

APPLICATION NOTE

Document NO. AN-UHF-096-A

Date : 6th Oct. 2008

Rev. Date : 22th Jun. 2010

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(Taking charge of Silicon RF by
MIYOSHI Electronics)

SUBJECT: RD07MUS2B single-stage amplifier
efficiency matching RF performance at $f = 450\text{-}527\text{MHz}$, $V_{dd} = 7.2\text{V}$

SUMMARY:

This application note shows the RF wide band characteristics data

(Frequency characteristics, Pout vs. Pin characteristics) at 450 to 527 MHz band.

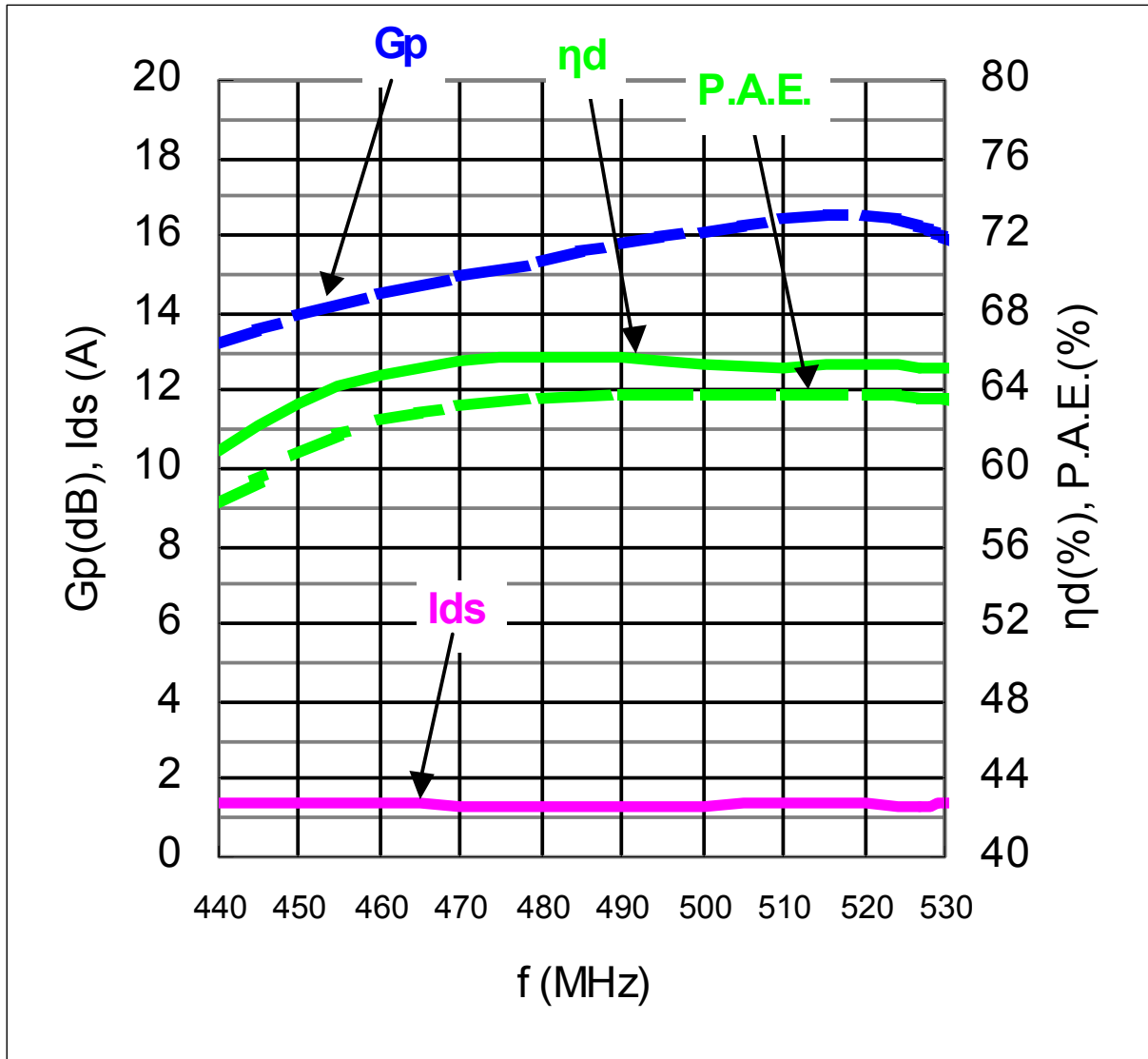
- Sample history :
RD07MUS2B: Lot number "083YH-G"

- Evaluate conditions :
RD07MUS2B @ $f = 450\text{ to }527\text{MHz}$: $V_{ds} = 7.2\text{V}$, $I_{dq} = 250\text{mA}$ (V_{gs} adjust)

- Results :
Page 2-3. shows the typical RF characteristics (Frequency characteristics) data.
Page 4-7. shows the typical RF characteristics (Pout vs. Pin characteristics) data.
Page 8. shows the efficiency matching equivalent circuit.
Page 9. shows the Input / Output impedance vs. Frequency characteristics.

