SEMICONDUCTOR

CHIPS
DATA BOOK

FIRST EDITION

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FIRST EDITION

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INTRODUCTION

The increasing complexity of today's electronic systems is accompanied by paralleling demands for increased component density, improved subsystem reliability and reduced functional costs. This triple requirement is leading to widespread adaptation of hybrid technologies and consequently, to a rapidly expanding demand for unencapsulated semiconductor components.

Motorola is responding to this demand by making available, in chip form, virtually all of the thousands of discrete and integrated circuit devices in its standard-product catalog. However, the purchase of chips is not always as clear-cut and routine as the purchase of standard packaged devices. Variations in shipping requirements, factory testing and guarantees, as well as delay times involved in the shipment of low-volume production items complicate the vendor/buyer communications interface. Hence, Motorola has developed a system of chip categories intended to reduce earlier complications.

Most important of these categories is an inventory of product chips that are manufactured and stocked just like their fully encapsulated counterparts. This "stock" chip line encompasses the more popular products from most of Motorola's product categories. All other products, though available, must be purchased on special order through individual negotiations.

In addition to these derivatives from standard production lines, Motorola manufactures special-process devices, e.g., beam-lead and flip-chip components, that are not necessarily available in encapsulated form. These devices, designed specifically for the manufacture of hybrid circuits, help to establish Motorola as a major supplier to the hybrid market.

This Chips Data Book is designed to acquaint the hybrid manufacturer not only with the most important products being offered by Motorola in chip form, but also with testing and shipping variations that are available. It does not cover every device that is being manufactured, but represents an authoritative first-evaluation selector guide to chip availability and use.

For complete characterization of the many thousands of components available in chip form, it would be necessary to consult the Motorola Semiconductor Data Library plus all the individual Motorola Data Books covering specific integrated circuit lines. To reduce the complexity of making suitable device selections, this book contains a compilation of available chips representing a cross-section of each major product category. The devices characterized herein include the most popular components covering the total performance spectrum of each product category. The selection consists of units from high volume production runs that insure long-term availability, early delivery and lowest cost.

GENERAL INFORMATION

CHIP AVAILABILITY

Motorola unencapsulated devices encompass three levels of availability: stock, standard and special. They are tested to the same rigid in-process controls of reliability and performance as packaged devices.

Stock Availability applies to chips that have been fully tested to a specified and guaranteed set of parameters. These chips are packaged in a variety of shipping carriers (see page1-8) and are stocked for off-the-shelf delivery at the factory and at Motorola distributors. Stock chips have their own

specific device type numbers and are listed in the Motorola price lists. In this book, stock chips are identified in the selection tables of the product sections by a dot (•) next to the device type number. For applications within the performance capabilities of stock chips, such units merit first consideration on the basis of off-the-shelf delivery and lowest cost.(See table 1.)

Standard Availability applies to all chips (other than stock chips) that are produced on Motorola assembly lines for encapsulated standard product. Such chips are not stocked in chip form and, therefore, are not available for off-the-shelf delivery. Nevertheless, delivery capability is good, particularly for chips coming off high-volume production lines running at a continuous rate. Price and delivery quotations can be obtained from your nearest Motorola sales representative. (See table 1.)

Table 1 — Availability of STOCK and STANDARD Chips by Product Lines

Product Line	Conventional Chip		Beam-Lead Chips	Flip-Chips
	Stock	Standard	Stock	Stock
Linear IC	MCC prefix Op Amps, Voltage Regulators, Comparators, Multipliers	All Linear ICs	MCBC Prefix Op Amps, Regulators, Multipliers, Comparators	MMCF Prefix Op Amps.
Digital Bipolar IC		All MTTL, MRTL, MDTL, MECL Logic Elements	MCBC Prefix, MTTL 5400 Series Functions	
McMOS IC	MCC14000/14500 Series of Complementary MOS Logic			
Silicon Power Transistors	MJC prefix; complementary chips for currents to 25 Amps and voltage to 60 Volts	All silicon power devices including Darlington		
Small-Signal Transistors, FETs, Switching Diodes	MMCS Prefix — broad selection of devices	Nearly all chips from Motorola's metal can, plastic, FET, signal diode product families		MMCF Prefix, Small-Signal Transistors and Diodes
RF Transistors	MMCS Prefix; popular small-signal devices	Most small-signal devices		
Thyristors, Triggers, and Rectifiers		Most signal thyristors, Unijunctions and Triggers Selected power thyristors and rectifiers		
Zener Diodes	MZC Prefix; from 1.8 – 200 Volts	Nearly all Zener Diodes and Current Regulators		
Passive Components	MMCR100 Multi-tap resistor MMCQ100 capacitors from 33 pF to 220 pF MMCQ101 Multi-tap binary capacitor, 1.0 pF to 31 pF	MMCRA Series Resistor chips from 0.1 Ohm – 5.1 M Ohm		

