White Paper

Anritsu Advancing beyond

Basics of Radar and Transmitter Measurements

Contents

1 Introduction

Radar technology, which was invented and developed for military uses, is now used for many public purposes covering a wide application range, including safe and efficient operation of transport systems, weather forecasting, automobile collision prevention, etc. Radar systems, which are part of the social infrastructure helping support our safe and stable societies, must operate accurately and reliably. In addition, radar radiowaves are a unique resource, and the radar frequency bands are also used by various radio communications equipment, satellite communications and broadcasting, and other radiowave measurement systems. Consequently, radar systems must meet certain international technology standards to avoid interference with other radio systems. The spread of advanced radar systems requires periodic maintenance tests of radar transmitters and effective measurement methods to assure stable operation and compliance with relevant laws.

This White Paper outlines measuring instruments for testing the basic radio performance of pulse-radar transmissions used mainly for meteorological observations and air traffic-control systems. At actual measurement, confirm the local regulations for the installation site as well as the detailed measurement conditions for the equipment.

2 Basic Principles of Radar

2.1 What is Radar?

The term "radar" is an abbreviation for RAdio Detection And Ranging; it is a system for detecting objects using reflected electromagnetic energy. Radar systems can measure the direction, altitude, range, and speed of distant objects far from the radar site. Advanced radar systems can identify the shape and type of the distant object to track its movement.

Radar systems have the following advantages in comparison to optical and mechanical measurement methods.

- Night and day measurement regardless of poor visibility
- Long-distance and wide-range measurement from radar site beyond visual and physical metrology measurement ability
- More accurate and detailed measurement by combining data collected using several different methods

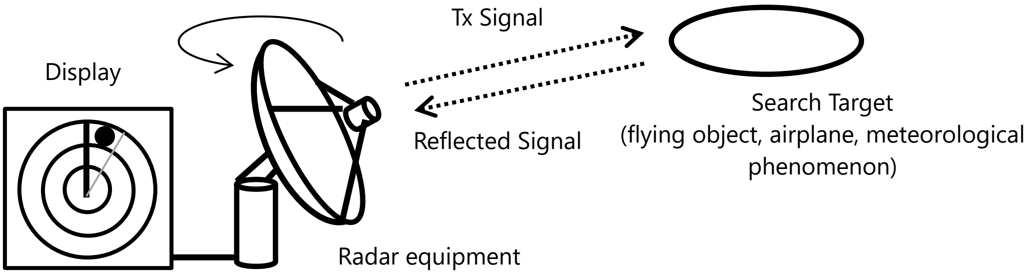

Fig. 2-1 Basic Concept of Radar

2.2 Radar Frequencies

Table 2–1 lists the radiowave frequency bands used by radar. In relative terms, the lower frequency bands can measure longer distance ranges, while higher frequency bands are better for measuring shorter distance ranges with higher resolution. In addition to military applications, these frequency bands are used for weather radar, maritime radar, air traffic-control radar, coastguard radar, etc., applications.

Radar systems using even higher frequency bands (24/60/76/79 GHz, etc.) is called millimeter-wave radar used by intelligent transport systems (ITS), especially automobile collision-prevention radar and more recently as sensing technology in the healthcare field.

Table 2-1 Main Radar Frequencies

IEEE Band Definition	Frequency Band	Maximum Range	Resolution	Antenna
UHF-Band	30 ~ 1,000 MHz	Long	Low	Large
L-Band	1,000 ~ 2000 MHz	⇕	⇕	⇕
S-Band	2,000 ~ 4,000 MHz			
C-Band	4,000 ~ 8,000 MHz			
X-Band	8 ~ 12 GHz			
Ku-Band	12 ~ 18 GHz			
K-Band	18 ~ 26.5 GHz	Short	High	Small

2.3 Outline of Radar System Configuration

Radar systems are composed of physical elements: an antenna, duplexer, transmitter, receiver, controller, and display.

Generally, the antenna is used for both transmitting and receiving; the duplexer switches the signal direction between transmit and receive. The radar radiowave is output from the antenna as a narrow beam with high directivity and concentrated energy. To increase the measurement range, the antenna may be either rotated mechanically, or an advanced electronic antenna array configuration may be used to search for target objects.

