MISSION INSTRUMENTS CORPORATION

MODEL: ZEBRA PLUS Electric Field Sensor

Installation and Operation Manual

Mission Instruments Corporation
2050 East 17th Street
Tucson, Arizona, 85719-6948

www.missioninstruments.com

(520) 721-9242

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1. UNPACKING THE ZEBRA FIELD MILL

Open the box and remove the contents. The system consists of three groups of parts: The Field Mill "head" (ZPV), the Field Mill Mounting Kit (ZMK-2101), and the Receiver Kit (DCPM). This is a good time to compare the parts with the diagrams here.

System Contents:

1 ea. ZPV Zebra-Plus-V Field Mill
1 ea. DCPM Data Collection and Processing Module
1 ea. ZMK-2101 Zebra Mounting Kit

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Zebra Plus FIELD MILL

ZEBRA PLUS FIELD MILL HEAD

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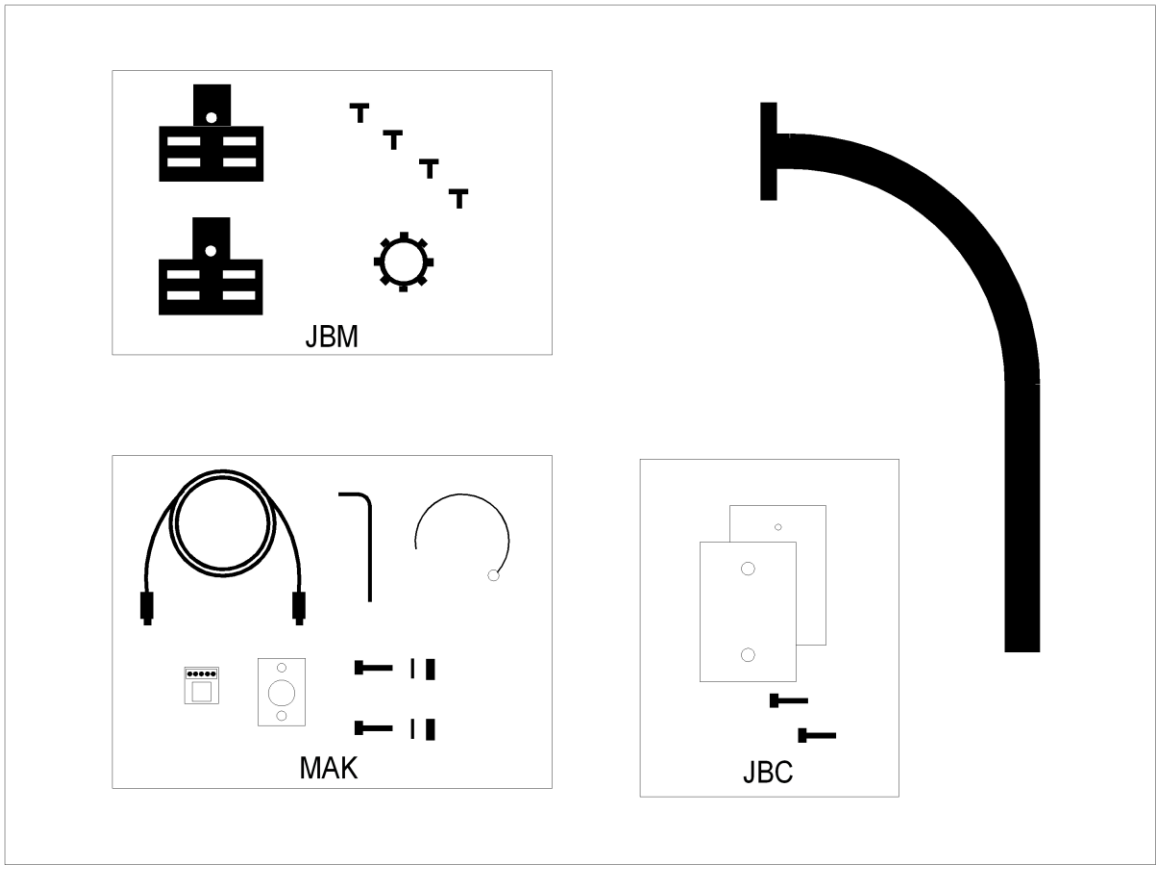
ZMK-2101 MOUNTING KIT COMPONENTS



The **ZMK-2101** Includes:

***JBM** Junction Box mounting hardware, brackets, Thread locking liquid
***MAK** Zebra Field Mill installation kit, with 3' cable, ZEB-A-007 Block, ground wire, mounting gasket and hardware.
***Cable**, 100 feet CAT-5e, STP Data Cable, NOT SHOWN
***MMA** Mill Mounting arm
***JBX** Junction box, rectangular electrical, NOT SHOWN
***JBC** Junction box cover, gasket, and screws

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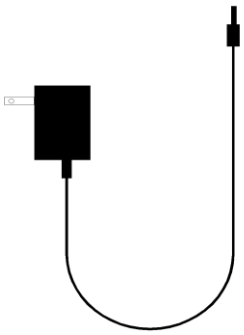
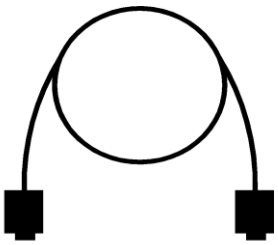
The **DCPM** Includes:

AC Power supply (100-240V)
RS-232 Output Cable
DCPM Data Module

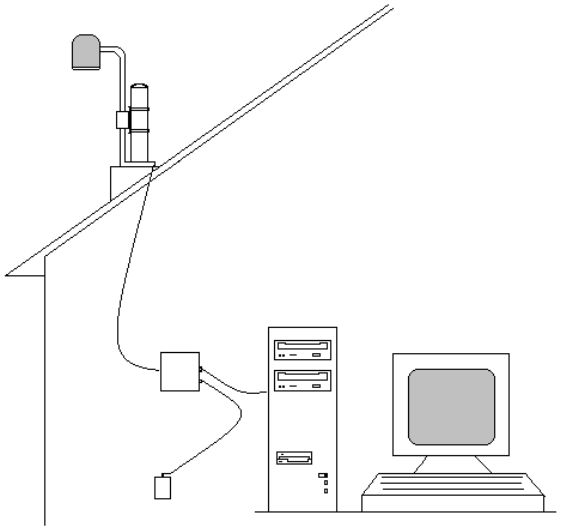




AC SUPPLY **RS-232 CABLE** **DCPM Module**

SYSTEM OVERVIEW

The Zebra Plus Field Mill System is a device which monitors atmospheric electrification. This information can be used to indicate a threat by lightning before the lightning occurs.



The Zebra Plus field mill sensor is mounted outdoors, usually on a rooftop, where it is exposed to the atmospheric electric field. Data from the sensor is sent through a long cable to a remote data collection module (DCPM), which offers visual performance indicators, system controls, and a 1200 baud streaming digital output on an RS-232 communications port.