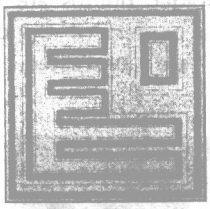
Special Availability refers to chips with special parameter selections or special processing of standard Motorola product. Except for devices requiring special parameter selection from high-volume production lines, delivery should normally be planned far in advance. Moreover, Motorola maintains the right to refuse orders for special devices where the production of such devices would adversely affect the production of standard products. Special devices, therefore, should be considered only if stock or standard devices cannot be adapted to a specific application – and then only if the quantity requirements are relatively large. Orders for special devices can be negotiated through your Motorola sales representative.

Chip Structures(1)

To facilitate the development of hybrid circuits, Motorola offers three different chip structures, permitting three different mounting methods: conventional (face-up) mounting, beam-lead mounting, and flip-chip mounting. Not all devices are offered in all three options, however. The information in Table I provides a quick overview of the kinds of discrete and integrated circuit components generally available in the various structures.

Chips for *conventional mounting* comprise the total assortment of semiconductor chips manufactured by Motorola for encapsulation in standard packages. Such chips are gold-plated on the bottom to provide a good eutectic bond with metallized areas of a hybrid circuit substrate. Connections to the device or circuit elements are made with conventional wire bonding techniques to bonding pads on the top face of the chip. Normally, conventional Motorola chips utilize aluminum for on-chip interconnecting and bonding pad metallization. Wire of either aluminum or gold may be used for connection between on-chip bonding pads and the external circuit.

Conventional Chip



Beam-Lead Chips are designed specifically for hybrid circuit manufacture. Their distinguishing feature is a set of on-chip cantilevered beams used to interconnect the chip circuit element with the substrate circuit bonding pads. In production, a complex integrated circuit chip with a large number of interconnecting beams can be wired to the substrate, forming all necessary interconnections in a single operation using wobble-bonding techniques. In addition, the entire surface of a beam-lead chip, except the beams, is covered with a passivating layer of silicon nitride that is as effective as a hermetically sealed package in protecting the circuit against contamination.

Initially, beam-lead devices were designed primarily for high-reliability applications. In certain applications, however, they can also offer a cost advantage due to the reduced labor cost associated with wiring such devices into a hybrid circuit.

Beam-Lead Chips

Flip-Chips, like beam-lead chips, can be mounted to a hybrid substrate in a single operation.

In the case of flip-chips, connection to the substrate bonding pads is made by means of raised "solder bumps" that protrude above the chip surface at the device or integrated-circuit bonding pads. The devices are mounted to the substrate metallization areas circuit side down, by means of conventional solder reflow techniques.

(1)Semiconductor chips are offered as basic components for the manufacture of hybrid circuits. Motorola also manufactures a wide range of discrete components in micro-miniature packages. Such packages, called micro-T, micro-H, and micro-L, are also suitable for use in hybrid circuits. Details for such packaged devices can be found in the Motorola Semiconductor Data Library, Volume II and the Reference Volume.

Motorola flip-chips are designed for automatic handling and low cost assembly. All transistor and diode chips are 0.030" square, regardless of the actual size of the active area, and all solder bumps are uniformly spaced near the corners of the chip. Flip-chip surfaces are protected by glass passivation.

