



# FORCE DETERMINATION ADAPTER AND DIGITAL INDICATOR



## Overview

The FD-4A force measuring adapter is engineered for accurate measurement of the force in tensile stress testing in a ductility machine. The unit features a platform for test sample placement and a stationary body which houses a linear variable differential transformer (LVDT). The LVDT detects movement of the platform and displays force to hundredths of a pound through the electronic digital transducer readout unit.

The FD-4A adapter is an improved version of the FD-4 apparatus. The FD-4A incorporates design changes which improve performance and offer a wider range of force measurements—up to 30 pounds. The unit is complete with a digital readout for the LVDT mounted in the adapter, a calibration stand and weight holder.

## Standard Features

- The FD-4A adapter is universal. It does not require any specific material, preparation, procedure or type of test. It simply measures and displays the force applied to the platform.
- No modifications to the ductilometer are necessary. The adapter can easily be positioned without tools between the ductilometer stand and the sample to be tested.
- The FD-4A is compact in size. The narrow width allows two units to be operated simultaneously on one ductilometer stand. Its short length does not significantly reduce overall ductilometer travel.
- Exclusive parallel spring design cancels out the width of the sample—only the tensile force of the test is measured. The design also provides for frictionless movement and there are no parts to wear.
- All electronic components are safely located out of the water bath. The digital transducer readout unit incorporates an analog output for connection to a strip chart recorder or data acquisition unit. Once started, tests can be monitored unattended so technicians are free for other work.
- The stainless steel construction eliminates rust and corrosion.
- Each FD-4 unit is serially numbered and individually calibrated before shipment.
- Copies of the calibration results are sent with each apparatus.

## New Features

- Two specially heat treated 0.091" thick stainless steel spring plates replace the two pair of 0.031" shim material. Travel distance per pound of force is ten times less and maximum tensile stress measurement capacity is doubled to 30 pounds without danger of spring deformation.
- Improved display stability for "English", "Metric", "Span" and zero adjustments. The miniature circuit board trimmers in the readout unit have been replaced with ten turn wire round precision potentiometers. Additionally, the range of the "Zero" adjustments has been reduced to increase ease of setting.
- A ground wire from the FD-4A directly to the digital readout unit prevents drifting of the display due to partial grounding or other interference.
- The analog output is calibrated lower to 0.1 VDC/pound of force with a maximum output of 3.0 VDC. This range is more compatible with strip chart recorders and data acquisition equipment.
- The metric display is changed from three decimal places to two that is closer to the sensitivity of the English scale.
- Since a calibration stand is now included, the FD-4A can be checked for accuracy at anytime. This ensures consistent results from test to test as well as from one lab to another.

- If you have an FD-4 adapter, it can be upgraded and the readout recalibrated to FD-4A specifications. The FD-4 does not become obsolete since you can build on your current investment.

## **Apparatus**

### **FD-4A Adapter:**

The body of the FD-4A adapter is drilled on the bottom such that it can be placed directly on the pin of either the ductilometer stand or carriage. It is constructed of stainless steel for corrosion resistance and stability while it functions to protect the LVDT and keep it out of the water bath. Attached to the top of the body are two parallel stainless steel spring plates which project down into the water and hold a movable platform onto which the test specimen is placed. An arm, fastened behind the spring plates, rises up and positions the core in the LVDT coil in exact relationship to the movement of the platform so that a force measurement can be determined.

### **Transducer:**

The AC operated LVDT features a stainless steel housing to provide electrostatic and electromagnetic shielding. It has a high density, glass filled polymer inner sleeve, which has low moisture absorption and excellent thermal stability. The coils are vacuum impregnated with varnish and epoxy encapsulated. The core is hydrogen-annealed nickel-iron for low harmonics, low null voltage and high sensitivity.

### **Digital Transducer Readout:**

The DTR-451 is a self contained, power line operated, high stability LVDT signal conditioner with a 4-½ digit readout. It supplies a high frequency AC voltage for the LVDT and a 0 to 3.0 VDC analog output for data acquisition interfacing. A switch on the front panel can change the display from pre-scaled English units to pre-scaled metric units.

### **Calibration Stand:**

This one piece phenolic block has a ledge and stainless pin to hold the FD-4A for calibration checks. It is lightweight and not susceptible to rust or corrosion. Other components which might come in contact with water or brine or stainless steel. An acrylic level vial is built into the stand for convenient leveling during set-up. Two countersunk screw holes are provided for permanent mounting or as an alternative, the back end has a 1 ½" long extension where a clamping device maybe located. The aluminum cable wheel is fitted with a ground ball bearing for low friction movement. Besides its calibrating function, the stand provides a safe resting place for the adapter when it is not in use.

