Instruction Manual
for
Monroe Electronics, Inc.

Multi-Point Fieldmeter and Alarm System

Model 177A

Specifications subject to change without notice.
P/N 0340184
092512
Firmware v 1.11
Software v1.05

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WARRANTY

Monroe Electronics, Inc., warrants to the Owners, this instrument to be free from defects in material and workmanship for a period of two years after shipment from the factory. This warranty is applicable to the original purchaser only.

Liability under this warranty is limited to service, adjustment or replacement of defective parts (other than tubes, fuses or batteries) on any instrument or sub-assembly returned to the factory for this purpose, transportation prepaid.

This warranty does not apply to instruments or sub-assemblies subjected to abuse, abnormal operating conditions, or unauthorized repair or modification.

Since Monroe Electronics, Inc. has no control over conditions of use, no warranty is made or implied as to the suitability of our product for the customer's intended use.

THIS WARRANTY SET FORTH IN THIS ARTICLE IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES AND REPRESENTATIONS, EXPRESS, IMPLIED OR STATUTORY INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS. Except for obligations expressly undertaken by Monroe Electronics, in this Warranty, Owner hereby waives and releases all rights, claims and remedies with respect to any and all guarantees, express, implied, or statutory (including without limitation, the implied warranties of merchantability and fitness), and including but without being limited to any obligation of Monroe Electronics with respect to incidental or consequential damages, or damages for loss of use. No agreement or understanding varying or extending the warranty will be binding upon Monroe Electronics unless in writing signed by a duly authorized representative of Monroe Electronics.

In the event of a breach of the foregoing warranty, the liability of Monroe Electronics shall be limited to repairing or replacing the non-conforming goods and/or defective work, and in accordance with the foregoing, Monroe Electronics shall not be liable for any other damages, either direct or consequential.

RETURN POLICIES AND PROCEDURES FACTORY REPAIR

Return authorization is required for factory repair work. Material being returned to the factory for repair must have a *Return Material Authorization* number. To obtain an RMA number, call 585-765-2254 and ask for Customer Service.

Material returned to the factory for warranty repair must be accompanied by a copy of a dated invoice or bill of sale, which serves as a proof of purchase for the material.

Repairs will be returned promptly. Repairs are normally returned to the customer by UPS within ten working days after receipt by Monroe Electronics, Inc. Return (to the customer) UPS charges will be paid by Monroe Electronics on warranty work. Return (to the customer) UPS charges will be prepaid and added to invoice for out-of-warranty repair work.

EXPEDITED FACTORY REPAIR:

All material returned to the factory by air or by an overnight service will be expedited. Expedited factory repairs will be returned to the customer by the same mode of transportation by which the material was returned to the factory for repair (i.e., material returned to the factory by an overnight service will be returned to the customer by an overnight service).

NOTE: Return (to the customer) transportation expenses for expedited factory repairs will always be at the expense of the customer despite the warranty status of the equipment.

FACTORY REPAIRS TO MODIFIED EQUIPMENT:

Material returned to the factory for repair that has been modified will not be tested unless the nature and purpose of the modification is understood by us and does not render the equipment untestable at our repair facility. We will reserve the right to deny service to any modified equipment returned to the factory for repair regardless of the warranty status of the equipment.

Section 1

GENERAL

Monroe Electronics' Multi-Point Fieldmeter and Alarm System, Model 177A measures electrostatic fields (potential gradient) in terms of voltage per unit distance. Using probe-to-surface separation as a calibration factor enables use of this instrument for measurement of surface voltage as well.

As with other models of Monroe Electronics' electrostatic fieldmeters, the Model 177A's primary application is measurement and monitoring of electrostatic charge accumulation. As a charge increases on the surface of a material, the electrostatic field in the vicinity increases proportionately. The Model 177A Multi-Point Fieldmeter and Alarm System produces a reliable output signal directly proportional to the surface charge accumulation while making NO PHYSICAL CONTACT with the material being monitored.

The Monroe Electronics Model 177A is an intrinsically safe system, using FM-listed Monroe Electronics Model 1036 sensors, which continuously monitor the critical points in your facility to detect and warn of electrostatic charge buildup before it becomes a problem. In a typical alarm-activated or PLC-connected setup, as static levels in your application surpass a preset value, beyond which there may be a danger to personnel or possible disruption or destruction to the process or product, an initial warning is triggered and the process is allowed to continue. If the problem is rectified, the "warning" returns to a "normal" state. If the condition persists and the static level exceeds a second, more crucial value, an alarm is activated. This second-level alarm can be used to shut down the process until it is brought under control, or to further warn the operator of the more serious condition.

Each Model 177A will monitor up to four locations using Monroe Model 1036 sensors placed at distances up to 1000 feet from the instrument. Processes can be continuously monitored and recorder outputs may be utilized for long term, drift free data acquisition. Cascading of up to 32 units via RS485 permits monitoring of up to 128 sensor locations using a PC and the supplied software.

Factory Mutual Research Corp. approves the Model 1036 probes for use in Class I, Division 1, Groups C and D hazardous locations. To comply, approved intrinsic safety (IS) barriers must be used with the Model 1036. Reference FM Standard Class Number 3610:January 2000

This document provides the user, for hazardous and non-hazardous areas, with operational instructions for Monroe Model 1036 sensors and the corresponding Model 177A Fieldmeter/Alarm System.

Section 2

SPECIFICATIONS

Monitor Console

Temperature Range:	+15° to +45° C
Analog Outputs (user selectable):	±10 V, 0 – 5V, (2.5V ±2.5V full scale); <10 Ω impedance; or simultaneous 4-20mA (optional)
RS232/485 Control:	Channel status, channel disable / enable, group control / setup
Accuracy:	± 3% of full scale at analog outputs ± 3% of full-scale ±2 counts +0.3 counts/°C at front panel meters
Displays:	Four 3½-digit LED's, 0.6" (one per input channel)
Power Requirements:	90-260 VAC, 47-60 Hz; 13 Watts maximum
Alarm Relays:	Per channel fail safe, NC (Form B) System O.K.; Channel O.K.; Warning; Alarm Contact Ratings: DC: 1A, 30V; AC: .05A, 125V
Connector Styles:	RS232/RS485 – DB9 Female Probe – DB9 Female Analog Out – BNC Test Connector – Screw Terminals 4-20 mA option – Screw Terminals
Dimensions:	1¾ x 19 x 11 inches (4.45x 48.26 x 27.9 cm) Mounts in a standard 19" rack
Weight:	6 lbs
Relay Contacts:	Switching load 30W 62.5VA; MAX switching voltage 110VDC, 125VAC 0.3A (rms), suggested limit 30VDC 1A MAX. Closed for normal conditions

1036 E(H) & F(H) Sensors

Standard Range	± 10kV/inch
Optional:	± 1kV/cm (100kV/m) ± 10kV/cm (1MV/m) ± 20kV/cm (2MV/m) ± 1kV/inch
Drift:	1% of full scale (typical), non-cumulative, long-term when purged according to manufacturer's instructions.
Noise:	<0.05% of full scale, peak-to-peak
Speed of Response:	1 second maximum, 10%-90% of full scale
Dimensions Model 1036E(H):	6.0 x 3.0 x 2.063 inches (15.24 x 7.62 x 5.24 cm)
Model 1036F(H):	1.75dia. x 1.22 inches (4.45 x 3.11 cm)
Maximum Cable Length:	1000 ft. (305 m)
Temperature Range:	-30° C to +80° C Models E & F -30° C to +100° C Models EH & FH

Enclosure (optional)

Capacity:	Two Monitor Consoles
Dimensions:	4.5 x 20 x 14 inches (11.4 x 50.8 x 35.6 cm)

Specifications are subject to change without notice.

Section 3

ELECTRIC FIELDS AND FIELDMETERS

Electric Field

An electric field is a region in space characterized by the existence of an electric force (*F*) generated by an electric charge (q). The electric force *F* acting on a charge *q* in an electric field is proportional to the charge itself. The relationship of these quantities is expressed by the electrostatic force law [1]:

$$F = qE$$

E is called the electric field strength and is determined by the magnitude and locations of the other charges acting upon charge *q*

$$E = F/q$$

The electric field strength, *E*, is usually displayed in the unit of volt/meter (V/m), volt/centimeter (V/cm) or volt/inch (V/in).

Electric Fieldmeters

Charge is often difficult or impossible to measure directly. We rely on detection and measurement of the electric field from the charged object to determine the existence of the charged and to estimate the relative magnitude of the charge. The electrostatic fieldmeter is the instrument that measures electric field strength.

Electric field strength measurements can be difficult to measure and interpret correctly because of several factors that can affect the electric field itself or affect the measurement of the electric field. Guidance is given in this document to help understand or minimize the effects of these factors, and to otherwise correctly interpret electric field measurements.

Fieldmeters measure the electrostatic field (voltage per unit distance) at the aperture of a grounded probe. Ideally, a uniform electric field is established between a charged surface and a grounded surface. The grounded surface may be the grounded surface of the fieldmeter probe, or the fieldmeter probe may also be placed in the plane of a grounded surface (better). The electric field is set up between the grounded surface and the charged surface some distance, D, away. Fieldmeters are calibrated at a particular distance, such as V/inch or V/cm. Therefore, using the manufacturer's calibrated distance (one inch or one centimeter) makes the measurement easier to interpret. Probe-to-surface separation should be carefully controlled for accurate measurement.

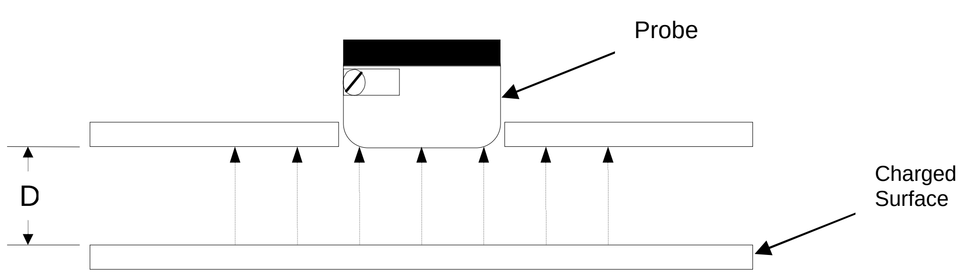


Figure 1: Probe-to-Charged-Surface Separation, D

Monroe Electronics electrostatic fieldmeters use a feedback-driven, null seeking design to assure accurate, drift-free, non-contacting measurements. Accuracy is typically a moderate 3% in a carefully controlled geometry.

Figure 2 illustrates a Monroe Model 1036 fieldmeter probe in simple graphical form. This particular fieldmeter is a chopper-stabilized design that operates reliably in both ionized and non-ionized environments (refer to Appendix II.)

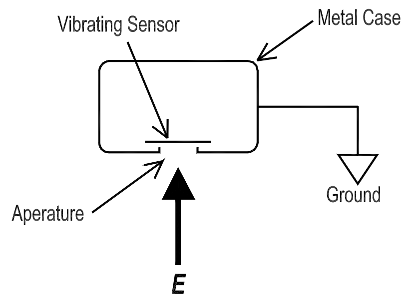


Figure 2: Monroe Model 1036 Fieldmeter Probe

Electrostatic fieldmeters measure electric field strength by non-contacting means. All the charged objects, voltage sources, and grounded conductors (including the fieldmeter probe housing) in the general area affect the electric field strength measurement. The fieldmeter measures the electric field strength only at its aperture. It does not have a viewing angle and it does not see the web or object directly in front of it as a separate entity. This can be demonstrated by measuring the electric field of an insulating sheet with a hole in it.

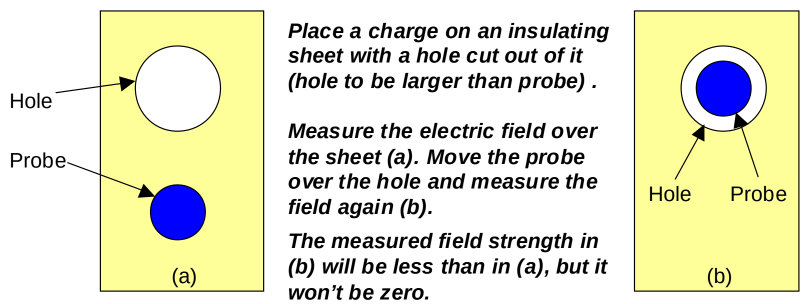


Figure 3: Insulating Sheet Electric Field Demo, Top View

The field over the hole will not be zero, even though there is no charge directly in front of the probe head. This is because the electric field at the probe aperture is a function of each charge on the sheet, and is also a function of the concentration of field due to the grounded probe itself.

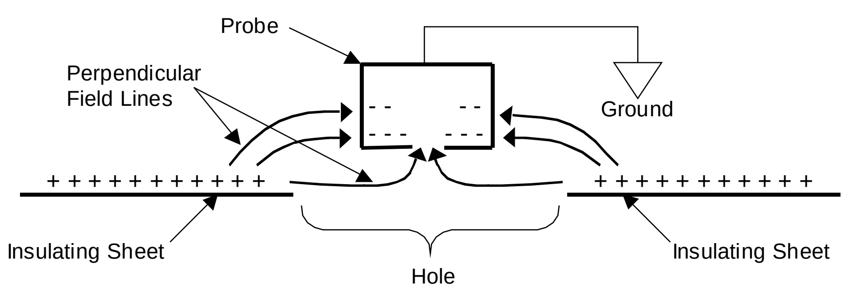


Figure 4: Insulating Sheet Electric Field Demo

Effect of Probe Type on Fieldmeter Readings

For measurement of insulating web surfaces, it is best to maintain the same distance from the fieldmeter to the web as when the fieldmeter was calibrated. Since most fieldmeters are calibrated at one inch, their apertures should be positioned one inch from the web. The Model 1036E probe will give accurate readings (as-is) at a measurement distance of one inch because its large grounded face helps to create a uniform electric field near the aperture of the probe. The Model 1036F probe is significantly smaller than the Model 1036E probe. Unless a grounded shroud is used to enlarge the smaller ground plane of the 1036F probe, the fieldmeter readings will be about 12% high because the electric field will converge on the small probe.

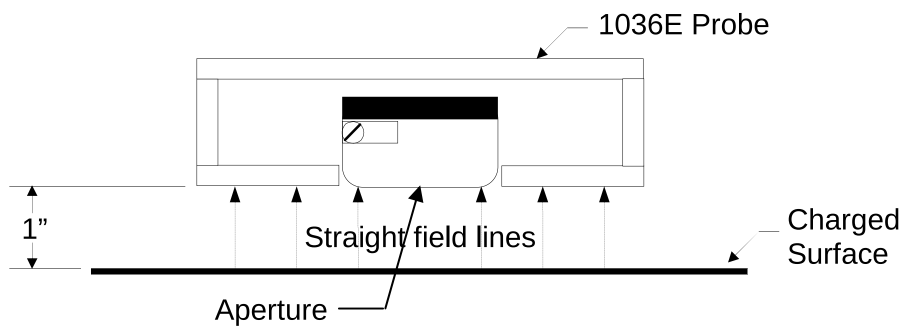


Figure 5: Field Lines Straight to 1036E Probe

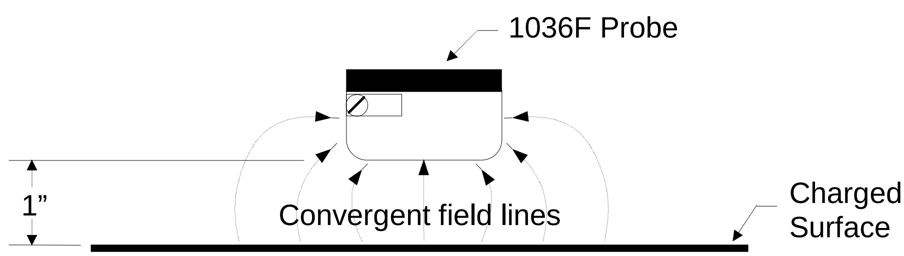


Figure 6: Field Lines Converging to 1036F Probe

Section 4

INSTALLATION

The Model 177A Multi-Point Fieldmeter and Alarm System, is designed to occupy a 1¾" space in a standard 19" equipment rack. A minimum of 4" should be left behind the instrument to allow for cable connections to the back panel.

For use in conjunction with central data collection and/or monitoring, the 177A may be placed at any convenient, centralized location provided that the distance to any one probe does not exceed 1000 feet. The probes should be placed at any location requiring the monitoring of charge buildup.

An earth ground is necessary for proper operation. The chassis of the instrument may be grounded through the line cord, but the chassis must be grounded. A three wire grounded line cord is provided with the unit. The power line connector is located on the rear of the instrument.

NOTE: The wire color code for the line cord provided is:

HIGH SIDE OF LINE — BLACK or BROWN
LOW SIDE OF LINE — WHITE or LIGHT BLUE
SAFETY GROUND — GREEN or GREEN/YELLOW

Probe Inputs:

Four probe-input connectors are located on the instrument back panel. These are 9-pin subminiature D female receptacles for mating to plugs on either the cables attached directly to the probes or extension cables or adapter cables used with them. Two captive screws normally furnished with the plugs may be secured to female thread inserts alongside each receptacle.

At least one probe must be connected for the 177A to operate.

Probes of different full scale sensitivities are available for use with the 177A. Each probe is marked with a number stamped on the gradient cap to indicate its sensitivity (see Table 1). As a default, each 177A is shipped with its firmware set to indicate 10KV full-scale. If the installation is using probes other than 10KV full-scale, the 177A will need to be re-set for a different full-scale value. To do this, reference the 177A Front Panel Programming Tree shipped with the unit. Place the 177A in Set-up mode and then navigate to the PT (Probe Type) block as shown in the tree. Change the probe type value stored to match the full-scale sensitivity of the probe being installed on that channel. Store the value and then exit the set-up mode.

Outputs:

Two types of outputs are available on the back panel to represent the inputs. Voltage outputs may be taken at four BNC connectors or 4-20 mA current outputs at screw terminals at JP2. Simultaneous 4-channel 4-20 mA current output is optional.

The two possible voltage outputs are: [1] ±10 volts, [2] 0 – 5 volts (±2.5 volts full scale).

The positive 4-20mA loop outputs are at terminals 2, 4, 6 and 8 of JP2 for Channels 1-4, respectively. The returns are at terminals 1, 3, 5 and 7, which are connected to common. The unit provides a 12V nominal supply which gives a compliance range of 7 volts. An external supply may be connected which will be used by all 4 channels. The external supply must be less than 25 volts. Output compliance is external supply minus 5 volts. Note that this supply will be referenced to chassis and Analog ground. These outputs are in addition to the four voltage outputs. See the overview of the 4-20mA module in Section 11 on page 30 for more information.

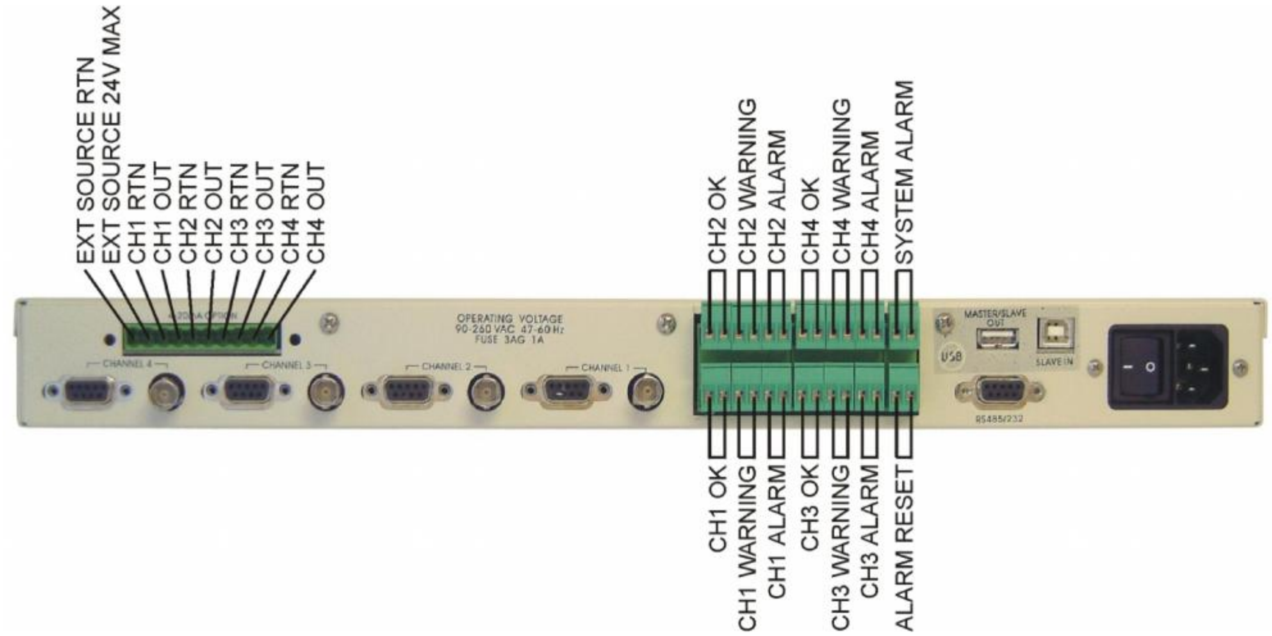


Figure 7: Rear panel relay hookups

Rear panel alarm relay connections:

Three status LEDs and relays are assigned to each channel. These LEDs and relays are referenced as **OK**, **WARNING**, and **ALARM**. External monitoring equipment can be connected to these relays and indicator LEDs via screw terminals located on the rear panel of the instrument and assigned as specified on the instruments cover.

Connections should be made using the following diagram as a guide. For operational information refer to the Rear Panel Relay Connection segment in Section 8 of this manual.

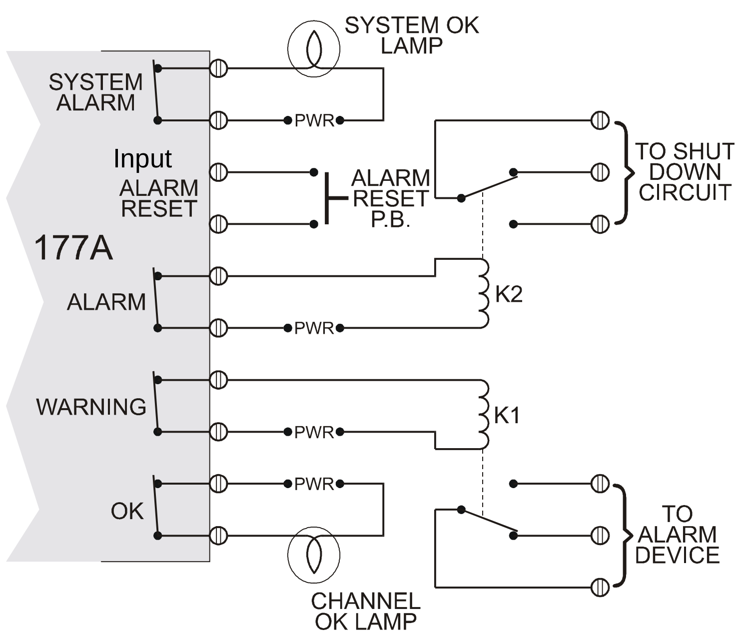


Figure 8: Rear Panel Relay Connections

Section 5

PRINCIPLE OF OPERATION

Refer to Figure 9 for the following discussion.

The probe is placed to “view” the target surface, which is assumed to be charged. In this instance, the gradient cap containing the aperture faces the target surface.

A sensitive electrode behind the aperture is vibrated perpendicular to the electric field by means of a drive coil (vibrated toward and away from the target surface). An A.C. signal is induced onto the sensitive electrode due to the motion of the vibrating electrode in the electric field, which is created by the charges on the target surface. The modulation amplitude of the A.C. signal, relative to the drive coil signal, is related to the polarity of the charge on the target surface.

This A.C. signal, conditioned by a preamplifier, filter, and signal amplifier, is fed into a phase-sensitive demodulator. This signal from this demodulator feeds an integrating amplifier. A fraction of the integrator’s output signal is fed back to the sensing electrode to null the signal from the external electric field.

The voltage signal from the integrator is thus directly proportional to the field intensity at the sensing electrode of the probe. The output signal from the integrator drives a meter for direct readout.

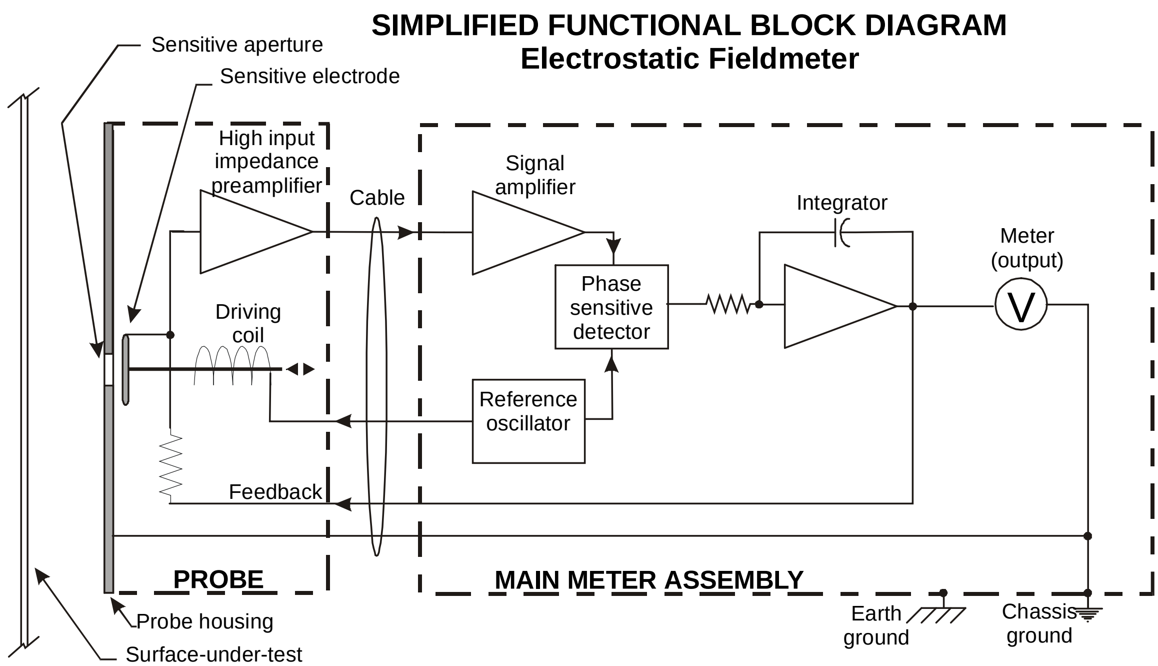


Figure 9

Section 6

Using 1036E and 1036F Sensors

General

Models 1036E and 1036F electrostatic fieldmeter probes are electrically identical and interchangeable. The major differences are physical. Model 1036F is a small (1.75” dia. x 1.25” H), lightweight version for general-purpose applications, or where available space is a problem. Model 1036E, for most industrial applications, is a 1036F probe built into a standard Crouse-Hinds ½”-FS1 electrical box with a stainless steel cover.

Both probes utilize the same vibrating capacitor modulator, and both have built-in provisions for purging with filtered air to prevent contamination and long-term drift. Inert gas may also be used for purging in hazardous areas where the probe will be used in an inert gas atmosphere. Purge gas flow in the Model 1036F exits through the sensitive aperture only. Gas flow in Model 1036E is directed across the face of the probe as well as through the sensitive aperture. Both probes are designed to be used with Monroe Electronics Model 177A Static Monitor 4 Channel Electrostatic Fieldmeter/Alarm System.

Static electricity is a natural occurrence resulting from common converting, laminating, and printing applications. At times static electricity is little more than an annoyance. However, in applications where significant electrostatic charges accumulate, the effects can be very serious. Typical probe applications include static level safety monitoring in explosive environments and static level quality monitoring in sensitive machine areas.

1036E, 1036F Fieldmeter Probe IS / I / 1 / CD / T5 Ta = 80^{0}C – 1036/10/A
1036E, 1036F Fieldmeter Probe IS / I / 1 / CD / T5 Ta = 100^{0}C – 1036/10/A

1. Parts of the Models 1036E and 1036EH Fieldmeter probe enclosures are constructed from plastic. To prevent the risk of electrostatic sparking the plastic surface shall only be cleaned with a damp cloth.
2. The Models 1036E, 1036EH, 1036F & 1036FH Fieldmeter Probe enclosure contains aluminum and is considered to present potential risk if ignition by impact or friction. Care must be taken into account during installation and use to prevent impact or friction.

Figure 10: Model 1036E Fieldmeter Probe

Figure 11: Model 1036F Fieldmeter Probe

Installation

Sensitivity:

Full-scale sensitivity for any properly standardized and calibrated probe/instrument combination is dependent upon the gradient cap (containing the aperture) on each probe. Full-scale sensitivity for any given system or channel (in the case of a multi-channel system such as the Model 177A) can be determined by inspecting the gradient cap on the probe. Each gradient cap is stamped on its face with a number, which represents a different size aperture. This number relates to the sensitivity of the probe as shown in the table below. Probes are standardized at the factory in a uniform electric field between two relatively large metal plates (see Figure 12). Once standardized in this manner, they may be interchanged at will.