RD07MUS2B single-stage amplifier Frequency characteristics 1

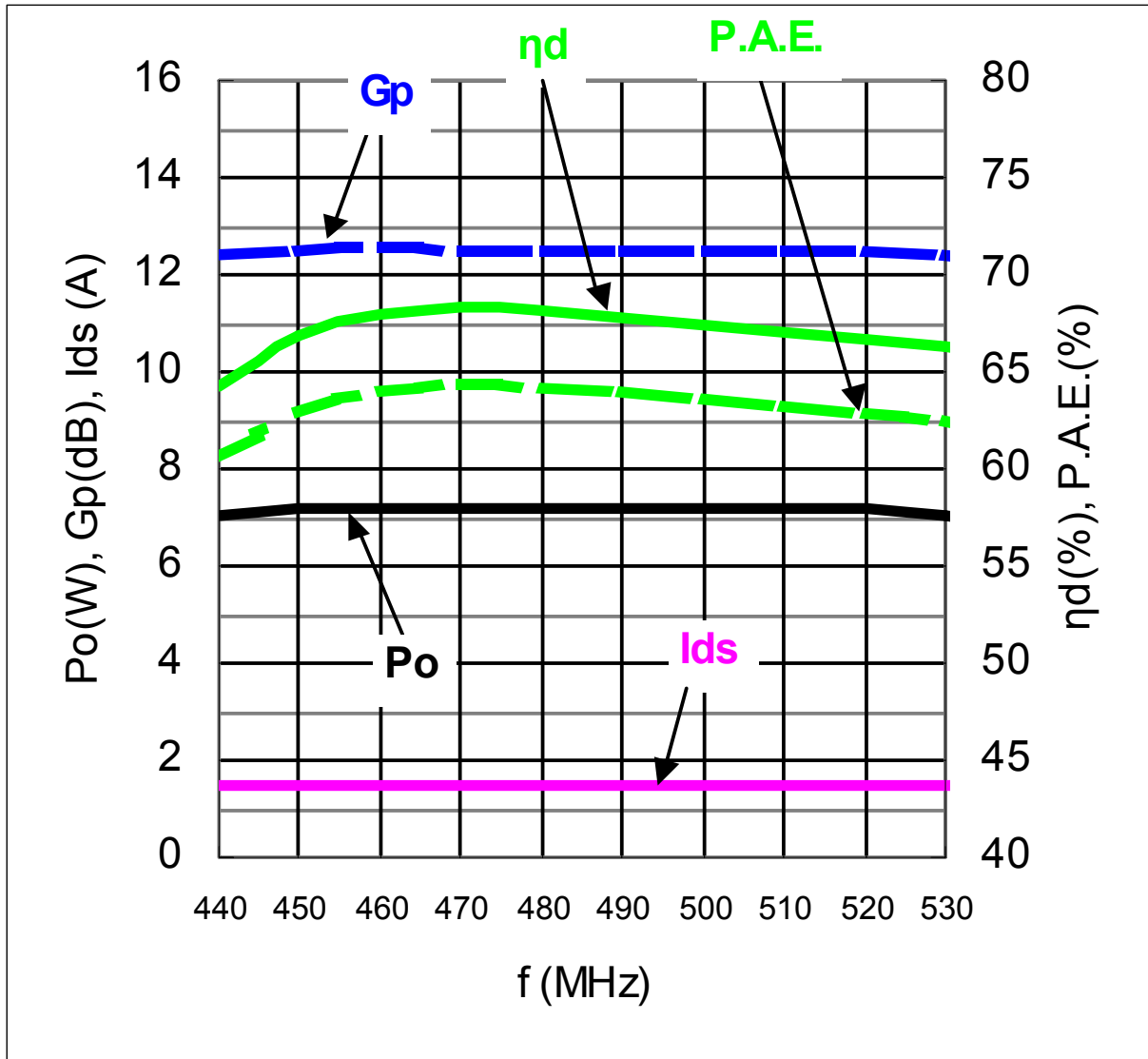
@ Vdd=7.2V, Idq=250mA, **Po=6.3W** (38dBm ; **ANT 5W + 1dB Condition**)



