

CATEGORY 3 - ELECTRONICS

A. SYSTEMS, EQUIPMENT AND COMPONENTS

Note 1: The control status of equipment and components described in 3A001 or 3A002, other than those described in 3A001.a.3 to 3A001.a.10 or 3A001.a.12, which are specially designed for or which have the same functional characteristics as other equipment is determined by the control status of the other equipment.

Note 2: The control status of integrated circuits described in 3A001.a.3 to 3A001.a.9 or 3A001.a.12 that are unalterably programmed or designed for a specific function for other equipment is determined by the control status of the other equipment.

N.B.: When the manufacturer or applicant cannot determine the control status of the other equipment, the control status of the integrated circuits is determined in 3A001.a.3 to 3A001.a.9 and 3A001.a.12. If the integrated circuit is a silicon-based "microcomputer microcircuit" or microcontroller microcircuit described in 3A001.a.3 having an operand (data) word length of 8 bit or less, the control status of the integrated circuit is determined in 3A001.a.3.

●3A001 Electronic components and specially designed components therefor, as follows (see List of Items Controlled).

License Requirements

Reason for Control: NS, MT, NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NS applies to entire entry	NS Column 2
MT applies to 3A001.a.1.a when usable in "missiles";	MT Column 1

and to 3A001.a.5.a when "designed or modified" for military use, hermetically sealed and rated for operation in the temperature range from below -54 °C to above +125 °C.

NP applies to pulse discharge capacitors in 3A001.e.2 and superconducting solenoidal electromagnets in 3A001.e.3 that meet or exceed the technical parameters in 3A201.a and 3A201.b, respectively

AT applies to entire entry AT Column 1

License Exceptions

- LVS: N/A for MT or NP
Yes for:
\$1500: 3A001.c
\$3000: 3A001.b.1, b.2, b.3, b.9, .d, .e, .f, and .g
\$5000: 3A001.a (except a.1.a and a.5.a when controlled for MT), and .b.4 to b.7
- GBS: Yes for 3A001.a.1.b, a.2 to a.12 (except .a.5.a when controlled for MT), b.2, b.8 (except for TWTAs exceeding 18 GHz), b.9., and .g.
- CIV: Yes for 3A001.a.3, a.4, a.7, and a.11.

List of Items Controlled

- Unit:* Number.
- *Related Controls:* 1.) The following commodities are under the export licensing authority of the Department of State, Directorate of Defense Trade Controls (22 CFR part 121) when "space qualified" and operating at frequencies higher than 31.8 GHz: helix tubes (traveling wave tubes (TWT)) defined in [3A001.b.1.a.4.c](#); microwave solid state amplifiers defined in [3A001.b.4.b](#) traveling wave tube amplifiers

(TWTA) defined in [3A001.b.8](#); and derivatives thereof; 2.) The following commodities are also under the export licensing authority of the Department of State, Directorate of Defense Trade Controls (22 CFR part 121): (a) “Space qualified” solar cells, coverglass-interconnect-cells or covered-interconnect-cells (CIC) assemblies, solar arrays and/or solar panels, with a minimum average efficiency of 31% or greater measured at an operating temperature of 301 K (28°C) under simulated 'AM0' illumination with an irradiance of 1,367 Watts per square meter (W/m²), and associated solar concentrators, power conditioners and/or controllers, bearing and power transfer assemblies, and deployment hardware/systems; (b) Radiation-hardened microelectronic circuits controlled by Category XV (d) of the United States Munitions List (USML); and (c) All specifically designed or modified systems or subsystems, components, parts, accessories, attachments, and associated equipment controlled by Category XV (e) of the USML. See also [3A101](#), [3A201](#), and [3A991](#).

- *Related Definitions:* For the purposes of integrated circuits in 3A001.a.1, $5 \times 10^3 \text{ Gy(Si)} = 5 \times 10^5 \text{ Rads (Si)}$; $5 \times 10^6 \text{ Gy (Si)/s} = 5 \times 10^8 \text{ Rads (Si)/s}$.
 - *Items:*
- a. General purpose integrated circuits, as follows:

Note 1: *The control status of wafers (finished or unfinished), in which the function has been determined, is to be evaluated against the parameters of 3A001.a.*

Note 2: *Integrated circuits include the following types:*

“Monolithic integrated circuits”;
“Hybrid integrated circuits”;

“Multichip integrated circuits”;
“Film type integrated circuits”, including silicon-on-sapphire integrated circuits;
“Optical integrated circuits”.

a.1. Integrated circuits designed or rated as radiation hardened to withstand any of the following:

a.1.a. A total dose of $5 \times 10^3 \text{ Gy (Si)}$, or higher;

a.1.b. A dose rate upset of $5 \times 10^6 \text{ Gy (Si)/s}$, or higher; *or*

a.1.c. A fluence (integrated flux) of neutrons (1 MeV equivalent) of $5 \times 10^{13} \text{ n/cm}^2$ or higher on silicon, or its equivalent for other materials;

Note: *3A001.a.1.c does not apply to Metal Insulator Semiconductors (MIS).*

a.2. “Microprocessor microcircuits”, “microcomputer microcircuits”, microcontroller microcircuits, storage integrated circuits manufactured from a compound semiconductor, analog-to-digital converters, digital-to-analog converters, electro-optical or “optical integrated circuits” designed for “signal processing”, field programmable logic devices, custom integrated circuits for which either the function is unknown or the control status of the equipment in which the integrated circuit will be used is unknown, Fast Fourier Transform (FFT) processors, electrical erasable programmable read-only memories (EEPROMs), flash memories or static random-access memories (SRAMs), having any of the following:

a.2.a. Rated for operation at an ambient temperature above 398 K (125°C);

a.2.b. Rated for operation at an ambient temperature below 218 K (-55°C); *or*

a.2.c. Rated for operation over the entire

ambient temperature range from 218 K (-55°C) to 398 K (125°C);

Note: 3A001.a.2 does not apply to integrated circuits for civil automobile or railway train applications.

a.3. “Microprocessor microcircuits”, “microcomputer microcircuits” and microcontroller microcircuits, manufactured from a compound semiconductor and operating at a clock frequency exceeding 40 MHz;

Note: 3A001.a.3 includes digital signal processors, digital array processors and digital coprocessors.

a.4. Storage integrated circuits manufactured from a compound semiconductor;

a.5. Analog-to-digital and digital-to-analog converter integrated circuits, as follows:

a.5.a. Analog-to-digital converters having any of the following:

a.5.a.1. A resolution of 8 bit or more, but less than 10 bit, with an output rate greater than 500 million words per second;

a.5.a.2. A resolution of 10 bit or more, but less than 12 bit, with an output rate greater than 200 million words per second;

a.5.a.3. A resolution of 12 bit with an output rate greater than 105 million words per second;

a.5.a.4. A resolution of more than 12 bit but equal to or less than 14 bit with an output rate greater than 10 million words per second; *or*

a.5.a.5. A resolution of more than 14 bit with an output rate greater than 2.5 million words per second;

a.5.b. Digital-to-analog converters with a

resolution of 12 bit or more and a “settling time” of less than 10 ns;

Technical Notes:

1. A resolution of n bit corresponds to a quantization of 2^n levels.

2. The number of bits in the output word is equal to the resolution of the analogue-to-digital converter.

3. The output rate is the maximum output rate of the converter, regardless of architecture or oversampling. Vendors may also refer to the output rate as sampling rate, conversion rate or throughput rate. It is often specified in megahertz (MHz) or mega samples per second (MSPS).

4. For the purpose of measuring output rate, one output word per second is equivalent to one Hertz or one sample per second.

a.6. Electro-optical and “optical integrated circuits”, designed for “signal processing” and having all of the following:

a.6.a. One or more than one internal “laser” diode;

a.6.b. One or more than one internal light detecting element; *and*

a.6.c. Optical waveguides;

a.7. ‘Field programmable logic devices’ having any of the following:

a.7.a. An equivalent usable gate count of more than 30,000 (2 input gates);

a.7.b. A typical “basic gate propagation delay time” of less than 0.1 ns; *or*

a.7.c. A toggle frequency exceeding 133 MHz;

Note: 3A001.a.7 includes:

- Simple Programmable Logic Devices (SPLDs),
- Complex Programmable Logic Devices (CPLDs),
- Field Programmable Gate Arrays (FPGAs),
- Field Programmable Logic Arrays (FPLAs), and
- Field Programmable Interconnects (FPICs).

Technical Note: ‘Field programmable logic devices’ are also known as field programmable gate or field programmable logic arrays.

a.8. [RESERVED]

a.9. Neural network integrated circuits;

a.10. Custom integrated circuits for which the function is unknown, or the control status of the equipment in which the integrated circuits will be used is unknown to the manufacturer, having any of the following:

a.10.a. More than 1,000 terminals;

a.10.b. A typical “basic gate propagation delay time” of less than 0.1 ns; or

a.10.c. An operating frequency exceeding 3 GHz;

a.11. Digital integrated circuits, other than those described in 3A001.a.3 to 3A001.a.10 and 3A001.a.12, based upon any compound semiconductor and having any of the following:

a.11.a. An equivalent gate count of more than 3,000 (2 input gates); or

a.11.b. A toggle frequency exceeding 1.2 GHz;

a.12. Fast Fourier Transform (FFT) processors

having a rated execution time for an N-point complex FFT of less than $(N \log_2 N)/20,480$ ms, where N is the number of points;

Technical Note: When N is equal to 1,024 points, the formula in 3A001.a.12 gives an execution time of 500 μ s.

b. Microwave or millimeter wave components, as follows:

b.1. Electronic vacuum tubes and cathodes, as follows:

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

a. Does not exceed 31.8 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 having all the following:

a) An average output power equal to or less than 50 W; and

b) Designed or rated for operation in any frequency band and having all of the following:

1) Exceeds 31.8 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. Tubes operating at frequencies exceeding 31.8 GHz;

b.1.a.2. Tubes 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, having any of the following:

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/cm²;

b.2. Microwave “Monolithic Integrated Circuits” (MMIC) power amplifiers having any of the following:

b.2.a. Rated for operation at frequencies exceeding 3.2 GHz up to and including 6 GHz and with an average output power greater than 4W (36 dBm) with a “fractional bandwidth” greater than 15%;

b.2.b. Rated for operation at frequencies exceeding 6 GHz up to and including 16 GHz and with an average output power greater than 1W (30 dBm) with a “fractional bandwidth” greater than 10%;

b.2.c. Rated for operation at frequencies exceeding 16 GHz up to and including 31.8 GHz and with an average output power greater than 0.8W (29 dBm) with a “fractional bandwidth” greater than 10%;

b.2.d. Rated for operation at frequencies exceeding 31.8 GHz up to and including 37.5 GHz;

b.2.e. Rated for operation at frequencies exceeding 37.5 GHz up to and including 43.5 GHz and with an average output power greater than 0.25W (24 dBm) with a “fractional bandwidth” greater than 10%; *or*

b.2.f. Rated for operation at frequencies exceeding 43.5 GHz.

Note 1: 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.

Note 2: The control status of the MMIC whose rated operating frequency includes frequencies listed in more than one frequency range, as defined by 3A001.b.2.a through 3A001.b.2.f, is determined by the lowest average output power control threshold.

