NATIONAL RADIO ASTRONOMY OBSERVATORY

COMPUTER DIVISION

SECOND EDITION OF

INTERNAL REPORT NO. 10

TPOWER AND SPOWER USER'S MANUAL

BY

THOMAS R. CRAM

REPORT NO. 10

(Second Edition)

JULY 1973

TABLE OF CONTENTS

I. FOREWORD

This report describes a data reduction system that may not be familiar to you. Most computer programs can be described as "black boxes" for which a magic card with a punch in column 41 makes everything work. These "black box" programs perform certain well defined tasks, e.g., reading data, computing temperatures, and printing paper. The TPOWER and SPOWER programs are by no means "black boxes". The user is required to interact with the program at all stages of reduction. He must specify just how his data will be treated and what data will be handled.

The medium of communication with the program is punched cards and/or an interactive graphic CRT terminal. The CRT terminal is experimental but adds a new dimension in data processing.

As with all projects, I am greatly indebted to many people for their helpful suggestions. I cannot name them all, but I would like to especially acknowledge John Ball for his long conversations about the observing techniques, Al Braun for his help with the 360 Operating System, Paul Baker for his detailed reading of the manuscript, and Steve Hirsch for his general assistance.

II. INTRODUCTION

A. PURPOSE

This report is written for the person who wants to reduce spectral line data collected at the NRAO 140' and 300' telescopes. Each of these instruments is equipped with an autocorrelation receiver whose output is Fourier transformed and recorded on magnetic tape by an on-line computer. The data is further reduced and displayed by the programs described in this publication. The programs support two modes of observation termed Total Power (TPOWER) and Switched Power (SPOWER). Most observations can be handled by one or the other of these modes.

The data reduction programs provide the user with powerful software routines to process his data. The routines are written in IBM's PL/I but it is not necessary to understand the programming implementation to utilize them. Instead, the programs provide a facility for invoking the routines by a simple command language. With a knowledge of the command language, the user can describe his reduction scheme to the program and control all important aspects of the data reduction with very little practice.

The remainder of this section I will discuss the modes of observation and program flow. Section III describes the quick look run which is made as soon as the telescope tapes arrive in Charlottesville. The editing run described in section IV will rarely be used and exists only to correct certain kinds of errors on the telescope tapes. The user will be most concerned with the contents of

Section V. In that section, the command language used to perform the final reduction and data display is described.

There are two approaches to learning the command language. The first is to learn the syntax of the language throughly and then practice constructing programs with the aid of the verb/adverb dictionary. The second approach is to turn directly to the examples provided after a quick reading of the description of the language. The examples not only show how to construct grammatically correct command expressions, but illustrate the commands used to reduce data in many common situations.

B. MODES OF OBSERVATION

For accurate spectral line measurements, it is necessary to compare the spectrum of the desired source to some reference spectrum. In this way, instrumental effects can be removed or minimized. With the total power technique, the reference spectrum is obtained by moving the telescope to a new position; with the switched power technique, the frequency is switched and the telescope remains stationary.

TPOWER and SPOWER system reduces data from the following on-line computer programs:

ON-LINE COMPUTER PROGRAMS

	140'		300'	
Autocorrelator	TPOWER	SPOWER	TPOWER	SPOWER
MOD II	AC7	AC9	AC6	AC8
MOD III	CA3	CA5	CA4	CA2

TABLE 1

In each observing mode, the operator positions the telescope and sets the start and stop time. In the total power mode, the operator also sets a switch which indicates whether the current point of observation is a source or reference position. The computer then records the pointing and control information on a 7-track tape. The output of the autocorrelation receiver is periodically transferred to the on-line computer where it is Fourier transformed and recorded on tape. The interval between these transfers is called the dump time. Correlator transfers are averaged for a given interval called sample rate before being written on tape. A logical collection of tape records is given a number and is called a "Scan".

A Scan is the smallest unit of data that the user will normally need to manipulate, but editing of individual tape records is supported. In the Switched Power mode, signal and reference information are obtained as parts of one scan; in the Total Power mode, signal and reference information are on separate scans.

C. PROGRAM STRUCTURE

The TPOWER and SPOWER programs are both described by the flowchart in Figure 1. The programs are divided into three sequential phases to conserve storage space. During the first phase, the program reads the 7-track telescope tape and averages the individual spectral records to produce scans. The method of averaging for TPOWER is straightforward--all dump records are added together and the sum is divided by the number of records in the scan. In SPOWER, the source and reference are used to compute "TSYS*(SOURCE - REFERENCE)/REFERENCE"

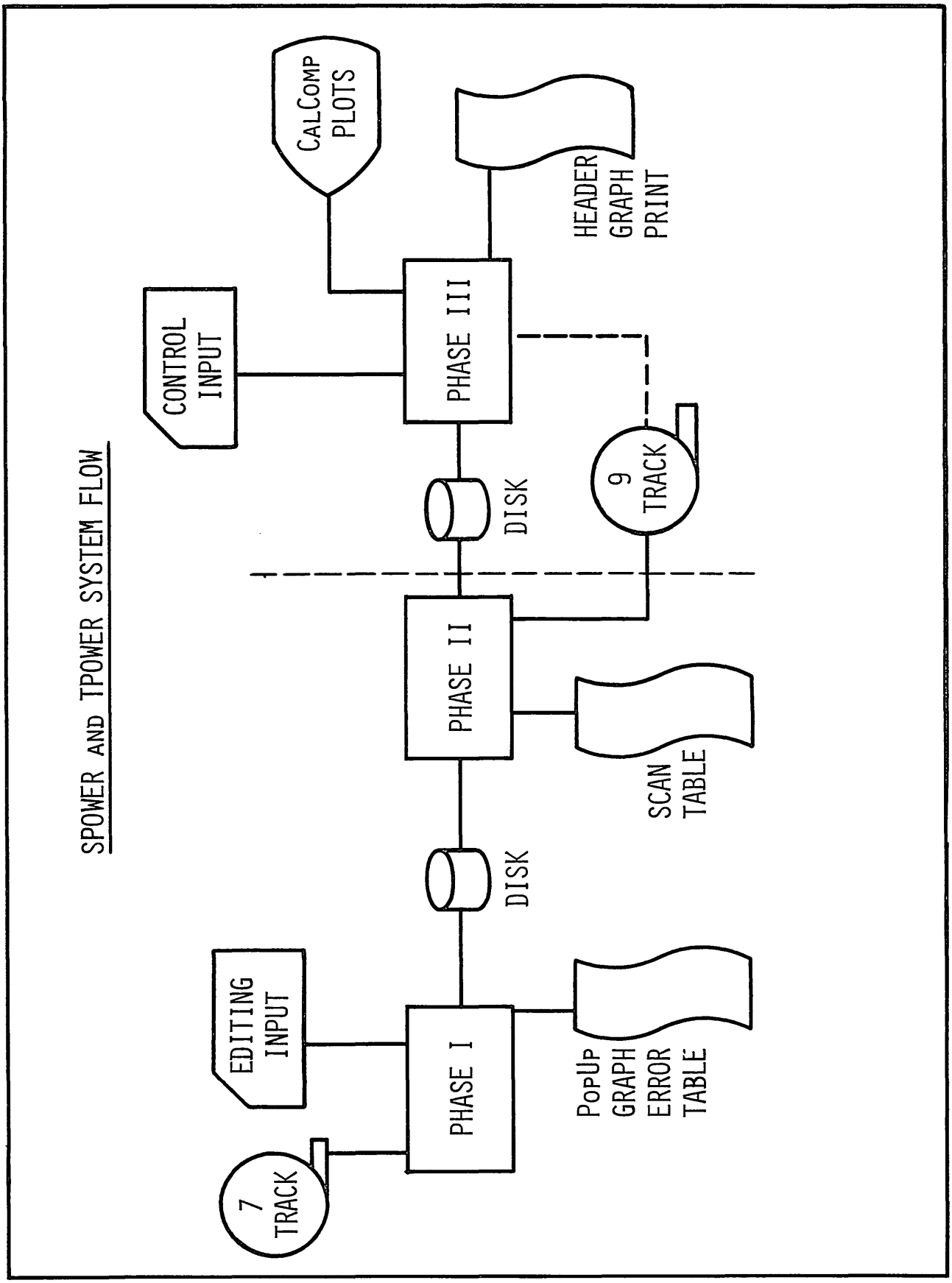

SPOWER AND TPOWER SYSTEM FLOW
CALCOMP PLOTS
CONTROL INPUT
PHASE III
HEADER GRAPH PRINT
DISK
9 TRACK
PHASE II
SCAN TABLE
DISK
EDITING INPUT
PHASE I
POPUP GRAPH ERROR TABLE
7 TRACK

Figure 1

for each record and sum over all records within a scan. TSYS is the system temperature for the signal data obtained from the analog path in the autocorrelator (power counters).

During the averaging process the program checks the individual records within a scan by producing a "POP-UP" graph. This quick look display helps to point out time scale interference. There is no provision for deleting interference spikes during the quick look run on the basis of the POP-UP graph, but it can be done in the editing run.

The scans produced by the first phase are left in disk storage for phase two which calculates center frequencies, pointing corrections, and velocities and prints a summary of the data. Phase two also produces the 9-track user tape. This tape contains all of the scans and permits the user to restart the program to use or alter any of the scans. If a scan is changed in an edit run, the modified scan is placed at the end of the tape. Subsequent requests to use this scan will retrieve the latest version. Older versions of a scan are preserved on the user tape but are inaccessible to TPOWER and SPOWER.

The third phase of the program allows the user to specify which scans are to be processed and the processing procedure. Phase three facilities include stacking (averaging of the scans), smoothing, interpolation, and frequency baseline removal. Documentation in the form of calcomp plots and tables is also produced. This phase can be restarted should the user wish more extensive documentation or reduction.

Normally, Phase III will produce all necessary documentation of the data. However, if the user desires to take his user tape to

his home institution for further reduction, Appendices B and C explain the format of the scan on the user tape.

III. QUICK LOOK RUN

The On-line computer in Green Bank writes a magnetic tape containing documentation and spectral data. The tape is shipped each morning to Charlottesville by car shuttle and processed through all three phases of the SPOWER or TPOWER program in a quick look run. The quick look run uses a standard procedure (given below) to process all data. The user can request the Charlottesville computer aide to change the procedure to suit his observing technique. The output is sent to Green Bank the same day by data link or the next day by car, unless other instructions are given.

Phase I of the program determines the quality of autocorrelation data by checking the repeatability of the measured values. Four quantities are important: spectral shape, system gain, system temperature, and pointing. The pop-up discussed below conveniently displays the repeatability of these quantities. See Appendix F for sample output.

Of the many tests of repeatability which have been tried, the best is a comparison of spectral values with the spectral values of the first record. The differences are scaled to the theoretical noise (sigma) for a given bandpass and sample rate. The result is three-dimensional: frequency, deviation, and time (record number). The line printer is only two-dimensional, therefore, a printing method is used to give a partial 3-D effect. The printing method used is called a pop-up graph.

To form this graph, two adjacent channels are summed, and differenced with the sum of the same two channels of the first record. The difference is then divided by the theoretical standard deviation, sigma, for the receiver set up. See Appendix E for a list of formulas used to calculate these sigmas. The normalized differences are then plotted on a two dimensional plot in which channel number runs across the printer page and deviation is vertical. Each record is superimposed on the preceding record, forming a band of points near zero deviation. Bad data will stand out or "Pop-up" from profiles near zero. The symbol used to plot a (deviation, channel number, record number) point is derived from the internal record number. The internal record number is the sequence number of records within a scan, and, modulo 36, is assigned to a character in the sequence 1-9, A-Z, #. The print position is checked for a blank character, the assigned character representing the record number replacing the blank. If the print position is not blank then an asterisk (*) replaces the original character to indicate more than one record for a given pair of channels has the same deviation.

Occasionally interference makes the first record unusable as an approximation of the mean. The band of points formed by the good data will not lie near zero deviation in this case. Alert telescope operators may prevent this problem by aborting any scan with a defective first record.

The quantities of system gain and temperature are also plotted in pop-up graphs. For these quantities the deviations are scaled to

show the percent change from the first record. The pointing is displayed in a similar manner except that the numbers are scaled by 10 seconds of arc change from the first record.

Immediately following the pop-up graphs appears a printed record of all program-detected errors. Each error message is printed with its scan and physical record number (see Appendix G). The errors detected are:

1. System temperature off scale (± 60%).
2. System gain off scale (± 60%).
3. Pointing off scale (± 300 seconds of arc).
4. Noise tube value less than 0.5% of the system temperature.
5. Deviations off scale (± 6 sigma).

Phase II prints a list of all scans which are processed and written on the 9-track output tape. See Appendix H for sample output.

Phase III, where the user controls all operations performed on his data, uses the following procedures to display the spectra:

TOTAL POWER	FETCH TEMP HEADER GRAPH
SWITCHED POWER	GET HEADER GRAPH

The computer aide punches a process card that directs the program to display all scans on each day's telescope tape. See Appendix I for sample header-graph output.

The user has all the options of Phase III during his first pass. However, he must supply all the control cards and instructions for the computer aide. Punched cards can be sent to Charlottesville by car shuttle or telephone data link. Using this option, one may average scans and get calcomp plots each day without being in Charlottesville and without delay.

IV. THE EDITING RUN

Normally, editing will be unnecessary and the user can ignore the facilities described in this section. However, should there be a problem on the data tape, the editing phase can be used to correct it.

The SPOWER and TPOWER programming system supports two types of editing: 1) deletion of records during the averaging process to form a scan, and 2) alteration of any variable in the scan. Editing is performed by invoking Phases I and II, with the original telescope tape as input; the modified scans are written at the end of the user's tape. The edited scan supersedes all previous copies when loaded onto the disk during Phase III of the program (see load verb).

To edit a telescope tape, the program needs the following information: A list of scan numbers for only the scans to be reprocessed, and

a list of physical record numbers to be deleted

or

a list of scans with alteration information.

Scans to be reprocessed are coded on "scan cards". Scan cards have the following free-field format:

SCAN NNNNO NNNNO to NNNNO

code as many entries per card and as many scan cards as necessary to list the scans to be processed. The keyword scan may be abbreviated by "SCN" or "S".

To delete records within a scan the user supplies a list of physical record numbers (PRN--DEFINED below) on a "DELETE CARD". Delete cards have the following free-field format:

DELETE NNNN NNNN to NNNN

Code as many entries per card and as many delete cards as necessary to list the records to be deleted. The keyword may be abbreviated by "DLT" or "D".

The scan and delete cards may appear in any order. The information may start in any column, but only one "DELETE" or "SCAN" should be coded on a single card.

The physical record number (PRN) is calculated using the following formula: PRN = IRN + FRN - 1, where IRN is the internal record number relative to the start of the scan, and FRN is the first record number in a scan. Messages in the error log give the physical record number directly.

The internal record number can be obtained from the symbols in the pop-up graph. The symbols used in the pop-up graph correspond to internal record numbers according to the following table.

The symbols used in the pop-up graph are convertable into internal record numbers by using the following table:

TABLE OF POP-UP CHARACTERS vs. RECORD NUMBER (IRN)

	00	10	20	30	40	50	60	70	80	90
1 - 1	B	L	V	5	F	P	Z	9	J
2 - 2	C	M	W	6	G	Q	#	A	K
3 - 3	D	N	X	7	H	R	1	B	L
4 - 4	E	O	Y	8	I	S	2	C	M
5 - 5	F	P	Z	9	J	T	3	D	N
6 - 6	G	Q	#	A	K	U	4	E	O
7 - 7	H	R	1	B	L	V	5	F	P
8 - 8	I	S	2	C	M	W	6	G	Q
9 - 9	J	T	3	D	N	X	7	H	R
10 - A	K	U	4	E	O	Y	8	I	S

TABLE 2

Note that the first record of a scan is not displayed on the pop-up graph. It is used as a reference for all the others.

If you have over 36 records within a scan, the symbols repeat (MODULO 36). This ambiguity is usually resolved by the error log.

The FRN is printed at the upper right-hand corner of every pop-up graph with the title of "first record".

At times there is a need to alter quantities computed by the off-line computer or recorder at the telescope. During the editing run, any quantity in the tape format statement may be changed on any scan by an alter assignment statement. "ALTER CARDS" are coded with the following format:

```
A    NNNNO          M.TAPE_VARIABLE=NNNN,
                    M.TAPE_VARIABLE='_ _ _ _ _ _ _ _';
```

Alter cards may extend over ten cards, each ending in a comma except the last, which must end with a semicolon.

Some of the most commonly altered variables are coded as:

```
M.OBS_NUMBER=4
M.RX.REST_FREQ(1)=1420.5
M.RX.CN_FORM(2)='6*L1 - 150'
```

The subscript corresponds to the receiver according to...

RECEIVER	NUMBER
A	1
B	2
C	3
D	4

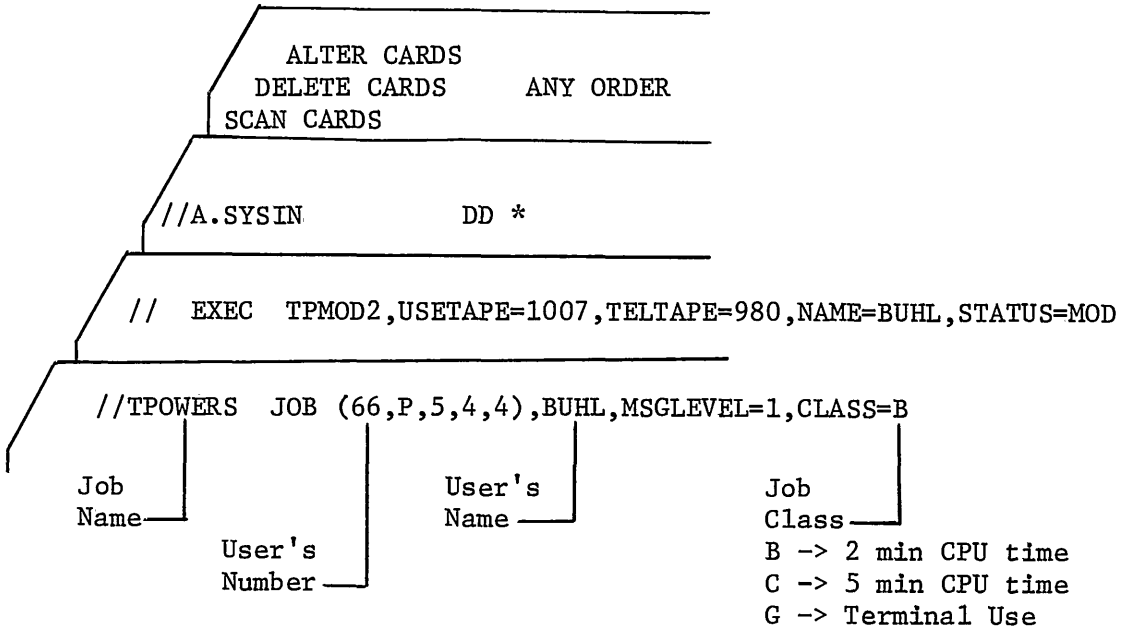
The printing of the pop-up graph can be suppressed at the user's option. Suppression takes place only if no off scale values are found. The user supplies the following card with his edit run or asks the computer aide to insert it in the initial run (free field):

```
OBS     NO_POP
```

JCL FOR THE EDITING RUN

The following JCL cards invoke procedures to run Phases I & II.

CASE 1. TOTAL POWER, MODEL II



CASE 2. SWITCHED POWER, MODEL II

```
//SPOWERS  JOB (165,P,5,4,4),GORDON,MSGLEVEL=1,CLASS=B
// EXEC SPMOD2,USETAPE=1007,TELTAPE=980,NAME=GORDON,STATUS=MOD
//A.SYSIN         DD *
```

CASE 3. TOTAL POWER, MODEL III

```
//TPOWERS  JOB (13,P,5,13,4),TURNER,MSGLEVEL=1,CLASS=B
// EXEC TPMOD3,USETAPE=1007,TELTAPE=980,NAME=BALL,STATUS=MOD
//A.SYSIN         DD *
```

CASE 4. SWITCHED POWER, MODEL III

```
//SPOWERS  JOB (4,P,5,13,4)ROBERTS,MSGLEVEL=1,CLASS=B
//EXEC SPMOD3,USETAPE=1007,TELTAPE=980,NAME=ROBERTS,STATUS=MOD
//A.SYSIN         DD *
```

JCL FOR THE EDITING RUN
(Continued)

CASE 5. SEVERAL TELESCOPE TAPES CAN BE PROCESSED IN ONE COMPUTER RUN BY STACKING EXECUTE CARDS. AN ADDITIONAL JCL CARD, OF THE FORM "//C.USER", IS REQUIRED BETWEEN STEPS.

```
//TPOWERS  JOB (165,P,5,4,4),GORDON,MSGLEVEL=1,CLASS=C
//E1 EXEC TPMOD2,USETAPE=2280,TELTAPE=967,NAME=GORDON,STATUS=MOD
//A.SYSIN         DD *
SCAN        32800 TO 32890
DELETE      363 364 367 376 384 403 411 413 422 430 432 435 437
//C.USER    DD VOL=(,RETAIN,SER=2280)
//E2 EXEC TPMOD2,USETAPE=2280,RELTAPE=856,NAME=GORDON,STATUS=MOD
//A.SYSIN         DD *
SCAN        33350 TO 33370
DELETE      199 285
A  33350     M.TYPE_SCAN=0;
A  33360     M.OFF_SCAN=33340;
```

V. FINAL REDUCTION AND DISPLAY OF THE DATA

Phase III of the reduction system can be invoked by itself in order to produce the graphical and tabular data that the experimenter needs to understand and present the results. When Phase III is invoked by itself, it reads the 9-track user tape and copies it to disk storage. Any particular scan is then easily accessible for processing. The user should familiarize himself with the capabilities of Phase III and invoke it as often as necessary to get the data displays he needs.

During Phase III the program simulates a processor which is available for use through the command language. The words of the language which form messages, are typed on punched cards or on an interactive graphics terminal. A word is a collection of non-blank characters that either begins a message or is separated by spaces. The processor interpretes each word in sequence and initiates the appropriate task. When finished, the program gets another message from cards or terminal.

The processor has three arrays, called ON, OFF and HOLD. Normally, ON ARRAY contains the source spectrum, OFF ARRAY contains the reference spectrum, and HOLD ARRAY is used for summing. Verbs of the command language are used to move scans to and from the arrays, and to print or plot the spectral information. For many verbs the response of the processor is modified by the values of certain variables stored in the computer. For example the verb CLIP clips the

spectrum so that its values lie between the CLIP_MIN and CLIP_MAX. Since variables like CLIP_MIN modify actions, they are the adverbs of the language.

The scan numbers and the names of the arrays constitute the nouns of the language and are used as objects of the verbs. With verbs, adverbs, and nouns we can construct expressions which describe the data reduction. However, one should keep in mind that the data reduction expressions do no more than sequentially activate routines that perform tasks. For every verb that the processor encounters, it performs one and only one task. For repetitive tasks, the tedious typing of identical messages for each step can be avoided by using a facility of the language for defining strings of verbs. The verb strings, called procedures, may be referenced as a single command and applied to a list of scan numbers.

