

Micropull IV

Semiautomatic Production Wire Bond Pull Tester

- For destructive and nondestructive testing
- Meets requirements of MIL-STD-883C Methods 2011 and 2023, and MIL-STD-1772
- As fast as one test per second with programmed printout
- 0.5 to 1000 gram-force range with interchangeable beams
- Available with fixed and rotatable hook beams
- Semiautomatic operation increases throughput
- Holders for most devices



According to industry statistics, insufficient bond strength is a major cause of device failure. Bond pull tests are routinely used to evaluate and/or control the mechanical strength of wire bonds in microcircuit devices. The Miyachi Unitek Micropull IV (MP4) is a semi-automatic machine designed to perform wire bond pull tests in the 0.5 to 1000 gram force range. It can automatically detect wire bond failures occurring during the test, as well as excessive wire bond loop height.

To perform a wire bond test, the operator need only position the hook directly under the midpoint of each wire bond. The hook is then raised until the bond is stressed to a

predetermined value (non-destructive pull test-NDPT), or the wire breaks (destructive pull test-DPT). The MP4 displays the results and outputs them via an RS-232 type serial interface. Using three interchangeable beams, the MP4 may perform these tests at rates of up to one test per second.

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 2023. MIL-STD-883 Method 2001 covers DPT. The MP4 complies fully with and performs wire pull tests that meet the requirements of MIL-STD-883.

The accuracy of the MP4 system is $\pm 2\%$ of reading or ± 2 gf, whichever is greater.

The MP4 software keeps track of the test number, device number and pull strength. At the conclusion of each test, the MP4 software displays and prints summary statistical data for the device and histogram information for the device or group of devices.

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Features of the Micropull IV

- Electronic Control Unit** – Uses a closed-loop servo-system to control the vertical position and pull rate of the beam module. It displays the peak force applied to the wire bond and transmits this data together with any error messages to the RS-232C interface.
- Beam Drive Module** – Contains the servomotor system which moves the beam arm assembly vertically within low friction linear ball bearing races. The beam arm contains five sets of mounting holes which allow a height adjustment of one inch.
- Beam Module** – Uses high output semiconductor strain gauges to measure the force applied by the hook. The nominal full scale beam deflection is 0.2 inch. The compliance of the beam allows measurements which are essentially free from the influence of normal shock and vibration. The design is such that any beam module can be installed on any MP4 with recalibration. The front of the beam housing slides out to facilitate easy hook installation.
- Control Lever** – Controls the vertical position of the hook.
- Peak Force Display** – 3-1/2 digit, 0.3 inch high light emitting diode display. The unit of measurement is selected by a rear panel switch.
- Zero Mode Switch (Rear Panel)** – In the manual zero mode, positive tare weights are displayed at the beginning of each test. In the auto zero mode, any positive tare is automatically subtracted from all readings. Negative tare, as low as 0.1% of full scale, is indicated by a minus sign preceding the displayed peak force.

- Nondestruct/Destruct Mode Switch** – Selects either the destruct or nondestruct test mode. In the destruct mode force is applied until either the wire bond breaks or the upstop is reached. The MP4 will detect and display wire bond failures which occur between 1.5% and 120% of full scale of the selected beam.

In the nondestruct mode, the pull force is present, in increments of 0.1 of full scale by using the three decade preset force thumbwheels. The minimum preset force is 1% of full scale or 0.5 gf, whichever is greater. As required by the MIL-STD, the peak force which is actually applied to the bond is displayed by the MP4. It is possible for the peak force to exceed the preset force as a result of excessive pull speed, inertia, and/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** – Changes the movement of the beam from 0.25 inch to 0.75 inch for full movement of the control lever. This feature accommodates deep packages and/or device holders whose height varies by as much as 2.0 inches.
- Downstop Control** – Provides a fast, convenient method to electronically adjust the position of the downstop a maximum of 0.75 inch.
- Upstop Control** – A ten turn potentiometer changes the position of the upstop. The resolution is 0.001 inch per minor division on the vernier dial. The red test status indicator light continuously blinks if the beam hits 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.