### **Weight Holder (weights not included):**

The weight holder will accommodate a maximum load of 30 pounds and itself is calibrated to weigh one pound (less cable and platform block). The nickel plated steel bottom has a ¼" diameter stainless shaft which allows for 9 ½" of combined weight height. The replaceable stainless steel cable has been selected for flexibility and strength. It has a drilled brass pull block attached on the other end to fit on the platform pin of the FD-4A adapter during calibration.

# Installation

## Connections and Start-up:

Carefully unpack the FD-4A apparatus. Save the box and packing materials in the event that the unit must be shipped in the future. The FD-4A adapter maybe placed on the calibration stand for hook at this time. Be sure to secure the test stand before hanging weights-refer to instructions under "calibration". Connect the power cord to the DTR-451 Digital Transducer Readout and to a 120 VAC grounded outlet. Connect the DTR-451 to the FD-4A using the attached cable with the 9-pin plug. Both sockets are located on the rear of the Digital Readout unit. Turn the unit on and allow it to warm up for 30 minutes or more. To reduce display variations due to temperature fluctuations it is recommended that the unit be left "on" 24 hours/day. Be sure the "HI-LO Sens" switch is in the "LO" position. This is a 10 to 1 ratio option for the display which will not be used in most test situations. (If the numbers flash on "HI Sens", it means the readings is too large to be displayed). Unless you are using metric, check to see that the "English/Metric" switch is set on "English". The DTR-451 unit will display pounds to two decimal places. On the metric scale it will display kilograms to the same resolution.

## Output Connections:

At this time, you may also wish to connect your strip chart recorder or data acquisition device. An analog output voltage is available on the 15-pin connector on the rear of the DTR-451 unit. A matching plug is furnished. The connections are soldered as follows: 1 is output (red), 2 is common (black), and 3 is the shield (not used). A meter, recorder, analog-to-digital converter, computer or other readout device may be used. One tenth of one volt output is equal to one pound of force on the adapter. Additional information regarding the 15-pin connector and the optional BCD interface (if required) is available.

# Calibration

## Set-up:

The FD-4A apparatus is factory calibrated before shipment and is ready to use. It is recommended, however, that the "zero" adjustment be checked regularly as well as other settings described below. Warning: before attempting any calibration, secure the test stand to a bench or work table by either clamping it down on the back end or using screws in the holes provided. This will prevent the weights from tipping the device forward. Locate the stand with minimum extension beyond the edge of the mounting surface as required to clear the weights. Be certain the stand is installed level preferably by adjusting the bench or table. Use shims under the calibration stand if this is not possible. Caution: do not over tighten the screws or clamp as this may cause the stand to warp. It is also necessary to have a container filled with cushioning materials at all times directly below where the weights hang. If the weights fell for some reason, this precaution would reduce the potential for damage and injury to personnel. After the calibration stand is level and secured to the work surface, the FD-4A adapter can be placed in position on the retaining pin. The DTR-451 readout units must be warmed up and the FD-4A adapter stabilized at room temperature before calibrations can be made. The weight holder cable can now be located in the pulley groove so the platform block fits on the FD-4A adapter pin. Slotted weights placed on the weight holder base will apply force to the adapter platform so the digital readout unit can be checked.

## **What to Expect During an Accuracy Check:**

Because of the design and construction of the FD-4A, you may observe slight differences in the readings for the same weight depending on whether it is being added or removed from the holder during calibration. Weight added may read a little low. As weight is removed, the springs will relax, but remaining weight might cause readings to be a little high. This usually amounts to about  $\pm 0.05$  pound in the higher ranges. As weight is added in the 15 pound and up range you may notice a few hundredths creep before the display stabilizes-this is normal. Remember that each 0.01 increment on the display is actually 0.000007" (seven millionths) travel of the FD-4A platform. After removing all weights, the readout may not return to 00.00. Allow the display to stabilize and/or adjust the "zero" then check the weights again. If properly adjusted, the unit should read a little high while removing them with the actual test weight value in between.

## **How to Adjust Display:**

Use the "zero" adjustment to zero the display as necessary when the unit is at rest. This applies to all temperature situations whether at room ambient or any controlled bath environment. Setting the display to zero sets the analog output to zero since they correspond. Use the "English" and "Metric" adjustment to set the display to the correct reading while the calibrating weight is acting on the FD-4A. It is best to do this with the heaviest test weight or highest anticipated load you will be using. Change the "English/Metric" switch to the desired scale and turn the appropriate potentiometer to adjust. The "English/Metric" adjustment do not change analog output voltage. Likewise the select switch changes only the display and does not alter the analog output voltage proportionally for the metric scale. Add and subtract weights and make adjustments until the readings are within tolerance. The output device or data acquisition equipment should also be checked to verify that the analog output voltage corresponds.

In most cases, calibration to correct the "zero" adjustment while the unit is at rest before performing a test. The calibration interval for the English and Metric settings on the display will depend on laboratory practice and/or specific test requirements.