Vds (V)	f (MHz)	Pi (W)	Pi (dBm)	Gp (dB)	Ids (A)	ηd (%)	P.A.E. (%)
7.2	440	0.296	24.7	13.3	1.43	61.0	58.1
	450	0.253	24.0	14.0	1.38	63.3	60.8
	460	0.221	23.4	14.6	1.35	64.9	62.6
	470	0.201	23.0	15.0	1.34	65.5	63.4
	480	0.185	22.7	15.3	1.33	65.7	63.7
	490	0.165	22.2	15.8	1.33	65.7	64.0
	500	0.154	21.9	16.1	1.34	65.4	63.9
	510	0.140	21.5	16.5	1.34	65.3	63.8
	520	0.140	21.4	16.6	1.34	65.3	63.8
	527	0.147	21.7	16.3	1.34	65.2	63.7
	530	0.158	22.0	16.0	1.35	65.2	63.6

RD07MUS2B single-stage amplifier Frequency characteristics 2

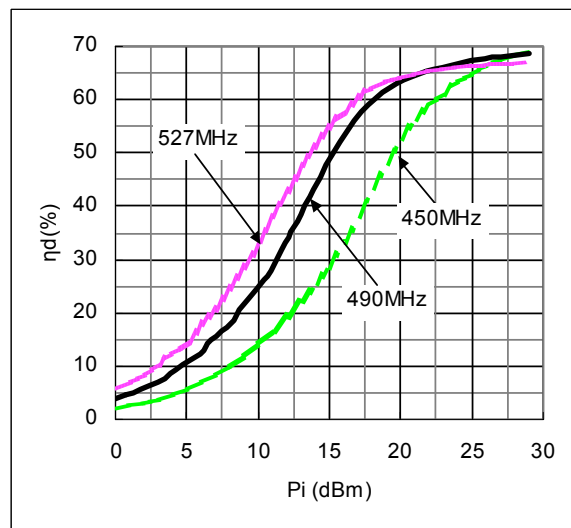
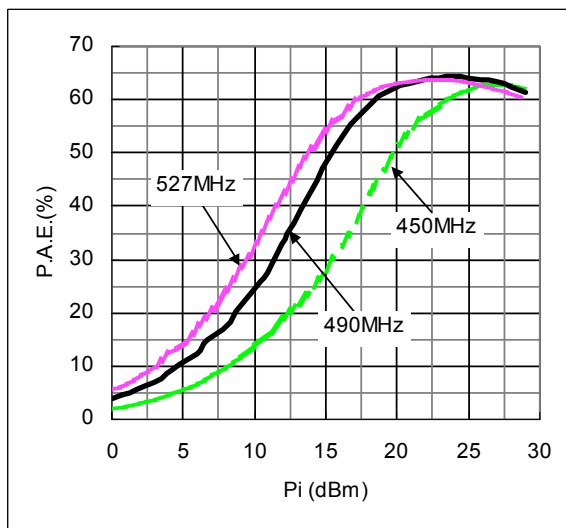
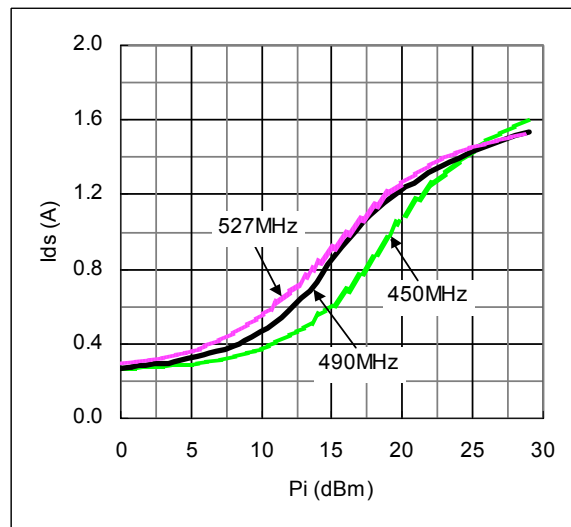
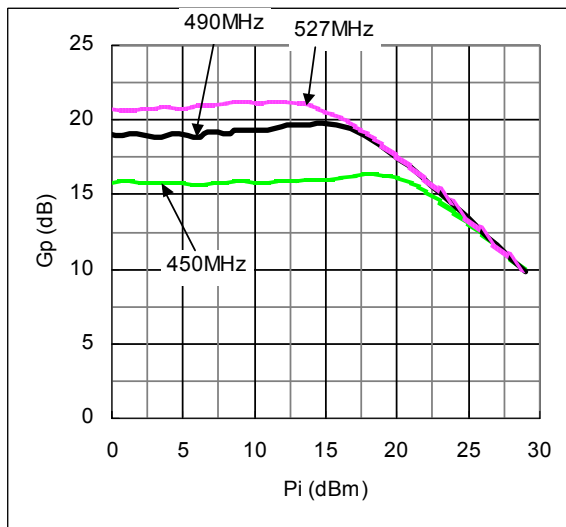
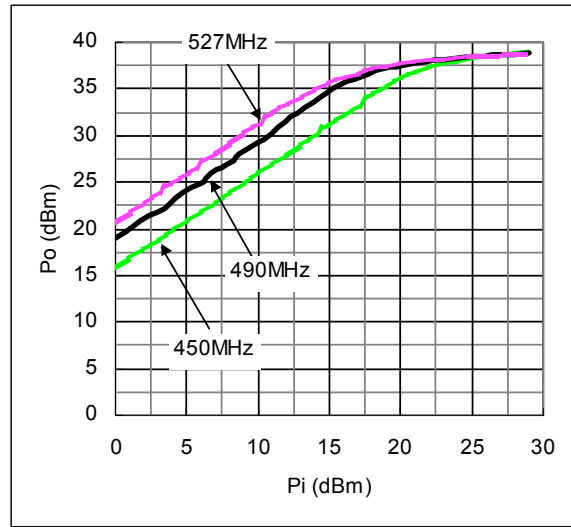
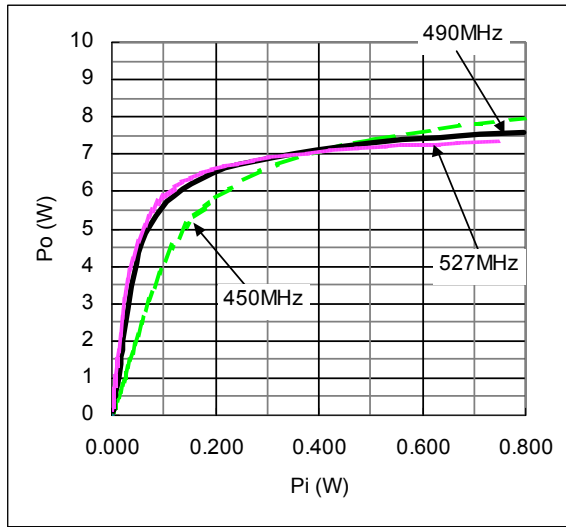
@ Vdd=7.2V, Idq=250mA, **Pi=0.4W** (26dBm)