Note 3: Notes 1 and 2 following the Category 3 heading for A. Systems, Equipment, and Components mean that 3A001.b.2. does not control MMICs if they are specially designed for other applications, e.g., telecommunications, radar, automobiles.

b.3. Discrete microwave transistors having any of the following:

b.3.a. Rated for operation at frequencies exceeding 3.2 GHz up to and including 6 GHz and having an average output power greater than 60W (47.8 dBm);

b.3.b. Rated for operation at frequencies exceeding 6 GHz up to and including 31.8 GHz and having an average output power greater than 20W (43 dBm);

b.3.c. Rated for operation at frequencies exceeding 31.8 GHz up to and including 37.5 GHz and having an average output power greater than

0.5W (27 dBm);

b.3.d. Rated for operation at frequencies exceeding 37.5 GHz up to and including 43.5 GHz and having an average output power greater than 1W (30 dBm); *or*

b.3.e. Rated for operation at frequencies exceeding 43.5 GHz;

Note: *The control status of a transistor whose rated operating frequency includes frequencies listed in more than one frequency range, as defined by 3A001.b.3.a through 3A001.b.3.e, is determined by the lowest average output power control threshold.*

b.4. Microwave solid state amplifiers and microwave assemblies/modules containing microwave solid state amplifiers, having any of the following:

b.4.a. Rated for operation at frequencies exceeding 3.2 GHz up to and including 6 GHz and with an average output power greater than 60W (47.8 dBm) with a “fractional bandwidth” greater than 15%;

b.4.b. Rated for operation at frequencies exceeding 6 GHz up to and including 31.8 GHz and with an average output power greater than 15W (42 dBm) with a “fractional bandwidth” greater than 10%;

b.4.c. Rated for operation at frequencies exceeding 31.8 GHz up to and including 37.5 GHz;

b.4.d. Rated for operation at frequencies exceeding 37.5 GHz up to and including 43.5 GHz and with an average output power greater than 1W (30 dBm) with a “fractional bandwidth” greater than 10%;

b.4.e. Rated for operation at frequencies exceeding 43.5 GHz; *or*

b.4.f. Rated for operation at frequencies above 3.2 GHz and all of the following:

b.4.f.1. An average output power (in watts), P, greater than 150 divided by the maximum operating frequency (in GHz) squared [$P > 150 \text{ W} \cdot \text{GHz}^2 / f_{\text{GHz}}^2$];

b.4.f.2. A “fractional bandwidth” of 5% or greater; *and*

b.4.f.3. Any two sides perpendicular to one another with length d (in cm) equal to or less than 15 divided by the lowest operating frequency in GHz [$d \leq 15 \text{ cm} \cdot \text{GHz} / f_{\text{GHz}}$];

Technical Note: *3.2 GHz should be used as the lowest operating frequency (f_{GHz}) in the formula in 3A001.b.4.f.3., for amplifiers that have a rated operation range extending downward to 3.2 GHz and below [$d \leq 15 \text{ cm} \cdot \text{GHz} / 3.2 f_{\text{GHz}}$].*

N.B.: *MMIC power amplifiers should be evaluated against the criteria in 3A001.b.2.*

Note 1: *3A001.b.4. does not control broadcast satellite equipment designed or rated to operate in the frequency range of 40.5 to 42.5 GHz.*

Note 2: *The control status of an item whose rated operating frequency includes frequencies listed in more than one frequency range, as defined by 3A001.b.4.a through 3A001.b.4.e, is determined by the lowest average output power control threshold.*

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 ($f_{\text{max}}/f_{\text{min}}$) in less than 10 μs and 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. [RESERVED]

b.7. Converters and harmonic mixers, designed to extend the frequency range of equipment described in 3A002.c, 3A002.d, 3A002.e or 3A002.f beyond the limits stated therein;

b.8. Microwave power amplifiers containing tubes controlled by 3A001.b.1 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 cm³;

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.

b.9. Microwave power modules (MPM), consisting of, at least, a traveling wave tube, a microwave “monolithic integrated circuit” and an integrated electronic power conditioner and having all of the following:

b.9.a. A ‘turn-on time’ from off to fully operational in less than 10 seconds;

b.9.b. A volume less than the maximum rated power in Watts multiplied by 10 cm³/W; *and*

b.9.c. An “instantaneous bandwidth” greater than 1 octave ($f_{\max} > 2f_{\min}$) and having any of the following:

b.9.c.1. For frequencies equal to or less than 18 GHz, an RF output power greater than 100 W; *or*

b.9.c.2. A frequency greater than 18 GHz;

Technical Notes:

1. To calculate the volume in 3A001.b.9.b., the following example is provided: for a maximum rated power of 20 W, the volume would be: $20 \text{ W} \times 10 \text{ cm}^3/\text{W} = 200 \text{ cm}^3$.

2. The ‘turn-on time’ in 3A001.b.9.a. refers to the time from fully-off to fully operational, i.e., it includes the warm-up time of the MPM.

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 6 GHz;

c.1.b. A carrier frequency exceeding 1 GHz, but not exceeding 6 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 μs 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 μs ; *or*

c.1.c. A carrier frequency of 1 GHz or less and having any of the following:

c.1.c.1. A product of the maximum

delay time and the bandwidth (time in μs and bandwidth in MHz) of more than 100;

c.1.c.2. A dispersive delay of more than 10 μs ; *or*

c.1.c.3. A frequency side-lobe rejection exceeding 55 dB and a bandwidth greater than 100 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 2.5 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 and having 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. ‘Cells’ and photovoltaic arrays as follows:

e.1.a. ‘Primary cells’ having an ‘energy density’ exceeding 550 Wh/kg at 293 K (20 °C);

e.1.b. Secondary cells having an ‘energy density’ exceeding 250 Wh/kg at 293 K (20 °C);

Technical Notes:

1. For the purpose of 3A001.e.1., ‘energy density’ (Wh/kg) is calculated from the nominal voltage multiplied by the nominal capacity in ampere-hours (Ah) divided by the mass in kilograms. If the nominal capacity is not stated, energy density is calculated from the nominal voltage squared then multiplied by the discharge duration in hours divided by the discharge load in Ohms and the mass in kilograms.

2. For the purpose of 3A001.e.1., a ‘cell’ is defined as an electrochemical device, which has positive and negative electrodes, an electrolyte, and is a source of electrical energy. It is the basic building block of a battery.

3. For the purpose of 3A001.e.1.a., a ‘primary cell’ is a ‘cell’ that is not designed to be charged by any other source.

4. For the purpose of 3A001.e.1.b., a ‘secondary cell’ is a ‘cell’ that is designed to be charged by an external electrical source.

Note: 3A001.e. does not control batteries, including single-cell batteries.

e.2. High energy storage capacitors as follows:

e.2.a. Capacitors with a repetition rate of less than 10 Hz (single shot capacitors) and 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) and

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 and 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*

e.3.c. Rated for a magnetic induction of more than 8 T or “overall current density” in the winding of more than 300 A/mm²;

● e.4. Solar cells, cell-interconnect-coverglass (CIC) assemblies, solar panels, and solar arrays, which are “space qualified,” having a minimum average efficiency exceeding 20% at an operating temperature of 301 K (28°C) under simulated ‘AM0’ illumination with an irradiance of 1,367 Watts per square meter (W/m²).

Technical Note: ‘AM0’, or ‘Air Mass Zero’, refers to the spectral irradiance of sun light in the earth’s outer atmosphere when the distance between the earth and sun is one astronomical unit (AU).

f. Rotary input type shaft absolute position encoders having any of the following:

f.1. A resolution of better than 1 part in 265,000 (18 bit resolution) of full scale; *or*

f.2. An accuracy better than ± 2.5 seconds of arc;

g. Solid-state pulsed power switching thyristor devices and ‘thyristor modules’, using either electrically, optically, or electron radiation controlled switch methods and having any of the following:

g.1. A maximum turn-on current rate of rise (di/dt) greater than 30,000 A/μs and off-state voltage greater than 1,100 V; *or*

g.2. A maximum turn-on current rate of rise (di/dt) greater than 2,000 A/μs and having all of the following:

g.2.a. An off-state peak voltage equal to or greater than 3,000 V; *and*

g.2.b. A peak (surge) current equal to or greater than 3,000 A.

Note 1: 3A001.g. includes:

- Silicon Controlled Rectifiers (SCRs)
- Electrical Triggering Thyristors (ETTs)
- Light Triggering Thyristors (LTTs)
- Integrated Gate Commutated Thyristors (IGCTs)
- Gate Turn-off Thyristors (GTOs)
- MOS Controlled Thyristors (MCTs)
- Solidtrons

Note 2: 3A001.g. does not control thyristor devices and ‘thyristor modules’ incorporated into equipment designed for civil railway or “civil aircraft” applications.

● **3A002 General purpose electronic equipment and accessories therefor, as follows (see List of**

Items Controlled).**License Requirements**

Reason for Control: NS, AT

Control(s) *Country Chart*

NS applies to entire entry NS Column 2

AT applies to entire entry AT Column 1

License Requirement Notes: See §743.1 of the EAR for reporting requirements for exports under License Exceptions.

License Exceptions

- LVS: \$3000: 3A002.a, .e, .f, .g;
\$5000: 3A002.b to .d
- GBS: Yes for 3A002.a.1.; and 3A002.b (synthesized output frequency of 2.6 GHz or less and a "frequency switching time" of 0.3 ms or more).
- CIV: Yes for 3A002.a.1 (provided all of the following conditions are met: 1) Bandwidths do not exceed: 4 MHz per track and have up to 28 tracks *or* 2 MHz per track and have up to 42 tracks; 2) Tape speed does not exceed 6.1 m/s; 3) They are not designed for underwater use; 4) They are not ruggedized for military use; *and* 5) Recording density does not exceed 653.2 magnetic flux sine waves per mm); and 3A002.b (synthesized output frequency of 2.6 GHz or less; and a "frequency switching time" of 0.3 ms or more).

List of Items Controlled

Unit: Number

- *Related Controls:* "Space qualified" atomic frequency standards defined in [3A002.g.1](#) are subject to the export licensing authority of the Department of State, Directorate of Defense

Trade Controls (22 CFR part 121.1, Category XV). See also [3A292](#) and [3A992](#).

Related Definitions: Constant percentage bandwidth filters are also known as octave or fractional octave filters.