The transmitter uses either a transmission tube, such as a klystron or a semiconductor element. The klystron in a typical transmission tube handles very large powers ranging from 25 to 1000 kW; it can be used for long-range, long-term searching but the maintenance costs are high due to the short life and there are issues with frequency stability and efficient use of frequency bands. Semiconductor radar has high parts reliability so maintenance costs are extremely low and unwanted emissions (spurious) can be low at stable frequencies. However, the output power is about 300 to 400 W, and large output powers of transmission tubes such as the klystron cannot be handled. In the future, the application range is expected to increase due to improved semiconductor performance and complementary technologies.

The receiver detects both unwanted signals such as external interference and noise as well as the wanted signal from the target. Generally, since the radiowaves reflected by the distant target are very low power, the receiver sensitivity is improved using amplifiers and filters with excellent noise factors (NF). The controller includes signal processing and data processing, then synchronizing among transmitter, receiver and dipplay. The display is designed to match the system requirements to present quick and clear images of the target, including overlay display on map data.

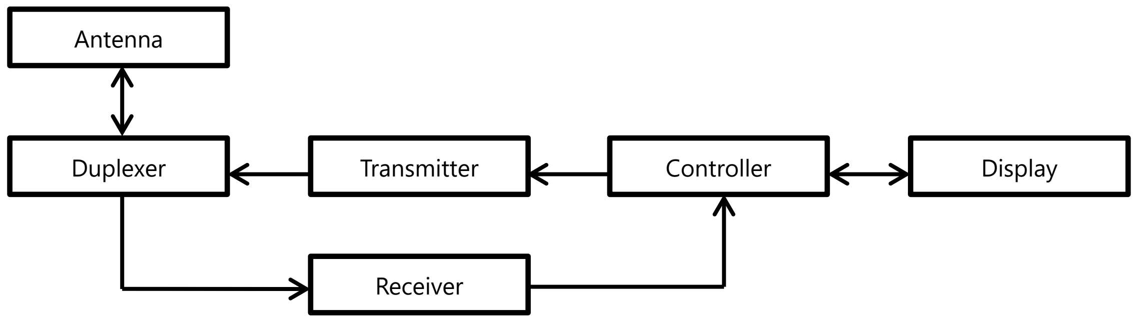

Fig. 2-2 Radar System Elements

2.4 Radar Methods

The main radar methods are divided broadly into pulse radar and FM-CW radar, based on the different signal modulation methods.

Pulse radar sends repeated square-wave pulses at fixed time intervals to determine the range from the time difference between received signals reflected by the target object. The pulse cycle time is the two-way time for the signal to travel the required maximum search range. The pulse-radar distance resolution and minimum search range are almost proportional to the pulse width. Targets at further distance ranges can be detected by widening the pulse width and increasing the Tx power, but the minimum detection range becomes longer as the Tx pulse repetition cycle becomes longer.

Generally, klystron-based radars have a short pulse combined with a high Tx antenna output power to detect targets at both long and short ranges. In comparison to klystron radars, solid-state radar has a low antenna power but can detect targets at both long and short ranges by transmitting a combination of long and short pulses. Pulse compression is a technology accommodating both maximum and minimum range detection; using this technology, a unique modulation is applied within a long pulse, which is converted to a narrow pulse at demodulation of the received signal. There are also pulse-radar technologies specified as long-pulse Q0N (where Q represents the angular modulation, 0 is an unmodulated signal, and N is no data), and short-pulse P0N (where P represents an unmodulated pulse, 0 is an unmodulated signal, and N is no data).

FM-CW radar uses a frequency modulated (FM) continuous wave (CW) signal to measure the distance range from the change in the FM frequency as well as the movement speed from the received frequency Doppler shift from the transmitted frequency. Since FM-CW radar achieves a high signal to noise (S/N) ratio without requiring a high Tx signal power in comparison to pulse radar, it is used in a wide range of applications, such as advanced compact aerospace implementations using semiconductors, meteorological radar, and automotive collision-prevention radar.

Recent, high-performance radar uses a combination of multiple technologies for high-resolution detection and position measurement over a wider range.

