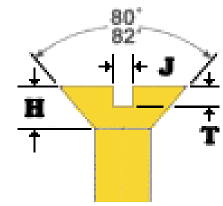
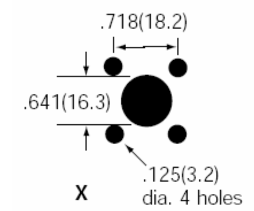
K8ZOA Quick Reference Prototyping Data

Nominal Size	Flat Head "A" Max	Flat Head "H" Max	Pan Head "A" Max	Phillips Driver Size	Torx Driver Size	Hex Key Size	Tap Drill	Body Drill Close	Body Drill Loose
2-56	.162	.051	.167	1	T6	.050	#50	#43	#41
4-40	.212	.067	.219	1	T8	1/16	#43	#32	#30
6-32	.262	.083	.270	2	T10	5/64	#36	#27	#25
8-32	.312	.100	.322	2	T15	3/32	#29	#18	#16
10-24	.362	.116	.373	2	T20	1/8	#25	#9	#7

Common Machine Screw Dimensions



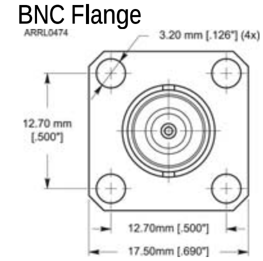


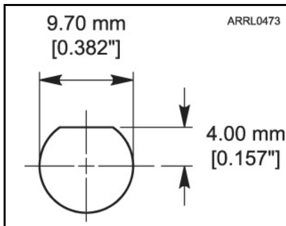
SO239 Flange Mount

Wire Table											
AWG	Dia-mils	TPI	Dia-mm	Circ-mils	Ohms/Kft	Ft/Ohm	Ft/Lb	Ohms/Lb	Lb/Kft	Amps @750cm/A	Amps @500cm/A
10	101.90	9.8140	2.5881	10383	0.9989	1001.1	31.819	0.0318	31.428	13.844	20.765
12	80.807	12.375	2.0525	6529.8	1.5883	629.61	50.593	0.0804	19.765	8.7064	13.060
14	64.083	15.605	1.6277	4106.6	2.5255	395.97	80.447	0.2031	12.431	5.4755	8.2132
16	50.820	19.677	1.2908	2582.7	4.0156	249.03	127.91	0.5136	7.8177	3.4436	5.1654
18	40.302	24.813	1.0237	1624.3	6.3851	156.62	203.39	1.2986	4.9166	2.1657	3.2485
20	31.961	31.288	0.8118	1021.5	10.153	98.496	323.41	3.2832	3.0921	1.3620	2.0430
22	25.346	39.453	0.6438	642.44	16.143	61.945	514.23	8.3009	1.9446	0.8566	1.2849
24	20.101	49.750	0.5106	404.03	25.669	38.958	817.66	20.987	1.2230	0.5387	0.8081
26	15.940	62.733	0.4049	254.10	40.815	24.501	1300.1	53.061	0.7692	0.3388	0.5082
28	12.641	79.105	0.3211	159.80	64.898	15.409	2067.3	134.15	0.4837	0.2131	0.3196
30	10.025	99.750	0.2546	100.50	103.19	9.6906	3287.1	339.18	0.3042	0.1340	0.2010
32	7.9503	125.78	0.2019	63.207	164.08	6.0945	5226.7	857.55	0.1913	0.0843	0.1264
34	6.3048	158.61	0.1601	39.751	260.90	3.8329	8310.8	2168.1	0.1203	0.0530	0.0795

Simple approximate relationship - #10 is 100 mills diameter & 1 ohm/1k ft. Every 3 gauge number change doubles or halves ohms/1Kft and diameter By .70. Every 6 gauge number change doubles or halves diameter and 1:4 or 4:1 ohms/1Kft

