

## CATEGORY 3—ELECTRONICS

### 3A SYSTEMS, EQUIPMENT AND COMPONENTS

*Notes:*

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), 3A001(a)(12) to 3A001(a)(14) and 3A001(b)(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. *(L.N. 85 of 2023)*
2. The control status of integrated circuits described in 3A001(a)(3) to 3A001(a)(9), 3A001(a)(12) to 3A001(a)(14) which are unalterably programmed or designed for a specific function for another 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), 3A001(a)(12) to 3A001(a)(14). *(L.N. 226 of 2009)*

3. The status of wafers (finished or unfinished), in which the function has been determined, is to be evaluated against the parameters of 3A001(a), 3A001(b), 3A001(d), 3A001(e)(4), 3A001(g), 3A001(h) or 3A001(i). *(L.N. 85 of 2023)*

*(L.N. 89 of 2013; L.N. 89 of 2021)*

#### 3A001 Electronic items, as follows: *(L.N. 89 of 2021)*

(a) General purpose integrated circuits, as follows:

*Note:*

Integrated circuits include the following types: *(L.N. 85 of 2023)*

“Monolithic integrated circuits”;

“Hybrid integrated circuits”;

“Multichip integrated circuits”;

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

“Optical integrated circuits”; *(L.N. 27 of 2015)*

“Three dimensional integrated circuits”; *(L.N. 89 of 2021)*

“Monolithic Microwave Integrated Circuits” (“MMICs”). *(L.N. 89 of 2021)*

*(L.N. 85 of 2023)*

- (1) Integrated circuits, designed or rated as radiation hardened to withstand any of the following:

(a) a total dose of  $5 \times 10^3$  Gy (Si), or higher; *(L.N. 65 of 2004)*

(b) a dose rate upset of  $5 \times 10^6$  Gy (Si)/s or higher; *or (L.N. 65 of 2004)*

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

*Note:*

3A001(a)(1)(c) does not apply to Metal Insulator Semiconductors (MIS).  
(L.N. 65 of 2004)

- (2) “Microprocessor microcircuits”, “microcomputer microcircuits”, microcontroller microcircuits, storage integrated circuits manufactured from a compound semiconductor, analogue-to-digital converters, integrated circuits that contain analogue-to-digital converters and store or process the digitized data, digital-to-analogue 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, Static Random-Access Memories (SRAMs) or ‘non-volatile memories’, having any of the following: (L.N. 132 of 2001; L.N. 254 of 2008; L.N. 89 of 2021; L.N. 85 of 2023)
  - (a) Rated for operation at an ambient temperature above 398 K (125°C);
  - (b) Rated for operation at an ambient temperature below 218 K (-55°C); or
  - (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 designed for civil automobile or railway train applications. (L.N. 89 of 2013; L.N. 85 of 2023)

*Technical Note:*

‘Non-volatile memories’ are memories with data retention over a period of time after a power shutdown. (L.N. 89 of 2021)

- (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. (L.N. 95 of 2006)

- (4) (Repealed L.N. 161 of 2011)
- (5) Analogue-to-Digital Converter (ADC) and Digital-to-Analogue Converter (DAC) integrated circuits, as follows: (L.N. 161 of 2011)
  - (a) Analogue-to-digital converters having any of the following:
    - N.B.:*
      - 1. See also 3A101.
      - 2. For integrated circuits that contain analogue-to-digital converters and store or process the digitized data, see 3A001(a)(14).
    - (1) A resolution of 8 bit or more, but less than 10 bit, with a “sample rate” greater than 1.3 Giga Samples Per Second (GSPS);

- (2) A resolution of 10 bit or more, but less than 12 bit, with a “sample rate” greater than 600 Mega Samples Per Second (MSPS);
- (3) A resolution of 12 bit or more, but less than 14 bit, with a “sample rate” greater than 400 MSPS;
- (4) A resolution of 14 bit or more, but less than 16 bit, with a “sample rate” greater than 250 MSPS;
- (5) A resolution of 16 bit or more with a “sample rate” greater than 65 MSPS;

*Technical Notes:*

- 1. A resolution of n bit corresponds to a quantization of  $2^n$  levels.
  - 2. The resolution of the ADC is the number of bits of the digital output of the ADC that represents the measured analogue input. Effective Number of Bits (ENOB) is not used to determine the resolution of the ADC.
  - 3. For “multiple channel ADCs”, the “sample rate” is not aggregated and the “sample rate” is the maximum rate of any single channel.
  - 4. For “interleaved ADCs” or for “multiple channel ADCs” that are specified to have an interleaved mode of operation, the “sample rates” are aggregated and the “sample rate” is the maximum combined total rate of all of the interleaved channels. (*L.N. 89 of 2021*)
- (b) Digital-to-Analogue Converters (DAC) having any of the following:
- (1) A resolution of 10 bit or more but less than 12 bit, with an ‘adjusted update rate’ exceeding 3 500 MSPS; (*L.N. 85 of 2023*)
  - (2) A resolution of 12 bit or more and having any of the following:
    - (a) An ‘adjusted update rate’ exceeding 1 250 MSPS but not exceeding 3 500 MSPS, and having any of the following:
      - (1) A settling time less than 9 ns to 0.024% of full scale from a full scale step;
      - (2) A ‘Spurious Free Dynamic Range’ (SFDR) greater than 68 dBc (carrier) when synthesizing a full scale analogue signal of 100 MHz or the highest full scale analogue signal frequency specified below 100 MHz;
    - (b) An ‘adjusted update rate’ exceeding 3 500 MSPS; (*L.N. 85 of 2023*)

*Technical Notes:*

- 1. ‘Spurious Free Dynamic Range’ (SFDR) is defined as the ratio of the RMS value of the carrier frequency (maximum signal component) at the input of the DAC to the RMS value of the next largest noise or harmonic distortion component at its output.
- 2. SFDR is determined directly from the specification table or from the characterisation plots of SFDR versus frequency.
- 3. A signal is defined to be full scale when its amplitude is greater than – 3 dBfs (full scale).

4. 'Adjusted update rate' for DACs:
  - (a) For conventional (non-interpolating) DACs, the 'adjusted update rate' is the rate at which the digital signal is converted to an analogue signal and the output analogue values are changed by the DAC. For DACs where the interpolation mode may be bypassed (interpolation factor of one), the DAC should be considered as a conventional (non-interpolating) DAC.
  - (b) For interpolating DACs (oversampling DACs), the 'adjusted update rate' is defined as the DAC update rate divided by the smallest interpolating factor. For interpolating DACs, the 'adjusted update rate' may be referred to by different terms including:
    - (1) input data rate;
    - (2) input word rate;
    - (3) input sample rate;
    - (4) maximum total input bus rate; *and*
    - (5) maximum DAC clock rate for DAC clock input. (*L.N. 161 of 2011*)
- (6) Electro-optical and "optical integrated circuits" designed for "signal processing" having all of the following:
  - (a) One or more than one internal "laser" diode;
  - (b) One or more than one internal light detecting element; *and*
  - (c) Optical waveguides;
- (7) Field programmable logic devices having any of the following: (*L.N. 42 of 2017*)
  - (a) A maximum number of single-ended digital input or outputs that is greater than 700; (*L.N. 89 of 2013*)
  - (b) An 'aggregate one-way peak serial transceiver data rate' of 500 Gb/s or greater; (*L.N. 89 of 2013*)

*Note:*

3A001(a)(7) includes:

- Complex Programmable Logic Devices (CPLDs)
- Field Programmable Gate Arrays (FPGAs)
- Field Programmable Logic Arrays (FPLAs)
- Field Programmable Interconnects (FPICs)

*(L.N. 89 of 2021)*

*N.B.:*

For integrated circuits having field programmable logic devices that are combined with an analogue-to-digital converter, see 3A001(a)(14). (*L.N. 89 of 2021*)

*Technical Notes:*

1. Maximum number of digital input or outputs in 3A001(a)(7)(a) is also referred to as maximum user input or outputs or maximum available input or

outputs, whether the integrated circuit is packaged or bare die. (L.N. 226 of 2009; L.N. 42 of 2017)

2. 'Aggregate one-way peak serial transceiver data rate' is the product of the peak serial one-way transceiver data rate times the number of transceivers on the FPGA. (L.N. 89 of 2013; L.N. 42 of 2017)
- (8) Deleted; (L.N. 132 of 2001)
- (9) Neural network integrated circuits;
- (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) More than 1 500 terminals; (L.N. 132 of 2001)
  - (b) A typical "basic gate propagation delay time" of less than 0.02 ns; or (L.N. 132 of 2001)
  - (c) An operating frequency exceeding 3 GHz; (L.N. 226 of 2009)
- (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) An equivalent gate count of more than 3 000 (2 input gates); or (L.N. 132 of 2001)
  - (b) A toggle frequency exceeding 1.2 GHz;
- (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  $\mu$ s. (L.N. 132 of 2001)
- (13) Direct Digital Synthesizer (DDS) integrated circuits having any of the following:
  - (a) A Digital-to-Analogue Converter (DAC) clock frequency of 3.5 GHz or more and a DAC resolution of 10 bit or more, but less than 12 bit;
  - (b) A DAC clock frequency of 1.25 GHz or more and a DAC resolution of 12 bit or more;

*Technical Note:*

The DAC clock frequency may be specified as the master clock frequency or the input clock frequency. (L.N. 89 of 2013)
- (14) Integrated circuits that perform or are programmable to perform all of the following:
  - (a) Analogue-to-digital conversions meeting any of the following:
    - (1) A resolution of 8 bit or more, but less than 10 bit, with a "sample rate" greater than 1.3 Giga Samples Per Second (GSPS);
    - (2) A resolution of 10 bit or more, but less than 12 bit, with a "sample rate" greater than 1.0 GSPS;

- (3) A resolution of 12 bit or more, but less than 14 bit, with a “sample rate” greater than 1.0 GSPS;
  - (4) A resolution of 14 bit or more, but less than 16 bit, with a “sample rate” greater than 400 Mega Samples Per Second (MSPS);
  - (5) A resolution of 16 bit or more with a “sample rate” greater than 180 MSPS;
- (b) Any of the following:
- (1) Storage of digitized data;
  - (2) Processing of digitized data;

*N.B.:*

- 1. For analogue-to-digital converter integrated circuits, see 3A001(a)(5)(a).
- 2. For field programmable logic devices, see 3A001(a)(7).