2. INSTALLATION

The Zebra Plus field mill system is installed in two sections, the field mill sensor outdoors, and the Data Module indoors. Before installation, select a suitable location for the sensor. The Zebra Plus field mill is designed primarily for rooftop mounting. The location should be open and as clear as possible of obstructions such as towers, chimneys, trees, and other tall objects. The Zebra Plus field mill sensor has been calibrated to operate satisfactorily atop a single-story building, with the sensor head 18" from the surface of the roof. Many factors will affect this calibration, including the above-mentioned factors and height of the building. Tall objects nearby may tend to "shield" the sensor, resulting in artificially lowered readings. Mounting the field mill on taller buildings will tend to result in artificially higher readings. The Zebra Plus system includes a means of

adjusting the site enhancement factor (sensitivity), but it is best to install the sensor as close to the standard location as possible.

The Field Mill sensor is designed to be bolted to a flat vertical surface or strapped to a vent pipe or similar object. The data module is to be installed indoors near the location where the data will be collected, such as computing device running the data collection software. The field mill and data module must be connected together with a 4-Pair CAT 5e Shielded (STP) Communications-type cable. The data module must be connected to AC (using the AC/DC external power supply) or DC power source. The data module also must be connected to a serial communications port on the computer.

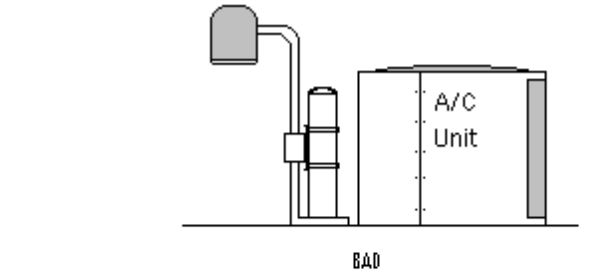
Caution: It is very important from a safety standpoint for the Field Mill assembly to be very well grounded. The "JBX" Junction box must be physically connected to a good, low-impedance ground, and the green ground wire furnished must be installed inside the JBX Junction box, bonding the "E" (Earth) terminal on the ZEB-A-007 junction block to the Junction box ground. In addition, the "E" terminal on the DCPM Data Module must also be connected to a good local ground.

INSTALLING THE FIELD MILL SENSOR

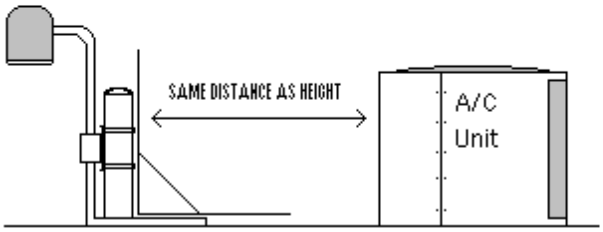
The Zebra Plus field mill system is supplied with most major components needed to install and use the sensor. Among items not included are mounting clamps or screws needed to fasten the Field Mill head assembly to available objects on the roof. Also not included is a protective conduit needed to protect the cable connecting the rooftop sensor to the indoor Data Module (DCPM). Such a conduit can be plastic or metallic, and should cover the cable over as much of the run as practical, especially while outdoors.

Very Important: The conduit must be routed away from the sensor, so that it does not cross below the sensor itself. It is also desirable to keep the cable away from sources of electrical noise, such as motors, switchgear, and fluorescent or H.I.D. lighting fixtures

Normally, mount the field mill sensor first on the roof and run the cable down to the data module location. Avoid "shielding" the sensor itself by locating field mill away from other objects:



BAD



GOOD

Install the data module by connecting the field mill cable to the "Sensor Cable" pluggable terminal strip, a safety ground to the same strip, the power supply to the DC input, and the 9-pin data cable from the Serial output to the PC COM port. The Data Module is small and is designed to free-stand on a table-top, shelf, or other protected location. An AC power adapter (with 100-240VAC input) is included, as is a standard DE-09 communications cable intended to connect the Data Module to a standard 9-pin DTE PC-type serial port. The serial port of the Zebra Plus field mill system is configured as DCE.

The supplied long cable can be cut to any length up to 100 feet. Longer cables (up to 150 feet) can be obtained locally and installed if needed. Runs longer than 150 feet may result in excessive power loss to the Zebra Plus field mill head and should be avoided. If heavier-gauge CAT 5e-compatible STP cable can be obtained, longer runs may be possible.

The serial output of the data module driving the host computer uses a standard RS-232 interface, which is designed to be extended up to 50 feet, maximum. Longer runs may require additional engineering, including use of modems. A six-foot cable with standard DE-9 connectors is supplied, which normally will connect to standard 9-pin PC-type COM ports.

The data module is supplied with a 15V DC power supply, which plugs into a local AC power source. AC Power cord(s) are supplied, and others can usually be obtained locally if required to match local electrical receptacles. The power supply is of a "universal", self-selecting input, switching design, and can be plugged into any power source of 100-240V, 50-60Hz No selection or other adjustment is needed. There is an additional DC input on the Data Module (marked "AUX DC IN"), which will accept Voltages of 20-30VDC if this type of input source is to be used. If the "AUX DC IN" input is used, do not use the 15V

power supply included in the kit. The Negative side of the "AUX DC IN" input is connected to chassis ground inside the Data Module, which is common with the "E" terminal of the SENSOR input clock and the common of the Serial output.

NEEDED SUPPLIES:

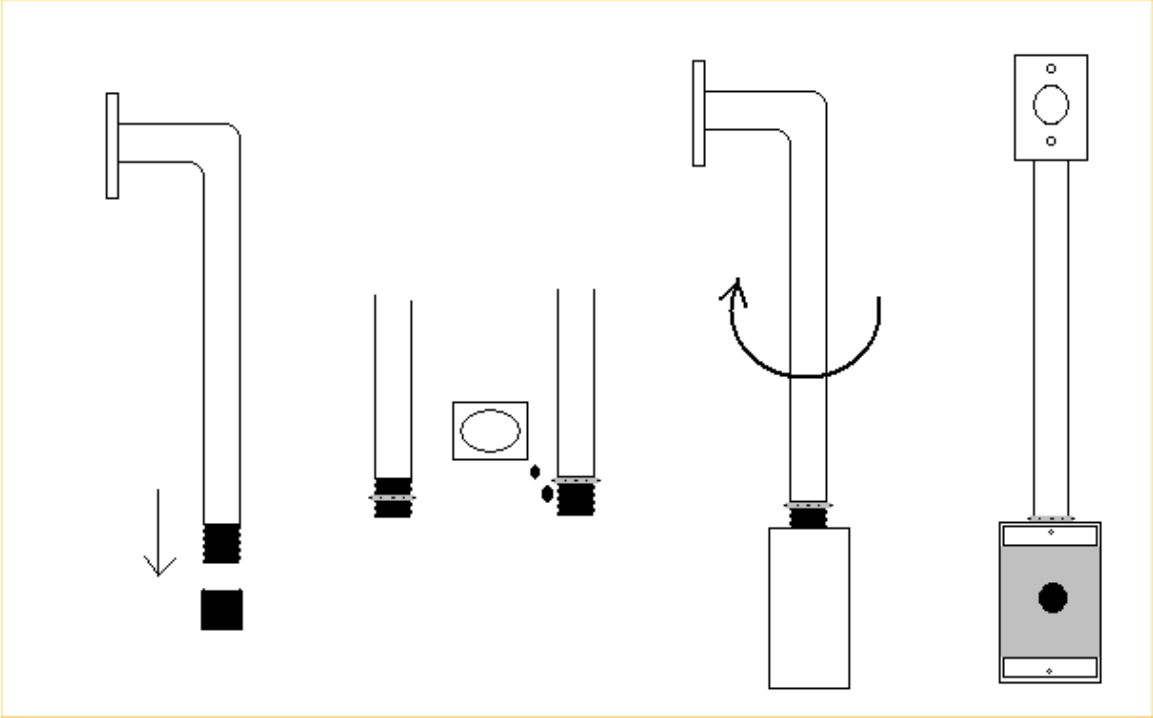
* Junction box mounting hardware
* Cable conduit
* Additional cable with securing fittings
* Hose clamps (if needed for pipe-mounting of Junction Box)

