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FEDERAL AVIATION ADMINISTRATION

SPECIFICATION

Microwave Landing System (MLS)

Interoperability and Performance Requirements

Information Handling Services, 1999
August 11, 1999 06:39:27

LIST OF EFFECTIVE PAGES

PAGE(S)	SCN
Cover	1
Inside Front Cover	1
i	1
ii-iii	0
iv-v	1
vi-viii	0
1	0
2-4	1
5-8	0
9	1
10-11	0
12	1
13-22	0
23	1
24	0
25	1
26-37	0
38	1
39	0
40	1
41-47	0
48	1
49-52	0
53	1
54	0
55	1
56-57	0
58-59	1
60-64	0
65	1
66-75	0

TABLE OF CONTENTS

Paragraph	Title	Page
1.	SCOPE AND CLASSIFICATION	1
1.1	Scope	1
1.2	Purpose	1
1.3	MLS system description	1
1.3.1	General	1
1.3.2	Signal format	1
1.3.3	Signal characteristics	1
1.3.4	Airborne receiver functions	1
1.3.5	Monitoring	2
1.4	Classification	2
1.4.1	Standard MLS	2
1.4.2	Expansion of the standard MLS	2
1.5	Definitions	3
1.5.1	Approach Azimuth	3
1.5.2	Approach Elevation	3
1.5.3	Auxiliary Data	3
1.5.4	Back Azimuth	3
1.5.5	Basic Data	3
1.5.6	Beam center	3
1.5.7	Beam width	3
1.5.8	Clearance guidance sector	3
1.5.9	Control motion noise (CMN)	3
1.5.10	Coordinate system - conical	3
1.5.11	Coordinate system - planar	4
1.5.12	Coverage sector	4
1.5.13	DME/P	4
1.5.14	Effective sidelobes	4
1.5.14a	Essential Data	4
1.5.15	Flare coverage zone	4
1.5.16	Function	4
1.5.17	Guidance sector	4
1.5.18	Mean course error	4
1.5.19	Mean glide path error	4

Information Handling Services, 1999
August 11, 1999 06:39:27

TABLE OF CONTENTS

Paragraph	Title	Page
1.5.20	Minimum glide path	4
1.5.21	MLS approach reference datum	4
1.5.22	MLS Back Azimuth reference datum	4
1.5.23	MLS datum point	4
1.5.24	Out-of-coverage indication (OCI) signal	5
1.5.25	Path following error (PFE)	5
1.5.26	Path following noise (PFN)	5
1.5.27	Proportional guidance sector	5
1.5.28	Separation angle	5
1.5.29	Time division multiplex (TDM)	5
1.5.30	TO and FRO scan	5
2.	APPLICABLE DOCUMENTS	5
2.1	Incorporated documents	5
2.2	Information documents	5
3.	SYSTEM REQUIREMENTS, ANGLE AND DATA FUNCTIONS	6
3.1	Radiated signal characteristics	6
3.1.1	Channeling	6
3.1.1.1	Channel arrangement	6
3.1.1.2	Channel pairing with DME/P	6
3.2	Signal format organization	6
3.2.1	Angle guidance functions	6
3.2.1.1	Preamble	8
3.2.1.1.1	Carrier acquisition	8
3.2.1.1.2	Receiver reference time code	8
3.2.1.1.3	Function identification code	8
3.2.1.2	Sector signals	9
3.2.1.2.1	Azimuth functions	9
3.2.1.2.1.1	Airborne antenna selection signal	9
3.2.1.2.1.2	Out-of-coverage indication pulses	9
3.2.1.2.1.3	Ground radiated test signals	9
3.2.1.2.2	Approach Elevation function	9
3.2.1.2.2.1	Out-of-coverage indication pulse	9
3.2.1.3	Angle guidance signals	10
3.2.1.3.1	Azimuth clearance signals	10
3.2.1.3.1.1	Fly left/fly right clearance pulses	10
3.2.1.3.2	Proportional guidance signals	12
3.2.1.3.2.1	Angle guidance encoding	12
3.2.1.3.2.2	Angle parameter values	12

Information Handling Services, 1999
August 11, 1999 06:39:27

TABLE OF CONTENTS

Paragraph	Title	Page
3.2.1.3.2.3	Tolerances	13
3.2.1.3.2.4	Azimuth scanning convention	13
3.2.1.3.2.5	Elevation scanning convention	13
3.2.2	Data functions	13
3.2.2.1	Data encoding	13
3.2.2.1.1	Differential phase shift keying (DPSK)	13
3.2.2.2	Basic Data structure	13
3.2.2.3	Auxiliary Data structure	15
3.2.3	Function rates	17
3.2.4	Time Division Multiplex format	17
3.2.4.1	Randomized transmissions	17
3.3	(Not used)	19
3.4	System coverage	19
3.4.1	Power densities - angle	19
3.5	System accuracies	20
3.5.1	(Not used)	21
3.5.2	Accuracy degradation	21
3.5.3	Accuracy in the runway region	22
3.5.4	DME/P Accuracy	23
3.6	Basic Data content	24
3.7	Auxiliary Data	33
3.7.1	Addresses	33
3.7.2	Content	33
3.7.2.1	Auxiliary data A content	33
3.7.3	(Not used)	34
4.	GROUND EQUIPMENT REQUIREMENTS, ANGLE AND DATA FUNCTIONS	43
4.1	Function transmissions	43
4.1.1	Function timing	43
4.1.2	Synchronization	43
4.1.3	Symmetrical scanning	43
4.1.4	Radio frequency characteristics	43
4.1.4.1	Radio frequency signal spectrum	43
4.1.4.2	Polarization	43
4.1.4.3	Frequency tolerance	43
4.1.4.4	Residual radiation	44
4.1.5	Modulation	44
4.1.5.1	Scanning beam transmissions	44
4.1.5.2	Data transmissions	44
4.1.5.3	Other transmissions	44

Information Handling Services, 1999
August 11, 1999 06:39:27

FAA-STD-022d
CHANGE NOTICE 1

TABLE OF CONTENTS

Paragraph	Title	Page
4.1.6	False guidance	44
4.2	Coverage	45
4.2.1	(Not used)	46
4.2.2	Approach Azimuth/Data	46
4.2.2.1	Approach region	46
4.2.2.2	Runway region (Approach)	50
4.2.2.2.1	Minimum proportional guidance	50
4.2.3	Back Azimuth/Data	50
4.2.3.1	Back Azimuth region	50
4.2.3.2	Runway region (Back Azimuth)	50
4.2.3.3	Minimum proportional guidance	51
4.2.4	Approach Elevation	51
4.2.4.1	Coverage limits	51
4.2.5	Data coverage	51
4.2.5.1	Basic Data	51
4.2.5.1.1	Approach azimuth	51
4.2.5.1.2	Back azimuth	51
4.2.5.2	Auxiliary Data	52
4.2.5.2.1	Approach azimuth	52
4.2.5.2.2	Back azimuth	52
4.2.6	Precision Distance Measuring Equipment (DME/P)	52
4.3	(Not used)	52
4.4	(Not used)	52
4.5	Scanning beam antenna patterns	52
4.5.1	Coordinate systems	52
4.5.2	Antenna patterns in the scan plane	52
4.5.2.1	Beamwidth	52
4.5.2.2	Beam shape	52
4.5.2.3	Sidelobes	52
4.5.2.3.1	Dynamic sidelobes	53
4.5.2.3.2	Effective sidelobe levels	53
4.5.2.3.3	Rising terrain	53
4.5.3	Antenna patterns in the plane orthogonal to scan	54
4.5.3.1	Azimuth	54

Information Handling Services, 1999
August 11, 1999 06:39:27

TABLE OF CONTENTS

Paragraph	Title	Page
4.5.3.2	Elevation	55
4.6	Monitor and control	55
4.6.1	Synchronization and monitoring	55
4.6.2	Azimuth	55
4.6.2.1	Monitor failure	55
4.6.2.2	Erroneous guidance control	55
4.6.3	Elevation	56
4.6.3.1	Monitor failure	56
4.6.3.2	Erroneous guidance control	56
4.6.4	Data transmissions	57
4.6.4.1	Monitor failure	57
5.	AIRBORNE EQUIPMENT CHARACTERISTICS	59
6.	MLS MEASUREMENT METHODOLOGY	59
6.1	PFE and CMN frequency components	59
6.2	Error evaluation	59
6.2.1	Azimuth and elevation functions	59

APPENDIX I

10.	MLS ANGLE, DATA AND DME/P CHANNELING	62
10.1	Angle and Data channels	62
10.2	Precision Distance Measuring Equipment (DME/P) channels	62

APPENDIX II

20.	FUNCTION TIMING TABLES	71
20.1	Event time slots of angle and data functions	71

Information Handling Services, 1999
August 11, 1999 06:39:27

TABLE OF CONTENTS

LIST OF FIGURES

	Title	Page
1.	Angle Function Organization	7
2.	Preamble Organization	7
3.	(Not used)	
4.	Clearance Pulse Conventions	11
5.	Scanning Conventions for Azimuth Guidance Functions	14
6.	Scanning Conventions for Approach Elevation Guidance Functions	15
7.	Basic Data Organization	15
8.	Auxiliary Data Word Organization	16
9.	Complete Multiplex Transmission Cycle	18
10.	Transmission Sequence Pair Which Provides for all MLS Angle Guidance Functions	18
11.	Transmission Sequence Pair Which Provides for the MLS High Rate Approach Azimuth Angle Guidance Function	19
12.	DPSK Phase Characteristics	45
13.	Approach Azimuth/Data Coverage	47
14.	Back Azimuth/Data Coverage	48
15.	Approach Elevation Coverage	49
16.	(Not used)	
17.	(Not used)	
18.	Far Field Dynamic Signal-In-Space	54
19.	Filter Configurations and Corner Frequencies	58
20.	MLS Measurement Methodology	60
21.	Coordinate Systems for Azimuth Functions	61
22.	Conical Coordinate System for Elevation Functions	61

Information Handling Services, 1999
August 11, 1999 06:39:27

TABLE OF CONTENTS

LIST OF TABLES

	Title	Page
1.	Function Identification Codes	8
2.	Value of Angle Guidance Parameters	12
3.	Function Rates	17
4.	Minimum Power Density Within Coverage Boundaries	20
5a.	Angle System Error Limits at the Reference Datum	22
5b.	Allowable DME/P Standard 1 System Errors	23
6.	Basic Data Words	26
7.	Auxiliary Data Word Address Codes	35
8.	Auxiliary Data	36
9.	(Not used)	
10.	(Not used)	
11.	(Not used)	
12.	MLS Channel Pairing	63
13.	(Not used)	
14.	Approach Azimuth Function Timing	71
15.	High Rate Approach Azimuth and Back Azimuth Function Timing	72
16.	Approach Elevation Function Timing	73
17.	Basic Data Function Timing	73
18.	Auxiliary Data Function Timing (Digital Data)	74
19.	Preamble Timing	74
20.	Auxiliary Data Function Timing (Alphanumeric Data)	75

Information Handling Services, 1999
August 11, 1999 06:39:27

MICROWAVE LANDING SYSTEM (MLS)

INTEROPERABILITY AND PERFORMANCE REQUIREMENTS

1. SCOPE AND CLASSIFICATION

1.1 Scope.- This standard provides the interoperability and performance requirements for the Microwave Landing System (MLS) equipment produced for use in the National Airspace System (NAS). Many of the requirements contained in this standard also are applicable to MLS equipment (e.g., military tactical systems) produced for special purposes.

1.2 Purpose.- This document provides the signal format standards that will insure interoperability between all ground and airborne MLS equipment and provides the essential technical requirements of MLS ground equipment, consistent with ICAO Standards and Recommended Practices (SARPS).

1.3 MLS system description

1.3.1 General.- The MLS is an air-derived system in which ground-based equipment transmit angular position and data signals to a receiver in the aircraft, and range information is provided by a conventional DME technique. Thus, the position information is provided as two angle coordinates and a range coordinate; data are transmitted in digital form. The channel plan provides 200 MLS channels as shown in Table 12.

1.3.2 Signal format.- Each angle guidance and data function contains a unique identification code which allows time-multiplexed transmissions on a single frequency between 5031 and 5090.7 MHz. The transmission sequences are randomized to reduce synchronous interference effects. The range information is provided by Precision Distance Measuring Equipment (DME/P) transmitting asynchronously in the frequency band between 979 and 1213 MHz. The DME/P uses an interrogate/reply format which is compatible with conventional DME.

1.3.3 Signal characteristics.- The angle guidance information is represented as the time difference between successive passages of an unmodulated, fan-shaped, scanning beam. The range information is represented by the elapsed time measured in the aircraft between the interrogator and transponder fast rise-time pulses. The data transmissions which identify each angle function and provide basic (and auxiliary) data are differentially encoded and modulated by phase shift keying of the RF carrier.

1.3.4 Airborne receiver functions.- The airborne equipment receives the ground generated signals associated with each function and, in sequence, determines the identity of the function and then decodes the scanning beam angle or data information. It subjects the received signals to acquisition criteria before they are accepted and continues validation following

Information Handling Services, 1999
August 11, 1999 06:39:27

acceptance to provide reliable information. The DME/P airborne interrogator/ receiver functions similarly to that of a conventional DME.

1.3.5 Monitoring.- The ground and airborne equipment are monitored to assure system performance and integrity and to provide the necessary alarms and alerts.

1.4 Classification

1.4.1 Standard MLS.- The standard configuration of the MLS shall be composed of the following:

(a) Approach Azimuth equipment, and associated monitor, remote control and indicator equipment.

(b) Approach Elevation equipment, and associated monitor, remote control and indicator equipment.

(c) Equipment for the encoding and transmission of essential data words, associated monitor, remote control and indicator equipment.

(d) Precision Distance Measuring Equipment (DME/P), and associated monitor, remote control and indicator equipment.

NOTE: In some cases a conventional DME may satisfy operational requirements.

1.4.2 Expansion of the standard MLS.- The signal format structure allows expansion of the standard MLS configuration by addition of one or more of the following functions or characteristic improvements:

(a) Back Azimuth equipment, and associated monitor, remote control and indicator equipment.

(b) Provisions for the encoding and transmission of additional non-essential auxiliary data words, associated monitor, remote control and indicator equipment.

(c) Larger proportional guidance sectors.

NOTE: Additional time is available in the signal format to accommodate functions not yet standardized.

Information Handling Services, 1999
August 11, 1999 06:39:27

1.5 Definitions.- The following definitions are pertinent to this standard:

1.5.1 Approach Azimuth.- Equipment which provides lateral guidance to aircraft in the approach and runway regions. This equipment may radiate the Approach Azimuth function or the High Rate Approach Azimuth function along with appropriate basic and auxiliary data.

1.5.2 Approach Elevation.- The equipment which provides vertical guidance in the approach region. This equipment radiates the Approach Elevation function.

1.5.3 Auxiliary Data.- Data, transmitted in addition to basic data, that provide ground equipment siting information for use in refining airborne position calculations and other supplementary information.

1.5.4 Back Azimuth.- The equipment which provides lateral guidance in the Back Azimuth and runway regions. This equipment radiates the Back Azimuth function along with appropriate basic and auxiliary data.

1.5.5 Basic Data.- Data transmitted by the ground equipment that are associated directly with the operation of the landing guidance system.

1.5.6 Beam center.- The midpoint between the -3 dB points on the leading and trailing edges of the scanning beam main lobe.

1.5.7 Beam width.- The width of the scanning beam main lobe measured at the -3dB points and defined in angular units on the antenna boresight, in the horizontal plane for the azimuth function and in the vertical plane for the elevation function.

1.5.8 Clearance guidance sector.- The volume of airspace, inside the coverage sector, within which the azimuth guidance information is not proportional to the angular displacement of the aircraft. Instead it is a constant fly-left or fly-right indication of the direction, relative to the approach course, that an inbound aircraft should fly in order to enter the proportional guidance sector. Also the corresponding volume of airspace in the back azimuth coverage sector for aircraft outbound.

1.5.9 Control motion noise (CMN).- That portion of the guidance signal error which could affect aircraft attitude and cause control surface, wheel and column motions during coupled flight, but which does not cause aircraft displacement from the desired course or glide path, (CMN measurement methodology is defined in paragraph 6).

1.5.10 Coordinate system - conical.- A function is said to use conical coordinates when the decoded guidance angle varies as the minimum angle between the surface of a cone containing the receiver antenna, and a reference plane perpendicular to the axis of the cone and passing through its apex. The apex of the cone is at the antenna phase center and contains the zero-degree azimuth radial. For Approach Azimuth or Back Azimuth functions, the reference plane is vertical and contains the zero degree azimuth radial. For Elevation functions the reference plane is horizontal. (See Figures 21 and 22).

Information Handling Services, 1999
August 11, 1999 06:39:27

1.5.11 Coordinate system - planar.- A function is said to use planar coordinates when the decoded guidance angle varies as the angle between the plane containing the receiver antenna and a reference plane. For azimuth functions, the reference plane is the vertical plane containing the 0 degree azimuth radial and the plane containing the receiver antenna is a vertical plane passing through the antenna phase center. (See Figure 21).

1.5.12 Coverage sector.- A volume of airspace within which service is provided by a particular function and in which the signal power density is equal to or greater than the specified minimum.

1.5.13 DME/P.- The range function associated with the MLS. It is a distance measuring equipment (DME) that is compatible with standard navigation DME while providing improved accuracy and additional channel capabilities.

1.5.14 Effective sidelobes.- The level of antenna sidelobes which, when caused to interfere with the antenna main lobe under conditions of unity reflection and static worst-case phase, causes an error not exceeding a specified value.

1.5.14a Essential Data.- Essential data words are Basic Data Words 1, 2, 3, 4 and 6; and Auxiliary Data Words A1, A2 and A3. Where Back Azimuth is installed, essential data will include Basic Data Word 5 and Auxiliary Data Word 4.

1.5.15 Flare coverage zone.- A zone that extends horizontally between the runway edges and longitudinally from 90 meters (300 feet) to 760 meters (2500 feet) along the runway from threshold and vertically from near the runway surface to a height of 45 meters (150 feet).

1.5.16 Function.- A particular service provided by the MLS e.g., Approach Azimuth guidance, Back Azimuth guidance or Basic Data, etc.

1.5.17 Guidance sector.- The area on the ground, above which MLS angle guidance is transmitted. The ground area frequently is a portion of a circle that is bounded by two radii and an intercepted arc.

1.5.18 Mean course error.- The mean value of the azimuth error along the runway extended centerline.

1.5.19 Mean glide path error.- The mean value of the elevation error along the specified glide path.

1.5.20 Minimum glide path.- The lowest angle of descent along the zero degree azimuth that is consistent with published approach procedures and obstacle clearance criteria.

1.5.21 MLS approach reference datum.- A point at a specified height located vertically above the intersection of the runway centerline and the threshold.

1.5.22 MLS Back Azimuth reference datum.- A point at a specified height above the runway center line at the runway midpoint.

1.5.23 MLS datum point.- The point on the runway centerline closest to the phase center of the Approach Elevation antenna.

Information Handling Services, 1999
August 11, 1999 06:39:27

1.5.24 Out-of-coverage indication (OCI) signal.- A signal radiated into areas outside the intended coverage sector where required to prevent removal of an airborne warning indication in the presence of misleading guidance information.

1.5.25 Path following error (PFE).- That portion of the guidance signal error which could cause aircraft displacement from the desired course or glide path. These perturbations fall within the loop guidance bandwidth of an aircraft. The path following error is composed of the path following noise and the mean course error, in the case of azimuth functions, or the mean glide path error, in the case of elevation functions, (PFE measurement methodology is defined in paragraph 6.).

1.5.26 Path following noise (PFN).- That portion of the guidance signal error which could cause aircraft displacement from the mean course line or mean glide path as appropriate.

1.5.27 Proportional guidance sector.- The volume of airspace within which the angular guidance information provided by a function is directly proportional to the angular displacement of the airborne antenna with respect to the zero angle reference.

1.5.28 Separation angle.- The difference between the angle coding of the direct signal and the angle coding of a multipath signal.

1.5.29 Time division multiplex (TDM).- A method of sequentially transmitting a number of functions on a single frequency channel by means of time separation.

1.5.30 TO and FRO scan.- The first and second scans (respectively) of the scanning beam from one coverage limit to the other. The direction of the FRO scan is opposite to the direction of the TO scan.