*Technical Notes:*

- 1. A resolution of n bit corresponds to a quantization of  $2^n$  levels.
- 2. The resolution of the ADC is the number of bits of the digital output of the ADC that represents the measured analogue input. Effective Number of Bits (ENOB) is not used to determine the resolution of the ADC.
- 3. For integrated circuits with non-interleaving “multiple channel ADCs”, the “sample rate” is not aggregated and the “sample rate” is the maximum rate of any single channel.
- 4. For integrated circuits with “interleaved ADCs” or with “multiple channel ADCs” that are specified to have an interleaved mode of operation, the “sample rates” are aggregated and the “sample rate” is the maximum combined total rate of all of the interleaved channels. (*L.N. 89 of 2021*)

- (b) Microwave or millimeter wave items, as follows: (*L.N. 89 of 2021*)

*Technical Note:*

For the purposes of 3A001(b), the parameter peak saturated power output may be referred to on product data sheets as output power, saturated power output, maximum power output, peak power output or peak envelope power output. (*L.N. 27 of 2015*)

- (1) “Vacuum electronic devices” and cathodes, as follows: (*L.N. 89 of 2021*)

*Notes:*

- 1. 3A001(b)(1) does not control “vacuum electronic devices” designed or rated for operation in any frequency band which meets both of the following characteristics: (*L.N. 89 of 2021*)
  - (a) Does not exceed 31.8 GHz; *and*
  - (b) Is “allocated by the ITU” for radio-communications services, but not for radio-determination.
- 2. 3A001(b)(1) does not control non-“space-qualified” “vacuum electronic devices” which meet both of the following characteristics: (*L.N. 45 of 2010; L.N. 89 of 2021*)
  - (a) An average output power equal to or less than 50 W; *and*

- (b) Designed or rated for operation in any frequency band which meets both of the following characteristics:
  - (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. *(L.N. 65 of 2004)*
- (a) Travelling-wave “vacuum electronic devices”, pulsed or continuous wave, as follows: *(L.N. 85 of 2023)*
  - (1) Devices operating at frequencies exceeding 31.8 GHz; *(L.N. 85 of 2023)*
  - (2) Devices having a cathode heater with a turn on time to rated RF power of less than 3 seconds; *(L.N. 85 of 2023)*
  - (3) Coupled cavity devices, or derivatives of those coupled cavity devices, with a “fractional bandwidth” of more than 7% or a peak power exceeding 2.5 kW;
  - (4) Devices based on helix, folded waveguide, or serpentine waveguide circuits, or derivatives of these items, with any of the following characteristics: *(L.N. 85 of 2023)*
    - (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) An “instantaneous bandwidth” of one octave or less, and average power (expressed in kW) times frequency (expressed in GHz) of more than 1;
    - (c) Being “space-qualified”;
    - (d) Having a gridded electron gun;
  - (5) Devices with a “fractional bandwidth” greater than or equal to 10% with any of the following: *(L.N. 85 of 2023)*
    - (a) An annular electron beam;
    - (b) A non-axisymmetric electron beam;
    - (c) Multiple electron beams; *(L.N. 89 of 2021)*
- (b) Crossed-field amplifier “vacuum electronic devices” with a gain of more than 17 dB; *(L.N. 89 of 2021)*
- (c) Thermionic cathodes designed for “vacuum electronic devices” producing an emission current density at rated operating conditions exceeding 5 A/cm<sup>2</sup> or a pulsed (non-continuous) current density at rated operating conditions exceeding 10 A/cm<sup>2</sup>; *(L.N. 89 of 2021)*
- (d) “Vacuum electronic devices” with the capability to operate in ‘dual mode’;
 

*Technical Note:*

‘Dual mode’ means the “vacuum electronic device” beam current can be intentionally changed between continuous-wave and pulsed mode operation by use of a grid and produces a peak pulse output power greater than the continuous-wave output power. *(L.N. 89 of 2021)*
- (2) “Monolithic Microwave Integrated Circuit” (“MMIC”) amplifiers that are any of the following:

*N.B.:*

For “MMIC” amplifiers that have an integrated phase shifter, see 3A001(b)(12).  
(*L.N. 89 of 2021*)

- (a) Rated for operation at frequencies exceeding 2.7 GHz up to and including 6.8 GHz with a “fractional bandwidth” greater than 15%, and having any of the following:
  - (1) A peak saturated power output greater than 75 W (48.75 dBm) at any frequency exceeding 2.7 GHz up to and including 2.9 GHz;
  - (2) A peak saturated power output greater than 55 W (47.4 dBm) at any frequency exceeding 2.9 GHz up to and including 3.2 GHz;
  - (3) A peak saturated power output greater than 40 W (46 dBm) at any frequency exceeding 3.2 GHz up to and including 3.7 GHz;
  - (4) A peak saturated power output greater than 20 W (43 dBm) at any frequency exceeding 3.7 GHz up to and including 6.8 GHz;
- (b) Rated for operation at frequencies exceeding 6.8 GHz up to and including 16 GHz with a “fractional bandwidth” greater than 10%, and having any of the following:
  - (1) A peak saturated power output greater than 10 W (40 dBm) at any frequency exceeding 6.8 GHz up to and including 8.5 GHz;
  - (2) A peak saturated power output greater than 5 W (37 dBm) at any frequency exceeding 8.5 GHz up to and including 16 GHz;
- (c) Rated for operation with a peak saturated power output greater than 3 W (34.77 dBm) at any frequency exceeding 16 GHz up to and including 31.8 GHz, and with a “fractional bandwidth” of greater than 10%;
- (d) Rated for operation with a peak saturated power output greater than 0.1 nW (-70 dBm) at any frequency exceeding 31.8 GHz up to and including 37 GHz;
- (e) Rated for operation with a peak saturated power output greater than 1 W (30 dBm) at any frequency exceeding 37 GHz up to and including 43.5 GHz, and with a “fractional bandwidth” of greater than 10%;
- (f) Rated for operation with a peak saturated power output greater than 31.62 mW (15 dBm) at any frequency exceeding 43.5 GHz up to and including 75 GHz, and with a “fractional bandwidth” of greater than 10%;
- (g) Rated for operation with a peak saturated power output greater than 10 mW (10 dBm) at any frequency exceeding 75 GHz up to and including 90 GHz, and with a “fractional bandwidth” of greater than 5%;
- (h) Rated for operation with a peak saturated power output greater than 0.1 nW (-70 dBm) at any frequency exceeding 90 GHz; (*L.N. 27 of 2015*)

*Notes:*

- 1. (*Repealed L.N. 161 of 2011*)
- 2. When the rated operating frequency of an “MMIC” includes frequencies listed in more than one frequency range, as defined by 3A001(b)(2)(a) to 3A001(b)(2)(h), the control status of the “MMIC” is determined by the lowest peak saturated power output threshold. (*L.N. 27 of 2015*)



3. Notes 1 and 2 to sub-category 3A of Category 3 mean that 3A001(b)(2) does not apply to “MMICs” if they are specially designed for other applications, e.g. telecommunications, radar, automobiles. (*L.N. 65 of 2004; L.N. 161 of 2011; E.R. 6 of 2020; L.N. 89 of 2021*)
- (3) Discrete microwave transistors that are any of the following:
    - (a) Rated for operation at frequencies exceeding 2.7 GHz up to and including 6.8 GHz and having any of the following:
      - (1) A peak saturated power output greater than 400 W (56 dBm) at any frequency exceeding 2.7 GHz up to and including 2.9 GHz;
      - (2) A peak saturated power output greater than 205 W (53.12 dBm) at any frequency exceeding 2.9 GHz up to and including 3.2 GHz;
      - (3) A peak saturated power output greater than 115 W (50.61 dBm) at any frequency exceeding 3.2 GHz up to and including 3.7 GHz;
      - (4) A peak saturated power output greater than 60 W (47.78 dBm) at any frequency exceeding 3.7 GHz up to and including 6.8 GHz;
    - (b) Rated for operation at frequencies exceeding 6.8 GHz up to and including 31.8 GHz and having any of the following:
      - (1) A peak saturated power output greater than 50 W (47 dBm) at any frequency exceeding 6.8 GHz up to and including 8.5 GHz;
      - (2) A peak saturated power output greater than 15 W (41.76 dBm) at any frequency exceeding 8.5 GHz up to and including 12 GHz;
      - (3) A peak saturated power output greater than 40 W (46 dBm) at any frequency exceeding 12 GHz up to and including 16 GHz;
      - (4) A peak saturated power output greater than 7 W (38.45 dBm) at any frequency exceeding 16 GHz up to and including 31.8 GHz;
    - (c) Rated for operation with a peak saturated power output greater than 0.5 W (27 dBm) at any frequency exceeding 31.8 GHz up to and including 37 GHz;
    - (d) Rated for operation with a peak saturated power output greater than 1 W (30 dBm) at any frequency exceeding 37 GHz up to and including 43.5 GHz;
    - (e) Rated for operation with a peak saturated power output greater than 0.1 nW (-70 dBm) at any frequency exceeding 43.5 GHz;
    - (f) Other than those specified in 3A001(b)(3)(a) to 3A001(b)(3)(e) and rated for operation with a peak saturated power output greater than 5 W (37.0dBm) at any frequency exceeding 8.5 GHz up to and including 31.8 GHz; (*L.N. 89 of 2021*)

