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# Project Report

PA-229-5  
(RSP)

C. R. Berndtson  
R. H. French  
D. E. Nessman

Data Reduction Program Documentation  
ALT10

(Effective: April 1971)

19635

7 April 1971

Prepared for the Advanced Research Projects Agency,  
the Department of the Army, and the Department of the Air Force  
under Electronic Systems Division Contract F19628-70-C-0230 by

## Lincoln Laboratory

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY  
LINCOLN LABORATORY

⑥

DATA REDUCTION PROGRAM DOCUMENTATION

ALT 10

(EFFECTIVE: APRIL 1971)

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Editors

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## FOREWORD

This is the fifth report in the Data Reduction Program Documentation series. It is dated according to the date of completion of the documentation. No implication is made that this program will not subsequently be modified, amended, or superseded; on the contrary, the history of radar data processing is one of continuous evolution of techniques, and it is unrealistic to assume that steady-state has been reached. The PA-229 series is being published for the convenience of interested parties, and Lincoln assumes no responsibility for the correctness of the information presented, nor for its currency.

The preparation of reports in this series is under the Editorship of Charles R. Berndtson of Lincoln, and of D. Nessman and R. French of Philco-Ford Corporation. Inquiries, suggestions, corrections, criticisms, and requests for additional copies should be directed to C. R. Berndtson.

The principal contributor to this report was J. R. Cornelius (Philco-Ford). Due to the intricate, evolutionary manner in which the programs came into being, the editors regret that it is in general impossible to give due credit to all-- mathematicians or radar analysts or programmers -- who contributed to the definition and writing of the programs.

  
Alan A. Grometsstein

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### COMMON SYMBOLS AND ABBREVIATIONS

(The units given for certain quantities are the units commonly used for those quantities, unless otherwise noted.)

ADT	ALCOR Data Tape
Alt	Altitude (km)
APS	Average Pulse Shape
ARS	ALTAIR Recording System
Avg	Average, Averaging
Az	Azimuth (deg)
CADJ	Adjusted Calibration Constant (db)
C-band	ALCOR frequency, 5664 MHz (NB) and 5667 MHz (WB)
EI	Elevation (deg)
EOF	End of File
GMT	Greenwich Mean Time
h	Hours
Hz	Hertz
in	Inches
LC	Left Circular Polarization
min	Minutes
NB	Narrow Band
NRTPOD	Non-real Time Precision Orbit Determination Program
POD	Project PRESS Operation and Data Summary Report
Phase	Presented in deg
PRF	Pulse Repetition Frequency (pps)
PRI	Pulse Repetition Interval (s)
pps	Pulses per second
pts	Points
R	Range (km)
$\dot{R}$	Range Rate (km/s)
rad	Radians
RC	Right Circular Polarization
RCS	Radar Cross Section (dbsm)
s	Seconds
$SD_w$	Standard Deviation of Wake Velocity

T	Time
TAL	Time After Launch (s)
UHF	ALTAIR Frequency; 415 MHz
V	Velocity
$V_d$	Doppler Velocity
$V_w$	Mean Wake Velocity
VHF	ALTAIR Frequency; 155.5 MHz
WB	Wide Band
$\theta$	Total Off-axis Angle (deg)
$\lambda$	Wavelength
*	Denotes Multiplication

FLOW DIAGRAM SYMBOLS



PROCESS, ANNOTATION



DECISION



TERMINATOR



SUBROUTINE: where NAME is the entry call into the subroutine



CONNECTOR: where P specifies a page in the flow diagram, and L designates a statement number in the program listing or a reference point in the flow diagram



CONNECTOR: where X implies a continuation of the diagram to the next page



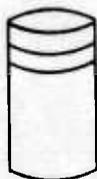
INPUT/OUTPUT OPERATION



MAGNETIC TAPE



PUNCHED CARD



DISK

ALT10

I. PURPOSE AND UTILIZATION

A. Source of Data

ALTAIR<sup>1</sup>

B. Data Input

ALTAIR transcription tape

C. Description

ALT10 is used primarily to produce plots of peak ~~RCS vs TAL.~~  
*radar cross sections* vs *time after launch.*

The program also produces plots of ~~RCS~~ in selected range gates vs ~~TAL.~~

D. Output

1. A listing of pertinent identification data.
2. Plots vs TAL of peak RCS and of RCS in selected range gates.

*radar cross sections vs time after launch.*

II. DESCRIPTION

ALT10 averages the RCS data in each range gate every 0.05 s, and searches the gates to find the peak RCS. It then plots peak RCS vs TAL. A plot of the RCS in each of the range gates is also produced.