Flip-Chips

Device Selection Data

The information presented in the subsequent product sections of this data book is compiled from individual product data sheets and from data contained in the Motorola Semiconductor Data Library. The selection tables are arranged to highlight the device characteristics most often needed for a first evaluation and preselection. And provided, as an aid to hybrid-circuit design engineers, are chip size, geometry and metallization.(2)

Chip Size. Each product section contains accurate data of chip periphery. Chip thickness is given only for those chips that depart from the norm, e.g., flip-chips. Conventional chips normally range from 5 mils (min) to 7 mils (max) for small signal devices, and from 7 mils (min) to 9 mils (max) for integrated circuits. Where chips are purchased from the same wafer, normal variation in thickness is less than 0.5 mils.

Chip Geometry. The geometry or front metallization pattern of each chip is illustrated by a sketch taken from the actual metallization mask. Each sketch clearly indicates the bonding pads by function, emitter, base, drain, etc., to assist the designer in formulating hybrid-circuit substrate design.

(2) Future improvements in device design may result in changes in the physical characteristics of chips. All chip sizes and geometries shown in this book are accurate at the time of publication and every effort will be made to advise Motorola chip users of design changes prior to shipment of devices.

Metallization. Each product line section of this book includes information regarding the metallization material used for both front and back faces of the chips and recommends specific die-and wire-bonding techniques.

Ordering Options for Standard Chips

For "standard" Motorola chips, the customer has the option of purchasing devices at various points during the conventional process cycle, which influences the device costs. These points, together with a brief overview of the tests and product characteristics at each point, are given in the flow-chart on pages 1-6 and 1-7.

The first order option, for example, occurs after "class probe," while the devices are still on the unscribed wafer. The class probe identifies the major dc parameters of the chips on the wafer on a sample basis, thereby permitting classification of the chips as to their specific device type numbers. As indicated, the chips are shipped in wafer form and must be scribed and broken by the user.

Subsequent order options permit the customer to order chips at more advanced processing and testing points. The chips become progressively more expensive, but require less work on the part of the user and guarantee a higher level of yield to tighter specifications.

Probe Capability

Individual chips are tested to the conventional data-sheet specifications for dc parameters within the limitations of chip probe capabilities. The following table presents unit probe capabilities of equipment in use at this time.

ELECTRICAL TEST CAPABILITY FOR PROBING OF BIPOLAR AND DIODE DISCRETE CHIPS

Parameter	Test Condition Limits	Limits
All Breakdown Voltages	10 μA–150 mA	0–500 V
All Leakage Currents	0–500 V	10 nA–1.5 mA
Current Gain (h_{FE})	100 μA–500 mA	0–1000 V
All Saturation and "on" Voltages	100 μA–500 mA	0–10 V
Forward Voltage (V_F)	0–150 mA	0–25 V

During unit probe, the desired tests and limits are programmed and all chips on the entire wafer are probed. Chips failing any test are automatically inked as a reject. Parameters that are outside the accuracies or limits of the test equipment can often be guaranteed by correlating to measurable values. Where necessary, on orders for special devices only, a wafer can be qualified to certain limits by encapsulating and measuring a sample of chips from the wafer on standard test set-ups.

