USER'S MANUAL NO. 990-180
REVISION B: July 2000

UNITEK EQUIPMENT®
World Leader in Precision Metals Joining

OPERATION AND MAINTENANCE MANUAL

FOR THE

MICROPULL®IV
WIRE BOND PULL TESTER

Model	Stock Number
MP4/115	6-099-04
MP4/230	6-099-04-01
MP4(CE)/115	6-099-05
MP4(CE)/230	6-099-05-01

Printed in the United States of America

Revision Record

Revision	EO	Date	Basis of Revision
A			Original publication
B	18347	6/00	Addition of CE version.

FOREWORD

Thank you for purchasing a Unitek Equipment Micropull® IV Wire Bond Pull Tester

Upon receipt of your equipment, please thoroughly inspect it for shipping damage prior to its installation. Should there be any damage, please immediately contact the shipping company to file a claim, and notify Unitek Equipment at:

1820 South Myrtle Avenue
P.O. Box 5033
Monrovia, CA 91017-7133
Telephone: (626) 303-5676
FAX: (626) 358-8048
e-mail: info@unitekequipment.com

The purpose of this manual is to supply operating and maintenance personnel with the information needed to properly and safely operate and maintain the Micropull IV Wire Bond Pull Tester.

We have made every effort to ensure that the information in this manual is accurate and adequate.

Should questions arise, or if you have suggestions for improvement of this manual, please contact us at the above location/numbers.

Unitek Miyachi Corporation is not responsible for any loss due to improper use of this product.

SAFETY NOTES

This instruction manual describes how to operate, maintain and service the Micropull IV, and provides instructions relating to its SAFE use. Procedures described in this manual MUST be performed, as detailed, by QUALIFIED and TRAINED personnel.

For SAFETY, and to effectively take advantage of the full capabilities of the tester, please read these instruction manuals before attempting to use the workstation.

Procedures other than those described in this manual or not performed as prescribed in it, may expose personnel to electrical hazards.

After reading this manual, retain it for future reference when any questions arise regarding the proper and SAFE operation of the tester.

Please note the following conventions used in this manual:

WARNING: Comments marked this way warn the reader of actions which, if not followed, might result in immediate death or serious injury.

CAUTION: Comments marked this way warn the reader of actions which, if not followed, might result in either damage to the equipment, or injury to the individual if subject to long-term exposure to the indicated hazard.

CONTENTS

ILLUSTRATIONS

TABLES

CHAPTER 1
DESCRIPTION

Section I: Features

The Micropull IV (herein called the MP4) is a semiautomatic machine designed to perform wire bond pull tests in the 0.5 to 1000 gram-force range, using three interchangeable beams, at rates of up to one test per second. The operator needs only to position the hook under the wire bond to be tested, and the MP4 will automatically center itself and perform DESTRUCTIVE or NONDESTRUCTIVE wire bond pull tests and display the test results, as well as transmit them to an optional RS-232C serial interface output connector. The MP4 can automatically detect wire bond failures which occur during the test as well as excessive wire bond loop height. This information is part of the output test data.

Bond pull tests are used routinely to evaluate and/or control the mechanical strength of wire bonds in microcircuit devices. The bond pull test is performed by placing the microelectronic device in an appropriate holder and positioning a hook under the wire midway between the two bonds. The hook is then raised until the wire bond breaks (destructive pull test - DPT), or until the bond is stressed to a predetermined value (nondestructive pull test-NDPT). The term "wire bond" commonly refers to the entire interconnection consisting of both welds and the wire span. The term "bond" is used to identify a welded area.

According to industry statistics, insufficient bond strength is a major cause of device failure. The intent of the NDPT is to use a force great enough to cause weak bonds to fail, yet insufficient to damage good bonds. Recommended values for the maximum safe forces for NDPT may be found in MIL-STD 883, Method 2011 and 2023. See Appendix B.

Section II: System Components

Description

The MP4 shown in figure 1-1, includes the Electronic Control Unit, the Beam Drive Module, Data Logging software, the RS-232C interface and cable, a base plate, Optic Mounting Assembly, a device holder for flat substrates, a set of calibration weights, spare fuses and this instruction manual. In addition, the user must order a separate beam, available in 10 gram, 100 gram, or 1000 gram. Included with each beam is an assortment of hooks, a hook insertion tool and spare lamps. Optional accessories include hooks, beams, optics, device holders, and a serial printer.

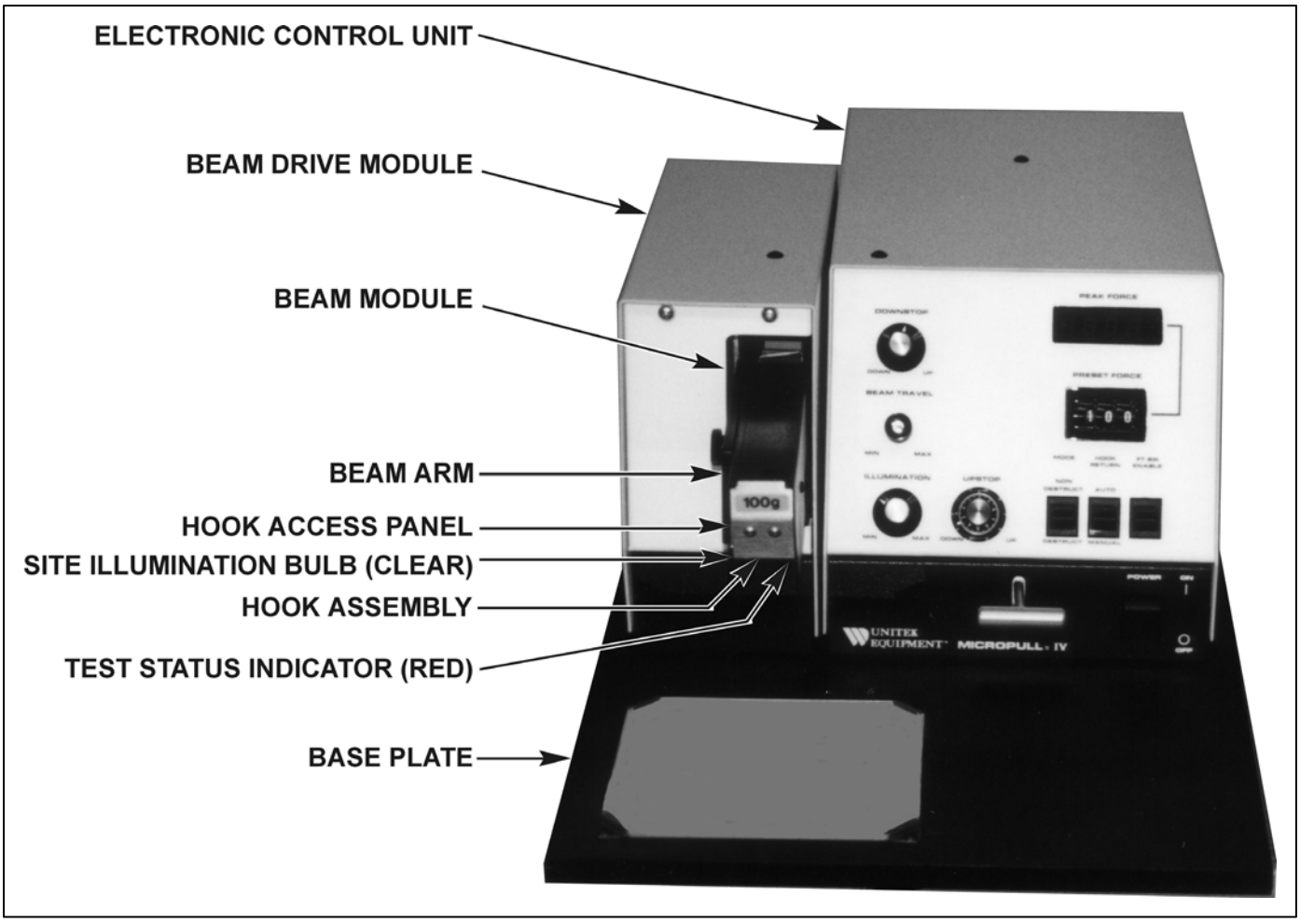


Figure 1-1. Micropull IV, Major Components

The accuracy of the MP4 system is ±2% of the reading or ±2% of the beam scale, whichever is greater. For example, the accuracy of the 10 gram beam is ±0.2 grams, the 100 gram beam is ±2 grams, and the 1000 gram beam is ±20 grams. The conversion from grams-force to Newtons is accurate to within ±2% using the force of gravity as 981 gm•cm/sec^2. The worst case error caused by the deflection of the beam is 0.4% which is included in the system error specification. The error caused by operator misalignment of the hook

with respect to the wire bond is less than 5% for misalignments of up to 5 degrees in either plane. The Zero Drift is ±0.3% of full scale during the first 15 minutes and negligible thereafter.

Electronic Control Unit.

The Electronic Control Unit uses a closed-loop servo system to control the vertical position and pull rate of the Beam Module. The control unit converts the analog information received from the Beam Module into digital data, displays the peak force, and transmits this data together with any error messages to the optional RS-232C Interface. This Interface, which is a single board computer, is capable of transmitting data in ASCII format to a user-supplied buffered serial printer at 1200 baud. The RS-232C interface can also transmit and receive data, at 1200 baud, to another computer such as an IBM-XT or most other PC compatibles.

Footswitch – The footswitch connects into the FOOTSWITCH connector on the rear of the MP4. It is used by the operator to signal the MP4 to start the next test and, in those cases where the printer or computer is used, process the data from the previous test. The footswitch also resets the display. If a customer-supplied switch is used, its contacts should be single pole, normally open, and capable of switching 125 mA peak current.

Remote Operation - the Beam Drive Module and/or the Electronic Control Unit may be removed from the baseplate and operated while separated by as much as 6 feet. The Control Lever potentiometer may also be replaced by a remote potentiometer or by a multiplying digital-to-analog converter. These modifications might be necessary if the MP4 is made part of an automatic machine and/or is controlled by an external computer.

Data Outputs – 13-line, 15 volt, positive true, BCD data is applied to the pins of an internal 50-pin connector. There are additional data lines for the Print Command output, the Computer Busy input, and MP4-generated Failure Code (table 1-1). The Print Command is held high for 10 milliseconds after the operator presses the footswitch. The data in the BCD data registers is stable during this period. The data and error code is then reset to zero and the MP4 performs the next test. An external device cannot clear the MP4, but can inhibit or enable it by means of the Computer Busy input. The logic levels are 0 and +15 volts for logical 0 and 1, respectively.

Table 1-1. Failure Codes

Code	Definition
0	No Test or Test In Process
1	No Failure in Non-Destruct Mode
2	No bond failure prior to reaching the Preset Force or a completed test in the Destruct Mode
3	Wire bond failure during Hold Time
5	Over-range indication in Non-Destruct Mode
8	Excessive loop height. Beam hit Upstop prior to exerting the Preset Force
9	Marginal loop height. Beam hit Upstop during Hold Time

Data Output Connector, J7. The signal and pin numbers on Data Output connector, J7, located on the logic PCB, are shown in table 1-2. In the table, A is the most significant digit and 8 is the most

significant bit in the 8, 4, 2, 1 BCD code format. A, B, C, and D are the data digits; H is the MP4 Failure Code.

When the footswitch is actuated, a +14 volt, 10 millisecond Print - Data Stable pulse appears on pin 29. The MP4 can be inhibited from making another test by placing a +15 volt BUSY signal on pin 26. The data on the BCD outputs are reset to zero within 10 ms after the end of the Data Stable pulse. The MP4 Failure Code Digits, pins 35 to 38, will change from zero as soon as one of the End of Test Conditions occurs.

Table 1-2. Data Output Connector, J7, Signals

Signal	Pin	Signal	Pin	Signal	Pin
Ground	1	A8, Ground	25	D2	44
Busy Input	26	B1	47	D4	45
Ground	28	B2	48	D8	46
Print-Data stable	29	B4	49	H1, Failure Code	35
Units	4	B8	50	H2	36
Decimal Point	2	C1	18	H4	37
Decimal Point	3	C2	19	H8	38
A1	22	C4	20	I2, Ground	7
A4, Ground	24	C8	21	I1,4,8 Logical 1	6,8,9

Beam Drive Module

The MP4 Beam Drive Module contains a servomotor which moves the beam arm assembly vertically within low friction, self compensating, linear ball bearing races. Within the Beam Drive Module is a precision potentiometer that accurately tracks the motion of the beam arm and transmits this information back to the Electronic Control Unit. The beam arm contains five sets of mounting holes which allow the beam height to be moved 1 inch in ¼-inch increments.

Beam Module – The beam module contains a lamp housing and a cantilevered beam that is gauged with high output semiconductor strain gauges to measure the applied force. The output of the strain gauges is applied to a preamplifier designed to reduce susceptibility to electrical noise. The design is such that any beam module can be installed on any MP4 without re-calibration. Each beam, upon installation, automatically changes the location of the decimal point and modifies the units of the PEAK FORCE display, if necessary. The beam housing contains two dowel pins that allow easy mounting in one of five sets of holes in the beam arm. The housing is held on the arm with a thumbscrew. Two electrical connectors are used, one carries the output data from the beam and the other carries power to the lamp housing. The front of the beam housing slides out to allow access to the front of the beam to facilitate installation of the hook assembly.

Beam – The beam is a low-mass, cantilevered beam with relatively large compliance. The deflection for full-scale output is 0.2 inch, with 20% over-range allowed in the Destruct Mode. The compliance of the beam allows measurements that are essentially free from the influence of normal shock and vibration. The tip of each beam is designed to accept a hook.

Model B10, B100, B1000 MIL-STD Beams - The design of the MP4 hook assembly insures the accuracy of the measuring system. Because of constraints imposed by MIL-STD-883B and 883C, the

hook is allowed to pivot through a limited angular range in the front-to-back plane and is not allowed to pivot from side-to-side. The MIL-STD also requires that the Non-Destruct pull should start with the hook positioned midway between the two bonds. Assuming single level bonds, the result is that the wire bond is reformed into an isosceles triangle wherein the pull force on each bond is equal, as shown in figure 1-2.

Model B100R Rotatable Hook Beam - This beam has a 360 degree manually rotatable hook affixed to the end of the beam. This design facilitates testing of long "stick-type" lead frames. The coupling design quickly dampens any swinging motion of the hook. This beam will meet the accuracy requirements of the MIL-STD when used with the supplied hooks, however the wire bonds are not always reformed in accordance with the MIL-STD.

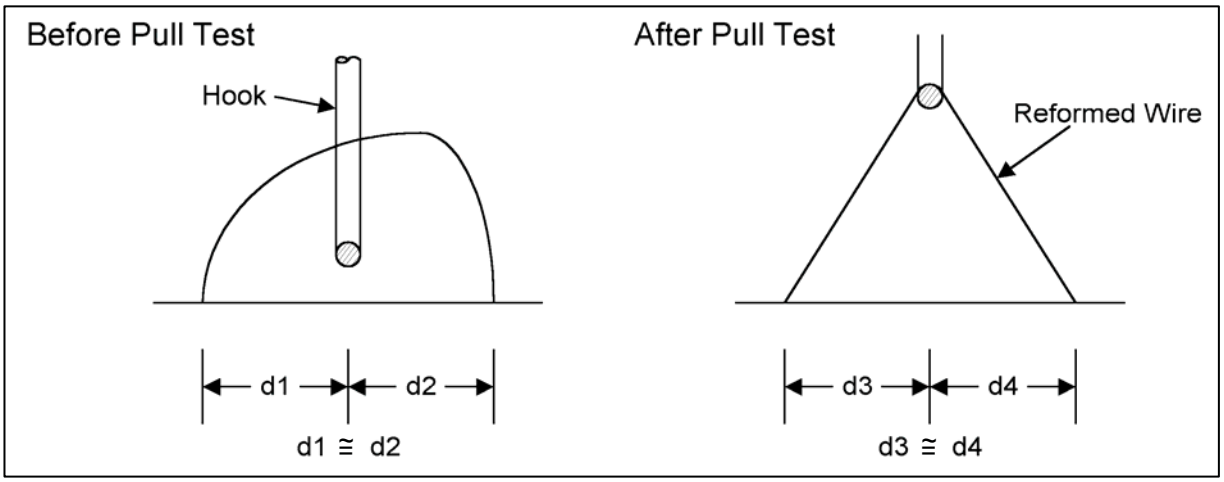


Figure 1-2. Nondestructive Pull Testing Reshaping the Wire Bonds

The Hook Assembly for the B10 and B100 beams is inserted into the beam using a special insertion tool (figure 1-3). The hook assembly for the B100R consists of several parts which are assembled using a T-handle insertion tool (figure 1-4). The hook on the 1000gf beam, figure 1-5, is attached to the bottom of the hook shaft. The weight of the hook assembly is critical to both the operation and the accuracy of the measuring system. Because of inertia, large massive hooks, whose weight typically exceeds 0.2 grams, cannot meet the accuracy requirements of the MIL-STD when used at normal speeds in the 0.5 to 10 gf pull range, on either the 10gf or 100gf beams. Hooks weighing up to 10 grams can be used on the 1000gf beam.

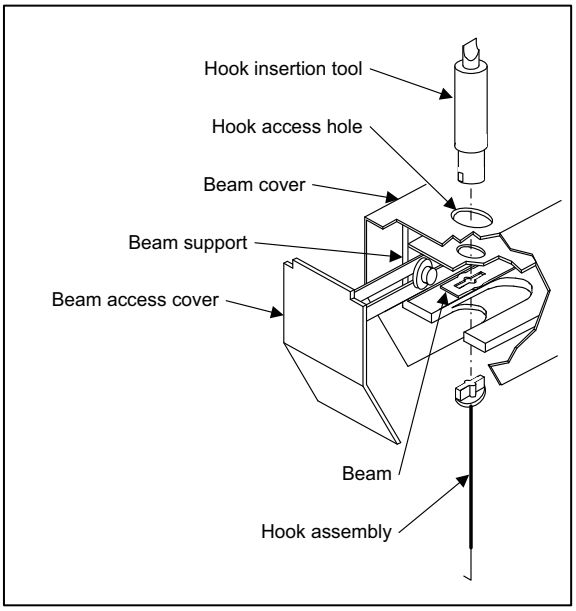


Figure 1-3. B10 and B100 Beam

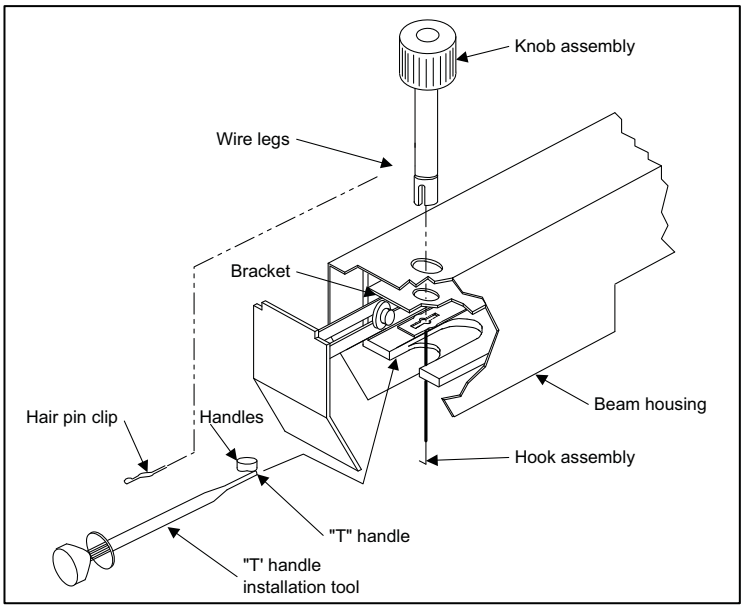


Figure 1-4. B100R Beam and Insertion Tool

Beam Specifications

Beam specifications are shown in table 1-3.

