WsComm1 Fragen inkl. Lösungen

Zusammengestellt von Luca Mazzoleni

1. Why is 50 Ohm as a cable impedance popular?
    a. It is close to the optimum for maximum efficiency of power transfer.
    b. Due to the center value of the Smith chart.
    c. Fixed nature constant, can't be changed.
    d. Results in the longest life time of a cable.

2. Which of the following facts is true?
    a. gamma is always independent of L' and C'.
    b. gamma is always independent of R' and G'.
    c. v inside the transmission line is depending on L' and C'.
    d. v inside the transmission line is always equal to c.

3. What is a good approximation of sqrt(1+x) for small x?
    a. 1 + x
    b. 1 + x/2
    c. 1 + 2x
    d. 1 + x^2

4. What is the propagation speed of a 50-Ohm PCB microstrip line on FR-4?
    a. c/10
    b. c/4
    c. c/3
    d. c/2

5. Who came up with the telegraph equations?
    a. Heinrich Hertz.
    b. Guillelmo Marconi.
    c. Oliver Heaviside.
    d. James Maxwell.

6. What are the telegraph equations?
    a. 2 decoupled quadratic differential equations.
    b. 2 coupled quadratic differential equations.
    c. 2 decoupled linear differential equations.
    d. 2 coupled linear differential equations.

7. Which of the following statements is true?
    a. The cable impedance is always real-valued.
    b. The cable impedance is always complex-valued.
    c. The real part of the cable impedance is positive.
    d. The real part of the cable impedance is negative.

8. What happens if you connect cables of different impedances?
    a. The connectors don't fit.
    b. Power is being radiated.
    c. There are reflections.
    d. The cables are being destroyed.

9. How large is the field part in air for striplines?
    a. Larger than for microstrip lines.
    b. Smaller than for microstrip lines.
    c. Equal to that of for microstrip lines.
    d. No statement can be made.

10. What happens to the effective permittivity of a PCB line with increasing width?
    a. It stays the same.
    b. It is decreasing.
    c. It is increasing.
    d. It gets frequency dependent.

11. What happens to the wave impedance of a PCB line with increasing width?
    a. It stays the same.
    b. It is decreasing.
    c. It is increasing.
    d. It gets frequency dependent.

12. What is the goal with impedance matching of a complex-valued load?
    a. The source impedance shall be equal to the load impedance.
    b. The source impedance shall be have the inverse sign of the load impedance.
    c. The source impedance shall be equal to the complex conjugate of the load impedance.
    d. The source impedance shall be as high as possible.

13. What does the s stand for with respect to the reflection parameters?
    a. Surface
    b. Source
    c. Scatter
    d. Smith

14. Which matrices are being multiplied when twoports are cascaded?
    a. Z-matrices
    b. Y-matrices
    c. S-matrices
    d. T-matrices

15. What can be said for passive, lossless twoports?
    a. |s11|^2+|s22|^2=1
    b. |s11|^2+|s12|^2=1
    c. |s11|^2+|s21|^2=1
    d. None of the above.

16. What return loss signifies a good matching situation?
    a. 0 dB
    b. -3 dB
    c. 20 dB
    d. -20 dB

17. What power proportion is reflected when the Return Loss is 10 dB?
    a. 1%
    b. 10%
    c. 50%
    d. 100%

18. Which value of the reflection coefficient does the center of the Smith-Chart correspond to?
    a. -1
    b. 0
    c. 1
    d. j

19. What advantage does a multistage matching circuit have (L-topology)?
    a. simple
    b. low price
    c. robust to interference
    d. more wideband

20. How many L-topologies of LC networks do exist?
    a. 2
    b. 4
    c. 8
    d. 16

21. How many L-topologies of LC networks can always be used at least for a given matching situatio...
    a. 1
    b. 2
    c. 4
    d. 8

22. A Lambda/4-line transforms the reflection factor in the Smith Chart ...
    a. by a 1/8 turn.
    b. by a 1/4 turn.
    c. by half a turn.
    d. by a full turn.

23. Which of the following lengths transforms a high-impedance load to a short-circuit?
    a. lambda/2
    b. 8*lambda/4
    c. 13*lambda/4
    d. 13*lambda/2

24. A transmission line of electrical length lambda transforms an impedance of (100+j50) Ohm into...
    a. (100+j50) Ohm
    b. (100-j50) Ohm
    c. (25+j50) Ohm
    d. (25-j50) Ohm

25. Which elements are parts of an SC filter?
    a. resistors
    b. inductors
    c. OpAmps
    d. mixers

26. The Q factor of a quartz filter is ...
    a. much higher than that of an LC filter.
    b. much lower than that of an LC filter.
    c. about the same as that of an LC filter.
    d. negative.

27. The loaded Q is ...
    a. always higher than the unloaded Q.
    b. always lower than the unloaded Q.
    c. the same as the unloaded Q.
    d. (depends on series or parallel resonance circuit).

28. What is the Richards transform?
    a. Conversion of open into short-circuited transmission lines.
    b. Conversion of capacitors into transmission lines.
    c. Conversion of capacitors into inductors.
    d. Prewarping of the frequency response.

29. What is a Kuroda transform?
    a. Linear spectrum becomes a repetitive spectrum.
    b. Current-voltage-conversion.
    c. Admittance-impedance-conversion.
    d. Using unit elements inductors may be transformed into capacitors.

30. What is the output attenuation of a resistive splitter?
    a. 0 dB
    b. 3 dB
    c. 6 dB
    d. 12 dB

31. The through loss T [dB] of a passive coupler is ...
    a. always 0
    b. a negative value
    c. a positive value
    d. none of the above

32. What can be said about coupling C [dB] vs. through loss T [dB] of a passive coupler?
    a. C=T
    b. C<T
    c. C>T
    d. none of the above

33. A choke balun is another word for ...
    a. current balun
    b. voltage balun
    c. transformerless balun
    d. discrete balun

34. What does the abbreviation SDMA stand for?
    a. Scatter-division multiple access
    b. Splutter-division multiple access
    c. Secret-division multiple access
    d. Space-division multiple access

35. What kind of channel access does GSM use?
    a. TDMA
    b. CDMA
    c. SDMA
    d. PDMA

36. What kind of channel access does UMTS use?
    a. TDMA
    b. CDMA
    c. SDMA
    d. PDMA

37. How are collisions avoided with the ALOHA protocol?
    a. by 'Listen-before-Talk'
    b. by random delay of the packets
    c. by increased transmission power
    d. by improved receivers

38. What drawback do spread-spectrum systems have?
    a. Near-far problem
    b. privacy
    c. fading immunity
    d. jamming immunity

39. Which system does not use OFDM?
    a. ADSL
    b. UMTS
    c. LTE
    d. DVB

40. How does OFDM turn a linear convolution into a circular convolution?
    a. cyclostationarity
    b. cyclic extension
    c. random cycles
    d. bicycles

41. What does the word 'Modem' stand for?
    a. modified demolisher
    b. modular Emulator
    c. modulator/demodulator
    d. modified employer

42. What is the use of Gray coding?
    a. Maximization of the symbol distance within the constellation
    b. Minimization of the bit-errors
    c. Encryption of the message
    d. Black-and-white colorization of the image information

43. How do you get the impulse response of a Raised-Cosine filter?
    a. It is the same as the impulse response of a Root-Raised-Cosine filter.
    b. By taking the square root of the impulse response of a Root-Raised-Cosine filter.
    c. By squaring the impulse response of a Root-Raised-Cosine filter.
    d. By convolving the impulse response of a Root-Raised-Cosine filter with itself.