- *Items:*

a. Recording equipment as follows and specially designed test tape therefor:

a.1. Analog 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.1.a. A bandwidth exceeding 4 MHz per electronic channel or track;

a.1.b. A bandwidth exceeding 2 MHz per electronic channel or track and having more than 42 tracks; *or*

a.1.c. A time displacement (base) error, measured in accordance with applicable IRIG or EIA documents, of less than $\pm 0.1 \mu\text{s}$;

Note: *Analog magnetic tape recorders specially designed for civilian video purposes are not considered to be instrumentation tape recorders.*

a.2. Digital video magnetic tape recorders having a maximum digital interface transfer rate exceeding 360 Mbit/s;

Note: *3A002.a.2 does not control digital video magnetic tape recorders specially designed for television recording using a signal format, which may include a compressed signal format, standardized or recommended by the ITU, the IEC, the SMPTE, the EBU, the ETSI, or the IEEE for civil television applications.*

a.3. Digital instrumentation magnetic tape data recorders employing helical scan techniques or fixed head techniques and having any of the

following:

a.3.a. A maximum digital interface transfer rate exceeding 175 Mbit/s; *or*

a.3.b. Being “space qualified”;

Note: 3A002.a.3 does not control analog magnetic tape recorders equipped with HDDR conversion electronics and configured to record only digital data.

a.4. Equipment having a maximum digital interface transfer rate exceeding 175 Mbit/s and designed to convert digital video magnetic tape recorders for use as digital instrumentation data recorders;

a.5. Waveform digitizers and transient recorders, having all of the following:

N.B.: See also 3A292.

a.5.a. Digitizing rates equal to or more than 200 million samples per second and a resolution of 10 bits or more; *and*

a.5.b. A 'continuous throughput' of 2 Gbit/s or more;

Technical Notes:

1. For those instruments with a parallel bus architecture, the 'continuous throughput' rate is the highest word rate multiplied by the number of bits in a word.
2. 'Continuous throughput' is the fastest data rate the instrument can output to mass storage without the loss of any information while sustaining the sampling rate and analog-to-digital conversion.

a.6. Digital instrumentation data recorders, using magnetic disk storage technique and having all of the following:

a.6.a. Digitizing rate equal to or more than

100 million samples per second and a resolution of 8 bits or more; *and*

a.6.b. A 'continuous throughput' of 1 Gbit/s or more;

b. “Frequency synthesizer” “electronic assemblies” having a “frequency switching time” from one selected frequency to another of less than 1 ms;

Note: The control status of “signal analyzers”, signal generators, network analyzers, and microwave test receivers as stand-alone instruments is determined by 3A002.c., 3A002.d., 3A002.e., and 3A002.f., respectively.

c. Radio-frequency “signal analyzers” as follows:

c.1. “Signal analyzers” capable of analyzing any frequencies exceeding 31.8 GHz but not exceeding 37.5 GHz and having a 3 dB resolution bandwidth (RBW) exceeding 10 MHz;

c.2. “Signal analyzers” capable of analyzing frequencies exceeding 43.5 GHz;

c.3. “Dynamic signal analyzers” having a “real-time bandwidth” exceeding 500 kHz;

Note: 3A002.c.3 does not control those “dynamic signal analyzers” 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 disciplined by the internal master reference oscillator, and having any of the following:

d.1. A maximum synthesized frequency exceeding 31.8 GHz, but not exceeding 43.5 GHz and rated to generate a 'pulse duration' of less than 100 ns;

d.2. A maximum synthesized frequency exceeding 43.5 GHz;

d.3. A “frequency switching time” from one selected frequency to another as specified by any of the following:

d.3.a. Less than 10 ns;

d.3.b. Less than 100 μ s for any frequency change exceeding 1.6 GHz within the synthesized frequency range exceeding 3.2 GHz but not exceeding 10.6 GHz;

d.3.c. Less than 250 μ s for any frequency change exceeding 550 MHz within the synthesized frequency range exceeding 10.6 GHz but not exceeding 31.8 GHz;

d.3.d. Less than 500 μ s for any frequency change exceeding 550 MHz within the synthesized frequency range exceeding 31.8 GHz but not exceeding 43.5 GHz; *or*

d.3.e. Less than 1 ms within the synthesized frequency range exceeding 43.5 GHz; *or*

d.4. A single sideband (SSB) phase noise better than $-(126 + 20 \log_{10}F - 20 \log_{10}f)$ in dBc/Hz, where F is the off-set from the operating frequency in Hz and f is the operating frequency in MHz;

Note 1: For the purpose of 3A002.d., frequency synthesized signal generators includes arbitrary waveform and function generators.

Note 2: 3A002.d. does not control equipment in which the output frequency is either produced by the addition or subtraction of two or more crystal oscillator frequencies, or by an addition or subtraction followed by a multiplication of the result.

Technical Notes:

1. Arbitrary waveform and function generators are normally specified by sample rate (e.g., GSample/s), which is converted to the RF domain by the Nyquist factor of two. Thus, a 1 GSample/s arbitrary waveform has a direct output capability of 500 MHz. Or, when oversampling is used, the maximum direct output capability is proportionately lower.

2. For the purposes of 3A002.d.1., 'pulse duration' is defined as the time interval between the leading edge of the pulse achieving 90% of the peak and the trailing edge of the pulse achieving 10% of the peak.

Note: 3A002.d does not control equipment in which the output frequency is either produced by the addition or subtraction of two or more crystal oscillator frequencies, or by an addition or subtraction followed by a multiplication of the result.

e. Network analyzers with a maximum operating frequency exceeding 43.5 GHz;

f. Microwave test receivers having all of the following:

f.1. A maximum operating frequency exceeding 43.5 GHz; *and*

f.2. Being capable of measuring amplitude and phase simultaneously;

●g. Atomic frequency standards being any of the following:

g.1. “Space qualified”;

g.2. Non-rubidium and having a long-term stability less (better) than 1×10^{-11} /month; *or*

g.3. Non-“space qualified” and having all of the following:

g.3.a. Being a rubidium standard;

g.3.b. Long-term stability less (better) than 1×10^{-11} /month; *and*

g.3.c. Total power consumption of less than 1 Watt.

3A003 Spray cooling thermal management systems employing closed loop fluid handling and reconditioning equipment in a sealed enclosure where a dielectric fluid is sprayed onto electronic components using specially designed spray nozzles that are designed to maintain electronic components within their operating temperature range, and specially designed components therefor.

License Requirements

Reason for Control: NS, AT

<i>Control(s)</i>	<i>Country Chart</i>
NS applies to entire entry	NS Column 2
AT applies to entire entry	AT Column 1

License Exceptions

LVS: N/A
 GBS: N/A
 CIV: N/A

List of Items Controlled

Unit: Number of systems, components in \$
Related Controls: N/A
Related Definitions: N/A
Items:

The list of items controlled is contained in the ECCN heading.

3A101 Electronic equipment, devices and components, other than those controlled by 3A001, as follows (see List of Items Controlled).

License Requirements

Reason for Control: MT, AT

<i>Control(s)</i>	<i>Country Chart</i>
MT applies to entire entry	MT Column 1
AT applies to entire entry	AT Column 1

License Exceptions

LVS: N/A
 GBS: N/A
 CIV: N/A

List of Items Controlled

Unit: Number
Related Controls: Items controlled in [3A101.a](#) are subject to the export licensing authority of the U.S. Department of State, Directorate of Defense Trade Controls (See 22 CFR part 121).
Related Definitions: N/A
Items:

- a. Analog-to-digital converters, usable in “missiles”, designed to meet military specifications for ruggedized equipment;
- b. Accelerators capable of delivering electromagnetic radiation produced by bremsstrahlung from accelerated electrons of 2 MeV or greater, and systems containing those accelerators, usable for the “missiles” or the subsystems of “missiles”.

Note: 3A101.b above does not include equipment specially designed for medical purposes.

3A201 Electronic components, other than those controlled by 3A001, as follows (see List of Items Controlled).

License Requirements

Reason for Control: NP, AT

Control(s) Country Chart

NP applies to entire entry NP Column 1

AT applies to entire entry AT Column 1

License Exceptions

LVS: N/A

GBS: N/A

CIV: N/A

List of Items Controlled

Unit: Number

Related Controls: (1) See ECCNs [3E001](#) (“development” and “production”) and [3E201](#) (“use”) for technology for items controlled under this entry. (2) Also see [3A001.e.2](#) (capacitors) and [3A001.e.3](#) (superconducting electromagnets). (3) Superconducting electromagnets specially designed or prepared for use in separating uranium isotopes are subject to the export licensing authority of the Nuclear Regulatory Commission (see 10 CFR part 110).

Related Definitions: N/A

Items:

a. Pulse discharge capacitors having either of the following sets of characteristics:

a.1. Voltage rating greater than 1.4 kV, energy storage greater than 10 J, capacitance greater than 0.5 μ F, and series inductance less than 50 nH; *or*

a.2. Voltage rating greater than 750 V, capacitance greater than 0.25 μ F, and series inductance less than 10 nH;

b. Superconducting solenoidal electromagnets

having all of the following characteristics:

b.1. Capable of creating magnetic fields greater than 2 T;

b.2. A ratio of length to inner diameter greater than 2;

b.3. Inner diameter greater than 300 mm; *and*

b.4. Magnetic field uniform to better than 1% over the central 50% of the inner volume;

Note: 3A201.b does not control magnets specially designed for and exported “as parts of” medical nuclear magnetic resonance (NMR) imaging systems. The phrase “as part of” does not necessarily mean physical part in the same shipment; separate shipments from different sources are allowed, provided the related export documents clearly specify that the shipments are dispatched “as part of” the imaging systems.

c. Flash X-ray generators or pulsed electron accelerators having either of the following sets of characteristics:

c.1. An accelerator peak electron energy of 500 keV or greater, but less than 25 MeV, and with a “figure of merit” (K) of 0.25 or greater; *or*

c.2. An accelerator peak electron energy of 25 MeV or greater, and a “peak power” greater than 50 MW;

Note: 3A201.c does not control accelerators that are component parts of devices designed for purposes other than electron beam or X-ray radiation (electron microscopy, for example) nor those designed for medical purposes.

Technical Notes:

(1) The “figure of merit” K is defined as: $K = 1.7 \times 10^3 V^{2.65} Q$. V is the peak electron energy in million electron volts. If the accelerator beam pulse duration is less than or equal to 1 μ s, then Q

is the total accelerated charge in Coulombs. If the accelerator beam pulse duration is greater than 1 μs, then Q is the maximum accelerated charge in 1 μs. Q equals the intergral of i with respect to t, over the lesser of 1 μs or the time duration of the beam pulse

(Q = ∫ idt), where i is beam current in amperes and t is time in seconds.

(2) “Peak power” = (peak potential in volts) x (peak beam current in amperes).

(3) In machines based on microwave accelerating cavities, the time duration of the beam pulse is the lesser of 1 μs or the duration of the bunched beam packet resulting from one microwave modulator pulse.

(4) In machines based on microwave accelerating cavities, the peak beam current is the average current in the time duration of a bunched beam packet.

3A225 Frequency changers (also known as converters or inverters) or generators, other than those described in 0B001.c.11, having all of the following characteristics (see List of Items Controlled).

License Requirements

Reason for Control: NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

License Exceptions

LVS: N/A
 GBS: N/A
 CIV: N/A

List of Items Controlled

Unit: Number

Related Controls: (1) See ECCNs [3E001](#) (“development” and “production”) and [3E201](#) (“use”) for technology for items controlled under this entry. (2) Frequency changers (also known as converters or inverters) specially designed or prepared for use in separating uranium isotopes are subject to the export licensing authority of the Nuclear Regulatory Commission (see 10 CFR part 110).

Related Definitions: N/A

Items:

- a. A multiphase output capable of providing a power of 40 W or more;
- b. Capable of operating in the frequency range between 600 and 2000 Hz;
- c. Total harmonic distortion below 10%; and
- d. Frequency control better than 0.1%.

3A226 High-power direct current power supplies, other than those described in 0B001.j.6, having both of the following characteristics (see List of Items Controlled).

License Requirements

Reason for Control: NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

License Exceptions

LVS: N/A
 GBS: N/A
 CIV: N/A

(“use”) for technology for items controlled under this entry. (2) Also see ECCN [3A991.k](#).

Related Definitions: N/A

Items:

a. Cold-cathode tubes, whether gas filled or not, operating similarly to a spark gap, having all of the following characteristics:

a.1. Containing three or more electrodes;

a.2. Anode peak voltage rating of 2.5 kV or more;

a.3. Anode peak current rating of 100 A or more; *and*

a.4. Anode delay time of 10 microsecond or less.

Technical Note: 3A228.a includes gas krytron tubes and vacuum spraytron tubes.

b. Triggered spark-gaps having both of the following characteristics:

b.1. An anode delay time of 15µs or less; *and*

b.2. Rated for a peak current of 500 A or more.

c. Modules or assemblies with a fast switching function having all of the following characteristics:

c.1. Anode peak voltage rating greater than 2 kV;

c.2. Anode peak current rating of 500 A or more; *and*

c.3. Turn-on time of 1µs or less.

3A229 Firing sets and equivalent high-current pulse generators (for detonators controlled by 3A232), as follows (see List of Items Controlled).

