Field Instrument Cable

Electrical Noise

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Electrical Noise

Instrument Cables are Susceptible to 4 Types of Noise:

- Static
- Magnetic
- Cross-Talk
- Common Mode

Static Noise

Static Noise is caused by an electric field radiated by a voltage source being coupled capacitively into the instrument circuit

Solution: Properly grounded shields which isolate the pair from outside noise influence

Static Noise

Static Noise Reduction

Ungrounded Shield	0 dB
Braid Shield	40.3 dB
Aluminum/Mylar & Drain	76.4 dB

Magnetic Noise

Magnetic Noise is produced by currents flowing through conductors and electrical equipment such as motors or generators. The current flow produces a magnetic field around the conductor or equipment.

Solution: Twisting the pairs sets up loop canceling

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Magnetic Noise

Magnetic Noise Reduction*
Field Reduction

Aluminum or Copper Tube	0 dB
1 Inch Steel Conduit	42.8 dB
1 Inch Interlocked Armor	28.8 dB
Parallel Wires	0 dB
4 Inch Pair Lay	23 dB
2 Inch Pair Lay	41 dB

*Magnetic Field 75 Gauss

Cross Talk

Cross-Talk occurs when multi-pair cables couple signals from one pair to an adjacent pair. The coupling creates noise (errors) on adjacent pair. (example: Telephone long distance cross-talk)

Solution: Individual properly grounded pair shields or staggered lay pairs

Common Mode Noise

Common Mode noise is caused by different ground potentials in a process plant. Two different ground potentials mean a current will flow between them

Solution: Proper grounding techniques. Pair shields grounded at one point (in the control room)

Field Instrument Cable

Electrical Performance

Inductance
Capacitance
Impedance

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Inductance microHenries/ft

- Inductance is based on a physical separation, it does not take into account the dielectric properties of the insulation
- Increasing the conductor diameter reduces the inductance of the pair
- Increasing the insulation thickness increases the inductance of the pair
- Inductance opposes a change in current flow

Capacitance picoFarads/ft

- Capacitance is determined by conductor diameter, insulation thickness, and insulation dielectric constant
- Increasing the dielectric constant increases the capacitance
- Increasing the insulation thickness decreases the capacitance
- Increasing the conductor diameter increases the capacitance

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Capacitance

- A high capacitance cable will restrict the length and frequency that digital signals can be transmitted
- Capacitance can be lowered further by injecting air or gas into the insulation creating foamed bubbles
- Capacitance is the cables ability to store a charge

Impedance

- The total opposition that a cable offers to the flow of varying current at a specific frequency

- Values used to calculate Impedance include AC resistance, Capacitance, Inductance, and Frequency.

Field Instrument Cable

Selection and Sizing of Conductors

- Voltage drop
- Current capacity
- Impedance matching
- Available driving voltage

Copper Conductor Resistance

AWG	Ohms/1000 ft
22	16.7
20	10.5
18	6.7
16	4.2
14	2.6
12	1.7

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Types of Conductors stock by Dekoron

Copper

- 10-20 AWG
- Bare or tinned copper
- 7 strand as standard
- 19 strand flexible and solid to special order only

Thermocouple Extension

- 16-20 AWG
- EX, JX, KX, TX, SX Extension alloys
- Solid as standard
- Stocked raw wire 16 & 20 AWG KX, JX, EX & TX

Conductor Data

Solid Copper Conductors						20°C Direct Current Resistance			
		Nominal Diameter		Approximate Weight		Bare		Tinned	
AWG / Size	CMA	mils	mm	lb/Mft	kg/km	ohms/Mft	ohms/km	ohms/Mft	ohms/km
20 / 0.52 mm²	1,020	32.0	0.81	3.10	4.61	10.10	33.20	10.50	34.60
18 / 0.82 mm²	1,620	40.3	1.02	4.92	7.32	6.39	21.00	6.64	21.80
16 / 1.31 mm²	2,580	50.8	1.29	7.81	11.60	4.02	13.20	4.18	13.70
14 / 2.08 mm²	4,110	64.1	1.63	12.40	18.50	2.52	8.28	2.63	8.61
12 / 3.31 mm²	6,530	80.8	2.05	19.80	29.40	1.59	5.21	1.65	5.42
10 / 5.26 mm²	10,380	101.9	2.59	31.43	46.77	0.99	3.28	1.04	3.41
Metric									
0.50 mm²	987	31.4	0.79	2.98	4.43	10.50	34.50	10.90	35.80
0.75 mm²	1,480	38.5	0.98	4.49	6.68	7.00	23.00	7.28	23.90
1.00 mm²	1,974	44.4	1.13	5.97	8.88	5.26	17.30	5.47	17.90
1.50 mm²	2,960	54.4	1.38	8.96	13.33	3.50	11.50	3.64	11.90
2.50 mm²	4,934	70.2	1.78	14.92	22.20	2.10	6.89	2.19	7.19
4.00 mm²	7,894	88.8	2.25	23.87	35.52	1.32	4.33	1.37	4.49

Concentric 7-Strand Class B Copper Conductors								20°C Direct Current Resistance			
		Nominal Strand O.D.		Approximate O.D.		Approximate Weight		Bare		Tinned	
AWG / Size	CMA	mils	mm	in	mm	lb/Mft	kg/km	ohms/Mft	ohms/km	ohms/Mft	ohms/km
20 / 0.52 mm²	1,020	12.1	0.31	0.036	0.91	3.15	4.71	10.30	33.90	10.70	36.00
18 / 0.82 mm²	1,620	15.2	0.39	0.046	1.17	5.01	7.46	6.54	21.40	6.92	22.70
16 / 1.31 mm²	2,580	19.2	0.49	0.058	1.47	7.97	11.86	4.10	13.40	4.35	14.30
14 / 2.08 mm²	4,110	24.2	0.62	0.073	1.85	12.68	18.88	2.58	8.45	2.68	8.78
12 / 3.31 mm²	6,530	30.5	0.78	0.092	2.34	20.16	30.00	1.63	5.32	1.69	5.53
10 / 5.26 mm²	10,380	38.5	0.98	0.116	2.95	32.06	47.71	1.02	3.34	1.06	3.48
Metric											
0.50 mm²	987	11.9	0.30	0.036	0.91	3.06	4.55	10.70	35.10	11.30	37.10
0.75 mm²	1,480	14.5	0.37	0.044	1.12	4.54	6.76	7.19	23.60	7.63	25.00
1.00 mm²	1,974	16.8	0.43	0.050	1.27	6.10	9.08	5.35	17.60	5.69	18.70
1.50 mm²	2,960	20.6	0.52	0.062	1.57	9.17	13.64	3.56	11.70	3.70	12.10
2.50 mm²	4,934	26.5	0.67	0.080	2.03	15.18	22.59	2.15	7.05	2.24	7.35
4.00 mm²	7,894	33.6	0.85	0.101	2.57	24.40	36.31	1.34	4.40	1.39	4.56