44. Where is the pulse shaping filter in a GMSK system?
    a. before the modulator (in the transmitter)
    b. after the modulator (in the transmitter)
    c. after the mixer but before the demodulator (in the receiver)
    d. after the demodulator (in the receiver)

45. What modulation index does MSK have?
    a. 0
    b. 0.3
    c. 0.5
    d. 1

46. What advantage does a CPM system have compared with switched oscillators for the generation of FSK?
    a. no phase jumps
    b. faster changes of the frequency
    c. cheaper
    d. smaller

47. How many amplitudes are there in a 16-QAM signal (baseband)?
    a. 1
    b. 2
    c. 3
    d. 4

48. How many amplitudes are there in a GMSK signal?
    a. 1
    b. 2
    c. 3
    d. 4

49. What phase change does an MSK signal produce during one symbol duration?
    a. ±22.5º
    b. ±45º
    c. ±90º
    d. ±180º

50. What diode is well suited as an RF switch?
    a. PIN diode
    b. Varactor diode
    c. Schottky diode
    d. Tunnel diode

51. What can be said for the quadratic range of a diode detector?
    a. The output voltage is proportional to the input power.
    b. The output voltage is proportional to the input power squared.
    c. The output voltage is proportional to the frequency of the input signal.
    d. The output voltage is proportional to the Fermi level.

52. What diode is well suited for a tunable oscillator?
    a. Schottky diode
    b. Zener diode
    c. Avalanche diode
    d. Varicap

53. Where does the Gunn diode derive its name?
    a. looks like a pistol
    b. looks like a gun
    c. globally distributed undoped double n-layer
    d. after a physicist

54. What does dBc mean?
    a. logarithmic ratio to elementary charge
    b. logarithmic power density compared to circle radiator
    c. dual-band (centered)
    d. logarithmic power ratio compared to carrier signal

55. Which characteristic is the least important for a power amplifier?
    a. linearity
    b. low noise
    c. high efficiency
    d. thermic capability

56. What does the expression conditional stability mean with respect to amplifiers?
    a. Instability might occur within a certain temperature range.
    b. Instability might occur for a certain power supply voltage.
    c. Instability might occur for a certain active load.
    d. Instability might occur for a certain passive load.

57. What are stability circles?
    a. Locations for poles to be found.
    b. Impedances on the circles result in stable designs.
    c. Impedances within stability circles are forbidden regions.
    d. Impedances within the circles result in stable designs.

58. The maximal transducer gain of an amplifier ...
    a. ... is larger than or equal to |s21|.
    b. ... is smaller than or equal to |s21|.
    c. ... is smaller than or equal to |s11|.
    d. ... can be made negative.

59. What are gain circles?
    a. Expert working groups for the design of amplifiers.
    b. Circles of constant gain. The gain increases outside the circles.
    c. Circles of constant gain. The gain decreases inside the circles.
    d. Circles of constant gain. The gain decreases outside the circles.

60. Which of the following amplifiers is the most linear one?
    a. Class AB
    b. Class A
    c. Class C
    d. Class D

61. Which of the following amplifiers is the most efficient one?
    a. Class AB
    b. Class A
    c. Class B
    d. Class D

62. What are noise circles?
    a. The same as gain circles.
    b. Forbidden like all gifting circles.
    c. Circles of constaint noise figure, which increases towards the center.
    d. Circles of constaint noise figure, which decreases towards the center.

63. Flicker noise ...
    a. ... is frequency independant.
    b. ... is more of a problem at lower frequencies.
    c. ... is more of a problem at higher frequencies.
    d. ... is only a problem at frequencies of visible light.

64. What is the amplitude density of quantization noise?
    a. Gaussian distributed
    b. uniformly distributed
    c. Laplace distributed
    d. amplitude discrete on two points

65. What is the amplitude density of thermal noise?
    a. Gaussian distributed
    b. uniformly distributed
    c. Laplace distributed
    d. amplitude discrete on two points

66. What is the thermal noise power at room temperature and a bandwidth of 2kHz?
    a. -111 dBm
    b. -114 dBm
    c. -144 dBm
    d. -141 dBm

67. Which parameter of a two-stage amplifier chain does the total noise figure not depend upon?
    a. noise figure of the 2nd stage
    b. gain of the 2nd stage
    c. noise figure of the 1st stage
    d. gain of the 1st stage

68. Which parameter of an amplifier usually has the highest RF level?
    a. IIP3
    b. 1dB compression point
    c. noise floor
    d. OIP3

69. Which frequencies do NOT emerge when using an amplifier with 3rd-order distortions only (input...
    a. f1
    b. f2
    c. 2*f1+f2
    d. f1+f2

70. What the the noise figure express?
    a. Frequency shape of noise.
    b. Acoustic phenomenon.
    c. Signal gain for high-level signals.
    d. Degradation of input SNR to output SNR.

71. How many diodes are there in a double-balanced mixer?
    a. 1
    b. 2
    c. 3
    d. 4

72. How do you call an active FET mixer?
    a. Gilbert Cell
    b. Dilbert Cell
    c. Cascode
    d. Current mirror

73. What is the benefit of a double-balanced mixer versus a single-balanced mixer?
    a. smaller conversion loss
    b. simpler
    c. higher signal levels
    d. higher port isolations

74. What components are there in a passive double-balance mixer besides diodes?
    a. FETs
    b. switches
    c. transformers
    d. bipolar transistors

75. How do you call the effect, when strong interferers are being mixed into the IF because of phase ...
    a. reciprocal mixing
    b. intermodulation
    c. spurious emission
    d. phase discrimination

76. The spectral shape of phase noise ...
    a. is always white.
    b. shows strictly 1/f tendency.
    c. shows 1/f^2 tendency.
    d. increases for higher frequency.

