

**Note 1:** 3A001.b.1 does not control tubes designed or rated for operation in any frequency band which meets all of the following characteristics:

- (a) Does not exceed 31 GHz; and
- (b) Is "allocated by the ITU" for radio-communications services, but not for radio-determination.

**Note 2:** 3A001.b.1 does not control non-"space-qualified" tubes which meet all the following characteristics:

- (a) An average output power equal to or less than 50 W; and
- (b) Designed or rated for operation in any frequency band which meets all of the following characteristics:
  - (1) Exceeds 31 GHz but does not exceed 43.5 GHz; and
  - (2) Is "allocated by the ITU" for radio-communications services, but not for radio-determination.
    - b.1.a. Traveling wave tubes, pulsed or continuous wave, as follows:
      - b.1.a.1. Operating at frequencies exceeding 31 GHz;
      - b.1.a.2. Having a cathode heater element with a turn on time to rated RF power of less than 3 seconds;
      - b.1.a.3. Coupled cavity tubes, or derivatives thereof, with a "fractional bandwidth" of more than 7% or a peak power exceeding 2.5 kW;
      - b.1.a.4. Helix tubes, or derivatives thereof, with any of the following characteristics:
        - b.1.a.4.a. An "instantaneous bandwidth" of more than one octave, and average power (expressed in kW) times frequency (expressed in GHz) of more than 0.5;
        - b.1.a.4.b. An "instantaneous bandwidth" of one octave or less, and average power (expressed in kW) times frequency (expressed in GHz) of more than 1; or
        - b.1.a.4.c. Being "space qualified";
        - b.1.b. Crossed-field amplifier tubes with a gain of more than 17 dB;
    - b.1.c. Impregnated cathodes designed for electronic tubes producing a continuous emission current density at rated operating conditions exceeding 5 A/cm<sup>2</sup>;
    - b.2. Microwave integrated circuits or modules having all of the following:
      - b.2.a. Containing "monolithic integrated circuits" having one or more active circuit elements; and
      - b.2.b. Operating at frequencies above 3 GHz;

**Note 1:** 3A001.b.2 does not control circuits or modules for equipment designed or rated to operate in any frequency band which meets all of the following characteristics:

- (a) Does not exceed 31 GHz; and
- (b) Is "allocated by the ITU" for radio-communications services, but not for radio-determination.

**Note 2:** 3A001.b.2 does not control broadcast satellite equipment designed or rated to operate in the frequency range of 40.5 to 42.5 GHz.

- b.3. Microwave transistors rated for operation at frequencies exceeding 31 GHz;
- b.4. Microwave solid state amplifiers, having any of the following:
  - b.4.a. Operating frequencies exceeding 10.5 GHz and an "instantaneous bandwidth" of more than half an octave; or

- b.4.b. Operating frequencies exceeding 31 GHz;

- b.5. Electronically or magnetically tunable band-pass or band-stop filters having more than 5 tunable resonators capable of tuning across a 1.5:1 frequency band ( $f_{\max}/f_{\min}$ ) in less than 10  $\mu$ s having any of the following:
  - b.5.a. A band-pass bandwidth of more than 0.5% of center frequency; or
  - b.5.b. A band-stop bandwidth of less than 0.5% of center frequency;

- b.6. Microwave "assemblies" capable of operating at frequencies exceeding 31 GHz;

- b.7. Mixers and converters designed to extend the frequency range of equipment described in 3A002.c, 3A002.e or 3A002.f beyond the limits stated therein;

- b.8. Microwave power amplifiers containing tubes controlled by 3A001.b and having all of the following:
  - b.8.a. Operating frequencies above 3 GHz;
  - b.8.b. An average output power density exceeding 80 W/kg; and
  - b.8.c. A volume of less than 400 cm<sup>3</sup>;

**Note:** 3A001.b.8 does not control equipment designed or rated for operation in any frequency band which is "allocated by the ITU" for radio-communications services, but not for radio-determination.

