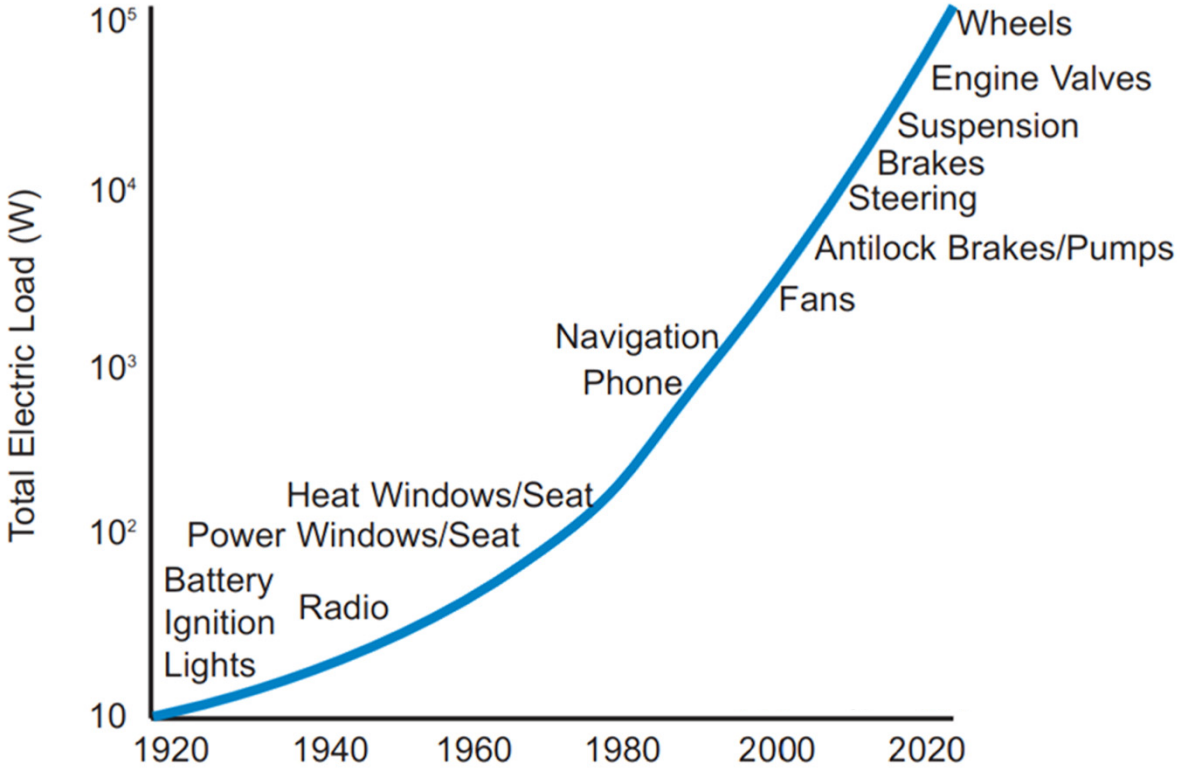
Example Application

48V VEHICLE ELECTRICAL SYSTEM

Automobile 12V Power

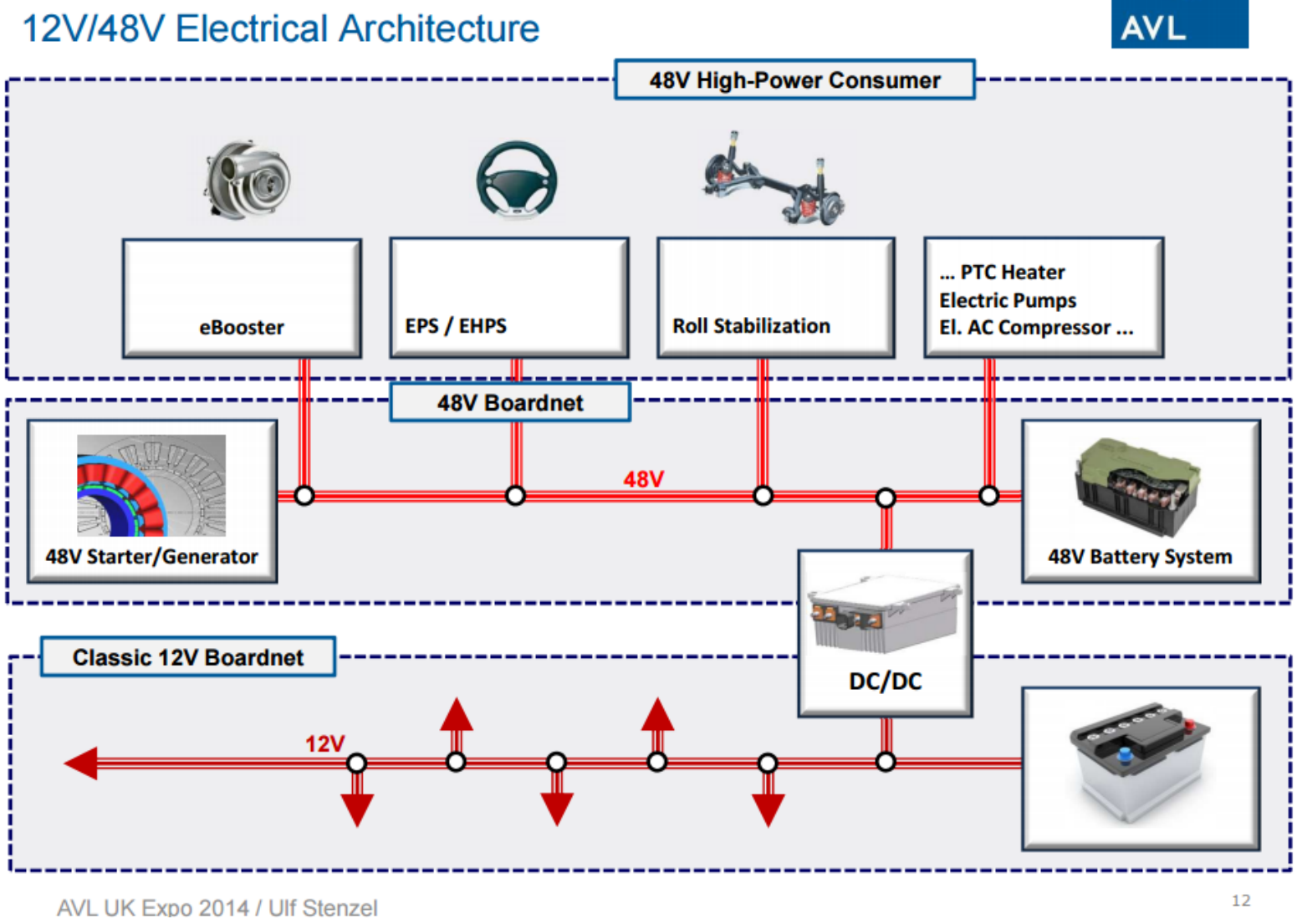
Figure 3. Electrification of the Auto



Source: Kasakian, Miller, and Traub, "Automotive Electronics Power Up," IEEE Spectrum *(May 2000).*

