

100	DATA PROCESSING SYSTEM ERROR OR FAULT HANDLING	26	...Artificial intelligence (e.g., diagnostic expert system)
1	.Reliability and availability	27	...Particular access structure
2	..Fault recovery	28	...Substituted emulative component (e.g., emulator microprocessor)
3	...By masking or reconfiguration		
4	....Of network		
5	....Of memory or peripheral subsystem	29	....Memory emulator feature
6	.....Redundant stored data accessed (e.g., duplicated data, error correction coded data, or other parity-type data)	30	....Built-in hardware for diagnosing or testing within- system component (e.g., microprocessor test mode circuit, scan path)
7	.....Reconfiguration (e.g., adding a replacement storage component)	31	....Additional processor for in- system fault locating (e.g., distributed diagnosis program)
8	.....Isolating failed storage location (e.g., sector remapping)	32	...Particular stimulus creation
9	.....Access processor affected (e.g., I/O processor, MMU, DMA processor)	33	...Derived from analysis (e.g., of a specification or by stimulation)
10	....Of processor	34	...Halt, clock, or interrupt signal (e.g., freezing, hardware breakpoint, single- stepping)
11	.....Concurrent, redundantly operating processors	35	...Substituted or added instruction (e.g., code instrumenting, breakpoint instruction)
12	.....Synchronization maintenance of processors		
13	.....Prepared backup processor (e.g., initializing cold backup) or updating backup processor (e.g., by checkpoint message)	36	...Test sequence at power-up or initialization
14	....Of power supply	37	...Analysis (e.g., of output, state, or design)
15	...State recovery (i.e., process or data file)	38	...Of computer software
16	....Forward recovery (e.g., redoing committed action)	39	...Monitor recognizes sequence of events (e.g., protocol or logic state analyzer)
17	.....Reexecuting single instruction or bus cycle	40	...Component dependent technique
18	....Transmission data record (e.g., for retransmission)	41	...For reliability enhancing component (e.g., testing backup spare, or fault injection)
19	....Undo record	42	...Memory or storage device component fault
20	....Plural recovery data sets containing set interrelation data (e.g., time values or log record numbers)	43	...Bus, I/O channel, or network path component fault
21	....State validity check	44	...Peripheral device component fault
22	....With power supply status monitoring	45	...Output recording (e.g., signature or trace)
23	...Resetting processor	46	...Operator interface for diagnosing or testing
24	...Safe shutdown	47	..Performance monitoring for fault avoidance
25	..Fault locating (i.e., diagnosis or testing)	48	..Error detection or notification

49	...State error (i.e., content of instruction, data, or message)	724	.Digital logic testing
50	....State out of sequence	725	..Programmable logic array (PLA) testing
51	.....Control flow state sequence monitored (e.g., watchdog processor for control-flow checking)	726	..Scan path testing (e.g., level sensitive scan design (LSSD))
52	.....Error checking code	727	...Boundary scan
53	....Address error	728	...Random pattern generation (includes pseudorandom pattern)
54	....Storage content error	729	...Plural scan paths
55	...Timing error (e.g., watchdog timer time-out)	730	...Addressing
56	....Bus or I/O channel device fault	731	...Clock or synchronization
57	..Error forwarding and presentation (e.g., operator console, error display)	732	..Signature analysis
699	PULSE OR DATA ERROR HANDLING	733	..Built-in testing circuit (BILBO)
700	.Skew detection correction	734	..Structural (in-circuit test)
701	.Data formatting to improve error detection correction capability	735	..Device response compared to input pattern
702	..Memory access (e.g., address permutation)	736	..Device response compared to expected fault-free response
703	.Testing of error-check system	737	..Device response compared to fault dictionary/truth table
704	.Error count or rate	738	..Including test pattern generator
705	..Pseudo-error rate	739	...Random pattern generation (includes pseudorandom pattern)
706	..Up-down counter	740	...Having analog signal
707	..Synchronization control	741	...Simulation
708	..Shutdown or establishing system parameter (e.g., transmission rate)	742	...Testing specific device
709	.Data pulse evaluation/bit decision	743	...Addressing
710	.Replacement of memory spare location, portion, or segment	744	...Clock or synchronization
711	..Spare row or column	745	..Determination of marginal operation limits
712	.Transmission facility testing	746	.Digital data error correction
713	..For channel having repeater	747	..Substitution of previous valid data
714	..By tone signal	748	..Request for retransmission
715	..Test pattern with comparison	749	...Retransmission if no ACK returned
716	...Loop-back	750	...Feedback to transmitter for comparison
717	..Loop or ring configuration	751	...Including forward error correction capability
718	.Memory testing	752	..Forward correction by block code
719	..Read-in with read-out and compare	753	...Double error correcting with single error correcting code
720	...Special test pattern (e.g., checkerboard, walking ones)	754	...Error correction during refresh cycle
721	..Electrical parameter (e.g., threshold voltage)	755	...Double encoding codes (e.g., product, concatenated)
722	..Performing arithmetic function on memory contents		
723	..Error mapping or logging		

