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September 9, 2013

Regulatory Policy Division
Bureau of Industry and Security
US Department of Commerce
Room 2099B
14th Street and Pennsylvania Avenue NW.
Washington DC 20230

Email: publiccomments@bis.doc.gov

Re: RIN 0694-AF64
Proposed Changes to Category 3 Electronics

Dear Ms. Hess:

M/A-COM Technology Solutions Inc. ("MACOM") is a leading provider of catalog and custom high performance analog semiconductor solutions for use in wireless and wireline applications across the radio frequency (RF), microwave and millimeterwave spectrum. Our primary markets are Networks, which includes cable television, cellular backhaul, and fiber optics applications; Aerospace and Defense, which includes military communications and public safety applications and civil and military radar applications; Automotive, which includes global positioning modules (GPS) for the automotive industry; and Multi-market, which includes industrial, medical, mobile and scientific applications.

MACOM is pleased to provide the following comments to the proposed changes to the EAR specific to category 3A611. MACOM's comments will be limited to the language and specifications of 3A611.c and 3A611.d. We recognize that it is the intent of the Departments of Defense, State and Commerce to tailor the control text so that it describes only MMIC power amplifiers and discrete microwave transistors that have significant military application. The underlying assumption in the proposed regulation is that the selected parameters of control: frequency range, saturated power, efficiency, and fractional bandwidth can be used to distinguish commercial devices from devices that have significant military applicability. In our experience, performance parameters alone are unable to distinguish commercial devices from military devices. These parameters do not inherently recognize the high performance power and efficiency requirements and other technological demands that manufacturers of state-of–the-art commercial technology are demanding of their vendors. In our view, these performance characteristics alone cannot be considered in isolation when attempting to identify a category of devices that have "significant military application."

The text of 3A611 attempts to identify "military" items using certain performance parameters related to MMIC power amplifiers and discrete power transistors. We believe that these performance parameters, even at the high performance levels enumerated in the text of 3A611, do not lead to a valid conclusion that a particular device is inherently military, or that a device is unlikely to be used in a commercial application or has little commercial appeal due to its inherent "significant military applicability".

- Efficiency. The demand for increased device efficiency has been a significant catalyst for technological innovation in both civil and military systems for decades. For example, manufacturers of commercial cellular base stations (which are essentially high power RF transmitters), are continually driving innovation for increased power and efficiency. This steady push for more powerful system architectures and lower operating costs is a constant driver for commercial innovation, as the demand for state-of-the–art technology grows and the marketplace demands more powerful and highly efficient communication technology. Similarly, in the military domain, increased power and efficiency is also a constant mission, as it can drive both cost and increased system capability.

- Saturated Power (or Total Power Out). Both civil and military systems utilize high power RF devices across the frequency spectrum. Again, using the cellular base station as an example, historically, high power levels were achieved by combining multiple low power devices to create a high power transmitter. As building block device technology has advanced, in particular with the introduction of GaN technology, a single powerful device can now accomplish what in years past took several devices combined together. The reduction in part count leads to simplified manufacturing, lower cost, and more efficient transmitter design; all forceful drivers in the development of ever more sophisticated, powerful and demanding civilian applications. Again, a parallel argument can be constructed for military applications.

- Bandwidth: Modern commercial communications systems are consuming larger and larger bandwidths. This is driven by the shear data volume of today's communications networks. Commercial network equipment OEMs are requiring vendors of semiconductor power device technologies to provide broader bandwidths for increased system capability, as well as for inventory management reasons. The requirements for military systems are very similar, which also require broadband technology. Given the commonality in the technical demands on semiconductor manufacturers to provide powerful building block amplifier devices for civil and military systems, it is not intuitively obvious that the above parameters can accurately and effectively be used to identify and distinguish "civil" versus "military" devices.