The verbs are the heart of the command language because they trigger the actions of the processor. The verbs fall into two grammatical classes. The first class or first conjugation are those verbs which require an OPERAND and/or explicit object. These verbs are always coded one verb to a message. The operand of the verb begins one space after the verb and may continue to column 80. The operand is coded free-field format. The most important verbs of the first conjugation are the following:

INITIAL - THIS VERB WHICH MUST PRECEDE ALL OTHERS, INITIALIZES THE PROCESSOR: OPENS DATA SETS, INITIALIZES ADVERBS AND COMMON STORAGE. IT REQUIRES A SINGLE OPERAND, "DISP='NEW'". THE TWO SINGLE APOSTROPHES MUST APPEAR IN THE OPERAND FIELD.

LOAD - THIS CAUSES THE 9-TRACK ARCHIVE TAPE TO BE READ ONTO DISK. THE OBSERVER'S USER NUMBER MUST BE GIVEN IN THE OPERAND FIELD.

ENTER - THIS VERB CAUSES THE ADVERBIAL INFORMATION IN THE OPERAND TO BE READ AND STORED IN THE PROCESSOR. INFORMATION ABOUT THE ADVERBS IS AVAILABLE IN THE ADVERB DICTIONARY AND ALSO IN THE DESCRIPTION OF THE VERBS WHICH REQUIRE THEM.

DEFINE - THE OPERAND OF THIS VERB IS A STRING OF SECOND CONJUGATION VERBS. THE SECOND CONJUGATION IS DISCUSSED BELOW. THE ACTION OF DEFINE IS TO MOVE THE VERB STRING INTO MEMORY WHERE IT CAN BE INVOKED BY A SUBSEQUENT PROCESS VERB. UP TO EIGHT OF THESE VERB STRINGS OR PROCEDURES MAY BE STORED IN THE MACHINE. THE PROCEDURE DEFINED BY A PARTICULAR STRING IS IDENTIFIED BY AN INTEGER APPENDED TO THE DEFINE VERB. FOR EXAMPLE, DEFINE3 INTRODUCES THE VERB STRING WHICH DEFINES PROCEDURE 3. PROCEDURE 3 CAN BE INVOKED BY THE VERB PROCESS3 OR BY DO D3.

PROCESS - THE OPERAND OF THIS VERB IS A LIST AND/OR RANGE OF SCAN NUMBERS. THE PROCESS VERB ALWAYS APPEARS WITH AN INTEGER APPENDED TO IT WHICH REFERS BACK TO A PRECEDING DEFINE VERB. EACH SCAN SPECIFIED ON THE PROCESS CARD IS PROCESSED BY THE CORRESPONDING PROCEDURE.

The above verbs are discussed in greater detail in the verb dictionary and in the examples. The dictionary also defines three minor first conjugation verbs called ON, OFF, and REMARK.

The rules for writing a first conjugation verb and its operand are summarized below:

RULE 1. VERBS ARE CODED IN THE OPERATOR FIELD, THE FIRST WORD OF A MESSAGE.

RULE 2. DIRECT OBJECTS (IF REQUIRED BY THE VERBS) ARE CODED AT LEAST ONE SPACE BEYOND THE OPERATOR FIELD.

RULE 3. IF THE VERB REFERENCES A PROCEDURE, THEN THE PROCEDURE NUMBER IS CODED AFTER THE VERB WITH NO SPACES.

The verbs of the second conjugation do not take an explicit object. The object of their actions is always one of the three arrays--ON, OFF, or HOLD. For some second conjugation verbs, the definition of the verb will specify which array or arrays it acts upon. The other verbs refer to a pointer called PMASTER in the program and act on the array to which it points. A verb may reset PMASTER or leave it unchanged depending on the definition of the verb.

As an example, consider the following sequence of verbs: FETCH BOXCAR TEMP BOXCAR. FETCH leaves PMASTER pointing to the OFF ARRAY. BOXCAR operates on this array and leaves PMASTER unchanged. By definition, temp operates on the arrays ON and OFF and leaves PMASTER pointing to the ON ARRAY. The second occurrence of boxcar will then operate on the ON ARRAY.

Verbs of the second conjugation are typed in the same manner as those of the first conjugation. Since they never take operands, the remainder of the message can be blank or contain additional second conjugation verbs. These verbs occur most commonly in strings of verbs which define procedures. They will thus appear in columns beyond the operator of a define card, each verb separated from its neighbor by at least one blank (for example, "DEFINE1 FETCH BOXCAR TEMP BOXCAR").

There are two special cases in the second conjugation. These are the verbs FETCH and GET. These two verbs never appear in the operator field, but one or the other will usually appear as the first verb in a procedure. Their purpose is to mediate between the list of scans in the process statement and the list of verbs in the DEFINE statement.

For each scan specified in the process statement, GET will move that scan into the ON ARRAY where it is processed by the rest of the verb string. When the list of scans is exhausted, the next card in the INPUT stream is read. GET is used with the switched power system and leaves PMASTER pointing to the ON ARRAY.

FETCH is used with the total power system. For each scan specified in the process statement, FETCH moves that scan into the ON ARRAY, and looks up the reference scan associated with the specified scan. The reference scan is then moved into the OFF ARRAY. PMASTER is left pointing to the OFF ARRAY. In the switched power mode, the signal and reference are compared in Phase I; in the total power mode this comparison is made in Phase III by the TEMP verb.

Adverbs modify verbs. Not all verbs have adverbs, but the ones that do require the adverbs to be assigned meaningful values. The program initializes many adverbs, but others require user input. Adverbs are assigned values by an assignment statement. Each adverb has a name like BDROP, NFIT, or NBOX. Values are assigned by name, using the form "NAME=VALUE". For example, the order of the baseline fit would be assigned as follows:

```
NFIT=2
```

Once adverbs are assigned a value, they maintain that value until reset by subsequent assignment statements. Adverbs may be initialized at any time by simple assignments, although for convenience, multiple assignments may be made in the Operand field of the verb ENTER that is:

```
ENTER     NFIT=2 NREGION(1,1)=12 NREGION(1,2)=170
```

Some adverbs modify the work of verbs for all receivers used and others for specific receivers. Adverbs that are received dependent are subscripted. Table 3 shows the relation between subscripts and receiver names.

Receiver	Subscript
A	1
B	2
C	3
D	4

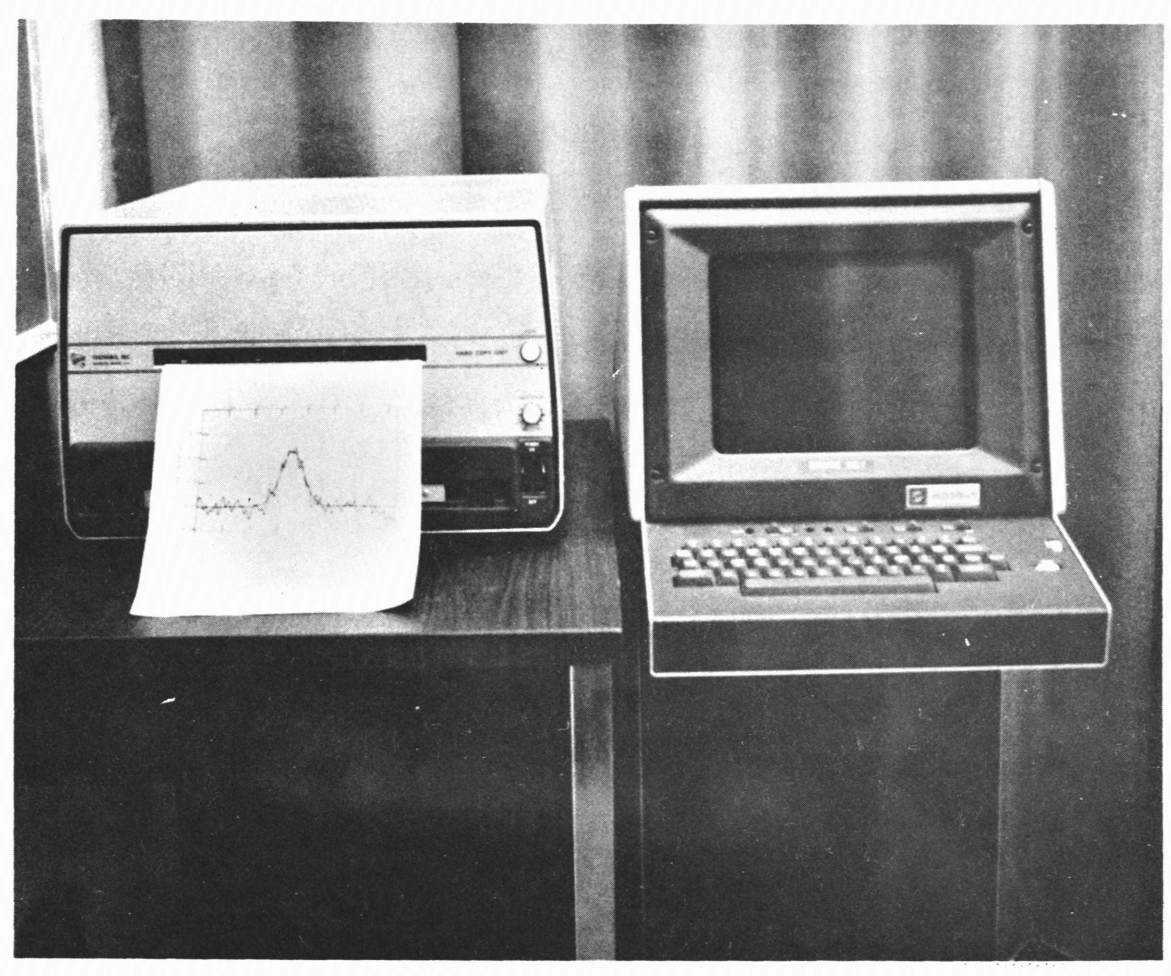
TABLE 3

Suppose we want to ignore channels 1-5 (first five) and 180-192 of (last thirteen) of receiver A, and channels 193-200 (first eight) and 380-384 (last five) of receiver B. Using the ENTER verb, the message would be coded as follows:

ENTER BDROP(1)=5 EDROP(1)=13 BDROP(2)=8 EDROP(2)=5

A few of the adverbs are altered by verbs. This is done primarily to communicate the results of a calculation from one step to another. However, the interaction of the smoothing verbs, BOXCAR and HANNING, with the adverbs BDROP and EDROP is more complicated. The user will normally set BDROP and EDROP to limit the range of velocity channels processed. The action of the smoothing verbs further reduces the range of velocity. The range remains reduced until a procedure is finished, at which point the velocity range reverts to that specified by the user.

A. INTERACTIVE GRAPHICS TERMINAL



Data reduction is at times a trial and error process to determine the best reduction procedure for a given observation. The interactive graphics terminal is an INPUT/OUTPUT device that can greatly speed up this process. The terminal gives the user the ability to input command messages to the computer and have the computer output displays on a Cathode Ray Tube (CRT), all within seconds. In this way the user can see the results of different order baseline fits, or smoothing, or of using a different off scan. Interaction increases confidence in both the data and the program, while improving user efficiency.

Our interactive graphics terminal equipment is the Tektronix 4010 graphics terminal and 4610 hard copier, as pictured in Figure 2. The graphics terminal is a storage tube device, which retains a picture on a CRT screen until erased by the user. Overlaid displays can be produced on this type device. A copy of a display can be made on paper by pushing the hard copy button.

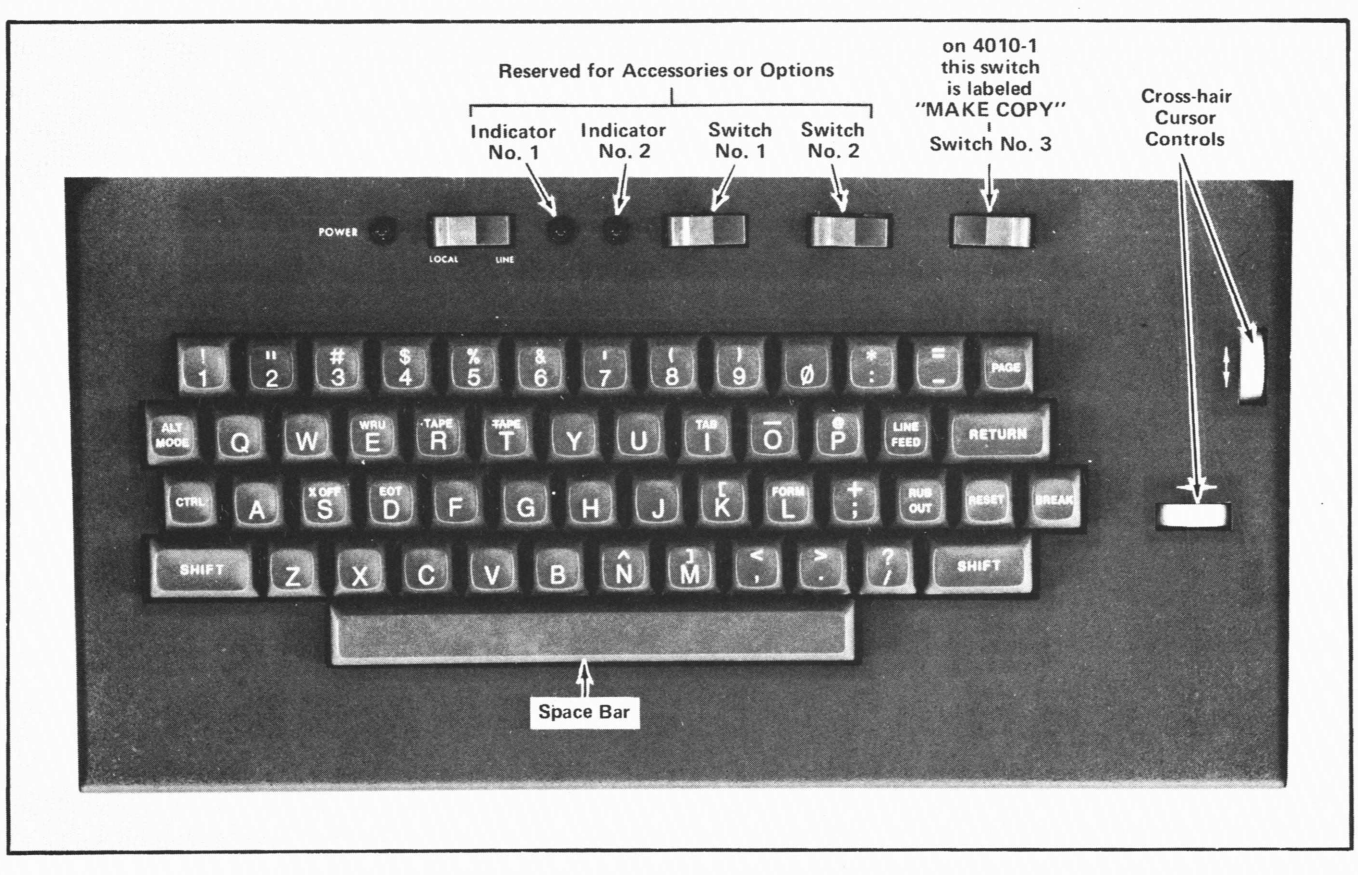


Figure 3 shows the keyboard layout. Note that it differs from that of a keypunch. There are several special keys and combinations of keys used when communicating with the control program. They are:

PAGE (PG) - ERASES THE VIEWING SCREEN: RESETS THE CURSOR TO THE UPPER LEFT-HAND CORNER; PUTS THE TERMINAL INTO THE CHARACTER MODE. NOTHING IS SENT TO THE COMPUTER.

BREAK (BR) - SENDS A SEQUENCE OF ZERO BITS TO THE COMPUTER, WHICH WHEN RECEIVED ARE INTERPRETED BY THE PROGRAM AS A CANCEL MESSAGE (THE ENTIRE LINE IS IGNORED AND THE PROGRAM WAITS FOR THE NEXT MESSAGE).

CTRL D (CTL) - WHEN THE D KEY IS STRUCK WHILE HOLDING DOWN THE CTRL KEY, AN END-OF-TRANSMISSION (EOT) CHARACTER IS SENT, NOTIFYING THE PROGRAM THAT A MESSAGE IS READY FOR PROCESSING. ALL MESSAGES MUST END WITH THIS COMBINATION OF KEY STROKES. (MESSAGES ARE 80 CHARACTERS LONG).

To use the interactive graphics terminal the user must supply an extra job control language card, set an additional adverb at initial time, and switch the input stream from cards to the terminal. The extra JCL card is:

```
//D.TUBE                DD UNIT=032
```

and must preceed the "//D.SYSIN DD*"Card in the job submittal deck. The user controls the origin of messages by setting the value of the adverb CRT. The terminal control program is initialized

by setting the adverb CRT equal to one in the operand field of the initial verb, i.e.,

```
INITIAL    DISP='OLD'    CRT=1
```

To switch from card to terminal I/O set CRT equal to two, and to switch from terminal to card input set CRT not equal to two. In this way both card and terminal control can be mixed in a single run. When the program is ready to receive a message, a "greater than" (>) character appears and the message can be entered. All messages must terminate with a CTRL D character.

TOTAL/SWITCHED POWER VERB/ADVERB DICTIONARY

As Of
Sunday, April 29, 1973

B. *** CURRENT STATUS ***

All elements of an adverb array may be initialized by a single assignment statement of the form BDROP=12.

OCT 21, 1972	VERSION 3.1	NEW VELOCITY CODES 0 - NO VELOCITY 1 - VELOCITY LSR RADIO 2 - VELOCITY SUN RADIO 3 - VELOCITY LSR OPTICAL 4 - VELOCITY SUN OPTICAL CHANGES MADE IN PHASE II TO CODE AND OUTPUT
DEC 5, 1972	VERSION 3.2	SLIDE VERB REDEFINED TO INCLUDE WEIGHTING BY INT. TIME
DEC 8, 1972		FLIP VERB REDEFINED TO USE SET1 ADVERBS INSTEAD OF FSET1 ADVERBS
JAN 15, 1973		CRT IO ADDED TO PROGRAM
JAN 30, 1973		WEIGHT VERB ADDED, SAVE AND RECALL REDEFINED TO USE NSAVE AND READ INTO CURRENTLY DEFINED ARRAY.

C. CONVENTIONS

1. Subscripted variables appear in the dictionary in the form: VARIABLE(N). This notation indicates that the variable takes on the values, Variable(1), Variable(2), ..., Variable(N). Since the subscript refers to the receiver, then by convention the numbers 1, 2, 3, and 4 refer to receivers A, B, C, and D.

2. The phrase "PMASTER REMAINS UNCHANGED" implies that the verb, if it acts on an array, will act on the array to which PMASTER points. The verb itself will not alter or set PMASTER.

3. The term scan number is defined to be the telescope scan number multiplied by 10, e.g. SCAN 222 becomes SCAN number 2220.

4. Channel numbers run continuously from 1 to 413 for the model II autocorrelator or 1 to 384 for the Model III autocorrelator. If you want to reference, as in the NREGION adverb, a channel number of a receiver, you add the beginning channel number for the receiver to the logical channel number and subtract one. For example, the 10th channel of the B receiver of the Model II autocorrelation receiver would be 193+10-1=202. The following is a table of receiver modes, logical receivers, and channel numbers.

CHANNELS vs. RECEIVERS

	MODEL II		MODEL III	
MODE 1				
	REC A	1 TO 384	REC A	1 TO 384
	REC C	385 TO 413		
MODE 2				
	REC A	1 TO 192	REC A	1 TO 192
	REC B	193 TO 384	REC B	193 TO 384
	REC C	385 TO 413		
MODE 3				
			REC A	1 TO 96
			REC B	97 TO 192
			REC C	193 TO 384
MODE 4				
			REC A	1 TO 96
			REC B	97 TO 192
			REC C	193 TO 288
			REC D	289 TO 384

TABLE 4

ADVERB SYNOPSIS

VARIABLE NAME	SHORT DESCRIPTION	ASSOCIATED VERBS	INITIAL VALUE
BGUASS	CHANNEL TO START FITTING A GAUSSIAN	GAUSS	-
EGAUSS	CHANNEL TO END FITTING A GAUSSIAN	GAUSS	-
BDROP(N)	NUMBER OF CHANNELS TO BE DROPPED AT THE LEFT OR LOW VELOCITY END	BOXCAR,HANNING GRAPH, PROFILE PLOT,REPLOT,SCALE WRITE,SHOW,RESHOW	10
EDROP(N)	NUMBER OF CHANNELS TO BE DROPPED AT THE RIGHT OR HIGH VELOCITY END	SAME	10
BWINDOW(N)	BEGINNING CHANNEL WINDOW	MOMENT	-
EWINDOW(N)	ENDING CHANNEL WINDOW	MOMENT	-
CENTER(J)	FIRST GUESS AT THE CENTER OF THE LINE TO BE FITTED	GAUSS, GMODEL	-
CLIP_MAX(N)	MAX LIMIT OF SPECTRAL VALUES	CLIP	10000
CLIP_MIN(N)	MIN LIMIT OF SPECTRAL VALUES	CLIP	-10000
CRT	TRANSFERS I/O BETWEEN CRT TERMINAL AND CARDS		0
FACT(N)	MULTIPLICATIVE CONSTANT FOR SCALING SPECTRAL VALUES	SCALE,BIAS	1
HEIGHT(J)	AMPLITUDE OF A GAUSSIAN TO BE CALCULATED	GAUSS,GMODEL	-
HWIDTH(J)	HALF POWER WIDTH FOR FIRST GUESS OF THE LINE TO BE FITTED	SAME	-
LOOSE(J)	CHANNEL TO BE REPLACED BY INTERPOLATING BETWEEN CHANNELS OR SET EQUAL TO 0	REMOVE ZERO	0

ADVERB SYNOPSIS
(Continued)

VARIABLE NAME	SHORT DESCRIPTION	ASSOCIATED VERBS	INITIAL VALUE
NBOX	NUMBER OF CHANNELS AVERAGED TOGETHER IN SMOOTHING	BOXCAR,SUM	3
NFIT	ORDER TO POLYNOMIAL	BASELINE	1
NGAUSS	NUMBER OF GAUSSIAN FUNCTIONS TO BE FIT	GAUSS GMODEL	1
NMOMENT	ORDER OF MOMENT	MOMENT	0
NREGION(N,M)	DEFINES REGIONS FOR WHICH A POLYNOMIAL WILL BE FITTED	BASELINE,RMS DCBASE	0
NSAVE	LOCATION WITHIN DISK STORAGE WHERE SCANS CAN BE STORED VALUES OF 0-9 LEGAL	SAVE,RECALL	0
OFFSET(N)	# OF CHANNELS SHIFT USED IN ALIGNING VELOCITIES	ADD ACCUM ALIGN ALIGN_R SLIDE	0
PRTEMP	IF PRTEMP=1, PRINT A MATRIX BLOCK OF THE SPECTRAL VALUES FOLLOWING THE PRINTER GRAPH	GRAPH	0
SET1 SET2 SET3	USED TO SELECT WHICH RECEIVER WILL BE PROCESSED WHEN USED IN CONJUNCTION WITH THE SELECT VERB	SELECT	1 1 1
SLIDE_TO	NUMBER OF THE RECEIVER WHICH IS USED AS THE BASE FOR AVERAGING	SLIDE	1
SLIDE_FROM	NUMBER OF THE RECEIVER WHICH IS USED TO AVERAGE WITH THE BASE	SLIDE	2
SQUEEZE	INCREASES THE PERSPECTIVE ON THE PRINTER PLOTS	GRAPH	1
WGT	TURN WEIGHTING BY TEMPERATURE OFF OR ON	GAUSS	0

