# INDEX

# PROGRAM REDUCE - INTRODUCTION

REDUCE is an all-purpose spectrographic reduction package aimed at generating intensity rectified spectra, radial velocities and/or line positions, equivalent widths and rotational velocities. It is written in modular form, so that one can perform a series of logically chosen operations on spectral data which may be derived from PDS scans (density vs microns) or RETICON records (intensity vs data point number), but which are stored on disk in FITS format (see PDSLOG, PDSKOPY, RETICON for the tape dumping information). The key to this whole reduction package is found in the existing programs (reduced to subroutines) VELMEAS and VLINE (see the two USER'S GUIDES by Hill 1981/1984). VELMEAS measures ARC positions and STELLAR radial velocities from FITS format data. VLINE operates on linearized data (wavelength, intensity, or rectified files) allowing measures of line position, equivalent width and rotational velocity.

REDUCE allows one to measure arcs, calibrations, clear plate, to define filters, as well as to process the resultant filtered intensity data to rectified intensity, or to analyse the results using VELMEAS or VLINE. In lieu of doing the processing while the data are in CORE MEMORY, the crucial link between the various functions (or OPERATIONAL OPTIONS as they are termed in Table 1, see below) is, a DISK READ/WRITE subroutine in FITS FORMAT (Wells et al. 1981), written by Roland Poeckert, which enables the user to store intermediate results in a condensed, quickly readable, form.

These various functions can best be summarized in a table of OPTIONS, termed the OPERATIONAL OPTIONS Table seen below.

**Table 1. OPERATIONAL OPTIONS**

| Index | Function |
|---|---|
| 3 | Read data from FTS DISK record. |
| 4 | Measure ARC - VELMEAS. |
| 5 | Read known ARC coefficients. |
| 6 | Measure CLEAR. |
| 7 | Read known CLEAR file. |
| 8 | Measure CALIBRATION. |
| 9 | Read known CALIBRATION file. |
| 10 | Create FILTER. |
| 11 | FILTER given file. |
| 12 | * Linearize STELLAR file. |
| 13 | Read processed FITS DATA |
| 14 | * Perform DENSITY to INTENSITY conversion. |
| 15 | * Measure CONTINUUM and then RECTIFY spectrum. |
| 16 | Measure STELLAR -- VLINE (RV, EW, v sin i) |
| 17 | Measure STELLAR -- VELMEAS (RV) |
| 18 | Measure STELLAR -- COMBINE SELECTED LINES |
| 19 | * Convert λ file to ln(λ) |

Each function, whose purpose is self-evident, is linked to an INDEX. The user enters these indices in order of use to create a sequence of operations that can be repeated over and over again on different data. This sequence of operations can be interrupted within any of the modules to give the USER the opportunity to change the sequence or to abort it. Other possibilities are described in Options 3 and 13. Not all sequences are permitted. Those that are, involving VLINE and VELMEAS, are displayed in Figure 1. Other constraints are: Data must be READ off disk before they can be operated on (don't laugh - this error occurs often). Data can be filtered at any time but cannot be stored until they have been linearized. These limitations are summarized in Table 2.

**Table 2. Sequence Limitations**

1. Paths to VLINE from the raw data must include LINEARIZATION.
2. A data file must be READ before it can be processed.
3. Data can be filtered at any stage but cannot be stored until they are LINEARIZED.

The indices in Table 1 have another function in that they govern the names of the files that are to be READ or WRITTEN (see Table 3). In attempting to understand this table one needs to know about the type of files being dealt with. The 5 character names of files coming off PDS tapes and hence off disk in FITS format are termed the FILE NAMES and will be prefixed by a T, L, F or S depending on whether they are calibration, clear, arc, or stellar (see Table 4 later).

