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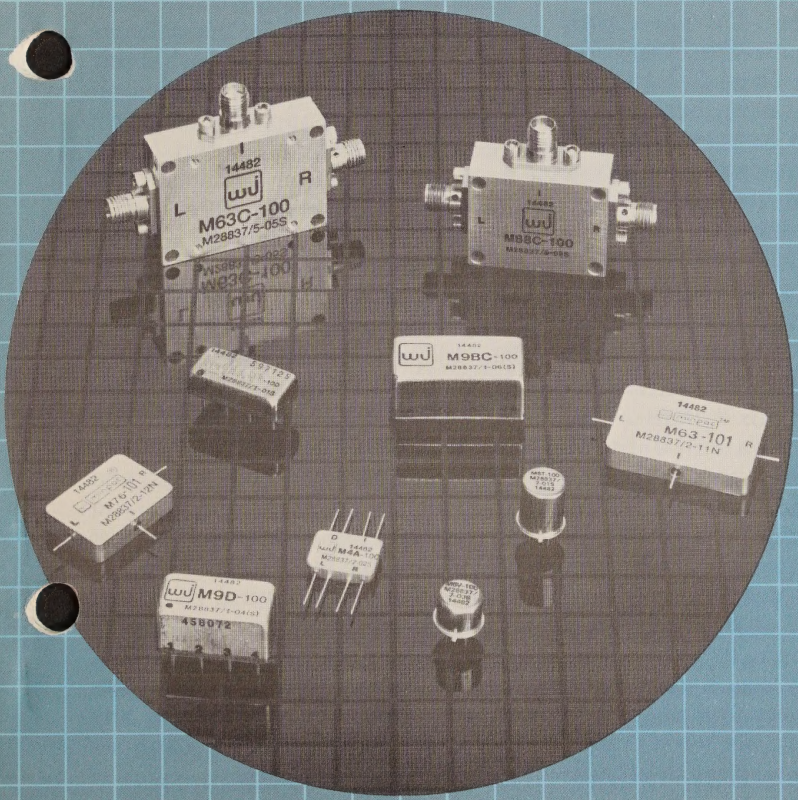
MIL-Specification Mixers



WATKINS-JOHNSON COMPANY Tech-notes

Over the last fifteen years there has been a rising awareness of the need for standardization in the military electronics industry. The Defense Electronics Supply Center (DESC), located in Dayton, Ohio, was created in 1962 as a branch of the Defense Logistics Agency (then the Defense Supply Agency) to consolidate military procurement of commonly-used electronic components within a single organization. DESC provides guidance to military system design engineers by encouraging the use of standard parts in new designs. This greatly enhances the maintainability of a new system by ensuring prompt deliveries, reasonable cost, and reliable performance.

A standard part is a component which is defined by a military specification and which is qualified by DESC to the requirements of that specification. MIL-S-19500, General Specification for Semiconductor Devices and MIL-C-39012, General Specification for Radio-Frequency Coaxial Connectors are two widely known examples of military standard parts specifications. In addition to standardization, these specifications are important because they describe appropriate environmental test methods for their respective technologies. This information is useful to the industry at large, even when standard parts are not being used.

MIL-M-28837, General Specification for Radio-Frequency Mixer Stages, was written in 1977. Watkins-Johnson Company has had mixers qualified to MIL-M-28837 since April of 1981. MIL-M-28837 is important not only as a standardization tool, but also because it applies the test methods of MIL-STD-202 in a comprehensive screening program to mixer technology. Mixers use a variety of assembly techniques that range from lumped element to microstrip to thin-film, making the application of other established screening programs such as MIL-STD-883 Method 5008, and MIL-M-38510 not entirely appropriate.