BNC Flange





BNC Single Hole

Powdered Iron Toroid Cores AL values (µh / 100 Turns)											
Mix	**26**	**3**	**15**	**1**	**2**	**7**	**6**	**10**	**12**	**17**	**0**
Color	Yel-Wh	Gray	Rd-Wh	Blue	Red	White	Yellow	Black	Grn-Wh	Bl-Ylw	Tan
Perm.	µ=75	µ=35	µ=25	µ=20	µ=10	µ=9	µ=8	µ=6	µ=4	µ-4	µ=1
Freq MHz / Core ID	Power. Frqy	05-.5	0.1-2	0.5-5	2-30	1-25	10-50	30-100	50-200	40-180	100-300
T12-	na	60	50	48	20	18	17	12	7.5	7.5	3.0
T16-	145	61	55	44	22	na	19	13	8.0	8.0	3.0
T20-	180	76	65	52	27	24	22	16	10.0	10.0	3.5
T25-	235	100	85	70	34	29	27	19	12.0	12.0	4.5
T30-	325	140	93	85	43	37	36	25	16.0	16.0	6.0
T37-	275	120	90	80	40	32	30	25	15.0	15.0	4.9
T44-	360	180	160	105	52	46	42	33	18.5	18.5	6.5
T50-	320	175	135	100	49	43	40	31	18.0	18.0	6.4
T68-	420	195	180	115	57	52	47	32	21.0	21.0	7.5
T80-	450	180	170	115	55	50	45	32	22.0	22.0	8.5
T94-	590	248	200	160	84	na	70	58	32.0	na	10.6
T106-	900	450	345	325	135	133	116	na	na	na	19.0

$$N = 100\sqrt{\frac{\mathrm{L}}{\mathrm{A_L}}} \quad L(\mu H) = \frac{A_L \times N^2}{10{,}000}$$

L=required inductance (µH) AL=Inductance index ((µH/100 turns) N=number of turns

120 Hz power supply ripple estimate:

$$C_{\mu F} \approx \frac{8333 I_{amp}}{\Delta V_{volts}}$$

$$\Delta V_{volts} \approx \frac{8333 I_{amp}}{C_{\mu F}}$$

For 100 Hz ripple, change 8333 to 10000
ΔV = ripple voltage, peak-to-peak, volts
I = load current amperes
C = filter capacitance, µF

Parallel Plate Capacitance

$$C = \frac{224.8AK}{d}$$

C capacitance in pF
A area of one plate in square inches
K dielectric constant
d plate separation in mills (1/1000 inch)

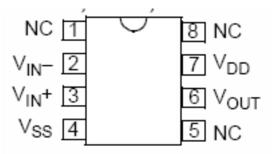
Ferrite Toroid Cores AL Values (mH/1000 Turns)							
CORE SIZE	MIX 43	MIX 61	MIX 75	MIX 77	Dimensions (inches)		
Perm.	µ = 850	µ =125	µ = 5000	µ = 1800			
MHz	.01 – 1	.2 – 10	.01-1	.001 – 2	OD	ID	Thick
FT23	188	25	-	396	0.23	0.12	0.06
FT37	420	55	2210	884	0.37	0.19	0.12
FT50	523	68	2750	1100	0.50	0.28	0.19
FT82	557	73	3000	1170	0.82	0.52	0.25
FT114	603	79	-	1270	1.14	0.75	0.30
FT140	1060	140	-	2250	1.40	0.90	0.50
FT240	1240	173	-	2740	2.40	1.40	0.50

$$L(mH) = \frac{A_L \times N^2}{1{,}000{,}000}$$

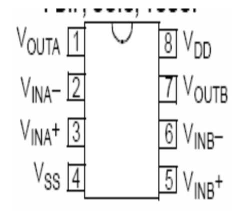
$$N = 1000\sqrt{\frac{\mathrm{L}}{\mathrm{A_L}}}$$

A_L=Inductance index ((mH/1,000 turns)
N=number of turns
L=required inductance (mH)