ADVERB SYNOPSIS
(Continued)

VARIABLE NAME	SHORT DESCRIPTION	ASSOCIATED VERBS	INITIAL VALUE
X_INCR(N)	UNITS PER INCH IN X AXIS SCALING	PLOT	-
Y_INCR(N)	UNITS PER INCH IN Y AXIS SCALING	PLOT	-
X_MIN(N)	MIN X VALUE USED IN USER SCALING OF CALCOMP PLOTS	PLOT	-99999
Y_MIN(N)	MIN X VALUE USED IN USER SCALING OF CALCOMP PLOTS	PLOT	-99999
X_TITLE	PLOT CAPTION	PLOT,PROFILE	'VELOCITY(KM/S)'
Y_TITLE	PLOT CAPTION	PLOT	'ANTENNA TEMPERATU
YINCR	INCHES BETWEEN SUCCESSIVE PROFILES	PROFILE	0.5
Z_LINE	CAUSES A ZERO LINE TO BE DRAWN WHEN SET TO 1	PLOT,PROFILE	0

VERB SYNOPSIS

ADD	ADDS SPECTRAL VALUES OF ON ARRAY TO SPECTRAL VALUES OF HOLD ARRAY, WEIGHTING = THE EFFECTIVE INTEGRATION TIME.
ALIGN	SET THE ADVERB OFFSET SUCH THAT SCANS WILL BE ALIGNED WHEN ADDED BY THE ACCUM VERB.
ALIGN_R	SET THE ADVERB OFFSET SUCH THAT RECEIVERS WILL BE ALIGNED WHEN AVERAGED BY THE SLIDE VERB.
AVE	DIVIDES ACCUMULATED SCANS BY THE EFFECTIVE INTEGRATION TIME.
BASELINE	COMPUTES THE COEFFICIENTS OF A CHEBYSHEV POLYNOMIAL FOR A GIVEN ORDER BY A LEAST SQUARES FIT FOR A SPECIFIED REGION OR REGIONS OF SPECTRAL VALUES.
BIAS	ADDS A FACTOR TO THE CURRENTLY REFERENCED SPECTRAL VALUES.
BOXCAR	SMOOTHES THE SPECTRAL VALUES BY AVERAGING WITH EQUAL WEIGHTING OVER AN ODD NUMBER OF CHANNELS AND REPLACES THE AVERAGED VALUE IN THE CENTER CHANNEL OF THE ODD INTERVAL.
C	PERFORMS NO OPERATION. INTRODUCES A COMMENT FIELD.
CLIP	LIMITS THE RANGE OF SPECTRAL VALUES TO A MAXIMUM AND MINIMUM VALUE.
COMBINE	ADDS CHANNELS TOGETHER.
DCBASE	COMPUTES THE AVERAGE SPECTRAL VALUE OVER A GIVEN CHANNEL RANGE AND SUBTRACTS THE AVERAGE VALUE FROM ALL SPECTRAL VALUES.
DCONT	ADDS ADDITIONAL VERBS OR ADVERBS TO A PROCEDURE.
DEFINE	SETS UP A PROCEDURE.
DEF_LIST	DISPLAYS ALL CURRENT PROCEDURE DEFINITIONS.
DIFF	SUBTRACTS THE SPECTRAL VALUES OF THE OFF ARRAY FROM THE CURRENTLY REFERENCED SPECTRAL VALUES.
DIVIDE	DIVIDES THE CURRENTLY REFERENCED SPECTRUM BY THE OFF SPECTRUM.

VERB SYNOPSIS

DO	CAUSES A PROCEDURE TO BE EXECUTED FOR A LIST OF SCANS.
DOC	PRINTS THE OPERAND OF THE LAST REMARK VERB.
ENTER	USED TO SET NEW VALUES FOR ADVERBS.
EXIT	CAUSES THE PROGRAM TO TERMINATE.
FETCH	GETS AN ON SCAN AND ITS ASSOCIATED OFF (TOTAL POWER).
FLIP	CORRECTS THE REFERENCE PORTION OF THE SPECTRA IN DUAL DICKE SWITCHED MODE.
GAUSS	FITS A GAUSSIAN TO SPECTRAL VALUES.
GET	READS THE CONTENTS OF THE DISK RECORD INTO THE ON ARRAY (RETRIEVES DATA IN THE SWITCHED POWER SYSTEM).
GMODEL	USES THE CURRENT VALUES OF THE ADVERBS HEIGHT, HWIDTH, & CENTER TO EVALUATE A GAUSSIAN. THE CALCULATED VALUES REPLACE THE SPECTRAL VALUES OF THE LAST REFERENCED ARRAY.
GRAPH	GIVES PRINTER PLOT OF SPECTRAL VALUES (TOP SCALE, VELOCITY IN KM/S: BOTTOM SCALE, CHANNEL NUMBER: Y = ANTENNA TEMPERATURE).
HANNING	SMOOTHS THE SPECTRAL VALUES USING 1/4-1/2-1/4 WEIGHTING.
HEADER	PRINTS DOCUMENTATION INFORMATION ABOUT THE LAST REFERENCE ARRAY.
INITIAL	INITIALIZES THE PROGRAM - CALLED BEFORE ANY OTHER VERBS.
INVERT	REVERSES THE ORDER OF THE SPECTRAL VALUES.
LOAD	READS A 9-TRACK TAPE AND WRITES A DIRECT ACCESS DATA SET (USER MAY SUPPLY A RA RANGE FOR SCANS TO BE LOADED).
MAP	WRITES ARRAY CARDS FOR CALCOMP CONTOURING PROGRAM (VELOCITY vs. POSITION).
MAP_VLB	WRITES CNTL CARDS FOR CALCOMP CONTOURING PROGRAM (GALACTIC LONGITUDE AND LATITUDE).

VERB SYNOPSIS

MAP_VRD	WRITES CNTL CARDS FOR CALCOMP CONTOURING PROGRAM (RIGHT ASCENSION vs. DECLINATION).
MOMENT	SUMS OVER A GIVEN CHANNEL RANGE AND PLACES RESULTS IN A ADVERB SIZE FOR USE BY OTHER VERBS.
OFF	READS THE CONTENTS OF THE DISK RECORD INTO THE OFF ARRAY.
ON	READS THE CONTENTS OF THE DISK RECORD INTO THE ON ARRAY.
OVERLAP	UNDOES THE EFFECT OF DUAL DICKE FREQUENCY SWITCHING.
PAUSE	WAITS UNTIL THE USER RESPONDS WITH A MESSAGE FROM THE CRT.
PLOT	A 5X10 INCH CALCOMP PLOT OF AN INDIVIDUAL SPECTRUM.
PMF	SETS PMASTER TO THE OFF ARRAY.
PMO	SETS PMASTER TO THE ON ARRAY.
PMH	SETS PMASTER TO THE HOLD ARRAY.
PROCESS	CAUSES A LIST OF SCANS TO BE PROCESSED BY A PROCEDURE.
PROFILE	A 25X10 INCH CALCOMP PLOT OF MANY SPECTRA.
RECALL	READS THE CONTENTS OF A DISK BUFFER INTO THE CURRENTLY REFERENCED ARRAY.
REMARK	CALCOMP PLOT LABEL OR IDENTIFICATION.
REMOVE	INTERPOLATES BETWEEN THREE CHANNELS TO REPLACE THE SPECTRAL VALUES OF THE CENTRAL CHANNEL.
REPLOT	DRAWS A SPECTRUM ON A CRT (TEK 4010) WITH THE PREVIOUS SCALING INFORMATION.

VERB SYNOPSIS

RESIDUAL	DIFFERENCES THE SPECTRAL VALUES FROM A GAUSSIAN USING THE ADVERBS HEIGHT HWIDTH AND CENTER TO COMPUTE THE GAUSSIAN. THE DIFFERENCE REPLACES THE SPECTRAL VALUES.
RMS	COMPUTES THE RMS FOR THE SPECTRAL VALUES WITHIN THE REGION SPECIFIED.
SAVE	WRITES THE CONTENTS OF THE CURRENTLY REFERENCED ARRAY INTO A DISK BUFFER.
SCALE	MULTIPLIES EACH CHANNEL FOR EACH RECEIVER BY A CONSTANT FACTOR.
SELECT	SELECTS THE RECEIVER OR RECEIVERS TO BE PROCESSED.
SHOW	DRAWS A SPECTRUM ON A CRT (TEK 4010) WITH A BORDER AND TITLE.
SLIDE	AVERAGES RECEIVERS A AND B (OR A AND C) AND PLACES THE AVERAGE IN RECEIVER A.
SUM	ADDS THE SPECTRAL VALUES OF THE OFF ARRAY TO THE CURRENTLY REFERENCED SPECTRAL VALUES.
TABLE	PRINTED TABLE OF CHANNEL NUMBERS, VELOCITIES, AND TEMPERATURES.
TELL	DISPLAYS CURRENT VALUE OF ADVERBS.
TEMP	COMPUTES THE TEMPERATURES BY USING THE FORMULA (S-R)/R*TSYS WHERE S IS THE SPECTRAL VALUES OF THE ON ARRAY, R IS THE SPECTRAL VALUES OF OFF ARRAY AND TSYS IS THE SYSTEM TEMPERATURE OF THE ON ARRAY.
TRF	TRANSFERS CURRENTLY REFERENCED ARRAY TO THE OFF ARRAY.
TRH	TRANSFERS CURRENTLY REFERENCED ARRAY TO THE HOLD ARRAY.
TRO	TRANSFERS CURRENTLY REFERENCED ARRAY TO THE ON ARRAY.
WEIGHT	MULTIPLIES THE INTEGRATION TIME BY 1/FACT**2.
WRITE	PUNCHES CARDS FOR SPECTRAL DATA.
ZERO	SETS SPECTRAL VALUES EQUAL TO ZERO FOR A REGION OF CHANNEL NUMBERS.

RECIPE INDEX

RECIPES

EXAMPLE 1

Average two or more scans together.

```
INITIAL
LOAD        USER_NUMBER=4
```

CASE A: Average six scans

```
DEFINE1     FETCH TEMP ACCUM
DEFINE2     AVE PLOT
REMARK      M101 (-30) 6 SCANS
PROCESS1    30360 28970 27680 24160 22770 19910
DO D2
```

CASE B: Associate a different 'OFF' with a given 'ON' and average

```
DEFINE1     FETCH TEMP ACCUM
DEFINE2     AVE PLOT
DEFINE3     GET TEMP ACCUM
C           USE SCAN 21900 AS 'OFF' SCAN FOR 21950
OFF         21900
PROCESS3    21950
C           PROCESS REMAINING SCANS NORMALLY
PROCESS1    19140 20520 24789 28160 29540
C           PROCESS2 IS PERFORMED ONLY ONCE
DO D2
```

CASE C: Average 'OFFS', associate with a 'ON' scan 39690 and average

```
DEFINE1     GET ACCUM
DEFINE2     AVE SAVE
DEFINE3     GET TEMP ACCUM
DEFINE4     AVE HEADER GRAPH
C           AVERAGE FIRST TWO 'OFF' SCANS AND SAVE
PROCESS1    35680 35700
NSAVE=1
DO D2
C           AVERAGE SECOND SET OF TWO 'OFF' SCANS AND SAVE
PROCESS1    35820 25860
NSAVE=2
DO D2
```

EXAMPLE 1, CASE C (Continued)

```
C           FORM TEMPERATURES WITH 'ON' SCAN 35690 USING FIRST AVE
C           OFF
PMF NSAVE=1 RECALL
PROCESS3    35690
C           FROM TEMPERATURES WITH 'ON' SCAN 35840 USING SECOND AVE
C           OFF
PMF NSAVE=2 RECALL
PROCESS3    35840
C           THIS PATTERN CAN BE REPEATED UP TO NINE TIMES
DO D4
```

RECIPES

EXAMPLE 2

Average receivers together

```
      INITIAL
      LOAD        USER_NUMBER=4
```

CASE A: Average Rec A and B

```
      DEFINE1     FETCH TEMP SLIDE HEADER GRAPH
      PROCESS1    30360 28970 27680
```

CASE B: Average Rec A and C after call to overlap in parallel mode

```
      DEFINE1     GET OVERLAP ACCUM
      DEFINE2     AVE SLIDE PLOT
      PROCESS1    37280 37300 38290
      C           AFTER OVERLAP THE REDUCED SPECTRA ARE IN LOCATION OF
      C           REC A AND C
      ENTER       SLIDE_TO=1 SLIDE_FROM=3
      DO D2
```

CASE C: Average Rec A and B, but not for every scan

```
      C           FOR BOTH A & B REC
      DEFINE1     GET ACCUM
      C           FOR REC A ONLY
      DEFINE2     GET SET1=1 SET2=1 SELECT ACCUM
      C           FOR REC B ONLY
      DEFINE3     GET SET1=2 SET2=2 SELECT ACCUM
      DEFINE4     PMH SET1=1 SET2=2 SELECT AVE HEADER GRAPH
      PROCESS1    3750 TO 3800
      PROCESS2    4010 4020
      PROCESS3    4030
      DO D4
```

RECIPES

EXAMPLE 3

Smoothing

```
      INITIAL
      LOAD        USER_NUMBER=115
```

CASE A: Hanning smooth a scan before plotting

```
      DEFINE1     FETCH TEMP HANNING PLOT
      PROCESS1    56800
```

CASE B: Smooth the 'OFF' scans to increase the S/N ratio

```
      DEFINE1     FETCH BOXCAR TEMP HEADER GRAPH
      C           BOXCAR WILL SMOOTH THE OFF ARRAY USING FIVE CHANNELS
      NBOX=5
      PROCESS1    56800 TO 56890
```

RECIPES

EXAMPLE 4

Frequency baseline removal

```
INITIAL
LOAD        USER_NUMBER=201
```

CASE A: Remove a linear baseline from receivers A and B (Mod II) using two regions to which the baseline will be fit

```
DEFINE1     FETCH TEMP BASELINE HEADER GRAPH
C           REC A CHANNELS 20 TO 70 AND 150 TO 180
ENTER       NREGION(1,1)=20  NREGION(1,2)=70  NREGION(1,3)=150
ENTER       NREGION(1,4)=180  NREGION(1,5)=0
C           REC B CHANNELS 210 TO 260 AND 310 TO 370
ENTER       NREGION(2,1)=210  NREGION(2,2)=260  NREGION(2,3)=310
ENTER       NREGION(2,4)=370  NREGION(2,5)=0
C           THE ORDER OF THE FIT
NFIT=1
PROCESS1    3470 3510
```

CASE B: Remove a baseline for only one receiver after averaging Recs A and B

```
DEFINE1     FETCH TEMP SLIDE SELECT BASELINE PLOT
C           REC A ONE REGION - CHANNELS 10 TO 180
ENTER       NREGION(1,1)=10  NREGION(1,2)=180  NREGION(1,3)=0
C           LIMIT PROCESSING TO REC A BY THE SELECT VERB AND THESE
C           ADVERBS
ENTER       SET1=1  SET2=1  SET3=1
C           USE A SECOND ORDER (PARABOLA) BASELINE
NFIT=2
PROCESS1    74550
```

RECIPES

EXAMPLE 5

Gaussian line fitting

```
INITIAL
LOAD        USER_NUMBER=4
```

CASE A: Fitting a Gaussian

```
DEFINE1     FETCH TEMP HEADER GRAPH BASELINE GAUSS
C           FIRST GUESS OF GAUSSIAN CENTER AND HALF WIDTH
ENTER       CENTER=90  HWIDTH=6
C           REGION OVER WHICH THE GAUSSIAN WILL BE LEAST SQUARES FIT
ENTER       BGAUSS=60  EGAUSS=120
C           BASELINE MUST BE REMOVED BEFORE GAUSS
ENTER       NREGION(1,1)=20  NREGION(1,2)=340  NREGION(1,3)=0 NFIT=1
PROCESS1    26800
```

CASE B: Fitting a Gaussian and plotting the evaluated Gaussian on top of the data

```
DEFINE1     FETCH TEMP HEADER BASELINE PLOT GAUSS GMODEL REPLOT
C           FIRST GUESS OF GAUSSIAN CENTER AND HALF WIDTH
ENTER       CENTER=56  HWIDTH=10
C           REGION OVER WHICH THE GAUSSIAN WILL BE LEAST SQUARES FIT
ENTER       BGAUSS=44  EGAUSS=69
C           BASELINE MUST BE REMOVED BEFORE GAUSS
ENTER       NREGION(1,1)=20  NREGION(1,2)=340  NREGION(1,3)=0 NFIT=1
PROCESS1    29430
```

CASE C: Fitting a Gaussian and plotting the residuals on a separate plot

```
DEFINE1     FETCH TEMP HEADER BASELINE PLOT GAUSS RESIDUAL PLOT
C           FIRST GUESS OF GAUSSIAN CENTER AND HALF WIDTH
ENTER       CENTER=260  HWIDTH=5
C           REGION OVER WHICH THE GAUSSIAN WILL BE LEAST SQUARES FIT
ENTER       BGAUSS=250  EGAUSS=270
C           BASELINE MUST BE REMOVED BEFORE GAUSS
ENTER       NREGION(1,1)=20  NREGION(1,2)=340  NREGION(1,3)=0 NFIT=1
PROCESS1    29440
```

RECIPES

EXAMPLE 5 (Continued)

CASE D: Gaussian line fitting using the interactive terminal.

```
DEFINE1    GET SELECT HANNING SHOW
DEFINE2    BASELINE TRH SHOW
DEFINE3    PMH SHOW PMO GMODEL RESHOW
DEFINE4    PMO GMODEL SHOW PMH TRF RESIDUAL RESHOW
C          DEFINE1   GET AND PREPARES THE SPECTRUM
C          DEFINE2   REMOVES THE BASELINE AND MOVES THE SPECTRUM
C                    TO THE HOLD ARRAY
C          DEFINE3   DISPLAYS THE ORIGINAL SPECTRUM IN THE HOLD
C                    ARRAY, CALCULATES THE GAUSSIAN MODEL AND
                     REPLACES IN THE ON ARRAY
C          DEFINE4   COMPUTES THE GAUSSIAN MODEL AND REPLACED IT
C                    IN THE HOLD ARRAY AND TRANSFERS THE ORIGINAL
C                    SPECTRUM TO THE OFF ARRAY WHERE IT IS
C                    DIFFERENCED FROM THE GAUSSIAN MODEL AND THE
C                    DIFFERENCE, BEING THE RESIDUAL REPLACES THE
C                    SPECTRUM IN THE OFF ARRAY
C
C          THE PROCEDURE GOES SOMETHING LIKE THIS
C
PROCESS    98680
ENTER      NREGION(1,1)=10  NREGION(1,2)=50  NREGION(1,3)=155
ENTER      NREGION(1,4)=180  NREGION(1,5)=0
DO D2
ENTER      CENTER(1)=98 CENTER(2)=105 HWIDTH(1)=12 HWIDTH(2)=155
ENTER      NGAUSS=2 BGAUSS=70 EGAUSS=140
GAUSS
DO D3
C          NOTE THAT BY POINTING TO THE HOLD ARRAY (PMH) THE
C          NEW GUESSES FOR THE INITIAL VALUES CAN BE ENTERED AND
C          THE GAUSSIAN REFIT.  PROCEDURES THREE AND FOUR ARE JUST
C          DISPLAY AND DO NOT DESTROY THE ORIGINAL DATA IN THE
C          HOLD ARRAY.
```

RECIPES

EXAMPLE 6

Calcomp plotting

```
INITIAL
LOAD        USER_NUMBER=49
```

CASE A: Default plotting (program scales both axes, and supplies titles.

```
DEFINE1     FETCH TEMP PLOT
C           DEFAULT ( SCALING - TITLE - NUMBER OF RECEIVERS )
PROCESS1    88980 90740
```

CASE B: User supplied Y scaling

```
DEFINE1     FETCH TEMP HEADER CLIP PLOT
C           SET TEMPERATURE AXIS TO BEGIN AT -2 DEGREES AND HAVE
C           A SCALE OF 1 DEGREE PER INCH (SCALE RUNS FROM -2 TO 3)
ENTER       Y_MIN=-2  Y_INCR=1
C           THESE SCALES REMAIN IN EFFECT UNTIL CHANGED BY THE USER
C           THE CLIP VERB IS USED TO LIMIT THE RANGE OF SPECTRAL
C           VALUES IF YOU ARE SURE YOU WILL NOT EXCEED THE RANGE DO
C           NOT CLIP FOR IT USES UP COMPUTER TIME
ENTER       CLIP_MIN=-2 CLIP_MAX=3
PROCESS1    460 490 510
```

CASE C: Plot after slide (only one receiver)

```
DEFINE1     FETCH TEMP HEADER SLIDE SELECT PLOT
C           SELECT LIMITS THE PROCESSING TO ONE RECEIVER
ENTER       SET1=1 SET2=1 SET3=1
PROCESS1    26800 27350 29430
```

RECIPES

EXAMPLE 7

Rescaling the spectra

```
INITIAL
LOAD        USER_NUMBER=89
```

CASE A: Rescale the data due to faulty determination of the noise tube value

```
DEFINE1     FETCH TEMP SCALE HEADER GRAPH
C           (NEW NOISE TUBE)/(OLD NOISE TUBE) = 1.234
ENTER       FACT(1)=1.264  FACT(2)=1.264  FACT(3)=1.264
PROCESS1    30360 28970 27680
```

CASE B: Reversing the sense of the spectra (simple flip about zero)

```
DEFINE1     FETCH TEMP SCALE HEADER GRAPH
C           FLIP ABOUT ZERO USING -1 FOR SCALE FACTOR
ENTER       FACT(1)=-1  FACT(3)=-1
PROCESS1    34910
```

RECIPES

EXAMPLE 8

Contour Mapping
(NB. see mapping verbs for additional JCL needed)

```
INITIAL
LOAD        USER_NUMBER=186
```

CASE A: Velocity coordinate map only receiver B

```
DEFINE1     FETCH TEMP SELECT BASELINE HANNING MAP
C           SELECT THE B RECEIVER, TAKE OUT A BASELINE, SMOOTH, AND
C           PUNCH 'ARRAY' CARDS
ENTER       SET1=2 SET2=2 SET3=1
ENTER       NREGION(2,1)=225 NREGION(2,2)=370 NREGION(2,3)=0 NFIT=1
C           THE USER MUST SEQUENCE THE SCANS IN THE COORDINATE HE
C           DESIRES TO MAP
PROCESS1    26900 TO 27890
```

CASE B: Coordinate-Coordinate (RA - DEC) map four receivers

```
DEFINE1     FETCH TEMP BASELINE HANNING AREA MAP_VRD
C           PREPARE THE DATA BY BASELINE REMOVAL AND SMOOTHING
C           COMPUTE THE INTEGRATED TEMPERATURE OVER 5 CHANNELS
C           ABOUT -139 KM/S YIELDING A VELOCITY INTERVAL OF 6.25 KM/S
ENTER       NREGION(1,1)=8 NREGION(2,2)=90 NREGION(1,3)=0 NFIT=1
ENTER       NREGION(1,2)=106 NREGION(2,2)=186 NREGION(2,3)=0
ENTER       NREGION(3,1)=200 NREGION(3,2)=280 NREGION(3,3)=0
ENTER       NREGION(4,1)=295 NREGION(4,2)=376 NREGION(4,3)=0
C           THE INTERVALS GIVEN IN CHANNEL NUMBERS
ENTER       BWINDOW(1)=30 EWINDOW(1)=35 BWINDOW(2)=126
ENTER       BWINDOW(3)=212 EWINDOW(3)=227 BWINDOW(4)=308
ENTER       EWINDOW(2)=131 EWINDOW(4)=313
PROCESS1    2680 TO 3010
```

RECIPES

EXAMPLE 9

Interchange an ON and OFF scan (useful in TPOWER at 300 foot)

```
INITIAL
LOAD        USER_NUMBER=186
```

CASE A: Interchange ON and OFF scans

```
DEFINE1     FETCH SAVE PMO TRF PMO RECALL TEMP SELECT HEADER GRAPH
PROCESS1    98690
```

G. Submitting The Program

Rather than supply all the required job control cards needed to run your program, you may use what is called a "Cataloged Procedure" to execute the program. Given below are the names of the cataloged procedures used with each observing technique and autocorrelation receiver. In each case Phase III of the programing system is invoked.

