TESTING TO STANDARDS

DO-160

Sections 16, 18, and 19

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Today's Webinar

- 35 minutes – DO 160 Testing Challenges
- 5 minutes – Section 16, 18, 19 Test Solutions
- 20 minutes – Your Questions (Q&A)

**Please add your questions to the Chat during this session, or offer your question during our Q&A

In-House Testing

- There are no requirements for having a certified testing laboratory in DO-160, MIL-STD 461, nor MIL-STD 704.
- Many companies perform their own testing and qualify their own equipment – for MIL-STD 461 the lab must meet the requirements of Section 4.

In-House Testing

- Bench testing does not require the use of a shielded enclosure for DO-160 or MIL-STD 704.
- Conductive benches which may be used are often copper but can be aluminum, brass or steel, and only the size ($\geq 2.25\ m^2$) and conductivity are required.

DO-160: Section 16

- Overvoltage, Undervoltage, variations and dwells
- Dropouts - e.g., 28 VDC to 0 VDC to 28 VDC with dwells for 50 mS, 200 mS, 1 Second
- Ramped “Momentary” Interruptions
  - Double dropouts for digital circuits are 10 mS or 50 mS apart

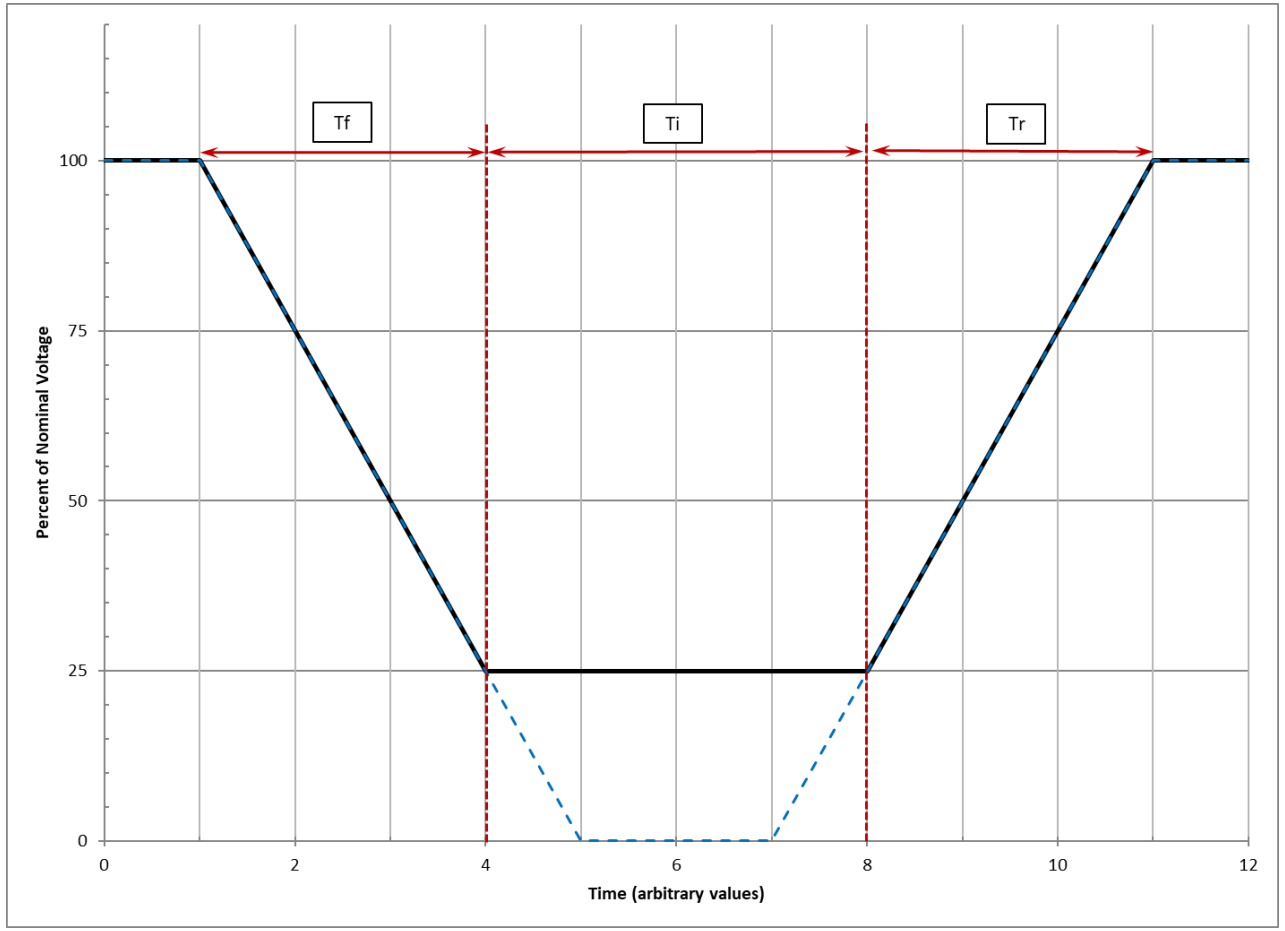
DO-160: Section 16

- Surge – Short duration excessive voltage with two levels
  - e.g., 80 VDC for 100 mS, then 48 VDC for 1 Second
- Engine Starting – 10 VDC to 20.5 VDC in 35 Seconds
- Inrush Current – 9X-3mS; 4X-500mS; 2X-2 Seconds

Input Power Testing Issue

- The use of a ground plane is acceptable but not required.
- Do NOT use LISNs during testing.
  - The LISN can distort the waveform and create an unfair advantage to the equipment.
- Note: DO-160H will expressly prohibit the use of LISNs for Section 16 testing.

Table 16-3 DC Interruptions



Test Condition	Tf (mSec)	Ti (mSec)	Tr (mSec)	% of V nominal (V min)	A	B	Z	D
1	<1	<1	2	0				
2	10	0	3	50				
3	17	8	4	15				
4	18	32	5	10				
5	19	56	5	5				
6	20	80	5	0				
7	20	180	5	0				
8	20	980	5	0				
9	10	0	4	80				
10	25	0	10	50				
11	50	0	20	0				
12	43	33	17	15				
13	48	53	19	5				
14	50	150	20	0				
15	50	950	20	0				
16	18	13	7	65				
17	20	15	2	60				
18	13	27	13	35				
19	5	20	5	0				
	Indicates test not required for category							

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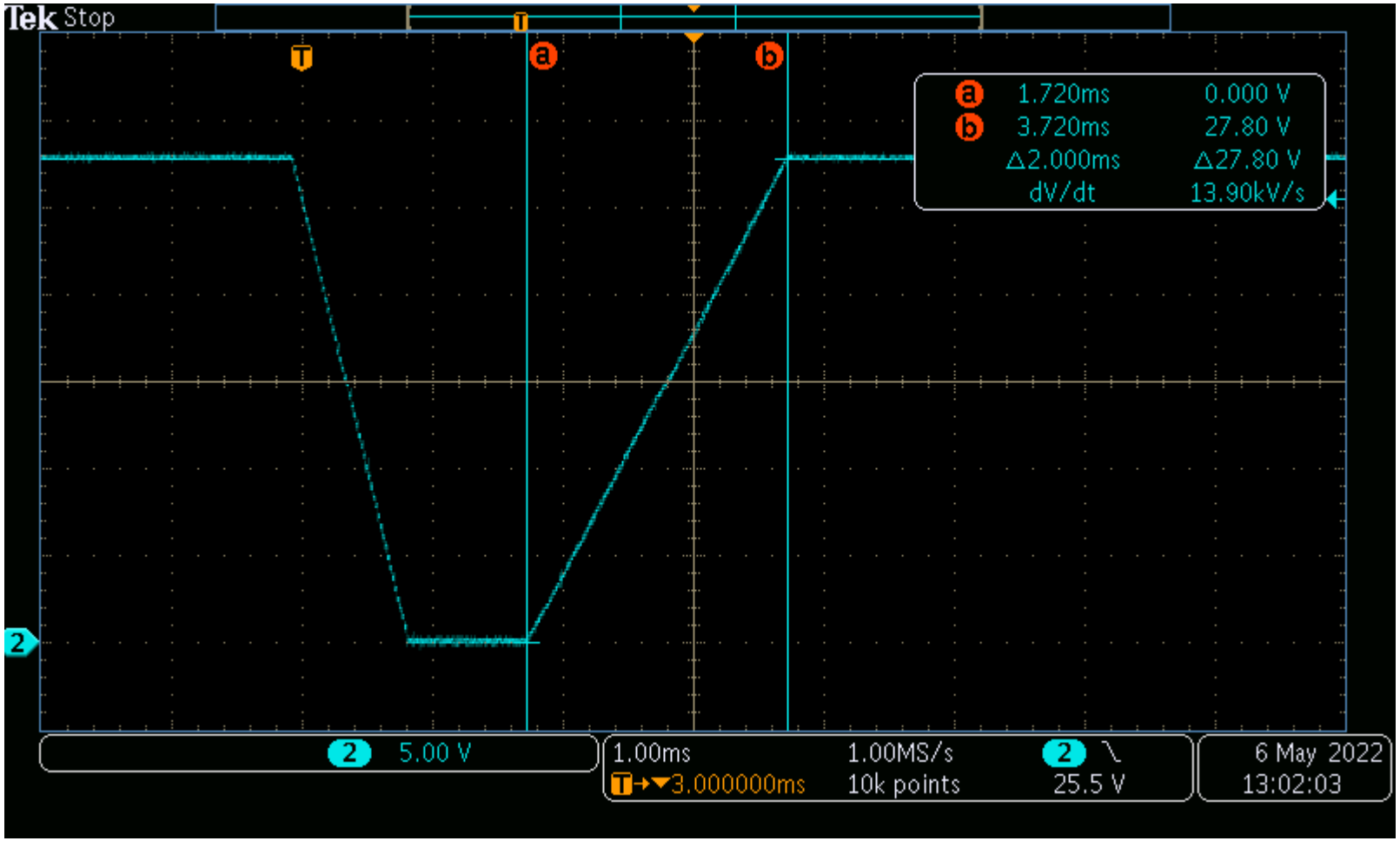
Table 16-3 Test Condition 1 waveform

- Durations are precise - 8 mS dwell at 4.2 VDC
- Ramp rates are very accurate 17 mS fall time and 4 mS rise time are smooth
- Modifications are simple.



