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Provisional Message Formats and Protocols for the DABS 32-Character Alphanumeric Display

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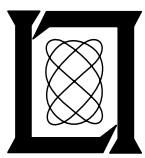

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16. Abstract

Formats and protocols are described for tactical ATC displays to be driven by the Standard Message interface of a DABS transponder and capable of handling a succession of data transmissions, each of which is individually acknowledged via a transponder reply before the transmission of the succeeding segment. Specific codes are defined for a display device of up to 32 alphanumeric characters.

Any displays defined or implied by this document are intended solely for use in the DABS test and evaluation program, and are not necessarily representative of recommended or required display devices for an operational DABS system.

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SECTION 1

INTRODUCTION

1.1 BACKGROUND

The DABS system has two basic ground-to-air data link modes: individual 56-bit messages may be transmitted using the Comm-A format which can be handled by the Standard Message interface of all DABS transponders [1]; messages of up to 1280 bits may be transmitted using the Comm-C Extended Length Message format which is available primarily to air carrier quality transponders.

Studies of ground-to-air ATC data-link message requirements [2] have indicated that a message length capability of 16 to 32 characters is needed to accommodate most ATC "tactical" messages. Such Intermediate Length Messages (ILM's) can be transferred as a succession of segments, each of which is transmitted by a single 56-bit Comm-A interrogation, and individually acknowledged before transmission of the succeeding segment.

The document defines the message protocols, display control functions, and data codes for display and readout devices capable of handling such messages. The codes and protocols for driving a display device of up to 32 alphanumeric characters are defined.

The code format selected for the alphanumeric display is based on the standard ASCII character set to assure compatibility with commercial display devices. There existed the option of either: (a) employing a complete 8-bit ASCII code which includes display control function and parity as well as alphanumeric characters, or (b) using an ASCII subset for alphanumeric characters and defining a special control code separate from the character code. A

special control code can provide display control only once per uplink transmission, i.e., once per segment of 8 alphanumeric characters.

Although the use of the full ASCII code would result in maximum compatibility with commercial display hardware, for test purposes a truncated 6-bit ASCII code with a separate control code has been selected to obtain more efficient DABS ground-to-air data transfer. (It provides a capacity for eight alphanumeric characters per transmission versus only six characters per transmission if a full ASCII code were employed.)

SECTION 2

32 CHARACTER DISPLAY DEVICE

2.1 GENERAL

The display formats and protocols described herein are designed for a display device capable of storing and displaying the 56-bit uplink message field of a series of DABS Comm-A interrogations. The control codes and protocols provide for the display of up to 32 alphanumeric characters organized in four "sections." Each section of the display is updated by a separate DABS Comm-A transmission containing one message "segment." Provisions are included for updating or clearing either individual sections or entire messages.

2.2 INTERFACE SIGNALS AND TIMING

The signals which operate the display appear at the Standard Message (SM) interface of the transponder [3] if, and only if, the message was addressed to this transponder. The entire content of the uplink transmission as received by the transponder, except the 24-bit address field, appears at the SM interface in serial form and in the same order as received. The data is synchronized by a clock which starts only when a properly addressed transmission is received. The clock stops after the transponder has replied to the interrogation. The levels and timing for the clock and data lines are described in Ref. [3].

2.2.1 Interface Formats

The formats for DABS interrogations and replies are described in Ref. [1], Fig. 4.4-1. All interrogations contain either 56 or 112 bits, of which the last 24 bits are the address/parity field. After removal of the address/

parity field by the transponder, either 32 or 88 bits appear at the SM interface. The data which operate the display are contained in the last 56 bits (the MA field) of the 88-bit pattern.

2.2.2 Interface Control Codes

The first 32 bits of SM interface data contain either information for other displays or control information used by the transponder or by all peripheral devices. Three of these bits are relevant to the 32-character display.

Bit 1: A zero in this position indicates that a "normal" (not All-Call, not ELM) transmission has been received. The transponder will not activate the SM interface if an ELM transmission is received. On the receipt of an All-Call interrogation, the transponder places a one in this position and the automatic capability reporting circuit is activated (see 2.6 and Ref. [3], para. 2.4.2).

Bit 2: A zero in this position indicates that only 32 data bits have been received, there is no MA field, and bit 3 (IT) is the only remaining bit to be evaluated by the display.

Bit 3: A one in this position indicates that the transmission originated from a "Standard" DABS sensor. The loss-of-DABS-contact timer, described in 2.5.2, will be retriggered only if this bit is a one.

2.3 DATA FIELD

2.3.1 Display Addressing

The display examines all outbound data on the SM interface for its unique Message Destination (MDES) code. Although the display is divided into four sections, all are accessed by means of the same MDES code. A separate section address code is included within the MA field to designate which display section is to receive the transmitted message segment.

2.3.2 Bit Allocations

The first 8 bits of the MA field are used for control functions. The remaining 48 bits are used for the transmission of eight characters.

2.3.3 The Control Code

The 8-bit message control field includes an Acknowledgment Request (AR) bit, a 3-bit MDES code, and four control bits. Two of these control bits, designated Display Clear (DC) and Display Enable (DE), control the display operation as follows:

> A message segment containing DC=1 clears all four sections of the display.
>
> A message segment containing DE=0 blanks (i.e., turns off) all four sections of the display, but does not erase the contents of the display memory registers.
>
> A message segment containing DE=1 activates (i.e., turns on) all four sections of the display.

The two additional bits, designated Section Address (SA) bits, indicate the segment number (0 through 3) of the associated message. Figure 1 illustrates the data format for each segment and summarizes the control codes.