**Table 3. Effects of the Sign of the INDEX in the OPERATIONAL OPTIONS Table**

| Function | Sign of INDEX | |
|---|---|---|
| | + ve | -ve |
| Measure ARC | STORE--Specific,generic | |
| READ known ARC | Specific | Generic |
| Measure CLEAR | STORE--Specific,generic | |
| READ known CLEAR | Specific | Generic |
| Measure CALIBRATION | STORE--Specific,generic | |
| READ known CALIBRATION | Specific | Generic |
| Create FILTER | STORE--Specific,generic | |
| FILTER STELLAR file | Read Specific | Read Generic |
| | STORE-- V file (+ . FTS) | |
| LINEARIZE Stellar | STORE-- W file (+ . FTS) | |
| READ processed files | | |
| DENSITY to INTENSITY | STORE-- I file (+ . FTS) | |
| Measure CONTINUUM | STORE-- R file (+ . FTS) | |
| Convert to ln(λ) | STORE-- U file (+ . FTS) | |
| | Do conversion and storing automatically | Do everything manually |

When read off disk this 5 character string must have an extension. All data converted to FITS disk records have the extension .FTS, in contrast to those files generated by measuring ARC, CLEAR, CALIBRATION, FILTER which are stored under the 'S' FILE NAMES (i.e. stellar file names) with extensions reflecting the nature of the measurement, e.g. .ARC, .CLR, .CAL and .FLT. These latter files are called INTERNAL files and associated with them are the GENERIC files ZZZZZ.+extension. The GENERIC files are simply the INTERNAL files containing the latest measurements. All processed files, i.e. those involved with LINEARIZATION, FILTERING, INTENSITY CONVERSION and RECTIFICATION are stored in FITS format also. Note that OUTPUT files containing the results from VLINE and VELMEAS can be freely named within their respective modules.

