Model 95236-1 / Model 95242-1

Bulk Current Injection Probes

User Manual

ETS•LINDGREN™
An ESCO Technologies Company

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Revision Record
MANUAL, CURRENT PROBE, 95236,95242 | Part #399263, Rev. D

Revision	Description	Date
A	Initial Release	October, 2001
B	Updates/edits	March, 2002
C	Updates/edits	February, 2005
D	Remove *Model 95252-1*; update frequency range specifications; rebrand	June, 2010

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Notes, Cautions, and Warnings

	**Note:** Denotes helpful information intended to provide tips for better use of the product.
CAUTION	**Caution**: Denotes a hazard. Failure to follow instructions could result in minor personal injury and/or property damage. Included text gives proper procedures.
WARNING	**Warning**: Denotes a hazard. Failure to follow instructions could result in SEVERE personal injury and/or property damage. Included text gives proper procedures.

 See the ETS-Lindgren *Product Information Bulletin* for safety, regulatory, and other product marking information.

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1.0 Introduction

The **ETS-Lindgren Bulk Current Injection Probe (BCIP) Series** is used to inject RF current into conductors and cables of electrical and electronic equipment undergoing susceptibility testing. This manual includes information for these BCIP models:

- Model 95236-1
- Model 95242-1

The BCIP provides a means of applying a controlled RF stress level to an instrument under test through interconnecting cables or power cables without requiring a direct connection to the conductor(s) of interest. The models in this series are simply clamped around the test conductor which then becomes a one turn secondary winding, with the current probe forming the core and primary winding of an RF transformer. RF energy can be injected onto single and multi-conductor cables, grounding and bonding straps, outer conductors of shielding conduits and coaxial cables, and so on.

Because of the high efficiency design, the probes can also be used as sensors.

	Frequency Range*	**Useful Range**
95236-1	1 MHz–100 MHz	10 kHz–100 MHz
95242-1	10 MHz–400 MHz	2 MHz–400 MHz

***** The BCIP Series is especially designed to provide minimum insertion loss over these frequency ranges.

Supporting Equipment

Contact ETS-Lindgren for sizes and sensitivities of other current probes.

When using the Model 95242-1 to perform susceptibility tests, the following equipment may be required.

Optional Injection Probe

The Model 93686-1 Current Probe with a 6.6 cm window diameter may be used as a bulk current injection probe over the frequency range 50 kHz to 2 MHz.

Model 95241-1 Calibration Jig

The Model 95241-1 Calibration Jig is used in equipment setup for measuring insertion loss of the current probe and is essential to set up equipment for some susceptibility test procedures.

Current Monitoring probes

Suggested current monitoring probes are Model 91550-1 (10 kHz to 100 MHz) and Model 94111-1 (1 MHz to 1 GHz). These probes have a 1.25-inch (3.2-cm) window size and a transfer impedance of 1 ohm to 6 ohms over the 50 kHz to 400 MHz frequency range.

Operation: Precautionary Measures

CAUTION

Before connecting any components, follow the safety information in the ETS-Lindgren *Product Information Bulletin* included with your shipment.

CAUTION

RF fields can be hazardous. Observe appropriate RF exposure limits.

When measuring conductors that are not insulated, use extreme care when installing the current probe and taking measurements. If possible, de-energize the test sample during assembly and disassembly of the setup. Also, arrange to center the test conductor in the current probe window for additional voltage breakdown protection.

Do not permit the uninsulated current probe connector and cable connectors to come in contact with the ground plane or other nearby conductors. This will prevent possible measurement error due to ground loops, and will avoid danger from high voltages.

Ensure that the 50-ohm load is capable of safely dissipating the incurred power. Should the load become disconnected, the developed voltage will be come much greater and may be very dangerous.

ETS-Lindgren Product Information Bulletin

See the ETS-Lindgren *Product Information Bulletin* included with your shipment for the following:

- Warranty information
- Safety, regulatory, and other product marking information
- Steps to receive your shipment
- Steps to return a component for service
- ETS-Lindgren calibration service
- ETS-Lindgren contact information

2.0 Maintenance

CAUTION

Before performing any maintenance, follow the safety information in the ETS-Lindgren *Product Information Bulletin* included with your shipment.

Maintenance of the Bulk Current Injection Probe is limited to external components such as cables or connectors.

If you have any questions concerning maintenance, contact ETS-Lindgren Customer Service.

Annual Calibration

See the *Product Information Bulletin* included with your shipment for information on ETS-Lindgren calibration services.

Service Procedures

For the steps to return a system or system component to ETS-Lindgren for service, see the *Product Information Bulletin* included with your shipment.