- c. Acoustic wave devices, as follows, and specially designed components therefor:

- c.1. Surface acoustic wave and surface skimming (shallow bulk) acoustic wave devices (*i.e.*, "signal processing" devices employing elastic waves in materials), having any of the following:
  - c.1.a. A carrier frequency exceeding 2.5 GHz;

- c.1.b. A carrier frequency exceeding 1 GHz, but not exceeding 2.5 GHz, and having any of the following:
  - c.1.b.1. A frequency side-lobe rejection exceeding 55 dB;
  - c.1.b.2. A product of the maximum delay time and the bandwidth (time in  $\mu$ s and bandwidth in MHz) of more than 100;
  - c.1.b.3. A bandwidth greater than 250 MHz; or
  - c.1.b.4. A dispersive delay of more than 10  $\mu$ s; or

- c.1.c. A carrier frequency of 1 GHz or less, having any of the following:
  - c.1.c.1. A product of the maximum delay time and the bandwidth (time in  $\mu$ s and bandwidth in MHz) of more than 100;
  - c.1.c.2. A dispersive delay of more than 10  $\mu$ s; or
  - c.1.c.3. A frequency side-lobe rejection exceeding 55 dB and a bandwidth greater than 50 MHz;

- c.2. Bulk (volume) acoustic wave devices (*i.e.*, "signal processing" devices employing elastic waves) that permit the direct processing of signals at frequencies exceeding 1 GHz;

- c.3. Acoustic-optic "signal processing" devices employing interaction between acoustic waves (bulk wave or surface wave) and light waves that permit the direct processing of signals or images, including spectral analysis, correlation or convolution;

- d. Electronic devices and 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:

- d.1. 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

- d.2. Frequency selection at all frequencies using resonant circuits with Q-values exceeding 10,000;

- e. High energy devices, as follows:

- e.1. Batteries and photovoltaic arrays, as follows:

**Note:** 3A001.e.1 does not control batteries with volumes equal to or less than 27 cm<sup>3</sup> (*e.g.*, standard C-cells or R14 batteries).

- e.1.a. Primary cells and batteries having an energy density exceeding 480 Wh/kg and rated for operation in the temperature range from below 243 K ( $-30^{\circ}\text{C}$ ) to above 343 K ( $70^{\circ}\text{C}$ );

- e.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  $\odot$  being the nominal capacity in ampere hours) when operating in the temperature range from below 253 K ( $-20^{\circ}\text{C}$ ) to above 333 K ( $60^{\circ}\text{C}$ );

**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.

- e.1.c. "Space qualified" and radiation hardened photovoltaic arrays with a specific power exceeding 160 W/m<sup>2</sup> at an operating temperature of 301 K ( $28^{\circ}\text{C}$ ) under a tungsten illumination of 1 kW/m<sup>2</sup> at 2,800 K ( $2,527^{\circ}\text{C}$ );

- e.2. High energy storage capacitors, as follows:

- e.2.a. Capacitors with a repetition rate of less than 10 Hz (single shot capacitors) having all of the following:

- e.2.a.1. A voltage rating equal to or more than 5 kV;

- e.2.a.2. An energy density equal to or more than 250 J/kg; and

- e.2.a.3. A total energy equal to or more than 25 kJ;

- e.2.b. Capacitors with a repetition rate of 10 Hz or more (repetition rated capacitors) having all of the following:

- e.2.b.1. A voltage rating equal to or more than 5 kV;

- e.2.b.2. An energy density equal to or more than 50 J/kg;

- e.2.b.3. A total energy equal to or more than 100 J; and

- e.2.b.4. A charge/discharge cycle life equal to or more than 10,000;

- e.3. "Superconductive" electromagnets and solenoids specially designed to be fully charged or discharged in less than one second, having all of the following:

**Note:** 3A001.e.3 does not control "superconductive" electromagnets or solenoids specially designed for Magnetic Resonance Imaging (MRI) medical equipment.

- e.3.a. Energy delivered during the discharge exceeding 10 kJ in the first second;

- e.3.b. Inner diameter of the current carrying windings of more than 250 mm; and