Modeling Broadband Ambient Noise

Multi-Fidelity Antenna Modeling

EMIT is built around a multi-fidelity approach to cosite analysis. At the core of this methodology is EMIT's ability to combine different methodologies for computing antenna-to-antenna (ATA) coupling within a single simulation.

Advanced Radio Models

EMIT's advanced radio modeling capabilities enable analysis work to begin early on with simple, high-level specification sheet data and to be seamlessly enhanced with higher fidelity data as it becomes available. This approach helps to organize and maintain all RF System data while providing the highest fidelity results in a timely manner.

Ease of Use

The graphical user interface for EMIT allows users to set up jobs, run simulations and analyze results through one interface. An interactive help feature in the EMIT GUI quickly takes users to relevant material in its extensive documentation.

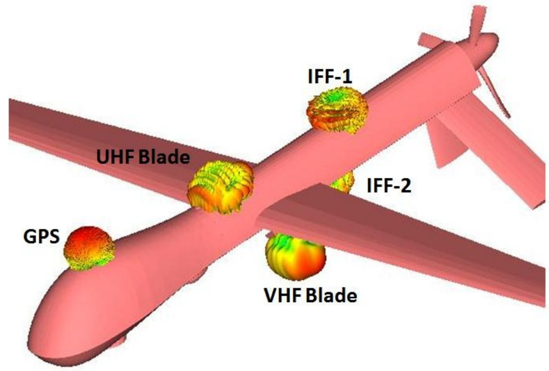
Large platforms with multiple RF systems present complex cosite environments. These RF systems can experience significant performance degradation if interference arises between the systems. Further complicating things, is the broadband emissions (ambient noise) from all of the electronic systems on-board the platform. While these emissions are typically several orders of magnitude lower than the intended RF emissions, they can still interfere with the operation of other systems.

To make matters worse, it is often difficult to identify issues arising from this ambient noise due to it's unpredictability; the noise is the result of radiated emissions from all the on-board electronic systems and its frequency content is determined by oscillators, non-linear effects, complex coupling paths, etc. Therefore, the typical way of characterizing the ambient noise spectral profile is through measurements.

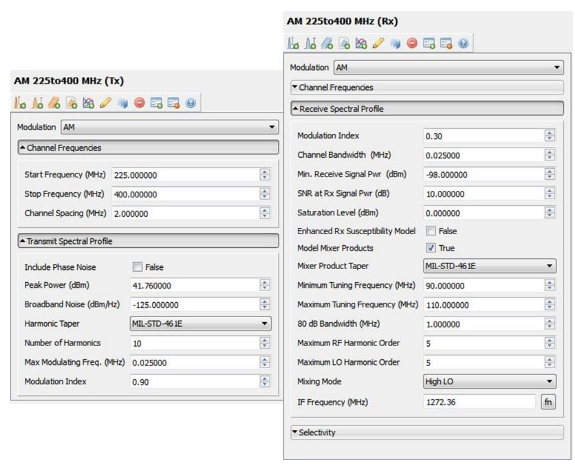
To illustrate how ambient noise can degrade system performance, let's look at a Predator drone with 5 RF Systems on-board: GPS, UHF Voice, VHF Voice, and 2 IFF systems. Detailed models of all of the radios are created in EMIT (a sample is shown to the right middle) and measured or simulated antenna-to-antenna coupling data is imported into EMIT for all of the antenna pairs as installed on the Predator.

The results of the cosite analysis are shown in the threat matrix, where the green boxes indicate that no interference is predicted between the specific Tx (across the top) and Rx (down the left side) pair. The absence of red boxes in the threat matrix signifies that EMIT predicts a completely benign, interference free environment. However, up to this point we have not looked at the effects of the ambient noise on the receivers' ability to operate interference free.

When broadband ambient noise measurements are available, the data should be incorporated into any cosite analysis as early in the platform design cycle as possible to reduce risk and cost. Problems that go undetected until final system testing with all of the systems installed often result in significant program delays and cost overruns. Fortunately, EMIT provides a simple, intuitive method for integrating the measured, broadband ambient noise spectrum with an existing cosite analysis.



A Predator UAV with multiple RF Systems located at various points along the fuselage



Sample transmitter and receiver properties showing the UHF Voice radio bands.

Rx \ Tx	IFF (Top)	IFF (Bottom)	VHF	UHF
GPS	[S]	[S]	[S]	[S]
IFF (Top)		[S]	[S]	[S]
IFF (Bottom)	[S]		[S]	[S]
VHF	[S]	[S]		[S]
UHF	[S]	[S]	[S]	

Threat matrix for Predator RF Systems. The [S] indicates measured or simulated S-parameter data was used to compute the ATA coupling between the radios. The green indicates no interference was predicted.

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CAD Formats

EMIT supports a variety of standard CAD formats such as ACAD Facet, IGES, Stereolithography, OBJ, WIPL-D and I-DEAS Universal. While EMIT does not perform any computational electromagnetic modeling, the CAD models are valuable for visualizing the location of the various RF systems and antennas on a platform.

RF System Characteristic Files (*.meas)

A native Delcross file format used to define raw channel data containing the spectral characteristics of transmitters and/or receivers. RF System Characteristic files use XML syntax to specify the frequency/amplitude pairs comprising a spectral profile.

