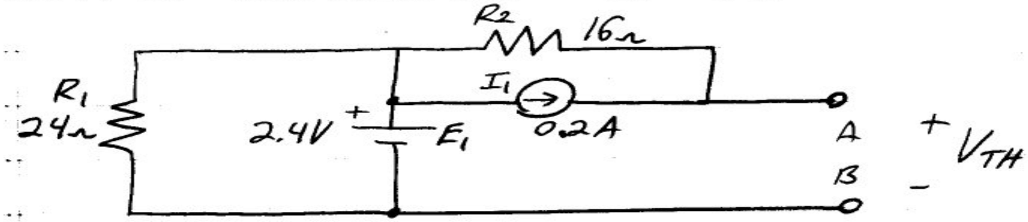
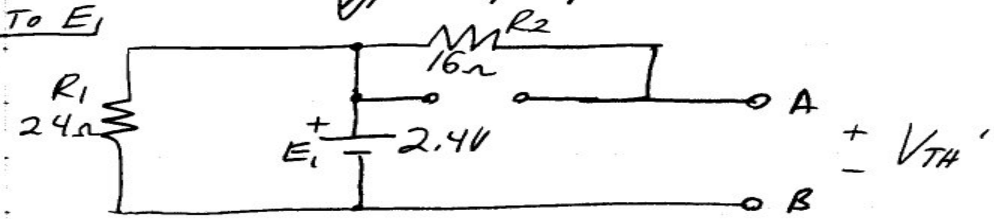
QUICK CALCULATION OF V_{TH}:



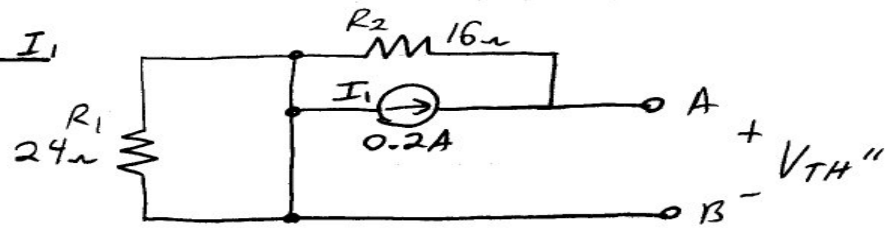
⇓ SUPERPOSITION

DUE TO E_1



$$V_{TH}' = \underline{2.4V}$$

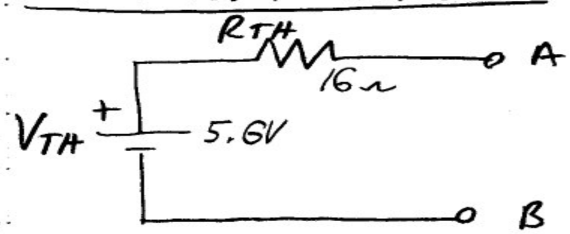
DUE TO I_1



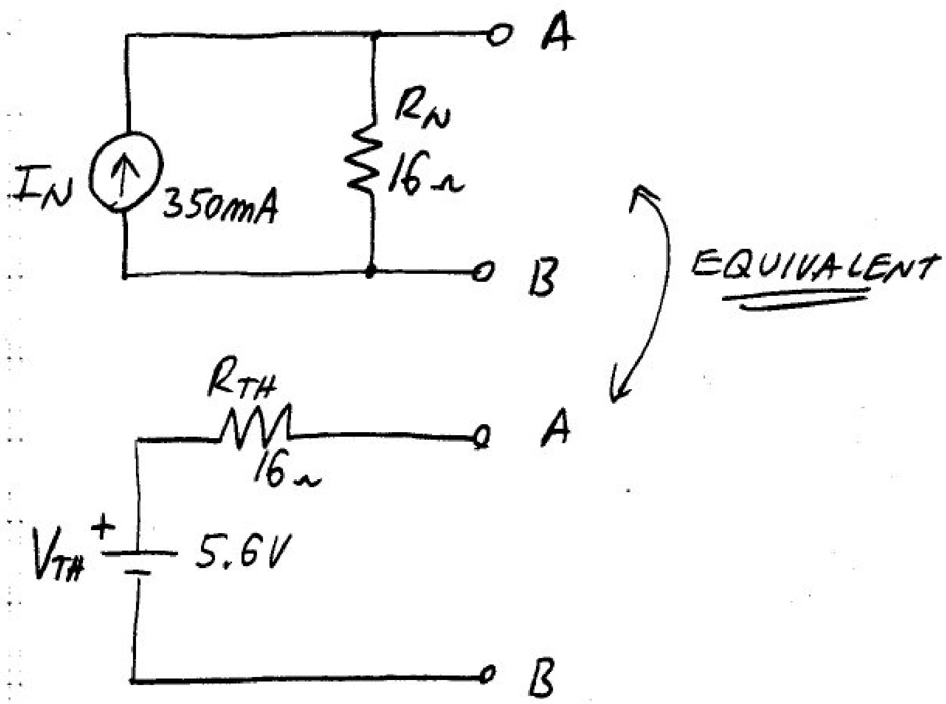
$$V_{TH}'' = I_1 R_2 = (0.2A)(16\Omega) = \underline{3.2V}$$