Vds (V)	f (MHz)	Po (W)	Po (dBm)	Gp (dB)	Ids (A)	ηd (%)	P.A.E. (%)
7.2	440	7.01	38.5	12.4	1.51	64.3	60.6
	450	7.17	38.6	12.5	1.49	66.8	63.0
	460	7.19	38.6	12.6	1.47	67.9	64.2
	470	7.18	38.6	12.5	1.46	68.3	64.5
	480	7.16	38.6	12.5	1.46	68.1	64.3
	490	7.17	38.6	12.5	1.47	67.8	64.0
	500	7.18	38.6	12.5	1.48	67.4	63.6
	510	7.20	38.6	12.5	1.49	67.1	63.3
	520	7.15	38.5	12.5	1.49	66.7	63.0
	530	7.04	38.5	12.4	1.47	66.3	62.5

RD07MUS2B single-stage amplifier Pout vs. Pin characteristics

@ $V_{dd}=7.2\text{V}$, $I_{dq}=250\text{mA}$, $f=450\text{MHz}$, 490MHz , 527MHz



RD07MUS2B single-stage amplifier Pout vs. Pin characteristics data

@ f=450MHz, Idq=250mA

Vds (V)	Pi (W)	Pi (dBm)	Po (W)	Po (dBm)	Gp (dB)	I _{ds} (A)	η _d (%)	P.A.E. (%)
7.32	0.001	0.1	0.039	15.9	15.8	0.26	2.0	1.9
7.32	0.001	1.0	0.049	16.9	15.9	0.27	2.5	2.4
7.32	0.002	2.0	0.061	17.8	15.8	0.27	3.1	3.0
7.32	0.002	3.1	0.077	18.8	15.8	0.28	3.8	3.7
7.32	0.003	4.0	0.096	19.8	15.8	0.28	4.7	4.5
7.32	0.003	5.1	0.122	20.9	15.8	0.29	5.8	5.6
7.32	0.004	6.1	0.152	21.8	15.7	0.30	6.9	6.8
7.32	0.005	7.1	0.192	22.8	15.7	0.31	8.4	8.2
7.32	0.006	8.1	0.241	23.8	15.7	0.33	10.0	9.8
7.31	0.008	9.0	0.306	24.9	15.8	0.35	12.0	11.7
7.31	0.010	10.1	0.388	25.9	15.8	0.37	14.2	13.8
7.31	0.013	11.1	0.490	26.9	15.8	0.40	16.6	16.1
7.31	0.016	12.1	0.625	28.0	15.9	0.44	19.3	18.8
7.30	0.020	13.1	0.789	29.0	15.9	0.49	22.2	21.6
7.30	0.026	14.1	1.017	30.1	16.0	0.55	25.5	24.9
7.29	0.032	15.0	1.270	31.0	16.0	0.61	28.7	27.9
7.28	0.040	16.1	1.657	32.2	16.1	0.68	33.3	32.5
7.27	0.051	17.1	2.118	33.3	16.2	0.77	37.7	36.8
7.26	0.065	18.1	2.775	34.4	16.3	0.88	43.5	42.5
7.25	0.081	19.1	3.409	35.3	16.2	0.99	47.7	46.6
7.24	0.103	20.1	4.167	36.2	16.1	1.09	52.9	51.6
7.23	0.129	21.1	4.799	36.8	15.7	1.18	56.4	54.9
7.22	0.162	22.1	5.349	37.3	15.2	1.26	59.0	57.2
7.22	0.203	23.1	5.842	37.7	14.6	1.32	61.2	59.1
7.21	0.256	24.1	6.305	38.0	13.9	1.38	63.3	60.7
