

## 11.8 SUMMARY

We have described some of the problems of designing and producing reliable software and how these problems are different from those associated with hardware reliability. The importance of being able to produce reliable and fault-tolerant software will continue to increase as the use of devices incorporating computers grows. Improved production methods will increase software reliability; however, it will remain difficult to make software-based systems tolerant of unanticipated errors. Safe failure of systems incorporating software will continue to depend in the last resort on hardware safety provisions.

For many real-time engineering applications loosely coupled distributed computer systems can be used. The advantage of such systems is that they can be made robust through the use of redundant processors and communication systems. The loose coupling permits the containment of faults to specific parts of the system thus reducing the extent of the performance failure and easing the problem of reinstatement. Most applications of this type are well defined and hence it is possible to specify closely actions to be taken in the event of expected failure modes and most systems can continue to operate in a degraded mode. For example, it is normal for tasks to be allocated at construction time to a specific node (processor) in the system and the action to be taken in the event of failure of that node is normally predetermined.

As with any distributed system there is the problem of system consistency and steps must be taken to ensure that at the end of the recovery procedure the system is returned to a consistent state. For many real-time engineering applications much of the data decreases in value as it ages and hence much of the system will automatically return to a consistent state as new plant data is obtained. The problem areas concern environmental data that is input in incremental rather than absolute form; in such cases consistency can only be regained by restarting the device or system from some known absolute datum.

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# Index

- actuator control, plant input and output signals, 142, 143 (Fig.)
- Ada, 165-6, 172, 174, 175, 184-6, 192, 195, 196
- adaptive control, 50-3
- address line, 73
- aerospace industry, 15, 51
- analog interfaces, 77, 83-85
- analog-digital converters (ADC), 83
- aperiodic tasks, 26, 27-28
- application-oriented software, 196-202
  - application languages, 202
  - block-structured software, 200-2
  - table-driven approach, 197, 198-200
- arithmetic and logic unit (ALU), 70
- arrays, 175-6, 195
- abstraction, description, 34
- assertion testing, 405-6
- automatic bank teller, 30
- autotuning, 53
- auxiliary storage, 71-2
  
- back-up copies, 412
- ballast coding, 119, 120, 121 (Fig.)
- BASIC, 172, 182-84, 186-87, 195, 209-10
- Basic Disk Operating System (BDOS), 214
- Basic Input Output System (BIOS), 214
- batch systems, 37, 39-42, 58-1
- BBC BASIC, indirection operator, 186-7
- binary semaphore, 256-8, 259 (Fig.), 260
- BISYNC, 106
- block-structured languages, 166-7
  - see also Modula-16
- board design and structure, 282
- Brown and Campbell, 15
- buffer,
  - data transfer,
    - with synchronisation, 267-9
    - without synchronisation, 263-66
  - IMPLEMENTATION MODULES, 267-8 (Figs)
- building control systems, 53, 131
  
- bumpless transfer, 118, 126-29
- bus structure, 72-3
  
- CAMAC, 109-10
- cascade control system, 134 (Fig.), 135
- CASE, description, 321
- catalytic cracking of oil, 37
- centralised computer control, 55-7
- central processing unit (CPU), 70-1
- channels, 76, 262, 263
- check points, 412
- chemical batch process, 40, 41 (Fig.), 42
- chemical reactor vessel, 39 (Fig.), 40
- classification of systems, 26-28
- clock, real-time, 27, 85-6, 89, 121-26
- clock-based tasks, 26, 27
- clock interrupt, description, 27
- code-sharing, 241-44
- communications see transmission of data
- communication tasks, 23-24, 25 (Fig.)
- components, description, 354
- computer control systems,
  - economics and benefits, 65-6
  - elements of, 18-24
  - example, 18-22
- computers, general purpose, 68-73
- concurrency, 24, 190-1, 193-94
- conditional transfer, 87, 88 (Fig.), 89 (Fig.)
- condition flag, mutual exclusion, 299-303
- condition queue, 257
- CONIC, 195, 196
- constants declaration, 165-6
- context switching, 220
- continuous systems, description, 37
- control and status lines, 73
- control engineer's role, 64-5
- controller designs based on plant models, 145-1
- controller parameters,
  - transfer using semaphore, 303-4, 305 (Fig.), 306
  - use of double buffering, 306-8