The cycle time for commercial technology innovation, as demonstrated by the steady introduction of "next generation" wireless consumer products with vastly increased capabilities, can frequently occur every year or two (think of the progression from 3G to 4G to LTE), while cycle time for military innovation can take a matter of years or even decades to deploy the next generation technology (think of the development and yet to be achieved product cycle for JSF). The development of state-of-the-art power amplifier devices designed for end use in for civil communications systems is driven by the ever increasing quantity of information transmitted over wireless networks. This data density drives:

- The use of high order modulations schemes requiring increased device linearity, in part achieved by operating the device many dB backed off from the saturated power level. To achieve the required radiated power under these linear conditions dictates that the saturated power of the device must increase.

- Higher quality network data links coupled with longer distances between cellular backhaul radios is yet an additional driver for increasing power requirements.

- Operation across broader frequency ranges coupled with OEMs demand to stock fewer parts generates an industry demand for broadband power amplifiers.

These technical and economic factors result in a constant demand for lower cost, higher power, broader bandwidth, and more efficient amplifiers for use in the latest generation of civil communication applications.

In the following sections, comments specific to 3A611.c and 3A611.d will be addressed.

3A611.c Microwave "monolithic integrated circuits" (MMIC) power amplifiers having any of the following…

Table 1 presents a comparison of the control parameters for 3A001.b versus the proposed parameters for 3A611. An analysis of the table will indicate several issues:

1. Power Definition:

    a. 3A001 uses "average output power" to measure the output power of a device. By its definition, "average output power" takes into account the rated duty cycle of the device. 3A611 uses "peak saturated output power" to measure the output power of a device. Thus, for a number of the frequency bands identified in these ECCNs, the only differentiation between 3A001 and 3A611 is the efficiency of the device. Device efficiency thus becomes the defining characteristic which is used to differentiate devices with military significance. Highly efficient devices are in considerable demand, and are currently "in normal commercial use" across

many civil and commercial applications. We do not believe that this characteristic is a valid differentiator to distinguish between civil and military end applications.

2. <u>Operation below 3.2 GHz.</u>

   a. 3A982 controls packaged HEMT devices rated for operation from 2.7 GHz to 3.2 GHz of a given size and power level (Table 2). 3A982 does not control un-packaged devices or bare die, and bare die power amplifier devices rated to operate at frequencies less than 3.2 GHz are currently EAR99. Thus, as proposed 3A611 would impose controls devices which are currently EAR99.

   b. The 2.7 – 2.9 GHz band is recognized world-wide as a standard civilian Air Traffic Control (ATC) band. Designers of modern civilian ATC systems demand high power, highly efficient amplifiers. 3A611 would have the effect of tightly controlling the high power MMICs and transistors that are used in civilian ATC radar systems deployed across the globe.

   c. 3A611.c.X.b, the broadband proposed language for each frequency range, in the definition of the broadband behavior regulates devices which operate far below and whose center frequency is below the performance limits of 3A001 and 3A982 (<2.7 GHz). For example, a MMIC with a 60% bandwidth which operates to 2.7 GHz would have a center frequency of ~2 GHz and a lower operating frequency of 1.45 GHz.

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Table 1 Comparison 3A001 versus 3A611

