

Index

Amplifiers

- amplifier stages, basics, 3.9
- cascode non peaking, 3.37
 - basic circuit analysis, 3.37–38
 - damping of Q_2 emitter, 3.37–40
 - input impedance, basic, 3.49
 - compensation of Q_2 , 3.46–47
 - step response and preshoot, 3.40
 - thermal compensation of Q_1 , 3.44
 - thermal distortion of step signal, 3.43
 - thermal stability,
 - bias optimization, 3.44
- cascode differential, 3.70–71, 5.108
 - improved Darlington, 5.109–110
 - feedforward correction, 5.111
- cascode emitter peaking, 3.49
 - circuit analysis, basic, 3.49–52
 - Bode plot of, 3.53
 - complex poles of, 3.53
 - input impedance irregularity, 3.50
 - input impedance compensation,
 - 3.54–56
 - poles, placement of,
 - see* complex poles
 - thermal problems, 3.42–46
- cascode folded, 3.68
- Cascomp, 5.112–114
- common base, 3.17
 - base emitter effective
 - capacitance, 3.19
 - effective emitter resistance, 3.35
 - input impedance, 3.18
 - transimpedance, 3.34
 - input impedance, 3.34
 - Miller capacitance, 3.33–34
- common emitter, 3.9
 - circuit analysis, 3.9–15
 - emitter resistance, 3.12
 - voltage gain, calculation of, 3.14–15
 - input impedance, 3.14
 - input pole, 3.15
 - Miller capacitance, 3.13
- CRT driver 3.10, 5.24
- differential, 3.69
 - circuit analysis of, 3.7–8
 - common mode operation, 3.70
- differential mode operation, 3.70
 - two stages example of, 5.9–10
 - drift correction of, 3.69, 5.106–107
 - simple, 5.43
 - active, 5.45
- envelope delay/advance,
 - definition of, 2.20–21
- error correction, 5.94, 5.98, 5.104
 - feedforward, 5.96–100, 5.111–116
 - improved voltage feedback, 5.80
 - negative feedback, voltage,
 - 5.95, 5.114
 - negative feedback, current, 5.62–79
- feedback (*see* error correction)
- feedforward (*see* error correction)
- frequency response, definition,
 - 2.14, 6.7–8, 6.21–26
- f_T -Doubler, 3.75
- Gilbert multiplier, 5.123
 - four-quadrant, 5.127
- gain control, continuous, 5.125–127
- introduction, 3.7
- improving linearity of, 120
- JFET source follower, 3.79
 - circuit analysis, 3.79–82
 - capacitances, inter-electrode, 3.80
 - envelope delay, 3.84–85
 - frequency response, 3.82–83
 - magnitude, 3.83
 - considering input generator
 - resistance, 3.93
 - with inductive generator
 - impedance, 3.90, 3.93
- input admittance, 3.92
- input impedance, 3.89–90
- input protection network of, 5.52
 - against long term overdrive,
 - 5.25–26
 - against static charges, 5.52–53
- negative input conductance,
 - normalized, plot of, 3.91
 - compensation of, 3.92
 - alternative compensation of, 3.94
- overdrive recovery, 5.47
- phase response, 3.84
- tendency to oscillate, 3.90, 3.93
 - similarity with Colpitts oscillator,
 - 3.90
- step response, 3.85–86
 - considering input generator
 - resistance, 3.87
- MOSFET source follower, 5.48
- maximum amplitude range, 4.65
- Miller capacitance, Miller effect, 3.13
- multistage, 4.9,
 - two stage, inductively peaked, 5.10
 - optimum number of stages for
 - minimum rise time, 4.17–19
- negative feedback (*see* error correction)
- non-peaking, multistage, DC coupled, 4.9
 - decibels per octave, explanation of,
 - 4.11
 - envelope delay, 4.12–13
 - frequency response, 4.9–10
 - optimum single stage gain, 4.17–18
 - optimum number of stages, 4.17–19

- phase response, 4.12
- rise time calculation, 4.15
- slew rate limit, 4.16–17
- step response, 4.13–15
- two-stages considering of 5.17–19
- upper half power frequency, calculation of, 4.10
- non-peaking multistage AC coupled, 4.21
 - analysis of, 4.21
 - frequency response, low frequency, 4.22