- control loop,
    - synchronisation, 118–25
      - ballast coding, 119, 120, 121
      - external interrupt, 119, 120–21
      - polling, 119–20
      - real-time clock, 121–26
  - control structures, 177 (Fig.), 178–80
  - control transformations, Yourdon methodology, 334, 336–41
  - control unit, 70
  - CORAL, 187, 195
  - CORE, 321
  - coroutines, 190–1
  - CSP, 195
  - CUTLASS, 77, 195, 196, 203–9
    - bad data, 206–7, 411
    - COMMON block, 207–8
    - data typing, 206–7
    - error handling, 186
    - features, 203–6
    - GLOBAL variables, 208–9
    - host-target configuration, 204 (Fig.)
    - language sub-sets, 207, 208 (Fig.)
    - major requirements, 203
    - SCHEME, 204
    - schemes and tasks application, 204–06
    - scope and visibility, 208–10
    - summary, 209
  - cyclic redundancy code, 407
  - cyclic tasks *see* clock-based tasks
  
  - damage containment and assessment, 409
  - DARTS, 321
  - data,
    - bad, 206–7, 409, 411–2
    - direct manipulation to specific registers, 186
  - data bus topology, 107
  - data dictionary, 329, 330 (Table)
  - data lines, 73
  - data transfer, 86–101, 262–69
    - comparison of techniques, 101
    - conditional transfer, 87
      - polling, 87, 88 (Fig.), 89 (Fig.)
    - interrupts *see* separate entry
    - unconditional transfer, 87
    - without synchronisation, 262–69
  - data transformations, Yourdon methodology, 334, 335–6, 337
  - data transmission *see* transmission of data
  - data types, 172–78
  - DDC, 44–53
    - advantages over analog control, 44–5
    - applications, 46–50
    - first computer system, 16–17
    - see also* computer control systems; loop control; PID controller
  - DDC algorithms,
    - bumpless transfer, 118, 126–29
    - choice of sampling interval, 139–40
    - digital form, 115–18
    - four-point difference method position algorithm, 144
    - implementation of controller designs based on plant models, 145–151
    - integral and derivative calculation, improved, 144–5
    - PID controller, 115–18, 145, 146–8
    - plant input/output signals, 140–44
    - saturation and integral action wind-up, 118 129–37
    - synchronisation of control loop, 118–25
    - tuning, 137–9
    - use of trapezoidal rule, 145
  - deadline mechanisms, 410–11
  - deadlock, description, 269–70
  - debugging aids, 90
  - declarations, 163–64
  - definitions of systems, 24, 26
  - DEFINITION MODULE for PROCESSES, 193–94
  - DELAY statement, 316, 317–18
  - dependability,
    - characteristics, 399, 400 (Fig.)
    - see also* reliability
  - design analysis *see* Petri nets; scheduling
  - design faults, 399
  - design of real-time systems,
    - board design, 282
    - development phase, 278, 280, 281 (Fig.)
    - hardware design, 282
    - software *see* software design
  - distribution of errors and costs of correcting errors, 280 (Table)
  - mutual exclusion *see* separate entry
  - planning phase, 278, 279 (Fig.)
  - preliminary design,
    - hardware, 286–7
    - software *see* software design
  - specification document, 280, 284–6
- device control block, 246, 247 (Table)
- device drivers, 243
- device queues and priorities, 252–54
- diagnostic checks, 408
- digital computers, applications, 15
- Digital Equipment Corp, 109, 290
- digital signal interfaces, 77–81
- digital signal processors, 76
- digital-to-analog conversion, 84
- digitisation, definition, 23
- direct digital control *see* DDC
- disks, 71
- distillation column control, 47, 49 (Fig.), 50
- distributed and hierarchical system, 61–3
- distributed computer control system, 18
- distributed systems, 61
- dual computer systems, 56 (Fig.), 57

- dynamic redundancy, 400
- embedded computers, description, 26
- entities, global and local declaration, 167-9
- environment, real and virtual, 343
- environmental model *see* Yourdon methodology, Ward and Mellor method
- EPROM, 71
- errors,
  - costs of correcting, 280 (Table)
  - detection, 181-86
  - distribution, 280 (Table)
- evaporation plant, 54, 55 (Fig.)
- event-based tasks, 26, 27-28
- executive control program, 219
- extended interpreter, 403
- external interrupt, 119, 120-21
  