FIELD MILL SENSOR MOUNTING

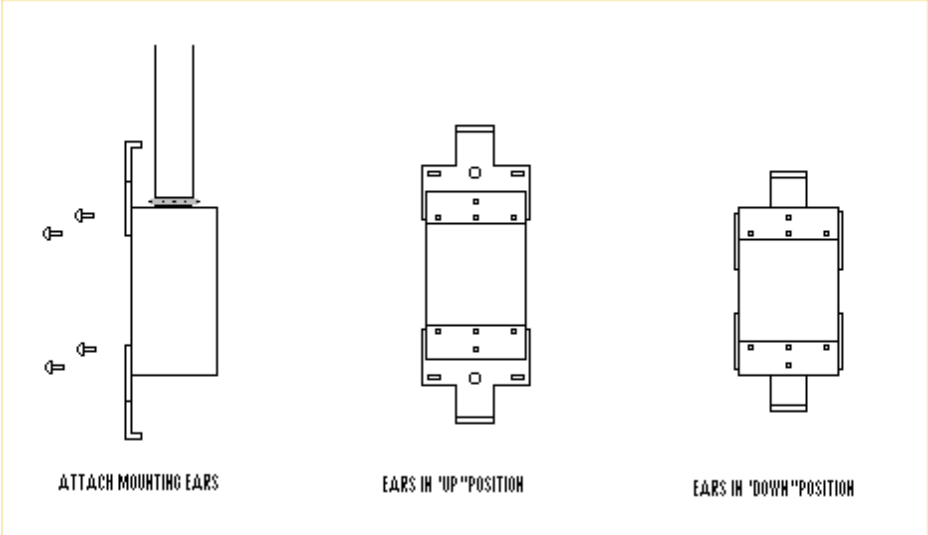
Once a suitable location has been selected, the Sensor and mounting kit should be prepared for installation.

The Mounting Kit consists of a cast aluminum Junction Box (**JBX**) and special mounting "ears" (**JBM** kit) which aid the installer in attaching the box to a vertical surface or pipe (with hose clamps, not provided in the kit). The Junction Box has a threaded hole (1/2" NPT) on its top and in its bottom. The bottom hole is available to the installer for installing the cable conduit to run to the Data Module indoors. The top hole accepts the Field Mill mounting arm, which screws into the box and is secured with an electrical-type locknut and liquid thread locker, included in the kit. The locknut and liquid are intended to insure that the Field Mill mounting arm can be adjusted to the correct position and that it will stay fixed in most expected environments.

To begin, locate the **ZMK** mounting kit, the **JBX** Junction Box, and the long cable. Open the **ZMK** bag and the **JBM** mounting kit and find the 1/2" locknut and small pouch of Thread locking liquid. Shake the thread locker pouch to mix the contents and cut open. Remove the blue protective cap from the long end of the mounting arm and install the locknut onto the threads, screwing it onto the pipe as far as possible (see diagram below). Apply the liquid thread locker liberally over the exposed threads. Screw the mounting arm into the threaded hole in either end of the junction box. Hand-or wrench-tighten the arm as much as possible, <u>but stop with the arm pointing directly over the open side of the junction box</u> (see final image below). If fitting becomes tight before arm reaches this point, loosen it until the arm is pointing the correct way. Tighten the lock nut back down onto the surface of the junction box, tightening with a wrench. The arm is made of aluminum and the locknut is zinc, so do not over-tighten. The liquid thread locker is intended to take over and lock the assemblies together once it has had time to set (24 hours). A bench vise will make this job easier. Be careful to avoid damaging the finish on the mounting arm and junction box.

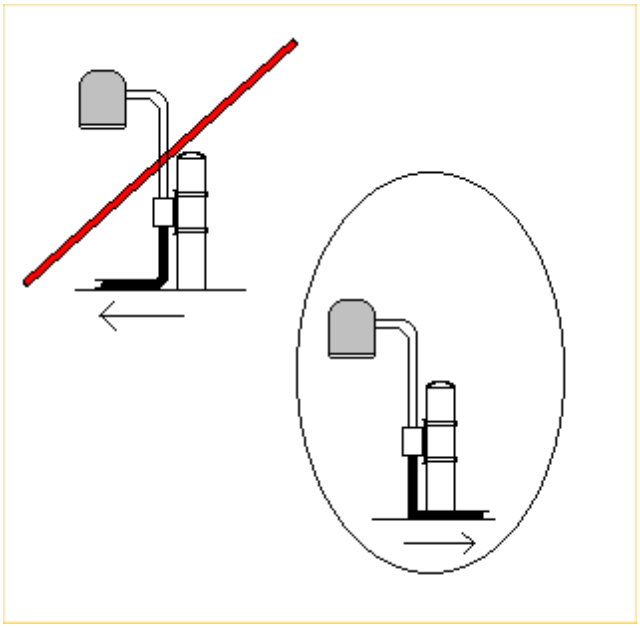


Next, determine the type of mounting to be used. The two "T" brackets ("EARS") are intended to be attached to the rear of the junction box using supplied screws. These brackets may then be attached to the chosen mounting surface. The brackets may be installed "down", closer to the box for added strength when using hose clamps, or "up" when it is desired to use the extra holes to fasten the box to a flat surface. See diagram.



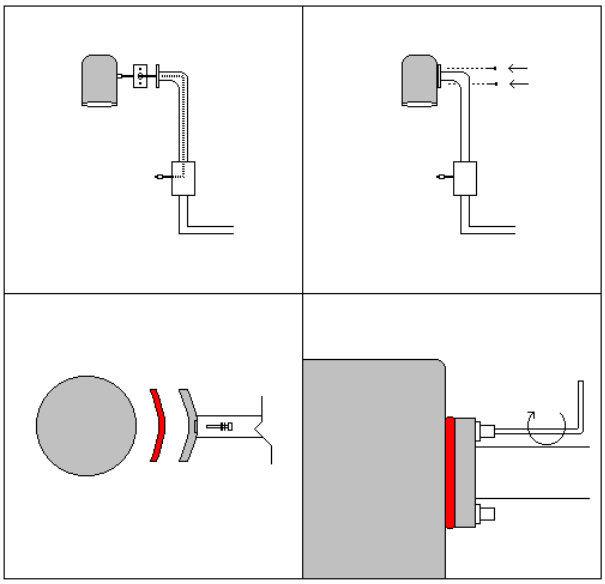
The outlet (bottom hole in the junction box) should be connected to the conduit, and the conduit should be routed away from the sensor and on to its destination.

