Index

6

64-bit addition, 189
64-bit logic shift left, 192
64-bit multiplication, 194
64-bit operations, 189
64-bit shifted right, 193
64-bit sign extension, 191
64-bit signed division, 197
64-bit subtraction, 190

A

ABI, 155
access assembly variable, 217
access C variables, 215
accumulator-based instruction set, 58
ACK, 48, 440, 442, 444, 445, 452
ADC, 387
  continuous mode, 394
  digital quantization, 388
  DMA, 403
  external trigger, 396
  freeze mode, 397
  quantization error, 392
  sample-and-hold amplifier, 390
  sampling time, 390, 391
  scan mode, 395
  single mode, 394
  software trigger, 396
  trigger, 396
add, 76
add with carry, 64, 76
ADR, 92
ADSR, 421
advanced high-performance bus, 55
advanced peripheral bus, 55
AHB, 55, 263
ALIGN, 202
aligned memory accesses, 204
alignment, 201
  double-word alignment, 201
  halfword alignment, 201
  word alignment, 201
alternative functions, 293
ALU, 19, 22, 23, 56, 58, 59, 71, 72, 73, 74
always, 102
analog watchdog, 395
APB, 55
application binary interface, 161, 179, 199
application program status register, 71, 101
APSR, 71, 88, 101
arithmetic
  add, 76
  add with carry, 76
  multiply and subtract, 76
  reverse subtract, 76
  subtract, 76
  subtract with carry, 76
arithmetic logic unit, 56
ARM EABI, 157
ARM state, 54
ARM32, 53, 54, 70
ARM64, 53, 70
Armstrong numbers, 141
ASCII, 47
assembly function in C programs, 212
assembly instruction, 63
assembly program, 2
asynchronous transmission, 427
AT commands, 438
atoi, 144
audio, 479
AVRCP, 437

B

Barrel shifter, 61, 73, 74, 79
base, 27, 221
BASEPRI, 14, 88, 260, 261
baud rate, 429
BCD encodes, 373
bias constant, 230
biased exponent, 230
big endianness, 94
binary executable, 1
binary interface, 155
binary numbers, 27, 29
binary search, 145
bipolar, 343

bit, 25
  bit mask, 81
  check a bit, 82
  clear a bit, 82
  set a bit, 82
  toggle a bit, 83
bit mask, 81
bit order, 84
bit stuffing, 467
bitwise logic
  AND, 80
  bit clear, 80
  move not, 80
BL, 106
Bluetooth, 436
  address, 436
  AT commands, 438
  HC-05, 437
  HC-06, 437
  paring, 437
BLX, 106
boot loader, 18
branch
  branch if equal, 104
  branch if negative, 104
  branch if not equal, 104
  branch if overflow set, 104
  branch if positive or zero, 104
  branch if signed greater or equal, 104
  branch if signed greater than, 104
  branch if signed less than, 104
  branch if signed less than or equal, 104
  branch if unsigned higher, 104
  branch if unsigned higher or same, 104
  branch if unsigned lower, 104
  branch if unsigned lower or same, 104
  branch label, 104
  table branch byte, 117
  table branch half-word, 117
branch and exchange, 65, 106, 152
branch and link, 65, 106, 152
branch indirect with link, 106
branch instruction, 104
branch with link and exchange, 65
break statement, 116
bubble sort, 147
buffered output, 411
bulk transfers, 468
bus, 4, 56
bus matrix, 55
BX, 106
byte, 25
byte order, 84
byte-addressable, 5

C

calendar time, 371
call a C function from assembly, 216
call an assembly subroutine from C, 214
caller, 9, 152, 155, 161, 163, 178
calloc, 8
carry flag, 34, 35, 40, 71
CBNZ, 106
CBZ, 106
CDC, 479
change processor state, 260
change-on-zero, 467
check a bit, 82
circular right rotate, 92
clear a bit, 82
clock arbitration, 442
clock phase, 460
clock polarity, 460
clock synchronization, 442
CMAR, 383
CNDTR, 383
collector, 295
comment, 2, 20, 60, 61, 62
compare and branch on non-zero, 106
compare and branch on zero, 106
compare and capture register, 319, 325
compare negative, 65, 72, 87
compound Boolean expression, 109
compound logical expression, 110
condition flags, 101, 107
conditional branch instruction, 104
conditional execution, 107
context switch, 493, 496, 498, 499
continue statement, 115
control register, 410, 452, 487, 489
control structures, 123
coordinated universal time, 371
Cortex-A, 54
Cortex-M, 54
Cortex-M0, 54, 275