2. APPLICABLE DOCUMENTS

2.1 Incorporated documents.- (Not used.)

2.2 Information documents.- The following publications provide information on MLS operational requirements and avionics characteristics.

(a) International Civil Aviation Organization, International Standards and Recommended Practices, Aeronautical Telecommunications, Annex 10.

(b) FAA Handbook 8260.3 United States Standard for Terminal Instrument Procedures (TERPS).

(c) Radio Technical Commission for Aeronautics, Minimum Operational Performance Standards for Microwave Landing System Airborne Receiver Equipment, Doc. No. DO-177.

(d) Radio Technical Commission for Aeronautics, Minimum Operational Performance Standards for Airborne Distance Measuring Equipment (DME) Operating Within the Frequency Range of 960-1215 MHz, Doc. No. DO-189.

Information Handling Services, 1999
August 11, 1999 06:39:27

3. SYSTEM REQUIREMENTS, ANGLE AND DATA FUNCTIONS

3.1 Radiated signal characteristics

3.1.1 Channeling

3.1.1.1 Channel arrangement.- The MLS angle and data functions shall operate between 5031 MHz and 5090.7 MHz on any one of the 200 channels shown in Table 12, Appendix I.

3.1.1.2 Channel pairing with DME/P.- The channel pairing with the L-band ranging function shall be in accordance with Table 12, Appendix I.

3.2 Signal format organization

3.2.1 Angle guidance functions.- The organization of angle guidance functions shall be as shown in Figure 1. The function shall begin with a preamble time slot followed by time slots for sector signals, and scanning beam signals.

Information Handling Services, 1999
August 11, 1999 06:39:27

Figure 1. Angle Function Organization

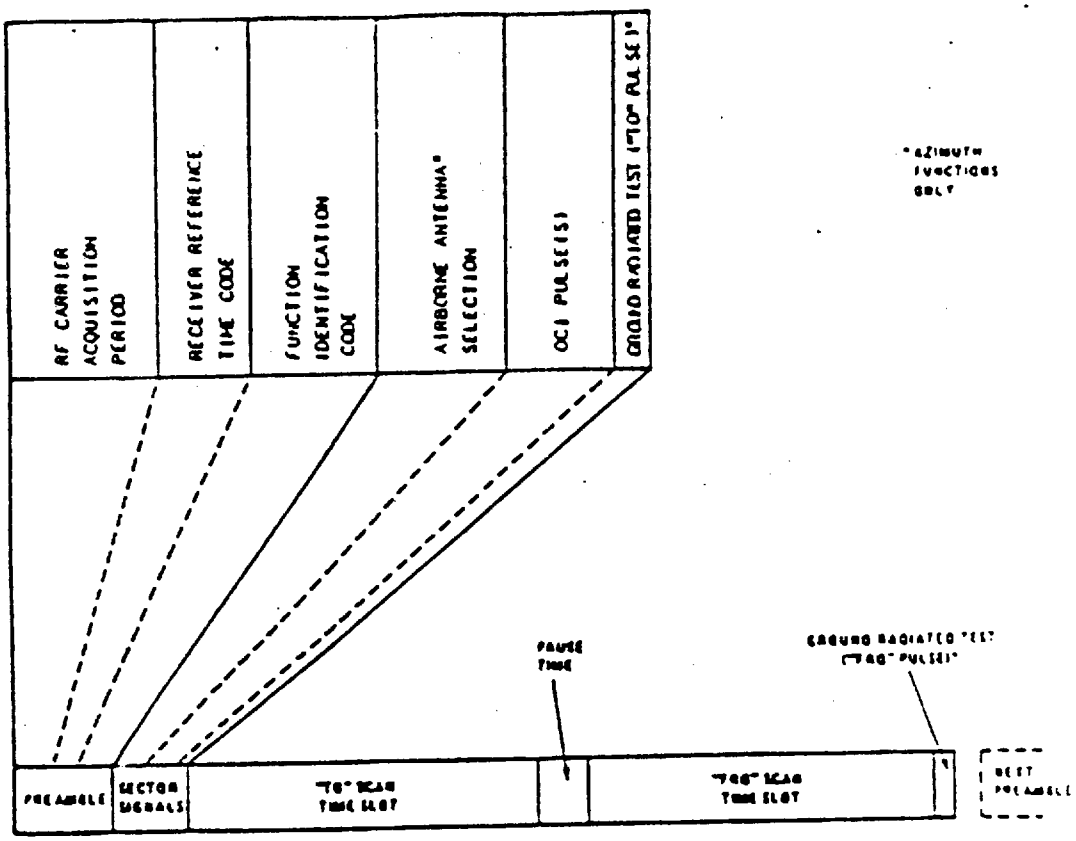
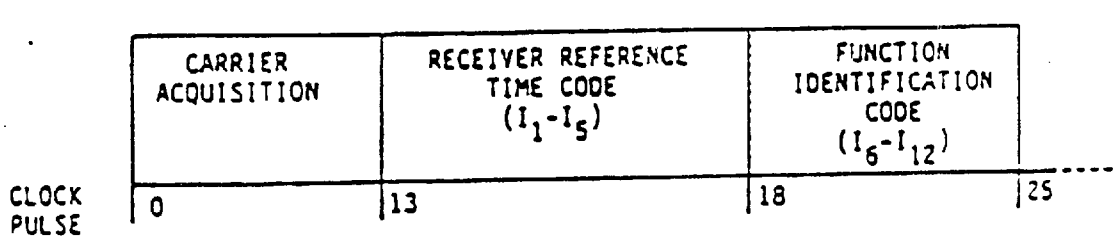


Figure 2. Preamble Organization



3.2.1.1 Preamble.- A preamble signal shall be transmitted throughout the applicable coverage sector to identify the particular function to follow. The preamble shall consist of a radio frequency carrier acquisition period, a receiver reference time code, and a function identification code as shown in Figure 2.

3.2.1.1.1 Carrier acquisition.- The preamble transmission shall begin with a period of unmodulated radio frequency carrier.

3.2.1.1.2 Receiver reference time code.- The receiver reference time code 11101 (bits I_1 to I_5), shall follow the carrier acquisition period. The time of the last phase transition midpoint in the code shall be the receiver reference time.

3.2.1.1.3 Function identification code.- A code for function identification shall follow the receiver reference time code. The code shall consist of the five information bits (I_6 to I_{10}) allowing identification of 31 different functions, plus two parity bits (I_{11} to I_{12}) as shown in Table 1.

Table 1. Function Identification Codes

FUNCTION	CODE I_6	I_7	I_8	I_9	I_{10}	I_{11}	I_{12}
APPROACH AZIMUTH	0	0	1	1	0	0	1
HIGH RATE APPROACH AZIMUTH	0	0	1	0	1	0	0
APPROACH ELEVATION	1	1	0	0	0	0	1
FLARE	0	1	1	0	0	0	1
BACK AZIMUTH	1	0	0	1	0	0	1
360° AZIMUTH	0	1	0	0	1	0	1
BASIC DATA 1	0	1	0	1	0	0	0
BASIC DATA 2	0	1	1	1	1	0	0
BASIC DATA 3	1	0	1	0	0	0	0
BASIC DATA 4	1	0	0	0	1	0	0
BASIC DATA 5	1	1	0	1	1	0	0
BASIC DATA 6	0	0	0	1	1	0	1
AUXILIARY DATA A	1	1	1	0	0	1	0
AUXILIARY DATA B	1	0	1	0	1	1	1
AUXILIARY DATA C	1	1	1	1	0	0	0

NOTE 1: The function identification codes have been chosen so that parity bits I_{11} and I_{12} satisfy the equations:

$$I_6 + I_7 + I_8 + I_9 + I_{10} + I_{11} = \text{EVEN}$$

$$I_6 + I_8 + I_{10} + I_{12} = \text{EVEN}$$

Information Handling Services, 1999
August 11, 1999 06:39:27

3.2.1.2.1 Azimuth functions.- The transmission format of any azimuth function shall include time slots for airborne antenna selection, out-of-coverage indication, and test pulses.

3.2.1.2.1.1 Airborne antenna selection signal.- A signal for airborne antenna selection shall be transmitted as a "zero" DPSK signal lasting for a six-bit period. The signal shall be available throughout the coverage sector in which Approach or Back Azimuth guidance is provided.

NOTE: The signal provides an opportunity for the selection of the most appropriate antenna in a multiple antenna airborne installation.

3.2.1.2.1.2 Out-of-coverage indication pulses.- In the installed environment, where out-of-coverage indication pulses are used, they shall be: (1) greater than any guidance signal in the out-of-coverage sector, (2) at least 5 dB less than the clearance signal level within the adjacent clearance sector, and (3) at least 5 dB less than the scanning beam signal level within the proportional coverage region. The duration of each pulse measured at the half amplitude point shall be at least 100 microseconds, and the rise and fall times shall be less than 10 microseconds. It shall be permissible to sequentially transmit two pulses in each out-of-coverage indication time slot. Where pulse pairs are used, the duration of each pulse shall be at least 50 microseconds, and the rise and fall times shall be less than 10 microseconds. The transmission of out-of-coverage indication pulses from antennas with overlapping coverage patterns shall be separated by at least 10 microseconds.

3.2.1.2.1.3 Ground radiated test signals.- Time slots shall be reserved in the Approach and Back Azimuth signal formats for the future use of ground radiated test signals.

3.2.1.2.2 Approach Elevation function.- The transmission format of the Approach Elevation function shall provide a time slot for an out-of-coverage indication (OCI) pulse.

3.2.1.2.2.1 Out-of-coverage indication pulse.- In the installed environment, where an out-of-coverage indication pulse is used, it shall be: (1) greater than any guidance signal in the out-of-coverage indication sector and (2) at least 5 dB less than the guidance signals within the guidance sector. The duration of the pulse measured at the half amplitude points shall be at least 100 microseconds, and the rise and fall times shall be less than 10 micro- seconds. It shall be permissible to sequentially transmit two pulses in the out-of-coverage indication time slot. Where pulse pairs are used, the dura- tion of each pulse shall be at least 50 microseconds, and the rise and fall times shall be less than 10 microseconds.

Information Handling Services, 1999
August 11, 1999 06:39:27

3.2.1.3 Angle guidance signals

3.2.1.3.1 Azimuth clearance signals

3.2.1.3.1.1 Fly left/fly right clearance pulses.- For azimuth equipment which provides proportional coverage less than ±40 degrees, clearance guidance shall be provided to produce a minimum guidance sector of ±40 degrees. Clearance guidance may be provided by scanning beyond the proportional coverage limits as designated in basic data or, alternately, by the transmission of fly left/fly right clearances pulses in the formats for the approach azimuth, high rate approach azimuth and back azimuth functions. When provided, clearance pulses shall conform to the following:

(a) Clearance guidance information shall be provided by transmitting pairs of pulses within the angle scan time slots. One pair shall consist of one pulse adjacent to the start time of the scanning beam TO scan and one pulse adjacent to the stop time of FRO scan. A second pair shall consist of one pulse adjacent to the stop time of the scanning beam TO scan and one pulse adjacent to the start time of the FRO scan. The fly right clearance pulses shall represent positive angles and the fly left clearance pulses shall represent negative angles. The duration of each clearance pulse shall be 50 microseconds with a tolerance of plus or minus 5 microseconds measured at the half-amplitude points. The transmitter switching time between the clearance pulses and the scanning beam transmissions shall not exceed 10 micro-seconds. The rise time at the edge of each clearance pulse not adjacent to the scanning beam shall be less than 10 microseconds.

(b) In the installed environment: within the fly right clearance guidance sector, the fly right clearance guidance signal shall exceed the scanning beam sidelobes and all other guidance and OCI signals by at least 5 dB; within the fly left clearance guidance sector, the fly left clearance guidance signal shall exceed the scanning beam sidelobes and all other guidance and OCI signals by more than 5 dB; within the proportional guidance sector, the clearance guidance signals shall be at least 5 dB below the proportional guidance signal.

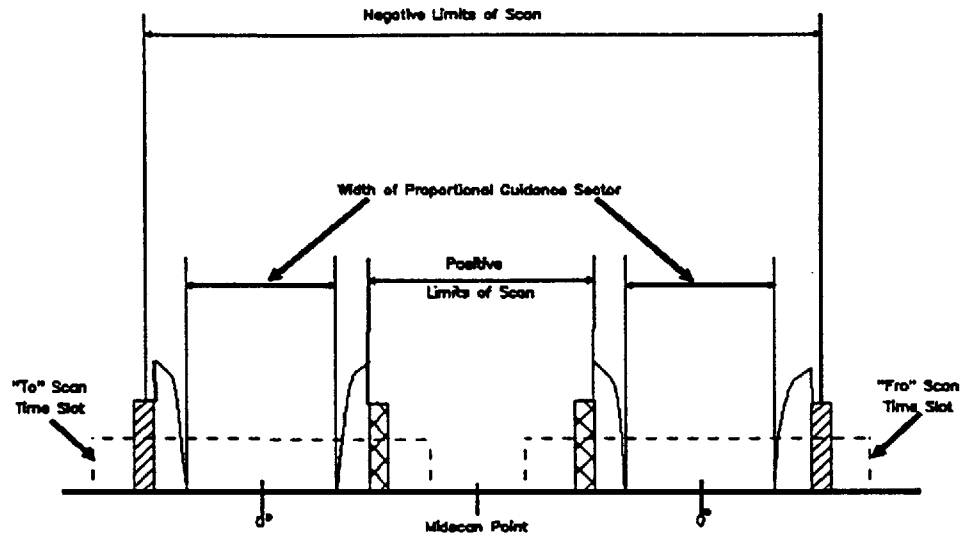
(c) Where used clearance pulses shall be transmitted adjacent to the scanning beam signals at the edges of proportional coverage as shown in the timing diagrams in Figure 4. The proportional coverage boundary shall be established at one beamwidth inside the scan start/stop angles, such that the transition between scanning beam and clearance signals occurs outside the proportional coverage sector.

(d) When clearance pulses are provided in conjunction with a one-degree beamwidth scanning antenna, the scanning beam antenna shall radiate for 15 microseconds while stationary at the scan start/stop angles.

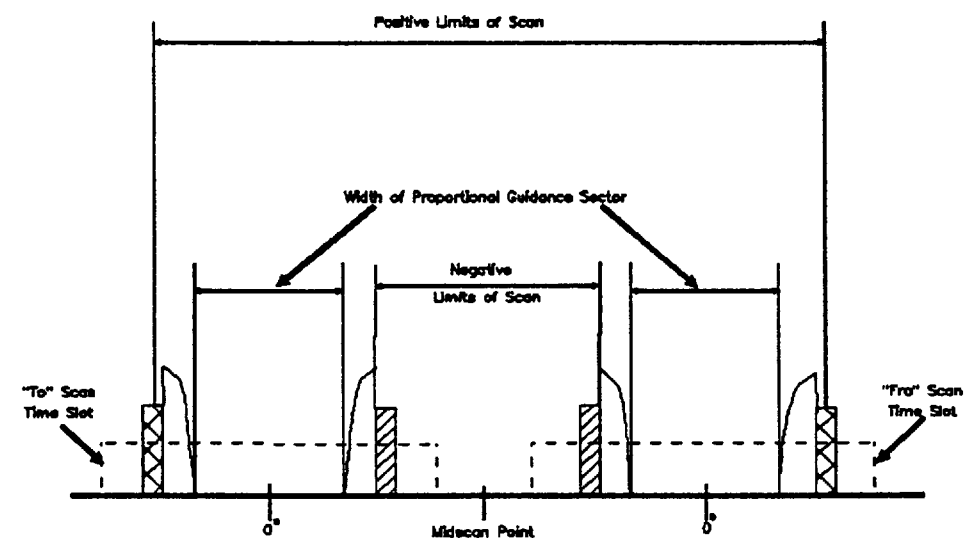
NOTE 1: The proportional coverage limits are transmitted in basic data as specified in 3.6.

Information Handling Services, 1999
August 11, 1999 06:39:27

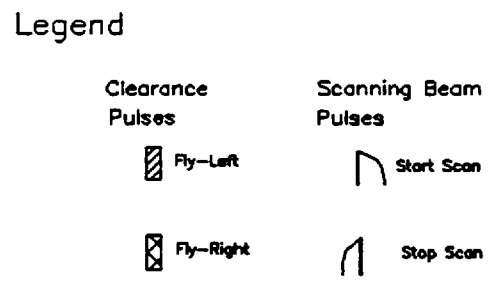
Figure 4. Clearance Pulse Conventions



(a) Approach Azimuth



(b) Back Azimuth



Information Handling Services, 1999
August 11, 1999 06:39:27

NOTE 2: It is not intended to limit the use of clearance pulses to the minimum sectors specified in 4.2 when operational advantages can be gained by providing a wider guidance sector.

3.2.1.3.2 Proportional guidance signals

3.2.1.3.2.1 Angle guidance encoding.- Angle guidance information shall be encoded by the amount of time separation between the centers of the received TO and FRO scanning beam main lobes. The coding shall be interpreted in the airborne equipment as a linear function of time as follows:

$$\theta = (T_0 - t)V/2$$

Where:

θ - Azimuth or elevation angle in degrees.

T_0 - Time separation in microseconds between TO and FRO beam centers corresponding to zero degrees.

t - Time separation in microseconds between TO and FRO beam centers.

V - Scan velocity scaling constant in degrees per microseconds.

3.2.1.3.2.2 Angle parameter values.- The values of the angle guidance parameters shall be as shown in Table 2.

Table 2. Value of Angle Guidance Parameters

Function	Maximum Scan Angle (degrees)	Value of t for Maximum Scan Angle (usec)	To (usec)	V (degrees/ (usec)
APPROACH AZIMUTH	-62 to +62	13 000	6 800	+0.020
HIGH RATE APPROACH AZIMUTH	-42 to +42	9 000	4 800	+0.020
BACK AZIMUTH	-42 to +42	9 000	4 800	-0.020
APPROACH ELEVATION	-1.5 to +29.5	3 500	3 350	+0.020
FLARE ELEVATION	-2 to +10	3 200	2 800	+0.010

Note: The maximum scan angles shown recognize that the scan angle must exceed the proportional coverage limit by at least one half of the width of the detected scanning beam envelope (in equivalent angle) to allow successful decoding.

Information Handling Services, 1999
August 11, 1999 06:39:27

3.2.1.3.2.3 Tolerances.- The tolerances on the ground equipment scanning beam velocity and the time separation between TO and FRO pulses corresponding to zero degrees shall be sufficient to satisfy the accuracy requirements specified in 4.3.

3.2.1.3.2.4 Azimuth scanning convention.- Scanning conventions for Azimuth guidance signals shall be in accordance with Figure 5. Each angle guidance transmission shall consist of a clockwise TO-scan followed by a counter-clockwise FRO-scan as viewed from above the antenna. For Approach Azimuth functions, increasing angle values shall be in the direction of the TO-scan. For the Back Azimuth function, increasing angle values shall be in the direction of the FRO-scan.

3.2.1.3.2.5 Elevation scanning convention.- Scanning conventions for elevation guidance signals shall be in accordance with Figure 6. Each angle guidance transmission shall consist of an upward TO-scan followed by a downward FRO-scan. The TO-scan shall be in the direction of increasing angle values. Zero elevation angle shall coincide with a horizontal plane through the antenna phase center.

3.2.2 Data Functions.- Provision shall be made in the MLS signal format for the transmission of Basic Data and Auxiliary Data.