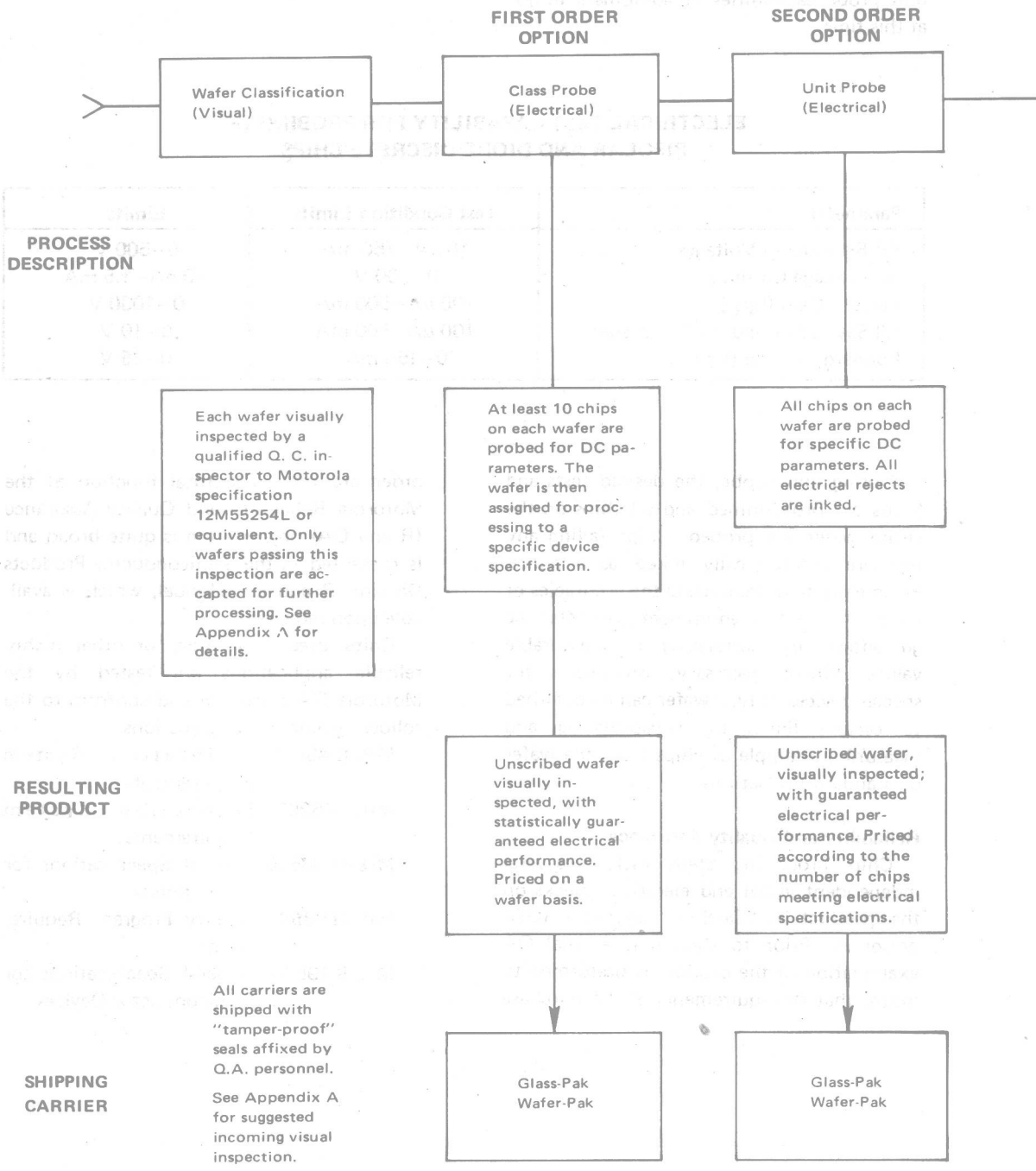
Reliability and Quality Assurance

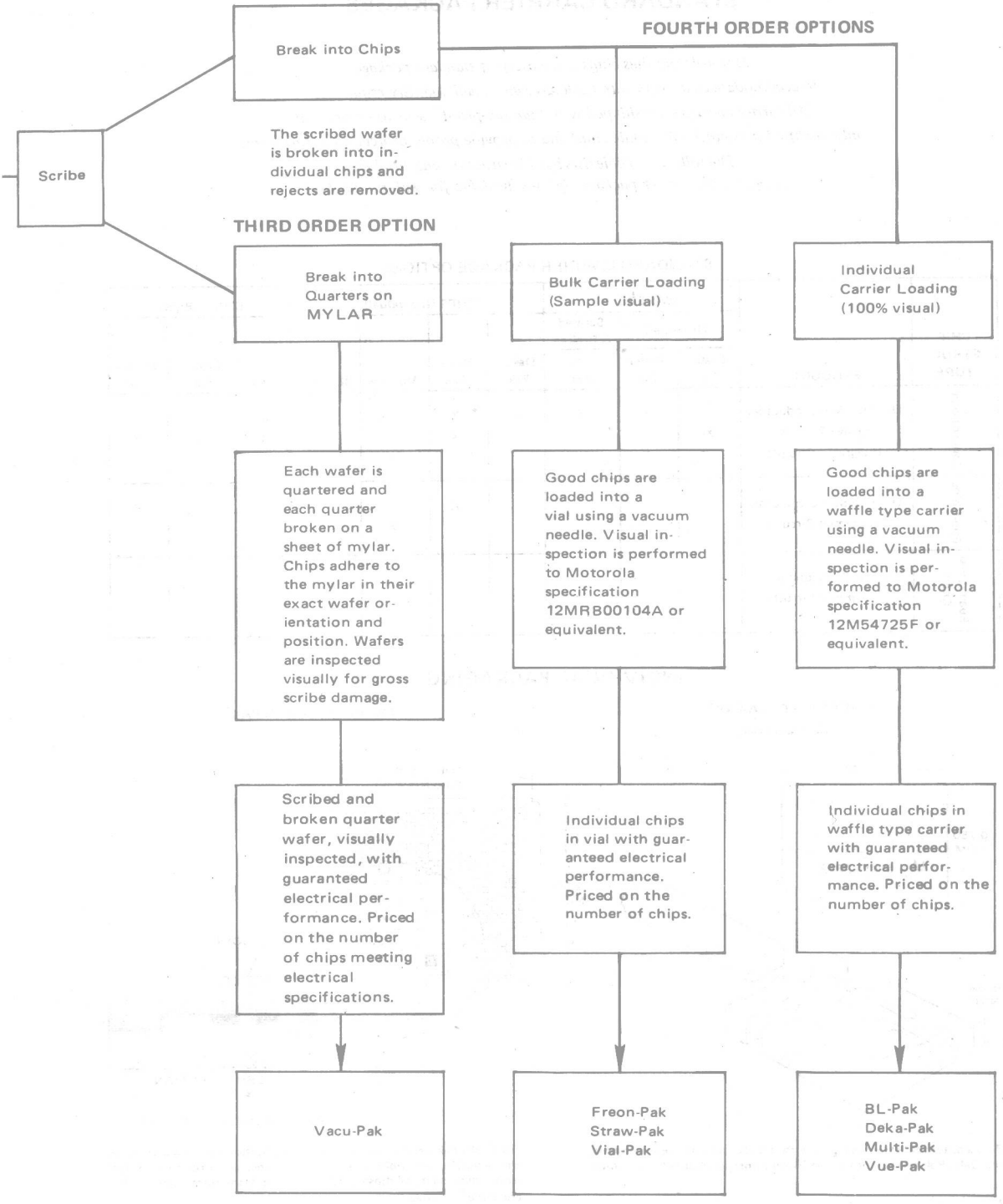
Chip Processing steps include several independent visual and electrical checks on the product by Quality Assurance (QA) personnel. Prior to shipment, a final QA examination of the product is preformed to insure that all requirements of the purchase order are met. The total function of the Motorola Reliability and Quality Assurance (R and QA) organization is quite broad and is presented in the Semiconductor Products Division R and QA Manual, which is available upon requests.

Chips used in military or other highly reliable applications are tested by the Motorola QA personnel and conform to the following military specifications:

MIL-C-45662	Calibration System Requirements
MIL-I-45208	Inspection System Requirements
MIL-M-38510	General Specifications for Microcircuits
MIL-Q-9858	Quality Program Requirements
MIL-S-19500	General Specifications for Semiconductor Devices

CHIP PROCESSING FLOW CHART




Scribe
Break into Chips
The scribed wafer is broken into individual chips and rejects are removed.
FOURTH ORDER OPTIONS
THIRD ORDER OPTION
Break into Quarters on MYLAR
Bulk Carrier Loading (Sample visual)
Individual Carrier Loading (100% visual)
Each wafer is quartered and each quarter broken on a sheet of mylar. Chips adhere to the mylar in their exact wafer orientation and position. Wafers are inspected visually for gross scribe damage.
Good chips are loaded into a vial using a vacuum needle. Visual inspection is performed to Motorola specification 12MRB00104A or equivalent.
Good chips are loaded into a waffle type carrier using a vacuum needle. Visual inspection is performed to Motorola specification 12M54725F or equivalent.
Scribed and broken quarter wafer, visually inspected, with guaranteed electrical performance. Priced on the number of chips meeting electrical specifications.
Individual chips in vial with guaranteed electrical performance. Priced on the number of chips.
Individual chips in waffle type carrier with guaranteed electrical performance. Priced on the number of chips.
Vacu-Pak
Freon-Pak
Straw-Pak
Vial-Pak
BL-Pak
Deka-Pak
Multi-Pak
Vue-Pak