7.21	0.321	25.1	6.713	38.3	13.2	1.44	64.8	61.7
7.20	0.402	26.0	7.083	38.5	12.5	1.48	66.3	62.5
7.20	0.506	27.0	7.411	38.7	11.7	1.53	67.4	62.8
7.19	0.634	28.0	7.680	38.9	10.8	1.57	68.2	62.6
7.19	0.800	29.0	7.942	39.0	10.0	1.60	68.9	62.0

RD07MUS2B single-stage amplifier RF performance at f=450-527MHz,Vdd=7.2V

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@ f=490MHz, Idq=250mA

Vds (V)	Pi (W)	Pi (dBm)	Po (W)	Po (dBm)	Gp (dB)	Ids (A)	η_d (%)	P.A.E. (%)
7.32	0.001	-0.3	0.075	18.7	19.0	0.27	3.8	3.7
7.32	0.001	0.8	0.095	19.8	19.0	0.28	4.7	4.6
7.32	0.001	1.7	0.119	20.8	19.1	0.28	5.7	5.7
7.32	0.002	3.0	0.153	21.9	18.8	0.29	7.1	7.0
7.32	0.002	3.8	0.191	22.8	19.0	0.30	8.6	8.5
7.32	0.003	4.8	0.242	23.8	19.1	0.32	10.3	10.2
7.32	0.004	5.9	0.304	24.8	18.9	0.34	12.3	12.1
7.31	0.005	6.7	0.396	26.0	19.2	0.36	15.0	14.8
7.31	0.006	8.0	0.509	27.1	19.1	0.39	17.9	17.7
7.31	0.007	8.7	0.636	28.0	19.3	0.42	20.6	20.4
7.30	0.010	9.9	0.826	29.2	19.3	0.46	24.4	24.1
7.30	0.012	10.9	1.043	30.2	19.3	0.51	27.8	27.5
7.29	0.015	11.9	1.384	31.4	19.5	0.57	33.1	32.7
7.28	0.019	12.8	1.755	32.4	19.6	0.65	37.3	36.9
7.27	0.025	13.9	2.278	33.6	19.7	0.73	43.0	42.5
7.27	0.030	14.7	2.853	34.6	19.8	0.82	47.7	47.2
7.26	0.037	15.7	3.465	35.4	19.7	0.92	52.1	51.5
7.25	0.047	16.7	4.085	36.1	19.4	1.01	56.0	55.3
7.24	0.059	17.7	4.630	36.7	18.9	1.09	58.9	58.2
7.23	0.075	18.8	5.135	37.1	18.3	1.15	61.5	60.6
7.23	0.095	19.8	5.528	37.4	17.7	1.21	63.1	62.0
7.22	0.120	20.8	5.877	37.7	16.9	1.27	64.3	63.0
7.22	0.153	21.8	6.193	37.9	16.1	1.31	65.3	63.7
7.21	0.195	22.9	6.472	38.1	15.2	1.36	66.1	64.1
7.20	0.246	23.9	6.708	38.3	14.3	1.40	66.7	64.3
7.20	0.313	25.0	6.926	38.4	13.4	1.43	67.2	64.2
7.20	0.394	25.9	7.107	38.5	12.6	1.46	67.5	63.8
7.20	0.499	27.0	7.284	38.6	11.6	1.49	67.9	63.3
7.20	0.633	28.0	7.443	38.7	10.7	1.51	68.3	62.5
7.19	0.797	29.0	7.583	38.8	9.8	1.54	68.7	61.5