The phase is adjusted at the factory and should not be changed. The span adjustment controls the analog output voltage and should not be adjusted either unless you have an accurate multi meter to check the setting. Normally the analog output voltage should not need adjustment and can be verified accurately enough on the output device or data acquisition equipment.

If you suspect that the analog output is not calibrated correctly, you may wish to return the unit to the factory for a complete recalibration or contact the factory for instructions.

## **Accuracy:**

The FD-4A unit should be approximately  $\pm 1\%$  accurate (or better) for the value of the calibration weight that is being used. The Humboldt digital readout unit has an accuracy of  $\pm 2$  counts (hundredths) so this should be allowed for the display itself. Therefore, the overall accuracy of the apparatus should be  $\pm 1\% + 2$  counts. This applies to the display and analog output voltage since they are in effect equivalent. The weight holder which weighs one pound, for example, should read between 0.97 and 1.03 on the display while the analog output voltage should be equal but only 1/10 of the display value.

## SAMPLE CALIBRATION VALUES

Tolerance =  $\pm 1\%$  + 2 counts

<u>POUNDS</u>	<u>KG</u>	<u>TOL LOW</u>	<u>TOL HIGH</u>
1.00	0.454	0.97	1.03
5.00	2.268	4.93	5.07
10.00	4.536	9.88	10.12
15.00	6.804	14.83	15.17
20.00	9.072	19.78	20.22
25.00	11.340	24.73	25.27
30.00	13.608	29.68	30.32

### NOTES:

1. For values not shown above, use tolerance formula at top page.
2. Display should read between high and low tolerance as closely as possible to the value of the calibration weight.
3. Analog output voltage is 1/10 of the weight. Output voltage must also be between high and low values as calculated by tolerance limits for any given calibration weight.

### Operation

Place the FD-4A adapter on the pin of the stationary ductilometer stand in place of the sample briquet. Use caution so as not to immerse the adapter beyond the marking. Since the stainless steel spring plates are sensitive to temperature changes, a shift on the digital readout maybe noticed when the adapter is immersed, especially if there is a large difference between the water bath temperature and the ambient temperature. Allow the adapter to stabilize for 30 to 60 minutes before conducting any testing. If necessary, use the "zero" adjustment to set the readout (and analog output) to null. Your weight calibrations will remain intact.

It will be necessary to determine a new starting position for the carriage of the ductilometer. This position can be easily found by using the sample and moving the carriage until the specimen slides freely over both the FD-4A platform pin and the pin on the ductilometer. Note this position on the indicator and return the carriage to this position at the beginning of each test. Now, with the sample in place, testing may begin. Occasionally, during course of test, the force exerted on the FD-4A adapter may exceed the 30 pound limit. Although this is not recommended, there is at least 10 pound overload safety margin where the spring plates will not experience any deformation. Before running the next test, be sure to check the zero setting and adjust if necessary. If the display cannot be adjusted to zero or the analog output does not correspond correctly with the display during calibration, it may be necessary to return the apparatus to the factory for recalibration.

**Remember:** If the unit is removed from the ductilometer and set on the calibration stand, it must be allowed to acclimate to room temperature before any weight checks can be made. Then readjust the zero before beginning.

## Notes/Caution

- Do not attempt to tighten screws on or disassemble the FD-4A unit, replace parts, adjust the transformer core, make internal adjustments to the DTR-451 or perform calibration routines other than those outlined above. Doing so may necessitate factory recalibration and/or repair
- The FD-4A unit, LVDT and DTR-451 digital readout unit function inter- dependently. All are serially numbered, individually calibrated and must remain together as a matched set Do not shorten or lengthen the cable from the FD-4A to the DTR-451. Components cannot be interchanged from one unit to another or ordered separately.

**Note:** *Because each DTR-451 unit is calibrated to a specific FD-4A adapter do not contact Humboldt Mfg. Co. directly if a problem develops with the readout unit. Repairs must be directed through the factory so components can be recalibrated after the repair.*

- Locate the DTR-451 unit in a protected area so water from the ductilometer bath splashed onto it. Allow space around the unit for heat dissipation. Leave the continually. A power conditioning unit is recommended especially if the apparatus is an area where nearby industrial machinery creates spikes or surges in the power line. Power fluctuations can affect the output to your recording devices.
- Do not immerse the FD-4A beyond the marking on the base. A one inch safety margin is allowed to protect the LVDT. Although the LVDT coil is vacuum impregnated with varnish and has a stainless steel casing, it is not a submersible design. Permanent damage may result if brine comes in contact with it for any period of time.

