Vessel-Mounted Acoustic Doppler Current Profiler

TECHNICAL MANUAL

RD Instruments

Acoustic Doppler Current Profilers

P/N 67119 (9/91-C0)

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RD INSTRUMENTS

VESSEL-MOUNTED ACOUSTIC DOPPLER CURRENT PROFILER (VM-ADCP) TECHNICAL MANUAL

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NOTE

This manual assumes you are using firmware version 17.07 (or later).

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CHAPTER 4
OUTPUT DATA FORMATS

4-0. INTRODUCTION

This chapter presents the format of ADCP output data. The output data can be in either an ASCII or binary format. You can select this option with an internal switch (Appendix W) or a direct command (W-command). Appendix D explains all direct commands. We explain the output data formats in enough detail to let you create your own data processing/analysis programs. RDI also has some ready-made data processing programs, which we describe in ¶4-3.

4-1. ASCII OUTPUT DATA FORMAT

Use the ASCII format when you are viewing raw ADCP data on a computer/dumb terminal. The ASCII format uses the ASCII codes for 0 through 9 for decimal data. An exception is the Status byte (Table 4-7). It uses a hexadecimal format. Other standard ASCII characters (text) and control commands (carriage return, line feed, end of file, etc) are interpreted normally.

In ASCII mode, the ADCP sends the data in lines of ASCII characters separated by a carriage return and line feed sequence (CR/LF). The maximum line length is 76 characters (exclusive of CR/LF). Figure 4-1 shows the ASCII data output format and how it looks on a CRT display. The first two lines contain leader data (see Table 4-2 for a description). In the ASCII data output mode, the leader is always the first data item sent. Subsequent lines contain the optional data selected by the O-command (velocity, spectral width, echo intensity, percent-good, status). We define these fields in Tables 4-3 through 4-7. Figure 4-2 shows the format of the ASCII output data.

For the ASCII data output shown in Figures 4-1 and 4-2, we used nine depth cells (bins) and selected all optional data outputs (velocity in beam coordinates, spectral width, echo intensity, percent-good, status) with the O-command. Nine bins of velocity data (all 1's in this example) are displayed after the leader starting on the third line. This is followed by nine bins each of spectral width (all 2's), echo intensity (all 3's), percent-good (all 4's), and status data (all 5's).

NOTE

INTERNALLY, THE ADCP STORES DATA IN BINARY FORMAT. AT DATA TRANSFER, THE ADCP CONVERTS THE DATA TO ASCII WHEN REQUESTED BY THE USER.

4-2. BINARY OUTPUT DATA FORMAT

Use the binary format when recording/processing ADCP data on an external device. This format uses less storage space and has a faster transmission time than the ASCII format. A dumb terminal is of little use in binary format because the terminal interprets some of the data as control characters.

The binary output data buffer contains a header, a leader, optional data selected by the O-command (velocity, spectral width, echo intensity, percent-good, status), and a checksum. All data in the output buffer are collected during an ensemble. Figure 4-3 shows the layout of the binary output buffer format and the sequence in which the ADCP sends it. Figures 4-4 through 4-9 show the layout of the individual items that make up the binary output buffer. Tables 4-1 through 4-8 list the format, bytes, fields, scaling factors, and a detailed description of every item in the binary output buffer.

4-3. RDI DATA PROCESSING PROGRAMS

RDI has a software program called COLLECT that you can use to process or examine ADCP data. This program is available from RDI at no charge. The COLLECT program has two features you may find useful - LOOK and TRANSLATION.

4-3.1. LOOK. The LOOK feature (previously released as LISTADCP) lets you quickly look at data collected in the standard ADCP format (i.e., the binary data output format). LOOK lets you make sure data are reasonable and intact. It also lets you do a variety of conversions, so you can use it to view the details of your data. LOOK processes your data for display ONLY. It NEVER alters your original data files. LOOK lets you:

- Quickly access display screens to view ADCP leader, velocity, spectral width, echo intensity, percent-good, and status data.
- Quickly convert measurement units (e.g., counts, mm/s, cm/s, etc).
- Display data in either earth or beam coordinates.
- Select the velocity data reference (to ADCP, average, bottom, etc).
- Select the depth cell (bin) and ensemble ranges to display.
- Adjust data for effects of roll, pitch, speed of sound, etc.

4-3.2. TRANSLATION. The TRANSLATION feature (previously released as LOGADCP) lets you convert selected binary data from the ADCP into ASCII text. You can then use the newly created ASCII files in other programs that accept and process this format. TRANSLATION never alters your original binary data files. TRANSLATION lets you:

- Select the binary data fields to convert to ASCII.
- Limit the bin range and ensemble range of the data to be converted.
- Monitor and control the progress of the conversion.

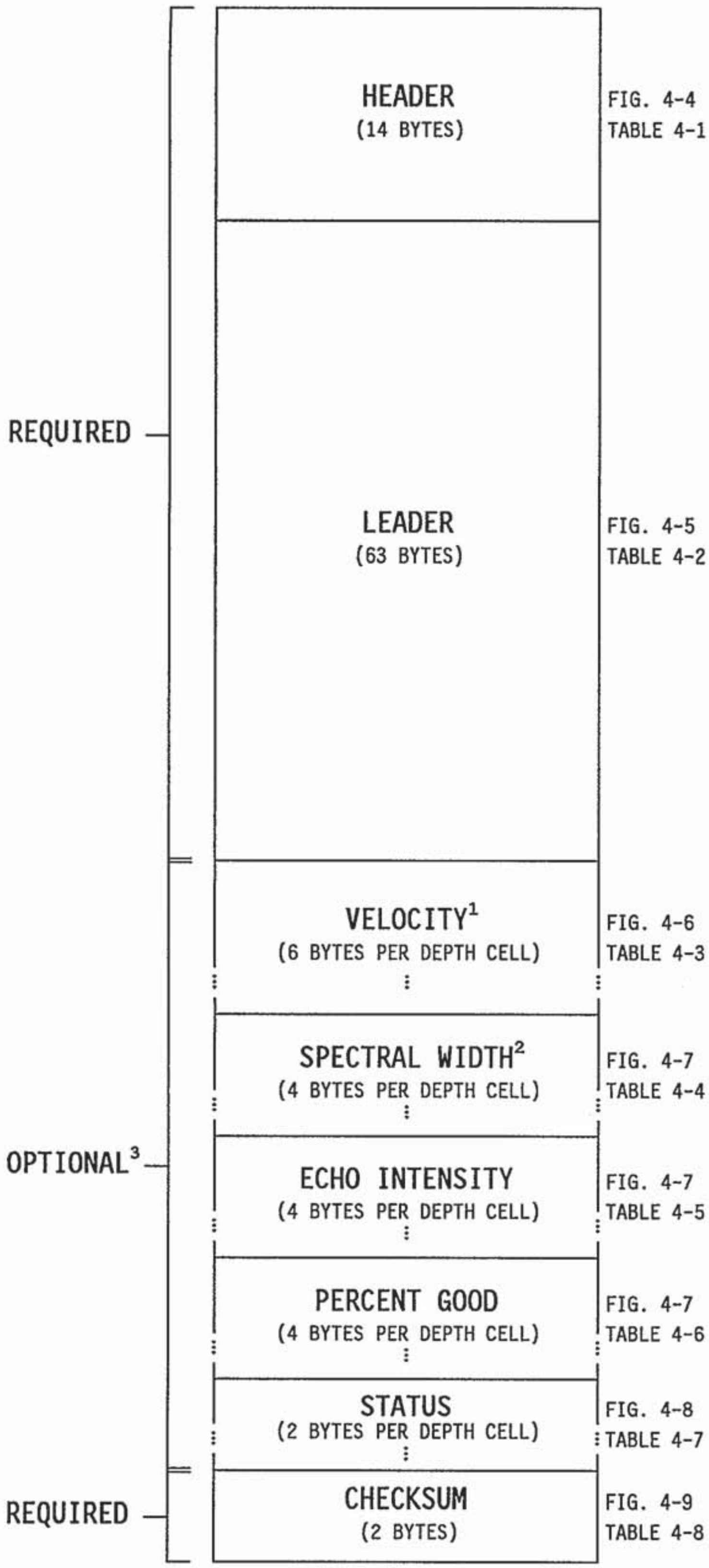
```
01012007260001000001000902040100000010009935256434964733000000000000230031830
0000000000000000000000000000000000000553555355535552926000000000000000000000
11111111111111111111111111111111111111111111111111111111111111111111111111111
11111111111111111111111111111111111111111111111111111111111111111111111111111
1111111111111111111111111111111111111111
22222222222222222222222222222222222222222222222222222222222222222222222222222
222222222222222222222222222222222222222222222222222222222222222222222
33333333333333333333333333333333333333333333333333333333333333333333333333333
333333333333333333333333333333333333333333333333333333333333333333333
44444444444444444444444444444444444444444444444444444444444444444444444444444
44444444444444444444
555555555555555555555555555555555555555555555555
```

NOTE: The values listed here do NOT represent actual data.

