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HYBRID DESIGN GUIDELINES

MTI has the following suggestions to guide the engineer in producing hybrid circuit designs that can be produced at an optimal cost.

■ Make sure to issue a complete specification. Disagreements on interpretation can be costly to vendor and buyer.

■ Never invoke MIL-Specifications or procedures for a commercial product. The result will be military product pricing. Specify what is needed, not ideals.

■ Be reasonable about packing densities. It is indeed possible to produce hybrids which contain two dozen integrated circuits on a 1 X 2 inch substrate. But that is a laboratory exercise, not a practical production situation. Increased complexities lead to lower yields on a logarithmic scale. Often it is less expensive to partition circuitry into two or more hybrids, rather than trying to stuff everything into a single package.

■ Wherever possible, utilize a standard package configuration. A conformally coated SIP style will be most economical in most instance.

■ Hermetic packages for hybrids are expensive. They are seldom needed in a commercial application. Plastic packages are quite reliable when they are properly designed and adequate process controls are observed.

■ Pay attention to capacitor values and utilize the smallest capacitance which can reasonably satisfy the requirements. Chip capacitors are relatively expensive, particularly in high values and close tolerances. The higher values are also physically large and wasteful of substrate area. In an RC combination, use a high value resistor (up to megohms) and a small capacitor. Precision NPO capacitor chips are particularly costly. Use great care to minimize values. Standard capacitance ranges and tolerances are as follows:

NPO	10pF - 6800pF	5%	50 volts
X7R/BX	1000pF - 0.1uF	10%	25 volts
Z5U	0.01uF - 0.5uF	+80-20%	25 volts

■ Thick film resistors are a bargain. When laser trimming is used, 1% resistor tolerances are routine. Specifying this level of resistor accuracy can improve your designs at little or no cost increase. Accuracies to 0.1% or even tighter in some cases are possible, but should not be specified unless required. Yield losses will increase prices.

■ In specifying semiconductor characteristics, use only those parameters which are significant in the specific application. For example, packaged discrete transistors usually have 20 to 30 specified characteristics. Many of these parameters can only be tested after packaging. In most applications, it is sufficient to specify general device type (example: 2N2222A or equivalent) and to indicate those parameters which are important; beta, current, voltage, frequency response, etc.

■ Minimize hybrid power dissipation if possible. Special heat sinking usually requires a special package and increases cost.

■ Design for easy testing. Nearly all hybrids require construction of special test boxes which interface to external instrumentation and exercise the hybrid under various conditions of load, input stimuli, etc. The ideal test setup simply shows a 'go' or 'no go' indication to the operator. Give adequate thought to testing and test interface requirements. Minimize test time and complexity. The customer should plan to build a test interface box and furnish it to the hybrid vendor, along with detailed test instructions.

■ Plan requirements to allow orderly, continuing production. In most cases, an annual contract is most economic and efficient as it offers you the lowest possible cost, and allows MTI to make longterm production plans which will insure on-time deliveries for you.

■ Be sure that your quantity requirements are large enough or the performance constraints are tight enough to warrant the conversion to hybrid form. Typical orders range from 5,000 to 100,000 units per year.

Following these guidelines will result in your receiving MTI hybrids at optimum cost and quality.

Micro-Technology, Inc.-Wisconsin N56 W13365 Silver Spring Drive Menomonee Falls, WI 53051
(414) 783-6080 FAX (414) 783-4959

MTI HYBRIDS ADD VALUE TO ITS CUSTOMER'S PRODUCTS

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Micro-Technology, Inc.-Wisconsin hybrids add value to its customer's products by reducing their costs while increasing quality.

We can do the same for your products.

COSTS are reduced because:

- Development and tooling charges for MTI hybrids are low.
- MTI processes are suited for mass production techniques.
- Prototypes, or evaluation units can be manufactured at a minimal cost in MTI's prototype line.
- The expertise of MTI's design group can accomplish your circuit changes with minimal time, effort, and cost.
- Your procurement costs for outside components are reduced as you will need to buy only one component rather than up to 40 different ones.
- Your incoming inspection time is reduced.
- Your inventory control and production line operation orders are reduced.
- Your final product assembly time is significantly reduced.

