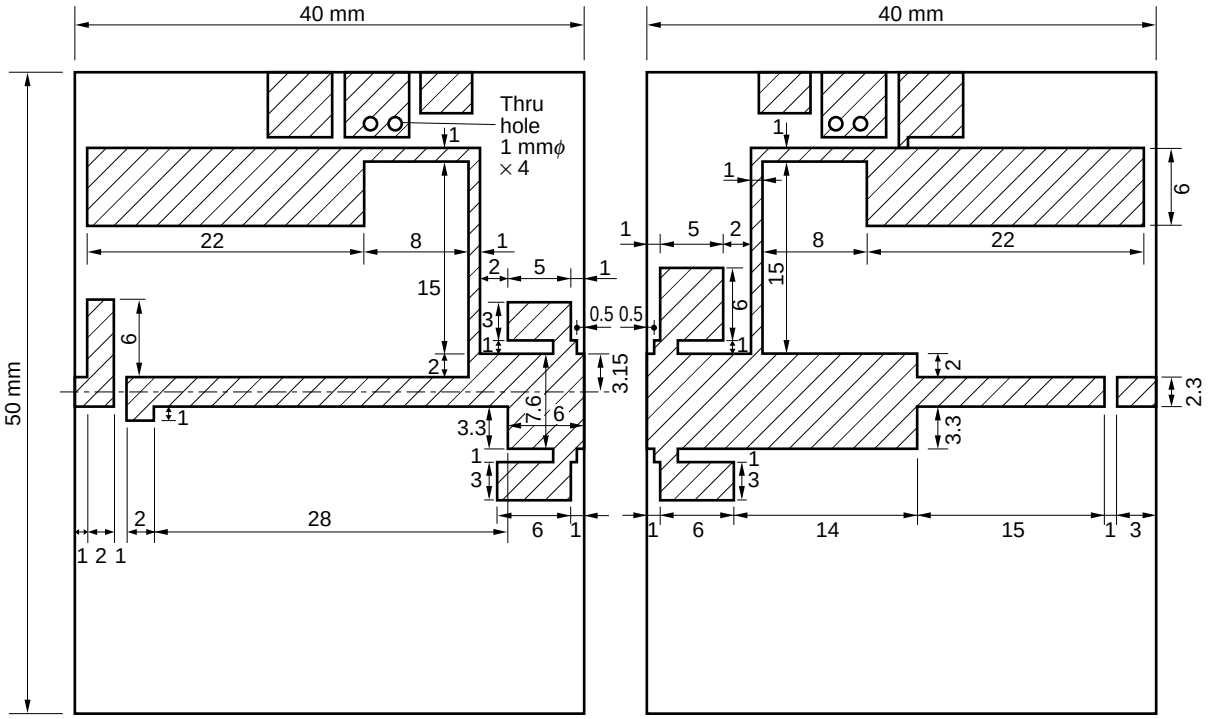


Z_O = 50 ohm

f [GHz]	Z_{in} [ohm]	Z_{out} [ohm]
1.80	7.2 + j11	4.8 – j8.4
1.90	8.0 + j10	4.1 – j7.8
1.97	10.4 + j11	3.7 – j7.4
2.00	13.5 + j11	3.0 – j6.1

