STI Vibration Monitoring Inc.

Field Application Note

Field Wiring Installation FWI

There are a number of items to consider when installing a permanently mounted vibration monitoring system. One of the most critical considerations is the selection and installation of the wire connecting the vibration transducers mounted on a machine to the associated Monitoring Instrument. Along with this wiring, there are a number of External Monitor Connections that require consideration. All of this Monitor System interconnection is often referred to as the "Field Wiring".

If the Field Wiring is not designed and installed in an appropriate manner, Noise or Line Interference can be induced into the Vibration Monitoring System. Since the induced noise is normally an alternating waveform, the Monitoring Instrument will interpret this signal as false vibration. The Vibration Monitoring System will then not function as a reliable and credible protection or information system.

Low Level Signals

Vibration monitoring systems utilize the low level (voltage) output signals available from vibration transducers. These signals represent the actual vibration or motion of the machine's shaft or bearing housing.

The following table provides a comparison of vibration transducer signal levels expected from a machine running at 3600 RPM.

Transducer Type	Expected Vibration	Transducer Scale Factor	Output Level
Proximity	1.0 mil	200 mV/mil	200 mV
Velocity	0.1 in/sec	100 mV/mil	10 mV
Accelerometer	0.1 g	100 mV/g	10 mV

As can be seen from this table, the signal level available from these transducers is quite low. Base Line Noise especially in Power Plants can be as high as 200 mV if the Vibration Monitoring System is not properly installed. Since a running speed of 3600 RPM is the same as 60 Hz, any noise induced on the Vibration Monitoring System by a power source will be interpreted as 1 times running speed vibration. These transducer signal levels are also frequency dependent. When the machine's designed running speed is increased, in general, the expected Displacement level will decrease, the expected Acceleration level will increase, and the expected Velocity level will remain constant.

Noise Sources

Noise or Line Interference can be induced in a Vibration Monitoring System in a number of ways. However, there must first exist a source for the induced noise. There are numerous noise sources available in an industrial or power generation plant:

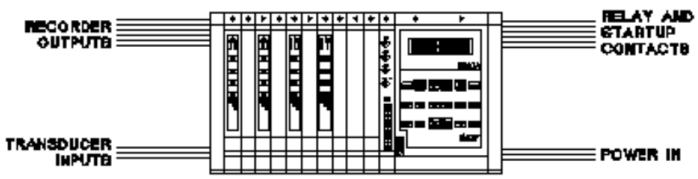
AC Power Transients
Ground Differentials
Switching Circuits
High Voltage Circuits
Improper Load Balance

Noise can be induced in a Vibration Monitoring System through Electrostatic (Capacitive), Electromagnetic (Inductive) or Conductive Coupling (Direct Connection). All noise will be induced in the monitoring system through one or more of its external connections or Field Wiring.

AC Power

The AC Power source for the Vibration Monitoring System or any other Electronic Instrument needs to be a "CLEAN" source. This implies that the source must be free of power surges and transient voltages. A power conditioning device, such as a Sola® Power Line Conditioner, can be installed to alleviate these power source problems. For installations with a switchable power source, an Uninterruptible Power Supply (UPS) will be required.

A Straight Blade 3-Wire Grounding Power Receptacle (Nema 5-15R) is required for the power connection. This AC Power Source should have a manually operated switch device, or circuit breaker, in line. A separately sourced Service Power Receptacle should be located near the Vibration Monitoring System for test equipment power. The Power Source should be checked for the following voltage tolerances at 50/60 Hz.



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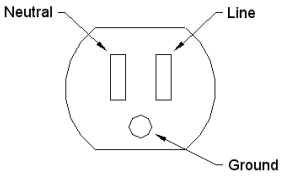

Typical 110 VAC
Power Receptacle

110 VAC Instrument Power

Neutral to Ground 0 VAC
Line to Neutral 105-126 VAC
Line to Ground 105-126 VAC

220 VAC Instrument Power

Line-1 to Line-2 207-242 VAC
Line-1 to Ground 104-121 VAC
Line-2 to Ground 104-121 VAC

Relay Connections

When a Monitor's Relay Contact Connections are used for annunciation or shutdown, these driven circuits must be free of noise or voltage transients. If these circuits present problems, Slave Relays should be utilized to isolate the Vibration Monitoring System from this known noise or transient sources.

