Interference and Direction Analyzer IDA-3106

Application Note

Using the IDA-3106 for rapid systematic detection and geographical localization of RF signals in an unknown environment

Summary

This Application Note describes a method using the new IDA-3106 handheld receiver with on-board spectrum management and direction finding functions, which is particularly suitable for use by special forces during tactical operations. One application scenario is the rapid systematic detection of unwanted or unauthorized communications during field operations and their elimination through tactical countermeasures such as active jamming. Another scenario is support in combating criminal or paramilitary activities and capturing the perpetrators by tactical localization of the communications equipment used without attracting attention.

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1 Introduction

Information about activity in the high frequency (RF) spectrum is extremely important when setting up flexible military field structures. On the one hand, it is about gaining as comprehensive an understanding of “enemy” communications as possible with the aim of eliminating them, and on the other hand about recording the communications of friendly units on international missions to ensure that there is no interference between them. Multiple transmitters can be detected, analyzed and localized with the proposed method. The preparation needed, the systematic field work process, and the subsequent interpretation of the results are all described here. The procedure complements existing fixed and mobile systems with a portable solution for individual soldiers, with the advantage that it can be used in areas where access is difficult, or under camouflage. This type of task demands speed, flexibility, and mobility above all. This Application Note describes how an unknown environment is characterized in five systematic steps using the Stuttgart airport environment as an example.

Figure 1. Stuttgart Airport. This environment was chosen as an example because of the multiple occupancy of the frequency spectrum.

2 Step 1: Spectrum analysis

The first step is to record the actual spectrum usage. This is done by adjusting the usual parameter settings on the spectrum analyzer and then taking a screenshot of the spectrum at the given location determined by its GPS coordinates, and saving this in the instrument. Figure 2 shows the spectrum of public FM radio broadcasts with the aircraft radio band at the upper end of the spectrum as an example. The marker has been used to highlight an initially unknown transmitter at 116.875 MHz in the aircraft radio band.

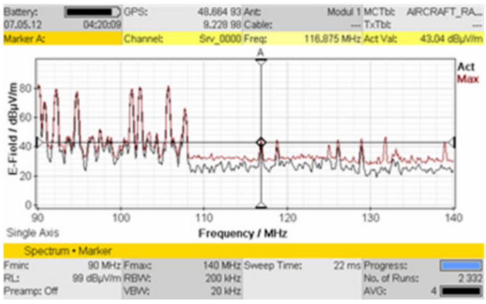

Figure 2. Actual FM and aircraft radio band usage at Stuttgart Airport, with an initially unidentified transmitter marked at 116.875 MHz

3 Step 2: Generating the Transmitter Table

Starting from the overview measurement made in step 1, the marker functions of the IDA are used to systematically collect all the suspect transmitters and others of interest together into a table, called a Transmitter Table (Example: Table 1).

Frequency	Service
86.475 MHz	Fire Brigade
112,500 MHz	Unknown T007
116,875 MHz	Unknown T008
118,800 MHz	Aircraft Radio Tower 1
119,050 MHz	Aircraft Radio Tower 1
126.125 MHz	Automatic Transmitter Identification System (ATIS)
136.825 MHz	Stuttgart Deicing
148.290 MHz	Bus Service Station Stuttgart
154.290 MHz	Technical Services

Table 1. Transmitter Table generated for the area around Stuttgart Airport

The transmitters or services that are selected for closer examination of their properties and locations are saved in the IDA-3106 as a transmitter table and are highlighted in color in Spectrum mode (Figure 3).

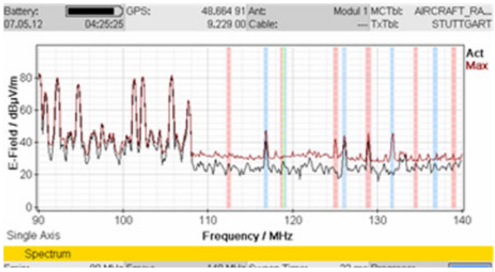

Figure 3. Highlighted entries in the Transmitter Table ready for further detailed investigation

The recorded transmitters are then analyzed one after the other as described below in step 3.

4 Step 3: Transmitter classification

Detailed characterization or classification of the transmitters is done, for example, by analog FM, AM, LSB and USB demodulation and listening to the audio band. An experienced listener can detect the Morse code for the combination of letters STG (for Stuttgart) in the initially unknown transmitter T008. Selecting a higher zoom factor reveals a main carrier at 116.850 MHz with sub carriers at 1020 kHz either side of it. Classification details can be determined by time domain analysis of this carrier. The oscilloscope function (Scope Mode) reveals the signal to be the VOR (VHF omnidirectional range) navigation transmitter for the airport. See references [3], [4] and figures 4 and 5.

Figure 4. Suspect transmitter T008 at 116.850 MHz displayed at high frequency resolution shows the typical sidebands of amplitude modulation

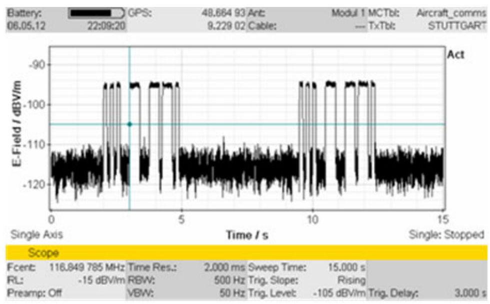

Figure 5. The time-domain display of the sideband of T008 reveals the Morse code letters STG repeated every 7.5 seconds. Comparison with the ICAO aeronautical chart [3] identifies the transmitter as the VOR (VHF omnidirectional range) navigation beacon.