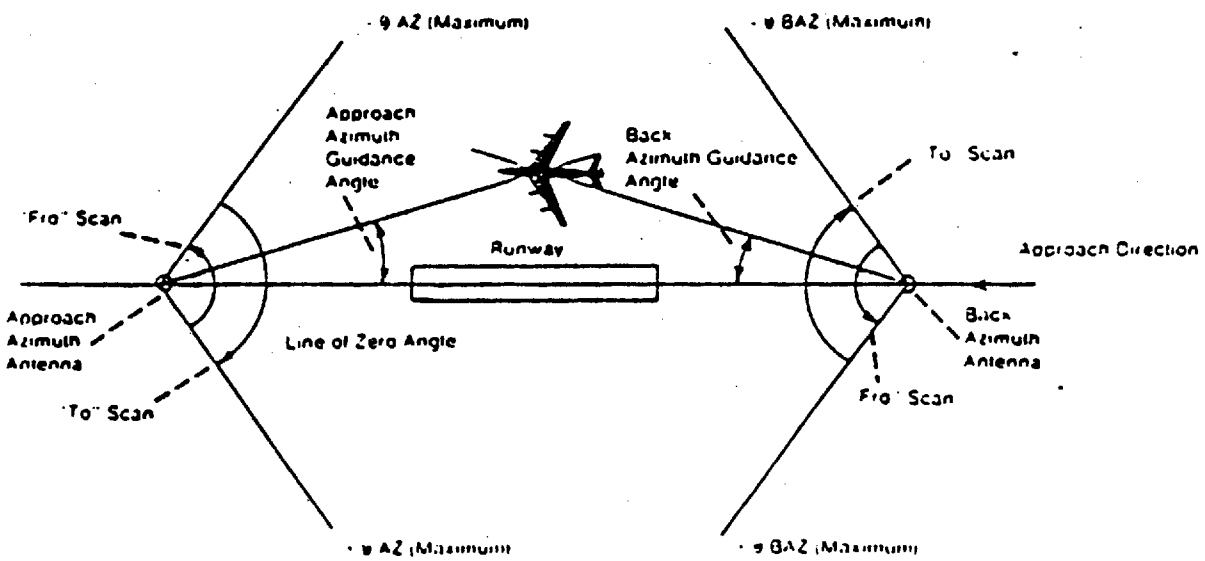
3.2.2.1 Data encoding

3.2.2.1.1 Differential phase shift keying (DPSK).- The preamble and other codes and the Basic and Auxiliary Data signals shall be transmitted by phase shift keying of the radio frequency carrier using differential coding. A "zero" shall be represented by a 0 degree plus or minus 10 degrees phase shift and a "one" shall be represented by a 180 degrees plus or minus 10 degrees phase shift.

3.2.2.2 Basic Data structure.- Basic Data shall be encoded as 32-bit words consisting of a function preamble (12 bits), data transmission (18 bits) and parity (2 bits) as specified in Figure 7. The preamble organization is the same as for the angle functions (3.2.1). Data containing digital information shall be transmitted Least Significant Bit first, and the smallest binary number shall represent the lower absolute range limit with increments in binary steps to the upper absolute range limit as specified in Table 6. The sign bit convention shall be as specified in Table 6.

Information Handling Services, 1999
August 11, 1999 06:39:27

Figure 5. Scanning Conventions for Azimuth Guidance Functions



NOTE: The Approach and Back Azimuth angles are negative for the position of the aircraft shown in Figure 5.

Information Handling Services, 1999
August 11, 1999 06:39:27

Figure 6. Scanning Conventions for Approach Elevation Guidance Functions

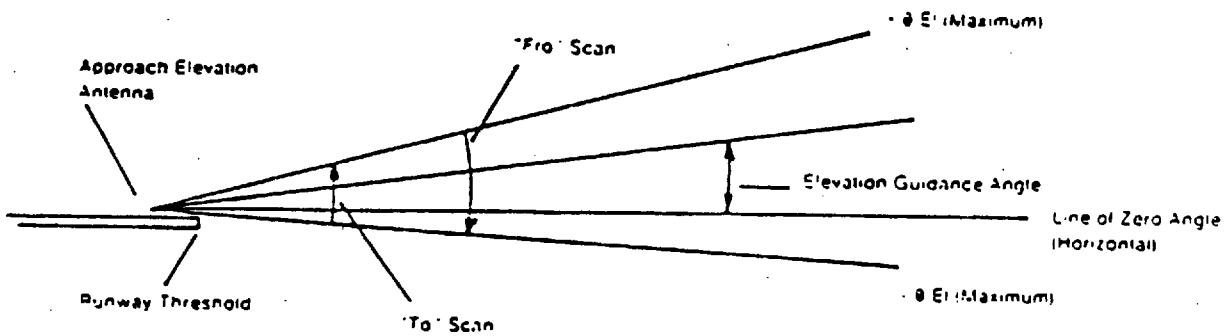


Figure 7. Basic Data Organization

	PREAMBLE (I_1-I_{12})		DATA TRANSMISSION (I_{13}-I_{30})		PARITY (I_{31}-I_{32})	
CLOCK PULSE	0	24	25	42	43	44

3.2.2.3 Auxiliary Data structure.- Auxiliary Data shall be organized into 76-bit words consisting of a preamble, an address, information bits and parity bits as shown in Figure 8. Two Auxiliary Data word formats shall be provided, one for digital data and one for alphanumeric character data. Data containing digital information shall be transmitted with the least significant bit first. Alphanumeric data characters shall be encoded in accordance with a 7-unit (ASCII) Code character set, using seven information bits, plus one even parity bit added to each character. Alphanumeric data shall be transmitted in the order in which they are to be read. The serial transmission of a character shall be with the lower order bit transmitted first and the parity bit transmitted last. When provided, Auxiliary Data shall be transmitted between the function sequences and shall be preceded by a 12-bit preamble as specified in 3.2.1.1.

Information Handling Services, 1999
August 11, 1999 06:39:27

Figure 8. Auxiliary Data Word Organization

PREAMBLE	ADDRESS	DATA	PARITY
I_1-I_{12}	I_{13}-I_{20}	I_{21}-I_{69}	I_{70}-I_{76}

(a) Digital Data

		ASCII CHARACTERS						
PREAMBLE	ADDRESS	#1	#2	#3	#4	#5	#6	#7
I_1-I_{12}	I_{13}-I_{20}	I_{21}-I_{28}	I_{29}-I_{36}	I_{37}-I_{44}	I_{45}-I_{52}	I_{53}-I_{60}	I_{61}-I_{68}	I_{69}-I_{76}

(b) Alphanumeric Data

Information Handling Services, 1999
August 11, 1999 06:39:27

3.2.3 Function rates.- Each function transmitted shall be repeated at the rates shown in Table 3.

Table 3. Function Rates

Function	Average Rate (Hz) measured over any 10 second period
APPROACH AZIMUTH	13 ± 0.5
HIGH RATE APPROACH AZIMUTH	39 ± 1.5
BACK AZIMUTH	6.5 ± 0.25
APPROACH ELEVATION	39 ± 1.5
BASIC DATA	See Table 6
AUXILIARY DATA	See Table 8

NOTE: When the proportional guidance sector is not greater than ±40 degrees and a need for flare elevation or other growth functions at that facility is not anticipated, the high rate azimuth function should be used.

3.2.4 Time Division Multiplex format.- Angle guidance and data functions shall be organized into time sequences and transmitted on a single radio frequency channel.

3.2.4.1 Randomized transmissions.- The time interval between repetitive transmissions of any one function shall be varied in a manner which provides protection from synchronous interference.

Each function transmission is an independent entity which can occur in any position in the TDM sequence (with the exception that Back Azimuth must be preceded by Basic Data word No. 2).

Some sequences which have demonstrated protection from synchronous interference and provide the transmission rates required are illustrated in Figure 9, 10, and 11. Care must be taken to assure sufficient de-correlation between consecutive samples of the same function.

Information Handling Services, 1999
August 11, 1999 06:39:27

Figure 9. Complete Multiplex Transmission Cycle

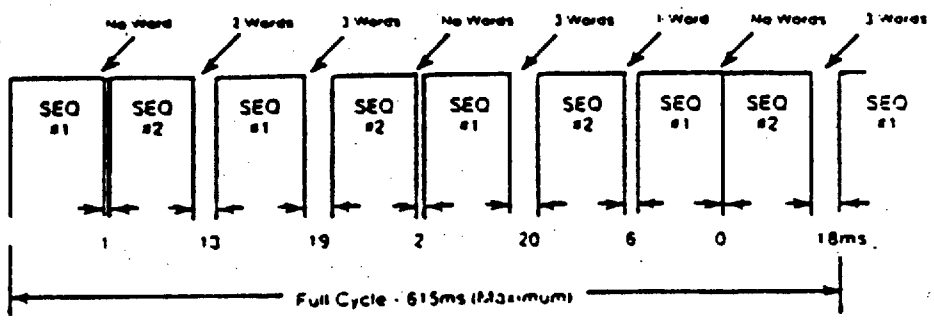
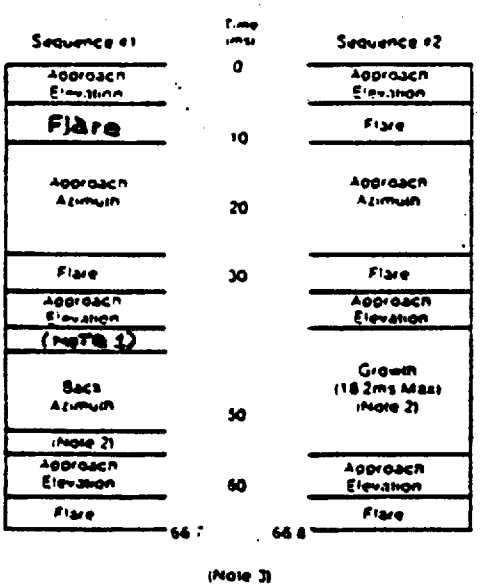


Figure 10. Transmission Sequence Pair Which Provides for all MLS Angle Guidance Functions

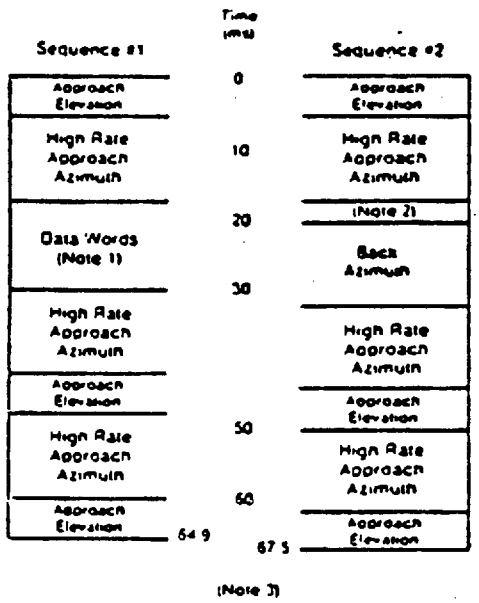


NOTES:

1. When Back Azimuth is provided Basic Data word #2 must be transmitted only in this position.
2. Data words may be transmitted in any open time periods.
3. The total time duration of sequence #1 plus sequence #2 must not exceed 134ms.

Information Handling Services, 1999
August 11, 1999 06:39:27

Figure 11. Transmission Sequence Pair Which Provides for the MLS High Rate Approach Azimuth Angle Guidance Function



NOTES:

1. Data words may be transmitted in any open time periods.
2. When Back Azimuth is provided, Basic Data word #2 must be transmitted only in this position.
3. The total time duration of sequence #1 plus sequence #2 must not exceed 134ms.

3.3 (Not used)

3.4 System coverage.- Azimuth, Elevation, range, and appropriate data signals shall be provided in the approach region to at least 20 nmi from the MLS datum point. For Systems with Approach Guidance Sectors wider than ±40 degrees, coverage outside the ±40-degree sector shall be provided to at least 14 nmi from the MLS datum point. For autoland operation, Azimuth, range, and Data signals shall be provided near the runway surface. For missed approach or departure guidance, Back Azimuth and range signals shall be provided to at least 20 nmi from the MLS datum point. The system coverage for each function shall be provided under all operational weather conditions with a 95 percent probability.

NOTE: The angular coverage limits for each function are specified in 4.2.

3.4.1 Power densities-angle.- The power density for data, clearance pulses, and angle guidance signals, to satisfy the system coverage requirement, shall be at least equal to the values indicated in Table 4 (including NOTES 1 and 2).

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 4. Minimum Power Density Within Coverage Boundaries (1) (3)
(dBW/m^2)

Function	Data Signals	Angle Signals for Various Antenna Beamwidths (2)				Clearance Signals
		1°	1.5°	2°	3°	
Approach Azimuth	-89	-78	--	-79	--	-86
High Rate Approach Azimuth	-89	-78	--	-79	-80	-86
Back Azimuth	-89	-78	--	-79	--	-86
Approach Elevation	-89	-84	-85	-86	--	--

NOTE 1: In the approach region within ±10 degrees azimuth of centerline, the power density shall exceed that given in Table 4 by 1.5 dB for data signals, 2 dB for azimuth signals and 6 dB for elevation signals. Below an elevation angle of 1.8° to the lower coverage limit, the power density for the elevation function may decrease linearly to -88 dBW/m^2.

NOTE 2: In the runway region at the reference datum, the power density for each function shall be at least 15 dB higher than those indicated in the Table. The approach azimuth power density at 8 ft. above the runway surface should not be less than -70 dBW/m^2 for all antenna configurations. Where this is not possible due to siting, the lower limit of coverage to be published is that where the minimum power density requirements given in table 4 and the accuracy requirements are satisfied. This is not to imply a restrictive categorization if the diminished lower coverage does not impact meeting the operational requirements at that site.

NOTE 3: The specified values are chosen to limit receiver thermal noise to minimum obtainable values consistent with transmitter power levels less than 20 watts and antenna designs of moderate to high efficiencies.

3.5 System accuracies.- The system accuracies discussed in this paragraph and its sub-paragraphs concern only the angle system, except those in sub-paragraph 3.5.4 which relate to the DME/P. The system angle errors shall not exceed those listed in Table 5a at the appropriate reference datum when using airborne equipment that satisfies the requirements specified in RTCA DO-177, (i.e., for receivers with Electrical Output B). At the appropriate reference datum, temporal sinusoidal noise components shall not exceed 0.025 degree peak in the frequency band 0.01 Hz to 1.6 Hz, and the CMN shall not exceed 0.10 degree. The accuracy shall be measured in accordance with paragraph 6.

Information Handling Services, 1999
August 11, 1999 06:39:27

NOTE: The intent of the CMN performance requirements is to permit auto-coupled approaches from near the coverage limits using flight control systems typical of the existing air-carrier fleet. The intent of the PFE and PFN performance requirements is to minimize the touchdown dispersions and to place the aircraft in a satisfactory attitude at the reference datum.

3.5.1 (Not used).-

3.5.2 Accuracy degradation.- From the appropriate reference datum to the coverage limit, the PFE, PFN and CMN limits, expressed in angular terms, shall be allowed to linearly increase as follows:

(1) For the approach azimuth function:

(a) With distance along the runway centerline extended, by a factor of 1.2 for the PFE and PFN limits and to ±.10 degree for the CMN limits.

(b) With azimuth angle, by a factor of 1.5 at the ±40 degree and a factor of 2.0 at the ±60 degree azimuth angles for the PFE, PFN and CMN limits.

(c) With elevation angle from +9 degrees to +15 degrees, by a factor of 1.5 for the PFE and PFN limits.

(d) Maximum angular limits. The PFE limits shall not exceed ±0.25 degree in any coverage region below an elevation angle of +9 degrees nor exceed ±0.50 degree in any coverage region above that elevation angle. The CMN limits shall not exceed ±0.10 degree in any coverage region within +10 degrees of runway centerline extended nor exceed ±0.20 degree in any other region within coverage.

NOTE: It is desirable that the CMN limits not exceed ±0.10 degree throughout the coverage.

(2) For approach elevation functions:

(a) With distance along the runway centerline extended at the minimum glide path angle, by a factor of 1.2 for the PFE and PFN limits and to ±0.10 degree for the CMN limits.

(b) With azimuth angle, from runway centerline extended to plus or minus 40 degrees, by a factor of 1.2 for the PFE and PFN limits and by a factor of 2.0 for CMN limits, with the limits remaining constant from 40 degrees to 60 degrees coverage extreme, if provided.

(c) With increasing elevation angles from +3 degrees to +15 degrees, by a factor of 2.0 for the PFE and PFN limits.

(d) With decreasing elevation angle from +3 degrees (or 60% of the minimum glide path angle, whichever is less) to the coverage extreme, by a factor of 3 for the PFE, PFN and CMN limits.

Information Handling Services, 1999
August 11, 1999 06:39:27

(e) Maximum angular limits. The CMN limits shall not exceed ±0.10 degree in any coverage region within ±10 degrees laterally of runway centerline extended which is above the elevation angle specified in (d) above.

NOTE: It is desirable that the CMN limits not exceed ±0.10 degree throughout the coverage region above the elevation angle specified in (d) above.

(3) For the back azimuth function:

(a) With distance along the runway centerline extended, by a factor of 1.2 for the PFE and PFN limits and to ±0.20 degrees for the CMN limits.

(b) With azimuth angle, by a factor of 1.5 at ±40 degrees for the PFE, PFN, and CMN limits.

(c) With elevation angle from +9 degrees to +15 degrees, by a factor of 1.5 for the PFE and PFN limits.

(d) Maximum angular limits. The PFE limits shall not exceed ±0.25 degrees in any coverage region below an elevation angle of +9 degrees nor exceed ±0.50 degrees in any coverage region above that elevation angle.

Note: It is desirable that the CMN limits not exceed ±0.20 degrees throughout the coverage.

Table 5a. Angle System Error Limits at the Reference Datum

Function	At Approach Reference Datum			At Back Azimuth Reference Datum		
	PFN	PFE	CMN	PFN	PFE	CMN
Approach Azimuth	±11.5ft	±20ft	±10.5ft	--	--	--
Approach Elevation	±0.087°	±0.133°	±0.050°	--	--	--
Back Azimuth	--	--	--	±11.5ft	±20ft	±10.5ft

3.5.3 Accuracy in the runway region.- The linear accuracies specified in Table 5a for the Approach Azimuth function shall be maintained throughout the runway coverage region specified in 4.2.2.2 except where degradation is allowed by 3.5.2(1).

Information Handling Services, 1999
August 11, 1999 06:39:27

3.5.4 DME/P Accuracy.- The DME/P accuracy standards specified herein shall be met on a 95 percent probability basis. These system limits include errors from all causes such as those from airborne equipment (for an interrogator that satisfies the requirements of RTCA/DO-189), ground equipment, propagation and random pulse interference effects.

Errors on the extended runway centerline shall not exceed the values given in Table 5b. In the approach sector, away from the extended runway centerline, the allowable PFE for the DME/P standard 1 shall be permitted to increase linearly with angle up to plus or minus 40 degrees MLS azimuth angle where the permitted error is 1.5 times that on the extended runway centerline at the same distance. The allowable CMN shall not increase with angle. There shall be no degradation of either PFE or CMN with elevation angle.

Table 5b. Allowable DME/P Standard 1 System Errors

LOCATION	MODE	PFE	CMN
20 NM to 5NM From MLS Approach Reference Datum	IA	±250 m (±820 ft) Reducing Linearly to ±85 m (±279 ft)	±68 m (±223 ft) Reducing Linearly to ±34 m (±111 ft)
5 NM to MLS Approach Reference Datum	FA	±85 m (±279 ft) Reducing Linearly to ±30 m (±100 ft)	±18 m (±60 ft)
See Note (3)	IA	±100 m (±328 ft)	±68 m (±223 ft)
At MLS Approach Reference Datum and throughout Runway Coverage	FA	±30 m (±100 ft)	±18 m (±60 ft)
5NM to Back Azimuth Reference Datum	IA/FA	±100 m (±328 ft)	±68 m (±223 ft)
20 NM to 5NM From Back Azimuth Reference Datum	IA	±250 m (±820 ft) Reducing Linearly to ±100m (±328 ft)	±68 m (±223 ft) Reducing linearly to ±34m (±111 ft)

Note: (1) Outside the Approach Azimuth and Back Azimuth coverage sectors the PFE shall not exceed ±375m (±1230 ft) and the CMN shall not exceed ±68m (±223 ft).

(2) The DME/P Final Approach (FA) mode supports flight operations in the final approach and runway regions. The DME/P Initial Approach (IA) mode is interoperable with DME/N and supports flight operations outside the final approach region.

(3) At distances from 5 nautical miles to the MLS approach reference datum and throughout the back azimuth coverage, the IA mode may be used when the FA mode is not operative.

Information Handling Services, 1999
August 11, 1999 06:39:27

3.6 Basic Data content.- Basic Data shall consist of the items specified in Table 6. Basic Data words shall be defined as follows:

(a) Approach azimuth to threshold distance shall represent the minimum distance between the approach azimuth antenna phase center and the vertical plane perpendicular to the centerline which contains the runway landing threshold.

(b) Approach azimuth proportional coverage limit shall represent the limit of the sector in which proportional Approach Azimuth guidance is transmitted.

NOTE: This limit does not represent the angle of the maximum flyable azimuth course. That will always be an angle less than the proportional limit and should be determined by flight inspection.

