APPLICATION NOTE

MITSUBISHI ELECTRIC
Silicon RF Power Semiconductors

Document NO. AN-UHF-105-A
Date : 22th Dec. 2009
Rev. Date :22th Jun. 2010
Prepared : Y.Takase
S.Kametani
Confirmed :T.Okawa
(Taking charge of Silicon RF by
MIYOSHI Electronics)

SUBJECT: RD07MUS2B TETRA single-stage amplifier at f=380-430MHz,Vdd=7.2V

SUMMARY:

This application note shows the TETRA data .

- Sample history :
  RD07MUS2B: Lot number “086ZE-G”, Sample No. “103”

- Evaluate conditions :
  @ f=380MHz, 405MHz, 430MHz, Vdd=7.2V, Idq=250mA
  π/4DQPSK, Filter (α=0.35), Symbol rate=18ksps, Band Width=18kHz

- Results :
  Page 2. shows the summary data.
  Page 3. shows the Pout characteristics data.
  Page 4. shows the Pin characteristics data.
  Page 5-7. shows the characteristics data.
  Page 8. shows the Input / Output impedance vs. Frequency characteristics.
  Page 9. shows the equivalent circuit.

1. Summary

@Vdd=7.2V, Idq=250mA (Vgg=1.49V)

f (MHz)	@ Po=3W (Pin ; control)					@ Po=4W (Pin ; control)				
	ACP_1L * (dBc)	ACP_1H * (dBc)	Idd (A)	ηd (%)	Gp (dB)	ACP_1L * (dBc)	ACP_1H * (dBc)	Idd (A)	ηd (%)	Gp (dB)
380	-42.1	-40.6	1.17	35.5	19.7	-37.8	-36.6	1.36	40.8	19.6
405	-41.2	-39.2	1.07	39.1	21.2	-35.5	-35.0	1.24	45.0	21.0
430	-40.0	-39.1	0.96	43.3	20.1	-33.9	-33.6	1.12	49.7	19.8

* ACP_1L ; ACP Low @Channel Spacing = 25kHz
  ACP_1H ; ACP High @Channel Spacing = 25kHz

Conditions

@ Modulation type ; π/4DQPSK, Filter (α=0.35, Current filter response ; Root cosine), Band Width=18kHz, Symbol rate=18ksps, PRBS9 (PN9)

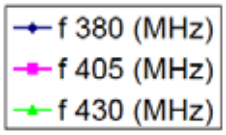
Setting ; Spectrum Analyzer

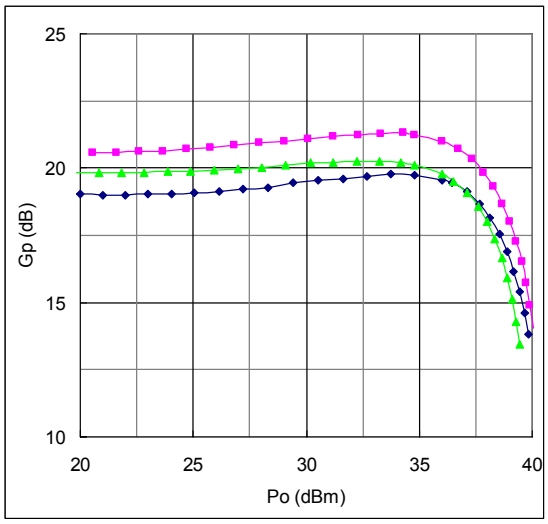
Resolution BW ; 300Hz, Video BW ; 3kHz, Sweep Time ; 1.5s,
Channel Spacing=25kHz (Band Width=18kHz),
Detector ; RMS, Average sweep count “8”