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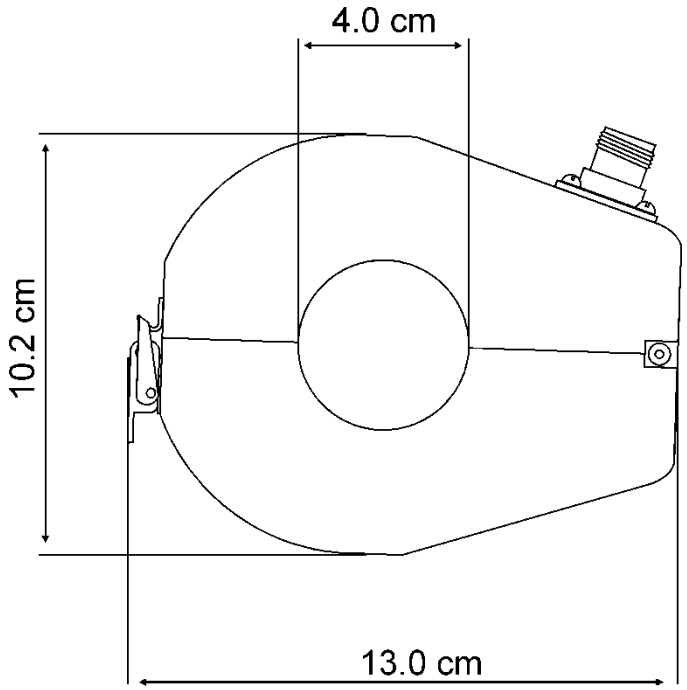
3.0 Specifications

Physical Specifications

Window Diameter:	4.0 cm (1.57 in)
Outside Diameter:	13.0 cm (5.11 in)
At Widest Point:	10.2 cm (4.01 in)
Height:	6.0 cm (2.36 in)
Weight:	1.60 kg (3.52 lb)
Output Connector:	Type N
Input Impedance:	50 Ω



Electrical Specifications

	95236-1	95242-1
Frequency Range:	1 MHz–100 MHz	10 MHz–400 MHz
Maximum Input Power:	100 W*	200 W**
Maximum Input Current:	20 Amperes	60 Amperes
Maximum Core Temperature:	80°C	80°C
Recommended Maximum Temperature Rise:	35°C	35°C
Maximum Time for Continuous Rating at Full Power:	30 minutes	30 minutes
Turns Ratio:	1:2	1:1
Inductance:	47 μH, ±20%	0.8 μH, ±20%

* **95236-1:** The power limit of the 95236-1 is 100 W. Powers in excess of 75 W should be used with care to avoid excessive temperature in the equipment under test. Prolonged testing should be avoided, particularly if unattended.

** **95242-1:** The power limit of the 95242-1 is 200 W. Powers in excess of 100 W should be used with care to avoid excessive temperature in the equipment under test. Prolonged testing should be avoided, particularly if unattended.

	Useful Range	Insertion Loss (Typical)	
		dB	Range
95236-1	10 kHz–100 MHz	< 15 dB -35 db ± 3 dB	1 MHz–100 MHz @ 10 kHz
95242-1	2 MHz–400 MHz	< 15 dB	10 MHz–400 MHz

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4.0 Application

The principal use of the Bulk Current Injection Probe (BCIP) is for inducing relatively large RF currents into the signal and power circuits of equipment under test for conducted susceptibility. A secondary application would be to use the same probe in a more familiar role as a sensor for measuring weak conducted RF currents.

Conducted Susceptibility

Conducted susceptibility testing is intended to ensure that RF signals, when coupled on to interconnecting cables and power supply lines of a device under test (DUT), will not cause malfunction or degradation of performance. In addition, this testing can provide an amplitude vs. frequency malfunction signature for the system which, when compared with the levels of current on the cables in a typical operating environment, can assist in the determination of adequate safety margins.

TYPICAL TEST SETUP

Typical conducted susceptibility tests require that all power and interconnecting cables be tested by subjecting them to the required current or voltage levels, while monitoring the applied current using a current probe. Usually, a reference level calibration is performed using a calibration jig with a specified impedance. This reference curve is then replayed to expose the DUT to a controlled stress level, while a current probe is used to ensure that a low impedance DUT is not overstressed.

Some tests may allow the reference calibration to be performed at a lower level and then scaled up to the required power level when applied to the DUT.

Entire cables or cable bundles may be tested, or each line may be broken out and tested individually. Some standards may also require simultaneous injection onto multiple cable bundles using several injection probes. Absorbing clamps may be required to isolate peripheral equipment from the DUT, and ensure that only the DUT is exposed to the required stress level. See the pertinent test standard for more details.

Test Setup Equipment

The following equipment may be needed to set up the test environment.