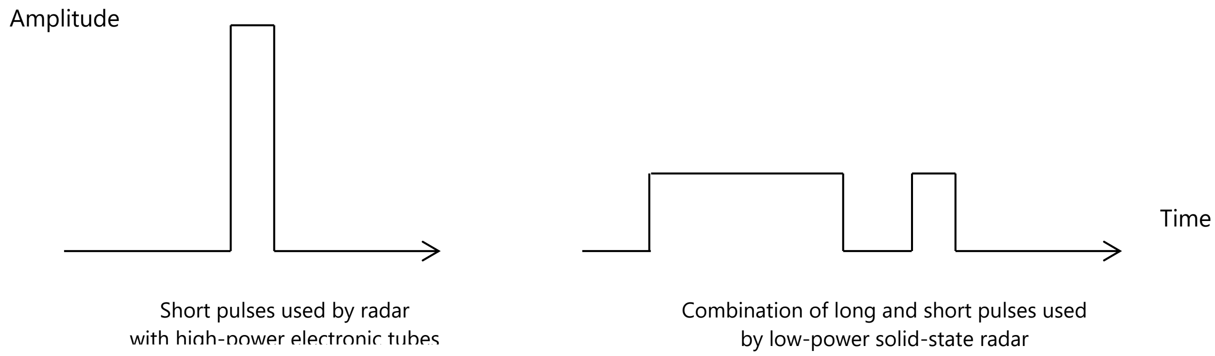

Fig. 2-3 Outline of Pulse Radar

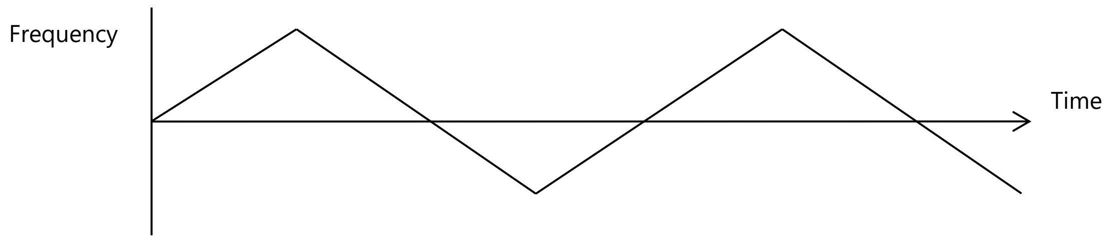

Fig. 2-4 Outline of FM-CW Radar

2.5 Radar Operation in Social Infrastructure

Radar systems support social infrastructure such as air traffic control, weather monitoring, ship navigation, etc.

Air Traffic Control Radar

Radar systems are used by air traffic control at regional airports to assure safe and effective operation of planes. There are various types of radar system for identifying aircraft both on the ground and in the air as well as providing information about speed, location and altitude. These include Airport Surveillance radar (ASR), Air Route Surveillance Radar (ARSR), Oceanic Route Surveillance Radar (ORSR), and Airport Surface Detection Equipment (ASDE).

ASR uses a carrier frequency between 2700 and 2900 MHz with a transmission power of 500 kW to cover a radius around the airport of 110 km. It provides information on the flight paths of departing and arriving planes as well as about distance between planes. ARSR uses a carrier frequency between 1200 and 1350 MHz with a transmission power of 2 MW to cover a radius around the airport of 460 km. ASDE is for assuring the safety of planes and other vehicles on the runway and taxiways; it uses a carrier frequency between 24.25 and 24.75 GHz with a transmission power of 30 kW to cover a radius of 5 km.

In addition to these fixed ground radar stations, planes also carry transponders providing automatic responses to air traffic control. These plane transponders receive signals in the 1-GHz band from Secondary Surveillance Radar (SSR) installed jointly with ground-based ASR and ARSR, and respond to the SSR with information about plane identity, altitude, etc.

Weather Radar

Weather radar broadcasts radiowaves to monitor the direction and size of rain and snow storms from the strength of the reflections and Doppler shift frequency returned from these storms. To perform long-range monitoring with no effects from obstructions such as mountains and buildings, weather radar installations are commonly installed at high locations, such as mountain tops and steel masts.