77. Which of the following blocks is not part of a PLL?
    a. phase discriminator
    b. FM modulator
    c. VCO
    d. loop filter

78. Which of the following frequencies cannot be produced by an integer-N synthesizer (ref freq = 10...
    a. 1000.10 MHz
    b. 9999.99 MHz
    c. 1'235.0 MHz
    d. 400 kHz

79. How many known, classical methods for the generation of SSB signals are there?
    a. 1
    b. 2
    c. 3
    d. 4

80. What is the key feature of a polar modulator?
    a. resistance to low temperature such as -50 degree Celsius
    b. separate conditioning of amplitude and phase
    c. antenna signal is in polar coordinates
    d. is the same as a direct-conversion tx

81. Wie nennt man einen nur mit Wärme betriebenen Motor?
    a. Ottomotor
    b. Perpetuum Mobile
    c. Wankelmotor
    d. Stirlingmotor

Fragen aus den Prüfungen
Hs 12

1. Mit welcher Analogmodulation lässt sich ein FSK-moduliertes Signal am ehesten vergleichen?
    a. FM
    b. AM mit Träger
    c. ISB
    d. VSB

Hs 13

2. What effects do parasitics have in RF?
    a. Highpass filters can turn into lowpass filters.
    b. They start nibbling away other components.
    c. Lowpass filters can turn into highpass filters.
    d. Highpass filters can turn into allpass filters.

3. Eddy currents are ...
    a. turbulent-flow currents
    b. currents in the outer layers of conductors
    c. radial currents with respect to the conductor.
    d. strongest at DC.

4. What is the skin depth of a highvoltage cable made of copper?
    a. 1mm
    b. 1cm
    c. 1dm
    d. Depends on the current strength.

5. How many elements does an equivalent circuit of a lossy transmission line consist of?
    a. 2
    b. 3
    c. 4
    d. 8

6. What is a wave impedance?
    a. Characteristic impedance of a transmission line.
    b. Reactance of a transmission line.
    c. Susceptance of a transmission line.
    d. Imaginary part of the following load.

7. What happens during the mirroring at the x-axis in the Smith chart?
    a. Inversion of the impedance
    b. Inversion of the real value of the impedance.
    c. Inductance turns into capacitance
    d. Everything stays the same.

8. What disadvantage do multistage transmission-line impedance matching networks have compared with
    a. single-stage networks?
        a. Use up more space.
        b. Only inductance can be compensated
        c. Only capacitance can be compensated.
        d. Only resistance can be compensated

Hs 14

9. How much more power is 33 dB?
    a. 200
    b. 500
    c. 2000
    d. 5000
10. Hyperbolic functions..
    a. Always have a real argument
    b. Always give a real result
    c. Always give a complex result
    d. None of the above

11. Which of the following setups is not a balanced setup?
    a. Twisted Pair
    b. Coplanar tansmission line
    c. Dipole antenna
    d. Coaxial cable
12. How many diodes are there in a double-balanced mixer?
    a. 1
    b. 2
    c. 3
    d. 4

Hs 15

13. What is the unit of γ?
    a. m
    b. m^{-1}
    c. dB
    d. no unit

14. What is the characteristic impedanz commonly also being called?
    a. Load impedance
    b. Line impedance
    c. Skin effect
    d. Loss resistance

15. Which S-matrix cannot belong to a passiv twoport?
    a. S= $\begin{matrix} s_{11} & s_{12} \\ s_{21} & s_{22} \end{matrix} = \begin{matrix} 0.8 & 0.9 \\ 0.9 & 0.8 \end{matrix}$

    b. S= $\begin{matrix} s_{11} & s_{12} \\ s_{21} & s_{22} \end{matrix} = \begin{matrix} 0.2 & 0.8 \\ 0.8 & 0.3 \end{matrix}$

    c. S= $\begin{matrix} s_{11} & s_{12} \\ s_{21} & s_{22} \end{matrix} = \begin{matrix} 0.5 & 0.5 \\ 0.5 & 0.501 \end{matrix}$

    d. S= $\begin{matrix} s_{11} & s_{12} \\ s_{21} & s_{22} \end{matrix} = \begin{matrix} 0.3 & j0.8 \\ j0.8 & 0.2 \end{matrix}$

16. The specific resistance due to skin effect is ..
    a. Proportional to the frequency f
    b. Inversely proportional to the frequency f
    c. Constant with respect to f
    d. None of the above is correct

17. What do you call the effect of strong interfers showing up at the IF due to phase noise?
    a. Intermodulation
    b. Phase discrimination
    c. Reciprocal mixing
    d. Spurious transmission

$$\gamma = \alpha + j\beta = \sqrt{(R' + j\omega L')(G' + j\omega C')} \tag{1}$$

$$Z_0 = \frac{R' + j\omega L'}{\gamma} = \sqrt{\frac{R' + j\omega L'}{G' + j\omega C'}} \tag{2}$$

$$v = \lambda \cdot f = \frac{2\pi}{\beta} \cdot f = \frac{\omega}{\beta} = \frac{1}{\sqrt{L'C'}} = \frac{1}{\sqrt{\mu\varepsilon}} = \frac{c_0}{\sqrt{\mu_r \varepsilon_r}} \tag{3}$$

$$\varepsilon_{r\,\mathrm{eff}} \approx \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2} \frac{1}{\sqrt{1 + 10h/w}} \tag{4}$$

$$\Gamma_{\mathrm{in}} = s_{11} + \frac{s_{12}\, s_{21}\, \Gamma_{\mathrm{L}}}{1 - s_{22}\, \Gamma_{\mathrm{L}}} \tag{5}$$

$$|s_{11}|^2 + |s_{21}|^2 = 1 \tag{6}$$

$$Z = \frac{Z_2 + Z_0 \tanh(\gamma l)}{Z_0 + Z_2 \tanh(\gamma l)} Z_0 \tag{7}$$

$$Z = \frac{Z_2 + jZ_0 \tan(\beta l)}{Z_0 + jZ_2 \tan(\beta l)} Z_0 \tag{8}$$

$$Z = \frac{Z_0^2}{Z_2} \tag{9}$$

$$h(t) = \frac{\sin\left((t/T)\pi\right)}{(t/T)\pi} \cdot \frac{\cos\left(\rho(t/T)\pi\right)}{1 - 4\rho^2(t/T)^2} \tag{10}$$

$$\omega_r = 2\pi f_r = \frac{1}{\sqrt{LC}} \tag{11}$$

$$C = C_0 \left(1 - \frac{U_b}{\Phi_b}\right)^{-n} \tag{12}$$

$$G_T = \frac{(1 - |r_s|^2)|s_{21}|^2(1 - |r_l|^2)}{|(1 - s_{11}r_s)(1 - s_{22}r_l) - s_{21}s_{12}r_s r_l|^2} \tag{13}$$

$$G_{T,\max} = \frac{1}{(1 - |s_{11}|^2)} |s_{21}|^2 \frac{1}{(1 - |s_{22}|^2)} \tag{14}$$

$$P_N = kT_E B \tag{15}$$

$$kT_0 = -174\,\mathrm{dBm/Hz} \tag{16}$$

$$F = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} + \ldots + \frac{F_K - 1}{G_1 G_2 \cdots G_{K-1}} \tag{17}$$

$$F = F_1 + \frac{L - 1}{G_1} + \frac{(F_2 - 1)L}{G_1} \tag{18}$$

$$\mathrm{HD}_3 = P_{\mathrm{out}} - 2(\mathrm{IIP}_3 - P_{\mathrm{in}}) = 3P_{\mathrm{out}} - 2\mathrm{OIP}_3 \tag{19}$$

$$\frac{1}{\mathrm{OIP}_{3,\mathrm{total}}} = \frac{1}{G_2 G_3 \mathrm{OIP}_{3,1}} + \frac{1}{G_3 \mathrm{OIP}_{3,2}} + \frac{1}{\mathrm{OIP}_{3,3}} \tag{20}$$

WsComm1 Fragen inkl. Lösungen

Zusammengestellt von Luca Mazzoleni

1. Why is 50 Ohm as a cable impedance popular?
   a. It is close to the optimum for maximum efficiency of power transfer.
   b. Due to the center value of the Smith chart.
   c. Fixed nature constant, can't be changed.
   d. Results in the longest life time of a cable.