 - phase response, 4.23
 - step response, 4.24
- operational amplifiers, 5.57
 - classical, voltage feedback, 5.57
 - high-speed
 - current feedback, 5.62
 - voltage feedback, 5.80
- overdrive, 5.89–91
 - large signal non-linearity, 5.47
 - recovery, 5.89, 5.120
- phase delay/advance, definition of, 2.20
- phase response, definition of, 2.21
- rise time, basic, definition of, 2.9
- slew rate, limiting, maximum, 4.16–17, 5.61
- with separate LF and HF path, 5.45–46
- Attenuators**
 - high resistance, 5.26
 - capacitively compensated, 5.26–40
 - envelope delay, 5.30–31
 - frequency response, 5.27–30
 - hook effect, 5.41–42
 - cause of, 5.41
 - compensation of, 5.42
 - input generator resistance
 - consideration 5.34
 - compensation of, 5.34–35
 - loop inductances, 5.37–38
 - damping of, 5.39–41
 - phase response, 5.30
 - step response, 5.32–33
- low resistance, 5.55
 - driver stage for, 5.54
 - electronic control, 5.122
- Convolution**, 1.37–39, 1.81–83, 7.7–13
- Coupling factor k** , (*see* T-coil 2-pole)
- Current Mirrors**, 3.72, 5.62–64, 5.69, 5.80, 5.82, 5.83, 5.127
 - current source in the emitter circuit, 3.72–74
 - current symmetry analysis, 3.72
 - improved current generator, analysis of, 3.74
- Delay lines**, 2.46–50, 5.24
- Filters**
 - analog, 7.43
 - analysis of MFB, 2-pole, 7.41
 - analysis of MFB, 3-pole, 7.37
 - analysis of 7-pole (of 13-pole Bessel), 7.28
 - frequency response, 7.23, 7.30
 - step response, 7.24–25, 7.31
 - envelope delay improvement, 7.32
 - with zeros, 7.34
 - digital, using convolution 7.33
 - equivalent 6-pole (of 13), 7.33
 - poles of, 6.29
 - impulse response, 7.33
 - mixed mode systems, 7.21
 - bandwidth improvement, 7.30
 - 13-pole Bessel system response in discrete samples, 7.33
 - poles of, compared with poles of the analog only filter, 7.28
- Fourier transform**
 - Fourier series, 1.11–16
 - calculation of frequency components, 1.13–15
 - Fourier integral 1.18–20
 - basic derivation of, 1.18–19
 - introduction of complex frequency s , 1.23
 - limits of, 1.24
 - Fast Fourier Transform (FFT) algorithm, *see* Numerical Methods
- Group advance, *see* Envelope advance**
- Group delay, *see* Envelope delay**
- Inductive peaking circuits, 2.7**
 - introduction, 2.7–8
 - comparison of Butterworth (MFA) frequency responses, 2.103
 - diagrams, 2.104
 - comparison of Bessel (MFED) step responses, 2.103
 - diagrams, 2.104
 - principle of, 2.9–11
 - series 2-pole, 2.13
 - bandwidth improvement, 2.26, Table 2.2.1
 - Bessel poles for MFED response, 2.16
 - circuit analysis of, 2.13–14
 - critical damping, 2.17
 - envelope delay, principle of, 2.20
 - envelope delay, calculation of, 2.21–22
 - frequency response, 2.17
 - input impedance, 1.25–26
 - m -parameter, calculation of, 2.18
 - overshoot, 2.26, Table 2.2.1
 - rise time improvement η_r , 2.26, Table 2.2.1
 - phase response, calculation of, 2.19
 - rise time improvement, calculation of, 2.24
 - step response, calculation of, 1.76–77
 - step response, double pole, calculation of, 2.23

- comparison of parameters, 2.26
- upper half power frequency ω_H ,
calculation of, 2.17–18
- series 3-pole, 2.27
 - circuit analysis of, 2.27–28
 - bandwidth improvement η_b , 2.34,
Table 2.3.1
 - comparison of parameters, 2.34,
Table 2.3.1
 - with Bessel poles (MFED), 2.29–30
 - with Butterworth poles (MFA),
2.28–29
 - envelope delay, calculation of, 2.32
 - frequency response,
calculation of, 2.28
 - m -parameter for MFA,
calculation of, 2.29
 - m -parameter for MFED,
calculation of, 2.29–30
 - n -parameter for MFA,