The data cards are not checked for validity. Subroutine ALREAD<sup>2</sup> makes a number of checks on transcription tape parameters. For some errors (missing format tables; end of file; target no., sampling pattern, or polarization not on tape) information is returned to main program for decision to terminate.

III. OPERATION

A. Input

Start and stop times (GMT)

Specified set of range gates

Target and sampling pattern numbers

Polarization

A sample input is shown in Appendix A.

CARD 1 (15A4)

Col. 1-16 Label for plots and listing  
 Col. 17-60 Additional labels for listing

CARD 2 (2I3, F7.3, 2I3, F7.3, 4X, 4I5)

Col. 1- 3	IH1 (I3)	}	Start time (GMT) in h, min, and s
Col. 4- 6	IM1 (I3)		
Col. 7-13	ZSEC1 (F7.3)		
Col. 14-16	IH2 (I3)	}	Stop time (GMT) in h, min, and s
Col. 17-19	IM2 (I3)		
Col. 20-26	ZSEC2 (F7.3)		
Col. 31-35	NRG		Number of range gates (I5)
Col. 36-40	INTARG		Target no. (I5)
Col. 41-45	IPAT		Sampling pattern in which initial gate is located
Col. 46-50	IPOL		Data channel: 1 = LC; 2 = RC; 3 = Az error*; 4 = El error* (I5)
Col. 51-55	ING**		The location within IPAT of initial gate (I5)

\*VHF transcriptions only.

\*\*Called ISTGAT in ALREAD.

B. Output

LISTING

Title

Target no. , frequency, and polarization

Start and stop times (GMT total seconds)

Identification of gate being plotted

Identification of peak gate being plotted

PLOTS

RCS vs TAL (abscissa is 4 s/in, ordinate is + 40 to - 60 dbsm at  
20 db/in)

Sample outputs are given in Appendix B.

IV.

PROGRAM LIMITATIONS

Start time	Must be on tape
Stop time	Must be on tape
NRG	$\leq 120$
INTARG	Must be on tape
Length of run	$\leq 300$ s

V. PROGRAMMING

A. ALT10 (see Appendices C and D).

ALT10 is the control section of ALT10. ALT10 reads the input cards, calls ALREAD, and averages the data returned. ALT10 also calls the plot routines, and prints the data.

B. ALREAD<sup>2</sup>

ALREAD is the Fortran driver for the machine language tape reading routines.

The call statement is ALREAD (TSTART, TSTOP, TLIFT, INTARG, INPAT, IPOL, NOPHA, NPTS, DFPG, NEWPAS, NRG, ISTGAT).

INPUT

TSTART	Start time of processing (GMT total seconds)
TSTOP	End time of processing (GMT total seconds)
INTARG	Target number to be processed
INPAT*	Sampling pattern in which initial gate is located
NRG	Number of range gates to be processed
ISTGAT**	Location within INPAT of initial gate wanted
NOPHA	1 (only RCS data wanted)
IPOL	Data channel: 1 = LC; 2 = RC; 3 = Az error; 4 = El error

INPUT AND OUTPUT PARAMETERS

NPTS <sup>†</sup>	Output: number of pulses of data returned Input: must be initialized by calling program before each call to ALREAD
NEWPAS <sup>††</sup>	Cycle and error pointer

\*Also called IPAT.

\*\*Also called ING or ISG.

† Set to zero for first call. Set to number of saved points for subsequent calls.

†† Also called IAGAIN.

### OUTPUT

TLIFT      Lift-off time (GMT total seconds)  
DFPG      Frequency and polarization (e.g. VHF LC)

### STORED IN COMMON

TIMES      Pulse times (GMT total seconds)  
XSPHA      RCS and phase for each pulse and gate  
RANGKM      R  
ALSAV\*      Alt  
IRGA      Range gate array associated with XSPHA  
NFPG      Frequency code: 1 = VHF; 2 = UHF

C.      REW

REW is an entry to subroutine BREADS<sup>3</sup> used to rewind the tape.

D.      PLOTEN

PLOTEN plots RCS vs TAL for every gate and for the peak gate.

E.      Plotting System Subroutines

They are REREAD, STOIDV, and PLTND.

\*Valid for first pulse of minor cycle. It is repeated for subsequent pulses.