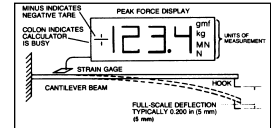
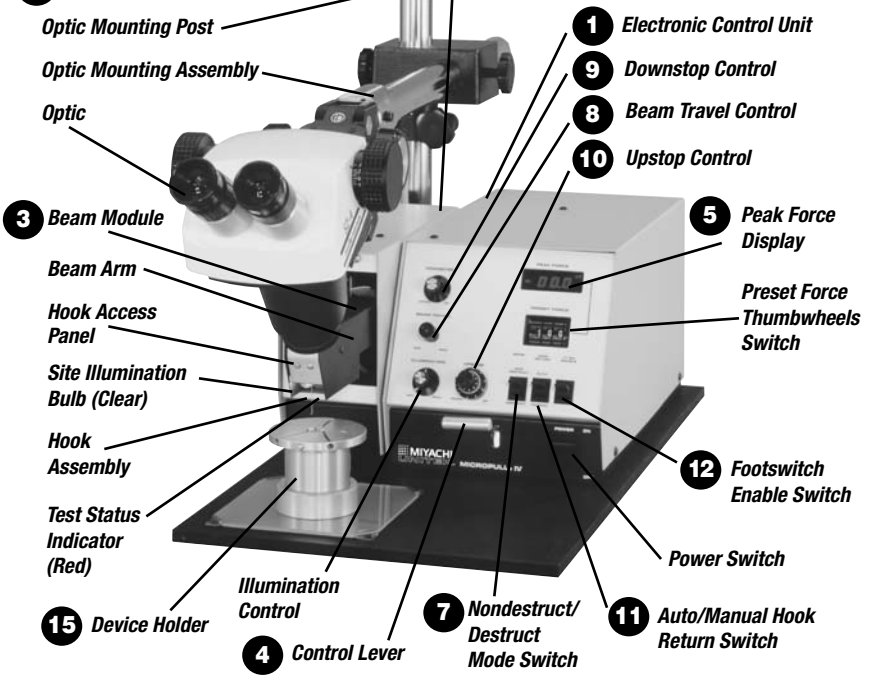
- Auto/Manual Hook Return Switch** – The manual hook return mode is normally used for testing multi-level substrates. In this mode, the hook will remain stationary after the completion of each test. The hook must be lowered to the desired level by using the control lever. After a test, the footswitch is inhibited until the applied pull force has been reduced by at least 5% as a result of lowering the hook. This feature prevents the operator from accidentally subjecting a bond to multiple tests.

In the auto return mode the hook automatically returns to the downstop in the event any of the following end-of-test conditions occur:

- Wire bond failure.

ON REAR PANEL

- Zero Mode Switch**
- Hold Time Control**
- Pull Rate Control**



- The preset force is reached and the hold time expires.
- The beam hits the upstop.

- Footswitch Enable Switch** – Returns control of the MP4 to the operator in the event one of the end-of-test conditions does not occur.

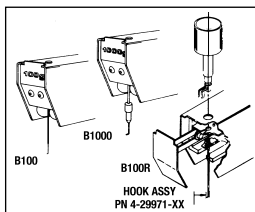
Footswitch – is used by the operator to signal the machine to start the next test.

- Hold Time Control (Rear Panel)** – Adjusts the hold time from 0.1 to 3 seconds. Hold time is the length of time for which the preset force is applied to the wire bond. In the nondestruct mode, hold time is useful when performing peel tests.
- Pull Rate Control (Rear Panel)** – Adjusts the pull rate from 5% to 57% of full scale force/second. When the force on the wire bond reaches 95% of the preset force, the pull rate is automatically reduced to 5% of full scale force per second in order to minimize, and in most cases, eliminate overshoot. The beam moves down at a fixed rate of 0.5 inch/sec. Movement in either direction may be inhibited by use of the control lever. The repeatability of the pull rate is $\pm 2\%$.