*Notes:*

1. When the rated operating frequency of a transistor mentioned in 3A001(b)(3)(a) to 3A001(b)(3)(e) includes frequencies listed in more than one frequency range, as defined by 3A001(b)(3)(a) to 3A001(b)(3)(e), the control status of the transistor is determined by the lowest peak saturated power output threshold. (*L.N. 85 of 2023*)
2. 3A001(b)(3) includes bare dice, dice mounted on carriers, or dice mounted in packages. Some discrete transistors may be referred to as power amplifiers,

but the control status of these discrete transistors is determined by 3A001(b)(3). (*L.N. 27 of 2015*)

- (4) Microwave solid state amplifiers and microwave assemblies/modules containing microwave solid state amplifiers, that are any of the following:
- (a) Rated for operation at frequencies exceeding 2.7 GHz up to and including 6.8 GHz with a “fractional bandwidth” greater than 15%, and having any of the following:
    - (1) A peak saturated power output greater than 500 W (57 dBm) at any frequency exceeding 2.7 GHz up to and including 2.9 GHz;
    - (2) A peak saturated power output greater than 270 W (54.3 dBm) at any frequency exceeding 2.9 GHz up to and including 3.2 GHz;
    - (3) A peak saturated power output greater than 200 W (53 dBm) at any frequency exceeding 3.2 GHz up to and including 3.7 GHz;
    - (4) A peak saturated power output greater than 90 W (49.54 dBm) at any frequency exceeding 3.7 GHz up to and including 6.8 GHz;
  - (b) Rated for operation at frequencies greater than 6.8 GHz up to and including 31.8 GHz with a “fractional bandwidth” greater than 10%, and having any of the following:
    - (1) A peak saturated power output greater than 70 W (48.45 dBm) at any frequency exceeding 6.8 GHz up to and including 8.5 GHz; (*L.N. 85 of 2023*)
    - (2) A peak saturated power output greater than 50 W (47 dBm) at any frequency exceeding 8.5 GHz up to and including 12 GHz;
    - (3) A peak saturated power output greater than 30 W (44.77 dBm) at any frequency exceeding 12 GHz up to and including 16 GHz;
    - (4) A peak saturated power output greater than 20 W (43 dBm) at any frequency exceeding 16 GHz up to and including 31.8 GHz;
  - (c) Rated for operation with a peak saturated power output greater than 0.5 W (27 dBm) at any frequency exceeding 31.8 GHz up to and including 37 GHz;
  - (d) Rated for operation with a peak saturated power output greater than 2 W (33 dBm) at any frequency exceeding 37 GHz up to and including 43.5 GHz, and with a “fractional bandwidth” of greater than 10%;
  - (e) Rated for operation at frequencies exceeding 43.5 GHz and having any of the following:
    - (1) A peak saturated power output greater than 0.2 W (23 dBm) at any frequency exceeding 43.5 GHz up to and including 75 GHz, and with a “fractional bandwidth” of greater than 10%;
    - (2) A peak saturated power output greater than 20 mW (13 dBm) at any frequency exceeding 75 GHz up to and including 90 GHz, and with a “fractional bandwidth” of greater than 5%;
    - (3) A peak saturated power output greater than 0.1 nW (-70 dBm) at any frequency exceeding 90 GHz;
  - (f) (*Repealed L.N. 89 of 2021*)

*N.B.:*

1. For “MMIC” amplifiers, see 3A001(b)(2).
2. For ‘transmit/receive modules’ and ‘transmit modules’, see 3A001(b)(12).
3. For converters and harmonic mixers, designed to extend the operating or frequency range of signal analysers, signal generators, network analysers or microwave test receivers, see 3A001(b)(7). (*L.N. 89 of 2021*)

*Notes:*

1. (*Repealed L.N. 161 of 2011*)
2. When the rated operating frequency of an item includes frequencies listed in more than one frequency range, as defined by 3A001(b)(4)(a) to 3A001(b)(4)(e), the control status of the item is determined by the lowest peak saturated power output threshold. (*L.N. 27 of 2015*)
3. (*Repealed L.N. 89 of 2021*)
- (5) Electronically or magnetically tunable band-pass or band-stop filters having more than 5 tunable resonators capable of tuning across a 1.5:1 frequency band ( $f_{\max}/f_{\min}$ ) in less than 10  $\mu$ s having any of the following:
  - (a) A band-pass bandwidth of more than 0.5% of centre frequency; *or*
  - (b) A band-stop bandwidth of less than 0.5% of centre frequency;
- (6) Deleted; (*L.N. 65 of 2004*)
- (7) Converters and harmonic mixers, that meet any of the following descriptions:
  - (a) Designed to extend the frequency range of “signal analysers” beyond 90 GHz;
  - (b) Designed to extend the operating range of signal generators:
    - (1) Beyond 90 GHz;
    - (2) To an output power greater than 100 mW (20 dBm) anywhere within the frequency range exceeding 43.5 GHz but not exceeding 90 GHz;
  - (c) Designed to extend the operating range of network analysers:
    - (1) Beyond 110 GHz;
    - (2) To an output power greater than 31.62 mW (15 dBm) anywhere within the frequency range exceeding 43.5 GHz but not exceeding 90 GHz;
    - (3) To an output power greater than 1 mW (0 dBm) anywhere within the frequency range exceeding 90 GHz but not exceeding 110 GHz;
  - (d) Designed to extend the frequency range of microwave test receivers beyond 110 GHz; (*L.N. 42 of 2017*)
- (8) Microwave power amplifiers containing “vacuum electronic devices” specified in 3A001(b)(1) and having all of the following: (*L.N. 254 of 2008; L.N. 89 of 2021*)
  - (a) Operating frequencies above 3 GHz;
  - (b) An average output power to mass ratio exceeding 80 W/kg; *and* (*L.N. 226 of 2009; L.N. 45 of 2010*)
  - (c) A volume of less than 400 cm<sup>3</sup>;

*Note:*

3A001(b)(8) does not include 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. (*L.N. 132 of 2001; L.N. 254 of 2008*)

- (9) Microwave power modules (MPM) consisting of, at least, a travelling-wave “vacuum electronic device”, a “Monolithic Microwave Integrated Circuit” (“MMIC”) and an integrated electronic power conditioner and having all of the following characteristics: (*L.N. 89 of 2021; L.N. 85 of 2023*)
- (a) A ‘turn-on time’ from off to fully operational in less than 10 seconds;
  - (b) A volume less than the maximum rated power in watts multiplied by 10 cm<sup>3</sup>/W;
  - (c) An “instantaneous bandwidth” greater than 1 octave ( $f_{\max} > 2f_{\min}$ ) and having any of the following characteristics:
    - (1) For frequencies equal to or less than 18 GHz, an RF output power greater than 100 W;
    - (2) A frequency greater than 18 GHz;

*Technical Notes:*

- 1. 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. (*E.R. 6 of 2020*)
- 2. 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 W × 10 cm<sup>3</sup>/W = 200 cm<sup>3</sup>. (*L.N. 254 of 2008*)

- (10) Oscillators or oscillator assemblies, specified to operate with a single sideband (SSB) phase noise, in dBc/Hz, less (better) than  $-(126 + 20 \log_{10} F - 20 \log_{10} f)$  anywhere within the range of  $10 \text{ Hz} \leq F \leq 10 \text{ kHz}$ ; (*L.N. 42 of 2017*)

*Technical Note:*

In 3A001(b)(10), F is the offset from the operating frequency in Hz and f is the operating frequency in MHz. (*L.N. 226 of 2009*)

- (11) “Frequency synthesiser” “electronic assemblies” having a “frequency switching time” as specified by any of the following: (*L.N. 161 of 2011*)
- (a) Less than 143 ps; (*L.N. 89 of 2013*)
  - (b) Less than 100 μs for any frequency change exceeding 2.2 GHz within the synthesised frequency range exceeding 4.8 GHz but not exceeding 31.8 GHz; (*L.N. 89 of 2013*)
  - (c) (*Repealed L.N. 89 of 2021*)
  - (d) Less than 500 μs for any frequency change exceeding 550 MHz within the synthesised frequency range exceeding 31.8 GHz but not exceeding 37 GHz;
  - (e) Less than 100 μs for any frequency change exceeding 2.2 GHz within the synthesised frequency range exceeding 37 GHz but not exceeding 75 GHz; (*L.N. 85 of 2023*)
  - (f) Less than 100 μs for any frequency change exceeding 5.0 GHz within the synthesised frequency range exceeding 75 GHz but not exceeding 90 GHz; (*L.N. 85 of 2023*)

- (g) Less than 1 ms within the synthesised frequency range exceeding 90 GHz; (L.N. 89 of 2013; L.N. 42 of 2017; L.N. 89 of 2021; L.N. 85 of 2023)

*N.B.:*

For general purpose “signal analysers”, signal generators, network analysers and microwave test receivers, see 3A002(c), 3A002(d), 3A002(e) and 3A002(f) respectively. (L.N. 45 of 2010)

- (12) ‘Transmit/receive modules’, ‘transmit/receive MMICs’, ‘transmit modules’, and ‘transmit MMICs’, rated for operation at frequencies above 2.7 GHz and having all of the following:
  - (a) A peak saturated power output (in watts),  $P_{sat}$ , greater than 505.62 divided by the maximum operating frequency (in GHz) squared [ $P_{sat} > 505.62 \text{ W} \cdot \text{GHz}^2 / f_{\text{GHz}}^2$ ] for any channel;
  - (b) A “fractional bandwidth” of 5% or greater for any channel;
  - (c) Any planar side with length  $d$  (in cm) equal to or less than 15 divided by the lowest operating frequency (in GHz) [ $d \leq 15 \text{ cm} \cdot \text{GHz} \cdot N / f_{\text{GHz}}$ ] where  $N$  is the number of transmit or transmit/receive channels;
  - (d) An electronically variable phase shifter per channel;

