Model 088A

Modal punch kit includes modal punch, Model 084A80 extender, Model 070A41 elect. conn. & (3) tips

Installation and Operating Manual

**For assistance with the operation of this product,
contact the PCB Piezotronics, Inc.**

Toll-free: 716-684-0001
24-hour SensorLine: 716-684-0001
Fax: 716-684-0987
E-mail: info@pcb.com
Web: www.pcb.com

Repair and Maintenance

PCB guarantees Total Customer Satisfaction through its "Lifetime Warranty Plus" on all Platinum Stock Products sold by PCB and through its limited warranties on all other PCB Stock, Standard and Special products. Due to the sophisticated nature of our sensors and associated instrumentation, **field servicing and repair is not recommended and, if attempted, will void the factory warranty**.

Beyond routine calibration and battery replacements where applicable, our products require no user maintenance. Clean electrical connectors, housings, and mounting surfaces with solutions and techniques that will not harm the material of construction. Observe caution when using liquids near devices that are not hermetically sealed. Such devices should only be wiped with a dampened cloth—never saturated or submerged.

In the event that equipment becomes damaged or ceases to operate, our Application Engineers are here to support your troubleshooting efforts 24 hours a day, 7 days a week. Call or email with model and serial number as well as a brief description of the problem.

Calibration

Routine calibration of sensors and associated instrumentation is necessary to maintain measurement accuracy. We recommend calibrating on an annual basis, after exposure to any extreme environmental influence, or prior to any critical test.

PCB Piezotronics is an ISO-9001 certified company whose calibration services are accredited by A2LA to ISO/IEC 17025, with full traceability to SI through N.I.S.T. In addition to our standard calibration services, we also offer specialized tests, including: sensitivity at elevated or cryogenic temperatures, phase response, extended high or low frequency response, extended range, leak testing, hydrostatic pressure testing, and others. For more information, contact your local PCB Piezotronics distributor, sales representative, or factory customer service representative.

Returning Equipment

If factory repair is required, our representatives will provide you with a Return Material Authorization (RMA) number, which we use to reference any information you have already provided and expedite the repair process. This number should be clearly marked on the outside of all returned package(s) and on any packing list(s) accompanying the shipment.

Contact Information

PCB Piezotronics, Inc.
3425 Walden Ave.
Depew, NY14043 USA
Toll-free: (800) 828-8840
24-hour SensorLine: (716) 684-0001
General inquiries: info@pcb.com
Repair inquiries: rma@pcb.com

For a complete list of distributors, global offices and sales representatives, visit our website, www.pcb.com.

Safety Considerations

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the precautions required to avoid injury. While our equipment is designed with user safety in mind, the protection provided by the equipment may be impaired if equipment is used in a manner not specified by this manual.

Discontinue use and contact our 24-Hour Sensorline if:

- Assistance is needed to safely operate equipment
- Damage is visible or suspected
- Equipment fails or malfunctions

For complete equipment ratings, refer to the enclosed specification sheet for your product.

Definition of Terms and Symbols

The following symbols may be used in this manual:

DANGER
Indicates an immediate hazardous situation, which, if not avoided, may result in death or serious injury.

CAUTION
Refers to hazards that could damage the instrument.

NOTE
Indicates tips, recommendations and important information. The notes simplify processes and contain additional information on particular operating steps.

The following symbols may be found on the equipment described in this manual:

This symbol on the unit indicates that high voltage may be present. Use standard safety precautions to avoid personal contact with this voltage.

This symbol on the unit indicates that the user should refer to the operating instructions located in the manual.

This symbol indicates safety, earth ground.

PCB工业监视和测量设备 - 中国RoHS2公布表

PCB Industrial Monitoring and Measuring Equipment - China RoHS 2 Disclosure Table

部件名称	有害物质					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
住房	O	O	O	O	O	O
PCB板	X	O	O	O	O	O
电气连接器	O	O	O	O	O	O
压电晶体	X	O	O	O	O	O
环氧	O	O	O	O	O	O
铁氟龙	O	O	O	O	O	O
电子	O	O	O	O	O	O
厚膜基板	O	O	X	O	O	O
电线	O	O	O	O	O	O
电缆	X	O	O	O	O	O
塑料	O	O	O	O	O	O
焊接	X	O	O	O	O	O
铜合金/黄铜	X	O	O	O	O	O