### REFERENCES

1. "ALTAIR Data User's Manual", LM-97, Lincoln Laboratory, M.I.T. (to be published), UNCLASSIFIED.
2. "Data Reduction Program Documentation, ALREAD, (Effective: March 1971)", PA-229-3, Lincoln Laboratory, M.I.T. (17 March 1971), UNCLASSIFIED.
3. "Data Reduction Program Documentation, ALTAIR Tape Read Package, (Effective: April 1970)", PA-229-4, Lincoln Laboratory, M.I.T. (17 March 1971), UNCLASSIFIED.



APPENDIX B  
ALT10 OUTPUTS

ALTAIR LINK 10 VERSION DATE 9 OCTOBER 1970  
FLP 1J03 ALT10 G108

TIME FROM 34418.0200 TO 34428.5000      TARGET 46 VHF-LC

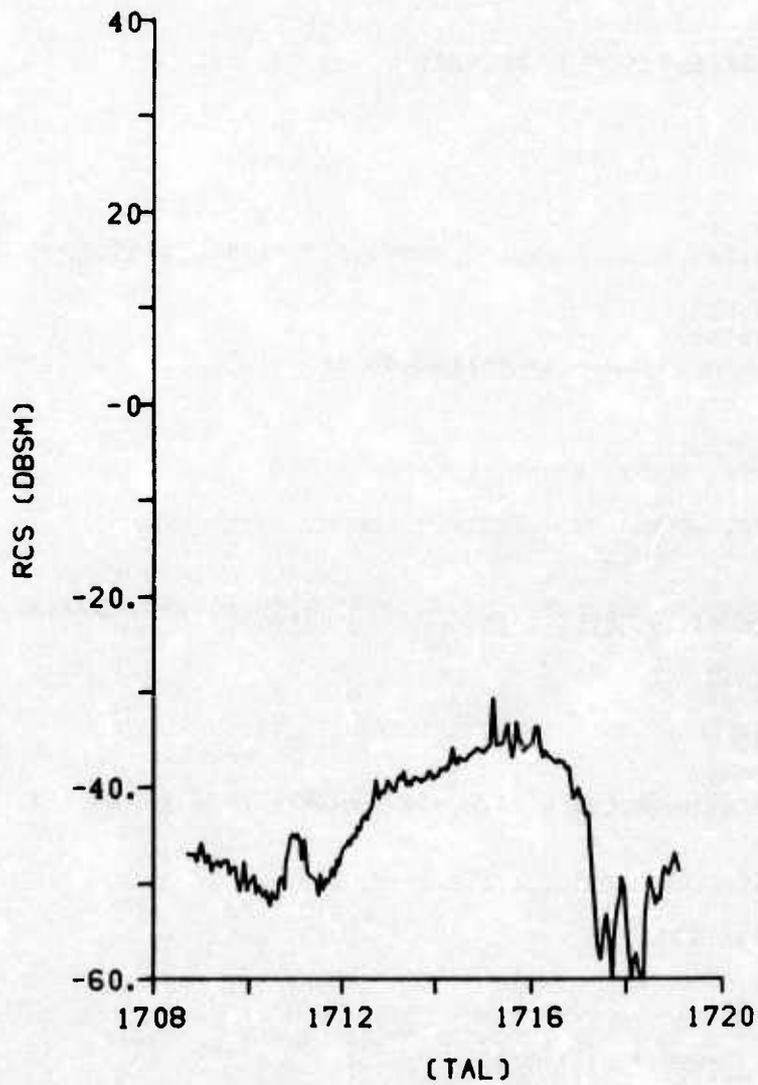
RANGE GATE	1 IS NOW PLOTTING				
RANGE GATE	2 IS NOW PLOTTING				
RANGE GATE	12345 IS NOW PLOTTING				
THE PEAK IS IN GATE	2 FROM	1708.7110	TO	1709.2110	
THE PEAK IS IN GATE	1 FROM	1709.2610	TO	1709.2610	
THE PEAK IS IN GATE	2 FROM	1709.3110	TO	1709.7610	
THE PEAK IS IN GATE	1 FROM	1709.8110	TO	1709.8110	
THE PEAK IS IN GATE	2 FROM	1709.8610	TO	1711.6610	
THE PEAK IS IN GATE	1 FROM	1711.7110	TO	1711.7110	
THE PEAK IS IN GATE	2 FROM	1711.7610	TO	1713.0610	
THE PEAK IS IN GATE	1 FROM	1713.1110	TO	1713.1610	
THE PEAK IS IN GATE	2 FROM	1713.2110	TO	1713.4110	
THE PEAK IS IN GATE	1 FROM	1713.4610	TO	1713.4610	
THE PEAK IS IN GATE	2 FROM	1713.5110	TO	1714.2610	
THE PEAK IS IN GATE	1 FROM	1714.3110	TO	1714.3610	
THE PEAK IS IN GATE	2 FROM	1714.4110	TO	1714.8110	
THE PEAK IS IN GATE	1 FROM	1714.8610	TO	1714.9610	
THE PEAK IS IN GATE	2 FROM	1715.0110	TO	1715.0110	
THE PEAK IS IN GATE	1 FROM	1715.0610	TO	1715.2610	
THE PEAK IS IN GATE	2 FROM	1715.3110	TO	1715.5610	
THE PEAK IS IN GATE	1 FROM	1715.6110	TO	1715.6610	
THE PEAK IS IN GATE	2 FROM	1715.7110	TO	1715.7110	
THE PEAK IS IN GATE	1 FROM	1715.7610	TO	1715.8610	
THE PEAK IS IN GATE	2 FROM	1715.9110	TO	1715.9610	
THE PEAK IS IN GATE	1 FROM	1716.0110	TO	1716.0610	
THE PEAK IS IN GATE	2 FROM	1716.1110	TO	1716.1110	
THE PEAK IS IN GATE	1 FROM	1716.1610	TO	1716.3110	
THE PEAK IS IN GATE	2 FROM	1716.3610	TO	1716.4110	
THE PEAK IS IN GATE	1 FROM	1716.4610	TO	1716.5610	
THE PEAK IS IN GATE	2 FROM	1716.6110	TO	1716.6610	
THE PEAK IS IN GATE	1 FROM	1716.7110	TO	1716.9110	
THE PEAK IS IN GATE	2 FROM	1716.9610	TO	1717.0610	
THE PEAK IS IN GATE	1 FROM	1717.1110	TO	1717.1110	
THE PEAK IS IN GATE	2 FROM	1717.1610	TO	1717.1610	
THE PEAK IS IN GATE	1 FROM	1717.2110	TO	1717.4610	
THE PEAK IS IN GATE	2 FROM	1717.5110	TO	1717.6610	
THE PEAK IS IN GATE	1 FROM	1717.7110	TO	1718.3110	
THE PEAK IS IN GATE	2 FROM	1718.3610	TO	1718.3610	
THE PEAK IS IN GATE	1 FROM	1718.4110	TO	1718.5610	
THE PEAK IS IN GATE	2 FROM	1718.6110	TO	1718.6610	

