

RSTN Decode User's Guide

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1 Introduction

Radio Solar Telescope Network (RSTN) Decode software is designed to convert the data from RSTN archive tapes into the format compatible with Sun workstations and personal computers employed at NGDC. RSTN archive tapes are written using 16 bit HP computers utilizing floating point format incompatible with the current IEEE Standard 754. RSTN Decode software converts the tape input data to ASCII text format and outputs it to disk.

RSTN Decode software consists of the command-line driven `rstn` program and an interactive `rstn_tape` shell script. All routine processing should be done with the `rstn_tape` script. This script is designed to process up to ten 3480 archive tapes at a time in batch mode. The `rstn_tape` script uses the `rstn` program to perform the actual processing. Both programs should be in the user's path to ensure proper operation.

The `rstn` program is written in ANSI standard C language and is compiled using GCC version 2.7.0. The program was only tested on a Sun workstation running Solaris 2.4, but it should work on any 32-bit computer running a System V variant of Unix. All features of the program except tape access should work on a personal computer running DOS or Windows 95/NT. The `rstn_tape` script is written for Bourne shell `sh`, which is bundled with the Solaris 2.X operating system.

2 Archive Tape Format

Before describing the use of the RSTN Decode software, we feel it is useful to briefly outline the format of the archive tapes. RSTN members supply their data to NGDC on 9-track (round reel) tapes. NGDC archive 3480 (square) tapes are created from the original 9-track tapes supplied by the RSTN observatories.

The 9-track tapes typically contain four or five days of data, arranged with approximately one day of data per file. An RSTN 9-track tape consists of a *tape directory* file, followed by four or five *daily save* files. Tape directory file consists of a small amount of information (number of daily save files on tape, year and date of the beginning and end of each data file, as well as the observing station ID) about each daily save file that follows. The tape directory file is always exactly 2550 bytes long. Daily save files consist of a header (containing the observatory information and a variety of detector and calibration parameters), followed by one-second data records and burst logs. Daily save files are typically three to five megabytes in size.

The 9-track tapes supplied by the RSTN observatories are collated to 3480 archive tapes at NGDC. Archive tapes consist of a *tape label* file (tape number, e.g. **A1234**, and the archive name), followed by the contents of the 9-track tapes. Thus, the typical layout of an archive tape is as follows:

Tape File	Contents
0	Tape Label (e.g. A1234)
1	Tape Directory from 9-track #1
2	Daily File #1 from 9-track #1
3	Daily File #2 from 9-track #1
4	Daily File #3 from 9-track #1
5	Tape Directory from 9-track #2
6	Daily File #1 from 9-track #2
7	Daily File #2 from 9-track #2
8	Daily File #3 from 9-track #2
...	...

3480 archive tapes can contain anywhere from 30 to 100 daily save files. When decoded, the information from each daily save file occupies anywhere from 5 MB to 10 MB, so the storage space requirements are quite substantial. Nevertheless, the decoded ASCII files compress to under one megabyte.

3 Routine Processing of RSTN Archive Tapes

Routine (batch) processing of RSTN tapes is performed using the `rstn_tape` script. The following is a sample processing session of 7 archive tapes mounted in the autoloader in drive 3. User input is shown in italics.

```
RSTN Archive Tape Decoder
-----
Select drive number [2] 3
Number of tapes to be processed [1] 7
Run in inventory mode [N]/Y N
Processing tape #1, saving log to A1234.log
...
...
Processing tape #7, saving log to A7890.log
```

For each daily save file on an archive tape, two ASCII files are created in the user's current directory, `YYYY.HHHH.SSSS.data` and `YYYY.HHHH.SSSS.burst`. The files contain one-second data entries and burst log entries, respectively.¹ The filename is composed of the year, hour into the year, and second into the hour of the first data entry in the corresponding input file. In addition to the data and burst files, `rstn_tape` script also saves the processing log for each archive tape into a file `Atape.log`, where `Atape` is the archive tape label. Thus, if seven tapes are successfully processed, there will be seven log files created in the current directory. A sample log file follows:

```
4 file(s) follow
#
```

¹Note that it is possible to run the `rstn_tape` script, as well as the `rstn` program itself, in inventory mode, in which case the data is read and checked, but only the log files are created.

```

File 01 | 1994.5182.3096.data
Total Number of Tape Records | 1219
Starting (MM/DD/YYYY HH:MM:SS) | 08/04/1994 22:51:36
Ending (MM/DD/YYYY HH:MM:SS) | 08/05/1994 08:48:12
ICAO Station ID | APLM
Number of 6-second Data Blocks | 6085
Number of Burst Entries | 0
#
File 02 | 1994.5206.3012.data
Total Number of Tape Records | 1289
Starting (MM/DD/YYYY HH:MM:SS) | 08/05/1994 22:50:12
Ending (MM/DD/YYYY HH:MM:SS) | 08/06/1994 09:27:12
ICAO Station ID | APLM
Number of 6-second Data Blocks | 6435
Number of Burst Entries | 0
#
...
...