本表格依据 SJ/T 11364 的规定编制。

O： 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。

X： 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。

铅是欧洲RoHS指令2011/65/ EU附件三和附件四目前由于允许的豁免。

CHINA RoHS COMPLIANCE

Component Name	Hazardous Substances					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Chromium VI Compounds (Cr(VI))	Polybrominated Biphenyls (PBB)	Polybrominated Diphenyl Ethers (PBDE)
Housing	O	O	O	O	O	O
PCB Board	X	O	O	O	O	O
Electrical Connectors	O	O	O	O	O	O
Piezoelectric Crystals	X	O	O	O	O	O
Epoxy	O	O	O	O	O	O
Teflon	O	O	O	O	O	O
Electronics	O	O	O	O	O	O
Thick Film Substrate	O	O	X	O	O	O
Wires	O	O	O	O	O	O
Cables	X	O	O	O	O	O
Plastic	O	O	O	O	O	O
Solder	X	O	O	O	O	O
Copper Alloy/Brass	X	O	O	O	O	O

This table is prepared in accordance with the provisions of SJ/T 11364.

O: Indicates that said hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement of GB/T 26572.

X: Indicates that said hazardous substance contained in at least one of the homogeneous materials for this part is above the limit requirement of GB/T 26572.
Lead is present due to allowed exemption in Annex III or Annex IV of the European RoHS Directive 2011/65/EU.

PCB PIEZOTRONICS INC.
VIBRATION DIVISION

Installation and Operating Manual
Model 088A ICP® Modal Punch

Manual Number 19199
Manual Revision: NR

Contents:

1.0 INTRODUCTION

The PCB® Modal Punch is ideally suited for structural behavior testing. The Modal Punch allows the user to reach impact locations previously inaccessible by conventional impulse hammers. Impulse testing the dynamic behavior of mechanical structures involves positioning the Modal Punch at the desired measurement location on the structure, then striking the force-instrumented Modal Punch with a standard non-instrumented hammer and measuring the resultant motion with an accelerometer(s). Integration of the acceleration signal yields velocity or displacement data for use in computing classical transfer characteristics such as inertance, compliance, impedance, and mobility. Structures generally respond as (1) rigid or elastic bodies, (2) finite elements, lumped constant models, and (3) distributed parameter models conducting stress-strain (sound) waves.

The impulse generated by the Modal Punch and the user's standard non-instrumented hammer consists of a nearly-constant force over a broad frequency range and is therefore capable of exciting all resonances in that range. The physical properties of the impact device, including size, weight, material, and velocity at impact determine the amplitude and frequency content (wave shape) of the force impulse. The impact cap material generally determines the frequency content. The mass of the Modal Punch and hammer, along with the velocity at impact, determine the energy content.

The type and size of the required impact device is determined by the test structure. The Model 088A Modal Punch was designed for use on intermediate size structures such as automotive axles, gearbox shafts, and machine tools. Large, heavy structures such as locomotive frames, tanks, and bridges require an instrumented sledge hammer (PCB® model numbers 086D20 or 086D50). Small structures such as compressor blades or some electrical circuit boards often require a miniature instrumented hammer (PCB® model number 086D80). Some very large structures may require a special mechanical ram instrumented with a force-sensing impact head.

The Modal Punch is instrumented with a precision, quartz, ICP® (low impedance) voltage mode force sensor. The built-in conditioning electronics allow ease of use and test set-up, while the naturally-polarized quartz sensing element offers long-term stability and repeatability.

2.0 Description

The Modal Punch consists of an integral ICP® (Integrated Circuit Piezoelectric), quartz force sensor mounted on the impact head. The sensing element and built-in, solid state micro-electronics inside the force sensor function to transfer impact force into a low impedance analog signal for display and analysis. The cable is connected on the side of the Modal Punch's Connector Adaptor model number 070A41 (supplied) just below the impact surface. An Extension Shaft model 084A80 is also supplied to adjust the Modal Punch to the desired length. Additional shafts may also be purchased. A foam grip is supplied to provide a comfortable and secure grip and may be replaced when needed.

The striking end of the Modal Punch's head has a threaded hole to accept a variety of impact tips. The tip functions to transfer the force of the impact into the sensor and protects the sensor face from damage. Tips of different stiffness allow the user to vary the pulse width and frequency content of the force.

All component parts (impact head, extender, and connector adaptor) are laser-welded and epoxied at the factory to ensure reliable operation in adverse environmental conditions.