756	....Cross-interleave Reed-Solomon code (CIRC)	791	...Sequential decoder (e.g., Fano or stack algorithm)
757	...Parallel generation of check bits	792	...Trellis code
758	...Error correcting code with additional error detection code (e.g., cyclic redundancy character, parity)	793	...Syndrome decodable (e.g., self orthogonal)
759	...Look-up table encoding or decoding	794	...Maximum likelihood
760	...Threshold decoding (e.g., majority logic)	795	...Viterbi decoding
761	...Random and burst error correction	796	...Branch metric calculation
762	...Burst error correction	797	..Majority decision/voter circuit
763	...Memory access	798	.Error detection for synchronization control
764	....Error correct and restore	799	.Error/fault detection technique
765	....Error pointer	800	..Parity bit
766	....Check bits stored in separate area of memory	801	...Parity generator or checker circuit detail
767	....Code word for plural n-bit (n>1) storage units (e.g., x4 DRAM's)	802	...Even and odd parity
768	....Error correction code for memory address	803	...Parity prediction
769	....Dynamic data storage	804	...Plural dimension parity check
770	.....Disk array	805	...Storage accessing (e.g., address parity check)
771	.....Tape	806	..Constant-ratio code (m/n)
772	....Code word parallel access	807	..Check character
773	....Solid state memory	808	...Modulo-n residue check character
774	...Adaptive error-correcting capability	809	..Code constraint monitored
775	...Synchronization	810	...Multilevel coding (n>2)
776	...For packet or frame multiplexed data	811	..Forbidden combination or improper condition
777	...Hamming code	812	...Specified digital signal or pulse count
778	...Nonbinary data (e.g., ternary)	813	...Two key-down detector
779	...Variable length data	814	...Data timing/clocking
780	..Using symbol reliability information (e.g., soft decision)	815	...Time delay/interval monitored
781	...Code based on generator polynomial	816	...Two-rail logic
782	....Bose-Chaudhuri-Hocquenghem code	817	...Noise level
783	....Golay code	818	...Missing-bit/drop-out detection
784	....Reed-Solomon code	819	..Comparison of data
785	....Syndrome computed	820	...Plural parallel devices of channels
786	..Forward error correction by tree code (e.g., convolutional)	821	....Transmission facility
787	...Random and burst errors	822	...Sequential repetition
788	...Burst error	823	....True and complement data
789	...Synchronization	824	...Device output compared to input
790	...Puncturing		

714E000 1 E-SUBCLASSES**
714E11001 1 ERROR DETECTION;
ERROR CORRECTION; MONITORING
(EPO)

The following subclasses beginning with the letter E are E-subclasses. Each E-subclass corresponds in scope to a classification in a foreign classification system, for example, the European Classification system (ECLA). The foreign classification equivalent to an E-subclass is identified in the subclass definition. In addition to U.S. documents classified in E-subclasses by U.S. examiners, documents are regularly classified in E-subclasses according to the classification practices of any foreign Offices identified in parentheses at the end of the title. For example, "(EPO)" at the end of a title indicates both European and U.S. patent documents, as classified by the EPO, are regularly added to the subclass. E-subclasses may contain subject matter outside the scope of this class. Consult the E-subclass definitions, or the documents themselves, to clarify or interpret titles.

