

Radio Monitoring

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Radio Monitoring

Problems, Methods, and Equipment

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Preface

Automated radio monitoring (ARM) technology obtained wide distribution as a tool for problem-solving in various areas, beginning from radio frequency spectrum usage control to the use of radio environment checks to search for illegal radio transmitters. Radio monitoring equipment serves as the basis of technical measures for counteracting unapproved information pick-up, including the all-important investigation of compromising emanations.

The list of problems solved with the help of ARM equipment includes:

- Revelation and analysis of radio emissions, for the identification of signal and interference sources,
- Measurement of radio emission parameters, and the estimation of their danger or value for the user,
- Electromagnetic field strength, or the power flow density measurement,
- Radio signals and interference direction-finding in the terrain.

In particular, ARM equipment allows radio engineering facilities and computer hardware to be checked for the presence and level of incidental emanations. As such, the main functions of ARM equipment are the permanent or periodic observations of airwaves in the wide frequency range, the effective detection, analysis and localization of potential or specially-organized channels of information drain.

Based on the authors' development experience, fundamental information concerning the described ARM systems, reference data, and recommendations on the best methods and approaches for obtaining solutions to the above-mentioned problems are included in the book, together with the classification and detailed description of modern high-efficient hardware-software ARM equipment, including equipment for detection, radio direction-finding, parameters measurement and their analysis, and the identification and localization of electromagnetic field sources. Examples of ARM equipment structure and application, within the complicated interference environments found in industrial centers, inside of buildings, and in the open terrain, are included, together with the software required for such applications.

The book is prepared on the basis of Russian and foreign publications and as a result of various research and implementation activities of IRCOS¹ company experts, under the supervision and direct participation of the authors.

The book contains 12 chapters.

In Chapter 2, the list of problems solved by ARM systems is discussed in detail. An analysis of the nomenclature, structure, functions and parameters of ARM equipment is performed, and the system hierarchy of the facilities is developed. The composition, the functions, and the main technical characteristics for each class of equipment are determined.

Chapter 3 is devoted to the basic parameters of up-to-date radio receivers affecting ARM problem fulfillment. The peculiarities of the digital receiver structure for the 9 kHz – 18 GHz frequency range are shown. Design examples and the characteristics of single-channel and double-channel digital receivers are discussed.

Chapter 4 is dedicated to the mathematical aspects of narrow-band signal detection, as well as the signals with dynamic frequency-time distribution (with frequency hopping) for single- and double-channel radio equipment.

ARM problem-solving via multi-channel panoramic digital receivers is analyzed in Chapter 5, together with the hardware and software structure peculiarities of these receivers and their main technical data.

Chapters 6 and 7 are devoted to the radio signals used in communication, broadcasting, TV and data transmission systems, and to the technical analysis and parameter measurement of modulated and non-modulated signals. Examples of radio signal parameter measurement are discussed and recommendations for software applications are given.

A review of and the theoretical bases for direction-finding methods are presented in Chapter 8, and the main parameters of radio direction finders are explained. Examples of multifunctional radio monitoring and direction-finding equipment in VHF, UHF, and microwave ranges are described. The affect of used digital receivers on direction-finding effectiveness is shown.

Chapter 9 is devoted to the development of geographically-distributed radio monitoring systems and to direction-finding systems for radio emission sources. The application of stationary, mobile, portable and hand-held ARM equipment is considered. Moreover, the problems related to ARM station system equipment, organization of data transmission through the communication, navigation and power supply channels, are considered in this chapter as well. The possible uses of software for signal detection, their parameter measurement, and direction-finding of radio emission sources – with positions indicated on an electronic map – are discussed.

Chapter 10 includes information on determining the position of radio emission sources by mobile radio monitoring stations, and estimation of field strength distribution, taking into account terrain relief and area reclamation, to obtain covering zones of broadcasting and communication. Solutions to the problems of

¹IRCOS means: Investigations on **R**adio **C**ontrol and **S**ystem design

electromagnetic compatibility and the parameters testing of radio electronic equipment are discussed also.