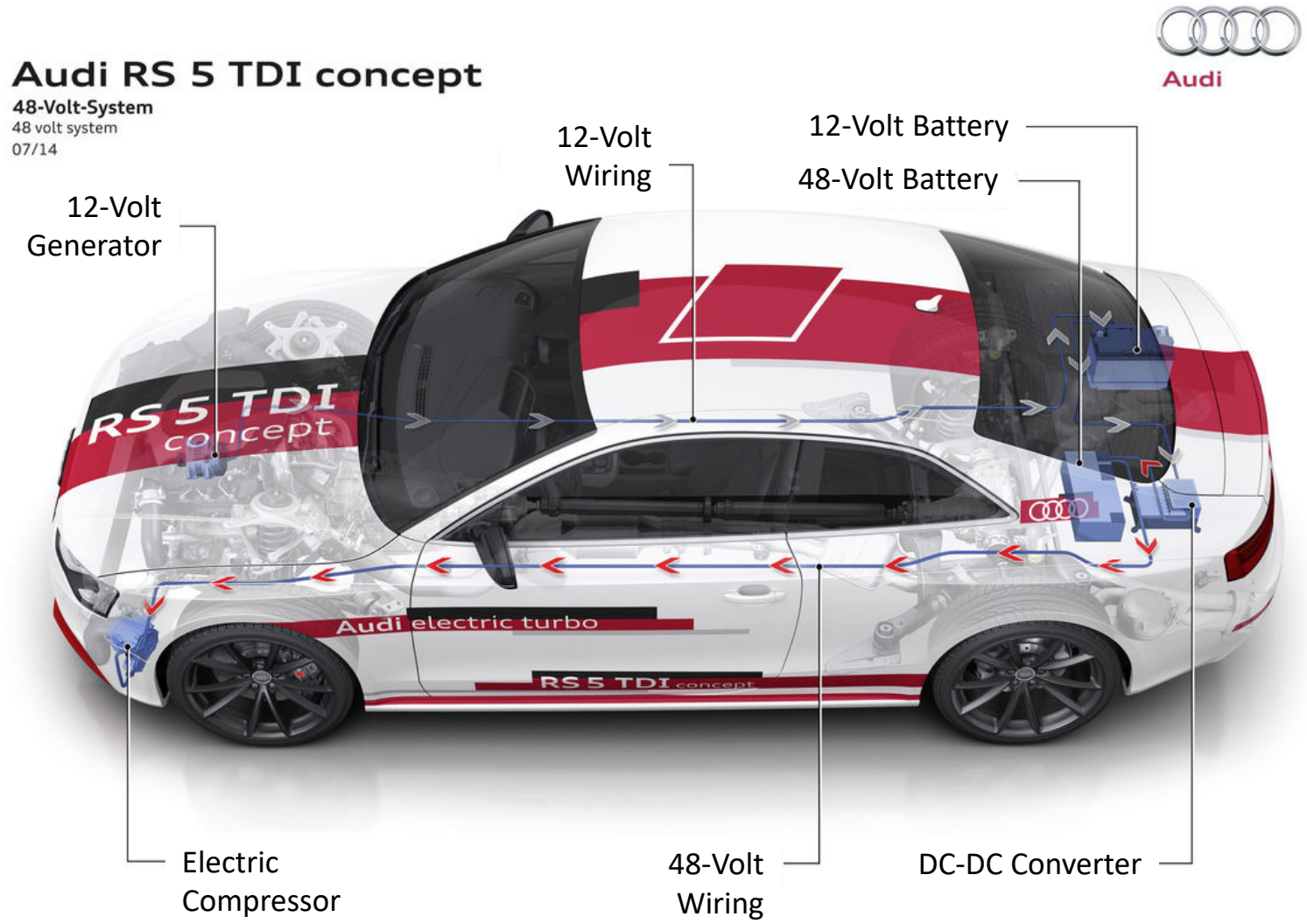
10kW @ 12V ~ 800A

48V Electrical System

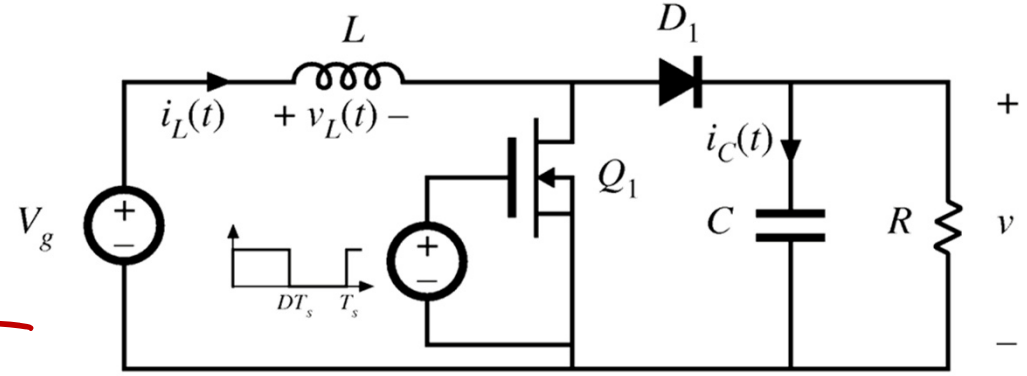


NXP Semi, "Semiconductors – enablers of future mobility concepts", 2011
Audi, "Electric biturbo and hybridization", 2014
AVL, "48V Mild Hybrid Systems"