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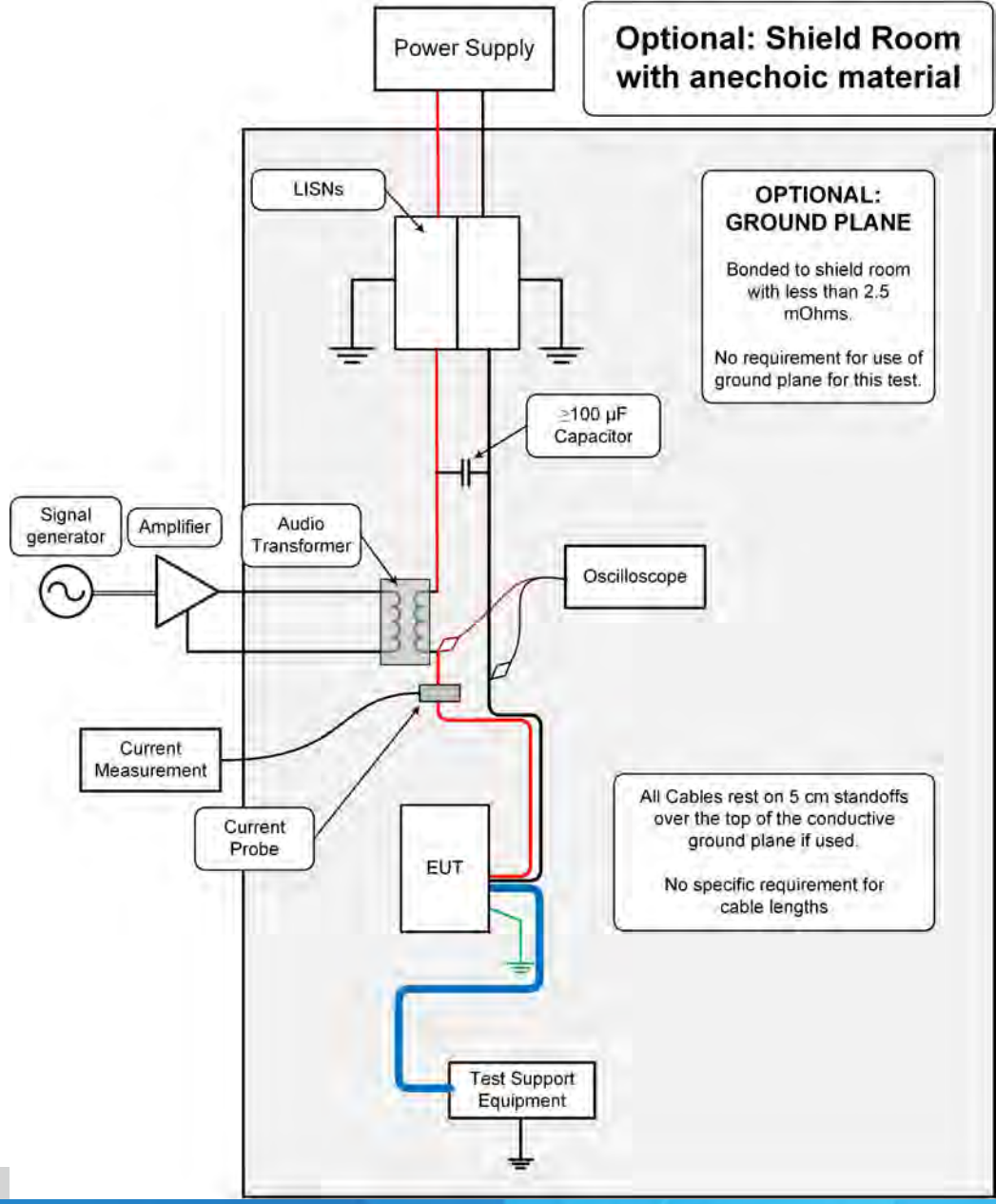
DO-160: Section 18

- Intent to assure equipment can operate when ripple caused by equipment on the same power bus is present.
- 30 frequency steps per decade, logarithmically spaced ($10^{(1/30)}$ or 7.978% higher)



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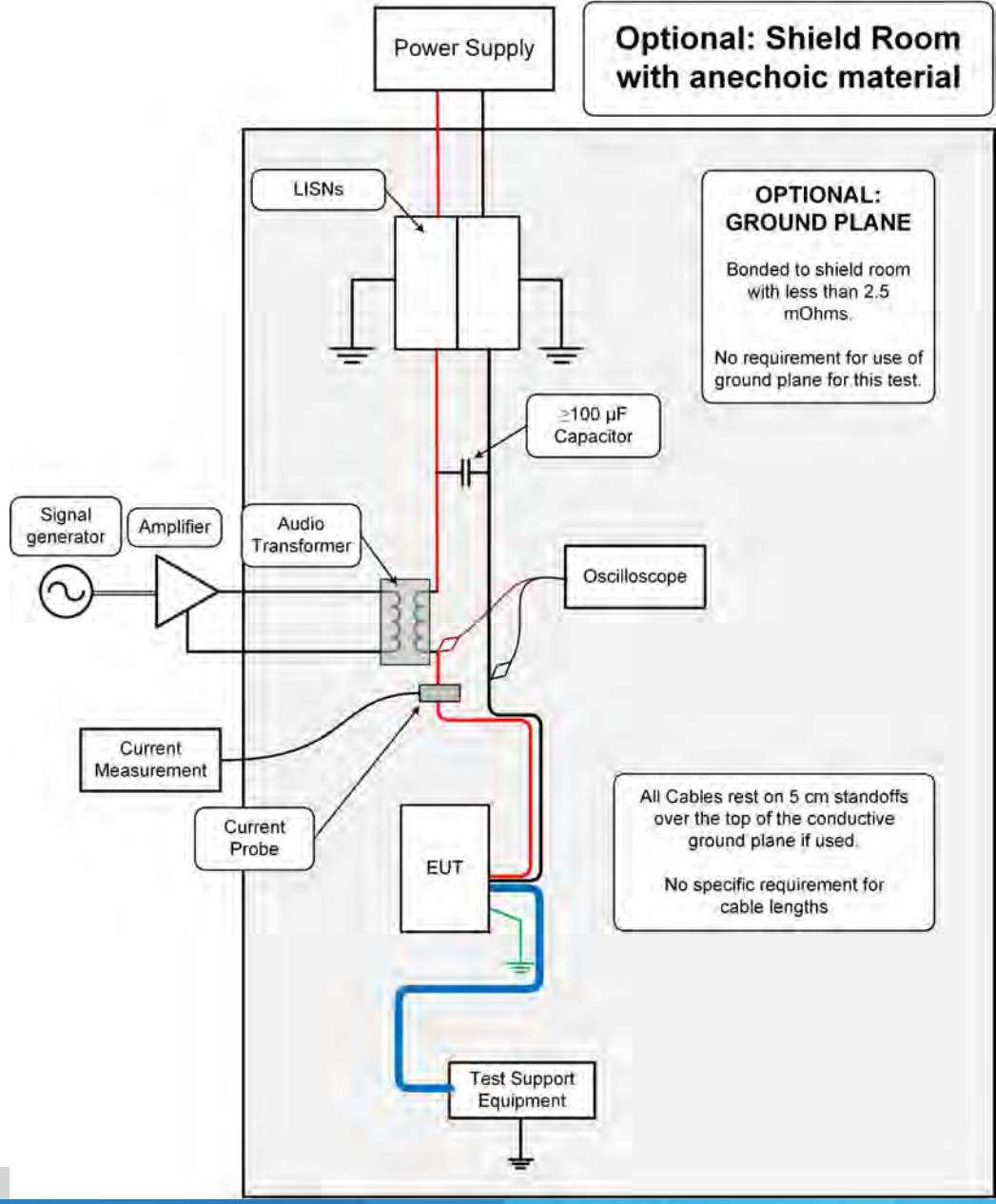
DO-160: Section 18

- Dwell time at each frequency is 60 seconds -
  Cat. Z = 2 hours 7 minutes
- Historically, the test required coupling audio frequency signals onto the power line through a coupling transformer.



