Index

3 dB frequency 131, 133, 176, 292
absolute tolerance 37
AC current mirrors 287
AC load 173
accumulation layer 31
accumulation region 41
active loaded long tailed pair 75
active transistor-loaded MOS amplifier 63
ADC 259
additive approach 144
aliasing 264
aluminum 44
amplitude modulation 256
AMS 0.35 32
analog–digital interface 259
analog multiplier 254
analog-to-digital converter 259
antenna 203
artificial L-C transmission line 144
aspect ratio 3, 25
Austria Micro Systems AG (AMS) 281
average surface temperature of the die 222
balun 204
band-pass filter 194, 195
bandwidth 168, 180, 181
Barkhausen criterion 158, 246, 247, 248, 253
basic MOS amplifiers 49
basic parameters 279
Bessel functions 257
bias dependence 37
bias the current source 287
biasing 53–4
bit resolution 273
Boltzmann constant 212
bonding wire 48, 107
bottom junction 29
breakdown 172
breakdown field strength 8
broad bandwidth 181
BSIM3 20
BSIM3-v3 23, 32
parameters of AMS, 035 micron MOS transistors 281
buffer 71, 252
built-in junction potential 29
bulk silicon 11
Butterworth 191
pole 184
calibration 271
path 260
capacitive coupling 194
carrier 255
frequency 203
cascaded tuned stages 181
cascading 143
diode 147
strategies 146
cascode amplifier 114
circuit 68
configuration 186
current mirror 288
center-tapped symmetrical inductors 47
CGBO 28
CGDO 28
CGSO 27
channel length modulation factor 23
channel resistance 213
characteristic curves 279
characteristic impedance 73, 144, 145, 204
Chebyshev 181, 184, 191
pole 184
Cherry–Hooper amplifier 148
CJ 29
CJSW 29
classical filter theory 181
clipping 49, 57, 84
clock jitter 265
CMFB 88, 134
CMOS inverter 118
as analog amplifier 63
CMRR 87
coaxial lines 204
codiagnoson 207
coefficient registers 260
Conpitts 246
oscillator 248, 249, 252
common-drain amplifier 70
common-gate amplifier 68, 110, 209
common-mode
feedback 75, 88, 134
gain 86
rejection ratio 87
signal 86
common-source amplifier 49, 97
complex-conjugate poles 121
component voltages in a series resonance circuit 172
contact resistance 32, 37
continuous-time analog signals 265
converter specifications 268
Copper 44
Correlated 220
coupled resonance circuits 155, 173, 186
coupling capacitor 173
coupling coefficient 190
critical field strength 12, 14
cross-connected oscillator 247
cross-coupled 239
crystal oscillators 251
amplifier 148
crowding 170
mirrors 287
source 64, 287
transfer ratio 291
current of L and C branches 169
current–voltage relations 3
under velocity saturation 11
without velocity saturation 4
cut-off frequency 145
DAC 259
damping 163
data converters 259
DC
current mirrors 287
current source 50, 287
gate bias 53
load 173
load line 49
resistance of the inversion region 215
sweep 4
deployment mode 41
difference amplifier 76
differential input–differential output 77
differential LNA 207, 232
differential negative resistance circuit 239
differential nonlinearity 271
differential oscillator 242
differential output voltage 76
differentially driven long tailed pair 140
digital frequency divider 254
digital-to-analog converter 259
diode connected transistor 287
Dirac delta 264
direct conversion systems 261
direct coupling 63
discrete-time sampled signals 265
discrete-time sampling 263
distributed amplifier 144
distributed capacitance 47
distributed R-C line 34
DNL 271
doped silicon layers 36
double-pole 121, 122
drain 1
noise current 217
series resistance 213
drain–gate capacitance 28
drain–gate overlap capacitance 95
drain-substrate capacitance 29
drawn geometries 24
dynamic characteristics
dynamic range 49, 52, 201
dynamic specifications 273
Ebers–Moll 16
effective gate voltage 4
effective impedance 176
effective parallel resistance 243
effective Q 179
effective quality factor 168, 250
effective resistance 162, 199
effective series resistance 237
effective transconductance 61, 78, 123
effective value 212
electromigration 170
electrostatic breakdown 21
emulated inductor 197, 200
ENOB 268, 273
envelope 255
equi-ripple 184
equivalent inductance 46
equivalent number of bits 268
equivalent transistor 123
error signal 88
error voltage 92
Esaki diode 238
EUROPRACTICE 282
even harmonics 232, 242
exact differential 249
exclusive-OR circuit 254
extrinsic resistance 31, 32
feedback approach 237, 245, 247
feedback block 245
fine-tuning 22, 60, 122, 194, 237
finger structure 35
flicker noise 256
floating inductor 197
floating tuning elements 43
folded-dipole antenna 207
folded-loop antenna 207
free-running frequency 254
frequency-dependent input conductance 101
frequency domain 263
superposition 264
frequency modulation 257