Figure 4-1. ASCII Output Data Format (CRT Display)

```
LEADER DATA (See Table 4-2 for description of fields)
     T        V       P    Q  L  I  J  K           BIT            TILT1                      TEMP        LVI
                                                   CONFIG                  TILT2                    HVI
                                          ENS.No.        N  M                          HDG                XMT
0101200726000100000100090204010000001000993525643496473300000000000230031830

CTDCOND                              BTV1            BTV4            BTR3        RSD              BTPG
          CTDTEMP                         BTV2            BTR1            BTR4     HSD
                    CTDDEPTH                   BTV3            BTR2          PSD        CTDMI
000000000000000000000000000000000000000553555355535553529260000000000000

VELOCITY DATA (See Table 4-3 for description of fields)
     BIN #1            BIN #2            BIN #3            BIN #4            BIN #5
Bm1 Bm2 Bm3 Bm4 Bm1 Bm2 Bm3 Bm4 Bm1 Bm2 Bm3 Bm4 Bm1 Bm2 Bm3 Bm4 Bm1 Bm2 Bm3
1111111111111111111111111111111111111111111111111111111111111111111111111111
         BIN #6            BIN #7            BIN #8            BIN #9   ...
Bm4 Bm1 Bm2 Bm3 Bm4 Bm1 Bm2 Bm3 Bm4 Bm1 Bm2 Bm3 Bm4 Bm1 Bm2 Bm3 Bm4
11111111111111111111111111111111111111111111111111111111111111111111...

SPECTRAL WIDTH DATA (See Table 4-4 for description of fields)
   BIN #1       BIN #2       BIN #3       BIN #4       BIN #5       BIN #6
 1  2  3  4  1  2  3  4  1  2  3  4  1  2  3  4  1  2  3  4  1  2  3  4  1
2222222222222222222222222222222222222222222222222222222222222222222222222222
 BIN #7    BIN #8       BIN #9   ...
2  3  4  1  2  3  4  1  2  3  4
22222222222222222222222222222222...

ECHO INTENSITY DATA (See Table 4-5 for description of fields)
   BIN #1       BIN #2       BIN #3       BIN #4       BIN #5       BIN #6
 1  2  3  4  1  2  3  4  1  2  3  4  1  2  3  4  1  2  3  4  1  2  3  4  1
3333333333333333333333333333333333333333333333333333333333333333333333333333
 BIN #7    BIN #8       BIN #9   ...
2  3  4  1  2  3  4  1  2  3  4
33333333333333333333333333333333...

PERCENT-GOOD DATA (See Table 4-6 for description of fields)
 BIN #1  BIN #2  BIN #3  BIN #4  BIN #5  BIN #6  BIN #7  BIN #8  BIN #9 ...
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
444444444444444444444444444444444444444444444444444444444444444444444444...

STATUS DATA (See Table 4-7 for description of fields)
BIN1 BIN2 BIN3 BIN4 BIN5 BIN6 BIN7 BIN8 BIN9...
123412341234123412341234123412341234
555555555555555555555555555555555555...
```

Figure 4-2. ASCII Output Data Format (Layout)



NOTES:

1. VELOCITY DATA CAN BE IN THE EARTH OR BEAM-COORDINATE SYSTEM.
2. SPECTRAL WIDTH DATA NOT SELECTABLE IF VELOCITY DATA ARE IN EARTH COORDINATES.
3. THE OPTIONAL DATA OUTPUTS ARE SELECTED BY THE O-COMMAND. OPTIONAL DATA OUTPUTS ARE IN BYTES PER DEPTH CELL. FOR EXAMPLE, IF THE Q-COMMAND (NO. OF DEPTH CELLS) = 23, AND ALL POSSIBLE DATA ARE SELECTED FOR OUTPUT, THE REQUIRED DATA BUFFER STORAGE SPACE IS 539 BYTES PER ENSEMBLE (SET BY R-COMMAND):

14	BYTES OF HEADER DATA (FIXED)
63	BYTES OF LEADER DATA (FIXED)
138	BYTES OF BEAM-VELOCITY DATA (6×23)
92	BYTES OF SPEC. WIDTH DATA (4×23)
92	BYTES OF ECHO INTENSITY DATA (4×23)
92	BYTES OF PERCENT-GOOD DATA (4×23)
46	BYTES OF STATUS DATA (2×23)
2	BYTES OF CHECKSUM DATA (FIXED)
539	BYTES OF DATA PER ENSEMBLE

Figure 4-3. Binary Output Data Buffer Format

BIT POSITIONS

BYTE NUMBER	7 6 5 4 3 2 1 0	
1	OUTPUT DATA	MSB
2	BUFFER SIZE	LSB
3	LEADER DATA	MSB
4	BUFFER SIZE	LSB
5	VELOCITY DATA	MSB
6	BUFFER SIZE	LSB
7	SPECTRAL WIDTH DATA	MSB
8	BUFFER SIZE	LSB
9	ECHO INTENSITY DATA	MSB
10	BUFFER SIZE	LSB
11	PERCENT-GOOD DATA	MSB
12	BUFFER SIZE	LSB
13	STATUS DATA	MSB
14	BUFFER SIZE	LSB

NOTE: SEE TABLE 4-1 FOR DESCRIPTION OF FIELDS

Figure 4-4. Binary Header Data Format

BIT POSITIONS 7 6 5 4 3 2 1 0

BYTE#	FIELD		
1	RTC MONTH		
2	RTC DAY		
3	RTC HOUR		[T]
4	RTC MINUTE		
5	RTC SECOND		
6	TBP MINUTES		
7	TBP SECONDS		[V]
8	TBP SEC/100		
9	PINGS PER ENSEMBLE	MSB	[P]
10		LSB	
11	No. OF BINS		[Q]
12	BIN LENGTH		[L]
13	XMT PULSE LNGTH		[I]
14	BLANK AFTER XMT		[J]
15	DLY AFTER BLANK		[K]
16	ENSEMBLE NUMBER	MSB	
17		LSB	
18	BIT STATUS		
19	ADCP CONFIG		
20	S/N THRESHOLD		[N]
21	%GD THRESHOLD		[M]
22	TILT 1 (PITCH)	MSB	
23		LSB	
24	TILT 2 (ROLL)	MSB	
25		LSB	
26	HEADING	MSB	
27		LSB	
28	ADCP TEMP	MSB	
29		LSB	
30	HI VOLT IN		
31	XMT CURRENT		
32	LO VOLT IN		
33	CTD CONDUCTIVITY COUNT	MSB	
34			
35		LSB	
36	CTD TEMPERATURE COUNT	MSB	
37			
38		LSB	
39	CTD DEPTH COUNT	MSB	
40			
41		LSB	
42	BTV1-H		
43	BTV1-L LSN / BTV2-H MSN		
44	BTV2-L	LSB	
45	BTV3-H	MSB	
46	BTV3-L LSN / BTV4-H MSN		
47	BTV4-L	LSB	
48	BT RANGE BEAM #1	MSB	
49		LSB	
50	BT RANGE BEAM #2	MSB	
51		LSB	
52	BT RANGE BEAM #3	MSB	
53		LSB	
54	BT RANGE BEAM #4	MSB	
55		LSB	
56	PITCH-STD DEV		
57	ROLL-STD DEV		
58	HEADING-STD DEV		
59	CTD MEASUREMENT INTERVAL	MSB	
60			
61		LSB	
62	BT%GD#1 / BT%GD#2		
63	BT%GD#3 / BT%GD#4		