2. Which of the following facts is true?
   a. gamma is always independent of L' and C'.
   b. gamma is always independent of R' and G'.
   c. v inside the transmission line is depending on L' and C'.
   d. v inside the transmission line is always equal to c.

3. What is a good approximation of sqrt(1+x) for small x?
   a. 1 + x
   b. 1 + x/2
   c. 1 + 2x
   d. 1 + x^2

4. What is the propagation speed of a 50-Ohm PCB microstrip line on FR-4?
   a. c/10
   b. c/4
   c. c/3
   d. c/2

5. Who came up with the telegraph equations?
   a. Heinrich Hertz.
   b. Guillelmo Marconi.
   c. Oliver Heaviside.
   d. James Maxwell.

6. What are the telegraph equations?
   a. 2 decoupled quadratic differential equations.
   b. 2 coupled quadratic differential equations.
   c. 2 decoupled linear differential equations.
   d. 2 coupled linear differential equations.

7. Which of the following statements is true?
   a. The cable impedance is always real-valued.
   b. The cable impedance is always complex-valued.
   c. The real part of the cable impedance is positive.
   d. The real part of the cable impedance is negative.

8. What happens if you connect cables of different impedances?
   a. The connectors don't fit.
   b. Power is being radiated.
   c. There are reflections.
   d. The cables are being destroyed.

9. How large is the field part in air for striplines?
   a. Larger than for microstrip lines.
   b. Smaller than for microstrip lines.
   c. Equal to that of for microstrip lines.
   d. No statement can be made.

10. What happens to the effective permittivity of a PCB line with increasing width?
    a. It stays the same.
    b. It is decreasing.
    c. It is increasing.
    d. It gets frequency dependent.

11. What happens to the wave impedance of a PCB line with increasing width?
    a. It stays the same.
    b. It is decreasing.
    c. It is increasing.
    d. It gets frequency dependent.

12. What is the goal with impedance matching of a complex-valued load?
    a. The source impedance shall be equal to the load impedance.
    b. The source impedance shall be have the inverse sign of the load impedance.
    c. The source impedance shall be equal to the complex conjugate of the load impedance.
    d. The source impedance shall be as high as possible.

13. What does the s stand for with respect to the reflection parameters?
    a. Surface
    b. Source
    c. Scatter
    d. Smith

14. Which matrices are being multiplied when twoports are cascaded?
    a. Z-matrices
    b. Y-matrices
    c. S-matrices
    d. T-matrices

15. What can be said for passive, lossless twoports?
    a. |s11|^2+|s22|^2=1
    b. |s11|^2+|s12|^2=1
    c. |s11|^2+|s21|^2=1
    d. None of the above.

16. What return loss signifies a good matching situation?
    a. 0 dB
    b. -3 dB
    c. 20 dB
    d. -20 dB

17. What power proportion is reflected when the Return Loss is 10 dB?
    a. 1%
    b. 10%
    c. 50%
    d. 100%

18. Which value of the reflection coefficient does the center of the Smith-Chart correspond to?
    a. -1
    b. 0
    c. 1
    d. j

19. What advantage does a multistage matching circuit have (L-topology)?
    a. simple
    b. low price
    c. robust to interference
    d. more wideband

20. How many L-topologies of LC networks do exist?
    a. 2
    b. 4
    c. 8
    d. 16

21. How many L-topologies of LC networks can always be used at least for a given matching situatio...
    a. 1
    b. 2
    c. 4
    d. 8

22. A Lambda/4-line transforms the reflection factor in the Smith Chart ...
    a. by a 1/8 turn.
    b. by a 1/4 turn.
    c. by half a turn.
    d. by a full turn.

23. Which of the following lengths transforms a high-impedance load to a short-circuit?
    a. lambda/2
    b. 8*lambda/4
    c. 13*lambda/4
    d. 13*lambda/2

24. A transmission line of electrical length lambda transforms an impedance of (100+j50) Ohm into...
    a. (100+j50) Ohm
    b. (100-j50) Ohm
    c. (25+j50) Ohm
    d. (25-j50) Ohm

25. Which elements are parts of an SC filter?
    a. resistors
    b. inductors
    c. OpAmps
    d. mixers

26. The Q factor of a quartz filter is ...
    a. much higher than that of an LC filter.
    b. much lower than that of an LC filter.
    c. about the same as that of an LC filter.
    d. negative.

27. The loaded Q is ...
    a. always higher than the unloaded Q.
    b. always lower than the unloaded Q.
    c. the same as the unloaded Q.
    d. (depends on series or parallel resonance circuit).

28. What is the Richards transform?
    a. Conversion of open into short-circuited transmission lines.
    b. Conversion of capacitors into transmission lines.
    c. Conversion of capacitors into inductors.
    d. Prewarping of the frequency response.

29. What is a Kuroda transform?
    a. Linear spectrum becomes a repetitive spectrum.
    b. Current-voltage-conversion.
    c. Admittance-impedance-conversion.
    d. Using unit elements inductors may be transformed into capacitors.

30. What is the output attenuation of a resistive splitter?
    a. 0 dB
    b. 3 dB
    c. 6 dB
    d. 12 dB

31. The through loss T [dB] of a passive coupler is ...
    a. always 0
    b. a negative value
    c. a positive value
    d. none of the above

32. What can be said about coupling C [dB] vs. through loss T [dB] of a passive coupler?
    a. C=T
    b. C<T
    c. C>T
    d. none of the above

33. A choke balun is another word for ...
    a. current balun
    b. voltage balun
    c. transformerless balun
    d. discrete balun

34. What does the abbreviation SDMA stand for?
    a. Scatter-division multiple access
    b. Splutter-division multiple access
    c. Secret-division multiple access
    d. Space-division multiple access

35. What kind of channel access does GSM use?
    a. TDMA
    b. CDMA
    c. SDMA
    d. PDMA

36. What kind of channel access does UMTS use?
    a. TDMA
    b. CDMA
    c. SDMA
    d. PDMA

37. How are collisions avoided with the ALOHA protocol?
    a. by 'Listen-before-Talk'
    b. by random delay of the packets
    c. by increased transmission power
    d. by improved receivers