License Requirements

Reason for Control: NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
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NP applies to entire entry	NP Column 1
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AT applies to entire entry	AT Column 1
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License Exceptions

LVS: N/A

GBS: N/A

CIV: N/A

List of Items Controlled

Unit: Number

- *Related Controls:* (1) See ECCNs [3E001](#) and 1E001 (“development” and “production”) and [3E201](#) and 1E201 (“use”) for technology for items controlled under this entry. (2) High explosives and related equipment for military use are subject to the export licensing authority of the U.S. Department of State, Directorate of Defense Trade Controls (see 22 CFR part 121).

Related Definitions: In 3A229.b.5, “rise time” is defined as the time interval from 10% to 90% current amplitude when driving a resistive load.

ECCN Controls: 3A229.b includes xenon flash-lamp drivers.

Items:

- a. Explosive detonator firing sets designed to drive multiple controlled detonators controlled by 3A232;

b. Modular electrical pulse generators (pulsers) having all of the following characteristics:

- b.1. Designed for portable, mobile, or ruggedized use;
- b.2. Enclosed in a dust-tight enclosure;
- b.3. Capable of delivering their energy in less than 15 μ s ;
- b.4. Having an output greater than 100 A;
- b.5. Having a “rise time” of less than 10 μ s into loads of less than 40 ohms;
- b.6. No dimension greater than 254 mm;
- b.7. Weight less than 25 kg; *and*
- b.8. Specified for use over an extended temperature range 223 K (-50 °C) to 373 K (100 °C) or specified as suitable for aerospace applications.

3A230 High-speed pulse generators having both of the following characteristics (see List of Items Controlled).

License Requirements

Reason for Control: NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

License Exceptions

- LVS: N/A
- GBS: N/A
- CIV: N/A

List of Items Controlled

Unit: Number

Related Controls: See ECCNs [3E001](#) (“development” and “production”) and [3E201](#) (“use”) for technology for items controlled under this entry.

Related Definitions: In 3A230.b, “pulse transition time” is defined as the time interval between 10% and 90% voltage amplitude.

Items:

- a. Output voltage greater than 6 V into a resistive load of less than 55 ohms; *and*
- b. “Pulse transition time” less than 500 ps.

3A231 Neutron generator systems, including tubes, having both of the following characteristics (see List of Items Controlled).

License Requirements

Reason for Control: NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

License Exceptions

- LVS: N/A
- GBS: N/A
- CIV: N/A

List of Items Controlled

Unit: Number; parts and accessories in \$ value

Related Controls: See ECCNs [3E001](#) (“development” and “production”) and [3E201](#) (“use”) for technology for items controlled under this entry.

Related Definitions: N/A

Items:

- a. Designed for operation without an external vacuum system; *and*
- b. Utilizing electrostatic acceleration to induce a tritium-deuterium nuclear reaction.

3A232 Detonators and multipoint initiation systems, as follows (see List of Items Controlled).

License Requirements

Reason for Control: NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

License Exceptions

LVS: N/A
 GBS: N/A
 CIV: N/A

List of Items Controlled

Unit: Number

- *Related Controls:* (1) See 1A007 for electrically driven explosive detonators. (2) See ECCNs [3E001](#) (“development” and “production”) and [3E201](#) (“use”) for technology for items controlled under this entry. (3) High explosives and related equipment for military use are subject to the export licensing authority of the U.S. Department of State, Directorate of Defense Trade Controls (see 22 CFR part 121).
Related Definitions: N/A
ECCN Controls: This entry does not control detonators using only primary explosives, such as lead azide.
- *Items:*

a. [RESERVED]

- b. Arrangements using single or multiple detonators designed to nearly simultaneously initiate an explosive surface over an area greater than 5,000 mm² from a single firing signal with an initiation timing spread over the surface of less than 2.5 μs.

Technical Note: The word *initiator* is sometimes used in place of the word *detonator*.

3A233 Mass spectrometers, other than those described in 0B002.g, capable of measuring ions of 230 atomic mass units or greater and having a resolution of better than 2 parts in 230, and ion sources therefor.

License Requirements

Reason for Control: NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
NP applies to entire entry	NP Column 1
AT applies to entire entry	AT Column 1

License Exceptions

LVS: N/A
 GBS: N/A
 CIV: N/A

List of Items Controlled

Unit: Number

- Related Controls:* (1) See ECCNs [3E001](#) (“development” and “production”) and [3E201](#) (“use”) for technology for items controlled under this entry. (2) Mass spectrometers specially designed or prepared for analyzing on-line samples of UF₆ gas streams are subject to the export licensing authority of the Nuclear Regulatory Commission (see 10 CFR

part 110).

Related Definitions: N/A

Items:

LVS: N/A

GBS: N/A

CIV: N/A

a. Inductively coupled plasma mass spectrometers (ICP/MS);

b. Glow discharge mass spectrometers (GDMS);

c. Thermal ionization mass spectrometers (TIMS);

d. Electron bombardment mass spectrometers that have a source chamber constructed from, lined with or plated with materials resistant to UF₆;

e. Molecular beam mass spectrometers having either of the following characteristics:

e.1. A source chamber constructed from, lined with or plated with stainless steel or molybdenum and equipped with a cold trap capable of cooling to 193 K (-80° C) or less; *or*

e.2. A source chamber constructed from, lined with or plated with materials resistant to UF₆;

f. Mass spectrometers equipped with a microfluorination ion source designed for actinides or actinide fluorides.

3A292 Oscilloscopes and transient recorders other than those controlled by 3A002.a.5, and specially designed components therefor.

License Requirements

Reason for Control: NP, AT

<i>Control(s)</i>	<i>Country Chart</i>
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NP applies to entire entry	NP Column 2
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AT applies to entire entry	AT Column 1
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License Exceptions

List of Items Controlled

Unit: Number

Related Controls: See ECCN [3E292](#) (“development”, “production”, and “use”) for technology for items controlled under this entry.

Related Definitions: "Bandwidth" is defined as the band of frequencies over which the deflection on the cathode ray tube does not fall below 70.7% of that at the maximum point measured with a constant input voltage to the oscilloscope amplifier.

Items:

a. Non-modular analog oscilloscopes having a bandwidth of 1 GHz or greater;

b. Modular analog oscilloscope systems having either of the following characteristics:

b.1. A mainframe with a bandwidth of 1 GHz or greater; *or*

b.2. Plug-in modules with an individual bandwidth of 4 GHz or greater;

c. Analog sampling oscilloscopes for the analysis of recurring phenomena with an effective bandwidth greater than 4 GHz;

d. Digital oscilloscopes and transient recorders, using analog-to-digital conversion techniques, capable of storing transients by sequentially sampling single-shot inputs at successive intervals of less than 1 ns (greater than 1 giga-sample per second), digitizing to 8 bits or greater resolution and storing 256 or more samples.

Note: *Specially designed components controlled by this item are the following, for analog oscilloscopes:*

1. *Plug-in units;*
2. *External amplifiers;*
3. *Pre-amplifiers;*
4. *Sampling devices;*
5. *Cathode ray tubes.*

psychological stress analysis equipment; electronic monitoring restraint devices; and specially designed parts and accessories, n.e.s.

License Requirements

Reason for Control: CC

<i>Control(s)</i>	<i>Country Chart</i>
CC applies to entire entry	CC Column 1

3A980 Voice print identification and analysis equipment and parts, n.e.s.

License Requirements

Reason for Control: CC

<i>Control(s)</i>	<i>Country Chart</i>
CC applies to entire entry	CC Column 1

License Exceptions

LVS: N/A
 GBS: N/A
 CIV: N/A

License Exceptions

LVS: N/A
 GBS: N/A
 CIV: N/A

List of Items Controlled

Unit: Equipment in number
Related Controls: N/A
Related Definitions: N/A
Items:

The list of items controlled is contained in the ECCN heading.

List of Items Controlled

Unit: Equipment in number
Related Controls: N/A
Related Definitions: N/A
Items:

The list of items controlled is contained in the ECCN heading.

3A991 Electronic devices and components not controlled by 3A001.

License Requirements

Reason for Control: AT

<i>Control(s)</i>	<i>Country Chart</i>
AT applies to entire entry	AT Column 1

License Requirements Notes:

See 744.17 of the EAR for additional license requirements for commodities classified as 3A991.a.1.

License Exceptions

3A981 Polygraphs (except biomedical recorders designed for use in medical facilities for monitoring biological and neurophysical responses); fingerprint analyzers, cameras and equipment, n.e.s.; automated fingerprint and identification retrieval systems, n.e.s.;

LVS: N/A
 GBS: N/A
 CIV: N/A

List of Items Controlled

Unit: Equipment in number

Related Controls: N/A

Related Definitions: N/A

Items:

a. “Microprocessor microcircuits”, “microcomputer microcircuits”, and microcontroller microcircuits having any of the following:

a.1. a.1. A performance speed of 5 GFLOPS or more and an arithmetic logic unit with an access width of 32 bit or more;

a.2. A clock frequency rate exceeding 25 MHz; *or*

a.3. More than one data or instruction bus or serial communication port that provides a direct external interconnection between parallel “microprocessor microcircuits” with a transfer rate of 2.5 Mbyte/s.

b. Storage integrated circuits, as follows:

b.1. Electrical erasable programmable read-only memories (EEPROMs) with a storage capacity;

b.1.a. Exceeding 16 Mbits per package for flash memory types; *or*

b.1.b. Exceeding either of the following limits for all other EEPROM types:

b.1.b.1. Exceeding 1 Mbit per package; *or*

b.1.b.2. Exceeding 256 kbit per package and a maximum access time of less than 80 ns;

b.2. Static random access memories (SRAMs) with a storage capacity:

b.2.a. Exceeding 1 Mbit per package; *or*

b.2.b. Exceeding 256 kbit per package and a maximum access time of less than 25 ns;

c. Analog-to-digital converters having any of the following:

c.1. A resolution of 8 bit or more, but less than 12 bit, with an output rate greater than 100 million words per second;

c.2. A resolution of 12 bit with an output rate greater than 5 million words per second;

c.3. A resolution of more than 12 bit but equal to or less than 14 bit with an output rate greater than 500 thousand words per second; *or*

c.4. A resolution of more than 14 bit with an output rate greater than 500 thousand words per second.

d. Field programmable logic devices having either of the following:

d.1. An equivalent gate count of more than 5000 (2 input gates); *or*

d.2. A toggle frequency exceeding 100 MHz;

e. Fast Fourier Transform (FFT) processors having a rated execution time for a 1,024 point complex FFT of less than 1 ms.

f. Custom integrated circuits for which either the function is unknown, or the control status of the equipment in which the integrated circuits will be used is unknown to the manufacturer, having any of the following:

f.1. More than 144 terminals; *or*

f.2. A typical “basic propagation delay time” of less than 0.4 ns.

g. Traveling wave tubes, pulsed or continuous wave, as follows:

g.1. Coupled cavity tubes, or derivatives thereof;

g.2. Helix tubes, or derivatives thereof, with any of the following:

g.2.a. An “instantaneous bandwidth” of half an octave or more; *and*

g.2.b. The product of the rated average output power (expressed in kW) and the maximum operating frequency (expressed in GHz) of more than 0.2;

g.2.c. An “instantaneous bandwidth” of less than half an octave; *and*

g.2.d. The product of the rated average output power (expressed in kW) and the maximum operating frequency (expressed in GHz) of more than 0.4;

h. Flexible waveguides designed for use at frequencies exceeding 40 GHz;

i. Surface acoustic wave and surface skimming (shallow bulk) acoustic wave devices (i.e., “signal processing” devices employing elastic waves in materials), having either of the following:

i.1. A carrier frequency exceeding 1 GHz; *or*

i.2. A carrier frequency of 1 GHz or less; *and*

i.2.a. A frequency side-lobe rejection exceeding 55 Db;

i.2.b. A product of the maximum delay time and bandwidth (time in microseconds and bandwidth in MHz) of more than 100; *or*

i.2.c. A dispersive delay of more than 10 microseconds.

j. Cells as follows:

j.1. Primary cells having an energy density of 550 Wh/kg or less at 293 K (20°C);

j.2. Secondary cells having an energy density of 250 Wh/kg or less at 293 K (20°C).