Cortex-M1, 54
Cortex-M4, 54, 70, 275
Cortex-R, 54
count digits, 136
count the number of 1-bits, 132
counter overflow, 341
counter underflow, 341
CPAR, 383
CPS, 260
CPSID, 261
CPSIE, 65, 261, 490, 491, 500
CRC, 469

D

DAC, 407
  buffered output, 411
  control register, 411
  data output register, 410
  resolution, 408
  sampling rate, 408
  trigger, 410
Darlington array, 354
data alignment, 201
data comparison, 87
data memory, 5, 7, 8, 9, 17, 18, 19, 20, 21, 22, 23, 55, 70, 129, 159, 188, 207, 318, 363, 366, 426
data memory barrier, 65
data minus, 466
data plus, 466
data structure padding, 203
data symbols, 1
data synchronization barrier, 65
DCB, 68
DCD, 68
DCQ, 68
DCW, 68
De Morgan's laws, 110
debouncing, 305
decimal, 27, 221
decode, 282
deformalized, 235
delay, 267
differential signals, 466
digital input filter, 330
digital quantization, 388
direct memory access, 381
directives, 3, 62, 66, 67, 69
dividing by zero, 272
DMA, 381, 403
DMA and interrupt enable register, 332
double precision, 230
double-word, 25
do-while loop, 114
duty cycle, 322
duty ratio, 357

E

EABI, 166, 214, 216
electromagnetic interference, 299
ELF, 3, 23, 514
embedded assembly in C programs, 213
EMI, 299
END, 67
end of packet, 469
endianess, 84
endianness, 94, 96, 119, 255
ENDP, 67
endpoint, 465, 468, 469, 470, 471, 472, 474, 477, 480
enumeration, 475
EOP, 468, 469, 470
EPSR, 71, 88
EQU, 68, 303
equal, 102
event generation register, 324
exception, 252
exception handling, 272
executable and linkable format, 3
executable file, 1
executable interface, 3
execution program status register, 71
execution view, 4
export, 163, 214
extern, 215, 217
external trigger, 397
external voltage reference, 393

F

factorial numbers, 131, 182
FAULTMASK, 14, 88, 260, 261
FHSS, 436
FILL, 68
find maximum, 134

fixed-point numbers, 222
accuracy, 224
addition, 225
division, 227
multiplication, 226
Qm.n format, 223
range, 224
resolution, 224
subtraction, 226
flash memory, 7
floating-point numbers, 228
addition, 240
bias constant, 230
biased exponent, 230
double precision, 229, 230
fraction field, 230
IEEE 754, 228
multiplication, 244
normalized notation, 229
overflow, 234
range, 236
rounding rules, 238
rounding to even, 239
rounding up, 240
sign bit, 230
single precision, 229
special values, 233
subnormal numbers, 235
truncation, 239
underflow, 234
floating-point unit, 222
flowcharts, 126
for loop, 112
FPU, 412
fraction field, 230
freeze mode, 397
frequency hopping, 436
FT232R, 430
full stepping, 345, 346, 347, 348, 349, 351
function, 151

G

GAVDP, 437
GCD, 165
general-purpose integer registers, 13
get, 69
global, 214
global static variable, 206
goto, 123
goto statement, 125
GPIO, 293
data input register, 302
data ouput register, 302
input data register, 294
open drain, 297
output data register, 294
pull down, 294
pull up, 294
push pull, 295
slew rate, 298
strong pull down, 295
strong pull up, 295
weak pull down, 295
weak pull up, 295
greatest common divisor, 165

H

half stepping, 349
half-word, 25
Hamming distance, 132
harmonics, 299, 420
Harvard architecture, 4, 7, 10, 17, 23
heap, 8, 148, 159, 207
hexadecimal, 27
HID, 479, 480
HID descriptor, 481, 483
HSI, 339