The main frequency bands used by weather radar are the S-band (3 GHz), C-band (5 GHz), and X-band (9 GHz). Generally, S-band weather radar with the best radius coverage of 500 to 600 km is used for monitoring whereas the X-band monitoring radius is 30 to 80 km. Multiparameter/MP (double polarized) radar is commonly used to monitor heavy rain storms based on the size differential of raindrops in the horizontal and vertical planes based on the property that raindrop size differences in the vertical and horizontal planes become bigger with bigger raindrops.

Compact X-band weather radar can monitor with a higher resolution than conventional S-band and C-band radar. Generally, the pulse width, which is related to the frequency band and distance resolution, is short pulses of 1 to 3 μs and long pulses of 30 to 350 μs for the C-band, and short pulses of 0.1 to 50 μs and long pulses of 128 μs for the X-band. Dense X-band radar installations can help prevent losses from mudslides, inundation, and flooding by predicting localized heavy rain storms. X-band weather radar is installed in planes to monitor storms in the flight path and plays a role in safe air navigation.

Maritime/Coastguard Radar

Radar installed in maritime vessels is generally used to confirm the vessel's position, prevent collisions with other vessels, and to monitor the weather and sea conditions. Coastguard radar monitors coastal shipping. These radar systems use the S- and X-bands. Maritime radar typically has an antenna power ranging from several to 20 or 30 kW with a pulse width of 20 or 30 ns to 1.2 μs. The earlier klystron-based radar systems are increasingly being replaced by long-life, solid-state radar.

3 Measuring Radar Transmitter

3.1 Main Measurements

The main radio specifications for pulse-radar transmitters are listed below.

- Peak power/average Tx power
- Pulse duration/pulse width
- Pulse rise time/fall time
- Tx frequency/frequency deviation
- Necessary frequency bandwidth/40-dB bandwidth

As explained previously, the main factors affecting radar performance are Tx frequency, Tx power, pulse width, and pulse cycle. Accurate measurement of these radio characteristics is required to assure stable operation and maintenance of radar systems. Consequently, instruments for measuring radar must satisfy the required performance and functions specified by international organizations and national legislation for radar. In addition, the measurement location and environment must also take the time and resources required for testing, the skills and experience of the test technician, the report format, and costs into consideration. With the increasing number of radar installations, an important issue is how to find effective low-cost test methods based on the latest standards and conventional methods.

3.2 Standards on Unwanted Emissions

Making effective use of limited radio resources is a key element for radio communications systems, including radar, and one fundamental technology requirement is suppression of interference with other radio systems. The International Telecommunications Union (ITU), which is a UN agency, defines the basic limits for spurious and out-of-band (OoB) unwanted emissions in ITU-R SM.329 Unwanted emissions in the spurious domain, and ITU-R SM.1541 Unwanted emissions in the out-of-band domain, while ITU-R M.1177 Techniques for measurement of unwanted emissions of radar systems, defines the measurement methods.

The spurious domain is the region outside the OoB domain where spurious emissions occur. The OoB domain is the region immediately outside the necessary frequency bandwidth (B_N; necessary bandwidth) with the modulated signal required for data transmission excluding the spurious domain. The OoB domain is the region where unwanted emissions are dominant.