38. What drawback do spread-spectrum systems have?
    a. Near-far problem
    b. privacy
    c. fading immunity
    d. jamming immunity

39. Which system does not use OFDM?
    a. ADSL
    b. UMTS
    c. LTE
    d. DVB

40. How does OFDM turn a linear convolution into a circular convolution?
    a. cyclostationarity
    b. cyclic extension
    c. random cycles
    d. bicycles

41. What does the word 'Modem' stand for?
    a. modified demolisher
    b. modular Emulator
    c. modulator/demodulator
    d. modified employer

42. What is the use of Gray coding?
    a. Maximization of the symbol distance within the constellation
    b. Minimization of the bit-errors
    c. Encryption of the message
    d. Black-and-white colorization of the image information

43. How do you get the impulse response of a Raised-Cosine filter?
    a. It is the same as the impulse response of a Root-Raised-Cosine filter.
    b. By taking the square root of the impulse response of a Root-Raised-Cosine filter.
    c. By squaring the impulse response of a Root-Raised-Cosine filter.
    d. By convolving the impulse response of a Root-Raised-Cosine filter with itself.

44. Where is the pulse shaping filter in a GMSK system?
    a. before the modulator (in the transmitter)
    b. after the modulator (in the transmitter)
    c. after the mixer but before the demodulator (in the receiver)
    d. after the demodulator (in the receiver)

45. What modulation index does MSK have?
    a. 0
    b. 0.3
    c. 0.5
    d. 1

46. What advantage does a CPM system have compared with switched oscillators for the generation of FSK?
    a. no phase jumps
    b. faster changes of the frequency
    c. cheaper
    d. smaller

47. How many amplitudes are there in a 16-QAM signal (baseband)?
    a. 1
    b. 2
    c. 3
    d. 4

48. How many amplitudes are there in a GMSK signal?
    a. 1
    b. 2
    c. 3
    d. 4

49. What phase change does an MSK signal produce during one symbol duration?
    a. ±22.5º
    b. ±45º
    c. ±90º
    d. ±180º

50. What diode is well suited as an RF switch?
    a. PIN diode
    b. Varactor diode
    c. Schottky diode
    d. Tunnel diode

51. What can be said for the quadratic range of a diode detector?
    a. The output voltage is proportional to the input power.
    b. The output voltage is proportional to the input power squared.
    c. The output voltage is proportional to the frequency of the input signal.
    d. The output voltage is proportional to the Fermi level.

52. What diode is well suited for a tunable oscillator?
    a. Schottky diode
    b. Zener diode
    c. Avalanche diode
    d. Varicap

53. Where does the Gunn diode derive its name?
    a. looks like a pistol
    b. looks like a gun
    c. globally distributed undoped double n-layer
    d. after a physicist

54. What does dBc mean?
    a. logarithmic ratio to elementary charge
    b. logarithmic power density compared to circle radiator
    c. dual-band (centered)
    d. logarithmic power ratio compared to carrier signal

55. Which characteristic is the least important for a power amplifier?
    a. linearity
    b. low noise
    c. high efficiency
    d. thermic capability

56. What does the expression conditional stability mean with respect to amplifiers?
    a. Instability might occur within a certain temperature range.
    b. Instability might occur for a certain power supply voltage.
    c. Instability might occur for a certain active load.
    d. Instability might occur for a certain passive load.

57. What are stability circles?
    a. Locations for poles to be found.
    b. Impedances on the circles result in stable designs.
    c. Impedances within stability circles are forbidden regions.
    d. Impedances within the circles result in stable designs.

58. The maximal transducer gain of an amplifier ...
    a. ... is larger than or equal to |s21|.
    b. ... is smaller than or equal to |s21|.
    c. ... is smaller than or equal to |s11|.
    d. ... can be made negative.

59. What are gain circles?
    a. Expert working groups for the design of amplifiers.
    b. Circles of constant gain. The gain increases outside the circles.
    c. Circles of constant gain. The gain decreases inside the circles.
    d. Circles of constant gain. The gain decreases outside the circles.

60. Which of the following amplifiers is the most linear one?
    a. Class AB
    b. Class A
    c. Class C
    d. Class D

61. Which of the following amplifiers is the most efficient one?
    a. Class AB
    b. Class A
    c. Class B
    d. Class D

62. What are noise circles?
    a. The same as gain circles.
    b. Forbidden like all gifting circles.
    c. Circles of constaint noise figure, which increases towards the center.
    d. Circles of constaint noise figure, which decreases towards the center.

63. Flicker noise ...
    a.... is frequency independant.
    b.... is more of a problem at lower frequencies.
    c.... is more of a problem at higher frequencies.
    d.... is only a problem at frequencies of visible light.

64. What is the amplitude density of quantization noise?
    a. Gaussian distributed
    b. uniformly distributed
    c. Laplace distributed
    d. amplitude discrete on two points

65. What is the amplitude density of thermal noise?
    a. Gaussian distributed
    b. uniformly distributed
    c. Laplace distributed
    d. amplitude discrete on two points

66. What is the thermal noise power at room temperature and a bandwidth of 2kHz?
    a. -111 dBm
    b. -114 dBm
    c. -144 dBm
    d. -141 dBm

67. Which parameter of a two-stage amplifier chain does the total noise figure not depend upon?
    a. noise figure of the 2nd stage
    b. gain of the 2nd stage
    c. noise figure of the 1st stage
    d. gain of the 1st stage

68. Which parameter of an amplifier usually has the highest RF level?
    a. IIP3
    b. 1dB compression point
    c. noise floor
    d. OIP3

69. Which frequencies do NOT emerge when using an amplifier with 3rd-order distortions only (input...
    a. f1
    b. f2
    c. 2*f1+f2
    d. f1+f2

70. What the the noise figure express?
    a. Frequency shape of noise.
    b. Acoustic phenomenon.
    c. Signal gain for high-level signals.
    d. Degradation of input SNR to output SNR.

71. How many diodes are there in a double-balanced mixer?
    a. 1
    b. 2
    c. 3
    d. 4

72. How do you call an active FET mixer?
    a. Gilbert Cell
    b. Dilbert Cell
    c. Cascode
    d. Current mirror

73. What is the benefit of a double-balanced mixer versus a single-balanced mixer?
    a. smaller conversion loss
    b. simpler
    c. higher signal levels
    d. higher port isolations

74. What components are there in a passive double-balance mixer besides diodes?
    a. FETs
    b. switches
    c. transformers
    d. bipolar transistors

75. How do you call the effect, when strong interferers are being mixed into the IF because of phase ...
    a. reciprocal mixing
    b. intermodulation
    c. spurious emission
    d. phase discrimination

76. The spectral shape of phase noise ...
    a. is always white.
    b. shows strictly 1/f tendency.
    c. shows 1/f^2 tendency.
    d. increases for higher frequency.