- E11.002 .Error detection other than by redundancy in data representation, operation, or hardware, or by checking the order of processing (EPO)
- E11.003 ..By time limit, i.e., time-out (EPO)
- E11.004 ..By count or rate limit, e.g., word- or bit count limit, etc. (EPO)
- E11.005 ..By other limits, e.g., analog values, etc. (EPO)
- E11.006 ..By bit configuration check, e.g., of formats or tags, etc. (EPO)
- E11.007 .Error correction, recovery or fault tolerance using at least two different redundancy techniques and at least one technique not involving redundancy (EPO)
- E11.008 ..Fault tolerant software (EPO)
- E11.009 ..In regular structures, i.e., all of the systems nodes have the same number of connections per node (EPO)
- E11.01 ...Interconnection networks, i.e., comprising interconnecting link and switching elements (EPO)
- E11.011 ...Fault-tolerant routing (EPO)
- E11.012 ...In rings and buses (EPO)
- E11.013 ...In n-dimensional structures, e.g., arrays, trees, cubes, etc. (EPO)
- E11.014 ...Neural networks (EPO)
- E11.015 ..By degradation, i.e., a slow-down occurs but full processing capability is maintained, e.g., discarding a faulty element or unit, etc. (EPO)
- E11.016 ..In systems, e.g., multiprocessors, etc. (EPO)
- E11.017 .Security measures, i.e., ensuring safe condition in the event of error, e.g., for controlling element (EPO)
- E11.018 .Protecting against parasitic influences, e.g., noise, temperatures, etc. (EPO)
- E11.019 .Identification, e.g., of a performed repair, of a defined circuit, etc. (EPO)
- E11.02 .Reliability or availability analysis (EPO)
- E11.021 .Responding to the occurrence of a fault, e.g., fault tolerance, etc. (EPO)
- E11.022 ..Error or fault processing without redundancy, i.e., by taking additional measures to deal with the error/fault (EPO)
- E11.023 ...Error or fault handling (EPO)
- E11.024 ...Error or fault detection or monitoring (EPO)
- E11.025 ...Error or fault reporting or logging (EPO)
- E11.026 ...Error or fault localization (EPO)
- E11.027 ...By collation, i.e., correlating different errors (EPO)
- E11.028 ...By identifying the faulty software code (EPO)
- E11.029 ...Error or fault analysis (EPO)
- E11.03 ..Error detection or correction by redundancy in data representation, e.g., by using checking codes, etc. (EPO)
- E11.031 ...Using codes with inherent redundancy, e.g., n-out-of-m codes (EPO)

