Ceramic packages for RF-transistors – the fog is not clearing away

This article being the continuation of the publication «Power RF transistors for Russian and foreign markets» (see EC1, 2013) is devoted to analyzing the analogs of ceramic packages from the world's manufacturers of the power RF transistors and some of the Russian packages. Such an extensive comparison of package analogs of the world's manufacturers is presented for the first time and have not been published before either in foreign countries or in Russia. This material will be useful both for the developers of radio equipment in which RF-transistors are used and for the developers of RF-transistors in foreign countries and in Russia. English version of the analog's comparison table will be presented on the English version of our websites [1].

Specialization of foreign and Russian manufacturers in the RF components market was considered in the first part of this article [2]. In that article there was also mentioned about the lack of single international unification of the ceramic and plastic (molded) packages designations for RF-transistors which is a serious deterrent and limiting factor for transistor and package manufacturers and consumers. The existing very large nomenclature of packages for RF-transistors designed for the different transistor types (bipolar, MOSFET, LDMOS), various output power and die materials (Si, GaAs, SiC, GaN etc) misleads the users by different designations of the identical construction and overall dimensions of the packages from different manufacturers. Moreover, even with the similarity of appearance in the construction, the packages dimensions differ among many manufacturers. Some dimensions (rounding-off radius, minimum and maximum dimension tolerances) do not have the defining value, while other dimensions (mounting dimensions) are very important for users.

The existent two systems of the packages linear overall dimensions (metric and inch) do not bring out any significant inconvenience to users, except for the packages with threaded bonding. In such packages (TO-60, 280 4L etc.) it is necessary to control the thread standard on the package and the nut.

Table 1 shows the summarized information about the main types of the ceramic packages for silicon RF bipolar and MOSFET-transistors in which metalized BeO ceramics is used as MESFET without using the metalized ceramics.

Word «close analog» means that the construction of this package is very close to the other packages in this product line but differ in one or several linear dimensions going beyond the range of their tolerance. As the basic construction and overall dimensions reference the Motorola packages were used, as well as their legal successor Freescale Semiconductor, who is using the identical designations. These companies along with NXP are using the largest nomenclature of the RF-packages in the world. In comparison of the package analogs the priority pair was always Motorola (Freescale)-NXP. As a source of information, package drawings and RF-transistors technical specifications of the companies like Motorola, Freescale, NXP, Microsemi, ST etc. were used [3-12].

As opposed to the IC packages and semiconductor devices, the manufacturers of the RF-transistors make frequent use of brand name packages, which are not unified with the other competitor companies. The will of the RF-transistors manufacturers to «attach» the users only to their own components on account of the proprietary package construction is understandable, but this circumstance even more confuses and complicates the choice. But if the production and consumption volumes of the low-frequency transistors in plastic packages like TO-220, TO-247 etc. are measured in tens and hundreds of millions, but for RF-transistors in the ceramic packages those volumes are measured in tens and hundreds of thousands. That is the reason for

the fact that the above tricks with a proprietary construction which the manufacturers of the expensive RF-transistors are using, do not normally work at the low frequency components market. The latter requires maximal universalization not only for plastic, but also for more expensive ceramic-and-metal and glass-metal packages (TO-264, TO-257, TO-258, SMD-1 etc.).

There is a one more very important feature of the low frequency ceramic-to-metal and glass-to-metal packages for transistors. While for RF-packages the leading manufacturers of RF-transistors have always been dictating their demands for the package design, but for low-frequency components the manufacturers are themselves the buyers of the ceramic-to-metal packages, developed by the specialized companies. This circumstance also makes the package universalization easier, because their suppliers are interested in the maximal sales volumes. RF-transistors manufacturers usually produced the RF-packages by themselves for their own purposes and were reluctant to supply them to their competitors.

The most «hazy» has been and still is the situation with RF-packages for bipolar and MOSFET transistors. By its construction their dies are isolated from the package base by metalized ceramics (BeO or AlN). BeO ceramics have a good thermal conductivity which is important for power and high-power devices, but the recent increasing of environmental restrictions forces to look for its replacement. For some applications it is still possible to use AlN ceramics. Some companies use the assembly technology without BeO ceramics, but for this device category BeO ceramics is still the mainly used material.