NOTE: SEE TABLE 4-2 FOR DESCRIPTION OF FIELDS

Figure 4-5. Binary Leader Data Format

<table>
<tr><th rowspan="2">BYTE</th><th colspan="2">BIT POSITIONS</th></tr>
<tr><th>7/S 6 5 4</th><th>3/S 2 1 0</th></tr>
<tr><td>1</td><td colspan="2">BIN #1, BEAM #1 MSB</td></tr>
<tr><td>2</td><td>BIN #1, BEAM #1 LSN</td><td>BIN #1, BEAM #2 MSN</td></tr>
<tr><td>3</td><td colspan="2">BIN #1, BEAM #2 LSB</td></tr>
<tr><td>4</td><td colspan="2">BIN #1, BEAM #3 MSB</td></tr>
<tr><td>5</td><td>BIN #1, BEAM #3 LSN</td><td>BIN #1, BEAM #4 MSN</td></tr>
<tr><td>6</td><td colspan="2">BIN #1, BEAM #4 LSB</td></tr>
<tr><td>7</td><td colspan="2">BIN #2, BEAM #1 MSB</td></tr>
<tr><td>8</td><td>BIN #2, BEAM #1 LSN</td><td>BIN #2, BEAM #2 MSN</td></tr>
<tr><td>9</td><td colspan="2">BIN #2, BEAM #2 LSB</td></tr>
<tr><td>10</td><td colspan="2">BIN #2, BEAM #3 MSB</td></tr>
<tr><td>11</td><td>BIN #2, BEAM #3 LSN</td><td>BIN #2, BEAM #4 MSN</td></tr>
<tr><td>12</td><td colspan="2">BIN #2, BEAM #4 LSB</td></tr>
<tr><td>⋮</td><td colspan="2">(This sequence continues for up to 128 bins.)</td></tr>
<tr><td>763</td><td colspan="2">BIN #128, BEAM #1 MSB</td></tr>
<tr><td>764</td><td>BIN #128, BEAM #1 LSN</td><td>BIN #128, BEAM #2 MSN</td></tr>
<tr><td>765</td><td colspan="2">BIN #128, BEAM #2 LSB</td></tr>
<tr><td>766</td><td colspan="2">BIN #128, BEAM #3 MSB</td></tr>
<tr><td>767</td><td>BIN #128, BEAM #3 LSN</td><td>BIN #128, BEAM #4 MSN</td></tr>
<tr><td>768</td><td colspan="2">BIN #128, BEAM #4 LSB</td></tr>
</table>

NOTE: SEE TABLE 4-3 FOR DESCRIPTION OF FIELDS

<u>LEGEND</u>:

S = SIGN BIT
MSB = MOST SIGNIFICANT BYTE
LSB = LEAST SIGNIFICANT BYTE
MSN = MOST SIGNIFICANT NIBBLE
LSN = LEAST SIGNIFICANT NIBBLE

Figure 4-6. Binary Velocity Data Format

BYTE	BIT POSITIONS 7/S, 6, 5, 4, 3, 2, 1, 0
1	BIN #1, BEAM #1
2	BIN #1, BEAM #2
3	BIN #1, BEAM #3
4	BIN #1, BEAM #4
5	BIN #2, BEAM #1
6	BIN #2, BEAM #2
7	BIN #2, BEAM #3
8	BIN #2, BEAM #4
⋮	(SEQUENCE CONTINUES FOR UP TO 128 BINS.)
509	BIN #128, BEAM #1
510	BIN #128, BEAM #2
511	BIN #128, BEAM #3
512	BIN #128, BEAM #4

NOTE: SEE TABLES 4-4, 4-5, AND 4-6 FOR DESCRIPTION OF FIELDS

Figure 4-7. Binary Spectral Width, Echo Intensity, and Percent-Good Data Format

BYTE	7, 6, 5, 4	3, 2, 1, 0
1	BIN #1, BEAM #1	BIN #1, BEAM #2
2	BIN #1, BEAM #3	BIN #1, BEAM #4
3	BIN #2, BEAM #1	BIN #2, BEAM #2
4	BIN #2, BEAM #3	BIN #2, BEAM #4
⋮	(SEQUENCE CONTINUES	FOR UP TO 128 BINS.)
255	BIN 128, BEAM 1	BIN 128, BEAM 2
256	BIN 128, BEAM 3	BIN 128, BEAM 4

NOTE: SEE TABLE 4-7 FOR DESCRIPTION OF FIELDS

Figure 4-8. Binary Status Data Format

BYTE	7, 6, 5, 4, 3, 2, 1, 0	
1	CHECKSUM	MSB
2	DATA	LSB

NOTE: SEE TABLE 4-8 FOR DESCRIPTION OF FIELD

Figure 4-9. Binary Checksum Data Format

Table 4-1. Binary Header Data Format

Byte	Field	Description
		GENERAL – In binary mode, header data is the first item sent by the ADCP to the output buffer. Figure 4-4 shows the format of the header data field. The ADCP does not send header data in ASCII mode.
1,2	Output Data Buffer Size	This field contains the size of the output buffer (in bytes) for one ensemble, excluding the 2-byte checksum (Figure 4-9; Table 4-8). For example, if each ensemble needed 539 bytes of storage space, this field would have a value of 537 (see example in Figure 4-3).
3,4	Leader Data Buffer Size	This field contains the number of bytes stored as leader data (Figure 4-5; Table 4-2) in the output buffer. It is fixed at 63 bytes.
5,6	Velocity Data Buffer Size	This field contains the number of bytes stored contiguously in the output buffer as velocity data (Figure 4-6; Table 4-3). All velocity data fields, whether in earth or beam coordinates, use six bytes of storage per depth cell. For example, if there are 128 depth cells in the profile, and you select velocity data for collection, this field will have a value of 768 (6 × 128). This means the ADCP will store 768 contiguous bytes of velocity data in the output buffer.
7,8	Spectral Width Data Buffer Size	This field contains the number of bytes stored contiguously in the output buffer as spectral width data (Figure 4-7; Table 4-4). All spectral width data fields use four bytes of storage per depth cell. For example, if there are 128 depth cells in the profile, and you select spectral width data for collection, this field will have a value of 512 (4 × 128). This means the ADCP will store 512 contiguous bytes of spectral width data in the output buffer. NOTE: Spectral width is not available for output if you collect velocity data in earth coordinates.
9,10	Echo Intensity Data Buffer Size	This field contains the number of bytes stored contiguously in the output buffer as echo intensity data (Figure 4-7; Table 4-5). All echo intensity data fields use four bytes of storage per depth cell. For example, if there are 128 depth cells in the profile, and you select echo intensity data for collection, this field will have a value of 512 (4 × 128). This means the ADCP will store 512 contiguous bytes of echo intensity data in the output buffer.
11,12	Percent-Good Data Buffer Size	This field contains the number of bytes stored contiguously in the output buffer as percent-good data (Figure 4-7; Table 4-6). All percent-good data fields use four bytes of storage per depth cell. For example, if there are 128 depth cells in the profile, and you select percent-good data for collection, this field will have a value of 512 (4 × 128). This means the ADCP will store 512 contiguous bytes of percent-good data in the output buffer.
13,14	Status Data Buffer Size	This field contains the number of bytes stored contiguously in the output buffer as status data (Figure 4-8; Table 4-7). All status data fields use two bytes of storage per depth cell. For example, if there are 128 depth cells in the profile, and you select status data for collection, this field will have a value of 256 (2 × 128). This means the ADCP will store 256 contiguous bytes of status data in the output buffer.