Note: plastic materials such as cable or plastic conduit can cause false readings when run below or close to the sensor. It is best to use metallic conduit (such as EMT thin wall) for at least the first few feet from the junction box to avoid this. If plastic conduit must be used leading from the junction box, be sure it is routed directly away from the sensor as much as possible. Never allow any conduit, wires, or other objects to fall directly below the sensor, nor let plastic conduit get closer than 18" to the curved flange on the mounting stand, to reduce chances of false readings.



To ensure optimal calibration, install the junction box/curved arm assembly to the mounting surface so that the bottom of the junction box is 6" from the surface of the roof. This will result in the bottom of the sensor being 18" from the same surface, once it is installed.

After the box is mounted and conduit installed, pull the cable into the junction box so that there is at lease 6" of free cable inside the box.



Open the **MAK** Mill Installation Kit bag and find the small black "007" Block. This block adapts the long cable to a circular "mini-DIN" connector which connects to the field mill head. Strip the cable and connect the wires to the terminal block.

Note: early production systems used 4-wire (Red, Green, Yellow, Black wires) cable in place of the better, quieter Cat 5e cable. Since these designations are imprinted on the hardware, we have retained the letters here. Connect the new, twisted pairs as indicated here:

BLUE and BLUE/WHITE wires (pair) should be stripped and twisted together (electrically, as one wire) and installed into the terminal marked "R".

Two pairs ORANGE, ORANGE/WHITE, GREEN, GREEN/WHITE should also be stripped and put together as one wire and installed in to the terminal marked G. Due to the small terminal size, these four wires may need to go in straight, not actually twisted.

BROWN/WHITE wire of the BRN-BRN/WHT pair should be installed into the terminal marked Y.

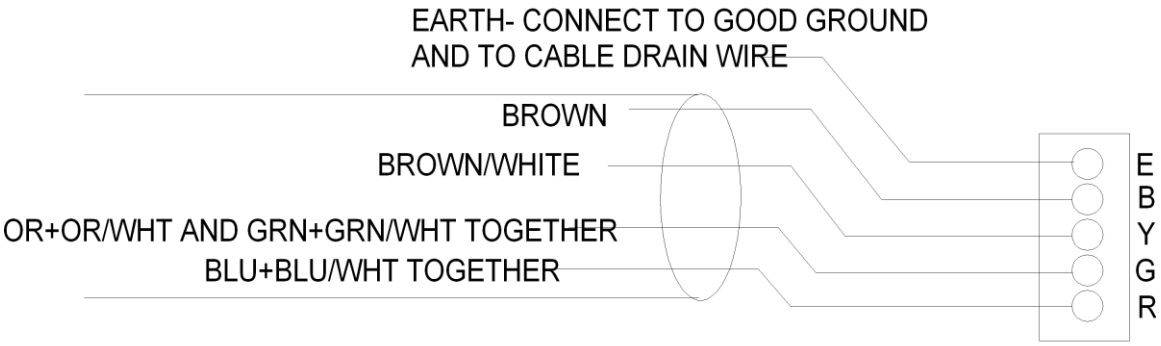
BROWN wire of the BRN-BRN/WHT pair should be installed into the terminal marked B.

CAUTION: Be sure that the wires are stripped at least 1/4". If they are not, the terminal clamp may "grab" the wire by its insulation, creating an open or intermittent connection which may not be readily visible during inspection.

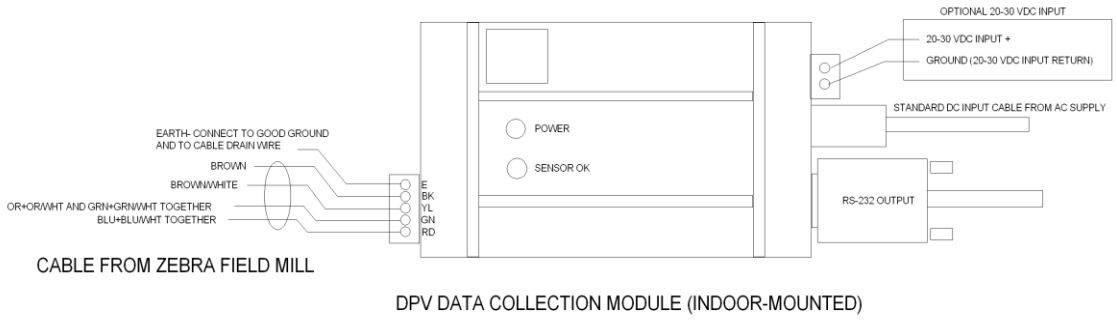
The shield ("drain") wire of the cable should be terminated only at the "indoor" end, at the DCPM Data Module. Do not connect it inside the junction box.

When done, pull on each wire separately to be sure each is secure and double-check for proper connection order. Find the green grounding jumper in the bag. Strip the free end and connect to the "Earth" terminal on the 007 block. Using the green screw included inside the Junction Box (**JBX**) package, attach the ring lug on the green wire to the grounding boss inside the junction box.

A good, low-impedance ground should also be connected to the Junction Box, either inside (to the green screw) or outside, to one of the mounting ears.



JUNCTION BOX WIRING- 007 BLOCK

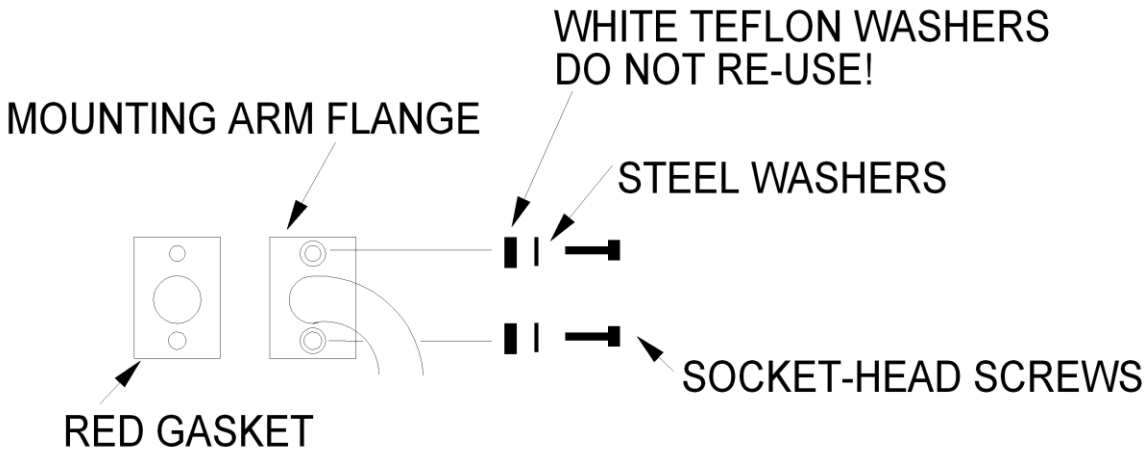


Locate the 36" cable in the kit with round "mini-din" connectors on both ends. Thread the cable through the hole in the center of the curved flange, through the mounting arm, and into the junction box. The connectors have been modified to ease this operation.