3.0 Installation

To assemble the Modal Punch, choose the number of extenders required to reach the desired impact location, screw the extender onto the force-instrumented impact head, and attach the connector adaptor to the extender or the force-instrumented impact head, if an extender is not being utilized. To ensure a proper mechanical coupling between the parts of the Modal Punch, each piece should be securely screwed together. Care should be used not to over-torque the parts, which will cause permanent damage to the interface and connectors. A firm, hand-tight torque is sufficient to ensure a proper coupling. If desired, a small amount of silicone grease (DC-4 or equivalent) may be applied between the interfacing parts for an improved coupling.

Accelerometers install and connect according to the procedures described in the specific sensor manual. Accelerometers utilized for impact testing include the 353 Series of single axis accelerometers, and the 356 Series of triaxial accelerometers. For additional information regarding sensors to meet your impact testing needs, feel free to contact the PCB® Vibration Division customer service group by calling toll-free in the USA 888-684-0013 (or outside the USA by calling 716-684-0001).

In general, sensors connect to the ICP® power unit at the jack labeled "XDCR". The jack labeled "SCOPE" is connected to the readout device, FFT analyzer, or computer. Please consult the ICP® power unit operating guide for proper installation and operating procedures.

4.0 Operation

Follow the below operation instructions:

1). Assemble the Modal Punch to the desired length using the supplied extension (if required) and connector adaptor. Please reference the above installation procedures.

2). Choose the impact tip which corresponds to your excitation requirements. In general:

A. A stiffer tip is recommended for higher frequency response.
B. A softer tip is recommended for improved low frequency response.

3). Connect the Modal Punch to an ICP® power supply or equivalent with a coaxial cable (not supplied). The Modal Punch requires a 10-32 microdot connector plug.

4). Connect the corresponding output cable (not supplied) from your ICP® power supply to your readout device. This step is not necessary if ICP® power is built into your readout device. Tighten the cable connectors securely by hand to ensure good electrical contact.

5). Install accelerometer(s) in the desired measurement location(s), referring to the appropriate operating guides for the accelerometer(s) and power supplies being used.

6). Switch power on and wait a minute for the sensor amplifier to turn on and the coupling capacitor to fully charge.

7). Check the ICP® power unit meter for normal operation. Normal operation is indicated when the meter pointer is pointing in the green area. If the meter reads in the red area, look for a shorted cable or connection. If the meter pointer is pointing in the yellow area, look for open cables or connections.

8). When all power unit meters indicate normal operation (meter pointer is pointing in the green area), proceed with tests, following all sensor, power unit, and analyzer operating instructions.

PCB®'s ICP® constant-current power supply units provide the necessary excitation power for proper operation of the Modal Punch. These units provide the correct power and have circuit fault indicating meters and a bias decoupling capability to remove MOSFET turn on bias voltage from the measurement signal. Power units are available in a variety of configurations, including battery or AC versions and with additional signal conditioning features such as gain, filtering, and integration. Some FFT analyzers incorporate the proper excitation power for direct connection to ICP® sensors. Be certain to confirm that the excitation from the power supply conforms to the requirements for the specific sensors being used. The Modal Punch requires 2 to 20 mA constant current and 24 to 27 VDC.

CAUTION: The Modal Punch was designed to operate only with ICP® power supply units. Do not attempt to troubleshoot the Modal Punch by connecting it to any device, such as an ohmmeter, which may introduce unregulated voltage, as damage to the precision internal micro-electronics may occur. If there is any doubt about the compatibility of a power supply unit or whether a power supply unit is required, feel free to contact the PCB® Vibration Division customer service group by calling toll-free in the USA 888-684-0013 (or outside the USA by calling 716-684-0001).

5.0 Testing

To test the behavior of your structure and to tailor the frequency bandwidth of the impact force, follow the below operation instructions:

1). Position the Modal Punch on the test structure at the desired location. Strike the punch with a standard non-instrumented hammer and process the results. Always take several averages to reduce the effects of spurious noises. ***CAUTION:*** Never impact without a tip properly installed on the Modal Punch, as permanent damage of the sensing element is likely to occur. Also, care should be exercised when striking the punch to ensure that the impact hammer does not slip and strike the operator's hand, causing personal injury.

2). Check the measured results for signal quality (adequate signal-to-noise) and no overloads (overloads lights or sharp flattening of time history peaks).

3). Analyze the results for frequency content and check to ensure that the reasonably flat portion of the force spectrum is sufficient to cover the structural resonances of interest present in the acceleration spectrum. Often, signal energy is sufficient to excite structural resonances at 20 dB below initial low frequency force levels.

