APPENDIX C
Data Formats

ASCII Asynchronous Format

The ASCII asynchronous format is capable of higher data transfer rates since it employs run-length encoding and does not send empty radials.

The ASCII data format is composed of normal, printable, ASCII characters. The format consists of several header lines to identify the radar image, followed by the radar's radial data and finishing with the line "ctrlZ END RADAR IMAGE".

- **Defined Header fields :**

Each of the header lines are preceded by one of the following Header descriptors. Not all header descriptors are used for all images. Certain header descriptors for example are only intended for RHI, PPI or VOLUMETRIC type images.

AZIM:	Used to identify an RHI's azimuth position (0.1 deg resolution)
ANGRES:	0.1 degree resolution.
COUNTRY:	ISO 3166 Country code to identify country of installation.
DATE:	Format is Julian Day Number then Year. i.e.. Feb. 1 1991 = 03291.
DBM2DBZ:	Value to be added to the dBm threshold information to obtain the correct dBz level for each threshold. See DBMLVL:
DBMLVL:	List of dBm levels beginning at the threshold for level 1 up to the number of thresholds for the current video resolution. See VIDRES:
ELEV:	Used to identify base elevation scan for PPI images (0.1 deg resolution).
FAULT:	error number followed by text message. (fault conditions only)
IMGFMT:	COMPPPI, PPI or RHI.
NAME:	Abbreviated name of radar site (8 characters maximum)
PASS:	Applicable only to volumetric images, pass number of total passes.
PRODUCT:	TEST, ERROR, CUSTOM, NORMAL,TAST or VOLUMETRIC the volumetric product includes a batch start time enclosed in square brackets after VOLUMETRIC ; e.g.. [010719891] $\Rightarrow$ 1:07gmt jdn.198 yr.1991
RNGRES:	2000 1000 500 250 metres
STARTRNG:	1000, 2000, 3000, 4000 metres
STNID:	station number, used by McIDAS connected systems.
TIME:	time that image was captured in GMT.
VERS:	current software version of Rapic Transmitter.
VIDEO:	Reflectivity or Velocity.
VIDRES:	6 or 16

- **Radial Representation**

Radials begin with the % character followed by the angle of the radial.
PPI radials can be any value between 0 and 359 (1 degree resolution).
RHI radials can be any value between 0.0 and 90.0 (0.1 degree resolution).

Radials are normally terminated with a carriage return.
X28 services terminate each radial with the '#' character. This ensures that the most effective use of packets is utilized for the duration of the radar data.

Radials that contain nil returns are not transmitted, **except** if radar data is being concurrently transmitted.

The radar data is typically offset by 4km. i.e.. there is no data for the first 4km. This can be overriden by use of the STARTRNG: header entry.

The default range resolution is 2km. The range resolution can be over-ridden by use of the header parameter RNGRES:
The maximum expected range is 512km.

The default video resolution is 6 levels. The video resolution can be over-ridden by use of the header parameter VIDRES:

Typical radials are laid out as follows:

PPI radial	RHI radial	
%314**********↵	%23.6**********↵	or
%314**********#	%23.6**********#	for X28 services

(where ********** represents the radar data)

- **Indicating End Of Transmission**

The end of transmission is indicated with the string:

<ctrl-Z> END RADAR IMAGE↵.

- **Typical ASCII image**

A typical ASCII image appears below:

```
COUNTRY: 036
NAME:  WkShop
STNID: 62
DATE:  19291
TIME:   07:10
VERS:  8.06
RNGRES: 2000
ANGRES: 1.0
VIDRES: 6
PRODUCT: NORMAL
IMGFMT: CompPPI
ELEV:  1.0
%010********
%210**********
%358********                    (***** represents radar data)
<ctrl-Z> END RADAR IMAGE
```

Six Level ASCII Encoding

Identified in ASCII header as: **VIDRES 6**

Two successive range cells are nibble packed into a byte and then encoded into a letter. Each letter therefore represents two nibbles, the lower nibble being the first cell followed by the upper nibble. The following translation table is used to decode the letters into the actual video levels of 0 to 6.

Video Level		First Range Bin						
		0	1	2	3	4	5	6
Second Range Bin	0	A	B	C	D	E	F	G
	1	H	I	J	K	L	M	N
	2	O	P	Q	R	S	T	U
	3	V	W	X	Y	a	b	c
	4	d	e	f	g	h	i	j
	5	k	l	m	n	o	p	q
	6	r	s	t	u	v	w	x

n.b. letter “Z” and “z” are not used.