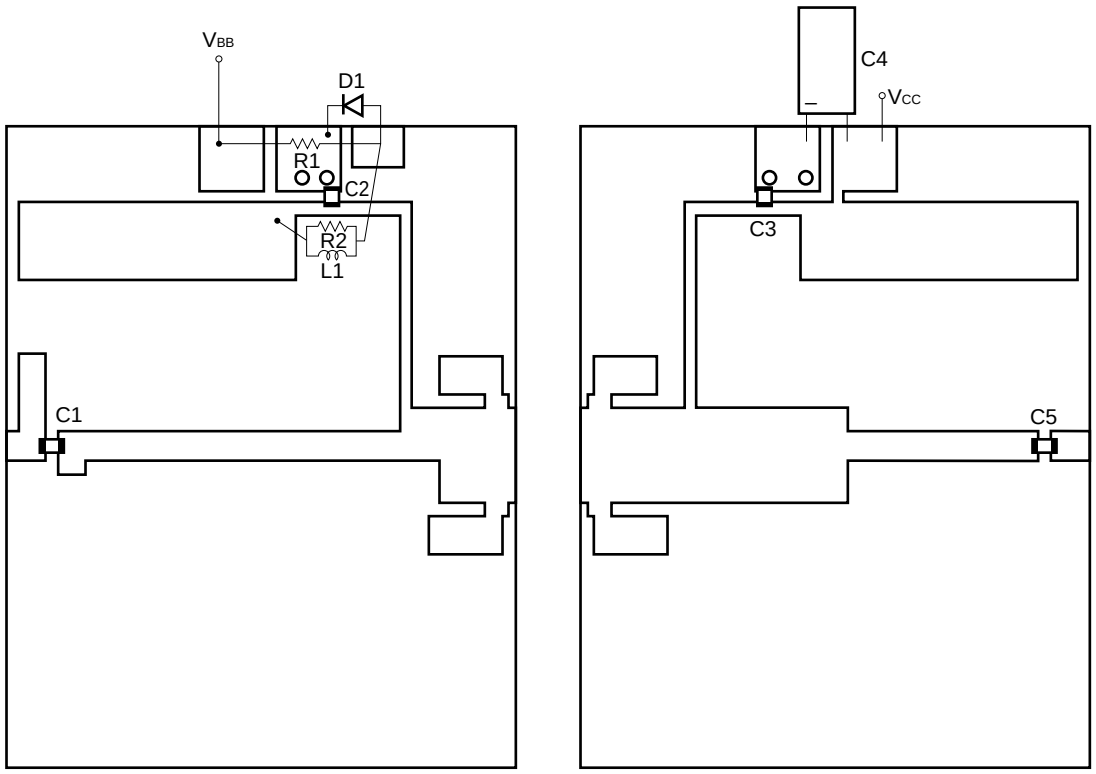


Circuit Drawing



SUBSTRATE
DICLAD 522T®
THICKNESS = 0.79 mm
DOUBLE SIDE 35 μm Cu
ε_r = 2.6

Components Layout



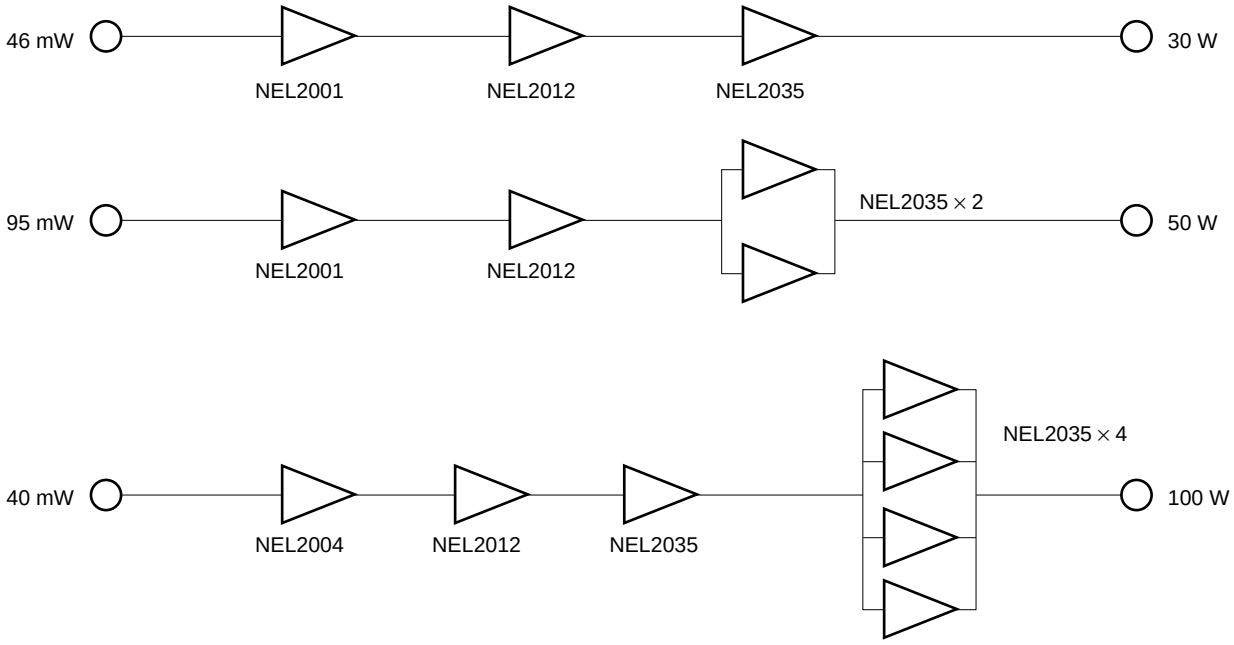
input output

R1: 5.1 Ω
R2: 30 Ω
L1: 5 mmϕ 10T Coil

D1: VO6C
C1, C2, C3, C5: MURATA
47 pF
C4: 22 μF, 50 V
Electrolytic Capacitor

APPLICATION

= Amplifier Diagrams =



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