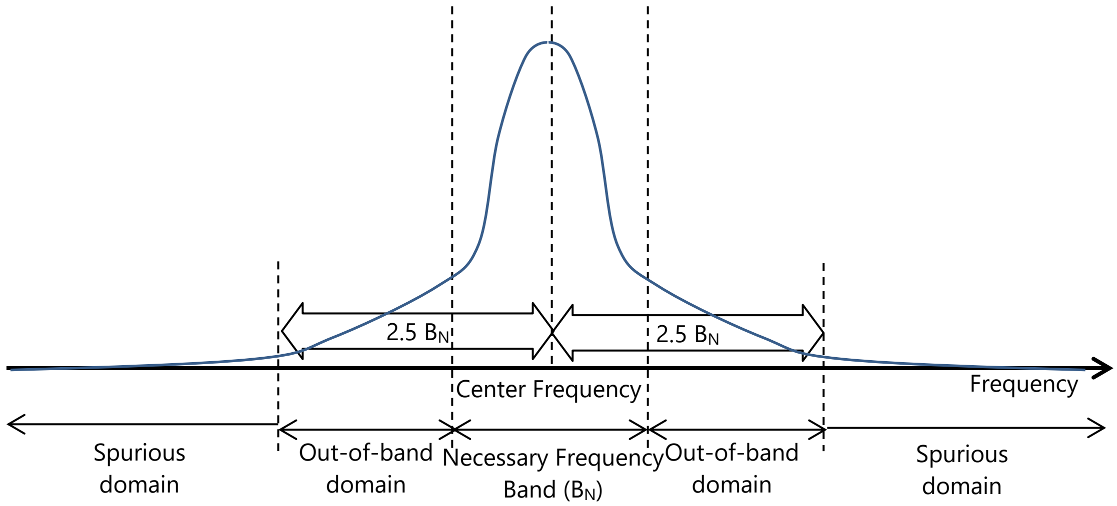

Fig. 3-1 Unwanted Spurious and Out-of-Band Emission Domains

ITU-R SM.329 defines the measurement frequency ranges of unwanted emissions shown in Table 3-1. Unwanted emissions are measured with the radar transmitter actually operating and transmitting the modulation waveform.

Table 3-1 Measured Frequency Range of Unwanted Emissions

Center Frequency Range	Measurement Frequency Range	
	Lo Frequency Limit	Hi Frequency Limit
100 ~ 300 MHz	9 kHz	10th Harmonic
300 ~ 600 MHz	30 MHz	3 GHz
600 MHz ~ 5.2 GHz	30 MHz	Fifth Harmonic
5.2 ~ 13 GHz	30 MHz	26 GHz
13 ~ 150 GHz	30 MHz	Second Harmonic

The permissible values for radar spurious-domain unwanted emissions are defined separately according to national and regional laws and radar type and operating conditions. For radio-positioning radar, ITU-R SM.329 Category A defines whichever is the smallest attenuation value of either 43 + 10logPEP or 60 dB as the spurious-domain unwanted emissions limit. PEP is the abbreviation for Peak Envelope Power expressed in watts (W). Systems for measuring spurious-domain unwanted emissions should have a measurement margin that is at least 10 dB more than the spurious level.

ITU-R SM.1541 defines the OoB mask limits for radar systems in Annex 8 “OoB domain emission limits for primary radar systems”. Although mask limits are defined in the frequency domain, the pulse duration (t) (or pulse width) and rise time (t_r) in the time domain determine the necessary bandwidth B_N. The duration of a pulse signal (t) is the time between the 50% amplitude points (Fig. 3-2). The rise time (t_r) is the time required for the antenna maximum amplitude to increase from 10% to 90% (Fig. 3-2).