Chapter 11 describes the structural peculiarities of radio monitoring equipment inside the premises and the revelation of technical channels of information leakage and unapproved radio emission sources. Revelation methods are discussed, together with these source localization methods on checked objects. Implementation examples for hardware-software facilities for technical channel leakage revelation, used both inside the premises and on the boundary of the checked zone, are presented.

In Chapter 12, the problems of radio system structure in performing compromising emanations investigation are considered. The theoretical aspects and the practical approaches for the revelation of the informative components are discussed, with calculation of the checked area and object immunity radii. The equipment and the software examples for these investigations are given.

The authors are confident that the materials offered in the book will be useful to experts in the area of radio monitoring, to operators and leaders of civil and military radio-checking services, and to security service employees of both state and commercial structures. The book can be recommended to the students of technical universities and colleges, studying in the appropriate fields.

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Acronyms

AA	- antenna array
ACS	- amplifying-converting section
ADC	- analog-digital converter
AE	- antenna element
AFH	- automatic frequency hopping
AFR	- amplitude-frequency response
AGC	- automated gain control
ALE	- automatic link establishment
AM	- amplitude modulation
AnM	- angle modulation
APM	- amplitude-pulse modulation
APSK	- amplitude-phase shift-keying
ARI	- Autofahrer Rundfunk Information
ARM	- automated radio monitoring
ARME	- automated radio monitoring equipment
ARQ	- Auto ReQuest
ARU	- antenna-receiver unit
AS	- antenna system
ASK	- amplitude shift-keying
BP	- bearing pair
BPT	- binary phase telegraphy
BRPSK	- binary relative phase shift-keying
BRPT	- binary relative phase telegraphy
BS	- basing station
BWLL	- Broadband Wireless Local Loop
CB	- Citizen's Band
CDCS	- Continuous Dynamic Channel Selection
CDMA	- Code Division Multiple Access
CE	- consumer equipment
CEE	- compromising electromagnetic emanation
CEEP	- compromising electromagnetic emanation and pick-up
CEPT	- Conference European for post and telecommunication
CF	- computing facility
CIM	- Correlation interferometric meter (correlative interferometer)

COFDM	- Coded Orthogonal Frequency Division Multiplexing
CP	- central post
CPFSK	- continuous phase frequency shift-keying
CRC	- Cyclic Redundance Check
CRT	- cathode-ray tube
CTF	- complex transfer factor
CW	- continuous wave
DAC	- digital-analog converter
DAM	- DAM modulation
DARC	- Data Radio Channel
DB	- database
DC	- distant control panel
DDM	- difference-distance measuring
DECT	- Digital Enhanced Cordless Telecommunications
DF	- direction finding, direction finder
DFT	- discrete Fourier transform
DPRS	- DECT Packet Radio Services
DPSK	- differential phase shift-keying
DRA	- distributed random antenna
DRM	- Digital Radio Mondiale
DRMS	- distant radio monitoring system
DRR	- digital radio receiver
DSBAM	- double sideband amplitude modulation
DSBSC	- double sideband suppressed carrier
DSP	- digital signal processing
DSSS	- Direct Sequence Spread Spectrum
DVBT	- Digital Video Broadcasting
EBU	- European Broadcasting Union
EDGE	- Enhanced Data rates for Global Evolution
EHF	- extremely high frequency
EMA	- electromagnetic availability
EMC	- electromagnetic compatibility
EMF	- electromagnetic field
EMW	- electromagnetic wave
ETSI	- European Telecommunication Standards Institute
FCU	- frequency conversion unit
FDMA	- Frequency Division Multiple Access
FEC	- Forward Error Correction
FFSK	- fast frequency shift-keying
FFT	- fast Fourier transform
FH	- frequency hopping
FM	- frequency modulation
FP	- frequency position
FS	- frequency synthesizer
FTD	- frequency-time diagram