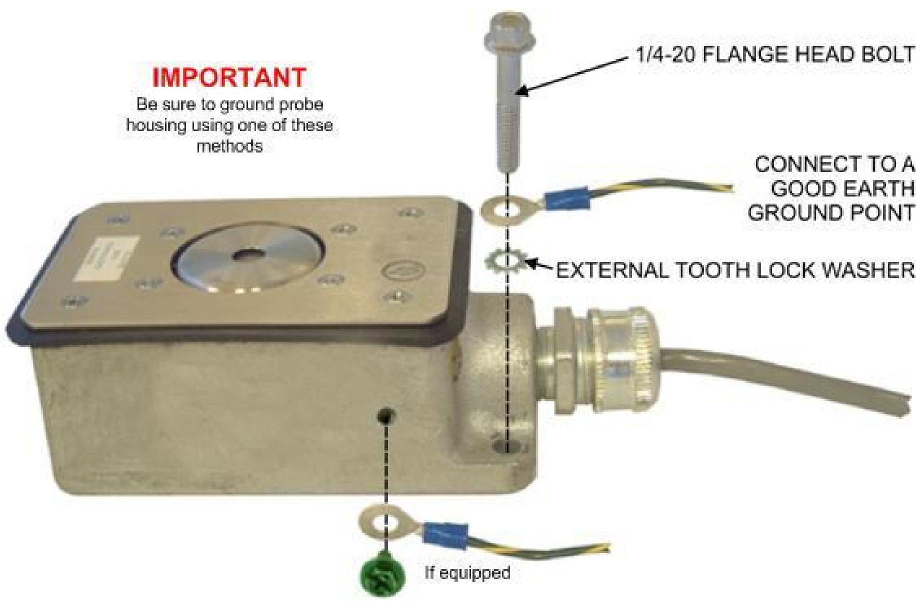
Probe Model	Full Scale Sensitivity	
1036_-3	±1 kV/cm	(±100 kV/M)
1036_-4	±10 kV/cm	(±1 MV/M)
1036_-5	±20 kV/cm	(±2 MV/M)
1036_-6	±10 kV/in	**Standard**
1036_-7	±1 kV/in	

Table 1: Probe Model vs. Full Scale Sensitivity

Mounting:

Probe mounting requirements for electrostatic field determinations will vary somewhat with the nature of the desired measurement. In general, it is best to mount the probe as near as practical to the surface being monitored, as long as the input signal remains less than the full-scale sensitivity of the probe. For example, mount the metric unit reading probes from Table 1 at one centimeter and the English unit reading probes at one inch, if feasible. It is strongly recommended that, where possible, the probe be mounted "looking" downward in order to minimize the probability of contaminants entering the aperture in the face.

Model 1036E is provided with two mounting flanges. The case should be electrically connected to ground. The gradient cap (containing the aperture) of the probe is a reference surface with its own ground connection. Do not make a separate ground connection to this surface. Stainless steel hardware is recommended as shown for this connection to avoid long-term corrosion issues.



Model 1036F may be held by hand to make rough measurements, or mounted by means of two threaded inserts installed in the mounting block. Care must be exercised when selecting screw length. Other temporary mounting options are friction clamps, adhesives or double-sided tape. The metal body of the probe is internally connected to instrument ground and should not normally be connected to any other ground.

Geometry:

A shroud is not necessary on 1036E probes mounted at 1in/1cm or less from the web because the large faceplate provides the same function as a shroud (creates a uniform field in front of the probe at one inch or less).

As a truly uniform field does not usually occur in most practical measurement situations using the 1036F probes, partly due to the introduction of the grounded probe itself, one must either:

- Improve the geometry by establishing a grounded plane (shroud) through which the fieldmeter probe can view the field under consideration. Refer to figure 6 on page 9. (see also Application Note –0003 in Appendix.)
- Establish a correction factor for the data, or
- Accept relative data. In many cases, this is acceptable practice once a fixed geometry is established and related to the <u>real</u> electric field.

Cables:

Both types of probes are normally equipped with 10-foot-long cables and subminiature D connectors that mate with Monroe Electronics Model 177A. This is Option 1 of 6 available wiring options – see Appendix A – Probe Connection Options for details. The first 3 options are for non-hazardous (non-classified) locations where there are no Intrinsic Safety (IS) considerations. The last 3 options are for hazardous (classified) locations where IS must be considered as part of the installation and barriers are in use.

Extension cables are available from Monroe in lengths up to 1000 feet, which is the maximum permissible length. These extension cables may be ordered in any length (up to 1000 feet) by part number 1036/12-nnnn, where nnnn is the length in feet.

The cable exit on Model 1036E is supplied through a packing gland which is screwed into a ½"-14 NPT tapped hole in a boss on one end of the housing. Inside the housing, the probe is plugged into a terminal block to which the cable attaches. Where it is desirable or necessary to connect Model 1036E probes to Model 177 Static Monitors with conduit, the original cable and packing gland can be removed and the cable replaced by any length (up to 1000 feet) pulled through the conduit with a connector on only the Model 177 end. Refer to Appendix A – Probe Connection Options, Options 3, 4 or 6 (depending on whether IS must be considered) for details.

Purging:

Any "contamination" present in the probe or near the measurement will have an adverse affect on performance. When insulative particles or liquid becomes charged and enters the probe or attaches near the aperture of the probe, it becomes a source of measurement error and drift. Less obvious is the influence of gaseous atmospheric constituents, including aerosols, which contaminate the probe by altering the contact potentials between critical surfaces.

Constant purging of the Model 1036 probe with clean dry air or an inert gas is recommended whenever practical to prevent airborne contaminants from entering the aperture in the gradient cap and being deposited on the electrode.

The air supply should meet standard ANSI/ISA-S7.0.01-1996 - Quality Standard for Instrument Air. A Koby "Junior" filter available from Koby, Inc., 297 Lincoln Street, Marlboro, MA 01752 should meet this standard and will provide sufficient mechanical and chemical filtration for one to four probes under most conditions.

A complete probe purge kit, Model 1017/22G, is available for Model 1036F from Monroe Electronics. It includes a low volume, long-life air pump, mechanical and chemical filters, and a supply of tubing. The pump is fully capable of 24-hour per day operation, thus keeping the probe ready for immediate use. A purge gas inlet tube supplied with each 1036F probe may be installed in either of two positions, the choice of which is primarily a matter of convenience in routing of the hose carrying the purge gas. These consist of tapped holes that exit at 90° to each other near the probe cable. If it is desired to move the purge tube to the other location, simply switch it with the Allen set screw plugging the other hole.

Purge the Model 1036E probe through a ¼"-18 NPT tapped hole in the end of the housing near the cable exit using common plumbing or tubing components.

Gas pressure to either probe type should be sufficient to produce a slight positive flow out of the probe and in no event should exceed a pressure of ½ psi.

Servicing

General:

It must be emphasized that the critical elements of these probes (gradient cap and sensing electrode) must be kept free from contaminants, e.g., dust, fumes, mists or any foreign material. The materials of which these probe elements are made were very carefully chosen to minimize contact potential. Any foreign matter which will cause relative electrical activity when combined with relative motion will tend to cause drift and measurement errors.

Therefore, it is recommended that:

- Probes be constantly purged even when not in use, if this is practical.
- Probes be kept tightly covered when not in use and are not being purged to prevent contamination. A covering such as a plastic bag or aluminum foil may be used. DO NOT cover the sensitive aperture with adhesive tape.
- Probes be cleaned only to the degree and frequency necessary to achieve the required stability.
- Gradient caps NOT be removed for cleaning unless absolutely essential.
- Major cleaning and reconditioning be should performed by the factory.

Cleaning:

The recommended cleaning solvent is instrument grade 70-100% isopropyl alcohol applied with a suitable soft, lint-free applicator. Use of a non-approved solvent may degrade performance permanently, requiring factory service.

Outside surfaces of the probe should first be wiped clean with a lint-free wiping tissue saturated in solvent. Then the interior surfaces should be flushed with solvent, using a plastic squeeze bottle through the aperture until no dirt or dust may be seen. The probe should then be allowed to drain and dry thoroughly. A 15-minute bake-out at 75°C is recommended to remove residual solvent.

Disassembly/Assembly, Model 1036E:

In order to rewire the cable terminal block, replace or standardize the probe assembly and, in most cases, to calibrate Model 1036E, it must first be removed from its housing. This is done by loosening the four cross point screws around the outer edge of the cover 1-1½ turns each, in turn, several times while lifting the cover and probe straight out of the housing until it is completely removed. DO NOT attempt to remove the screws completely one at a time. These four screws have circular

"E-rings" installed on them under the cover plate to make the screws captive and prevent their falling into machinery below.
The probe assembly will need to be removed from the cover plate, for standardizing, calibration, or to replace the gradient cap. This is done by removing the four cross point screws which secure the phenolic mounting block to the hex standoffs, leaving the standoffs attached to the cover plate.

To reassemble the probe unit, reverse the above procedure. After the phenolic mounting block has been re-secured to the four hex standoffs, the probe unit should be inspected to assure that an even air gap exists completely around the gradient cap between the cap and the cover plate. If not, loosen the two cross point screws which secure the probe body to the phenolic mounting block, and adjust the probe body so that it is centered and completely surrounded by an even air gap.

Partially mate the card-edge fingers into the terminal block connector in the housing and tighten the four outer screws in the cover plate 1-1½ turns at a time until the assembly is secured in the housing.

Standardization:
A simple accurate means of standardizing Model 1036 probes using any channel of the Model 177A Static Monitor as a test vehicle is given here.

The primary reason for standardization of type 1036 probes is to assure interchangeability of probes. The procedure is not suggested as routine, but is presented here in the event it becomes necessary to re-standardize following replacement of a gradient cap or major probe overhaul. It should be performed only under controlled conditions in a suitably equipped electronics laboratory. Monroe Electronics recommends that all probe standardization be performed at its facility.

All type 1036 probes are shipped from the factory standardized in a uniform (parallel) electric field using a fixture similar to that shown in Figure 12. The fixture consists of two flat rigid metal plates, which are parallel and separated with insulators by a distance "d" of one inch and have side dimensions of at least 5d (the bigger, the better; within practical limitations). The ground plate has a hole in its center just large enough to provide clearance around the probe so that the probe does not make contact with the plate. A calibrating voltage is applied to the gradient plate to establish a reference field in the volume between the plates. This fixture is available from Monroe Electronics, Inc. as part number 96102A.

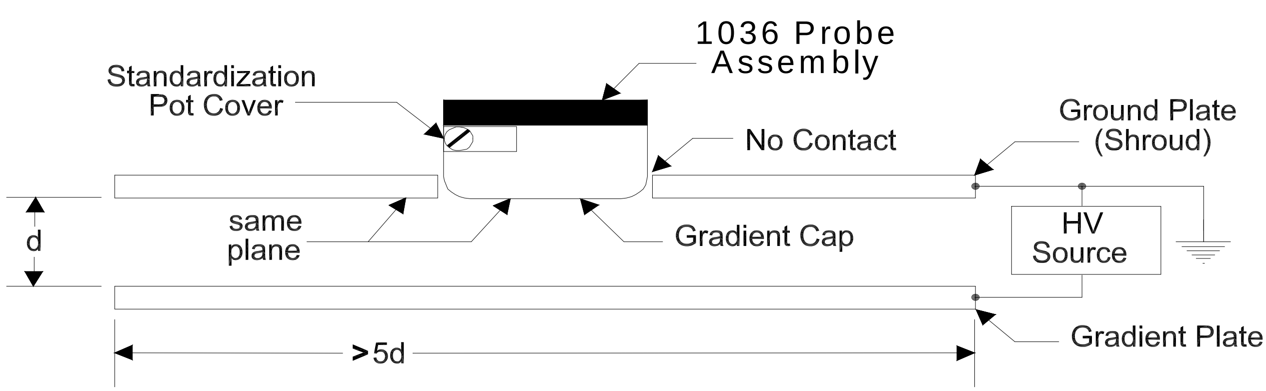


Figure 12: Standardization Fixture (P.N. 96102) Setup for 1036 Probes

A Probe Standardization/Test Cable, Model number 1036/22C shown in Figure 13 below is required to standardize or bench-test type 1036E-X probes. No special cable is required for type 1036F-X probes.

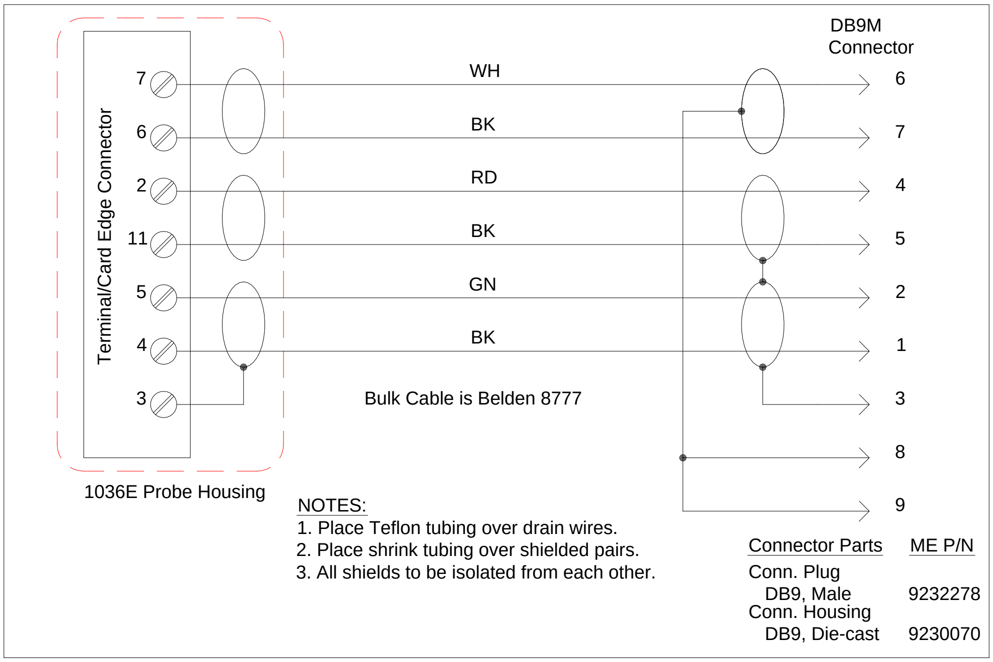


Figure 13: 1036E Standardization/Test Cable, Model No. 1036/22C

The standardization procedure is as follows:

- Set up apparatus as outlined above. Set a precision calibrating voltage source to zero volts.
- Set the Model 177A Static Monitor zero control of the selected channel to read a value of 0.000 at its ±10V analog output using a high quality, 4½ digit digital multimeter (DMM).
- Apply calibrating source voltage (V_{HV}) shown in Table 2 for the probe model being standardized.
- Adjust the standardization potentiometer in the probe to produce value (V_{IND}), as shown in Table 2, at the analog output of the selected channel using the same DMM as above.

Probe Model	Sensitivity	V_{HV}	V_{IND}
1036_-3	±1 kV/cm	2540 V	10.00 V
1036_-4	±10 kV/cm	2540 V	1.00 V
1036_-5	±20 kV/cm	2540 V	0.50 V
1036_-6	±10 kV/in	1000 V	1.000 V
1036_-7	±1 kV/in	1000 V	10.00 V

Table 2: HV Source and Meter Reading for Probe Standardization

Full Scale Range* Maximum Surface Voltage	**Probe**	**Probe to Surface Spacing**	
		inches	cm.
20.0 kV	20 kV/cm (-5)	0.4 in	1.0 cm
	10 kV/cm (-4)	0.8 in	2.0 cm
	10 kV/in (-6)	2.0 in	5.1 cm
	1.0 kV/cm (-3)	7.9 in	20 cm
10.0 kV	10 kV/cm (-4)	0.4 in	1.0 cm
	10 kV/in (-6)	1.0 in	2.5 cm
	1.0 kV/cm (-3)	3.9 in	10 cm.
1.0 kV	1.0 kV/cm (-3)	0.4 in	1.0 cm

***Called "Probe type" in Software**

Table 2A: Probe Selection/Sensitivity Chart

Intrinsic Safety (IS) Barriers:

Model 1036E and 1036F Electrostatic Fieldmeter Probes meet Factory Mutual Research Corporation requirements for Class I, Division 1, Groups C and D hazardous locations when installed in accordance with the appropriate Monroe Electronics, Inc. control drawings. To comply, approved safety barriers must be used as shown in the drawings. These drawings are included in Appendix B – Intrinsic Safety Barriers or are available from Monroe Electronics. Copies of the Factory Mutual Research Corporation report 1Q3A9.AX specific to these probes are also available on request.

Section 7

Typical Setup

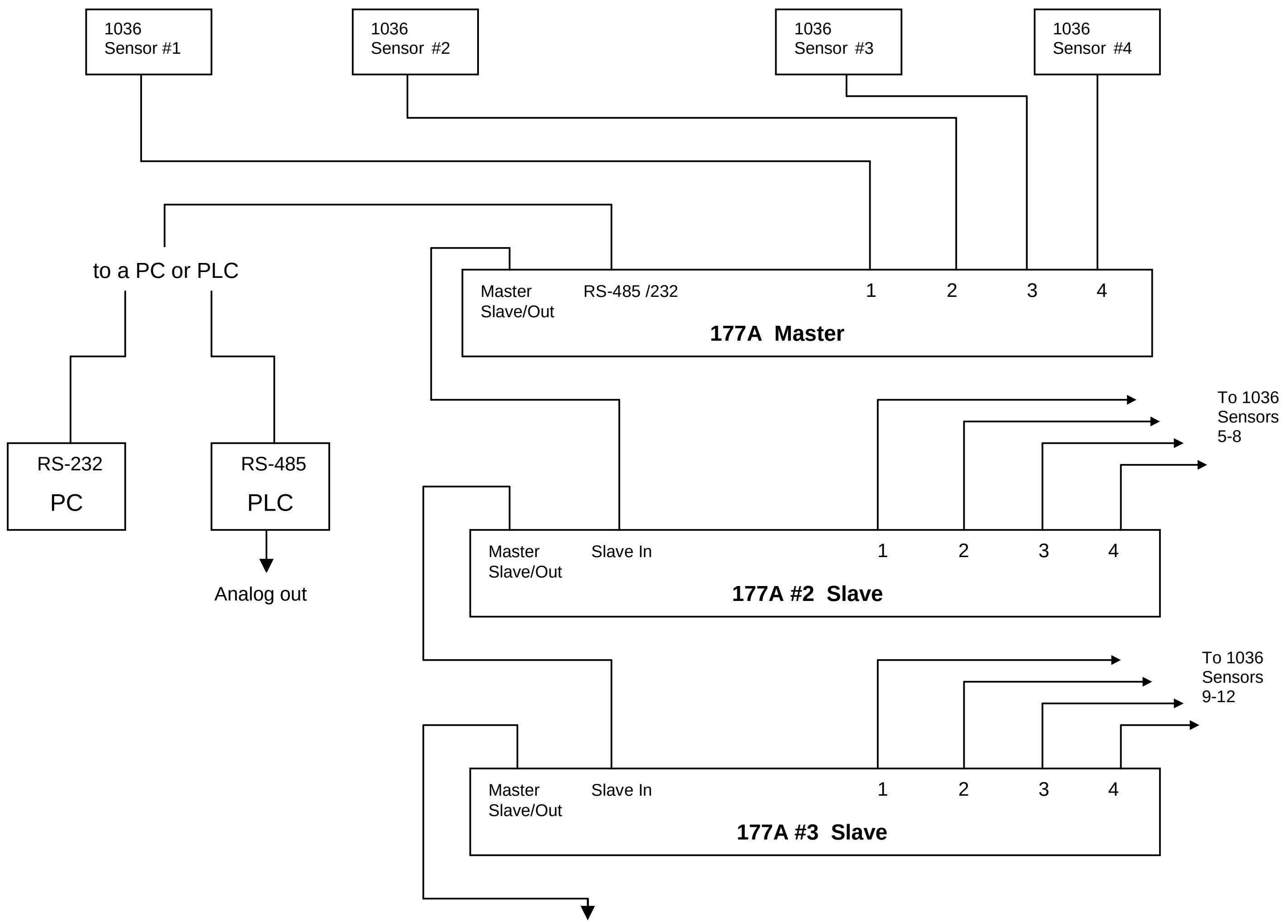


Figure 14 – Block Diagram of a typical set up

Analog Inputs

Monitoring equipment for voltage levels may be connected to any or all of the for channels via the BNC connectors located adjacent to each channel probe connector on the rear panel on the instrument.

Monitoring equipment for current levels may be connected to the optional 4-20mA pcb via screw terminals located on the rear panel of the instrument.

Section 8

OPERATION

Front Panel Features

Figure 15: Front Panel View

Console Switches

PWR – Switches unit ON or OFF (There is a main power switch on the rear panel that supplies DC power. The front panel console push button switches the power to the to the unit's power supply.) If line power is lost, the 177A will return to operational status when power is restored.

GROUP ENA/DIS - All channels in the group (of four) are enabled on power-up. These channels may be immediately and simultaneously disabled by pressing the **GROUP ENA/DIS** button on the front panel or clicking the **GROUP ENA/DIS** button on the program monitor screen.

SETUP – Initiates programming via the front panel. Yellow Program LED lights when **SETUP** button is pressed and remains lit for duration that instrument is in program mode.

TEST – Initiates testing of all connected and enabled probes. Pressing and holding down the **TEST** button causes a shift in the probe reading to the minus direction, the reading should return to normal when the button is released, indicating a good probe.

ENTER – Press **ENTER** to accept changes during programming or to perform a function.

EXIT – Press **EXIT** to escape the changes or exit the program mode.

Console LEDs

POWER – Green LED lights when power is applied to the instrument. A flashing power LED indicates a problem with the instrument's power supplies. If this occurs refer to the Return Policy on page 3 for servicing.

PROGRAM – Yellow LED lights when the SETUP switch is depressed and remains lit until the program mode is exited. If master/slave units are utilized the program light will pulse on the master unit which drives probe oscillation. If it is a slave unit the program light will not be lit.

The program LED does not pulse when the unit is in program mode.

The program light flashes (pulses at a slower rate) when the unit is receiving a firmware update. If the update is interrupted either, by the user or power failure, the light will flash and remain flashing until the update is completed successfully.

FP LOCK – Red LED indicates that the front panels controls have been locked. When locked the front panel buttons do not function except for **Power**, **Setup** and **Exit**. FP lock can be enabled or disabled via the front panel controls or the pc software supplied.

REMOTE – Lights when the PC program is in use.

Rear Panel Relay Connections

Three status LEDs and relays are assigned to each channel. These LEDs and relays are referenced as **OK**, **WARNING**, and **ALARM**. External monitoring equipment can be connected to these via screw terminals located on the rear panel of the instrument. Connections are specified in Figure 7 on page 10 and on the instrument's cover.

Three modes of operation are available:

Alarm Mode - Latching

Under normal operating conditions (i.e. the monitored static level is less than the preset warning and alarm levels) all three relays are energized initiating a contact closure. The green or **OK** status LED is blinking while the yellow or **WARNING** and red or **ALARM** status LEDs are not lit.

When static levels reach the preset Warning level and the preset Alarm Delay has expired (refer to Program Setup in Section 9 for details) the Warning relay will open and the Warning LED will light. The OK LED will continue to blink. Whenever the instrument achieves Warning mode it will stay in that condition until the problem is corrected or the static level falls to less than the preset warning.

When static levels reach the preset Alarm level and the preset Alarm Delay has expired (refer to Program Setup in Section 9 for details) the Alarm relay will open and the Alarm LED will light. The OK LED will continue to blink and the Warning LED remains lit as well.

System Alarm - Upon realization of an alarm condition the System Alarm relay will open. Upon opening the System button on the Monitor screen on your pc will flash red.

Whenever the instrument achieves Alarm mode it will stay in that condition until the problem is corrected and the instrument is manually reset by toggling the channel's **ENA/DIS** button on the instrument console or via the pc program provided or by momentarily shorting the Alarm Reset terminals on the back panel.

Alarm Mode – Non-Latching

Under normal operating conditions (i.e. the monitored static level is less than the preset warning and alarm levels) all three relays are energized initiating a contact closure. The green or **OK** status LED is blinking while the yellow or **WARNING** and red or **ALARM** status LEDs are not lit.

When static levels reach the preset Warning level and the preset Alarm Delay has expired (refer to Program Setup in Section 9 for details) the Warning relay will open and the Warning LED will light. The OK LED will continue to blink. Whenever the instrument achieves Warning mode it will stay in that condition until the problem is corrected or the static level falls to less than the preset warning level.

When static levels reach the preset Alarm level and the preset Alarm Delay has expired (refer to Program Setup in Section 9 for details) the Alarm relay will open and the Alarm LED will light. The OK LED will continue to blink and the Warning LED remains lit as well.

System Alarm - Upon realization of an alarm condition the System Alarm relay will open. Upon opening the System button on the Monitor screen on your pc will flash red.

Whenever the instrument achieves Alarm mode it will stay it that condition until the static level falls to less than the preset warning level resetting to normal operation.

Non-Alarm Mode

In non-alarm mode the alarms are disabled, the green or **OK** remains lit continuously. Warning and Alarm are not triggered. The instrument continues to monitor static levels regardless of operating conditions.

Channel Switches

ENA/DIS – Toggles the channel status between Disable / Enable / Alarm

ZERO – Press and release the **ZERO** button to zero the channel. Display will return to pre-set zero level. The channel display to the immediate right of the channel display being zeroed will count down the pre-set zero time out. (For Channel 4 the channel display immediately to the left will count down the zero time out.) If zero level is reached within the pre-set time the channel display will read ***don*** for "done." If the zero level is not reached within the pre-set time the display will read ***err*** for "error."

Auto-Zero – Press and release the Zero button (< 1sec)

Manual Zero – Press and hold the zero button then push the up or down arrow buttons to adjust the zero reading

Channel LEDs

Green (left) LED – Lights and remains lit when a probe is connected and the channel is enabled (Non-Alarm mode). Lights and flashes when a probe is connected and the channel alarm is enabled. (Alram Mode: Latching and non-latching.) LED remains flashing even as the Yellow, Warning and Red, Alarm LEDs light during warning and alarm conditions.

Yellow (center) LED – Lights when the pre-set voltage warning level is reached. Remains lit until voltage level drops below warning level (non-latching) or until the condition corrected and the channel is reset (Latching).

Red (right) LED - Lights when the pre-set voltage alarm level is reached. Remains lit until voltage level drops below warning level (non-latching) or until the condition corrected and the channel is reset (Latching).

177A Relay and LED Functions

Initially all Ok, warning, alarm relays are closed (shorted or activated). The Ok LED is on; warning and alarm LEDs are off.

Channel Ok relay is open (the green LED off) when:

- The channel is enabled and has no probe.
- The channel is disabled.

Channel Warning relay is open (the ember LED on) when:
The channel is enabled and the reading is on or above the warning level.

Channel Alarm relay is open (the red LED on) when:

- The channel is enabled and has no probe.
- The channel is enable and the reading is on or above the alarm level.

If the unit is in alarm latching mode and the reading comes back down, the relay will not close until the [Ena/Dis] or [GRP] button is depressed.

System relay is normally closed. It is open when:

- One or more of the alarm relay is open.
- One or more of the enabled channel has no probe.
- Power supplies have failed.

Power LED:
On when the unit is powered up. Slow blink if power supply has failed.

Program LED:
Normally off. It is on when doing front panel setup.
Pulses on when the unit is a master. See section on master/slave operation in the User Manual.Note: if USB cable A & B are connected to the same unit, oscillator is disabled.

FP Lock LED:
Normally off. On when the front panel is locked.
When the front panel is locked, only the [Setup] and arrow buttons work. You can unlock the unit, or browse the program setup but cannot change it.

Master/Slave out & Slave in:

Purpose

These connections provide synchronization of the probe modulators on multiple 177A's. When probes are attached to common mountings from multiple 177A's they can interact and cause zero shifts and low frequency oscillations without synchronization of the modulators.

Setup

Master/Slave out and Slave in connectors are provided on each 177A. The Master/Slave out either generates or passes through reference signal for synchronization. Multiple units can be daisy chained as shown in Fig 14, on page 17.. The Slave in connector accepts the Reference and forces the modulator to be synchronized with the other 177A's. Standard USB cables with Type A/B connectors are used for interconnects. These are supplied with the 177As.

Note. T**hese connectors are NOT USB Ports**

Remote LED

Normally off. Blinks when serial port is receiving.