QUALITY is improved through increased performance and reliability:

- Every product is tested before leaving MTI.
- Savings in size, weight, and volume can be achieved over a circuit constructed form discrete components on a PC board.
- Close resistor tolerances and ratio matches are achievable.
- MTI can functionally adjust resistors on our computer-controlled laser trim systems to compensate for parametric variations of other components to optimize circuit performance.
- Your product is more reliable when using MTI hybrids; this increase in reliability is due to the reduction in the number of physical interconnections which is the most common failure mode of discrete components.
- The replacement of a large percentage of the circuits solder connections reduces the susceptibility to wiring errors, shock, and vibration.

Micro-Technology, Inc.-Wisconsin hybrids add value to its customers's products.
Let us do the same for your products.

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THICK FILM CIRCUITS

MICRO-TECHNOLOGY
WISCONSIN

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Quality is Our Policy

MTI intends to be a quality leadership company. This is being accomplished with the continued emphasis on designing processes which conform to clear quality standards at every stage of the operation, and with our commitment to the achievement of individual excellence on the part of each employee for every job in the company.

We understand that product quality means fulfilling the needs and reasonable expectations of those whom the product serves, as they perceive it, from the moment the order is placed, to the time it is delivered and throughout the product life.

We recognize that it is vitally important to:

- Supply products that consistently conform to all product specifications and satisfy the actual needs and reasonable expectations of the customer.
- Change the process or work with the customer to officially change the specification if the process does not consistently conform to expectations.
- Maintain a quality reputation by making certain that quality is established as an important built-in ingredient of all company functions.
- Integrate into each individual operation the disciplines necessary to meet the objectives of this policy.

Gregory S. Martinek
President and CEO

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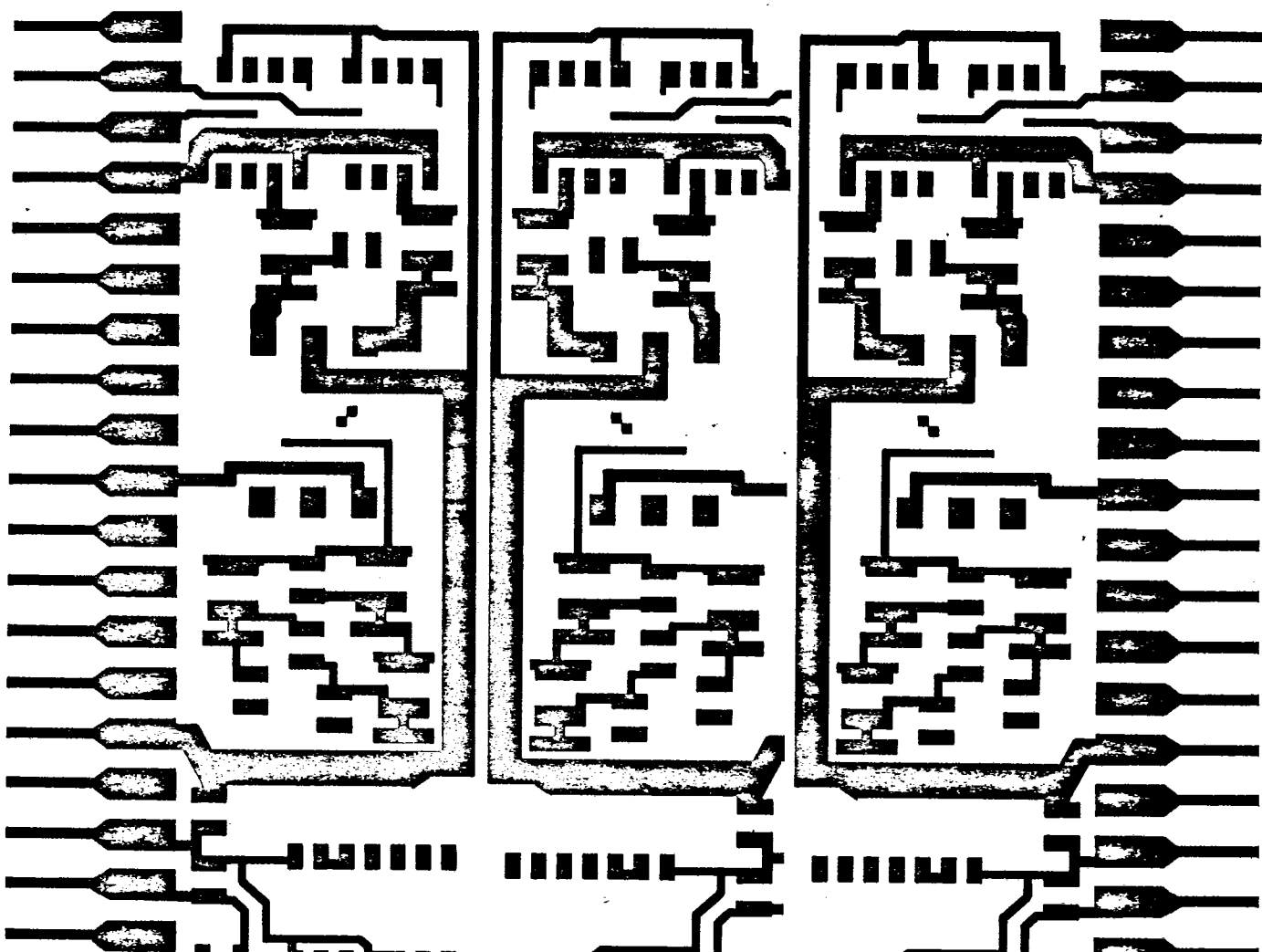
General