5 Step 4: Transmitter localization

Localization of several suspect signals is done by systematically working through the transmitters in the Transmitter Table.

Figure 6 shows the principle of triangulation necessary for finding the bearings of several transmitters that all operate at different frequencies. A so-called “localization project” is opened on the instrument in order to work through all the positions and transmitters of interest; this is not closed (saved) until all the necessary bearings have been taken. Further bearings can be added to the result at any time by reopening the localization project.

Figure 7 shows a single bearing taken on transmitter T008 in a polar diagram as the result of a Horizontal Scan. Note that the 360° scan shown represents an almost ideal situation. In many cases, multipath propagation and more than one transmitter on the same frequency would disturb precise localization, but this would be immediately apparent from the polar diagram.

Figure 8 shows the instrument display of a triangulation on transmitter T008 with F_{center} = 116.850 MHz. The transmitter is now geographically identified as the VOR transmitter at the northern end of the runway.

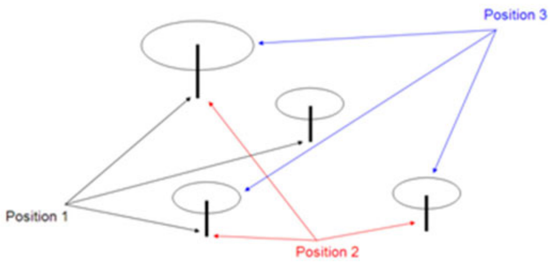

Figure 6. Diagram of the principle of taking cross-bearings on several transmitters, all operating at different frequencies

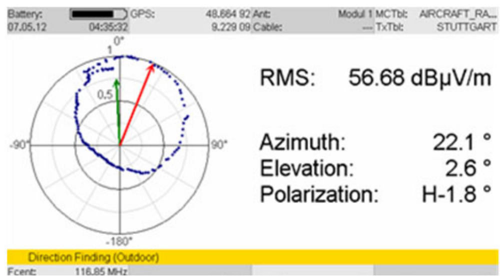

Figure 7. Using a Horizontal Scan to find the bearing of T008 in a northerly direction from the location of the IDA-3106 south of the runway as determined by GPS.

Figure 8. Triangulation of 116.850 MHz VOR (VHF omnidirectional range) transmitter with the identifier STG

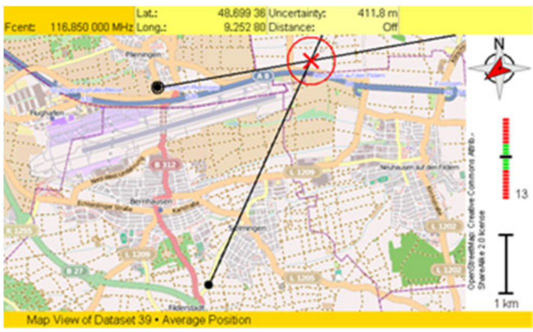

Figure 9. Performing a Horizontal Scan with IDA-3106 to find the bearing of a transmitter.

6 Step 5: RF transmitter map

Once all the bearings for all the frequencies of interest have been taken at all the selected positions and saved, the localization project on the instrument is closed and all the transmitter locations that have been determined are indicated on a RF transmitter map displayed by the instrument. The name, center frequency and GPS coordinates are shown for each transmitter marked on the map.

Figure 10. RF transmitter map with localization of all transmitters and signals of interest

7 Optional preparation procedures using Multi-Channel Tables

It can be useful to pre-load the IDA-3106 with the known service tables for the frequency range of interest before starting a radio monitoring project. These services are often nationally or internationally regulated and can be researched using public sources (Internet) and loaded on to the instrument as Multi-Channel Tables (Table 2). This type of configuration simplifies the correlation of a selected transmitter with the corresponding service.

Example: At the start of this report, the marked transmitter in the spectrum display (figure 2) is indicated as belonging to the AIRCRAFT RADIO service.

Frequency Band	Service
47 ÷ 68 MHz	Television
68 ÷ 88 MHz	4-m Land Mobile Radio
88 ÷ 108 MHz	FM Radio
108 ÷ 136 MHz	Aircraft Radio Navigation
144 ÷ 174 MHz	2-m Band
174 ÷ 230 MHz	Television Band III
230 ÷ 400 MHz	Aircraft Radio Communication
430 ÷ 440 MHz	70 cm Band Amateur Radio
440 ÷ 470 MHz	70 cm Band Land Mobile, PMR
470 ÷ 790 MHz	Television Band IV / V
864 ÷ 868 MHz	Short Range Services
858 ÷ 887 MHz	Cordless Phones

Table 2. Typical frequency tables for national and international radio services

8 Conclusions

The example described has demonstrated that a RF transmitter map can be generated quickly and effectively for tactical applications or similar purposes. Suspect signals are analyzed technically, classified and located geographically. The necessary tactical measures can then be taken, such as assigning communications channels or specific jamming of unauthorized transmitters. The concept described here for the IDA-3106 is called “Smart DF”, and it intelligently combines technologies that fulfill all the essential requirements regarding speed, flexibility, and mobility.

References

[1] Handbook on Spectrum Monitoring, ITU 2011

[2] Interference and Direction Analyzer brochure, Narda 2012

[3] Aeronautical Chart ICAO 1:500000 Stuttgart 2011 (NO 47/6), DFS Deutsche Flugsicherung GmbH

[4] VHF omnidirectional range (VOR), Wikipedia

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