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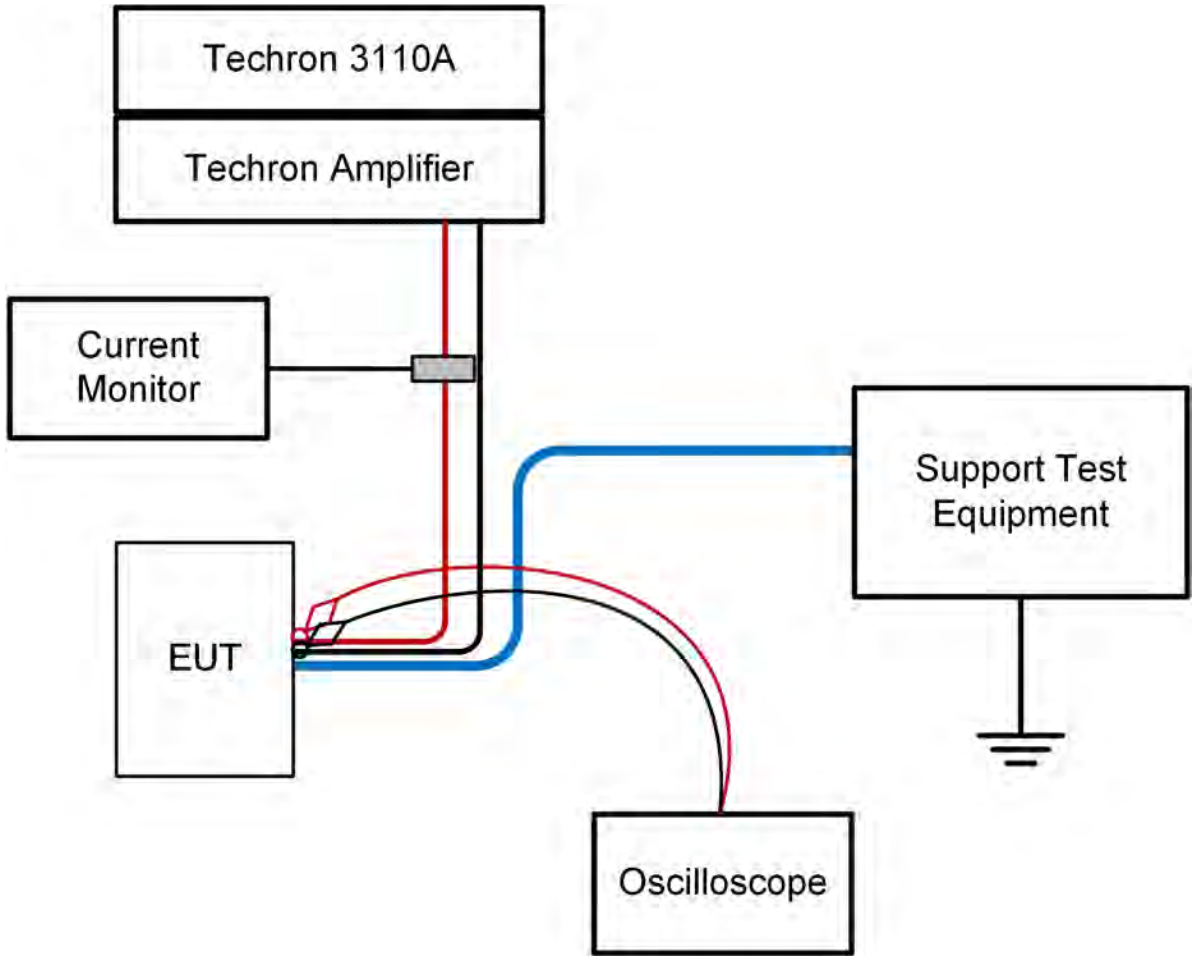
Alternative Section 18 Method

- The 3110A can place a ripple voltage at a specific amplitude superimposed on the power line.
- Set the power and apply a ripple voltage at the specified amplitude and frequency per the specification, or as desired.



DO-160: Section 19

- Five Different Tests:
  - Magnetic Fields Induced into Equipment
  - Electric Fields Induced into Equipment
  - Magnetic Fields Induced into Interconnecting Cables
  - Electric Fields Induced into Interconnecting Cables
  - Spikes Induced into Interconnecting Cables

DO-160: Section 19

- Four Different Categories
  - (Cat A, B, C, and Z)
- Three aircraft primary power sources
  - (called C, N, and W)

Paragraph	Test	Category ZN	Category AN	Category BN	Category CN
19.3.1	Magnetic Fields induced into the equipment	20 A rms at 350 Hz and 650 Hz	20 A rms at 350 Hz and 650 Hz	20 A rms at 350 Hz and 650 Hz	20 A rms at 350 Hz and 650 Hz
19.3.2	Electric Fields induced into the equipment	170 V rms at 400 Hz	170 V rms at 400 Hz	170 V rms at 400 Hz	170 V rms at 400 Hz
19.3.3	Magnetic fields induced into interconnecting cables	IxL=30 A-m from 350 to 650 Hz and reducing to 0.8 A-m at 26 kHz	IxL=18 A-m from 350 to 650 Hz	Not Applicable	IxL=120 A-m from 350 to 650 Hz reducing to 1.6 A-m at 26 kHz
19.3.4	Electric Fields induced into interconnecting cables	VxL=1800 V-m from 350 to 650 Hz	VxL=360 V-m from 350 to 650 Hz	Not Applicable	VxL=5400 V-m from 350 to 650 Hz reducing to 135 V-m at 26 kHz
19.3.5	Spikes induced into interconnecting cables	Figure 19-4 L=3.0 m	Figure 19-4 L=3.0 m	Figure 19-4 L=1.2 m	Figure 19-4 L=3.0 m

From Table 19-1 of DO-160G, © 2010 RTCA, Inc. - Used with permission.

DO-160: Section 19

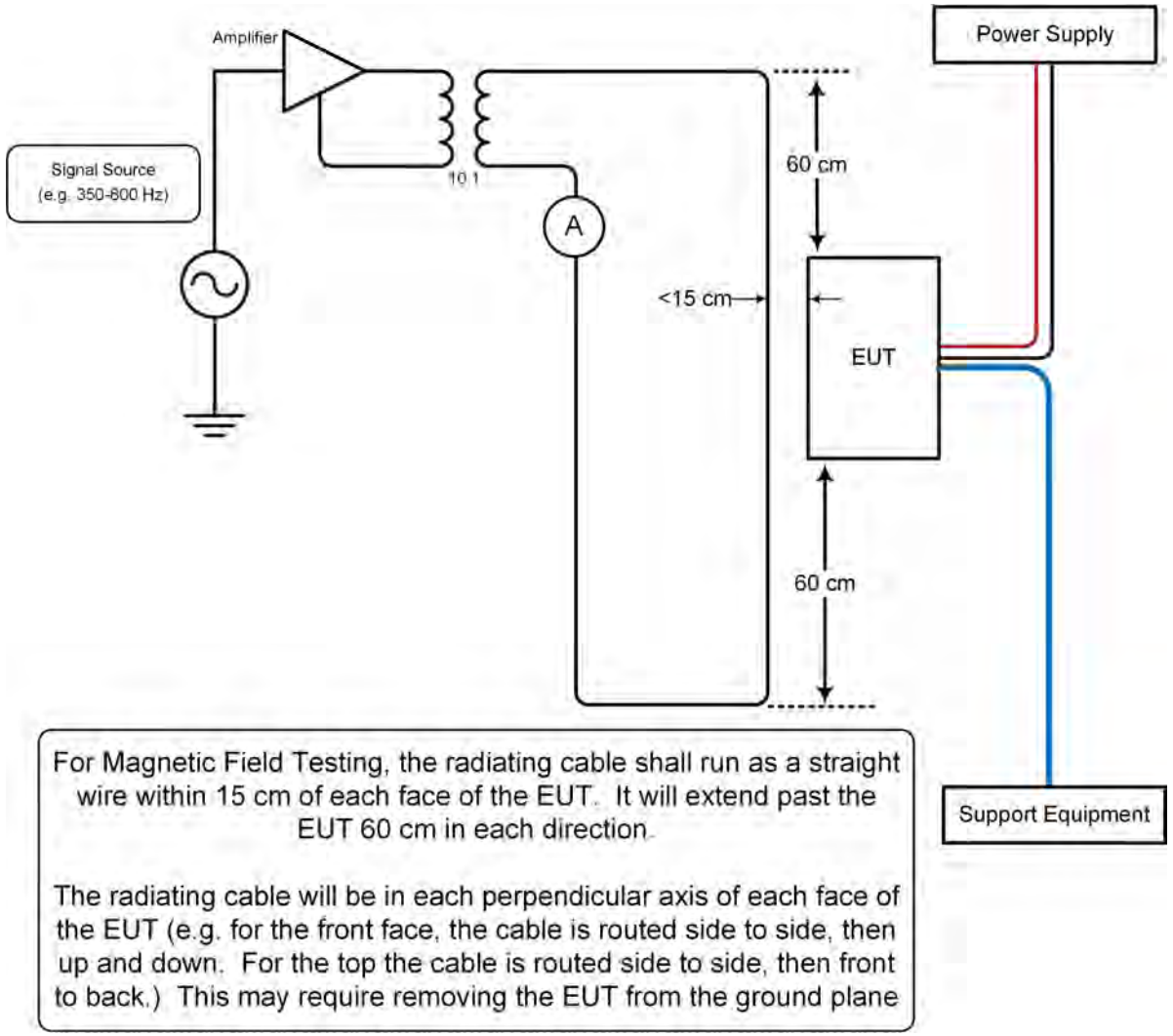
- Note: Primary power may not be your equipment power.
- A unit operating from 28 VDC may be on an aircraft which uses primary power from 350-800 Hz (wide or W category).

DO-160: Section 19

- Sweeps:
  - 30 frequency steps per decade, logarithmically spaced ($10^{(1/30)}$)
  - Dwell time at each frequency is 10 seconds
- Reduced level when installed cable is less than 3.3 meters.
- Test not required for installed cables < 1.5 meters.

Magnetic Fields Induced into Equipment

- The cable can be handheld.
- Assure cable is large enough to handle current.
- To obtain full current level the radiating cable should not be coiled.