Procedure Name	Observing Technique	Receiver
TPMOD2A	TOTAL POWER	MOD II
SPMOD2A	SWITCHED POWER	MOD II
TPMOD3A	TOTAL POWER	MOD III
SPMOD3A	SWITCHED POWER	MOD III

These procedures contain most of the JCL except for certain parameters (such as your tape number) which you must supply. They have been written to simplify your input while allowing a large degree of versatility.

The rules for using the cataloged procedures are given below and examples of common usage follow. It is assumed that your input, either tape of disk, has been generated by the standard procedure.

1. Your data set name must be specified by name=_____
   and must match the name given when the tape was created.
2. A. If your input comes from tape, your tape number must be specified by tape=_____. Remember that cards reading

```
INITIAL
LOAD          USER_NUMBER=NNN
```

   must be supplied in the D.SYSIN FILE. See Example 1.

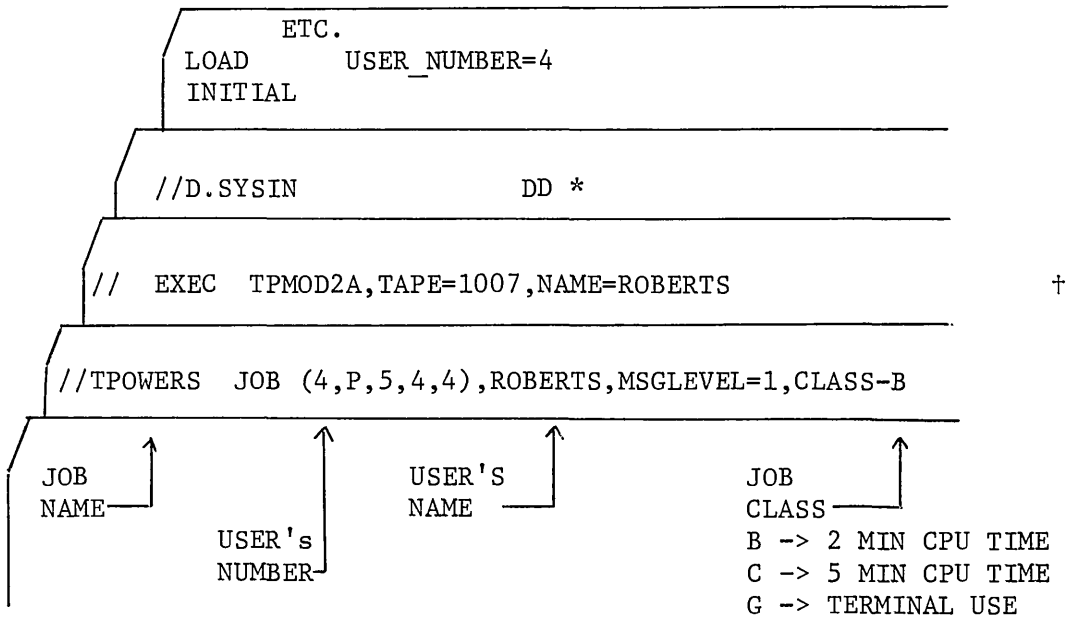
3. The disposition of the disk data set (which will be created by the program if your input comes from tape) can be specified. The default disposition is (NEW,DELETE), i.e., the disk file is created by the program and deleted afterwards. If you wish to retain the disk file for subsequent program runs, specify (NEW,CATLG) (see Example 2). If your input is a cataloged disk file and you wish to keep it, specify DISP=OLD (Example 3). If you wish to destroy the cataloged disk file after the program runs, specify DISP=(OLD,DELETE).
4. Your printed output is printed 8 lines to the inch by default. Since the printer normally prints 6 lines per inch, the computer operators must reconfigure the printer before and after your printout, and this takes time. If you have only a small amount of printout, you can specify 6 lines per inch by coding FORMAT=A, and thus save a lot of printer time.

CAUTION: Disk space is very limited. You are urgently requested to destroy your disk data file as soon as possible. The Computer Division will be merciless to violators.

Examples of Job Control Language used to run the program:

NOTE: A space on the following JCL cards mean "one or more" spaces. It is disastrous to insert blanks.

CASE 1: Using tape as input.



CASE 2: Using tape as input, but saving the disk file for later use.

```
//TPOWERS  JOB (165,P,5,4,4),GORDON,MSGLEVEL=1,CLASS=B,TIME=2
// EXEC TPMOD2A,TAPE=1007,NAME=GORDON,DISP='(NEW,CATLG)'        ††
//D.SYSIN                DD *
INITIAL
LOAD       USER_NUMBER=165
         ETC.
```

CASE 3: Using the saved disk file as input.

```
//TPOWERS  JOB (13,P,5,4,4),TURNER,MSGLEVEL=1,CLASS=C,TIME=5
// EXEC TPMOD2A,UNIT=DISK,NAME=TURNER,DISP=OLD,FORMAT=A          †††
```

CASE 4: Using the saved disk file as input, but deleting the file when processing is finished.

```
//TPOWERS  JOB (66,P,5,4,4),BUHL,MSGLEVEL=1,CLASS=B,TIME=2
// EXEC TPMOD2A,UNIT=DISK,NAME=BUHL,DISP='(OLD,DELETE)'         ††
//D.SYSIN                DD *
INITIAL    DISP='OLD'
         ETC.
```

(Footnotes on following page)

† DISP='(NEW,DELETE)' IS ASSUMED BY DEFAULT IN THIS CASE.

†† SINGLE QUOTATION MARKS MUST SURROUND A PARAMETER CONTAINING IMBEDDED PUNCTUATION MARKS.

††† PRINTOUT AT 6 LINES PER INCH.

H. ERROR CODES

SYSTEM ABENDS		"REASON"
IHE012I	ABENDED AT OFFSET XXXXX FROM ENTRY POINT LOADING WITH CC 813	THE NAME SPECIFIED ON EXEC CARD DOES NOT MATCH THE DSNAME ON TAPE.
IHE027I	GET STRING - UNRECOGNIZABLE DATA NAME	CHECK SPELLING OF ADVERBS IN ENTER STATEMENT.
IHE153I	FILE USER - BLOCKSIZE NOT SPECIFIED	TAKE THE LOAD CARD OUT WHEN YOU USE THE DISK.
IHE300I	OVERFLOW AT OFFSET XXXXX FROM ENTRY POINT STEP	CHECK TO SEE THAT THE A/C MODEL NO. MATCHES THE PROCEDURE USED IE. TPMOD2 TO TPMOD3.
SYSTEM COMPLETION CODE OF2		YOU LEFT OUT THE "//D.TUBE DD UNIT=032" CARD WHEN YOU WANTED THE TERMINAL.

PROGRAM ABENDS	
OPERAND _____ IS UNKNOWN OR ILLEGAL VERB	CHECK YOUR SPELLING OR YOU TRIED TO USE A VERB OF THE SECOND CONJ. IN THE OPERATOR FIELD.
ERROR IN OPERAND FILED	CHECK OPERAND FIELD OF PROCESS CARD.
UNKNOWN SCAN	NO SCAN BY SUCH A NUMBER TRANSFERED FROM TAPE. CHECK THE CONSISTANCY OF USER NUMBER CODED AT THE TELESCOPE.
SCAN _____ RECEIVER HAS CHANNEL OFFSET OF ____ SCAN IGNORED.	VELOCITY OFFSET BETWEEN SCANS IS TOO LARGE. CHECK CENTER VELOCITIES AND FREQUENCIES OF ALL SCANS INVOLVED.

PROGRAM ABENDS (Continued)	"REASON"
YOUR LIMIT IS 20 VERBS	MORE THAN 20 VERBS IN A DEFINITION OF A PROCEDURE.
UNUSABLE NBOX _____	NBOX WAS ENTERED WITH THE VALUE OF 1 OR ZERO.
UNUSABLE NBOX _____ NBOX NOW EQUALS _____	NBOX WAS ENTERED AS AN EVEN NUMBER BOXCAR SUBTRACTED ONE TO MAKE IT ODD.
ERROR IN GAUSS VERB -- PROCEDURE BYPASSED	CHECK BGAUSS, EGAUSS FOR APPROPRIATE REGION, CENTER, & HWIDTH GUESS.
UNKNOWN ADVERB	AN ADVERB IS MISPELLED IN AN ENTER STATEMENT.
UNKNOWN VERB	A VERB IS MISSPELLED IN A DEFINE STATEMENT.

VI. UTILITY PROGRAM - ACPROG

ACPROG provides the following functions:

1. Archive a Telescope tape.
2. List an Archive tape.
3. List a User tape
4. Dump a User tape.
5. Copy a User tape.
6. Alter a User tape.

The program is used in the following way:

JCL CARDS--

```
//SAMPLE     JOB (190,P,1,1,15),MSGLEVEL=1,CLASS=C
//           EXEC PGM=ACPROG,PARM='ISASIZE(6K)'
//STEPLIB    DD DSN=AUTOCORR.LIBRARY,DISP=SHR
//           DD DSNAME=PL1.LINKLIB,DISP=SHR
//SYSPRINT   DD SYSOUT=A,DCB=(RECFM=FA,BLKSIZE=133)
```

ADDITIONAL CARDS FOR EACH FUNCTION--

1. ARCHIVE A TELESCOPE TAPE:

```
//BUGS       DD SYSOUT=A,DCB=(RECFM=FA,BLKSIZE=133)
//DDP116     DD UNIT-SYSSQ7,VOL=SER=XXXX,LABEL=(,NL,,IN),DISP=OLD,
//               DCB=(...USER SUPPLIED...,BUFNO=1)
//ARCHIVE  DD UNIT=TAPE,VOL=SER=XXXX,DSN=XXXXXX,DISP=NEW,
--(PICK ONE OF THE FOLLOWING THREE CARDS)--
   FOR TP2,TP3:
//              DCB=(RECFM=FB,LRECL=2192,BLKSIZE=4384,BUFNO=1)
   FOR SP2:
//              DCB=(RECFM=FB,LRECL=3848,BLKSIZE=7696,BUFNO=1)
   FOR SP3:
//              DCB=(RECFM=FB,LRECL=3704,BLKSIZE=7408,BUFNO=1)
```

2. LIST AN ARCHIVE TAPE:
3. LIST A USER TAPE:
4. DUMP A USER TAPE:

```
//DATA       DD UNIT=TAPE,VOL=SER=XXXX,DSN=XXXXXX,DISP=OLD
```

5. COPY A USER TAPE:

```
//FROM       DD UNIT=TAPE,VOL=SER=XXXX,DSN=XXXXXX,DISP=OLD
//TO         DD UNIT=TAPE,VOL=SER=XXXX,DSN=XXXXXX,DISP=NEW,
--(PICK ONE OF THE FOLLOWING TWO CARDS)--
   FOR TP2,SP2:
```

```
//          DCB=(RECFM=F,BLKSIZE=2296)
  FOR TP3,SP3:
//          DCB=(RECMF=F,BLKSIZE=2340)
```

6. ALTER A USER TAPE: * FUNCTION NOT SUPPORTED AT THIS TIME *

USER INPUT--

```
//SYSIN    DD *
  OPERATION='PPPPPPPPPPPPPPP',FORMAT='QQQ';
```

```
WHERE  PPPPPPPPPPPPPPPP = ARCHIVE                AND  QQQ = TP2
                          LIST ARCHIVE TAPE                 TP3
                          LIST USER TAPE                    SP2
                          DUMP USER TAPE                OR SP3
                          COPY USER TAPE
                        OR ALTER USER TAPE
```

STRAIGHTFORWARD AND UNAMBIGUOUS KEYWORDS AND KEYWORDS AND KEYWORD RESPONSES, SUCH AS OP, FMT, 'D' (BUT NOT 'A' OR 'L'), 'S2', 'DUMP', 'LIST U', 'LA', ETC., WILL ALSO BE ACCEPTED. THE TERMINATING SEMICOLON MUST APPEAR.

FOR THE 'DUMP USER TAPE' ('DUMP', ETC.) OPERATION ONLY:

OPTIONALLY INCLUDE THE FOLLOWING CARD TO DUMP A SPECIFIC SCAN RANGE AND/OR INDICATE THAT THE SPECTRUM ARRAY IS TO BE DUMPED:

```
BEGIN=XXXX,LOW=XXXX,HIGH=XXXX,END=XXXX,DUMP_SPECTRA='YES';
```

DEFAULT ACTION DUMPS THE ENTIRE DATA SET WITHOUT SPECTRA.
DUMP TIME IS APPROXIMATELY 3 SECONDS PER RECORD (WITH SPECTRA).

FOR THE 'COPY USER TAPE' ('COPY', ETC.) OPERATION ONLY:

OPTIONALLY INCLUDE THE FOLLOWING CARD TO COPY A SPECIFIC SCAN RANGE AND/OR ADJUST SCAN NUMBER (ALL COPIED SCAN NUMBERS WILL BE ADJUSTED BY THIS VALUE; IT WILL BE ADDED TO EACH SCAN NUMBER):

```
BEGIN=XXXX,LOW=XXXX,HIGH=XXXX,END=XXXX,SCAN#_ADJUSTMENT=XXXX;
```

DEFAULT ACTION COPIES THE ENTIRE DATA SET UNCHANGED.

CONCERNING BEGIN/END AND LOW/HIGH SCAN RANGES:
(THE APPROPRIATE COMMENTS APPLY IF THE KEYWORD IS ASSIGNED A VALUE:
"PROCESSING" REFERS TO THE DUMP AND COPY FUNCTIONS OF ACPROG.)

BEGIN - PROCESSING BEGINS WITH THIS SCAN NUMBER.

LOW - RECORDS WITH SCAN NUMBERS LESS THAN THIS VALUE ARE NOT PROCESSED.

HIGH - RECORDS WITH SCAN NUMBER GREATER THAN THIS VALUE ARE NOT PROCESSED.

END - PROCESSING ENDS WITH THIS SCAN NUMBER.

NOTICE THAT ALL LIMITING VALUES ARE INCLUSIVE--
THE SCANS SPECIFIED ARE ALSO PROCESSED.

THE KEYWORDS (OR ABBREVIATIONS/ALTERNATES SUCH AS START, L, MAX, STOP, ETC.) MAY BE COMBINED IN ANY FASHION IN ORDER TO ACHIEVE THE DESIRED PROCESSING. NO WARNING IS GIVEN IF THE RESULTANT SPECIFIED/DEFAULT SCAN RANGE COMBINATION RESULTS IN NO SCANS BEING PROCESSED.

WARNING: ANY OR ALL THE ADDITIONAL INPUT ITEMS FOR THE DUMP AND COPY OPERATIONS MAY BE OMITTED. HOWEVER, TO AVOID POSSIBLY DISABLING ERRORS, IF ALL ITEMS ARE OMITTED THEN INSERT A SECOND SEMICOLON AS PART OF THE BASIC INPUT. FOR EXAMPLE:

```
OPERATION='COPY USER TAPE',FORMAT='SP2';;
```

CONCERNING DATA SET NAMES:

FOR THE JCL OUTLINED EARLIER THE USER MUST SUPPLY THE DATA SET NAME WHICH APPEARS ON THE INPUT VOLUME. THE NAME WILL NOT NECESSARILY BE OF THE FORM "TPOWER.SOMETHING". A SYSTEM COMPLETION CODE OF 813 IS THE USUAL RESULT OF SUPPLYING A NAME WHICH IS NOT ON THE VOLUME.

APPENDIX

A

VERB DICTIONARY

ACCUM

DESCRIPTION

A routine which adds the spectral values of the ON ARRAY to the spectral values of the HOLD ARRAY with weighting. The weighting is the effective integration time. On the first call to ACCUM the routine copies the ON ARRAY to the HOLD ARRAY. On subsequent calls to ACCUM, the spectral values are summed but the scan header stored in the HOLD will remain unchanged. ACCUM also sums the effective integration time.

PMASTER

Is set to the HOLD ARRAY.

OPERANDS

None.

ADVERBS

OFFSET(N) - Used only for unaligned profiles after the first call.

REMARKS

Most commonly used for stacking scans. The offset adverb is effective only after the first call to ACCUM, since the spectral values are directly copied to the HOLD ARRAY, as a pattern for further processing. OFFSET is initialized to zero, therefore channel one is added to channel one.

ERRORS

None.

ADD

DESCRIPTION

A routine which adds the spectral values of the ON ARRAY to the spectral values of the HOLD ARRAY with weighting. Weighting is the effective integration time.

PMASTER

Is set to the HOLD ARRAY.

OPERANDS

None.

ADVERBS

OFFSET(N) - Used only for unaligned profiles.

REMARKS

* See the verb ACCUM for most stacking applications. ADD is used for procedures in which a subset of the scans is to be averaged first, and then more scans are to be included in the average. ADD is used to resume the accumulation of scans in the HOLD ARRAY after the verb AVE has been invoked. If ACCUM is used after AVE, the HOLD ARRAY is reinitialized.

ERRORS

None.

ALIGN

DESCRIPTION

ALIGN calculates the value of the variable OFFSET required to center a spectral line in the filter set. By using this verb prior to ACCUM, the user can average scans taken with different L.O. settings.

PMASTER

Is set to the HOLD ARRAY.

OPERANDS

None.

ADVERBS

OFFSET(N) - This variable is set by the verb ALIGN using information in the scan heading, namely, the rest frequency of the line and the L.O. setting.

OUTPUT

The calculated OFFSETS for each receiver for each scan processed.

REMARKS

None.

ERRORS

When the OFFSET is greater than 150 channels the routine prints the following message:

SCAN _____ RECEIVER HAS CHANNEL OFFSET OF ____ SCAN IGNORED

ALIGN_R

DESCRIPTION

A routine which computes the velocity difference between two receivers within a scan as referenced by the adverbs SLIDE_TO and SLIDE_FROM. The difference is expressed in whole channel numbers and is left in the OFFSET adverb.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

SLIDE_TO	-	Number of the receiver which is used as the base for averaging.
SLIDE_FROM	-	Number of the receiver which is used to average with the base.
OFFSET(N)	-	The number of channels OFFSET between two sets of spectral values to achieve velocity alignment.

OUTPUT

None.

REMARKS

None.

ERRORS

None.

AVE

DESCRIPTION

A routine which divides the scans accumulated in the HOLD ARRAY by the total accumulated weighting factor (effective integration time). As a result of this operation, the weighted average of the scans is placed in the HOLD ARRAY.

PMASTER

Is set to the HOLD ARRAY.

OPERANDS

None.

ADVERBS

None.

OUTPUT

None.

REMARKS

None.

ERRORS

None.

BASELINE

DESCRIPTION

A routine which computes the coefficients of a Chebyshev polynomial of a given order by a least squares fit for a specified region or regions of spectral values. The polynomial is then evaluated over all channels and subtracted from the spectral values.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

NREGION(N,M) - Used to specify the region or regions over which the polynomial will be fit. N is the receiver, and M is the start or stop channel number. For each value of N, i.e., for each receiver, M = 1,3,5, or 7 specifies the start channel and M = 2,4,6, or 8 specifies the stop channel. Up to four regions may be described in this manner. Fewer than four regions are specified by setting the start channel of the first unwanted region to zero. For example, if one wanted to fit a BASELINE for receiver A for channels 30 to 80 and 100 to 180 then the variables would be coded as follows:
NREGION(1,1)=30,NREGION(1,2)=80,NREGION(1,3)=100.
NREGION(1,4)=180,NREGION(1,5)=0.

NFIT - The order of the polynomial to be fitted. E.G., NFIT=2 for a parabola.

OUTPUT

If the polynomial can not be fitted to required accuracy then an error message is logged.

REMARKS

Note the convention for numbering the channels continuously from 1 to 413 or 384 depending on the autocorrelator used. See the section on conventions at the beginning of this section.

The use or misuse of BASELINE is a very easy way to create or destroy spectral lines. Either give regions for all receivers, or limit the receiver coverage by use of the select verb.

BIAS

DESCRIPTION

A routine that adds a constant to each spectral value.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

FACT(N) - The factor which is added to each channel, one for each receiver.
BDROP(N) - Number of channels to be dropped at the beginning of a receiver.
EDROP(N) - Number of channels to be dropped at the end of a receiver.

OUTPUT

None.

REMARKS

None.

ERRORS

None.

BOXCAR

DESCRIPTION

A smoothing routine which averages with equal weighting over an odd number of channels and then replaces the averaged spectral value in the center channel of the odd interval. BOXCAR smooths over all channels of a receiver less the number of channels to be dropped and increases the number of channels to be dropped by an INTEGER of the half width - actually INTEGER(NBOX/2). If NBOX = 5 then BDROP(1) = BDROP(1) + 2.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

BDROP(N) - Number of channels to be dropped at the beginning of a receiver.
EDROP(N) - Number of channels to be dropped at the end of a receiver.
NBOX - Number of channels over which to smooth. NBOX must be odd.

OUTPUT

None.

REMARKS

None.

ERRORS

1) If NBOX is an even number then NBOX is set equal to NBOX - 1 with an appropriate message.
2) If NBOX is less than two the routine is bypassed with an appropriate message.

C

C

DESCRIPTION

This routine has no reduction function. The card image will appear in the record of all control cards.

PMASTER

Remains unchanged.

OPERANDS

Any character or string of characters.

ADVERBS

None.

OUTPUT

None.

REMARKS

The OPERAND field may contain comments for documentation.

ERRORS

None.

CLIP

DESCRIPTION

CLIP limits the range of spectral values to a maximum and minimum value by comparing all spectral values with two input variables. Values outside the specified range are reset to the nearest limit.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

CLIP_MAX(N) - The maximum value of the range.
CLIP_MIN(N) - The minimum value to the range.

OUTPUT

None.

REMARKS

CLIP has been used to examine the low intensity, high velocity neutral hydrogen emission by clipping the values of the local hydrogen and plotting the temperatures between -1 and 4 degrees. Another application would be examining a BASELINE or clipping a bad channel.

ERRORS

None.

COMBINE

DESCRIPTION

The operation performed is the same as BOXCAR smoothing; but the routine does not divide by the number of channels.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

NBOX - The number of channels over which the summation will occur.