Table 1-3. Beam Specifications

Model	Full Scale g-f	Full Scale N	Range (gf)	Maximum Deflection (in.)
B10	10	0.1	0.5 – 12.00	0.24
B100	100	1	1 – 120.0	0.24
B1000	1000	10	40 – 1,200	0.24

Model B100R is a manually rotatable hook version of B100

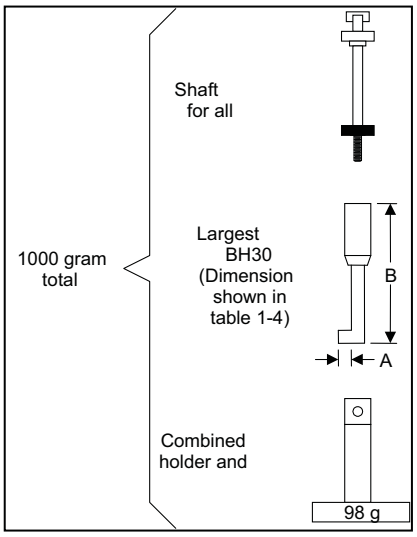


Figure 1-5. 1000g Beam Hook and Calibration System

Hook Specifications

Hook specifications are shown in table 1-4.

Table 1-4. Hook Specifications

NOTE: Many specifications require that the hook diameter be approximately 2.5 times that of the wire being tested.

Model	Weight (g)	Diameter (in.)	Maximum Pull (g-f)	Dimension A* (in.)	Dimension B* (in.)	Used On
BH3	0.1	0.003	20	0.007	2	B10, B100
BH5	0.1	0.005	50	0.011	2	B10, B100
BH8	0.1	0.008	125	0.015	2	B10, B100
BH12	0.1	0.012	300	0.025	¾	B1000
BH20	0.1	0.020	850	0.040	¾	B1000
BH30	0.1	0.030	2000	0.050	¾	B1000
BH3R	0.1	0.003	20	0.007	2	B100R
BH5R	0.1	0.005	50	0.011	2	B100R
BH8R	0.1	0.008	125	0.015	2	B100R

* See figure 1-5

Model MPIT Insertion Tool

This tool is used to insert and remove hooks from the beams. One tool is included with each MP4.

Software

The data logging software for the MP4 can be used to interpret and format data which is provided via the MP4's RS-232 Printer Interface. This software is designed for both Destruct and Non-destruct testing, The processing time is less than one second per test in either mode

The Non-destruct software counts the number of tests. And at user's option, either prints the data for all bonds or only for those bonds that fail and/or are not subjected to the proper pull. An option is provided which allows the user to enter a six-digit location code to identify the location of any bond which fails.

The Destruct software records the data from all tests together with the appropriate, but optional, one digit MIL-STD-883B Bond Failures Location Code entered by the user. At the completion of each set of tests, the program calculates and prints the Average Pull Strength, the Standard Deviation, of the data and the Normal Distribution Limit for the individual device. At the user's option a histogram of any device, or group of devices, can be printed.

The program includes an input screen to collect information that can be used as a heading for the reports. A user option allow the test data to be copied to a disk file in the Lotus ".PRN" format which can be imported into Lotus Development Corporation's Lotus 1-2-3® Release 2. In the Destruct Mode, the user can elect to omit printing the data, provided that an election is made to copy the data to a disk file.

The MP4 Data Logging Software is intended to provide a general purpose, "plain vanilla" method of data collection. Source code is provided which should allow the user to make any necessary modifications. The program is supplied in three formats, on a 5-1/4 inch, unprotected, PC/MS-DOS compatible diskette. MP4.BAS is a n interpreted BASIC program which has been tested, using IBM PC-DOS Version 3.21, with BASICA Version 3.2, and Microsoft MS-DOS Version 3.21, with GWBASIC Version for MP4.EXE which was compiles using Microsoft Corportiaion's QuickBASIC ® Version 4.0. Templates named NONDEST.WK1 and DESTRUCT.WK1, are used to import the ".PRN" files generated by the MP4 software into Lotus 1-2-3.

The system hardware requirements are: an IBM PC, or most compatibles, with a minimum of 256K RAM and two disk drives, one of which is a hard drive. The system must have an Asynchronous Communications Adapter, equipped with a male DB-25 connector., capable of operating at 1200 baud.

Our experience indicates that the cursor keypad on the "5151" type keyboard works as expected. The cursor pad on the enhanced IBM AT style keyboard does not function properly. This software requires a printer whose instruction set is IBM compatible.

RS-232C Serial Interface

This interface is a single-board computer that converts the information, presented as parallel data on the Data Output connector, to 1200 baud, ASCII coded, serial data, available on an RS-232C connector on the rear of the MP4. The RS232C interface inserts the decimal point into the correct position in the data. This interface is capable of driving a serial-buffered printer or communicating with an external computer. Data resulting from each test is transmitted while the MP4 performs the next test. The actual transmission consists of ten bit characters sent serially. Each character has one start bit, eight ASCII coded data bits, and one stop bit. The communication is bi-directional and asynchronous, but flows in one direction at a time. This is commonly referred to as Half Duplex Communication. The codes, listed in table 1-5, are generated by the MP4, converted to the corresponding message by the single-board computer, and connected to the RS-232C Connector.

Table 1-5. Serial Interface Codes

Code	Message
0	No test
1	Valid test
2	Wire broke
3	Wire broke/Hold time
5	Over range
8	Hit Upstop
9	Hit Upstop/Hold time
–	False error X (Where X = 4,6,7,10,11,12,13,14,15)

Random False Errors are caused by touching the hook during a test or by the hook hitting the substrate. The False Error Message number is helpful when troubleshooting the RS-232C board.

The pin connections on the RS-232 printer/computer connector are such that the MP4 receives data on pin 2 and transmits data on pin 3. This means that an external Null Modem is not required to transmit data to either a printer or computer.

The signal and pin numbers for J1, the RS-232C Interface connector, are shown in table 1-6.

Table 1-6. RS-232 Interface Connector, J1, Signals

Pin	Description
2	Received data
3	Transmitted data
7	Signal ground

The MP4 can understand the eight-bit binary-coded messages shown in table 1-7.

Table 1-7. Message Codes Understood by MP4

Binary Code	Response by MP4
196	Disables the footswitch. Colon will light.
197	Enables the footswitch. Colon will go out.
212	Current Peak Force reading and message will be transmitted.

The MP4 includes a 4-foot long RS-232 extension cable, with DB25 male connectors, used to connect the MP4 to either a serial printer or the RS-232C serial port of a computer.

Calibration Weights

A set of uncertified calibration weights is supplied with the MP4. When used carefully, with the weight hanger supplied, they provide an effective method of re-calibration. The weights supplied with the MP4 are: 1, 2, 5, 10, 20, 50 and 100 grams. A weight hanger and a 300 and a 500 gram weight are supplied with the 1000gf beam. The weight rack, which is supplied, provides a convenient method for storing the weights. These uncertified weights are within 1/4% of the weight indicated.

Standard Device Holder

The Model DHF device holder, included with each MP4, is designed for flat substrates which range from 1/4 to 2 inches square. The base of the device holder is spring loaded so that it can be manually depressed up to 1/4 inch. This feature allows easy removal of the hook from deep packages. The overall size of this device holder is 3 inches (7.6 cm) diameter by 2.375 inches (6 cm) high.

In additional to the standard device holder, the following optional device holders may be ordered:

a Model DHD device holder, with spring-loaded base, is designed for 0.3 to 0.6 inch wide side-brazed or 0.250 inch wide CERDIP packages with lengths up to 2.070 inch.

b Model DHL device holder is designed for lead frames which have eight to 40 leads.

Optics

An optional stereo zoom optic may also be ordered. The unit has 0.7 – 3x magnification, with 20x eyepiece and a 0.5 object lens. The optic includes the arm and porthole assembly.

Controls and Indicators

The operator controls and indicators are shown in figures 1-6 (front view) and 1-7 (rear view), and described below.

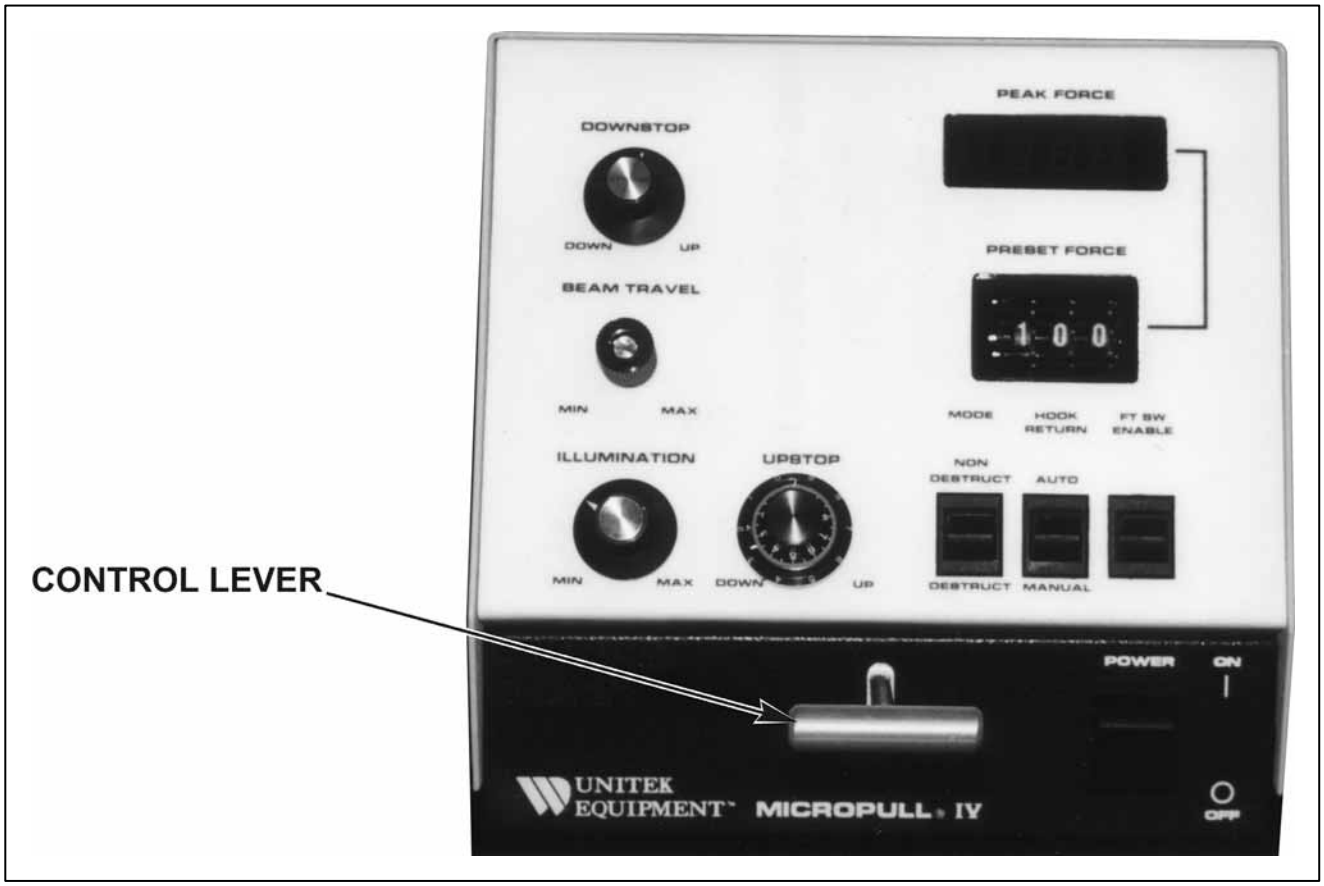


Figure 1-6. MP4, Controls and Indicators

Electronic Control Unit

POWER Switch (figure 1-6) – The POWER switch controls both sides of the incoming power line.

Control Lever – This control changes the vertical position of the hook. A closed-loop servo system insures that the movement of the hook accurately tracks the movement of the Control Lever.

PEAK FORCE Display – This is a 3½-digit, 0.3-inch-high, light emitting diode (LED) display. The rear panel UNITS switch (see below) selects the unit of measurement as grams- force or millinewtons for the 10 and 100gf beams and grams-force or newtons for the 1000gf beam. The selected unit of measurement is displayed to the right of the reading.

Measuring Rate – In the Non-Destruct Mode, the measurement rate is 100 microseconds per bit, or approximately 100 milliseconds for a full scale input. In the Destruct Mode, the measurement rate is 120 milliseconds per bit.

Negative Tare Indicator – This is a minus sign to the left of the PEAK FORCE display. This error condition will be displayed for negative inputs which exceed 0.1% of full scale.

Computer Busy Indicator - A colon lights to the left of the PEAK FORCE display if the MP4 is inhibited from further operation as a result of receiving the appropriate message, via the RS-232C interface, from an external source. A printer cannot inhibit the MP4. The Computer Busy feature prevents data from being lost before it is recorded by the data logging system.

MODE Switch - In the DESTRUCT position, force is applied until either the wire bond breaks or the beam reaches the Upstop. The maximum peak force applied by the hook will be displayed until reset. The MP4 is designed to detect wire bond failures that occur between 4% and 120% of full scale, as defined in table 1-3. In the NON-DESTRUCT position, the pull force is preset, in 0.1% of full scale increments, by using the three decade PRESET FORCE thumbwheel switches. The minimum guaranteed PRESET FORCE is 1% of full scale or 0.5 gf, whichever is greater. As required by MIL-STD, the peak force which is actually applied to the bond is displayed by the MP4. Under some circumstances the peak force can exceed the PRESET FORCE as a result of excessive pull speed, inertia, or vibration from an external source. Should a wire bond fail before reaching the PRESET FORCE, the force at which the failure occurred will be displayed.

BEAM TRAVEL Control – This control changes the movement of the beam from ¼ to ¾ inch for full movement of the Control Lever. The ratio of the Control Lever movement to beam movement is variable from 4.5:1 to 13:1. Device holders with height variations up to 2 inches can be accommodated by using the five mounting positions for the Beam Module together with the DOWNSTOP control and BEAM TRAVEL control. This control is a screwdriver adjustment to prevent inadvertent changes.

DOWNSTOP Control – This control provides a fast, convenient method to electronically adjust the position of the Downstop. The range of adjustment is ¾ inch when the BEAM TRAVEL control is set to MIN and is reduced to ¼ inch when the BEAM TRAVEL control is set to MAX.

UPSTOP Control – This is a ten-turn potentiometer which changes the position of the Upstop. The resolution is 0.001 inch per minor division on the vernier dial. The red Test Status Indicator, visible at the test site, continuously blinks if the beam reaches the Upstop. The Upstop can be set to activate in any position between full-scale travel and approximately 0.003 inch from the location of the Downstop. A mechanical lock is provided to prevent inadvertent changes.

HOOK RETURN Switch - the HOOK RETURN switch is set to MANUAL for testing multilevel substrates. In this mode, the hook will remain stationary after the completion of each test. In the Non-Destruct Mode test, the red Test Status Indicator will go out, as a signal to the operator to lower the hook, after the PRESET FORCE is reached and the HOLD TIME expires. The hook must be lowered to the desired level by using the Control Lever. The hook cannot be raised until the operator actuates the footswitch, which in turn lights the red Test Status Indicator. After a test, the footswitch is inhibited until the applied pull force has been reduced by at least 5%, by lowering the hook. This feature prevents the operator from accidentally subjecting a bond to multiple tests. When the HOOK RETURN switch is set to MANUAL, the rear panel ZERO switch (see below) should be set to MAN (in the out position). Otherwise if the operator should press the footswitch before the force on the hook is completely removed, the force would be considered as tare and would be added to the force applied during the next test.

End-Of-Test Conditions – When the HOOK RETURN switch is set to AUTO, the hook automatically slews to the Downstop in the event any of the following end-of-test conditions occur:

1 A bond failure.

2 The PRESET FORCE is reached and the HOLD TIME expires.

3 The Beam hit the Upstop.4 The MP4 MODE switch is in the NON-DESTRUCT position and the force reaches 100% of full scale.

FT SW (Footswitch) ENABLE Switch – This momentary-action, spring-loaded switch returns control of the MP4 to the operator in the absence of a completed test, as defined by one of the four End-Of-Test Conditions.

ILLUMINATION Control – This control changes the intensity of the test site lighting.

RS-232C Mode (PRINTER/CMPTR) Switch (figure 1-7)– This switch selects communications with a PRINTER (out) or the CMPTR (computer) (in).

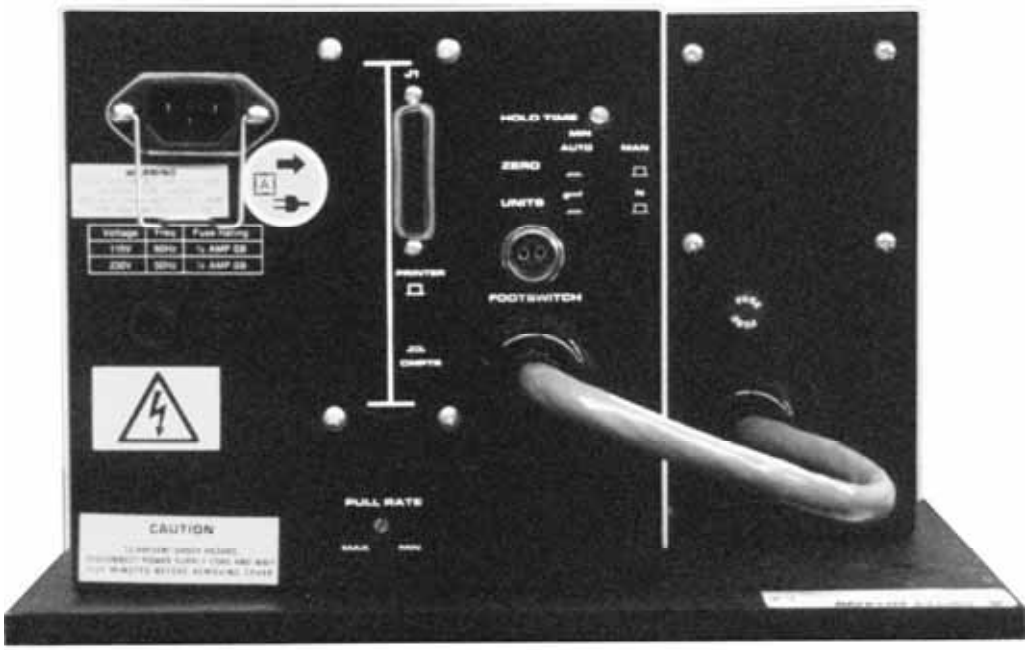
PULL RATE Adjustment – This control adjusts the pull rate from 0.0115 inch/sec. to 0.115 inch/sec,.±20%. This is equivalent to 5% to 57% of the full-scale force per second. The upward speed of the beam cannot exceed the preset MAX PULL RATE. When the force on the wire bond approaches 95% of the PRESET FORCE, the PULL RATE is automatically reduced to 5% of full-scale-per-second in order to minimize, and in most cases, eliminate overshoot. The beam moves down at a fixed rate of 0.5 inches/second. Movement in either direction may be inhibited by use of the Control Lever unless one of the four End Of Test Conditions, described above, occurred. The repeatability of the PULL RATE is ±2%.

HOLD TIME Adjustment – Hold time is the length of time for which the PRESET FORCE is applied to the wire bond. This control is used to adjust that time, when operating in the Non-Destruct Mode, from 0.1 to 3 seconds, ±20%. Although this feature is active in both the Automatic and Manual Hook Return Mode, its meaning is insignificant in the Manual Mode as the operator manually returns the hook. A wire bond failure during the hold time is indicated by a unique message which can be recorded using the optional RS-232C interface. Repeatability is ±2%. HOLD TIME is useful when performing peel tests. It should be set to MIN for all other tests.

ZERO Mode Switch - In the MAN (manual) position (out), positive tare is displayed at the beginning of each test. In the AUTO position (in), any positive tare is automatically subtracted from all readings. The MP4 does not recognize negative inputs and, therefore, cannot compensate for them. The ZERO switch should not be set for AUTO (in) when the HOOK RETURN switch (above) is set to the MANUAL position.