77. Which of the following blocks is not part of a PLL?
    a. phase discriminator
    b. FM modulator
    c. VCO
    d. loop filter

78. Which of the following frequencies cannot be produced by an integer-N synthesizer (ref freq = 10...
    a. 1000.10 MHz
    b. 9999.99 MHz
    c. 1'235.0 MHz
    d. 400 kHz

79. How many known, classical methods for the generation of SSB signals are there?
    a. 1
    b. 2
    c. 3
    d. 4

80. What is the key feature of a polar modulator?
    a. resistance to low temperature such as -50 degree Celsius
    b. separate conditioning of amplitude and phase
    c. antenna signal is in polar coordinates
    d. is the same as a direct-conversion tx

81. Wie nennt man einen nur mit Wärme betriebenen Motor?
    a. Ottomotor
    b. Perpetuum Mobile
    c. Wankelmotor
    d. Stirlingmotor

Fragen aus den Prüfungen
Hs 12

1. Mit welcher Analogmodulation lässt sich ein FSK-moduliertes Signal am ehesten vergleichen?
    - **a. FM**
    - b. AM mit Träger
    - c. ISB
    - d. VSB

Hs 13

2. What effects do parasitics have in RF?
    - a. Highpass filters can turn into lowpass filters.
    - b. They start nibbling away other components.
    - **c. Lowpass filters can turn into highpass filters.**
    - d. Highpass filters can turn into allpass filters.

3. Eddy currents are ...
    - **a. turbulent-flow currents**
    - b. currents in the outer layers of conductors
    - c. radial currents with respect to the conductor.
    - d. strongest at DC.

4. What is the skin depth of a highvoltage cable made of copper?
    - a. 1mm
    - **b. 1cm**
    - c. 1dm
    - d. Depends on the current strength.

5. How many elements does an equivalent circuit of a lossy transmission line consist of?
    - a. 2
    - b. 3
    - **c. 4**
    - d. 8

6. What is a wave impedance?
    - **a. Characteristic impedance of a transmission line.**
    - b. Reactance of a transmission line.
    - c. Susceptance of a transmission line.
    - d. Imaginary part of the following load.

7. What happens during the mirroring at the x-axis in the Smith chart?
    - a. Inversion of the impedance
    - b. Inversion of the real value of the impedance.
    - **c. Inductance turns into capacitance**
    - d. Everything stays the same.

8. What disadvantage do multistage transmission-line impedance matching networks have compared with
    a. single-stage networks?
    - **a. Use up more space.**
    - b. Only inductance can be compensated
    - c. Only capacitance can be compensated.
    - d. Only resistance can be compensated

Hs 14

9. How much more power is 33 dB?
    a. 200
    b. 500
    c. 2000
    d. 5000
10. Hyperbolic functions..
    a. Always have a real argument
    b. Always give a real result
    c. Always give a complex result
    d. None of the above

11. Which of the following setups is not a balanced setup?
    a. Twisted Pair
    b. Coplanar tansmission line
    c. Dipole antenna
    d. Coaxial cable
12. How many diodes are there in a double-balanced mixer?
    a. 1
    b. 2
    c. 3
    d. 4

Hs 15

13. What is the unit of γ?
    a. m
    b. m^{-1}
    c. dB
    d. no unit

14. What is the characteristic impedanz commonly also being called?
    a. Load impedance
    b. Line impedance
    c. Skin effect
    d. Loss resistance

15. Which S-matrix cannot belong to a passiv twoport?
    a. $\mathbf{S=\begin{matrix} s_{11} & s_{12} \\ s_{21} & s_{22} \end{matrix}=\begin{matrix} 0.8 & 0.9 \\ 0.9 & 0.8 \end{matrix}}$

    b. $S=\begin{matrix} s_{11} & s_{12} \\ s_{21} & s_{22} \end{matrix}=\begin{matrix} 0.2 & 0.8 \\ 0.8 & 0.3 \end{matrix}$

    c. $S=\begin{matrix} s_{11} & s_{12} \\ s_{21} & s_{22} \end{matrix}=\begin{matrix} 0.5 & 0.5 \\ 0.5 & 0.501 \end{matrix}$

    d. $S=\begin{matrix} s_{11} & s_{12} \\ s_{21} & s_{22} \end{matrix}=\begin{matrix} 0.3 & j0.8 \\ j0.8 & 0.2 \end{matrix}$

16. The specific resistance due to skin effect is ..
    a. Proportional to the frequency f
    b. Inversely proportional to the frequency f
    c. Constant with respect to f
    d. None of the above is correct

17. What do you call the effect of strong interfers showing up at the IF due to phase noise?
    a. Intermodulation
    b. Phase discrimination
    c. Reciprocal mixing
    d. Spurious transmission

$$\gamma = \alpha + j\beta = \sqrt{(R' + j\omega L')(G' + j\omega C')} \tag{1}$$

$$Z_0 = \frac{R' + j\omega L'}{\gamma} = \sqrt{\frac{R' + j\omega L'}{G' + j\omega C'}} \tag{2}$$

$$v = \lambda \cdot f = \frac{2\pi}{\beta} \cdot f = \frac{\omega}{\beta} = \frac{1}{\sqrt{L'C'}} = \frac{1}{\sqrt{\mu\varepsilon}} = \frac{c_0}{\sqrt{\mu_r \varepsilon_r}} \tag{3}$$

$$\varepsilon_{r\,\mathrm{eff}} \approx \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2} \frac{1}{\sqrt{1 + 10h/w}} \tag{4}$$

$$\Gamma_{\mathrm{in}} = s_{11} + \frac{s_{12}\, s_{21}\, \Gamma_{\mathrm{L}}}{1 - s_{22}\, \Gamma_{\mathrm{L}}} \tag{5}$$

$$|s_{11}|^2 + |s_{21}|^2 = 1 \tag{6}$$

$$Z = \frac{Z_2 + Z_0 \tanh(\gamma l)}{Z_0 + Z_2 \tanh(\gamma l)} Z_0 \tag{7}$$

$$Z = \frac{Z_2 + jZ_0 \tan(\beta l)}{Z_0 + jZ_2 \tan(\beta l)} Z_0 \tag{8}$$

$$Z = \frac{Z_0^2}{Z_2} \tag{9}$$

$$h(t) = \frac{\sin\left((t/T)\pi\right)}{(t/T)\pi} \cdot \frac{\cos\left(\rho(t/T)\pi\right)}{1 - 4\rho^2(t/T)^2} \tag{10}$$

$$\omega_r = 2\pi f_r = \frac{1}{\sqrt{LC}} \tag{11}$$

$$C = C_0 \left(1 - \frac{U_b}{\Phi_b}\right)^{-n} \tag{12}$$

$$G_T = \frac{(1 - |r_s|^2)|s_{21}|^2(1 - |r_l|^2)}{|(1 - s_{11}r_s)(1 - s_{22}r_l) - s_{21}s_{12}r_s r_l|^2} \tag{13}$$