I

I²C, 439
ACK, 440
NACK, 440
open drain, 439
SCL, 439
SDA, 439
start, 440
stop, 440
ICPSC, 331
if-then statement, 108
if-then-else statement, 111
immediate number, 58, 61, 76, 88, 91, 92, 93, 277, 282, 283, 285, 490
import, 163, 215

include, 69
initialized data segment, 8
injected channel, 400
inline assembly, 212, 213
input capture, 329
  prescaler, 331
instruction memory, 5, 7, 8, 13, 14, 18, 20, 21, 23, 53, 55, 56, 276
instruction synchronization barrier, 65
interface class, 472
internal reference voltage, 393
interrupt, 249
  active bit register, 254
  clear pending register, 254
  controller type register, 254
  enable and disable, 255
  external interrupt, 252, 269
  interrupt levels, 258
  interrupt number, 254
  pending bit, 255
  preemption priority, 257
  priority, 251
  set enable register, 254
  set pending register, 254
  software interrupts, 271
  software trigger, 255
  stacking, 253
  unstacking, 253
interrupt clear enable register, 254
interrupt priority, 257
interrupt priority register, 257
interrupt program status register, 71
interrupt service routine, 249
interrupt transfers, 468
intra-procedure-call register, 156
Intra-Procedure-Call register, 156
IP, 257
IPSR, 71, 88
ISER, 254, 255, 256, 257, 379
isochronous transfers, 468, 474, 479
IT instruction, 105
itoa, 170

J

J state, 467
Java executables, 1
JEOC, 400

K

K state, 467
keypad reverse scanning, 311
keypad scanning algorithm, 308

L

label, 2, 60, 62, 117, 126
last-in-first-out, 153
LCD, 355
  bias, 357, 358
  common terminals, 362
  data memory, 363
  display memory, 363
  duty ratio, 357
  encoding, 366
LDR, 92
LDRB, 65, 98, 116, 142, 143, 144, 164, 167, 168, 171, 174, 184, 200, 201, 213, 214, 220, 503, 504, 510
LDRSB, 65, 97, 98, 200, 201, 503, 510
leap second, 372
LIFO, 153
linkable interface, 3
little endianness, 94, 255
load
  load byte, 98
  load half-word, 98
  load multiple words, 98
  load signed byte, 98
  load signed half-word, 98
  load word, 98
load constant into registers, 91
load register exclusive, 65
load register with byte, 200, 201
load register with double-word, 201
load register with signed byte, 200
load register with signed halfword, 201
loading effects, 411
loading view, 4
load-store instruction set, 58, 59
local static variable, 206, 208
logic shift left, 64, 279
logic shift right, 64, 193
lookup table, 412
loop structure, 124

M

machine program, 1, 3, 4, 17
main stack, 14, 250, 254, 273, 487, 497, 498, 499, 501
major opcode, 279
malloc, 8
mask, 81
matrix transpose, 172
memory
  data memory, 4
  instruction memory, 4
  main memory, 4
memory address index formats, 97
memory address modes, 95
memory addressing modes, 95
  pre-index, 96
micro-stepping, 351
minor opcode, 278, 279
MISO, 457
mnemonic, 2, 60, 61, 72
MOSI, 457
move 16-bit immediate value to bottom halfword, 91
move 16-bit immediate value to top, 91
move from general register to special register, 88
move from special register to general register, 88
move not, 88
move the bitwise inverse of 8-bit immediate value, 91
MSC, 479
MSP, 250
multiply and subtract, 76
multiply-accumulate, 64
multiply-subtract, 64
musical
  ADSR, 421
  amplitude, 420
  duration, 421
  pitch, 420
  timbre, 420
  tone, 420

N

NACK, 440, 444, 445
NaN, 233
negative, 102
negative flag, 71
NMI, 14, 260
noise filtering, 330
non-preemptive, 249
non-return-to-zero inverted, 466
non-static variable, 207
non-system interrupts, 254
non-volatile, 4, 7, 211
normalized presentation, 235
NOT, 88
not any number, 233
note equal, 102
NRZI, 466
NULL, 48, 49, 52, 143, 149, 164, 168, 171, 218, 436
NULL terminator, 48
NVIC, 56, 250, 253, 254, 255, 256, 259, 260, 262, 270, 432, 463, 498
Nyquist–Shannon, 408