OUTPUT

None.

REMARKS

This verb is used to test the validity of the data by watching the intensity of the spectral line as the bandwidth is increased and the noise decreased.

ERRORS

None.

DCBASE

DESCRIPTION

A routine which computes an average spectral value over a given channel range and then subtracts the average value from all spectral values.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

NREGION(N,M) - The region over which the average will be calculated for each receiver. Restricted to one interval per receiver. (See the description for the BASELINE verb).

OUTPUT

Spectral values are altered as specified in the description.

REMARKS

The most conservative means of frequency BASELINE removal.

ERRORS

None.

DCONT

DESCRIPTION

A routine which adds additional verbs or adverbs to the last defined procedure (a continue card).

PMASTER

Remains unchanged.

OPERANDS

The OPERAND field is coded as in the DEFINE verb. The OPERAND of the DCONT card is considered to be a continuation of the OPERAND of the preceding DEFINE or DCONT card.

ADVERBS

None.

OUTPUT

None.

REMARKS

More than one DCONT card may be coded, but the total number of verbs or adverbs in each of the five procedures is limited to twenty.

ERRORS

When the limit of 20 verbs or adverbs is exceeded, the program prints the following message:

YOUR LIMIT IS 20 VERBS

The procedure being defined is set to a 'NOP'.

DEFINE

DESCRIPTION

The DEFINE verb sets up a procedure for later use. The OPERAND field of DEFINE contains the string of verbs or adverb assignments which constitute the procedure. Up to eight procedures are permitted. They are distinguished by an INTEGER which must be appended to the DEFINE verb (e.g., DEFINE3).

PMASTER

Remains unchanged.

OPERANDS

The OPERAND field contains verbs and adverb assignments which define the procedure. If the procedure is too long for one card, the DCONT verb is used to continue it onto the next card.

ADVERBS

None.

OUTPUT

None.

REMARKS

None.

ERRORS

When the routine can not recognize a verb name, the program prints the following message:

UNKNOWN VERB

The procedure being defined is set to a 'NOP', meaning that any reference to this procedure will produce no change in the arrays or movement of data.

CHECK SPELLING.

When the limit of 20 verbs or adverbs is surpassed, the routine prints the following message:

YOUR LIMIT IS 20 VERBS.

The procedure being defined is set to a 'NOP'.

DEF_LIST

DESCRIPTION

This verb is used on the graphics terminal to monitor procedure definitions during program execution.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

None.

OUTPUT

A list (or display) of all currently defined procedures.

REMARKS

None.

ERRORS

None.

DIFF

DESCRIPTION

A routine which subtracts the spectral values of the OFF ARRAY from the spectral values in the currently referenced array.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

BDROP(N) - Number of channels to be dropped at the beginning of a receiver.
EDROP(N) - Number of channels to be dropped at the end of a receiver.

OUTPUT

None.

REMARKS

This verb can be used in the switched power system to remove Baselines by subtracting an off source scan.

ERRORS

None.

DO

DESCRIPTION

DO is used to apply a previously defined procedure (see DEFINE) to a list of scans. The list may give both individual scans and ranges of scans. The procedure is referenced by specifying the definition number, e.g. DO DEFINE1.

PMASTER

Not applicable.

OPERANDS

The OPERAND field contains a reference to the definition that defined the procedure and its number. The definition reference may be abreviated by "D". The remainder of the field contains scan numbers or ranges of scan numbers. The number must be separated by one or more spaces. No other punctuation is permitted. A range of scans is specified by giving the first and last scan numbers separated by the word "TO". For example, five scans - 1210, 1350, 1410, 1420, 1430 - are to be processed by procedure created by DEFINE3, would be coded as follows:

```
DO D3    1210   1350 1410 TO 1430
```

REMARKS

DO usually operates on a list of scans, the first verb of the procedure usually being GET or FETCH. Sometimes the user will define a procedure for convenience which will not use a data transfer verb. In this case the OPERAND field is either blank, contains the number one, or the word 'ONCE'.

ERRORS

When the routine cannot decode the OPERAND field it prints the following message:

```
ERROR IN OPERAND FIELD
```

The process statement is ignored. Check Syntax.

DOC

DESCRIPTION

This verb writes a character string on the printed output for documentation purposes. The character string is set by the remark verb.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

None.

OUTPUT

A printed line containing documenting information.

REMARKS

None.

ERRORS

None.

ENTER

DESCRIPTION

The ENTER verb is used to set value of ADVERBS which may be used by subsequent verbs.

PMASTER

Remains unchanged.

OPERANDS

The OPERAND field contains a list of adverb assignments separated by one or more spaces. Each item consists of a variable name followed by an equal sign followed by the value of the variable, e.g.

```
ENTER    CENTER=-10. HWIDTH=8
```

ADVERBS

The adverbs given in the OPERAND field of the ENTER verb are set to the specified values.

OUTPUT

None.

REMARKS

Note that the underline symbol is part of the spelling of some of the adverbs. CLIP MAX is two words and is not equivalent to CLIP_MAX which is one word. The underline character is an upper case "W" on the 029 keypunch.

ERRORS

When the routine can not recognize an adverb name the program prints the following message:

```
   IHE0271  GET STRING - UNRECOGNIZABLE DATA NAME
CHECK SPELLING.
```

and continues execution.

EXIT

DESCRIPTION

A routine that terminates the program.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

None.

OUTPUT

None.

REMARKS

None. Used mostly by graphic terminal users to terminate execution.

ERRORS

None.

FETCH

DESCRIPTION

FETCH initiates the processing of scans specified on a process statement. Since this is its only use, FETCH appears only as the first verb of a string of verbs in a DEFINE statement. FETCH takes each of the scan numbers in the process statements in turn and determines whether it is a source or reference scan. Reference scan numbers given in the process statement are ignored but each source scan is read into the ON ARRAY. After FETCH places a source scan in the ON ARRAY it finds the scan number of the corresponding reference scan in the record format of the source scan and reads that reference scan into the OFF ARRAY.

PMASTER

Set to the OFF ARRAY.

OPERANDS

None.

ADVERBS

The current index of the process verb.

REMARKS

This is the normal way of reading data into core from the disk in the total power system. It ignores off scans as indexed, so there is no worry about sorting off scans in the process verb. If a source scan has been erroneously designated as a reference scan, the user can still process it using the ON or OFF VERBS.

ERRORS

Message:

XXXXX UNKNOWN SCAN

This message appears when the program cannot locate the requested scan. All remaining verbs in the current DEFINE list are ignored, and control is passed back to the process verb. NOTE: Either you do not have the scan you wanted (operators have been known to skip scan numbers) or you have not loaded it from disk. See the LOAD verb for selective loading when you may have over 570 scans.

FLIP

DESCRIPTION

In some observing procedures the line will appear in the reference spectrum. In the usual spectrum, (S - R)/R*TSYS, the line will appear inverted. The verb FLIP calculates (R - S)/S*TSYS from the values of TSYS and (S - R)/R in the referenced array and places the new values in the referenced array. If the line appears in both the signal and reference spectrum, (i.e., when using SPOWER) use the overlap verb.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

None.

OUTPUT

Spectral values are changed per description.

REMARKS

See the author before using this verb.

ERRORS

None.

GAUSS

DESCRIPTION

A routine which fits a Gaussian function:

F(X) = A*EXP(-2.772*(X-CENTER)**2/HWIDTH**2)

over a given interval of data points. The routine requires an initial guess for the center and half intensity width, and returns the values of center, half intensity width and height. The standard error is calculated for each parameter of the Gaussian fit.

PMASTER

Remains unchanged.

ADVERBS

CENTER(J) - First guess for the center of the Gaussian.
HWIDTH(J) - First guess for the half intensity width.
BGAUSS - First channel to fit the Gaussian.
EGAUSS - Last channel to fit the Gaussian.
NGUASS - The number of Gaussian to be fit; NGAUSS less than of equal to 5.
To hold either HWIDTH or CENTER constant during fitting, set the value of the initial guess for each parameter to be held negative.
WGT - When set equal to 1, the derivatives are weighted by line temperatures.

OUTPUT

Printout of height, half width, center. RMS and RMS error for each parameter.

The computed values replace the first guess values of CENTER and HWIDTH.

REMARKS

The frequency BASELINE must be removed before calling GAUSS.

NOTE: Include the first guesses for both center and HWIDTH each time you call GAUSS; do not rely on the last values being reasonable since the program uses them to return the calculated values.

See also the verbs GMODEL and RESIDUAL.

ERRORS

Error in GAUSS verb -- procedure bypassed.

If the height = -100K then an uncorrectable error occurred, try again.

GET

DESCRIPTION

A routine which reads the contents of the disk record into the on array. The routine uses the OPERAND of the process verb as the index by which the record is retrieved. GET normally appears as the first verb in a string of verbs which define a procedure. GET moves each scan specified on the process statement into the on array where it is processed by the rest of the procedure.

PMASTER

Is set to the ON ARRAY.

OPERANDS

None.

ADVERBS

The current index of the process verb.

OUTPUT

Error message if necessary.

REMARKS

This is the main verb for retrieving data in the switched power system. N.b., this verb must not be coded in the operator field or unpredictable results will occur.

ERRORS

If the scan numbers do not increase monotonically, the program writes out an error message indicating that a scan number could not be found in the disk directory, and bypasses the remaining verbs of the DEFINE list.

GMODEL

DESCRIPTION

A routine which generates a Gaussian function and replaces the spectral values in the array referenced by PMASTER with the computed function.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

HEIGHT(J)	-	Should be set by the GAUSS verb
WIDTH(J)	-	or set by an ENTER statement
CENTER(J)	-	
NGAUSS	-	The number of Gaussian to be fit.

OUTPUT

The evaluated Gaussian replaces the spectral values in the currently referenced array.

REMARKS

None.

ERRORS

None.

GRAPH

DESCRIPTION

A routine which gives printer displays of the spectral values for each receiver. The bottom scale on the plot represents velocity in km/s if the velocity indicator (input parameter at the telescope) is not equal to zero. The top scale indicates channel number. The Y-axis is the antenna temperature.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

BDROP(N) - Number of channels to be dropped at the beginning of a receiver.
EDROP(N) - Number of channels to be dropped at the end of a receiver.
SQUEEZE - A value by which the constant computed from the spectral values for the scale in units/division is multiplied to increase the perspective.
PRTEMP - When set equal to 1, print the temperature for each channel at the end of the second graph.

OUTPUT

Printer plot of spectral values.

REMARKS

Used for quick look display. If squeeze is set equal to zero then the program will ABEND.

ERRORS

None.

HANNING

DESCRIPTION

A smoothing routine which averages three channels with 1/4, 1/2, 1/4 weighting over the channels of a given receiver. It then replaces the spectral values with the averaged values. Smoothing begins with the first channel plus the number of channels to be dropped and ends with the last channel minus number of channels to be dropped by one for the remainder of the procedure. It is reset to the initial value for each new procedure.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

BDROP(N) - Channels to be dropped at the beginning of a scan.
EDROP(N) - Channels to be dropped at the end of a scan.

OUTPUT

None.

REMARKS

None.

ERRORS

None.

HEADER

DESCRIPTION

A routine which prints formatted documentation information about the most recently referenced array. See Appendix for sample output.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

None.

OUTPUT

Printed HEADER information for each scan or group of scans, beginning on a new page.

REMARKS

None.

ERRORS

None.

INITIAL

DESCRIPTION

A routine which initializes the program. It must be called before any other verb.

PMASTER

Remains unchanged.

OPERANDS

DISP - Disposition of the direct access data set. For most cases code "DISP='NEW';".
CRT - When set equal to 1, the graphics terminal is initialized.

ADVERBS

None.

OUTPUT

None.

REMARKS

This verb must be called before any other verb, or program will ABEND.

ERRORS

None.

INVERT

DESCRIPTION

A routine which interchanges the spectral values end-for-end.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

None.

OUTPUT

The spectral values in the array referenced by PMASTER are arranged in reverse order.

REMARKS

INVERT is used to reverse the velocity axis to correspond to increasing velocity if an error was made at the telescope in specifying the sense RF to IF. See inversion code in telescope setup cards.

ERRORS

None.

LOAD

DESCRIPTION

A routine which reads a 9-track user tape and writes a direct access data set. The data set is required by the program. 570 unique (by scan number) scans are written on the disk; for records with identical scan numbers, the latest one encountered is written. The user must supply his user number to the program, since only scans with matching observer number are loaded onto the disk. An optional right ascension range may be supplied to limit the scans to be loaded.

PMASTER

Is set to the on array.

OPERANDS

USER_NUMBER - Observer number used at the telescope to identify the data (required). This option can be disabled by specifying a user number greater than or equal to 999.

BRANGE - The minimum right ascension in hours (1950 coordinates) of scans to be loaded onto the disk.

ERANGE - The maximum right ascension in hours of scans to be loaded onto the disk.

LNAME - The name of source (as it appears on the telescope tape) of scans to be loaded onto the disk.

ADVERBS

None.

REMARKS

When 570 unique scans are read, the load verb passes control back to the main program.

If one has more than 570 unique scans, use the range option to insure that all desired scans are loaded. If you are using TPOWER, you may want OFF scans taken before or after the ON. In that event, specify a range which contains that of your source positions.

ERRORS

None.

MAP

DESCRIPTION

A routine which writes "ARAY" type records for the calcomp contouring program. The coordinates are velocity vs. position. The user must input scans in the order he wishes to see them displayed on the calcomp plot.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

BDROP(N) - Number of channels to be dropped at the beginning of a receiver.
EDROP(N) - Number of channels to be dropped at the end of a receiver.

OUTPUT

25 element array of temperatures for "ARAY" type calcomp plot.

REMARKS

Before the MAP verb is used the user should define which receiver will be used by means of the SELECT verb.

The user must add a DD Card to define the output file. For example, if he wants card output the following card should be placed in the deck before his data cards:

```
//D.MAPPING          DD SYSOUT=B,DCB=(RECFM=F,BLKSIZE=80)
```

ERRORS

If the file has not been created, the program will ABEND with a message from the operating system regarding the missing DD card.

MAP_VLB

DESCRIPTION

A routine which writes "CNTL" cards for the calcomp contouring program. The OUTPUT parameters are galactic longitude and latitude, and the variable size. The order of the scans is insignificant, since "CNTL" cards are for randomly spaced data.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

Size - current value. Size is initialized by the MOMENT verb.

OUTPUT

Card images in the "CNTL" format.

REMARKS

The user must add a DD card to DEFINE the output file. For example, if he wants card output the following card should be placed in the deck before the data cards:

```
//D.MAPPING          DD SYSOUT=B,DCB=(RECFM=F,BLKSIZE=80)
```

ERRORS

If the file has not been created, the program will ABEND with a message from the operating system regarding the missing DD card.

MOMENT

DESCRIPTION

A routine which calculates a MOMENT of a profile over given channel range and places the result in the variable size for use by other verbs.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

BWINDOW(N) - The channel number where the MOMENT is to BEGIN.
EWINDOW(N) - The channel number where the MOMENT is to END.
NMOMENT - The order of the MOMENT calculated.
0 -> AREA
1 -> CENTROID
2 -> DISPERSION SQUARED
3 -> SKEW
4 -> KURTOSIS

OUTPUT

SIZE(N) - The result of MOMENT over the range BWINDOW to EWINDOW.

REMARKS

The MOMENT verb is used to get the total intensity of a spectral line or feature; the variable size is then available to other verbs, such as MAP_VRD, to produce a coordinate-coordinate map.

ERRORS

None.

OFF

DESCRIPTION

A routine which reads the contents of a disk record into the OFF array. This routine requires an OPERAND and must not be used in a procedure.

PMASTER

Is set to the OFF array.

OPERANDS

An individual scan number referencing a record within the disk file. The number must be in the OPERAND field.

ADVERBS

None.

OUTPUT

Error message if necessary.

REMARKS

This verb is used to force a scan to be called an OFF in the total power system.

ERRORS

If the record number is not in the disk directory then the record is not read and an error message is logged; if additional verbs utilize the results of this verb, unpredictable results may occur.

ON

DESCRIPTION

A routine which reads the contents of a disk record into the ON array. This routine requires an OPERAND and must not be used in a procedure.

PMASTER

Is set to the ON array.

OPERANDS

The scan number of a record within the disk file that is to be read into the ON array. This number must be in the OPERAND field of the card.

ADVERBS

None.

OUTPUT

Error message if necessary.

REMARKS

This verb is used to force a scan to be called an ON. It is typically used to force different associations in the TOTAL POWER system.

ERRORS

If the record number is not in the disk directory then the record is not read and an error message is logged; if additional verbs utilize the results of this verb, then unpredictable results may occur.

OVERLAP

DESCRIPTION

This verb is used when a line appears in both the signal and reference spectrum in the switched power mode. This observing technique is known variously as the dual dicke-switching or OVERLAPPED frequency switching.

As many as four receivers can be processed in the SPOWER system. The receivers are identified by the letters, A, B, C, and D. When the OVERLAP verb is invoked for a scan in the parallel mode the A and B receivers are divided into two parts and renamed; A becomes A and B and B becomes C and D. The old C and D receivers are lost.

The OVERLAP verb calculates in which of the four half-receivers the line appears in the signal spectrum and in which it appears in the reference spectrum. When the line appears in the reference spectrum for a particular receiver, the verb FLIP is used to recover the correct line sense. The paired receivers, A-B and C-D, are next processed by the ALIGN_R verb to determine the velocity offset between receivers. The verb SLIDE is called next to average A and B (leaving the result in A) and to average C and D (leaving the result in C). Note that the user does not invoke the verbs FLIP, ALIGN_R, or SLIDE; they are called by OVERLAP itself.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

None.

OUTPUT

Spectral values modified in the manner described above.

REMARKS

To average the A and C receivers use the SLIDE verb with the adverbs SLIDE_TO=1 and SLIDE_FROM=3.

ERRORS

None.

PAUSE

DESCRIPTION

A routine which waits for the user to input a message from the CRT terminal before processing is resumed. The message can contain adverbial assignment statements which are entered immediately.

PMASTER

Remains unchanged.

OPERANDS

Adverbial assignment statements.

ADVERBS

Any.

REMARKS

This verb is used in procedures after an intermediate result is displayed. It is also used to set adverbs that are used in the remaining verbs of the procedure.

ERRORS

None.

PLOT

DESCRIPTION

A routine which displays for each "SELECTED" receiver (or all of them by default) a calcomp plot of spectral values. The X-axis represents either velocity or channel numbers depending on the velocity indicator set at the telescope. The scales are set by a call to calcomp subroutine scale, or the user may supply his own scales for either axis. The DEFAULT plot labels may also be overridden.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

X_TITLE	-	Twenty characters used for the X-Axis label.
Y_TITLE	-	Twenty characters used for the Y-Axis label.
X_MIN(N)	-	The smallest velocity or channel number depending on the velocity indicator set at the telescope to be plotted. If this value is less than -99999 then the program scales the data by calling the calcomp scale subroutine.
X_INCR(N)	-	The increment in units/inch for the X-Axis.
Y_MIN(N)	-	The smallest value of the temperature axis to be plotted.
Y_INCR(N)	-	The increment in units/incr for the Y-Axis
Z_LINE	-	If this adverb is set to 1 then a zero line will be drawn through the data for all plots until it is set not equal to one.
BDROP(N)	-	Channels to be dropped at the beginning of a scan; these channels will not appear on the plot.
EDROP(N)	-	Channels to be dropped at the end of a scan; these channels will not appear on the plot.

OUTPUT

Plots are as shown in the Appendix.

REMARKS

If the user wishes to use his own scales, then it is advisable to use the CLIP verb to limit the spectral values to the range he wishes to plot. Failure to do so may result in insufficient disk space due to an attempt to plot lines from Charlottesville to the Goddard Space Flight Center or beyond. If in doubt then CLIP; it will only increase computer time.

ERRORS

None.

PMF PMH PMO

DESCRIPTION

Sets the reference pointer, PMASTER, to either the OFF, HOLD, or ON arrays.

PMASTER

PMF sets PMASTER to OFF.
PMH sets PMASTER to HOLD.
PMO sets PMASTER to ON.

OPERANDS

None.

ADVERBS

None.

OUTPUT

None.

REMARKS

None.

ERRORS

None.

PROCESS

DESCRIPTION

PROCESS is used to apply a previously defined procedure (see DEFINE) to a list of scans. The list may give both individual scans and ranges of scans. An INTEGER number is appended to the PROCESS verb to specify which procedure is to be used (e.g., PROCESS3).

PMASTER

Not applicable.

OPERANDS

The OPERAND field contains scan numbers or ranges of scan numbers. The numbers must be separated by at least one blank. No other punctuation is permitted. A range of scan numbers is specified by giving the first and last scan numbers separated by the word "TO". For example, five scans - 1210, 1350, 1410, 1420, 1430 - are processed by procedure number 3 using the following control card:

```
PROCESS3     1210 1350 1410 TO 1430
```

ADVERBS

None.

REMARKS

PROCESS usually operates on a list of scans, the first verb of the procedure being GET or FETCH. Sometimes, however, the user will define a procedure just for convenience--to avoid writing a sequence of verbs in several places.

ERRORS

When the routine cannot decode the OPERAND field, it prints the following message:

```
    ERROR IN OPERAND FIELD
The PROCESS statement is ignored.
    CHECK SYNTAX.
```

PROFILE

DESCRIPTION

PROFILE plots many spectral profiles on a 10 by 25 inch calcomp plot. Each call to PROFILE after the first plots a new PROFILE, displaced from the last PROFILE by the adverb YINCR. If the next PROFILE cannot fit within the given 25 inches, then a new plot is started.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

SAME AS PLOT PLUS

YINCR - Separation in inches between PROFILES.

OUTPUT

10 by 25 inch calcomp plot, an example of which is shown in the Appendix.

REMARKS

None.

ERRORS

None.

RECALL

DESCRIPTION

A routine which reads the contents of the disk buffer into the currently referenced array.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

NSAVE - The slot number of the array to be retrieved (0 - 9).

OUTPUT

None.

REMARKS

If the verb SAVE with the same NSAVE value was not used to store a record in the disk buffer, then unpredictable results will occur.

ERRORS

None.

REMARK

DESCRIPTION

A routine which initializes a character string with the contents of the OPERAND field of the control card. The character string is printed at the lower left-hand corner of all calcomp plots, CRT displays, and anytime the DOC verb is invoked.

PMASTER

Remains unchanged.

OPERANDS

The OPERAND field of the control card contains the character string.

ADVERBS

None.

OUTPUT

None.

REMARKS

Used to document data displays.

ERRORS

None.

REMOVE

DESCRIPTION

This routine interpolates between three channels to replace the spectral value of the central channel. This verb is useful with filterband receivers.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

LOOSE(5) - Up to five channels per record for which interpolation is desired. The (N+1)ST element of LOOSE should be set to zero to indicate end of channels to interpolate.

OUTPUT

None.

REMARKS

This verb is not recommended for autocorrelation data.
LOOSE(N+1) must be set to zero unless N equals five.

ERRORS

None.

REPLOT

DESCRIPTION

A routine that plots the spectral values (usually modified by GMODEL) on top of the last calcomp plot.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

None.

OUTPUT

Plot.

REMARKS

Usually used to plot a Gaussian function fitted to a Profile.

ERRORS

None.