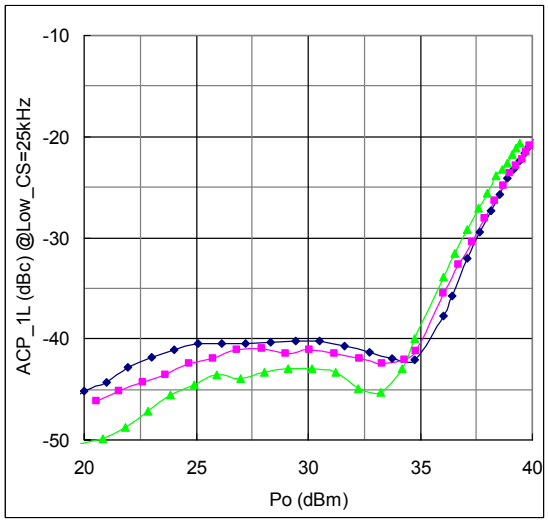
2. RF characteristics

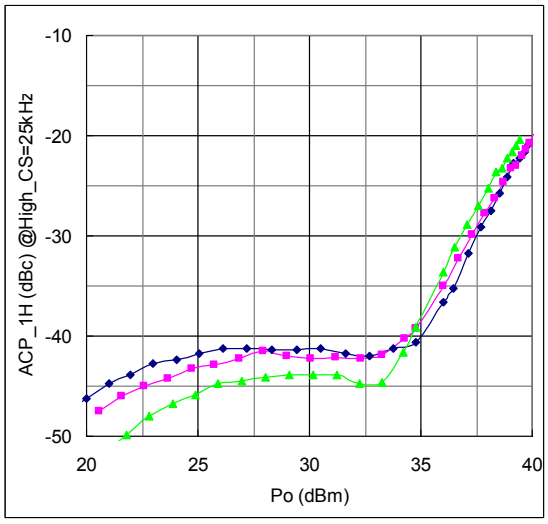
2-1. Pout vs.

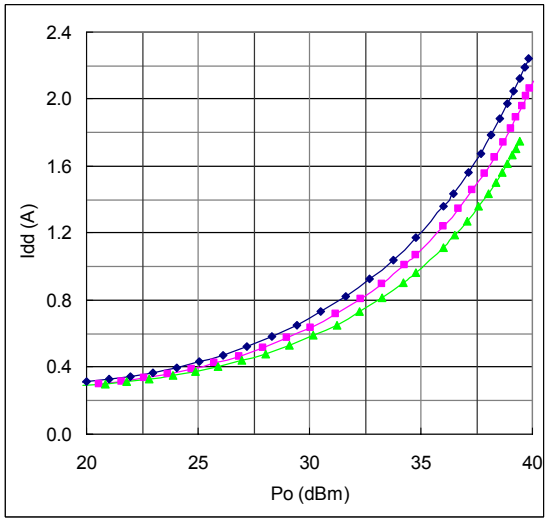
@ Vdd=7.2V, Idq=250mA, f=380MHz, 405MHz, 430MHz