Detailed Results Plots

EMIT's detailed results plots enable quick identification of the source of interference by overlaying the Tx and Rx spectrums with the ATA coupling data and the computed EMI margins.

Mitigating Interference

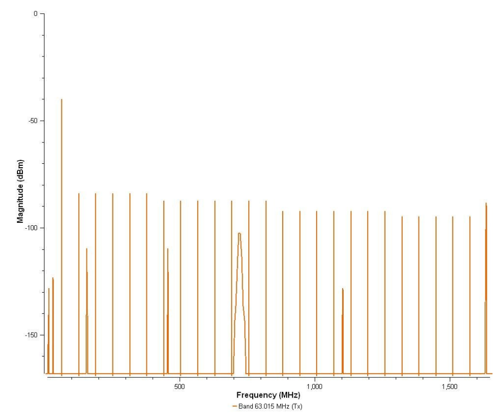
EMIT's analysis engine is tailored to enable various cosite mitigation strategies to be tested in a quick, efficient manner and presents the results in an easy to interpret way. For example, increasing the *Fixed Coupling* value from 0 to 20 dB quickly shows the impact of adding 20 dB of additional isolation between the ambient noise source and the RF Systems' antennas.

EMIT's RF System Characteristic File format uses a simple XML style syntax to specify frequency/amplitude pairs comprising a spectral profile. An RF System Characteristic file can be created from spectrum analyzer measurements or by using Delcross's Automated Measurement System (AMS), which can be run directly from EMIT. In this case, the spectral profile representing the ambient noise is created from spectrum analyzer measurements and is shown on the right (top). The large peak is due to an oscillator in one of the electronic systems operating at 63.015 MHz and its harmonics as well as other large, unidentified spurious emissions are also clearly evident.

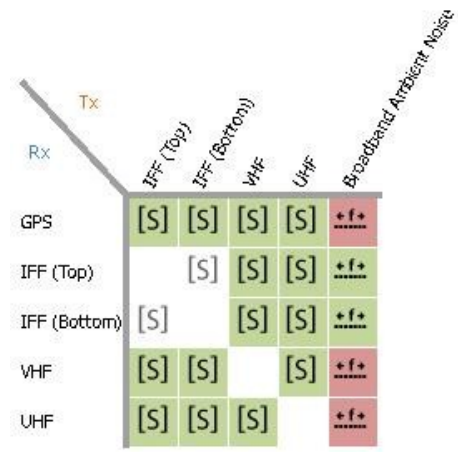
To model this in EMIT, a new transmitter is created with a single *Tx Band*. The *Tx Band* is then defined by selecting *Import a Tx Measurement File* from the *Tx Band's* toolbar. Since this "Transmitter" is intended to represent the ambient noise level, no antenna is assigned to the transmitter, which tells EMIT to apply the *Fixed Coupling* method of ATA coupling as shown by the ←f→ in the threat matrix (right-middle). The *Fixed Coupling* value should be left at the default value of 0 dB. The rest of the scenario is modeled in the typical manner before running the simulation.

Modeling the ambient noise in this fashion assumes that the spectral energy enters a specific receiver through its antenna port (though the characteristics of the antenna are ignored) and the characteristics of any outboard components (filters, amplifiers, cables, etc.) that exist between the Rx antenna and the actual radio will affect the ambient noise spectrum. With well shielded coaxial cables this is the most likely interference path, though any existing outboard components can be toggled on/off to determine if their presence combined with the ambient noise impacts the performance of the receiver. Toggling an outboard component off in this manner, is equivalent to injecting the ambient noise between the toggled component and the receiver (rather than at the antenna port.

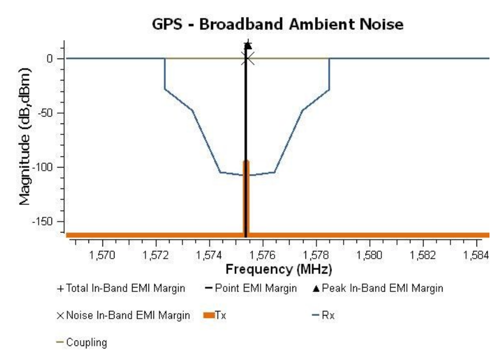
As the threat matrix shows, the ambient noise can result in significant interference. The 25th harmonic of the 63.015 MHz oscillator falls directly in the GPS Rx's L1 channel (right-bottom), resulting in interference. A similar analysis of the VHF and UHF receiver spectrums, shows that the measured ambient noise floor leads to a low level of interference and a slight performance degradation. With this knowledge of the likely causes of interference in hand, appropriate steps can quickly be taken to develop a mitigation strategy to eliminate the interference and EMIT can quickly and efficiently verify that compliance is obtained.



Measured broadband ambient noise spectrum resulting from electronic systems in the Predator fuselage



Threat matrix for Predator RF Systems with broadband ambient noise modeled. The green indicates no interference and the red indicates interference is likely.



Detailed results plot displaying the interference in the GPS Rx due to the 25th harmonic of a 63.015 MHz oscillator.

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