RD07MUS2B single-stage amplifier RF performance at f=450-527MHz,Vdd=7.2V

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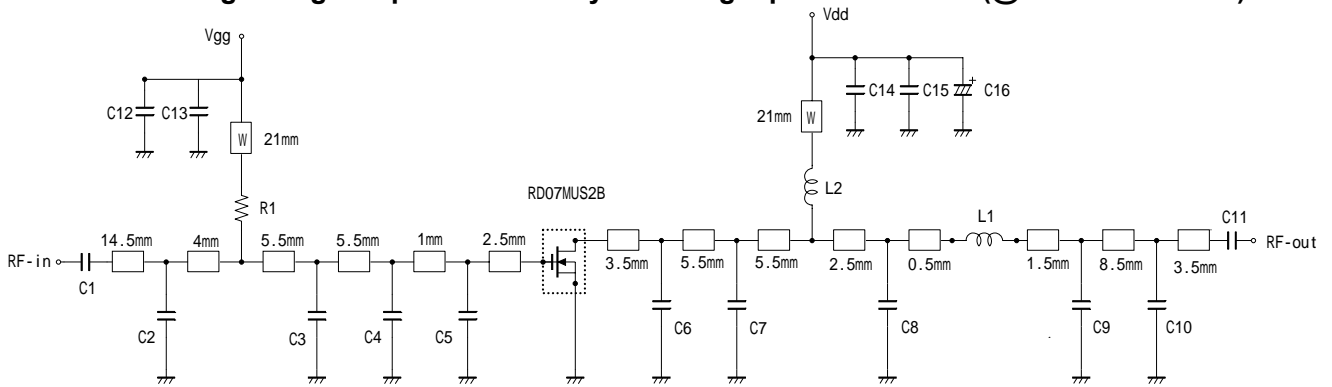
@ **f=527MHz**, Idq=250mA

Vds (V)	Pi (W)	Pi (dBm)	Po (W)	Po (dBm)	Gp (dB)	Ids (A)	η_d (%)	P.A.E. (%)
7.32	0.001	0.0	0.119	20.8	20.7	0.29	5.6	5.5
7.32	0.001	1.1	0.150	21.8	20.6	0.30	6.8	6.8
7.32	0.002	2.1	0.192	22.8	20.8	0.31	8.4	8.4
7.32	0.002	3.1	0.241	23.8	20.8	0.32	10.1	10.0
7.32	0.003	4.0	0.309	24.9	20.9	0.34	12.3	12.2
7.31	0.003	5.2	0.390	25.9	20.8	0.36	14.7	14.5
7.31	0.004	6.1	0.505	27.0	21.0	0.39	17.8	17.7
7.31	0.005	7.0	0.635	28.0	21.0	0.42	20.7	20.5
7.30	0.006	8.0	0.819	29.1	21.1	0.46	24.5	24.3
7.30	0.008	9.1	1.057	30.2	21.2	0.50	28.7	28.5
7.29	0.010	10.1	1.343	31.3	21.1	0.56	33.1	32.8
7.28	0.013	11.1	1.708	32.3	21.2	0.62	37.9	37.7
7.28	0.016	12.1	2.136	33.3	21.2	0.69	42.8	42.5
7.27	0.021	13.1	2.619	34.2	21.0	0.76	47.5	47.1
7.27	0.025	14.0	3.103	34.9	20.9	0.83	51.2	50.7
7.26	0.032	15.1	3.618	35.6	20.5	0.91	54.6	54.1
7.25	0.041	16.1	4.149	36.2	20.1	0.99	57.8	57.2
7.24	0.051	17.1	4.656	36.7	19.6	1.07	60.3	59.7
7.23	0.064	18.0	5.085	37.1	19.0	1.14	61.9	61.2
7.23	0.080	19.0	5.495	37.4	18.4	1.20	63.3	62.4
7.22	0.099	20.0	5.816	37.6	17.7	1.26	64.1	63.0
7.22	0.124	20.9	6.119	37.9	16.9	1.31	64.8	63.5
7.21	0.155	21.9	6.369	38.0	16.1	1.35	65.3	63.7
7.21	0.194	22.9	6.573	38.2	15.3	1.39	65.6	63.7
7.20	0.243	23.9	6.753	38.3	14.4	1.42	66.0	63.6
7.20	0.305	24.8	6.906	38.4	13.6	1.45	66.2	63.3
7.20	0.380	25.8	7.033	38.5	12.7	1.47	66.4	62.8
7.20	0.477	26.8	7.154	38.5	11.8	1.49	66.6	62.2
7.20	0.596	27.8	7.262	38.6	10.9	1.51	66.8	61.3
7.20	0.749	28.7	7.368	38.7	9.9	1.53	67.1	60.3