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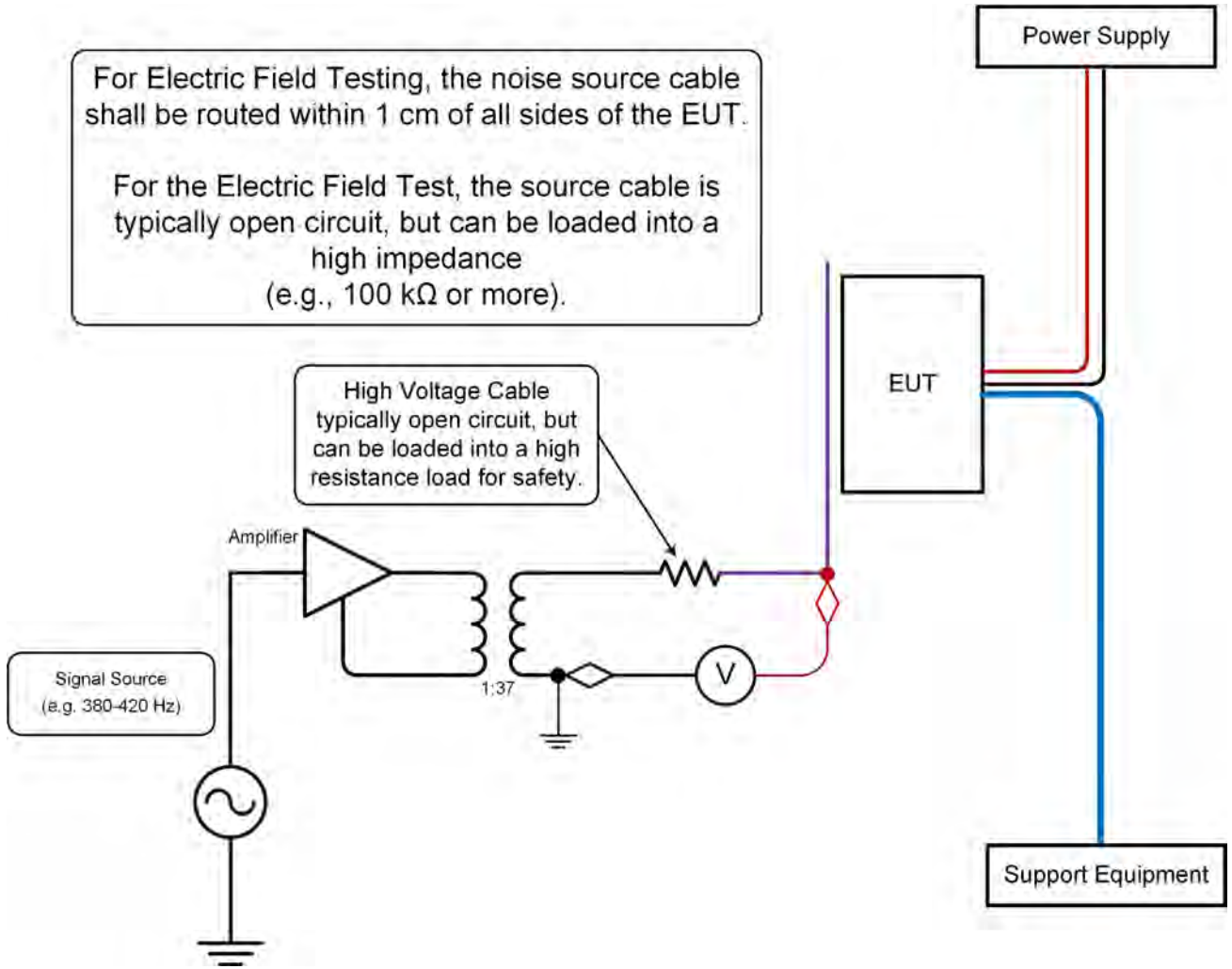
Electric Fields Induced into Equipment

- Required only for equipment without a conductive metal enclosure (no chassis or non-conductive chassis).
- Wire should not be handheld.



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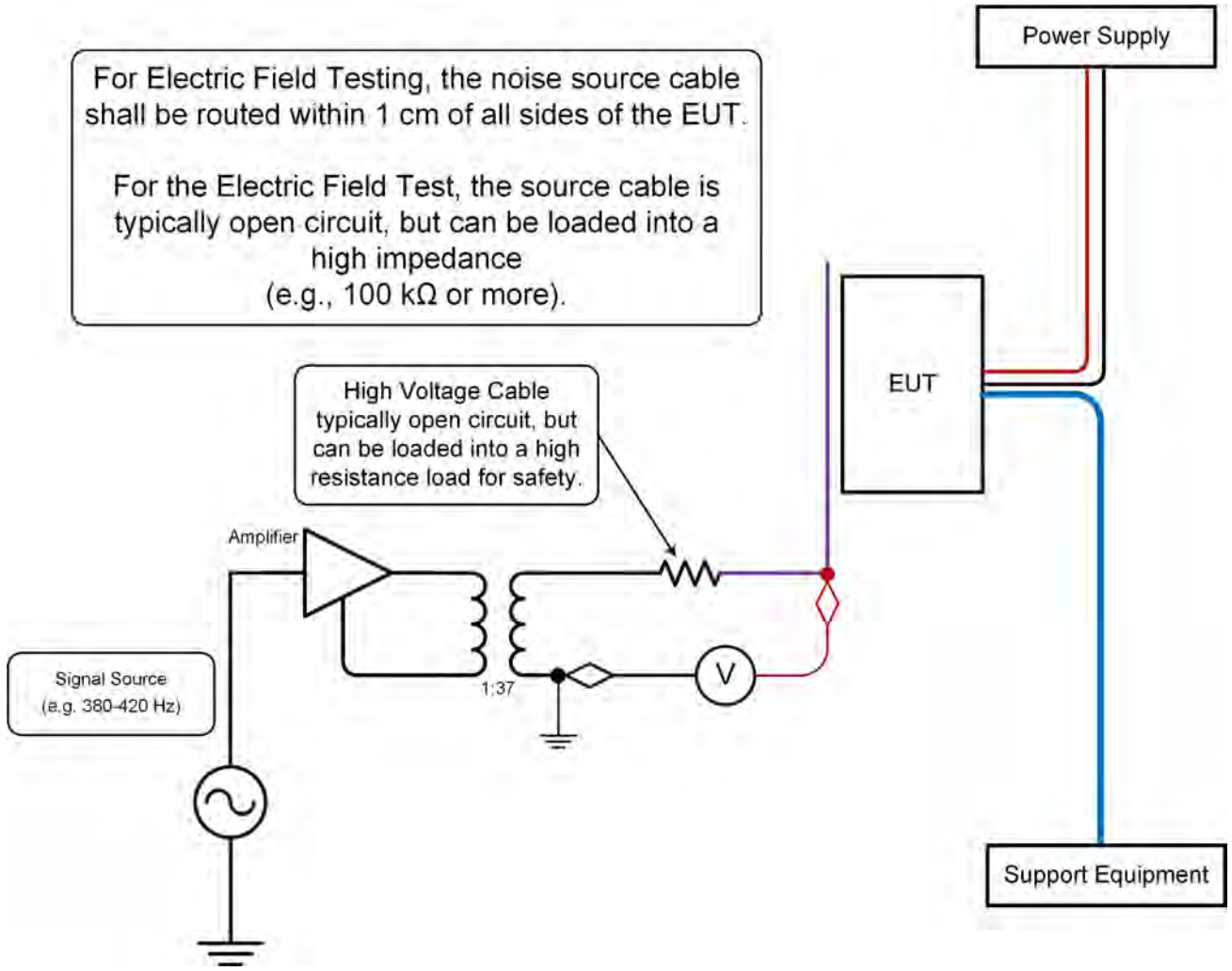
Electric Fields Induced into Equipment

- Assure cable is rated for high voltage – such as having silicone insulation.
- Voltage measurements must be with high voltage probes and meters.