**Note:** *While the FD-4A adapter is immersed in a cold bath, water from the air may condense on the upper portion of the body where the LVDT is located. High humidity and/or condensation will not adversely affect the transformer or core.*

- Securing the calibration stand to a workbench or table is required. The lightweight phenolic base will tip forward in the higher weight ranges. Always use the cable and weight holder supplied with the unit to hold your weights. Do not exceed 30 pounds of weight for calibrating purposes.
- Do not clean the calibration stand with strong solvents such as methyl ethyl ketone. Do not immerse the stand in solvent or water.
- Be careful when removing weights from the weight holder. The cable will untwist somewhat as weights are applied and it must be allowed to twist back as weights are removed. If all 30 pounds are removed suddenly, the cable may coil and/or kink.

## Data Acquisition

To gain full advantage of the FD-4A apparatus, some type of data acquisition system is required. Although tests can be run with a strip chart recorder or other output device, computerized data acquisition has the advantage of being able to analyze, calculate, compare, store and present data gathered from tests according to user requirements. It is fast, accurate, and flexible.

Data acquisition cards and matching software packages which are compatible with various personal computers and existing spreadsheet programs are available from numerous sources. Many will work with the analog output from the DTR-451.

**CAUTION:** *Keep hands, clothing and other objects away from moving parts when the machine is in operation.*



## Specifications

### FD-4A

Height: 4.50"

Width: 1.73"

Length: 5.69"

Weight: 5.51lbs.

Wetted parts: stainless steel

types 302,303,304,17-7 PH

Max tensile stress measurement:  
30 lbs.

Spring plates:

Thickness 13GA (0.091)

Material 17-7 PH

Heat treat cond TH 1050

### Transducer and Digital Readout

Readout Model DTR-451

Height: 2.1"

Width: 6.125"

Length: 10.0"

Weight 2.75 lbs.

Input from FD-4A:

9-pin D-subminiature

Output:

15-pin IC-subminiature

0.1 VDC/lb. (analog)

Platform travel from rest position:  
w/ 30 lbs approx. 0.021 "  
back travel 0.003"

Dia. of pin on platform: 0.250"

Dia. of drilled hole (body): 0.257"

Max submersion depth 2.125"

Cable to DTR unit:  
Length: 72"

LVDT Model 100 HR

Dia: 0.812"

Length: 1.81"

## Calibration Stand

Height: 1.75"

Width: 2.94"

Length: 11.50"

Weight 2.2 lbs.

Material: Phenolic

Level vial accuracy:  
35 arc minutes

## Weight Holder

Base diameter: 2.80"

Base height: 0.438"

Material: Nickel plated steel

Rod diameter: 0.250"

Length 9.5"

Material: Stainless steel

Cable diameter: 0.031"

Length: 11"

Construction: 7x19

Material: Stainless

Min. breaking: 72 lbs.

Cable Wheel:

Dia: 1.75"

Cable groove width: 0.063"

Cable groove depth 0.063"

Material: Aluminum

Mounting holes will accept 1/4 dia. flat head screws

Platform block:

Height: 10mm

Width: 18mm

Length: 1.25"

Pin hole diameter: 0.257"

Material: Brass

Holder weight (w/o cable & block):

1.00 lb.

## Maintenance

No special maintenance is required for the FD-4A adapter other than routine cleaning of parts with appropriate cleaner. Careful handling is recommended to ensure best performance. Do not attempt disassembly or repairs.

No special maintenance is required for the DTR-451 digital readout unit and 100-HR LVDT.

Maintenance on the calibration stand is limited to cleaning off foreign material that may accumulate and checking the pulley bearing for free rotation. The bearing may be cleaned and oiled with a light weight lubricant if necessary--avoid heavy greases which increase friction. Bearing replacement may be required if water enters and damages it. Check the level on the stand from time to time and make adjustments if necessary. Be certain that the screws or clamp which secure the stand are tight.

No special maintenance is required for the weight holder assembly other than periodic inspection of the cable for wear or damage. Replace cable if necessary.



## Warranty

Humboldt Mfg. Co. warrants its products to be free from defects in material or workmanship. The exclusive remedy for this warranty is Humboldt Mfg. Co., factory replacement of any part or parts of such product, for the warranty of this product please refer to Humboldt Mfg. Co. catalog on Terms and Conditions of Sale. The purchaser is responsible for the transportation charges. Humboldt Mfg. Co. shall not be responsible under this warranty if the goods have been improperly maintained, installed, operated or the goods have been altered or modified so as to adversely affect the operation, use performance or durability or so as to change their intended use. The Humboldt Mfg. Co. liability under the warranty contained in this clause is limited to the repair or replacement of defective goods and making good, defective workmanship.

### **Humboldt Mfg. Co.**

3801 North 25th Avenue  
Schiller Park, Illinois 60176 U.S.A.

U.S.A. Toll Free: 1.800.544.7220

Voice: 1.708.456.6300

Fax: 1.708.456.0137

Email: [hmc@humboldtmgf.com](mailto:hmc@humboldtmgf.com)

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