- E11.032 ...Adding special bits or symbols to the coded information, e.g., parity check, casting out 9's or 11's, etc. (EPO)
- E11.033Using arithmetic codes i.e., codes which are preserved during operation, e.g., modulo 9 or 11 check, etc. (EPO)
- E11.034In memories (EPO)
- E11.035In static stores (EPO)
- E11.036Integrated on a chip (EPO)
- E11.037In cache or content addressable memories (EPO)
- E11.038In sector programmable memories, e.g., flash disk, etc. (EPO)
- E11.039In multilevel memories (EPO)
- E11.04To protect a block of data words, e.g., CRC, checksum, etc. (EPO)
- E11.041To protect individual data words written into, or read out of, the addressable memory subsystem of data processing equipment (EPO)
- E11.042Codes or arrangements adapted for a specific type of error (EPO)
- E11.043Error in accessing a memory location, i.e., addressing error (EPO)
- E11.044Error in check bits (EPO)
- E11.045Identification of the type of error (EPO)
- E11.046Adjacent error, e.g., error in n-bit ($n > 1$) wide storage units, i.e., package error, etc. (EPO)
- E11.047Simple parity (EPO)
- E11.048Unidirectional errors (EPO)
- E11.049Arrangements adapted for a specific error detection or correction feature (EPO)
- E11.05Bypassing or disabling error detection or correction (EPO)
- E11.051Updating check bits on partial write, i.e., read/modify/write (EPO)
- E11.052Correcting systematically all correctable errors, i.e., scrubbing (EPO)
- E11.053Using single parity bit (EPO)
- E11.054 ..Error detection or correction of the data by redundancy in hardware (EPO)
- E11.055 ...Error detection by comparing the output signals of redundant hardware (EPO)
- E11.056In static storage, e.g., matrix, registers, etc. (EPO)
- E11.057In coding, decoding circuits, e.g. parity circuits (EPO)
- E11.058In communications, e.g., transmission, interfaces, etc. (EPO)
- E11.059Control processors, e.g., for sensors, actuators, etc. (EPO)
- E11.06With exchange of data between units (EPO)
- E11.061With data processors, i.e., data processors compare their computations (EPO)
- E11.062In storage with relative movement between record carrier and transducer, e.g., tapes, disks, etc. (EPO)
- E11.063In systems, i.e. comprising a multiplicity of resources, e.g., cpu with its memory and I/O, etc. (EPO)
- E11.064In arithmetic, logic or counter circuits or a combination thereof, e.g., alu, adder, etc. (EPO)
- E11.065In I/O devices or adapters therefor (EPO)
- E11.066Displays (EPO)
- E11.067 ...Timing and synchronization therein (EPO)
- E11.068By using fault tolerant clocks (EPO)
- E11.069 ...Using passive fault-masking of the redundant circuits, e.g., by quadding or by majority decision circuits, etc. (EPO)
- E11.07Synchronization therefor (EPO)
- E11.071 ...Using active fault-masking, e.g., by switching out faulty elements or by switching in spare elements, etc. (EPO)
- E11.072In systems, e.g., multiprocessors, etc. (EPO)
- E11.073In distributed systems (EPO)
- E11.074In regular structures (EPO)
- E11.075Array of processors, e.g., systolic arrays, etc. (EPO)

- E11.076Hypercubes (EPO)
 E11.077Trees (EPO)
 E11.078In interconnections, e.g., rings, etc. (EPO)
 E11.079Bus (EPO)
 E11.08Data exchange between units, e.g., for updating backup units, etc. (EPO)
 E11.081For control, e.g., actuators, etc. (EPO)
 E11.082In arithmetic units (EPO)
 E11.083Redundant power supplies (EPO)
 E11.084Masking faults in storage systems using spares and/or by reconfiguring (EPO)
 E11.085Removing defective units from operation (EPO)
 E11.086Bypassing defective units on a serial bus (EPO)
 E11.087With address translations and modifications (EPO)
 E11.088Handling defects in a Redundant Array of Inexpensive Disks (RAID) by remapping (EPO)
 E11.089Managing spare storage units (EPO)
 E11.09Hot spares (EPO)
 E11.091Via redundancy in hardware accessing the storage components (EPO)
 E11.092Using redundant I/O processors, storage control units or array controllers (EPO)
 E11.093With serial buses (EPO)
 E11.094To file servers (EPO)
 E11.095Connection redundancy between storage system components (EPO)
 E11.096With serial buses (EPO)
 E11.097To file servers (EPO)
 E11.098Using the replication of data, e.g., with two or more copies, etc. (EPO)
 E11.099Duplex memories, e.g., twin boot ROMs, etc. (EPO)
 E11.1Duplexed caches, e.g., cache paired with non-volatile storage, etc. (EPO)
 E11.101Mirroring, i.e., the concept of maintaining data on two or more units in the same state at all times (EPO)
 E11.102Resynchronization of failed mirrors (EPO)
 E11.103Mirror management, e.g., pairing of units, etc. (EPO)
 E11.104Mirroring on the same storage unit (EPO)
 E11.105Mirroring on different storage units with a common controller (RAID 1) (EPO)
 E11.106Mirroring with multiple controllers (EPO)
 E11.107Asynchronous mirroring (EPO)
 E11.108Synchronous mirroring (EPO)
 E11.109De-clustering of replicated data (EPO)
 E11.11Using more than two copies (EPO)
 E11.111In Logic Arrays, e.g., programmable or iterative logic arrays, etc. (EPO)
 E11.112 ..Error detection or correction of the data by redundancy in operation (EPO)
 E11.113 ...Saving, restoring, recovering or retrying (EPO)
 E11.114At machine instruction level (EPO)
 E11.115Checkpointing the instruction stream (EPO)
 E11.116For bus or memory accesses (EPO)
 E11.117Of application data (EPO)
 E11.118Backing up, restoring or mirroring files or drives (EPO)
 E11.119Backing up, i.e., point-in-time backup (EPO)
 E11.12Hardware arrangements for backup (EPO)
 E11.121Backup Management techniques (EPO)
 E11.122Recovery techniques (EPO)
 E11.123Selection of contents (EPO)
 E11.124Scheduling policy (EPO)
 E11.125For networked environments (EPO)
 E11.126Nondisruptive backup (EPO)
 E11.127Mirroring (EPO)
 E11.128Distributed database systems; Replica control (EPO)