(c) Clearance signal type shall indicate the method of providing the azimuth clearance signal.

(d) Minimum glide path shall represent the minimum glide path as defined in 1.5.20.

(e) Back azimuth status shall represent the operational status of the Back Azimuth equipment.

(f) DME status shall represent the operational status of the DME equipment.

(g) Approach azimuth status shall represent the operational status of the Approach Azimuth equipment.

(h) Approach elevation status shall represent the operational status of the Approach Elevation equipment.

(i) Beamwidth shall represent, for a particular function, the antenna beamwidth as defined in 1.5.7.

(j) DME distance shall represent the minimum distance between the DME antenna phase center and the vertical plane perpendicular to the runway center line which contains the MLS datum point.

(k) Approach azimuth magnetic orientation shall represent the angle measured in the horizontal plane clockwise from Magnetic North to the zero-degree angle guidance radial of the Approach Azimuth antenna. The vertex of the measured angle shall be at the Approach Azimuth antenna phase center.

NOTE: For example, this data item would be encoded 090 for an approach Azimuth antenna serving runway 27, (assuming the magnetic heading is 270 degrees), when sited such that the zero degree radial is parallel to centerline.

Information Handling Services, 1999
August 11, 1999 06:39:27

(l) Back azimuth magnetic orientation shall represent the angle measured in the horizontal plane clockwise from Magnetic North to the zero-degree angle guidance radial of the Back Azimuth antenna. The vertex of the measured angle shall be at the Back Azimuth antenna phase center.

NOTE: For example, this data item would be encoded 270 for a Back Azimuth Antenna serving runway 27, (assuming the magnetic heading is 270 degrees), when sited such that the zero degree radial is parallel to centerline.

(m) Back azimuth proportional coverage limit shall represent the limit of the sector in which proportional Back Azimuth guidance is transmitted.

NOTE: This limit does not represent the angle of the maximum flyable azimuth course. That will always be an angle less than the proportional limit and should be determined by flight inspection.

(n) MLS ground equipment identification shall represent the three characters of the system identification. The characters shall be encoded in accordance with the International Alphabet No. 5 (IA-5) using bits B_1 through B_6.

NOTE: Bit B_7 of this code may be reconstructed in the airborne receiver by taking the complement of bit B_6.

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 6. Basic Data Words

BASIC DATA WORD #1

DATA BIT #	DATA ITEM DEFINITION	LSB VALUE	DATA BIT VALUE
1	Preamble (See Note 8)	N/A	1
2			1
3			1
4			0
5			1
6			0
7			1
8			0
9			1
10			0
11			0
12			0
13	Approach azimuth to threshold distance	100m	100m
14	(0m - 6300m)		200m
15			400m
16			800m
17			1600m
18			3200m
19	Approach azimuth proportional coverage	2°	-2°
20	limit (negative limit)		-4°
21	(0° to -60°) (See Note 9)		-8°
22			-16°
23			-32°
24	Approach azimuth proportional coverage	2°	2°
25	limit (positive limit)		4°
26	(0° to +60°) (See Note 9)		8°
27			16°
28			32°
29	Clearance signal type	N/A	0 = pulse; 1 = SB
30	Spare		Transmit zero
31	Parity: (13+14+15...+30+31 = ODD)	N/A	N/A
32	Parity: (14+16+18...+30+32 = ODD)	N/A	N/A

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 6. Basic Data Words (cont.)

BASIC DATA WORD #2

DATA BIT #	DATA ITEM DEFINITION	LSB VALUE	DATA BIT VALUE
1	Preamble (See Note 8)	N/A	1
2			1
3			1
4			0
5			1
6			0
7			1
8			1
9			1
10			1
11			0
12			0
13	Minimum glide path	0.1°	0.1°
14	(2.0° to 14.7°)		0.2°
15			0.4°
16			0.8°
17			1.6°
18			3.2°
19			6.4°
20	Back azimuth status		see note 4
21	DME status		see note 6
22			
23	Approach azimuth status		see note 4
24	Approach elevation status		see note 4
25	Spare		Transmit zero
26	Spare		Transmit zero
27	Spare		Transmit zero
28	Spare		Transmit zero
29	Spare		Transmit zero
30	Spare		Transmit zero
31	Parity: (13+14+15...+30+31 = ODD)	N/A	N/A
32	Parity: (14+16+18...+30+32 = ODD)	N/A	N/A

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 6. Basic Data Words (cont.)

BASIC DATA WORD #3

DATA BIT #	DATA ITEM DEFINITION	LSB VALUE	DATA BIT VALUE
1	Preamble (See Note 8)	N/A	1
2			1
3			1
4			0
5			1
6			1
7			0
8			1
9			0
10			0
11			0
12			0
13	Approach azimuth beamwidth	0.5°	0.5°
14	(0.5° - 4.0°) (See note 7)		1.0°
15			2.0°
16	Approach elevation beamwidth	0.5°	0.5°
17	(0.5° to 2.5°) (See note 7)		1.0°
18	Note: values greater than 2.5° are invalid		2.0°
19	DME distance	12.5m	12.5m
20	(0m to 6387.5m)		25.0m
21			50.0m
22			100.0m
23			200.0m
24			400.0m
25			800.0m
26			1600.0m
27			3200.0m
28	Spare		Transmit zero
29	Spare		Transmit zero
30	Spare		Transmit zero
31	Parity: (13+14+15...+30+31 = ODD)		
32	Parity: (14+16+18...+30+32 = ODD)	N/A	N/A

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 6. Basic Data Words (cont.)

BASIC DATA WORD #4

DATA BIT #	DATA ITEM DEFINITION	LSB VALUE	DATA BIT VALUE
1	Preamble (See Note 8)	N/A	1
2			1
3			1
4			0
5			1
6			1
7			0
8			0
9			0
10			1
11			0
12			0
13	Approach azimuth magnetic	1°	1°
14	orientation		2°
15	(0° to 359°)		4°
16			8°
17			16°
18			32°
19			64°
20			128°
21			256°
22	Back azimuth magnetic	1°	1°
23	orientation		2°
24	(0° to 359°)		4°
25			8°
26			16°
27			32°
28			64°
29			128°
30			256°
31	Parity: (13+14+15...+30+31 = ODD)	N/A	N/A
32	Parity: (14+16+18...+30+32 = ODD)	N/A	N/A

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 6. Basic Data Words (cont.)

BASIC DATA WORD #5

DATA BIT #	DATA ITEM DEFINITION	LSB VALUE	DATA BIT VALUE
1	Preamble (See Note 8)	N/A	1
2			1
3			1
4			0
5			1
6			1
7			1
8			0
9			1
10			1
11			0
12			0
13	Back azimuth proportional	2°	-2°
14	coverage negative limit		-4°
15	(0° to -40°) (See Note 9)		-8°
16			-16°
17			-32°
18	Back azimuth proportional	2°	2°
19	coverage positive limit		4°
20	(0° to +40°) (See Note 9)		8°
21			16°
22			32°
23	Back azimuth beamwidth	0.5°	0.5°
24	(0.5° to 4.0°) (See note 7)		1.0°
25			2.0°
26	Back Azimuth Status		See Note 10
27	Spare		Transmit zero
28	Spare		Transmit zero
29	Spare		Transmit zero
30	Spare		Transmit zero
31	Parity: (13+14+15...+30+31 = ODD)	N/A	N/A
32	Parity: (14+16+18...+30+32 = ODD)	N/A	N/A

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 6. Basic Data Words (cont.)

BASIC DATA WORD #6

DATA BIT #	DATA ITEM DEFINITION	LSB VALUE	DATA BIT VALUE
1	Preamble (See Note 8)	N/A	1
2			1
3			1
4			0
5			1
6			0
7			0
8			0
9			1
10			1
11			0
12			1
(13 - 30)	MLS ground equipment identification (Note 3)		
13	Character 2	N/A	B1
14			B2
15			B3
16			B4
17			B5
18			B6
19	Character 3	N/A	B1
20			B2
21			B3
22			B4
23			B5
24			B6
25	Character 4	N/A	B1
26			B2
27			B3
28			B4
29			B5
30			B6
31	Parity: (13+14+15...+30+31 = ODD)	N/A	N/A
32	Parity: (14+16+18...+30+32 = ODD)	N/A	N/A

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 6. Basic Data Words (cont.)

NOTE 1: The Basic Data Words shall be transmitted throughout the appropriate guidance sectors at minimum average rates (measured over a 10 second period) indicated below.

	Transmission Rates (Hertz)		
	App. Az only	If Back Az Provided	
Word	App. Az	App. Az	Back Az
1	1.0	1.0	N/A
2	6.5	6.5	N/A
3	1.0	1.0	N/A
4	1.0	0.75	0.25
5	N/A	0.25	0.75
6	1.0	0.75	0.25

NOTE 2: The all zero state of the data field represents the lower limit of the absolute range of the coded parameter unless otherwise noted.

NOTE 3: Characters are encoded using the International Alphabet Number 5 (IA-5), bits B_1 through B_6.

NOTE 4: Coding for status bit:

0 = Function not radiated, or radiated in test mode (not reliable for navigation).
1 = Function radiated in normal mode (for system with Back Azimuth, this also indicates that a Back Azimuth transmission follows).

NOTE 5: Data items which are not applicable to a particular ground equipment shall be transmitted as all zeros.

NOTE 6: Coding for status bits:

I_{21}	I_{22}	
0	0	DME transponder inoperative or not available.
1	0	Only IA mode or DME/N available.
0	1	FA mode, Standard 1, available.
1	1	FA mode, Standard 2, available.

NOTE 7: The value coded shall be the actual beamwidth (as defined in 1.5.7) rounded to the nearest 0.5°.

NOTE 8: The 12 data bits of the preamble are preceded by a 0.832 millisecond interval (13 clock pulses) of CW for carrier acquisition (See Table 19).

NOTE 9: The scan limits will be greater than the proportional coverage limits as described 3.2.1.3.2.2.

NOTE 10: Coding for status bit:

0 = Function not radiated, or radiated in test mode (not reliable for navigation).
1 = Function radiated in normal mode.

Information Handling Services, 1999
August 11, 1999 06:39:27

3.7 Auxiliary data.

3.7.1 Addresses.- The address codes of the auxiliary data words shall be as shown in Table 7.

3.7.2 Content.- Three function identification codes are reserved to indicate transmission of Auxiliary Data A, Auxiliary Data B and Auxiliary Data C. Auxiliary Data A contents that have been defined shall be specified below, Auxiliary Data B contents shall be reserved for future use, and Auxiliary Data C contents shall be reserved for national use.

3.7.2.1 Auxiliary data A content.- The data items specified in Table 8 are defined as follows:

(a) Approach azimuth antenna offset shall represent the minimum distance between the Approach Azimuth antenna phase center and the vertical plane containing the runway centerline.

(b) Approach azimuth to MLS datum point distance shall represent the minimum distance between the Approach Azimuth antenna phase center and the vertical plane perpendicular to the centerline which contains the MLS datum point.

(c) Approach azimuth alignment with runway center line shall represent minimum angle between the Approach Azimuth antenna zero-degree guidance plane and the runway center line.

(d) Approach azimuth antenna coordinate system shall represent the coordinate system (planar or conical) of the angle data transmitted by the Approach Azimuth antenna.

(e) Approach elevation antenna offset shall represent the minimum distance between the Elevation antenna phase center and the vertical plane containing the runway centerline.

(f) MLS datum point to threshold distance shall represent the distance measured along the runway centerline from the MLS datum point to the runway threshold.

(g) Approach elevation antenna height shall represent the height of the Elevation antenna phase center relative to the height of the MLS datum point.

(h) DME offset shall represent the minimum distance between the DME antenna phase center and the vertical plane containing the runway centerline.

(i) DME to MLS datum point distance shall represent the minimum distance between the DME antenna phase center and the vertical plane perpendicular to the centerline which contains the MLS datum point.

Information Handling Services, 1999
August 11, 1999 06:39:27

(j) Back azimuth antenna offset shall represent the minimum distance between the Back Azimuth antenna phase center and the vertical plane containing the runway centerline.

(k) Back azimuth to MLS datum point distance shall represent the minimum distance between the Back Azimuth antenna and the vertical plane perpendicular to the centerline which contains the MLS datum point.

(l) Back azimuth antenna alignment with runway centerline shall represent the minimum angle between the Back Azimuth antenna zero-degree guidance plane and the runway centerline.

(m) Approach azimuth antenna height shall represent the vertical location of the antenna phase center with respect to the MLS datum point.

(n) MLS datum point elevation shall represent the datum point elevation relative to mean sea level (msl).

(o) Runway threshold height shall represent the vertical location of the intersection of the runway threshold and centerline with respect to the MLS datum point.

(p) DME antenna height shall represent the vertical location of the antenna phase center with respect to the MLS datum point.

(q) Runway stop-end distance shall represent the distance along centerline between the runway stop-end and the MLS datum point.

(r) Back azimuth antenna coordinate system shall represent the coordinate system (planar or conical) of the angle data transmitted by the Back Azimuth antenna.

(s) Back azimuth height shall represent the vertical location of the antenna phase center with respect to the MLS datum point.

(t) Runway visual range (RVR) shall represent measurement of instrument RVR at touchdown zone, midpoint, and stop end of the runway and trend values.

(u) Surface wind shall represent wind speed and direction (magnetic).

3.7.3 (Not used)

Information Handling Services, 1999
August 11, 1999 06:39:27

TABLE 7. Auxiliary Data Word Address Codes

No.	I_{13}	I_{14}	I_{15}	I_{16}	I_{17}	I_{18}	I_{19}	I_{20}	No.	I_{13}	I_{14}	I_{15}	I_{16}	I_{17}	I_{18}	I_{19}	I_{20}
1.	0	0	0	0	0	1	1	1	33.	1	0	0	0	0	1	0	1
2.	0	0	0	0	1	0	1	0	34.	1	0	0	0	1	0	0	0
3.	0	0	0	0	1	1	0	1	35.	1	0	0	0	1	1	1	1
4.	0	0	0	1	0	0	1	1	36.	1	0	0	1	0	0	0	1
5.	0	0	0	1	0	1	0	0	37.	1	0	0	1	0	1	1	0
6.	0	0	0	1	1	0	0	1	38.	1	0	0	1	1	0	1	1
7.	0	0	0	1	1	1	1	0	39.	1	0	0	1	1	1	0	0
8.	0	0	1	0	0	0	1	0	40.	1	0	1	0	0	0	0	0
9.	0	0	1	0	0	1	0	1	41.	1	0	1	0	0	1	1	1
10.	0	0	1	0	1	0	0	0	42.	1	0	1	0	1	0	1	0
11.	0	0	1	0	1	1	1	1	43.	1	0	1	0	1	1	0	1
12.	0	0	1	1	0	0	0	1	44.	1	0	1	1	0	0	1	1
13.	0	0	1	1	0	1	1	0	45.	1	0	1	1	0	1	0	0
14.	0	0	1	1	1	0	1	1	46.	1	0	1	1	1	0	0	1
15.	0	0	1	1	1	1	0	0	47.	1	0	1	1	1	1	1	0
16.	0	1	0	0	0	0	1	1	48.	1	1	0	0	0	0	0	1
17.	0	1	0	0	0	1	0	0	49.	1	1	0	0	0	1	1	0
18.	0	1	0	0	1	0	0	1	50.	1	1	0	0	1	0	1	1
19.	0	1	0	0	1	1	1	0	51.	1	1	0	0	1	1	0	0
20.	0	1	0	1	0	0	0	0	52.	1	1	0	1	0	0	1	0
21.	0	1	0	1	0	1	1	1	53.	1	1	0	1	0	1	0	1
22.	0	1	0	1	1	0	1	0	54.	1	1	0	1	1	0	0	0
23.	0	1	0	1	1	1	0	1	55.	1	1	0	1	1	1	1	1
24.	0	1	1	0	0	0	0	1	56.	1	1	1	0	0	0	1	1
25.	0	1	1	0	0	1	1	0	57.	1	1	1	0	0	1	0	0
26.	0	1	1	0	1	0	1	1	58.	1	1	1	0	1	0	0	1
27.	0	1	1	0	1	1	0	0	59.	1	1	1	0	1	1	1	0
28.	0	1	1	1	0	0	1	0	60.	1	1	1	1	0	0	0	0
29.	0	1	1	1	0	1	0	1	61.	1	1	1	1	0	1	1	1
30.	0	1	1	1	1	0	0	0	62.	1	1	1	1	1	0	1	0
31.	0	1	1	1	1	1	1	1	63.	1	1	1	1	1	1	0	1
32.	1	0	0	0	0	0	1	0	64.	0	0	0	0	0	0	0	0

NOTE 1.

Parity bits I_{19} and I_{20} are chosen to satisfy the equations:

$$I_{13} + I_{14} + I_{15} + I_{16} + I_{17} + I_{18} + I_{19} = \text{EVEN}$$

$$I_{14} + I_{16} + I_{18} + I_{20} = \text{EVEN}$$

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 8. Auxiliary Data

Word (See Note 5)	Data Content	Type of Data	Bits Used	Range Of Values	Least Significant Bit
A1	Preamble	digital	12		
	Address		8		
	Approach azimuth antenna offset		10	-511 m to +511m (see Note 3)	1 m
	Approach azimuth to MLS datum point distance		13	0 m to 8 191 m	1 m
	Approach azimuth antenna alignment with runway centerline		12	-20.47° to 20.47° (see Note 3)	0.01°
	Approach azimuth antenna coordinate system		1	(see Note 2)	
	Approach azimuth antenna height		7	-63 m to +63 m (see Note 3)	1 m
	spare		6		
	Parity		7	(see Note 1)	

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 8. Auxiliary Data (Cont'd)

Word Least (See Note 5)	Type of Data Content	Data	Bits Used	Range Of Values
A2	Preamble	digital	12	
	Address	8		
	Approach elevation antenna offset		10	-511 m to +511 m 1 m (See Note 3)
	MLS datum point to threshold distance		10	0 m to 1,023 m 1 m
	Approach elevation antenna height		7	-6.3 m to +6.3 m 0.1 m (See Note 3)
	MLS datum point to elevation	1 m	13	-4,095 m +4,094 m
	Runway threshold height		7	-6.3 m to +6.3 m 0.1 m (see Note 3)
	Spare	2		
	Parity	7	(See Note 1)	

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 8. Auxiliary Data (Cont'd)

Word Least Significant (See Note 5)	Type of Data Content	Data	Bits Used	Range Of Values
A3	Preamble (See Note 4)	digital	12	
	Address	8		
	DME offset m	12	-2047 m to +2047 m (See Note 3)	1
	DME to MLS datum point distance	14	-8,191 m to +8, 191 m (See Note 3)	1 m
	DME antenna height	7	-63 m to +63 (see Note 3)	1 m
	Runway stop end distance	14	0 m to 16,383	1 m
	Spare	2		
	Parity	7	(See Note 1)	

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 8. Auxiliary Data (Cont'd)

Word Least (See Significant Note 5)	Data Content	Type of Data	Bits Used	Range Of Values
A4	Preamble	digital	12	
	Address	8		
	Back azimuth antenna offset +511 m 1m		10	-511 m to +511 m (See Note 3)
	Back azimuth to MLS datum point distance 2,047 m 1 m		11	0 m to
	Back azimuth antenna alignment with runway centerline to 20.47° 0.01°		12	-20.47° (See Note 3)
	Back azimuth antenna coordinate system		1	(see Note 2)
	Back azimuth antenna height +63 m 1 m		7	-63 m to +63 m (see Note 3)
	Spare	8		
	Parity	7	(See Note 1)	

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 8. Auxiliary Data (Cont'd)

Word Least Significant (See Note 5)	Data Content	Type of Data	Bits Used	Range Of Values
A5	Preamble	digital	12	
	Address	8		
	RVR (touchdown)		11	
0-2555m	5 m			
			(see Note 6)	
	RVR (midpoint)		11	
0-2555m	5 m			
			(see Note 6)	
	RVR (stopend)		11	
0-2555m	5 m			
			(see Note 6)	
	Surface Wind Speed	7	0-127 knots	1 knot
	Surface Wind Direction (magnetic)		9	0-359 deg 1
	Parity	7	see Note 1	

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 8. Auxiliary Data (Cont'd)

NOTE 1: Parity bits I_{70} to I_{76} are chosen to satisfy the equations which follow.

