Safety Precautions

Prior to energizing the current clamp, the following must be completed.

1) The injection probe and appropriate calibration fixture must be well connected to a ground plane.

2) All cables under test must be securely positioned inside the injection probe and the probe firmly closed and latched shut.

3) The RF Power cables must be completely and securely connected to the injection probes Type-N Input Connector.

4) While testing is in progress, the injection probe and all cables must never be handled. Voltages may be present.

5) After the test is completed, the signal generator and amplifier must be de-energized before the injection probe can be handled.

6) Do not handle injection probe while testing is in progress. Hazardous Voltages may be present.

NOTE: THE REMOVAL OF ANY EXTERNAL SCREWS ON THE INJECTION PROBE OR MATCHING NETWORK VOIDS

DESCRIPTION

1.0 PURPOSE

A current clamp is a current injection transformer that utilizes inductive coupling to inject current on a cable connected to an EUT under test. It is commonly referred to as an injection probe. The device has been specifically designed to couple large RF, CW and modulated power into equipment in accordance with IEC-801-6.

The injection probe shall be used as an injection method on shielded and unshielded cables or conductors that have electrical performance characteristics that will be adversely affected by other types of coupling decoupling networks. The injection probe shall not be used on power mains cables unless there are no CDNs available for the current required.

When several cables coming from an EUT are routed close together over a Length of more than 10 meters, they can be treated as one cable, and current injection can be used.

Auxiliary Equipment (AE) must be placed on insulating support 10 cm above the ground plane.

All cables connected to each AE, other than those being connected to the EUT, shall be connected to Decoupling networks. The Decoupling networks shall be connected no further than 30 cm from the AE. The cable(s) in between the AE the Decoupling network(s) or in between the AE and the injection clamp shall never be bundled or wrapped, and kept 3 to 5 cm above the ground plane.

Figure 1 shows a typical current clamp test setup.

2.0 ELECTRICAL CHARACTERISTICS

2.1 SCHEMATIC

The schematic of a current clamp is also shown in Figure 2. The elements of the current clamp is its external faraday shield, magnetic

2.1.1 INPUT POWER RATING

100 Watts for a duration of 30 minutes.

2.2 ATTENUATION

The other important characteristic of the current clamp is its attenuation. IEC-801-6 does not specify any values, however, it is beneficial to keep it as small as possible. The attenuation magnitude is the parameter that controls the amount of power that is lost between the coaxial input terminals of the current clamp and the EUT terminals. This parameter is related to coupling factor which is described in paragraph 2.2.2 of this document.

2.2.1 MEASUREMENT OF ATTENUATION

IEC-801-6 specifies that 150 to 50 ω adapters shall be incorporated into the method of measuring attenuation. These adapters are also incorporated in the test setup to measure the injected immunity levels, and are basically a 100 ω series resistance. The 150-50 Ω adapters are shown in Figures 7e and 7f of IEC-1000-4-6/ENV 50141.

The attenuation measurement test configuration is shown in Figure 3. The signal source is adjusted to any convenient magnitude capable of being measured by the spectrum analyzer connected to the EUT port of the current clamp through the 150-50 Ω adapter. This is the common mode of voltage that will be injected into the EUT. In order to ensure that the current clamp is efficiently coupled to the conductor under test, a calibration fixture is recommended. The fixture permits the probe to be coupled properly to the 150 - 50 ohm adapters and is also shown in Figure 3. The fixture designation is Model FCC-BCICF-4.

The common mode voltage level measured at the forward voltage port of the directional coupler is the voltage developed by the signal source. The ratio of the EUT voltage divided by the directional coupler voltage

is the attenuation. By computing 20 log of the ratio, the attenuation can be expressed in dB. The attenuation factor is useful in predicting the

2.4 COUPLING FACTOR

A current clamp coupling factor is defined as the open circuit voltage obtained at the EUT 150 - 50 ohm (common mode) connector divided by the open circuit voltage of the signal source. The coupling factor is not specified, but it is desirable to be kept to a minimum value. This explanation is provided as background on discussions contained in IEC-1000-4-6. The practical factor to utilize is the attenuation described previously. The coupling factor is measured by first establishing a 0 dB reference level using the test setup shown in Figure 5. Then with the signal source maintained at the same level and using the test setup shown in Figure 6, measure the magnitude of the voltage generated with the spectrum analyzer. The dB difference in voltage between Figures 5 and 6 is the coupling factor. The coupling factor is approximately 10 dB less than the attenuation factor.

3.0 SETTING IMMUNITY LEVELS

In order to establish the correct test setup and immunity levels of injected RF voltages, the following procedure is to be followed. The test setup for this is shown in Figure 7. Carry out the following steps to inject the proper immunity levels:

1) The first step is to establish the correct setting of the unmodulated test level. Therefore, the input power shall be CW and unmodulated.

2) In order to inject the proper CW signal level, the amplifier output is increased until the 50-ohm spectrum analyzer measures the following magnitudes for each category of immunity.

Level 1	0.167 VRMS
Level 2	0.500 VRMS
Level 3	1.670 VRMS

NOTE: - The above levels have been established by dividing the open circuit specification magnitude by 6. The factor of 6 comes due to the following:

value. This is how the one-sixth factor enters into the calculation.

3) The next step is to activate the 1 kHz sine wave modulator, and modulate the CW power with 80% modulation, which is verified using the spectrum analyzer.

4.0 TYPICAL TEST SETUP

A test setup using an current clamp is shown in Figure 1.

5.0 EXPECTED AMPLIFIER POWER

The CW amplifier power required to generate the maximum level is expected to be <20 watts.The 20 watts includes the power required to develop the 10 volt level, the 80% modulation at 1 kHz, as well as the power used up by a 3 dB attenuator placed between the amplifier and the injection probe for impedance matching.

The above assumptions take into account the typical attenuation of the F-120-9A Injection Probe and three dB of attenuation placed between the amplifier and the current clamp. The attenuator, if required, will reduce the reflected power caused by the EM Clamp VSWR. The attenuator will be required if the amplifier cannot operate satisfactorily when terminated into large values of VSWR.

It is recommended that an amplifier be selected that will not only provide the CW power required, but also maintain linear operation when being modulated 80% with a 1 kHz sine wave.

AE equipment. Therefore, diagnostic techniques will have to be used to isolate whether the RF is influencing the AE, EUT, or both. The intent of the specification is to ascertain the influence on the EUT only.

7.0 MECHANICAL CHARACTERISTICS

The F-120-9A injection probe has an aperture of 1.6 inches. This will permit it to clamp around cables having a diameter of 1.6 inches.