Example 12/48 V Vehicle



System to Design



Param	Value
V_g	12 V
V_{out}	48 V
R_{out}	48 Ω
ΔV_{out}	0.1 V

Ideal Analysis

$V = 48V$

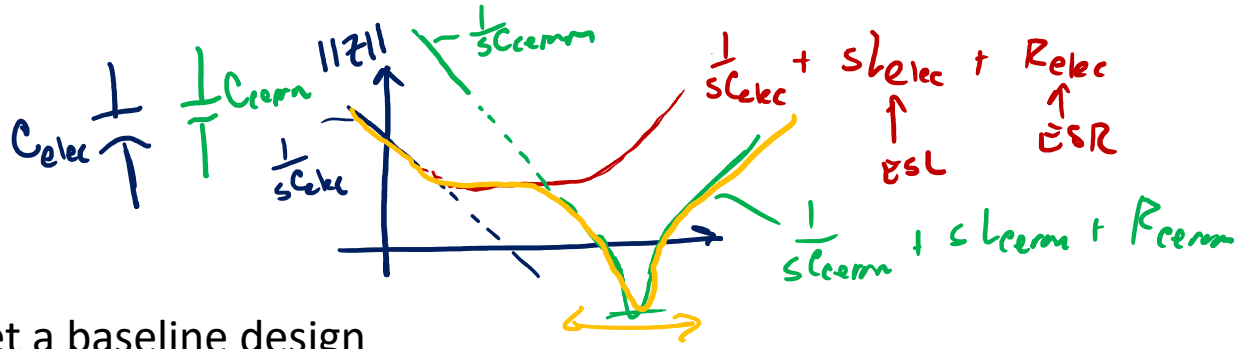
$M = \frac{V}{V_g} = \frac{1}{D'} = \frac{48V}{12V} = 4 \rightarrow D = 0.75$

$P_{out} = \frac{V^2}{R} = 48W$

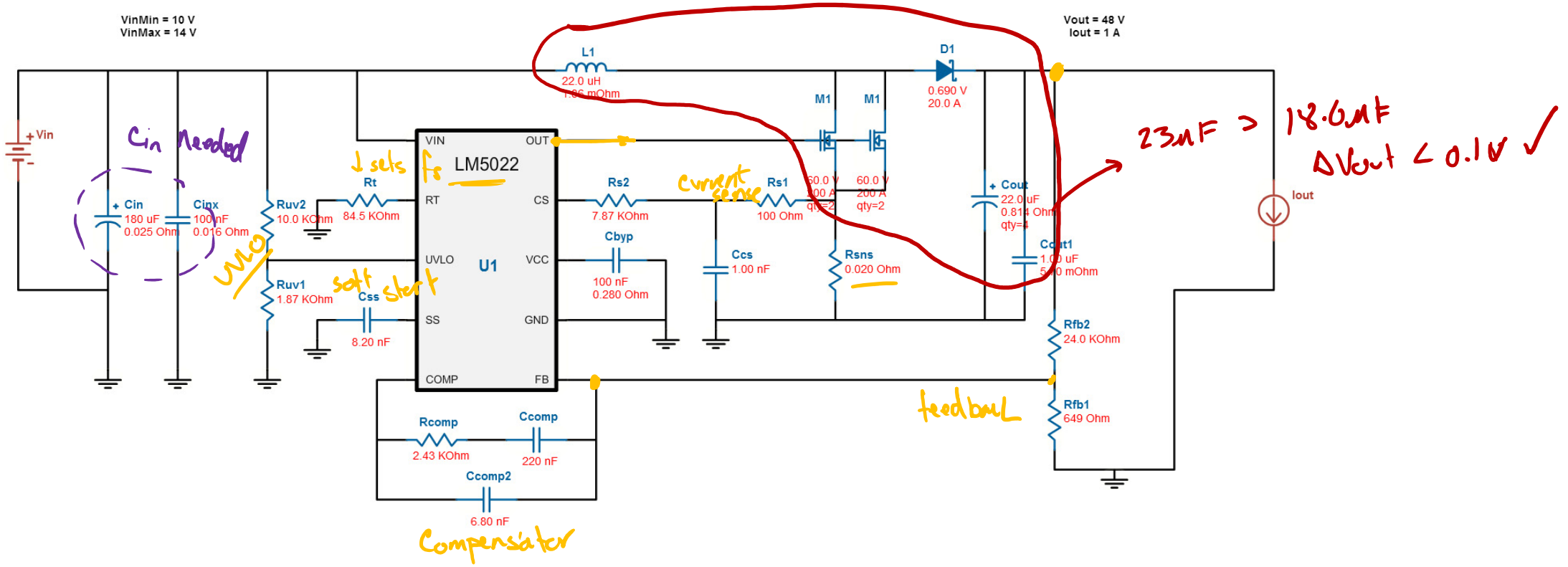
$2\Delta V = \frac{V/R}{C} DT_s \rightarrow C = \frac{\frac{V}{R}}{2\Delta V_{out}} DT_s$