RESHOW

DESCRIPTION

A routine that plots the spectral values (usually modified by GMODEL) on top of the last CRT display.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

Same as SHOW.

OUTPUT

CRT display of the spectral values.

REMARKS

None.

ERRORS

None.

RESIDUAL

DESCRIPTION

A routine which computes the RESIDUALS after the verb GAUSS sets the height, half width, and center.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

Assumes the values of center, HWIDTH, and height have been set by GAUSS or by an ENTER statement.

OUTPUT

The RESIDUALS replace the spectral values in the currently referenced array.

REMARKS

None.

ERRORS

None.

RMS

DESCRIPTION

A routine which computes the root mean square for the spectral values within the region or regions specified for the BASELINE verb, or over the entire range of channels less the beginning and ending drop variables.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

NREGION(N,M) - The region over which a BASELINE is to be fitted. See BASELINE verb. If NREGION(N,1)=0 where N is the receiver number, then all channels less the number to be dropped are used to compute the RMS value.

OUTPUT

A printed message giving the receiver and the computed RMS.

REMARKS

The RMS is defined as the sample RMS.

ERRORS

None.

SAVE

DESCRIPTION

A routine which writes the contents of the currently referenced array into a disk buffer for subsequent retrieval. The disk buffer holds ten arrays; previously stored information is erased by the next SAVE with the same value of NSAVE.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

NSAVE - The slot number for the SAVED array (0 - 9).

OUTPUT

A copy of the referenced array is moved to a disk buffer.

REMARKS

None.

ERRORS

If NSAVE is less than zero the program will terminate with an operating system error message, and if greater than 9 will over write scans stored on the disk.

SCALE

DESCRIPTION

A routine which multiplies the spectral values in each channel of each receiver by a constant factor. Each receiver has a separate scale factor.

PMASTER

Remains unchanged.

ADVERBS

FACT(N) - The factor by which each channel is multiplied, one for each receiver.

OUTPUT

None.

REMARKS

Typically used to adjust the system temperature after the fact. A rotation of the spectrum about the zero level is achieved by scaling by -1.

ERRORS

None.

SELECT

DESCRIPTION

A routine which selects the receiver or receivers to be processed. Each record contains three parameters that control which receivers are processed after selection. SELECT changes these parameters in the currently referenced array, and they remain changed until RESET by SELECT.

PMASTER

Remains unchanges.

OPERANDS

None.

ADVERBS

SET1 - The following Table gives the values of the SET variables
SET2 that must be coded to SELECT a given receiver configuration.
SET3

RECEIVER	SET1	SET2	SET3
A	1	1	1
B	2	2	1
C	3	3	1
D	4	4	1
AB	1	2	1
ABC	1	3	1
ABCD	1	4	1
BC	2	3	1
BCD	2	4	1
CD	3	4	1
AC	1	3	2
AD	1	4	3
BD	2	4	2

REMARKS

This verb is usually used to select one or two receivers to be processed. For example, the verb MAP can process only one receiver at a time; SELECT is used to limit the processing to one receiver. CAUTION: Using SELECT before ACCUM sets the DEFAULT receivers for any future reference to the HOLD array. If different receivers are selected during the ACCUMING process, care must be taken to select before AVE to ensure that all receivers are averaged.

ERRORS

None.

SHOW

DESCRIPTION

A routine which displays for each "SELECTED" receiver (or all of them by DEFAULT) a CRT display of spectral values. The X-axis represents either velocity or channel number depending on the velocity indicator set at the telescope. The scales are set by a call to a scaling subroutine, or the user may supply his own scales for either axis. The DEFAULT labels displayed may also be overridden.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

X_TITLE	-	Twenty characters used for the X-axis label.
Y_TITLE	-	Twenty characters used for the Y-axis label.
X_MIN(N)	-	The smallest velocity or channel number to be plotted if this value is less than -99999 then the program scales the data by calling the calcomp scale subroutine.
X_INCR(N)	-	The increment in units/tick for the X-axis.
Y_MIN(N)	-	The smallest value of the temperature axis to be plotted. See X_MIN.
Y_INCR(N)	-	The increment in units/tick for the Y-axis.
Z_LINE	-	If this adverb is set to 1 then a zero line will be drawn through the data for all plots until it is set not equal to one.
BDROP(N)	-	Channels to be dropped at the beginning of a scan; these channels will not appear on the plot.
EDROP(N)	-	Channels to be dropped at the end of a scan; these channels will not appear on the plot.

OUTPUT

CRT displays as shown in the Appendix.

REMARKS

If the user wishes to use his own scales, then it is advisable to use the CLIP verb to limit the spectral values to the range he wishes to display.

ERRORS

None.

SLIDE

DESCRIPTION

A routine which averages the spectral values of two receivers. Using the integration times for weight. The results replace the spectrum with the lower number receiver. If the velocities are not aligned then an OFFSET must be entered by use of the ENTER verb with the adverb OFFSET, or by using the ALIGN_R verb.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

OFFSET(N) - The number of channels by which the receiver referenced by SLIDE_FROM must be OFFSET to achieve velocity alignment with the receiver referenced by the SLIDE_TO.

SLIDE_TO - Number of the receiver which is used as the base for averaging.

SLIDE_FROM - Number of the receiver which is used to average with the base.

REMARKS

SLIDE is an independent verb and is not used in conjunction with AVE or ACCUM. If you have a large velocity OFFSET you may want to increase the number of channels to be dropped so that only the overlapped portion of the spectrum is displayed.

ERRORS

None.

SUM

DESCRIPTION

A routine which adds the spectral values of the OFF array to the spectral values in the array currently referenced by PMASTER.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

None.

OUTPUT

None.

REMARKS

None.

ERRORS

None.

TABLE

DESCRIPTION

An output routine which prints for each receiver a table containing channel number, velocity, and temperature. The number of channels printed is reduced by BDROP and EDROP.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

BDROP(N) - Number of channels to be dropped at the beginning of a receiver.
EDROP(N) - Number of channels to be dropped at the end of a receiver.

OUTPUT

A printed table containing the channel number, velocity, and temperature of each receiver.

REMARKS

A hangover from hand data reduction days, but good documentation.

ERRORS

None.

TELL

DESCRIPTION

This verb is used to monitor adverb values during program execution.

PMASTER

Remains unchanged.

OPERANDS

A list of adverb names whose values are to be told.

ADVERBS

None.

OUTPUT

Current adverb values.

REMARKS

None.

ERRORS

Self-explanatory error messages are printed (or displayed) whenever user input is invalid or causes program errors.

TEMP

DESCRIPTION

Computes the temperatures for each channel using the formula:

(S - R) / R * TSYS

WHERE S IS THE SIGNAL SPECTRUM FOUND IN THE ON ARRAY,
R IS THE REFERENCE SPECTRUM FOUND IN THE OFF ARRAY, AND
TSYS IS THE SYSTEM TEMPERATURE OF THE SIGNAL SPECTRUM FOUND IN THE ON ARRAY.

The results replace the spectral values in the ON array.

PMASTER

Is set to the ON ARRAY.

OPERANDS

None.

ADVERBS

None.

OUTPUT

None.

REMARKS

This routine is used in the total power system to compute the temperatures by using ON and OFF source scans. FETCH is the input verb that initializes both the ON and OFF arrays.

ERRORS

None.

TRF TRH TRO

DESCRIPTION

A set of three routines which copy the contents of the currently referenced array to either the OFF, HOLD, or ON array respectively.

PMASTER

TRF sets the PMASTER to the OFF array.
TRH sets the PMASTER to the HOLD array.
TRO sets the PMASTER to the ON array.

OPERANDS

None.

ADVERBS

None.

OUTPUT

None.

REMARKS

Used in averaging OFF scans together. See recipes.

ERRORS

None.

WEIGHT

DESCRIPTION

A routine which multiplies the integration time by one over the adverb FACT squared (1/FACT**2).

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

FACT(N) - The factor which multiplies the integration time.

REMARKS

None.

ERRORS

None.

WRITE

DESCRIPTION

A routine which writes the velocities and temperatures for each receiver in fixed format BCD records. As many records as necessary are written to specify all spectral values within a receiver. Each record is consecutively sequenced within a receiver block.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

BDROP(N) - Number of channels to be dropped at the beginning of a receiver.
EDROP(N) - Number of channels to be dropped at the end of a receiver.

OUTPUT

The format of each record is as follows:

SCAN NUMBER	REC NUMBER	SEQ NUMBER	5 (VELOCITY, TEMPERATURES)	
F(5)	F(1)	F(2)	F(7,2)	F(7,3)

REMARKS

The user must supply a DD card, placed before the "//D.SYSIN" card. For example, to get punched output, punch the following card.

```
//D.MAPPING   DD SYSOUT=B,DCB=(RECFM=F,BLKSIZE=80)
```

N.B. This verb cannot be used in a procedure.

ERRORS

None.

ZERO

DESCRIPTION

Sets spectral values equal to zero.

PMASTER

Remains unchanged.

OPERANDS

None.

ADVERBS

LOOSE(5) - One or two pairs of numbers that are the beginning and ending channel numbers to be ZEROED. Set the first element of the next pair = 0 to signify no additional pairs.

OUTPUT

None.

REMARKS

None.

ERRORS

None.

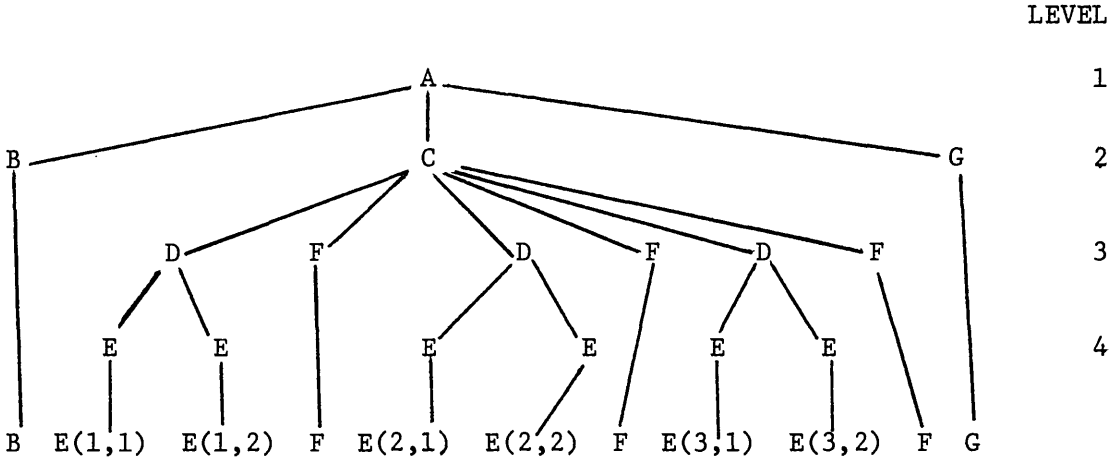
B. APPENDIX - TAPE FORMATS

The tape formats used on the 9-track user tape are given on the following pages. The tape formats are described by a PL/1 structure declaration. Each variable is preceded by a logical level number which specifies the variables' place in a tree structure. Users who are unfamiliar with PL/1 concepts can find help in the IBM manual. However, the only point which is really relevant is the fact that only the bottom level of the structure (those elements which have no subelements) is actually written on tape. The following example may help.

Structure Declaration--

```
DCL 1 A,
      2 B,
      2 C(3),
        3 D(2),
          4 E,
        3 F,
      2 G;
```

The tree structure defined by the above is:



Actual sequence of variables in the structure when written on tape.

The properties of a variable are declared after its name. The following Table gives the corresponding Fortran IV description of the variables:

PL/1	LENGTH IN BYTES	S/360 FORTRAN IV
(M)	-	DIMENSION - SAME CONVENTION AS FORTRAN
BASED(PMASTER)	-	NONE - THIS ATTRIBUTE IS UNAVAILABLE IN FORTRAN.
BIN FIXED(31)	4	INTEGER*4
BIN FIXED(15)	2	INTEGER*2
BIN FLOAT(53)	8	REAL*8
BIN FLOAT	4	REAL*4
CHAR(N)	N	STRING OF N CHARACTERS. CHARACTER STRINGS CAN BE USED IN FORTRAN WITHOUT SPECIFIC DECLARATION. JUST RESERVE STORAGE - ONE INTEGER VARIABLE PER 4 CHARACTERS.

TAPE FORMAT - MODEL II AUTOCORRELATION RECEIVER

```
DCL 1 TP_FMT_MODII BASED (PMASTER),
     (2 SCAN_NUMBER, 2 OFF_SCAN) BIN FIXED(31),
      2 OBS_NAME CHAR(20),2 SOURCE CHAR(10), 2 COMMENTS CHAR(30),
     (2 ORIENT   ,2 LST, 2 EST), BIN FIXED(31),
     (2 MONTH,2 DAY,2 YEAR,2 TYPE_OBS,2 OBS_NUMBER,2 SAMPLE_RATE,
      2 TELESCOPE,2 PAD1(4),2 TYPE_SCAN,2 AMOUNT,2 CMONTH,
      2 CDAY,2 CYEAR)  BIN FIXED(15),
     (2 RA_IND,2 DEC_IND) BIN FIXED(31),
      2 RX(3),
              (3 REST_FREQ,3 CNTR_FREQ) BIN FLOAT(53),
              (3 TSYS,3 NOISE_TUBE,3 INTEGRATION,
               3 CNTR_VEL, 3 DEL_VEL,3 RVSYS,3 RVSUN,
               3  RA_TRUE,3 DEC_TRUE,3 RA_1950,3 DEC_1950,
               3 L_GAL, 3 B_GAL) BIN FLOAT,
               3 WEIGHT BIN FIXED (31),
              (3 POINT,3 CLAB,3 VEL,3 INVER) BIN FIXED(15),
               3 CN_FORM CHAR(24),
     (2 LO(6),2 LOFF(3),2 PAD2(3) BIN FLOAT (53),
      2 SPECTRA(413) BIN FLOAT,
     (2 P_COUNTERS(9),2 CH_ZERO (6),2 SCALE_FACTOR) BIN FIXED(31),
     (2 BLANKING_TIME, 2 BANDWIDTH(3)) BIN FIXED (15),
      2 AC(3), (3 ATTENUATOR, 3 GAIN_MODULATOR) BIN FIXED (15),
     (2 MODE,2 SWITCH_RATE,2 DUMP_TIME, 2 SPARE_WORD, 2 DIGITAL,
      2 CLIPPER, 2 FRONT_END, 2 NOISE_TUBE_MODE, 2 SENSE,
      2 DUTY_CYCLE,
         2 IREC, 2 FREC, 2 INCR, 2 SPACE(3)) BIN FIXED(15);
        /*  CREATED AUG 9, 1971   UPDATED MAR 9, 1972  */
```

C. APPENDIX

TAPE FORMAT - MODEL III AUTOCORRELATION RECEIVER

```
DCL 1 TP_FMT_MODIII BASED (PMASTER),
      (2 SCAN_NUMBER, 2 OFF_SCAN) BIN FIXED(31),
       2 OBS_NAME CHAR(20), 2 SOURCE CHAR(10),2 COMMENTS CHAR (30),
      (2 ORIENT   ,2 LST, 2 EST) BIN FIXED(31),
      (2 MONTH,2 DAY,2 YEAR,2 TYPE_OBS,2 OBS_NUMBER,2 SAMPLE_RATE,
       2 TELESCOPE,2 PAD1(4),2 TYPE_SCAN,2 AMOUNT,2 CMONTH,
       2 CDAY,2 CYEAR) BIN FIXED(15),
      (2 RA_IND,2 DEC_IND) BIN FIXED(31),
       2 RX(4),
              (3 REST_FREQ,3 CNTR_FREQ) BIN FLOAT(53),
              (3 TSYS,3 NOISE_TUBE,3 INTEGRATION,
               3 CNTR_VEL,3 DEL_VEL,3 RVSYS,3 RVSUN,
               3 RA_TRUE,3 DEC_TRUE,3 RA_1950,3 DEC_1950,
               3 L_GAL,3 B_GAL) BIN FLOAT,
               3 WEIGHT BIN FIXED (31),
              (3 POINT,3 CALB,3 VEL,3 INVER) BIN FIXES(15),
               3 CN_FORM CHAR(24),
      (2 LO(6),2 LOFF(3),2 PAD2(3)) BIN FLOAT (53),
       2 SPECTRA (384) BIN FLOAT,
      (2 P_COUNTERS(16), 2 CH_ZERO (8),
       2 CH_385 (2),2 BLANK_TIME   ,2 SIGNAL_TIME,2 REF_TIME,
       2 SCALE_FACTOR,2 PAD3(5)) BIN FIXED (31),
      (2 BANDWIDTH (4),2 MODE,2 FRONT_NOISE,2 MODULATOR,
       2 SENSE,2 SWITCHING,2 CLIPPER,2 DIGITAL,2 CPD,2 STM,
          2 IREC,2 FREC,2 INCR) BIN FIXED(15);
/*    CREATED  MAY 27, 1971     UPDATED JULY 20, 1971     */
```

D. APPENDIX

DESCRIPTION OF FIELDS ON THE USER TAPE RECORDS
MODEL II AUTOCORRELATION RECEIVER
THREE RECEIVERS--OFTEN REFLECTED IN SUBSCRIPTS

OFFSET	FIELD NAME	TYPE	DESCRIPTION
0	SCAN_NUMBER	I*4	SCAN NUMBER
4	OFF_SCAN	I*4	SCAN # OF ASSOCIATED REFERENCE SCAN
8	OBS_NAME(20)	L*1	OBSERVER'S NAME
28	SOURCE(10)	L*1	NAME OF SOURCE
38	COMMENTS(30)	L*1	COMMENTS FROM TELESCOPE SITE
68	ORIENT	I*4	ORIENTATION OF THE FEEDS. UNITS ARE 1/2**30 OF ONE COMPLETE REVOLUTION
72	LST	I*4	LOCAL SIDEREAL TIME. UNITS ARE TURNS * 2**30
76	EST	I*4	EASTERN STANDARD TIME. UNITS SAME AS LST
80	MONTH	I*2	MONTH
82	DAY	I*2	DAY
84	YEAR	I*2	YEAR
86	TYPE_OBS	I*2	CODE INDICATING TYPE OF OBS: LINE, CONTINUUM, ETC.
88	OBS_NUMBER	I*2	# ASSIGNED TO OBSERVER
90	SAMPLE_RATE	I*2	INTEGRATION TIME FOR ONE RECORD
92	TELESCOPE	I*2	TELESCOPE BY SIZE: 300 140 85
94	PAD1(4)	I*2	EIGHT SPARE BYTES
102	TYPE_SCAN	I*2	ON OR OFF SCAN
104	AMOUNT	I*2	# OF RECORDS / SCAN
106	CMONTH	I*2	UNUSED
108	CDAY	I*2	UNUSED
110	CYEAR	I*2	UNUSED
112	RA_IND	I*4	RIGHT ASCENSION INDICATED BY TELESCOPE
116	DEC_IND	I*4	DECLINATION INDICATED BY TELESCOPE
120	RX(3)		INDENTED BLOCK REPEATS 3 TIMES ONCE FOR EACH RECEIVER BYTE # IS FOR FIRST BLOCK
120	REST_FREQ	R*8	OBSERVED LINE FREQ IN MHZ
128	CNTR_FREQ	R*8	FREQ AT CENTER OF OBSERVED BAND IN MHZ
136	TSYS	R*4	SYSTEM TEMPERATURE (INCLUDES CONTINUUM)
140	NOISE_TUBE	R*4	NOISE TUBE TEMPERATURE
144	INTEGRATION	R*4	TOTAL INTEGRATION TIME FOR ENTIRE SCAN =SAMPLE_RATE*SMOUNT
148	CNTR_VEL	R*4	VELOCITY OF SOURCE NEEDED TO ACCOUNT FOR DIFFERENCE OF CNTR_FREQ FROM REST_FREQ
152	DEL_VEL	R*4	DELTA VELOCITY: VELOCITY CHANGE / CHANNEL
156	RVSYS	R*4	THE LINE OF SIGHT VELOCITY OF THE OBSERVER USED TO CORRECT THE DOPPLER LINE SHIFT ACCORDING TO THE CODE IN 'VEL'

OFFSET	FIELD NAME	TYPE	DESCRIPTION
160	RVSUN	R*4	THE VELOCITY OF THE OBSERVER RELATIVE TO THE SUN
164	RA_TRUE	R*4	RIGHT ASCENSION FOR CURRENT EPOCH
168	DEC_TRUE	R*4	DECLINATION FOR CURRENT EPOCH A CORRECTION FOR TELESCOPE POINTING ERRORS, DEFORMATION, ATMOSPHERE, ETC. IS PLANNED FOR RA_TRUE AND DEC_TRUE
172	RA_1950	R*4	RIGHT ASCENSION EPOCH 1950
176	DEC_1950	R*4	DECLINATION EPOCH 1950
180	L_GAL	R*4	GALACTIC LONGITUDE II
184	B_GAL	R*4	GALACTIC LATITUDE II
188	WEIGHT	I*4	UNUSED
192	POINT	I*2	SEE FORTHCOMING MEMO (ONLY FOR 300 FT)
194	CALB	I*2	UNUSED
196	VEL	I*2	CODE MEANS CORRECT VELOCITY FOR 0 NO CORRECTION 1 CORRECTED TO LOCAL STANDARD OF REST 2 CORRECTED TO SUN
198	INVER	I*2	0 => ON SITE COMPUTER REVERSED DIRECTION OF INCREASING FREQUENCY IN CHANNELS 1 => NO REVERSE NORMALLY HETERODYNING ARRANGES DATA SO THAT FREQUENCY DECREASES WITH INCREASING CHANNEL # (VELOCITY INCREASES). IF HETERODYNING DOES NOT DO THIS, ON SITE COMPUTER DOES AND SETS THIS FIELD.
200	CN_FORM(24)	L*1	FORMULA FOR CALCULATING CENTER FREQ. AFTER HETERODYNING. THE FORM IS: # * LOCAL OSCILLATOR FREQ - IF OF LINE EXAMPLE: 6*LO-150
432	LO(6)	R*8	LOCAL OSCILLATOR FREQ. SIX VALUES ARE PROVIDED BECAUSE THERE MAY BE 2 UNIVERSAL LO'S, EACH HAVING HIGH AND LOW REFERENCE FREQUENCIES, AND ONE SIGNAL FREQUENCY
480	LOFF(3)	R*8	ADDITIONAL HARDWARE OFFSET FOR 3 RECEIVERS
504	PAD2(3)	R*8	THREE SPARE DOUBLE WORDS
528	SPECTRA(413)	R*4	RELATIVE INTENSITY OF 413 FREQUENCIES
2180	P_COUNTERS(9)	I*4	TOTAL POWER IN BAND THREE RECEIVERS EACH HAVE SIGNAL, SIGNAL PLUS NOISE TUBE AND REFERENCE

OFFSET	FIELD NAME	TYPE	DESCRIPTION
2216	CH_ZERO(6)	I*4	CHANNEL ZERO OF AUTOCORRELATOR EQUALS TOTAL NUMBER OF AUTOCORRELATIONS IN RECORD SINCE CHANNEL ZERO IS AUTOCORRELATION OF SIGNAL WITH ITSELF WHICH IS ALWAYS ONE.
2240	SCALE_FACTOR	I*4	POSITION OF BINARY POINT IN DATA FROM ON SITE COMPUTER
			SEE FOOTNOTE CONCERNING THE FOLLOWING FIELDS
2244	BLANKING_TIME	I*2	TIME REQUIRED FOR AUTOCORRELATOR TO RESET ITSELF BETWEEN DUMPS
2246	BANDWIDTH(3)	I*2	BANDWIDTH FOR EACH RECEIVER
2252	AC(3)		INDENTED BLOCK REPEATS 3 TIMES BYTE # IS FOR FIRST BLOCK
2252	ATTENUATOR	I*2	CODE FOR DB'S SIGNAL WAS REDUCED
2254	GAIN_MODULATOR	I*2	AMOUNT ADDED TO PUT SIGNALS IN SAME RANGE
2264	MODE	I*2	CODE 1: A 1-384; C 385-413. CODE 2: A 1-192; B 193-384; C 385-413
2266	SWITCH_RATE	I*2	RATE AT WHICH RECEIVER SWITCHES FROM SOURCE TO REFERENCE AND BACK TO SOURCE. CURRENTLY, IT IS USUALLY 1 HZ BUT MAY BE SET TO 5 OR 10 HZ. ALSO INCLUDES PERCENT OF TIME SPENT ON SIGNAL AND REFERENCE
2268	DUMP_TIME	I*2	TIME DURING WHICH AUTOCORRELATOR SUMS THEREFORE, TIME BETWEEN DUMPS TO COMPUTER ON SITE
2270	SPARE_WORD	I*2	TWO SPARE BYTES
2272	DIGITAL	I*2	TEST INFORMATION
2274	CLIPPER	I*2	TEST INFORMATION
2276	FRONT_END	I*2	SIGNAL OR REFERENCE OR HOW MODULATED
2278	NOISE_TUBE_MODE	I*2	NOISE TUBE MODE
2280	SENSE	I*2	SETTING OF SWITCHES OF AUTOCORRELATOR
2282	DUTY_CYCLE	I*2	% OF SIGNAL TIME WHICH HAS NOISE TUBE ON

OFFSET	FIELD NAME	TYPE	DESCRIPTION
			THREE FOLLOWING FIELDS ARE CONTROL WORDS FOR TPOWER AND SPOWER
2284	IREC	I*2	INITIAL RECEIVER TO BE PROCESSED
2286	FREC	I*2	FINAL RECEIVER TO BE PROCESSED
2288	INCR	I*2	INCREMENT IN RECEIVER NUMBER
2290	SPACE(3)	I*2	SIX SPARE BYTES
2296			

THE INFORMATION IN THE FIELDS STARTING WITH 'BLANKING_TIME' IS IN CODES. THESE CODES AND MORE DETAILED INFORMATION OF THEIR MEANING MAY BE OBTAINED FROM:

SHALLOWAY, A. M.: MAUZY, R.: GREENHALGH, J.: AND WEINREB, S., AUTOCORRELATION RECEIVER MODEL II: OPERATIONAL DESCRIPTION, NRAO ELECTRONICS DIVISION INTERNAL REPORT NO. 75

SOME FIELDS ARE ONLY FOR DOCUMENTATION AND HAVE ALREADY BEEN USED IN PROCESSING THE DATA.