ELP 1J03 ALT10

TARGET 46

PEAK GATE

VHF-LC



APPENDIX C  
ALT10 PROGRAM LISTING

```
DIMENSION AVXS(120),DFPG(2),IPGATE(6000),PEAKXS(6000),PLOTAG(15),
1SINK(120),TPLT(6000),XSPLT(6000)
DOUBLE PRECISION SEC,T1,T2,TIMES,TLIFT,TOTIM,TOUT,TPLT,TSV,
1TSTART,TSTOP,ZSEC1,ZSEC2
COMMON/RDCOM/TIMES(300),XS(120,300),RANGE(300),ALT(300),IRGA(120)
1,NFPG
EQUIVALENCE (TPLT(1),XS(1,1)),(XSPLT(1),XS(1,151)),
1(PEAKXS(1),XS(1,201)),(IPGATE(1),XS(1,251))
DATA AVXS/120*0.0/
DATA TINC/0.05/
TOTIM(IH,IM,SEC)=DFLOAT(60*(60*IH+IM))+SEC
CALL REREAD(99,540)
TSTOP=0.0
IAGAIN=0
READ(5,40)PLOTAG
40  FORMAT(15A4)
CALL STOIDV(PLOTAG,59,0)
60  READ(5,80,END=900)IH1,IM1,ZSEC1,IH2,IM2,ZSEC2,NRG,INTARG,IPAT,IPOL
1,ING
80  FORMAT(2(2I3,F7.3),4X,5I5)
TSTART=TOTIM(IH1,IM1,ZSEC1)
IF((TSTART.GT.TSTOP).AND.(IAGAIN.NE.44))GO TO 90
CALL REW
IAGAIN=1
90  TSTOP=TOTIM(IH2,IM2,ZSEC2)
NPTS=0
NREC=0
KOUNT=0
T1=TSTART
T2=T1+TINC
100 CALL ALREAD(TSTART,TSTOP,TLIFT,INTARG,IPAT,IPOL,1,NPTS,DFPG,IAGAIN
1,NRG,ING)
IF(IAGAIN.EQ.55)GO TO 900
IF(IAGAIN.EQ.66)GO TO 60
IF(NPTS.NE.0)GO TO 160
120 IF(NREC.NE.0)GO TO 500
WRITE(6,140)IH1,IM1,ZSEC1
140 FORMAT('1 AT TIME = ',I2,I3,F8.4,' NO VALID POINTS WERE FOUND - R
1UN HAS BEEN ABORTED.')
```