The Space and Naval Warfare Systems Command is one of the military organizations responsible for generating and maintaining general specifications for standard parts. DESC-ECT (Electronic Component and Tube branch) is the agent that establishes these documents. Information is gathered from interested manufacturers of the subject component and from users of that electronic component before the specification is issued. Manufacturers also provide a detailed description of individual parts, including military usage history, outline, environmental, and electrical data, to DESC-ECT to be included in the detail specification (referred to as a *slash sheet*) associated with the main document. It is only after this data has been incorporated into the slash sheets that a manufacturer may submit an application for approval to begin qualification testing. As part of the application, a Master Equipment List identifying all test equipment, and a copy of the manufacturer's internal documentation for qualification and production must be submitted for review and approval by DESC. DESC also audits manufacturers on a periodic basis — a successful audit is a prerequisite to approval to begin qualification testing. Once a manufacturer has completed qualification testing and is approved by DESC, the qualified part is added to the Qualified Parts List (QPL) attached to the General Specification. There are several rules that qualified suppliers are required to follow. These conditions, listed below, protect the government from changes to parts after qualification and any attempt to use qualification as government endorsement.

Conditions Regarding Qualification Approval

1. Qualified Products List (QPL) listing does not guarantee acceptance of the product in any future purchase.
2. QPL listing does not constitute a waiver of any requirements of the specification or of the provisions of any contract.
3. Advertising of qualification information is permitted. Permission to use such information for advertising or publicity purposes is granted provided that such publicity or advertising does not state or imply that the product is the only product of that type qualified or that the Department of Defense in any way recommends or endorses the manufacturer's product.
4. The listing applies only to products manufactured in the plant(s) specified in the letter of notification.
5. The listing applies to future amendments or revisions of the specification, unless otherwise notified.
6. The listing applies only to products identical to that (those) qualified. The qualifying activity must be advised of any change to the product. Failure to notify the qualifying activity of a change in design is cause for removal from the Qualified Products List, regardless of the extent of the design change.
7. Continued qualification listing is dependent upon the manufacturer's compliance with the retention of qualification, verification of qualification, or periodic requalification requirements, as applicable, in the specification to which the manufacturer's products are qualified. For specifications not containing specific qualification verification or retention requirements, DD Form 1718 must be submitted at intervals to be specified by DESC.

MIL-Specification Mixer Screening

Qualification testing per MIL-M-28837, as described in Table 1, is designed to verify that a specific mixer model meets the physical, environmental and electrical characteristics described in the slash sheets. The screening performed in Groups I and II is nearly identical to that required on each "screened" production lot, stressing the diodes (burn-in) and mechanical construction of the mixer (thermal shock, vibration, mechanical shock, and seal). Group III is a series of tests designed to verify package integrity (solderability, terminal strength, resistance to solvents, and moisture resistance).

Mixer QPL production lots are screened per Group A of MIL-M-28837, as described in Table 2. QPL-qualfied parts are produced to two screening levels: screened (level "s") and non-screened (level "n"). The nonscreened QPL part is a basic commercial mixer which has been verified to meet the electrical and mechanical description contained in the slash sheets. The screened QPL mixer is subjected to a preconditioning bake, 96-hour burn-in, and post burn-in electrical test on a 100% basis. The remaining tests are performed on an AQL of 1.0 per MIL-STD-105.

Qualification maintenance inspection per Group B of MIL-M-28837, as described in Table 3, requires mixers which have successfully completed level "s" screening to be subjected to the same tests described for initial qualification, with the exception of visual mechanical inspection, preconditioning bake, burn-in, and post burn-in electrical test (these screening operations were performed during production

Test	MIL-STD-202 Method	Condition
Group I (4 Sample Units)		
Visual and Mechanical Inspection		Manufacturer In-House Criteria
Bake		24 hours at +100°C
Burn-In		96 hours at +25°C
Post Burn-In Electrical Test	(Note 1)	
Group II (2 Sample Units)		
Thermal Shock	107	B
Vibration	204	D
Mechanical Shock	213	A
Hermeticity	112	C, IIIA
Electrical Test	(Note 1)	
Group III (2 Sample Units)		
Solderability	208	All Terminals
Resistance to Solvents	215	
Resistance to Soldering Heat	210	B
Electrical Test at Temperature Extremes	(Note 1)	
Terminal Strength	211	A, ½ pound applied
Moisture Resistance	106	
Electrical Test	(Note 1)	

Notes:
1. Per the applicable MIL-M-28837 slash sheet.
2. All operations in this table may be modified by the appropriate slash sheet.