```

Each log entry contains the file name of the ASCII decoded data, the corresponding start and end times, the observing station code, and the number of data and burst records. In case of processing errors, the log file will contain an indication of where on tape the error occurred, and whether the processing was aborted or resumed. *It is essential to examine the log files for possible processing errors.*

4 Processing Disk Files and Original RSTN Tapes

In some cases (e.g., when archive tape is corrupted) it may be necessary to process RSTN files by hand. Occasionally, there may be a need to process an *original* RSTN tape. In these cases the `rstn` program must be used.

4.1 Processing Disk Files

In case of an error during batch processing of an archive tape, the following procedure should be used.

1. Position the tape at the first file to be processed manually. For example, to set the tape drive 2 to file # 10 (file 0 being the archive tape label), use the command

```
mt -f /dev/rmt/4ln fsf 10
```

In the above example substitute `/dev/rmt/5ln` to use drive 3.

2. Copy raw files from tape (drive 2 in this example) to disk using

```
dd if=/dev/rmt/4ln of=raw001 ibs=32768
dd if=/dev/rmt/4ln of=raw002 ibs=32768
...
...
mt -f /dev/rmt/4ln offline
```

In the above example substitute `/dev/rmt/5ln` to use drive 3. Repeat the `dd` commands to copy the necessary number of files from tape. The `mt` command rewinds the tape and ejects it from the tape drive. To rewind the tape *without* ejecting it use `rewind` instead of `offline`.

3. Run the `rstn` program on the disk file sequence

```
rstn -f raw,1
```

The argument of the `rstn` command is `raw`, which is the filename prefix of the file sequence (`raw001`, `raw002`, etc.), and the number of the first file (1 in this case).

4. Note how many data files were processed by the `rstn` program. This is the number of daily save files *only*, i.e., not including the tape directory file. Thus, if the `rstn` program reports that it processed 4 files, the current batch contained 5 files, and the processing should be resumed at file 6, with the command

```
rstn -f raw,6
```

4.2 Processing Original RSTN Tapes

Using the `rstn` program it is possible to process original 9-track RSTN tapes. Original tapes contain only one file batch per tape, so the processing is effected with a single `rstn` command per tape. To decode the tape, load it into the 9-track drive and execute the commands (drive 0 is assumed below)

```
rstn -t /dev/rmt/0ln -b 2550
mt -f /dev/rmt/0ln offline
```

Substitute `/dev/rmt/1ln` if the tape is in drive 1. The `-b 2550` argument to the `rstn` command is necessary because the original RSTN tapes are written with 2550 bytes per block.