For BIT I_{70}

$$\text{EVEN} = (I_{13} + \ldots + I_{18}) + I_{20} + I_{22} + I_{24} + I_{25} + I_{28} + I_{29} + I_{31} + I_{32} + I_{33} + I_{35} + I_{36} + I_{38} + I_{41} + I_{44} + I_{45} + I_{46} + I_{50} + (I_{52} + \ldots + I_{55}) + I_{58} + I_{60} + I_{64} + I_{65} + I_{70}$$

For BIT I_{71}

$$\text{EVEN} = (I_{14} + \ldots + I_{19}) + I_{21} + I_{23} + I_{25} + I_{26} + I_{29} + I_{30} + I_{32} + I_{33} + I_{34} + I_{36} + I_{37} + I_{39} + I_{42} + I_{45} + I_{46} + I_{47} + I_{51} + (I_{53} + \ldots + I_{56}) + I_{59} + I_{61} + I_{65} + I_{66} + I_{71}$$

For BIT I_{72}

$$\text{EVEN} = (I_{15} + \ldots + I_{20}) + I_{22} + I_{24} + I_{26} + I_{27} + I_{30} + I_{31} + I_{33} + I_{34} + I_{35} + I_{37} + I_{38} + I_{40} + I_{43} + I_{46} + I_{47} + I_{48} + I_{52} + (I_{54} + \ldots + I_{57}) + I_{60} + I_{62} + I_{66} + I_{67} + I_{72}$$

For BIT I_{73}

$$\text{EVEN} = (I_{16} + \ldots + I_{21}) + I_{23} + I_{25} + I_{27} + I_{28} + I_{31} + I_{32} + I_{34} + I_{35} + I_{36} + I_{38} + I_{39} + I_{41} + I_{44} + I_{47} + I_{48} + I_{49} + I_{53} + (I_{55} + \ldots + I_{58}) + I_{61} + I_{63} + I_{67} + I_{68} + I_{73}$$

For BIT I_{74}

$$\text{EVEN} = (I_{17} + \ldots + I_{22}) + I_{24} + I_{26} + I_{28} + I_{29} + I_{32} + I_{33} + I_{35} + I_{36} + I_{37} + I_{39} + I_{40} + I_{42} + I_{45} + I_{48} + I_{49} + I_{50} + I_{54} + (I_{56} + \ldots + I_{59}) + I_{62} + I_{64} + I_{68} + I_{69} + I_{74}$$

For BIT I_{75}

$$\text{EVEN} = (I_{13} + \ldots + I_{17}) + I_{19} + I_{21} + I_{23} + I_{24} + I_{27} + I_{28} + I_{30} + I_{31} + I_{32} + I_{34} + I_{35} + I_{37} + I_{40} + I_{43} + I_{44} + I_{45} + I_{49} + (I_{51} + \ldots + I_{54}) + I_{57} + I_{59} + I_{63} + I_{64} + I_{69} + I_{75}$$

For BIT I_{76}

$$\text{EVEN} = I_{13} + I_{14} + \ldots + I_{75} + I_{76}$$

NOTE 2: Code for I_{56} is: 0 = conical
1 = planar

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 8. Auxiliary Data (Cont'd)

NOTE 3: The convention for the coding of negative numbers is as follows:

-MSB is the sign bit

0 = +
1 = -

- Other bits represent the absolute value.

The convention for the antenna location is as follows:

As viewed from the MLS approach reference datum looking toward the datum point, a positive number shall represent a location to the right of the runway centerline (lateral offset) or above the runway (vertical offset), or towards the stop end of the runway (longitudinal distance).

The convention for the antenna alignment is as follows:

As viewed from above, a positive number shall represent clockwise rotation from the runway centerline to the respective zero-degree guidance plane.

NOTE 4: The Auxiliary Data Words shall be transmitted throughout the appropriate guidance sectors at the minimum average rates (measured over a 10 second period) indicated below.

	Transmission Rates (Hertz)		
	App. Az only	If Back Az Provided	
Word	App. Az	App. Az	Back Az
1	1.0	1.0	N/A
2	1.0	1.0	N/A
3	1.0	0.75	0.25
4	N/A	0.25	0.75
5	1.0	0.75	0.25

NOTE 5: The designation "A1" represents the function identification code for "Auxiliary Data A" and address code number 1.

NOTE 6: The tenth and eleventh bits transmitted for each RVR value are used to provide trend information. The convention for coding is as follow:

	Tenth bit	Eleventh bit
Off	0	0
Decreasing	1	0
Equal	0	1
Increasing	1	1

Information Handling Services, 1999
August 11, 1999 06:39:27

NOTE 7: Where appropriate data are available, auxiliary data word A5 shall be transmitted throughout the approach azimuth sector and back azimuth sector, if provided.

4. GROUND EQUIPMENT REQUIREMENTS, ANGLE AND DATA FUNCTIONS

4.1 Function transmissions

NOTE: Requirements for the DME/P are contained in FAA-E-2721/13.

4.1.1 Function timing.- Event time slots for each angle and data function shall be as specified in Tables: 14, 15, 16, 17, 18, and 19, Appendix II. The equipment internal timing accuracy of each listed event, including jitter, shall be the specified nominal value, plus or minus 2 microseconds. The timing jitter (i.e., the variations over a number of measurement sets) shall be less than 1 microsecond.

NOTE: The times listed indicate the beginning of the event time slot and the end of the previous event time slot. The characteristics of the actual transmissions are as specified in the applicable paragraphs.

4.1.2 Synchronization.- The transmission from the various angle and data ground equipment serving a particular runway shall be time synchronized to assure interference-free operations on the common radio frequency channel of operation.

4.1.3 Symmetrical scanning.- The TO and FRO scan transmissions shall be symmetrically disposed about the mid-scan point listed in each of Tables 14, 15, and 16. The mid-scan point and the center of the time interval between the TO and FRO scan shall coincide with a tolerance of plus or minus 10 microseconds.

4.1.4 Radio frequency characteristics

4.1.4.1 Radio frequency signal spectrum.- The transmitted signal shall be such that, during the transmission time, the mean power density above a height of 600 meters (2,000 feet) shall not exceed -94.5 dBW/m^2 for angle guidance and data, as measured in a 150 kHz bandwidth centered 840 kHz or more from the nominal frequency.

4.1.4.2 Polarization.- The radio frequency transmissions from all ground equipment shall be nominally vertically polarized. The effect of any horizontally polarized component shall not cause the PFE limit to be exceeded at any location when the airborne antenna is rotated 30 degrees from the vertical position.

4.1.4.3 Frequency tolerance.- The operating radio frequency of the ground equipment shall not vary more than plus or minus 10 kHz from the assigned frequency. The frequency stability shall be such that there is no more than a plus or minus 50 Hz deviation from the nominal frequency when measured over a one-second interval.

Information Handling Services, 1999
August 11, 1999 06:39:27

4.1.4.4 Residual radiation.- The residual radiation of a transmitter associated with an MLS function during time intervals when it should not be transmitting shall not adversely affect the reception of any other function. The residual radiation of an MLS function at times when another function is radiating shall be at least 70 dB below the level provided when transmitting.

4.1.5 Modulation

4.1.5.1 Scanning beam transmissions.- Transmissions during the angle scan period shall be unmodulated continuous wave except that the rise/fall times at the beginning and end of scan shall be controlled as required by 4.1.4.1.

4.1.5.2 Data transmissions.- All codes and data shall be modulated by phase shift keying between the 0 degree and the 180 degree phase states of the radio frequency carrier with a tolerance of ±10 degrees. The signalling rate shall be 15,625 bits per second. A phase transition shall be completed within 10 microseconds, and the phase shall advance (or retard) monotonically throughout the transition region. (see figure 12). Amplitude modulation during the phase transition period shall not be used.

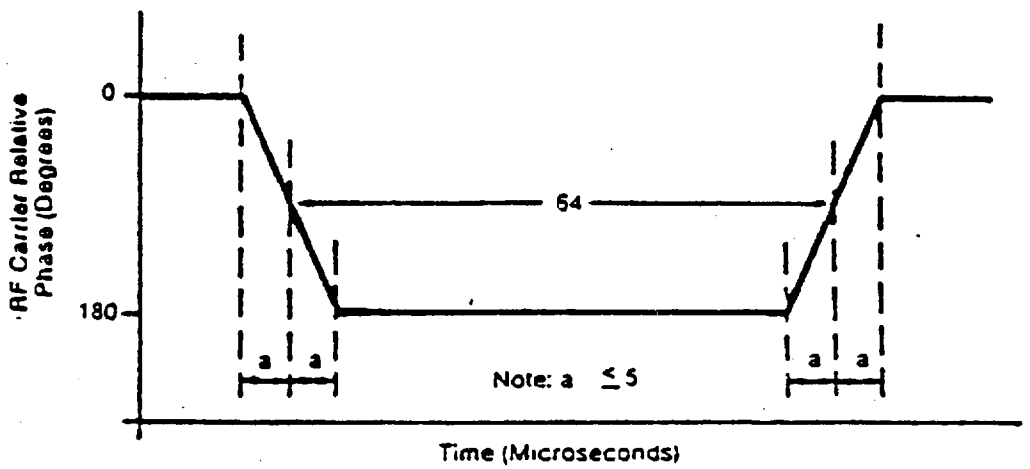
4.1.5.3 Other transmissions.- Other transmissions required in the function formats shall be continuous wave pulses with durations and rise/fall times as specified.

4.1.6 False guidance.- False courses which can be acquired and tracked by an aircraft shall not exist anywhere either inside or outside of the MLS coverage sector within line of sight from the antenna phase center. False courses which would otherwise exist outside of the minimum coverage sector may be suppressed by the use of OCI.

NOTE: False courses may be due to (but not limited to) MLS airborne receiver acquisition of the following types of false guidance: reflections of the scanning beam, scanning beam antenna sidelobes, scanning beam antenna grating lobes, and incorrect clearance.

Information Handling Services, 1999
August 11, 1999 06:39:27

Figure 12. DPSK Phase Characteristics



4.2 Coverage

NOTE 1: The ground equipment coverage requirements are specified based on an allowance for certain probabilistic propagation losses. These losses include rain, atmospheric effects, polarization, and horizontal and vertical multipath. The allowed probabilistic losses are 4.3 dB for data and pulsed clearance signals, 3.1 dB for azimuth guidance signals, and 2.5 dB for elevation guidance signals. The rain loss contribution is 2.2 dB. This will allow for the following rain conditions:

- 50 millimeters (2 inches) per hour through a distance of 5 nautical miles.

- 25 millimeters (1 inch) per hour through a distance of 15 nautical miles.

NOTE 2: Figures 13, 14, and 15 illustrate the coverage requirements for the Approach Azimuth/Data, Back Azimuth/Data Coverage, and Approach Elevation functions respectively. The coverages shown are defined to include both proportional and clearance guidance. The maximum proportional scan limits are shown in Table 2.

NOTE 3: Where intervening obstacles penetrate the 0.9 degree lower coverage surface, it is not intended that guidance be provided at less than line of sight heights. Line of sight (LOS) here means the electrical line of sight which is defined as follows:

Information Handling Services, 1999
August 11, 1999 06:39:27

LOS (deg) = Optical LOS (deg) + 57.3 * SQRT (0.2/R)
Where R = distance from antenna to intervening obstacle (feet)

4.2.1 (Not used)

4.2.2 Approach Azimuth/Data.- The Approach Azimuth/Data ground equipment shall provide guidance information in at least the following volumes of space as illustrated in Figure 13.

4.2.2.1 Approach region

(a) Horizontally within a sector plus or minus 40 degrees about the runway center line originating at the MLS datum point and extending in the direction of the approach to 20 nautical miles. For those systems providing Azimuth guidance to ±60-degrees, coverage shall extend to at least 14 nautical miles beyond ±40-degrees.

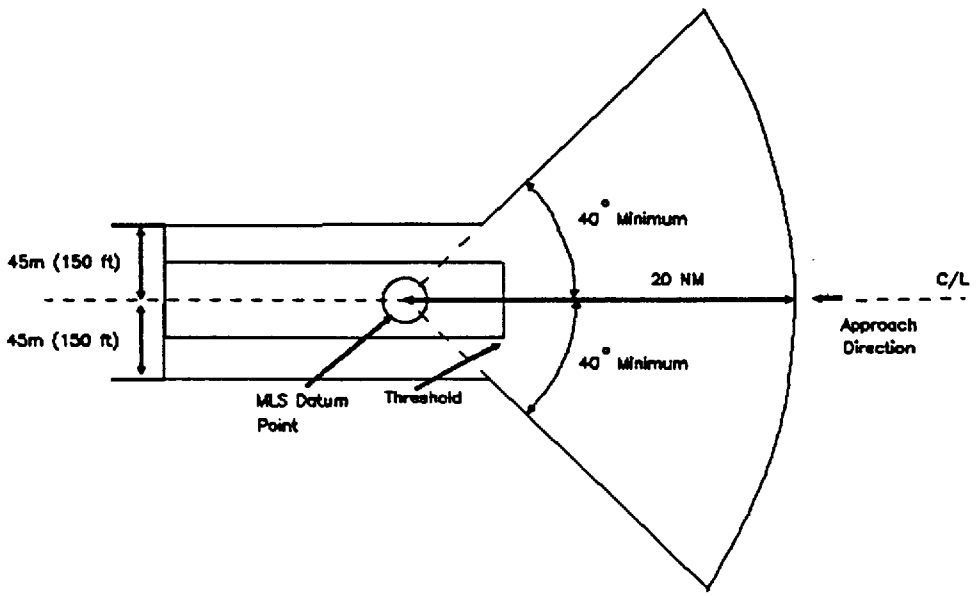
(b) Vertically between conical surfaces which originate on a vertical line passing through the MLS datum point, of which:

(1) The lower surface crosses threshold at 2.5 meters (8 ft) above the runway centerline inclined at 0.9 degree above the horizontal;

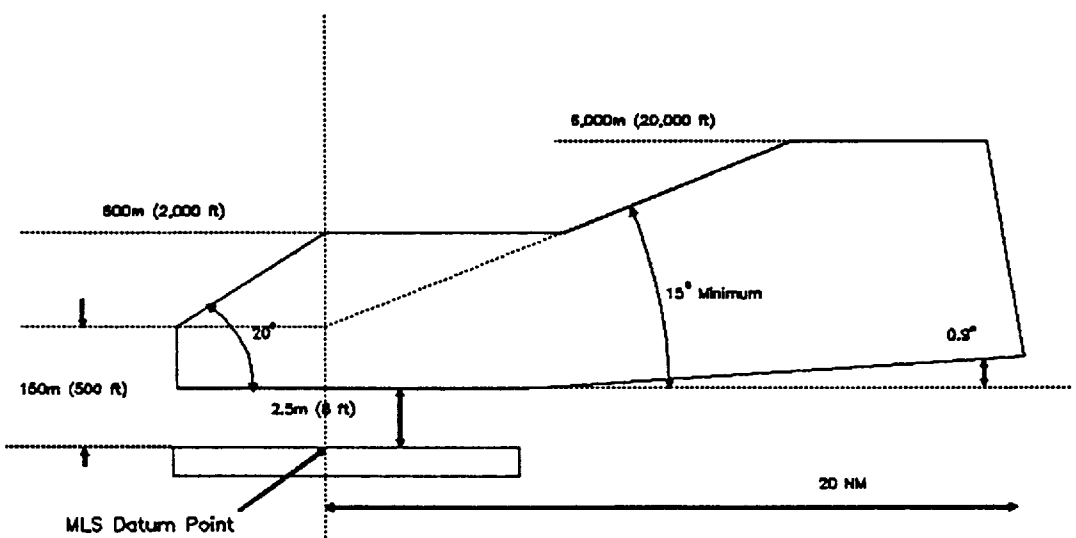
(2) The upper surface crosses threshold at 600 meters (2,000 ft) above centerline inclined at 15 degrees above the horizontal to a height of 6,000 meters (20,000 ft).