@ $f_s = 200kHz$ $C = 18.6\mu F$

Baseline Design



- Use TI WebBench (webench.ti.com) to get a baseline design



Device Parameters

Diode

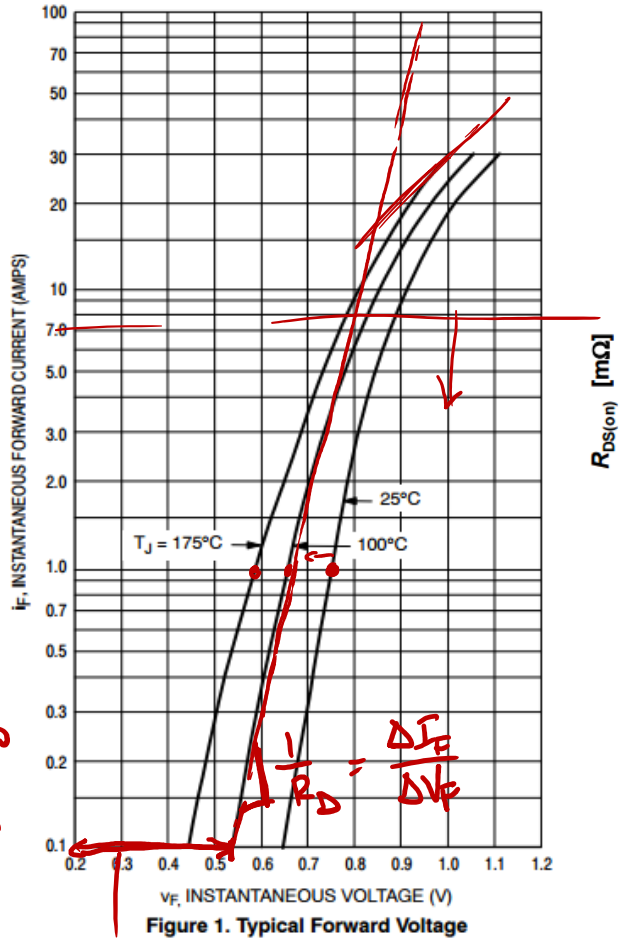


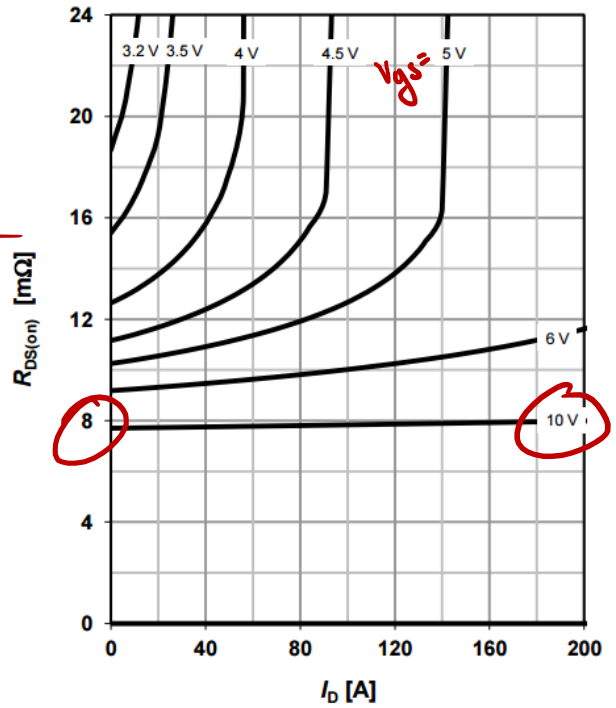
Figure 1. Typical Forward Voltage

$\frac{1}{R_D} = \frac{\Delta I_F}{\Delta V_F}$

$V_D \approx 0.5V$ @ 100°C $R_D \approx 0.1\Omega$

0.65V @ 25°C

MOSFET



$R_{DS(on)} = 8m\Omega$

2x in parallel

$R_{on} = 4m\Omega$

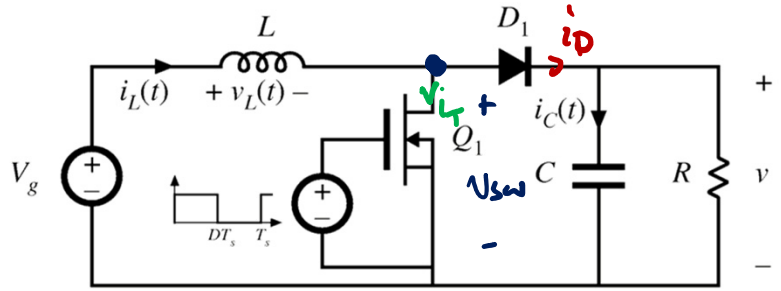
Inductor

DC Resistance

Part number[1]	Inductance[2] ±10% (µH)	DCR[3] (mOhms) nom	DCR[3] (mOhms) max	SRF typ[4] (MHz)
SER2915L-152KL	1.5	1.50	1.65	60
SER2915H-222KL	2.2	1.86	2.05	40
SER2915L-222KL	2.2	1.50	1.65	50
SER2918H-332KL	3.3	2.60	2.86	40
SER2915H-332KL	3.3	1.86	2.05	30
SER2915L-332KL	3.3	1.50	1.65	40
SER2918H-472KL	4.7	2.60	2.86	30
SER2915H-472KL	4.7	1.86	2.05	25
SER2915L-472KL	4.7	1.50	1.65	30
SER2918H-682KL	6.8	2.60	2.86	25
SER2915H-682KL	6.8	1.86	2.05	20
SER2915L-682KL	6.8	1.50	1.65	25
SER2918H-103KL	10	2.60	2.86	20
SER2915H-103KL	10	1.86	2.05	15
SER2915L-103KL	10	1.50	1.65	20
SER2918H-153KL	15	2.60	2.86	16
SER2915H-153KL	15	1.86	2.05	12
SER2915L-153KL	15	1.50	1.65	15
SER2918H-223KL	22	2.60	2.86	15
SER2915H-223KL	22	1.86	2.05	10
SER2915L-223KL	22	1.50	1.65	10
SER2918H-333KL	33	2.60	2.86	10
SER2915H-333KL	33	1.86	2.05	8
SER2915L-333KL	33	1.50	1.65	7