calculation of, 2.29
 - n -parameter for MFED,
calculation of, 2.29
 - overshoot, 2.34 Table 2.3.1
 - phase response, 2.31
 - pole placement, 2.34
 - rise time improvement η_r , 2.34,
Table 2.3.1
 - special parameters (SPEC), 2.31
 - table of main parameters, 2.26
 - step response, 2.32–33
- shunt 2-pole, 2.73
 - bandwidth improvement η_b , 2.81,
Table 2.7.1
 - circuit analysis of, 2.73–74
 - comparison of parameters, 2.81
 - envelope delay, 2.75
 - frequency response, 2.74
 - m -parameter for MFA,
calculation of, 2.74
 - m -parameter for MFED,
calculation of, 2.75
 - overshoot, 2.81, Table 2.7.1
 - phase response, 2.74–75
 - pole placement, 2.81
 - rise time improvement η_r , 2.81,
Table 2.7.1
 - step response, 2.78–80
- shunt 3-pole, 2.83
 - bandwidth improvement η_b , 2.89,
Table 2.8.1
 - circuit analysis of, 2.83
 - envelope delay, 2.86
 - frequency response, 2.86
 - m -parameter for MFA,
calculation of, 2.84
 - m -parameter for MFED,
calculation of, 2.84
 - n -parameter for MFA,
calculation of, 2.84
 - n -parameter for MFED,
calculation of, 2.84
 - overshoot, 2.89, Table 2.8.1
 - comparison of parameters, 2.89
 - phase response, 2.86
 - poles, calculation of, 2.85
 - rise time improvement η_r , 2.89,
Table 2.8.1
 - step response, 2.88
- shunt-series, 2.91
 - bandwidth improvement η_b , 2.101,
Table 2.9.1
 - Braude parameters, 2.96
 - circuit analysis of, 2.91–96
 - comparison of parameters, 2.101
 - envelope delay, 2.97
 - frequency response, 2.96
 - MFA, PS/EM parameters, 2.96
 - MFED, PS/EM parameters, 2.96
 - overshoot, 2.101, Table 2.9.1
 - phase response, 2.97
 - pole placement, 2.101
 - rise time improvement η_r , 2.101,
Table 2.9.1
 - Shea parameters, 2.96
 - step response, 2.99–100
- T-coil 2-pole, 2.35
 - all pass pole/zero placement, 2.40
 - bandwidth improvement η_b , 2.48,
Table 2.4.1
 - bridging capacitance C_b ,
calculation of, 2.40
 - circuit analysis of, 2.35–42
 - coupling factor k , calculation of, 2.41
 - envelope delay, 2.43
 - frequency response, 2.42
 - mutual inductance L_M , analysis,
basic relations, 2.35–36
 - overshoot, 2.48, Table 2.4.1
 - phase response, 2.34
 - pole placement, 2.40
 - rise time improvement η_r , 2.48,
Table 2.4.1
 - step response, 2.45
 - all pass, 2.46–47
 - example of TV interconnections,
2.48–50
- T-coil 3-pole, 2.51
 - bandwidth improvement η_b , 2.59,
Table 2.5.1
 - capacitance ratio C/C_i
 - for MFA, 2.54
 - for MFED, 2.53
 - for CD, 2.54
 - circuit analysis of, 2.51–54
 - comparison of parameters, 2.59
 - envelope delay, 2.56
 - frequency response, 2.54–55

- low coupling cases, 2.58–59
- coupling factor k , 2.53
- n -parameter, calculation of, 2.52–53
- overshoot 2.59, Table 2.5.1
- phase response, 2.55
- rise time improvement η_r , 2.59, Table 2.5.1
- step response, 2.57–58
- trigonometric relations, 2.52
- variation of parameters,
 - frequency response, 2.59–61
 - step response, 2.59–61
- L+T peaking, 2.63
 - bandwidth improvement η_b , 2.71, Table 2.6.1
 - bridging capacitance C_b ,
 - calculation of, 2.65
 - capacitance ratio C_b/C , 2.71, Table 2.6.1
 - capacitance ratio C/C_i , 2.71, Table 2.6.1
 - characteristic circle diameter ratio, 2.63
 - comparison of main parameters, 2.71, Table 2.6.1
 - coupling factor k , calculation of, 2.65
 - envelope delay, 2.69
 - frequency response, 2.66–67
 - m -parameter, calculation of, 2.65
 - n -parameter, calculation of, 2.64
 - overshoot, 2.71, Table 2.6.1
 - phase response, 2.68
 - rise time improvement η_b , 2.71, Table 2.6.1
 - step response, 2.69–71
 - MFA, formula of, 2.7
 - MFED, formula of, 2.70