*Technical Notes:*

1. A ‘transmit/receive module’ is a multifunction “electronic assembly” that provides bidirectional amplitude and phase control for transmission and reception of signals.
2. A ‘transmit module’ is an “electronic assembly” that provides amplitude and phase control for transmission of signals.
3. A ‘transmit/receive MMIC’ is a multifunction “MMIC” that provides bidirectional amplitude and phase control for transmission and reception of signals.
4. A ‘transmit MMIC’ is a “MMIC” that provides amplitude and phase control for transmission of signals.
5. 2.7 GHz should be used as the lowest operating frequency ( $f_{\text{GHz}}$ ) in the formula in 3A001(b)(12)(c) for ‘transmit/receive modules’ or ‘transmit modules’ that have a rated operation range extending downward to 2.7 GHz and below [ $d \leq 15 \text{ cm} \cdot \text{GHz} \cdot N / 2.7 \text{ GHz}$ ].
6. 3A001(b)(12) applies to ‘transmit/receive modules’ or ‘transmit modules’ with or without a heat sink. The value of length  $d$  in 3A001(b)(12)(c) does not include any portion of the ‘transmit/receive module’ or ‘transmit module’ that functions as a heat sink.
7. ‘Transmit/receive modules’, ‘transmit/receive MMICs’, ‘transmit modules’ or ‘transmit MMICs’ may or may not have  $N$  integrated radiating antenna elements where  $N$  is the number of transmit or transmit/receive channels. (L.N. 89 of 2021)

- (c) Acoustic wave devices, as follows, and specially designed components therefor:
  - (1) Surface acoustic wave and surface skimming (shallow bulk) acoustic wave devices, having any of the following: (L.N. 226 of 2009)
    - (a) A carrier frequency exceeding 6 GHz;

- (b) A carrier frequency exceeding 1 GHz, but not exceeding 6 GHz, and having any of the following: *(L.N. 254 of 2008)*
  - (1) A ‘frequency side-lobe rejection’ exceeding 65 dB; *(L.N. 226 of 2009)*
  - (2) A product of the maximum delay time and the bandwidth (time in  $\mu\text{s}$  and bandwidth in MHz) of more than 100;
  - (3) A bandwidth greater than 250 MHz; *or*
  - (4) A dispersive delay of more than 10  $\mu\text{s}$ ; *or*
- (c) A carrier frequency of 1 GHz or less, having any of the following:
  - (1) A product of the maximum delay time and the bandwidth (time in  $\mu\text{s}$  and bandwidth in MHz) of more than 100;
  - (2) A dispersive delay of more than 10  $\mu\text{s}$ ; *or*
  - (3) A ‘frequency side-lobe rejection’ exceeding 65 dB and a bandwidth greater than 100 MHz; *(L.N. 226 of 2009)*

*Technical Note:*

The term ‘frequency side-lobe rejection’ means the maximum rejection value specified in data sheet. *(L.N. 226 of 2009)*

- (2) Bulk (volume) acoustic wave devices which permit the direct processing of signals at frequencies exceeding 6 GHz; *(L.N. 226 of 2009)*
- (3) Acoustic-optic “signal processing” devices employing interaction between acoustic waves (bulk wave or surface wave) and light waves which permit the direct processing of signals or images, including spectral analysis, correlation or convolution; *(L.N. 254 of 2008)*

*Note:*

3A001(c) does not include acoustic wave devices that are limited to a single band pass, low pass, high pass or notch filtering, or resonating function. *(L.N. 226 of 2009)*

- (d) Electronic devices and circuits containing components, manufactured from “superconductive” materials specially designed for operation at temperatures below the “critical temperature” of at least one of the “superconductive” constituents, with any of the following:
  - (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*
  - (2) Frequency selection at all frequencies using resonant circuits with Q-values exceeding 10 000; *(L.N. 132 of 2001)*
- (e) High energy devices, as follows:
  - (1) ‘Cells’ as follows:
    - (a) ‘Primary cells’ having any of the following at 20°C:
      - (1) ‘Energy density’ exceeding 550 Wh/kg and a ‘continuous power density’ exceeding 50 W/kg;
      - (2) ‘Energy density’ exceeding 50 Wh/kg and a ‘continuous power density’ exceeding 350 W/kg; *(L.N. 89 of 2021)*

- (b) ‘Secondary cells’ having an ‘energy density’ exceeding 350 Wh/kg at 20°C; (L.N. 89 of 2013; L.N. 89 of 2021)

*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 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.
5. For the purpose of 3A001(e)(1)(a), ‘continuous power density’ (W/kg) is calculated from the nominal voltage multiplied by the specified maximum continuous discharge current in ampere (A) divided by the mass in kilograms. ‘Continuous power density’ is also referred to as specific power. (L.N. 89 of 2021)

*Note:*

3A001(e)(1) does not apply to batteries, including single cell batteries. (L.N. 85 of 2023)

- (2) High energy storage capacitors, as follows:

*N.B.:*

See also 3A201(a) and the Munitions List. (L.N. 27 of 2015)

- (a) Capacitors with a repetition rate of less than 10 Hz (single shot capacitors) having all of the following:
- (1) A voltage rating equal to or more than 5 kV;
  - (2) An energy density equal to or more than 250 J/kg; *and*
  - (3) A total energy equal to or more than 25 kJ;
- (b) Capacitors with a repetition rate of 10 Hz or more (repetition rated capacitors) having all of the following:
- (1) A voltage rating equal to or more than 5 kV;
  - (2) An energy density equal to or more than 50 J/kg;
  - (3) A total energy equal to or more than 100 J; *and*
  - (4) A charge/discharge cycle life equal to or more than 10 000;
- (3) “Superconductive” electromagnets and solenoids specially designed to be fully charged or discharged in less than one second, having all of the following:

*N.B.:*

See also 3A201(b).

- (a) Energy delivered during the discharge exceeding 10 kJ in the first second;
- (b) Inner diameter of the current carrying windings of more than 250 mm; *and*
- (c) Rated for a magnetic induction of more than 8 T or “overall current density” in the winding of more than 300 A/mm<sup>2</sup>;

*Note:*

3A001(e)(3) does not control “superconductive” electromagnets or solenoids specially designed for Magnetic Resonance Imaging (MRI) medical equipment.

- (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 metre (W/m<sup>2</sup>); (*L.N. 45 of 2010*)

*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). (*L.N. 254 of 2008*)

- (f) Rotary input type absolute position encoders having an “accuracy” equal to or less (better) than 1.0 second of arc and specially designed encoder rings, discs or scales for such encoders; (*L.N. 226 of 2009; L.N. 89 of 2021; L.N. 85 of 2023*)
- (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 characteristics:
  - (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;
  - (2) A maximum turn-on current rate of rise (di/dt) greater than 2 000 A/μs and having all of the following characteristics:
    - (a) An off-state peak voltage equal to or greater than 3 000 V;
    - (b) A peak (surge) current equal to or greater than 3 000 A;

*Notes:*

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

*Technical Note:*

For the purposes of 3A001(g), a ‘thyristor module’ contains one or more thyristor devices. (*L.N. 254 of 2008*)



- (h) Solid-state power semiconductor switches, diodes, or ‘modules’, having all of the following:
- (1) Rated for a maximum operating junction temperature greater than 488 K (215°C);
  - (2) Repetitive peak off-state voltage (blocking voltage) exceeding 300 V;
  - (3) Continuous current greater than 1 A;

*Notes:*

1. Repetitive peak off-state voltage in 3A001(h) includes drain to source voltage, collector to emitter voltage, repetitive peak reverse voltage and peak repetitive off-state blocking voltage.
2. 3A001(h) includes:
  - Junction Field Effect Transistors (JFETs)
  - Vertical Junction Field Effect Transistors (VJFETs)
  - Metal Oxide Semiconductor Field Effect Transistors (MOSFETs)
  - Double Diffused Metal Oxide Semiconductor Field Effect Transistor (DMOSFET) (*L.N. 85 of 2023*)
  - Insulated Gate Bipolar Transistor (IGBT)
  - High Electron Mobility Transistors (HEMTs)
  - Bipolar Junction Transistors (BJTs)
  - Thyristors and Silicon Controlled Rectifiers (SCRs)
  - Gate Turn-Off Thyristors (GTOs)
  - Emitter Turn-Off Thyristors (ETOs)
  - PiN Diodes
  - Schottky Diodes
3. 3A001(h) does not include switches, diodes, or ‘modules’, incorporated into equipment designed for civil automobile, civil railway or “civil aircraft” applications. (*L.N. 27 of 2015*)

*Technical Note:*

For the purposes of 3A001(h), ‘modules’ contain one or more solid-state power semiconductor switches or diodes. (*L.N. 226 of 2009*)

- (i) Intensity, amplitude, or phase electro-optic modulators, designed for analogue signals and having any of the following:
- (1) A maximum operating frequency of more than 10 GHz but less than 20 GHz, an optical insertion loss equal to or less than 3 dB and having any of the following:
    - (a) A ‘half-wave voltage’ ( $V\pi$ ) less than 2.7 V when measured at a frequency of 1 GHz or below;
    - (b) A  $V\pi$  less than 4 V when measured at a frequency of more than 1 GHz;
  - (2) A maximum operating frequency equal to or greater than 20 GHz, an optical insertion loss equal to or less than 3 dB and having any of the following:
    - (a) A  $V\pi$  less than 3.3 V when measured at a frequency of 1 GHz or below;
    - (b) A  $V\pi$  less than 5 V when measured at a frequency of more than 1 GHz;

*Note:*

3A001(i) includes electro-optic modulators having optical input and output connectors (e.g. fibre-optic pigtails).