- failure detection, 89, 400
- fast access memory, 71
- fast digital signal processors, 68
- fault detection, 404-8
- fault tolerance, 399-404, 409-412
- feedback control, 23-24 (Fig.), 47, 48 (Fig.), 50 (Fig.)
- feedback loop closure, 138
- Ferranti Argus 200 system, 16-17, 195
- float glass process, 42, 43 (Fig.)
- foreground-background operation, 121
- FORTH, 195
- FORTRAN 163-64, 166, 171, 172, 187, 195
- FORTRAN libraries, 109-10
  
- general embedded systems, 38-9
- general purpose registers, 70
- GOTO statements, 178-9
  
- Hamming code, 407
- hardware, use of redundancy, 401
- hardware and software interface, 22 (Fig.)
- hardware design, 282, 286-7
- hardware failure indication, 89
- hardware systems, reliability, 399-401
- hardware timers, 82
- Harvard architecture, 76
- Hatley and Pirbhai methodology *see* Yourdon methodology
- HDLC, 106
- Hewlett Packard Co., GPIB, 110
- hierarchical systems, 57-61
  - see also* distributed and hierarchical system
- hierarchy topology, 108
- historical background to real-time systems, 15-18
- HOOD, 321, 323, 366
- hot-water supply, control of water temperature, 134 (Fig.), 135
- human-computer interface (HCI), 63-64
- indefinite postponement, 270
- industrial installation of computer system,
  - first, 15
- inferential control, 47, 48 (Fig.)
- information hiding, 214
- information transfer, 71
- initialisation of variables, 164-5
- INMOS, 74-76
- input devices, description, 23
- input image, description, 23
- input/output interface, 23, 72, 77-80
- input/output subsystem *see* IOSS
- integral wind-up action,
  - illustration, 130 (Fig.)
  - techniques for dealing with, 131-37
- Intel XX86 series, 68
- interactive systems, 26, 28
- interface devices, examples, 22
- interfaces, standard, 109-1
  - IEEE 488 bus system, 110
  - ISO seven-layer model, 110 (Table), 111 (Fig.)
  - OSI model, 111
- interpretative interface, 402 (Fig.)
- interrupts, 88-101
  - alarm inputs, 89
  - debugging aids, 90
  - description, 88-9, 90 (Fig.)
  - device handling, 191-3
  - hardware failure indication, 89
  - hardware vectored interrupts, 94-97
  - input mechanisms, 92 (Fig.), 93 (Fig.), 94
  - manual override, 89
  - masking, 98, 99 (Fig.)
  - multi-level interrupts, 98 (Fig.), 99-101
  - power failure warning, 90
  - priority determination, 97
  - real-time clock, 89
  - response mechanisms, 94
  - response vector, 94, 97
  - saving and restoring registers, 90-3
  - servicing routine, (Fig.), 101
  - uses, 89-90
- IOSS, 244-54
  - detailed arrangement, 246 (Fig.)
  - device control block, 246, 247 (Table)
  - device queues and priorities, 252-54
  - example, 248-9
  - general structure, 245 (Fig.), 246
  - input of data, 250-1, 252 (Fig.)
  - system commands for RTOS, 249 (Table)
- Jackson System Development methodology, 321-322-23
- keyboard input, example, 250-1
- laboratory systems, description, 38

- languages,
  - formal specification, list of main ones, 366
  - see also* real-time language
- livelock, description, 269
- liveness, 269-70
- local-area networks *see* transmission of data
- logical devices, description, 214
- loop control, 42, 44-53
  - see also* DDC
- low coupling, 256
  
