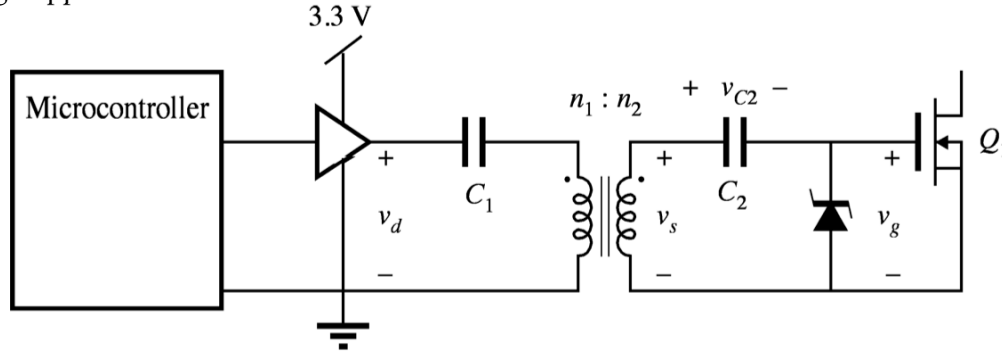


Sample Quiz Problems: Exp. 3 Part 1

ECEN 4517/5517

1. Operation of isolated gate drive circuit

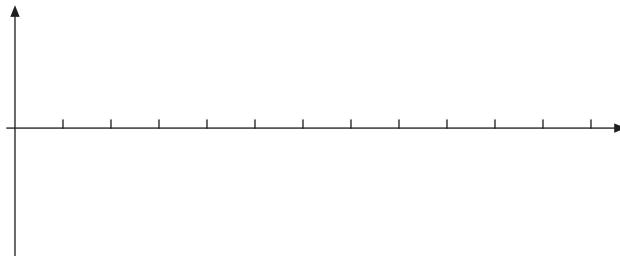
In the isolated gate driver circuit illustrated below, the MOSFET is a “logic-level” device that is turned fully on by a gate-source voltage v_g of 5V. A microcontroller generates a 50 kHz PWM logic signal that is fed to a nonisolated driver IC. The output of this IC (v_d) is a signal that switches between 0 V and 3.3 V. Capacitors C_1 and C_2 are large in value, with very small voltage ripple.



- (a) Choose the turns ratio n_2/n_1 and the zener diode voltage required to make the circuit work as described above.

The microcontroller commands a duty cycle of $D = 1/3$.

- (b) What is the capacitor voltage v_{C2} ?
- (c) Sketch $v_s(t)$ on the axes below. Label the numerical values of the maximum and minimum voltage.

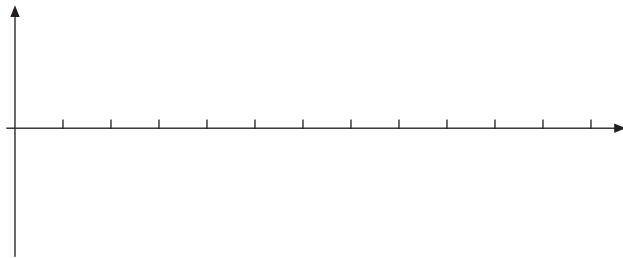


2. Design of gate drive transformer

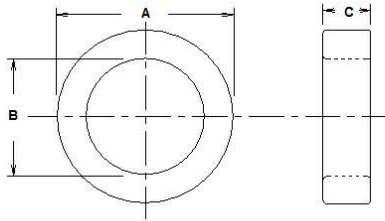
It is desired to design the gate drive transformer of the circuit of Problem 1. Your kit contains a ferrite toroid, part number 13-07-06; a datasheet containing dimensions for standard ferrite toroids is appended to this exam. The gate driver operates with the voltages and frequency as specified in Problem 1.

- (a) We want the peak flux density B_{pk} to be 0.1 T at $D = 1/3$. Choose n_1 to achieve this.