UNITS Switch – The UNITS switch selects the unit of measurement as grams-force (gmf) (in) or newtons (N) (out) (for the 1000gf beam) or millinewtons (for the 10 and 100gf beams). The selected unit of measurement is displayed to the right of the PEAK FORCE indicator (above) reading.

Non-CE Configuration



CE Configuration

Figure 1-7. Rear View of MP4

Beam Drive Module (figures 1-1 and 3-4)

Zero Adjustment - The output of the strain gauge preamplifier can be re-zeroed by slowly turning the four-turn screwdriver adjustable potentiometer, accessible through the top of the beam module cover, until the minus sign on the PEAK FORCE display just goes out. This control may be set to +0.3% of full scale with the ZERO switch in the MAN position (out). The switch can then be set to AUTO (in) and used without further adjustment.

Site Illumination - The intensity of the site illumination lamp can be changed by using the ILLUMINATION control (located on the front panel of the Electronic Control Unit). The bulb is a T-3.25, 12 volt, miniature bayonet lamps (GE 1891); UMC part number 435-047.

Test Status Indicator - The red Test Status Indicator indicates the following:

a. Each time a new test is initiated by pressing the footswitch, this lamp will light and will remain lit until the PRESET FORCE is reached or the HOLD TIME expires and the hook returns to the downstop.

b. When blinking, it indicates that the beam has hit the Upstop - the result of either excessive loop height, the hook slipping from the bond, or a bond which broke at less than 4% of full scale.

c. When extinguished, it indicates the completion of a Non-Destruct test.

d. When lit in the Non-Destruct Mode, the footswitch is inhibited.

The bulb is a red T-3.25, 12 volt, miniature bayonet lamps (UMC part number 4-29441-01).

CHAPTER 2
GETTING STARTED

Section I: Planning for Installation

Space Requirements

The dimensions of the MP4 are:

Width:	11.75 in. (29.85 cm)
Depth:	26 in. (66 cm)
Height:	7.60 in. (19.3 cm)
Weight:	40 lb. (18 kg)

Power Requirements

115 V ±13%, 60/50 Hz or 230 V ±13%, 60/50 Hz
Power: 20 watts
Fuses: 115 V operation: both Beam Drive Module and Control Unit use a 0.5 A (slow blow) fuse.
230 V operation: Beam Drive Module uses a 0.5 A (slow blow) fuse;
Control Unit uses a 0.25 A (slow blow) fuse.

Other Considerations

Environment should be clean, dry atmosphere, with relatively stable temperature.

Mounting should be to a surface that is rigid, free from shock and vibration, reasonably level.

Section II: Set-up

Incoming Inspection and Unpacking

Inspect all shipping containers for evidence of in-transit damage. Noted damage should be reported to the carrier's agent immediately. Reasonable precautions have been taken to ensure the maximum protection of this instrument during shipment. The delicate nature of this instrument, like any other extremely accurate test equipment, makes it susceptible to shipping abuse.

Carefully unpack all containers included in the shipment. Save containers for possible re-use.

Loosen the Allen type button head screws located on the both sides of the Electronic Control Unit and on the left side of the Pull Module. Remove both covers by lifting vertically. Inspect for damage and/or loose connectors. Replace covers and re-tighten screws.

Mounting Optic Mounting Assembly

WARNING: Disconnect power to the MP4 prior to installation of the optic mounting assembly.

NOTE: Installation of the optic mounting assembly will require gaining access to the bottom of the base plate. For easier installation of the mounting post, it is recommended that the instrument be oriented on the workbench so that base plate-to-post holes are exposed over the edge of the bench.

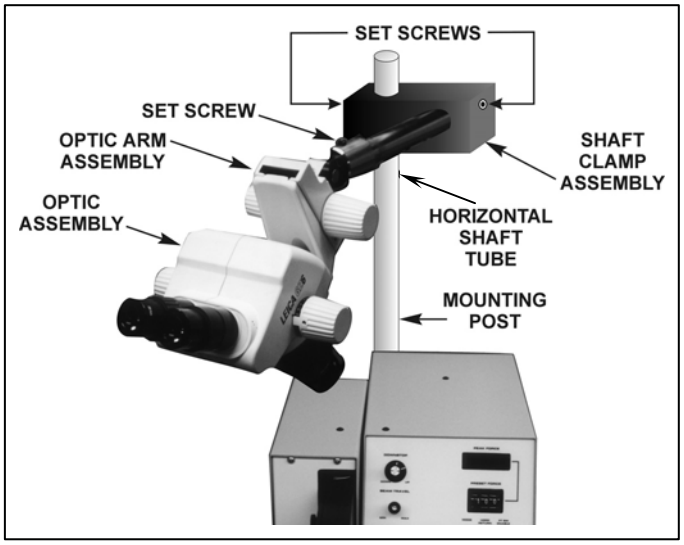


Figure 2-1. Optic Mounting Assembly

1 Secure the mounting post (figure 2-1) to the base plate with the three 1/4-20 x 1/2 inch flathead screws which are provided.

2 Slip the shaft clamp assembly down the mounting post and secure it at the appropriate height with the set screw on the left-hand side of the shaft clamp assembly

3 Insert the horizontal shaft tube into the shaft clamp assembly and, positioning the horizontal shaft tube with the set screw facing upward, tighten the set screw on the right-hand side of the shaft clamp assembly.

4 Insert the optic arm assembly into the end of the horizontal shaft tube and tighten the set screw in the horizontal shaft tube.

5 Adjust the optic assembly in accordance with instructions provided with that assembly. Adjust as necessary so that the field of view is correct.

Beam Module Installation

NOTE: Do not install the hook at this time

1 With the POWER switch set to OFF, install the beam module to insure that both connectors are connected.

2 Remove the thumbscrew on the left side of the beam.

3 Place the beam next to the beam mounting arm.

4 Insert the blue ribbon cable connector in the receptacle on the top of the beam.

5 Insert the three-pin black connector in its receptacle as illustrated in figure 2-2.

6 Align the dowel pins on the beam with the mounting holes on the mounting arm.

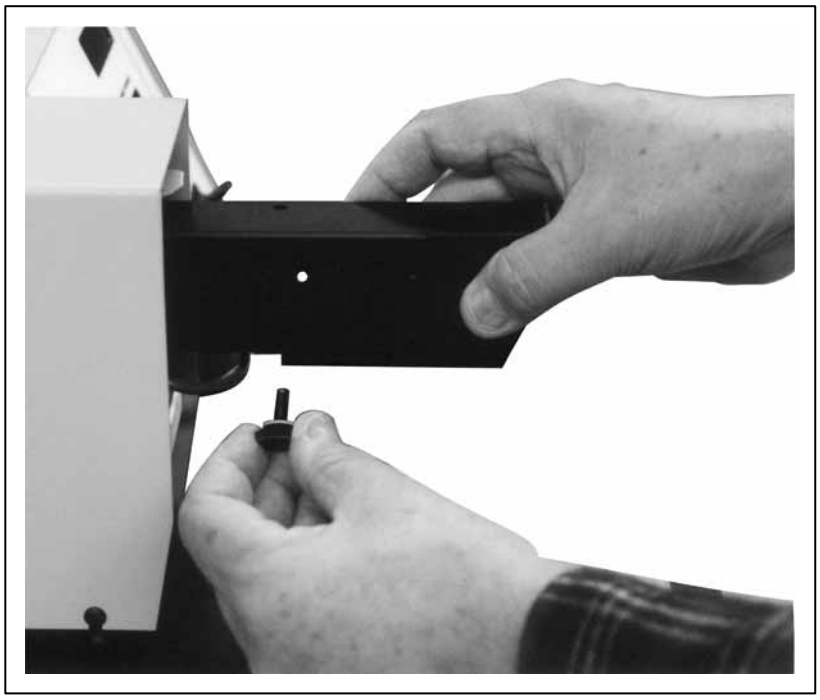


Figure 2-2. Attaching Beam Module to the Beam Arm

7 Making sure that the beam is parallel to the beam mounting arm and install the thumbscrew.

Beam Module Removal

Making sure that the ribbon cable is carefully removed from its receptacle, remove the beam module by reversing the procedure outlined above.

Switch and Cable Installation

WARNING: To prevent injury to yourself, or damage to the device holder, always remove it from the base plate prior to moving the MP4 on the bench.

1 Connect the footswitch to the footswitch receptacle located on the rear of the Electronic Control Unit.

2 Connect the cable from the Pull Module to the mating connector located on the rear of the Electronic Control Unit. The locating tabs on the plug should align with the mating slots in the receptacle. Tighten the threaded locking ring.

3 Check both fuses to see that they are correctly installed. One fuse is located on the rear of the Electronic Control Unit and the other is on the rear of the Beam Pull Module.

Section III. Software Installation

NOTE: These instructions assume that the reader has a reasonable understanding of PC/MS-DOS and Lotus 1-2-3.

1 The programs contained on the Distribution Diskette can be copied to a sub-directory on the hard drive named "\MP4" by using the INSTALLH.BAT Program on the Distribution Diskette. The Distribution Diskette should be placed in Drive A. Enter the DOS Command <A:>, which will change the default directory to Drive A. Have a blank diskette available as the first instruction to be executed will make a "back-up" copy of the Distribution Diskette. Enter the command INSTALLH.BAT. Follow the instructions that appear during the DISKCOPY Program to make multiple copies. Remove the diskette from Drive A and store it in an appropriate manner. The instructions executed by INSTALLH.BAT are:

DISKCOPY A: A:	Make a backup copy of the Distribution Disk
C:	Create MP4 Subdirectory
MD \MP4	
CD \MP4	Make MP4 the current directory
COPY A:MP4.BAS	COPY 5 files to the MP4 Subdirectory
COPY A:MP4.ASC	
COPY A:MP4.EXE	
COPY A:NONDEST.WK1	
COPY A:DESTRUCT.WK1	
CD \	Make the main directory the current directory
COPY A:MP4BAS.BAT	COPY 3 files to the main directory
COPY A:MP4GW.BAT	
COPY A:MP4EXE.BAT	

2 To print a copy of the software manual, enter the command TYPE A:MANUAL.ASC >PRN. The manual is 24 pages in length.

3 To print a copy of the MP4.BAS source code, enter the command TYPE A MP4.ASC>PRN. The listing is 9 pages long.

4 If you elect to use MP4.BAS, then the PATH must be set so that BASICA.COM or GWBASIC.EXE can be found. MP4.EXE, which executes much faster than the interpreted versions, does not require any support programs.

5 All versions of "MP4" require a maximum of 256 bytes be allocated to the receive buffer for the RS-232 Port. Since BASIC normally allocates 256 bytes for the receive buffer, the instruction to run the program from DOS should be: BASICA MP4 or GWBASIC MP4.

6 MP4.EXE can be recompiled with Quickbasic. Quickbasic allocates 512 bytes for the receive buffer. The following options should be selected from the QuickBASIC Compile Option Menu:

Stand-Alone EXE File
Produce Debug Code

7 For those users who elect to use the interpreted version of MP4, batch files, MP4BAS.BAT and MP4GW.BAT, have been created which contain the following instructions:

```
ECHO OFF CLS
PATH \DOS;\BASIC;\MP4;\LOTUS
CD\MP4
BASICA MP4 -or- GWBASIC MP4
```

For those users who elect to use the compiled version, MP4.EXE, a batch file, MP4EXE.BAT, has been created which contains the following instructions:

```
ECHO OFF
CLS
PATH  \DOS;\BASIC;\MP4;\LOTUS
CD\MP4
MP4
```

The PATH Instruction assumes that DOS, BASICA (GWBASIC) , and LOTUS are located in subdirectories which bear their names. MP4BAS.BAT, MP4GW-BAT and MP4EXE.BAT may be deleted if they do not apply.

8 The RS-232 Cable provided in the shipping kit of the MP4 should be connected between the Jl connector on the rear of the MP4 and either the COM-1 or COM-2 connector on the rear of the computer. The PRINTER/CMPTR switch on the rear of the MP4 should be pressed in to select the computer (CMPTR) mode.

NOTE: If this switch is left out, in the PRINTER position, the software will appear to operate properly, however the footswitch will have to be pressed in order to make the End of Test function keys operate properly.

CHAPTER 3
OPERATING INSTRUCTIONS

Section I: Operating Precautions

General Operator Safety

WARNING

Always wear safety goggles any time you are operating the MP4.

Section II: Preparing for Operation

Initial Operating Procedure

The following procedure is designed to familiarize you with the operation and features of the MP4. After once performing these instructions in detail, you should be able to devise a simple procedure specifically tailored to your requirements.

1 Assure that the power plug from the MP4 is connected to the appropriate power receptacle.

2 Switch the POWER switch to ON. The site illumination lamp should light.

3 Press the footswitch, the beam should move and/or follow the control lever.

Installing the Hook on B10 and B100 Beam

WARNING: Switch the POWER switch to OFF.

1 Pull the beam access cover forward. Select the proper hook. Many specifications require that the Hook diameter be approximately 2.5 times the bond wire diameter.

2 Place the slotted end of the hook insertion tool through the hook access hole in the beam housing (figure 3-1) until it rests on top of the beam.

NOTE: Be sure the slotted end is resting on the beam and that the slot is parallel to the length of the beam.

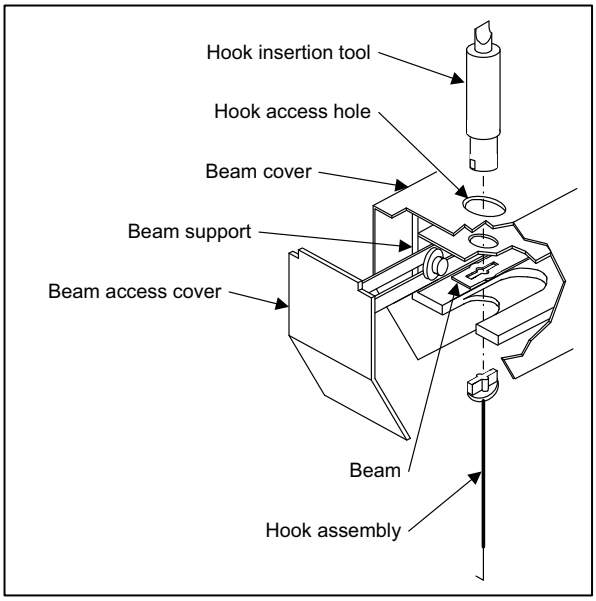


Figure 3-1. Installing Hook on B10 and B100 Beams

3 Insert the hook assembly into the beam assembly and align "T" pin with the slot in the beam. Gently apply pressure to both the hook and the insertion tool in a manner which allows the "T" to pass through the slot in the beam and penetrate into the slot in the insertion tool.

4 Rotate the tool 90 degrees. The "T" should now be perpendicular to the slot. Make certain the "T" is resting in the grooves on the top of the beam. The hook should point toward the MP4 or the operator.

5 The hooks for the B1000 beam screw onto the bottom of the hook shaft as shown in figure 3-2. Note that the hook swings parallel to the beam with relatively little force but resists movement perpendicular to the length of the beam.

6 Remove the tool and store it properly in the hole provided on the base- plate. Bent beams will not measure properly and are not covered under warranty. Hooks are difficult to install without the tool.

7 Insert a device in the appropriate device holder. Do not place the device holder under the hook at this time.

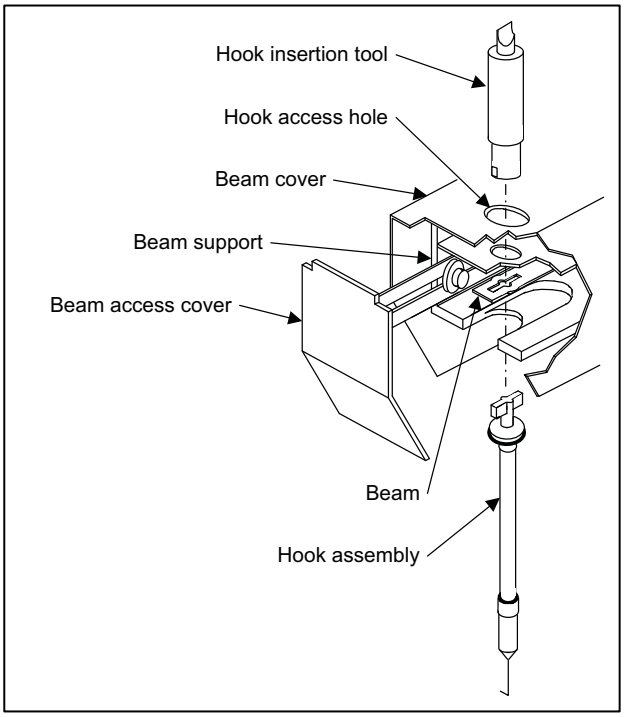


Figure 3-2. B1000 Beam

Installing the Rotatable Hook - B100R Beam

WARNING: Set the POWER switch to OFF.

1 Pull the beam access cover forward. Select the proper hook. Many specifications require that the Hook diameter be approximately 2.5 times the bond wire diameter.

NOTE: The shaft and knob assembly should not be in position while installing the rotatable hook assembly.

2 Insert the hook assembly into the beam assembly and align "T" pin with the slot in the beam (see figure 3-3). Gently apply pressure to both the hook and the insertion tool in a manner which allows the "T" to pass through the slot in the beam and penetrate into the slot in the insertion tool.

3 Rotate the tool 90 degrees. The "T" should now be perpendicular to the slot. Make certain the "T" is resting in the grooves on the top of the beam. The hook should point toward the MP4 or the operator.

4 With the “T” handle installation tool, pick up the “T” handle by its handle and carefully slip it onto the hex bushing affixed to the top of the rotatable hook.

5 Rotate the “T” handle gently until it falls into place. Release the installation tool and carefully rotate the “T” handle until the handles are positioned parallel to the beam.

6 Rotate the knob while installing so that the legs slip through the slot in the bracket and fall into alignment with the “T” handle. When the knob is fully seated, insert retaining clip into the shaft groove to capture the knob assembly.

7 Turn the adjustment screw in the knob to obtain clearance as shown in figure 3-3. This will prevent the “T” handle from flying off during operation.

8 To remove the rotatable hook assembly, reverse the above procedure.

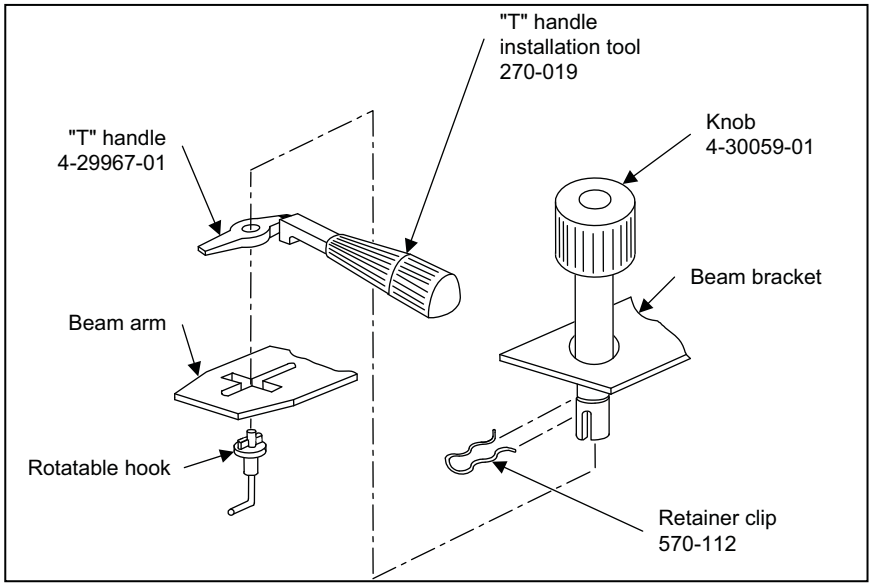


Figure 3-3. B100R Rotatable Beam and Hook Assemblies

Setup Controls

1 Set or adjust the controls on the Electronic Control Unit (figure 1-6, 1-7) as follows:

Control	Setting
POWER switch	ON
ILLUMINATION control	As desired
PRESET FORCE thumb wheels	2 - 10 gf beam 20 - 100 gf beam 200 - 1000 gf beam
MODE switch	NON-DESTRUCT
HOOK RETURN switch	MANUAL
UPSTOP control	10.0 (fully CW to UP)
BEAM TRAVEL control	MIN (fully CCW)
DOWNSTOP control	DOWN (fully CCW)
* ZERO switch	MAN (out)
* PULL RATE control	MAX (fully CCW)
* HOLD TIME control	MIN (fully CCW)
* UNITS switch	gmf (in)
* PRINTER/CMPTR switch	PRINTER (out)

* located on Rear Panel

2 Use the screwdriver end of the hook insertion tool and slowly turn the zero adjust potentiometer on the Beam Module, figure 3-4, clockwise until the minus sign in front of the PEAK FORCE reading lights. Then, turn the zero adjust counterclockwise until the minus sign just goes out.

