TABLE OF CONTENTS

Description - This section contains theory for raw scan data (types and file structure).

1- RAW DATA TERMINOLOGY

It is useful to know the following:

Frame: 256 sample pairs (512 words), or 512 sample pairs (1024 words)

Sample: I & Q channels = 2 words or 1 longword

Word: 2 bytes (16 bits).

Longword: 4 bytes (32 bits).

View: A sequence that acquires one or more frames of data at a particular phase-encoding value. For instance, a four-echo scan has four frames of data per view. In relation to viewing raw data, one view corresponds to one horizontal display line of a raw data file (e.g., View 1, Echo 1 = first horizontal display line of the first echo image).

Each frame corresponds to the 256 raw data samples taken during one Data-in Window (see Illustration L1873A).

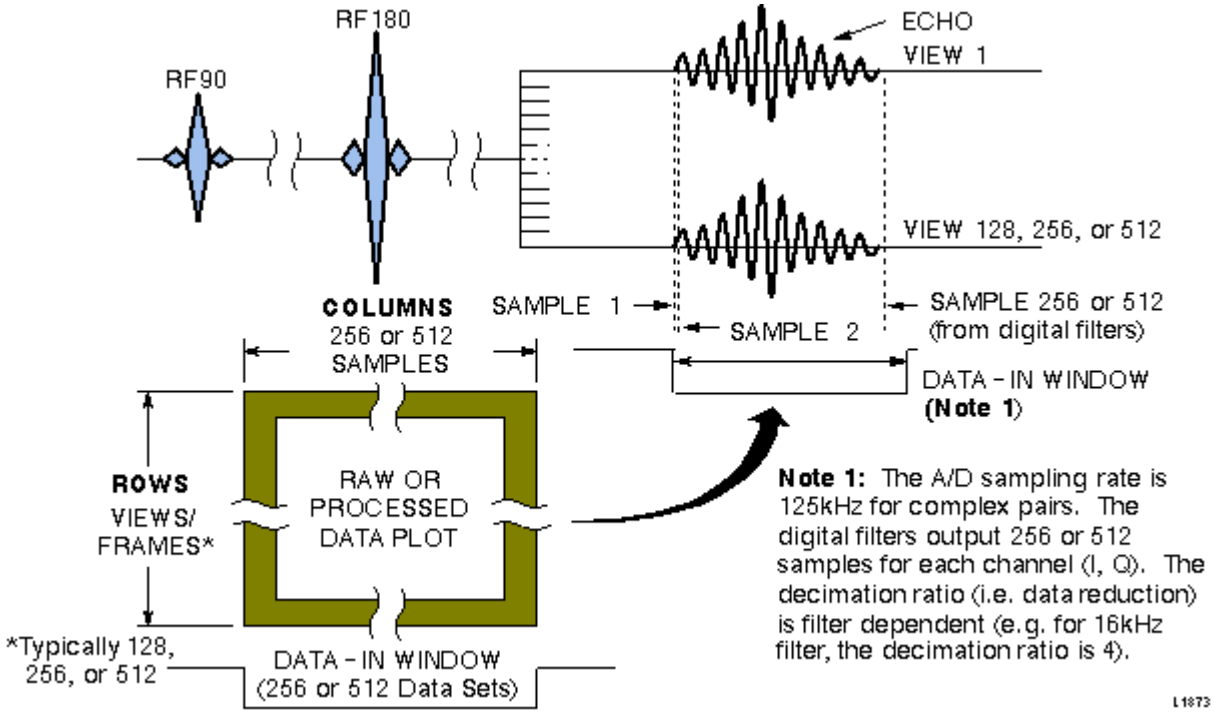
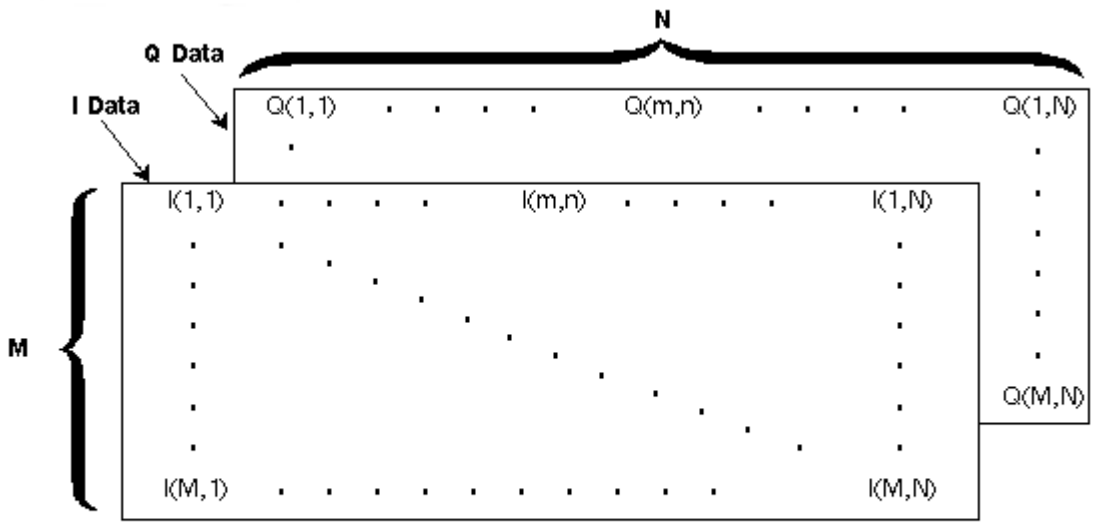