Mount the Field Mill Sensor to the curved flange as follows:

CAUTION: This following procedure must be done carefully to avoid water leakage into the sensor which can destroy it. The gaskets on the flange and under the screws must be installed properly!

Locate the socket-head screws, the steel washers, the white Teflon washers, the rectangular red silicone gasket, and the ball-end 9/64" hex key in the MAK kit.



First, prepare the screws by slipping one steel washer on the screw, then screwing the screw into one of the white Teflon washers using the hex key. This procedure "cuts" threads into the Teflon washer and is an important part of the sealing process. DO NOT FORCE THE WASHER OVER THE SCREW. Prepare both screws with one steel washer and one Teflon washer each. Extra Teflon washers are provided, as they can be used only once. If a bolt is used to install the field mill sensor onto the mounting arm, but is later removed for any reason, you MUST replace the Teflon washer on the screw before reinstalling to avoid water leaks. The Teflon washer is deformed as it is tightened and is not likely to be an exact match if installed a second time.

Take the red silicone gasket from the kit and feed the cable hanging from the mounting arm through the large hole in the center of the gasket. Carefully plug the free and of the cable into the side socket in the sensor. Feed the cable back into the mounting arm and position the sensor against the curved flange with the "open" end of the sensor pointing down. Allow excess cable to fall through the junction box. Align the two threaded holes in the sensor with the two holes in the curved flange. Using the two prepared socket-head screws and ball-end hex key, install the two screws to secure the sensor to the curved flange. Thread the screws in carefully, the threads are aluminum. When the screws are "finger tight", tighten them alternately, a little on the top screw, a little on the bottom. Repeat the tightening until the red silicone gasket is seen to JUST BEGIN to bulge out from between the curved flange and the sensor housing. When the

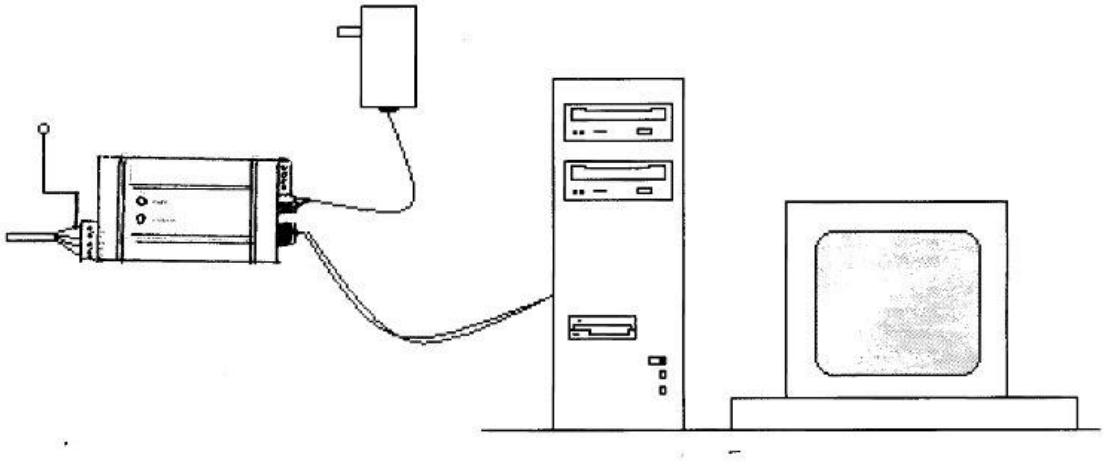
gasket just begins to bulge out, the torque is correct. Do this carefully to avoid water leaks and sensor destruction. If in doubt, the screws can be loosened and retightened to test their torque. As long as the screws are not removed completely the Teflon washers do not need to be replaced.

Plug the end of the cable in the junction box into the socket on the **007** block. Coil the excess cable back into the junction box. Open the **JBC** bag and remove the junction box cover, gasket and screws. Assemble the cover, gasket and screws and install the cover on the junction box. The junction box may be left open at this point in case inspection is needed if there is trouble during start-up.

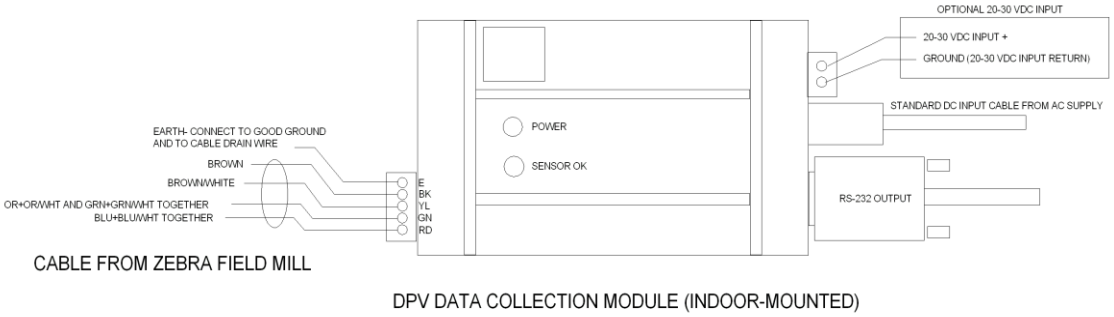
This completes the installation of the sensor.

DATA MODULE INSTALLATION

Once the sensor and cable is installed from the sensor location to the Data Module location, the Data Module can be wired.



The data module typically has four connections: Sensor, Power, data, and ground.



DPV DATA COLLECTION MODULE (INDOOR-MOUNTED)

The four-pair cable from the sensor connects to the screw terminal block marked "sensor cable". This terminal block may be unplugged, if desired, during the wiring process.

BLUE and BLUE/WHITE wires (pair) should be stripped and twisted together (electrically, as one wire) and installed into the terminal marked "RD".

Two pairs ORANGE, ORANGE/WHITE, and GREEN, GREEN/WHITE should also be stripped and put together as one wire and installed in to the terminal marked "G". Due to the small terminal size, these four wires may need to go in straight, not actually twisted.

BROWN/WHITE wire of the "BROWN" pair should be installed into the terminal marked "Y".

BROWN wire of the "BROWN" pair should be installed into the terminal marked "B".

The shield ("drain") wire of the cable should be connected to the terminal marked "E" at the DCPM module end only. Also, this "E" terminal should be connected to a local earth ground.

CAUTION: Be sure that the wires are stripped at least 1/4". If they are not, the terminal clamp may "grab" the wire by its insulation, creating an open or intermittent connection which may not be readily visible during inspection.

Power is normally supplied by an included switching power supply, which plugs into the jack marked "DC IN". If the user wishes to operate the Zebra Plus Field Mill System from an external DC power source of 20-30 Volts DC, this power source may be connected to the screw terminals marked "**AUX DC IN**". Observe polarity. This terminal block may be unplugged if desired to ease wiring. If using external DC input, the AC power supply must not be used. The Zebra Plus system draws approximately 200mA from the DC power source at 24 Volts. Note that the (-) terminal of the AUX DC INPUT is common with the earth ground terminal "E" and the SERIAL OUT interface common.

3. TESTING

Testing the Zebra Plus system is easy, thanks to built-in diagnostics.

Before applying power for the first time, check all connections to be sure all wires are connected to the correct terminals and are secure. Check the junction box block connections as well as those on the Data Collection Module.