Note: 3A991.j. does not control batteries, including single cell batteries.

Technical Notes:

1. For the purpose of 3A991.j energy density (Wh/kg) is calculated from the nominal voltage multiplied by the nominal capacity in ampere-hours divided by the mass in kilograms. If the nominal capacity is not stated, energy density is calculated from the nominal voltage squared then multiplied by the discharge duration in hours divided by the discharge load in Ohms and the mass in kilograms.

2. For the purpose of 3A991.j, a ‘cell’ is defined as an electrochemical device, which has positive and negative electrodes, and electrolyte, and is a source of electrical energy. It is the basic building block of a battery.

3. For the purpose of 3A991.j.1, a ‘primary cell’ is a ‘cell’ that is not designed to be charged by any other source.

4. For the purpose of 3A991.j.2., a ‘secondary cell’ is a ‘cell’ that is designed to be charged by an external electrical source.

k. “Superconductive” electromagnets or solenoids specially designed to be fully charged or discharged in less than one minute, having all of the following:

Note: 3A991.k does not control “superconductive” electromagnets or solenoids designed for Magnetic Resonance Imaging (MRI) medical equipment.

k.1. Maximum energy delivered during the

discharge divided by the duration of the discharge of more than 500 kJ per minute;

k.2. Inner diameter of the current carrying windings of more than 250 mm; *and*

k.3. Rated for a magnetic induction of more than 8T or “overall current density” in the winding of more than 300 A/mm².

l. 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:

l.1. Resonant operating frequencies exceeding 1 MHz;

l.2. A stored energy density of 1 MJ/M³ or more; *and*

l.3. A discharge time of less than 1 ms;

m. Hydrogen/hydrogen-isotope thyratrons of ceramic-metal construction and rate for a peak current of 500 A or more;

n. Digital integrated circuits based on any compound semiconductor having an equivalent gate count of more than 300 (2 input gates).

o. Solar cells, cell-interconnect-coverglass (CIC) assemblies, solar panels, and solar arrays, which are “space qualified” and not controlled by 3A001.e.4.

3A992 General purpose electronic equipment not controlled by 3A002.

License Requirements

Reason for Control: AT

Control(s)

AT applies to entire entry

Country Chart

AT Column 1

License Exceptions

LVS: \$1000 for Syria for .a only

GBS: N/A

CIV: N/A

List of Items Controlled

Unit: Equipment in number

Related Controls: N/A

Related Definitions: N/A

Items:

a. Electronic test equipment, n.e.s.

b. Digital instrumentation magnetic tape data recorders having any of the following any of the following characteristics;

b.1. A maximum digital interface transfer rate exceeding 60 Mbit/s and employing helical scan techniques;

b.2. A maximum digital interface transfer rate exceeding 120 Mbit/s and employing fixed head techniques; *or*

b.3. "Space qualified";

c. 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;

3A999 Specific processing equipment, n.e.s., as follows (see List of Items Controlled).

License Requirements

Reason for Control: AT

Control(s)

Country Chart

AT applies to entire entry. A license is required for items controlled by this entry to North Korea for anti-terrorism reasons. The Commerce Country Chart is not designed to determine AT licensing requirements for this entry. See §742.19 of the EAR for additional information.

License Exceptions

LVS: N/A
 GBS: N/A
 CIV: N/A

List of Items Controlled

Unit: \$ value
Related Controls: See also 0B002, [3A225](#) (for frequency changes capable of operating in the frequency range of 600 Hz and above), [3A233](#)
Related Definitions: N/A
Items:

- a. Frequency changers capable of operating in the frequency range from 300 up to 600 Hz, n.e.s.;
- b. Mass spectrometers n.e.s.;
- c. All flash x-ray machines, and components of pulsed power systems designed thereof, including Marx generators, high power pulse shaping networks, high voltage capacitors, and triggers;
- d. Pulse amplifiers, n.e.s.;
- e. Electronic equipment for time delay generation or time interval measurement, as follows:
 - e.1. Digital time delay generators with a resolution of 50 nanoseconds or less over time intervals of 1 microsecond or greater; *or*
 - e.2. Multi-channel (three or more) or modular time interval meter and chronometry equipment with resolution of 50 nanoseconds or less over time intervals of 1 microsecond or greater;

f. Chromatography and spectrometry analytical instruments.

B. TEST, INSPECTION AND PRODUCTION EQUIPMENT

●**3B001 Equipment for the manufacturing of semiconductor devices or materials, as follows (see List of Items Controlled) and specially designed components and accessories therefor.**

License Requirements

Reason for Control: NS, AT

<i>Control(s)</i>	<i>Country Chart</i>
NS applies to entire entry	NS Column 2
AT applies to entire entry	AT Column 1

License Requirement Notes: See §743.1 of the EAR for reporting requirements for exports under License Exceptions.

License Exceptions

LVS: \$500
 GBS: Yes, except 3B001.a.2 (metal organic chemical vapor deposition reactors), a.3 (molecular beam epitaxial growth equipment using gas sources), .e (automatic loading multi-chamber central wafer handling systems *only* if connected to equipment controlled by 3B001.a.2, a.3, or .f), and .f (lithography equipment).
 CIV: Yes for equipment controlled by 3B001.a.1.

List of Items Controlled

Unit: Number
Related Controls: See also [3B991](#)
Related Definitions: N/A

● *Items:*

a. Equipment designed for epitaxial growth as follows:

a.1. Equipment capable of producing a layer of any material other than silicon with a thickness uniform to less than $\pm 2.5\%$ across a distance of 75 mm or more;

a.2. Metal Organic Chemical Vapor Deposition (MOCVD) reactors specially designed for compound semiconductor crystal growth by the chemical reaction between materials controlled by 3C003 or 3C004;

a.3. Molecular beam epitaxial growth equipment using gas or solid sources;

b. Equipment designed for ion implantation and having any of the following:

b.1. A beam energy (accelerating voltage) exceeding 1MeV;

b.2. Being specially designed and optimized to operate at a beam energy (accelerating voltage) of less than 2 keV;

b.3. Direct write capability; *or*

b.4. A beam energy of 65 keV or more and a beam current of 45 mA or more for high energy oxygen implant into a heated semiconductor material “substrate”;

c. Anisotropic plasma dry etching equipment as follows:

c.1. Equipment with cassette-to-cassette operation and load-locks, and having any of the following:

c.1.a. Designed or optimized to produce critical dimensions of 180 nm or less with $\pm 5\%$ 3 sigma precision; *or*

c.1.b. Designed for generating less than 0.04 particles/cm² with a measurable particle size greater than 0.1 μm in diameter;

c.2. Equipment specially designed for equipment controlled by 3B001.e. and having any of the following:

c.2.a. Designed or optimized to produce critical dimensions of 180 nm or less with $\pm 5\%$ 3 sigma precision; *or*

c.2.b. Designed for generating less than 0.04 particles/cm² with a measurable particle size greater than 0.1 μm in diameter;

d. Plasma enhanced Chemical Vapor Deposition (CVD) equipment as follows:

d.1. Equipment with cassette-to-cassette operation and load-locks, and designed according to the manufacturer's specifications or optimized for use in the production of semiconductor devices with critical dimensions of 180 nm or less;

d.2. Equipment specially designed for equipment controlled by 3B001.e. and designed according to the manufacturer's specifications or optimized for use in the production of semiconductor devices with critical dimensions of 180 nm or less;

e. Automatic loading multi-chamber central wafer handling systems having all of the following:

e.1. Interfaces for wafer input and output, to which more than two pieces of semiconductor processing equipment are to be connected; *and*

e.2. Designed to form an integrated system in a vacuum environment for sequential multiple wafer processing;

Note: 3B001.e. does not control automatic robotic wafer handling systems not designed to operate in a vacuum environment.

f. Lithography equipment as follows:

f.1. Align and expose step and repeat (direct step on wafer) or step and scan (scanner) equipment for wafer processing using photo-optical or X-ray methods and having any of the following:

f.1.a. A light source wavelength shorter than 245 nm; *or*

f.1.b. Capable of producing a pattern with a 'minimum resolvable feature size' of 180 nm or less;

Technical Note: *The 'minimum resolvable feature size' is calculated by the following formula:*

$$MRF = \frac{(an\ exposure\ light\ source\ wavelength\ in\ nm) \times (K\ factor)}{numerical\ aperture}$$

where the K factor = 0.45
 MRF = 'minimum resolvable feature size'.

f.2 Imprint lithography equipment capable of production features of 180 nm or less;

Note: 3B001.f.2 includes:

- Micro contact printing tools
- Hot embossing tools
- Nano-imprint lithography tools
- Step and flash imprint lithography (S-FIL) tools

f.3. Equipment specially designed for mask making or semiconductor device processing using direct writing methods and having all of the following:

f.3.a. Using deflected focused electron beam, ion beam or "laser" beam; and

f.3.b. Having any of the following:

f.3.b.1. A spot size smaller than 0.2 μm;

f.3.b.2. Being capable of producing a pattern with a feature size of less than 1 μm; or

f.3.b.3. An overlay accuracy of better than ± 0.20 μm (3 sigma);

g. Masks and reticles, designed for integrated circuits controlled by 3A001;

h. Multi-layer masks with a phase shift layer;

Note: 3B001.h. does not control multi-layer masks with a phase shift layer designed for the fabrication of memory devices not controlled by 3A001.

i. Imprint lithography templates designed for integrated circuits by 3A001.

3B002 Test equipment, specially designed for testing finished or unfinished semiconductor devices, as follows (see List of Items Controlled), and specially designed components and accessories therefor.

License Requirements

Reason for Control: NS, AT

<i>Control(s)</i>	<i>Country Chart</i>
NS applies to entire entry	NS Column 2
AT applies to entire entry	AT Column 1

License Exceptions

LVS: \$500
 GBS: Yes

CIV: N/A

List of Items Controlled

Unit: Number

Related Controls: See also [3A999.a](#) and [3B992](#)

Related Definitions: N/A

Items:

- a. For testing S-parameters of transistor devices at frequencies exceeding 31.8 GHz;
- b. [RESERVED]
- c. For testing microwave integrated circuits controlled by 3A001.b.2.

3B991 Equipment not controlled by 3B001 for the manufacture of electronic components and materials, and specially designed components and accessories therefor.

License Requirements

Reason for Control: AT

Control(s) Country Chart

AT applies to entire entry AT Column 1

License Exceptions

LVS: N/A

GBS: N/A

CIV: N/A

List of Items Controlled

Unit: Equipment in number, and components and accessories in \$ value

Related Controls: N/A

Related Definitions: ‘Sputtering’ is an overlay coating process wherein positively charged ions are accelerated by an electric field

towards the surface of a target (coating material). The kinetic energy of the impacting ions is sufficient to cause target surface atoms to be released and deposited on the substrate. (Note: Triode, magnetron or radio frequency sputtering to increase adhesion of coating and rate of deposition are ordinary modifications of the process.)