*Technical Note:*

For the purposes of 3A001(i), a ‘half-wave voltage’ ( $V\pi$ ) is the applied voltage necessary to make a phase change of 180 degrees in the wavelength of light propagating through the optical modulator. (L.N. 89 of 2021)

3A002 General purpose “electronic assemblies”, modules and equipment, as follows: (L.N. 89 of 2021)

(a) Recording equipment and oscilloscopes, as follows: (L.N. 27 of 2015)

(1)-(4) (Repealed L.N. 27 of 2015)

(5) Deleted;

*N.B.:*

For waveform digitizers and transient recorders, see 3A002(h). (L.N. 89 of 2021)

(6) Digital data recorders having all of the following:

(a) A sustained ‘continuous throughput’ of more than 6.4 Gbit/s to disk or solid-state drive memory;

(b) “Signal processing” of the radio frequency signal data while it is being recorded;

*Technical Notes:*

1. For recorders 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 record to disk or solid-state drive memory without the loss of any information while sustaining the input digital data rate or digitizer conversion rate. (L.N. 89 of 2021)

(7) Real-time oscilloscopes having a vertical root mean square (rms) noise voltage of less than 2% of full scale at the vertical scale setting that provides the lowest noise value for any input 3 dB bandwidth of 60 GHz or greater per channel;

*Note:*

3A002(a)(7) does not apply to equivalent-time sampling oscilloscopes. (L.N. 27 of 2015)

(b) (Repealed L.N. 45 of 2010)

(c) “Signal analysers” as follows: (L.N. 42 of 2017)

(1) “Signal analysers” having a 3 dB resolution bandwidth (RBW) exceeding 40 MHz anywhere within the frequency range exceeding 31.8 GHz but not exceeding 37 GHz; (L.N. 89 of 2021)

(2) “Signal analysers” having a Displayed Average Noise Level (DANL) less (better) than  $-150$  dBm/Hz anywhere within the frequency range exceeding 43.5 GHz but not exceeding 90 GHz; (L.N. 89 of 2013; L.N. 85 of 2023)

- (3) “Signal analysers” having a frequency exceeding 90 GHz; (*L.N. 89 of 2013*)
- (4) “Signal analysers” having all of the following:
  - (a) ‘Real-time bandwidth’ exceeding 170 MHz;
  - (b) Having any of the following:
    - (1) 100% probability of discovery with less than a 3 dB reduction from full amplitude due to gaps or windowing effects of signals having a duration of 15 µs or less;
    - (2) A ‘frequency mask trigger’ function with 100% probability of trigger (capture) for signals having a duration of 15 µs or less; (*L.N. 85 of 2023*)

*Technical Notes:*

*(Repealed L.N. 85 of 2023)*

*Technical Notes:*

1. For the purposes of 3A002(c)(4)(a), ‘real-time bandwidth’ is the widest frequency range for which the analyser can continuously transform time-domain data entirely into frequency-domain results, using a Fourier or other discrete time transform that processes every incoming time point, without a reduction of measured amplitude of more than 3 dB below the actual signal amplitude caused by gaps or windowing effects, while outputting or displaying the transformed data.
2. For the purposes of 3A002(c)(4)(b)(1), probability of discovery is also referred to as probability of intercept or probability of capture.
3. For the purposes of 3A002(c)(4)(b)(1), the duration for 100% probability of discovery is equivalent to the minimum signal duration necessary for the specified level measurement uncertainty.
4. For the purposes of 3A002(c)(4)(b)(2), a ‘frequency mask trigger’ is a mechanism where the trigger function is able to select a frequency range to be triggered on as a subset of the acquisition bandwidth while ignoring other signals that may also be present within the same acquisition bandwidth. A ‘frequency mask trigger’ may contain more than one independent set of limits. (*L.N. 85 of 2023*)

*Note:*

3A002(c)(4) does not apply to those “signal analysers” using only constant percentage bandwidth filters (also known as octave or fractional octave filters). (*L.N. 89 of 2013*)

- (5) (*Repealed L.N. 89 of 2021*)
- (d) Signal generators having any of the following: (*L.N. 42 of 2017*)
  - (1) Specified to generate pulse-modulated signals having all of the following, anywhere within the frequency range exceeding 31.8 GHz but not exceeding 37 GHz: (*L.N. 27 of 2015; L.N. 42 of 2017*)
    - (a) ‘Pulse duration’ of less than 25 ns;
    - (b) On/off ratio equal to or exceeding 65 dB; (*L.N. 89 of 2013*)

- (2) An output power exceeding 100 mW (20 dBm) anywhere within the frequency range exceeding 43.5 GHz but not exceeding 90 GHz; *(L.N. 161 of 2011; L.N. 89 of 2013)*
- (3) A “frequency switching time” as specified below: *(L.N. 161 of 2011)*
  - (a) *(Repealed L.N. 89 of 2013)*
  - (b) Less than 100  $\mu$ s for any frequency change exceeding 2.2 GHz within the frequency range exceeding 4.8 GHz but not exceeding 31.8 GHz; *(L.N. 89 of 2013)*
  - (c) *(Repealed L.N. 42 of 2017)*
  - (d) Less than 500  $\mu$ s for any frequency change exceeding 550 MHz within the frequency range exceeding 31.8 GHz but not exceeding 37 GHz; *or (L.N. 161 of 2011)*
  - (e) Less than 100  $\mu$ s for any frequency change exceeding 2.2 GHz within the frequency range exceeding 37 GHz but not exceeding 75 GHz; *(L.N. 161 of 2011; L.N. 85 of 2023)*
  - (f) *(Repealed L.N. 42 of 2017)*
  - (g) Less than 100  $\mu$ s for any frequency change exceeding 5.0 GHz within the frequency range exceeding 75 GHz but not exceeding 90 GHz; *(L.N. 85 of 2023)*
- (4) Single sideband (SSB) phase noise, in dBc/Hz, specified as being any of the following: *(L.N. 42 of 2017)*
  - (a) Less (better) than  $-(126 + 20 \log_{10}F - 20 \log_{10}f)$  anywhere within the range of  $10 \text{ Hz} \leq F \leq 10 \text{ kHz}$  anywhere within the frequency range exceeding 3.2 GHz but not exceeding 90 GHz;
  - (b) Less (better) than  $-(206 - 20 \log_{10}f)$  anywhere within the range of  $10 \text{ kHz} < F \leq 100 \text{ kHz}$  anywhere within the frequency range exceeding 3.2 GHz but not exceeding 90 GHz; *(L.N. 89 of 2013)*

*Technical Note:*

In 3A002(d)(4), F is the offset from the operating frequency in Hz and f is the operating frequency in MHz. *(L.N. 226 of 2009)*

- (5) ‘RF modulation bandwidth’ of digital baseband signals, specified as being any of the following:
  - (a) Exceeding 2.2 GHz within the frequency range exceeding 4.8 GHz but not exceeding 31.8 GHz;
  - (b) Exceeding 550 MHz within the frequency range exceeding 31.8 GHz but not exceeding 37 GHz;
  - (c) Exceeding 2.2 GHz within the frequency range exceeding 37 GHz but not exceeding 75 GHz; *(L.N. 85 of 2023)*
  - (d) Exceeding 5.0 GHz within the frequency range exceeding 75 GHz but not exceeding 90 GHz; *(L.N. 85 of 2023)*

*Technical Note:*

‘RF modulation bandwidth’ is the Radio Frequency (RF) bandwidth occupied by a digitally encoded baseband signal modulated onto an RF signal. It is also referred

to as information bandwidth or vector modulation bandwidth. I/Q digital modulation is the technical method for producing a vector-modulated RF output signal, and that output signal is typically specified as having an ‘RF modulation bandwidth’. (L.N. 89 of 2021)

- (6) A maximum frequency exceeding 90 GHz; (L.N. 89 of 2021)

*Notes:*

1. For the purpose of 3A002(d), signal generators include arbitrary waveform and function generators.
2. 3A002(d) does not apply to 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. (L.N. 254 of 2008)

*Technical Notes:*

1. The maximum frequency of an arbitrary waveform or function generator is calculated by dividing the sample rate, in samples/second, by a factor of 2.5. (L.N. 89 of 2013)
2. For the purposes of 3A002(d)(1)(a), ‘pulse duration’ is defined as the time interval from the point on the leading edge that is 50% of the pulse amplitude to the point on the trailing edge that is 50% of the pulse amplitude. (L.N. 27 of 2015)

- (e) Network analysers having any of the following:

- (1) An output power exceeding 31.62 mW (15 dBm) anywhere within the operating frequency range exceeding 43.5 GHz but not exceeding 90 GHz; (L.N. 89 of 2013)
- (2) An output power exceeding 1 mW (0 dBm) anywhere within the operating frequency range exceeding 90 GHz but not exceeding 110 GHz; (L.N. 89 of 2013)
- (3) ‘Nonlinear vector measurement functionality’ at frequencies exceeding 50 GHz but not exceeding 110 GHz;

*Technical Note:*

‘Nonlinear vector measurement functionality’ is an instrument’s ability to analyse the test results of devices driven into the large-signal domain or the nonlinear distortion range. (L.N. 89 of 2013)

- (4) A maximum operating frequency exceeding 110 GHz; (L.N. 89 of 2013)

- (f) Microwave test receivers having all of the following:

- (1) A maximum operating frequency exceeding 110 GHz; and (L.N. 65 of 2004; L.N. 89 of 2013)
- (2) Being capable of measuring amplitude and phase simultaneously;

- (g) Atomic frequency standards being any of the following:

- (1) “Space-qualified”;
- (2) Non-rubidium and having a long-term stability less (better) than  $1 \times 10^{-11}$ /month;
- (3) Non-“space-qualified” and having all of the following characteristics:
  - (a) Being a rubidium standard;
  - (b) Long-term stability less (better) than  $1 \times 10^{-11}$ /month;

- (c) Total power consumption of less than 1 Watt; (*L.N. 254 of 2008; L.N. 45 of 2010*)
- (h) “Electronic assemblies”, modules, or equipment, specified to perform all of the following:
  - (1) Analogue-to-digital conversions meeting any of the following:
    - (a) A resolution of 8 bit or more, but less than 10 bit, with a “sample rate” greater than 1.3 Giga Samples Per Second (GSPS);
    - (b) A resolution of 10 bit or more, but less than 12 bit, with a “sample rate” greater than 1.0 GSPS;
    - (c) A resolution of 12 bit or more, but less than 14 bit, with a “sample rate” greater than 1.0 GSPS;
    - (d) A resolution of 14 bit or more, but less than 16 bit, with a “sample rate” greater than 400 Mega Samples Per Second (MSPS);
    - (e) A resolution of 16 bit or more with a “sample rate” greater than 180 MSPS;
  - (2) Any of the following:
    - (a) Output of digitized data;
    - (b) Storage of digitized data;
    - (c) Processing of digitized data;

*N.B.:*

Digital data recorders, oscilloscopes, “signal analysers”, signal generators, network analysers and microwave test receivers are specified in 3A002(a)(6), 3A002(a)(7), 3A002(c), 3A002(d), 3A002(e) and 3A002(f), respectively.