5 Sample Output Files

5.1 One-Second Data

One-second data files consist of a header containing station information and calibration parameters, followed by a single one-second data readout (total flux value at each of the nine frequencies and burst (B) and calibration (C) flags) per line. Note that the start and end of data are delimited by hash mark (#) symbols.

```
Total Number of Tape Records | 1328
Starting (HH/DD/YYYY HH:MM:SS) | 08/05/1989 22:38:48
Ending (HH/DD/YYYY HH:MM:SS) | 08/06/1989 09:42:12
ICAO Station ID | APLH
WHO Station Number | 94302
Observatory Latitude | -9.77
Observatory Longitude | 114.08
Observatory Elevation | 10.97
Astronomical Correction Factor | 1.02882
Frequency | 245.0 410.0 610.0 1415.0 2695.0 4995.0 8900.0 15400.0 0.0
Calibration Method | SI SE SI SE SI SE SI SE SI
Boise Tube Output | 1.120000E+01 1.972000E+01 3.273000E+01 3.020000E+01 1.344100E+02 9.480000E+01 1.110000E+02 4.400000E+02 5.000000E+02
50-Ohm Load Output | 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
Harter NR-8 Sensitivity | 1.000000E+00 1.000000E+00 1.000000E+00 1.000000E+00 1.000000E+00 1.000000E+00 1.000000E+00 1.000000E+00 1.000000E+00
Slave NR-8 Sensitivity | 4.000000E+02 4.000000E+02 4.000000E+02 1.000000E+02 2.000000E+01 2.000000E+01 2.000000E+01 2.000000E+01 1.000000E+00
Harter NR-8 Flux/Volt | -1.261070E+02 -2.098480E+00 -1.550333E+01 -2.727045E+01 -1.889013E+02 -2.189128E+02 -2.482180E+02 -1.578176E+02 -1.673981E+02
Slave NR-8 Flux/Volt | -9.181617E+03 -2.281702E+04 -1.912862E+04 -8.151244E+03 -1.691342E+03 -2.472190E+03 -2.920736E+03 -5.661543E+02 5.267881E+08
Harter NR-8 Sky Backgr. | 3.363383E-38 1.679547E-37 3.270931E-37 3.295609E-39 8.937430E-39 8.348216E-39 7.898590E-39 -9.834378E-01 4.561285E-39
Slave NR-8 Sky Backgr. | 1.032907E-37 -4.674353E-38 1.228862E-37 3.295499E-38 -4.566561E-37 2.246135E-37 -6.523993E-38 -1.690067E-38 1.095372E-35
Local Noon Flux (IFLUX) | 1.474560E+05 7.948689E-25 1.363485E-06 2.269073E-15 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
IFLUX HH/DD/YYYY | 08/06/1989 08/06/1989 08/06/1989 08/06/1989 08/06/1989 08/06/1989 08/06/1989 08/06/1989 12/31/1988
IFLUX HH:MM:SS | 04:11:24 04:11:24 04:11:24 04:11:24 04:11:24 04:11:24 04:11:24 04:11:24 00:00:00
#
APLH 08/05/1989 22:38:48 | 1.548205E+01 ... 2.230658E+01 ... 4.740945E+01 ... 1.292718E+02 ... 1.196188E+02 ... 2.058625E+02 ... 2.543934E+02 ... 2.465039E+02 ... 4.617150E+03 ...
APLH 08/05/1989 22:38:49 | 1.558405E+01 ... 2.242121E+01 ... 4.750455E+01 ... 1.293693E+02 ... 1.198295E+02 ... 2.060642E+02 ... 2.545825E+02 ... 2.222173E+02 ... 2.763397E+02 ...
```

```

APLH 08/05/1989 22:39:50 | 2.217594E+01 C. 2.401569E+01 C. 4.862459E+01 C. 2.898883E+01 C. 1.788843E+02 C. 1.224854E+00 C. 3.585132E+01 C. 8.249536E+01 C. 3.030186E+01 C.
...
APLH 08/05/1989 22:39:51 | 2.219953E+01 B 2.399608E+01 B 4.857812E+01 B 2.914883E+01 .. 1.790268E+02 .. 1.493652E+00 .. 3.613373E+01 .. 8.986816E+01 C. 3.050596E+01 C.
#
6565 6-second block(s) output

```

5.2 Burst Logs

Burst Logs consist of a header, identical to the header of the corresponding one-second data file, and zero or more burst records. The start and end of burst data are delimited by hash mark (#) symbols. Each burst record is delimited by four dashes (----). In the discrete burst frequency bitmap, X symbols indicate the frequencies at which bursts are occurring, with the leftmost symbol corresponding to the lowest frequency.

```

Total Number of Tape Records | 1328
Starting (HH/DD/YYYY HH:MM:SS) | 08/05/1989 22:38:48
Ending (HH/DD/YYYY HH:MM:SS) | 08/06/1989 09:42:12
ICAD Station ID | APLH
WHO Station Number | 94302
Observatory Latitude | -9.77
Observatory Longitude | 114.08
Observatory Elevation | 10.97
Astronomical Correction Factor | 1.02882
Frequency | 245.0 410.0 610.0 1415.0 2695.0 4995.0 8800.0 15400.0 0.0
Calibration Method | SU SU SU SU SU SU SU SU SU
Noise Tube Output | 1.120000E+01 1.972000E+01 3.273000E+01 3.020000E+01 1.344100E+02 9.480000E+01 1.110000E+02 4.400000E+02 5.000000E+02
50-Dm Load Output | 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
Master HK-8 Sensitivity | 1.000000E+00 1.000000E+00 1.000000E+00 1.000000E+00 1.000000E+00 1.000000E+00 1.000000E+00 1.000000E+00 1.000000E+00
Slave HK-8 Sensitivity | 4.000000E+02 4.000000E+02 4.000000E+02 1.000000E+02 2.000000E+01 2.000000E+01 2.000000E+01 2.000000E+01 1.000000E+00
Master HK-8 Flux/Volt | -1.261070E+02 -2.098480E+00 -1.550333E+01 -2.727045E+01 -1.889013E+02 -2.189128E+02 -2.482180E+02 -1.578176E+02 -1.673981E+02
Slave HK-8 Flux/Volt | -9.181617E+03 -2.281702E+04 -1.912862E+04 -8.151244E+03 -1.691342E+03 -2.472190E+03 -2.920736E+03 -5.661543E+02 5.267881E+08
Master HK-8 Sky Backgr. | 3.363383E-38 1.679547E-37 3.270931E-37 3.295609E-39 8.937430E-39 8.348216E-39 7.898590E-39 -9.834378E-01 4.561285E-39
Slave HK-8 Sky Backgr. | 1.032907E-37 -4.674353E-38 1.228862E-37 3.295499E-38 -4.566561E-37 2.246135E-37 -6.523993E-38 -1.690067E-38 1.095372E-35
Local Moon Flux (IFLUX) | 1.474560E+05 7.948689E-25 1.363485E-06 2.269073E-15 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00 0.000000E+00
IFLUX HH/DD/YYYY | 08/06/1989 08/06/1989 08/06/1989 08/06/1989 08/06/1989 08/06/1989 08/06/1989 12/31/1988
IFLUX HH:MM:SS | 04:11:24 04:11:24 04:11:24 04:11:24 04:11:24 04:11:24 04:11:24 04:11:24 00:00:00
#
Burst Number | 1
Starting (HH/DD/YYYY HH:MM:SS) | 08/06/1989 00:48:54
Ending (HH/DD/YYYY HH:MM:SS) | 08/06/1989 00:55:44
IAW AHS& 105-32 Burst Type | 3
Burst Type | Discrete Burst
Discrete Frequency Bitmap | XXXXXXXX
Maximum Flux Observed | 9.364191E+01
----
...
----
Burst Number | 36
Starting (HH/DD/YYYY HH:MM:SS) | 09/13/1989 00:00:00
Ending (HH/DD/YYYY HH:MM:SS) | 09/13/1989 00:00:00
IAW AHS& 105-32 Burst Type | 0
Burst Type | Sweep Burst
Burst Importance | 0
Burst Frequency Range (MHz) | 0 0
Burst Location (Angle, kx100) | 0 0
----
...
----
Burst Number | 37
Starting (HH/DD/YYYY HH:MM:SS) | 08/06/1989 07:46:06
Ending (HH/DD/YYYY HH:MM:SS) | 08/06/1989 07:51:44
IAW AHS& 105-32 Burst Type | 3
Burst Type | Discrete Burst
Discrete Frequency Bitmap | ...XXXX
Maximum Flux Observed | 1.205514E+02
----
...
----
Burst Number | 38
Starting (HH/DD/YYYY HH:MM:SS) | 08/06/1989 08:07:30
Ending (HH/DD/YYYY HH:MM:SS) | 08/06/1989 08:08:08
IAW AHS& 105-32 Burst Type | 3
Burst Type | Discrete Burst
Discrete Frequency Bitmap | X.....
Maximum Flux Observed | 1.918833E+02
----
#
40 burst(s) output