Micro-Technology, Inc.-Wisconsin was founded in 1976 as a consulting firm to the thick and thin film industries. After two years of extensive worldwide assignments, MTI started it's own design, development, and manufacturing facility in 1978 in Menomonee Falls, Wisconsin, a Milwaukee suburb.

MTI has grown into one of the leading and largest independent manufacturers of commercial and industrial grade custom thick film hybird circuits and resistor networks in the United States. MTI operates in a modern, 20,500 square foot facility that is equipped with manufacturing lines suited for both small and high volume production. A second facility has been established in Singapore to provide support for MTI's growing number of Asian customers.

MTI has specialized in the total systems integration of active and passive components into space-efficient and reliable functional circuit modules. Our wide range of resistor capabilities, SMT and leaded component mounting capabilities and hybrid package configurations offer the electronics systems designer the necessary flexibility to reduce system cost and increase system performance.

MTI's hybrid circuits can be found in the leading OEMs of telecommunication equipment, test instrumentation, medical instrumentation, computers and computer peripherals such as Winchester Disk Drives and Tape Drives, and industrial controls. Our commitment to these customers and new ones is evident by our continued investment in state-of-the-art equipment and our development of leading edge process technologies and capabilities.



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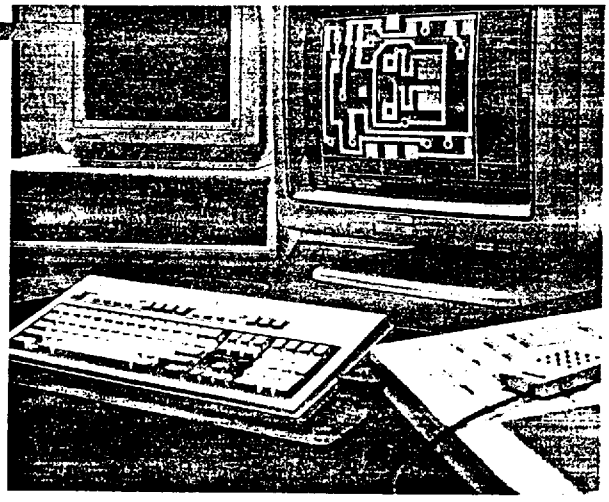
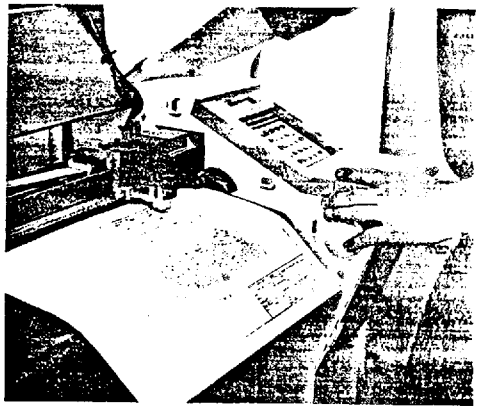
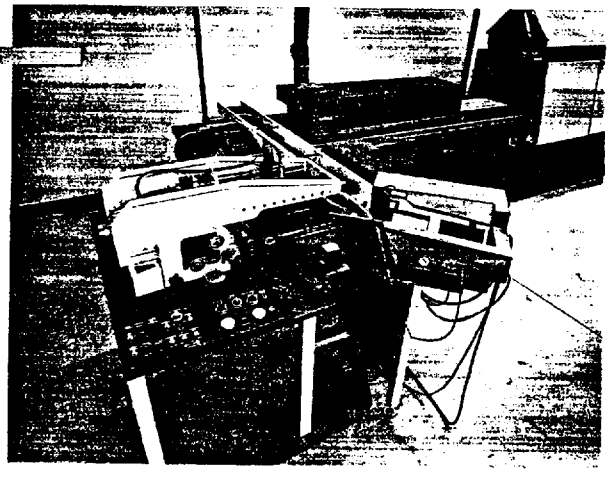
Computer Aided Design