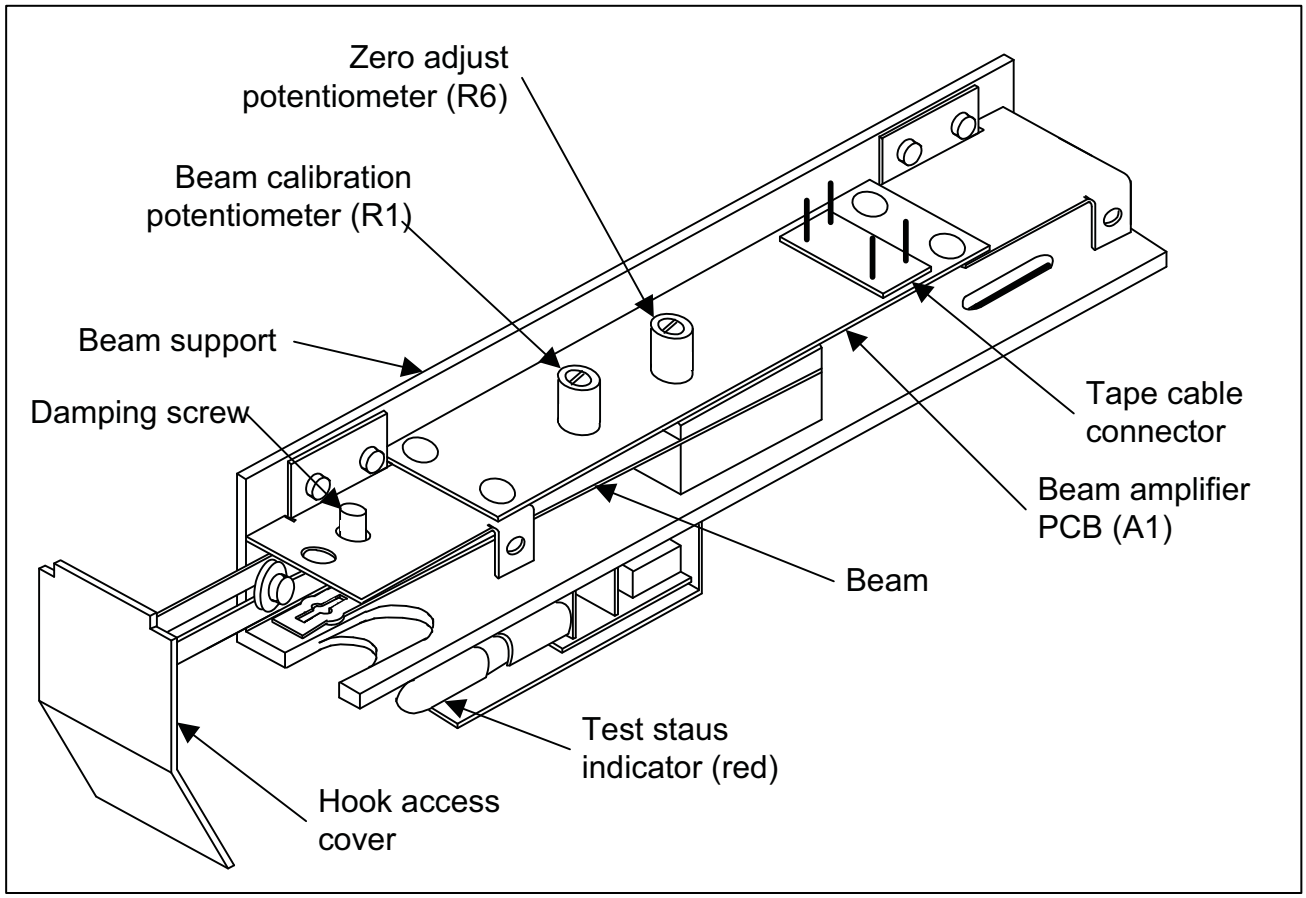


Figure 3-4. Beam Assembly Adjustments

Beam Travel Adjust

CAUTION: Move the device holder so that it is not under the hook before adjusting the beam travel to eliminate the possibility of bending the hook.

1 Push The Control Lever down. The beam arm is now in its lowest position. The relative position of the hook can be changed by using the five sets of mounting holes in the beam

2 Raise the Control Lever. The hook should move 1/4-inch vertically.

3 Actuate the footswitch, if necessary. Return the Control Lever to its lowest position.

4 With the BEAM TRAVEL control at MIN turning the DOWNSTOP control to UP should raise the hook position by about 1/4 inch.

5 Turn the BEAM TRAVEL control to MAX. The beam should now travel 3/4-inch when the Control Lever is raised.

6 With the Control Lever in its lowest position the DOWNSTOP control will now adjust the hook position approximately 1/4 inch.

NOTE: These controls interact. Specifically, they divide a total of one-inch movement in the following manner:

BEAM TRAVEL Control	Actual Beam Travel	Actual DOWNSTOP Adjustment
MIN	1/4"	3/4"
MAX	3/4"	1/4"
Midpoint	1/2"	1/2"

7 Select the beam travel which best suits your package.

NOTE: The End Of Test Conditions are met when:

a A bond failure occurs
b The PRESET FORCE is reached and the HOLD TIME expires.
c The beam hits the electronic Upstop.
d The MP4 is in the Non-Destruct Mode and the force reaches 100% of full scale.

DOWNSTOP Adjust

NOTE: As the BEAM TRAVEL and the DOWNSTOP controls interact, the BEAM TRAVEL should be adjusted before adjusting the DOWNSTOP control.

1 Adjust the BEAM TRAVEL so that the travel exceeds the height of the package. With the Control Lever down, adjust the DOWNSTOP control so that the device can slide under the hook.

2 Readjust the DOWNSTOP control so that the hook is close to, but does not hit the device substrate. If the adjustment is insufficient, switch the POWER switch to OFF and move the beam module to a different location on the beam arm . Check that both adjustments are set so that the device can be easily placed under the hook without damage.

3 With the Control Lever in the up position, turn the UPSTOP control counterclockwise until the red Test Status indicator just blinks. The Upstop is now set to the position that corresponds to the highest position of the beam arm as determined by the BEAM TRAVEL adjustment. This should be between 1/4-inch and 3/4-inch above the device substrate.

4 Place the MODE switch to NON-DESTRUCT and the HOOK RETURN switch to AUTO. The beam will automatically return to the Downstop after it hits the Upstop.

5 Press the footswitch and the process will be repeated. If you raise the Upstop the hook will not return unless you return it manually as none of the End Of Test conditions are met. When the HOOK RETURN switch is set to MANUAL, the beam stops when any one of the conditions is met.

6 When the HOOK RETURN switch is set to AUTO, the hook automatically slews to the Downstop in the event that any of the End Of Test conditions is met.

Zero Adjust

1 On the rear of the Electronic Control Unit, set the ZERO switch to MAN (out).

2 Slowly turn the zero adjust potentiometer (R6) (figure 3-4) on the beam clockwise using the insertion tool screwdriver until the PEAK FORCE indicator minus sign just lights.

3 Turn the zero adjust potentiometer (R6) counterclockwise until the PEAK FORCE indicator minus sign barely extinguishes. Ignore the displayed digits as they will not change. The beam amplifier output is now zero.

4 Press the footswitch and note that the PEAK FORCE display reads 000.

5 Pull down, gently, on the hook. Release it, then press the FT SW ENABLE switch followed by the footswitch. The display should re-zero.

6 Turn the zero adjust potentiometer (R6) until the display reads 003.

7 On the rear of the Electronic Control Unit, press the ZERO switch in (AUTO). Notice that the display automatically zeros after each simulated test.

NOTE: The reason for setting the amplifier three counts positive is that negative readings cannot be read and, therefore, cannot be automatically corrected. Three counts compensates for the drift which normally occurs during warm-up.

In the AUTO ZERO MODE the MP4 display reads the net force applied to the wire bond EXCEPT when the Minus Sign is lit.

Section III: Operation Procedures

Example of Non-Destruct Mode Testing

You are now ready to apply 2 gf to the wire bond. In the case of the 1000 gf beam the force will be 200 gf.

1 Place the MODE switch to NON-DESTRUCT and the HOOK RETURN switch to MANUAL. On the rear of the Electronic Control Unit, set the ZERO switch to MAN (out).

NOTE: In normal operation, when you work in the Manual Zero Mode the MP4 should be zeroed. But, for the purpose of this illustration it is not necessary.

2 Use your left hand to manipulate the device holder and your right hand to operate the Control Lever. Press the footswitch, signaling the MP4 that you are ready to start the test. The red Test Status Indicator will light.

3 Move the hook, as necessary, in order to position it under the wire bond.

4 Raise the Control Lever. The hook will track the movement of the Control Lever until the PRESET FORCE is applied to the wire bond, 2 gf less 3 counts, in this case. The Test Status Indicator will go out

signaling that the hook should be lowered. However, the hook will remain under the wire applying 2 gf until the Control Lever is lowered.

5 Lower the hook and press the footswitch to signal the start of a new test.

6 Repeat this test with the MODE switch set to NON-DESTRUCT, the HOOK RETURN switch set to AUTO, and the ZERO switch (on the rear panel) pushed in (AUTO). Note that the hook automatically returns to the Downstop as soon as the actual force equals or exceeds the PRESET FORCE. With the PULL RATE control (on the rear panel) set to MAX, you are applying the force at the maximum rate which is 50% of the full scale force per second. Any overshoot is a result of inertia and can usually be eliminated by adjusting the PULL RATE control CW (toward MIN).

7 When switching the ZERO switch from MANUAL to AUTO, it is considered good practice to reset by pressing the FT SW ENABLE switch followed by the footswitch. The purpose of this procedure is to insure that the tare is subtracted from the ensuing test result.

8 Turn the HOLD TIME control (on the rear panel) to its maximum (fully CW) position and repeat the previous test. The PRESET FORCE will now be applied to the wire bond for 3 seconds before the hook is automatically lowered to the Downstop. This feature is useful in performing peel tests. The setting of the HOLD TIME control has no meaning when the HOOK RETURN switch is set to MANUAL.

9 Repeat the previous test. While the hook is applying force to the wire bond, hit the table with your fist. This will give you some indication of the force that can be transmitted to the wire bond as a result of excessive shock transmitted to the wire bond through the table. Notice that this excessive force is recorded by the MP4 as required by the MIL-STD.

10 Set the MODE switch to NON-DESTRUCT and the HOOK RETURN switch to MANUAL. On the rear panel, set the UNITS switch to the N position (out). Notice the position of the decimal point in the PEAK FORCE display changes. Both the reading and the Preset Force are now in millinewtons (newtons for the 1000 gf beam). One newton, in the MP4 is 101.97 grams force. In this mode, all forces will be applied and displayed in terms of millinewtons.

11 Repeat the test with the PRESET FORCE set to 000. Notice that the MP4 does not operate.

NOTE: Setting the PRESET FORCE to 000 has no meaning and therefore further operation of the MP4 is inhibited when the MODE switch is set to NON-DESTRUCT.

12 Set the PRESET FORCE to 020 (200 on the 1000 gf beam).

13 With the Control Lever in the up position, turn the UPSTOP control CCW until the red Test Status Indicator just blinks. The Upstop is now set to the position that corresponds to the highest position of the beam arm as determined by the beam travel adjustment. This should be between 1/4-inch and 3/4-inch above the device substrate. Record the setting.

14 Repeat the pull test with the UPSTOP control set at 000. The red Test Status Indicator should blink continuously and the footswitch will appear to be inoperative.

NOTE: Setting the Upstop below the Downstop inhibits operation in both the Non-Destruct and Destruct Modes.

15 Increase the UPSTOP control until the MP4 functions properly. Verify that the MODE switch is set to NON-DESTRUCT and the HOOK RETURN switch to MANUAL. Hook a wire bond. Then decrease the UPSTOP control until the Test Status Indicator just starts to blink and a force equal to the PRESET FORCE is displayed on the PEAK FORCE indicator. This is a trial and error process requiring several cycles. Now the Upstop is located at a point corresponding to the top of the non-destructively stressed wire bond. Every minor division on the UPSTOP control vernier represents 0.001 inch. If loop height is critical in your devices, increase the UPSTOP control by 2 to 10 minor divisions and use the control to detect excessive loop height. Otherwise, set the UPSTOP control to a setting which is greater than the loop height but less than, or equal to, the setting previously recorded in step 13.

NOTES:

- The distance between the the Downstop and the Upstop must exceed .003 inch.
- The MIL-STD states that the NON-DESTRUCT pull should be made in the center of the wire bond and that the wire bond should be reformed into an equilateral triangle, as shown in figure 1-3. This requirement means that the hook must either face the MP4, or the operator, and the bond must be oriented parallel to the front of the MP4.

16 Set the MODE switch to NON-DESTRUCT /and the HOOK RETURN switch to AUTO. Make Non-Destruct tests at successively lower force settings until the footswitch fails to reset the cycle. This setting plus one least significant digit, represents the lowest Non-Destruct force that should be preset (on the PRESET thumb-wheels) for this beam. This value should be 0.10 gf (010) for the 10 gf beam; 1.5 gf (015) for the 100 gf beam and 100 gf (100) for the 1000 gf beam.

NOTE: Proper operation of the failure detection electronics is not guaranteed below 2% of full scale force.

Example of Destructive Mode Testing

1 Set the MODE switch to DESTRUCT /and the HOOK RETURN switch to MANUAL.

2 With the Control Lever in the up position, turn the UPSTOP control CCW until the red Test Status Indicator just blinks. The Upstop is now set to the position that corresponds to the highest position of the beam arm as determined by the beam travel adjustment. This should be between 1/4-inch and 3/4-inch above the device substrate.

3 Position the hook under the center of the wire bond.

4 Press the footswitch. Force will be applied to the bond until it breaks or the beam hits the Upstop. The peak force required to break the wire bond will be displayed on the PEAK FORCE indicator. The Test Status Indicator remains lit. A blinking Test Status Indicator indicates that the beam hit the Upstop.

NOTE: Beams can be used at forces up to 20% over their nominal rating. That is, 12 gf, 120 gf, and 1200 gf for the 10gf, 100gf and 1000gf Beam, respectively.

5 Place the MODE switch to DESTRUCT /and the HOOK RETURN switch to AUTO.

6 Repeat the previous test on another wire bond. Notice that when the hook automatically returns, it occasionally rests on top of the broken wire bond. For this reason you may wish to perform Destruct Tests with the HOOK RETURN set to MANUAL.

Section IV. Printer Operation

Set-up and Interpreting Readouts

NOTES:

- Throughout this manual the convention < > means "the computer key labeled." For example, <4> means the key labeled 4. <Enter> means the key labeled Enter (or Return).
- For the following operations to work, as shown, the following conditions must exist:

  The computer printer must be on line,

  The computer RS-232 port must be connected to the MP4 RS-232 port (J1), and

  The MP4 PRINTER/CMPTR switch must be in the CMPTR (computer) position (in).

1 Set the POWER switch on the MP4 to ON. Use the computer's keyboard to type MP4EXE, MP4BAS, or MP4GW followed by <Enter> to run the MP4 program. The Title Screen appears momentarily.

2 To change an entry on either of the next two screens, use the <F9> key to indicate that you wish to make a change. In those cases where only two answers are possible, the selection will automatically toggle. Use the <Enter> key to terminate changes on those entries which do not toggle. On some keyboards, the cursor keys will move the cursor within the entry. Other keyboards require that the <4> and <6> keys be used. The <Backspace> key should perform its intended function. <Enter>, <8>, or the <2> keys will step the pointer from line-to-line. The cursor keys will also perform this function on some keyboards. To signify that no further changes are desired, press <Fl0>.

Define Hardware

FIELD	CONTENTS
Date	12-06-87
> Communications Port	COM 1
DESTRUCT or NON-DESTRUCT Test (D/N)	N
Beam Size 10, 100, 1000 or 2000gf	100
Unit of Measure	gf
Non-Destruct Pull - Min.= 0.9	2.5
Non-Destruct Max. -	2.7
Print All Data (Y/N)	Y
Accept Failure Location Codes (Y/N)	N
Load Histogram History File (Y/N)	N

Use cursor keys to move, <F9> to change, and <F10> to exit

3 The "Date" entry displays the DOS System date. If the date is incorrect, return to DOS and change it using the DOS Command DATE.

4 Press <F9> to select communications port #1 or #2. The software will open the communications port even if the MP4 is not connected to the computer because the status of the "Request To Send" and "Clear To Send" lines are ignored.

5 Press <F9> to toggle the contents of the "Destruct or Non-Destruct Test (D/N)" field between N and D. The software will only allow the user to enter responses that are appropriate for the specified mode. The Non-Destruct Pull Limits are erased whenever the Destruct Mode is selected.

6 The test limits for the Non-Destruct Mode are shown in table 3-1.

Table 3-1. Test Limits for Non-Destruct Mode

Beam	Units	Test Limits
B10	gf	0.5 – 10
	mN	5 – 100
B100	gf	0.9 – 100
	mN	9 – 1000
B1000	gf	40 – 1000
	N	0.4 – 10
B2000	gf	80 – 1999
	N	0.8 – 19.9

7 The Maximum Non-Destruct Test Limit must be at least 1 count higher than the Minimum Test Limit. The recommended minimum is 2 counts.

8 A "Y" in the "PRINT ALL DATA" field will cause the software to print all of the data transmitted by the MP4. An "N" response will result in the Non-Destruct software printing only that data which is outside the limits defined by the contents of the Non-Destruct Minimum and Maximum Test Limit fields. An "N" will inhibit printing in the DESTRUCT Mode provided the contents of the "Echo Data to a Disk File" field, on the next screen, contains a "Y".

9 In the NON-DESTRUCT Mode, a "Y" in the "Accept Failure Location Codes" field will cause the program execution to stop after each bond that fails to meet the Test Limits and wait for the operator to enter a six-digit location code to facilitate the inspection and/or repair of these bonds. In the Destruct Mode, a "Y" will cause the program to wait for the operator to enter a single numeric Failure Location Code, between 1 and 8. The codes listed are taken from MIL-STD-883B.

10 In the DESTRUCT Mode, a "Y" in the "Load Histogram History File" field instructs the software to load the Histogram History File. That file, named "PULLS.TXT," is located in the \MP4 Subdirectory on Drive C. If this file does not exist, the software will create it. This file contains 261 entries that contain the number of tests with bond pull strengths within the 0.5% pull range represented by that

entry. For example, on a 100 gf beam, the ninth entry would contain all of the bonds that broke between 4.5 (9 x 0.005 x 100gf) and 4.9 gf.

CHANGE HEADER INFORMATION

FIELD	CONTENTS
Operator's Name	
Part Number	
Lot Number	
Serial Number	1
Increment Serial No. (Y/N)	Y
No. Pulls per Assembly	16
Echo Data to Disk File (Y/N)	N
Disk Drive (A, B, C, or D)	C
Path Name	\MP4\
File Name	DATA

Use cursor keys to move, <F9> to change, and <F10> to exit

11 Press <Fl0> to proceed to the Change Header Information Screen. Enter up to 15 characters in the Operator's Name and Assembly Number Fields. The Serial Number can be numeric or alphanumeric. If numeric, the Serial Number will be automatically incremented at the completion of each assembly provided the "Increment Serial No." field contains a "Y". If this field contains an "N", the program will stop at the end of each test series and wait for the operator to enter a new Serial Number. The maximum number which can be entered in the "No. Pulls per Assembly" field is 9999.