ILLUSTRATION L1873A
RAW DATA ACQUISITION

If the typical raw data file consists of M views (complex arrays) consisting of N complex sample pairs each, the raw data file may be represented as shown in Illustration L1962A.



(m,n) = a specific complex sample pair index in the raw data matrix.
m = 1 to M , where **M** = 128, 256, or views, (ie. M = "Y" (vertical) resolution for the scan).
n = 1 to N , where **N** = 256 or 512, (ie. N = "X" (horizontal) resolution for the scan).
S(m,n) = I(m,n) + jQ(m,n), complex time domain data.

ILLUSTRATION L1962A
RAW DATA FILE ORDER

2- RAW DATA FILE STRUCTURE

For using some of the system analysis tools, it is helpful to understand the raw scan data file structure for an image, since these tools give you the capability of manipulating these data in different ways. There are two types of raw data with the TPS/ISE architecture:

- NOREC (no reconstruction)
- NOPROC (no preprocessing by TPS/ISE DAB; no reconstruction by AP)

The normal raw data type is NOREC; reconstructing these data produces an image. NOPROC raw data type can be acquired only by setting CVs during a scan prescription. For NOPROC, select **[Modify CVs]** and set `rhdacqctrl` = 1 and `rhrcctrl` = 0.

The Rawplot and Anaphas tools automatically check the Raw Data Scan File Header to determine if the raw data are NOREC (normal), or NOPROC, in order to process them accordingly.

2-1 NOREC Raw Data

For a normal scan, the raw scan data are referred to as *NOREC data* (i.e., prior to image reconstruction). NOREC raw data are preprocessed, accumulated, and sorted on the Data Acquisition Board (DAB) before being stored in the TPS/ISE Memory Board. An example of a normal raw scan data file is shown (see Illustration L1874A) for a 0.5-NEX, 256 x 256, two-slice, two-echo scan. The resultant raw data file consists of 128 acquired views (0.5 NEX halves the prescribed number of views), plus eight overscans, for a total of 136 views ("YRES," or vertical resolution on IP with raw tools).