When all is well, apply external power. The green "POWER" light should light within two seconds. If it does not, disconnect power and troubleshoot. When the

green "POWER" light is lit, watch and wait for the "SENSOR OK" light to indicate activity. This should happen within about 3 seconds after power is applied. If it does not light, remove power and check all wiring between the sensor and the Data Module.

There is complex communication activity taking place between the DCPM Data Module and the Zebra Plus field mill head during startup. See next section, "Description of system operation"

With power applied, the "Sensor OK" LED will blink several times for several seconds, then, once communication with field mill head is established, will appear to be continuously lit. If the Data Module loses contact with the Field Mill Sensor for any reason, the "SENSOR OK" light will extinguish and/or begin to flash, indicating a problem.

It the "Sensor OK" light continues to blink ("setup" mode), this usually indicates that the DCPM Data Module is unable to contact the field mill head. Check all cable connections.

See "Troubleshooting Section" for troubleshooting suggestions

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4. Description of System Operation

The Zebra Plus system is equipped with an adjustable enhancement factor, which allows tailoring field mill sensitivity to the site. Enhancement factor is set by a set of rotary switches in the DCPM Data Module, then, when power is applied to the system, the selected factor is communicated to the field mill head to complete adjustments before full operation begins. Thus, each time power is turned on, there is a brief setup routine, which requires about 5-10 seconds.

Upon power-up, the DCPM Data Module sends setup information to the field mill head, as indicated by a flashing of the "SENSOR OK" light on the DCPM. When the field mil head has completed setting itself up, it begins transmitting measured data back to the DCPM. At this point, the DCPM ceases sending setup data to the field mill, and begins processing the measured data, sending the results out through the user Serial port. If the field mill head stops sending data, due to such causes as removal, disconnection, or failure of the field mill head, the DCPM returns to setup mode and will continue to attempt contact with the head indefinitely, as long as power is applied. Once the sensor is restored and begins to send data, the **DCPM** will return to normal operation, as indicated by a steady green "SENSOR OK" LED.

In the event of certain types of shutdowns, a built-in watchdog timer will cycle system power and attempt to restart the system automatically.

The "SENSOR OK" light will only light continuously when power is present, the sensor is properly connected, and the sensor is operating correctly. The microprocessor inside the DCPM Data Module turns this light on when it is receiving the proper signal from the Field Mill Sensor. This light flashes when the DCPM is not receiving data from the field mill head and it is trying to contact the head.

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Testing the Digital Interface: Complete testing of the digital output requires a functioning computer program compatible with the Binary, 1200 Baud data stream, such as Vaisala's ALARM software. Connect the supplied (or equivalent) serial cable from the "SERIAL OUT" DE-09 connector on the Data Module to the Windows PC or other display device.

If the field mill is properly installed, it should be reading the current atmospheric electric field outdoors. A typical reading found on a clear sunny day can be expected to be in the range of 200-300 Volts per meter.

A further test can be performed if an assistant is available. Watch the output while an assistant takes any piece of plastic up to the field mill sensor. Use any scrap of plastic, a bag, a screwdriver handle, etc. Rub it vigorously on a pant leg, for example, then quickly hold it directly below the sensor while operating. The output should climb to a high value while the "charged" plastic is held in position. This is a good, quick test to show that the Zebra Plus Field Mill is operating properly. This test is less effective in humid environments.

5. OPERATION

The Zebra Plus Field Mill is designed to operate 24 hours per day. Removing power during normal operation is not recommended unless necessary for testing or maintenance. The motor lubricants and electronic circuitry will remain more stable with continuous operation. Secondly and more importantly, the continuously-spinning rotor will discourage the entry of insects or foreign objects. In addition, in cold climates, the heat generated by the Zebra Plus Field Mill will help keep the system stable.

Applying Power

After installing and wiring the Zebra Plus field mill system and making any necessary adjustments to the Enhancement Factor (see "Site Corrections"), apply power by connecting the supplied DC "wall transformer"-type power supply

to the Data Module, and plugging into an appropriate AC mains receptacle. Check the ratings on the power supply to be sure that the power supply is appropriate for the intended AC power source. The standard power supply is designed to operate from 100-240V AC, 50-60Hz mains, which is appropriate for almost any location. The standard power supply has an IEC 60320 connector built-in. This is the same as is used on most desktop PC's, in addition to thousands of other electronic devices.

System Startup and Normal Operation

As soon as power is applied to the Data Module, the system enters "setup" mode. In this mode, the Power light illuminates, and the "SENSOR OK" light will begin to flash. Each flash corresponds to the transmission of setup information from the Data Module to the remote Field Mill Head. After several such transmissions, the Field Mill Head will have stabilized and received enough data to set its gain (enhancement factor) and begin transmitting electric field data to the DCPM Data Module. When these transmissions begin, the Data Module exits "setup" mode, begins processing the electric field data and sending this data out of the serial port to the host PC. These transmissions are sent at a rate of about one per second, but can be increased to approximately 15 per second by installing a wire jumper inside the field mill head. The "SENSOR OK" light remains on as long as data are being received from the field mill.

System Output

The digital output is in the form of an RS-232 serial signal, with baud rate permanently set for 1200 Baud, 8 data bits, 2 stop bits and no parity. The connector is a standard female DE-09, subminiature "D" connector, as is used commonly in personal computers. Pin 5 is ground, and pin 2 is the data line equal to DCE configuration. This connector can be plugged (using the supplied cable) directly into the com port of most PC's without use of a null modem or other adapter

The data streams continuously and the DCPM Data Module accepts no commands from the user-supplied host

The binary output is given in VOLTS. Full-scale of the system is 5.0 Volts, which is equal to 10,000 V/m of electric field. The Windows client software is responsible for converting this "Voltage" reading to the desired units, such as Volts/Meter of electric field, using the above-described relationship.

The output can be converted from BINARY format to ASCII Format. To do this, the DCPM must be opened, and a shorting jumper (0.1" spacing) placed across the terminals labeled "J1" just below the PLCC processor on the circuit board.

6. SITE CORRECTIONS

The Zebra Plus Field Mill is designed to offer a means of making atmospheric electric field measurements. To this end, the relatively simple rooftop mounting scheme is suggested. One potential pitfall in this scheme is the uncertainty of site performance. Varying roof heights, shielding from trees or building components and such can affect the sensitivity of the any field mill. The Zebra Plus has been designed and calibrated to operate with reasonable accuracy when installed near the center of the roof of a single-story building, with trees, towers, and other tall objects at a distance equal to at least their height

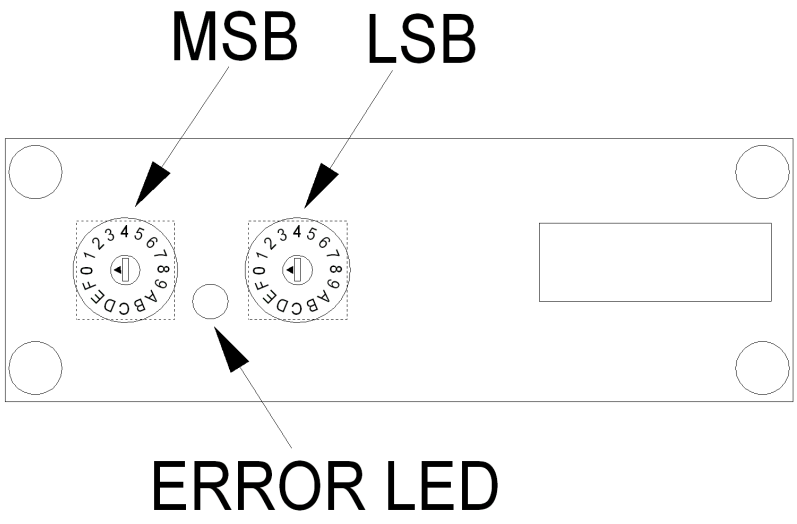
In addition, the Zebra Plus field mill features an adjustable "Enhancement Factor". This allows adjustment of the field mill's sensitivity to suit most installations. The field mill's gain may be adjusted from a minimum of approximately one-half to a maximum of approximately four times the normal sensitivity.