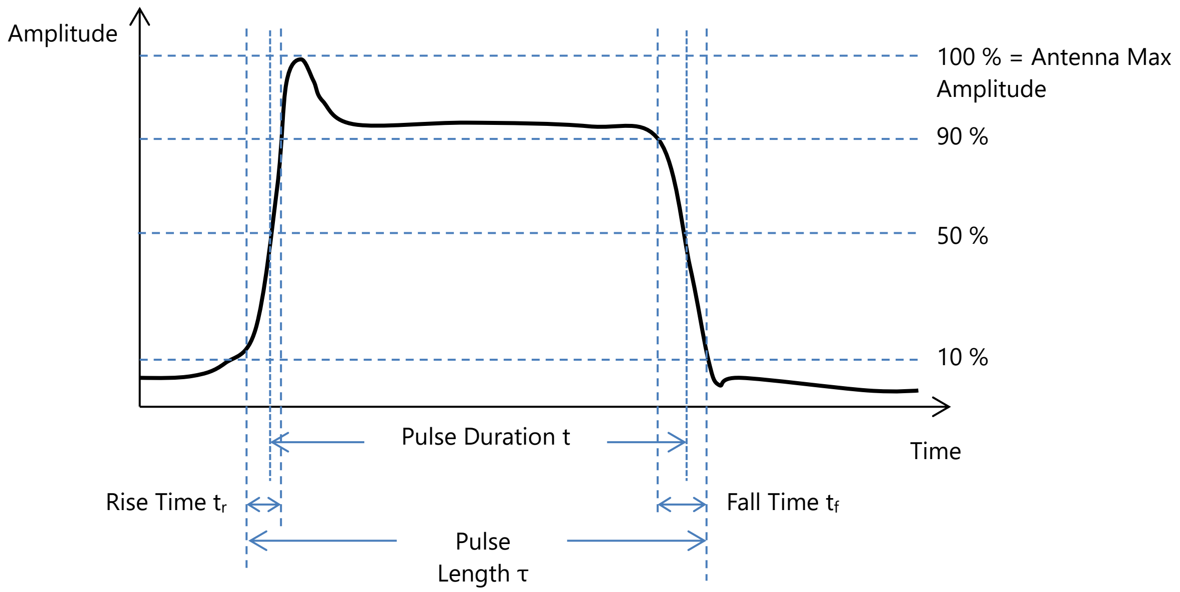

Fig. 3-2 Changes in Pulse Signal with Time

The necessary bandwidth B_N for non-FM modulated radar is found from the following equation.

$$B_N = \frac{1.79}{\sqrt{t \cdot t_r}} \; or \; \frac{6.36}{t}$$

The necessary bandwidth B_N for FM pulse radar is found from the following equation. Here, Bc is frequency shift range.

$$B_N = \frac{1.79}{\sqrt{t \cdot t_r}} + 2Bc$$

The upper limit for OoB unwanted emissions is basically determined by the 40-dB bandwidth (B_{-40}) of the Tx waveform spectrum. This value is determined by parameters calculated using the output level, output frequency, and type of modulation method. The B_{-40} value for non-FM pulse radar is determined by the following equation. Here, the value of *K* for radars with output levels exceeding 100 kW is 6.2, but is 7.6 for radio-navigation radars with an output level of less than 100 kW using frequencies from 2900 to 3100 MHz or from 9200 to 9500 MHz.

$$B_{-40} = \frac{K}{\sqrt{t \cdot t_r}} \; or \; \frac{64}{t}$$

The 40-dB bandwidth (B_{-40}) for FM pulse radar is found from the following equation.

$$B_{-40} = 1.5\left\{B_C + \sqrt{\pi} \cdot [ln(B_C \cdot \tau)]^{0.53} \cdot \left[Min\left(B_{rise}, B_{fall}, B_{rise\&fall}\right) + Max\left(B_{rise}, B_{fall}, B_{rise\&fall}\right)\right]\right\}$$

$$B_{rise} = \frac{1}{\sqrt{\tau \cdot t_r}} \quad B_{fall} = \frac{1}{\sqrt{\tau \cdot t_f}} \quad B_{rise\&fall} = \frac{1}{\sqrt[3]{\tau \cdot t_r \cdot t_f}}$$

Use the above equation when the product $B_C \cdot Minimum(t_r, t_f)$ is greater than or equal to 0.10, and the product of $B_C \cdot \tau$ or the compression ratio is greater than 10. Use the following equation in other cases. A is numeric coefficient (0.105 when K is 6.2, and 0.0065 when K is 7.6).

$$B_{-40} = \frac{K}{\sqrt{t \cdot t_r}} + 2\left(Bc + \frac{A}{t_r}\right)$$

The OoB mask line is drawn to fall gently from the 40-dB to the spurious level and is either 20 dB/decade, 30 dB/decade, or 40 dB/decade, depending on the waveform type. The term "per decade" expresses the attenuation when the frequency increases tenfold logarithmically. When the center frequency of the 40-dB bandwidth is at 0%, the frequency for that 40-dB bandwidth is expressed as –50% to +50%; when the attenuation at 10 times from one 50% side (or at 500%) is 20 dB, it is 20 dB/decade. As this logarithmic attenuation value becomes larger, since the mask drawn from both sides of the 40-dB bandwidth reaches the spurious level with the smallest frequency change, it is necessary to suppress unwanted spurious in the nearby spectrum.