4). Change Modal Punch tips to modify dynamic behavior, if necessary. The following are general guidelines; the specific test structure plays an integral part in the selection:

A. To obtain higher frequency response, use a stiffer, harder tip and a smaller hammer mass.
B. To obtain improved low frequency response, use a softer hammer tip and larger hammer mass.

C. To increase signal energy of impact, increase the impact velocity and/or hammer mass.

5). Repeat steps 1 through 4 until satisfactory results are obtained.

Generally speaking, the impact tips affect the impulse frequency content, while the mass of the impact device and velocity of impact affect the signal energy level. Frequency content and energy level are interrelated. Therefore, both will be affected by different hammer structures and Modal Punch configurations. Hammer velocity at impact will also affect both. In general, massive structures with lower stiffness require the use of a soft impact tip and large mass to adequately excite low frequency resonances.

During testing, occasionally check and tighten the electrical and mechanical connections. Repeated impacting may loosen connections, which may result in erratic, noisy signals.

Multiple impacts or penetration into the structure may occur when using too heavy a mass on too light a structure. This will appear as a series of peaks of decreasing amplitude in the time history data. Reject such data. Careful techniques used in the impact process can avoid this problem. In particular, if the Modal Punch is held against the test structure and allowed to freely recoil after impact, the double impact phenomena will be reduced or eliminated. Some skill and practice may be required to perfect this technique.

Distortion, undershoot, and oscillation of the analyzer display is caused by ringing of the analyzer's anti-aliasing filters. This behavior is normal. To view the correct impulse waveform, switch the analyzer to a higher frequency range.

6.0 Calibration

Calibration involves testing the functional transfer behavior (sensitivity) of the sensor under controlled laboratory conditions. Sensitivities to various inputs such as force, temperature, current, and frequency can be derived by relating the corresponding output to changes in these inputs. For impact hammers and the Modal Punch, the most important of these relationships is the sensitivity to the force input. The desired behavior is linear, since ideal sensors treat output and input amplitudes proportionally. In addition, the nominal sensitivity should be constant (linear frequency response) within the specific frequency range, and there should be no induced phase shift in the response (no delay in the signal).

Different Modal Punch and hammer combinations have different sensitivities because the structure experiences a force greater than the crystal-sensing elements. The force of impact on the test structure is a function of the total mass of the Modal Punch and hammer, while the force on the crystals is a function of the mass behind them. The impact tip is located in front of the crystal. The differences in mass depend on the ratio of the tip mass to the mass behind the crystal. This is automatically compensated for when the Modal Punch is properly calibrated.

The Modal Punch can be calibrated by hitting a freely-suspended mass instrumented with a quartz reference accelerometer. The mass, pendulously suspended or placed on a piece of foam rubber, will behave as a rigid body. According to Newton's second law of motion, at any instant in time, the force experienced by the mass is simply the mass multiplied by the measured acceleration.

On a storage oscilloscope, dividing the peak output signal of the hammer (mV) by the mass (lb) times the peak acceleration (g's) gives the hammer sensitivity directly in mV/lb. Calibration on a FFT analyzer produces the same result as a function of frequency. The transfer function of acceleration versus force produces a calibration constant (ideally 1/M) at each discrete frequency. This calibration curve is linear over a specified frequency range.

PCB®'s Model 963A Gravimetric Calibrator is ideally suited for calibration of the Modal Punch. The device calibrates accelerometers, force sensors, and PCB® Impulse Force Test Hammers and tests the functional transfer behavior, sensitivity, and phase of sensor structures.

7.0 Maintenance

The rigid construction of the Modal Punch is designed to provide reliable, long-term service life. Problems may arise when the instrument is exposed to temperatures exceeding the specific range, prolonged exposure to moisture, or extremely high mechanical shock. There are no user-serviceable components in the Modal Punch, so users should not attempt to make repairs to the unit (and doing so will void the unit's warranty).

Should service be required, the Modal Punch should be returned to the factory, along with a description of the problem, in order to expedite the repair process. Before sending the Modal Punch back to the factory for service, PCB recommends that all cables and connections be checked to verify that they are not the cause of the problem.

8.0 Cautions

Although the Modal Punch is rugged in construction, personal injury or damage to the unit may result from misuse. When observed, the following precautions can ensure long service life and safe, accurate data acquisition:

1). Do not attempt to dismantle the sensor element from the Modal Punch structure. All service should be performed at the factory.

2). Never generate more than five times the rated impact force range for the Modal Punch. In general, observe the maximum force rating for a 10V output. 100 volts will destroy the precision built-in micro-electronics and/or the sensing element.