STANDARD CARRIER PACKAGES

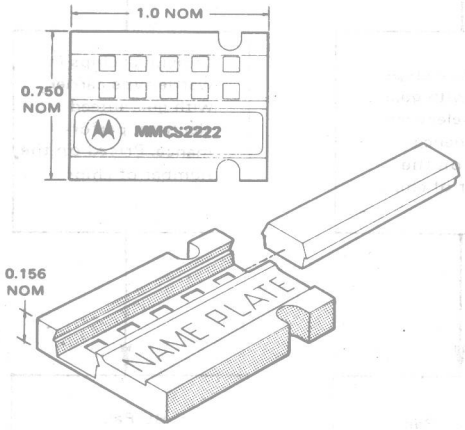
Motorola supplies chips in a variety of standard packages to accomodate customers with both large and small quantity requirements. All carrier packages are shipped with "tamper-proof" seals to ensure that only qualified personnel will handle chips and to provide proper protection during transit. The following Table lists by chip structure and product category, the carrier package options available for wafers and chips.

STANDARD CARRIER PACKAGE OPTIONS

CHIP STRUCTURE	PRODUCT	WAFERS			CHIPS (Individual)				CHIPS (Bulk)		
		Unscribed		Scribed & Broken							
		Glass-Pak	Wafer-Pak	Vacu-Pak	Deka-Pak	Multi-Pak	Vue-Pak	BL-Pack	Vial	Freon-Pak	Straw-Pak
Conventional	Discrete Semiconductors	X	X	X	X	X			X	X	X
	Passive Devices	X			X	X			X	X	X
	Integrated Circuits		X				X				
Flip-Chips	Discrete Semiconductors					X					X
	Integrated Circuits						X				
Beam-Lead Chips	Discrete Semiconductors							X			
	Integrated Circuits							X			

INDIVIDUAL PACKAGING

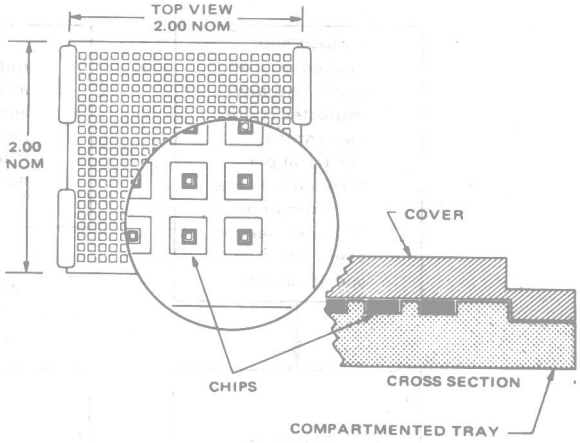
FIGURE 1 – DEKA-PAK▲
(10-chip carrier)



To accommodate the customer with limited quantity requirements, the Deka-Pak carrier contains individual compartments for 10 chips.

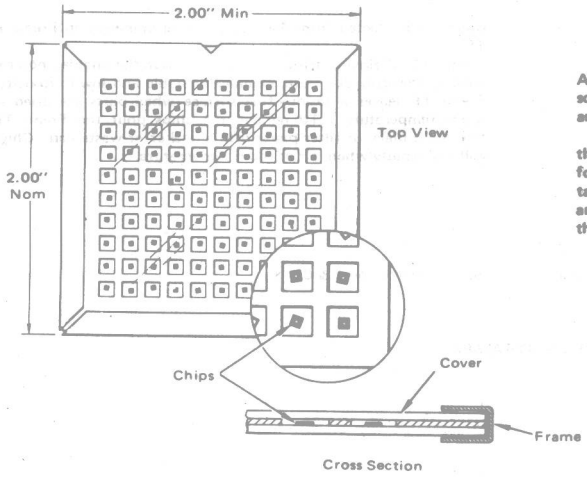
▲Trademark of Motorola Inc.

FIGURE 2 – MULTI-PAK▲



The Multi-Pak carrier is designed for production use. Two versions are available, one holding 400 small chips, and one holding 100 large chips, such as those used for power transistors. All carriers are 2-inch squares.

