METHOD AND APPARATUS FOR ESTIMATING ELECTROMAGNETIC ENVIRONMENTAL EFFECTS ON RF DEPENDENT SYSTEMS

BACKGROUND

1. Technical Field

[0001] Embodiments described herein generally relate to systems and methods for estimating the impact of electromagnetic environmental effects (E3) on radio frequency (RF) dependent systems and sub-systems, and specifically to electromagnetic compatibility (EMC) and electromagnetic interference (EMI) at the platform level.

2. Description of the Related Art

[0002] Platform RF source/affected RF component testing is one of several tests utilized to provide certification data that prove to an authorization agency that the platform EMC meets the authorization agency requirements. This testing is sometimes referred to as source/victim testing because the "victim" component has an unintentional and undesirable response to the RF signals transmitted by the source. Such testing provides a structured approach for demonstrating EMC, and if EMI is discovered, the interference can be resolved before operational use. For complex platforms such as aircraft, these tests can be lengthy and costly. These tests include ground operation of every electrical and electronic system while monitoring each electrical and electronic system where EMI could adversely affect the safety of the platform or impair the capability of the platform to perform its mission. The source equipment is operated in modes that are considered worst-case for RF emissions and electromagnetic transient generation. The RF dependent systems are monitored while they operate in modes that are considered most susceptible to RF emissions and electromagnetic transients.

[0003] An instrumented radio ground test is a subset of the source/victim component test. This test consists of connecting a spectrum analyzer at the radio antenna port and sweeping the operating frequency of a radio receiver under test, or "victim," for both ambient and source systems operations. All onboard systems are energized but not transmitting. Conventionally, this test is performed in a quiet RF environment (*e.g.*, anechoic chamber). These tests, however, take days to install the instrumentation and can take weeks to take the measurements if used to identify receiver performance under cosite operational conditions.

[0004] In certain aspects, the present disclosure addresses the need to estimate the impact of E3 on RF dependent systems and sub-systems more efficiently than in the prior art.

SUMMARY

[0005] The present disclosure provides systems and related test methods that provide significant improvement in test accuracy, as well as reduction of test time for Electromagnetic Environmental Effects (E3) system level testing. Generally, systems according to the present disclosure may include a real time spectrum analyzer, a network analyzer, and a switching/ filtering/coupling network controlled by an information processing device, such as a general purpose computer. Systems according to the present disclosure may be able to scan all frequencies at each receiver. For example, in less than six seconds, a system according to the present disclosure can scan from 2 MHz to 26 GHz.

[0006] According to a first aspect of the present invention, there is provided a method for performing RF source-affected RF receiver testing on a platform having a plurality of RF dependent devices. The method: comprising connecting a set of the plurality of RF dependent devices to an RF signal communication network; connecting a plurality of acquisition antennas to the RF signal communication network; connecting a real time spectrum analyzer to the RF signal communication network; continuously monitoring an ambient electromagnetic state at the platform using the real time spectrum analyzer and the plurality of acquisition antennas; operating an RF source to transmit an RF signal, wherein the RF source is one of the RF dependent device in the set; estimating an operating parameter of each RF dependent device in the set using the real time spectrum analyzer; identifying a signal of interest using the estimated operating parameter and the ambient electromagnetic state; and identifying an affected RF dependent device using the signal of interest.

[0007] According to a second aspect of the present invention, there is provided an apparatus for estimating electromagnetic effects (E3) on a platform having a plurality of RF dependent devices. The apparatus comprising an RF signal communication network having a plurality of signal carriers, each signal carrier being configured to couple to an associated RF dependent device of the plurality of RF dependent devices, the RF signal communication network, allowing signal communication with each associated RF dependent device; a spectrum analyzer in signal communication with the RF signal communication network and configured to take near-instantaneous wide band measurements of induced RF in the signal carriers coupled to the RF dependent devices; at least one acquisition antenna in signal communication with the

RF signal communication network, the at least one acquisition antenna being configured to collect ambient E3 information in at least one frequency range; and an information processor in signal communication with the RF signal communication network, the information processor being configured to generate E3 characterization data using the at least one acquisition antenna and information generated by the real time spectrum analyzer.

[0008] In example, the present disclosure provides an apparatus for estimating electromagnetic effects (E3) on a platform having a plurality of RF dependent devices. The apparatus may include: an RF signal communication network having a plurality of signal carriers, each signal carrier being configured to couple to an antenna of each of the plurality of RF dependent devices, the RF filter thereby allowing selective signal communication with each antenna; a real time spectrum analyzer, in signal communication with the RF signal communication network and configured to take near-instantaneous wide band measurements of induced RF in the signal carriers coupled to the RF dependent devices; a network analyzer in signal communication with the RF signal communication network and configured to measure a operating parameter associated with each RF dependent device of the plurality of RF devices; and an RF amplifier and one or more antennas, the RF amplifier and at least one acquisition antenna cooperating to collect ambient E3 information in at least one frequency range; and an information processor in signal communication with the RF signal communication network, the information processor being configured to generate E3 characterization data using the RF signal acquisition unit, information generated by the real time spectrum analyzer, and information generated by the network analyzer.

[0009] In further example, the present disclosure provides a method for performing RF source-affected RF receiver testing on a platform having a plurality of RF dependent devices. The method may include the steps of: connecting a set of the plurality of RF dependent devices to an RF signal communication network; estimating an ambient E3 using at least one acquisition antenna and a real time spectrum analyzer; estimating an operating parameter associated with each RF dependent device of the set using a network analyzer in signal communication with the RF signal communication network; and selectively switching between each antenna of each RF dependent device in the set using the RF signal communication network, wherein the ambient E3 and each operating parameter are estimated in a predetermined frequency range and at a selected bandwidth.