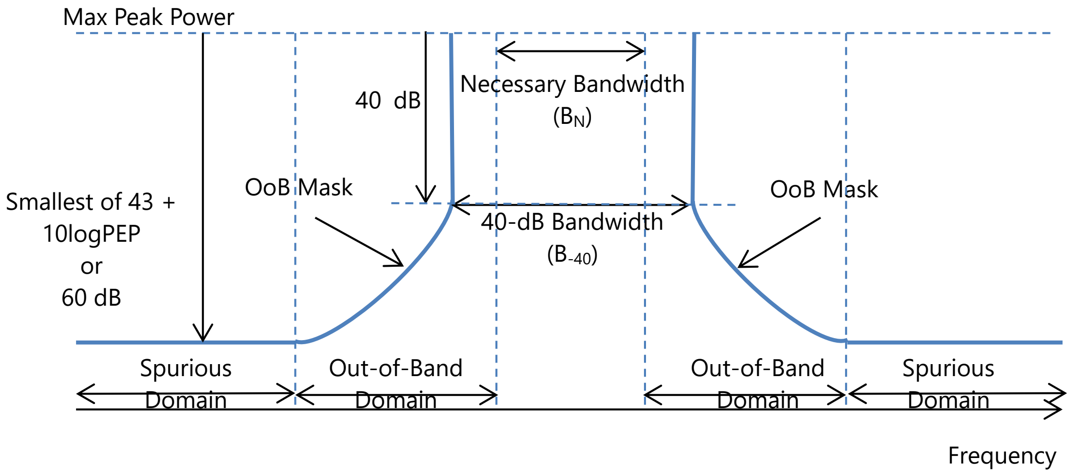

Fig. 3-3 Radar Tx Signal Maximum Unwanted Emissions

ITU-R M.1177 defines the direct and indirect measurement methods for the operating frequency bands used by measured radar installations in Annex 1 and Annex 2. The former covers radars operating at frequencies from 50 to 400 MHz and above 400 MHz. The latter covers radars operating up to 50 MHz, and from 50 to 400 MHz. When using the direct method, an anechoic chamber is used to measure the power radiated from the radar antenna by using a measurement antenna. Using the indirect method, far-field calibration is performed by calculation using the measured power at the output terminal of the transmitter and the antenna characteristics. At actual measurement, it is important to construct a test environment taking the type of radar system, form of operation, test interface, and related specifications and standards into consideration.

3.3 Measuring Instruments for Testing Radar Transmitter Radio Characteristics

When measuring the radio characteristics of a radar transmitter, the transmission power is measured with a power meter/sensor, the transmission frequency and frequency deviation are measured with a frequency counter, and the pulse duration transitions are measured with an oscilloscope. Measurements in the frequency domain, such as necessary bandwidth, and unwanted emissions in the OoB and spurious domains are usually measured with a spectrum analyzer. One reason for this is the many previous definitions for measurement methods using basic instruments as well as standards and regulations for each radio type. In addition, it is customary to use particular models of measuring instrument.

As recent measuring instruments have become more high-performance with diversified functions, all these measurements can be performed efficiently using a single measuring instrument supporting a wide range of measurement items. After considering candidate instruments supporting multiple measurements based on relevant test specifications, it is now possible to configure a measurement system at much lower cost than previously by understanding the features and characteristics of each instrument and the correlation with measurement results of previous instruments to choose the best system.

Power Meter/Sensor

The power meter is used as a reference standard for measuring the power of other instruments and measures power with excellent accuracy. When measuring a pulse-radar signal, a power sensor covering a wide bandwidth (more than 50 MHz) and supporting fast rise times (better than 1 µs) is selected. There are models for direct measurement of pulse width and rise time.

Frequency Counter

The counter is used when measuring the RF signal frequency and frequency deviation. It has a built-in high-stability reference oscillator and opens a gate at precise time units to pass and convert the signal to be measured to a pulse signal that can be counted to find the frequency. There are models that can detect the radar-signal pulse to measure the pulse width by calculation from a clock count.