3). Never strike an object without an impact tip properly installed in front of the force-sensing element. Damaging the precision-lapped surface of the Modal Punch's sensor can affect its behavior.

4). During testing, periodically check and tighten tip, extensions, impact cap, and cable connections. Continuous impacting and vibration tends to loosen these interfaces, resulting in faulty operation. Machined flats on the tips facilitate tightening and removal.

5). Do not apply voltage to the unit without constant current protection.

6). Do not apply more than 20 mA's of current.

7). Do not exceed 30 volts supply voltage.

8). Do not subject the unit to temperatures above 250° F (121° C).

9). Exercise extreme caution when impacting the Modal Punch with a hammer. Missing the impact cap may lead to personal injury to the user.

9.0 CUSTOMER SERVICE

PCB Piezotronics guarantees **Total Customer Satisfaction**. If, at any time, for any reason, you are not completely satisfied with any PCB product, PCB will repair, replace, or exchange it at no charge. You may also choose, within the warranty period, to have your purchase price refunded. Contact PCB Vibration Division Customer Service personnel by calling toll-free in the USA at 1-888-684-0013 or outside the USA at 716-684-0001, or send an email to *vibration@pcb.com*

PCB offers to all customers, at no charge, 24-hour phone support. This service makes product or application support available to our customers, day or night, seven days a week. When unforeseen problems or emergency situations arise, call the **PCB 24-Hour Sensorline at (716) 684-0001**, and an application specialist will assist you.

PCB PIEZOTRONICS INC
VIBRATION DIVISION

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Model Number 088A	MODAL PUNCH	Revision: D ECN #: 54444

Performance	ENGLISH	SI	
Sensitivity(± 15 %)	10 mV/lbf	2.25 mV/N	
Measurement Range	± 500 lbf pk	± 2,224 N pk	
Frequency Range(- 10 dB)(Hard Tip)	8,000 Hz	8,000 Hz	[1][2]
Frequency Range(- 10 dB)(Medium Tip)	2,500 Hz	2,500 Hz	[1][2]
Resonant Frequency	≥ 10 kHz	≥ 10 kHz	
Non-Linearity	≤ 1 %	≤ 1 %	
Electrical			
Excitation Voltage	20 to 30 VDC	20 to 30 VDC	
Constant Current Excitation	2 to 20 mA	2 to 20 mA	
Output Impedance	≤ 100 Ohm	≤ 100 Ohm	[1]
Output Bias Voltage	8 to 14 VDC	8 to 14 VDC	
Discharge Time Constant	≥ 2,000 sec	≥ 2,000 sec	[1]
Physical			
Sensing Element	Quartz	Quartz	
Sealing	Epoxy	Epoxy	
Hammer Mass	3.5 oz	100 gm	[1]
Head Diameter	0.625 in	15.9 mm	
Tip Diameter	0.25 in	6.4 mm	
Size - Height	6.6 in	167.6 mm	
Extender Mass Weight	2.8 oz	80 gm	[1]
Electrical Connector	10-32 Coaxial Jack	10-32 Coaxial Jack	

CE

UK CA [3]

All specifications are at room temperature unless otherwise specified.
In the interest of constant product improvement, we reserve the right to change specifications without notice.
ICP® is a registered trademark of PCB Piezotronics, Inc.

OPTIONAL VERSIONS

Optional versions have identical specifications and accessories as listed for the standard model except where noted below. More than one option may be used.

NOTES:

[1]Typical.
[2]Varies depending on test structure. These values are from hitting a stiff steel mass. Hammer did not have extender mass attached.
[3]See PCB Declaration of Conformance PS068 for details.

SUPPLIED ACCESSORIES:

Model 070A41 Modal punch connector adapter, 10-32 connector (1)
Model 084A20 Special steel tip, 2" x 1/8" dia. (for Modal punch only) (1)
Model 084A80 Modal punch extender, 6" (1)
Model 084B03 Hard Tip- Hard (S.S) (1)
Model 084B04 Hammer Tip- Medium (White Plastic) (1)
Model 085A10 Vinyl Cover For Medium Tip (Blue) (1)
Model 085A25 Foam Grip (1)
Model HCS-2 Calibration of Series 086 instrumented impact hammers (1)

Entered: ND	Engineer: NJF	Sales: KK	Approved: NJF	Spec Number:
Date: 12/27/2023	Date: 12/27/2023	Date: 12/27/2023	Date: 12/27/2023	088-1010-80