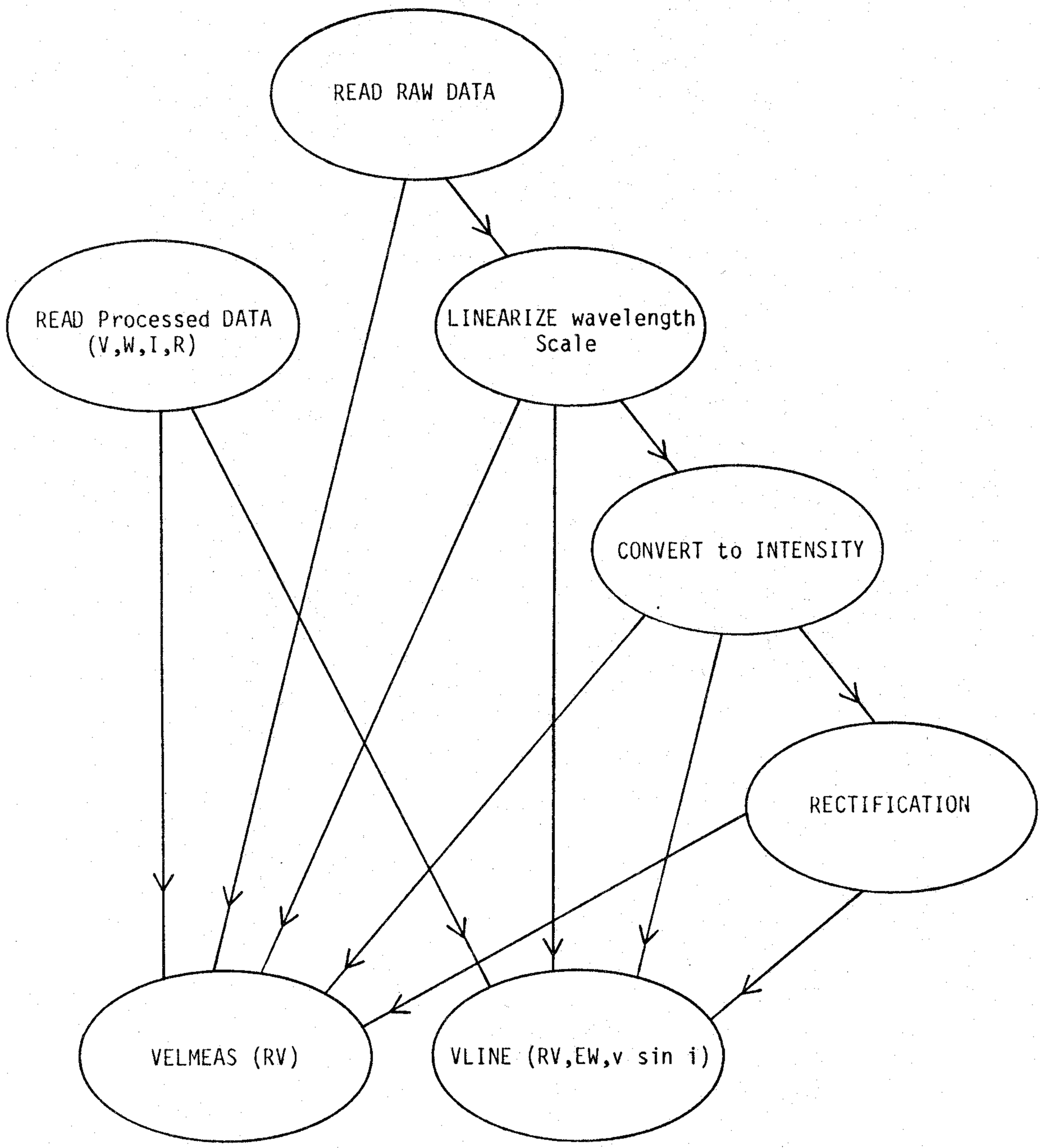


Figure 1. Permitted Paths to VELMEAS and VLINE

There are 4 automatic operations that can be invoked in this table by adding the letter A to the numerical entry. The 4 functions that are automated are:

1. Linearization in λ.
2. Density to intensity conversion.
3. Continuum rectification.
4. Linearization in ln λ.

These options are identified by an asterisk in the Operational Options Table. There is room for confusion in the automatic logarithmic linearization conversion since there already is an automatic option there. The difference here is that the 18A Option allows the user to pick the wavelength limits and ln λ increments on the initial pass to use them automatically on later passes. The automatic option 18 does the automatic conversion on the wavelength limits (and increments) found in the data when they are read from disk. The 12A Option is identical to 18A in that in the initial pass the data limits etc. are fixed and used thereafter in subsequent passes. The density to intensity conversion is straight-forward. The continuum fitting may not be that useful except for reticon data of high and consistent quality. To recap, the most useful functions are 12A and 18A.

## FILE NAMING

In understanding how data are labelled it helps to know how the data are scanned on the PDS and reassembled. I term a cut (others call it a row) as one complete scan down the spectrum. An ARC scan is comprised of one cut per side and then the combined data are assembled end-to-end under one file name. A stellar spectrum scan may comprise a number of cuts since the spectrum is often wide in comparison with the length of the scanning slit. These multiple cuts are converted to transmission, averaged, and converted back to density to form one file. Normally only one CLEAR cut is made along the spectrum. The calibrations are each treated as independent files and thus must be treated differently from the above ARC, STELLAR and CLEAR files. Here we must know which CALIBRATION scan we are dealing with and therefore the file name must reflect this.

A file name on Tape is identified by four letters or numbers (usually the last four digits of the plate number) and a letter prefix identifying the type of file (arc, stellar, etc). The exception to this rule gleaned from the preamble is the calibration file. Here the first of the 4 digits, normally reserved for the plate number, identifies the scan number. Zero is scan 1 (or $\lambda_1$) 1 is scan 2 (or $\lambda_2$), etc. Note that this limitation will be removed soon when we combine

all the PDS calibration scans within one file with the T prefix and the following 4 characters identical to the F or S names. The convention we have adopted is shown in Table 4. It should be noted that the program keys on these prefixes and any deviation from this convention in scanning plates will result in a fatal incompatibility with REDUCE. Check with Wes Fisher before scanning any plates to be used with REDUCE.

**TABLE 4. DATA FILE NAMING CONVENTION**

| File Type | Prefix | | Example Plate 12345 |
|---|---|---|---|
| **Raw Data** | | | |
| Arc | F | | F2345 |
| Stellar | S | | S2345 |
| Calibration | T | Scan 1 ($\lambda_1$) | T0345* |
| | | Scan 2 ($\lambda_2$) | T1345 |
| | | Scan 3 ($\lambda_3$) | T2345 |
| Clear | L | | L2345 |
| **Processed Stellar Data** | | | |
| Filtered | V | | V2345 |
| Linearized ($\lambda$) | W | | W2345 |
| Intensity | I | | I2345 |
| Rectified | R | | R2345 |
| Averaged profile | P | | P2345 |

*There may be only one file when you use this program.

