**Onboard Star Catalogue Dataset**

The onboard catalogue is split into three parts – the pointer table, the main catalogue and the addendum. It is stored on EEPROM B, Mid 5.

The three parts of the catalogue follow each other sequentially, with no gaps, as in fig. 1 below. A much more detailed memory map, with addresses for each sky area within the main catalogue, is autogenerated on catalogue preparation, and stored in file memorymap.dat. This file can be found in the star catalogue archive provided.

| Address | Data stored |
|---|---|
| 0x6f39c | End of addendum data |
| 0x6f26d | Start of addendum data |
| 0x6f26c | End of main catalogue |
| 0x1413 | Start of main catalogue |
| 0x1412 | End of pointer table |
| 00000 | Start of pointer table |

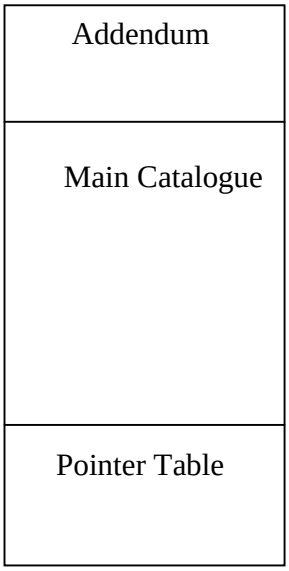


Fig 1 – Memory Map

The Pointer Table

This is stored from address 0 to address 0x1412 inclusive.

Each pointer is 2 words long.

The first 44 pointers point to the start of each declination band within the pointer table itself. The bands run in order from the north band nearest the equator to the north polar band, followed by the south band nearest the equator to the south polar band.

The next 2524 pointers point to the start of each sky area in the main catalogue. The sky areas run along the declination bands, in increasing order of RA.

The last pointer points to the start of the addendum.

The last entry in the pointer table is a one word CRC value.

## The Main Catalogue

This is stored from address 0x1413 to address 0x6f26c inclusive.

It contains 223807 entries. These are stored according to sky area, with sky areas arranged as in the pointer table.

Each entry is stored as two words;
The first byte is its RA offset from the origin of the sky area.
The second is the declination offset.
The third is its magnitude code.
The fourth is its colour index code.

Each sky area ends in a one word CRC value.

## The Addendum

This is stored from address 0x6f26d to address 0x6f39c inclusive.

It contains space for 100 entries, each of which is stored as three words;
The first byte is the RA division the source is in.
The second byte is an encoded version of its declination band.
The third byte is the RA offset from the origin of its sky area.
The fourth is the declination offset.
The fifth is its magnitude code.
The sixth is its colour index code.

It also contains an end of list marker consisting of three words, all of them 0xFFFF. This will be positioned at the end of the relevant entries in the addendum. If there are no entries it will be at the beginning of the addendum. All allotted space after the end of list marker will be zero filled.

The last word of the addendum is the CRC value.

**Star Catalogue Onboard Software**

This consists of an ada package called starcat.

The only function of this package is to search the onboard star catalogue for sources located within a requested field of view, and return information from any sources found.

Using the Package

To initiate a search call STARCAT.START_SEARCH(RA, DEC, RAD).

RA is the right ascension of the centre of the field of view in degrees, as a float.
DEC is its declination, also in degrees, as a float.
RAD is the radius of the field of view, in *arcmin*, as a float.

Please note that RA runs from 0.0 to 360.0 and Dec from –90.0 to 90.0.

To retrieve all the sources in the field of view, call STARCAT.GET_STAR(FINISHED, CRC_ERROR, SOURCE_OFFSET, SOURCE_MAG, SOURCE_INDEX, SOURCE_RA, SOURCE_DEC, SKY_AREA, ORIG_OFFSETS) continuously until FINISHED is returned as true. This final return will contain dummy values for the three source parameters, which should be ignored.

FINISHED is a boolean, which will be set to true if all sources have been returned, and false otherwise.
CRC_ERROR is a boolean, which will be set to true if any of the CRC checks made during execution discovered memory corruption in the onboard catalogue. In that case the final return would be issued immediately, and all information from previous calls should be ignored. See later for further details.
SOURCE_OFFSET is the angular distance between the found source and the centre of the field of view, in arcmin, as a float.
SOURCE_MAG is the magnitude code of the source (see later), as an integer.
SOURCE_INDEX is the colour index code of the source (see later), as an integer.
SOURCE_RA is the RA stored in the onboard catalogue for the source.
SOURCE_DEC is the declination stored in the onboard catalogue for the source.
SKY_AREA is an encoded version of the sky area the source is in – see the CRC section below for the method of decoding it.
ORIG_OFFSETS contains the offsets of the source from the origin of the sky area, the first byte is the RA offset and the second is the declination offset.