$$\therefore \; V_{TH} = 2.4 + 3.2 = \underline{5.6V}$$

EQUIVALENT CIRCUIT



SUMMARY

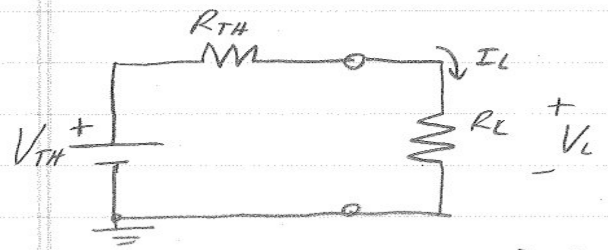


$$V_{TH} = (I_N)(R_N) = (0.35A)(16\Omega) = \underline{\underline{5.6V}} \ \checkmark$$

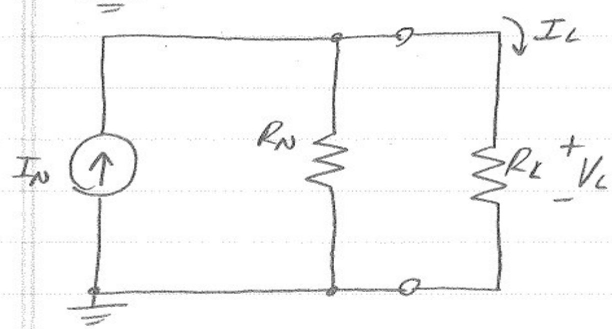
$$I_N = \frac{V_{TH}}{R_{TH}} = 5.6V/16\Omega = \underline{\underline{350mA}} \ \checkmark$$

9.5 MAXIMUM POWER TRANSFER THEOREM

A LOAD WILL RECEIVE MAXIMUM POWER FROM A LINEAR BILATERAL DC NETWORK WHEN ITS TOTAL RESISTIVE VALUE IS EXACTLY EQUAL TO THE THÉVENIN RESISTANCE OF THE NETWORK AS "SEEN" BY THE LOAD.



$P_{RLMAX} \Rightarrow$ WHEN $R_L = R_{TH}$



$P_{RLMAX} \Rightarrow$ WHEN $R_L = R_N$

(EXAMPLE) LET $V_{TH} = 10V$

$R_{TH} = 50\Omega$

$V_L = V_{TH}\left(\frac{R_L}{R_L + R_{TH}}\right)$

$V_L = 10\left(\frac{R_L}{R_L + 50}\right)$ (1)