O

object codes, 3
OCM, 317
OCREF, 317
octal, 27
one's complement, 32
opcode, 60, 277, 278, 279, 283, 284, 285
open collector, 439
open drain, 295, 296, 297, 302, 303, 307, 310, 319, 439
operands, 2, 11, 22, 32, 37, 43, 44, 45, 47, 53, 56, 58, 59, 60, 61, 62, 76, 77, 79, 87, 93, 189, 223, 227, 245, 276, 277, 278, 279, 283
output compare mode, 317
over-capture flag, 332
overflow, 37, 40
  overflow on addition, 37
  overflow on subtraction, 38
overflow clear, 102, 104
overflow flag, 34, 71
overflow set, 102

P

packed, 204
packed data structure, 203
padding, 203
palindrome string, 142

parity, 137
  even parity, 137
  odd parity, 137
parity bit, 428
part per million, 466
pass arguments, 157
pass by reference, 158, 159
pass by value, 158, 159, 164
PC-relative addressing, 18, 93, 98, 99, 290
perfect number, 139
peripheral interrupt, 254, 255, 256, 257, 259
permutation, 185
PHDC, 479
piconet, 436
plus, 102, 104
polling, 250, 252, 306, 311, 312
positive or zero, 102
post-index format, 95
pot, 399
potentiometer, 399
power dissipation, 387
PPM, 466
preempt priority, 257, 258
preemptive, 249
pre-index format, 95
prescaler, 316
PRIMASK, 14, 88, 260, 261, 491, 500
privileged state, 487, 489, 491
PROC, 67
procedure, 151
process stack, 14, 254, 487, 497, 498, 499, 500, 501
processor exception, 254
program counter, 14
program status register, 71
program status registers, 88
pseudo instruction, 18, 63, 92, 93, 99, 143
PSR, 71, 72, 88, 253, 268, 273, 491, 495, 497, 499, 500
pull down, 294, 295
pull up, 294
push button, 304
push pull, 295, 296, 297, 299, 302, 303, 307, 310, 319, 335
PVD output, 271
PWM, 321
  control register, 324
  mode, 324

Q

QNaN, 233
quantization error, 392
Quiet NaN, 233

R

radio frequency interference, 299
radix, 221
read-only section, 4
read-write section, 4
real number, 25, 221, 224, 231, 247
real-time clock, 371
recursive function, 180
register allocation, 12
registers, 11
  general purpose registers, 11
  live range, 128
  register reuse, 128
  scratch registers, 155, 161
  special purpose registers, 11
  virtual registers, 213
regular channel, 400
resolution, 387
reverse bits, 84
reverse byte order, 84
reverse subtract, 64, 76
RFCOMM, 437
RFI, 299
rise time, 446
ROR, 199
rotate
  rotate right, 64, 74
  rotate right with extend, 74
rotate right with extend, 64
round to even, 239
round to the nearest, 238
round toward negative infinity, 238
round toward plus infinity, 238
round toward zero, 238
rounding up, 240
Round-robin, 493
round-robin scheduler, 501
routine, 151
RRX, 199
RS-232, 430
RS-422, 430

RS-485, 430
RTC, 271, 365, 371, 372, 374, 375, 377, 378, 379, 380
  alarm time comparison, 377
RTC alarm, 377
RTC alarm event, 271
RTC tamper and time stamp events, 271

S

S suffix, 72, 84, 282, 285
sample-and-hold amplifier, 388, 390
sampling rate, 387
sampling time, 391
saturation, 78
saturation flag, 71
scanning algorithm, 309
SCB, 258, 260, 272
SCLK, 457
SE0, 467
SE1, 467
selection structure, 124
sequence structure, 124
servo motor, 343
set a bit, 82
shift
  arithmetic shift right, 64, 74
  logical shift left, 74
  logical shift right, 74
shift and rotate, 74
SHP, 258
sign and magnitude, 31
sign and zero extension, 86
sign extension, 200, 395
Signaling NaN, 233
signed division, 46, 74
signed greater or equal, 102
signed greater than, 102
signed integer, 29
signed less than, 102
signed less than or equal, 102
signed long multiply-accumulate, 64
signed saturate, 76, 78
single precision, 230
single-ended signal, 467
sinusoidal, 420
slave select line, 457
slew rate, 298
SNaN, 233
SOF, 470
software trigger, 397
software trigger interrupt register, 254, 255
SPACE, 68
SPI, 457
SPI mode, 460
SSAT, 64, 71, 76, 78, 79
stack, 8, 9, 13, 58, 65, 152, 153, 154, 155, 156, 157, 161, 166, 178, 179, 180, 182, 187, 188, 199, 212, 213, 253, 261, 273, 274, 414, 487, 488, 489, 490, 491, 493, 495, 496, 497, 498, 499, 500, 501, 502
  ascending stack, 154
  descending stack, 154
  empty stack, 154
  full stack, 154
stack frame pointer, 496
stack-based instruction set, 58
stacking, 253
start-of-frame, 470
static variable, 206
statically-allocated, 4
step angle, 345
stepper motor, 343
  full stepping, 347
  half stepping, 349
  micro-stepping, 351
  wave stepping, 347
stepwise refinement, 125
STIR, 254, 255
store
  store lower byte, 98
  store lower half-word, 98
  store multiple words, 98
  store register byte, 201
  store register halfword, 201
  store word, 98
strcat, 167, 185, 186, 218
string
  itoa, 170
  remove a character, 174
  reverse a string, 184
  string comparison, 49, 168
  string concatenation, 167
  string permutation, 185
  strlen, 214, 216
strong pull down, 295, 308
strong pull up, 295, 308