12 A "Y" in the "Echo Data to Disk File" field will cause all of the data received from the MP4, in either mode, to be reformatted into a Lotus ".PRN" format and saved to the disk file specified by the contents of the "Disk Drive," "Path," and "File Name" fields. As shown above, the Path Name must start and end with a "\". The File Name will always be given the extension ".PRN" and be written in a format that allows the data to be imported into Lotus 1-2-3. The specified file, C:\MP4\DATA.PRN in this example, will be over-written whenever the ECHO Feature is selected.

13 Press <Fl0> to exit.

Non-Destruct Testing Program

NOTE: If the printer is not on line, the program will not proceed beyond this point and a "Device timeout…" error will result.

1 Assuming the appropriate Operator, Part and Lot No. information was entered in the Change Header Information Screen, the following will be printed at the top of the first page of the report:

NON-DESTRUCTIVE PULL TEST

Date: 12-06-1987 14:23
Operator: M.P. PHFOUR
Part No: A1234567890
Lot No: 4-234-789

Beam Size: 100 gf
Pull Test Limit: 2.5 - 2.7 gf
No. Bonds / Device: 16
Serial No: 1005

The following will be displayed on the computer screen:

NON-DESTRUCT TESTING

TEST PULL(gf)

Start Testing

2 During Non-Destruct Testing the function keys, which are displayed in reverse video at the bottom of the screen, have the meanings shown below:

NOTE: The function keys are inoperative whenever the computer is waiting for the operator to enter a new serial number. Therefore, if it is necessary to use a function key as part of serial number entry, press <Enter> prior to pressing the necessary function key.

KEY	DEFINITION
Fl	That was the last test. Print results and gets ready for next device.
F3	End testing, return to Change Header screen.
F4	End testing, return to Configure Hardware screen.
F7	The last test was invalid. Ignore this data.
F10	Exit program

3 The messages that can be received from the MP4 in the Non-Destruct Mode are:

VALID TEST
NO TEST
HIT UPSTOP
WIRE BROKE / HOLD TIME
FALSE ERROR

An "OUT OF LIMITS" message is generated by the software whenever the Pull Value is less than the contents of the Minimum or greater than the Maximum Non-Destruct Limit fields. A "NO TEST / OPERATOR" message is generated by the software whenever the operator presses <F7>. The software replaces the "Valid Test" message with a space and skips any test which contains the "NO TEST" message.

4 Press the footswitch and proceed with the first test. The data resulting from this test will be displayed immediately after the footswitch is depressed for the second test.

5 The following is an example of a typical printout. In this example, eight tests were performed and the "Print All Data" field contains a "Y." The printout indicates that the operator pressed <F7> during the second test. Therefore the test was printed, but was not included in the test results ("No. of Good Tests"). During the fifth test the wire broke after the proper pull was applied to the bond. Because the "Accept Failure Location Codes" field contained a "Y," the operator was able to enter a location (A12B44) to assist the repair personnel in locating the defective bond.

BOND	PULL (gf)	LOCATION ERROR
1	2.5 gf	
2	.3 gf	NO TEST/OPERATOR
2	2.5 gf	
3	2.6 gf	
4	2.5 gf	A12B44 WIRE BROKE /HOLD TIME
5	2.6 gf	
6	2.5 gf	
7	2.6 gf	
8	2.5 gf	

Serial Number:	1005
No. of Tests:	8
No. of Good Tests:	7
No. of Bad Tests:	1

6 Just after the last test, the computer sounds two tones as a signal to the operator to press <Fl> to confirm that this test was the last for the device. Testing will not end until either <Fl>, <F3>, <F4>, or <Fl0> is pressed. The computer inhibits the MP4 immediately after the last test is made, and a colon is displayed on the MP4, to the left of the Peak Force Display. As the operator pressed <Fl> after the eighth test, the summary was printed.

7 If the "Increment Serial Number" field contains an "N", the request for a new serial number will be made as illustrated below. The serial number is keyed in; <Enter> is pressed to terminate the entry.

```
NON-DESTRUCT TESTING

TEST        PULL(gf)
  16            2.5
Enter Next Serial No: 10010
```

8 If a function key is pressed before any tests are made, the following report will be printed:

```
          Beam Size:      100 gf
     Pull test Limit:     2.5 – 2.7 gf
 No. Bonds/Device:        16
          Serial No.:     10010
Bond #     Pull (gf)     Error
---------------------------------------
NOT TESTED
```

9 To exit this program, press <F10>. This will close all open files. enable the MP4 and restore BASIC Default Legends to the bottom of the screen. Type SYSTEM <Enter>, to return to DOS.

Destruct Testing Program

1 A "Y" in the "Load Histogram History File" field will cause the program to load the data contained in the file "C: \MP4 \PULLS. TXT". An "N," entered before testing begins, will permit the operator to overwrite the "PULLS.TXT" file with new data at the end of the test. During testing, the results will be added to the data contained in the "PULLS.TXT" file.

NOTE: Exiting the program does not erase the contents of the "PULLS.TXT" file. If the file does not exist, the software will assume that it does, and that it contains zeros.

The PULLS.TXT file consists of 261 entries (cells), each containing the number of pulls that broke within the limits of that particular cell. Each cell represents 0.5% of the full scale rating of the beam. For example, on the 100 gf beam, each cell would represent 0 .5 gf or 5 mN. Cell #0 would contain the number of bonds that broke at less than 0.5 gf. Cell #1 would contain the number of bonds that broke between 0.5 gf and 0.9 gf, etc. The contents of PULLS.TXT can be examined using any word processor which can read and write ASCII files.

2 Whenever a histogram is plotted using the <F5> Graph command, the software will save the data to an ASCII file named, "PULLS.TXT" unless the "Load the Histogram History File" field in the "Define Hardware" option screen contains an "N".

In that case, the software permits the user to change his earlier decision not to save data to "PULLS.TXT" by asking, "Save Histogram Data to PULLS.TXT (Y/N)?" A response of <Y> will cause the data to be saved to "PULLS.TXT." Any data that was stored in "PULLS.TXT" will then be over-written. A response of "N" will cause the software to query, "Erase Histogram Data from Memory (Y/N)?" A response of <Y> will start the accumulating of new data; a response of <N> will keep the current data base.

NOTE: Memory is RAM memory, not PULLS.TXT file memory.

3 Assuming the Destruct Test Mode is selected, the "Accept Failure Location Code" field contains a "Y," and the appropriate Operator, Part and Lot No. information is entered in the Change Header Information Screen, the following will be printed at the top of the first page of the report:

```
                    DESTRUCTIVE PULL TEST

                    Date:          12-06-1987  14:25
                    Operator:      M..P. PHFOUR
                    Part No:       A1234567890
                    Lot No:        4-234-789
------------------------------------------------------------

 WIRE BOND FAILURE LOCATION CODES per MIL-STD-883B
 1 - Wire Break at neckdown point.
 2 - Wire Break at any other point.
 3 - Failure in bond interface at die.
 4 - Failure in bond interface at substrate or post.
 5 - Lifted metallization from die.
 6 - Lifted metallization from substrate or post.
 7 - Fracture of die.
 8 - Fracture of substrate.
------------------------------------------------------------
              Beam Size:     100 gf
 No. Bonds / Device:     16
              Serial No:     1015
 BOND # PULL(gf)     LOCATION - ERROR
 ------------------------------------------------------------
```

4 During Destruct Testing the function keys, which are displayed in reverse video at the bottom of the screen, have the meanings shown below:

NOTE: The function keys are inoperative whenever the computer is waiting for the operator to enter a new serial number. Therefore, if it is necessary to use a function key as part of serial number entry, press <Enter> prior to pressing the necessary function key.

KEY	DEFINITION
Fl	That was the last test. Print results and gets ready for next device.
F3	End testing, return to Change Header screen.
F4	End testing, return to Configure Hardware screen.
F5	End testing, plot histogram, save / erase pull data.
F7	The last test was invalid. Ignore this data.
F10	Exit program

5 The messages that can be received from the MP4 in the Destruct Mode are:

VALID TEST
NO TEST
HIT UPSTOP
WIRE BROKE
FALSE ERROR

A "NO TEST / OPERATOR" message is generated by the software whenever the operator presses <F7>. The software replaces the MP4 "Valid Test" message with "MP4 IN NONDESTRUCT." The "WIRE BROKE" message is replaced with a space and any test that contains the "NO TEST" message is skipped.

6 The following is displayed on the computer's screen:

DESTRUCT TESTING

TEST PULL(gf)

Start Testing

WIRE BOND FAILURE LOCATION CODES per MIL-STD-883B
1 - Wire Break at neckdown point.
2 - Wire Break at any other point.
3 - Failure in bond interface at die.
4 - Failure in bond interface at substrate or post.
5 - Lifted metallization from die.
6 - Lifted metallization from substrate or post.
7 - Fracture of die.
8 - Fracture of substrate.

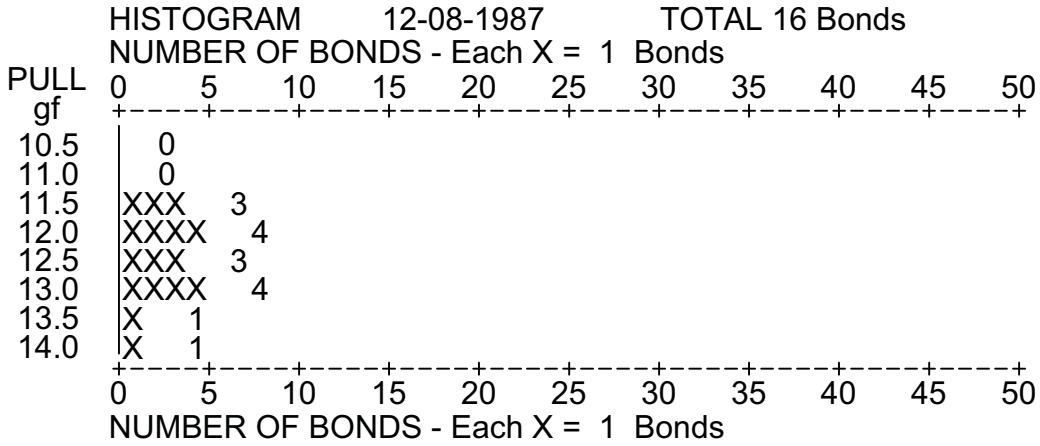
7 Press the footswitch and proceed with the first test. The data resulting from this test will be displayed immediately after the footswitch is depressed for the second test.

8 The following Information would be added to the header shown in step 3, assuming the "Accept Failure Location Codes" field contains a "Y".

BOND	PULL (gf)	LOCATION ERROR
1	12.3 gf	1
2	.5 gf	NO TEST/OPERATOR
2	12.2 gf	1
3	12.0 gf	1
4	12.2 gf	1
5	13.2 gf	1
6	13.3 gf	1
7	13.5 gf	1
8	14.2 gf	1
9	13.0 gf	1
10	12.6 gf	1
11	12.5 gf	1
12	12.8 gf	1
13	13.1 gf	2
14	11.7 gf	1
15	11.5 gf	1
16	11.7 gf	1

Serial Number:	1015
No. of Tests:	16
Aver. Pull Strength:	12.6 gf
Standard Deviation:	0.7 gf
Standard Deviation:	5.8%
Aver. – 3 (Std Dev.):	10.4 gf

9 By pressing <F5>, the operator may graph a histogram of the data resulting from the 16 tests in this example. It will be similar to that shown below:



No. of Bond Tests:	16
Aver. Pull Strength:	12.5 gf
Standard Deviation:	0.7 gf
Standard Deviation:	5.9%
Aver. – 3 (Std Dev.):	10.2 gf

10 The Average Pull Strength, Standard Deviation and related values shown with the histogram may differ slightly from the results obtained from the actual data as the value assigned to each cell is used for the histogram calculations and the actual data is used for calculating the summary for each test. Specifically, if the data taken in step 8 was used, the results would have been:

	HISTOGRAM	ACTUAL
No. of Tests:	16	16
Aver. Pull Strength:	12.5 gf	12.6 gf
Standard Deviation:	0.7 gf	0.7 gf
Standard Deviation:	5.9%	5.8%
Mean - 3(Std Dev.):	10.2 gf	10.4 gf

11 If the "Echo Data to Disk File" field contains a "Y" all of the information received from the MP4 will be reformatted into a Lotus 1-2-3 ".PRN" file. The Disk File named on the Change Header Screen will be over-written whenever the Echo feature is selected.

DESTRUCT TESTING

TEST PULL(gf)
16 11.7 gf

Save Histogram Data to PULLS.TXT (Y/N) ? N
Erase Histogram Data from Memory (Y/N) ?

12 If the "Increment Serial Number" Query was answered <N>, the request for a new serial number will be made at the completion of each assembly in the following manner, where A-123456 represents the previous serial number. The operator keys in the next serial number followed by <Enter>.

DESTRUCT TESTING

TEST PULL(gf)
16 11.7 gf

Enter Next Serial No. A-123456

13 To exit this program, press <F9>. This closes all open files, enables the MP4 RS-232 port and restores BASIC Default Legends to the bottom of the screen. Type SYSTEM <Enter>, to return to DOS.

Printed Reports

1 The format of the data generated when the MP4 is connected directly to a serial printer is:

2.5 gf	VALID TEST	25 mN	VALID TEST
2.7 gf	VALID TEST	27 mN	VALID TEST
2.7 gf	VALID TEST	27 mN	VALID TEST
2.5 gf	VALID TEST	25 mN	VALID TEST
2.6 gf	VALID TEST	26 mN	VALID TEST
2.5 gf	VALID TEST	25 mN	VALID TEST
1.2 gf	WIRE BROKE	25 mN	VALID TEST
.0 gf	NO TEST	26 mN	VALID TEST
0.9 gf	FALSE ERROR 7	25 mN	VALID TEST
2.5 gf	WIRE BROKE / HOLD TIME	26 mN	VALID TEST

2 The Reports generated by this software contain much more information than that shown above. The Non-Destruct and Destruct Test Reports are illustrated below:

NON-DESTRUCTIVE PULL TEST

Date:	12-06-1987 14:23
Operator:	M.P. PHFOUR
Part No:	A1234567890
Lot No:	4-234-789

Beam Size:	100 gf
Pull Test Limit:	2.5 - 2.7 gf
No. Bonds / Device:	16
Serial No:	1

BOND #	PULL (gf)	ERROR

NO FAILURES

Serial Number:	1
No. of Tests:	16
No. of Good Tests:	16
No. of Bad Tests:	0

Beam Size:	100 gf
Pull Test Limit:	2.5 - 2.7 gf
No. Bonds / Device:	16
Serial No:	2

BOND #	PULL (gf)	ERROR
1	.3 gf	NO TEST/OPERATOR
1	2.5 gf	
2	2.6 gf	
3	2.5 gf	
4	2.6 gf	
5	.5 gf	WIRE BROKE
6	2.6 gf	
7	2.5 gf	
8	2.6 gf	
9	2.5 gf	
10	2.6 gf	
11	2.6 gf	
12	2.5 gf	
13	2.6 gf	
14	2.5 gf	
15	2.6 gf	

```
    16              2.6  gf

                Serial Number:              2
                No. of Tests:              16
             No. of Good Tests:            15
              No. of Bad Tests:             1
------------------------------------------------------------
                   Beam Size:         100 gf
              Pull Test Limit:    2.5 - 2.7 gf
           No. Bonds / Device:              16
                    Serial No:               3
 BOND #      PULL (gf)        ERROR
------------------------------------------------------------
 NOT TESTED
```

Explanation of Non-Destruct Test Report. The printout for Serial No. 1 shows the result when the "Print All Data" field contains an "N". Had there been a failure during the testing of this device, the data for that test would have been printed in a format as shown for Serial No. 2, Test #5. Serial No.2 illustrates the format when the "Print All Data" field contains a "Y." "NO TEST/OPERATOR" can be generated by the operator by pressing <F7> on the computer. This data is printed, but it is not used in either the Non-Destruct or Destruct Test results.

```
                DESTRUCTIVE PULL TEST
                    Date:        12-06-1987 14:25
                Operator:        M.P. PHFOUR
                 Part No:        A1234567890
                  Lot No:        4-234-789
-------------------------------------------
 WIRE BOND FAILURE LOCATION CODES per MIL-STD-883B
 1 - Wire Break at neckdown point.
 2 - Wire Break at any other point.
 3 - Failure in bond interface at die.
 4 - Failure in bond interface at substrate or post.
 5 - Lifted metallization from die.
 6 - Lifted metallization from substrate or post.
 7 - Fracture of die.
 8 - Fracture of substrate.

                Beam Size:          100 gf
 No. Bonds / Device:                16
                Serial No:          1015
 BOND #PULL (gf) LOCATION – ERROR
-----------------------------------------------------------------
```

1	12.3 gf	1
2	12.2 gf	1
3	12.0 gf	1
4	12.2 gf	1
5	13.2 gf	1
6	13.3 gf	1
7	13.5 gf	1
8	14.2 gf	1
9	13.0 gf	1
10	12.6 gf	1
11	12.5 gf	1
12	12.8 gf	1
13	13.1 gf	1
14	11.7 gf	1
15	11.5 gf	1
16	11.7 gf	1

Serial Number:	1015
No. of Tests:	16
Aver. Pull Strength:	12.6 gf
Standard Deviation:	0.7 gf
Standard Deviation:	5.8%
Aver. - 3(Std Dev.):	10.4 gf

==========

Disk Files and LOTUS 1-2-3

1 The following procedure is used to import data into Lotus 1-2-3, assuming the disk file contains data from a series of bonds made in the Non-Destruct or the Destruct Mode.

2 Load Lotus 1-2-3. Change the Default Directory to the MP4 Subdirectory using the /WGDD Command, and use the /FR Command to retrieve the appropriate template file:

NONDEST.WK1 for Datalogs containing Non-Destruct Test Data
DESTRUCT.WK1 for Datalogs containing Destruct Test Data

The following example uses data collected from a series of bonds made using the Destruct Mode. The data was saved in a file named DESTRUCT.PRN.

When the data appears on the screen, invoke the "Load Macro" by pressing <ALT> <L>. This macro will erase the data portion of the template and will conclude with a list of the possible ".PRN" files displayed on the command line. Move the cursor to the appropriate name, DESTRUCT in this case, and press <Enter>. Save this file under whatever name is appropriate, using the /FS Command. Invoke the "Calculate Macro" by pressing <ALT> <C>. Invoke the "Print Macro" by pressing <ALT> <P>.

3 Load NONDEST.WKI AND DESTRUCT.WK1 into LOTUS 1-2-3 to see the format of these files.

Suggestions

1 Use the <Fl0> to terminate the MP4 program. This ensures that the MP4 is not inadvertently inhibited by the PC. Switch the MP4 to the PRINTER MODE by releasing the switch on the rear panel.