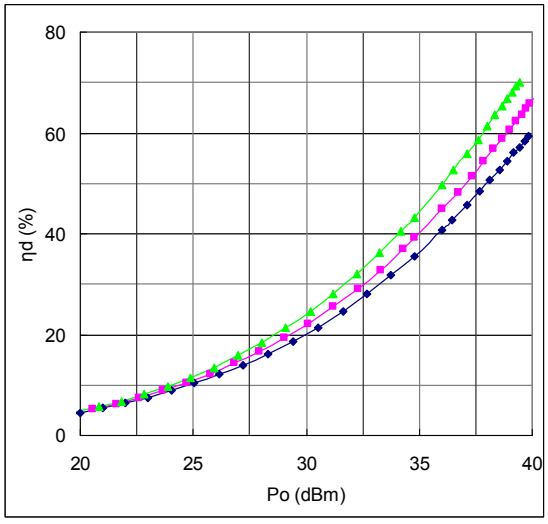






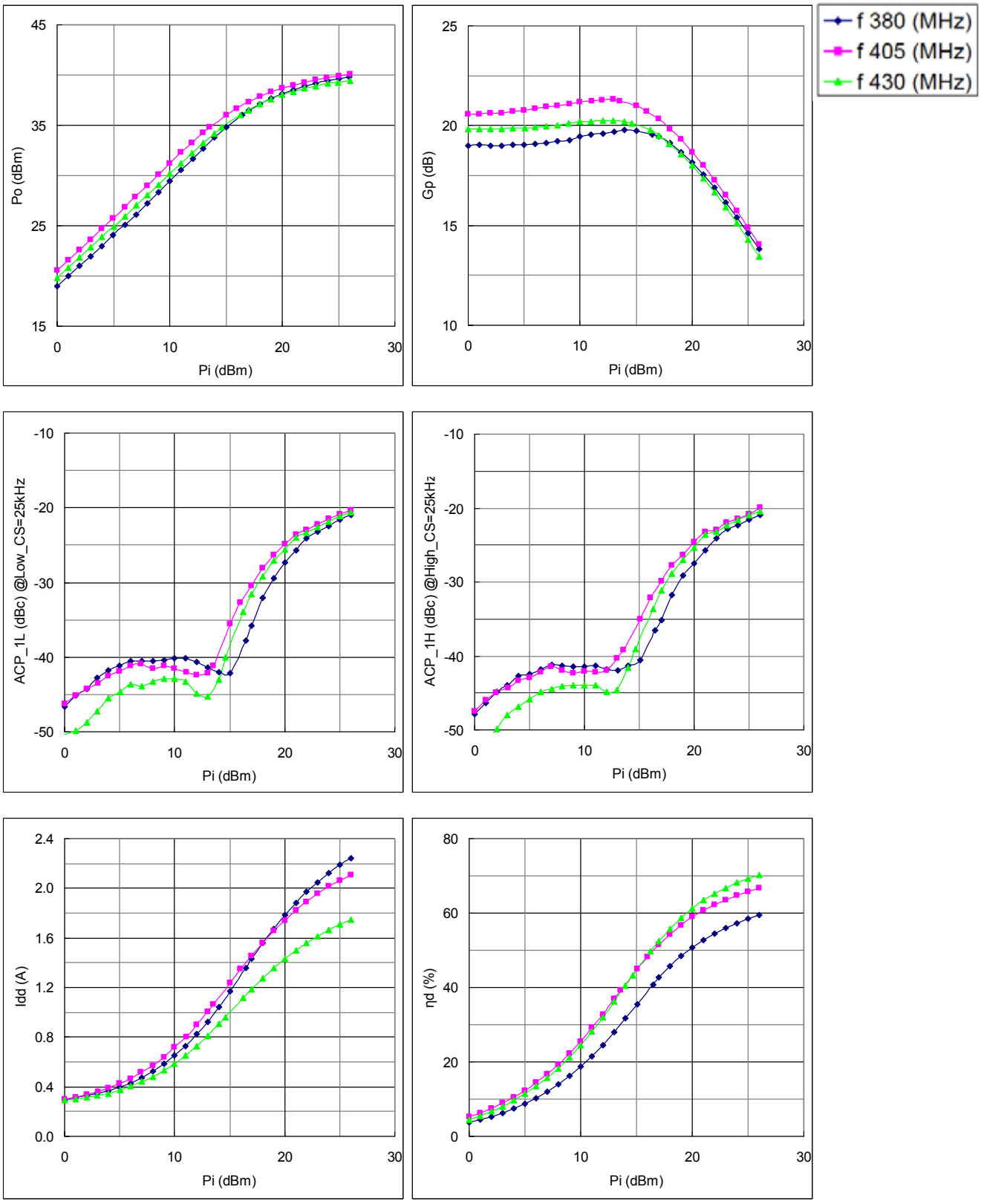






2-2. Pin vs.