- E11.129Synchronization between mobile agents and networked agents (EPO)
- E11.13Using logs or checkpoints (EPO)
- E11.131In transactions (EPO)
- E11.132At operating system level (EPO)
- E11.133Boot up procedures (EPO)
- E11.134Reconfiguring to eliminate the error (EPO)
- E11.135During software upgrading (EPO)
- E11.136At file system or disk access level (EPO)
- E11.137Restarting or rejuvenating (EPO)
- E11.138Resetting or repowering (EPO)
- E11.139Cleaning up resources (EPO)
- E11.14Suspending and resuming a running system (EPO)
- E11.141Transmit or communication errors (EPO)
- E11.142 ...Error detection (EPO)
- E11.143 ...By time redundancy (EPO)
- E11.144 .Error avoidance, e.g., error spreading countermeasures, fault avoidance, etc. (EPO)
- E11.145 .Detection or location of defective computer hardware by testing during standby operation or during idle time, e.g., start-up testing, etc. (EPO)
- E11.146 ..Verification or detection of system hardware configuration (EPO)
- E11.147 ..Logging of test results (EPO)
- E11.148 ..Test methods (EPO)
- E11.149 ...Power-On Test, e.g., POST, etc. (EPO)
- E11.15Configuration test (EPO)
- E11.151 ...Background testing (EPO)
- E11.152 ...Periodic testing (EPO)
- E11.153 ...Test trigger logic (EPO)
- E11.154 ..Marginal checking (EPO)
- E11.155 ..Testing of logic operation, e.g., by logic analyzers, etc. (EPO)
- E11.156 ...Using Fault Dictionaries (EPO)
- E11.157 ...Using Expert Systems (EPO)
- E11.158 ...Using Neural Networks (EPO)
- E11.159 ..Functional testing (EPO)
- E11.16 ...Reconfiguring circuits for testing, e.g., LSSD, partitioning, etc. (EPO)
- E11.161Test of buses, lines or interfaces, e.g., stuck-at or open line faults, etc. (EPO)
- E11.162Test or error correction or detection circuits (EPO)
- E11.163Test of input/output devices or peripheral units (EPO)
- E11.164Test of ALU (EPO)
- E11.165Test of interrupt circuits (EPO)
- E11.166Test of CPU or processors (EPO)
- E11.167 ...By simulating additional hardware, e.g., fault simulation, (EPO)
- E11.168Emulators (EPO)
- E11.169 ...Built-in tests (EPO)
- E11.17 ...Tester hardware, i.e., output processing circuits, etc. (EPO)
- E11.171Test interface between tester and unit under test (EPO)
- E11.172Using a storage for the test inputs, e.g., test-ROM, script files, etc. (EPO)
- E11.173Remote test (EPO)
- E11.174Using a dedicated service processor for test (EPO)
- E11.175With comparison between actual response and known fault-free response, e.g., signature analyzer, etc. (EPO)
- E11.176In Multi-processor systems, e.g., one processor becoming the test master, etc. (EPO)
- E11.177 ...Generation of test inputs, e.g., test vectors, patterns or sequences, etc. (EPO)
- E11.178 .By checking the correct order of processing (EPO)
- E11.179 .Monitoring (EPO)
- E11.18 ..With visual or acoustical indication of the functioning of the machine (EPO)
- E11.181 ...Visualization of programs or trace data (EPO)
- E11.182 ...Display for diagnostics, e.g., diagnostic result display, self-test user interface, etc. (EPO)
- E11.183Display of waveforms, e.g., of logic analyzers, etc. (EPO)