FV	- flying vehicle
GEG	- gasoline electric generator
GFSK	- Gaussian frequency shift-keying
GIS	- geo-information system
GPRS	- General Packet Radio Service
GPS	- Global Positioning System
GSM	- Global System for Mobile communications
GTC	- gain-transfer characteristic
HFF	- high-frequency filter
HiperLAN	- High Performance Local Area Network
ICAO	- International Civil Aviation Organization
IEEE	- Institute of Electrical and Electronic Engineers
IF	- intermediate frequency
IFM	- instantaneous frequency measurement
IMC	- intermodulation component
INS	- inertial navigation system
IP	- interception point
ISSB	- Independent Single Sideband
ITA2	- International Teleprinter Alphabet
ITU	- International Telecommunication Union
LCD	- liquid-crystal display
LF	- low frequency
LMSK	- frequency shift-keying with minimal shift and with level regulation
LNA	- low-noise amplifier
LO	- local oscillator
LRA	- lumped random antenna
LSB	- lower sideband
LW	- long waves
MASK	- multiple amplitude shift-keying
MF (UHF)	- microwave frequency
MFSK	- Multiple frequency shift-keying
MMDS	- Multichannel Multipoint Distribution System
MP	- monitored premise
MPC	- microprocessor control
MSK	- Minimum Shift Keying
MUSIC	- Multiple Signal Classification
MW	- medium waves
NB	- Normal Burst
NFM	- Narrow Frequency Modulation
NICAM	- Near Instantaneous Companded Audio Multiplex
OBW	- occupied bandwidth
OFDM	- Orthogonal Frequency Division Multiplexing
OOK	- On/Off Keying
OQPSK	- offset quadrature phase shift-keying
PBF	- pass-band filter

PC	- personal computer
PM	- phase modulation
POFT	- programmable operating frequency tuning
PPM	- phase-pulse modulation
PS	- phase-shifter
PSA	- panoramic spectral analysis
PSF	- power source filter
PSK	- phase shift-keying
PTA	- panoramic-technical analysis
PWM	- pulse-width modulation
QAM	- quadrature amplitude modulation
QASK	- quadrature amplitude shift-keying
QM	- quadrature modulation
QPSK	- quadrature phase shift-keying
RDS	- Radio Data System
REE	- radio electronic environment
REM	- radio electronic means
RES	- radio emission source
RF	- radio frequency
RFA	- radio frequency amplifier
RFS	- radio frequency spectrum
RMD	- reference-methodical documentation
RMS	- root-mean-square value (deviation)
RO	- reference oscillator
RPSK	- relative phase shift-keying
RPU	- reception and processing unit
RR	- radio receiver
RRMS	- Remote Radio Monitoring System
RSS	- reference spatial signal
RTTY	- Radio Tele Type
SA	- spectrum analyzer, space apparatus
SAN	- system of active noisiness
SBD	- spectral and bearing data
SCA	- Sub-carrier Communication Allocation
SFH	- Slow Frequency Hopping
SG	- signal generator
SGU	- signal generation unit
SHF	- super high frequency
SMPS	- switch-mode power supply
SMS	- special mathematical software
SNR	- signal/noise ratio
SPS	- secondary power source
SQPSK	- staggered quadrature phase shift-keying
SR	- Selective Repeat
SRNS	- satellite radio navigation system

SS	- software support
SSBh	- single-side band (higher)
SSBl	- single-side band (lower)
SSBSC	- Single Sideband Suppressed Carrier
SV	- space vehicle
SW	- short waves
SWRV	- standing-wave factor on voltage
TCIL	- technical channel of information leakage
TCP/IP	- Transport Control Protocol/Internet Protocol
T-DAB	- Terrestrial Digital Audio Broadcasting
TDM	- Testing and Detection Mutual
TDMA	- Time Division Multiple Access
TDS	- Testing and Detection Separate
TOI	- Third Order Intercept
TTF	- tactical-technical features
UE	- user equipment
UHF	- Ultra High Frequency
UMTS	- Universal Mobile
UPS	- uninterrupted power supply
URES	- unwanted radio emission source
US	- user station
USB	- Upper Sideband
VHF	- very high frequency
VLf	- very low frequency
VSB	- Vestigal Side Band
VSWR	- Voltage Standing Wave Ratio
WARC	- World Administration Radio Conference
WCDMA	- Wideband-Code Division Multiple Access
WFM	- Wide Frequency Modulation
WLAN	- Wireless Local Area Network
WMAN	- Wireless Metropolitan Area Network
WPAN	- Wireless Personal Area Network
WTSC	- World Telecommunication Standards Conference