index 257
frequency of oscillation 156
frequency response 95
frequency-selective circuits 155
frequency-selective RF circuits 155
frequency spectrum 255
frequency stability 237, 249, 250
fringe-field effect 38
fully differential 77
amplifier 132
OTA 23
gain–bandwidth product 100, 112, 140
gain enhancement techniques 143
gain error 269
gain with feedback 245
gate bias voltage 49
gate-bulk capacitance 41
gate capacitance 3, 20
gate–drain overlap capacitance 28
gate length 24
modulation coefficient 3
gate overdrive 14, 25
gate polysilicon 37
gate resistance 218
gate–source capacitance 26, 95
gate–source overlap capacitance, 26, 27
gate–substrate capacitance 28
gate width 24
\( \varepsilon_{\mathrm{SiC}} \)
circuits 155
filters 195
GPS receivers 206
grading coefficient 29
Groszkowski 250
ground shield 47
grounded gate amplifier 68
grounded source amplifier 49
Gummel–Poon 16
gyrator 155, 194, 195
HF front-end 259
high-frequency (RF) 260
behavior 129
figure of merit 30
performance 24, 31, 60, 117
high resistivity polysilicon 37
high-value on-chip inductances 194
high-\( Q \) inductors 155
ideal gyrator 196, 197
image current 47
image spectrum 264
impedance converting transformers 204
impedance matching 204
incremental noise current 219
initial condition 243
INL 271
input admittance 101, 112, 177, 179
input and output admittances 140
input conductance 66, 106
input impedance 174
matching 203
of gyrator 195
input resistance 69
input RF amplifier 155
instability 200
integral nonlinearity 271
interdigitated capacitor 38
intermediate frequency amplifiers 155, 186, 261
internal nodes 95
intrinsic bandwidth 114
intrinsic resistance 31
inversion charge 4
density 4
profile 6
inversion layer 11
inverted-F antenna 207
jitter 265
Johnson 212
junction capacitance 29, 95
kinetic energy 156
lambda parameter 9, 23
large-signal behavior 84
latch-up 25
lateral electric field strength 12
L-C filters 155
load 98
oscillators 164
least significant bit 269
limit-cycle 258
linear mode 2
LNA 128, 202
load resistor 49
local oscillator 237
long tailed pair 75
lookup tables 260
loop gain 245, 247
low-field mobility 12, 20
low-frequency current transfer ratio 27
low-noise amplifiers 202
low-pass filter 195, 254
low-Q inductors 155
LSB 269
magnetic coupling 186
  coefficient 192
magnetically induced current 47
magnitude characteristic 99
MatLab 257
maximally flat 181
mean square
  drain noise current 227
  noise current 212
  noise voltage 212
mechanical resonance 251
  frequency 251
metal–insulator–metal capacitor 38
MIM capacitor 36, 38, 250
admittance 97, 101, 103, 115
component 177, 179
effect 75, 140
  theorem 95
transformation 97
mirroring coefficient 75, 80, 288
mirroring factor 137, 287
MJ 29
MISW 29
mobile telephones 206
mobility 3, 20
  degradation 60, 181, 277
model parameters 19
modified Wheeler formula 44
modulation theory 256
multi-finger structure 218
multi-stage amplifier 181
multiplicative approach 144
narrow band 172
natural frequency 158, 247
negative conductance 107, 164
negative feedback 53, 245
negative input conductance 165
negative resistance 237
  approach 237
  factor 211
  in amplifiers 210
  in high frequency ICs 275
  in LNAs 224
  spectral density 216
  voltage drop 217
nonlinear distortion 49, 52, 61, 84, 57, 255
non-velocity saturated transistor 30
  normal saturation region 291
Norton–Thévenin transformation 68, 111
npn bipolar transistor 16
NRS 32
Nyquist 212
off-line calibration 260
offset error 269
on-line calibration 260
on-resistance 11
  capacitors 38, 156
  inductors 43, 155, 186
  resistors 36
onset
  of saturation 27
  of the pinch-off 10
  of velocity saturation 13, 14
open circuit 57
operating point 49
operational amplifier 135
oscillate 178
oscillation 107
OTA 77, 88, 142, 195
output
  characteristic curve 9, 10
  characteristics 14
  conductance 9, 56, 55
  internal resistance 70
  resistance 24, 179
  voltage dynamic range 68
  voltage swing 49
overshoot 121
overtone oscillator 253
overtone resonances 252
parallel resonance 252
parallel voltage feedback 151, 210
parasitic capacitances 26, 95
parasitic components 95
parasitic resistances 31, 95
parasitic source resistance 62
parasitics
  of a non-ideal gyrator 197
  of MOS transistors 25
  of passive on-chip capacitors 39
  passive MOS loaded amplifier 50
  passive on-chip capacitors 38
  passive on-chip components 36
PB 29, 40
phase angle of the impedance 169, 172
phase
  characteristic 99, 133
comparator 254
noise 255
stability 237
phase-lock technique 253
phase-locked loop 253
piezo-electric effect 251
pilot oscillator 237