- M-out-of-N code, 407
- magnetic tape, 71
- manual override, 89
- MASCOT, 276, 321, 353-65, 366, 375
  - access interface, 360, 365
  - ACP diagram, 355 (Fig.)
  - basic features, 354
  - communication methods, 356
  - constants, 362
  - constraints, 362-3
  - context qualifiers, 363
  - data flow, 362
  - development facilities, 363-64
  - direct data visibility, 362
  - example, 355-6
  - general design approach, 356-9
  - MASCOT kernel, 364-5
  - network level diagram 356, 357 (Fig.)
  - paths and ports, 356
  - qualifiers, 362-3
  - status conditions, 363 (Table)
  - summary, 365
  - template constants, 362
  - templates, 354
  - textual representations, 359-61
  - windows, 356
- MASCOT 16, 17, 364-5
- MASCOT 17, 375
- MASCOT virtual machine, 196
- memory, working, 219
- memory access, direct, 72, 86, 101
- memory management, 217, 236-41
  - floating memory, 238
  - non-partitioned memory, 236, 237 (Fig.)
  - partitioned memory, 237 (Fig.), 238
  - task chaining and swapping, 238-40
  - task overlaying, 240 (Fig.)
- memory mapping techniques, 71
- memory protection, 71
- mesh topology, 108
- microcontroller, description, 73
- microprocessor, advent of, 18
- MIMD computer systems, 74, 76 (Fig.)
- minicomputer, 18
- MISD computer architecture, 74, 75 (Fig.)
- mixed mode systems, 37
- model-reference adaptive control, 52 (Fig.), 53
  
- Modula-2, 166-7, 196
  - access to primitives, 187-8
  - advantages and disadvantages, 196
  - concurrency, 190-1
  - constants declaration, 165
  - data type, 172-74
  - DEFINITION MODULE, 170-1, 188-9
  - EXPORT AND IMPORT lists, 170
  - IMPLEMENTATION MODULE, 170
  - independent compilation units, 172
  - interrupts and device handling, 192-3
  - multi-tasking operations, 216
  - nesting of modules, 169-170
  - RTOS creation, 270-76
  - software design - foreground/background system, 292-3
  - syntax layout, 162
  - use of monitor, 310-2
- modularity, 169-71
- modular programs compilation, 171-2
- modulating control *see* loop control
- modules,
  - coupling and cohesion, 283
  - definition, 34
  - nesting, 169-70
  - subdivision, 282, 283, 318
- monitoring of plant, 20
- monitors, 219, 260, 261 (Fig.), 310-3
- Motorola 680XX series, 68
- multi-level interpreter system, 402 (Fig.), 403
- multi-tasking, 216, 217 (Fig.)
  - description and verification, 32-33
  - mutual exclusion, 297-110, 318
  - requirements, 296-7
- multi-user systems, 216 (Fig.)
- multiplexer, description, 83
- mutual exclusion, 254-61, 297-310, 318
  - binary semaphore, 256-58, 259 (Fig.), 260
  - modelling by Petri nets, 380-84, 387
  - semaphores, 301-11
  - use of monitors, 260, 261 (Fig.), 310-3
  - using condition flag, 299-303
  
- names, reuse of, 167-9
- National 32XXX series, 68
- noise, plant input/output signals, 140-2
  
- occam, 76
- operating systems, 212-277
  - general purpose system, 212, 213 (Fig.)
  - general structure, 213-214, 215 (Fig.)
  - minimal system, 213, 214 (Fig.)
- OS/2, 216
- output image, description, 23
- output interface *see* input/output interface
  
