

# PD power, $V_{pse}$ and $R_{cable}$

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# Cable current, PSE power

- The equation for  $I_{\text{cable}}$  is a quadratic:
  - $R * I^2 - V_{\text{PSE}} * I + P_{\text{PD}} = 0 \Rightarrow I = ((V_{\text{PSE}} \pm \text{SQRT}(V_{\text{PSE}}^2 - 4 * R * P_{\text{PD}})) / 2 * R)$ 
    - The 'plus' solution is an unstable mode, use on the 'minus' solution
  - $P_{\text{PSE}} = V_{\text{PSE}} * I$

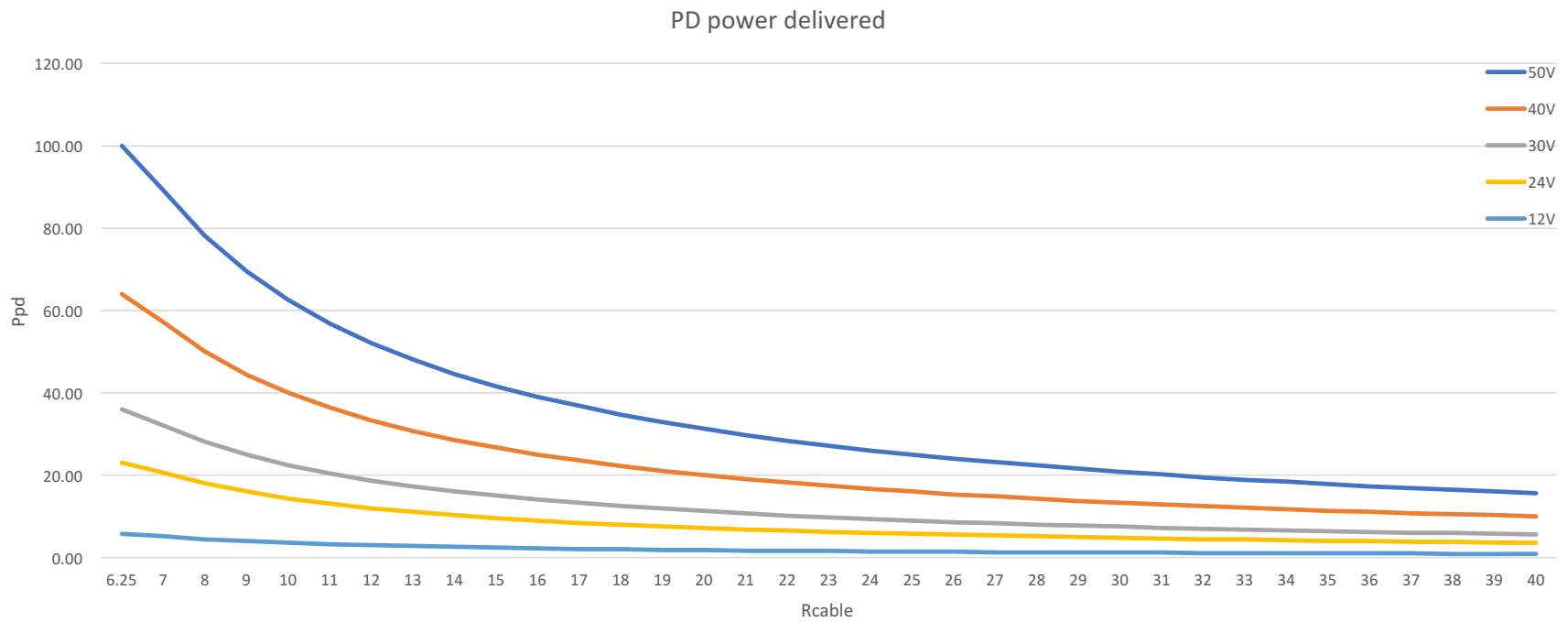
$$P_{\text{PSE}} = V_{\text{PSE}} ( (V_{\text{PSE}} - \text{SQRT}(V_{\text{PSE}}^2 - 4 * R * P_{\text{PD}})) / 2 * R )$$