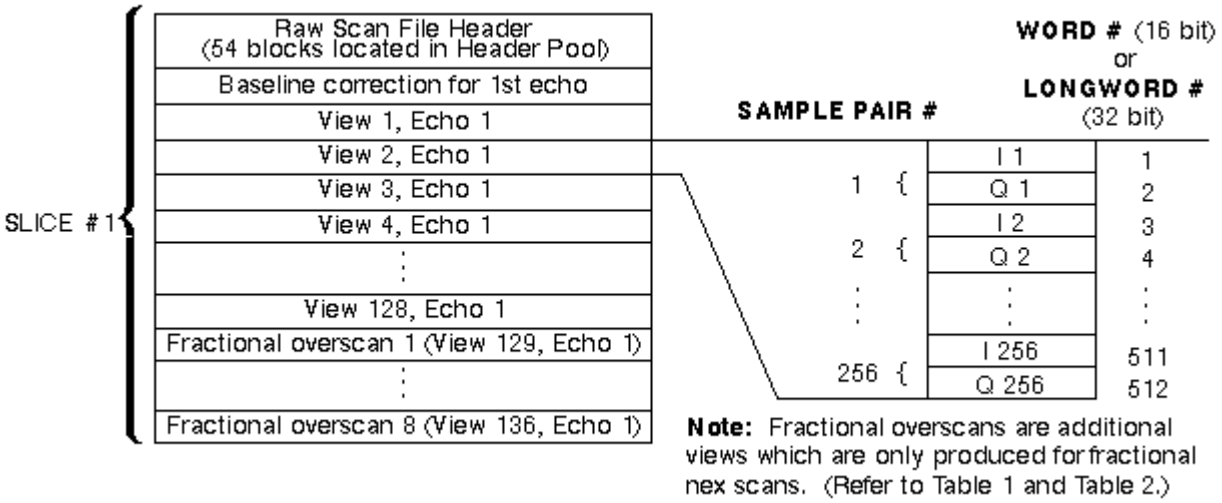


ILLUSTRATION L1874A
NOREC (NORMAL) RAW SCAN DATA FILE STRUCTURE

For NEX>1 scans, positive-going and negative-going echo frames are collected for the purpose of averaging, and for DC offset elimination. For NOREC scans where NEX>1, each echo/chopper pair is accumulated (subtracted; note that averaging, or dividing out, is done during reconstruction). Therefore, the chopper raw data portion does not exist in the NOREC raw scan data file. For NOREC scans where NEX<1, a number of baselines are collected. A baseline is a frame of data that contains only noise (including DC offset). For NOREC scans, these baseline frames are accumulated and added on the DAB prior to storage in TPS/ISE memory. Each echo consists of complex I (real) and Q (imaginary) raw data sample pairs, which are obtained during demodulation of the received MR signal on the Receiver Board.

2-2 NOPROC Raw Data

NOPROC raw data are acquired without preprocessing, accumulating, or sorting (normally performed on the DAB). Since no sorting is performed, the acquired data are stored in the order in which they were acquired (referred to as "time-ordered"). An example of a NOPROC raw scan data file is shown (see Illustration L1877A for a 0.5-NEX, 256 x 256, two-slice, two-echo scan. For fractional NEX scans, additional overscans are taken. For this example, the resultant raw data file consists of 128 acquired views (0.5 NEX halves the prescribed number of views), plus eight overscans, for a total of 136 views.

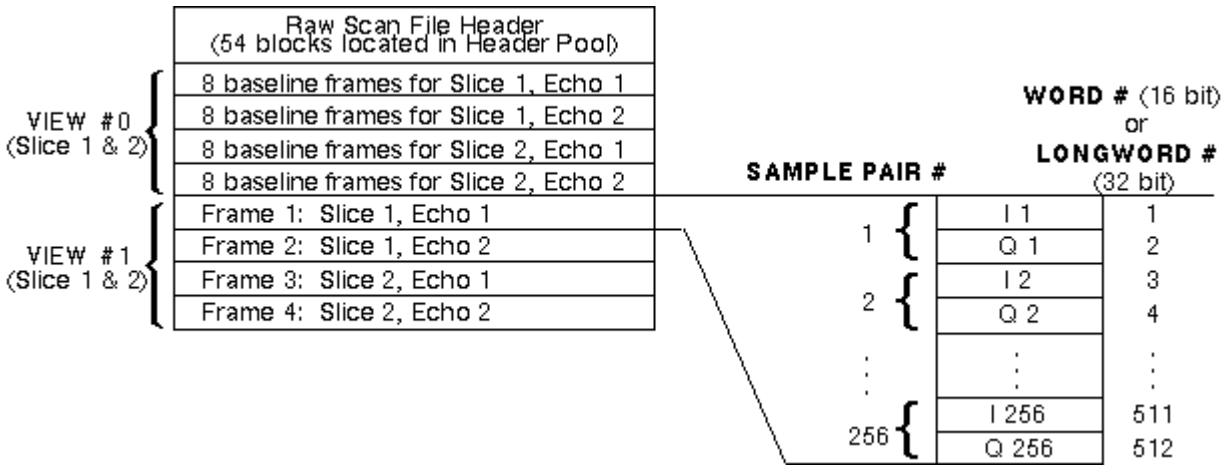


ILLUSTRATION L1877A
OPROC (NO PREPROCESSING) RAW SCAN DATA FILE STRUCTURE

As previously mentioned, NOPROC raw data are acquired without preprocessing, accumulating, or sorting (normally performed on the DAB). In addition, for NEX>1, the raw scan data file for this type scan contains both echo and chopper data (see Illustration L1880A Each echo or chopper consists of I (real) and Q (imaginary) raw data sample pairs. In addition, since no sorting is performed, the acquired data are stored is the order in which they were acquired (which can be non-sequential for some scans such as exorcist).