DESCRIPTION OF FIELDS ON THE USER TAPE RECORDS
MODEL III AUTOCORRELATION RECEIVER
FOUR RECEIVERS--OFTEN REFLECTED IN SUBSCRIPTS

OFFSET	FIELD NAME	TYPE	DESCRIPTION
0	SCAN_NUMBER	I*4	SCAN NUMBER
4	OFF_SCAN	I*4	SCAN # OF ASSOCIATED REFERENCE SCAN
8	OBS_NAME(20)	L*1	OBSERVER'S NAME
28	SOURCE(10)	L*1	NAME OF SOURCE
38	COMMENTS(30)	L*1	COMMENTS FROM TELESCOPE SITE
68	ORIENT	I*4	ORIENTATION OF THE FEEDS. UNITS ARE 1/2**30 OF ONE COMPLETE REVOLUTION
72	LST	I*4	LOCAL SIDEREAL TIME. UNITS ARE TURNS * 2**30
76	EST	I*4	EASTERN STANDARD TIME. UNITS SAME AS LST
80	MONTH	I*2	MONTH
82	DAY	I*2	DAY
84	YEAR	I*2	YEAR
86	TYPE_OBS	I*2	CODE INDICATING TYPE OF OBS" LINE, CONTINUUM, ETC.
88	OBS_NUMBER	I*2	# ASSIGNED TO OBSERVER
90	SAMPLE_RATE	I*2	INTEGRATION TIME FOR ONE RECORD
92	TELESCOPE	I*2	TELESCOPE BY SIZE: 300 140 85
94	PAD1(4)	I*2	EIGHT SPARE BYTES
102	TYPE_SCAN	I*2	ON OR OFF SCAN
104	AMOUNT	I*2	# OF RECORDS / SCAN
106	CMONTH	I*2	UNUSED
108	CDAY	I*2	UNUSED
110	CYEAR	I*2	UNUSED
112	RA_IND	I*4	RIGHT ASCENSION INDICATED BY TELESCOPE
116	DEC_IND	I*4	DECLINATION INDICATED BY TELESCOPE
120	RX(4)		INDENTED BLOCK REPEATS 4 TIMES ONCE FOR EACH RECEIVER BYTE # IS FOR FIRST BLOCK
120	REST_FREQ	R*8	OBSERVED LINE FREQ IN MHZ
128	CNTR_FREQ	R*8	FREQ AT CENTER OF OBSERVED BAND IN MHZ
136	TSYS	R*4	SYSTEM TEMPERATURE (INCLUDES CONTINUUM)
140	NOISE_TUBE	R*4	NOISE TUBE TEMPERATURE
144	INTEGRATION	R*4	TOTAL INTEGRATION TIME FOR ENTIRE SCAN =SAMPLE_RATE*AMOUNT
148	CNTR_VEL	R*4	VELOCITY OF SOURCE NEEDED TO ACCOUNT FOR DIFFERENCE OF CNTR_FREQ FROM REST_FREQ
152	DEL_VEL	R*4	DELTA VELOCITY: VELOCITY CHANGE / CHANNEL
156	RVSYS	R*4	THE LINE OF SIGHT VELOCITY OF THE OBSERVER USED TO CORRECT THE DOPPLER LINE SHIFT ACCORDING TO THE CODE IN 'VEL'

OFFSET	FIELD NAME	TYPE	DESCRIPTION
160	RVSUN	R*4	THE VELOCITY OF THE OBSERVER RELATIVE TO THE SUN
164	RA_TRUE	R*4	RIGHT ASCANSION FOR CURRENT EPOCH
168	DEC_TRUE	R*4	DECLINATION FOR CURRENT EPOCH A CORRECTION FOR TELESCOPE POINTING ERRORS, DEFORMATION, ATMOSPHERE, ETC. IS PLANNED FOR RA_TRUE AND DEC_TRUE
172	RA_1950	R*4	RIGHT ASCANSION EPOCH 1950
176	DEC_1950	R*4	DECLINATION EPOCH 1950
180	L_GAL	R*4	GALACTIC LONGITUDE II
184	B_GAL	R*4	GALACTIC LATITUDE II
188	WEIGHT	I*4	UNUSED
192	POINT	I*2	SEE FORTHCOMING MEMO (ONLY FOR 300 FT)
194	CALB	I*2	UNUSED
196	VEL	I*2	CODE MEANS CORRECT VELOCITY FOR 0 NO CORRECTION 1 CORRECTED TO LOCAL STANDARD OF REST 2 CORRECTED TO SUN
198	INVER	I*2	0 => ON SITE COMPUTER REVERSED DIRECTION OF INCREASING FREQUENCY IN CHANNELS 1 => NO REVERSE NORMALLY HETERODYNING ARRANGES DATA SO THAT FREQUENCY DECREASES WITH INCREASING CHANNEL # (VELOCITY INCREASES). IF HETERODYNING DOES NOT DO THIS, ON SITE COMPUTER DOES AND SETS THIS FIELD.
200	CN_FORM(24)	L*1	FORMULA FOR CALCULATING CENTER FREQ. AFTER HETERODYNING. THE FORM IS: # * LOCAL OSCILLATOR FREQ - IF OF LINE EXAMPLE: 6*LO-150
536	LO(6)	R*8	LOCAL OSCILLATOR FREQ. SIX VALUES ARE PROVIDED BECAUSE THERE MAY BE 2 UNIVERSAL LO'S, EACH HAVING HIGH AND LOW REFERENCE FREQUENCIES, AND ONE SIGNAL FREQUENCY
584	LOFF(3)	R*8	ADDITIONAL HARDWARE OFFSET FOR 3 RECEIVERS
608	PAD2(3)	R*8	THREE SPARE DOUBLE WORDS
632	SPECTRA(384)	R*4	RELATIVE INTENSITY OF 384 FREQUENCIES
2168	P_COUNTERS(16)	I*4	TOTAL POWER IN BAND FOUR RECEIVERS EACH HAVE SIGNAL, SIGNAL PLUS NOISE TUBE, REFERENCE, AND REFERENCE PLUS NOISE TUBE

OFFSET	FIELD NAME	TYPE	DESCRIPTION
2232	CH_ZERO(8)	I*4	CHANNEL ZERO OF AUTOCORRELATOR EQUALS TOTAL NUMBER OF AUTOCORRELATIONS IN RECORD SINCE CHANNEL ZERO IS AUTOCORRELATION OF SIGNAL WITH ITSELF WHICH IS ALWAYS ONE.
2264	CH_385(2)	I*4	TOTAL COUNT CHANNEL USED IN CROSS CORRELATION
2272	BLANK_TIME	I*4	TIME REQUIRED FOR AUTOCORRELATOR TO RESET ITSELF BETWEEN DUMPS
2276	SIGNAL_TIME	I*4	ACTUAL TIME ON SIGNAL
2280	REF_TIME	I*4	ACTUAL TIME ON REFERENCE
2284	SCALE_FACTOR	I*4	POSITION OF BINARY POINT IN DATA FROM ON SITE COMPUTER
2288	PAD3(5)	I*4	FIVE SPARE WORDS
			SEE FOOTNOTE CONCERNING THE FOLLOWING FIELDS
2308	BANDWIDTH(4)	I*2	CODE FOR BANDWIDTH FOR EACH RECEIVER
2316	MODE	I*2	CODE RECEIVER IS CHANNELS 1 A 0-383 2 A 0-191 C 192-383 3 A 0-095 B 96-191 C 192-383 4 A 0-095 B 96-191 C 192-287 D 288-383 OTHER MODES MAY BE IMPLEMENTED LATER
2318	FRONT_NOISE	I*2	COMBINATION OF FRONT END SWITCH AND NOISE TUBE SWITCH FRONT END SWITCH (TWO BITS) 0 = SIGNAL 1 = REFERENCE 2 = MODULATE NOISE TUBE SWITCH (TWO BITS) 0 = ON 1 = OFF 2 = 1/2 SWITCH FREQUENCY 3 = SWITCH FREQUENCY (NT ON SIGNAL
2320	MODULATOR	I*2	ONE BIT INDICATING ON OR OFF FOR EACH RECEIVER
2322	SENSE	I*2	SETTING OF SWITCHES OF AUTOCORRELATOR
2324	SWITCHING	I*2	TWO BIT WORD 0 = SIDEREAL OSC.(EXT. 10 KHZ) 1 = SIDEREAL OSC.(INT. 10 KHZ) 2 = SOLAR OSC.(INT. 1 KHZ)

OFFSET	FIELD NAME	TYPE	DESCRIPTION
2326	CLIPPER	I*2	TEST INFORMATION
2328	DIGITAL	I*2	TEST INFORMATION
2330	CPD	I*2	AUTOCORRELATOR CYCLES PER DUMP
2332	STM	I*2	STANDARD TIME MODES A CODE INDICATING WHICH STANDARD MODE OF THE AUTOCORRELATOR WAS USED TO DETERMINE BLANK_TIME, SIGNAL_TIME, REF_TIME AND CPD. 0 = STANDARD MODE NOT USED VALUES SET BY OBSERVER 1, 2 OR 3 = A STANDARD MODE OF THE AUTOCORRELATOR WAS USED. 4 THRU 9 MAY BE AVAILABLE LATER
			THREE FOLLOWING FIELDS ARE CONTROL WORDS FOR TPOWER AND SPOWER:
2334	IREC	I*2	INITIAL RECEIVER TO BE PROCESSED
2336	FREC	I*2	FINAL RECEIVER TO BE PROCESSED
2338	INCR	I*2	INCREMENT IN RECEIVER NUMBER

THE INFORMATION IN THE FIELDS STARTING WITH 'CH_385' IS IN CODES. THESE CODES AND MORE DETAILED INFORMATION OF THEIR MEANING MAY BE OBTAINED FROM:

ARTHUR M. SHALLOWAY'S MEMO TO JOE GREENHALGH,
DATED MARCH 29, 1971.

SOME FIELDS ARE ONLY FOR DOCUMENTATION AND HAVE ALREADY BEEN USED IN PROCESSING THE DATA.

E. APPENDIX - SIGMAS USED IN POP-UP GRAPH

SWITCH POWER

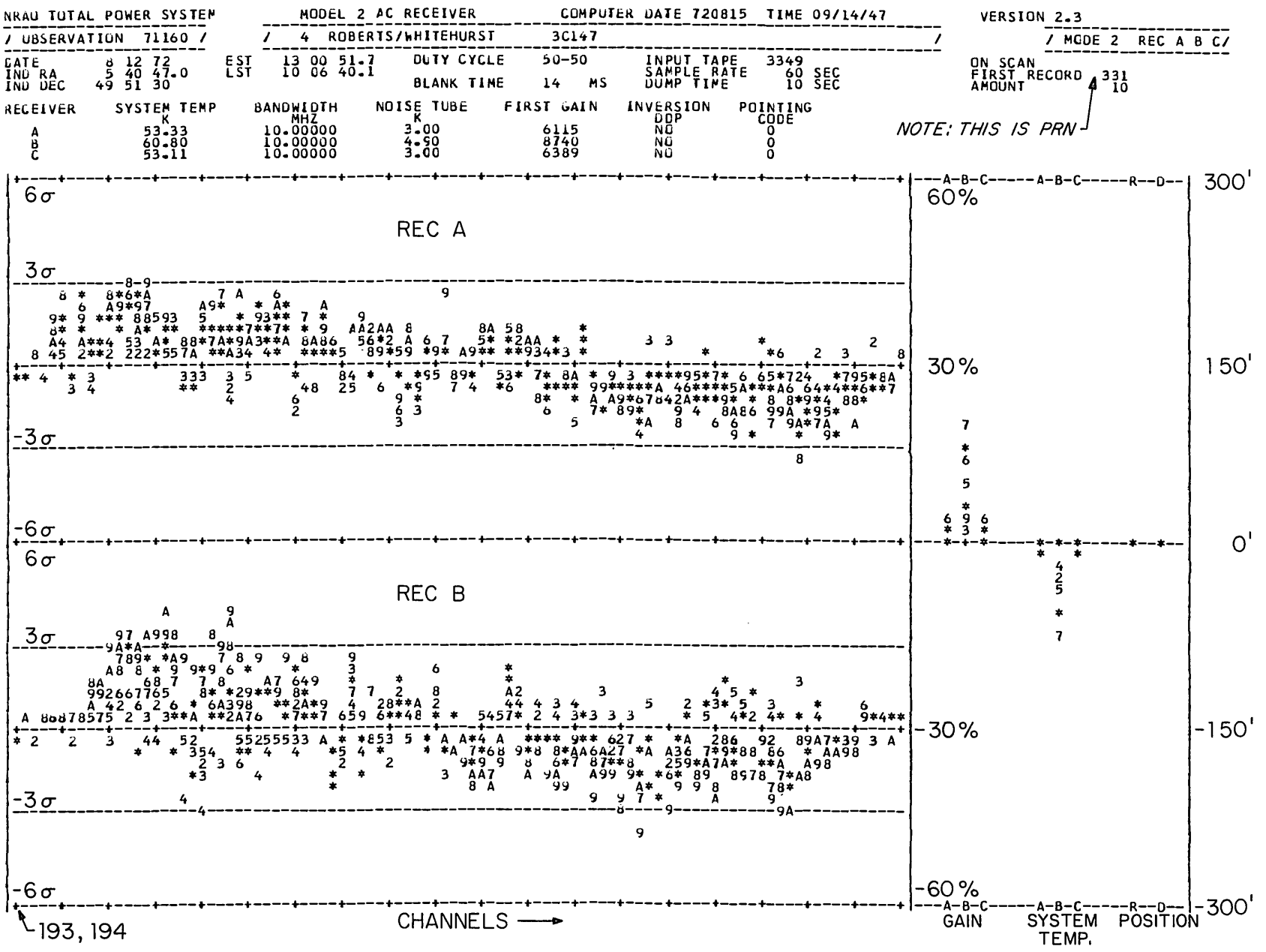
SIGMA = (1.53 * 1.414 * 1.414) / SQRT(1.21 * B / N * T)

TOTAL POWER

SIGMA = 1.53 / SQRT(1.21 * B / N * T)

WHERE:

B	IS THE BANDWIDTH IN HZ
N	IS THE NUMBER OF CHANNELS IN A GIVEN RECEIVER SET UP
T	IS THE SAMPLE RATE AS DEFINED ON TELESCOPE TAPE
1.53	IS THE CORRECTION FACTOR FOR CLIPPING LOSS
1.21	IS THE CORRECTION FACTOR FOR FILTER SHAPE



F. POP-UP GRAPH

APPENDIX G - ERROR LOG

```
WARNING --    SIGMAS      WERE OFF SCALE IN SCAN     7560  RECORDS    2
          6     7     8

WARNING -- COORDINATES  WERE OFF SCALE IN SCAN     7560  RECORDS
          5    23 14 34      15 43 10
          6    23 27 45      14 59 00
          7    23 42 37      14 30 29
          8    23 59 59      14 07 53

WARNING -- GAIN OR TEMP WERE OFF SCALE  - SCAN     7560  RECORD    4
           GAIN =        56  TSYS=       4050.45

NOISE TUBE PROBLEM IN SCAN   7560  RECORD       8 -- GAIN IS       34

LENGTH ERROR

PARITY ERROR

OPERATOR INT.
```

WARINIGS ARE INDICATIONS OF POSSIBLE ERRORS, CHECK FURTHER.

NOISE TUBE PROBLEM IS AN ERROR IN CALIBRATION. THE DIFFERENCE IN POWER LEVELS BETWEEN NOISE TUBE ON AND OFF IS LESS THEN .5 PERCENT OF THE SYSTEM TEMPERATURE. WHEN THIS MESSAGE IS LOGGED, THEN DIFFERENCE IS SET TO .5 PERCENT OF THE SYSTEM TEMPERATURE (NB).

LENGTH, PARITY, AND OPERATOR INTERVENTION MESSAGES HAVE TO DO WITH THE KIND, QUALITY, OR OPERATOR INTERACTION WITH THE TELESCOPE TAPE. IF THESE ERRORS OCCUR, PLEASE SEE A MEMBER OF THE COMPUTER DIVISION STAFF FOR HELP.

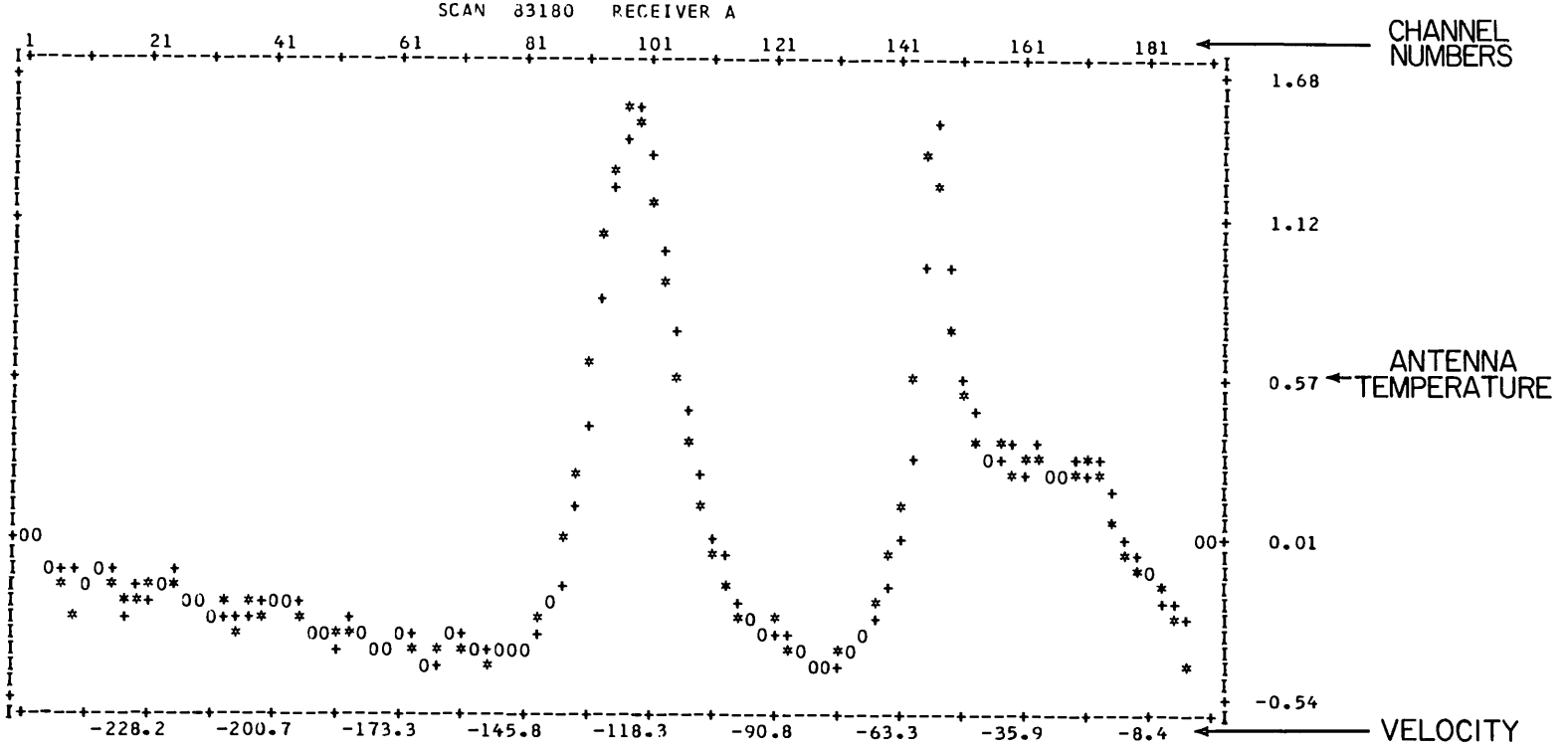
NRAO TOTAL POWER SYSTEM MODEL 3 AC RECEIVER COMPUTER DATE 730515 TIME 14/54/48 VERSION 4.0
USER TAPE 2420