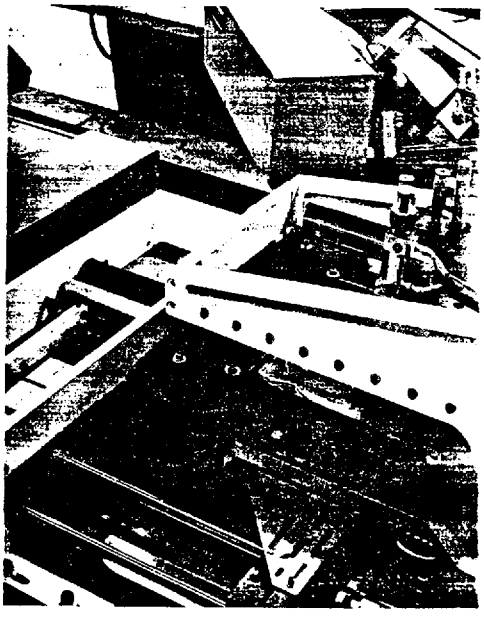
All hybrid circuit layouts are generated by our in-house CAD System. CAD system allows us to achieve shorter turnaround times in design, lower development costs, and better design control over previously used hand-design processes.





Printing and Firing Capabilities





TECHNOLOGY

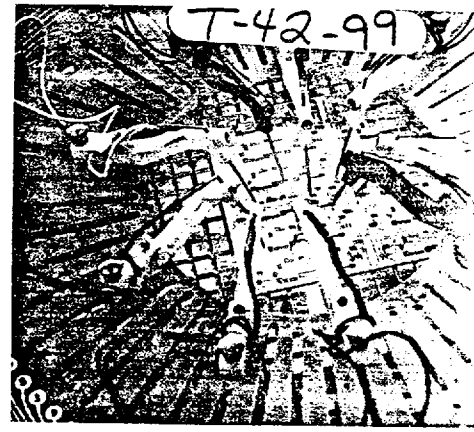
MTI has precision resistor capabilities that are second to none in our industry. We manufacture resistors from 1.0 ohms to 1000 megohms with tolerances as tight as ±0.01%, temperature coefficients of 50 and 100ppm/°C, and matching and ratio tolerances of 0.50%.

MTI is the leader in the development and manufacturing of thick film metallization of plated-through-holes for interconnecting both sides of alumina substrates. Hundreds of holes can be machined by CO_2 lasers through the substrate and metallized to obtain state-of-the-art packaging densities. Our feed-through technology results in a double-sided hybrid that is both economical and easily manufactured.

EQUIPMENT

MTI uses the most advanced equipment available in it's screen printing of metallizations, resistors, and dielectric pastes onto alumina ceramic substrates. Our high volume lines are supported by automatic printing systems that have cassette load/unload capability and multiatmosphere belt furnaces that have cassette load/unload capability. In addition many semi-automatic machines are used to support our high volume lines and our small orders/prototype line.

Laser Trimming



MTI uses Chicago Laser Trim and ESI laser trim systems to adjust printed thick film resistors. The lasers are used for precision passive trimming as well as functional trimming for such active parameters as DC voltage, AC voltage, phase, frequency, and time intervals. Using the laser technology MTI also checks printed crossovers for possible shorts.