Table 4-2. Leader Data Format

ASCII Digit	Binary Byte	Field	Description
			GENERAL – ASCII users refer to Figure 4-2. Binary users refer to Figure 4-5.
1,2 3,4 5,6 7,8 9,10	1 2 3 4 5	T: RTC Month RTC Day RTC Hour RTC Minute RTC Second	These fields contain the time from the ADCP's real-time clock (RTC) that the current ensemble began. The T-command (Set Real-Time Clock) initially sets the clock. Each ensemble stores the month, day of month, hour, minute, and second. The ADCP does not store the year and assumes February always has 28 days (leap years not accounted for). *ASCII Scaling:* Units of month, day, hour, minute, and second *Binary Scaling:* Bytes 1-5 are in packed binary coded decimal (BCD) format with the upper nibble (bits 7-4) representing the most significant decimal digit (MSD) and the lower nibble (bits 3-0) representing the least significant decimal digit (LSD) for month, day, hour, minute, and second.
11,12 13,14 15,16	6 7 8	V: TBP Minutes TBP Seconds TBP Sec/100	These fields contain the amount of time between each ping in the ensemble. The V-command initially sets the Time Between Pings. The ADCP stores the most recent input value, or the default value after a Z-command (Reset to Factory Defaults). *ASCII Scaling:* Units of minutes, seconds, and hundredths of seconds *Binary Scaling:* Bytes 6-8 are in packed BCD format. The upper nibble is the MSD, and the lower nibble represents the LSD for minutes, seconds, and hundredths of seconds.
17-21	9,10	P / Pings Per Ensemble	This field contains the number of pings averaged together during an ensemble. The P-command initially sets the number of Pings Per Ensemble. The ADCP stores the most recent input value, or the default value after a Z-command. *Scaling:* LSD = 1 ping; RANGE = 1 to 65,535 pings
22-24	11	Q / No. of Bins	This field contains the number of bins (depth cells) over which the ADCP collects data. The Q-command initially sets the Number of Depth Cells. The ADCP stores the most recent input value, or the default value after a Z-command. *Scaling:* LSD = 1 bin; RANGE = 1 to 128 bins

Table 4-2. Leader Data Format (Continued)

ASCII Digit	Binary Byte	Field	Description
25,26	12	L / Bin Length	This field contains the length of one bin (depth cell). The L-command initially sets the Depth Cell Length. The value stored is the value entered through the L-command, so $2^{L\text{-}COMMAND}$ yields bin length in meters. The ADCP stores the most recent input value or the default value after a Z-command. *Scaling:* LSD = 2^0meter = 1 meter; RANGE = 0 to 5 units (1, 2, 4, 8, 16, or 32 meters)
27,28	13	I / Xmt Pulse Lngth	This field contains the length of the transmitted sonar pulse. The I-command initially sets the Transmit Pulse Length. The ADCP stores the most recent input value, or the default value after a Z-command. *Scaling:* LSD = 1 meter; RANGE = 1 to 99 meters
29,30	14	J / Blank After Xmt	This field contains the distance blanked out by the ADCP to allow time for the transducers to recover after transmitting the sonar pulse. The J-command initially sets the Blank After Transmit distance. The ADCP stores the most recent input value, or the default value after a Z-command. Though the input value is in meters and tenths, the ADCP truncates the decimal portion in the output. For example, the ADCP would use an input of J999 (99.9 meters) for its calculations but display it in the output buffer as 99 meters. *Scaling:* LSD = 1 meter; RANGE = 0 to 99 meters
31,32	15	K / Dly After Blank	This field contains a delay distance added to the J-command value where echo processing for the first depth cell will begin. *Scaling:* LSD = 1 meter; RANGE = 0 to 99 meters
33-37	16,17	ENS. NO. / Ensemble Number	This field contains the sequential number of the ensemble to which the data in the output buffer apply. *Scaling:* LSD = 1 ensemble; RANGE = Ens. 1 to Ens. 65,535 NOTE: The first ADCP ensemble is 00001. At "rollover," we have the following sequence: 00001 = Ensemble number 1 ⋮ 65535 = Ensemble number 65,535 00000 = Ensemble number 65,536 00001 = Ensemble number 65,537 ⋮

Table 4-2. Leader Data Format (Continued)

<table>
<tr><th>ASCII Digit</th><th>Binary Byte</th><th>Field</th><th>Description</th></tr>
<tr><td>38-40</td><td>18</td><td>BIT /
BIT Status</td><td>This field contains the results of the Built-In Test function. The BIT-1 test checks the transmit, receive, and echo processing functions after the last ping of each data collection cycle (ensemble). If the BIT detects only one fault, the ADCP stores the test result code in the output buffer after the first ping of the next ensemble. The output buffer can store only one test result code per ensemble. If more than one fault exists, the ADCP remembers all faults and displays the result codes in successive ensembles. A zero code indicates a successful BIT result. See ¶6-3 for a detailed explanation of the BIT function and all its result codes. Briefly, the following decimal codes indicate the more common problems.
<table>
<tr><th>CODES</th><th>DESCRIPTION</th></tr>
<tr><td>17-31</td><td>BEAM 1 RELATED PROBLEM</td></tr>
<tr><td>33-47</td><td>BEAM 2 RELATED PROBLEM</td></tr>
<tr><td>49-63</td><td>BEAM 3 RELATED PROBLEM</td></tr>
<tr><td>65-79</td><td>BEAM 4 RELATED PROBLEM</td></tr>
<tr><td>81</td><td>VERY LOW TRANSMITTER CURRENT</td></tr>
<tr><td>82</td><td>LOW TRANSMITTER CURRENT (BATTERY ALERT IN SC-ADCPs)</td></tr>
<tr><td>83</td><td>HIGH TRANSMITTER CURRENT</td></tr>
</table>
</td></tr>
<tr><td>41,42</td><td>19</td><td>CONFIG /
ADCP Config</td><td>This field contains information about the ADCP's configuration. The following information explains how to interpret the bits within the configuration byte (ASCII users must first convert this field to a binary value).
<table>
<tr><th>BIT</th><th>DESCRIPTION</th></tr>
<tr><td>0</td><td>VELOCITY RANGE SWITCH SETTING
0 = LOW RANGE (HIGH RESOLUTION)
1 = HIGH RANGE (LOW RESOLUTION)</td></tr>
<tr><td>1</td><td>VELOCITY REFERENCE (FROM O-COMMAND)
0 = RELATIVE TO ADCP (BEAM-COORDINATE SYSTEM)
1 = RELATIVE TO EARTH (EARTH-COORDINATE SYSTEM)</td></tr>
<tr><td>2</td><td>TRANSDUCER ORIENTATION (FROM SWITCH SETTINGS)
0 = UPWARD-LOOKING
1 = DOWNWARD-LOOKING</td></tr>
<tr><td>3</td><td>TRANSDUCER BEAM PATTERN
0 = CONVEX
1 = CONCAVE</td></tr>
<tr><td>4,5,6</td><td>ADCP ACOUSTIC FREQUENCY
000 = 76.8 kHz (75-kHz MODEL)
001 = 153.6 kHz (150-kHz MODEL)
010 = 307.2 kHz (300-kHz MODEL)
011 = 614.4 kHz (600-kHz MODEL)
100 = 1228.8 kHz (1200-kHz MODEL)
101 = 115.0 kHz (115-kHz MODEL)
111 = NONSTANDARD</td></tr>
<tr><td>7</td><td>BYTE VALIDITY CHECK
0 = THIS BYTE DOES <u>NOT</u> CONTAIN VALID DATA
1 = THIS BYTE <u>DOES</u> CONTAIN VALID DATA</td></tr>
</table>
</td></tr>
</table>

Table 4-2. Leader Data Format (Continued)