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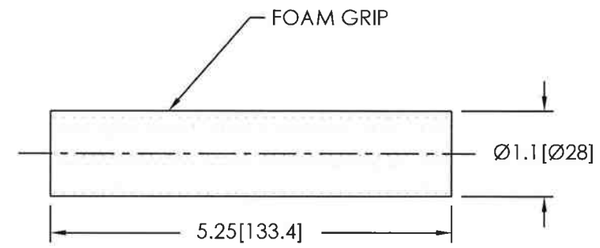
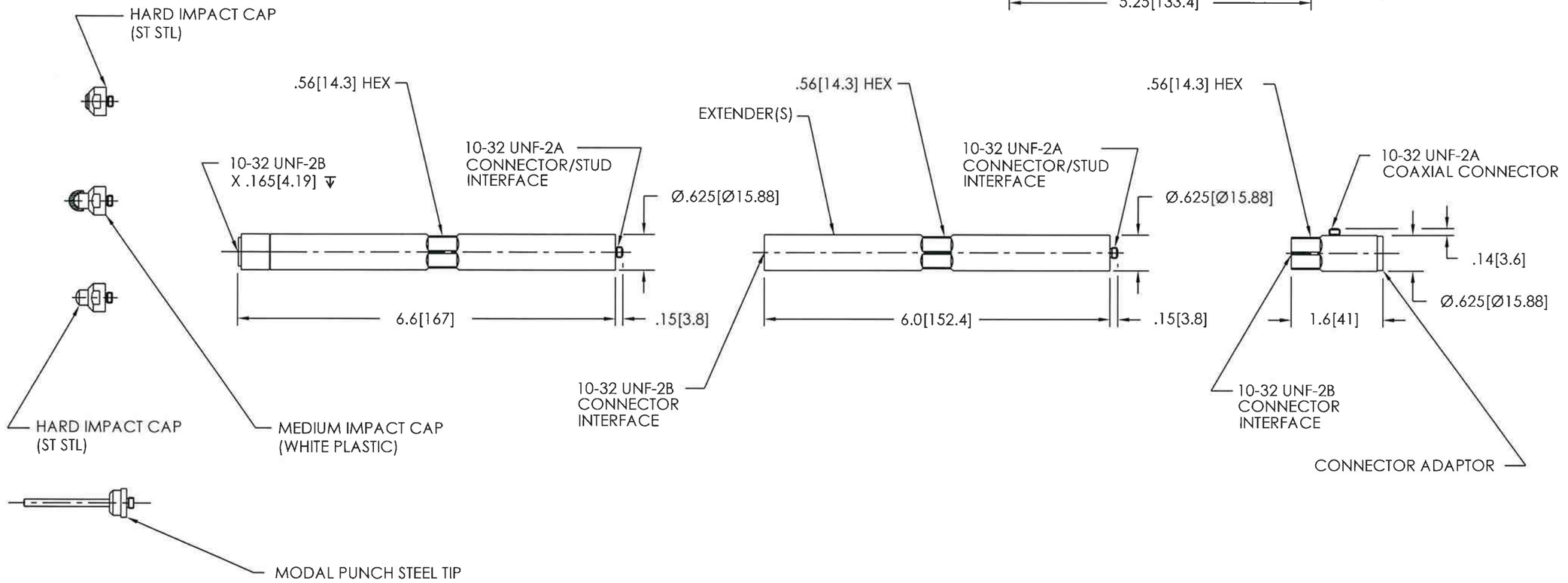
088-1010-95

REVISIONS			
REV	DESCRIPTION	ECN	APP'D
D	REVISED PER ECN	18984	DM 7/04
E	UPDATE TIPS	27211	CO 4/08





UNLESS SPECIFIED TOLERANCES	
DIMENSIONS IN INCHES DECIMALS XX ±.03 XXX ±.010 ANGLES ±2 DEGREES	DIMENSIONS IN MILLIMETERS [IN BRACKETS] DECIMALS X ±0.8 XX ±0.25 ANGLES ±2 DEGREES
FILLETS AND RADII .003 - .005	FILLETS AND RADII [0.07 - 0.13]
DD012 REV. D 01/17/08	

DRAWN	DRM	4/23/08	MFG	PRR	4/23/08
CHK'D	EOR	4/24/08	ENGR	CL	4/23/08
APP'D	EB	4/23/08	SALES	RL	4/23/08

TITLE: OUTLINE DRAWING
MODEL 088A
MODEL PUNCH

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CODE IDENT. NO. 52681 | DWG. NO. 088-1010-95

SCALE: 1/2 | SHEET 1 OF 1