

# Injection Current Probe Series Operation Manual

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# INTRODUCTION

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## INJECTION CURRENT PROBE SPECIFICATIONS

Model Number	Frequency Range	Insertion Loss (dB)	Max continuous Power (Watts)	Aperture (inches / CM)	Weight (lb's / Kg)
ICP-621	10 KHz – 100 MHz	33 to 8	100	1.5" / 3.8cm	6.5 / 2.95
ICP-622	2 MHz – 500 MHz	4 to 16	200	1.5" / 3.8cm	4.0 / 1.81

# GENERAL INFORMATION

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## INTENDED PURPOSES

This equipment is intended for general laboratory use in a wide variety of industrial and scientific applications, and designed to be used in the process of generating, controlling and measuring high levels of electromagnetic Radio Frequency (RF) energy. It is the responsibility of the user to assure that the device is operated in a location which will control the radiated energy such that it will not cause injury and will not violate regulatory levels of electromagnetic interference.

## GENERAL DESCRIPTION

Injection Current Probes are used to inductively couple large RF currents into conductors passing through their aperture.

The conductors are signal, control and power circuits of equipment under test for conducted susceptibility or immunity.

Typical specifications requiring the use of injection probes are:

- DO-160
- EN-50081-1
- IEC 801-6
- TR-EOP-000063

The purpose of the test is to determine that RF signals in the range of 10 KHz to 400 MHz, when coupled onto conductors and cable bundles will not cause failure or degradation of their circuit performance.

Bundles of wires will be tested with the injection current probes clamped around all wires. If primary power wires utilize the same connector as control and signal lines, they will be included in the test.

Every primary power wire will be tested as a single circuit. If they are contained within a bundle, they will be separated and tested.

Aircraft flight safety critical equipment will have their wires tested individually for compliance to DO-160.

## PROBES AND TEST FIXTURES

In order to carry out a Bulk Current Injection Test, the following probes and fixture will be required:

- Calibration Test Fixture
- Current Probes (Monitor Probes)
- Injection Current Probes

### CALIBRATION TEST FIXTURE, MODEL CPF-630

The specifications require a calibration fixture for precalibration.

The test fixture is composed of an electrically short section of trough transmission line. The short section permits the measurement of current in the center conductor of the line, while the current probe is clamped around the center conductor. The fixture's output terminal is terminated in a  $50\Omega$  receiver, spectrum analyzer or RF voltmeter. A measurement of the voltage developed by this RF voltmeter permits the calculation of current flowing in the center conductor. The trough is large enough to permit the current probe to be clamped around the center conductor, with the outer conductor of the trough extending around the current probe's outer shield.

A mechanical outline of the fixture and a typical injection probe mounted in the fixture is shown in Figure 1. This fixture is useable over the frequency range of 10 kHz to 400 MHz.

### CURRENT PROBES (MONITOR PROBES)

During the equipment test a RF current probe (monitoring probe) is clamped around the same wire or wire bundle that the injection probe is clamped around. The broadband current probe shall be calibrated for the test frequencies and cable of operating with 1 ampere of RF current. The broadband current probe shall be located approximately 5 cm from the injection current probe.

### INJECTION CURRENT PROBES

Injection current probes must be capable of injecting the specified current levels into the circuit under test. Each probe has its own technical description and model number, and each has its own individual technical literature.

# TEST METHODS

## TEST METHOD FOR PRECALIBRATION

Due to the occurrence of large variable circuit impedances and resonances in cables, a calibration fixture is used to establish the forward power into the injection probe, which develops defined currents in the calibration fixture.

The limits of current are established in a "Precalibration Test Set Up". This test configuration is shown in Figure 2.

## PRECALIBRATION TEST PROCEDURE

This test procedure consists of precalibration to establish the levels of forward power necessary to generate the specification limits while clamped onto the calibration fixture.

The precalibration is described in the following, and should be carried out first.

- 1) The injection probe will be clamped in the calibration fixture as shown in Figure 2.
- 2) The calibration fixture will be terminated in a 50 ohm, 50 watt RF load at one end and a 50 ohm receiver 30 dB attenuator will be required to protect the receiver or spectrum analyzer. The VSWR of the terminations at both ends of the calibration fixture will be less than 1.2:1 over the frequency range of the test.
- 3) The injection probe receives signal levels from the signal generator and power amplifier. The limits of injected current in the calibrating fixture are precalibrated for two levels of current magnitude:
  - a) An accept/reject level of current which should not cause a malfunction in the equipment under test.
  - b) A level of current which will cause a malfunction in the equipment under test, without creating permanent damage to it, or the specification level.