 - group A, formula of, 2.70
 - group C, formula of, 2.70
 - Chebyshev with 0.05° phase ripple, formula of, 2.71
 - Gaussian to -12 dB, formula of, 2.71
 - double 2nd-order Bessel pole pairs, formula of, 2.71
- trigonometric relations, 2.63–65
 - misaligned T-coil parameters,
 - step responses of, 2.105
- T-coil construction, 2.105
 - coupling factor k diagram of, 2.106
- T-coil BJT inter stage coupling, 3.57
 - bridging capacitance C_b , 3.60
 - circuit analysis, 3.57–60
 - coupling factor k , 3.60
 - envelope delay, 3.62
 - frequency response, 3.61
 - mutual inductance M_L , 3.59
 - phase response, 3.62
 - step response, 3.64
 - consideration of base lead stray inductance, 3.66–67
 - consideration of collector to base spread capacitance, 3.67
 - consideration of Q_1 input resistance, 3.65
 - Table of, *see* Appendix 2.4 (on the CD)
- Laplace transform**, Introduction to, 1.5–6
- Laplace transform, direct**, 1.23
 - sinusoidal function, 1.7–8
 - three different ways of expression, 1.7
 - derivation of, 1.23
 - examples of, 1.25
 - unit step function, 1.25
 - exponential function, 1.26
 - sinusoidal function, 1.26–27
 - cosine function, 1.27
 - damped oscillations, 1.27–28
 - linear ramp, 1.28
 - function t^n , 1.28–29
 - function $te^{-\sigma_1 t}$, 1.29–30
 - function $t^n e^{-\sigma_1 t}$, 1.29–30
 - Table of direct transforms, 1.30
 - properties of, 1.31
 - convolution, calculation of, 1.37–39
 - convolution, example of, 1.81
 - convolution, graphical
 - presentation of, 1.82
 - final value, 1.37–38
 - impulse $\delta(t)$, 1.35–36
 - initial value, 1.37
 - linearity (1), 1.31
 - linearity (2), 1.31
 - real differentiation, 1.31–32
 - real integration, 1.32–35
 - change of scale, 1.34–35
 - applications to
 - capacitance, 1.41–42
 - inductance, 1.41
 - parallel RC , 1.42–43
 - resistance, 1.42
- Complex line integrals, 1.45
 - definition, 1.45
 - examples of, 1.49–51
 - Table of complex vs. real integrals, 1.48
- Contour integral
 - around the pole at $z = 0$, 1.50–51
 - encircling a regular domain, 1.53
 - encircling an irregular domain, 1.53, 1.55, 1.65–72
 - encircling a single pole at $z = a$, 1.53, 1.71–72
- Cauchy's way of expressing analytic functions, 1.55–56
- Residues of function with many poles, 1.57
 - calculation of 1.58–59
- Residues of function with multiple poles,

- 1.61–62
- Laurent series, 1.61
 - examples of, 1.63
- Complex integration around many poles, 1.65, 1.69,
 - Cauchy–Goursat Theorem, 1.65–66
- Equality of Integrals
 - $\oint F(s)e^{st} ds$ and $\int_{c-j\infty}^{c+j\infty} F(s)e^{st} ds$, 1.67
- Laplace transform, inverse**, 1.72
 - application of, 1.73–79
 - RLC* circuit impulse response, calculation of 1.73–76
 - RLC* circuit step response, calculation of, 1.76–78
 - RLC* circuit step response, graphical presentation of, 1.79
 - convolution, graphical presentation of, 1.82
 - convolution, calculation of, 1.37–39, 7.12–13
- Mutual inductance**,
 - see* Inductive peaking, T-coil 2-pole
- Numerical analysis**
 - aliasing of sampled signals, 7.17
 - alias spectrum, 7.26, 7.30, 7.35
 - convolution, 7.7
 - examples of, 7.9–13
 - as digital filtering, 7.33
 - VCON routine, 7.8
 - discrete signal representation in time and frequency domain, 6.37
 - envelope delay, 6.31
 - Fast Fourier Transform (FFT) algorithm, 6.40–41
 - frequency response
 - Bode plots, 6.26, 6.27
 - complex domain $\{F(s)\}$, 6.24
 - imaginary domain $\{F(j\omega)\}$, 6.25
 - magnitude $M(\omega) = |F(s)|$, 6.22
 - Nyquist diagram, 6.25
 - impulse response calculation, 6.36
 - ATDR routine, 6.59