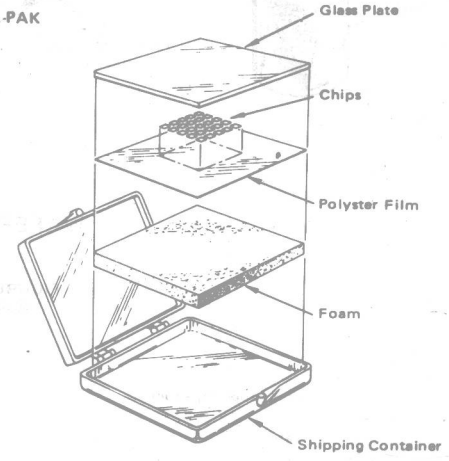
FIGURE 3 – VUE PAK[A]
INTEGRATED CIRCUIT CHIP CARRIER



All Motorola integrated circuit chips are packaged in a 2-inch square carrier as shown in Figure 3. This carrier is protected with an anti-static coating.

Each chip is placed in its compartment, geometry side up, so that incoming visual inspection of both chip surfaces may be performed prior to breaking the carrier seal. In addition, the container permits the customer to remove only a portion of the devices and the carrier can be resealed and used as a storage container for the unused chip.

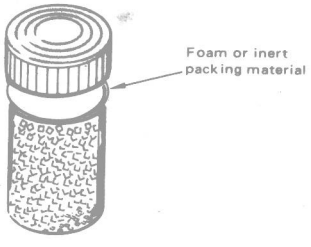
FIGURE 4 – BL-PAK



The shipping carrier for beam-lead chips is a 2" square glass plate on which the chips are placed with the beams flat against the glass. A thin layer of polymer film covers the plate and retains the placement of chips. The chips do not adhere to the film when it is lifted to remove them from the carrier. Care must be exercised when removing the chips from the carrier to ensure that the beams are not bent. A vacuum pickup is useful for this purpose.

BULK PACKAGING

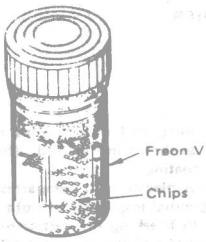
FIGURE 5 – VIAL-PAK



The vial-pak is designed for the large quantity user. Chips are held in position with foam or inert packing material.

FIGURE 6 – FREON VIAL

Bulk-Pak (5000 Chip Maximum)

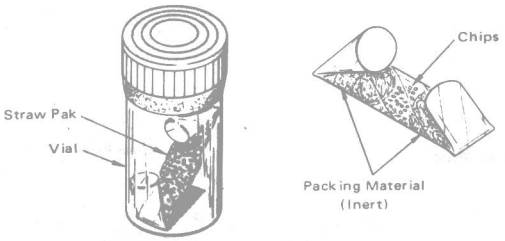


Chips are protected from damage by being immersed in Freon R TF.

Freon TF (Trichlorotrifluoroethane) is non-flammable, non-explosive, exceptionally pure, chemically stable and low in toxicity. Freon TF leaves a residue-free surface when parts are dried at room temperature. To remove the chips pour the Freon TF through a piece of filter paper into a beaker or waste can. Chips will dry rapidly when left at room temperature.

® Freon is Registered Trademark of E.I. DuPont, DeNemours & Co., Inc.

FIGURE 7 – STRAW-PAK

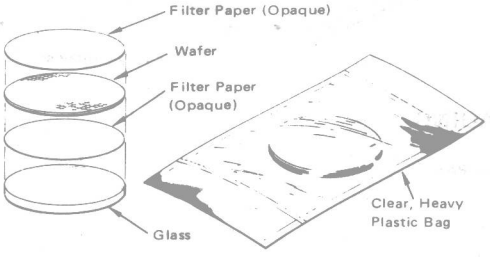


The chips are contained in a section of straw which is placed in a plastic vial. Packing material as indicated prevents movement of the chips and keeps the chips from being crushed by the top bend of the straw during packaging and subsequent opening and closing for inspection and use.