$$G_{T,\max} = \frac{1}{(1 - |s_{11}|^2)} |s_{21}|^2 \frac{1}{(1 - |s_{22}|^2)} \tag{14}$$

$$P_N = kT_E B \tag{15}$$

$$kT_0 = -174\,\mathrm{dBm/Hz} \tag{16}$$

$$F = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} + \ldots + \frac{F_K - 1}{G_1 G_2 \cdots G_{K-1}} \tag{17}$$

$$F = F_1 + \frac{L - 1}{G_1} + \frac{(F_2 - 1)L}{G_1} \tag{18}$$

$$\mathrm{HD}_3 = P_{\mathrm{out}} - 2(\mathrm{IIP}_3 - P_{\mathrm{in}}) = 3P_{\mathrm{out}} - 2\mathrm{OIP}_3 \tag{19}$$

$$\frac{1}{\mathrm{OIP}_{3,\mathrm{total}}} = \frac{1}{G_2 G_3 \mathrm{OIP}_{3,1}} + \frac{1}{G_3 \mathrm{OIP}_{3,2}} + \frac{1}{\mathrm{OIP}_{3,3}} \tag{20}$$

(1) Ausbreitungskonstante in Leitungen als Fkt der Leitungsparameter

(2) Leitungsimpedanz als Fkt der Leitungsparameter

(3) Ausbreitungsgeschwindigkeit in Leitungen

(4) Effektive Permittivität von Microstripleitungen

(5) Eingangsreflexionsfaktor eines Zweitores

(6) Leistungserhaltung eines passiven, verlustlosen Zweitores

(7) Transf. Impedanz einer verlustbehafteten Ltg.

(8) Transf. Impedanz einer verlustlosen Ltg.

(9) Transf. Impedanz einer $\lambda/4$-Ltg.

(10) Impulsantwort eines Raised-Cosine Filters

(11) Resonanzfrequenz eines Schwingkreises

(12) Kapazität einer Diode (Varaktordiode)

(13) Transduceer Gain eines Verstärkers

(14) Max. Transducer Gain eines Verstärkers

(15) Thermisches Rauschen nach Boltzmann

(16) Thermische Rauschleistungsdichte

(17) Rauschzahl einer Empfängerkette

(18) Rauschzahl einer Empfängerkette mit passivem Element

(19) Verzerrung dritter Ordnung

(20) Interzept-Punkt (invertiert) einer Empfängerkette

ABC	always best connected (G4 slogan)
AC	alternating current
ACK	acknowledgment
ADC, A/D	analog-to-digital converter
adf	amplitude density function
ADSL	asymmetric digital subscriber line
AF	audio frequency
AGC	automatic gain control
AGCH	access grant channel
A-GPS	aided GPS
AGW	Anlagegrenzwert
ALOHA	random access system
AM	amplitude modulation
AMPS	Advanced Mobile Phone Service
AOA	angle of arrival
ARFCN	absolute radio frequency channel number
ARQ	automatic repeat request
ARRL	American Radio Relay League
AS	anti-spoofing
ASK	amplitude shift keying
ASP	air space polyethylene
AST	air space teflon
AUC	authentication center
AWGN	additive white Gaussian noise
BAFU	Bundesamt für Umwelt
BAKOM	Bundesamt für Kommunikation
BB	baseband
BCCH	broadcast control channel
BCH	Bose-Chaudhuri-Hocquenghem Code
BCH	broadcast channel
BER	bit error rate
BLE	Bluetooth Low-Energy (standard)
BNC	Bayonet Neill-Concelman (connector)
BP	band pass (filter)
BPSK	binary phase shift keying
BS	base station
BSC	base station controller
BSS	base station subsystem
BT	bandwidth-time product
BTS	base transceiver station
BW	bandwidth
C/A	coarse acquisition
CATV	cable television
CCCH	common control channel
CCH	control channel
cdf	cumulative density function
CD	compact disc
CDMA	code division multiple access
CEM	comutational electromagnetics
CEP	circle error probable
CIR	channel impulse response
CM	constant modulus
CMA	constant-modulus algorithm
CORDIC	COrdinate Rotation DIgital Computer (algorithm)
CPM	continuous-phase modulation
CRT	cathode ray tube
Cs	caesium, chemical element nr. 55
CTF	channel transfer function
CW	continuous wave
DAB	digital audio broadcasting
DAC, D/A	digital-to-analog converter
DBM	double-balanced mixer
DC	direct current
DCCH	dedicated control channel
DCF-77	Deutschland, Continuous Wave (CW), Frankfurt, 77.5 kHz
DCO	digitally controlled oscillator
DCS	digital cellular system
dd	decision directed
DDS	direct digital synthesizer
DECT	digital enhanced cordless telecommuniations
DFE	decision-feedback equalizer
DGPS	differential GPS
DLL	delay-locked loop
$C/N0$	carrier-to-noise-density ratio
DFT	discrete Fourier transform
DMT	discrete multitone
DPSK	differential phase shift keying
DQPSK	differential quaternary phase shift keying
DS	direct sequence
DSB	double sideband
DSP	digital signal processor
DSSS	direct sequence spread spectrum
DTTB	Digital Terrestrial Television Broadcasting
DTV	digital television
DUT	device under test
DVB	digital video broadcasting
DVB-C	digital video broadcasting, over cable
DVB-H	digital video broadcasting for handhelds
DVB-S	digital video broadcasting over satellite
DVB-T	digital video broadcasting, terrestrial system
$Eb/N0$	bit energy over noise power density
E-911	extended emergency location
ECC	error control code
EDGE	enhanced data rates for GSM evolution
EGPRS	enhanced general packet radio service (subset of EDGE)
EGNOS	European Geostationary Navigation Overlay Service
EHF	extremely high frequency (30–300 GHz)
EIR	equipment identity register
EIRP	equivalent isotropic radiated power
EM	electro-magnetic
ENR	excess noise ratio
E-OTD	enhanced observed time difference
ERP	equivalent radiated power (with respect to dipole)
ESA	European Space Agency
ETSI	European Telecommunications Standards Institute
EVM	error vector magnitude
FAA	Federal Aviation Agency
FACCH	fast associated control channel
FAQ	frequently asked questions
FCC	Federal Communications Commission
FCCH	frequency correction channel
FDD	frequency division duplex
FDMA	frequency division multiple access
FE	foam polyethylene
FEC	forward error correction
FFSK	fast frequency shift keying
FFT	fast Fourier transform