Section 9

177A Software

Connecting the instrument to a PC (via RS232 serial port)

Connect the 177A to your PC using the DB9-M/F straight through cable in your accessories. Plug the male end of the cable into the RS-485/232 receptacle on the rear of the instrument. Plug the female end of the cable into the appropriate connector on your PC.

Connecting via RS485

Refer to Appendix III for RS-485 connections details.

Installing the Software

Insert the supplied disk into the appropriate drive. A Launch program should automatically begin running. Follow the instructions for the desired action. (i.e. to install the software click the Installation button.) If the Launch program does not automatically start refer to the following instructions:

Click on **Start** on your task bar and then select **Run –**

Type the appropriate drive letter for the disk and "Install-177A-105.exe" (i.e. - a:\ Install-177A-105.exe) on the disk and follow the subsequent instructions.

Upon completion, the program icon will be displayed in a window. Click on and drag the icon to your desktop to place a short cut there. Close the window.

Programming via PC

The software included with the 177A is designed to program, monitor and test the instrument via RS-232 or RS-485 connections using the toolbar on the program's main screen.

Connect – Select the appropriate comport and baud rate to be used for the monitor from the drop-down menus. The baud rate should reflect the current Windows setting for this comport.

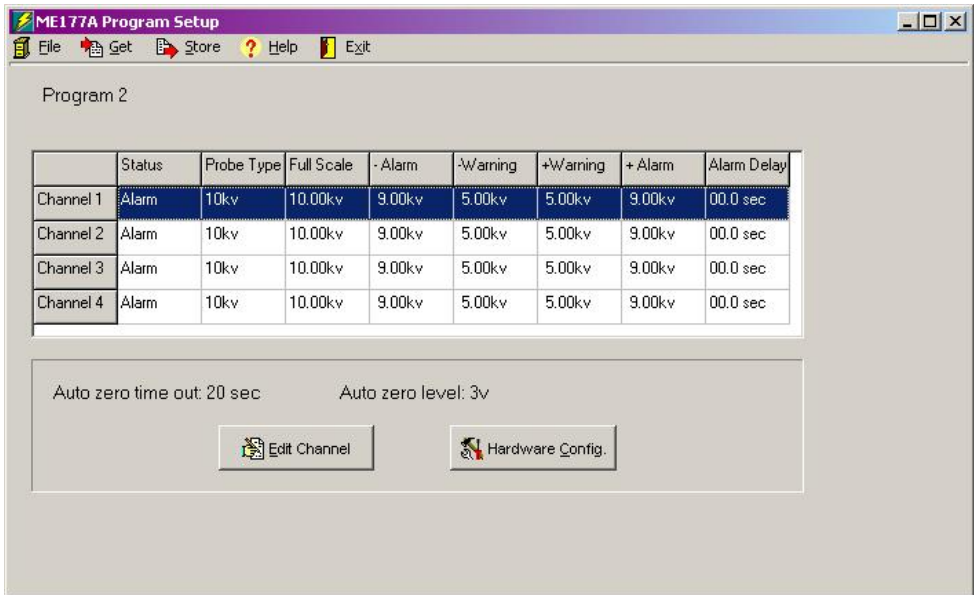
Program Setup – Permits enable/disable of alarms; setting of warning and alarm levels; full scale; alarm delay; auto zero time and level; and decimal position. Four user-defined programs are available which can be set up and stored. The instrument is set to P0, the default setup program. P1 – P4 are initialized to the default settings, resetting these four programs is accomplished via the ME177A program.

From the **Program Setup** drop-down menu:

Click on **Read Setup from 177A** to select program 1 – 4, or retrieve the active program.

Click on **Open Program on disk** to retrieve a program (*.prg) from a file.

Upon retrieving a program the following window will open:



From the **File** drop-down menu:

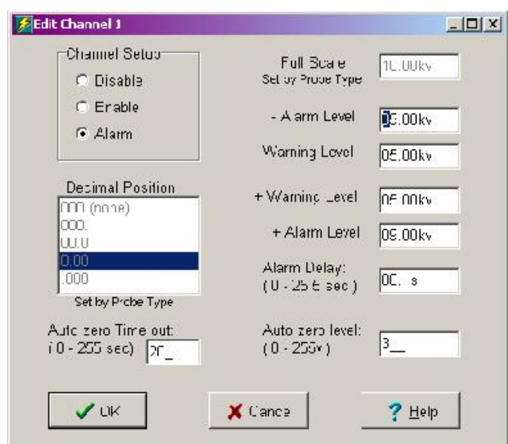
Select **Open** to retrieve a stored program fileneme.prg

Select **Save** to save a program

Select **Restore Defaults** to restore the default settings to all channels

Click on **Get** to select program 1 - 4, or retrieve the active program

Edit Channel- Each channel has its own alarm and warning levels, full-scale setting and decimal setting. The auto zero time out and level are the same for all 4 channels.



Disable Disables the channel display (three dashes across display)
Enable Enables the channel display (display is active with green LED lit)
Alarm Enables the channel and alarm (display is active with green LED flashing)
Full-scale Sets the full scale range for the channel display. Default is 1000v.

ï **Alarm Level** – When value exceeds this setting the alarm, if set, will activate. Default is 9000v.

ï **Warning Level** - When value exceeds this setting the alarm, if set, will activate. Default is 500v.

Note: Alarm level must be greater than the Warning level. Full scale setting must be greater than or equal to the alarm levels.

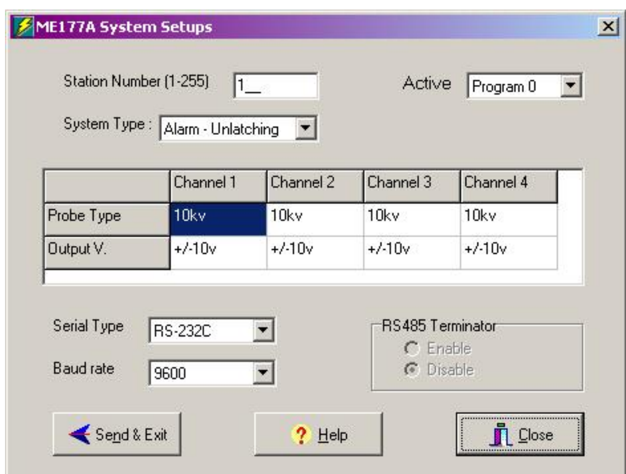
Alarm Delay – Delay time for the alarm/warning relay to open after the value exceeds the set level. Default is 0 seconds. Setting an alarm delay can prevent erroneous alarms.

Auto zero – Time and Level – When the **Zero** button is pressed auto-zero begins. If the channel reading reaches the level within the time period, the process stops and shows done. If it times out without reaching the level, it will show error and exit out of the auto-zero process. Default time for Auto-Zero time is 20 seconds. Default for Auto-Zero level is ± 3v.

After editing a program you may save it to your hard drive or send it to the 177A as it's active program. First exit the Edit Channel window by clicking on O.K., then from the **Store drop-**down menu:

Click on **Active Program** or **Program 1, 2, 3, or 4** to store your program into permanent memory. If program 1, 2, 3, or 4 is set as your active program those changes will also be applied.

Hardware Config – Permits selection of the station (unit) number, system type, active program, probe type, outputs, serial port, and baud rate.



Station Number – Each 177A should be assigned a unique number for identification, especially when more then one unit is connected to the RS-485 bus. Station numbers may range from 1 to 255.

Active Program – Selects the program P0 (default) or P1 – P4 to be activated.

System Type – Selects the alarm mode for the instrument

Non-Alarm – Alarms are disabled

Alarm Latching – When the probe reading exceeds the alarm level the alarm relay latches causing the alarm LED for that channel to light. Alarm remains in latched or in Alarm mode until the corresponding channel ENA/DIS button is pressed on the instrument's front panel, reset from the PC or by external reset connection.

Alarm Unlatching - When the probe reading exceeds the alarm level the alarm relay latches causing the alarm LED for that channel to light.

Alarm remains in latched or in Alarm mode until the probe reading falls back under the alarm level at which point the relay unlatches.

Probe Type – Must be set from the front panel set-up mode. Please refer to the Front Panel Programming Tree included on your disk.

Output Voltage - Click in a specific channel's probe type box to set the output voltage to either 0-5V or ± 10V.

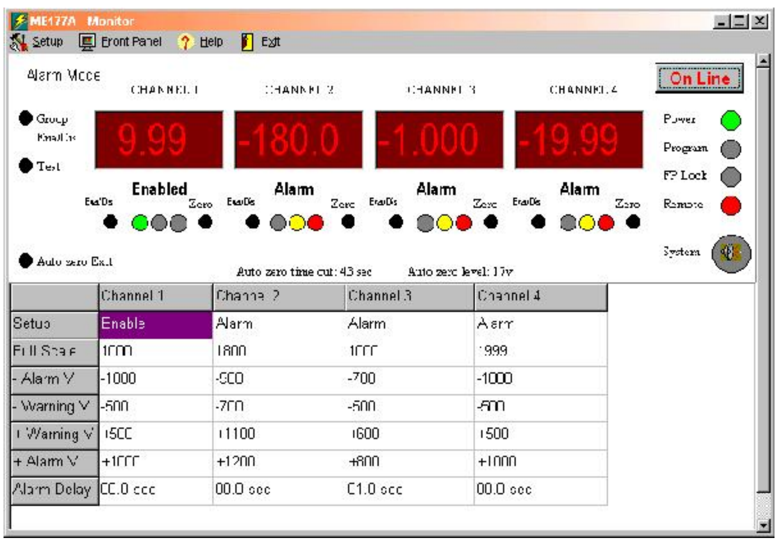
Serial Type – Set serial connection type: RS-232 RS-485Half, or RS-485Full. If RS-485Full is selected and there are more then two units connected, the RS-485 Terminator should be enabled on the first and last units on the bus. ***Note: If the serial configuration is not properly set up the instrument will lock up. If this happens turn off the unit, disconnect the plug, reset the firmware to the correct type, restart and reconfigure the software.***

Baud Rate – Set the appropriate baud rate for your system. Should be the setting used under "Connect."

Monitor

The monitor screen enables you to observe the 177A console in real time. It reads data from the 177A console and updates the screen at approximately 3 times per second. The top half of the Monitor screen mimics the instrument's front panel, while the bottom half of the Monitor screen displays the active program from the 177A.

From the Monitor drop-down menu select **Monitor**, the following window will open:



Use the pc mouse to activate the instrument controls via the monitor screen.

Group ENA/DIS – All channels in the group (of four) are enabled on power-up. These channels may be immediately and simultaneously disabled by pressing the **GROUP ENA/DIS** button on the front panel or clicking the **GROUP ENA/DIS** button on the program monitor screen.

Test Button – Tests the probe. Click on and hold causing an output and display shift in the minus direction. Release the button, the reading will return to normal if the probe is functioning properly.

On Line – Click on to set the instrument for continuous monitoring
Off Line – Click off to end continuous monitoring

Ena/Dis – Toggles channel status Disable / Enable / Alarm for the corresponding channel

Zero – Initiates Auto Zeroing for the corresponding channel

Auto Zero Exit – Stops ongoing auto zeroing

FP Lock – Click on the button on the monitor screen or select **FP**

From the **Front panel** drop-down menu:

Lock/Unlock – Select to toggle the front panel between lock / unlock. Red LED indicates that the front panels controls have been locked. When locked the front panel buttons do not function except for **Power**, **Setup** and **Exit**. FP lock can be enabled or disabled via the front panel controls or the pc software supplied.

Alarm/Non-Alarm –Select to set the Alarm mode. In Alarm mode channels can be set to enable / disable / alarm. In Non-Alarm mode channels can be set to enable / disable only.

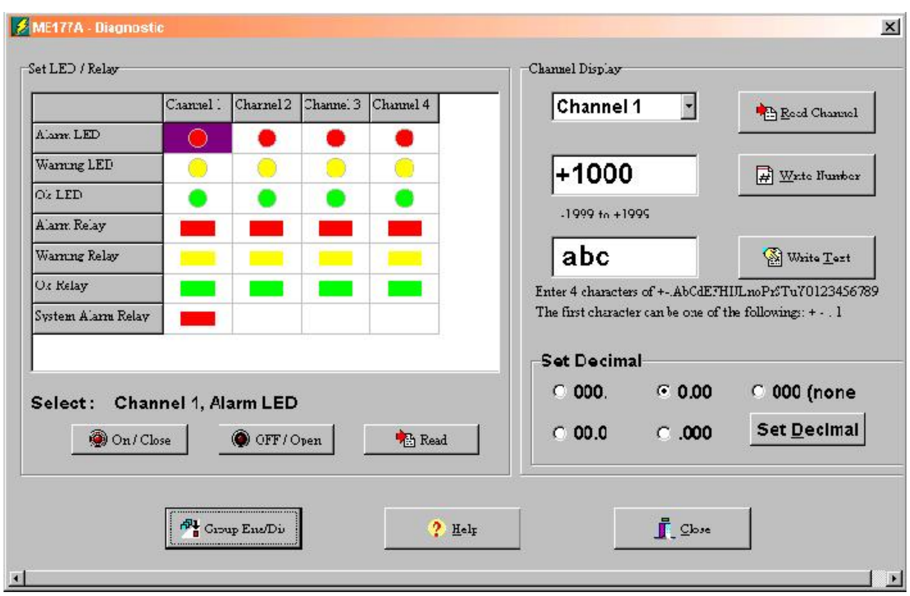
System Diagnostic – Indicates if a system error exists. Select to test the system. If the System icon is blinking it may be due to one or more of the following:

- A channel is enabled, the alarm is set but no probe is connected. **Fix**: Disable the channel or connect a probe to the channel.
- A channel, with its alarm activated, has reached the alarm level. **Fix**: When the level has returned to its normal range toggle the channel's ENA/DIS button to clear the alarm.
- System power supply is below normal. Check power supply.

Change Password – Select to change the password. Enter the default password (Default password is 1 9 5 3) as prompted. Enter the new password as prompted. Upon completion, the system will confirm the password change if accepted.

Diagnostic

From the Monitor drop-down menu select **Diagnostic**, the following window will open:



Selecting this window from the **MONITOR** drop-down menu on the main screen permits reading and writing to the front panel displays, LEDs, and exercising the system relay contacts. Before using this feature, the 177A must be connected and set to **Group-Disable** to permit control of these items. This feature is helpful in testing all external relay contact wiring to external devices.

To turn an LED or relay contact on or off or to obtain it's status, click on the appropriate box on the Set LED/Relay grid, then click the **O**n, **Of**f, or **Read** button. Remember that the relay contacts are set to be "fail safe" meaning that when conditions are O.K. in normal operation, these contacts are closed. They will then open under caution or alarm conditions or system failures. See Figure 8, on page 10, for examples of connecting external devices.

To read a register (channel display), select the channel in the Channel Display box in the right of the Diagnostic window, and then click the **Read** button. The selected channel display data is shown in the window below the channel display pull-down.

Numerical or text data can be written to any channel display by first selecting the channel in the Channel Display pull-down in the right of the Diagnostic window, entering the data to be written in the boxes below and then clicking the **Write Number** or **Write Text** button.

Display decimal points can be checked by using the **Set Decimal** box. Select the decimal position to be written and then click the **Set Decimal** button. The display should show the correct decimal point with associated zeros. This only checks the functionality of the decimal point and does not alter the setting used in the **Edit Channel** screen of the **Program Setup**.

Any settings written to the unit during diagnostic checks are automatically canceled when the unit is cycled back to **Group Enable**.

The Read / Write commands use MODBUS protocol. The addresses for the relays, LEDs, and displays are listed below and in the Coil Address Table in the
help menu of the Read / Write Coils window.

Register (Channel) addresses for MODBUS communications:
Channel 1 Display =Register 0
Channel 2 Display =Register 1
Channel 3 Display =Register 2
Channel 4 Display =Register 3

Coil (LED and Relays) addresses:
Channel 1 Alarm LED (red) = Coil 0 ---- Alarm Relay = Coil 12
Channel 2 Alarm LED (red) = Coil 1 ---- Alarm Relay = Coil 13
Channel 3 Alarm LED (red) = Coil 2 ---- Alarm Relay = Coil 14
Channel 4 Alarm LED (red) = Coil 3 ---- Alarm Relay = Coil 15
Channel 1 Warning (amber LED) = Coil 0 ---- Warning Relay = Coil 16
Channel 2 Warning (amber LED) = Coil 1 ---- Warning Relay = Coil 17
Channel 3 Warning (amber LED) = Coil 2 ---- Warning Relay = Coil 18
Channel 4 Warning (amber LED) = Coil 3 ---- Warning Relay = Coil 19
Channel 1 OK LED (green) = Coil 8 ---- OK Relay = Coil 20
Channel 2 OK LED (green) = Coil 9 ---- OK Relay = Coil 21
Channel 3 OK LED (green) = Coil 10 ---- OK Relay = Coil 22
Channel 4 OK LED (green) = Coil 11 ---- OK Relay = Coil 23
System Alarm Relay = Coil 24

To exit the **Diagnostic** window, click on the **Close** button.
To close the program software click on **Exit** on the main program window.

Section 10

Programming via the Front Panel

A programming tree is supplied to facilitate instrument programming via the front panel. Use the programming tree in conjunction with the front panel features detailed at the beginning of Section 9 to work your way through the programming sequences. Refer to the Front Panel Program tree included on the CD provided.

To enter the programming mode via the front panel press the **SETUP** button.

Use the Up / Down / Left / Right arrow buttons to move between the displays.

Press the **ENTER** button to accept changes or perform the function.

Press the **EXIT** button to escape the changes or to exit **SETUP** mode.

Section 11

Optional 4 – 20 mA Module

General

The optional 4-20 mA module provides 4 separate channel outputs in addition to the normal voltage outputs. All channels have a common ground. The instrument provides a 12-volt nominal supply which gives a compliance range of 7-volts. No external supply is required provided the 7-volt compliance is observed.

An external supply may be connected which would be used by all four channels. The external supply must be less than 25-volts. Output compliance of the is the external supply minus 5-volts. Note that this supply will be referenced to chassis and analog ground.

A termination resistor must be installed on the 4-20 mA receiving equipment and must be less than the compliance voltage, or

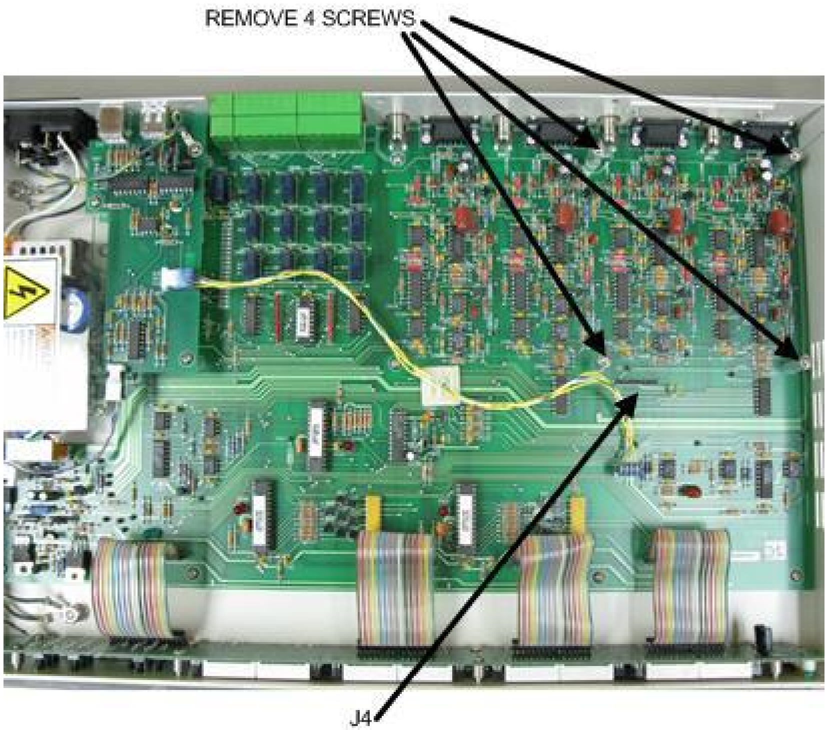
$V_{complaince} > .020 * R_{in}$ where R_{in} is the receiver input resistance

Specifications

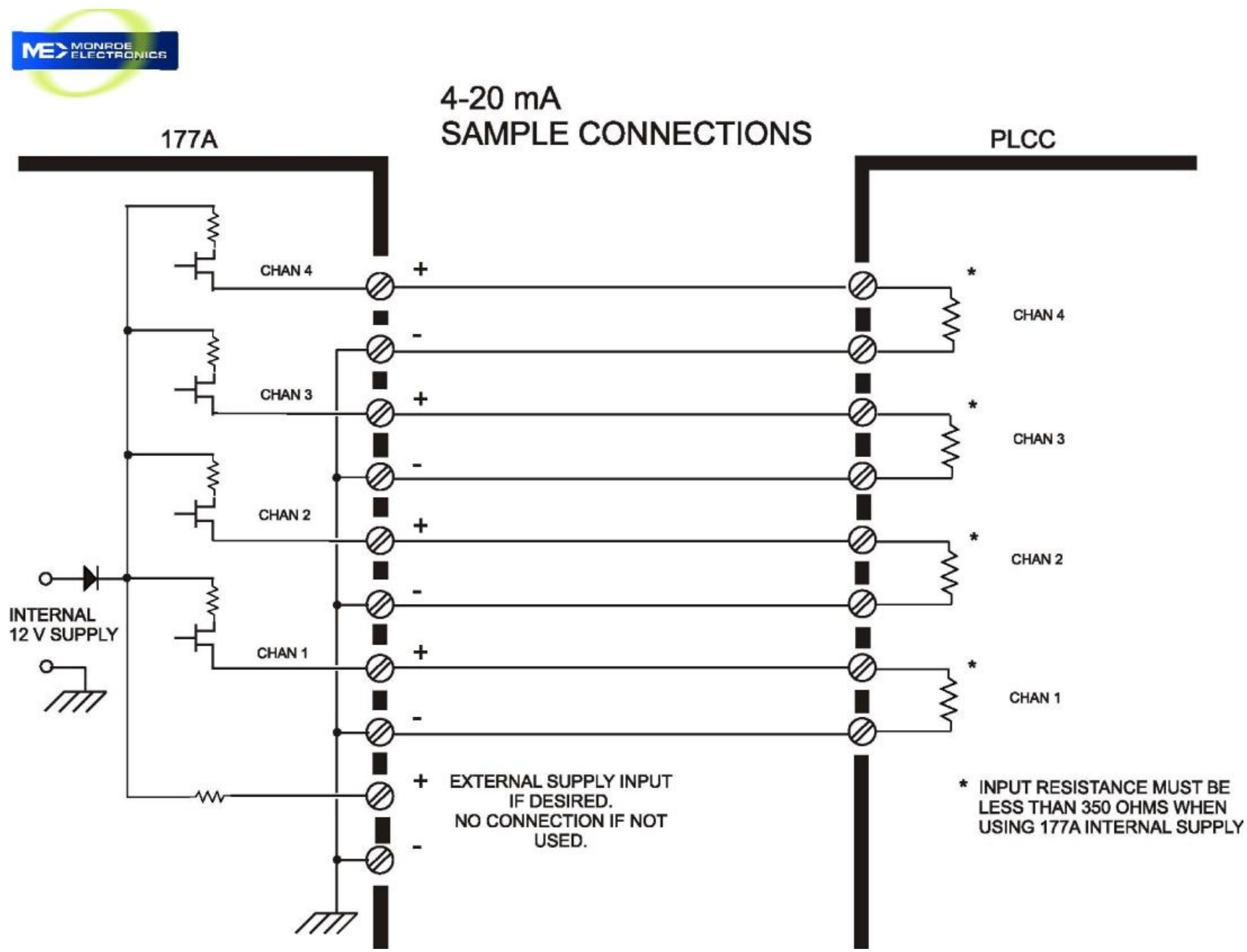
Internal Supply:	11 volts min
External Supply:	24 volts max

4 – 20 ma Option Board Installation Instructions

1. Un-plug all external connections to the 177A including the power cord.
2. Remove the 7 phillips-head screws that hold the cover of on the chassis. Remove the cover and set aside.
3. Remove the 2 screws holding the 4-20 ma option cover on the 177A back panel. Discard these parts.
4. Remove the 4 phillips-head screws from the tops of the mounting stand-offs as shown below.



5. Remove mating connector from 177A/22A.
6. Align the electrical connector on the 177A/22A with J4 on the 177A main board.
7. Press down and engage this connector with J4 until the board is seated on all 4 mounting stand-offs.
8. Re-install the 4 screws removed in step 4.
9. Replace the 177A cover and re-install it's mounting screws.
10. Installation complete. Connect the 4-20 ma outputs as shown on next page using mating connector supplied.



4_20_APPNOTE_060607.cdr 060607EPF

Section 12

Upgrading the Firmware

From time to time firmware upgrades may be available. With units version 1.03 or higher this upgrade can be accomplished using the 177A software and obtained via download from our website, e mail, or CD. Units that are version 1.02 require reprogramming of the processor and cannot be upgraded via the 177A software. To check the version of your unit read the Channel 2 display at power up. **Note:** For the duration of the firmware upgrade (approximately 6 minutes) the instrument is not functional and the system is not monitoring. If you have any questions regarding firmware upgrades please contact Monroe Electronics.

To initiate firmware upgrade, click on Update Firmware in the Program Setup drop-down menu. The following window will appear:

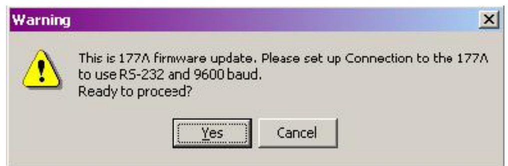
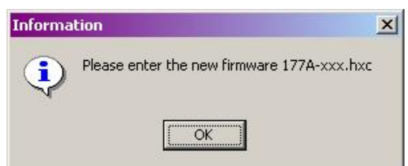


Diagram 1

Clicking on Yes will present the following window:



Clicking on OK will present the following window:

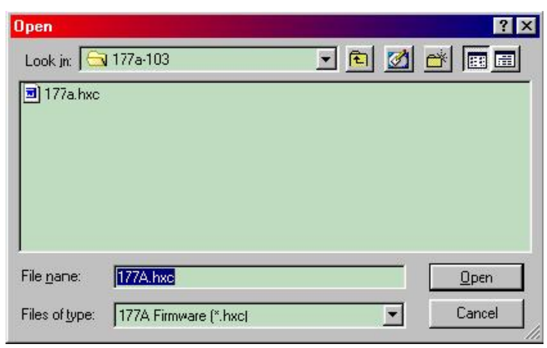


Diagram 2

The source file may be on a CD or downloaded from the Internet. If not available via our web site please contact Monroe Electronics to obtain to receive firmware updates. Upon selecting the appropriate upgrade file the instrument will "check" the update file and display the following if it is O.K. for use. Or, if the file is not ok, "**Invalid file format. File not loaded**" will be displayed.

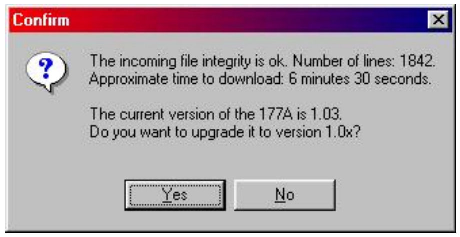


Diagram 3

Click on Yes to begin the download.

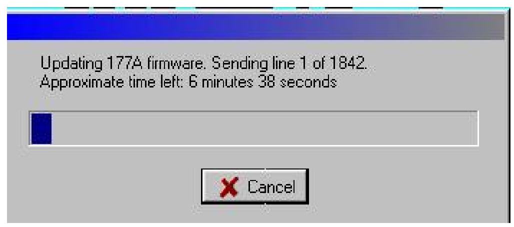


Diagram 4

If the unit is powered up in Load Program mode (caused by a previously incomplete loading process due to power or user interruption) and Update Firmware is selected on the Main screen drop-down menu the following window will be displayed:

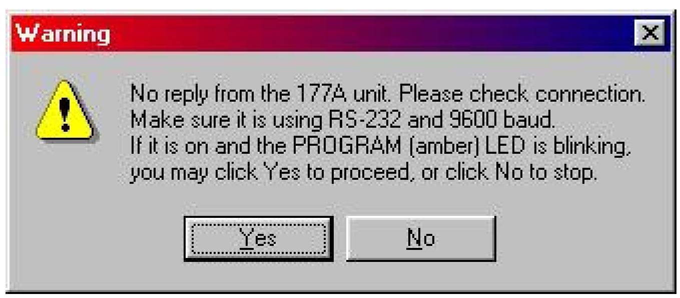


Diagram 5

If your connections are good and power is supplied to the unit click on Yes and proceed to open the source file (Diagram 2.)

During the download, if the chip is bad (doesn't accept data), show:

"**The program chip is defective**."
"**Please contact the manufacturer for replacement**."