*Technical Notes:*

1. A resolution of n bit corresponds to a quantization of  $2^n$  levels.
2. The resolution of the ADC is the number of bits of the digital output of the ADC that represents the measured analogue input. Effective Number of Bits (ENOB) is not used to determine the resolution of the ADC.
3. For non-interleaved multiple-channel “electronic assemblies”, modules, or equipment, the “sample rate” is not aggregated and the “sample rate” is the maximum rate of any single-channel.
4. For interleaved channels on multiple-channel “electronic assemblies”, modules, or equipment, the “sample rates” are aggregated and the “sample rate” is the maximum combined total rate of all the interleaved channels.

*Note:*

3A002(h) includes ADC cards, waveform digitizers, data acquisition cards, signal acquisition boards and transient recorders. (*L.N. 89 of 2021*)

*(L.N. 42 of 2017)*

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;

*(L.N. 65 of 2004)*

3A101 Electronic equipment, devices and components, other than those controlled by 3A001, as follows:

- (a) Analogue-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; *(L.N. 254 of 2008; L.N. 89 of 2021)*

*Note:*

3A101(b) does not control equipment specially designed for medical purposes.

*Technical Note:*

*(Repealed L.N. 89 of 2021)*

3A102 ‘Thermal batteries’ designed or modified for ‘missiles’;

*Technical Notes:*

- 1. In 3A102, ‘thermal batteries’ are single use batteries that contain a solid non-conducting inorganic salt as the electrolyte. These batteries incorporate a pyrolytic material that, when ignited, melts the electrolyte and activates the battery.
- 2. In 3A102, ‘missiles’ means complete rocket systems and unmanned aerial vehicle systems capable of a range exceeding 300 km.

*(L.N. 254 of 2008)*

3A201 Electronic components, other than those controlled by 3A001, as follows: *(L.N. 95 of 2006)*

- (a) Capacitors having either of the following sets of characteristics:
  - (1) (a) Voltage rating greater than 1.4 kV;
  - (b) Energy storage greater than 10 J;
  - (c) Capacitance greater than 0.5  $\mu\text{F}$ ; *and*
  - (d) Series inductance less than 50 nH; *or*
  - (2) (a) Voltage rating greater than 750 V;
  - (b) Capacitance greater than 0.25  $\mu\text{F}$ ; *and*
  - (c) Series inductance less than 10 nH;
- (b) Superconducting solenoidal electromagnets having all of the following characteristics:
  - (1) Capable of creating magnetic fields greater than 2 T;
  - (2) A ratio of length to inner diameter greater than 2;

- (3) Inner diameter greater than 300 mm; *and*
- (4) Magnetic field uniform to better than 1% over the central 50% of the inner volume; *(L.N. 65 of 2004)*

*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. *(L.N. 65 of 2004)*

- (c) Flash X-ray generators or pulsed electron accelerators having either of the following sets of characteristics:
  - (1) (a) An accelerator peak electron energy of 500 keV or greater but less than 25 MeV; *and*
  - (b) With a ‘figure of merit’ (K) of 0.25 or greater; *or*
  - (2) (a) An accelerator peak electron energy of 25 MeV or greater; *and*
  - (b) 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 (e.g. electron microscopy) 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  $\mu$ s, then Q is the total accelerated charge in Coulombs. If the accelerator beam pulse duration is greater than 1  $\mu$ s, then Q is the maximum accelerated charge in 1  $\mu$ s.

Q equals the integral of i with respect to t, over the lesser of 1  $\mu$ s or the time duration of the beam pulse ( $Q = \int i dt$ ), where i is beam current in amperes and t is time in seconds.

2. ‘Peak power’ = (peak potential in volts)  $\times$  (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  $\mu$ s 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. *(L.N. 65 of 2004)*

3A202      *(Repealed L.N. 183 of 1999)*



3A225 Frequency changers or generators, other than those specified in 0B001(b)(13), usable as a variable or fixed frequency motor drive, having all of the following characteristics: *(L.N. 95 of 2006; L.N. 42 of 2017)*

*N.B.:*

1. “Software” specially designed to enhance or release the performance of a frequency changer or generator to meet the characteristics of 3A225 is specified in 3D225.
  2. “Technology” in the form of keys or codes to enhance or release the performance of a frequency changer or generator to meet the characteristics of 3A225 is specified in 3E225.
- (a) Multiphase output providing a power of 40 VA or greater;
  - (b) Operating at a frequency of 600 Hz or more;
  - (c) Frequency control better (less) than 0.2%;

*Note:*

3A225 does not control frequency changers or generators if they have hardware, “software” or “technology” constraints that limit the performance to less than that specified above, provided they meet any of the following descriptions:

1. They need to be returned to the original manufacturer to make the enhancements or release the constraints;
2. They require “software” as specified in 3D225 to enhance or release the performance to meet the characteristics of 3A225;
3. They require “technology” in the form of keys or codes as specified in 3E225 to enhance or release the performance to meet the characteristics of 3A225.

*Technical Notes:*

1. Frequency changers in 3A225 are also known as converters or inverters.
2. Frequency changers in 3A225 may be marketed as Generators, Electronic Test Equipment, AC Power Supplies, Variable Speed Motors Drives, Variable Speed Drives (VSDs), Variable Frequency Drives (VFDs), Adjustable Frequency Drives (AFDs), or Adjustable Speed Drives (ASDs).

*(L.N. 65 of 2004; L.N. 42 of 2017)*

3A226 High-power direct current power supplies, other than those controlled by 0B001(j)(6), having both of the following characteristics: *(L.N. 95 of 2006)*

- (a) Capable of continuously producing, over a time period of 8 hours, 100 V or greater with current output of 500 A or greater; *and*
- (b) Current or voltage stability better than 0.1% over a time period of 8 hours;

*(L.N. 65 of 2004)*

- 3A227 High-voltage direct current power supplies, other than those controlled by 0B001(j)(5), having both of the following characteristics: *(L.N. 95 of 2006)*
- (a) Capable of continuously producing, over a time period of 8 hours, 20 kV or greater with current output of 1 A or greater; *and*
  - (b) Current or voltage stability better than 0.1% over a time period of 8 hours;
- (L.N. 65 of 2004)*

- 3A228 Switching devices, as follows:
- (a) Cold-cathode tubes, whether gas filled or not, operating similarly to a spark gap, having all of the following characteristics:
    - (1) Containing three or more electrodes;
    - (2) Anode peak voltage rating of 2.5 kV or more;
    - (3) Anode peak current rating of 100 A or more; *and*
    - (4) Anode delay time of 10  $\mu$ s or less;

*Note:*  
3A228(a) includes gas krytron tubes and vacuum sprytron tubes. *(L.N. 85 of 2023)*
  - (b) Triggered spark-gaps having both of the following characteristics:
    - (1) An anode delay time of 15  $\mu$ s or less; *and*
    - (2) Rated for a peak current of 500 A or more;
  - (c) Modules or assemblies with a fast switching function, other than those specified in 3A001(g) or 3A001(h), having all of the following characteristics: *(L.N. 254 of 2008; L.N. 161 of 2011)*
    - (1) Anode peak voltage rating greater than 2 kV;
    - (2) Anode peak current rating of 500 A or more; *and*
    - (3) Turn-on time of 1  $\mu$ s or less;
- (L.N. 65 of 2004)*

- 3A229 High-current pulse generators as follows: *(L.N. 226 of 2009)*
- N.B.:*  
See also Munitions List. *(L.N. 226 of 2009; L.N. 42 of 2017)*
- (a) Detonator firing sets (initiator systems, firesets), including electronically-charged, explosively-driven and optically-driven firing sets, other than those specified in 1A007(a), designed to drive multiple controlled detonators specified in 1A007(b);
  - (b) Modular electrical pulse generators (pulsers) having all of the following characteristics:
    - (1) Designed for portable, mobile, or ruggedized-use;
    - (2) Capable of delivering their energy in less than 15  $\mu$ s into loads of less than 40 ohms;

- (3) Having an output greater than 100 A;
- (4) No dimension greater than 30 cm;
- (5) Weight less than 30 kg;
- (6) Specified for use over an extended temperature range 223 K (-50°C) to 373 K (100°C) or specified as suitable for aerospace applications;

*Note:*

3A229(b) includes xenon flash-lamp drivers.

(c) Micro-firing units having all of the following characteristics:

- (1) No dimension greater than 35 mm;
- (2) Voltage rating of equal to or greater than 1 kV;
- (3) Capacitance equal to or greater than 100 nF; (*L.N. 42 of 2017*)

*(L.N. 65 of 2004; L.N. 42 of 2017)*

3A230 High-speed pulse generators, and ‘pulse heads’ for such generators, having both of the following characteristics: (*L.N. 42 of 2017*)

- (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; (*L.N. 65 of 2004*)

*Technical Notes:*

- 1. In 3A230, ‘pulse transition time’ is defined as the time interval between 10% and 90% voltage amplitude.
- 2. ‘Pulse heads’ are impulse forming networks designed to accept a voltage step function and shape it into a variety of pulse forms that can include rectangular, triangular, step, impulse, exponential, or monocycle types. ‘Pulse heads’ can be an integral part of the pulse generator, they can be a plug-in module to the device or they can be an externally connected device. (*L.N. 42 of 2017*)

3A231 Neutron generator systems, including tubes, having both of the following characteristics:

- (a) Designed for operation without an external vacuum system; *and*
- (b) Utilizing:
  - (1) Electrostatic acceleration to induce a tritium-deuterium nuclear reaction; *or*
  - (2) Electrostatic acceleration to induce a deuterium-deuterium nuclear reaction and capable of an output of  $3 \times 10^9$  neutrons/s or greater; (*L.N. 42 of 2017*)

*(L.N. 65 of 2004)*

3A232 Multipoint initiation systems, other than those specified in 1A007, as follows:

*N.B.:*

See also Munitions List. See 1A007(b) for detonators.