2 If there is a problem receiving data from the MP4, use the PC-DOS utility program named COMM.BAS. List Line 210, which reads:

210 LOCATE 21,3:COMFILE$="COM1 : : +SPEED$+","+PARITY$+","+BITS$+","+STP$

Change it to:

210 LOCATE 21,3:COMFILE$="COM1 : : +SPEED$+","+PARITY$+","+BITS$+","+STP$+"RS,DS"

Save the modified program as COMMP4 by entering SAVE "COMMP4". Run the modified program and configure if for:

Selection 6 - Other Service
BAUD RATE 1200 -the Default Value for the MP4
NUMBER OF BITS PER CHARACTER 8
NUMBER OF STOP BITS 1
CHARACTERS ECHOED TO SCREEN (Y/N) Y

3 The second technique is to connect a serial printer to the RS-232 connector.

Program Documentation

1 Format of a ".PRN" file in the NON-DESTRUCT and DESTRUCT MODES

DESTRUCT PULL TEST
Date: 03-01-1988 17:17
Operator: M.P. PHFOUR
Part No: Al234567890
Lot No: 4-234-789
Beam Size: 100
Units: gf

SERIAL NO.	TEST NO.	PULL ERROR"
1	1	9.600001
1	2	9
1	3	8.600001
1	4	7

1	5	8.5
1	6	7.5
1	7	8.399999
1	8	7.3
1	9	10.2
1	10	8.2

Reference Listing for MP4.BAS Release 1.0

Symbol	Reference Line -			
0	1535,	7620		
105	1805,	1860,	5255	
110	5305,	5310.	5325	
120	125,	135		
125	125,	130		
135	130			
140	130			
150	110			
155	110			
160	110			
205	5255,	7430,	7535,	7545
225	241,	245,		
230	230			
235	230			
245	230			
250	230			
270	205			
1005	1440,	2585,	10125	
1015	1440,	2585		
1205	1430			
1220	1210			
1305	1320,	1365		
1340	1330			
1345	1325,	1330,	1335	
1350	1340			
1355	1315			
1405	1355			
1430	1410			
1505	1010			
1510	1535			
1515	1310,	2325		
1525	1510,	1540,	1555,	1560

Symbol	Reference Line -		
1590	1505		
1595	1230,	2235	
1605	1755		
1610	1760		
1615	1760		
1620	1635,	1760	
1625	1605,	1760	
1635	1760		
1705	1020,	5005,	7005
1710	7005		
1715	5005		
1720	215,	5280	
1755	1230,	1875,	2235
1805	1215,	2215	
1855	1340		
1905	2560,	2570	
1910	1910		
1915	1910		
2105	1020		
2205	2575		
2220	2210		
2305	2335,	2380	
2315	2315,	2320	
2320	2320		
2325	2310		
2355	2340,	2345	
2365	2330		
2405	2370		
2430	2370		
2490	2405,	2530	
2505	2435		
2525	2510		

Symbol	Reference Line -
2570	2560
2575	2415, 2430, 2565, 2570
5005	1015
5120	5125
5205	5110
5210	5260
5230	5105, 5110, 5125, 5260
5235	5105
5240	5230
5245	5230, 5235
5255	5205
5280	5205
5305	5255
5310	5255
5325	5255
5705	5285
7005	1005
7115	7120
7205	7110, 7310
7255	7105, 7110, 7120, 7310
7260	7105
7265	7255
7290	7255, 7260, 7535
7305	7105
7405	7305
7415	7305
7425	7305
7430	7430
7435	7305
7445	7435
7450	5255, 7305
7505	7430, 7445, 7535, 7605
7520	7510
7525	7510
7535	7305, 7535
7540	7305
7545	7545
7605	7105
7615	7605
7635	7620
10000	15
11005	1435, 2580

Symbol	Reference Line
A!	Temporary Variable 2415. 2495. 7525. 7535, 7610,10030.
A$	Temporary Variable 125, 130, 230, 240, 1510, 1535, 1910, 1915, 2560, 2570, 5120, 5125,10025
A%	Temporary Variable 115, 120, 125, 135, 140, 155, 220, 225, 241, 245, 1530, 1535,10025
AC$	All valid alphabetical characters 5015. 5305.10035,10040
AN$	Alpha-numberic string used for keyboard input 115, 140, 160, 220, 250. 255, 1805, 1860, 5255, 5260, 5305. 5310, 5315, 5325. 7305, 7310. 7405. 7415. 7430. 7435, 7440. 7445. 7450, 7535, 7540. 7545.10035
AVERPULL!	Average Pull 2410, 2420, 2490, 2495, 2496, 2550,10030
B$	Temporary Variable 7115, 7120
BAD%	Number of Bad Pulls - Non-Destruct Test 1210, 1340, 1405, 1415, 1420, 1425, 1865,10025
BAI)FLAG%	Bad Test Flag - Operator pressed FKeY 7 1305, 1325, 1350, 1360, 1610, 1865, 2305, 2320, 2340, 2360, 2365,10025
BF%	Beam Factor - a constant for each beam 2365, 2510, 2540, 7505, 7535, 7540, 7545, 7610,10104
BMSIZE%	Beam Size - 10, 100, 1000 or 2000 1220, 5725, 7430, 7440, 7505, 7510,10104
CELL%(	Cell Number - 0 to 260 10, 2365, 2510, 2512, 2515, 2520, 2540, 2565, 2570, 7620
EDITCNFG%	Edit Configuration Flag - Operator pressed FKey 4 1020, 1440, 1615, 2585,10025
COMM$	Used to open communications port 1505
COMM%	Communications Port Number - 1 or-2 1505, 7625,10102
CRLF$	Carriage Return + Line Feed String - CHR$(13)+CHR$(10) 1540,10035
DT$	System Date in Mo-Da-YEAR format 1110, 2110, 2535, 5720,10035
E$	Error Message portion of Test Data received from MP4 1320, 1325, 1330, 1335, 1345, 1350, 1565. 1855. 1865. 2335. 2340, 2345, 2350, 2355, 2360,10035
EDITHDR%	Edit Header Flag - Operator pressed FKeY 3 1020, 1430, 1620, 2575,10025
FAILCODE%	Accept Failure Location Code Flag 1225, 1340, 2115, 2205, 2225, 2310, 5730, 7615,10109

Symbol	Reference Line
FIRST%	First Cell Number in PULLS.TXT which contains data 2505, 2515, 2540,10025
HDR$(	Various text used in Headers 5255. 5260. 5280. 5305. 5310. 5325. 5705, 5710. 5715, 7010, 7015. 7255. 7260. 7265, 7290. 7305. 7310. 7415. 7425, 7525, 7530, 7535. 7540, 7605. 7615. 7625.10101,10102,10103,10104, 10105,10106,10107,10108,10109,10110,10115,10116,10117,10118, 10119,10120,10121,10122,10123,10124
HILIMIT!	Maximum limit for Non-Destruct Pull Test 1220, 1330, 1335, 7540. 7545. 7610.10107
INCRSN%	Increment Serial Number Flag 1215, 2215, 5280,10119
LAST%	Last Cell Number in PULLS.TXT which contains data 2505, 2520, 2540,10025
LASTFLAG%	Last Test Flag - Operator pressed FKey 1 1020, 1210, 1220, 1355, 1560, 1625, 2210, 2215, 2370, 2375, 10025
LASTTEST%	Number of bonds to be tested - Last Test Number 1210, 1360, 1625, 2210, 2375,10025
LDHIST%	Load Histogram Flag - Histogram loaded before testing started 2560, 7615, 7620,10110
LG%	Allowable length of alpha-numeric input 125, 140, 155, 160, 220, 235, 240, 255, 1805, 1860, 5255. 5305. 5310. 5325. 7305.10025
LOCATION$	Location Code either Mode 1350, 1860, 2210, 2320, 2360,10035
LOT$	Lot Number 1110, 2110, 5280. 5720,10117
LOWLIMIT!	Minimum allowable Non-Destruct Pull Test 1220, 1330, 1335, 7535. 7540, 7545, 7610,10106
MAXCOUNT%	Maximum count found in any cell in PULLS.TXT 2505, 2512, 2530,10025
MS1	Mean - 3 * Standard Deviation 2412, 2425, 2490, 2496, 2555,10030
NC$	All valid numeric characters 5015. 5305,10035.10040
NU$	Temporary string for numeric input from keyboard 220, 235, 240, 241, 245, 250, 255, 270,10040
NUMPULL%	Current number of pulls 1210, 1220, 2210, 2220, 5280,10120
NUMTESTS!	Number of tests contained in PULLS.TXT 2405, 2490, 2495, 2505, 2512, 2535, 2550,10030
OPER$	Operator's Name 1110, 2110, 5280, 5720,10115
P$(	Text used in printing screens

Symbol	Reference Line
	10, 1205, 2115, 2205,10051,10052,10053,10054,10055,10056, 10058,10059,10060.10061,10062,10063,10064,10065,10066
PO$	Template for printing pull test values 2420, 2425, 2540, 2550, 2555, 7510, 7515. 7520, 7525. 7540
Pl$,P2$, P3$	Text used to print Histogram 2535, 2545,10040
PART$	Part Number 1110, 2110, 5280, 5720,10116
PCOL%	Screen Column Number 115, 120, 140, 220, 235,245, 1805, 1860, 5015, 5240, 5245. 5320. 5325. 7025. 7265. 7290.10025
PROW%	Screen Row Number 115, 140, 220, 225, 235, 241, 245, 1805, 186o, 5015, 5255, 7025. 7305. 7540,10025
PRTDATA%	Print All Data Flag 1345, 1415, 1870, 2105, 2220, 2355, 2370, 2415, 5280, 7615, 10108
PRTHIST%	Print Histogram Flag - Operator pressed FKeY 5 1605, 2430, 2575,10025
PULL!	Pull Test Value 1330. 1335. 1350, 1565. 2360, 2365, 2512,10030
PULLSUM!	Sum of all Pulls 2210, 2365, 2495, 2505, 2512,10030
QT$	Single Quote Mark (") 1350, 2360. 5715. 5720, 5725. 5730. 5735,10040
QT2$	Two Quote Marks ("") 1350, 2360, 5720, 5725. 5730, 5735.10040
QUIT%	Quit Flag - Operator pressed FKey 10 1435. 1635. 2580. 5120, 5290, 7115, 7630,10025
R$	String which contains the data sent from the MP4 for 1 test 1345, 1545, 1555. 1560, 1565, 1855, 2355,10040
RB$	Temporary string used to empty communications buffer 1510, 1530, 1535, 1540, 1545, 1550, 1555,10040
RECFLAG%	Receive Flag - Message received from MP4 1565, 1590,10025
ROW%	Screen Row 5015. 5230. 5235. 5240, 5245. 5255, 7025, 7255. 7260, 7265, 7290. 7305. 7540.10025
S1	Standard Deviation M = STANDARD DEVIATION/AVERAGE PULL 2410, 2420, 2490, 2496, 2555,10030
SAV%	Save Flag - Echo Data to Disk File 1350, 2360, 5280, 5285,10121
SCALE%	Scale for Histogram 2530. 2535. 2540, 2545,10025
SERIAL$	Serial Number

Symbol	Reference Line
	1215, 1220, 1350, 1410, 1420, 1805, 2215, 2220, 2360, 2370, 2415, 5280,10118
STDDEVI	Standard Deviation gf, mN or N 2410, 2420, 2490, 2495, 2496, 2550,10030
SUMPULLSQ!	Sum of the square of each pull value 2210, 2365, 2495, 2505, 2512,10030
TEST%	Test Number 1210, 1315, 1345, 1350, 1360, 1405, 1410, 1420, 1625, 1855, 2210, 2310, 2330, 2355, 2360. 2365, 2370, 2375, 2405, 2410, 2415.10025
TEXT$(	Text for input screens 10, 5010, 7015,10101,10102,10103,10104,10105,10106,10107. 10108,10109,10110.10115,10116,10117,10118,10119,10120,10121, 10122,10123,10124
UNIT$	Unit of measure gf, mN or N 1205, 1220, 1225, 2205, 2220, 2410, 2412, 2420, 2425, 2535, 2545, 2550. 2555. 5725, 7425, 7445, 7505,10105
VC$	Valid input characters for keyboard input 125, 5015, 5305,10040
X%	Temporary Variable 1205, 1540, 1545, 1705, 1715, 2115, 2205, 2365, 2510, 2512, 2515, 2520, 2540, 2565, 2570, 5010, 5015, 5240, 5245, 5255, 5260. 7015. 7025. 7265, 7290. 7305, 7310. 7540, 7620-10015, 10025,10040
Z%	Temporary Variable 1530. 5315. 7525, 7530,10025

CHAPTER 4
USER MAINTENANCE

Section I: Precautions

General Operator Safety

WARNINGS

Lethal voltages exist within the MP4. Take appropriate actions to prevent electrocution, particularly when making electrical measurements with power applied.

Always wear safety goggles any time you are operating the MP4.

Section II: Operator Maintenance

Calibration

Test Equipment Required

1 Oscilloscope
2 Digital Voltmeter (4 1/2 digits)
3 Regulated variable DC Power Supply
4 Weight Hanger
5 Calibration Weights
6 Simulated wirebond substrate

Preliminary

NOTE: Refer to figure 4-1 for location of components.

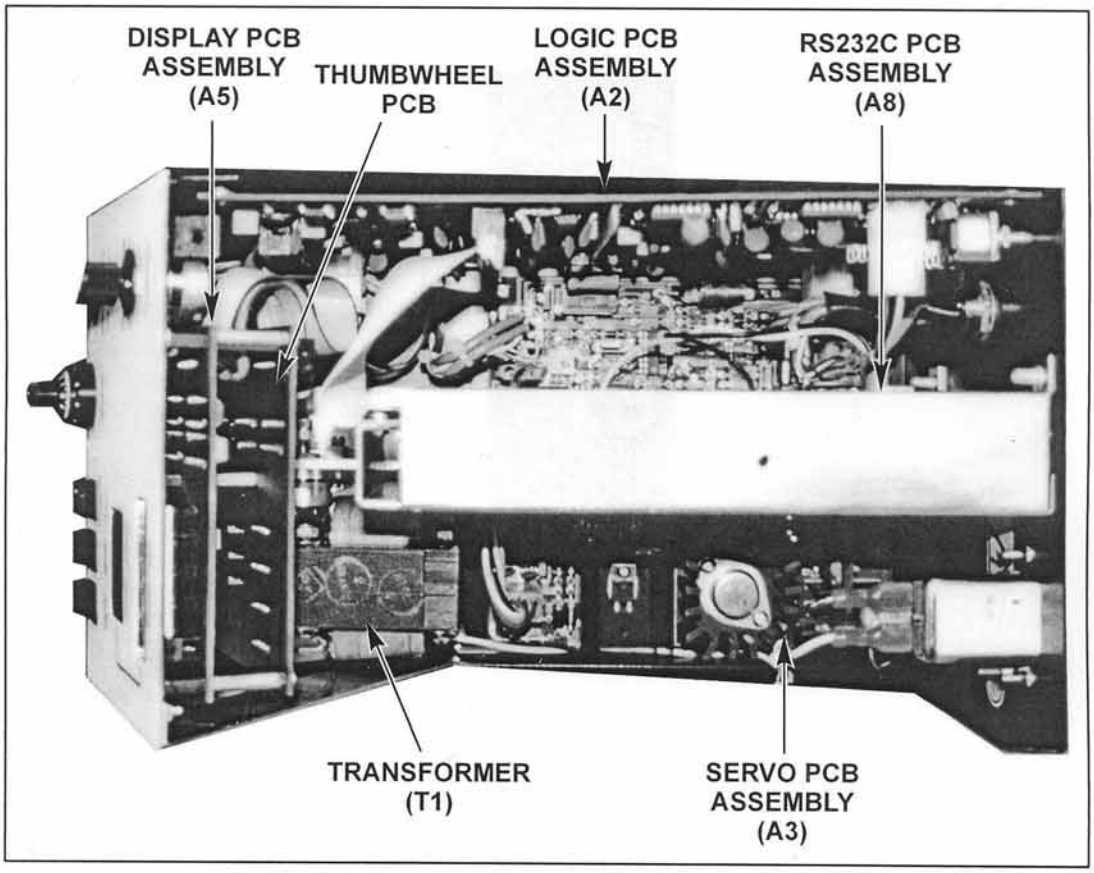


Figure 4-1. Location of Components

1. On Servo PCB Assembly A3, unplug the flat cables from connectors J4 and J5. See figure 4-2.
2. Set the MP4 as controls follows:

   POWER switch - ON
   ILLUMINATION control - Adjust to desired level
   PRESET FORCE thumb-wheels - 100
   MODE switch - NON-DESTRUCT
   HOOK RETURN switch - AUTO
   UPSTOP control - 10.0 (max)
   BEAM TRAVEL control - MIN (fully CCW)
   DOWNSTOP control - Midpoint
   * ZERO switch - MAN (out)
   * PULL RATE control - MIN (fully CW)
   * HOLD TIME control - MIN (fully CW)
   * UNITS switch - gmf (in)
   * PRINTER/CMPTR switch - PRINTER

(*) Located on rear panel

3. Connect a DVM across C17 on the Servo PCB and turn variable resistor R32 fully counter-clockwise. This can be adjusted through the hole provided in the right side of the chassis.
4. Set the POWER switch to ON and adjust variable resistor R32 for a DVM reading of +14.00 ±0.01 volts.

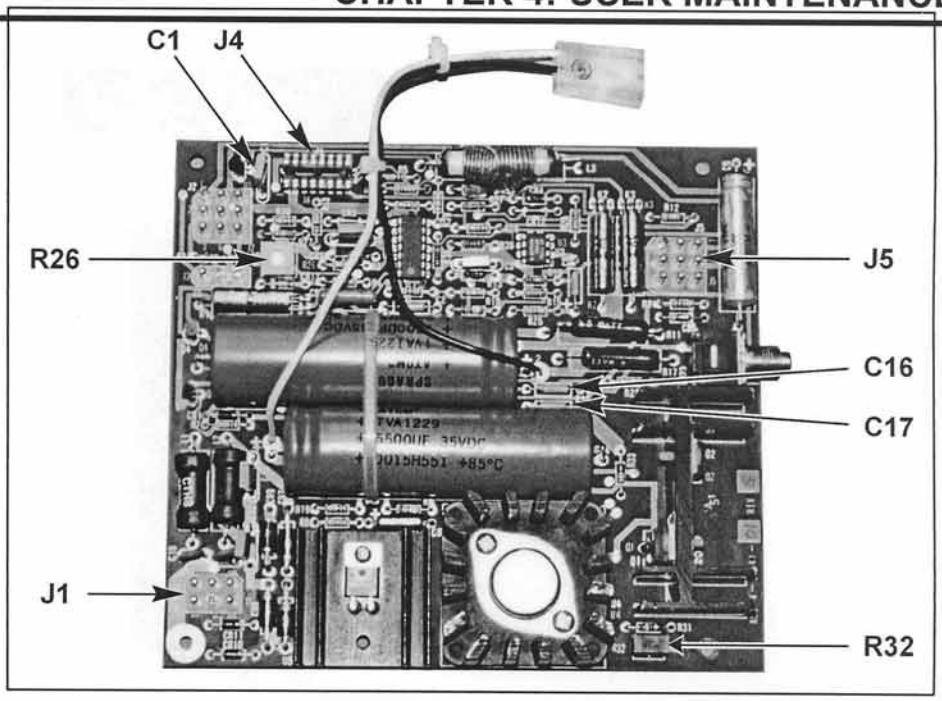


Figure 4-2. Servo PCB Assembly A3

5. Measure the voltage across C16. It should measure -15 ±0.6 volts.
6. Measure the voltage across C1 on the Servo PCB. It should be +5 ±0.2 volts.
7. Set the POWER switch to OFF. Reconnect flat cable connectors to J4 and J5. Rotate variable resistor R26 on the Servo PCB fully clockwise.
8. Set the POWER switch back to ON and verify the DVM still reads +14.00 ±0.01 V. If necessary, re-adjust R32.

Beam Travel Calibration

1. Connect the footswitch to the rear panel FOOTSWITCH connector. Remove the cover on the Beam Drive Module by loosening the socket head screws on the left side and lifting vertically.
2. Set the POWER switch to ON. Gently pull down on the hook shaft until 10% of full scale is displayed on the MP4 PEAK FORCE readout and the hook is automatically returned to the Downstop.
3. Rotate the DOWNSTOP control slowly CCW while watching the stop pin on the cable drive shaft. When the DOWNSTOP control is fully CCW, the shaft stop pin should be within 0.030 inch of, but not touching, the fixed stop pin.
4. Press the footswitch. The beam should raise about 1/4 inch. Rotate the DOWNSTOP control slowly CW (toward UP), making certain that the two drive shaft stop pins do not touch. Adjust variable resistor R26, on the Servo PCB so that the stop pins are within 0.030 inch of each other, but do not touch the fixed pin.
5. Replace the cover on the Beam Drive Module.