ASCII Digit	Binary Byte	Field	Description
43,44	20	N / S/N Threshold	This field contains the signal-to-noise threshold value used to determine good data. The N-command initially sets the Signal-to-Noise Threshold. The ADCP stores the most recent input value, or the default value after a Z-command. *Scaling:* LSD = 0.1 dB; RANGE = 0 to 9.9 dB
45,46	21	M / %Gd Threshold	This field contains the percent-good threshold value. The M-command initially sets the Percent-Good Threshold. The ADCP stores the most recent input value, or the default value after a Z-command. *Scaling:* LSD = 1 percent; RANGE = 0 to 99 percent
47-51	22,23	TILT 1 (Pitch)	This field contains the Tilt-1 angle from the internal tilt pendulums or external gyrocompass (if present). Tilt-1 angles correspond to PITCH (x-axis with beam 3 facing north). *Scaling:* LSD = 360/65536 degrees; RANGE = See below

ORIENTATION	SIGN	VALUES	PHYSICAL
DOWNWARD-FACING	+	INCREASING VALUES FROM 0 TO 32766 INDICATE INCREASING POSITIVE VALUES	BEAM 3 HIGHER THAN BEAM 4
	-	DECREASING VALUES FROM 65535 TO 32767 INDICATE INCREASING NEGATIVE VALUES	BEAM 4 HIGHER THAN BEAM 3
UPWARD-FACING	+	INCREASING VALUES FROM 0 TO 32766 INDICATE INCREASING POSITIVE VALUES	BEAM 4 HIGHER THAN BEAM 3
	-	DECREASING VALUES FROM 65535 TO 32767 INDICATE INCREASING NEGATIVE VALUES	BEAM 3 HIGHER THAN BEAM 4

Table 4-2. Leader Data Format (Continued)

<table>
<tr><th>ASCII Digit</th><th>Binary Byte</th><th>Field</th><th>Description</th></tr>
<tr><td>52-56</td><td>24,25</td><td>TILT 2
(Roll)</td><td>This field contains the Tilt-2 angle from the internal tilt pendulums or external gyrocompass (if present). Tilt-2 angles correspond to ROLL (y-axis with beam 3 facing north).

Scaling: LSD = 360/65536 degrees; RANGE = See below

<table>
<tr><th>ORIENTATION</th><th>SIGN</th><th>VALUES</th><th>PHYSICAL</th></tr>
<tr><td rowspan="2">DOWNWARD-FACING</td><td>+</td><td>INCREASING VALUES FROM 0 TO 32766 INDICATE INCREASING POSITIVE VALUES</td><td>BEAM 2 HIGHER THAN BEAM 1</td></tr>
<tr><td>-</td><td>DECREASING VALUES FROM 65535 TO 32767 INDICATE INCREASING NEGATIVE VALUES</td><td>BEAM 1 HIGHER THAN BEAM 2</td></tr>
<tr><td rowspan="2">UPWARD-FACING.</td><td>+</td><td>INCREASING VALUES FROM 0 TO 32766 INDICATE INCREASING POSITIVE VALUES</td><td>BEAM 1 HIGHER THAN BEAM 2</td></tr>
<tr><td>-</td><td>DECREASING VALUES FROM 65535 TO 32767 INDICATE INCREASING NEGATIVE VALUES</td><td>BEAM 2 HIGHER THAN BEAM 1</td></tr>
</table></td></tr>
<tr><td>57-61</td><td>26,27</td><td>HDG /
Heading</td><td>This field contains the heading angle of the ADCP from the internal flux-gate compass or external gyrocompass. The ADCP assumes that the beam 3-4 axis corresponds to the earth's north-south axis.

Scaling: LSD = 360/65536 degrees; RANGE = 360 degrees</td></tr>
<tr><td>62-66</td><td>28,29</td><td>TEMP /
ADCP Temp</td><td>This field contains the water temperature as measured by the thermistor in the transducer head. The range of the water temperature output is from -5°C to +45°C. A zero in this field corresponds to -5°C. A value of 4096 corresponds to +45°C. To determine water temperature from this field, use the formula: Temperature = 45 - (50 × Value / 4096).

Scaling: LSD = 50/4096°C; RANGE = See above</td></tr>
<tr><td>67-69</td><td>30</td><td>HVI /
Hi Volt In</td><td>This field contains the level of the high voltage input to the transducer's power amplifier (V2 battery power for SC-ADCPs).

Scaling: LSD = 0.17 VDC; RANGE = 0 to 43.35 VDC</td></tr>
<tr><td>70-72</td><td>31</td><td>XMT /
Xmt Current</td><td>This field contains the amount of transmitter current being used by the ADCP. Scaling is power-dependent:

<table>
<tr><th>POWER TYPE</th><th>LSD</th><th>RANGE</th></tr>
<tr><td>LOW-POWER</td><td>≈0.01</td><td>0 TO 2.55 A</td></tr>
<tr><td>HIGH-POWER</td><td>≈0.02</td><td>0 TO 5.12 A</td></tr>
</table></td></tr>
</table>

Table 4-2. Leader Data Format (Continued)

ASCII Digit	Binary Byte	Field	Description
73-75	32	LVI / Lo Volt In	This field contains the level of the low voltage input to the ADCP's electronics (V1 battery power in SC-ADCPs). *Scaling:* LSD = 0.05 VDC; RANGE = 0 to 12.75 VDC
76-83	33-35	CTDCOND / CTD Conductivity Count	This field contains the conductivity count from the optional conductivity sensor. To convert these counts to their real measurement value, use the manufacturer's calibration sheet, which lists all coefficients and conversion formulas. *ASCII Scaling:* Multiply the five most significant digits by 256 and add the result to the three least significant digits. You can now use the manufacturer's calibration sheet for conversion. *Binary Scaling:* LSD=1 count; RANGE=0 to 16,777,215 counts
84-91	36-38	CTDTEMP / CTD Temperature Count	This field contains the temperature count from the optional temperature sensor. To convert these counts to their real measurement value, use the manufacturer's calibration sheet, which lists all coefficients and conversion formulas. *ASCII Scaling:* Multiply the five most significant digits by 256 and add the result to the three least significant digits. You can now use the manufacturer's calibration sheet for conversion. *Binary Scaling:* LSD=1 count; RANGE=0 to 16,777,215 counts
92-99	39-41	CTDDEPTH / CTD Depth Count	This field contains the depth (pressure) count from the optional depth sensor. To convert these counts to their real measurement value, use the manufacturer's calibration sheet, which lists all coefficients and conversion formulas. *ASCII Scaling:* Multiply the five most significant digits by 256 and add the result to the three least significant digits. You can now use the manufacturer's calibration sheet for conversion. *Binary Scaling:* LSD=1 count; RANGE=0 to 16,777,215 counts
100-103 104-107 108-111 112-115	42-47	BTV1/BTV1-H&L BTV2/BTV2-H&L BTV3/BTV3-H&L BTV4/BTV4-H&L	These fields contain the velocity of the ADCP in relation to the sea-bottom (or surface) as determined by each beam. Bottom-Track Velocities have the same format and scale factor as profiling velocities. Bad bottom-track data are shown the same way as bad profiling velocities. See Table 4-3 for details and scaling factors.

Table 4-2. Leader Data Format (Continued)

ASCII Digit	Binary Byte	Field	Description
116-119 120-123 124-127 128-131	48-55	BTR1┐ BT Range BTR2├ Beam 1 BTR3│ through BTR4┘ Beam 4	These fields contain the range from the ADCP to the sea bottom (or surface) as determined by each beam. The validity of bottom-track range coincides with the validity of bottom-track velocity. *Scaling:* LSD = 1 meter; RANGE = 0 to 9999 meters
132,133	56	PSD / Pitch-Std Dev	This field contains the standard deviation (accuracy) of TILT 1 (pitch; x-axis) from the pendulum/gyrocompass. *Scaling:* LSD = 0.1 degree; RANGE = 0 to 9.9 degrees
134,135	57	RSD / Roll-Std Dev	This field contains the standard deviation (accuracy) of TILT 2 (roll; y-axis) from the pendulum/gyrocompass. *Scaling:* LSD = 0.1 degree; RANGE = 0 to 9.9 degrees
136,137	58	HSD / Heading-StdDev	This field contains the standard deviation (accuracy) of heading from the compass. *Scaling:* LSD = 1.0 degree; RANGE = 0 to 99 degrees
138-145	59-61	CTDMI / CTD Measurement Interval	This field contains the CTD measurement interval used in conversion calculations for external Conductivity, Temperature, and Depth (pressure) sensors. *ASCII Scaling:* Multiply the five most significant digits by 256 and add the result to the three least significant digits. Now multiply the resultant by 0.001 second to yield the measurement interval. *Binary Scaling:* LSD = 0.001 s; RANGE = 0 to 16,777.215 s
146-150	62,63	BT%Gd#1 BT%Gd#2 BT%Gd#3 BT%Gd#4	These fields contain bottom-track percent-good data for each beam. This percentage indicates the reliability of the bottom-track data. It is the percentage of bottom-track pings that have passed the bottom-track detection threshold (FF command) during an ensemble. *ASCII Scaling:* Convert this field to a binary value, and then use the binary scaling description. *Binary Scaling:* The four nibbles that make up these fields represent beams 1, 2, 3, and 4 (Beam 1 is the most significant nibble). Because nibbles (four bit places) are used, the least significant bit in each nibble is equal to 6.67% (100/15).