@ Vdd=7.2V, Idq=250mA, f=380MHz, 405MHz, 430MHz



3. RF characteristics data

3-1. @ **f=380MHz,** Vdd=7.2V, Idq=250mA (Vgg=1.49V)

Pin		Po		Gp	Idd	ηd	ACP_1L*	ACP_1H*
(dBm)	(W)	(dBm)	(W)	(dB)	(A)	(%)	(dBc)	(dBc)
0.0	0.001	18.9	0.08	19.0	0.30	3.7	-47	-48
1.0	0.001	20.0	0.10	19.0	0.31	4.5	-45	-46
2.0	0.002	21.0	0.13	19.0	0.33	5.3	-44	-45
3.0	0.002	22.0	0.16	19.0	0.35	6.4	-43	-44
4.0	0.003	23.0	0.20	19.0	0.37	7.5	-42	-43
5.0	0.003	24.0	0.25	19.0	0.40	8.9	-41	-42
6.0	0.004	25.1	0.32	19.1	0.43	10.3	-41	-42
7.0	0.005	26.1	0.41	19.1	0.47	12.1	-41	-41
8.0	0.006	27.2	0.53	19.2	0.52	14.0	-41	-41
9.0	0.008	28.3	0.68	19.3	0.58	16.2	-40	-41
10.0	0.010	29.4	0.88	19.4	0.65	18.7	-40	-41
11.0	0.013	30.5	1.13	19.5	0.73	21.5	-40	-41
12.0	0.016	31.6	1.45	19.6	0.82	24.6	-41	-42
13.0	0.020	32.7	1.87	19.7	0.93	28.0	-41	-42
14.0	0.025	33.8	2.38	19.8	1.04	31.7	-42	-41
15.1	0.032	34.8	3.00	19.7	1.17	35.5	-42	-41
16.5	0.044	36.0	4.00	19.6	1.36	40.8	-38	-37
17.0	0.050	36.4	4.40	19.4	1.44	42.6	-36	-35
18.0	0.063	37.1	5.14	19.1	1.56	45.7	-32	-32
19.0	0.079	37.7	5.85	18.7	1.67	48.5	-29	-29
20.0	0.100	38.1	6.52	18.2	1.79	50.7	-27	-28
21.0	0.126	38.5	7.16	17.5	1.88	52.8	-26	-26
22.0	0.159	38.9	7.74	16.9	1.97	54.4	-24	-24
23.0	0.200	39.2	8.27	16.2	2.05	56.0	-23	-23
24.0	0.252	39.4	8.76	15.4	2.13	57.3	-22	-22
25.0	0.318	39.6	9.21	14.6	2.19	58.5	-22	-22
26.0	0.397	39.8	9.59	13.8	2.24	59.4	-21	-21

*ACP_1L ; ACP Low @Channel Spacing = 25kHz

ACP_1H ; ACP High @Channel Spacing = 25kHz

3-2. @ **f=405MHz,** Vdd=7.2V, Idq=250mA (Vgg=1.49V)

Pin		Po		Gp	Idd	ηd	ACP_1L*	ACP_1H*
(dBm)	(W)	(dBm)	(W)	(dB)	(A)	(%)	(dBc)	(dBc)
0.0	0.001	20.5	0.11	20.6	0.30	5.2	-46	-48
1.0	0.001	21.6	0.14	20.6	0.32	6.3	-45	-46
2.0	0.002	22.6	0.18	20.6	0.34	7.5	-44	-45
3.0	0.002	23.7	0.23	20.6	0.36	8.9	-44	-44
4.0	0.002	24.7	0.30	20.7	0.39	10.5	-43	-43
5.0	0.003	25.7	0.38	20.7	0.42	12.3	-42	-43
6.0	0.004	26.8	0.48	20.8	0.47	14.4	-41	-42
7.0	0.005	27.9	0.62	20.9	0.52	16.6	-41	-42
8.0	0.006	29.0	0.80	21.0	0.57	19.3	-42	-42
9.0	0.008	30.1	1.02	21.1	0.64	22.2	-41	-42
10.0	0.010	31.2	1.32	21.2	0.72	25.5	-42	-42
11.0	0.013	32.3	1.69	21.2	0.80	29.2	-42	-42
12.0	0.016	33.3	2.13	21.3	0.90	32.8	-42	-42
13.0	0.020	34.3	2.68	21.3	1.01	36.9	-42	-40
13.6	0.023	34.8	3.00	21.2	1.07	39.1	-41	-39
15.0	0.032	36.0	4.01	21.0	1.24	45.0	-36	-35
16.0	0.040	36.7	4.69	20.7	1.35	48.3	-33	-32
17.0	0.050	37.3	5.40	20.3	1.46	51.5	-30	-30
18.0	0.063	37.9	6.10	19.8	1.56	54.4	-28	-28
19.0	0.079	38.3	6.77	19.3	1.66	56.8	-26	-26
20.0	0.100	38.7	7.40	18.7	1.74	58.9	-25	-25
21.0	0.126	39.0	7.98	18.0	1.82	60.7	-24	-23
22.0	0.158	39.3	8.49	17.3	1.89	62.3	-23	-23
23.0	0.199	39.5	8.97	16.5	1.96	63.6	-22	-22
24.0	0.251	39.7	9.41	15.7	2.02	64.8	-22	-21
25.0	0.317	39.9	9.79	14.9	2.07	65.9	-21	-21
26.0	0.399	40.1	10.12	14.0	2.11	66.8	-20	-20

