

3. A dispersive delay of more than 10 microseconds;
  2. Bulk (volume) acoustic wave devices (i.e., "signal processing" devices employing elastic waves) which permit direct processing of signals at frequencies exceeding 1 GHz;
  3. Acoustic-optic "signal processing" devices employing interaction between acoustic waves (bulk wave or surface wave) and light waves which permit the direct processing of signals or images, including spectral analysis, correlation or convolution;
- NOTE:**  
1031.1.c.3. does not embargo devices specially designed for civil television, video or AM and FM broadcasting equipment.
1031. 1. d. Electronic devices or circuits containing components, manufactured from "superconductive" materials specially designed for operation at temperatures below the "critical temperature" of at least one of the "superconductive" constituents, with any of the following:
1. Electromagnetic amplification:
    - a. At frequencies equal to or less than 31 GHz with a noise figure of less than 0.5 dB; *or*
    - b. At frequencies exceeding 31 GHz;
  2. Current switching for digital circuits using "superconductive" gates with a product of delay time per gate (in seconds) and power dissipation per gate (in watts) of less than  $10^{-14}$  J; *or*
  3. Frequency selection at all frequencies using resonant circuits with Q-values exceeding 10,000;
1031. 1. e. High energy devices, as follows:
1. Batteries, as follows:
 

**NOTE:**  
1031.1.e.1. does not embargo batteries with volumes equal to or less than  $26 \text{ cm}^3$  (e.g., standard C-cells or UM-2 batteries).

    1. a. Primary cells and batteries having an energy density exceeding 350 Wh/kg and rated for operation in the temperature range from below 243 K (-30°C) to above 343 K (70°C);
    1. b. Rechargeable cells and batteries having an energy density exceeding 150 Wh/kg after 75 charge/discharge cycles at a discharge current equal to C/5 hours (C being the nominal capacity in ampere hours) when operating in the temperature range from below 253 K (-20°C) to above 333 K (60°C);
 

**Technical Note:**  
Energy density is obtained by multiplying the average power in watts (average voltage in volts times average current in amperes) by the duration of the discharge in hours to 75% of the open circuit voltage divided by the total mass of the cell (or battery) in kg.
  1. c. "Space qualified" and radiation hardened photovoltaic arrays with a specific power exceeding  $160 \text{ W/m}^2$  at an operating temperature of 301 K (28°C) under a tungsten illumination of  $1 \text{ kW/m}^2$  at 2,800 K (2,527°C);
1031. 1. e. 2. High energy storage capacitors, as follows:
- a. Capacitors with a repetition rate of less than 10 Hz (single shot capacitors) having all of the following:
    1. A voltage rating equal to or more than 5 kV;
    2. An energy density equal to or more than 250 J/kg; *and*
    3. A total energy equal to or more than 25 kJ;
  - b. Capacitors with a repetition rate of 10 Hz or more (repetition rated capacitors) having all of the following:
    1. A voltage rating equal to or more than 5 kV;
    2. An energy density equal to or more than 50 J/kg;
    3. A total energy equal to or more than 100 J; *and*
    4. A charge/discharge cycle life equal to or more than 10,000;
1031. 1. e. 3. "Superconductive" electromagnets or solenoids specially designed to be fully charged or discharged in less than one minute, having all of the following:
- NOTE:**  
1031.1.e.3. does not embargo "superconductive" electromagnets or solenoids specially designed for Magnetic Resonance Imaging (MRI) medical equipment.
- a. Maximum energy delivered during the discharge divided by the duration of the discharge of more than 500 kJ per minute;
  - b. Inner diameter of the current carrying windings of more than 250 mm; *and*
  - c. Rated for a magnetic induction of more than 8 T or "overall current density" in the winding of more than  $300 \text{ A/mm}^2$ ;
1031. 1. e. 4. Circuits or systems for electromagnetic energy storage, containing components manufactured from "superconductive" materials specially designed for operation at temperatures below the "critical temperature" of at least one of their "superconductive" constituents, having all of the following:
- a. Resonant operating frequencies exceeding 1 MHz;
  - b. A stored energy density of  $1 \text{ MJ/m}^3$  or more; *and*
  - c. A discharge time of less than 1 ms;
1031. 1. e. 5. Flash discharge type X-ray systems, including tubes, having all of the following:
- a. A peak power exceeding 500 MW;
  - b. An output voltage exceeding 500 kV; *and*
  - c. A pulse width of less than 0.2 microsecond;
1031. 1. f. Rotary input type shaft absolute position encoders having either of the following:
1. A resolution of better than 1 part in 265,000 (18 bit resolution) of full scale; *or*
  2. An accuracy better than  $\pm 2.5$  seconds of arc;
1031. 2. General purpose electronic equipment:
- a. Recording equipment, as follows, and specially designed test tape therefor:
    1. Analogue instrumentation magnetic tape recorders, including those permitting the recording of digital signals (e.g., using a high density digital recording (HDDR) module), having any of the following:
      - a. A bandwidth exceeding 4 MHz per electronic channel or track;
      - b. A bandwidth exceeding 2 MHz per electronic channel or track and having more than 42 tracks; *or*
      - c. A time displacement (base) error, measured in accordance with applicable IRIG or EIA documents, of less than  $\pm 0.1$  microsecond;
    2. Digital video magnetic tape recorders having a maximum digital interface transfer rate exceeding 180 Mbit/s, *except* those specially designed for television recording as standardized or recommended by the CCIR or the IEC for civil television applications;
    3. Digital instrumentation magnetic tape data recorders having any of the following characteristics:
      - a. A maximum digital interface transfer rate exceeding 60 Mbit/s and employing helical scan techniques;
      - b. A maximum digital interface transfer rate exceeding 120 Mbit/s and employing fixed head techniques; *or*
      - c. "Space qualified";

**NOTE:**  
1031.2.a.3 does not embargo analogue magnetic tape recorders equipped with HDDR conversion electronics and configured to record only digital data.
    4. Equipment, with a maximum digital interface transfer rate exceeding 60 Mbit/s, designed to convert digital video magnetic tape recorders for use as digital instrumentation data recorders;
  - b. "Frequency synthesiser" "assemblies" having a "frequency switching time" from one selected frequency to another of less than 1 ms;
  - c. "Signal analysers", as follows:
    1. Capable of analysing frequencies exceeding 31 GHz;
    2. "Dynamic signal analysers" with a "real-time bandwidth" exceeding 25.6 kHz, *except* those using only constant percentage bandwidth filters (also known as octave or fractional octave filters);
  - d. Frequency synthesized signal generators producing output frequencies, the accuracy and short-term and long-term stability of which are controlled, derived from or