Items:

- a. Equipment specially designed for the manufacture of electron tubes, optical elements and specially designed components therefor controlled by 3A001 or 3A991;
- b. Equipment specially designed for the manufacture of semiconductor devices, integrated circuits and “electronic assemblies”, as follows, and systems incorporating or having the characteristics of such equipment:

Note: 3B991.b also controls equipment used or modified for use in the manufacture of other devices, such as imaging devices, electro-optical devices, acoustic-wave devices.

b.1. Equipment for the processing of materials for the manufacture of devices and components as specified in the heading of 3B991.b, as follows:

Note: 3B991 does not control quartz furnace tubes, furnace liners, paddles, boats (except specially designed caged boats), bubblers, cassettes or crucibles specially designed for the processing equipment controlled by 3B991.b.1.

b.1.a. Equipment for producing polycrystalline silicon and materials controlled by 3C001;

b.1.b. Equipment specially designed for purifying or processing III/V and II/VI semiconductor materials controlled by 3C001, 3C002, 3C003, 3C004, or 3C005 except crystal pullers, for which see 3B991.b.1.c below;

b.1.c. Crystal pullers and furnaces, as follows:

Note: 3B991.b.1.c does not control diffusion and oxidation furnaces.

b.1.c.1. Annealing or recrystallizing equipment other than constant temperature furnaces employing high rates of energy transfer capable of processing wafers at a rate exceeding 0.005 m² per minute;

b.1.c.2. “Stored program controlled” crystal pullers having any of the following characteristics:

b.1.c.2.a. Rechargeable without replacing the crucible container;

b.1.c.2.b. Capable of operation at pressures above 2.5 x 10⁵ Pa; *or*

b.1.c.2.c. Capable of pulling crystals of a diameter exceeding 100 mm;

b.1.d. “Stored program controlled” equipment for epitaxial growth having any of the following characteristics:

b.1.d.1. Capable of producing a silicon layer with a thickness uniform to less than ±2.5% across a distance of 200 mm or more;

b.1.d.2. Capable of producing a layer of any material other than silicon with a thickness uniformity across the wafer of equal to or better than ± 3.5%; *or*

b.1.d.3. Rotation of individual wafers during processing;

b.1.e. Molecular beam epitaxial growth equipment;

b.1.f. Magnetically enhanced ‘sputtering’ equipment with specially designed integral load locks capable of transferring wafers in an isolated

vacuum environment;

b.1.g. Equipment specially designed for ion implantation, ion-enhanced or photo-enhanced diffusion, having any of the following characteristics:

b.1.g.1. Patterning capability;

b.1.g.2. Beam energy (accelerating voltage) exceeding 200 keV;

b.1.g.3. Optimized to operate at a beam energy (accelerating voltage) of less than 10 keV; *or*

b.1.g.4. Capable of high energy oxygen implant into a heated “substrate”;

b.1.h. “Stored program controlled” equipment for the selective removal (etching) by means of anisotropic dry methods (e.g., plasma), as follows:

b.1.h.1. Batch types having either of the following:

b.1.h.1.a. End-point detection, other than optical emission spectroscopy types; *or*

b.1.h.1.b. Reactor operational (etching) pressure of 26.66 Pa or less;

b.1.h.2. Single wafer types having any of the following:

b.1.h.2.a. End-point detection, other than optical emission spectroscopy types;

b.1.h.2.b. Reactor operational (etching) pressure of 26.66 Pa or less; *or*

b.1.h.2.c. Cassette-to-cassette and load locks wafer handling;

Notes: 1. “Batch types” refers to machines not specially designed for production processing of

single wafers. Such machines can process two or more wafers simultaneously with common process parameters, e.g., RF power, temperature, etch gas species, flow rates.

2. “Single wafer types” refers to machines specially designed for production processing of single wafers. These machines may use automatic wafer handling techniques to load a single wafer into the equipment for processing. The definition includes equipment that can load and process several wafers but where the etching parameters, e.g., RF power or end point, can be independently determined for each individual wafer.

b.1.i. “Chemical vapor deposition” (CVD) equipment, e.g., plasma-enhanced CVD (PECVD) or photo-enhanced CVD, for semiconductor device manufacturing, having either of the following capabilities, for deposition of oxides, nitrides, metals or polysilicon:

b.1.i.1. “Chemical vapor deposition” equipment operating below 10^5 Pa; *or*

b.1.i.2. PECVD equipment operating either below 60 Pa (450 millitorr) or having automatic cassette-to-cassette and load lock wafer handling;

Note: 3B991.b.1.i does not control low pressure “chemical vapor deposition” (LPCVD) systems or reactive “sputtering” equipment.

b.1.j. Electron beam systems specially designed or modified for mask making or semiconductor device processing having any of the following characteristics:

b.1.j.1. Electrostatic beam deflection;

b.1.j.2. Shaped, non-Gaussian beam profile;

b.1.j.3. Digital-to-analog conversion rate exceeding 3 MHz;

b.1.j.4. Digital-to-analog conversion accuracy exceeding 12 bit; *or*

b.1.j.5. Target-to-beam position feedback control precision of 1 micrometer or finer;

Note: 3B991.b.1.j does not control electron beam deposition systems or general purpose scanning electron microscopes.

b.1.k. Surface finishing equipment for the processing of semiconductor wafers as follows:

b.1.k.1. Specially designed equipment for backside processing of wafers thinner than 100 micrometer and the subsequent separation thereof; *or*

b.1.k.2. Specially designed equipment for achieving a surface roughness of the active surface of a processed wafer with a two-sigma value of 2 micrometer or less, total indicator reading (TIR);

Note: 3B991.b.1.k does not control single-side lapping and polishing equipment for wafer surface finishing.

b.1.l. Interconnection equipment which includes common single or multiple vacuum chambers specially designed to permit the integration of any equipment controlled by 3B991 into a complete system;

b.1.m. “Stored program controlled” equipment using “lasers” for the repair or trimming of “monolithic integrated circuits” with either of the following characteristics:

b.1.m.1. Positioning accuracy less than ± 1 micrometer; *or*

b.1.m.2. Spot size (kerf width) less than 3 micrometer.

b.2. Masks, mask “substrates”, mask-making

equipment and image transfer equipment for the manufacture of devices and components as specified in the heading of 3B991, as follows:

Note: The term “masks” refers to those used in electron beam lithography, X-ray lithography, and ultraviolet lithography, as well as the usual ultraviolet and visible photo-lithography.

b.2.a. Finished masks, reticles and designs therefor, except:

b.2.a.1. Finished masks or reticles for the production of unembargoed integrated circuits; *or*

b.2.a.2. Masks or reticles, having both of the following characteristics:

b.2.a.2.a. Their design is based on geometries of 2.5 micrometer or more; *and*

b.2.a.2.b. The design does not include special features to alter the intended use by means of production equipment or “software”;

b.2.b. Mask “substrates” as follows:

b.2.b.1. Hard surface (e.g., chromium, silicon, molybdenum) coated “substrates” (e.g., glass, quartz, sapphire) for the preparation of masks having dimensions exceeding 125 mm x 125 mm; *or*

b.2.b.2. “Substrates” specially designed for X-ray masks;

b.2.c. Equipment, other than general purpose computers, specially designed for computer aided design (CAD) of semiconductor devices or integrated circuits;

b.2.d. Equipment or machines, as follows, for mask or reticle fabrication:

b.2.d.1. Photo-optical step and repeat cameras capable of producing arrays larger than

100 mm x 100 mm, or capable of producing a single exposure larger than 6 mm x 6 mm in the image (i.e., focal) plane, or capable of producing line widths of less than 2.5 micrometer in the photoresist on the “substrate”;

b.2.d.2. Mask or reticle fabrication equipment using ion or “laser” beam lithography capable of producing line widths of less than 2.5 micrometer; *or*

b.2.d.3. Equipment or holders for altering masks or reticles or adding pellicles to remove defects;

Note: 3B991.b.2.d.1 and b.2.d.2 do not control mask fabrication equipment using photo-optical methods which was either commercially available before the 1st January, 1980, or has a performance no better than such equipment.

b.2.e. “Stored program controlled” equipment for the inspection of masks, reticles or pellicles with:

b.2.e.1. A resolution of 0.25 micrometer or finer; *and*

b.2.e.2. A precision of 0.75 micrometer or finer over a distance in one or two coordinates of 63.5 mm or more;

Note: 3B991.b.2.e does not control general purpose scanning electron microscopes except when specially designed and instrumented for automatic pattern inspection.

b.2.f. Align and expose equipment for wafer production using photo-optical or X-ray methods, e.g., lithography equipment, including both projection image transfer equipment and step and repeat (direct step on wafer) or step and scan (scanner) equipment, capable of performing any of the following functions:

Note: 3B991.b.2.f does not control

photo-optical contact and proximity mask align and expose equipment or contact image transfer equipment.

b.2.f.1. Production of a pattern size of less than 2.5 micrometer;

b.2.f.2. Alignment with a precision finer than ± 0.25 micrometer (3 sigma);

b.2.f.3. Machine-to-machine overlay no better than ± 0.3 micrometer; *or*

b.2.f.4. A light source wavelength shorter than 400 nm;

b.2.g. Electron beam, ion beam or X-ray equipment for projection image transfer capable of producing patterns less than 2.5 micrometer;

Note: For focused, deflected-beam systems (direct write systems), see 3B991.b.1.j or b.10.

b.2.h. Equipment using “lasers” for direct write on wafers capable of producing patterns less than 2.5 micrometer.

b.3. Equipment for the assembly of integrated circuits, as follows:

b.3.a. “Stored program controlled” die bonders having all of the following characteristics:

b.3.a.1. Specially designed for “hybrid integrated circuits”;

b.3.a.2. X-Y stage positioning travel exceeding 37.5 x 37.5 mm; *and*

b.3.a.3. Placement accuracy in the X-Y plane of finer than ± 10 micrometer;

b.3.b. “Stored program controlled” equipment for producing multiple bonds in a single operation (e.g., beam lead bonders, chip carrier bonders, tape bonders);

b.3.c. Semi-automatic or automatic hot cap sealers, in which the cap is heated locally to a higher temperature than the body of the package, specially designed for ceramic microcircuit packages controlled by 3A001 and that have a throughput equal to or more than one package per minute.

Note: 3B991.b.3 does not control general purpose resistance type spot welders.

b.4. Filters for clean rooms capable of providing an air environment of 10 or less particles of 0.3 micrometer or smaller per 0.02832 m³ and filter materials therefor.

3B992 Equipment not controlled by 3B002 for the inspection or testing of electronic components and materials, and specially designed components and accessories therefor.