- Device Holder (optional)** – See back page.

Model B10, B100, B1000 Beams

Each beam is designed to move the hook vertically as the beam is raised or lowered. Because of constraints imposed by MIL-STD-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 nondestruct 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. The design of the MP4 hook assembly insures the accuracy of the measuring system.



Model B100 Rotatable Hook Beam – This beam has a 360° manually rotatable hook affixed to the end of the beam. This design allows easy testing of large packages.

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 may not be reformed in accordance with the MIL-STD.

Calibration Weights – A set of uncertified calibration weights provide an effective method of recalibration. The weights supplied with the MP4 are: 1, 2, 5, 10, 20, 50 and 100 grams. A weight hanger and 100, 300 and 500 gram weights are supplied with the 1000 gf beam. The weight rack, which is supplied, provides a convenient method of storing the smaller weights.

Standard Device Holder – A model DHF device holder is included with each MP4. This holder is designed for flat substrates which range from 0.250 to 2.0 inches square. The base of the device holder is spring loaded so that it can be manually depressed up to 0.250 inch. This feature allows easy removal of the hook from deep packages.

RS-232 – This internal interface converts the information, which is presented in parallel on the data output connector, to 1200 baud serial data which is available on an RS-232C connector on the rear of the MP4. This interface is programmed to drive a serial buffered printer or to communicate with an external computer. Data which results from each test is transmitted while the MP4 performs the next test. The actual transmission consists of ten bit bytes, sent serially by bit, with one start bit, 8 ASCII coded data bits and one stop bit. The communications is bi-directional and asynchronous, but flows in one direction at a time – half duplex.

The codes, listed below, are generated by the MP4, and transmitted via the RS-232 Connector:

CODE MESSAGE

- | | |
|------------------------|------------------------|
| 0 No Test | 5 Over Range |
| 1 Valid Test | 8 Hit Upstop |
| 2 Wire Broke | 9 Hit Upstop/Hold Time |
| 3 Wire Broke/Hold Time | |

Includes the RS-232C extension cable with DB25 connectors, which connects the MP4 to a serial data logging device.

Micropull IV Data Logging Software

The MP4 software can be used for both destructive and nondestructive testing. The processing time is less than one second in either mode. The nondestructive software counts the number of tests and at the user's option either records all data or only those bonds which fail and/or are not subjected to the proper pull. The destructive software

records the data from all tests together with the appropriate, but optional, one digit bond failure location code entered by the operator. At the completion of each set of tests, the program calculates and prints the average and standard deviation of the data for the individual device and at the user's option a histogram of any device or group of devices.

The MP4 software is compatible with DOS 2.1 and up, and is furnished on 5.25" diskettes. The software documentation is provided so that the user can make any modifications necessary to customize it for a specific application.

Typical Serial Printer Report

This system requires no computer.

26 mN	VALID TEST
25 mN	VALID TEST
25 mN	VALID TEST
30 mN	WIRE BROKE/HOLD TIME
25 mN	VALID TEST
26 mN	VALID TEST
25 mN	VALID TEST
25 mN	VALID TEST
26 mN	VALID TEST
25 mN	VALID TEST
26 mN	VALID TEST
27 mN	WIRE BROKE/HOLD TIME
25 mN	VALID TEST
25 mN	VALID TEST
1 mN	HIT UPSTOP
1 mN	HIT UPSTOP
26 mN	VALID TEST
26 mN	VALID TEST
26 mN	VALID TEST
26 mN	VALID TEST

TYPICAL NONDESTRUCTIVE PULL TEST REPORT

NON-DESTRUCTIVE PULL TEST

Operator: H. GOODGUY
 Part No.: SN74LS374
 Lot No: 227C
 Date: 09/12/83

Beam Size: 100 gf
 Pull Test Limit: 2.5 - 2.7 gf
 No. Bonds / Devices: 10
 Device No: 1