Table 4-3. Velocity Data Format

ASCII Digit	Binary Byte	Field	Description
			GENERAL – The ADCP can reference velocity data to either the four radial beams or the earth as selected by the O-command. The beam velocities correspond to beams one through four. The earth-referenced velocity components correspond to east, north, vertical, and an error velocity, respectively.
			The velocity data scale factor depends on the setting of the HIGH/LOW RANGE switch on the Peripherals 2 board (Appendix W) and the transducer frequency. The following table lists the scale factors based on system frequency and the setting of the HIGH/LOW RANGE switch (see note 1). These scale factors assume a water sound velocity of 1536 m/s (see note 2). The table also lists the Doppler frequency shift (in Hz per count) from which the ADCP derives the radial-beam velocity components.

MODEL FREQ. (kHz)	HIGH RANGE[1] / LOW RESOLUTION					LOW RANGE[1] / HIGH RESOLUTION				
	SCALE FACTOR (cm/s PER COUNT) Beam	SCALE FACTOR (cm/s PER COUNT) Earth	MAXIMUM VELOCITY[2] (cm/s) Beam	MAXIMUM VELOCITY[2] (cm/s) Earth	Hz/COUNT	SCALE FACTOR (cm/s PER COUNT) Beam	SCALE FACTOR (cm/s PER COUNT) Earth	MAXIMUM VELOCITY[2] (cm/s) Beam	MAXIMUM VELOCITY[2] (cm/s) Earth	Hz/COUNT
75	0.25	0.5	512	1024	0.25	0.25	0.5	512	1024	0.25
150	0.25	0.5	512	1024	0.5	0.125	0.25	256	512	0.25
300	0.25	0.5	512	1024	1.0	0.125	0.25	256	512	0.5
600	0.25	0.5	512	1024	2.0	0.125	0.25	256	512	1.0
1200	0.25	0.5	512	1024	4.0	0.125	0.25	256	512	2.0

NOTES:
1. HIGH RESOLUTION DECREASES MAXIMUM VELOCITY RANGE. POLE 7 OF SWITCH 2 ON THE PERIPHERAL 2 BOARD SETS VELOCITY RESOLUTION (OPEN = HIGH RANGE/LOW RESOLUTION, CLOSED = LOW RANGE/HIGH RESOLUTION).
2. THE ASSUMED SPEED OF SOUND IS 1536 m/s. FOR TRUE VELOCITIES, MULTIPLY BY [ACTUAL SPEED OF SOUND / 1536].

The ADCP can flag bad velocity data in two ways:

1. If Status data (Table 4-7) are <u>not</u> selected for output, a velocity value of 2048 (100000000000_2) indicates bad velocity data.
2. If Status data are selected for output, a nonzero Status value indicates bad data (see Table 4-7).

NOTE

YOU MAY NEED TO TAKE PRECAUTIONS WHEN USING STATUS DATA AS AN INDICATOR OF BAD DATA. IN SUCH CASES, A VELOCITY DATA VALUE OF 2048 DOES <u>NOT</u> INDICATE BAD DATA. THEREFORE, IF YOU HAVE DEVELOPED SOFTWARE THAT ONLY CHECKS VELOCITY DATA FOR VALUES OF 2048 AS AN INDICATION OF BAD DATA, YOU MAY BE INCLUDING BAD VALUES IN YOUR DATA. IF STATUS DATA ARE SELECTED FOR OUTPUT, USE IT TO CHECK FOR VELOCITY DATA VALIDITY.

Table 4-3. Velocity Data Format (Continued)

ASCII Digit	Binary Byte	Field	Description
			When Status data are an output, and P=1 (Pings Per Ensemble), a velocity data value of zero indicates bad data. When Status data are an output and P>1, the ADCP provides velocity data independent of the Status indication when any ping within the sampling interval (R-command) passes the signal-to-noise threshold (N-command). When bottom-tracking is ON (FH-command) and the bottom is detected, a DR or VM-ADCP may flag velocity data as bad for depth cells (bins) within 15% of the range to the bottom. However, you may override this automatic data rejection with the O-command. If this override function is ON, the data may or may not be valid. SC-ADCPs do not reject any bottom-track velocity data. **ASCII FORMAT** – With velocity data selected for output, the first digit of velocity data follows the CR/LF sequence after the leader data (see Figures 4-1 and 4-2). ASCII velocity data require four digits per depth cell (bin) per beam. The range of ASCII counts for velocity data is 0-4096. If the count is more than 2048, the Doppler shift is negative. To get the negative count value, subtract 4096 from counts greater than 2048. For example, if the ASCII count is 3010, the actual ASCII count is 3010 - 4096, or -1086 counts. To convert velocity counts to cm/s, use the table in the general description above. We explain the format for only the first 16 digits of the ASCII velocity data format (Bin #1). The same 16-digit sequence continues for up to 128 bins. The number of 16-digit bin groups depends on the number of bins selected for profiling by the Q-command. With all 128 bins selected, the output uses 2048 ASCII digits (16 × 128) for velocity data. **BINARY FORMAT** – With velocity data selected for output, the first byte of binary velocity data follows the last byte of leader data (see Figure 4-3). Binary velocity data use 6 bytes of output buffer space per depth cell (bin). Figure 4-6 shows how each byte "looks." These 6 bytes store data for each of the four beams. Each beam uses 12 bit positions (1 byte + 1 nibble). The output buffer stores velocity data in two's complement, so either Bit 7 (for Most Significant Bytes) or Bit 3 (for Most Significant Nibbles) serves as the Sign Bit. When the sign bit is set, the velocity data for that bin/beam is a negative value. To convert the ADCP velocity counts to cm/s, use the table in the general description above. We explain the format for only the first 6 bytes of the binary velocity data format (Bin #1). The same 6-byte sequence continues for up to 128 bins. The number of 6-byte bin groups depends on the number of bins selected for profiling (Q-command). With all 128 bins selected, the output buffer uses 768 bytes (6 × 128) of storage space for velocity data.

Table 4-3. Velocity Data Format (Continued)

ASCII Digit	Binary Byte	Field	Description
1-4	1,2	Bin 1, Beam 1	This field contains the velocity data for bin #1, beam #1. See the descriptions above for more information.
5-8	2,3	Bin 1, Beam 2	This field contains the velocity data for bin #1, beam #2. See the descriptions above for more information.
9-12	4,5	Bin 1, Beam 3	This field contains the velocity data for bin #1, beam #3. See the descriptions above for more information.
13-16	5,6	Bin 1, Beam 4	This field contains the velocity data for bin #1, beam #4. See the descriptions above for more information.
17-2048	7-768	Bins 2 - 128 (if used)	These fields contain the velocity data for bins 2 through 128 (depending on the setting of the Q-command) for all four beams. These fields follow the same format as listed above for bin 1.