## Max Current, Max PD power

- The max of that quadratic can be found by taking the derivative wrt  $I$ , solving for  $I$ . But I don't really care about  $I_{MAX}$  as much as I want to know  $P_{PD\_MAX}$
- $P_{PD\_MAX}$  occurs when  $P_{PD} = P_{CABLE}$
- $V_{PSE} * I - R * I^2 = R * I^2 \Rightarrow I = V_{PSE} / 2 * R$
- And  $P_{PD} = V_{PD} * I = (V_{PSE} / 2) * V_{PSE} / 2 * R = V_{PSE}^2 / 4 * R$

$$P_{PD\_MAX} = V_{PSE}^2 / 4 * R$$

# Which is more important, $R_{CABLE}$ or $V_{PSE}$



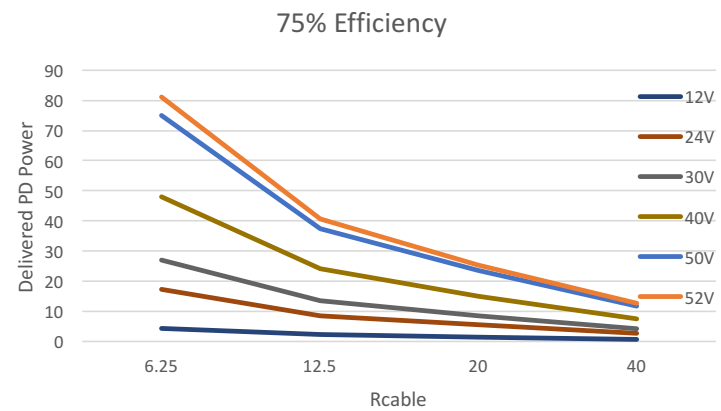
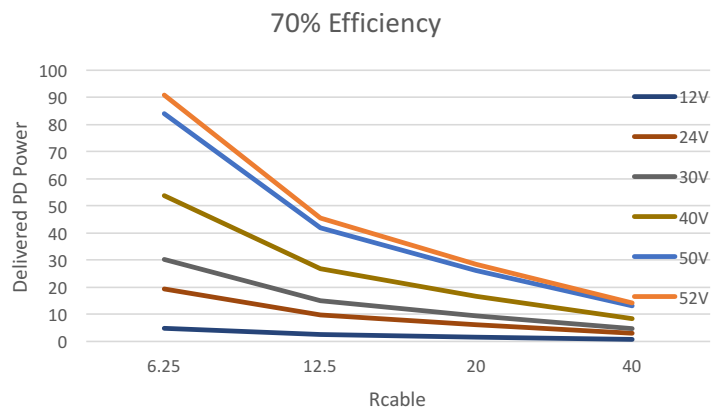
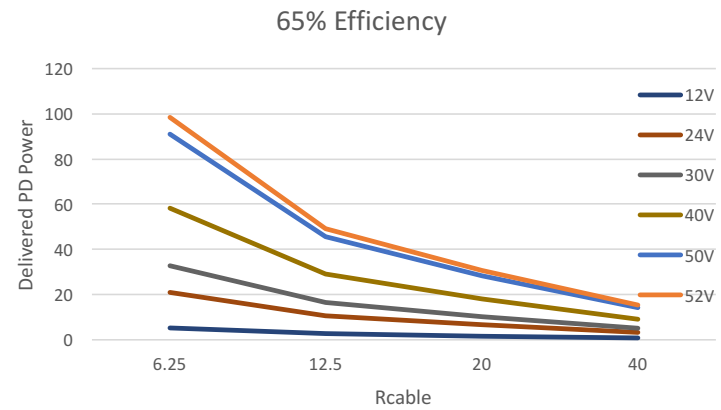
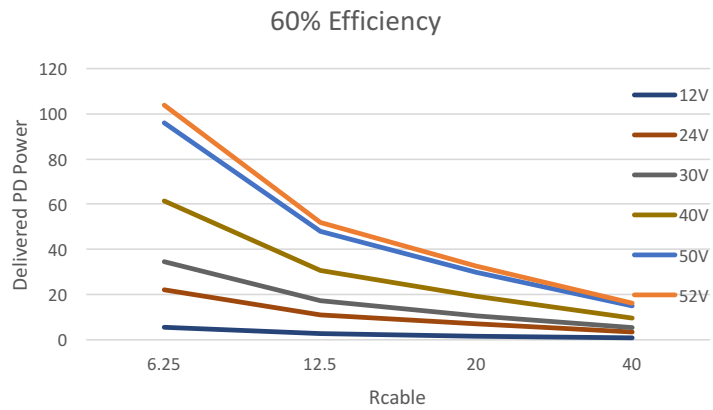
# Efficiency

- The problem with the previous analysis is it ignores efficiency
  - It's not ignored, it's just 50%.