- **Six Level Run Length Encoding**

Run-length compression is used to improve radial compression.
A number occurring after a letter implies that the previous **character** is repeated that number of times.

The examples following illustrate how the six level encoding operates:

- **Six Level ASCII examples**

AHIa decodes to 0,0, 0,1, 1,1 4,3,
A H I a

A2HIa5 decodes to 0,0, 0,0,0,0, 0,1, 1,1, 4,3, 4,3,4,3,4,3,4,3,4,3
A 2 H I a 5

A10H1adecodes to 0,0, 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0, 0,1, 0,1, 4,3
A 10 H I a

Sixteen Level ASCII Encoding

Identified in ASCII header as: **VIDRES 16**

There are sixteen characters which define the sixteen video levels absolutely, and forty nine characters which allow a deviation of up to ±3 levels for two successive range bins to be encoded.

An absolute level character is used in the following two instances:
1. The first range bin of a radial &
2. When the deviation between two successive range bins is greater than 3 levels.

The sixteen characters that define absolute levels are as below:

Code	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Level	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

The forty nine characters that define the deviation encoding are as below:

Deviation		First Range Bin						
		-3	-2	-1	0	1	2	3
Second Range Bin	-3	!	[	a	b	c	]	@
	-2	/	d	e	f	g	h	\
	-1	i	j	k	<	l	m	n
	0	o	p	-	.	+	q	r
	1	s	t	u	>	v	w	x
	2	(	y	S	T	U	V	)
	3	$	{	W	X	Y	}	&

- **Sixteen Level Run Length Encoding**

Run length encoding is utilized to improve the compression of radials.
A number occurring after a letter implies that the last encoded **video level** repeats for the next number of range bins.

The examples below illustrate how the 16 level encoding operates:

- **Sixteen Level ASCII examples**

A4v2XJ decodes to 0, 0,0,0,0, 1,2, 2,2, 2,5, 9
A 4 v 2 X J

ATm3x6A decodes to 0, 0,2, 4,3, 3,3,3, 6,7, 7,7,7,7,7,7, 0
A T m 3 x 6 A

Thirty Two Level ASCII Encoding

Identified in ASCII header as: **VIDRES 32**

See the description for 160 Level encoding

Sizty Four Level ASCII Encoding

Identified in ASCII header as:**VIDRES 64**

See the description for 160 Level encoding

One Hundred and Sixty Level ASCII Encoding

Identified in ASCII header as:**VIDRES 160**

The ASCII encoding for video levels greater than 16 behaves in an identical fashion to 16 level encoding except that an extended Absolute Table is used:

Level	ASCII	Level	ASCII	Level	ASCII	Level	ASCII
0	A - 0x41	40	0x88	80	0xb0	120	0xd8
1	B - 0x42	41	0x89	81	0xb1	121	0xd9
2	C - 0x43	42	0x8a	82	0xb2	122	0xda
3	D - 0x44	43	0x8b	83	0xb3	123	0xdb
4	E - 0x45	44	0x8c	84	0xb4	124	0xdc
5	F - 0x46	45	0x8d	85	0xb5	125	0xdd
6	G - 0x47	46	0x8e	86	0xb6	126	0xde
7	H - 0x48	47	0x8f	87	0xb7	127	0xdf
8	I - 0x49	48	0x90	88	0xb8	128	0xe0
9	J - 0x4a	49	0x91	89	0xb9	129	0xe1
10	K - 0x4b	50	0x92	90	0xba	130	0xe2
11	L - 0x4c	51	0x93	91	0xbb	131	0xe3
12	M - 0x4d	52	0x94	92	0xbc	132	0xe4
13	N - 0x4e	53	0x95	93	0xbd	133	0xe5
14	O - 0x4f	54	0x96	94	0xbe	134	0xe6
15	P - 0x50	55	0x97	95	0xbf	135	0xe7