Startup Connections

When Startup Contact Connections are used to initiate a Monitor's Startup feature, the drive circuit (dry contact) must be free of noise or voltage transients. Again, if these circuits present problems, Slave Relays should be utilized to isolate the Vibration Monitoring System from this known noise or transient sources.

Transducer Instrument Wiring

The Instrument Wire from the Vibration Transducer to its Monitor should be either a twisted pair or triad cables depending on the Transducer's requirement. These cables should be stranded, individually insulated, shielded, and overall jacket. The shields or drain wires must be insulated or isolated from each other and the conduit. The use of multi-conductor cable with a single shield is strongly discouraged due to its susceptibility to induced noise and line interference.

The gauge or thickness of the Instrument Wire is determined by the distance between the Vibration Transducer and Monitor. Long lengths of Instrument Wire acts as a low pass filter, and will attenuate high frequency signals. This situation can be a problem when monitoring gear mesh Frequencies, blade passage, or roller element bearings with a high frequency accelerometer.

The following table offers a guideline to help select the proper Instrument Wire gauge (AWG).

Transducer Type	Length of Cable Runs <200'	<1000'	>1000'
Non-Contacting	22 AWG	20 AWG	18 AWG
Velocity	22 AWG	20 AWG	18 AWG
Accelerometer	20 AWG	18 AWG	--

The following table is a partial list of Belden® Cables that should be used for the Instrument Wire. These part numbers can be cross-referenced to equivalent cables from other manufactures. These cables are polyethylene insulated, twisted, with beldfoil shield and drain wire, and PVC jacket.

	Belden Part Numbers			
	Pair	Nom. O.D.	Triad	Nom. O.D.
18 AWG	8760	0.22"	8770	0.25"
20 AWG	8762	0.20"	8772	0.22"
22 AWG	8761	0.17"	8771	0.19"

A color code convention should be used when installing the Instrument Wire as outlined in the following list.

Red - Power
Black - Common
Clear - Signal

Recorder Outputs

The cable from the Vibration Monitor's Recorder Outputs to any Recording Device should be a twisted pair cable. These cables should be stranded, individually insulated, shielded, and overall jacket. Before installing these cables, the manuals for both the Vibration Monitor and the Recording Device should be reviewed for proper connections of Signal, Common, and Shield.

Junction Boxes

An important piece of hardware for installing Vibration Transducers is Junction Boxes. These should be located at the machine for mounting the Non-Contacting Pickup's Signal Sensors and interfacing terminal strips.

A Junction Box is also the transition point of Flexible Conduit to the Vibration Transducer and Rigid Conduit to the Monitor. The Junction Boxes should be installed close to the monitored point and within the length of the Vibration Transducer's extension cable. The Junction Boxes should be mounted in a convenient location for serviceability. They should not be mounted under machine skirts or other inaccessible locations when the machine is running.

Following is a list of available SKF-CM NEMA 4X Junction Boxes.

Eddy Probes

Two Channel (2 Drivers)	P/N CMCP-150-02
Four Channel (4 Drivers)	P/N CMCP-150-04
Six Channel (6 Drivers)	P/N CMCP-150-06

Accelerometer

6"H x 6"W x 4"D	P/N CMCP260-01
8"H x 6"W x 4"D	P/N CMCP-260-02
10"H x 8"W x 6"D	P/N CMCP-260-03

Following is a list of available Extension Cable Lengths for location distance from the associated transducer.

5mm Eddy Probe	5 or 10m
8mm Eddy Probe	5, 10, or 15m
CMCP793V Velocity Pickup	5, 10, or 20m
CMCP1100 Accelerometers	5, 10, or 20m

Conduit

For a quality Vibration Monitoring System installation, it is critical that conduit be utilized on the Vibration Transducer and its associated Instrument Wiring. The use of conduit greatly reduces the possibility of induced noise or line interference on the signal path. The conduit system should be dedicated solely to the Vibration Monitoring System, and no other wiring of any classification should be in the same conduit.

Cable Trays, Wire Ways, or Instrument Trays are an unacceptable alternative to dedicated conduit. This conduit must be routed as far as possible away from any power cables. This is also the case when the Vibration Monitor is installed in a cabinet. The Instrument Wire for the transducers must be separated as much as possible from both Power and Relay Contact cables. All conduit must be installed and grounded in compliance with the appropriate

Articles of the National Electrical Code, in effect at time of installation.