3A001					3A611				
ECCN	Frequency (GHz)	Power (W) [1]	Bandwidth (%)	Efficiency (%)			Power (W) [2]	Bandwidth (%)	Efficiencies (%)
EAR99	< 3.2	Any	Any	NA	.c.1.a	2.7 – 2.9	>75	>15	≥50
				NA	.c.1.b	2.7 – 2.9	>150	>60	Any
				NA	.c.2.a	2.9 – 3.2	>55	>15	≥45
				NA	.c.2.b	2.9 – 3.2	>110	>55	Any
.b.2.a	3.2 – 6.8	>4	>15	NA	.c.3.a	3.2 – 3.7	>40	>15	≥45
				NA	.c.3.b	3.2 – 3.7	>80	>50	Any
				NA	.c.4.a	3.7 – 6.8	>20	>15	≥40
				NA	.c.4.b	3.7 – 6.8	>40	>45	Any
.b.2.b	6.8 – 16	>1	>10	NA	.c.5.a	6.8 – 8.5	>10	>10	≥40
				NA	.c.5.b	6.8 – 8.5	>20	>40	Any
				NA	.c.6.a	8.5 – 16	>5	>10	≥35
				NA	.c.6.b	8.5 – 16	>10	>40	Any
.b.2.c	16 – 31.8	>0.8	>10	NA	.c.7	16 – 31.8	>3	>10	>20
.b.2.d	31.8 – 37	>0.1nW		NA	.c.8	31.8 – 37	>2	Any	Any
.b.2.e	37 – 43.5	>1		NA	.c.9	37 – 43.5	>1	>10	≥15
.b.2.f	43.5 – 75	>0.03162 (15 dBm)	>10	NA	.c.10	43.5 – 75	>0.3162 (15 dBm)	>10	≥10
.b.2.g	75 – 90	>0.01 (10 dBm)	>5		.c.11	75 – 90	0.01 (10 dBm)	>10	≥10
.b.2.h	>90	0.1nW (-70 dBm)			.c.12	90 – 110	0.001 (0dBm)	Any	Any
					c.13	>110	>100nW (-40 dBm)	Any	Any

[1] 3A001 defines Power as Average Power
[2] 3A611 defines Power as Saturated Peak Power

Table 2 Comparison between 3A982 and 3A611

3A982[3]					3A611				
ECCN	Frequency (GHz)	Power (W) [1]	Bandwidth (%)	Efficiency (%)	ECCN	Frequency (GHz)	Power (W) [2]	Bandwidth (%)	Efficiencies (%)
.b.1	2.7 – 3.2	≥15[1]	Any	Any	.c.1.a	2.7 – 2.9	>75	>15	≥50
.b.2	2.7 – 3.2	≥75[2]	Any	Any	.c.1.b		>150	>60	Any
					.c.2.a	2.9 – 3.2	>55	>15	≥45
					.c.2.b		>110	>55	Any

[1] Average Power
[2] Pulsed Power with 20% duty cycle
[3] Packaged MMIC power amplifiers with physical dimensions less than 43 mm per side

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Table 3 Predominant Civil Applications for Effected By Proposed 3A611 Limits

ECCN	Frequency Range (GHz)	Predominant Civil Application
3A611.c.3.a	3.2 – 3.7	• Covers WiMAX frequency of 3.3 – 3.8 GHz at relevant power levels
3A611.c.3.b		• Covers WiMAX frequency of 3.3 – 3.8 GHz at relevant power levels
3A611.c.4.a	3.7 – 6.8	• Covers WiFi Applications. 20W peak powers are forecast as future system requirements
3A611.c.5.a	6.8 – 8.5	• Covers the 7 GHz and 8 GHz frequency bands used for Point to Point Radios for cellular backhaul. • Bandwidth (BW) used in PA MMICs for this application are >40% • PA power levels are increasing to >10W with increasing efficiency with adoption of GaN
3A611.c.6.a	8.5 – 16.0	• Covers the 10GHz, 11 GHz, 13 GHz and 15 GHz frequency bands used for Point to Point radios for cellular backhaul • BW used in PA MMICs in the band are typically >10% as multiple bands are typically used within the same radio platform • PA power levels are increasing to >3W. The increase is due to higher order modulation schemes and longer path lengths • The industry is pushing toward efficiencies >35% with the adoption of GaN based device technology
3A611.c.7	16 – 31.8	• Commercial Ka-band (29.5 – 30 GHz) commonly using PA output powers >4W and increasing (Applications: Satellite based wireless internet ground stations, Satellite "cable" TC) • Commercial Cellular Backhaul Bands effected by frequency Range: 18 GHz, 23 GHz, 24 GHz, 26 GHz, 28 GHz • BW typically >10% • PA Power levels are on the order of 3W with an industry trend to increase power level due to high order modulation schemes and longer path lengths supported by radios • 24 GHz unlicensed ISM band is gaining popularity for transport of wireless data from the street to the house, within house, business to business, etc. Power levels are currently below 3W but are anticipated to increase as