Enhancement factor is selected by means of two rotary Hexidecimally-encoded switches, located inside the Data Module. There are two switches, each with a range of "0" (Zero) to "F", thus each Enhancement Factor setting has a corresponding two-digit hexadecimal number associated with it. See the chart in the "Site Corrections" section (below) for a listing of available settings.

To adjust the Enhancement Factor, first make a site measurement to determine the desired Enhancement Factor. There are a number of ways of determining this. One is to compare readings of the "new" field mill with another field mill, either a temporarily-installed standard, or perhaps an older unit being replaced. Another technique is to observe the "fair" weather field on a clear sunny day. If a typical reading for the location is known from previous experience, use that figure. The fair weather field in many locations is often fairly constant and can be used to estimate the sensitivity of the new field mill. If no historical value is available, assume that the field on a clear, sunny day with no clouds is 200-300V/m, and of positive polarity. Monitor the field measured by the Zebra Plus for a period of time, perhaps taking several measurements over several hours, mid-day. If the average value is at or near 200-300V/m, the field mill calibration is probably reasonably good. If it is higher or lower, then determine the Enhancement Factor required to correct the output. Once the desired factor is determined, look up the value in the chart and note the corresponding 2-digit code to achieve that Enhancement Factor. Find the two rotary switches in the end panel of the Data Module (see the figure) and dial in the two digits.

If the required value is outside the range of those values available in the list, the installation may need to modified. The field mill head can be raised up higher from the rooftop to increase readings, or moved closer to the rooftop to reduce them.

ENHANCEMENT SETTING SWITCHES



The factory default value giving an Enhancement Factor of 1.0 is the two-digit code 2B. To enter this value, use a small screwdriver to rotate the switch further from the green field mill cable connector (MSB) to "2", and the switch nearer the connector (LSB) to "B". Always turn power off before making this adjustment to ensure that the new value will be properly read by the system controller on startup.

ILLEGAL ENHANCEMENT VALUES

Some values (those higher than 6C) may not be used, as they would push the sensor outside of its design limits. To ensure that these values are not used, the system processor will not allow the system to operate with those values entered on the switches.

If an "illegal" value is selected, a red "ERROR" LED installed between the rotary switches will illuminate the next time the power is applied, and the system will not start. Because the system is halted in this state, the hardware-based watchdog timer will try to restart the system every 10 seconds until the switch settings are corrected. ALWAYS MAKE IT A PRACTICE TO TURN THE SYSTEM POWER OFF AND THEN BACK ON AFTER ALL ADJUSTMENTS ARE COMPLETED TO ENSURE THAT THE PROPER SETTING IS IN EFFECT.

ZEBRA PLUS GAIN SWITCH SETTINGS

ENHANCEMENT_FACTOR_TABLE

Sensor gain = 1/EF

Settings above 6C are not to be used

EF	Switch	EF	Switch	EF	Switch	EF	Switch
4.16	6C	1.80	51	1.15	36	0.84	1B
4.00	6B	1.75	50	1.13	35	0.83	1A
3.85	6A	1.72	4F	1.12	34	0.83	19
3.65	69	1.69	4E	1.11	33	0.82	18
3.45	68	1.66	4D	1.10	32	0.81	17
3.35	67	1.64	4C	1.08	31	0.80	16
3.23	66	1.60	4B	1.06	30	0.80	15
3.12	65	1.56	4A	1.05	2F	0.79	14
3.00	64	1.54	49	1.04	2E	0.79	13
2.93	63	1.52	48	1.03	2D	0.78	12
2.86	62	1.50	47	1.02	2C	0.77	11
2.74	61	1.47	46	1.00	2B	0.76	10
2.63	60	1.43	45	0.99	2A	0.76	0F
2.56	5F	1.41	44	0.98	29	0.75	0E
2.50	5E	1.39	43	0.97	28	0.75	0D
2.41	5D	1.37	42	0.95	27	0.74	0C
2.33	5C	1.35	41	0.94	26	0.73	0B
2.28	5B	1.33	40	0.93	25	0.72	0A
2.22	5A	1.30	3F	0.93	24	0.72	09
2.17	59	1.28	3E	0.92	23	0.71	08
2.13	58	1.26	3D	0.91	22	0.70	07
2.06	57	1.25	3C	0.90	21	0.69	06
2.00	56	1.23	3B	0.89	20	0.69	05
1.96	55	1.22	3A	0.88	1F	0.69	04
1.92	54	1.20	39	0.87	1E	0.68	03
1.89	53	1.18	38	0.86	1D	0.68	02
1.85	52	1.16	37	0.85	1C	0.67	01
						0.67	00

7. TROUBLESHOOTING

The Zebra Plus Field Mill system is engineered to be simple to install, connect, and operate. All Zebra Plus systems are thoroughly tested at the factory before shipment, and so if problems are experienced in the field, the first place to look for trouble is in the installation, particularly in the wiring and external connections.

All interfaces in the Zebra Plus system contain various degrees of protection against damage from lightning as well as improper electrical connections made during installation. However, these systems can only take a certain amount of overloading, so If the system does not appear to be operating correctly upon initial power-up, remove power as soon as possible to reduce the chance of damage occurring to the system if electrical connections are wrong.

No Power Light

*Check power source: AC outlet, DC power source, if used. Try temporarily connecting an alternate power source (20 to 30VDC) to the "AUX DC IN" input terminals

*Disconnect SENSOR cable from the DCPM Data Module (the green terminal strip can be unplugged from the module). If POWER light returns, there may be a short circuit in either the cable, the Junction Box, or the Zebra Plus Field Mill. The DCPM contains automatic-resetting overcurrent protection devices. If the system is overloaded, these devices will open-circuit, and reset themselves when the fault is removed. Also, the supplied switching power supply has automatic foldback protection, so an overload normally results in its shutting down until the overload is removed.

Power Light goes off momentarily every 10 seconds

This behavior indicates that the "watchdog" timer is trying to restart the system. The "watchdog" is activated whenever the "SENSOR OK" light is not flashing. Note: during normal operation, the light appears to be steady, but actually has short, invisible interruptions programmed in to keep the watchdog inactive.

Sensor OK light flashes continuously

A continuous flashing of the light indicates that the system is remaining in SETUP mode. The flash can be fast (several flashes per second), or slow (once per second), depending on elapsed time since power-up.