RD07MUS2B single-stage amplifier RF performance at $f=450\text{-}527\text{MHz}$, $V_{dd}=7.2\text{V}$

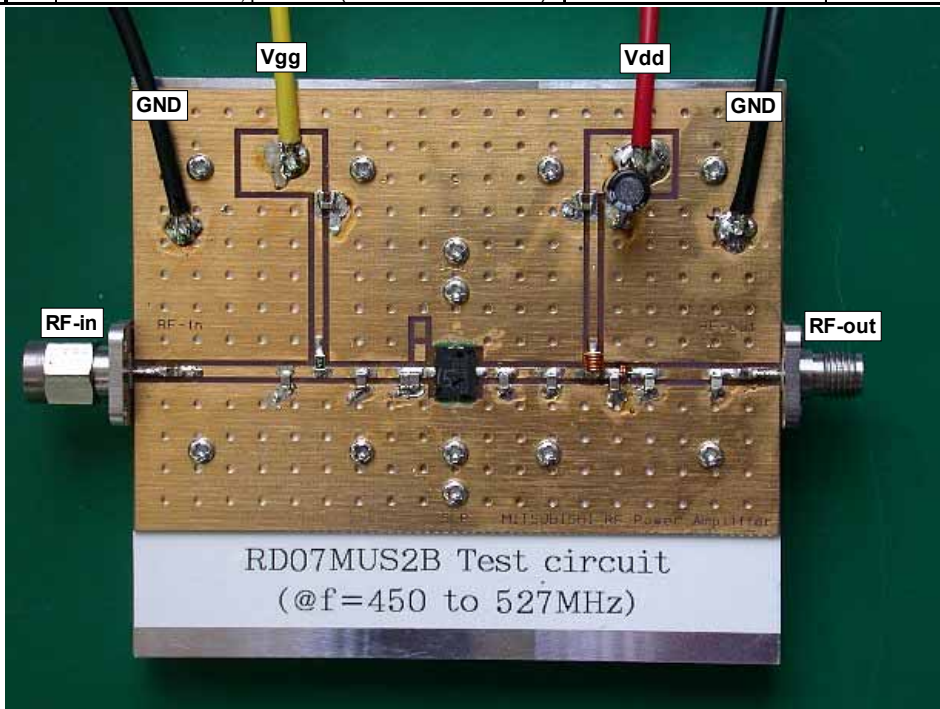
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RD07MUS2B single-stage amplifier efficiency matching equivalent circuit (@ $f=450$ to 527MHz)



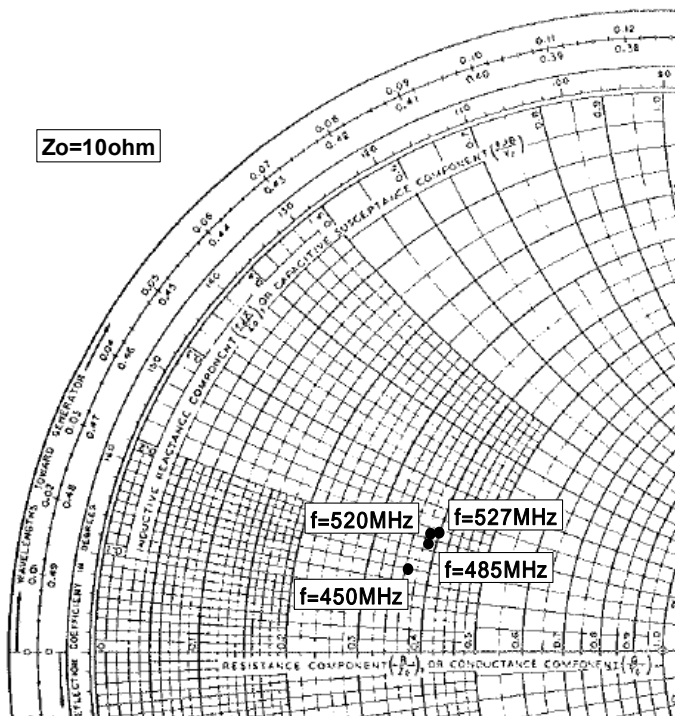
Note: Board material - Glass-Epoxy Substrate
 Micro strip line width=1.3mm/500HM, er:4.8, t=0.8mm
 W: Line width=1.0mm