WAFER PACKAGING

FIGURE 8 – GLASS-PAK

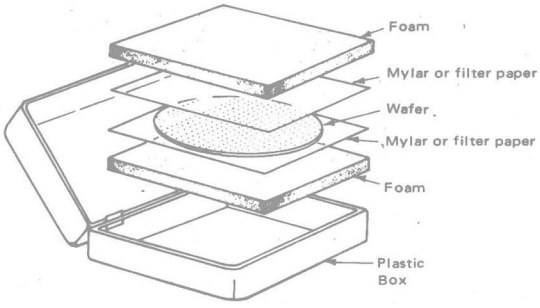
(Wafer – Unscribed)



The unscribed wafer is held between two pieces of filter paper and is protected from breakage by the thick glass plate. The wafer and the glass plate are held together firmly in the evacuated and thermally sealed plastic bag.

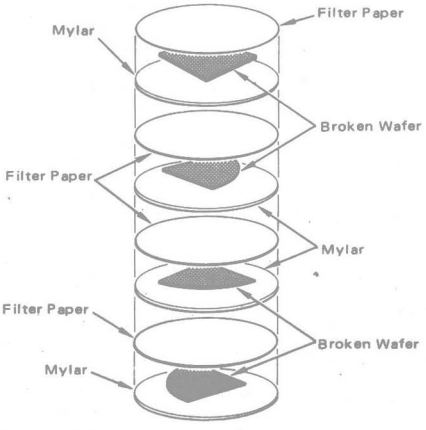
(See Page 1-11 for handling precautions)

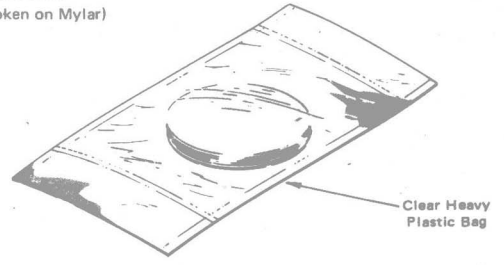
FIGURE 9 – WAFER-PAK
(Wafer – Unscribed)



Wafers are shipped between two layers of mylar or inert filter paper sandwiched between two layers of polyfoam pressed together in a plastic box. This technique prevents movement or damage to the wafer in shipment.

FIGURE 10 – VACU-PAK▲
(Wafer-Scribed and Broken on Mylar)





Each quarter wafer is scribed and broken on a sheet of mylar with the gold-backed side against the mylar. The chips stick to the mylar and maintain their exact wafer orientation and spacing. A maximum of four-quarter wafer sections are packaged as illustrated. The evacuated plastic bag is thermally sealed, holds the contents securely, and allows no chip movement. See handling precautions for Vacu-Pak Carrier.

VACU-PAK – HANDLING PRECAUTIONS

Care must be exercised when opening the package to avoid disturbing the chips. The following procedure is recommended:

Step 1: Place the Vacu-Pak on a flat surface with the opaque filter paper side of the sandwich up and the mylar side down.

Step 2. With a sharp knife, cut through three sides of the top of the plastic bag so it can be carefully rolled back. Gently hold the top piece of filter paper in position as the bag is rolled back.

Step 3. Roll back the filter paper on the top layer of scribed and broken wafer quarters making sure no chips adhere to the filter paper.

Step 4. With tweezers grasp the uppermost mylar sheet and slide the exposed quarter wafer on to a grease plate, bonding platform or container for storage. Do not make waves in the mylar.

Step 5. Keep the mylar on a flat, smooth surface. Individual chips can be easily lifted off the mylar with a vacuum pick-up needle without disturbing the remaining chips.

RECOMMENDED INCOMING INSPECTION PROCEDURES

Motorola assures that the devices will meet the customers' incoming visual inspection when inspected to the visual criteria and LTPD limits specified. Inspection must be performed at the power and magnification indicated. Motorola guarantees dc parameters to LTPD limits specified.

Return Components

It is suggested that the customer perform incoming inspection in the following sequence:

1. Visual
2. Test dc electrical parameters

A. If the lot fails visual inspection, containers must be closed and secured and the entire lot returned to Motorola with a detailed inspection report. In no case will Motorola accept rejected material that the customer has inspected 100%.

B. After the lot has passed incoming visual inspection, samples are selected and subjected to electrical tests of the dc parameters. If samples do not pass the electrical tests, they shall be packaged separately and identified with all the information from the original package of chips. The shipping container must be closed and secured. The entire lot together with the test samples and a detailed inspection report shall be returned to Motorola. In no case will Motorola accept rejected material that the customer has inspected 100%.

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