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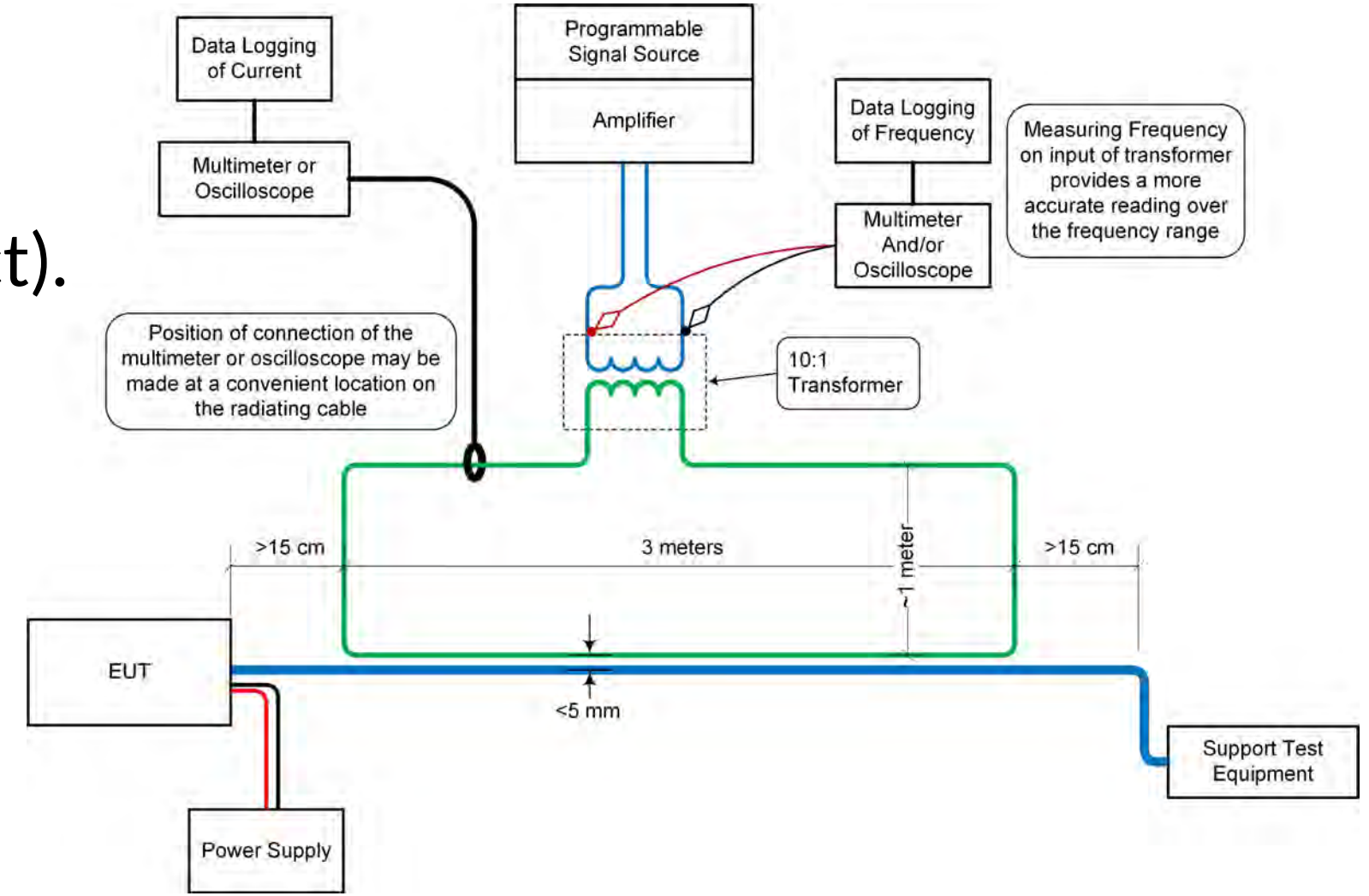
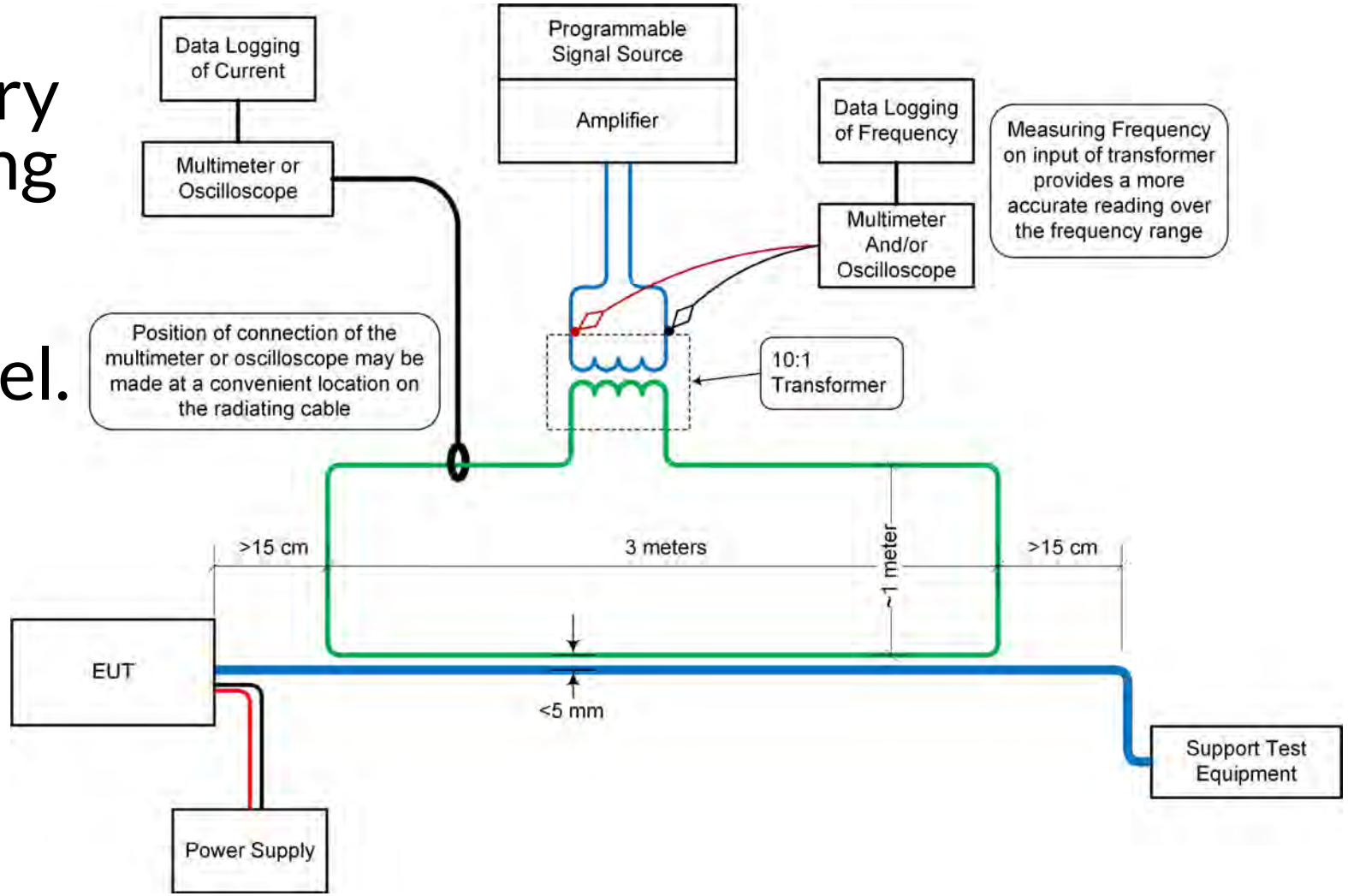
Magnetic Fields Induced into Interconnecting Cables

- Typically placed next to interconnecting bundle (direct contact).
- Assure cable is large enough to handle current.



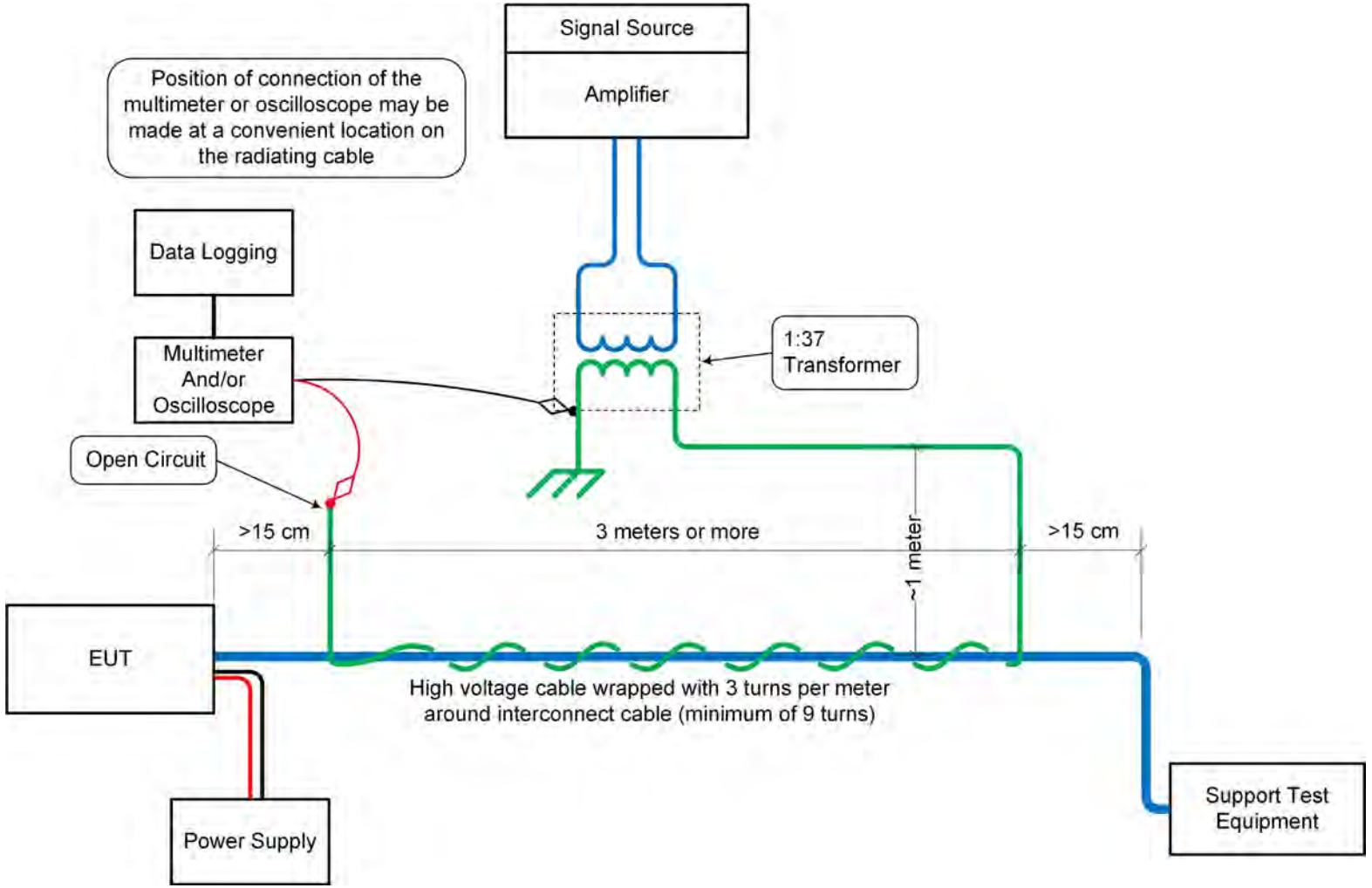
Magnetic Fields Induced into Interconnecting Cables

- Assure the cable is very long but extra radiating cable should not be coiled or wrapped to obtain full current level.
- If less than 3 meters are exposed, the induced current must be increased proportionately.