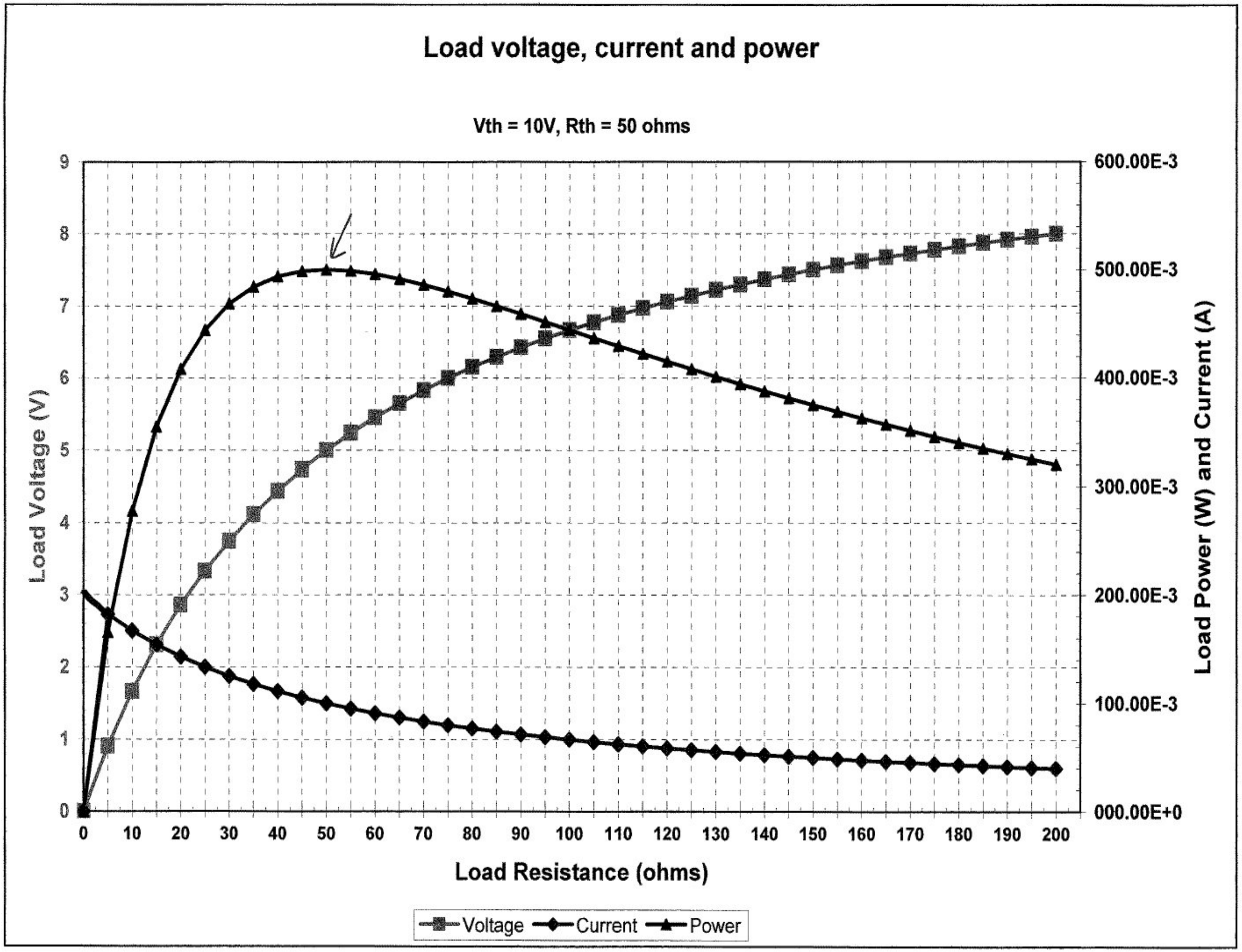
$I_L = \frac{V_L}{R_L}$ (2)

$P_L = (I_L)^2 R_L$ (3)