Table 4-4. Spectral Width Data Format

ASCII Digit	Binary Byte	Field	Description
			GENERAL — If you collect velocity data in earth coordinates (set by O-command), the ADCP cannot collect spectral width data. The spectral width scale factor is twice the velocity data scale factor (see Table 4-3). The ADCP can flag bad spectral width data in two ways: 1. If Status data (Table 4-7) are not selected for output, a spectral width value of zero indicates bad spectral width data. 2. If Status data are selected for output, a nonzero Status value indicates bad data (see Table 4-7). **ASCII FORMAT** — When selected for output, the first digit of spectral width data follows the CR/LF sequence after the last data field collected (see Figure 4-2). Spectral width data use 3 digits per bin per beam, so the first 12 digits correspond to Bin #1. This 12-digit sequence continues for up to 128 bins (determined by Q). Selecting all 128 bins uses 1536 digits (12 × 128) for spectral width data. To convert spectral width counts to cm/s, see the discussion in Table 4-3. **BINARY FORMAT** — When selected for output, the first byte of spectral width data follows the last byte of the last data field collected (see Figure 4-3). Spectral width data use 4 bytes of output buffer space per bin, with each byte storing data for one beam (see Figure 4-7). The first 4 bytes of spectral width data correspond to Bin #1. This 4-byte sequence continues for up to 128 bins (determined by Q). Selecting all 128 bins uses 512 bytes (4 × 128) of buffer space for spectral width data. Spectral width is in two's complement, with Bit 7 being the Sign Bit. When the Sign Bit = 1, spectral width data for that bin/beam is negative. To convert spectral width counts to cm/s, see the discussion in Table 4-3.
1-3	1	Bin 1, Beam 1	This field stores spectral width data for bin #1, beam #1. See the descriptions above for more information.
4-6	2	Bin 1, Beam 2	This field stores spectral width data for bin #1, beam #2. See the descriptions above for more information.
7-9	3	Bin 1, Beam 3	This field stores spectral width data for bin #1, beam #3. See the descriptions above for more information.
10-12	4	Bin 1, Beam 4	This field stores spectral width data for bin #1, beam #4. See the descriptions above for more information.
13-1536	5-512	Bins 2 - 128 (if used)	These fields store spectral width data for bins 2 through 128 (depending on the Q-command) for all four beams. These fields follow the same format as listed above for bin 1.

Table 4-5. Echo Intensity Data Format

ASCII Digit	Binary Byte	Field	Description
			GENERAL – The echo intensity scale factor is about 0.45 dB per ADCP count. The ADCP does not directly check for the validity of echo intensity data. **ASCII FORMAT** – When selected for output, the first digit of echo intensity data follows the CR/LF sequence after the last data field collected (see Figure 4-2). Echo intensity data use 3 digits per bin per beam, so the first 12 digits correspond to Bin #1. This 12-digit sequence continues for up to 128 bins (determined by Q). Selecting all 128 bins uses 1536 digits (12 × 128) for echo intensity data. To convert echo intensity counts to dB, multiply counts by 0.45 dB. **BINARY FORMAT** – When selected for output, the first byte of echo intensity data follows the last byte of the last data field collected (see Figure 4-3). Echo intensity data use 4 bytes of output buffer space per bin, with each byte storing data for one beam (see Figure 4-7). The first 4 bytes of echo intensity data correspond to Bin #1. This 4-byte sequence continues for up to 128 bins (determined by Q). Selecting all 128 bins uses 512 bytes (4 × 128) of buffer space for echo intensity data. To convert echo intensity counts to dB, multiply counts by 0.45 dB.
1-3	1	Bin 1, Beam 1	This field stores echo intensity data for bin #1, beam #1. See the descriptions above for more information.
4-6	2	Bin 1, Beam 2	This field stores echo intensity data for bin #1, beam #2. See the descriptions above for more information.
7-9	3	Bin 1, Beam 3	This field stores echo intensity data for bin #1, beam #3. See the descriptions above for more information.
10-12	4	Bin 1, Beam 4	This field stores echo intensity data for bin #1, beam #4. See the descriptions above for more information.
13-1536	5-512	Bins 2 - 128 (if used)	These fields store echo intensity data for bins 2 through 128 (depending on the Q-command) for all four beams. These fields follow the same format as listed above for bin 1.

Table 4-6. Percent-Good Data Format

ASCII Digit	Binary Byte	Field	Description
			GENERAL – The percent-good data field is a data-quality indicator that reports the percentage (0-99) of GOOD data collected for each depth cell (bin) of the velocity profile. The meaning of the percent-good data depends on whether you collect the velocity data in EARTH or BEAM coordinates (set by O-command).

Earth-coordinate velocities – With velocities in EARTH coordinates, decode the percent-good field as follows:

```
BIN n (1 THROUGH 128)
xx  xx  xx  xx
            └─ PERCENT OF GOOD FOUR-BEAM SOLUTIONS
        └───── SPARE (ALWAYS 99)
    └───────── PERCENT OF GOOD ERROR VELOCITIES
└───────────── PERCENT OF GOOD THREE AND FOUR-BEAM SOLUTIONS
```

Beam-coordinate velocities – With velocities in BEAM coordinates, decode the percent-good field as follows:

```
BIN n (1 THROUGH 128)
xx  xx  xx  xx
            └─ PERCENT OF GOOD DATA FOR BEAM #4
        └───── PERCENT OF GOOD DATA FOR BEAM #3
    └───────── PERCENT OF GOOD DATA FOR BEAM #2
└───────────── PERCENT OF GOOD DATA FOR BEAM #1
```

Example – At the start of the velocity profile, the echo intensity is usually high on all four beams. Under this condition the ADCP uses all 4 beams to calculate the orthogonal and error velocities. As the echo returns from far away bins, echo intensity decreases. At some point, the echo will be weak enough on any given beam to cause the ADCP to reject some of its bin data. This causes the ADCP to calculate velocities with 3 beams instead of 4 beams. When the ADCP does 3-beam solutions, it stops calculating the error velocity because it needs 4 beams to do this. At some further bin, the ADCP rejects all bin data because of the weak echo. The following example represents percent-good from a distant bin where some data are being rejected, and the ADCP is doing 3-beam solutions.

```
BIN 60
9 9  8 5  9 9  4 5
                       EARTH                          | BEAM
               └─ PERCENT OF GOOD FOUR-BEAM SOLUTIONS | BEAM #4
          └────── SPARE (ALWAYS 99)                   | BEAM #3
     └─────────── PERCENT OF GOOD ERROR VELOCITIES    | BEAM #2
└──────────────── PERCENT OF GOOD 3 AND 4-BEAM SOLUTIONS | BEAM #1
```

With velocities collected in BEAM coordinates, the example values show the percentage of pings having good solutions in bin 60 for each beam based on the Signal-to-Noise Threshold (N-command). Here, beam 1=99%, beam 2=85%, beam 3=99%, beam 4=45%.

Table 4-6. Percent-Good Data Format (Continued)