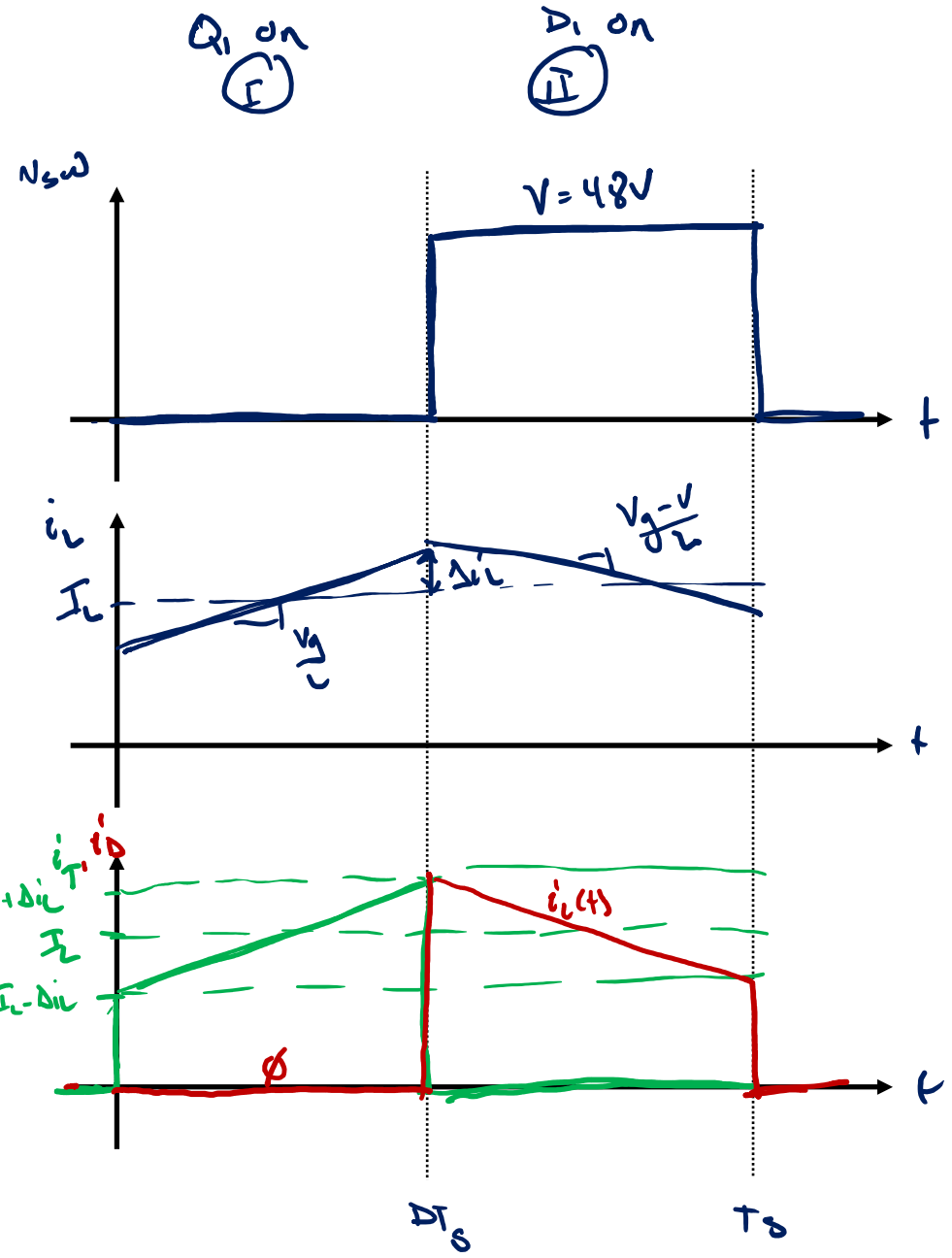
$R_L = 1.86m\Omega hm$

Expected Behavior

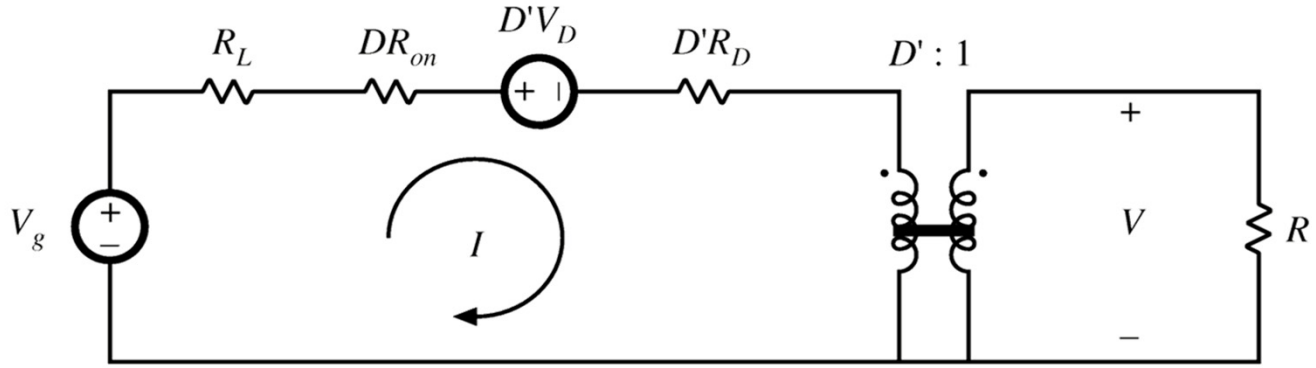


$$I_L = \frac{V}{RD'} = 4A$$

$$2\Delta i_L = \frac{V_g}{L} DT_s \rightarrow \Delta i_L = 1A$$



Equivalent Circuit Model



$$V = \left(\frac{1}{D'}\right)\left(V_g - D'V_D\right)\left(\frac{D'^2R}{D'^2R + R_L + DR_{on} + D'R_D}\right)$$

$$\frac{V}{V_g} = \left(\frac{1}{D'}\right)\left(1 - \frac{D'V_D}{V_g}\right)\left(\frac{1}{1 + \frac{R_L + DR_{on} + D'R_D}{D'^2R}}\right)$$

Ideal $\uparrow$ $\quad$ η

Ideal = 0.75

D = 0.756

model-predicted
η = 97.6%