*ACP_1L ; ACP Low @Channel Spacing = 25kHz

ACP_1H ; ACP High @Channel Spacing = 25kHz

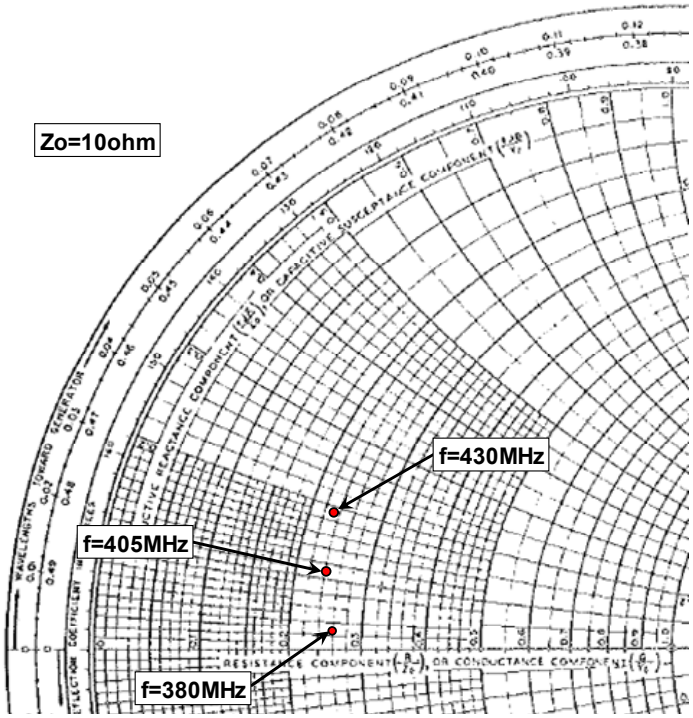
3-3. @ f=430MHz, Vdd=7.2V, Idq=250mA (Vgg=1.49V)