### 4) Precalibration Procedure Steps

- a) Increase the test signal to the injection probe until the accept/reject level of current is flowing in the calibration fixture.
- b) Record the forward power and reverse power necessary to generate the accept/reject level of current.

- c) Increase the test signal until the specification levels of current are achieved.
- d) Record the forward power and reverse power necessary to generate the specification levels of current.
- e) Repeat steps 1-4 over the required frequency range. The calibration frequency range can extend from 10 kHz to 400 MHz.
- f) The forward power in steps 1-4 identifies the total power from the amplifier required to achieve the necessary current levels. The reverse power permits the ability to 1) establish the VSWR of injection probe, 2) the power forward - power reverse establishes the net power delivered to the load attached to the calibration fixture.
- g) The test report shall document steps 1-4 data.

### INJECTION OF CURRENT INTO EQUIPMENT CABLES PROCEDURE

The equipment test shall be applied to individual wires and entire cables as required by the specifications.

A test procedure will be prepared that identifies each wire and cable to be tested.

In all cases of injected current, the test configuration used shall be as shown in Figure 3.

The broadband current probe shall be placed at the specified distance from the injection probe. This distance is approximately 5 cm for most specifications.

### EQUIPMENT PROCEDURE TEST STEPS

- 1) Carry out the Precalibration Procedure Steps again in this test configuration and record the current from the broadband current probe.
- 2) At each test frequency, increase the signal level until a malfunction occurs or until the specification current level is measured by the broadband current probes.  
Record the following:  
  
Current from the Broadband Current Probe  
Forward power injected  
Reverse power injected
- 3) Repeat this test for all frequencies necessary. Measure enough frequencies to be sure that all susceptibility levels have been determined.

4) At frequencies where the equipment under test shows susceptibility, reduce the signal levels until the susceptibility stops. Record the same data as in step 2.

## SAFETY

Caution during all of these tests is advised. High RF voltages and currents are being generated during these tests. Personnel conducting tests should not come in contact with any exposed metallic items of the test setup.

Use extreme care when clamping current probes around bare conductors. It is advised to de-energize the test item during assembly and disassembly of the test setup. Place all conductors passing through the aperture of probes in the center of the aperture for additional voltage breakdown protection. Do not allow the current probe connector and cable connectors to come in contact with the ground plane or other adjacent conductors.