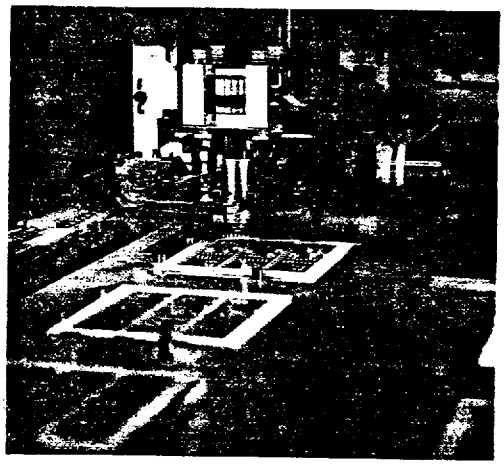
The accuracy of the laser's measurement systems coupled with the high speed capabilities of the lasers gives MTI the ability and capacity to produce high volumes of precision hybrids and networks.

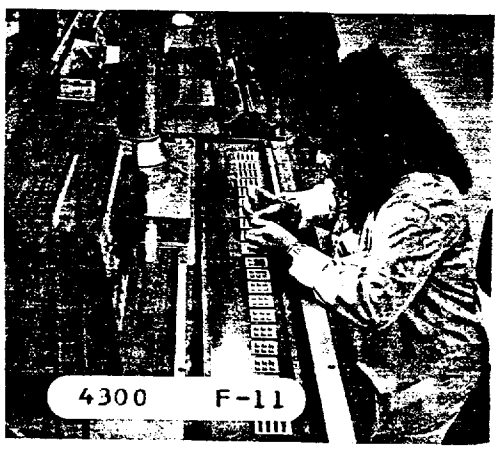
Assembly

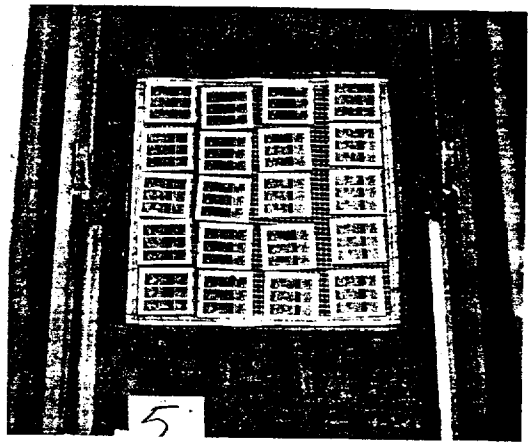
MTI uses high speed, pick and place machines to automatically mount SMT style components and also various discrete leaded components. Our manual assembly lines provide us the flexibility to mount nonstandard component packages, as well as the capability to manufacture smaller sized lots. This flexibility allows us to meet the needs of all our customers, regardless of volume.

Single sided hybrids are reflow soldered on one of three Browne Reflow Machines. Component solder attachment for double-sided hybrids is performed in our vapor phase system.

Various encapsulation methods can be employed, depending on customer preference. In many cases an enclosure is not necessary and therefore not worth the additional cost. However, in situations where extra protection or security is needed, an epoxy based conformal coating or silicone based coating can be used to encapsulate the hybrid. In addition, MTI offers the capability of attaching a plastic lid or cover over the hybrid for those customers who want to machine insert the hybrids into their PCBs.