- (a) *(Repealed L.N. 226 of 2009)*
- (b) Arrangements using single or multiple detonators designed to nearly simultaneously initiate an explosive surface (over greater than 5 000 mm<sup>2</sup>) from a single firing signal (with an initiation timing spread over the surface of less than 2.5 µs);

*Note:*

3A232 does not control detonators using only primary explosives, such as lead azide.

*(L.N. 226 of 2009)*

3A233 Mass spectrometers, other than those controlled by 0B002(g), capable of measuring ions of 230 atomic mass units or greater and having a resolution of better than 2 parts in 230, as follows, and ion sources therefor:

- (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 having all of the following features:
  - (1) Having a molecular beam inlet system that injects a collimated beam of analyte molecules into a region of the ion source where the molecules are ionized by an electron beam;
  - (2) Having one or more ‘cold traps’ that can be cooled to a temperature of 193 K (-80°C);

*Technical Notes:*

1. Electron bombardment mass spectrometers in 3A233(d) are also known as electron impact mass spectrometers or electron ionization mass spectrometers.
2. In 3A233(d)(2), a ‘cold trap’ is a device that traps gas molecules by condensing or freezing them on cold surfaces. For the purposes of 3A233(d)(2), a closed loop gaseous helium cryogenic vacuum pump is not a ‘cold trap’. *(L.N. 42 of 2017)*

- (e) *(Repealed L.N. 42 of 2017)*
- (f) Mass spectrometers equipped with a microfluorination ion source designed for actinide or actinide fluorides; *(L.N. 42 of 2017)*

3A234 Striplines to provide low inductance path to detonators with the following characteristics:

- (a) Voltage rating greater than 2 kV; *and*
- (b) Inductance of less than 20 nH;

*(L.N. 42 of 2017)*

3B TEST, INSPECTION AND PRODUCTION EQUIPMENT

3B001 Equipment for the manufacturing of semiconductor devices or materials, as follows, and specially designed components and accessories therefor:

*N.B.:*

See also 2B226. (*L.N. 89 of 2021*)

(a) Equipment designed for epitaxial growth, as follows: (*L.N. 65 of 2004*)

(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; (*L.N. 95 of 2006*)

*Note:*

3B001(a)(1) includes Atomic Layer Epitaxy (ALE) equipment. (*L.N. 226 of 2009*)

(2) Metal Organic Chemical Vapour Deposition (MOCVD) reactors designed for compound semiconductor epitaxial growth of material having 2 or more of the following elements:

(a) aluminium;

(b) gallium;

(c) indium;

(d) arsenic;

(e) phosphorus;

(f) antimony;

(g) nitrogen; (*L.N. 89 of 2013*)

(3) Molecular beam epitaxial growth equipment using gas or solid sources; (*L.N. 132 of 2001*)

(b) Equipment designed for ion implantation, having any of the following: (*L.N. 65 of 2004*)

(1) (*Repealed L.N. 89 of 2013*)

(2) Being designed and optimized to operate at a beam energy of 20 keV or more and a beam current of 10 mA or more for hydrogen, deuterium or helium implant; (*L.N. 89 of 2013*)

(3) Direct write capability; (*L.N. 89 of 2013*)

(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”; (*L.N. 65 of 2004*)

(5) Being designed and optimized to operate at a beam energy of 20 keV or more and a beam current of 10 mA or more for silicon implant into a semiconductor material “substrate” heated to 600°C or greater; (*L.N. 89 of 2013*)

(c) (*Repealed L.N. 89 of 2021*)

(d) (*Repealed L.N. 89 of 2013*)

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

(1) Interfaces for wafer input and output, to which more than two functionally different ‘semiconductor process tools’ specified by 3B001(a) or 3B001(b) are designed to be connected; (*L.N. 89 of 2013; L.N. 89 of 2021*)

- (2) Designed to form an integrated system in a vacuum environment for ‘sequential multiple wafer processing’;

*Note:*

3B001(e) does not apply to automatic robotic wafer handling systems specially designed for parallel wafer processing.

*Technical Notes:*

1. For the purpose of 3B001(e), ‘semiconductor process tools’ refers to modular tools that provide physical processes for semiconductor production that are functionally different, such as deposition, implant or thermal processing. *(L.N. 89 of 2021)*
  2. For the purpose of 3B001(e), ‘sequential multiple wafer processing’ means the capability to process each wafer in different ‘semiconductor process tools’, such as by transferring each wafer from one tool to a second tool and on to a third tool with the automatic loading multi-chamber central wafer handling systems. *(L.N. 45 of 2010)*
- (f) Lithography equipment, as follows: *(L.N. 65 of 2004)*
- (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, having any of the following:
    - (a) A light source wavelength shorter than 193 nm; *(L.N. 95 of 2006; L.N. 42 of 2017)*
    - (b) Capable of producing a pattern with a ‘Minimum Resolvable Feature size’ (MRF) of 45 nm or less; *(L.N. 132 of 2001; L.N. 65 of 2004; L.N. 95 of 2006; L.N. 161 of 2011; L.N. 42 of 2017)*

*Technical Note: (L.N. 132 of 2001)*

The ‘Minimum Resolvable Feature size’ (MRF) is calculated by the following formula:

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

where the K factor = 0.35. *(L.N. 95 of 2006)*

- (2) Imprint lithography equipment capable of producing features of 45 nm or less; *(L.N. 42 of 2017)*

*Note:*

3B001(f)(2) includes:

- (a) Micro contact printing tools;
  - (b) Hot embossing tools;
  - (c) Nano-imprint lithography tools; *and*
  - (d) Step and flash imprint lithography (S-FIL) tools. *(L.N. 254 of 2008)*
- (3) Equipment specially designed for mask making having all of the following characteristics: *(L.N. 89 of 2021)*
    - (a) Using deflected focussed electron beam, ion beam or “laser” beam;
    - (b) Having any of the following characteristics:

- (1) A full-width half-maximum (FWHM) spot size smaller than 65 nm and an image placement less than 17 nm (mean + 3 sigma); *(L.N. 89 of 2021)*
  - (2) *(Repealed L.N. 89 of 2021)*
  - (3) A second-layer overlay error of less than 23 nm (mean + 3 sigma) on the mask; *(L.N. 89 of 2021)*
  - (4) *(Repealed L.N. 85 of 2023)*
- (4) Equipment designed for device processing using direct writing methods, having all of the following:
- (a) A deflected focused electron beam;
  - (b) Having any of the following:
    - (1) A minimum beam size equal to or smaller than 15 nm;
    - (2) An overlay error less than 27 nm (mean + 3 sigma); *(L.N. 85 of 2023)*
- (g) Masks and reticles designed for integrated circuits controlled by 3A001;
- (h) Multi-layer masks with a phase shift layer not specified in 3B001(g) and designed to be used by lithography equipment having a light source wavelength less than 245 nm; *(L.N. 89 of 2021)*
- (1)-(2) *(Repealed L.N. 89 of 2021)*

*Note:*

3B001(h) does not apply to multi-layer masks with a phase shift layer designed for the fabrication of memory devices not specified in 3A001. *(L.N. 89 of 2013)*

*N.B.:*

For masks and reticles, specially designed for optical sensors, see 6B002. *(L.N. 85 of 2023)*

- (i) Imprint lithography templates designed for integrated circuits specified in 3A001; *(L.N. 254 of 2008)*
- (j) Mask “substrate blanks” with multilayer reflector structure consisting of molybdenum and silicon, and having all of the following:
  - (1) Specially designed for ‘Extreme Ultraviolet’ (‘EUV’) lithography;
  - (2) Compliant with SEMI Standard P37;

*Technical Note:*

‘Extreme Ultraviolet’ (‘EUV’) refers to electromagnetic spectrum wavelengths greater than 5 nm and less than 124 nm. *(L.N. 89 of 2021)*

*(L.N. 161 of 2011)*

- 3B002 Test equipment, specially designed for testing finished or unfinished semiconductor devices, as follows, and specially designed components and accessories therefor: *(L.N. 95 of 2006)*
- (a) For testing S-parameters of items controlled by 3A001(b)(3); *(L.N. 65 of 2004)*
  - (b) *(Repealed L.N. 95 of 2006)*
  - (c) For testing items controlled by 3A001(b)(2); *(L.N. 132 of 2001)*
  - (d) *(Repealed L.N. 132 of 2001)*

3C MATERIALS

3C001 Hetero-epitaxial materials consisting of a “substrate” having stacked epitaxially grown multiple layers of any of the following:

- (a) Silicon;
- (b) Germanium; (L.N. 132 of 2001)
- (c) Silicon carbide; or (L.N. 132 of 2001)
- (d) “III/V compounds” of gallium or indium; (L.N. 132 of 2001; L.N. 85 of 2023)

*Note:*

3C001(d) does not apply to a “substrate” having one or more P-type epitaxial layers of GaN, InGaN, AlGaN, InAlN, InAlGaN, GaP, GaAs, AlGaAs, InP, InGaP, AlInP or InGaAlP, independent of the sequence of the elements, except if the P-type epitaxial layer is between N-type layers. (L.N. 89 of 2013; L.N. 89 of 2021)

- (e) Gallium Oxide (Ga<sub>2</sub>O<sub>3</sub>); (L.N. 85 of 2023)
- (f) Diamond; (L.N. 85 of 2023)

3C002 Resist materials, as follows, and “substrates” coated with the following resists: (L.N. 254 of 2008)

- (a) Resists designed for semiconductor lithography as follows:
  - (1) Positive resists adjusted (optimized) for use at wavelengths less than 193 nm but equal to or greater than 15 nm; (L.N. 89 of 2021)
  - (2) Resists adjusted (optimized) for use at wavelengths less than 15 nm but greater than 1 nm; (L.N. 89 of 2013)
- (b) All resists designed for use with electron beams or ion beams, with a sensitivity of 0.01 µcoulomb/mm<sup>2</sup> or better;
- (c) (Repealed L.N. 89 of 2013)
- (d) All resists optimized for surface imaging technologies; (L.N. 89 of 2013)

*Technical Note:*

(Repealed L.N. 89 of 2021)

- (e) All resists designed or optimized for use with imprint lithography equipment specified in 3B001(f)(2) that use either a thermal or photo-curable process; (L.N. 254 of 2008; L.N. 45 of 2010)

3C003 Organo-inorganic compounds, as follows:

- (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%;

*Note:*

3C003 only controls compounds whose metallic, partly metallic or non-metallic element is directly linked to carbon in the organic part of the molecule.