```

6 Implementation Notes

The following items may be of interest to a user of RSTN Decode software.

- Examples of HP floating point format on page 10 of the *Data User's Guide for RSTN Archived Magnetic Tape Data* seem to be wrong. Decimal numbers obtained by decoding the HP format according to the description on page 10 of the *Guide* are off by a factor of 2 from the values given in the examples. Algorithm described in the text of the *Guide*, as opposed to what one would infer from the examples was implemented.
- Station ID field in tape directory files is blank, inconsistent with the format described in Attachment 1 of the *Guide*. The station ID output by the `rstn` program is obtained from the daily save files.
- The `rstn` program corrects all date-time values read from the raw archive data by subtracting 24 hours, as noted by AF letter dated 8 Dec 1988, and as implemented in the Fortran RSTN decode software written by Chris Wells for use on a UNIVAC computer.
- The `rstn` program, as well as, to the author's knowledge, the RSTN archive data, are *Year 2000* compliant. All year values are stored and manipulated in four-digit precision (i.e., 1996 as opposed to 96), and leap years are treated properly. Note that the UNIVAC code does not compute the number of days in February 2000 properly.
- The archived one-second data consists of Quiet Sun Flux, Relative Flux, and Raw Amplifier Output values. The `rstn` program only outputs the total flux (the sum of the Quiet Sun and Relative fluxes). This is consistent with the behavior of the UNIVAC code.
- The ASCII one-second data output is over 132 characters wide, but it can be printed by using the command
- Raw RSTN one-second data contain extensive information about the observing state, including the type of burst if one is in progress, and the type of detection calibration being performed, if any. The `rstn` program only outputs the burst flag (i.e., burst or no burst) and the calibration flag. This behavior is consistent with that of the UNIVAC code.

```
enscript -r -fCourier6 filename.data
```

- Headers of the archived RSTN data files contain the starting and ending times of data stored in each file. It was noted during testing that the ending times are usually unreliable, i.e., the ending time indicated in the header may be slightly ahead or behind the time corresponding to the last data entry in the file.
- RSTN Decode software requires System V (as opposed to BSD) semantics for accessing tape drives. This is a Solaris 2.X feature and is implemented on the computer system `terra` at NGDC. This amounts to using `/dev/rmt/4ln` instead the usual `/dev/nrst2` and `/dev/rmt/5ln` instead `/dev/nrst3` when referring to drives 2 and 3, respectively.