Pin		Po		Gp	Idd	ηd	ACP_1L*	ACP_1H*
(dBm)	(W)	(dBm)	(W)	(dB)	(A)	(%)	(dBc)	(dBc)
0.0	0.001	19.8	0.10	19.8	0.29	4.6	-50	-52
1.0	0.001	20.8	0.12	19.9	0.30	5.6	-50	-51
2.0	0.002	21.8	0.15	19.8	0.31	6.7	-49	-50
3.0	0.002	22.8	0.19	19.8	0.33	8.1	-47	-48
4.0	0.003	23.9	0.24	19.9	0.35	9.7	-46	-47
5.0	0.003	24.9	0.31	19.9	0.37	11.5	-45	-46
6.0	0.004	25.9	0.39	19.9	0.40	13.5	-44	-45
7.0	0.005	27.0	0.50	20.0	0.44	15.8	-44	-45
8.0	0.006	28.0	0.64	20.0	0.48	18.4	-43	-44
9.0	0.008	29.1	0.81	20.1	0.53	21.3	-43	-44
10.0	0.010	30.2	1.04	20.2	0.59	24.6	-43	-44
11.0	0.013	31.2	1.32	20.2	0.65	28.1	-43	-44
12.0	0.016	32.3	1.68	20.2	0.73	32.0	-45	-45
13.0	0.020	33.3	2.11	20.3	0.81	36.2	-45	-45
14.0	0.025	34.2	2.63	20.2	0.90	40.4	-43	-42
14.6	0.029	34.8	3.00	20.1	0.96	43.3	-40	-39
16.3	0.042	36.0	4.00	19.8	1.12	49.7	-34	-34
17.0	0.050	36.5	4.49	19.5	1.19	52.6	-32	-31
18.0	0.063	37.1	5.12	19.1	1.27	55.8	-29	-29
19.0	0.080	37.6	5.74	18.6	1.36	58.7	-27	-27
20.0	0.100	38.0	6.32	18.0	1.43	61.2	-26	-25
21.0	0.126	38.4	6.85	17.4	1.50	63.5	-24	-24
22.0	0.159	38.7	7.34	16.7	1.56	65.3	-23	-23
23.0	0.199	38.9	7.76	15.9	1.62	66.8	-23	-22
24.0	0.252	39.1	8.18	15.1	1.67	68.1	-22	-22
25.0	0.316	39.3	8.50	14.3	1.71	69.2	-21	-21
26.0	0.400	39.5	8.83	13.4	1.75	70.2	-21	-20

*ACP_1L ; ACP Low @Channel Spacing = 25kHz
ACP_1H ; ACP High @Channel Spacing = 25kHz

4. Input / Output Impedance vs. Frequency characteristics

Zout* (f=380,405,430MHz)

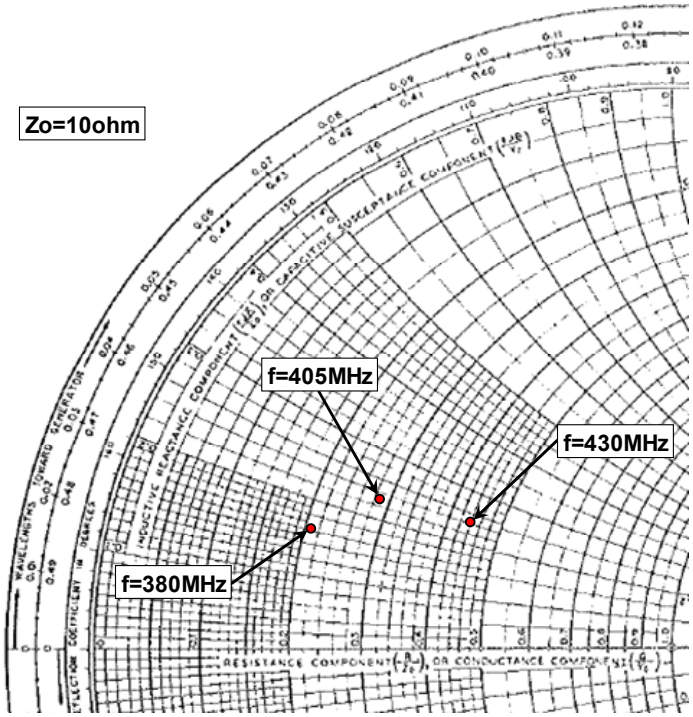


@Po=4W, Vdd=7.2V, Idq=250mA(Vgg adj.)

f (MHz)	Zout* (ohm)
380	2.61+j0.25
405	2.46+j1.07
430	2.34+j1.88

Zout* : Complex conjugate of Output impedance.