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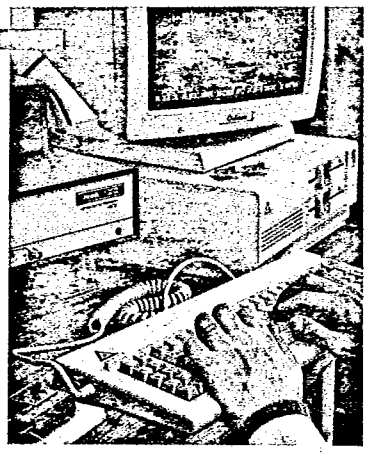
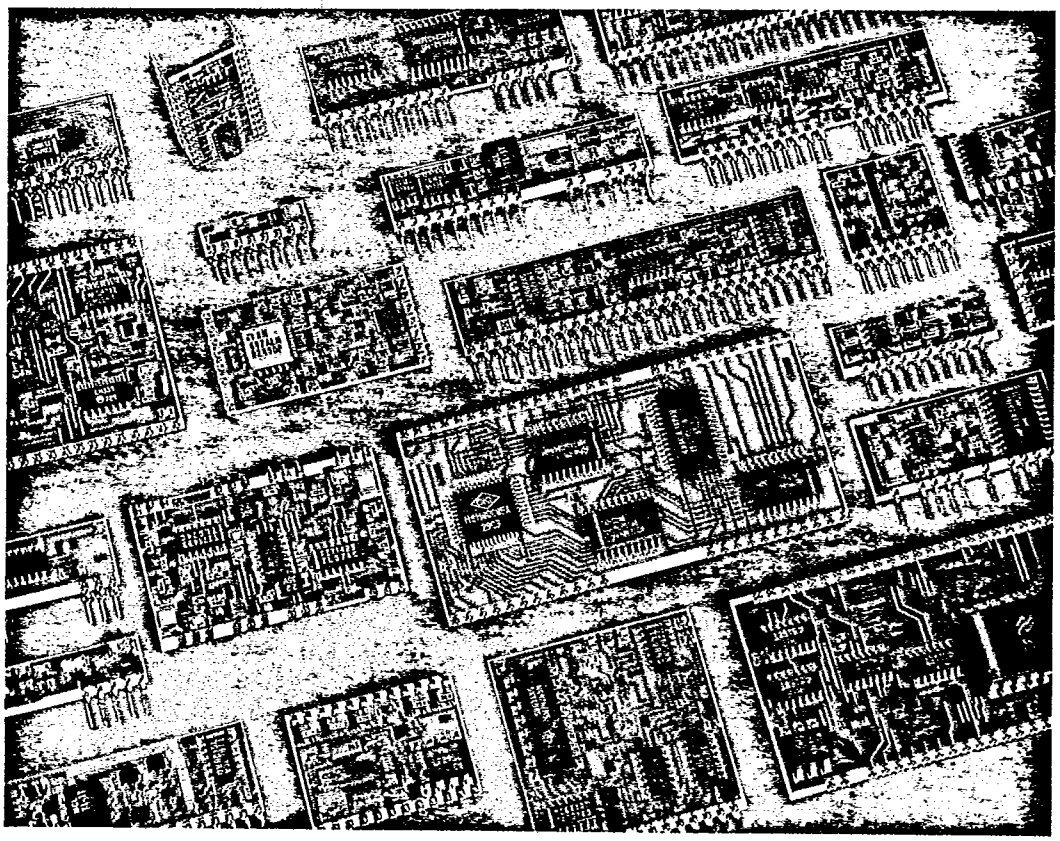
Final Test

MTI utilizes computer integrated custom test fixtures to perform a 100% functional test on each hybrid it manufacturers to insure that the performance requirements specified by our customers are met. If desired, MTI can perform burn-in tests on hybrids to remove possible infant mortalities.

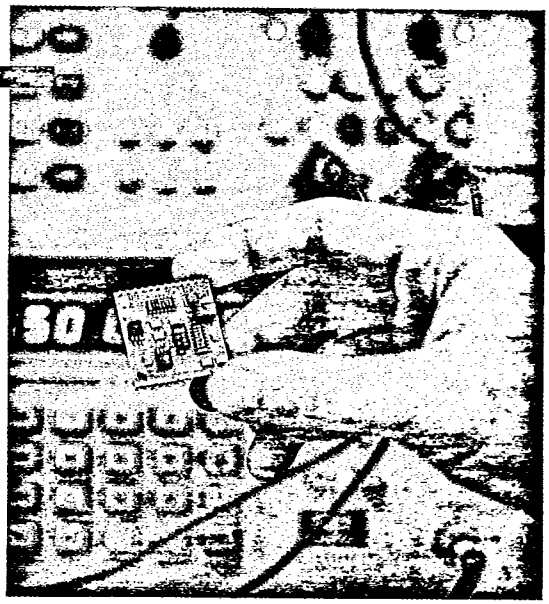




Quality Assurance

MTI's management maintains product quality and reliability at the top of it's operational policy. Our reputation has been established by delivering hybrid circuits that work in our customer's systems, and which frequently exceed quality and reliability requirements.

Our Quality Assurance System is a full-circle integrated system starting with piece-parts acquisition and incoming inspection, providing both process and in-process control during manufacture and then final assurance that the completed hybrid meets the exacting specifications of our customers.



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