Modern silicon LDMOS and GaN MESFET do not use BeO ceramics that is why during the recent years the ceramic packages of such transistors have become appreciably universalized by its construction and overall dimensions but not by the reference designations. Each RF-transistor manufacturer is still using their own designation of the each type of package, though it is identical to the other manufacturers' packages. It is ironic that some of the RF-transistors manufacturers do not even try to assume their own name for such RF-transistors. Thus, Mitsubishi confined themselves to banal package designations: Ceramic (Large) and Ceramic (Small). TriQuint Semiconductor, also following this tendency, designates their packages as Flanged (with flanges) Unflanged (without flanges). But as far as TriQuint has 4-5 types of flanged and unflanged packages each type and both with different dimensions, the author had to assign them numbers from 1 to 6 in order not to confuse the users finally. I hope TriQuint does not count this as an attempt on their intellectual property.

Unfortunately, in Russia the situation with packages for RF-transistors are even more «hazy». In the time of developing the packages for bipolar transistors in former USSR (there just hadn't been RF MOSFET and LDMOS at that time), all the more, there was no objective to unify the construction and dimensions in compliance with the packages of international companies. Modern packages KT-81, KT-82, KT-83 for RF MOSFET also do not have completely unified analogs from any other world manufacturer although they are very close to some of the foreign packages. Packages KT-55, KT-57, KT-59, KT-61, KT-62 etc, used by the plant «Pulsar» are even more far from the international unification, therefore the author did not even include them into the final table. It is obvious, that such «soviet» approach forces these packages to be the products of internal usage only and completely ruins the possibility to export them abroad even for building of the civil transistors with these packages.

There is one more extended version of the file, that was created by the author with the package analog types which includes the part numbers of the world's leading RF-packages manufacturers and suppliers from the USA, Europe and Asia. This version is constantly expanding and used only for company's internal needs for commercial purposes.

The author would like to give a wider coverage to Russian packages, but domestic manufacturers did not give us enough grounds for that, constantly getting out of the discordant steps of the world's RF-market and continue «to be out of step». Most likely, with the lapse of time they will catch this step that is however achieved only at the expense of «labor corns».

In the meantime, I can recommend to Russian customers who want to keep step with the present-day market, to contact our company for choosing the required RF-package type and receiving a service offer for delivery and development in short lead time of the new types of packages both for the RF-transistors and for low-frequency components, sensors, light-emitting diodes, hybrid modules and large-scale integration circuits.

Knowing the market and production problems well, we offer the shipment of burn-in sockets to Russian customers to accommodate the required types of packages.

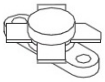
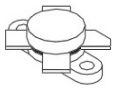
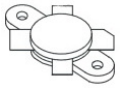
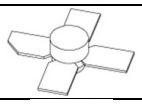
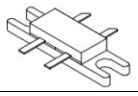
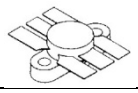
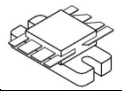
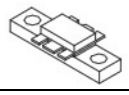
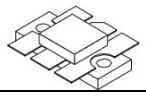
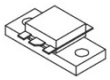
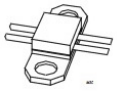
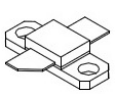
Conclusion

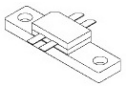
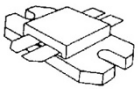
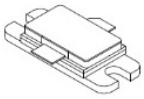
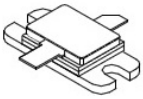
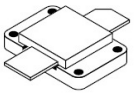
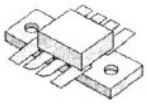
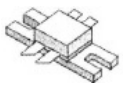
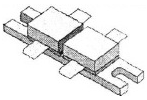
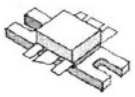
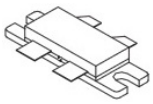
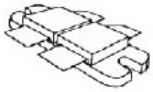
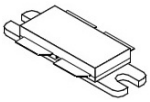
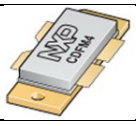
1. There is no international unification of reference designations of ceramic packages for RF-transistors, which complicates the interaction among the developers and suppliers of the packages, transistors and equipment modules.
2. Packages for RF-transistors from Russian manufacturers, including modern RF LDMOS, are carrying on the domestic tendency of several years' standing of noncompliance with even few existing international unification standards.
3. Published for the first time, the extensive comparison of ceramic package analogs for RF transistors from leading world's manufacturers will be helpful to the developers, manufacturers and customers both in Russia and abroad.