When the upgrade is completed successfully "**Firmware Upgrade Success**!" will be displayed:

APPENDIX I

PROBE CONNECTION OPTIONS

There are at least six wiring options for the Model 177A with regards to the Model 1036E or 1036F probes. The first three options are for non-hazardous (non-classified) locations where there are no Intrinsic Safety (IS) considerations. The last three options are for hazardous (classified) locations where Intrinsic Safety (IS) must be considered as part of the installation.

OPTION 1: All probes (1036E or 1036F) use factory installed cables, no extension cables, no IS considerations

Probes are normally factory equipped with ten-foot-long cables. To use or test this system, simply plug the probes into the appropriate connectors on the back of the instrument.

OPTION 2: Probes use factory-installed cables and factory supplied extension cables, no IS considerations

Extension cables are available in lengths up to 1000 feet. The extension cable order number is *1036/12-XXXX* where *"XXXX"* denotes the length of the cable in feet. Factory supplied extension cables will be labeled with this part number near one end.

The connector at one end mates with the connector on the end of the cable attached to the probe and the one on the other end mates with the appropriate connector on the back of the instrument. Although it is virtually impossible to err, it is advisable to test the system "on the bench" in a confined area before permanently installing long cable runs.

OPTION 3: 1036E probes with long customer installed cables with or without extension cables, no IS considerations (see Figure A-I-1)

Wiring connections for customer installed 1036E probe cables for use in a non-IS installation are shown in Figure A-I-1. Model 1036E probes have terminal blocks inside their housings to which the cable wires are directly attached.

Note: 1036F probes have permanently attached cables and that this option does not apply.

As in OPTION 2, it is advisable to "bench test" the system before removing the factory-attached cables.

There are a couple of valid reasons for constructing your own cables:

a. You may be able to save money, although, in the long run, troubleshooting may prove to be more costly than using factory-supplied cables.

or

b. It is necessary to pull the cable through a fairly long run of conduit and the connector won't fit. The largest rectangular cross sectional dimensions of each connector are $^5/_8$" x $1^1/_4$". The minimum conduit ID through which this can be pulled is $1^3/_8$", although, it would be possible, with a great deal of care, to pull up to five cables simultaneously through that ID in a smooth straight run by staggering the connectors.

There are a couple of ways to approach (b. [above]):

a. 1. Buy factory fabricated *1036/12-XXXX* extension cables (where *"XXXX"* is the length of the cable in feet) that are long enough to reach from the console location, through the conduit, to the probe location with a few feet extra for measurement error.

   2. Remove and discard the factory supplied (usually ten foot) cable from the probe and mount the probe housing.

   3. Cut the female DB9 connector plug off of the extension cable.

   4. Pull the cable from the instrument end of the conduit to the probe end.

   5. Connect the wires to the terminal block in the probe housing as shown in Figure A-I-1.

b. 1. Buy bulk cable and pull as above. Cable construction details are provided in Figure A-I-1.

OPTION 4: 1036E probes with factory attached cables, extension cables (factory or customer supplied) and IS barriers (see drawing 1036/10 [SHT. 2 of 3])

Please refer to drawing 1036/10 [SHT. 2 of 3]. This drawing shows wiring for one channel. Generally, all channels would be wired alike. All barriers (four per channel) may be located in a single barrier enclosure.

Note that on each side of the barrier enclosure, you have the option of using connectors or "hard wiring" the cables directly to terminals on each barrier. Hard wiring, again, allows the cables to be pulled through conduit without interference associated with connectors.

Cable construction details are provided in Figure A-I-1.

OPTION 5: 1036F probes, extension cables (factory or customer supplied) and IS barriers (see drawing 1036/10 [SHT. 3 of 3])

Cables are captive to Model 1036F probes.

OPTION 6: 1036E probes with customer supplied cables and IS barriers

(see drawing 1036/10 [SHT. 1 of 3])

Wiring must be as shown in drawing 1036/10 [SHT. 1 of 3]. Refer to Figure A-I-1 and Figure A-I-2 for cable construction details.

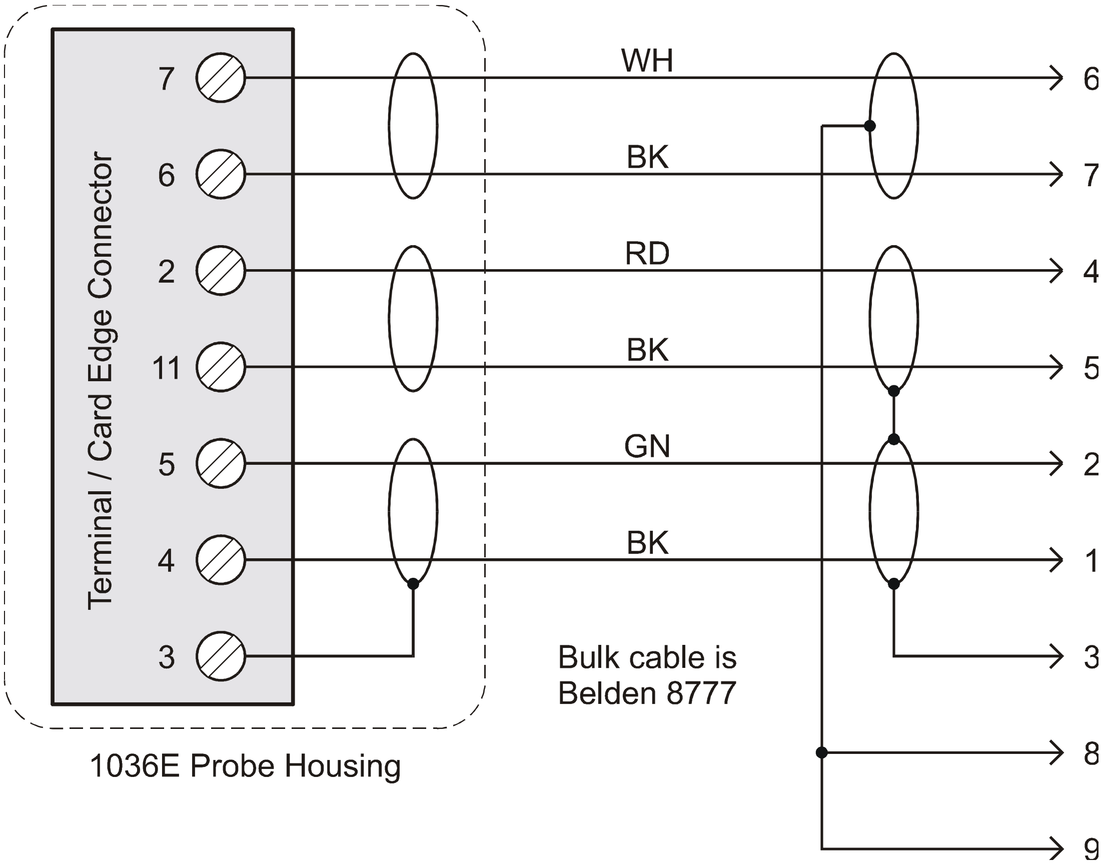

WH
BK
RD
BK
GN
BK
Terminal / Card Edge Connector
7
6
2
11
5
4
3
6
7
4
5
2
1
3
8
9
Bulk cable is
Belden 8777
1036E Probe Housing

Figure A-I-1

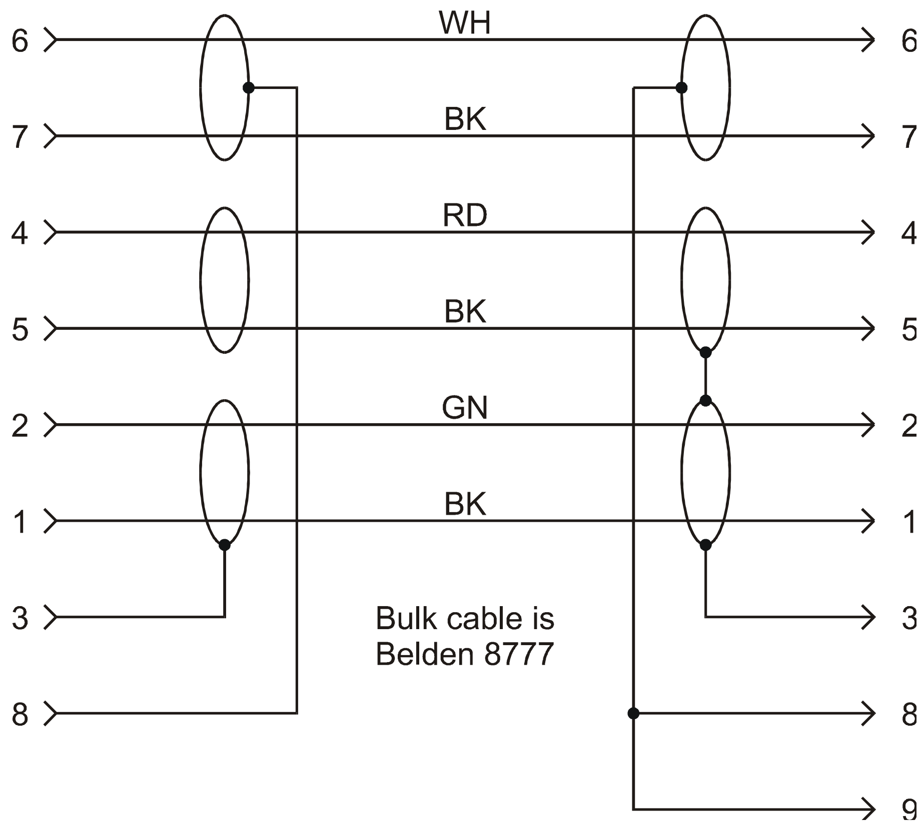
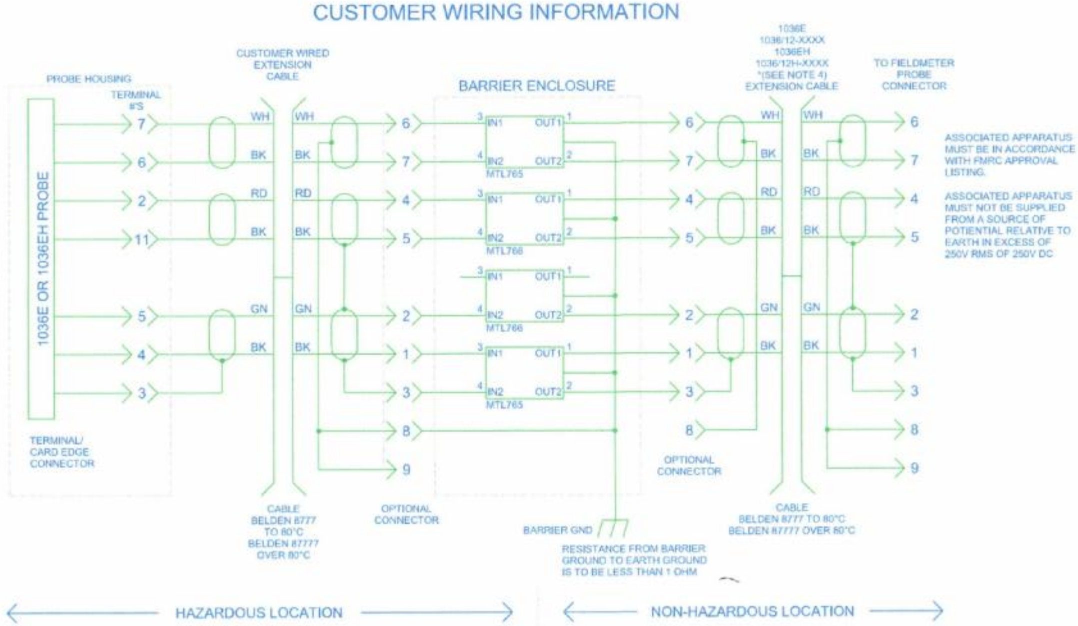


Figure A-I-2

CUSTOMER WIRING INFORMATION



NOTES:
1) WIRE COLORS ARE FOR REFERENCE ONLY AND APPLY ONLY TO BELDEN 87777 OR 8777 CABLES.
2) THE ABOVE DRAWING SHOWS THE CABLE WIRING FOR EXTENSION CABLES WHEN USING A BARRIER AND THE CUSTOMER SUPPLIED EXTENSION CABLE.
3) THE CONNECTORS AT THE BARRIER ARE OPTIONAL.
4) THE -XXXX INDICATES THE CABLE LENGTH IN FEET WITH MAX. LENGHT 1000 FEET. (EX. 1036/12-0300 IS A 300 FOOT CABLE)
5) MTL SHUNT DIODE SAFETY BARRIERS MUST NOT BE SUPPLIED FROM A SOURCE OF POTENTIAL RELATIVE TO EARTH IN EXCESS OF 250V RMS OR 250V DC.
6) MAXIMUM TOTAL CABLE LENGTH IS 1000 FEET.
7) MAXIMUM CABLE PARAMETERS:
   - CAPACITANCE - 60 PICOFARADS PER FOOT
   - INDUCTANCE - 0.20 MICRO HENRIES PER FOOT
8) REFER TO APPARATUS INSTRUCTION MANUALS FOR WIRING CONNECTIONS.
9) THE PROBE AND MOUNTING MUST BE CONNECTED TO GROUNDED EQUIPMENT AND MUST NOT INTRODUCE A NEW GROUND INTO THE HAZARDOUS AREA.
10) PART OF THE ENCLOSURE IS CONSTRUCTED FROM PLASTIC. TO PREVENT THE RISK OF ELECTROSTATIC SPARKING THE PLASTIC SURFACE SHOULD ONLY BE CLEANED WITH A DAMP CLOTH.

NO REVISIONS CAN BE RELEASED WITHOUT APPROVAL FROM FACTORY MUTUAL.

PROBE HEAD ASSY

REV	ECN NUMBER	DESCRIPTION	DRAWN	CH'KD	APP'D	DATE
C1		MTL765 WAS MTL7765, MTL766 WAS MTL7766	DLB		CGP	3/7/12
C	1799	MTL7765 WAS MTL765, MTL7766 WAS MTL766 ADDED NOTE 10	DLB		CGP	2/8/12
B	1799	ADDED 87777 CABLE AND TEMP	DLB			9/23/11
A	N/A	RELEASED	MG		CGP	11/15/93

MTL765	9002/77-150-300-00
MTL766	9002/22-240-160-00
MTL	R.STAHL INC.
EQUIVALENT SAFETY BARRIER	

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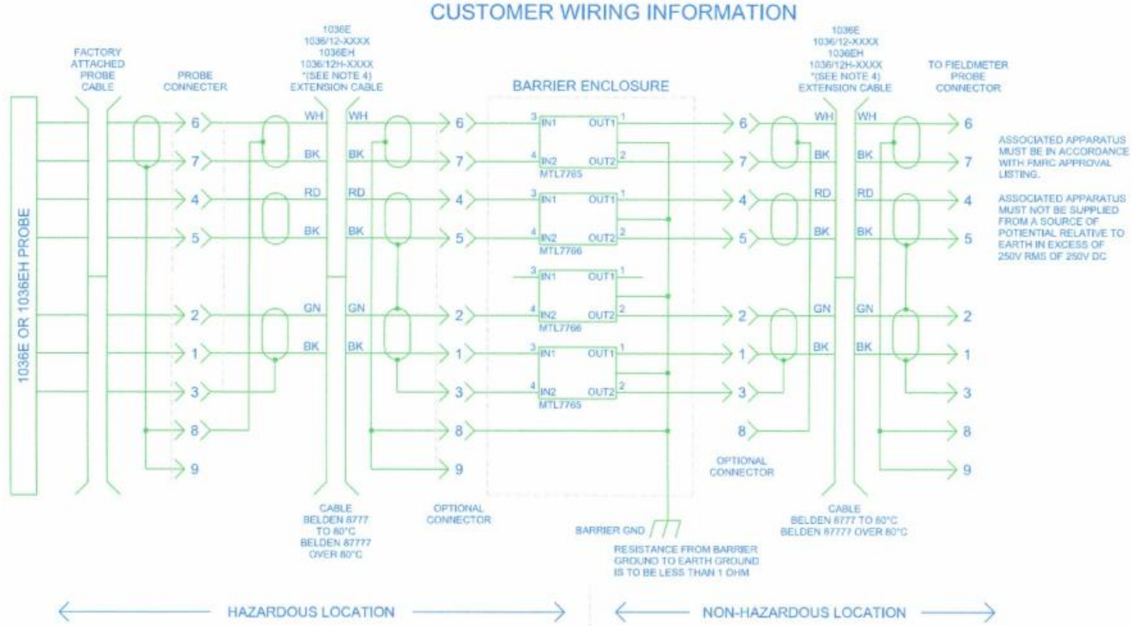
NEXT ASSEMBLY N/A
SCALE N/A | SHEET 1 OF 3
DRAWN VAS | DATE 11/15/93
ELECTRONIC NAME C1_1036_10-1.dwg | CH'KD TPM | DATE 8/31/94
COMPUTER NUMBER N/A | APP'D CGP | DATE 8/31/94
TOLERANCES UNLESS OTHERWISE SPECIFIED: TWO PLACE DECIMAL ± .020 THREE PLACE DECIMAL ± .005 FRACTIONAL ± 1/64 ANGULAR ± 1°
MATERIAL N/A

MONROE ELECTRONICS

MODEL 1036E/17 & MODEL 1036EH/17
CUSTOMER WIRING OUTLINE

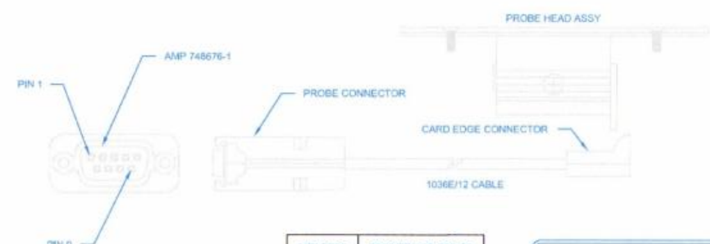
DRAWING NO. 1036/10
REVISION C

CUSTOMER WIRING INFORMATION



NOTES:
1) WIRE COLORS ARE FOR REFERENCE ONLY AND APPLY ONLY TO BELDEN 87777 or 8777 CABLES.
2) THE ABOVE DRAWING SHOWS THE CABLE WIRING FOR EXTENSION CABLES WHEN USING A BARRIER AND THE CABLE FACTORY SUPPLIED WITH PROBE.
3) THE CONNECTORS AT THE BARRIER ARE OPTIONAL.
4) THE -XXXX INDICATES THE CABLE LENGTH IN FEET WITH MAX. LENGHT 1000 FEET. (EX. 1036/12-0300 IS A 300 FOOT CABLE)
5) MTL SHUNT DIODE SAFETY BARRIERS MUST NOT BE SUPPLIED FROM A SOURCE OF POTENTIAL RELATIVE TO EARTH IN EXCESS OF 250V RMS OR 250V DC.
6) MAXIMUM TOTAL CABLE LENGTH IS 1000 FEET.
7) MAXIMUM CABLE PARAMETERS:
 - CAPACITANCE - 60 PICOFARADS PER FOOT
 - INDUCTANCE - 0.20 MICRO HENRIES PER FOOT
8) REFER TO APPARATUS INSTRUCTION MANUALS FOR WIRING CONNECTIONS.
9) THE PROBE AND MOUNTING MUST BE CONNECTED TO GROUNDED EQUIPMENT AND MUST NOT INTRODUCE A NEW GROUND INTO THE HAZARDOUS AREA.
10) PART OF THE ENCLOSURE IS CONSTRUCTED FROM PLASTIC. TO PREVENT THE RISK OF ELECTROSTATIC SPARKING THE PLASTIC SURFACE SHOULD ONLY BE CLEANED WITH A DAMP CLOTH.

NO REVISIONS CAN BE RELEASED WITHOUT APPROVAL FROM FACTORY MUTUAL.



MTL7765	9002/77-150-300-00
MTL7766	9002/22-240-160-00
MTL	R.STAHL INC.
EQUIVALENT SAFETY BARRIER	

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REV	ECN NUMBER	DESCRIPTION	DRAWN	CH'KD	APP'D	DATE
C	1799	MTL7765 WAS MTL765, MTL7766 WAS MTL766 ADDED NOTE 10	DLB		CGP	2/8/12
B	1799	WAS BELDEN 8777	DLB			9/23/11
A	N/A	RELEASED	MG		CGP	11/15/93

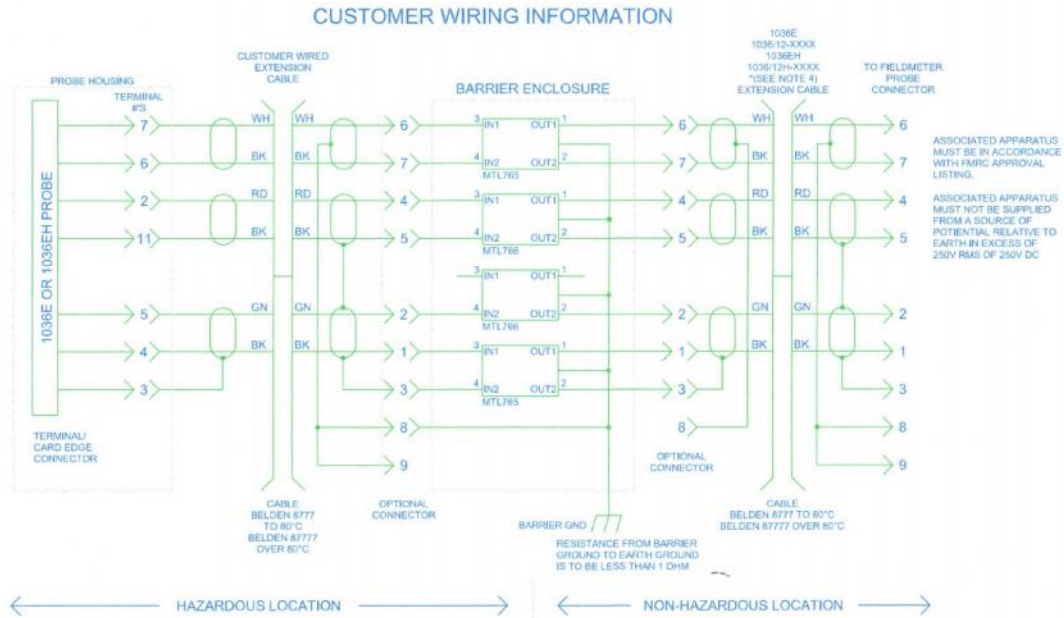
NEXT ASSEMBLY: N/A | SCALE: N/A | SHEET 2 OF 3
DRAWN: MG | DATE: 10/29/93
ELECTRONIC NAME: 1036_10-2.dwg | CH'KD: VAS | DATE: 10/29/93
COMPUTER NUMBER: N/A | APP'D: CGP | DATE: 8/31/94
TOLERANCES UNLESS OTHERWISE SPECIFIED: TWO PLACE DECIMAL ± .020, THREE PLACE DECIMAL ± .005, FRACTIONAL ± 1/64, ANGULAR ± 1°
MATERIAL: N/A

MONROE ELECTRONICS

MODEL 1036E/18 & MODEL 1036EH/18
CUSTOMER WIRING OUTLINE

DRAWING NO. 1036/10 | REVISION C

CUSTOMER WIRING INFORMATION



NOTES:
1) WIRE COLORS ARE FOR REFERENCE ONLY AND APPLY ONLY TO BELDEN 87777 OR 8777 CABLES.
2) THE ABOVE DRAWING SHOWS THE CABLE WIRING FOR EXTENSION CABLES WHEN USING A BARRIER AND THE CUSTOMER SUPPLIED EXTENSION CABLE.
3) THE CONNECTORS AT THE BARRIER ARE OPTIONAL.
4) THE -XXXX INDICATES THE CABLE LENGTH IN FEET WITH MAX. LENGHT 1000 FEET. (EX. 1036/12-0300 IS A 300 FOOT CABLE)
5) MTL SHUNT DIODE SAFETY BARRIERS MUST NOT BE SUPPLIED FROM A SOURCE OF POTENTIAL RELATIVE TO EARTH IN EXCESS OF 250V RMS OR 250V DC.
6) MAXIMUM TOTAL CABLE LENGTH IS 1000 FEET.
7) MAXIMUM CABLE PARAMETERS:
 - CAPACITANCE - 60 PICOFARADS PER FOOT
 - INDUCTANCE - 0.20 MICRO HENRIES PER FOOT
8) REFER TO APPARATUS INSTRUCTION MANUALS FOR WIRING CONNECTIONS.
9) THE PROBE AND MOUNTING MUST BE CONNECTED TO GROUNDED EQUIPMENT AND MUST NOT INTRODUCE A NEW GROUND INTO THE HAZARDOUS AREA.
10) PART OF THE ENCLOSURE IS CONSTRUCTED FROM PLASTIC. TO PREVENT THE RISK OF ELECTROSTATIC SPARKING THE PLASTIC SURFACE SHOULD ONLY BE CLEANED WITH A DAMP CLOTH.

NO REVISIONS CAN BE RELEASED WITHOUT APPROVAL FROM FACTORY MUTUAL.

MTL765	9002/77-150-300-00
MTL766	9002/22-240-160-00
MTL	R.STAHL INC.
EQUIVALENT SAFETY BARRIER	

REV	ECN NUMBER	DESCRIPTION	DRAWN	CH'KD	APP'D	DATE
C1		MTL765 WAS MTL7765, MTL766 WAS MTL7766	DLB		CGP	3/7/12
C	1799	MTL7765 WAS MTL765, MTL7766 WAS MTL766 ADDED NOTE 10	DLB		CGP	2/8/12
B	1799	ADDED 87777 CABLE AND TEMP	DLB			9/23/11
A	N/A	RELEASED	MG		CGP	11/15/93

NEXT ASSEMBLY: N/A	SCALE: N/A	SHEET 1 OF 3	MONROE ELECTRONICS
	DRAWN: VAS	DATE: 11/15/93	
ELECTRONIC NAME: C1_1036_10-1.dwg	CH'KD: TPM	DATE: 8/31/94	MODEL 1036E/17 & MODEL 1036EH/17
COMPUTER NUMBER: N/A	APP'D: CGP	DATE: 8/31/94	CUSTOMER WIRING OUTLINE
TOLERANCES UNLESS OTHERWISE SPECIFIED: TWO PLACE DECIMAL ± .020 THREE PLACE DECIMAL ± .005 FRACTIONAL ± 1/64 ANGULAR ± 1°			DRAWING NO.: 1036/10 — REVISION: C
MATERIAL: N/A			

APPENDIX II

INTRINSIC SAFETY BARRIERS

Model 1036E and 1036F Electrostatic Fieldmeter Probes meet Factory Mutual Research Corporation requirements for Class I, Division 1, Groups C and D hazardous locations when installed in accordance with the appropriate Monroe Electronics, Inc. control drawings included in this manual. Approved safety barriers must be used as shown in the drawings to comply.

Copies of the Factory Mutual Research Corporation report 1Q3A9.AX specific to these probes are available on request from Monroe Electronics, Inc.

Two manufacturers of IS barriers are currently approved:

MTL, Incorporated
8576 Wellington Road
PO Box 1690
Manassas, VA 22110-1690

www.mtl-inst.com
Tel. (703) 361-0111
Fax. (703) 368-1029

and

R. Stahl, Inc.
9001 Knight Road
Houston, TX 77054

www.rstahl.com
(800) 782-4357
(713) 792-9300
Fax. (713) 797-0105

Barrier requirements and recommended enclosures are shown in the tables below:

Number of Channels →	1	2	4	6	8	10	12	14	16
	Number of Barriers								
MTL 765	2	4	8	12	16	20	24	28	32
MTL 766	2	4	8	12	16	20	24	28	32
	Recommended Enclosures								
MT 5	1								
MT 12		1							
MT 24			1	1		2	2		
MT 32					1			2	2

Table 3 — MTL

NOTES for MTL Systems:

- Enclosures include barrier mounting hardware, tagging strips, etc. Labeled wiring ducts are included with MT 32.
- Listed enclosures are glass-filled polycarbonate with transparent lids. They are impact resistant, flame retardant and dustproof to IEC529:IP65.
- MTL will install barriers at no charge if supplied with position (sequence) information.
- "Internals" (everything that normally goes in an enclosure but no enclosure) are available.

Number of Channels →	1	2	4	6	8	10	12	14	16
	Number of Barriers								
9002/77-150-300-00	2	4	8	12	16	20	24	28	32
9002/22-240-160-00	2	4	8	12	16	20	24	28	32
	Recommended Enclosures								
S 806 NF-12	1	1							
S 1412 NF-25			1	1					
S 1412 NF-50					1	1	1		
S24H20BLP-80								1	1

Table 4 - R. Stahl

NOTES for R. Stahl Systems:

- Enclosures include mounting rails, insulating standoffs, ground terminals and labels.
- Listed enclosures are Hoffman NEMA-4.