PLOT FOR $0_\Omega \leq R_L \leq 200_\Omega$

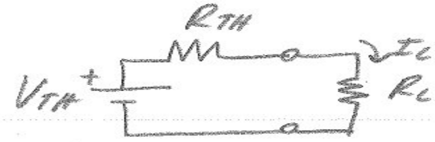
0.2

Vth	10	V	
Rth	50	ohms	
RL ohms	VL Volts	IL Amps	PL Watts
0	000.00E+0	000.00E+0	000.00E+0
5	909.09E-3	181.82E-3	165.29E-3
10	1.67E+0	166.67E-3	277.78E-3
15	2.31E+0	153.85E-3	355.03E-3
20	2.86E+0	142.86E-3	408.16E-3
25	3.33E+0	133.33E-3	444.44E-3
30	3.75E+0	125.00E-3	468.75E-3
35	4.12E+0	117.65E-3	484.43E-3
40	4.44E+0	111.11E-3	493.83E-3
45	4.74E+0	105.26E-3	498.61E-3
50	5.00E+0	100.00E-3	500.00E-3
55	5.24E+0	95.24E-3	498.87E-3
60	5.45E+0	90.91E-3	495.87E-3
65	5.65E+0	86.96E-3	491.49E-3
70	5.83E+0	83.33E-3	486.11E-3
75	6.00E+0	80.00E-3	480.00E-3
80	6.15E+0	76.92E-3	473.37E-3
85	6.30E+0	74.07E-3	466.39E-3
90	6.43E+0	71.43E-3	459.18E-3
95	6.55E+0	68.97E-3	451.84E-3
100	6.67E+0	66.67E-3	444.44E-3
105	6.77E+0	64.52E-3	437.04E-3
110	6.88E+0	62.50E-3	429.69E-3
115	6.97E+0	60.61E-3	422.41E-3
120	7.06E+0	58.82E-3	415.22E-3
125	7.14E+0	57.14E-3	408.16E-3
130	7.22E+0	55.56E-3	401.23E-3
135	7.30E+0	54.05E-3	394.45E-3
140	7.37E+0	52.63E-3	387.81E-3
145	7.44E+0	51.28E-3	381.33E-3
150	7.50E+0	50.00E-3	375.00E-3
155	7.56E+0	48.78E-3	368.83E-3
160	7.62E+0	47.62E-3	362.81E-3
165	7.67E+0	46.51E-3	356.95E-3
170	7.73E+0	45.45E-3	351.24E-3
175	7.78E+0	44.44E-3	345.68E-3
180	7.83E+0	43.48E-3	340.26E-3
185	7.87E+0	42.55E-3	334.99E-3
190	7.92E+0	41.67E-3	329.86E-3
195	7.96E+0	40.82E-3	324.86E-3
200	8.00E+0	40.00E-3	320.00E-3



Load voltage, current and power
Vth = 10V, Rth = 50 ohms
Load Voltage (V)
0
1
2
3
4
5
6
7
8
9
Load Power (W) and Current (A)
000.00E+0
100.00E-3
200.00E-3
300.00E-3
400.00E-3
500.00E-3
600.00E-3
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Load Resistance (ohms)
Voltage
Current
Power

$P_{L\,MAX} \rightarrow$ WHEN $\underline{\underline{R_L = R_{TH}}}$



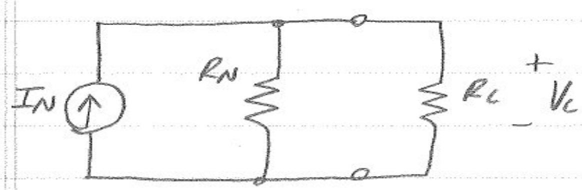
$$P_L = I_L^2 R_L = \left(\frac{V_{TH}}{R_L + R_{TH}}\right)^2 R_L$$

FOR $R_L = R_{TH}$: $P_{L\,MAX} = \left(\frac{V_{TH}}{R_{TH} + R_{TH}}\right)^2 R_{TH}$

$$P_{L\,MAX} = \frac{V_{TH}^2}{(2R_{TH})^2} \; R_{TH}$$

$$\boxed{P_{L\,MAX} = \frac{V_{TH}^2}{4R_{TH}}}$$

FOR $R_L = R_{TH}$



$$P_L = \frac{V_L^2}{R_L}$$

$$V_L = I_N \cdot (R_N /\!/ R_L)$$

FOR $R_L = R_N = R_{TH}$:

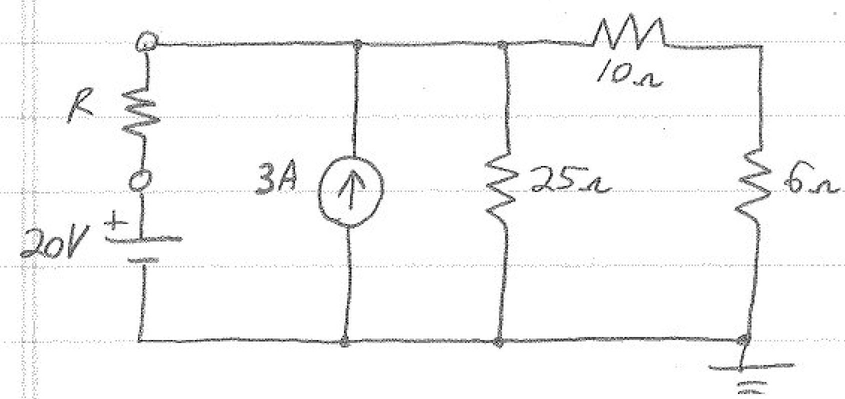
$$V_L = I_N \cdot \frac{R_N}{2}$$

$$\therefore P_{L\,MAX} = \frac{\left(\frac{I_N \cdot R_N}{2}\right)^2}{R_N}$$

$$\boxed{P_{L\,MAX} = \frac{I_N^2 R_N}{4}}$$

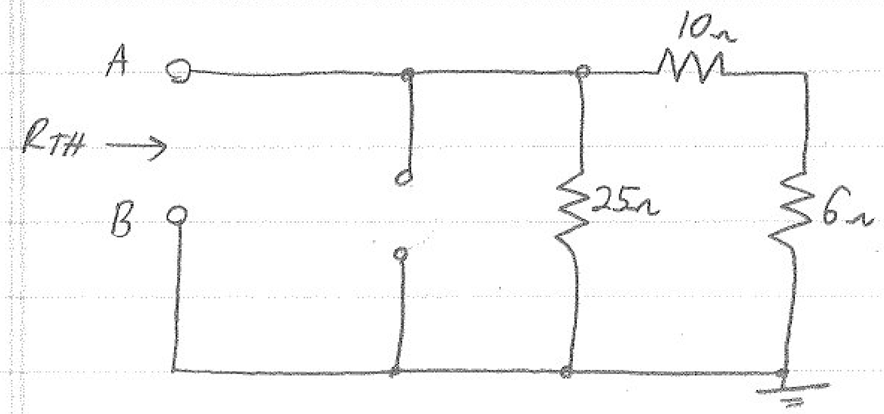
FOR $R_L = R_N$

Find the value of R for maximum power transfer (to R) + determine the maximum power to R.



- FIND V_{TH}, R_{TH}
- SET $R = R_{TH}$ + CALCULATE P_{Lmax}

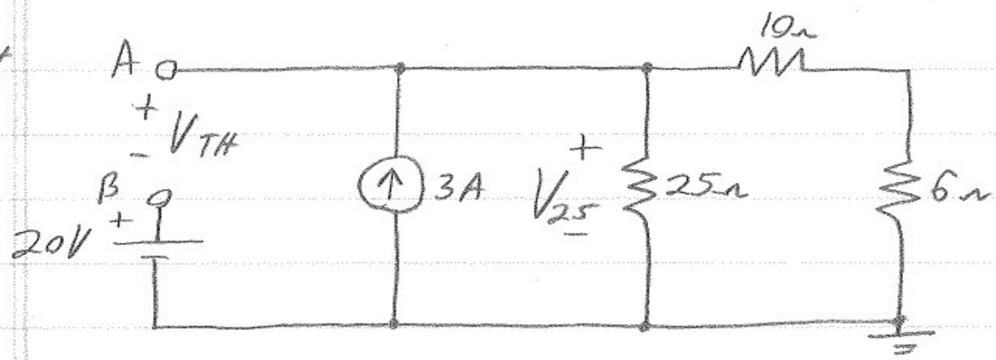
$\underline{R_{TH}}$



$$R_{TH} = (6+10) \parallel 25 = 16\Omega \parallel 25\Omega$$

$$\underline{\underline{R_{TH} = 9.756\Omega}}$$

$\underline{V_{TH}}$

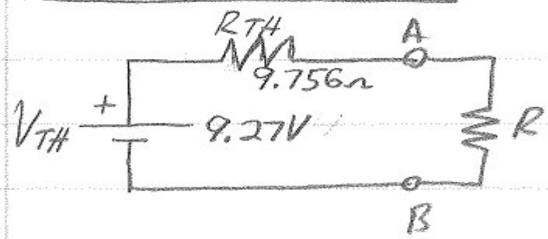


$$V_{25} = 3A\left[25\Omega \,//\, (10\Omega + 6\Omega)\right]$$
$$= (3A)(9.756\Omega)$$
$$\underline{V_{25} = 29.27V}$$

KVL: $+20 + V_{AB} - V_{25} = 0$

$$V_{AB} = V_{25} - 20$$
$$= 29.27 - 20$$
$$V_{AB} = \underline{\underline{V_{TH} = 9.27V}}$$

<u>THEVENIN EQUIV.</u>



$\boxed{R = R_{TH} = 9.756\Omega}$ FOR $P_{L\,MAX}$

$$P_{L\,MAX} = \frac{(V_{TH})^2}{4R_{TH}} = \frac{(9.27V)^2}{4(9.756\Omega)}$$

$$\boxed{P_{L\,MAX} = 2.2W}$$