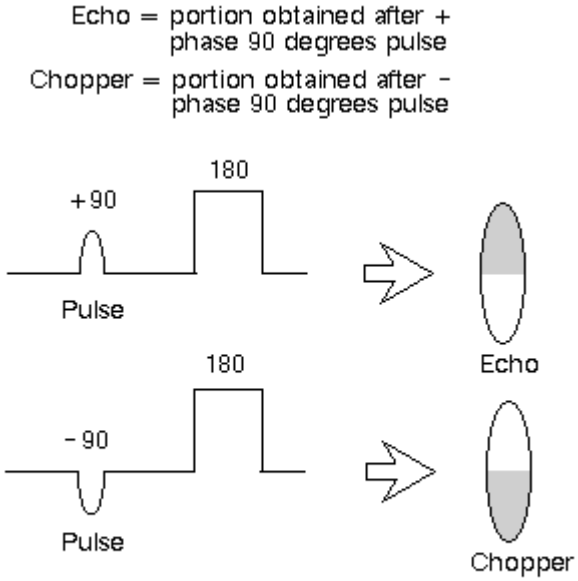


ILLUSTRATION L1880A
MULTI-ECHO/CHOPPER DATA EXAMPLE

Illustration L1881A shows a raw scan data file for a two-NEX, 256 x 128, two-slice, two-echo scan. The raw data file format for the same scan is shown for both NOPROC and NOREC raw file types. Note that the NOREC raw file is smaller, due to data accumulation of echo/chopper pairs. For NOREC scans, the frames are sorted together on an image basis so that RECON can begin immediately after the raw data for the first image are completely acquired (this allows concurrent scanning and reconstruction for multi-image scans).

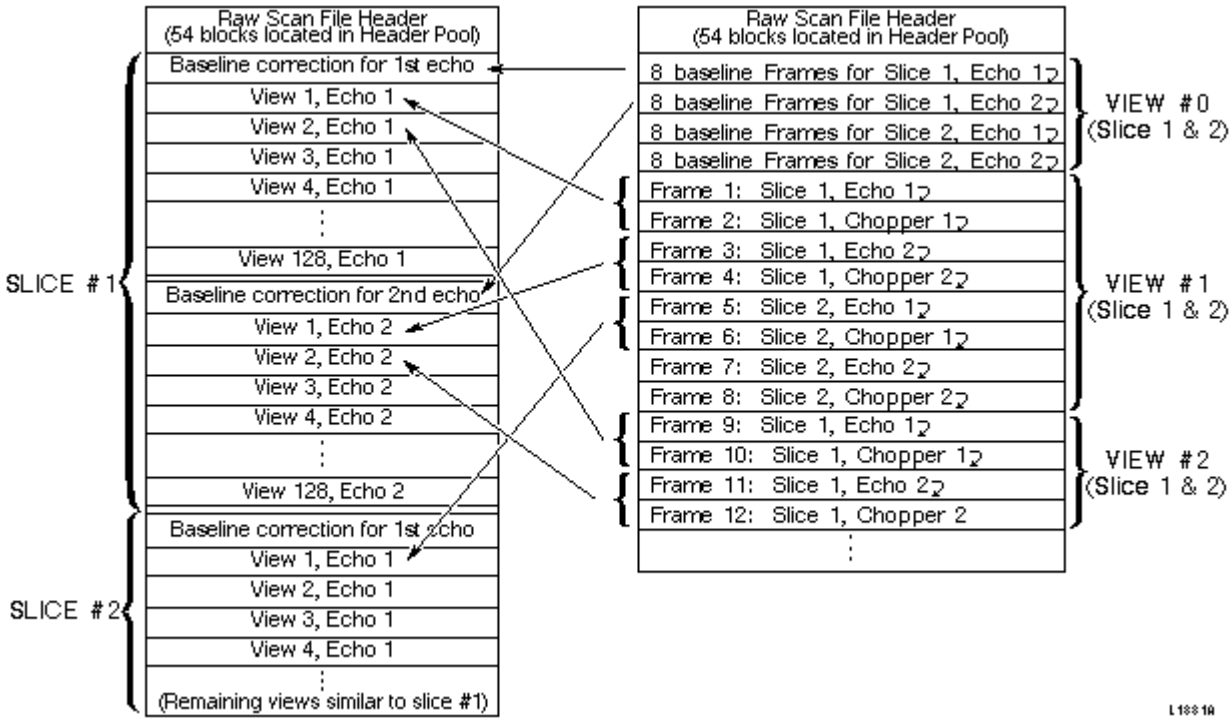


ILLUSTRATION L1881A
NOREC/NOPROC EXAMPLE RAW SCAN DATA FILE STRUCTURE

3- SCAN DATA TYPES

Different scan types are available including No Phase Wrap, Rectangular FOV, .75 NEX, and 0.5 NEX. Each of these scans affects the amount of raw data acquired in a slightly different way (see Table 1). Examples of each scan data type are provided (see Table 2). These examples are based on product PSDs. It is possible to obtain unexpected results with a special PSD (e.g., if a user modifies a PSD at a research site).