ECCN	Frequency Range (GHz)	Predominant Civil Application
		modulations schemes become more complex
3A611.c.8	31.8 – 37	• 32 GHz licensed band for commercial cellular backhaul is effected by the low end of the band • PA output powers are typically ~2W. Industry trend to increase power due to higher order modulation schemes and longer path lengths
3A611.c.9	37 – 43.5	• 38 GHz (37 – 39.5 GHz) and 42 GHz (40.5 – 43.5) point to point radio cellular backhaul bands. Radio OEMs are driving toward common PAs between the 38GHz and 42 GHz bands pushing BW >10% • PA power today is 0.5 W. 1.0W requirements will be introduced in 2014.
3A611.c.10	43.5 – 75	• V-band (59-64GHz) unlicensed band is increasing use for commercial small cell cellular networks • V-Band PA MMIC power level are >10 dBm and will increase as higher order modulation schemes and longer path lengths are implemented • A large international market for V-Band radios is emerging with potentially millions of links installed per year. The proposed regulations would effectively eliminate US suppliers from this market • E-Band (71 -76 GHz, 81 – 86 GHz) licensed band is increasing in use for high capacity aggregated cellular backhaul and small cell cellular networks • E-Band PA MMIC power levels exceed 20 dBm with a push to 30 dBm power levels in 2014 driven by higher order modulation schemes and longer path lengths. • E-Band is a large international which is emerging with potentially millions of links installed per year. The proposed regulations would effectively eliminate US suppliers from this market
3A611.c.12	90 – 110	• W-Band: 75-110GHz – the 94GHz region is under consideration for next generation small cell cellular networks. • Systems will require MMIC Pas with power levels >10 dBm

ECCN	Frequency Range (GHz)	Predominant Civil Application
		• Low Noise Amplifier (LNA) output powers in this frequency band will exceed the 0 dBm threshold – thus controlling both power amplifiers and low noise amplifiers, restricting US participation in both transmit and receive chains

From Table 3, it is clear that the proposed 3A611 regulations will impact devices that are currently in normal commercial use, across numerous civilian applications, and that the power, bandwidth and efficiency thresholds, as proposed, will not effectively limit controls to devices with "significant military application." Today, similar and/or higher performing commercial devices are governed by 3A001. The increased regulatory restrictions associated with 3A611 will place a significant burden on US manufacturers, restricting free movement of their product, damaging their ability to compete in a worldwide marketplace.

3A611.d: Discrete Microwave Transistors

Table 4 presents a comparison of the control parameters for transistors operating at frequencies below 3.7 GHz.

- The definition of output power is inconsistent. 3A001 uses "average output power"; 3A982 uses both "average output power" and "pulsed output power"; and 3A611 uses "saturated power". This variation will create confusion and inconsistent results.

- The frequency range from 2.7 GHz– 2.9 GHz is internationally recognized as a standard band for civilian ATC systems. Regulating devices in this band has the effect of limiting US participation in the global civil air traffic control market, and providing an unfair advantage to our worldwide competitors, as well as an incentive for our foreign competitors to invest in developing their own amplifier technology. This particular frequency band is predominantly used for civil ATC rather than military applications. In addition, as we look to the future, the international ATC band is under consideration to be expanded upwards to 3.2 GHz, due to conflicts with civil communications in the lower end of the band.

- The frequency range from 3.1 – 3.5 GHz is not restricted to military use only. The International Telecommunications Union (ITU) designates this band for radio location and the band is also in active use internationally as an additional civilian ATC band. Air traffic control radar requires high power transistors to create high power transmitters for the radar system. The technology evolution from Silicon based devices to GaN based

devices has enabled an increase in power and efficiency of the base transistor. Increased output power both simplifies the design of the transmitter and lowers its overall manufacturing cost. Increased efficiency results in lower operating costs. Today's transistors for ATC can exhibit efficiencies which commonly exceed 60%. See for example Integra Technologies Part: IGN2729M500, a >600W transistor product designed for civil air traffic control, with an efficiency > 60%.