strrchr, 52
strstr, 52
structured programming, 123, 124, 125
subroutine, 151
  pass arguments through stack, 178
  pass by reference, 158
  pass by value, 158
  passing arguments, 157
subtract, 76
subtract with carry, 64, 76
successive-approximation, 387
suffix S, 107
supervisor call, 272
swap, 164, 184
switch statement, 117
synchronous protocol, 458
system control block, 258, 260
system exception, 254
system handler priority, 258
system interrupt, 254
system tick timer, 261
SysTick, 68, 210, 211, 261, 262, 263, 266, 268, 273, 274, 498

T

table branch byte, 117
table branch half-word, 117
TBB, 117
TBH, 117
temporal locality, 12
test, 87
test equivalence, 87
test equivalent, 65
Thumb, 53, 54, 70, 275, 276, 277, 278, 503, 505
Thumb state, 54
Thumb-2, 53, 70, 275, 276
time division duplex, 436
timer, 313
  center-aligned counting, 314
  compare and capture register, 319
  downcounting, 314
  input capture, 329
  output compare mode, 317
  overflow, 314
  prescaler, 316
  PWM, 324
  underflow, 314
  upcounting, 314
toggle a bit, 83
token packet, 469
transmission bus, 4, 7
trap, 272
truncation, 239
two's complement, 33

U

UART, 427
UEV, 324
ULN2803, 354
ultrasonic distance sensor, 336
ultrasonic waves, 337
unaligned memory accesses, 204
unaligned memory layout, 204
unconditional branch instruction, 104
uninitialized data segment, 8
uninitialized variables, 4
unipolar, 343
unique numbers, 175
Unix Epoch, 371, 380
unprivileged state, 487, 489
unsigned decimal, 29
unsigned division, 46, 74, 197
unsigned higher, 102
unsigned higher or same, 102
unsigned long multiply-subtract, 64
unsigned lower, 102
unsigned lower or same, 102
unsigned numbers, 28
unsigned saturate, 76, 78
unstacking, 253
update event, 324, 327, 340, 341, 397, 416
update interrupt flag bit, 324
USAT, 64, 71, 76, 78, 79
USB, 465
  address field, 469
  bulk transfers, 468
  bus layer, 466
  class layer, 479
  CRC, 469
  data field, 469
  descriptors, 471
  device layer, 468
  differential signals, 466
  end of packet, 469

endpoint, 468, 474
enumeration, 475
functions layer, 471
GET_DESCRIPTOR requests, 477
HID, 480
interrupt transfers, 468
isochronous transfers, 468
J state, 467
K state, 467
NRZI, 466
packet identification field, 469
power supply, 472
product ID, 471
SET_ADDRESS request, 477
speed, 466
start-of-frame, 470
SYNC, 468
transfer type, 468
vendor ID, 471
UTC, 371, 372

V

variable live range, 13
video, 479
virtual decimal place, 222
volatile, 4, 5, 7, 206, 210, 211
volatile variable, 210
von Neumann, 4, 23

W

wait for event, 65
wait for interrupt, 65
wave stepping, 346, 347
weak, 215, 217
weak pull down, 295
weak pull up, 295
while loop, 113
word, 25

X

xPSR, 14

Y

year 2038 problem, 371

Z

zero flag, 71
zero-initialized data section, 4, 7