Failure of system to exit SEUP mode and enter RUN mode usually means that there is either a failure in the connections/cabling to the Field Mill sensor, or a loss of or damage to the sensor.

Check all wiring and connections between the Field Mill and DCPM, including connectors and wiring inside the field mill stand and junction box. Be sure that there is adequate power being supplied to the DCPM, as too-low voltage arriving at the field mill's location at the end of the long cable can cause the field mill to operate improperly, even though the Data Module is receiving power. There must be a minimum of 12V between the R and G terminals AT THE JUNCTION BOX 007 connection block. If the Field mill has been shut down for extended periods in cold weather (below 0 degrees F), it may take some time to warm up enough to operate correctly. If this happens, allow at least 1/2 hour for the instrument to warm up after applying power.

"Sensor OK" light is OFF

When the "SENSOR OK" light is steadily OFF with power ON, it usually indicates that an "illegal" Enhancement Factor switch code has been entered. This condition will also be indicated by the illumination of the small red LED between the rotary switches. Reset the code to a proper value and cycle the input power to correct.

Lights are on steadily, but there is no digital output

Check the functioning of the Host PC. Be sure the communications port is correctly configured. A "dumb" terminal (or communications software such as "Hyperterminal") set for 1200 Baud may be used to verify presence of digital output. Such devices, expecting ASCII characters instead of binary data normally display the letter "U" when each binary message is sent.

BE sure the serial data cable is wired and connected correctly. Remember that the output DE-09 connector is configured as DCE, which normally is compatible with typical PC communications ports, which are configured as DTE.

8. MAINTENANCE

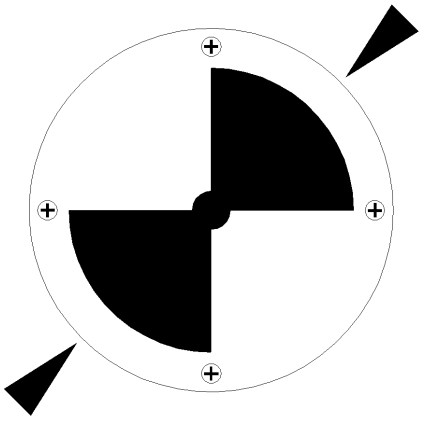
The Zebra Plus Field Mill is designed to operate with very little maintenance.

The Zebra Plus will require occasional cleaning. When installed in harsh environments (seashore, areas with heavy airborne contaminants), the Zebra Plus may require more frequent cleaning. The Zebra Plus field mill sensor may need to be removed from its mount and partially disassembled for cleaning. The Data Collection module requires no periodic maintenance of any kind.

Indications: Lower sensitivity or any unusual behavior usually indicates the need for cleaning.

Since each installation will have its own characteristics and experience different amounts and types of contaminations, it is suggested that the user begin by inspecting the Zebra Plus at 6-month intervals as described in this section. After two or three such inspections, the user will be able determine the frequency required for future inspections and cleanings. Environments free of heavy contaminants may only need occasional removal of excess dust as described below.

A) Light cleaning. At 6-month intervals, it is suggested that the Zebra Plus sensor be inspected for contamination. Look closely inside the openings for dust, insects,



CLEAN OPENINGS WITH AIR

or any other foreign objects or substances. Light dust is not detrimental to the Zebra Plus's operation and can be ignored. An aerosol duster such as is used on computer equipment can be used to clear the interior if needed, and is recommended. If there are signs of heavier contamination such as heavy soil accumulation inside the openings, insect infestation, or the like, a "major" cleaning is probably in order.

B)_ Major cleaning.

Remove Mill from stand- have fresh white Teflon washers available for reinstallation (see page 20 for mounting information).

Remove stator- see step 1 in diagram. Note location of the fifth "key" hole in the stator and remember that this must be engaged during reassembly.

Remove rotor- single screw in center. See step 2.

Remove sensor plate- 3 screws. See step 3. Note that one screw is shorter than the other two. This is to be installed in the larger metal insert in the Teflon base.

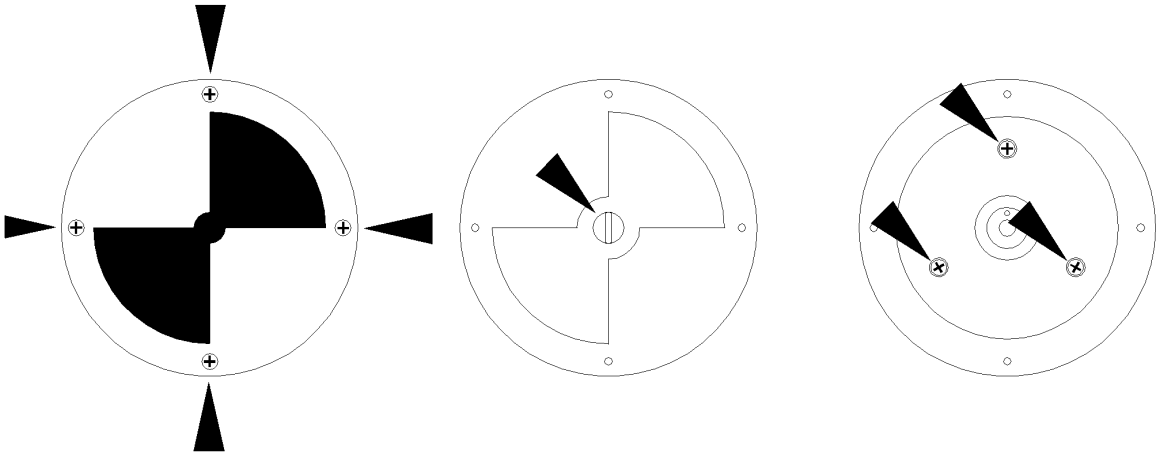
Wipe interior clean with a damp cloth. If available, use aerosol "Air" cleaners (such as used to clean photographic equipment or computers) to clean between the ribs in the white Teflon insulator.

Do not get any contaminants into deep recess directly around motor shaft.

Reassemble, by reversing process. Do not over-tighten screws!

The sensor plate has countersunk holes- be sure these face out.

The rotor is keyed, but may be installed with either side out.
Be sure the key pin engages the key hole in the stator plate (not shown in diagram).



9. SPECIFICATIONS, ZEBRA PLUS

Operational

Accuracy……..+/- 10%
Response Time……1 second
Signal Interface……..8 bit binary, RS-232
Sampling……..Streaming, fixed 1200 Baud
Range …….10kV/m, maximum

Electrical

Power Requirements: 100-240VAC (50-60 HZ) or 20-30 V DC
Power Protection: Multi-Stage Transient Protection
Power consumption: Approximately 3 watts

Mechanical

Motor……Brushless - 80,0000+ hours / MTBF
Weight ……1.5 lb
Dimensions Height 6"
Diameter 3"

Cable Interface:
Cat 5e STP Communications cable 4-twisted pair, 24 AWG min
Terminations: Screw-type terminal blocks

Environmental

Operating Temperature Range…..-10 to +30°F, -23 to + 44°C

Communications

Output: RS-232, streaming, fixed 1200 Baud, Binary format

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