Some National Fire Prevention Association (NFPA) publications dealing with the subject of Intrinsic Safety (IS) are:

- NFPA 497A - *Classification of Class I (Classified) Locations for Electrical Installations in Chemical Process Areas* (pamphlet)
- NFPA 497M - *Classification of Gases, Vapors and Dusts for Electrical Equipment in Hazardous (Classified) Locations* (pamphlet)
- NFPA 493 - *Intrinsically Safe Apparatus for Use in Division 1 Hazardous Locations* (pamphlet)
- NFPA 325M - *Fire Hazard Properties of Flammable Liquids, Gases and Volatile Solids* (pamphlet)
- NFPA 496 - *Purged and Pressurized Enclosures for Electrical Equipment* (pamphlet)
- *Electrical Installations in Hazardous Locations* by Peter J. Schram and Mark W. Earley - ISBN 0-87765-356-9 (book)

The above are available from:

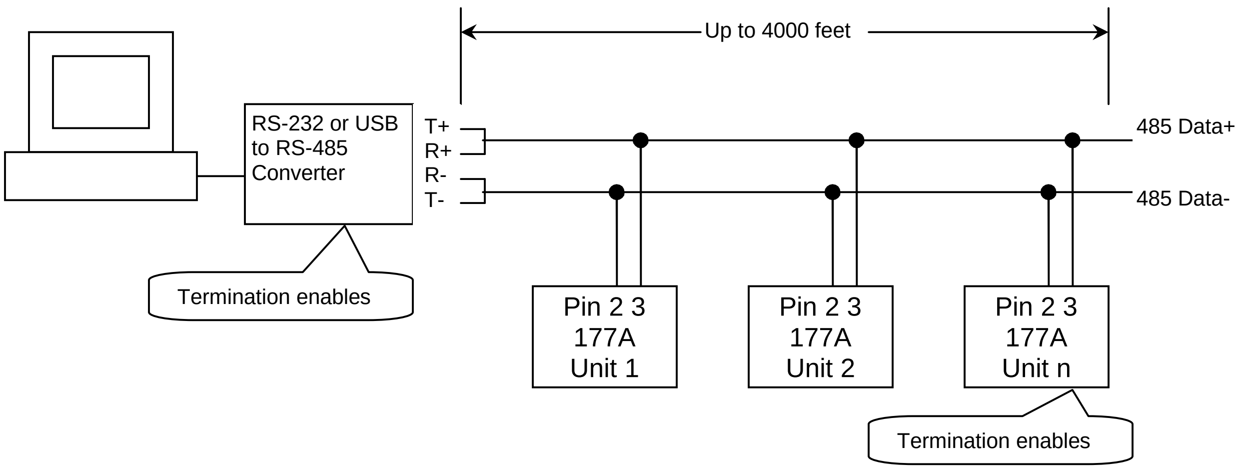
National Fire Protection Association
1 Batterymarch Park
PO Box 9101
Quincy, MA 02269-9101
Tel. (800) 344-3555

III.

RS-485 Half Duplex / Full (RS-422) Connection To 177A

RS-485 is a specialized interface that is very common in the data acquisition world. An RS-485 network can be connected in a 2 or 4-wire mode (bi-directional - half duplex - multi-drop Communications over a single or dual twisted pair cable). All the devices in the same network should be connected in daisy chain (see diagram below). Maximum cable length can be as much as 4000 feet.

RS-485 Half Duplex



Tools and procedures to setup the 177A units for RS-485 communication:

- Station ID, RS-485 and Terminator setup.
- RS-232 to RS-485 Converter.
- Cable

Station ID, RS-485 and Terminator setup: Each 177A on the same RS-485 bus must have its own unique ID (1-255). This can be set via ME177A software or from the front panel Setup. Baud rate is 9600 by default.

Setup RS-485 from the 177A front panel:

Press Key	Display(blinking)	Display Description
Setup	Lo	Front panel Lock
Up	SS	System Setup
Right	bAu	Baud rate
Down	IT	Interface Type
Right	+232	RS-232
Down	485 - HAF	RS-485 Half duplex
Enter		

Setup Terminator (continue from above):

Press Key	Display(blinking)	Display Description
Left	+485	
Down	TEr	Terminator
Right	on	Press up/down to select terminator on / oFF
Enter		

Setup Station ID (continue from above):

Press Key	Display(blinking)	Display Description
Left	IT	Interface Type
Down	Sn	Station number
Right	001	Enter station ID
Enter		

Setup RS-485 from ME177A software: Connect the 177A unit to the PC's comport. On the main entries screen, click on Get – Active Program. This leads to Program Setup screen. Click on [Hardware Config] button to go to the System Setup Screen. Enter the Station ID, Select Serial Type and Terminator. Click the [Send & Exit]

RS-232 To RS-485 Converters:
When connecting to the PC's comport, an RS-232 to RS-485 converter may be needed (see Diagram above). When connecting to the PC's USB port, an USB to RS-485 converter is needed (see Diagram above). The following device has been tested to use with 177A: VScom USB-COMi Adapter.

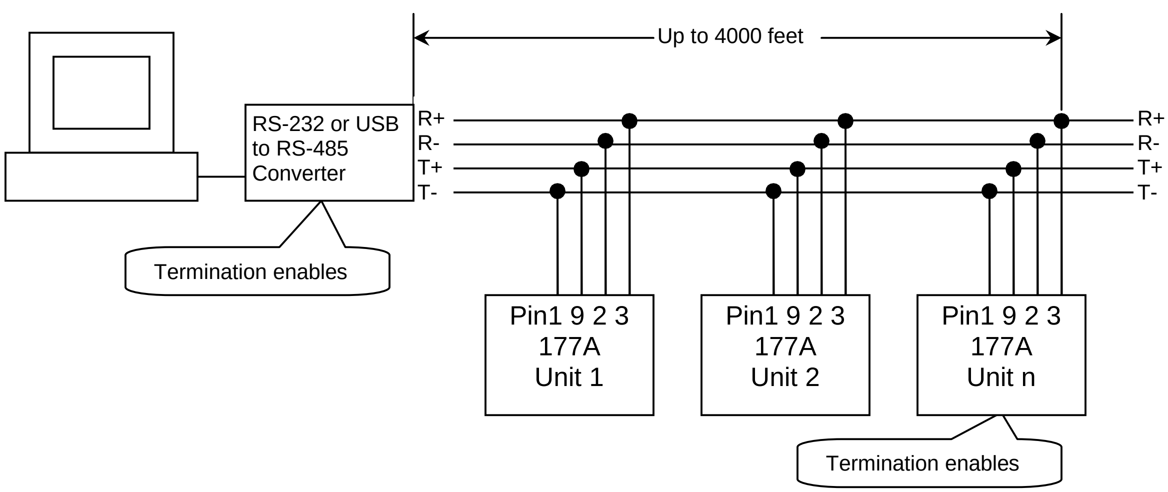
Connection to the 177A: Locate the DB-9 connecter on the back of the unit, connect the two wires to the 485 data as follows:

RS-485Bus		**177A DB-9**
Data+	→	Pin3
Data-	→	Pin2

For correct operation of the transmitter and the receiver, a return signal path between the grounding of individual devices is required. It may be realized either by a third wire, or by grounding each device (third pole in the mains socket).

Cable Selection For RS-485 Systems
Category 5 cable is available as shielded twisted pair (STP) as well as unshielded twisted pair (UTP) and generally exceeds the recommendations for RS-422 making it an excellent choice for RS-485 systems

RS-485 Full Duplex (RS-422)



Setup for the Station ID and Terminator is the same as setup RS-485 Half, see above for details.

Setup RS-485 Full duplex from the 177A front panel:

Press Key	Display(blinking)	Display Description
Program	Lo	Front panel Lock
Up	SS	System Setup
Right	bAu	Baud rate
Down	IT	Interface Type
Right	+232	RS-232
Down	485 - FuL	RS-485 Full duplex
Enter		

Connection to the 177A: Locate the DB-9 connecter on the back of the unit; connect the four wires to the 485 bus as follows:

RS-485Bus		**177A DB-9**
T-	→	Pin1
T+	→	Pin9
R-	→	Pin2
R+	→	Pin3

APPENDIX IV

Communication with ME 177A using MODBUS Protocol

Read Channel LEDs or Relays (read coil)
Write Channel LEDs or Relays (write coil)
Read Channel display (read register)
Write Channel display (write register)

<u>Read Channel LEDs or Relays (read-coil):</u>

From Master (PC software or PLC):

Unit#	Command	CoilAdrH	CoilAdrL	lenHigh	lenLow	crcH	crcL
1-255	0x01	0	0-24	0	1		

The request consisted of the unit# and the command code 01 followed by a 2 byte starting address, specifying the variable to be read.

Length high must be 0, length low is 1.

CoilAdrH is 0
CoilAdrL is as follows:

0	Channel 1 Alarm (red) LED
1	Channel 2 Alarm (red) LED
2	Channel 3 Alarm (red) LED
3	Channel 4 Alarm (red) LED
4	Channel 1 Warning (Amber) LED
5	Channel 2 Warning (Amber) LED
6	Channel 3 Warning (Amber) LED
7	Channel 4 Warning (Amber) LED
8	Channel 1 OK (Green) LED
9	Channel 2 OK (Green) LED
10	Channel 3 OK (Green) LED
11	Channel 4 OK (Green) LED
12	Channel 1 Alarm Relay
13	Channel 2 Alarm Relay
14	Channel 3 Alarm Relay
15	Channel 4 Alarm Relay
16	Channel 1 Warning Relay
17	Channel 2 Warning Relay
18	Channel 3 Warning Relay
19	Channel 4 Warning Relay
20	Channel 1 OK Relay
21	Channel 2 OK Relay
22	Channel 3 OK Relay
23	Channel 4 OK Relay
24	System Alarm Relay

177A reply to read coil:

Unit#	command	# of data	Coil Value	crcH	crcL
1-255	0x01	1	0=Off, 0xff=On		

Write Channel LEDs or Relays (write coil):

From Master (PC software or PLC):

Unit#	Command	CoilAdrH	CoilAdrL	New Value	0	crcH	crcL
1-255	0x05	0	0-24	0=Off, 0xff=On			

The request consisted of the Unit address and the command code 05 followed by a 2 byte starting address, specifying the variable to be set, a data byte, specifying the binary value to set (ON = 0xff, OFF = 0) and an additional byte always set to 0.

177A reply to write single coil is identical to the received packet:

Unit#	Command	CoilAdrH	CoilAdrL	New Value	0	crcH	crcL
1-255	0x05	0	0-24	0=Off, 0xff=On			

Read Channel display (read register):

From PC or PLC:

Unit#	Command	RegAdrH	RegAdrL	LenH	LenL	crcH	crcL
1-255	0x03	0	0-3	0	1		

RegAdrL is as follows:

0	Channel 1
1	Channel 2
2	Channel 3
3	Channel 4

177A reply:

Unit#	Command	# of data	dataH	dataL	crcH	crcL
1-255	0x03	1	##	##		

Write Channel display (write register):

From PC or PLC:

Unit#	Command	RegAdrH	RegAdrL	dataH	dataL	crcH	crcL
1-255	0x06	0	0-3	##	##		

177A reply to write single Register is identical to the received packet:

Unit#	Command	RegAdrH	RegAdrL	dataH	dataL	crcH	crcL
1-255	0x06	0	0-3	##	##		

Note:

If the Unit# is 0, the 177A units will execute the Write-Coil and Write-Register commands, but No reply.

The followings are examples of Read Channel command from PC to 177A, ID=1.
The command is 8-byte in length. They are in hex.

```
Read channel 1:
01  03    00  00     00  01    84   0A
ID  Cmd   Channel1            crcH crcL

Read channel 2:
01  03    00  01     00  01    D5   CA
ID  Cmd   Channel2            crcH crcL

Read channel 3:
01  03    00  02     00  01    25   CA
ID  Cmd   Channel3            crcH crcL

Read channel 4:
01  03    00  03     00  01    74   0A
ID  Cmd   Channel4            crcH crcL
```

\---

Example1: Reply from the 177A. It is 7-byte in length, shown in hex:

```
01  03   02               00     33         f8   51
ID  Cmd  2-byte data    dataHi dataLo     crcH crcL

01: Unit ID
03: Read channel command
02: two data bytes followed

00: data high byte
33: data low byte.  With the previous high-byte: 00 33 is
    the channel reading in hex. Its decimal value is 51.
    If the channel is set up for a 10kv probe, the display is 0.51.

f8: crc High byte
51: crc low byte
```

\---

Example2: Reply from the 177A. It is 7-byte in length, shown in hex:

```
01  03   02               fe     58          f9   de
ID  Cmd  2-byte data    dataHi dataLo     crcH crcL

01: Unit ID
03: Read channel command
02: two data bytes followed

fe: data high byte
58: data low byte.  With the previous high-byte: fe 58 is
    the channel reading in hex. Its decimal value is -424.
    If the channel is set up for a 10kv probe, the display is -4.24.

f9: crc High byte
de: crc low byte
```

\---

Application Note APNE-0003

Fieldmeter Measurement Techniques Using Monroe Electronics Model 1036 Probes

Monroe Electronics Model 1036 fieldmeter probes are calibrated (or, more correctly, "standardized") in a true uniform or homogeneous field. The calibration fixtures used are designed to produce parallel field lines.

As a true uniform field does not usually occur in most practical measurement situations, partly due to the introduction of the grounded probe itself, one must either:

1. Attempt to better the geometry by establishing a grounded plane, through which the fieldmeter probe can view the field under consideration,
2. Establish a correction factor for the data, or
3. Accept relative data. In many cases, this is perfectly acceptable practice once a fixed geometry is established.

Some guidelines are offered here.

During the standardization procedure, these probes are configured as shown in Figure 15 with the face of the probe flush with the bottom of the upper metal plate or "shroud" which is referenced at ground potential. This shroud effectively increases the area of the face of the probe. It and the surface under test (in this case, gradient plate) can be considered to be infinitely large as long as the size of the plates exceeds 5 or 6 times the distance between the plates.

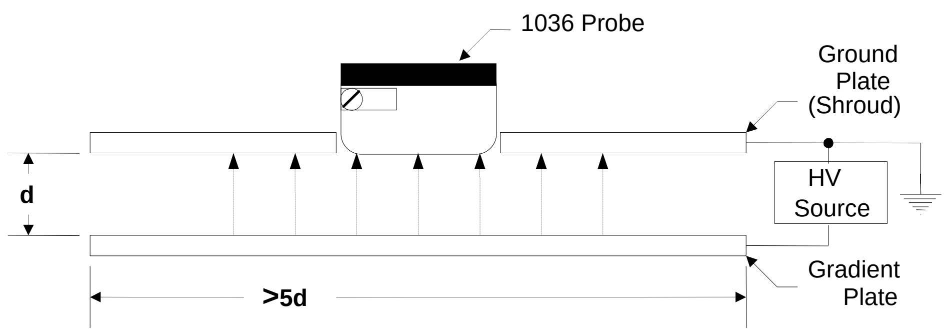


Figure 15

Please note that the diameter of the face of the Model 1036F probe is approximately 1½ inches. The face of the Model 1036E is 4¼ inches by 2¾ inches. Either probe type used on its own without a shroud will tend to perturb a field as shown in Figure 16.

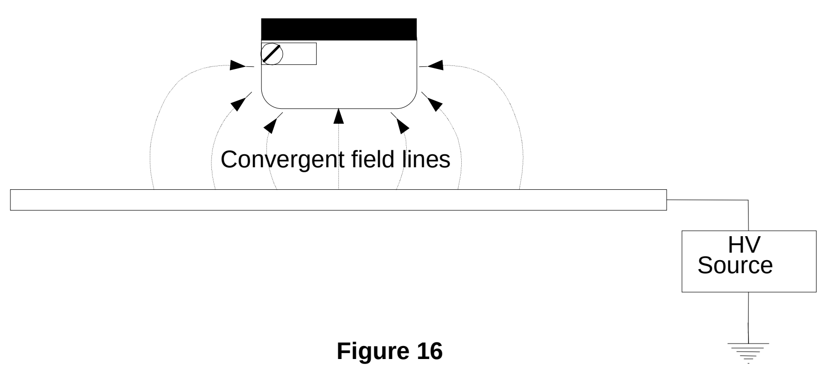


Figure 16

Convergent field lines such, as these tend to “enhance” the measurement and cause the apparent field strength to increase, thus producing a high reading. Although this may be relatively inconsequential where a direct measurement of surface voltage is desired — for example, where a probe whose specified sensitivity is 10kV/cm is being used at 1cm to produce an indicated full scale value of up to 10,000 volts — given a large enough surface and a properly sized shroud, that same probe could be used to produce a measurement of surface voltage up to 100,000 volts at 10cm with fairly good accuracy.

Tests performed in our laboratory produced the following:

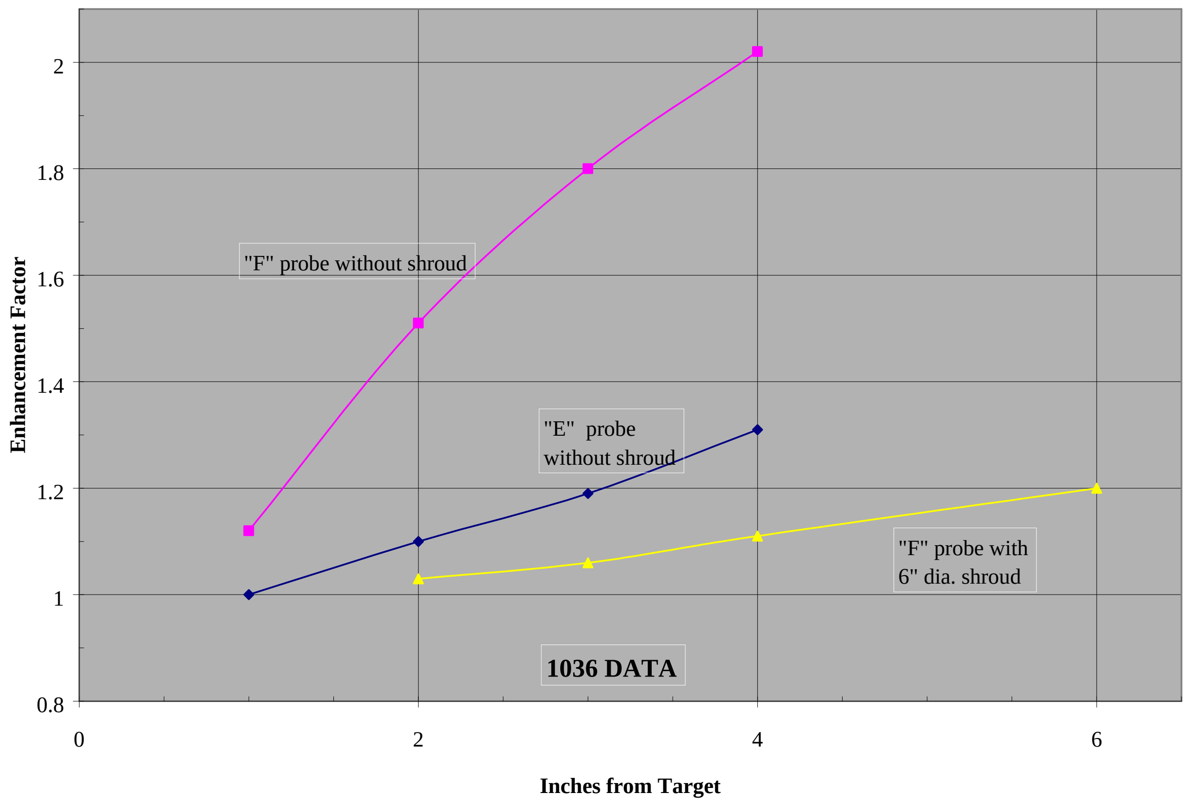


Figure 17

Some conclusions may be drawn from the data shown in Figure 17 :

1. An "F” probe produces a reading about 12% high with no shroud at 1" (25mm) and about double at 4" (100mm).
2. When provided with a 6" diameter shroud, the error drops to fewer than 10% at spacings of up to almost 4".
3. A shroud is unnecessary on an "E" probe at 1" or less and would produce the same improvement as with the "F" probe at greater spacing.
4. As a general rule of thumb, a shroud (or the size of the face of the probe) should be about 1½ times the spacing to keep errors to about 10% or less.

APPLICATION NOTE APNE-0014
Electrostatic Charging In Web Converting

Table of Contents

IV.

I. Introduction

Why Is It Important To Understand, Measure And Control Static Electricity In Web Coating, Converting, And Printing?

Statically charged materials on the converting machine, the web, or both may attract or repel the web to itself or to the machine. This material misbehavior can adversely affect the manufacturing process by causing jams and downtime, reduced productivity, and/or poor product quality.

Static on the web can attract contamination such as dust and other particulates, resulting in coating or printing defects.

Static shocks received by operators can cause dangerous physical reactions by the persons receiving the shocks, possibly resulting in injuries or death from moving machinery.

Static sparks in hazardous operations such as solvent-based coating or printing can cause fires and explosions, possibly resulting in injuries or death to people, destruction of the equipment or facility, and lost production.

Overall Review Of Static Generation, Measurement, And Continuous Control Of Static In Web Handling Operations

This document provides the reader with a review of web static charging mechanisms, web and machine factors most involved in static charging, typical locations of web static charging, and techniques to minimize web charging.

Generation and control of static in web converting depends upon many varying conditions in the web material, the converting machine, the surrounding atmosphere, and the static control measures used on the machine. It is impossible to predict and control all of these conditions because they can change without one realizing it until a statically caused event occurs. Changing conditions can alter the amount of static charge accumulation, so although static is under control today, it may not be under control tomorrow.

The keys to continuous static control are (1) the correct determination of critical areas of the machine to monitor for static charge accumulation, (2) application of static countermeasures and devices that prevent or control static charge accumulation, and (3) continuous electric field measurement in these critical areas using permanent fieldmeters, which are alarmed to warn or shutdown the operation when web static charge levels increase beyond predetermined set points.

II. How Electrostatic Charge Builds-Up on a Moving Web

Electrostatic Charging On A Web Converting Machine

Electrostatic charging can occur in several different ways, but for the purposes of this document, we will limit our discussion to contact and separation (triboelectric) charging between two surfaces. Triboelectric charging is a surface event that occurs when two surfaces are brought together and then separated or rubbed against each other (friction).

Different materials have different abilities to hold onto their free electrons (work function). During contact and separation of materials, one material will give up free electrons to the other, resulting in a net positive charge on one material and a net negative charge on the other material. Of the two materials, the material with the lower work function gives up electrons to the other material and becomes positively charged. The material with the higher work function takes electrons from the other material and becomes negatively charged.

Theoretically, if two surfaces are chemically and mechanically identical in structure and surface finish on an atomic or molecular level, then their work functions will be identical. When they are separated or rubbed together, no charge transfer will take place. Unfortunately, real materials are seldom completely pure, and they often have surface finishes and/or contamination that strongly influence their charging characteristics. Unwinding a roll of plastic sheeting can demonstrate this by sparking where the sheet separates from the roll, and by static attraction of contaminants to the sheet after separation. See Figure IV-1.

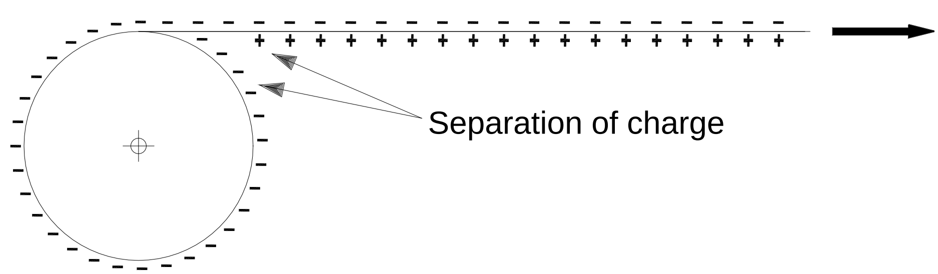


Figure IV-1

Unwinding Roll of Plastic Sheeting

Table IV-1 is a short triboelectric series that provides an indication of the order of some common materials. The way to use a triboelectric series is to note the relative positions of the two materials of interest. The material that charges positively will be the one that is closer to the positive end of the series, and the material closer to the negative end will charge negatively.

Asbestos	**most positive**
Glass	⇑
Nylon	
Wool	
Lead	
Silk	
Aluminum	
Paper	
Cotton	
Steel	
Hard rubber	
Nickel & copper	
Brass & silver	
Synthetic rubber	
Orlon	
Saran	
Polyethylene	
Teflon	⇓
Silicone rubber	**most negative**

Table IV-1

Triboelectric Series

If only one surface has a significant electrical resistance while the other surface is a good electrical conductor, most of the charges still will not be able to return to their original surface. This again leaves an excess of positive charges on one surface and an excess of negative charges on the other. Under this condition, however, the surface charges on the conductor can freely move throughout the conductive body. Unless this charged conductive body is able to obtain opposite polarity charges from ground to remain electrically neutral, it is isolated (a charged capacitor) and can become a static spark hazard.

Factors That Most Affect Triboelectric Charging

Contact Pressure: Increased pressure increases contact area by reducing the air gap between surfaces.

Contact Time: Increased contact time can increase charge transfer by enlarging the contact area.

Draining Velocity: The speed at which charges travel along the web toward recombination. It is relatively constant and independent of parting velocity, but is directly related to web front/back surface and bulk conductivity. Net charge builds on a web when parting velocity is greater than draining velocity.

Electric Field: The electric field generated at the location where the surfaces separate may provide enough force to affect the return of charges to their original surfaces.

Humidity: As humidity is increased, generally material conductivity increases, and charge accumulation decreases due to charge backflow.

Particulate Contamination: Dust and other particulates on surface layers affect surface chemistry and contact area, which affect charging.

Parting Velocity or Separation Speed: Affects the time electrons have available for returning to their original surface. Generally, the faster the surfaces are separated the more charge is left on the surfaces.

Slip (or Slide): Causes frictional charging due to relative motion between surfaces. This can also cause transfer of actual material from one surface to the other, which will affect charging as well.

Surface Hardness: Soft surfaces make contact that is more intimate and tend to cause more charging during separation.

Surface Layer Chemistry: Affects how charging takes place when surfaces of differing work functions contact each other.

Surface Roughness: Charge transfer decreases as surface roughness increases due to less contact area between the surfaces.

Temperature: Elevated surface temperatures usually result in increased charge transfer due to higher molecular energy levels as well as to decreased surface moisture films.

Locations Of Charge Transfer In Web Converting Machines

When the web is wound into roll form, the face and back are in contact. So charge transfer can occur during unwinding (see Figure IV-1 for example). Surface chemistry and intimacy of contact are important factors here. Sometimes "charge balancing" is attempted by chemists who add surfactants and other chemicals to the surfaces to control front-to-back charging. In addition, the more intimate (greater) the contact between layers, the more charge is transferred. Intimacy is influenced by such factors as surface hardness, roughness, thickness, force concentration, and winding tension. Roll history (moisture changes, temperature changes, winding tension) can be an important factor because it may affect conductivity or contact area.

Corona discharge treatment (CDT) is applied to the web in some converting processes. CDT treatment is used to increase the web’s ability to accept coating or printing layers. Because CDT purposely generates large quantities of ions to alter the web’s physical characteristics, high charges are also left on the web, which then must be reduced or eliminated.

Webs and rollers exchange charge because of differences in material properties. The factors that we saw above translate into the following factors in a coating, converting, or printing machine:

Roller bulk conductivity and surface conductivity

Roller surface chemistry (material and contamination)

Roller surface roughness, texture, and venting

Roller/Web alignment and tracking

Roller/Web frictional drag (bearing failure)

Roller/Web intimacy of contact (surface hardness or compliance)

Roller/Web wrap angle

Web bulk conductivity and front/back surface conductivity

Web slip and weave

Web speed and tension

Web surface chemistry (material, antistatic agents, surfactants and contamination)

Web surface roughness and texture

Any other object that the web touches, such as turning bars, splice board, and the operator's hand, can also cause charge transfer.

High electric fields that occur at the separation of surfaces, such as at the nip of unwinding rolls or roller/web contacts, can result in corona discharges (glow). Corona discharges produce ions of both polarities that tend to reduce the overall web charge. Static control devices (passive or active ionizers) ionize air in order to control charges on the web by attracting opposite polarity air ions to neutralize the charges on the web.

Strong electric fields on insulating surfaces in the converting machine can charge ungrounded conductors (including people) by induction, especially at wind-up and delivery areas. These charged conductors could then release dangerous sparks to any other nearby conductor.

Typical Web Charging Scenario

If we select values of the above factors and hold them constant while allowing the web and roller to make multiple identical contacts, the charge that is transferred follows an exponential charging relationship versus time. The web charge density then gradually approaches equilibrium at velocity V.