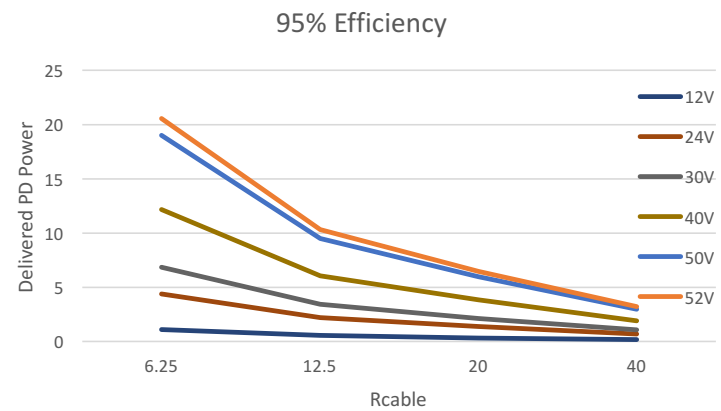
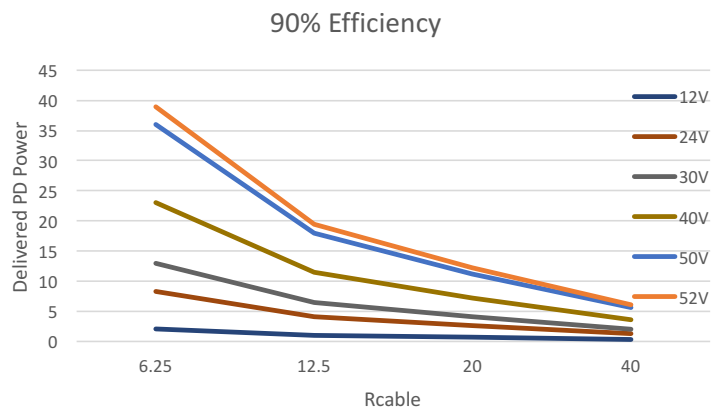
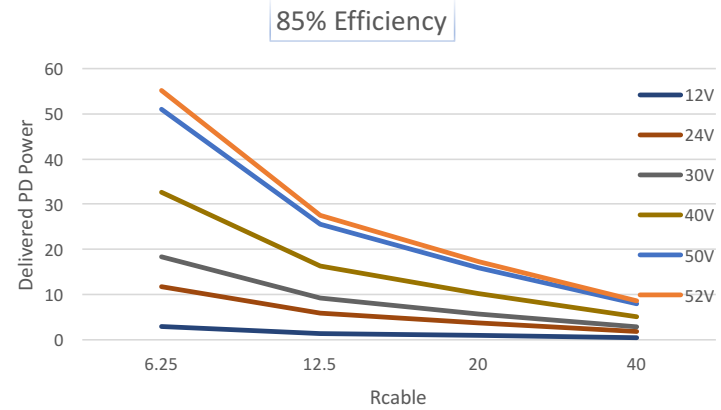
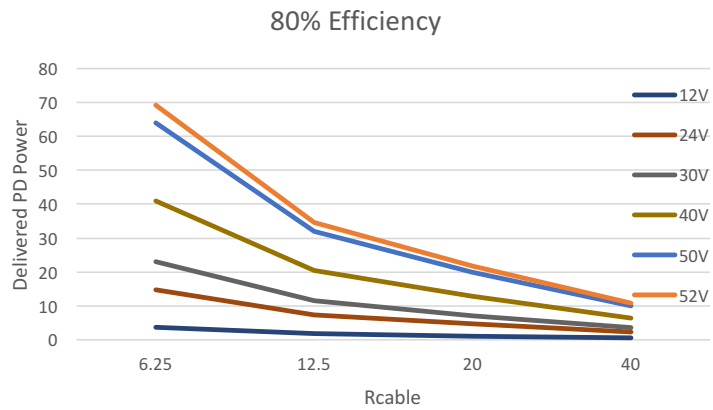
STANDARD/TYPE	$V_{PSE}$	$R_{CABLE}$	$P_{PSE}$	$P_{PD}$	EFFICIENCY
AF	44V	20 Ohms	15.4W	13W	84%
AT	50V	12.5 Ohms	30W	25.5W	85%
BT Type 3	50V	6.25 Ohms	60W	51W	85%
BT Type 4	52V	6.25 Ohms	91W	71.3W	78%
BT Type 4*	52V	6.25 Ohms	100W	75W	75%