Digital Measurement Circuit Calibration

1. Unplug the power cord. On Logic PBC Assembly A2, remove the plug from J1 (see Figure 4-3). Rotate variable resistor R29 fully CW.
2. Connect a regulated variable DC power supply to J1 pin 1 (+) and J1 pin 5 (-).
3. Connect the DVM across the variable power supply output and adjust the power supply for a reading of 10.000 ±0.003 volts.
4. Set the POWER switch to ON and press the FT SW ENABLE switch followed by the footswitch. The PEAK FORCE display on the MP4 should read less than 1000.
5. Carefully rotate variable resistor R29 CW until the PEAK FORCE display reads 1000. As this is a peak reading system, the displayed number cannot be decremented except by using the footswitch, as above.
6. Using the FT SW ENABLE switch and the footswitch, check to see that the reading remains at 1000. If not, carefully readjust variable resistor R29.
7. Switch the UNITS so that the display reads in millinewtons. Actuate the footswitch in conjunction with the Ft/Sw ENABLE switch. The display should read 981 +/– 2%.

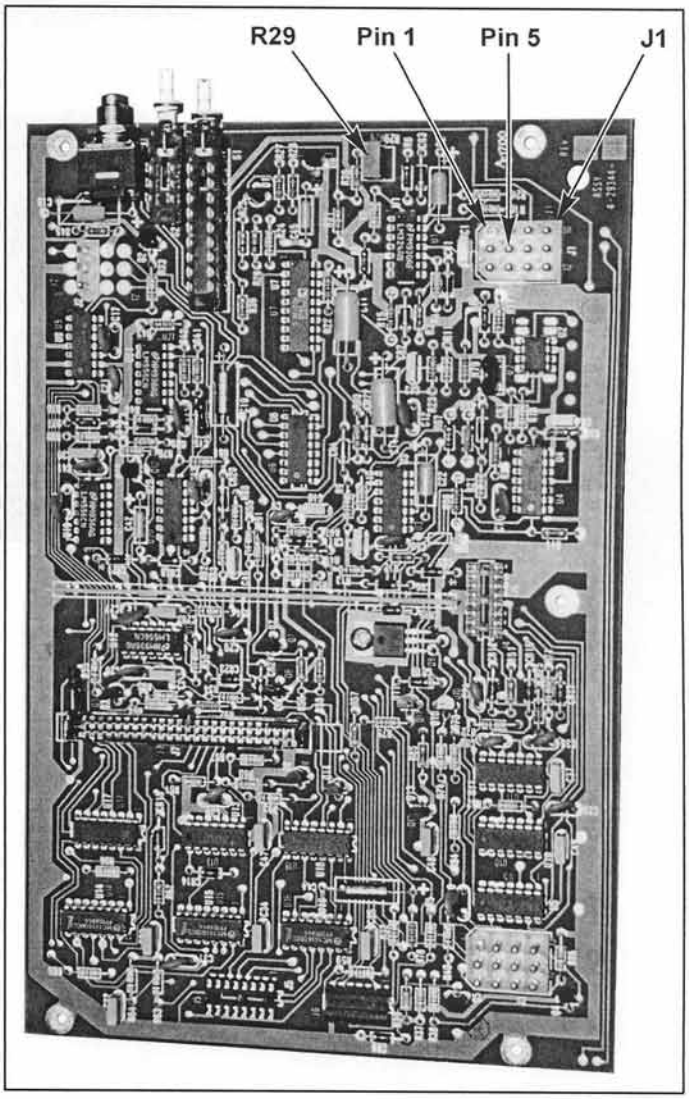


Figure 4-3. Logic PCB Assembly A2

8. With the power cord unplugged, reconnect the plug to Jl.

Calibration Of The Beam Module

1. Remove the Beam Module and remove its cover. Reinstall the coverless Beam Module on the beam arm.
2. Install the weight hanger on the beam in place of the hook.
3. On the rear panel, verify that the UNITS switch is set to gmf (in) and that the ZERO switch is set to MAN (out). On the front panel, set the MODE switch to DESTRUCT and the HOOK

RETURN switch to MANUAL. Turn the nylon damping screw (figure 3-4) so that it does not touch the beam.

4. Manually zero out the weight of the weight hanger by rotating the Zero Adjust potentiometer R6 (figure 3-4) until a minus sign appears to the left of the PEAK FORCE display. Now carefully re-adjust the Zero Adjust potentiometer until the minus sign barely goes out.
5. Place a weight corresponding to 50% of the full scale rating of the beam on the weight hanger.
6. Wait for all of the swinging and vertical oscillation of the weight to stop. Be careful not to disturb the MP4 chassis in a manner that cause the weight to move. Press the FT SW ENABLE switch, followed by the footswitch.
7. Adjust Beam Calibration potentiometer, Rl (figure 3-4) in the proper direction to make the display reading agree with the value of the calibration weight.
8. Check the linearity of the beam by using weights corresponding to 100% and 10% of full scale using the procedure defined above. The values should agree within the following limits:

l0gf beam	±0.20 gf
100gf beam	±0.50 gf at 10 gf
100gf beam	±1.00 gf at 50 gf
1000gf beam	±15 gf

9. Place weights on the holder totaling 120% of full scale. The display reading should agree within ±2.5%.
10. Replace the weight hanger with a hook and re-zero the Beam Amplifier using the Zero Adjust potentiometer, R6.
11. Adjust the damping screw to just barely touch the beam so that each time the display is reset, it reads 001. Now carefully rotate the damping screw 2 or 3 degrees CCW until the PEAK FORCE display reads 000 when reset. The damping screw to beam clearance should be virtually zero.

Units Display

On the rear panel, activate the UNITS pushbutton switch to gmf (in) and N (out), and verify that the decimal point and units displayed change according to the following:

BEAM	UNITS Switch In (gmf)		UNITS Switch Out (N)	
	Decimal Point Location	Units	Decimal Point Location	Units
10	X.XX	gf	XX.X	mN
100	XX.X	gf	XXX	mN
1000	XXX	gf	X.XX	N

Auto Zero

1. With the ZERO switch set to MAN (out), reset the PEAK FORCE display to 000 by adjusting the Zero Adjust potentiometer, R6 (figure 3-4), on the Beam Amplifier PCB and purposely misadjust the zero-to read about 005 on the PEAK FORCE display.
2. Push the ZERO switch to AUTO (in) and again reset using the FT SW ENABLE and the footswitch. Verify that the PEAK FORCE display resets to 000.
3. Return to the ZERO switch to MAN (out) and re-zero the Beam Amplifier (re-adjust Zero Adjust potentiometer, R6), using the minus sign in the PEAK FORCE display as an indicator.

Non-Destruct Test Performance

1. Use an unbreakable wire bond on a test substrate. Set the controls as follows:

UPSTOP control	-	Fully CW
BEAM TRAVEL control	-	MIN (fully CCW)
DOWNSTOP control	-	As necessary to insure that the hook doesn't touch either the wire or the substrate.
MODE switch	-	NON-DESTRUCT
HOOK RETURN switch	-	AUTO
UNITS switch	-	As desired
ZERO switch	-	MAN (out)

2. Using various settings of the PRESET FORCE thumbwheels between 020 and 999, make several pulls at various settings of PULL RATE and HOLD TIME to verify that the actual peak force applied seldom overshoots more than one digit in the least significant digit column of the PEAK FORCE display.

Troubleshooting

Table 4-1 provides common problems and possible causes, which can be corrected by the operator.

Table 4-1. Troubleshooting Table

Problem	Probable Cause/Solution
Machine is locked up, lights are on, PEAK FORCE display won't clear.	Upstop is below the Downstop
	PRESET FORCE thumb-wheels are set to 000.
	Colon is lit. Computer is busy.
Hook moves extremely slowly.	PRESET FORCE thumb-wheels are set too low in the Non-Destruct Mode.
	ZERO switch is set to AUTO (in) and tare is set too high.
Hook won't return automatically.	Test not completed.
	Wire broke at a force that was less than 2% of full scale.
MP4 measures all calibration weights high.	Needs re-calibration.
	Set MP4 on two inches of foam. If problem disappears, excessive vibration is being transmitted via the table.
	Improperly zeroed MP4.
	Weight of weight holder was not zeroed out (10 and 100gf beams only).
Red Test Status Light won't light.	Burned out bulb.
	Lamp power cable is not connected.
Footswitch won't initiate MP4 below 2 or 3 gf when the ZERO switch is set to AUTO (in).	Zero offset too large. Reset to 3 counts positive.
Colon displayed when MP4/RS232 is connected to printer.	Set PRINTER/CMPTR switch to PRINTER (out) and switch the MP4 POWER switch to OFF then back to ON.
Function Keys (MODE, HOOK RETURN, or FT SW ENABLE) do not work without first pressing the footswitch.	Set PRINTER/CMPTR switch to CMPTR (in).

Repair

If problems cannot be resolved using the above troubleshooting table, contact Unitek Equipment at the address/telephone/fax shown in the Foreword. Ask for the Applications Department. PLEASE know your model and serial number when calling. You will find a nameplate with the model number, serial number and line voltage typed on it, located on the rear of the power supply.

APPENDIX A
SPECIFICATIONS

Overall Unit

Dimensions

Width:	11.75 in. (29.85 cm)
Depth:	26 in. (66 cm)
Height:	7.60 in. (19.3 cm)
Weight:	40 lb. (18 kg)

Power Requirements

115 V ±13%, 60/50 Hz or 230 V ±13%, 60/50 Hz
Power: 20 watts
Fuses: 115 V operation: both Beam Drive Module and Control Unit use a 0.5 A (slow blow) fuse.
230 V operation: Beam Drive Module uses a 0.5 A (slow blow) fuse;
Control Unit uses a 0.25 A (slow blow) fuse.

Other Considerations

Environment should be clean, dry atmosphere, with relatively stable temperature.

Mounting should be to a surface that is rigid, free from shock and vibration, reasonably level.

Other Specifications

Upstart Control	0.001”/minor division of vernier dial Full scale travel to 0.003” from downstop location
Hold Time Adjust	0.1 to 3 seconds ±20%, repeatibility ±2%
Pull Rate Control	5% to 57% of full-scale force/second ±20% (Reduces to 5% of full-scale force/second when wire bond reaches 95% of preset force.) Repeatability is ±2%
Beam Down Travel	0.5”/second
Calibrated weights	Uncertified weights are within 0.25% if the indicated weight.
Conversion of gram-force to newtons	Accurate to ±2%
Absolute accuracy	±2% of reading or ±2% of beam scale, whichever is greater.
Wire bond failure between 1.5% and 120% of full-scale of the selected beam.	
Minimum preset force is 1% of full-scale or 0.5 gf, whichever is greater	
Beam Travel Control	¼” to ¾”
Down Stop Control	Maximum – ¾”

Table A-1. Beam Specification

Model	Full Scale g-f	Full Scale N	Range (gf)	Maximum Deflection (in.)
B10	10	0.1	0.5 – 12.00	0.24
B100	100	1	1 – 120.0	0.24
B1000	1000	10	40 – 1,200	0.24

Model B100R is a manually rotatable hook version of B100

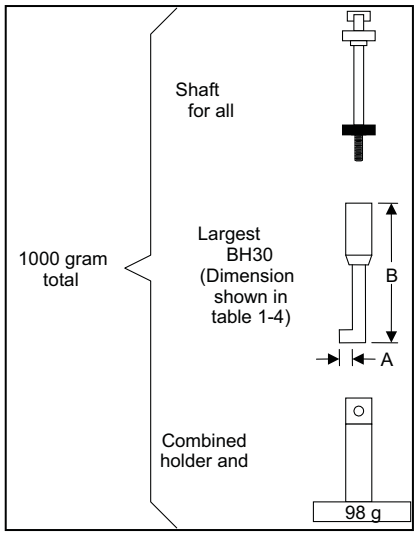


Figure A-1. 1000g Beam Hook and Calibration System

Table A-2. Hook Specifications

NOTE: Many specifications require that the hook diameter be approximately 2.5 times that of the wire being tested.

Model	Weight (g)	Diameter (in.)	Maximum Pull (g-f)	Dimension A* (in.)	Dimension B* (in.)	Used On
BH3	0.1	0.003	20	0.007	2	B10, B100
BH5	0.1	0.005	30	0.011	2	B10, B100
BH8	0.1	0.005	125	0.015	2	B10, B100
BH12	0.1	0.012	300	0.025	¾	B1000
BH20	0.1	0.020	850	0.040	¾	B1000
BH30	0.1	0.030	2000	0.050	¾	B1000
BH3R	0.1	0.003	20	0.007	2	B100R
BH5R	0.1	0.005	50	0.011	2	B100R
BH8R	0.1	0.008	125	0.015	2	B100R

* See figure A-1

APPENDIX B
BACKGROUND AND REFERENCE INFORMATION

Section I. Background Information

To understand the NDPT, one must first correlate the measured pull strength, as determined by the pull test with the stress in the wire, which depends upon the geometry of the bond system. Figure B-1 illustrates the geometrical variables for a typical two-level bond. The general case is represented, where terminal and die are on different levels. The wire bonds are separated by horizontal distance d, and by vertical distance H. A force F, acting at an angle ϕ from the vertical, pulls the wire at some point, such that the angles between wire and bonding pads are θ_t at the terminal and θ_d at the die. The vertical distance between the terminal bond and the point of application of force F is represented as h, and the corresponding horizontal distance is ϵd.

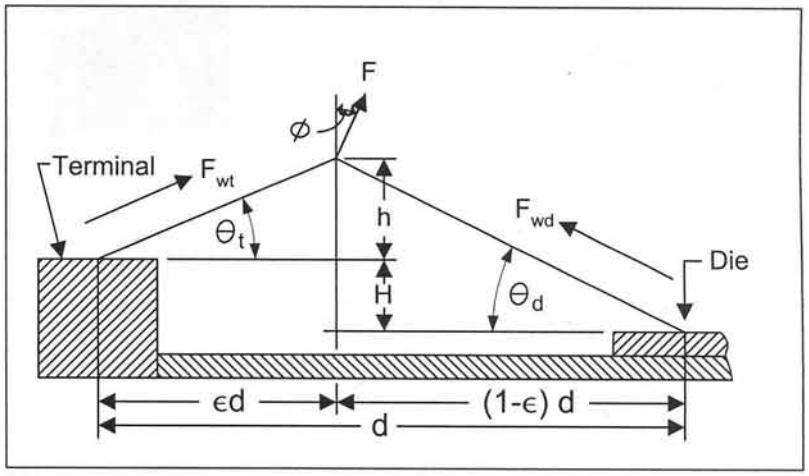


Figure B-1. Geometric Variables of the Wire Bond Pull Test

The force in the wire at the die, F_{wd} and in the wire at the terminal, F_{wt}, are related to the pull force, F, as follows:

$$(1)\quad F_{wt} = F\,\frac{\cos(\theta_d - \Phi)}{\sin(\theta_d + \theta_t)} \qquad (2)\quad F_{wd} = F\,\frac{\cos(\theta_t - \Phi)}{\sin(\theta_d + \theta_t)}$$

For the single level wire bond, where $\phi = 0$, $\theta_t = \theta_d = 0$, and $\epsilon = ½$, equations (1) and (2) reduce to:

$$(3)\quad F_{wt} = F_{wd} = \frac{F}{2\sin\theta} = \frac{F}{2}\left[1 + \left(\frac{d}{2h}\right)^2\right]^{½}$$

It can be shown by using Equation (3) that a loop height, h, less than about 25% of the bond-to-bond spacing, d, places inordinately high forces on the wire and the bonds. Equations (1) and (2) indicate that the position of the hook is also important. When the hook is placed directly over one of the bonds, and/or slides so that it is directly over one of the bonds, *all* of the pull force is applied to that bond. Therefore, this condition will yield low pull test values in the Destruct Mode, or an over stressed condition in the Non-Destruct Mode.

Test data obtained from National Bureau of Standards studies indicate that the pull rate has no significant effect on wire bond pull strength, providing the application of force is at a rate between 1 and 77 grams of force per second, and that the response time of the weighing system is fast enough to measure the force accurately. The ASTM specification requires that the hook diameter be approximately 2.5 times that of the wire being tested. The devices may be placed either in a horizontal plane, or tilted so that the hook is perpendicular to the plane containing the two bonds.

Users of NDPT devices must be aware of the limitations of the test. The test will perform only one function. It will remove weak, poorly made wire bonds with pull strengths below the chosen pull force level at the time the test is performed. It provides no assurance against degradation from other causes encountered later in the process.

Section II. Reference Literature

ASTM Specification: F458, *Recommended Practice for Nondestructive Pull Testing of Wire Bonds.*

ASTM Specification: F459, *Pull Strength of Individual Microelectronic Wire Bonds.*

Bertin, A.P., "Development of Microcircuit Bond-Pull Screening Techniques", RADC-TR-73-123, AD 762 33, April 1973.

Harman, G.G. , "A Metallurgical Basis for the Non-Destructive Wire-Bond Pull Test", 12th Annual Proceedings, Reliability Physics, pp 205-210, April 1974.

——— , "Metallurgical Failure Modes of Wire Bonds", *ibid*, pp 131-141.

——— and Cameron, C.A., "The Microelectronic Wire Bond Pull Test - How to Use It, How to Abuse It", Proceedings 1978, IEEE Components Conference.

MIL-STD-883C: Method 2011 "Bond Strength," Method 2023 "Nondestructive Bond Pull."

NBS Special Publication 400-18: "The Destructive Bond Pull Test."

NBS Special Publication 400-2: "Semiconductor Measurement Technology: Microelectronic Ultrasonic Bonding."

NBS Technical Note 786: "Methods for Testing Wire Bond Electrical Connections."

SEMI Equipment Communications Standards Part I, January 1980, and Part II, August 1982.

Section III. MIL-STD-883B Excerpts

MIL-STD-883C 15 May 1984	METHOD 2023.1 NONDESTRUCTIVE BOND PULL	METHOD 2023.1 4 November 1990

I. PURPOSE - The purpose of this method is to reveal nonacceptable wire bonds while avoiding damage to acceptable wire bonds. This procedure is usable for bonds made by either ultrasonic or thermal compression techniques.

2. APPARATUS - The apparatus of this test shall consist of suitable equipment for applying the specified stress to the bond, lead wire or terminal as required in the specified test condition. A calibrated measurement and indication of the applied stress In grams force (gf) shall be provided by equipment capable of measuring stresses up to twice the specified limit value, with an accuracy of ± 5% or ± 0.3 gf, whichever is greater.

a. The diameter of the wire used to make the "J" hook utilized to apply force to the interconnect wire shall be 2 to 3 times the tested interconnect wire diameter.

b. The "J" hook shall be smooth and free of defects which could compromise the test results or damage the wire being pulled.

c. Any impact loading as the hook initially contacts the wire shall be no more than 20% of the specified nondestructive bond pull force.

d. Final hook placement shall be accomplished under observation at 15X minimum magnification. A microscope with a zoom capability may be used for indexing the hook.

e. The fixturing which holds the package shall allow positioning the hook for optimum force application to the wire.

f. An indicator shall either (1) measure the force required to cause failure of the interconnect and/or (2) provide visual indication that the predetermined load has been applied.

g. The hook shall be in a fixed position which restricts motion along a straight line between each bond so that it will not rise to the highest point which could result in a test for only one bond (e.g.: as for a boll bond).