- PABX, 107



- PAISLey system, 321, 324, 353, 366–75  
 definition of processes, 368  
 definition of system structure, 367–8  
 description and features, 366–7, 372, 374  
 exchange functions, 371  
 graphical notation, 375 (Fig.)  
 process control example, 367–70  
 specification example, 373–4 (Fig.)  
 state transition diagram, 371–2  
 timing constraints, 371  
 weaknesses, 374–5
- parallel computers, 74, 75 (Fig.), 76  
 parity and error coding checks, 407
- Pascal, 165
- PEARL, 196
- periodic tasks *see* clock-based tasks
- Petri nets, 376–87, 397  
 analysing, 384–7  
 reachability tree, 386, 387 (Fig.)  
 basic ideas, 377–80  
 execution, 379–80  
 firing of transition, 380  
 graph representation, 377  
 marked 378 (Fig.), 379 (Fig.)  
 modelling mutual exclusion, 380–84, 387 (Fig.)  
 preconditions, 387  
 timed, 384
- PI control, 45, 135, 136 (Fig.), 137
- PID algorithm, 145  
 bumpless transfer, 118, 126–29  
 general form, 45  
 implementation, 117–18  
 positional algorithm, 127  
*see also* DDC algorithms
- PID controller, 45–6, 53, 115–6, 146–8  
 plant input and output signals,  
 actuator control, 142, 143 (Fig.)  
 basic division control software, 140, 141 (Fig.)  
 computational delay, 143–44  
 DDC algorithms, 140–44  
 filtering before using analog filter, 141, 142 (Fig.)  
 noise, 140–2
- pointers, 176, 178
- polling, 28, 87–9, 101, 119–20
- pools, 262, 263
- positional algorithm, 127
- power failure warning, 90
- printer queue, 253 (Fig.), 254
- printing devices, output to, 250–2
- priority encoder, 96 (Fig.), 97
- priority structures, 217, 221–26
- PROCEDURE blocks, 166–7
- process plant, definition, 34
- process specifications, 334, 337
- process-related interfaces, 76–86  
 analog interfaces, 77, 83–85  
 analog quantities, 77  
 digital quantities, 77  
 digital signal interfaces, 77–81  
 pulse interfaces, 77, 81–3  
 pulses and pulse rates, 77  
 real-time clock, 85–6  
 telemetry, 77
- program, definition, 34
- program classification, 31–33
- programmable logic controllers, 42, 44
- programmed adaptive control, 50, 51 (Fig.)
- programming errors, detection, 157
- PROM, 71
- protocol, 106
- pseudo-code, 337
- pseudo-concurrent system, 24
- pulse interfaces, 77, 81–3
- pulse width modulation (PWM), 82
- RAM, 71
- re-entrant code, 242, 243–44 (Figs)
- READ (INPUT) timing diagram, 79 (Fig.)
- real-time language, 155–211  
 application-oriented software, 196–202  
 application languages, 202  
*see also* CUTLASS  
 main approaches, 197–202  
 block-structured software, 200–2  
 table-driven approach, 197, 198–200
- BASIC *see* BASIC
- concurrency, 193–94
- constants declaration, 165–6
- control structures, 177 (Fig.), 178–80
- coroutines, 190–1
- CUTLASS *see* separate entry
- data types, 172–78
- declarations, 163–4
- errors *see* separate entry
- exception handling, 181–86
- global and local declaration of entities, 167–9
- initialisation of variables, 164–5
- low-level facilities, 186–9
- modular programs compilation, 171–2
- overview, 195–6
- requirements, 156–60
- run-time support, 194–5
- scope and visibility, 166–7, 169–171
- syntax layout and readability, 160–2
- real-time program, 26, 43
- recovery blocks, 409–10
- redundancy, 399–401, 409–10
- registers, saving and restoring, 90–3
- reliability, 399–401  
*see also* dependability; faults
- rendezvous, 313–18
- replication checks, 404–5

- requests,
  - buffered, 248, 253 (Fig.)
  - non-buffered, 248, 253 (Fig.), 254
  - overlapping, 247-8
- requirements dictionary *see* data dictionary
- requirements document, 280, 284-6
- resource allocation, 343-45
- resource control - input/output subsystem *see* IOSS
- resource sharing, 274-5 (Fig.), 276
- RETURN and EXIT statements, 179-80
- reversal checks, 407
- Rex architecture, 276
- ring topology, 108-9
- RISC, 68
- ROM, 71
- RTL/2, bit manipulation, 187
- RW-300 computer, 16, 17
  