Parts Type	Value	Type name	Vender	
Capacitor	C1	100pF	GRM2162C1H101GD01E	Murata Manufacturing Co., Ltd.
	C2	8pF	GRM2162C1H8R0DD01E	Murata Manufacturing Co., Ltd.
	C3	8pF	GRM2162C1H8R0DD01E	Murata Manufacturing Co., Ltd.
	C4	12pF	GRM2162C1H120GD01E	Murata Manufacturing Co., Ltd.
	C5	54pF	GRM2162C1H540GD01E	Murata Manufacturing Co., Ltd.
	C6	24pF	GRM2162C1H240GD01E	Murata Manufacturing Co., Ltd.
	C7	24pF	GRM2162C1H240GD01E	Murata Manufacturing Co., Ltd.
	C8	9pF	GRM2162C1H9R0DD01E	Murata Manufacturing Co., Ltd.
	C9	5pF	GRM2162C1H5R0DD01E	Murata Manufacturing Co., Ltd.
	C10	4pF	GRM2162C1H4R0DD01E	Murata Manufacturing Co., Ltd.
	C11	100pF	GRM2162C1H101GD01E	Murata Manufacturing Co., Ltd.
	C12	22000pF	GRM216R11H223KA01E	Murata Manufacturing Co., Ltd.
	C13	1000pF	GRM216R11H102KA01E	Murata Manufacturing Co., Ltd.
	C14	1000pF	GRM216R11H102KA01E	Murata Manufacturing Co., Ltd.
	C15	22000pF	GRM216R11H223KA01E	Murata Manufacturing Co., Ltd.
	C16	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	34.5nH Enameled wire 5Turns, Diameter:0.43mm,φ2.46mm (the out side diameter)	4005C	Yoneda Processing Place Co.,Ltd.



RD07MUS2B Input / Output Impedance vs. Frequency characteristics

Z_{out}^* ($f=450,490,520,527\text{MHz}$)

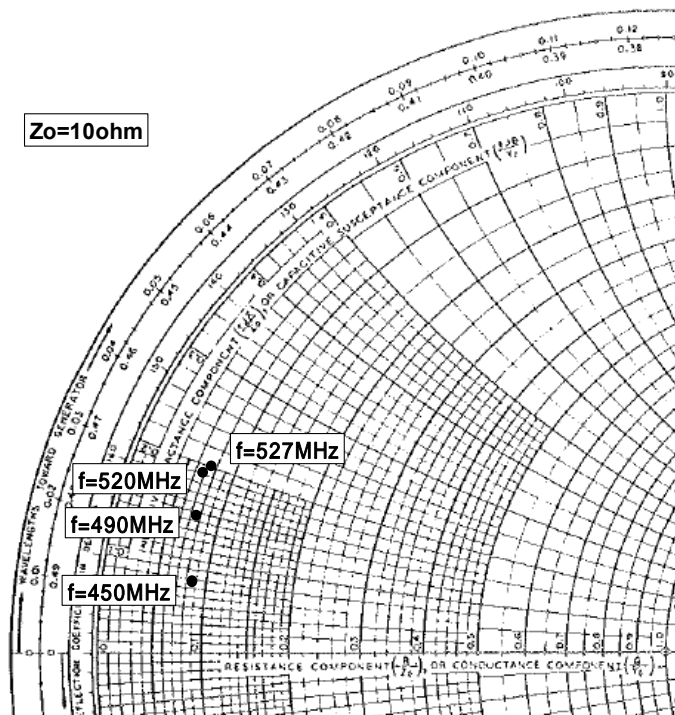


@ $P_{in}=0.4\text{W}$, $V_{dd}=7.2\text{V}$,
 $I_{dq}=250\text{mA}$ (V_{gg} adj.)

f (MHz)	Z_{out}^* (ohm)
450	$3.65+j1.40$
490	$3.89+j1.95$
520	$3.89+j2.10$
527	$3.92+j2.14$

Z_{out}^* : Complex conjugate of Output impedance.

Z_{in}^* ($f=450,490,520,527\text{MHz}$)



@ $P_{in}=0.4\text{W}$, $V_{dd}=7.2\text{V}$,
 $I_{dq}=250\text{mA}$ (V_{gg} adj.)

f (MHz)	Z_{in}^* (ohm)
450	$0.85+j0.77$
490	$0.74+j1.44$
520	$0.69+j1.91$
527	$0.73+j1.99$

Z_{in}^* : Complex conjugate of Input impedance.