 - from complex frequency response, using FFT, 6.36
 - from residues, 6.57
 - normalization
 - amplitude, ideal, 6.44
 - amplitude, unity gain, 6.46
 - time scale, 6.46
 - TRESP routine, 6.49
 - Matlab command syntax and terminology, 6.11
 - phase response, 6.28
 - poles
 - Bessel–Thomson, 6.17
 - BESTAP routine, 6.19
 - Butterworth, 6.15
 - BUTTAP routine, 6.16
 - optimized pole families, 6.13
 - step response
 - as a time integral of the impulse response, 6.45–50
 - directly as the sum of residues, 6.57
- Phase advance, principle of**, 2.21
- Phase delay, principle of**, 2.20
- Poles**
 - Butterworth (MFA), 4.27, 6.15
 - calculation routine (BUTTAP), 6.16
 - envelope delay, 4.33
 - derivation of, 4.27–30
 - frequency response, 4.31–32
 - ideal MFA, frequency response, 4.36–37
 - Paley–Wiener Criterion, 4.37
 - phase response, 4.32
 - Table of, 4.35
 - step response, 4.34
 - Bessel (MFED), 4.39, 6.17
 - calculation routine (BESTAP), 6.19
 - derivation of, 4.39–40
 - envelope delay, 4.45
 - frequency response, 4.42
 - Gaussian freq. resp. vs. 5-pole Bessel, comparison of, 4.49
 - phase response, 4.43–44
 - with linear frequency scale, 4.44
 - Table of, 4.48
 - step response, 4.45–46
 - Gaussian step resp. vs. 5-pole Bessel, comparison of, 4.49–50
 - staggered poles, 4.63–64
 - repeated complex pole pairs, 4.63–64
 - Bessel (MFED) normalized to equal cut off frequency, 4.51
 - envelope delay response, 4.53
 - frequency response, 4.51
 - phase response, 4.52
 - Table of, 4.54
 - step response, 4.53
 - comparison of 5th-order Butterworth and 5th-order Bessel, 6.61
 - interpolation between MFA and MFED poles, 4.55
 - practical interpolation procedure, 4.56–57
 - derivation of modified Bessel poles, 4.55
 - envelope delay, example of, 4.61
 - frequency response, example of, 4.59
 - interpolation procedure, 4.56
 - practical example of, 4.59–62
 - step response, example of, 4.62
 - Table of modified Bessel poles, 4.58
 - MFA, Maximally Flat Amplitude, *see* Butterworth

- MFED, Maximally Flat Envelope Delay,
see Bessel
 optimized system families, 6.13
Time advance, *see* Envelope advance
Time delay, *see* Envelope delay
Transistor BJT
 as an impedance converter, 3.17
 from base to emitter, general
 analysis, 3.20
 from emitter to base, general
 analysis, 3.17–19, 3.20–21
 Table of, 3.25
 common base small signal
 model, 3.20
 Early voltage of, 3.46
 conversions of impedances, 3.25,
 Table 3.2.1
 examples of impedance conversion,
 3.21
 capacitor in the emitter circuit,
 3.22–23
 inductance in the base circuit,
 3.23–24
 transform of combined impedances, 3.26
 as seen from base, 3.27–28
 example of, 3.28
 as seen from emitter, 3.26
 example of, 3.27
 complete input impedance, 3.26, 3.28
 thermal stability, optimum bias, 3.44
Transistor JFET (*see* JFET source follower)
Transistor MOSFET, 5.50
Spectrum
 discrete
 complex, bilateral, 1.9–13
 real, unilateral, 1.14
 of a square wave, 1.11–12, 1.14
 of timely spaced square waves,
 1.17–18
 sampled, 6.37
 continuous
 of a single square wave, 1.19–20
 from discrete to continuous, 1.18
 from Fourier integral to direct Laplace
 transform, 1.23
 frequency limited, Gibbs' phenomenon,
 1.16
 spectral filtering
 multiplication in frequency domain
 equals convolution in time domain,
 1.83, 7.13
 anti-alias filters, 7.21
Signal
 Gibbs' phenomenon, 1.16, 4.36–37, 6.51
 impulse $\delta(t)$ (Dirac function), 1.35
 ramp, 1.28
 saw-tooth, 1.13
 step $h(t)$ (Heaviside function), 1.25
 sine wave, 1.7–8, 1.26–27
 sine wave, damped, 1.27–28
 square wave, 1.11–12