- (b) For your design of part (a), sketch $B(t)$ on the axes below. Clearly label the maximum and minimum numerical values.



TSC Ferrite International



TSC FERRITE INTERNATIONAL TOROID DIMEN

PART #	A		B		C	
	in	mm	in	mm	in	mm
10-05-03	0.375 +/-0.010	9.53 +/-0.25	0.187 +/-0.005	4.75 +/-0.13	0.125 +/-0.005	3.18 +/-0.13
10-05-06	0.375 +/-0.010	9.53 +/-0.25	0.187 +/-0.005	4.75 +/-0.13	0.250 +/-0.005	6.35 +/-0.13
13-07-05	0.500 +/-0.010	12.70 +/-0.25	0.281 +/-0.010	7.14 +/-0.25	0.188 +/-0.005	4.78 +/-0.13
13-07-06	0.500 +/-0.010	12.70 +/-0.25	0.281 +/-0.010	7.14 +/-0.25	0.250 +/-0.010	6.35 +/-0.25
13-08-03	0.500 +/-0.010	12.70 +/-0.25	0.312 +/-0.010	7.92 +/-0.25	0.125 +/-0.005	3.18 +/-0.13
13-08-06	0.500 +/-0.010	12.70 +/-0.25	0.312 +/-0.010	7.92 +/-0.25	0.250 +/-0.010	6.35 +/-0.25
16-09-05	0.625 +/-0.012	15.88 +/-0.25	0.357 +/-0.010	9.07 +/-0.25	0.185 +/-0.005	4.70 +/-0.13
16-09-10	0.625 +/-0.012	15.88 +/-0.30	0.357 +/-0.010	9.07 +/-0.25	0.375 +/-0.010	9.53 +/-0.25
22-14-06	0.870 +/-0.017	22.10 +/-0.43	0.540 +/-0.012	13.72 +/-0.30	0.250 +/-0.010	6.35 +/-0.25
22-14-07	0.870 +/-0.017	22.10 +/-0.43	0.540 +/-0.012	13.72 +/-0.30	0.275 +/-0.010	6.99 +/-0.25
22-14-13	0.870 +/-0.017	22.10 +/-0.43	0.540 +/-0.012	13.72 +/-0.30	0.500 +/-0.010	12.70 +/-0.25
25-16-08	1.000 +/-0.020	25.40 +/-0.51	0.610 +/-0.015	15.49 +/-0.38	0.312 +/-0.010	7.92 +/-0.25
29-19-08	1.142 +/-0.025	29.01 +/-0.61	0.748 +/-0.016	19.00 +/-0.41	0.300 +/-0.010	7.62 +/-0.25
29-19-15	1.142 +/-0.025	29.01 +/-0.61	0.748 +/-0.016	19.00 +/-0.41	0.600 +/-0.010	15.24 +/-0.25
32-19-06	1.250 +/-0.025	31.75 +/-0.64	0.740 +/-0.148	18.80 +/-0.38	0.250 +/-0.005	6.35 +/-0.13
32-19-11	1.250 +/-0.025	31.75 +/-0.64	0.740 +/-0.148	18.80 +/-0.38	0.435 +/-0.009	11.05 +/-0.23
36-23-15	1.432 +/-0.025	36.37 +/-0.61	0.890 +/-0.020	22.61 +/-0.51	0.605 +/-0.010	15.37 +/-0.25
37-30-16	1.469 +/-0.029	37.31 +/-0.75	1.168 +/-0.023	29.67 +/-0.59	0.625 +/-0.013	15.88 +/-0.33
38-19-25	1.500 +/-0.030	38.10 +/-0.76	0.750 +/-0.015	19.05 +/-0.38	1.000 +/-0.020	25.40 +/-0.51
40-24-16	1.574 +/-0.032	39.98 +/-0.81	0.944 +/-0.019	23.98 +/-0.48	0.629 +/-0.013	15.98 +/-0.33
49-34-16	1.932 +/-0.039	49.07 +/-0.99	1.332 +/-0.027	33.83 +/-0.69	0.625 +/-0.013	15.88 +/-0.33
51-32-19	2.000 +/-0.040	50.80 +/-1.02	1.250 +/-0.025	31.75 +/-0.64	0.750 +/-0.015	19.05 +/-0.38