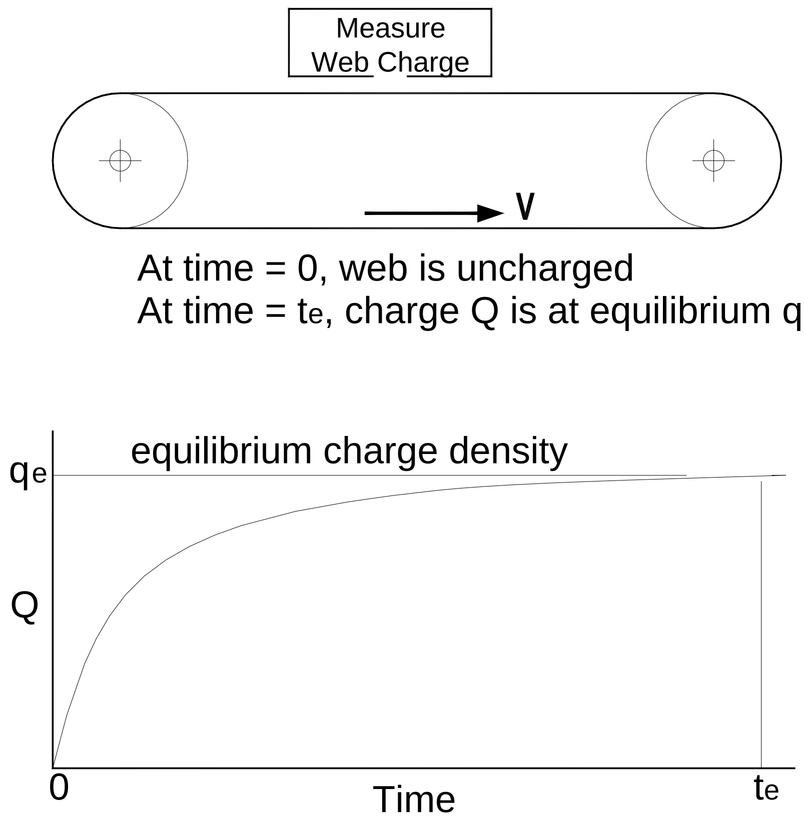


Figure II-2

Typical Roller/Web Charging Scenario

Techniques To Minimize Web Charge And How They Work

As much as possible, control the factors that govern charge transfer from objects (e.g. rollers, web laps) to the web. Usually, not all factors are known and/or controllable. Some general guidelines for reducing web charge transfer can be given, but they may be product and process dependent.

- Electrically ground all conductive machine parts including rollers (use conductive bearings and conductive bearing lubricants) to eliminate dangerous sparking from capacitive discharges to another conductor such as a person or metal. Please note that grounded conductive rollers cannot reduce charges of insulating web surfaces that pass over them! The purpose of grounding the rollers is to prevent the rollers from becoming highly charged.
- Maintain web-converting machines in excellent condition, making sure rollers are in alignment and turning freely.
- Use web substrates and coating materials that are conductive or dissipative, or can be made so before converting begins with the addition of antistatic agents.
- Use web substrates that were manufactured, wound, and packaged in environments with 50% or higher relative humidity (RH).
- Control RH in the web converting machine environment to 50-55%. Higher levels can cause iron and steel parts to rust, and may be uncomfortable to operators working in the area. In building areas with uncontrolled humidity, increased static charging is usually very dramatic during the winter when RH in heated buildings can frequently drop to less than 10%.
- If possible, avoid using pinch drive rollers. If they must be used, minimize the pinch roller pressure and tackiness.
- Reduce machine speed and web tension as much as practical.
- Increase web and roller surface roughness as much as practical.
- Clean machine rollers frequently. Web/roller electrification can be affected by previous products because of web material transfer to the rollers.
- Control drying conditions of web coatings to as low a temperature, and as high a relative humidity, as practical.
- Cover conductive rollers only with sleeves made of conductive or dissipative material. Large amounts of charge can be stored at the interface of resistive sleeve material and a conductor, which can be released in very hazardous sparks either spontaneously or when approached by a person (conductor).

Use passive and/or active ionization devices to reduce web charge density. If properly installed in the correct locations, it may be possible to initially control all static problems on the web-converting machine using ionization. Over time, though, the effectiveness of all these devices will degrade, and they will have to be cleaned, maintained, or replaced to return their effectiveness to original condition. The proper operation and effectiveness of ionization systems can be verified by continuous downstream monitoring using permanent installations of Monroe Electronics Model 177A fieldmeters with Monroe 1036 fieldmeter probes.

The application note, *ANPE-0015 Electric Fields and Fieldmeters*, deals with the practical issues of measuring and interpreting electric fields with the Monroe Electronics Models 265A and 282 handheld fieldmeters to determine where continuous monitoring is necessary.

V. Continuous Static Control

Control of static is not something that occurs once and can then be forgotten. It requires the implementation of continuous procedures such as charge neutralization using ionizers with electric field monitoring using permanent fieldmeters and probes to verify that the ionizers are working effectively.

Passive Ionizers

Passive ionizers connected to ground (e.g. tinsel, conductive brushes) rely on the electric field produced by the charge on the web to produce positive and negative ions by corona discharge. Passive ionizers feature points that concentrate the electric field to produce field strengths that, when they exceed the dielectric breakdown strength of air (30,000 volts per centimeter, V/cm), produce positive and negative air ions at the points. Passive ionizers rely on the electric field from the web to pull these air ions to the web to partially neutralize the charges on the web. Since passive ionizers rely on the electric field from the web to produce ionization, they are not very effective at field strengths below 1000 V/cm, but become very effective at higher field strengths. The effectiveness of passive ionizers also depends on point cleanliness and sharpness, number of points per unit area, distance from the web, web span length, and proximity to other conductors.

Electric Powered Active Ionizers

Electric powered active ionizers produce corona discharge ionization by applying a high voltage to geometrically arranged emitter elements. Ionizers made for reducing web charge use AC voltage, producing large amounts of both negative and positive air ions, or DC voltage producing only one polarity of air ion.

Various designs are used, depending upon the ionizer’s purpose, but the high voltage emitter elements are usually needle points or thin wires. Operating details vary with different designs, but, as with passive ionizers, they rely on the electric field from the web to pull opposite polarity air ions from the emitter elements to the web for charge neutralization. Since they do not rely on the electric field from the web to produce ionization, they are effective at all but the highest field strengths. Some models use blowers or compressed air assistance to drive ions further distances toward the web. The effectiveness of active ionizers also depends greatly upon their design, their operating voltage, the web speed, point cleanliness and sharpness, web span length, distance from the web, and proximity to conductors.

Some electronic ionizers claim to be able to monitor the charge on the web. These ionizers monitor their own ion current. They provide an indication of the performance of the ionizer. They are not true monitors of the charges on web materials, and are not a replacement for electrostatic fieldmeters that are placed downstream of the ionizers to monitor web charging.

Radioactive (Nuclear) Powered Active Ionizers

Nuclear ionizers use radiation (α or β particles) that strip electrons from air molecules to make both positive and negative air ions. The air ions are attracted to the web by the electric field produced from the charge on the web. These ionizers usually can’t produce as many ions per unit time as do electric powered ionizers. Since there is a specific amount of radioactive material in each device and radioactive decay occurs independent of process variables, the rate of ion production is not controllable and is independent of the amount of charge on the web. For example, Polonium 210, a Beta emitter, has a half life of 138 days, at which time its ion production is reduced by half.

Nuclear ionizers do not employ the use of high voltage to create air ions. Therefore, they do not create a threat of explosion or fire when used with solvents-based coating or printing applications.

Nuclear ionizers are a controlled device subject to licensing and regulation.

Key To Continuous Static Control

The keys to continuous static control are: (1) Correct determination of critical machine areas to (2) monitor continuously. Then (3) implement static control devices and continuous electric field measurement in these critical areas using permanent fieldmeters which are (4) alarmed to warn or shutdown the operation when web static charge levels increase beyond predetermined set points.

APPLICATION NOTE APNE-0015
Electric Fields and Fieldmeters in Web Converting

VI.

Table of Contents

VII. I. Introduction

Content

This document provides the reader with a review of how fieldmeters operate to measure electric fields, the effects of web-converting machine geometry and operator techniques when measuring electric fields, how handheld fieldmeters are used to investigate where static problem areas exist on machines, and techniques for interpreting fieldmeter readings.

This document is the second in a series of three application notes about static charging of materials and equipment in web converting machines, including recommendations for static measurement, control, and continuous monitoring. The first document in this series is application note *APNE-0014 Electrostatic Charging In Web Converting*.

Review

Generation and control of static in web converting depends upon many varying conditions in the web material, the converting machine, the surrounding atmosphere, and the static control measures used on the machine. It is impossible to predict and control all of these conditions because they can change without one realizing it until a statically caused event occurs. Changing conditions can alter the amount of static charge accumulation, so although static is under control today, it may not be under control tomorrow.

The keys to continuous static control are

1. The correct determination of critical areas of the machine to monitor for static charge accumulation,
2. Application of static countermeasures and devices that prevent or control static charge accumulation, and
3. Continuous electric field measurement in these critical areas using permanent fieldmeters, which are alarmed to warn or shutdown the operation when web static charge levels increase beyond predetermined set points.

VIII. II. Electric Fields and Fieldmeters

Electric Field

An electric field is a region of space characterized by the existence of an electric force (*F*) generated by an electric charge (q). The electric force *F* acting on a charge *q* in an electric field is proportional to the charge itself. The relationship of these quantities is expressed by the electrostatic force law [1]:

$$F = qE$$

E is called the electric field strength and is determined by the magnitude and locations of the other charges acting upon charge *q*:

$$E = F/\boldsymbol{q}$$

The electric field strength, *E*, is usually displayed in the unit of volt/meter (V/m), volt/centimeter (V/cm) or volt/inch (V/in).

Electric Fieldmeters

Charge is often difficult or impossible to measure directly. We rely on detection and measurement of the electric field from the charged object to determine the existence of the charge and to estimate its magnitude. The electrostatic fieldmeter is the instrument that measures electric field strength.

Electric field strength measurements can be difficult to measure and interpret correctly because of several factors that can affect the electric field itself or affect the measurement of the electric field. Guidance is given in this document to help understand or minimize the effects of these factors, and to otherwise correctly interpret electric field measurements.

Fieldmeters measure the electrostatic field (voltage per unit distance) at the aperture of a grounded probe. Ideally, a uniform electric field is established between a charged surface and a grounded surface. The grounded surface may be the grounded surface of the fieldmeter probe, or the fieldmeter probe may also be placed in the plane of a grounded surface (better). The electric field is set up between the grounded surface and the charged surface some distance, D, away. Fieldmeters are calibrated at a particular distance, such as V/inch or V/cm. Therefore, using the manufacturer's calibrated distance (one inch or one centimeter) makes the measurement easier to interpret. Probe-to-surface separation should be carefully controlled for accurate measurement.

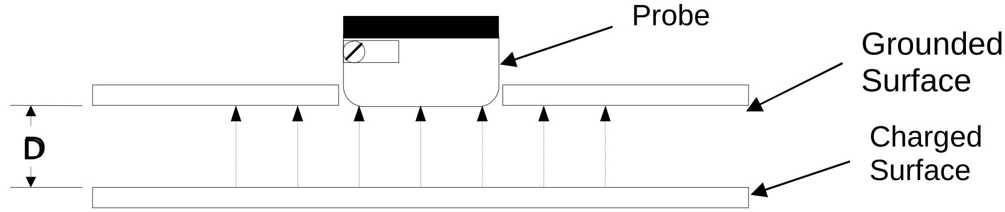


Figure II-1

Probe-to-Charged-Surface Separation, D

Monroe Electronics' electrostatic fieldmeters use a feedback-driven, null seeking design to assure accurate, drift-free, non-contacting measurements. Accuracy is typically 2% to 5% in a carefully controlled geometry.

Figure II-2 illustrates a Monroe Electronics Model 1036 fieldmeter probe in simple graphical form. This particular fieldmeter is a chopper-stabilized design that operates reliably in both ionized and non-ionized environments. The probe can be physically located at the desired measurement location, while the instrumentation portion of the fieldmeter is remotely located. Because of its 'intrinsically safe' (IS) rating, the probe can operate continuously in hazardous (explosive) environments provided that it is installed according to Monroe Electronics' instructions, and used with the approved intrinsic safety barriers.

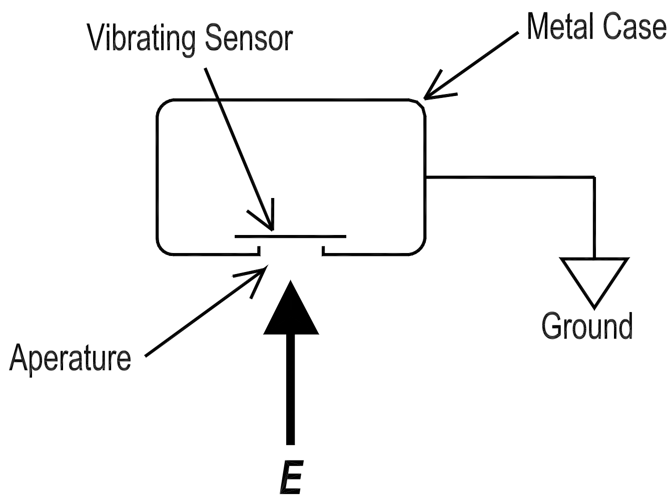


Figure II-2

Monroe Model 1036 Fieldmeter Probe

Electrostatic fieldmeters measure electric field strength by non-contacting means. All the charged objects, voltage sources, and grounded conductors (including the fieldmeter probe housing) in the general area affect the electric field strength measurement. The fieldmeter measures the electric field strength only at its aperture. It does not have a viewing angle and it does not see the web or object directly in front of it as a separate entity. This can be demonstrated by measuring the electric field of an insulating sheet with a hole in it.

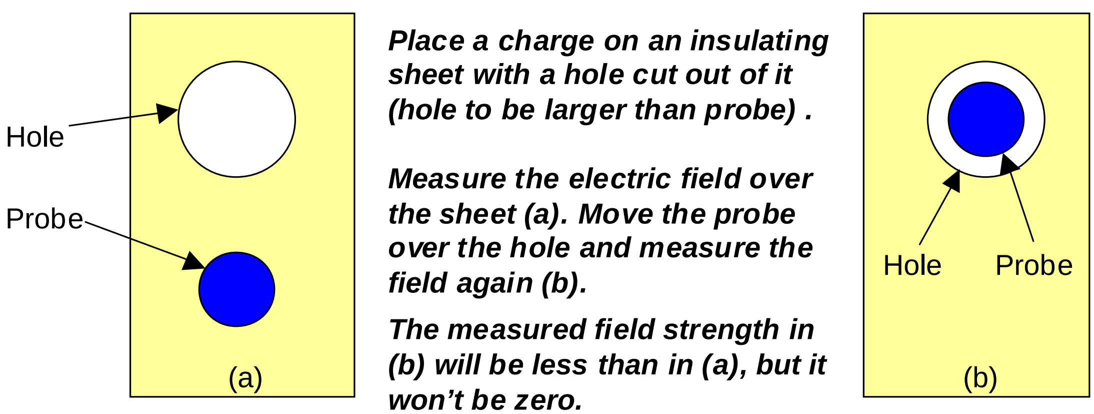


Figure II-3

Insulating Sheet Electric Field Demo, Top View

The field over the hole will not be zero even though there is no charge directly in front of the probe head. This is because the electric field at the probe aperture is a function of each charge on the sheet, and is also a function of the concentration of field due to the grounded probe itself.

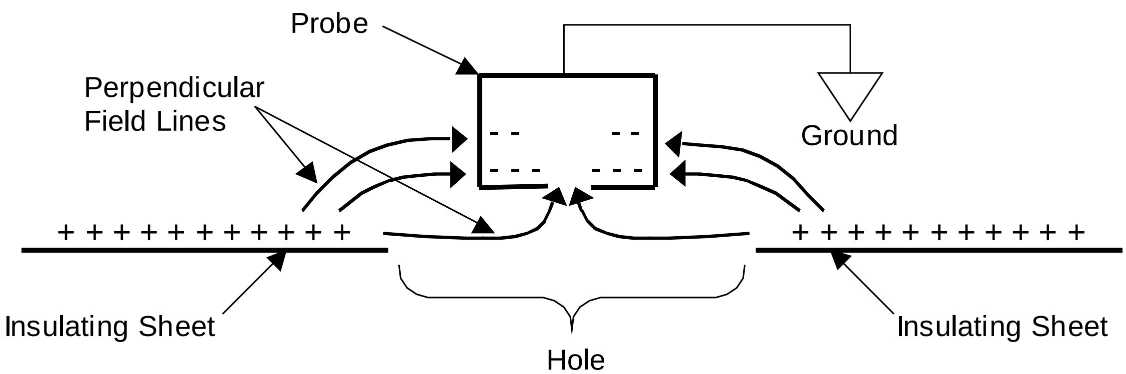


Figure II-4

Insulating Sheet Electric Field Demo, Front View of Figure II-3(b)

Effect of Probe Type On Fieldmeter Readings

For measurement of insulating web surfaces, it is best to maintain the same distance from the fieldmeter to the web as when the fieldmeter was calibrated. Since most fieldmeters are calibrated at one inch, their apertures should be positioned one inch from the web while measurements are taken. Accurate readings can be obtained using the Monroe Electronics 265A and 282A handheld fieldmeters as-is, provided the web is wide enough and there are no nearby grounds or other charged surfaces to influence the electric field.

The situation is more complex for the Monroe Electronics Models 257D and 177A fieldmeters, which both use the Model 1036 probes[3]. The Model 1036 probes are primarily used for permanent installations once the high-field locations have been determined using one of the handheld meters. The Model 1036E probe will give accurate readings (as-is) at a measurement distance of one inch because its large grounded face helps to create a uniform electric field near the aperture of the probe.

The Model 1036F probe is significantly smaller than the Model 1036E probe. Unless a grounded shroud is used to enlarge the smaller ground plane of the 1036F probe, the fieldmeter readings will be about 12% high because the electric field will converge on the small probe[3]

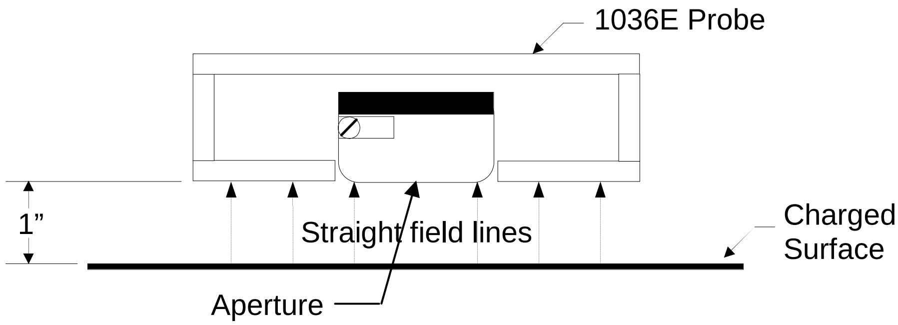


Figure II-5

Field Lines Straight to 1036E Probe

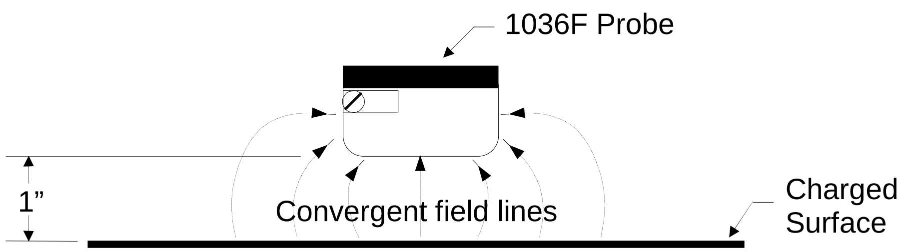


Figure II-6

Field Lines Converging to 1036F Probe

Investigation of High Electric Field Problem Areas with Handheld Fieldmeters

Unless the humidity of a web converting machine area is controlled to 50-60% RH, the highest electric fields tend to be found during 'worst case' humidity conditions such as the driest winter months. The typical indoor humidity of industrial buildings is usually less than 15% RH during these periods, and the opportunity of obtaining the most meaningful electric field data is at its best.

It may already be apparent where high electric field problem areas exist on a web-converting machine due to previous incidents such as fires, shocks to people, web transfer problems and/or poor product quality. However, new problems areas may appear due to changes in raw materials, environmental conditions, machine mechanical components, etc. The locations and electric field strength of problem areas should be determined and recorded using portable fieldmeters.

Monroe Electronics manufactures portable fieldmeters that are capable of easily and accurately determining high-field problem areas. Two fieldmeters that are recommended for surveying web converting machines are the Monroe Electronics Models 282A and 282IS. (See also Application Note *APNE-0012, Comparison of Monroe Electronics' Handheld Fieldmeters*.)

For accuracy, ease of use, and **flammable atmospheres**

The Monroe Electronics Model 282A Digital Stat-Arc 3™ Electrostatic Fieldmeter features the highest available accuracy (5%) and voltage resolution (10 volts) in a hand-held fieldmeter. The Model 282A also features a ranging system, consisting of two pulsing LED's, that show the operator when the fieldmeter is being held one inch from the target surface. It includes a HOLD button to capture and hold the readings made at locations where the display cannot be viewed during the measurement. An intrinsically safe version of the Model 282A, which is the Model 282IS, is rated for use in many hazardous environments.

Both the Model 282A and 282IS are chopper stabilized for drift-free operation, even in ionized environments.

™ StatArc is a registered trademark of Monroe Electronics, Inc.

Effect of Operator Presence on Fieldmeter Readings

Fieldmeters are calibrated in fixtures without a person holding them, so the effect of the grounded operator holding the fieldmeter probe while taking measurements must be minimized. For best results, handheld fieldmeters, such as the Monroe 265A and 282A, should be held by the operator's outstretched arm and away from the body so as to minimize the effect of the body on the measurement. The fieldmeter should be held in such a way that the fieldmeter is closer to the web than is the arm or body of the operator.

Taking Handheld Fieldmeter Measurements

Several factors must be considered before and during the measurement process to obtain accurate readings for analysis. Figure II-7 below and the decision chart that follows provide the necessary guidance.

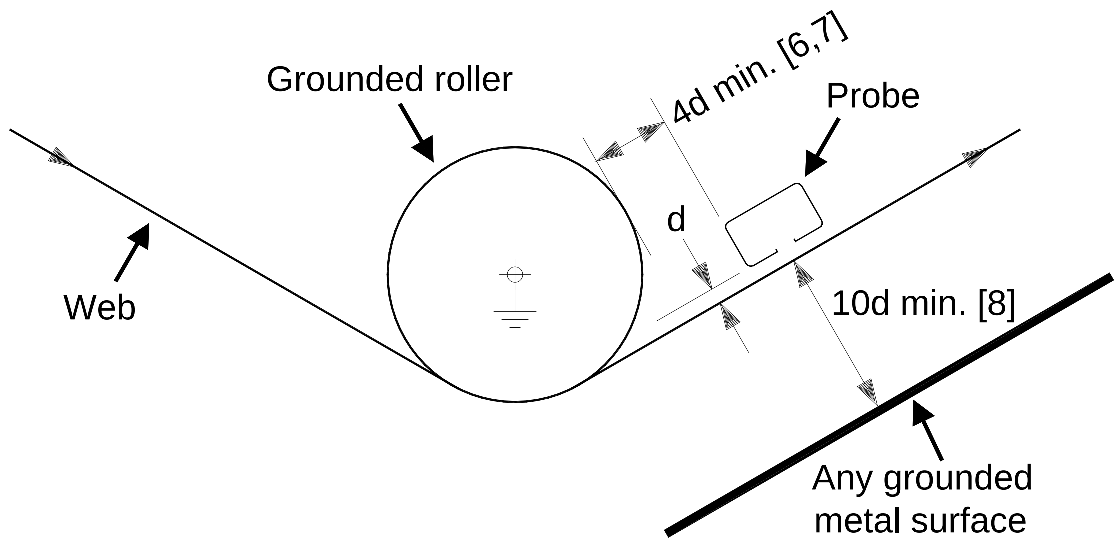


Figure II-7

Minimum Distances of Probe to Grounded Rollers and Surfaces

Notes on using the simple "net charge" static survey decision chart:

Decision Chart Page 1:

All insulating materials are 'transparent' to electric fields, so it is not possible to distinguish on which side of an insulating sheet the charges are located (when measured in free space) [4]. Only the average charge (net charge) can be measured by a fieldmeter. Fortunately, net charge is usually the quantity we are looking for on a charged insulator.

"Bound" charges within the volume of the insulator are also included in the net charge measured by the fieldmeter. Bound charges are most likely to be generated by:

Different chemical and/or mechanical properties of the starting web top and bottom surfaces.

Conductive layer(s) placed on or inside the web, as with metal foil coatings.

Corona discharge treatment (CDT) of the web at any time during its life cycle.

Pinch roller operation, as when the web runs over a metal gravure cylinder with a rubber impression roller applying pressure to the cylinder.

One must be careful that a high ‘bound’ charge is not captured within the insulator, lest a condition for highly energetic propagating brush discharges be established [4,9].

Bound charge investigation requires the use of a properly shielded electrostatic voltmeter (see www.monroe-electronics.com/esd_pages/voltmeters.htm) in addition to a fieldmeter, and is best left to an expert.

Decision Chart Page 2:

Typical locations for verifying low web fields are at hazardous operations such as rotogravure solvent printing. Measure electric fields after the last grounded roller (or after any ionizer), but before the gravure printing roller, and then after the gravure roller (or after any ionizer), but before the next grounded roller.

High fields that are causing electrostatic discharges (ESD) in a moving web-converting machine can be quickly located by moving along the machine holding a portable AM radio tuned off-station in an unused frequency band. The static heard over the speaker or headphones will increase near the ESD locations, and may produce a discrete popping noise. The radio picks up the static discharges because they generate broadband electromagnetic radiation.

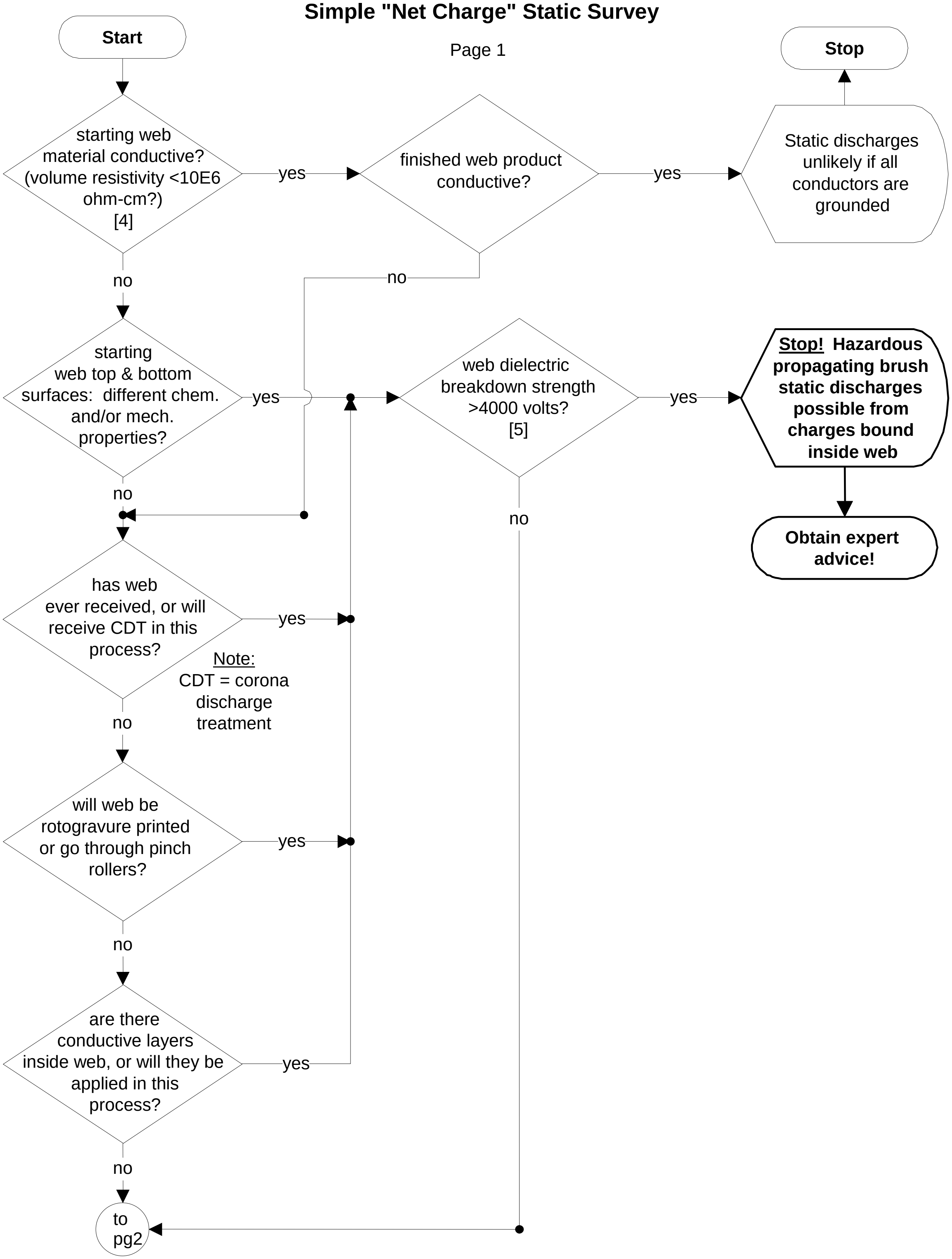
Decision Chart Page 3:

For fields beginning to exceed ±20kV/in on the Model 282A fieldmeter, move the Model 282A to four inches from the web and observe the reading. Multiply the reading by a factor of two to obtain the actual field strength, up to ±40kV/in. If the reading on the 282A begins to exceed ±20kV/in at four inches, back off to 6.5 inches and multiply the reading by 3 to obtain the result, up to ±60kV/in. If the reading on the 282A begins to exceed ±60kV/in at 6.5 inches, back off to 8.5 inches and multiply the reading by 4 to obtain the result, up to ±80kV/in.Keep in mind that the available web target size specified in Note 5 needs to increase by a factor of 4 times d.