2.3.4 The Message Code

Each character of the display is encoded using a modified 6-bit subset of the ASCII code as illustrated in Fig. 2. This code consists of columns 2, 3, 4, and 5 of the standard 7-bit ASCII code matrix. Four of the ASCII symbols have been replaced by arrows and a fifth symbol has been replaced by a test symbol indicating the activation of all of the segments or dots in the selected character location. The addresses of the new symbols in the ASCII matrix are given in Table 1.

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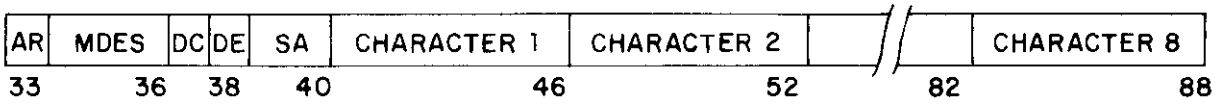

AR: Acknowledgement Request

DC: Display Clear — 0 = No action; 1 = Clear

DE: Display Enable — 0 = Blank; 1 = Display

MDES: Display Device Code = 001

SA: Section Address Code

Bits 39 and 40	Section No.
0 0	0
0 1	1
1 0	2
1 1	3

Fig. 1. Format of DABS MA field for one segment of the ground-to-air message for a 32-character display device.

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							1_0	1_1	0_0	0_1
b_6	b_5	b_4	b_3	b_2	b_1	Row ↓ / Column →	2	3	4	5
		0	0	0	0	0	SP	0	@	P
		0	0	0	1	1	!	1	A	Q
		0	0	1	0	2	↑	2	B	R
		0	0	1	1	3	#	3	C	S
		0	1	0	0	4	↓	4	D	T
		0	1	0	1	5	%	5	E	U
		0	1	1	0	6	&	6	F	V
		0	1	1	1	7	←	7	G	W
		1	0	0	0	8	(	8	H	X
		1	0	0	1	9	)	9	I	Y
		1	0	1	0	10	*	:	J	Z
		1	0	1	1	11	+	;	K	[
		1	1	0	0	12	,	<	L	→
		1	1	0	1	13	-	=	M	]
		1	1	1	0	14	.	>	N	■
		1	1	1	1	15	/	?	O	_

Fig. 2. Modified 6-bit ASCII code for ATC alphanumeric display.

Table 1. ASCII symbol replacement.

Original ASCII Symbol	ASCII Column	ASCII Row	Replaced by
(")	2	2	(↑)
(&)	2	4	(↓)
(')	2	7	(←)
(\)	5	12	(→)
(^)	5	14	(■)(test symbol)

This character set is consistent with the character set used by the DOT Transportation Systems Center for test and evaluation of tactical ATC displays of this type. The 6-bit code for each character is transmitted in ascending order; e.g., bit position No. 41 in Fig. 1 (the first bit position of character 1) contains ASCII bit b_1 for character 1.

2.4 MESSAGE PROTOCOLS

2.4.1 Link Protocol for Complete Ground-to-Air Message

Transmission of a complete message (all display sections updated) is initiated by a Comm-A interrogation directed to the display by means of the 001 MDES code and with DC=1 to clear the previous display contents and DE=0 or 1 (depending on whether the message segments are to be displayed as received, DE=1, or not until the total message is delivered, DE=0). If this is the only segment to be transmitted, DE=1. SA can have any allowable value depending on the desired display format and order of transmission. The first segment, and all subsequent segments, must be acknowledged by means of a transponder reply prior to transmission of a subsequent segment; if the reply is not received, the same segment is retransmitted. As soon as this reply is received, the next segment may be transmitted. All but the first segment of the message are transmitted with DC=0 in order not to erase previous segments; again, DE may be 0 or 1, except that on the final segment DE must be

1 in order to activate the display. If pilot acknowledgment of the message is required, the AR bit is set in the Comm-A interrogation containing the final segment.

2.4.2 Individual Section Update

Any section of the display may be modified by the transmission of a single segment with DC=0 and DE=1. This action overwrites the new segment into the display section designated by the SA bits; the other display sections are unaffected by this transmission. As in the case of a complete message, the transponder reply acknowledges receipt of the segment. A pilot acknowledgment may be requested by setting the AR bit.

2.4.3 Individual Section Clearing

A single section may be cleared by addressing it separately with a Comm-A transmission and writing "spaces" into each character.

2.5 INITIALIZATION AND LOSS OF DABS CONTACT

2.5.1 Initialization

A circuit is included in the display which clears all stored display control codes and blanks all character locations when power is first applied to the unit.

2.5.2 Loss of DABS Contact

A timing circuit is included in the display which senses the presence or absence of DABS roll-call interrogations and controls an indicator on the display face. The timing circuit senses the receipt of a valid interrogation from a standard sensor by examining the third bit (the IT bit) of every outbound data stream on the standard message interface. An IT=1 indicates the receipt of an interrogation from a standard sensor, and retriggers the timing circuit. The timing circuit will remain latched in the "DABS contact" condition for 16 $\pm$ 2 sec following the receipt of the last interrogation with IT=1. At the end of the timeout period, a "Contact Lost" indication will appear on the display face; however, any data being displayed at that time will continue to be visible.

2.6 CAPABILITY REPORTING

An optional circuit may be included in the display which automatically reports the presence of the 32-character display via the SM interface upon receipt of an All-Call interrogation. The details are described in Ref. [3], para. 2.4.2.

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[1] P. R. Drouilhet, Ed., "Provisional Signal Formats for the Discrete Address Beacon System (Revision 1)," M. I. T. Lincoln Laboratory Project Report ATC-30, Rev. 1, April 1974, FAA-RD-74-62.

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[3] G. V. Colby, P. H. Robeck, and J. D. Welch, "Provisional Data Link Interface Standard for the DABS Transponder," M. I. T. Lincoln Laboratory Project Report ATC-34, April 1974, FAA-RD-74-64.