ASCII Digit	Binary Byte	Field	Description
			On the other hand, with velocities collected in EARTH coordinates, the example values show (from right to left): · Percent of good 4-beam solutions-45% of the velocity data collected during the ensemble for bin 60 was calculated using 4 beams · Spare-Always 99 · Percent of good error velocities-Shows the percent of error velocity (85%) that was less than the CB-command setting. CB has a default of 10000. The ADCP multiplies CB by the velocity scale factor setting to get the error in cm/s. This large CB setting effectively prevents the ADCP from rejecting data based on error velocity. · Percent of good 3 and 4-beam solutions-Shows the TOTAL percentage of successful velocity calculations (99%) using 3 and 4-beam solutions. Subtracting the percentage of 4-beam solutions (45%) from the percentage of 3 and 4-beam solutions (99%), yields the percentage of calculations for bin 60 done using 3-beam solutions (54%). The value in this field decreases to zero at some point where the echo intensity is too weak to measure in any beam. **ASCII FORMAT** – When selected, percent-good data follow the CR/LF after the last data field collected (Figure 4-2). Percent-good data use 2 digits per bin per beam in beam coordinates, or 2 digits per field in earth coordinates. In either case, the first 8 digits correspond to bin 1. This 8-digit sequence continues for up to 128 bins (set by Q). Selecting all 128 bins uses 1024 digits (8 × 128). **BINARY FORMAT** – When selected, percent-good data follow the last byte of the last data field collected (Figure 4-3). Percent-good data use 4 bytes of output buffer space per bin (Figure 4-7). The first 4 bytes correspond to bin 1. This 4-byte sequence continues for up to 128 bins (set by Q). Selecting all 128 bins uses 512 bytes (4 × 128) of buffer space.
1-2	1	Bin 1, Beam 1	This field stores percent-good data for Bin #1: beam #1 (BEAM) or percent of good 3 and 4-beam solutions (EARTH). See above.
3-4	2	Bin 1, Beam 2	This field stores percent-good data for Bin #1: beam #2 (BEAM) or percent of good error velocities (EARTH). See above.
5-6	3	Bin 1, Beam 3	This field stores percent-good data for Bin #1: beam #3 (BEAM) or spare (EARTH). See above.
7-8	4	Bin 1, Beam 4	This field stores percent-good data for Bin #1: beam #4 (BEAM) or percent of good 4-beam solutions (EARTH). See above.
9-1024	5-512	Bins 2 - 128 (if used)	These fields store percent-good data for bins 2 through 128 (depending on Q), following the same format as listed above for bin 1.

Table 4-7. Status Data Format

ASCII Digit	Binary Byte	Field	Description
			GENERAL – These fields contain information about the status and quality of ADCP data. To conserve buffer space, the status data fields are condensed and represent a series of flags (bits) being set or not set. The setting of each bit shows a particular status condition for each beam and the overall depth cell (bin) quality at that depth. When you view the Status data, most times it will show all zeros. This means NO bits are set and data quality is 100%. Toward the end of the ADCP's profiling range as the acoustic signal begins to die out, the echo intensity gets weaker and is approaching levels equal to, and finally less than the thermal noise levels in each receive channel of the ADCP. It is in this area that the ADCP begins reporting varying status conditions about the data it is collecting and rejecting. The following information and example explain how to interpret the bits within the status field (ASCII users must first convert the hexadecimal digits to binary).

BIT	BEAM STATUS DESCRIPTION
0	IF SET, THE PERCENTAGE OF DATA REJECTED DUE TO THE SIGNAL-TO-NOISE CRITERIA SET BY THE M-COMMAND HAS BEEN EXCEEDED. THE M-COMMAND SETS THE MINIMUM PERCENTAGE OF GOOD DATA ALLOWED IN ANY BIN (TYPICALLY 25%). IF THIS BIT IS SET, THE ECHO INTENSITY FOR THIS BEAM WAS TOO WEAK FOR THE ADCP TO PROCESS.
1	ALWAYS 0.
2	BIT 2 WILL BE SET IF BIT 0 IS SET, OR IF THE BOTTOM-TRACK RANGE IS BEYOND THE BOTTOM (OR SURFACE). THIS MEANS IF YOU ARE USING BOTTOM TRACK, AND THE VELOCITY DATA ARE BEYOND THE DETECTED OCEAN BOTTOM, THE ADCP SETS BIT 2.
3	ALWAYS 0 WHEN COLLECTING VELOCITY DATA IN BEAM COORDINATES. WHEN COLLECTING VELOCITY DATA IN EARTH COORDINATES, THE ADCP COMBINES THE BIT-3s FROM EACH BEAM TO CREATE A SEPARATE NIBBLE THAT PROVIDES A BIN STATUS CODE. DECODE THE BITS IN THIS BIN-STATUS NIBBLE AS FOLLOWS:

BIT	BIN STATUS DESCRIPTION
0	IF SET, THE NUMBER OF 4-BEAM SOLUTIONS WAS LESS THAN THE PERCENT-GOOD THRESHOLD SET BY THE M-COMMAND (TYPICALLY 25%). THIS MEANS BIT 0 OF THE BIN STATUS WILL BE SET IF THE ADCP COLLECTED MORE THAN 75% OF THE DATA USING 3-BEAM SOLUTIONS.
1	ALWAYS 0.
2	IF SET, ERROR VELOCITY DOES NOT MEET CRITERIA SET BY THE REASONABLENESS THRESHOLD (CB-COMMAND). CB'S DEFAULT IS 10000 AND IS MULTIPLIED BY THE RANGE SWITCH SCALE FACTOR (0.25 FOR HIGH RANGE AND 0.125 FOR LOW RANGE). THIS DEFAULT VALUE EFFECTIVELY DISABLES THE ABILITY OF THE ADCP TO DISCARD DATA IF ERROR VELOCITY IS LARGE.
3	IF SET, THE NUMBER OF 3 AND 4-BEAM SOLUTIONS WAS LESS THAN THE M-COMMAND THRESHOLD (TYPICALLY 25%).

Example – The following sample data are from an "end-of-range" bin where the echo intensity is approaching the thermal noise floor. The velocity data were collected in earth coordinates. We will use a status value of D058.

Table 4-7. Status Data Format (Continued)

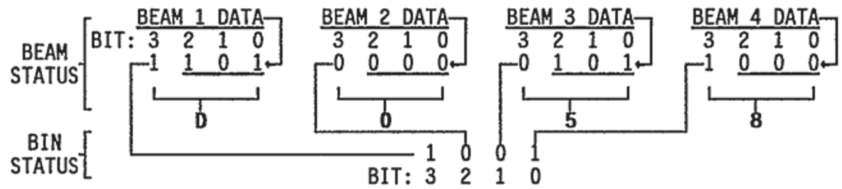
ASCII Digit	Binary Byte	Field	Description
			Decode the status bytes nibble by nibble (4 bits each). The first 3 bits in every nibble represent the status for a particular BEAM. Combine the last bit (the MSB) with the MSBs from the other BEAM status nibbles to create the BIN status nibble.  In this example, beams 1 and 3 rejected data based on M-command criteria (Bit 0 = 1 in BEAM STATUS nibbles). Bit 2 is set for beams 1 and 3 only because their Bit 0's were set. The BIN DATA in this example collected more than M-command percent of the bin data using three beams (Bit 0 = 1 in BIN STATUS nibble). Also, the number of three and four-beam solutions was less than the M-command threshold for this BIN (Bit 3 = 1 in BIN STATUS nibble). **ASCII FORMAT** — When selected for output, the first digit of status data follows the CR/LF sequence after the last data field collected (see Figure 4-2). Status data use 1 hexadecimal digit per bin per beam, so the first 4 hexadecimal digits correspond to Bin #1. This 4-digit sequence continues for up to 128 bins (determined by Q). Selecting all 128 bins uses 512 digits (4 × 128) for status data. **BINARY FORMAT** — When selected for output, the first nibble of status data follows the last byte of the last data field collected (see Figure 4-3). Status data use 2 bytes (4 nibbles) of output buffer space per bin, with each nibble storing data for one beam (see Figure 4-8). The first 2 bytes of status data correspond to Bin #1. This 2-byte sequence continues for up to 128 bins (determined by Q). Selecting all 128 bins uses 256 bytes (2 × 128) of buffer space for status data.
1	1MSN	Bin 1, Beam 1	This field stores status data for bin #1, beam #1. See the descriptions above for more information.
2	1LSN	Bin 1, Beam 2	This field stores status data for bin #1, beam #2. See the descriptions above for more information.
3	2MSN	Bin 1, Beam 3	This field stores status data for bin #1, beam #3. See the descriptions above for more information.
4	2LSN	Bin 1, Beam 4	This field stores status data for bin #1, beam #4. See the descriptions above for more information.
5-512	3-256	Bins 2 - 128 (if used)	These fields store status data for bins 2 through 128 (depending on the Q-command) for all four beams. These fields follow the same format as listed above for bin 1.

Table 4-8. Binary Checksum Data Format

Byte	Field	Description
1,2	Checksum Data	This field contains a modulo 65536 checksum. The ADCP computes the checksum by summing all the bytes in the output buffer excluding the checksum (see Figure 4-3).