License Requirements

Reason for Control: AT

Control(s) Country Chart

AT applies to entire entry AT Column 1

License Exceptions

LVS: N/A
 GBS: N/A
 CIV: N/A

List of Items Controlled

Unit: Equipment in number
Related Controls: See also [3A992.a](#).
Related Definitions: N/A
Items:

a. Equipment specially designed for the inspection or testing of electron tubes, optical elements and specially designed components therefor controlled by 3A001 or 3A991;

b. Equipment specially designed for the inspection or testing of semiconductor devices, integrated circuits and "electronic assemblies", as follows, and systems incorporating or having the characteristics of such equipment:

Note: 3B992.b also controls equipment used or modified for use in the inspection or testing of other devices, such as imaging devices, electro-optical devices, acoustic-wave devices.

b.1. "Stored program controlled" inspection equipment for the automatic detection of defects, errors or contaminants of 0.6 micrometer or less in or on processed wafers, "substrates", other than printed circuit boards or chips, using optical image acquisition techniques for pattern comparison;

Note: 3B992.b.1 does not control general purpose scanning electron microscopes, except when specially designed and instrumented for automatic pattern inspection.

b.2. Specially designed "stored program controlled" measuring and analysis equipment, as follows:

b.2.a. Specially designed for the measurement of oxygen or carbon content in semiconductor materials;

b.2.b. Equipment for line width measurement with a resolution of 1 micrometer or finer;

b.2.c. Specially designed flatness measurement instruments capable of measuring deviations from flatness of 10 micrometer or less with a resolution of 1 micrometer or finer.

b.3. "Stored program controlled" wafer probing equipment having any of the following characteristics:

b.3.a. Positioning accuracy finer than 3.5 micrometer;

b.3.b. Capable of testing devices having more than 68 terminals; *or*

b.3.c. Capable of testing at a frequency exceeding 1 GHz;

b.4. Test equipment as follows:

b.4.a. "Stored program controlled" equipment specially designed for testing discrete semiconductor devices and unencapsulated dice, capable of testing at frequencies exceeding 18 GHz;

Technical Note: Discrete semiconductor devices include photocells and solar cells.

b.4.b. "Stored program controlled" equipment specially designed for testing integrated circuits and "electronic assemblies" thereof, capable of functional testing:

b.4.b.1. At a 'pattern rate' exceeding 20 MHz; *or*

b.4.b.2. At a 'pattern rate' exceeding 10 MHz but not exceeding 20 MHz and capable of testing packages of more than 68 terminals.

Notes: 3B992.b.4.b does not control test equipment specially designed for testing:

1. Memories;

2. "Assemblies" or a class of "electronic assemblies" for home and entertainment applications; and

3. Electronic components, "assemblies" and integrated circuits not controlled by 3A001 or 3A991 provided such test equipment does not incorporate computing facilities with "user accessible programmability".

Technical Note: For purposes of 3B992.b.4.b, 'pattern rate' is defined as the maximum frequency of digital operation of a

tester. It is therefore equivalent to the highest data rate that a tester can provide in non-multiplexed mode. It is also referred to as test speed, maximum digital frequency or maximum digital speed.

b.4.c. Equipment specially designed for determining the performance of focal-plane arrays at wavelengths of more than 1,200 nm, using “stored program controlled” measurements or computer aided evaluation and having any of the following characteristics:

b.4.c.1. Using scanning light spot diameters of less than 0.12 mm;

b.4.c.2. Designed for measuring photosensitive performance parameters and for evaluating frequency response, modulation transfer function, uniformity of responsivity or noise; *or*

b.4.c.3. Designed for evaluating arrays capable of creating images with more than 32 x 32 line elements;

b.5. Electron beam test systems designed for operation at 3 keV or below, or “laser” beam systems, for non-contactive probing of powered-up semiconductor devices having any of the following:

b.5.a. Stroboscopic capability with either beam blanking or detector strobing;

b.5.b. An electron spectrometer for voltage measurements with a resolution of less than 0.5 V; *or*

b.5.c. Electrical tests fixtures for performance analysis of integrated circuits;

Note: *3B992.b.5 does not control scanning electron microscopes, except when specially designed and instrumented for non-contactive probing of a powered-up semiconductor device.*

b.6. “Stored program controlled” multifunctional focused ion beam systems specially designed for manufacturing, repairing, physical layout analysis and testing of masks or semiconductor devices and having either of the following characteristics:

b.6.a. Target-to-beam position feedback control precision of 1 micrometer or finer; *or*

b.6.b. Digital-to-analog conversion accuracy exceeding 12 bit;

b.7. Particle measuring systems employing “lasers” designed for measuring particle size and concentration in air having both of the following characteristics:

b.7.a. Capable of measuring particle sizes of 0.2 micrometer or less at a flow rate of 0.02832 m³ per minute or more; *and*

b.7.b. Capable of characterizing Class 10 clean air or better.

C. MATERIALS

3C001 Hetero-epitaxial materials consisting of a "substrate" having stacked epitaxially grown multiple layers of any of the following (see List of Items Controlled).

License Requirements

Reason for Control: NS, AT

<i>Control(s)</i>	<i>Country Chart</i>
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NS applies to entire entry	NS Column 2
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AT applies to entire entry	AT Column 1
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License Exceptions

LVS: \$3000

GBS: N/A
 CIV: N/A

they are not controlled by 3C002.b through .e.

- CIV: Yes for positive resists not optimized for photolithography at a wavelength of less than 365 nm, provided that they are not controlled by 3C002.b through .e.

List of Items Controlled

Unit: \$ value

Related Controls: This entry does not control equipment or material whose functionality has been unalterably disabled are not controlled.

Related Definitions: III/V compounds are polycrystalline or binary or complex monocrystalline products consisting of elements of groups IIIA and VA of Mendeleev's periodic classification table (e.g., gallium arsenide, gallium-aluminium arsenide, indium phosphide).

Items:

- Silicon;
- Germanium;
- Silicon Carbide; *or*
- III/V compounds of gallium or indium.

●3C002 Resist materials as follows (see List of Items Controlled) and “substrates” coated with the following resists.

License Requirements

Reason for Control: NS, AT

<i>Control(s)</i>	<i>Country Chart</i>
NS applies to entire entry	NS Column 2
AT applies to entire entry	AT Column 1

License Exceptions

LVS: \$3000

- GBS: Yes for positive resists not optimized for photolithography at a wavelength of less than 365 nm, provided that

List of Items Controlled

Unit: \$ value

Related Controls: N/A

Related Definitions: Silylation techniques are defined as processes incorporating oxidation of the resist surface to enhance performance for both wet and dry developing.

Items:

- Positive resists designed for semiconductor lithography specially adjusted (optimized) for use at wavelengths below 245 nm;
- All resists designed for use with electron beams or ion beams, with a sensitivity of 0.01 $\mu\text{coulomb}/\text{mm}^2$ or better;
- All resists designed for use with X-rays, with a sensitivity of 2.5 mJ/mm^2 or better;
- All resists optimized for surface imaging technologies, including silylated resists;
- e. All resists designed or optimized for use with imprint lithography equipment specified by 3B001.f.2. that use either a thermal or photo-curable process.

3C003 Organo-inorganic compounds, as follows (see List of Items Controlled).

License Requirements

Reason for Control: NS, AT

<i>Control(s)</i>	<i>Country Chart</i>
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NS applies to entire entry NS Column 2

AT applies to entire entry AT Column 1

License Exceptions

LVS: \$3000
 GBS: N/A
 CIV: N/A

List of Items Controlled

Unit: \$ value
Related Controls: This entry controls only compounds whose metallic, partly metallic or non-metallic element is directly linked to carbon in the organic part of the molecule.
Related Definition: N/A
Items:

- a. Organo-metallic compounds of aluminium, gallium or indium having a purity (metal basis) better than 99.999%;
- b. Organo-arsenic, organo-antimony and organo-phosphorus compounds having a purity (inorganic element basis) better than 99.999%.

3C004 Hydrides of phosphorus, arsenic or antimony, having a purity better than 99.999%, even diluted in inert gases or hydrogen.

License Requirements

Reason for Control: NS, AT

Control(s) Country Chart

NS applies to entire entry NS Column 2

AT applies to entire entry AT Column 1

License Exceptions

LVS: \$3000
 GBS: N/A
 CIV: N/A

List of Items Controlled

Unit: \$ value
Related Controls: N/A
Related Definition: N/A
Items:

The list of items controlled is contained in the ECCN heading.

Note: This entry does not control hydrides containing 20% molar or more of inert gases or hydrogen.

●3C005 Silicon carbide (SiC), gallium nitride (GaN), aluminum nitride (AlN) or aluminum gallium nitride (AlGaN) “substrates”, or ingots, boules, or other preforms of those materials, having resistivities greater than 10,000 ohm-cm at 20°C.

License Requirements

Reason for Control: NS, AT

Control(s) Country Chart

NS applies to entire entry NS Column 2

AT applies to entire entry AT Column 1

License Exceptions

LVS: \$3000
 GBS: Yes
 CIV: Yes

List of Items Controlled

Unit: \$ value
Related Controls: See ECCN [3E001](#) for related development and production technology, and ECCN [3B991.b.1.b](#) for related production equipment.

Related Definition: N/A

Items:

The list of items controlled is contained in the ECCN heading.

●3C006 “Substrates” specified in 3C005 with at least one epitaxial layer of silicon carbide, gallium nitride, aluminum nitride or aluminum gallium nitride.

License Requirements

Reason for Control: NS, AT

<i>Control(s)</i>	<i>Country Chart</i>
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NS applies to entire entry	NS Column 2
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AT applies to entire entry	AT Column 1
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License Exceptions

LVS: \$3000

GBS: Yes

CIV: Yes

List of Items Controlled

Unit: \$ value

Related Controls: See ECCN [3D001](#) for related “development” or “production” “software”, ECCN [3E001](#) for related “development” and “production” “technology”, and ECCN [3B991.b.1.b](#) for related “production” equipment.

Related Definition: N/A

Items:

The list of items controlled is contained in the ECCN heading.

3C992 Positive resists designed for semiconductor lithography specially adjusted (optimized) for use at wavelengths between 370 and 245 nm.

License Requirements

Reason for Control: AT

<i>Control(s)</i>	<i>Country Chart</i>
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AT applies to entire entry	AT Column 1
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License Exceptions

LVS: N/A

GBS: N/A

CIV: N/A

List of Items Controlled

Unit: \$ value

Related Controls: N/A

Related Definitions: N/A

Items:

The list of items controlled is contained in the ECCN heading.

D. SOFTWARE

3D001 "Software" specially designed for the "development" or "production" of equipment controlled by 3A001.b to 3A002.g or 3B (except 3B991 and 3B992).

License Requirements

Reason for Control: NS, AT

<i>Control(s)</i>	<i>Country Chart</i>
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NS applies to "software" for equipment controlled by 3A001.b to 3A001.f, 3A002, and 3B	NS Column 1
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AT applies to entire entry	AT Column 1
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License Requirement Notes: See §743.1 of

the EAR for reporting requirements for exports under License Exceptions.

ECCN heading.

License Exceptions

- CIV: N/A
- TSR: Yes, except for “software” specially designed for the “development” or “production” of Traveling Wave Tube Amplifiers described in 3A001.b.8 having operating frequencies exceeding 18 GHz.

3D002 “Software” specially designed for the “use” of any of the following (see List of Items Controlled).

License Requirements

Reason for Control: NS, AT

Control(s) Country Chart

NS applies to entire entry NS Column 1

AT applies to entire entry AT Column 1

List of Items Controlled

Unit: \$ value

- *Related Controls:* “Software” specially designed for the “development” or “production” of the following equipment is under the export licensing authority of the Department of State, Directorate of Defense Trade Controls (22 CFR part 121): 1.) When operating at frequencies higher than 31.8 GHz and “space qualified”: Helix tubes (traveling wave tubes (TWT)) defined in [3A001.b.1.a.4.c](#); microwave solid state amplifiers defined in [3A001.b.4.b](#); and traveling wave tube amplifiers (TWTA) defined in [3A001.b.8](#); 2.) “Space qualified” solar cells, coverglass-interconnect-cells or covered-interconnect-cells (CIC) assemblies, solar arrays, and/or solar panels, with a minimum average efficiency of 31% or greater at an operating temperature of 301°K (28°C) under simulated 'AM0' illumination with an irradiance of 1,367 Watts per square meter (W/m²), and associated solar concentrators, power conditioners, and/or controllers, bearing and power transfer assemblies, and deployment hardware/systems. 3.) “Space qualified” atomic frequency standards defined in [3A002.g.2](#). See also [3D101](#).
 - *Related Definitions:* N/A
- Items:*

License Exceptions

- CIV: N/A
- TSR: Yes

List of Items Controlled

Unit: \$ value

Related Controls: Also see [3D991](#).