Table 1. MIL-M-28837 qualification inspection[2].

Level "N"	Level "S"	Test	MIL-STD-202 Method	Condition	MIL-STD-105 Level II AQL
		Prescreening			
X	X	Preliminary Hermeticity	112	C, IIIA	100%
	X	Bake		25 hours at +100°C	100%
	X	Burn-In		96 hours at +25°C	100%
	X	Post Burn-In Electrical Test	(Note 1)		100%
		Subgroup I			
X	X	Visual and Mechanical Inspection		Manufacturer In-House Criteria	1.0
X	X	Hermeticity	112	C, IIIA	1.0
X	X	Electrical Test	(Note 1)		1.0
		Subgroup II			
	X	Thermal Shock	107	B	1.0
	X	Vibration	204	D	1.0
	X	Hermeticity	112	C, IIIA	1.0
	X	Final Electrical Test	(Note 1)		1.0
X	X	Final Quality Inspection		Manufacturer In-House Criteria	100%

Notes:
1. Per the applicable MIL-M-28837 slash sheet.
2. All operations in this table may be modified by the appropriate slash sheet.

Table 2. MIL-M-28837 Group A inspection[2].

testing). To maintain a QPL listing, Group B inspection must be performed once every two years for each qualified part. Any updates to the Master Equipment List must also be submitted with the Group B report. The qualified manufacturer is subject to DESC audits at any time.

Test	MIL-STD-202 Method	Condition
Subgroup I (2 Sample Units)		
Thermal Shock	107	B
Vibration	204	D
Mechanical Shock	213	A
Hermeticity	112	C, IIIA
Electrical Test	(Note 1)	
Subgroup II (2 Sample Units)		
Solderability	208	All Terminals
Resistance to Solvents	215	
Resistance to Soldering Heat	210	B
Electrical Test at Temperature Extremes	(Note 1)	
Terminal Strength	211	A, ½ pound applied
Moisture Resistance	106	
Electrical Test	(Note 1)	

Notes:
1. Per the applicable MIL-M-28837 slash sheet.
2. All operations in this table may be modified by the appropriate slash sheet.

Table 3. MIL-M-28837 Group B inspection[2].

If any consumer of QPL-qualified mixers identifies a serious quality problem with a particular part, the consumer may issue an alert or request DESC to issue an alert to the industry, identifying the problem, the model(s) affected, and the manufacturers corrective action. All sales of the part(s) may be suspended until the alert is resolved. However, the stringent quality requirements placed on QPL-qualified parts are designed to minimize the frequency of alerts.

Advantages and Disadvantages

There are many advantages to procuring a QPL-qualified mixer over a non-qualified mixer. There is no need to create a specification or source control drawing for a QPL-qualified part. Simply buying to the military part number assigned by DESC, provided the mixer model and manufacturer are listed on the latest issue of the Qualified Products List, will secure a standard part all of whose aspects are described and controlled by MIL-M-28837. Another advantage is reduced delivery time, as the manufacturer has the option to build the QPL-listed items for stock, not to custom order. Prices are considerably less than for special Hi-Rel requirements due to the fact that there are many customers for a given QPL mixer, and the manufacturer is thus able to produce in volume. There are also no nonrecurring engineering (NRE) charges or lot charges involved in QPL procurement. Perhaps most important of all, however, is the knowledge that the quality of the part is constantly being monitored by DESC. Qualification data is available for review, as are qualification maintenance reports. QPL-qualified mixers are controlled so as to improve the maintainability of the systems in which they are used. Procuring spares is also an easy task with a QPL-qualified unit.