pinch-off 2
pinched-off region 214
planar inverted-F antenna 207
PLL 253
p-n junction 25
p-n varactor 40
pole 99, 163
frequency 100
pole–zero diagram 99, 175, 183
poly1–poly2 capacitor 38, 250
positive feedback 245
potential energy 156
precision 237
pre-pinch-off region 214
pre-saturation 10
pre-saturation region 7
process technology 24
production tolerance 21
programmable digital signal processing 261
propagation delay 34
proximity effects 170
PSpice 19, 59, 68, 107, 122
Q-enhancement 164, 185, 200
quadratic characteristic 14
quality factor 48, 160
of a capacitor 39
of an inductor 44
of MOS varactors 42
quantization error 267
quantization noise 267, 273
quartz crystal 250
oscillator 237
quiescent drain current 54
radiation losses 203
radiation pattern 203
rail-to-rail 123
R-C load 99
R-C loaded long tailed pair 129
RDSW 32
real gyrator 197
reciprocal 203
reconfigurable digital signal processing 261
reference current 287
reference oscillator 254, 255
relative tolerance 37
reliability 37
resistive region 7
resolution of the converter 269
resonance 128, 156
circuits 155, 156
return loss 207
reverse-based p-n junction 40
RF choking coil 53
RF oscillators 237
ringing 107
ripple 184
root locus 157, 159
root mean square value 212
safety margin 35, 73, 241, 247
sample-and-hold 263
circuit 264
sampling frequency 264
sampling rate 264
saturation
current 6
mode 2
region 10
velocity 2, 7, 11
velocity of holes 31
voltage 2
Seabough 238
secondary effects 19, 60
self resonance frequency 48
sensitivity 64, 75, 165, 200, 250, 287
series
parasitic resistance 188
resistance 156, 95
resonance 252
resonance circuit 170
source (or drain) resistance 31
SFDR 273
sheet resistance 32, 36
short-circuit 57
SINAD 273
side-bands 203
side-band 203
side-frequencies 255, 257
side-wall junctions 29
signal delay 144
per sector 145
signal path 260
signal-to-noise ratio 203, 211, 273
signal-to-noise-and-distortion ratio 273
silicide block 37
silicon to metal contacts 32
simultaneous switching noise 275
single-ended LNA 207
single-ended output 75
long tailed pair 135
single-tuned amplifiers 155
sinusoidal oscillators 237
skew 162, 168, 178
Index

skin effect 47
slew rate 65, 123
small-signal equivalent circuit 54, 56, 68
small-signal voltage gain 52, 58
SNDR 273
SNR 211, 268, 273
source 1
source degenerated cascode amplifier 224
source degeneration 123
source follower 70, 103, 239
source region resistance 32
source series resistance 213
source–substrate capacitance 29
spectral density 213
spectral purity 237
SPICE 22, 95
SPIRAL 45
spreading resistance 32
spurious-free-dynamic range 273
SSN 275
stability 134, 237
staggered tuning, 155, 173, 181
standing wave ratio (SWR) 207
static specifications 269
substrate bias 22
sub-threshold current 15
operation 19
regime 15
slope 18
super-heterodyne receivers 186
superposition principle 79, 87
surface inversion 1
surface potential 17
suspended inductor 48
sustained oscillation 238, 243, 247
tail current 78, 85, 241
source 129, 258
Taylor series 54
Tellegen 195
temperature coefficient 37, 249, 250, 252
temperature of the channel region 222
THD 273
THD+N 273
termal noise 211, 213
of a resistor 212
teral resistance 223
thick metal layer 36, 44
thin conductive films 36
threshold decision 267
threshold voltage 1, 3, 15, 21
time domain 163, 262
tolerances 37, 249
total harmonic distortion 273
plus noise 273
total mean square drain noise current 222
total noise power 230
total voltage gain 181
track-and-hold 264
trade-off 24, 125, 134, 165, 230
transadmittance 226
amplifier 132, 134, 135, 145, 148, 151
transconductance 30, 55, 56, 112, 208
amplifier 77, 132
parameter 20, 25
transfer impedance 190
transient simulation 57, 166, 243
transimpedance amplifier 114, 118, 148, 151
transmission line 73, 107, 190
transresistance amplifier 66, 69
transversal electric field 12, 20
trimming 249
tuned amplifiers 172
tuned cascode amplifier 179
tuned LNA 210
tuning range 40, 42
tunnel diode 238
oscillator 238
twin power supplies 64, 71
uncorrected 220
uniform sampling theorem 264
usable maximum frequency 35
van der Ziel 213, 215
varactor 38, 40, 173, 237, 250
VCO 237
velocity of electrons 7
velocity saturated transistor 31
velocity saturation 241, 292
region 14, 56, 176
region 291
voltage amplifier 132, 147
voltage-controlled oscillator 237
voltage divider 53
voltage follower 70
voltage gain 99, 112, 174, 176
voltage transfer curve 60, 63
VTH0 22
wide-band LNA 210
worst case conditions 81
wound inductors 155
Young modulus 251
zero bias junction capacitance 29
zero-crossing frequency 168
zero-crossing point 258