If these data are written to DISK (see later), the above file names will have .FTS appended.

Other files used in Table 1 are those resulting from reductions of ARC, CLEAR, CALIBRATION and FILTER. We term these files INTERNAL FILES as they can be PURGED from one's DIRECTORY once the conversions to intensity and wavelength have been made. With the exception of the calibration the names of these files are consistent with the 'S' FILE NAME (last four digits of Tape file name with an S prefixed) and further identified by an appropriate suffix, see Table 5.

We also specify a GENERIC file which is automatically stored upon measurement. Thus if one is using a calibration for more than one spectrum REDUCE will not pick up the new stellar file name associated with the extension .CAL since a file of this name was never measured. However a GENERIC name is useful since it can be selected automatically

by the manner of entry into the OPERATIONAL OPTIONS Table previously discussed (Table 1, page 4) and one need not enter the old file name each time. By these means one is saved many keystrokes.

**TABLE 5. EXAMPLE OF INTERNAL FILE NAMES FOR PLATE 12345**

| FUNCTION | SPECIFIC | GENERIC |
|---|---|---|
| Measure ARC | S2345.ARC | ZZZZZ.ARC |
| Measure CLEAR | S2345.CLR | ZZZZZ.CLR |
| Measure CALIBRATION* | S0345.CAL | ZZZZZ.CAL |
| Measure FILTER | S2345.FLT | ZZZZZ.FLT |

*Note that the reduced calibration file is named after the first calibration read off tape. This file may be renamed (e.g. S2345.CAL in Table 5) so it can be acquired automatically in the READ CAL mode (Option 9). Recent scans are free from this limitation.

One file that we cannot categorize as an INTERNAL FILE is a mask file needed to process non-DAO calibrations. These calibrations, which are usually in the form of spots, are scanned in a standard way on the PDS such that they conform closely to a standard mask contained in REDUCE. Small differences between the actual data and the standard mask can be easily handled but we still need the relative intensities of the spots (in log I). These values REDUCE expects to find in the file ZZZZZ.MSK, described later in the program PDSKOPY.

## USE OF OPERATIONAL OPTIONS TABLE

This table (Table 1) must be understood before REDUCE can be used effectively. It is the basis for all operations so read the previous material carefully. The permitted paths have been discussed previously (Figure 1, Table 2) as well as the meaning of the signed indices (see Table 3). The order in which the indices are entered is the order in which the operations are performed. As each index is entered it is recorded on the screen as a plus (+ve index) or an minus (-ve index). In addition, a number is written to indicate the order that a function will be performed. End these entries with a zero. After a zero has been entered one is prompted

PROMPT: THIS OKAY? Y, R = Restart, L = List anew

Reply. Y and the OPERATIONAL SEQUENCE begins.

R and the OPTIONS Table is initialized for a fresh beginning. A useful mode if you find you have made an error.

L Lists the OPTIONS Table anew and the current entries.

The operational options sequence may be modified if needed in certain circumstances without restarting the sequence. These possibilities are described in Option 3 and 13.

## RUNNING REDUCE

Reduce is run by a COMMAND PROCEDURE (DISK1:[HILL]REDUCE.COM). However a warning is in order. To use REDUCE one must have a good working knowledge of the VAX. File handling (SORTING, APPENDING, EDITING, etc.) in particular, so that the preparations for the run can be easily accomplished and the various reduction attempts can be consolidated.

### ** WARNING **

As the default option, REDUCE writes a considerable amount of summary data to the line printer on logical unit 3. If you do not plan to look at much of the output, and are happy to peruse a disk file, then I suggest that you assign the output to a dummy disk file (DUM.DAT for example) that can later be deleted.

There are 2 possible ways to do this

i) If you have copied the command procedure (REDUCE.COM) to your directory then replace

```
$ASS LPA0: FOR003
```

by

```
$ASS DUM.DAT FOR003
```

ii) If you are running REDUCE from DISK1:[HILL] via @[HILL]REDUCE then start the command procedure. When the program begins, abort it with CTRL-Y and then do the above assignment.

```
$ASS DUM.DAT FOR003
```

Then run the program REDUCE

```
$R DISK1:[HILL]REDUCE
```

All subsequent line printer output will then be directed to DUM.DAT.