- Current Injection Probes: 95236-1
  95242-1
- Calibration Jig 95241-1
- Current Monitoring Probes
- Signal Source/Generator
- Power Amplifier(s): The power amplifier should be capable of supplying the full rated power into the current injection probes (which have a high VSWR) with a low harmonic content.
- Spectrum Analyzer or Measuring Receivers
- Directional Coupler
- RF Voltmeter(s)
- RF Absorbing Clamp
- RF Attenuator
- RF Loads

Sample Conducted Susceptibility Calibration Setup Diagrams

DIAGRAM 1

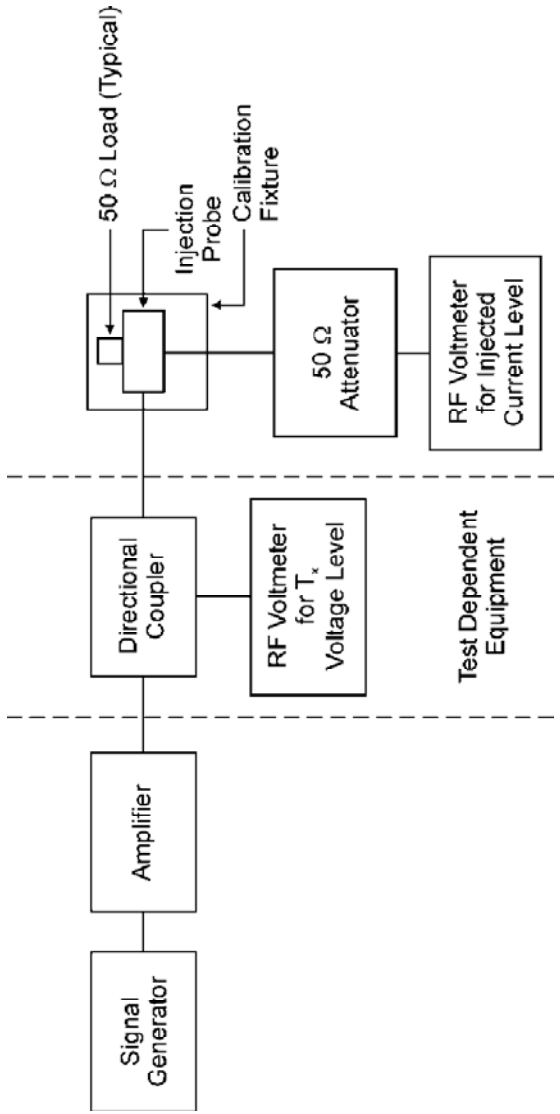
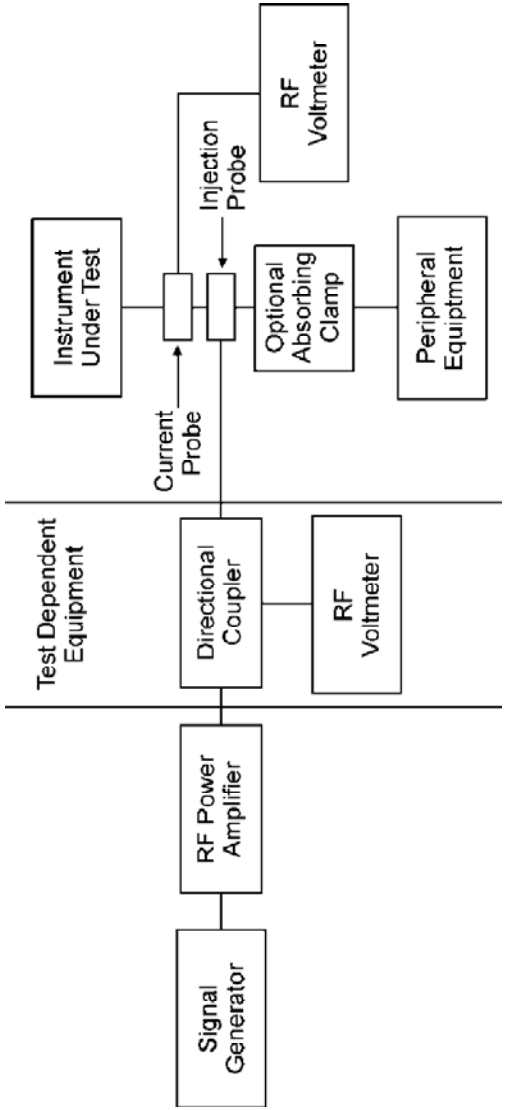


DIAGRAM 2


Signal Generator
RF Power Amplifier
Test Dependent Equipment
Directional Coupler
RF Voltmeter
Current Probe
Instrument Under Test
Injection Probe
RF Voltmeter
Optional Absorbing Clamp
Peripheral Equiptment