Information Handling Services, 1999
August 11, 1999 06:39:27

Figure 13. Approach Azimuth/Data Coverage



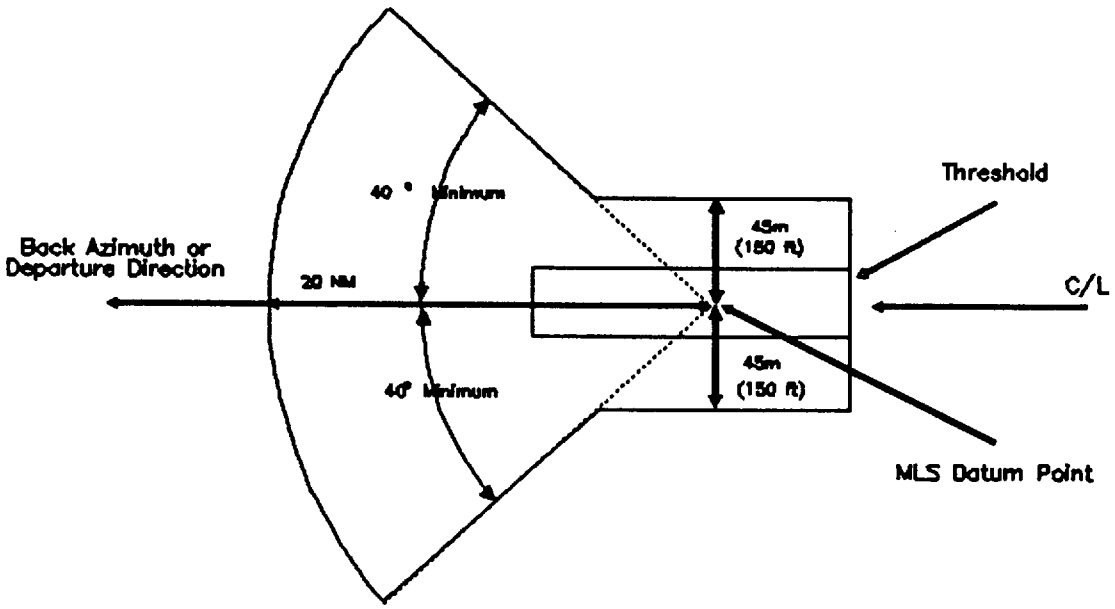
(a) Horizontal coverage



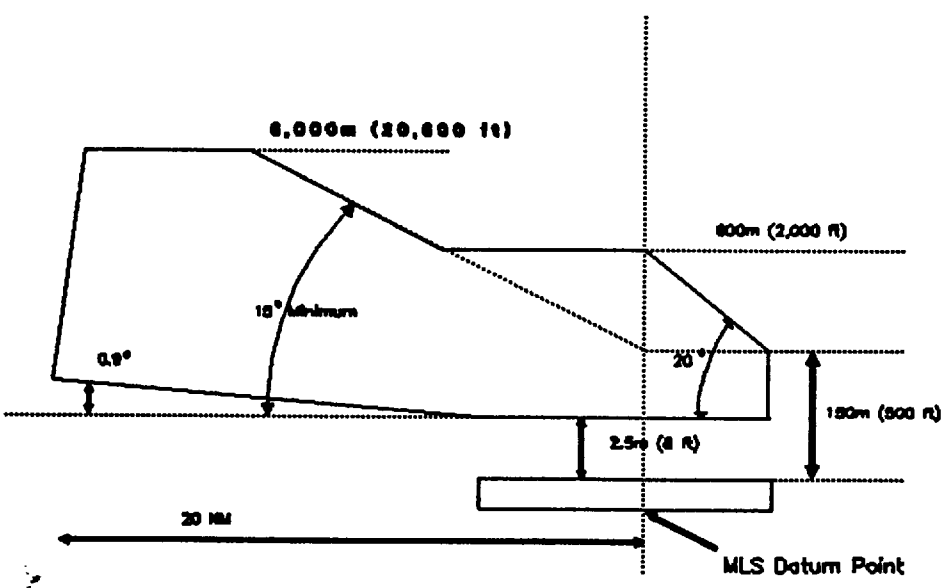
(b) Vertical Coverage

Information Handling Services, 1999
August 11, 1999 06:39:27

Figure 14. Back Azimuth/Data Coverage



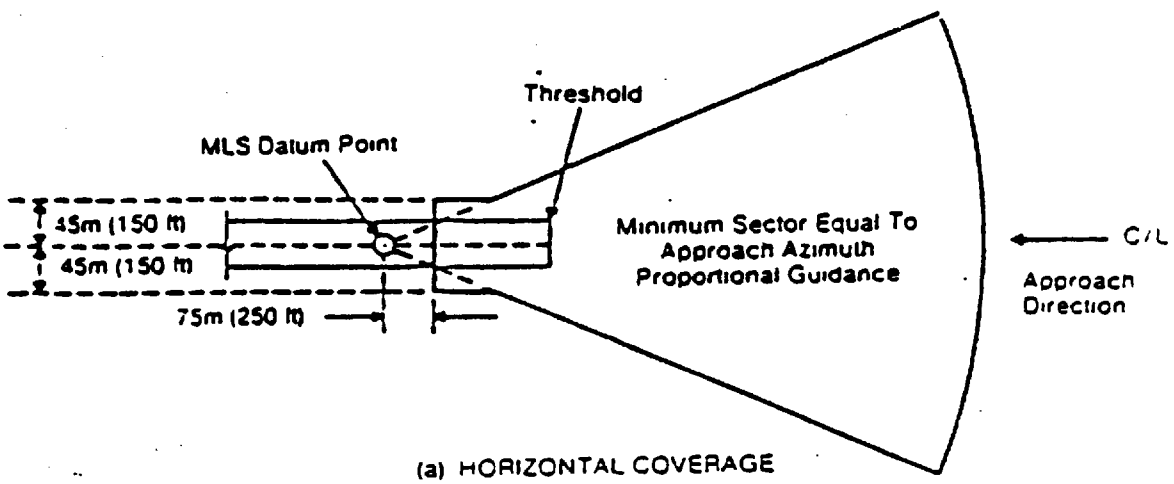
(a) Horizontal Coverage



(b) Vertical Coverage

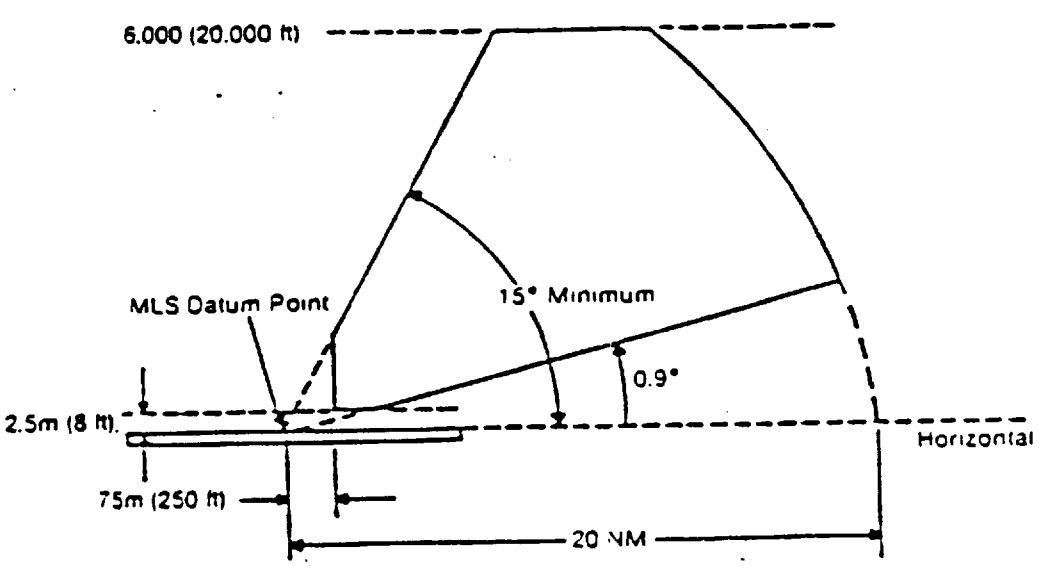
Information Handling Services, 1999
August 11, 1999 06:39:27

Figure 15. Approach Elevation Coverage



(a) HORIZONTAL COVERAGE

(a) Horizontal Coverage



(b) Vertical Coverage

Information Handling Services, 1999
August 11, 1999 06:39:27

4.2.2.2 Runway region (Approach)

(a) Horizontally within a sector 45 meters (150 ft) each side of the runway centerline beginning at the stop end and extending parallel with the runway centerline in the direction of the approach to join the approach region.

(b) Vertically between:

(1) A horizontal surface which is 2.5 meters (8 ft) above the runway centerline; and

(2) A conical surface originating along the centerline extended beyond the stop end of the runway which crosses the stop end at 150 meters (500 ft) above centerline inclined at 20 degrees above the horizontal up to a height of 600 meters (2,000 ft).

4.2.2.2.1 Minimum proportional guidance.- Proportional guidance shall be provided throughout the runway region and in a sector of at least plus or minus 10 degrees about the runway centerline extended in the approach region.

4.2.3 Back Azimuth/Data

4.2.3.1 Back Azimuth region.- The Back Azimuth/Data ground equipment shall provide information in at least the following volume of space as illustrated in Figure 14.

(a) Horizontally in the Back Azimuth region within a sector plus or minus 40 degrees about the runway centerline originating at the MLS datum point and extending in the direction of the missed approach at least to 20 nautical miles.

(b) Vertically in the Back Azimuth region between conical surfaces which originate on a vertical line passing through the MLS datum point, of which:

(1) The lower surface crosses the stop end at 2.5 meters (8 ft) above the runway centerline inclined at 0.9 degrees above the horizontal;

(2) The upper surface crosses the stop end at 600 meters (2,000 ft) above centerline inclined at 15 degrees above the horizontal to a height of 6,000 meters (20,000 ft).

4.2.3.2 Runway region (Back Azimuth)

(a) Horizontally within a sector 45 meters (150 ft) each side of the runway centerline beginning at the threshold and extending parallel with the runway centerline in the direction of the stop end to join the Back Azimuth region.

Information Handling Services, 1999
August 11, 1999 06:39:27

(b) Vertically between:

(1) A horizontal surface which is 2.5 meters (8 ft) above the runway centerline; and

(2) A conical surface originating along the centerline extended beyond the threshold of the runway which crosses the threshold at 150 meters (500 ft) above centerline inclined at 20 degrees above the horizontal up to a height of 600 meters (2,000 ft).

4.2.3.3 Minimum proportional guidance.- Proportional guidance shall be provided throughout the runway region and in a sector of at least plus or minus 10 degrees about the runway centerline extended in the Back Azimuth region.

4.2.4 Approach Elevation

4.2.4.1 Coverage limits.- The Approach Elevation ground equipment shall provide proportional guidance information in at least the following volume of space as illustrated in Figure 15.

(a) Laterally throughout the approach and runway regions within which proportional guidance is provided by the Approach Azimuth ground equipment.

(b) Longitudinally from 75 meters (250 ft) from the MLS datum point in the direction of the approach to 20 nautical miles.

(c) Vertically within the sector bounded by:

(1) A surface which is the locus of points 2.5 meters (8 ft) above the runway;

(2) A conical surface originating at the MLS datum point and inclined 0.9 degree above the horizontal; and

(3) A conical surface originating at the MLS datum point and inclined 15 degrees above the horizontal up to a height of 6,000 meters (20,000 ft).

4.2.5 Data Coverage

4.2.5.1 Basic data

4.2.5.1.1 Approach azimuth: Basic Data Words 1, 2, 3, 4, and 6 shall be transmitted throughout the Approach Azimuth coverage sector.

4.2.5.1.2 Back azimuth: When the Back Azimuth function is provided, Basic Data Words 4, 5, and 6 shall be transmitted throughout the Approach Azimuth and Back Azimuth coverage sectors.

Information Handling Services, 1999
August 11, 1999 06:39:27

4.2.5.2 Auxiliary data

4.2.5.2.1 Approach azimuth: Auxiliary Data Words A1, A2, and A3 shall be transmitted throughout the Approach Azimuth coverage sector.

4.2.5.2.2 Back azimuth: When the Back Azimuth function is provided, Auxiliary Data Words A3 and A4 shall be transmitted throughout the Approach Azimuth and Back Azimuth coverage sectors.

NOTE: The composition of the data words is given in 3.6 and 3.7.

4.2.6 Precision Distance Measuring Equipment (DME/P).- DME/P information shall be provided at least throughout the coverage volume in which Approach and Back Azimuth guidance is available.

4.3 (Not used).-

4.4 (Not used).-

4.5 Scanning beam antenna patterns.- Azimuth ground equipment antennas shall produce a fan-shaped beam which is narrow in the horizontal plane and broad in the vertical plane. Elevation ground equipment antennas shall produce a fan-shaped beam which is narrow in the vertical plane and broad in the horizontal plane.

4.5.1 Coordinate systems.- Azimuth guidance information shall be radiated in either conical or planar coordinates as illustrated in Figure 21. Approach elevation guidance information shall be radiated in conical coordinates as illustrated in Figure 22. The coordinate system used for Azimuth guidance shall be identified in auxiliary data word A1.

4.5.2 Antenna patterns in the scan plane

4.5.2.1 Beamwidth.- The antenna beamwidth shall not exceed 4 degrees at boresight.

NOTE: It is intended that the detected scanning beam envelope throughout the coverage not exceed 250 microseconds in order to insure proper angle decoding by the airborne equipment.

4.5.2.2 Beam shape.- The Azimuth scanning beam envelope on the antenna boresight and the elevation scanning beam envelope at the minimum glide path angle, as detected by a standard receiver, shall conform to the limits specified in Figure 18 under conditions of high SNR and negligible multipath, (e.g., during a trial on an antenna range). The -10 dB points on the beam envelope shall be displaced from the beam center by at least 0.76 beamwidth, but not more than 0.96 beamwidth.

4.5.2.3 Sidelobes

NOTE: The antenna pattern characteristics may also depend upon equipment or propagation error budgets contained in equipment specifications.

Information Handling Services, 1999
August 11, 1999 06:39:27

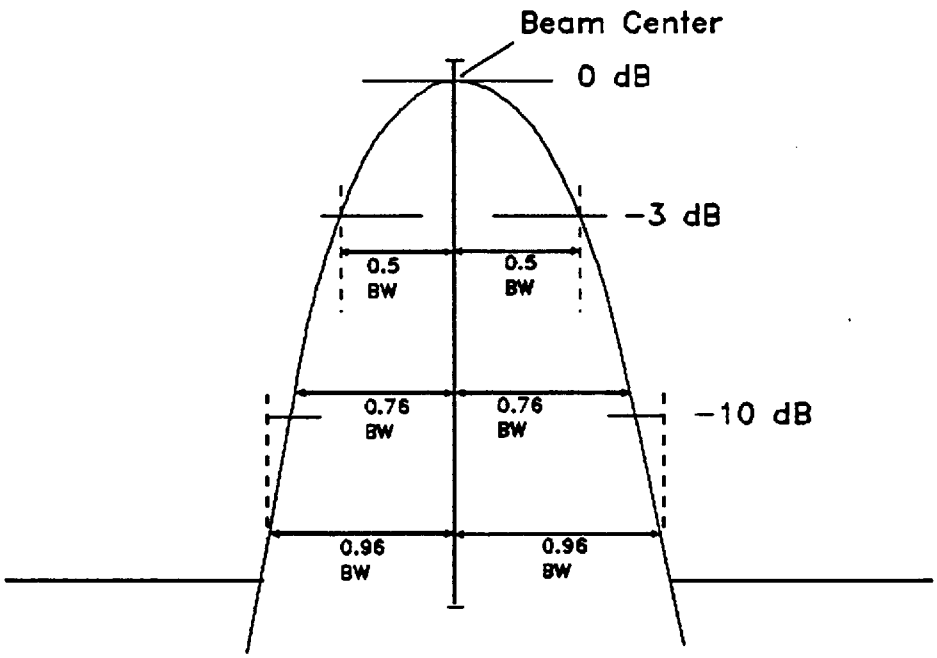
4.5.2.3.1 Dynamic sidelobes.- At any point in space around the antenna, the level of the dynamic sidelobes or any other signal generated by the scanning beam antenna shall be at least 10 dB below the minimum level of the main lobe within the guidance sector.

4.5.2.3.2 Effective sidelobe levels.- The scanning beam antenna sidelobes in the plane of scan shall not cause control motion noise in excess of that allocated to the propagation budget for azimuth functions or path following error and control motion noise in excess of that allocated in the propagation budget for elevation functions.

4.5.2.3.3 Rising terrain.- In order to accommodate rising terrain in the approach region, elevation antennas shall be able to achieve the performance requirements of paragraph 3.5 when a mainlobe reflection attenuated by 23 dB exists at a separation angle of 0.8 beamwidths or greater with worst-case relative phase.

Information Handling Services, 1999
August 11, 1999 06:39:27

Figure 18. Far Field Dynamic Signal-In-Space



4.5.3 Antenna patterns in the plane orthogonal to scan

4.5.3.1 Azimuth.- The azimuth antenna pattern above the horizontal shall be consistent with the coverage and RF signal spectrum requirements (4.1.4.1). Below the horizontal, the pattern shall be shaped to limit PFE due to the ground reflection and to limit the variations caused by changing terrain conditions in the ground reflection regions.

Information Handling Services, 1999
August 11, 1999 06:39:27

4.5.3.2 Elevation.- The horizontal pattern of the elevation antenna shall be shaped to limit multipath errors in the installed environment consistent with the propagation error allowance for CMN.

NOTE: Typically, the horizontal pattern of the Approach Elevation antenna is reduced by 3 dB at 20 degrees off the boresight and by more than 6 dB at angles greater than 40 degrees.

4.6 Monitor and control

4.6.1 Synchronization and monitoring.- The synchronization of the time-division-multiplexed angle guidance and data transmissions which are listed in Table 3 shall be monitored.

4.6.2 Azimuth.- The Approach Azimuth and Back Azimuth monitor systems shall cause the radiation of their respective functions to cease and a warning shall be provided at the designated control points if any of the following conditions persist for longer than the periods specified:

(a) There is a change in the ground equipment contribution to the mean course error component such that the PFE at the approach reference datum or in the direction of any Azimuth radial, exceeds the limits specified in Table 5 for a period not to exceed one second.

(b) There is a reduction in the radiated power to less than that necessary to satisfy the requirements specified in Table 4 for a period not to exceed one second.

(c) There is an error in the preamble DPSK transmissions which occurs more than once in any one second period.

(d) There is an error in the TDM synchronization of a particular Azimuth function such that interference-free transmissions between functions are not maintained, and this condition persists for more than one second.

(e) Erroneous signals are transmitted during the interval between function transmissions for a period not to exceed one second.

4.6.2.1 Monitor failure.- Design and operation of the monitor system shall cause radiation to cease and a warning shall be provided at the designated control points in the event of failure of the monitor system itself.

4.6.2.2 Erroneous guidance control.- The period during which erroneous guidance information is radiated, including period(s) of zero radiation and fault detection (4.6.2) shall not exceed one second. Attempts to clear a fault by resetting the primary ground equipment or by switching to standby ground equipment shall be completed within this time. If the fault is not

Information Handling Services, 1999
August 11, 1999 06:39:27

cleared within the time allowed, the radiation shall cease. After shutdown, no attempt shall be made to restore service until a period of 20 seconds has elapsed.

4.6.3 Elevation.- The Approach Elevation monitor system shall cause the radiation to cease and warning shall be provided at the designated control point if any of the following conditions persist for longer than the periods specified:

(a) There is a change in the ground equipment contribution to the mean glide path error component such that the PFE at the approach reference datum or on any glide path consistent with published approach procedures exceeds the limits specified in Table 5 for a period not to exceed one second.

(b) There is a reduction in the radiated power to less than that necessary to satisfy the requirements specified in Table 4 for a period not to exceed one second.

(c) There is an error in the preamble DPSK transmissions which occurs more than once in any one-second period.

(d) There is an error in the TDM synchronization of a particular elevation function such that the interference-free transmissions between functions are not maintained and this condition persists for more than one second.

(e) Erroneous signals are transmitted during the interval between function transmissions for a period not to exceed one second.

4.6.3.1 Monitor failure.- Design and operation of the monitor system shall cause radiation to cease and a warning shall be provided at the designated control points in the event of failure of the monitor system itself.

4.6.3.2 Erroneous guidance control.- The period during which erroneous guidance information is radiated, including period(s) of zero radiation and fault detection (4.6.3) shall not exceed one second. Attempts to clear a fault by resetting the primary ground equipment or by switching to standby ground equipment shall be completed within this time. If the fault is not cleared within the time allowed, radiation shall cease. After shutdown no attempt shall be made to restore service until a period of 20 seconds has elapsed.

Information Handling Services, 1999
August 11, 1999 06:39:27

4.6.4 Data transmissions.- The monitor system shall cause radiation of a data word to cease and warning shall be provided at the designated control point if any of the following conditions persist for longer than the periods specified:

a. There is a reduction in the radiated power to less than that necessary to satisfy the requirements in Table 4, for a period of not to exceed one second.

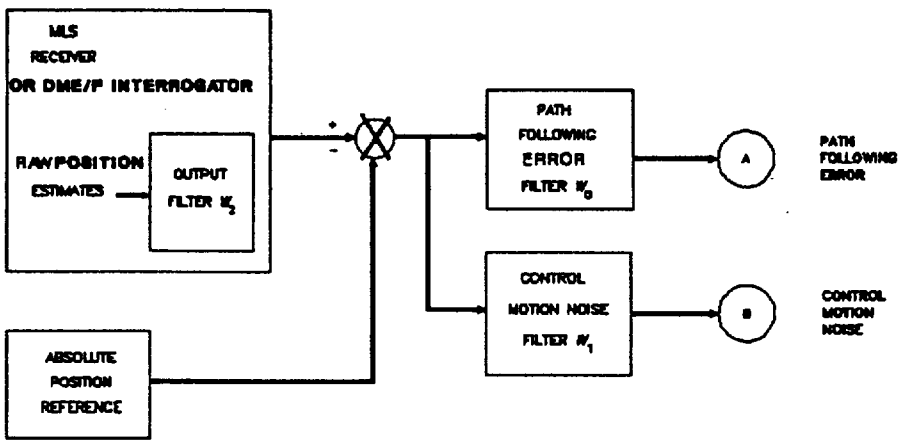
b. There is an error in a data word in two consecutive samples.

c. There is an error in the TDM synchronization of any data words such that interference-free transmissions between functions are not maintained and this condition persists for more than one second.

4.6.4.1 Monitor failure.- Design and operation of the monitor system shall cause radiation to cease and a warning shall be provided at the designated control points in the event of failure of the monitor system itself.

Information Handling Services, 1999
August 11, 1999 06:39:27

Figure 19. Filter Configurations and Corner Frequencies

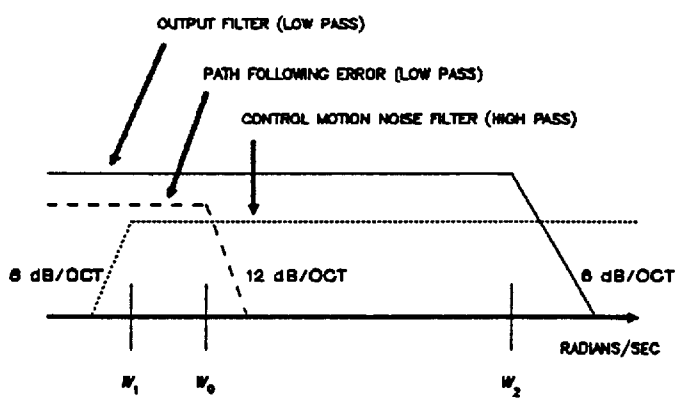


Guidance Function	Corner Frequencies (Radians/Sec)		
	ω_0	ω_1	ω_2
Azimuth (1)	0.5	0.3	10
Approach Elevation	1.5	0.5	10
Flare	2.0	0.5	10
DME/P	1.5	0.5	10

RECEIVER OUTPUT FILTER $\dfrac{\omega_2}{S+\omega_2}$

PATH FOLLOWING FILTER $\dfrac{\omega_n^2}{S^2+2\zeta\omega_n S+\omega_n^2}$ $\zeta=1,\ \omega_0=.64\omega_n$

CONTROL MOTION NOISE FILTER $\dfrac{S}{S+\omega_1}$ $S=j\omega$



NOTE (1): Applies to Approach Azimuth, High Rate Approach Azimuth, and Back Azimuth.