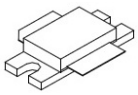
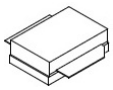
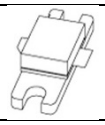
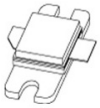
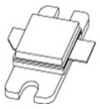
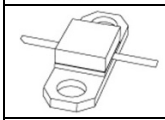
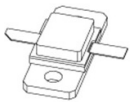
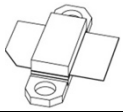
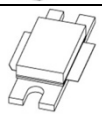
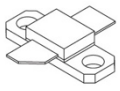
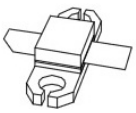
Source literature

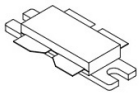
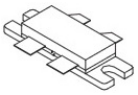
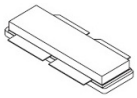
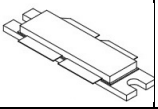
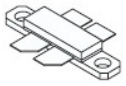
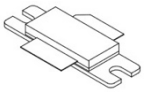
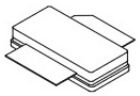
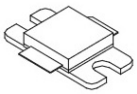
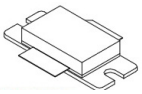
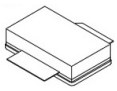
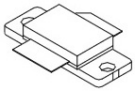
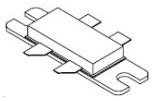
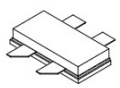
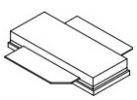
1. *www.syntezmicro.ru, www.syntezmicro.com.*
2. *Dmitry Bodnar. Power RF transistors and packages for Russian and foreign markets. Electronic components. No.1. 2013.*
3. *Motorola Wireless Semiconductor Solutions. Rev.19. 2000.*
4. *Freescale Semiconductor Device Data. RF Product. Rev.16. 2006.*
5. *www.freescale.com.*
6. *www.nxp.com.*
7. *www.microsemi.com.*
8. *www.st.com.*
9. *www.toshilba.co.jp.*
10. *www.semelab.com.*
11. *www.cree.com.*
12. *www.triquint.com.*

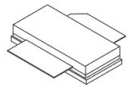
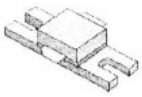
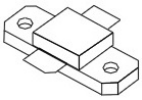
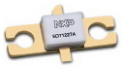
Table 1: Analogs of ceramic packages of RF Transistors manufacturers

View	Dimensions, mm	Russia	Motorola, Freescale	ST	Microsemi	Toshiba	NXP	Semelab	Cree	TriQuint
Bipolar and MOSFET Transistors										
	D-7,24	KT-16	.280 4L; STUD; 244	M122	M122 55FT		SOT122A			
	D-9,28	KT-17	.380 4L STUD; 145A-09	M135	M135	2-10G1A	SOT120A			
	A-25,14; B-6.47; D-9,9	KT-30	211-07	M113	M113	2-10H1A	SOT123A	DA		
	A-25,14; B-6,47; D-12,96		211-11	M174	M174; 55HT; 55HX	2-13B1A	SOT121B	DM		
	A-28,96; B-6,96; D-14,1			M177	M177			DMX		
	D-7,26		249-06		M123; 55FU		SOT122D	DW		
	A-11,18	KT-4-2	TO-60	TO-60	TO-60; M137		---			
	A-25,01; B-6,73		412-01	----	----		SOT268A	DK close analog		
	A-25,14; B-6,6; D-12,95	KT-32 close analog	.500 6L; 316-01	M111	M111; 55HV	2-13C1A	SOT160A	DT		
	A-23.11; B-10,03		744A-01; .400 8FLG	M168	M168; 55JT		SOT161A close analog	DD		
	A-25,01; B-9,52		.230 6LFL; 319-07	M142	M142		SOT273A			
	A-9,27; B-5,96		319A-02	----	----		----			
	A-25,02; B-11,81	KT-56	333-04	----	55JU close analog		---	DV close analog		
	A-25,02; B-10,41		333A-02	----	-----		SOT273A close analog			
	A-24,9; B-5,97		----		----		SOT171A	SOT171		
	A-19,05; B-6,6	KT-44	395B-01; BMA-2	M156	M156		SOT324B	DQ close analog		
	A-19,05; B-6,6		395C-01	----	----		SOT390A			