- safety-critical applications, 68
- sampling interval, choice, 139-40
- sampling rate, feedback control, 27
- saturation and integral action wind-up, 118, 129-37
- scheduler and real-time clock interrupt handler, 230-36
- scheduling, 317, 387-97
  - constraints, 388-9
  - on-line, 389-95
    - algorithms, 389, 393-95
    - schedulability analysis, 389, 390-3
    - pre-run-time, 389, 395-6
  - strategies,
    - real-time multi-tasking system, 219-21
      - example, 220-21
      - priority structures, 221-26
      - task synchronisation, 396-7
      - task timing notation, 388 (Fig.)
  - scope and visibility, 166-7, 169-171
  - security of language, 157
- SELECT statement, 305
  - use with ELSE, 307
- semaphores, mutual exclusion, 303-13
- sequential programming, description and verification, 32
- serially reusable code, 242
- set point, 20
- shared memory, problems of, 254-6
- signal, definition, 261
- SIMD computer architecture, 74, 75 (Fig.)
- single-chip microcomputers and microcontrollers, 73
- SISD computer architecture, 74, 75 (Fig.)
- software design,
  - basic modules, 287 (Fig.)
  - methodologies, 282, 283
  - module subdivision, 282, 283
  - preliminary design, 287-97
  - foreground/background system, 290, 291 (Fig.), 292-96
    - buffering of parameter input data, 294-5
    - example, 292-93
    - modules showing data storage, 293, 294 (Fig.)
    - multi-tasking approach, 296-97
    - single-program approach, 288-90
  - problems, 33
  - reasons why user should write, 196-7
    - see also* application-oriented software
    - use of redundancy, 401
  - software modelling phases, 322 (Fig.)
  - specialised processors, 74-6
  - specification document, 280, 284-6
  - SR, 196
  - star topology, 107-8
  - state transition diagram, 337, 338 (Fig.), 339 (Fig.)
  - state transition matrix, 337, 338 (Fig.), 340 (Fig.)
  - static redundancy, 400
  - steam boiler control scheme, 46, 47 (Fig.)
  - storage, 71-2
  - structural checks, 407-8
  - structure of system, 218 (Fig.), 219
  - subroutine, problems with sharing, 241 (Fig.), 242
  - supervisory control, 16, 53-55, 56
  - synchronisation between external processes and internal actions, 26-28
  - syntax layout and readability, 160-2
  - system development methodologies, 320-75
    - abstract model production, 320, 321
    - implementation model development, 320
    - implementation process, 321
    - MASCOT *see* separate entry
    - mathematical techniques, 323-4
    - PAISLEY *see* separate entry
    - software modelling phases, 322 (Fig.)
    - summary, 321 (Table)
    - see also* individual methodology, eg CORE
- tagged data, 411-2
- tagged storage, 408
- task, definition, 34
- task activation diagram, 345 (Fig.)
- task chaining and swapping, 238, 239 (Fig.), 240
- task co-operation and communication, 254-69
  - data transfer, 262-69
  - mutual exclusion, 254-61
  - task synchronisation without data transfer, 261-2
- task management, 227-30
  - functions, 227
  - real-time multi-tasking system module, 219
  - task descriptor, 228-30
  - task states, 227 (Fig.), 228, 229 (Table)

- task overlaying, 240 (Fig.)
- tasks, assignment of priority *see* priority structures
- task structure and allocation of tasks, 344-5
- telemetry, 77
- temperature controller, 51
- temperature control loop, 28-30
- time constants, description, 27
- time constraints, 28-31
- Time Out, use of, 316-7
- time slicing, 86
- TOPSY 204, 205, 206
- transmission of data, 102-109
  - asynchronous, 103, 104 (Fig.), 109
  - data transmission links, 102 (Fig.)
  - local-area networks, 106-9
  - parallel digital transmission, 102
  - protocol, 106
  - serial methods, 102
  - stop-start system, 103
  - synchronous, 103, 105 (Fig.), 106, 108-9
  - topologies, 106-9
  - wide-area networks, 106
- transputer, 68
- triple modular redundancy (TMR), 400
- tuning, 137-9
- UNIX, 216
- user interfaces *see* human-computer interface (HCI)
- valves controlling flows, 71
- vapour phase chromatograph, 38
- VDM, 323-24
- velocity algorithm, 128
- VIPER, features, 74
- Voyager spacecraft, 164
- Ward and Mellor method *see* Yourdon methodology
- watch-dog timers, 406
- wide-area networks *see* transmission of data
- Yourdon methodology, 321, 323, 324-51
  - comparison of methodologies, 346 (Table), 347, 350-51
  - description, 324
  - example, 324-27
  - Hatley and Pirbhai method, 345-50
    - architecture model, 349-51
    - requirements model, 345-9
  - Ward and Mellor method, 327-45
    - abstract modelling approach, 327 (Fig.), 328
    - behavioural model, 327-28
    - building implementation model, 341
    - data dictionary, 329-31
    - enhancing model, 341-43
    - essential model, 327, 328
      - behavioural model, 331-34
      - checking, 341
      - environmental model, 328-31
    - flow notations, 329 (Table), 334 (Fig.)
    - implementation model, 328
    - relationship between models and diagrams, 328 (Fig.)
    - resource allocation, 343-45
    - transformations, 331-33, 336, 337-41
- Ziegler-Nichols rules, tuning, 137
- Zilog Z80 and Z8000 series, 68

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