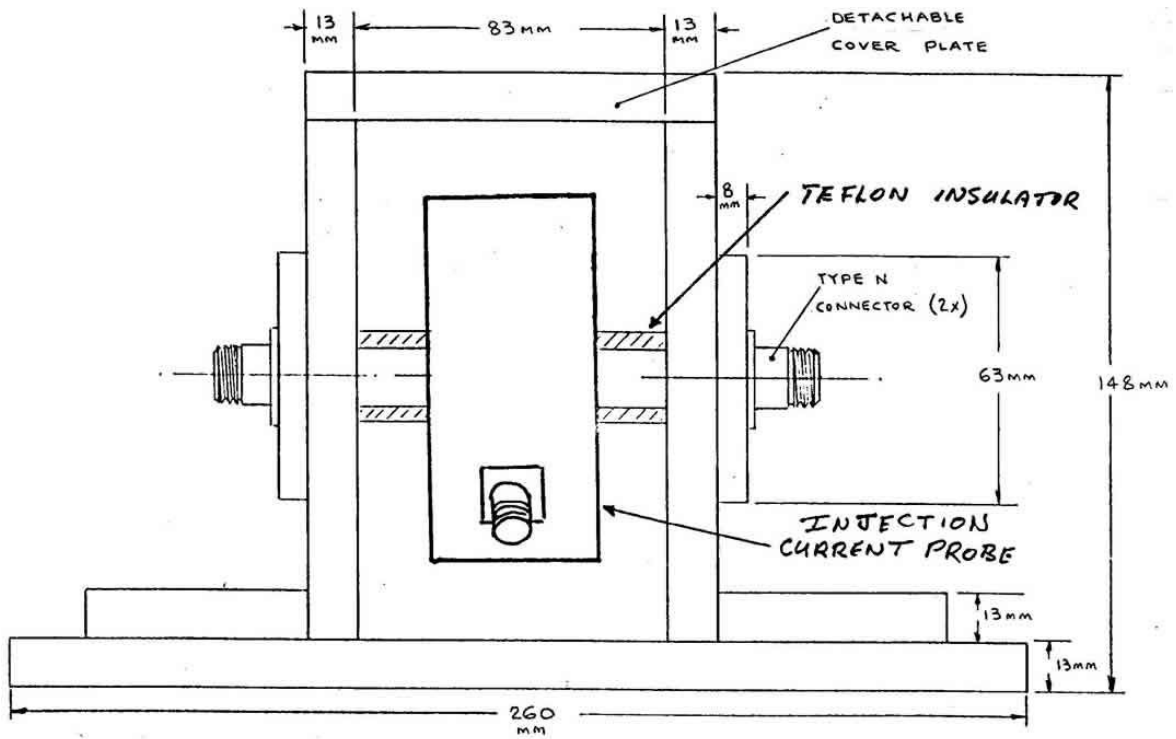


Figure 1

### Mechanical Outline

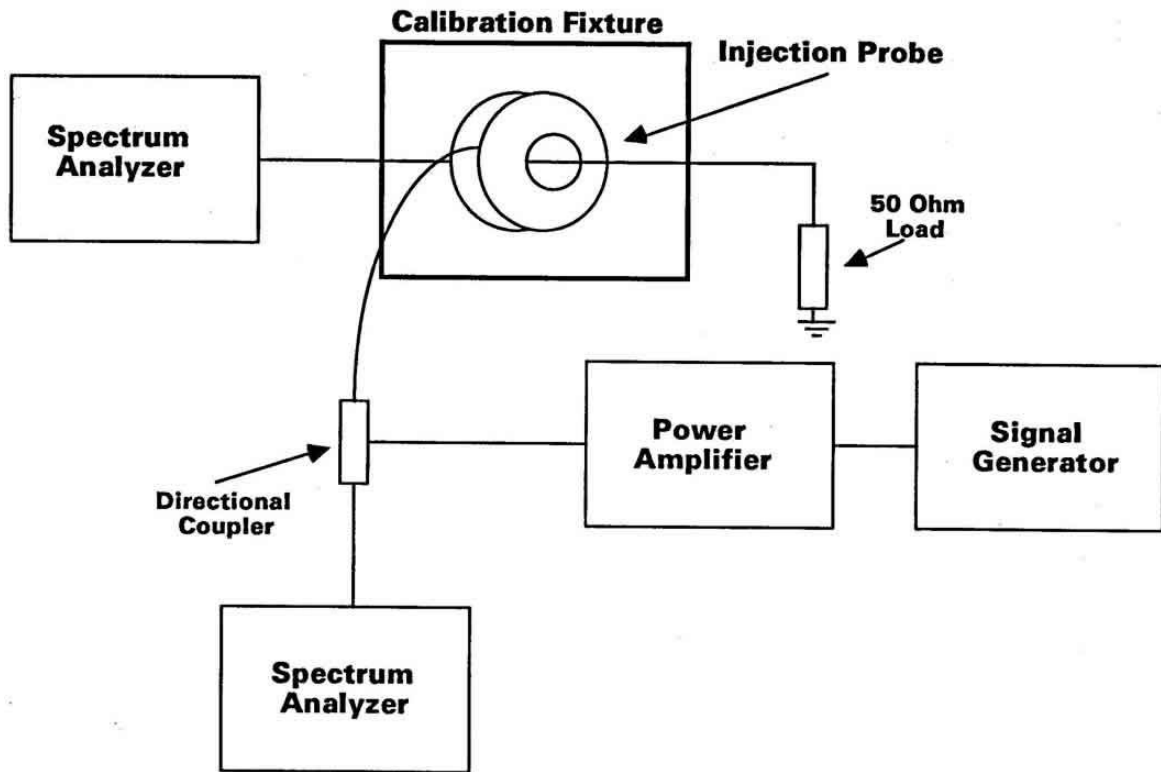


Figure 2

**Precalibration of Injection Current Probe**

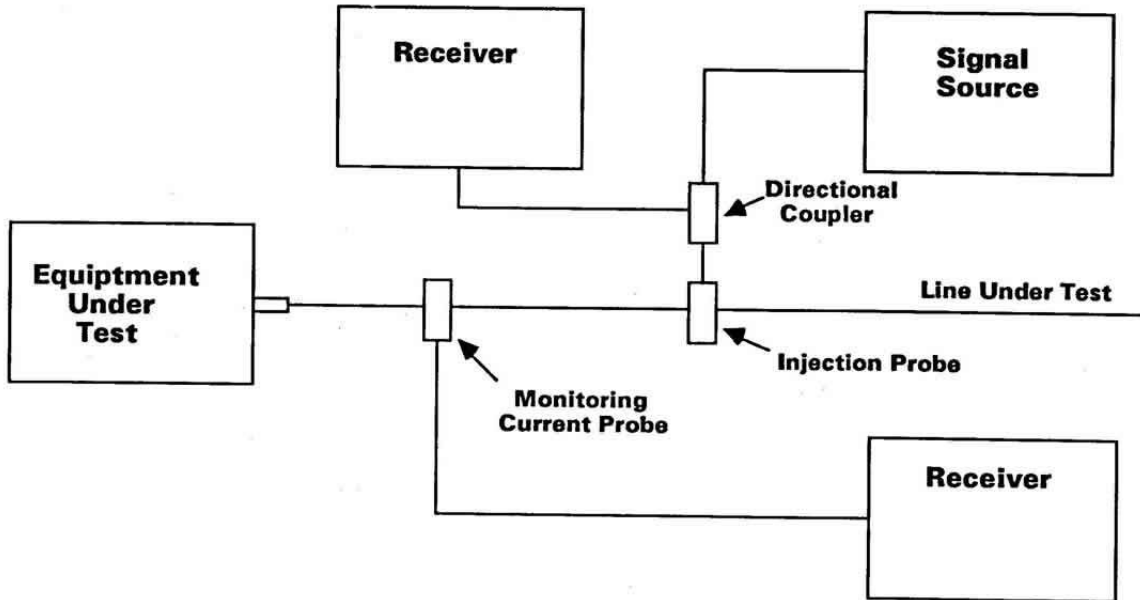


Figure 3

### Test Configuration for Current Injection

## FORMULAS AND CALCULATIONS

A specific Transfer Impedance Factor is associated with each frequency. This number is to be subtracted from the receiver reading in order to convert to dBuA

$$\text{dB}\mu\text{A} = \text{dB}\mu\text{V (from Receiver)} - \text{Transfer Impedance (dB}\Omega) - \text{cable Loss (dB)}$$

### **EXAMPLE:**

**Assume that the frequency of interest is 80 KHz and we need to find the current at this frequency. Connect the probe per figure 1**

**Frequency: 80 KHz**

**Transfer Impedance: -2.76 dB ohms**

Cable Loss: 0.1dB

Receiver Reading: -33.0dBuV

$$\text{dB}\mu\text{A} = \text{dB}\mu\text{V (from Receiver)} - \text{Transfer Impedance (dB}\Omega) + \text{cable Loss (dB)}$$

$$\text{dB}\mu\text{A} = -33.0 - -2.76 - -0.1$$

$$\text{dB}\mu\text{A} = -30.14$$

When injecting current:

$$\text{Injection current (dB)} = \text{Input current (dB)} - \text{Insertion loss (dB)} - \text{Cable loss}$$

Maximum power rating : 100 Watts for 30 minutes

Do not handle injection probe while testing is in progress.

Hazardous voltages may be present.

# MAINTENANCE

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To ensure reliable and repeatable long-term performance, annual re-calibration of your current probe by A.H. Systems experienced technicians is recommended. Our staff can recalibrate almost any type or brand of antenna.

For more information about our calibration services or to place an order for antenna calibration visit our website at <http://www.AHSystems.com> or call 1(818) 998-0223.

## WARRANTY INFORMATION

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A.H. Systems Inc., warrants that our Antennas, Sensors and Probes will be free from defects in materials and workmanship for a period of three (3) years. All other products delivered under contract will be warranted for a period of two (2) years. A.H. Systems' obligation under this warranty shall be limited to repairing or replacing, F.O.B. Chatsworth, California, each part of the product which is defective, provided that the buyer gives A.H. Systems notice of such defect within the warranty period commencing with the delivery of the product by A.H. Systems.

The remedy set forth herein shall be the only remedy available to the buyer, and in no event shall A.H. Systems be liable for direct, indirect, incidental or consequential damages.

This warranty shall not apply to any part of the product which, without fault of A.H. Systems has been subject to alteration, failure caused by a part not supplied by A.H. Systems, accident, fire or other casualty, negligence, misuse or normal wear of materials.

Except for the warranty set forth above, there are no other warranties, expressed or implied, with respect to the condition of the product or its suitability for the use intended for them by the buyer.

For prompt service, please contact our service department for a Return Material Authorization Number before shipping equipment back to us.