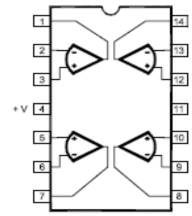
Standard DIP Op-Amp Connections



Single section.
Note Pins 1 & 5 may be used in some models for offset nulling

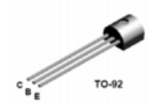


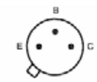
Dual Section



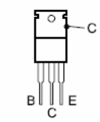
Quad Section

Common NPN & PNP Transistors



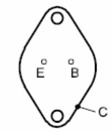


TO-220



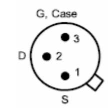
Front View

TO-204

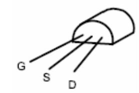


Bottom View

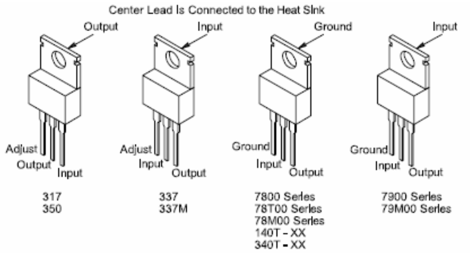
U310

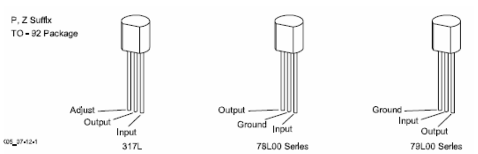


RF NJFET
2N5484
2N5485
2N5486
2N5670
2N5668
2N5669
J308
J309
J310



3-Lead Regulators

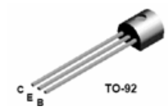




2N7000 MOSFET

Common Power MOSFETs

MPSH-10, MPSH-11 & MPSH-81



Impedance of Various Two-Conductor Lines

	—— *Twists per Inch* ——				
Wire Size	*2.5*	*5*	*7.5*	*10*	*12.5*
no. 20	43	39	35		
no. 22	46	41	39	37	32
no. 24	60	45	44	43	41
no. 26	65	57	54	48	47
no. 28	74	53	51	49	47
no. 30			49	46	47

Measured in ohms at 14.0 MHz.

Single Layer Air Core Solenoid

$$L\,(\mu H) = \frac{d^2\, n^2}{18d + 40\ell} \qquad (66)$$

where:
L = inductance in microhenrys,
d = coil diameter in inches (from wire center to wire center),
ℓ = coil length in inches, and
n = number of turns.

$$n = \frac{\sqrt{L\,(18\,d + 40\,\ell)}}{d}$$

Capacitor Tolerance Codes

Code	Tolerance
C	±1/4 pF
D	±1/2 pF
F	±1 pF or ±1%
G	±2 pF or ±2%
J	±5%
K	±10%
L	±15%
M	±20%
N	±30%
P or GMV*	–0%; +100%
W	–20%; +40%
Y	–20%; +50%
Z	–20%; +80%

Series/Parallel Transforms

RESISTANCE AND INDUCTANCE

$$Z = R_S + j\omega L_S = \frac{j\omega L_P R_P}{R_P + j\omega L_P} = \frac{R_P + jQ^2\omega L_P}{1 + Q^2}$$

$$Q = \frac{1}{D} = \frac{\omega L_S}{R_S} = \frac{R_P}{\omega L_P}$$

$$L_S = \frac{Q^2}{1 + Q^2} L_P = \frac{1}{1 + D^2} L_P$$

$$L_P = \frac{1 + Q^2}{Q^2} L_S = (1 + D^2) L_S$$

$$R_S = \frac{1}{1 + Q^2} R_P; \quad R_P = (1 + Q^2) R_S$$

$$R_S = \frac{\omega L_S}{Q}; \quad R_P = Q\omega L_P$$

RESISTANCE AND CAPACITANCE

$$Z = R_S + \frac{1}{j\omega C_S} = \frac{\dfrac{R_P}{j\omega C_P}}{R_P + \dfrac{1}{j\omega C_P}} = \frac{D^2 R_P + \dfrac{1}{j\omega C_P}}{1 + D^2}$$