3. PROCEDURE - The test shall be conducted as specified in the applicable procurement document, as a sample or as a screen, and shall be consistent with the particular bond materials and construction. All bond wires in each device shall be pulled and counted and the specified sampling, acceptance and added sample provisions shall be observed, as applicable. Where there is any adhesive, encapsulant or other material under, on or surrounding the wire such as to increase the apparent bond strength, the test shall be performed prior to the application of the material.

a. Set the rate of force application.

b. Mount the specimen to be tested and set the lifting mechanism to apply the specified force for the appropriate wire size and material.

c. The device shall be rotated and positioned such that the "J" hook contacts the wire between midspan and die edge and the pulling force is applied in a direction within 10 degrees of the

normal to the die or substrate, or normal to a straight line between bonds. CAUTION: Pulling force shall be applied with the specified angle (i.e.: 10 degrees).

d. The lifting mechanism shall be actuated to stress the wire bond such that the specified stress is applied with minimum impact loading and with no overshoot greater than the specified accuracy of the indicator at any time during the bond pull. The dwell time of maximum force application shall be a maximum of one second.

e. Observe whether the bond breaks.

f. If the bond breaks, reject the device and proceed to the next device unless rework is acceptable. If so record the identification of the broken bond and the device containing the bond, If rework is permitted, all bonds shall be tested prior to any bond rework and reworked bonds shall be tested.

g. If no bonds on the device break, accept the device as satisfactory.

h. Repeat a. through g. for all bonds to be tested.

i. Record the total number of wires or wire bonds that fail when subjected to the predetermined stress.

J. Record the number of devices that failed the test.

3.1 FAILURE CRITERIA - Any bond pull which results in separation (of, bonds at the bond interface or breakage of the wire or interconnect anywhere along the entire span including bond heels) at an applied stress less than the specified stress for the applicable material and construction shall constitute a failure. Unless otherwise specified, the applied nondestructive pull stress shall be 80 percent of the preseal minimum bond strengths for the applicable material, size and construction given in TABLE I or Figure 2011-1 of Method 2011. TABLE I lists pull force values for commonly used wire sizes.

TABLE I NONDESTRUCTIVE PULL FORCES

AL & AU Wire Diameter	**Pull Force**
0.0007 inch	1.2 gf
0.0010	2.0
0.00125	2.5
0.0013	2.5
0.0015	3.0
0.0030	9.5

NOTES:
1. Nondestructive pull force values for wire sizes not specified shall be 80% of the Preseal Forces for Aluminum wire given in Method 2011.
2. Tolerance shall be +/-0.3 gf for pull forces up to 6 gf and +/-5% for pull forces above 6 gf.
3. Any bond subjected to a nondestructive pull force exceeding the specified pull force and the positive tolerance shall be eliminated and not counted toward the PDA failures.

4. SUMMARY - The following details shall be specified in the applicable procurement document:

a. The applied lifting force if other than as specified in 3.1.

b. The sampling, acceptance, or screening requirements.

a. The percent defective allowable (PDA) as applied to the number of failures with respect to the number of DEVICES tested.

d. The requirements for reporting of failure categories, when applicable.

MIL-STD-833C, 15 May. 1984	METHOD 2011.3 BOND STRENGTH	METHOD 2011.3 16 May 1979

1. PURPOSE - The purpose of this test is to measure bond strengths, evaluate bond strength distributions, or determine compliance with specified bond strength requirements of the applicable procurement document. This test may be applied to the wire-to-die bond, wire-to-substrate bond, or the wire-to-package lead bond inside the package of wire-connected microelectronic devices bonded by soldering, thermo-compression, ultrasonic, or related techniques. It may also be applied to bonds external to the device such as those from device terminals-to-substrate or wiring board or to internal bonds between die and substrate in non-wire-bonded device configurations such as beam lead or flip chip devices.

2. APPARATUS - The apparatus for this test shall consist of suitable equipment for applying the specified stress to the bond, lead wire or terminal as required in the specified test condition, A calibrated measurement and indication of the applied stress in grams force (gf) shall be provided by equipment capable of measuring stresses up to twice the specified minimum limit value, with an accuracy of +/-5% or +/-0.25 gf, whichever is greater.

3. PROCEDURE - The test shall be conducted using the test condition specified in the applicable procurement document consistent with the particular device construction. All bond pulls shall be counted and the specified sampling, acceptance, and added sample provisions shall be observed, as applicable. Unless otherwise specified, for conditions A, C, and D, the LTPD specified for the bond strength test shall determine the minimum sample size in terms of the minimum number of bond pulls to be.accomplished rather than the number of complete devices in the sample, except that the required number of bond pulls shall be randomly selected from a minimum of 4 devices. Bond pulls in accordance with test conditions D, F, G, and H while involving two or more bonds shall count as a single pull for bond strength LTPD purposes. Unless otherwise specified, for conditions F, G, and H, the LTPD specified shall determine the number of die to be tested (not bonds). For hybrid or multichip devices (all conditions), a minimum of 4 die on a minimum of 2 completed devices shall be used. Where there is any adhesive, encapsulant or other material under, on or surrounding the die such as to increase the apparent bond strength test shall be performed prior to application.

When flip chip or beam-lead chips are bonded to substrates other than those in completed devices, the following conditions shall apply:

a. The sample of chips for this test shall be taken at random from the same chip population as that used in the completed devices that they are intended to represent.

b. The chips for this test shall be bonded on the same bonding apparatus as the completed devices, during the time period within which the completed devices are bonded.

c. The test chip substrates shall be processed, metallized, and handled identically with the completed device substrates, during the same time period within which the completed device substrates are processed.

3.1 Test conditions:

3.1.1 Test condition A - Bond peel. This test is normally employed for bonds external to the device package. The lead or terminal and the device package shall be gripped or clamped in such a manner that a peeling stress is exerted with the specified angle between the lead or terminal and the board or substrate.

Unless otherwise specified, an angle of 90 degrees shall be used. When a failure occurs, the force causing the failure and the failure category shall be recorded.

3.1.2 Test condition C - Wire pull (single bond). This test is normally employed for internal bonds at the die or substrate and the lead frame of microelectronic devices. The wire connecting the die or substrate shall be cut so as to provide two ends accessible for pull test, In the case of short wire runs, it may be necessary to cut the wire close to one termination in order to allow pull test at the opposite termination. The wire shall be gripped in a suitable device and simple pulling action applied to the wire or to the device (with the wire clamped) in such a manner that the force is applied within *5* degrees of the normal to the surface of the die or substrate. When a failure occurs, the force causing the failure and the failure category shall be recorded.

3.1.3 Test condition D - Wire pull (double bond). This procedure is identical to that of test condition C, except that the pull is applied by inserting a hook under the lead wire (attached to die, substrate or header at both ends) with the device clamped and the pulling force applied approximately in the center of the wire in a direction within *5* degrees of the normal to the die or substrate surface or normal to a straight line between the bonds. When a failure occurs, the force causing the failure and the failure category shall be recorded.

3.1.4 Test condition F - Bond shear (flip chip). This test normally employed for internal bonds between a semiconductor die and a substrate to which it is attached in a face-bonded configuration. It may also be used to test the bonds between a substrate and an intermediate carrier or secondary substrate to which the die is mounted. A suitable tool or wedge shall be brought in contact with the die (or carrier) at a point just above the primary substrate and a force applied perpendicular to one edge of the die (or carrier) and parallel to the primary substrate, to cause bond failure by shear. When a failure occurs, the force at the time or failure, and the failure category shall be recorded.

3.1.5 Test condition G - Push-off test (beam lead). This test is normally employed for process control and is used on a sample of semiconductor die bonded to a specially prepared substrate. Therefore, it cannot be used for random sampling of production or inspection lots. A metallized substrate containing a hole shall be employed, The hole, appropriately centered, shall be sufficiently large to provide clearance for a push tool, but not large enough to interfere with the bonding areas. The push tool shall be sufficiently large to minimize device cracking during testing, but not large enough to contact the beam leads in the anchor bond area. Proceed with push-off tests as follows: The substrate shall be rigidly held and the push tool inserted through the hole. The contact of the push tool to the silicon device shall be made without appreciable impact (less than 0.01 inch/minute <0.254 mm/minute>) and forced against the underside of the bonded device at a constant rate. When failure occurs, the force at time of failure, and the failure category shall be recorded.

3.1.6 Test Condition H - Pull-off Test (beam lead). This test is normally employed on a sample basis on beam lead devices which have been bonded down on a ceramic or other suitable substrate. The calibrated pull-off apparatus (see 2) shall include a pull-off rod (for instance, a current loop of nichrome or kovar wire) to make connection with a hard setting adhesive material (for instance, heat sensitive polyvinyl acetate resin glue) on the back (top side) of the beam lead die. Care should be taken to assure that no adhesive flows down the beam or under the die. The substrate shall be rigidly installed in the pull-off fixture and the pull-off rod shall make firm mechanical connection to the adhesive material. The device shall be pulled within 5 degrees of the normal to at least the calculated force (see 3.2), or until the die is at 2,54 mm (0.10 inch) above the substrate. When a failure occurs, the force at the time of failure, the calculated force limit, and the failure category shall be recorded.

3.2 Failure criteria. Any bond pull which results in separation under an applied stress less than that indicated in Table I as the required minimum bond strength for the indicated test condition, composition, and construction shall constitute a failure.

3.2.1 Failure category. Failure categories are as follows: When specified, the stress required to achieve separation and the category of separation or failure shall be recorded.

a. For internal wire bonds:
   (a-1) Wire break at neckdown point (reduction of cross section due to bonding process).
   (a-2) Wire break at point other than neckdown.
   (a-3) Failure in bond (interface between wire and metallization) at die.
   (a-4) Failure in bond (interface between wire and metallization) at substrate, package post, or other than die.
   (a-5) Lifted metallization from die.
   (a-6) Lifted metallization from susbstrate or package post.
   (a-7) Fracture of die.
   (a-8) Fracture of substrate.
b. For external bonds connecting device to wiring board or substrate:
   (b-1) Lead or terminal break at deformation point (weld affected region).
   (b-2) Lead or terminal break at point not affected by bonding process.
   (b-3) Failure in bond interface (in solder or at point of weld interface between lead or terminal and the board or substrate conductor to which the bond was made).
   (b-4) Conductor lifted from board or substrate.
   (b-5) Fracture within board or substrate.
c. For flip-chip configurations:
   (c-1) Failure in the bond material or pedestal, if applicable.
   (c-2) Fracture of die (or carrier) or substrate (removal of portion of die or substrate immediately under the bond).
   (c-3) Lifted metallization (separation of metallization or bonding pedestal from die (or carrier) or substrate.
d. For beam lead devices:
   (d-1) Silicon broken.
   (d-2) Beam lifting on silicon.
   (d-3) Beam broken at bond.
   (d-4) Beam broken at edge of silicon.
   (d-5) Beam broken between bond and edge of silicon.
   (d-6) Bond lifted.
   (d-7) Lifted metallization (separation of metallization) from die, separation of bonding pad.
   (d-8) Lifted metallization.

TABLE I. MINIMUM BOND STRENGTH

MINIMUM BOND STRENGTH (gf)

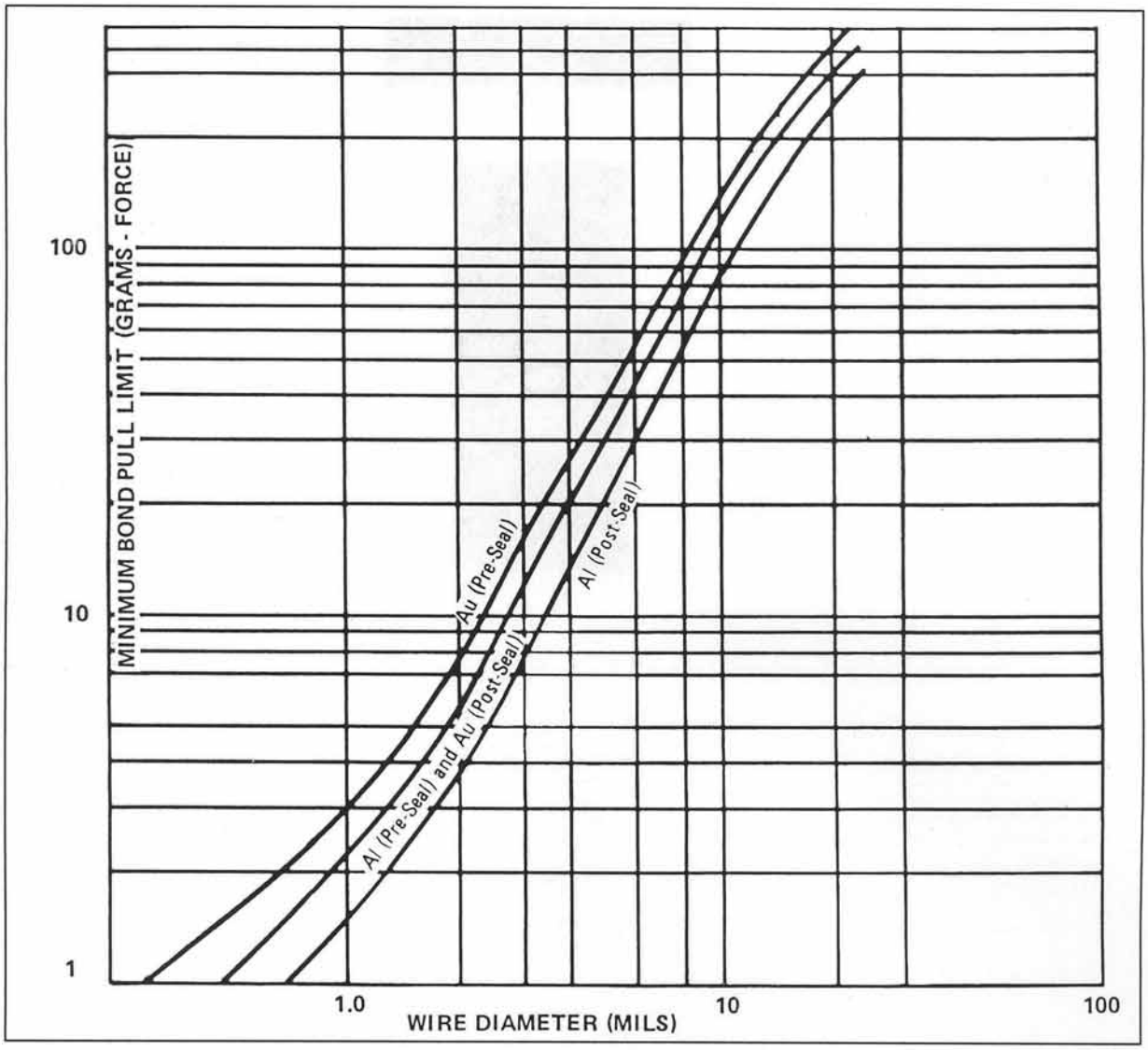
TEST CONDITION	WIRE COMPOSITION AND DIAMETER (2)	TYPE (1)	PRE SEAL	POST SEAL and OTHER PROCESSING
A	-	-	Given in Applicable Document	
C or D	AL 0.0007 in	Wire	1.5	1.0
C or D	AU 0.0007 in		2.0	1.5
C or D	AL 0.0010 in	Wire	2.5	1.5
C or D	AU 0.0010 in		3.0	2.5
C or D	AL 0.00125 in	Wire	3.0	2.0
C or D	AU 0.00125 in	Wire	4.0	3.0
C or D	AL 0.0013 in	Wire	3.0	2.0
C or D	AU 0.0013 in	Wire	4.0	3.0
C or D	AL 0.0015 in	Wire	4.0	2.5
C or D	AU 0.0015 in	Wire	5.0	4.0
C or D	AL 0.0030 in	Wire	12.0	8.0
C or D	AU 0.0030 in	Wire	15.0	12.0
F	ANY	FLIP CHIP	5 grams force X number of bonds (bumps)	
G or H	ANY	BEAM LEAD	30 grams force per linear mm of nominal underformed beam width (3)	

NOTES:

(1) For ribbon wire, use the equivalent round wire diameter which gives the same cross-sectional area as the ribbon wire being tested.
(2) For wire diameters not specified, use the curve of figure 2011-1 to determine the bond pull limit.
(3) For condition G or H, the bond strength shall be determined by dividing the breaking force by the total of the nominal beam widths before bonding.

4. -SUMMARY- The following details shall be specified in the applicable procurement document:

a. Test condition letter (see 3).
b. Minimum bond strength if other than specified in 3.2 or details of required strength distributions if applicable.
a. LTPD or number and selection of bond pulls to be tested on each device, and number of devices, if other than 4.
d. For test condition A, angle of bond peel if other than 90 degrees, and bond strength limit (see 3.2).
e. Requirement for reporting of separation forces and failure categories, when applicable (see 3.2.1).


MINIMUM BOND PULL LIMIT (GRAMS - FORCE)
100
10
1
1.0
10
100
WIRE DIAMETER (MILS)
Au (Pre-Seal)
Al (Post-Seal)
Al (Pre-Seal) and Au (Post-Seal)

APPENDIX C
CONVERSION FOR DIFFERENT INPUT VOLTAGE

MP4s are shipped from the factory pre-wired for either 115 VAC or 230 VAC, per your order. If at any time you need to change the voltage from one to the other, perform the following steps:

WARNING: Unplug the unit from power source before changing transformer jumpers

1 Loosen the Allen type button head screws located on the both sides of the Electronic Control Unit . Remove the cover by lifting vertically.

2 The power transformer is located on the right-hand side of the Electronic Control Unit, just behind the front panel. For 115 volt operation, jumper wires are connected between terminal 1 and terminal 3 and between terminal 2 and terminal 4. For 230 volt operation, a single jumper wire is connected between terminal 2 and 3, as shown in figure C-1.

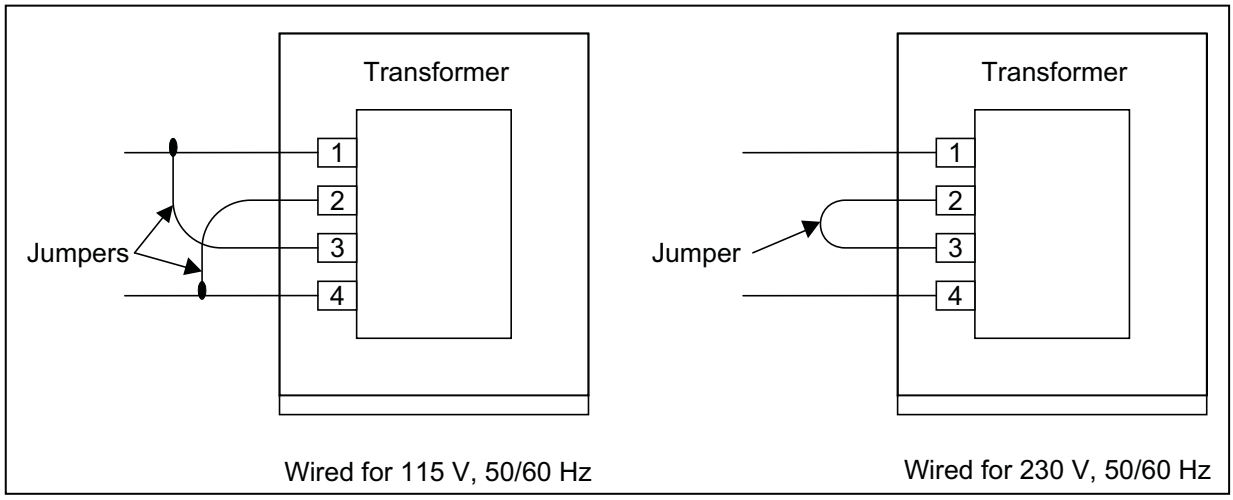


Figure C-1. Jumper Connections for Control Transformer

CAUTION: Do not wiggle the terminals of the control transformer. Pry Fastons off using the blade of a screwdriver.

3 Use the following fuse on the rear of the Electronic Control Unit, as appropriate:

For 120 Vac, use a 1/2 amp slow-blow fuse

For 230 Vac, use a 1/4 amp slow-blow fuse

CAUTION: Do not change fuse, F3, on the Pull Module. Regardless of the line voltage, this fuse should always be rated 0.5 amp, slow-blow.

4 Replace the plug from the existing line cord with the appropriate plug.

5 Replace the cover and re-tighten screws.

INDEX

-O (continued)-

-P-

-R-

-R (continued)-

-S-

-T-