E11.184 ...Display of status information (EPO)
 E11.185By lamps or LED's (EPO)
 E11.186For error or online/offline status (EPO)
 E11.187Alarm or error message display (EPO)
 E11.188Computer systems status display (EPO)
 E11.189 ..Recording or statistical evaluation of computer activity, e.g., of down time, of input/output operation, etc. (EPO)
 E11.19 ...Of interconnections, e.g., interconnecting networks, etc. (EPO)
 E11.191 ...Of parallel or distributed programming (EPO)
 E11.192 ...Performance measurement (EPO)
 E11.193Workload generation, e.g., scripts, playback etc. (EPO)
 E11.194Benchmarking (EPO)
 E11.195Time measurement, e.g., response time, etc. (EPO)
 E11.196Of active or idle time (EPO)
 E11.197 ...Performance evaluation by modeling or statistical analysis (EPO)
 E11.198 ...Performance evaluation by simulation (EPO)
 E11.199Trace driven simulation (EPO)
 E11.2 ...Performance evaluation by tracing or monitoring (EPO)
 E11.201For interfaces, buses (EPO)
 E11.202For systems (EPO)
 E11.203Address tracing (EPO)
 E11.204Data logging (EPO)
 E11.205Circuit details, i.e., tracer hardware (EPO)
 E11.206For I/O devices (EPO)
 E11.207 .Preventing errors by testing or debugging software (EPO)
 E11.208 ..Software debugging (EPO)
 E11.209 ...Compilers or other tools operating on the source text (EPO)
 E11.21 ...Debuggers (EPO)
 E11.211 ...Error checking code in the program under test (EPO)
 E11.212 ...Tracing methods or tools (EPO)
 E11.213 ...By using additional hardware (EPO)
 E11.214By making modifications to the CPU (EPO)

E11.215By monitoring the bus (EPO)
 E11.216By emulating the CPU (EPO)
 E11.217 ..User interfaces for testing or debugging software (EPO)
 E11.218 ..Methods or tools for writing reliable software and for evaluating software (EPO)
 E11.219 ...Methods or tools to render software testable (EPO)
 E11.22 ...Software metrics (EPO)

FOREIGN ART COLLECTIONS**FOR 000 CLASS-RELATED FOREIGN DOCUMENTS**

Any foreign patents or non-patent literature from subclasses that have been reclassified have been transferred directly to FOR Collections listed below. These Collections contain ONLY foreign patents or non-patent literature. The parenthetical references in the Collection titles refer to the abolished subclasses from which these Collections were derived.

MEMORY TESTING (371/21.1)**DIGITAL LOGIC TESTING (371/22.1)****DIGITAL DATA ERROR CORRECTION (371/30)**

FOR 100 .Scan path testing (LSSD) (371/22.3)
 FOR 101 .Including test pattern generator (371/27)
 FOR 102 .Block code (371/37.1)
 FOR 103 ..Memory access (371/40.1)
 FOR 104 .Convolutional code (371/43)
 FOR 288 **ERROR/FAULT ANTICIPATION (371/4)**
 .Replacement with spare device or system (371/8.1)
 FOR 289 ..Transmission facility or channel (371.8.2)
 FOR 290 ..Memory (371/10.1)
 FOR 291 ..Transmission facility (371/11.2)
 FOR 292 ..Data processor or computer (371/11.3)
DIAGNOSTIC TESTING (371/15.1)
 FOR 293 .Programmable processor testing (371/16.1)
 FOR 294 ..Emulator device (371/16.2)

- FOR 295 ..Watchdog timer (e.g., time-out)
(371/16.3)
- FOR 296 ..Processor within diverse
(microwave, photocopier) (371/
16.4)
- FOR 297 ..Error or fault, logging or
tracking (371/16.5)
- FOR 298 ..Dedicated maintenance subsystem
(371/18)
- FOR 299 .Testing of external device by
programmable digital computer
(371/20)
- FOR 300 **ERROR DETECTION FOR
SYNCHRONIZATION CONTROL (371/
47.1)**