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

*Note:*

3C004 does not control hydrides containing 20% molar or more of inert gases or hydrogen.

- 3C005 High resistivity materials as follows:

- (a) Silicon carbide (SiC), gallium nitride (GaN), aluminium nitride (AlN), aluminium gallium nitride (AlGaN), gallium oxide (Ga<sub>2</sub>O<sub>3</sub>) or diamond semiconductor “substrates”, or ingots, boules, or other preforms of those materials, having resistivities greater than 10 000 ohm-cm at 20°C;
- (b) Polycrystalline “substrates” or polycrystalline ceramic “substrates”, having resistivities greater than 10 000 ohm-cm at 20°C and having at least one non-epitaxial single-crystal layer of silicon (Si), silicon carbide (SiC), gallium nitride (GaN), aluminium nitride (AlN), aluminium gallium nitride (AlGaN), gallium oxide (Ga<sub>2</sub>O<sub>3</sub>) or diamond on the surface of the “substrate”;

*(L.N. 89 of 2021; L.N. 85 of 2023)*

- 3C006 Materials, not specified in 3C001, consisting of a “substrate” specified in 3C005 with at least one epitaxial layer of silicon carbide (SiC), gallium nitride (GaN), aluminium nitride (AlN), aluminium gallium nitride (AlGaN), gallium oxide (Ga<sub>2</sub>O<sub>3</sub>) or diamond

*(L.N. 85 of 2023)*

### 3D SOFTWARE

- 3D001 “Software” specially designed for the “development” or “production” of equipment controlled by 3A001(b) to 3A002(h) or 3B;

*(L.N. 89 of 2021)*

- 3D002 “Software” specially designed for the “use” of equipment specified in 3B001(a), 3B001(b), 3B001(e), 3B001(f) or 3B002;

*(L.N. 65 of 2004; L.N. 42 of 2017; L.N. 89 of 2021)*

3D003 ‘Computational lithography’ “software” specially designed for the “development” of patterns on EUV-lithography masks or reticles;

*Technical Note:*

‘Computational lithography’ is the use of computer modelling to predict, correct, optimize and verify imaging performance of the lithography process over a range of patterns, processes, and system conditions.

*(L.N. 85 of 2023)*

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

*(L.N. 65 of 2004)*

3D005 “Software” specially designed to restore normal operation of a microcomputer, “microprocessor microcircuit” or “microcomputer microcircuit” within 1 ms after an Electromagnetic Pulse (EMP) or Electrostatic Discharge (ESD) disruption, without loss of continuation of operation;

*(L.N. 89 of 2021)*

3D006 ‘Electronic Computer-Aided Design’ (‘ECAD’) “software” specially designed for the “development” of integrated circuits having any “Gate-All-Around Field-Effect Transistor” (‘GAAFET’) structure, and having any of the following:

- (a) Specially designed for implementing ‘Register Transfer Level’ (‘RTL’) to ‘Geometrical Database Standard II’ (‘GDSII’) or equivalent standard;
- (b) Specially designed for optimization of power or timing rules;

*Technical Notes:*

1. ‘Electronic Computer-Aided Design’ (‘ECAD’) is a category of “software” tools used for designing, analyzing, optimizing, and validating the performance of integrated circuit or printed circuit board.
2. ‘Register Transfer Level’ (‘RTL’) is a design abstraction which models a synchronous digital circuit in terms of the flow of digital signals between hardware registers, and the logical operations performed on those signals.
3. ‘Geometrical Database Standard II’ (‘GDSII’) is a database file format for data exchange of integrated circuit or integrated circuit layout artwork.

*(L.N. 85 of 2023)*

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

*(L.N. 89 of 2021)*

3D225 “Software” specially designed to enhance or release the performance of a frequency changer or generator to meet the characteristics of 3A225;

*(L.N. 42 of 2017)*

3E TECHNOLOGY

3E001 “Technology” according to the General Technology Note for the “development” or “production” of equipment or materials specified in 3A, 3B or 3C;

*Notes:*

1. 3E001 does not include “technology” for equipment or components specified in 3A003. *(L.N. 89 of 2021)*
2. 3E001 does not include “technology” for integrated circuits specified in 3A001(a)(3) to (12), having all of the following characteristics: *(L.N. 89 of 2021)*
  - (a) Using “technology” at or above 0.130  $\mu\text{m}$ ; *(L.N. 161 of 2011)*
  - (b) Incorporating multi-layer structures with three or fewer metal layers. *(L.N. 161 of 2011)*
3. 3E001 does not control ‘Process Design Kits’ (‘PDKs’) unless they include libraries implementing functions or technologies for items specified in 3A001.

*Technical Note:*

A ‘Process Design Kit’ (‘PDK’) is a software tool provided by a semiconductor manufacturer to ensure that the required design practices and rules are taken into account in order to successfully produce a specific integrated circuit design in a specific semiconductor process, in accordance with technological and manufacturing constraints (each semiconductor manufacturing process has its particular ‘PDK’). *(L.N. 89 of 2021)*

*(L.N. 254 of 2008)*

3E002 “Technology” according to the General Technology Note other than that specified in 3E001 for the “development” or “production” of a “microprocessor microcircuit”, “microcomputer microcircuit” or 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:

- (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 processor unit’ is 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 and vector registers of at least 32 elements each. *(L.N. 89 of 2021)*

- (b) Designed to perform more than four 64-bit or larger ‘floating-point’ operation results per cycle; *(L.N. 27 of 2015)*

- (c) Designed to perform more than eight 16-bit ‘fixed-point’ multiply-accumulate results per cycle (e.g. digital manipulation of analogue information that has been previously converted into digital form, also known as digital “signal processing”); (*E.R. 6 of 2020; L.N. 89 of 2021*)

*Note:*

*(Repealed L.N. 89 of 2021)*

*Technical Notes:*

1. For the purposes of 3E002(a) and 3E002(b), ‘floating-point’ is defined by IEEE-754.
2. For the purposes of 3E002(c), ‘fixed-point’ refers to a fixed-width real number with both an integer component and a fractional component, and which does not include integer-only formats. (*L.N. 85 of 2023*)

*Notes: (L.N. 85 of 2023)*

1. 3E002 does not control “technology” for multimedia extensions. (*L.N. 89 of 2021*)
2. 3E002 does not include “technology” for microprocessor cores, having all of the following characteristics:
  - (a) Using “technology” at or above 0.130 µm;
  - (b) Incorporating multi-layer structures with 5 or fewer metal layers. (*L.N. 89 of 2021*)
3. 3E002 includes “technology” for the “development” or “production” of digital signal processors and digital array processors. (*L.N. 89 of 2021*)

*(L.N. 254 of 2008; L.N. 85 of 2023)*

3E003 Other “technology” for the “development” or “production” of:

- (a) Vacuum microelectronic devices;
- (b) Hetero-structure semiconductor electronic devices such as high electron mobility transistors (HEMT), hetero-bipolar transistors (HBT), quantum well and super lattice devices; (*L.N. 89 of 2013*)

*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. (*L.N. 65 of 2004; L.N. 89 of 2021*)

- (c) “Superconductive” electronic devices;
- (d) Substrates of diamond for electronic components; (*L.N. 85 of 2023*)
- (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; (*L.N. 132 of 2001*)
- (g) “Vacuum electronic devices” operating at frequencies of 31.8 GHz or higher; (*L.N. 65 of 2004; L.N. 89 of 2021*)
- (h) Substrates of gallium oxide for electronic components; (*L.N. 85 of 2023*)

3E004 “Technology” “required” for the slicing, grinding and polishing of 300 mm diameter silicon wafers to achieve a ‘Site Front least sQuares Range’ (‘SFQR’) less than or equal to 20 nm at any site of 26 mm × 8 mm on the front surface of the wafer and an edge exclusion less than or equal to 2 mm.

*Technical Note:*

For the purposes of 3E004, ‘SFQR’ is the range of maximum deviation and minimum deviation from front reference plane, calculated by least square method with all front surface data including site boundary within a site.

*(L.N. 85 of 2023)*

3E101 “Technology” according to the General Technology Note for the “use” of equipment or “software” specified in 3A001(a)(1) or (2), 3A101, 3A102 or 3D101;

*(L.N. 254 of 2008)*

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

3E201 “Technology” according to the General Technology Note for the “use” of equipment specified in 3A001(e)(2), 3A001(e)(3), 3A001(g), 3A201, 3A225 to 3A234;

*(L.N. 183 of 1999; L.N. 254 of 2008; L.N. 42 of 2017)*

3E225 “Technology” in the form of keys or codes to enhance or release the performance of a frequency changer or generator to meet the characteristics of 3A225;

*(L.N. 42 of 2017)*