IAGAIN=49  
GO TO 60

```
160 DO 400 J=1,NPTS
IF(T1.GT.TIMES(J))GO TO 400
KOUNT=KOUNT+1
DO 200 I=1,NRG
XSQM=10.0**(XS(I,J)/10.0)
AVXS(I)=AVXS(I)+XSQM
200 CONTINUE
IF(T2.GT.TIMES(J))GO TO 400
IF(KOUNT.LE.0)GO TO 240
COUNT=KOUNT
DO 220 I=1,NRG
AVXS(I)=10.*ALOG10(AVXS(I)/COUNT)
IF(I.EQ.1)GO TO 210
IF(AVXS(I).LE.PEAK)GO TO 220
```

```

210  IPGAT=IRGA(I)
      PEAK=AVXS(I)
220  CONTINUE
      TOUT=T1-TLIFT
      WRITE(4) TOUT, IPGAT, PEAK, (AVXS(I), I=1, NRG)
      NREC=NREC+1
      IF(NREC.GT.6000) GO TO 500
240  DO 260 I=1, NRG
      AVXS(I)=0.0
260  CONTINUE
      T1=T2
      T2=T1+TINC
      KOUNT=0
      IF(T2.GT.TSTOP) GO TO 500
      IF(T2.LE.TIMES(NPTS)) GO TO 400
      IF(IAGAIN.EQ.0) GO TO 120
      NPTS=NPTS-J
      DO 280 K=1, NPTS
      JK=J+K
      TIMES(K)=TIMES(JK)
      RANGE(K)=RANGE(JK)
      ALT(K)=ALT(JK)
      DO 280 L=1, NRG
      XS(L,K)=XS(L,JK)
280  CONTINUE
      GO TO 100
400  CONTINUE
      IF(IAGAIN.EQ.0) GO TO 120
      NPTS=0
      GO TO 100
500  REWIND 4
      WRITE(6,520) PLOTAG,TSTART,TSTOP,INTARG,DPPG
520  FORMAT('1'/8X,'ALTAIR LINK 10 VERSION DATE 9 OCTOBER 1970'/2X,
115A4//2X,'TIME FROM ',F10.4,' TO ',F10.4,6X,'TARGET ',I3,2X,2A4//)
      DO 700 I=1, NRG
      DO 660 J=1, NREC
      IF(I.NE.1) GO TO 600
      READ(4) TPLT(J), IPGATE(J), PEAKS(J), XSPLT(J)
      GO TO 660
600  KIN=1
      KOUT=I-1
      READ(4) TPLT(J), IPGATE(J), PEAKS(J), (SINK(K), K=KIN, KOUT), XSPLT(J)
660  CONTINUE
      REWIND 4
      CALL PLOTEN(TPLT, XSPLT, NREC, DPPG, IRGA(I), INTARG, PLOTAG)
700  CONTINUE
800  NDRG=12345
      CALL PLOTEN(TPLT, PEAKS, NREC, DPPG, NDRG, INTARG, PLOTAG)
      TSAV=TPLT(1)
      ISGAT=IPGATE(1)
      NOUT=0
      DO 840 I=2, NREC
      IF(IPGATE(I).EQ.ISGAT) GO TO 820
      WRITE(6,820) ISGAT, TSAV, TPLT(I-1)
820  FORMAT(' THE PEAK IS IN GATE ',I3,' FROM ',F11.4,' TO ',F11.4)
      ISGAT=IPGATE(I)
      TSAV=TPLT(I)
      NOUT=NOUT+1
840  CONTINUE
      IF(NOUT.EQ.0) WRITE(6,820) ISGAT, TPLT(1), TPLT(NREC)
      IAGAIN=49
      GO TO 60
900  CALL PLTND
      RETURN
      END

```

APPENDIX D  
ALT10 FLOW DIAGRAM