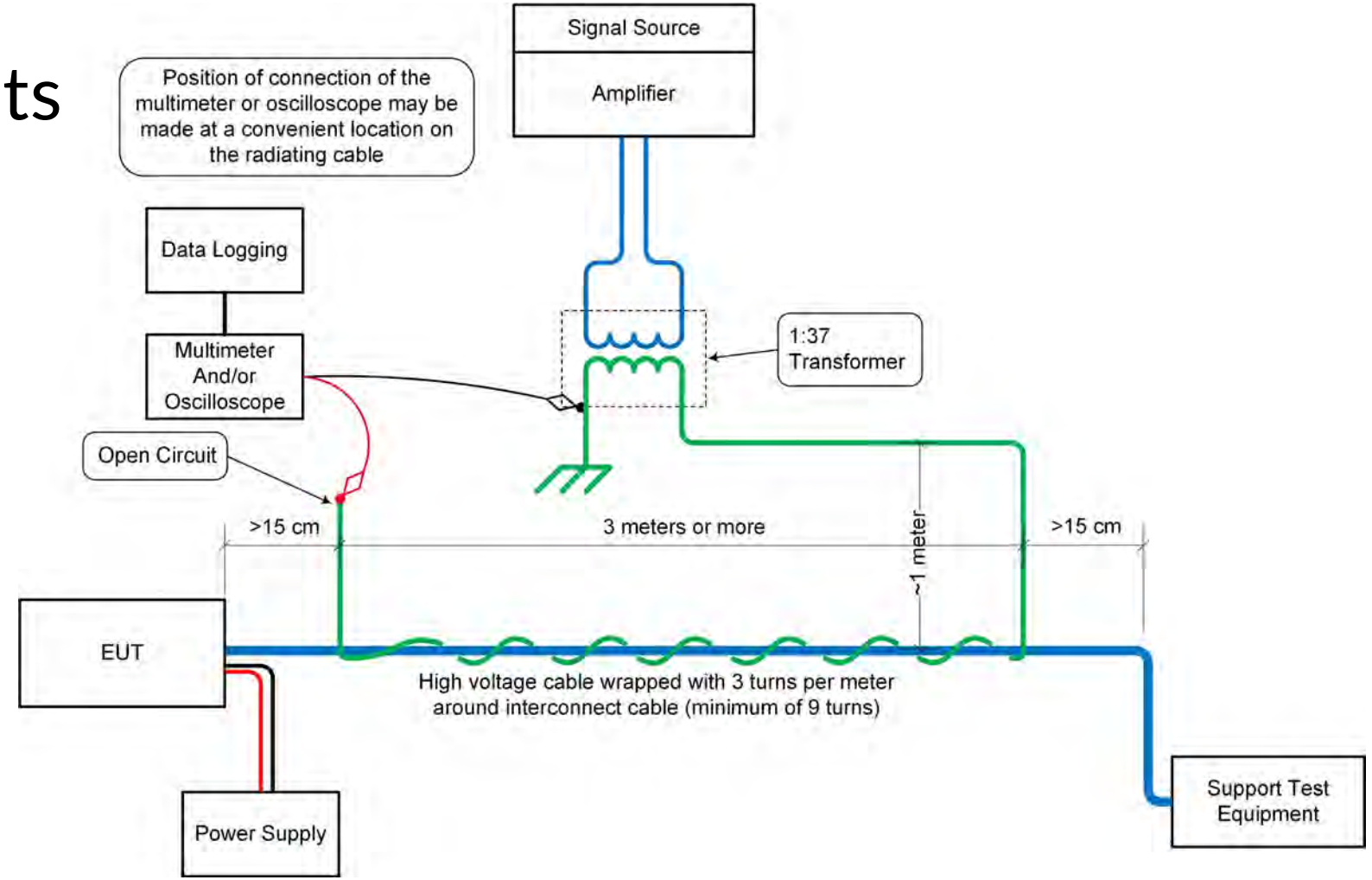
Electric Fields Induced into Interconnecting Cable

- Wire is wrapped 3 turns per meter
- Assure cable is rated for high voltage – such as having silicone insulation.



Electric Fields Induced into Interconnecting Cable

- Voltage measurements must be with high voltage probes and meters.
- If less than 3 meters are exposed, the induced current must be increase proportionately.



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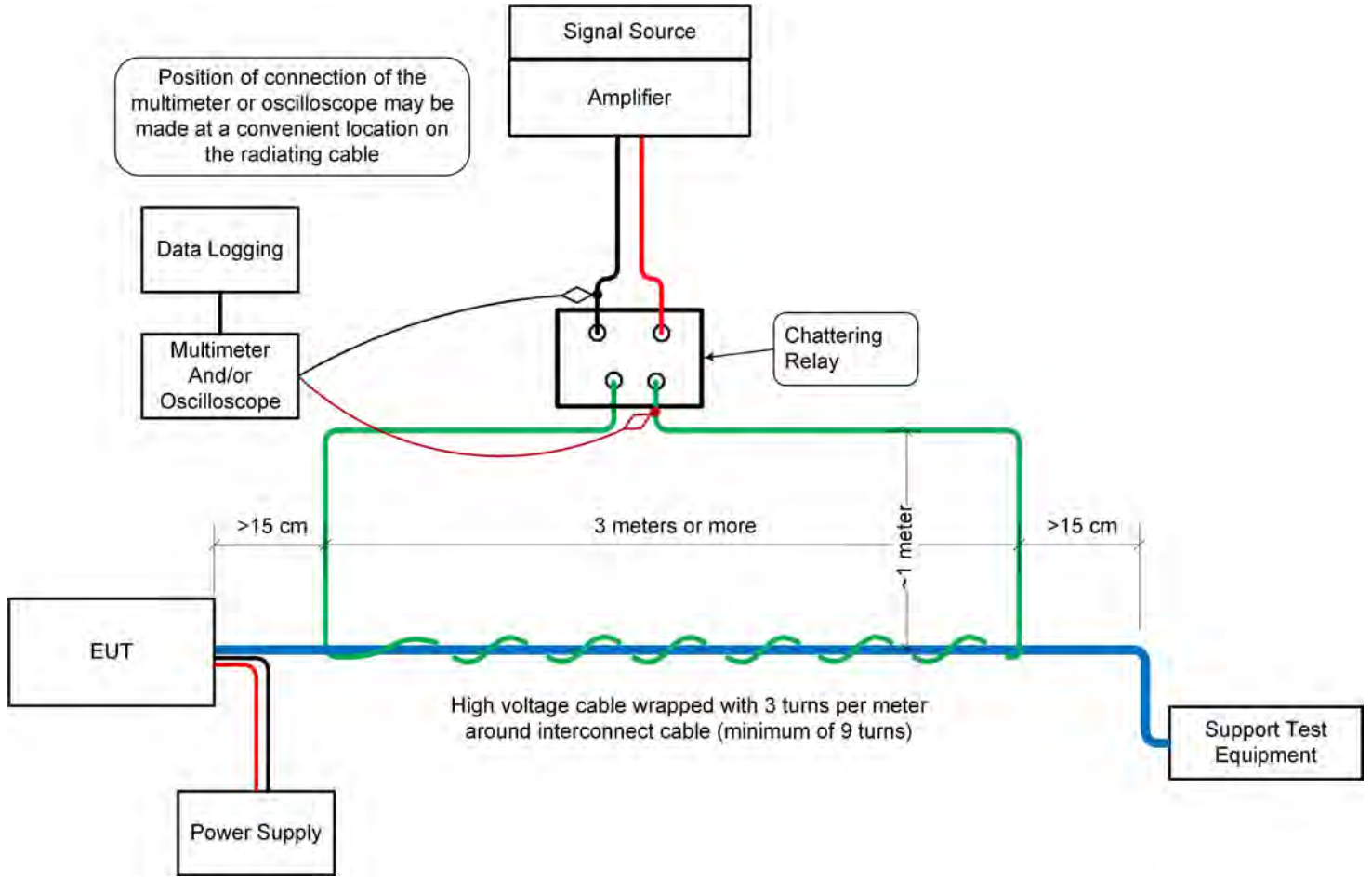
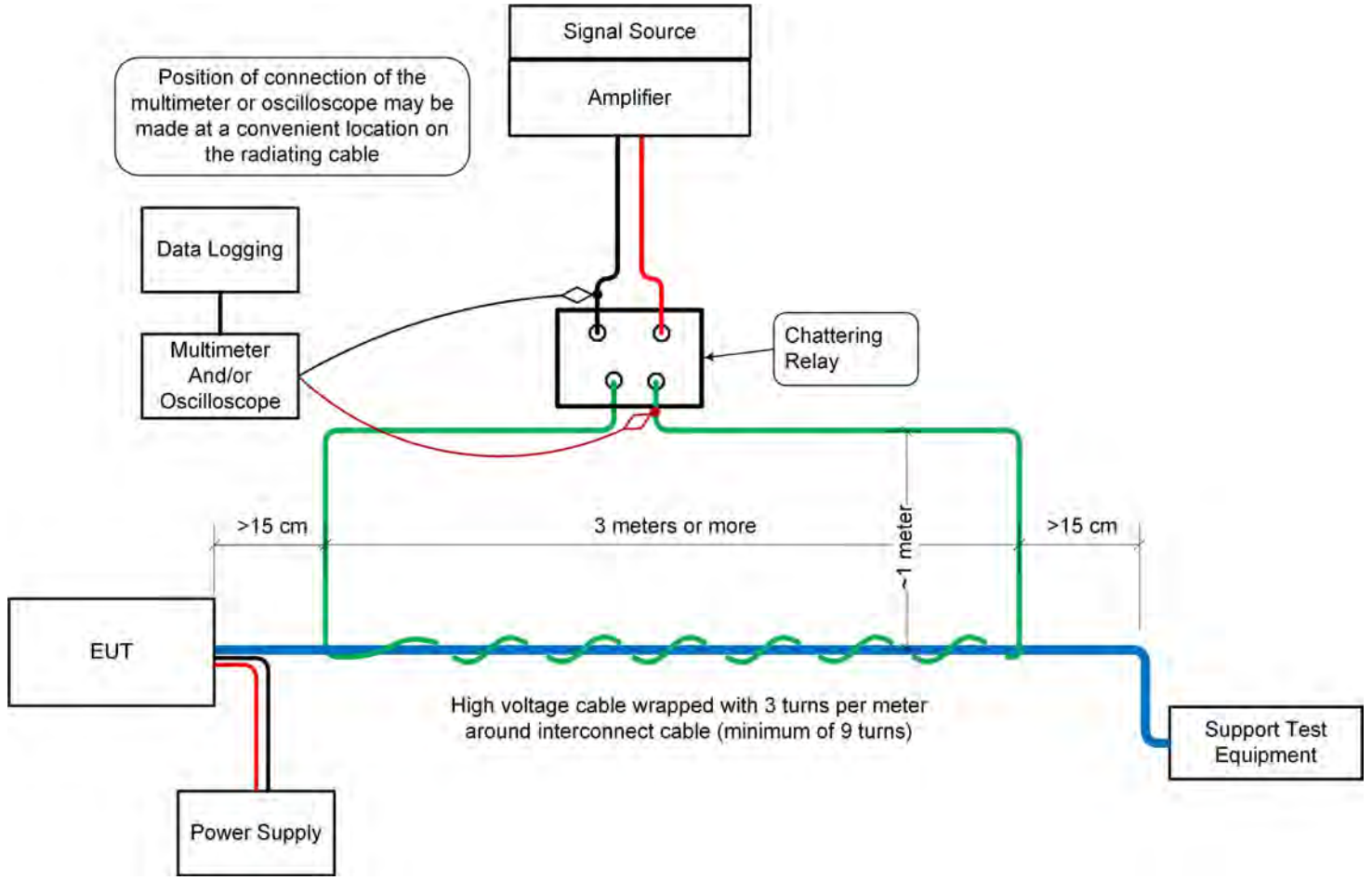
Spikes Induced into Interconnecting Cable