Disadvantages also exist for potential users of QPL mixers. The largest drawback is that a QPL part must be screened to exactly meet the requirements of MIL-M-28837, no more, no

less. If a design engineer requires an electrical test not included in the slash sheets, or desires additional printing on the unit, or any such deviation, no matter how minor, the military part number must be removed from the mixer. This is mainly due to DESC's concern that an item printed with the military part number but having special requirements beyond those of MIL-M-28837 would not be able to be differentiated from a normal QPL part, and that when such a part is repaired or reordered it is probable that a normal QPL will be purchased without the additional screening. Another disadvantage is that the variety of mixers listed on the QPL list, although it is growing constantly, cannot encompass the variety of catalog mixers currently available in the industry. In order to take advantage of QPL-qualified mixers, a system designer may have to redraw a board to accept the package style that is qualified. It should be noted that if a part with the desired electrical performance does not appear on the Qualified Parts List, a qualified manufacturer such as Watkins-Johnson Company can screen any of its mixer models to the QPL *equivalent* level per Group A of MIL-M-28837. (These mixers may *not* be printed with a military part number unless qualification testing is performed on the first article produced for the contract.)

There are disadvantages for the manufacturer of QPL-qualified mixers as well. Any change in design of a currently qualified model must be approved by DESC, and if it is deemed necessary, a new qualification may be required. Even if further testing is not required, written approval may involve a wait of several months. Qualifying a mixer to MIL-M-28837 involves a substantial time, money, and energy investment on the part of the manufacturer. To add a model to the slash sheets, the appropriate data must be gathered and submitted to DESC-ECT. A wait of 9 to 24 months is typical prior to the incorporation of this data into the slash sheets. Another several months is consumed by DESC review of the manufacturer's application to perform qualification testing and the manufacturer's documentation. The actual qualification testing takes approximately two months to complete. Finally, there is another wait of several months for DESC to approve the qualification and add the model to the QPL list. This adds up to a minimum of two years' effort by the manufacturer to add a model to the Qualified Products List.

In spite of the time imvolved, many motivations exist for a manufacturer to expend the necessary effort to become qualified. The creation of a Hi-Rel "standard" eliminates many small volume programs which each require unique documentation and engineering attention. QPL-listed mixers are produced in volume, leaving the engineer free to concentrate on manufacturing rather than documentation. The qualification also may be used to perform qualification by similarity for unique programs where qualification is required. This allows the qualified manufacturer to avoid duplication of labor-intensive qualification testing. The QPL listing also demonstrates that the manufacturer has a high quality production facility.

Interpreting The Slash Sheets

Having clearly established the benefits of specifying QPL-listed mixers, it is essential to gain a full understanding of the slash sheets. To determine if a mixer of a certain package type is described in the slash sheets, a quick scan is necessary. Each slash sheet (there are currently nine) contains a