SCAN	OFF POINTER	SOURCE	INTEG. TIME	REC	MHZ BANDWIDTH	CNTR VEL OPTIC-SUN	TSYS K	POSITION 1950 RA	POSITION 1950 DEC	GALACTIC L	GALACTIC B
44090 (OFF)	0	3C175	460	A	10.000	182926.56	170.6	7 01 05.5	11 51 21	203.78	8.07
				C	10.000	178587.75	173.2	7 01 05.5	11 51 21	203.78	8.07
44100 (ON)	44090	3C175	460	A	10.000	182925.88	174.1	7 10 15.5	11 51 19	204.79	10.08
				C	10.000	178587.06	175.1	7 10 15.5	11 51 19	204.79	10.08
44110 (OFF)	44090	3C181 X2	460	A	10.000	182924.75	173.0	7 25 19.6	14 43 50	203.75	14.63
				C	10.000	178585.94	175.6	7 25 19.6	14 43 50	203.75	14.63
44120 (ON)	44110	3C181 X2	460	A	10.000	182924.19	170.5	7 34 30.0	14 43 47	204.72	16.64
				C	10.000	178585.38	172.8	7 34 30.0	14 43 47	204.72	16.64
44130 (OFF)	44110	3C196	460	A	10.000	232335.44	143.0	8 00 45.4	48 22 09	170.98	31.71
				C	10.000	227067.94	142.1	8 00 45.4	48 22 09	170.98	31.71
44140 (ON)	44130	3C196	460	A	10.000	232335.13	163.6	8 09 54.7	48 22 06	171.17	33.22
				C	10.000	227067.63	162.5	8 09 54.7	48 22 06	171.17	33.22
44150 (ON)	44130	3C196	460	A	10.000	232334.88	142.9	8 19 04.0	48 22 11	171.31	34.74
				C	10.000	227067.38	142.3	8 19 04.0	48 22 11	171.31	34.74
44160 (OFF)	44130	4C17.46	460	A	10.000	208628.81	145.5	8 46 52.5	17 04 56	209.95	33.55
				C	10.000	203817.94	155.0	8 46 52.5	17 04 56	209.95	33.55
44170 (ON)	44160	4C17.46	460	A	10.000	208628.63	146.3	8 56 02.1	17 04 60	210.94	35.58
				C	10.000	203817.75	155.9	8 56 02.1	17 04 60	210.94	35.58
44180 (ON)	44160	4C17.46	460	A	10.000	208628.44	144.4	9 05 11.7	17 05 03	211.95	37.61
				C	10.000	203817.56	154.4	9 05 11.7	17 05 03	211.95	37.61
44220 (OFF)	44190	4C28.25	460	A	10.000	266784.88	148.9	10 02 35.2	28 04 07	201.98	53.35
				C	10.000	260817.00	145.4	10 02 35.2	28 04 07	201.98	53.35
44230 (ON)	44220	4C28.25	460	A	10.000	266785.00	155.8	10 11 45.1	28 04 16	202.50	55.35
				C	10.000	260817.13	151.7	10 11 45.1	28 04 16	202.50	55.35
44240 (ON)	44220	4C28.25	460	A	10.000	266785.19	154.7	10 20 55.0	28 04 04	203.02	57.35
				C	10.000	260817.31	150.7	10 20 55.0	28 04 04	203.02	57.35
44250 (OFF)	44220	4C09.37	460	A	10.000	187395.25	144.8	10 38 38.6	9 46 50	236.55	54.62
				C	10.000	182976.06	137.7	10 38 38.6	9 46 50	236.55	54.62
44260 (ON)	44250	4C09.37	460	A	10.000	187395.63	149.4	10 47 49.1	9 46 56	238.84	56.47
				C	10.000	182976.44	155.4	10 47 49.1	9 46 56	238.84	56.47
44270 (ON)	44250	4C09.37	460	A	10.000	187395.94	148.7	10 56 58.7	9 46 51	241.34	58.28
				C	10.000	182976.75	155.1	10 56 58.7	9 46 51	241.34	58.28
44280 (OFF)	44250	P1127-14	460	A	10.000	196486.06	136.6	11 18 28.1	-14 32 57	272.57	42.65
				C	10.000	191901.31	144.9	11 18 28.1	-14 32 57	272.57	42.65
44290 (ON)	44280	P1127-14	460	A	10.000	196486.56	139.9	11 27 37.5	-14 32 54	275.29	43.64
				C	10.000	191901.81	149.0	11 27 37.5	-14 32 54	275.29	43.64
44300 (ON)	44280	P1127-14	460	A	10.000	196487.13	135.3	11 36 47.9	-14 33 01	278.12	44.54
				C	10.000	191902.38	144.5	11 36 47.9	-14 33 01	278.12	44.54
44310 (OFF)	44280	4C29.45X2	460	A	10.000	206999.69	131.4	11 56 57.3	29 31 28	199.41	78.37
				C	5.000	202219.56	126.1	11 56 57.3	29 31 28	199.41	78.37
44320 (ON)	44310	4C29.45X2	460	A	10.000	207000.25	130.4	12 06 06.8	29 31 28	197.77	80.34
				C	5.000	202220.13	124.8	12 06 06.8	29 31 28	197.77	80.34
44330 (OFF)	44310	3C279.	460	A	10.000	124572.69	209.0	12 44 25.3	- 5 31 11	300.90	57.06
				C	10.000	121215.88	211.9	12 44 25.3	- 5 31 11	300.90	57.06
44340 (ON)	44330	3C279.	460	A	10.000	124573.56	214.4	12 53 35.5	- 5 31 05	305.10	57.06
				C	10.000	121216.75	217.3	12 53 35.5	- 5 31 05	305.10	57.06
44350 (ON)	44330	3C279.	460	A	10.000	124574.44	209.3	13 02 46.0	- 5 31 20	309.28	56.91
				C	10.000	121217.63	212.7	13 02 46.0	- 5 31 20	309.28	56.91
44360 (OFF)	44330	3C286	460	A	10.000	207006.06	138.4	13 19 38.1	30 45 53	61.52	82.51
				C	5.000	202225.94	133.0	13 19 38.1	30 45 53	61.52	82.51
44370 (ON)	44360	3C286	460	A	10.000	207006.88	148.0	13 28 48.3	30 45 56	56.53	80.68
				C	5.000	202226.75	143.1	13 28 48.3	30 45 56	56.53	80.68
44380 (ON)	44360	3C286	460	A	10.000	207007.69	134.4	13 37 57.7	30 45 59	53.39	78.79
				C	5.000	202227.56	129.9	13 37 57.7	30 45 59	53.39	78.79
44390 (ON)	44360	3C295	460	A	2.500	207010.75	134.4	14 00 18.3	52 26 14	99.86	61.65
				C	2.500	202230.63	129.9	14 00 18.3	52 26 14	99.86	61.65

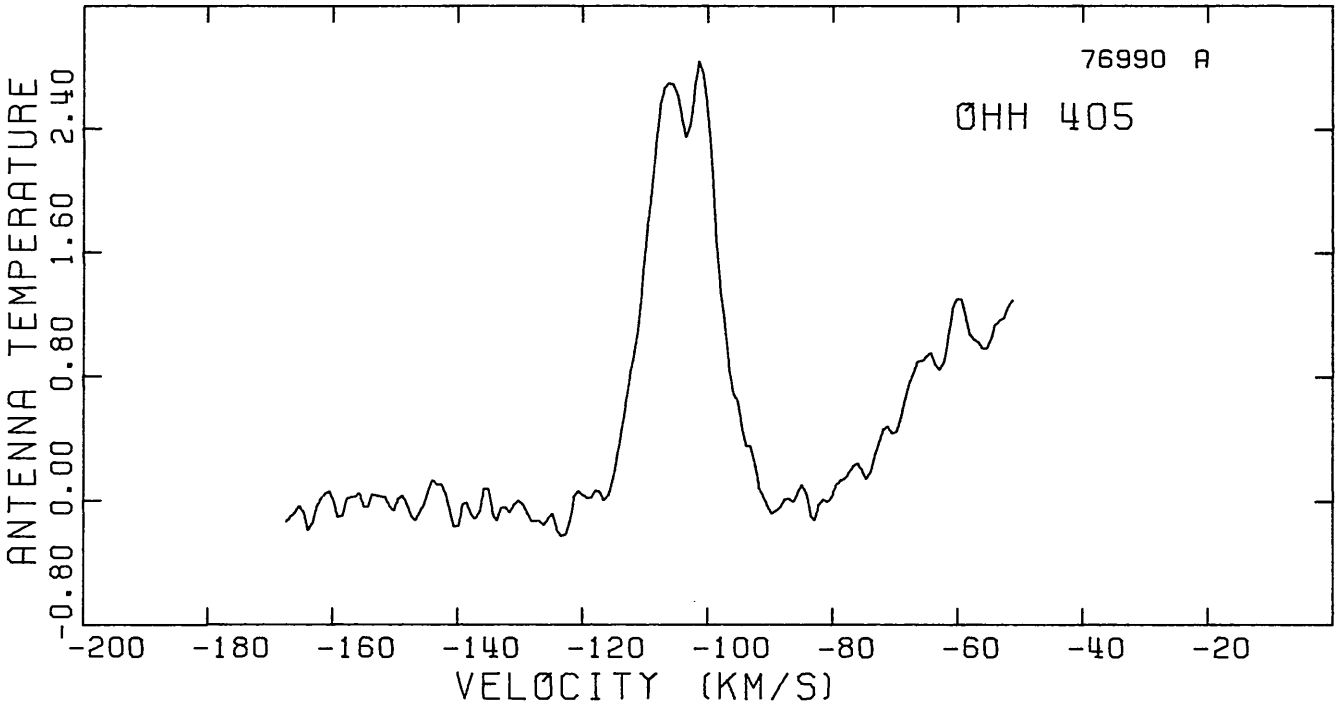
H. TABLE OF SCANS PROCESSED

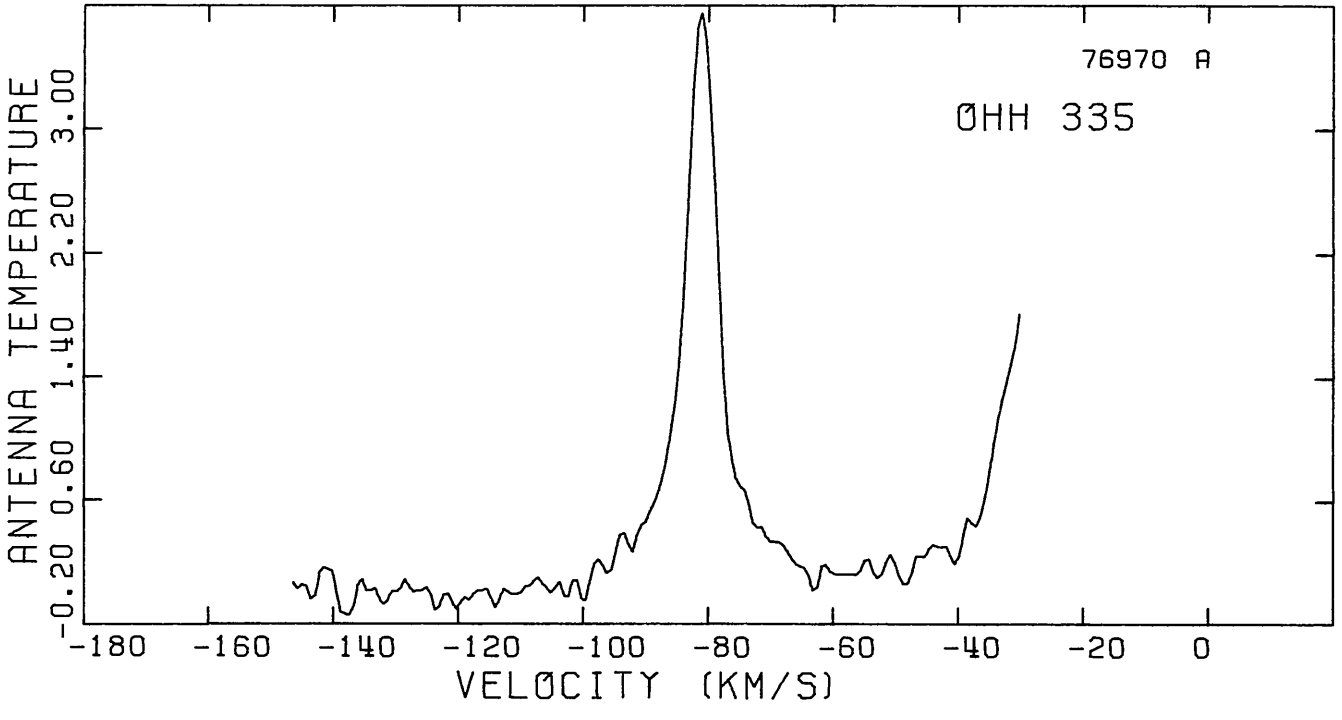
```
NRAO TOTAL POWER SYSTEM          MODEL 2 AC RECEIVER          COMPUTER DATE 730707  TIME 11/34/47          VERSION 4.0
/ OBSERVATION  83180 /          / 190  PG TRC GLV                    M1.10                                  /  / MODE 2  REC A B C/
 DATE            TIME                    IND POSITION        ROTATION      ZENITH      TELESCOPE      OFF
                 EST          LST          RA          DEC                  DISTANCE                   SCAN
 8 20 72   16 57 10.7   14 35 10.1   11 21 13.0   43 06 21     221.00         36.50          140          0
LOCAL OSCILLATOR SETTINGS  LO1                                                                  LO2
      L1              L1F1              L1F2              L2              L2F1              L2F2
  261.834392        261.990092        261.990092        0.000000          0.000000          0.000000
RECEIVER      CNTR FORMULA        CNTR FREQ      REST FREQ      CNTR VEL     DEL VEL     RVSYS     VEL SUN     CNTR VEL
                                     MHZ            MHZ         RADIO        RADIO       LSR        KM/S       OPTICAL
                                                                  KM/S         KM/S       KM/S                   KM/S
    A        6*L1-150              1421.00635     1420.40560    -123.796      1.374     -3.000      1.553     -123.743

                 APPARENT                  1950                  GALACTIC          TSYS      BANDWIDTH      EFF INTG
                RA          DEC          RA          DEC          L         B         K          MHZ          TIME SEC
    A      11 21 13.0   43 06 21   11 19 58.6   43 13 48      165.82     66.05      47.91      1.25000          832.0
```

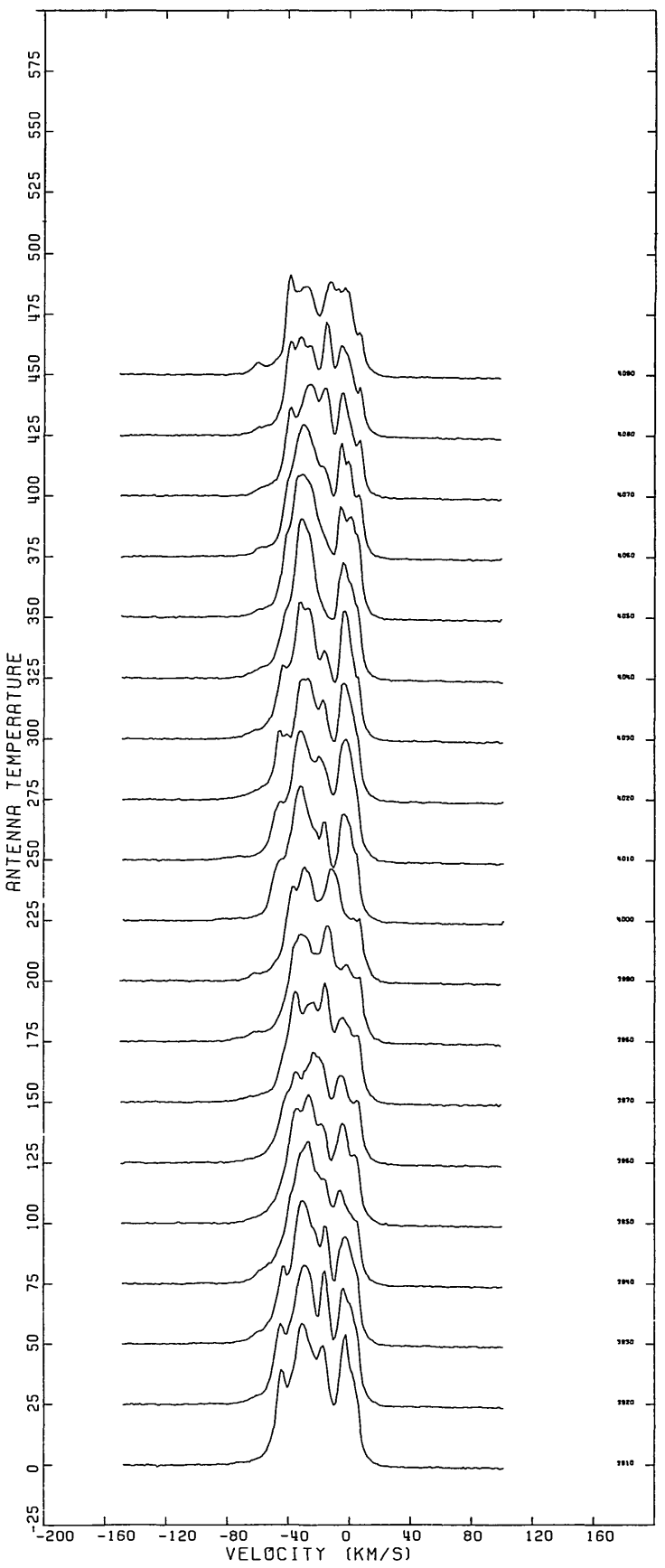


I. HEADER AND GRAPH

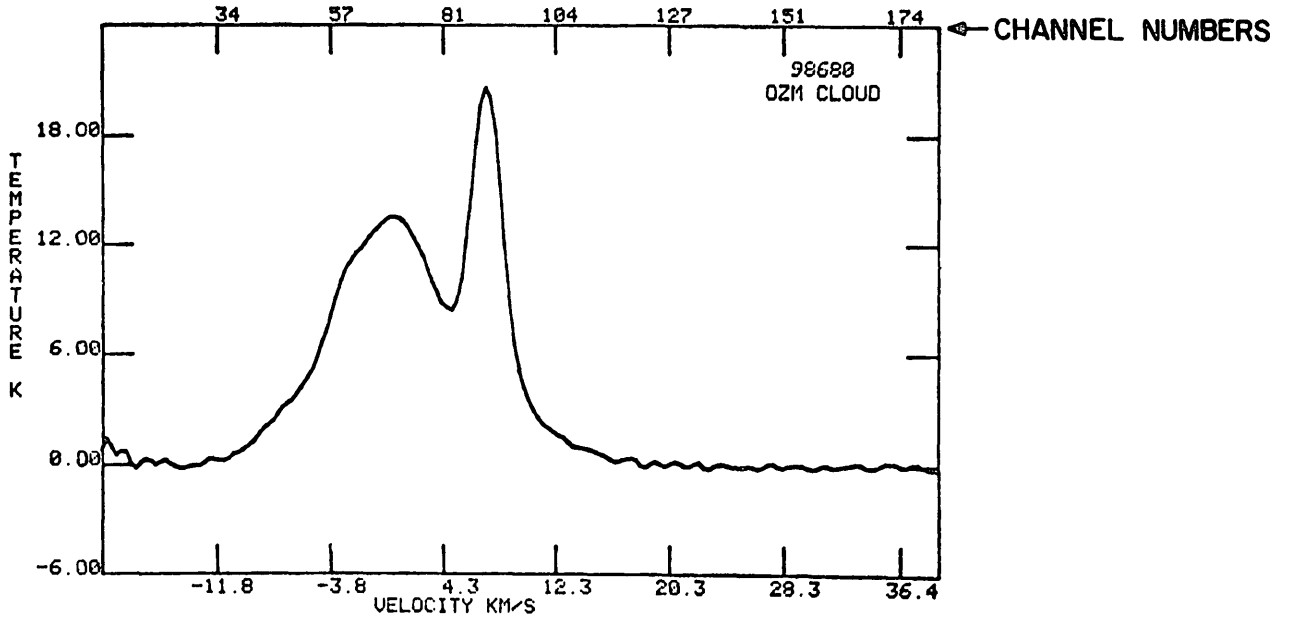


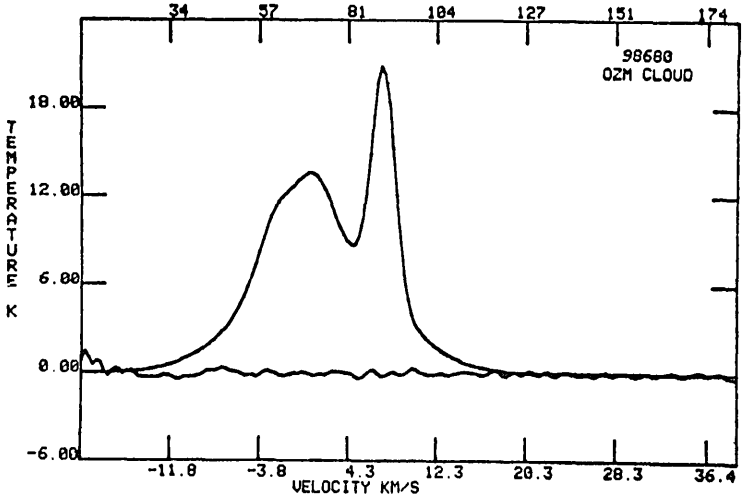


J. CALCOMP PLOT (PLOT VERB)

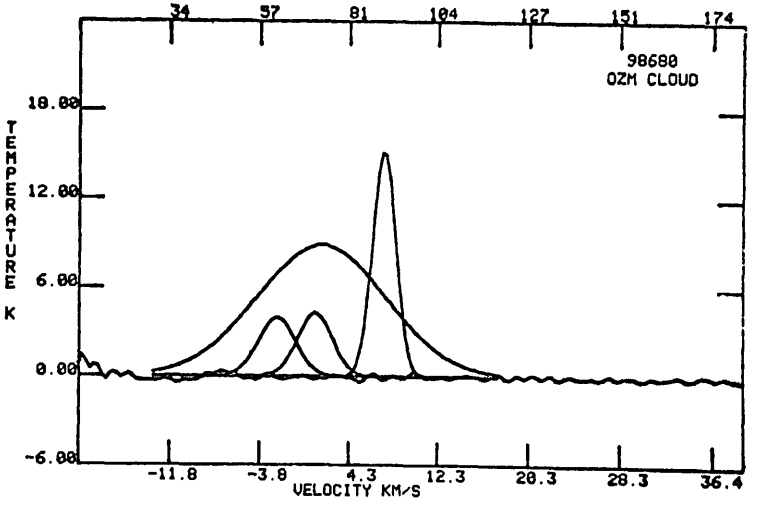


J. CALCOMP PLOT (PROFILE VERB)





GAUSSIAN MODEL AND RESIDUAL



GAUSSIAN COMPONENTS AND RESIDUAL

L. CRT PLOTS

REFERENCES

Bevington, P. R., Data Reduction and Error Analysis for the Physical Sciences, McGraw-Hill Book Company, New York, 1969.

Shalloway, A. M., Mauzy, R., Greenhalgh, J., and Weinreb, S., "Autocorrelation Receiver Model II: Operational Description", NRAO Electronics Division Internal Report No. 75.

Weinreb, S., "A Digital Spectral Analysis Technique and Its Application to Radio Astronomy", Massachusetts Institute of Technology Technical Report 412, 1963.