View	Dimensions, mm	Russia	Motorola, Freescale	ST	Microsemi	Toshiba	NXP	Semelab	Cree	TriQuint
	A-24,9; B-5,97		---	M229	---		SOT279A			
	A-28,19; B-11,81		398-03; .450 BAL	M173	M173; 55RT		SOT289A			
	A-23,11; B-10,03		355E-01; 55AW	SO38; M112	M112; 55AW		SOT473A			
	A-25,05; B-10,03		355J-02	----	close analogs 55SM,M198		SOT448A close analog			
	A-23,11; B-10,03		355C-02	----	55KT		close analogs SOT473A SOT439A			
	A-38,35; B-25,65	KT-102-1	368-03	----	----		---			
	A-23,11; B-10,03	KT-45	744A-01 close analog	----	----		SOT161A			
	A-20,6; B-6,6	KT-81	---; 395B-01 close analog	----	----		--- SOT324B close analog			
	A-38; B-10,1	KT-82	---	----	55KV close analog		---			
	A-20,6; B-6,6	KT-83	---	----	----		---			
	A-34,29; B-10,41		375-04	M208	M208	2-22C2A close analog	SOT262A close analog			
	A-34,17; B-9,91		375-04 close analog	M208 close analog	M208 close analog		SOT262A1 SOT262A1	DR		
	A-42,8; B-11,56		----		M175		----			
	A-34,29; B-10,03		375A-01	M208 close analog	M208 close analog		----			
	A-44,5; B-15,4		----	----	-----		SOT800			
	A-23,11; B-10,16		376B-02	----	M112 close analog		SOT443A close analog			

View	Dimensions, mm	Russia	Motorola, Freescale	ST	Microsemi	Toshiba	NXP	Semelab	Cree	TriQuint
	A-25,53; B-9,91		451-04	----	55QZ close analog		---			
	A-15,88; B-10,41		451A-01	----	----		---			
	A-22,99; B-9,91		----		55AR close analog		SOT391A			
	A-11,54; B-10,93		----				SOT391B			
	A-22,99; B-9,91		----				SOT422A			
	A-22,99; B-9,91		----		55KS close analog		SOT423A			
	A-22,99; B-9,91		----		55LT		SOT437A			
	A-23,1; B-9,9		----		close analogs 55AP,M138		SOT443A			
	A-20,46; B-5,18		----				SOT445A			
	A-25,53; B-9,91		----				SOT448A			
	A-22,99; B-6,43		----				SOT460A			
	A-25,53; B-9,91		----		55QZ		SO468A			
Si LDMOS, SiC MESFET, GaN HEMT Transistors										
	A-20,45; B-5,97		360B-05	M243	55CT 55CX		SOT467C		440095	Flanged EF1
	A-9,78; B-5,97		360C-05; 360C-03	M250	----		---		440206	Unflanged EU1
	A-20,57; B-6,09		360B-01	M243	55CT 55CX		SOT467A		440193	Flanged EF2

View	Dimension, mm	Russia	Motorola, Freescale	ST	Microsemi	Toshiba	NXP	Semelab	Cree	TriQuint
	A-34,16; B-9,91	KT-103 A-1	375G-04	M252	----		SOT540A	D1		
	A-34,29; B-10,41		375-04	M244	M208		SOT1214A			
	A-32,38; B-10,29		375E-04	----	----		SOT539B			
	A-41,28; B-10,29		375D-05; 375D-04	----	----		SOT979A SOT539A			Flanged EF4(20275)
	A-29,1; B-5,97		375F-04	M246	----		SOT1228A		440199	
	A-4,58; B-3,81		458B-03	----	----		SOT1227B		440109	
	A-34,16; B-9,91		465-06	M265	55QX		SOT502A	D2		
	A-20,7; B-9,91		465A-06	----	----		SOT502B		440177	
	A-20,44; B-9,9		465E-04	----	55AR close analog		SOT608A		440162	
	A-10,29; B-10,29		465F-04	----	----		SOT608B		440161	
	A-34,16; B-13,8		465B-03	----	55QM		SOT634			Flanged EF3
	A-23,24; B-13,8		465C-02	----	----		----			Unflanged EU3
	A-27,3; B-9,91		465D-05	----	----		SOT541A			Flanged EF5
	A-34,16; B-9,91		465M-01	----	----		SOT1121A close analog			
	A-20,7; B-9,91		465H-02	----	----		SOT1121B close analog			
	A-23,24; B-9,91		2194				----			

View	Dimension, mm	Russia	Motorola, Freescale	ST	Microsemi	Toshiba	NXP	Semelab	Cree	TriQuint
	A-23,24; B-9,91		2279				----			
	A-9,78; B-5,97		---	----	----		SOT467B			
	A-20,5; B-6,2	KT-55C-1	----	----	55CT 55CX Close analog		SOT504A			
	A-23; B-11	KT-57A-1	---	----	----		---			
	A-13,97; B-4,06						SOT1227A		Style101 440166	
	A-5,08; B-4,06						SOT1227B		Style001 440196	Unflanged EU6

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Package size designation