FH	frequency hopping
FIR	finite impulse response
FOEN	Federal Office for the Environment
FM	frequency modulation
FMCW	frequency-modulation continuous wave (radar)
FS	full slot
FS	fractionally spaced
FS	foam polystyrene
FSE	fractionally spaced equalizer
FSK	frequency shift keying
FSM	finite state machine
GaAs	Gallium-Arsenide
GEO	geostationary earth orbit
GMSK	Gaussian minimum shift keying
GNSS	global navigation satellite system
GOS	grade of service
GPR	ground-penetrating radar
GPRS	general packet radio service
GPS	Global Positioning System
GSM	global system for mobile communications
HDTV	high-definition television
HF	high frequency (3–30 MHz)
HLR	home location register
HPBW	half-power beamwidth
HS	half slot
HSCSD	high-speed circuit switched data (GSM)
HSDPA	high-speed downlink packet access (UMTS)
HSI	high side injection
HTx	hilly terrain (speed x km/h)
IC	integrated circuit
ICI	interchannel interference
ICNIRP	international commission on nonionizing radiation protection
IEEE	Institute of Electrical and Electronics Engineers
IF	intermediate frequency
IFF	information friend or foe (secondary radar)
IFFT	inverse fast Fourier transform
IGW	Immissionsgrenzwert
i.i.d.	independent and identically distributed
IIP	input-refered intercept point
IL	insertion loss
IM	intermodulation
IMSI	international mobile subscriber identity
IMT	international mobile telecommunications
IMTS	improved mobile telephone systems
IQ	in-phase/quadrature
IS	intermediate standard (e.g., IS-95)
ISB	independent sideband
ISDN	integrated services digital network
ISI	intersymbol interference
ISM	industrial, scientific, medical
ITU	International Telecommunications Union
JPO	Joint Program Office
LBS	location-based service
LCP	left-hand circularly polarized
LEO	low earth orbit
LF	low frequency (30–300 kHz)
LFM	linear frequency modulation
LHCP	left-hand circularly polarized
LHS	left-hand side
LMS	least mean square
LMU	location measurement unit
LNA	low-noise amplifiers
LO	local oscillator
LOS	line of sight
LS	least square
LSB	lower sideband
LSI	low side injection
LTE	Long Term Evolution
LUT	look-up table
MAC	medium-access control
MAC	multiply and accumulate
MC	Monte-Carlo
MCS	master control station
MDS	minimum discernible signal
MEO	medium earth orbit
MER	message error rate
MF	medium frequency (300 kHz–3 MHz)
MIMO	multiple in—multiple out
ML	maximum likelihood
MMSE	minimum mean square error
MS	mobile station
MSAS	Multi-Functional Satellite Augmentation System
MSC	mobile switching center
MSE	mean square error
MSK	minimum shift keying
MSS	mobile satellite service
MTS	mobile telephone systems
NADC	North American Digital Cellular
NAK	negative acknowledgment
NATEL	Nationales Autotelefon
NAVSTAR	Navigation System with Timing and Ranging
NCO	numerically controlled oscillator
NEP	noise equivalent power
NF	noise figure
NIR	non-ionizing radiation
NIS	nichtionisierende Strahlung
NISV	Verordnung über den Schutz vor nichtionisierender Strahlung
NLOS	non-line of sight
NMT	nordic mobile telephone
NOMA	non-orthogonal multiple access
NSS	network and switching subsystem
OCS	operational control segment
OCXO	oven-controlled crystal oscillator
OEM	original equipment manufacturer
OFDM	orthogonal frequency division multiplex
OIP	output-refered intercept point
OKA	Orte für kurzfristigen Aufenthalt
OMC	operating and maintenance center
OMEN	Orte mit empfindlicher Nutzung
ONIR	ordinance relating to protection from non-ionizing radiation
OSI	open system interconnection
OSL	open, short, load (calibration method)
OSM	open, short, match (calibrationmethod)
PA	power amplifier
PAM	pulse amplitude modulation (ASK)
PAN	personal area network
PCB	printed circuit board
PCH	paging channel
PCM	pulse code modulation

PCS	Personal Communication System
PDC	Personal Digital Cellular
PE	polyethylene
pdf	probability density function
PDMA	polarization division multiple access
PHY	physical layer
PIFA	printed inverted-F antenna
PLL	phase-locked loop
PM	phase modulation
PMR	Private Mobile Radio
ppm	parts per million
PPS	precise positioning service
PR	pseudo random
PRN	pseudo random noise
PRS (Galileo)	publicly regulated service
P/S	parallel to serial
PSK	phase shift keying
PSTN	public switched telephone network
PVT	position, velocity, time (GPS)
QAM	quadrature amplitude modulation
QOS	quality of service
QPSK	quaternary phase shift keying
RACH	random access channel
RADAR	radio detection and ranging
RAx	rural area (speed x km/h)
Rb	rubidium, chemical element nr. 37
RBW	resolution bandwidth
RC	raised cosine
RCP	right-hand circularly polarized
RCS	radar cross section
RF	radio frequency
RFID	radio frequency identification
RHCP	right-hand circularly polarized
RHS	right-hand side
RLS	recursive least square
RMS	root mean square
rpm	revolutions per minute
RRC	root raised cosine
RS	Reed-Solomon Code
RSSI	receiver signal strength indicator
RTOF	roundtrip time of flight
RTTY	radio transmission technology
SA	selective availability
SACCH	slow associated control channel
SAR	specific absorption rate
SAR	synthetic aperture radar
SAW	surface acoustic wave
SBAS	satellite based augmentation systems
SBM	single-balanced mixer
SC	stress compensated (crystal cut)
SCH	synchronization channel
SDCCH	stand-alone dedicated control channel
SDMA	space division multiple access
SDR	software-defined radio
SER	symbol error rate
SFDR	spurious-free dynamic range
SHF	super high frequency (3–30 GHz)
SIM	subscriber identity module
SMS	short message service
SNR	signal-to-noise ratio
SOC	system-on-a-chip
S/P	serial to parallel
SPS	standard positioning service
SRD	short-range device
SS	spread spectrum
SSB	single sideband
ST	solid teflon
SV	space vehicle
SWR	standing-wave ratio
SWT	sweep time
TA	timing advance
TCH	traffic channel
TCXO	temperature-controlled crystal oscillator
TDD	time division duplex
TDMA	time division multiple access
TDOA	time difference of arrival
TDR	time-domain reflectometry
TETRA	Terrestrial Trunked Radio
TOA	time of arrival
TRF	tuned RF set
TS	time slot
TS	training sequence
TUx	typical urban (speed x km/h)
TV	television
TWT	travelling wave tubes
UE	unit element
UHF	ultra high frequency (300 MHz–3 GHz)
UIM	user identification module
UMTS	Universal Mobile Telecommunication System
USB	upper sideband
UTRAN UMTS	terrestrial radio access network
UWB	ultrawideband
VA	Viterbi algorithm
VBW	video bandwidth
VCO	voltage controlled oscillator
VHF	very high frequency (30–300 MHz)
VLF	very low frequency (3–30 kHz)
VLR	visitor location register
VNA v	ector network analzyer
VoWLAN	voice over WLAN
VSB	vestigial sideband
VSWR	voltage standing wave ratio
WAAS	wide-area augmentation systems
W-CDMA	wideband CDMA
WHO	World Health Organization
WLAN	wireless local area network
w.r.t.	with respect to
XO	crystal oscillator