Level	ASCII	Level	ASCII	Level	ASCII	Level	ASCII
16	" - 0x22	56	0x98	96	0xc0	136	0xe8
17	’ - 0x27	57	0x99	97	0xc1	137	0xe9
18	* - 0x2a	58	0x9a	98	0xc2	138	0xea
19	, - 0x2c	59	0x9b	99	0xc3	139	0xeb
20	’:’ - 0x3a	60	0x9c	100	0xc4	140	0xec
21	; - 0x3b	61	0x9d	101	0xc5	141	0xed
22	= - 0x3d	62	0x9e	102	0xc6	142	0xee
23	? - 0x3f	63	0x9f	103	0xc7	143	0xef
24	Q - 0x51	64	0xa0	104	0xc8	144	0xf0
25	R - 0x52	65	0xa1	105	0xc9	145	0xf1
26	Z - 0x5a	66	0xa2	106	0xca	146	0xf2
27	^ - 0x5e	67	0xa3	107	0xcb	147	0xf3
28	_ - 0x5f	68	0xa4	108	0xcc	148	0xf4
29	z - 0x7a	69	0xa5	109	0xcd	149	0xf5
30	| - 0x7c	70	0xa6	110	0xce	150	0xf6
31	~ - 0x7e	71	0xa7	111	0xcf	151	0xf7
32	0x80	72	0xa8	112	0xd0	152	0xf8
33	0x81	73	0xa9	113	0xd1	153	0xf9
34	0x82	74	0xaa	114	0xd2	154	0xfa
35	0x83	75	0xab	115	0xd3	155	0xfb
36	0x84	76	0xac	116	0xd4	156	0xfc
37	0x85	77	0xad	117	0xd5	157	0xfd
38	0x86	78	0xae	118	0xd6	158	0xfe
39	0x87	79	0xaf	119	0xd7	159	0xff

Delta encoding is still constrained to +- 3 levels. Transitions outside this are fixed to a new absolute value.

Binary Async Format

The Binary Async format is used primarily to disseminate the raw ADC data read from the DVIP.

- **Encoding Method**

No encoding is performed upon the data other than Run Length Encoding regions of data whose value equals 0 or 1.

The data is encoded such that should a '0' or a '1' be detected, the detected value is written out and then the next value in the stream is actually a run count.

For example to encode a sequence of 10 nulls ie 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00, the output will be 0x00 0x0a. Note that a single isolated null will actually be encoded as 0x00 0x01, this is actually wasteful since two bytes now occupy the space for one byte but this should normally be the exception rather than the rule.

The end of radial is logically marked as 0x00 0x00 since this sequence can never appear in the encoded data stream.

If a sequnce of more than 256 nulls should occur, the run length is broken down into two segments.

Since radar images tend to have a lot of null data, the compression achieved is reasonably good despite having full 8 bit data available.

- **Radial Header**

Each binary async radial starts with the '@' symbol as distinct from the '%' symbol used for Normal ASCII async data.

Following the @ is the azimuth, elevation and offset time and remaining length for each radial as follows:

@AAA.A,EEE.E,TTT=HHLL

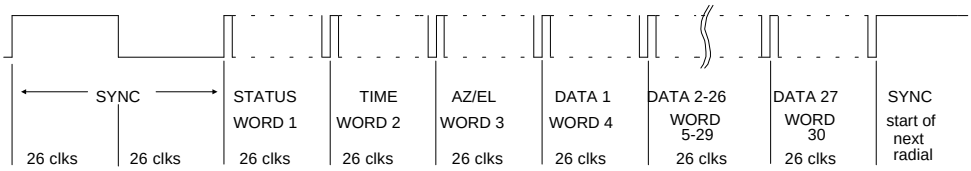
where: AAA.A is the azimuth angle
EEE.E is the elevation angle
TTT is the offset time from the start of this scan for this radial in seconds
HH is the 8 MS bits of a 16 bit count value
LL is the 8 LS bits of a 16 bit count value.

The length is the number of bytes which immediately follow this radial header, including the terminating null characters.

The radial header always occupies the same number of bytes regardless of antenna angle, i.e. all values include leading zeroes.

Synchronous Format

The Synchronous format is the current format used for transmission of radar pictures. It consists of a serial data stream of the format below:



There are up to 32 words, each of 26 bit size to create each radial of radar information.

The first 52 bits make up a sync pattern of 26 high and then 26 low bits. This indicates the start of a radial.

WORD 1 contains current radar status and is not used by the Rapic Tx.
WORD 2 holds the station identification code and the time of the current picture. Note that the date is not part of the Synchronous format. This is supplied by the PC Rapic.
WORD 3 holds the azimuth and elevation of the current radial.
WORDS 4-30 hold the radar rain-rate data. There are 27 of these data words, each of range 16km. Therefore the maximum range available using the Synchronous format is 432km.

The bit definitions for the words used in the Synchronous format are shown below.