Information Handling Services, 1999
August 11, 1999 06:39:27

5. AIRBORNE EQUIPMENT CHARACTERISTICS

NOTE 1: Requirements for the DME/P airborne equipment are contained in Minimum Operational Performance Standards for Airborne Distance Measuring Equipment (DME) Operating Within the Frequency Range of 960-1215 MHz, Doc. No. DO-189.

NOTE 2: Requirements for the angle airborne equipment are contained in Minimum Operational Performance Standards for Microwave Landing System (MLS) Airborne Receiver Equipment, RTCA, Doc. No. DO-177.

6. MLS MEASUREMENT METHODOLOGY

6.1 PFE and CMN frequency components.- The PFE shall be comprised of those frequency components of the guidance signal error at the output of the airborne receiver which lie below 0.5 radian per second for Azimuth guidance information or below 1.5 radians per second for elevation and DME/P guidance information. The control motion noise shall be comprised of those frequency components of the guidance signal error at the output of the airborne receiver which lie above 0.3 radian per second for Azimuth guidance or above 0.5 radian per second for elevation and DME/P guidance information. The output filter corner frequency of the receiver used for this measurement is 10 radians per second.

6.2 Error evaluation.- The PFE estimates shall be obtained at the output of the PFE filter (test point A in Figure 19). The CMN estimates shall be obtained at the output of the CMN filter (test point B in Figure 19). Filter corner frequencies shall be as shown in Figure 19.

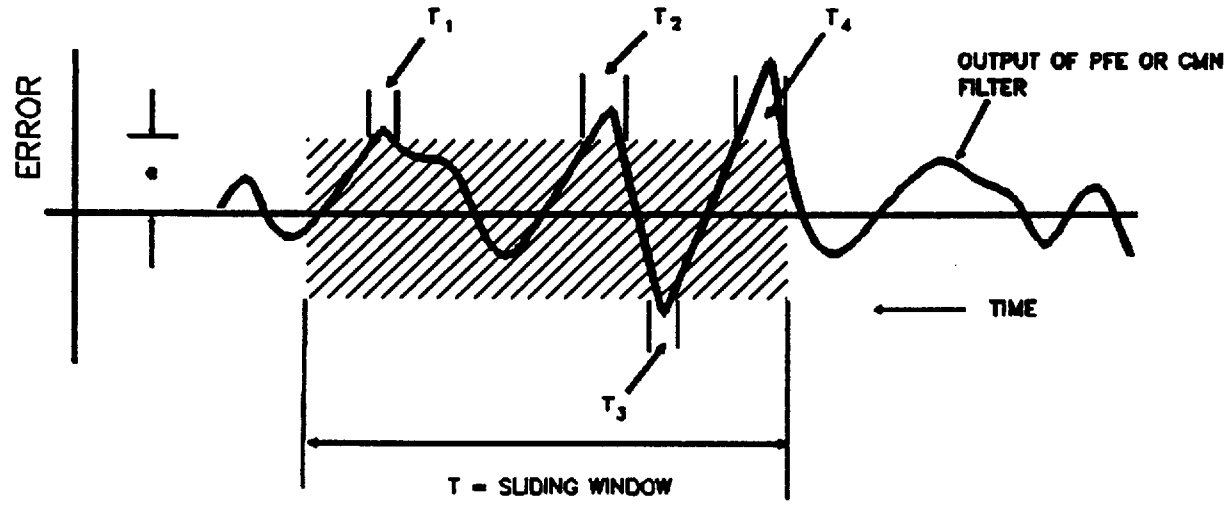
6.2.1 Azimuth and elevation functions.- The PFE and CMN for Approach Azimuth, Back Azimuth, and DME/P (IA Mode) shall be evaluated over any 40-second interval of the flight error record taken within the coverage limits (i.e., T=40 in Figure 20). The PFE and CMN for Approach Elevation and DME/P (FA Mode) shall be evaluated over any 10-second interval of the flight error record taken within the coverage limits (i.e., T=10 in Figure 20.)

NOTE 1: The 95 percent probability requirement is interpreted to be met if the PFE or CMN does not exceed the specified error limits for more than 5 percent of the evaluation interval (see Figure 20).

NOTE 2: The PFN is derived by setting the mean error of the PFE over any evaluation interval to zero.

Information Handling Services, 1999
August 11, 1999 06:39:27

Figure 20. MLS Measurement Methodology



NOTES:

e = ERROR SPECIFICATION

T = REGION TO BE EVALUATED

T_1 T_2 T_3 . . . = TIME INTERVALS THAT ERROR EXCEEDS SPECIFICATONS FOR THE GROUND EQUIPMENT TO BE ACCEPTABLE IN THIS REGION. THE FOLLOWING INEQUALITY SHOULD BE TRUE

$$\frac{(T_1+T_2+T_3+\ldots)}{T} \leq 0.05$$

Information Handling Services, 1999
August 11, 1999 06:39:27

Figure 21. Coordinate System for Azimuth Functions

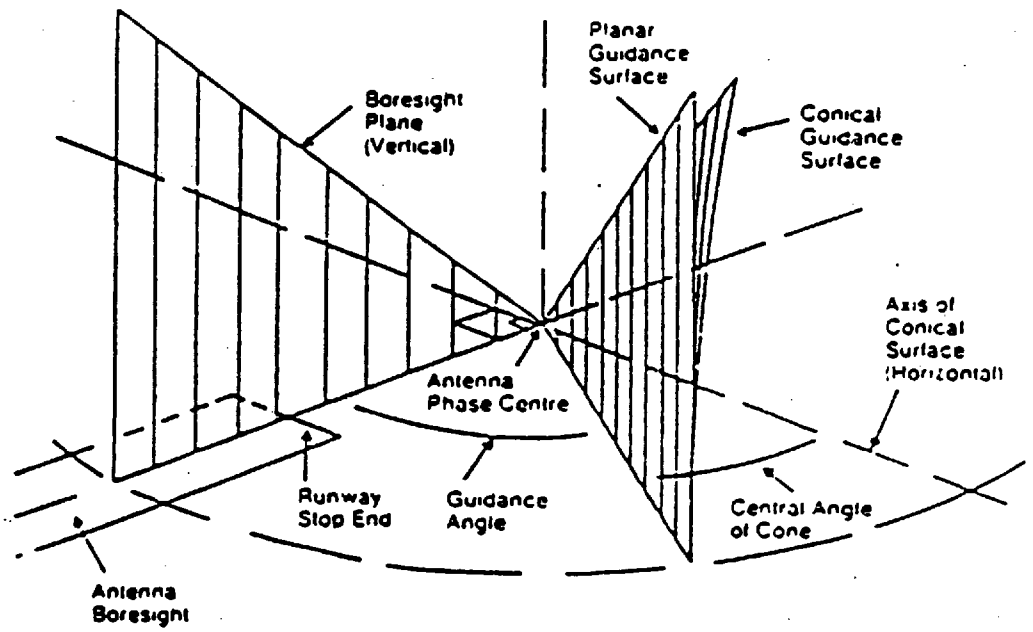
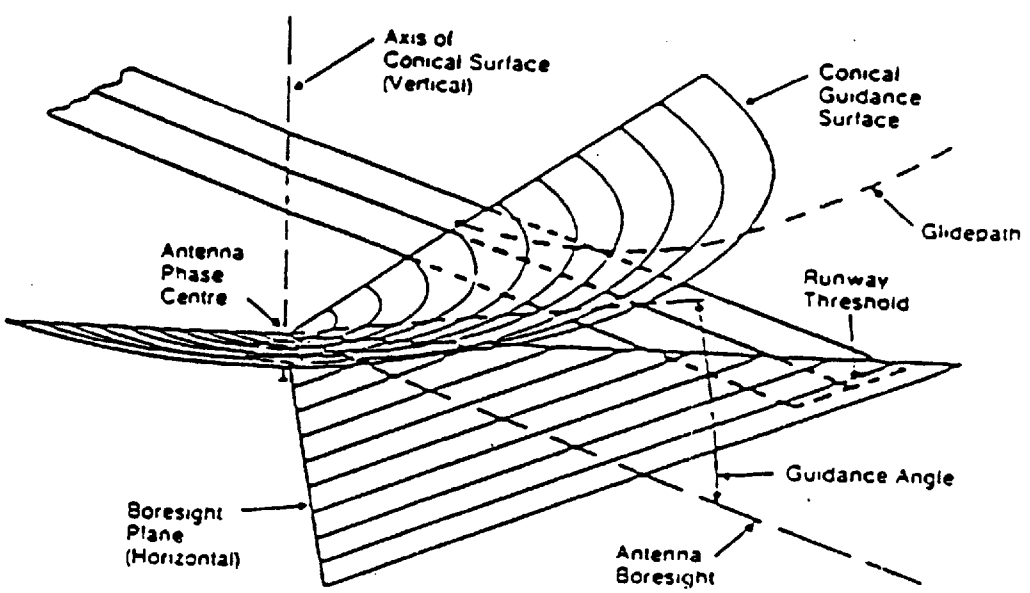


Figure 22. Conical Coordinate Systems for Elevation Functions



Information Handling Services, 1999
August 11, 1999 06:39:27

APPENDIX I

10. MLS ANGLE, DATA AND DME/P CHANNELING

10.1 Angle and Data channels.- The channeling of MLS Angle and Data functions shall be as shown in Table 12.

10.2 Precision Distance Measuring Equipment (DME/P) channels.- The channeling of DME/P equipment and the pairing with angle channels shall be as shown in Table 12.

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 12. MLS Channel Pairing

Channel Pairing				DME Parameters					
				Interrogation				Reply	
					Pulse Codes				
						DME/P Mode			
DME No	VHF Freq. MHz	MLS Angle Freq. MHz	MLS CH No	Freq. MHz	DME/N µs	IA µs	FA µs	Freq MHz	Pulse Codes µs
* 1X	-	-	-	1025	12	-	-	962	12
** 1Y	-	-	-	1025	36	-	-	1088	30
* 2X	-	-	-	1026	12	-	-	963	12
** 2Y	-	-	-	1026	36	-	-	1089	30
* 3X	-	-	-	1027	12	-	-	964	12
** 3Y	-	-	-	1027	36	-	-	1090	30
* 4X	-	-	-	1028	12	-	-	965	12
** 4Y	-	-	-	1028	36	-	-	1091	30
* 5X	-	-	-	1029	12	-	-	966	12
** 5Y	-	-	-	1029	36	-	-	1092	30
* 6X	-	-	-	1030	12	-	-	967	12
** 6Y	-	-	-	1030	36	-	-	1093	30
* 7X	-	-	-	1031	12	-	-	968	12
** 7Y	-	-	-	1031	36	-	-	1094	30
* 8X	-	-	-	1032	12	-	-	969	12
** 8Y	-	-	-	1032	36	-	-	1095	30
* 9X	-	-	-	1033	12	-	-	970	12
** 9Y	-	-	-	1033	36	-	-	1096	30
*10X	-	-	-	1034	12	-	-	971	12
**10Y	-	-	-	1034	36	-	-	1097	30
*11X	-	-	-	1035	12	-	-	972	12
**11Y	-	-	-	1035	36	-	-	1098	30
*12X	-	-	-	1036	12	-	-	973	12
**12Y	-	-	-	1036	36	-	-	1099	30
*13X	-	-	-	1037	12	-	-	974	12
**13Y	-	-	-	1037	36	-	-	1100	30
*14X	-	-	-	1038	12	-	-	975	12
**14Y	-	-	-	1038	36	-	-	1101	30
*15X	-	-	-	1039	12	-	-	976	12
**15Y	-	-	-	1039	36	-	-	1102	30
*16X	-	-	-	1040	12	-	-	977	12
**16Y	-	-	-	1040	36	-	-	1103	30
▽ 17X	108.00	-	-	1041	12	-	-	978	12
17Y	108.05	5043.0	540	1041	36	36	42	1104	30
17Z	-	5043.3	541	1041	-	21	27	1104	15
18X	108.10	5031.0	500	1042	12	12	18	979	12
18W	-	5031.3	501	1042	-	24	30	979	24
18Y	108.15	5043.6	542	1042	36	36	42	1105	30
18Z	-	5043.9	543	1042	-	21	27	1105	15
19X	108.20	-	-	1043	12	-	-	980	12
19Y	108.25	5044.2	544	1043	36	36	42	1106	30
19Z	-	5044.5	545	1043	-	21	27	1106	15
20X	108.30	5031.6	502	1044	12	12	18	981	12
20W	-	5031.9	503	1044	-	24	30	981	24
20Y	108.35	5044.8	546	1044	36	36	42	1107	30
20Z	-	5045.1	547	1044	-	21	27	1107	15

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 12. MLS Channel Pairing (cont)

Channel Pairing				OME Parameters					
				Interrogation				Reply	
					Pulse Codes				
						OME/P Mode			
OME No	VHF Freq. MHz	MLS Angle Freq. MHz	MLS CH. No	Freq. MHz	OME/N µs	IA µs	FA µs	Freq. MHz	Pulse Codes µs
21X	108.40	-	-	1045	12	-	-	982	12
21Y	108.45	5045.4	548	1045	36	36	42	1108	30
21Z	-	5045.7	549	1045	-	21	27	1108	15
22X	108.50	5032.2	504	1046	12	12	18	983	12
22W	-	5032.5	505	1046	-	24	30	983	24
22Y	108.55	5046.0	550	1046	36	36	42	1109	30
22Z	-	5046.3	551	1046	-	21	27	1109	15
23X	108.60	-	-	1047	12	-	-	984	12
23Y	108.65	5046.6	552	1047	36	36	42	1110	30
23Z	-	5046.9	553	1047	-	21	27	1110	15
24X	108.70	5032.8	506	1048	12	12	18	985	12
24W	-	5033.1	507	1048	-	24	30	985	24
24Y	108.75	5047.2	554	1048	36	36	42	1111	30
24Z	-	5047.5	555	1048	-	21	27	1111	15
25X	108.80	-	-	1049	12	-	-	986	12
25Y	108.85	5047.8	556	1049	36	36	42	1112	30
25Z	-	5048.1	557	1049	-	21	27	1112	15
26X	108.90	5033.4	508	1050	12	12	18	987	12
26W	-	5033.7	509	1050	-	24	30	987	24
26Y	108.95	5048.4	558	1050	36	36	42	1113	30
26Z	-	5048.7	559	1050	-	21	27	1113	15
27X	109.00	-	-	1051	12	-	-	988	12
27Y	109.05	5049.0	560	1051	36	36	42	1114	30
27Z	-	5049.3	561	1051	-	21	27	1114	15
28X	109.10	5034.0	510	1052	12	12	18	989	12
28W	-	5034.3	511	1052	-	24	30	989	24
28Y	109.15	5049.6	562	1052	36	36	42	1115	30
28Z	-	5049.9	563	1052	-	21	27	1115	15
29X	109.20	-	-	1053	12	-	-	990	12
29Y	109.25	5050.2	564	1053	36	36	42	1116	30
29Z	-	5050.5	565	1053	-	21	27	1116	15
30X	109.30	5034.6	512	1054	12	12	18	991	12
30W	-	5034.9	513	1054	-	24	30	991	24
30Y	109.35	5050.8	566	1054	36	36	42	1117	30
30Z	-	5051.1	567	1054	-	21	27	1117	15
31X	109.40	-	-	1055	12	-	-	992	12
31Y	109.45	5051.4	568	1055	36	36	42	1118	30
31Z	-	5051.7	569	1055	-	21	27	1118	15
32X	109.50	5035.2	514	1056	12	12	18	993	12
32W	-	5035.5	515	1056	-	24	30	993	24
32Y	109.55	5052.0	570	1056	36	36	42	1119	30
32Z	-	5052.3	571	1056	-	21	27	1119	15
33X	109.60	-	-	1057	12	-	-	994	12
33Y	109.65	5052.6	572	1057	36	36	42	1120	30
33Z	-	5052.9	573	1057	-	21	27	1120	15
34X	109.70	5035.8	516	1058	12	12	18	995	12
34W	-	5036.1	517	1058	-	24	30	995	24
34Y	109.75	5053.2	574	1058	36	36	42	1121	30

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 12. MLS Channel Pairings (Cont.)

Channel Pairing				DME Parameters					
				Interrogation				Reply	
					Pulse Codes				
						DME/P Mode			
DME No	VHF Freq MHz	MLS Angle Freq MHz	MLS CH No	Freq MHz	DME/N µs	IA µs	FA µs	Freq MHz	Pulse Codes µs
34Z	-	5053.5	575	1058	-	21	27	1121	15
35X	109.80	-	-	1059	12	-	-	996	12
35Y	109.85	5053.8	576	1059	36	36	42	1122	30
35Z	-	5054.1	577	1059	-	21	27	1122	15
36X	109.90	5036.4	518	1060	12	12	18	997	12
36W	-	5036.7	519	1060	-	12	30	997	24
36Y	109.95	5054.4	578	1060	36	36	42	1123	30
36Z	-	5054.7	579	1060	-	21	27	1123	15
37X	110.00	-	-	1061	12	-	-	998	12
37Y	110.05	5055.0	580	1061	36	36	42	1124	30
37Z	-	5055.3	581	1061	-	21	27	1124	15
38X	110.10	5037.0	520	1062	12	12	18	999	12
38W	-	5037.3	521	1062	-	24	30	999	24
38Y	110.15	5055.6	582	1062	36	36	42	1125	30
38Z	-	5055.9	583	1062	-	21	27	1125	15
39X	110.20	-	-	1063	12	-	-	1000	12
39Y	110.25	5056.2	584	1063	36	36	42	1126	30
39Z	-	5056.5	585	1063	-	21	27	1126	15
40X	110.30	5037.6	522	1064	12	12	18	1001	12
40W	-	5037.9	523	1064	-	24	30	1001	24
40Y	110.35	5056.8	586	1064	36	36	42	1127	30
40Z	-	5057.1	587	1064	-	21	27	1127	15
41X	110.40	-	-	1065	12	-	-	1002	12
41Y	110.45	5057.4	588	1065	36	36	42	1128	30
41Z	-	5057.7	589	1065	-	21	27	1128	15
42X	110.50	5038.2	524	1066	12	12	18	1003	12
42W	-	5038.5	525	1066	-	24	30	1003	24
42Y	110.55	5058.0	590	1066	36	36	42	1129	30
42Z	-	5058.3	591	1066	-	21	27	1129	15
43X	110.60	-	-	1067	12	-	-	1004	12
43Y	110.65	5058.6	592	1067	36	36	42	1130	30
43Z	-	5058.9	593	1067	-	21	27	1130	15
44X	110.70	5038.8	526	1068	12	12	18	1005	12
44W	-	5039.1	527	1068	-	24	30	1005	24
44Y	110.75	5059.2	594	1068	36	36	42	1131	30
44Z	-	5059.5	595	1068	-	21	27	1131	15
45X	110.80	-	-	1069	12	-	-	1006	12
45Y	110.85	5059.8	596	1069	36	36	42	1132	30
45Z	-	5060.1	597	1069	-	21	27	1132	15
46X	110.90	5039.4	528	1070	12	12	18	1007	12
46W	-	5039.7	529	1070	-	24	30	1007	24
46Y	110.95	5060.4	598	1070	36	36	42	1133	30
46Z	-	5060.7	599	1070	-	21	27	1133	15
47X	111.00	-	-	1071	12	-	-	1008	12
47Y	111.05	5061.0	560	1071	36	36	42	1134	30
47Z	-	5061.3	561	1071	-	21	27	1134	15
48X	111.10	5040.0	530	1072	12	12	18	1009	12
48W	-	5040.3	531	1072	-	24	30	1009	24

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 12. MLS Channel Pairings (Cont.)