BOND #	PULL (gf)	ERROR
1	2.5 gf	
2	2.6 gf	
3	2.5 gf	
4	2.6 gf	
5	2.5 gf	
6	2.5 gf	
7	2.6 gf	NO TEST-OPERATOR
8	2.3 gf	WIRE BROKE
9	2.5 gf	
10	2.6 gf	

Device Number: 1
 No. of Tests: 10
 No. of Good Tests: 9
 No. of Bad Tests: 1

The MP4 software keeps track of the test number and the device number and is capable of logging data at the rate of one test per second plus 10 seconds per device to print the summary and heading. To avoid the possibility of lost data, the MP4 is inhibited whenever the MP4 software is waiting for keyboard input from the operator. At the conclusion of testing each device, the MP4 software displays and prints: the average pull strength; the standard deviation of the data in units; the standard deviation as a percentage of the average pull strength; and the normal distribution limit, i.e. the average pull strength less three times the standard deviation.

Typical Destructive Pull Test

DESTRUCTIVE PULL TEST

Operator: H. GOODGUY
 Part No: SN74LS374
 Lot No: 227C
 Date: 09/12/83

WIRE BOND FAILURE LOCATION CODES per MIL-STD-883B
 a1 - Wire Break at neckdown point.
 a2 - Wire Break at any other point.
 a3 - Failure in bond interface at die.
 a4 - Failure in bond interface at substrate or post.
 a5 - Lifted metallization from die.
 a6 - Lifted metallization from substrate or post.
 a7 - Fracture of die.
 a8 - Fracture of substrate.

Beam Size: 100 gf
 No. Bonds / Device: 10
 Device No: 1

BOND #	PULL (gf)	LOCATION
1	11.3 gf	1 -
2	13.4 gf	1 -
3	10.7 gf	1 -
4	14.9 gf	2 -
5	14.0 gf	1 -
6	13.2 gf	1 -
7	14.5 gf	1 -
8	11.6 gf	1 -
9	18.4 gf	1 -
10	11.5 gf	1 -

Device Number: 1
 No. of Tests: 10
 Aver. Pull Strength: 13.4 gf
 Standard Deviation: 2.3 gf
 Standard Deviation: 17.1 %
 Mean - 3(Std Dev.): 6.5 gf

The operator can make the following selections:

- Accept operator entry of bond failure location code.
- Load pull test history file.
- Plot histogram.

TYPICAL HISTOGRAM FOR HYBRID DEVICE WITH 106 BONDS

HISTOGRAM 09/12/83 TOTAL 106 Bonds

PULL gf	NUMBER OF BONDS - Each x = 1 Bonds
10.5	1 0
11.0	XXXXXXXXXX 10
11.5	XXXXXXXXXXXX 12
12.0	XXXXXXXXXXXXXXXXXXXXXXXXXXXX 32
12.5	XXXXXXXXXXXXXXXXXXXX 17
13.0	XXXXXXXXXXXXXXXXXXXX 18
13.5	XXXXXXXXXXXX 12
14.0	XXXXXX 5
14.5	1 0

NUMBER OF BONDS - Each x = 1 Bonds

No. of Bonds Tested: 106
 Mean Pull Strength: 12.4 gf
 Std. Deviation: 0.8 gf
 Std. Deviation: 6.4 %
 Mean - 3x (Std. Dev.): 10.0 gf

Micropull IV Specifications

Model Number	Description
MP4/RS232	Micropull IV destructive/non-destructive wire bond pull tester. 115V-50/60Hz. Includes electronic control unit, beam drive module, RS-232C interface with Miyachi Unitek protocol, 5-ft. RS-232C extension cable with DB25 connectors, hook insertion tool, footswitch hook, optic mounting assembly, model DHF device holder, calibration weight kit, and spare fuses. Also available in 230VAC version (specify MP4/230). Requires optic, beam, and hook (see required accessories, below).