- Wire is wrapped 3 turns per meter
- Assure cable is rated for high voltage – use the same cable as E-Field test.
- Voltage measurements must be with high voltage probes and meters.



Spikes Induced into Interconnecting Cable

- If less than 3 meters are exposed, there is no provision for changes in testing (either time, or amplitude).
- Trick: To assure full levels, add inductance to power line (solenoid side).



DO 160 Test Solutions

Sections 16, 18, and 19
Product Overview

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CIS-25: Conducted/Induced Susceptibility Test Kit

TESTING SPECS:

- DO 160G Section 16 (14V, 28V)
- DO 160G Sections 18 & 19
- Airbus & Boeing
- MIL-STD 461 (CS101)

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Aviation Testing

This Test Kit Includes:

- 3110A Standards Waveform Generator
- 7234 Amplifier/Power Supply
- 3 Coupling Transformers
- Chattering Relay
- All Cables, Monitor, Keyboard, and Mouse

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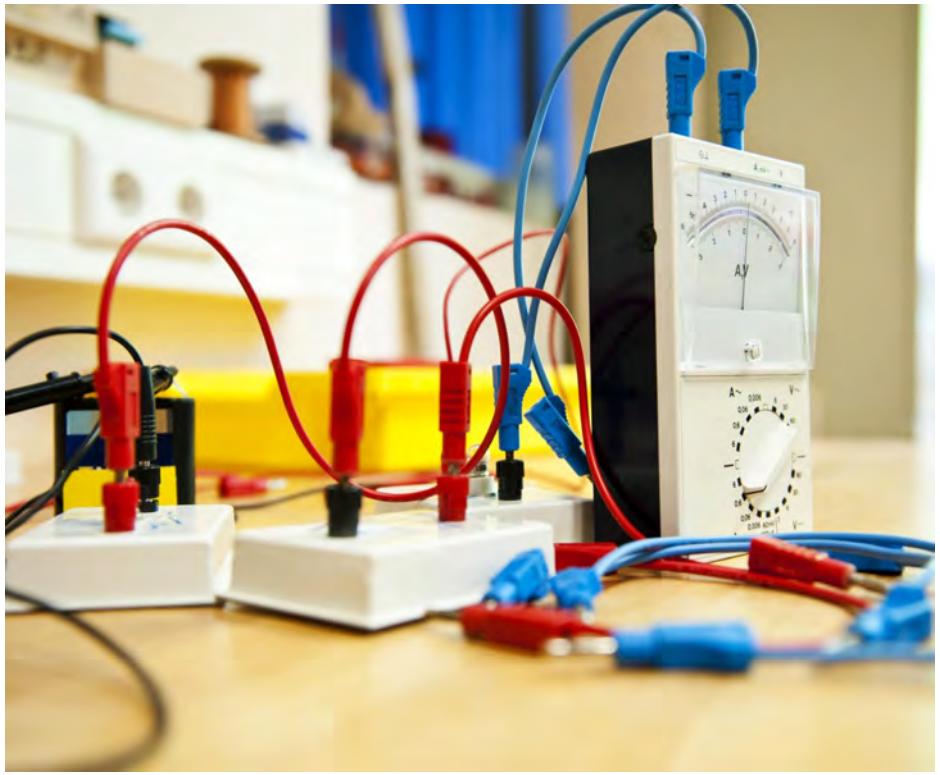
Transformer Role in Testing

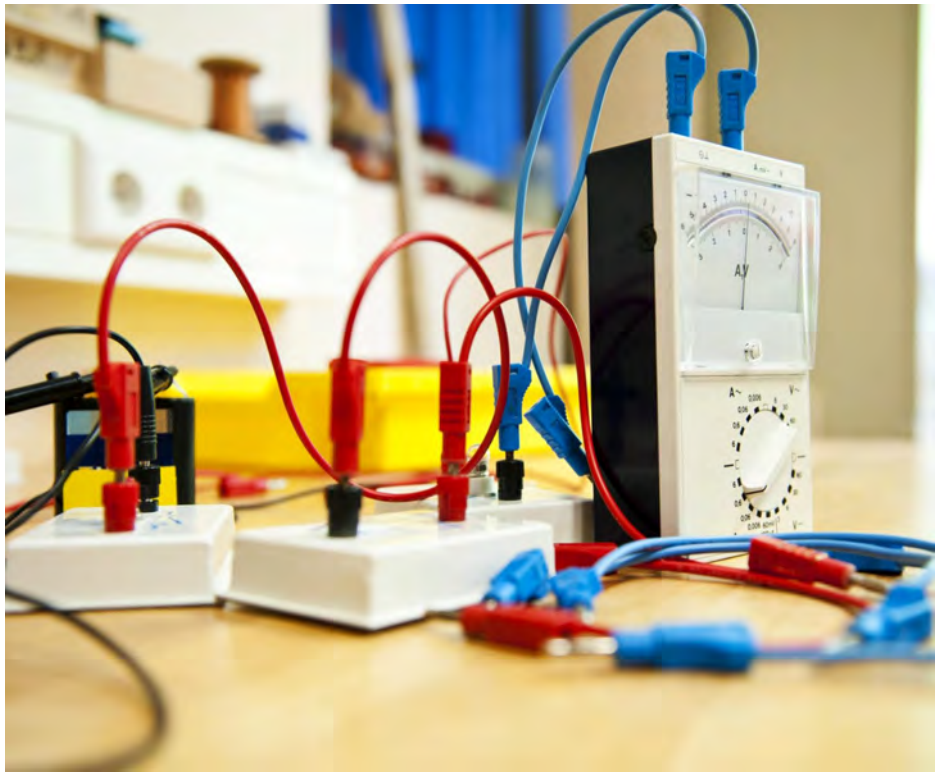
Coupling transformers act as bandpass devices, crucial in signal transmission within 100Hz to 150kHz frequency range.

For ripple tests in that range, the transformer is not always operating in its ideal 2:1 step-down region.



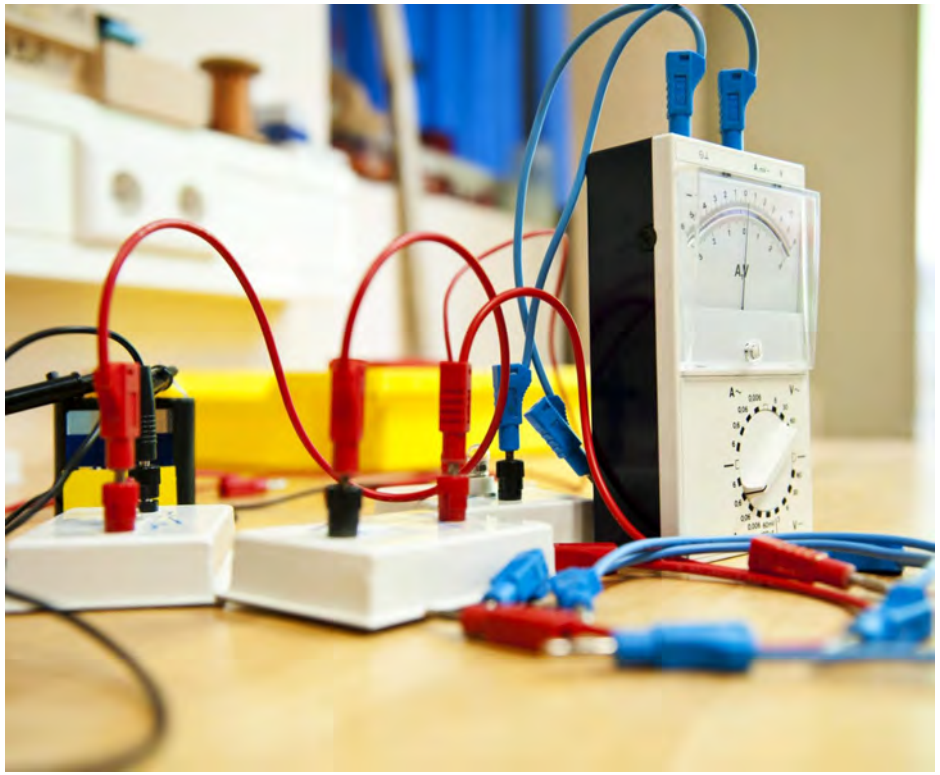
Manual Gain Adjustment Challenges

Users have to manually measure and adjust amplifier gain at each test frequency to ensure the imposed ripple meets the required standards.