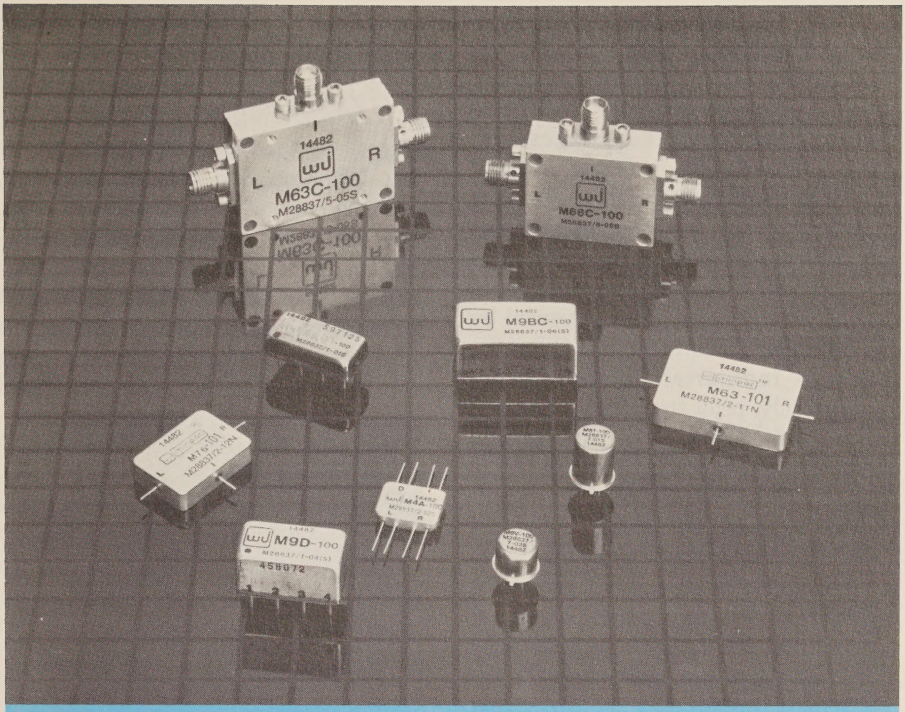


Figure 1. The variety of QPL-qualified package styles.

different package style. For example, slash sheet 1 describes plug-in outlines, slash sheet 2 describes packages with solderable leads, slash sheet 5 describes units with SMA female connectors, and slash sheet 7 describes mixers in TO-5 packages. Once an appropriate package style is located, the next task is to review the electrical description in the slash sheets to determine the desired dash number. The "substitutability data" table at the end of each slash sheet will provide a listing of manufacturers' codes for each dash number. This, however, does not mean that the part has been qualified. The Qualified Products List must be reviewed to determine if that part is qualified, and which manufacturer is qualified to produce it. Currently, mixers are qualified on slash sheets 1, 2, 5, and 7. Watkins-Johnson Company has nineteen qualified mixer models covering input frequencies from 0.05 MHz to 18 GHz. Figure 1 illustrates the variety of qualified product styles. The proper method of calling out a military part number is illustrated in Figure 2.

M28837	/1	-01	S
a	b	c	d

a. The general specification for the component type (i.e., mixers, capacitors, etc.).

b. The appropriate slash sheet for the package style (i.e., plug-in, SMA female connectorized, solderable leads, etc.).

c. The specific electrical characteristics as described in the slash sheets.

d. Indicates screened (s) or nonscreened (n) level testing.

Figure 2. How to interpret a military part number.

In 1972, the Department of Defense (DoD) chartered DESC as the first Military Parts Control Advisory Group (MPCAG) responsible for the Parts Control Program in accordance with MIL-STD-965. The program, covered by DoD Instruction 4120.19 became mandatory for all weapon systems procurements in August 1983. This instruction requires that electronic and mechanical parts be reviewed by technical consultants at DESC and the Defense Industrial Supply Center, respectively, prior to procurement and use in the system. These consultants aid designers in selection and application of components using the maximum number of standard parts possible. Under this program, nonstandard part approval requests must be submitted by the system contractor, reviewed by MPCAG, and approved by the military acquisition office for the system. This process is effectively reducing the number of new stock numbers in the Department of Defense, eliminating duplicate documentation, decreasing the cost of military systems, and improving the reliability of equipment. In the fiscal year ending 30 September 1987, the DESC Military Parts Control Advisory Group supported 934 contracts and has supported over 2,850 contracts since 1972.

There are many advantages to specifying QPL-qualified mixers including, reduced cost, shortened delivery time, and improved reliability. The manufacturer of QPL-qualified mixers may concentrate engineering efforts on maintaining a high-quality production line instead of creating documentation for a variety of virtually idential requirements. The systems manufacturer is relieved of the need to create a source or specification control drawing as the mixer is fully specified by its military part number. The creation of MIL-M-28837 has also filled a need in the military electronics industry for a comprehensive screening program applicable to mixer technology. Through the standardization efforts of the Department of Defense, both the systems designer and the components manufacturer reap benefits, thereby simplifying the process of military systems design and parts procurement.

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Ms. Schindler is also the prime contact for Hi-Reliability mixer products sold internationally. Her involvement in such projects includes interfacing with international customers, providing quotations on technical performance and price, and program management. Among her program management responsibilities are procurement of materials, provision of manufacturing instructions such as scheduling, documentation, assembly, test, and Quality Assurance inspections, and any additional direction to assure product compliance towards customer requirements and satisfaction.

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