Oscilloscope

The oscilloscope performs A/D conversion of signals to measure the change in voltage and amplitude components over time. As described here, the selected oscilloscope must have excellent time resolution to measure extremely short pulse widths with very fast rise times. When measuring radar signals with an oscilloscope, a detector is inserted at the first stage to convert the RF signals to voltage.

Signal/Spectrum Analyzer

The signal/spectrum analyzer converts the input signal to an IF signal using the superheterodyne method before sampling the A/D-converted direct signal (signal analyzer function) by sweeping the specified frequency range in the reference bandwidth (spectrum analyzer function). If the required conditions are met, one signal/spectrum analyzer completely covers all the key measurements for a radar transmitter for easy testing and maintenance.

The signal analyzer function samples the radar RF signal at a specific time and span at the set center transmission frequency; the IQ signal with these spectral components is converted to digital data using a high-speed processor to measure the Tx power, Tx frequency, pulse width, and pulse rise time. The pulse-width measurement analysis function is determined by the set span (signal analyzer analysis bandwidth). As a general rule, it is 0.02 µs when the analysis bandwidth is 31.25 MHz (50-MHz sampling rate), and 0.8 ns when the analysis bandwidth is 1 GHz (1300-MHz sampling rate).

At measurement of unwanted spurious using the spectrum analyzer function, it is set so that one pulse cycle is included in the unit sweep time and the specified frequency range is swept. The performance of the measurement system, internal and external attenuators, and instrument display average noise level (DANL) has a large impact on the unwanted emissions measurement margin. The maximum permissible power at the RF input terminal of a general signal/spectrum analyzer is 1 W (+30 dB). In particular, when measuring a high-output radar signal, it is necessary to insert a sufficiently large attenuator in the signal path at the first stage of the measuring instrument to prevent instantaneous input of an excessively large power. When using the direct method, the measuring-instrument external attenuation value is determined by the loss in free space and gain of the test Rx antenna; when using the indirect method and monitor terminal, the external attenuation value is determined by referencing the specifications of the output terminal.

For example, when measuring an X-band (9 GHz) radar with a maximum antenna output power of 1 kW (+60 dBm) at the transmitter terminal, the signal/spectrum analyzer maximum input level is 1 W (+30 dBm), and an external 40-dB attenuator must be inserted. To accurately measure and display the properties of the radio-signal waveform itself, the internal attenuator value at the first-stage mixer must be tuned to the appropriate setting to prevent distortion of the waveform by the signal/spectrum analyzer internal mixer circuits. When the optimum internal attenuator value is 30 dB when using a signal/spectrum analyzer with a DANL of −145 dBm/Hz and RBW of 1 MHz, the sweep noise floor is about −145 + 40 + 30 + 60 = −15 dBm/MHz, which is the measurable range of the radar signal itself, meaning that the margin is 15 dB (10 dB minimum) for a spurious level of 60 dB (+60 − 60 = +0 dBm), but the margin is actually smaller than this considering uncertainties at more detailed measurement.

When measuring high-output radar signals, the unwanted-emissions measurement margin can be obtained easily by separating-out measurement items other than unwanted emissions and measuring with a separate system. When measuring only unwanted emissions, the measurement margin can be increased by reducing the internal attenuation even if the radar-signal waveform is slightly distorted, because there is no impact on measurement. Moreover, when wanting to increase the measurement margin, the external attenuation amount can be reduced by using a notch filter to attenuate the power of the radar bandwidth upstream of the external attenuator.

Reference Materials

[1] ITU-R M.1177-4 "Techniques for measurement of unwanted emissions of radar systems"

[2] ITU-R SM.329-12 "Unwanted emissions in the spurious domain"

[3] ITU-R SM.1541-4 "Unwanted emissions in the out-of-band domain"

[4] Takashi Yoshida / Radar Engineering Revised Edition" The Institute of Electronics, Information and Communication Engineers

[5] MIC: Ministry of Internal Affairs and Communications <https://www.soumu.go.jp>

[6] MLIT: Ministry of Land, Infrastructure, Transport and Tourism <https://www.mlit.go.jp>

[7] Japan Meteorological Agency <http://www.jma.go.jp/jma/index.html>

[8] Anritsu Company, "Radar Testing with Simulation Signals", Application Note, Part Number: 11410-00752

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