5.0 Conducted Emission: Transfer Impedance

The Bulk Current Injection Probe (BCIP) may also be used as a sensor for measuring conducted emission. The RF current I_P (in microamperes) in the conductor under test is determined from the measuring receiver reading of the probe output E_S (in microvolts) divided by the probe transfer impedance Z_T (in ohms).

$$I_P = E_S / Z_T$$

Or, in dB:

$$I_P(dB\mu A) = E_S(dB\mu V) - Z_T(dB)$$

The transfer impedance is determined by passing a known RF current I_P through the primary test conductor and noting the voltage E_S developed across a 50 ohm load on the probe output.

$$Z_T = E_S / I_P$$

Calibration gig 95241-1 may be used for this determination. Following are the typical transfer impedance values when the BCIP is used as a sensor.

High sensitivity and minimal core gap indicate that the current probe should be used only on signal lines where heavy currents are not encountered. Heavy currents may affect measurement accuracy should current probe core saturation occur.

Frequency (MHz)	Z_T (Ω)
1	16
2	20
3	19
4	19
5	19
6	19
7	19
8	19
9	19
10	19
20	18
30	18
40	17
50	16
60	15
70	14
80	13
90	12
100	11

Frequency (MHz)	Z_T (Ω)
2	7
4	13
6	19
8	22
10	27
20	25
30	27
40	30
50	32
60	32
70	32
80	30
90	30
100	30
200	33
300	32
400	30

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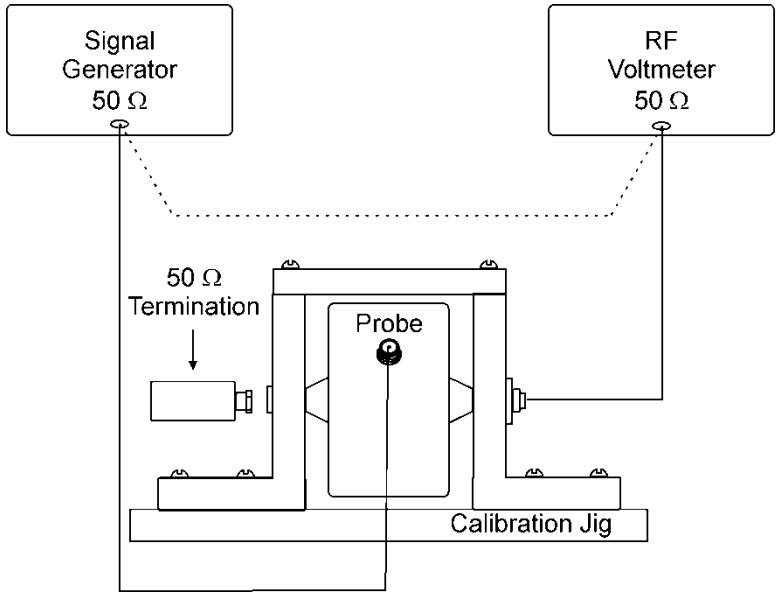
6.0 Insertion Loss

Insertion loss of the Bulk Current Injection Probe (BCIP) may be measured at low signal levels. ETS-Lindgren offers this measurement as a calibration service. See the *Product Information Bulletin* included with your shipment for information on ETS-Lindgren calibration services.

Equipment

Signal Generator (50 Ohms):	10 kHz to 400 MHz
RF Voltmeter (50 Ohms):	10 kHz to 400 MHz
Calibration Jig:	95241-1
50 Ohm Termination:	VSWR <1.2
Bulk Injection Current Probe:	95236-1 or 95242-1

Typical Reference Calibration Setup



Procedure

1. Connect the signal generator output directly to the RF voltmeter input as show in *Typical Reference Calibration Setup* on page 25, indicated by the dashed line. Use the same cables which connected the calibration jig and the injection probe under test. Tune to the test frequency and adjust the signal level for a reference of 0 dBm indication on the RF voltmeter.
2. Without changing control settings, connect the signal generator output to the bulk current injection probe input and connect the calibration jig connector to the RF voltmeter input.
3. Note the RF voltmeter output in dB. The difference between this reading and 0 dB is the insertion loss. In this measurement, the loss cannot be less than 3 dB since half the injected power is absorbed by the 50 ohm termination that is particularly loading (50%) the calibration jig.

Appendix A: Warranty

See the *Product Information Bulletin* included with your shipment for the complete ETS-Lindgren warranty for your Bulk Current Injection Probe.

Duration of Warranties for Bulk Current Injection Probe

All product warranties, except the warranty of title, and all remedies for warranty failures are limited to two years.

Product Warranted	Duration of Warranty Period
Model 95236-1 Bulk Current Injection Probe	2 Years
Model 95242-1 Bulk Current Injection Probe	2 Years