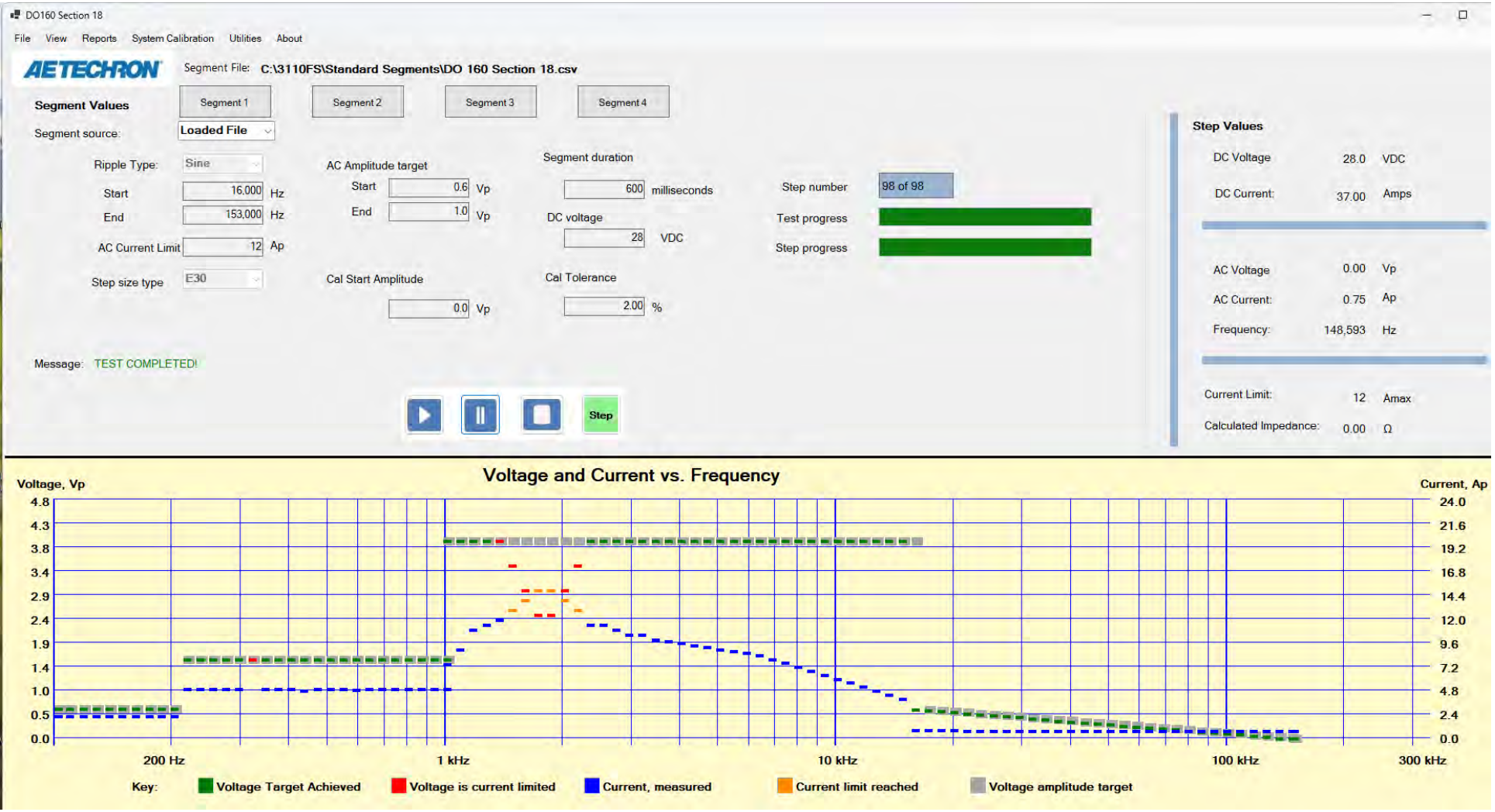


SOLUTION:
Closed-Loop Control

Automated system measures output and adjusts gain dynamically, improving accuracy and efficiency in ripple testing.



Introducing…



Key Benefits of our ALC Technology:

- Fully automated amplitude determination with 30 steps—no manual tuning required

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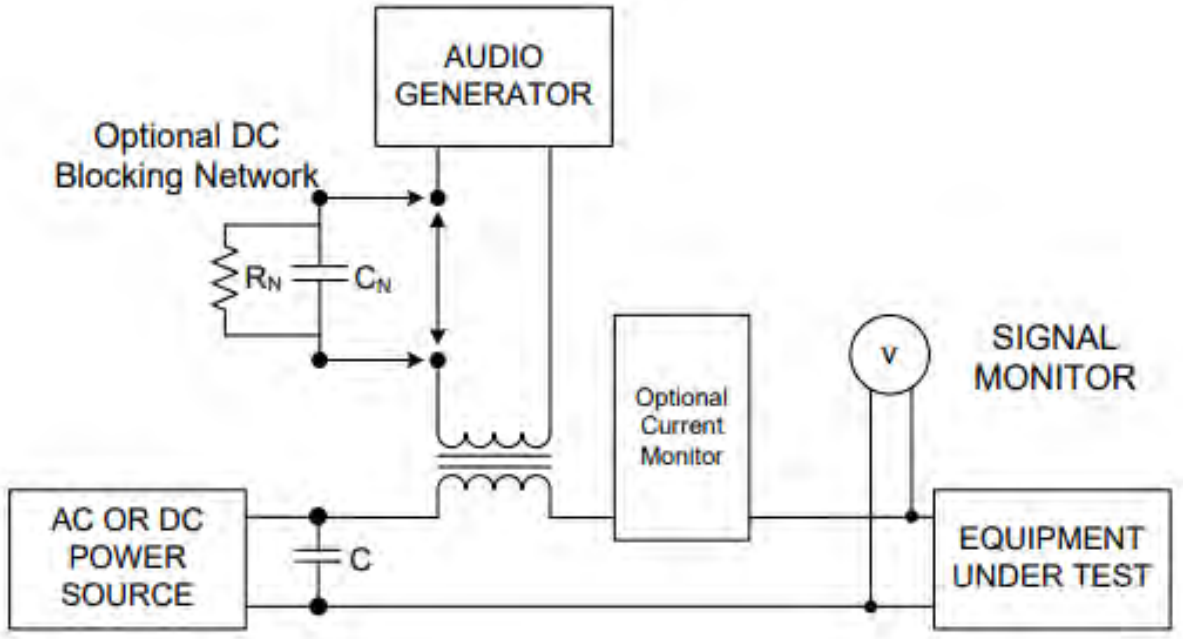
Introducing…

AUTOMATED LEVEL CONTROL (ALC)

Key Benefits of our ALC Technology:

- Voltage sense performed on secondary side of coupling transformer
- Active impedance sensing prevents over-testing
- Seamless integration with CIS-25ALC and DSR 425 systems



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Introducing…

CIS-25 ALC: Conducted/Induced Susceptibility Test Kit

TESTING SPECS:

- DO 160G Section 16 (14V, 28V)
- DO 160G Sections 18 & 19
- Airbus & Boeing
- MIL-STD 461 (CS101)

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Introducing…

CIS-25 ALC: Conducted/Induced Susceptibility Test Kit

Includes:

- 3110A Standards Waveform Generator
- 7234 Amplifier/Power Supply
- **ALC –Automated Level Control (Sec. 18)**
- 3 Coupling Transformers
- Chattering Relay
- All Cables, Monitor, Keyboard, and Mouse

AETECHRON®

DSR 400 Test System

Drop-out, surge, ripple simulator
and AC/DC voltage source

Complete, single-box solution for:

- DO 160G Section 16 (14VDC, 28VDC, 115V)
- Boeing & Airbus
- MIL-STD 704G
- Can be configured up to 160Ap
- Available with either Siglent or Keysight ARB (TAA Compliant)

AETECHRON®

Introducing…

DSR 425 Complete Test System

Drop-out, surge, ripple simulator
and AC/DC voltage source

COMPLETE, SINGLE-BOX SOLUTION FOR:

- DO 160G Sections 16 (14VDC, 28VDC, 115V, 230V and 270VDC)
- DO 160G Sections 18, 19
- MIL-STD 704G, Sections 1-8
- MIL-STD 461 (CS101)

AETECHRON®

Introducing…

DSR 425 Complete Test System

- 4-Quadrant
- ±425VDC, 360VAC, up to 160A
- DC to 150 kHz bandwidth
- 3mΩ DC Source Impedance
- Includes 3 Coupling Transformers, Chattering Relay, Cables, Monitor and Keyboard
- Also includes **ALC – Automated Level Control (Sec. 18)**

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e Aero – High Voltage Ripple

Models	HVR 1000CS, 1200RG, 2000CS/RG
DC Output Voltage	Up to 2000Vp
AC Ripple Current	Up to 600Ap (1200Ap-p)
AC Ripple Voltage	0 – 150Vp / 300Vp-p
DC Power/Current	Up to 60 kW, 160A DC
Bandwidth	10 Hz – 300 kHz
System Type	Incl. DC supply (CS) or without (RG)
Key Benefit	Simple low-power, complete solution including DO 160, MIL-STD tests

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Thank You

Questions & Answers

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