Channel Pairing				DME Parameters					
				Interrogation				Reply	
					Pulse Codes				
						DME/P Mode			
DME No	VHF Freq MHz	MLS Angle Freq MHz	MLS CH No	Freq MHz	DME/N µs	IA µs	FA µs	Freq MHz	Pulse Codes µs
48Y	111.15	5061.4	602	1072	36	36	42	1135	30
48Z	-	5061.7	603	1072	-	21	27	1135	15
49X	111.20	-	-	1073	12	-	-	1010	12
49Y	111.25	5062.2	604	1073	36	36	42	1136	30
49Z	-	5062.5	605	1073	-	21	27	1136	15
50X	111.30	5040.6	532	1074	12	12	18	1011	12
50W	-	5040.9	533	1074	-	24	30	1011	24
50Y	111.35	5062.8	606	1074	36	36	42	1137	30
50Z	-	5063.1	607	1074	-	21	27	1137	15
51X	111.40	-	-	1075	12	-	-	1012	12
51Y	111.45	5063.4	608	1075	36	36	42	1138	30
51Z	-	5063.7	609	1075	-	21	27	1138	15
52X	111.50	5041.2	534	1076	12	12	18	1013	12
52W	-	5041.5	535	1076	-	24	30	1013	24
52Y	111.55	5064.0	610	1076	36	36	42	1139	30
52Z	-	5064.3	611	1076	-	21	27	1139	15
53X	111.60	-	-	1077	12	-	-	1014	12
53Y	111.65	5064.6	612	1077	36	36	42	1140	30
53W	-	5064.9	613	1077	-	21	27	1140	15
54X	111.70	5041.8	536	1078	12	12	18	1015	12
54W	-	5042.1	537	1078	-	24	30	1015	24
54Y	111.75	5065.2	614	1078	36	36	42	1141	30
54Z	-	5065.5	615	1078	-	21	27	1141	15
55X	111.80	-	-	1079	12	-	-	1016	12
55Y	111.85	5065.8	616	1079	36	36	42	1142	30
55Z	-	5066.1	617	1079	-	21	27	1142	15
56X	111.90	5042.4	538	1080	12	12	18	1017	12
56W	-	5042.7	539	1080	-	24	30	1017	24
56Y	111.95	5066.4	618	1080	36	36	42	1143	30
56Z	-	5066.7	619	1080	-	21	27	1143	15
57X	112.00	-	-	1081	12	-	-	1018	12
57Y	112.05	-	-	1081	36	-	-	1144	30
58X	112.10	-	-	1082	12	-	-	1019	12
58Y	112.15	-	-	1082	36	-	-	1145	30
59X	112.20	-	-	1083	12	-	-	1020	12
59Y	112.25	-	-	1083	36	-	-	1146	30
** 60X	-	-	-	1084	12	-	-	1021	12
** 60Y	-	-	-	1084	36	-	-	1147	30
** 61X	-	-	-	1085	12	-	-	1022	12
** 61Y	-	-	-	1085	36	-	-	1148	30
** 62X	-	-	-	1086	12	-	-	1023	12
** 62Y	-	-	-	1086	36	-	-	1149	30
** 63X	-	-	-	1087	12	-	-	1024	12
** 63Y	-	-	-	1087	36	-	-	1150	30
** 64X	-	-	-	1088	12	-	-	1151	12
** 64Y	-	-	-	1088	36	-	-	1025	30
** 65X	-	-	-	1089	12	-	-	1152	12
** 65Y	-	-	-	1089	36	-	-	1026	30

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 12. MLS Channel Pairing (cont)

Channel Pairing				OME Parameters					
				Interrogation				Reply	
					Pulse Codes				
						OME/P Mode			
OME No	VHF Freq. MHz	MLS Angle Freq. MHz	MLS CH. No	Freq. MHz	OME/N µs	IA µs	FA µs	Freq. MHz	Pulse Coces µs
**66X	-	-	-	1090	12	-	-	1153	12
**66Y	-	-	-	1090	36	-	-	1027	30
**67X	-	-	-	1091	12	-	-	1154	12
**67Y	-	-	-	1091	36	-	-	1028	30
**68X	-	-	-	1092	12	-	-	1155	12
**68Y	-	-	-	1092	36	-	-	1029	30
**69X	-	-	-	1093	12	-	-	1156	12
**69Y	-	-	-	1093	36	-	-	1030	30
70X	112.30	-	-	1094	12	-	-	1157	12
**70Y	112.35	-	-	1094	36	-	-	1031	30
71X	112.40	-	-	1095	12	-	-	1158	12
**71Y	112.45	-	-	1095	36	-	-	1032	30
72X	112.50	-	-	1096	12	-	-	1159	12
**72Y	112.55	-	-	1096	36	-	-	1033	30
73X	112.60	-	-	1097	12	-	-	1160	12
**73Y	112.65	-	-	1097	36	-	-	1034	30
74X	112.70	-	-	1098	12	-	-	1161	12
**74Y	112.75	-	-	1098	36	-	-	1035	30
75X	112.80	-	-	1099	12	-	-	1162	12
**75Y	112.85	-	-	1099	36	-	-	1036	30
76X	112.90	-	-	1100	12	-	-	1163	12
**76Y	112.95	-	-	1100	36	-	-	1037	30
77X	113.00	-	-	1101	12	-	-	1164	12
**77Y	113.05	-	-	1101	36	-	-	1038	30
78X	113.10	-	-	1102	12	-	-	1165	12
**78Y	113.15	-	-	1102	36	-	-	1039	30
79X	113.20	-	-	1103	12	-	-	1166	12
**79Y	113.25	-	-	1103	36	-	-	1040	30
80X	113.30	-	-	1104	12	-	-	1167	12
80Y	113.35	5067.0	620	1104	36	36	42	1041	30
80Z	-	5067.3	621	1104	-	21	27	1041	15
81X	113.40	-	-	1105	12	-	-	1168	12
81Y	113.45	5067.6	622	1105	36	36	42	1042	30
81Z	-	5067.9	623	1105	-	21	27	1042	15
82X	113.50	-	-	1106	12	-	-	1169	12
82Y	113.55	5068.2	624	1106	36	36	42	1043	30
82Z	-	5068.5	625	1106	-	21	27	1043	15
83X	113.60	-	-	1107	12	-	-	1170	12
83Y	113.65	5068.8	626	1107	36	36	42	1044	30
83Z	-	5069.1	627	1107	-	21	27	1044	15
84X	113.70	-	-	1108	12	-	-	1171	12
84Y	113.75	5069.4	628	1108	36	36	42	1045	30
84Z	-	5069.7	629	1108	-	21	27	1045	15
85X	113.80	-	-	1109	12	-	-	1172	12
85Y	113.85	5070.0	630	1109	36	36	42	1046	30
85Z	-	5070.3	631	1109	-	21	27	1046	15
86X	113.90	-	-	1110	12	-	-	1173	12
86Y	113.95	5070.6	632	1110	36	36	42	1047	30

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 12. MLS Channel Pairing (cont)

Channel Pairing				OME Parameters					
				Interrogation				Reply	
					Pulse Codes				
						OME/P Mode			
OME No	VHF Freq. MHz	MLS Angle Freq. MHz	MLS CH No	Freq. MHz	OME/N µs	IA µs	FA µs	Freq. MHz	Pulse Codes µs
86Z	-	5070.9	633	1110	-	21	27	1047	15
87X	114.00	-	-	1111	12	-	-	1174	12
87Y	114.05	5071.2	634	1111	36	36	42	1048	30
87Z	-	5071.5	635	1111	-	21	27	1048	15
88X	114.10	-	-	1112	12	-	-	1175	12
88Y	114.15	5071.8	636	1112	36	36	42	1049	30
88Z	-	5072.1	637	1112	-	21	27	1049	15
89X	114.20	-	-	1113	12	-	-	1176	12
89Y	114.25	5072.4	638	1113	36	36	42	1050	30
89Z	-	5072.7	639	1113	-	21	27	1050	15
90X	114.30	-	-	1114	12	-	-	1177	12
90Y	114.35	5073.0	640	1114	36	36	42	1051	30
90Z	-	5073.3	641	1114	-	21	27	1051	15
91X	114.40	-	-	1115	12	-	-	1178	12
91Y	114.45	5073.6	642	1115	36	36	42	1052	30
91Z	-	5073.9	643	1115	-	21	27	1052	15
92X	114.50	-	-	1116	12	-	-	1179	12
92Y	114.55	5074.2	644	1116	36	36	42	1053	30
92Z	-	5074.5	645	1116	-	21	27	1053	15
93X	114.60	-	-	1117	12	-	-	1180	12
93Y	114.65	5074.8	646	1117	36	36	42	1054	30
93Z	-	5075.1	647	1117	-	21	27	1054	15
94X	114.70	-	-	1118	12	-	-	1181	12
94Y	114.75	5075.4	648	1118	36	36	42	1055	30
94Z	-	5075.7	649	1118	-	21	27	1055	15
95X	114.80	-	-	1119	12	-	-	1182	12
95Y	114.85	5076.0	650	1119	36	36	42	1056	30
95Z	-	5076.3	651	1119	-	21	27	1056	15
96X	114.90	-	-	1120	12	-	-	1183	12
96Y	114.95	5076.6	652	1120	36	36	42	1057	30
96Z	-	5076.9	653	1120	-	21	27	1057	15
97X	115.00	-	-	1121	12	-	-	1184	12
97Y	115.05	5077.2	654	1121	36	36	42	1058	30
97Z	-	5077.5	655	1121	-	21	27	1058	15
98X	115.10	-	-	1122	12	-	-	1185	12
98Y	115.15	5077.8	656	1122	36	36	42	1059	30
98Z	-	5078.1	657	1122	-	21	27	1059	15
99X	115.20	-	-	1123	12	-	-	1186	12
99Y	115.25	5078.4	658	1123	36	36	42	1060	30
99Z	-	5078.7	659	1123	-	21	27	1060	15
100X	115.30	-	-	1124	12	-	-	1187	12
100Y	115.35	5079.0	660	1124	36	36	42	1061	30
100Z	-	5079.3	661	1124	-	21	27	1061	15
101X	115.40	-	-	1125	12	-	-	1188	12
101Y	115.45	5079.6	662	1125	36	36	42	1062	30
101Z	-	5079.9	663	1125	-	21	27	1062	15
102X	115.50	-	-	1126	12	-	-	1189	12
102Y	115.55	5080.2	664	1126	36	36	42	1063	30

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 12. MLS Channel Pairing (cont)

Channel Pairing				DME Parameters					
				Interrogation				Reply	
					Pulse Codes				
						DME/P Mode			
DME No	VHF Freq MHz	MLS Angle Freq MHz	MLS CH No	Freq. MHz	DME/N µs	IA µs	FA µs	Freq MHz	Pulse Codes µs
102Z	-	5080.5	665	1126	-	21	27	1063	15
103X	115.60	-	-	1127	12	-	-	1190	12
103Y	115.65	5080.8	666	1127	36	36	42	1064	30
103Z	-	5081.1	667	1127	-	21	27	1064	15
104X	115.70	-	-	1128	12	-	-	1191	12
104Y	115.75	5081.4	668	1128	36	36	42	1065	30
104Z	-	5081.7	669	1128	-	21	27	1065	15
105X	115.80	-	-	1129	12	-	-	1192	12
105Y	115.85	5082.0	670	1129	36	36	42	1066	30
105Z	-	5082.3	671	1129	-	21	27	1066	15
106X	115.90	-	-	1130	12	-	-	1193	12
106Y	115.95	5082.6	672	1130	36	36	42	1067	30
106Z	-	5082.9	673	1130	-	21	27	1067	15
107X	116.00	-	-	1131	12	-	-	1194	12
107Y	116.05	5083.2	674	1131	36	36	42	1068	30
107Z	-	5083.5	675	1131	-	21	27	1068	15
108X	116.10	-	-	1132	12	-	-	1195	12
108Y	116.15	5083.8	676	1132	36	36	42	1069	30
108Z	-	5084.1	677	1132	-	21	27	1069	15
109X	116.20	-	-	1133	12	-	-	1196	12
109Y	116.25	5084.4	678	1133	36	36	42	1070	30
109Z	-	5084.7	679	1133	-	21	27	1070	15
110X	116.30	-	-	1134	12	-	-	1197	12
110Y	116.35	5085.0	680	1134	36	36	42	1071	30
110Z	-	5085.3	681	1134	-	21	27	1071	15
111X	116.40	-	-	1135	12	-	-	1198	12
111Y	116.45	5085.6	682	1135	36	36	42	1072	30
111Z	-	5085.9	683	1135	-	21	27	1072	15
112X	116.50	-	-	1136	12	-	-	1199	12
112Y	116.55	5086.2	684	1136	36	36	42	1073	30
112Z	-	5086.5	685	1136	-	21	27	1073	15
113X	116.60	-	-	1137	12	-	-	1200	12
113Y	116.65	5086.8	686	1137	36	36	42	1074	30
113Z	-	5087.1	687	1137	-	21	27	1074	15
114X	116.70	-	-	1138	12	-	-	1201	12
114Y	116.75	5087.4	688	1138	36	36	42	1075	30
114Z	-	5087.7	689	1138	-	21	27	1075	15
115X	116.80	-	-	1139	12	-	-	1202	12
115Y	116.85	5088.0	690	1139	36	36	42	1076	30
115Z	-	5088.3	691	1139	-	21	27	1076	15
116X	116.90	-	-	1140	12	-	-	1203	12
116Y	116.95	5088.6	692	1140	36	36	42	1077	30
116Z	-	5088.9	693	1140	-	21	27	1077	15
117X	117.00	-	-	1141	12	-	-	1204	12
117Y	117.05	5089.2	694	1141	36	36	42	1078	30
117Z	-	5089.5	695	1141	-	21	27	1078	15
118X	117.10	-	-	1142	12	-	-	1205	12
118Y	117.15	5089.8	696	1142	36	36	42	1079	30

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 12. MLS Channel Pairing (cont)

Channel Pairing				DME Parameters					
				Interrogation				Reply	
					Pulse Codes				
						DME/P Mode			
DME No	VHF Freq. MHz	MLS Angle Freq. MHz	MLS CH No	Freq. MHz	DME/N µs	IA µs	FA µs	Freq MHz	Pulse Codes µs
118Z	-	5090.1	697	1142	-	21	27	1079	15
119X	117.20	-	-	1143	12	-	-	1205	12
119Y	117.25	5090.4	698	1143	36	36	42	1080	37
119Z	-	5090.7	699	1143	-	21	27	1080	15
120X	117.30	-	-	1144	12	-	-	1207	12
120Y	117.35	-	-	1144	36	-	-	1081	37
121X	117.40	-	-	1145	12	-	-	1208	12
121Y	117.45	-	-	1145	36	-	-	1082	37
122X	117.50	-	-	1146	12	-	-	1209	12
122Y	117.55	-	-	1146	36	-	-	1083	37
123X	117.60	-	-	1147	12	-	-	1210	12
123Y	117.65	-	-	1147	36	-	-	1084	37
124X	117.70	-	-	1148	12	-	-	1211	12
**124Y	117.75	-	-	1148	36	-	-	1085	37
125X	117.80	-	-	1149	12	-	-	1212	12
**125Y	117.85	-	-	1149	36	-	-	1086	37
126X	117.90	-	-	1150	12	-	-	1213	12
**126Y	117.95	-	-	1150	36	-	-	1087	37

NOTES:

* These channels are reserved exclusively for national allotments.

** These channels may be used for national allotment on a secondary basis. The primary reaon for reserving these channels is to provide protection for the Secondary Surveillance Radar (SSR) system.

▽ 108.0 MHz is not scheduled for assignment to ILS service. The associated DME operating channel No. 17X may be assigned to the emergency service.

Information Handling Services, 1999
August 11, 1999 06:39:27

APPENDIX II

20. FUNCTION TIMING TABLES

20.1 Event time slots of angle and data functions.- The event times for angle and data functions shall be as shown in the following tables and as described in 4.1. The times indicate the beginning of the listed event time slot and the end of the previous time slot.

Table 14. Approach Azimuth Function Timing

EVENT	EVENT TIME SLOT BEGINS AT: 15.625 kHz CLOCK PULSE (NUMBER)	TIME (milliseconds)
PREAMBLE	0	0
UNUSED (TRANSMIT ZERO)	25	1.600
ANTENNA SELECT	26	1.664
OCI	32	2.048
OCI	34	2.176
OCI	36	2.304
TO TEST	38	2.432
TO SCAN*	40	2.560
PAUSE		8.760
MIDSCAN POINT		9.060
FRO SCAN*		9.360
FRO TEST		15.560
END FUNCTION (AIRBORNE)		15.688
END GUARD TIME; END FUNCTION (GROUND)		15.900

* The actual commencement and completion of the TO and the FRO scan transmissions are dependent on the amount of proportional guidance provided. The time slots provided shall accommodate a maximum scan of plus or minus 62.0 degrees. Scan timing shall be compatible with accuracy requirements.

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 15. High Rate Approach Azimuth and Back Azimuth Function Timing

EVENT	EVENT TIME SLOT BEGINS AT: 15.625 kHz CLOCK PULSE (NUMBER)	TIME (milliseconds)
PREAMBLE	0	0
UNUSED (TRANSMIT ZERO)	25	1.600
ANTENNA SELECT	26	1.664
OCI	32	2.048
OCI	34	2.176
OCI	36	2.304
TO TEST	38	2.432
TO SCAN*	40	2.560
PAUSE		6.760
MIDSCAN POINT		7.060
FRO SCAN*		7.360
FRO TEST PULSE		11.560
END FUNCTION (AIRBORNE)		11.688
END GUARD TIME; END FUNCTION (GROUND)		11.900

* The actual commencement and completion of the TO and the FRO scan transmissions are dependent on the amount of proportional guidance provided. The time slots provided will accommodate a maximum scan of plus or minus 42.0 degrees. Scan timing shall be compatible with accuracy requirements.

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 16. Approach Elevation Function Timing

EVENT	EVENT TIME SLOT BEGINS AT: 15.625 kHz CLOCK PULSE (NUMBER)	TIME (milliseconds)
PREAMBLE	0	0
PROCESSOR PAUSE	25	1.600
OCI	27	1.728
TO SCAN*,	29	1.856
PAUSE		3.406
MIDSCAN POINT		3.606
FRO SCAN*		3.806
END FUNCTION (AIRBORNE)		5.356
END GUARD TIME; END FUNCTION (GROUND)		5.600

* The actual commencement and completion of the TO and FRO scan transmissions are dependent upon the amount of proportional guidance provided. The time slots provided will accommodate a maximum scan of -1.5 degrees to +29.5 degrees. Scan timing shall be compatible with accuracy requirements.

Table 17. Basic Data Function Timing

EVENT	EVENT TIME SLOT BEGINS AT: 15.625 kHz CLOCK PULSE (NUMBER)	TIME (milliseconds)
PREAMBLE	0	0
DATA TRANSMISSION: (BITS I13 - I30)	25	1.600
PARITY TRANSMISSION: (BITS I31 - I32)	43	2.752
END FUNCTION (AIRBORNE)	45	2.880
END GUARD TIME; END FUNCTION (GROUND)		3.100

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 18. Auxiliary Data Function Timing (Digital Data)

EVENT	EVENT TIME SLOT BEGINS AT: 15.625 kHz CLOCK PULSE (NUMBER)	TIME (milliseconds)
PREAMBLE	0	0
ADDRESS TRANSMISSION (BITS I_{13}-I_{20})	25	1.600
DATA TRANSMISSION: (BITS I_{21}-I_{69})	33	2.112
PARITY TRANSMISSION: (BITS I_{70}-I_{76})	82	5.248
END FUNCTION (AIRBORNE)	89	5.696
END GUARD TIME; END FUNCTION (GROUND)	—	5.900

Table 19. Preamble Timing*

EVENT	EVENT TIME SLOT BEGINS AT: 15.625 kHz CLOCK PULSE (NUMBER)	TIME (milliseconds)
CARRIER ACQUISITION: (CW TRANSMISSION)	0	0
RECEIVER REFERENCE TIME CODE		
I1 = 1	13	0.832
I2 = 1	14	0.896
I3 = 1	15	0.960
I4 = 0	16	1.024
I5 = 1	17	1.088**
FUNCTION IDENTIFICATION:		
I6	18	1.152
I7	19	1.216
I8	20	1.280
I9	21	1.344
I10 (See Table 1)	22	1.408
I11	23	1.472
I12	24	1.536
END PREAMBLE		1.600

*Applies to all functions transmitted.
**Reference time for receiver synchronization for all function timing.

Information Handling Services, 1999
August 11, 1999 06:39:27

Table 20. Auxiliary Data Function Timing (Alphanumeric Data)

EVENT	EVENT TIME SLOT BEGINS AT: 15.625 kHz CLOCK PULSE (NUMBER)	TIME (milliseconds)
PREAMBLE	0	0
ADDRESS TRANSMISSION (BITS I_{13}-I_{20})	25	1.600
DATA TRANSMISSION: (BITS I_{21}-I_{76})	33	2.112
END FUNCTION (AIRBORNE)	89	5.696
END GUARD TIME; END FUNCTION (GROUND)	—	5.900

Information Handling Services, 1999
August 11, 1999 06:39:27