Zin* (f=380,405,430MHz)

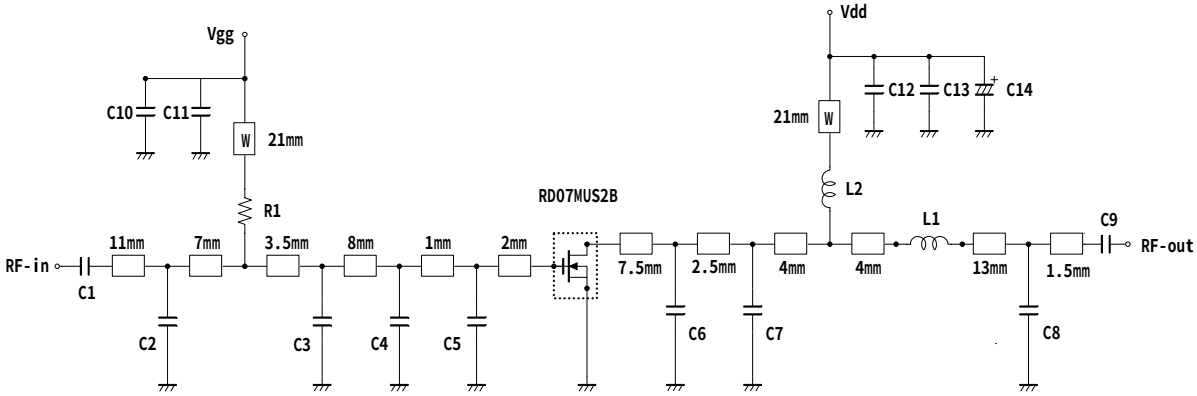


@ Po=4W, Vdd=7.2V, Idq=250mA(Vgg adj.)

f (MHz)	Zin* (ohm)
380	2.09+j1.58
405	2.86+j2.25
430	4.40+j2.41

Zin* : Complex conjugate of Iutput impedance.

5. Equivalent circuit (@f=380 to 430MHz)



Note:Board material- Glass-Epoxy Substrate
Micro strip line width=1.3mm/50OHM,er:4.8,t=0.8mm
W:Line width=1.0mm

Parts Type		Value	Type name	Vender
Capacitor	C1	100pF	GRM2162C1H101JA01D	Murata Manufacturing Co., Ltd.
	C2	18pF	GRM2162C1H180JZ01D	Murata Manufacturing Co., Ltd.
	C3	27pF	GRM2162C1H270JZ01D	Murata Manufacturing Co., Ltd.
	C4	12pF	GRM2162C1H120JZ01D	Murata Manufacturing Co., Ltd.
	C5	56pF	GRM2162C1H560JZ01D	Murata Manufacturing Co., Ltd.
	C6	30pF	GRM2162C1H300JZ01D	Murata Manufacturing Co., Ltd.
	C7	22pF	GRM2162C1H220JZ01D	Murata Manufacturing Co., Ltd.
	C8	8pF	GRM2162C1H8R0DZ01D	Murata Manufacturing Co., Ltd.
	C9	100pF	GRM2162C1H101JA01D	Murata Manufacturing Co., Ltd.
	C10	22000pF	GRM216R11H223KA01E	Murata Manufacturing Co., Ltd.
	C11	1000pF	GRM188B11H102KA01	Murata Manufacturing Co., Ltd.
	C12	1000pF	GRM188B11H102KA01	Murata Manufacturing Co., Ltd.
	C13	22000pF	GRM216R11H223KA01E	Murata Manufacturing Co., Ltd.
	C14	22μF	A0603	NICHICON CORPORATION
Resistance	R1	4.7K OHM	CR1/10-472JB	Hokuriku Electric Industry Co.,Ltd.
Inductance	L1	6.6nH Enameled wire 2Turns, Diameter:0.23mm,φ1.66mm (the out side diameter)	2302S	Yoneda Processing Place Co.,Ltd.
	L2	31.0nH Enameled wire 6Turns, Diameter:0.23mm,φ1.66mm (the out side diameter)	2306C	Yoneda Processing Place Co.,Ltd.