TABLE 1
SCAN DATA TYPES

SCAN DATA TYPE	EFFECT ON RAW DATA SIZE		
	# PRESCRIBED SAMPLES	# PRESCRIBED VIEWS	MISCELLANEOUS
NP (No Phase wrap)	No Effect	Doubles it and:	Scan also halves the NEX (if original NEX = 1.5, see .75 NEX; if original NEX = 1.0, see .5 NEX for additional effects)
RT (Rectangular)	No Effect	Halves it	- -
.75 NEX	No Effect	Takes 3/4 ths	- -
.5 NEX (See note below)	No Effect	Halves it and:	Scan also collects **8** "Overscans" (without No Phase Wrap) Scan also collects **16** "Overscans" (with No Phase Wrap)
Note: Gradient recalled scans do not allow .5 NEX scans due to unacceptable image quality.			

TABLE 2
SCAN DATA TYPE EXAMPLES

SCAN DATA TYPE	RAW DATA CALCULATIONS	COMMENTS
NP (No Phase wrap) 256 x 128, NP, 1 NEX	256 samples and (128 x 2) / 2 = 128 views 128 views + 16 Overscans = 144 "frames"	NP doubles prescribed views and halves the NEX (.5 NEX now)
RT (Rectangular) 256 x 256, RT	256 samples and 256 / 2 = 128 views	RT halves the prescribed views
Fractional NEX 256 x 256, .75 NEX	256 samples and 256 / 2 = 128 views 128 views + 256/4 overscans = 192 "frames"	Fractional NEX halves prescribed views Fractional NEX also adds overscans
Fractional NEX 256 x 256, .5 NEX	256 samples and 256 / 2 = 128 views 128 views + 8 overscans = 136 "frames"	Fractional NEX halves prescribed views Fractional NEX also adds overscans

Note: For NOREC raw data, the # frames = # views + # fractional overscans; e.g. 128 views and 8 fractional overscans = 136 frames, where frame #130 corresponds to fractional overscan #2).

4- RAW FILE TYPES

There are three types of raw files with the TPS/ISE architecture: Locked, Permed, and "Normal" (see Table 3). These raw files may contain NOREC or NOPROC raw data. Locked and Permed raw files can be acquired by setting a CV during a scan prescription, or immediately following the scan by using the **[Raw File Mgmnt]** software tool selections ("Save - from TPS/ISE mem. to Disk" to lock a raw file; "Perm TPS/ISE mem. Data File" to perm a raw file).

TABLE 3
RAW DATA TYPES

SCAN DATA TYPE	RAW DATA CALCULATIONS	COMMENTS
NP (No Phase wrap) 256 x 128, NP, 1 NEX	256 samples and (128 x 2) / 2 = 128 views 128 views + 16 Overscans = 144 "frames"	NP doubles prescribed views and halves the NEX (.5 NEX now)
RT (Rectangular) 256 x 256, RT	256 samples and 256 / 2 = 128 views	RT halves the prescribed views
Fractional NEX 256 x 256, .75 NEX	256 samples and 256 / 2 = 128 views 128 views + 256/4 overscans = 192 "frames"	Fractional NEX halves prescribed views Fractional NEX also adds overscans
Fractional NEX 256 x 256, .5 NEX	256 samples and 256 / 2 = 128 views 128 views + 8 overscans = 136 "frames"	Fractional NEX halves prescribed views Fractional NEX also adds overscans

Note: For NOREC raw data, the # frames = # views + # fractional overscans; e.g. 128 views and 8 fractional overscans = 136 frames, where frame #130 corresponds to fractional overscan #2).

Conditions for Valid TPS/ISE Memory Raw Data

The raw data from the last scan is valid in TPS/ISE memory only if:

- The TPS/ISE power was not turned off
- The TPS/ISE was not manually reset
- TPS/ISE diagnostics were not run
- No other scans have completed, or are in progress
- Tools or processes that use TPS/ISE memory are not active
- The entire scan could fit in TPS/ISE memory at one time

REVISION HISTORY

REV	DATE	AUTHOR	PRIMARY REASONS FOR CHANGE
0	Aug 19, 1998	R. Hawthorne	Initial conversion to Word
1	Oct 13, 1999	M. Keber	Added correct proprietary heading to document.