$$D = \frac{1}{Q} = \omega R_S C_S = \frac{1}{\omega R_P C_P}$$

$$C_S = (1 + D^2) C_P; \quad C_P = \frac{1}{1 + D^2} C_S$$

$$R_S = \frac{D^2}{1 + D^2} R_P; \quad R_P = \frac{1 + D^2}{D^2} R_S$$

$$R_S = \frac{D}{\omega C_S}; \quad R_P = \frac{1}{\omega C_P D}$$

$$R_P = \frac{R_S^2 + X_S^2}{R_S} \qquad R_S = \frac{R_P X_P^2}{R_P^2 + X_P^2}$$

and

$$X_P = \frac{R_S^2 + X_S^2}{X_S} \qquad X_S = \frac{R_P^2 X_P}{R_P^2 + X_P^2}$$

Transmission Line

$$\rho = \frac{SWR - 1}{SWR + 1}$$

where ρ = 0.01 × (reflection coefficient in %)

$$\rho = 10^{\frac{-RL}{20}}$$

where RL = return loss (dB)

$$\rho = \sqrt{1 - (0.1^X)}$$

where X = A/10 and A = attenuation (dB)

$$SWR = \frac{1 + \rho}{1 - \rho}$$

Return loss (dB) = –8.68589 ln (ρ)
where ln is the natural log (log to the base e)

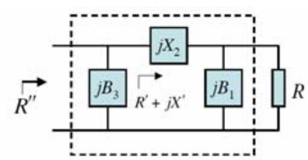
Attenuation (dB) = –4.34295 ln $(1–\rho^2)$
where ln is the natural log (log to the base e)

Distributed Capacitance

$f_1/fo = \sqrt{Cd/(C + Cd)}$ .... (eq. 3-6)

Where, f_1: measurement frequency.
fo: self-resonant frequency of sample.
Cd: distributed capacitance of sample.
C: tuning capacitance of Q meter.

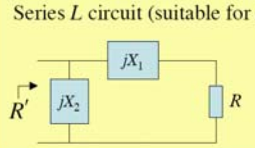
Pi Net Matching



For $R'' > R$	For $R'' < R$
1. Select Q_1 according to the max Q.	1. Select Q_2 according to the max Q.
2. Find R' using $R' = R(1+Q_1^2)$	2. Find R' using $R' = R''(1+Q_2^2)$
3. Get Q_2 using $Q_2^2 = \frac{R'}{R''} - 1$	3. Get Q_1 using $Q_1^2 = \frac{R'}{R} - 1$
4. Obtain X_1 using $X_1 = Q_1 R$.	4. Obtain X_1 using $X_1 = Q_1 R$.
5. $B_2 = (Q_1 + Q_2)/R'$	5. $B_2 = (Q_1 + Q_2)/R'$
6. $X_3 = Q_2 R''$	6. $X_3 = Q_2 R''$

L Match

Series L circuit (suitable for $R' > R$) :

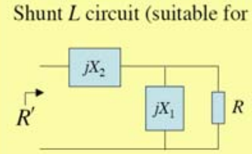


$$R' = R(1 + Q^2)$$

$$jX_2 = -jX_1\left(1 + \frac{1}{Q^2}\right) = -\frac{jR'}{Q}$$

$$Q = \frac{X_1}{R}$$

Shunt L circuit (suitable for $R' < R$) :



$$R' = \frac{R}{1 + Q^2}$$

$$jX_2 = -\frac{jX_1}{1 + \dfrac{1}{Q^2}} = -jR'Q$$

$$Q = \frac{B_1}{G} = \frac{R}{X_1}$$

Tapped C Matching

$Rin > R_{Load}$

$$Q_L > \sqrt{\frac{Rin}{R_{Load}} - 1}$$

$$Q_L = \frac{f}{f_2 - f_1}$$

$$X_L = \frac{Rin}{2Q_L}$$

$$L = \frac{X_L}{2\pi f_0}$$

$$C_T = \frac{2Q_L}{2\pi f_0 Rin} \times 10^6$$

$$\frac{C1}{C2} \approx \sqrt{\frac{Rin}{R_{Load}}} - 1 = k$$

$$C1 = C_T \frac{k+1}{k}$$

$$C2 = C_T (k+1)$$

Where:
Frequencies are in MHz
L is µH
C is in pF