Instrument Wire Conduit and Power Cable Conduit parallel runs should be avoided when possible. When parallel runs cannot be avoided, the following spacing should be used.

Length of Run	120/240V Circuits	480-6900V Circuits
0-100'	2'	4'
100-250'	4'	8'
250-400'	6'	12'
400-550'	8'	16'

This recommended spacing is based on a 500-Ampere Circuit and can be adjusted proportionally for other loads. However, a minimum spacing of (1) foot should be maintained. At conduit cross over locations, a minimum spacing of one (1) foot should be maintained.

Rigid Metal Conduit

Rigid Metal Conduit (IMC) continuously bonded made of ferrous (magnetic) material must be used between the Vibration Monitoring system and the Junction Boxes located at the machine.

Flexible Metal Conduit

Flexible Coated Metal Conduit (Sealtite® or Liquatite®) continuously bonded may be used from the Junction Box to the Vibration Transducer or machine entry point provided it is made of ferrous (magnetic) material.

When installing Instrument Wire Conduit, the Conduit must not be overfilled with Instrument Wires. As a rule, only 40% to 50% of the Conduit's cross sectional area should be filled with Instrument Wires. This fill ratio allows easier installation of the Instrument Wires with some future expansion capability. Following is a cross-reference table of recommended cables, conduit size, and number of cables installed in the conduit.

	NUMBER OF CABLES PER CONDUIT					
CONDUIT:	1/2"	3/4"	1"	1-1/2"	2"	2-1/2"
CABLE						
8760	3	6	11	26	43	61
8762	4	8	13	31	51	73
8761	6	11	17	43	69	99
8770	3	5	9	21	35	50
8772	4	7	11	27	44	64
8771	5	8	14	34	56	80

Grounding/Shielding

A "Single Point Grounding" scheme should be utilized when installing a Vibration Monitoring System. This scheme of grounding means that all grounds are connected or tied down at one location. It is highly recommended that for a Vibration Monitoring System installation the Single Point Ground should be at the Monitor not at the Machine. On a large machine or where multiple machines are being monitored, substantial ground differentials (potentials) can be found between transducer locations.

All Instrument Wire shields must be grounded at one end of the cable, and the other end left floating or not connected. The Instrument Wire should be grounded at the Vibration Monitoring System. If the shield is not grounded, the shield will become an antenna increasing induced noise on the signal path. If the shield is grounded at both ends, it will allow ground differential (potential) current (ground loop) to flow through the shield seriously increasing induced noise and voltage transients.

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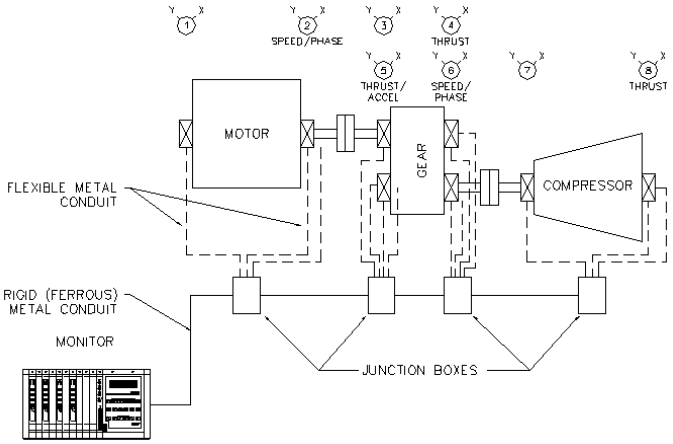
Typical Layout Drawing Checklist

- ❑ AC Instrument Power
    1. Proper Voltage
    2. Power Ground
    3. Common to Ground < 5 Volts
    4. System Neutral to Ground = 0 Volts
- ❑ Junction Boxes Used and Accessible
- ❑ Solid Ferrous Metal Conduit (Monitor to J-Box)
- ❑ Flexible Conduit (J-Box to Transducer)
- ❑ Instrument Wire
    1. Individual Wires Used
    2. Insulated, Shielded, Twisted
    3. Proper Gauge
- ❑ Common Point Ground Scheme
- ❑ Shield Grounded One End Only



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