Related Definitions: N/A

Items:

- a. Equipment controlled by 3B001.a. to f.; or
- b. Equipment controlled by 3B002.

3D003 Physics-based simulation “software” specially designed for the “development” of lithographic, etching or deposition processes for translating masking patterns into specific topographical patterns in conductors, dielectrics or semiconductor materials.

License Requirements

Reason for Control: NS, AT

Control(s) Country Chart

The list of items controlled is contained in the

NS applies to entire entry

NS Column 1

TSR: Yes

AT applies to entire entry

AT Column 1

List of Items Controlled

License Exceptions

CIV: N/A

TSR: Yes

Unit: \$ value

Related Controls: N/A

Related Definitions: N/A

Items:

List of Items Controlled

Unit: \$ value

Related Controls: N/A

Related Definitions: 1.) Libraries, design attributes or associated data for the design of semiconductor devices or integrated circuits are considered as “technology”. 2.) ‘Physics-based’ in 3D003 means using computations to determine a sequence of physical cause and effect events based on physical properties (e.g., temperature, pressure, diffusion constants and semiconductor materials properties).

Items:

The list of items controlled is contained in the ECCN heading.

3D101 “Software” specially designed or modified for the “use” of equipment controlled by 3A101.b.

License Requirements

Reason for Control: MT, AT

Control(s)

Country Chart

MT applies to entire entry

MT Column 1

AT applies to entire entry

AT Column 1

The list of items controlled is contained in the ECCN heading.

3D004 “Software” specially designed for the “development” of the equipment controlled by 3A003.

License Exceptions

CIV: N/A

TSR: N/A

License Requirements

Reason for Control: NS, AT

Control(s)

Country Chart

NS applies to entire entry

NS Column 1

AT applies to entire entry

AT Column 1

List of Items Controlled

Unit: \$ value

Related Controls: N/A

Related Definitions: N/A

Items:

The list of items controlled is contained in the ECCN heading.

License Exceptions

CIV: N/A

3D980 “Software” specially designed for the “development”, “production”, or “use” of

License Requirement Note: See §743.1 of the EAR for reporting requirements for exports under License Exceptions.

License Exceptions

- CIV: N/A
- TSR: Yes, except N/A for MT, and “technology” specially designed for the “development” or “production” of: (a) Traveling Wave Tube Amplifiers described in [3A001.b.8](#), having operating frequencies exceeding 19 Ghz; and (b) solar cells, coverglass-interconnect-cells or covered-interconnect-cells (CIC) assemblies, solar arrays and/or solar panels, which are “space qualified,” having a minimum average efficiency exceeding 20% but less than 31% described in [3A001.e.4](#).

List of Items Controlled

- Unit: N/A
- **Related Controls:** 1.) See also [3E101](#) and [3E201](#). 2.) “Technology” according to the General Technology Note for the “development” or “production” of the following commodities is under the export licensing authority of the Department of State, Directorate of Defense Trade Controls (22CFR part 121): (a) When operating at frequencies higher than 31.8 GHz and “space qualified”: helix tubes (traveling wave tubes (TWT)) defined in [3A001.b.1.a.4.c](#); microwave solid state amplifiers defined in [3A001.b.4.b](#); or traveling wave tube amplifiers (TWTA) defined in [3A001.b.8](#); (b) “Space qualified” solar cells, coverglass-interconnect-cells or covered-interconnect-cells (CIC) assemblies, solar arrays, and/or solar panels, with a minimum average efficiency of 31% or greater at an operating temperature of 301°K (28°C) under simulated 'AM0' illumination with an irradiance of 1,367 Watts per square meter (W/m²), and associated solar concentrators, power

conditioners, and/or controllers, bearing and power transfer assemblies, and deployment hardware/systems. and (c) “Space qualified” atomic frequency standards defined in [3A002.g.2](#).

- **Related Definition:** N/A
Items:

The list of items controlled is contained in the ECCN heading.

Note 1: 3E001 does not control “technology” for the “production” of equipment or components controlled by 3A003.

Note 2: 3E001 does not control “technology” for the “development” or “production” of integrated circuits controlled by 3A001.a.3 to a.12, having all of the following:

- a) Using “technology” of 0.5 μm or more; and
- b) Not incorporating multi-layer structures.

- **Technical Note:** Multi-layer structures in Note 2 of 3E001 do not include devices incorporating a maximum of three metal layers and three polysilicon layers.

3E002 Technology” according to the General Technology Note other than that controlled in 3E001 for the “development” or “production” of a “microprocessor microcircuit”, “micro-computer microcircuit” and microcontroller microcircuit core, having an arithmetic logic unit with an access width of 32 bits or more and any of the following features or characteristics (see List of Items Controlled).

License Requirements

Reason for Control: NS, AT

Control(s) Country Chart

NS applies to entire entry NS Column 1

AT applies to entire entry AT Column 1

a processor element with built-in instructions that perform multiple calculations on floating-point vectors (one-dimensional arrays of 32-bit or larger numbers) simultaneously, having at least one vector arithmetic logic unit.

License Exceptions

CIV: Yes, for deemed exports, as described in §734.2(b)(2)(ii) of the EAR, of “technology” for the “development” or “production” of general purpose microprocessors with a vector processor unit with operand length of 64-bit or less, 64-bit floating operations not exceeding 32 GFLOPS, or 16-bit or more floating-point operations not exceeding 32 GMACS (billions of 16-bit fixed-point multiply-accumulate operations per second). Deemed exports under License Exception CIV are subject to a Foreign National Review (FNR) requirement, see §740.5 of the EAR for more information about the FNR. License Exception CIV does not apply to ECCN 3E002 technology also required for the development or production of items controlled under ECCNs beginning with 3A, 3B, or 3C, or to ECCN 3E002 technology also controlled under ECCN 3E003.

b. Designed to perform more than two 64-bit or larger floating-point operation results per cycle; *or*

c. Designed to perform more than four 16-bit fixed-point multiply-accumulate results per cycle (e.g., digital manipulation of analog information that has been previously converted into digital form, also known as digital signal processing).

Note: 3E002.c does not control technology for multimedia extensions.

Notes:

1. 3E002 does not control “technology” for the “development” or “production” of microprocessor cores, having all of the following:

a. Using “technology” at or above 0.130 μm; and

b. Incorporating multi-layer structures with five or fewer metal layers.

2. 3E002 includes “technology” for digital signal processors and digital array processors.

TSR: Yes

List of Items Controlled

Unit: N/A

Related Controls: N/A

Related Definitions: N/A

Items:

a. A vector processor unit designed to perform more than two calculations on floating-point vectors (one dimensional arrays of 32-bit or larger numbers) simultaneously;

Technical Note: *A vector processing unit is*

3E003 Other "technology" for the "development" or "production" of items described in the List of Items Controlled.

License Requirements

Reason for Control: NS, AT

Control(s) Country Chart

NS applies to entire entry NS Column 1

AT applies to entire entry AT Column 1

License Exceptions

CIV: N/A

TSR: Yes, except .f and .g

List of Items Controlled

Unit: N/A

Related Controls: 1) Technology for the “development” or “production” of “space qualified” electronic vacuum tubes operating at frequencies of 31.8 GHz or higher, described in [3E003.g](#), is under the export license authority of the Department of State, Directorate of Defense Trade Controls (22 CFR part 121); 2) See [3E001](#) for silicon-on-insulation (SOI) technology for the “development” or “production” related to radiation hardening of integrated circuits.

Related Definitions: N/A

Items:

- a. Vacuum microelectronic devices;
- b. Hetero-structure semiconductor devices such as high electron mobility transistors (HEMT), hetero-bipolar transistors (HBT), quantum well and super lattice devices;

Note: 3E003.b does not control technology for high electron mobility transistors (HEMT) operating at frequencies lower than 31.8 GHz and hetero-junction bipolar transistors (HBT) operating at frequencies lower than 31.8 GHz.
- c. "Superconductive" electronic devices;
- d. Substrates of films of diamond for electronic components;
- e. Substrates of silicon-on-insulator (SOI) for integrated circuits in which the insulator is silicon dioxide;
- f. Substrates of silicon carbide for electronic components;

g. Electronic vacuum tubes operating at frequencies of 31.8 GHz or higher.

3E101 “Technology” according to the General Technology Note for the “use” of equipment or “software” controlled by 3A001.a.1 or .2, 3A101, or 3D101.

License Requirements

Reason for Control: MT, AT

<i>Control(s)</i>	<i>Country Chart</i>
MT applies to entire entry	MT Column 1
AT applies to entire entry	AT Column 1

License Exceptions

CIV: N/A

TSR: N/A

List of Items Controlled

Unit: N/A

Related Controls: N/A

Related Definitions: N/A

Items:

The list of items controlled is contained in the ECCN heading.

3E102 “Technology” according to the General Technology Note for the “development” of “software” controlled by 3D101.

License Requirements

Reason for Control: MT, AT

<i>Control(s)</i>	<i>Country Chart</i>
MT applies to entire entry	MT Column 1

AT applies to entire entry

AT Column 1

Related Definitions: N/A

Items:

License Exceptions

CIV: N/A

TSR: N/A

The list of items controlled is contained in the ECCN heading.

List of Items Controlled

Unit: N/A

Related Controls: N/A

Related Definitions: N/A

Items:

The list of items controlled is contained in the ECCN heading.

3E292 “Technology” according to the General Technology Note for the “development”, “production”, or “use” of equipment controlled by 3A292.

License Requirements

Reason for Control: NP, AT

Control(s)

Country Chart

NP applies to entire entry

NP Column 2

AT applies to entire entry

AT Column 1

3E201 “Technology” according to the General Technology Note for the “use” of equipment controlled by 3A001.e.2 or .e.3, 3A201 or 3A225 to 3A233.

License Exceptions

CIV: N/A

TSR: N/A

License Requirements

Reason for Control: NP, AT

Control(s)

Country Chart

NP applies to “technology” for equipment controlled by 3A001.e.2, or .e.3, 3A201 or 3A225 to 3A233 for NP reasons

NP Column 1

List of Items Controlled

Unit: N/A

Related Controls: N/A

Related Definitions: N/A

Items:

The list of items controlled is contained in the ECCN heading.

AT applies to entire entry

AT Column 1

License Exceptions

CIV: N/A

TSR: N/A

3E980 “Technology” specially designed for “development”, “production”, or “use” of items controlled by 3A980 and 3A981.

License Requirements

Reason for Control: CC, AT

List of Items Controlled

Unit: N/A

Related Controls: N/A

Control(s)

Country Chart

CC applies to entire entry CC Column 1

AT applies to entire entry AT Column 1

License Exceptions

CIV: N/A

TSR: N/A

License Exceptions

CIV: N/A

TSR: N/A

List of Items Controlled

Unit: N/A

Related Controls: N/A

Related Definitions: N/A

Items:

List of Items Controlled

Unit: N/A

Related Controls: N/A

Related Definitions: N/A

Items:

The list of items controlled is contained in the ECCN heading.

The list of items controlled is contained in the ECCN heading.

EAR99 Items subject to the EAR that are *not* elsewhere specified in this CCL Category or in any other category in the CCL are designated by the number *EAR99*.

3E991 “Technology” for the “development”, “production”, or “use” of electronic devices or components controlled by 3A991, general purpose electronic equipment controlled by 3A992, or manufacturing and test equipment controlled by 3B991 or 3B992, or materials controlled by 3C992.

License Requirements

Reason for Control: AT

Control(s) *Country Chart*

AT applies to entire entry AT Column 1