TSC Ferrite International

DIMENSIONS	TSC FERRITE INTERNATIONAL TOROIDAL CORE EFFECTIVE PARAMETERS						INDUCTANCE INDEX				
							AL nH/N ²				
	MAGNETIC PATH LENGTH	EFFECTIVE CORE AREA	EFFECTIVE CORE VOLUME	WINDOW AREA	POWER HANDLING CAPABILITY INDEX	CORE WEIGHT	ASTM Material Type				
							ASTM P7099 ASTM P5099	ASTM P7070	ASTM P8040 ASTM F3000 P5025-100	ASTM F5000	ASTM F010K
PART #	Le cm	Ae cm ²	Ve cm ³	Wa cm ²	WaAe cm ⁴	GRAMS	TSC Ferrite Material Grade				
							TSF-BOOST TSF-7099 TSF-5099 +30%	TSF-7070 +25%	TSF-8040 TSF-50ALL Flat Line +25%	TSF-5000 +25%	TSF-010K +30%
10-05-03	2.07	0.07	0.15	0.18	0.01	0.8	885	972	1,370	2,209	4,390
10-05-06	2.07	0.15	0.30	0.18	0.03	1.6	1,765	1,944	2,740	4,419	6,615
13-07-05	2.95	0.13	0.38	0.40	0.05	2.0	1,100	1,210	1,706	2,752	5,430
13-07-06	2.95	0.17	0.51	0.40	0.07	2.6	1,465	1,610	2,269	3,659	7,225
13-08-03	3.12	0.07	0.23	0.49	0.04	1.2	600	659	928	1,497	2,975
13-08-06	3.13	0.15	0.47	0.49	0.07	2.4	1,200	1,318	1,857	2,995	5,935
16-09-05	3.72	0.16	0.58	0.65	0.10	3.0	1,050	1,158	1,632	2,632	5,520
16-09-10	3.72	0.32	1.18	0.65	0.20	6.1	2,130	2,347	3,307	5,334	11,040
22-14-06	5.42	0.26	1.42	1.48	0.39	7.2	1,210	1,333	1,878	3,029	6,040
22-14-07	5.42	0.29	1.56	1.48	0.42	7.9	1,330	1,466	2,065	3,331	6,645
22-14-13	5.42	0.52	2.83	1.48	0.77	14.4	2,420	2,665	3,755	6,057	12,080
25-16-08	6.17	0.39	2.37	1.89	0.73	12.1	1,565	1,724	2,429	3,917	7,825
29-19-08	7.32	0.38	2.75	2.84	1.07	13.8	1,290	1,419	1,999	3,224	6,340
29-19-15	7.32	0.75	5.50	2.84	2.13	27.8	2,580	2,837	3,998	6,447	12,895
32-19-06	7.59	0.40	3.05	2.78	1.12	15.7	1,330	1,465	2,064	3,329	6,105
32-19-11	7.59	0.70	5.31	2.78	1.84	27.3	2,315	2,549	3,591	5,793	11,580
36-23-15	8.92	1.04	9.26	4.01	4.17	47.0	2,925	3,216	4,531	7,309	13,400
37-30-16	10.43	0.60	6.30	6.91	4.18	30.6	1,455	1,602	2,257	3,640	7,280
38-19-25	8.30	2.32	19.29	2.85	6.61	104.9	7,045	7,750	10,915	17,600	35,210
40-24-16	9.62	1.25	12.04	4.52	5.65	61.6	3,270	3,595	5,064	8,168	16,330
49-34-16	12.73	1.20	15.22	8.99	10.79	75.6	2,365	2,600	3,660	5,900	11,805
51-32-19	12.50	1.78	22.27	7.92	14.10	112.9	3,580	3,940	5,551	8,954	17,900