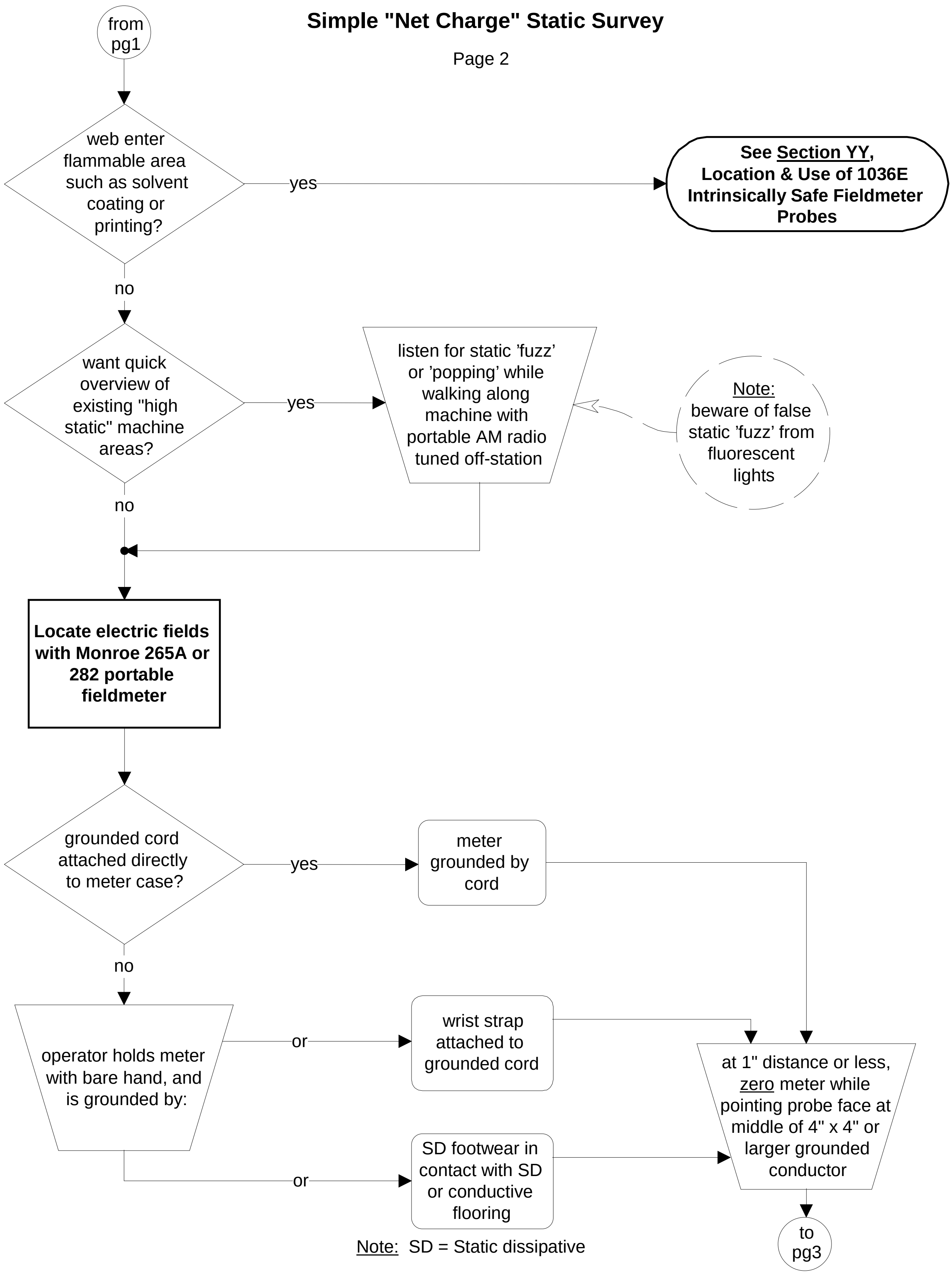
For both the 282A and 282IS fieldmeters, the minimum distances shown in Figure II-7 must increase by the indicated factor times the measurement distance, d (Note 1 & Note 2). These minimum distances must be maintained to prevent conductive, grounded surfaces from suppressing the electric field.

Simple "Net Charge" Static Survey

Page 1



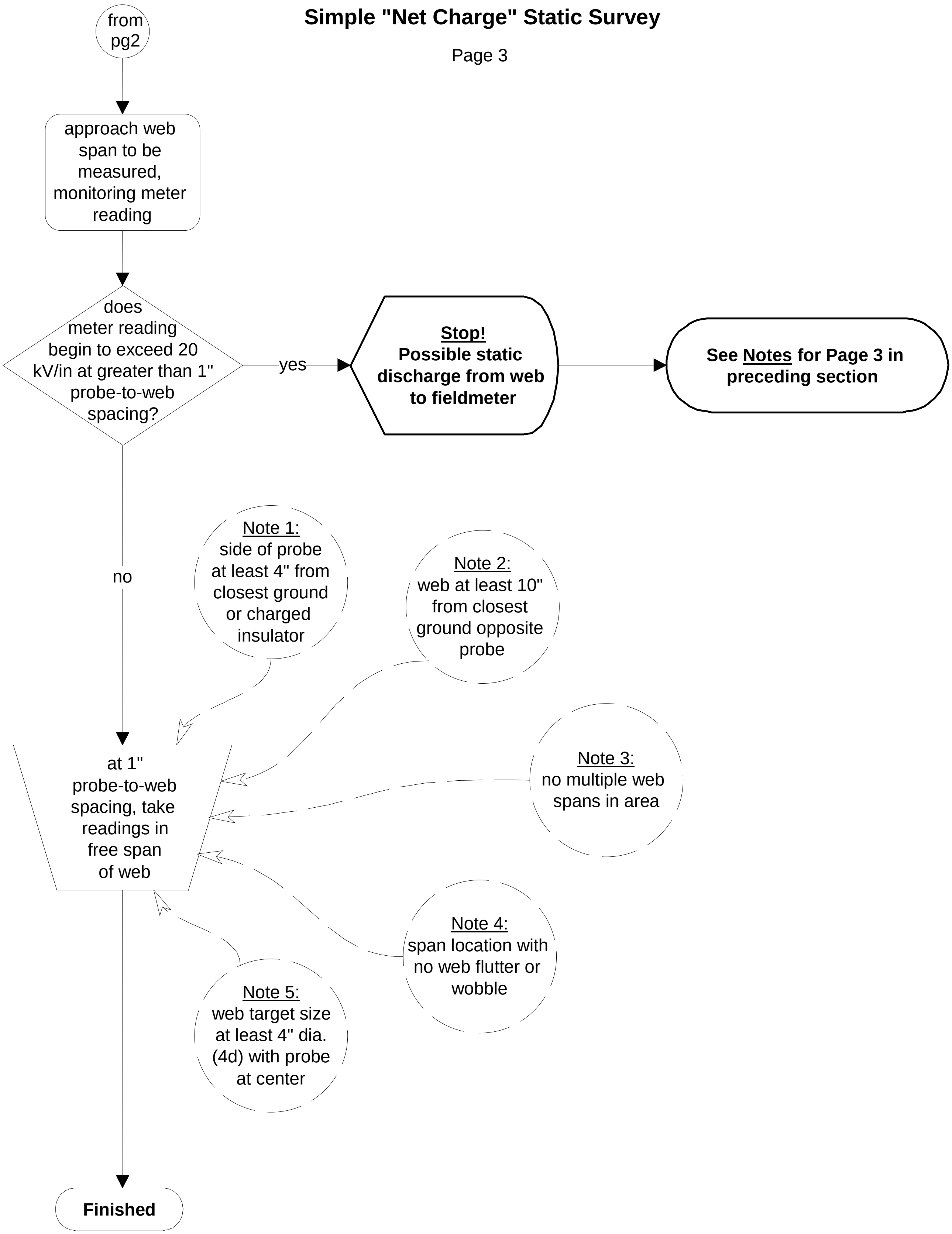
Simple "Net Charge" Static Survey



Note: SD = Static dissipative

Simple "Net Charge" Static Survey

Page 3



Calculating Web Surface Charge Density

Providing that fieldmeter readings are taken in compliance with the limiting conditions specified above, web surface charge density (charge per unit area, q/A) can be calculated from these readings as follows [2,4]:

Surface charge density(σ) = Electric field(E) x Permittivity of free space(ε)

<u>e.g.</u> for a reading of 5,000 V/in:

σ (q/A) = {5,000 V/in} x {8.85 x 10^{-12} coulomb(C)/volt(V)•meter(m)} or,

σ (q/A) = 1.74 x 10^{-6} C/m^2, or 1.74 μC/m^2 where: $\mu = 10^{-6}$

Relating Web Surface Charge Density To The Real World

It is widely reported in literature and texts that the maximum practical charge density a surface can hold is about 25 μC/m^2. Discharges to nearby conductors and surrounding air are responsible for this limitation. It has been stated by Seaver [2] that “Industry has used an unwritten ‘rule-of-safety’, known as the 5000 Volts Rule, to keep static charge on a web at a reasonable level. The rule states that if the potential on a free-span of web is kept below 5000 volts, then the web should remain free of static discharge problems within that free-span. This rule was established when fieldmeters were usually specified to be operated at 2.5 cm (≈ 1 inch) from the web.”

Referring to the charge density calculation in the previous section, where σ = 1.74 μC/m^2 at E = 5000 V/in, Seaver [2] states “This charge density is over an order of magnitude below the 25 μC/m^2 required for a guaranteed discharge from the web. Thus, the 5000 Volts Rule is equivalent to keeping the surface charge density below one tenth the discharge value.” and “The 5000 Volts Rule is a good safety rule for non-conductive webs, but it must be remembered that the measurement needs to be made with the fieldmeter held 2.5 cm from the surface of a true free-span of web. The 5000 Volts Rule ensures the web has a surface charge density that is less than 2 μC/m^2.”

Lower charge levels, while safe from discharges, may still attract contaminants and cause contamination problems in many processes.

Continuous Monitoring Of Electric Fields In High-Risk Machine/Product Performance Areas

Antistatic measuring and control systems are needed in practice because the conditions for static elimination always change [10].

Permanent fieldmeters are especially necessary in hazardous areas to verify nonhazardous web surface charge density levels. The probes are installed immediately downstream of passive or active ionizers to make sure the ionizers are working correctly. This scenario assumes all rollers but the gravure and impression to be outside the classified area. All electrically powered equipment installed in these classified locations must be approved for the solvent atmosphere in which they are located, so both the probes and ionizers must be approved for the classified areas in which they are installed.

For details on continuous monitoring, see the next document in this series, APNE-0016, Static Control in Web Converting.

IX. III References

[1] Crowley, J.M., *Fundamentals of Applied Electrostatics*, Wiley-Interscience, New York (1985)

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[3] Application Note APNE-0003, "*Fieldmeter Measurement Techniques Using Monroe Electronics Model 1036 Probes*", http://www.monroe-electronics.com/.

[4] Taylor, D.M. and Secker, P.E., *Industrial Electrostatics: Fundamentals and measurements*, Research Studies Press, John Wiley (1994)

[5] Maurer, B., Glor, M., Luttgens, G. and Post, L., "*Hazards Associated with Propagating Brush Discharges on Flexible Intermediate Bulk Containers, Compounds and Coated Materials*", Electrostatics '87, Inst Phys Confr Series No. 85, London (1987)

[6] Vosteen, W.E., Monroe Electronics, Inc., "*A Review of Current Electrostatic Measurement Techniques and Their Limitations*" presented at the Electrical Overstress Exposition, April 24-26, 1984

[7] TANTEC Static Elimination Guidebook, *A Guidebook On Using Electrostatics For the Elimination of Static Charges on Industrial Surfaces*, Schaumburg, IL (1998)

[8] Seaver, A.E., "*Moving Ground Plane Electrostatic Fieldmeter Measurements*", J. Electrostatics, Vol. 42, Elsevier, New York (1997)

[9] Haase, H., *Electrostatic Hazards: Their Evaluation and Control*, Verlag Chemie, New York (1977)

[10] Horváth, T. and Berta, I., *Static Elimination*, Research Studies Press, Chichester (1982).

APPLICATION NOTE APNE-0016

Static Control in Web Converting

Table of Contents

I. Continuous Measurement and Control of Web Static Levels in Critical Machine Areas

Content

Control of static is not something that occurs once and can then be forgotten. It requires the implementation of continuous procedures such as charge neutralization using ionizers and electric field monitoring using permanent fieldmeters to verify that the ionizers are working effectively. Antistatic measuring and control systems are needed in practice because the conditions for static elimination always change [1].

This document is the third in a series of three application notes about static charging of materials and equipment in web converting machines, including recommendations for static measurement, control, and continuous monitoring. The first document in the series is *APNE-0014 Electrostatic Charging In Web Converting* and the second is *APNE-0015 Electric Fields and Fieldmeters in Web Converting*.

This document provides the reader, working in either hazardous or non-hazardous areas, with the practical tools necessary to determine where permanent static control devices and Monroe Electronics Model 1036 fieldmeter probes should be mounted on web converting machines. This document includes installation and usage instructions for the 1036 probes.

The reader should first attempt to minimize web charging by becoming familiar with Application Note *APNE-0014 Electrostatic Charging In Web Converting* before proceeding with the recommendations in this document.

Machine Grounding Hazard Elimination

The most critical static control item to implement is electrical bonding and grounding of the web-processing machine. Unless intrinsically connected by virtue of construction (bolted together, gears with conductive grease, etc.), all conductive[1] parts on or near[2] the machine must be electrically bonded together [3]. The bonding wires or straps should then be electrically grounded on both sides of the bonding run to prevent electrical isolation of conductive components in case a bond breaks. Proper grounding and bonding need to be checked by an electrician at least yearly, and after any mechanical work is done on the machine.

Machine Part Geometry Hazard Elimination

Be careful to avoid incentive brush discharges[3] from a charged web to conductive machine parts in hazardous areas due to part geometry. Brush discharges can occur in electric fields measured lower than 30 kV/cm at the web. These discharges are due to conductive protuberances or corners (e.g., those with an edge diameter of less than 10 mm) near the web, which concentrate the field to the 30 kV/cm breakdown strength of air [4].

Determining Locations For Continuous Static Control And Monitoring In Nonhazardous Areas Using Portable Fieldmeters

To determine where static control devices and permanent static monitoring fieldmeter probes should be located, portable fieldmeters must first be used to determine the machine locations where fields are highest and need to be controlled (see *APNE-0015 Electric Fields and Fieldmeters In Web Converting*).

Passive and/or active ionizers (see Application Note *APNE-0014 Electrostatic Charging In Web Converting*) should be installed at the chosen locations and in the proper manner [3,5]. For high-speed or difficult-to-control operations, it may be necessary to install multiples of one or both type ionizers for complete static control.

Permanent fieldmeter probes (Monroe Model1036E or 1036F) then need to be installed downstream of the static control device(s) in critical locations to monitor their effectiveness.

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[1] A part is considered conductive if it is metal, or exhibits a volume resistivity less than 10^6 ohm•cm [2].

[2] A charged web can charge an ungrounded conductor by induction, setting up a spark risk to another conductor, including a human body.

[3] A discharge between a conductor and an insulator that is often characterized by crackling without sparking.

Hints For Maximum Static Control And Effective Monitoring

High-speed operations might require a second static neutralizer along the web between some rollers to sufficiently reduce the web charge.

For web materials thinner than 50mil, one ionizer and fieldmeter should be able to neutralize and measure both sides of web. For web materials thicker than 50mil, an ionizer and fieldmeter may be needed for both sides of web. The only way to know for sure is to install an ionizer on one side of the web, and then measure the residual field on both sides of the web. If the non-ionized side exhibits a higher field than the ionized side, then both sides require neutralization, measurement, and control.

If all proper spacing requirements can be met for web materials thinner than 50mils, the fieldmeter probes should be mounted with the measurement aperture facing downward. This is necessary to minimize foreign material entering the sensitive probe aperture.

For optimal performance, static eliminators need to be positioned using fieldmeters to obtain the lowest readings, both for distance from the web as well as distance from the previous roller. This can best be done using permanently installed fieldmeter probes after the eliminators.

Determining Locations For Continuous Static Monitoring In Hazardous (Flammable) Areas

As described in the section of this document *Machine Grounding Hazard Elimination* above, the most critical static control item to implement is effective grounding and bonding of conductive machine parts. Make sure conductive machine part shapes cannot also contribute to the static hazard problem by observing the recommendations in the section of this document, *Machine Part Geometry Hazard Elimination*. Then locate the general machine static monitoring positions as described in the section of this document *Determining Locations For Continuous Static Control And Monitoring In Nonhazardous Araes Using Portable Fieldmeters*.

Last, but most important, particular attention must be focused on the hazardous operations themselves. In a web converting process, these are usually flammable, solvent-based printing and other gravure operations, or coating, impregnating, and spreading operations. Charge neutralization devices should be installed after the web roller just prior to the hazardous operation roller. Additional devices should also be installed after the hazardous operation roller, and after each drying and turning roller in the hazardous rated area [3]. The devices installed in hazardous locations need to be rated Intrinsically Safe for the atmosphere in which they are placed.

Permanent fieldmeters should then be installed after each charge neutralization device to monitor its performance and indicate when maintenance on it is required.

Permanent fieldmeters are especially necessary in hazardous areas to verify that nonhazardous web surface charge density levels are maintained. The probes are installed downstream of passive or active ionizers to ensure that the ionizers are operating correctly. This scenario assumes that all rollers but gravure and impression to be outside the classified area. All electrically powered equipment installed in these classified locations must be approved for the solvent atmosphere in which they are located, so both the fieldmeter probes and the ionizers must be approved for the classified areas in which they are installed.

In hazardous locations, it is recommended that backup fieldmeters be installed, in case the primary fieldmeter at that position fails. Typically, one probe is located about one-third of the way across the web, and the other probe is located about two-thirds of the way across the web, attached to the same mounting bracket.

Continuous Monitoring Of Fields In High-Risk Machine/Product Performance Areas.

Permanent Fieldmeter System. The Monroe Electronics Model 177A Static Monitor is a four-channel electrostatic fieldmeter. The Model 177A is the only system designed for long-term unattended monitoring of static levels in industrial environments. The Model 177A accepts up to four Model 1036E or Model1036F electric-field-sensing probes. The probes measure the electric field in the particular locations where they are installed, and they continuously monitor for electric field levels that may indicate safety hazards or quality concerns. The probes can be mounted up to 1000 feet from the Model 177A. Probes should be air purged for long-term stability.

Choice of locations for the probes is critical. Locations should be chosen based on an understanding of machine/process performance. Handheld fieldmeters are used to help characterize the machine and select locations (see *APNE-0015 Electric Fields and Fieldmeters In Web Converting*).

Fieldmeters located immediately following active or passive charge control devices (ionizers) monitor the effectiveness of the devices.

Zeroing needs to be checked at least monthly to compensate for drift of the zero point. Model 1036 probe calibrations should be checked yearly during routine machine maintenance shutdowns. Monroe Electronics provides this probe calibration service.

The Model 177A Static Monitor includes programmable output alarms. If static levels in your application exceed your defined values, a first-level alarm is triggered to warn about the elevated static levels. The process is allowed to continue at this first (warning) level. If the problem is rectified and static levels return to normal, the first-level alarm is extinguished and the static monitor returns to a normal state.

If the problem persists and if the static levels rise to exceed a second-level (crucial) alarm, a second-level alarm is triggered. The second level alarm signal(s) can be used to shut down the operation until it is brought under control, or to further warn the operator of the more serious condition.

Consult the Model 177A Operator's Manual for information about its features and operation. A full description of the operation of the Model 177A Static Monitor is contained in its operating manual. This information will not be repeated within this application note.

II. Using Models 1036E and 1036F Electrostatic Fieldmeter Probes

General

Models 1036E and 1036F electrostatic fieldmeter probes are electrically identical and interchangeable. The major differences are physical. Model 1036F is a small (1.75" dia. x 1.25" H), lightweight version for general-purpose applications, or where available space is a problem. Model 1036E, for most industrial applications, is a 1036F probe built into a standard Crouse-Hinds ½"-FS1 electrical box with a stainless steel cover.

Both probes utilize the same vibrating capacitor modulator, and both have built-in provisions for purging with filtered air to prevent contamination and long-term drift. Inert gas can also be used for purging in hazardous areas where the probe will be used in an inert gas atmosphere. Purge gas flow in the Model 1036F exits only through the sensitive aperture in the gradient cap[4]. Gas flow in Model 1036E is directed across the face of the gradient cap as well as through the sensitive aperture.

Typical applications are static level safety monitoring in flammable atmospheres, and static level quality monitoring in sensitive machine areas.

Figure II-1

Model 1036E Fieldmeter Probe

Figure II-2

Model 1036F Fieldmeter Probe

[4] The gradient cap is the reference surface of the fieldmeter probe that contains the aperture and that faces the target surface during measurements.

Installation

Sensitivity

Full-scale sensitivity for any properly standardized and calibrated probe/instrument combination is dependent upon the gradient cap (containing the aperture) on each probe. The full-scale sensitivity for any given fieldmeter system or channel can be determined by inspecting the gradient cap on the probe. Each gradient cap is stamped on its face with a number that represents a different size aperture. This number is related to the sensitivity of the probe as shown in Table II-1 below. The probes are standardized at the factory in a uniform electric field. Once standardized in this manner, they may be interchanged at will.

Probe Model	Full Scale Sensitivity	
1036_-2	±100 V/cm	(±10 kV/M)
1036_-3	±1 kV/cm	(±100 kV/M)
1036_-4	±10 kV/cm	(±1 MV/M)
1036_-5	±20 kV/cm	(±2 MV/M)
1036_-6●	±10 kV/in	**Standard**
1036_-7	±1 kV/in	

Table II-1

Probe Model vs. Full Scale Sensitivity

Mounting

Probe mounting requirements for electrostatic field measurements will vary somewhat with the nature of the desired measurement. Whenever possible, mount the metric-reading probes from Table II-1 at one centimeter and the English-reading probes at one inch. When this is not possible, it is best to mount the probe as near as practical to the surface being monitored, as long as the input signal remains less than the full-scale sensitivity of the probe. It is strongly recommended that the probe be mounted "looking" downward in order to minimize the probability of contaminants entering the aperture in the face.

Model 1036E is provided with two mounting flanges that accommodate ¼" bolts or screws. The case should be electrically connected to ground. The gradient cap (containing the aperture) of the probe is a reference surface with its own ground connection. Do not make a separate ground connection to this surface.

Model 1036F may be held by hand to make rough measurements, or mounted by means of two threaded inserts in the back plate of the probe. Care must be exercised when selecting screw length. These are blind holes with a depth of 0.089". They will accommodate up to five full #4-40 threads. Some additional, temporary mounting options are friction clamps, adhesives, or double-sided tape. The metal body of the probe is internally connected to instrument ground and should not normally be connected to any other ground.

Geometry

A shroud[5] is not necessary on 1036E probes mounted at one inch or less from the web because the large faceplate provides the same function as a shroud (creates a uniform electric field in front of the probe at one inch or less). For more information about shrouds, see Application Note *APNE-0003 Fieldmeter Measurement Techniques Using Monroe Electronics Model 1036 Probes*.

[5] A shroud in this instance is a grounded surface in the plane of the gradient cap. For more information about shrouds, see Application Note *APNE-0003 Fieldmeter Measurement Techniques Using Monroe Electronics Model 1036 Probes*.

As a truly uniform field does not usually occur in most practical measurement situations using the 1036F probes, partly due to the introduction of the grounded probe itself, one must either:

- Improve the geometry by establishing a grounded plane (shroud) through which the fieldmeter probe can “view” the target surface,
- Establish a correction factor for the data, or
- Accept relative data. In many cases, this is an acceptable practice once a fixed geometry is established and that data is related to the real electric field.

Cables:
Both Models 1036E and 1036F probes are normally equipped with 10-foot-long cables and subminiature D connectors, which mate with the Monroe Electronics Model 177A Static Monitor. This is Option 1 of six available wiring options. See Appendix A – Probe Connection Options for details. The first three options are for non-hazardous (non-classified) locations where there are no Intrinsic Safety (IS) considerations. The last three options are for hazardous (classified) locations where Intrinsic Safety must be considered as part of the installation.

Extension cables are available from Monroe Electronics in lengths up to 1000 feet, which is the maximum permissible length. These cables may be ordered in any length (up to 1000 feet) by part number 1036/12-*nnnn*, where *nnnn* is the length in feet.

The cable exit on the Model 1036E is through a packing gland that is screwed into a ½"-14 NPT tapped hole in a boss on one end of the housing. Inside the housing, the probe is plugged into a terminal block to which the cable attaches. Where it is desirable or necessary to connect Model 1036E probes to Model 177A Static Monitors using conduit, the original cable and packing gland can be removed and the cable replaced by any length (up to 1000 feet) pulled through the conduit. Refer to Appendix A – Probe Connection Options, Options 3, 4 or 6 (depending on whether Intrinsic Safety must also be considered) for details, including wiring information.

Purging
Any contamination present in the probe or near the measurement will have an adverse affect on performance. When insulative particulate or liquid becomes charged and enters the probe or attaches near the aperture of the probe, it becomes a source of measurement error and drift. Less obvious is the influence of gaseous atmospheric constituents, including aerosols, which contaminate the probe by altering the contact potentials[6] between critical surfaces.

Constant purging of the Model 1036 probe with clean dry air or an inert gas is recommended whenever practicable to prevent airborne contaminants from entering the aperture in the gradient cap and being deposited on the electrode.

The air supply should meet standard *ANSI/ISA-7.0.01-1996 - Quality Standard for Instrument Air*. A Koby "Junior" filter available from Koby, Inc., 299 Lincoln Street, Marlboro, MA 01752 should meet this standard and will provide sufficient mechanical and chemical filtration for up to four probes under most conditions.

A complete probe purge kit, Model 1017/22G, is available for the Model 1036F from Monroe Electronics. It includes a low volume, long-life air pump, mechanical and chemical filters, and a supply of tubing. The pump is fully capable of 24-hour-per-day operation, thus keeping the probe ready for immediate use. A purge gas inlet tube supplied with each 1036F probe may be installed in either of two positions, the choice of which is primarily a matter of convenience in routing of the hose carrying the purge gas. These consist of tapped holes that exit at 90° to each other near the probe cable. If it is desired to move the purge tube to the other location, simply switch the purge tube with the Allen set screw plugging the other hole.

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[6] Contact potential between two conductors is caused by their different work functions, which are the energies needed to remove an electron from the conductor. This gives rise to a potential (voltage) difference. This energy is affected by the properties of the surface region. Thus, the work function is very sensitive to surface conditioning, contamination, etc.

Purge the Model 1036E probe through a ¼"-18 NPT tapped hole in the end of the housing near the cable exit using common plumbing or tubing components.

Gas pressure to either probe type should be only great enough to produce a slight positive flow out of the probe and in no event should it exceed a pressure of ½ psi.

Servicing

General

It must be emphasized that the critical elements of these probes (gradient cap and sensing electrode) must be kept free from contaminants, e.g., dust, fumes, mists, or any foreign material. The materials of which these elements are made were very carefully chosen to minimize contact potential. Any foreign matter that will cause relative electrical activity when combined with relative motion will tend to cause drift and measurement errors.

Therefore, it is recommended that:

- Probes be constantly purged even when not in use, if this is practical.
- Probes be kept tightly covered when not in use and are not being purged to prevent contamination. A covering such as a plastic bag or aluminum foil may be used. DO NOT cover the sensitive aperture with adhesive tape.
- Probes be cleaned only to the degree and frequency necessary to achieve the required stability.
- Gradient caps NOT be removed for cleaning unless absolutely necessary.
- Major cleaning and reconditioning be performed by the factory.