Required Accessories

OPTIC	
SZO	Leica stereo zoom optic, 4.4 - 19X magnification, with 20X eyepieces and a 0.32X object lens. Includes arm and porthole assembly.
BEAMS	
B10	Beam, 10gm, for MP4. Includes five (5) BH3 hooks.
B100	Beam, 100gm, for MP4. Includes two (2) BH3, two (2) BH5, and one (1) BH8 hooks.
B100R	Beam, rotatable hook, 100gm, for MP4. Includes two (2) BH3R, two (2) BH5R, and one (1) BH8R hooks.
B1000	Beam, 1000gm, for MP4. Includes one (1) BH12, one (1) BH20, and one (1) BH30 hook.
HOOKS	
BH2	Hooks for B10 and B100 beams. .0015 dia x .006 long foot, 5 hooks per package. 10 gf.
BH2R	Hooks, rotatable, for B10 and B100 beams. .0015 dia x .006 long foot, 5 hooks per package. 10 gf.
BH3	Hooks for B10 and B100 beams. .0027 dia x .006 long foot, 5 hooks per package. 20 gf.
BH3/20	Hooks for B10 and B100 beams. .0027 dia x .020 long foot, 5 hooks per package. 20 gf.
BH3R	Hooks, rotatable, for B100R beam. .0027 dia x .006 long foot, 5 hooks per package. 20 gf.
BH3S	Hooks for B10 and B100 beams. .0027 dia x .0035 long foot, 5 hooks per package. 20 gf.
BH4R	Hooks, rotatable, for B100R beam. .0032 dia x .006 long foot, 5 hooks per package. 20 gf.
BH5	Hooks for B100 beam. .005 dia x .008 long foot, 5 hooks per package. 50 gf.
BH5/20	Hooks for B100 beam. .005 dia x .020 long foot, 5 hooks per package. 50 gf.
BH5R	Hooks, rotatable for B100R beam. .005 dia x .008 long foot, 5 hooks per package. 50 gf.
BH8	Hooks for B100 beam. .0075 dia x .014 long foot, 5 hooks per package. 125 gf.
BH8R	Hooks, rotatable, for B100R beam. .0075 dia x .014 long foot, 5 hooks per package. 125 gf.
BH12	Hooks for B1000 beam. .012 dia x .025 long foot, 2 hooks per package. 300 gf.
BH20	Hooks for B1000 beam. .020 dia x .040 long foot, 2 hooks per package. 850 gf.
BH30	Hooks for B1000 beam. .030 dia x .050 long foot, 2 hooks per package. 2000 gf.

Optional Accessories

DHD	Device holder for 0.3 - 0.6" wide side brazed packages and .250" wide CERDIP/plastic packages with lengths up to 2.070 inches. Spring loaded base. (See below)
DHF (included)	Device holder for flat substrates or packages .250 inch to 2 inches square. Spring loaded base. (See below)
DHL	Device holder for lead frames which have 8 to 40 leads. (See below)
MPIT	Spare insertion tool is used to insert and remove hooks from the beams.
MP4WK	Weight kit for MP4 includes 1, 2, 2, 5, 10, 20, 20, 50, 100 gram weights. Weight rack and MP4 weight holder.

Model DHD – Device holder for 0.3 – 0.6 inch wide side brazed or 0.25 inch wide cerdip/plastic packages with lengths up to 2.07 inches. With spring loaded base.



Model DHF – Device holder designed for flat substrates which range from 0.50 to 2 inches square. The base of the device holder is spring loaded so that it can manually depressed up to 0.250 inch allowing for easy removal of the hook from deep packages.



Model DHL – Device holder for lead frames which have 8 to 40 leads.

Physical Characteristics

Overall	H x W x D Inches (mm)	7.6 x 11.7 x 26.0 (193.0 x 297.2 x 660.4)
	Weight lbs (Kg)	40 (18)

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