\*802.3bt does not have a 100W  $P_{PSE}$  mode, this is the theoretical max for demonstration purposes

# How does efficiency affect power delivered?



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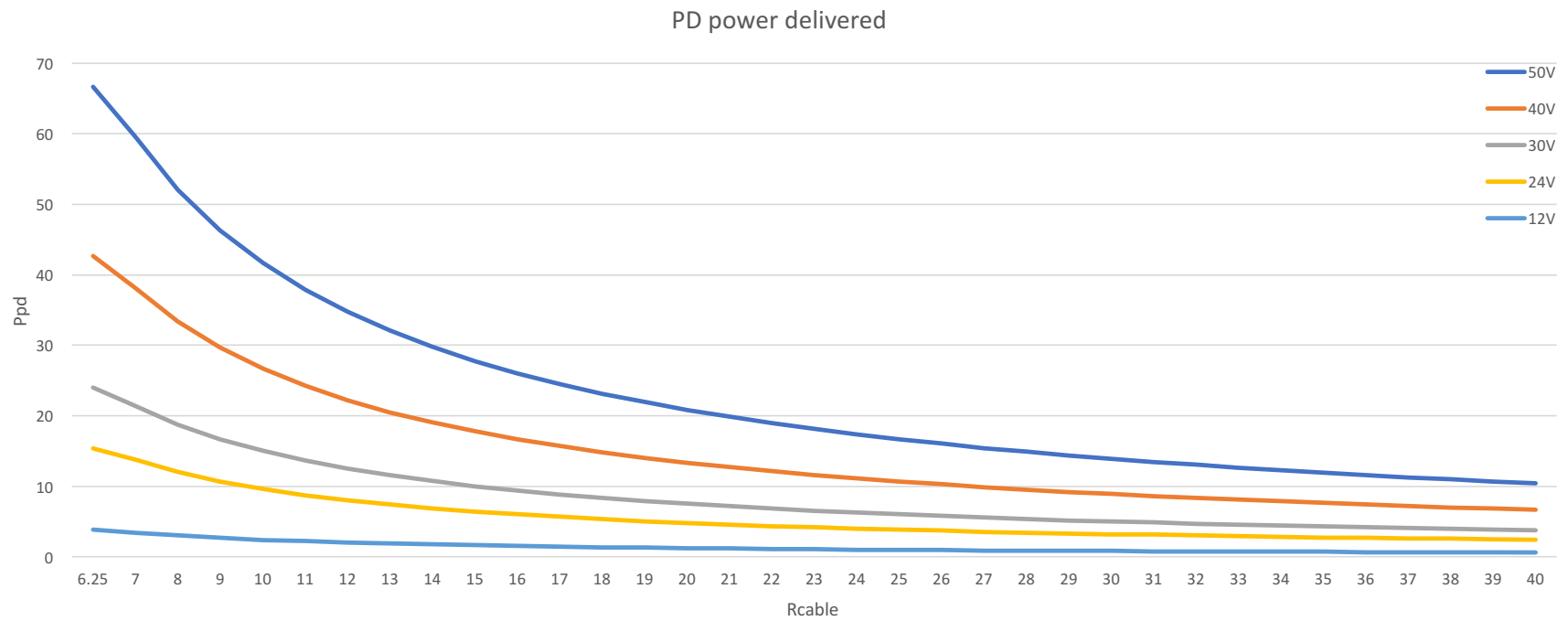
## Efficiency

$$\text{More realistic: } P_{PD} = V_{PSE}^2 / 6 * R$$

This yields an efficiency of about 80% and is good simple guide to estimate power delivered to a PD



# More Realistic Efficiency



# Conclusions

- Need to keep  $V_{PSE}$  higher,  $R_{CABLE}$  lower.
- Target worst case efficiency of about 80%.
- 12V  $V_{PSE}$  is a tough target. Looking at less than 4W  $P_{PD}$ .
- 24V can deliver about 10W over 10 ohms.
- Can get significant power from 50V with a reasonable  $R_{CABLE}$  (10 ohms is about 42W).