Cleaning

The recommended cleaning solvent is clean 70-100% isopropyl alcohol applied with a suitable soft, lint-free applicator. Use of a non-approved solvent may degrade performance permanently, requiring factory service.

Outside surfaces of the probe should first be wiped clean with a lint-free wiping tissue saturated in solvent. Then the interior surfaces should be flushed with solvent, using a plastic squeeze bottle[7], through the aperture until no dirt or dust may be seen. The probe should then be allowed to drain and dry thoroughly. A 15-minute bake-out at 75°C is recommended to remove residual solvent.

Model 1036E Disassembly/Assembly

In order to rewire the cable terminal block, replace, or standardize the probe assembly, it must first be removed from its housing. This is done by loosening the four crosspoint screws around the outer edge of the cover 1-1½ turns each, in turn, several times while lifting the cover and probe straight out of the housing until it is completely removed. DO NOT attempt to remove the screws completely one at a time. These four screws have circular "E-rings" installed on them under the cover plate to make the screws captive and prevent their falling into machinery below.

The probe assembly will need to be removed from the cover plate on the bench for standardization, calibration, or to replace the gradient cap. This is done by removing the four crosspoint screws that secure the phenolic mounting block to the hex standoffs, leaving the standoffs attached to the cover plate.

To reassemble the probe unit, essentially reverse the above procedure. Once the phenolic mounting block has been secured to the four hex standoffs, the probe unit should be inspected to assure that an even gap exists completely around the gradient cap between the gradient cap and the cover plate. If not, loosen the two crosspoint screws that secure the probe body to the phenolic mounting block, and adjust the probe body so that it is centered and completely surrounded by an even air gap.

Partially mate the card-edge fingers into the terminal block connector in the housing and tighten the four outer screws in the cover plate 1-1½ turns at a time until the assembly is secured in the housing.

[7] Soft plastic wash bottles with an attached nozzle are available from scientific supply distributors.

Standardization

A simple, accurate means of standardizing Model 1036 probes using any channel of the Model 177A Static Monitor is given here.

The primary reason for standardization of Model 1036 probes is to assure interchangeability of probes. The procedure is not suggested as routine, but is presented here in the event it becomes necessary to re-standardize following replacement of a gradient cap or major probe overhaul. It should be performed only under controlled conditions in a suitably equipped electronics laboratory.

All Model 1036 probes are shipped from the factory standardized in a uniform (parallel) field. The calibration fixture consists of two flat rigid metal plates that are parallel and separated with insulators by a distance "d" of one inch and have side dimensions of at least 5d (the bigger, the better; within practical limitations). Refer to Figure II-2 for a description of this fixture and the calibration method.

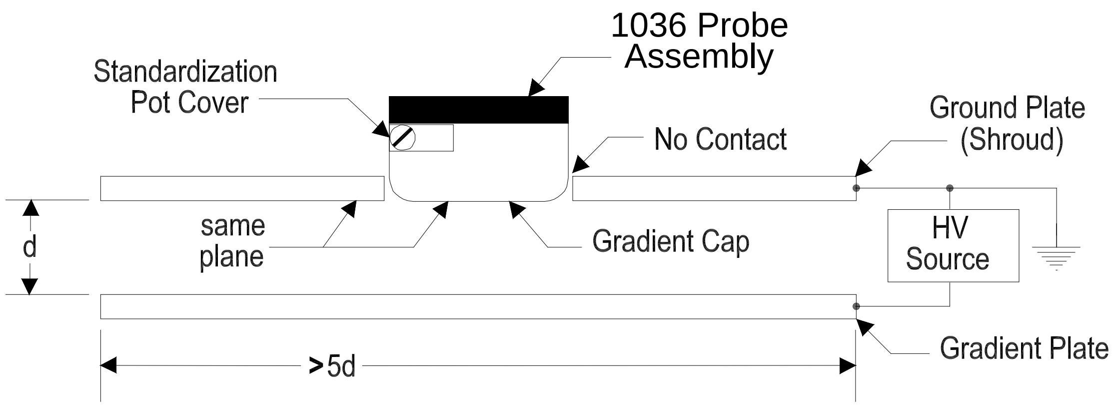


Figure II-2

Standardization Fixture (P.N. 96102A) Setup for 1036 Probes

The ground plate has a hole in its center just large enough to provide clearance around the probe so that the probe does not make contact with the plate. A calibrating voltage is applied to the gradient plate of the fixture to establish a reference field in the volume between the plates. This fixture is available from Monroe Electronics, Inc. as part number 96102A.

A Probe Standardization/Test Cable, Monroe Electronics model number 1036/22C, is required to standardize or bench-test Model 1036E probes. No special cable is required for Model 1036F probes.

The standardization procedure is as follows:

- Set up the apparatus as outlined above. Set a precision calibrating voltage source to zero volts.
- Set the Model 177A Static Monitor zero control of the selected channel to read a value of 0.000 at its analog output using a high-quality digital multimeter (DMM).
- Table II-2 lists the precision high voltage (V_{HV}) source requirements for standardization of the various probes. Apply the calibrating source voltage (V_{HV}), as shown in Table II-2, for the probe model being calibrated.
- Adjust the calibration potentiometer in the probe to produce value (V_{IND}), as shown in Table II-2, at the analog output of the selected channel using the same DMM as above.

Probe Model	Sensitivity	V_{HV}	V_{IND}
1036_-2	±100 V/cm	254 V	100.0 V
1036_-3	±1 kV/cm	2540 V	1.000 kV
1036_-4	±10 kV/cm	2540 V	1.00 kV
1036_-5	±20 kV/cm	2540 V	0.50 kV
1036_-6	±10 kV/in	1000 V	1.000 kV
1036_-7	±1 kV/in	1000 V	1.00 kV

Table II-2

HV Source and Meter Reading for Probe Standardization

Intrinsic Safety (IS) Barriers

Model 1036E and 1036F Electrostatic Fieldmeter Probes meet Factory Mutual Research Corporation requirements for Class I, Division 1, Groups C and D hazardous locations when installed in accordance with the appropriate Monroe Electronics, Inc. control drawings. To comply, approved safety barriers must be used as shown in these control drawings. These drawings are included in Appendix B – Intrinsic Safety Barriers, in the Model 177A Instruction Manual that is shipped with the instrument, or are available from Monroe Electronics.

Copies of the Factory Mutual Research Corporation report 1Q3A9.AX, specific to these probes, are available on request from:

III. Principle of Operation

Refer to Figure III-1 for the following discussion.

The probe is placed to “view” the target surface, which is assumed to be charged. In this instance, the gradient cap containing the aperture faces the target surface.

A sensitive electrode behind the aperture is vibrated perpendicular to the electric field by means of a drive coil (vibrated toward and away from the target surface). An A.C. signal is induced onto the sensitive electrode due to the motion of the vibrating electrode in the electric field, which is created by the charges on the target surface. The modulation amplitude of the A.C. signal, relative to the drive coil signal, is related to the polarity of the charge on the target surface.

This A.C. signal, conditioned by a preamplifier, filter, and signal amplifier, is fed into a phase-sensitive demodulator. This signal from this demodulator feeds an integrating amplifier. A fraction of the integrator’s output signal is fed back to the sensing electrode to null the signal from the external electric field.

The voltage signal from the integrator is thus directly proportional to the field intensity at the sensing electrode of the probe. The output signal from the integrator drives a meter for direct readout.

The fieldmeter gives a reading of the field intensity at any spacing. If the spacing is known, the voltage on the target surface can be determined.

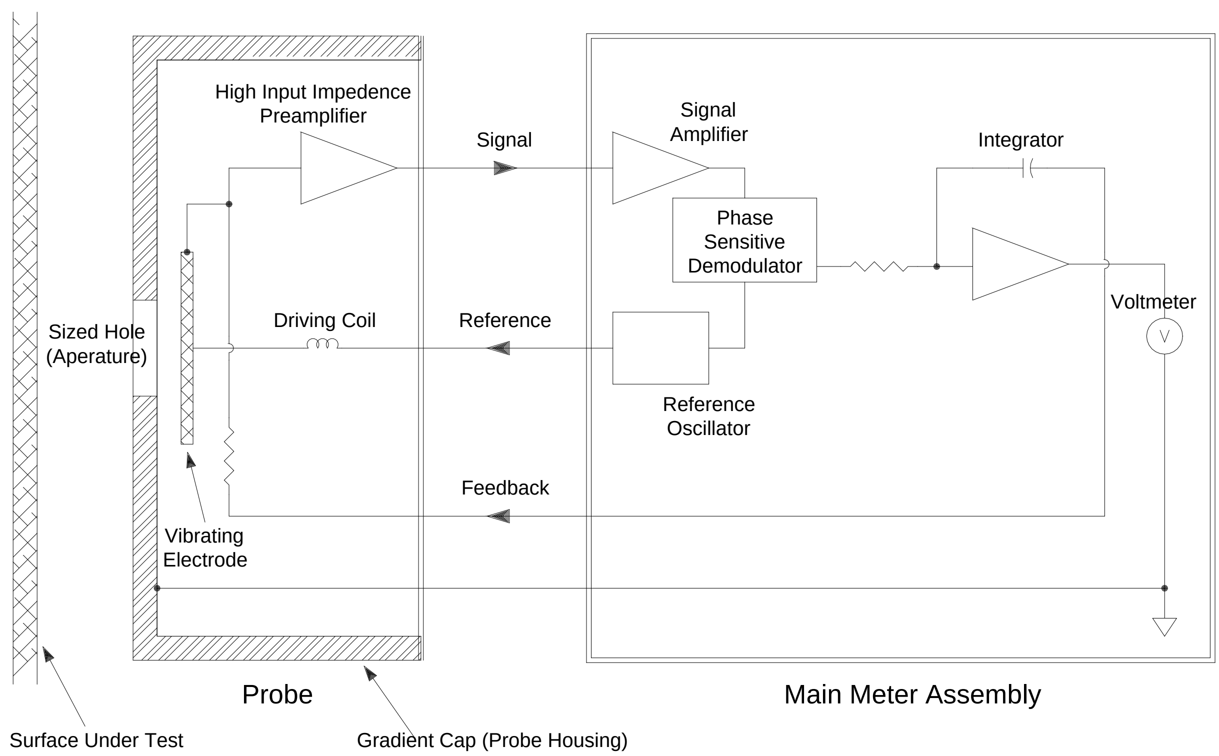


Figure III-1

Simplified Block Diagram for an Electrostatic Fieldmeter

IV. References

This Document

[1] Horváth, T. and Berta, I., *Static Elimination*, Research Studies Press, Chichester (1982).

[2] *ESD STM11.12-2000: Volume Resistance Measurement of Static Dissipative Planar Materials*, ESD Association, Rome, NY (2000)

[3] *NFPA 77: Recommended Practice on Static Electricity*, 2000 Edition, National Fire Protection Association, Quincy, MA (2000).

[4]] Walmsley, H.L., "Avoidance of Electrostatic Hazards in the Petroleum Industry", J. Electrostatics, Vol. 27, No. 1 & No. 2, Elsevier, New York (1992)

[5] TANTEC Static Elimination Guidebook, *A Guidebook On Using Electrostatics For the Elimination of Static Charges on Industrial Surfaces*, Schaumburg, IL (1998)

General Fieldmeter References

The following references are available from Monroe Electronics, Inc.

"Standards Related to Static Electricity", www.monroe-electronics.com/esd_appntspdf/apne-0001.pdf

"Fieldmeter Measurement Techniques Using Monroe Electronics Model 1036 Probes", www.monroe-electronics.com/esd_appntspdf/apne-0003.pdf

WILLIAM E. VOSTEEN, Monroe Electronics, Inc., "A *Review of Current Electrostatic Measurement Techniques and their Limitations"* Presented at the ELECTRICAL OVERSTRESS EXPOSITION, April 24-26,1984.

LT 18: MARK BLITSHTEN, The Simco Company, Inc., *"Measuring the Electric Field of Flat Surfaces with Electrostatic Fieldmeters"* Presented at the ELECTROSTATICS SOCIETY OF AMERICA CONFERENCE ON ELECTROSTATICS, June 20-22, 1984.

LT 21: R.G. CUNNINGHAM, Eastman Kodak Co., *"Use of Fieldmeters for Charge Measurements on Moving Webs"* in *1975 ANNUAL REPORT. CONFERENCE ON ELECTRICAL INSULATION AND DIELECTRIC PHENOMENA*, NATIONAL ACADEMY OF SCIENCES pp. 13-20, 1978.

LT 22: A. VAN ROGGEN, E.I. du Pont de Nemours & Company, *"The Use of Electric Field Meters for Precision Measurements"* in *1972 ANNUAL REPORT. CONFERENCE ON ELECTRICAL INSULATION AND DIELECTRIC PHENOMENA*, NATIONAL ACADEMY OF SCIENCES, pp. 9-16, 1973.

LT 25: Monroe Electronics, Inc., "*Guide to Monroe Electronics Electrostatic Fieldmeters*"

Useful Hazardous (Classified) Location and Intrinsic Safety References

American National Standards Institute (ANSI) and International Society for Measurement and Control (ISA)

ISA-12.00.01-1999 (IEC 60079-0 Mod)
Electrical Apparatus for Use in Class I, Zones 0 & 1 Hazardous (Classified) Locations - General Requirements

ISA-12.01.01-1999
Definitions and Information Pertaining to Electrical Instruments in Hazardous (Classified) Locations

ISA-12.02.01-1999 (IEC 60079-11 Mod)
Electrical Apparatus for Use in Class I, Zones 0, 1, & 2 Hazardous (Classified) Locations - Intrinsic Safety Requirements

ANSI/ISA-RP12.6-1995
Wiring Practices for Hazardous (Classified) Locations Instrumentation Part I: Intrinsic Safety

ANSI/ISA-TR12.24.01-1998 (IEC 79-10 Mod)
Recommended Practice for Classification of Locations for Electrical Installations Classified as Class I, Zone 0, Zone 1, or Zone 2

ISA
PO Box 12277, 67 Alexander Drive
Research Triangle Park, NC 27709
Telephone: 919-549-8411
Fax: 919-549-8288
E-Mail: info@isa.org

National Fire Prevention Association (NFPA)

NFPA 34:
Standard for Dipping and Coating Processes Using Flammable or Combustible Liquids

NFPA 77:
Recommended Practice on Static Electricity

NFPA 325:
Guide to Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids

NFPA 497:
Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas

Electrical Installations in Hazardous Locations

National Fire Protection Association
1 Batterymarch Park
PO Box 9101
Quincy, MA 02269-9101
Tel: (800) 344-3555
Fax: (617) 770-0700
Email: custserv@nfpa.org

V. Appendix A – Probe Connection Options

General

Model 1036E or 1036E Probes may be wired to the Model 177A Static Monitor in at least six different ways. The first 3 options are for non-hazardous (non-classified) locations where there are no Intrinsic Safety (IS) considerations. The last 3 options are for hazardous (classified) locations where Intrinsic Safety must be considered as part of the installation.

Option 1: Probes (1036E or 1036F) use factory installed cables; no extension cables; no Intrinsic Safety considerations

Probes are normally factory equipped with ten-foot-long cables, although longer or shorter cables are available on special order. To use or test this system, simply plug the probes into the appropriate connectors on the back of the Model 177A.

Option 2: Probes (1036E or 1036F) use factory installed cables and factory supplied extension cables; no Intrinsic Safety considerations

Extension cables are available in lengths up to 1000 feet. The extension cable part number is 1036/12-nnnn, where nnnn denotes the length of the cable in feet. Factory supplied extension cables will be labeled with this part number near one end.

The extension cable female connector mates with the 1036 probe cable male connector, and the extension cable male connector mates with the female connector on the back of the Model 177A.

Although it is virtually impossible to err, it is advisable to test the system "on the bench" before permanently installing long cable runs.

Option 3: 1036E probes with long customer installed cables, with or without extension cables (factory or customer supplied); no Intrinsic Safety considerations

This option does not apply to 1036F probes, which have permanently attached cables.

Wiring connections for customer installed 1036E probe cables for use in a non-IS installation are shown in Figure V-1. Wiring connections for customer supplied extension cables for use in a non-IS installation are shown in Figure V-2. Model 1036E probes have terminal blocks inside their housings to which the cable wires are directly attached.

As in Option 2, it is advisable to "bench test" the system before removing the factory-attached cables to ensure it is working properly. It is also advisable to test the system "on the bench" after attaching the customer-installed cables, with any extension cables, before permanently installing long cable runs.

Option 4: 1036E probes with factory installed cables, extension cables (factory or customer supplied) and Intrinsic Safety barriers

Refer to drawing 1036/10 [SHT. 2 of 3] in the Model 177A Instruction Manual. This drawing shows wiring for one channel. Generally, all channels are wired alike. All barriers (four per channel) may be located in a single barrier enclosure.

Note that on each side of the barrier enclosure) you have the option of using connectors or "hard wiring" the cables directly to terminals on each barrier. Hard wiring allows the cables to be pulled through conduit without interference associated with connectors. Model 1036E probes have terminal blocks inside their housings to which the cable wires are directly attached. Wiring details for customer supplied extension cables are shown in Figure V-2.

As in the previous options, it is advisable to test the system "on the bench" after attaching the customer installed cables, with any extension cables, before permanently installing long cable runs.

Option 5: <u>1036F probes with factory installed cables, extension cables (factory or customer supplied) and Intrinsic Safety barriers</u>

Refer to drawing 1036/10 [SHT. 3 of 3] in the Model 177A Instruction Manual. This drawing shows wiring for one channel. Generally, all channels are wired alike. All barriers (four per channel) may be located in a single barrier enclosure.

Note that (on each side of the barrier enclosure) you have the option of using connectors or "hard wiring" the cables directly to terminals on each barrier. Hard wiring allows the cables to be pulled through conduit without interference associated with connectors. Wiring details for customer supplied extension cables are shown in Figure V-2.

As in the previous options, it is advisable to test the system "on the bench" after attaching the extension cables before permanently installing long cable runs.

Option 6: <u>1036E probes with customer installed cables, extension cables (factory or customer supplied) and Intrinsic Safety barriers</u>

Refer to drawing 1036/10 [SHT. 1 of 3] in the Model 177A Instruction Manual. This drawing shows wiring for one channel. Generally, all channels are wired alike. All barriers (four per channel) may be located in a single barrier enclosure.

Note that (on each side of the barrier enclosure) you have the option of using connectors or "hard wiring" the cables directly to terminals on each barrier. Model 1036E probes have terminal blocks inside their housings to which the cable wires are directly attached. Hard wiring allows the cables to be pulled through conduit without interference associated with connectors. Wiring details for customer installed 1036E probe cables are shown in Figure V-1. Wiring details for customer supplied extension cables are shown in Figure V-2.

It is advisable to "bench test" the system before removing the factory-attached cables to ensure it is working properly. As in the previous options, it is advisable to test the system "on the bench" after attaching the customer installed cables, with any extension cables, before permanently installing long cable runs.

Constructing Your Own Cables

There are a couple of reasons why you may want to construct your own cables:

1. To save money.

   You may be able to save money if everything goes OK. However, troubleshooting may prove to be more costly in the end than using factory supplied cables.

2. *Conduit must be used for cable runs, but cable connectors won't fit through conduit you normally use.*

   The largest rectangular cross sectional dimensions of each connector are ⅝" x 1¼". The minimum conduit ID through which this can be pulled is 1⅜". However, it is possible, with a great deal of care, to pull up to five cables simultaneously through that ID in a smooth straight run by staggering the connectors.

There are a couple different approaches for constructing your own cables to fit through your conduit:

1. *Buy factory extension cables and modify them.*

   Cable construction details for 1036E probes with customer installed cables are provided in Figure V-1. This option does not apply to 1036F probes, which have permanently attached cables.

   Extension cables are available in lengths up to 1000 feet. The extension cable part number is *1036/12-nnnn*, where *nnnn* denotes the length of the cable in feet. Factory supplied extension cables will be labeled with this part number near one end. The cables need to be long enough to reach from the console location, through the conduit, and to the probe location with a few feet extra for measurement error.

Remove and discard the factory supplied (usually ten-foot) cable from the probe (Model 1036E only), and mount the probe housing at the measurement location.

Cut the female DB9 connector plug off the extension cable.

Pull the cable from the IS Barrier and/or Model 177 instrument end of the conduit to the probe end.

2. *Buy bulk cable and connect both ends manually.*

   Cable construction details for 1036E probes with customer installed cables are provided in Figure V-1. This option does not apply to 1036F probes, which have permanently attached cables.

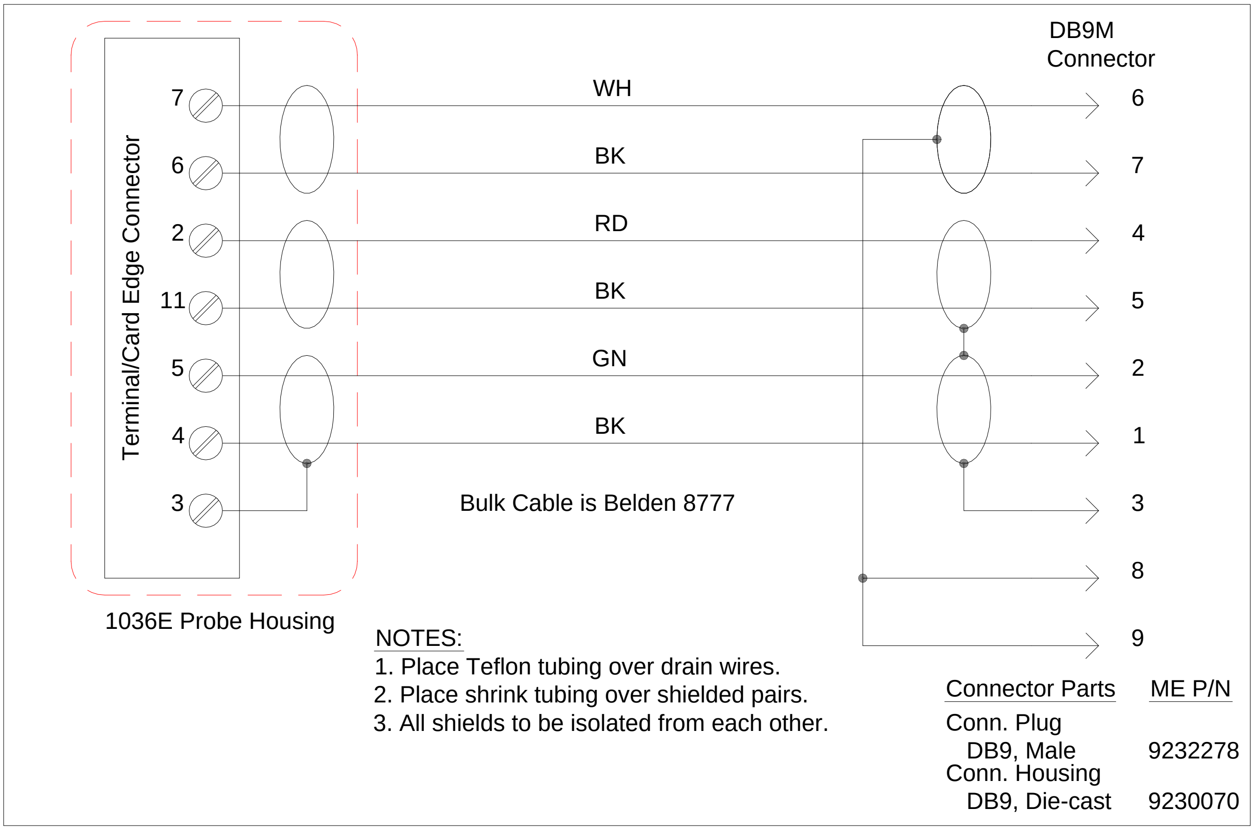
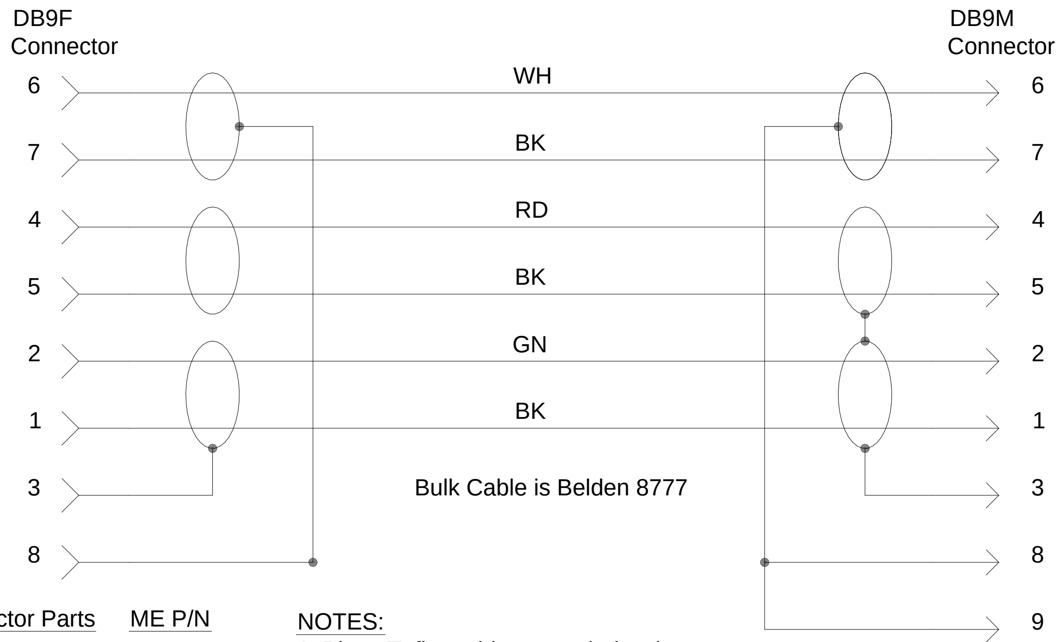


Figure V-1

1036E Customer Installed Cable



Connector Parts	ME P/N
Conn. Plug	
DB9, Fem.	9230003
Conn. Housing	
DB9, Die-cast	9230070
Female Screwlock	
2-56 x .560 lg.	9230087

NOTES:
1. Place Teflon tubing over drain wires.
2. Place shrink tubing over shielded pairs.
3. All shields to be isolated from each other.

Connector Parts	ME P/N
Conn. Plug	
DB9, Male	9232278
Conn. Housing	
DB9, Die-cast	9230070

Figure V-2

1036 Customer Installed Extension Cable

VI. Appendix B – Intrinsic Safety Barriers

General

Model 1036E and 1036F Electrostatic Fieldmeter Probes meet Factory Mutual Research Corporation requirements for Class I, Division 1, Groups C and D hazardous locations when installed in accordance with the appropriate Monroe Electronics, Inc. control drawings included in this document. Approved safety barriers must be used as shown in the drawings to comply.

Copies of the Factory Mutual Research Corporation report 1Q3A9.AX specific to these probes are available on request from:

Monroe Electronics, Inc.
100 Housel Avenue
Lyndonville, NY 14098
Tel. (716) 765-2254
Fax. (716) 765-9330

Manufacturers of Approved IS Barriers

Two manufacturers of IS barriers are currently approved:

MTL, Incorporated 8576 Wellington Road PO Box 1690 Manassas, VA 22110-1690 Tel. (703) 361-0111 Fax. (703) 368-1029	and	R. Stahl, Inc. 150 New Boston St. Woburn, MA 01801-6204 Tel. (617) 933-1844 Fax. (617) 933-7896

Barrier requirements and recommended enclosures are shown in the tables below:

MTL Barriers and Enclosures

Number of Channels	1	2	4	6	8	10	12	14	16
	Number of Barriers								
MTL 765	2	4	8	12	16	20	24	28	32
MTL 766	2	4	8	12	16	20	24	28	32
	Recommended Enclosures								
MT 5	1								
MT 12		1							
MT 24			1	1		2	2		
MT 32					1			2	2

Table VI-1

Notes for MTL Systems:

Enclosures include barrier mounting hardware, tagging strips, etc. Labeled wiring ducts are included with MT 32.

Listed enclosures are glass-filled polycarbonate with transparent lids. They are impact resistant, flame retardant and dustproof to IEC529:IP65.

MTL will install barriers at no charge if supplied with position (sequence) information.

"Internals" (everything that normally goes in an enclosure but no enclosure) are available.

R. Stahl Barriers and Enclosures

Number of Channels	1	2	4	6	8	10	12	14	16
	Number of Barriers								
9002/77-150-300-00	2	4	8	12	16	20	24	28	32
9002/22-240-160-00	2	4	8	12	16	20	24	28	32
	Recommended Enclosures								
S 806 NF-12	1	1							
S 1412 NF-25			1	1					
S 1412 NF-50					1	1	1		
S24H20BLP-80								1	1

Table VI-2

Notes for R. Stahl Systems:

Enclosures include mounting rails, insulating standoffs, ground terminals and labels.

Listed enclosures are Hoffman NEMA-4.