Code Overview and CRC error checking

The code runs as follows;

Receive a call to start_search.
CRC check the pointer table.
Locate and CRC check the addendum.
Work out which declination bands are in the field of view.
Loop through the bands.
    For each band work out which sky areas are in the field of view.
    Loop through the sky areas.
        For each sky area, run a CRC check
        For each sky area call package astro to calculate the angular separation of each source within it from the centre of the field of view. Return any sources within the field of view via get_star.
        After each sky area check the addendum to see if any of its entries are within that sky area. Repeat the angular calculation for any sources found and return them via get_star if necessary.
Return a 'finished' flag via get_star.

If any CRC check is failed the code will automatically return get_star with the 'finished' flag set. It will also send an NHK message, 'Corrupted EEPROM Data'. The first parameter of the NHK message will be the catalogue identifier, 0x0004, and the second will identify the catalogue area that is corrupted, as follows;
0xEEEE – the pointer table
0xAAAA – the addendum
< 0x4E20 - one of the individual sky areas in the main catalogue. To work out which,

a) convert it to a decimal value
b) *left* pad it with zeroes to make a 5 digit number
c) if the first digit is 1, it is a southern hemisphere area, otherwise it is northern
d) the second and third digits are the declination band
e) the fourth and fifth digits are the right ascension division

so for example, 0x04C0 becomes decimal 01216, which indicates sky area north 12 16.

To find the location any of these areas in memory read the file memorymap.dat, which is in the star catalogue archive.

## **Stored Data Details**

Sky Area Grids and Naming Convention

The sky is taken to be two hemispheres that are mirror images of each other.

Each hemisphere is split into 22 declination bands, numbered 0 to 21 starting from the equator and going to the pole. Each band is 255 arcmin wide except for the polar bands, which are 45 arcmin wide. Any source within half an arcmin of the equator is taken to be in the first band of the northern hemisphere only.

Each declination band is divided into a number of equal right ascension divisions, the number depending on how the width of the field of view changes with respect to right ascension at each declination.
Bands 0 to 4 have 90 divisions each.
Bands 5 and 6 have 80 divisions each.
Band 7 has 75 divisions.
Bands 8 to 10 have 72 divisions each.
Band 11 has 60 divisions.
Band 12 has 54 divisions.
Band 13 has 50 divisions.
Band 14 has 45 divisions.
Band 15 has 40 divisions.
Band 16 has 36 divisions.
Band 17 has 27 divisions.
Band 18 has 24 divisions.
Band 19 has 15 divisions.
Band 20 has 8 divisions.
Band 21 has 2 divisions.

The right ascension divisions are numbered from 0 upwards starting at RA 0.0 degrees.

So for example, sky area south 12 30 would be in the southern hemisphere in declination band 12, which extends from –51 degrees to –55 degrees 15 arcmin, and right ascension division 30, which in this band extends from 200 degrees to 206 degrees 40 arcmin.

Each sky area is then subdivided into a 255 by 255 grid and every source assigned to its nearest gridpoint. The RA and declination offsets stored in the catalogue are the coordinates of this gridpoint within the sky area, counting from 0 to 254 in each axis. These are the offsets stored in ORIG_OFFSETS Positional accuracy in the field of view in either axis is to half an arcmin or better at all times.

If any source in the catalogue is given offset coordinates of (255,255) that is an indication to the code that this source has been ‘deleted’ from the catalogue. That source will be ignored by the code.

Magnitude Codes

The magnitude code stored on board is derived from the visual magnitude (Johnson V magnitude).

If V is < -1.4 then the code is 0.

From there on, the magnitudes are gathered into bands, each 0.1 of a magnitude wide, numbered from 1 to 134 ascending.

So for example,
-1.3 > V >= -1.4 has code 1.
-1.2 > V >= -1.3 has code 2.
11.9 > V >= 11.8 has code 133.
V >= 11.9 has code 134.

No source fainter than V = 12.0 will be stored in the catalogue.

Colour Index Codes

In this case the colour index is B-V in Johnson magnitudes. This is split into uneven bands as follows;

B-V < -0.33 has code 0.
-0.33 <= B-V < -0.27 has code 1.
-0.27 <= B-V < -0.17 has code 2.
-0.17 <= B-V < -0.11 has code 3.
-0.11 <= B-V < 0.01 has code 4.
0.01 <= B-V < 0.15 has code 5.
0.15 <= B-V < 0.30 has code 6.
0.30 <= B-V < 0.44 has code 7.
0.44 <= B-V < 0.52 has code 8.
0.52 <= B-V < 0.63 has code 9.
0.63 <= B-V < 0.68 has code 10.
0.68 <= B-V < 0.74 has code 11.
0.74 <= B-V < 0.81 has code 12.
0.81 <= B-V < 1.10 has code 13.
1.10 <= B-V < 1.49 has code 14.
1.49 <= B-V < 01.64 has code 15.
B-V >= 1.64 has code 16.