- Today, a bare die transistor of any output power, designed to operate in the civilian ATC frequency range of 2.7 GHz – 2.9 GHz, is classified as EAR99. The proposed 3A611 control parameters would control devices with >400W saturated power (40W average power, 10% duty for a pulsed transistor) with an efficiency of ≥50% (a low value for today's technology). Transistors with these performance parameters are currently in normal commercial use. The effect of the proposed 3A611 language is to move these dual use, uncontrolled devices to a highly controlled category rather than moving devices currently on the USML to the CCL.

- Today, pulsed transistors, packaged or bare die designed for pulsed application with average power <60W (600W Saturated with a 10% duty cycle) are classified as EAR99. The proposed 3A611 language would move devices with >115W, 45% PAE (a low efficiency) from EAR99 to 3A611 control in contradiction to the stated objective of moving devices from the USML to the CCL.

Table 4 Comparison of Transistor Control Parameters below 3.7 GHz

3A001		**3A982 [4]**		**3A611 [5]**		
Freq. (GHz)	**Power[1]**	**Freq. (GHz)**	**Power (W)**	**Freq. (GHz)**	**Power (W)**	**PAE (%)**
		2.7 – 3.2	48 [2]	2.7 – 2.9	>400	≥50
			240 [3]			
				2.9 – 3.2	>205	≥50
3.2 – 6.8	>60			3.2 – 3.7	>115	≥45

[1] Power defined as average power
[2] Power Defined as average power
[3] Power defined as output power with 20% duty cycle
[4] Controls packaged HEMT device with size <43mm per side
[5] Power defined as output power or saturated power

Summary

An analysis of the 3A611 control parameters for MMIC and discrete transistor devices reveals that the proposal has direct impact on devices used in applications which are primarily civil. In many cases, the proposed regulations will move devices from EAR99 status to 3A611 rather than the stated objective of moving devices currently covered by the USML to the CCL.

Underlying the proposed regulations is the assumption that one can measure military significance by using fixed criteria based on performance thresholds measured by power, frequency, bandwidth and efficiency, and one can use this performance data to construct a set of parameters which segregates and identifies devices that have significant military application and that are not in normal commercial use.

If one examines the performance parameters of the wide variety of amplifying devices used in defense critical radar, communications and electronic warfare systems, one finds amplifiers (MMIC and transistor) at a given frequency ranging from very low power to very high power, of narrow to broad bandwidth with a common system push to higher and higher device efficiency. Likewise, civil applications (radar– both ATC and weather, cellular backhaul and other communications applications) span the frequency spectrum. Civil applications require amplifiers from low power to high power, narrow to broadband bandwidth, and are constantly under pressure from commercial marketplace to achieve higher and higher efficiency and greater power levels.

Semiconductor components are the most basic building block of all electronic systems. These basic component level parts are often designed without specific knowledge about the type of system they will be used in, as the desire for power, efficiency and breadth of frequency range are common objectives of both civilian and military systems. At this fundamental building block level, there is no practical way to define a device as inherently “military” based on performance threshold alone. With the tremendous demands on civilian communication networks today, commercial innovation is often the leader in engineering and technological advances, introducing new and more powerful technology every year; while innovations in military systems often occurs at a slower pace, with program lifecycles that can be measured in decades. The lines between civilian and military are not distinguishable by performance alone.

There is wide foreign availability of both amplifier design (Europe- UMS for example, Africa- ELTA for example, Asia- SEDI for example) and semiconductor manufacturing of amplifiers (Europe, Asia). This results in the market reality of highly competitive environment, with widespread global availability of amplifier devices (MMIC and transistor) outside of the United States. Specific to GaN based technology, UMS, SELEX, WIN Semi, SEDI all offer a broad range of GaN based amplifier devices across a broad frequency spectrum. It is fully expected that these companies and others will continue to invest in research and development, and

continually expand their product portfolios in support of the broad international market. The proposed 3A611 regulations will have the effect of severely limiting US participation in civil applications internationally, weakening US companies and technologies while strengthening our international competitors.

Sincerely,

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